Massachusetts Offshore Wind Transmission Technical Conference

Tuesday, March 3, 2020

Massachusetts Department of Energy Resources

Massachusetts Clean Energy Center

Offshore Wind in Massachusetts and the Region

MASSACHUSETTS CLEAN ENERGY CENTER

Overview

- MassCEC - offshore wind
- Offshore wind market update
- Leases in Southern New England
- Procured projects
- Offshore wind transmission
- Proposed transmission
- Future projects
- Sector development
- Gulf of Maine Task Force

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Massachusetts Clean Energy Center

Our Mission: Grow the state's clean energy industry while helping to meet the Commonwealth's clean energy, climate and economic development goals.

INVEST

Invest in programs that increase **clean energy adoption** by residents, businesses and communities.

CONNECT

Connect employers, job seekers, students, communities and investors within and across the clean energy industry.

INNOVATE

Help to spur innovation through **infrastructure, funding and technology development support**.

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MassCEC - offshore wind

Advance and support the responsible development of offshore wind and increase local jobs and economic activity.

PLANNING, ANALYSIS & ENGAGEMENT

Technical projects and stakeholder engagement on marine wildlife, fisheries, habitat, met-ocean, transmission, etc.

SECTOR DEVELOPMENT

In coordination with partner agencies, expand manufacturing, suppliers, and services and support workforce development.

RESEARCH & INNOVATION

Support for and collaboration with institutions, industry, and government to advance technology innovation, learn from early deployments, and expand offshore energy research in the Commonwealth.

Offshore wind: climate and economic benefits

- Significant local renewable energy resource, close to “load” (energy consumption)
- Essential to meeting GHG reduction/net-zero goals
- Regional retirements create room for new generation
- System benefits
  - Competitive pricing
  - Production profile coincident with winter peak demand
- Economic effects
  - $70B opportunity for offshore wind supply chain
  - 2018 MA assessment - 1,600 MW of offshore wind:
    - 2,000 to 3,000 direct job years over next 10 years
    - $675M to $800M economic impact
- Vineyard Wind and Mayflower Wind projects:
  - Eliminate 3.36M tons CO2 annually (750,000 cars/year)
  - $7.4B in energy related savings

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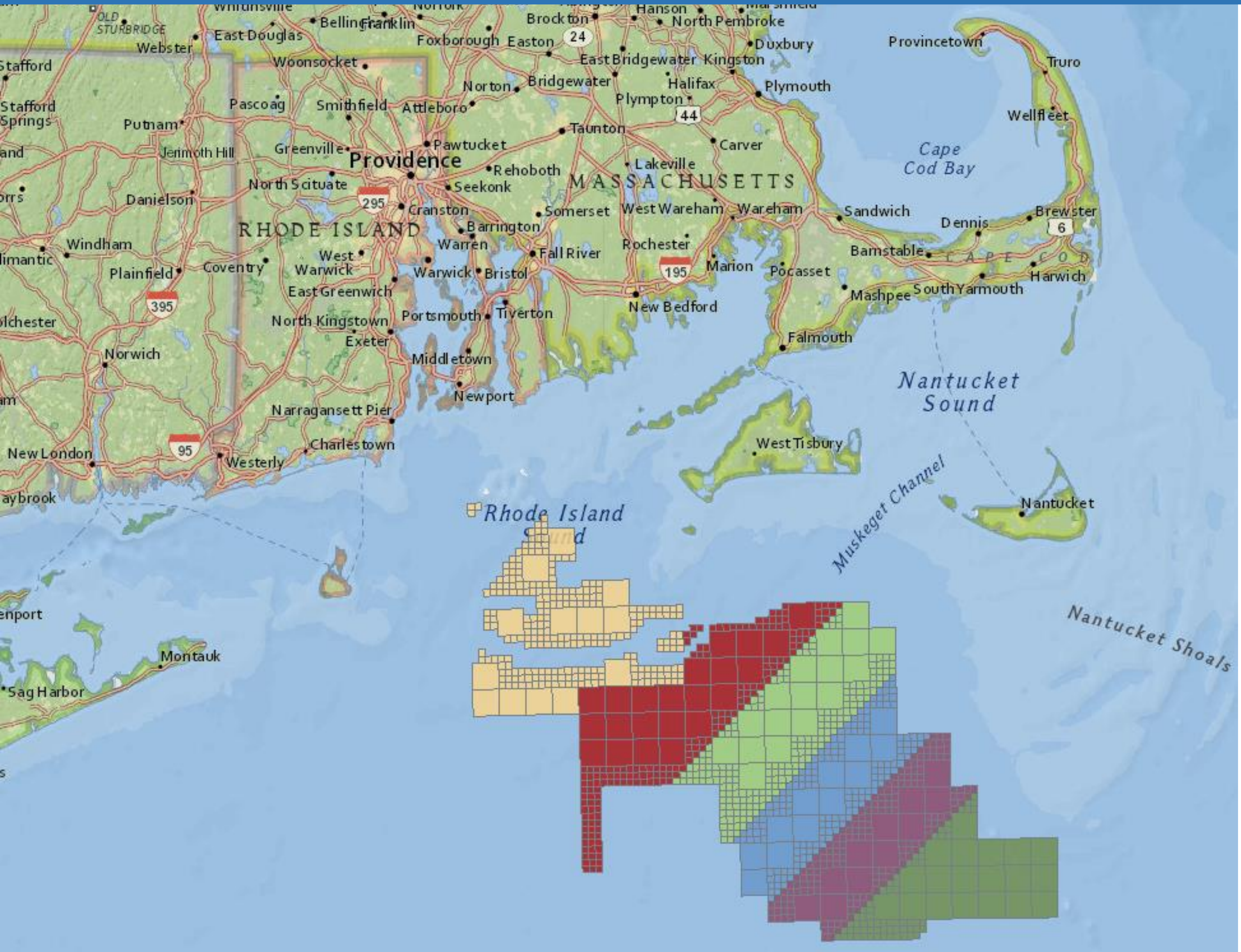
US offshore wind market

	State target (MW)	MW selected (offtake)
Maine	-	~10
Massachusetts	3,200	1,600
Rhode Island	430	430
Connecticut	2,000	1,100
New York	9,000	1,826
New Jersey	7,500	1,100
Maryland	1,200	368
Virginia	2,652	2,652
Total	**25,952**	**9,086**

Offshore wind leases: Southern NE



Ørsted/Eversource

- Leases #486, 487
- Lease #500

Vineyard Wind (CIP/Avangrid)

- Lease #501
- Lease #522

Equinor US

- Lease #520

Mayflower Wind (Shell/EDPR)

- Lease #521

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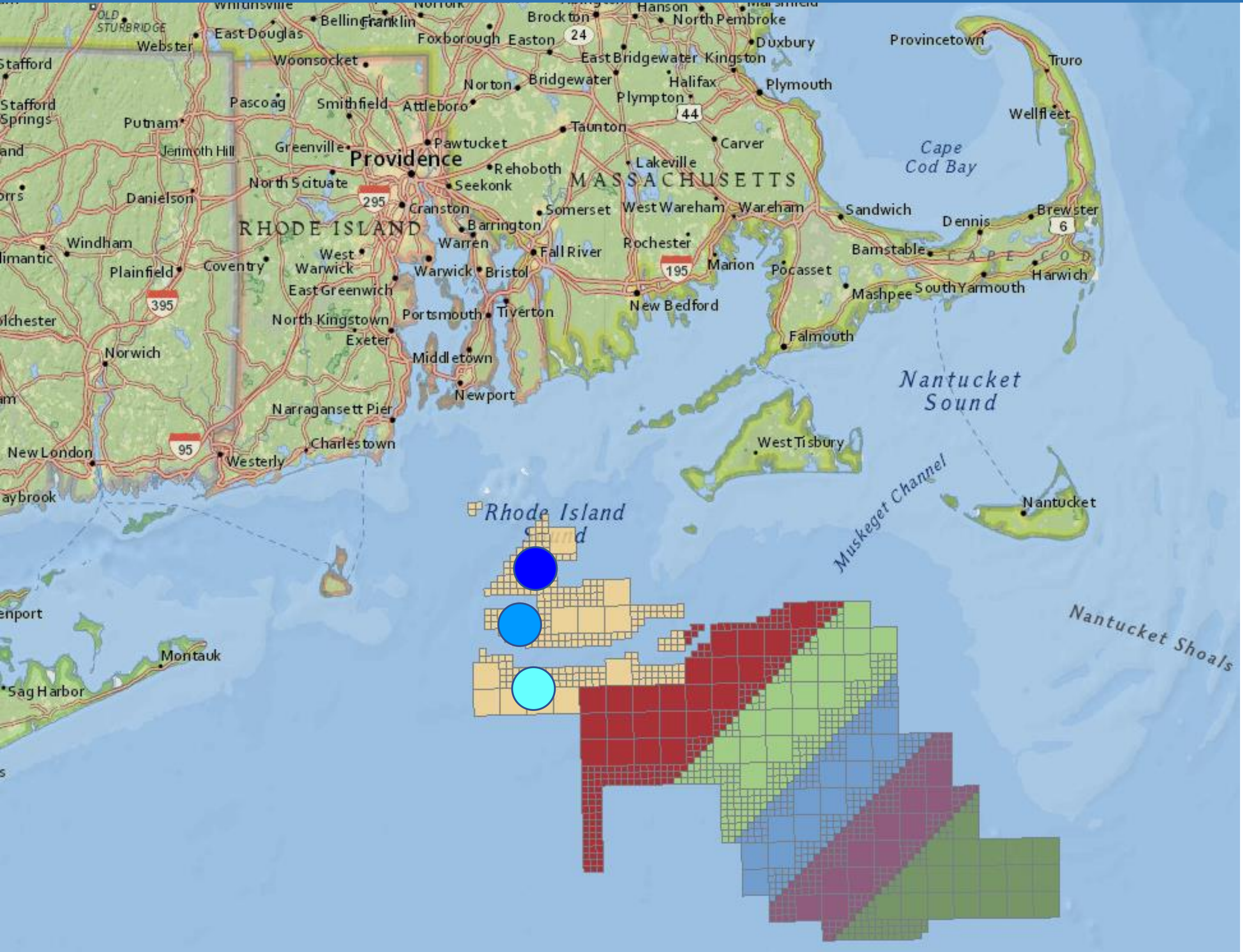
Projects with offtake: Ørsted/Eversource



Ørsted/Eversource

- Revolution Wind
  - 700 MW (RI & CT)
- South Fork Wind
  - 130 MW (LIPA)
- Sunrise Wind
  - 880 MW (NY)

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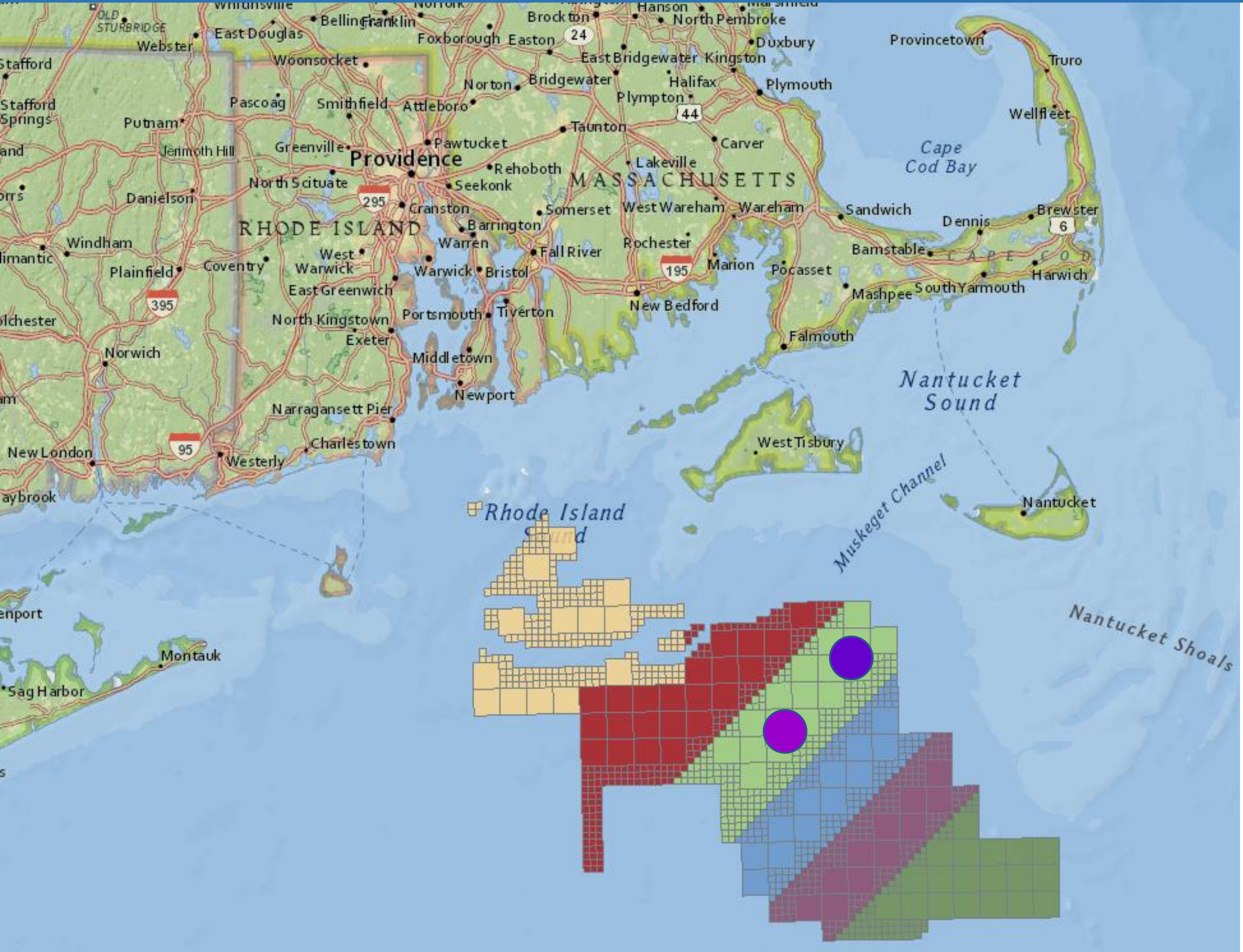
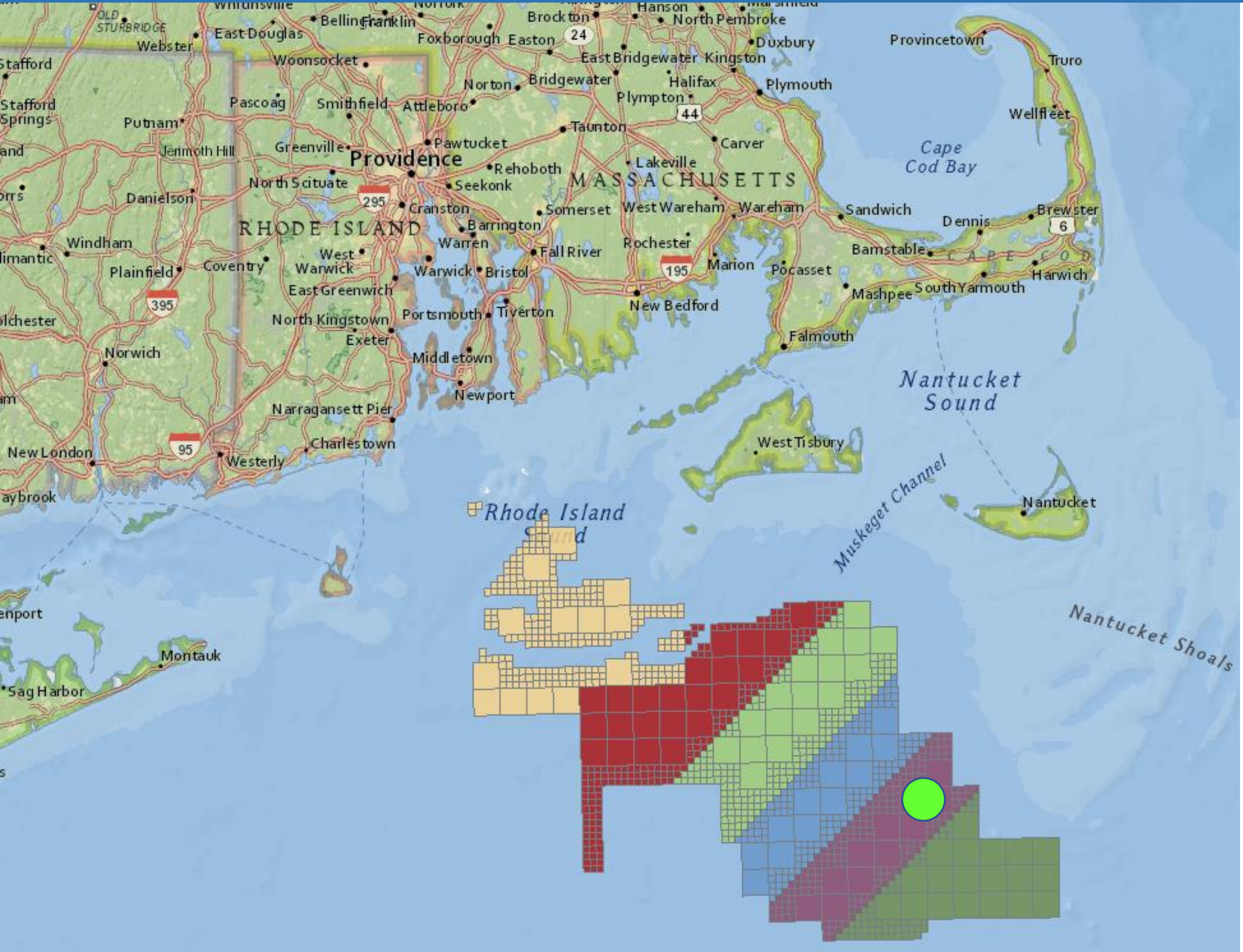
Projects with offtake: Vineyard Wind



Vineyard Wind (CIP/Avangrid)

- Vineyard Wind (1)
  - 800 MW (MA)
- Park City Wind
  - 800 MW (CT)

Projects with offtake: Mayflower



Mayflower Wind (Shell/EDPR)

- Mayflower Wind
  - 800 MW (MA)

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Offshore wind transmission

- Transmission represents significant component of offshore wind projects
- ~20-25% CapEx
  - Inter-array cables
  - Offshore collector and/or substations
  - Export cables
  - Onshore substations
- Interconnection locations and siting routes have major implications for project costs, technology selection, permitting/consenting
- Stakeholder concerns
  - Fishing, benthic habitat, navigation
  - Infrastructure type, location, installation

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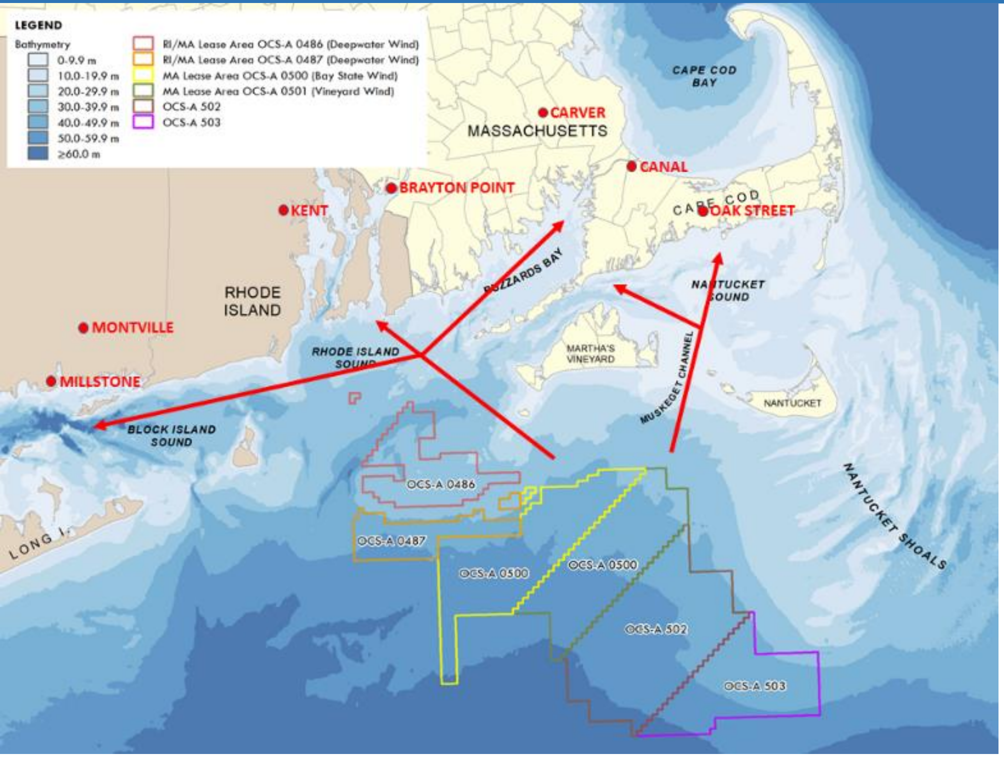
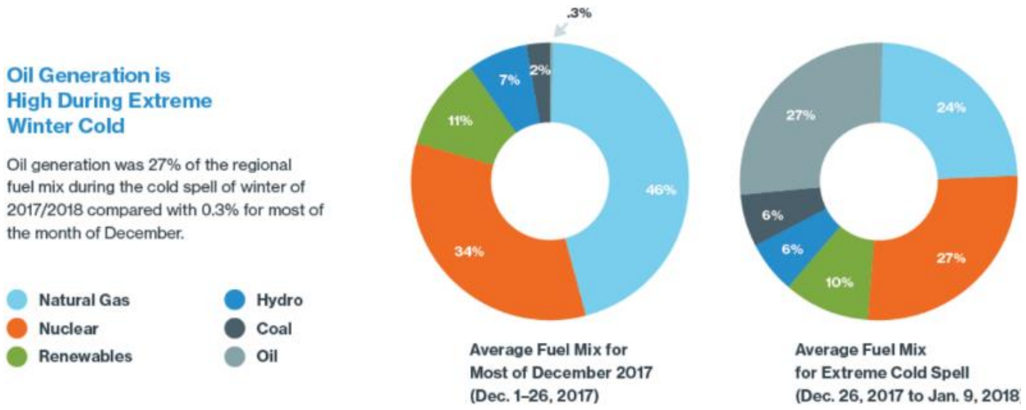
Transmission studies





Source: ISO-NE

- Infrastructure to connect OSW (2014)
  - Analyze and understand transmission necessary to interconnect future OSW
- ISO-NE assessment of impact of OSW additions during severe cold spell (2018)
  - 16-day period Dec. 24, 2017 to Jan. 8, 2018
  - 1,600 MW successfully displace marginal fossil production:
    - ✓ 70% capacity factor → 435,000 MWh
    - ✓ $80-85M savings in production costs
    - ✓ 11% of CO_2 emissions avoided
- NESCOE request: ISO-NE study currently underway on integration of 8 GW of OSW by 2030

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ISO-NE OSW interconnection requests

Year	# of Requests	MW	State
2001	1	420	MA
2013	1	12	ME
2014	1	10	ME
		442 MW	
2016	2	1,600	MA
2017	5	2,463	MA
2018	7	5,422	MA, RI, CT
2019	7	4,980	MA, RI, CT
		14,465 MW	

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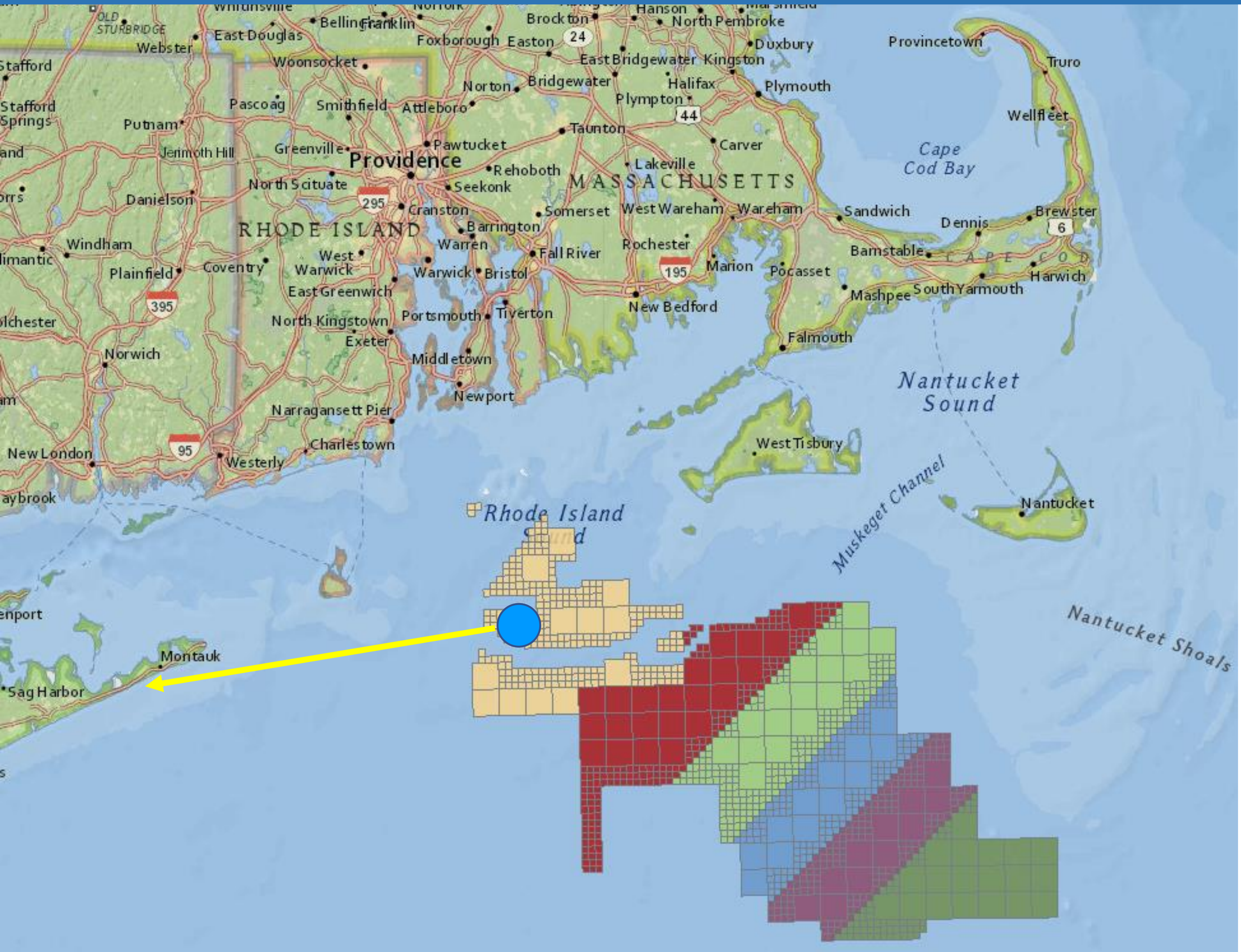
South Fork Wind proposed transmission



Ørsted/Eversource

- South Fork Wind
- Export: 1 x 138 kV AC cable
- Landfall: East Hampton, NY
- Interconnection point: East Hampton, NY (Buell Lane Substation)

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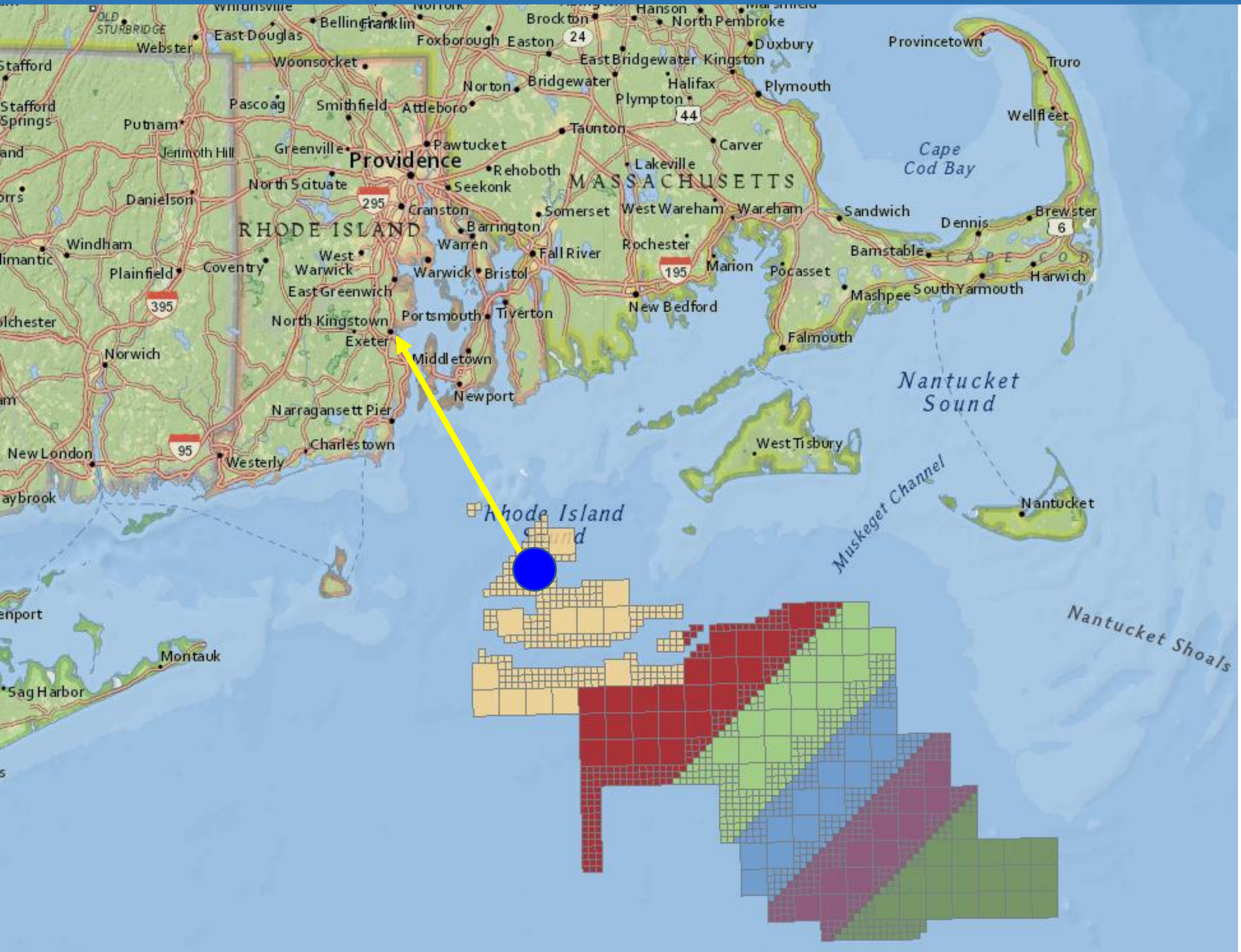
Revolution Wind proposed transmission



Ørsted/Eversource

- Revolution Wind
  - Export: TBD - AC cables
  - Landfall: North Kingston, RI
  - Interconnection point: North Kingston, RI (Davisville Substation)

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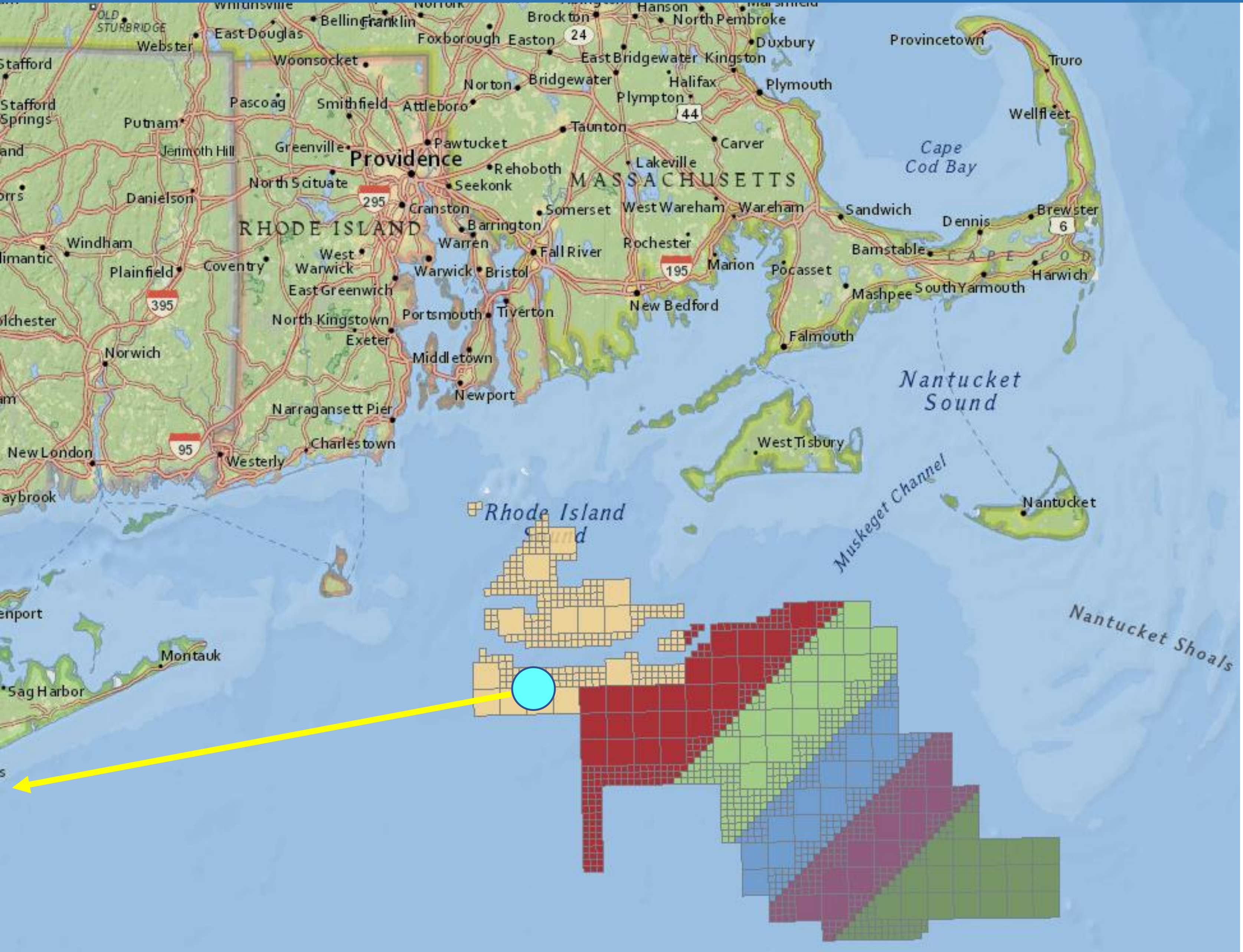
Sunrise Wind proposed transmission



Ørsted/Eversource

Sunrise Wind

- Export: TBD - AC cables
- Landfall: Shirley, NY
- Interconnection point: Ronkonkoma, NY (Holbrook Substation)

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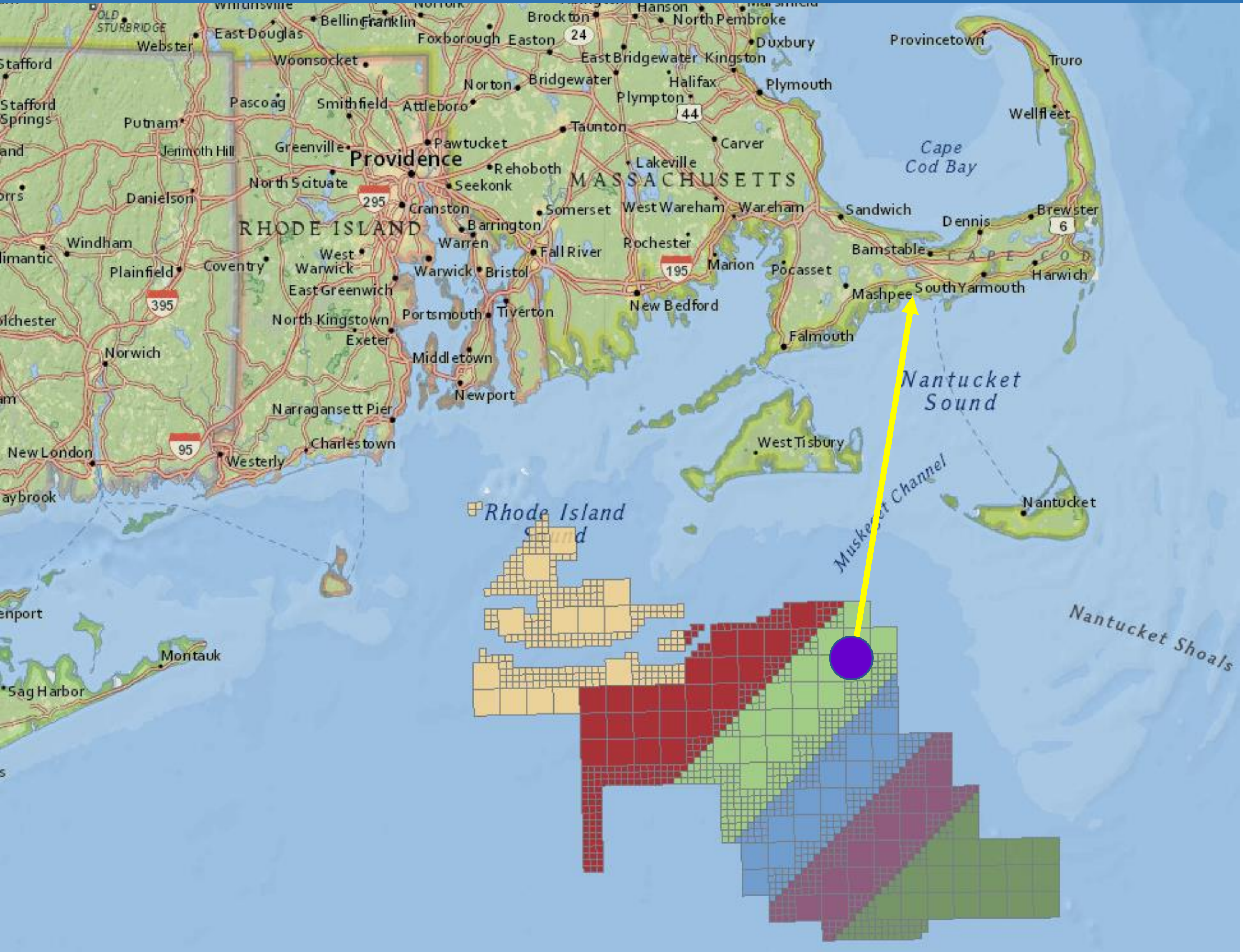
Vineyard Wind proposed transmission



Vineyard Wind (CIP/Avangrid)

- Vineyard Wind (1)
- Export: 2 x 220 kV AC cables
- Landfall: Barnstable, MA
- Interconnection point: Barnstable, MA (Barnstable Switching Station)

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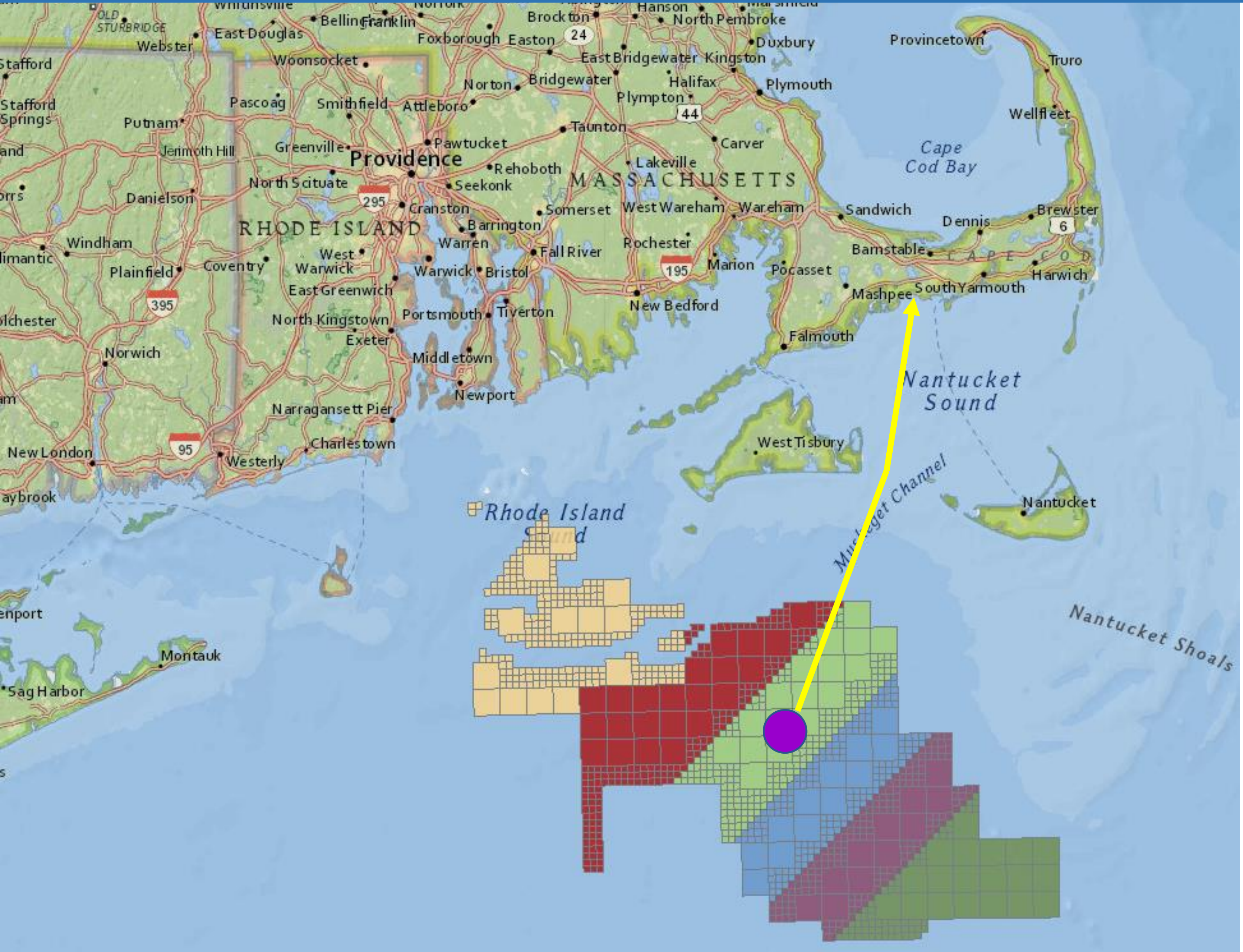
Park City Wind proposed transmission



Vineyard Wind (CIP/Avangrid)

- Park City Wind
- Export: TBD - AC cables
- Landfall: Barnstable, MA
- Interconnection point: Barnstable, MA (West Barnstable Substation)

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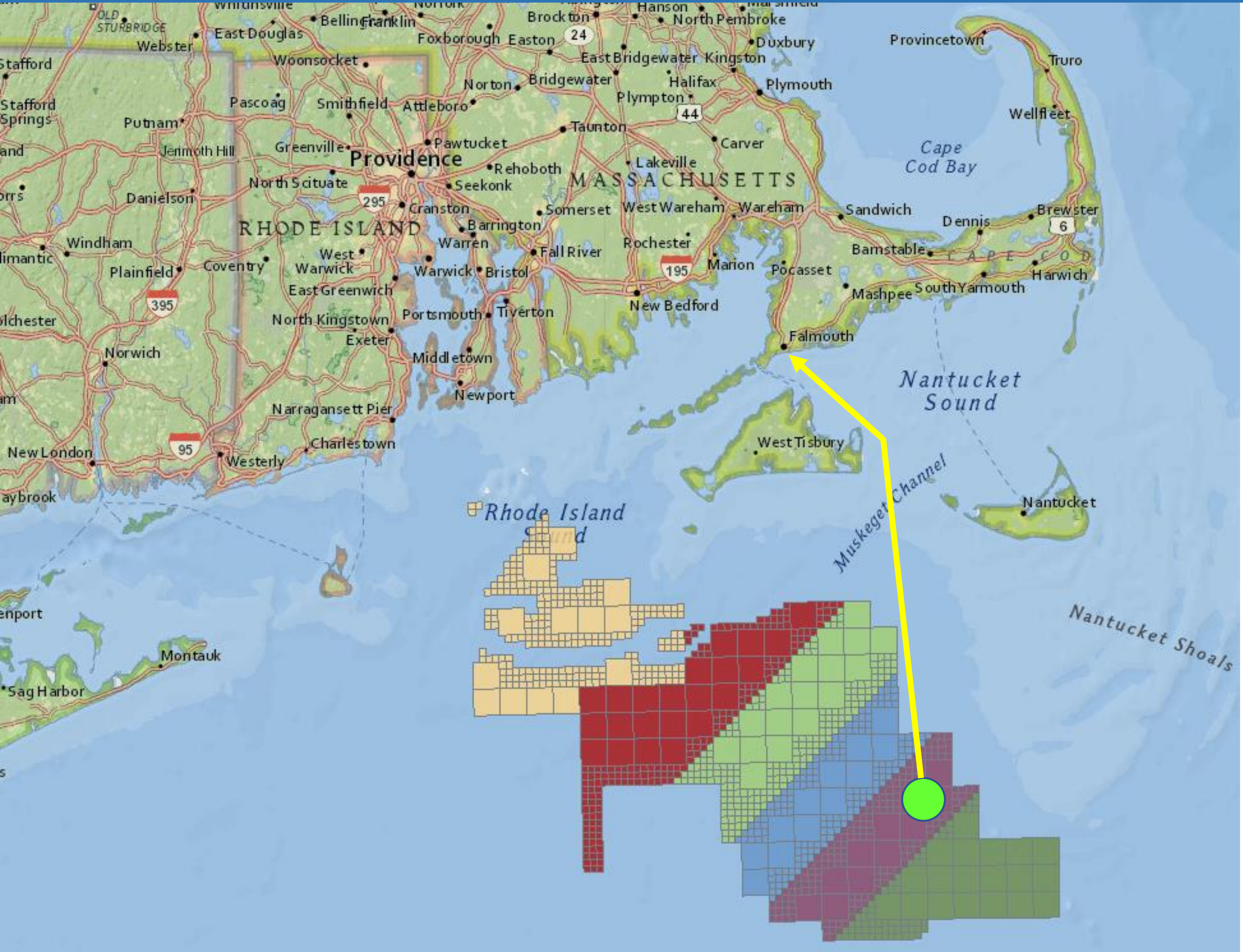
Projects with offtake: Mayflower



Mayflower Wind (Shell/EDPR)

Mayflower Wind

- Export: TBD - AC cables
- Landfall: Falmouth, MA
- Interconnection point: Bourne, MA (Bourne Switching Station)

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Future OSW procurements

Massachusetts

- OSW Solicitation #3
  - 2022 - 800 MW
- OSW Solicitation #4
  - 2024 - 800 MW

Rhode Island

- OSW Solicitation?

Connecticut

- OSW Solicitation #2
  - TBD - 1,200 MW

New York

- OSW Solicitation #2
  - 2020 - 1,000+ MW

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Sector development

- Ports and infrastructure assessment
  - 19 sites: South Coast and metro Boston
  - Existing conditions and re-use scenarios
- OSW Supply Chain Directory
  - New online portal directory.masscec.com
- Supply chain forums and “Meet the Buyer”
  - Connecting OSW industry with local services and suppliers
- Workforce training and development
  - 2019 grant awards:
    - GWO safety and technical training
    - Education programs and certificates
  - 2020 grant solicitation out March 3

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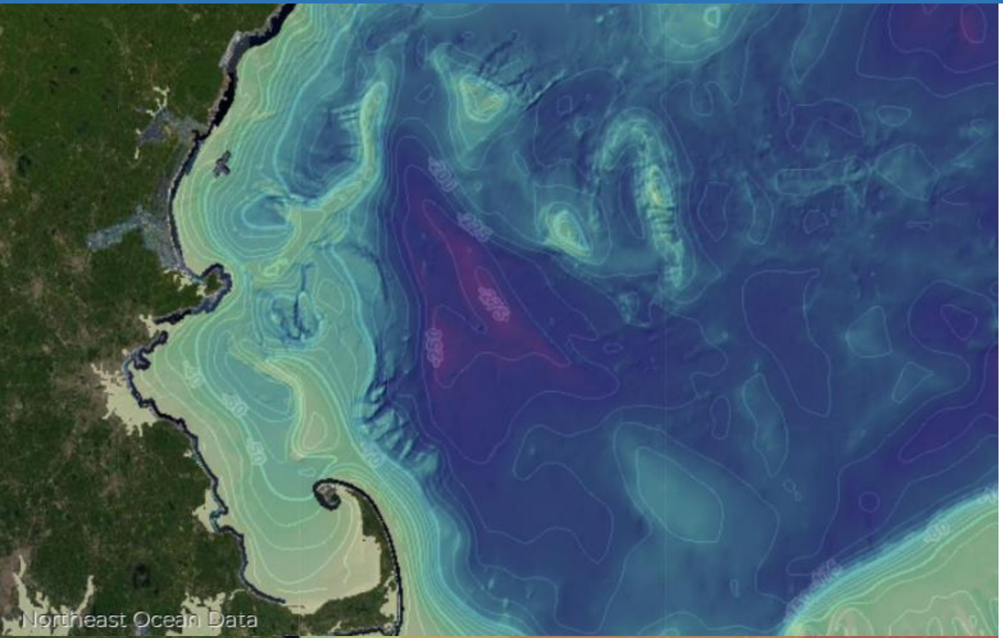
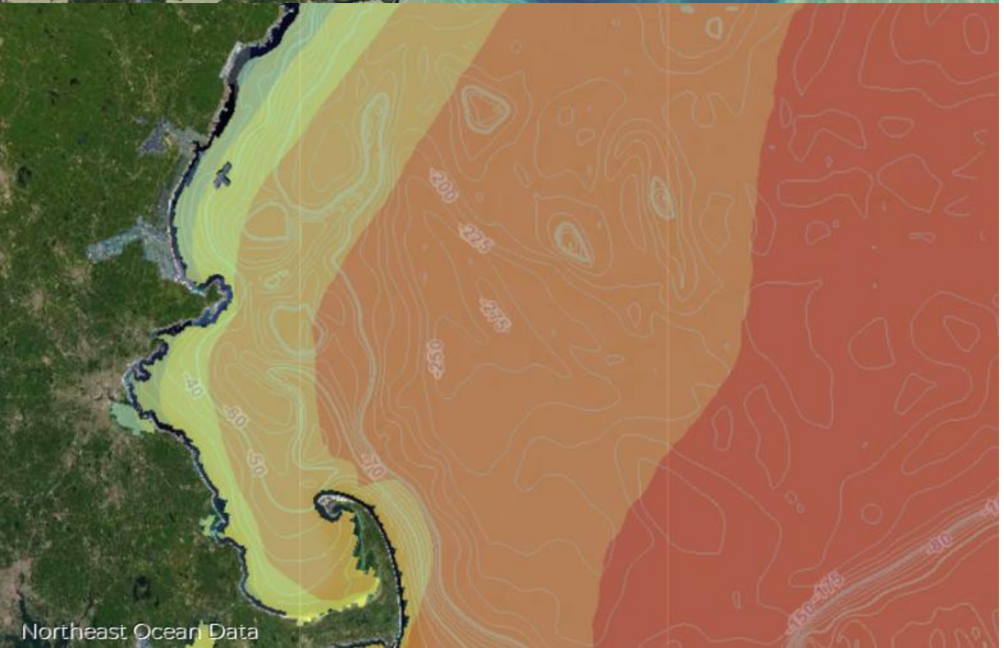
Gulf of Maine offshore wind





- BOEM formation of the Gulf of Maine Renewable Energy Task Force
- Representatives from MA, NH, ME, federal agencies and municipalities
- 1st Task Force meeting December 2019
- Deeper waters: 50m to 200m
- Greater wind resource farther offshore
- Interconnection points at existing/retiring generation facilities
- Next Task Force meeting - late summer/early Fall
- Phased, multi-year process from planning to siting and leasing

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Thank you

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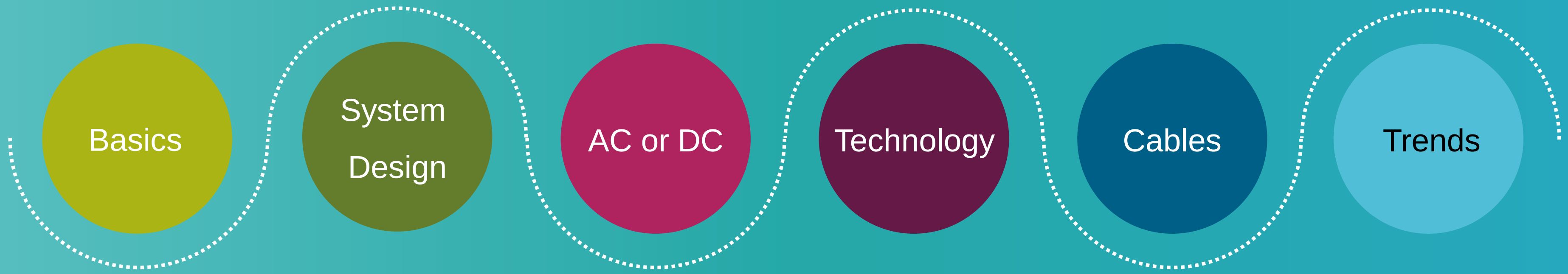
Offshore transmission technology

Alastair Mills
March 3, 2020

Overview



Offshore Transmission 101

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- Size
- Location
- Performance
- Operation

Generation

- Number of projects
- Array string length
- Metering
- Services

Collection

- Distance to shore
- Energy
- Cable corridor
- System needs
- Controllability

Transmission

- System state
- Distance
- Access constraints
- Energy / Capacity
- Inertia

Interconnect

What is the correct technology for offshore transmission?

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HVDC - Voltage Sourced Converter, Symmetrical Monopole

- Adaptation of proven onshore technology; todays technology up to ~1200MW
- Incoming feeders from wind farm at 66, 155 or 220kV

Export Circuit Rated at ±320 kV DC

Topside, Dimensions: ~250' x 120' x 120' (feet) Weight: ~8,000 - 11,000Te

Standard Foundation Jacket (6 or 8 legged)

Installation Heavy Lift of Float-Over

HVAC – Step-Up Offshore Substation

- Application of proven onshore technology 700-900MW
- Fully redundant design using 2 transformers and reactors to "offset" cable

Export Circuit Rated at ~220kV

Topside, Dimensions: ~165' x 115' x 85' (feet) Weight: ~3,000 – 4,000Te

Standard Foundation Jacket (4 or 6 legged)

Installation Heavy Lift

**Image courtesy of HSM Offshore B.V.*

Other HVAC offshore transmission applications

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HVAC – OFTO Connections

- Transmission asset considered in sympathy to the generation asset
- Built with the generation plant; “all in one budget”
- Significant onshore substation to comply to a defined grid codes

Export Circuit 132 / 155 / 220 / 230 / 275kV (Which ever is best)

Topside, Dimensions: ~115’ x 82.5’ x 50’ (feet) Weight: ~1,300 - 2,500Te

Standard Foundation Monopile or Jacket (3 or 4 legged)

Installation Lift or Heavy Lift

HVAC – Switchyard

- Application of a switching station, effectively an offshore “Extension Cord”
- Concept used due to restrictions in the export cable corridor
- Multiple projects can feed in

Topside, Dimensions: ~165’ x 115’ x 85’ (feet) Weight: ~2,5000 - 3,000Te

Standard Foundation Jacket

Installation Heavy Lift

**Image source Elia / Offshorewind.biz*

Technology Influences and design elections

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Codes for system design
Authority and Precedence

Operational Philosophy
Generation, Transmission, Grid

Network Integration
Grid or Generation services

Balance
Goals
Plan

Guarantees and Obligations
Energy or Capacity

Distance offshore
Length of route and accessibility

Regulation
Market structure and governance

The industry trend is clear, we must be ready for the future

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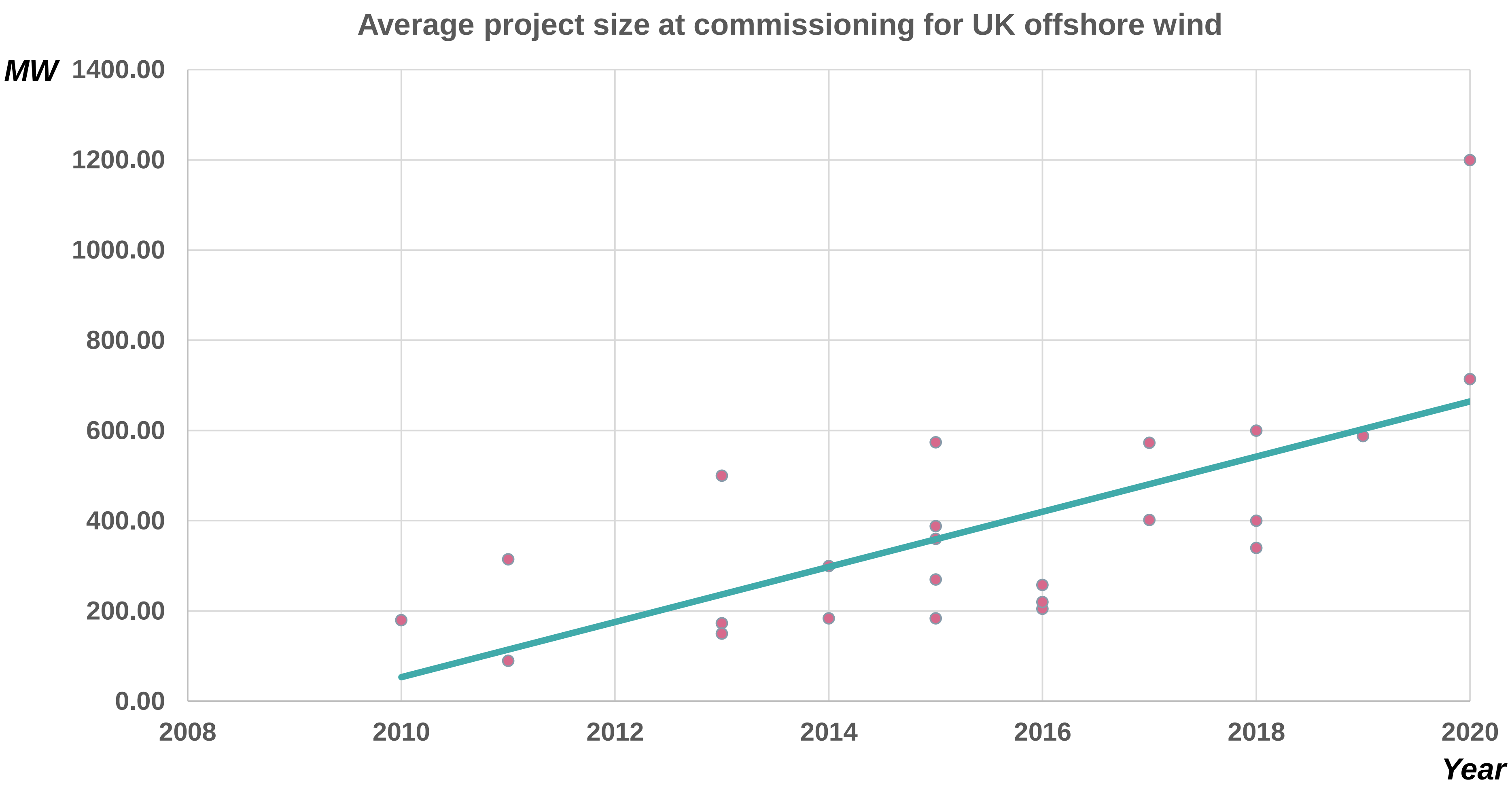

Cables – the question is really the corridor

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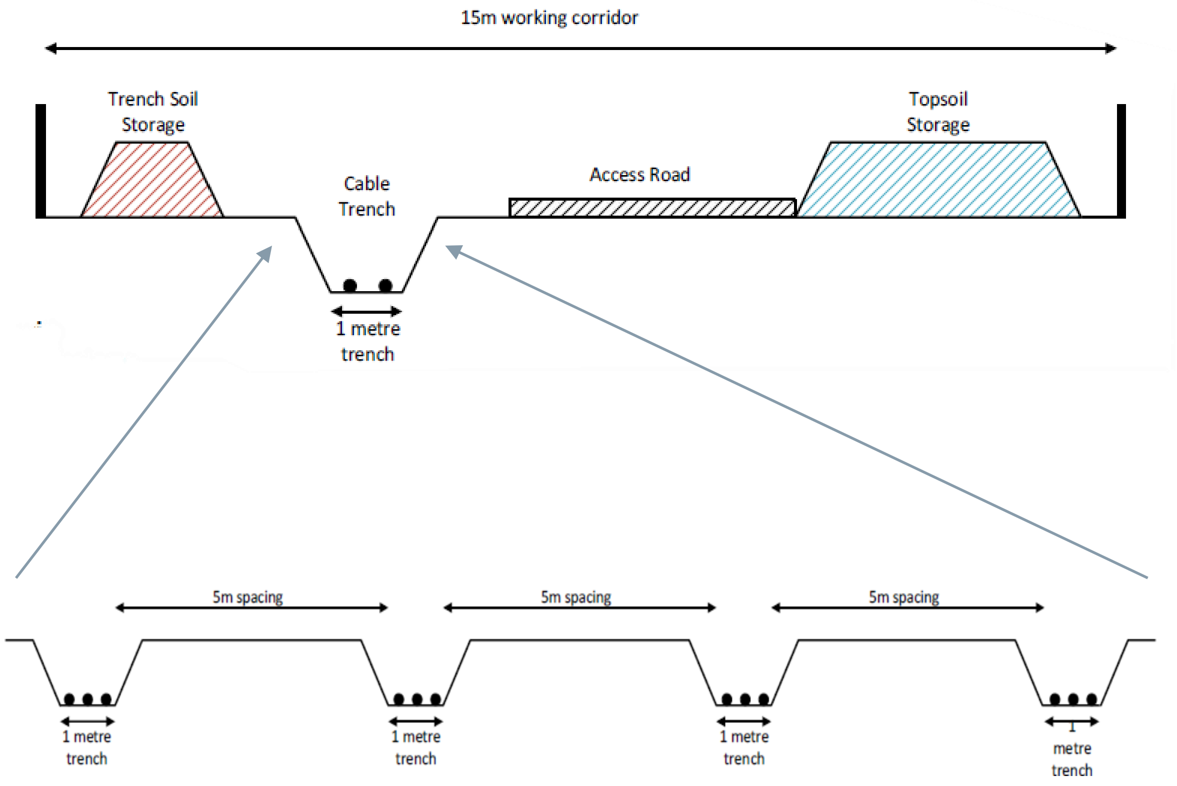


HVDC

- 2x cables onshore/offshore for monopole
- 3x cables onshore/offshore for bipole
- Cable thermal limit means ~1,800/2,000MW

HVAC

- Onshore: 3x single phase cables per circuit
- Offshore: single 3-phase cable per circuit
- 200 -> 300 -> 400 -> 500MW per circuit

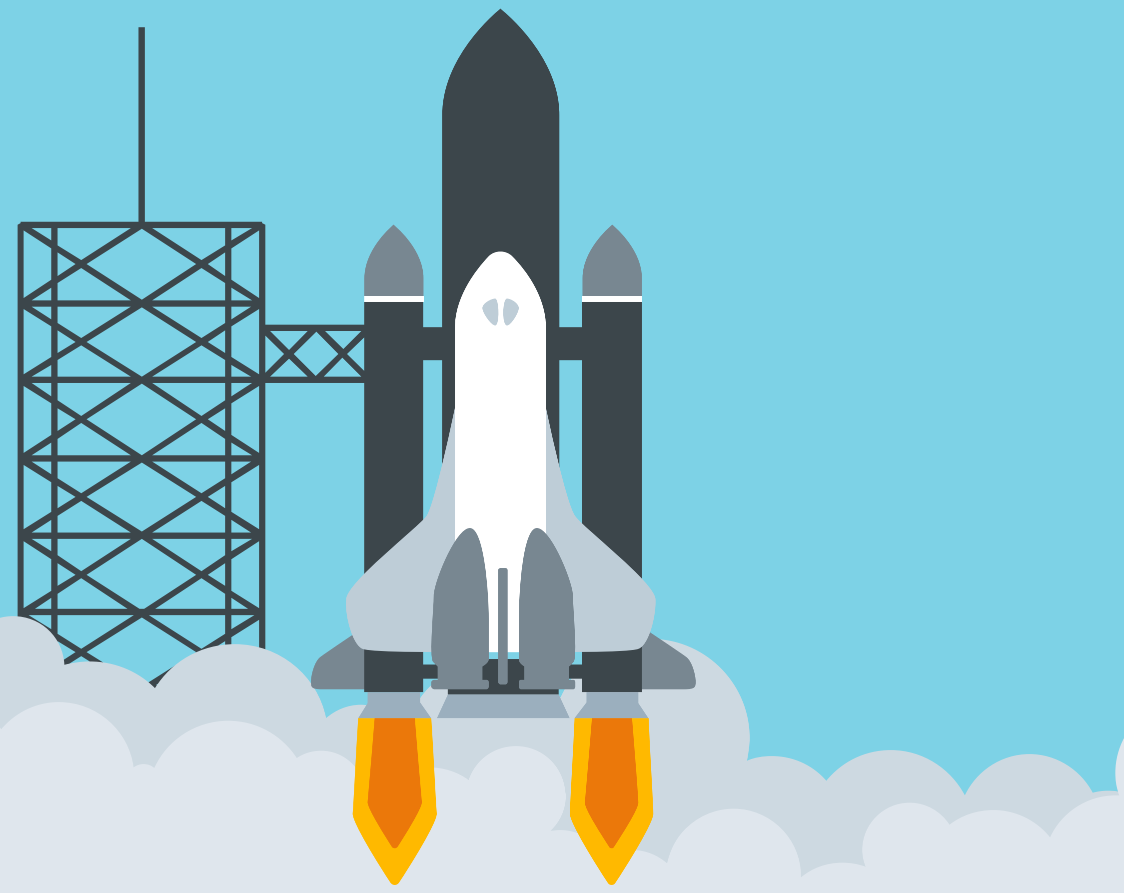
Trends in the rapidly growing offshore wind market

Generation Trends

- Reduction in cost of energy
- Consistency to supply chain
- Larger generation units
- Quicker construction
- Data analytics

Transmission Trends

- Increasing capacity
- Further offshore
- Grid services (stability/support)
- Network, Radial, Hybrid
- Consistency to supply chain

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ISO New England's Interconnection Process and Integrating Offshore Wind into the Regional Power System

Massachusetts Offshore Wind Transmission Technical Conference

Alan McBride

DIRECTOR, TRANSMISSION STRATEGY & SERVICES

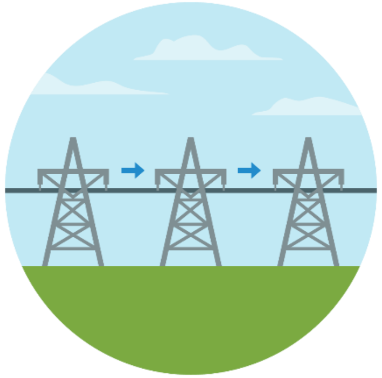
ISO New England (ISO) Has Two Decades of Experience Overseeing the Region's Restructured Electric Power System

- **Regulated** by the Federal Energy Regulatory Commission (FERC)
- **Reliability Coordinator** for New England under the North American Electric Reliability Corporation (NERC)
- **Independent** of companies in the marketplace and **neutral** on technology

ISO New England Performs Three Critical Roles to Ensure Reliable Electricity at Competitive Prices

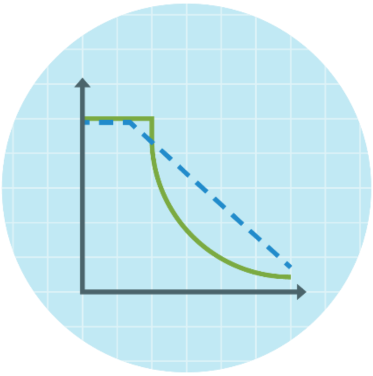
Grid Operation

Coordinate and direct the flow of electricity over the region's high-voltage transmission system



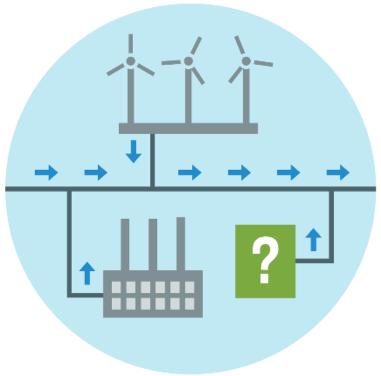
Market Administration

Design, run, and oversee the markets where wholesale electricity is bought and sold



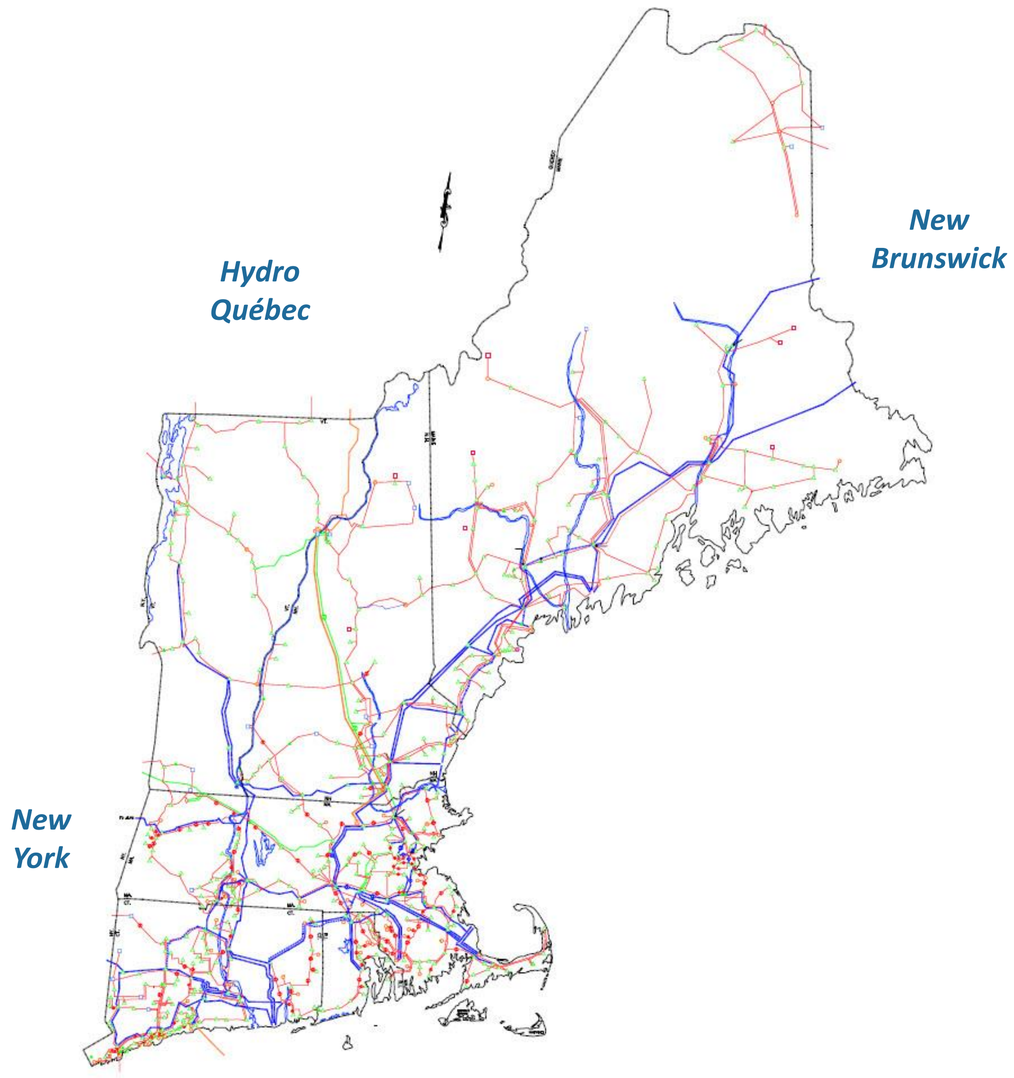
Power System Planning

Study, analyze, and plan to make sure New England's electricity needs will be met over the next 10 years



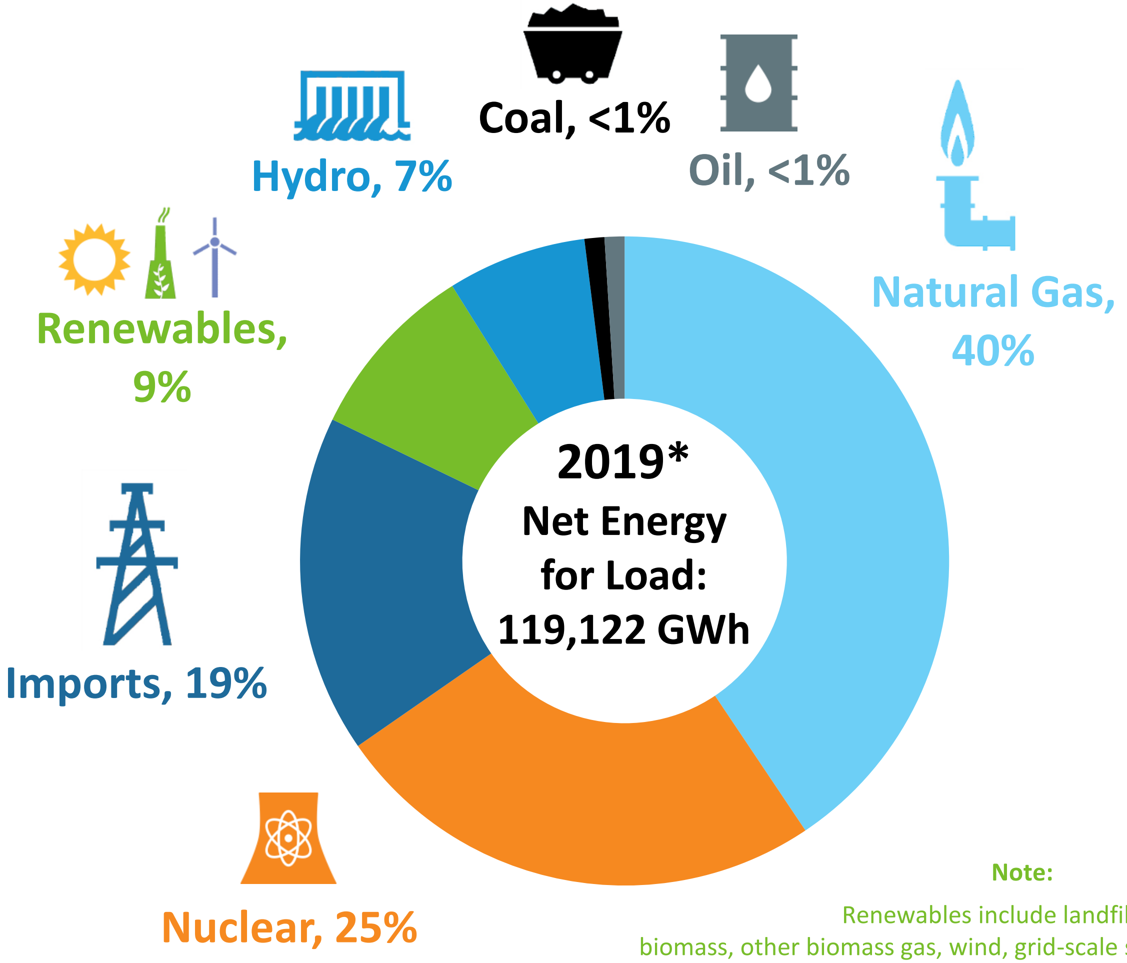
New England's Transmission Grid Is the Interstate Highway System for Electricity

- **350 dispatchable generators** in the region, with roughly 31,000 MW of generating capacity
- **9,000 miles** of high-voltage transmission lines (115 kV and above)
- **13 transmission interconnections** to power systems in New York and Eastern Canada
- **19%** of region's energy needs met by imports in 2019
- **$10.9 billion** invested to strengthen transmission system reliability since 2002; **$1.5 billion** planned
- Developers have proposed multiple transmission projects to access **non-carbon-emitting resources** inside and outside the region



Lower-Emitting Sources of Energy Supply Most of New England's Electricity Needs

- In 2019, most of the region's energy needs were met by natural gas, nuclear, imported electricity (mostly hydropower from Eastern Canada), renewables, and other low- or non-carbon-emitting resources
- The region is transitioning away from older coal and oil resources
- State policies are driving investments in renewable energy, including Renewable Portfolio Standards and greenhouse gas emissions reductions goals (≈ 80% by 2050)
  - To meet their goals, some states are pursuing large-scale procurement efforts for clean energy



Note:
Renewables include landfill gas, biomass, other biomass gas, wind, grid-scale solar, municipal solid waste, and miscellaneous fuels.

*Data is subject to adjustment

States Accelerate Clean Energy Procurements

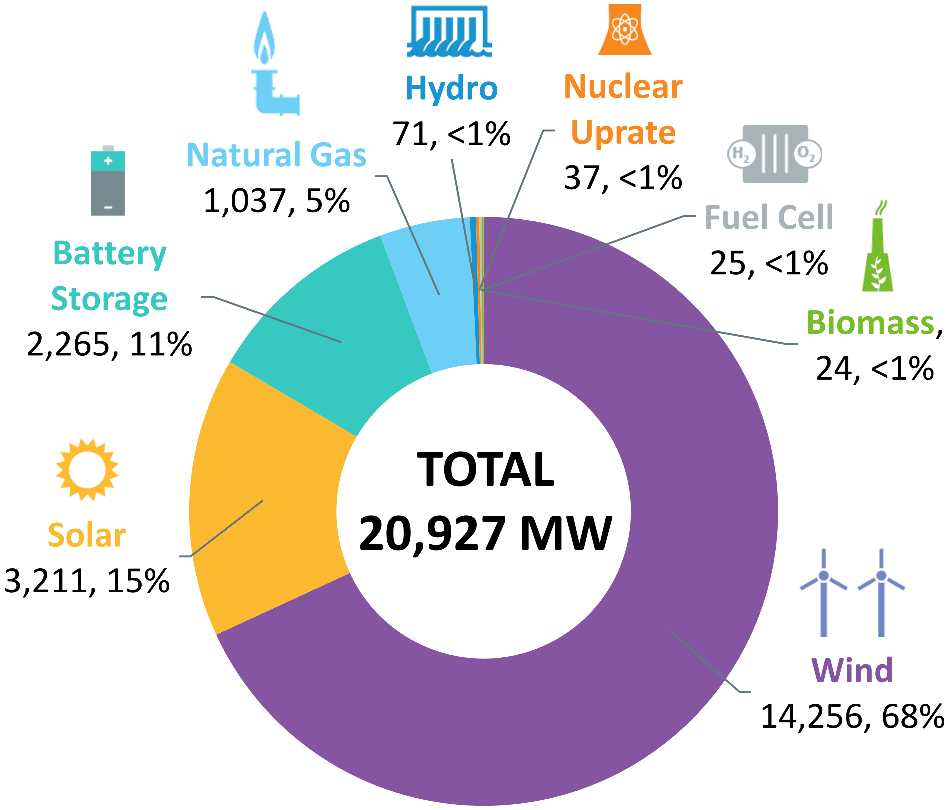
- To meet their public policy goals, the states are seeking to develop (or retain) clean energy resources through large-scale procurement efforts

State(s)	State Procurement Initiatives for Large-Scale Clean Energy Resources	Resources Eligible/Procured	Target MW (nameplate)
CT	2019 Offshore Wind RFP	Offshore Wind	400 – 2,000 MW
MA	2019 Section 83C II Offshore Wind RFP	Offshore Wind	800 MW
RI	2018 Renewable Energy RFP	Solar, Wind, Biomass, Small Hydro, Fuel Cells and Other Eligible Resources	400 MW
CT	2018 Zero-Carbon Resources RFP	Nuclear, Hydro, Class I Renewables, Energy Storage	Approx. 1,400 MW (11,658,080 MWh)
CT	2018 Clean Energy RFP	Offshore Wind, Fuel Cells, Anaerobic Digestion	252 MW
MA RI	2017 Section 83C I Offshore Wind RFP	Offshore Wind	800 MW (MA) 400 MW (RI)
MA	2017 Section 83D Clean Energy RFP	Hydro Import	Approx. 1,200 MW (9,554,000 MWh)
MA, CT, RI	2015 Multi-State Clean Energy RFP	Solar, Wind	390 MW

Note: Nameplate megawatts (MW) may be higher than qualified Forward Capacity Market (FCM) capacity MW.

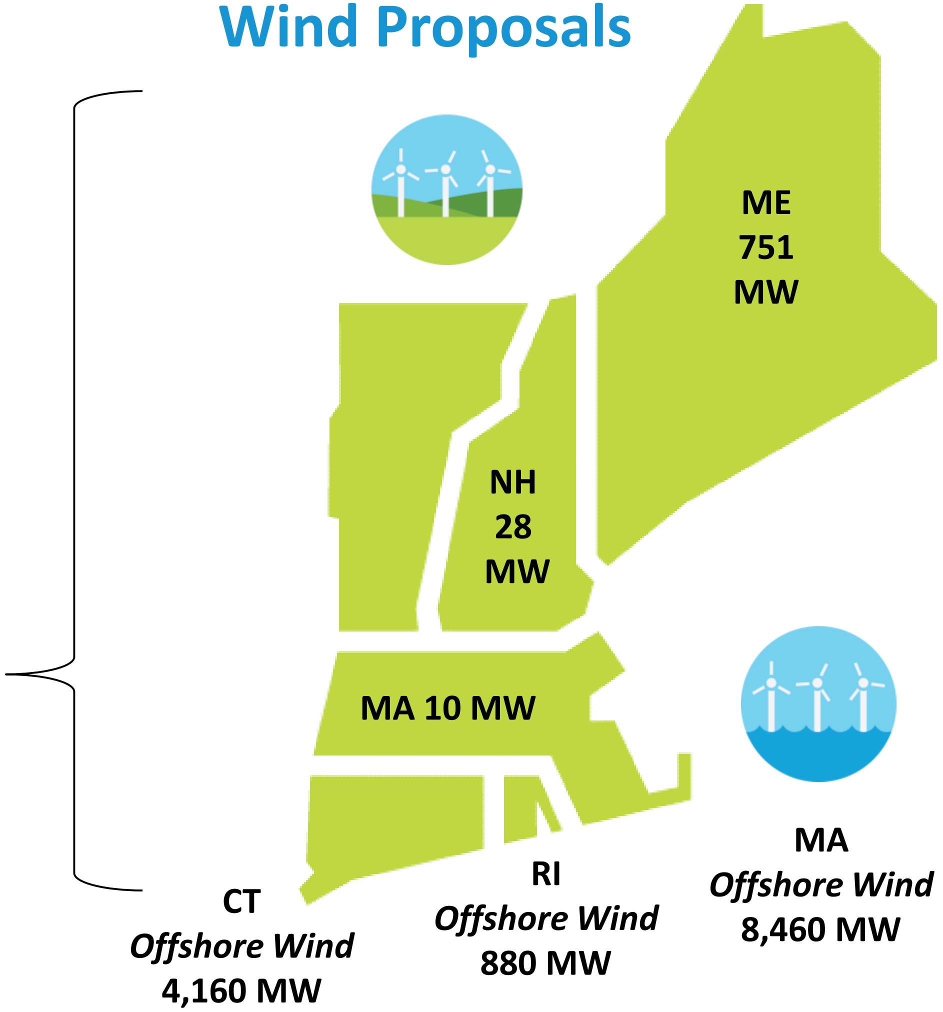
Wind Power Comprises Nearly Two Thirds of New Resource Proposals in the ISO Interconnection Queue

All Proposed Resources



Source: ISO Generator Interconnection Queue (January 2020)
FERC and Non-FERC Jurisdictional Proposals; Nameplate Capacity Ratings
Note: Some natural gas proposals include dual-fuel units (with oil backup).
Some natural gas, wind, and solar proposals include battery storage.

Wind Proposals



Generator Proposals Are Subject to a Reliability Review Involving Extensive Engineering Studies

1 Interconnection Request → 2 Scoping Meeting

3 Feasibility Study

4 System Impact Study

5 Facilities Study

6 Interconnection Agreement

7 Commercial Operation

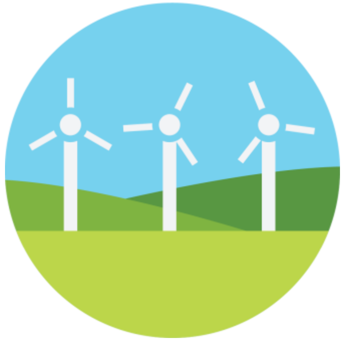
Upon completion of these studies, an Interconnection Agreement between the ISO, the generator, and the interconnecting transmission owner is executed

Elective Transmission Upgrades are subject to a similar reliability review

Several Enhancements Made to ISO New England's Interconnection Study Queue Process

Facilitate projects proposed in response to state procurement efforts for clean energy

1. **New Elective Transmission Upgrade (ETU) Rules**
   – Enable ETUs to establish and hold a firm queue position and ensure these resources are able to deliver capacity and energy into the wholesale electricity markets



2. **New Technical Data Requirements for Wind and Other Inverter-Based Generators**
   – Make wind and other inverter-based generator projects more "study-ready," similar to conventional generators

3. **New Clustering Methodology**
   – Alleviate queue backlog in Maine and, in the future, elsewhere on the New England transmission system should similar conditions arise

Lines represent types of ETUs private developers have proposed in recent years

Source: ISO Interconnection Queue (January 2020)

Developers Are Proposing Large-Scale Transmission Projects to Deliver Clean Energy to Load Centers

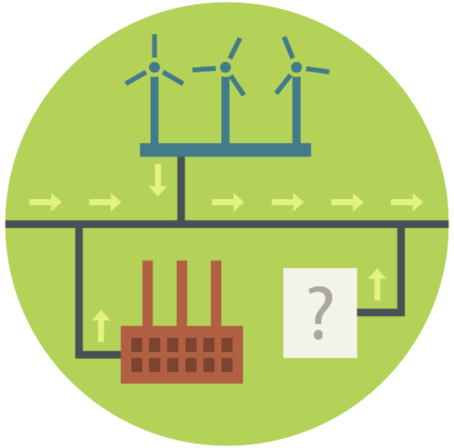
- Developers are proposing roughly **15** elective transmission upgrades (ETUs) to help deliver about **11,000 MW** of clean energy to New England load centers
- Wind projects make up roughly **68%** of new resource proposals in the ISO Queue
  - Most are offshore wind proposals in southern New England, but some are onshore wind proposals in northern New England and **would require transmission** to deliver the energy to load centers

OFFSHORE WIND ANALYSIS CURRENTLY UNDERWAY

2019 Economic Study Requests

ISO New England's Economic Study Process Provides Opportunity to Analyze Alternative Future New England System Scenarios

- In addition to the engineering studies conducted regularly to ensure long-term reliability of the region's bulk power system, ISO New England conducts up to three economic studies annually at the request of regional stakeholders
- Each study analyzes the **economic impacts** of power system scenarios developed by those requesting the study
- Each study's **scope of work** and **assumptions** of future conditions are largely defined by the requestors, with input from both the Planning Advisory Committee and ISO New England
- Study results can provide useful information to **stakeholders** considering whether and where to develop resources or retire resources on the regional power system, and for **policymakers** as they consider energy goals and strategies



More information on the Planning Advisory Committee is available at: https://www.iso-ne.com/committees/planning/planning-advisory/

Each Year, ISO New England Solicits Economic Study Requests from Regional Stakeholders

Three Economic Study requests were submitted in 2019; vetted through Planning Advisory Committee

Requester	Purpose of Request
New England States Committee on Electricity (NESCOE)	Impacts on transmission system and wholesale market of increasing penetrations of offshore wind resources https://www.iso-ne.com/static-assets/documents/2019/04/a2_nescoe_2019_economic_study_request_presentation.pptx
Anbaric Development Partners (Anbaric)	Impacts on energy market prices, air emissions, and regional fuel security of large penetrations of offshore wind resources https://www.iso-ne.com/static-assets/documents/2019/04/anbaric_2019_economic_study_request.pdf
Renew Northeast (Renew)	Economic impact of conceptual increases in hourly operating limits on the Orrington-South interface from conceptual transmission upgrades https://www.iso-ne.com/static-assets/documents/2019/04/a2_renew_2019_economic_study_request_presentation.pdf

Summary: NESCOE and Anbaric Scenarios Are Modeling Varying Degrees of Resource Expansions

NESCOE Year 2030	Gross Demand	Energy Efficiency	Behind-the-Meter PV (Nameplate)	Utility Scale PV (Nameplate)	Supply (incl. Demand Resources)	Retirements	RFP Committed Generation	Offshore Wind Additions (Nameplate)	Demand from Heat Pumps	Demand from Electric Vehicles	Battery Storage Additions
NESCOE_2000	Based on 2019 CELT Forecast				2019 CELT generators and cleared FCA 13 resources	FCA 13 and Mystic 8&9	NECEC (1,090 MW of firm import) 1,000 MW of offshore wind (nameplate)[1]	1,000 MW	None	550,000 vehicles	2,000 MW
NESCOE_3000								2,000 MW			
NESCOE_5000								4,000 MW			
NESCOE_6000								5,000 MW	2,050 MW		
NESCOE_8000								7,000 MW			

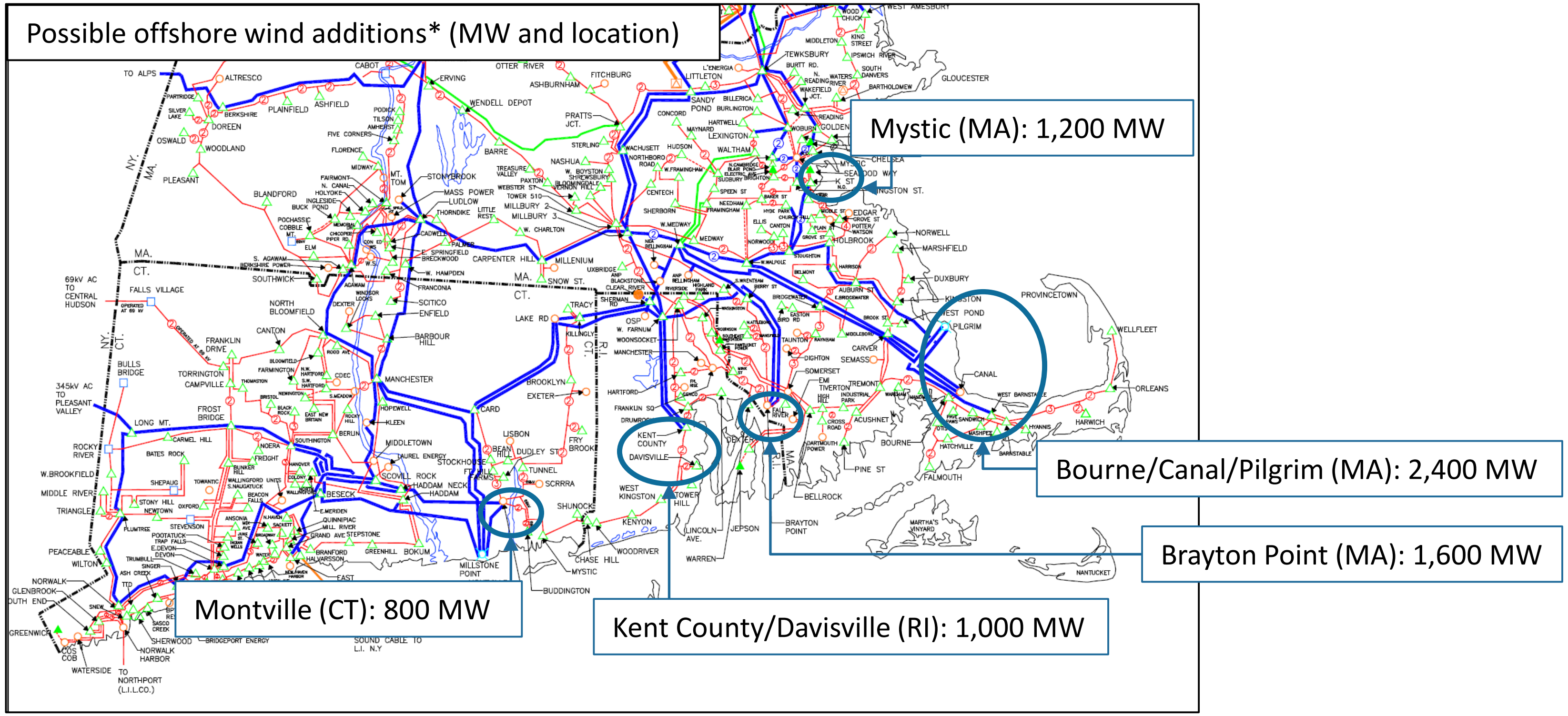
[1] Includes Vineyard Wind (800 MW) and Revolution Wind (200 MW)

Anbaric Year 2030	Gross Demand	Energy Efficiency	Behind-the-Meter PV (Nameplate)	Utility Scale PV (Nameplate)	Supply (incl. Demand Resources)	Retirements	RFP Committed Generation	Offshore Wind Additions (Nameplate)	Demand from Heat Pumps	Demand from Electric Vehicles	Battery Storage Additions
Anbaric_8000	Based on 2019 CELT Forecast				2019 CELT generators and cleared FCA 13 resources	FCA 13, Mystic 8&9, 2,000 MW of nuclear generation, oil/coal units in CT & ME	NECEC (1,090 MW of firm import) 2,300 MW of offshore wind (nameplate)[2]	5,700 MW	None	None	2,000 MW
Anbaric_10000								7,700 MW			
Anbaric_12000								9,700 MW			
Anbaric_Sens								7,700 MW	2,050 MW	550,000 vehicles	4,000 MW

[2] Includes 1,600 MW from Massachusetts RFPs, 300 MW from Connecticut RFPs, and 400 MW from Rhode Island RFP

The NESCOE and Anbaric Scenarios Are Modeling Different Transmission Expansion Options

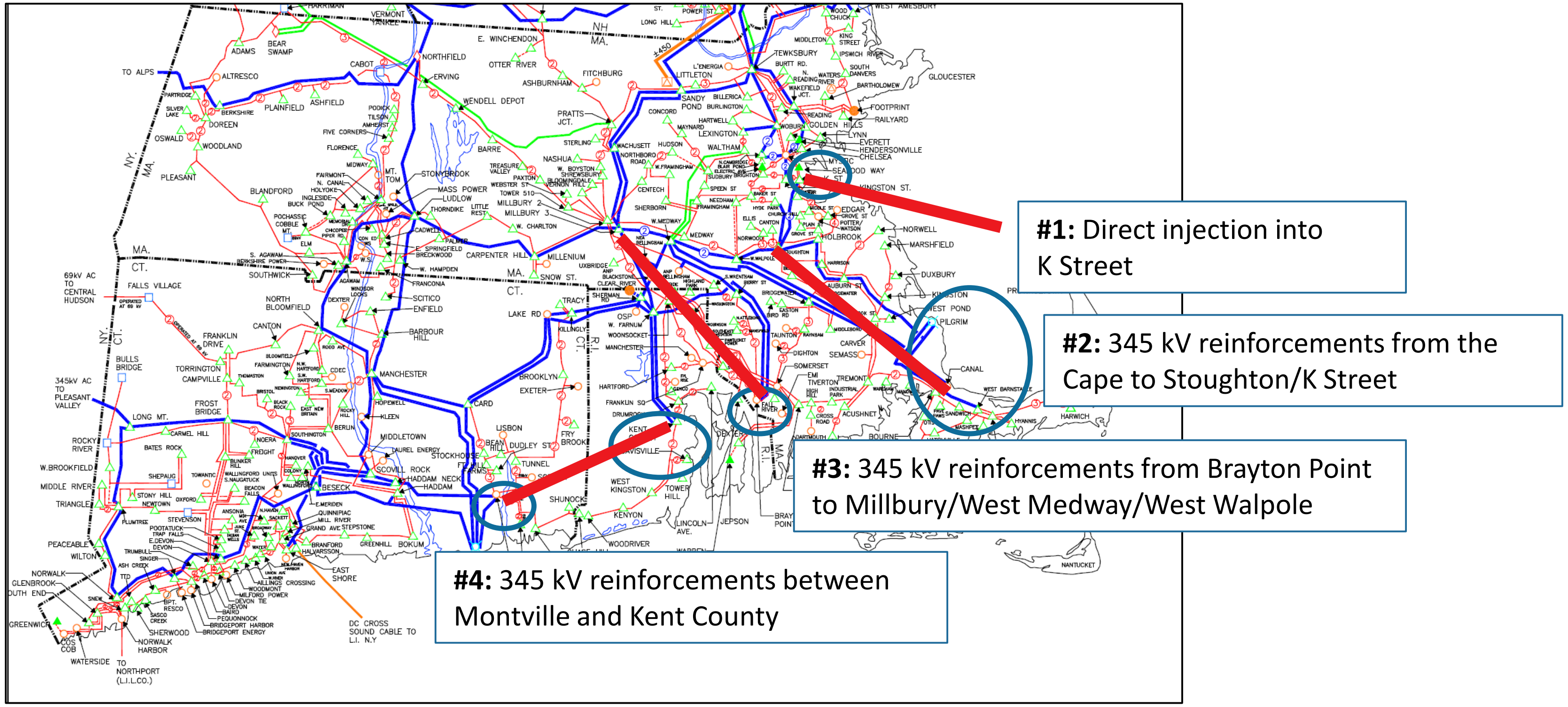
- The transmission system is being modeled using 2030 internal transmission-interface transfer capabilities
- Based on the currently expected transmission system for 2030, the ISO anticipates that the following levels of offshore wind additions **(approx. 7,000 MW)** have the potential to avoid major additional 345 kV reinforcements*
  - This assumes FCA 13 retirements have occurred, including the retirement of Mystic 8 & 9



*Some 345 kV reinforcement/expansion may still be needed for this scenario. This anticipation is preliminary (system impact studies have not been completed for all of these MW). This anticipates minimal interconnection at nameplate levels and capacity interconnection at intermittent capacity values – does not anticipate all of the MW being able to run simultaneously at nameplate levels at all times on the system.

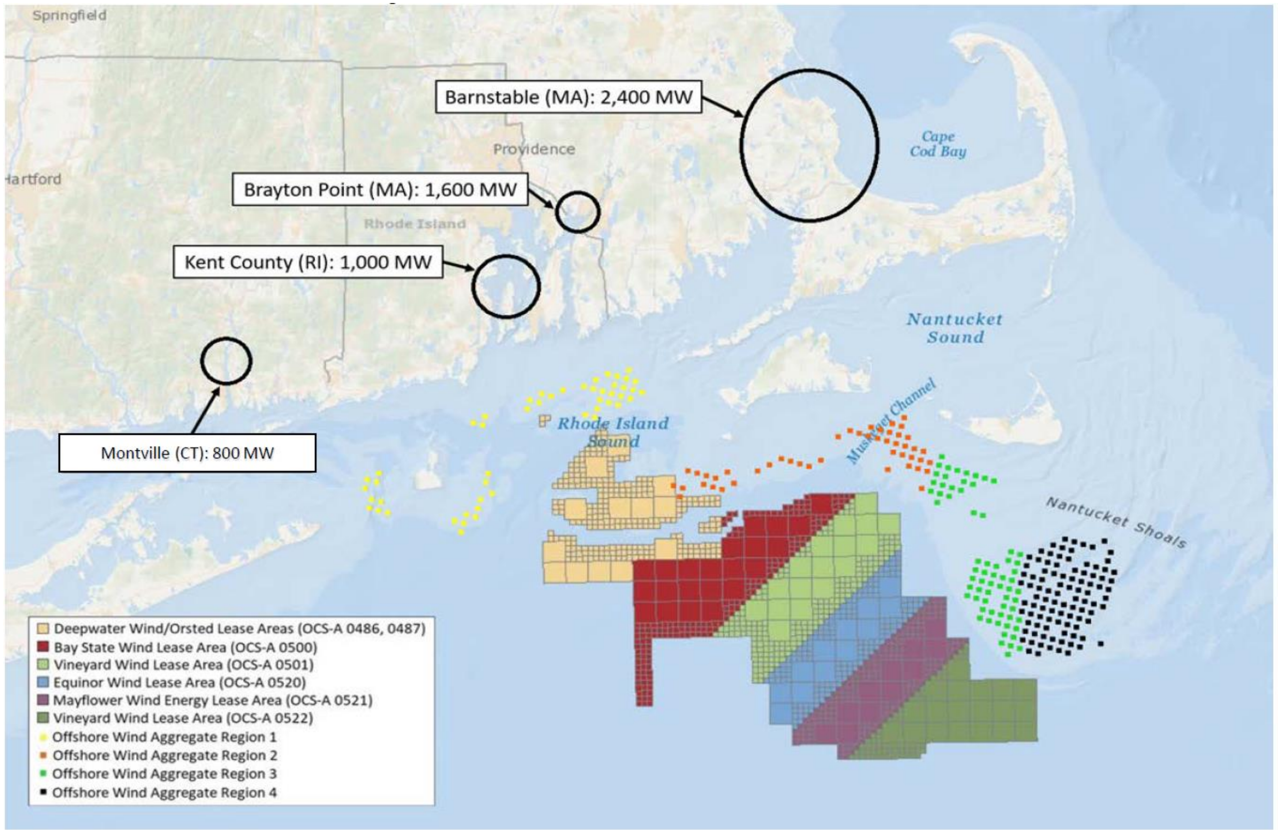
The NESCOE and Anbaric Scenarios Are Modeling Different Transmission Expansion Options, *continued*

- Offshore wind additions **above 7,000 MW** as shown on the prior slide would require:
  - Additional large units to be assumed retired in areas of new injections; and/or
  - Potential need for significant transmission reinforcements, as shown below
    - The ISO will need to assess the allowable level of injections of the assumed transmission reinforcements



The NESCOE and Anbaric Scenarios Are Modeling Different Transmission Expansion Options, *continued*

- Offshore wind additions are being modeled to cover areas off the coast of Rhode Island and Southern Massachusetts that are close to the areas that have been auctioned by the Bureau of Ocean Energy Management (BOEM)
  - Based on National Renewable Energy Laboratory (NREL) data, those are the sites with the highest capacity factor



Next Steps for the 2019 Economic Studies

- Next steps for NESCOE and Anbaric Economic Study requests:
  - Perform and complete additional analyses by Q2 of 2020
    - Ancillary service analysis (NESCOE request)
    - High-level order-of-magnitude transmission cost estimates (NESCOE and Anbaric request)
  - Post final reports by Q2 and Q3 of 2020

Questions

Legal and Regulatory Issues Associated with the Development of Offshore Wind Transmission: An Overview

Mark C. Kalpin, Partner

Holland & Knight LLP

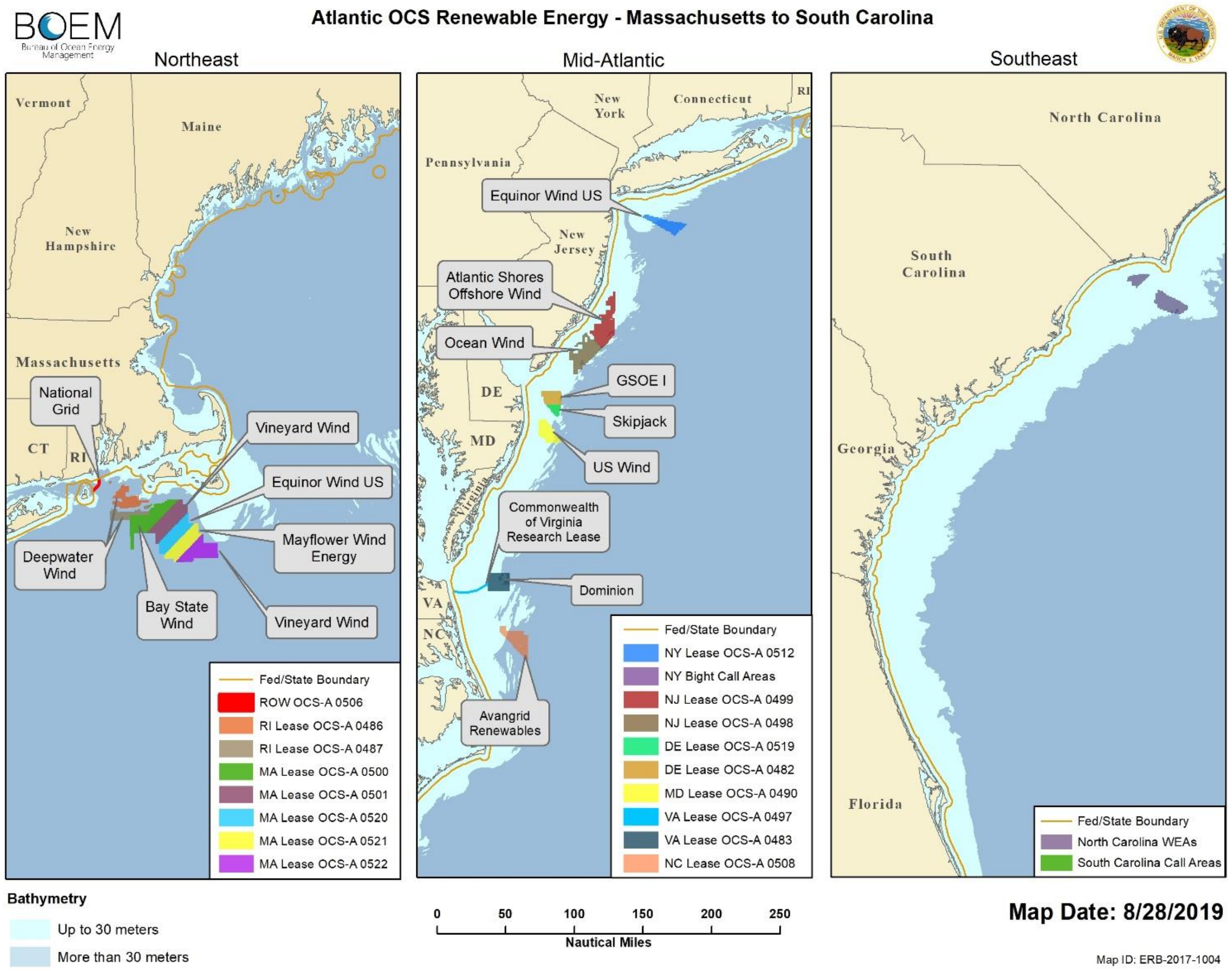
Massachusetts Offshore Wind Technical Conference

Boston, Massachusetts

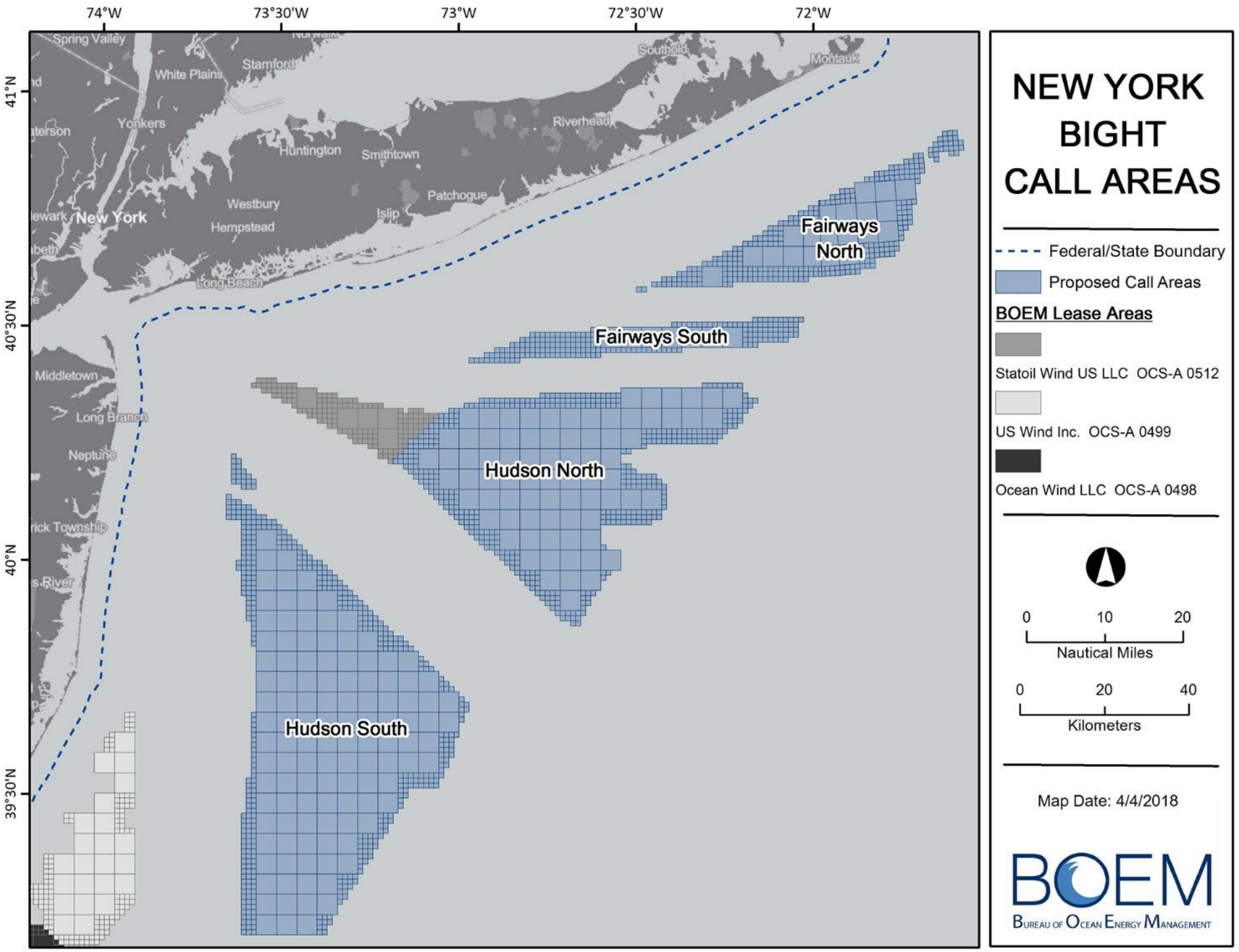
March 3, 2020

Holland & Knight

Existing BOEM Renewable Energy Lease Areas



BOEM NY Bight Call Areas



Applicable Legal / Regulatory Framework

- Outer Continental Shelf: Bureau of Ocean Energy Management
  - OSW Generation Project
    - Renewable Energy Lease with Appurtenant Transmission Easement
    - Site Assessment Plan and Construction and Operations Plan for the “Project”
    - Consolidated Environmental Review of the “Project”
  - Independent OSW Transmission
    - Right-of-Way Grant
    - General Activities Plan
    - Independent Environmental Review
- Massachusetts State Waters
  - Energy Facilities Siting Board
  - Department of Public Utilities
  - Chapter 91 Waterways License

Primary Environmental Permitting Requirements

- National Environmental Policy Act
- Endangered Species Act
- Marine Mammal Protection Act
- National Historic Preservation Act
- Clean Water Act
- Rivers and Harbors Act
- Clean Air Act
- Coastal Zone Management Act
- Applicable State Analogues and Independent Requirements

Primary Energy-Regulatory Considerations

- Generator Lead Line (Single or Bundled)
  - FERC Order 807: 5 Year "Safe Harbor" until Open Access Requirements Apply
- Merchant Line (Elective Transmission Upgrade)
  - FERC's *Chinook* Test evaluates justness / reasonableness of rates; potential for undue discrimination or preference; and regional reliability and operational efficiency
  - FERC's *Final Policy Statement on the Allocation of Capacity* allows developers to select a subset of customers, based on not unduly discriminatory or preferential criteria, and negotiate directly with those customers to reach agreement on the key rates, terms, and conditions for procuring up to the full amount of capacity, when the developers broadly solicit interest from potential customers
- ISO-NE Planning
  - Selection through Regional Transmission Planning Process and Cost Recovery through the ISO-NE OATT
  - FERC Order 1000 "Public Policy Transmission Upgrade" Process
  - Interconnection Queue Process and "Single Contingency" Limitations

Relevant Stakeholder Considerations

- Minimizing Costs to Ratepayers
  - Electricity, Stranded Capacity, Cost Overruns, Damage Payments
- Achieving Carbon Emission Reduction Goals
- Minimizing Offshore and Onshore Environmental Impacts
- Minimizing Impacts on Navigation
- Maximizing Commercial Fishing Access
- Minimizing Visual Impacts
- Providing Economic and Employment Benefits
- Ensuring Reliability

Challenges / Opportunities / Important Questions

- What are the Specific Results You are Trying to Achieve?
- What are the Specific Issues that Must Be Addressed?
  - Coordination of OSW Generation and OSW Transmission Procurement Processes
  - Coordination of Environmental Review and Permitting Processes
  - Coordination of Specific Engineering Designs and Actual Construction Timing
  - Project-on-Project Risk and Liability for Failure to Perform
  - Risk of Unutilized Capacity, Stranded Costs and Cost Overruns
  - The Need for Required Upgrades to the Onshore Transmission System
  - Conformance to FERC / ISO-NE Requirements
  - Impediments to the Use of the Traditional ISO-NE Transmission Planning Process
  - Ability to Successfully Use the Order 1000 PPTU Process in a Multi-State RTO
- Does the Process/Project Selected Actually Address the Relevant Issues and Actually Achieve the Desired Results?

Questions?

Mark C. Kalpin, Partner
Holland & Knight LLP
+1-617-305-2076
mark.kalpin@hklaw.com

OFFSHORE WIND TRANSMISSION TECHNICAL CONFERENCE

TRANSMISSION OWNERSHIP, FINANCING, AND PLANNING MODELS

MARCH 3, 2020

NAVIGANT
A Guidehouse Company

TRANSMISSION CHALLENGES – COMMON THEMES AMONG RENEWABLE INITIATIVES

- Challenges include
  - Resources are remote from load centers
  - Limited points of interconnection; mostly to unit retirements
  - Limited delivery integration capability
  - Limited experience in offshore vs. onshore

TRANSMISSION SOLUTION OPTIONS

- Renewable resource developer/owner build
- Transmission System Owner build (incumbent)
- Transmission System Owner build (non-incumbent)
- Merchant build

DEVELOPER OPTION

- Solutions

  Developer Build – generator is responsible for interconnection and integration costs

  – generation developer bears the cost and responsibility to develop and construct its facility as well as the transmission needed to connect it to the grid
  – Generation developer would then be eligible for interconnection rights for that project and related expansions
  – Access by others enabled by purpose-built projects
  – Funded through consolidated contract for delivered energy

TRANSMISSION SYSTEM OWNER OPTION

- Solutions

  Transmission System Owner Build – socialized cost of expanding the network
  - Moves funding to ratepayers away from resource developers
  - Oversight by centralized planner, usually with regulatory oversight
  - Viewed as a ‘renewable market enabler’
  - FERC Order 1000 contemplates public policy upgrades
  - Can be a grid system or directed build
  - Access for developers provided through
    - Transmission service request
    - Auction mechanism
  - Funding recovery through
    - Regulated tariff provision
    - Negotiated rates

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CASE STUDY: TEXAS COMPETITIVE RENEWABLE ENERGY ZONES

- Case study:

  Texas: Competitive Renewable Energy Zones (CREZ)

  – Authorized by the Texas Public Utilities Commission
  – Planned and designed by the centralized grid operator (ERCOT)
  – Built and owned by multiple third-party owners
  – Access through ERCOT
  – Funded through regulated rates
  – Technology challenges when first operational

    https://www.powerworld.com/files/weccconf_May2014/WECC_ERCOT_Presentation.pdf

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CALIFORNIA: RENEWABLE ENERGY TRANSMISSION INITIATIVE

- Case study:

  California: Renewable Energy Transmission Initiative (RETI)

  – Authorized by the California Public Utilities Commission
  – Planned and designed by the centralized grid operator (CAISO)
  – Built and owned by incumbent Participating Transmission Owners
  – Access through CAISO
  – Funded through regulated rates approved by the Federal Energy Regulatory Commission (FERC)

CALIFORNIA: LOCATION CONSTRAINED RESOURCE INTERCONNECTION

- Case study:

  California: Location Constrained Resource Interconnection (LCRI)

  – Authorized by the Federal Energy Regulatory Commission

  – Planned and designed by the centralized grid operator (CAISO)

  – Built and owned by Participating Transmission Owners and Project Sponsors

  – Access through CAISO

  – Funded through regulated rates

  – Demonstration of market need, vetted with the CAISO Board, approved by FERC

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EUROPE

Two offshore grid development models are applied in Europe.

- The ‘Developer Build’ model, where commercial parties develop and operate the offshore transmission assets
- The ‘TSO Build’ model, where the offshore grid development and operation is mandated to the local TSO by the national government

As Europe’s offshore wind industry matures and expands, secure integration of offshore wind energy is a topic of increasing importance.

- Historically, projects were developed closer to shore and grid integration could be facilitated with minimal grid reinforcements
- Future large-scale and far offshore wind clusters will be costly and likely require innovative system integration solutions to keep cost levels down, including flexibility options like electricity conversion and storage

POLICY CONSIDERATIONS

As the wind turbine capacity and total wind farm size are increasing, the market is progressively switching to higher voltage levels of inter-array cables,

– Where are favorable financing conditions that being benefits to customers?

– Does an investor have sufficient financial health for large capital investment?

– How to manage risks for project viability?

	TSO Build	Developer Build
Pro	TSO's benefit from more favorable financing conditions and a stable pipeline of projects can reduce costs.	Commercial parties could have more flexible financing options (e.g. higher debt shares which could result in lower Weighted Average Cost of Capital) and competition could lead to cost reductions.
Con	Larger amounts of (pre-) investment capital is required. TSO's do not face the same market (cost) pressures as developers in competitive tenders.	Higher cost of capital (e.g. including transaction costs from developer to OFTO) and a lower potential to reduce societal costs through a coordinated approach

Navigant: Connecting Offshore Wind Farms July 1, 2019 and https://guidehouse.com/-/media/www/site/downloads/energy/2019/navigant-dutch-offshore-wind-market-update-2019.pdf

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LOOKING FORWARD

Most of the current installed capacity is close to shore and connected via alternating current (AC)

Offshore connections with long transmission distances have been connected via direct current (DC) to optimize the transmission system in terms of costs and electrical losses

The ‘tipping point’ for cost efficient application of HVDC technology is determined by the distance from shore (80 km-100 km) and capacity level (>1 GW)

- **Cost-efficient and secure integration of offshore wind in the energy system?**
- **Development models for offshore electricity transmission infrastructure?**
- **Grid connection costs have become a larger component of total cost of electricity**
- **Large offshore infrastructure investments require careful consideration**

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[1] On October 11, 2019, Guidehouse LLP completed its previously announced acquisition of Navigant Consulting Inc. In the months ahead, we will be working to integrate the Guidehouse and Navigant businesses. In furtherance of that effort, we recently renamed Navigant Consulting Inc. as Guidehouse Inc.

CONTACTS

LAURA J. MANZ
Director
916.631.3262
Laura.Manz@guidehouse.com

https://www.navigant.com/-/media/www/site/downloads/energy/2019/navigant-dutch-offshore-wind-market-update-2019.pdf

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Offshore wind transmission – lessons from Europe

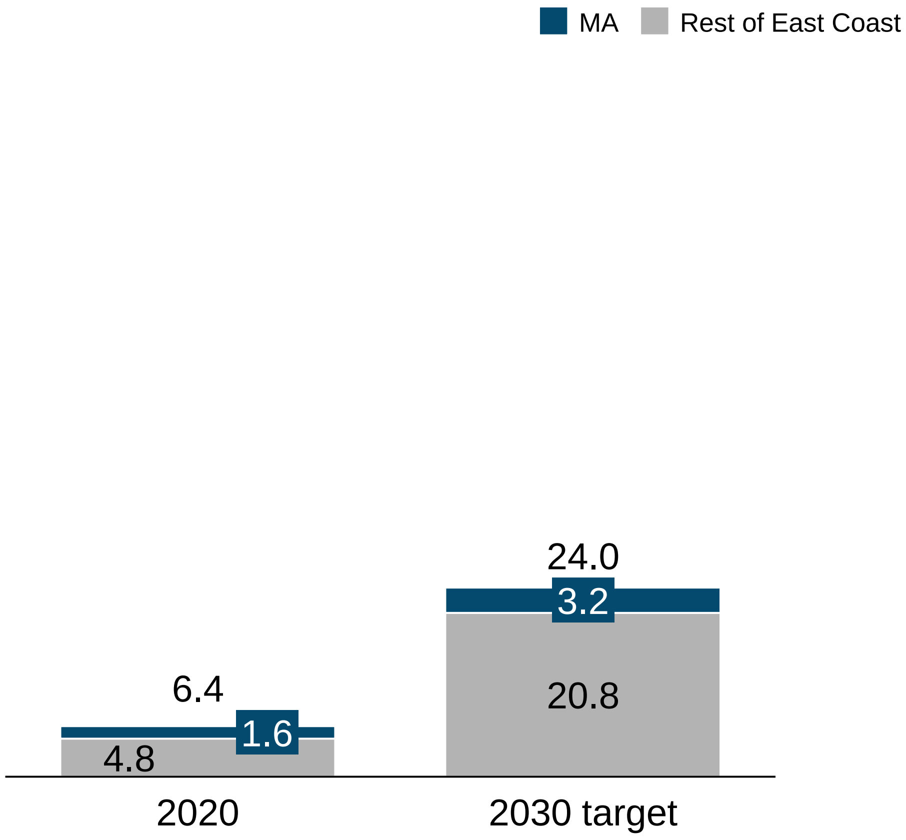
DOER/MassCEC Offshore Wind Transmission Technical Conference

MARCH 3, 2020

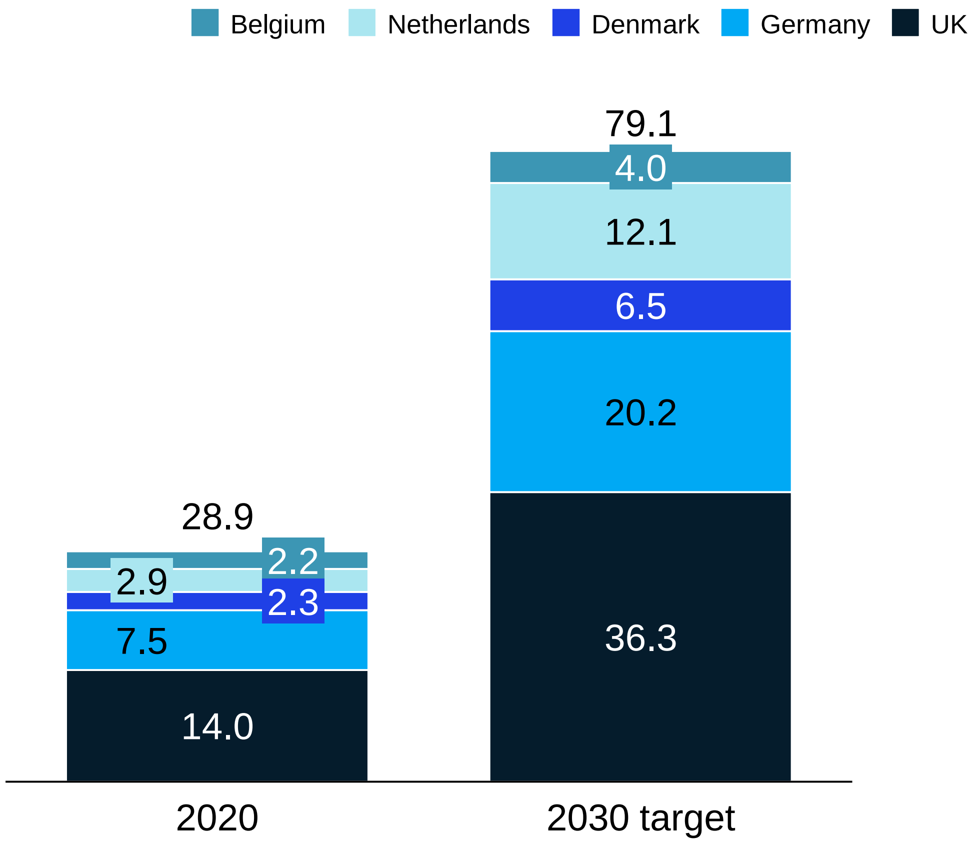
Offshore wind by the numbers

OSW capacity GW

MA installed/procured[1] and target OSW capacity



EU installed/procured[1] and target OSW capacity



1. Installed, under construction, and auctioned capacity

Source: 4COffshore offshore wind market report (Dec 2019), press search

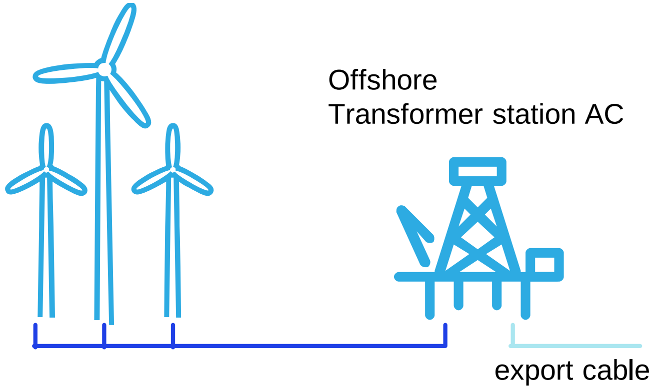
What we'll cover today

- Lessons from offshore wind leaders in Europe – Denmark, the Netherlands, UK and Germany
- Findings are based on research that McKinsey has conducted over past ~2 years, engaging with developers, transmission system operators (TSOs), regulators and other experts on the ground in Europe
- Today we will focus on several topics from our European case work:
  - Offshore grid design
  - Offshore grid ownership and incentives
  - Onshore grid ownership and cost allocation
- … and there are a number of important topics out of scope for this discussion, including (but not limited to) permitting, siting process, interconnection process, etc.

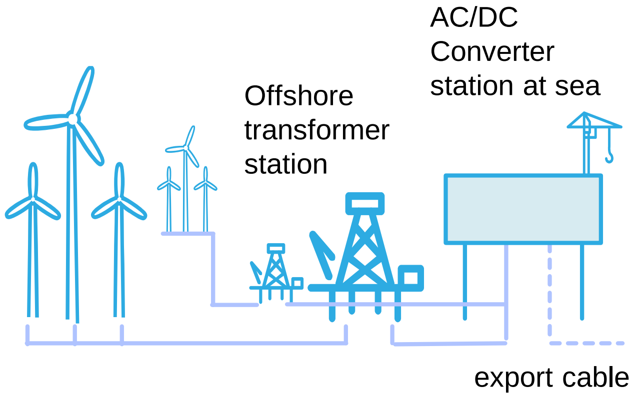
Level-setting on core topics

Offshore grid design

Radial



Network



Offshore grid ownership

Who is responsible for building the offshore transmission asset and ownership after commissioning:

- TSO (Transmission System Operator)
- Developer
- 3rd party

Offshore grid incentive alignment

How developers are compensated for construction delays and outages in case another party builds/owns the offshore grid:

- Fully compensated
- Partially compensated
- Not compensated

Onshore grid development and cost allocation

Who is responsible for onshore grid development and bears the costs:

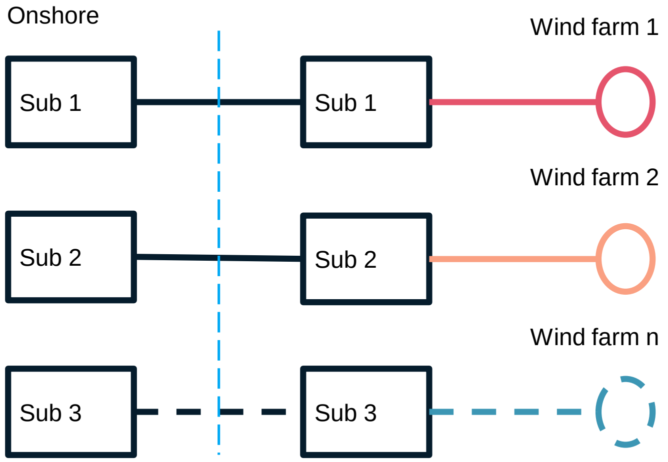
- TSO-coordinated, covered by rate payers
- TSO-coordinated, covered by all grid users
- TSO-coordinated, covered by generator

Across European countries, different T&I development and ownership models exist today

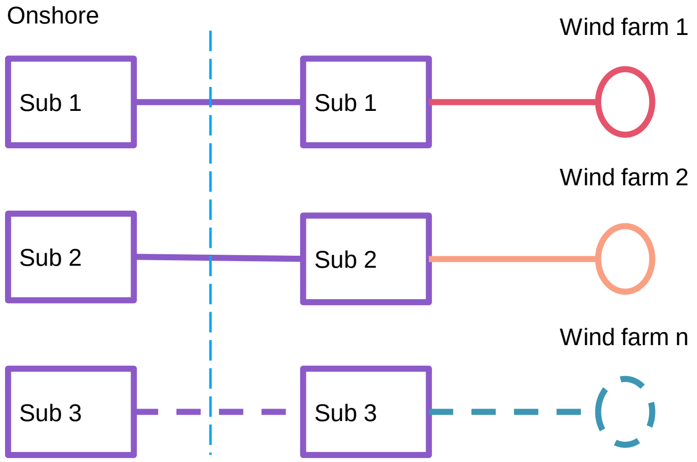
Owner/ operator view

Government/TSO[1] owned | Developer 1 | Developer 2 | Developer n | Offshore transmission owner

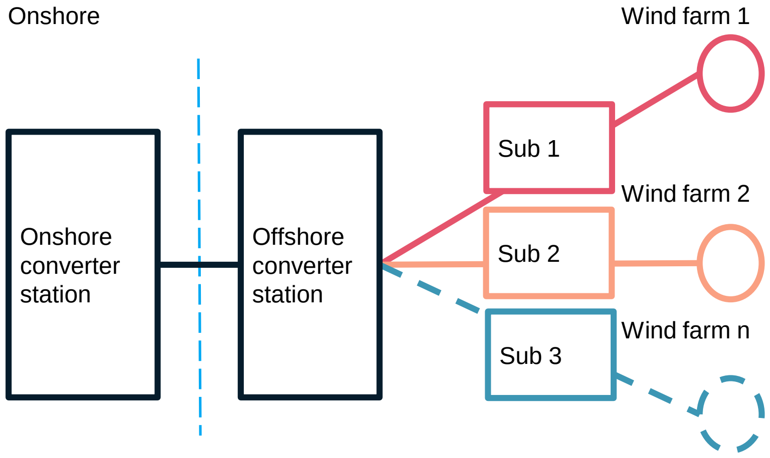
Denmark and the Netherlands have driven developer competition through central T&I planning



UK allows developers to execute on development of T&I, but requires third-party ownership



Germany uses a backbone network T&I system, with mixed TSO and developer ownership of offshore transmission



1 Transmission System Operator

Contextualizing lessons from Europe

Illustrative

	Developer-led site and transmission development	Central site and transmission development	
Unconstrained coastline (relative to population)	**UK** (radial) Coastline: 7,700mi *Developers dominate a competitive development process (across an increasingly crowded coast)*	**Denmark** (radial) Coastline: 4,500 mi *Pioneer in the industry; government executes on upfront site sourcing and builds/owns offshore transmission*	
Constrained coastline (relative to population)	**Massachusetts** Coastline: 192 mi *First sites have been developer-led*	**Germany** (network) Coastline: 1,500 mi *The TSO has created a 'backbone' for developers to tie into offshore*	**Netherlands** (radial) Coastline: 280 mi *Government executes on upfront site sourcing and builds/owns offshore transmission*

Considerations for Massachusetts

1	**Offshore grid design**	• Given expected solicitation patterns, will there be enough sub-scale offshore wind development to warrant serious consideration of a network model?
2	**Offshore grid ownership and incentive alignment**	• How will Massachusetts ensure proper incentive alignment between the offshore transmission operator and generation owners, in the event this is built and/or owned and operated by a third party?
3	**Onshore grid capacity and cost allocation**	• What kind of planning is required for Massachusetts ensure sufficient onshore interconnection points?

Panel: Opportunities and challenges for offshore wind transmission in Massachusetts and the region

Moderator: Steve Pike, Massachusetts Clean Energy Center

Alastair Mills, Siemens Energy

Alan McBride, ISO-New England

Mark Kalpin, Holland & Knight

Laura Manz, Navigant

Ksenia Kaladiouk, McKinsey & Co.

DOER Massachusetts Department of Energy Resources

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