New York State Great Lakes Wind Energy Feasibility Study: Economic Development and Workforce Opportunities

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NEW YORK STATE | NYSERDA

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Advance clean energy innovation and investments to combat climate change, improving the health, resiliency, and prosperity of New Yorkers and delivering benefits equitably to all.

New York State Great Lakes Wind Energy Feasibility Study: Economic Development and Workforce Opportunities

Final Report

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Notice

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Abstract

The Great Lakes Wind Feasibility Study investigates the feasibility of adding wind generated renewable energy projects to the New York State waters of Lake Erie and Lake Ontario. The study examines myriad issues, including environmental, maritime, economic, and social implications of wind energy areas in these bodies of freshwater and the potential contributions of these projects to the State's renewable energy portfolio and decarbonization goals under the New York State Climate Act.

The study, which was prepared in response to the New York Public Service Commission Order Case 15-E-0302, presents research conducted over an 18-month period. Twelve technical reports were produced in describing the key investigations while the overall feasibility study presents a summary and synthesis of all twelve relevant topics. This technical report offers the data modeling and scientific research collected to support and ascertain Great Lakes Wind feasibility to New York State.

To further inform the study in 2021, NYSERDA conducted four public webinars and a dedicated public feedback session via webinar, to collect verbal and written comments. Continuous communication with stakeholders was available through greatlakeswind@nyserda.ny.gov NYSERDA's dedicated study email address. Additionally, NYSERDA and circulated print advertisements in the counties adjacent to both Lake Erie and Lake Ontario as to collect and incorporate stakeholder input to the various topics covered by the feasibility study.

Keywords

Great Lakes, offshore wind, economic development, workforce

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Acronyms and Abbreviations

CapEx	capital expenditures
COD	commercial operation date
FTE	full-time equivalent
GDP	gross domestic product
GW	gigawatts
I-O	input-output
JEDI	Jobs and Economic Development Impact model
MW	megawatts
NREL	National Renewable Energy Laboratory
NYSERDA	New York State Energy Research and Development Authority
O&M	operations and maintenance
OpEx	operational expenditures
ORBIT	Offshore Renewables Balance-of-system Installation Tool
U.S.	United States

Executive Summary

This report provides an assessment of potential economic development and workforce opportunities for a hypothetical wind energy project in Lake Erie and Lake Ontario. Much like other large-scale infrastructure projects, Great Lakes wind energy projects would be labor and capital intensive to construct and operate. Gross jobs and economic impacts were modeled in association with Great Lakes wind energy development, manufacturing and supply chain, installation (ports, staging, and vessels), and operations and maintenance. Jobs and economic impacts were estimated for two scenarios representing different percentages of a project's labor and capital expenditures coming from within the state – a base case with some content coming from outside the state, and 100% state content assumption which determined the maximum possible contribution to the state's gross domestic product (GDP). Both lakes were assessed using a hypothetical wind project size of 400 megawatts (MW). For Lake Erie, developing a 400-MW fixed bottom project in New York State could support 4,100 – 7,900 full-time equivalent (FTE) job years and generate $590 million - $1.1 billion in gross domestic product (GDP) during the construction phase, depending on which state content scenario is assumed. For Lake Ontario, a 400-MW floating wind project could support 6,900 – 10,500 FTE job years and generate $960 million–$1.5 billion in GDP, depending on the scenario. The projects would also create additional jobs from induced impacts during the construction and operations phases. The greatest opportunity for workforce and economic development in New York State stemming from Great Lakes wind energy development is through fabrication and assembly of substructures, supporting New York port infrastructure, developing Great Lake vessel capabilities, and long-term operations and maintenance jobs.

1 Introduction

This report provides an assessment of economic development and workforce opportunities for a 400-megawatt (MW) wind energy project in either Lake Erie or Lake Ontario. Much like other large-scale infrastructure developments, Great Lakes wind energy projects would be labor and capital extensive to construct and operate. The Jobs and Economic Development Impact (JEDI) model estimates the gross jobs and economic impacts from five industry segments for Great Lakes wind energy, including:

- development
- manufacturing and supply chain
- installation: ports and staging
- installation: vessels
- operations and maintenance

There are 157,000 clean energy jobs in New York State as of 2020, in which 23,000 are in renewable electric power generation. As the State spends Climate Act investments[1] to drive supply chain localization, build labor capacity, and ensure firms benefit from offshore wind, this activity is expected to spur more jobs and economic growth, with an employment increase of 172,000 jobs in the State by 2030. Wages in these new jobs are expected to be relatively high, enabling support for workers' families, delivering high value to customers, supporting disadvantaged communities and underserved populations, and facilitating job transfer to the clean energy workforce from fossil-based jobs (NYSERDA, 2022). Many of the jobs are expected to be in offshore wind on the New York State Atlantic coast; however, deploying wind energy in the Great Lakes can also contribute to meeting climate targets while growing the clean energy workforce in upstate, specifically near Lakes Ontario and Erie. Strategic investments in substructure assembly, ports, vessels, and training institutions for workers to support these activities and operations and maintenance could reinforce more jobs and economic growth. This assessment provides estimates of the job and economic impacts assisted by the development of a 400-MW wind energy project in either Lake Erie or Lake Ontario. The study looks at two scenarios for the State, one assuming a base case State, content derived from current trends (projected impact), and a more aggressive 100% State content scenario which determines the maximum potential with all impact.

2 Methodology

2.1 Analysis Tools

The job and economic impacts were estimated using NREL's Jobs and Economic Development Impact (JEDI) Offshore Wind Model rel.2021-2 model, which was customized for this project.[2] The model is a technology specific tool that estimates the direct, indirect, and induct impacts using an input-output (I-O) methodology with 2019 IMPLAN economic data for New York State.[3] Jobs, gross domestic product (also known as value added), earnings, and gross output are the primary gross economic metrics for each five segments for Great Lakes wind energy. These outputs are defined as:

- Job years: expressed as full-time equivalent (FTE). One FTE job a year is the equivalent of one person working 40 hours per week, for an entire year or 2,080 hours (e.g., two people working full time for six months equal one FTE). Jobs are not limited to those who work for an employer; they could include other types of workers, such as self-employed (sole proprietors).
- Gross domestic product (GDP): the value of an industry's production to the region of analysis. It comprises labor payments, property-type income (including profits), and taxes. Also akin to value added.
- Earnings: any type of income from work, generally an employee's wage or salary and supplemental costs paid by employers, such as health insurance and retirement.
- Gross output: the total amount of economic activity that occurs within an economy (within the region of analysis). It is the sum of all expenditures. A scenario in which a developer purchases a locally manufactured $500,000 wind turbine rotor blade that used $100,000 of locally procured fiberglass represents $600,000 in gross output.

The economic analysis area is defined as New York State; therefore, results should be viewed as the potential economic impacts that can result in the State and not necessarily the area near the Great Lakes. The precise location where the wind installation is placed in Lake Ontario or Lake Erie does not affect the jobs and economic activity that results from this JEDI model scenario, but it may affect which part of the State is engaged.

A primary input for I-O models, such as JEDI, are project-based capital expenditures (CapEx) and operational expenditures (OpEx). The total CapEx and OpEx values, in dollars per kilowatt-hour, are taken from the New York State Great Lakes Wind Energy Feasibility Study: Cost Analysis (NYSERDA 2022g), which incorporates technology characteristics and assumptions specific to the Great Lakes. JEDI requires a detailed cost breakdown to attribute costs into different economic industry segments. A cost breakdown for a 400-MW Great Lakes wind energy project in Lake Ontario or Lake Erie was obtained by modeling the project using the Offshore Renewables Balance-of-system Installation Tool (ORBIT).[4] The ORBIT model also provided process-based installation times to refine the vessel workforce needs and portside utilization times to refine workforce needs for substructure fabrication and assembly.

Results are provided for a 400-MW Great Lakes wind energy project in Lake Ontario or Lake Erie.[5] The commercial operation date (COD) for the Lake Erie project is 2030 and for Lake Ontario is 2035.[6] The results for the two lakes vary considerably because the Lake Erie project incorporates a fixed bottom design installation while the Lake Ontario project incorporates floating technology which currently is at a more nascent stage of development. Technology and siting considerations incorporated into the assumptions of this economic impact assessment are detailed in New York State Great Lakes Wind Energy Feasibility Study: Infrastructure Assessment (NYSERDA 2022d) and New York State Great Lakes Wind Energy Feasibility Study Cost Analysis (NYSERDA 2022g).

The direct, indirect, and induced impacts of both Great Lakes wind energy projects are reported. Stated estimates include direct and indirect impacts during the construction and operations phase (annually) from the five industry segments. There are additional induced impacts during the construction and operations phase (annually), which are spurred from workers spending their earnings in the State and other money circulating directly and indirectly in the State economy.

2.1.1 Caveats, Limitations, and Sensitivities

As with all economic I-O economic models, there are caveats and limitations to the use of the JEDI model. JEDI provides estimates of economic impacts given the user-specified expenditures and economic conditions when input-output data were compiled. There can be any number of changes in a dynamic economy that JEDI does not consider, so these results should not be considered a forecast for future activity. They simply reflect how a project might look if it were completed in the current economy under the prescribed cost and local content assumptions.

JEDI results are based on project inputs, and these inputs can change from project to project. This is especially true of nascent technologies or technologies that have not yet been widely deployed in the U.S. JEDI does not evaluate whether inputs are reasonable, nor does it determine whether a project is feasible or profitable.

Limitations of I-O economic impact models include the following:

- Results reflect gross economic impacts and not net impacts. The model calculates what economic activity would be supported by demand created by project expenditures but does not consider possible jobs lost from other displaced industries. However, the jobs created to develop, design, construct and operate a Great Lakes wind energy project are very similar to offshore fossil and marine operations industries. If these workers were displaced, they could readily adapt to a Great Lakes wind development.
- The results do not reflect many other economic impacts such as jobs created from constructing manufacturing and supply chain facilities, and the build-up of the required ports and grid infrastructure.[7]
- I-O models in general use fixed, proportional relationships between economy sectors. Factors that could change economic sectors, such as price changes that lead households to alter consumption patterns, are not considered.
- The order of magnitude of JEDI results is largely a function of a project's scale and how much is spent within the region under consideration. Larger, more expensive projects tend to generate more jobs. These jobs may not all be in State; some jobs may be created further down the supply chain, or they may be a result of expenditures made by investors.

Limitations to the scope of this analysis include the following:

- This analysis does not consider multiple Great Lakes wind energy projects. When a pipeline of Great Lakes wind energy projects is considered, workers would be utilized across multiple projects; therefore, results are not necessarily additive for each additional Great Lakes wind energy project.
- A standard set of State content assumptions was developed based on a current understanding of the ability to source labor and materials from the New York State and a hypothetical future in which investments are made to increase local content utilization (Table 1).

2.2 Industry Segments

Five industry segments are analyzed to provide a comprehensive economic impact assessment of Great Lakes wind energy. FTE job years, GDP, earnings, and gross output include both direct and indirect economic impacts. Induced impacts are reported separately from the total job and economic impacts of the project. The five industry segments include:

- Development represents the job and related expenditures to conduct site assessments, financing, plant design and engineering, project management, permitting review, stakeholder engagement and other activities that occur prior to the installation of the wind energy project. For this analysis, it is assumed that development activities occur over a four-year period, starting prior to the installation of the wind energy project and lasting until COD.

- Manufacturing and supply chain include all the job and related labor and material expenditures to produce offshore wind equipment, components, subcomponents, parts, and materials from all tiers of equipment suppliers.[8] This estimation involved conducting an economic impact assessment for each component using an analysis-by-parts approach linking different components and subcomponents to applicable industry sectors aggregations. Job roles would include regional professionals, factory-level management, design and engineering, quality and safety, factory-level worker, and facilities maintenance. It is assumed that component production starts one year prior to COD. Component production is spread across two years to indicate production at manufacturing facility for many components but also at quayside for components such as substructures.
- Installation: ports and staging represent the job and related expenditures and fees to operate the port and lease the port for assembly or installation activities in the Great Lakes.[9] These costs are multiplied through an input-output methodology assigning the costs into a transportation sector industry aggregation. Jobs roles would include terminal crews, logistics, and management roles located portside. For this installation analysis, it is assumed that ports and staging activities start at the same time as vessel activities, two years before COD, and last until the installation is complete.
- Installation: vessels include expenditures (including day rates) and labor requirements on all vessels to install foundations/substructures, wind turbines (e.g., nacelles, blades, towers), substations, scour protection, array cables, and export cables. A different installation strategy is modeled for fixed bottom and floating technologies. For fixed bottom technologies a strategy is deployed that includes transporting components to the lake by vessel or barge and installing with crane. For floating technologies, a strategy of towing the components into the lake and using vessels to position the turbine is used, and then mooring lines are separately installed. The ORBIT model provides installation times for different types of vessels to complete installation tasks. These processes and times are paired with skill set and labor requirements to provide a process-based estimation of FTEs on a single vessel for each component. All vessels (indirect) represent the labor and economic impacts supported by the contracted day rates from the vessels. Job roles would include marine crews, engineers/management, oversight, and installation crews. For this installation analysis, it is assumed that vessel activities start at the same time as ports and staging activities, two years before COD, and last until the installation is complete.
- Operation and maintenance (O&M) include all the jobs and expenditures to operate and maintain the plant, including labor, spare parts, operating facilities, and environmental, health, and safety monitoring. Estimates in this analysis are reported on an annual basis. Job roles include wind technicians, vessel marine crews, and associated operating plant management. O&M jobs represent a long-term workforce, starting at COD and lasting the operational life of the project.

2.3 New York Content Utilization

Jobs and economic impacts are estimated for two State content scenarios for wind energy projects developments in Lake Ontario and Lake Erie. Local for this analysis is defined as New York State, and all labor and content assumptions would accrue within the State. The two scenarios are defined as:

1. **Base Case State Content:** The base case scenario is the more likely economic impact scenario with a realistic percentage of content coming from outside the State. This scenario is based on forecasts consistent with today's industry environment but assumes an increase in New York State labor, vessel, and component supply chain utilization by 2030 and 2035 to support fabrication and installation near Lake Erie and Lake Ontario.
2. **One Hundred Percent State Content:** The 100% State content scenario is modeled to estimate the maximum job and economic impact possible from Great Lakes wind energy, assuming all labor, components and materials are sourced from New York State businesses.

A standard set of assumptions is shown in Table 1 for the first scenario based on current trends. These assumptions incorporate content assumptions from prior studies and input from subject matter experts to provide a high-level approximation of where New York State content levels may be in 2030 and 2035.

Table 1. Base Case State Content Assumptions for New York State (projected impact)

	State Content (%)	
Industry Segment	Lake Erie (2030 COD)	Lake Ontario (2035 COD)
Development		
Engineering and Management, Legal	75	75
Financial	75	75
Manufacturing and Supply Chain		
Nacelle	15	15
Blades	50	50
Tower	75	75
Fixed Bottom (Substructure)	75	-
Fixed Bottom (Scour Protection)	100	-
Floating (Substructure)	-	75
Floating (Mooring)	-	50
Substation (Topside)	50	50
Substation (Substructure)	100	100
Array Cable	15	15
Export Cable	15	15

Table 1 continued

	State Content (%)	
Industry Segment	**Lake Erie (2030 COD)**	**Lake Ontario (2035 COD)**
Installation (Vessel)		
Turbine	100	100
Fixed Bottom (Substructure)	100	100
Scour Protection	100	100
Substation	100	100
Cable	100	100
All Vessels (Indirect)	50	50
Installation (Ports)		
Ports and Staging	100	100
Operations and Maintenance		
Vessel Crew	100	100
Wind Technicians	100	100
Onshore Operations	100	100
Indirect	75	75

For the development industry segment, by 2030 the State is expected to have experience with offshore wind development in the Atlantic so many New York State consulting firms and businesses supporting offshore wind could support Great Lakes wind energy. For manufacturing and supply chain, various suppliers may contribute to subcomponents, parts, and materials for all components; however, it is assumed that a State tower manufacturing facility will exist and fabrication and assembly of substructures at quayside is likely—leading to a higher percentage of content. For the substation (topside), many internal components may be manufactured outside New York State, lowering State content, but it is assumed the topside will be assembled at quayside. Based on an assessment of vessels, all vessels will need to be sourced or constructed in the Great Lakes to support projects; therefore, it is assumed to be full State content, except for indirect vessel impacts because some of those expenditures, related to day rates, may leak out of the State economy. In Lake Erie, it is possible to bring large vessels over from other Great Lakes states such as Ohio and Michigan if they are built there or already exist. In Lake Ontario, the vessels are more constrained coming from the western lakes and from the Atlantic. If a New York State port is selected for installation to support development, this would also increase State content. Finally for O&M, it is assumed the plant operator will source and train workers from within the State.

Table 2 shows the 100% State content scenario in which all labor, components, subcomponents, materials, vessels, and ports are used for the five industry segments. The 100% State content scenario represents the maximum possible number of jobs and economic impact supported for a Great Lakes wind energy project, assuming policies and programs develop the capability to supply all labor, contractors, components, parts, and materials.

Table 2. One Hundred Percent State Content Assumptions for New York State (maximum potential impact)

	State Content (%)	
Industry Segment	**Lake Erie (2030 COD)**	**Lake Ontario (2035 COD)**
Development		
Engineering and Management, Legal	100	100
Financial	100	100
Manufacturing and Supply Chain		
Nacelle	100	100
Blades	100	100
Tower	100	100
Fixed Bottom (Substructure)	100	100
Fixed Bottom (Scour Protection)	100	100
Floating (Substructure)	100	100
Floating (Mooring)	100	100
Substation (Topside)	100	100
Substation (Substructure)	100	100
Array Cable	100	100
Export Cable	100	100
Installation (Vessel)		
Turbine	100	100
Fixed Bottom (Substructure)	100	100
Scour Protection	100	100
Substation	100	100
Cable	100	100
All Vessels (Indirect)	100	100
Installation (Ports)		
Ports and Staging	100	100
Operations and Maintenance		
Vessel Crew	100	100
Wind Technicians	100	100
Onshore Operations	100	100
Indirect	100	100

3 Results and Discussion

This section presents the jobs and economic impact results for a 400-MW Great Lakes wind energy project in Lake Erie or Lake Ontario. Results are presented for the base case and 100% State content scenarios for the five industry segments (development, manufacturing and supply chain, installation: ports and staging, installation: vessels, and O&M). Results are followed by a discussion on key areas to increase the local content utilization in New York State to pursue the maximum jobs and economic development potential as estimated under the 100% State content scenario.

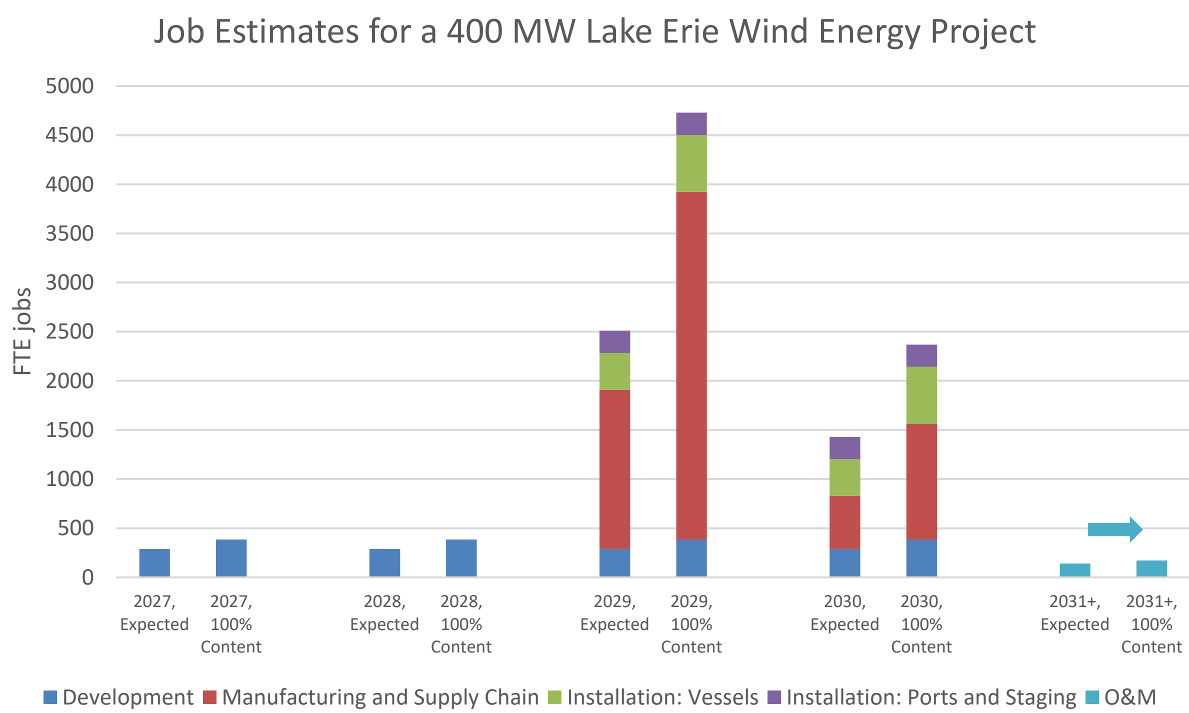
3.1 Lake Erie

The JEDI model results indicate that the development of a 400-MW Lake Erie wind energy project in New York State could support 4,100 FTE job years and generate $590 million in GDP across the State during the construction phase when incorporating assumptions for the base case State content scenario, with the potential to support up to 7,900 FTE job years and $1.1 billion in GDP for the 100% State content scenario. The project would also create additional jobs from induced impacts (Table 3).

Figure 1 shows the timing of jobs spread across years when the workers completing tasks for each of the industry segments for the base case State content and 100% State content scenarios. Manufacturing and supply chain represent the largest job and economic contribution, followed by development, installation activities related to vessels and ports. A Lake Erie (fixed bottom) project with a COD of 2030 would support the highest number of jobs in 2029, when components are both manufactured and the installation process starts in the same year.

Figure 1. Total Number of Jobs Each Year during the Construction Phase for a 400-Megawatt Lake Erie Wind Energy Project

For base case content (projected impact) and 100% State content—maximum potential impact.



Manufacturing and supply chain represent the largest job and economic contribution, followed by development, and then installation activities related to vessels and ports. The magnitude and alignment of FTE jobs estimates for Great Lakes wind energy are similar to a NYSERDA study which estimated an annual FTE employment of 350 workers for project management and development, 470 workers for installation and commissioning, and 2,250 manufacturing workers during an annual construction phase to meet a market scenario of 2.4 gigawatt- (GW) of New York offshore wind capacity by 2030 (NYSERDA, 2017).

Table 3 breaks down the total job and economic impacts for a Lake Erie (fixed bottom) for the base case State content and 100% State content scenarios (maximum potential impact). The estimates are broken out into four industry segments during the construction phase as well as a detailed assessment at the subcomponent level. Manufacturing and supply chain represent the largest job and economic contribution, followed by development, and then installation activities related to vessels and ports.

Table 3. Summary of FTE Job Years and Economic Impacts during Construction Phase

Assuming Base Case State Content and (100% State Content) a 400-Megawatt Lake Erie Wind Energy Project.

Category	FTE Job Year	Value Added $ millions	Earnings $ millions	Output $ millions
Development	**1154 (1539)**	**248.8 (331.7)**	**204.0 (272)**	**408.3 (544.4)**
Engineering and Management, Legal	681 (908)	101.1 (134.8)	100.8 (134.4)	204.2 (272.2)
Financial	473 (631)	147.7 (196.9)	103.2 (137.6)	204.2 (272.2)
Manufacturing and Supply Chain	**2162 (4719)**	**250.7 (551.8)**	**155.3 (349.7)**	**591.7 (1340.1)**
Nacelle	258 (1718)	30.6 (204.2)	20.5 (136.4)	77.1 (514.1)
Blades	216 (432)	29.5 (59)	14.7 (29.4)	59.2 (118.3)
Tower	445 (593)	52.4 (69.8)	31.2 (41.6)	114.5 (152.6)
Fixed Bottom (Substructure)	916 (1221)	99.8 (133)	66.8 (89)	257.8 (343.7)
Fixed Bottom (Scour Protection)	32 (32)	5.2 (5.2)	2.3 (2.3)	10.8 (10.8)
Substation (Topside)	142 (284)	16.7 (33.4)	8.4 (6.7)	25.3 (50.6)
Substation (Substructure)	103 (103)	11.2 (11.2)	7.5 (7.5)	29.0 (29)
Array Cable	18 (121)	2.0 (13)	1.5 (9.7)	6.5 (43.6)
Export Cable	32 (215)	3.5 (23)	2.6 (17.1)	11.6 (77.4)
Installation (Vessel)	**748 (1156)**	**101.9 (161.1)**	**71.9 (101.1)**	**186.6 (330.5)**
Turbine	140 (140)	13.6 (13.6)	13.6 (13.6)	13.6 (13.6)
Fixed Bottom (Substructure)	90 (90)	8.9 (8.9)	8.9 (8.9)	8.9 (8.9)
Scour Protection	47 (47)	7.8 (7.8)	7.8 (7.8)	7.8 (7.8)
Substation	3 (3)	0.5 (0.5)	0.5 (0.5)	0.5 (0.5)
Cable	60 (60)	11.9 (11.9)	11.9 (11.9)	11.9 (11.9)
All Vessels (Indirect)	408 (816)	59.2 (118.4)	29.2 (58.4)	143.9 (287.8)
Installation (Ports)	**453 (453)**	**31.3 (31.3)**	**28.6 (28.6)**	**55.0 (55.0)**
Ports and Staging	453 (453)	31.3 (31.3)	28.6 (28.6)	55.0 (55.0)
Direct and Indirect Total	**4137 (7867)**	**592.2 (1075.9)**	**432.3 (751.4)**	**1139.3 (2270)**
Induced	**1706 (2544)**	**209.6 (313.0)**	**105.1 (157.8)**	**326.7 (487.3)**
All Total	**5843 (10411)**	**801.8 (1388.9)**	**537.4 (909.2)**	**1466 (2757.3)**

[a] FTE = full-time equivalent

Table 4 shows the job and economic impacts of a 400-MW Lake Erie (fixed bottom technology) project during the operations phase for the base case State content and 100% State content scenarios (maximum potential impact) during the lifetime of the project. An estimated 140 jobs could be supported annually with the potential to support up to 170 FTE job years annually. Operating a Lake Erie wind energy project could support an added value of $20 million in GDP annually, with the potential to support $26 million in GDP annually. The vessel crew, wind technician, and onshore operation are jobs directly related to supporting the wind energy project. The indirect impacts estimates are related to replacements parts, supplying materials, and operation logistics. The project would also support additional induced impacts on an annual basis.

Table 4. Summary of FTE Job Years and Economic Impacts during Operation Phase

Assuming base case State content and (100% State content) scenarios for a 400-MW Lake Erie wind energy project. Results are annual and ongoing over the lifetime of the wind energy plant.

Category	FTE Job Year, annually	Value Added, $ millions, annually	Earnings, $ millions, annually	Output, $ millions, annually
Vessel Crew	4 (4)	0.3 (0.3)	0.3 (0.3)	0.3 (0.3)
Wind Technicians	32 (32)	2.1 (2.1)	2.1 (2.1)	2.1 (2.1)
Onshore Operations	11 (11)	1.1 (1.1)	1.1 (1.1)	1.1 (1.1)
Indirect	94 (125)	16.9 (22.5)	10.4 (13.8)	33.8 (45)
Direct and Indirect Total	**141 (172)**	**20.4 (26.0)**	**13.9 (17.3)**	**37.3 (48.5)**
Induced	**46 (61.9)**	**5.7 (7.6)**	**3.1 (4.1)**	**8.9 (11.8)**
All Total	**187 (233.9)**	**26.1 (33.6)**	**17.0 (21.4)**	**46.2 (60.3)**

[a] FTE = full-time equivalent

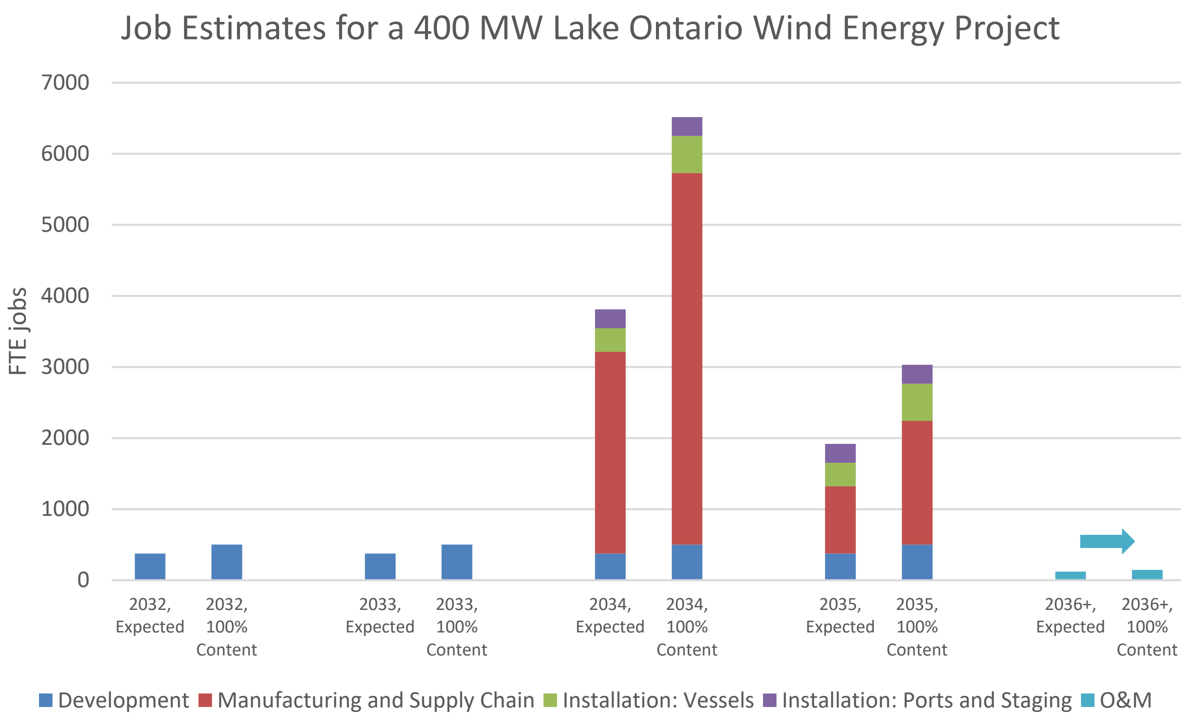
3.2 Lake Ontario

The development of a 400-MW Lake Ontario wind energy project in New York State could support 6,900 FTE job years and generate $960 million in GDP across the State during the construction phase when incorporating assumptions for the base case State content scenario, with the potential to support up to 10,500 FTE jobs years and $1.5 billion in GDP for the 100% State content scenario. The project would also support additional induced impacts (Table 5).

Figure 2 shows the timing of jobs spread across years when the workers completed tasks for each of the industry segments for the base case State content and 100% State content scenarios. Manufacturing and supply chain represent the largest job and economic contribution, followed by development, and then installation activities related to vessels and ports. A Lake Ontario (floating technology) project with a COD of 2035 would support the highest number of jobs in 2034 when components are both manufactured and the installation process starts in the same year.

Figure 2. Total Number of Jobs Each Year during the Construction Phase for a 400-Megawatt Lake Ontario Wind Energy Project

For base case State content and 100% State content.



These magnitude and alignment of FTE jobs estimates for Great Lakes wind energy are similar to a study on estimates for the New York State offshore wind industry, which estimated an annual FTE employment of 350 workers for project management and development, 470 workers for installation and commissioning, and 2,250 manufacturing workers during an annual construction phase to meet a market scenario of 2.4 GW of State offshore wind capacity by 2030 (NYSERDA, 2017).

Table 5 breaks down the total job and economic impacts for a Lake Ontario (floating technology) for the base case State content and 100% State content scenarios. The estimates are broken out into four industry segments during the construction phase as well as a detailed assessment at the subcomponent level.

Floating substructures are currently more costly than fixed bottom substructures; therefore, these substructures likely have a higher labor component due to a more intensive process to manufacture at quayside. For example, if you consider assumptions that some floating designs such as the TetraSpar require more bolting and less welding, as well as require assembling the turbine onto the substructure, the tasks to assemble may necessitate more labor at quayside.

Table 5. Summary of FTE Job Years and Economic Impacts during Construction Phase

Assuming base case State content and (100% State content) for a 400-MW Lake Ontario wind energy project.

Category	FTE Job Years	Value Added, $ millions	Earnings, $ millions	Output, $ millions
Development	**1502 (2002)**	**341.6 (455.4)**	**303.5**	**531.6**
Engineering and Management, Legal	793 (1057)	100.7 (134.2)	103.9	152.1
Financial	709 (945)	240.9 (321.2)	199.7	379.5
Manufacturing and Supply Chain	**3785 (6971)**	**433.9 (811.3)**	**273.4**	**1062.0**
Nacelle	258 (1718)	30.6 (204.2)	20.5	77.1
Blades	216 (432)	29.5 (59)	14.7	59.2
Tower	445 (593)	52.4 (69.8)	31.2	114.5
Floating (Substructure)	2396 (3194)	260.9 (347.8)	174.5	674.3
Floating (Mooring)	187 (373)	28.2 (56.3)	13.5	67.8
Substation (Topside)	142 (284)	16.7 (33.4)	8.4	25.3
Substation (Substructure)	101 (101)	11.3 (11.3)	7.4	29.1
Array Cable	25 (165)	2.6 (17.6)	2.0	8.9
Export Cable	17 (111)	1.8 (11.9)	1.3	6.0

Table 5 continued

Category	FTE Job Years	Value Added, $ millions	Earnings, $ millions	Output, $ millions
Installation (Vessel)	**660 (1043)**	**88.5 (144.1)**	**60.4 (87.8)**	**168.1 (303.3)**
Turbine, Floating (Substructure)	92 (92)	12.5 (12.5)	12.5 (12.5)	12.5 (12.5)
Mooring Lines	112 (112)	12.2 (12.2)	12.2 (12.2)	12.2 (12.2)
Substation	3 (3)	0.4 (0.4)	0.4 (0.4)	0.4 (0.4)
Cables	70 (70)	7.8 (7.8)	7.8 (7.8)	7.8 (7.8)
All Vessels (Indirect)	383 (766)	55.6 (111.2)	27.5 (54.9)	135.2 (270.4)
Installation (Ports)	**532 (532)**	**44.7 (44.7)**	**36.8 (36.8)**	**79.3 (79.3)**
Ports and Staging	532 (532)	44.7 (44.7)	36.8 (36.8)	79.3 (79.3)
Direct and Indirect Total	**6861 (10548)**	**964.3 (1455.5)**	**701.5 (1042.4)**	**1976.2 (3089.9)**
Induced	**2196 (3218)**	**269.8 (395.7)**	**135.2 (198.9)**	**420.6 (616.3)**
All Total	**9057 (13766)**	**1234.1 (1851.2)**	**836.7 (1241.3)**	**2396.8 (3706.2)**

[a] FTE = full-time equivalent

Table 6 shows the job and economic impacts of a Lake Ontario (floating technology) project during the operations phase for the base case State content and 100% State content scenarios during the lifetime of the project. An estimated 120 FTE job years could be supported annually with the potential to support up to 150 FTE jobs years annually. Operating a Lake Ontario wind energy project could support an added value of $17 million in GDP annually, with the potential to support $21 million in GDP annually. The vessel crew, wind technician, and onshore operation are jobs directly related to supporting the wind energy project. The indirect impacts estimates are related to replacements parts, supplying materials, and operation logistics. The project would also support additional induced impacts on an annual basis.

Table 6. Summary of FTE Job Years and Economic Impacts during Operation Phase

Assuming base case State content and 100% State content scenarios for a 400-MW Lake Ontario wind energy project. Results are annually and ongoing over the lifetime of the wind energy plant.

Category	FTE Job Years Annually	Value Added $ Millions Annually	Earnings $ Millions Annually	Output $ Millions Annually
Vessel Crew	4 (4)	0.3 (0.3)	0.3 (0.3)	0.3 (0.3)
Wind Technicians	32 (32)	2.1 (2.1)	2.1 (2.1)	2.1 (2.1)
Onshore Operations	11 (11)	1.1 (1.1)	1.1 (1.1)	1.1 (1.1)
Indirect	74 (98)	13.1 (17.5)	8.0 (10.7)	26.3 (35.1)
Direct and Indirect Total	**121 (145)**	**16.6 (21)**	**11.5 (14.2)**	**29.8 (38.6)**
Induced	**36 (48)**	**4.5 (5.9)**	**2.4 (3.2)**	**6.9 (9.2)**
All Total	**157 (193)**	**21.1 (26.9)**	**13.9 (17.4)**	**36.7 (47.8)**

[a] FTE = full-time equivalent

3.3 Industry Segment Considerations

To achieve the magnitude of economic impacts estimated for the base case State and 100% State content scenarios, there are several considerations to maximum jobs and economic development potential.

For development, a high labor and economic impact is expected because by 2030 many professionals will support offshore wind energy in New York State. It is expected that these professionals can develop Great Lakes wind energy while also hiring people near the Great Lakes; however, some labor leakage may occur if out-of-state development professionals are hired to support projects. To increase the local utilization, Great Lakes wind energy projects should look to State firms and businesses to support projects.

The category manufacturing and supply chain represents the largest area for jobs and economic impacts; however, it is also the largest area for increasing a contribution through developing a robust supply chain by producing more Great Lakes wind energy components.[10] Fixed bottom substructure components are the largest contribution of impacts as they will likely require portside fabrication and assembly. To reach higher local content utilization, Great Lakes wind energy should ensure ports have the required capabilities and trained labor to fabricate large metal substructures quayside. Because of an announced transition piece and tower facility in the State, a higher local content is assigned to towers.[11] Other critical components, such as blades, towers, and electrical cabling have some expenditures in the supply chain to represent some in-State sourcing, but there is a higher likelihood these components will be manufactured out-of-state. Increasing the sourcing of sub-components, parts, and materials will lead to a higher labor utilization and greater economic impacts for New York State from Great Lakes wind energy.

As explained in New York State Great Lakes Wind Energy Feasibility Study: Infrastructure Assessment (NYSERDA 2022d), all vessels, barges, or tows that support Great Lakes wind energy will need to be built or sourced from the Great Lakes. Because of the unique geographic location of Lake Erie, and especially Lake Ontario, transport of vessels from other Great Lakes will be difficult; therefore, for installation, all direct labor is base case to be sourced entirely from the New York State. To achieve this local content utilization, vessels will need to be built in the Great Lakes, which will require a capable workforce or marine crews, engineers, oversight, and construction crews. For indirect costs associated with vessels, some expenditures related to day rates are assumed not to be spent within the State.

For O&M related impacts, the job and economic impacts are annual estimates, so impacts occur over the life of the Great Lakes wind energy project. O&M impacts are more permanent. A high local content assumes the Great Lakes project will hire technicians and O&M professionals on or near Lake Erie and Lake Ontario. Project operators should consider partnering with local education institutions to source their O&M workforce to further develop the energy workforce in New York State.

3.4 New York Port Infrastructure

To realize State jobs and economic impacts from port infrastructure, Great Lakes wind energy would need to utilize the port infrastructure in the State. An assessment of four ports in New York State reveals that the ports support 1,349 FTE job years and $142 million in economic activity across several current activities (Martin Associates, 2018).[12] Great Lakes wind energy represents an area for growth for State ports; however, all ports would require significant upgrades to support such wind energy development.[13]

Using port infrastructure to install a 400-MW Lake Erie wind energy project in the State could support 450 FTE job years and $31 million in GPD. Using port infrastructure to install a 400-MW Lake Ontario wind energy project in the State could support 530 FTE job years and $45 million in GDP. The higher jobs and GDP estimates for a Lake Ontario wind energy project is because of more time and cost to assemble the substructure and turbine quayside. The Infrastructure Assessment for Great Lakes Wind describes the location and characteristics of New York State ports that could support assembly and installation of wind turbines on the Great Lakes.

Port and staging occupational roles can be categorized into four main types, including marine crew, terminal crew, port and logistics management, and facilities management (Table 7). Marine crews consist of the crews that work on vessels to support port operations and navigate vessels into anchorages. Port terminal crews include those occupations that are involved with (1) helping to dock the shipping vessel, (2) receiving, inspecting, and documenting the material and products at the terminal, and (3) transporting the material and products to the marshalling area. Port management occupations are responsible for managing the port and may operate independently of the customer, materials, or goods. Facilities management occupations are responsible for port logistics, management, and facility maintenance.

Table 7. Typical Occupational Roles and Breakdown for Ports and Staging

Occupational Category	Roles	Contribution to Port Workforce (Approximate %)[a]
Marine Crew	Captain/master, mates, boatswain, seamen (able-bodies and ordinary), ship engineer, tunnel person, pilot.	6%
Terminal Crew	Laborer, rigger/roustabout, longshoreman, main/auxiliary crane operator, foreman, heavy lift supervisor, truck driver, customs officer, port police, QA/Qc manager/specialist, QA/QC inspector.	73%
Port and Logistics Management	Port/terminal manager, operations supervisor, safety officer, marketing, IT personnel, human resources, freight forwarder/custom brokers, logistics/materials manger, material coordinator, inspection/expediting manager, data control manager.	12%
Facilities Management Crew	Maintenance and facilities supervisor, maintenance engineer, cleaning staff.	9%

a Based on a stakeholder interview with a representative from the Port of Oswego in New York.

3.5 Workforce Development

To increase workforce and economic opportunity for the Lake Erie and Ontario regions of New York State, there should be a focus on partnering with existing education and training programs near the lakes to support substructure fabrication and assembly, supporting installation activities on ports and vessels, and training wind technicians for operation activities. The State has built-out education and training programs to support the offshore wind industry on the east coast, such as supporting the State University of New York (SUNY) in advancing the Offshore Wind Training Institute (OSWTI) and coordinating industry efforts (NYSERDA, 2022). New York State could consider expanding this approach to the Great Lakes region.

Figure 3. shows the location of education and training programs near Lake Erie and Lake Ontario that could support Great Lakes wind energy development. An education and training program assessment provides an understanding of the current institutions that can supply a trained workforce.

Figure 3. Map Showing the Locations of Educational Institutions and Training Programs near the Great Lakes that Can Train a Knowledgeable Workforce

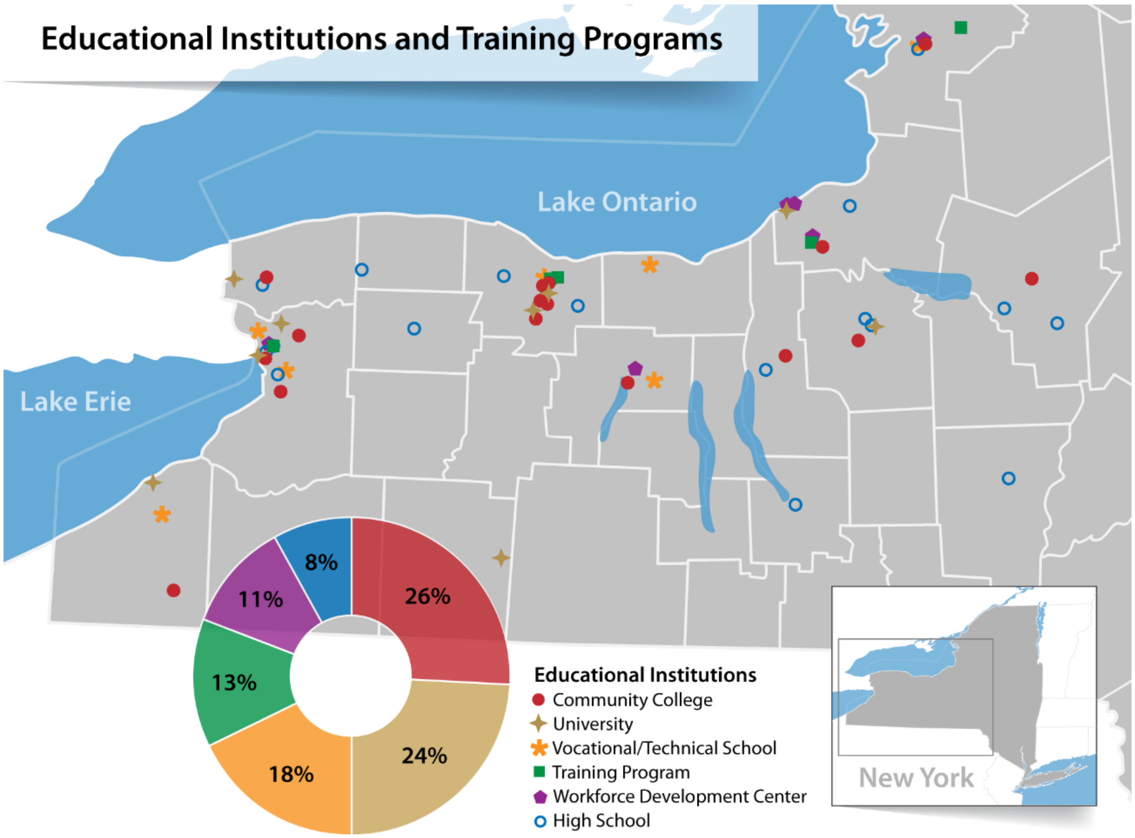


Table 8 lists the name, institution type, and city of these educational institutions. An investigation into the type of courses, programs, and training opportunities revealed that no programs have a direct focus or curriculum on wind energy. However, there are existing curricula or programs in several different institutions that could be expanded to support the skill sets needed for engineering, skilled trades, or other professional support roles (Table 9). Table 8 provides a summary of existing educational and training programs that could potentially be partners in developing a Great Lakes wind energy workforce. Several programs have a renewable energy focused center or coursework.

Table 8. List of Educational and Training Programs near the Great Lakes in New York State

Education Institutions Name	Institution Type	Nearest Lake	State	City
University of Rochester	University	Ontario	New York	Rochester
University at Buffalo	University	Erie	New York	Buffalo
Niagara University	University	Ontario	New York	Niagara Falls
State University of New York at Fredonia	University	Erie	New York	Fredonia
D'Youville College	University	Erie	New York	Buffalo
Alfred University	University	Inland	New York	Alfred
Suny Oswego	University	Ontario	New York	Oswego
Syracuse University	University	Inland	New York	Syracuse
Rochester Institute of Technology	University	Ontario	New York	Rochester
Niagara County Community College	Community College	Ontario	New York	Sanborn
SUNY Erie Community College	Community College	Erie	New York	Williamsville
Genesee County Community	Community College	Ontario	New York	Batavia
Finger Lakes Community College	Community College	Ontario	New York	Canandaigua
Monroe Community College	Community College	Ontario	New York	Rochester
Jefferson Community College	Community College	Ontario	New York	Watertown
Cayuga Community College	Community College	Ontario	New York	Auburn
Mohawk Valley Community College - Rome	Community College	Ontario	New York	Rome
Onondaga Community College	Community College	Ontario	New York	Syracuse
Jamestown Community College	Community College	Erie	New York	Jamestown
The Oswego County Workforce NY (OCWNY) Career Center	Training Program	Ontario	New York	Fulton
Rochester Educational Opportunity Center	Training Program	Ontario	New York	Rochester
Job Corps - Rochester	Training Program	Ontario	New York	Rochester
Fort Drum U.S. Army Education Center	Training Program	Ontario	New York	Fort Drum
Northland Workforce Training Center	Training Program	Erie	New York	Buffalo
Board of Cooperative Educational Services	High School	Erie	New York	State
Hutchinson Central Technical High School	High School	Erie	New York	Buffalo
Institute of Technology at Syracuse Central	High School	Ontario	New York	Syracuse
Ontario County Workforce Development	Workforce Development Center	Ontario	New York	Canandaigua
Jefferson-Lewis Workforce Development Board	Workforce Development Center	Ontario	New York	Watertown
Buffalo Employment & Training Center (BETC)	Workforce Development Center	Erie	New York	Buffalo
Workforce Development Board, Inc., of Oswego County Local Plan	Workforce Development Center	Ontario	New York	Oswego
Potter Career and Technical Center (Erie1BOCES)	Vocational/Technical School	Erie	New York	Buffalo
Cassadaga Job Corps Academy	Vocational/Technical School	Erie	New York	Cassadaga
Kenton Career and Tech Center	Vocational/Technical School	Erie	New York	Tonawanda
Rochester Education Opportunity Center	Vocational/Technical School	Ontario	New York	Rochester
Finger Lakes Technical Career Center	Vocational/Technical School	Ontario	New York	Stanley
Charles H. Bohlen Technical Center	Vocational/Technical School	Ontario	New York	Watertown
Wayne Technical and Career Center	Vocational/Technical School	Ontario	New York	Williamson

Table 9 provides general characteristics for these programs. Sixty-four percent are located closer to Lake Ontario, 31% are closer to Lake Erie, and 5% are more in-land but close to the Great Lakes. These types of programs can utilize existing curriculum or develop new programs, enabling a workforce for the Great Lakes wind energy project.

Table 9. Summary of Existing Wind-Energy Related Educational and Training Programs

Education or Training Program	Program Count	Relevant Training Program to Support Great Lakes Wind Energy
University	9	3
Community College	10	8
High School	3	0
Vocational/Technical School	7	5
Workforce Training Program	5	1
Workforce Development Center	4	0

Unions have also played a large role in supplying trained labor to support construction, ports, and vessels. Table 90 lists the type of union organizations that could support Great Lakes wind energy.

Table 10. Unions Available to Support Great Lakes Wind Energy Projects across Different Industry Segments

Union Name
AFL-CIO
North Americas Buildings Trades Unions
International Brotherhood of Electrical Workers
International Brotherhood of Teamsters
Laborers' International Union of North America
United Association
International Association of Sheet Metal, Air, Rail and Transportation Workers
International Union of Operating Engineers
International Association of Bridge, Structural, Ornamental, and Reinforcing Iron Workers
International Union of Painters and Allied Trades
United Steel Workers
Communications Workers of America
United Brotherhood of Carpenters and Joiners of America
Utility Workers Union of America
Seafarers International Union

Table 10 continued

Union Name
Union of Pile Drivers and Divers
Transport Workers Union of America
International Longshore and Warehouse Union
Syracuse Labor Council
Buffalo Central Labor Council
Rochester & Genesee Valley Area Labor Federation

Partnerships and collaboration among government, industry academic institutions, and unions are key to addressing Great Lakes wind energy workforce needs efficiently and effectively—ensuring a higher rate of local labor, while also ensuring the local labor is qualified with the necessary skills to obtain and retain jobs. Partnerships with State and local government primarily include funding, networking opportunities, and assistance with establishing training facilities and acquiring equipment. Industry can support the development of curriculum and program development through guidance, review, and feedback. Educational and training programs are working together to develop, implement, and support offshore wind programs by providing guidance on program development, access to equipment, and collaboration on research topics. Unions are partnering with educational and training institutions by participating on curriculum advisory committees and collaborating on workforce development.

Many workers from the fossil fuel industry have relevant skills and could transition to roles to support Great Lakes wind energy projects, such as skilled and basic trades, management, or engineering.[14] However, there are challenges and considerations related to transitioning workers, including the geographic concentration of the existing workforce and the need for wind turbine-specific safety training to learn about the unique risks of the Great Lakes wind environment. Workers in the fossil fuel industry can leverage their previous experience while completing additional wind energy training to support projects on the Great Lakes at ports—fabricating substructures and/or during operations.

4 Conclusions

The research team for this project considered two scenarios in New York State (1) a base case State content (projected impact) and (2) a 100% State content (maximum potential impact) to analyze the jobs and economic impacts of a single 400-MW Great Lakes wind project in Lake Erie and a single 400-MW project in Lake Ontario. Across both projects a 400-MW Great Lakes wind energy project on average could support 5,500 FTE job years and $780 million in GDP across the State during the construction phase when incorporating likely State content assumptions, with the potential to support up to 9,200 FTE job years and $1.3 billion in GDP under a 100% State content scenario. During the operation phase on Lake Ontario and Lake Erie, on an annual and ongoing basis, a 400-MW Great Lakes wind energy project on average could support between 130 FTE jobs and $20 million in GDP across the State during the operations phase when incorporating likely State content assumptions, with the potential to support up to 160 FTE job years and $24 billion in GDP under a 100% State content scenario. These O&M jobs are sustained jobs over the lifetime of the wind energy project. There are additional induced impacts during the construction and operations phase (annually). The greatest opportunity for workforce and economic development in New York State stemming from Great Lakes wind energy is through fabrication and assembly of fixed bottom and floating substructures, supporting State port infrastructure, developing Great Lakes vessel capabilities, and long-term O&M jobs. To achieve a higher workforce utilization to support these industry segments and increase economic growth, the State should consider partnering with and building up existing educational and training programs, including union apprenticeships, near the Great Lakes.

5 References

New York State Energy Research and Development Authority (NYSERDA). 2022. "New York State Great Lakes Wind Energy Feasibility Study: Infrastructure Assessment," NYSERDA Report Number 22-12d. Prepared by the National Renewable Energy Laboratory, Golden, CO. nyserda.ny.gov/publications

New York State Energy Research and Development Authority (NYSERDA). 2022. "New York State Great Lakes Wind Energy Feasibility Study: Cost Analysis," NYSERDA Report Number 22-12g. Prepared by the National Renewable Energy Laboratory, Golden, CO. nyserda.ny.gov/publications

New York State Energy Research and Development Authority. 2022. "Toward a Clean Energy Future: A Strategic Outlook 2022 through 2025." GEN-so-2022-r-1-v1. https://www.nyserda.ny.gov/-/media/Files/About/Strategic-Plan/strategic-outlook.pdf

New York State Energy Research and Development Authority. 2017. "The Workforce Opportunity of Offshore Wind in New York." NYSERDA Report 17-25t. https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Biomass-Solar-Wind/Master-Plan/17-25t-Workforce-Opportunity-Study.pdf(Martin Associates. 2018. "Economic Impacts of Maritime Shipping in the Great Lakes-St. Lawrence Region." Lancaster, PA. https://greatlakesseaway.org/wp-content/uploads/2021/07/2018-glsls-study-en-hr.pdf

Endnotes

1 The Climate Leadership and Community Protection Act was signed into law in 2019 and requires New York to reduce economy-wide greenhouse gas emissions 40 percent by 2030 and no less than 85 percent by 2050 from 1990 levels. More information is available at https://climate.ny.gov/

2 More information and a public version of the JEDI model is available at: https://www.nrel.gov/analysis/jedi/

3 This IMPLAN economic dataset would be representative of economic conditions with New York State prior to the economic effects of COVID-19 pandemic.

4 More information on NREL's ORBIT model is available at https://www.nrel.gov/docs/fy20osti/77081.pdf

5 A 400-MW scenario was analyzed for this economic impact assessment to compare projects in both Lake Erie and Lake Ontario. The 100-MW Lake Eric and 800-MW Lake Ontario scenarios were not analyzed. Jobs and economic impacts would likely increase with investment cost, especially the 800-MW Lake Ontario project. While additional investment would likely mean more labor-hours and economic development, it does not necessarily mean more workers, as the same number of workers could manufacture or install components over time.

6 Commercial operation date (COD) means the date when the wind energy project produces electricity, after the project has been installed, commissioned, and tested.

7 Other macroscopic economic changes may take place that JEDI does not consider, including supply-side impacts, such as price changes, changes in taxes or subsidies, tariffs on foreign steel, or utility rate changes. JEDI also does not incorporate far-reaching effects such as those caused by greenhouse gas emissions, displacement of some other type of economic activity due to investment in this particular project, or potential side effects of a project such as recreation or tourism. Base case renewable energy credit (REC) prices are not connected to the number of direct jobs created by a Great Lake wind energy project, but if the cost of renewable energy goes up because of labor requirements, this may increase REC prices.

8 Manufacturing and supply chain estimates do not include jobs associated with building the manufacturing facilities, only jobs associated with producing offshore wind components.

9 Estimates do not include the jobs or economic impacts from any port infrastructure upgrades. If component production occurs at a port, the jobs associated with the production of those components are categorized under manufacturing and supply chain and not under ports and staging.

10 The labor or economic development associated with building manufacturing, supply chain, or quayside facilities are not included in this analysis; this investment and development may be significant if it is a first of a kind project on one of the lakes.

11 An announced manufacturing facility in the Port of Albany is expected to produce towers and transition pieces for the offshore wind industry and may have the capability to support Great Lakes wind energy.

12 The four ports include Port of Buffalo Port of Ogdensburg, Port of Oswego, and Port of Rochester.

13 The labor or economic development associated with investments and construction of port upgrades are not included in this analysis; this investment and development may be significant for the Great Lakes.

14 A quantitative assessment was not completed as part of this report to estimate the amount of displacement anticipated from the fossil fuel industry or the role of Great Lake wind energy projects in providing jobs for displaced workers.

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