WORKFORCE DEVELOPMENT INSTITUTE

NEW YORK STATE AND THE JOBS OF

Offshore Wind Energy

A WORKFORCE-FOCUSED RESEARCH REPORT FROM THE WORKFORCE DEVELOPMENT INSTITUTE

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ABOUT NEW YORK'S WORKFORCE DEVELOPMENT INSTITUTE

The Workforce Development Institute (WDI) is a statewide non-profit with a mission to grow and retain good jobs. We facilitate projects that build skills and provide opportunities for New York's workforce via a range of tools that includes research, ground-level information, funding, and workforce expertise. Our work and flexible funding fills gaps seldom covered by government agencies.

WDI recognizes the pivotal role of the energy sector in our economy and respects the trend toward clean energy. We are helping prepare the workforce for this transition. Our focus on energy-related jobs began more than a decade ago and developed into a focus on renewable energy and development of a smart grid.

WDI's workforce development grants have trained electrical workers represented by the International Brotherhood of Electrical Workers (IBEW), plumbers and pipefitters represented by the United Association (UA), industrial workers, equipment operators, and many more members of the skilled trades. We have also funded programs at community colleges to help advance their clean energy programs, such as the Wind Tech Maintenance Program at Clinton Community College.

WDI also developed coalitions on clean energy topics such as solar, offshore wind, and the creation of a smart grid. Through these activities, we established a reputation as a convener of energy sector stakeholders in order to develop consensus strategies related to workforce challenges in the energy sector.

Ed Murphy, Executive Director
Workforce Development Institute

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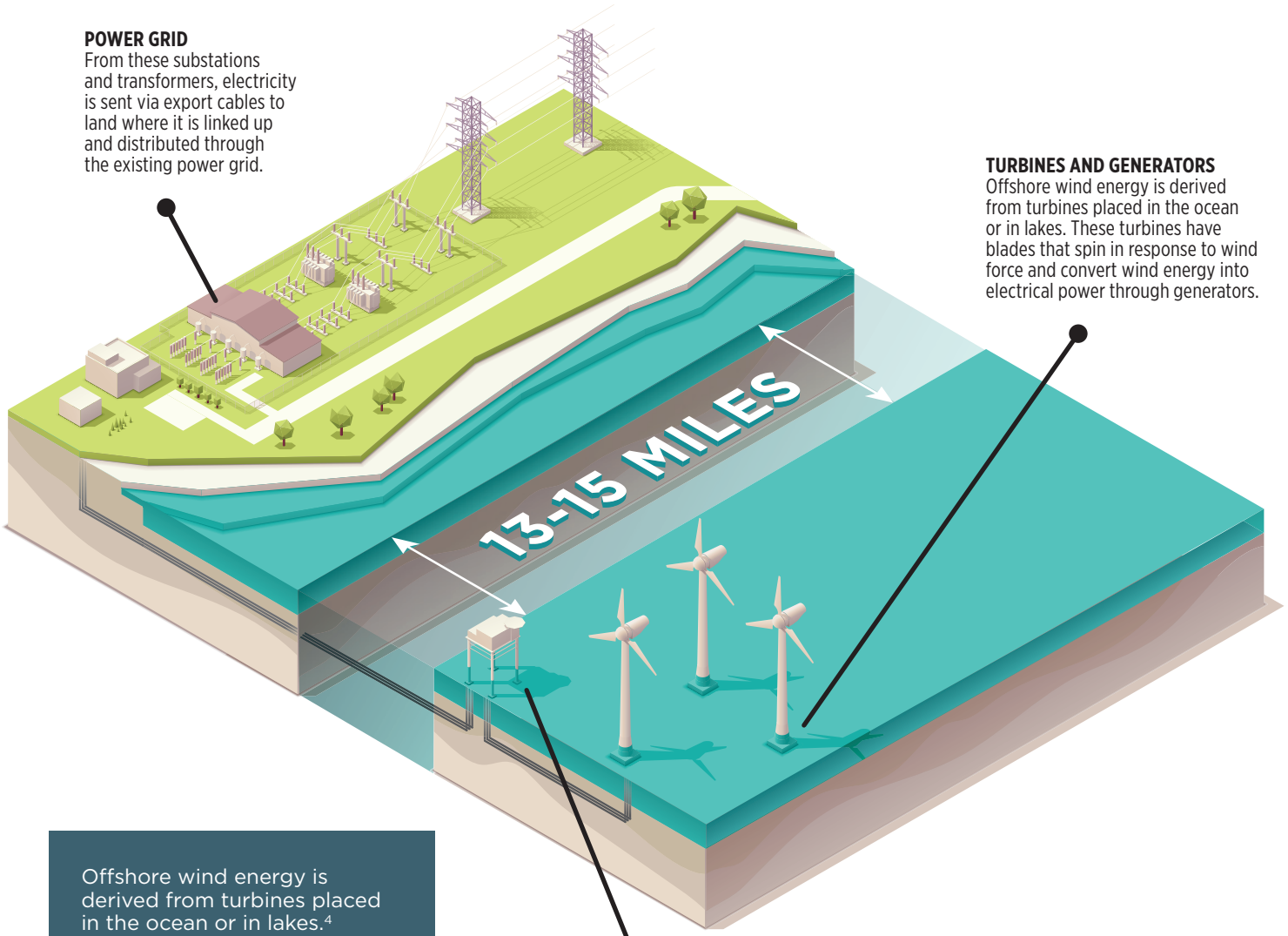


Offshore wind energy is derived from turbines placed in the ocean or in lakes.[4] These turbines have blades that spin in response to wind force. The generators send power through undersea cables to offshore substations and transformers. From these substations and transformers, power is sent via export cables to land where it is linked up and distributed through the existing power grid.

Executive Summary

New York State is undergoing an energy revolution.

We are changing our relationship to energy: how we use it, which sources of fuel we use, the skills required by those who work with it, and the value we give to it. The technologies that generate and deliver electricity are changing. Policymakers are changing the rules that govern how energy markets operate, not only in New York through the Public Service Commission's Reforming the Energy Vision (REV) process, but also in California, Massachusetts and other states.[1] Regulators are taking steps to align utility and electricity transmission markets with state clean energy, economic and pollution reduction goals. Along with these changes, the workforce and the skills required within the energy industry are also evolving.

For policymakers, it is important to track emerging industries that will be a part of this energy transformation so that the appropriate policies are implemented and resources are invested to support them. Offshore wind is an emerging industry that is set to take off in the United States (US). To capture the full benefits of this industry, policymakers in New York must continue and amplify their efforts.

THE GUIDEPOSTS FOR THE OFFSHORE WIND ENERGY INDUSTRY ARE ALIGNING:

- **The renewable energy industry is among the fastest growing sectors in the US;**
- **Globally, offshore wind is maturing as an industry;**
- **Offshore wind projects in the US are advancing;**
- **Financial investors are increasingly interested in offshore wind;**
- **The industry is beginning to receive policy support, especially at the state level; and**
- **Costs for offshore wind energy have declined and are continuing to decline.**

Over the last decade, the US installed large amounts of renewable energy. More renewable energy was installed in 2015 than conventional sources of energy. The US has tripled its installed wind power from 25 gigawatts at the end of 2008 to over 75 gigawatts today.[2] This represents enough electricity to supply 20 million average American homes. New York now generates 26% of its electricity from renewable sources of energy and has a regulatory requirement to generate 50% from renewable resources by 2030.

The number of jobs needed to meet the increasing demand for renewable energy has grown. Wind Turbine Technician is the fastest growing occupation in the country.[3]

The first offshore wind power plant went into service in 1991. The industry is mature globally. Global markets for offshore wind have exhibited strong growth with over 84,000 workers and 12 gigawatts of installed wind energy. There are currently offshore wind power

Watts, megawatts, and gigawatts are the units of power that represent the rate at which energy is generated or consumed.

A watt is likely to be the rating most familiar to many because a consumer may see energy rates such as 60 watts or 100 watts when shopping for lightbulbs. A megawatt is the standard measure of electric power plant generating capacity. One of the six megawatt turbines installed at the Block Island Wind Farm generates enough electricity for 3,400 homes.

Large "utility scale" power plants can be measured in gigawatts. For example, the Robert Moses Niagara power plant is 2.5 gigawatts. One gigawatt equals 1,000 megawatts; one megawatt equals 1,000 kilowatts; and one kilowatt equals 1,000 watts.

plants in 15 countries.[5] In the US, the first offshore wind power plant began to operate in December of 2016. There is noteworthy development in the US and these projects are gaining momentum. Eleven developers have obtained the rights to build offshore wind power plants from the Bureau of Ocean Energy Management (BOEM). Many are moving forward and performing environmental, engineering, and other developmental studies. Several of the developers of the leased areas state that their power plants could be operational by 2020 and may still have room for expansion within the same lease areas. These nine leased wind energy areas could, if all built, provide over 5,000 megawatts of power. This represents enough electricity to power over 1.8 million average US homes annually.[6] BOEM also recently released an offshore wind vision that would provide electricity for 23 million homes by the year 2050.[7]

New York also has a significant potential offshore wind market. The New York State Energy Research and Development Authority (NYSERDA) recently identified a potential for 39 gigawatts of offshore wind energy off New York's shore, enough to power 15 million homes annually.[8] New York is also experiencing noteworthy development activity. The federal government leased an area off the coast of Long Island to Statoil. The area is capable of hosting up to an 800-megawatt offshore wind power plant. This project could see construction as early as 2021. Governor Cuomo recently set a target for building 2.4 gigawatts of offshore wind by 2030. NYSERDA is developing an Offshore Wind Master Plan to serve as a comprehensive guide for growing the industry in New York. Finally, there have been several additional wind energy areas identified as possible power plant locations off the New York coast. Offshore wind is a smart choice for New York State. Investors are pouring money into the industry in the United States (US). It is a labor-intensive industry that creates jobs in a wide variety of occupations like the building and construction trades, manufacturing, and power plant operations. US-based investment firms such as Goldman Sachs and DE Shaw are investing in the industry. US companies such as General Electric (GE) have made major investments to become a part of the supply chain. Foreign companies such as Statoil, DONG Energy and Copenhagen Infrastructure Partners are not only saying that the US is the next frontier, but are backing up those claims with substantial financial investments.[9] As demonstrated when Statoil, a Norwegian energy company paid a record $42 million to lease the wind energy area off the coast of New York. Overall, five businesses and NYSERDA competed for the lease.

There is work for New Yorkers in this industry. The Block Island Wind Farm, the nation's first offshore wind farm, was small but still employed electricians, welders, ironworkers, pipefitters, pile drivers, engineers, scientists, vessel operators, lawyers and sales representatives. The five-turbine demonstration project put more than 300 people to work. Forty workers including electricians, ironworkers and pipefitters assembled the turbines. Almost 20 pile drivers installed the five foundations.

New York is in a unique position to capture many parts of the industry supply chain benefits because:

- It offers a broad workforce;
- It features a diverse set of occupations with experience in a cross section of industries needed for the offshore wind energy industry;

- It has significant heavy industry infrastructure, such as ports and manufacturing, as well as the construction and building trades with experience building heavy infrastructure; and
- It possesses the trades registered apprenticeship programs and a diverse and well-developed education system.

PURPOSE AND SCOPE OF THIS REPORT

This report serves as a tool to define and describe the jobs of this industry and to illuminate how New York's workforce can participate in this industry and benefit from its advancement in the region. Our research focuses on the specific jobs found in each phase of offshore wind energy production. Other studies have broadly explored the topic of job creation and offshore wind energy. This report advances understanding regarding the workforce by exploring and sharing practical, frontline information from companies, workers, unions, and others who are already engaged in the offshore wind energy industry.[10]

For this study, WDI's staff interviewed labor union leaders, dozens of industry experts and participants, training professionals, development specialists, and construction companies to provide a unique first-hand account of the "nuts and bolts" of the industry. Our research efforts also included an extensive literature review.

We engaged in this study to clearly demonstrate the opportunities for New York's workforce from building offshore wind power plants. In the report, we provide a picture of the occupations, work performed, skills required, and potential pay range estimates for those working in the offshore wind power industry. In addition, we compiled information about New York State's workforce and analyzed existing workforce gaps to be addressed. We also include a review of the training programs and analyzed New York State's current training infrastructure to determine how, if at all, it would require modification to develop a skilled offshore wind energy workforce. Finally, we highlight the work performed by various occupations required to build the Block Island Wind Farm, the first American offshore wind power plant located off the coast of Rhode Island. From this comprehensive review, interested parties will be able to better understand the offshore wind energy workforce.

THE REPORT IS ARRANGED INTO THE FOLLOWING SECTIONS:

1 **Section One** introduces offshore wind power and the industry that builds it and reviews the methodology used in developing this paper.

2 **Section Two** is a primer setting out a description of the technology of the industry and the phases of building an offshore wind power plant and examples of occupations within those phases.

3 **Section Three** focuses on the labor organizations involved in the offshore wind industry. Labor organizations have already been involved in the industry as they possess a highly skilled workforce and an existing training infrastructure that has experience in the safety and technical trainings.

4 **Section Four** focuses on an assessment of New York's workforce as it relates to offshore wind energy. This section begins with a picture of some of the occupations likely to be employed by the offshore wind industry such as construction workers, utility workers, scientists, engineers,

Offshore wind energy has many benefits for New York, including:

Creating jobs

Keeping energy dollars in the New York economy

Reducing pollution and improving public health

Producing large amounts of electricity close to where it is needed most

Ensuring New York can meet its goal to produce 50% electricity from renewable energy sources by 2030

and lawyers as examples. Next we identify existing workforce gaps that will need to be addressed. This section offers a host of recommendations as well as further areas for study.

5 **Section Five** describes training programs that were in use in Europe as well as the training that was implemented for Block Island Wind Farm. This section also highlights the training infrastructure that exists in New York, such as the registered apprenticeships in the various trades working in the energy and construction industries.

6 **Section Six** provides a case study of the workforce involved in the Block Island Wind Farm. This section provides a description of the work performed at the only offshore power plant currently operating in the U.S.

Key Research Findings and Conclusions

The US offshore wind energy industry, although nascent, has the potential to develop over 5,000 megawatts from currently leased wind energy areas. This is enough power for an estimated 1.8 million homes. Building an offshore wind power plant is a large and complex construction project that requires a diverse, highly skilled, and well-trained workforce. Our research identified an estimated 74 occupations that perform work across the phases of an offshore wind power plant. Most of these occupations are well-established in New York's economy. Occupations such as scientists, engineers, lawyers, and sales representatives are needed during the development phase. Electricians, ironworkers, and welders construct wind farms and support the operations phase. Training and research professionals work across all phases of the project.

With the appropriate policy actions and investments, New York could capture significant workforce benefits. New York's workforce includes many of the occupations required by the industry. However, just a small subset of professionals currently possesses experience in offshore construction projects. If New York follows roughly the same path as Europe and the United Kingdom, the state could be well positioned to supply many occupations to the offshore wind supply chain.

New York State has recently taken positive steps to support its use of offshore wind power. Governor Andrew Cuomo has committed to obtaining 2,400 megawatts of electrical power from offshore wind. In addition, the Long Island Power Authority approved the purchase of power for Long Island companies and residents from what has the potential to be the largest wind plant in the US.[11] However, additional leadership is needed to ensure that the state responsibly and sustainably maximizes the economic and workforce benefits that the industry offers to New Yorkers.

KEY FINDINGS:

General Offshore Wind Energy Industry Information

- Building an offshore wind power plant requires a diverse technical workforce spanning an estimated 74 occupations.
- Projects need financing to move forward. US banks seem cautious because these are unfamiliar investments. New York should explore options for helping to incent financing of offshore wind. The Green Bank and Clean Energy Fund provide two sources of financing.
- The offshore wind industry is expected to see strong growth over the coming decade.
- The impact of manufacturing jobs resulting from offshore wind energy is likely years away. Large wind component manufacturing firms are looking for steady, predictable growth in the US offshore wind energy market before locating turbine and related manufacturing facilities here.
- Small and medium-sized manufacturing companies in New York could see an impact sooner from localized purchasing of turbine components and related products such as lighting,

wire harnesses, bolts, safety devices, or other ancillary equipment.
- Offshore wind development requires national, state and local leaders prepared to advocate, educate citizens, and guide companies through the regulatory and permitting processes.
- There is one offshore wind power plant that has been completed in the United States. Plans to lease offshore resources and a variety of proposals are in the pipeline. The immaturity of the US offshore wind energy industry means we must learn from the already existing global market.

Workforce Associated with Offshore Wind
- Building an offshore wind power plant requires a diverse technical workforce spanning an estimated 74 occupations.
- While there are workforce commonalities across the offshore wind energy industry, each offshore wind power plant follows its own staffing pattern and there is no single formula.
- Wages in offshore wind energy are, in general, higher than comparable industries.[12] However, there is no single way to quantify the difference as it depends on the hiring and compensation policies of a wide variety of employers. The question of wage differentials will be determined over time.[13]

Potential for Offshore Wind Energy Industry in New York State
- New York State has the potential both in terms of wind resources and workforce to build a substantial amount of offshore wind energy plants. Many industry companies and observers view New York State as a viable next location for offshore wind energy development.
- Offshore wind is needed for New York State to reach its goals of obtaining 50% of its electricity from renewables by the year 2030.
- Without deliberate actions, collaboration and planning on many fronts, including workforce development, the potential offshore wind energy in New York State will not be realized.
- **To successfully take advantage of the workforce benefits from offshore wind, New York State should commit to a clear procurement schedule and financeable offtake mechanism that will allow the state to achieve its goal of 2,400 megawatts.**
- Other states are pursuing offshore wind energy. Therefore, no single state will capture all the jobs or economic benefit. As such, it seems likely that a regional approach will prevail. If one region leads the way, it stands to benefit from being an early adopter and first mover. Conversely, there could be a "loss" for other regions from a jobs perspective.
- **New York State has many of the requisite workforce resources. There are some potential issues and gaps that must be addressed, so collaboration and planning need to start now.**
- New York has strong existing systems in place for the technical and safety training required by the industry: labor union training, apprenticeships, training programs, technical high schools, colleges, and universities.
- **Investments in the supply chain and the workforce will provide New York with many benefits, including attracting business and increasing the technical skills of the workforce.**
- Offshore wind energy projects should be viewed as a complement to land-based wind energy power plants, not a replacement of them.

New York State's Workforce
- New York's current workforce contains all of the estimated 74 occupations required to build

offshore wind power plants.
- **New York State has a significant number of unions with strong apprenticeship models that emphasize a culture of safety—a prerequisite for offshore wind projects.**
- New York's current workforce is stressed by the fact that many in the workforce are nearing the age of retirement.
- New York State has the workforce required to build a substantial number of offshore wind power plants. But without deliberate actions, collaboration and planning on many fronts including workforce development (including planning for training and retirements for example), the potential offshore wind industry in New York State will not be realized.
- The need for workers in the emerging offshore wind energy industry will exacerbate pressures on workforce supply that is occurring as baby boomers retire in larger and larger numbers.
- New York State's investments in the occupations of offshore wind will benefit those occupations in their work outside the industry as well.
- New York needs to bring stakeholders together from energy, training, construction, and labor to assess New York's current workforce and the needs of the industry.

TRAINING INFRASTRUCTURE AND GAPS

- **Worker safety standards remain a high priority concern for the offshore wind energy industry. While progress has been made, further attention and resources are needed to ensure that offshore wind energy can be scaled up in a manner that provides health and safety safeguards for all workers.**
- New York State already has training infrastructure in place for land-based wind. The training infrastructure can be retooled to help meet demand from the emerging offshore wind industry.
- New York State has a strong state educational system and private colleges that already provide education and training in some of the areas needed for the industry. However, academia must be engaged in the industry and work with industry to adapt and modify existing programs.
- **As noted, offshore wind energy projects make demands on portions of the workforce already experiencing hiring challenges, skill shortages, or employment gaps in New York State and around the country. Therefore action, planning, and collaboration around workforce development need to start early.**

RECOMMENDATIONS FOR FURTHER ACTION

To provide the needed workforce support to bolster the industry, we recommend the actions below. The actions are listed in general, logical order. We recommend that these actions be pursued in a way that promotes open communication and collaboration among stakeholders.

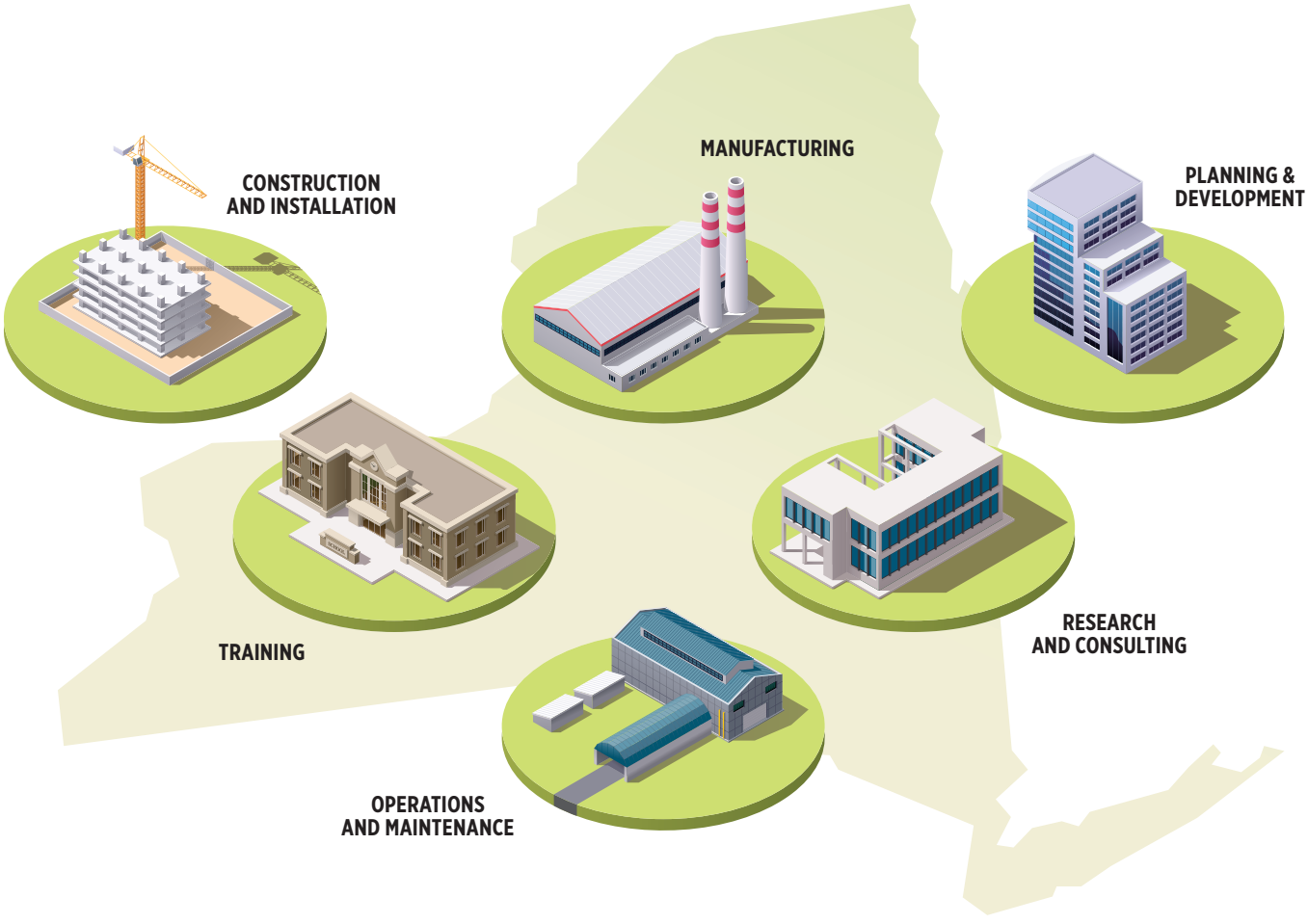
1 Action 1: Exhibit Leadership to Capitalize on Workforce Opportunities in Offshore Wind. Many organizations share responsibility for moving these recommendations forward. Policymakers are needed to carry out legislative or agency actions relating to procurement and purchasing of electricity. The industry, labor organizations and academics, as well as government must take steps to address workforce gaps and develop appropriate training programs.

2 Action 2: Create and Implement a Long-Term Strategic Plan. Government, industry, academic

Building an offshore wind power plant is a large and complex construction project that requires a diverse, highly skilled and well-trained workforce. Our research identified an estimated 74 occupations that perform work across the phases of an offshore wind power plant. Most of these occupations are well-established in New York's economy. Occupations such as scientists, engineers, lawyers, and sales representatives are needed during the development phase. Electricians, ironworkers and welders construct wind farms and support the operations phase. Training and research professionals work across all phases of the project.

organizations, labor organizations, and environmental organizations need to create a strategic plan that integrates state, regional, and national initiatives and resources for skills and workforce development. With regard to workforce, a statewide or regional strategic plan should include voluntary minimum training and health and safety standards, registered apprenticeship programs for jobs/roles where programs do not already exist, and internships and partnerships with high schools to promote knowledge about the field and interest among secondary students. The workforce development system, with the local Workforce Investment Boards at the core, needs to be integrated with a flexible framework to train for skills needed for the industry. New York State must commit to a long-term plan for realizing Governor Cuomo's target of 2,400 megawatts of offshore wind energy development by 2030 that includes financeable offtake mechanisms. This would provide the certainty developers, manufacturers and investors require to make investment decisions and workforce training plans.

3 **Action 3: Continue Conversation and Encourage Partnerships.** Take the information in this report and others and continue the



conversation about workforce and the offshore wind industry. State agencies, industry, labor organizations, workforce boards, environmental organizations, trade associations, academics, and training professionals should convene to facilitate a conversation surrounding workforce, workforce development, standards and best practices, and regulations.

4 **Action 4: Study industry lessons learned.** Examine the global industry and prepare lessons learned so that New York's workforce agencies, training providers and the industry are prepared to take action. These groups must develop a deeper understanding of the workforce issues and economic benefits, much of which can be learned from places overseas where the offshore wind industry has matured.

5 **Action 5: Address current workforce gaps in New York.** New York State must invest to address its workforce gaps. The steps required to address industry needs have the added benefit of proving workforce skills needed by other industries.

6 **Action 6: Create Employer Networks.** These arrangements lead to the sharing of information about workforce needs that can lead to workforce development solutions to meet the needs of the industry.

CONCLUSION

The offshore wind energy industry is a new industry for New York State. It requires workers across all project phases: planning and development; manufacturing; construction and installation; operations and maintenance; and training, research and consulting. New York's investment and embrace of such an emerging industry represents an opportunity for a wide variety of New York's workforce.

This report is intended as a call to action to develop a workforce implementation strategy. If steps are not taken now, New York State may never capture the full potential of the industry. We encourage partners to offer feedback and continue this conversation with us.

WDI plans to convene labor unions, environmentalists, policymakers, and businesses in the industry to further the dialogue. WDI can be contacted at **518.272.3500** and **info@wdiny.org**.

1

Introduction

This report focuses on New York State and the workforce involved in all the phases of an offshore wind power plant by looking at the occupations, skills and wages in the industry. Our research seeks to offer practical and industry-validated information by answering the following questions:

1. What are the jobs involved in offshore wind power plants?
2. What labor unions are associated with those jobs?
3. What skills do the jobs require?
4. In which phase(s) of offshore wind energy development are the various jobs involved?
5. What are the pay ranges for offshore wind energy jobs?
6. To what extent can New York's existing workforce fill the demands of offshore wind energy?
7. What skills gaps or job shortages exist?
8. What training programs exist or are needed to address any gaps or shortages?

These questions were developed with input from a diverse group of organizations representing organized labor, academia, environmentalists, and other interests. By exploring these questions in the context of New York State, this report serves as a tool to define and describe the jobs of this industry and to demonstrate the impact on workforce from offshore wind energy power plants.

For those curious for information about other aspects of offshore wind energy, an appendix of suggested further reading has been attached.[14]

1.1. METHODOLOGY

Our research methodology is a multi-pronged approach including a literature review, data aggregation and analysis, and extensive interviews with organizations directly involved in the offshore and land-based wind energy industries. Through this approach we identify models of project phases, common staffing patterns and practical job details. We also studied job types and estimates from economic models in relation to the wind industry's own practices in the US, the United Kingdom (UK), and Europe.

This report focuses on direct jobs by addressing two guiding questions:

"What jobs directly touch on or are involved with offshore wind power plants?"

"What are the jobs without which offshore wind power plants cannot be developed, constructed, or maintained?"

We can confidently assert that each offshore wind power plant involves an impressive variety of occupations. What our research cannot provide is a single, definitive record of every job title that touches on an offshore wind energy project. Nor can we offer infallible estimates of the number of jobs or job-years to be had by each occupation in each project phase. This is too uncertain and potentially counterproductive when introducing readers to the workforce of offshore wind energy.

2

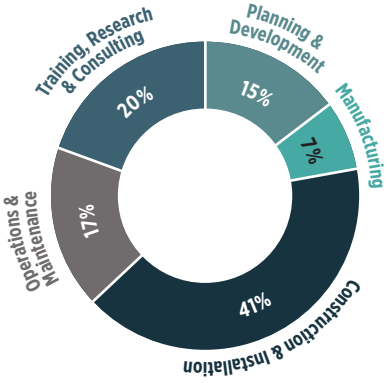
Exploring the Phases and Workforce of Offshore Wind Energy

2.1. A PRIMER ON THE WIND ENERGY INDUSTRY

2.1.1. GLOBAL INDUSTRY

The offshore wind energy industry is quickly growing. Since 2011, approximately 8,000 megawatts have been installed globally.[15] The offshore wind workforce has grown rapidly as well. There are currently an estimated 84,000 jobs in the offshore wind industry worldwide. From 2004 to 2009 the offshore wind industry created more than 60,000 jobs. From 2007 to 2014, offshore wind sector employment in the European Union increased twelve-fold, from 6,370 jobs to 75,000, according to the International Renewable Energy Agency (IRENA).[16] The UK offshore wind workforce quadrupled between 2007 and 2010 to 3,100 full-time equivalent jobs (FTE).[17] The industry's trade association, RenewableUK, reports that employment in the offshore wind energy industry has more than doubled FTEs since 2011, from 3,100 to 6,830.[18]

OFFSHORE WIND POWER PLANTS
Estimated Share of Direct US Workforce by Phase



The industry is expected to see continued significant growth. The European Wind Energy Association (EWEA) projects 40 gigawatts of offshore wind by 2020 and 150 gigawatts by 2030. DONG Energy, the world's largest developer and owner of offshore wind power plants, aims to install over 3.5 gigawatts of additional offshore wind by 2020.[19]

2.1.2. UNITED STATES INDUSTRY

The US Department of Energy (DOE) estimates that the US has the potential to capture over 2,000 gigawatts of offshore wind, which is twice the annual electricity consumption by the US.[20] The DOE recently published the National Offshore Wind Strategy, which aims to enable 86 gigawatts by 2050. The DOE projects that 86 gigawatts would support 160,000 gross jobs in coastal regions and around the country.[21]

Signs point to an industry that could experience job growth over the next 10 years in the US. Reasons for this optimism include:

- Increasing investment in the industry: Foreign companies and investment companies headquartered in the US are increasing investments in the industry.
- Federal commitments: The DOE's Smart from the Start program has been removing barriers to the development and construction of an offshore wind power plant. BOEM has been working to make additional locations available for commercial lease. Finally, the DOE recently published a strategy "to facilitate the development of a robust and sustainable offshore wind industry in the United States."[22]
- State commitments: New York has committed to obtaining 2,400 megawatts of offshore wind power by 2030. Massachusetts enacted legislation calling for 1,600 megawatts of offshore wind by 2027.
- Development of infrastructure to support the industry: The first commercial marine port for offshore wind has been constructed in New Bedford, Massachusetts.

- Construction of the first offshore wind power plant: Construction is completed on the Block Island Wind Farm.

2.1.3. NEW YORK STATE INDUSTRY

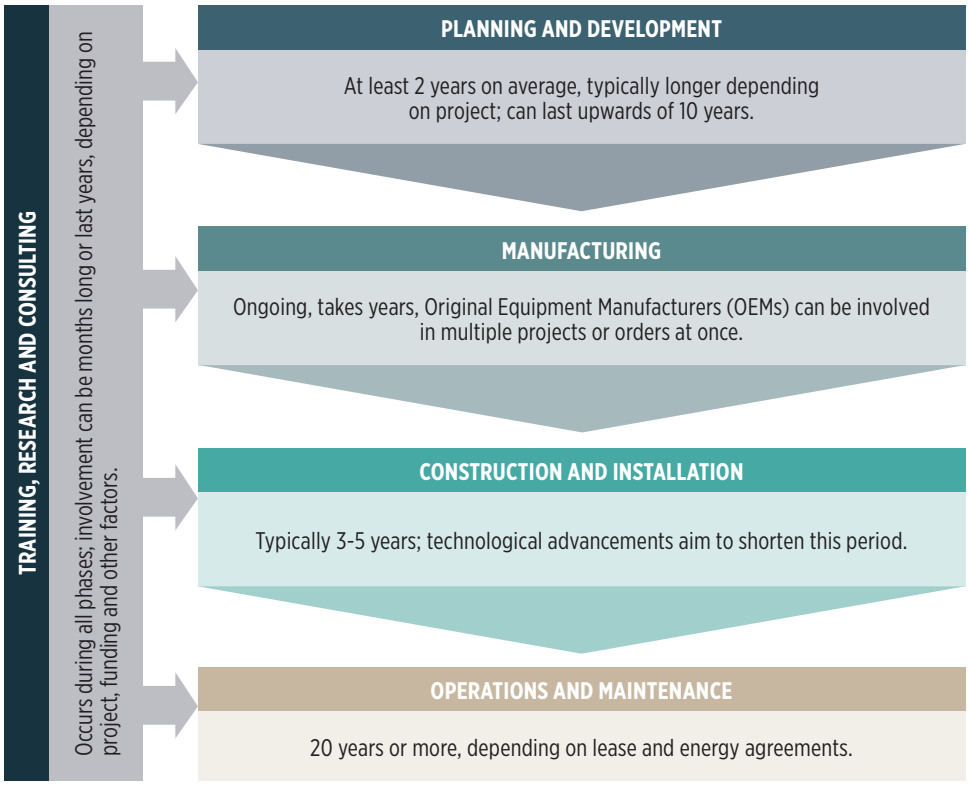
In 2016, the New York Public Service Commission established a Clean Energy Standard calling for the generation of 50% of New York's electricity from renewable energy sources by the year 2030. In 2017, Governor Andrew Cuomo committed to obtaining 2,400 megawatts of electricity from offshore wind by 2030.

2.1.3.1. OFFSHORE WIND MASTER PLAN

In his 2016 State of the State Address, Governor Andrew Cuomo stated that New York would create the "New York Offshore Wind Master Plan" that will serve as a comprehensive guide for the future of offshore wind in New York, as well as for a study of a potential deep water port for use by the industry. A Blue Print for the Master Plan was published on September 15, 2016.[23] NYSERDA plans to meet with stakeholders, perform additional studies and take public comments on the draft plan and a final plan is anticipated by the end of 2017.

2.1.3.2. NEW YORK WIND ENERGY AREA

There is currently an 81,000-acre wind energy area (WEA) located approximately 11 miles south of the Rockaways on Long Island that has been identified for commercial development of offshore wind.[24] In a record-breaking auction, Statoil agreed to pay more than



$42 million to secure the rights to develop an offshore wind power plant in this area. If the full area is developed, the area has the potential for up to 800 megawatts of capacity, which would provide electricity to almost 300,000 homes.

2.1.3.3. DEEPWATER LONG ISLAND

In a second and separate initiative, the Long Island Power Authority approved purchasing electricity from a 15 turbine, 90-megawatt offshore wind power plant from a developer that holds the lease of a wind energy area off the coasts of Massachusetts and Rhode Island. It is believed that construction could begin as early as 2019 and operation would begin around 2022.

2.2. THE WORKFORCE OF OFFSHORE WIND POWER PLANTS: A SUMMARY OF JOBS AND PHASES

Offshore wind power plants involve an impressive, highly skilled array of professionals. Each phase of an offshore wind energy project requires significant logistical coordination, the orchestration of workers and equipment as well as a high degree of attention paid to safety. This report organizes the work of offshore wind power plants into five distinct but interrelated phases:

The data contained in this report represent a practical, generalized model of occupations, job titles and phases as they are currently known. Previous research on offshore wind energy's workforce includes a large collection of reporting on the jobs impact to be had from offshore wind power plants. The table below represents a small sample from recent offshore wind job research related to the Construction and Operations and Maintenance phases.

NAME	SUBJECT AREA / PROJECT	# OF TURBINES	MEGAWATT CAPACITY	ESTIMATED JOBS	SOURCE
Arkona Offshore Wind Power Plant	Baltic Sea region, Germany	60	385	400 Construction & Installation; 50 Operations & Maintenance	E.ON and various media reports
London Array	London Array, DONG Energy, Thames Estuary, United Kingdom	175	630	1,000 Construction & Installation Jobs; 90 Operations & Maintenance Jobs	DONG Energy and various media reports
New York Power Authority	Long Island-New York City Wind Project (low-end development)	N/A	350	2,300 "Development, Construction & Installation" Jobs; 85 "Operations & Maintenance" Jobs	AWS Truepower & Camoin for New York Power Authority
LeedCo	Near Cleveland, Ohio	6	20	525 "Fabrication & Construction" Jobs	http://www.leedco.org/FAQs
EDP Renewables	Marble-River Land-Based Wind Power Plant, Clinton County, New York	70	215	300 Construction & Installation; 13 Operations & Maintenance	http://marbleriverwindfarm.com
Galloo Island Wind Farm	Jefferson County, New York	N/A	110	449 Construction & Installation; 24 Operations & Maintenance	Galloo Wind Farm Report (Jan 2016)

Wages in the Offshore Wind Energy Industry
In general, workers working in the offshore wind energy industry can expect to earn a somewhat higher level of pay than they would in comparable sectors. According to 2010 report from the US Bureau of Labor Statistics, engineers working in wind power can expect salaries "comparable to earning for engineers in general…dependent on a number of factors, such as experience, education and training, licensure and certifications, the size and type of company, geographic location, and the complexity of the work." The lack of an established offshore wind energy industry in the US prevents researchers from learning exactly what the pay differences might be in offshore wind energy as compared to similar fields.

Given the relative dearth of such knowledge in the US at present, professionals with deep expertise in the permitting and development aspects of offshore wind could expect to earn salaries above their peers in other industries. The same would also apply to geotechnical engineers, offshore project managers, vessel operators, scientists, and consultants with experience in the surveying and design of offshore wind project sites.

The nature of the work of each offshore wind project phase shapes the amount and type of compensation for various occupations. For example, building trades workers may begin at a staging or port site and be organized in shorter day shifts. As the project moves out to water, they might move to longer shifts to improve efficiency and reduce the amount of vessel trips to transport personnel. In total, teams of workers such as welders, electricians, carpenters, steelworkers, and painters may be involved in an offshore wind project for a matter of weeks or months. This is similar to work they perform for other large scale construction projects. Their wages and benefits are paid by the hour. In contrast to the building trades, workers such as a site engineer, a wind turbine technician, or a plant operator's management team are more likely to be salaried employees who might work on a specific power plant for a matter of years. Manufacturing occupations can expect to be employed over a course of years, assuming a relatively steady rate of product orders, with salaries in line with similar industries. Professionals in the training, research and consulting phase might be hired for offshore wind projects on a short-term basis as part of their full-time employment with a consulting firm, a university or other institution.

TECHNICAL SKILLS

- Carpentry
- Composites/advanced materials
- Data analysis
- Diving
- Energy resource management
- Experience with power plant, renewable energy and electrical grid projects
- Experience with wind power plants, land-based or offshore
- Hydraulics
- Logistics
- Machining
- Proficiency with office productivity software
- Rigging and material handling
- Understanding of electromechanical systems
- Welding

SOFT SKILLS

- Ability to lead and motivate staff
- Ability to work independently and in groups
- Analytical thinking
- Comfort working at heights and in open waters
- Commitment
- Continuous quality and process improvement
- Customer service
- Physical stamina
- Strong written, verbal and interpersonal communication
- Troubleshooting

SAFETY AND OFFSHORE-SPECIFIC SKILLS

- Advanced Rescue
- Experience with vessel fleet coordination
- Familiarity with offshore safety standards and USCG protocols
- Fire Awareness/Fire fighting
- First Aid
- Marine Safety Training
- Regional Compliance/OSHA 10
- Saturation Diving
- Sea Survival
- Strong understanding of safety and health standards
- Weather prediction/meteorology

Another aspect that is likely to influence wages of offshore wind energy relative to comparable industries is the credentialing and training required to work on-site in the open water. This is perhaps the most significant difference between land-based and offshore wind power plants. **The risk, rigor and requirements of working at sea are significant for jack-up barge crews or wind turbine technicians and others who carry out their duties at the project site. Those with the work ethic, stamina and skills to carry out this work should expect to be in high demand.**

The following sections will provide more information about the skills, type of work and jobs found in each of the phases of building an offshore wind power plant.

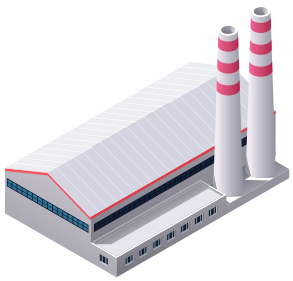
2.2.1. COMMON SKILLS AND CREDENTIALS REQUIRED IN OFFSHORE WIND ENERGY

The many professionals that contribute to the work of offshore wind power plants possess a robust and diverse range of skills. These skills can be understood in a general, simplified sense as fitting into one of three broad categories: technical skills, soft skills, and safety/offshore-specific skills. Some skills are in-demand across all phases while others are leveraged on a shorter-term, targeted basis. Among the most common and critical skill areas are engineering, building trades and construction, environmental sciences, project management, and finance. On the previous page is a sampling of the most common and important skills areas by category.[25]

Credentials found in the offshore wind energy industry encompass all levels of education and training, from high school diplomas to associate's, bachelor's, master's, and doctoral degrees to apprenticeships and specialized training programs. As the industry matures, more developed career pathways are emerging. These pathways will allow professionals to advance their career in more predictable and rewarding steps, which also benefits individual companies and the industry.

2.3. THE PLANNING AND DEVELOPMENT PHASE

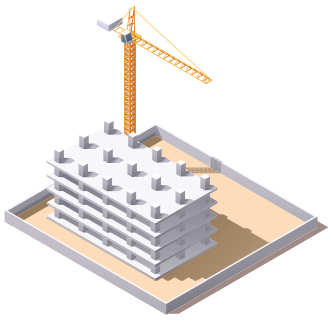
The chief tasks of this phase involve identifying potential offshore wind power plant sites; conducting the necessary surveys, data collection and environmental reviews; obtaining permits, leases, and project financing; designing the wind power plant; and procuring the components that will make up the power plant once it is constructed and connected to the electrical grid.



2.4. THE MANUFACTURING PHASE

A manufacturing company is responsible for designing, producing, testing, and selling one or more of the components that make up an offshore wind power plant. A single manufacturing facility may employ engineers (e.g., aeronautical, civil, design, electrical,

environmental, industrial, mechanical, quality, machinists, research, structural, production, sub-sea structure design, high voltage electrical), quality managers, control systems specialists, technicians, welders, attorneys, health and safety specialists, back office and administration professionals, assemblers, public relations and marketing professionals, logisticians, and site/plant managers.



2.5. THE CONSTRUCTION AND INSTALLATION PHASE

Construction of the offshore wind power plant is the most labor

OFFSHORE WIND ENERGY JOB IN FOCUS:

WIND TURBINE TECHNICIAN

Wind turbine technicians execute scheduled and unscheduled maintenance and repair of the wind turbine, its control systems, and components. Technicians must possess strong electromechanical skills and be able to work both at sea and at heights in a consistently safe manner. They must also have strong communication skills in order to work with their team and with the other operations and maintenance staff members at the power plant.

According to recently available salary data, land-based wind turbine technicians in the US earn an average annual salary of $53,000. This salary is comparable to some estimates from the UK and European job markets. The US BLS recently reported that employment of onshore wind turbine technicians is growing at a rate faster than any other nationwide. "Employment of wind turbine service technicians…is projected to grow 108 percent from 2014 to 2024, much faster than the average for all occupations," reports the BLS. "However, because it is a small occupation, the fast growth will result in only about 4,800 new jobs over the 10-year period."[28] This growth should impact salaries for technicians, though it is uncertain exactly how. If offshore wind energy finds footing in the US, qualified offshore turbine technicians will be in high demand.[29]

[29] The wage figures provided in this report are based on salary data from the US Bureau of Labor Statistics. Since the offshore wind energy industry in the United States is so new, the data sources on which our wage figures are based do not yet account for the impact of this industry on national or state-level salary averages. This projection from BLS does not account for the jobs of offshore wind, which could result in an even larger job growth for wind technicians over the next decade.

intensive phase of the project. In simple terms, the objectives of this phase are to move the power plant components — turbines, cables, foundations, etc. — to the selected site, conduct any necessary fabrications, and install the components according to the site design plan, connect the power plant to the existing electrical grid, and finally test the electrical service from the turbines. For large projects, the construction phase may span several years, but typically takes one-and-a-half to three years to complete. Many of the jobs of this phase are temporary in nature. Workers may be hired for the duration of this phase or to carry out tasks lasting only a matter of weeks or months.

The construction and installation phase is the most likely to involve a high concentration of unionized labor. Unionized workers involved in this phase include electricians, painters, pile drivers, laborers, stevedores, millwrights, ironworkers, carpenters, welders, plumbers, and others. Installation of the array cables and export cables requires utility workers to prepare the cable in large coils. Once the cable is ready to install, a crew of specialized professionals operate an undersea cable installation vessel.

Ports close to the power plant site rent quayside space and a storage area to the contractors. Workers such as carpenters, steelworkers, electricians, plumbers, welders, stevedores, crane operators, and project managers have a hand in the work executed at the port site.

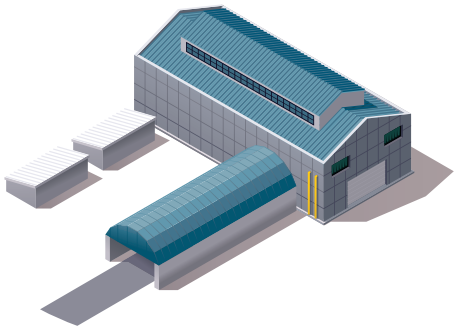
CONSTRUCTION AND INSTALLATION JOBS IN FOCUS:

ELECTRICIANS AND LINE WORKERS

Electricians plan the layout and installation of electrical wiring, equipment, or fixtures, based on job specifications and local codes. They place conduit, pipes, or tubing inside designated partitions, walls, or other concealed areas and pull insulated wires or cables through the conduit to complete circuits between boxes. Electrical power line installers and repairers install and maintain the power grid. Line workers who maintain the interstate power grid work in crews that travel to work locations throughout a large region to maintain transmission lines and towers. Workers employed by utilities work mainly with lower voltage distribution lines, maintaining equipment such as transformers, voltage regulators, and switches.

According to recently available salary data, electricians and line workers in New York earn an average annual wage within a general range of $55,000 to $77,000. The US BLS estimates there are over 40,000 electricians in New York State. This data should be considered as rough estimates, especially for this title since workers trained in electrical work may be working in related fields under different titles.[26]

[26] The wage figures provided in this report are based on salary data from the US Bureau of Labor Statistics. Since the offshore wind energy industry in the United States is so new, the data sources on which our wage figures are based do not yet account for the impact of this industry on national or state-level salary averages.



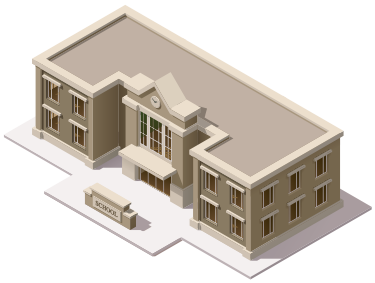
2.6. THE OPERATIONS AND MAINTENANCE PHASE

During the operation and maintenance phase, regular inspection and repair of turbines, foundations, and cables and any necessary remedial work is performed. Vessel crews are a vital piece of this phase as they provide the daily access to the turbines required to perform maintenance and inspection tasks. Other staff includes site or plant managers, executives, engineers, back office and administrative professionals, logisticians, and public engagement or marketing specialists.

Similar to power plants using other fuel and generation sources, offshore wind plant owners must deal with the question of repowering. Repowering an offshore wind power plant may entail decisions about complete or partial replacement of turbines, foundations, and the overall layout of the plant.

2.6.1. DECOMMISSIONING

The decommissioning of the power plant is the final step of the operations and maintenance phase. "The range of skilled personnel required for decommissioning will be similar to that for the construction phase," explains one industry report.[27] Building trades workers and engineers develop and implement a plan to deconstruct the power plant's components and remove them from the offshore site. Workers such as electricians, utility employees, and riggers disconnect the cables, substations, and transformers from the electrical grid. Barges and their crew handle the deconstruction of the plant's components and their movement to shore. Vessel crew transport employees from ports to the offshore work site, just as they do for the other phases.



2.7. THE TRAINING, CONSULTING AND RESEARCH PHASE

This phase overlaps in one form or another with all of the other project phases. It has its own unique job functions and workforce considerations. **The many functions and roles that researchers and consultants could fill for an offshore wind power plant include:**

- Technical services and advisement;
- Surveys on environmental impact, geotechnical analysis;
- Oversight and certification on health and safety and engineering matters;
- Advancement of methods and technologies used in the industry;
- Delivery of training and credentialing in technical areas as well as offshore safety, industry best practices and soft skills;
- Advocacy on technical, economic, workforce, policy, technological, and other aspects of the industry.

3

Labor Unions Associated with Offshore Wind Energy Jobs

Labor unions have a long history training highly skilled workers in New York State's energy industry. The unions whose members work in energy include the Utility Workers Union of America, International Brotherhood of Electrical Workers, United Association of Plumbers, Pipefitters and Steamfitters, Laborers International Union of North America, and the International Union of Operating Engineers, among others. Their members perform work in transmission and distribution, power generation, the construction and operation and maintenance of power plants. The workers in these and other unions are highly skilled and can apply their skills in the offshore wind energy sector.[30]

Construction trade unions whose members include electricians, welders, ironworkers, pile drivers, plumbers, pipefitters, stevedores and elevator constructors were all represented in the Block Island offshore wind project. As the industry grows and manufacturing of components begins to occur in the US, other labor organizations such as the United Steelworkers, whose members currently manufacture components for onshore wind turbines, and the United Autoworkers will likely participate in the manufacturing phase of offshore wind.

4

Measuring the Available Workforce in New York State

4.1. A SNAPSHOT OF THE NEW YORK STATE WORKFORCE

New York State's workforce contains workers with skills in energy, construction, finance, legal, technology, telecommunication, maritime industries, science, and engineering. All of these industries have skill sets that are called upon for offshore wind power plants.

Energy: New York's energy workforce has experience in all forms of electricity generation, including land-based wind. With 1,014 land-based turbines, 110 companies with specific wind energy products or services, and 300 companies with experience working in the wind market, New York already has a relatively strong land-based wind industry. The American Wind Energy Association (AWEA) estimates that New York has 1,000 to 2,000 employed in onshore wind energy. New York has eight businesses that currently manufacture components for onshore wind turbines.[31] Our interviews and research have uncovered a small percentage of individuals currently working in the offshore wind energy industry.

Construction: New York has a large and robust construction industry. New York's top five occupations in the building and construction industry are carpenter, construction laborer, first-line supervisor of construction trades and extraction work, construction manager, and general and operations manager.[32] Among specialty trade contractors, the five most common occupations are electricians; plumbers, pipefitters and steamfitters; construction laborers; carpenters; and general and operations managers.[33] All of these occupations are required in the offshore wind power plant construction.

Finance: The financial industry is perhaps one of the industries most associated with New York. New York City is widely recognized as the financial capital of the US. New York is home to many investment banking firms and venture capitalists, including DE Shaw and Blackstone Group—two firms that already participate in the offshore wind industry.

Science and Engineering: New York has strengths in engineering and environmental services. New York currently boasts roughly 60,000 engineers.[34]

Legal Industry: New York has almost 300,000 attorneys and is home to "a high percentage of the most highly regarded law firms in the world."[35]

Maritime: New York has a strong maritime industry and robust ports infrastructure with a supporting port workforce. The Port Authority of New York and New Jersey is the nation's third-largest port developer and administrator. New York ports include: Howland Hook Marine

Terminal (Staten Island) and Red Hook Marine Terminal (Brooklyn).

Union Membership: New York has a significant number of highly skilled and well-trained workers that belong to craft and trade unions. Roughly 25% of New York's workforce is represented by labor unions.[36] Approximately 40% of the workers in the utility sector belong to a trade union. One in three members of the construction workforce belongs to a trade or craft union. This is important because unions feature an apprenticeship model with a strict schedule that incorporates heavy emphasis on health and safety training on the job and in the classroom.

New York's workforce has consistently demonstrated the knowledge, skills and abilities to accomplish significant energy and other infrastructure construction, including work in marine environments. New York workers have built:

a) The first electric grid at Pearl Street, New York City;
b) The Robert Moses Niagara Power plant;
c) The World Trade Center and Freedom Tower;
d) One of the world's largest public transportation systems; and
e) A full complement of electrical generation units ranging from nuclear to onshore wind.

4.1.1. NEW YORK STATE WORKFORCE GAPS

In order to ensure the availability of a highly skilled and well-trained workforce it is necessary to assess the gaps in the workforce. A gap exists when the demand for workforce outstrips the supply of qualified, available workers. There are a host of workforce gaps that currently exist in New York. New York State is not alone; many of these same workforce gaps exist in other states. In addition to gaps, the skills required for participation in the offshore wind industry are possessed by many other industries in New York. As such, other exigent industries will compete for the same workers and demand similar skill sets as the offshore wind energy industry.

Below is a sampling of current, known workforce gaps in New York State:

- Offshore wind specific skills, such as sea survival and other marine related safety skills.
- A middle skills gap. Middle skills are mechanical, technical, and production careers that require greater than a High School diploma but less than a four-year college degree.[37]
- A high skills gap in Science Technology Engineering and Math (STEM) related fields. High skills are those that often require a college or advanced degree.
- Employers in all industries across the state complain that new workers are lacking in soft skills, such as communication and critical thinking skills.
- Utilities are having difficulty finding new workers with basic technical understanding of the industry.
- On the manufacturing front, small, medium and large sized manufacturers face challenges in finding qualified assemblers, welders and machinists. The US offshore wind energy industry is not expected to generate a high number of manufacturing jobs in its early stages. However, as offshore wind energy matures, firms like Siemens and General Electric may locate facilities in the Eastern US. These companies will compete for the same manufacturing employees as exigent firms, thereby further straining the worker shortage many New York State companies are currently experiencing.

4.2. RECOMMENDATIONS AND AREAS FOR FURTHER STUDY

Level of Construction Activity: The construction sector and the offshore wind sector use much of the same workforce. Construction projects such as roads, bridges, buildings, and sports stadiums require electricians, ironworkers, laborers, welders, plumbers, pipefitters, and operating engineers. The level of activity in these other construction projects will impact the workforce available for offshore wind power plants.[38] It is vital to inventory major construction projects in the region to understand their workforce demands relative to offshore wind. In addition, knowing which skill sets and professionals will be in high demand will enable offshore wind energy planners to more effectively position themselves in the labor market.

Aging Workforce: Looking ahead over the next decade, the impending retirement of many baby boomers will contribute to job opportunities in the construction and building trades, small and large scale manufacturing, and many other industries prevalent in New York State.[39] Therefore the need for workers in the emerging offshore wind industry will exacerbate the issue of not enough people entering middle skills in the fields of construction and manufacturing. Planning needs to take into account expected retirements and the jobs and sectors they will impact the most.

Growth of Competing Industries: Industry must also consider the pressures on the workforce created by competing industries and anticipated growth in sectors that require similar skills.

Significant Industries: In 2015, New York State Department of Labor (DOL) released a report on the statewide significant industries in New York. An industry is considered significant when it meets one of the following criteria:

a) high number of jobs;
b) above average job growth,
c) above average expected job growth,
d) it has been identified as an area of economic development priority by the ESD.

DOL performed this exercise as a way to provide data to the state's workforce investment boards to use in making decisions about how to allocate its workforce development resources. It is instructive here because growth in these priority industries could create workforce gaps in the future. Five of the six significant industries are industries

that are required in the development of an offshore wind power plant, including construction, manufacturing, financial activities, professional and business services, and educational services.[40] It is currently very difficult to assess the full scope of the workforce needs of the US offshore wind energy industry because it is so young. As the industry and labor organizations look to grow and develop the skills of the workforce, we offer the following recommendations around actions, below:

SHORT-TERM RECOMMENDATIONS

- New York should take steps to be an early adopter.
- New York should foster a dialogue and partnerships between labor organizations, industry, environmental organizations, universities and colleges, elementary/secondary education institutions, training professionals, workforce investment boards, community-based organizations, and government to identify workforce issues for the emerging offshore wind industry.
- NYS DOL, NYSERDA, labor organizations, academics, and workforce development organizations should study existing offshore wind training programs.
- NYS DOL, NYSERDA, labor organizations, academics, and workforce development organizations should examine existing training programs for industries with similar skill sets.
- The industry should create employer networks.
- Federal and state governments must increase the level of funding for workforce development for this sector.

LONG-TERM RECOMMENDATIONS

- Government, industry, academic organizations, labor organizations, and environmental organizations need to create a strategic plan that integrates state, regional, and national initiatives and resources for skills and workforce development.
- Industry and labor organizations should develop voluntary minimum standards.
- New York should include apprenticeship clauses in procurement actions to ensure appropriate training.
- NYS DOL, NYSERDA, industry, labor organizations and workforce development professionals should develop registered apprenticeship programs for jobs/roles where they do not already exist, such as for the wind technician role.
- The industry should create internships and partnerships with high schools to promote knowledge about the field and interest among secondary students.
- The workforce development system, with the local Workforce Investment Boards at the core, needs to have a flexible framework to train for skills needed for the industry.

5

Training and Credentialing in Offshore Wind Energy

An available, highly skilled and well-trained workforce is a key factor for a successful industry. Developing the appropriate workforce training programs play an important role in this success.[41] Industry, labor organizations, academic institutions, and policymakers must not forget about the importance of having a dialogue about workforce development.

In addition to requiring highly skilled workers, the challenges and health and safety risks associated with working in the marine environment require specialized training for both worker safety and to protect the equipment from damage. As the industry is developing, it should be looking to set workers and trainees on a career pathway to advance as the industry grows. There is a need to plan and develop training programs, standards, and certifications to ensure not only a highly skilled workforce, but also a safe, healthy work environment.

5.1. EXISTING OFFSHORE WIND TRAINING PROGRAMS

Developers and manufacturers in offshore wind energy have created their own proprietary training programs. One developer has a 30-hour, basic offshore wind power training course to equip new hires with a fundamental knowledge of the industry, its technology, and the process of building an offshore wind power plant. Some manufacturers have developed technical training curriculum for their specific turbines, as well as safety training. Siemens has created five training centers throughout the world to provide both technical and safety training. In Europe, the industry collaborated to create safety standards and basic commercial standards in a number of areas. Universities have developed degree programs, courses or curricula. Trade associations have worked to develop agreed upon standards. In the US, there also has been some offshore wind specific training developed.

5.2. NEW YORK'S EXISTING TRAINING, EDUCATION, AND UNION APPRENTICE INFRASTRUCTURE

New York does not currently have any offshore wind-specific education or training programs. It does, however, have a well-established and responsive training and education infrastructure in place. Its workforce development organizations are recognized as world class.[42] It has some of the top colleges and universities in the country, including the highly-regarded state and city education systems, the State University New York and the City University of New York. New York is also home to several nationally recognized engineering universities, including Rochester Institute of Technology, and Rensselaer Polytechnic Institute. Clinton Community College Wind Technician Training Program is designed to provide students a foundation in real-world troubleshooting for onshore wind. This program has potential to be retooled or expanded to suit the needs of offshore wind power plants.

New York already has in place a significant amount of technical and health and safety training though its labor unions. The New York Statewide Workforce Investment Board (SWIB), Regional Workforce Development Boards (WDB), and the NY Association of Training and Employment Professionals (NYATEP) are positioned to address the workforce needs of offshore wind as the industry continues to emerge.


BIWF1
AIR DRAFT
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6

Workforce Case Study: Block Island Wind Farm, Block Island, Rhode Island

The Block Island Wind Farm (BIWF) demonstrated that a workforce with a diverse set of skills is required to complete an offshore wind power plant. The BIWF workforce has included project managers, engineers, scientists, lawyers, commercial finance, regulatory, electricians, welders, plumbers, pipefitters, operating engineers, cement masons, laborers, mechanics, machinists, dockworkers, truck drivers, training professionals, health and safety experts, vessel builders, and vessel operators.

The Block Island project tapped into unions, contractors and businesses locally based in Rhode Island. It also relied upon experienced workers and companies from Europe. According to public statements by Deepwater Wind, more than 300 local workers participated.

6.1.1. OVERVIEW OF THE BLOCK ISLAND WIND FARM OFFSHORE WIND POWER PLANT

The BIWF consists of five turbines that are rated at six megawatts each. They are installed at depths of between 23 and 28 meters, or 75 to 92 feet. These five turbines will generate an annual output of 125,000 megawatt hours, which is enough electricity for an estimated 17,000 homes.

The turbines were installed on five lattice work platforms that sit on the sea floor. They are connected by 6.5 miles of cable to a substation on Block Island. The substation supplies electricity to Block Island and is connected via an underground cable to a new substation on Block Island. Block Island has been connected to the mainland from this substation with 21.8 miles of bidirectional cable buried six meters beneath the sea floor. In Narragansett, Rhode Island the cable connects to another new substation that serves as the interconnection point to the grid on the mainland.

6.1.2. PHASE BY PHASE DISCUSSION OF THE WORKFORCE

6.1.2.1. DEVELOPMENT

The work during development of BIWF included: regulatory, site survey and assessment, legal, commercial/finance, government and stakeholder relations, project management, and supply chain procurement. The BIWF had project managers, finance experts, lawyers, scientists, engineers, as well as vessel operators employed during development.

6.1.2.2. MANUFACTURING

Being the first of its kind project in the US, many of the major parts and components, with the exception of the foundation, were manufactured outside of the US. The turbine blades were manufactured by LM Wind in Denmark. The generators and nacelles were manufactured by GE in France. GE produced the tower pieces in Spain.

6.1.2.3. CONSTRUCTION AND INSTALLATION

Over 200 skilled construction crafts and trades workers completed construction and installation of the BIWF. The workers included members of unions representing laborers, carpenters, electrical workers, ironworkers, plumbers, pipefitters, cement masons, operating engineers, and stevedores.[43]

During the construction phase, workers built port infrastructure, assembled and installed foundations, built a temporary climate controlled assembly facility, assembled the turbines, and installed the turbines in the ocean off Block Island. Work also included transporting components by vessel and trucks, cable laying, and substation construction.

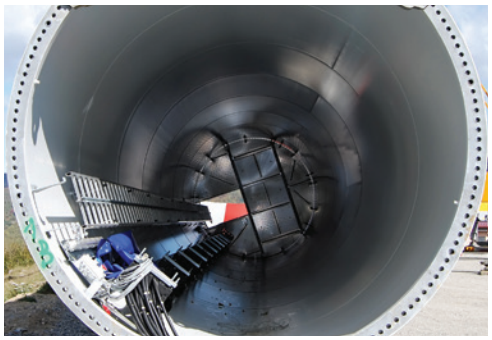
Foundation Assembly: For the 18-month period required to assemble and install the five foundations, 200 workers (100 of which were local) and dozens of vessels, including barges, tugboats, and crew ships were employed on the project. The main pieces for the lattice work structures were built in Louisiana by Gulf Island Fabrications, a company with experience making foundations for offshore oil and gas operations.

At the same time, in early 2015, steel jackets, decks, and piles were fabricated by welders and other trade workers at Specialty Diving Services, a marine construction firm based at Quonset Point in North Kingstown, Rhode Island.

Foundations Installation: In early summer 2015, the foundations were delivered to Rhode Island from Louisiana. The installation occurred over a 28-week period. Work on foundations was performed by heavy equipment operators, pile drivers and welders. Divers supported construction of the turbine platforms by disconnecting the underwater rigging from the cranes when the structures were set down on the sea floor.

Assembling Temporary Manufacturing Facility: The complex project

management logistics of BIWF also included construction of a "massive climate controlled tent" located onshore to protect the workers from inclement weather. GE hired 40 trades workers to construct and assemble a temporary facility for assembling turbines, including electricians, ironworkers, operating engineers, and longshore workers. Members of the United Association of Plumbers, Fitters, Welders and Service Technicians contributed heating and cooling systems as well as instruments and components of the turbine. The International Brotherhood of Electrical Workers (IBEW) supplied electricians to run wires and conduit for the manufacturing facility.



Assembling Towers: All told, as many as 160 workers at the Port of Providence facility have played a role in assembling the towers. Sixty local workers were hired to work at the temporary manufacturing facility to assemble the components and tower sections.[44] Workers installed electrical, mechanical and safety equipment in bottom tower sections. Electricians and ironworkers installed four platforms in each tower. The platforms were outfitted with switchgear and mechanical components and other equipment. Workers from the International Union of Elevator Constructors assembled and installed a lift in each tower. In addition, members of the International Union of Painters and Allied Trades performed coating and sealing of the towers and foundations.

Ten electricians per turbine worked on one turbine at a time to install the inverter, transformer, switchgear, and low-voltage electrical distribution cabinet, which are located at the tower base. In addition, millwrights installed hydraulic pumps for cooling systems, connected hydraulic piping associated with pumps and transformers, and installed temporary hydraulic equipment to move components into place.

Installing Towers in Water: In late July 2016, final preparations for installation of the towers began and the wind turbines were installed in the ocean over an 18-day period. In August, electricians and ironworkers worked around the clock in 12 hour shifts seven days a week. Electricians performed medium volt work and cable splicing in the towers in the water. Ironworkers rigged and welded components. Heavy equipment operators operated cranes and lifts on the barge "Heavy Tern." In addition, crews staffed boats to monitor marine traffic and wildlife entering the construction site. Members of the International Association of Ironworkers worked to perform rigging, fabricating components, concrete reinforcement, and erection of the towers in the ocean. A team of pile drivers and divers from the United Brotherhood of Carpenters

and Joiners of America worked to install the turbine foundations and performed welding tasks at sea.

Logistics: Transporting, Staging and Storing Components: The construction and installation also involved over 100 support jobs related to the transportation of components and workers. Vessel crews for each vessel are typically 5-6 individuals. Vessels included construction and transport barges, tugboats, and monitor vessels. Trucks were also required for moving components on land. This provided work for captains and boat crews, as well as truck drivers.

Cables and Substations: BIWF construction and installation also required laying of cables beneath the sea floor, substation construction, underground cables on land, and upgrades to overhead lines. Workers from the IBEW played a vital part in the installation of inverters, transformers and other electrical components.

A 20 member crew drilled a shaft underground to lay cable on Block Island over a six to seven month period. A total of 3,000 feet of cable was laid at a pace that started at about 30-50 feet per day then sped up to about 80 feet per day.[45]

6.1.2.4. OPERATION AND MAINTENANCE

The project is now in the operation and maintenance phase. Operation and maintenance will require administrative personnel to handle day-to-day operations, vessel crew, and a maintenance and repair crew. In preparation for operation and maintenance, ironworkers constructed a building for the storage of maintenance equipment for the turbines.

6.1.2.5. TRAINING, CONSULTING AND RESEARCH

During construction, a small amount of technical training related to the installation of the equipment was provided by GE as the turbine manufacturer. Health and safety training SCTW 95 was required by the Coast Guard. Additionally, each contractor had a safety plan and orientation for workers.

7

Matrix of Jobs and Phases

The matrix that follows is intended as a general guide laying out the functional areas, occupations, and common job titles to be found in the offshore wind energy industry. The matrix applies broadly to the industry as it is constituted across projects and labor markets. Titles, wages and credentials may vary from project to project and around the country.

It is important to note that the wage data presented in this report and in the table below is intended as a broad orientation for the occupations involved in offshore wind energy. It is not intended as a model to be emulated. A number of factors will determine actual wages for those who will work in the offshore wind energy industry in New York State. Since the offshore wind energy industry in the United States is so new, the data sources on which our wage figures are based do not yet account for the impact of this industry on national or state-level salary averages.

Wage data contained in this report reflects salary levels only. It does not take into account total compensation, which would likely be higher due to the costs of employee health care, retirement contributions, and other factors. Cost of living and labor market dynamics also influence wages from region to region and between industries.

The data in this matrix was compiled and adapted from various sources including: "A National Skills Assessment of the U.S. Wind Industry in 2012, National Renewable Energy Laboratory; "Maximising employment and skills in the offshore wind supply chain, Volume 1-Main report," UK Commission for Employment and Skills; "U.S. Offshore Wind Training, A Comprehensive Survey and Categorization of Training Elements," Northeast Offshore Renewable Energy Training Center; "Maine Energy (Wave and Tidal) and Offshore Wind Skills Analysis," EMB; "Workers Wanted: The EU wind energy sector skills gap," European Wind Energy Technology Platform; "Training a Domestic Skilled Workforce Support the Development of a US Offshore Wind Industry," Clean Energy Group; "Wind at Work, Wind energy and job creation in the EU," European Wind Energy Association; "Wind Career Map," United Stated Department of Energy; O*NET Online; United States Department of Labor, Bureau of Labor Statistics; Burning Glass, Labor Insight; New York State Department of Labor; and various interviews with offshore wind energy and workforce professionals.

MATRIX OF OFFSHORE WIND ENERGY JOBS BY PHASE

FUNCTIONAL AREA	OCCUPATION	MINIMUM / COMMON CREDENTIALS	ESTIMATED ANNUAL NYS WAGES	P&D	MFG	C&I	O&M	T,R&C
Accounting, Finance & Procurement	Accountant	Bachelor's Degree	$91,630	*	*	*	*	*
	Bookkeeper	High school diploma or equivalent	$42,740	*	*	*	*	*
	Buyer	Bachelor's Degree	$67,890	*				
	Insurer and Underwriter	Bachelor's Degree	$78,610	*	*	*		
	Power Marketer and Analyst	Bachelor's Degree	$77,280	*	*	*	*	
Admin, Clerical & Back Office	Admin and Clerical Staff	High school diploma or equivalent	$31,220 - $52,490	*	*	*	*	*
	Human Resources Professional	Bachelor's Degree	$72,380	*	*	*	*	*
	Information Technology Specialists	Bachelor's Degree	$40,530 - $111,170	*	*	*	*	*
	Public relations officer	Bachelor's Degree	$158,100	*	*	*	*	*
Construction & Assembly Workers	Assemblers of Electrical and Electromechanical Equipment	Apprenticeship or post-secondary certificate / license	$32,850 - $37,110		*	*		
	Construction Laborer	Apprenticeship or post-secondary certificate / license	$36,400 - $47,370			*	*	
	Laborers and Freight, Stock, and Material Movers, Hand	Apprenticeship or post-secondary certificate / license	$30,040		*	*	*	
Consultants & Researchers	Health and Safety Specialist	Apprenticeship or post-secondary certificate / license	$71,910	*	*	*	*	*
	Operations Research Analyst	Bachelor's Degree	$101,540				*	*
Development Technical Specialists	Regulatory & Permitting Expert	Bachelor's Degree	$110,100	*				
Directors and Executives	Director of Business Development	Master's Degree or higher	$186,940	*		*		
	Director of Finance	Master's Degree or higher	$162,210	*	*	*	*	
	Director of Health, Safety, and Risk	Master's Degree or higher	$55,420 - $71,910	*	*	*	*	
	Director of Procurement	Master's Degree or higher	$129,030	*	*	*	*	
	Director of Sales	Master's Degree or higher	$183,610	*	*			
Engineers	Aerospace / Aeronautical Engineer	Bachelor's Degree	$113,080		*			*
	Civil Engineer	Bachelor's Degree	$91,110	*		*		*
	Composite Materials Engineer	Bachelor's Degree	$87,930		*			*
	Control systems Engineer	Bachelor's Degree	$55,490		*			
	Design Engineer	Bachelor's Degree	$81,010	*	*			*
	Electrical Engineer	Bachelor's Degree	$98,430	*	*	*	*	*
	Environmental Engineer	Bachelor's Degree	$90,220		*			*
	Geotechnical, GIS, and geophysical engineer	Bachelor's Degree	$51,590 - $91,370	*	*			*
	Industrial Engineer	Bachelor's Degree	$85,460		*			*
	Marine Engineer	Bachelor's Degree	$91,660	*	*	*		*
	Mechanical Engineer	Bachelor's Degree	$85,840	*	*	*	*	*
	Sales Engineer	Bachelor's Degree	$107,010		*			
	Test Engineer	Bachelor's Degree	$95,550	*	*	*		*
	Wind Energy Engineer	Bachelor's Degree		*	*	*	*	*
Legal	Attorneys	Law Degree	$155,050	*	*	*	*	*
	Paralegal	Bachelor's Degree	$57,920	*	*	*	*	*
Management and Supervisors	Commercial Site Manager	Apprenticeship or post-secondary certificate / license	$79,460				*	
	Construction Project Manager	Apprenticeship or post-secondary certificate / license	$114,330			*		
	Engineering Manager / Chief Engineer	Master's Degree or higher	$151,740	*	*		*	
	Production Supervisor / Manager	Bachelor's Degree	$64,520		*		*	
	Quality Manager	Master's Degree or higher	$120,390		*	*		
	Site / Plant Manager or Operations Manager	Bachelor's Degree	$79,460		*	*	*	
	Wind Project Manager	Bachelor's Degree	$110,100				*	

KEY TO PHASE ABBREVIATIONS: **P&D**=Planning & Development; **MFG**=Manufacturing; **C&I**=Construction & Installation; **T,R&C**=Training, Research & Consulting.

FUNCTIONAL AREA	OCCUPATION	MINIMUM / COMMON CREDENTIALS	ESTIMATED ANNUAL NYS WAGES	P&D	MFG	C&I	O&M	T,R&C
Maritime, Port & Terminal Professions	Divers	Apprenticeship or post-secondary certificate / license	$84,940	*		*	*	*
	Stevedore / Longshoreman	Apprenticeship or post-secondary certificate / license	$30,040 - $46,530			*	*	
Scientists	Archaeologist	Bachelor's Degree	$82,580	*				*
	Ecologist	Bachelor's Degree	$70,640	*				*
	Environmental Scientists	Bachelor's Degree	$75,780 - $96,010	*				*
	Geoscientist / Geologist & Hydrologist	Bachelor's Degree	$78,320 - $87,030	*				*
	Marine & Wildlife Biologist	Bachelor's Degree	$65,870 - $77,430	*				*
	Meteorologist	Bachelor's Degree	$83,400	*		*		*
Technicians	CAD Specialist / Technician	Bachelor's Degree	$44,650 - $70,630	*	*			
	Environmental Science Technician	Bachelor's Degree	$48,560	*			*	
	Wind Turbine Technician	Apprenticeship or post-secondary certificate / license	$53,000 (based on national data)				*	
Trade Workers	Cement Worker / Concrete Operative	Apprenticeship or post-secondary certificate / license	$60,810			*	*	
	CNC Operator	Apprenticeship or post-secondary certificate / license	$46,330		*			
	Crane Operator	Apprenticeship or post-secondary certificate / license	$78,870			*	*	*
	Electrician: Inside	Apprenticeship or post-secondary certificate / license	$72,540			*	*	
	Electrician: Outside	Apprenticeship or post-secondary certificate / license	$77,070			*	*	
	Ironworker / Steelworker	Apprenticeship or post-secondary certificate / license	$84,750			*	*	
	Machinists	Apprenticeship or post-secondary certificate / license	$43,560		*			
	Operating Engineer	Apprenticeship or post-secondary certificate / license	$72,610			*		
	Rigger	Apprenticeship or post-secondary certificate / license	$45,870 - $58,060			*	*	
	Rodbuster	Apprenticeship or post-secondary certificate / license	$96,210			*	*	
	Welder	Apprenticeship or post-secondary certificate / license	$43,310		*	*	*	
Trainers, Teachers & Professors	Professor	Master's Degree or higher	$91,260 - $110,280					*
	Technical Trainer / Instructor	Apprenticeship or post-secondary certificate / license	$65,970					*
	Training & Development Manager	Master's Degree or higher	$135,620					*
Transport & Logistics	Heavy-Load Truck Drivers	Apprenticeship or post-secondary certificate / license	$47,500		*	*	*	
	Logistician	Bachelor's Degree	$73,930	*	*	*	*	
	Transportation Worker	Apprenticeship or post-secondary certificate / license	$38,760	*	*	*	*	
Vessels & Aircraft Workers	Commercial Aircraft Pilots	Apprenticeship or post-secondary certificate / license	$94,840	*		*	*	*
	Deck Crew (Mates, Ship Boat and Barge)	Apprenticeship or post-secondary certificate / license	$65,450	*		*	*	*
	Ship and Boat Captains	Apprenticeship or post-secondary certificate / license	$73,130	*	*	*	*	*

It is important to note that the wage data presented in this report and in the table below is intended as a broad orientation for the occupations involved in offshore wind energy. It is not intended as a model to be emulated. A number of factors will determine actual wages for those who will work in the offshore wind energy industry in New York State. Since the offshore wind energy industry in the United States is so new, the data sources on which our wage figures are based do not yet account for the impact of this industry on national or state-level salary averages.

Wage data contained in this report reflects salary levels only. It does not take into account total compensation, which would likely be higher due to the costs of employee health care, retirement contributions, and other factors. Cost of living and labor market dynamics also influence wages from region to region and between industries.

Endnotes

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13 It is important to note that the wage data presented in this report is intended as a broad orientation for the occupations involved in offshore wind energy. A number of factors will determine actual wages for those who will work in the offshore wind energy industry in New York State.

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26 The wage figures provided in this report are based on salary data from the US Bureau of Labor Statistics. Since the offshore wind energy industry in the United States is so new, the data sources on which our wage figures are based do not yet account for the impact of this industry on national or state-level salary averages.

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WORKFORCE DEVELOPMENT
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NEW YORK STATE
AND THE JOBS OF

Offshore Wind Energy

A Workforce-Focused Research Report from the
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