

Offshore Wind

Workshop 2020-12-21 v1.0

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Key Questions



- Where will the pinch points arise for offshore wind in the north east?
 - Landing points/ports
 - Interconnection locations
 - Grid capacity/other system issues/offtake
- Are there other process concerns
 - Permitting times becoming longer
 - Community/public opposition
 - Political/policy
- What are the recent developments in the market
 - We hear some of the ISOs are re-structuring – is this the case and what does it mean
 - Are there regulatory initiatives that will change the market structure
 - What are the north eastern states declared policy/bidding/consultation processes for the next 2-3 years or so
 - PPA pricing view from NAGP for offshore

Overview



- State climate action is accelerating as more states are taking increasingly ambitious actions throughout the country.
 - Currently, 15 states and territories have taken legislative or executive action to move toward a 100 percent clean energy future.
 - States' public policy goals along with state incentives and favorable outer continental shelf (OCS) conditions will continue to drive offshore wind development.
- These factors are more favorable on the U.S. East Coast than the West Coast, which is the main reason the East Coast is developed with goals and plans.
- At the same time, there are several physical, administrative and financial "pinch points" or challenges facing offshore wind.



State Clean Energy Targets are driving regional development of offshore wind

State	Renewable & Clean Energy Goals	Offshore Wind Commitment (MW)	OSW Awarded (MW)	OSW Under Solicitation (MW)
Massachusetts	35% by 2030 80% Clean Energy by 2050	3,200 MW	1,600	0
Rhode Island	100% by 2030	Unspecified	430	0
Connecticut	48% by 2030 100% Carbon-free Electricity by 2040	2,300 MW	1,108	0
New York	70% by 2030 100 % Clean Energy by 2040	9,000 MW	1,826	2,500
New Jersey	50% by 2030 100% Clean Energy by 2050	7,500 MW	1,100	2,400
Maryland	50% by 2030 100% Clean Energy by 2040	2,000 MW	368	1,200
Virginia	30% by 2030 100% Renewable Energy by 2050	5,212 MW	12	0
California	44% by 2024; 52% by 2027; 60% by 2030 100% clean energy by 2045	*	*	*
TOTAL		28,612 MW	6,444	6,100

Note:

1. On October 30, 2020, North Carolina, South Carolina and Virginia announced a partnership to further develop offshore wind. It is expected that NC and SC will set targets in addition to the above. Avangrid recently won the Kitty Hawk lease.
2. In New Hampshire, steps have been taken to establish an intergovernmental offshore renewable energy task force to deliberate on the identification of wind energy areas off its coast.
3. There is currently only one (1) commercially operating wind farm in the U.S.: The 30 MW Block Island Wind Farm (five turbines). CoD December 2016.

New Jersey Solicitation Tranches (7,500 MW by 2035)

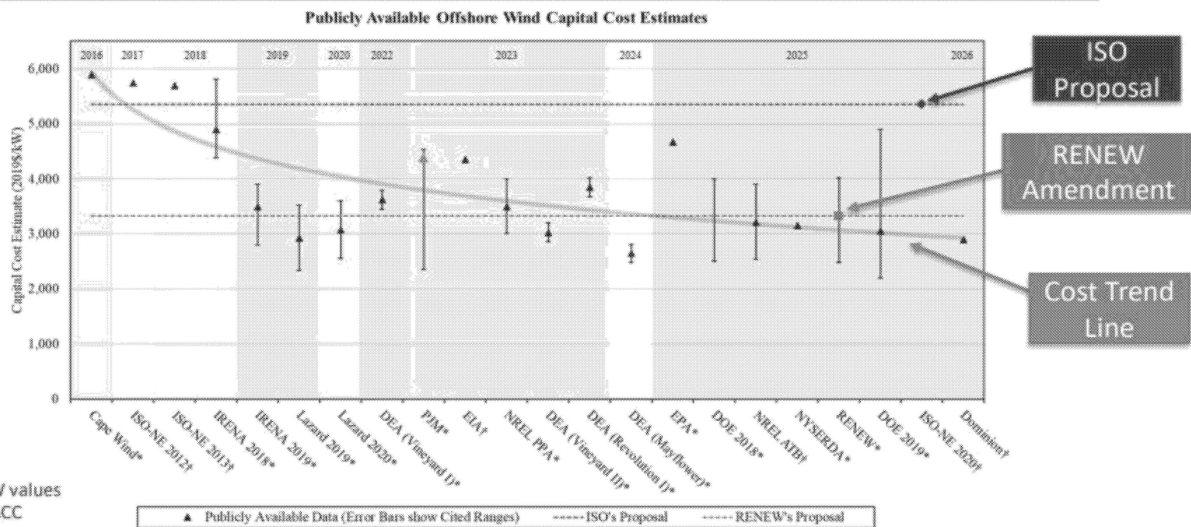


Solicitation	Capacity Target (MW)	Issue Date	Submittal Date	Award Date	Estimated Commercial Operation
1	1,100	Q3 2018	Q4 2018	Q2 2019	2024
2	1,200	Q3 2020	Q4 2020	Q2 2021	2027
3	1,200	Q3 2022	Q4 2022	Q2 2023	2029
4	1,200	Q2 2024	Q3 2024	Q1 2025	2031
5	1,400	Q2 2026	Q3 2026	Q1 2027	2033
6	1,400	Q2 2028	Q3 2028	Q1 2029	2035

Note:

1. PSEG recently acquired a 25% stake in Orsted's 1.1 GW Ocean Wind (NJ).
2. This is NJ's "first" offshore wind project, with a COD by the end of 2024.
3. Ocean Wind's first year OREC was \$98.10/MWhr with a 2% annual escalation over the 20-year OREC term.
4. Additionally, PSEG & Orsted own 50% of Garden State Offshore Energy.
5. On Nov. 18, the NJ BPU approved an order to align its OSW transmission goals with PJM's transmission planning process.
6. On Dec. 11, NJ announced that EDF & Shell (Atlantic Shores) and Orsted (Ocean Wind 2) had submitted bids for the second solicitation, between 1,200 and 2,400 MW.

Recent Highlights: Capital Cost Estimates



DEA and RENEW values updated for WACC

*Installed Capital Costs
†Overnight Capital Costs (excludes cost of interest during construction)
‡Shaded bands indicate the year of expected/actual COD

Note: An extensive discussion of the data in this figure is included with the meeting materials as a separate document



Contract Structure: Various State-level Mechanisms to Fund OSW Development



Fixed price PPA: Block Island (MA)

- State directs the utility to run a competitive bidding process for offtake.
- Winner enters into contract with the local utility.
- Winning bid \$244/MWhr with annual escalation.

“Fixed” OREC: Ocean Wind (NJ)

- One OREC for one MWh of generation.
- Winning bid \$98.10/MWhr (2024) with 2% annual escalation.
- Every 12 months the actual and index market revenues for energy plus capacity sales will be credited in the calculation of net OREC cost.
- Maximum allowed 4,851,489 MWhs per year.
- Carry forward OREC.

“Indexed” OREC: Empire Wind & Sunrise Wind (NY)

- Competitive bidding process for offshore wind energy credits (ORECs)
- Developers estimate an all-in cost to construct and operate the facility, along with a forecast of future revenue from the power markets
- Because the market revenue is expected to be less than the cost of the facility, the OREC price is the difference between the cost and market revenue.
- The projects with the lowest project cost are expected to have the most competitive OREC bids.
- The state allocates the cost as a non-bypassable charge to ratepayers.
- The projects selected in NY's Phase I solicitation (Empire Wind and Sunrise Wind) have an estimated all-in development cost of \$83.36/MWhr, with an OREC price of \$25.14/MWhr.

Offshore Wind Offtake Agreements



Project	Year Signed	Size (MW)	Duration (years)	Offtake State	Offtake Mechanism	Regulator Approved	Levelized Price \$/Megawatt-hour (MWh)	Power Delivery	Power Purchaser
Block Island Wind Farm	2010	30	20	RI	PPA	Yes	244	2016	National Grid
South Fork	2017	130	20	NY	PPA	Yes	163	2023	Long Island Power Authority (LIPA)
US Wind	2017	248	20	MD	MD OREC	Yes	131.94	2023	PJM
Skipjack	2017	120	20	MD	MD OREC	Yes	131.94	2023	PJM
Vineyard Wind	2018	400	20	MA	PPA	Yes	74	2023	National Grid, Eversource, Until
Vineyard Wind	2018	400	20	MA	PPA	Yes	65	2024	National Grid, Eversource, Until
Coastal Virginia Offshore Wind	2018	12	20	VA	Utility Owned	Yes	780	2020	Dominion Energy*
Revolution Wind	2018	200	20	CT	PPA	Yes	99.50	2023	Eversource & UIL
Revolution Wind	2018	104	20	CT	PPA	Yes	98.43	2023	Eversource & UIL
Revolution Wind	2019	400	20	RI	PPA	Yes	98.43	2023	National Grid
Ocean Wind	2019	1,100	20	NJ	NJ OREC	Yes	116.82	2024	PJM
Empire Wind	2019	816	25	NY	NY OREC	Yes	83.36	2024	New York Independent System Operator (NYISO)
Sunrise Wind	2019	880	25	NY	NY OREC	Yes	83.36	2024	NYISO
Aqua Ventus	2019	12	20	ME	PPA	Yes	Undisclosed	TBD	Central Maine Power
Mayflower Wind	2020	400	20	MA	PPA	Yes	58.47	2025	National Grid, Eversource, Until
Mayflower Wind	2020	404	20	MA	PPA	Yes	58.47	2025	National Grid, Eversource, Until
Park City Wind		804	20	CT	PPA	Pending	N/A	2025	Eversource & UIL
Icebreaker		21	TBD	OH	PPA	Pending	N/A	TBD	TBD

Source: Belter et al. (2020)

Note: Offtake agreements signed in 2019 and 2020 are in green text

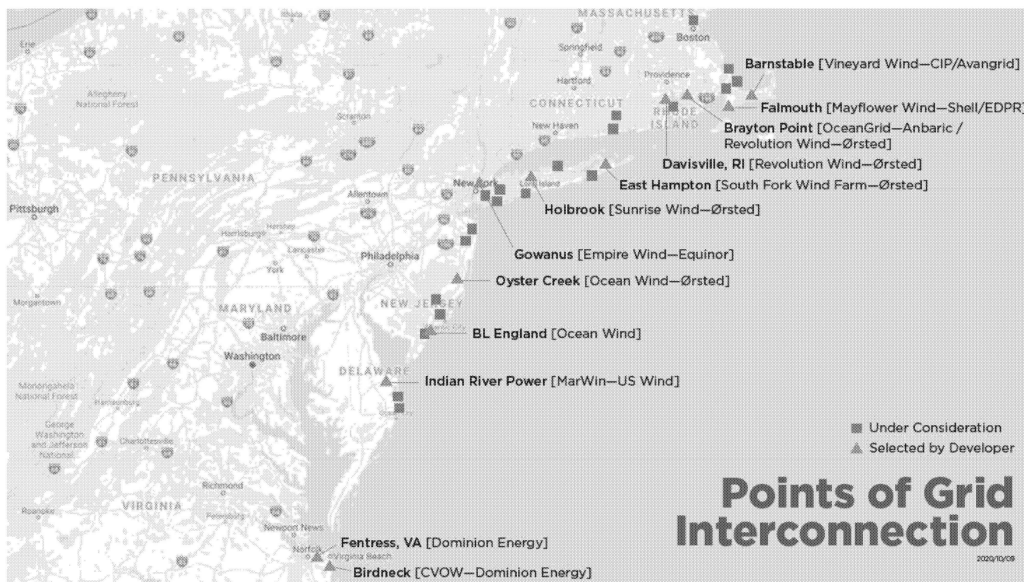
Source: U.S. Department of Energy, 2019 Offshore Wind Technology Data Update, October 2020; NREL

Port Development



- **New Jersey**
 - A greenfield site for offshore wind
 - NJ “Wind Port” Planned for Southern NJ
 - Adjacent to Hope Creek Nuclear station
 - Phase 1: Marshalling facilities, 30 Acres (Start 2021)
 - Phase 2: Marshalling and manufacturing, 150 Acres (TBD)
- **New York**
 - Developers to propose projects with port development as part of their bids
 - Developers to work with existing port operators
 - Equinor announced plans for South Brooklyn Marine Terminal
 - Expect other port development further north in Hudson River
 - Several retired power plants along Hudson River may be used
- **New England**
 - Significant state-level financial investments are being made in ports to facilitate OSW

Points of Interconnection



Source:

1. "Offshore Wind Transmission White Paper," Oct. 2020, presented at FERC OSW Technical Conference.



Challenges: Transmission

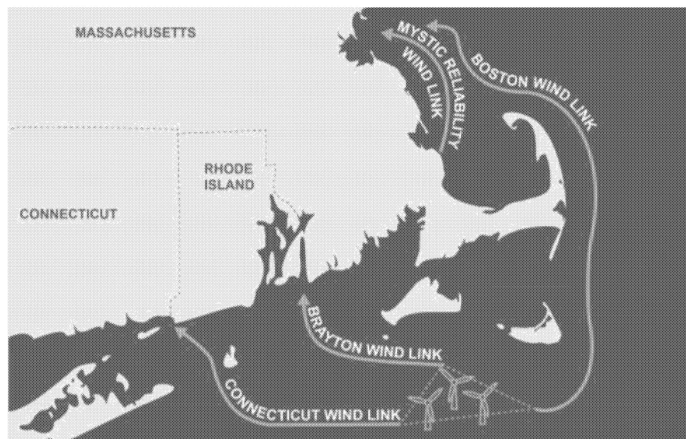
- The RTO transmission planning process overly relies on the interconnection queue to determine transmission needs;
- RTOs evaluate transmission needs based on requirements for reliability, market efficiency, resilience and “public policy” in an unintegrated manner
 - This analysis does not reflect the true mix of resources that will be relied upon
- Cost allocation methods fail to recognize the broader system benefits and the beneficiaries of offshore wind transmission.
- The RTO planning process also does not prioritize the transmission projects that will be required to meet State clean energy goals.
- Some RTO/ISOs also require site control or a federal offshore wind lease in order to process an interconnection request so interconnection requests are limited to current lease holders and do not reflect future lease holders and anticipated capacity.

Source: <https://www.ferc.gov/sites/default/files/2020-10/Panel-2-Anne-Marie-McShea-OW-Ocean-Winds-Statement.pdf>

New England: Transmission Solutions



- Some U.S. jurisdictions have planned transmission infrastructure to facilitate onshore renewables
 - Texas CREZ, California Tehachapi, MISO MVPs
- Anbaric (a private transmission developer) has proposed a similar construct for New England
 - Anbaric estimates savings of \$1 billion with this approach



Source:

1. Brattle/Anbaric Presentation to ISO-NE August 2020 .

NY and Mid-Atlantic: Transmission Solutions



New York/NYISO

- The New York State Electric Research & Development Authority (NYSERDA) recommended a direct radial transmission approach dedicated to specific projects and owned by the developer in the State's first and second solicitations for offshore wind energy¹.
- Going forward, the State will continue to evaluate the potential of a backbone approach – or offshore transmission grid – in its effort to provide an optimized set of solutions to New York's ratepayers.

Mid-Atlantic/PJM

- Transmission developers propose projects to the PJM.
- PJM will run the solicitation of the project for NJ.
- BPU will select the least cost project for the ratepayers.
- Costs will be shared by ratepayers.

1. Transmission and New York's Electricity Grid - NYSERDA



Challenges: Siting and Permitting

- **Bureau of Offshore Energy Management (BOEM) Process**
 - Some wind developers recently raised concerns with staffing at BOEM.
 - BOEM does not have the staff to simultaneously review Construction and Offshore Plans (COPs) for multiple projects.
 - Vineyard Wind and Skipjack have experienced delays that they attribute to BOEM.
 - As of Dec 2020, Vineyard Wind's permit application has been withdrawn as the developer requested to temporarily halt the permit review so that it could submit changes reflecting a new model of wind turbines. This could delay the project an additional 6–18 months.
 - Staggering project review and approval will push the projects out decades.
 - Congress recently increased BOEM appropriations \$3M (but more is needed).
- **Public Opposition**
 - NIMBY: Not In My Back Yard; BANANA: Build Absolutely Nothing Anywhere Near Anything.
 - Offshore wind development has faced well-publicized opposition from politically-connected interests, even those interests that are generally support progressive policies.
- **Environmental and Similar Impacts**
 - There is opposition from the US commercial fishing industry relating to a debate over the environmental/marine life and fishery impacts.
 - Bird and bat migratory patterns also need to be considered.
 - Shipping routes and marine navigation.
 - Impacts on Department of Defense radar, surveillance and other operations.

Challenges: Customer Impact



- The relatively high cost of offshore wind will cause ratepayers (end-use customers) to push back on significant development.
 - Ratepayers in states such as NY are currently paying some of the highest rates in the country and these states have enacted a variety of above-market programs:
 - Zero Emissions Credits (ZECs)
 - Renewable Energy Credits (RECs)
 - NY just proposed expansion of its existing Tier 1, 2, & 3 REC program and a new Tier 4 to incent a transmission line from Quebec to NYC
 - Energy Efficiency
 - Subsidies to Low Income Customers

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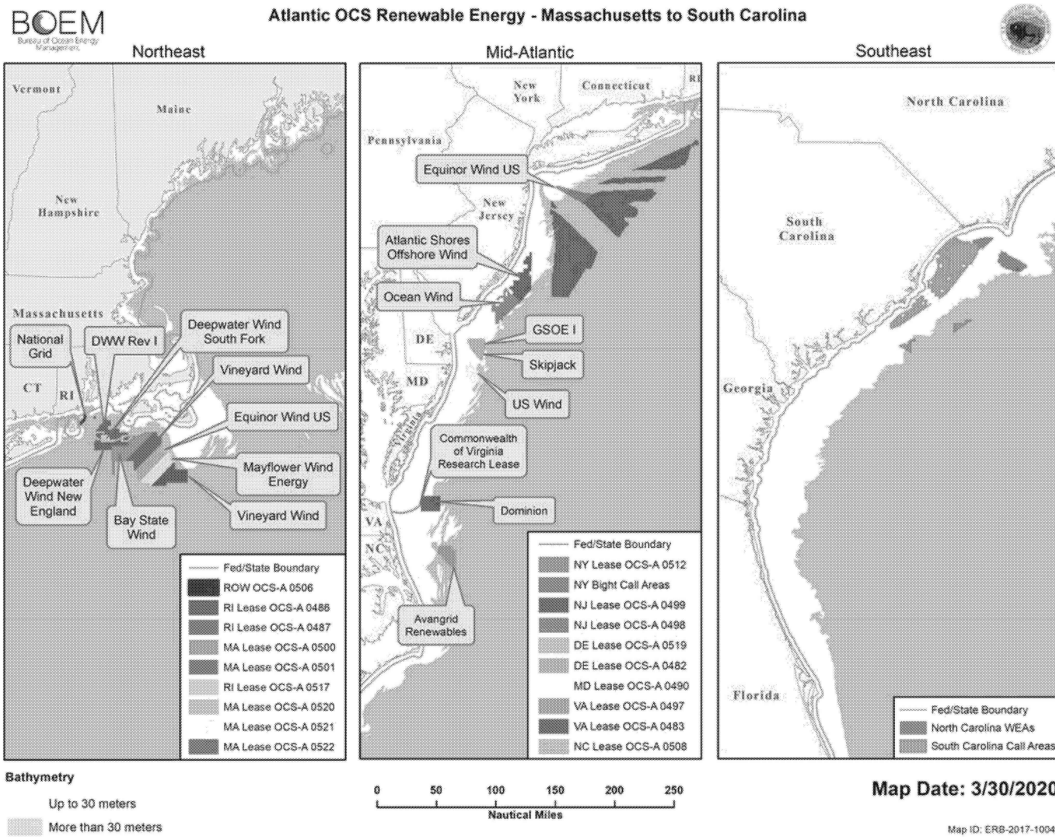
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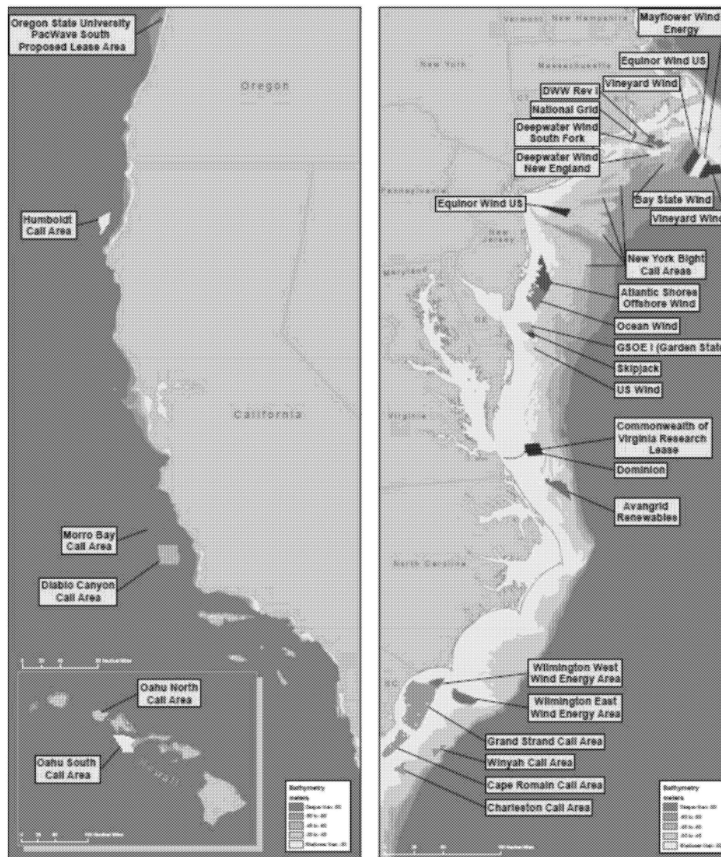


- U.S. BOEM OCS Lease Locations
- Additional Detail on State-level Port and Infrastructure Investment
- Additional CapEx Ranges and Forecasts
- Additional Offtake Agreement Data
- Transmission Cost Estimates

U.S. Bureau of Offshore Energy Management
(BOEM) Outer Continental Shelf (OCS)
Development Potential (1/2)



U.S. Bureau of Offshore Energy Management
(BOEM) Outer Continental Shelf (OCS)
Development Potential (2/2)



Note:

- West Coast shown on the left; roll-up of all East Coast locations on the right.



U.S. State Port and Infrastructure Investments



U.S. State Port and Infrastructure Investments Near \$2 Billion					
State	Location	Announced Date	Amount	Investor(s)	Description
Massachusetts	New Bedford Marine Commerce Terminal	2/10/2020	N/A	Avangrid/CIP EDPR/Shell	Vineyard Wind signed an 18-month lease starting in December 2020. They also signed a subsequent lease to use the terminal for the Mayflower Wind project, which is expected to start construction in 2024.
	Brayton Point	5/13/2019	\$650 million	Anbaric Partners	Develop premier offshore wind development center. Investments include a 1,200-MW HVDC converter, a 400-MW battery, additional laydown space, and a maintenance dock.
Rhode Island	Port of Providence	6/3/2019	N/A	Ørsted & Eversource	Support the construction of the Revolution Wind projects.
	Quonset Point		N/A	Ørsted & Eversource	Support the construction of the Revolution Wind projects. Pier 2 is being upgraded to support offshore wind activities.
New Jersey	Port of Paulsboro	6/3/2019	N/A	Ørsted	Signed a memorandum of understanding with EEW, a German steel manufacturer, to construct a monopile manufacturing facility to support Ocean Wind project and other projects in the U.S. pipeline.
	New Jersey Wind Port	6/16/2020	\$300–\$400 million	NJ Economic Development Authority	Develop port in Lower Alloways Creek Township to support offshore wind construction and operations. Initial phase to include 30 acres for marshalling and 25 acres for component manufacturing, with construction to begin in 2021. Second phase to add 150 acres for marshalling and manufacturing.
Maryland	Tradepoint Atlantic	7/23/2019	\$13.2 million	Ørsted	Strengthen ground-bearing capacity at the port to allow heavy-lift cranes and specialized transporters to move wind turbine components, some weighing as much as 2,000 tons, from ships onto the site. Will support the Skipjack project.
New York	Port of Coeymans	11/14/2019	\$287 million	New York State	Increase laydown space and prepare the port to support construction and staging needs for the Empire Wind project. Partnered with heavy-lift specialists Mammoet to invest in a new heavy-lift crane and other specialty equipment.
	New York ports	7/21/2020	\$400 million	New York State	Request for proposals for investment in port infrastructure. Priorities are offshore wind staging and/or manufacturing and related uses. Up to \$200 million from New York state, matched 1:1 by private investment.
Connecticut	New London State Pier	2/12/2020	\$157 million	Ørsted & Eversource	Increase laydown space, the number and size of vessel berths, and the ability to lift and store heavy cargo. The redevelopment is expected to be complete by 2022. The pier will be used for turbine preassembly and project staging for Revolution Wind, South Fork, and Sunrise Wind projects.
	Bridgeport	11/11/2019	N/A	Avangrid	Redevelop a currently underutilized 18.3-acre waterfront to do critical foundation transition piece steel fabrication and final outfitting. Port will also serve as an operation and maintenance hub for the Park City Wind project.
Virginia	Portsmouth Marine Terminal	1/28/2020	\$33 million	Ørsted	Signed a lease for the construction of the Coastal Virginia Offshore Wind Project. Will also install cranes and other specialty improvements.

Source: U.S. Department of Energy, 2019 Offshore Wind Technology Data Update, October 2020; NREL



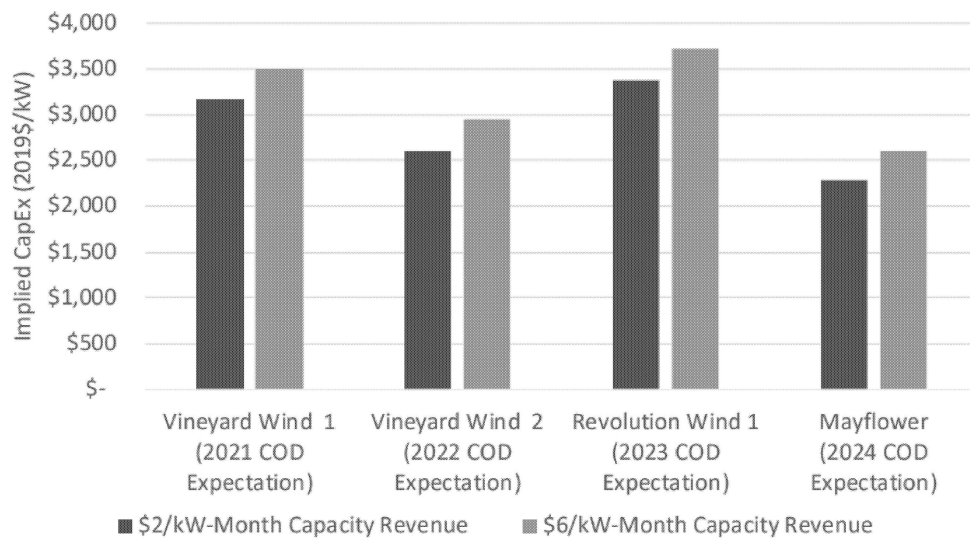
State	Procurement	Economic Investment
Massachusetts	<ul style="list-style-type: none"> • Authority to procure 1,600 MW of cost-effective offshore wind by 2027 • Authority for DOER to require an additional 1,600 MW to be solicited by 2035 	<ul style="list-style-type: none"> • +\$100m state investment in port infrastructure in New Bedford • Secured \$15m from developer for offshore wind accelerator fund. • Secured \$15m in resiliency and affordability funds • Secured \$16m in host community agreement
Connecticut	<ul style="list-style-type: none"> • Authority to procure 3% of load from offshore wind • Authority to procure zero carbon resources which include offshore wind • Pending legislation proposes to establish 2,000 MW offshore wind goal" 	<ul style="list-style-type: none"> • \$35.5m state investment its port facility in New London • Secured \$35m from developers for port improvements and other in-state construction commitments • \$22.5m in previously committed from developer for State Pier infrastructure improvements
New Jersey	<ul style="list-style-type: none"> • Authority for 3,500 MW of offshore wind by 2030 	<ul style="list-style-type: none"> • \$100m Offshore Wind Tax Credit Program
New York	<ul style="list-style-type: none"> • Authority for 2,400 MW of offshore wind by 2030 • State goal for 9,000 MW of offshore wind by 2035 	<ul style="list-style-type: none"> • \$200m state investment in port infrastructure
Rhode Island	<ul style="list-style-type: none"> • No set target for offshore wind • Procuring offshore wind under two statutes for renewable energy 	<ul style="list-style-type: none"> • Secured \$40m from developers for port improvements
Maryland	<ul style="list-style-type: none"> • 2.5% carve-out for offshore wind in the RPS • Legislation passed to double the RPS, requiring 1,200 MW of additional offshore wind to meet 2.5% carve-out 	<ul style="list-style-type: none"> • Secured \$39.6m for port improvements and \$76m in steel fabrication plant from developers



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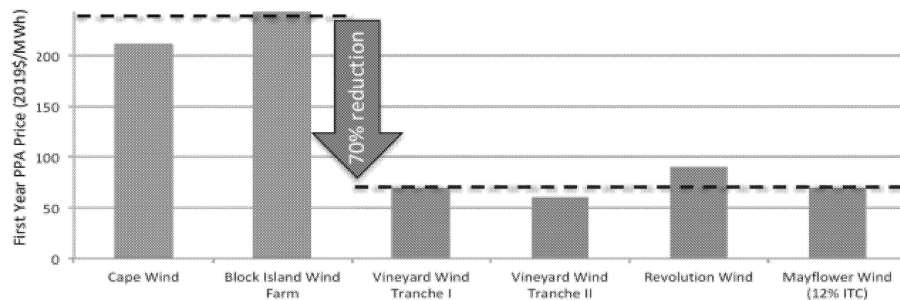


Implied CapEx ranges from \$2300-\$3700/kW (in 2019\$)



A Decade of Falling New England Offshore Wind Prices

- In 10 years there has been a 70% reduction in local offshore wind contract prices driven by both capital and operating cost reductions



Year of PPA		2010	2009	2019	2019	2019	2020
Contract Products Included	Energy	x	x	x	x	x	x
	RECs	x	x	x	x	x	x
	Capacity	x	x				



Transmission Cost Estimates (1/2)

- Transmission infrastructure will be required both onshore and offshore.
 - Offshore: Delivers power to the point of interconnection (electrical landing point). Typically, an integral part of the OSW farm.
 - Onshore: Delivers the power to the load centers. Upgrades are often required to ensure deliverability of the OSW power to the electrical load centers, and also avoid curtailment of the OSW power during grid congestion.
- The capital investment for 30 GW of OSW by 2030 is estimated to be \$100 billion¹
 - Of that, \$15-20 billion is estimated to be offshore transmission
 - Onshore transmission is also expected to be significant
 - PJM has said \$6.4 billion onshore required for 15 GW of OSW; this translates to \$413 per kW of OSW capacity
 - Similar analysis in New England shows costs from \$10/kW to \$1,850/kW

Source: "Offshore Wind Transmission White Paper," Oct. 2020, presented at FERC OSW Technical Conference.



Transmission Cost Estimates (2/2)

- Onshore points of interconnection (POI) will be critical
 - POIs closest to load centers could minimize onshore upgrades
- POIs that utilize former generator interconnections could also minimize onshore upgrades
 - The site of the former Brayton Point 1,500 MW coal plant in Massachusetts should have value for its proximity to a load center (Boston), its deliverability (1,500 MW), and its proximity to the shore (located on the coastline at Mount Hope Bay).
 - The site of the former Oyster Creek 636 MW nuclear plant in New Jersey should have value for the similar reasons as Brayton Point.
- Cost-sharing between projects could capture economies-of-scale
- Onshore transmission will face siting challenges
- Some U.S. jurisdictions have planned transmission infrastructure to facilitate onshore renewables