NEW JERSEY OFFSHORE WIND

STRATEGIC PLAN

NAVIGATING OUR FUTURE

> > >

PREPARED FOR
New Jersey Board of Public Utilities
and the Interagency Taskforce on Offshore Wind

PREPARED BY
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DATE
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LET'S NAVIGATE OUR FUTURE, TOGETHER.

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PREAMBLE

MESSAGE FROM NEW JERSEY GOVERNOR PHIL MURPHY

"The development of New Jersey's offshore wind infrastructure will create thousands of high-quality jobs, bring millions of investment dollars to our state, and make our state a global leader in offshore wind development and deployment. The Offshore Wind Strategic Plan is a critical blueprint that will guide us toward our goal of 7,500 megawatts of offshore wind power by 2035 and help us achieve 100 percent clean energy by 2050."

MESSAGE FROM NEW JERSEY BOARD OF PUBLIC UTILITIES PRESIDENT JOSEPH L. FIORDALISO

"Offshore wind represents a once-in-a-generation opportunity for New Jersey. By investing in this renewable resource we can provide jobs, clean energy, and millions of dollars in economic activity for our state. The new Offshore Wind Strategic Plan is a comprehensive roadmap for achieving Governor Murphy's goal of 7,500 megawatts of installed capacity by 2035 and ensures we are working toward the best value for New Jersey ratepayers."

MESSAGE FROM NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION COMMISSIONER CATHERINE R. McCABE

"The Offshore Wind Strategic Plan is another example of the Murphy Administration's commitment to a climate-smart economic development policy that responsibly cultivates New Jersey's clean energy economy while ensuring the protection of our plentiful marine and coastal resources. In the face of climate risks like our state's rapidly rising sea levels, this strategy demonstrates how New Jersey can both adapt to climate change and fight its impacts by building resilient infrastructure that will power our economy while reducing greenhouse gas emissions to help diminish further global warming."

MESSAGE FROM NEW JERSEY ECONOMIC DEVELOPMENT AUTHORITY CHIEF EXECUTIVE OFFICER TIM SULLIVAN

"Expanding New Jersey's offshore wind industry not only protects our environment but also creates good jobs and new opportunities for businesses. This is always important, but will be particularly crucial as we recover from the economic impact of COVID-19. Development of the Offshore Wind Strategic Plan is a critical step toward maximizing the environmental and economic potential of this brand new industry."

MESSAGE FROM NEW JERSEY DEPARTMENT OF LABOR AND WORKFORCE DEVELOPMENT COMMISSIONER ROBERT ASARO-ANGELO

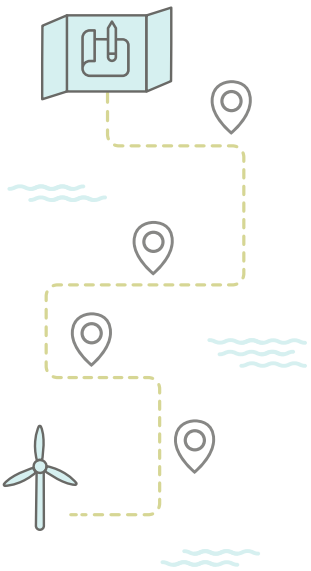
"We are fortunate to live in a state with abundant coastline and some of the best wind resources in the world, so it is natural for New Jersey to expand this reliable, renewable, cost-effective energy source. This industry has the potential for exponential growth, with tens of thousands of good-paying, family sustaining jobs. Our Construction & Energy Industry Partnership with leading coastal research institutions such as Rutgers, Monmouth, and Stockton universities gives us a big advantage in training our workforce for careers in this revolutionary new industry."

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

On November 19, 2019, Governor Phil Murphy signed Executive Order No. 92, which more than doubled New Jersey's previous offshore wind energy generation goal from 3,500 megawatts (MW) to 7,500 MW. Under the leadership and direction of Governor Murphy, New Jersey has developed this Offshore Wind Strategic Plan (OWSP) to serve as a roadmap to meet the state's goal of producing 7,500 MW of offshore wind power (commonly referred to as wind energy) by 2035. New Jersey's development of offshore wind energy, together with other clean and renewable energy sources, will be critical to addressing the challenges associated with climate change and to building a clean energy economy. Governor Murphy has established an aggressive and achievable vision of 100% clean energy by 2050, and the OWSP helps set the course for New Jersey to achieve this vision through the responsible development of offshore wind energy. The 2019 New Jersey Energy Master Plan estimates that offshore wind will supply 23% of the state's clean energy in 2050.

New Jersey's offshore wind energy goal: 7,500 MW by 2035



OFFSHORE WIND STRATEGIC PLAN: ROADMAP FOR SUCCESS

On January 31, 2018, Governor Murphy signed Executive Order No. 8, which directed the New Jersey Board of Public Utilities (NJBPU) to develop and implement the OWSP. As major offshore wind projects come to New Jersey and the rest of the US East Coast, it is essential to build a thoughtful and proactive roadmap for successfully developing New Jersey's offshore wind resources. This plan includes stakeholder input, scientific evaluations, economic analyses, and recommendations for a path forward.

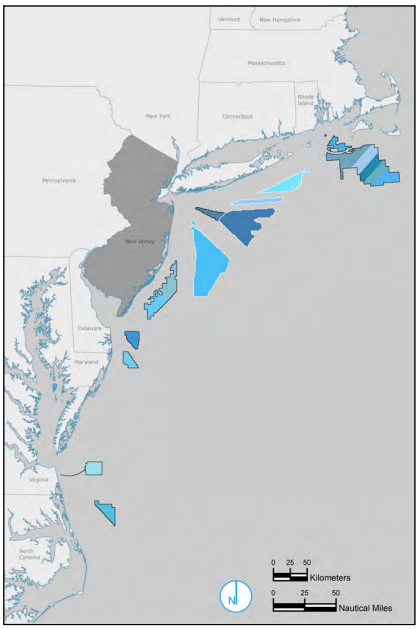
Offshore wind development is technically complex and capital intensive, consisting of large components and a vast footprint — the locations of project elements range from offshore waters, to coastal ports, to onshore electrical grid interconnections and transmission infrastructure conveying electricity to ratepayers. The offshore wind industry also includes a complex network of global, regional, and local supply chain manufacturers and suppliers. Responsible offshore wind development must include both building a new economy and protecting New Jersey's valuable coastal and marine resources. New Jersey leaders and stakeholders have consistently stated that offshore wind resources should be developed in a careful and responsible fashion.

The successful realization of 7,500 MW of offshore wind energy (representing 50% of New Jersey's projected 2035 load) includes its implementation in a cost-effective manner, while developing the necessary infrastructure in a way that protects our natural resources. Success also includes leveraging the investment in offshore wind infrastructure to create jobs and economic benefits for the state. The OWSP is a guide to establishing a new offshore wind industry to benefit New Jersey residents and mitigate climate change by developing a clean, renewable energy source.

OVERVIEW AND AREAS OF ANALYSIS

The areas for potential development of offshore wind energy extend along the East Coast from Massachusetts to North Carolina. There are currently 17 Bureau of Ocean Energy Management (BOEM) designated offshore wind lease areas along the East Coast, six of which are located off the New Jersey coast. BOEM is currently evaluating several additional wind energy areas (WEAs) as potential offshore wind lease areas along the East Coast. As the geographic center of this large development area and the owner of many "firsts" in offshore wind, New Jersey will continue to lead and has the unique opportunity to become the nexus of the majority of offshore wind industry in the United States. For example, Governor Murphy recently announced the New Jersey Wind Port, which will be the first major new port facility dedicated specifically to service the offshore wind industry.

POTENTIAL DEVELOPMENT AREAS ALONG THE EAST COAST



Five key subject areas of offshore wind development for New Jersey were evaluated and incorporated into the OWSP. Each assessment includes strategic recommendations that set the course for the successful development of offshore wind in New Jersey. A summary of each critical subject area is provided below, and a more detailed narrative is provided further in the OWSP.

Environmental and Natural Resource Protection

New Jersey's coastal ocean provides some of the world's most advantageous conditions for offshore wind development, including good wind resources, favorable ocean seabed and depth, and proximity to large population centers. Leveraging these conditions to achieve 7,500 MW of offshore wind energy by 2035 is a critical element of meeting the state's goal of 100% clean energy by 2050, which is a necessary step in addressing a changing climate. The characteristics that make New Jersey's coastal ocean ideal for offshore wind also contribute to a distinctive ocean environment with many important and sensitive natural resources. New Jersey leaders and stakeholders have expressed a desire to protect these resources while developing this renewable energy source for the environmental and economic benefits it assures.

The OWSP sets the course for responsible implementation of offshore wind energy by recommending the following:

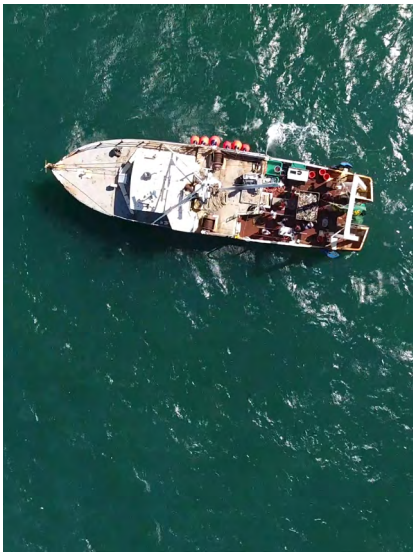
- Prioritize development in areas that are less sensitive to impacts from offshore wind development
- Leverage research by developers, state universities, government agencies, and state contracts to contribute to planning efforts, closing of data gaps, and meeting of long-term monitoring needs
- Utilize the New Jersey Environmental Resources Offshore Wind Working Group (Environmental Working Group) to enhance communication and coordination between conservation communities and state and federal agencies
- Implement avoidance and minimization measures to protect New Jersey's marine and coastal resources
- Carry out further environmental studies to assess specific environmental impacts and fill data gaps for offshore wind development

Commercial and Recreational Fisheries

New Jersey's commercial and recreational fisheries are of significant importance to the state. Critical elements of this marine heritage include the intrinsic value of the natural resource, the industries' significant contribution to the economy with an estimated value of $2.5 billion, and the multigenerational way of life for many of New Jersey's residents. Therefore, New Jersey must develop offshore wind in a manner that maintains and protects robust commercial and recreational fishing, while recognizing that the environmental benefits of offshore wind and new

economic opportunities it brings also have the potential to support these industries. The roadmap to New Jersey's offshore wind development will include an ongoing process to incorporate and protect commercial and recreational fishing interests by recommending the following:

- Avoidance, where possible, of high-value fishing grounds
- Use of avoidance and minimization measures designed to protect fisheries resources during construction and operation of offshore wind projects
- Continued collection of data to form the basis of a long-term marine monitoring program for assessing potential cumulative impacts from offshore wind development
- Collaboration with other state and federal entities to conduct regional fisheries monitoring and data sharing
- Collaboration and continued engagement between the commercial and recreational fishing industries and offshore wind developers through both existing associations and targeted outreach efforts, the Environmental Working Group, and the Wind Innovation and New Development (WIND) Institute through all phases of offshore wind development



Supply Chain and Workforce Development

The development of 7,500 MW of offshore wind energy creates a unique opportunity for New Jersey to invest in a new industry. The manufacturing, construction, and operation of offshore wind farms will demand large facilities and a specialized workforce. New Jersey can leverage its offshore wind goals into the development of in-state manufacturing facilities, ports, and training facilities.

> *"There is no other renewable energy resource that provides us with either the electric-generation or economic-growth potential of offshore wind...When we reach our goal of 7,500 megawatts, New Jersey's offshore wind infrastructure will generate electricity to power more than 3.2 million homes and meet fifty percent of our state's electric power need. Our offshore wind industry will generate billions of dollars in investments in New Jersey's future, that will, in turn, create thousands of jobs. We have an immense opportunity to maximize our potential and make this region – and, specifically New Jersey – the nexus of the global offshore wind industry."*[1]
> ***Governor Phil Murphy***

The OWSP focuses on capturing the economic benefits of this emerging industry, including new and re-purposed port facilities, manufacturing facilities, and jobs, by recommending the following:

- A balanced approach that encourages New Jersey economic benefit through the development of a New Jersey offshore wind supply chain while keeping the cost of energy for offshore wind projects low for initial projects and resulting in the lowest possible levelized cost of energy by 2035
- Development of nacelle, turbine blade, foundation assembly, and/or other component manufacturing facilities in New Jersey
- Utilization of the WIND Institute to serve as a center for education, research, innovation, and workforce training related to the development of offshore wind in New Jersey and the Northeast and Mid-Atlantic regions

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[1] State of New Jersey. 2019. Governor Murphy Signs Executive Order to Increase Offshore Wind Goal to 7,500 Megawatts by 2035. Office of the Governor, Trenton, NJ. Accessed May 22, 2020. Available at: https://www.nj.gov/governor/news/news/562019/approved/20191119b.shtml.

Ports and Harbors

New Jersey is an "ocean state" with over 130 miles of coastline, including deep-water commercial and industrial ports, as well as multiple smaller port facilities along the Atlantic Ocean shoreline. Because offshore wind facility components are typically large and difficult to transport by land, ports are well suited for staging, construction, and manufacturing of these components. In addition, ports and harbors located along New Jersey's coastline are ideally situated to support operations and maintenance (O&M) activities to service wind farms during their 25 years or more of operation. The OWSP assesses New Jersey's current and potential port inventory, identifies potential opportunities, and establishes a course for the development and expansion of port facilities.

The OWSP recommends the following:

- Full development of the New Jersey Wind Port to provide the facilities necessary for full manufacturing and marshaling build-out
- Development of additional marshaling and manufacturing ports to support the roll out of subsequent solicitations in addition to supporting other offshore wind projects in neighboring states
- Investment in existing ports such as Paulsboro that can more quickly meet the needs for laydown and staging of components for the initial phase of 1,100 MW of offshore wind development
- Expansion of New Jersey's suite of financing and incentive programs, including grants, tax credits, and low-interest funding, to stimulate investment in marshaling and manufacturing ports

Energy Markets and Transmission

Energy markets serve a vital role in the safe and reliable coordination and delivery of energy to consumers. Offshore wind development is key to transitioning from existing fossil fuel sources to renewable energy in New Jersey. Likewise, developing a modern and efficient transmission infrastructure is essential to a competitive offshore wind market in New Jersey.

New Jersey's 2019 Energy Master Plan includes a clear strategy to accelerate deployment of renewable energy and distributed energy resources. The OWSP explores how best to utilize state-jurisdictional energy policy to optimize a wholesale energy market and electrical transmission infrastructure that facilitates the renewable energy goals of New Jersey. Strategic recommendations for energy markets and transmission improvements include the following:

- Continue to support incentives such as offshore wind renewable energy certificates (ORECs) to build a local offshore wind industry and assess reducing incentives as the market matures
- Encourage developers to use the latest technology, including the largest-available wind turbine generators, to reduce the levelized cost of energy
- Evaluate regional and local energy markets to understand more fully the cost implications for ratepayers of developing offshore wind resources
- Evaluate the potential advantages of offshore energy transmission infrastructure, including radial and backbone scenarios, as well as ownership structure
- Work with PJM Interconnection LLC (PJM) and local utilities to develop an onshore grid transmission study to integrate 7,500 MW of offshore wind energy by 2035

CONCLUSIONS AND STRATEGIC RECOMMENDATIONS

Offshore wind is an evolving industry in New Jersey with rapidly changing market conditions. With the aid of the strategic-level recommendations of this OWSP, New Jersey can lead the development of the East Coast offshore wind market. The economic health of the state will be enhanced as the responsible and safe development of the ocean waters off New Jersey and other nearby states proceeds.

Offshore wind is coming to the United States and bringing billions of investment dollars and thousands of jobs along with it … This is a once-in-a-generation opportunity to not only grow New Jersey's economy, but also move rapidly toward a clean energy future that puts us on a path to 100 percent clean energy by 2050[2]

GOVERNOR PHIL MURPHY

[2] State of New Jersey. 2020. Governor Murphy's Wind Council Releases Report on Plan for New Jersey WIND Institute. Office of the Governor, Trenton, NJ. Accessed May 17, 2020. Available at: https://nj.gov/governor/news/news/562020/approved/20200422a.shtml.

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STRATEGIC PLAN INTRODUCTION

STRATEGIC PLAN INTRODUCTION

Led by Governor Phil Murphy, New Jersey has a goal of using 100% clean energy by 2050. At the center of the plan is the development of offshore wind energy. On November 19, 2019, Governor Murphy signed Executive Order No. 92, which directed the New Jersey Board of Public Utilities (NJBPU), the New Jersey Department of Environmental Protection (NJDEP), and other state agencies to "promote and realize the development of wind energy off the coast of New Jersey to meet a goal of 7,500 megawatts of offshore wind energy generation by the year 2035."[3]

Prior to the executive order setting this new offshore wind goal, New Jersey had established itself as a leader in offshore wind development by enacting the Offshore Wind Economic Development Act (OWEDA) in 2010, which was the initial step to develop offshore wind. The Murphy administration has continued to lead by:

- Establishing, in January of 2018, the initial state offshore wind goal of 3,500 megawatts (MW) by 2030
- Establishing the New Jersey Offshore Wind Interagency Taskforce
- Issuing the state's first solicitation for 1,100 MW of offshore wind energy generation in September 2018
- Awarding the largest state issued offshore wind power agreement to the 1,100 MW Ocean Wind project in June 2019
- Adopting the Offshore Wind Energy Certificate funding rule in January 2019, which establishes the process by which an offshore wind program is funded and how revenues earned from each project flow back to ratepayers
- Creating a New Jersey Offshore Wind Supply Chain Registry that enables investors exploring offshore wind–related projects in the state to find New Jersey–based companies to partner with or purchase from
- Establishing the Council for the Wind Innovation and New Development (WIND) Institute, which will develop a plan for the creation of a hub for the burgeoning offshore wind industry in the Northeast region and the state
- Engaging in outreach with New Jersey's fishing industry and conservation community to facilitate responsible offshore wind development that considers the needs of New Jersey's commercial and recreational fishing industries and ensures that natural resources are protected[3]

> **Our goal is to grow offshore wind in a way that creates jobs and reduces our dependence on fossil fuels**
>
> **GOVERNOR PHIL MURPHY**

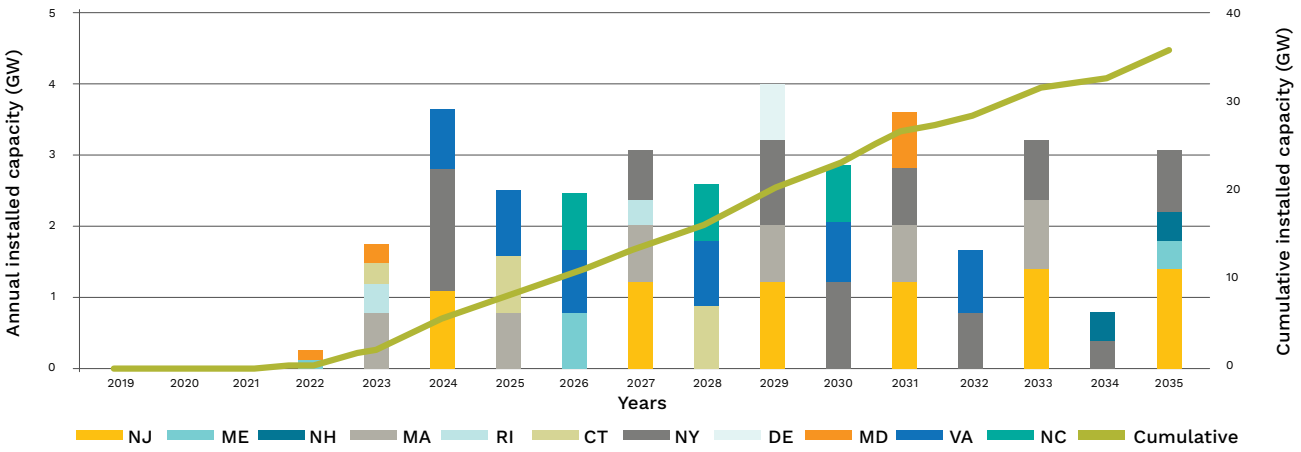
[3] State of New Jersey. 2019. Executive Order No. 92. Office of the Governor, Trenton, NJ. Available at: https://nj.gov/infobank/eo/056murphy/pdf/EO-92.pdf.

The forward-looking New Jersey offshore wind development goals create tremendous opportunity for the establishment of a new industry in New Jersey, with investments in port facilities like the New Jersey Wind Port, which will support development of manufacturing facilities and creation of good local jobs. In addition to providing a clean, renewable source of energy, New Jersey's plan will greatly enhance economic development within the state. Further, New Jersey residents broadly support the development of offshore wind off their coast, with 76% in favor based on a 2019 Monmouth University poll.[4]

1.1 OFFSHORE WIND INDUSTRY GROWTH

With New Jersey as a leader, a new industry is being born along the East Coast of the United States. The East Coast offshore wind industry grew from 30 MW in 2018 to a pipeline of over 35 gigawatts (GW) by 2035. Individual state offshore wind initiatives, together with federal government action to designate East Coast areas for offshore wind generation, have shaped a bright future for the offshore wind industry. Figure 1-1 shows the projected East Coast offshore wind market through 2035. Market projections are predominantly driven by offshore wind commitments announced by individual states. In addition to New Jersey's commitment to 7,500 MW by 2035, the nearby states of Maryland and New York have committed 1,200 MW and 9,000 MW of offshore wind energy, accounting for approximately 50% of the East Coast market.

FIGURE 1-1: SHARE OF EAST COAST MARKET

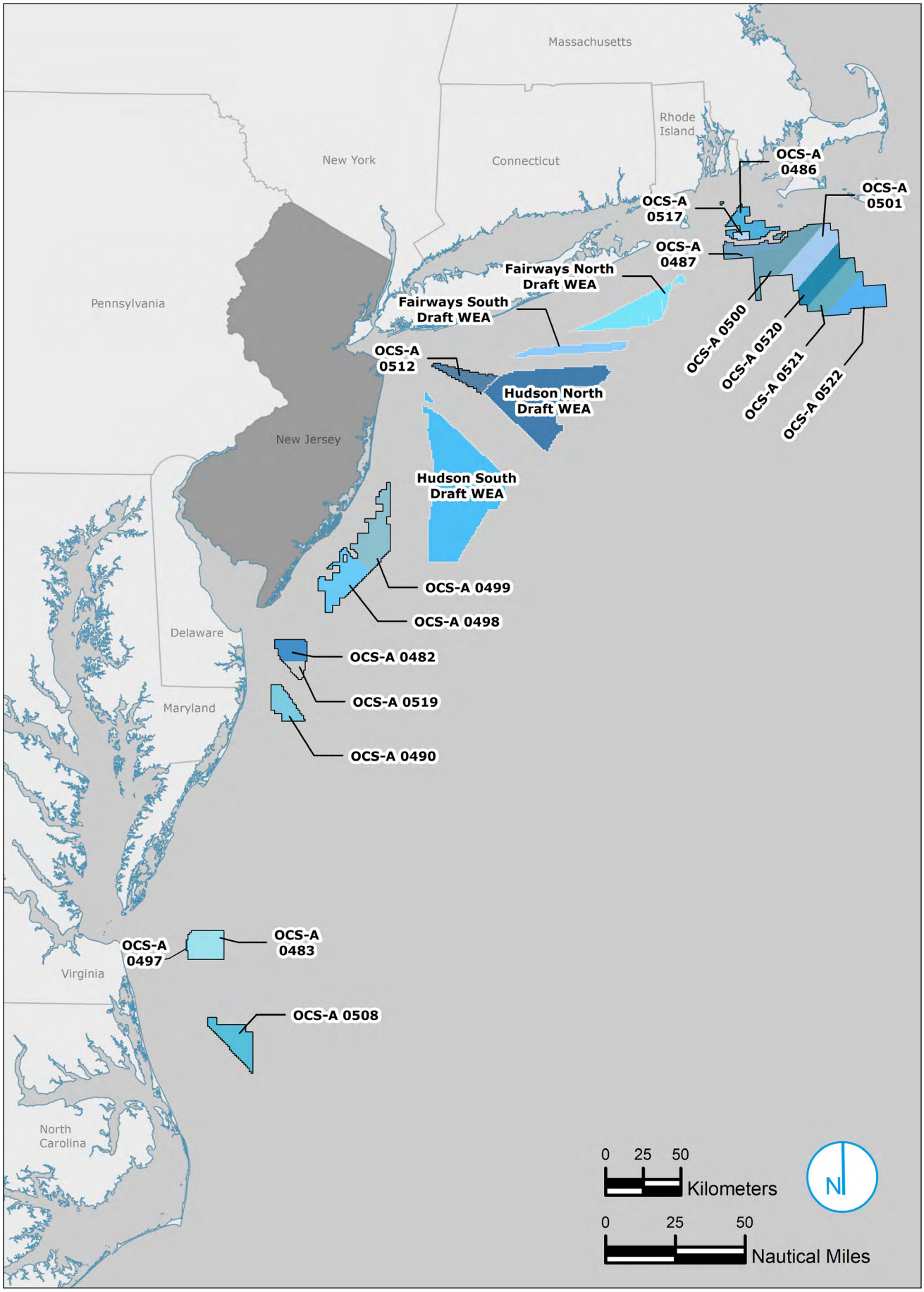


The Bureau of Ocean Energy Management (BOEM) has designated 21 areas for potential wind development and/or leases along the East Coast; Figure 1-2 depicts these areas and demonstrates the scope of the industry's potential. Seventeen lease areas have been awarded to several developers, with a total potential capacity of more than 21 GW.[5]

[4] Monmouth University Polling Institute. 2019. Strong Support for Wind Energy. Available at: https://www.monmouth.edu/polling-institute/reports/monmouthpoll_nj_040319/.

[5] Bureau of Ocean Energy Management. 2019. BOEM's Renewable Energy Program. US Department of the Interior, Bureau of Ocean Energy Management, Washington, DC. Available at: https://www.boem.gov/sites/default/files/environmental-stewardship/Mid-Atlantic-Regional-Planning-Body/RenEn-Program-8.28.19_2.pdf.

FIGURE 1-2: EAST COAST OFFSHORE WIND AREAS AND LEASES

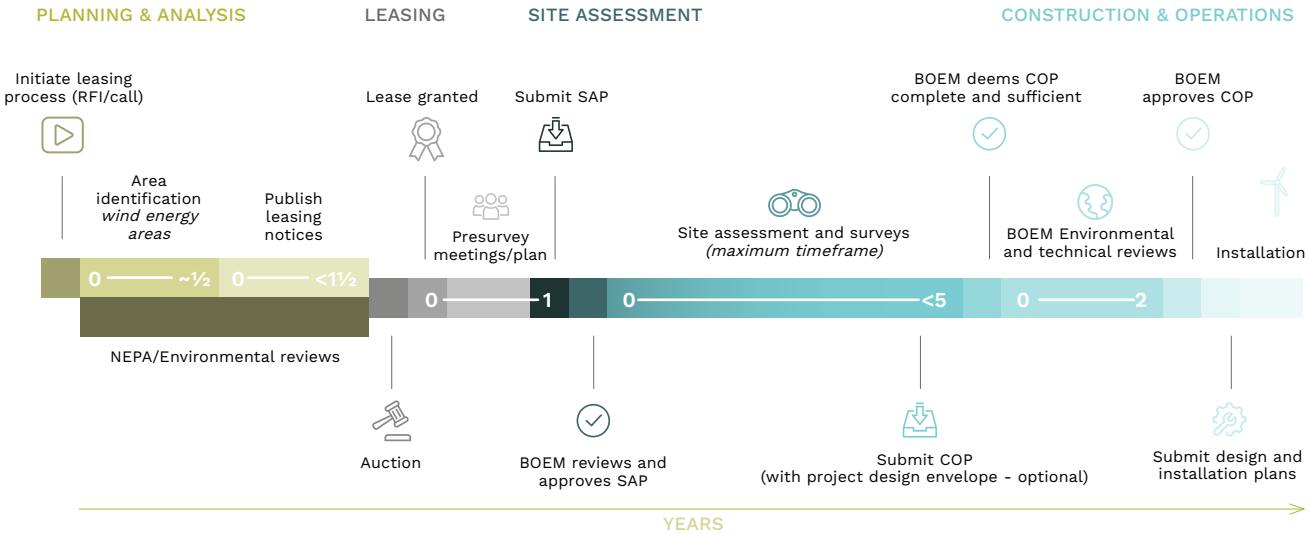


1.2 OFFSHORE WIND PROCESS

The federal government, led by BOEM, is responsible for identifying, leasing, and reviewing offshore wind areas and projects located between three and 200 nautical miles from the US coast. Early in the process (Figure 1-3), BOEM identifies wind energy areas (WEAs), which are locations in federal waters found by BOEM to be most suitable for offshore wind development. After WEAs have been designated, BOEM conducts further reviews and identifies smaller sections within the WEAs as lease areas to be specifically developed as offshore wind farms. These lease areas are auctioned by BOEM to offshore wind developers who bid for the opportunity to plan, construct, and operate offshore wind projects. States and other stakeholders work with developers and federal agencies to plan and approve the development of specific wind farms.

Selection of WEAs, lease areas, and individual project development are all subject to the federal environmental review process under the National Environmental Policy Act (NEPA). Developers also submit a site assessment plan (SAP) and a construction operation plan (COP) to BOEM for review and commentary before the public comment period begins. Public comments will be addressed, and these documents will be revised, based upon BOEM's comments, and resubmitted for final approval.

FIGURE 1-3: FEDERAL OFFSHORE WIND PROCESS



This figure represents estimated timeframes for each step. Reviews for each project may vary depending on individual circumstances.

States play an important role in the offshore wind project review process. New Jersey is a key stakeholder and has authority under the federal Coastal Zone Management Act to review project consistency with state coastal plans. NJDEP is the lead agency for the state permitting process and has regulatory oversight over offshore wind energy transmission cables and infrastructure built in state waters, as well as onshore activities. NJDEP will also be designated as a cooperating agency for the federal environmental review processes and can make recommendations for measures to minimize and mitigate potential natural resources impacts.

New Jersey, along with other states, solicits the purchase of offshore wind energy in the form of electricity generated by a proposed project over a specified timeframe. New Jersey's mechanism for funding offshore wind projects is based on the offshore wind renewable energy certificate (OREC). OWEDA requires the NJBPU to designate offshore wind projects eligible to receive ORECs, which are then called Qualified Projects. The

OREC is fixed for each year over the first 20 years of each phase of the project's commercial operation. For each megawatt-hour generated and delivered to the transmission grid, an approved project will be credited with one OREC. In return for the sale of ORECs, Qualified Projects are required to return all revenues received, including, but not limited to, from sales of energy, capacity, and, if applicable, ancillary services, into PJM's wholesale markets.

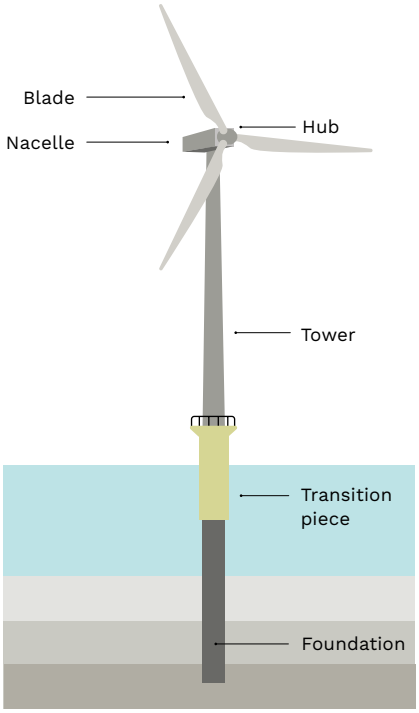
1.3 OFFSHORE WIND INFRASTRUCTURE

Offshore wind development involves the construction and maintenance of a large and complex series of components, including the following key infrastructure (Figures 1-4 and 1-7):

- Wind turbine – captures the wind energy and generates electricity; the turbine includes the following main parts:
  - → Hub – holds the blades and directs their angles
  - → Blades – moving parts that capture the wind energy
  - → Nacelle – houses the components that produce the energy
  - → Tower – out-of-water structure that supports turbine components
  - → Foundation – secures the tower and turbine components to the seafloor
  - → Transition piece – connects the tower to the foundation and typically includes structures such as boat landings, ladders, and platforms, which are often painted yellow
- Array cables – offshore inter-turbine cables (i.e., electrical collection system)
- Offshore substation – collects and stabilizes power
- Export cables – transmission cables to shore
- Onshore substation – collects offshore power and transfers it to onshore grid systems
- Onshore transmission grid – conveys electricity to ratepayers

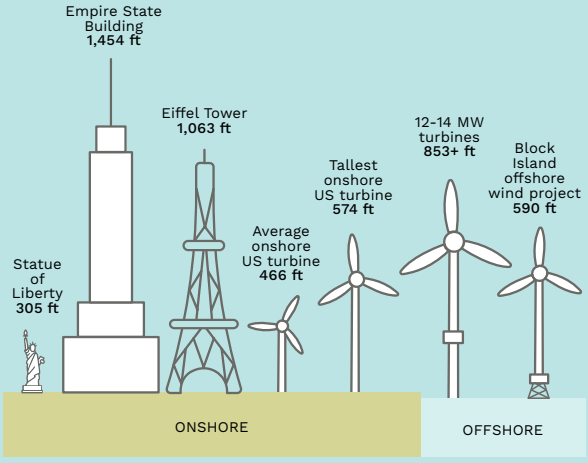
As wind projects are planned, designed, reviewed, constructed, and operated, many factors are considered for each of the various components. For example, wind turbine technology continues to evolve: the proposed turbine size for the first New Jersey project is 12 MW (see comparison below), with expectations that larger turbine capacity will be developed for future wind projects. As turbine size increases, the number of structures for each project decreases, reducing cost and environmental footprint. Larger turbines are heavier, with larger components adding new challenges related to manufacturing, transportation, and installation.

FIGURE 1-4: OFFSHORE WIND TURBINE MAIN PARTS



ADVANCING TECHNOLOGY

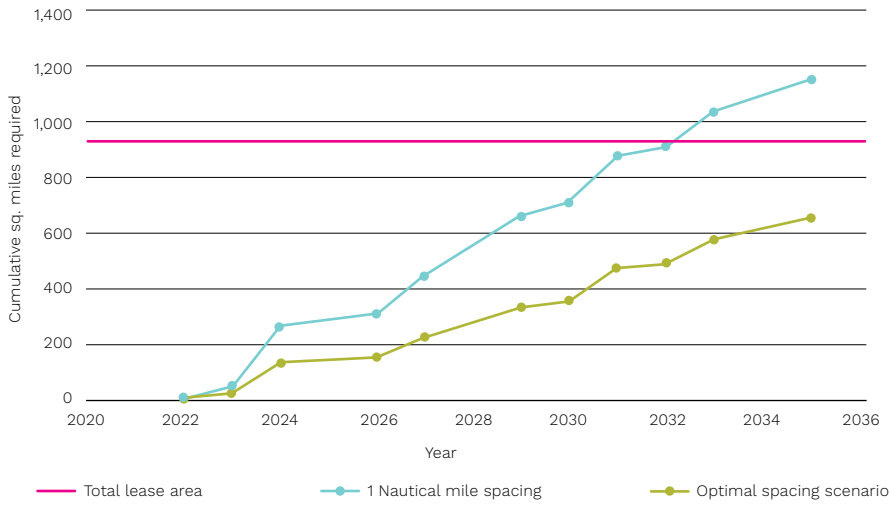
Offshore wind turbines are growing in size and capacity, requiring new standards and innovations in port development and offshore wind construction. The first project likely to be built using New Jersey ports committed to a 12 MW turbine, and 14 MW turbines are currently being developed.



Source: GE, Vox research

Similarly, the layout of turbines within a lease area should consider distance from shore, water depths, seabed geology, size and number of turbines, transit by fishers through and/or around the wind farm, and access for construction and maintenance. Turbine layout and spacing must consider often competing interests between fishing access, optimizing energy production, vessel navigation, infrastructure costs, and environmental considerations. Figure 1-5 shows the estimated area required for potential offshore wind projects that may be located in leases off the New Jersey coast through 2035,[6] under an optimal turbine spacing scenario[7] and a less dense one nautical mile spacing scenario. The red line in Figure 1-5 represents the total area of current offshore wind leases off the New Jersey coast, which is a maximum value since some portions of lease areas will be excluded from use for logistical, environmental, or other considerations.

FIGURE 1-5: ESTIMATED AREA REQUIRED FOR POTENTIAL PROJECTS



Foundations are also a key component of offshore wind project construction. There are several types of foundations used depending on water depth, seafloor geology, environmental concerns, and cost. The three main foundation concepts proposed for US East Coast projects, pictured in Figure 1-6, are:

Monopiles - consist of two tubular steel structures: a lower foundation pile and an upper transition piece, which connects to the tower. They are the most widely used foundation type in the industry, accounting for approximately 80% of installed structures as of 2019.[8]

Jacket - is a lattice structure made from steel tubes with three or four legs. Piles are driven into the seabed at each leg. A transition piece is mounted to the top of the jacket, which connects to the tower. Jackets are the second most widely used foundation type, accounting for 10% of installed structures.[8]

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[6] All New Jersey, Maryland, and Delaware estimated offshore wind energy projects shown in Figure 1-1 and 50% of New York projects.

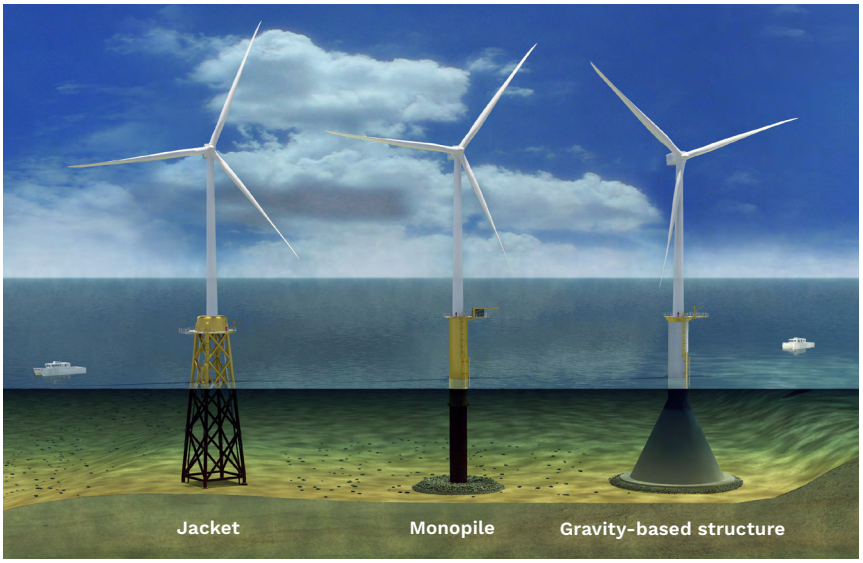
[7] Optimal spacing is defined as nine times the rotor diameter in the main wind direction and six times the rotor diameter in the cross-wind direction.

[8] Wind Europe. 2020. Offshore Wind in Europe. Key Trends and Statistics 2019.

Gravity-Based Structure (GBS) - is a reinforced concrete structure that utilizes its large mass to hold the wind turbine in place by gravity. It has a flat base and a conical structure onto which the tower is mounted. GBSs account for approximately 6% of installed structures.[8]

There are also other promising variants of monopile and jacket foundation concepts that use large buckets at the base of the structure to suck them silently into the seabed instead of using a large noisy hammer to drive piles. Floating foundation technology is also being developed for offshore wind and will likely become the preferred technology for deeper waters.

FIGURE 1-6: FOUNDATION CONCEPTS INCLUDING JACKET, MONOPILE, AND GRAVITY-BASED

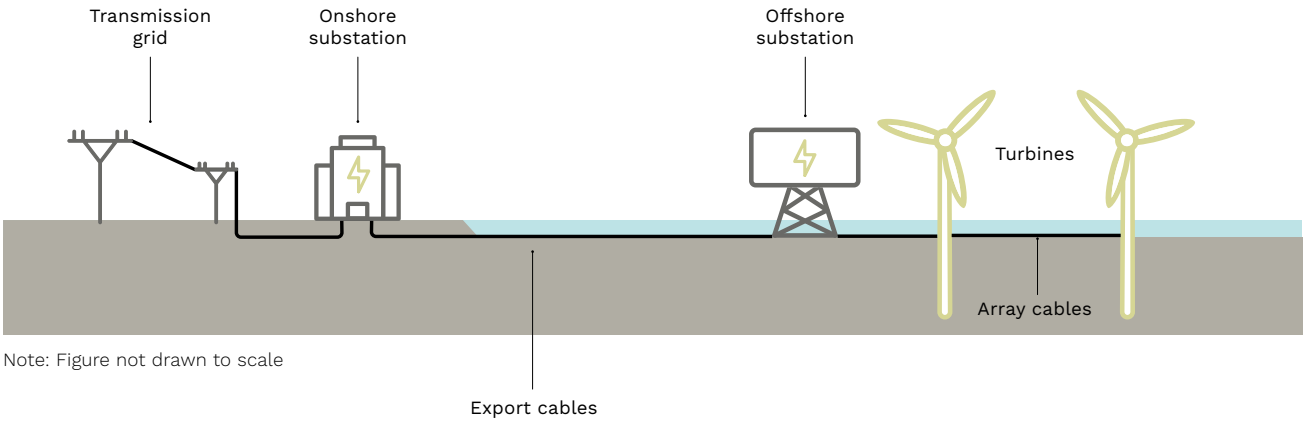


Offshore substations collect and export the power generated by turbines through specialized submarine cables. The substations stabilize and maximize the voltage of power generated offshore, reduce potential electrical losses, and transmit electricity to shore in a more cost-effective manner.

Underwater cables connect the wind turbine generators to the offshore substation, and the offshore substation to the onshore substation. Cables are typically buried into the seafloor to minimize impacts to marine life and conflicts with navigation and fishing. As the cable nears shore, horizontal directional drilling may be used to bury cables under sensitive coastal habitat to further reduce environmental impacts and conflicts with other infrastructure.

Onshore substation upgrades and connections are generally overseen by the network operator, which in New Jersey is PJM Interconnection LLC (PJM). The wind developer needs to coordinate onshore landing of the export cables with PJM, landowners, and local and state government. Both state and local permits are required for onshore substations and their connections.

FIGURE 1-7: OFFSHORE WIND INFRASTRUCTURE



Note: Figure not drawn to scale

1.4 NEW JERSEY'S 7,500 MW GOAL – SOLICITATIONS

In September 2018, the NJBPU solicited the first 1,100 MW of offshore wind capacity — the largest single solicitation issued by any state at that time. In June 2019, the NJBPU granted the state's first offshore wind award to Ørsted's Ocean Wind 1,100 MW project, initiating the opportunity to build New Jersey's first major offshore wind facility. The Ocean Wind project is expected to power approximately 500,000 homes and generate $1.17 billion in economic benefits.[9] The announcement of the award was the first major step toward meeting the state's goal of 7,500 MW of offshore wind energy generation by 2035 and advances Governor Murphy's vision of achieving 100% clean energy by 2050.

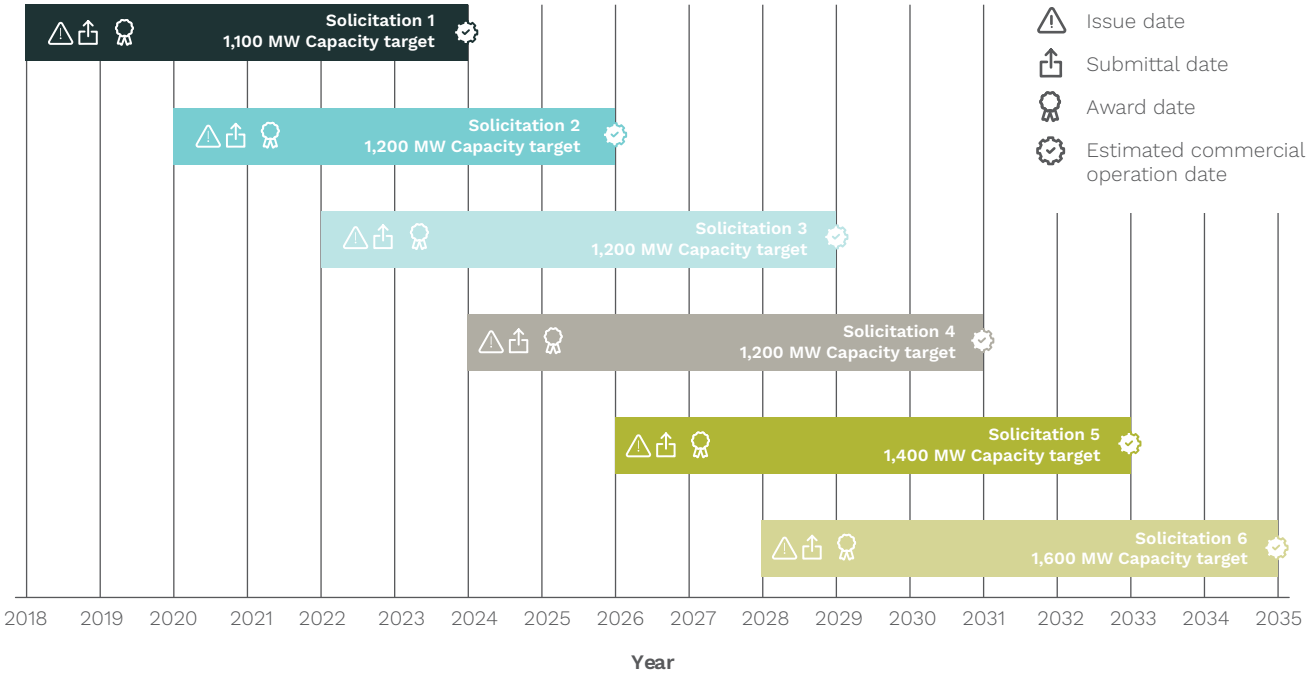
Subsequent to the governor's executive order announcing New Jersey's new goal of 7,500 MW by 2035, the NJBPU announced a schedule for solicitations to meet the goal. Figure 1-8 below shows the proposed schedule. As each solicitation approaches, capacity targets and schedule will be evaluated based on conditions existing at that time, including availability of tax credits or grants, establishment of supply chain, transmission solutions, technology advancements, and levelized cost of energy (LCOE) trends. Totaling 7,500 MW, these solicitations will set the path to foster project development along a timeline that is extremely attractive to the offshore wind industry, ultimately resulting in competitive energy rates and incentives to develop local businesses and a local workforce. New Jersey's offshore wind goal has the potential to power over 3.2 million homes and meet 50% of the state's electricity needs.[10] The target and long-term forecast of anticipated wind development provides the offshore wind industry confidence that New Jersey is committed to being the center for offshore wind development in the United States.

New Jersey's Ocean Wind project to power 500,000 homes and generate $1.17 billion in economic benefits

[9] State of New Jersey. 2019. New Jersey Board of Public Utilities Awards Historic 1,100 MW Offshore Wind Solicitation to Ørsted's Ocean Wind Project. Office of the Governor, Trenton, NJ. Accessed May 21, 2020.

[10] State of New Jersey. 2020. Governor Murphy Announces Offshore Wind Solicitation Schedule of 7,500 MW through 2035. Office of the Governor, Trenton, NJ. Accessed May 17, 2020. Available at: https://www.nj.gov/governor/news/news/562020/20200228a.shtml.

FIGURE 1-8: PROPOSED OFFSHORE WIND SOLICITATION SCHEDULE THROUGH 2035



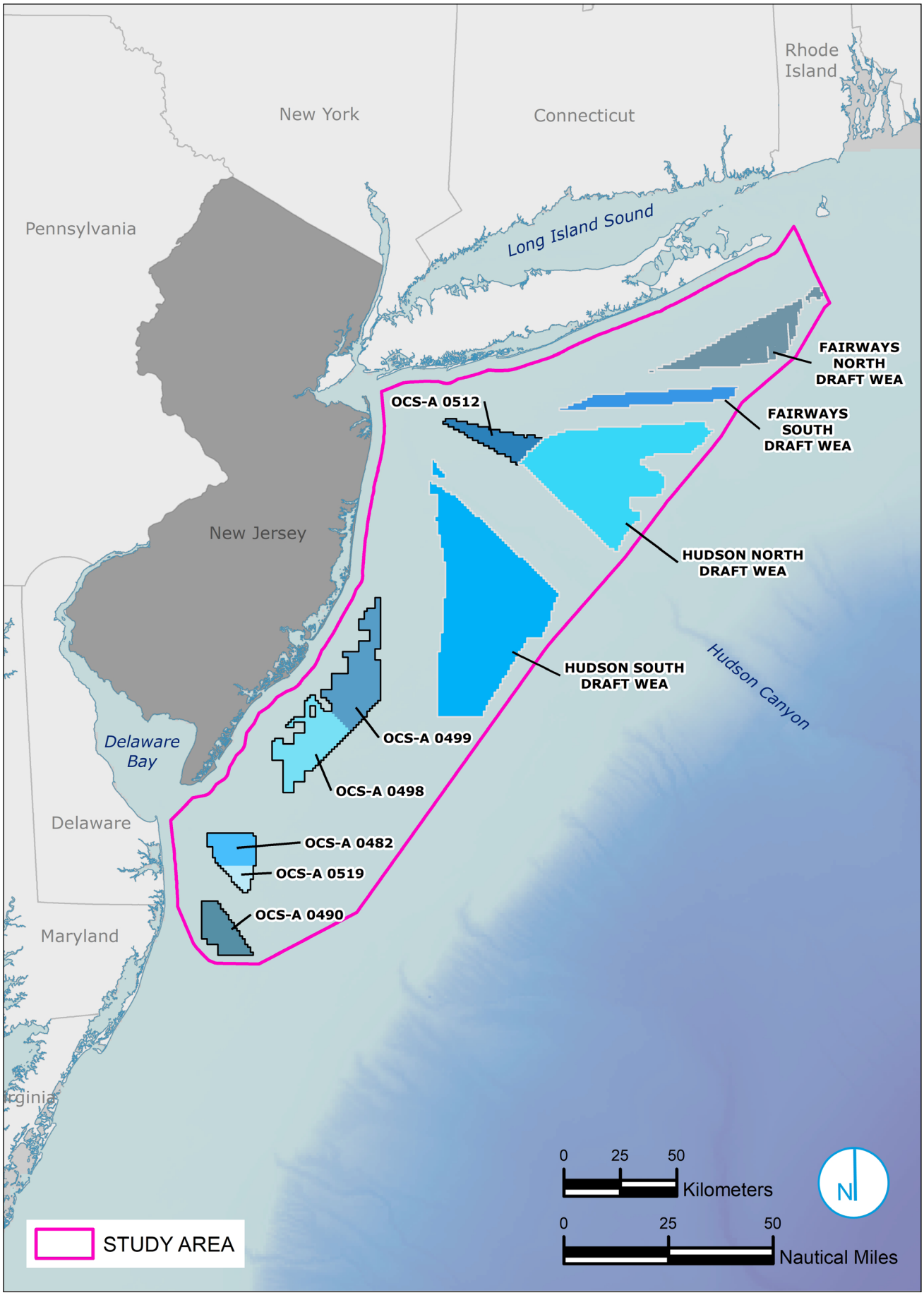
1.5 OFFSHORE WIND STRATEGIC PLAN

Recognizing the need to plan and prepare for significant development in the next 15 years, the governor has directed the preparation of the OWSP. As the initial 1,100 MW of New Jersey offshore wind is advanced, the state is taking immediate and future steps to foster this new industry. The above commitment to five strategically timed future solicitations adds clarity and certainty to developers' and manufacturers' investments and planning, and the OWSP adds additional commitments and recommendations to further set the course. The OWSP incorporates scientific studies and data, state agency input, industry expertise, and stakeholder input to create a path forward for meeting New Jersey's offshore wind goals.

1.5.1 Study Area

The geographical area evaluated as part of the OWSP is more than 12,500 square miles of the Atlantic Ocean located generally east of New Jersey, extending north to Long Island and south to an area off the coast of Ocean City, Maryland. The inshore boundary of the study area is the 3 nautical mile state jurisdictional boundary, and the offshore boundary is located at the practical outer edge of non-floating wind farm technologies (approximately 60 meters [197 feet] of water depth). The northern boundary of the study area is the federal outer continental shelf (OCS) administrative boundary just north of the Fairways North New York Bight wind energy areas (WEAs). The southern boundary was developed to include lease area OCS-A 0490, with a 2 nautical mile wide buffer applied to the southern edge. Included in this area are six lease areas and four draft WEAs (Figure 1-9).

FIGURE 1-9: MAP OF STUDY AREA



Lease Areas

The BOEM lease areas within the study area are located 7-27 nautical miles offshore (nearest point) in water depths of 11-40 meters (36–131 feet). Current leases include:

- OCS-A 0498 – leased by Ocean Wind LLC (Ørsted)
- OCS-A 0499 – leased by Atlantic Shores Offshore Wind, LLC (a joint venture between Shell New Energies US LLC and EDF Renewables North America)
- OCS-A 0512 – leased by Equinor Wind US LLC; location of the Boardwalk Wind and Empire Wind projects
- OCS-A 0482 – leased by Garden State Offshore Energy, LLC (GSOE I, LLC), a joint venture between Ørsted and PSEG
- OCS-A 0519 – leased by Skipjack Offshore Energy, LLC (Ørsted)
- OCS-A 0490 – leased by US Wind, Inc.

There are also four BOEM draft WEAs within the study area, the Hudson North and Hudson South WEAs and the Fairways North and South WEAs. It is expected that BOEM will designate portions of the draft WEAs as lease areas.

1.5.2 OWSP Summary

Under the direction of Governor Murphy, the NJBPU, with the assistance of other state agencies, has developed this OWSP to serve as a roadmap on how to achieve the goal of 7,500 MW of offshore wind energy in New Jersey by 2035. The goal of the OWSP is to ensure competition, competitive pricing, net economic benefits, environmental and natural resource protection, and the overall best value for New Jersey ratepayers. The OWSP focuses on the existing lease areas and the potential areas to be leased off the New Jersey coast and analyzes five key subject areas that are critical to offshore wind development:

- Environmental and natural resource protection
- Commercial and recreational fisheries
- Supply chain and workforce development
- Ports and harbors
- Energy markets and transmission

For each topic, the OWSP describes its strategic importance, includes a summary of stakeholder outreach conducted for the OWSP, summarizes current studies and findings, and, most importantly, sets forth specific recommendations for successful offshore wind development.

02

ENVIRONMENTAL AND NATURAL RESOURCE PROTECTION

ENVIRONMENTAL AND NATURAL RESOURCE PROTECTION

Climate change poses a real, immediate, and growing threat to New Jersey's economy, infrastructure, ecology, and human well-being. Increases in average temperatures, fluctuating extremes in precipitation, warming oceans, and sea level rise, along with other related impacts, will affect New Jersey's unique terrestrial, aquatic, and marine ecological communities well into the future. New Jersey's commitment to move away from carbon-emitting energy sources is critical to protecting its sensitive and unique natural resources. New Jersey's goal of 7,500 MW of offshore wind energy is central to attaining the state's goal of 100% clean energy by 2050 and will further strengthen New Jersey's economy. Offshore wind will be a major element in addressing the challenges of climate change and will create both economic and environmental benefits for generations to come.

Climate change poses a real, immediate, and growing threat to New Jersey's economy, infrastructure, ecology, and human well-being

2.1 STRATEGIC IMPORTANCE TO NEW JERSEY

Implementation of 7,500 MW of offshore wind development off the New Jersey coast will provide clean, renewable energy and offset traditional sources of power that are associated with the emissions that contribute to a changing climate. Utility-scale offshore wind energy constitutes a tremendous opportunity for economic growth and a significant source of renewable energy with commensurate environmental and health benefits such as mitigating rising temperatures and improving air quality. However, multiple use of ocean resources by many stakeholders requires careful consideration and coordination. It is important to acknowledge that the potential also exists for natural resource impacts associated with large-scale offshore wind projects. However, in the context of these opportunities and challenges, New Jersey will continue to lead offshore wind development, including in the area of environmental stewardship. New Jersey's leadership in environmental stewardship is evidenced by more than 16 years[11] of foresight, planning, guidance, and study in the field of offshore wind.

The ocean off the New Jersey coast is a highly dynamic system driven by a unique combination of winds, tides, currents, freshwater outflow from local rivers and estuaries, and local bathymetry. Collectively these drivers lead to a

[11] New Jersey embarked on environmental stewardship for offshore wind as early as 2004 with the establishment of the Blue Ribbon Panel on Development of Offshore Wind Turbine Facilities.

distinctive ocean environment that has an abundant and diverse suite of natural, social, and economic resources and includes some of the most ideal physical settings for offshore wind development. The coastal and ocean environments of New Jersey are special resources that require continued stewardship for shared use and protection of valued characteristics.

Elements that are key to the strategic importance of environmental and natural resource protection in the context of offshore wind development and operations in New Jersey are as follows:

- New Jersey's ocean has unique features that make it one of the most ideal physical settings for offshore wind development in the world (e.g., reliable wind, wide and shallow continental shelf, proximity to population centers) and that lead to a unique ecosystem
- New Jersey has a vast shoreline and marine areas that provide important habitat for birds, bats, marine mammals, turtles, fish, and benthic life
- New Jersey's coastal environment contributes significantly to the economy through recreation, tourism, and commerce activities (e.g., beach going, boating, fishing, nature viewing, swimming)
- New Jersey's coastal environment contributes to community quality of life and sense of place
- New Jersey's geography makes the state vulnerable to severe storms, sea level rise, tidal flooding, and other challenges associated with a changing climate that impact the state's natural resources and economy and residents' health and well-being
- New Jersey has strong and engaged regulatory agencies and research institutions to monitor and protect the state's coastal and marine environment
- New Jersey's coastal ocean is used by a wide variety of stakeholders for diverse purposes
- New Jersey's goal of 7,500 MW can be met only through the development of utility-scale projects located offshore in federal waters

New Jersey's coastal ocean is used by a wide variety of stakeholders for equally diverse purposes

2.2 STAKEHOLDER INPUT

Gathering stakeholder input has been an ongoing processes and has included the development of the New Jersey Environmental Resources Wind Working Group. Stakeholder input specific to the development of the OWSP for the protection of environmental resources began in a collaborative manner with multiple stakeholders during an environmental and natural resource protection roundtable discussion hosted by NJBPU on March 1, 2019 at Rutgers University's Cook Campus. Participants included environmental groups, non-governmental organizations, business interests, offshore wind industry representatives, and local communities. Participants were asked to comment on a range of environmental issues, including climate change, important species, habitat, and outdoor recreation specifically in the context of the development of the OWSP. Key issues raised by stakeholders included climate change, sensitive environmental receptors, and adequate monitoring, which were used in the development of the OSWP. A complete summary of the environmental and natural resource protection roundtable discussion and key input received from stakeholders is provided in Appendix A.

NEW JERSEY ENVIRONMENTAL RESOURCES OFFSHORE WIND WORKING GROUP (ENVIRONMENTAL WORKING GROUP)

The New Jersey Department of Environmental Protection is leading a working group of fishing and conservation groups to provide guidance on the overall strategy and approach to achieving New Jersey's offshore wind goals.

- Enhancing communication and coordination between commercial and recreational fishing and conservation communities and state and federal agencies
- Providing a platform for the fishing and conservation communities to have meaningful input to assist the state with its decision making as New Jersey moves forward with its clean energy goals
- Sharing existing data, research, and information sources with fishing and environmental groups
- Providing information on current uses of proposed offshore wind areas in order to allow NJDEP and other agencies to better address, and potentially mitigate, any potential conflicts
- Supporting scientific and technical research at state and regional levels to address issues related to offshore wind energy project planning, siting, construction, operation, and monitoring

2.3 SUMMARY OF EVALUATION

As part of this OWSP, a planning-level environmental analysis was undertaken to support assessment of the relative suitability of waters off the coast of New Jersey for the responsible development of offshore wind. The analysis completed was not a comprehensive review of environmental and natural resource impacts for the purposes of permitting or evaluation of project-specific impacts. Rather, this evaluation was a generalized study using recent and available data that was conducted to provide an overview of potential conflicts with various phases of offshore wind development. This was accomplished by evaluating the sensitivity of certain biological resources and ocean uses to offshore wind development which is defined as relative susceptibility in this analysis. The analysis also recognizes the value and uniqueness of New Jersey coastal ocean. The focus of the analysis was the ocean area of potential offshore wind development previously defined as the study area, as depicted in Figure 1-9.

The weighted susceptibility analysis (WSA) is intended to inform the development of offshore wind in New Jersey by providing a depiction of relatively high and low areas of potential conflict for offshore wind development. Importantly, these results do not preclude offshore wind development in any area and do not substitute for site-specific environmental reviews. For example, areas identified as having a greater susceptibility to adverse impacts may represent locations where there may be a need for mitigation measures prior to offshore wind development. Similarly, areas identified with lower conflict should not necessarily be assumed to be the best areas for offshore wind development, since this analysis does not consider every environmental element, biological resource, or process.

Two primary evaluations were conducted. The first was a WSA that examined key biological resource subgroups (i.e., birds, fish, cetaceans, sea turtles, habitat, benthic invertebrates) to adverse impacts by using abundance data and an assigned susceptibility weighting factor (see discussion in Appendix B). The second was an unweighted resource evaluation (URE) that depicted data for other ocean uses (e.g., military use) relative to candidate wind development areas (i.e., lease areas, WEAs). Both evaluations used a geographic information system (GIS) that incorporated relevant and appropriate spatial information to identify where resources and features occur and the potential relative susceptibility with respect to the four primary stages of offshore wind development (preconstruction, construction, operations, decommissioning). While it is recognized that new data and information is continually produced and updated, the data used in the evaluations was generally the most recent available at the time of the analysis. Examples of potential resource impacts include the following:

- Injury and mortality to birds and bats due to interactions with wind turbines[12]
- Injury and mortality to marine mammals or other fauna (e.g., sea turtles) due to collisions with in-water structures or vessels (e.g., vessels used in material delivery, installation, inspection, operations, and maintenance)
- Displacement or injury to biological resources associated with physical infrastructure or noise from survey vessels and construction/ decommissioning activities
- Attraction to wind infrastructure due to lighting and reef effects, leading to the potential for wildlife injuries
- Changes in behavior associated with the electromagnetic field generated via energized transmission cables of an operating wind farm
- Disturbance to habitat and organisms associated with installation/ decommissioning of turbine foundations and transmission cables
- Challenges associated with vessel navigation and shipping (e.g., obstacle avoidance)

[12] Bats were identified as a data gap in this analysis (see Appendix B); however, the potential for impacts to bats is generally considered categorically similar to that of birds (i.e., in-flight conflicts). “Interactions” in this statement acknowledges the potential for attraction, collisions, displacement, or barometric trauma.

2.3.1 Weighted Susceptibility Analysis

The WSA identifies areas of higher and lower susceptibility to offshore wind development within the study area. The URE presents information regarding diverse ocean uses and the potential for conflict with wind planning areas (leases and WEAs). A detailed discussion of the technical information, methods, and important assumptions integral to these evaluations is presented in the Environmental and Natural Resource Technical Appendix (Appendix B). An overview of the approach to these evaluations is provided below. The analysis included the use of GIS mapping to show resource areas and employs a weighted sum of the relative susceptibility of biological resources across the area to impacts from offshore wind development. The six biological resource subgroups are as follows:

Birds: Data layers representing over 40 species of birds

Fish: Data layers representing over 80 species of fish

Cetaceans: Data layers representing over 30 species of cetaceans

Sea turtles: Data layers representing loggerhead turtles, leatherback turtles, and green sea turtles

Habitat: Data layers representing essential fish habitat and artificial reefs

Benthic invertebrates: Data layers representing scallops, Atlantic surfclams, ocean quahogs, and other benthic invertebrates

Results of the WSA are presented below.

Combining the results of all subgroups evaluated in the WSA yields a depiction of the overall susceptibility of certain biological resources to offshore wind development within the study area (Figure 2-2). The primary drivers of relative susceptibility are commensurate with the susceptibilities for particular resources identified in Figure 2-1 and described in detail in Appendix B. A trend of increased susceptibility with depth and distance from shore is observable in the composite analysis. The existing lease areas appear to be areas of lower susceptibility to offshore wind compared to the rest of the study area. Although this analysis is not a site-specific impact assessment, it does indicate that environmental susceptibility will vary within leases and that project planning and development should address the avoidance and minimization of adverse effects to environmental resources. It should be noted that certain resource subgroups evaluated in the WSA were subject to data gaps, as further detailed in Appendix B.

FIGURE 2-1: RELATIVE SUSCEPTIBILITY OF BIOLOGICAL RESOURCE SUBGROUPS TO OFFSHORE WIND DEVELOPMENT

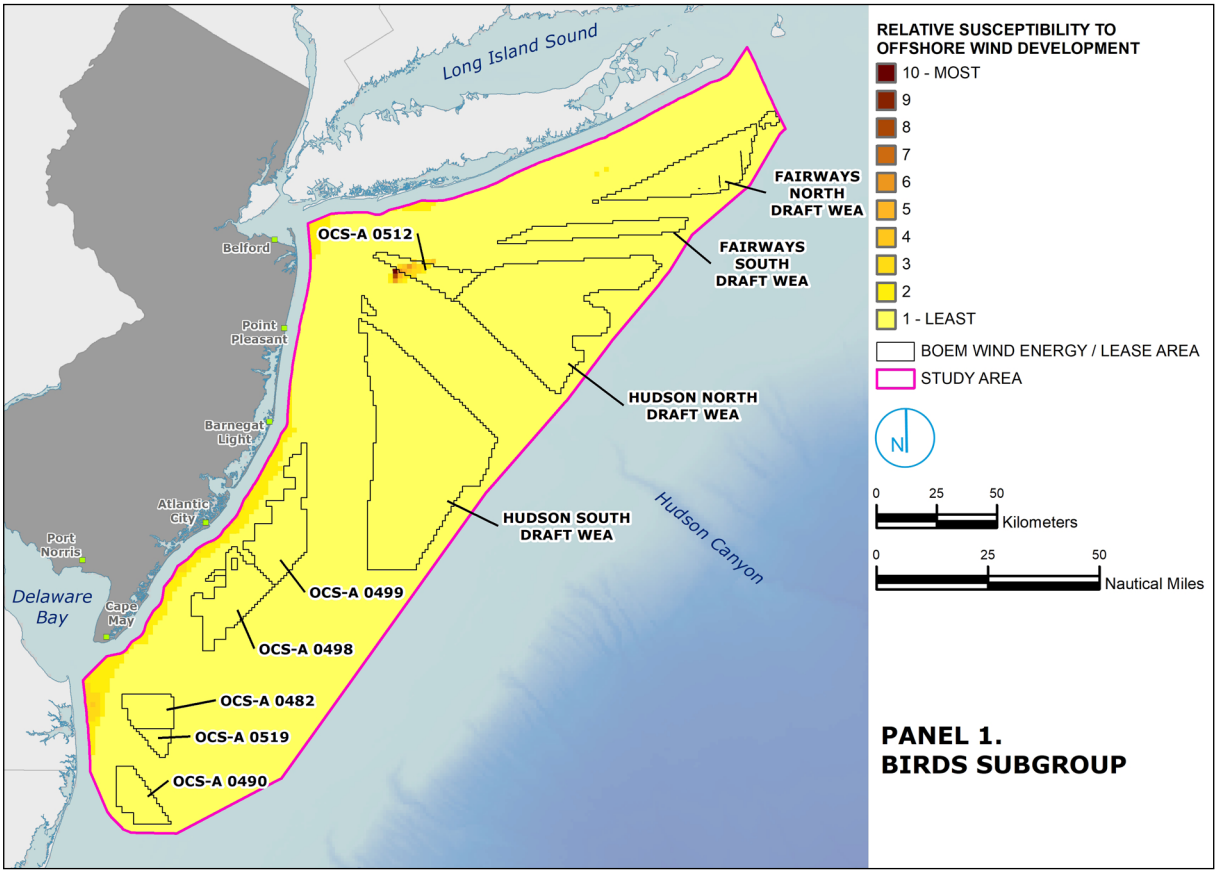
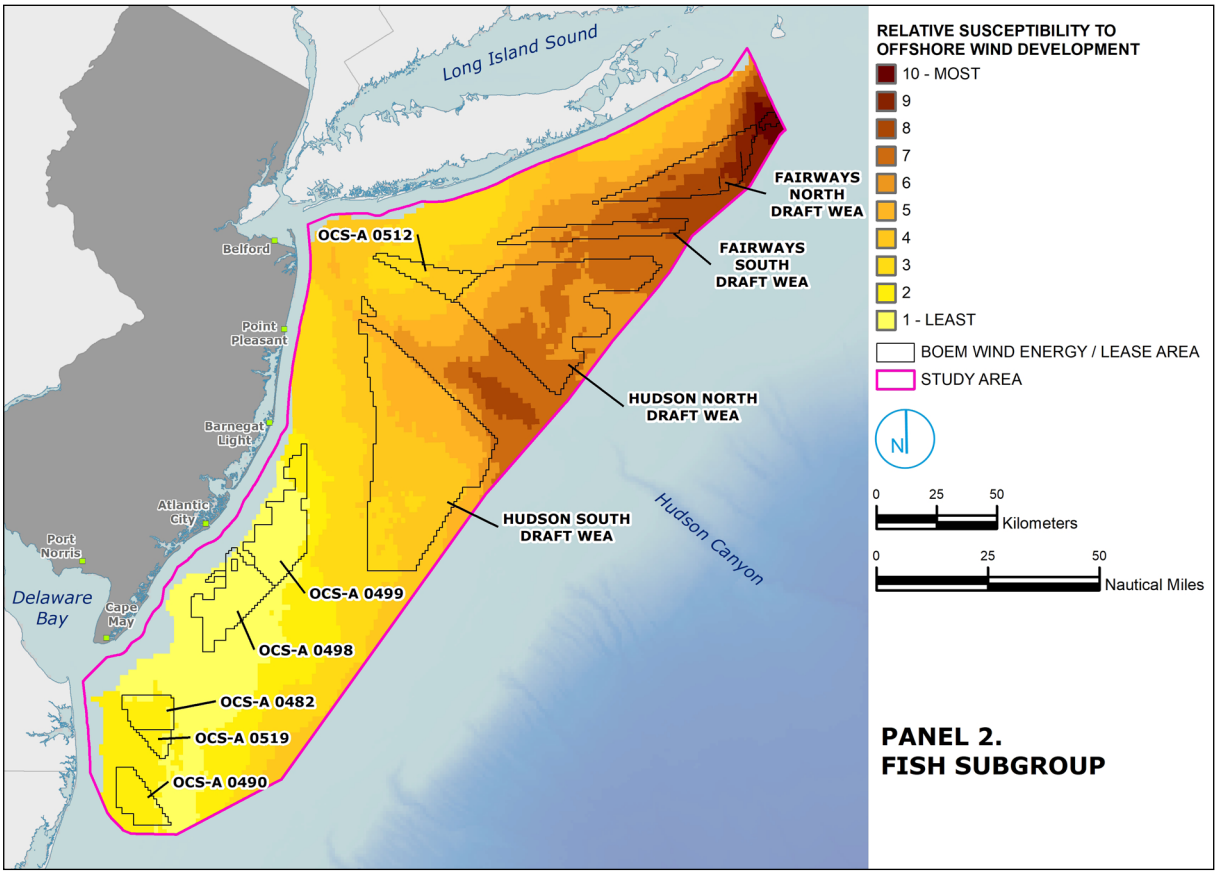


FIGURE 2-1: RELATIVE SUSCEPTIBILITY OF BIOLOGICAL RESOURCE SUBGROUPS TO OFFSHORE WIND DEVELOPMENT (CONTINUED)



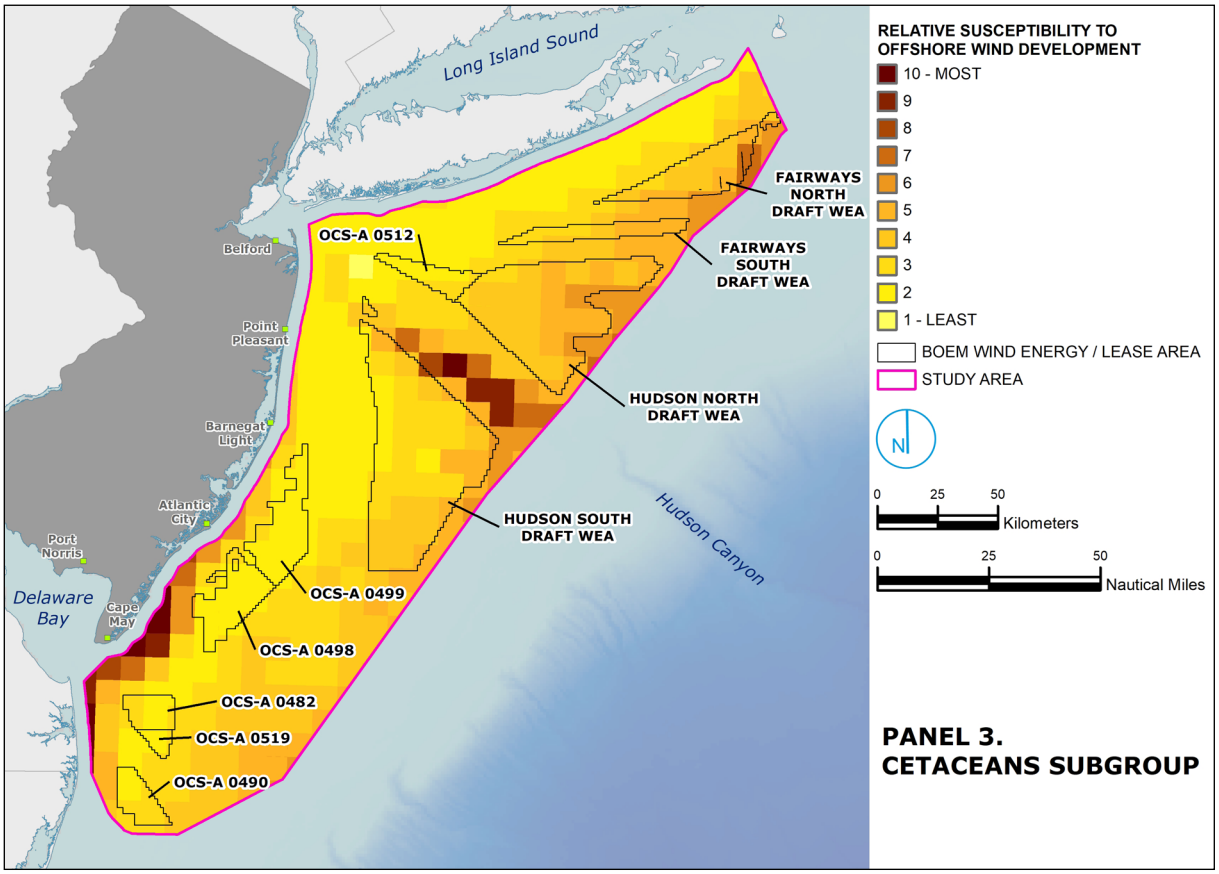
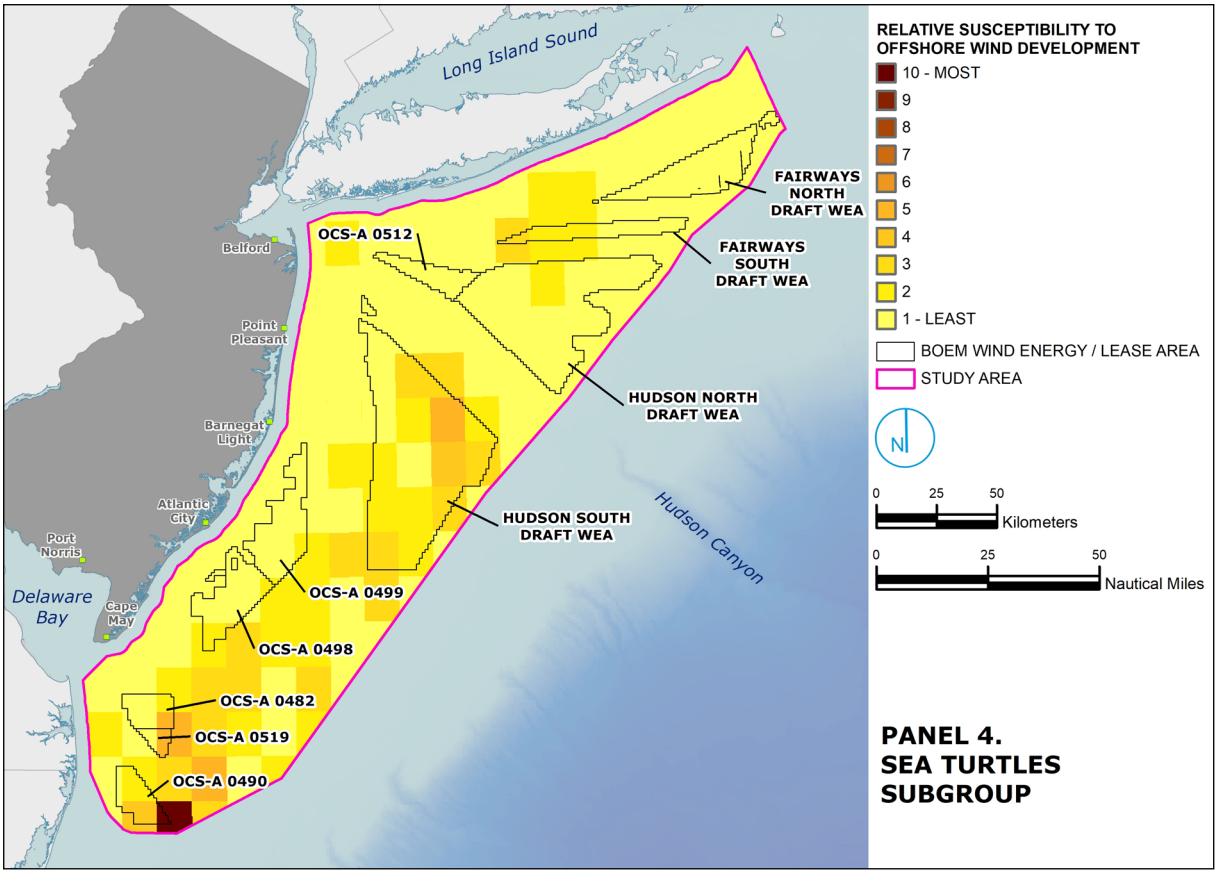


FIGURE 2-1: RELATIVE SUSCEPTIBILITY OF BIOLOGICAL RESOURCE SUBGROUPS TO OFFSHORE WIND DEVELOPMENT (CONTINUED)



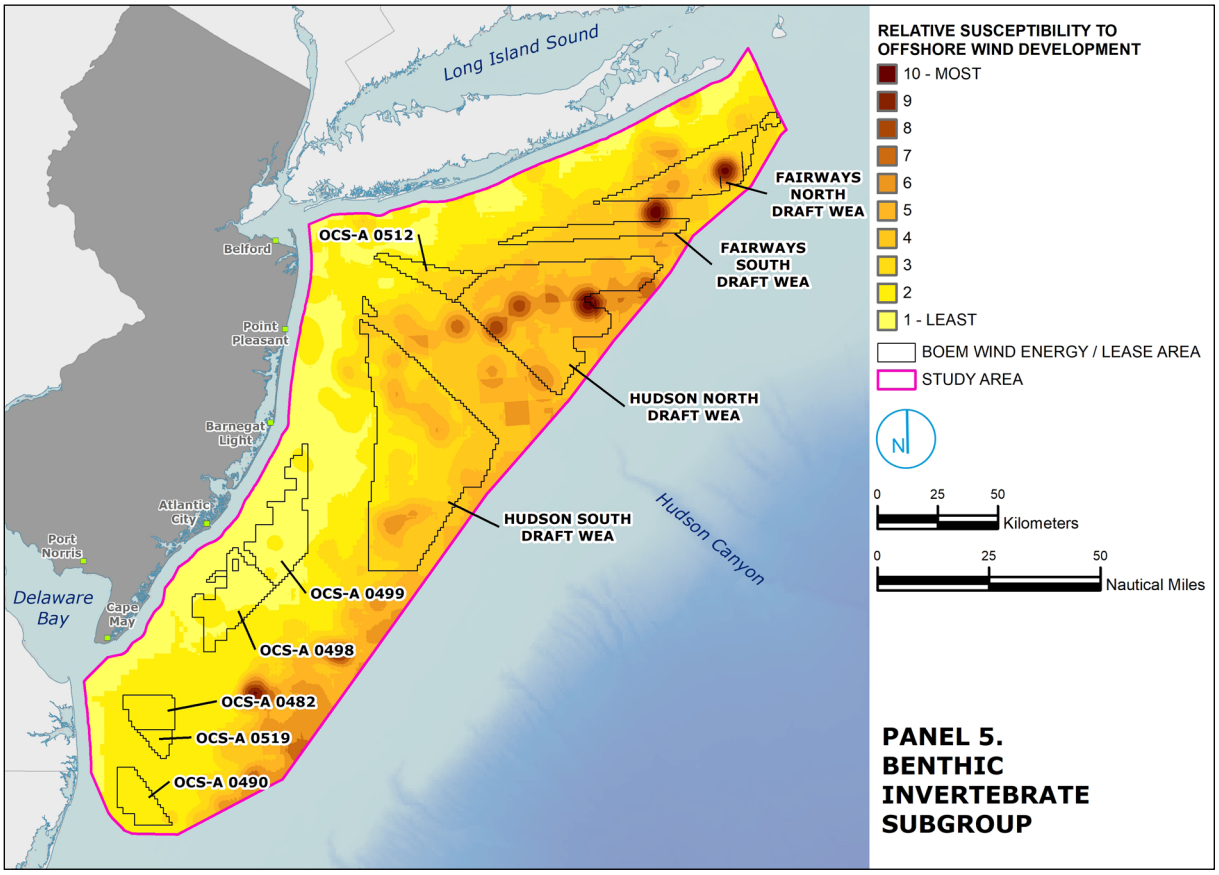


FIGURE 2-1: RELATIVE SUSCEPTIBILITY OF BIOLOGICAL RESOURCE SUBGROUPS TO OFFSHORE WIND DEVELOPMENT (CONTINUED)

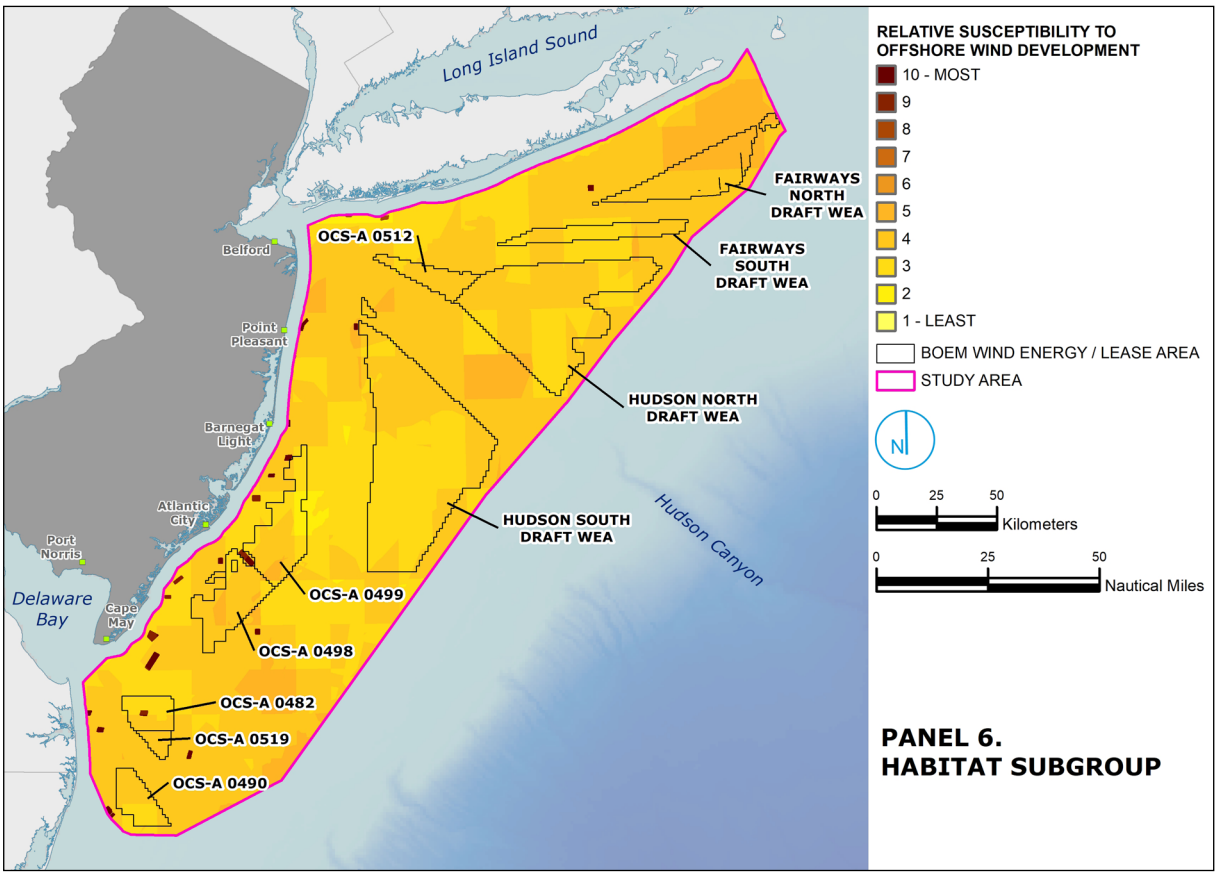
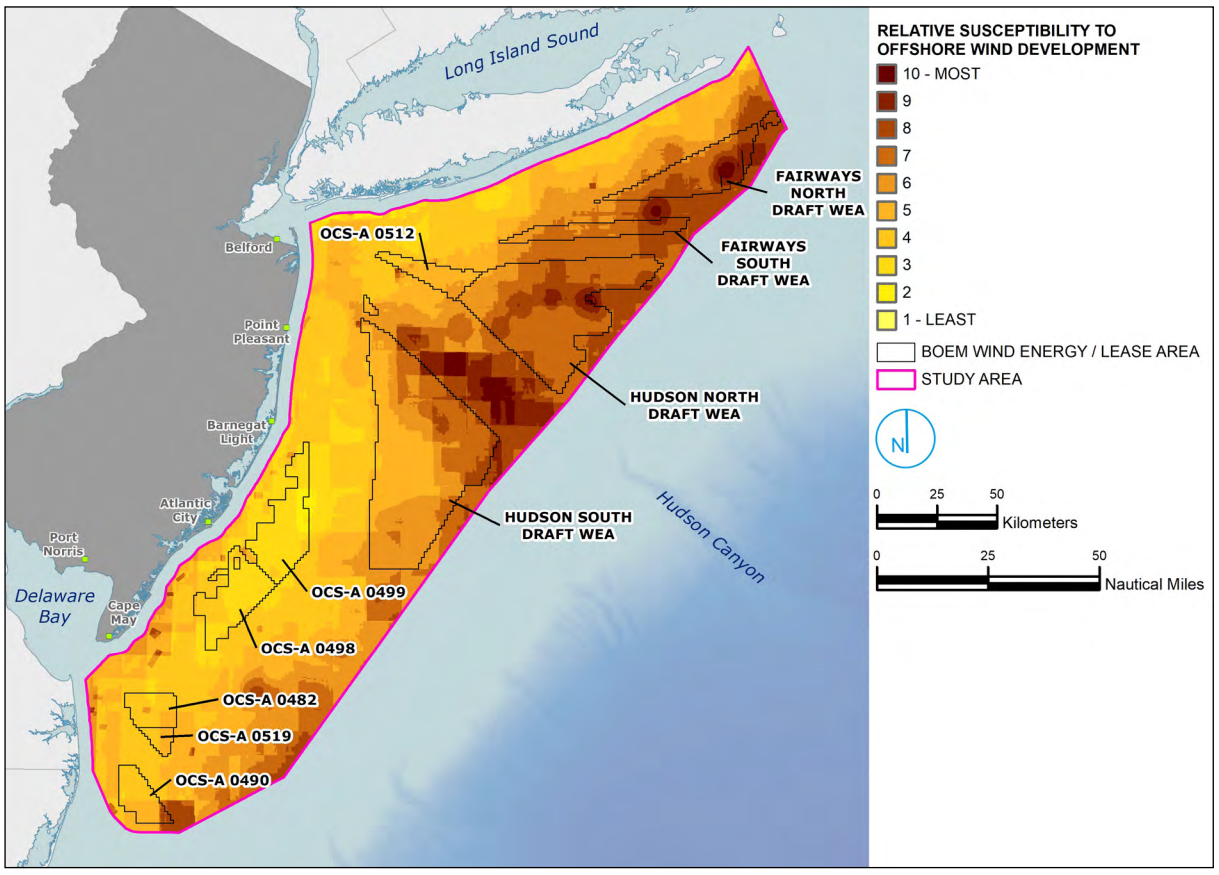


FIGURE 2-2: COMBINED RELATIVE SUSCEPTIBILITY OF BIOLOGICAL RESOURCE SUBGROUPS TO OFFSHORE WIND DEVELOPMENT



The WSA to adverse impacts represents a planning-level assessment of the relative susceptibility of certain biological resources within the study area based on existing and available data. Project-specific impacts associated with developing offshore wind in a given lease area are not captured in this evaluation. Such impacts are subject to regulatory review by BOEM where they occur in federal waters and review by New Jersey state agencies (e.g., NJDEP) where elements (e.g., cable landfalls, other coastal infrastructure) occur within state jurisdictions (on or within three nautical miles of shore). The areas of higher or lower susceptibility shown on the subgroup figures are relative susceptibilities (1-least susceptible, 10-most susceptible) and should be interpreted only in the context of this analysis within the defined study area. The relative susceptibilities presented in the WSA figures should also be considered alongside other recommended studies, analyses, and conservation priorities. Although the WSA and associated figures are intended to provide technical insights into the anticipated susceptibility of biota and fisheries activities to offshore wind development, it should be noted that these efforts reflect a broad overview, not a comprehensive study of all available scientific information. The WSA highlights the areas of relative susceptibility for focusing offshore wind development efforts so that the impacts can be either avoided or minimized.

New Jersey is a state known for its ocean resources and valued geography, which are both the setting and the destination of a variety of uses

2.3.2 Unweighted Resource Evaluation

A URE was conducted to assess other facets of ocean resource use relative to potential offshore wind development within the study area. The URE depicts occurrence data of specific ocean uses and resources such that their collocation with candidate lease areas and WEAs is identified (Figures 2-3 and 2-4). This section presents a summary of the URE analysis in the context of the use categories listed below. Note that the URE was also conducted for commercial and recreational fisheries and is discussed in the following section.

Social use: Data layers include commercial whale watching areas, prominent scuba sites, and marine protected areas

Utility resources: Data layers include undersea cables and additional miscellaneous ocean use (e.g., disposal sites, pilot boarding areas, anchorages)

Restricted use: Data layers include danger zones, restricted areas, unexploded ordnance, and zones of military use

Vessel density: Data generated by vessels with an automatic identification system (AIS) are captured in this dataset

Detailed discussion of the URE is presented in Appendix B. In general, the URE conducted in support of the Environmental and Natural Resource Protection section identified low potential for conflicts between offshore wind and social uses based on collocated activity. Social use data layers were limited and all known use is not captured on Figure 2-3 Panel 1 (e.g., whale watching activities are known to occur off southern New Jersey originating from Cape May); however, offshore wind activities are generally not expected to have high levels of conflict with unmapped social use of New Jersey's coastal ocean. Undersea cables run throughout the study area and intersect with lease areas OCS-A 0499, OCS-A 0512, and the Hudson South and the Hudson North draft WEAs. Coordination with utilities and undersea cable owners will be necessary when planning survey activity and turbine layouts. The area of military use overlaps portions of all the lease areas or WEAs but is not expected to be a major limiting factor for offshore wind development due to the encompassing allocation of potential areas of military use and the vast other suitable operational areas expected to be utilized and preferable. The URE identified that most lease areas and WEAs were deliberately situated to avoid shipping lanes. The implementation of offshore wind projects may lead to additional vessel traffic in the study area. However, vessel traffic associated with offshore wind is expected to follow major navigation courses (e.g., shipping lanes, traffic separation schemes) except during the period of transit to and from wind farms. Vessel traffic is expected to be highest during the construction and decommissioning phases of offshore wind development.

FIGURE 2-3: OTHER OCEAN USES

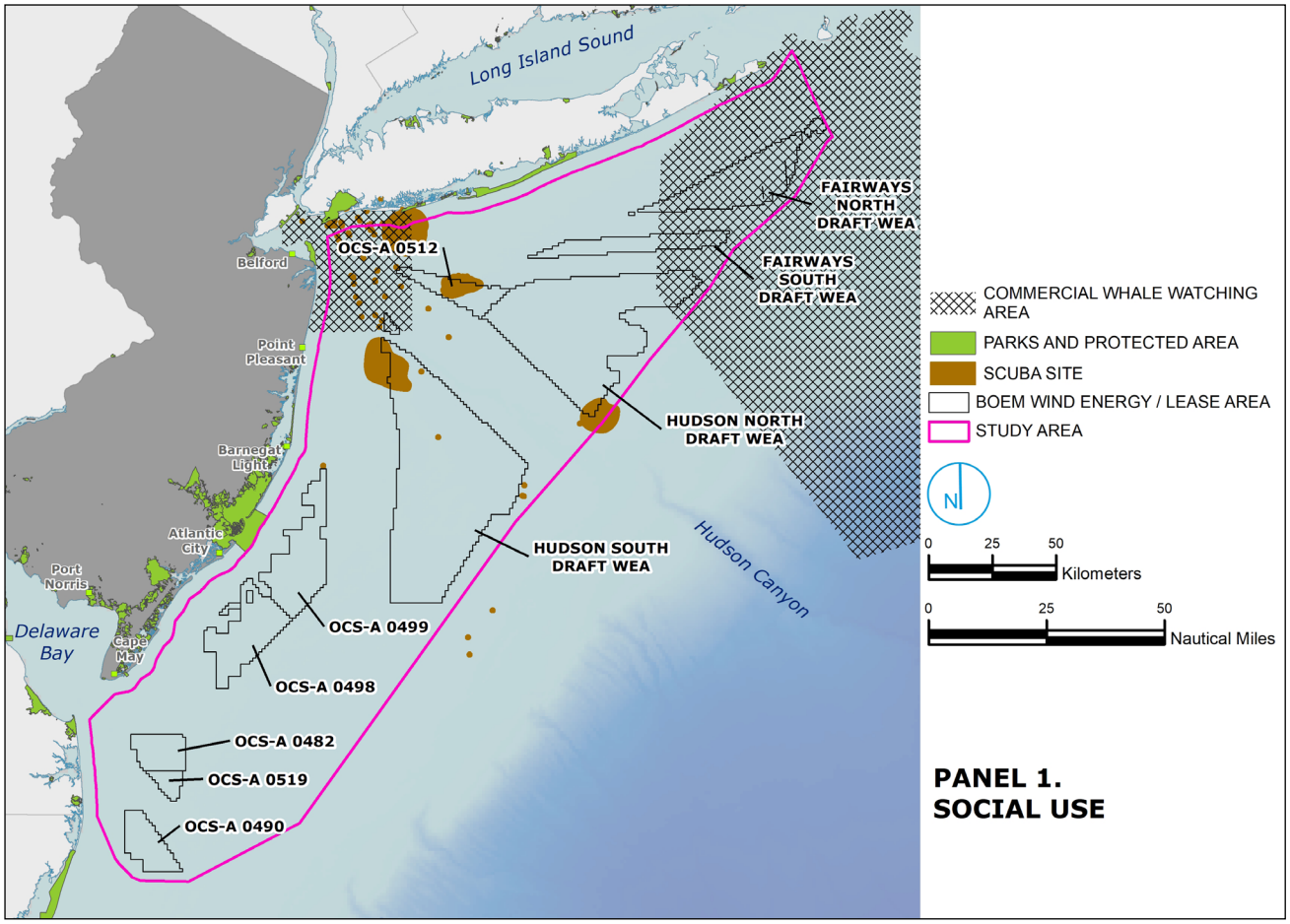
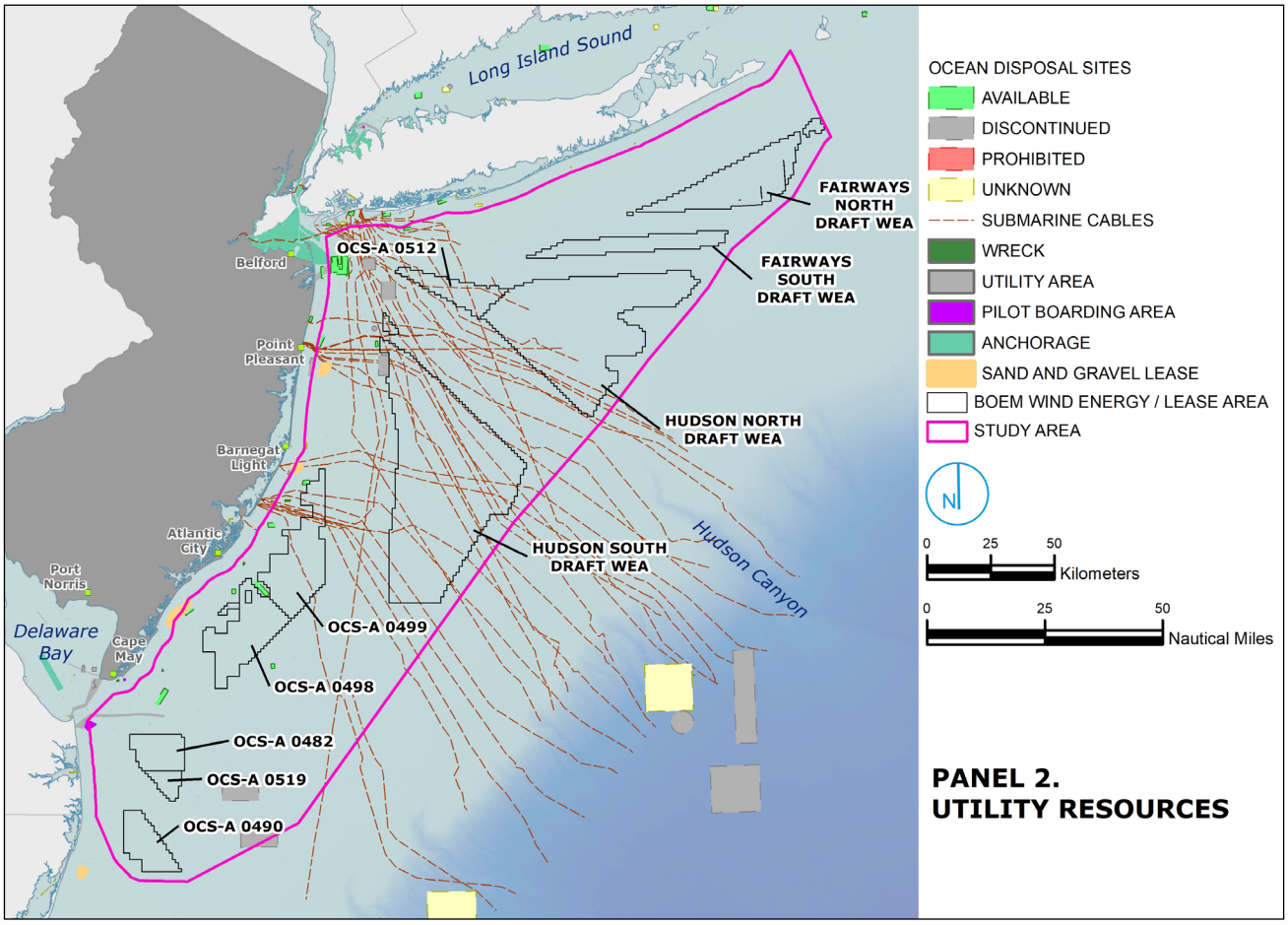


FIGURE 2-3: OTHER OCEAN USES (CONTINUED)



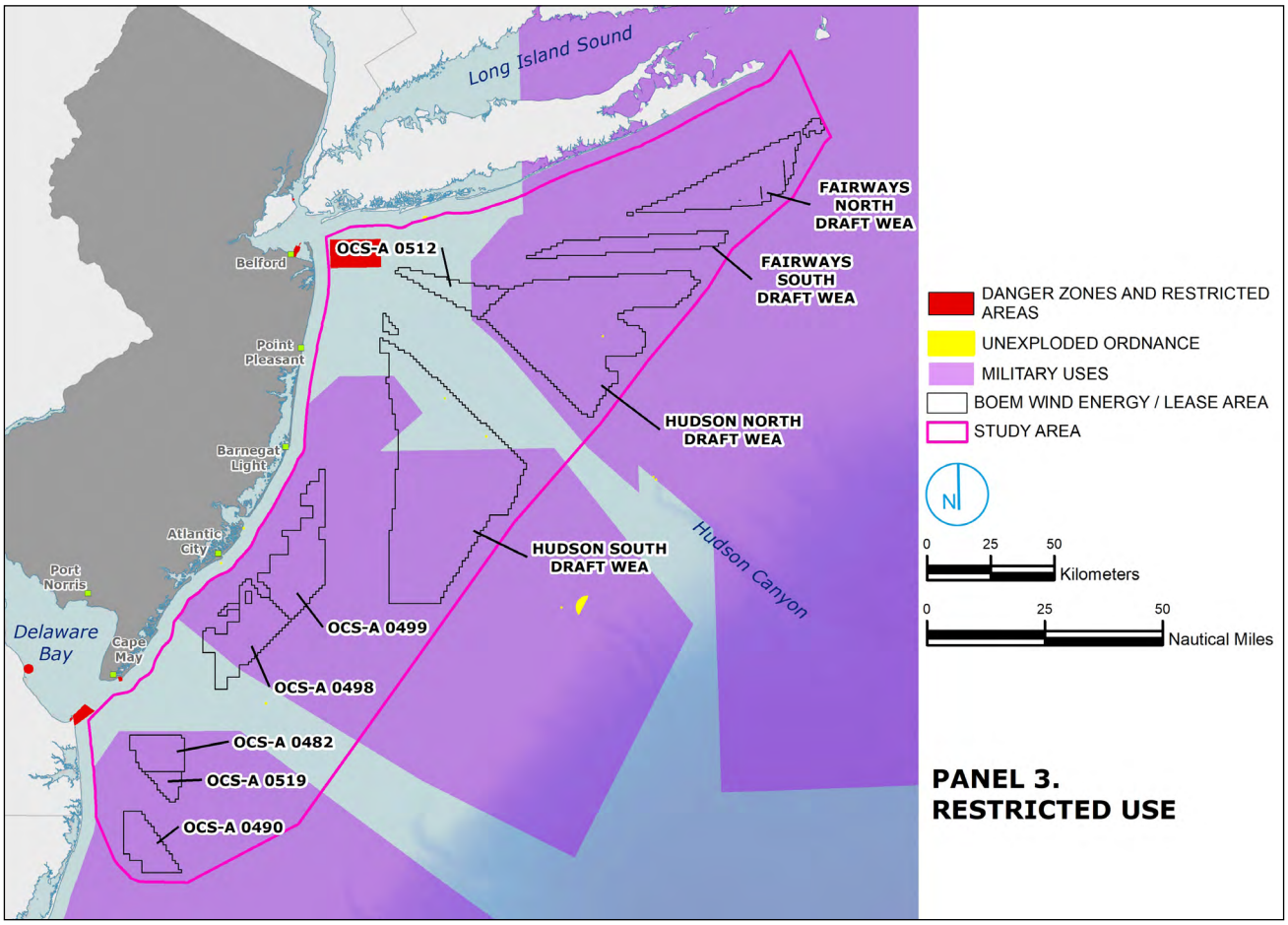


FIGURE 2-3: OTHER OCEAN USES (CONTINUED)

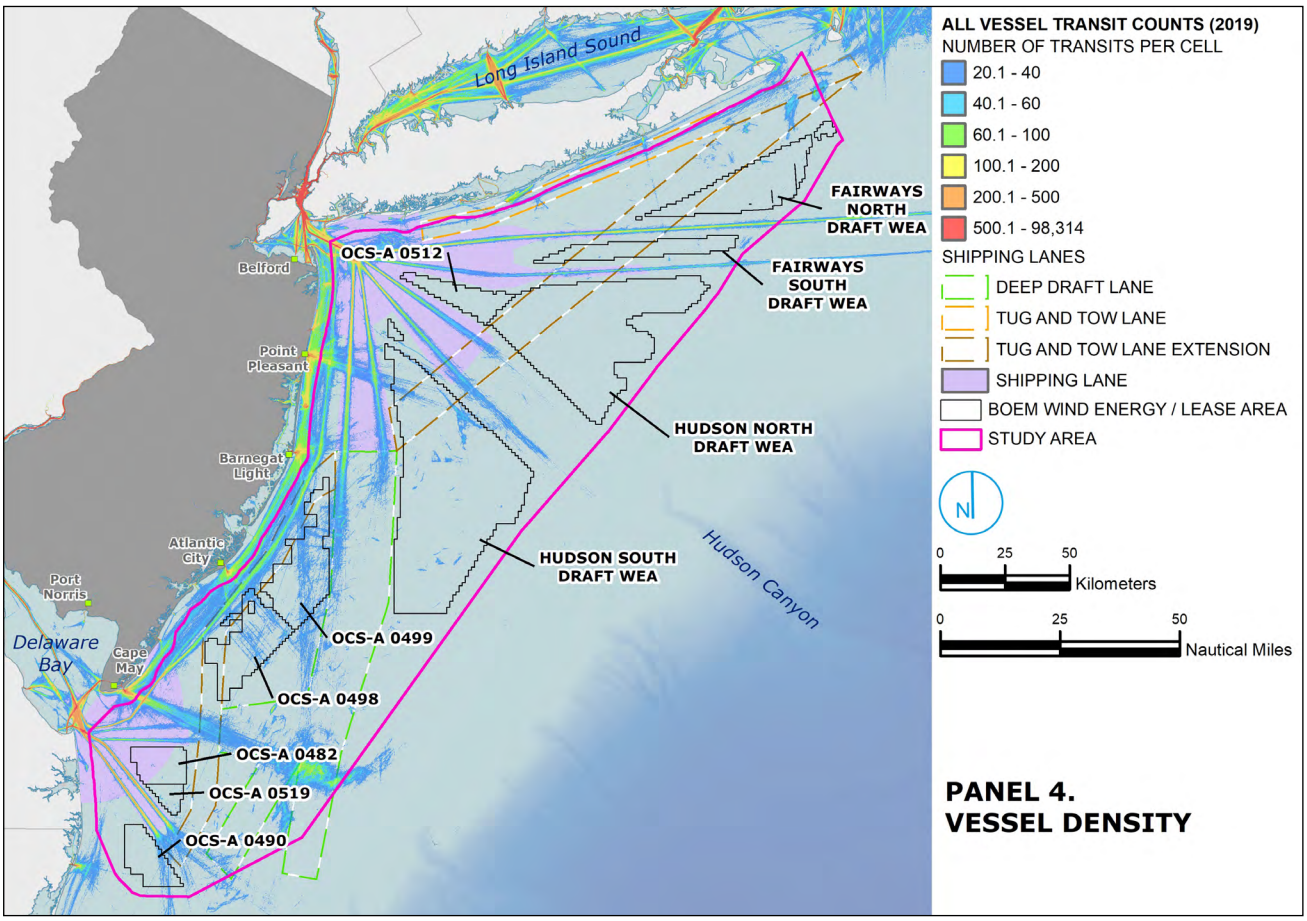
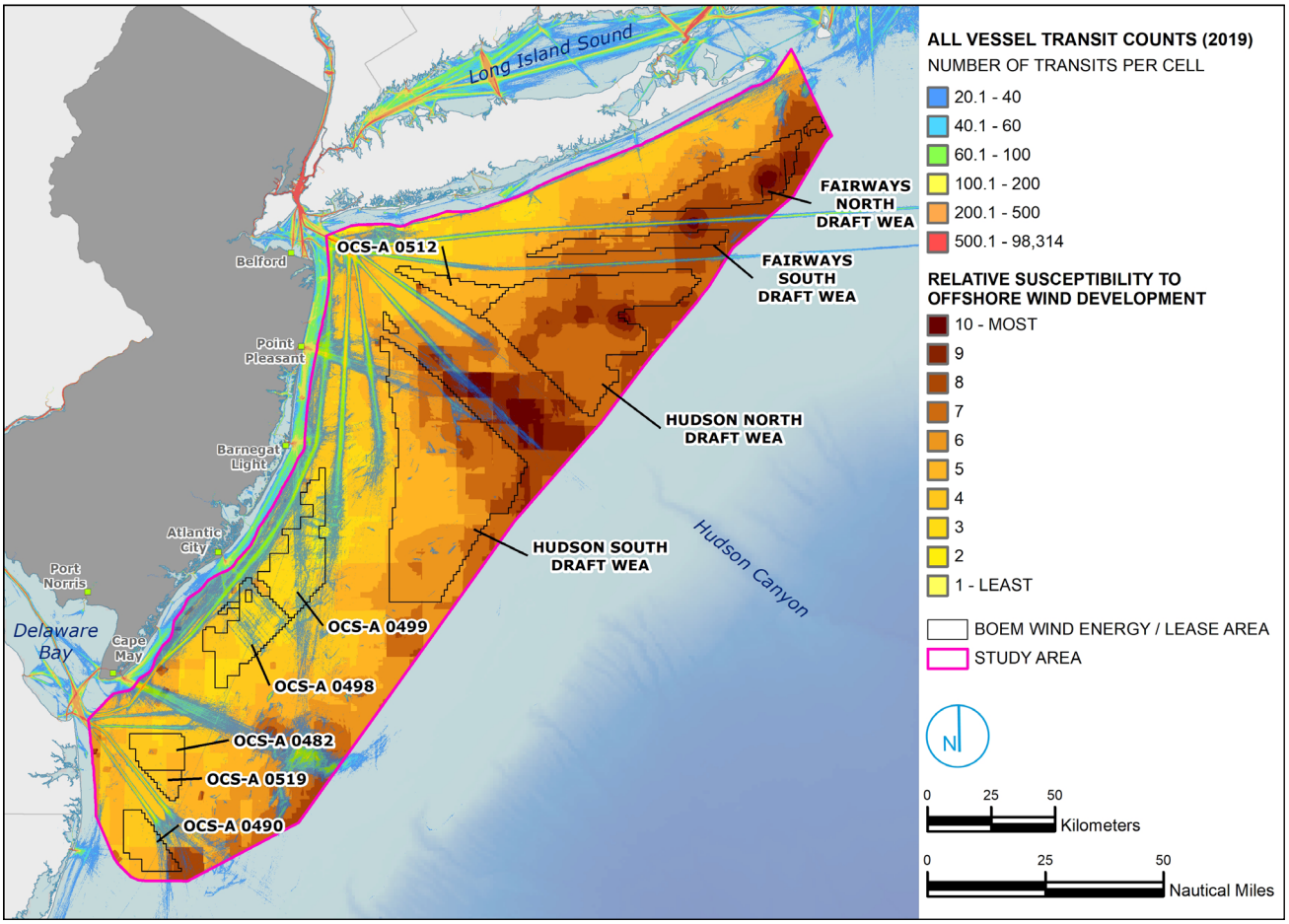


FIGURE 2-4: ENVIRONMENTAL SUSCEPTIBILITY AND VESSEL TRAFFIC



ENVIRONMENTAL AND NATURAL RESOURCE PROTECTION

STRATEGIC RECOMMENDATIONS

Achieving New Jersey's offshore wind energy goals is an important step in achieving 100% clean energy by 2050 and meeting the challenges of climate change. Offshore wind development has the potential to affect natural and other ocean resources that require consideration and protection. Through the implementation of appropriate avoidance, minimization and mitigation measures, it is possible to achieve the goal of 7,500 MW by 2035 while protecting valued environmental and natural resources and ensuring that the uniqueness of New Jersey is enjoyed in perpetuity.

Strategic recommendations and next steps for environmental and natural resource protection to meet New Jersey's 7,500 MW goal of offshore wind energy include the following:

- Prioritize the development of areas of lower relative susceptibility to offshore wind within existing offshore wind lease areas and proposed wind energy areas.
- Leverage research by developers, state universities, government agencies, and state contracts including the New Jersey Ocean Trawl survey and require sharing of all state-funded information, environmental studies, and findings to contribute to planning efforts, closing of data gaps, and meeting of long-term monitoring needs. Efforts should include baseline monitoring as well as monitoring of development and operations of offshore wind projects.
- As part of the offshore wind energy solicitation process, require the use of "best available technology" within the industry to achieve the goal of limiting environmental effects (e.g., use of larger turbines reduces the overall wind farm footprint and reduces environmental impacts accordingly).
- Enhance communication and coordination between conservation communities and state and federal agencies through the newly established New Jersey Environmental Resources Offshore Wind Working Group (Environmental Working Group) or through regional, multistate, and multisector collaborations.
- Review the existing area contingency plan[13] and update it as appropriate to account for potential environmental incidents related to offshore wind development. Require that developers adhere to an approved spill control and response plan.

[13] An area contingency plan is a reference document used for guiding the response to environmental emergencies. In the coastal setting, the United States Coast Guard is the designated lead agency for preparing and administering the area contingency plan (US Environmental Protection Agency in inland settings).

- Consider updating the NJDEP 2009 Technical Manual for Evaluating Wildlife Impacts of Wind Turbines to include newly available information, guidance, and trends (e.g., distance from shore, number and size of turbines to meet the 7,500 MW goal).
- Consider additional evaluations, studies, or assessments[14] that aim to close data gaps, address comments from stakeholder groups, and evaluate the potential for near-term, long-term, and cumulative environmental effects and that allow for quantifying physical changes to the environment that may result from wind turbines or other environmental changes such as climate change. Specific studies should be identified by the New Jersey Environmental Resources Offshore Wind Working Group and could include a focus on commercially or economically important species, protected species, data gaps, long-term evaluations, air quality improvements and human health effects.
- Consider implementation of avoidance and minimization measures for each offshore wind project. Below are example measures for each resource subgroup and ocean use category.

→ Birds
  - Reduce impacts to shorebirds by planning onshore interconnect locations to avoid sensitive times of year and habitat[15]
  - Conduct activities during daylight hours to the extent possible
  - Deploy night lighting techniques that reduce attractiveness to birds (e.g., strobes, low intensity, non-white)[16]
  - Limit the suitability of turbines, bases, and platforms for perching or roosting[16]

→ Fish
  - Where practicable, install cables at depths sufficient to limit impacts associated with electromagnetic field (EMF) and entanglement risk to activities such as fishing and research surveys utilizing bottom-tending gear
  - Ensure that the strategic seasonal timing and phasing of construction occur to coincide with optimal patterns of migration (including diadromous) and sensitivity and minimize disruption to any long-term, ongoing research surveys[16,17]
  - Minimize impacts to substrates (e.g., sand ridges, lumps) used by fish in various life stages (e.g., spawning, ambush cover, refugia, foraging, juveniles); substrates to avoid include hard-bottom habitats, submerged aquatic vegetation, marshes, estuaries, natural and artificial reefs, and structurally diverse or complex habitats[15,16]

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[14] Funding sources for specific studies could include direct funding from the state or federal agencies, newly established entities (e.g., WIND Institute), grants (through or independent from academia), and conservation organizations.

[15] Tetra Tech, Inc. 2012. Block Island Wind Farm and Block Island Transmission System Environmental Report/Construction and Operations Plan. September.

[16] Tetra Tech, Inc., Dominion Resources, Inc., and Virginia Department of Mines, Minerals, and Energy. 2015. Research Activities Plan. Virginia Offshore Wind Technology Advancement Project. April.

[17] Bureau of Ocean Energy Management. 2018. Summary Report: Best Management Practices Workshop for Atlantic Offshore Wind Facilities and Marine Protected Species (2017). US Department of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, DC. OCS Study BOEM 2018-015.

→ Cetaceans and sea turtles
  – Conduct activities during daylight hours to the extent possible
  – Avoid and minimize noise-generating activities (e.g., pile driving) consistent with BOEM-developed periods of protection[17] and use soft/slow start procedures that allow individuals to vacate the area
  – Incorporate avoidance measures that facilitate deconfliction (e.g., separation distances and shutdown or close encounter protocols)[17]
  – Deploy protected species observers in critical phases of offshore wind development

→ Benthic invertebrates and habitat
  – Where practicable, install cables using minimally invasive techniques at depths sufficient to limit impacts to burrowing species[18]
  – Monitor species assemblages on structures/foundations for abundance and diversity,[19] as well as the presence of invasive species
  – Avoid wind development projects in areas where ecologically and economically important shellfish beds are prevalent
  – Use appropriate planning to select cable routings that avoid hard-bottom habitats, submerged aquatic vegetation, and other benthic resources[15,16]

→ Social use
  – Avoid areas of known social resource use
  – Consider new opportunities to engage the public with ecotourism, facility tours, helicopter tours, or similar activities

→ Utility resources
  – Limit the interaction of offshore wind cables with other subsurface infrastructure on the seabed

[18] Laporte C, Alber M. 2011. Offshore Wind Energy: Considerations for Georgia. Prepared by the Georgia Coastal Research Council, for the Georgia Department of Natural Resources, Coastal Resources Division. 41 pp.

[19] Kraus SD, Kenney RD, Thomas L. 2019. A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles. Prepared for the Massachusetts Clean Energy Center, Boston, MA, and the Bureau of Ocean Energy Management, Washington, DC. May.

→ Restricted use
  – Coordinate with the Department of Defense during offshore wind development projects as appropriate

→ Vessel density
  – Install adequate lighting and sound-producing devices on above-water infrastructure to facilitate safe navigation
  – Ensure all above-water infrastructure has maximum radar signatures to facilitate safe navigation
  – Install automatic identification systems on turbines and substations to facilitate safe navigation
  – Address navigation safety concerns, such as directional transit, and incorporate guidance from the United States Coast Guard on how activities will operate within the arrays
  – Maximize fishing access without compromising project safety and efficiency
  – To the extent practicable, make choices that maintain access to wind energy areas by the users who currently rely on them, including fishing and transit

03

COMMERCIAL AND RECREATIONAL FISHERIES

COMMERCIAL AND RECREATIONAL FISHERIES

Offshore wind development has the potential to improve the environment by supplying a significant source of clean energy, thereby offsetting the use of fossil fuels; however, this new industry will also compete for the shared use of the ocean resource. The commercial and recreational fishing industries are important to New Jersey, and offshore wind development needs to carefully consider the potential for conflicts with these critical ocean stakeholders. Addressing the potential conflicts with the fishing industry is critical as New Jersey moves forward with the responsible development of 7,500 MW of offshore wind energy by 2035.

New Jersey's fishing industries land more than 100 varieties of finfish and shellfish, and the state is a leading supplier of surfclams and ocean quahogs to the nation and to the world

3.1 STRATEGIC IMPORTANCE TO NEW JERSEY

New Jersey's commercial and recreational fisheries constitute a multi-billion-dollar economic segment that supports thousands of jobs, and they are a key part of the nation's food supply. New Jersey's fishing industry lands more than 100 species of finfish and shellfish, and the state is a leading supplier of Atlantic surfclams and ocean quahogs to the nation and to the world. Offshore wind development in New Jersey should consider the interests of the fishing community to better understand potential impacts to the commercial and recreational fishing industries and opportunities to provide employment and training to capitalize on the growth of offshore wind.

New Jersey's commercial and recreational fishing industries are significant economic drivers for the state:

- In 2016 (most recent data available), New Jersey's commercial fishing industry created more than 37,000 jobs and generated over $6 billion in sales, $1.4 billion in income, and $2.2 billion in value added to the economy[20]
- The most valuable fisheries in New Jersey, based on annual revenue, are Atlantic sea scallop ($83.1 million), squid (shortfin and longfin; $14.5 million), menhadens ($12.9 million), Atlantic surfclam ($11.5 million), blue crab ($8.7 million), and summer flounder ($4.5 million)[20,21]
- According to the New Jersey Department of Agriculture, there are six primary commercial fishing ports in New Jersey: Atlantic City, Barnegat Light, Belford, Cape May, Point Pleasant, and Port Norris (see Figure 3-1)
- Recreational fishing provides at least 15,000 jobs and adds $1.7 billion in sales, $0.7 billion in income, and $1.1 billion in value added to the economy[21] from millions of anglers and angler trips per year[22]

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[20] National Marine Fisheries Service. 2018. Fisheries Economics of the United States, 2016. US Department of Commerce, Washington, DC. NOAA Technical Memorandum NMFS-F/SPO-187a. 243 pp.

[21] NOAA Fisheries Office of Science and Technology, Commercial Landings Query, Available at: https://foss.nmfs.noaa.gov/apexfoss/f?p=215:200; Accessed 06/18/2020

[22] National Marine Fisheries Service. 2020. Fisheries of the United States, 2018. US Department of Commerce, Washington, DC. NOAA Current Fishery Statistics No. 2018.

3.2 STAKEHOLDER INPUT

The gathering of input from key stakeholders of the commercial and recreational fishing industries was recognized as an important step in identifying potential conflicts with offshore wind development. Consistent with the engagement done for other topics in the development of this strategic plan, a collaborative roundtable discussion was held to solicit feedback specifically in the context of the development of the OWSP, on a wide range of concerns and potential challenges relating to commercial and recreational fisheries and the development of offshore wind, including gear types, changing water temperature conditions, and current species fished. The discussion took place on March 1, 2019 at Rutgers University's Cook Campus. Participants included fishers, members of the fishing industry, seafood purveyors, representatives of governmental organizations, and fisheries protection groups. Concerns raised included potential conflicts with fishing interests, biological impacts, and monitoring requirements. A complete summary of the roundtable discussion and input received from stakeholders is provided in Appendix A. Stakeholder engagement continues with the commercial and recreational fishing industries led by the Environmental Working Group.

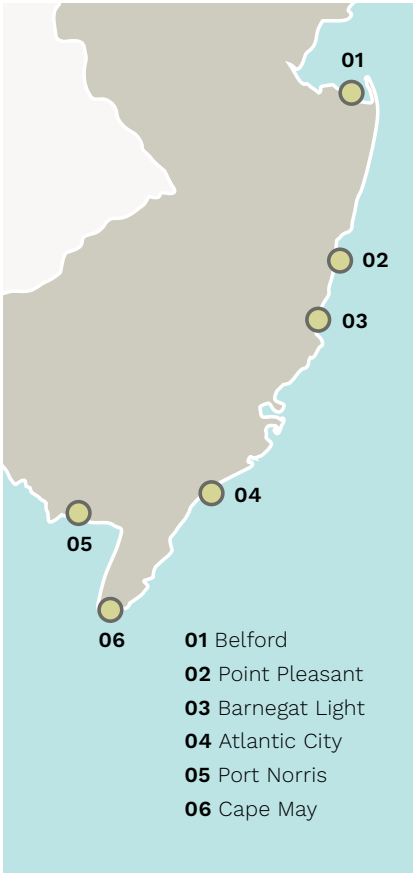
3.3 SUMMARY OF EVALUATION

The spatial relationship between commercial and recreational fisheries and the development of offshore wind was evaluated through an unweighted resource evaluation (URE) (as was done for other ocean uses and discussed in Section 2.3.2). The URE depicts spatial information within the study area to identify the potential for conflict based on the collocation of shared ocean use. The URE focused separately on commercial and recreational fishing because of the significant differences and implications where conflict is identified. Evaluation of multiple datasets allowed for broad characterization of various fisheries resources to identify areas of potential conflict with offshore wind development. While the evaluation identifies the potential for conflict, it does not represent actual conflict, impacts, or project-specific concerns. Rather, by depicting the spatial relationship between fisheries and potential offshore wind development, areas in need of greater consideration, avoidance, and minimization are identified. Conflicts with fisheries resources may include reduction, injury, or displacement of target species and reduced access to fishing grounds.

Commercial fishing: The commercial fishing URE includes assessment of fishing activity based on available vessel monitoring system (VMS) data and evaluation of vessel trip reporting (VTR) data, which include per-trip information on gear type, area fished, and estimated weight of species landed. Major fisheries evaluated include Atlantic sea scallop, ocean quahog, Atlantic surfclam, multispecies groundfish, monkfish, and pelagics. The most current available VMS and VTR data were used as well as data from older reporting timeframes to identify patterns or trends. Also included in the evaluation of commercial fishing is an assessment of mean annual revenue, as presented by Kirkpatrick (2017).[23]

Recreational fishing: Recreational fisheries were assessed using GIS mapping tools designed to illustrate important recreational fishing locations, artificial reef sites, and associated species off New Jersey's coast. These map layers were generated in 2003 and updated in 2018 using information provided by recreational fishing vessel captains and Home Port Charts, Inc. fishing charts.

FIGURE 3-1: PRIMARY NEW JERSEY FISHING PORTS



[23] Kirkpatrick AS. 2017. Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the US Atlantic: Volume I - Report Narrative. Bureau of Ocean Energy Management, US Department of the Interior, Washington, DC.

The URE for commercial and recreational fishing resulted in nearly 30 figures depicting important fisheries activity information in a “heat map” (magnitude depicted by varying colors) format. The results of the URE are summarized below. All figures developed to assess commercial and recreational fisheries, as well as the details of the URE, are provided in Appendix B. Figure 3-2 below indicates the location of lease and wind energy areas within the study area.

COMMERCIAL FISHING

Atlantic sea scallop: The VMS data showed that the areas of Atlantic sea scallop catches are migrating eastward to deeper and colder waters, and the southernmost leases in the study area (OCS-A 0490, 0519, 0482, 0498, and 0499) exhibited little scalloping activity from 2011 through 2016 (Appendix B, Figures 59 and 60). Management measures have a significant effect on sea scallop catches and likely caused the apparent “eastward” migration. Scalloping activities were conducted during this period in the southern portion of the Hudson South WEA, within the entire Hudson North WEA, and within portions of the Fairways South and North draft WEAs (Appendix B, Figures 59 and 60).

The VTR data were consistent with the VMS data, indicating low amounts of dredge-type fishing in the southernmost leases in the study area (OCS-A 0490, 0519, 0482, 0498, and 0499) and greater activity to the east and north in deeper waters (Appendix B, Figures 74 and 75).

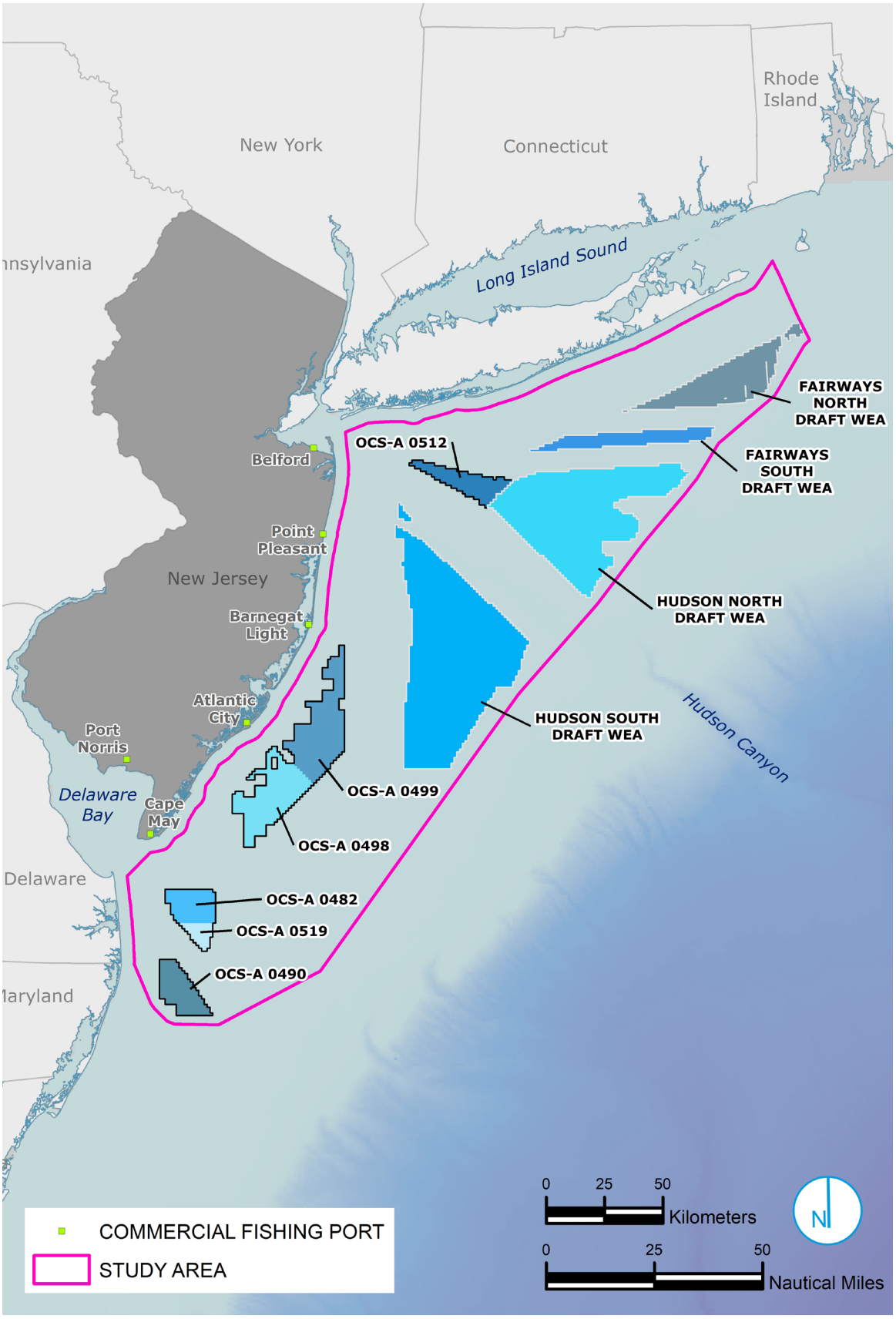
Ocean quahog: The VMS data indicated that for the 2006-2010 period, there were high levels of ocean quahog fishing in the lease area OCS-A 0499 and a significant portion of the Hudson South draft WEA. The Hudson North draft WEA, Fairways South draft WEA, Fairways North draft WEA, and OCS-A 0490 show medium-high levels of activity. The lowest levels of activity are observed in lease areas OCS-A 0519 and 0482 (Appendix B, Figure 61). The 2012-2014 VMS data may indicate a general migration of this fishery to the north and east to deeper waters (Appendix B, Figure 62). Lower levels of fishing activity were identified in 2015-2016 VMS data, with smaller areas of vessel activity in the central portions of the study area relative to the 2012-2014 reporting period (Appendix B, Figure 63).

The VTR data were consistent with the VMS data, indicating low amounts of dredge-type fishing in the southernmost leases in the study area (OCS-A 0490, 0519, 0482, 0498, and 0499) and greater activity to the east and north in deeper waters (Appendix B, Figures 74 and 75).

Atlantic surfclam: The VMS data indicated that for 2006-2010, there were high levels of Atlantic surfclam fishing in the lease area OCS-A 0499 and a significant portion of the Hudson South draft WEA. The Hudson North draft WEA, Fairways South draft WEA, Fairways North draft WEA, and OCS-A 0490 show medium-high levels of activity (Appendix B, Figure 61). The 2012-2014 VMS data may indicate a general migration of this fishery to the north and east to deeper waters (Appendix B, Figure 62). Lower levels of fishing activity for Atlantic surfclam were identified in 2015-2016 VMS data, with smaller areas of vessel activity in the central portion of the study area relative to the 2012-2014 reporting period (Appendix B, Figure 63).

The VTR data were consistent with the VMS data, indicating low amounts of dredge-type fishing in the southernmost leases in the study area (OCS-A 0490, 0519, 0482, 0498, and 0499) and greater activity to the east and north in deeper waters (Appendix B, Figures 74 and 75).

FIGURE 3-2: LEASE AREAS AND WEAS WITHIN THE OFFSHORE WIND STRATEGIC PLAN STUDY AREA



Multispecies groundfish: The VMS data indicated that between 2006 and 2010, there were high levels of this type of fishing to the east of the study area (Appendix B, Figure 49). There was also a significant amount of activity in the Hudson Canyon, partially affecting the area collocated with the Hudson South draft WEA. The Fairways North draft WEA is largely covered by medium-low to medium-high fishing activity (Appendix B, Figure 49). By 2011-2014 and 2015-2016, there was much less fishing for these species in the study area, and the fishing that did occur took place in small areas of the Hudson Canyon and off the south shore of Long Island (Appendix B, Figures 50 and 51).

The VTR data for pots, traps, and bottom trawl-type gear supported the VMS data and indicate minimal fishing for these species within the lease areas and BOEM WEAs (Appendix B, Figures 68, 69, 70, 71, 78, and 79).

Monkfish: The VMS data indicated that little fishing for this species took place in the southernmost leases in the study area (OCS-A 0490, 0519, 0482, 0498, and 0499) from 2006 to 2010. There was a high level of activity off northern New Jersey and within the Hudson Canyon, particularly within the Hudson South draft WEA and the northern tip of the Fairways North draft WEA (Appendix B, Figure 52). The 2011-2014 VMS data indicated a general reduction in this fishery, with only a minor overlap with the Hudson North draft WEA and the Fairways North draft WEA (Appendix B, Figure 53). Further reductions in monkfish-associated fishing vessel activity were observed in the 2015-2016 dataset, indicating little fishing activity for this species and a general reduction in this fishery over time in the study area (Appendix B, Figure 54).

The VTR data for pots, traps, bottom trawl, and gill nets also indicated minimal catches for this fishery in the lease areas and BOEM WEAs (Appendix B, Figures 68, 69, 70, 71, 78, and 79).

Pelagic species: The 2014 VMS data for pelagic species (herring, mackerel, and squid) indicated little fishing activity on the landward side of the continental shelf break and only minor overlap with the southernmost leases in the study area (OCS-A 0490, 0519, 0482, 0498, and 0499) and the BOEM WEAs. The western tip of OCS-A 0512 is shown as a high value area for this fishery (Appendix B, Figure 66).

The 2015-2016 VMS data for pelagic species are consistent with the 2014 data for this group, showing little fishing activity on the continental shelf south of the Hudson Canyon. Relative to the 2014 data, these data show much more fishing activity in the lease area/draft WEAs north of the Hudson Canyon at medium-high levels (Appendix B, Figure 67).

Mean annual revenue: The mean annual revenue dataset was built by the National Marine Fisheries Service to illustrate revenue intensity offshore.[22] (Note: the mean annual revenue is not for every species caught and landed in the OWSP study areas.) The revenue intensity data were developed by merging spatial data on fishery catch (VTR and VMS) with data collected by at-sea observers. The price data were drawn from commercial fisheries dealer reports. The revenue calculated for the study area represents the total fishing activity that may be affected by offshore wind development; it is not a measure of economic impact or loss. The actual economic impact will depend on whether the vessel is able to adapt its fishing area — if alternative fishing grounds are near, the economic impact will be lower. Economic impacts may also be associated with changes in transit routes, time, or distance between ports and fishing

grounds or between fishing grounds. The areas with the highest mean annual revenue exist outside of the OWSP study area (Appendix B, Figure 80). The Hudson North draft WEA has the highest average mean annual revenue over its area of $12,176 per square kilometer. The Hudson South draft WEA has the highest total mean annual revenue of $31,785,550, which is expected due to its size and the prevalence of fisheries in and around the Hudson Canyon. The southernmost leases in the study area (OCS-A 0490, 0519, 0482, 0498, and 0499) have considerably lower mean annual revenue average values. OCS-A 0499 has the highest value of the southern lease areas, with an average mean annual revenue value of $3,032 per square kilometer. These results are consistent with the results from VMS and VTR that show greater fishing activity within the more northern lease areas and draft WEAs.

RECREATIONAL FISHING

Recreational fishing was assessed using information generated by the NJDEP Bureau of Marine Fisheries through direct interviews with recreational fishing boat captains in 2003. Information from 2003 was updated in 2018 to include artificial reef sites and recreational fishing areas identified by Home Port Charts, Inc. Artificial reefs (which are often preferred fishing areas for recreational anglers) within the OWSP study area intersect the lease areas or WEAs. Thirteen percent of the OWSP study area is covered by these mapped recreational fishing areas, which include point locations identified by recreational fishing boat captains, artificial reefs, and other known prime fishing grounds. The highest percent coverage is in OCS-A 0482 (29%), followed by OCS-A 0499 (14%), the Fairways South draft WEA (10%), and the Hudson South draft WEA (9%). The majority of the recreational fishing sites exist further offshore, outside of the OWSP study area. For this reason, and the fact that recreational fishing gear (e.g., rod and reel fishing) is less likely than commercial gear (e.g., dredges and trawls) to conflict with offshore wind structures, recreational fishing grounds may be less susceptible to the effects of offshore wind development. It is also possible that reefing effects associated with offshore turbines could provide benefits to recreational fishers.

The URE in Appendix B includes a total of 37 figures generated using VMS, VTR, and recreational fishing data.

COMMERCIAL AND RECREATIONAL FISHERIES

STRATEGIC RECOMMENDATIONS

Commercial and recreational fishing in New Jersey constitute a significant part of the economy and are a cultural heritage. Offshore wind represents a once-in-a-generation opportunity to embark on a new industry that is poised to create jobs and economic growth for decades to come as well as address important environmental challenges by offsetting emissions through the creation of clean energy. The commercial and recreational fishing industries are critical, and offshore wind development should consider methods to minimize conflicts while enhancing both industries. Meeting New Jersey's goal for offshore wind development will help mitigate the impacts of climate change, which threatens New Jersey's fisheries.

Strategic recommendations and next steps related to commercial and recreational fisheries include:

- Ensure continuation of data collection efforts off the East Coast in support of New Jersey state and regional fisheries management decisions and to form the basis of a long-term marine monitoring program for assessing potential cumulative impacts associated with offshore wind development. Determine what survey methodology changes and/or project siting recommendations could be implemented to maintain the continuity and long-term consistency of assessment programs.
- Collaborate with other states, academic, and environmental entities, and use regional, multistate, and multisector collaborations to develop and conduct regional fisheries monitoring and data sharing.
- Leverage existing commercial and recreational fisheries that currently provide valuable information on existing conditions to conduct ecological monitoring in support of construction and operations of offshore wind farms.
- Utilize the New Jersey Offshore Wind Environmental Resources Working Group to continue engagement between the state and the commercial and recreational fishing community throughout each project's life cycle and request that developers and the state identify fishing industry liaisons. Establish cooperative research initiatives to provide a means for commercial and recreational fishers to become involved in the collection of important fisheries information to support the development and evaluation of fisheries management.

- Implement harbor management plans[24] for facilities located in areas with significant commercial fishing operations to determine any impacts on dock access, fuel access, or other activities that may interact with fishing operations.
- Enhance communication and coordination between fishing communities and state and federal agencies through the Offshore Wind Environmental Resources Working Group.
- During project design and layout, assess the need for one or more fairways in lease areas for commercial and recreational fishing vessels.
- To the extent practicable, make choices that maintain access to and transit through wind energy areas by the users who currently rely on them, including fishing and transit without compromising project safety and efficiency.
- Ensure that interconnect and transmission cables are buried to a depth sufficient to avoid interaction with benthic fishing gear and inspect them regularly to ensure adequate cover.
- To the extent practicable, incorporate habitat enhancements to attract commercially targeted species and provide long-term benefits to commercial and recreational fisheries.

[24] Harbor management plans are focused on sustainable and coordinated use of the finite spaces of harbors that are often in demand among competing interests (e.g., recreational, commercial, industrial, government). These plans are an extension of planning efforts conducted landward in other contexts and are developed and implemented by local government with technical and financial support from state government.

04

SUPPLY CHAIN AND WORKFORCE DEVELOPMENT

SUPPLY CHAIN AND WORKFORCE DEVELOPMENT

New Jersey's development of offshore wind brings along significant economic opportunity. Large-scale offshore wind development requires a supply chain composed of companies and the workforce needed to build, operate, and maintain offshore wind facilities. At the top of the supply chain are the offshore wind developers that build and operate offshore wind farms. The next links in the chain are companies that manufacture, assemble, and install large components (e.g., turbines, cables, foundations, nacelles) and provide services (e.g., environmental surveys and studies) that are purchased directly by the developers. Integral to the supply chain are companies that provide the large manufacturers with goods or services, such as electrical components for substations or vessel operators to transport components. The supply chain continues to branch out and includes those companies and workers that indirectly support offshore wind projects. In addition to manufacturing, a large part of the supply chain for New Jersey will be the people, vessels, and equipment needed to operate and maintain wind farms over an operational period of 25 years or longer. The development of a local offshore wind supply chain will bring a new industry and jobs to New Jersey to achieve the goal of 7,500 MW of offshore wind energy by 2035 and support the rapidly expanding offshore wind industry along the US East Coast.

The development of a local offshore wind supply chain will bring a new industry and jobs to New Jersey

4.1 STRATEGIC IMPORTANCE TO NEW JERSEY

New Jersey is making strategic investments to be the hub for the US East Coast offshore wind industry. Currently, the offshore wind supply chain is predominantly located in Europe, but as the US offshore wind market continues to grow, a domestic supply chain will develop. Domestic manufacturing reduces the risks and costs associated with the transportation of large offshore wind components, but there must be enough sustained domestic demand to justify the investment in new facilities. New Jersey offers many advantages to offshore wind manufacturing and services companies seeking to locate new facilities for the US East Coast market:

- The New Jersey solicitations for 7,500 MW by 2035 provide a clear pipeline of regular offshore wind solicitations to attract supply chain companies, with 1,100 MW already awarded
- New Jersey's central location on the East Coast and major investments in port infrastructure make it an attractive location for new offshore wind manufacturing facilities
- New Jersey has access to an estimated 90,000[25] highly skilled workers in offshore wind-adjacent industries and more than 150 higher education institutions poised to train a robust talent pool of new offshore wind workers

[25] New Jersey Economic Development Authority. 2020. International Partnering Forum for Offshore Wind, April 22, 2020.

- New Jersey has a strongly supported business environment, including a $100 million Offshore Wind Tax Credit[26] to support the build-out of the offshore supply chain through 2035 and beyond
- New Jersey is building the offshore wind supply chain through the establishment of the New Jersey Offshore Wind Supply Chain Registry, which connects offshore wind companies with potential partners in New Jersey, and the Supply Chain Technical Assistance Program, which supports local companies to develop the skills and competencies needed to participate in the industry
- The development of a local offshore wind supply chain will bring a new industry and jobs to New Jersey

4.2 STAKEHOLDER INPUT

In addition to ongoing stakeholder engagement regarding offshore wind supply chain and workforce development, a OWSP roundtable discussion was held on April 5, 2019 at the New Jersey Transportation Planning Authority. Participants included offshore wind developers, supply chain companies, educational institutions, and labor unions. They were asked to comment on a full range of issues, including supply chain development strategy, offshore wind manufacturing, professional services, and research and development specifically in the context of the development of the OWSP. The complete summary is provided in Appendix A.

4.3 SUMMARY OF EVALUATION

An evaluation of the offshore wind supply chain and workforce development was conducted for New Jersey to identify opportunities for capturing parts of the supply chain and to identify the types and number of potential jobs (see Appendix C). The key elements of the offshore wind supply chain include the following:

- **Developers:** Typically, offshore wind development companies are responsible for developing wind farms within designated lease areas. The developers lead the development, construction, and operation phases of offshore wind projects.
- **Original equipment manufacturers:** Original equipment manufacturers provide the major components to developers; these components include nacelles, blades, towers, foundation elements, transition pieces, substation, and cables.
- **Primary, secondary, tertiary, and quaternary manufacturers and suppliers:** These firms typically provide materials and/or manufactured components to the original equipment manufacturers for manufacturing of the main offshore wind farm components.
- **Service and support providers:** There are a wide variety of service and support positions associated with offshore wind, and jobs include those in the areas of production, management, installation, maintenance and repair, science, engineering and architecture, business and finance operations, transportation and logistics, office and administrative support, and sales and related occupations.
- **Marine, port and harbor service providers:** These firms typically provide the facilities, vessels, equipment, and labor associated with the ports and marine industries. They may provide barges to transport materials between manufacturing facilities, installation vessels, and operations and maintenance (O&M) vessels. The related port facilities require cranes, stevedores, warehouses, logistics systems, and security.
- **Educational institutions:** Colleges and universities train workers and conduct relevant research to support offshore wind development.

> **“New Jersey’s workforce is well-positioned to support the region’s burgeoning offshore wind industry and become an integral part of the economic growth that offshore wind will generate in years to come”**
>
> **NEW JERSEY WIND COUNCIL REPORT**

[26] New Jersey Economic Development Authority. 2020. Offshore Wind. Office of Economic Transformation, Trenton, NJ. Accessed May 17, 2020. Available at: https://www.njeda.com/Office-of-Economic-Transformation/Offshore_Wind.

- **Labor unions:** Labor unions provide and support workers that are essential to the development, construction, and operation of offshore wind projects.
- **Other entities:** Many other entities make up the offshore wind supply chain. Examples include utilities, state agencies, and non-government agencies.

The supply chain and workforce development evaluation for New Jersey explored two scenarios to evaluate the tradeoff between encouraging investment in a local supply chain and the lowest cost to develop and operate an offshore wind project. Results indicated that a balanced approach would lead to the lowest levelized cost for projects by the third solicitation, once the most viable parts of the supply chain develop locally. The results of the scenario based on a balance between cost and New Jersey–based content are presented in this section. It should be noted that the estimates presented below are based on the projected size of the US market at the time of the analysis. The US offshore wind market is expected to expand rapidly, and these estimates could increase if market pipeline increases. The full detailed analysis is provided in Appendix C. The evaluation considered the likelihood that New Jersey will capture parts of the supply chain for New Jersey projects or projects for other states. Suppliers will prioritize localizing parts of the supply chain based on the risk and cost associated with the following:

- Transportation of products from existing factories
- The location, complexity, and potential synergies of the supply chain
- The expansion of existing facilities

Table 4-1 lists elements of the supply chain with potential to locate in New Jersey with appropriate investment. Green indicates a potential for high local content in New Jersey, blue indicates limited New Jersey local content, and gray indicates unlikely local content. Activities such as project management and development, onshore works, wind farm operations, and turbine maintenance generally need to be done locally and do not require large capital investment. Manufacturing of nacelles and hubs, turbine blades, towers, and foundations typically requires large capital investments in new manufacturing facilities. Other services provided by existing specialized installation companies or the production of components such as cables are less likely to be located in New Jersey. New Jersey's investment in ports is critical to developing offshore wind manufacturing since large components like blades and towers must be manufactured at ports as they can only be transported by vessels.

TABLE 4-1: SUPPLY CHAIN ELEMENTS WITH POTENTIAL TO LOCATE IN NEW JERSEY

Solicitation	1	2	3–6
Estimated project construction years	2022-2024	2025-2027	2028-2035
Project management and development			
Turbine nacelle and hub			
Turbine blades			
Turbine tower			
Foundations			
Subsea cables			
Substation structure			
Substation electrical			
Installation of turbine, foundation, and subsea cable (specialized vessels)			
Onshore works			
Wind farm operations and maintenance			

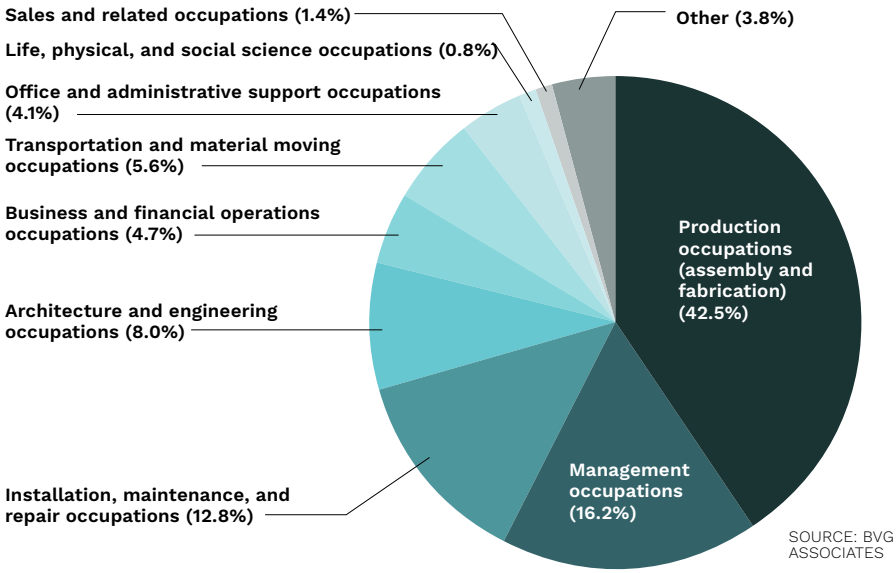
LEGEND

	High local content in New Jersey
	Limited local content in New Jersey
	Unlikely local content in New Jersey

The growing offshore wind industry in the United States will require workers across a range of occupations including engineers, wind turbine technicians, and welders. For New Jersey's offshore wind industry, trade jobs will become increasingly important to the development of a local supply chain. Specifically, there will be a short-term need for welders and offshore wind–specific occupations that are not yet established in the United States, such as wind turbine technicians. New Jersey's large and professional workforce will allow for the offshore wind industry to pull workers from similar industries, but there will be a need for retraining and credentialing of existing workers to meet industry needs. The existing strong base of workforce development assets in New Jersey can be leveraged to position the state's workforce for offshore wind development. Existing workforce development tools can be utilized to develop offshore wind–specific skills, certifications, and knowledge. Additional workforce development assets necessary to address the industry's more immediate needs include establishing Global Wind Organization (GWO) safety certification programs and facilities, introducing wind turbine technician training, and expanding welding certification programs.

Offshore wind projects require workers from diverse occupations, including engineers, technical specialists, office workers, and laborers, who can be involved in project development prior to construction, during construction, and throughout operation and maintenance of the wind farm over 25 years or more. Figure 4-1 shows the types of jobs that are estimated to be created by the offshore wind supply chain in New Jersey through 2035. The highest proportion of workers will be engaged in production, management, installation, and maintenance.

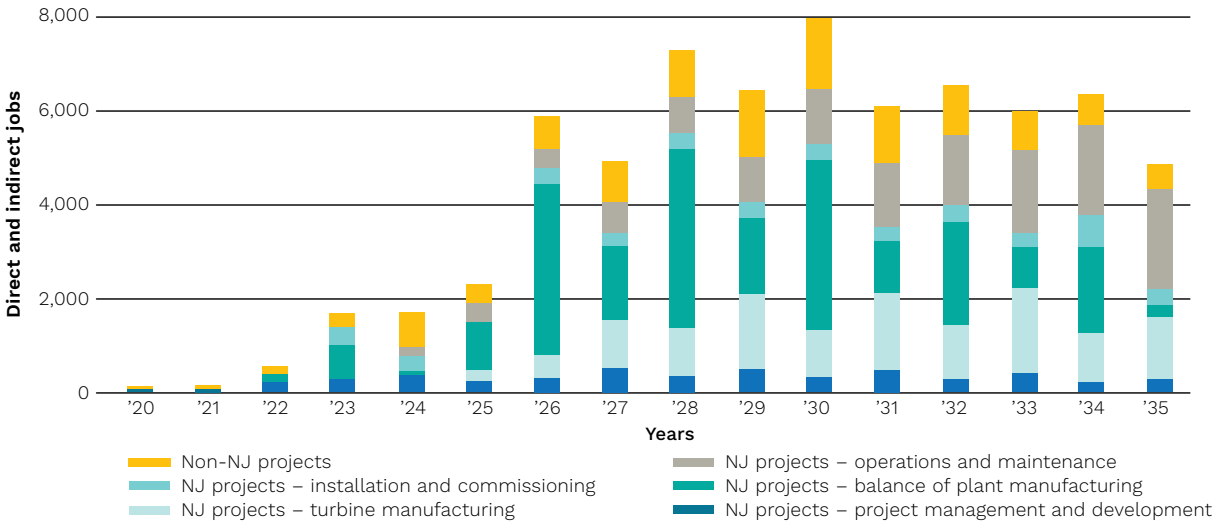
FIGURE 4-1: OCCUPATIONS ANALYSIS – SPLIT OF JOB TYPES CREATED



SOURCE: BVG ASSOCIATES

Figure 4-2 shows the estimated number of New Jersey direct and indirect jobs from offshore wind. The analysis indicates that, overall, offshore wind will create between 6,000 and 8,000 jobs per year from 2028 to 2034. Cumulatively 68,340 job years will be created from 2020 to 2035. The analysis did not project jobs beyond 2035, but jobs in the industry would be expected to continue, as operations jobs are required for the life of the project.

FIGURE 4-2: ESTIMATED NEW JERSEY OFFSHORE WIND JOBS



The findings from the study include the following:

- New Jersey should follow a balanced approach to offshore wind development that considers both New Jersey job creation and reasonable costs to the ratepayers to achieve the lowest levelized cost of energy and to support the build-out of the offshore wind supply chain in New Jersey.
- A range of different types of jobs will be created by offshore wind, with the majority of the jobs in production (manufacturing), in management, and in installation, maintenance, and repair.
- Foundation, tower, nacelle, and blade manufacturing are the most likely offshore wind facilities to locate in New Jersey.
- Many offshore wind–related jobs are anticipated to be for operations and maintenance of the wind farms because of the 25 year plus life span of a typical project.
- Ports are key infrastructure that support offshore wind manufacturing facilities in New Jersey. Ports and harbors for offshore wind are further discussed in Section 5, Ports and Harbors.

SUPPLY CHAIN AND WORKFORCE DEVELOPMENT

STRATEGIC RECOMMENDATIONS

New Jersey has established a pipeline of utility-scale projects to attract the offshore wind supply chain with the commitment to 7,500 MW of offshore wind energy. New Jersey has the geographical location, political support, and economic incentives to capitalize on significant opportunities to develop the offshore wind supply chain in the state.

Strategic recommendations and next steps for supply chain and workforce development to meet New Jersey's 7,500 MW goal of offshore wind energy include the following:

- Take a balanced approach that encourages local content and the development of a New Jersey offshore wind supply chain while keeping the levelized cost of energy for offshore wind projects low for initial projects and ensuring that the levelized cost of energy continues to decline, resulting in the lowest possible cost by 2028.
- Continue engagement with industry leaders, developers, and supply chain entities via mechanisms such as the New Jersey Offshore Wind Supply Chain Registry and Supply Chain Technical Assistance Program.
- Develop and utilize the WIND Institute to act as a centralized hub for offshore wind workforce development and champion research and innovation that unlocks market potential.
- Continue to work with turbine suppliers, developers, educational institutions, coastal communities, and labor unions to provide workforce training, apprenticeship, and recruitment programs and develop and communicate clear health and safety training standards for workers in the offshore wind industry, including developing a Global Wind Organization (GWO) certification program.
- Engage with original equipment manufacturers, developers, and potential ports on the development of manufacturing facilities for turbine blades, towers, and nacelles and hubs in New Jersey to meet expected projected demand in the 2025-2027 timeframe. Demand for foundations is also expected to require a facility in the 2022-2024 timeframe, such as the one proposed at the Port of Paulsboro, New Jersey.

Wind Innovation and New Development (WIND) Institute

The WIND Institute will become a center for education, research, innovation, and workforce training for offshore wind energy development in New Jersey and the Northeast and Mid-Atlantic region.

- Provide support and technical assistance for investment in offshore wind manufacturing facilities, such as the New Jersey Offshore Wind Tax Credit Program. Because ports are the critical infrastructure required for offshore wind supply chain development, additional incentives (e.g., grants, loans, and other tax credits) should be targeted at leveraging private investment for developing New Jersey ports for the offshore wind industry.
- Provide incentives such as support for community-based meetings, funds to support retraining, and funds to retool fishing vessels to provide various offshore wind workflow components.

NEW JERSEY OFFSHORE WIND TAX CREDIT PROGRAM

This program is a powerful financial tool designed to spur capital investment and employment growth in major, land-based offshore wind industry projects. A company making a capital investment of $50 million or more in an offshore wind–related facility and creating at least 300 new, full-time jobs can apply for a tax credit equaling up to 100% of the qualified capital investments made (capped at $100 million). The awards will be subject to a net positive economic benefits test, which means a project must demonstrate that because of the capital investment and the resultant job creation, New Jersey will receive at least 110% of the total tax credit amount over a 10 year period.

The majority of offshore wind-related jobs will be in manufacturing, in management, and in installation, maintenance, and repair

05

PORTS AND HARBORS

PORTS AND HARBORS

Offshore wind farms involve large components, including turbine blades and foundations; these components are getting larger as technology advances. Components require large areas for staging and assembly, otherwise known as "marshaling," before installation at wind farm sites. Transportation of offshore wind components over land is impractical, given their size; therefore, ports and harbors along the New Jersey coast are critical for meeting the state's offshore wind development goal of 7,500 MW by 2035. Ports are also where the operations of wind facilities are managed; often, they have offices for personnel and logistics, and they have the marine infrastructure for vessels that take technicians out to the offshore farms to conduct maintenance. Developing New Jersey ports is essential to attracting offshore wind facilities (e.g., preassembly, storage, manufacturing, and operations) and associated jobs to New Jersey. Developed ports can support not only the development of wind farms supplying power to New Jersey but also the development of wind farms in the Mid-Atlantic region, on the East Coast, and in future market areas. Port development and offshore wind manufacturing and operation in New Jersey presents a unique opportunity to expand economic benefit and job creation leveraged from anticipated offshore wind activities.

Offshore wind farms involve large components that are best transported by water, making ports essential

5.1 STRATEGIC IMPORTANCE TO NEW JERSEY

New Jersey's ambitious wind energy goals, its central location along the East Coast, and its existing coastal facilities and infrastructure are strategic and significant advantages for the state. Developing ports to service offshore wind energy will be critical if New Jersey is to benefit directly from its initial development of 1,100 MW of energy and achieve the goal of 7,500 MW by 2035. New Jersey can serve as a center for the Mid-Atlantic supply chain and provide services to the larger regional offshore wind market. The following summarizes New Jersey's strategic key port assets:

- The New Jersey Wind Port is a purpose-built 200+ acre development project that will position New Jersey as a hub for the East Coast offshore wind industry.
- New Jersey sits at the epicenter of the emerging East Coast offshore wind industry. It is centrally located on the Mid-Atlantic coast, with 17 lease areas within 200 miles of New Jersey, representing billions of dollars of potential capital investment and economic opportunity.
- New Jersey's goal of 7,500 MW will help facilitate regional growth in capacity to more than 35 GW by 2035, by providing a large portion of the initial offshore wind project pipeline to capture more of the regional supply chain and jobs market. New Jersey is therefore making commitments like developing the New Jersey Wind Port, which provides the offshore wind industry with confidence that offshore wind is coming to the US East Coast and that it is economically viable to invest in the New Jersey offshore wind marketplace.

- New Jersey has access to a highly trained workforce with experienced port operators, logistical experts, and maritime workers, as well as the capacity to train the next-generation workforce.
- New Jersey has 130 miles of coastline, with deep-water commercial and industrial ports to support the offshore wind industry.
- Both southern and northern New Jersey offer port clusters that could be advantageous to offshore wind development. Northern New Jersey ports can support the development of New Jersey, New York, and New England state projects. Southern New Jersey ports can support the development of New Jersey projects as well as those in states to the south such as Delaware, Maryland, and Virginia.

The New Jersey Wind Port is a purpose-built 200+ acre development project that will position New Jersey as a hub for the East Coast offshore wind industry

5.2 STAKEHOLDER INPUT

To solicit stakeholder input specifically to develop the OWSP, a ports and harbors roundtable discussion was held on April 5, 2019 at the New Jersey Transportation Planning Authority in Newark, New Jersey. Roundtable participants included port authorities, port operators, offshore wind developers, local agencies, and non-governmental organizations. Participants were asked to comment on a full range of issues relating to ports and harbors, including development strategies, assessment of currently available assets, and potential infrastructure improvements specifically in the context of the development of the OWSP. A complete summary is provided in Appendix A.

5.3 SUMMARY OF EVALUATION

As part of the development of the OWSP, an evaluation of existing New Jersey ports and potential port areas was conducted. The New Jersey Ports and Harbors Evaluation also assessed properties and locations that are not currently port facilities (e.g., brownfield sites, vacant sites, and former power plants). A full copy of this detailed evaluation is provided in Appendix D. The evaluation focused on locations that could support different types of offshore wind facilities. Types of ports supporting the offshore wind industry include the following:

- **Marshaling port facilities:** These facilities are the focal point of wind farm construction operations because they are the reception terminals or prepositioned equipment storage sites where arriving personnel, equipment, and materials are assembled and prepared for deployment to the lease areas. Offshore wind components such as blades, nacelles, and foundations are brought to the port for assembly and preparation before being transported offshore for installation. Typically the port is used for two years for a single project, with foundations and cables constructed in the first year and turbines in the second year. These ports must be capable of supporting the heavy weights of large offshore wind components. Ideally these facilities are large areas located close to the open ocean, with no vertical air draft restrictions such as bridges or other obstructions that would limit the size of the structures that could be transported from the port. Therefore, suitable locations for marshaling port development are limited. Development of a marshaling port such as the New Jersey Wind Port is critically important to meeting the state's 7,500 MW goal by 2035.
- **Manufacturing port facilities:** Manufacturing of offshore wind components such as blades, turbines, and foundations will take place at ports with good access to materials and a skilled workforce. Currently, there are limited existing port infrastructure and facilities in the New Jersey or the Mid-Atlantic region that can be used for manufacturing without investment in port improvements. During some of the initial projects, offshore wind components will be manufactured at existing facilities in Europe, but with investment in port infrastructure, manufacturing facilities will locate in the United States.

- **Operations and maintenance (O&M) port facilities:** O&M ports will be used by developers to operate and maintain offshore wind farms over the 25 plus year life of offshore facilities. O&M ports are typically smaller and are located within a two-to-three-hour transit time from wind farms to minimize travel distance when crews are transported to and from the offshore facilities during crew transfer vessel operations. Service operation vessels, or hotel-style ships, are less sensitive to their home-port locations. Many of the ports along the Atlantic coast of New Jersey could support crew transfer vessel operations, and service operation vessel operations could be supported by additional inland port locations within the state.

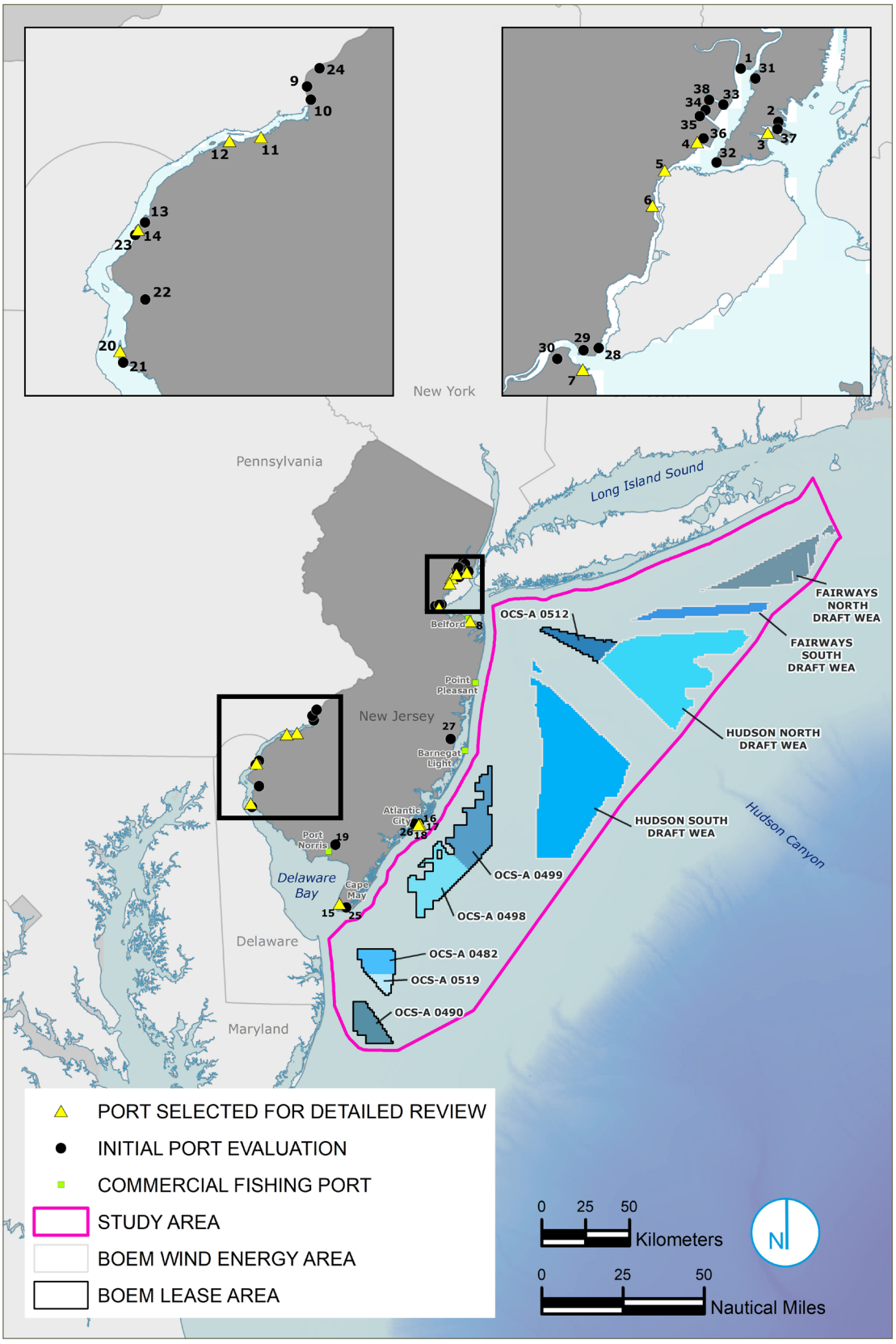
The different offshore wind port types have distinct infrastructure requirements (e.g., quay length, size of laydown areas, and soil-bearing capacities). For example, a potential marshaling port, where offshore wind components are assembled and transported to the offshore wind farms, will have very different requirements than a manufacturing port that stages foundations or manufactures cables.

As part of the OWSP, and as detailed in Appendix D, 38 New Jersey properties were evaluated as potential ports to support the development of offshore wind. First, each of these properties was evaluated using the following screening criteria:

- Waterfront access
- Size of the property
- Depth of the existing berth
- Depth of the nearby navigational channel
- Air draft (i.e., bridge height limitations)
- Availability for future development as an offshore wind port

After a two-stage screening process (see Appendix D), 13 properties were selected for further assessment. These properties were evaluated in greater detail, which included assessment of potential offshore wind uses at each port and cost estimates to redevelop the ports for offshore wind use. Selection of these 13 sites for assessment does not eliminate other New Jersey properties for consideration or development as offshore wind facilities. Figure 5-1 depicts the locations of the 38 properties evaluated, including the 13 sites selected for further assessment.

FIGURE 5-1: LOCATIONS EVALUATED AS POTENTIAL PORTS FOR OFFSHORE WIND



1 – Veckridge Chemical
2 – Weeks Marine
3 – Military Ocean Terminal, Bayonne
4 – North & McLester
5 – Construction & Marine Equipment
6 – Chemours Co., Linden
7 – Werner Power Station
8 – Naval Weapons Station Earle
9 – Balzano Marine Terminal
10 – Broadway Marine Terminal
11 – Port of Paulsboro
12 – Dupont Repauno
13 – Chemours Carney's Point
14 – Chemours Chambers Works
15 – Cape May Ferry
16 – Atlantic City Marina District
17 – Gardner's Basin
18 – Atlantic City NJ Ave
19 – Dorchester Shipyard
20 – The New Jersey Wind Port
21 – Hope Creek Generating Station
22 – Salem Terminal
23 – Calpine Power Plant
24 – Petty Island
25 – Schellengers Landing
26 – Golden Nugget
27 – Oyster Creek Nuclear Power Plant
28 – Port of Perth Amboy
29 – Perth Amboy Point
30 – Chevalier Avenue Brownfield
31 – Bayfront
32 – Bayonne Bridge Point
33 – Foreign Auto Preparation
34 – Port Newark Container Terminal
35 – Maher Terminals
36 – APM Terminals
37 – GCT Port Jersey
38 – Red Hook Newark

TABLE 5-1: NEW JERSEY PORTS AND HARBORS EVALUATION SUMMARY TABLE

	MARSHALING PORT	O&M PORT	MANUFACTURING/ LAYDOWN: CABLES, BLADES, NACELLES	MANUFACTURING/ LAYDOWN: FOUNDATIONS, TOWER SECTIONS, SUBSTATIONS
NEW JERSEY WIND PORT (LOWER ALLOWAYS CREEK)				
PAULSBORO MARINE TERMINAL (SOUTHERN NJ)				
FORMER DUPONT – REPAUNO (SOUTHERN NJ)				
CHEMOURS (LINDEN) (NORTHERN NJ)				
CHEMOURS CHAMBERS WORKS (PENNSVILLE TOWNSHIP – SOUTHERN NJ)				
MILITARY OCEAN TERMINAL AT BAYONNE* (NORTHERN NJ)				
NAVAL WEAPONS STATION EARLE (SANDY HOOK – NORTHERN NJ)				
NORTH & MCLESTER (NORTHERN NJ)*				
WERNER GENERATING STATION (SOUTH AMBOY)				
GARDNER'S BASIN (ATLANTIC CITY – ATLANTIC COAST)				
CAPE MAY – LEWES FERRY (SOUTHERN NJ)				
NORTH NEW JERSEY AVE (ATLANTIC CITY – ATLANTIC COAST)				
CONSTRUCTION AND MARINE EQUIPMENT (ELIZABETH – NORTHERN NJ)				

*** Facility is owned/operated by the Port Authority of NY and NJ (PANY/NJ)**

LEGEND

	Suitable site to support offshore wind industry
	Site with major constraints or location with extended distances from wind lease areas

Each of the 13 sites was evaluated as a potential marshaling, O&M, or manufacturing port. Table 5-1 summarizes the evaluation as follows:

- Suitable sites to support the offshore wind industry (green). The preliminary estimated fees associated with required upgrades per facility are discussed in the ports and harbors evaluation included in Appendix D.
- Sites with major constraints such as limited space or vertical bridge or overhead cable restrictions, or locations with extended distances from wind lease areas (blue).

The assessment as depicted in Table 5-1 identified six locations that were potentially suitable as marshaling ports. All locations would require major improvements of greater than $100 million dollars. Nine ports were identified as potential manufacturing facilities; all of them would require major improvements, including increasing the load-bearing capacity of quaysides and laydown areas for large components. Ten of the facilities were identified as potentially suitable for O&M. The O&M sites would require limited improvements and investment because of the less stringent infrastructure requirements for O&M ports.

Development of marshaling ports—from where construction of an offshore wind project is launched—is critical. Once the port infrastructure is in place, manufacturers and developers will choose to locate facilities and operations at nearby ports. The development of local facilities and manufacturing in turn will create local jobs and drive down the overall cost of developing offshore wind projects and/or provide net economic benefits for New Jersey. Based on the pipeline of projects expected, four to seven marshaling ports will be required on the East Coast in the 2022-2035 timeframe. A single New Jersey marshaling port could likely support 7,500 MW of offshore wind, assuming project construction is staggered to allow for two years of project construction. Other states, including Maryland, Virginia, and New York, have committed to or are planning port development, which may impact New Jersey. (See summary of regional ports in Appendix D.)

Investment in New Jersey ports is key to supporting the offshore wind industry in New Jersey. The Port of Paulsboro's recently upgraded wharf will allow for roll-on roll-off of offshore wind components using self-propelled modular transporters (SPMTs) and is anticipated to support the manufacturing of monopile foundations by 2023. SPMTs are many wheeled vehicles designed to transport massive objects and can roll large offshore wind components on to and off of vessels, avoiding the need for large heavy lift cranes. Roll-on roll-off logistics allow ports not specifically designed for offshore wind use to support offshore wind use without expensive improvements required to support heavy lift cranes.

Governor Murphy has also recently announced that the New Jersey Wind Port (Lower Alloways Creek site) will be developed by New Jersey and others as a manufacturing and marshaling site (Figure 5-2). Because of its size, its location, and, importantly, its unlimited air draft restrictions, this site has been identified to be developed into a major offshore wind port. Construction is planned in two phases, beginning in 2021. Phase 1 will develop a 30-acre site to accommodate marshaling activities and a 25-acre component manufacturing site. Phase 2 adds another 150+ acres to accommodate expanded marshaling activities and extensive manufacturing facilities for turbine components like blades and nacelles. The New Jersey Economic Development Authority (NJEDA) is leading development and is currently considering a range of public, private, and public-private partnership (P3) financing options. This first phase of development is expected to be completed in 2023 to support the first phase of offshore wind construction. Because Lower Alloways Creek has a total of 320 acres, New Jersey expects future phases of investment will attract additional manufacturing and marshaling activity at this site, to support full build-out of offshore projects to deliver 7,500 MW by 2035.

It is likely that a distributed network of smaller port facilities for initial equipment staging and later manufacturing will develop in the vicinity of centralized marshaling ports. Further details of the analysis are provided in the New Jersey Ports and Harbors Evaluation (Appendix D).

FIGURE 5-2: RENDERING OF PROPOSED NEW JERSEY WIND PORT LOCATED AT LOWER ALLOWAYS CREEK

PORTS AND HARBORS

STRATEGIC RECOMMENDATIONS

In addition to New Jersey's goal of 7,500 MW, it is anticipated that more than 35 GW of offshore wind energy will be developed along the East Coast, representing an unprecedented opportunity for New Jersey to lead the offshore wind industry. Because of the state's central location and with investment in the state's existing port and coastal infrastructure, New Jersey is positioned to become a major hub for offshore wind development. By fostering the development of ports, New Jersey can attract offshore wind developers, original equipment manufacturers, and supply chain companies to establish operations within the state. Marshaling, manufacturing, and laydown port development are key components for meeting New Jersey's offshore wind goals and will require significant capital investment and time to permit and construct. For O&M ports, an investment in infrastructure is less critical, but regional planning and coordination with existing uses such as the fishing industry are necessary. For the state's commercial fishing centers (i.e., Atlantic City, Barnegat Light, Belford, Cape May, Point Pleasant, and Port Norris), port redevelopment activities should minimize potential impacts to the fishing industry and prioritize creating additional economic opportunities for the local fishing community. Ports are essential to the development of New Jersey's offshore wind industry requiring an emphasis on stimulating investment and streamlining development.

Strategic recommendations and next steps for ports and harbors development to meet New Jersey's 7,500 MW goal of offshore wind energy include the following:

- Support the development of the New Jersey Wind Port in phases to establish a new offshore wind marshaling and manufacturing site.
- Support investment in existing ports such as Paulsboro to meet the needs for laydown and staging of components for the initial 1,100 MW of offshore wind development.
- Develop additional New Jersey marshaling and manufacturing facilities to support the development of future solicitations in addition to supporting other offshore wind projects in neighboring states. Potential marshaling/manufacturing ports with no air draft restrictions should be prioritized for development.
- Focus the initial development of ports to support the initial 1,100 MW project, recognizing the need to also support future growth in New Jersey and the region. Innovations in port design for large-scale projects

using next-generation turbines and technologies may place New Jersey at the cutting edge of port development and set the stage for New Jersey as the regional offshore wind supply chain and services hub.

- Include net zero carbon features (e.g., green building and the use of electric vehicles) in innovations in port design, to reflect a green economy.
- Encourage innovation in port design to reflect the needs of port communities, especially around workforce development and supply chain development.
- Continue engagement and planning with coastal communities to identify and develop O&M ports that will support local communities with offshore wind jobs and training over the 25 plus year life span of offshore wind facilities. This effort should include coordination of the interests of both the offshore wind industry and the commercial fishing industry.
- Evaluate and expand New Jersey's suite of financing and incentive programs to stimulate investment in marshaling and manufacturing ports, including grants, tax credits, and low-interest funding. Marshaling and manufacturing port facilities will require on the order of hundreds of millions of dollars in upgrades to support the development of offshore wind, and state investment should leverage federal and private investments. The use of public funding will serve to decrease the risk associated with the construction of such facilities for developers and original equipment manufacturers.
- Utilize offshore wind port incentives to also benefit the commercial and recreational fisheries tenants. Such benefits could include improvements in navigational safety measures, deeper channels, and other port amenities. Another potential benefit would be more co-location, or at least adjacent locations, of offshore wind O&M facilities and existing, poor-condition fishing support infrastructure such as quaysides and bulkhead, to result in more robust and safer infrastructure for both parties.
- Evaluate the potential of strategically important offshore wind port locations and conduct the necessary assessments to facilitate design, permitting, and construction. Evaluations could include environmental, financial, zoning, and planning readiness. Preparing sites for development will increase certainty to attract port investment.

06

ENERGY MARKETS AND TRANSMISSION

ENERGY MARKETS AND TRANSMISSION

Reaching New Jersey's goal of 100% clean energy by 2050 requires bold action, as demonstrated by Governor Murphy's goal of 7,500 MW of offshore wind energy by 2035. The transition to a clean energy economy will require planning and investment to transform the state's energy markets and transmission systems. New Jersey's investment in a clean energy future will lead to the economic benefits of low-cost renewable energy generation and the development of a new offshore wind industry in New Jersey.

Reaching New Jersey's goal of 100% clean energy by 2050 requires bold action, as demonstrated by Governor Murphy's goal of 7,500 MW of offshore wind energy by 2035

6.1 STRATEGIC IMPORTANCE TO NEW JERSEY

To meet the state's offshore wind goal, the Offshore Wind Economic Development Act (OWEDA) establishes that a percentage of New Jersey's electricity must be purchased from offshore wind projects through the offshore wind renewable energy certificate (OREC) program. The price of an OREC (dollars per megawatt hour [$/MWh]) is the all-in cost of the offshore wind project (i.e., the total project capital and operating costs offset by any tax or production credits and other subsidies or grants). The OREC price is a 20-year fixed price. The price paid by ratepayers is the OREC price less any non-OREC revenues generated by the offshore wind project including from the wholesale energy or capacity markets.

The electricity markets serve a vital role in the safe, reliable coordination and delivery of energy to local utilities and ultimately consumers. In New Jersey, PJM is the regional transmission organization that purchases and coordinates the movement of wholesale electricity from generators through the transmission system to all, or part, of 13 states and the District of Columbia. Acting as an independent party under the regulation of the Federal Energy Regulatory Commission, PJM operates one of the world's largest competitive wholesale electricity markets that provides power for over 65 million people. Given the broad base of public support for offshore wind development, New Jersey must coordinate and collaborate with PJM, local utilities, and other stakeholders to develop the energy markets and transmission infrastructure reforms necessary to integrate and support offshore wind. Key strategic considerations for New Jersey include the following:

- New Jersey's current electrical transmission infrastructure is oriented towards moving energy from generation resources on land such as coal, natural gas, nuclear, and hydroelectric and will need to adapt to transmission from offshore wind generation

- New Jersey electricity costs are high relative to those in the rest of the United States, and reducing the costs to ratepayers is important
- The New Jersey Energy Master Plan sets out a clear least cost path to support the goal of carbon-free energy by 2050 that relies on offshore wind energy development and transmission planning to meet these goals
- Good wind resources and shallow waters off the coast of New Jersey make the development of offshore wind generally more cost-effective
- New Jersey's population density limits the areas available for the development of onshore renewable energy, such as wind and solar power, making offshore wind energy critical to meeting New Jersey's goal of 100% clean energy by 2050
- Planning and building electrical infrastructure will take time
- Opportunities exist to work with adjacent states to leverage significant combined offshore wind commitments in support of development of attractive energy markets and regional investment in shared infrastructure

6.2 STAKEHOLDER INPUT

Wholesale energy market and transmission roundtable discussions were held on April 22, 2019 at Princeton University to engage stakeholders in the development of the OWSP. Roundtable participants included PJM, utilities, and New Jersey Division of Rate Counsel. Participants were asked to comment on a full range of issues relating to offshore wind, including energy and capacity pricing, interregional offshore wind capacity and regional transmission solutions, transmission upgrades, transmission options, energy storage, and PJM integration studies specifically in the context of the development of the OWSP. A complete summary is provided in Appendix A.

6.3 SUMMARY OF EVALUATION

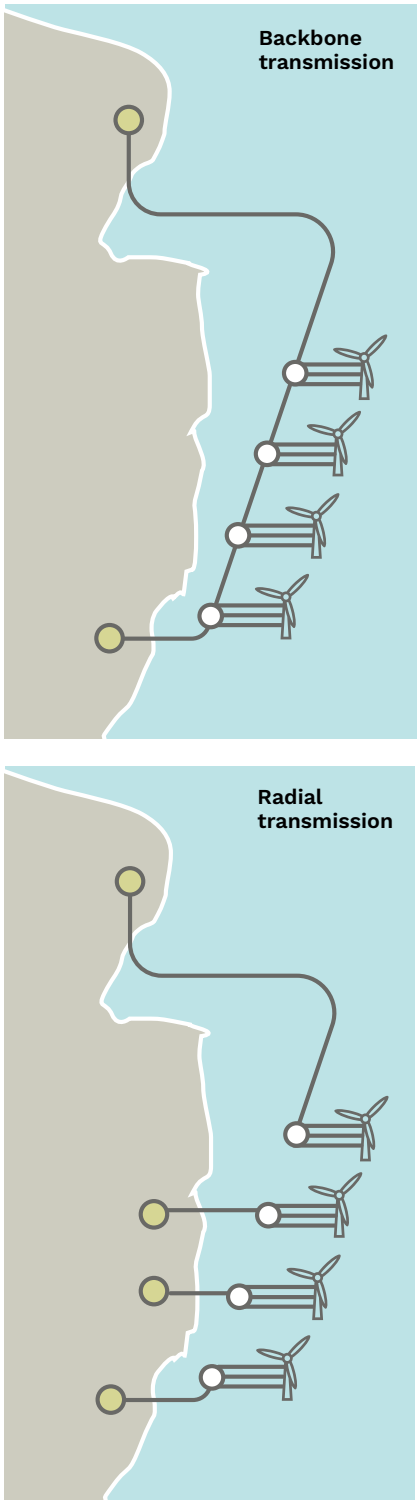
The strategic plan included a levelized cost of energy (LCOE) assessment, the results of which are summarized at the end of this section and detailed in Appendix E. Further studies on energy markets and energy transmission are also planned to support the state's offshore wind goals and are described below.

6.3.1 Wholesale Energy and Transmission Evaluation

Offshore wind technology is rapidly evolving and its prevalence on the eastern seaboard is increasing. Thoughtful reevaluation of the changing landscape and interdependencies of this industry on the energy markets and infrastructure is necessary. Further assessments are proposed to determine how to maximize the benefits of developing 7,500 MW of offshore wind while minimizing the costs. The cost of transmission should be assessed under several scenarios, associated with the six solicitations, for a total of 7,500 MW of offshore wind capacity. Development of the transmission infrastructure should consider the following scenarios (Figure 6-1):

- Optimization of backbone transmission to accommodate New Jersey's goal of 7,500 MW
- Optimization of interregional backbone transmission to accommodate up to 15,000 MW
- Single radial point of interconnection, sized (e.g., single build) to accommodate the six solicitations totaling 7,500 MW
- Multiple radial points of interconnection, developed over time (e.g., each project in each solicitation needs its own radial line and point of interconnection)

FIGURE 6-1: OFFSHORE WIND TRANSMISSION



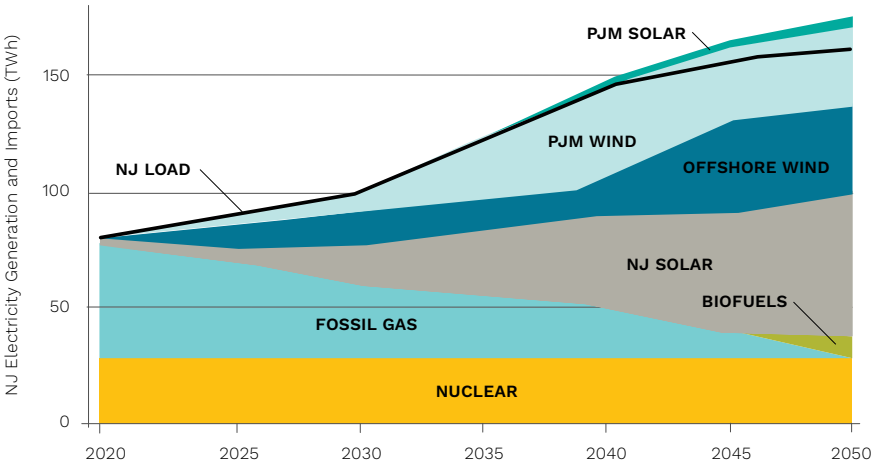
It is anticipated that electrical transmission grid upgrade costs will be paid by a combination of the developers and ratepayers. Such grid upgrades, if they are borne by the developer, will affect the LCOE and ultimately the OREC prices.

The estimated market revenue associated with offshore wind projects will also be assessed under six solicitations, for a total of 7,500 MW. The revenue generated will offset OREC costs, resulting in the net OREC cost. Estimates should consider both the locational marginal prices (wholesale energy market) and the capacity additions and retirements and associated costs (capacity market). The analysis could consider carbon pricing scenarios, including participation in the regional greenhouse gas initiative auctions starting in 2020 and the possible adoption of a carbon pricing mechanism by PJM. Different policy scenarios should be evaluated such as rulings by the Federal Energy Regulatory Commission (FERC) regarding PJM's Minimum Offer Price Rule (MOPR) and how it will affect capacity revenue for developers and costs for consumers.

6.3.2 Energy Master Plan

The New Jersey 2019 Energy Master Plan (EMP)[27] encompasses a dramatically broader scope than any previous New Jersey EMP. The 2019 EMP defines "100% clean energy by 2050" to mean 100% carbon-neutral electricity generation by 2050. Energy system modeling conducted for the EMP found that New Jersey can cost-effectively reach its goals of 100% clean energy and reduce its greenhouse gas emissions in a reasonable timeframe. Offshore wind is key to meeting these goals in a cost-effective and timely manner. Figure 6-2 shows the projected change in New Jersey energy generation in the least cost scenario to meet the goal of "100% clean energy by 2050."

FIGURE 6-2: ELECTRICITY GENERATION, LEAST COST SCENARIO



[27] NJBPU, NJEDA. 2020. New Jersey Energy Master Plan. Available at: https://nj.gov/emp/docs/pdf/2020_NJBPU_EMP.pdf.

6.3.3 Levelized Cost of Energy

For offshore wind energy, it is important to understand the LCOE for developing offshore wind projects to determine the effect on New Jersey ratepayers, as well as how OREC prices or other incentives should be implemented to support offshore wind development. It is also important to understand the impact of several key variables on the LCOE from offshore wind farms.

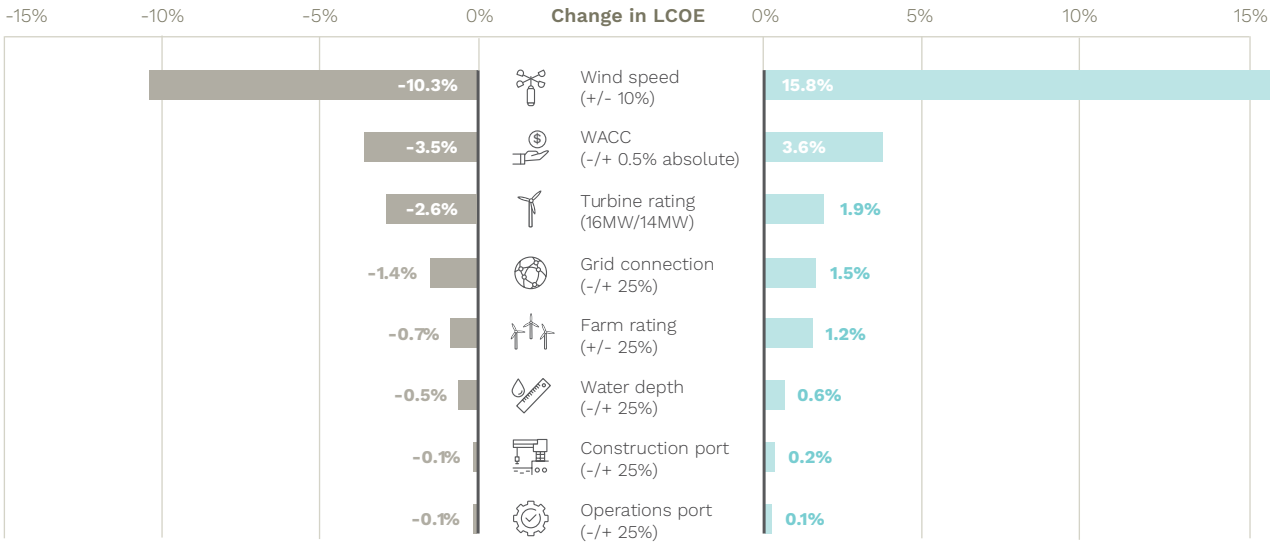
Modeling of the LCOE was conducted as part of the OWSP (see Appendix E) and covered two scenarios:

- A balanced scenario (balance between local economic benefits and LCOE)
- A low LCOE scenario (low LCOE is emphasized at the expense of local economic benefits)

Each of the two scenarios resulted in notably different LCOEs and economic benefits to New Jersey through the first two solicitations. Interestingly, LCOEs for both scenarios converge over time, with similar expected costs in the last two solicitations. The balanced scenario allows for the development of a local supply chain, which results in the lowest LCOE by the third solicitation. In addition, a sensitivity analysis was completed to evaluate how varying key parameters changes LCOE. The key findings of the analysis are the following:

- The factors with the greatest influence on LCOE are wind speed, weighted average cost of capital, turbine rating, distance to grid connection point, and wind farm rating (Figure 6-3)
- An increase of average wind speed by approximately 1 meter per second can result in a 10% decrease in LCOE

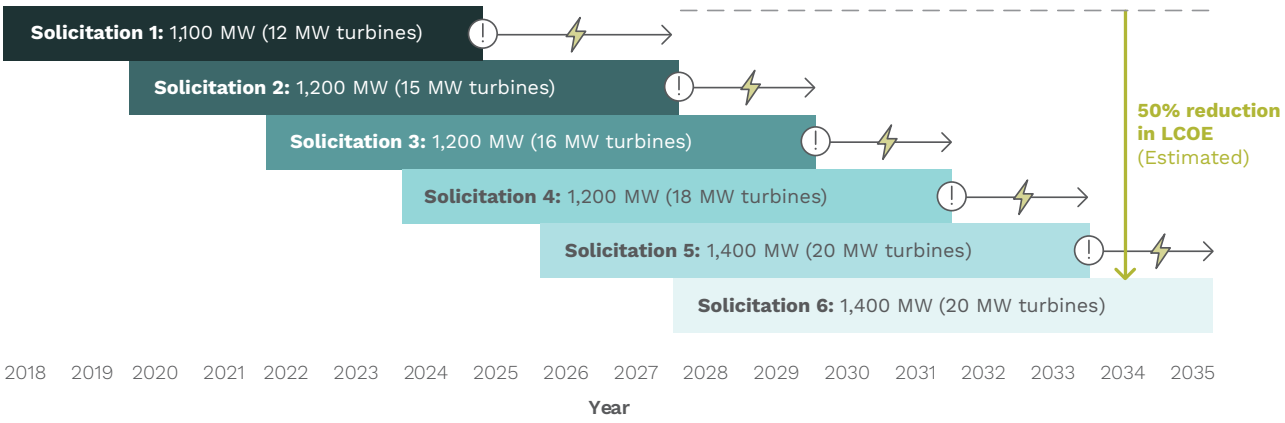
FIGURE 6-3: PERCENT CHANGE IN LCOE FROM KEY FACTORS



*Balanced scenario A - 2027 LCOE

- Weighted average cost of capital (WACC) is highly sensitive; half a percent change (+/-) impacts LCOE by a corresponding +/-3.5%
- The larger, more advanced wind turbines produce more energy for a given wind speed; increasing from a 15 MW turbine to a 16 MW turbine could reduce LCOE by 2.6%

FIGURE 6-4: LCOE TIMELINE



COD - Commercial operation date

Energy production (Estimated 25 years)

*Solicitation estimates per NJBPU; Timing and sizes are subject to change.

- A 25% smaller project increased LCOE by 1.2%
- For the scenarios evaluated, changing the distance to the grid connection by 25% changed LCOE about 1.5%; at longer distances, effects on LCOE may be greater
- The analysis evaluated monopile and jacket foundations and identified that although jackets may have some structural advantages for deeper water and larger turbines, they are expected to increase LCOE by approximately 2%
- Changing the spacing of turbines from an optimal spacing to a minimum of 1 nautical mile would increase LCOE by 0.4% just from increased cable lengths and O&M considerations despite reduced wake losses; the 1 nautical mile spacing would be a 40% increase in the area of the wind farm; increasing spacing more than 1 nautical mile further increases LCOE
- The analysis shows that LCOE is expected to drop by 50% over the six proposed solicitations with the potential to reach parity with other generation sources (Figure 6-4)

ENERGY MARKETS AND TRANSMISSION

STRATEGIC RECOMMENDATIONS

Bold action is required to reach New Jersey's energy goals, and offshore wind energy offers a least cost path to 100% clean energy by 2050. Investments in planning and infrastructure are necessary to build the transmission infrastructure and regional markets needed for offshore wind energy to support a clean energy future. New Jersey's leadership in offshore wind can drive regional cooperation between energy stakeholders to address energy market and transmission challenges that cross jurisdictions and state boundaries. New Jersey's return on investment for 7,500 MW of offshore wind by 2035 includes not just a clean energy future but the economic benefits of low-cost renewable energy generation and the development of a new offshore wind industry in New Jersey.

Strategic recommendations and next steps for wholesale energy market development and transmission to meet New Jersey's 7,500 MW goal of offshore wind energy include the following:

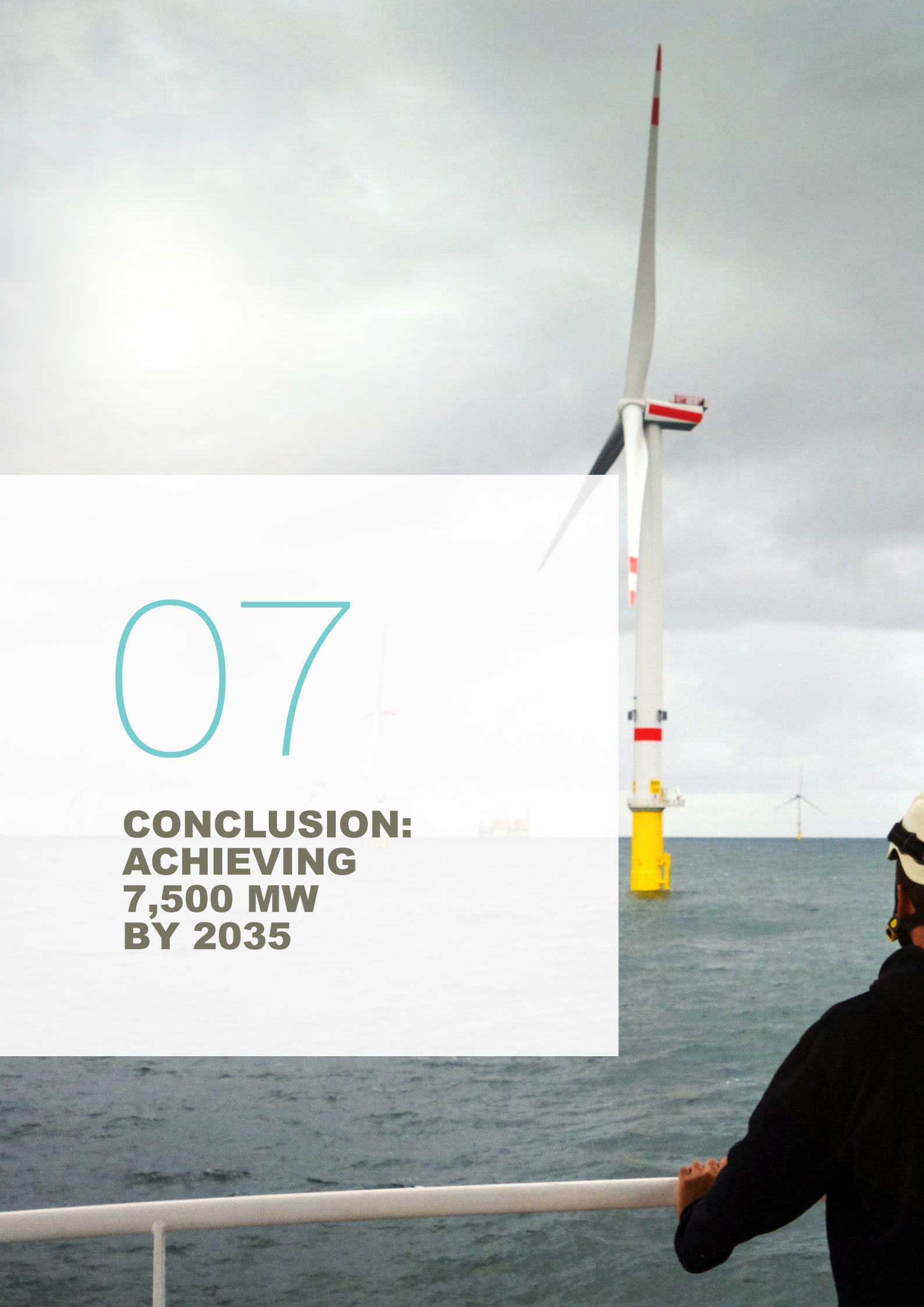
- Continue to support incentives for the initial development of a local offshore wind industry until mechanisms such as ORECs are no longer necessary. Offshore wind is expected to have a downward impact on energy market prices, especially with the technological advancements being achieved in offshore wind generation. The NJBPU needs to consider OREC prices to allow ratepayers to take advantage of the decreasing price anticipated for offshore wind projects. The price of ORECs established by New Jersey is important to ensure that ratepayers are not unduly impacted by incorporating offshore wind into the transmission grid.
- Reevaluate the industry and market landscape regularly, and at least prior to each solicitation, to maximize opportunities to drive down LCOE and optimize transmission considerations. These periodic evaluations could influence the timing and/or size of solicitations.
- Encourage coordination and planning between projects in adjacent lease areas to minimize impacts from wake effects.
- Encourage spatial planning that is cost-effective, while considering adequate access for other interests such as fishing.
- Evaluate the potential for future offshore wind energy solicitations beyond 7,500 MW and assess the future need for incentives such as ORECs or power purchase agreements.

- Evaluate regional and local energy markets to understand more fully the cost implications to ratepayers of developing offshore wind resources.
- Encourage developers to use the latest technology, including the largest-available wind turbine generators, to reduce the LCOE.
- Evaluate the incorporation of 2,000 MW of energy storage by 2030 and the development of smart grid technologies associated with offshore wind–derived energy.
- Collaborate with PJM, as set forth in the New Jersey Energy Master Plan, to assure transmission infrastructure accommodates renewable energy such as offshore wind.
- Work with PJM and local utilities to develop a grid transmission study to integrate 7,500 MW of offshore wind energy by 2035. Develop a short-, mid-, and long-term strategy regarding energy transmission, with particular emphasis on the limitations in New Jersey.
- Evaluate the current transmission regulatory review process to consider both the need for offshore wind transmission upgrades and the need for assessing community impacts, including those within environmental justice areas.
- Evaluate the potential advantages of offshore energy transmission infrastructure, including radial open, radial closed, and backbone scenarios, as well as ownership structures.
- Advocate, along with other states, for measures that advance clean energy policies with FERC and PJM so that technologies like offshore wind, solar power, and storage do not face barriers to entry in energy markets.[28,29,30]

[28] Patel S. 2019. Mixed Reactions to FERC's Recent MOPR Order from Power Generators. POWER Magazine, December 30. Available at: https://www.powermag.com/mixed-reactions-to-fercs-recent-mopr-order-from-power-generators/.

[29] Cleary K. 2020. What the Minimum Offer Price Rule (MOPR) Means for Clean Energy in PJM. Resources, January 21. Accessed May 19, 2020. Available at: https://www.resourcesmag.org/common-resources/what-minimum-offer-price-rule-mopr-means-clean-energy-pjm/.

[30] Goggin M, Gramlich R. 2019. Consumer Impacts of FERC Interference With State Policies: An Analysis of the PJM Region. August. Available at: https://gridprogress.files.wordpress.com/2019/08/consumer-impacts-of-ferc-interference-with-state-policies-an-analysis-of-the-pjm-region.pdf.



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CONCLUSION: ACHIEVING 7,500 MW BY 2035

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Led by Governor Murphy, New Jersey is at the forefront of developing offshore wind renewable energy to address climate change. New Jersey is one of the leading states in the country setting a course to achieve 100% clean energy. The state is taking specific action to develop this new offshore wind energy source and industry that will transform New Jersey's economy while protecting its environment and natural resources. To meet the challenge of 7,500 MW by 2035 successfully, New Jersey developers, manufacturers, workers, and residents must not only continue efforts related to this first phase but also plan towards the delivery of subsequent phases over the next 15 years.

The recommendation summary provided below outlines New Jersey's strategic plan for success. Further details are provided in the specific recommendations laid out in previous sections. The roadmap identifies actions to be implemented in preparation for remaining solicitations to reach the 7,500 MW goal. The recommendations are supported by various analyses conducted as part of the OWSP, including an environmental and natural resource assessment, a ports assessment, a supply chain analysis, and an LCOE study.

- Support the first 1,100 MW solicitation and future solicitations by leveraging public and private financing tools to encourage investment in the New Jersey Wind Port as the region's first major offshore wind manufacturing and marshaling port
- Implement a balanced approach to project selection that encourages local content and the development of a New Jersey offshore wind supply chain, while keeping the LCOE for offshore wind projects low for initial projects and ensuring that the LCOE continues to decline, resulting in the lowest possible cost by 2035
- Engage with original equipment manufacturers, developers, and potential ports on the development of manufacturing facilities in New Jersey to meet expected projected demand in the 2024-2026 timeframe
- Utilize the WIND Institute to support research, innovation, stakeholder engagement, and training to position the state for efficient development
- Utilize the Environmental Working Group to continue engagement and address environmental, natural resource, and fishery issues
- Continue meaningful collaboration with PJM on the issue of offshore wind interconnection and efficient transmission expansion to accommodate the board's second and future solicitations
- Determine a method to ensure that offshore wind resources can continue to provide capacity value to New Jersey ratepayers

> **I want to see us move far beyond to a place that we have never been before. The emerging offshore wind industry is one that gives us this tremendous growth potential**
>
> **GOVERNOR PHIL MURPHY**

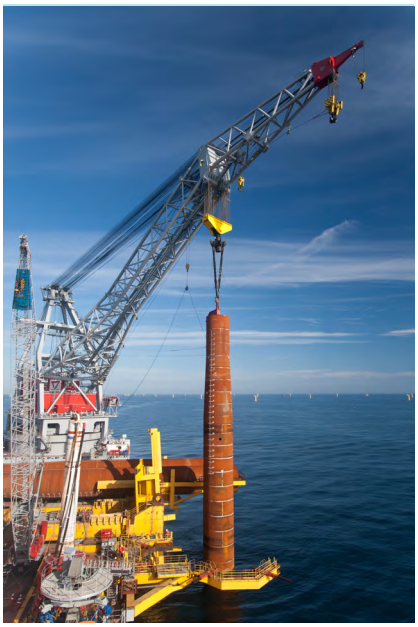
- Continue to utilize offshore wind energy purchase incentives via long-term contract agreements such as ORECs to support the development of a local offshore wind industry to drive down development costs
- Prioritize projects located in areas of low relative environmental susceptibility
- Prioritize projects that can reduce environmental impacts and lower the LCOE by using the largest turbines and "best available technology"
- During solicitation, require a commitment to implement New Jersey's recommended environmental avoidance and minimization measures
- For each solicitation, consider the potential environmental and natural resource impacts, and provide mechanisms to incorporate recommended avoidance and minimization measures to address identified impacts
- Utilize the best available experts at the WIND Institute to work with turbine suppliers, developers, educational institutions, and labor unions to provide workforce training and recruitment programs to make New Jersey a hub for the offshore wind O&M industry, because most New Jersey offshore wind jobs will come from O&M of wind farms
- Work with developers, service providers, educational institutions, and labor unions to develop and communicate clear health and safety training standards for workers in the offshore wind industry and support the development of training programs in New Jersey to meet industry standards
- Continue engagement with industry leaders, developers, and supply chain entities via mechanisms such as the New Jersey Offshore Wind Supply Chain Registry
- Continue engagement and planning with coastal communities to identify and develop O&M ports that will support local communities with offshore wind jobs and training over the 25 plus year life span of offshore wind facilities
- Evaluate the potential of strategically important offshore wind port locations and conduct the necessary assessments to facilitate design, permitting, and construction; evaluations could include environmental, financial, zoning, and planning readiness; preparing sites for development will increase certainty to attract port investment
- Include innovative net-zero carbon features (e.g., green buildings and use of electric equipment) in offshore wind port upgrade designs to reflect a green economy
- Undertake future environmental studies as recommended in previous sections to support decision-making moving forward, including the following:
  - → An evaluation of cumulative environmental impacts of offshore wind development, undertaken with BOEM and the East Coast states, which includes using the New Jersey Stock Assessment Program for long-term evaluation and monitoring of offshore wind
  - → Species-specific studies on rare, threatened, and endangered species (e.g., Atlantic sturgeon, North Atlantic right whale, red knot) and highly migratory species and benthic invertebrates, in cooperation with federal stakeholders
  - → An evaluation that incorporates data and expertise from industry, non-profit and academic sources to model ocean current and atmospheric data, which can be used to assess potential environmental impacts and provide critical data to developers on locating turbines to maximize the wind resource
  - → An evaluation of decommissioning activities, including removal of structures and the potential for offshore wind structures to provide habitat

- Undertake the following energy studies:
  - → In advance of each solicitation, evaluate regional and local energy markets to understand more fully the cost implications for ratepayers of offshore wind resources
  - → Evaluate the potential advantages of offshore energy transmission infrastructure, including radial and backbone scenarios to minimize costs and environmental impacts; include an evaluation of potential impacts from export cables on sensitive habitat and historical resources
  - → Evaluate the incorporation of energy storage and smart grid technology associated with offshore wind–derived energy

New Jersey's oversight and management of offshore wind development will need to continue over the various phases of its plan through 2035 and beyond. Over time, adjustments and new programs may be necessary to adapt to this new and evolving industry. Longer-term actions include additional studies, continued stakeholder collaboration, and assessment of regional markets to determine appropriate action for New Jersey. The OWSP should be an evolving document that adjusts to changing dynamics both within the state and regionally.

New Jersey is poised to benefit from its commitment to renewable energy and, specifically, its investment in offshore wind. Cleaner air, a stronger workforce, cheaper and cleaner energy, new and improved ports, and more manufacturing are just some of the attributes offshore wind development brings. New Jersey's commitment today will deliver a cleaner and stronger environment for tomorrow.

DISCLAIMER



This Offshore Wind Strategic Plan (“Strategic Plan”) was prepared by Ramboll US Corporation (“Ramboll”) and its subcontractors for the Board of Public Utilities (“the Board”) as a planning document under the directive of Executive Order No. 8 (“EO8”) and Executive Order No. 92 (“EO92”). Among other things, EO8 called for the Board to engage stakeholders and solicit input from the public “to promote and realize the development of wind energy off the coast of New Jersey.”

At the time of publication of this Strategic Plan, the Board has made no determinations in response to the modeling, analysis and recommendations contained herein. This information may be used to facilitate the development of offshore wind energy in the future; however this Strategic Plan does not represent the Board’s views or policies for offshore wind development. The Board makes no warranties or representations, expressed or implied, as to the fitness of any proposed methods, processes or other information contained, described, disclosed or referenced in this Strategic Plan.