NEW YORK STATE OFFSHORE WIND MASTER PLAN

Charting a Course to 2,400 Megawatts of Offshore Wind Energy

NYSERDA Report 17-25

New York State will help develop 2,400 megawatts of offshore wind energy by 2030, enough to power up to 1.2 million homes

The New York State Offshore Wind Master Plan prepared by:

New York State Energy Research and Development Authority

Prepared in coordination with:

Department of Environmental Conservation
Department of Labor
Department of State
Department of Public Service
Empire State Development
Long Island Power Authority
New York Power Authority
Office of Parks, Recreation and Historic Preservation

Cover Photo: Siemens

Credit: Deepwater Wind

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Acronyms and Abbreviations

BMP – Best Management Practice

BOEM – Bureau of Ocean Energy Management

Commission – New York Public Service Commission

FLOWW – Fishing Liaison with Offshore Wind and Wet Renewables Group

GW – Gigawatt

LiDAR – Light detention and ranging

MW – Megawatt

NO_x – Oxides of Nitrogen

NYSERDA – New York State Energy Research and Development Authority

OREC – Ocean Renewable Energy Credit

$PM_{2.5}$ – fine particulate matter

PPA – power purchase agreement

REC – Renewable Energy Credit

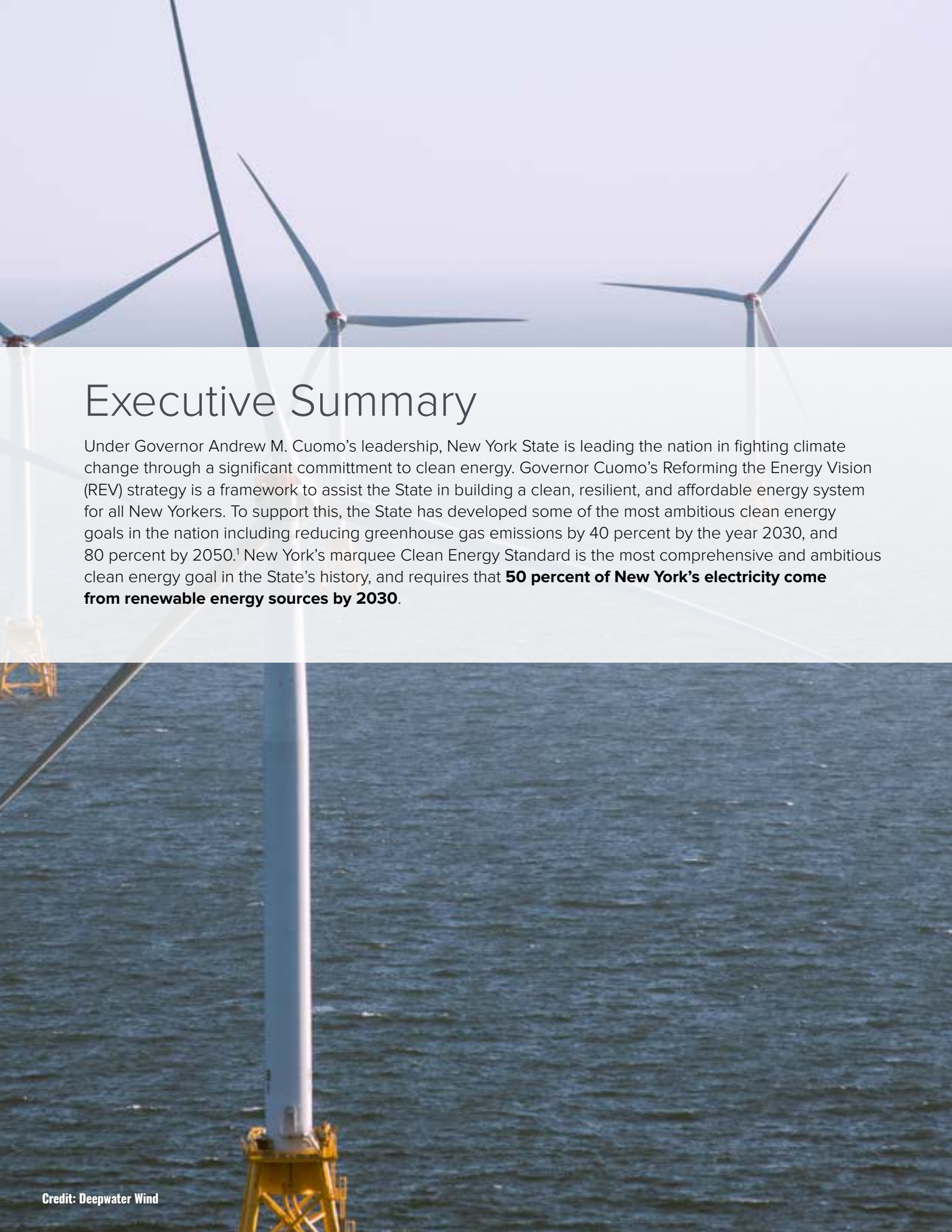
SO_x – Oxides of Sulfur

U.S. – United States

UOG – Utility Owned Generation

Executive Summary

Under Governor Andrew M. Cuomo's leadership, New York State is leading the nation in fighting climate change through a significant committment to clean energy. Governor Cuomo's Reforming the Energy Vision (REV) strategy is a framework to assist the State in building a clean, resilient, and affordable energy system for all New Yorkers. To support this, the State has developed some of the most ambitious clean energy goals in the nation including reducing greenhouse gas emissions by 40 percent by the year 2030, and 80 percent by 2050.[1] New York's marquee Clean Energy Standard is the most comprehensive and ambitious clean energy goal in the State's history, and requires that **50 percent of New York's electricity come from renewable energy sources by 2030**.



Credit: Deepwater Wind

In light of the Clean Energy Standard mandate, and recognizing the enormous potential renewable energy resource that exists off of its Atlantic coast, New York has set its sights squarely on offshore wind energy as a key component of the State's clean energy strategy. Governor Cuomo directed the State to engage community members, environmental advocates, and government partners at all levels to create the New York Offshore Wind Master Plan.[2] Then, as part of his 2017 State of the State Address, Governor Cuomo set a nation-leading offshore wind energy development goal of 2,400 MW by 2030, enough to power up to 1.2 million New York households.[3] Taking the first step to reach this goal, Governor Cuomo, in his 2018 State of the State Address, called for the procurement of at least 800 megawatts (MW) of offshore wind power between two solicitations to be issued in 2018 and 2019.[4] In addition, Governor Cuomo directed NYSERDA to invest $15 million in clean energy workforce development and infrastructure advancement to train workers for jobs in this good-paying industry, including offshore wind construction, installation, operation, maintenance, design, and associated infrastructure.

After two years of in-depth research, analysis, and outreach, New York State presents its Offshore Wind Master Plan (Master Plan)—the most comprehensive offshore wind planning process to be undertaken by any state, which charts a course toward achievement of the State's bold offshore wind energy objectives.

Large-scale adoption of offshore wind power will improve public health and environmental quality, and combat climate change and its effects, including sea-level rise and extreme weather events, which have already significantly impacted New Yorkers.

Offshore wind can also diversify the State's energy system by providing abundant clean energy where New York's energy system is most strained—New York City and Long Island—thereby aiding the State's interconnected energy system and spreading the environmental benefits of this home-grown, renewable, and low-carbon source of energy. The development of offshore wind energy also will stimulate the State's economy, support revitalization of maritime communities, spur infrastructure investment, and help create a new American industry centered in New York State that will create thousands of new jobs for skilled workers.

The development of offshore wind energy is an opportunity that plays to New York's historic strengths in delivering some of the largest and most ambitious infrastructure projects in the world. With assets including a world-class workforce, unmatched intellectual capital, physical infrastructure and financial institutions, and national clean energy policy leadership, New York has all of the ingredients to become a global hub for the offshore wind energy industry. This Master Plan establishes the State's pathway for achieving that goal.

New York State is committed to the responsible, common-sense development of offshore wind energy in the Atlantic Ocean. As outlined in this Master Plan, the State has launched a comprehensive planning process to minimize the negative impacts of offshore wind development in a concerted effort to protect our treasured marine environment and critically important activates like fishing, boating, and shipping that buoy our regional economy. This exhaustive effort will protect sensitive ecosystems, maintain pre-existing areas of vital economic activity, and ensure public safety. Offshore wind presents a tremendous opportunity to realize a clean energy future that will power the State's homes and businesses with renewable energy, while creating good jobs and spurring economic growth in our coastal communities.

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[1] Executive Order 166. https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/EO%20%23166.pdf

[2] 2016 New York State of the State Policy Book, pgs. 80-82. https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/2016_State_of_the_State_Book.pdf

[3] 2017 New York State of the State Policy Book, pgs. 54-57. https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/2017StateoftheStateBook.pdf

[4] 2018 New York State of the State Policy Book, pgs. 218-220. https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/2018-stateofthestatebook.pdf

Introduction to the Master Plan

Describes the objectives and methodology of the State's planning process, and identifies the 20 studies the State undertook to gather data on environmental, social, economic, regulatory, and infrastructure issues relevant to offshore wind energy development. These studies, conducted over the last two years, inform the path toward achieving the State's goals, and cover a wide variety of topics related to siting, regulatory, wildlife, commercial, economic, and other important considerations. This section also reviews the State's extensive outreach efforts with interested agencies, entities, communities, and individuals, which helped achieve a balanced evaluation of the potential for offshore wind development.

Background

Sets the policy drivers and market context for New York's commitment to develop its offshore wind energy resources. The State's Clean Energy Standard and the Governor's charge to develop 2,400 MW of offshore wind power by 2030 are essential components of the State's strategy to meet its broader policy goals and achieve the important objectives of improving New Yorkers' quality of life and environment, and doing its part in the broader fight against climate change. This section also describes the mature European offshore wind energy market, the burgeoning Asian market, and the nascent U.S. market. To advance the development of the U.S. market, in October 2017, New York State issued a request to the federal government asking the U.S. Bureau of Ocean Energy Management (BOEM) to create and lease at least four new Wind Energy Areas (WEAs). In that request, the State recommended areas that it believes, after extensive analysis, to be the most promising for the development of projects that could serve New York.

Benefits and Cost-Reduction Pathways

Addresses both the benefits that New York State will realize from offshore wind development and the current costs and projected cost reductions that can be achieved. The State's analysis concludes that offshore wind development will enhance the State's job market, supply chain, and economy; reduce the use of fossil fuels; and provide other public health, environmental, and societal benefits. The discussion of costs and cost-reducing strategies focuses on State options for contracting related to offshore wind energy, including hedging approaches and cost-containment provisions, as well as possible State financing, job-training programs, and infrastructure investments.

Ongoing Activities to Advance Development of Offshore Wind Energy

Details the steps the State will take after issuing this Master Plan. In particular, the State will undertake additional research and convene technical working groups concerning the key subjects of fishing, maritime commerce, the environment, jobs, and the supply chain. These technical working groups will inject diverse views and information into future decision-making, and will develop a series of best management practices (BMPs) to effectively reduce or eliminate impacts that could result from offshore wind energy development.

Taken together, the information assembled in this Master Plan provides an unparalleled level of data collection, analysis, public input, and strategic forethought that will empower New York and its partners to take the steps needed to capitalize on the unique opportunity presented by offshore wind energy.

Credit: Deepwater Wind

Offshore wind is an energy resource with the potential to transform New York's energy system in ways that will have extraordinary environmental, energy, and economic benefits for the State and beyond.

The work still to come, including that described in this Master Plan, will set New York firmly on course to **make that potential a reality**.

Credit: Siemens

Introduction to the Master Plan

New York State's commitment under the Clean Energy Standard to develop 2,400 MW of offshore wind energy by 2030—enough to power up to 1.2 million homes—is among the nation's most aggressive offshore wind energy goals. This large-scale renewable energy resource would diversify the State's energy system with abundant clean energy and further the State's broader goal to introduce home-grown, renewable, low-carbon sources of energy to the grid. Developing renewable energy sources at this scale would also allow the State to achieve the greenhouse gas reduction and renewable energy goals stated in the 2015 State Energy Plan.

The development of offshore wind resources would provide energy where the State's energy system is most strained—New York City and Long Island. All New Yorkers will benefit from an improved interconnected energy system. Introducing a new energy source into the statewide grid will extend environmental benefits and stimulate this emerging industry, creating thousands of new skilled jobs.

Clean Energy Standard

requires 50% of the State's electricity come from renewable energy sources by 2030.

Objectives

Since 2016, the State has been conducting research, analysis, and outreach in order to evaluate the potential for offshore wind development and to inform the State's path for meeting its goal of 2,400 MW of offshore wind energy generation by 2030. This Master Plan sets forth the State's comprehensive strategy to reach that goal. Specifically, this document:

- Identifies the most favorable areas for potential offshore wind energy development
- Describes the economic and environmental benefits of offshore wind energy development
- Addresses mechanisms to procure offshore wind energy at the lowest ratepayer cost
- Analyzes costs and cost-reduction pathways
- Recommends measures to mitigate potential impacts of offshore wind energy development
- Identifies infrastructure requirements and assesses existing facilities
- Identifies workforce opportunities

20 studies

provide a body of information and support the Master Plan.

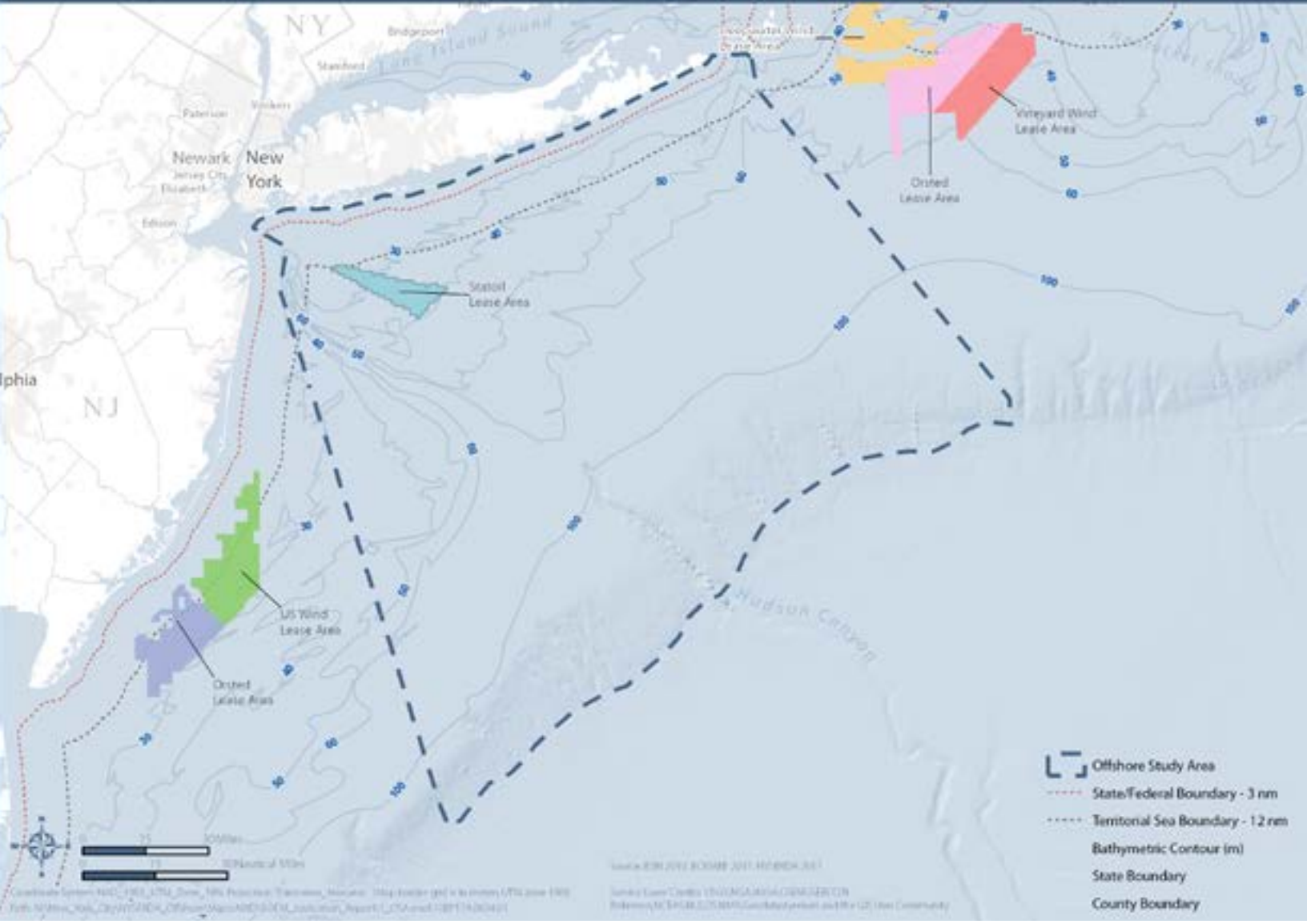


Figure 1. Offshore Study Area

The Master Plan process has been and will continue to be a joint effort of the New York State Energy Research and Development Authority (NYSERDA), the New York State Department of Environmental Conservation, the New York State Department of Labor, the New York State Department of State, the New York State Department of Public Service, the New York State Office of Parks, Recreation and Historic Preservation, Empire State Development, the Long Island Power Authority, and the New York Power Authority.

Methodology and Appended Documents

This Master Plan is supported by a suite of 20 appended studies prepared by or on behalf of the State. These studies provide a body of information concerning a variety of environmental, social, economic, regulatory, and infrastructure-related issues implicated in planning for future offshore wind energy development.

Decision making with respect to each of the 20 studies began with an assessment of a 16,740-square mile (43,356-square kilometer) offshore study area in the Atlantic Ocean, which extends from New York City and the south shore of Long Island to beyond the continental shelf break and slope. Figure 1 depicts the offshore study area. For each particular topic of study, the State team refined the offshore study area into a larger or smaller Area of Analysis based on study-specific factors or stakeholder and public input.

The 20 supplemental studies supporting this Master Plan and are identified below.

A. Analysis of Multibeam Echo Sounder and Benthic Survey Data. This study characterizes the geological (sediment size/type), geotechnical (bottom density), and benthic (animal habitat) characteristics of the ocean floor within the offshore study area.

B. Assessment of Ports and Infrastructure. This study assesses the potential for job creation; assesses existing facilities along New York's shoreline and their potential to support staging for offshore wind farm construction and operation; and identifies probable costs for potential port upgrades.

C. Aviation and Radar Assets Study. This study assesses the potential compatibility of wind energy development in the offshore study area with civil and military aviation assets.

D. Birds and Bats Study. This study characterizes current knowledge as to the use of the offshore study area by birds and bats, and addresses the risk of collision with offshore wind turbines.

E. Cable Landfall Permitting Study. This study assesses the existing onshore resources needed to determine areas of opportunity, sensitivity, and risk associated with the site selection for cable landings of offshore wind farms.

F. Cables, Pipelines, and Other Infrastructure. This study assesses the constraints to offshore wind energy development posed by existing submerged infrastructure and summarizes cable crossing scenarios, methodologies, and technologies.

G. Consideration of Potential Cumulative Effects. This study identifies potential cumulative effects on key resources associated with offshore wind energy development and other relevant actions, and prepares a framework for future project-specific assessments of cumulative effects.

H. Cultural Resources Study. This study uses both desktop analysis and field research to assess the archaeology and cultural heritage of the offshore study area.

I. Environmental Sensitivity Analysis. This study analyzes the distribution of environmental parameters (e.g., marine mammal distribution, essential fish habitat) used to evaluate environmental and permitting risks of wind energy development. Map products and a weighting system were developed to allow a comparative analysis of the potential risks of construction and operation of offshore wind farms on marine resources at various locations.

J. Fish and Fisheries Study. This study collects existing socioeconomic and ecological fisheries data, determines the feasibility of updating priority data, and creates a database of previous fisheries stakeholder engagement resources on offshore wind. The study describes engagement with fisheries stakeholders, vets new data products, and utilizes information and feedback from stakeholders to develop best management practices for offshore wind energy development.

K. Health and Safety Study. This study reviews existing federal and state legislation and codes, standards, best practice guidance, and previous research that may apply to the development, construction, and operations of offshore wind energy projects off the coast of New York.

L. Marine Mammals and Sea Turtles Study. This study summarizes the existing marine mammal and sea turtle occurrence data and examines more specifically North Atlantic right whale occurrence within and near the offshore study area. The study also proposes a work plan for a passive acoustic monitoring study to be conducted after this Master Plan's publication.

M. Marine Recreational Uses Study. This study assesses and locates the recreational uses that occur in and adjacent to the offshore study area, and discusses potential impacts of offshore wind energy development on those uses.

Credit: Siemens

N. Offshore Wind Injection Assessment. This study assesses the feasibility of injecting offshore wind energy into various connection points in New York City and Long Island.

O. Preliminary Offshore Wind Resource Assessment. This study characterizes the wind, wave, and ocean current environment of the offshore study area.

P. Sand and Gravel Resources Study. This study identifies and maps the locations of proposed, active, or inactive sand and gravel mining areas within the offshore study area and provides context for the regulatory framework associated with these resources.

Q. Shipping and Navigation Study. This study describes how future leases should consider current and future navigational hazards and risks posed by offshore wind development.

R. U.S. Jones Act Compliant Offshore Wind Turbine Installation Vessel Study. This study examines the required functionality and business case for U.S.-built, Jones Act compliant offshore wind turbine installation vessels and feeder barges.

S. Visibility Threshold Study. This study evaluates the potential visual impacts of offshore wind energy development.

T. The Workforce Opportunity of Offshore Wind in New York. This study estimates the numbers, types, and locations of jobs that will be created in the offshore wind energy supply chain, as well as the numbers and types of additional jobs that may be created by investment in the U.S. by domestic companies or overseas suppliers.

Four additional documents also support this Master Plan.

U. New York State Area for Consideration for the Potential Locating of Offshore Wind Energy Areas. The State's October 2017 submission to BOEM fulfills one of the Master Plan's key goals by identifying area for and requesting that BOEM lease at least four new Wind Energy Areas in the Atlantic Ocean. This is discussed further in "Area for Consideration and Request for Wind Energy Areas."

V. Offshore Wind Policy Options Paper. NYSERDA's January 2018 submission to the New York State Public Service Commission (Commission) assesses different procurement mechanisms that could be used to procure offshore wind energy and associated attributes. This is discussed further in "Procurement and Other Cost-Reduction Pathways."

W. Outreach and Engagement Summary. Summary of the outreach and engagement campaign undertaken by the State in connection with the Master Plan and its studies.

X. Table of Permits and Approvals. Non-exhaustive table of permits and approvals that are anticipated to be required for a future offshore wind energy development project.


Credit: NYSERDA

Public Outreach

Outreach has been and continues to be a critical component of the State's Master Plan process, particularly throughout the development of each of the 20 studies. **The State solicited early and frequent input** from interested agencies, entities, communities, and individuals during the process in order to ensure a balanced evaluation of the potential development of offshore wind energy sites. The State's outreach activities involved a multi-year process of meeting with, consulting, and soliciting input from a wide variety of parties, which is the most robust public outreach conducted by any state considering the development of offshore wind. Parties that provided input to this process include:

- Commercial and Recreational Fishing Interests
- Elected Officials
- Indigenous Nations and Tribal Communities
- Labor and Business Organizations
- Long Island and New York City Communities
- Non-Governmental Organizations
- Offshore Wind Energy Industry
- State and Federal Agencies
- Submarine Cable and Offshore Infrastructure Owners

The State held seven public information meetings in 2017 related to the Master Plan in New York City and on Long Island. Each event was widely advertised to ensure local communities had the opportunity to engage and ask questions of representatives from relevant State agencies and authorities. More than 500 individuals attended the public meetings, including community members, federal and State elected officials, the media, city government agencies, non-governmental organizations, and local community planning groups.

The public was also invited to submit comments online, at the public information meetings, and by mail for the State agencies to consider throughout the drafting of the Master Plan. The State received more than 150 comments, which were thoroughly considered in the development of this Master Plan.

For a detailed account of the State's outreach efforts undertaken as part of the Master Plan process, see *Appendix W: Outreach and Engagement Summary*. New York's plans for continuing public outreach and engagement are described in "Continuing Outreach and Public Engagement."

Credit: Deepwater Wind

Background

New York State developed this Master Plan as part of its continuing mission to increase the availability of renewable energy, which offers significant benefits to New Yorkers. This background information portrays the broader context in which the Master Plan was developed, including a summary of the State's renewable energy-related policies and goals, an explanation of the general benefits associated with renewable energy, and a description of the growth of offshore wind energy development in the U.S. and around the world. This section introduces the regulatory framework that controls the leasing and development of offshore wind energy facilities in federal and State waters. Also discussed is the State's extensive analysis of the area off its shores and identification of those areas most suitable for wind energy development, along with the October 2017 request that the federal government identify and lease at least four new Wind Energy Areas within that area.

State Greenhouse Gas Reduction and Renewable Energy Policies

The 2015 State Energy Plan recognized the importance of ensuring New York's power system is modern, clean, and diverse. Accordingly, the State Energy Plan established goals of 50 percent of the State's electricity to come from renewable energy sources (such as offshore wind) and reducing statewide greenhouse gas emissions by 40 percent, all by 2030. New York State has adopted increasingly proactive policies to combat climate change and modernize its electric system to improve its efficiency, affordability, resiliency, and sustainability. In August 2016, the Commission adopted the State Energy Plan's goal of 50 percent renewables by 2030 as the Clean Energy Standard.[5] The Commission's Clean Energy Standard Order requires State utilities and other load-serving entities source 50 percent of their electricity from renewable sources by 2030, and establishes a system to ensure compliance with that requirement.[6]

In January 2017, Governor committed New York State to pursuing development of 2,400 MW of offshore wind energy by 2030 — enough to power up to 1.2 million homes. The development of this resource supports the State's energy goals and will provide clean, abundant energy to New York City and Long Island. In addition, it will further the State's goal of introducing home-grown, renewable, low-carbon sources of energy to the grid.

New York State has adopted increasingly proactive policies to combat climate change and modernize its electric system to improve its efficiency, affordability, resiliency, and sustainability.

Credit: Siemens

[5] New York State Public Service Commission, Order Adopting a Clean Energy Standard, Cases 15-E-0302 and 16-E-0270, August 1, 2016 (Clean Energy Standard Order).

[6] In the Clean Energy Standard Order, the Commission found that the benefits of developing offshore wind energy and other renewables include: improving air quality and fighting climate change by reducing total emissions of pollutants resulting from fossil fuel combustion; improving human health; and stimulating the economy. Clean Energy Standard Order at pgs. 3, 18.

Growth of Offshore Wind Energy

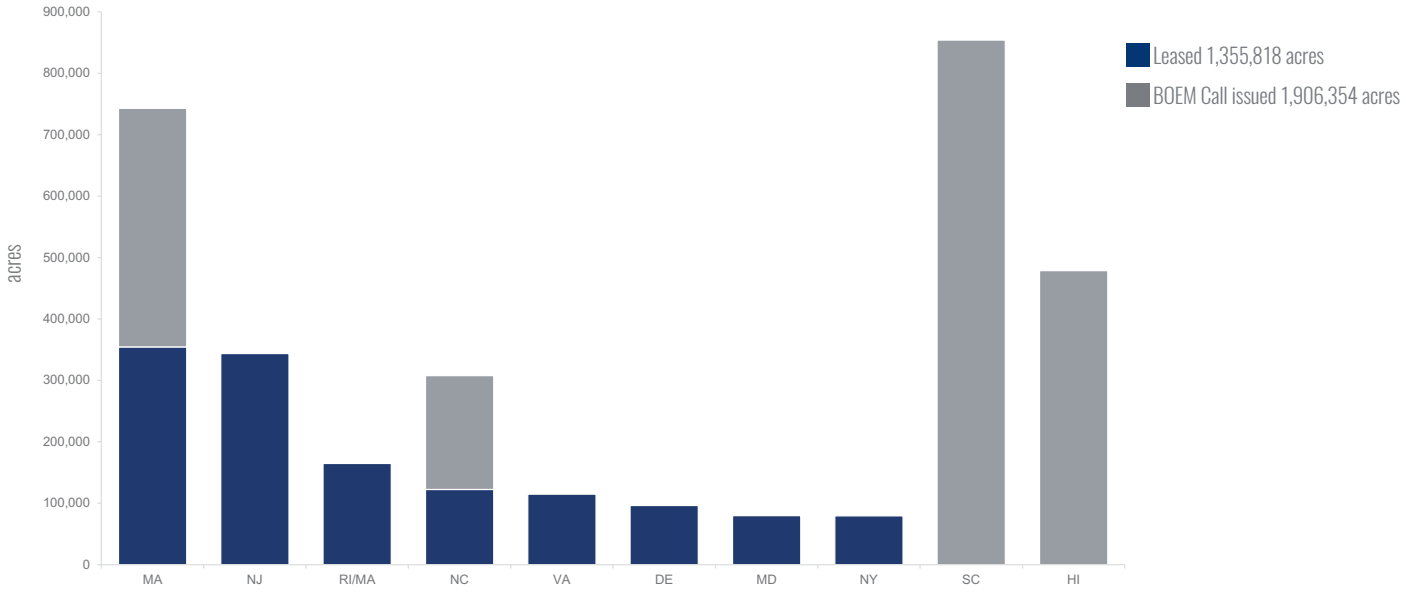
Global

Worldwide, offshore wind energy capacity reached about 14.4 gigawatts (GW) in 2016.[7] Europe and the United Kingdom have led the development of offshore wind farms and now have more than 12.6 GW of offshore wind energy infrastructure in operation and 24.2 GW of approved offshore projects in the pipeline.[8] China has significant offshore wind energy capacity as well, totaling about 1.6 GW of capacity in 2016.[9] Supply chain, jobs, and procurement (offtake conditions) have evolved considerably in the past few years.

National

With more than 2,000 GW of potential wind energy capacity using existing technology, the U.S. has enormous potential for offshore wind energy development.[10] There is already a healthy pipeline of offshore wind projects under development. BOEM leased nearly 1.4 million acres for wind energy development, and nearly 2 million more acres are under consideration and scoping by BOEM. The first U.S. offshore wind farm, off the southern coast of Block Island, Rhode Island, began operating in December 2016 and has a capacity of 30 MW.

Figure 2. BOEM Leasing Activity by State



[7] http://gwec.net/global-offshore-wind-capacity-reaches-14-4gw-in-2016/

[8] https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2016-Infographic.pdf

[9] http://www.gwec.net/wp-content/uploads/2017/02/7_Annual-and-Global-Cumulative-Offshore-wind-capacity-in-2016.jpg

[10] USDOE, 2016 National Offshore Wind Strategy.

In April 2017, BOEM executed a lease with Statoil Wind US LLC for what could become the first large wind development project off of New York's coast. BOEM also executed leases for Wind Energy Areas off the coasts of Massachusetts, Rhode Island, New Jersey, Delaware, Maryland, Virginia, and North Carolina, some of which could eventually contain offshore wind energy projects that would provide energy to New Yorkers.[11] In fact, the Long Island Power Authority contracted for 90 MW of power from Deepwater Wind's South Fork Wind Farm off the southern coast of Rhode Island and Massachusetts, east of Montauk. Figure 3 shows the locations of these existing lease areas, along with those that are currently being considered by BOEM for future leasing. Some areas have projects with offtake secured, while others are undergoing site assessment in order to prepare for eventual offtake competitions. Maryland awarded offtake to two projects in May 2017;[12] Massachusetts solicited bids of up to 800 MW that were received in December 2017 and committed to additional procurements over the next 10 years towards its 1,600 MW goal;[13] and New Jersey's 2010 Offshore Economic Development Act requires the state to procure at least 1,100 MW of offshore wind energy.[14]

Most of the nation's offshore wind energy development activity has been off the East Coast, where there are high winds, shallow waters, and high demand from major cities situated adjacent to the Atlantic Ocean. The conditions on the West Coast are not as favorable given current technology because deeper waters there preclude the use of traditional bottom-fixed turbines. However, floating wind farm technology is advancing, and BOEM and the state of California have initiated the competitive planning and leasing process for offshore wind energy development off that state's coast.[15] Additional research efforts to identify the potential benefits and impacts of renewable hydrokinetic (wave) energy projects off the West Coast also are underway.[16]

Credit: Deepwater Wind

Most of the nation's offshore wind energy development activity has been off the East Coast,

where there are high winds, shallow waters, and high demand from major cities situated adjacent to the Atlantic Ocean.

[11] When considering the availability of generation sites, it is not required – and in fact may not be the case – that projects located in leased Wind Energy Areas situated most closely to a particular state supply their generation to that state. While transmission to that closest state may be most cost-effective, other cost considerations may militate for constructing transmission to another state, or energy may be sold into a neighboring state after being delivered into that closest state but then "wheeled" through the regional transmission operator systems.

[12] Maryland Public Service Commission, "Maryland PSC Awards ORECS to Two Offshore Wind Developers Projects to Create Jobs, Economic Development in New Energy" (May 11, 2017), available at http://www.psc.state.md.us/wp-content/uploads/PSC-Awards-ORECs-to-US-Wind-Skipjack.pdf

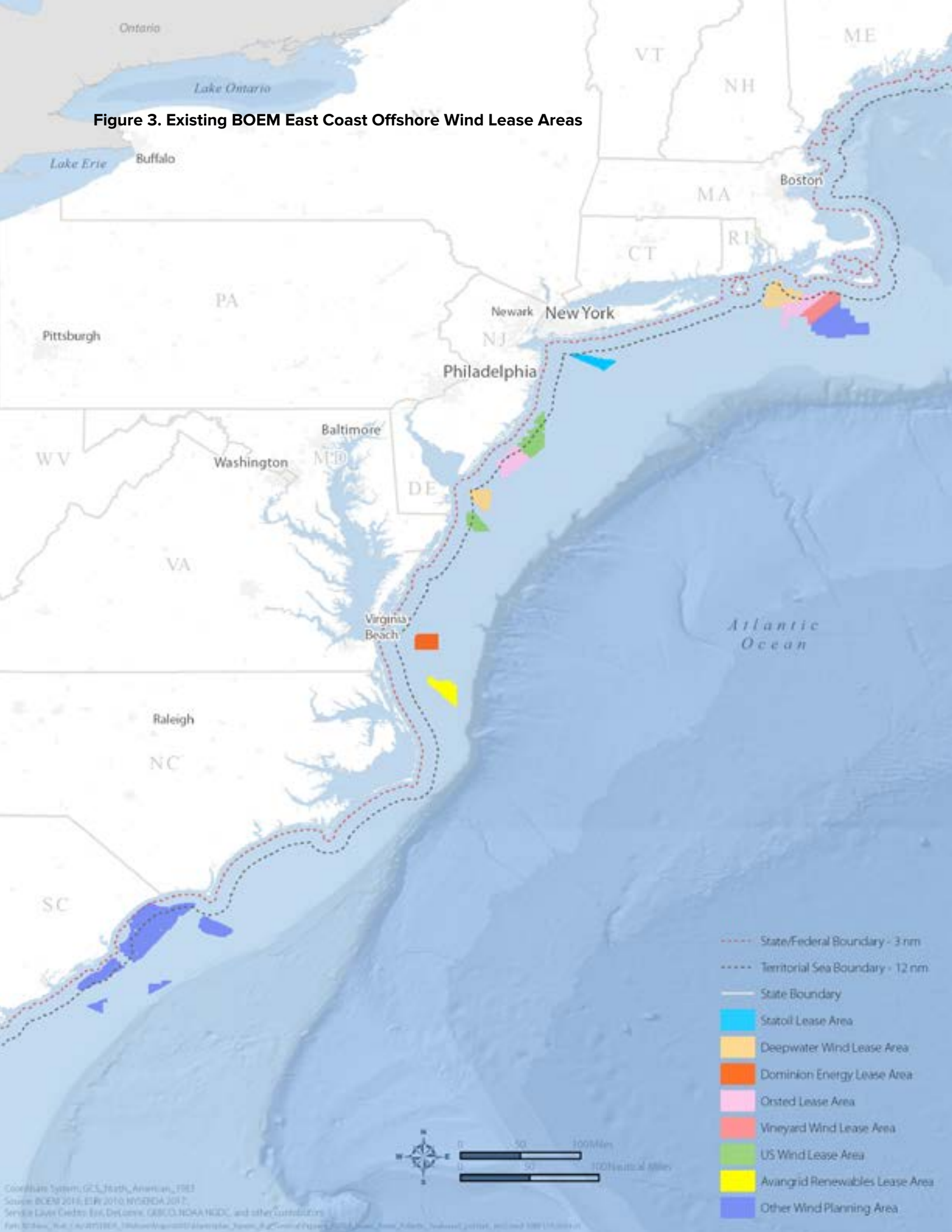
[13] Massachusetts Request for Proposals: Massachusetts Department of Energy Resources, "Request for Proposals for Long-Term Contracts for Offshore Wind Energy Projects" (June 29, 2017), available at https://pierceatwoodwhatsup.com/26/207/uploads/rfp-for-offshore-wind-energy-projects-in-massachusetts.pdf
Legislation: "An Act Relative to Energy Diversity" (H.4568), https://malegislature.gov/Laws/SessionLaws/Acts/2016/Chapter188

[14] New Jersey "Offshore Wind Economic Development Act" (2010), available at ftp://www.njleg.state.nj.us/20102011/S2500/2036_R2.PDF

[15] https://www.boem.gov/California/

[16] https://www.boem.gov/Oregon/

Figure 3. Existing BOEM East Coast Offshore Wind Lease Areas



Regulatory Framework

Federal

The **Submerged Lands Act of 1953** (43 United States Code [U.S.C.] §1301 et seq.) granted states title to the submerged lands and natural resources within three nautical miles of their coastline (10 nautical miles for the Gulf Coasts of Texas and Florida) and preserved federal jurisdiction over submerged lands and resources seaward of states' submerged lands boundary. In the same year, the **Outer Continental Shelf Lands Act** (43 U.S.C. §1331 et seq.) defined submerged lands under federal jurisdiction as the outer continental shelf and assigned authority for leasing and regulating mineral exploration and development of the outer continental shelf to the Secretary of the Interior. This authority is administered by BOEM, a bureau of the Department of the Interior, although other federal agencies have different roles with respect to permitting and regulating an offshore area. In 2005, the **Energy Policy Act** (42 U.S.C. §13201 et seq.) amended the Outer Continental Shelf Lands Act to clarify uncertainties about offshore wind and granted development authority to the Secretary of the Interior. BOEM administers this authority by promulgating rules and guidelines and issuing leases for offshore wind development on the outer continental shelf.[17]

State

States retain authority for administering renewable energy development in state waters, and permitting regimes differ from state to state. However, most offshore wind developers will likely favor sites on the outer continental shelf to minimize marine use conflicts and potential environmental impacts, and thus will be regulated under federal jurisdiction by BOEM. Still, the majority of offshore wind farms developed in federal waters will have associated cables that must traverse state waters to transmit the energy onshore. In New York, the cables will trigger a Department of Public Service Article VII proceeding and a variety of other state approval and permitting requirements, which are discussed in *Appendix E: Cable Landfall Permitting Study.* Environmental assessments associated with offshore wind development likely will need to consider the existing environments in both federal and State waters.

Local

Local municipalities regulate land use and zoning within their borders, and thus also will likely be involved in permitting and regulating the onshore elements of offshore wind developments. For example, if not allowed as of right, a cable landfall may require a special use permit.[18] In addition, a building permit from the relevant municipality will likely be required before construction of any onshore infrastructure begins.

While each offshore wind energy project will involve its own permitting, consultation, and approval processes, *Appendix X: Table of Permits and Approvals* contains a representative, but not necessarily exhaustive, list of relevant federal and State permits that may be required for an offshore wind energy development project off the coast of New York State.

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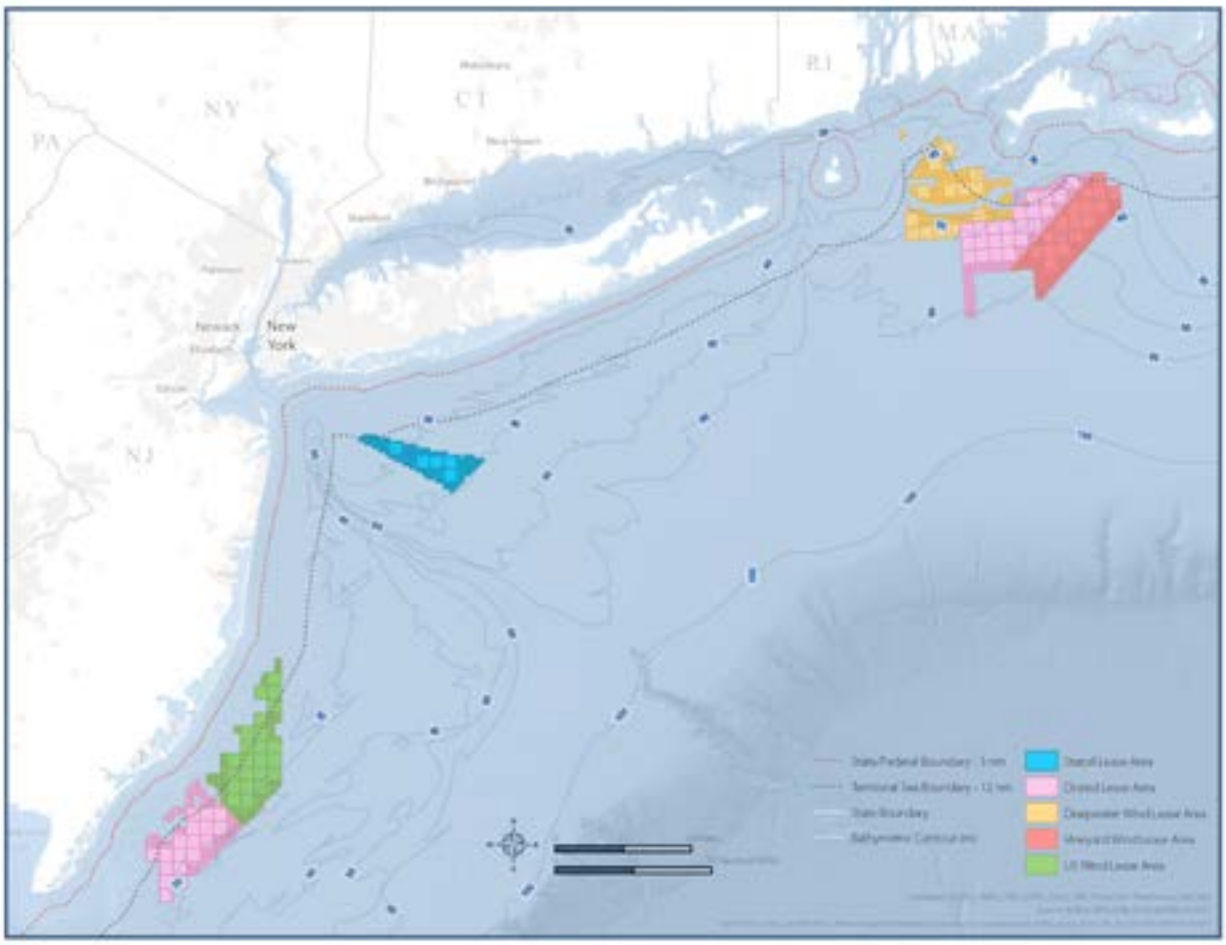
[17] https://www.boem.gov/Regulatory-Development-Policy-and-Guidelines/

[18] The nearshore areas of some municipalities on Long Island are subject to colonial-era (1600s) land grants called Dongan Patents, which typically are held by elected municipal trustees and restrict development activities. These municipalities therefore may have jurisdiction over nearshore and onshore elements.

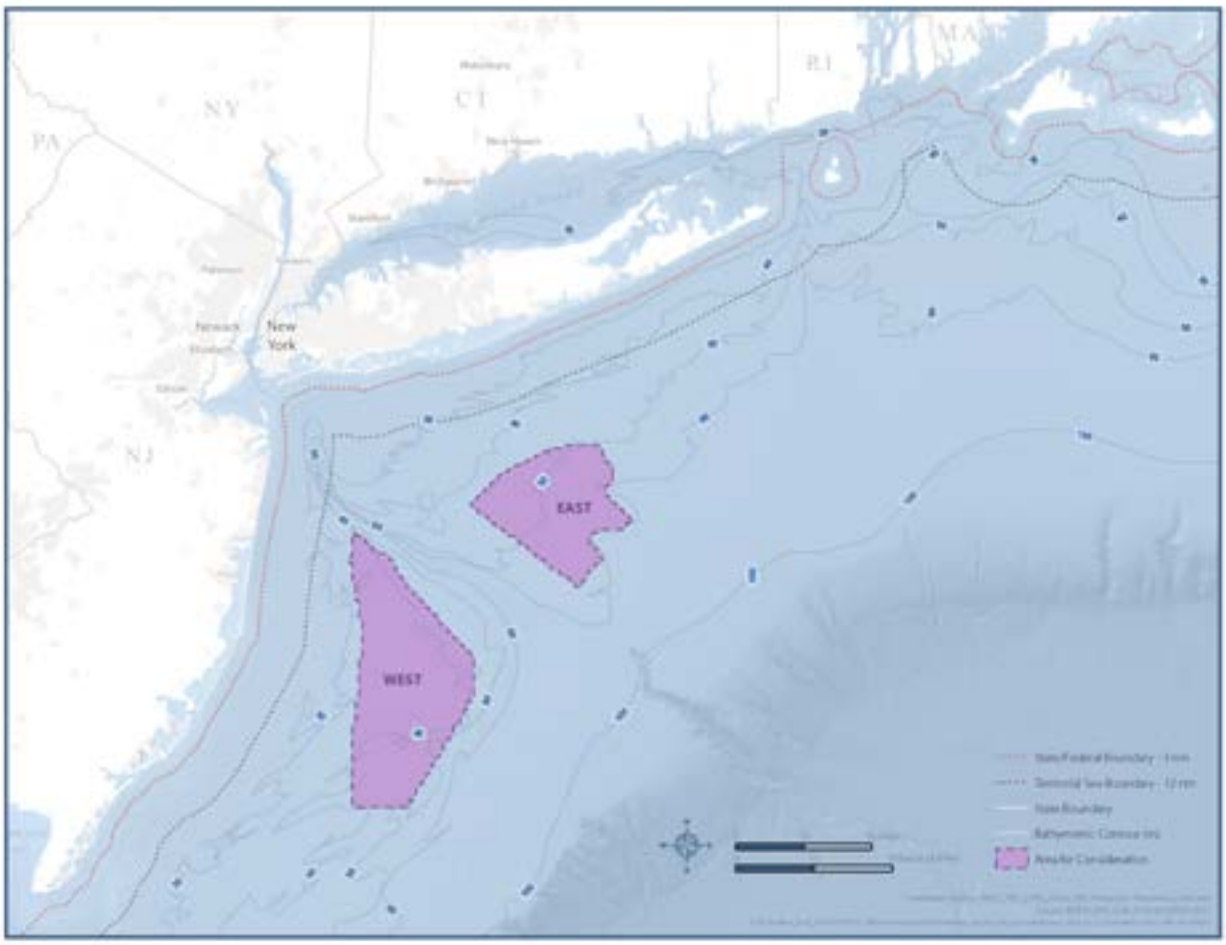
Figure 4. Existing BOEM Lease Areas capable of supplying offshore wind to New York State



Area for Consideration and Request for Wind Energy Areas

To achieve New York's offshore wind energy objectives in a cost effective and responsible manner, the geographic areas eligible for offshore wind energy development must have the capacity necessary to site 2,400 MW of energy generation. As shown in Figure 4, six existing Wind Energy Areas are currently available to contribute to the State's offshore wind energy goals. However, these areas will also be available to support the renewable energy goals of other nearby states, and the costs associated with long-distance transmission to New York can increase overall costs. While offshore wind energy can be a regional resource, such that a single Wind Energy Area may meet the demands of multiple states, it is also critical that new Wind Energy Areas be identified and leased to ensure an adequate and competitive supply of areas are available to meet New York's demand at the lowest cost.

Figure 5. New York State Area for Consideration for Offshore Wind Development



Based on a robust analysis of the detailed studies, fieldwork, and stakeholder input obtained through the Master Plan process, in October 2017, New York State identified an Area for Consideration for potential offshore wind development and formally requested that BOEM identify and lease at least four new Wind Energy Areas within the Area for Consideration, each capable of supporting at least 800 MW of offshore wind.[19] The State determined the Area for Consideration shown in Figure 5 has the best potential to be the most cost-effective and desirable area for future wind development off New York's coast. The Area for Consideration encompasses 1,061,802 acres and is more than 21 miles from land at its closest point. Using the analysis from the Visibility Threshold Study,[20] the State set a minimum distance of 20 miles for the Area for Consideration in order to ensure that, for the vast majority of the time, turbines would have no discernable or visible impact for a casual viewer on the shore. With greater distance, the potential for turbine visibility is further reduced.[21] The Area for Consideration presents, on balance, the fewest overall conflicts with ocean users, natural resources, infrastructure, and wildlife. BOEM's identification and leasing of new Wind Energy Areas within the area the State proposed would increase competition, drive down ratepayer costs, and provide ample capacity to meet New York's 2,400 MW goal of offshore wind by 2030, even if some portions of the area remain undeveloped, are only partially developed, or serve other markets in part or in whole.

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[19] The State's submission to BOEM, entitled New York State Area for Consideration for the Potential Locating of Offshore Wind Energy Areas, is attached as Appendix U and also can be found at: https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind/New-York-Offshore-Wind-Master-Plan/Area-for-Consideration

[20] Visibility Threshold Study, Appendix S.

[21] As described in the Options Paper submitted to the Commission, New York State may elect to set a minimum distance from shore as a criterion for its procurements.

Credit: Siemens

Benefits and Cost-Reduction Pathways

This section describes the benefits that can be realized by New York State through the achievement of its offshore wind energy goals, identifies several steps already taken toward that end, and analyzes procurement and other strategies to reduce development costs of offshore wind energy at scale.

Benefits of Offshore Wind Energy Development for New York State

Environmental Benefits

Electricity generation of all types can have adverse effects on human health, wildlife, and habitats. At the simplest level, not developing renewable resources such as offshore wind energy will result in increased burning of traditional fuels (e.g., oil, natural gas, and coal) to meet electricity requirements, which have well-understood adverse environmental impacts. The extraction and burning of fossil fuels leads to the production of greenhouse gas emissions, which drives climate change and ocean acidification. Furthermore, burning of fossil fuels results in air pollutants that are responsible for adverse environmental and economic impacts including the degradation of lakes, streams, and forests from acid deposition; elevated levels of mercury in fish and other wildlife; and human morbidity and mortality from poor air quality related to ozone and particulate matter. In addition, steam electric generating power plants in New York State use up to 17 billion gallons of water per day, which leads to the entrainment, impingement, and death of fish and fish larvae.[22] The development of offshore wind energy resources can mitigate or offset each of these impacts.

It is not possible to precisely quantify all of the environmental benefits that may result from developing offshore wind energy. However, the magnitude of some benefits — as discussed below — can be estimated and monetized. Even with this partial view, it is evident that the monetary values of the benefits of offshore wind energy would be significant, and justify the investment of public resources in policies to promote offshore wind energy development.

Burning of fossil fuels results in air pollutants that are responsible for adverse environmental and economic impacts.

Development of offshore wind energy can mitigate or offset each of these impacts.

[22] Nieder W. 2010. The relationship between cooling water capacity utilization, electric generating capacity utilization, and impingement and entrainment at New York State steam electric generating facilities. New York State Department of Environmental Conservation.

Credit: Siemens

Greenhouse Gas Emission Reductions from Offshore Wind

Development of 2,400 MW of offshore wind energy would annually reduce greenhouse gas emissions in New York State by more than five million short tons, which is the equivalent of removing nearly one million cars from the road by 2030. This accounts for approximately one-third of the expected greenhouse gas reductions from new renewable energy projects that will be constructed by 2030 to meet the Clean Energy Standard 50 percent renewable electricity target.

This emissions-reduction benefit would amount to approximately $1.9 billion (net present value) based on the "social cost of carbon" published by the U.S. Environmental Protection Agency.[23] The concurrently released *Appendix V: Offshore Wind Policy Options Paper*, discussed further in "Procurement and Other Cost-Reduction Pathways," estimates that this emissions-reduction benefit alone would approximately equal the program costs of procuring offshore wind energy, even before accounting for the wider economic development and health benefits.[24]

Air Quality Improvement from Offshore Wind Energy

The production of zero-emission energy close to the two largest load pockets in New York State — New York City and Long Island — could improve local air quality and public health in these locations and beyond by reducing the need for high-emission generation facilities.

Offshore wind energy's potential contribution to reducing emissions is particularly important for the New York City metropolitan area, which has a high population and high density of emissions sources. Concentrations of fine particulate matter ($PM_{2.5}$) and ozone — two pollutants with public health impacts that include respiratory and cardiovascular disease — are higher in the New York City metropolitan area than in the rest of the State. Each year in New York City, $PM_{2.5}$ at levels higher than background are estimated to be associated with more than 2,000 premature deaths, 4,800 emergency department visits for asthma, and 1,500 hospitalizations for respiratory and cardiovascular disease.[25] Reducing pollution by even modest amounts in such a highly populated area would have significant benefits.

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[23] https://archive.epa.gov/epa/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf

[24] Offshore Wind Policy Options Paper, Appendix V; also Massachusetts RFP: Massachusetts Department of Energy Resources, "Request for Proposals for Long-Term Contracts for Offshore Wind Energy Projects" (June 29, 2017), available at https://pierceatwoodwhatsup.com/26/207/uploads/rfp-for-offshore-wind-energy-projects-in-massachusetts.pdf. Legislation: "An Act Relative to Energy Diversity" (H.4568), https://malegislature.gov/Laws/SessionLaws/Acts/2016/Chapter188.

[25] New York City Department of Health and Mental Hygiene. New York, NY. 2013. New York City Trends in Air Pollution and its Health Consequences.

[26] All scenarios included realization of the Clean Energy Standard; therefore, the offshore wind scenario was compared to a scenario with the same amount of upstate electricity generation from renewable sources. PROMOD, a production cost modeling tool created by ABB, was used to simulate the impacts of offshore wind energy development on the electricity market and the resulting air pollution emissions at fossil-fuel power plants in New York and 14 other states in the region (including Connecticut, Delaware, Illinois, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, Ohio, Pennsylvania, Rhode Island, Virginia, Vermont, and West Virginia).

Credit: Alpine Ocean

Reducing pollution by even modest amounts in such a highly-populated area would have significant benefits.

The State conducted a screening-level analysis of the air quality benefits if 2,400 MW of offshore wind energy were to supply electricity to New York City and Long Island in 2030.[26] This analysis showed, with the deployment of 2,400 MW offshore wind energy, more than 1,800 tons of nitrogen oxides (NO_x), 780 tons of sulfur dioxide (SO_2), and 180 tons of $PM_{2.5}$ would be avoided as compared to a scenario without the development of this offshore wind energy.

The State estimated how changes in ambient air quality affect public health outcomes, and then estimated the monetary value of the public health impacts.[27] This screening-level analysis found that the offshore wind energy scenario would result in eight to 18 fewer premature deaths annually and would avoid multiple adverse health outcomes in 2030 across the northeast U.S. The total annual health benefits of the 2030 offshore wind scenario are valued between $73 million and $165 million. These benefits would continue well beyond 2030 since offshore turbines have a 25-year lifespan.

Total annual health benefits of the 2030 offshore wind scenario are valued between $73 and $165 million.

A recent study, *Health and climate benefits of offshore wind facilities in the Mid-Atlantic United States* concluded that the magnitude of emission reduction benefits associated with offshore wind energy is significant.[28] This study evaluated differently-sized wind energy projects off the coasts of New Jersey and Maryland for the years 2012 and 2017,[29] and compared them to baseline conditions without any offshore wind energy. The monetized benefits predicted from estimated public-health improvements due to offshore wind energy ranged from $53 million to $400 million per year depending on the size of the offshore facility, the type of electrical generating unit (e.g., coal or natural gas), and the amount of generation displaced.

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[27] The screening-level analysis was conducted using the U.S. EPA, Co-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool. https://www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool. COBRA estimates how emission reductions would affect ambient air quality and health throughout a region.

[28] Buonocore, J. J., Luckow, P., Fisher, J., Kempton, W., & Levy, J. I. (2016). Health and climate benefits of offshore wind facilities in the Mid-Atlantic United States. Environmental Research Letters, 11(7), 074019.

[29] The study considered 1,000 MW projects in Maryland and New Jersey for 2012, and considered 200, 300, 400 and 1,000 MW projects for Maryland, and 1,100 and 3,000 MW projects for New Jersey for 2017.


Credit: Siemens

Jobs, Supply Chain, and Economic Benefits

Given the established supply chain in Europe and the capital intensity of offshore wind energy farms, development of new U.S. facilities will require long-term market certainty. State actions such as infrastructure investments and energy procurements are expected to be a key factor in locating the long-term U.S. supply chain and the resulting workforce and economic benefits.

Accordingly, Governor Cuomo, in his 2018 State of the State address,[30] announced that NYSERDA will invest $15 million in clean energy workforce development and infrastructure advancement. This will support training workers for jobs in offshore wind construction, installation, operation, maintenance, and design. To attract private investment in port infrastructure and manufacturing, the State will also work with the offshore wind industry to determine promising infrastructure investments, which will jumpstart project development, drive job growth, and secure New York's status as the undisputed home for the emerging offshore wind industry in the U.S.

A progressive energy landscape already exists across New York State, as evidenced by the approximately 22,000 New Yorkers working in the renewable energy industry (including solar, land-based wind, and hydropower).[31] The State's vision to create a clean, resilient, and affordable energy system has resulted in policy standards that have triggered job growth across a range of technologies. Offshore wind is the next addition to the State's fast-growing clean energy industry and is expected to be a key driver in the increasing demand for renewable energy workers in New York.

NYSERDA conducted an analysis (Workforce Study) that considered the economic development and potential job impacts, associated with offshore wind by assessing three primary industry needs:

- Component and equipment manufacturing
- Port infrastructure expansion (which supports manufacturing, installation and operations and maintenance activities)
- Required workforce skills needed to support any New York-based manufacturing, installation, or operations and maintenance activities[32]

The Workforce Study quantified the potential demand for workers from both the New York and regional wind energy development industry and matched that demand to the workforce strengths already existing in the State.

[30] 2018 New York State of the State Policy Book, pg. 220. https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/2018-stateofthestatebook.pdf

[31] 2017 New York Clean Energy Industry Report, NYSERDA 2017. The broader clean energy industry, including energy efficiency, clean transportation and advanced grid technologies employs over 146,000 workers today.

[32] The Workforce Opportunity of Offshore Wind in New York, Appendix T.

Credit: Deepwater Wind

In total, the Workforce Study estimates that the total demand for New York workers could peak at nearly 5,000 jobs in 2028.

The Workforce Study finds that New York is ideally suited for sustained offshore wind workforce opportunities:

- New York can realize nearly 5,000 new jobs in manufacturing, installation, and operation of OSW facilities, with a regional commitment to scale development of the resource. Nearly 3,500 of these jobs are expected to support New York wind farms, with the remaining supporting regional projects.
- Nearly 2,000 of these jobs are in operations and maintenance (O&M), providing sustained career opportunities for New Yorkers as the average OSW facility life span is at least 25 years.
- The Workforce Study forecasts that the State's successful attainment of offshore wind energy workforce and infrastructure can result in more than $6 billion of in-state expenditure
- Many New Yorkers already possess most of the skills necessary to attract OSW manufacturers and developers, and skill development support from New York State will ensure new workers will have the skills needed to participate in this industry.
- New York's existing infrastructure is well positioned for OSW development throughout the region, with ports and manufacturing assets that are uniquely suited to OSW needs.

The Workforce Study demonstrates there are a range of potential outcomes for offshore wind's workforce impact, and achievement of the highest potential job creation will depend on numerous factors, including New York's ability to compete with other states for development, manufacturing, and other supply chain investments.

New York has several important attributes that will support its ability to compete:

- An industry-leading procurement commitment of 2,400 MW of offshore wind energy will provide a powerful mechanism to attract developers and supply chain partners to invest in New York
- Central location between Northeastern and mid-Atlantic states, where the majority of U.S. offshore wind energy projects will be built in the near term, with existing port facilities ideally positioned to service wind farms across the region
- Core manufacturing competencies that are well-suited to the offshore industry
- A workforce equipped to support the offshore wind energy industry, as many New York trade workers and assemblers already possess skills that can be directly translated to the offshore wind energy industry

In total, the Workforce Study estimates the total demand for New York workers could peak at nearly 5,000 jobs in 2028. The Study also found that the State's workforce is expected to primarily benefit from the long-term operations and maintenance sector, which is estimated to support nearly 2,000 jobs. These positions will support the ongoing maintenance of the wind farms for the duration of their 25-year useful life. Operations and maintenance workers must be able to respond quickly to any on-site requests, making their proximity to the wind farms critical. New York can therefore see nearly all of these as baseline jobs, confident they will be sourced locally.

Incremental to operations and maintenance, the manufacturing and installation and commissioning sectors can support approximately 2,700 jobs, and project management and development could support as many as 350 jobs. These positions will be required during the development and construction phases of the project life cycle; therefore, not offering the same long-term benefits as the baseline operations and maintenance jobs. The local content of these sectors will be a function of the industry's use of New York ports.

New York's central location and experienced workforce make its port facilities ideal for offshore wind development.

The use of local workforce and infrastructure also carries the benefits of economic stimulus and possible reductions of energy cost. Beyond the projected generation of $6 billion of in-state expenditure, the manufacturing, installation, and staging of components in New York ports can also reduce transportation costs, a benefit that could be seen through reduced ratepayer costs. While New York's central location and experienced workforce make its port facilities ideal for offshore wind development, the State can take steps to support its aspiration to be an offshore wind energy hub.

To maximize the skillset of local workers and facilitate cost-efficient development, the State will need to ensure the training and certification requirements of the offshore wind energy industry are clear and readily available to the labor and educational communities. As discussed in "Jobs and Supply Chain Technical Working Group," the State will convene a Technical Working Group to develop and implement programs that ensure New York workers have the skills, training, and certifications necessary to participate in the offshore wind energy industry. Beyond this, however, opportunity for New York workers will stem from the emergence of offshore wind energy-related infrastructure within the State.

Credit: Orsted

Credit: Deepwater Wind

Due to the large scale of the physical components of offshore wind energy projects, the industry demands a dedicated array of physical infrastructure. While construction material such as steel, carbon fiber, and copper (Tier 2 manufacturing) may be produced in diverse locations, the primary offshore wind components, including towers, blades, and cables, among others (Tier 1), will likely need to be produced at waterfront port facilities. Manufacturers are actively considering investment in new U.S. facilities, and the most cost-efficient solutions will optimize several key variables, including distance to Wind Energy Areas, physical site suitability, and experience of the local workforce. As a large portion of offshore wind energy jobs relate to the manufacturing, assembly, and installation of Tier 1 components, the development of port infrastructure in New York is critical for the creation of new in-State jobs.

In addition to its nation-leading commitment, the State's central location should attract investment and make its port facilities ideally positioned to service wind farms across the region. New York also has the core manufacturing competencies to serve the offshore wind energy industry. However, industry-specific design and manufacturing knowledge, as well as access to quayside facilities, will need to be developed. New York's engagement with Tier 1 and Tier 2 manufacturers, to both attract new facilities and to expand the technical capabilities of existing infrastructure, will be critical in maximizing local supply.

Development of port infrastructure in New York is critical for the creation of new in-State jobs

New York benefits from three distinct coastal geographies each of which can serve the port industries required by offshore wind energy development.

Credit: Deepwater Wind

The State benefits from three distinct coastal geographies — New York Harbor, the Hudson River, and along the coast of Long Island — each of which can serve the port industries required by offshore wind energy development. NYSERDA conducted a screening assessment[33] of the physical characteristics of 65 port sites within the State to support the development of a local offshore wind energy supply chain, and found that New York Harbor offers sites that are suitable for all elements of manufacturing, fabrication, assembly, and staging activities. Sites along the Hudson River are generally appropriate for various manufacturing needs, with possibilities for turbine, blade, tower, and cable manufacturing and assembly. Long Island, given its shallow navigable depths and other physical constraints, is best suited for operations and maintenance facilities. As discussed in "Jobs and Supply Chain Technical Working Group," to further the development of a local supply chain, the State will evaluate existing port facilities to determine which could be expanded or redeveloped to support offshore wind energy development.

Procurement and Other Cost-Reduction Pathways

Long-term technology cost reductions and cost-effective procurement are essential parts of New York's strategy to deliver its 2,400 MW goal. State policies and undertakings can influence the costs associated with developing offshore wind energy projects and procuring the energy created by those facilities.

Concurrent with the publication of this Master Plan, NYSERDA has filed an *Offshore Wind Policy Options Paper* (Options Paper) with the Commission. In completing this task, NYSERDA conducted an analytical assessment of different mechanisms that could be used to procure offshore wind energy and associated attributes, and analyzed each mechanism's potential to result in cost-efficient project development. The Options Paper also considers offshore wind's role in achieving New York's 50 percent renewables by 2030 goal and a transmission and interconnection strategy. The Options Paper is found in Appendix V.

In Europe, offshore wind development costs have decreased dramatically in recent years; in many cases offshore wind is cost-competitive with land-based renewables. The cost reductions seen in Europe depended to a material extent on local learning and local infrastructure development resulting from economies of scale. With achievement of the 2,400 MW goal contributing to similar scale economies in the U.S. Northeast, NYSERDA projects that by 2030 the cost to procure offshore wind will be lower than the cost of Tier 1 Renewable Energy Credits (RECs) associated with other large-scale renewable technologies. Offshore wind therefore has the potential to lower the cost of meeting the 50 by 30 target.

[33] Assessment of Ports and Infrastructure, Appendix B.

Credit: Deepwater Wind

Near-term challenges for developing offshore wind energy projects include higher costs relative to other renewables, relatively long development lead-times, and limited competition between projects in initial procurements. However, policy approaches will evolve as the market matures, and these near-term challenges are likely to diminish over the longer term. Accordingly, Governor Cuomo announced in his 2018 State of the State Address that New York State will procure a total of at least 800 MW of offshore wind over two solicitations to be issued in 2018 and 2019.[34] This initial phase of deployment is considered in NYSERDA's Options Paper.

NYSERDA has examined a range of options for procurement of transmission and interconnection structures. NYSERDA believes that joint procurement of the generating assets and transmission and interconnection structures presents the most easily-implementable and feasible option for the initial 2018 and 2019 solicitations. Alternative options of procuring transmission and interconnection through a separate solicitation, or in the form of regulated assets, could offer advantages in particular where transmission and interconnection should be developed through a "network" or "backbone" approach that would support a number of offshore wind projects, as opposed to "radial" transmission and interconnection structures that meet the needs of the specific offshore wind energy project in question. However, these are subject to additional implementation challenges. Because of the limited number of developers and lease sites in the near term, the network approach would likely become more important for subsequent solicitations, but it is noted that network-type procurement aspects could be accommodated in each of the transmission and interconnection procurement structures.

NYSERDA expects offshore wind funding for a first phase of procurements would be provided by a compliance obligation placed on load-serving entities through an administrative structure similar to the Zero-Emissions Credit program.

New York State will procure a total of at least 800 megawatts of offshore wind over two solicitations to be issued in 2018 and 2019.

[34] 2018 New York State of the State Policy Book, pgs. 218-220. https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/2018-stateofthestatebook.pdf

Credit: Siemens

Within the Options Paper, NYSERDA assessed other cost-reduction pathways that could be realized through procurement of offshore wind, including potential financing by NY Green Bank. These assessments are summarized below.

Procurement Mechanisms

NYSERDA assessed a range of procurement options that could be utilized to deliver the 2,400 MW offshore wind target

In its Options Paper, NYSERDA assessed a range of procurement options that could be utilized to deliver the 2,400 MW offshore wind target. The cost analysis performed in support of the Options Paper demonstrates the procurement option choice for offshore wind deployment has a critical impact on the resulting cost. Key differentiating factors between procurement models are the extent to which hedging benefits are provided against risks of commodity revenue uncertainty, and the level of involvement of NYSERDA and other organizations, such as utilities.

The cost of offshore wind energy is a function not only of technology costs, but also the financing costs associated with the investor's target rate of return. The combined effect of these two types of costs are contained within a single metric, the levelized cost of energy. While technology costs are largely out of the State's control, financing costs can be contained by establishing a procurement mechanism that mitigates long-term hedging against commodity risk. Because the procurement model ultimately selected by the State will significantly impact the cost and viability of future offshore wind energy development, **procurement models in use around the world were surveyed**. The optimal procurement model should balance the scale, pace, and design of procurements needed to rapidly drive down offshore wind energy cost while minimizing the ratepayer cost.

In the Options Paper, NYSERDA focuses on seven procurement mechanisms in detail, with the goal of assessing — and helping the Commission to select — the most feasible mechanism(s) for the first phase of offshore wind energy procurements.

The following seven Phase I potential procurement models, along with their relative advantages and disadvantages, are described and assessed in the Options Paper.

Procurement Option 1 – Fixed REC: NYSERDA's past large-scale renewables procurement auctions under the RPS Main Tier, and current procurements under Tier 1 of the Renewable Energy Standard, employ a structure that provides a limited revenue hedge. Under this approach, winning large-scale renewables projects receive a fixed, as-bid REC price throughout the contract lifetime, but no hedge is provided against changes in commodity electricity (energy and/or capacity) prices. Projected program costs under this option would thus be higher than those expected under other options with more far-reaching hedging benefits.

Procurement Option 2 – Bundled PPA: This procurement structure — assessed in past State analyses as bundled power purchase agreements (PPA)[35] — provides a hedge against commodity electricity price risk, and thus could unlock significant reductions in project cost of finance. Under this approach, one or more utilities would competitively procure offshore wind projects and make an all-in, fully-hedged revenue stream for commodity value and RECs available to winning projects.

Procurement Option 3 – Utility-Owned Generation (UOG): Like the Bundled PPA option, this option would involve competitive procurement by one or more utilities. Offshore wind developers would develop, design, build, and potentially operate offshore wind facilities; and once completed, project ownership would be transferred to the utility or utilities. UOG represents an alternative form of hedged procurement that would benefit from the low costs of capital that would be available through rate-basing utility investments.

Credit: Orsted

Procurement Option 4 – Split PPA: This option pairs NYSERDA fixed-price REC procurement (as under Option 1) with fixed-price commodity energy and capacity procurement by a utility. From a developer's perspective, this option would be similar to the Bundled PPA option in its hedging benefit, effectively providing a fully-hedged product consisting of a fixed commodity and a fixed REC-price component. However, from the perspective of the State's ratepayers, the effective cost premium associated with the REC-price component would depend on the level of the fixed commodity value compensation offered by the utility.

Procurement Option 5 – Market OREC:[36] Unlike the Bundled PPA, Utility Ownership and Split PPA options, the Market OREC structure would provide commodity hedging benefits without necessitating utility involvement. Under this option, NYSERDA would provide a premium payment to projects based on the net difference, from time to time, between the project's winning bid price (expressed as an all-in revenue amount) and the actual revenue the project was able to achieve from its commodity sales (whether in the regulated wholesale markets or through other transactions). While this would deliver a perfect commodity hedge, jurisdictional concerns may arise regarding the link to the project's actual commodity sales transactions. In addition, this approach could result in a potential disincentive to project operators to maximize their sales revenue.

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[35] http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7b26BD68A2-48DA-4FE2-87B1-687BEC1C629D%7d

[36] Offshore wind renewable energy credit

Procurement Option 6 – Index OREC: Under this option, NYSERDA would provide a premium payment to projects under an offshore wind REC (OREC) contract based on the net difference, from time to time, between the project's winning bid price (expressed as an all-in revenue amount) and the average commodity market price as expressed in a market index or composite of indices, whether the project sold its commodities into the regulated wholesale markets or not. While this option provides most of the hedging benefits of alternative fully-hedged options previously discussed, this structure would address jurisdictional concerns by avoiding a link between premium payments and the project's actual commodity sales. This option would also provide the advantage of incentivizing generators to maximize the commodity sales value of offshore wind energy.

Procurement Option 7 – Forward OREC: Like New York's Zero-Emissions Credit program, this option would provide a payment to winning projects that would adjust every two years. Unlike the Zero-Emissions Credit structure, however, this approach would allow for both upward and downward adjustment of payments. The OREC premium level of each two-year period would be calculated prior to the beginning of the tranche according to two-year energy and capacity price forecasts or forward indices and would remain fixed for the duration of the tranche. This option would aim to provide long-term hedging benefits for the lifetime of projects by leveraging shorter-term (two-year) hedging products to bridge the period between REC premium level adjustments; accordingly, its success in unlocking the cost benefits of a hedged procurement structure depends on funders' confidence in the availability of two-year hedging products in the market for the duration of the asset life.

As described more fully in the Options Paper, NYSERDA analyzed each of the above procurement mechanisms in depth with respect to key cost indicators, including incremental program cost, bill impact, gross program cost, and net program cost. NYSERDA also considered these options against other non-cost-related evaluation criteria, such as feasibility, scale of application, and compatibility and acceptability.

Credit: Deepwater Wind

On balance, NYSERDA concludes from the analysis described in the Options Paper that the following options for offshore wind procurement in New York during Phase I do not offer a similar level of benefits as the other five potential approaches:

- Fixed REC, due to the relatively high projected costs; and
- Market OREC, unless jurisdictional uncertainties can be addressed.

NYSERDA recommends that the Commission should focus attention for its Phase I decision on one or more of the remaining options, and should base its decision on the following considerations:

- The Split PPA option should be carefully evaluated for feasibility, due to the limited scale of deployment, implementation complexities, and uncertainties around effective costs to ratepayers.
- Although the Commission has previously declined to advance a UOG option for land-based renewables, there may be a limited role for this structure to reflect the specific early development challenges of the U.S. offshore wind sector.
- The Forward OREC would need validation of feasibility from market participants, due to its novel nature and uncertainty on funders' assessment of this structure and resulting costs of finance.
- Options that depend on utility participation (Bundled PPA, Split PPA and UOG) should only be adopted as the sole procurement option for one or more procurement rounds if and when critical uncertainties would have been resolved either through a Commission Order or through firm commitments from the utility or utilities in question, in particular on the scale of the utility's commitment and, in the case of Split PPA, the level of the fixed long-term energy and capacity prices the utility would be prepared to offer.
- Any of the utility-led options could potentially be included as alternative bid options in a solicitation by utilities, which would allow for direct comparison of benefits and risks associated with each option.
- In the absence of firm utility commitments, these options could still be progressed in parallel with another procurement option, such as Index OREC.

The Options Paper will be subject to a formal party comment process and ultimate Commission decision making, leading to Commission action that may initiate New York's statewide offshore wind procurements in the coming year.

Green Bank Financing

Many of the offshore wind energy procurement structures, as discussed above, can provide an effective means of reducing offshore wind project risk. In addition, the offshore wind energy finance supply chain is robust, and poised to directly deploy capital for U.S. generation projects utilizing well understood project revenue and economic models. While NYSERDA recognizes that costs associated with the pre-solicitation project development stage may be subject to financing challenges for independent or smaller project developers, this is not expected to be a concern for the project developers with access to Phase I sites. It is, therefore, expected that adequate sources of finance will be available to enable construction of Phase I offshore wind projects, particularly if New York offshore wind energy projects are substantially similar to precedent transactions previously financed in the global marketplace.

There may be roles for NY Green Bank. For example, NY Green Bank can consider acting — subject to its investment criteria, due diligence, and financial analysis — as a lender or credit enhancement (guarantees, reserves, etc.) provider.

Credit: National Geographic

Ongoing Activities to Advance Development of Offshore Wind Energy

New York is committed to the responsible development of offshore wind energy in the Atlantic Ocean. Offshore wind energy presents a tremendous opportunity to embrace a clean energy future that will power the State's homes and businesses, while creating jobs and boosting other economic benefits. New Yorkers also rely on the ocean for food, jobs, and recreation. As a result, the State must make certain that offshore wind energy technology is developed in a manner that is responsive to the offshore environment, including marine life as well as to existing water-dependent human activities. While appropriate offshore wind energy development can move forward today, the State believes the efforts set forth in this section will help **maximize the potential benefits** and **minimize the potential impacts** of such development and ensure the process remains responsive to all interests concerned.

Following the issuance of this Master Plan, the State will continue to foster outreach and public engagement, conduct additional research, and convene Technical Working Groups focused on fishing, maritime commerce, the environment, jobs, and the supply chain. These efforts will further the State's environmental, engineering, economic, and other studies and preliminary planning processes, through the identification of different perspectives and environmental information that can inform future decision making. For example, the working groups could develop BMPs intended to supplement federal requirements and help minimize impacts from future offshore wind energy development on existing ocean uses.

Offshore wind energy presents a tremendous opportunity to embrace a clean energy future.

Credit: Siemens

Continuing Outreach and Public Engagement

The Atlantic Ocean and coastlines of New York City and Long Island have richly contributed to the State's history and identity. The Port of New York and New Jersey is the nation's third-largest port by tonnage, and New York's ocean economy has long benefitted from robust maritime commerce, as well as commercial and recreational fishing activities. Other maritime uses in the offshore area include sand mining for beach nourishment, aquaculture, recreational activities such as diving and whale watching, and various military operations. Participants in these industries and activities, among others, have an interest in any potential development that could change the ocean environment.

One of New York State's primary goals is to ensure public input is considered at each phase of offshore wind energy planning and development. As previously described in "Public Outreach" and detailed in Appendix W, the Master Plan benefitted from months of outreach with governmental entities, elected officials, coastal communities,

non-governmental organizations, indigenous nations, and others. In many ways, this Master Plan represents the beginning of the process by which offshore wind energy will be considered and developed. In order to ensure the most responsible development of offshore wind energy projects, the State will continue to foster public feedback at every step, and provide timely, transparent responses to public concerns and questions. In its ongoing public engagement, the State will continually evaluate the most effective approaches to sharing information and receiving public feedback. The State will also coordinate with the federal government and eventual project developers to ensure the continuation of robust public engagement.

In addition, the State will continue to create opportunities for facilitating dialogue among developers, the public, and specific interested parties. NYSERDA's Offshore Wind website – nyserda.ny.gov/offshorewind – will continue to function as a one-stop-shop for public inquiries, with NYSERDA acting as an intermediary by directing interested parties to the appropriate information holder. New York will also sponsor and/or host in-person group meetings, conferences, webinars, workshops, and/or public information sessions and may support specialty liaisons to serve as a point of contact for particular groups.

Initial Technical Working Groups

- jobs and supply chain
- commercial and recreational fishing
- maritime activities
- environmental issues

Technical Working Groups to be Convened

New York believes the responsible development of offshore wind energy requires widespread collaboration with individuals and entities who have technical knowledge, practical experience, and professional interest in topics relevant to this nascent industry. To maximize the value of this collaboration, the State will convene and continue to foster the development of multiple Technical Working Groups consisting of experts and interested parties in different areas.

Throughout 2017, NYSERDA consulted with experienced professionals in the offshore wind energy industry to fully understand the challenges surrounding offshore work. NYSERDA formed a Market Advisory Group that included representatives from companies that develop offshore infrastructure and manufacture wind energy equipment, offshore wind industry groups, engineering firms, and law firms. The Market Advisory Group, which will continue to meet periodically going forward, has provided the State with insights into some of the issues that would benefit from the attention of dedicated Technical Working Groups.

The State will convene several specific Technical Working Groups to begin addressing some of the challenges associated with offshore wind development. Additional working groups will be created as needed. The initial Technical Working Groups will be in the areas of jobs and supply chain, commercial and recreational fishing, maritime activities, and environmental issues. It is anticipated each working group will determine its own management and decision-making structure, and NYSERDA will participate in and provide oversight and direction to the groups. Each Technical Working Group should identify the key federal and/or State regulatory entity(ies) that must be consulted and should vet the findings of the working group's report for feasibility, necessity, and applicability to federal regulatory process to ensure the working groups do not inadvertently create undue or unnecessary delay or obstacles to development. These groups and their initial charges are described in more detail in the sections that follow.

Credit: Siemens

Jobs and Supply Chain Technical Working Group

New York State is uniquely positioned to realize significant economic benefits from offshore wind energy development. These benefits will be far reaching, but seen most visibly in local job creation and the expansion of port infrastructure. The State also recognizes the workforce and supply chain serving offshore wind in the U.S. will develop in a competitive environment, with contributions coming from neighboring states as well as other countries. Therefore, it is imperative New York take a proactive position in workforce and supply chain development to maximize its economic benefits.

To this end, the State will develop and convene a Jobs and Supply Chain Technical Working Group comprised of unions and other labor groups; governmental entities, including the New York State Department of Labor, Empire State Development, the Port Authority of New York/New Jersey; and representatives of the New York State college and university system, including two maritimes colleges, Kings Point and State University of New York Maritime. Objectives of this working group could include developing and implementing programs, in partnership with labor unions and developers, to ensure New York workers have the skills, training, internships, apprenticeships, and certifications necessary to participate in the offshore wind energy industry. This working group will help the State utilize best practices for labor participation, as well as leverage successful past infrastructure development efforts. Coordination with the group's participants could also be used to connect New York companies to offshore wind developers and manufacturers, an essential step in solidifying New York's position in the offshore wind supply chain.

Credit: Siemens

Credit: Siemens

Core workforce skills required for an offshore wind energy project are primarily associated with **trade workers and assemblers.**

Jobs. The core workforce skills required for an offshore wind energy project are primarily associated with trade workers and assemblers, with responsibilities including manufacturing, fabrication, staging, and maintenance. Such skilled trade workers and assemblers are anticipated to represent 85 percent of the required jobs.[37] Companies involved in offshore wind energy include those focused on engineering and design; turbine and component manufacturing and installation; and operations and maintenance. State labor and trade organizations are well-suited to contribute to and benefit from the development of offshore wind energy at scale, but the State must take the lead to ensure the skilled labor force within the State is best positioned to serve this industry.

Although some of the trade and assembler positions will require technical or industry certifications, the State's workforce is well equipped to accommodate industry needs. In many cases, the skills of New York's trade workers and assemblers are directly transferable to the offshore wind industry, though some industry-specific and product-specific training will likely be required. Many workers will need to be trained to work offshore, which requires additional levels of safety training beyond land-based positions. In addition to training in standard occupational safety and health administration courses, offshore workers will also require Standards of Training, Certification and Watchkeeping for Seafarers and, possibly, Global Wind Organization safety training. Standards of Training, Certification and Watchkeeping for Seafarers training is required for all seagoing personnel, whereas Global

[37] The Workforce Opportunity of Offshore Wind in New York, Appendix T.

Wind Organization requirements will be determined by project-specific developers and manufacturers. While Standards of Training, Certification and Watchkeeping for Seafarers courses are readily available in New York, currently there are no Global Wind Organization training programs in the U.S. that provide the Sea Survival module required for offshore wind.

The offshore wind energy industry will leverage technical training that already exists in New York, specifically the broad spectrum of apprenticeship and welding programs, but will also create demand for skills less common in New York, such as composite manufacturing. To maximize the employment of local workers in the offshore wind industry, the Jobs and Supply Chain Technical Working Group will ensure certification and training requirements covering the diverse requirement of offshore wind are clear and readily available through a combination of educational, technical, and labor institutions.

Supply Chain. In addition to having one of the leading offshore wind commitments in the nation, New York State is in a strong position to attract infrastructure investment given it is centrally located between Northeastern and mid-Atlantic states, making its port facilities ideally positioned to service wind farms across the region. The State also benefits from three distinct geographies offering waterfront access: New York Harbor, Long Island, and the Hudson River. Between these areas, New York's port infrastructure is capable of supporting all elements of the offshore wind supply chain.

Appendix B: Assessment of Ports and Infrastructure identifies existing port facility capabilities, and the port facilities that may be well suited for specific offshore wind energy activities. The study concludes that varying degrees of upgrades will be needed at the existing facilities. To follow up on this important work, the Jobs and Supply Chain Technical Working Group could conduct detailed engineering and cost assessments of the port facilities with the potential to be expanded or redeveloped to support offshore wind energy component manufacturing, staging, and long-term operations and maintenance.

This working group could also help facilitate the connection of local manufacturers, suppliers, and service providers with offshore wind energy developers and major equipment manufacturers. To complement that activity, the State will compile a resource directory of New York-based companies qualified for specific roles in offshore wind energy development, which will serve as a valuable resource to manufacturers and developers. Finally, State agencies will arrange site tours and facility assistance for companies interested in locating their manufacturing facilities in New York State.

New York State is centrally located between Northeastern and mid-Atlantic states, making its port facilities ideally positioned to service wind farms across the region.

Credit: Orsted

Commercial and Recreational Fishing Technical Working Group

New York considers the fishing community to be a key stakeholder group

New York considers the fishing community to be a key stakeholder group and believes the effective development of offshore wind energy will require coordinated and consistent engagement with commercial and recreational fishers. A project's potential impacts on the fishing community are a function of several factors, including siting decisions, turbine spacing and alignment, cable routing, burial considerations, and the use of BMPs. Early outreach and frequent dialogue with fishers on such priority issues can have a beneficial impact on projects and reduce offshore wind energy development conflicts with commercial, for-hire (charter), and recreational fishing industries.

To foster that outreach and dialogue, the State will convene a Commercial and Recreational Fishing Technical Working Group that includes commercial and for-hire recreational fishers. This working group could work together to define strategies and activities that could help members engage effectively in offshore wind energy development through improved communications, coordination, and specific activities. There are ample lessons from documented experience, such as the United Kingdom's Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW), a body comprised of representatives from wind energy developers, fisheries, and conservation, regulatory and government oversight agencies in the United Kingdom and Europe.[38] A variety of other structures and methods have proven to be effective and can be considered by this working group. The State will encourage this group to pursue several early activities, including the following.

Credit: NYSERDA

Development of Fisheries Best Management Practices. BMPs are practices determined to be an effective means of preventing or reducing impacts associated with offshore wind energy development. Virtually all groups involved in offshore wind energy development in New York have expressed that fishing should continue in offshore wind farm areas. BMPs for commercial fishing and fisheries can help build a cooperative framework and provide mutual points of reference intended to optimize the coexistence of activities and minimize project impacts at all phases, from design through survey, installation, operation and maintenance, and decommissioning. Careful development and application of BMPs can substantially mitigate potential impacts on productive, valuable fisheries. BMPs can help to gauge and maintain the socioeconomic vitality of fishing and maritime communities while reducing project risks, delays, and costs.

Meetings and dialogue with the Commercial and Recreational Fishing Technical Working Group and other relevant parties (e.g., regulators) will help identify unique local and regional issues, mitigate conflict, and improve mutual understanding while strengthening channels of communication during the formulation of BMPs. The group could also assess the effectiveness of BMPs, including measures used to mitigate adverse effects of anthropogenic sources

[38] http://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/offshore-wind-energy/working-with-us/floww/

Credit: iStockphoto

of underwater noise. Ample precedent for such group activities is available from existing BMP documents, which provide frameworks that can be adapted to the specific region and requirements. Offshore renewable energy agencies, companies, and authorities in Europe, the United Kingdom, Asia, and the U.S. have implemented BMPs or similar guidelines in order to facilitate the long-term success of fishing communities, the sustainability of the marine environment, and marine energy development. In the United Kingdom, for example, the Fishing Liaison with FLOWW adopted the complex and comprehensive *FLOWW Best Practices Guide*,[39] which will provide a valuable reference source as the this working group develops fisheries-related BMPs. An additional discussion of and information on BMPs is presented in *Appendix J: Fish and Fisheries Study* and *Appendix Q: Shipping and Navigation Study*.

Identification of Research Needs and Coordination. New York fishers can benefit from better understanding of the location, abundance, and behavior of marine life in the Atlantic Ocean. The Commercial and Recreational Fishing Technical Working Group could help identify the most pressing research needs, as well as implement research programs that could yield important data relevant to fishers and offshore wind energy developers. This working group would consult the New York Ocean Action Plan,[40] the goal of which is to improve the health of the ocean ecosystem and coordinate with existing management programs. With these concepts applied, the working group could, for example, help develop and implement a cooperative fisheries research program for State waters and the larger New York Bight. This program could collect information on ocean movement of contaminants and fish diseases, the impact of mobile fishing gear on benthic communities, the modification of fishing gear to reduce bycatch of non-targeted or protected species, fish stock data, and the factors potentially affecting the long-term success of fisheries. Similarly, predator-prey dynamics within foraging hotspots could be studied. This group also could design and implement surveys to monitor the distribution and abundance of sea turtles, finfish, large pelagiids, and endangered and threatened marine species, as well as of aquatic invasive species, in the New York Bight.

Development of a Framework for Understanding Commercial Fishing Impacts. Commercial fishing representatives have raised concerns relating to potential loss of access to profitable fishing grounds due to offshore wind development. Any evaluation of potential impacts would need to be grounded in the specifics of a proposed project in the context of the site assessment, construction, and operations phases. The Commercial and Recreational Fishing Technical Working Group could engage fishing representatives, other states, and federal agencies to develop a framework with evidence-based options, which would facilitate future conversations between the fishing community and developers.

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[39] http://www.thecrownestate.co.uk/media/5693/floww-best-practice-guidance-for-offshore-renewables-developments-recommendations-for-fisheries-liaison.pdf

[40] http://www.dec.ny.gov/docs/fish_marine_pdf/nyoceanactionplan.pdf

Credit: Getty Images

Offshore wind development must allow for the continued efficient and safe operation of all vessels.

Maritime Technical Working Group

The Port of New York and New Jersey is the nation's third largest port, with large ocean-going vessels using three major traffic separation corridors in and out of New York Harbor. Additional vessel traffic follows less formal, traditional coastwise trade routes. These nonregulated corridors are primarily closer to shore and used by tug and barge operators to bring goods from port to port. At the same time, fishing vessels operate in, near, and between these traffic lanes and corridors. Offshore wind energy development must allow for the continued efficient and safe operation of all vessels in the area.

The State will convene a Maritime Technical Working Group that includes relevant agencies such as the U.S. Coast Guard and the Port Authority of New York and New Jersey, as well as the Port of New York and New Jersey Harbor Operations and Safety Committee (or some of its member groups), as well as representatives from the commercial and recreational boating communities. In early discussions, this working group could define strategies and activities that could help members engage effectively in offshore wind energy development through improved communications, coordination, and specific activities. The State will encourage this working group to pursue several activities, including the following.

Development of Maritime Best Management Practices. BMPs for the maritime industry can help to build a cooperative framework that will help optimize coexistence of activities and minimize project impacts at all phases of offshore wind energy development. Thoughtful BMPs can substantially mitigate potential impacts on various maritime activities. BMPs can help gauge and maintain the socioeconomic vitality of maritime communities while reducing project risks, delays, and costs. Virtually all groups involved in offshore wind energy development in the New York area have expressed that maritime activities should continue in offshore wind farm areas. Offshore renewable energy agencies, companies, and authorities in Europe, the United Kingdom, Asia, and the U.S. have implemented BMPs or Best Practices Guidelines to facilitate the long-term success of the maritime community, the marine environment, and marine energy development. An additional discussion of and information on BMPs is presented in *Appendix J: Fish and Fisheries Study* and *Appendix Q: Shipping and Navigation Study*.

BMPs relating to maritime users will be one area of focus for the Maritime Technical Working Group. Meetings and dialogue with this working group and other relevant parties (e.g., regulators) will help identify unique local and regional issues, mitigate conflict, and improve mutual understanding while strengthening channels of communication. More specifically, this working group, together with NYSERDA, New York State Department of State, New York State Department of Environmental Conservation, Department of Public Service, U.S. Coast Guard, and BOEM, will develop BMPs for siting offshore wind farms, including turbine layouts and spacing, cable burial details, and construction operations, to minimize the impacts on maritime industries from the development of wind energy off the coast of New York. Examples of such BMPs include:

- Maritime safety in the area of wind farms during surveys, construction, and operation (notices; markings; lighting; additional safety-related equipment such as Automatic Identification System (locator) beacons, repeaters and cell antennas; coordination of vessel traffic in and out of the harbor; search and rescue within wind farms)
- Potential locations for mooring areas for offshore wind vessels standing by and equipment transfers (e.g., from barge to wind turbine installation vessel)
- Cable routes and burial with respect to existing and future anchorages as well as emergency anchoring
- Terms to define liability and potential compensation for cable snags

Identification of Analysis Needs and Coordination. Additional studies relating to the potential impact of offshore wind energy development on maritime users could help inform project siting and decision making. For example, a vessel route study could identify the impact on vessels having to re-route around wind farms, potentially including extra time spent, fuel used, and the distance vessels would be required to travel.

A cooperative framework will help optimize coexistence of activities and minimize project impacts at all phases of offshore wind energy development.

Credit: Deepwater Wind

Credit: Getty Images

Credit: Getty Images

Environmental Technical Working Group

Collaboration with municipal, regional, and federal government agencies and other partners will be important to leverage the necessary resources to accomplish all of the multifaceted priorities associated with the goals of this Master Plan. With a significant portion of the New York Bight and ocean resources extending beyond New York's territorial boundary at three nautical miles from shore, New York sees federal government leadership, participation, and resources as a vital component to accomplish the goals set out in this Master Plan.

In 2018, the State will host a scientific workshop with marine life scientists, governmental regulators, industry representatives, and scientists representing environmental non-governmental organizations, for the purpose of, among other things, presenting the State's baseline environmental research and forming a consensus on the state of science. New York then will convene an Environmental Technical Working Group comprised of scientists from universities, environmental non-governmental organizations, and government agencies, that will focus on measures to avoid, minimize, and mitigate anticipated impacts on wildlife during offshore wind energy development activities. The State will encourage the adoption of an ecosystems-centered approach that establishes strong partnerships and uses sound science to address complex ocean-use issues, and will encourage this working group to pursue the following activities.

Development of Wildlife Best Management Practices. The Environmental Technical Working Group will help develop wildlife BMPs, which have already been developed for a range of industries and spatial scales. BMPs have guided onshore wind energy development in the U.S.; they include the U.S. Fish and Wildlife Service's Land-based Wind Energy Guidelines,[41] numerous State guidelines, and a variety of taxon-specific guidelines for bats, eagles, and other species. These guidelines tend to focus on siting, pre-construction assessment and monitoring approaches, and post-construction monitoring.

Although relevant, many onshore BMP methodologies are inapplicable to the offshore environment. However, many of the offshore BMPs developed in Europe may be applicable. Acoustic disturbance from pile-driving noise, for example, has been identified as a concern for marine mammals in the Baltic Sea,[42] and a range of processes have been developed to minimize these potential impacts at development sites, from halting construction activities when animals are known to be present to gradually "ramping up" loud noises

[41] U.S. Fish and Wildlife Service. 2012. U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines. 82 pp.

[42] Bergström L, Kautsky L, Malm T, Rosenberg R, Wahlberg M, Capetillo A, Wilhelmsson D. 2014. Effects of offshore wind farms on marine wildlife – a generalized impact assessment. Environmental Research Letters 9: 030412.

to allow nearby animals sufficient time to leave the area of potential impact. BMPs used in other types of marine construction in this region may also be applicable to offshore wind energy development. This working group could identify applicable existing BMPs, as well as identify new ones that focus on the species and habitats relevant to offshore wind energy development in the New York region.

Identification of Research Needs and Coordination. The Environmental Technical Working Group could help identify research needs, such as achieving a better understanding of the distribution, habitat, abundance, and other environmental variables of many taxonomic groups, including cetaceans, sea turtles, fish of commercial importance or conservation concern, and seabirds. An examination of the distributions and relative abundance of these target species groups by season could involve the coordination of multiple three- to five-year New York Bight field studies and could use a combination of methods (e.g., passive acoustic monitoring, hydrophones, bat acoustic detectors, infrared surveys, statistical modeling). Some survey approaches could serve multiple purposes. For example, surveys for cetaceans could also collect data on sea turtles and seabirds, and passive acoustic monitoring systems generally record full-spectrum sound data, so these recordings could be used to examine wildlife and ambient noise. This Working Group also could help develop and support a framework that facilitates the coordination of the activities of State and federal agencies, academic researchers, environmental non-governmental organizations, and developers to ensure that maximum value is gained from collected data.

Credit: Normandeau Associates Inc./APEM Ltd.

Coordination for Adaptive Management. Development of offshore wind would benefit from continued coordination among the various states, federal partners, and other stakeholders involved in the process. Multi-partner coordination could be particularly beneficial to maintain conservation goals and minimize potential impacts on wildlife, especially from cumulative impacts. Regional ocean planning is already coordinated by the Mid-Atlantic Regional Planning Body and Northeast Regional Planning Body. These bodies are led by state, federal, tribal, and Fishery Management Council partners, with the involvement of ocean-based industries, commercial and recreational fishers, academics, local communities, and others. The state-led Northeast Regional Ocean Council and Mid-Atlantic Regional Council on the Ocean operate online data portals that incorporate multiple data sources to support regional planning. The State will share Master Plan data and studies with these portals, will continue to use these portals, and may formalize a plan to coordinate with these entities.

Credit: Getty Images

The Environmental Technical Working Group could seek to develop a multi-partner adaptive management plan specific to planned offshore wind activities. Adaptive management plans typically are drafted by partnerships of managers, scientists, and other stakeholders that can draw from a large knowledge base. The flexibility of such planning is particularly useful when implementing new technology, because it allows for the development of innovative solutions.

Consider Creation of an Environmental Conservation Fund. The development of new offshore wind energy projects would likely have some negative environmental effects. An Environmental Conservation Fund (also called a mitigation or reclamation fund, or a mitigation bank) could be created to fund projects to address offshore wind development impacts on wildlife that are larger than the scale of a single project, such as understanding an at-risk species' life cycle or population status, or assessing the cumulative effects of numerous wind farms.[43] An Environmental Conservation Fund could be funded as a procurement contract requirement and/or directly by developers on a per-acre or per-MW basis, and controlled by third parties to ensure funding contributes to prioritized research, technology, and conservation efforts. The fund could provide significant benefits for building an offshore study area-wide knowledge base that might not otherwise exist.[44] The Environmental Technical Working Group could develop a framework for arriving at how such a fund would be subsidized and administered, assessing residual impacts on environmental interests, and determining whether a project's contribution to the fund may be appropriate.

Additional studies will build on the New York's analytical work and contribute to a better understanding of the potential impacts and benefits of offshore wind energy development.

Future Studies and Analyses

Additional studies would build on the State's analytical work conducted to date and contribute to a better understanding of the potential impacts and benefits of offshore wind energy development. Accordingly, any such additional studies would provide a more developed baseline for project-specific assessments. Technical Working Groups will help identify ways to advance the cost-effective and responsible development of offshore wind energy. In the meantime, the State believes the studies described in the following sections should advance development in the near term.

Environmental Studies

Metocean

A strong knowledge of meteorological and oceanographic — metocean — conditions is essential for the safe and efficient design and operation of offshore installations. Better metocean characterization of the wind, wave, and ocean current environment of the offshore study area would help increase certainty of development conditions, which are useful in planning activities such as the refinement of project layout and turbine siting, and are key variables in lease auctions and offtake.

[43] Cole, S. G. (2011), Wind Power Compensation is not for the Birds: An Opinion from an Environmental Economist. Restoration Ecology, 19: 147–153. doi:10.1111/j.1526-100X.2010.00771. x.

[44] Clement, J.P., Belin, A., Bean, M.J., Boling, T.A. and Lyons, J.R., 2014. A strategy for improving the mitigation policies and practices of the Department of the Interior. A report to the Secretary of the Interior from the Energy and Climate Change Task Force, Washington, DC.


Credit: Orsted

In 2017, NYSERDA published a Metocean Plan[45] that recommended parameters for a wind resource assessment that could be carried out at a potential offshore wind farm site. The aim of the Metocean Plan was to provide reliable wind resource data for a wind farm developer in an effort to reduce uncertainty and risk while increasing attractiveness to developers and investors.

New York State will pursue the collection of new metocean data via the deployment of metocean Light Detection and Ranging (LiDAR) system(s) — remote sensing equipment that uses pulsed laser light to determine wind speeds at altitude — in or around areas identified by BOEM for lease auctions. The deployment will follow NYSERDA's Metocean Plan and the systems will be outfitted with an array of sensors to monitor multiple environmental and biological parameters. The core goals of this undertaking will be to:

- Accelerate the deployment of wind energy development off the coast of the State
- Reduce the cost of offshore wind energy, maximizing the benefit for State ratepayers
- Obtain and make public high-quality metocean and other data sufficient to conduct a robust wind resource assessment for yield prediction purposes, or to inform further studies to better understand the offshore study area's wind energy resources

Metocean Plan

provides reliable wind resource data for a wind farm developer in an effort to reduce uncertainty and risk while increasing attractiveness to developers and investors

[45] https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/16-35-Metocean-Plan-Wind-Energy.pdf

Credit: Orsted

Development of offshore wind energy presents an opportunity for substantial air quality and public health benefits.

Quantification of Air Quality Benefits

As discussed in "Benefits of Offshore Wind Energy Development for New York State," the development of offshore wind energy presents an opportunity for substantial air quality and public health benefits by offsetting electricity generation from fossil-fuel electrical generators. Offshore wind energy with a capacity of 2,400 MW feeding downstate New York could offset electricity generation at fossil-fuel sources throughout the northeastern U.S., which would improve air quality in regions neighboring or downwind of those fossil-fuel sources. Due to the high population density in the region, the number of adverse health impacts avoided (and consequently the magnitude of monetized health benefits) is expected to be significant even for small improvements in air quality.

Building from the preliminary analysis described in "Benefits of Offshore Wind Energy Development for New York State," the State will explore undertaking a detailed assessment of the air quality and health impacts relating to achieving New York's goal of 50 percent renewable energy by 2030, including the impacts of 2,400 MW of offshore wind energy supplying New York City and Long Island with electricity in 2030. A fine-scale air quality model could be used to predict the resulting air quality for New York City, and New York City-specific concentration-response functions could be used for the health impact analysis. In addition, an effort could be made to better understand when and where offshore wind has the most impact, such as supporting high electrical demand days in New York City where the health benefits could be significant due to the high population.

Wildlife

One of the most pressing data needs is contemporary baseline data on potential wildlife exposure to offshore wind energy development. Knowledge about species' presence or absence in proposed development areas is valuable for conducting required environmental reviews and reducing risk to both development and wildlife. Regional-scale baseline information on wildlife distributions, abundance, and movements by season can inform a comparison of the relative biodiversity of the development sites. Wildlife surveys can also provide a better understanding of the potential effects of individual projects, as well as any potential cumulative effects of multiple projects. Additionally, discussions with ocean users, regulators, and scientists suggest that wildlife distributions in the offshore study area appear to be shifting over time. Some species seem to be shifting farther north or toward deeper water, and the timings of migrations may be changing. Maps of seasonal patterns could be used to assist with the identification of important habitat areas and to predict areas of high use in the future, providing a better understanding of how offshore wind energy development may affect wildlife.

Credit: Getty Images

Not all species and habitats near an offshore wind energy project site would be adversely affected. Some species may respond to a project through avoidance or attraction, but the behavioral change may have little adverse effect on an individual or population. Consequently, developers and regulators must determine which species are most likely to be vulnerable to the hazards of the development. Research from existing projects in Europe, as well as existing vulnerability indices, could help inform this consultation. Additional facts, such as public interest, economic value, and conservation status, may result in the prioritization of certain species regardless of their known vulnerability to offshore wind energy development. Prioritizing species and habitats of particular interest would allow environmental assessments to be designed to address questions specific to those resources.

Credit: Getty Images

New York State will work with appropriate federal agencies, universities, and scientists to collect relevant baseline data by supporting the following studies.

Digital Aerial Wildlife Survey

Digital, high-resolution aerial imagery surveys are being used to collect data on birds, marine mammals, sea turtles, fish shoals, cartilaginous fishes, and other taxa encountered offshore. Surveys began in the summer of 2016 and are being conducted four times a year over three years. The surveys use the latest digital and sensor technology to provide high identification success. Data and results are publicly available at https://remote.normandeau.com/nys_overview.php and are being provided directly to agencies and organizations for incorporation into existing databases. This work will continue to be supported and potentially expanded to include higher-density collections (more images collected) over identified Wind Energy Areas.

Credit: Normandeau Associates Inc./APEM Ltd.

Avian Risk Assessment

Early identification of species, areas, or topics of greatest concern will lead to more informed decision making through the environmental review process and improved outcomes for wildlife, since resources will be applied to the areas of greatest need. Some species may be disproportionately impacted by offshore wind energy development in certain locations, and those species should be identified to allow for targeted research on their life history and behaviors, as well as to determine options for risk prevention or mitigation. A vulnerability assessment could assist with defining species priorities and refining the scope of future research efforts, including targeted monitoring and mitigation, and attempts to detect changes in abundance or distribution following construction.[46]

Passive acoustic monitoring studies targeting marine mammals are ongoing in the offshore study area.

Marine Mammals and Ambient Noise

Passive acoustic monitoring studies targeting marine mammals are ongoing in the offshore study area. An expansion of this work before construction begins would allow for the development of an acoustic baseline, which would improve understanding of ambient noise and cetacean presence. Collection of baseline levels of noise and occurrence of marine mammal vocalizations in the offshore study area could provide a better understanding of sound propagation, seasonal occurrence patterns of marine mammals, and potential cumulative impacts of additional noise in the local environment. Baseline data should ideally be collected before nearby wind energy projects outside the offshore study area move forward with noise-generating components, which may displace marine mammals from nearby regions and influence the results of an study. Localized marine mammal presence data may be useful for developers conducting analyses required by agencies involved in permitting procedures, such as under the Marine Mammal Protection Act and the Endangered Species Act.

Environmental Sensitivity Analysis

The Environmental Sensitivity Analysis (see Appendix I) would benefit from iterative model updates to ensure new data are incorporated into the model. Since the incorporation of additional or updated datasets would require the completion of new model runs, the updates would need to adhere to planned, scheduled updates. A rerun of the model every two to three years would allow for sufficient time to reprocess data and generate new model outputs. Suggested target datasets for future inclusion are as follows: updated predicted species densities for marine mammals that include the Atlantic Marine Assessment Program for Protected Species survey data;[47] new seal distribution datasets; new sea turtle distribution datasets; seasonal fish datasets; seasonal bird datasets; benthic species datasets; and any site-specific fine-scale data. In particular, if a bat distribution dataset of sufficient quality to meet the modeling standards is released, the data should be incorporated into the model.

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[46] Rein C.G., Lundin, A.S., Wilson, S.J.K., Kimbrell, E. 2013. Offshore Wind Energy Development Site Assessment and Characterization: Evaluation of the Current Status and European Experience. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2013-0010. 273 pp.

[47] Roberts J.J., B.D. Best, L. Mannocci, E. Fujioka, P.N. Halpin, D.L. Palka, L.P. Garrison, K.D. Mullin, T.V.N. Cole, C.B. Khan, W.A. McLellan, D.A. Pabst, and G.G. Lockhart. 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6:22615. doi:10.1038/srep22615. Accessed from: http://www.nature.com/articles/srep22615

Credit: Blount

Movements of and Offshore Habitat Use by Species Listed under the Endangered Species Act

Data on the individual movements of species listed as threatened or endangered are useful for determining whether these species should be of concern to regulators during permitting. Atlantic sturgeon and all species of sea turtles present in New York State waters are protected under the Endangered Species Act. As such, they will be priority species for regulators during the environmental permitting process for offshore wind energy developments. More information about their habitat use and movements would be valuable to ensure offshore wind energy development does not cause irreparable damage to vulnerable populations. Other aquatic species of interest could also be added to the study design as needed, allowing for taxonomic flexibility to match the species priorities of State and federal regulators. While there are many methods to examine animal movement patterns, an expansion of the existing underwater acoustic receiver network offshore of New York to detect tagged fish and sea turtle movements in and around potential development areas would be valuable.

Wildlife Dynamics in a Changing Ecosystem

Discussions with ocean users, regulators, and scientists suggest wildlife distributions in the offshore study area may be shifting over time. Some species may be shifting farther north or toward deeper water, and the timings of migrations may be changing. Developing a greater understanding of these shifts would help inform siting decisions and provide information about changing risks to wildlife at particular sites.

Several environmental parameters, such as temperature and salinity, exhibit covariance with wildlife. As these factors change, spatial and temporal changes in wildlife distribution and occurrence can occur. In particular, changes in environmental conditions are linked to primary and secondary productivity, and shifts in the lower trophic levels can prompt changes in the upper trophic levels for species such as fish, sea turtles, marine mammals, and birds. Efforts to understand how changes in environmental conditions may influence primary and secondary productivity and upper trophic level species in the context of potential impacts from offshore wind energy development, would support better-informed siting and an understanding of wildlife and fisheries resource risks.

Credit: Siemens

New York State-Based Research and Development

New York is home to several world-class universities with deep expertise and ongoing research in areas of interest to the successful development of offshore wind energy. Much of this work is directly related to key issues in offshore wind turbine siting, construction, performance optimization, and environmental impacts. In addition, institutional knowledge in related fields such as oceanography, meteorology, marine bioscience, and materials engineering represents a unique resource that could help advance cost-effective and responsible development of offshore wind energy.

Universities provide great near-term value supporting industrial partners with solutions for system development barriers and by providing communities with an objective source of information on offshore wind energy benefits and impacts. These participants also can position the State to capture federal research and development investment in this space.[48]

Offshore wind energy is a nascent industry in the U.S., with unique technical challenges specific to each region's marine environment, infrastructure, local conditions, and constraints. The State will act in collaboration with its public and private universities to coordinate direct and indirect research efforts to address these challenges.

[48] For example, in June 2017 the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) published a notice of intent to issue a Funding Opportunity Announcement for a four-year, $20 million study that will address U.S.-specific offshore wind energy technology challenges. EERE Notice of Intent No. DE-FOA-0001786. Available at https://eere-exchange.energy.gov/#Foaldebe0ee16-477c-4c6e-b4c3-d080b80f9660

Potential areas for university and innovation partner collaboration are discussed below.

Wind Resource Assessment

Development and siting of offshore wind energy projects requires an accurate prediction of the available wind resource to validate economic models and secure financing. Existing techniques such as floating LiDAR buoys and models vary in resolution and accuracy, and these techniques face siting, application, and deployment challenges. Sensing and monitoring technology enhancements and meteorological models specific to New York's coast will improve near- and long-term prediction of wind energy production, reducing uncertainty and development costs.

Component and System Design and Testing

Offshore wind turbines present engineering challenges that are in some ways more difficult than those of their land-based counterparts. Offshore wind energy projects will have to address extreme conditions, including Nor'easters and hurricanes. In addition, the logistics of maintenance and repair at sea are costly. Testing of turbines, foundations, and critical components (e.g., blades) can help equipment manufacturers improve reliability and reduce costs. Research in condition-based monitoring for preventive maintenance can optimize performance while reducing the frequency of unplanned outages and costly site visits. The State may call for test sites to be included within offshore wind projects that supply New York. Test sites may be used to certify new turbines, test new foundation designs and other research and development activities.

Environmental Risk Reduction

New York's coast is home to a rich variety of marine animals, including the critically endangered North Atlantic right whale. To avoid injuring these animals, construction of offshore wind energy development projects is curtailed when some species are in the area. Today, whales are spotted visually, which carries a low degree of certainty and limits construction to times of good daylight and visibility. Research in advanced detection techniques such as passive acoustics or other emerging technologies could help protect whales more effectively while lowering construction costs.

Community Impact Research

Wind energy farms can fill a critical need for clean power and benefit the communities they serve. Like any large construction project, they can also affect the communities where they are located or where construction materials are manufactured or staged. Research in stakeholder communities can help determine the best way to integrate offshore wind energy development with coastal communities for the maximum benefit of all parties. Externality research and other methods can help quantify the positive and negative impacts of offshore wind energy development to better inform stakeholders and decision makers.

Workforce Development

Just as New York's universities, technical colleges, and vocational schools trained the workers who built the State's current energy infrastructure, these institutions will help build the local workforce needed to develop, install, operate, and maintain offshore wind energy systems and other components of New York's future renewable power grid. The State will ensure certification and training requirements are clear and readily available through a combination of educational, technical, and labor institutions.

Conclusion

The information assembled in this Offshore Wind Master Plan draws upon two years of extensive research, study, and public engagement, and represents the **most comprehensive offshore wind planning approach** ever conducted by a state. The Master Plan provides New York with the foundation it needs to lead the country in this important clean energy industry, fight climate change, and create thousands of good jobs—2018 will be a year of building on that foundation. As directed by Governor Cuomo, the State has commenced a process to enable the procurement of no less than **800 MW of offshore wind** in 2018 and 2019, and the first solicitation will occur before the end of this year.

As detailed in this Master Plan, the State will convene new working groups to execute a nation-leading offshore wind economic development and job creation strategy, build consensus regarding scientific and natural resource matters, and ensure that New York continues to set the standard for public engagement and science-based decision making in the responsible siting of offshore wind farms. NYSERDA will respond to Governor Cuomo's directive to allocate **$15 million to workforce training and infrastructure enhancements** to position New York at the front of the pack nationally in the race to host this new industry.

Subject to federal leasing and permitting processes, new offshore wind energy farms are expected become operational in 2024–2025. As New York presses forward, the State's ability to remain on schedule will, to some extent, depend upon successful collaboration with the federal government. This Master Plan reiterates New York's calls for the federal government to expedite the advancement of the offshore wind industry and allow for the creation of thousands of clean energy jobs.

New York State is strongly committed to realizing Governor Cuomo's vision that, by 2030, up to 1.2 million New York households will be powered by clean, renewable energy generated by Atlantic Ocean winds.

Offshore wind is now positioned as a key element of the Governor's Reforming the Energy Vision strategy, and is vital to the success of the Clean Energy Standard. Guided by the Master Plan, New York State's bold offshore wind agenda will fuel the clean energy economy, create thousands of good jobs, lead the fight against climate change, and **secure a better future for generations of New Yorkers to come**.

Credit: Deepwater Wind

Notice

This Offshore Wind Master Plan was prepared by the State of New York and its agencies and public-benefit corporations (State) as a planning document. The State's intent is to facilitate the responsible and cost-effective development of 2,400 megawatts of electrical energy capacity for the State from new offshore wind farms by the year 2030.

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Neither this Master Plan nor any of its appended material commits the State, its agencies or authorities, or any other governmental entity, to any specific course of action with respect to the development of future offshore wind energy projects. In the event that the U.S. Bureau of Ocean Energy Management awards a future lease at a new Wind Energy Area that could provide electrical energy capacity for New York State, that lease will be required to meet all additional State and federal permitting and licensing requirements prior to proceeding with the development of an offshore wind project. Neither this Master Plan nor its appended material constitutes a substitute review or pre-determination of the outcome for any process under any applicable State or federal law, including but not limited to the Coastal Zone Management Act, the State Environmental Quality Review Act, and the National Environmental Policy Act, or other State or federal permitting or licensing prerequisite to any successful award of a new Wind Energy Area lease.

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Information contained in this Master Plan, such as website addresses, is current at the time of publication.

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