Offshore Wind Energy and Potential Economic Impacts in Long Island

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Executive Summary

This study assesses the offshore wind energy and its potential economic impacts on Long Island. The study consists of four parts. It first reviews the literature on economic development benefits associated with wind energy development. We also assess the resource and market potentials of offshore wind based on four factors: (a) prior estimates of offshore wind potential; (b) federal leasing of submerged lands; (c) state policies in support of offshore wind; and (d) proposed offshore wind projects. Existing research on the offshore wind supply chain is reviewed. These reviews are followed with an assessment of potential impacts on employment and economic activity in Long Island. This study employs JEDI model developed by National Renewable Energy Lab to determine the job creation and economic output associated with offshore wind development under two scenarios. This study reaches four major conclusions on the economic impacts of offshore wind energy on Long Island.

First, offshore wind energy can bring significant job and economic benefits to local economies. Previous studies provide varying estimates. Job creation associated with offshore wind development ranges from 7 to 42 jobs for each megawatt. It is reasonable, however, to conclude that offshore wind can generate about 20 jobs in a region with well-developed supply chain and approximately $3.3 million of new local economic development activity.

Second, states in the mid-Atlantic and northeast are rich in offshore wind resources, and have also established policies to support renewable energies, in certain cases including offshore wind. Our review of wind resources, siting and permitting restrictions, federal leasing, state policies, and market demand for offshore wind energy suggests that a Long Island-based offshore-wind industry can have a near-term addressable market of approximately 8,850 MW.

Third, the near-term local economic development opportunities are likely in foundations, blades and marine operations. Long Island is competitive in these areas because of its large, skilled labor base, experience in the aerospace industry and maritime industries.

This analysis finds that each offshore wind farm can produce hundreds of Long Island-based jobs and millions of dollars for the local economy. A single offshore wind farm (250 MW) built off Long Island coast can create 2,864 full-time equivalent (FTE) jobs on Long Island or about 11 per MW, as well as approximately $645 million in local economic output, under a scenario assuming that the first offshore wind projects will have to use more service providers and equipment manufacturers outside Long Island as the Long Island supply-chain is built out. Under another scenario that assume Long Island offshore wind industry can achieve a scale of supporting 2,500 MW, more than 58 thousand FTE jobs and approximately $12.9 billion in local economic output can be expected. Our analysis suggests that offshore wind constitutes a significant opportunity for job creation and economic development on Long Island.

1. Introduction

Recent studies and planning exercises conducted by the New York Department of State (DOS)[1] and the New York Energy Research and Development Authority (NYSERDA)[2] have shown significant potential for offshore wind off the coast of Long Island, based on the area's high energy costs, large electric loads, robust wind resources, and existing industrial capacity. The Bureau of Ocean Energy Management (BOEM) – the federal agency with authority over the leasing of offshore areas for renewable energy production –leased one area in the Massachusetts and Rhode Island Area of Mutual Interest (MA/RI AMI) that is located off the coast of Long Island[3] for offshore wind development and is in the process of gathering information about leasing another area in the coming year[4].

To provide policymakers with context for planning the development and deployment of offshore wind off the coast of Long Island, we conducted an assessment of the potential economic impacts on Long Island of offshore wind electricity in the Atlantic Ocean.

This report starts with a review of literature on the economic impacts and supply chain of offshore wind energy, and offshore wind potential in the northeast of the United States. It is followed with a description of the model and key assumptions used to estimate the job and economic value creation in Long Island resulting from offshore wind development.

A number of studies on the potential economic impacts of renewable energy have been reported (2013)[5]. These studies found that renewable energy in general, and offshore wind specifically, can bring significant benefits to regions where these projects--and firms involved in the supply chains--are located. Increase in regional economic activities and job creation are the two major economic benefits. In Europe, most of the studies showed that offshore wind project can create about 20 jobs per MW of installed capacity. For the United States, Department of Energy (DOE) estimates that 43 thousand permanent jobs by 2030, with over 1.1 million job-years and $200 billion in new economic activity associated with meeting its goal of 54 GW of offshore wind capacity.

European Union

Wind energy has experienced very rapid growth in the European Union (EU) in recent years, and hence has created many direct and indirect employments. From 2000 to 2007, installed capacity increased by 339% and reached over 56 GW in 2007[6,7]. Wind energy sector created, on average, about 12 thousand new jobs per year between 2002 and 2007. It employed more than 108 thousand in 2007, and about 154 thousand if indirect employment included. About three quarters of them are concentrated in Denmark, Germany, and Spain, the world's hubs of turbine manufacturing.

As of December 2013, 69 offshore wind farms consisting of 2080 turbines, with a combined capacity of 6,562 MW, were in operation in ten European countries [8]. Annual investment in offshore wind is projected to exceed $20 billion per year for the next ten years [9]. There were about 58 thousand full time equivalent (FTE) jobs in the offshore wind industry in 2012, with growth expected up to 191 thousand in 2020 [10].

New York State

NYSERDA's recent review of the Main Tier program found that it has resulted in significant economic benefits for New York State[11]. New York State implemented a Renewable Portfolio Standard (RPS) in 2004 and has conducted eight centralized procurements for large-scale renewable energy projects through its "Main Tier" program. Through these procurements, NYSERDA has entered into contracts with 65 large-scale projects with a total capacity of 1,880 MW. The major economic benefits include

- Direct investment in New York State of approximately $2.7 billion;
- Net economic benefits of between $1.6 Billion to $3.5 Billion, with a benefit-cost ratio between 5 to 1 and 9 to 1 (depending on CO_2 prices);
- Cumulative net increase in gross state product of approximately $2 billion; and
- Net gain of approximately 670 jobs in the New York economy.

This review also found that all of these benefits are provided with no impact on rates, when taking into account wholesale electric price suppression that resulted from the Main Tier program.

New York Power Authority (NYPA) evaluated the economic development benefits of an offshore wind farm in the range of 350 to 700 MW for New York City, Long Island (Nassau and Suffolk Counties), Rockland, and Westchester Counties[12]. This study found that a 350 MW offshore wind project could generate "$1 billion in sales, 8,700 job-years and $610 million in wages" and that a 700 MW project would generate "$3 billion in sales, 17,000 job-years and $1 billion in wages." This reflects 25 job-years per MW of offshore wind capacity (=8,700 job-years/350 MW) and a ranges $2.8 million to $4.3 million per MW of new sales over the 3 years of construction and installation period and 20 years of operation.

A study on the economic benefits of offshore wind in the context of Rhode Island has similar findings. In connection with the review of the power purchase agreement for the Block Island Wind Farm, the Rhode Island Economic Development Corporation (RI EDC) commissioned Levitan & Associates to evaluate the economic development benefits of a 30 MW demonstration-scale offshore wind farm and a 385 MW utility-scale offshore wind farm[13]. This study found that the 30 MW project would contribute $107 million to Rhode Island GDP. Similarly, the study found that the larger 385 MW project would generate $893 million of economic activity in the State of Rhode Island. This reflects a value of $2.3 million of total value added per MW of offshore wind. The study did not estimate new job creation associated with these projects.

These studies suggest that wind power, and especially offshore wind power, has great potentials for job creation and economic development. Although different studies provide varying estimates on the job and economic benefits of offshore wind development, it is reasonable to conclude that each megawatt of offshore wind development can generate about 20 new job-years and approximately $3.3 million of new local economic development activity.

2. Offshore Wind Potential

The total economic benefits for Long Island from offshore wind development are decided by the total potential offshore wind development in the surrounding region. The total potential wind development is a result of several key factors, including offshore wind resource; total potential of the lease areas identified by BOEM, with a particular emphasis on the areas nearest to Long Island, and the renewable energy policies of states close to Long Island. These factors, as well as previously proposed offshore wind projects, are reviewed in this section. Our review is focused on the east coast, between Maine and Virginia, because these regions are the most likely markets for Long Island firms in offshore wind supply chain.

Our analysis focus on project sites that could be developed with technologies commercially-available today and that would pose the least permitting risk. For this reason, this analysis excludes from consideration any sites in water depths greater than 60 meters, where conventional gravity-base, monopile or jacket foundations can't be used cost effectively. Any sites that are less than 12 miles from shore, where public opposition would likely prohibit development, are also excluded.

Offshore Wind Energy Resource

A study by National Renewable Energy Laboratory (NREL) used wind speed, water depth, and distance from the shore to identify sites for offshore wind energy development across the United States, and to estimate the potential resource[14]. Site with an annual average wind speed of 7 m/s or higher is considered suitable for offshore wind development. Figures 1 and 2 show wind speed offshore in the United States. Long Island has excellent offshore wind resources, with an average wind speed between 9 and 9.5 m/s.

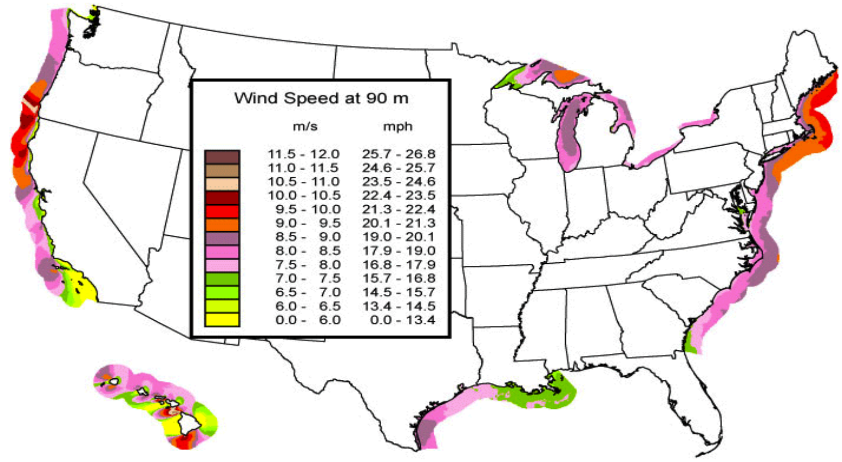

Figure 1. United States Average Annual Offshore Wind Speed at 90 meters. (Source: National Renewable Energy Laboratory[15].)

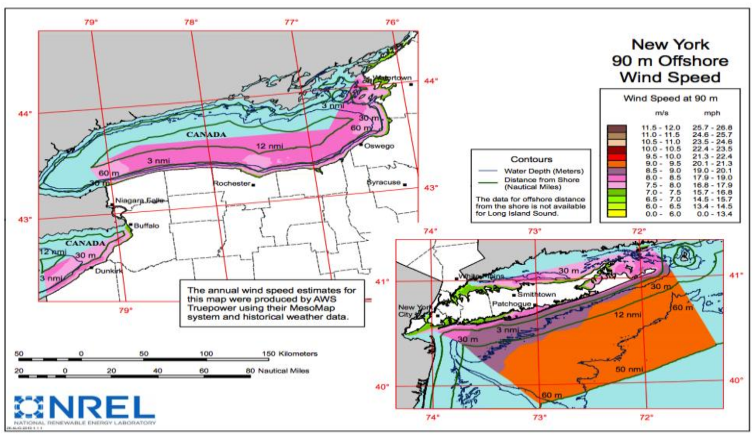

Figure 2. Offshore 90 meter Wind Maps and Wind Resource Potential (Source*:* National Renewable Energy Renewable Laboratory[16])

While NREL database suggests that the total potential for offshore wind in the U.S. exceeds 4,150 GW, much of that potential is in water depths greater than 60 meter or less than 12 miles from shore. For the purpose of this analysis, we excluded those sites, as having high permitting risk and high cost due to deep waters. The area between Maine and Virginia has the potential for over 240 GW of potential offshore wind development, as shown in Table 1, below.

These estimates do not account for constraints such as permitting restrictions or alternative uses that will likely restrict the potential development. NREL data in Table 1 suggests a potential of nearly 39 GW of offshore wind energy in New York State. Taking into consideration the constraints identified in DOS's 2013 Atlantic Ocean study[17], NYSERDA[18] estimated the potential resource is between 2.5 GW, and 3.5 GW with an "optimistic" plan.

Table 1. Technical Potential of Offshore Wind of Northern Atlantic States

State	Area (km^2)	MW
Maine	65	326
New Hampshire	45	227
Massachusetts	10,708	53,542
Rhode Island	1,397	6,987
Connecticut	0	0
New York	7,792	38,971
New Jersey	13,672	68,369
Delaware	1,180	5,903
Maryland	4,193	20,972
Virginia	9,293	46,476
TOTAL	48,346	241,773

Source: Reformatted from: Schwartz, M.; Heimiller, D.; Haymes, S.; Musial, W. (2010).[19]

Federal Leasing of Submerged Lands on the Outer Continental Shelf

BOEM has issued leases for offshore wind developments in Massachusetts, Delaware, Rhode Island, Maryland, the MA/RI Area of Mutual Interest and Virginia, and more issuing in the coming years is anticipated. To accelerate the leasing process, the BOEM established joint task forces with the states of Maine, Massachusetts, Rhode Island, New York, New Jersey, Delaware, Maryland and Virginia[20] that identify viable areas for offshore wind leasing, as summarized in Table 2, below.

Table 2. Offshore Wind Leasing [21]

State	Acres	Area (km^2)	MW
Maine	14,233	58	288
Massachusetts	772,399	3,126	15,629
Rhode Island*	164,750	667	3,334
New York	81,130	328	1,642
New Jersey	354,407	1,434	7,171
Delaware*	96,430	390	1,951
Maryland	79,707	323	1,613
Virginia*	112,799	456	2,282
TOTAL	1,675,855	6,782	33,910

** denotes leases that have already been executed*

As shown in Table 2 above, BOEM has already initiated the leasing process on sites within the addressable market of the Long Island offshore wind supply chain totaling nearly 34 GW of capacity and has completed the leasing for over 7 GW of that capacity.

State Policies Supporting Offshore Wind

Most states in the Mid-Atlantic and Northeast have established policies to support renewable energy, in certain cases including offshore wind. A review was conducted for each state's energy goals with a focus on the role of offshore wind. For the energy plans of most states in the Mid-Atlantic and Northeast, offshore wind is recognized for its potential contribution to meeting long-term energy goals.

New York

The draft 2014 New York State Energy Plan establishes an explicit goal to support the development of onshore and offshore wind projects. New York has a Renewable Portfolio Standard (RPS) target of 30% by 2015. New York's 2014 draft identifies wind energy as a primary measure to achieve its goals of energy independence, serving growing energy needs and supporting economic growth.[22] Table 3 shows the plan's projected percentage of wind energy in New York in 2020 and 2030.

Table 3. Wind Energy in New York State Energy Plan [23]

	Wind
In-State GWh Generation (2011)	2,828
% of Statewide Electricity Requirement	2%
Projected % of Statewide Electricity Requirement (2020)	5.7%
Projected % of Statewide Electricity Requirement (2030)	18%

In 2012, New York State's electricity consumption was 143 TWh [24]. To achieve the target of 18% generation from wind by 2013 would require the addition of new wind generation of more than 6,500 MW of offshore wind (assuming a 45% NCF) or nearly 9,800 MW of onshore wind (assuming a 30% NCF) of new wind generation. Given the siting and transmission constraints associated with building land-based wind in upstate New York, we estimate that up to half of this new renewable capacity – or approximately 3,000 MW – could come from offshore wind.

New Jersey

New Jersey's Energy Master Plan establishes the goal of achieving its 22.5% RPS by 2021, partially with offshore wind technologies[25]. New Jersey was the first state to create an offtake mechanism specifically for offshore wind with the passage of the Offshore Wind Economic Development Act (OWEDA) of 2010. This legislation codified New Jersey's goal of generating at least 1,100 MW from offshore wind. New Jersey expects that installation capacity of offshore wind could reach up to 3,000 MW.

Rhode Island

Rhode Island's RPS requirement is 16% by 2019, and the Rhode Island Climate Risk Reduction Act of 2010 established the Climate Change Commission to help achieve the RPS goals[26]. To support offshore wind energy development, in 2009 Rhode Island enacted new legislation establishing a "Long Term Contracting Standard for Renewable Energy[27]," which enables the local electric distribution company to purchase energy from two offshore wind facilities:

- The "Town of New Shoreham Project" – a 30 MW demonstration-scale project located off the coast of Block Island; and
- The "Utility-Scale Offshore Wind Project" – an offshore wind farm of approximately 300 MW (between 100 MW and 150 MW of average output, reflecting a 45% NCF).

Connecticut

Connecticut has an RPS requirement of 27% by 2020. The state's Climate Preparedness Plan advocates developing offshore wind to reduce greenhouse gas emissions, saying: "tapping into Connecticut's offshore wind will be a critical component of meeting those goals." Given Connecticut's annual electrical generation of 29,492,338 MWh[28], fully serving its RPS would require over 2,000 MW of offshore wind. While it is unlikely that Connecticut would fulfill its entire RPS obligation with offshore wind, we estimate that the state could purchase 500 MW from projects near New York or New England, which would represent only 25% of the RPS or 6% of total load.

Massachusetts

Massachusetts has an RPS of 15% by 2020, increasing by 1% every year thereafter. State legislation requires a reduction in emissions by 25% from 1990 levels by 2020 and by 80% by 2050. To meet these goals, Massachusetts has set a goal in its "Clean Energy and Climate Plan of 2020" of 2,000 MW of offshore wind energy to achieve their RPS requirements.[29]

Maryland

Maryland's RPS goal is 20% by 2022, based on their Climate Change plan for reducing greenhouse gas emissions by 25% by 2020.[30] The Maryland Offshore Wind Energy Act of 2013 incentivizes the development of wind energy in the state by establishing Offshore wind Renewable Energy Credits (ORECs) which would support approximately 200 MW of offshore wind development in the near term[31]. Given 2013 electricity consumption of 62 TWh, fully serving its RPS would require approximately 3,100 MW of offshore wind.

Delaware

Delaware is also a member of Regional Greenhouse Gas Initiative (RGGI) and plans to meets its RPS of 25% by 2025[32]. Given 2012 electricity consumption of 11.5 TWh, fully serving its RPS would require 700 MW of offshore wind. The state previously directed its electric distribution company to purchase approximately 200 – 300 MW of offshore wind, after offshore wind won a competitive bidding process called for by legislation seeking price stable, clean energy.

Maine

A preliminary review of the state of Maine found that the state has approximately 1,700 MW of land-based wind in operation or in active development[33]. Maine's electricity use in 2012 was very close to that of Delaware. Assuming a 30% of capacity factor, these onshore wind farms can generate 4.5 TWh of electricity per year, which represents 39% of the total electricity sale in 2012. Offshore wind would have to compete with these onshore projects for the market.

Virginia

Virginia is unique among the Mid-Atlantic and Northeast states, as its utility service remains fully regulated with a vertically-integrated electric utility. Virginia has established a voluntary RPS of 15% by 2025. Given 2012 electricity sale of 108 TWh, fully serving its voluntary RPS would require approximately 4,100 MW of offshore wind.

Offshore wind projects previously proposed

As detailed in Appendix 2, over 3,300 MW of offshore wind projects have been proposed and throughout the states discussed above. Although some of these projects are no longer being actively developed, the northeast and Mid-Atlantic region represents a significant potential market if the correct incentive and support structures to make projects viable are in place.

The development of offshore wind is constrained by a number of factors, including physical space, siting and permitting restrictions, federal leasing, state policy, and commercial demand for offshore wind energy. Based on our review of these materials described above, we believe that the near-term addressable market for Long Island to be approximately 8,850 MW, as detailed in Table 4.

This estimate of market potential is reinforced by the fact that, as detailed in Appendix 2 below, over 3,300 MW of offshore wind projects have been proposed or are in various stages of development today.

Table 4. Potential Offshore Wind Development (MW)

State	*subject to…* Physical Space Constraints (NREL)	Siting and Permitting Restrictions (NYSERDA)	Federal Leasing (BOEM)	Commercial Offtake (States)	All Constraints
Maine	326	21	288	0	0
New Hampshire	227	15	N/A	N/A	0
Massachusetts	53,542	3,435	15,629	2,000	2,000
Rhode Island	6,987	448	3,334	300	300
Connecticut	0	0	N/A	500	500
New York	38,971	2,500	1,642	3,000	2,500
New Jersey	68,369	4,386	7,171	1,100	1,100
Delaware	5,903	379	1,951	200	200
Maryland	20,972	1,345	1,613	750	750
Virginia	46,476	2,981	2,282	1,500	1,500
TOTAL	241,773	15,510	33,910	9,350	8,850

3. Offshore Wind Supply Chain

Navigant Offshore Wind Manufacturing and Supply Chain Study

In their 2013 study for the DOE[34], Navigant identified three categories of supply chain opportunities for the U.S. supply chain in offshore wind, ranked by their upfront capital cost and their flexibility in being used for other applications:

- ***Favorable*** - - Among the most attractive near-term opportunities in the offshore wind supply chain are the fabrication of foundations and substructures, the fabrication of towers, the supply of blade materials and the manufacturing of power converters and transformers.
- ***Moderate*** - - Wind Turbine assembly and the manufacturing of wind turbine components, along with substations and array cable were viewed as moderate opportunities, able to produce jobs , but entailing significant capital investments and risk regarding use of the facilities
- ***High-Risk*** - - Manufacturing of export cable was viewed as high risk due to high capital cost and lack of flexibility in production.

GL Garrad Hassan Study of U.S. Offshore Wind Port Readiness

In their 2013 report to the DOE on Port Readiness[35], GL Garrad Hassan identified five uses for offshore wind ports: (i) foundation manufacturing; (ii) offshore substation manufacturing; (iii) foundation & cable staging; (iv) turbine staging; and (v) operations & maintenance. These uses require greater quayside bearing capacity than typical cargo ports, and also require deeper drafts to allow installation vessels to jack up next to the quayside. GL Garrad Hassan found that the U.S. has or can develop sufficient port capacity for wind development through 2030, but that U.S. ports will require significant additional investment to be capable of supporting the five primary uses described above. GL Garrad Hassan also estimates that at least 2 major port facilities will be required in the North Atlantic to meet planned offshore wind developments.

Tetra Tech Study of Port and Infrastructure for Offshore Wind Development

In their 2010 report to the Massachusetts Clean Energy Center on needs for offshore wind port facilities in Massachusetts[36], Tetra Tech found a need for significant investment in port facilities in order to support offshore wind development. Tetra Tech also developed a business plan for a newly developed multi-cargo port facility to serve offshore wind and determined that such a facility could cover all of its operating expenses with a combination of offshore wind and other cargo operations.

Clean States Energy Alliance Supply Chain Opportunities for New York

In their 2012 evaluation of state-specific opportunities for offshore wind development[37], the Clean States Energy Alliance identified the following advantages for New York in offshore wind:

- Strategic Location near major offshore wind developments;
- Well-Developed Ports, in both New York City and Long Island;
- World-Class Workforce Development Organizations and Technology Transfer Offices;
- Industrial Development Agencies, such as Empire State Development Corp.; and
- Economic Incentive Programs and State / Municipal Energy Agencies.

The nearest term supply chain opportunities for offshore wind development are in (i) foundations; (ii) blades and (iii) marine / port operations. Long Island is well positioned to capitalize on these opportunities, but doing so will require an investment in port facilities. There exists a near term opportunity for Long Island to establish itself as a hub of offshore wind supply chain and logistics, given that few other suitable port facilities are ready to support offshore wind development.

4. Potential economic impacts in Long Island

We use the Jobs and Economic Development Impact (JEDI) model developed by NREL to estimate the economic impacts of the construction and operation of offshore wind projects in the Mid-Atlantic and Northeast states from Maine to Virginia.[38] This JEDI model was designed to estimate job creation, earning, and total economic activity that may be attributed to offshore wind projects based on regional economic multipliers derived from Impact Analysis for Planning (IMPLAN) software. Our analysis was specific to Long Island (Suffolk and Nassau Counties), based on the IMPLAN data sets for these counties.

We reviewed estimates of total capital cost of offshore wind (required by the JEDI model), based on studies conducted by NREL, DOE, international agencies, and a local energy research consulting firm to provide a comprehensive range of capital cost estimates. We next reviewed estimates of the proportion of the costs that would be locally sourced, defined as the labor and materials that would be provided by Long Island and New York State based firms.

With no installed capacity of offshore wind energy in the United States to generate data for evaluation, we used scenario analysis to make estimates and predictions. Based on our review of market potential and previously proposed projects, we developed the capacity of an initial 'Pilot Project' and an additional scenario for a full industry build-out. We developed plausible assumptions for each scenario, based on a comprehensive review of cost estimates.

Assumptions and model Inputs

We first derived the regional economic multipliers from IMPLAN, which establishes multipliers for the direct, indirect, and induced economic benefits. For this study, we used IMPLAN's Nassau and Suffolk County datasets for the regional (Long Island) economic analysis. These IMPLAN multipliers were then used within the JEDI model to estimate job creation, earning, and total economic activity that are attributed to offshore wind farm development.

The total capital cost and its breakdown were estimated by NYEPI based on a review of the literature, proposed offshore wind projects, and interviews with industry professionals, attached as Appendix 3, below. For the purpose of this study, we used the standard NREL estimate of offshore wind capital cost of $6,209 / kW of installed capacity, detailed in Table 5 below.

While this capital cost estimate is standard for the JEDI model, we note that it reflects a 5 MW turbine, which is likely more capital intensive than the state-of-the-art 6 MW to 8 MW turbines that may be deployed over the coming years.[39]

We estimated the job creation and economic development impacts of two offshore wind development scenarios to examine the impact of different levels of wind power capacity and the impact when we assume different local shares. The local share reflects the development of regional labor force and supply chain in support of an offshore wind industry. For consistency with the JEDI model, both scenarios assume that 5 MW wind turbine is used. Total installed capacity in scenario 1 – a single 'Pilot Project' – is 250 MW, and in scenario 2 – full industry build-out – is 2,500 MW. Our analysis assumes that construction begins in 2015 and finishes in 2018.

Table 5. *NREL Cost Breakdown for JEDI Model*

	USD$/kW
Turbine Capital Cost	1,834
Materials and Other Equipment Total	1,386
Basic Construction	9
Foundation	174
Substructure	116
Project Collection System	157
HV Cable	268
Converter	400
Substation	262
Labor and Installation	1,039
Foundation	654
Substructure	368
Management/Supervision	17
Insurance During Construction	134
Development Services/Other Total	945
Engineering	30
Legal Services	6
Public Relations	2
Ports and Staging	250
Site Certificate/Permitting	20
Air Transportation	16
Marine Transportation	43
Erection/Installation	378
Decommissioning Bonding	200
Construction Financing	707
Other Miscellaneous	35
Sales Tax	129
Total Construction Cost	6,209

Results

As detailed in Tables 6 and 7 below, the JEDI model estimated significant job, earnings and output impacts for Long Island resulting from the construction and operations of offshore wind projects. A single 250 MW offshore wind project is estimated to result in 2,864 construction and operations phase jobs on Long Island, as well as approximately $645 million in Long Island economic output during construction and operations. If Long Island were to capture 2,500 MW of the potential offshore wind development, the JEDI model projects that Long Island would benefit from 58,457 construction and operations phase jobs, as well as approximately $12.9 billion in local economic output.

Table 6. Full-Time Equivalent Jobs under Two Offshore Wind Development Scenarios (during period 2015-2018)

	Scenario 1 (250 MW)	Scenario 2 (2,500 MW)
During construction period		
Project development and onsite labor impacts	761	17,549
Construction and interconnection labor	658	15,684
Construction related services	104	1,865
Turbine and supply chain impacts	1,245	25,607
Induced impacts	728	13,690
Total impacts	2,735	56,845
During operating years (annual)		
Onsite labor impacts	22	109
Local revenue and supply chain	70	1,044
Induced impacts	36	458
Total impacts	129	1,612

Note: Construction and operating jobs are full time equivalent (FTE) for a period of one year, 1 FTE = 2080 hours.

Table 7. Earnings and Output Impacts of Offshore Wind Development on Long Island

	Earnings (million $)		Output (million $)	
	Scenario 1 (250 MW)	Scenario 2 (2,500 MW)	Scenario 1 (250 MW)	Scenario 2 (2,500 MW)
During construction period				
Project development and onsite labor impacts	109	2482	144	3095
Construction and interconnection labor	92	2200		
Construction related services	17	282		
Turbine and supply chain impacts	92	2001	358	7485
Induced impacts	39	725	99	1870
Total impacts	239	5208	601	12,450
During operating years (annual)				
Onsite labor impacts	2.66	13.28	2.66	13.28
Local revenue and supply chain	5.31	82.75	36.54	455.80
Induced impacts	2.02	25.15	5.14	64.21
Total impacts	9.98	121.18	44.34	533.28

5. Conclusions

Our review of the literature, BOEM's leasing and state policies related to offshore wind suggest that Long Island's near term addressable market for offshore wind development is approximately 8,850 MW, of which 2,500 MW is in federal waters abutting New York State.

Our review of the supply chain literature found that the near-term opportunities of offshore wind development include: (i) foundations; (ii) blades; and (iii) port / marine operations – all fields that Long Island is well positioned to serve given its large, skilled workforce, it's experience with aerospace manufacturing and it's robust maritime industries. No ports, however, are currently capable of serving offshore wind without significant investments. There will be a need for a limited number of ports in the near term. This situation suggests both high barriers to entry and significant first-move advantages for those places that develop the first offshore wind farms and offshore wind port facilities.

Our economic modeling, using NREL's JEDI model, found that a single offshore wind farm built off Long Island coast can create 2,864 jobs on Long Island, as well as approximately $645 million in local economic output. For both jobs and economic output, our analysis of a single project shows lower estimates than previous studies, which suggested about 20 job-years and approximately $3.3 million in economic output per MW of installed offshore wind. This analysis reflects the first offshore wind projects, which will have to use more service providers and equipment manufacturers outside Long Island, i.e., share economic development opportunities with other locations, as the Long Island supply-chain is built out.

Our analysis further shows that if the Long Island offshore wind industry can achieve a scale of constructing 2,500 MW of capacity, that it would benefit from 58,457 full-time equivalent jobs (or job-years), as well as approximately $12.9 billion in local economic output. These figures are in line with estimates in the literature and reflect the benefits of bringing a strong supply chain to Long Island.

This analysis suggests that offshore wind energy can bring significant economic benefits to Long Island. To achieve this full potential, Long Island needs to establish itself as a hub for development on the east coast.

Appendix 1: Summary of Job Creation Estimates

Place	Source	# of Jobs	Capacity	Jobs / MW	By Year
Europe	EWEA 2009	215,637	300GW	7	2030
Europe	EWEA 2011	169,500	40GW	42	2020
Europe	EWEA 2011	300,000	150GW	20	2030
United Kingdom	Institute for Public Policy	70,000	32GW	22	2020
United Kingdom	renewableUK 2011	45,000	18GW	25	2020
United Kingdom	Carbon Trust 2008	40,000-70,000	29GW	14-24	2020
United Kingdom	SQW Energy 2008, Institute for Public Policy Research 2009	23,000	N/A	N/A	2020
Germany – North Coast	Various secondary sources	30,000	12GW	25	2030
USA	Department of Energy 2011	43,000	54GW	8	2030
USA – Atlantic Coast	Department of Energy 2012	1,500-7,500	200 MW/yr - 1GW/yr	N/A	2020
USA – Mid-Atlantic Region	IHS Inc./Atlantic Wind Connection	17,000	7 GW	N/A	2026
Lake Erie, Ohio	LEEDCO/Nortech 2010	8,000	5GW	16	2030
Maine Deepwater Plan	The University of Maine 2011	7,000-15,000	5GW	14	2030

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Appendix 2: Previously Proposed Offshore Wind Projects

Long Island- New York City Offshore Wind Project[40] [41]

Type of Project	Location	Type of Initiative	Generation Capacity	Collaborators	Goal	Status	Projected Operation
Offshore	Atlantic Ocean. Long wedge-shaped area between shipping channels, directionally aligned southwest of the Rockaway Peninsula with its westerly most point approximately 14 nautical miles (13 to 15 standard miles) due south of Nassau County	Proposed	350 MW Capacity. 1,226,000 MWH Annually 700MW Expansion	Con Edison, Long Island Power Authority (LIPA), New York Power Authority (NYPA)	To meet 45% of electricity needs by the year 2015	Assessment Studies- feasibility, environmental and wind-strength.	2017

Cape Wind Offshore (Massachusetts)[42]

Type of Project	Location	Type of Initiative	Turbines	Generation Capacity	Collaborators	Goal	Status	PPA	Projected Operation
Offshore	In a shallow area of water toward the center of Nantucket Sound, Cape Cod, called Horseshoe Shoal	Approved	130 (Seimens Model 3.6 MW)	468 MW	Energy Management Inc. (Cape Wind)	Meet the demand for energy while creating new jobs	In financing state. (Recently secured $600 million from Danish Agency)	77.5%	Begin ocean construction in 2015 and commission the project in 2016. There after, it sees 25 years of operation.

Delaware Offshore Wind Project[43 44]

Type of Project	Location	Type of Initiative	Generation Capacity	Collaborators	Goal	Status	Projected Operation
Offshore	Off Delaware coast	Proposed	450MW	NRG's Bluewater Wind. Supported by Babcock and Brown	Reduced carbon emissions. Supporting the Obama Administration-5 million new "green collar" jobs.	Study and financial phase	Forecasted for construction and installation in the next 12-36 months.

Block Island Offshore Wind Farm[45]

Type of Project	Location	Type of Initiative	Turbines	Generation Capacity	Collaborators	Goal	Status	PPA	Projected Operation
Offshore	3 miles southeast of Block Island, Rhode Island.	Proposed	5 (Seimens Model 6MW)	30MW capacity. 120, 000 MW Hours Annually	Deepwater Wind	Reduced carbon emissions. Power over 17,000 homes.	Permitting and approvals process	20 year PPA from National Grid	Transmission construction completion as early as 2014 and offshore construction in 2015

Deepwater Wind Energy Center[46]

Type of Project	Location	Type of Initiative	Generation Capacity	Collaborators	Goal	Status	PPA	Projected Operation
Offshore	Atlantic Ocean. 30 miles east of Montauk, New York	Proposed	1000 MW	Deepwater Wind	Displace over 1.7 million tons of CO_2. Power over 350, 000 homes.	Permitting and approvals process	100%	First phase in operation by 2017. Second phase by 2018

Fisherman's Energy Phase I (New Jersey)[47]

Type of Project	Location	Type of Initiative	Turbines	Generation Capacity	Collaborators	Goal	Status	Projected Operation
Offshore	2.8 miles off shore (State waters)	Proposed	5 (XEMC-Darwind 5 MW)	25 MW	Fisherman's Energy	Meet growing energy needs	Fully permitted.	Denied settlement from BPU- therefore completion date is unclear.

Fisherman's Offshore Energy New Jersey[48]

Type of Project	Location	Type of Initiative	Turbines	Generation Capacity	Collaborators	Goal	Status	Projected Operation
Offshore	Federal waters- New Jersey	Proposed	66 (XEMC-Darwind 5 MW)	330 MW	Fisherman's Energy	Meet growing energy needs	Interim lease for initial assessment	2018

Garden State Offshore Wind Energy Farm New Jersey[49]

Type of Project	Location	Type of Initiative	Turbines	Generation Capacity	Collaborators	Goal	Status	Projected Operation
Offshore	16 miles from shore- New Jersey	Proposed	58-70 (5-6 MW)	350 MW	Deepwater Wind and PSEG Renewable Generation.	Meet growing energy needs	Study	2019

Appendix 3: Capital Cost Estimates for Offshore Wind Projects

This appendix reviews the publically available capital cost data for offshore wind, required by the JEDI model. Four data sets were selected from the literature in order to provide a range of estimates from a variety of reliable sources: the US Department of Energy's National Renewable Energy Lab, International Renewable Energy Agency, European Wind Energy Association, and Levitan and Associates. Each data set will be briefly described below; for further details, see each respective full report.

United States Department of Energy, National Renewable Energy Lab[50]

The National Renewable Energy Lab conducted a detailed analysis in which they determined estimates of the near-term installed capital costs of offshore wind energy in the United States, based on 3.6 MW turbines. The study conducted parallel assessments including a review of the published literature, an analysis of global market data, and a series of interviews with current offshore wind developers in the US.

Capital cost data from the NREL offshore wind database was used in this estimate. The database includes cost data for 98% of the total installed capacity, estimates of 31 projects that are under development in Europe, and 13 proposed projects in the United States. Data was collected from a variety of sources including industry white papers, developer websites, press releases, and peer-reviewed journals. Cost estimates from most sources originated from project developers, and when multiple estimates were provided for one project, the costs were averaged. All costs were inflated in original currency and converted to 2010 US dollars. The report acknowledges the following limitations of their dataset:

- Reported costs were typically rounded estimates.
- Many sources did not break down cost estimates, making it difficult to determine if the reported costs reflected total costs.
- Several estimates were calculated prior to 2009, and therefore may not accurately represent current cost expectations.

Because most of the available data is Europe focused, the extent to which it represents capital costs for US projects is uncertain. For this reason, NREL reviewed documents associated with the Cape Wind and Block Island Wind Projects and interviewed developers regarding the specific capital costs that they expect. Based on this analysis, a baseline US estimate was determined to be 5,600 2010 US dollars per kW, which is at the high end of the aforementioned database range, 2,500 to 6,500 US dollars per kW.

Specific component capital costs were then determined by applying percentage estimates to the baseline estimate. The share of each component to the total capital cost was based on several recent publications,[51,52,53] interviews with US developers, and NREL's Wind Turbine Cost and

Scaling Model.[54,55]

	USD$/kW
Turbine Capital Cost	1,789
Balance of Station	2,918
Development (permits, engineering, and site assessment)	58
Project Management	117
Support Structure	1,021
Port and Staging	73
Electrical Infrastructure	540
Transportation and Installation	1,109
Soft Costs	730
Insurance	94
Surety Bond (decommissioning)	165
Contingency	471
Construction Financing Cost	163
Total Capital Cost	5,600

International Renewable Energy Agency/Douglas-Westwood[56]

This study by the International Renewable Energy Agency reports the 2010 capital cost structure of offshore wind systems based on a study by Douglas-Westwood for the Research Council of Norway[57] that describes trends in the costs of wind power projects. Costs were determined by price assessments of turbine manufacturers and research into component costs, based on several recent projects. All costs were converted in the IRENA study from Norwegian Krone into 2010 US Dollars. The reported costs are based on 3 MW turbines.

	USD$/kW
Turbine Capital Cost	1,970
Foundations	712

Electrical Infrastructure	762
Installation	580
Planning and Development	447
Total Cost	4,471

European Wind Energy Association[58]

The capital costs reported in a study by the European Wind Energy Association were determined based on two Danish offshore wind farms, the Horns Rev project that was completed in 2002, and the Nysted farm that was completed in 2004. The projects consist of 80, 2 MW turbines, and 72, 2.3 MW turbines, respectively. The costs in the table below represent the average capital costs associated with these two farms. Costs have been converted from 2006 Euros per MW to 2014 US Dollars per kW, and were rounded to the nearest dollar.

	1,000Euros/MW	US$/kW
Turbines, Transport, and Erection	815	1120
Transformer station and main cable to coast	270	370
Internal grid between turbines	85	116
Foundations	350	480
Design and project management	100	137
Environmental analysis	50	69
Miscellaneous	10	14
Total Cost	1680	2,307

Levitan & Associates, Inc.[59]

The report by Levitan & Associates estimates the economic impacts of a potential wind farm project off the coast of Rhode Island. The capital costs of the Block Island Wind Farm were directly estimated by Deepwater Wind Block Island, the developers of the proposed farm. The project will consist of 5 turbines for a total of 30 MW.

	USD$	USD$/kW
Engineering design	3,909,000	130
Fabrication and supply	140,015,029	4,667
Offshore installation	29,096,940	970
Project management and inspection	9,719,339	324
Development	10,000,000	333
Insurance during construction	3,930,959	131
Financing costs	8,732,245	290
Total Cost	205,403,512	6,845

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