DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof. Reference herein to any social initiative (including but not limited to Diversity, Equity, and Inclusion (DEI); Community Benefits Plans (CBP); Justice 40; etc.) is made by the Author independent of any current requirement by the United States Government and does not constitute or imply endorsement, recommendation, or support by the United States Government or any agency thereof.

A Regional Approach to Offshore Wind Energy Manufacturing in the Central Atlantic: Workforce

Bailey Pons, Jeremy Stefek, Brinn McDowell, and Matt Shields

National Renewable Energy Laboratory

Produced under direction of National Offshore Wind Research and Development Consortium by NREL under Interagency Agreement FIA-22-23288.

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated under Contract No. DE-AC36-08GO28308

This report is available at no cost from NREL at www.nrel.gov/publications.

Strategic Partnership Project Report
NREL/TP-5000-92377
September 2025

A Regional Approach to Offshore Wind Energy Manufacturing in the Central Atlantic: Workforce

Bailey Pons, Jeremy Stefek, Brinn McDowell, and Matt Shields

National Renewable Energy Laboratory

Suggested Citation
Pons, Bailey, Jeremy Stefek, Brinn McDowell, and Matt Shields. 2025. *A Regional Approach to Offshore Wind Energy Manufacturing in the Central Atlantic: Workforce*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-92377. https://www.nrel.gov/docs/fy25osti/92377.pdf.

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated under Contract No. DE-AC36-08GO28308

This report is available at no cost from NREL at www.nrel.gov/publications.

Strategic Partnership Project Report
NREL/TP-5000-92377
September 2025

15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nrel.gov

NOTICE

This work was authored by NREL for the U.S. Department of Energy (DOE), operated under Contract No. DE-AC36-08GO28308. Support for the work was also provided by National Offshore Wind Research and Development Consortium under Agreement FIA-22-23288. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government.

This report is available at no cost from NREL at www.nrel.gov/publications.

U.S. Department of Energy (DOE) reports produced after 1991 and a growing number of pre-1991 documents are available free via www.OSTI.gov.

Cover photos (clockwise from left): Josh Bauer, NREL 61725; Visualization from the NREL Insight Center; Getty-181828180; Agata Bogucka, NREL 91683; Dennis Schroeder, NREL 51331; Werner Slocum, NREL 67842.

NREL prints on paper that contains recycled content.

Acknowledgments

This study was funded by the National Offshore Wind Research and Development Consortium (NOWRDC) with additional funds provided by the Maryland Energy Administration and the North Carolina Department of Commerce. The authors would like to thank the external stakeholders that contributed to the scope and content of this report, including Christine Sloan (NOWRDC), Kori Groenwald (NOWRDC), Jennifer Mundt (North Carolina Department of Commerce), John Hardin (North Carolina Department of Commerce), Joshua Levy (North Carolina Department of Commerce), Emma Stoney (Maryland Energy Administration), Samuel Beirne (Maryland Energy Administration), Ken Jurman (Virginia Department of Energy), Thomas Noyes (Delaware Department of Natural Resources and Environmental Control), Tim Mack (US Wind), and Garry Harris (Center for Sustainable Communities). Peer reviewers include:

- Stephanie Ayers (NC Ports Authority)
- Joanna Barnekov-Staib (Delaware Workforce Development Board)
- Steve Cook (Hampton Road Council)
- Cynthia Finely (IREC)
- Josh Levy (North Carolina Department of Commerce)
- Stephanie McClellan (Turn Forward)
- Jennifer Mundt (North Carolina Department of Commerce)
- Sam Schacht (Clean Energy States Alliance)
- Chanel Viator (Department of Labor).

Any errors or omissions are the sole responsibility of the authors.

List of Acronyms

ACS	American Community Survey
CNC	computer numerically controlled
LQ	location quotient
NCES	National Center for Education Statistics
NREL	National Renewable Energy Laboratory
PMT	Portsmouth Marine Terminal
SMART-POWER	Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources
RAP	registered apprenticeship program
RAPIDS	Registered Apprenticeship Partners Information Database System
SOC	Standard Occupational Classification

Executive Summary

Any growth in the offshore wind industry is likely to involve job creation. Meeting the additional job requirements is likely to involve intentional and effective recruitment practices and training program development across all occupations (e.g., skilled trades, engineers, professionals) at state, regional, and local levels.

As the first commercial-scale offshore wind projects begin construction in the United States, the industry faces various challenges in meeting skilled workforce needs and is considering workforce development initiatives. Workforce development initiatives operate within a complex ecosystem of workers, companies, and training programs, and can be influenced by limiting factors such as the economic and labor market of an area, geographic obstacles, limited access to transportation, wraparound services, policy barriers, and more. Moreover, companies in the offshore wind industry often require unique occupational skill sets that can be hard to find because of a lack of applicants with the desired experience (McDowell et al. 2024). While many occupations have the foundational skills required for offshore wind jobs, the specialized knowledge sought by companies in the offshore wind industry may necessitate that workers pursue further training or upskilling, which in turn may require local education and training programs to modify or expand their curricula. However, the organizations that develop specialized training programs are often constrained by limited access to competing resources, such as limited funding and a lack of collaboration with industry firms to help them predict future skill and workforce demands. Additionally, barriers to public transportation in some communities may prevent workers with transferable skills from commuting to training institutions and job sites.

Due to the complexity of the workforce development ecosystem, especially for an industry like offshore wind, assessing the readiness of an area to support the workforce needs of new manufacturing facilities involves evaluating numerous economic and training factors at an occupational level.

Funded by the National Offshore Wind Research and Development Consortium and led by the National Renewable Energy Laboratory, this report represents one part of a two-part study that explores the challenges and opportunities for Delaware, Maryland, Virginia, and North Carolina in fostering regional collaboration to build a domestic supply chain for the U.S. offshore wind energy sector. The companion report, titled *A Regional Approach to Offshore Wind Energy Manufacturing in the Central Atlantic: Supply Chain* (Pérez et al. 2025), focuses on:

- Supply chain challenges and industry needs, such as the business opportunities and challenges related to investing in major component facilities and the implications for nearby communities
- Port locations and port communities, including technical port selection criteria, and port community profiles
- Community capacities such as workforce readiness of evaluated locations and small and medium-sized business opportunities
- Additional opportunities for the mid-Atlantic region, including marshalling ports, storage, and alternative foundation fabrication.

This report focuses on the methods and analysis included in the Community Capacities section of the companion Supply Chain report (Pérez et al. 2025) and aims to evaluate a multitude of workforce indicators on both in-state commuting and regional scales, identifying opportunities to leverage strengths and address gaps through community and regional connectivity across the SMART-POWER[1] states. It also evaluates the relevant training programs across the region that are available to train the workforce needed at an offshore wind manufacturing facility. Unlike the Supply Chain report (Pérez et al. 2025), this report does not address supply chain challenges and industry needs or technical criteria for selecting the evaluated port locations.[2]

To perform this analysis, we created occupational maps specific to offshore wind components, an education and training database, and a workforce readiness calculator. The occupational maps align occupation titles with the Standard Occupational Classification code system and compile applicable job descriptions, possible certification needs, and average level of education required for each occupation. The occupations were grouped into job categories to allow for analysis at the levels of factory worker, factory management and engineering, and facilities maintenance. The education and training database is a compilation of two-year and four-year higher education programs and registered apprenticeship programs within each state aligned with the occupational maps for the evaluated manufacturing facilities.

Once the occupational maps and education and training database resources were finalized, the workforce readiness calculator, a tool to conduct in-state and regional workforce assessments, was developed for comprehensive analysis within this project. The workforce readiness calculator leverages multiple indicators to inform results at the in-state commuting, regional commuting, and state commuting levels. For this report, workforce readiness is defined as an area's ability to support a new blade, monopile, or tower manufacturing facility with an available workforce that has existing relevant skill sets and with workforce development training initiatives and program support. The in-state commuting zone was defined as the in-state counties that have residents that reportedly traveled for work to the county that could host the potential manufacturing facility. The regional commuting zone was defined as the out-of-state counties who have residents that reportedly traveled for work to the county that could host the potential manufacturing facility. The commuting flows were determined by the U.S. Census Bureau's American Community Survey. The commuting zones for this analysis do not use commuting flow magnitudes to show workforce numbers; rather, the commuting flow magnitudes are used to distinguish between counties that have historically had residents who commuted into the locations of interest. The American Community Survey data use a 5-year survey average, which allows for a "historical" look on likely commuting flows. The results from the workforce calculator and contextual factors of the nearby areas were leveraged to assess the

[1] The Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER) states include Maryland, Virginia, and North Carolina, with participation from Delaware.
[2] The One Big Beautiful Bill Act affects investment opportunities in major component facilities and shifts supply chain findings closer to the sensitivity case with zero advanced manufacturing production tax credit. This workforce analysis does not account for the number of facilities or the likelihood of investing in blade, tower, or monopile manufacturing facilities. Instead, it assumes that a manufacturing facility could be established at any port location and analyzes the potential impacts of such development. The analysis herein is current as of January 2025; subsequent developments may not be included.

four SMART-POWER states and the six chosen port locations, which were determined by the supply chain study found in the companion report (Pérez et al. 2025).

The information detailed in this report contributes to or provides context for the results of the workforce readiness calculator, which is further discussed in the companion Supply Chain report (Pérez et al. 2025) (Figure ES-1).

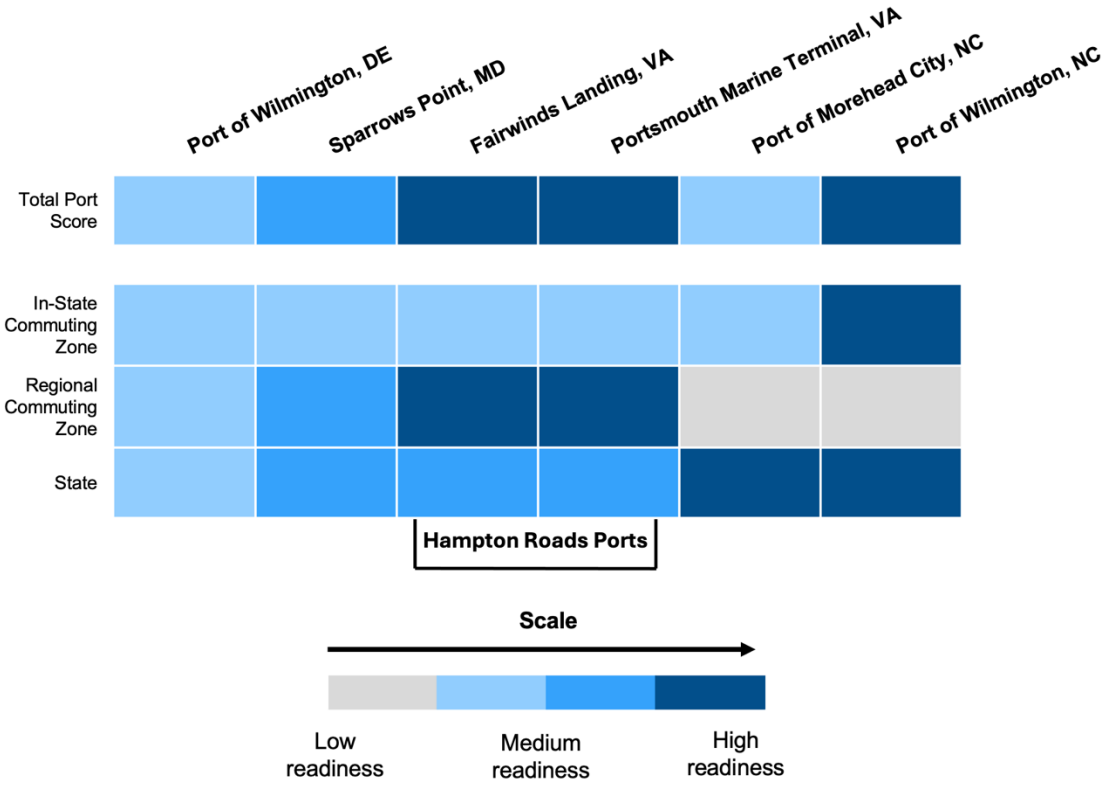

Figure ES-1. Readiness scores for all ports with respect to in-state commute, regional commute, state commute, and total readiness score for each port.[3]

In the following paragraphs, we summarize insights from the workforce study conducted at the state, regional, and in-state commuting levels. This provides a comprehensive understanding of the readiness of the area surrounding each port to produce major components for the offshore wind industry, from a workforce perspective. The report is structured so that each state or port location is presented as a distinct yet comparative assessment, offering detailed information to decision makers interested in their respective areas and to gain an understanding of their respective area across a region.

[3] The results for this figure are further discussed within *A Regional Approach to Offshore Wind Energy Manufacturing in the Central Atlantic: Supply Chain* (Pérez et al. 2025).

State Assessments

At the state level, strengths, gaps, challenges, and opportunities were evaluated and summarized in key takeaways for Delaware, Maryland, Viginia, and North Carolina. We share the reasons for the workforce readiness scope and occupational strengths for each state.

Delaware

At the state level, Delaware was determined to have a lower workforce readiness compared to the other SMART-POWER states because there are fewer established training programs and less manufacturing involvement. However, Delaware's workforce readiness level was still calculated as "medium" due to growing manufacturing employment and a relatively high unemployment rate across the state, which respectively indicate an increase in manufacturing specialization and a large pool of available workers to hire or train from if a facility were placed in the state. Additionally, Delaware's advantageous location within the SMART-POWER region near other offshore wind markets makes the state a promising partner for regional collaboration. The analysis showed that Delaware, like other SMART-POWER states, has a relative occupational strength in factory-level management and engineering roles, and a relative occupational weakness in factory-level workers, which was illustrated in the training gap for the selected high-demand and highly specialized occupations, except for electricians. Therefore, to increase the workforce readiness level of Delaware, not only is it important to develop in-state training programs to support relevant occupations, but there is also opportunity to leverage regional connectivity to train the workforce for a facility in other SMART-POWER states.

Maryland

Maryland was deemed to have a relatively average level of workforce readiness across the state, primarily driven by growing investments in the offshore wind sector and a high number of education and training programs, particularly for the factory-level management and engineering roles needed at an offshore wind manufacturing facility. However, compared to the other states, Maryland currently has limited involvement in the manufacturing sector and a relatively low unemployment rate, indicating that the workforce may be employed in other industries with fewer transferable skills to manufacturing-related roles. Additionally, Maryland (and the region as a whole) was noted to have fewer occupations related to the factory-level job category in the state compared to facilities maintenance and factory-level management and engineering roles. Therefore, continuing to focus on developing training for factory-level worker roles, especially those related to high-demand and highly specialized occupations, while leveraging regional connectivity with other states for recruitment could be beneficial to developing a workforce to support a manufacturing facility for the offshore wind industry in Maryland.

Virginia

Virginia was found to have a relatively average workforce readiness level when compared to the other SMART-POWER states. The workforce readiness level was positively impacted as a result of the state's historic manufacturing and maritime involvement, relatively available workforce, and higher number of education and training programs for occupations relevant to an offshore wind manufacturing facility. Regarding high-demand and highly specialized occupations, a training gap was found for computer numerically controlled (CNC) operators in the state; however, due to the state's robust education and training system and central location in the region, there is an opportunity to modify or expand existing in-state programs or leverage the

expertise and training from other SMART-POWER states to train for this occupation. Therefore, Virginia has workforce strengths and robust regional resources to support the development of an offshore wind manufacturing facility.

North Carolina

Compared to the other SMART-POWER states, North Carolina demonstrated relative strength in their workforce readiness level to support a component manufacturing facility for the offshore wind sector. This relative strength was primarily driven by the state's historical involvement in manufacturing and robust education and training system for roles relevant to an offshore wind manufacturing facility. The robust education and training system was exemplified by the relatively fewer training gaps found in the assessment of high-demand or highly specialized occupations. North Carolina was the only state in the SMART-POWER region identified to have program support for CNC operators—a high-demand occupation utilized across all three evaluated component manufacturing facilities. However, it is important to recognize that there is a lower unemployment rate in the state compared to the region, indicating that there may be fewer available workers to recruit for a facility. Overall, the state's relatively higher workforce readiness level signifies that there may be a higher potential for the North Carolina workforce and education and training system to support a manufacturing facility placed in the state.

Port Location of Interest Assessments

The in-state and regional workforce assessments identified strengths, challenges, opportunities, and gaps related to workforce development for potential manufacturing facility locations. An assessment of each port location was conducted for blade, tower, and monopile components. The key takeaway is the value and need for coordination across states to enable effective regional workforce development to support component manufacturing for the offshore wind sector.

Across the SMART-POWER states, the six selected port locations were determined to have varying strengths and weaknesses pertaining to each area's workforce readiness to support the occupations needed at an offshore wind manufacturing facility.[4] Although area attributes differ significantly on a county-by-county basis and between in-state and regional commuting evaluations, on average, the Port of Wilmington, North Carolina, and the Hampton Roads ports of Fairwinds Landing and Portsmouth Marine Terminal were shown to have relative strengths from a workforce perspective to support a blade, tower, or monopile manufacturing facility. In addition to evaluating specific counties in the in-state and regional commuting areas for the ports, five high-demand and highly specialized occupations were also assessed: CNC operator, rolling machine setter/tower rolling machinist, mechanical support/composite blades technician, electrician, and crane operator/auxiliary crane operator/heavy-lift crane operator.

Port of Wilmington, Delaware

Despite more limited manufacturing involvement in the area when compared to the other port locations evaluated, Port of Wilmington has a low to medium total workforce readiness level. This was mostly due to the higher unemployment rate in the area and program support for manufacturing and offshore wind energy workforce development at both the in-state and regional

[4] The criteria leveraged to select the six port locations is expanded upon in *A Regional Approach to Offshore Wind Energy Manufacturing in the Central Atlantic: Supply Chain* (Pérez et al. 2025).

commuting levels, in addition to robust regional connectivity demonstrated by the commuting flows. Conversely, the assessment of high-demand and highly specialized occupations indicated there were training gaps for a few roles, including CNC operator, rolling machine setters, and crane operators. This is also the case at the state level, meaning it could be difficult to hire these occupations if a facility were to be placed near the port. Therefore, if an offshore wind manufacturing facility were located at Port of Wilmington, workers in some high-demand and highly specialized occupations would need to come from other states.

Sparrows Point, Maryland

Sparrows Point has an overall medium workforce readiness level. The workforce readiness level at Sparrows Point is enhanced by regional connectivity between the SMART-POWER states increasing access for employers to an existing network of relevant education and training programs and a workforce with transferable skills. Manufacturing employment is relatively greater in the counties near Sparrows Point but less than in other SMART-POWER port locations. However, compared to the SMART-POWER locations of interest, Sparrows Point has more relevant industry closures, including a steel mill closure, indicating that many workers in the nearby communities may have transferable skill sets to component manufacturing for the offshore wind sector. Heavy steel industries are an important part of the community identity, which means offshore wind manufacturing could expand on the community's identity. At an occupational level, there are training gaps for rolling machine setter or tower rolling machinist and crane operator/auxiliary crane operator or heavy-lift crane operators at the state, regional, and in-state levels with no registered apprenticeship programs or two-year or four-year programs to train those occupations. One key to workforce development in Sparrows Point could be using a regional approach to engage workers in communities in the regional commuting zone around Sparrows Point, with a focus on training programs in Virginia and Delaware. Leveraging support through programs like Maryland Works for Wind would also help improve the foundation for workforce readiness for an offshore wind manufacturing facility at Sparrows Point.

Portsmouth Marine Terminal, Virginia, and Fairwinds Landing, Virginia

Both Hampton Roads ports evaluated (Portsmouth Marine Terminal and Fairwinds Landing) have a relatively strong workforce foundation to support a component manufacturing facility at the state level (medium readiness) and regional commuting zone level (higher readiness). However, both areas were determined to have a relatively average workforce readiness level within the in-state commuting area. While the in-state commuting area has ongoing involvement in offshore wind and maritime manufacturing, the evaluated counties were determined to have a less available workforce due to a relatively lower unemployment rate than the other analyzed areas. Alternatively, the regional commuting zone poses less of a challenge for recruiting a workforce with skill sets transferable to offshore wind manufacturing than the other evaluated areas because it has more workforce availability. Therefore, if a manufacturing facility were to be placed at Portsmouth Marine Terminal or Fairwinds Landing, there may be opportunities to leverage regional support to train and recruit a workforce for the facility. With respect to high-demand and highly specialized occupations, CNC operators, rolling machine setter/tower rolling machinists, and crane operators/auxiliary crane operator/heavy-lift crane operators were each identified as having training gaps at the in-state commuting and regional commuting levels, indicating that there may be more of a challenge when trying to train for these occupations.

Port of Wilmington, North Carolina

Because of its location, the Port of Wilmington would be less likely to leverage other SMART-POWER states for workforce support, but its historic and current involvement in manufacturing improved its workforce readiness assessment in the in-state commuting zone. However, program support from workforce development boards is lacking at the in-state commuting level, and the area has fewer incentives at the state level for manufacturing or offshore wind sector development than other port locations in the SMART-POWER region. Regarding high-demand and highly specialized occupations, it was determined that there is at least one existing training program in the in-state commuting zone that could be leveraged or modified to train CNC operators, electricians, and composite blade technicians. To support workforce readiness for an offshore wind manufacturing facility near the Port of Wilmington, it is key to leverage the area's manufacturing strengths and leadership and the region's existing training programs.

Port of Morehead City, North Carolina

At the in-state commuting level, Port of Morehead City was determined to have a high workforce readiness level when compared to the other port locations in the SMART-POWER states. This was primarily driven by worker availability and the in-state commuting zone's historical manufacturing involvement. However, the port's location within the SMART-POWER region reduces its opportunity to leverage workforce from other states. Port of Morehead City and its regional area have fewer education and training capabilities than other evaluated port locations, but degree programs and a registered apprenticeship program related to the occupations of CNC operators and electricians were identified. Therefore, Port of Morehead City has the potential to support a workforce for an offshore wind manufacturing facility at a local level, but there are challenges when it comes to recruiting from the other SMART-POWER states due to its location.

Key Takeaways

The following key takeaways were identified to enhance in-state commuting and regional workforce readiness levels to support offshore wind manufacturing in the SMART-POWER region:

Key Takeaway #1: More attention is likely needed across the region for factory-level worker occupations, especially for high-demand and highly specialized occupations, such as CNC operator, tower rolling machinist, and crane operators. The factory-level worker job category was noted as a weakness across the region, although specific occupational strengths and weaknesses varied by location. Increasing the number of properly trained workers in factory-level occupations could be achieved by developing two- and four-year certificate and degree programs and registered apprenticeship programs with specialized curriculum development for relevant skills and certifications needed to work in the offshore wind industry.

Key Takeaway #2: While expertise varies by state and county, the SMART-POWER region has historic manufacturing involvement, leading to a robust foundation for workforce readiness and future workforce development if intentionally planned. However, at the state level (except for Maryland), there is a lack of offshore wind manufacturing workforce development programs and initiatives. More offshore-wind-specific skills and certifications could be incorporated into existing manufacturing education and training programs across the SMART-POWER states.

Key Takeaway #3: Ports located more centrally in the SMART-POWER region have a greater opportunity to leverage regional connectivity; however, reducing transportation barriers is important to ensure access to training facilities and job sites.

Key Takeaway #4: Quality training programs near the manufacturing facility or port location, particularly for high-demand and highly specialized occupations, are beneficial to develop a properly trained workforce. While certain ports were determined to have a high level of workforce readiness despite a lack of education and training programs nearby, they may not have a pipeline of qualified workers to support a facility. This is especially true for port locations with less regional connectivity.

Table of Contents

List of Figures

List of Tables

1 Introduction

The offshore wind industry in the United States is a sector that could develop training and career pathways across job roles in skilled trades, engineering, professional roles, and more. To produce major components at domestic manufacturing facilities, the industry could recruit, train, and hire workers while addressing community, regional, and state economic development goals. Addressing this issue and others is crucial, not only to support the build-out of a domestic supply chain for offshore wind but also to ensure that communities receive the economic and workforce benefits that come with industry growth. As a domestic supply chain develops, strategic investment in workforce development can mitigate potential community-based challenges introduced by the burgeoning industry and ensure communities economically benefit from the growth of offshore wind energy.

This report is part of the SMART-POWER[5] Workforce and Supply Chain Analysis effort, which explores challenges and opportunities for Delaware, Maryland, Virginia, and North Carolina in fostering regional collaboration to build a domestic supply chain for the U.S. offshore wind sector. Funded by the National Offshore Wind Research and Development Consortium and led by the National Renewable Energy Laboratory (NREL), the effort aims to evaluate a multitude of workforce indicators within in-state commuting and regional commuting zones and identify opportunities to leverage strengths and address gaps across the SMART-POWER states to effectively prepare for offshore wind energy deployment.

The results of the study are disseminated in two reports: this report, referred to as the Workforce report, and its companion, *A Regional Approach to Offshore Wind Energy Manufacturing in the Central Atlantic: Supply Chain* (Pérez et al. 2025), referred to as the Supply Chain report. The Supply Chain report summarizes the connection between in-state and regional workforce readiness for Tier 1 manufacturing for the SMART-POWER states and port communities. It also focuses on the business opportunities and challenges related to investing in major component facilities and the implications for nearby communities, small and medium-sized businesses, and offshore wind energy deployment in the region and along the East Coast.

Blades, towers, and monopiles were selected as three focus areas for the SMART-POWER region based on the Supply Chain report. Many different types of job roles would be needed for these manufacturing facilities, including factory-level management and engineering, factory-level workers, and facilities maintenance (Appendix C). Table 1 shows employment estimates for a representative Tier 1 manufacturing facility for each component per facility.

[5] SMART-POWER is the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources.

Table 1. Tier 1 Manufacturing Facility Employment Estimates

Component Facility Type	Number of Employees
Blades	500
Towers	500
Monopiles	550

The recruitment and hiring timeline for jobs related to manufacturing facilities is dependent on a plant's announcement date. Therefore, the timing of these job estimates is not discussed within this report.

In the Workforce report, the objective was not to estimate job demand but rather to focus on an analysis of economic, labor market, and training data that factor into the workforce readiness metric reported at a state level. These data are also used to evaluate in-state and regional commuting zones for port communities. The Workforce report also evaluates occupational needs and training program availability to support offshore wind manufacturing facilities across the region.

2 Resources and Calculator

Through the SMART-POWER Workforce and Supply Chain Analysis effort, two main resources were developed, including offshore wind energy occupational maps for blades, tower, and monopile component manufacturing and an education and training database specific to Maryland, Delaware, North Carolina, and Virginia. Leveraging these resources, along with datasets gathered through various publicly available sources, such as the U.S. Bureau of Labor Statistics and U.S. Census Bureau, a calculator was created to compare workforce readiness levels at selected locations for supporting a blade, tower, or monopile component manufacturing facility.

2.1 Occupational Mapping

Component-level occupational maps were developed to understand what roles may be required at an offshore wind manufacturing facility. The maps compile information on the relevant occupations for a blade, tower, or monopile component manufacturing facility so that the existing workforce can be assessed on an occupational and geographical scale. The maps for this project only involve the roles that are possibly needed at the facility itself, which includes occupations related to job categories such as factory-level management and engineering, factory-level workers, and facilities maintenance; therefore, the occupational maps do not include corporate-based roles, as these occupations are more likely to be remote or based out of a company's headquarters, not located in the state or community of the facility. The relevant occupations were aligned with the Standard Occupational Classification (SOC) code system, which is a federal statistical standard to classify the workforce in occupational categories, as sourced from the U.S. Bureau of Labor Statistics (2018). NREL researchers then compiled applicable job descriptions, possible certification needs, and average level of education needed in the occupational maps. The certifications are sourced from the Certification Finder by CareerOneStop, an organization sponsored by the U.S. Department of Labor (CareerOneStop 2024). The level of education was compiled from research on O*NET and classified through identifying language that aligns with the education and training database (O*NET 2024a). The occupational maps found in Appendix C were drafted in May 2024 based on previous NREL research.[6]

2.2 Education and Training Database

The education and training database—compiled by NREL researchers for the purpose of this analysis—is a comprehensive resource to identify the existing training pathways for the offshore wind energy workforce across the SMART-POWER states. The database is a compilation of two-year and four-year higher education programs and registered apprenticeship programs within the states. The programs were identified based on the occupational maps determined for blade, tower, and monopile manufacturing facilities, explained above. The maps only identify occupations at the facility and divide the occupations into job categories aligned with the occupational maps, including factory-level management and engineering, factory-level workers, and facilities maintenance. In the workforce readiness assessment, collecting and evaluating the education and training programs on a component-specific and county-specific level informs the

[6] The Offshore Wind Energy Occupational Maps are published separately from this report at https://openei.org/wiki/Wind_Workforce/Offshore_Wind_Energy_Occupational_Maps.

program support for workforce development surrounding a facility. An example of the education and training database is shown in Figure 1.

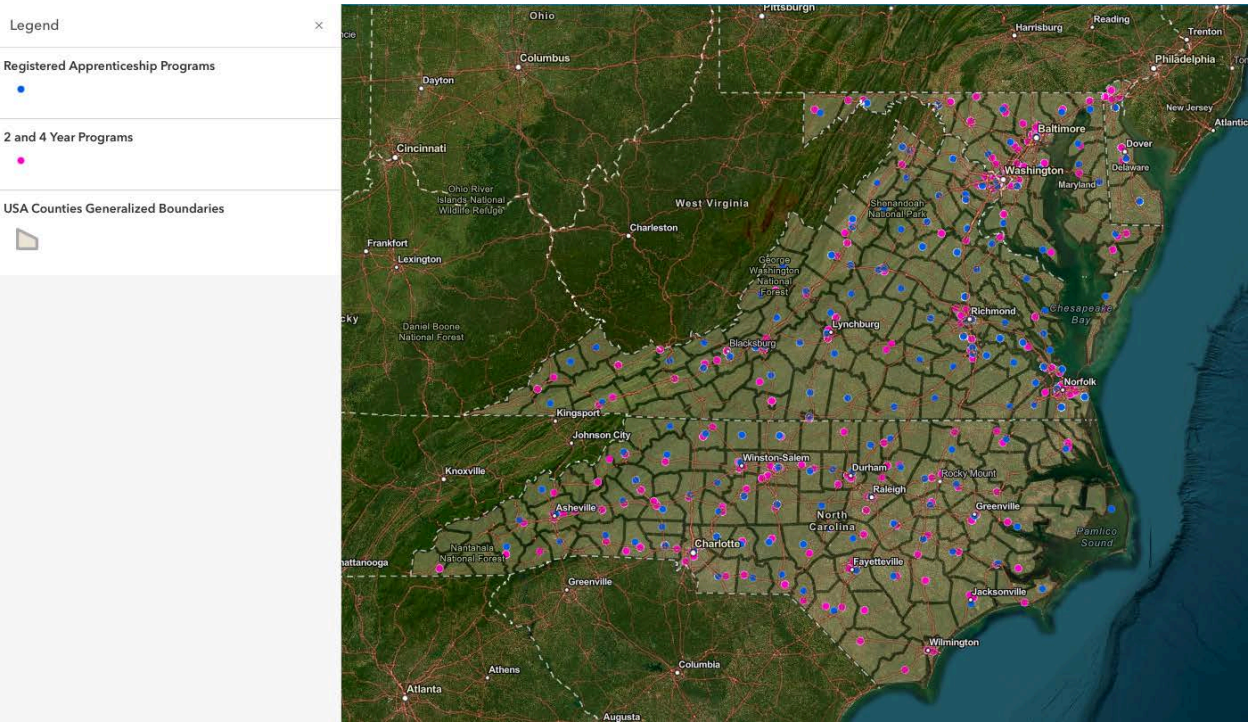

Figure 1. Image of the education and training database for the SMART-POWER states

A variety of publicly available data sources were used to identify two-year certificate and degree programs, four-year certificate and degree programs, and registered apprenticeship programs. For two-year and four-year certificate and degree programs, the data are sourced from the National Center for Education Statistics (NCES), which is the primary federal entity for collecting and analyzing data related to education. NCES designed an information tool called College Navigator for the public to explore more than 7,000 higher education programs across the country (NCES 2024b). The tool includes a variety of program components, such as institution name, program/major name, address of the institution, website of the institution, type of institution, campus setting, student population, graduation rate, transfer-out rate, net price rate, and more. The process to build the database began with identifying the SOC code for an occupation relevant to a blade, tower, or monopile manufacturing facility. To find programs based on the occupational maps, a crosswalk compiled by NCES was used to translate from SOC codes to the associated Classification of Instructional Programs codes (NCES 2024a). The list of programs/major names was also supplemented by subject matter experts to create the most comprehensive list of programs for the database. The final list of programs/major names included in the database can be found in Appendix A.

The Registered Apprenticeship Partners Information Database System (RAPIDS) from ApprenticeshipUSA by the U.S. Department of Labor was used for registered apprenticeship programs. It includes program information like location, occupation, and industry affiliation. NREL researchers determined which programs to include based on the occupational maps for blade, tower, and monopile manufacturing. The programs were then aligned through an SOC and

RAPIDS code crosswalk that provides associated RAPIDS codes given occupational titles (O*NET 2024b). The education and training database includes a comprehensive list of education and training programs for relevant occupations for an offshore wind manufacturing facility.

2.3 Workforce Readiness Calculator

The workforce readiness calculator encapsulates economic and education and training indicators at both occupational and geographic scales. The workforce readiness metric can be used to compare the ability of multiple areas to support the placement of a manufacturing facility from a workforce perspective at a singular point in time. For this report, the calculator is used to compare the workforce readiness level of specific locations across the SMART-POWER states for an offshore wind manufacturing facility. It is important to note that this metric is intended to be used in conjunction with other metrics and should not be the single indicator for evaluating manufacturing facility site selection decisions. Furthermore, this metric does not quantitively consider the magnitude of needed occupations in its calculations but evaluates readiness levels based on the likelihood that a geographic location and its surrounding region has the workforce development foundation to support the occupations needed by a new facility. The foundation for workforce development is defined in terms of workforce availability, existing skill sets, and training program support, and specific indicators were identified to evaluate each criterion.

The workforce readiness metric is calculated through multiple indicators informing an in-state commuting score, regional score, and state score. Each score comprises economic and education and training indicators that differ based on geographic delineation and occupational maps. The individual scores are aggregated into a total score—the workforce readiness metric (Figure 2). For the in-state and regional scores, the geographic areas are determined by in-state and out-of-state commuting zones,[7] which leverage county-level data. For the state score, the geographic area is based on state boundaries, and the data were compiled across the entire state (not dependent on commuting zones). For all scores, the education and training indicators were determined by the education and training database at the occupational level, as dictated by the occupational maps.

[7] The in-state commuting zone was defined as the in-state counties who have residents that reportedly traveled to the potential manufacturing facility county for work. The regional commuting zone was defined as the out-of-state counties who have residents that reportedly traveled to the potential manufacturing facility county for work. The commuting flows were determined by the U.S. Census Bureau American Community Survey (ACS). The commuting zones for this analysis are not using commuting flow magnitudes to show workforce numbers; they are being used to distinguish between counties that have historically had residents who commuted into the location of interest. The ACS data uses a 5-year survey average which allows for a "historical" look on likely commuting flows.

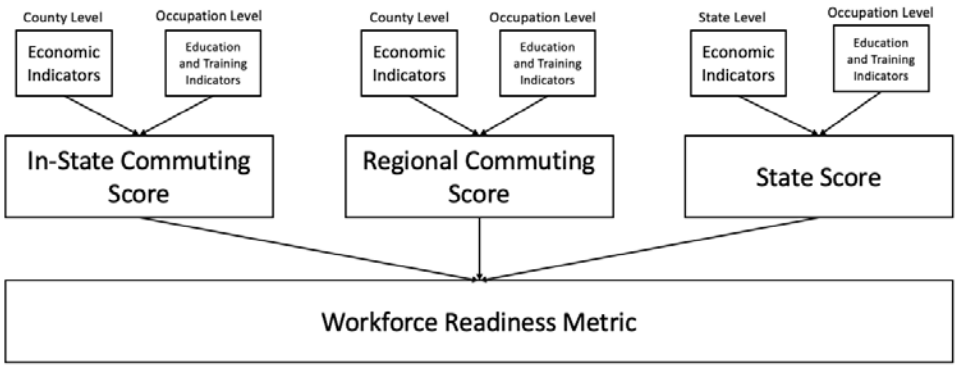

Figure 2. Conceptual mapping of the Workforce Readiness Calculator

2.3.1 Calculation Method for In-State Commuting and Regional Commuting Scores

To calculate the in-state commuting and regional commuting scores for each evaluated location, the raw data for each of the economic and education and training indicators were converted into a z-score, a statistical measure that describes how many standard deviations a data point is from the mean of a data set. The z-score was chosen to aid in comparing evaluated locations at the in-state commuting zone, regional, and component levels. The z-scores for each variable that contributes to the economic indicator were averaged separately across each county in the in-state and regional commuting zones. Similarly, the z-scores for each variable that contribute to the education and training indicators were averaged across each occupation for the component being evaluated. This calculation resulted in two average z-scores—one for the economic indicator, and one for the education and training indicator.[8]

Next, the economic indicator and education and training indicator z-scores were averaged to get a total in-state commuting score and a total regional score by location of interest and component. The z-score for the location score and regional score by component were then converted to a percentile on a normal distribution.

2.3.2 Calculation Method for State Score

The state score was calculated similarly to the in-state commuting and regional commuting scores. First, the raw data for each of the economic and education and training indicators were converted into a z-score for comparison. The z-scores for each variable that contributed to the economic indicator were averaged for each state, and the z-scores for each variable that contribute to the education and training indicators were averaged across each occupation for the selected components. The z-scores for both the economic and education and training indicators were averaged into the total state z-score by component and finally converted into a percentile on a normal distribution.

[8] The z-score methodology was adapted from Economic Development Agency & Argonne National Laboratory. https://disgeoportal.egs.anl.gov/EDCI/?page=Indicator-Overview.

2.3.3 Total Score Calculation Method

To calculate the total score for the evaluated location by component, the z-scores for the in-state commuting, regional commuting, and state scores were averaged to get the total z-score. The total z-score was then converted into a percentile on a normal distribution. This total score is referred to as the workforce readiness metric. Multiple variables inform the indicators leveraged to calculate the workforce readiness metric. Appendix C displays the variables, data sources, and assumptions.

3 Offshore Wind Workforce by State

To understand how the SMART-POWER states—Delaware, Maryland, Virginia, and North Carolina—could support offshore wind development as a region, the individual states' strengths, weaknesses, gaps, and opportunities for improvement need to be understood. Each state's individual contributions to the region were evaluated by leveraging contextual factors of the state's existing workforce and industry portfolio, the offshore wind energy occupational maps, the education and training database, and the workforce readiness calculator. The offshore wind workforce strengths and weaknesses were evaluated based on an aggregation of:

1. Occupational specialization, as measured by location quotients (LQs), for offshore wind occupations within the state's workforce as compared to nation and region
2. The number of education and training programs related to that occupation as compared to the other SMART-POWER states.

It was assumed that if there was a relatively higher occupational specialization within the state and a larger number of programs and majors associated with training that occupation, then the occupation would be considered a strength for the state. If there was a relatively lower occupation specialization and a smaller number of applicable programs and majors associated with training that occupation, then the occupation would be considered a weakness for the state. Appendix D displays a summary of the occupational strengths and weaknesses by state and component.

In addition to the occupational strengths and weaknesses assessment, a training gap analysis was performed on select offshore wind energy manufacturing occupations that were deemed to be of high demand or that required highly specialized training to work in a blade, tower, or monopile manufacturing facility. In this analysis, a high-demand occupation means that this occupation would be required across all of the evaluated component manufacturing facilities and is indicated through previous research and outreach to be an occupation needed in large quantities at a facility. Highly specialized occupations were defined as occupations that require focused training, skills, or knowledge bases to work in a blade, tower, or monopile manufacturing facility. Based on these definitions, NREL researchers selected the occupations computer numerically controlled (CNC) operator, rolling machine setter/tower rolling machinist, mechanical support/composite blades technician, electrician, and crane operator/auxiliary crane operator/heavy-lift crane operator to be evaluated further within each SMART-POWER state and selected port area. Appendix D provides a table that supplies the competency requirements for these occupations. Additionally, the high-demand and highly specialized occupation responsibilities and competencies are defined below.

- **CNC operators** are responsible for the efficient operations of CNC machines and use technical expertise to develop machining methods, monitor operations, and fabricate metal parts.
- **Rolling machine setter/tower rolling machinists** operate rolling machines to shape metal into offshore components like towers and monopiles.
- **Mechanical support/composite blades technicians** work with advanced materials and techniques to ensure the structural integrity and performance of composite blades. This

includes conducting quality inspections, adhering to technical specifications, and collaborating with engineering teams to optimize blade designs.
- **Electricians** are responsible for executing electrical protection designs; integrating major power equipment; installing, maintaining, and repairing electrical wiring, equipment, and fixtures; and ensuring that work is in accordance with relevant codes.
- **Crane operator/auxiliary crane operator/heavy-lift crane operators** are pivotal in the manufacturing and assembly of offshore wind energy projects, expertly maneuvering cranes and tower equipment to ensure safe and efficient operations.

The same identified occupations are evaluated across each state and port to allow for a comparison of the complementary strengths and weaknesses within the evaluated locations of the region. A complete list of occupations can be found in Appendix A.

The training gap was determined by comparing the selected occupations to the education and training database. If there were no programs identified to train the occupation, then the occupation was considered to have a training gap within the evaluated state or port. If there were applicable training programs identified, it was determined to not have a training gap. As the magnitude of the workforce was not considered in this analysis, the size of the training gap was not evaluated. Therefore, it is important to note that just because an occupation does not have a training gap indicated, it does not mean that there are enough programs in the state to support the training demands. It only means that there is at least one existing program that can be leveraged for training the following occupations. Appendix D displays a summary of the training gaps for the selected occupations by state.

3.1 Delaware

Delaware is located at the northeast corner of the SMART-POWER region and is bordered by Maryland, New Jersey, and Pennsylvania. The top five largest industries within the state include:

1. Educational services, health care, and social assistance (24.8%)
2. Professional, scientific, management, administrative, and waste management services (11.1%)
3. Retail trade (10.2%)
4. Finance, insurance, real estate, rental, and leasing (9.6%)
5. Arts, entertainment, recreation, accommodation, and food services (9.0%).

While not within the top five industries, the manufacturing industry ranked as the sixth largest within the state. Manufacturing is a top industry in Delaware's economic development pipeline, employing 8.7% of the civilian employed population 16 years and over (U.S. Census Bureau 2024a).

Compared to the other SMART-POWER states, Delaware had a higher workforce readiness score when considering the state's labor market information, which is primarily due to the high unemployment rate (4.2%) for 2022 and the large one-year percentage change in industry involvement for manufacturing when seasonally adjusted (5.1%). The growth in the manufacturing industry could be driven in part by the state's central location on the East Coast and because manufacturers who are headquartered in Delaware sell products elsewhere in the

country. These factors have allowed Delaware's manufacturing industry, especially in the chemical manufacturing sector, to increase substantially in recent years (Munroe 2024).

Overall, when labor market information was combined with occupation and education and training data, Delaware had a middle to lower level of workforce readiness to support a manufacturing facility at the state level when compared to the other SMART-POWER states. This score was mainly driven by the lower specialization of required occupations within the state and a general lack of programs that could train these occupations. Delaware Technical Community College has a partnership with the University of Delaware for teaching the Global Wind Organisation Basic Safety Training certification—which is a specific credential often required to work in offshore wind energy construction and operations and maintenance—but this program is not related to the training required for roles at blade, tower, or monopile manufacturing facilities and therefore would not be counted as a training program that could teach specialized manufacturing knowledge in this assessment. However, the development of this training program highlights Delaware's ability to be responsive when there are newer occupations or certifications needed by an industry.

Despite a lack of offshore wind manufacturing involvement for Tier 1 components, Delaware's involvement in offshore wind energy development has been increasing. In September 2024, the governor of Delaware signed the Delaware Energy Solution Act of 2024 (Senate Bill 265), which not only enables the state to issue an offshore wind solicitation to procure 1.2 GW of offshore wind generation capacity but also allows Delaware to participate in regional transmission planning. Furthermore, the offshore wind projects off the coast of Maryland and Delaware were approved in September 2024 as well, which would require Delaware to grant permission for the project to connect the wind farms' export cables to substation facilities located on Delaware's shores. These policies, in addition to Delaware's strategic location in relation to the SMART-POWER states, help to secure the state's position as a key player in the offshore wind industry. Therefore, it is essential to examine how economic and workforce development opportunities from this growing industry can benefit the state.

3.1.1 Occupational and Educational Strengths and Weaknesses

Within the state, Delaware has the most training capacity for occupations within the factory-level management and engineering job category. Although, compared to the other SMART-POWER states, Delaware did not have an occupational strength in any of the job categories evaluated. The relatively largest occupational weakness was within the factory-level worker job category, which aligns with the SMART-POWER region. This was mainly driven by a lack of applicable two-year and four-year degree programs and lower occupational specialty for factory-level worker occupations when compared to the other states.

Table 2 displays the relatively strongest occupations, and relatively weakest occupations by component and job category as measured by Delaware's specialty for that occupations and the number of identified programs that could be leveraged to train that role. The specialty for an occupation in a geographic area was measured by the location quotient. The occupational ranking does not vary greatly between components, as the SOC codes that drive the calculator are similar between all component manufacturing facilities evaluated. It is important to note that specialized training or certifications may differ between the varying components.

Table 2. Table of Delaware's Occupational Strengths and Weaknesses by Job Category and Component.

Blades		
Strengths	Factory-Level Management and Engineering	Engineering Manager/Director Plant Manager
	Factory Level Workers	Electrician Industrial Truck and Tractor Operator
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Cleaning Staff
Weaknesses	Factory-Level Management and Engineering	Engineering Technician Surface Engineer
	Factory Level Workers	Coil Worker* Fiberglass Technician* Driller* Milling Machinist* Laser Operator* Grinder Operator* Rigger* Hoist and Winch Operator*
	Facilities Maintenance	Industrial Machinery Electrician Maintenance Technician
Towers		
Strengths	Factory-Level Management and Engineering	Engineering Manager/Director Plant Manager
	Factory Level Workers	Industrial Truck and Tractor Operator Health, Safety, and Environment (HSE) Technician
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Industrial Machinery Electrician
Weaknesses	Factory-Level Management and Engineering	Engineering Technician Surface Engineer, Metal Grinder
	Factory Level Workers	Rigger* Rolling Machine Setter* Welding Machinist/Welding Engineer, Laser Operator* Plater, Blasting Technician (Applier)* Grinder Operator* Hoist and Winch Operator*
	Facilities Maintenance	Maintenance Supervisor Cleaning Staff*
Monopiles		
Strengths	Factory-Level Management and Engineering	Engineering Manager/Director Plant Manager
	Factory Level Workers	Industrial Truck and Tractor Operator Health, Safety, and Environment (HSE) Technician
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Industrial Machinery Mechanic

Weaknesses	Factory-Level Management and Engineering	Engineering Technician Surface Engineer, Metal Grinder
	Factory Level Workers	Blasting Technician (Applier)* Driller* Hoist and Winch Operator* Laser Operator, Welding Machinist/Welding Engineer* Milling Machinist* Plater* Rigger* Rolling Machine Setter*
	Facilities Maintenance	Industrial Machinery Electrician Maintenance Technician

*The Bureau of Labor Statistics does not report the locational quotient, which decreases the occupation's average z-score for occupational specialty and available education and training programs.

3.1.2 Gap Analysis for Specialized or High-Demand Occupations

Four of the five evaluated occupations (Table 3) were determined to have a training gap within the state of Delaware. There was not a training gap for electricians. Placing an offshore wind manufacturing facility in Delaware would necessitate specific considerations for worker training.. Leveraging other relevant training programs within the region, such as within commuting zones of Maryland, would be important for ensuring a workforce is properly trained to meet workforce competency requirements. While there could be supplemental support from states outside the SMART-POWER region (e.g., Pennsylvania, New Jersey), that was not analyzed as a part of this study. Additionally, the education level, skills, and certifications required or preferred may differ based on the employer.

Table 3. Training Gap Analysis for High-Demand or High-Specialization Occupations in Delaware

Occupation	High Demand/High Specialization	Training Gap?
CNC operator	High Demand and Specialization	Yes
Rolling machine setter/tower rolling machinist	High Specialization	Yes
Mechanical support/ composite blades technician	High Specialization	Yes
Electrician	High Demand	No
Crane operator/auxiliary crane operator/ heavy-lift crane operator	High Demand	Yes

3.2 Maryland

Maryland's long-term investments and policies aimed at strengthening the manufacturing sector and workforce programs have positioned the state as a regional leader in component manufacturing for the offshore wind industry. Within the SMART-POWER region, Maryland shares land borders with Delaware and Virginia and, importantly, shares part of the shoreline of the Chesapeake Bay with Virginia.

Overall, Maryland has strong health, professional, science, and defense sectors. The top five industries by employment in Maryland are:

1. Education services, health care, and social assistance (23.7%)
2. Professional, scientific, management, administrative, and waste management services (16.7%)
3. Public administration (11%)
4. Retail trade (8.8%)
5. Arts, entertainment, recreation, accommodation, and food services (8.1%).

Notably, 4.6% of the civilian employed population 16 years and over in Maryland work in the manufacturing sector (U.S. Census Bureau 2024b). The largest employers in the state include the U.S. Department of Defense at Fort Meade and Naval Air Station Patuxent River, the University of Maryland system, Johns Hopkins Health System, Northrop Grumman, Marriott International, Walmart, and Under Armor (Maryland Department of Labor 2024a). As Maryland seeks to expand the manufacturing sector, a focus on skilled trade workforce development could assist the state in being ready to support offshore wind component manufacturing.

Maryland is ranked third in state-level workforce readiness among the SMART-POWER states. This score is driven by current economic and education and training indicators, so new and ongoing workforce investments and programs, like Maryland Works for Wind, are expected to increase workforce readiness.

Economic metrics indicate Maryland has a tight labor market with few available workers to fill jobs, despite a large labor pool. Maryland had a relatively higher labor force participation rate (66.6%) among the SMART-POWER states, exceeding the national average (62.7%), indicating a large workforce in the state. However, the state's unemployment rate for 2022–2023 was 1.8%, which indicates most of the available workforce is employed and there are fewer workers available to staff a manufacturing facility if one were placed in Maryland (Maryland.gov 2024).

The existing manufacturing sector in Maryland is currently less established compared to other SMART-POWER states. Maryland has a lower percentage of the population working in manufacturing (3.9%) compared to North Carolina, which had a relatively higher percentage among SMART-POWER states (9.5%). Maryland recorded 4,677 manufacturing firms employing 113,565 people:

- Computer and electronic products industry (22,837 jobs)
- Food manufacturing (18,057 jobs)
- Chemical manufacturing (14,546 jobs).

The fabricated metal product industry, which employs people with similar skill sets needed for monopile and tower production, employed 7,922 people (Maryland Department of Labor 2024a). However, the manufacturing industry grew last year with a 2.1% increase, the second fastest among SMART-POWER states behind Delaware (5.1%). The Maryland Manufacturing Extension Partnership and Regional Manufacturing Institute of Maryland are working to advance

the manufacturing sector and offer funding to overcome the skills gap through the Incumbent Worker Training Program and Manufacturing Internship Program (Maryland MEP n.d.).

Maryland's education system appears ready to support occupations within the factory-level management and engineering occupations and may need to develop or expand programs to better support factory-level workers and facilities maintenance occupations. Maryland's high number of two-year and four-year degree programs support the high employment in health, professional, and science-based roles. A large defense industry also indicates the state has many active-duty military personnel and veterans that may have applicable skills that transfer to offshore wind component manufacturing.

Maryland has made strategic policies and investments to support the offshore wind industry in the state, which have been pivotal for creating the robust workforce development foundation related to the offshore wind industry that is noted in the state today.[9] In 2023, Maryland passed the Promoting Offshore Wind Energy Resources (POWER) Act establishing a new goal of 8.5 GW by 2031 (Maryland Energy Administration 2024a). In 2024, the Maryland State Legislature passed Maryland House Bill 1296 to strengthen the state's ability to reach that goal by reopening offshore wind projects currently under contract and allowing for renegotiation. Alongside these procurement goals, Maryland has invested in workforce development for the offshore wind industry. The Maryland Works for Wind program is a $22 million+ regional consortium, providing grants to establish Maryland as a destination for offshore wind training, fabrication, and employment and supporting the skilled trades, manufacturing, and transportation and logistics sectors (Maryland Department of Labor 2024b). In addition, the Maryland Energy Administration announced the Maryland Offshore Wind Workforce Training and Education Program to grant new or existing workforce training centers funds to expand course offerings and educational opportunities in 2025 (Maryland Energy Administration 2024b). A focus of many grants could be expanding skilled trade training programs to support offshore wind component manufacturing.

Historically, Maryland has not been as prominent a manufacturing state as other SMART-POWER states. However, Maryland is seizing new opportunities brought by the emerging offshore wind industry and investing in training programs to develop a manufacturing specialization across the workforce, supplementing the robust higher education programs with skilled trades training pathways and apprenticeship programs.

3.2.1 Occupational and Educational Strengths and Weaknesses

Maryland's workforce strengths include its two-year and four-year certificate and degree programs across the state that could train factory-level management and engineering occupations. There are more training programs that train factory-level management and engineering roles than programs that train factory-level worker roles. For factory-level workers, the state scored low for the number of two-year, four-year, and registered apprenticeship programs that could train skilled trade workers. There are two-year and four-year programs in

[9] Many of the previous investments can be correlated with a merger settlement—including a $32 million fund for offshore wind energy—between Constellation Energy Group and Exelon Energy in 2011. https://chesapeakeclimate.org/maryland-wind-power-gains-under-constellation-exelon-merger/

Maryland to train 60.71% of the occupations identified for manufacturing and registered apprenticeship programs to train 21.43% of the occupations identified for a manufacturing facility.

Table 4 displays the relatively strongest occupations, and relatively weakest occupations by component and job category as measured by Maryland's specialty for that occupations and the number of identified programs that could be leveraged to train that job role. The occupational ranking does not vary greatly between components, as the SOC codes that drive the calculator are similar between all manufacturing facilities evaluated. It is important to note that specialized training or certifications may differ between the varying components.

Table 4. Table of Maryland's Occupation Strengths and Weaknesses by Job Category and Component.

Blades		
Strengths	Factory-Level Management and Engineering	Information Technology Manager Plant Manager
	Factory Level Workers	Inventory Clerk, Material Coordinator Hoist and Winch Operator
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Maintenance Supervisor
Weaknesses	Factory-Level Management and Engineering	Engineering Technician* Surface Engineer* Purchaser/Buyer*
	Factory Level Workers	Fiberglass Technician* Driller* Coatings Inspector, Specialist Coating Technician (Applier) Assembler
	Facilities Maintenance	Industrial Machinery Mechanic Maintenance Technician
Towers		
Strengths	Factory-Level Management and Engineering	Information Technology Manager Plant Manager
	Factory Level Workers	Inventory Clerk, Material Coordinator Hoist and Winch Operator
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Maintenance Supervisor
Weaknesses	Factory-Level Management and Engineering	Engineering Technician* Surface Engineer, Metal Grinder Purchaser/Buyer
	Factory Level Workers	Driller* Metal Cutters Millwrights
	Facilities Maintenance	Industrial Machinery Mechanic Maintenance Technician
Monopiles		
Strengths	Factory-Level Management and Engineering	Information Technology Manager

		Plant Manager
	Factory Level Workers	Inventory Clerk, Material Coordinator Hoist and Winch Operator
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Maintenance Supervisor
Weaknesses	Factory-Level Management and Engineering	Engineering Technician* Surface Engineer, Metal Grinder
	Factory Level Workers	Metal Cutters Driller* Millwrights
	Facilities Maintenance	Industrial Machinery Mechanic Maintenance Technician

*The Bureau of Labor Statistics does not report the locational quotient, which decreases the occupation's average z-score for occupational specialty and available education and training programs.

3.2.2 Gap Analysis for Specialized or High-Demand Occupations

Two out of the five specialized or high-demand occupations have a training gap in Maryland: rolling machine setter/tower rolling machinist and crane operator/auxiliary crane operator/heavy-lift crane operator. Two-year, four-year, or registered apprenticeship programs exist to train CNC operators, mechanical support/composite blades technicians, and electricians. Overall, the select high-demand or highly specialized occupations with training gaps could be prioritized at the state level. Creating new registered apprenticeships programs could be particularly effective to train rolling machine setter/tower rolling machinists and crane operator/auxiliary crane operator/heavy-lift crane operators.

Table 5 shows the training gaps across high-demand or highly specialized occupations for blade, tower, and monopiles facilities. The education level, skills, and certifications required or preferred may differ based on employer.

Table 2. Training Gap Analysis for High-Demand or High-Specialization Occupations in Maryland

Occupation	High Demand/High Specialization	Training Gap?
CNC operator	High Demand and Specialization	No
Rolling machine setter/tower rolling machinist	High Specialization	Yes
Mechanical support/ composite blades technician	High Specialization	No
Electrician	High Demand	No
Crane operator/auxiliary crane operator/ heavy-lift crane operator	High Demand	Yes

3.3 Virginia

Virginia's business-friendly landscape and robust education system has allowed the Commonwealth to become a leader across many industries, including offshore wind energy. According to the Virginia Employment Commission, Economic Information and Analytics, Quarterly Census of Employment and Wages, in the first quarter of 2024, Virginia's top five industries by employment included:

1. Government (735,919)
2. Health care and social assistance (487,940)
3. Professional, scientific, and technical services (468,168)
4. Retail trade (388,324)
5. Manufacturing (242,570).

The top five largest employers consisting of the U.S. Department of Defense, Wal Mart, Fairfax County Public Schools, Sentara Healthcare, and Amazon Fulfillment Services Inc. (Virginia Works 2024d). Virginia has a higher labor force participation rate (63.8%) than the national average (62.7%) and ranked as the second highest among the SMART-POWER states. However, the state's unemployment rate is low, meaning that as a percentage of the labor force, more people are employed than unemployed, which could limit the availability of the workforce.

At a state level, Virginia has a higher percentage of the population working in manufacturing compared to Maryland and Delaware, although it is not as high as North Carolina. A high percentage of the workforce working in manufacturing indicates that people in Virginia could potentially support an offshore wind manufacturing facility through existing transferable skill sets. Historically, manufacturing has played a large role in Virginia in the tobacco manufacturing, shipbuilding, and textile industries (Virginia Museum of History & Culture 2024). While these industries are still present in Virginia, it is estimated that in 2023 the largest manufacturing employment was in transportation equipment manufacturing, food manufacturing, fabricated metal product manufacturing, plastics and rubber products manufacturing, and machinery manufacturing. Furthermore, between 2023 and 2025, manufacturing employment in Virginia is projected to increase by 1.011%, showing a general positive trend in the industry (Virginia Works Department of Workforce Development and Advancement 2024).

The Virginia Clean Economy Act of 2020 (House Bill 1526) established an offshore wind energy target for Dominion Energy, directing Dominion to generate 5.2 GW of offshore wind energy by Dec. 31, 2034 (DSIRE 2024). In 2023, this date was amended to Dec. 31, 2032 (Virginia Legislative Information System 2023). This procurement goal in addition to Dominion's 2024 integrated resource plan, which includes 3.4 GW of new offshore wind capacity in addition to the 2.6 GW of capacity from the Coastal Virginia Offshore Wind project, has been helping to drive offshore wind deployment in the state (Dominion Energy 2024). However, many of the components are being sourced from global supply chains due to a lack of nearby Tier 1 component manufacturing facilities.

Regarding education, Lumina estimated in 2022 (the most recently available data) that 59.0% of Virginians aged 25 to 64 had earned either a workforce certificate, certification, or associate's

degree, which ranked the state sixth in the nation for post-secondary education attainment. Virginia's State Council of Higher Education set a strategic goal of 70% post-secondary education attainment by 2030 and aims to reach this target by increasing access to education and training, expanding prosperity, and lowering cost to students (State Council of Higher Education for Virginia 2021). One program that focus on these goals at the state level is the "Get a skill. Get a job. Get ahead." tuition assistance program. This program focuses on training in-demand manufacturing and construction skilled trades occupations through the state's 23 community colleges by helping to remove the financial barrier of earning a certificate or degree. Some of the highlighted skilled trades occupations include computer-controlled machine tool operator and manufacturing engineering technician, which are also required in offshore wind component manufacturing facilities.

Both the workforce development foundation at the state level in addition to the unique skill sets needed for manufacturing a specific component are important to consider when discussing how ready a state is to support a facility at an occupational and educational level.

3.3.1 Occupational and Educational Strengths and Weaknesses

Virginia was determined to have a relative strength in training for occupations typically associated with factory-level management and engineering roles. This is primarily driven by the number of two-year and four-year certificate and degree programs in the state that have been identified to train occupations in this job category. Facilities maintenance, while not as strong as factory-level management and engineering roles, are also a strength in Virginia due to the relatively high number of registered apprenticeship programs and relatively high occupational specialty on average for occupations in this job category. Within Virginia, occupations within the factory-level worker job category posed the largest weakness in terms of occupational specialty and available education and training programs; however, compared to the other SMART-POWER states, Virginia ranked as the second highest behind North Carolina. Occupations within the factory-level workers job category were noted as an occupational weakness in comparison to the other job categories across all SMART-POWER states.

Table 6 displays the relatively strongest occupations and relatively weakest occupations by component and job category as measured by Virginia's specialty for that occupation and the number of identified programs that could be leveraged to train that job role. The occupation ranking does not vary greatly between components, as the SOC codes that drive the calculator are similar between all manufacturing facilities evaluated. It is important to note that specialized training or certifications may differ between the varying components.

Table 6. Virginia's Occupation Strengths and Weaknesses by Job Category and Component

Blades		
Strengths	Factory-Level Management and Engineering	Engineering Manager/Director Information Technology Manager
	Factory Level Workers	Electrician Grinder Operator Inventory Clerk, Material Coordinator
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Industrial Machinery Electrician
Weaknesses	Factory-Level Management and Engineering	Engineering Technician* Surface Engineer
	Factory Level Workers	Hoist and Winch Operator* Driller CNC Operator
	Facilities Maintenance	Cleaning Staff Maintenance Technician
Towers		
Strengths	Factory-Level Management and Engineering	Information Technology Manager Engineering Manager/Director
	Factory Level Workers	Grinder Operator Steel Production Engineer, Metal Fitter, Structural Metal Fabricator
	Facilities Maintenance	Industrial Machinery Electrician Installation, Maintenance, and Repair Worker Helpers
Weaknesses	Factory-Level Management and Engineering	Engineering Technician* Surface Engineer, Metal Grinder
	Factory Level Workers	Hoist and Winch Operator* Driller CNC Operator
	Facilities Maintenance	Cleaning Staff Maintenance Technician
Monopiles		
Strengths	Factory-Level Management and Engineering	Engineering Manager/Director Information Technology Manager
	Factory Level Workers	Grinder Operator Inventory Clerk, Material Coordinator
	Facilities Maintenance	Industrial Machinery Mechanic Installation, Maintenance, and Repair Worker Helpers
Weaknesses	Factory-Level Management and Engineering	Engineering Technician* Surface Engineer, Metal Grinder
	Factory Level Workers	Hoist and Winch Operator* Driller CNC Operator
	Facilities Maintenance	Cleaning Staff Maintenance Technician

*The Bureau of Labor Statistics does not report the locational quotient, which decreases the occupation's average z-score for occupational specialty and available education and training programs.

3.3.2 Gap Analysis for Specialized or High-Demand Occupations

From the five evaluated occupations, three were determined to have a training gap in the state of Virginia, including crane operator/auxiliary crane operator/heavy-lift crane operator, rolling machine setter/tower rolling machinist, and CNC operators (Table 7). Crane operators and CNC operators are roles required across various manufacturing industries. If a training program for these occupations were to be set up in Virginia, it could be important to consider transferable skills among industries and training modules specific to offshore wind skills within curriculum development. Furthermore, leveraging regional connectivity among the SMART-POWER states by placing the training program in a commuting county with out-of-state commuters could promote more workers with these qualifications across the region to support additional manufacturing facilities. The only specialized occupation that was identified to have a training gap in Virginia was rolling machine setter/tower rolling machinist; therefore, if a tower or monopile facility were placed in Virginia, leveraging regional connectivity to train workers or developing a specialized training program could be important for successful workforce development. Additionally, the education level, skills, and certifications required or preferred may differ based on the employer.

Table 7. Training Gap Analysis for High-Demand or High-Specialization Occupations in Virginia

Occupation	High Demand/High Specialization	Training Gap?
CNC Operator	High Demand and Specialization	Yes
Rolling machine setter/tower rolling machinist	High Specialization	Yes
Mechanical support/ composite blades technician	High Specialization	No
Electrician	High Demand	No
Crane operator/auxiliary crane operator/ heavy-lift crane operator	High Demand	Yes

3.4 North Carolina

North Carolina is situated on the southeast coast of the SMART-POWER region bordering Virginia, Tennessee, and South Carolina. Across the state, the key industries for the working population are:

1. Educational services, health care, and social assistance (1,175,385)
2. Professional, scientific, management, administrative, and waste management services (679,217)
3. Manufacturing (614,073)
4. Retail trade (567,942)
5. Arts, entertainment, and recreation, and accommodation and food services (454,167) (U.S. Census Bureau 2024c).

Currently, North Carolina is the second-best state for manufacturing in the United States, with the largest manufacturing workforce across the Southeast (Economic Development Partnership

of North Carolina 2024a). Furthermore, the state has historical involvement in various manufacturing industries such as tobacco, textiles, and furniture manufacturing, which indicates a robust foundation and expertise for manufacturing activities within the state. In addition to these key industries, North Carolina's military operations and spending support 653,263 jobs across the state (Regional Economic Models Inc. and North Carolina Department of Commerce 2022). Annually, 20,000 active-duty personnel in North Carolina reenter the workforce, bringing with them experience and transferable skill sets to support manufacturing activities related to the emerging offshore wind energy industry (Economic Development Partnership of North Carolina 2024b).

The workforce readiness metric for North Carolina, on the statewide level, ranked relatively high among the SMART-POWER states. The state's readiness was augmented by the average percentage of the population working in manufacturing, location quotient for the manufacturing industry, the number of two-and four-year certificate and degree programs, and the number of registered apprenticeship programs. This indicates there is a higher manufacturing employment magnitude and specialization across the workforce with a robust education system to train roles relevant to the offshore wind sector. There is an opportunity to improve workforce readiness by building workforce development programs and initiatives for the manufacturing and offshore wind industry at the state level.

In 2021, North Carolina Executive Order 218 (EO218) titled "Advancing North Carolina's Economic and Clean Energy Future with Offshore Wind" was signed. The order established targets for offshore wind production, with the goal of 2.8 GW by 2030 and 8 GW by 2040. Apart from setting strategic goals for the state, EO218 created a position for an Assistant Secretary of Clean Energy Economic Development within the Department of Commerce to find economic and workforce development opportunities for the state, particularly in the offshore wind industry. The order also established a task force to provide offshore wind energy subject matter expertise to the governor and other state policymakers on matters related to the industry, with a particular focus on economic development and job creation (Governor Roy Cooper 2021). To prepare for potential in-state manufacturing facility investments, initiatives like EO218 increase workforce readiness by fostering early coordination and planning.

It is important to have statewide support for workforce development; however, it is also key to understand workforce readiness on the occupational and educational level with a focus on the community and surrounding regions where the facility could be placed.

3.4.1 Occupational and Educational Strengths and Weaknesses

North Carolina's workforce was determined to be well-prepared for the occupations typically associated with factory-level management and engineering roles. This is mostly due to the number of two-year and four-year certificate and degree programs across the state that were identified to train roles in the job category. While not as robustly supported as factory-level management and engineering, the roles involved in facilities maintenance are also a strength for the state. This is primarily driven by the number of registered apprenticeship programs and a relatively higher occupational specialization for facilities maintenance roles across the state. The largest weakness in terms of occupational specialty and existing education and training programs in North Carolina is for factory-level worker roles. However, in relation to the other SMART-POWER states, North Carolina ranked as the top state in terms of workforce readiness.

Table 8 displays the top relatively strongest occupations, and bottom relatively weakest occupations by component and job category as measured by North Carolina's specialty for that occupations and the number of identified programs that could be leveraged to train that job role. The occupation ranking does not vary greatly between components, as the SOC codes that drive the calculator are similar between all manufacturing facilities evaluated. It is important to note that specialized training or certifications may differ between the varying components.

Table 8. Table of North Carolina's Occupation Strengths and Weaknesses by Job Category and Component

Blades		
Strengths	Factory-Level Management and Engineering	Plant Manager Production Supervisor/Manager, Quality Assurance (QA)/Quality Control (QC) Manager
	Factory Level Workers	Metal Fitter Electrical Support
	Facilities Maintenance	Maintenance Technician Installation, Maintenance, and Repair Worker Helpers
Weaknesses	Factory-Level Management and Engineering	Engineering Technician Purchaser/Buyer
	Factory Level Workers	Driller Milling Machinist
	Facilities Maintenance	Cleaning Staff Industrial Machinery Electrician
Towers		
Strengths	Factory-Level Management and Engineering	Plant Manager Production Supervisor/Manager, Quality Assurance (QA)/Quality Control (QC) Manager
	Factory Level Workers	Steel Production Engineer, Metal Fitter, Structural Metal Fabricator Electrical Support
	Facilities Maintenance	Maintenance Technician Installation, Maintenance, and Repair Worker Helpers
Weaknesses	Factory-Level Management and Engineering	Engineering Technician Purchaser/Buyer
	Factory Level Workers	Driller Rolling Machine Setter
	Facilities Maintenance	Cleaning Staff Industrial Machinery Electrician
Monopiles		
Strengths	Factory-Level Management and Engineering	Plant Manager Production Supervisor/Manager, Quality Assurance (QA)/Quality Control (QC) Manager
	Factory Level Workers	Steel Production Engineer, Metal Fitter, Structural Metal Fabricator Laser Operator, Welding Machinist/Welding Engineer CNC Operator
	Facilities Maintenance	Industrial Machinery Mechanic Installation, Maintenance, and Repair Worker Helpers

Weaknesses	Factory-Level Management and Engineering	Engineering Technician Purchaser/Buyer
	Factory Level Workers	Driller Rolling Machine Setter
	Facilities Maintenance	Cleaning Staff Industrial Machinery Electrician

*The Bureau of Labor Statistics does not report the locational quotient, which decreases the occupation's average z-score for occupational specialty and available education and training programs.

3.4.2 Gap Analysis for Specialized or High-Demand Occupations

In North Carolina, there are training programs to support three out of the five high-demand or high-specialization occupations (Table 9). While the education level, skills, and certifications required or preferred may differ based on the employer, the data show there is at least one existing training program for the evaluated occupations at an offshore wind manufacturing facility that could be leveraged to ensure that individuals are properly trained and certified. It is important to note that training programs for the mechanical support or composite blades technician, electrician, and CNC operator roles are mostly two- and four-year training programs, which reflects a strength in two- and four-year programs compared to registered apprenticeship programs in the state. Moreover, there is a training gap for a rolling machine setter/tower rolling machinist and crane operator/auxiliary crane operator/heavy-left crane operator roles. There are no existing training programs for a rolling machine setter/tower rolling machinist, indicating there is a potential need to develop new training programs or focus recruitment efforts in the regional commuting zones for these roles. Overall, North Carolina is well-placed to train high-demand or high-specialization occupations for an offshore wind component manufacturing facility at the state level.

Table 9. Training Gap Analysis for High-Demand or High-Specialization Occupations in North Carolina

Occupation	High Demand/High Specialization	Training Gap?
CNC operator	High Demand and Specialization	No
Rolling machine setter/tower rolling machinist	High Specialization	Yes
Mechanical support/ composite blades technician	High Specialization	No
Electrician	High Demand	No
Crane operator/auxiliary crane operator/ heavy-lift crane operator	High Demand	Yes

4 Offshore Wind Workforce by Port

Similar to the process used for the SMART-POWER states, the following ports were evaluated for their strengths, weaknesses, and opportunities to support offshore wind component manufacturing:

- Port of Wilmington, Delaware
- Sparrows Point, Maryland
- Portsmouth Marine Terminal (PMT), Virginia
- Fairwinds Landing, Virginia
- Port of Wilmington, North Carolina
- Port of Morehead City, North Carolina.

This evaluation was conducted through a contextual analysis of existing industry and offshore wind energy involvement, a strengths and weaknesses assessment of the labor markets within the respective in-state and regional commuting zones of the ports, and a gap analysis of education and training programs to support training for high-demand or highly specialized occupations. This does not consider an area's infrastructure or technical capabilities, as the evaluation is meant to be leveraged to understand workforce readiness solely.[10]

The evaluated ports' labor markets, as defined by workforce economic indicators, were evaluated at the in-state and regional commuting zone levels. It is assumed that if a port's labor market is determined to be a strength, then it may be less of a challenge to recruit a workforce with existing manufacturing skills as compared to other evaluated areas. Alternatively, if a port is determined to have a labor market weakness, then it is assumed that it may be more of a challenge to recruit a workforce in assessed communities with the existing manufacturing skills as compared to the other evaluated areas. The labor market strength and weakness analyses are intended to help determine the potential ease of recruiting a workforce to work in an offshore wind manufacturing facility in an evaluated port area.

Similar to the state-level evaluation, the training gaps were determined through a comparison of the selected occupations to the number of programs within the education and training database that were identified to support the offshore wind manufacturing workforce needs. If there were no programs identified to train the occupation, then the occupation was considered to have a training gap within the evaluated state or port. Alternatively, if there was an applicable training program identified, it was considered to not have a training gap. For the ports, the training gap was evaluated for two-year and four-year degrees and registered apprenticeship programs, separately, at the in-state commuting zone and regional commuting zone levels. The occupations evaluated for the ports remained consistent with the occupations evaluated at the state level to support geographic comparison.

[10] Infrastructure and technical capabilities of the area are discussed in *A Regional Approach to Offshore Wind Energy Manufacturing in the Central Atlantic: Supply Chain* (Pérez et al. 2025).

4.1 Port of Wilmington, Delaware

Port of Wilmington is located on the Delaware River and is accessible from various highways in the area. The port operates as a full-service deep-water port and marine terminal, with a large amount of equipment, such as four gantry cranes and one 100-ton mobile harbor crane. Port of Wilmington opened in 1922, and has hosted a wide variety of industries (Port Wilmington 2024). The top five industries by employment in the wider Wilmington area are:

1. Health care and social assistance (5,673)
2. Educational services (3,351)
3. Retail trade (3,262)
4. Finance and insurance (3,085)
5. Professional, scientific, and technical services (2,470).

While not in the top five, the manufacturing industry is the eighth most prominent industry by employment in Wilmington, employing 2,108 people (DataUSA 2024c). Regarding offshore wind energy, there is a 60-acre site available for development that is designated for wind turbine component manufacturing; however, further consideration on how the site could support a manufacturing facility would be needed to support development.

As described in the Supply Chain report (Pérez et al. 2025), Port of Wilmington was determined to have a relatively average workforce readiness level overall due to its medium to low regional commuting score, in-state commuting score, and state score. Figure 3 shows the gradient of the workforce readiness score.

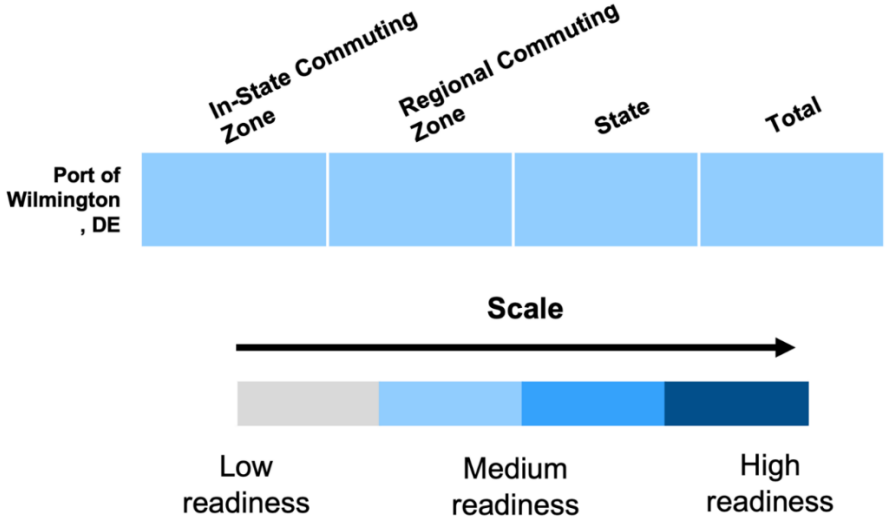

Figure 3. Port of Wilmington (Delaware) in-state, regional, state, and total readiness score

While the drivers of the workforce readiness score are described in the Supply Chain report (Pérez et al. 2025), the following sections take a deeper look at the labor market strengths, weaknesses, opportunities and threats, and analyze education and training for high-demand and highly specialized occupations.

4.1.1 Labor Market Strengths, Weaknesses, Opportunities, and Threats Analysis

The counties near Port of Wilmington were found, on average, to have labor market attributes that were conducive to supporting an offshore wind component manufacturing facility; however, levels of workforce readiness were shown to vary on a county-by-county basis. The counties within a 25-mile radius of the port (or approximately the average one-way commuting distance to work in the United States) and in the SMART-POWER region include New Castle, Delaware, and Cecil, Maryland. These counties could be essential for recruiting, hiring, and training a qualified workforce to support a new facility (U.S. Census Bureau 2024d).[11]

The commuting area for workers into Port of Wilmington (New Castle County) was reported, through the U.S. Census Bureau's American Community Survey (ACS) data, to be larger than other counties within the 25-mile radius of the port county. Therefore, the top three counties that contributed the most to the workforce readiness score in both the in-state commuting area and regional commuting area were evaluated to find locations that may have a stronger current labor market foundation to support an offshore wind component facility. While these counties were found to have relative strengths for the area and were noted in the ACS to have commuters into the county of the port, each has varying labor market and travel factors that could impact a qualified workforce's access to Port of Wilmington. If the commute was longer than 50 miles, that county was determined to have a greater challenge commuting to the port. If the commute was shorter than 50 miles, that county was determined to have a higher opportunity for commuting to the port.

Table 10. Summary of Labor Market Analysis for the Top Three In-State and Regional Commuting Counties for Port of Wilmington, Delaware

Commuting Zone	County	Workforce Readiness Positive Drivers	Commuting Threshold
In-state	New Castle County, DE	Manufacturing employment magnitude, unemployment rate	Opportunity (<50 miles)
In-state	Kent County, DE	Unemployment rate, related industry closures	Challenge (>50 miles)
In-state	Sussex County, DE	Manufacturing employment specialty, unemployment rate	Challenge (>50 miles)
Regional	Anne Arundel County, MD	Manufacturing employment magnitude, related industry closures, and local program support	Challenge (>50 miles)
Regional	Baltimore County, MD	Manufacturing employment magnitude, related industry closures, and local program support	Challenge (>50 miles)

[11] While Salem County, New Jersy; Chester County, Pennsylvania; and Delaware County, Pennsylvania are within a 25-mile radius, these counties were not included in the regional assessment approach because they are outside the SMART-POWER region.

Commuting Zone	County	Workforce Readiness Positive Drivers	Commuting Threshold
Regional	Robeson County, NC	Manufacturing employment specialty, unemployment rate	Challenge (>50 miles)

4.1.2 In-State Commuting Zone

The top three counties identified as relative strengths in the in-state commuting zone for their labor markets were New Castle County, Kent County, and Sussex County, all in Delaware. Strengths and weaknesses for the counties are based on data in the workforce readiness calculator and are compared to each other within the respective commuting zone. All three counties have program support from local workforce development boards for the manufacturing of offshore wind industry.

New Castle County has a relative strength in terms of the labor market primarily due to its existing relatively higher manufacturing employment magnitude (11,230) and relatively average unemployment rate within the in-state commuting zone. Because Port of Wilmington is located within this county, the proximity indicates a higher opportunity to hire workers from the communities near the port who may have existing skill sets in manufacturing. However, many workers with the necessary skill sets may already have manufacturing jobs, requiring additional training for new workers.

Kent County has a relative strength in terms of the labor market primarily because of its higher level of unemployment and the presence of related industry closures. The county's workforce readiness level was decreased due to its relatively average specialty for manufacturing in terms of county employment (LQ 0.91) and lower manufacturing annual average employment. While Kent County does not have a higher manufacturing capability, there is an available workforce with potentially transferable skill sets to reskill or upskill to support offshore wind manufacturing facilities. Kent County is approximately 50 miles south of Port of Wilmington, indicating that transportation time to work may pose a challenge for workers, and they may require additional training.

Sussex County has a relative strength in terms of the labor market primarily due to its relatively average specialty for manufacturing in terms of county employment (LQ 1.31) and relatively average unemployment rate. However, Sussex County is the farthest in-state commuting zone county from where a manufacturing facility could potentially be placed, posing a more significant transportation challenge for an everyday commuter.

4.1.3 Regional Commuting Zone

The top three counties calculated to have a relative strength in terms of the labor market in the regional commuting zone were Anne Arundel County, Maryland, Baltimore County, Maryland, and Robeson County, North Carolina. Strengths and weaknesses for the counties are based on data in the workforce readiness calculator and are compared to each other within the respective commuting zone.

Anne Arundel County has a relative strength for the regional commuting zone primarily due to its relatively higher manufacturing employment magnitude, recent related industry closures, and

local program support. This indicates there is a potentially available workforce with transferable skill sets and support from local government entities for an offshore wind manufacturing facility. However, within this county there is a relative weakness as it pertains to workforce availability because the unemployment rate is lower, indicating a workforce that is currently working. In addition, the county has a relatively average manufacturing annual average employment LQ (0.77), indicating that while there are manufacturing jobs, the number of people working in manufacturing relative to the entire working population is lower. Furthermore, the county is approximately 75 miles away from where a manufacturing facility could potentially be placed, posing a transportation challenge for an everyday commuter.

Baltimore County has a relative strength in terms of the labor market primarily due to its relatively higher manufacturing employment magnitude in Maryland, recent related industry closures, and programmatic support for manufacturing or offshore wind through the local workforce or economic development boards. This indicates there is a potentially available workforce with transferable skill sets and support from local government entities for an offshore wind manufacturing facility. Similar to Anne Arundel County, a relative weakness is the low unemployment rate (indicating a relatively lower available workforce), and relatively lower average manufacturing annual average employment LQ (0.49), indicating most of the working age population is not in the manufacturing industry. Baltimore County is greater than 50 miles from Port of Wilmington, so the commute time may pose a challenge for recruiting a workforce from this area.

Robeson County has a relatively higher manufacturing employment specialty and a relatively higher unemployment rate, indicating a manufacturing capability in the county with an available workforce. However, within this county there is a relative weakness as it pertains to local program support and related industry closures. There may be an available workforce with transferable skill sets but there may be less related to offshore wind manufacturing needs and the lack of support from workforce or economic development boards may make recruiting harder. Additionally, the county is over 500 miles away from where a manufacturing facility could potentially be placed, posing a significant transportation challenge for an everyday commuter.

4.1.4 Gap Analysis for Specialized Occupations

If an offshore wind manufacturing facility was placed at Port of Wilmington, it is important to understand the potential training pathways for the workforce to be prepared to staff the facility, especially for high-demand and highly specialized occupations (Table 11). From the selected occupations, the only one with registered apprenticeship training support at the in-state commuting level is electrician. Conversely, at the in-state commuting level for the other selected occupations, there is an indicated training gap in both two- and four-year programs and registered apprenticeship programs.

In the regional area, there are identified training pathways for electricians at the two-year and four-year degree and registered apprenticeship program levels. Furthermore, there is not a training gap for two-and four-year programs training mechanical support/composite blades technician roles. However, it was determined that CNC operators, rolling machine setters, and crane operators all face potential training program gaps at the regional level. Therefore, there is room for improvement across the in-state commuting and regional level to expand or develop new training programs to fill the training gaps for the selected occupations. It is important to note

that there could be commuters from counties outside of the SMART-POWER states; however, those states were not analyzed as a part of this study.

Table 11. In-State Commuting and Regional Training Program Gaps for Select Occupations for Port of Wilmington, Delaware

Occupation	Training Pathway	In-State Commuting Program Training Gap	Regional Program Training Gap
CNC Operator	2-year to 4-year	Yes	Yes
	Registered apprenticeship program (RAP)	Yes	Yes
Rolling machine setter/tower rolling machinist	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes
Mechanical support/composite blades technician	2-year to 4-year	Yes	No
	RAP	Yes	Yes
Electrician	2-year to 4-year	Yes	No
	RAP	No	No
Crane operator/auxiliary crane operator/heavy-lift crane operator	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes

4.2 Sparrows Point, Maryland

Sparrows Point is located in Baltimore County close to major workforce centers such as Baltimore, Washington, D.C., and surrounding communities in Anne Arundel and Howard counties with workers commuting into the port on Highway 695. In Baltimore County the largest industries based on employment are:

1. Health care and assistance (69,664)
2. Educational services (46,987)
3. Retail trade (43,956)
4. Professional, Scientific, and Technical Services (39,698)
5. Public Administration (34,413).

Additionally, the manufacturing industry in Baltimore County has 24,403 people employed, composing 5.68% of the total workforce. With offshore wind manufacturing occupations in mind, 11.3% of Baltimore, County employment is management occupations, 3% in production occupations, and 2.77% in installation, maintenance and repair occupations (DataUSA 2024a). Sparrows Point has already been identified as a development location for a component manufacturing facility. Tradepoint Atlantic is a 3,300-acre facility located off the Patapsco River on the Chesapeake Bay. As a former iron and steel factory, Tradepoint Atlantic is under redevelopment as a container terminal and potential site for Sparrows Point Steel, a monopile production facility. According to Sparrows Point Steel, long-term manufacturing jobs are estimated to be around 530 workers for the monopile facility (US Wind 2023).

As described in the Supply Chain report (Pérez et al. 2025), Sparrows Point was determined to have a relatively average workforce readiness level overall due to its medium regional and state scores and relatively lower in-state commuting score. Figure 4 shows the gradient of workforce readiness score.

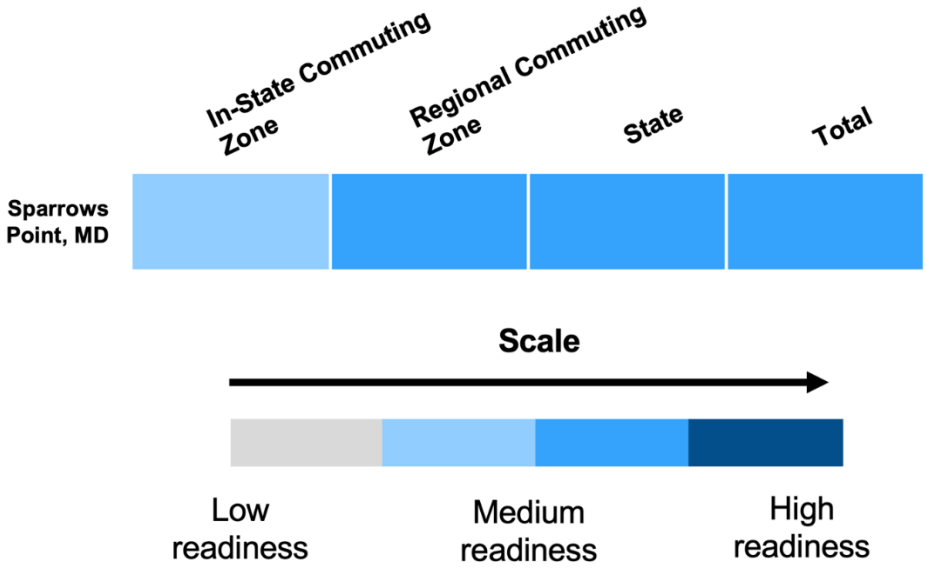

Figure 4. Sparrows Point in-state commuting, regional, state, and total readiness scores

While the drivers of the workforce readiness score are described in the Supply Chain report (Pérez et al. 2025), the following sections take a deeper look into the labor market strengths, weaknesses, opportunities and threats, and analyze education and training for high-demand and highly specialized occupations.

4.2.1 Labor Market Strengths, Weaknesses, Opportunities, and Threats Analysis

The counties near Sparrows Point were found on average to have labor market attributes that were conducive to potentially supporting an offshore wind component manufacturing facility; however, levels of workforce readiness were shown to vary on a county-by-county basis. Sparrows Point is located off Highway 695, which connects major metropolitan areas such as Baltimore, Washington, D.C., and several nearby suburban communities with commuting patterns into Sparrows Point. The counties within a 25-mile radius of the port (or approximately the average one-way commuting distance to work in the United States) and in the SMART-POWER region include Anne Arundel County, Baltimore County, Carroll County, Harford County, and Howard County, all within Maryland. The city of Baltimore is also included in this radius. These counties could be essential for recruiting, hiring, and training a qualified workforce to support a new facility.

The commuting area for workers into Sparrows Point (Baltimore County) was reported, through the U.S. Census Bureau's ACS data, to be larger than the counties within the 25-mile radius of the port county. Therefore, the top three counties that contributed the highest to the workforce readiness score in both the in-state commuting area and regional commuting area were evaluated to find locations that may have a stronger workforce labor market foundation to support an offshore wind major component facility from a workforce perspective. While these counties

were found to have relative strengths for the area and were noted through the ACS survey to have commuters into the county of the port location, each county has varying labor market and travel factors that could impact a qualified workforce's access to Sparrows Point, Maryland. Each county was evaluated for its unique strengths and weaknesses and distance from the county port being evaluated. If the commute was longer than 50 miles, that county was indicated to have a greater challenge commuting to the port. If the commute was shorter than 50 miles, that county was determined to have a higher opportunity for commuting to the port.

Table 12. Summary of Labor Market Analysis for the Top Three In-State and Regional Commuting Counties for Sparrows Point, Maryland

Commuting Zone	County	Workforce Readiness Positive Drivers	Commuting Threshold
In-state	Baltimore County, MD	Manufacturing employment magnitude, related industry closures, and local program support	Opportunity (<50 miles)
In-state	Anne Arundel County, MD	Manufacturing employment magnitude, related industry closures, and local program support	Opportunity (<50 miles)
In-state	Allegany County, MD	Unemployment rate, related industry closures	Challenge (>50 miles)
Regional	Mecklenburg County, NC	Manufacturing employment magnitude, local program support	Challenge (>50 miles)
Regional	Newport News, VA	Manufacturing employment specialty, manufacturing employment magnitude	Challenge (>50 miles)
Regional	Kent County, DE	Unemployment rate, related industry closures, and local program support	Challenge (>50 miles)

4.2.2 In-State Commuting Zone

The top three counties in Maryland calculated to have relative strength in the in-state commuting zone were Baltimore County, Anne Arundel County, and Allegany County. Strengths and weaknesses for the counties are based on data in the workforce readiness calculator and are compared to each other within the respective commuting zone.

Baltimore County was indicated to have relative strength in terms the labor market primarily due to its existing relatively higher manufacturing annual average employment and local program support. Another notable strength is the related industry closures near Sparrows Point. After the steel mill closure, heavy steel industries continue to be an important community identity, so many workers in the nearby communities may still have skill sets that could transfer to component manufacturing, especially monopile and tower facilities. Baltimore County is indicated to have relative weakness in terms of the labor market primarily due to its low unemployment rate, meaning there are less workers to recruit, train, and hire into a new manufacturing facility. Baltimore County is the closest of the top three counties, within a few miles of Sparrows Point. This closer proximity would allow for more workforce hiring opportunity for a manufacturing facility.

Anne Arundel County was found to have relative strengths for its labor market because of higher manufacturing employment magnitude, recent industry closures, and local program support for manufacturing or offshore-wind-specific workforce development initiatives. Anne Arundel County is also proximate to the steel mill closure, indicating a workforce with similar skill sets for tower and monopile manufacturing facilities. Anne Arundel County has relative weakness because of its relatively lower unemployment rate and manufacturing annual average employment LQ. This indicates the majority of the existing workforce in the area is not working in manufacturing and that there are fewer available workers available to support a new facility—both are factors that may require training opportunities. However, Anne Arundel County has easy access to Sparrows Point via a short commute on Highway 695, presenting an opportunity to support this county with new economic and workforce development.

Allegany County is located more than 125 miles from Sparrows Point, so workers would have a greater challenge commuting to the port. However, this county is included in the top three relative strengths because of its relatively higher unemployment rate and related manufacturing industry closures in recent years. In this county, there may be an available workforce to reskill and upskill for occupations in an offshore wind manufacturing facility.

4.2.3 Regional Commuting Zone

The top three counties or cities calculated to have relative strength in the regional commuting zone were Mecklenburg County, North Carolina, the city of Newport News, Virginia, and Kent County, Delaware. Strengths and weaknesses for the counties are based on data in the workforce readiness calculator and are compared to each other within the respective commuting zone.

Mecklenburg County, North Carolina, was found to have relative strengths to support an offshore wind manufacturing facility because of its higher manufacturing employment magnitude and local program support for manufacturing or offshore-wind-specific workforce development initiatives. Furthermore, the county is more than 450 miles away from where a manufacturing facility could potentially be placed, posing a more significant transportation challenge for an everyday commuter.

Newport News, Virginia, has relative strengths based on its manufacturing capacity with a higher manufacturing annual average employment LQ (3.24) and relatively large manufacturing employment magnitude. This manufacturing capacity combined with local program support for offshore wind or manufacturing training initiatives makes the county an attractive place to recruit, train, and hire workers. While it was indicated that people do commute to Sparrows Point from Newport News, the transportation time may pose a challenge for an everyday commuter because the distance is more than 200 miles.

Kent County, Delaware, has a relatively higher unemployment rate, related industry closures, and/or manufacturing-specific or offshore-wind-specific workforce development initiatives within the regional commuting zone. However, the workforce has a relatively lower manufacturing specialty, with a lower manufacturing employment number and manufacturing annual average employment LQ, which indicates Kent County does not have a manufacturing specialty. Kent County is approximately 100 miles from Sparrows Point, so workers from this county may also have a greater challenge commuting to the port. However, there may be an

available workforce to consider recruiting and training if in-state communing zone counties closer to the port have a tighter labor market.

4.2.4 Gap Analysis for Specialized Occupations

People in communities near Sparrows Point can commute to in-state or regional programs to receive training in occupations needed to support blade, monopile, and tower facilities. The in-state commuting zone has an average availability of registered apprenticeship programs, and above-average score for two-year and four-year programs. An in-state commuting zone training program gap is identified for rolling machine setter, tower rolling machinist and crane operator/auxiliary crane operator/heavy-lift crane operator, as there are no registered apprenticeship programs or two-year or four-year programs to support training these occupations within commuting counties near Sparrows Point. A regional training program also does not exist for these two occupations. It is important to note that for monopile and tower facilities, a training gap in rolling machinists is a critical gap for producing heavy steel structures.

For CNC operator, composite blades technicians, and electrician occupations, the in-state commuting zone and regional training programs could train workers for the necessary skill sets for component manufacturing. The availability of registered apprenticeship programs increases when including counties in Delaware and especially Virginia, indicating an opportunity for regional collaboration.

Table 13 shows the offshore-wind-specific education and training programs at the in-state commute and regional level for several occupations that span multiple components (e.g., CNC operator, electrician, crane operators) and select occupations for blades (composite blade technician) and towers/monopiles (rolling machine setter).

Table 13. In-State Commute and Regional Training Program Gaps for Select Occupations for Sparrows Point, Maryland

Occupation	Training Pathway	In-State Commute Program Training Gap	Regional Program Training Gap
CNC Operator	2-year to 4-year	Yes	Yes
	Registered apprenticeship program (RAP)	Yes	No
Rolling machine setter, tower rolling machinist	2-year to 4-year	No	No
	RAP	No	No
Mechanical support, composite blades technician	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes
Electrician	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes
Crane operator/auxiliary crane operator/heavy-lift crane operator	2-year to 4-year	No	No
	RAP	No	No

4.3 Hampton Roads Ports in Virginia

The Hampton Roads area comprises 15 unique communities encompassing more than 1.8 million residents. Located in the southeastern portion of Virginia on the shores of the Chesapeake Bay and Atlantic Ocean, the Hampton Roads area is known for its maritime and military presence, which offers transferable skills for the offshore wind and maritime manufacturing industries (Hampton Roads Alliance 2024). The Regional Maritime Training System, which is a collaboration between industry, education and training institutions, and community-based organizations, is one example of a coalition focused on increasing the maritime workforce of the Hampton Roads area. The Regional Maritime Training System brings together partners to train workers for career such as welders, offshore wind turbine technicians, machinists, and marine painters, to name a few. Due to investments in training programs related to offshore wind manufacturing and the area's historic military and maritime presence, the Hampton Roads region has attracted attention from offshore wind manufactures. Siemens Gamesa had planned to build the country's first offshore wind blade manufacturing facility at PMT in Hampton Roads (Memija 2023), though plans were discontinued in 2023 primarily due to increased supply chain costs. In 2024 LS GreenLink, a high-voltage direct current submarine cable manufacturer, announced it would be building a facility in Chesapeake, Virginia (Governor of Virginia: Glenn Youngkin 2024), specifically citing the workforce in the area as a driving factor in the company's decision (Samora 2024). In addition to an in-state commuting workforce, the location of Hampton Roads near the border of Virginia and North Carolina means a significant number of out-of-state workers could commute to the area, unlocking the potential for an available workforce with transferable skills to support offshore wind component manufacturing through regional connectivity (Virginia Works 2024a).

For the purpose of this study, two specific marine terminals in Hampton Roads were evaluated for their workforce readiness level: PMT and Fairwinds Landing. These marine terminals were chosen because of their laydown area and navigation channel depth. While these marine terminals are close to one another and share similar economic and workforce factors, it is important to note that they have operational differences and are in separate counties. However, because of their proximity and ability to leverage the same resources to hire and train a workforce, the in-state and regional commuting zones—and therefore the economic and education and training indicators used for analysis within the report—were assumed to be the same.

4.3.1 Portsmouth Marine Terminal, Virginia

Located in Portsmouth, Virginia, PMT is one of the largest facilities in the Port of Virginia and is located on the west bank of the Elizabeth River. According to the Virginia Employment Commission (Virginia Works 2024c.), the top five industries by employment in Portsmouth are:

1. Government Total (18,481)
2. Health Care and Social Assistance (5,926)
3. Administrative and Support and Waste Management (3,303)
4. Retail Trade (2,720)
5. Accommodation and Food Services (2,275).

While it does not rank in the top five, the manufacturing industry employs 1,369 people, ranking as the eighth industry by employment in the PMT area (Virginia Works 2024c). The top five employers are the U.S. Department of Defense, Portsmouth City Public Schools, City of Portsmouth, Aya Healthcare, and Bon Secours Health System Inc. In addition to these varying industries, PMT specifically has had historical involvement in the manufacturing industry and currently has growing contributions to activities related to maritime, transportation and logistics, unmanned systems, advanced manufacturing, and offshore wind energy.

As described in the Supply Chain report (Pérez et al. 2025) PMT was shown to have a higher workforce readiness level overall due to its relatively high regional score, relatively average in-state commute score, and relatively high state score. Figure 5 shows the gradient of the workforce readiness score.

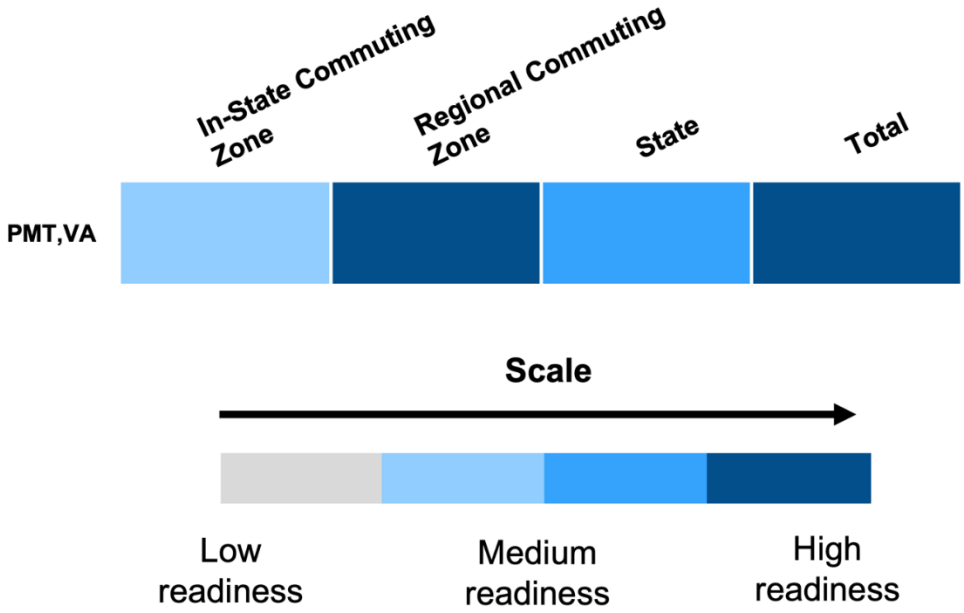

Figure 5. Portsmouth Marine Terminal, Virginia, in-state commute, regional, state, and total readiness scores

4.3.2 Fairwinds Landing, Virginia

Fairwinds Landing is a 111-acre maritime operations and logistics site located in Norfolk, Virginia, across the Elizabeth River from PMT. This site is primarily intended to support Hampton Roads' offshore wind, defense, and transportation industries. Specifically, the Fairwinds Landing Monitoring and Coordination Center, which will likely complete construction in 2025, would be used to monitor offshore wind farm asset performance and perform operations and maintenance, signifying the area's involvement in offshore wind development. In addition to offshore wind, defense, and transportation, the Norfolk area at large has had a long history of various industry involvement. Currently, the top five industries by employment according to the Virginia Employment Commission (Virginia Works 2024b) include:

1. Government Total (38,331)
2. Health Care and Social Assistance (21,564)

3. Professional, Scientific, and Technical Services (11,913)
4. Accommodation and Food Services (10,396)
5. Retail Trade (10,038).

Additionally, the manufacturing industry employs 5,986 people in the Norfolk area, which ranks as the eighth industry by employment. The top five employers across the Norfolk area are U.S. Department of Defense, Sentara Healthcare, Norfolk City School Board, City of Norfolk, and Old Dominion University (Virginia Works 2024b).

As described in the Supply Chain report (Pérez et al. 2025), Fairwinds Landing was shown to have a higher workforce readiness level overall due to its higher regional score, relatively average in-state commute score, and greater state score. Figure 6 displays the gradient of workforce readiness for the area.

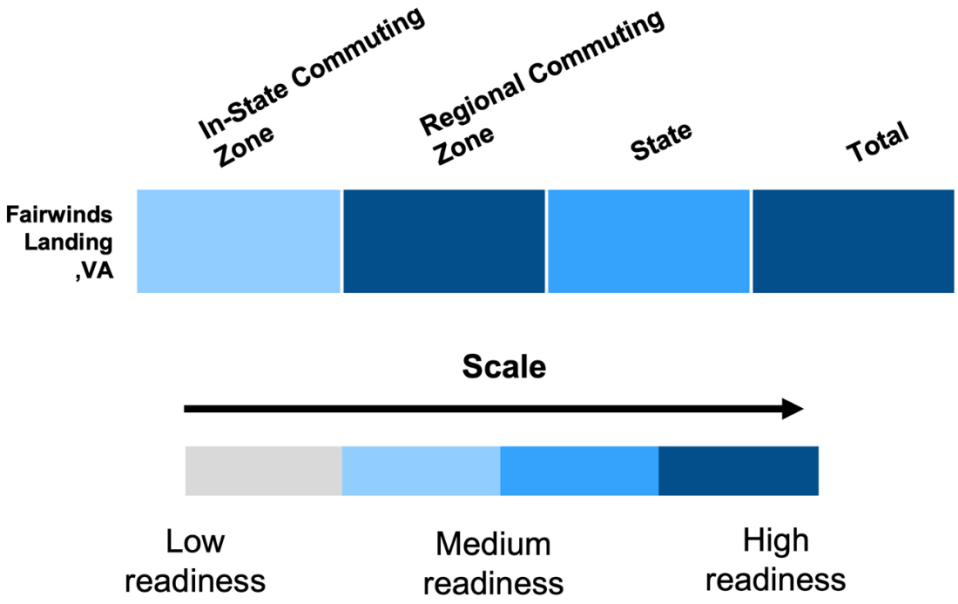

Figure 6. Fairwinds Landing, Virginia, in-state commute, regional, state, and total readiness scores

While the drivers of the workforce readiness score are described in the Supply Chain report (Pérez et al. 2025), the following sections take a deeper look into the labor market strengths, weaknesses, opportunities and threats, and analyze education and training for high-demand and highly specialized occupations.

4.3.3 Labor Market Strengths, Weaknesses, Opportunities, and Threats Analysis

Both evaluated ports, counties, and independent cities within the Hampton Roads area were found on average to have labor market attributes that were conducive to potentially supporting an offshore wind component manufacturing facility; however, levels of workforce readiness were shown to vary on a county-by-county basis. The counties or independent cities within a 25-mile radius of the port facility, or approximately the average one-way commuting distance to work in the United States, include Isle of Wight County and the cities of Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, Suffolk, and Virginia Beach, all in Virginia. These locations could be essential for recruiting, hiring, and training a qualified workforce to support a new facility.

The commuting area for workers was reported through the U.S. Census Bureau's ACS data to be larger than the counties within the 25-mile radius. Therefore, the top three counties that contributed the highest to the workforce readiness score in both the in-state commuting area and regional commuting area were evaluated to detail locations that may have a stronger current workforce labor market foundation to support an offshore wind major component facility from a workforce perspective. While these counties were found to have relative strengths for the area and were noted through the ACS to have commuters into the county of the port location, each county has varying labor market and travel factors that could impact a qualified workforce's access to PMT and Fairwinds Landing. Each county was evaluated for its unique strengths and weaknesses and distance from the county port being evaluated. Strengths and weaknesses for the counties are based on data in the workforce readiness calculator and are compared to each other within the respective commuting zone. If the commute was longer than 50 miles, that county was indicated to have a greater challenge commuting to the port. If the commute was shorter than 50 miles, that county was determined to have a higher opportunity for commuting to the port. Although farther away counties in the in-state or regional commuting zones may have a greater challenge recruiting a workforce, these areas that have been deemed to have relative labor market strengths could still amplify regional or in-state connectivity through knowledge sharing and training. Table 14 provides a summary of the labor market analysis for the top three in-state and top three regional commuting counties.

Table 14. Summary of Labor Market Analysis for the Top Three In-State and Regional Commuting Counties for Hampton Roads, VA

Commuting Zone	County	Workforce Readiness Positive Drivers	Commuting Threshold
In-state	Greensville County, VA	Relative manufacturing specialization strength and local program support	Challenge (>50 miles)
In-state	Smyth County, VA	Relative manufacturing specialization strength and local program support	Challenge (>50 miles)
In-state	Newport News (city), VA	Relative manufacturing strength and local program support	Opportunity (<50 miles)
Regional	Kent County, DE	Workforce availability	Challenge (>50 miles)
Regional	Durham County, NC	Relative manufacturing specialization strength and local program support	Challenge (>50 miles)
Regional	Mecklenburg County, NC	Relative manufacturing annual average employment and local program support	Challenge (>50 miles)

4.3.3.1 In-state Commuting Zone

The top three counties or independent cities identified as relative strengths in the in-state commuting zone were Greensville County, Virginia, Smyth County, Virginia, and Newport News, Virginia.

Greensville County, Virginia, was indicated to have relative strength in terms of the labor market primarily due to its higher level of local program support for manufacturing or offshore-wind-related training initiatives, and its relatively high specialty for manufacturing in terms of county employment (LQ 3.55). The county's workforce readiness level was decreased due to its relatively average unemployment rate (3.8%) in comparison to the other evaluated counties. A lower unemployment rate may signal that there is a less available workforce able to support a new facility in the region. However, while it was indicated that people from Greensville County commute to the Hampton Roads area, this county is over 50 miles away from where a manufacturing facility would be located, indicating that transportation time to work may pose a challenge for daily commuters from this area.

Smyth County, Virginia, was also measured to have relative workforce readiness strength in terms of the labor market because of its relatively high specialty for manufacturing employment (LQ 3.05) and higher level of local program support for manufacturing or offshore-wind-related training initiatives. However, the area's relatively average unemployment rate may indicate that there is a less available workforce to recruit from for a manufacturing facility. Additionally, the county is over 300 miles away from where a manufacturing facility could potentially be placed, posing a more significant transportation challenge for an everyday commuter.

Newport News, Virginia, is the closest of the top three counties/cities, at approximately 20 miles from where a manufacturing facility could be placed. This proximity increases the opportunity for an industrial firm to hire a workforce from this city. Newport News' relative strength is primarily driven by the local program support for offshore wind or manufacturing training initiatives, manufacturing annual average employment LQ (3.24), and relatively large manufacturing employment number, indicating a prominent manufacturing foundation and opportunity for transferable skill sets into offshore wind.

4.3.3.2 Regional Commuting Zone

The top three counties calculated to have relative strength in the regional commuting zone were Kent County, Delaware, Durham County, North Carolina, and Mecklenburg County, North Carolina.

Kent County, Delaware, was measured to have relative strength for the regional commuting zone primarily due to its higher unemployment rate, recent related industry closures, and its local program support for manufacturing or offshore-wind-related training initiatives. These indicators show that there might be a more available workforce to support a new manufacturing facility. However, within this county there is relative weakness as it pertains to manufacturing employment magnitude and specialty as compared to the other evaluated regional commuting zone areas, which signifies that while the workforce may be available, workers may not have as many transferable skill sets into the manufacturing sector and could require upskilling or training. Furthermore, the county is more than 150 miles away from where a manufacturing facility could potentially be placed, posing a more significant transportation challenge for an everyday commuter.

Durham County, North Carolina, was found to have relatively high manufacturing annual average employment, recent related industry closures, and higher local program support when compared to the other evaluated regional commuting zone areas. While these indicators show

that there may be a workforce with transferable skill sets into the offshore wind manufacturing sector, the relatively average to low unemployment rate of the area could signify a less available workforce to support new job demand because more people are currently employed. Additionally, Durham County is more than 150 miles away from where a manufacturing facility could be placed at the port, so while it was indicated that people do commute to the Hampton Roads area from this county, commute time may pose a challenge for recruiting a workforce from this area.

Mecklenburg County, North Carolina, similarly to Durham County, was determined to have relatively high annual average employment in manufacturing, recent industry closures, and higher local program support when compared to the other evaluated regional commuting zone areas, indicating there may be a workforce with transferable skills. However, the county is more than 300 miles away from the Hampton Roads port location, so while it was indicated that people do commute to the Hampton Roads area, the transportation time may pose a challenge for everyday commuters.

4.3.4 Gap Analysis for Specialized Occupations

The Hampton Roads area has a robust workforce training network related to offshore wind component manufacturing occupations. At both the in-state commute and regional levels PMT and Fairwinds Landing were indicated to have relative strength in the number of applicable education and training programs when compared to the other evaluated port locations. This relative strength indicates that for offshore wind manufacturing occupations, overall, there is a higher potential for the workforce to be trained to meet the needs of the facility. Looking specifically at high-demand and highly specialized occupations required for offshore wind, CNC operators, rolling machine setter/tower rolling machinists, and crane operators/auxiliary crane operator/heavy-lift crane operators were all identified to have training gaps at both the in-state commute and regional levels, indicating that there may be a greater challenge to train these occupations if a facility were placed in PMT. Alternatively, electricians were found to not have a training gap at the in-state or regional commuting zones, demonstrating that there are opportunities to find training programs for electricians in the PMT commuting zone. Furthermore, mechanical support/composite blade technicians were found to have a training gap only at the regional commuting zone level but not at the in-state commuting zone level, meaning there may be more in-state support for training this occupation.

Table 15. In-State Commute and Regional Training Program Gaps for Select Occupations for Hampton Roads Ports in Virginia

Occupations	Training Pathway	In-State Commute Program Training Gap	Number of Programs Regionally
CNC Operator	2-year to 4-year	Yes	No
	Registered apprenticeship program (RAP)	Yes	Yes
Rolling machine setter, tower rolling machinist	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes
Mechanical support, composite blades technician	2-year to 4-year	No	Yes
	RAP	No	Yes
Electrician	2-year to 4-year	No	No
	RAP	No	No
Crane operator/auxiliary crane operator/heavy-lift crane operator	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes

4.4 Port of Wilmington, North Carolina

Located in Wilmington, North Carolina, the Port of Wilmington is a well-developed port on the Cape Fear River. Port of Wilmington is the closest port to key metropolitan areas on the I-85 corridor in North Carolina, such as Raleigh-Durham, Greensboro, and Charlotte. There are ongoing developments to improve the connectiveness of the port to regional and national highway networks for surface transportation to and from Wilmington (Noth Carolina Ports 2024b). The most profitable industries in the Wilmington area are Utilities ($83,264), Professional, Scientific, and Technical Services ($61,151), and Manufacturing ($56,208). The key industries by employment for the population in the area are:

1. Health Care and Social Assistance (8,502)
2. Retail Trade (7,875)
3. Accommodation and food Services (6,675)
4. Professional, Scientific, and Technical Services (6,161)
5. Educational Services (5,491).

While not ranking in the top five, the manufacturing industry employs 5.55% of the workforce in Wilmington, with 3,352 people (DataUSA 2024d). As described in the Supply Chain report (Pérez et al. 2025), Port of Wilmington was determined to have a relatively high workforce readiness level overall due to its lesser regional score, greater in-state commute score, and higher state score. Figure 7 shows the gradient of readiness.

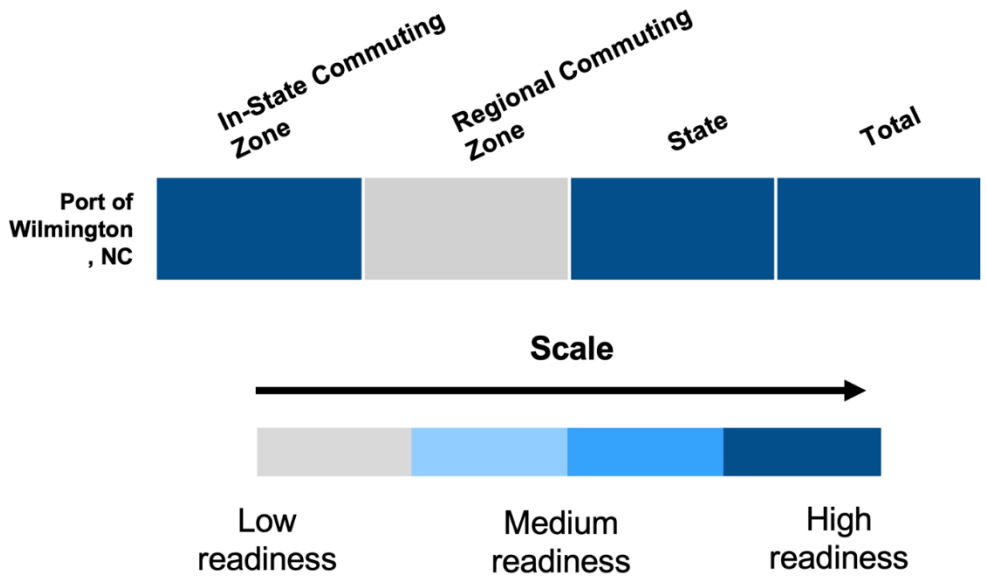

Figure 7. Port of Wilmington, North Carolina, in-state commute, regional, state, and total readiness scores

While the drivers of workforce readiness score are described in the Supply Chain report (Pérez et al. 2025), the following sections take a deeper look at the labor markets strengths, weaknesses, opportunities, and threats, and analyzes education and training for high-demand and highly specialized occupations.

4.4.1 Labor Market Strengths, Weaknesses, Opportunities, and Threats Analysis

Port of Wilmington was found to have a relatively high workforce readiness level in terms of the in-state commuting zone labor market and a relatively low workforce readiness level in terms of the regional commuting zone labor markets when compared to the other selected port areas. However, levels of workforce readiness varied on a county-by-county basis due to area labor market attributes. Additionally, it is important to note that there could be commuting counties outside of the SMART-POWER states, but those areas were outside the scope of this study. The counties within a 25-mile radius, or approximately the average one-way commuting distance to work in the United States, include Brunswick County, New Hanover County, and Pender County, all in North Carolina. These counties could be necessary for recruiting, hiring, and training a qualified workforce to support a new facility.

The commuting area for workers into Port of Wilmington (which is in New Hanover County) was reported through the U.S. Census Bureau's ACS data to be larger than the counties within the 25-mile radius. As a result, the top three counties that contributed the most to the workforce readiness score in both the in-state commuting area and regional commuting area were assessed to highlight areas that may have a stronger current workforce labor market foundation to support an offshore wind major component facility. While these counties were found to have relative strengths for the area and were noted through the ACS to have commuters into the county of the port location, each county has varying labor market and travel factors that could impact a qualified workforce's access to the Port of Wilmington. Each county was evaluated for its unique strengths and weaknesses and distance from the port location. Strengths and weaknesses for the counties are based on data in the workforce readiness calculator and are compared to each other

within the respective commuting zone. If the commute was longer than 50 miles, that county was indicated to have a greater challenge commuting to the port. If the commute was shorter than 50 miles, that county was determined to have a higher opportunity for commuting to the port. Although farther away counties in the in-state or regional commuting zones may have a greater challenge recruiting a workforce, these areas that have been deemed to have relative labor market strengths could still amplify regional or in-state connectivity through knowledge sharing and training. Table 16 provides a summary of the labor market analysis for the top three counties in-state and regional commuting counties.

Table 16. Summary of Labor Market Analysis for the Top Three In-State and Regional Commuting Counties for Port of Wilmington, North Carolina

Commuting Zone	County	Workforce Readiness Positive Drivers	Commuting Threshold
In-state	Catawba County, NC	Manufacturing employment specialty, local program support, related industry closures	Challenge (>50 miles)
In-state	Guilford County, NC	Manufacturing employment magnitude, local program support, related industry closures	Challenge (>50 miles)
In-state	Mecklenburg County, NC	Manufacturing employment magnitude, local program support	Challenge (>50 miles)
Regional	Richmond, VA	Local Program Support	Challenge (>50 miles)
Regional	Baltimore County, MD	Unemployment rate, manufacturing average annual employment magnitude, nearby related industry closures	Challenge (>50 miles)
Regional	Virginia Beach, VA	Local Program Support	Challenge (>50 miles)

4.4.1.1 In-state Commuting Zone

The top three counties identified as relative strengths in the in-state commuting zone were Catawba County, Guilford County, and Mecklenburg County, all in North Carolina.

Catawba County was indicated to have relative strength in terms of the labor market, primarily driven by nearby related industry closures, local program support for manufacturing or offshore wind workforce development initiatives, and relatively high manufacturing specialization (LQ 3.24) and employment magnitude. The county's workforce readiness level was decreased due to its relatively average unemployment rate (3.4%) in comparison to the other evaluated counties. However, while it was reported that people from Catawba County commute to the Port of Wilmington area, the county is over 250 miles away from where a manufacturing facility could be placed, signifying that transportation time to the facility may pose a challenge for recruiting daily commuters from this area.

Guilford County was calculated to have relative strength in terms of nearby related industry closures, local program support, and relatively higher annual manufacturing average employment

magnitude than other applicable counties. These attributes indicate that there may be a workforce with transferable skills for offshore wind component manufacturing in this area. While no indicators evaluated were considered relative weaknesses, Guilford County is over 200 miles away from the Port of Wilmington, so while it was indicated that people do commute to this county, the transportation time may pose a challenge for an everyday commuter.

While Mecklenburg County has relatively high manufacturing annual average employment when compared to the other in-state commuting counties, manufacturing employment was not noted to be a specialty of the county (LQ 0.57). However, with their relatively high manufacturing employment magnitude and local program support for manufacturing or offshore-wind-specific workforce development initiatives, this county was considered to have relative strength for supporting an offshore wind manufacturing facility through its workforce. However, while it was reported that people from Mecklenburg County commute to the Port of Wilmington area, the county is over 200 miles away from where a manufacturing facility could be placed, indicating that the commute time to the facility may pose a challenge for daily commuters.

4.4.1.2 Regional Commuting Zone

While the regional commuting zone was not indicated to be a relative strength regarding labor market indicators overall, the top three counties or cities calculated to have a relatively higher score than the other counties include: Richmond, Virginia, Baltimore County, Maryland, and Virginia Beach, Virginia. Both Virginia Beach and Richmond were determined to be relative strengths due to their local program support for offshore wind or manufacturing training initiatives. However, both cities are greater than 250 miles away from where a manufacturing facility could be located. Therefore, while it was indicated that people commute to Wilmington, North Carolina, from these locations, the farther commuting distance may pose a challenge for daily commuters.

Similarly, Baltimore County, Maryland, was also deemed to have relative strength in the regional commuting zone. This was primarily driven by the area's relatively high unemployment rate and manufacturing average annual employment magnitude and nearby related industry closures, indicating a potentially available workforce with transferable skills. However, Baltimore County is more than 400 miles away, which would pose a large challenge for recruiting a workforce from this area.

4.4.2 Gap Analysis for Specialized Occupations

For the Port of Wilmington's in-state commuting zone, there are no training gaps for CNC operator or electrician roles. Likewise, there are no training gaps for two-year and four-year degree programs for the mechanical support or composite blade technician roles. However, in the in-state commuting zone, there are training program gaps for rolling machine setter or tower rolling machinist and crane operator roles. In the regional area, there are identified two- and four-year programs to support the training for mechanical support or composite blade technician roles and registered apprenticeship programs for electricians. Conversely, there are no identified programs for CNC operator, rolling machine setter or tower rolling machinist, and crane operator roles, indicating that there is a training gap. Therefore, there is room to improve the education and training system in the in-state and regional commuting zones surrounding the Port of Wilmington.

Table 17. In-State Commute and Regional Training Program Gaps for Select Occupations for Port of Wilmington, North Carolina

Occupation	Training Pathway	In-State Commute Training Gap	Regional Training Gap
CNC Operator	2-year to 4-year	No	Yes
	Registered apprenticeship program (RAP)	No	Yes
Rolling machine setter, tower rolling machinist	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes
Mechanical support, composite blades technician	2-year to 4-year	No	No
	RAP	Yes	Yes
Electrician	2-year to 4-year	No	Yes
	RAP	No	No
Crane operator/auxiliary crane operator/heavy-lift crane operator	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes

4.5 Port of Morehead City, North Carolina

Located in Morehead City, North Carolina, Radio Island is a facility within the Port of Morehead City only 4 miles from the Atlantic Ocean. Radio Island is a 150-acre site, fit for port industrial development and supplied with municipal water and sewer (North Carolina Ports 2024a). There has not been much development at Radio Island until recently when the North Carolina Ports Authority announced a proposed project to construct the Radio Island Multi-Use Terminal (North Carolina Ports 2024c) to support new industry, including offshore wind, at the Port of Morehead City and in the surrounding area. According to DataUSA (2024b), the top five industries by employment in Morehead City are:

1. Health Care and Social Assistance (904)
2. Retail Trade (395)
3. Manufacturing (378)
4. Educational Services (340)
5. Accommodation and Food Services (328).

As described in the Supply Chain report (Pérez et al. 2025), Port of Morehead City was shown to have a relatively average workforce readiness level overall due to its lower regional score, medium in-state commute score, and greater state score. Figure 8 shows the gradient of readiness.

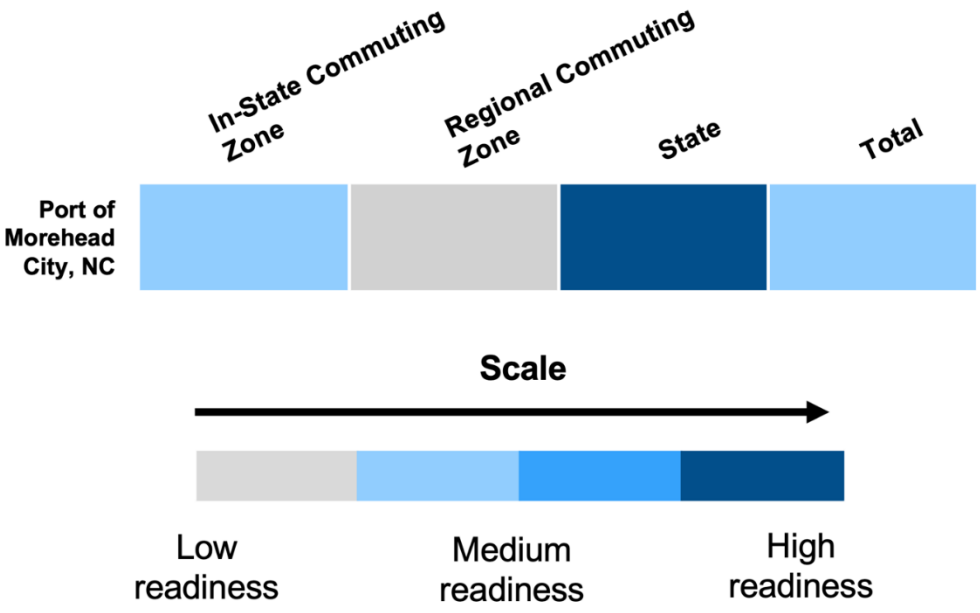

Figure 8. Port of Morehead City, North Carolina, in-state commute, regional, state, and total readiness scores

While the drivers of workforce readiness score are described in the Supply Chain report, the following sections take a deeper look at the labor market strengths, weaknesses, opportunities, and threats, and analyze education and training for high-demand and highly specialized occupations.

4.5.1 Labor Market Strengths, Weaknesses, Opportunities, and Threats Analysis

Port of Morehead City was found to have a relatively average workforce readiness level in terms of the in-state commuting zone labor market and a relatively low workforce readiness level in terms of the regional commuting zone labor markets when compared to the other selected port areas. However, levels of workforce readiness varied on a county-by-county basis because of local labor market attributes. The counties or independent cities within a 25-mile radius, or approximately the average one-way commuting distance to work in the United States, only include Carteret County, North Carolina, where Morehead City is located, indicating that local labor market factors will have a large impact on the workforce available for supporting a manufacturing facility.

The commuting area for workers into Port of Morehead City (Carteret County) was reported through the U.S. Census Bureau's ACS data to be larger than the county within the 25-mile radius. As a result, the top three counties that contributed the highest to the workforce readiness score in both the in-state commuting area and regional commuting area were assessed to highlight areas that may have a stronger current workforce labor market foundation to support an offshore wind major component facility. While these counties were found to have relative strengths for the area and were noted through the ACS to have commuters into the county of the port location, each county has varying labor market and travel factors that could impact a qualified workforce's access to the Port of Morehead City. Each county was evaluated for its unique strengths and weaknesses and distance from the port location. Strengths and weaknesses for the counties are based on data in the workforce readiness calculator and are compared to each

other within the respective commuting zone. If the commute was longer than 50 miles, that county was indicated to have a greater challenge commuting to the port. If the commute was shorter than 50 miles, that county was determined to have a higher opportunity for commuting to the port. Although farther away counties in the in-state or regional commuting zones may have a greater challenge recruiting a workforce, these areas that have been deemed to have relative labor market strengths could still amplify regional or in-state connectivity through knowledge sharing and training. Table 18 provides a summary of the labor market analysis for the top three counties in in state and regional commuting counties.

Table 18. Summary of Labor Market Analysis for the Top Three In-State and Regional Commuting Counties for Port of Morehead City, North Carolina

Commuting Zone	County	Workforce Readiness Positive Drivers	Commuting Threshold
In-state	Durham County, NC	Manufacturing annual average employment, nearby related industry closures, and local program support	Challenge (>50 miles)
In-state	Guilford County, NC	Manufacturing annual average employment, nearby related industry closures, and local program support	Challenge (>50 miles)
In-state	Wilson County, NC	Unemployment rate, local program support, and manufacturing employment specialization	Challenge (>50 miles)
Regional	Frederick County, VA	Manufacturing employment specialization	Challenge (>50 miles)

4.5.1.1 In-state Commuting Zone

The top three counties identified as relative strengths in the in-state commuting zone were Durham County, Guilford County, and Wilson County, all in North Carolina.

Durham County was indicated to have relative strength in the in-state commuting zone due to its higher manufacturing annual average employment, nearby related industry closures, and local program support. These factors signify that there may be a workforce with transferable skill sets to offshore wind component manufacturing in Durham County. However, compared to the other in-state commuting counties, there is a relatively low unemployment rate, which may indicate that the workforce in this county is less available to support a manufacturing facility. While it was reported that people from Durham County commute to the Port of Morehead City area, the county is over 150 miles away from the where a component manufacturing facility could be placed, indicating that the commute time to the facility may pose a challenge for daily commuters.

Similar to Durham County, Guilford County was also indicated to potentially have a workforce with transferable skill sets to offshore wind component manufacturing. This relative strength was primarily due to the higher manufacturing annual average employment, nearby related industry closure, and local program support. While there were no relative weaknesses determined in the

workforce readiness calculator datasets, Guilford County was noted to be more than 200 miles away from where a component manufacturing facility could be placed, indicating that transportation time to the facility may pose a challenge for recruiting daily commuters from this area.

Wilson County was calculated to have relative strength due to the area's higher unemployment rate, local program support, and higher manufacturing employment specialization (LQ 2.52) compared to the other counties in the in-state commuting zone for Port of Morehead City. The relatively higher unemployment rate and manufacturing specialization within the workforce indicate that there could potentially be an available workforce with transferable skills into offshore wind component manufacturing. While there were no relative weaknesses determined in the workforce readiness calculator datasets, Wilson County was noted to be more than 120 miles away from where a component manufacturing facility could be placed, indicating that the commute time to the facility may pose a challenge for daily commuters from this area.

4.5.1.2 Regional Commuting Zone

The only county with identified commuters into Port of Morehead City, North Carolina, from the regional commuting zone was Frederick County, Virginia. Frederick County has a relatively high manufacturing LQ (2.05), indicating that the county has a specialization for employees related to the manufacturing industry. However, Frederick County is located over 300 miles away from where a component manufacturing facility could be placed, indicating that the commute time to the facility may pose a larger challenge to daily commuters.

4.5.2 Gap Analysis for Specialized Occupations

It is important to understand the training programs in the in-state and regional commuting zones surrounding Port of Morehead City to ensure workers can be trained for necessary roles if a facility were to be placed there. From the selected occupations (Table 19), the only occupations without a training program gap for both training pathways in the in-state commuting zone are CNC operator and electrician. The two- and four-year programs in the in-state commuting zone could also support training for mechanical support or composite blade technician roles. In the regional area, the only occupation that could be trained from the registered apprenticeship program pathway was electrician. This shows that there is opportunity to greatly improve the training programs for both pathways in the in-state and regional commuting zones to support workforce training and recruiting for an offshore wind manufacturing facility placed at Port of Morehead City.

Table 19. In-State Commute and Regional Training Program Gaps for Select Occupations for Port of Morehead City, North Carolina

Occupation	Training Pathway	In-State Commute Program Training Gap	Regional Program Training Gap
CNC Operator	2-year to 4-year	No	Yes
	Registered apprenticeship program (RAP)	No	Yes
Rolling machine setter, tower rolling machinist	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes
Mechanical support, composite blades technician	2-year to 4-year	No	Yes
	RAP	Yes	Yes
Electrician	2-year to 4-year	No	Yes
	RAP	No	No
Crane operator/auxiliary crane operator/heavy-lift crane operator	2-year to 4-year	Yes	Yes
	RAP	Yes	Yes

5 Conclusion

In the coming years, the offshore wind energy industry could need a properly trained and adequately sized workforce to support potential manufacturing facilities. Optimizing regional connectivity by leveraging complementary regional strengths could help mitigate workforce development risks. While offshore wind investments could provide economic benefits to the community where the facility is located, it is important to note that benefits like job creation expand well beyond the immediate site. Therefore, analyzing the workforce strengths and weaknesses at the state, in-state commuting, and regional levels is essential in determining the readiness of an area to support a manufacturing facility from a workforce perspective.

While this analysis provides a foundation to evaluate the workforce readiness levels of a specific location, future research could include:

- The magnitude of the manufacturing workforce needs and competition between industries for skill sets in an area
- Port-specific commuting flows to better understand the communities where workers live and travel from in relation to the port
- More connections between communities and workforce development training and recruitment activities.

References

CareerOneStop. 2024. “Toolkit.” 2024. https://www.careeronestop.org/Toolkit/Training/find-certifications.aspx.

DataUSA. 2024a. “Baltimore County, MD.” https://datausa.io/profile/geo/baltimore-county-md.

DataUSA. 2024b. “Morehead City, NC.” https://datausa.io/profile/geo/morehead-city-nc#employment_by_industries.

DataUSA. 2024c. “Wilmington, DE.” https://datausa.io/profile/geo/wilmington-de.

DataUSA. 2024d. “Wilmington, NC.” https://datausa.io/profile/geo/wilmington-nc/.

Dominion Energy. 2024. *2024 Integrated Resource Plan*. https://www.dominionenergy.com/our-company/irp.

DSIRE. 2024. “Offshore Wind Energy Target.” https://programs.dsireusa.org/system/program/detail/22618/offshore-wind-energy-target.

Economic Development Partnership of North Carolina. 2024a. “Advanced Manufacturing.” https://edpnc.com/industries/advanced-manufacturing/.

Economic Development Partnership of North Carolina. 2024b. “Workforce & Education.” https://edpnc.com/why-nc/workforce-education/

Governor Roy Cooper. 2021. “Advancing North Carolina’s Economic and Clean Energy Future with Offshore Wind.” Executive Order No. 218 of June 9, 2021. https://governor.nc.gov/documents/files/executive-order-no-218/open.

Governor of Virginia: Glenn Youngkin. 2024. “Submarine Cable Manufacturer to Locate in Virginia.” July 9, 2024. https://www.governor.virginia.gov/newsroom/news-releases/2024/july/name-1030531-en.html.

Hampton Roads Alliance. 2024. “Welcome to Hampton Roads.” https://hamptonroadsalliance.com/welcome-to-hampton-roads/.

Maryland.gov. 2024. “Maryland at a Glance.” https://msa.maryland.gov/msa/mdmanual/01glance/economy/html/manufact.html#most.

Maryland Department of Labor. 2024a. “Maryland -Major Employer Lists – Workforce Information & Performance.” https://labor.maryland.gov/lmi/emplists/maryland.shtml.

Maryland Department of Labor. 2024b. “Maryland Works for Wind- Workforce Development and Adult Learning.” https://www.labor.maryland.gov/employment/marylandworksforwind/.

Maryland Energy Administration. 2024a. “Maryland Offshore Wind.” https://energy.maryland.gov/Pages/Info/renewable/offshorewind.aspx.

Maryland Energy Administration. 2024b. “Maryland Offshore Wind Workforce Training & Education Program.” https://energy.maryland.gov/Pages/Info/renewable/offshorewindworkforce.aspx.

Maryland MEP. No date. “Talent & Workforce.” https://mdmep.org/workforce/.

McDowell, Brinn, Jeremy Stefek, Elena Smith, Bailey Pons, and Quaran Ahmad. 2024. *National Wind Energy Workforce Assessment: Challenges, Opportunities, and Future Needs*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-87670. https://www.nrel.gov/docs/fy24osti/87670.pdf.

Memija, Adnan. 2023. “Siemens Gamesa Halts Plans for USD 200 Million Offshore Wind Turbine Blade Factory in US.” offshoreWIND.biz. November 13, 2023. https://www.offshorewind.biz/2023/11/13/siemens-gamesa-halts-plans-for-usd-200-million-offshore-wind-turbine-blade-factory-in-us/.

Munroe, John A., Carol E. Hoffecker. 2024. “Industry of Delaware.” Britannica. https://www.britannica.com/place/Delaware-state/Industry.

National Center for Education Statistics (NCES). 2024a. “The Classification of Instructional Programs.” 2024. https://nces.ed.gov/ipeds/cipcode/search.aspx?y=56.

National Center for Education Statistics (NCES). 2024b. “College Navigator.” https://nces.ed.gov/collegenavigator/.

O*Net. 2024a. “O*Net OnLine.” https://onetonline.org.

O*Net. 2024b. “RAPIDS Crosswalk Search.” https://www.onetonline.org/crosswalk/RAPIDS?s=.

North Carolina Ports. 2024a. “Port of Morehead City.” https://ncports.com/port-facilities/port-of-morehead-city/.

Noth Carolina Ports. 2024b. “Port of Wilmington.” https://ncports.com/port-facilities/port-of-wilmington/.

North Carolina Ports. 2024c. “Public Notices.” https://ncports.com/about-the-ports/public-notices/.

Port Wilmington. 2024. “Port Wilmington.” https://portwilmington.com.

Pérez, Paula, George Hagerman, Gianna White, Bailey Pons, Jeremy Stefek, Brinn McDowell, Matt Shields. 2025. *A Regional Approach to Offshore Wind Energy Manufacturing in the Central Atlantic: Supply Chain.* Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-92432. https://www.nrel.gov/docs/fy25osti/92432.pdf.

Regional Economic Models Inc. and North Carolina Department of Commerce. 2022. *Military Economic Impact on North Carolina*. https://ourncmilitary.nc.gov/military-economic-impact-nc-2022/open.

Samora, Sara. 2024. "LS GreenLink USA to build $680M subsea cable plant in Virginia." Manufacturing Dive. July 16, 2024. https://www.manufacturingdive.com/news/ls-greenlink-usa-subsea-cables-chesapeake-virginia-terminal-offshore-wind/721376/.

State Council of Higher Education for Virginia. 2021. "Pathways to Opportunity: The Virginia Plan for Higher Education." https://www.schev.edu/home/showpublisheddocument/1044/637811987952970000.

U.S. Census Bureau. 2024a. "Delaware". https://data.census.gov/profile/Delaware?g=040XX00US10.

U.S. Census Bureau. 2024b. "Maryland." https://data.census.gov/profile/Maryland?g=040XX00US24.

U.S. Census Bureau. 2024c. "North Carolina." https://data.census.gov/profile/North_Carolina?g=040XX00US37.

U.S. Census Bureau. 2024d. "United States Commuting at A Glance: American Community Survey 1-year Estimates." https://www.census.gov/topics/employment/commuting/guidance/acs-1yr.html.

U.S. Bureau of Labor Statistics. 2018. "Standard Occupation Classification." 2024. https://www.bls.gov/soc/.

US Wind. 2023. "Sparrows Point Steel." 2024. https://uswindinc.com/sps/.

Virginia's Legislative Information System. 2023. An Act to amend and reenact § 56-585.1:11 of the Code of Virginia, relating to development of offshore wind capacity; cost recovery. https://legacylis.virginia.gov/cgi-bin/legp604.exe?231+ful+CHAP0809.

Virginia Museum of History & Culture. 2024. "Industrialization in Virginia." https://virginiahistory.org/learn/industrialization-virginia#:~:text=Tobacco%20manufacturing%2C%20flour%20and%20textile,wool%2C%20became%20booming%20textile%20centers.

Virginia Works. 2024a. Virginia Community Profile Hampton Roads. VA: Virginia Works, Economic & Analytics Division. https://virginiaworks.com/_docs/Local-Area-Profiles/5115000456.pdf.

Virginia Works. 2024b. Virginia Community Profile Norfolk city. Richmond, VA: Virginia Works, Economic & Analytics Division. https://virginiaworks.com/_docs/Local-Area-Profiles/5104000710.pdf.

Virginia Works. 2024c. Virginia Community Profile Portsmouth city. Richmond, VA: Virginia Works, Economic & Analytics Division. https://virginiaworks.com/_docs/Local-Area-Profiles/5104000740.pdf.

Virginia Works. 2024d. Virginia Community Profile Statewide. Richmond, VA: Virginia Works, Economic & Analytics Division. https://virginiaworks.com/_docs/Local-Area-Profiles/5101000000.pdf.

Virginia Works Department of Workforce Development and Advancement. 2024. "Virginia's Career and Workforce: Labor Market Information." https://virginiaworks.com/Industry-Projections.

Appendix A. Education and Training Database Programs

Table A-1. List of Programs/Majors for Two- and Four-Year Programs From Education and Training Database

Program/Majors From Education and Training Database		
3-D Modeling and Design Technology/Technician	Energy Systems Technology/Technician	Materials Engineering
Accounting and Computer Science	Engineering Acoustics	Materials Science
Administrative Assistant and Secretarial Science, General	Engineering Chemistry	Mathematics and Computer Science
Aeronautical/Aerospace Engineering Technology/Technician	Engineering Design	Mechanic and Repair Technologies/Technicians, Other
Aerospace, Aeronautical, and Astronautical/Space Engineering, General	Engineering Mechanics	Mechanical Drafting and Mechanical Drafting CAD/CADD
Aerospace, Aeronautical, and Astronautical/Space Engineering, Other	Engineering Physics/Applied Physics	Mechanical Engineering
Applied Engineering Technologies/Technicians	Engineering Science	Mechanical Engineering Related Technologies/Technicians, Other
Applied Engineering Technologies/Technicians	Engineering-Related Technologies/Technicians, Other	Mechanical/Mechanical Engineering Technology/Technician
Architectural Engineering	Engineering, General	Mechanics and Repairers, General
Architectural Engineering Technologies/Technicians	Engineering, Other	Mechanics and Repairers, General
Audio Engineering Technology/Technician	Engineering/Industrial Management	Mechatronics, Robotics, and Automation Engineering
Bioengineering and Biomedical Engineering	Entrepreneurship/Entrepreneurial Studies	Metal Fabricator
Blasting/Blaster	Environmental Control Technologies/Technicians, Other	Metal Fabricator
Building/Construction Site Management/Manager	Environmental Health	Metallurgical Engineering
Building/Property Maintenance	Environmental/Environmental Health Engineering	Metallurgical Technology/Technician
Business Administration and Management, General	Facilities Planning and Management	Metallurgical Technology/Technician

Program/Majors From Education and Training Database		
Business Administration and Management, General	Finance, General	Mining and Mineral Engineering
Business Operations Support and Secretarial Services, Other	Financial Risk Management	Mining Technology/Technician
Business/Commerce, General	Forklift Operation/Operator	Mobil Crane Operator/Operation
Business/Commerce, General	Forklift Operation/Operator	Motorsports Engineering Technology/Technician
CAD/CADD Drafting and/or Design Technology/Technician	Geological/Geophysical Engineering	Naval Architecture and Marine Engineering
Chemical Engineering	Geotechnical and Geoenvironmental Engineering	Network and System Administration/Administrator
Chemical Engineering Technology/Technician	Geothermal Energy Technology/Technician	NO MATCH
Chemical Engineering, Other	Glazier	Non-Profit/Public/Organizational Management
Civil Engineering, General	Heating, Ventilation, Air Conditioning and Refrigeration Engineering Technology/Technician	Occupational Health and Industrial Hygiene
Civil Engineering, Other	Heavy Equipment Maintenance Technology/Technician	Occupational Safety and Health Technology/Technician
Composite Materials Technology/Technician	Heavy/Industrial Equipment Maintenance Technologies/Technicians, Other	Ocean Engineering
Computer and Information Sciences, General	Human Resources Management and Services, Other	Operational Oceanography
Computer and Information Systems Security/Auditing/Information Assurance	Human Resources Management/Personnel Administration, General	Operations Management and Supervision
Computer Engineering Technologies/Technicians, Other	Hydraulics and Fluid Power Technology/Technician	Parts and Warehousing Operations and Maintenance Technology/Technician
Computer Engineering Technology/Technician	Hydroelectric Energy Technology/Technician	Parts, Warehousing, and Inventory Management Operations
Computer Engineering, General	Industrial Electronics Technology/Technician	Plastics and Polymer Engineering Technology/Technician
Computer Engineering, Other	Industrial Electronics Technology/Technician	Polymer/Plastics Engineering

Program/Majors From Education and Training Database		
Computer Hardware Technology/Technician	Industrial Engineering	Precision Metal Working, Other
Computer Installation and Repair Technology/Technician	Industrial Mechanics and Maintenance Technology/Technician	Precision Production Trades, General
Computer Numerically Controlled (CNC) Machinist Technology/CNC Machinist	Industrial Mechanics and Maintenance Technology/Technician	Process Safety Technology/Technician
Computer Science	Industrial Production Technologies/Technicians, Other	Purchasing, Procurement/Acquisitions and Contracts Management
Computer Software Engineering	Industrial Production Technologies/Technicians, Other	Quality Control Technology/Technician
Computer Software Technology/Technician	Industrial Safety Technology/Technician	Radar Communications and Systems Technology
Computer Systems Networking and Telecommunications	Industrial Technology/Technician	Radiation Protection/Health Physics Technician
Computer/Computer Systems Technology/Technician	Industrial Technology/Technician	Risk Management
Construction Engineering	Information Resources Management	Science/Technology Management
Construction/Heavy Equipment/Earthmoving Equipment Operation	Information Resources Management	Sheet Metal Technology/Sheet working
Construction/Heavy Equipment/Earthmoving Equipment Operation	Information Science/Studies	Social Entrepreneurship
Data Modeling/Warehousing and Database Administration	Information Science/Studies	Structural Engineering
Data Modeling/Warehousing and Database Administration	Information Technology	Surveying Engineering
Data Processing and Data Processing Technology/Technician	Information Technology Project Management	Systems Engineering
Data Science, General	Instrumentation Technology/Technician	Tool and Die Technology/Technician
Drafting and Design Technology/Technician, General	International Business/Trade/Commerce	Traffic, Customs, and Transportation Clerk/Technician
Economics and Computer Science	Ironworking/Ironworker	Transportation and Infrastructure Planning/Studies
Electrical and Computer Engineering	Knowledge Management	Transportation/Mobility Management

Program/Majors From Education and Training Database		
Electrical and Electronics Engineering	Laser and Optical Technology/Technician	Transportation/Mobility Management
Electrical and Power Transmission Installation/Installer, General	Line worker	Truck and Bus Driver/Commercial Vehicle Operator and Instructor
Electrical, Electronic, and Communications Engineering Technology/Technician	Logistics, Materials, and Supply Chain Management	Water Resources Engineering
Electrical, Electronics, and Communications Engineering, Other	Logistics, Materials, and Supply Chain Management	Welding Engineering Technology/Technician
Electrical/Electronics Equipment Installation and Repair Technology/Technician, General	Machine Shop Technology/Assistant	Welding Technology/Welder
Electrical/Electronics Maintenance and Repair Technologies/Technicians, Other	Machine Shop Technology/Assistant	Wind Energy System Installation and Repair Technology/Technician
Electrician	Machine Tool Technology/Machinist	Wind Energy Technology/Technician
Electromechanical Engineering	Machine Tool Technology/Machinist	Energy Systems Installation and Repair Technology/Technician
Energy Systems Engineering, General	Management Information Systems and Services, Other	Energy Systems Maintenance and Repair Technologies/Technicians, Other
Energy Systems Engineering, Other	Management Information Systems, General	Energy Systems Technologies/Technicians, Other
Energy Systems Installation and Repair Technology/Technician	Management Science	Manufacturing Engineering
Manufacturing Engineering Technology/Technician	Marine Engineering Technology/Technician	

Appendix B. Metrics, Assumptions, Sources

Table B-1. Variables in In-State and Regional Scores for the Workforce Readiness Calculator

Variables	Meaning	Data Source	Assumption
Civilian Labor Force Participation Rates	Civilian labor force is defined as percent of population age 16+ and consists of people classified as employed or unemployed.	U.S. Census Bureau	If the civilian labor force in the radius is higher than the regional average than we are assuming it will be more feasible to have a workforce there.
Related Industry Closures	Industries that are closing or laying off people with related skills.	WARN	If there are related industries with closures, then we are assuming some of those people could be qualified and will transfer to OSW industry. Therefore, it will raise the feasibility score.
Local Program Support	Local government programs that support workforce development initiatives or offshore wind.	Local government websites	If there is programmatic support for either offshore wind or manufacturing, then we are assuming that it will be more feasible for residents nearby to enter the workforce. Therefore, increasing the feasibility score.
Manufacturing Annual Average Employment Locational Quotient (LQ)	Annual Average Employment Location Quotient for Private Manufacturing by county.	U.S. Bureau of Labor Statistics	If there is an above average LQ for manufacturing, then we are assuming there will be people with the skill sets needed to work in OSW. Therefore, it is considered more feasible.
Manufacturing Annual Average Employment	Magnitude of Annual Average Employment in Private Manufacturing.	U.S. Bureau of Labor Statistics	If there is large magnitude of people employed in manufacturing in a county, then we are assuming there will be more people with the skill sets needed to work in OSW manufacturing. Therefore, it will raise the feasibility score.
Existing 2-year Programs	Existing education and training programs that typically take around 2 years to complete. This is by occupation.	National Center for Education Statistics	If there are related programs in the radius it will raise the feasibility to train.
Existing 4-year programs	Existing education and training programs that typically take around 4 years to complete. This is by occupation.	National Center for Education Statistics	If there are related programs in the radius it will raise the feasibility to train.
Existing RAPs	Existing Registered Apprenticeship Programs. This is by occupation.	State websites or U.S. Department of Labor	If there are related programs in the radius it will raise the feasibility to train.
Commuting Flow	The origin to destination flow of people between residence and workplace.	U.S. Census Bureau	This metric is used to help create a more realistic border of where people who will work in the manufacturing facility reside. This can help inform funding, and training program development.

Table B-2. Variables for State Score in the Workforce Readiness Calculator

Variables	Meaning	Type of metric	Sources	Assumptions
Civilian Labor Force Participation Rate	Civilian labor force is defined as percent of population age 16+ and consists of people classified as employed or unemployed.	State	U.S. Census Bureau	If the civilian labor force in the radius is higher than the regional average than we are assuming it will be more feasible to develop a workforce there.
Offshore wind focused workforce program or initiatives	Workforce development initiatives dedicated to offshore wind occupations.	State	State websites	If there are direct funds from the state for offshore wind workforce development programs, then we are assuming there is more state support, and it will be easier to develop a qualified workforce.
State unemployment rate	The number of unemployed people divided by the labor force.	State	U.S. Bureau of Labor Statistics	If the unemployment rate is high, then we are assuming there is a more available number of workers.
1-year percent change in industry employment, seasonally adjusted for manufacturing	One-year trend of the manufacturing industry employment that is adjust for normal seasonal employment changes.	State	U.S. Bureau of Labor Statistics	If the percent of the manufacturing workforce in a state is decreasing, then we are assuming that there may be a decreasing number of workers with transferable skill sets to offshore wind.
Percent of population working in manufacturing	The number of people working in manufacturing divided by the total population of working people.	State	U.S. Bureau of Labor Statistics	If the percent of the population working in manufacturing is higher than the national average, then we assume that there are more workers with transferable knowledge to offshore-wind-specific manufacturing.
Locational quotient	LQ compares the concentration of employment in an occupation within a specific area to the concentration of employment in an occupation nationwide. LQ greater than 1 indicates an occupation has a greater share of the state employment than is the case nationwide.	Component-specific & occupational level	U.S. Bureau of Labor Statistics	If the LQ is higher than the national average (1), then we are assuming that there is more specialization of the occupation within that state and therefore could lead to more workers with transferable knowledge to offshore wind manufacturing demands.
# of Registered apprenticeship programs	Existing Registered Apprenticeship Programs. This is by occupation.	Component-specific & occupational level	State websites or U.S. Department of Labor	If there are related programs in the radius it will raise the feasibility to train.
# of Two-year college/university programs	Existing education and training programs that typically take around 2 years to complete. This is by occupation.	Component-specific & occupational level	National Center for Education Statistics	If there are related programs in the radius it will raise the feasibility train.
# of Four-year college/university programs	Existing education and training programs that typically take around 2 years to complete. This is by occupation.	Component-specific & occupational level	National Center for Education Statistics	If there are related programs in the radius it will raise the feasibility to train.

Appendix C. Occupational Maps

Factory-level management and engineering: Responsible for the management and oversight of the factory and are involved in plantwide processes, such as operations, management, or production.

Plant Manager

Facilities and Maintenance Manager

Information Technology Manager

Composite Blade Manager

Production Supervisor/Manager

Quality Assurance (QA) / Quality Control (QC) Manager

Purchasing Director

Purchasing Manager

Warehouse Manager

Engineering Manager/Director

Purchaser/Buyer

Human Resource Representative

Document Controller

Production/Manufacturing Engineer

Quality Assurance (QA) / Quality Control (QC) Engineer

Process Engineer

Composite Materials Engineer

Thermoplastics Engineer

Drafter

Engineering Technician

Health, Safety, and Environment Manager

Steel Production Engineer

Surface Engineer

Coatings Inspector

Factory-level workers: Responsible for the physical processes involved in production

Electrical Technician

Quality Assurance (QA) / Quality Control (QC) Technician

Composite Blades Technician

Mechanical Support

Health, Safety, and Environment (HSE) Technician

Inventory Clerk

Material Coordinator

Electrician

Rodbuster

Steel Worker

Electrical Support

Millrights

Rigger

Coil Worker

Metal Fitter

Structural Metal Fabricator

Fiberglass Technician

Assembler

Rolling Machine Setter

Metal Cutters

Driller

Metal Grinder

Milling Machinist

Casting Machinist

Welder

Laser Operator

Welding Machinist/Welding Engineer

Blasting Technician (Applier)

Plater

Grinder Operator

Nondestructive test and inspection technician

Ultrasonic Welding Tester

Specialist Coating Technician (Applier)

CNC Operator

Heavy lift supervisor

Warehouse Coordinator

Truck Driver

Crane Operator

Heavy-Lift Crane Operator

Main/Auxiliary Crane Operator

Hoist and Winch Operator

Industrial Truck and Tractor Operator

Materials Handler

Warehouse Support

Stockers and Order Fillers

Facilities Maintenance: Responsible for repairs or ensuring cleanliness and hygiene of the plant

Cleaning Staff

Maintenance Supervisor

Industrial Machinery Electrician

Industrial Machinery Mechanic

Maintenance Technician

Installation, Maintenance, and Repair Worker Helpers

Appendix D. Summary Tables Across States

Table D-1. Summary Table of Occupation Strengths and Weaknesses by Job Category and Component for Delaware, Maryland, North Carolina, and Virginia

	Job Category	Delaware	Maryland	North Carolina	Virginia
		Blades			
Strengths	Factory-Level Management and Engineering	Engineering Manager/Director Plant Manager	Information Technology Manager Plant Manager	Plant Manager Production Supervisor/Manager, Quality Assurance (QA)/Quality Control (QC) Manager	Engineering Manager/Director Information Technology Manager
	Factory-Level Workers	Electrician Industrial Truck and Tractor Operator	Inventory Clerk, Material Coordinator Hoist and Winch Operator	Metal Fitter Electrical Support	Electrician Grinder Operator Inventory Clerk, Material Coordinator
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Cleaning Staff	Installation, Maintenance, and Repair Worker Helpers Maintenance Supervisor	Maintenance Technician Installation, Maintenance, and Repair Worker Helpers	Installation, Maintenance, and Repair Worker Helpers Industrial Machinery Electrician
Weaknesses	Factory-Level Management and Engineering	Engineering Technician Surface Engineer	Engineering Technician* Surface Engineer Purchaser/Buyer	Engineering Technician Purchaser/Buyer	Engineering Technician* Surface Engineer
	Factory-Level Workers	Coil Worker* Fiberglass Technician* Driller* Milling Machinist* Laser Operator* Grinder Operator* Rigger* Hoist and Winch Operator*	Fiberglass Technician* Driller* Coatings Inspector, Specialist Coating Technician (Applier) Assembler	Driller Milling Machinist	Hoist and Winch Operator* Driller Computer Numerically Controlled (CNC) Operator
	Facilities Maintenance	Industrial Machinery Electrician Maintenance Technician	Industrial Machinery Mechanic Maintenance Technician	Cleaning Staff Industrial Machinery Electrician	Cleaning Staff Maintenance Technician

	Job Category	Delaware	Maryland	North Carolina	Virginia
		Towers			
Strengths	Factory-Level Management and Engineering	Engineering Manager/Director Plant Manager	Information Technology Manager Plant Manager	Plant Manager Production Supervisor/Manager, Quality Assurance (QA)/Quality Control (QC) Manager	Information Technology Manager Engineering Manager/Director
	Factory-Level Workers	Industrial Truck and Tractor Operator Health, Safety, and Environment (HSE) Technician	Inventory Clerk, Material Coordinator Hoist and Winch Operator	Steel Production Engineer, Metal Fitter, Structural Metal Fabricator Electrical Support	Grinder Operator Steel Production Engineer, Metal Fitter, Structural Metal Fabricator
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Industrial Machinery Electrician	Installation, Maintenance, and Repair Worker Helpers Maintenance Supervisor	Maintenance Technician Installation, Maintenance, and Repair Worker Helpers	Industrial Machinery Electrician Installation, Maintenance, and Repair Worker Helpers
Weaknesses	Factory-Level Management and Engineering	Engineering Technician Surface Engineer, Metal Grinder	Engineering Technician* Surface Engineer, Metal Grinder Purchaser/Buyer	Engineering Technician Purchaser/Buyer	Engineering Technician* Surface Engineer, Metal Grinder
	Factory-Level Workers	Rigger Rolling Machine Setter Welding Machinist/Welding Engineer, Laser Operator Plater, Blasting Technician (Applier) Grinder Operator Hoist and Winch Operator	Driller* Metal Cutters Millwrights	Driller Rolling Machine Setter	Hoist and Winch Operator* Driller CNC Operator
	Facilities Maintenance	Maintenance Supervisor Cleaning Staff	Industrial Machinery Mechanic Maintenance Technician	Cleaning Staff Industrial Machinery Electrician	Cleaning Staff Maintenance Technician

	Job Category	Delaware	Maryland	North Carolina	Virginia
		Monopiles			
Strengths	Factory-Level Management and Engineering	Engineering Manager/Director Plant Manager	Information Technology Manager Plant Manager	Plant Manager Production Supervisor/Manager, Quality Assurance (QA)/Quality Control (QC) Manager	Engineering Manager/Director Information Technology Manager
	Factory-Level Workers	Industrial Truck and Tractor Operator Health, Safety, and Environment (HSE) Technician	Inventory Clerk, Material Coordinator Hoist and Winch Operator	Steel Production Engineer, Metal Fitter, Structural Metal Fabricator Laser Operator, Welding Machinist/Welding Engineer CNC Operator	Grinder Operator Inventory Clerk, Material Coordinator
	Facilities Maintenance	Installation, Maintenance, and Repair Worker Helpers Industrial Machinery Mechanic	Installation, Maintenance, and Repair Worker Helpers Maintenance Supervisor	Industrial Machinery Mechanic Installation, Maintenance, and Repair Worker Helpers	Industrial Machinery Mechanic Installation, Maintenance, and Repair Worker Helpers
Weaknesses	Factory-Level Management and Engineering	Engineering Technician Surface Engineer, Metal Grinder	Engineering Technician* Surface Engineer, Metal Grinder	Engineering Technician Purchaser/Buyer	Engineering Technician* Surface Engineer, Metal Grinder
	Factory-Level Workers	Blasting Technician (Applier) Driller Hoist and Winch Operator Laser Operator, Welding Machinist/Welding Engineer Milling Machinist Plater Rigger Rolling Machine Setter	Metal Cutters Driller* Millwrights	Driller Rolling Machine Setter	Hoist and Winch Operator* Driller CNC Operator
	Facilities Maintenance	Industrial Machinery Electrician Maintenance Technician	Industrial Machinery Mechanic Maintenance Technician	Cleaning Staff Industrial Machinery Electrician	Cleaning Staff Maintenance Technician

*The Bureau of Labor Statistics does not report the locational quotient, which decreases the occupation's average z-score for occupational specialty and available education and training programs.

Table D-2. Competency Requirements for High-Demand and Highly Specialized Occupations

Occupation	Education Level	Skills	Certifications	High Demand/ High Specialization
CNC operator	High school diploma or GED, trade or vocational school certificate preferred but not required, completion of relevant apprenticeship; on-the-job training may be provided	Interpersonal Communication and Collaboration Safety Compliance, Management, and Awareness CNC Machine Training, Programming, Operations, and Monitoring	Certifications vary based on machine Machining Level I - CNC Milling: Programming Setup and Operations ISA Certified Control Systems Technician National Institute for Metalworking Skills CNC machinist and CNC Operator OSHA 10 or 30 ISO 9001: Quality Management Systems Certification	High Demand and Specialization
Rolling machine setter/tower rolling machinist	High school diploma or GED, trade or vocational school certificate preferred but not required, completion of relevant apprenticeship; on-the-job training may be provided	Machine Setup, Operations, Maintenance and Repair, Monitoring and Evaluation Product Quality Management and Assurance Safety Compliance, Management, and Awareness Teamwork and Collaboration	Screw Machining Level II - Operate with Multiple Spindles II Screw Machine Operations II, Screw Machining Level III-Set Up and Operate with Multiple Spindles III Screw Machining Level II - Operate with Single Spindles II National Institute for Metalworking Skills Certifications OSHA 10 or 30	High Specialization
Mechanical support/ composite blades technician	High school diploma or GED, associate degree; on-the-job training may be provided	Safety Compliance, Management, and Awareness Technical Knowledge of Composite Materials	Certified Engineering Technologist Certified Automation Professional Certified Bearing Specialist PMMI Mechatronics: Mechanical Components SACA Certified Industry Automation Systems Specialist Corrosion Technologist Certified Automation Professional Certified Quality Technician	High Specialization

Occupation	Education Level	Skills	Certifications	High Demand/ High Specialization
			Certified Manufacturing Technician OSHA Certification	
Electrician	Electrician apprenticeship	Analytical Skills on Technical Systems Mathematics Calculation Verbal and Written Communication Electrical System Design, Integration, Compliance, and Maintenance Safety Compliance, Management, and Awareness	Journeyman Electrician License Master Electrician License Certified Electrical Inspector ETT Certified Assistant Technician Electrical Certification Electrical Code Specialist Electrical Plans Examiner Residential and Commercial Electrical Inspector OSHA 10 or 30 ACU (Autodesk Certified User) BOEM Approved Certified Verification Agent ISO 9001: Quality Management Systems Certification NFPA 70 - National Electrical Code NFPA 70B (Electrical Equipment Maintenance) NFPA 70E (Standard for Electrical Safety in the Workplace) EIT (Engineer-in-Training) PE (Professional Engineer License) State specific licenses may be needed	High Demand
Crane operator/auxiliary crane operator/ heavy-lift crane operator	High school diploma or GED or completion of relevant apprenticeship; on-the-job training may be provided	Interpret hand signals, radio communications, and written instructions accurately Crane Operation, Maintenance and Repair	Service Truck Crane Operator Tower Crane Operator Certification Tower Crane Inspector Overhead Crane Inspector/Operator and Rigger/Signalperson	High Demand

Occupation	Education Level	Skills	Certifications	High Demand/ High Specialization
		Safety Compliance, Management, and Awareness	Aerial Lift Operator and Inspector	
			Mobile Crane Operator	
		Teamwork and Collaboration	Mobile Crane Inspector	
			Lift Director - Tower Cranes	
			API Crane Inspector Certification	
			Articulating Boom Crane, Boom	
			Truck-Fixed Cab Operator	
			Certified Crane Operator (CIC)	
			Commercial Driver's License (CDL)	
			Lattice Boom Crane	
			LEEA Power Lifting Machines (PLM) Certification	
			Mobile Crane Operator Certification	
			NCCCO: National Commission for the Certification of Crane Operators Certification	
			Certified Rigger	
			TWIC (Transportation Worker Identification Credential)	
			API advanced certificates	
			OSHA 30-hour training	

Table D-3. Summary Table of Occupation Training Gap Analysis for Selected Occupations in Delaware, Maryland, North Carolina, and Virginia

Occupation	Delaware Training Gap	Maryland Training Gap	North Carolina Training Gap	Virginia Training Gap	High Demand/ High Specialization
CNC operator	Yes	No	No	Yes	High Demand
Rolling machine setter/tower rolling machinist	Yes	Yes	Yes	Yes	High Specialization
Mechanical support/ composite blades technician	Yes	No	No	No	High Specialization
Electrician	No	No	No	No	High Demand
Crane operator/auxiliary crane operator/ heavy-lift crane operator	Yes	Yes	Yes	Yes	High Demand