New York State Offshore Wind Master Plan

The Workforce Opportunity of Offshore Wind in New York

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

NYSERDA Report 17-25t
December 2017

NYSERDA's Promise to New Yorkers:

NYSERDA provides resources, expertise, and objective information so New Yorkers can make confident, informed energy decisions.

Mission Statement:

Advance innovative energy solutions in ways that improve New York's economy and environment.

Vision Statement:

Serve as a catalyst – advancing energy innovation, technology, and investment; transforming New York's economy; and empowering people to choose clean and efficient energy as part of their everyday lives.

Cover Image Source: LM Windpower

New York State Offshore Wind Master Plan
The Workforce Opportunity of Offshore Wind in New York

Final Report

Prepared for:

New York State Energy Research and Development Authority

Prepared by:

BVG Associates

Cricklade, United Kingdom

Stantec

New York, New York

GLWN

Cleveland, Ohio

NYSERDA Report 17-25t December 2017

Notice

This study was prepared by BVG Associates, Stantec, and GLWN (Contractors) in the course of performing work contracted for and sponsored by the State of New York through its agencies and public-benefit corporations (the State). The State and the Contractors make no warranties or representations, expressed or implied, as to the fitness for particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed, or referred to in this study. The State and the Contractors make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this study.

No State or federal agency or entity has committed to any specific course of action with respect to the future development of offshore wind projects discussed in this study. This study does not commit any governmental agency or entity to any specific course of action, or otherwise pre-determine any outcome under State or federal law. Any future offshore wind project will be required to meet all State and federal permit or license approvals, including but not limited to under the Coastal Zone Management Act, prior to proceeding with development.

The State makes every effort to provide accurate information about copyright owners and related matters in the documents we publish. Contractors are responsible for determining and satisfying copyright or other use restrictions regarding the content of reports that they write, in compliance with State policies and federal law. If you are the copyright owner and believe a study has not properly attributed your work to you or has used it without permission, please email print@nyserda.ny.gov.

Information contained in this study, such as web page addresses, are current at the time of publication.

Table of Contents

Notice ..... **iii**
List of Figures ..... **v**
List of Tables ..... **vi**
Acronyms and Abbreviations ..... **vii**
Summary **S-1**
1 Introduction **1**
2 Methodology **3**
2.1 Supply Chain Analysis 3
2.2 Demand for New York Workers 4
2.2.1 Supply Chain Narratives 4
2.2.2 Worker Demand Analysis 6
3 Supply Chain Analysis **9**
3.1 Project Development and Management 9
3.2 Turbine Supply 10
3.2.1 Nacelle and Rotor Assembly 10
3.2.2 Blades 15
3.2.3 Towers 19
3.3 Balance of Plant 23
3.3.1 Foundation 23
3.3.2 Array and Export Cables 28
3.3.3 Substation Supply and Operational Infrastructure 32
3.4 Installation and Commissioning 36
3.5 Operations and Maintenance 42
3.6 Discussion 47
4 Economic Impacts of Offshore Wind **49**
4.1 New York Job Creation and Economic Impacts 49
4.1.1 High Market, High Local Content 50
4.1.2 High Market, Base Local Content 53
4.1.3 Low Market, High Local Content 56
4.1.4 Low Market, Base Local Content 58
4.2 Offshore Wind Lifetime Costs 60
4.3 Discussion 62

5 References 64
Appendix A. Detail of Education and Skills Requirements A-1
Appendix B. Technical Training Provision B-1
Appendix C. New York Ports Analysis C-1
Appendix D. Supply Chains Narratives D-1

List of Figures

Figure 1. Annual and Cumulative Capacity to 2030 in the High and Low Market Scenarios 6
Figure 2. Diagram Showing the Main Turbine Components. 11
Figure 3. Nordex Wind Turbine Hub Assembly. 14
Figure 4. Vestas blade Factory in Windsor, CO. 15
Figure 5. Siemen's Gamesa Blade Production. 16
Figure 6. Ventower Welding Tower Sections. 20
Figure 7. Ventower Welding Tower Flange. 20
Figure 8. Fabrication of the Block Island Foundations at Gulf Island Fabrication in Houma, Louisiana 24
Figure 9. Gulf Island Fabrication Welders Working on the Jacket Foundation for Block Island 26
Figure 10. Array and Export Cable Routes for the London Array Wind Farm 28
Figure 11. Prysmian Lexington SC High-Voltage Cable Factory. 29
Figure 12. ABB Cable Manufactured and Loaded onto Installation Vessels at Karlskrona, Sweden. 30
Figure 13. Westermost Rough Wind Farm Substation in Yorkshire, UK 32
Figure 14. Veja Mate Offshore Substation. 33
Figure 15. Geosea's New-build Installation Vessel Orion (due to enter service in 2019) 36
Figure 16. MHI Vestas Nacelle Arrives for Pre-assembly in Belfast for Orsted Energy's Burbo Bank Extension OSW Farm 38
Figure 17. OSW Turbine Maintenance 42
Figure 18. Siemens OSW Blade Repair 43
Figure 19. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects by OSW Element in the High Market, High Local Content Scenario. 51
Figure 20. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects in the High Market, High Local Content Scenario. 51
Figure 21. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects by OSW Element in the High Market, Base Local Content Scenario 54
Figure 22. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects in the High Market, Base Local Content Scenario 54
Figure 23. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects by OSW Element in the Low market, High Local Content 57

Figure 24. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects in the Low Market, High Local Content Scenario....57
Figure 25. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects by OSW Element In The Low Market, Base Local Content Scenario....59
Figure 26. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects in the Low Market, Base Local Content Scenario....59
Figure 27. The Projected Lifetime Discounted Expenditure (figures are in $millions, real terms in 2015 prices) of 2.4 GW of NY OSW Building in the 2020s....60
Figure 28. Contribution of Supply Elements and Sub-elements to the Levelized Cost of Energy for an Average New York OSW Farm Built in the 2020s....61

List of Tables

Table 1. Elements and Sub-elements of the OSW Supply Chain 4
Table 2. Functional Areas of Nacelle and Rotor Assembly....13
Table 3. Post-secondary Trade or Technical Certifications Preferred in Nacelle and Rotor Assembly....14
Table 4. Functional Areas of Blade Production....18
Table 5. Post-secondary Trade or Technical Certifications Preferred in Blade Production. 18
Table 6. Functional Areas of Tower Production....22
Table 7. Post-secondary Trade or Technical Certifications Preferred in Tower Production 22
Table 8. Functional Areas of Foundation Production....27
Table 9. Post-Secondary Trade or Technical Certifications Preferred in Foundation Production....27
Table 10. Functional Areas of Cable Production 31
Table 11. Post-Secondary Trade or Technical Certifications Preferred in Cable Production....31
Table 12. Functional Areas of Substation Production....35
Table 13. Post-Secondary Trade or Technical Certifications Preferred in Substation Production....35
Table 14. Functional Areas of Installation and Commissioning....39
Table 15. Post-secondary Trade or Technical Certifications Preferred in Installation and Commissioning....40
Table 16. Functional Areas of O&M 45
Table 17. Post-secondary Trade or Technical Certifications Preferred in O&M....46
Table 18. Demand for Direct and Indirect NY Workers from NY OSW Farms in the High Local Content Scenarios[a] 52
Table 19. Demand for Direct and Indirect NY workers from NY OSW Farms in the Base Local Content Scenarios[a] 55
Table 20. Average Demand for New York Workers for Both New York and Regional Projects 62

Acronyms and Abbreviations

ACMA	American Composites Manufacturers Association
AWS	American Welding Society
BOCES	Board of Cooperative Education Services
CCT	Certified Composite Technician
CNC	Computer numerically controlled
COWI	COWI North America
DOL	New York State Department of Labor
DOT	New York State Department of Transportation
FTE	full-time equivalent
GE	General Electric
GVA	gross value added
GW	gigawatt
GWO	Global Wind Organisation
LBW	land-based wind
LPT	large power transformer
MW	megawatt
NYSERDA	New York State Energy Research and Development Authority
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
OSW	offshore wind
QC	quality control
STCW	Standards of Safety, Certification and Watchkeeping for Seafarers
WTIV	wind turbine installation vessel

Summary

The New York State Energy Research and Development Authority (NYSERDA) commissioned this analysis to evaluate new workforce opportunities in New York associated with large-scale development of offshore wind (OSW) electricity generation. This analysis accounts for OSW development scenarios that could be supported by policies in New York, which has committed to a goal of installing 2.4 gigawatts (GW) of OSW by 2030, the largest commitment in the United States, as well as policies in other states in the Northeast.

In addition to energy and environmental benefits, OSW presents a significant economic development opportunity for the State of New York. The Study finds that New York is ideally suited for sustained OSW workforce opportunities:

- New York can realize nearly 5,000 new jobs in manufacturing, installation, and operation of OSW facilities, with a regional commitment to scale development of the resource. Nearly 3,500 of these jobs are expected to support New York wind farms, with the remaining supporting regional projects.
- Nearly 2,000 of these jobs are in operations and maintenance (O&M), providing sustained career opportunities for New Yorkers as the average OSW facility life span is at least 25 years.
- Many New Yorkers already possess most of the skills necessary to attract OSW manufacturers and developers, and skill development support from New York State will ensure new workers will have the skills needed to participate in this industry.
- New York's existing infrastructure is well positioned for OSW development throughout the region, with ports and manufacturing assets that are uniquely suited to OSW needs.

This Study considers the economic development, and potential job impacts, associated with OSW by assessing three primary industry needs: (1) component and equipment manufacturing, (2) port infrastructure (which supports manufacturing, installation, and O&M activities), and (3) required workforce skills needed to support any New York-based manufacturing, installation or O&M activities. The Study quantifies the demand for workers in this emerging industry and compares the needs of the OSW industry with the worker strengths already existing within New York.

The highly competitive environment must be a forefront consideration in assessing New York's OSW workforce opportunities. In developing workforce support strategies, such competition will come from neighboring states seeking to advance the OSW industry, as well as the established and mature supply chain that is largely based in Europe.

However, New York does possess several important attributes that will help its competitive position:

- New York's industry-leading procurement commitment of 2.4 GW of OSW will provide a powerful mechanism to attract developers and supply chain partners to invest in New York.
- New York is centrally located between Northeast and mid-Atlantic states, where the majority of U.S. OSW projects will be built in the near term, and therefore New York's existing port facilities are ideally positioned to service wind farms across the region.
- New York has core manufacturing competencies that are well-suited to the offshore industry.
- New York's workforce is well equipped to support the OSW industry, as many of New York's trade workers and assemblers already possess the skills that can be directly translated to the OSW industry.

In addition, the State's success in creating a clean, resilient, and affordable energy system has resulted in market opportunities that have triggered job growth across a range of technologies. New York already possesses a strong clean energy workforce, evidenced by the 22,000 New Yorkers who are working in renewable energy across the State.[1]

OSW is poised to be the next clean energy industry to establish roots in New York, and to be a key driver in the increasing demand for clean energy workers in the State. Focused attention to ensuring that OSW development maximizes local content, through use of existing ports and manufacturing infrastructure, will be key in realizing the workforce potential in New York.

This Study finds that New York's workforce is expected to primarily benefit from the long-term O&M sector, which is estimated to support as many as 1,830 jobs. These positions will support the ongoing maintenance of the wind farms for the duration of their 25-year useful life. O&M workers must be able to respond quickly to any on-site requests, making their proximity to the wind farms critical. New York can, therefore, see nearly all of these as baseline jobs, confident they will be sourced locally. Project management and development, as well as installation and commissioning, are expected to create up to 580 additional baseline jobs.

Incremental to baseline jobs, the manufacturing and installation and commissioning sectors could support up to 2,250 and 220 jobs, respectively. The demand for these positions will be during the

[1] 2017 New York Clean Energy Industry Report, NYSERDA 2017.

development and construction phases of the project life cycle, and their local content will be a function of the industry's use of New York ports.

The analysis forecasts that the State's attainment of OSW workforce and infrastructure can result in as much as $6.3 billion of expenditure in New York, an impact that is also subject to the use of local infrastructure. While New York's natural assets of a central location and experienced workforce make its port facilities ideal for OSW development, the State should take steps to improve its competitive position as an OSW hub. Specifically, New York should focus efforts on the following:

- Engagement with Tier 1 and Tier 2 manufacturing, which can provide local jobs and incentivize the development of related port infrastructure.
- Promotion and investment of port infrastructure, ensuring New York's facilities are suitable and available to the industry.
- Investment and partnership opportunities in workforce development, ensuring technical and labor institutions are positioned to train and certify OSW workers.

Given the established supply chain in Europe and the capital intensity of OSW, development of new U.S. facilities requires action from the State to build industry confidence and certainty that New York is a committed partner is OSW development. State actions such as infrastructure investments and energy procurements are, therefore, expected to be a key factor in locating the long-term U.S. supply chain and the resulting workforce and economic benefits.

S.1 Manufacturing

Current domestic and international OSW component manufacturers already identify New York as an attractive location to develop production manufacturing operations. Several manufacturers are currently conducting preliminary evaluations for operations in the State. Because of New York's long-standing and sophisticated industrial base, there are existing core manufacturing competencies that can readily serve the OSW industry. OSW provides opportunities to expand these capacities though industry-specific design and manufacturing knowledge. Tier 1 manufacturing, including elements such as blades, towers, and nacelles, will require new facilities and will ideally be collocated with OSW installation and staging facilities. Lower tier manufacturing, which includes material manufacturing such as steel, fiberglass, and copper wire, already serves a variety of industries and will likely expand to service the OSW industry. Ready access to port facilities, common in many areas of New York, is also a positive characteristic for locating manufacturing facilities. New York has an opportunity to engage with Tier 1 and Tier 2 manufacturers to attract new facilities and expand the technical capabilities of existing infrastructure.

S.2 Port Infrastructure

New York benefits from three distinct coastal geographies that can each serve the OSW port industry: New York Harbor, the Hudson River, and the coast of Long Island. NYSERDA conducted a screening assessment[2] of the physical characteristics of 65 port sites in these areas that could support the development of a local OSW supply chain.

Each of these geographies offers opportunity for the OSW industry. New York Harbor offers sites that are suitable for all elements of manufacturing, fabrication, assembly, and staging activities. Sites along the Hudson River are generally appropriate for various manufacturing needs, with possibilities for turbine, blade, tower, and cable manufacturing and assembly. Long Island, given its shallow navigable depths and other physical constraints, is best suited for O&M facilities.

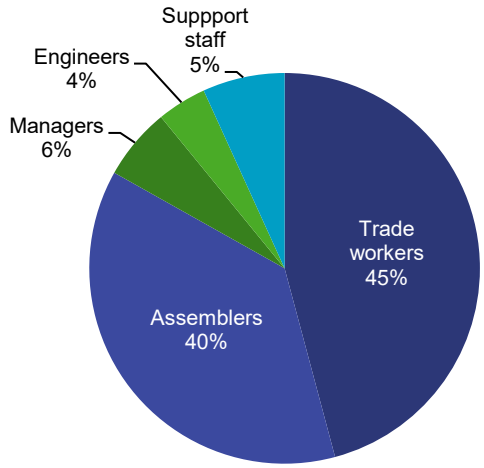
New York's port facilities benefit from their proximity to existing and proposed OSW lease areas, including those off the shores of neighboring states. Proximity to major development sites is expected to be a primary consideration in siting new OSW port facilities. Nearly all sites in the region will require upgrades tailored to the demands of OSW, but that is expected for a new industry with the scale of OSW technology. Further evaluation and careful planning will be required to determine which sites should be prioritized and positioned for possible manufacturing, fabrication, staging, and O&M activities.

S.3 Workforce Skills

The core workforce skills required for OSW development and operation are primarily associated with trade workers and assemblers, with responsibilities including manufacturing, fabrication, staging, and maintenance. Skilled trade workers and assemblers are anticipated to represent 85% of the required direct jobs (see Figure S-1). In addition, there exist indirect manufacturing job opportunities for goods and services that will be needed to support a growing OSW industry.

[2] New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017.

Figure S-1. Breakdown of Directly Employed Workers by Job Type



The skills of New York's trade workers and assemblers are generally applicable to the OSW industry, though some industry-specific training and certifications will likely be required. Much of this training will be product specific and delivered by the suppliers. There is opportunity for the State to ensure that certification and training requirements are clear and readily available through a combination of educational, technical, and labor institutions. This base of existing talent, as well as an established network for expanding skills development also provides a ready-made foundation for training new workers to also seek opportunities in OSW.

Primarily, New York workers will need to be trained to work offshore, which requires additional levels of safety training beyond land-based positions. Beyond standard Occupational Safety and Health Administration (OSHA) courses, offshore workers will also require Standards of Training, Certification and Watchkeeping for Seafarers (STCW) and, possibly, Global Wind Organisation (GWO) safety training. STCW training is required for all seagoing personnel and is readily available in New York. GWO requirements will be determined by project-specific developers and manufacturers, and there are currently no U.S. GWO training programs that provide the Sea Survival module required for OSW. Therefore, New York can work to ensure this training becomes locally accessible.

New York can leverage the technical training that already exists in the State for OSW application, specifically the broad spectrum of apprenticeship (see Appendix B) and welding programs, but OSW will also create demand for skills that are less prevalent, such as composite certification required for the fabrication of turbine components. The American Composites Manufacturers Association (ACMA) offers Certified Composites Technician (CCT) training, but no in-State educational facilities currently offer suitable programs.

New York can ensure training and certification requirements of OSW are clear to the labor and education communities, and collaborate with both to ensure appropriate programs are in place to serve the workforce. Once established, the opportunity for New York workers will stem from the emergence of OSW development within the State and surrounding region.

S.4 Demand for New York Workers

This workforce opportunity study has been designed along two regional build scenarios:[3]

- High case where 8 GW is deployed by 2030.
- Low case where 4 GW is deployed by 2030.

The outcomes of these scenarios were also tested by two sensitivities based on the level of New York market support:

- **High local content:** significant actions are made by the State to support workforce readiness, supply chain development, and infrastructural improvements.
- **Base local content:** limited additional intervention is taken to attract new industry.

The Study considers how each element (manufacturing, port infrastructure, workforce skills) of a New York-based OSW industry would develop through 2030.

In all scenarios, New York is a primary supplier of O&M workers, with some additional demand from project management and development. Also, all scenarios anticipate investment in a New York staging and installation port facility, resulting in New York jobs that facilitate regional OSW development.

[3] Both scenarios assume execution of New York's 2.4 GW deployment goal.

In the high local content scenario, New York can successfully attract investments for turbine assembly, blade, tower, and cable manufacturing. In the base local content scenario, there is a more limited demand for jobs; New York's workforce presence would principally occur in the O&M sector, with more modest job numbers in installation and commissioning, and project management and development.

The average demand for New York workers under each scenario and sensitivity is shown in Table S-1. The number of New York O&M and project management jobs is relatively equal between each scenario, as these are considered baseline jobs.

Table S-1. Average Demand for New York Workers from New York and Regional Projects

Scenario		Project management and development workers	O&M workers	Installation and commissioning workers	Manufacturing workers
High market	High local content	350	1,830	470	2,250
	Base local content	330	1,820	200	90
Low market	High local content	340	1,790	420	1,310
	Base local content	330	1,780	250	50

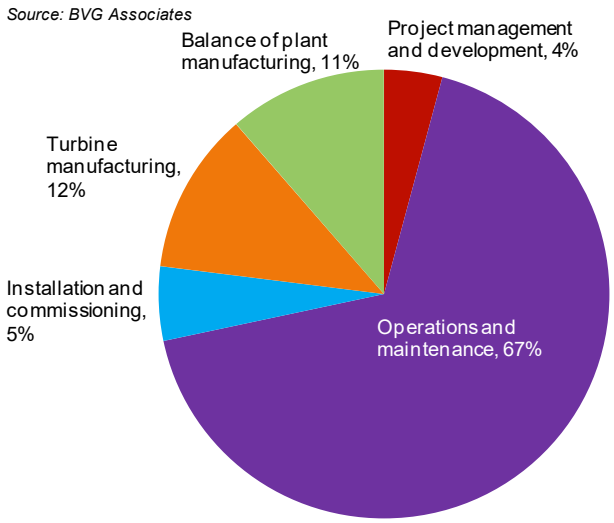
Manufacturing, project management and development, and installation and commissioning averages are calculated from 2024 to 2028. O&M averages represent long-term employment from 2030 onwards

Installation and commissioning jobs are prevalent in both high-market and low-market cases. The base local content scenario shows more installation and commissioning jobs in New York under a low-market case. This is a function of New York facing more competition for these jobs in the high-market case, reflecting higher levels of regional deployment.

The biggest initial demand for New York manufacturing workers, which is seen predominantly in the high local content scenarios, will come from major suppliers, such as turbine, blade, tower, and cable manufacturers, that are required to operate out of OSW-dedicated ports and coastal facilities. Additional gains from lower tier suppliers, such as subcomponent and materials manufacturers, are less likely and require greater market intervention to attain.

One dynamic worth noting is that O&M positions will serve the projects throughout their 25-year operational lives. Therefore, when considering the number and duration of each of the jobs created by each of the workforce sectors, O&M is expected to account for 67% of total projected job years (see Figure S-2) under the high market, high local content scenario. As discussed above, these long-term O&M jobs are expected to be retained by New York regardless of the volume of regional deployment or the level of market support.

Figure S-2. Demand for New York Workers in the High-Market, High Local Content Scenario in Terms of Total Job years. Demand is from both New York and regional projects



1 Introduction

New York State is taking significant steps to develop a domestic offshore wind (OSW) industry. The Clean Energy Standard requires that 50% of New York's electricity requirements comes from renewable energy sources by 2030. Supporting this broad renewable energy policy, New York has advanced a goal of installing 2.4 gigawatts (GW) of OSW generation by 2030. Supporting these policies, the New York State Energy Research and Development Authority (NYSERDA) is coordinating the development of the New York State OSW Master Plan, which establishes a framework for responsible and cost-effective OSW development. This workforce opportunity study supports a key co-benefit of these renewable energy policies—to create new job opportunities for New Yorkers, and to maximize potential economic benefits to the State.

To inform the Master Plan and the workforce opportunity potential, NYSERDA sought to understand the OSW industry's workforce needs and the influencing factors of

- The size of the market in New York and neighboring states
- The opportunities for establishing a New York and domestic U.S. supply chain, transitioning from an existing, largely European, base
- The relative and absolute strengths of New York's workforce skills, supply chain, and port infrastructure

NYSERDA commissioned BVG Associates, GLWN, and Stantec to undertake this assessment, which is structured as follows:

- Section 2 describes the methodology and sources of data used in the analysis and defines the scenarios used.
- Section 3 considers, for each defined sector of the OSW supply chain, the requirements of the industry, New York's existing capabilities, and actions needed to augment existing New York capacities for
    - Manufacturing
    - Port infrastructure
    - Workforce skills
- Section 4 considers scenarios for the development of OSW and presents the annual demand of workers for each scenario.
- Section 5 includes a list of references.
- Appendices A and B detail the education, skill, and technical training requirements of the OSW workforce.

- Appendix C details the existing port infrastructure in New York and examines its suitability for support of the OSW industry. This analysis is based on an initial screening of sites provided by COWI North America (COWI).[4]
- Appendix D details the supply chain narratives that were created using the analysis discussed in Section 3.

This Study provides information to NYSERDA and other State agencies in their preparation of the Master Plan, in addition to OSW developers and manufacturers that are considering investing in New York.

[4] New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017.

2 Methodology

2.1 Supply Chain Analysis

This analysis provides the baseline information for the quantitative jobs analysis, which is detailed in Section 2.2. The ability of New York to maximize the local economic benefits of OSW depends on three areas:

- Manufacturing
- Port infrastructure
- Workforce skills

The following were considered for all elements of the OSW supply chain, as listed in Table 1:

- The manufacturing, infrastructure, and workforce requirements of the OSW industry
- The current ability of New York to meet those requirements
- The competition from neighboring states, including manufacturing facilities, infrastructure investments, and educational programs

The analysis was performed by conducting industry interviews, desktop research, and reference of recent workforce training, supply chain, and infrastructure reports and databases. Reference sources are used in Appendix E. The supply chain assessment produced the following:

- A review of the current New York manufacturing sector, including the capabilities within the State to produce each OSW sub-element and, where reasonable, identification of the top two New York suppliers with capabilities to produce each sub-element
- An assessment of the direct labor staffing, special trade, or technical skills and certifications expected to be required for each of the OSW supply chain sub-elements
- Strengths and gaps within New York's existing workforce training programs, as applicable to the skills required for OSW
- An analysis of the port infrastructure requirements of each sub-element, including a suitability assessment of potential OSW port locations

Table 1. Elements and Sub-elements of the OSW Supply Chain

Phase	Element	Sub-element
Capital expenditure	Project development and management	n/a
	Turbine supply	Nacelle, rotor, and assembly
		Blades
		Tower
	Balance of plant	Foundation
		Array cables
		Export cable
		Substation supply and operational infrastructure
	Installation and commissioning	Turbine
		Foundation
		Subsea cable
		Other installation
Operational expenditure	Operations and maintenance	Wind farm operation
		Turbine maintenance and service
		Foundation maintenance and service
		Subsea cable maintenance and service
		Substation maintenance and service

2.2 Demand for New York Workers

2.2.1 Supply Chain Narratives

To quantify the demand for New York workers, the first step was to develop narratives for the evolution of the New York OSW supply chain. The narratives were developed by considering

- the results of the New York sector analysis
- OSW market dynamics, such as market thresholds for investment, manufacturing capacity in existing facilities in Europe and Asia, and the logistical benefits of local supply

For the analysis, the evolution of the New York supply chain was considered in four periods:

- 2019–2021 (inclusive)
- 2022–2024
- 2025-2027
- 2028-2030

Supply Chain Categories. The supply chain was categorized into five elements:

- Project development and management
- Turbine supply
- Balance of plant
- Installation and commissioning
- Operation and maintenance

These were further categorized into 17 sub-elements, as shown in Table 1. For each period and sub-element, an assessment was made of what products and services were likely to be supplied from New York.

Local Content Sensitivities. For each supply chain sub-element and period, the level of New York supply was considered under two sensitivities:

- High local content, where New York provides significant incentives for investment and/or local supply. In effect, this sensitivity capitalizes on the strengths New York's skills, supply chain and infrastructure, the absolute and relative attractiveness of the New York market, and the logistical benefits of using locally based suppliers.
- Base local content, where New York provides no additional market support. The State promotes the opportunities from OSW, but does not provide significant incentives or impose any local supply requirements on developers.

Market Scenarios. This analysis was based on two market scenarios:

- High: 2.4 GW of New York capacity built by 2030 with an additional 5.6 GW of capacity built in the northeastern U.S. over the same period
- Low: 2.4 GW of New York capacity built by 2030 with an additional 1.6 GW of capacity built in the northeastern U.S. over the same period.

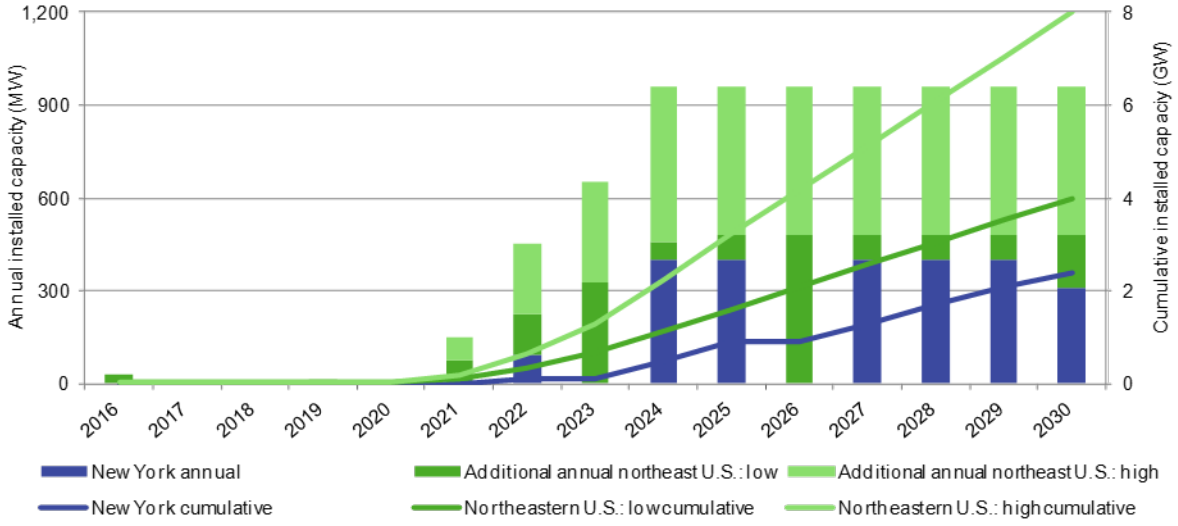
Figure 1 shows the annual and cumulative installed capacities for these scenarios. The profiles were developed to provide a stable level of demand and do not consider the timing of specific projects.

For each local content sensitivity and market scenario combination, a narrative was developed to describe how the New York supply developed in each period, considering, in addition to the supply chain assessments:

- The relative and absolute attractiveness as a location from major investment
- The logistical benefits of local supply to local projects
- To what extent interventions by NYSERDA or other public agencies can increase the attractiveness of New York for OSW investment

These narratives are included in Appendix D and summarized in Section 4.1.

Figure 1. Annual and Cumulative Capacity to 2030 in the High and Low Market Scenarios



2.2.2 Worker Demand Analysis

For each narrative, the demand for New York workers was quantified by translating the conclusions in each narrative into local content assessments and employing an economic model developed in-house by BVGA. This method was preferred to a more conventional approach for the reasons that follow.

Conventional Economic Methodology

Conventional modeling of economic impacts for most industrial sectors relies on government statistics, for example those based on North American Industry Classification System (NAICS).
These are produced at Federal level by the Department of Commerce Bureau of Economic Statistics and can be appropriate for traditional industries at a national level, but are unsatisfactory for use with the OSW supply chain because the industry classifications do not map easily onto the OSW sector. The development of new codes for a maturing sector, such as OSW, takes time. This means that conventional economic analyses of OSW would need to map existing NAICS data onto OSW activities, which is a manual process and subject to error.

OSW is ideally suited to a more robust approach that considers current and future capability of local supply chains because:

- Projects tend be large and have distinct procurement processes from one another
- Projects tend to use comparable technologies and share supply chains

The BVGA model derives bespoke multipliers based on the specific features of different parts of the OSW supply chain. It is informed by BVGA's extensive experience in the industry.

The BVGA methodology's first input is the unit cost of each of the supply chain sub-elements. These forecasted costs recognize that earlier costs are likely to be higher because the U.S. industry is relatively inexperienced and that later costs will be lower as companies gain more experience and benefit from innovations in the global industry.

The next step was to estimate how much of the cost of each sub-element would be formed by the depreciated cost of these capital assets. The remaining expenditure is analogous to the direct and indirect gross value added (GVA) created. GVA is the aggregate of labor costs and operational profits. Therefore, it is possible to model FTE employment from GVA, provided one understands some key variables. In the BVGA economic impact methodology, employment impacts are calculated using the following equation:

$$FTE_a = \frac{(GVA - M)}{Y_a + W_a}$$

where:

FTE_a = Annual FTE employment
GVA = Gross value added ($)
M = Total operating margin ($)
Y_a = Average annual wage ($)
W_a = Non-wage average annual cost of employment ($)

This report calculates employment as annual FTE employment using the above methodology, but uses the terms "jobs" and "workers" to represent the forecasted annual FTEs.

To make robust assessments, each major component in the OSW supply chain was considered and typical salary levels, costs of employment, and profit margins were estimated, bringing together BVGA's specific sector knowledge and research into typical labor costs for the work undertaken in each supply chain sub-element.

The analysis considered all the jobs created in the supply chain, other than

- Those from the construction of capital assets. The demand for workers from the construction of factories and vessels is difficult to assign to a specific year and was, therefore, excluded.
- Induced jobs, which are the result of personal expenditure of the labor force.

The resulting calculation represents both direct jobs, which are those of the wind farm owners and their primary contractors, and indirect jobs, which are those of suppliers and subsuppliers to the owners and their primary contractors.

Salary levels and costs of employment in New York were researched from public sources, such as the New York State Department of Labor (DOL). Future profit margins are highly uncertain, and assumed comparable with those in the European supply chain. The outputs were validated against known employment levels in the European market.

3 Supply Chain Analysis

3.1 Project Development and Management

Engaging with federal, state, and local government agencies and business entities, OSW developers do most of the groundwork for project investment by signing offtake agreements, negotiating leases, procuring equipment, and overseeing permitting, design, and construction.

Once a project is nearing final investment decision, a developer will establish a project management team to provide oversight for the main tender packages to be contracted: turbines, foundations, submarine cable, onshore substation and grid connection, and marine operations and logistics. Each of the packages will have its own set of supply chain needs and the following are examples of items likely to be contracted locally.

- Facilities and infrastructure: access control and security, office trailers, and turbine assembly facilities
- Equipment: material handling, such as crawler and heavy lift cranes, and rental equipment
- General services: contractors, hospitality, and emergency repair
- Materials: aggregate, communications, concrete, electrical controls, electrical wiring, fence, fender, bollards, fuels and lubricants, paint, steel conduit, steel rebar, drainage, water, and welding supplies

There are approximately 10 major OSW developers starting up in four regions of the U.S.—Atlantic Coast, Great Lakes, Gulf, and Pacific Coast—many of which have set up operation offices in multiple states.

Infrastructure. OSW developers typically open regional offices in the state where the project is being constructed. This has been the case for recent projects in the U.S. where Deepwater Wind, Vineyard Wind, and Orsted opened offices in Massachusetts for the development of projects in New England. Deepwater Wind is headquartered in Providence, Rhode Island, and Orsted opened its U.S. headquarters in Boston, Massachusetts. A regional headquarters office typically requires 465 square meters of space for approximately 20 to 25 personnel. This could increase to include additional personnel during the construction phase of the project.

Project development and management requires office space for the professional staff, which is usually located close to transportation, state agencies, and business services. This office space involves medium- to long-term leases and has the potential to function as an operations office (overseeing the port-based

service base) over the life of the project. Additional temporary office space at the staging and installation facilities will be required and may take the form of trailers parked on site. With a typical project installation period of three years at most, these on-site offices are likely to be temporary. It is up to the developer to select a suitable location for its main office in addition to its construction management office near the staging and installation facility.

OSW developers hire numerous consulting, scientific, and engineering companies for project development. Typically, they use a mix of large engineering firms and specialized consultants. Many of these firms will have existing offices in the region.

It is likely that offices in New York will open to serve State projects and it is also possible that regional headquarters will open if they are not already established. New York's central location in the mid-Atlantic region makes it an ideal location for an OSW regional headquarters.

Workforce Skills. The developer is responsible for the permitting, engineering, design, financing, management, and legal aspects of a project. Once the project is approved, the developer has control over the installation and commissioning process and selects which companies will carry out the work, coordinating amongst all parties to ensure that the project is kept on schedule and within budget. The planning and procurement process typically takes between three and five years.

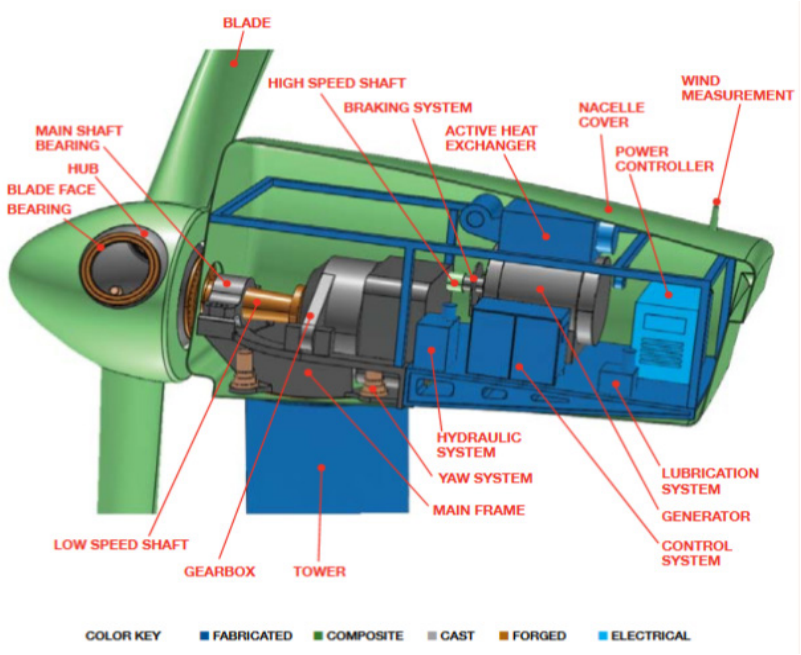
The team of a typical developer includes the chief executive officer, president, chief financial officer, general counsel, corporate paralegal, vice president of states or regions, vice president of operations and engineering, vice president of development, development associate, director of external relations, and senior electrical engineer. Managerial positions include the development manager, manager of permitting and environmental affairs, manager of performance analytics and resource assessment, manager of construction, manager of O&M, manager of marine affairs, manager of fisheries liaison, wind farm manager, and office manager.

3.2 Turbine Supply

3.2.1 Nacelle and Rotor Assembly

The nacelle consists of a drivetrain, power take-off, controls, structure and enclosure. The major drivetrain components are the rotor hub, main bearing, main shaft, gearbox (or direct drive system), gearbox suspension, brake, high-speed shaft, generator, and mainframe (see Figure 2).

Figure 2. Diagram Showing the Main Turbine Components



The nacelle housing provides environmental protection to the nacelle components. Current nacelle dimensions for a 6- to 8-megawatt (MW) turbine are about 7 meters by 7 meters by 18 meters with a mass of about 360 metric tons. A 6 MW rotor hub has a diameter of about 5 meters and a mass of about 50 metric tons.

Transportation logistics require nacelle assembly at coastal locations, ideally near to the point of final installation. The wind turbine manufacturer is responsible for acquiring all drivetrain components, the rotor, and any ancillary hardware. The manufacturing of the nacelle's subcomponents is likely to occur elsewhere, and turbine manufacturers will be cautious about moving nacelle production too far from its main suppliers.

Manufacturing. No OSW nacelle assembly exists in the U.S. today. The three major wind turbine manufacturers—General Electric (GE), Vestas, and Siemens-Gamesa—have only land-based wind (LBW) nacelle assembly in the U.S., and most facilities are in the Midwest. Siemens-Gamesa had a Northeast nacelle assembly facility in the Philadelphia, Pennsylvania area, but that facility is now closed.

The main OSW turbine manufacturers only have European manufacturing facilities. There are Asian offshore turbine manufacturers, but these are unlikely to export for the foreseeable future.

Rotor hubs are cast and machined. Seven castings facilities exist in the Midwest and Northeast (one in Pennsylvania, four in Ohio, one in Indiana, and one in Michigan) that are capable of making up to 2 MW rotor hubs. None of these facilities are currently capable of casting the much larger rotor hubs needed for OSW.

Infrastructure. Nacelle and rotor assembly facilities must have the capability to manufacture or import each of the subcomponents for final assembly. Many components have large weights such as the generator, gearbox, and bed plate requiring heavy lift capability. A good transportation network of road, rail, and waterside shipment access is required. Complete offshore nacelles have a mass of several hundred metric tons so high load bearing quayside is required for export. Nacelles are typically transported
in storage frames that require heavy lift vessels for shipment to the staging port (also referred to as an installation or marshalling port).

Below are the minimum physical parameters anticipated for a nacelle and rotor assembly facility.[5] These parameters will vary based on a number of factors, including manufacturer specifications and vessel type. The parameters below assume that the facility is not used for staging and construction, with horizontal transport of the components and use of a feeder barge.

- Waterfront site area: 10 hectares
- Wharf length: 50 meters
- Vessel draft: 4 meters
- Air draft: 15 meters
- Wharf live load capacity: 20 metric tons per square meter

Appendix C contains the physical characteristics of existing New York port facilities.

Currently there are no utility-scale offshore nacelle manufacturing and assembly facilities in operation from Maine to Virginia. OSW turbines are currently being manufactured in Europe and Asia for those markets.

[5] All minimum port parameters are from New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017.

The Massachusetts Clean Energy Center conducted an engineering assessment of sites with the potential to be redeveloped by private industry investment to support OSW component manufacturing, installation and staging, and long-term O&M.[6]

Virginia commissioned an OSW Port Readiness Evaluation Report in 2015. This study evaluated port facilities for blade manufacturing, generator manufacturing, nacelle assembly, tower manufacturing, foundation manufacturing, submarine cable manufacturing, and construction staging.[7]

Workforce Skills. A nacelle factory workforce comprises 81% manufacturing labor and 19% facility management and support personnel. A detailed breakdown of the job functions is provided in Appendix A.

Assembly workers for mechanical and electrical assembly and quality control (QC) inspectors account for 71% of jobs (see Table 2). Assembly workers typically require a high school diploma and an additional small percentage require post-secondary training and/or technical certification (see Figure 3).

Table 2. Functional Areas of Nacelle and Rotor Assembly

Functional area	% of jobs
Trade workers	10%
Assembly workers	71%
Managers	5%
Engineers	7%
Other support staff	7%

6 Massachusetts Offshore Wind Ports & Infrastructure Assessment (MACEC 2017).

7 Virginia offshore wind port readiness evaluation (BVGA 2015).

Figure 3. Nordex Wind Turbine Hub Assembly

Certifications include QC Inspector for all quality managers and inspectors, and welding certification for mechanical maintenance functions (see Table 3). Welding certification requires specific skills and a combination of qualifying education and work experience.

Table 3. Post-secondary Trade or Technical Certifications Preferred in Nacelle and Rotor Assembly

Certificate	% of jobs[a]
Computer Numerical Control (CNC) Machining	0%
Welding	3%
QC Inspector	6%
Six Sigma	1%
No certifications required	91%

Note:

[a] Table may not add to 100% as some jobs require multiple forms of training/certification.

Safety certification will be required for nacelle assembly operations, primarily Occupational Safety and Health Administration (OSHA) 45001 and 18001, plus a variety of OSHA general and industry-specific safety certifications. A listing of relevant safety certification programs is provided in Appendix B.

Because assembly workers for nacelle and rotor production will not require graduate degrees or post-secondary trade or technical certificates, it is assumed that the New York workforce is sufficient to undertake nacelle assembly functions without expanding or implementing career paths specific to assembly. This should not dissuade community colleges or technical schools from expanding programs that play key roles in improving the efficiency of assembly production, such as lean manufacturing and Six Sigma certification.

Schooling, certification, and experience in lean manufacturing can increase the skills and productivity of a manufacturing production line. Both lean and Six Sigma programs are currently supported in New York at universities, community colleges, workforce development agencies, and technical institutes.

New York is equally positioned with other states along the East Coast to provide the required skilled workforce to support nacelle and rotor assembly.

3.2.2 Blades

Blades capture the wind's energy from the swept area and convert that energy into the torque needed to generate electrical power. Blades are designed as an integral part of the turbine but are manufactured as distinct components and are connected to the rotor at the time of final assembly, usually offshore.

OSW blades for turbines being installed today are 65 to 80 meters in length, but recent technology improvements have led to the development of blades in excess of 100 meters. While larger blades may increase turbine efficiency and enable larger capacity generators, they also exacerbate a number of transportation limitations that will require OSW blades to be manufactured in coastal locations, preferably near the point of final installation (see Figure 4).

Figure 4. Vestas blade Factory in Windsor, CO

Manufacturing. Sixteen blade manufacturers are located in the U.S. (eight US-owned, seven European-owned, and one Asian-owned) with 20 total facilities, but these cater to the U.S. LBW industry, which utilizes blades with a maximum length of 55 meters. LBW manufacturing facilities are unsuitable for OSW blades because of the larger blade size and difficulty of moving such large structures by road or

rail to coastal locations. Inland manufacturing of OSW blades is possible. The blades for GE's turbines for the Merkur project in Germany are being manufactured at LM Wind Power's factory at Castellón in Spain, which is 45 km from the nearest suitable port.

Of the 16 domestic manufacturers, only TPI Composites and Blade Dynamics (now owned by GE) have prototype facilities that can manufacture blades greater than 65 meters. TPI Composites' Fall River, Massachusetts site has water access, which positions the company to participate in the OSW market. Top-tier OSW turbine manufacturers have blade manufacturing facilities across Europe, primarily in Denmark, Germany, and the UK (see Figure 5).

Figure 5. Siemen's Gamesa Blade Production

The blade manufacturer will acquire the following materials: glass fiber woven mats, carbon fiber woven mats, epoxy or polyester resins, foam cores, T-bolts, barrel nuts, gelcoat, and lightning protection. These materials are not specific to OSW as they are also used for automotive and marine applications and, therefore, can be sourced from existing production facilities, domestic or international.

There are currently no blade manufacturers in New York. The top two potential composite structure suppliers in the State are Derecktor Shipyards and Scarano Ship Building. The leading third-party blade supplier, LM Wind Power, which is now a part of GE, had a similar background in composite boat building. The transition into blade manufacture from boat building may be difficult now that the market and technology have matured.

Current U.S. and European blade manufacturers are evaluating potential sites with a focus on New York, Massachusetts, Maryland, New Jersey, and Maine. It would take two to three years to fully

develop a manufacturing facility. To incentivize investment of a new facility, blade manufactures would likely require a three- to five-year contract with a wind turbine manufacturer. Most blades are manufactured in-house by turbine manufacturers, which would also require at least three years of bookings to justify investment.

Infrastructure. The size and length of OSW turbine blades require quayside manufacturing and laydown area. Next generation blades are expected to have lengths greater than 100 meters, requiring future port facilities to plan for this larger scale. Materials for blade manufacturing can be transported by standard heavy goods vehicles or sea-borne containers and stored on site in standard warehousing or suitable bulk liquid storage tanks. Typically, blades are either stored in frames for transport to the staging and installation port facility or loaded directly onto an installation vessel. If necessary, blades can be transported from the manufacturing site to a deeper water export berth using a shallow draft barge.

The minimum physical parameters assume horizontal transport of the components and use of a feeder barge:[8]

- Waterfront site area: 10 hectares
- Wharf length: 120 meters
- Vessel draft: 4 meters
- Air draft: 15 meters
- Wharf live load capacity: 2 metric tons per square meter

Currently, there are no utility-scale OSW blade manufacturing facilities or infrastructure in operation from Maine to Virginia.

Workforce Skills. A blade production facility will be about 83% manufacturing staff and 17% facility management and support personnel. A detailed breakdown of manufacturing processes and associated job functions is provided in Appendix A.

To support processes such as web and shell lay-up, trimming, sanding, and attaching other ancillary components, 68% of the jobs will be assembly workers. Another 15% of jobs will be trade workers

[8] All minimum port parameters are from New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017.

needed for material inspection, computer numerically controlled (CNC) foam cutting, root face machining, final inspection, mold repair, and mechanical and electrical maintenance (see Table 4).

Table 4. Functional Areas of Blade Production

Functional area	% of jobs
Trade workers	15%
Assembly workers	68%
Managers	7%
Engineers	4%
Other support staff	6%

Approximately 75% of all jobs will require some form of composite technology certification (see Table 5). Certified Composite Technician (CCT), which is the industry standard for composites training and certification, is offered through the American Composites Manufacturing Association (ACMA). CCT training and certification is designed to strengthen industry standards, elevate production performance, and upgrade individual levels of knowledge and skill in composites. Composite certification will apply to all assembly workers and most trade workers in a blade facility.

Table 5. Post-secondary Trade or Technical Certifications Preferred in Blade Production

Certificate	% of jobs[a]
CNC Machining	10%
Welding	0%
Composite technology	75%
QC inspector	11%
Six Sigma	4%
No certification required	11%

Note:

[a] Table may not add to 100% as some jobs require multiple forms of training/certification.

Some job functions will require other certifications in addition to composite technology certification, such as CNC Machining certification for machining, drilling and mold repair processes, and QC Inspector certification for line inspectors and quality engineers. Further information on composite certifications are provided in Appendix B. Safety certification will be required for blade production operations, primarily OSHA 45001 and 18001, plus a variety of OSHA general and industry-specific safety certifications for the overall workforce. A listing of relative safety certification programs is provided in Appendix B.

Certification is offered by national technical institutes and associations. The ACMA, located in Arlington, Virginia, offers CCT certification in the following focus areas:

- Cast polymer
- Compression molding
- Corrosion
- Instructor
- Light resin transfer molding
- Open molding
- Vacuum infusion
- Wind blade repair

No New York community colleges, universities, or technical institutes offer composite programs that could support OSW blade production. The State of Maine dominates the support of education and training programs that prepare students for ACMA composite certification.

The Institute for Advanced Composites Manufacturing Innovation states that many community colleges across the U.S. offer programs to prepare students for lucrative careers in the composite industry, including four community colleges along the East Coast. Composites education and research is also available in the Northeast region through several university technology programs. New York can consider expanding composite education and research programs similar to those currently in place in nearby states

3.2.3 Towers

Towers support the mass of the nacelle, rotor, and blades, as well as the wind forces on these components. Towers are steel conical structures manufactured from a series of welded steel cans, contributing up to 15% of the total turbine cost (see Figure 6).

Figure 6. Ventower Welding Tower Sections

The towers for a 6 to 8 MW OSW turbine are up to about 7 meters in diameter at the base and 100 meters in height, with wall thicknesses ranging from 35 to 70 millimeters. The total mass of a tower is 500 metric tons and greater. Given the size and mass of these tower sections, they will need to be manufactured close to the quayside for final build out and, ideally, loading onto installation vessels for transportation to the OSW farm.

Specialty fabricators typically supply towers to the turbine manufacturer. The tower manufacturer sources steel plates, forged steel flanges (see Figure 7), ladders, lifts and platforms, fasteners, rolled or steel plate door frames, and coatings. Electrical equipment is installed at the base of the tower to reduce nacelle mass and sourced by the turbine manufacturer.

Figure 7. Ventower Welding Tower Flange

Tower manufacturers purchase a variety of materials and components for tower production and final assembly. Internal components of towers include steel platforms, ladders and railings, wiring, conduits, lighting, and the lift assist system. These components account for roughly 15% of the total cost of the tower. Steel plate and forged flanges together account for about 60% of the total cost of the tower.

Manufacturing. Current U.S. and global tower manufactures have core competencies in the rolling and welding of steel plates. Tower manufacturing is a low margin business and suppliers will seek to automate processes and optimize high volume production. An OSW tower order may be worth $100 million or more and the manufacturer needs sufficient financial backing. An OSW tower manufacturer would ideally have two or more turbine customers to provide consistent levels of factory output and reduce supply chain risk to the customer.

Currently, there are no LBW tower manufacturers located in the northeast. Although New York has over 100 steel fabricators with the majority of them being involved in structural steel building fabrication, none of these are located at or close to coastal water transport. Any of the existing New York steel fabricators would have to acquire the OSW tower technology specifications from a U.S. or international tower manufacturer and secure a suitable coastal location. The top steel fabricators in the State include Nucor Steel in Auburn, New York and Vass Pipe & Steel in Mineola, New York.

Infrastructure. The size and mass of the OSW turbine towers requires quayside manufacturing. The larger steel plates would typically be imported by sea and rolled and welded into cans that can be assembled for towers of varying lengths. The tower is typically transported in two sections and bolted together at the staging and installation port with a single offshore lift. Finished sections have a weight of 500 metric tons or more, so heavy-lift capability and ground-bearing capacity is required. The preferred method for transporting towers and transition sections to the wind farm is in the vertical position with the use of a jack-up vessel. If necessary, towers can be transported horizontally from the manufacturing site in a shallow draft barge to a deeper export berth, but this would require double handling of the units.The minimum physical parameters assume horizontal transport of the components and use of a feeder barge:[9]

[9] All minimum port parameters are from New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017.

- Waterfront site area: 10 hectares
- Wharf length: 50 meters
- Vessel draft: 4 meters
- Air draft: 15 meters
- Wharf live load capacity: 5 metric tons per square meter

Workforce Skills. A tower production operation will be 80% manufacturing labor and 20% management and support personnel. A detailed breakdown of the manufacturing processes and associated job functions is provided in Appendix A.

To support the many fabrication, welding, and inspection processes, qualified trade workers will account for 55% of total production jobs (see Table 6). About 25% of jobs are assembly workers for sand blasting, painting, coating, mechanical and electrical installations, and packaging functions.

Table 6. Functional Areas of Tower Production

Functional Area	% of jobs
Trade workers	55%
Assembly workers	25%
Managers	9%
Engineers	6%
Other support staff	5%

Wind towers are fabricated in segments and welding is needed to create each "can" and combine them to form each of the three sections. A welding certification, will be mandatory for approximately 40% of the total jobs which requires specific skills plus a combination of qualifying education and work experience. QC inspector certification will be needed for all quality inspectors and quality managers, which account for approximately 12% of jobs (see Table 7).

Table 7. Post-secondary Trade or Technical Certifications Preferred in Tower Production

Certificate	% of jobs[a]
CNC Machining	4%
Welding	40%
QC inspector	12%
Six Sigma	6%
No certification required	39%

Note:

[a] Table may not add to 100% as some jobs require multiple forms of training/certification.

Safety certification will be required for tower production operations, primarily OSHA 45001 and 18001, plus a variety of OSHA general and industry specific certifications for the workforce. A listing of relative safety certification programs is provided in Appendix B. Availability of technical training for the New York workforce will continue to be key as the OSW industry begins to take shape in the US.

A majority of the jobs for tower production are trade workers requiring welding skills and certification. New York has well established training programs with at least nine colleges and technical school programs in welding that prepare students for the required American Welding Society (AWS) welding certifications, or the New York State Department of Transportation (DOT) field welding certification. According to the American Jobs Center, New York is projected to have an 8% increase in employment for welders, cutters, solderers, and brazers by 2024, compared to a 4% increase nationally.

New York has several community colleges, State and private universities, technical institutes, and industry organizations that currently offer education and hands-on skills training in preparation for industry certification.

Students can find welding programs at many community colleges or Board of Cooperative Education Services (BOCES) centers, and technical institutes that provide the education and training necessary for welding certification. These are listed in Appendix B.

Regionally, programs are limited, with only one training center in Massachusetts and three in New Jersey. Maine has five colleges with training centers for welding, and Virginia leads the Atlantic coast states with more than 20 colleges and technical institutes offering welding programs.

3.3 Balance of Plant

3.3.1 Foundation

For this study, the analysis of the foundation sub-element has been limited to the jacket foundation, including the fabricated tower transition piece. A jacket foundation can leverage current U.S. infrastructure and is likely to be the choice for New England projects. The other types of foundations in use today, although not detailed in this study, are monopiles, tripods, tripiles, mono-suction bucket, and gravity bases. The project developer and engineering firms determine the best type of foundation for a given location based on water depth, sea floor and geologic conditions, wave loading, turbine

loading, and cost. The manufacturing requirements of different steel foundation types are generally similar, although jackets typically use less steel than a monopile but need a larger labor force. Gravity foundations, which have not been widely used to date, are likely to have a concrete base and a steel tubular upper structure.

A jacket foundation is a three- or four-legged lattice structure consisting of corner tubulars 1 to 3 meters in diameter interconnected with bracings with diameters between 0.5 and 1 meter (see Figure 8). The transition piece forms the connection between the main jacket and the tower of the wind turbine. The jacket is secured to the sea bed with driven pin piles, typically 50 meters tall and 2 meters in diameter. Pin pile systems may also be used to secure the foundations to the sea bed. The dimensions of the main lattice start at 18 meters by 18 meters at the base, and 10 meters by 10 meters at the top with a height of 40 meters.

Figure 8. Fabrication of the Block Island Foundations at Gulf Island Fabrication in Houma, Louisiana

The jacket foundation provides the support for the wind turbine in water depths of 30 to 60 meters. With the size and mass of foundations at final assembly, the foundation will need to be manufactured close to the quayside for final build out and loading onto vessels for transport to the OSW farm. An option is the remote production of jacket sections with more local final assembly. A staging and installation port will be needed if the manufacturing site is a long way from the wind farm location.

Materials account for about a third of the total cost of the foundation, with labor accounting for the remaining two-thirds. The foundation contributes up to 13% of the total life cycle cost of an OSW farm.

Manufacturing. Four U.S. and eight global foundation manufacturers have core competencies in the rolling and welding of steel plate and tubular pipe braces. Foundation manufacturing is a low-margin business, and suppliers will seek to automate processes and optimize high-volume production. An OSW foundation order may be $150 million or more, requiring the manufacturer to have sufficient financial backing. Several European jacket manufacturers have faced financial difficulties. An OSW foundation manufacturer would ideally have two or more turbine customers in order to support consistent levels of factory output.

Currently, there are no current foundation manufacturers in New York. As mentioned in Section 3.2.3, New York has over 100 steel fabricators, but all would require product modification or expansion to support OSW foundation production.

None of the current U.S. foundation manufacturers are located in the Northeast region. Jacket foundations are used today in the oil and gas industry and are being made in the Gulf region by companies such as Kiewit, Gulf Island Fabricators, Keppel AmFELS and Enerfab. The disadvantage to the Gulf region is the cost and time to transport materials to the Northeast. However, this region may also benefit from lower average wages and the availability of coastal infrastructure.

Infrastructure. The size and mass of the OSW turbine foundations require manufacturing at quayside. Specialized moving equipment such as self-propelled modular transporters can be used to transport the large sections on site. The main jacket structure can have a weight of 600 to 800 metric tons, so heavy lift capability and ground bearing capacity is required. Finished foundations such as jackets or monopiles are exported by barge using onshore cranes for loading and transportation to the staging and installation port or transported directly to the wind farm site for installation. Heavy lift vessels are used to place the jacket foundations on location. These same vessels may collect the foundations from the port or a feeder vessel may be used.

4.1.2 High Market, Base Local Content

Key Figures
• The annual demand for New York workers from New York and non-New York projects peaks in 2029 at 1,950. • The annual demand for New York workers from only New York projects peaks in 2029 at 1,900. • Total expenditure in New York is $4.3 billion.

The demand for workers in the high market, base local content scenario peaks at almost 2,000 in the years 2029 and 2030 (see Figures 21 and 22 and Table 19). Although there is demand in the Northeast for workers from new manufacturing facilities, New York does not have existing suppliers or infrastructure and the lack of intervention in New York means these jobs are provided from other states. Although relatively local staging and installation ports will be needed for New York projects, suitable facilities at lower cost with little logistical penalty are likely to be found in neighboring states for early New York projects. In this scenario, the demand for workers is mainly for baseline jobs in project management and development, local support services in installation and commissioning, and day-to-day O&M.

Nevertheless, New York is likely to provide some local support to offshore installation, with crew vessels and accommodation vessels using New York port facilities.

In this scenario, O&M creates the biggest opportunity because the proximity of the operations base to the wind farm is the over-riding factor. The development of New York OSW farms creates a demand for specialist wind farm maintenance services that is met by New York companies. These may be existing New York companies or companies from outside the State with relevant skills that decide to develop a New York base. With first mover advantage, these companies are well placed to win business at other northeast wind farms. Even for New York wind farms built before 2030, the demand for New York workers persists for the long-term operation of its wind farms.

Installation and commissioning also creates a demand for workers from the use of a New York staging and installation port for later projects. Staging and installation ports in themselves do not create a significant demand for workers with the major employers being the installation contractors and the turbine manufacturer's installation teams.

Table 8. Functional Areas of Foundation Production

Functional area	% of jobs
Trade workers	76%
Assembly workers	15%
Managers	5%
Engineers	2%
Other support staff	2%

Advanced welding skills are needed for foundation production. Certified welders will be required for foundation production, accounting for 69% of the total jobs (see Table 9). Quality managers and quality inspectors, which represent approximately 11% of jobs, will require QC certification. Some job functions will require more than one certification, including all quality inspectors and quality engineers.

Table 9. Post-Secondary Trade or Technical Certifications Preferred in Foundation Production

Certificate	% of jobs[a]
CNC Machining	0%
Welding	69%
QC inspector	11%
Six Sigma	2%
No certification required	29%

Note:

[a] Table may not add to 100% as some jobs require multiple forms of training/certification.

Safety certification will be required for foundation production operations, primarily OSHA 45001 and 18001, plus a variety of OSHA general and industry specific certifications for the workforce. A listing of relative safety certification programs is provided in Appendix B.

A majority of the jobs for foundation production are trade workers requiring welding skills and certification. As stated for towers, New York has well established training programs with at least nine colleges and technical school program identified in welding that prepare students for the required AWS welding certifications, or the DOT Field Welding certification.

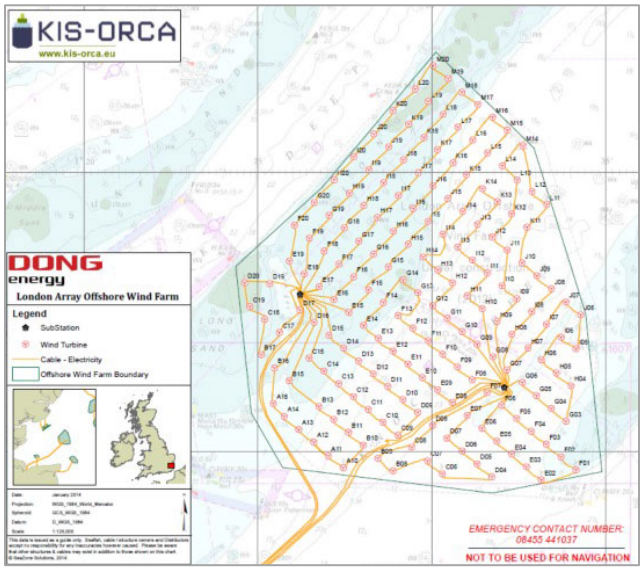
3.3.2 Array and Export Cables

Array cables (typically rated up to 66 kV) connect the turbines to the offshore substation platforms to collect the power generated at each turbine before being transmitted to shore (see Figure 10).

Export cables (rated up to 320 kV) connect the offshore and onshore substations, and are heavier than array cables and typically needed in longer lengths. Ideally subsea cables are loaded onto an installation vessel at the manufacturing facility, but onshore or offshore storage may be necessary depending on the installation timetable. If the manufacturing facility is a long way from the wind farm site, the cable may be transported as freight on carousels or reels. Cable cores may be manufactured inland but future manufacturing can occur only at sites with suitable waterfront, ideally coastal, infrastructure.

The array and export cables contribute up to 2% of the total life cycle cost of an OSW farm.

Figure 10. Array and Export Cable Routes for the London Array Wind Farm



Manufacturing. There are 15 global manufactures of subsea cables, with 10 located in Europe and five in Asia. Three of the European manufacturers have a presence in the U.S., but their facilities have not been used for subsea cables. Prysmian and Nexans both have high-voltage cable manufacturing plants in South Carolina for LBW applications (see Figure 11).

There are no current subsea cable manufacturers in New York, though there are several copper wire and cable manufacturers that could serve as a supplier of copper wire to a subsea cable manufacturer. Examples of these suppliers include Omega Wire and OWL Wire & Cable, LLC.

Infrastructure. The scale and mass of the OSW cables will require manufacturing at quayside or in proximity where cables can be loaded directly onto the cable installation vessels (see Figure 12). The production process is typically laid out in long horizontal bays with gantry cranes to move finished components. Finished components are stored on large-capacity carousels or reels inside or outside the factory. Export cable comes in long lengths and is typically spooled from the manufacturing facility directly onto a cable laying vessel for installation at the wind farm. Array cables are loaded and transported in a similar fashion. Logistics and parts supply would likely be from a local port during the installation process.

Figure 11. Prysmian Lexington SC High-Voltage Cable Factory

Figure 12. ABB Cable Manufactured and Loaded onto Installation Vessels at Karlskrona, Sweden[11]

The minimum physical parameters of a cable manufacturing facility are as follows.[12]

- Waterfront site area: 12 hectares
- Wharf length (if needed): 125 meters[13]
- Vessel draft: 12 meters
- Air draft: 50 meters
- Wharf live load capacity: 5 tons per square meter

Currently, there are no utility-scale OSW cable manufacturing facilities or infrastructure in operation from Maine to Virginia. Subsea cables for OSW farms are currently manufactured in Europe and Asia.

Workforce Skills. The export and array cable workforce will be 86% manufacturing labor and 14% management and support staff, running a two-shift operation. A detailed breakdown of the manufacturing processes and associated job functions is provided in Appendix A.

To support the mechanical extrusion and assembly and inspection processes, 81% of the jobs will be assembly workers (see Table 10). Only 5% of the jobs will be trade workers for electrical and mechanical maintenance functions.

---

11 The factory has recently been acquired by NKT Cables.

12 All minimum port parameters are from New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017.

13 Some subsea cable factories, such as Prysmian's at Arco Felice in Italy, do not have deep water access and spool the cables along a pier.

Table 10. Functional Areas of Cable Production

Functional area	% of jobs
Trade worker	5%
Assembly worker	81%
Managers	6%
Engineers	5%
Other support staff	3%

Assembly workers, for the most part, will not require any specialty skills, post-secondary training, or technical certification. Only 5% of workers will require CNC Machining certification for the mechanical and electrical maintenance functions, and 6% will require QC inspection certificates for material and final inspection functions (see Table 11).

Table 11. Post-Secondary Trade or Technical Certifications Preferred in Cable Production

Certificate	% of jobs[a]
CNC Machining	5%
Welding	0%
QC inspector	6%
Six Sigma	3%
No certification required	85%

Note:

[a] Table may not add to 100% as some jobs require multiple forms of training/certification.

Safety certification will be required for subsea cable production operations, primarily OSHA 45001 and 18001, plus a variety of OSHA general and industry specific certifications for the workforce. A listing of relative safety certification programs is provided in Appendix B.

No specific submarine cable engineering career paths were identified in New York. This should provide an opportunity for New York technical institutes to partner with established European submarine cable engineering training programs.

Subsea power cable development that will support OSW needs will be a new industry for the U.S. No training or education career paths specific to submarine power transmission cable design, production, or installation were identified in the Northeast.

3.3.3 Substation Supply and Operational Infrastructure

Substation infrastructure can be considered in two segments: the electrical system, and the platform and foundation.

The electrical system consists of switchgear and reactive compensation systems, high-voltage transformers, and low-voltage systems. Most substations work with alternating current, but wind farms located further than 80 kilometers from shore may wish to convert the power to direct current. Direct current systems are generally more expensive, but these costs are offset by lower electrical losses than an alternating current system.

The platform houses the electrical system, along with blast protection, emergency accommodations, and structural elements such as walkways and gratings (see Figures 13 and 14). The onshore substation contains similar components, with the likely addition of a wind farm control room.

The foundation may be a monopile or a jacket. For purposes of this analysis, it is assumed that substations are supported by the jacket foundations that were analyzed in the previous section. Therefore, this section focuses only on the substation electrical system and platform.

Figure 13. Westermost Rough Wind Farm Substation in Yorkshire, UK

Figure 14. Veja Mate Offshore Substation

Manufacturing. The main electrical components are the transformers, reactors, and switchgear.

Substations use one or more large power transformers (LPTs) up to 500 mega-volt amperes (MVA). In addition to the opening of Georgia Transformer's facility in Rincon, Georgia, in 2010, at least three new or expanded facilities now produce extra-high-voltage LPTs in the U.S., including SPX's plant in Waukesha, Wisconsin, and Hyundai Heavy Industries' newly inaugurated plant in Montgomery, Alabama. In addition, Mitsubishi Heavy Industries proposed to locate a plant in Memphis, Tennessee. GE has a transformer plant in Shreveport, Louisiana.

Reactors are needed because transmission along subsea cables creates capacitive resistance as a result of voltage and current becoming out of phase. Reactive compensation reverses this phenomenon.

Substations use medium-voltage switchgear (at the array cable voltage) and high-voltage switchgear (at export cable voltage). These switchgear bays may be kept separate because the high-voltage transmission assets are typically under separate ownership from the medium-voltage wind farm assets. Both onshore and offshore substations use gas-insulated switchgear because these use less space than air-insulated switchgear.OSW substation electrical components are not significantly different from those used in onshore power transmission and distribution.

No LPT manufacturers currently exist in the Northeast, and the aging regional electric grid infrastructure will likely require replacements in the near future. This provides an opportunity for a New York LPT factory, which could require 300 employees, to capitalize on the emerging OSW industry and the aging electric grid.

The substation platform is similar in construction to an offshore oil or gas platform. OSW substations, however, are generally custom-built for a specific project, and unlike foundation production, do not require investment in serial manufacturing capability. Manufacturers can supply both the OSW and oil and gas sectors. This will favor offshore fabricators in the Gulf.

Infrastructure. Component equipment such as steel plate, power electronics, wiring, transformers, and associated equipment can arrive by multiple transportation methods. The manufacturing process, conventional or self-installing jack-up, involves the fabrication of complex, integrated systems. Final assembly requires heavy-lift cranes for large components. The finished units can have dimensions upwards of 30 meters by 50 meters and weigh hundreds to thousands of metric tons. Substations are typically custom-built for a specific project, although there have been some attempts to standardize. These manufacturing sites typically require heavy lift and ground bearing capacity. Heavy-lift vessels are required to transport the substation from the manufacturing site to the installation site.

Below are the minimum physical parameters for a substation manufacturing facility[14]. These parameters are based on the minimum vessel size required to transport a typical substation unit. Because few substations are needed relative to other components, electrical components are typically manufactured in the same facilities that manufacture onshore electrical components, as opposed to a dedicated facility. The foundations for the substations may be manufactured at the same facility as the turbine foundations. They are rarely contracted together because of the different ownership of the wind farm and transmission assets in most territories.

- Waterfront site area: 10 hectares
- Wharf length: 50 meters
- Vessel draft: 4 meters
- Air draft: 40 meters
- Wharf live load capacity: 20 metric tons per square meter

Currently there are no utility-scale OSW substation manufacturing facilities in operation from Maine to Virginia, although shipbuilders exist with core competencies and infrastructure to fabricate and assemble these substations. There are numerous shipyards along the U.S. East Coast that could be utilized for this purpose.

---

[14] All minimum port parameters are from New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017.

Workforce Skills. The substation supply and support structure production will be 74% manufacturing labor and 26% management and support staff. A detailed breakdown of the manufacturing processes and associated job functions is provided in Appendix A.

To manufacture the substation electrical system, 46% of the jobs will be trade workers specializing in welding (see Table 12). Assembly workers account for 29% of jobs, supporting component assembly, material movement, and inspection functions.

Table 12. Functional Areas of Substation Production

Functional area	% of jobs
Trade workers	46%
Assembly workers	29%
Managers	8%
Engineers	8%
Other support staff	9%

Welding certification is the primary skill requirement for installing the many electrical components and support frames for the substation, required by 51% of all workers (see Table 13). Approximately 42% of job functions will not require any trade or technical certifications.

Table 13. Post-Secondary Trade or Technical Certifications Preferred in Substation Production

Certificate	% of jobs[a]
CNC Machining	0%
Welding	51%
QC inspector	9%
Six Sigma	7%
No certification required	42%

Note:

[a] Table may not add to 100% as some jobs require multiple forms of training/certification.

Safety certification will be required for the substation production operations, primarily OSHA 45001 and 18001, plus a variety of OSHA general and industry-specific certifications for the workforce. A listing of relative safety certification programs is provided in Appendix B.

A majority of the jobs for substation foundation production are trade workers requiring welding skills and certification. New York has well-established training programs with at least nine colleges and technical school program identified in welding that prepare students for the required AWS welding certifications or the DOT field welding certification.

For the assembler functions, New York is equally positioned with other East Coast states to provide the required workforce to support the substation assembly.

3.4 Installation and Commissioning

Installation and commissioning involves the final assembly of the wind turbines onshore; the transport of the foundations, towers, turbines, and cables to the offshore site; the installation of all components; and the commissioning of the facility.

There are several approaches to OSW turbine installation. The most common practice in Europe is to use a self-propelled jack-up vessel known as a wind turbine installation vessel (WTIV) to erect the fully or partially assembled tower and install the nacelle, hub, and individual blades. Up to 10 turbine sets have been carried on a vessel, but four sets is the norm for 6 to 8 MW turbines. Several vessels are undergoing modifications to keep them suitable for installation work, usually involving increases in the crane capacity and lift height. Figure 15 presents a rendering of Geosea's new-build installation vessel Orion, a next-generation installation vessel due to enter service in 2019.

Figure 15. Geosea's New-build Installation Vessel Orion (due to enter service in 2019)

The developer controls the installation and commissioning process, procuring all equipment and selecting which companies will carry out the work. The installation and commissioning process requires various types of vessels for installation and support and supply of sea fastenings, mobilization, and crew services. The main installation vessels are heavy-lift vessels, WTIVs, and cable-laying vessels. Few suitable vessels are Jones-Act compliant, though cable installation is generally not considered as being within the scope of the Act. The other more common relevant vessels in use today in New York are tugs, general cargo (coasters), construction vessels, barges, crew transfer vessels, accommodation vessels, and dive support vessels.

The Jones Act requires any ship that carries goods (cargo) between two U.S. points to fly a U.S. flag and to be registered in the U.S. Once an OSW turbine foundation is installed, it is then considered a point. This means that WTIVs sailing from European countries would not be able to dock in the U.S. and subsequently transit with cargo to the turbine installation site. Currently, there are no U.S.-flagged WTIVs.

One possible solution is for a specialized foreign installation vessel to work and remain offshore, but not bring cargo from the port to the point where the turbine is being built. The installation vessel would be supplied with the wind farm components by U.S.-flagged feeder vessels. The transfer of nacelles and blades has not been attempted for technical cost and safety reasons. Even if technical and safety issues can be resolved, this is a costly option for turbine installation because more vessels need to be mobilized and, for a commercial-scale wind farm, the feeder vessels would need to be able operate in the same sea conditions as the WTIV, which uses its jack-up legs for stability.

Jackets are typically installed in a two-stage process, with piles installed first, followed by the transition sections. If monopiles are used, piling is followed by the installation and grouting of the transition piece, usually by the same vessel.

Many installation vessels have been used for both turbine and foundation installation, but the fleet is increasingly diverging. Turbine installation vessels need to make high lifts but at low tonnage, while foundation installation typically needs greater lift capacity but at lower heights. Foundations may be installed from a floating vessel, and this can be quicker because jacking up and down is weather sensitive and takes several hours. GeoSea's Orion is one of three new vessels developed for the European foundation installation market (see Figure 15).

As described in Section 3.3.2, export cables are typically loaded directly from the cable manufacturing facility onto a specialized cable installation vessel and transported to the installation site. Array cables are shorter in length and can be pre-cut and stored on the installation vessel or stored on drums or carousels for delivery to the staging and installation port for subsequent installation. Jet plowing equipment is typically deployed in conjunction with the cable-laying vessel to provide burial of the cable. There are variations on this approach depending on soil conditions.

The long-term development of the American OSW industry will demand U.S.-built specialized vessels if it is to achieve costs of energy in line with those in Europe.

Infrastructure. Staging and installation port facilities are the final assembly and deployment facilities for the construction of wind farms. Ideally, these facilities, also referred to as marshalling ports, are situated close to the wind farm to minimize transit time to the wind farm sites and to lower construction risk. Staging and installation ports typically receive shipment of components (towers, blades, and nacelles) for trans-shipment and installation at the wind farm site (see Figure 16). The logistics for the operation of a staging and installation port must be well-timed and choreographed.

Figure 16. MHI Vestas Nacelle Arrives for Pre-assembly in Belfast for Orsted Energy's Burbo Bank Extension OSW Farm

For a 100-unit installation, the installation of foundations would ideally occur in the first construction season, followed by installation of the turbines in the second construction season. This requires sites of sufficient size for laydown area and the movement of components. Significant load-bearing capacity is required, as is the ability to move components on and off ships in an efficient manner. Crawler cranes with the ability to lift hundreds of metric tons are needed. Components may arrive by coaster,

barge, or other vessels to be stored on-site and subsequently loaded onto WTIVs or heavy-lift vessels for transportation to the installation site. Sufficient laydown of components may be needed to meet to meet the construction schedule.

The minimum physical requirements for an installation facility are listed below.[15] Ranges are provided for
wharf length and vessel draft to accommodate two different vessel types. The lower bound of these ranges represents a feeder barge, while the upper bound represents a WTIV.

- Waterfront site area: 10 hectares
- Wharf length: 100 to 200 meters
- Vessel draft: 4 to 12 meters
- Air draft: 120 meters
- Wharf live load capacity: 20 metric tons per square meter

Ports in the New York Harbor area are particularly well-suited for staging and installation port facilities.

Workforce Skills. Approximately 86% of the installation and commissioning jobs are projected to be for construction and marine labor trade workers; management and support personnel will make up the remaining 14% (see Table 14). Detailed breakdowns of the work processes and associated jobs are provided in Appendix A.

Table 14. Functional Areas of Installation and Commissioning

Functional area	% of jobs
Trade workers	86%
Assembly	0%
Managers	5%
Engineers	3%
Other support staff	6%

Trade workers will include electrical and mechanical fitters, riggers, marine engineering technicians, and wind turbine technicians. Heavy-lift crane vessels are often used to place the foundations, towers, nacelles, and blades into position. The equipment needed to lift and guide these into position needs skilled technical operators. Cable laying is performed by specialized companies that employ technicians

[15] All minimum port parameters are from New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017.

who may work four weeks at sea (12 hours a day, seven days a week) followed by four weeks leave. These technicians may have degrees in mechanical or electrical engineering and qualifications to handle special pieces of equipment. Ports are expected to employ electrical and mechanical fitters to perform some of the offshore work, as well as skilled crane operators and riggers to handle the heavy turbine components. Support staff will include specialty job functions such as logistics and operations, quality inspectors, and geology engineers.

Trade workers will likely require some form of post-secondary education or trade or technical certification to support final assembly of components at the port. For 63% of these trade workers, apprenticeship training will be preferred (see Table 15) to qualify for installation and commissioning job functions that are portside (final assembly and preparation of components) or on vessel (installation of components). Original equipment manufacturers and vessel suppliers will each have their own operations certification process that will qualify staff for final assembly and installation of the component. Apprenticeship programs are the prerequisite for operations certification and can be provided by local unions and other organizations, in partnership with component manufacturers and vessel contractors. Some job functions will require additional certifications for quality inspector and mechanical fitter job functions. A list of apprenticeship training programs, and associated labor union and independent sponsors that registered through the DOL can be found in Appendix B.

Table 15. Post-secondary Trade or Technical Certifications Preferred in Installation and Commissioning

Certificate	% of jobs[a]
Apprenticeship training / OEM operations	49%
Welding	9%
QC inspector	4%
Ship master	7%
No certification required	40%

Note:

[a] Table may not add to 100% as some jobs require multiple forms of training/certification.

Safety certifications will be required for installation and commissioning operations, including Standards of Training and Certification of Watchkeeping (STCW) Basic Safety Training and the Global Wind Organisation (GWO) certifications for all workforce that will be on vessels conducting installation tasks. Additionally, a variety of OSHA safety certifications will be required for the general workforce. A listing of relative safety certification programs is provided in Appendix B.

New York apprenticeship certification training programs exist for a wide variety of trades, many of which are applicable to the OSW industry. The DOL is empowered to oversee this process of apprentice certifications by working directly with trade groups to establish new programs.

The Central New York Joint Apprenticeship and Training Committee develops a skilled, knowledgeable, and able workforce for the unionized electrical industry within the Central New York area. The International Brotherhood of Electrical Workers Local 43 and the Finger Lakes National Electrical Contractors Association jointly sponsor this apprenticeship program, which offers the opportunity to earn wages and benefits while learning the skills necessary for a career as a construction electrician.

The Central New York Joint Apprenticeship and Training Committee currently offers a program for inside wiremen, also referred to as journeyman electricians, who primarily perform electrical construction work in commercial and industrial settings. This is a highly skilled person who must complete a five-year apprenticeship that includes the planning and installation of complete electrical systems. Inside wiremen install conduits, electrical wiring, fixtures, and electrical apparatus for a range of industrial settings, including wind farms.[16] As an example, for OSW component installation, a certified inside wireman could fill the job function of electrical fitter, who would install, connect, and check electrical equipment during pre-commissioning of the wind turbine or substation while at the port, or offshore during testing and commissioning of cables, turbines, or substations.

Onboard the turbine installation vessel, the turbine manufacturer generally deploys its own workforce to complete any required final assembly of the turbine before and after the offshore lift. The turbine supplier may offer mechanical and electrical apprenticeships to support these job functions or may recruit and retrain local workers already trained and experienced from other industries.

New York is home to the State University of New York Maritime College, which provides a variety of maritime courses, including those required for certification by STWC.

---

[16] A full list of the trades apprentice job descriptions registered with the State of New York can be viewed at https://www.labor.ny.gov/apprenticeship/general/occupations.shtm. A list of State-registered Sponsors and Training Programs for Trades certifications are available at https://www.labor.ny.gov/apprenticeship/sponsor/index.shtm.

The Seaman's Church Institute, although headquartered in New York, has two maritime training centers in Texas and Kentucky that provide a variety of maritime training, American Waterway Operators—Responsible Carrier Program programs, and STWC certification.

Military Sealift Command has compiled a nationwide list of U.S. Coast Guard-approved maritime training schools. Programs in New York include the Sea School in Baldwin and the New School of Seamanship in Staten Island. Graduate degrees in maritime disciplines are available at the U.S. Merchant Marine Academy at Kings Point.

3.5 Operations and Maintenance

O&M activities for wind farm operation, turbine maintenance, subsea cable maintenance, and substation maintenance are carried out over the entire lifetime of a wind farm (see Figures 17 and 18). It is vital to keep everything running reliably and efficiently, and to fix problems quickly to maximize the amount of power generated.

Figure 17. OSW Turbine Maintenance

Figure 18. Siemens OSW Blade Repair

There are supply chain opportunities for suppliers of transport vessels and helicopters that are used to transport maintenance crew, service parts, and equipment from the operations port to the wind farm. Other opportunities involve the service replacement parts, repair parts, oil, lubricants, filters, and other ancillary parts. The wind turbine manufacturers have lists of typical spare parts needed for a given model and most are willing to work with local distributors.

Developers typically enter into a service agreement with the turbine manufacturer, which may be for five to 15 years depending on its O&M strategy. On expiry, the developer may extend the agreement, award the contract to a third-party service provider, or bring the service in house. The service agreement will cover planned maintenance, generally in the summer, and unplanned maintenance, some of which may require jack up vessels for the repair or replacement of components. The current generation of wind turbines have been designed for high reliability and maintainability, recognizing that failures can lead to significant periods of downtime during severe weather when energy yields are high.

There is also a need for balance of plant inspection and repair. The foundations need to have structural checks and be kept free of marine growth. The foundation platform and boat-landing system need to be kept clean to keep the working environment clean and safe.

Cable repair is a key service because faults can prevent power export to the grid. Cable failure continues to be a problem; in European OSW they are the single biggest source of insurance claims. Wind farms will typically store sections of spare cable and cable joints. Cable repairs are typically undertaken by the same companies that install them.

Infrastructure. O&M facilities provide operational support for the wind farm after construction is completed. These facilities are typically in operation for 25 years or more, and provide wharf and docking space for crew transfer vessels and the ability to transport smaller components for service and repairs. Ideally, they are located close the wind farms to minimize distance and travel time. Service is conducted on a regular annual schedule and repairs must be completed in a short time frame to minimize the time the turbines are off-line. Typical vessels are twin hulled for maximum stability, comfort, and speed. These vessels typically are up to 20 meters in length, have a shallow draft of 2 meters, and provide room for passengers and crew of 15, a small cargo space, and a crane.

The minimum O&M facility parameters are as follows[17]:

- Waterfront site area: 4 hectares
- Wharf length: 20 meters
- Vessel draft: 5 meters
- Air draft: 20 meters
- Wharf live load capacity: 2 metric tons per square meter

An O&M port needs to be available 24 hours a day and a developer will, therefore, avoid tidal or lock-bound ports, those with competing access from other users or where activity is prohibited at night.

Currently, there is a single U.S. O&M facility in operation at Quonset Point, Rhode Island, for the Block Island Wind Farm. Quonset Point is managed by the Quonset Development Corporation. Rhode Island has committed $90 million to upgrade facilities (Pier 2) to provide support activities for other potential wind farms.

Numerous regional ports are physically suited for O&M and will look to capitalize on the pipeline of OSW projects expected to come online in the mid-2020s. New York's Long Island is particularly well positioned to serve as an O&M hub given its proximity to OSW lease areas.

[17] All minimum port parameters are from New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017.

Workforce Skills. As O&M positions are required throughout the lifecycle of an OSW farm, these jobs provide long-term stability for skilled workers. There are opportunities for both graduates and non-graduates within O&M, from engineers and technicians who work on the turbines and other wind farm equipment, to skippers of vessels who ferry workers to and from the wind farm site.

For the total O&M workforce, 80% of workers will be conducting direct O&M functions as trade workers, with O&M management and support staff making up the remaining 20% of jobs (see Table 16). Trade workers will serve as wind turbine technicians, heavy-lift crane vessel operators, helicopter pilots, skippers, marine engineering technicians, and deckhands. A detailed breakdown of the O&M processes and job functions is provided in Appendix A.

Table 16. Functional Areas of O&M

Functional area	% of jobs
Trade workers	80%
Assembly	0%
Managers	7%
Engineers	4%
Other support staff	9%

Apprentice training and operations certification will be required for 31% of the O&M jobs. Apprentice training will be a prerequisite for attaining the operations certification for job functions such as wind turbine technician, heavy-lift crane vessel operator, and marine technician (see Table 17). A list of apprenticeship programs, and associated labor union and independent sponsors that are registered through the DOL is provided in Appendix B.

Safety certification will be required for O&M staff, including the STCW and the GWO certifications that are needed for all workforce operating from vessels. Additionally, a variety of OSHA general and construction specific certifications will be required for the general workforce. A listing of relative safety certification programs is provided in Appendix B.

Table 17. Post-secondary Trade or Technical Certifications Preferred in O&M

Certificate	% of jobs
Apprenticeship training / OEM operations	31%
Welding	0%
QC inspector	4%
Ship master	4%
No certification required	61%

Wind turbine manufacturers often retrain electricians, plumbers, and ex-military staff who have previous apprenticeship training and transferable skills. Deck crew members can start their careers with basic maritime qualifications, while boat skippers will have trained for a ship's master qualifications, which gives them the skills and experience to be responsible for the boat and its crew.

Most OSW turbines are maintained by the turbine manufacturer as part of a service agreement. Wind turbine technicians are based at the operations port and are responsible for the day-to-day maintenance of the wind farms, which includes traveling to and from the wind turbines daily.

Maintenance training programs are generally provided by the component manufacturers and vessel contractors. New York community colleges and technical institutes could partner with these prime contractors to develop joint training programs to satisfy the requirements of OSW O&M. As LBW has developed, several wind turbine manufacturers have collaborated with community colleges to implement training programs to support wind turbine maintenance. GE affiliate Granite Services International has expanded its wind technician training programs at Mesalands Community College's North American Wind Research and Training Center in Tucumcari, New Mexico. Chicago-based Goldwind Americas and Casper College of Casper, Wyoming, announced in 2017 that they are partnering to host the first two-week wind technician training course. Northern Maine Community College created a wind power technician program in collaboration with industry partners such as Vestas. These LBW maintenance programs are examples of how OSW O&M training programs can be developed at New York community colleges in collaboration with OSW component manufacturers.

OSW farm O&M is a new industry and all states will be in the same position as the OSW industry develops. Land-based wind turbine O&M technicians would have a skills advantage transferred to the offshore industry, although the equipment will be larger and of a different model, requiring some additional training.

3.6 Discussion

Transportation constraints limit the manufacturing and assembly of most OSW components to quayside facilities. These facilities must also accommodate the demanding technical specifications required to store, haul, and load OSW components.

There are relatively few suitable port facilities in the northeastern U.S. eith the potential to efficiently serve OSW, especially when considering the distance to existing wind energy areas. New York is ideally positioned to support regional wind farms due to its proximity to existing wind energy areas, its extensive coastline, its access to port facilities along the Hudson River, and the scale and versatility of New York Harbor. The utilization of in-State port resources will be critical for New York State to capture a significant portion of the OSW supply chain, as local ports will drive workforce and manufacturing demand.

New York has the potential to host all the port facilities required for the construction of an OSW farm. There will, however, be significant competition from both neighboring states and international suppliers. Appendix C analyzes potential sites in New York, considering their ability to support the various elements of the supply chain. In preparation for the arrival of OSW, New York is considering the ability of its workforce to serve the needs of these various facilities.

This section has identified the strengths and weaknesses of New York's workforce as applied to the OSW industry. In general, New York's existing academic institutions, technical schools, and labor training programs are well suited for the demands of OSW. However, there are several training and certification areas that should be considered for expansion or incremental investment:

- **Composite technology** – Certification in composites is expected to be required for various elements of turbine manufacturing, primarily blades. Certification is currently offered through the ACMA, but no in-state educational institutions offer suitable programs.
- **Welding** – Various levels of welding certifications are required across the OSW supply chain, as this skill is required for not only the fabrication of turbine components and foundations, but also for repair and maintenance. New York has well-established welding certification programs through colleges and technical schools that prepare students for AWS and DOT welding certifications, but these programs may require expansion to supply the increasing demand provided by OSW and other industries.

- **Apprenticeship training / operations certificates** – Apprenticeship training is a pre-requisite for OEM and vessel supplier operations certification, and thus existing programs should be examined to ensure alignment with the demands of OSW. Apprenticeships exist for electricians, iron workers, machinists, skilled construction laborers and operating engineers, among others. These programs are prevalent throughout New York, and are sponsored primarily by labor unions and private organizations. While operations certificates are applicable for O&M and installation workers, apprenticeship programs may also be valuable for trade workers in the turbine manufacturing and balance of plant sectors, though not explicitly required.
- **STCW safety training** – While STCW is readily available in New York, current providers should coordinate with OSW vessel suppliers to ensure that training standards are aligned. STCW training is required for all personnel on seagoing ships, which includes installation and commissioning and O&M workers.
- **GWO safety training** – GWO training is expected to be required for all installation and commissioning and O&M workforce. There are limited GWO training programs in the U.S, and none along the east coast. GWO training consists of various modules, and current U.S. programs support all modules except for Sea Survival, which is applicable for OSW. Various other sea survival training program exist in the U.S., catered to industries such as oil and gas, fishing, and sailing, but it is unclear if these will be accepted for OSW.
- **Ship Master qualification** – Though only required by a small fraction of the OSW workforce, access to this qualification is critical for all seagoing aspects of the supply chain. Certification is issued by the U.S. Coast Guard. Multiple schools exist in New York that offer training approved by the U.S. Coast Guard.

New York is also well-prepared to provide the other training and certifications required for OSW, namely QC Inspector certification, OSHA safety training, Six Sigma certification, and CNC Machining training. The various safety training programs that are expected to be required for OSW personnel, including those of OSHA, STCW, and GWO, will undoubtedly contain overlap of content. OSHA generally requires employers across all employment sectors to train all employees in the safety and health aspects of their job, whereas STCW and GWO programs are specific to seagoing personnel and wind technicians, respectively. Whereas OSHA and STCW training is managed by the U.S. government, GWO is a non-profit consisting of various wind turbine owners and manufacturers. Thus, the existence of GWO training requirements may be specific to each project.

Appendix A includes a more precise analysis of the education and skill requirements for each element of the supply chain. See Appendix B for additional details on all technical training programs and a listing of the apprenticeship trade programs in New York and their associated sponsors.

4 Economic Impacts of Offshore Wind

4.1 New York Job Creation and Economic Impacts

This section presents conclusions on how the New York supply chain can develop under four scenarios and the demand for direct and indirect workers in New York:

- High-market, high local content
- High-market, base local content
- Low-market, high local content
- Low-market, base local content

As discussed in Section 2, the high-market scenario assumes 8 GW of regional deployment by 2030, while the low-market scenario assumes 4 GW of regional deployment. In both cases, New York is assumed to reach its goal of deploying 2.4 GW by 2030.

The outcomes of these scenarios were tested by two sensitivities based on the level of New York State market support. In the high local content sensitivity, New York is assumed to provide significant incentives for investment and/or local supply. This sensitivity capitalizes on the strengths of New York's skills, supply chain and infrastructure, the absolute and relative attractiveness of the New York market, and the logistical benefits of using locally based suppliers. Alternatively, the base local content sensitivity assumes New York provides no additional market support and does not provide significant incentives or impose any local supply requirements on developers.

Underlying the calculations for each scenario are narratives, assessing the evolution of the New York supply chain as the market grows and matures. The notable features of these narratives are described in this section and Appendix D contains fuller descriptions.

The Study considered all the jobs created in the supply chain, other than those from the construction of capital assets. The figures presented are for direct and indirect workers and, therefore, exclude induced jobs, which are the result of personal expenditure of the labor force.

All scenarios create a demand for what can be termed baseline jobs. These are those jobs for which there are no compelling reasons why the work would not be undertaken in New York. These include workers in development and project management, installation and commissioning, and O&M.

Baseline Jobs
For project management and development, developers can readily recruit local New York labor that understands the political and regulatory environment. There are also benefits to being located near the project site for project management. In installation and commissioning, there will be a demand for baseline jobs to provide local services to offshore contractors, even in a scenario where the main and installation port is located outside New York. There is also a considerable demand for local workers for the onshore construction of the substation, cable route and operations base. It is likely that New York wind farm operators will use an onshore O&M strategy with technicians travelling daily from port to the wind farm using crew transfer vessels. Operations bases will, therefore, be sited at the nearest port that can provide the necessary access and facilities at a competitive price.

4.1.1 High Market, High Local Content

Key Figures
• The annual demand for New York workers from New York and non-New York projects peaks in 2028 at 4,930. • The annual demand for New York workers from only New York projects peaks in 2028 at 3,520. • Total expenditure in New York is $6.3 billion.

In the high market scenarios, New York contributes 30% of total northeastern U.S. OSW capacity to 2030. In the high-market, high local content scenario (see Figures 19 and 20 and Table 18), incremental to the baseline jobs, New York manages to maximize the demand for workers both for New York and other non-New York projects in the Northeast. For later projects, New York has a supply chain that can provide all major wind farm components with the exception of foundations and offshore substations. Major nacelle components are also imported both from U.S. and European factories. The analysis excludes the demand for workers from the construction of the manufacturing facilities. This would be significant for a short period.

There is significant demand for workers from installation and commissioning, although contractors are based outside New York and the demand for New York workers comes from the staging and installation ports, which support both New York and other Northeast wind farms. In 2028, about 30% of the demand for New York workers comes from other Northeast wind farms. This is because New York is likely to be the single largest state market and it manages to provide sufficient incentives and support for companies to overcome any disadvantages in labor costs.

Figure 19. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects by OSW Element in the High Market, High Local Content Scenario

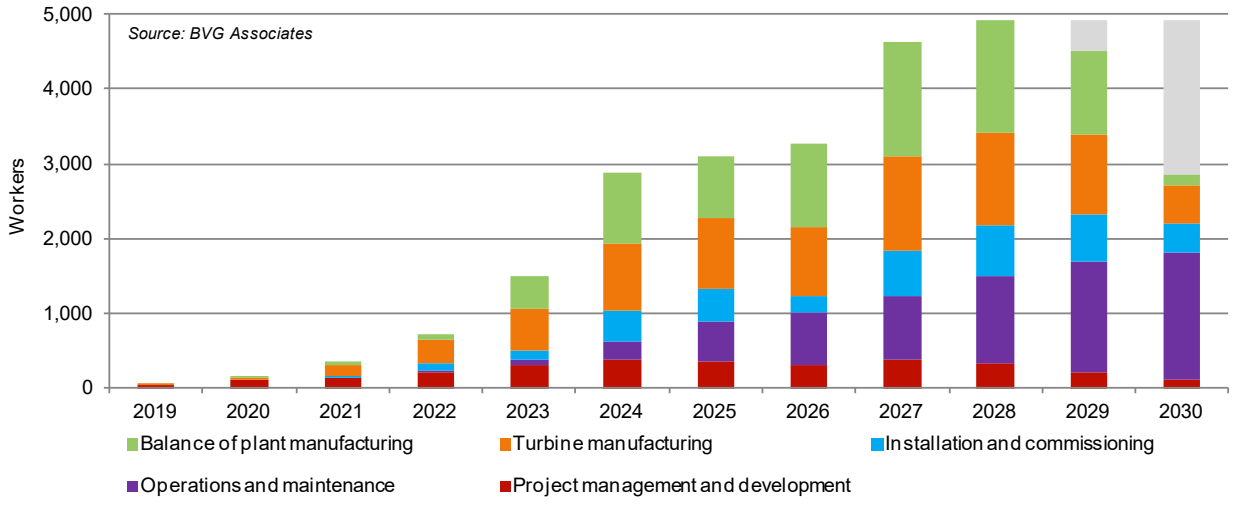


Figure 20. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects in the High Market, High Local Content Scenario

Demand from NY Projects is broken down by supply chain element.

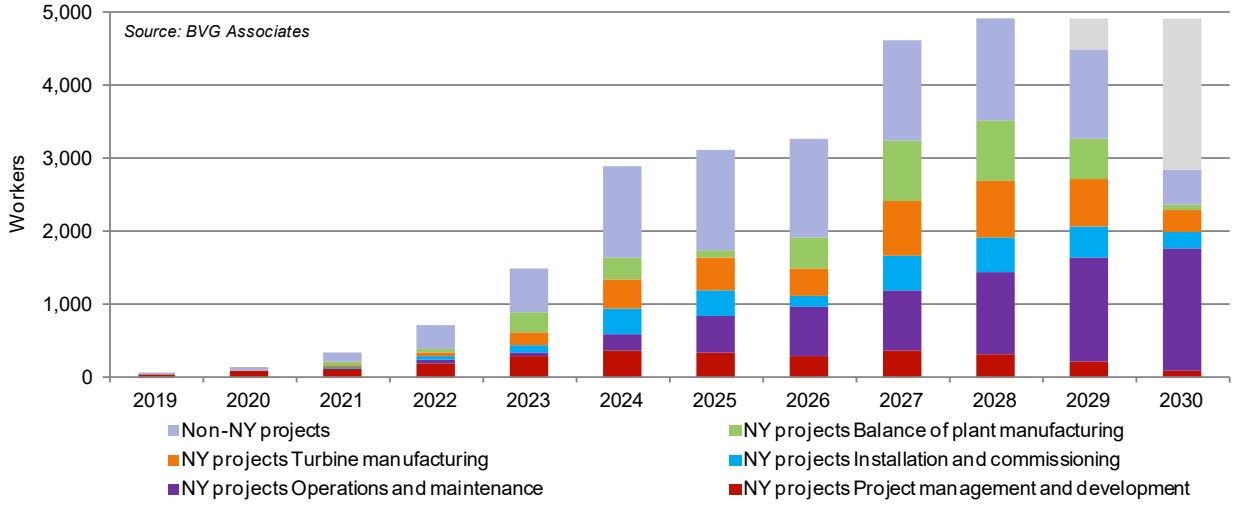


Table 18. Demand for Direct and Indirect NY Workers from NY OSW Farms in the High Local Content Scenarios[a]

Element	Sub-element	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Average[b]
Project development and management		10	40	90	120	200	280	370	330	280	360	310	210	100	330
Turbine supply	Nacelle, rotor and assembly	0	0	0	0	0	0	0	10	20	70	140	110	60	48
	Blades	0	0	0	0	30	50	210	340	250	490	450	370	180	348
	Tower	0	0	0	30	20	120	200	80	120	190	190	160	60	156
Balance of plant	Foundation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Array cables	0	0	0	0	0	0	10	0	50	170	180	120	10	82
	Export cable	0	0	0	0	0	10	20	10	100	360	370	250	30	172
	Substation supply and operational infrastructure	0	0	10	50	70	280	250	90	270	290	270	180	20	234
Installation and commissioning	Turbine	0	0	0	0	0	0	30	60	20	80	80	70	40	54
	Foundation	0	0	0	0	0	10	70	120	50	160	160	150	80	112
	Subsea cable	0	0	0	10	20	30	90	60	30	90	90	80	40	72
	Other	0	0	0	10	30	50	160	110	50	150	150	140	80	124
Operations and maintenance	Wind farm operations	0	0	0	0	10	30	80	190	240	290	390	490	570	570
	Turbine maintenance and service	0	0	0	0	20	40	140	330	430	530	720	900	1060	1,060
	Foundation maintenance and service	0	0	0	0	0	0	0	0	0	0	10	10	10	10
	Subsea cable maintenance and service	0	0	0	0	0	0	0	0	10	10	10	20	20	20
	Substation maintenance and service	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		**10**	**40**	**100**	**220**	**400**	**900**	**1,630**	**1,730**	**1,920**	**3,240**	**3,520**	**3,260**	**2,360**	**3,392**

Notes:

[a] The amounts correspond to the NY project data on Figure 20.

[b] Project development and management, turbine supply, balance of plant, and installation and commissioning averages are calculated from 2024 to 2028. O&M averages represent long-term employment from 2030 onwards.

4.1.2 High Market, Base Local Content

Key Figures
• The annual demand for New York workers from New York and non-New York projects peaks in 2029 at 1,950. • The annual demand for New York workers from only New York projects peaks in 2029 at 1,900. • Total expenditure in New York is $4.3 billion.

The demand for workers in the high market, base local content scenario peaks at almost 2,000 in the years 2029 and 2030 (see Figures 21 and 22 and Table 19). Although there is demand in the Northeast for workers from new manufacturing facilities, New York does not have existing suppliers or infrastructure and the lack of intervention in New York means these jobs are provided from other states. Although relatively local staging and installation ports will be needed for New York projects, suitable facilities at lower cost with little logistical penalty are likely to be found in neighboring states for early New York projects. In this scenario, the demand for workers is mainly for baseline jobs in project management and development, local support services in installation and commissioning, and day-to-day O&M.

Nevertheless, New York is likely to provide some local support to offshore installation, with crew vessels and accommodation vessels using New York port facilities.

In this scenario, O&M creates the biggest opportunity because the proximity of the operations base to the wind farm is the over-riding factor. The development of New York OSW farms creates a demand for specialist wind farm maintenance services that is met by New York companies. These may be existing New York companies or companies from outside the State with relevant skills that decide to develop a New York base. With first mover advantage, these companies are well placed to win business at other northeast wind farms. Even for New York wind farms built before 2030, the demand for New York workers persists for the long-term operation of its wind farms.

Installation and commissioning also creates a demand for workers from the use of a New York staging and installation port for later projects. Staging and installation ports in themselves do not create a significant demand for workers with the major employers being the installation contractors and the turbine manufacturer's installation teams.

In balance of plant, the demand for workers comes from construction of the onshore transmission and operational facilities.

Figure 21. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects by OSW Element in the High Market, Base Local Content Scenario

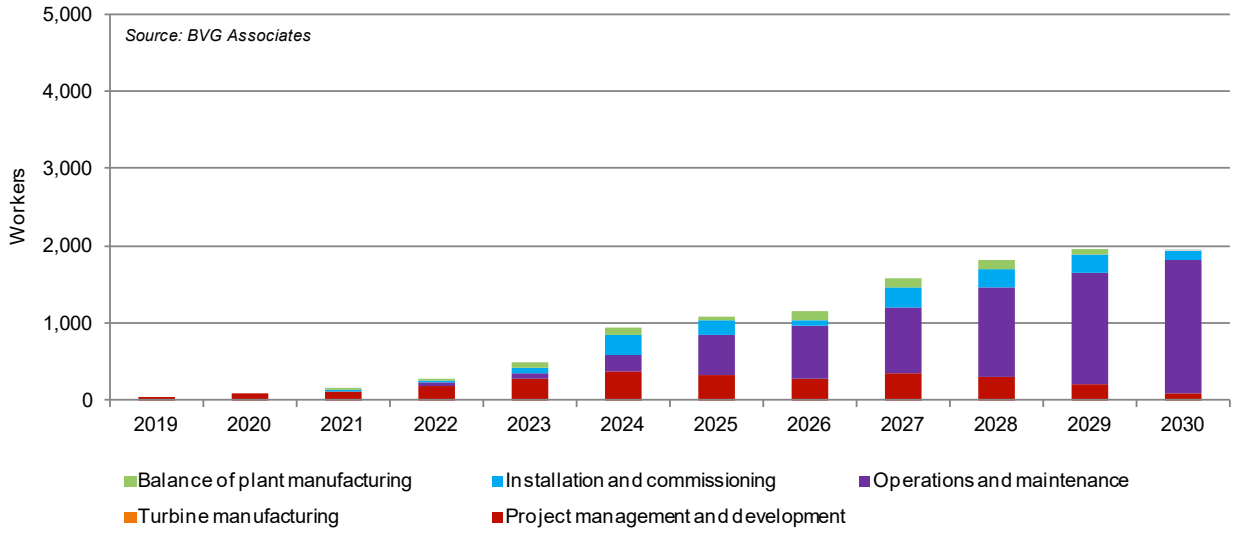


Figure 22. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects in the High Market, Base Local Content Scenario

Demand from NY projects is broken down by supply chain element.

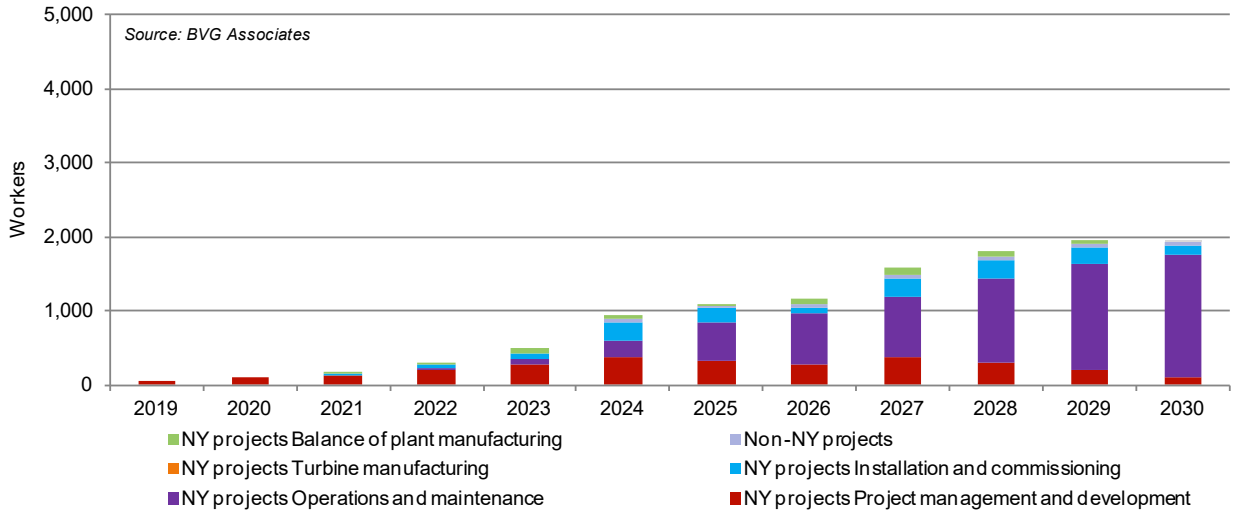


Table 19. Demand for Direct and Indirect NY workers from NY OSW Farms in the Base Local Content Scenarios[a]

Element	Sub-element	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Average[b]
Project development and management		10	40	90	120	200	280	370	330	280	360	310	210	100	330
Turbine supply	Nacelle, rotor and assembly	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blades	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tower	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Balance of plant	Foundation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Array cables	0	0	0	0	0	0	0	0	10	10	10	0	0	6
	Export cable	0	0	0	0	0	0	10	0	10	20	10	10	0	10
	Substation supply and operational infrastructure	0	0	0	10	10	60	50	20	50	60	50	40	0	46
Installation and commissioning	Turbine	0	0	0	0	0	10	30	20	10	30	30	20	10	24
	Foundation	0	0	0	0	10	20	60	40	20	50	50	50	30	44
	Subsea cable	0	0	0	10	20	30	90	60	30	90	90	80	40	72
	Other	0	0	0	10	10	20	80	60	20	80	70	70	40	62
Operations, maintenance and service	Wind farm operations	0	0	0	0	10	30	80	190	240	290	390	490	570	570
	Turbine maintenance and service	0	0	0	0	20	40	140	330	430	530	720	900	1,060	1,060
	Foundation maintenance and service	0	0	0	0	0	0	0	0	0	0	10	10	10	10
	Subsea cable maintenance and service	0	0	0	0	0	0	0	0	10	10	10	20	20	20
	Substation maintenance and service	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		**10**	**40**	**90**	**150**	**280**	**490**	**910**	**1,050**	**1,110**	**1,530**	**1,750**	**1,900**	**1,880**	**2,254**

Notes:

[a] The amounts correspond to the NY project data on Figure 22.

[b] Project development and management, turbine supply, balance of plant, and installation and commissioning averages are calculated from 2024 to 2028. O&M averages represent long-term employment from 2030 onwards.

Although there is a significant opportunity for New York companies to export goods to wind farms outside the State, New York is not able to attract the investment to export major components to other states in the Northeast. Other states are also able to stimulate their own supply chains, creating a competitive environment for New York companies. Therefore, New York companies are unable to take advantage of the larger market in other states in the Northeast. The demand for New York workers in neighboring states is only marginally higher than in the low-market, base local content scenario discussed in Section 4.1.4.

4.1.3 Low-Market, High Local Content

Key Figures
• The annual demand for New York workers from New York and non-New York projects peaks in 2027 at 3,690. • The annual demand for New York workers from only New York projects peaks in 2028 at 3,520. • Total expenditure in New York is $5.2 billion.

In the low-market, high local content scenario, New York provides 60% of the total Northeast installed capacity to 2030. The demand for workers is almost as great as in the high market, high local content scenario, as most New York jobs are expected to support New York projects. Although the demand from other Northeast wind farms is limited because of the smaller market size, the regional volume is still sufficient to make a business case for infrastructure investment in New York.

Including the demand for baseline jobs, the demand for New York workers increases to about 3,690 in 2028 (see Figures 23 and 24) and this will be at least sustained with a longer-term pipeline of projects. A high local content scenario with success in attracting local investment is likely to lead to a continued appetite for OSW after 2030.

Under the high-market, high local content scenario described in Section 4.1.1, New York's status as market leader means that it is able to secure investment in a tower manufacturing facility and a blade facility. For similar reasons, this low market scenario also forecasts investment in a cable factory for both array and export cables. The small market outside New York, however, means there is low demand for New York workers for projects in other states.

Figure 23. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects by OSW Element in the Low-Market, High Local Content

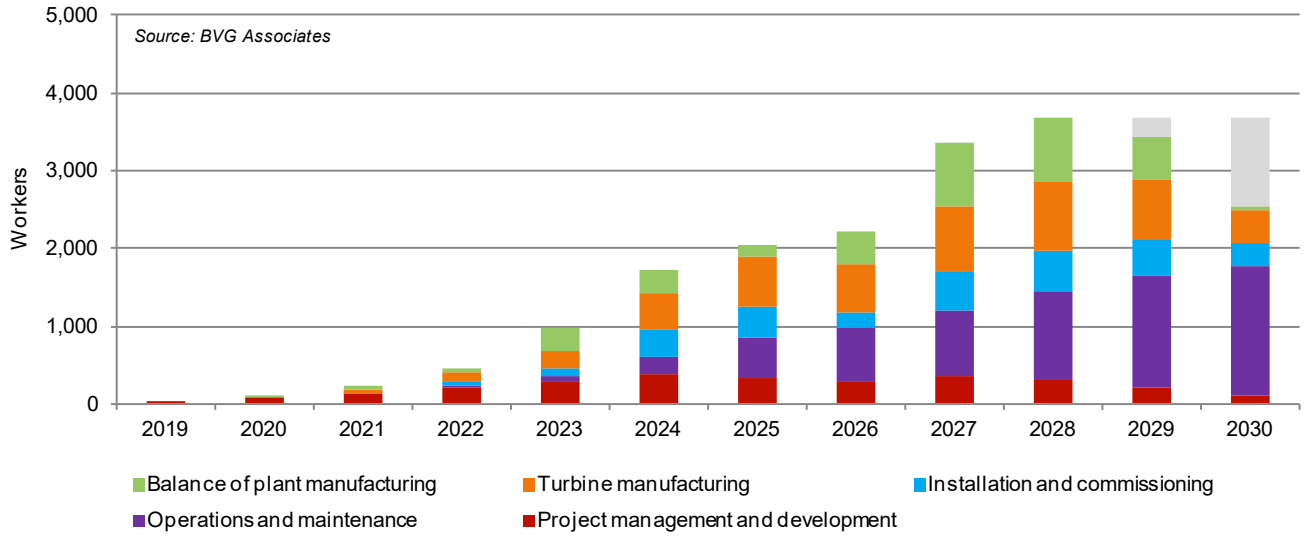
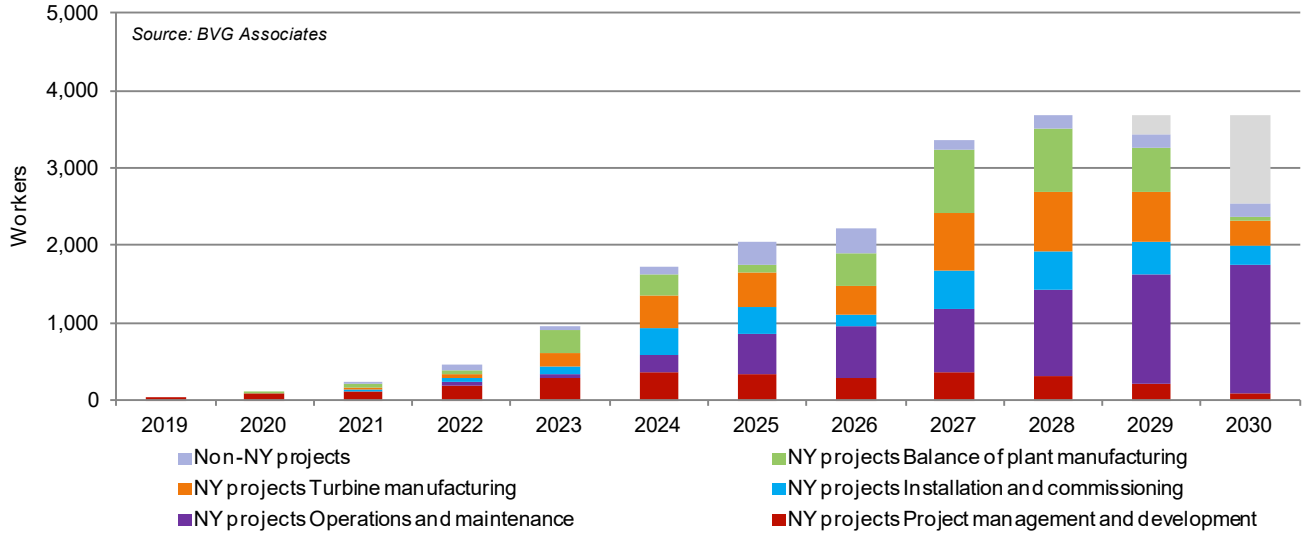


Figure 24. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects in the Low-Market, High Local Content Scenario

Demand from NY projects is broken down by supply chain element.



4.1.4 Low Market, Base Local Content

Key Figures
• The annual demand for New York workers from New York and non-New York projects peaks in 2029 at 1,950. • The annual demand for New York workers from only New York projects peaks in 2029 at 1,900. • Total expenditure in New York is $4.3 billion.

In the low market, base local content scenario, the demand for New York workers is mainly for baseline jobs. The demand for workers peaks at almost 2,000 in 2029 and 2030 (see Figures 25 and 26).

This is partly because the overall U.S. market is relatively small, with annual installed capacity little more than 400 MW. This does not provide enough demand for new manufacturing facilities and New York does not have existing suppliers or infrastructure. Although relatively local staging and installation ports will be needed for New York projects, suitable manufacturing facilities at lower cost with little logistical penalty are likely to be found in neighboring states or elsewhere for early New York projects.

Installation and commissioning also creates a demand for workers from the use of a New York staging and installation port for later projects. Staging and installation ports in themselves do not create a significant demand for workers with the major employers being the installation contractors and the turbine manufacturer's installation teams.

In this scenario, there is limited capacity built in other states in the Northeast and the absence of support or incentives for New York companies means they do not create a significant demand for New York workers.

The development of New York OSW farms creates a demand for specialist wind farm maintenance services that is met by New York companies. These may be existing New York companies or companies from outside the State with relevant skills that decide to develop a New York base. With first-mover advantage, these companies are well placed to win business at other northeast wind farms. Even for New York wind farms built before 2030, the demand for New York workers persists for the long-term operation of its wind farms.

Figure 25. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects by OSW Element In The Low-Market, Base Local Content Scenario

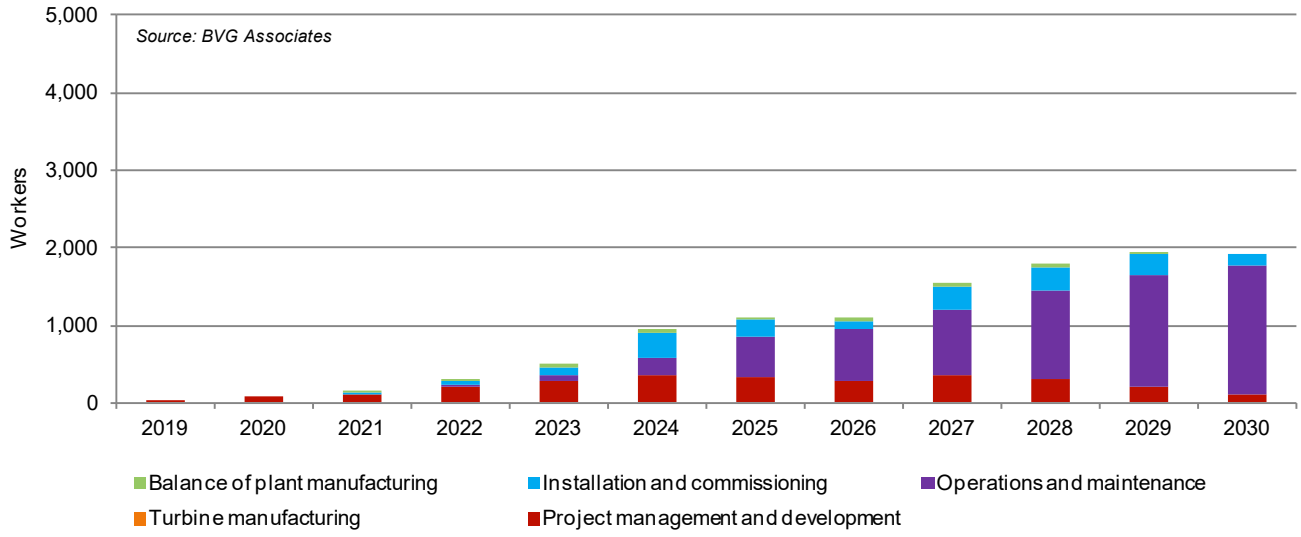
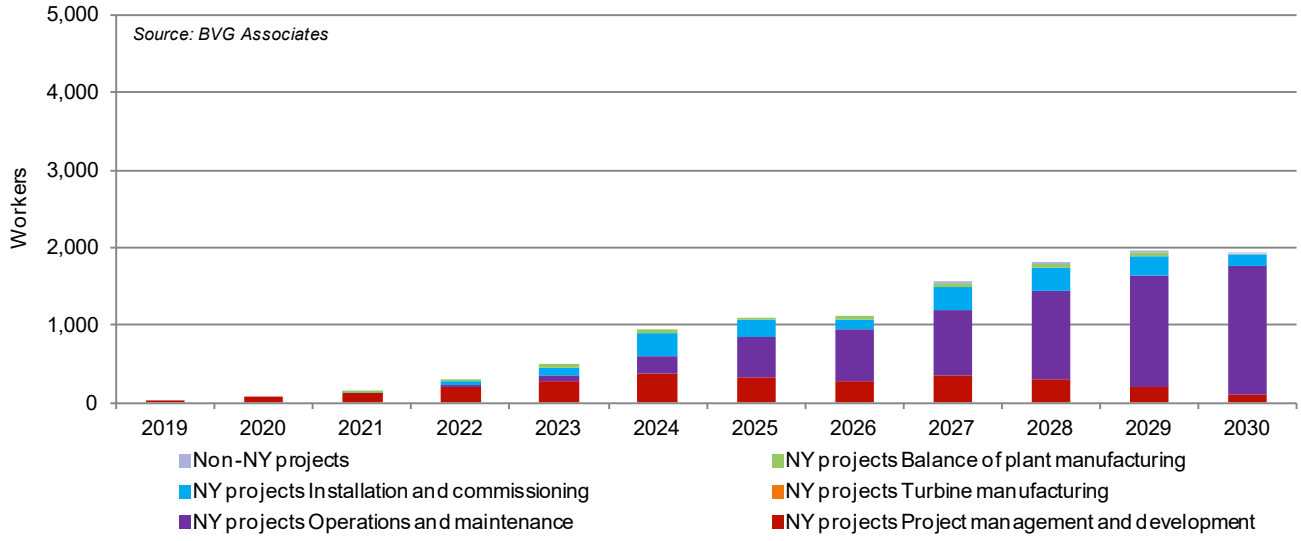


Figure 26. Demand for Direct and Indirect NY OSW Workers from NY and Non-NY Projects in the Low-Market, Base Local Content Scenario

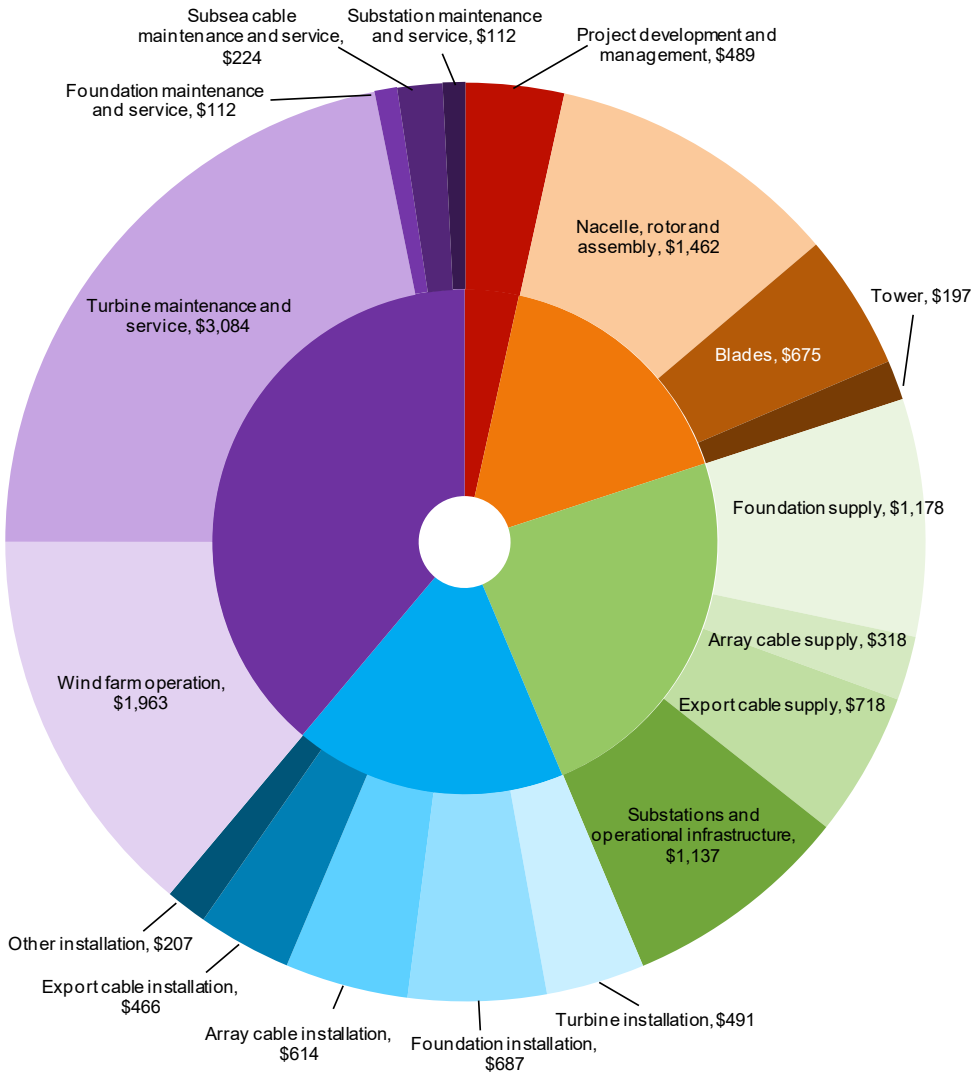
Demand from NY projects is broken down by supply chain element.



4.2 Offshore Wind Lifetime Costs

Figure 27 shows the projected average lifetime discounted expenditure (real terms in 2015 prices) of 2.4 GW of New York OSW built in the 2020s. The analysis assumes that there are year-on-year cost reductions that reflect the learning in the U.S. industry and innovations being developed globally. Total discounted expenditure is $14.1 billion.

Figure 27. The Projected Lifetime Discounted Expenditure (figures are in $millions, real terms in 2015 prices) of 2.4 GW of NY OSW Building in the 2020s

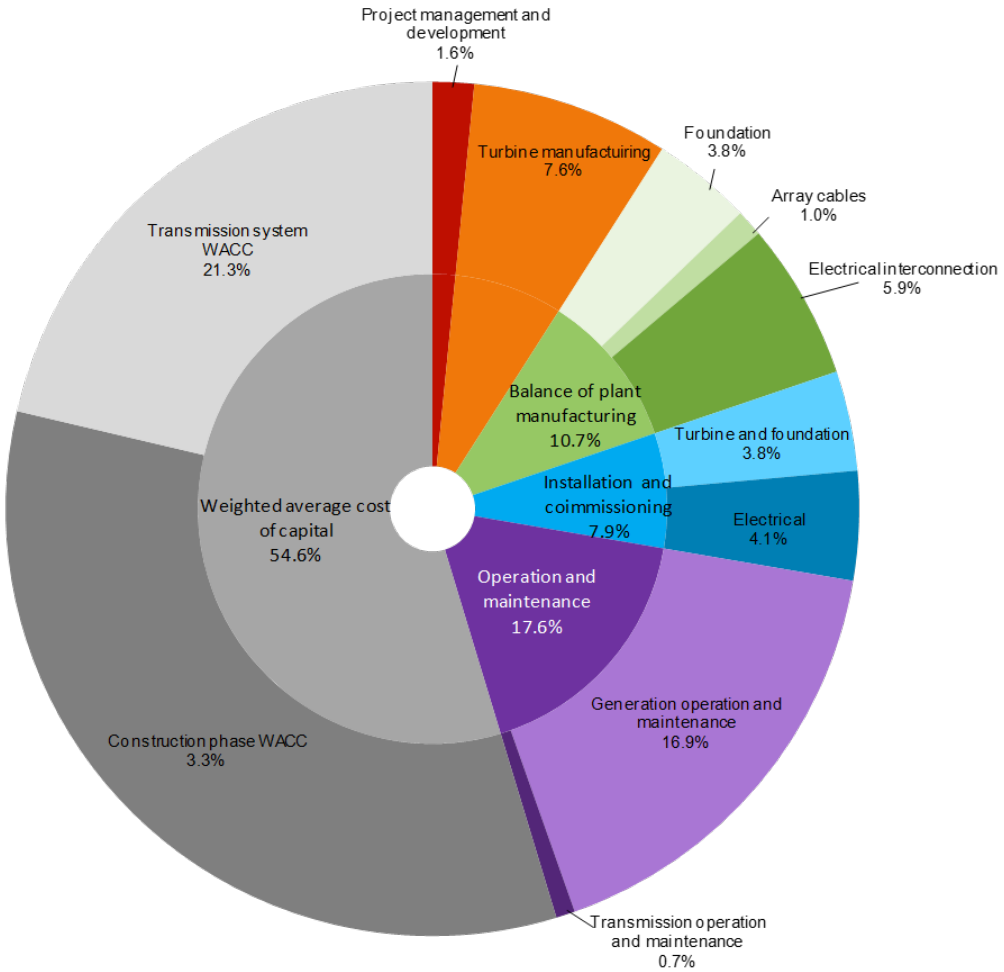


While Figure 27 shows total expenditure, it does not include the costs of finance, which are considerable and have a major impact on the levelized cost of energy. Figure 28 shows the significant contribution that financing costs make to levelized cost of energy. Inevitably, this creates jobs in financial services, but these have not been considered in this analysis.

A key feature of the chart is lower contribution of O&M. This is because the calculation considers the net present value of the expenditure at final investment decision.

Undiscounted expenditure is often preferred in modeling job creation so that job creation can be interpreted in the context of the future size of the working population.

Figure 28. Contribution of Supply Elements and Sub-elements to the Levelized Cost of Energy for an Average New York OSW Farm Built in the 2020s



4.3 Discussion

Under the high-market scenarios, 8 GW of regional OSW deployment creates a peak demand for New York workers of 4,930 in the high local content scenario and 1,950 in the base local content scenario. The base local content scenario represents the baseline demand for New York workers that, in normal circumstances, the market alone will create without significant market support from the State. The main sub-elements that create this baseline demand are project management and development, installation and commissioning, and O&M. Table 20 shows the average demand for New York workers. These figures represent average job numbers, with the scenarios envisioning peak employment from 2024 to 2028 for manufacturing, project management and development, and installation and commissioning, and continuous O&M jobs for the life of the facilities from 2030 onwards.

Table 20. Average Demand for New York Workers for Both New York and Regional Projects

Scenario		Project management and development workers	O&M workers	Installation and commissioning workers	Manufacturing workers
High Market	High local content	350	1,830	470	2,250
	Base local content	330	1,820	200	90
Low Market	High local content	340	1,790	420	1,310
	Base local content	330	1,780	250	50

Additional demand, which separates the high and low local content scenarios, is most likely to come from investments by Tier 1 suppliers, notably turbine manufacturers and cable manufacturers. To attract this investment, public-sector intervention may be required because New York, like most other regional states, has no established supply chain or infrastructure to supply components to the OSW sector. Investors must, therefore, conclude that they will capture sufficient market share to make the business case; and New York provides the best economic choice as a location.

If New York does attract investment from major suppliers, as it is expected to in the high local content scenarios, it is still unlikely that it will capture the whole market. Competition between turbine suppliers is expected to result in multiple U.S. facilities, and they will each likely choose different locations to base their operations. For example, if there are three turbine manufacturers competing in the U.S. market, New York might only capture half the market even if it attracts the market leader to the State.

There are also sub-elements that are most likely out of reach. The U.S.'s existing offshore strengths in fabrication and marine contracting are located in southern states where there are lower labor costs, a more experienced workforce, and coastal infrastructure developed for other sectors. There is a theoretical lower cost from local supply, but the Northeast market would likely need to be larger than even the high market scenario, with long-term visibility, to attract investment in foundation fabrication. For marine contractors, the only requirement will be for Jones Act-compliant vessels. The European market has shown that there is no driver for localized operational facilities for installation contractors and vessels can be mobilized many hundreds of miles from the wind farm location.

Another challenge in securing a greater share is that the demand for workers from Tier 1 suppliers represents only a fraction of the total demand. In the turbine supply chain, for example, large turbine components will be made in factories that supply other sectors globally, often with a highly qualified workforce. While final assembly at a coastal facility will be necessary, near-term U.S. deployment may not be a sufficient driver to result in new manufacturing facilities for all individual components and subcomponents.

5 References

AWS (American Welding Society). 2017. "Your Career in Welding: Taking the First Step to a Bright Future..." Accessed August – November 21, 2017. https://app.aws.org/pr/careerpresentation.pdf.

BOEM (Bureau of Ocean Energy Management). 2017. BOEM – State Activities. Accessed October 17, 2017. https://www.boem.gov/Renewable-Energy-State-Activities/.

Business Network for Offshore Wind. 2017. "More Jobs for Marylanders Act." Accessed August 24, 2017. http://www.bizmdosw.org/jobs-marylanders-act/.

BVGA (BVG Associates). 2014. *UK offshore wind supply chain: capabilities and opportunities*. A report prepared by BVG Associates for the Department for Business, Innovation and Skills. January 2014. Accessed August 18, 2017. http://www.energysupplychain.com/technical_library/4710/bis-gov-uk-offshore-wind-supply-chain-capabilities-opportunities-2014.pdf.

_____. 2015. *Virginia offshore wind port readiness evaluation Report 1: An Evaluation of 10 Virginia Ports*. A report to the Virginia Department of Mines, Minerals and Energy. April 2015. https://www.dmme.virginia.gov/de/LinkDocuments/OffshoreWind/PortsStudy-Report1.pdf.

_____. 2015. *Virginia offshore wind port readiness evaluation Report 2: Port Utilization Scenarios*. A report to the Virginia Department of Mines, Minerals and Energy. April 2015. https://www.dmme.virginia.gov/de/LinkDocuments/OffshoreWind/PortsStudy-Report2.pdf.

_____. 2015. *Virginia offshore wind port readiness evaluation Report 3: High-impact Investment Opportunities*. A report to the Virginia Department of Mines, Minerals and Energy. June 2015. https://www.dmme.virginia.gov/de/LinkDocuments/OffshoreWind/PortsStudy-Report3.pdf.

_____. 2015. "Virginia Offshore Wind Port Readiness." Final Review Meeting. June 12, 2015.

_____. 2017. *US Job Creation in Offshore Wind*. A report for the Roadmap Project for Multi-State Cooperation on Offshore Wind. July 2017. 33pp.

Career One Stop – "AWS certification training." Accessed August – November 21, 2017. https://www.careeronestop.org/Toolkit/ACINet.aspx.

Central New York Joint Apprenticeship and Training Committee for the Electrical Industry (CNYJATC). "Career opportunities." Accessed August – November 21, 2017. http://www.cnyjatc.org/opportunities.html.

Skinner Creative, Inc. 2011. Composites Consultants, "Universities, Laboratories and Research Organizations." Accessed August – November 21, 2017. http://www.compositesconsultants.com/cats/universities.php.

COWI (COWI North America). 2017. *New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure.* December 2017.

The Crown Estate. 2010. "Your Career in Offshore Wind." Accessed August – November 21, 2017. https://www.thecrownestate.co.uk/media/5480/ei-km-in-sc-skills-112010-your-career-in-offshore-wind.pdf.

Deepwater Wind. 2017. *Block Island Wind Farm – America's First Offshore Wind Farm.* Accessed August 22, 2017. http://dwwind.com/project/block-island-wind-farm/>.

DOE (U.S. Department of Energy). 2015. *Offshore Wind Jobs and Economic Development in the United States.* Accessed September 12, 2017. https://www.nrel.gov/docs/fy15osti/61315.pdf.

_____. 2016. *U.S. Department of Energy Wind Energy Technologies Office Funding in the United States: Offshore Wind Projects*. Fiscal Years 2006-2016. September 2016. Accessed August 15, 2017. https://energy.gov/sites/prod/files/2016/09/f33/Offshore-Wind-Project-Report_September2016.pdf.

_____. 2016. 2016 *Offshore Wind Technologies Market Report*. Accessed September 6, 2017. https://energy.gov/eere/wind/downloads/2016-offshore-wind-technologies-market-report.

DOL (New York State Department of Labor). 2017. "Millwrights Recruit Apprentices press release." April 18, 2017. Accessed August – November 21, 2017. https://www.labor.ny.gov/pressreleases/currentrecruitments/millwrights-eastern-april-18-2017.shtm.

DOL Division of Research and Statistics (New York State Department of Labor Division of Research and Statistics). 2016. *The Skilled Trades in New York State*. Accessed August – November 21, 2017. https://www.labor.ny.gov/stats/PDFs/The-Skilled-Trades-in-NYS.pdf.

DOS (New York State Department of State). 2013. *Offshore Atlantic Ocean Study*. July 1, 2013. https://docs.dos.ny.gov/communitieswaterfronts/ocean_docs/NYSDOS_Offshore_Atlantic_Ocean_Study.pdf.

Global Wind Organisation. 2017. "Safety First." Accessed August – November 21, 2017. http://www.globalwindsafety.org.

Maine Aqua Ventus. 2017. "About Maine Aqua Ventus." Accessed August – November 21, 2017. http://maineaquaventus.com/index.php/the-project/about-maine-aqua-ventus/.

Maryland Public Service Commission. 2017. "Renewable Energy." Accessed October 18, 2017. http://www.psc.state.md.us/electricity/renewable-energy/.

MACEC (Massachusetts Clean Energy Center). 2017. "Offshore Wind." Accessed October 18, 2017. http://www.MACEC.com/offshore-wind.

_____. 2017. "New Bedford Marine Commerce Terminal." Accessed August 25, 2017. http://www.MACEC.com/facilities/new-bedford-marine-commerce-terminal.

_____. 2017. *Offshore Wind – Wind Port Strategy Study*. Accessed October 27, 2017. http://www.MACEC.com/massachusetts-offshore-wind-ports-infrastructure-assessment.

_____. 2017. *Massachusetts Offshore Wind Ports and Infrastructure Assessment*.

Military Sealift Command. 2017. “Find a Training School.” Accessed August – November 21, 2017. https://sealiftcommand.com/maritime-resources/training-school-search/.

Moffatt & Nichol. 2012. *Connecticut’s Deep Water Port Strategy Study*. Presented to the State of Connecticut. September 2012. Accessed August 30, 2017. http://www.governor.ct.gov/malloy/lib/malloy/ct_deep_water_port_strategy_study_-_final_report_full_-_sept_2012.pdf.

New Jersey’s Clean Energy Program. 2017. “Offshore Wind.” Accessed August 23, 2017.: http://www.njcleanenergy.com/renewable-energy/technologies/wind/shore-wind#BO.

NREL (National Renewable Energy Laboratory). *An Assessment of Economic Potential of Offshore Wind in US from 2015–2030*. Accessed September 6, 2017. https://www.nrel.gov/docs/fy17osti/67675.pdf.

NYSERDA (New York State Energy Research and Development Authority). 2017. *Offshore Wind* Masterplan. Accessed October 18, 2017. https://www.nyserda.ny.gov/.

_____. 2017. *2017 New York Clean Energy Industry Report*. https://www.nyserda.ny.gov/About/Publications/2017-New-York-Clean-Energy-Industry-Report.

_____. 2017. *U.S. Jones Act Compliant Offshore Wind Turbine Installation Vessel Study – Gusto MSC*. Accessed December 12, 2017. https://www.cesa.org/.

Offshorewind.biz. 2017. “Port of Davisville Counting on Offshore Wind, Upgrading Pier 2.” February 16, 2017. Accessed August 26, 2017. http://www.offshorewind.biz/2017/02/16/port-of-davisville-counting-on-offshore-wind-upgrading-pier-2/.

Port Authority of New York and New Jersey. 2017. “Overview of Facilities and Services.” Accessed August 31, 2017. https://www.panynj.gov/about/facilities-services.html.

Port of New Bedford. 2017. “New Bedford Marine Commerce Terminal.” Accessed August 25, 2017. http://www.portofnewbedford.org/shipping/operating-areas-marine-terminals/south-port-area.php.

Port of Virginia. 2017. “Facilities.” Accessed August 31, 2017. http://www.portofvirginia.com/facilities/.

Port of Wilmington Delaware. 2017. “Port Profile.” Accessed August 28, 2017. http://www.portofwilmington.com/.

Quonset Development Corporation. 2017. “Port Facilities.” Accessed August 26, 2017. http://www.quonset.com/sea/port-facilities/.

Siemens. 2012. “Siemens 6.0 MW Offshore Wind Turbine.” Accessed August 3, 2017. https://www.energy.siemens.com/hq/pool/hq/power-generation/renewables/wind-power/6_MW_Brochure_Jan.2012.pdf.

South Jersey Port Corporation. 2015. “Paulsboro Marine Terminal.” Accessed August 28, 2017. http://southjerseyport.com/facilities/paulsboro-marine-terminal/.

_____. 2017. “Paulsboro Marine Terminal. An Innovative Omniport Rising on the Banks of the Delaware River.” Accessed August 28, 2017. http://www.co.gloucester.nj.us/civica/filebank/blobdload.asp?BlobID=3746.

U.S. Department of Energy and U.S. Department of the Interior. 2016. *National Offshore Wind Strategy. Facilitating the Development of the Offshore Wind Industry in the United States*. September 2016. Accessed August 15, 2017. https://energy.gov/sites/prod/files/2016/09/f33/National-Offshore-Wind-Strategy-report-09082016.pdf.

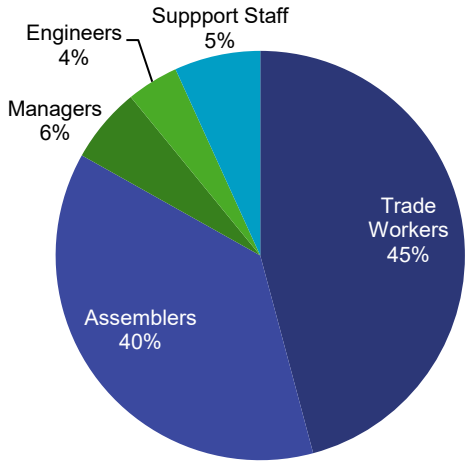
U.S. Department of Labor, Bureau of Labor Statistics. 2017. “Bureau of Labor Stats on Welders.” Accessed August – November 21, 2017. https://www.bls.gov/ooh/production/welders-cutters-solderers-and-brazers.htm#tab-9.

Workforce Development Institute. 2017. *New York State and the Jobs of Offshore Wind Energy*. Spring 2017. Accessed July 17, 2017. https://wdiny.org/Portals/0/New%20York%20State%20and%20The%20Jobs%20Of%20Offshore%20Wind%20Energy_%20WDI2017.pdf?ver=2017-05-03-150746-023.

Appendix A. Detail of Education and Skills Requirements

Workforce skills required for an OSW project will be, by a large majority, trade workers and assemblers. Skilled trade workers and assemblers collectively represent 85% of the required combined direct jobs (see Figure A-1).

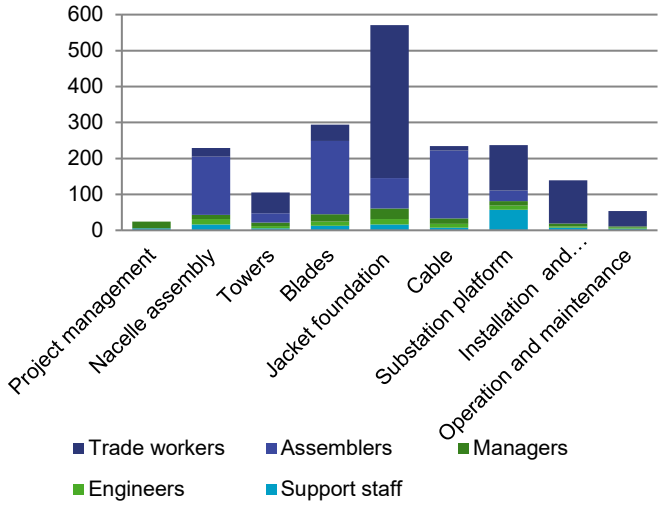
Figure A-1. Percentage of Total Direct Job Functions Sufficient to support Installation of 600 MW/year



Although some of these trades and assembler positions will require technical or industry certifications, the skills and certifications required are not new to today's New York workforce. New York trade workers will be familiar with the job functions of OSW, which include welding, mechanical and electrical maintenance, incoming material and final inspection, material testing, and QC.

Job functions for New York workers serving as assemblers will also be familiar, including mechanical and electrical assembly; sandblasting, spraying, coating, and painting; fiberglass layup, forming, molding, and finishing; installing various subcomponents and connecting components (bolts, screws, fasteners). Production of the foundation for both the turbine and the substation will demand the most skilled trades. Production of the nacelle, blades, and subsea cable (array and export) will demand the most assemblers (Figure A-2).

Figure A-2. Total Direct Job Functions Sufficient to Support Installation of 600 MW/year



While the scale and specifics of OSW components may be new to New York workers, current workforce skills for trade workers and assemblers are transferrable to the OSW industry. New York educational and technical institutions, as well as labor unions, have well-established career paths that support skilled workforce training and certification.

New York faces the same challenge as other east coast states of "filling the funnel" for skilled workers. According to DOL's 2016 *Skilled Trades in New York State* report, "Employers throughout New York State currently report they are facing labor shortages as they attempt to hire workers in the skilled trades. These worker shortages are expected to worsen in the coming years due to a combination of demographic (such as retiring baby boomers) and economic (such as increased demand for workers in the skilled trades) factors." OSW development will add to this increased demand for skilled trades, general manufacturing, and construction labor.

Nacelle and Rotor Assembly

100 nacelles assembled per year [2-shift operation]		230 FTEs	EDUCATION REQUIREMENTS						Post-Secondary Professional Certificate (Journeyman, Trade/ Technical Programs)				
NY WDI Job Function	Process Name	% FTEs	High School Diploma	Post-Secondary/Certification (Journeyman, Trade/Tech)	Associate's Degree	Bachelor's Degree	Post-Bachelor Professional Certification (e.g., CPA, PE)	Master's Degree, Ph.D.	CNC Machining Certificate	Welding Certificate	Composite Tech. Cert. National Composite Center	QC Inspector Cert. (ISO 9001)	Lean Six Sigma Cert. Green or Black Belt
MANUFACTURING STAFF													
Assembly	mechanical assembly	57%	x										
Assembly	electrical assembly	11%	x										
Assembly	QC Inspector	3%	x									x	
Trade Worker	production team leader	5%		x									
Trade Worker	Maintenance Electrical	2%		x									
Trade Worker	Maintenance Mechanical	3%		x						x			
	Manufacturing Staff	81%											
					x								
MANUFACTURING SUPPORTING STAFF						x							
Admin/Clerical	Admin/Clerical (for GM)	0.4%				x							
Mfg Managers	Plant/General Manager	0.4%			x								
Mfg Managers	Operations Manager	1%				x							
Mfg Managers	Floor Supervisors (50 emp:1 Super, 5 Teams)	2%				x							
Mfg Managers	PC&L Manager (Procurement & Logistics)	0.4%			x								
Mfg Managers	HR Manager	0.4%				x							
Admin/Clerical	HR support	1%			x								
Mfg Managers	EHS Manager	0.4%				x							
Engineers	EHS engineer	1%			x								
Mfg Managers	Quality manager	0.4%				x						x	x
Engineers	Quality inspectors	3%			x							x	
Engineers	Manufacturing Engineer	0.0%				x							
Engineers	Plant maintenance Engineer	1%				x							
Engineers	Product Engineer	0.0%											
Mfg Managers	Industrial Engineering manager	0.4%				x							
Engineers	Industrial Engineer	2%			x								
Accounting	Finance Manager	0.4%				x							
Accounting	Finance Support	1%			x								
Sales/Training	Sales	0.0%											
SC & Purch	Purchasing/material control support	2%			x								
SC & Purch	Logistic operators	3%		x									
	Support Staff	19%											

Towers

100 towers produced per year [2-shift operation]		105 FTEs	EDUCATION REQUIREMENTS						Post-Secondary Prof. Certificate Journeyman, Trade/Tech. Programs			
			High School Diploma	Post-Secondary/Certification (Journeyman, Trade/Tech)	Associate's Degree	Bachelor's Degree	Post-Bachelor Professional Certification (e.g., CPA, PE)	Master's Degree, Ph.D.	CNC Machining Certificate	Welding Certificate	QC Inspector Cert. (ISO 9001)	Lean Six Sigma Cert. Green or Black Belt
NY WDI Job Function	Process Area	% FTEs										
MANUFACTURING PRODUCTION STAFF												
Assembly	Handling, Clean/Grit Blast Plate	4%	x									
	Primer Coat, Printing											
Trade Worker	CNC Plasma Cutting	4%							x			
	Beveling			x								
Trade Worker	Rolling, Tack Weld & Can Rounding	6%		x						x		
Trade Worker	Longitudinal Weld	8%		x						x		
Trade Worker	Second Rolling & QC	4%		x							x	
Trade Worker	Flange, Shell, Assembly	4%		x						x		
Trade Worker	Circular Weld	8%		x						x		
Trade Worker	NDT, MP, QC	4%		x							x	
Trade Worker	Door Frame Roll and Weld	4%		x						x		
Trade Worker	Bushing Hatch Welding	4%		x						x		
Assembly	Sand Blasting	4%	x									
Assembly	Zinc Spraying	2%	x									
Assembly	Final Paint	4%	x									
Assembly	Mechanical/Electrical Installations	8%	x									
Trade Worker	Final Inspection QC	4%		x							x	
Assembly	Packaging and Shipping Prep	4%	x									
Trade Worker	Maintenance Mechanical	4%		x						x		
Trade Worker	Maintenance Electrical	4%		x						x		
	Manufacturing Staff	**80%**										
MANUFACTURING SUPPORTING STAFF												
Admin/Clerical	Admin/Clerical (for GM)	1%				x						
Mfg Managers	Plant/General Manager	1%				x						
Mfg Managers	Operations Manager	2%				x						
Mfg Managers	Floor Supervisors or Team Leads	4%			x							
Mfg Managers	Production, Control & Logistics Mgr	1%				x						
Engineers	Quality Engineer	1%				x					x	x
Engineers	Manufacturing Engineer	3%				x						x
Engineers	Plant Engineer	1%				x						x
Engineers	Product Engineer	0.5%				x						x
Engineers	Industrial Engineer	1%				x						x
Mfg Managers	HR / Safety Manager	1%				x						
Accounting	Finance Manager	0.5%				x						
Accounting	Finance Support	0.5%				x						
Sales/Training	Sales	0.5%				x						
SC & Purch	Purchasing	1%				x						
SC & Purch	Logistics Operators	2%			x							
	Support Staff	**20%**										

Blades

300 Blades produced per year [3-shift operation]		300 FTEs	EDUCATION REQUIREMENTS						Post-Secondary Professional Certificate (Journeyman, Trade/ Technical Programs)				
NY WDI Job Function	Process Name	% FTEs	High School Diploma	Post-Secondary/Certification (Journeyman, Trade/Tech)	Associate's Degree	Bachelor's Degree	Post-Bachelor Professional Certification (e.g., CPA, PE)	Master's Degree, Ph.D.	CNC Machining Certificate	Welding Certificate	Composite Tech. Certificate through ACMA	QC Inspector Cert. (ISO 9001)	Lean Six Sigma Cert. Green or Black Belt
MANUFACTURING STAFF			225										
Trade Worker	Incoming Material Inspection QC	3%		x							x	x	
Assembly	Kitting of cut to length glass sheets	4%	x								x		
Trade Worker	CNC Cutting of foam	2%		x					x				
Assembly	Girder Layup	6%	x								x		
	Girder cure and De-mold												
Assembly	Spar Cap and Shear Web Layup	6%	x								x		
Assembly	Spar Cap and Shear Web Infusion-Cure	6%	x								x		
	Spar Assembly												
Assembly	Pre-fab root Ring Section	4%	x								x		
Assembly	Shell Layup Top	10%	x								x		
Assembly	Shell Layup bottom	10%	x								x		
Assembly	Shell Infusion and UT Scan QC	1%	x								x	x	
	Shell Curing in Mold	1%	x								x		
	Shell Clamping and Bonding	1%	x								x		
Assembly	Shell Curing in Oven	2%	x								x		
Assembly	De-molding & transfer - UT Scan QC	4%		x							x	x	
Assembly	Flash Trimming and Sanding	4%	x								x		
	Patching Inside and Outside												
Assembly	Outer Edge Reinforcement	2%	x								x		
Trade Worker	Root Face Machining & Drilling	2%		x					x				
Assembly	Install T-bolts	2%	x								x		
	Connect LPS system												
Assembly	Weigh and Balancing	2%	x								x		
	Resin fill and balance												
Assembly	Paint (pre-polish optional)	2%	x								x		
Assembly	Final Cure	1%	x								x		
Trade Worker	Final Inspection QC	2%		x							x	x	
Assembly	Install Internal end cap & labels	1%	x								x		
Assembly	Place in Outside Storage	1%	x								x		
Trade Worker	Mold Repair	2%		x					x				
Trade Worker	Maintenance Mechanical	2%		x					x				
Trade Worker	Maintenenace Electrical	2%		x					x				
	Manufacturing Staff	85%											
MANUFACTURING SUPPORTING STAFF													
Admin/Clerical	Admin/Clerical (for GM)	0.3%				x							
Mfg Managers	Plant/General Manager	0.3%				x							
Mfg Managers	Operations Manager	1%				x							
Mfg Managers	Floor Supervisors (20 emp:1 Super)	5%			x								
Mfg Managers	Production, Control & Logistics Mgr	0.3%				x							
Mfg Managers	HR / Safety Manager	0.3%				x							
Engineers	Quality Engineer	1%				x						x	x
Engineers	Manufacturing Engineer	2%				x							x
Engineers	Plant Engineer	0%				x							x
Engineers	Product Engineer	0%				x							x
Engineers	Industrial Engineer	0%				x							x
Accounting	Finance Manager	0%				x							
Accounting	Finance Support	1%				x							
Sales/Training	Sales	0.3%				x							
SC & Purch	Purchasing	1%				x							
SC & Purch	Logistics Operators	2%			x								
	Support Staff	15%											

Foundations (Jacket and Transition Piece)

100 foundations produced per year [3-shift operation]		564 FTEs	EDUCATION REQUIREMENTS						Post-Secondary Prof. Certificate Journeyman, Trade/Tech. Programs			
NY WDI Job Function	Process area	% FTE	High School Diploma	Post-Secondary/Certification (Journeyman, Trade/Tech)	Associate's Degree	Bachelor's Degree	Post-Bachelor Professional Certification (e.g., CPA, PE)	Master's Degree, Ph.D.	CNC Machining Certificate	Welding Certificate	QC Inspector Cert. (ISO 9001)	Lean Six Sigma Cert. Green or Black Belt
MANUFACTURING PRODUCTION STAFF												
Main Lattice												
Trade Worker	Circular Weld Leg Pipes 27m+20m	2%		x						x		
Trade Worker	Circular Weld Leg Pipe End pc 2m	2%		x						x		
Trade Worker	Weld Bracing Pipe X's	13%		x						x		
Trade Worker	Weld Bracing Pipe X's to (2) Legs	4%		x						x		
Trade Worker	Fixture 2 sides Vertically	3%		x						x		
Trade Worker	Weld 4 Bracing Pipe X's to (2) Sides	4%		x						x		
Trade Worker	Weld 4 Horiz Bracing pipes Top & Bot	2%		x						x		
Trade Worker	Final NDT inspect/document all welds	6%		x						x		
Assembly	Grit Blast	4%	x									
Trade Worker	Carboline 656 Coating Carboline 134 Coating Carboline 890 Coating	3%	x									
Trade Worker	Inspect / Document	5%		x						x	x	
Assembly	Prepare for Shipment	2%	x									
Trade Worker	Maintenance - Electrical	1%		x								
Trade Worker	Maintenance - Mechanical	1%		x								
	Manufacturing Staff Main Lattice	**54%**										
Transition Piece												
Trade Worker	Plasma Cut & Bevel Plates	2%		x						x		
Trade Worker	Roll plates and tack weld	3%		x						x		
Trade Worker	L Weld Cans	2%		x						x		
Trade Worker	Circular weld cans and flange (4)	3%		x						x		
Trade Worker	Plasma Cut Plate (3)	2%		x						x		
Trade Worker	Weld I Beams (99) to Plate (3)	3%		x						x		
Trade Worker	Weld can section to plate	2%		x						x		
Trade Worker	Weld bracing pipes to can & plate	3%		x						x		
Trade Worker	NDT inpsect all joint welds QC	3%		x						x	x	
Assembly	Grit Blasts	2%	x									
Assembly	Spray Galvanize	2%	x									
Assembly	Apply 3 paint coats	2%	x									
Trade Worker	Final Inspect / document QC	2%		x						x	x	
Assembly	Prepare for shipment	2%	x									
Trade Worker	Maintenance - Electrical	1%		x								
Trade Worker	Maintenance - Mechanical	1%		x								
	Manufacturing Staff Trasition Piece	**36%**										
MANUFACTURING SUPPORTING STAFF												
Admin/Clerical	Admin/Clerical (for GM)	0.2%				x						
Mfg Managers	Plant/General Manager	0.2%				x						
Mfg Managers	Operations Manager	1%				x						
Mfg Managers	Floor Supervisors	4%			x							
Mfg Managers	Production, Control & Logistics Mgr	0.2%				x						
Mfg Managers	HR / Safety Manager	0.2%				x						
Engineers	Quality Engineer	1%				x					x	x
Engineers	Manufacturing Engineer	1%				x						x
Engineers	Plant Engineer	0.2%				x						x
Engineers	Product Engineer	0.2%				x						x
Engineers	Industrial Engineer	0.2%				x						x
Accounting	Finance Manager	0.2%				x						
Accounting	Finance Support	0.4%				x						
Sales/Training	Sales	0.2%				x						
SC & Purch	Purchasing	0.4%				x						
SC & Purch	Logistic operators	1.1%			x							
	Support Staff	**10%**										

Array and Export Cable

Producing 25 miles of array cable and 20 miles of export cable to install 100 turbines/yr. [3-shift operation]		234 FTEs	High School Diploma	Post-Secondary/Certification (Journeyman, Trade/Tech)	Associate's Degree	Bachelor's Degree	Post-Bachelor Professional Certification (e.g., CPA, PE)	Master's Degree, Ph.D.	CNC Machining Certificate	Welding Certificate	QC Inspector Cert. (ISO 9001)	Lean Six Sigma Cert. Green or Black Belt
			EDUCATION REQUIREMENTS						Post-Secondary Prof. Certificate Journeyman, Trade/Tech. Programs			
NY WDI Job Function	Process area	% FTE's										
MANUFACTURING STAFF												
Assembly	Mechanical extrusion & assembly	71%	x									
Assembly	QC Inspector	5%	x								x	
Trade Worker	Maintenance Mechanical	3%	x						x			
Trade Worker	Maintenance Electrical	3%	x						x			
Assembly	Production team leader	5%	x									
	Manufacturing Staff	86%										
MANUFACTURING SUPPORTING STAFF												
Admin/Clerical	Admin/Clerical (for GM)	0.4%				x						
Mfg Managers	Plant/General Manager	0.4%				x						
Mfg Managers	Operations Manager	1%				x						
Mfg Managers	Floor Supervisors (20 emp:1 Super)	4%				x						
Mfg Managers	Production, Control & Logistics Mgr.	0.4%				x						
Mfg Managers	HR / Safety Manager	0.4%				x						
Engineers	Quality Engineer	1%				x					x	
Engineers	Manufacturing Engineer	2%				x						x
Engineers	Plant Engineer	0.4%				x						x
Engineers	Product Engineer	0.4%				x						x
Engineers	Industrial Engineer	0.4%				x						x
Accounting	Finance Manager	0.4%				x						
Accounting	Finance Support	1%				x						
Sales/Training	Sales	0.4%				x						
SC & Purch	Purchasing	1%				x						
	Support Staff	14%										

Substation Structure

One substation structure produced for every 100 turbines [3-sift operation]		105 FTEs	EDUCATION REQUIREMENTS						Post-Secondary Prof. Certificate Journeyman, Trade/Tech. Programs			
NY WDI Job Function	Process area	% FTEs	High School Diploma	Post-Secondary/Certification (Journeyman, Trade/Tech)	Associate's Degree	Bachelor's Degree	Post-Bachelor Professional Certification (e.g., CPA, PE)	Master's Degree, Ph.D.	CNC Machining Certificate	Welding Certificate	QC Inspector Cert. (ISO 9001)	Lean Six Sigma Cert. Green or Black Belt
MANUFACTURING STAFF												
Trade Worker	Welders	13%		x						x		
Assembly	Assembly and material movement	8%	x									
Assembly	Team Leader	3%		x								
Assembly	QC Inspector	3%		x						x	x	
Trade Worker	Maintenance Mechanical & Millwright	4%		x						x		
Trade Worker	Maintenance Electrical	4%		x						x		
	Manufacturing Staff	33%										
MANUFACTURING SUPPORTING STAFF												
Admin/Clerical	Admin/Clerical (for GM)	0.4%				x						
Mfg Managers	Plant/General Manager	0.4%				x						
Mfg Managers	Operations Manager	1%				x						
Mfg Managers	Floor Supervisors (20 emp to 1 Super)	1%			x							
Mfg Managers	PC&L Manager (Production, Control & Logistics)	0.4%				x						
Mfg Managers	HR / Safety Manager	0.4%				x						
Engineers	Quality Engineer	1%				x					x	x
Engineers	Manufacturing Engineer	1%				x						x
Engineers	Plant Engineer	0.4%				x						x
Engineers	Product Engineer	0.4%				x						
Engineers	Industrial Engineer	0.4%				x						
Accounting	Finance Manager	0.4%				x						
Accounting	Finance Support	0.4%				x						
Sales/Training	Sales	0.4%				x						
SC & Purch	Purchasing	1%				x						
SC & Purch	Logistics Operators	1%				x						
	Support Staff	11%										

Installation and Commissioning

Direct FTEs sufficient to install & commission 600MW per year. [1-shift operation]		139 FTEs	EDUCATION REQUIREMENTS						Post-Secondary Prof. Certificate Journeyman, Trade/Tech. Programs			
NY WDI Job Function	Construction Area	% FTEs	High School Diploma	Post-Secondary/Certification (Journeyman, Trade/Tech)	Associate's Degree	Bachelor's Degree	Post-Bachelor Professional Certification (e.g., CPA, PE)	Master's Degree, Ph.D.	Apprenticeship Training	Welding Certificate	QC Inspector Cert. (ISO 9001)	Ship Master Qualifications
INSTALLATION & COMMISSIONING OPERATIONS STAFF												
Trade Worker	Electrical Fitters	6%		x					x			
Trade Worker	Mechanical Fitters	9%		x					x	x		
Trade Worker	Crane Operators	4%		x					x			
Trade Worker	Riggers	9%		x					x			
Trade Worker	Subsea Cable Installer	4%		x								
Trade Worker	Heavy Lift Crane Vessel Operator	4%		x					x			
Trade Worker	Wind Turbine Technician	6%			x				x			
Trade Worker	Skippers	7%		x								x
Trade Worker	Marine Engineering Technician	12%		x					x			
Trade Worker	Deck Hands	12%		x								
Trade Worker	Quality Inspector	3%		x							x	
Trade Worker	Land based logistics and operations	12%		x								
	Construction Operations Staff	86%										
INSTALLATION & COMMISSIONING SUPPORTING STAFF												
Admin/Clerical	Admin/Clerical (for GM)	1%		x								
Cons. Mgr.	Construction General Manager	1%				x						
Mfg Managers	Construction Project Manager	3%				x						
Mfg Managers	Asset Managers	1%				x						
Mfg Managers	Production, Control & Logistics Mgr	1%				x						
Engineers	Quality Engineer	1%				x					x	
Engineers	Geology Engineer	1%				x						
Mfg Managers	HR / Safety Manager	1%				x						
Accounting	Finance Manager	1%				x						
Accounting	Finance Support	1%				x						
Sales/Training	Sales	1%				x						
SC & Purch	Purchasing	1%				x						
SC & Purch	Logistics Operators	1%				x						
	Construction Support Staff	14%										

Operations and Maintenance

Direct jobs for O&M, and Service for 600MW of installation per year. [1-shift operation]		54
NY WDI Job Function	OMS Area	% FTEs
OMS OPERATIONS STAFF		
Trade Worker	Wind Turbine Technician	22%
Trade Worker	Heavy Lift Crane Vessel Operator	2%
Trade Worker	Helicopter pilot	4%
Trade Worker	Skippers	4%
Trade Worker	Marine Engineering Technician	7%
Trade Worker	Deck Hands	7%
Trade Worker	Quality Inspector	4%
Trade Worker	Land based logistics and opertions	30%
	O&M Staff	80%
OMS SUPPORTING STAFF		
Admin/Clerical	Admin/Clerical (for GM)	2%
Mfg Managers	O&M Project Manager	2%
Mfg Managers	Asset Manager	2%
Mfg Managers	Production, Control & Logistics Mgr	2%
Engineers	Maintenance and Performance Eng.	4%
Mfg Managers	HR / Safety Manager	2%
Accounting	Finance Manager	2%
SC & Purch	Purchasing	2%
SC & Purch	Logistics & Purchasing	4%
	OMS Support Staff	20%

EDUCATION REQUIREMENTS						Post-Secondary Prof. Certificate Journeyman, Trade/Tech. Programs			
High School Diploma	Post-Secondary/Certification (Journeyman, Trade/Tech)	Associate's Degree	Bachelor's Degree	Post-Bachelor Professional Certification (e.g., CPA, PE)	Master's Degree, Ph.D.	Apprenticeship Certificate	Welding Certificate	QC Inspector Cert. (ISO 9001)	Ship Master Qualifications
		x				x			
	x					x			
	x								
	x								x
	x					x			
	x								
	x							x	
	x								
	x								
			x						
			x						
			x						
			x						
			x						
			x						
			x						
			x						
			x						

Appendix B. Technical Training Provision

B.1 Technical Training

Technical training is offered by a broad range of providers in New York, including community colleges, State and private universities, technical institutes, and industry organizations.

CNC Machining Certificate. CNC certification qualifies students to apply skills necessary to operate CNC machine tools, such as lathes, precision measuring tools, mills, and related attachments and accessories, and to perform machining functions, such as cutting, shaping, drilling, and finishing products and component parts. Additionally, training programs that prepare students for certification frequently include in-depth instruction in CNC terminology, programming, setup, operations, and troubleshooting; machining; blueprint reading; technical mathematics; equipment capabilities; lathe and mill operations; computer literacy; shop and safety practices; CAD/CAM systems; and regulations and laws.

CNC Machining certificates are readily available to community colleges and technical institutes throughout New York. Examples of Community Colleges offering CNC Machining Beginning and/or Advanced certificates include: Rochester Institute of Technology, Mohawk Valley Community College, New York City College of Technology, Pratt Institute, Monroe Community College Applied Technologies Center, Erie Community College - North Campus, Corning Community College, Onondaga Community College, and Hudson Valley Community College.

Welding Certificates. In New York, students can find welding programs at community colleges BOCES centers. These schools' offerings include individual classes, training programs, certificates, and certification preparation and upgrade tracks. New York colleges and technical schools offering programs that prepare students for weld certification include

- Corning Community College, Corning, New York
- Onondaga Community College, Syracuse, New York
- Hudson Valley Community College, Troy, New York
- Suffolk County Community College - Corp Training Center, Brentwood, New York
- Genesee Valley Educational Partnership, Le Roy, New York
- School of Cooperative Technical Education Welding, New York, New York

- Modern Welding School, Schenectady, New York
- Apex Technical School – NYC Welding, New York, New York
- Capital Region BOCES Welding Program, Albany, New York
- Delhi State University of New York Welding Program, Delhi, New York

Several industry associations and organizations offer welding and weld inspection certification, including the American Society of Mechanical Engineers, AWS, American Petroleum Institute, and DOT.

- American Society of Mechanical Engineers offers a Boiler and Pressure Vessel Certification Program that conforms to the rules governing the design, fabrication, assembly, and inspection of boiler and pressure vessel components during construction. The American Society of Mechanical Engineers Boiler and Pressure Vessel certification program for pressure vessels would apply to similar production requirements for tower and jacket foundation production.
- AWS is the largest organization in America that certifies welders. AWS offers various certifications for welding including Certified Welding Inspector, Certified Welder, Certified Radiographic Interpreter, Certified Welding Educator, Certified Welding Engineer, Certified Welding Supervisor, and Certified Robotic Arc Welder, all applicable to the production of OSW fabricated components such as the tower and jacket foundation components.
- The American Petroleum Institute primarily provides certification for processes associated with the oil and gas industry, piping production, and pressure vessel production. Some certifications are applicable to the production of wind turbine towers and jacket foundations, such as Pressure Vessel Inspector, Piping Inspector, Corrosion and Materials, and Welding Inspection and Metallurgy.
- DOT offers a Field Welder Certification Program through their Structures Design and Construction Division. Because DOT erects and performs repairs on many steel structures that require field welding, this certification is in place to ensure the quality of its field welds. As with components for OSW applications, the quality of welds for DOT's large civil works is critical to the safety and durability of these structures. This weld certification could likely satisfy similar requirements to those of an AWS certification.

Apprenticeship Training. For job functions associated with installation and commissioning, and O&M, original equipment manufacturers will prefer that candidates have completed various apprenticeship training programs. Apprenticeship programs are the pre-requisite for operators certification and can be provided by local unions, and other organizations, in partnership with component manufacturers and vessel contractors. A list of available apprenticeship programs certified through the DOL is provided.

Management, quality, engineering, operations, and production personnel will also have preferred, or in some cases, required certifications, which may include the following:

- QC Inspector Certificate (International Standards Organization 9001). For the purposes of tower production, the QC inspectors would need to be certified specifically in weld inspection. QC Inspector certification is offered through AWS and Field Weld Inspection certification is offered through the DOT.
- Lean Six Sigma Certificate (Black or Green Belt). Although the American Quality Society is the principal certifying agency for Six Sigma Green and Black Belt, there are various educational and professional organizations that also provide training in Six Sigma disciplines. The International Association for Six Sigma Certification is a professional association that exclusively facilitates and delivers centralized universal Lean Six Sigma Certification Standards testing and Lean Six Sigma training program accreditations. Six Sigma training is offered through universities, community colleges, for-profit and not-for-profit businesses, and organizations, and is readily available throughout New York.
- CCT. Certification is through the ACMA, which is widely recognized in the composites industry for production and/or management personnel working with or producing composite components, such as blades, or nacelle and rotor housings. CCT certification is offered through the following program areas:
    - CCT Open Molding certification is for those working with fiberglass composites for either hand lay-up or spray-up applications, such as with wind blades, and nacelle and rotor housings production.
    - CCT Wind Blade Repair was developed to serve the growing demand for composites training in the wind energy sector for servicing and repairing wind turbine blades. The program certification, applicable to those in production or repair, covers general composite knowledge, composite manufacturing processes, composite materials, QC, composites in wind energy, composite materials in wind energy, composite fabrication in wind energy, composite component repair, wind energy and composite quality assurance, and wind blade repair.

New York academic institutions can partner with ACMA through their ACMA Academic Partnership program to supplement their own curriculum with ACMA's study materials, which will provide their students the opportunity to achieve a nationally recognized credential in composites.

Safety training will be required in all aspects of OSW component manufacturing, and wind farm construction, installation, and ongoing O&M. Programs relative to OSW will be through International Standards Organization certification or GWO. The following chart indicates safety certifications relative to the OSW component production and project phases.

B.2 Safety Certification

Global Wind Organisation

Global Wind Organisation (GWO) has developed training and certifications for the onshore and offshore wind industry. Below are the requirements which are standard to developers and component manufacturers such as Dong Energy, GE, Alstom, Siemens-Gamesa, Vestas, MHI, and others.
NOTE: Not all employees will require the training and certification indicated. This chart indicates which certification will be realtive to each sub-element being assessed in this report.

Safety Certification	Description	Installation/Commissioning				Operational Expenditure			
		TURBINE	FOUNDATION	SUBSEA CABLE	OTHER INSTALLATION	WIND FARM OPERATIONS	TURBINE MAINT/SERVICE	SUBSEA CABLE MAINT/SERVICE	SUBSTATION MAINT/SERVICE
Global Wind Organisation - First Aid	Lifesaving first aid, Automatic External Defibrillator (AED) , ordinary first aid, secondary first aid, first aid equipment	X	X	X	X	X	X	X	X
Global Wind Organisation - Manual Handling	Developing muscular/skeletal injuries, correct handling of equipment, symptoms of injuries related to poor Manual Handling techniques, problem solving approach to Manual Handling in a wind turbine environment, risk reduction techniques	X	X	X	X	X	X	X	X
Global Wind Organisation - Fire Awareness	Causes of fires in wind turbines, identify any sign of a fire in a wind turbine environment, contingency plans in a wind turbine environment including smoke detection and emergency escape procedures, correct actions on discovering a fire including correct operation and fire extinguishing by means of the firefighting equipment in a wind turbine generator.	X	X	X	X	X	X	X	X
Global Wind Organisation - Working at Heights	Hazards and risks associated with working at heights, specific to a wind turbine geneartor, correct identification of PPE, including identification of European/Global standard markings e.g. harness, hard hat, lanyards, etc., correctly inspect, service, storage, donning, and use of elevant PPE, e.g. harness, lanyards, fall arresters and work positioning equipment, correct use of evacuation devices, rescue situations in wind turbine generators	X	X	X	X	X	X	X	X
Global Wind Organisation - Sea Survival	Dangers and symptoms related to hypothermia and drowning, advantages and limitations of the different LSA, PPE and PFPE commonly used offshore in the wind energy industry and are able to don and use them accordingly, safe transfer from vessel to dock, vessel to foundation and vessel to vessel, emergency and safety procedures on installations, vessels and wind turbine generator, Maritime Search and Rescue (SAR), and Global Maritime Distress and Safety System (GMDSS), recovery and First Aid treatment of a "man over board", evacuation from wind turbine generator to water by means of "Constant Rate Descender", individual and collective survival techniques at sea.	X	X	X	X	X	X	X	X

Occupational Safety and Health Administration/International Standards Organization Certifications

OSHA / ISO Certifications typically required for manufacturing, installation and operations and maintenance services.
NOTE: Not all employees will require the training and certification indicated. This chart indicates which certification will be realtive to each sub-element being assessed in this report.

Safety Training Program and Certification	Description	Manufacturing of components						Installation/Commissioning				Operational Expenditure			
		NACELLE ASSEMBLY	BLADES	TOWER	FOUNDATION	SUBSEA CABLE	SUBSTATION	TURBINE	FOUNDATION	SUBSEA CABLE	OTHER INSTALLATION	WIND FARM OPERATIONS	TURBINE MAINT/SERVICE	SUBSEA CABLE MAINT/SERVICE	SUBSTATION MAINT/SERVICE
Standards of Training and Certification of Watchkeeping (STCW)	The STCW Basic Safety Training course is mandated by ALL flag States for all working seafarers. It is the international standard, approved by MCA, USCG, the Marshall Islands Registry and nearly every leading flag state in the world.							X	X	X	X				
ISO 45001 Occupational Health and Safety	The standard is currently being developed and will follow other generic management system approaches such as ISO 14001 and ISO 9001. It will take into account other International Standards in this area such as OHSAS 18001, the International Labour Organization's ILO-OSH Guidelines, various national standards and the ILO's international labour standards and conventions.	X	X	X	X	X	X								
OHSAS 18001 Occupational Health and Safety Management	OHSAS 18001 sets out the minimum requirements for occupational health and safety management best practice.	X	X	X	X	X	X								
OSHA 10-Hour Training For Construction	Prevent and predict common construction site includes material handling, OSHA Focus Four and more hazards							X	X	X	X				
OSHA 10-Hour Training For General Industry	Exit routes, emergency action plans & fire prevention, bloodborne pathogens, Personal Protective Equipment	X	X	X	X	X	X								
OSHA 30-Hour Training For Construction	Training for construction professionals includes scaffolding safety, fall protection.							X	X	X	X				
OSHA 30-Hour Training For General Industry	Hazards and general industry risks like material handling, ergonomics, and machine guarding	X	X	X	X	X	X								
OSHA 1910 Standards Training For General Industry	Safety and health principles for the General Industry	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA 1926 Standards Training For Construction Online	OSHA online training covers principles for construction industry safety, healthy workplaces, procedures & more							X	X	X	X				
OSHA 40-Hour EM 385-1-1 Hazard Recognition	US Army Corps of Engineers Contractor Safety & Health Requirement. How contractors can prevent hazards related to equipment, technique practices.							X	X	X	X				
OSHA Bloodborne Pathogens	Potential exposure to bloodborne pathogens. Adapt OSHA bloodborne pathogen regulations to your workplace & practices	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Concrete and Masonry Safety for Construction	Learn to recognize unsafe practices and jobsite hazards. Topics will include reinforcing steel, concrete buckets, & PPE.								X		X				
OSHA Confined Space Entry for General Industry	Course covers OSHA regulations and standards for confined space entry	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Cranes, Derricks, Hoists, Elevators and Conveyors	OSHA course covers safe usage and risks with common construction equipment. Type of equipment covered include cranes, hoists, elevators & more							X	X	X	X				
OSHA Electrical For Construction	Helps workers understand electrical hazards on jobsites. Familiarization with wiring and equipment use under OSHA regulations							X	X	X	X				
OSHA Ergonomics Certificate For General Industry	Designed to mitigate hazards related to specialized, repetitive tasks. Students will learn to recognize health issues related to poor ergonomics	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Excavations Safety Training	OSHA online training covers injury prevention during excavation, terminology, risks, & more										X				
OSHA Fall Protection Certificate Course	Covers OSHA regulations for when and how to use fall protection. Learn how to avoid falling objects & struck-by hazards	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Fire Detection and Protection Safety Training for General Industry	Fire prevention and potential fire preparation best practices. Training designed for schools, factories, offices and more	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Hazard Communication Update Certificate Program	OSHA regulations for hazard classification and communication. Safety Data Sheets (SDS), employee training.							X	X	X	X				
OSHA Health Hazards in Construction Safety	Identify construction site hazards. Acute & chronic hazards. OSHA online training recommended for all construction employees							X	X	X	X				
OSHA Introduction To OSHA Safety Training For General Industry	Designed for employees in factories, schools, hospital, & offices. OSHA online training will cover ergonomics, safe working surfaces & more							X	X	X	X				
OSAH Introduction to OSHA Safety Training for Construction	OSHA Online Training course may help reduce jobsite risks. Covers common construction site hazards like falls & electrocution							X	X	X	X				
OSHA Lockout / Tagout Certificate Course	Preventing injuries through controlling hazardous energy. Basics of lockout/tagout procedures for machines & equipment. Employee training requirements.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Machine Guarding Certificate Course	Machine operation & hazard avoidance. Machine guarding techniques. Preventing hazards through machine maintenance & training.	X	X	X	X	X	X								
OSHA Personal Protective Equipment (PPE) Certificate Course	Reduce hazard exposures with appropriate PPE. Respirator training, welding operations & much more. Choosing the right PPE for the right jobs	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Record Keeping Course Certificate Program	OSHA Online Training ensures record keeping best practices are enacted. Learn how to document workplace illnesses & injuries.	X	X	X	X	X	X	X	X	X	X				
OSHA Compliant Rigging And Material Handling Safety Training	Understand the basics of load rigging, rigging inspection & more. Preventing rigging & material hazards.	X	X	X	X	X	X	X	X	X	X				
OSHA-Compliant Safety Programs and Subpart C Safety Training	Online OSHA Training covers fire prevention, emergency access. Important industry terms, Personal Protective Equipment (PPE), and Competent Person (CP).	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSAH Safety And Health Training Programs For General Industry	Health and safety overview for General Industry. Safely maintaining walking & working surfaces	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Scaffolds	Online OSHA Training standards for scaffolding. Understanding different types of scaffolding. Requirements for training employee scaffolding use.				X			X	X	X	X				
OSHA Stairways And Ladders	Preventing fall hazards from stairways & ladders. Fixed and portable ladder operation & safety. Detailed OSHA injury prevention standards.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Standards And Inspection Procedures	How to apply OSHA Construction Standards. Preparing for OSHA inspection. Understanding standards keep workers and jobsites safe.							X	X	X	X				
OSHA Struck-By Hazard Protection	OSHA online training provides methods for preventing (and protecting oneself from) projectile hazards							X	X	X	X				
OSHA Walking and Working Surfaces For General Industry	Keeping working and walking surfaces safe. Understanding regulations for railings and stairs. Scaffolding and working surface hazards.	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Welding and Cutting Safety Training	Safety and efficiency for welders and cutters. Best practices for hot work precautions, heat-related risks and more. Cutting and Welding PPE.			X	X		X		X						

B.3 Apprenticeship Training

Apprenticeship training programs serve as the prerequisite training for manufacturers and vessel supplier operations certification. Table B-1 presents a listing of apprentice trade programs and their associated sponsors, which include labor unions, for profit, and non-profit organizations. Apprenticeships in the lowest demand for OSW would be carpenter, sheet-metal worker, and pipefitter, although they could be used if the construction of a temporary building for final assembly and storage of electrical components would be needed. Training time for each apprentice program ranges from 24 to 60 months, which includes the on-the-job training working beside a skilled worker.

Manufacturers and vessel supplier operations certification will provide component specific training and operations certification that are dependent on each suppliers' own requirements and standards for certification.

Table B-1. New York State Department of Labor registered Sponsors/Active Apprenticeship Programs[a]

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Boilermakers NE Area JAC LU #5	24 Van Siclen Avenue, Floral Park, NY 11001	Boiler Maker Construction	Long Island	48
Boilermakers NE Area LU #7	5745 Big Tree Road Orchard Park, NY 14127	Boiler Maker Construction	Western New York	48
Boilermakers NE LU #175	28 W. Bridge Street, Oswego, NY 13126	Boiler Maker Construction	Central	48
Boilermakers Northeastern JAC LU #5 Zone 197	75 South Dove Street, Albany, NY 12202	Boiler Maker Construction	Capital	48
SKF Aeroengine North America	1 Maroco Road, Falconer, NY 14733	Calibration Technician	Western New York	32-48
Bast Hatfield Construction, LLC	1399 Vischers Ferry Road, Clifton Park, NY 12065	Carpenter	Capital	32-48
Carpenter's JATC of NYC & Vicinity	395 Hudson Street,2nd floor New York, NY 10014	Carpenter	New York City	32-48
Clarence Wall and Ceiling, Inc.	9393 Main Street, Clarence, NY 14031	Carpenter	Western New York	32-48
Empire State Merit Apprenticeship Alliance	109 Twin Oaks Drive, Syracuse, NY 13206	Carpenter	Central	32-48
Gypsum Systems, Inc.	640 Pound Road, Elma, NY 14059	Carpenter	Western New York	32-48
Hi-Lume Corporation	175 Kennedy Drive, Hauppauge, NY 11788	Carpenter	Long Island	32-48

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
LoDuca Associates, Inc.	113 Division Ave, Blue Point, NY 11715	Carpenter	Long Island	32-48
Northeast Carpenters Apprenticeship Fund	270 Motor Parkway Department B, Hauppauge, NY 11788	Carpenter	Long Island	32-48
Northeast Carpenters Apprenticeship Fund	16 Corporate Circle, Albany, NY 12203	Carpenter	Capital	32-48
Northeast Carpenters Apprenticeship Fund	21 Jet View Drive, Rochester, NY 14624	Carpenter	Finger Lakes	32-48
Northeast Carpenters Apprenticeship Fund	270 Motor Parkway, Hauppauge, NY 11788	Carpenter	Long Island	32-48
Northland Associates, Inc.	4701 Buckley Road, Liverpool, NY 13088	Carpenter	Central	32-48
Notias Construction, Inc.	29-10 120th Street, Flushing, NY 11354	Carpenter	New York City	32-48
Pioneer Construction Company of Northport, Inc.	217 Woodbine Avenue, Northport, NY 11768	Carpenter	Long Island	32-48
Purcell Construction Corporation	566 Coffeen Street, Watertown, NY 13601	Carpenter	North Country	32-48
Structural Associates, Inc.	5903 Fisher Road, East Syracuse, NY 13057	Carpenter	Central	32-48
Carpenter's JATC of NYC & Vicinity	395 Hudson Street,2nd floor New York, NY 10014	Carpenter(Piledriver/ Dockbuilder)	New York City	32-48
Chesterfield Associates, Inc.	56 S. Country Road, Westhampton Beach, NY 11978	Carpenter(Piledriver/ Dockbuilder)	Long Island	32-48
City of Sherrill Power & Light	210 Elmwood Place, Sherrill, NY 13461	Elec Outside Line Worker	Mohawk Valley	42
M. L. Caccamise Electric Corporation	721 Portland Avenue, Rochester, NY 14621	Elec Outside Line Worker	Finger Lakes	42
NE Joint Apprenticeship-Training Comm.	649 N. Lewis Road, Suite 210, Limerick, PA 19468	Elec Outside Line Worker	Out of State	42
Oneida-Madison Electric Co-op, Inc.	6630 State Route 20, Bouckville, NY 13310	Elec Outside Line Worker	Central	42
Public Works Utilities	T4004 First Street West, Fort Drum, NY 13602	Elec Outside Line Worker	North Country	42
Salamanca Board of Public Utilities	225 Wildwood Avenue, Salamanca, NY 14779	Elec Outside Line Worker	Western New York	42
Town of Massena Electrical Department	71 East Hatfield Street, Massena, NY 13662	Elec Outside Line Worker	North Country	42
Village of Arcade	17 Church Street, Arcade, NY 14009	Elec Outside Line Worker	Finger Lakes	42
Village of Endicott Municipal Light Department	409 Hunt Avenue, Endicott, NY 13760	Elec Outside Line Worker	Southern Tier	42

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Village of Greene Municipal Electric Dept	49 Genesse Street, Greene, NY 13778	Elec Outside Line Worker	Capital	42
Village of Philadelphia, Inc.	56 Main Street, Philadelphia, NY 13673	Elec Outside Line Worker	North Country	42
Village of Richmondville Power and Light	295 Main Street Richmondville, NY 12149	Elec Outside Line Worker	Mohawk Valley	42
Village of Solvay Electric Department	507 Charles Avenue, Solvay, NY 13209	Elec Outside Line Worker	Central	42
Village of Springville	51 Nason Blvd, Springville, NY 14141	Elec Outside Line Worker	Western New York	42
Village of Theresa	124 Commerical Street, Theresa, NY 13691	Elec Outside Line Worker	North Country	42
JATC Elec Ind Nassau/Suffolk #25	370 Motor Parkway, Hauppauge, NY 11788	Electrical Maintenance Technician	Long Island	60
A and S Electric, Inc.	952 Flushing Avenue, Suite #3, Brooklyn, NY 11206	Electrician	New York City	60
A.C. Spear Electric, Inc.	1869 Pierce Creek Road, Binghamton, NY 13903	Electrician	Southern Tier	60
A.M.R. Electrical Contracting Corp.	875 East 145th Street, Bronx, NY 10455	Electrician	New York City	60
AE Rosen Electrical Co., Inc.	178 Catherine Street, Albany, NY 12202	Electrician	Capital	60
All American Electrical Corp	308 Lefferts Avenue, Brooklyn, NY 11225	Electrician	New York City	60
Anker's Electric Service, Inc.	10 South Fifth Street, Locust Valley, NY 11560	Electrician	Long Island	60
B and R Mechanical, Inc.	16 Sawgrass Dr; Suite 1, Bellport, NY 11713	Electrician	Long Island	60
BD Remodeling & Restoration NY, LLC	1420 The Gloaming, Fishers Island, NY 06390	Electrician	Long Island	60
Blake Electric Contracting Co., Inc.	311 East 150th Street, Bronx, NY 10451	Electrician	New York City	60
Brunswick Electric, Inc.	290 Hoosick Street, Troy, NY 12180	Electrician	Capital	60
C.M. Armitage, Inc.	723 Washington Avenue, Rochester, NY 14617	Electrician	Finger Lakes	60
C.M. Richey Electrical Contractors, Inc.	77 Air Park Drive, Ronkonkoma, NY 11779	Electrician	Long Island	60
Comalli Group, Inc.	111 Exchange Street, Albany, NY 12205	Electrician	Capital	60
Commerce Electrical Contracting Corp	23-86 BQE West, Astoria, NY 11103	Electrician	New York City	60
Demand Electric, Inc.	3133 31st Street,2nd Floor Astoria, NY 11106	Electrician	New York City	60

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Demco New York Corp.	6701 Manlius Center Road, East Syracuse, NY 13057	Electrician	Central	60
Double R Contracting, Inc.	19 W. Jefryn Blvd., Deer Park, NY 11729	Electrician	Long Island	60
Douglas Electric Company, Inc.	1812 Brighton Henrietta Rd, Rochester, NY 14623	Electrician	Finger Lakes	60
Dow Electric, Inc.	3874 St. Rte. 11, Malone, NY 12953	Electrician	North Country	60
Driscoll Electrical Construction, Inc.	32 Cypress Street, BUFFALO, NY 14205	Electrician	Western New York	60
DS Electric of the Hudson Valley, LLC	23 S. Creek Road, Staatsburg, NY 12580	Electrician	Mid-Hudson	60
Electricians JAC Binghamton LU #325	142 Corporate Dr., Binghamton, NY 13904	Electrician	Southern Tier	60
Electricians JAC Buffalo LU #41	S. 3546 California Road, Orchard Park, NY 14127	Electrician	Western New York	60
Electricians JAC Ithaca LU #241	134 Cecil A. Malone Drive, Ithaca, NY 14850	Electrician	Southern Tier	60
Electricians JAC of Elmira LU #139	415 West Second St., Elmira, NY 14901	Electrician	Southern Tier	60
Electricians JAC of Jamestown Local #106	322 James Avenue, Jamestown, NY 14701	Electrician	Western New York	60
Electricians JAC-Watertown LU #910	25001 Water Street, Watertown, NY 13601	Electrician	North Country	60
Electricians LU #43 Syracuse District	4566 Waterhouse Road, Clay, NY 13041	Electrician	Central	60
Gaines Electrical Contracting, Inc.	2074 Lockport Rd., Niagara Falls, NY 14305	Electrician	Western New York	60
Geneva Electrical JATC Local #840	1401 Routes 5 & 20, Geneva, NY 14456	Electrician	Finger Lakes	60
Global Electrical Contractors of Westchester, Inc.	965 Nepperhan Ave, Yonkers, NY 10703	Electrician	Mid-Hudson	60
Goforth Electric, Inc.	16 Liberty Street, Brockport, NY 14420	Electrician	Finger Lakes	60
Gordon and Zoerb Electrical Contractors, Inc.	420 South Harris Hill Road, Williamsville, NY 14221	Electrician	Western New York	60
Halcyon, Inc.	865 County Road #6, Phelps, NY 14532	Electrician	Finger Lakes	60
HDE Electric, Inc.	5841 Seneca Street, Elma, NY 14059	Electrician	Western New York	60
Highline Electric Corp.	168-01 Rockaway Blvd, Jamaica, NY 11434	Electrician	New York City	60
IBEW Local Union 363	67 Commerce Drive, South, Harriman, NY 10926	Electrician	Mid-Hudson	60

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Innovative Electric NY, Inc.	661 South Columbus Avenue, Bronx, NY 10550	Electrician	New York City	60
Interphase Electric Corp.	79 Rocklyn Avenue, Lynbrook, NY 11563	Electrician	Long Island	60
JAC IBEW Electrical LU #3	158-11 Harry VanArsdale Jr. Avenue, Flushing, NY 11365	Electrician	New York City	60
JATC Elec Ind Nassau/Suffolk #25	370 Motor Parkway, Hauppauge, NY 11788	Electrician	Long Island	60
JEMCO Electrical Cont., Inc.	271 42nd Street, Brooklyn, NY 11232	Electrician	New York City	60
JLS Electric, Inc.	3182 Route 22, Dover Plains, NY 12822	Electrician	Mid-Hudson	60
Koval Contracting, LLC	110 Button Road, Waterford, NY 12188	Electrician	Capital	60
Landmark Electric, Inc.	50 Commerce Drive, Rochester, NY 14623	Electrician	Finger Lakes	60
Lippolis Electric, Inc.	25 Seventh Street, Pelham, NY 10803	Electrician	Mid-Hudson	60
Locust Valley Electric, Inc.	93 Glen Cove Avenue, Glen Cove, NY 11542	Electrician	Long Island	60
M and J Electrical Contractors Corp.	23-24 Steinway Street, Astoria, NY 11105	Electrician	New York City	60
Mannino Electric, Inc.	4 Buckingham Aveue, Poughkeepsie, NY 12601	Electrician	Mid-Hudson	60
MC Superior Electrical Systems, Inc.	1783 Albany Post Road, Wallkill, NY 12589	Electrician	Mid-Hudson	60
Mechanical Electrical Corp.	876 Jamaica Avenue, Brooklyn, NY 11208	Electrician	New York City	60
Millennium Maintenance & Electrical Contractors	64 Freeman Street, Brooklyn, NY 11222	Electrician	New York City	60
Modern Electrical Construction, Inc.	5983 Transit Road, Lockport, NY 14094	Electrician	Western New York	60
Moonlight Electric of Jamestown, LLC	1080 East 2nd Street,Unit #3 Jamestown, NY 14701	Electrician	Western New York	60
Nelcorp Electrical Contracting Corp.	35 North Kelly Avenue, Endwell, NY 13760	Electrician	Southern Tier	60
Niagara County Electricians LU# 237	8803 Niagara Falls Blvd., Niagara Falls, NY 14304	Electrician	Western New York	60
Ocean Electric Corp.	158 CR 39, Southampton, NY 11968	Electrician	Long Island	60
Ohm's Electrical Corp.	65-10 Central Avenue, Glendale, NY 11385	Electrician	New York City	60
Optimation Industrial Services, LLC	1600 Lexington Avenue, Rochester, NY 14606	Electrician	Finger Lakes	60

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
P & W Electric, Inc.	484 Sunrise Highway, West Babylon, NY 11704	Electrician	Long Island	60
P and D Electric of Hudson Valley, Inc.	53 Eliza Street, Beacon, NY 12508	Electrician	Mid-Hudson	60
Panko Electric and Maintenance, Inc.	1080 Chenango Street, Binghamton, NY 13901	Electrician	Southern Tier	60
Public Works Utilities	T4004 First Street West, Fort Drum, NY 13602	Electrician	North Country	60
RADEC Corporation	100 Rockwood Street, Rochester, NY 14610	Electrician	Finger Lakes	60
Relle Electric Corp.	26 Sawgrass Drive, Bellport, NY 11713	Electrician	Long Island	60
Rochester Electrical JATC #86	470 W. Metro Park,Suite B Rochester, NY 14623	Electrician	Finger Lakes	60
Rondout Electric, Inc.	Rondout Electric, Inc., Highland, NY 12528	Electrician	Mid-Hudson	60
Sajiun Electric, Inc.	109 West 26th Street, Suite 2B New York, NY 10001	Electrician	New York City	60
SUNation Solar Systems	171 Remington Blvd, Ronkonkoma, NY 11779	Electrician	Long Island	60
T and R Alarm and Electrical Systems, Inc.	205 W Houston Street, New York, NY 10014	Electrician	New York City	60
Tambe Electric, Inc.	614 Fishers Run, Victor, NY 14564	Electrician	Finger Lakes	60
Tap Electric Metro, JV	926B Lincoln Avenue, Holbrook, NY 11741	Electrician	Long Island	60
Tap Electrical Contracting Service, Inc.	926 Lincoln Avenue, Holbrook, NY 11741	Electrician	Long Island	60
TC Electric, LLC	14-45 117th Street, College Point, NY 11356	Electrician	New York City	60
Telsan Electric, Inc.	26 Charles Street, Centereach, NY 11720	Electrician	Long Island	60
Top Shelf Electric Corporation	3917 Amboy Rd, Staten Island, NY 10308	Electrician	New York City	60
Tri-City Electricians JATC LU #236	428 Old Niskayuna Road, Latham, NY 12110	Electrician	Capital	60
United Ranger, Inc. DBA United Electric Co	35 Urban Avenue, Westbury, NY 11590	Electrician	Long Island	60
USIS Electric, Inc.	35 West Jefferson Ave, Pearl River, NY 10965	Electrician	Mid-Hudson	60
Valentine Electric, Inc.	374 Greenbush Road, Blauvelt, NY 10913	Electrician	Mid-Hudson	60
Veith Enterprises, Inc.	100 Parker Avenue, Poughkeepsie, NY 12601	Electrician	Mid-Hudson	60

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Wade Enterprises, Inc. dba Wade Electric	175 Mason Drive, Vestal, NY 13850	Electrician	Southern Tier	60
Westchester- Fairfield JATC LU #3 IBEW	200 Bloomingdale Road, White Plains, NY 10605	Electrician	Mid-Hudson	60
White Electric of New York, LLC	128 Fulton Street, White Plains, NY 10606	Electrician	Mid-Hudson	60
Wittburn Enterprises, Inc.	32 Cypress Street, Buffalo, NY 14204	Electrician	Western New York	60
Yonkers Electric Contracting Corp.	145 Saw Mill River Road, Yonkers, NY 10701	Electrician	Mid-Hudson	60
Dresser-Rand Group, Inc.	100 Chemung Street, Painted Post, NY 14870	Electronics Technician	Southern Tier	48
Marquardt Switches, Inc.	2711 Route 20 East, Cazenovia, NY 13035	Electronics Technician	Central	48
Progressive Machine and Design LLC	727 Rowley Road, Victor, NY 14564	Industrial Eqmt Wirer & Assem.	Finger Lakes	48
Cummins, Inc.	4720 Baker Street Ext., Lakewood, NY 14750	Industrial Machinery Mechanic	Western New York	48
Dresser-Rand Group, Inc.	100 Chemung Street, Painted Post, NY 14870	Industrial Machinery Mechanic	Southern Tier	48
APC Paper Company of NY, Inc.	100 Remington Ave, Norfolk, NY 13667	Instrument & Electrical Mechanic	North Country	45
SCA Tissue North America, LLC	1 River Street, South Glens Falls, NY 12803	Instrument & Electrical Mechanic	Capital	45
PACTIV, LLC	74 Weed Street, Plattsburgh, NY 12901	Instrument Mechanic	North Country	48
Occidental Chemical Corporation	4700 Buffalo Avenue, Niagara Falls, NY 14302	Instrument Technician	Western New York	48
Iron Workers JAC LU #60	500 West Genesee Street, Syracuse, NY 13204	Iron Worker (Outside)	Central	36-48
Iron Workers JAC of Albany LU #12	890 Third Street Ste 2, Albany, NY 12206	Iron Worker (Outside)	Capital	36-48
Iron Workers LU #33 JAC Rochester	154 Humboldt Street, Rochester, NY 14610	Iron Worker (Outside)	Finger Lakes	36-48
Ironworkers JAC District 1 - Local #440	10 Main Street, Suite 100, Whitesboro, NY 13492	Iron Worker (Outside)	Mohawk Valley	36-48
Ironworkers JAC District 2 - LU #440	10 Main Street, Suite 100, Whitesboro, NY 13492	Iron Worker (Outside)	Mohawk Valley	36-48
Ironworkers JAC LU #417 Newburgh	583 Route 32, Wallkill, NY 12589	Iron Worker (Outside)	Mid-Hudson	36-48
Ironworkers JAC LU #6	2660 William Street, Cheektowaga, NY 14227	Iron Worker (Outside)	Western New York	36-48

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Ironworkers Local #9 JAC of Niagara County	412 39th Street, Niagara Falls, NY 14303	Iron Worker (Outside)	Western New York	36-48
Ironworkers LU #40 and #361	35-23 36th Street, Astoria, NY 11106	Iron Worker (Outside)	New York City	36-48
Piasecki Steel Construction Corp.	1264 Route 9, Castleton, NY 12033	Iron Worker (Outside)	Capital	36-48
United Derrickmen and Riggers LU #197	35-53 24th Street, Long Island City, NY 11106	Iron Worker (Stone Derrickman and Rigger)	New York City	36
Advan-Tech Manufacturing, Inc.	3645 California Road, Orchard Park, NY 14127	Machinist	Western New York	48
ARCONIC, Inc.	PO Box 150, Park Avenue East, Massena, NY 13662	Machinist	North Country	48
BNP Machine, Inc.	700 Railroad Street, Rome, NY 13440	Machinist	Mohawk Valley	48
Cameron Manufacturing and Design	727 Blostein Boulevard, Horseheads, NY 14845	Machinist	Southern Tier	48
CEM Machine, Inc.	571 West End Road, Carthage, NY 13619	Machinist	North Country	48
World Kitchen, LLC	One Steuben Street, Corning, NY 14830	Machinist	Southern Tier	48
Advantech Industries, Inc.	3850 Buffalo Road, Rochester, NY 14624	Machinist (CNC)	Finger Lakes	48
Amada Tool America, Inc.	4A Treadeasy Avenue, Batavia, NY 14020	Machinist (CNC)	Finger Lakes	48
BNP Machine, Inc.	700 Railroad Street, Rome, NY 13440	Machinist (CNC)	Mohawk Valley	48
CEM Machine, Inc.	571 West End Road, Carthage, NY 13619	Machinist (CNC)	North Country	48
Charles A. Rogers Enterprises	51 Victor Heights Parkway, Victor, NY 14564	Machinist (CNC)	Finger Lakes	48
Cryomech, Inc.	113 Falso Drive, Syracuse, NY 13211	Machinist (CNC)	Central	48
Current Applications, Inc.	275 Bellew Ave South, Watertown, NY 13601	Machinist (CNC)	North Country	48
Falk Precision, Inc.	5917 Fisher Road, East Syracuse, NY 13057	Machinist (CNC)	Central	48
JMA Wireless	7645 Henry Clay Blvd, Liverpool, NY 13088	Machinist (CNC)	Central	48
Lakeside Precision, Inc.	208 Dove Street, Dunkirk, NY 14048	Machinist (CNC)	Western New York	48
Machine Tool Research, Inc.	405 Blossom Road, Rochester, NY 14610	Machinist (CNC)	Finger Lakes	48
Palma Tool and Die Co., Inc.	40 Ward Road, Lancaster, NY 14086	Machinist (CNC)	Western New York	48

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Peko Precision Products, Inc.	1400 Emerson Street, Rochester, NY 14606	Machinist (CNC)	Finger Lakes	48
PPI Corp. dba FTT Manufacturing	275 Commerce Drive, Rochester, NY 14623	Machinist (CNC)	Finger Lakes	48
Precise Tool and Manufacturing, Inc.	9 Coldwater Crescent, Rochester, NY 14624	Machinist (CNC)	Finger Lakes	48
Prototype Manufacturing Corp.	836 Wurlitzer Drive, Tonawanda, NY 14120	Machinist (CNC)	Western New York	48
S&H Machine Company, Inc.	83 Clyde Avenue, Buffalo, NY 14215	Machinist (CNC)	Western New York	48
Teke Machine Corporation	114 West Avenue, Rochester, NY 14611	Machinist (CNC)	Finger Lakes	48
Trident Precision Manufacturing, Inc.	734 Salt Road, Webster, NY 14580	Machinist (CNC)	Finger Lakes	48
W. Kintz Plastics, Inc.	165 Caverns Road, Howes Cave, NY 12092	Machinist (CNC)	Mohawk Valley	48
BorgWarner Ithaca, LLC	800 Warren Road, Ithaca, NY 14850	Maintenance Machinist	Southern Tier	48 & 60
Marquardt Switches, Inc.	2711 Route 20 East, Cazenovia, NY 13035	Maintenance Mechanic (Auto Eqmt)	Central	48
Revere Copper Products, Inc.	One Revere Park, Rome, NY 13440	Maintenance Mechanic (Auto Eqmt)	Mohawk Valley	48
Cameron Manufacturing and Design	727 Blostein Boulevard, Horseheads, NY 14845	Millwright	Southern Tier	31-48
Carpenter's JATC of NYC & Vicinity	395 Hudson Street,2nd floor New York, NY 10014	Millwright	New York City	31-48
Eastern Millwright Regional Council ATF	21 Jet View Drive, Rochester, NY 14624	Millwright	Finger Lakes	31-48
Optimation Industrial Services, LLC	1600 Lexington Avenue, Rochester, NY 14606	Millwright	Finger Lakes	31-48
C.O. Falter Construction Corp.	403 West Bear Street, Syracuse, NY 13204	Optg. Engineer (Heavy Eqmt)	Central	36
Carver Construction, Inc.	494 Western Turnpike, Altamont, NY 12009	Optg. Engineer (Heavy Eqmt)	Capital	36
Chesterfield Associates, Inc.	56 S. Country Road, Westhampton Beach, NY 11978	Optg. Engineer (Heavy Eqmt)	Long Island	36
D. F. Stone Contracting Ltd.	1230 Station Road, Medford, NY 11763	Optg. Engineer (Heavy Eqmt)	Long Island	36
Empire State Merit Apprenticeship Alliance	109 Twin Oaks Drive, Syracuse, NY 13206	Optg. Engineer (Heavy Eqmt)	Central	36

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Engineers JTF LU 463 DBA Upstate NY Eng. 463	5612 Business Avenue, Cicero, NY 13039	Optg. Engineer (Heavy Eqmt)	Central	36
Engineers JTF LU 545 DBA NY Engineers LU 158	5612 Business Avenue, Cicero, NY 13039	Optg. Engineer (Heavy Eqmt)	Central	36
Engineers JTF LU#832 DBA Upstate Engineers 158	5612 Business Avenue, Cicero, NY 13039	Optg. Engineer (Heavy Eqmt)	Central	36
Grant Street Construction, Inc.	48 Grant Street, Cortland, NY 13045	Optg. Engineer (Heavy Eqmt)	Central	36
Int'l Union Operating Engineers LU #138 ETC LI	575 Horseblock Road, Brookhaven, NY 11719	Optg. Engineer (Heavy Eqmt)	Long Island	36
L.F.G. Rigging, Inc.	94 Cocoanut Street, Brentwood, NY 11717	Optg. Engineer (Heavy Eqmt)	Long Island	36
Operating Engineers JAC LU #17	2342 Pleasant Avenue, Lakeview, NY 14085	Optg. Engineer (Heavy Eqmt)	Western New York	36
Operating Engineers LU #15 JAC	Local 15 Training Site, South Ozone Park, NY 11420	Optg. Engineer (Heavy Eqmt)	New York City	36
Terry Contracting and Materials, Inc.	1146 Osborn Avenue, Riverhead, NY 11901	Optg. Engineer (Heavy Eqmt)	Long Island	36
Tom Kubricky Company, Inc. dba TKC	Thousand Oaks Park,1166 Route 9 Gansevoort, NY 12831	Optg. Engineer (Heavy Eqmt)	Capital	36
Empire Paving of Schenectady	1982 Duanesburg Road, Duanesburg, NY 12056	Optg. Engineer (Universal Eqmt)	Capital	25-36
Midland Asphalt Materials, Inc.	640 Young Street, Tonawanda, NY 14150	Optg. Engineer (Universal Eqmt)	Western New York	25-36
Occhino Corporation	2650 Seneca Street, West Seneca, NY 14224	Optg. Engineer (Universal Eqmt)	Western New York	25-36
Operating Engineers JAC Albany LU #106	44 Hannay Lane, Glenmont, NY 12077	Optg. Engineer (Universal Eqmt)	Capital	25-36
Operating Engineers Local 825 NY	96 Bates/Gates Road, New Hampton, NY 10958	Optg. Engineer (Universal Eqmt)	Mid-Hudson	25-36
Operating Engineers LU #137 Appr. Skills	1360 Pleasantville Road, Briarcliff Manor, NY 10510	Optg. Engineer (Universal Eqmt)	Mid-Hudson	25-36
Operating Engineers LU #14-14B JAC	141 57 Northern Blvd, Flushing, NY 11354	Optg. Engineer (Universal Eqmt)	New York City	25-36
Finishing Trades Institute of New York	45-15 36th Street, Long Island City, NY 11101	Painter (Structural Steel-Bridges)	New York City	36
Finishing Trades Institute of NY @ Albany	191 Broadway, Menands, NY 12204	Painter (Structural Steel-Bridges)	Capital	36
Finishing Trades Institute of Western-Central NY	585 Aero Drive, Cheektowaga, NY 14225	Painter (Structural Steel-Bridges)	Western New York	36

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Kenron Industrial Air Conditioning, Inc.	299 Gregory Street, Rochester, NY 14620	Pipefitter	Finger Lakes	60
Lawman Heating and Cooling, Inc.	206 Ambrose Street, Sackets Harbor, NY 13685	Pipefitter	North Country	60
Optimation Industrial Services, LLC	1600 Lexington Avenue, Rochester, NY 14606	Pipefitter	Finger Lakes	60
Plumbers and Steamfitters JAC LU #267 (Syracuse)	107 Twin Oaks Drive, Syracuse, NY 13206	Pipefitter	Central	60
United Service Workers #355 JATC	267 Knickerbocker Avenue, Bohemia, NY 11716	Pipefitter	Long Island	60
ARCONIC, Inc.	PO Box 150, Park Avenue East, Massena, NY 13662	Plant Maintenance-Electrician	North Country	48
BorgWarner Ithaca, LLC	800 Warren Road, Ithaca, NY 14850	Plant Maintenance-Electrician	Southern Tier	48
Canton Potsdam Hospital	50 Leroy Street, Potsdam, NY 13676	Plant Maintenance-Electrician	North Country	48
Cornell University	B20 Humphreys Service Bldg., Ithaca, NY 14853	Plant Maintenance-Electrician	Southern Tier	48
Cummins, Inc.	4720 Baker Street Ext., Lakewood, NY 14750	Plant Maintenance-Electrician	Western New York	48
Dresser-Rand Group, Inc.	100 Chemung Street, Painted Post, NY 14870	Plant Maintenance-Electrician	Southern Tier	48
General Mills Operations, LLC (Cereal Division)	54 South Michigan Avenue, Buffalo, NY 14203	Plant Maintenance-Electrician	Western New York	48
General Mills Operations, LLC (Flour Division)	54 South Michigan Avenue, Buffalo, NY 14203	Plant Maintenance-Electrician	Western New York	48
GM Components Holdings, LLC	200 Upper Mountain Road, Lockport, NY 14094	Plant Maintenance-Electrician	Western New York	48
GM Powertrain Division-Tonawanda Engine Plant	2995 River Road, Buffalo, NY 14207	Plant Maintenance-Electrician	Western New York	48
JATC Lighting Maintenance Association LU #3	158-11 Harry VanArsdale, Jr. Avenue, Flushing, NY 11365	Plant Maintenance-Electrician	New York City	48
Lehigh Northeast Cement Company	313 Warren Street, Glens Falls, NY 12801	Plant Maintenance-Electrician	Capital	48
NYS DOCS Statewide	825 Central Avenue, Albany, NY 12226	Plant Maintenance-Electrician	Capital	48
PACTIV LLC	74 Weed Street, Plattsburgh, NY 12901	Plant Maintenance-Electrician	North Country	48
Potsdam Specialty Paper, Inc.	547A Sissonville Road, Potsdam, NY 13676	Plant Maintenance-Electrician	North Country	48
Quad Graphics, Inc.	56 Duplainville Road, Saratoga Springs, NY 12866	Plant Maintenance-Electrician	Capital	48

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Revere Copper Products, Inc.	One Revere Park, Rome, NY 13440	Plant Maintenance-Electrician	Mohawk Valley	48
SKF Aeroengine North America	1 Maroco Road, Falconer, NY 14733	Plant Maintenance-Electrician	Western New York	48
St. Lawrence County	48 Court Street, Canton, NY 13617	Plant Maintenance-Electrician	North Country	48
Van De Mark Chemical, Inc.	1 North Transit Road, Lockport, NY 14094	Plant Maintenance-Electrician	Western New York	48
World Kitchen, LLC	One Steuben Street, Corning, NY 14830	Plant Maintenance-Electrician	Southern Tier	48
Anchor Glass Container Corp.	151 E. McCann's Boulevard, Elmira Heights, NY 14903	Plant Maintenance-Mechanic	Southern Tier	48
APC Paper Company of NY, Inc.	100 Remington Ave, Norfolk, NY 13667	Plant Maintenance-Mechanic	North Country	48
ARCONIC, Inc.	PO Box 150, Park Avenue East, Massena, NY 13662	Plant Maintenance-Mechanic	North Country	48
BorgWarner Ithaca, LLC	800 Warren Road, Ithaca, NY 14850	Plant Maintenance-Mechanic	Southern Tier	48
General Mills Operations, LLC	54 South Michigan Avenue, Buffalo, NY 14203	Plant Maintenance-Mechanic	Western New York	48
Van De Mark Chemical, Inc.	1 North Transit Road, Lockport, NY 14094	Plant Maintenance-Mechanic	Western New York	48
World Kitchen, LLC	One Steuben Street, Corning, NY 14830	Plant Maintenance-Mechanic	Southern Tier	48
Dresser-Rand Group, Inc.	100 Chemung Street, Painted Post, NY 14870	Plant Maintenance-Millwright	Southern Tier	48
Dunn Paper- Natural Dam, Inc.	4921 Route 58 North, Gouverneur, NY 13642	Plant Maintenance-Millwright	North Country	48
Goodyear Tire and Rubber Company JAC	5500 Goodyear Drive, Niagara Falls, NY 14304	Plant Maintenance-Millwright	Western New York	48
Imerys Fused Minerals	2000 College Avenue, Niagara Falls, NY 14305	Plant Maintenance-Millwright	Western New York	48
Lehigh Northeast Cement Company	313 Warren Street, Glens Falls, NY 12801	Plant Maintenance-Millwright	Capital	48
PACTIV, LLC	74 Weed Street, Plattsburgh, NY 12901	Plant Maintenance-Millwright	North Country	48
SCA Tissue North America, LLC	1 River Street, South Glens Falls, NY 12803	Plant Maintenance-Millwright	Capital	48
SKF Aeroengine North America	1 Maroco Road, Falconer, NY 14733	Plant Maintenance-Millwright	Western New York	48
Morton Salt, Inc.	45 Ribaud Ave. E., Silver Springs, NY 14550	Plant Maintenance-Pipefitter	Finger Lakes	48

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Occidental Chemical Corporation	4700 Buffalo Avenue, Niagara Falls, NY 14302	Plant Maintenance-Welder	Western New York	48
A Plus Sheetmetal, Inc.	105 DaVinci Dr, Bohemia, NY 11716	Sheet Metal Worker	Long Island	48-60
All-City Metal, Inc.	54-35 46th Street, Maspeth, NY 11378	Sheet Metal Worker	New York City	48-60
Area Sheet Metal Workers JAC of Elmira, LU #112	1200 Clemens Center Parkway, Elmira, NY 14902	Sheet Metal Worker	Southern Tier	48-60
Capital District Sheetmetal JAC LU #83	900 Commerce Drive, Clifton Park, NY 12065	Sheet Metal Worker	Capital	48-60
Comfort Systems USA (Syracuse), Inc.	6500 New Venture Gear Drive, East Syracuse, NY 13057	Sheet Metal Worker	Central	48-60
D.B.H. Sheet Metal, Corp. dba Blake Sheet Metal	118 Keyland Court, Bohemia, NY 11716	Sheet Metal Worker	Long Island	48-60
Halcyon, Inc.	865 County Road #6, Phelps, NY 14532	Sheet Metal Worker	Finger Lakes	48-60
Isaac Heating and Air Conditioning, Inc.	50 Holleder Parkway, Rochester, NY 14615	Sheet Metal Worker	Finger Lakes	48-60
J and J Sheet Metal Works	414 Commerce Road, Vestal, NY 13850	Sheet Metal Worker	Southern Tier	48-60
J and K Plumbing and Heating Co., Inc.	24 Thorp Street, Binghamton, NY 13905	Sheet Metal Worker	Southern Tier	48-60
Kennedy Mechanical Plumbing and Heating, Inc.	11 Comfort Street, Rochester, NY 14620	Sheet Metal Worker	Finger Lakes	48-60
Kenron Industrial Air Conditioning, Inc.	299 Gregory Street, Rochester, NY 14620	Sheet Metal Worker	Finger Lakes	48-60
Lawman Heating and Cooling, Inc.	5813 Stonehill Road, Lakeville, NY 14480	Sheet Metal Worker	Finger Lakes	48-60
Lawman Heating and Cooling, Inc.	206 Ambrose Street, Sackets Harbor, NY 13685	Sheet Metal Worker	North Country	48-60
Optimation Industrial Services LLC	1600 Lexington Avenue, Rochester, NY 14606	Sheet Metal Worker	Finger Lakes	48-60
Pyramid Air Conditioning, Inc.	90 East Jefryn Blvd, Deer Park, NY 11729	Sheet Metal Worker	Long Island	48-60
RLT Heating and Air Conditioning, Inc.	119 Sheridan Avenue, Albany, NY 12210	Sheet Metal Worker	Capital	48-60
S & O Construction Services, Inc.	11 Charles Street, Pleasant Valley, NY 12569	Sheet Metal Worker	Mid-Hudson	48-60
Sheet Metal JAC of Rochester LU #46	244 Paul Road, Rochester, NY 14624	Sheet Metal Worker	Finger Lakes	48-60
Sheet Metal Workers JAC West. LU #38	38 Starr Ridge Road, Brewster, NY 10509	Sheet Metal Worker	Mid-Hudson	48-60
Sheet Metal Workers Local #28	139-20 Jamaica Avenue, Jamaica, NY 11435	Sheet Metal Worker	New York City	48-60

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Sheetmetal Workers JAC LU #71	24 Liberty Avenue, Buffalo, NY 14215	Sheet Metal Worker	Western New York	48-60
Sheetmetal Workers JAC Syracuse LU #58	301 Pulaski Street, Syracuse, NY 13204	Sheet Metal Worker	Central	48-60
Sheetmetal Workers Jamestown JAC LU #112	827 East 2nd Street, Jamestown, NY 14701	Sheet Metal Worker	Western New York	48-60
United Service Workers #355 JATC	267 Knickerbocker Avenue, Bohemia, NY 11716	Sheet Metal Worker	Long Island	48-60
Total Safety Consulting, LLC	36-06 43rd Avenue, Long Island City, NY 11101	Site Safety Manager	New York City	24
Anjo Construction Ltd.	794 Watervliet Shaker Road, Latham, Ny 12110	Skilled Construction Craft Laborer	Capital	24
Asbestos, Lead & Haz. Waste Laborers LU #78	42-53 21st Street, Long Island City, NY 11101	Skilled Construction Craft Laborer	New York City	24
Barrett Paving Materials, Inc.	4530 Wetzel Road, Liverpool, NY 13088	Skilled Construction Craft Laborer	Central	24
Buffalo Laborers Training JAC	1370 Seneca Street, Buffalo, NY 14210	Skilled Construction Craft Laborer	Western New York	24
C.O. Falter Construction Corp.	403 West Bear Street, Syracuse, NY 13204	Skilled Construction Craft Laborer	Central	24
Carver Construction, Inc.	494 Western Turnpike, Altamont, NY 12009	Skilled Construction Craft Laborer	Capital	24
Chesterfield Associates, Inc.	56 S. Country Road, Westhampton Beach, NY 11978	Skilled Construction Craft Laborer	Long Island	24
Cold Spring Construction Co.	3 Jackson Street, Akron, NY 14001	Skilled Construction Craft Laborer	Western New York	24
Construction and General Laborers' LU #633	7051 Fly Road, East Syracuse, NY 13057	Skilled Construction Craft Laborer	Central	24
Construction General Bldg Laborers LU#79	42-53 21st Street, Long Island City, NY 11101	Skilled Construction Craft Laborer	New York City	24
D. F. Stone Contracting Ltd.	1230 Station Road, Medford, NY 11763	Skilled Construction Craft Laborer	Long Island	24
DC16 Cement-Concrete Workers Training	29-18 35th Avenue, Long Island, NY 11106	Skilled Construction Craft Laborer	New York City	24

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
DelSignore Blacktop Paving, Inc.	42 Brick Church Road, Troy, NY 12180	Skilled Construction Craft Laborer	Capital	24
Eastern New York Laborers Training Center	666 Wemple Road, Box 100, Glenmont, NY 12077	Skilled Construction Craft Laborer	Capital	24
Empire Paving of Schenectady	1982 Duanesburg Road, Duanesburg, NY 12056	Skilled Construction Craft Laborer	Capital	24
Empire State Highway Contractors Assn., Inc.	2481 Higby Road, Frankfort, NY 13340	Skilled Construction Craft Laborer	Mohawk Valley	24
Empire State Merit Apprenticeship Alliance	109 Twin Oaks Drive, Syracuse, NY 13206	Skilled Construction Craft Laborer	Central	24
General Building Laborers' LU #66 Training Fund	1600 Walt Whitman Rd, Melville, NY 11747	Skilled Construction Craft Laborer	Long Island	24
Grant Street Construction, Inc.	48 Grant Street, Cortland, NY 13045	Skilled Construction Craft Laborer	Central	24
L.F.G. Rigging, Inc.	94 Cocoanut Street, Brentwood, NY 11717	Skilled Construction Craft Laborer	Long Island	24
Laborer Local 235	41 Knollwood Rd., Elmsford, NY 10523	Skilled Construction Craft Laborer	Mid-Hudson	24
Laborers Intern'l Union of NA #785 Ithaca JAC	622 West State Street, Ithaca, NY 14850	Skilled Construction Craft Laborer	Southern Tier	24
Laborers LU #91 Education Training Fund JAC	2556 Seneca Avenue, Niagara Falls, NY 14305	Skilled Construction Craft Laborer	Western New York	24
Lipsky Enterprises, Inc.	814 Montauk Highway, Bayport, NY 11705	Skilled Construction Craft Laborer	Long Island	24
LIUNA Laborers LU #35	10 Main Street, Whitesboro, NY 13492	Skilled Construction Craft Laborer	Mohawk Valley	24
LIUNA LU #17	451-C Little Britain Rd, Newburgh, NY 12550	Skilled Construction Craft Laborer	Mid-Hudson	24
LIUNA LU #1822 JAC Massena	49 1/2 Maple Street, Massena, NY 13662	Skilled Construction Craft Laborer	North Country	24

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
LIUNA LU #731-Training Fund	34-11 35th Avenue, Astoria, NY 11106	Skilled Construction Craft Laborer	New York City	24
LIUNA LU #754	215 Old Nyack Turnpike, Chestnut Ridge, NY 10977	Skilled Construction Craft Laborer	Mid-Hudson	24
Local 1010 Pavers JAC	17-20 Whitestone Expy,2nd Floor Whitestone, NY 11357	Skilled Construction Craft Laborer	New York City	24
Milcon Construction Corp.	142 Dale Street, West Babylon, NY 11704	Skilled Construction Craft Laborer	Long Island	24
New Frontier Excavating and Paving, Inc.	7003 Brown Hill Road, Boston, NY 14025	Skilled Construction Craft Laborer	Western New York	24
Occhino Corporation	2650 Seneca Street, West Seneca, NY 14224	Skilled Construction Craft Laborer	Western New York	24
Peter Luizzi and Bros. Contracting, Inc.	49 Railroad Avenue, Albany, NY 12205	Skilled Construction Craft Laborer	Capital	24
Racanelli Construction Co., Inc.	1895 Walt Whitman Road, Suite 1, Melville, NY 11747	Skilled Construction Craft Laborer	Long Island	24
Rifenburg Construction, Inc.	159 Brick Church Road, Troy, NY 12180	Skilled Construction Craft Laborer	Capital	24
Road and Heavy Construction Laborers LU #1298	1611 Locust Avenue, Bohemia, NY 11716	Skilled Construction Craft Laborer	Long Island	24
Rochester Laborers LU#435	20-22 Fourth Street, Rochester, NY 14609	Skilled Construction Craft Laborer	Finger Lakes	24
Seneca Roadways, Inc.	263 Dakota Street, Rochester, NY 14606	Skilled Construction Craft Laborer	Finger Lakes	24
Southern Tier Laborers' JAC LU #621	1521 North Union Street, Olean, NY 14760	Skilled Construction Craft Laborer	Western New York	24
Stephen Miller General Contractors, Inc.	301 Riceville Road, Gloversville, NY 12078	Skilled Construction Craft Laborer	Mohawk Valley	24
The Landtek Group, Inc.	235 County Line Road, Amityville, NY 11701	Skilled Construction Craft Laborer	Long Island	24

Table notes are at the end of the table.

Table B-1 continued

Sponsor Name	Address	Trade	Regional Economic Development Corpo	Duration (Months)
Tom Kubricky Company, Inc. dba TKC	Thousand Oaks Park,1166 Route 9 Gansevoort, NY 12831	Skilled Construction Craft Laborer	Capital	24
United Plant and Production Workers #175	99 Mineola Avenue, Roslyn Heights, NY 11577	Skilled Construction Craft Laborer	Long Island	24
Villager Construction, Inc.	425 Old Macedon Center Road, Fairport, NY 14450	Skilled Construction Craft Laborer	Finger Lakes	24
Visone Construction, Inc.	79 Sheldon Avenue, Depew, NY 14043	Skilled Construction Craft Laborer	Western New York	24
Wenger Construction Company, Inc.	91 Commercial Street, Plainview, NY 11803	Skilled Construction Craft Laborer	Long Island	24
Thomas Gleason, Inc.	501 Salt Point Turnpike, Poughkeepsie, NY 12601	Skilled Construction Craft Laborer	Mid-Hudson	24
West/Putnam Construction Craft Laborer	140 Broadway, Hawthorne, NY 10532	Skilled Construction Craft Laborer	Mid-Hudson	24
NYS DOCS Statewide	825 Central Avenue, Albany, NY 12226	Welder (Industrial)	Capital	48
Optimation Industrial Services, LLC	1600 Lexington Avenue, Rochester, NY 14606	Welder (Industrial)	Finger Lakes	48

[a] As of November 10, 2017.

Appendix C. New York Ports Analysis

New York has numerous publicly and privately-owned port facilities located in New York Harbor, on the Hudson River, and along the coastline of Long Island. These facilities are well positioned to support the full lifecycle of OSW projects from manufacturing to staging, installation, and O&M. To realize the full potential of these sites, upgrades will be needed at most locations. Large component manufacturing and staging and installation ports will need higher levels of upgrades while O&M sites will require significantly less.

This section provides an analysis of physical port requirements versus existing conditions at potential New York facilities. OSW port facilities can generally be grouped into three categories based on activities and functions, with some overlap:

- Manufacturing and fabrication
- Staging and installation
- O&M

As an example of overlap, some manufacturing activities can be collocated with the staging and installation facility, reducing transportation costs, and increasing construction efficiency.

A further breakdown of port facilities, by sub-element, is provided in Table C-1. The table also lists the minimum physical parameters required for each type of facility. Generally, turbine components can be transported between manufacturing facilities and the staging and installation port using shallow-draft barges. Cables, on the other hand, are usually transported by dedicated cable vessels. While Table C-1 shows minimum physical parameters, the combination of multiple components or functions at a site would likely require additional infrastructure. These parameters are sourced from COWI,[18] who assume horizontal loading of components and the use of shallow draft barges to transport final components to the staging and installation facility.

[18] New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure, COWI 2017

Table C-2. Minimum OSW Port Parameters

Component	Site area (hectares)	Wharf length (meters)	Vessel draft (meters)	Air draft (meters)	Wharf live load capacity (metric tons per square meter)	Vessel type considered
Nacelle, rotor and assembly	10	50	4	15	20	Feeder barge
Blade manufacture	10	120	4	15	2	Feeder barge
Tower manufacture	10	50	4	15	5	Feeder barge
Foundation manufacture	10	50	4	30	20	Feeder barge
Array and export cable manufacture	12	125	12	50	5	Cable vessel
Substation manufacture	10	50	4	40	20	Feeder barge or heavy lift vessel
Staging and installation	10	100 to 200[a]	4 to 12[a]	120	20	Feeder barge or WTIV
Operations and maintenance	4	20	5	20	2	Crew transfer vessel or service operation vessel

[a] Lower bound of range represents barge transport; upper bound represents a WTIV.

COWI performed a screening of 54 waterfront sites in New York Harbor and on the Hudson River and 11 distinct areas along the coastline of Long Island. This evaluation was summarized in a report titled *New York State Offshore Wind Master Plan Assessment of Ports and Infrastructure* dated December 2017.

C.1 Component Manufacturing, Staging and Installation

COWI has identified many sites, generally within New York Harbor and along the Hudson River, that are suitable for component manufacturing and staging and installation. Long Island sites are challenged by shallow navigable depths and, in some cases, long distances to potential OSW sites, relative to other potential sites in New York.

Wind turbine generators can be installed in a variety of ways and configurations. Developers and manufacturers in all cases will seek to limit risk and maximize efficiencies during construction. Air draft restrictions can reduce the efficiency of construction activities. Current preferred methods of construction for projects in Europe includes the use of WTIVs. To maximize efficiency, multiple sets of towers, nacelles and blades can all be loaded onto the WTIV simultaneously. The preferred method

of transporting the tower and transition sections is to pre-assemble on land and transport in the upright (vertical) position. Current towers in the industry reach lengths exceeding 82 meters. WTIVs utilize jack-up legs for stability at the staging port and the installation site and can have jack-up legs more than 90 meters long.

Air draft restrictions within New York Harbor and along the Hudson River range from 18.3 meters at the Dunn Memorial Bridge on the Hudson River at Albany to a maximum of 65.5 meters at the centerline of the Verrazano-Narrows Bridge in New York Harbor. These constraints will need to be considered when developing port facilities as well as transportation and installation methods and plans.

As previously mentioned, turbine components can be transported from manufacturing facilities horizontally using a feeder barge, a method that would have less air draft concerns. Substations do not benefit from horizontal transport, and cabling is generally transported only using dedicated cable installation vessels. These two components, therefore, are also subject to certain air draft restrictions.

WTIVs, which typically travel from the staging facility to the offshore installation site, may face air draft restrictions due to either the components onboard or the jack-up legs themselves. However, some components could be transported horizontally, and future generation WTIVs could potentially lower or angle its legs to pass beneath vertical constraints. A full evaluation of these concepts and other innovative methods is beyond the scope of this report. Of the sites considered for further evaluation by COWI, one New York site, located at the former Shoreham nuclear facility in Shoreham, has unrestricted air draft.

C.2 Operations and Maintenance

O&M port facilities are generally far less demanding, in terms of physical scale, vessel draft, and air draft requirements, than manufacturing and staging and installation facilities.

Many of the potential O&M sites on Long Island that would be closest to the wind farms are currently catering to the recreational boating or fishing community and would require expansion or re-purposing to support wind farm O&M activities. COWI identified several areas along the Long Island coast that display potential to serve as O&M facilities due to their available acreage, proximity to the wind energy areas, and existing waterfront infrastructure.

Sites in New York Harbor are also suitable for O&M activity, but their ability to also host various manufacturing and staging facilities make O&M less of a priority. O&M activities could be supported in conjunction with other activities at many port facilities.

C.3 Key Findings

COWI identified 16 New York waterfront sites that are particularly notable for their potential to support OSW. These sites are shown below in Table C-2. Most of the New York Harbor sites (eight sites) identified would be suitable for manufacturing and fabrication and O&M activities. This finding is based on site size, access to deep navigation channels, proximity to the wind energy areas, and current industrial use among other considerations. Staging and installation with the use of WTIVs will encounter challenges where air draft restrictions are present. However, innovations in staging and installation methods, as discussed above, could be developed to make use of more constrained locations. Varying degrees of site upgrades would be needed at most sites.

Most of the Hudson River sites (three sites) considered for further evaluation would be suitable for manufacturing and second tier support activities. This finding is based on site size, channel depths, distance from wind energy areas, and bridge restrictions. Bridge and channel restrictions increase proceeding north on the Hudson River. Components that do not have bridge height restrictions for shipment or can be transported horizontally on barges could be manufactured at sites along the Hudson River. These could include foundations, towers, blades, nacelles, and cables. Varying degrees of site upgrades would be needed at most sites.

The five Long Island regions considered for further evaluation are well suited to O&M activities. Four regions and multiple sites within these regions were recommended for further evaluation. O&M activities often require rapid response and proximity to the wind energy areas. Current uses for recreational boating and commercial fishing can be expanded to include the O&M function. Varying degrees of site upgrades would be needed at most sites.

C.4 Additional Findings

- There are data gaps regarding existing site information from published reports such as wharf live load bearing capacity, berth depths and geotechnical conditions, quayside conditions, and site availability.
- There are challenges in the form of air draft restrictions, site upgrade requirements, and ownership/development issues.
- Large scale component manufacturing requires large sites (typically 10 hectares or more) with significant quayside requirements and the capability to construct industrial manufacturing facilities.
- Staging and installation facilities require large sites (typically 10 hectares or more) with deep berths, high wharf live load bearing capacity, and unrestricted air clearance among other requirements.
- O&M facilities will require smaller sites (typically 4 hectares), less channel depth, and less ground bearing capacity than manufacturing or staging and installation facilities.

Table C-3. Notable Waterfront Sites for Potential OSW Use, as Identified by COWI

Area / sub-area	Site	Site area (hectares)	Minimum Wharf length (meters)	Vessel draft (meters)	Limiting air draft (meters)	Distance to NY wind energy area	Usage (M&F = manufacturing & fabrication)
New York Harbor – Upper Bay	Military Ocean Terminal at Bayonne	21.0	Berth A: 68.6; Berth B & C: 106.1; L-shaped pier: 36.6 + 30.5 + 33.5 + 27.4	Channel: 16.1; Berth: 14.6	Verrazano Bridge: 60 for the center 610 meters; 65.5 max at centerline	84.8	M&F of all components, staging
New York Harbor – Upper Bay	Weeks Marine, Inc.	17.8	(2) each at 300	Channel: 16.1	Verrazano Bridge: 60 for the center 610 meters; 65.5 max at centerline	87.4	M&F of all components, staging
New York Harbor – Upper Bay	South Brooklyn Marine Terminal	35.6	Multiple: 216.1, 306.3 and 167.6 +185.9	Channel: 16.1; Berth: 0-10.9	Verrazano Bridge: 60 for the center 610 meters; 65.5 max at centerline	85.6	M&F of all components, staging
New York Harbor – Upper Bay	Red Hook Brooklyn	32.0	4,876.8	Channel: 11.5-12.8; Berth: 12.8	Verrazano Bridge: 60 for the center 610 meters; 65.5 max at centerline	89.8	M&F of all components, staging
New York Harbor – Upper Newark Bay	Veckridge Chemical Co.	9.2	N/A	Channel: 9.1	I-78 Newark Bay Bridge: 41.1	95.4	M&F of blades and towers
New York Harbor – Arthur Kill	Rossville Waterfront	32.4	304.8 with dolphins	Channel: 10.7	Arthur Kill Railroad Bridge to the north: 41.1; Outerbridge Crossing to the south: 43.6	96.1	M&F of all components
New York Harbor – Arthur Kill	Vanbro	21.4	N/A	Channel: 10.7	Arthur Kill Railroad Bridge to the north: 41.1; Outerbridge Crossing to the south: 43.6	95.4	M&F of all components
New York Harbor – Arthur Kill	Former GATX Site	273.6	Berths 3, 5, 6 & 7: 335.3; Berth 2: 64 with dolphins; Berth 1: 109.7	Channel: 10.7	Arthur Kill Railroad Bridge to the north: 41.1; Outerbridge Crossing to the south: 43.6	92.2	M&F of all components
Hudson River	Indian Point Energy Center	78.0	74	Channel: 9.8	Tappan Zee Bridge: Center Span: 42.4; East and West spans: 37.5	152.9	M&F of all components
Hudson River	Port of Coeymans Marine Terminal	161.8	Can accommodate vessels up to 228.5	Channel: 9.8; Berth: 9.1	Mid-Hudson Bridge: 40.8	298.5	M&F of all components

Table C-2 continued

Area / sub-area	Site	Site area (hectares)	Minimum Wharf length (meters)	Vessel draft (meters)	Limiting air draft (meters)	Distance to NY wind energy area	Usage (M&F = manufacturing & fabrication)
Hudson River	Port of Albany-Rensselaer	107.6	Albany side: 1,280; Renssalaer side: 335.3	Channel: 9.8	Mid-Hudson Bridge: 40.8	314.1	M&F of all components
Long Island – Jones Inlet and East Hempstead Bay	Multiple	N/A	N/A	Channel: NOAA Chart 12352: "The buoys and soundings in this inlet are not charted because of continual change."	None at inlet; Meadowbrook State Parkway Bascule Bridge: Horizontal restriction of 15.2	39.3	O&M
Long Island – Great South Bay	Multiple	N/A	N/A	Channel: 1.5, varies	Robert Moses Causeway Bridge: 19.8 for the middle 141 meters	37.0	O&M
Long Island – Shinnecock Bay and Canal	Multiple	N/A	N/A	Channel: 1.8	Shinnecock Railway Bridge (halfway through the canal): 6.7, none at inlet	93.2	O&M
Long Island – Montauk Harbor	Multiple	N/A	N/A	Channel: Reach A: 3.7; Reach B: 3.0	Montauk Airport	170.6	O&M
Long Island – Shoreham Inlet	Multiple	N/A	N/A	Channel: not determined	Unrestricted	252.0	M&F of all components, staging

Appendix D. Supply Chains Narratives

D.1 High Market, High Local Content

Table D-4. Supply Chain Narrative for the High Market, High Local Content Scenario

		2019-2021	2022-2024	2025-2027	2028-2030
	NY York new capacity (MW)	0	490	800	1110
	Other northeast new capacity (MW)	87	518	637	327
Project development and management	New York projects	Initial underway for Statoil lease site; site surveys expected	Project management, development services, environmental surveys, site investigations	Project management, development services, environmental surveys, site investigations	Project management, development services, environmental surveys, site investigations
	Other northeast project	None	Some development and environmental services	Some development and environmental services	Some development and environmental services
Nacelle, hub and assembly	New York projects	None	None	NY assembly for half of projects, imported major components	NY assembly for half of projects, imported major components
	Other northeast project	None	None	NY assembly half of projects. imported major components	NY assembly half of projects. imported major components
Blade supply	New York projects	None	NY supply; small NY supply chain, imported materials	NY supply to one project; small NY supply chain, imported materials	NY supply to one project; small NY supply chain, imported materials
	Other northeast project	None	NY supply to one project; small NY supply chain, imported materials	NY supply to two project; small NY supply chain, imported materials	NY supply to two projects; small NY supply chain, imported materials
Tower supply	New York projects	None	NY supply; imported steel and internals	NY supply to one project, imported steel and materials	NY supply to one project, imported steel and materials
	Other northeast project	None	NY supply to one project, imported steel and materials	NY supply to two projects, imported steel and materials	NY supply to two projects, imported steel and materials
Foundation supply	New York projects	None	None	None	None
	Other northeast project	None	None	None	None

Table D-1 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Array cable supply	New York projects	None	NY cable logistics hub	NY supply to half NY projects Cable logistics hub	NY supply to half NY projects Cable logistics hub
	Other northeast project	None	NY cable logistics hub	NY supply to half projects Cable logistics hub	NY supply to half projects Cable logistics hub
Export cable supply	New York projects	None	Cable logistics hub	NY supply to half NY projects Cable logistics hub	NY supply to half NY projects Cable logistics hub
	Other northeast project	None	Cable logistics hub	NY supply to half projects Cable logistics hub	NY supply to half projects Cable logistics hub
Substation and operational infrastructure supply	New York projects	None	Onshore infrastructure (structure for onshore substation and O&M base)	Onshore infrastructure (structure for onshore substation and O&M base)	Onshore infrastructure (structure for onshore substation and O&M base)
	Other northeast project	None	None	None	None
Turbine installation	New York projects	None	Investment in NY staging port - used for all NY projects	Investment in NY staging port - used for all NY projects	Investment in NY staging port - used for all NY projects
	Other northeast project	None	NY staging port for one project	NY staging port for one project	NY staging port for one project
Foundation installation	New York projects	None	Investment in NY staging port - used for all NY projects	Investment in NY staging port - used for all NY projects	Investment in NY staging port - used for all NY projects
	Other northeast project	None	NY staging port for one project	NY staging port for one project	NY staging port for one project
Subsea cable installation	New York projects	None	Local logistics support. NY crew vessels, testing and termination. No NY cable vessels	Local logistics support. NY crew vessels, testing and termination. No NY cable vessels	Local logistics support. NY crew vessels, testing and termination. No NY cable vessels
	Other northeast project	None	NY testing and termination services for one project	NY testing and termination services for one project	NY testing and termination services for one project

Table D-1 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Other installation	New York projects	None	All onshore works done with NT contractors. NY logistical support services to offshore substation installation	All onshore works done with NT contractors. NY logistical support services to offshore substation installation	All onshore works done with NT contractors. NY logistical support services to offshore substation installation
	Other northeast project	None	Low level of logistical support services	Low level of logistical support services	Low level of logistical support services
Wind farm operation	New York projects	None	Asset management and operations from NY.-NY crew vessels	Asset management and operations from NY.-NY crew vessels	Asset management and operations from NY.-NY crew vessels
	Other northeast project	None	None	None	None
Turbine maintenance and service	New York projects	None	Minor service from NY under service agreement NY regional hub for turbine spares NY blade inspection and repair	Minor service from NY under service agreement NY regional hub for turbine spares NY blade inspection and repair	Minor service from NY under service agreement NY regional hub for turbine spares NY blade inspection and repair
	Other northeast project	None	NY regional hub for turbine spares NY blade inspection and repair	NY regional hub for turbine spares NY blade inspection and repair	NY regional hub for turbine spares NY blade inspection and repair
Foundation maintenance and service	New York projects	None	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY
	Other northeast project	None	NY inspection and repair on one project	NY inspection and repair on one project	NY inspection and repair on one project
Subsea cable maintenance and service	New York projects	None	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY
	Other northeast project	None	NY inspection and repair on one project	NY inspection and repair on one project	NY inspection and repair on one project

Table D-1 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Substation maintenance and service	New York projects	None	Low level logistics support	Low level logistics support	Low level logistics support
	Other northeast project	None	None	None	None

D.2 High Market, Base Local Content

Table D-5. Supply Chain Narrative for the High Market, Base Local Content Scenario

		2019-2021	2022-2024	2025-2027	2028-2030
	NY York new capacity (MW)	0	490	800	1110
	Other northeast new capacity (MW)	87	518	637	327
Project development and management	New York projects	Initial underway for Statoil lease site; site surveys expected	Project management, development services, environmental surveys, some site investigations	Project management, development services, environmental surveys, some site investigations	Project management, development services, environmental surveys, some site investigations
	Other northeast project	None	Some development and environmental services	Some development and environmental services	Some development and environmental services
Nacelle, hub and assembly	New York projects	None	None	None	NY assembly for half of projects, imported major components
	Other northeast project	None	None	None	NY assembly for the only projects. imported major components
Blade supply	New York projects	None	None	NY supply; small NY supply chain, imported materials	NY supply; small NY supply chain, imported materials
	Other northeast project	None	None	NY supply to one project; small NY supply chain, imported materials	NY supply to one project; small NY supply chain, imported materials
Tower supply	New York projects	None	NY supply; imported steel and internals	NY supply to one project, imported steel and materials	NY supply to one project, imported steel and materials
	Other northeast project	None	NY supply chain, imported materials	NY supply to one project, imported steel and materials	NY supply to one project, imported steel and materials
Foundation supply	New York projects	None	None	None	None
	Other northeast project	None	None	None	None

Table D-2 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Array cable supply	New York projects	None	None	NY cable logistics hub	NY supply to half NY projects Cable logistics hub
	Other northeast project	None	None	NY cable logistics hub	NY supply to all projects Cable logistics hub
Export cable supply	New York projects	None	None	Cable logistics hub	NY supply to half NY projects Cable logistics hub
	Other northeast project	None	None	Cable logistics hub	NY supply to all projects Cable logistics hub
Substation and operational infrastructure supply	New York projects	None	Onshore infrastructure (structure for onshore substation and O&M base)	Onshore infrastructure (structure for onshore substation and O&M base)	Onshore infrastructure (structure for onshore substation and O&M base)
	Other northeast project	None	None	None	None
Turbine installation	New York projects	None	Installation from neighboring state; some local logistics from NY	Investment in NY staging port - used for all NY projects	Investment in NY staging port - used for all NY projects
	Other northeast project	None	None	NY staging port for one project	NY staging port for one project
Foundation installation	New York projects	None	Installation from neighboring state; some local logistics from NY	Investment in NY staging port - used for all NY projects	Investment in NY staging port - used for all NY projects
	Other northeast project	None	None	NY staging port for one project	NY staging port for one project
Subsea cable installation	New York projects	None	Local logistics support. NY crew vessels, testing and termination. No NY cable vessels	Local logistics support. NY crew vessels, testing and termination. No NY cable vessels	Local logistics support. NY crew vessels, testing and termination. No NY cable vessels
	Other northeast project	None	None	NY testing and termination services for one project	NY testing and termination services for one project

Table D-2 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Other installation	New York projects	None	All onshore works done with NT contractors. NY logistical support services to offshore substation installation	All onshore works done with NT contractors. NY logistical support services to offshore substation installation	All onshore works done with NT contractors. NY logistical support services to offshore substation installation
	Other northeast project	None	None	Low level of logistical support services	Low level of logistical support services
Wind farm operation	New York projects	None	Asset management and operations from NY. NY crew vessels	Asset management and operations from NY. NY crew vessels	Asset management and operations from NY. NY crew vessels
	Other northeast project	None	None	None	None
Turbine maintenance and service	New York projects	None	Minor service from NY under service agreement NY regional hub for turbine spares NY blade inspection and repair	Minor service from NY under service agreement NY regional hub for turbine spares NY blade inspection and repair	Minor service from NY under service agreement NY regional hub for turbine spares NY blade inspection and repair
	Other northeast project	None	NY regional hub for turbine spares NY blade inspection and repair	NY regional hub for turbine spares NY blade inspection and repair	NY regional hub for turbine spares NY blade inspection and repair
Foundation maintenance and service	New York projects	None	Low level logistics support	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY
	Other northeast project	None	None	NY inspection and repair on one project	NY inspection and repair on one project
Subsea cable maintenance and service	New York projects	None	Low level logistics support	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY
	Other northeast project	None	None	NY inspection and repair on one project	NY inspection and repair on one project

Table D-2 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Substation maintenance and service	New York projects	None	Low level logistics support	Low level logistics support	Low level logistics support
	Other northeast project	None	None	None	None

D.3 Low Market, High Local Content

Table D-6. Supply Chain Narrative for the Low Market, High Local Content Scenario.

		2019-2021	2022-2024	2025-2027	2028-2030
	NY York new capacity (MW)	0	490	800	1110
	Other northeast new capacity (MW)	87	518	637	327
Project development and management	New York projects	Initial underway for Statoil lease site; site surveys expected	Project management, development services, environmental surveys, some site investigations	Project management, development services, environmental surveys, some site investigations	Project management, development services, environmental surveys, some site investigations
	Other northeast project	None	Some development and environmental services	Some development and environmental services	Some development and environmental services
Nacelle, hub and assembly	New York projects	None	None	None	NY assembly for half of projects, imported major components
	Other northeast project	None	None	None	NY assembly for the only projects. imported major components
Blade supply	New York projects	None	None	NY supply; small NY supply chain, imported materials	NY supply; small NY supply chain, imported materials
	Other northeast project	None	None	NY supply to one project; small NY supply chain, imported materials	NY supply to one project; small NY supply chain, imported materials
Tower supply	New York projects	None	NY supply; imported steel and internals	NY supply to one project, imported steel and materials	NY supply to one project, imported steel and materials
	Other northeast project	None	NY supply chain, imported materials	NY supply to one project, imported steel and materials	NY supply to one project, imported steel and materials
Foundation supply	New York projects	None	None	None	None
	Other northeast project	None	None	None	None

Table D-3 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Array cable supply	New York projects	None	None	NY cable logistics hub	NY supply to half NY projects Cable logistics hub
	Other northeast project	None	None	NY cable logistics hub	NY supply to all projects Cable logistics hub
Export cable supply	New York projects	None	None	Cable logistics hub	NY supply to half NY projects Cable logistics hub
	Other northeast project	None	None	Cable logistics hub	NY supply to all projects Cable logistics hub
Substation and operational infrastructure supply	New York projects	None	Onshore infrastructure (structure for onshore substation and O&M base)	Onshore infrastructure (structure for onshore substation and O&M base)	Onshore infrastructure (structure for onshore substation and O&M base)
	Other northeast project	None	None	None	None
Turbine installation	New York projects	None	Installation from neighboring state; some local logistics from NY	Investment in NY staging port - used for all NY projects	Investment in NY staging port - used for all NY projects
	Other northeast project	None	None	NY staging port for one project	NY staging port for one project
Foundation installation	New York projects	None	Installation from neighboring state; some local logistics from NY	Investment in NY staging port - used for all NY projects	Investment in NY staging port - used for all NY projects
	Other northeast project	None	None	NY staging port for one project	NY staging port for one project
Subsea cable installation	New York projects	None	Local logistics support. NY crew vessels, testing and termination. No NY cable vessels	Local logistics support. NY crew vessels, testing and termination. No NY cable vessels	Local logistics support. NY crew vessels, testing and termination. No NY cable vessels
	Other northeast project	None	None	NY testing and termination services for one project	NY testing and termination services for one project

Table D-3 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Other installation	New York projects	None	All onshore works done with NT contractors. NY logistical support services to offshore substation installation	All onshore works done with NT contractors. NY logistical support services to offshore substation installation	All onshore works done with NT contractors. NY logistical support services to offshore substation installation
	Other northeast project	None	None	Low level of logistical support services	Low level of logistical support services
Wind farm operation	New York projects	None	Asset management and operations from NY. NY crew vessels	Asset management and operations from NY. NY crew vessels	Asset management and operations from NY. NY crew vessels
	Other northeast project	None	None	None	None
Turbine maintenance and service	New York projects	None	Minor service from NY under service agreement NY regional hub for turbine spares NY blade inspection and repair	Minor service from NY under service agreement NY regional hub for turbine spares NY blade inspection and repair	Minor service from NY under service agreement NY regional hub for turbine spares NY blade inspection and repair
	Other northeast project	None	NY regional hub for turbine spares NY blade inspection and repair	NY regional hub for turbine spares NY blade inspection and repair	NY regional hub for turbine spares NY blade inspection and repair
Foundation maintenance and service	New York projects	None	Low level logistics support	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY
	Other northeast project	None	None	NY inspection and repair on one project	NY inspection and repair on one project

Table D-3 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Subsea cable maintenance and service	New York projects	None	Low level logistics support	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY
	Other northeast project	None	None	NY inspection and repair on one project	NY inspection and repair on one project
Substation maintenance and service	New York projects	None	Low level logistics support	Low level logistics support	Low level logistics support
	Other northeast project	None	None	None	None

D.4 Low Market, Base Local Content

Table D-7. Supply Chain Narrative for the Low Market, Base Local Content Scenario.

		2019-2021	2022-2024	2025-2027	2028-2030
	NY York new capacity (MW)	0	490	800	1110
	Other northeast new capacity (MW)	87	518	637	327
Project development and management	New York projects	Initial underway for Statoil lease site; site surveys expected	Project management, development services, environmental surveys, some site investigations	Project management, development services, environmental surveys, some site investigations	Project management, development services, environmental surveys, some site investigations
	Other northeast project	None	None	None	None
Nacelle, hub and assembly	New York projects	None	None	None	None
	Other northeast project	None	None	None	None
Blade supply	New York projects	None	None	None	None
	Other northeast project	None	None	None	None
Tower supply	New York projects	None	None	None	None
	Other northeast project	None	None	None	None
Foundation supply	New York projects	None	None	None	None
	Other northeast project	None	None	None	None
Array cable supply	New York projects	None	None	None	None
	Other northeast project	None	None	None	None
Export cable supply	New York projects	None	None	None	None
	Other northeast project	None	None	None	None
Substation and operational infrastructure supply	New York projects	None	Onshore infrastructure (structure for onshore substation and O&M base)	Onshore infrastructure (structure for onshore substation and O&M base)	Onshore infrastructure (structure for onshore substation and O&M base)
	Other northeast project	None	None	None	None

Table D-4 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Turbine installation	New York projects	None	Installation from neighboring state; some local logistics from NY	Installation from neighboring state; some local logistics from NY	Installation from neighboring state; some local logistics from NY
	Other northeast project	None	None		None
Foundation installation	New York projects	None	Installation from neighboring state; some local logistics from NY	Installation from neighboring state; some local logistics from NY	Installation from neighboring state; some local logistics from NY
	Other northeast project	None	None	None	None
Subsea cable installation	New York projects	None	Local logistics support. No NY cable vessels	Local logistics support. No NY cable vessels	Local logistics support. No NY cable vessels
	Other northeast project	None	None	None	None
Other installation	New York projects	None	All onshore works done with NT contractors. NY logistical support services to offshore substation installation	All onshore works done with NT contractors. NY logistical support services to offshore substation installation	All onshore works done with NT contractors. NY logistical support services to offshore substation installation
	Other northeast project	None	None	None	None
Wind farm operation	New York projects	None	Asset management and operations from NY. NY crew vessels	Asset management and operations from NY. NY crew vessels	Asset management and operations from NY. NY crew vessels
	Other northeast project	None	None	None	None
Turbine maintenance and service	New York projects	None	Minor service from NY under service agreement	Minor service from NY under service agreement Blade inspection and rope access services	Minor service from NY under service agreement Blade inspection and rope access services
	Other northeast project	None	None	Blade inspection and rope access services	Blade inspection and rope access services
Foundation maintenance and service	New York projects	None	Low level logistics support	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY
	Other northeast project	None	None	NY inspection and repair on one project	NY inspection and repair on one project

Table D-4 continued

		2019-2021	2022-2024	2025-2027	2028-2030
Subsea cable maintenance and service	New York projects	None	Low level logistics support	Low level logistics support NY inspection and repair Vessels from outside NY	Low level logistics support NY inspection and repair Vessels from outside NY
	Other northeast project	None	None	NY inspection and repair on one project	NY inspection and repair on one project
Substation maintenance and service	New York projects	None	Low level logistics support	Low level logistics support	Low level logistics support
	Other northeast project	None	None	None	None

NYSERDA, a public benefit corporation, offers objective information and analysis, innovative programs, technical expertise, and support to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce reliance on fossil fuels. NYSERDA professionals work to protect the environment and create clean-energy jobs. NYSERDA has been developing partnerships to advance innovative energy solutions in New York State since 1975.

To learn more about NYSERDA's programs and funding opportunities, visit nyserda.ny.gov or follow us on Twitter, Facebook, YouTube, or Instagram.

New York State Energy Research and Development Authority

17 Columbia Circle
Albany, NY 12203-6399

toll free: 866-NYSERDA
local: 518-862-1090
fax: 518-862-1091

info@nyserda.ny.gov
nyserda.ny.gov

State of New York
Andrew M. Cuomo, Governor

New York State Energy Research and Development Authority
Richard L. Kauffman, Chair | Alicia Barton, President and CEO