U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

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# Atlantic Offshore Wind Transmission + Next Steps for the Northeast


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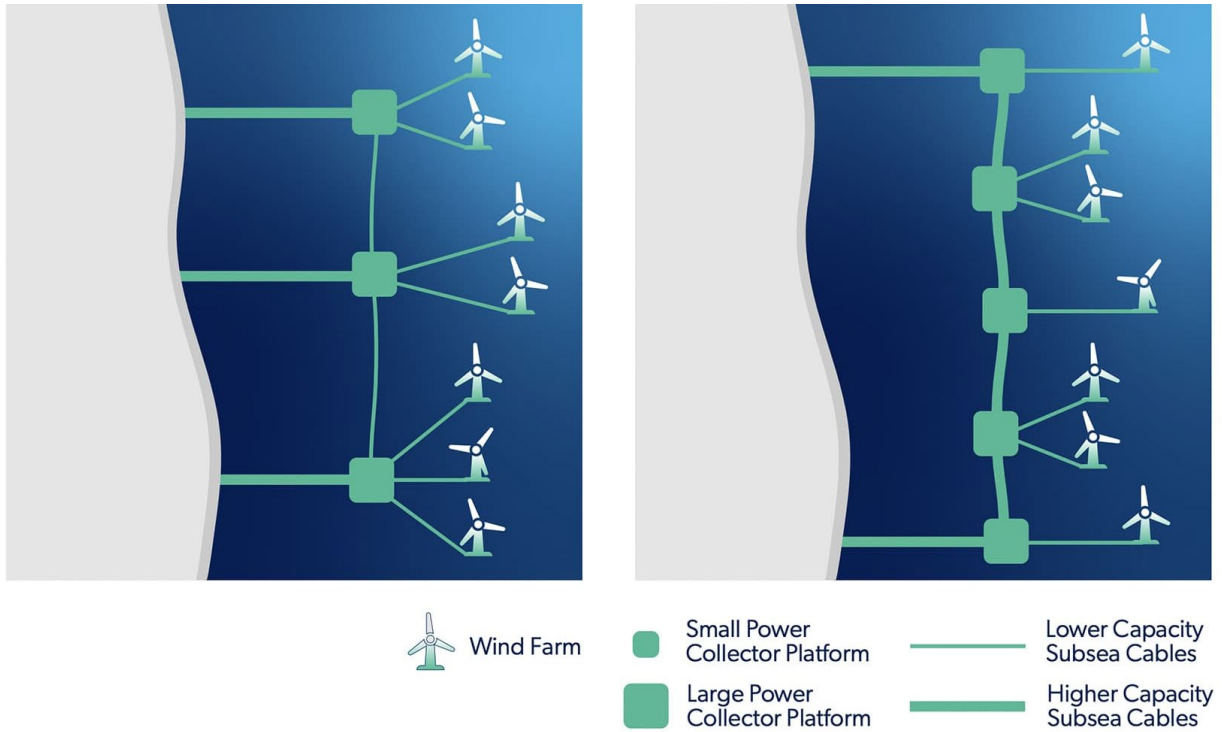
# Background & Context

- Decarbonization → Rapid deployment of OSW in the U.S. necessary
- Transmission build-out & upgrades necessary


montclair.edu; wbur.com

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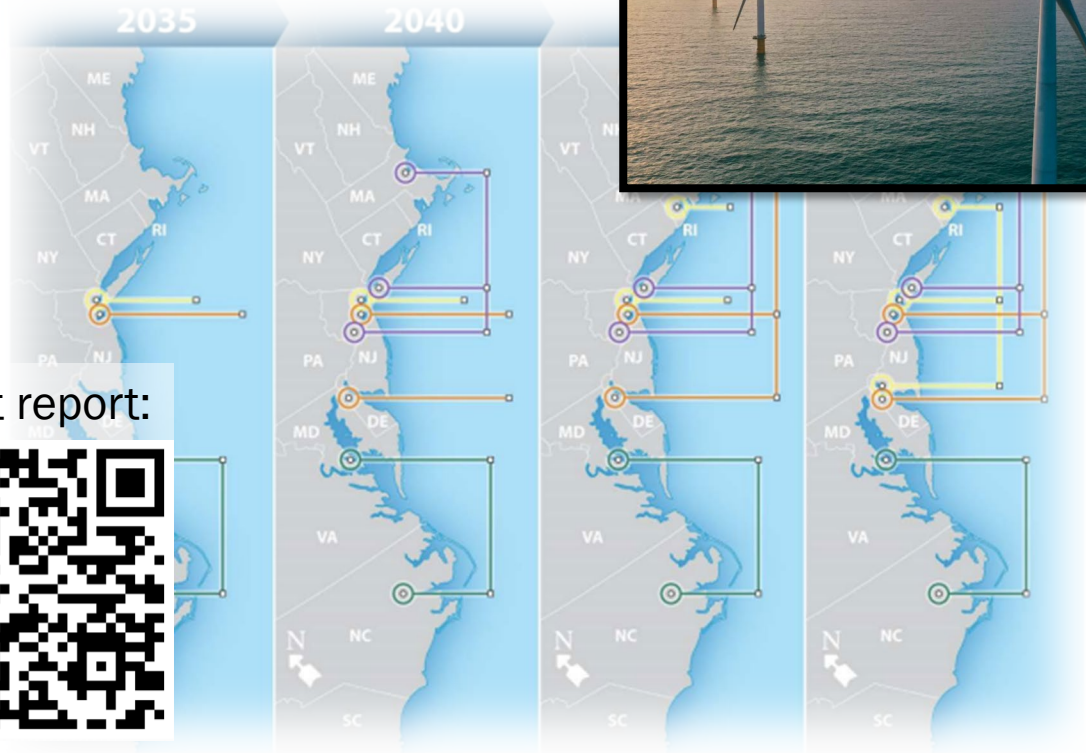
# Atlantic Offshore Wind Transmission Study (AOSWTS)

- **Study funders:**
  - Wind Energy Technologies Office (WETO) (DOE)
  - Grid Deployment Office (GDO) (DOE)

- **Study authors:**
  - National Renewable Energy Laboratory
  - Pacific NW National Laboratory


Full text report:

# Major Questions of AOSWTS

- What are the costs, benefits, and impacts of OSW transmission networks on the Atlantic Coast?
- I will emphasize a few key points of the study, not all

What is the cost of interlinking offshore platforms?

What are the economic benefits of different offshore grid philosophies?

How could offshore transmission impact reliability and resilience?


Could there be a sequence that achieves benefits without adding near-term hurdles?

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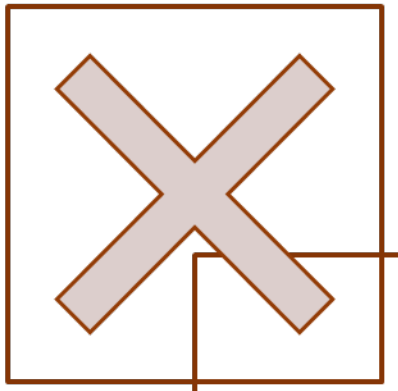
## Study is…

- Hypothetical cable routing analysis
- Operations, economics, and reliability analysis of these routes
- Long-term planning analysis of the grid in a low carbon scenario



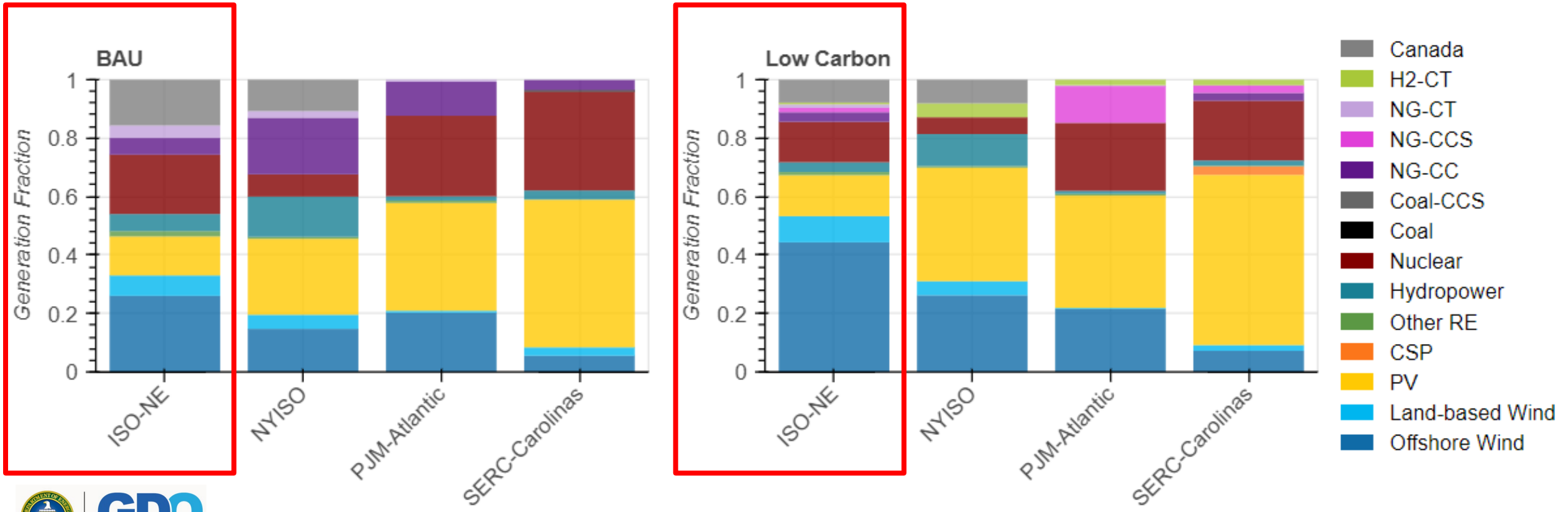
## Study is not…

- Detailed interconnection study
- Siting or permitting study
- Prescriptive for exact points of interconnection (POI) or transmission line locations

# Offshore wind is projected to be a key part of achieving low carbon future for the Atlantic States.

2 capacity expansion scenarios in 2050:

- **Business as Usual (BAU)**
- Low Carbon 2050 (~**85 GW** of OSW)

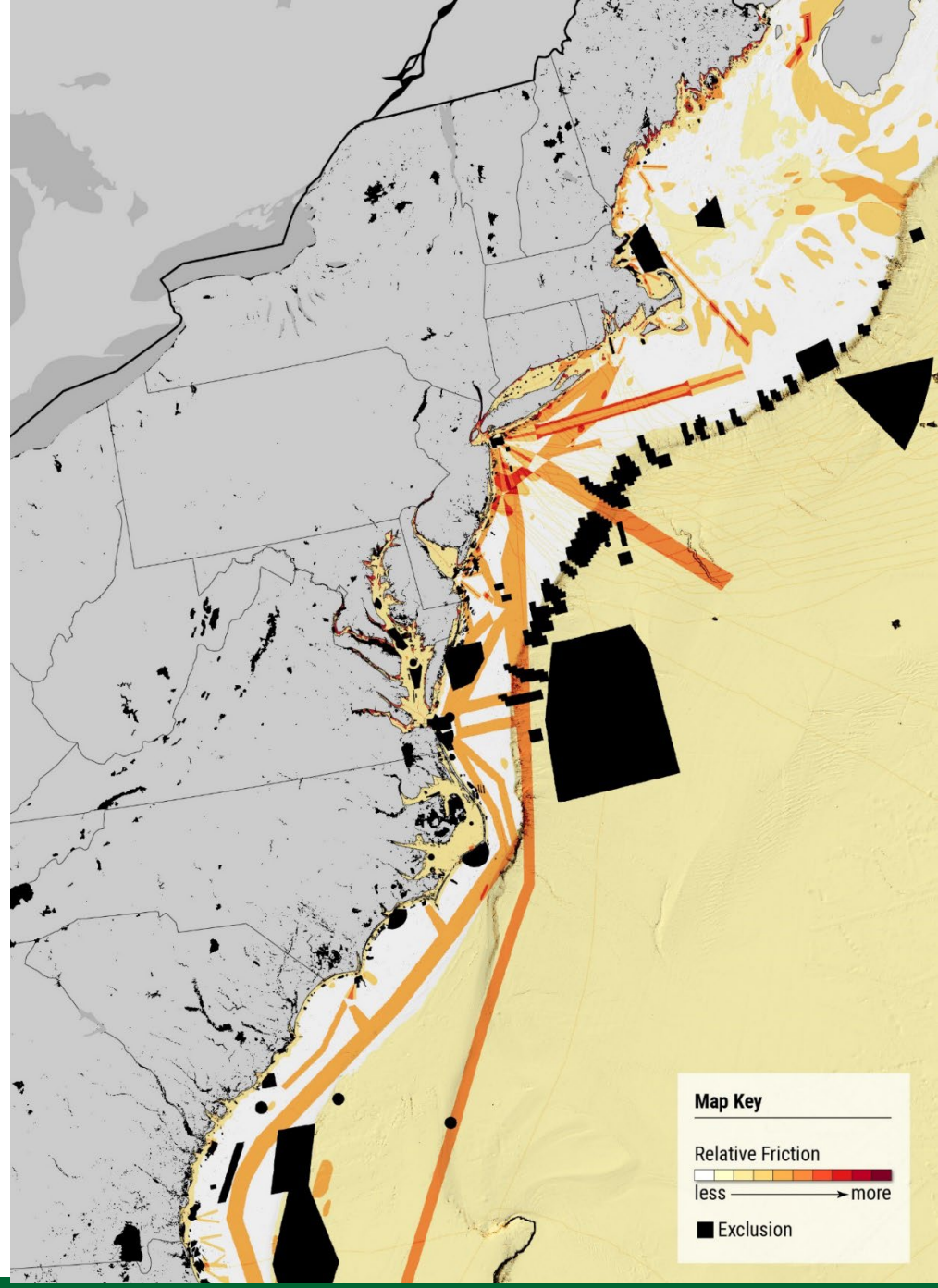



2050 Electricity Generation Fraction by Resources

# Offshore Transmission can be planned while considering ocean co-uses and environmental constraints.

- 26 data layers → hypothetical cable routes (next slide)
  - Shipping, military, conservation, EPAs, fisheries, and other considerations

- Not comprehensive siting study
- Can help identify large-scale issues

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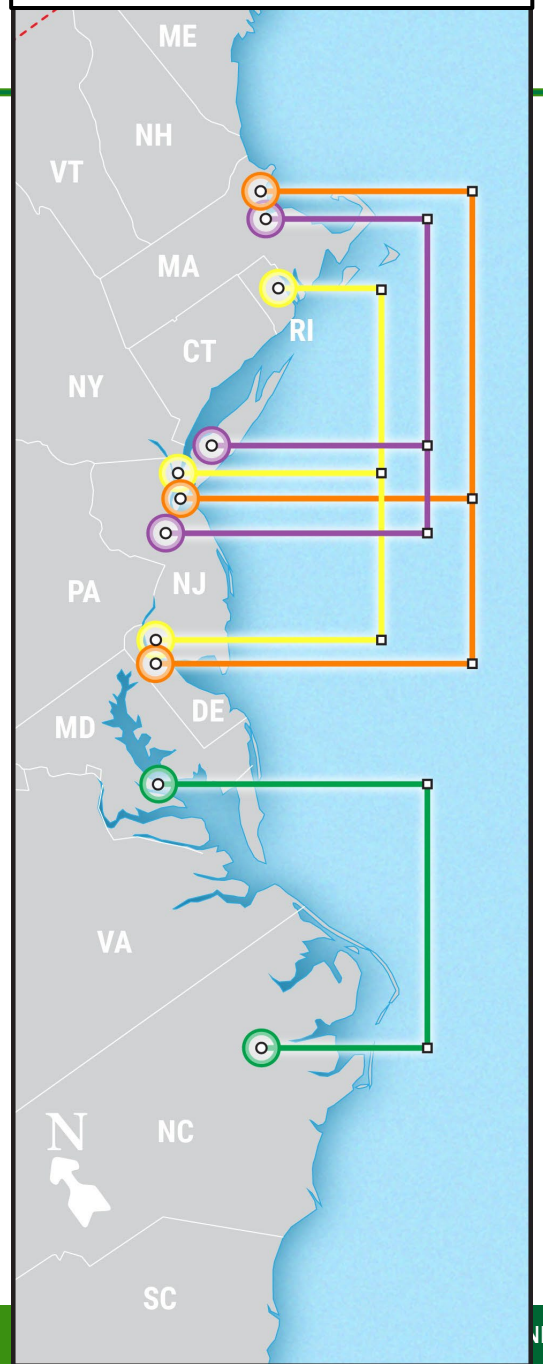
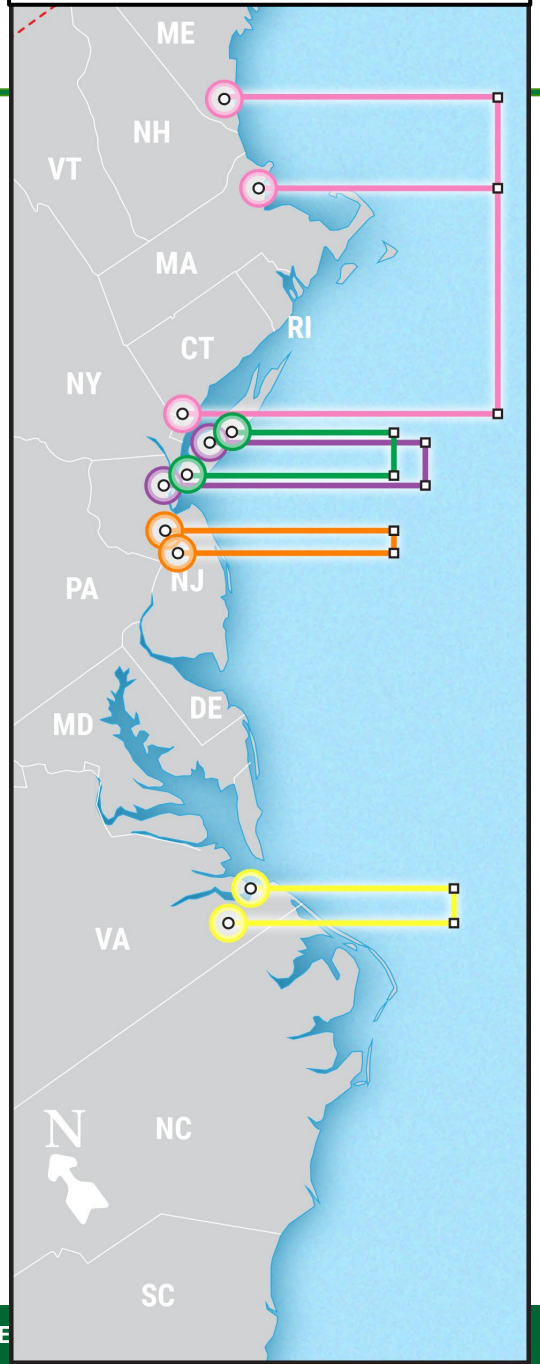
# 85 GW Radial Reference Topology


- Current state of affairs
- Each OSW farm connects to land individually
- NOT an OSW transmission network
- Total of 51 points of interconnection (POIs) selected
- From Maine - South Carolina

Interregional



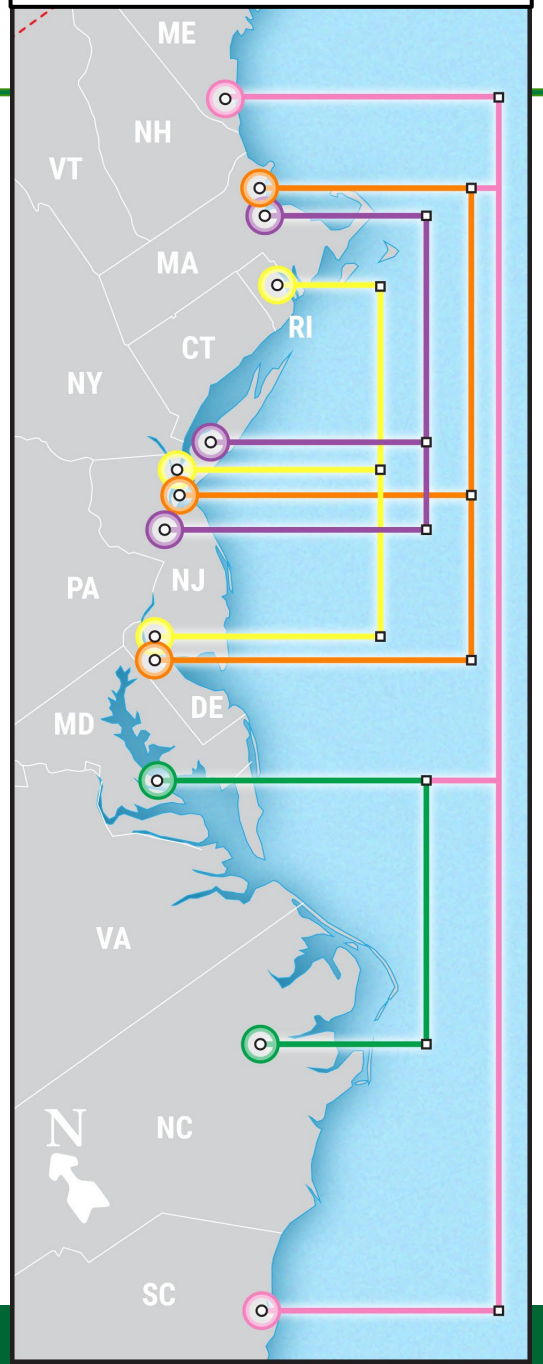

Intraregional




Inter-Intra regional

[Not Pictured]

Backbone



# Benefits of offshore transmission networking outweigh the costs, often by a ratio of 2:1 or more.

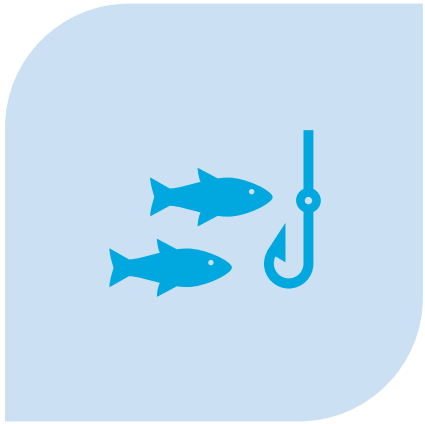
| Scenario | Net Annual Value ($M) | Benefit Cost Ratio |
|---|---|---|
| Intraregional | 330 | 2.3 |
| Interregional | 1560 | 2.9 |
| Inter-Intra | 1760 | 2.6 |
| Backbone | 2470 | 2.7 |

2050 benefits-annual costs

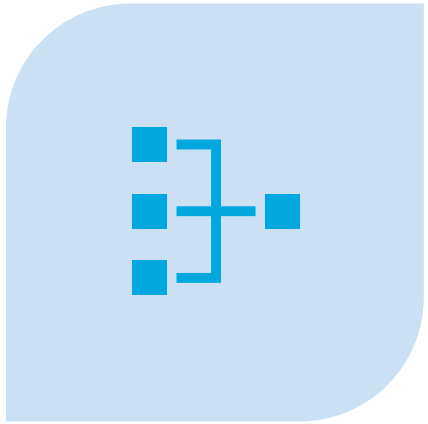
- Majority of costs are cables
- Benefit: cost ratio highest for interregional topology, but all network topologies beneficial

# Key Findings

OSW ESSENTIAL TO DECARBONIZATION OF THE NE



CAN BE PLANNED CONSIDERING ENVIRONMENT, CO-USES (MPAS, FISHERIES)



NETWORK OF INTER-STATE OSW TRANSMISSION LINES COST-EFFECTIVE

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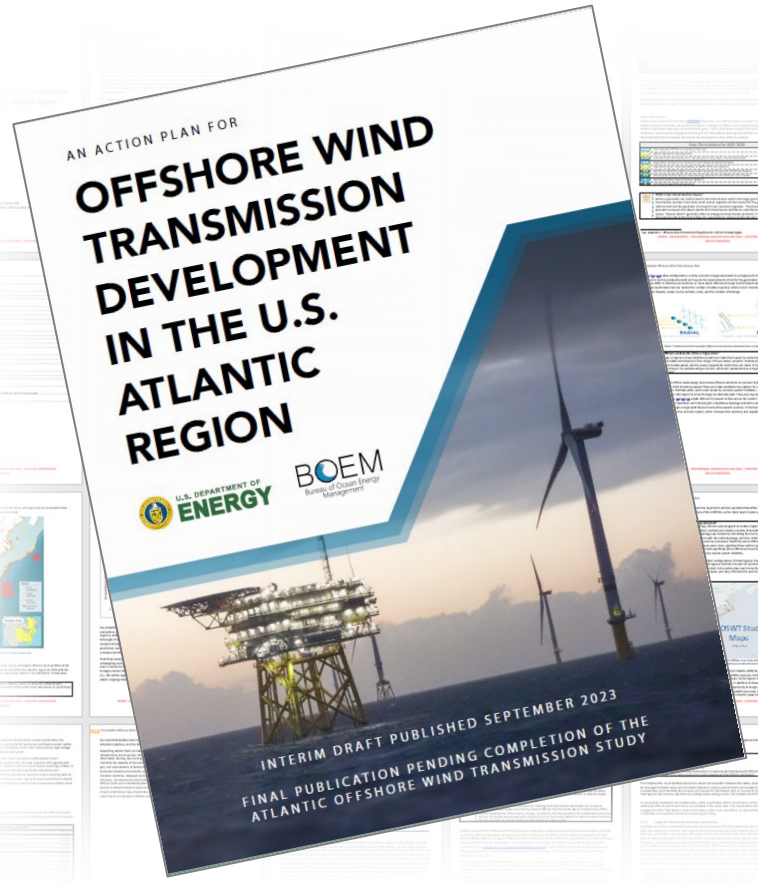
# Atlantic Offshore Wind Transmission Action Plan


- Co-authored by DOE and BOEM
- Published March 21, 2024

- 41 recommendations
- Spanning 2023-2050 timeframe
- 5 categories

- Read the plan at energy.gov:

BOEM
BUREAU OF OCEAN ENERGY MANAGEMENT

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# Immediate Recommendations


| Immediate Actions Before 2025 | | Reference Section |
|---|---|---|
| ★ ★ ★ | Multi-State Offshore Wind Transmission Collaborative | 1.1.1 |
| ★ ★ ★ | Regional Transmission Planning Collaborative | 1.1.2 |
| ★ ★ ★ | Tribal Nation Engagement | 1.1.3 |
| ★ ★ ★ | Systematic Evaluation of POI Capacities | 2.1.2 |
| ★ ★ ★ | NERC Reliability Standards Around Offshore Transmission | 2.3.1 |
| ★ ★ ★ | Voluntary Cost Allocation Assignments | 4.1.1 |
| ★ ★ ★ | Offshore Transmission Investment Tax Credits | 4.2.1 |
| ★ ★ | "Network-Ready" Equipment Standards | 3.1.1 |
| ★ ★ | Equipment Rating Standardization for Transmission Components | 3.1.2 |
| ★ ★ | R&D for Offshore Transmission Technology Commercialization | 3.3.1 |
| ★ ★ | Expansion of Domestic Supply Chain and Manufacturing | 3.4.2 |
| ★ ★ | Skilled U.S. Workforce Development | 3.4.2 |
| ★ ★ | Federal-State Aligned Offshore Wind Transmission Siting | 5.1.3 |
| ★ ★ | Guidance for Federal Environmental Review and Permitting Requirements and Procedures | 5.2.1 |
| ★ ★ | Permitting Agency Resources and Staffing | 5.2.3 |
| | Environmental R&D for Offshore Wind Transmission | 3.3.2 |
| | Relevant Federal Funding, Financing, and Technical Support | 4.2.2 |

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# State-led Recommendations


| Recommendation | | Action (summarized) | Criticality | Timing |
|---|---|---|---|---|
| **Partnerships and Collaborations** | | | | |
| 1.1.1 | Offshore Wind Transmission State Collaborative | Encourage the Atlantic states to collectively form an Offshore Wind Transmission State Collaborative to establish a shared vision on policy and approach to coordination for offshore transmission development. | ☆☆☆ | 2023 |
| **Planning and Operations** | | | | |
| 2.1.1 | State-led Transmission Planning | State-led transmission planning be pursued in partnership with regional transmission operators. | ☆☆ | All |
| 2.2.1 | Interregional Offshore Topology Planning | State Collaborative communicate support for interregional HVDC transmission topology scenarios to respective transmission planning entities and JIPC conduct a collaborative study process between the ISOs/RTOs and planners in non-ISO/RTO neighboring regions. | ☆☆☆ | 2025 |
| **Technologies and Standardization** | | | | |
| 3.1.1 | Network-ready Equipment Standards | Design and expand network-ready equipment standards for both HVAC and HVDC to enable future expansion. The multi-state collaborative take the lead to drive enforcement of standards within member states. Require projects to comply with specifications or through mandates in permits. | ☆☆ | 2024 |
| 3.1.2 | Equipment Rating Standardization for Transmission Components | State solicitations be prescriptive to match the small, medium, and large transmission designs. Establishing equipment standards for transmission cable voltage and current capacity, connectors, and collector stations. | ☆☆ | 2023 |
| **Economics and Support Initiatives** | | | | |
| 4.1.1 | Voluntary Cost Allocation Assignments | States pursue, and ISOs/RTOs and other transmission providers to facilitate, voluntary cost allocation based on a mutually agreed-upon method. | ☆☆☆ | 2023 |
| 4.1.4 | Equity in Ratemaking | Public utility commissions adopt best practice standards to ensure that low-income and vulnerable populations do not continue to be disproportionately impacted by high energy burdens. | ☆ | All |
| 4.2.1 | Relevant Federal Funding, Financing, and Technical Support | Developers and states looking to develop offshore wind transmission projects carefully review and apply for existing and upcoming funding programs to access BIL and IRA funding. | ☆ | All |
| **Siting and Permitting** | | | | |
| 5.1.4 | Multi-state Partnership on Clean Energy Standards and Offshore Wind Goals | State clean energy standards and/or offshore wind goals be amended to allow for full or partial credit of the installed capacity of an offshore wind plant toward state clean energy standards when an investment in offshore wind infrastructure helps a neighboring state achieve its goals. | ☆☆ | 2028 |

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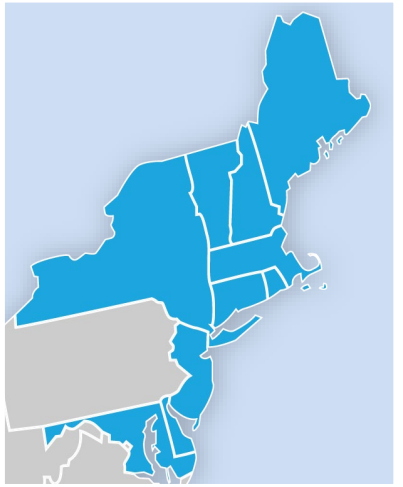
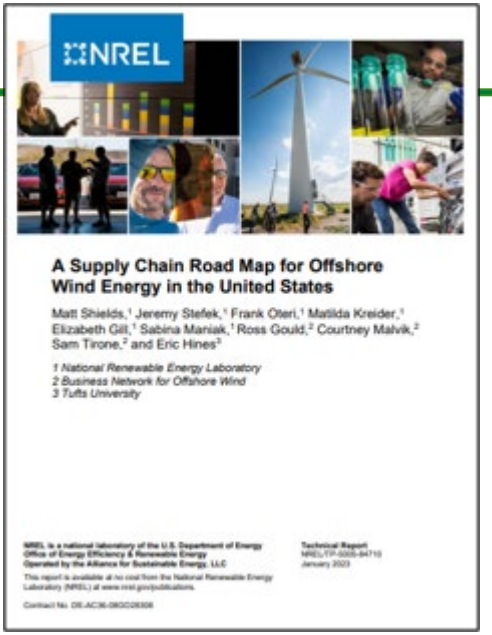
# Ongoing DOE work

- **HVDC Standards**
  - $8.5 million awarded for 4 projects on HVDC standards and controls
- **Supply Chain Expansion**
  - 2 volume Roadmap (2022, 2023)
- **Tribal Technical Program**
  - Educational resources
  - “Phone an expert” (consultations)
  - Participation support
- **NE States Collaborative**
  - NE states requested (& granted) funding
- **Transmission Studies in other regions**







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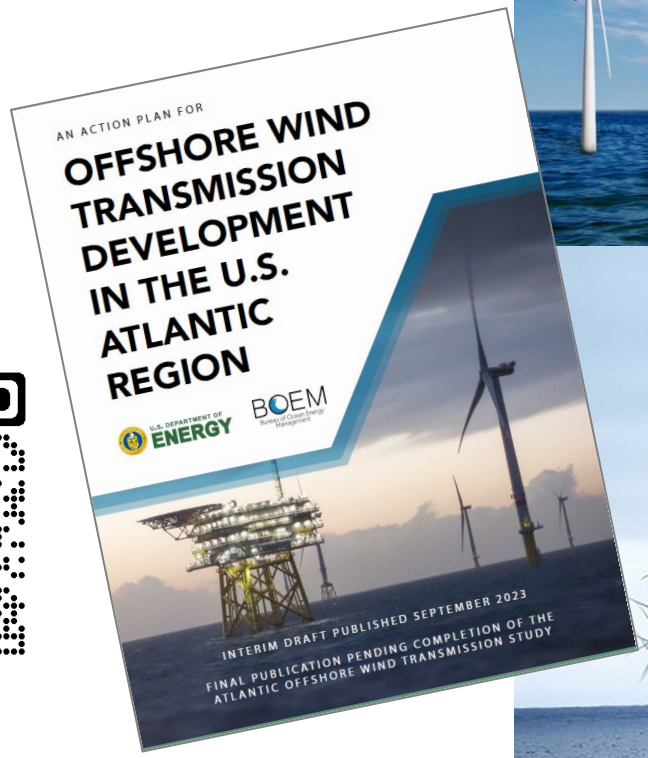
# Questions? colette.fletcher-hoppe [at] ee.doe.gov

- **Thank you!**
  - Jian Fu, WETO
  - Mike Mullaley, GDO
  - Greg Brinkman, NREL
- **AOSWTS:**
- **AOSW TAP:**





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# Back-up slides

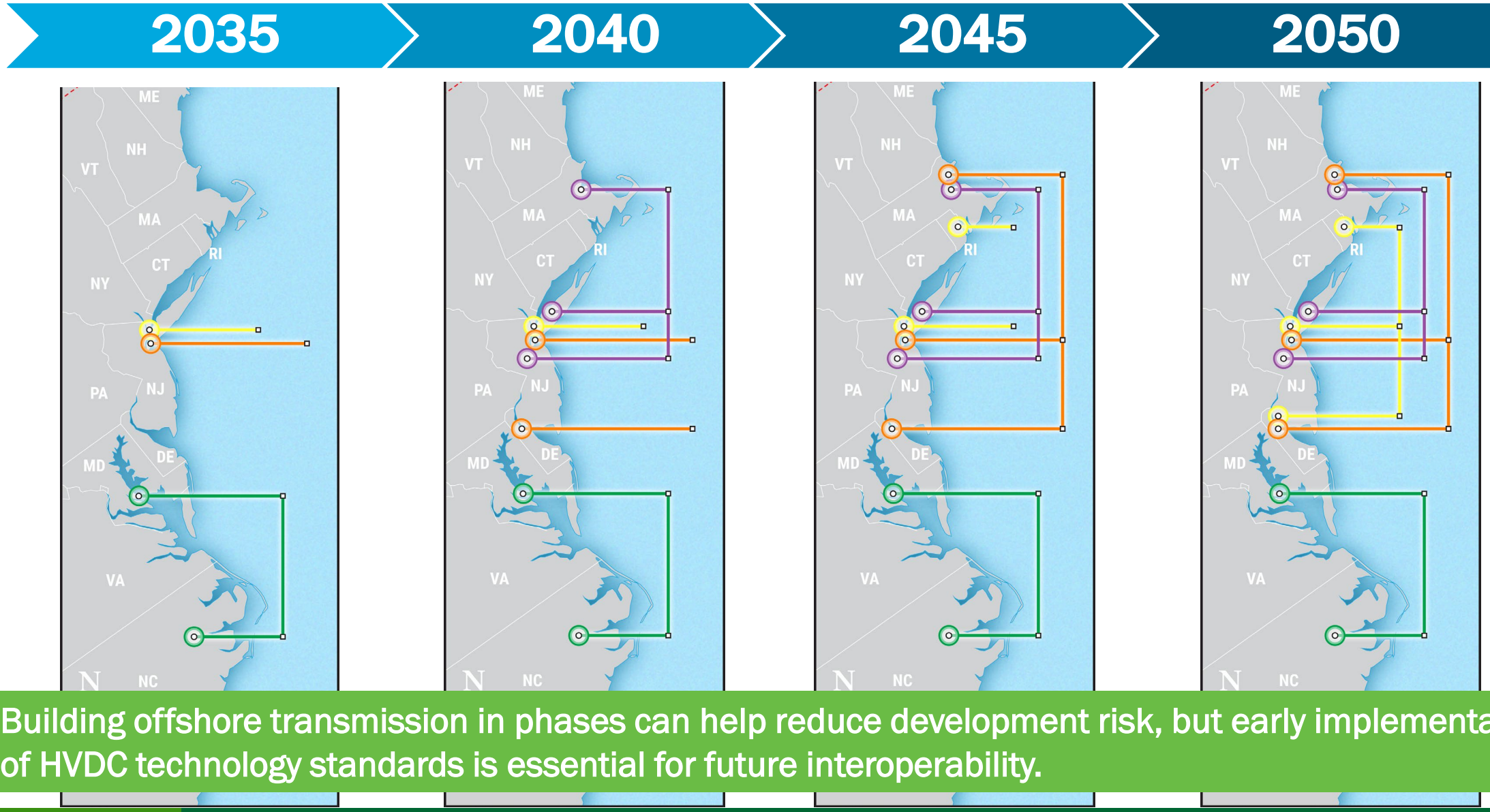
# Study is...

- An analysis of the operation, economics, and reliability implications of different types of offshore wind transmission networks
- A long-term planning analysis of the grid in 2050 in a low carbon scenario
- A focus area from Maine to South Carolina
- Cable routing analysis

# Study is not...

- An interconnection study level of detail for offshore wind injections
- An analysis of impacts of electrification (approximately doubling electricity demand) on the transmission system at all voltage levels (transmission elements below 230 kV are simplified in this study)
- A detailed siting or permitting analysis
- A prescription or suggestion for Points of Interconnection or exact interlinks

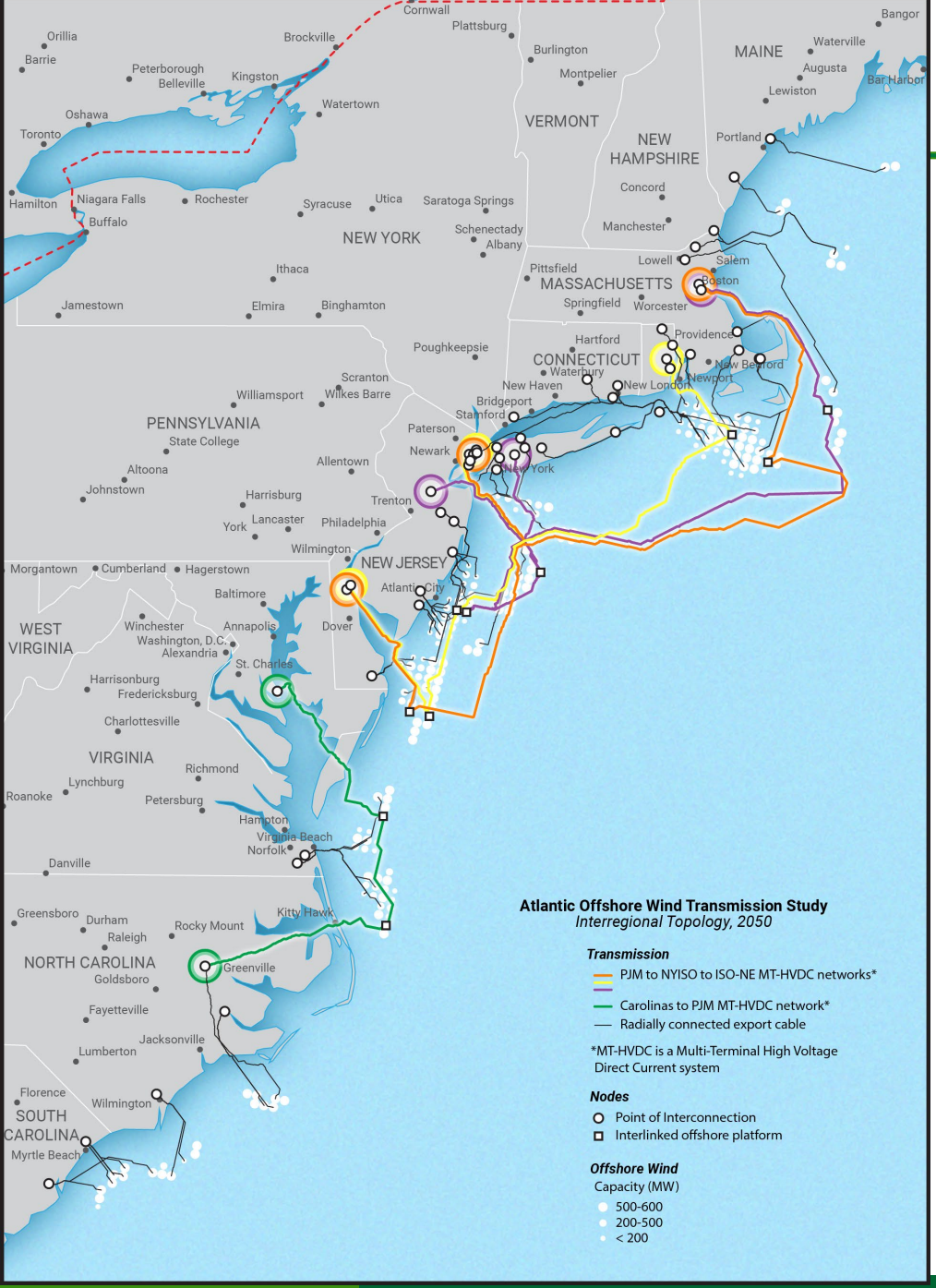
# Transition from Radial 2030 to Interregional 2050

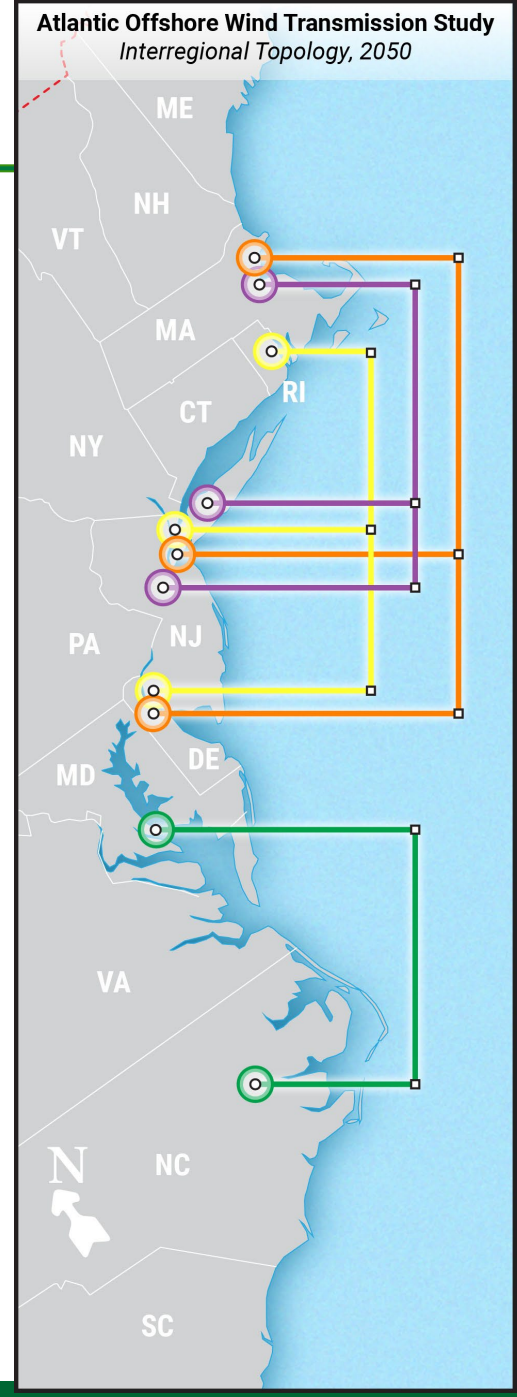



Building offshore transmission in phases can help reduce development risk, but early implementation of HVDC technology standards is essential for future interoperability.

# Interregional Topology

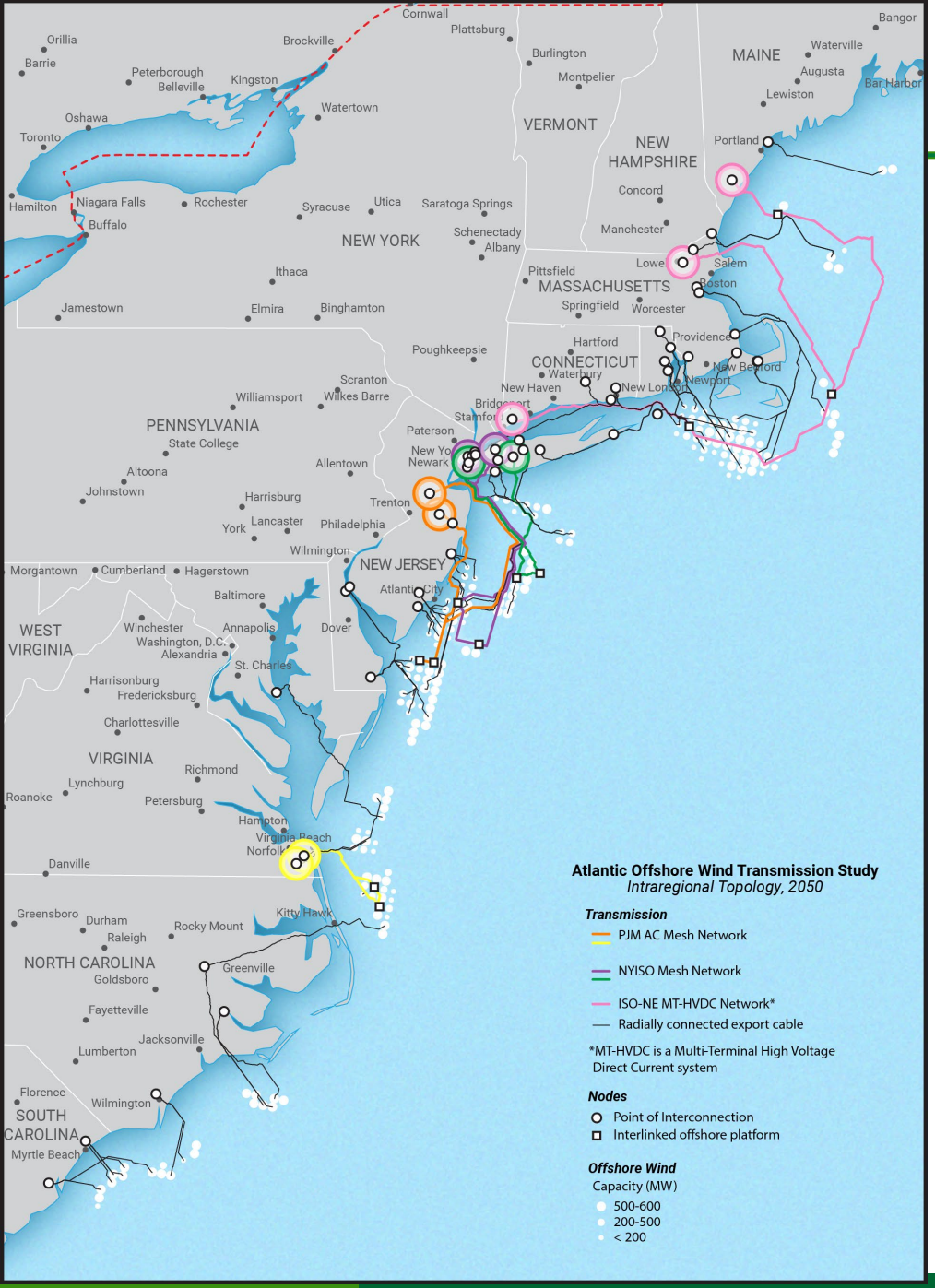
- Hypothetical
- Seven new cables, interlinking 11 platforms
- 14 GW interregional capacity

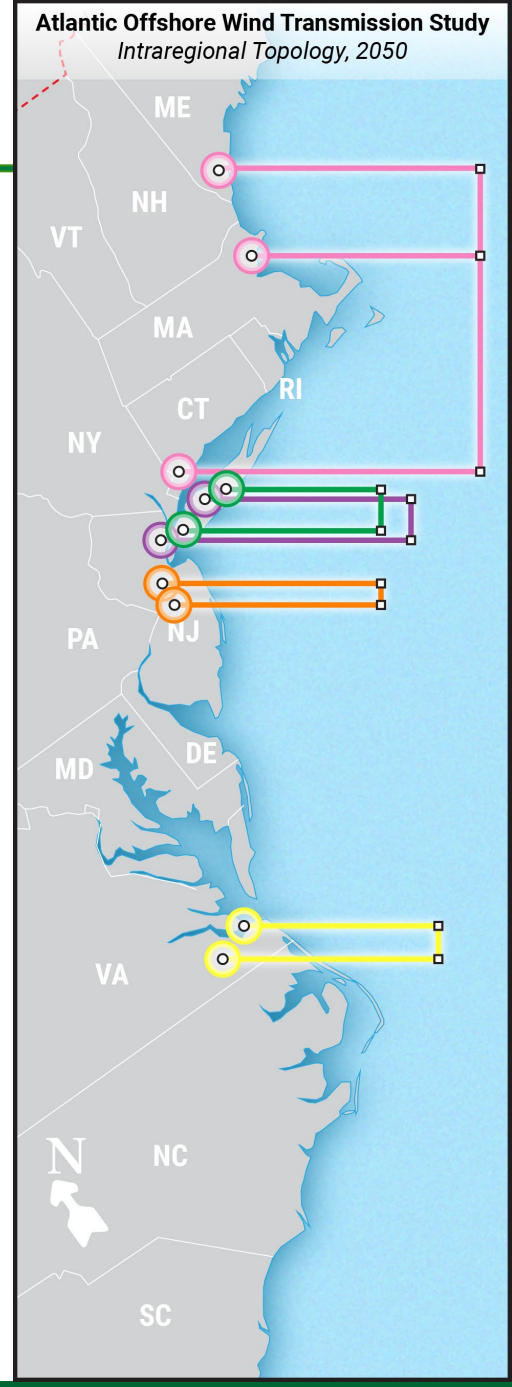


# Intraregional Topology

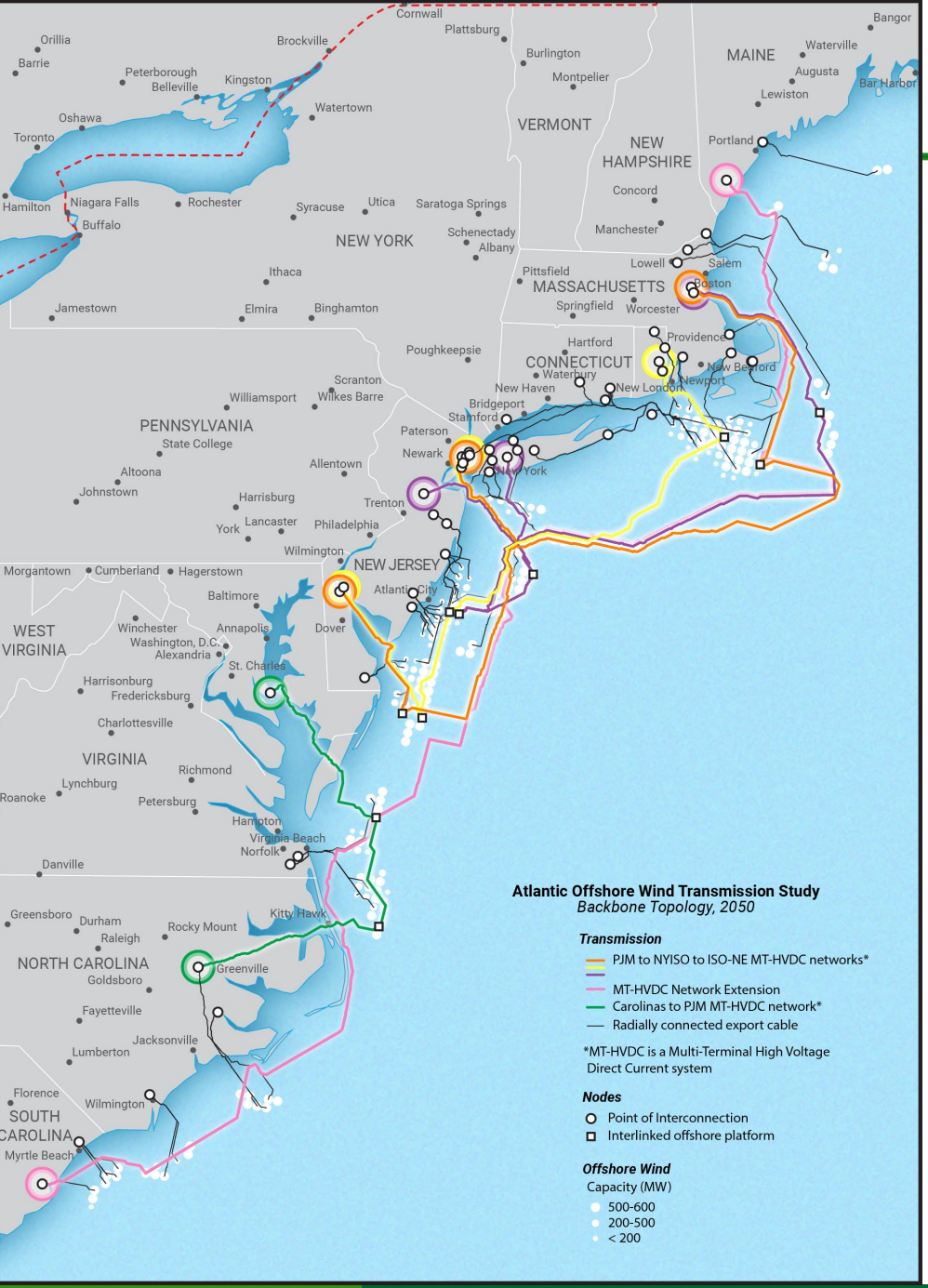
- Six more cables, interlinking 11 platforms
- HVDC in New England, HVAC elsewhere

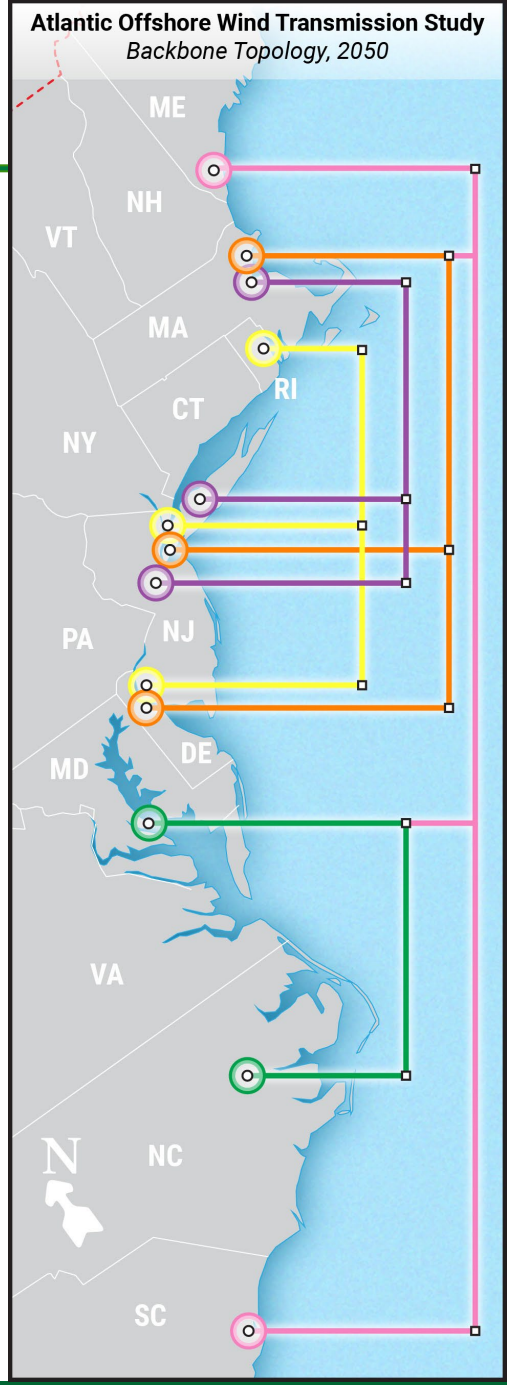


# Backbone Topology

- Added corridor from South Carolina to Maine to the Interregional

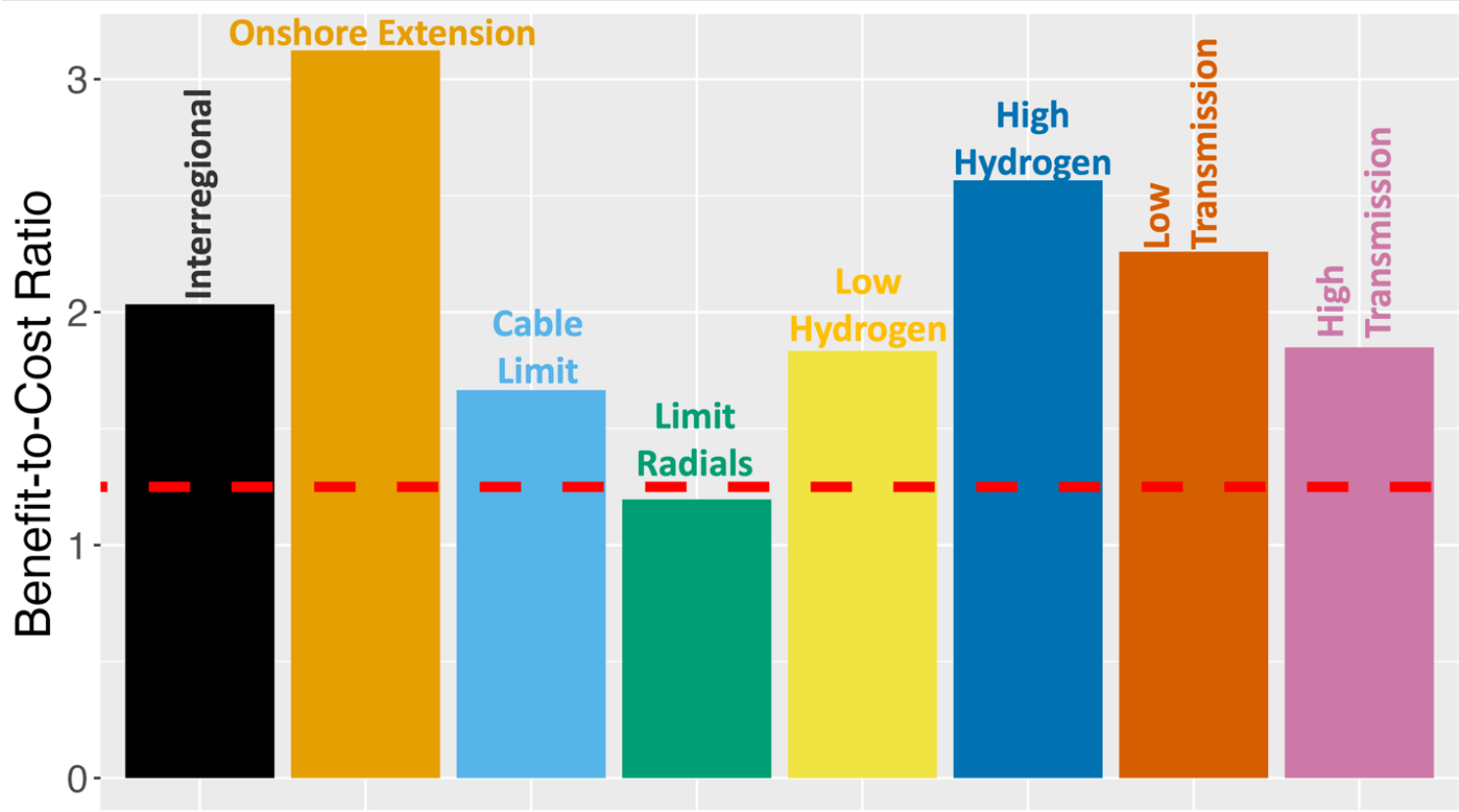


# Positive Benefit to Cost Ratio to wide range of sensitivities

The interregional topology maintains benefit to cost ratio above one with a variety of scenarios:

- *Onshore Extension*: More east-west transmission exists in PJM to access lower-cost renewable power
- *Cable Limit*: Interregional flows limited to 1200 MW
- *Limit Radials*: Radial export cables only flow from offshore to POI (note this is below 1.25)
- *Hydrogen prices*: $20/mmbtu in Interregional, $10 in Low and $30 in High
- *Transmission costs*: +/- 10%



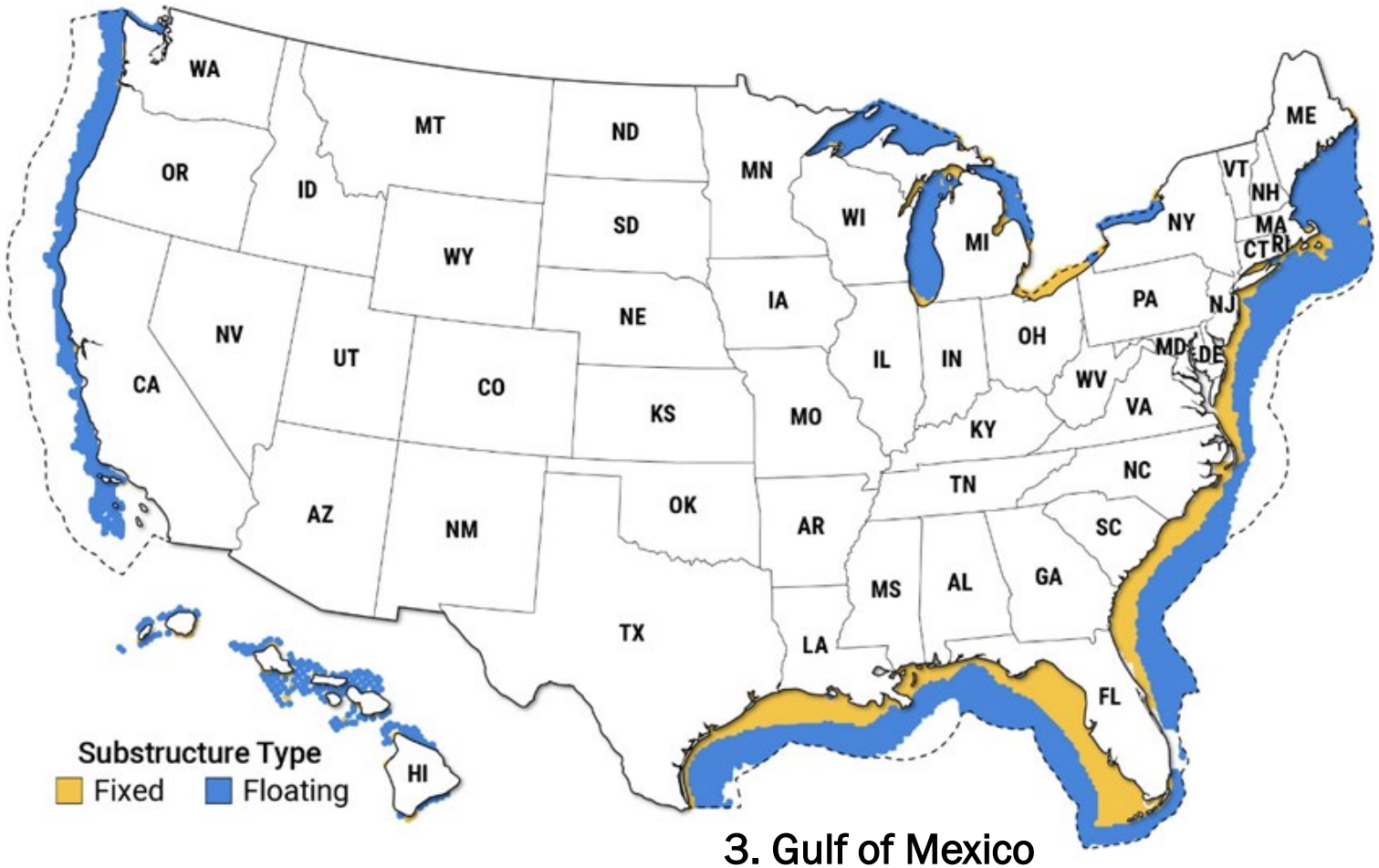

Red line represents 1.25 benefit to cost ratio. Values do not include resource adequacy

# DOE Offshore Wind Transmission Studies

### 3. West Coast

Lit. Review and Gap analysis: Feb 2023

Study:
Launched May 2023




### 1. Atlantic

Lit. Review and Gap analysis: Oct 2021

Study: Mar 2024

Action plan: Sept 2023, Mar 2024

### 3. Gulf of Mexico

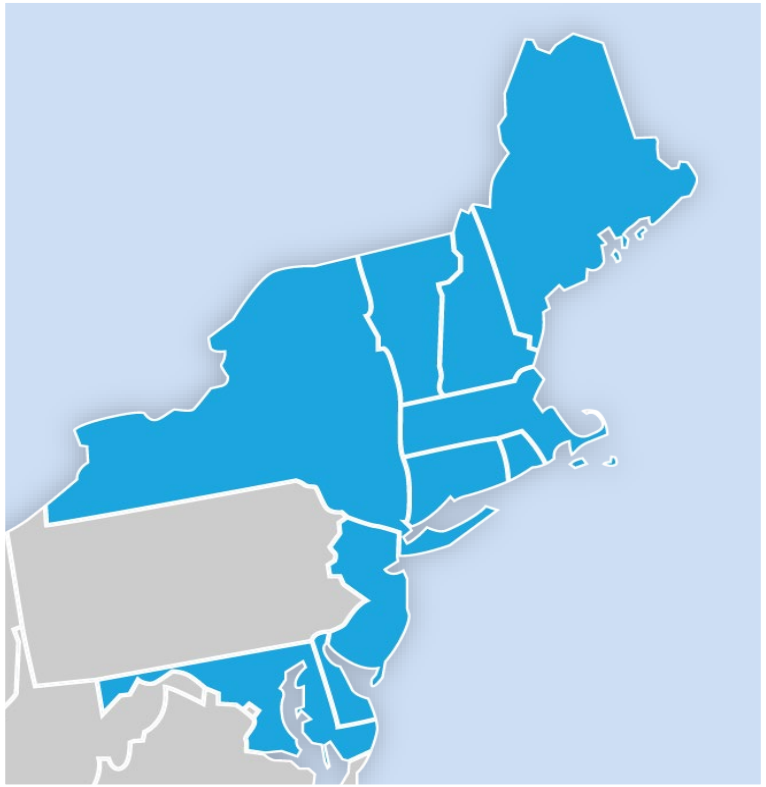
Lit. Review and Gap analysis:
Launched Sept 2023

# Northeast States Collaborative on Interregional Transmiss

Partnership & Collaborations

## Action Plan Recommendation 1.1.1 Offshore Wind Transmission State Collaborative

- Eight northeastern states sent a letter to DOE in June 2023 requesting support for interregional and offshore transmission planning efforts (2 more have joined since).
- Asked DOE to assist in forming a “Northeast States Collaborative on Interregional Transmission”
- The collaborative is working to:
  - identify barriers to economic planning and development of interregional transmission
  - identify potential multi-state projects that may be suitable for ISO/RTO study
  - develop a strategy for state cooperation on technical standards for OSW transmission equipment
- Also closely related to Action Plan Recommendation 1.1.2: Regional Transmission Planning Collaborative



MAINE

NEW HAMPSHIRE

VERMONT

NEW YORK

MASSACHUSETTS

RHODE ISLAND

CONNECTICUT

NEW JERSEY

DELAWARE

MARYLAND

# Tribal Nation Technical Assistance Program

Partnership & Collaborations

## Action Plan Recommendation 1.1.3 Tribal Nation Engagement

- New national program
- Technical assistance and trainings to support Federally Recognized Tribes to successfully engage in transmission planning and development for offshore wind
- The program was informed by conversations with Tribal Nations and is comprised of:

**Capacity Building** (Educational Resources)

Educational events and webinars that may cover topics such as transmission topologies; available technologies and supply chain; siting and permitting; interconnection process; and environmental research. Webinar slides and recordings; virtual trainings; and presentations at national Tribal Nation forums will be made available.

**Expert Match** (Phone-an-Expert)

Consultation with national laboratory subject matter experts to leverage existing expertise and resources.

**Participation Support** (Convening and Event Attendance)

Funding available to Tribal Nation members to participate in offshore wind transmission events.

Continued collaboration with Tribal Nations and integration of Indigenous Traditional Ecological Knowledge into new studies and decision-making.