Offshore Wind Grid Integration Mapping in the Northeast U.S.

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Renewable Energy

Link to video presentation

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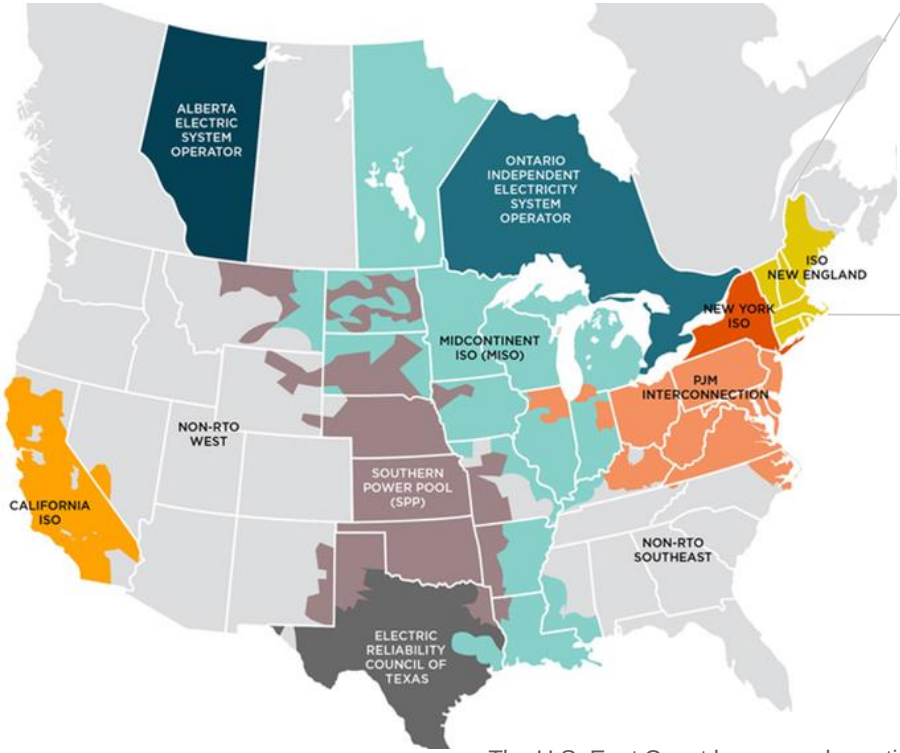
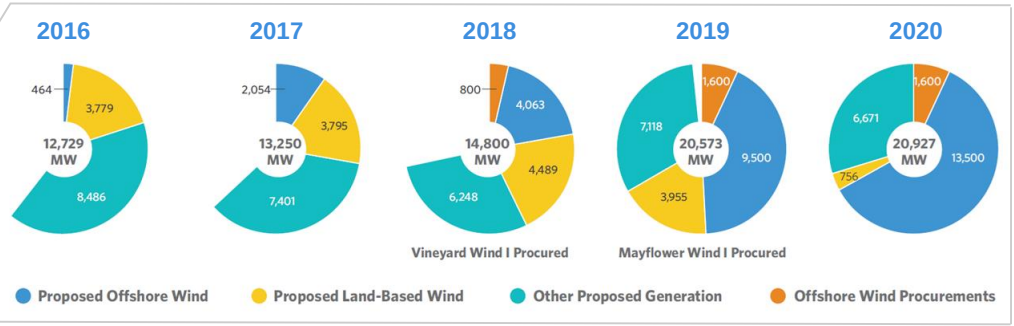
Clean Energy Education & Empowerment (C3E)

Framing the Momentum



Proposed Generation by Type in ISO-NE Queue



Offshore Wind State Commitments by Year

State	Dec 1, 2016	Dec 1, 2017	Dec 1, 2018	Dec 1, 2019	Today
Maine	--	--	--	12	12
Massachusetts	1,600	1,600	1,600	3,200	3,200
Rhode Island	30	30	430	430	430
Connecticut	--	--	--	2,300	2,300
New York	--	2,400	9,000	9,000	9,000
New Jersey	--	--	3,500	7,500	7,500
Maryland	368	368	368	1,568	1,568
Virginia	--	--	--	2,512	5,200
Total	**1,998**	**4,398**	**14,898**	**26,522**	**29,210**

The U.S. East Coast has seen dramatic growth in offshore wind development interest, evident through large state commitments and lengthening queues to study grid interconnection for new projects.

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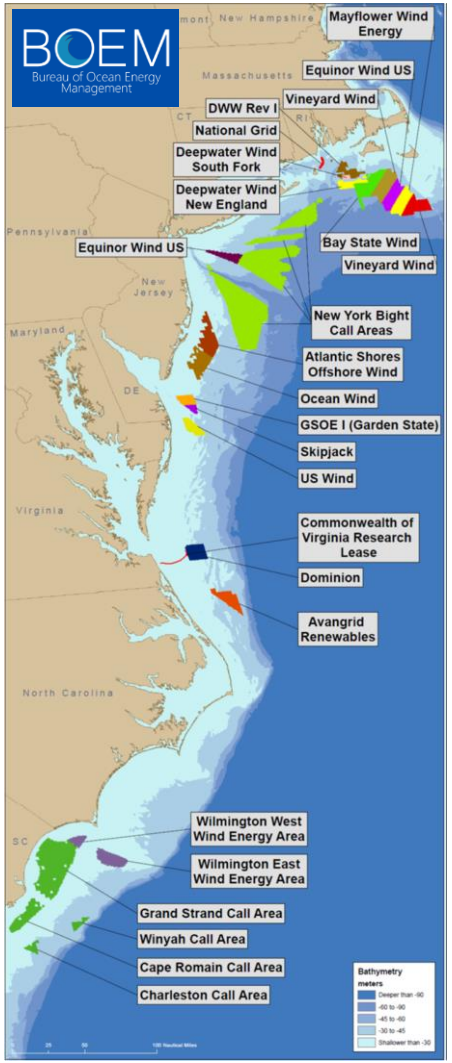
Research Objectives

- Quantify the **full offshore wind build-out capacity** within existing Wind Energy Areas (WEAs) and proposed call areas, as delineated by the Bureau of Ocean Energy Management (BOEM).
- Study the onshore grid topology. Estimate the **capacity of existing coastal transmission infrastructure** by aggregating the nameplate capacities of operating and retired power plants nearby.
- Contextualize independent system operator (ISO) grid **interconnection queues as an indicator of market interest** and site viability.
- Contribute to timely public discourse around offshore wind transmission and grid integration (i.e., MA DOER, NJ BPU, FERC)



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Methods –Turbine Layout & Capacity

On Nov 1, 2019, the leaseholders offshore MA & RI submitted a joint proposal to the U.S. Coast Guard for a uniform 1 x 1 nautical mile wind turbine layout to facilitate vessel transit:

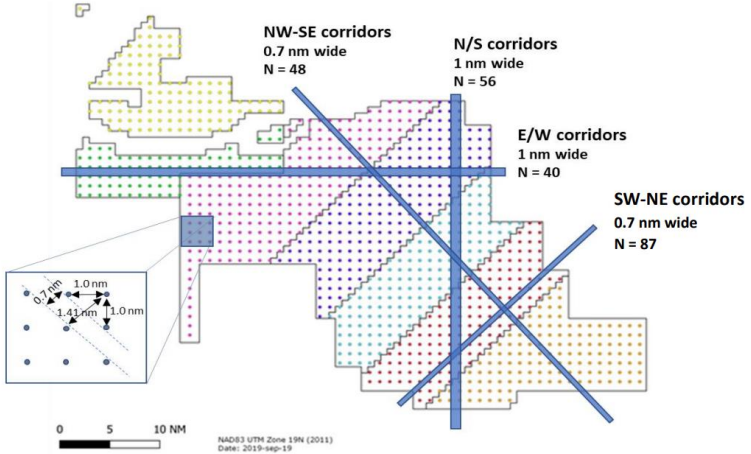

Figure 1: A full 1 X 1 nm E-W, N-S grid creates the equivalent of 231 transit lanes in four different key directions: E-W, NW-SE, N-S and SW-NE.

Ørsted EVERSOURCE VINEYARD WIND equinor MAYFLOWER WIND

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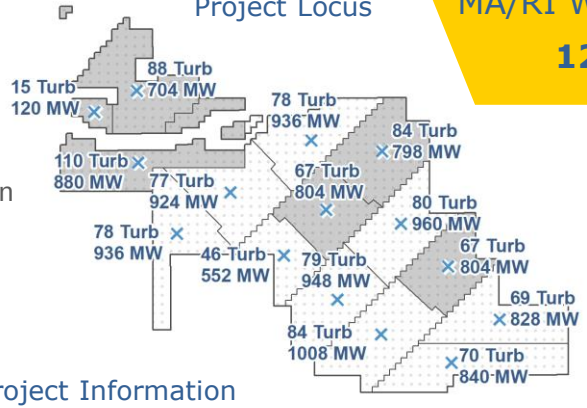
Wind energy area (WEA) capacity estimate basis:

- 1 x 1 nm grid layout
- Procured project information (summarized in table)
- Assumed 12-MW turbines where otherwise unknown

Project Locus

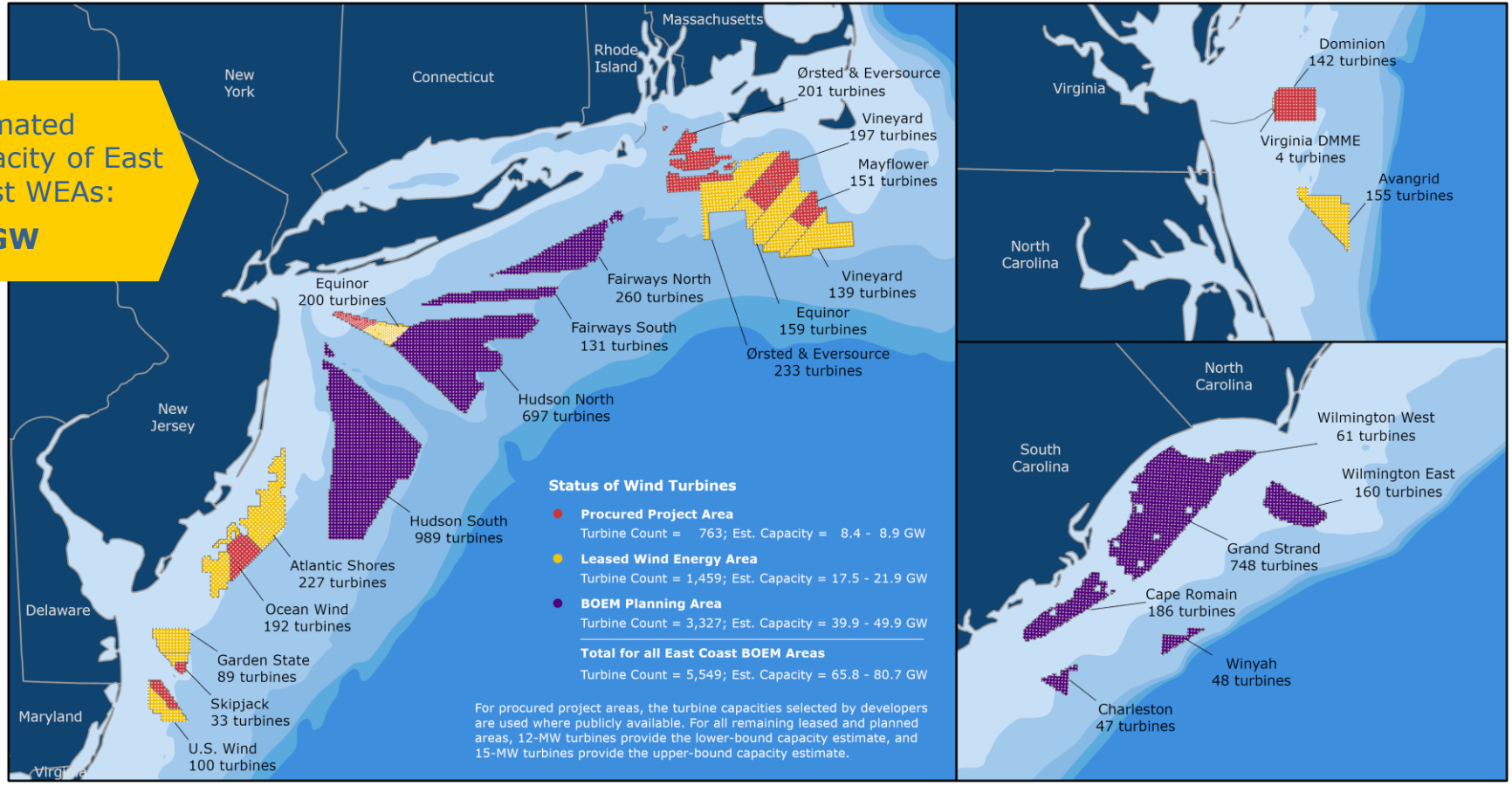


Estimated Capacity of MA/RI WEAs: 12 GW

Procured Offshore Wind Project Information

Project Name	Date Award Announced	Turbine Count	Turbine Capacity	Project Capacity	Point of Grid Interconnection	Export Cable
South Fork Wind Ørsted/Eversource	Jan. 25, 2017 NY PPA finalized	15	8 MW	120 MW	Buell Lane Substation (NY)	1 x 138 kV AC
Vineyard Wind 1 Vineyard Wind	May. 23, 2018 MA contract awarded	84	9.5 MW	798 MW	Barnstable Switching Sta. (MA)	2 x 220 kV AC
Revolution Wind Ørsted/Eversource	May. 23, 2018 RI contract awarded Jun. 13, 2018 CT contract awarded	88	8 MW	704 MW	Davisville Substation (RI)	AC
Sunrise Wind Ørsted/Eversource	Jul. 18, 2019 NY contract awarded	110	8 MW	880 MW	Holbrook Substation (NY)	AC
Mayflower Wind 1 Mayflower Wind	Oct. 31, 2019 MA contract awarded	67	12 MW	804 MW	Bourne Switching Sta. (MA)	AC
Park City Wind Vineyard Wind	Dec. 5, 2019 CT contract awarded	67	12 MW	804 MW	West Barnstable Substation (MA)	AC

Note: White cells indicate researched, publicly available information. Light green cells are assumed or calculated.



Turbine Layout Scenario for East Coast BOEM Wind Energy Areas

Total Estimated Capacity = 65.8 - 80.7 GW

July 13, 2020

0 30 60 90 120+ Meters (Depth)

0 20 40 80 Miles (Distance)

N

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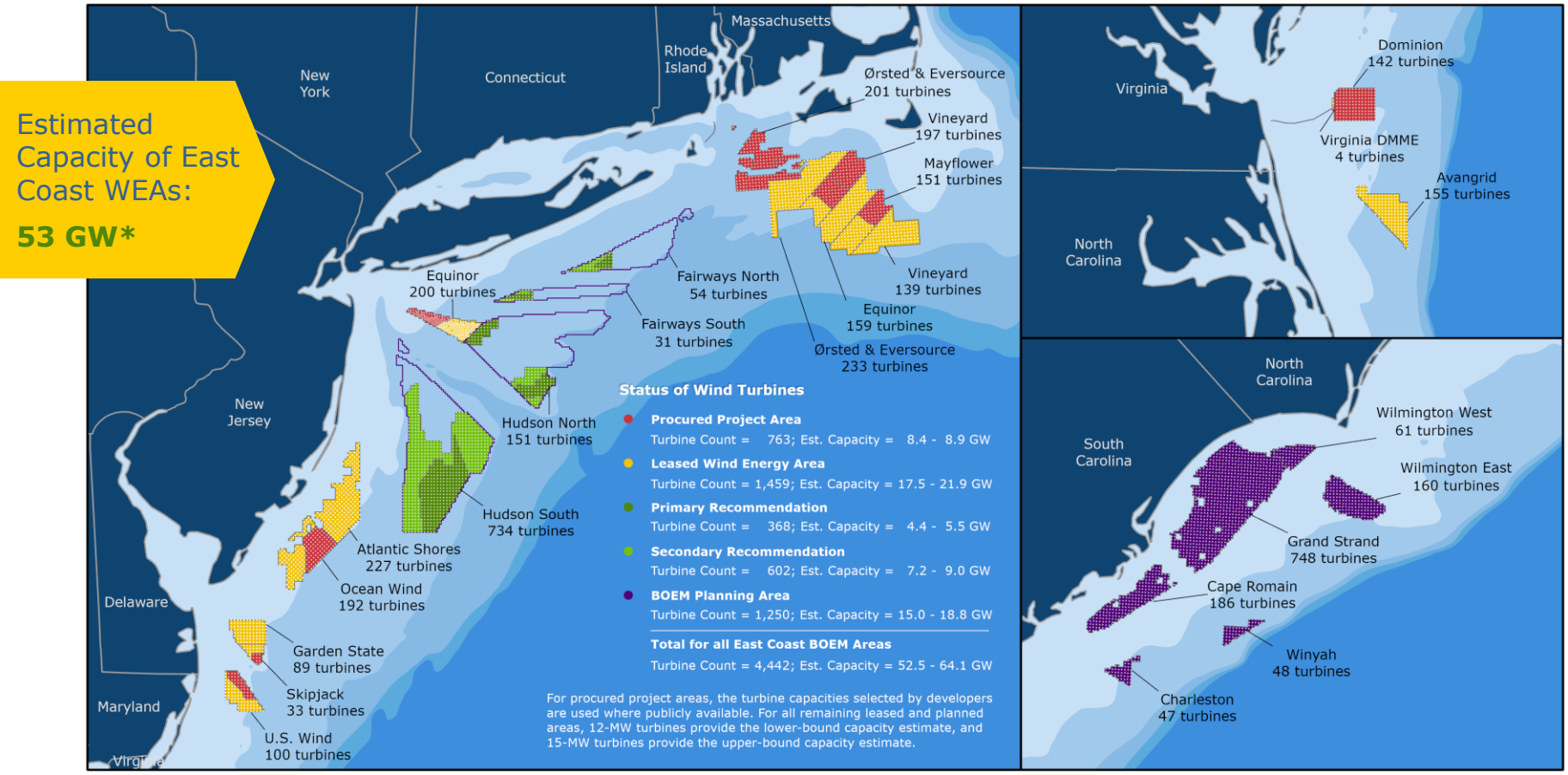

Turbine Layout Scenario for East Coast BOEM Wind Energy Areas

Total Estimated Capacity = 52.5 - 64.1 GW

July 20, 2020

* New value reflects the BOEM process of reducing call areas in response to stakeholder input

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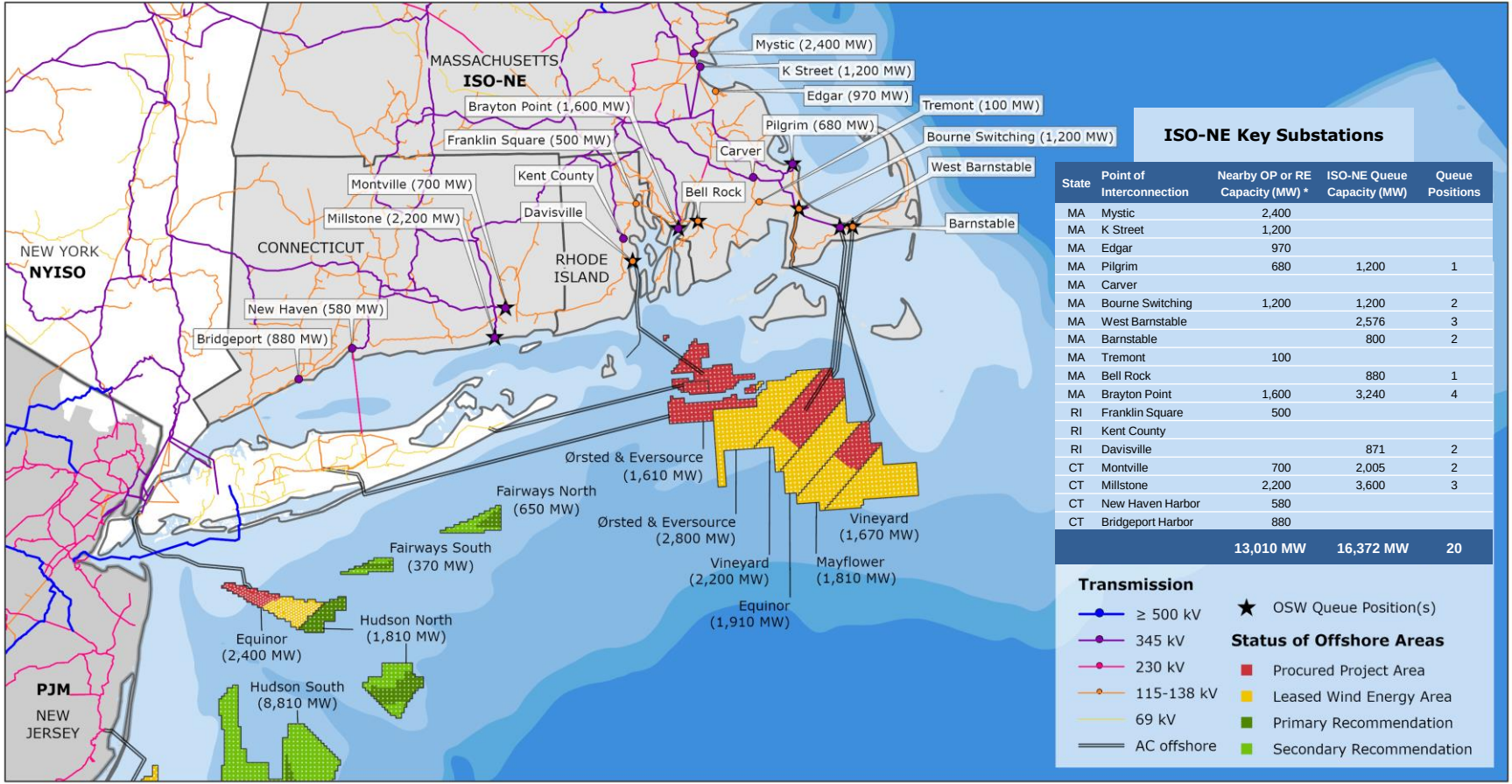

ISO-NE Key Substations

State	Point of Interconnection	Nearby OP or RE Capacity (MW) *	ISO-NE Queue Capacity (MW)	Queue Positions
MA	Mystic	2,400		
MA	K Street	1,200		
MA	Edgar	970		
MA	Pilgrim	680	1,200	1
MA	Carver			
MA	Bourne Switching	1,200	1,200	2
MA	West Barnstable		2,576	3
MA	Barnstable		800	2
MA	Tremont	100		
MA	Bell Rock		880	1
MA	Brayton Point	1,600	3,240	4
RI	Franklin Square	500		
RI	Kent County			
RI	Davisville		871	2
CT	Montville	700	2,005	2
CT	Millstone	2,200	3,600	3
CT	New Haven Harbor	580		
CT	Bridgeport Harbor	880		
		13,010 MW	16,372 MW	20

Transmission

- ≥ 500 kV
- 345 kV
- 230 kV
- 115-138 kV
- 69 kV
- AC offshore

★ OSW Queue Position(s)

Status of Offshore Areas

- Procured Project Area
- Leased Wind Energy Area
- Primary Recommendation
- Secondary Recommendation

New England Independent System Operator (ISO-NE) Points of Interconnection and Capacity Estimates

October 11, 2020

0 30 60 90 120+ Meters (Depth)

0 15 30 60 Miles (Distance)

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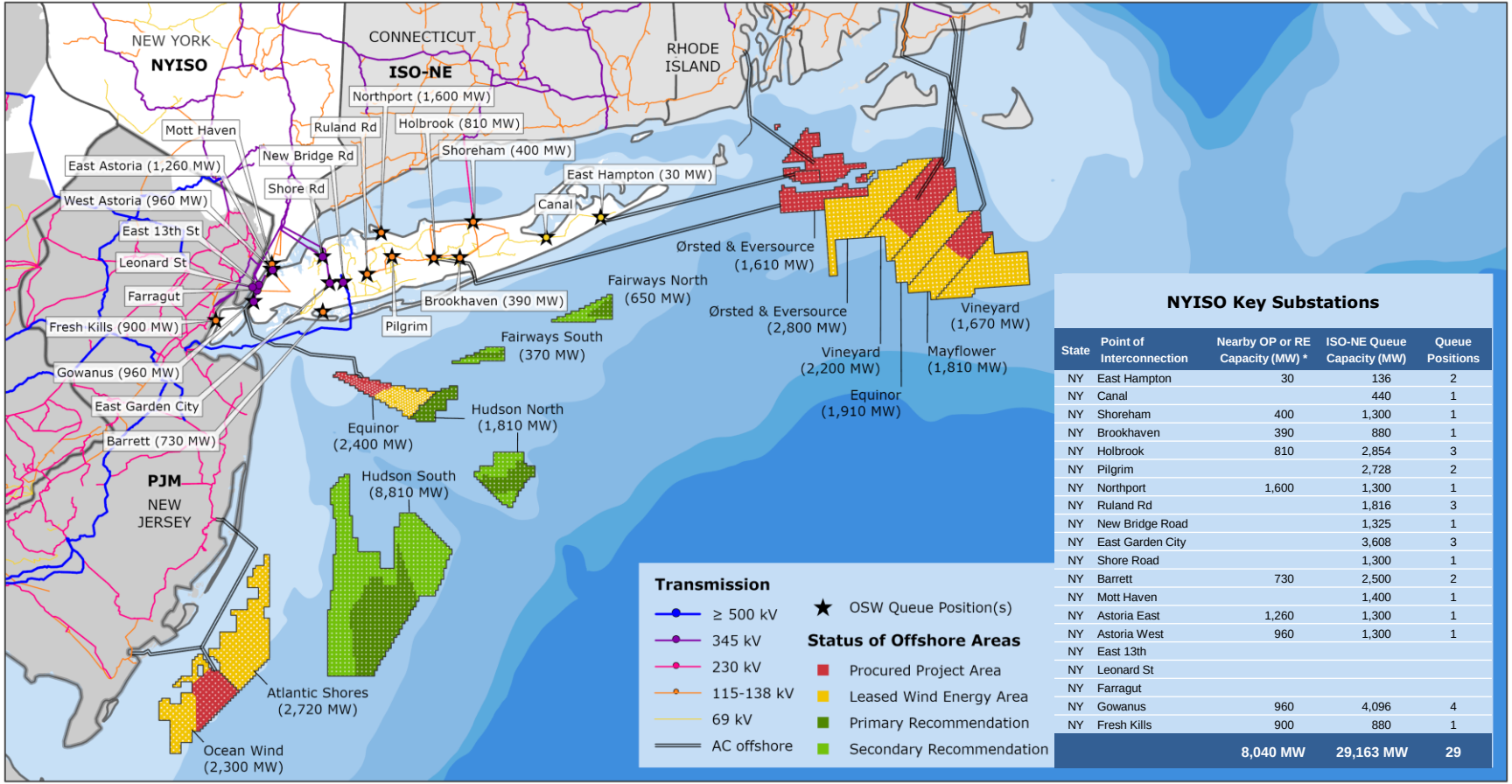
* Operating or retired power plants from the HIFLD GIS database



NYISO Key Substations

State	Point of Interconnection	Nearby OP or RE Capacity (MW) *	ISO-NE Queue Capacity (MW)	Queue Positions
NY	East Hampton	30	136	2
NY	Canal		440	1
NY	Shoreham	400	1,300	1
NY	Brookhaven	390	880	1
NY	Holbrook	810	2,854	3
NY	Pilgrim		2,728	2
NY	Northport	1,600	1,300	1
NY	Ruland Rd		1,816	3
NY	New Bridge Road		1,325	1
NY	East Garden City		3,608	3
NY	Shore Road		1,300	1
NY	Barrett	730	2,500	2
NY	Mott Haven		1,400	1
NY	Astoria East	1,260	1,300	1
NY	Astoria West	960	1,300	1
NY	East 13th			
NY	Leonard St			
NY	Farragut			
NY	Gowanus	960	4,096	4
NY	Fresh Kills	900	880	1
		8,040 MW	29,163 MW	29

New York Independent System Operator (NYISO) Points of Interconnection and Capacity Estimates

October 11, 2020

* Operating or retired power plants from the HIFLD GIS database

0 30 60 90 120+ Meters (Depth)

0 15 30 60 Miles (Distance)

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Conclusions

- The future northeast electricity grid will require **systems-level upgrades** both onshore and offshore in order to reach ambitious state-level goals for carbon reduction and offshore wind procurement.
- State commitments to offshore wind have grown faster than expected, prompting a need to **consider the full build-out capacity** of wind energy areas with respect to proposed procurement schedules.
- Decision makers at all levels of government must look ahead for problems and **change regulatory frameworks** in anticipation of what will come.

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Future Work

WITHIN 2020

Tufts Power Systems and Markets
public docket submission to the Federal
Energy Regulatory Commission (FERC)

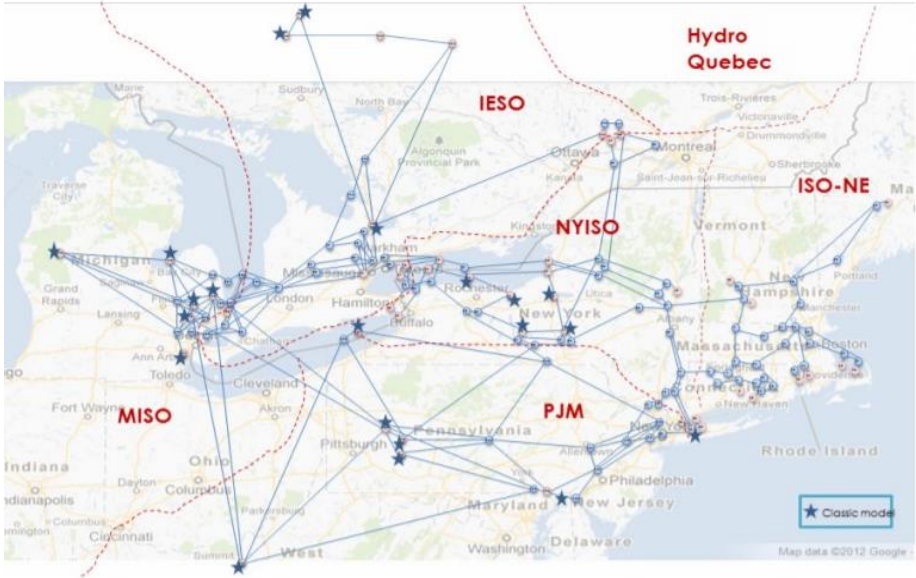
October 27, 2020:
FERC Technical Conference regarding
Offshore Wind Integration in RTOs/ISOs

OSPRE OffShore Power Research & Education Collaborative

December 2020:

OSPRE White Paper
Offshore Wind Grid Integration

NEXT
1-2 YEARS



Transmission Expansion Planning Models for rapid scenario analysis of a future integrated onshore/offshore electricity grid

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Acknowledgments

The **Tufts Power Systems & Markets Research Group** is a transdisciplinary team of students and faculty providing public information on the global transition to renewables.

In April 2020, the group responded to the Massachusetts Department of Energy Resources request for comments on offshore wind transmission (MA DOER submission available here). In August 2020, the group responded to the New Jersey Board of Public Utilities Docket No. QO20060463 seeking information about offshore wind transmission (NJ BPU submission available here).

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