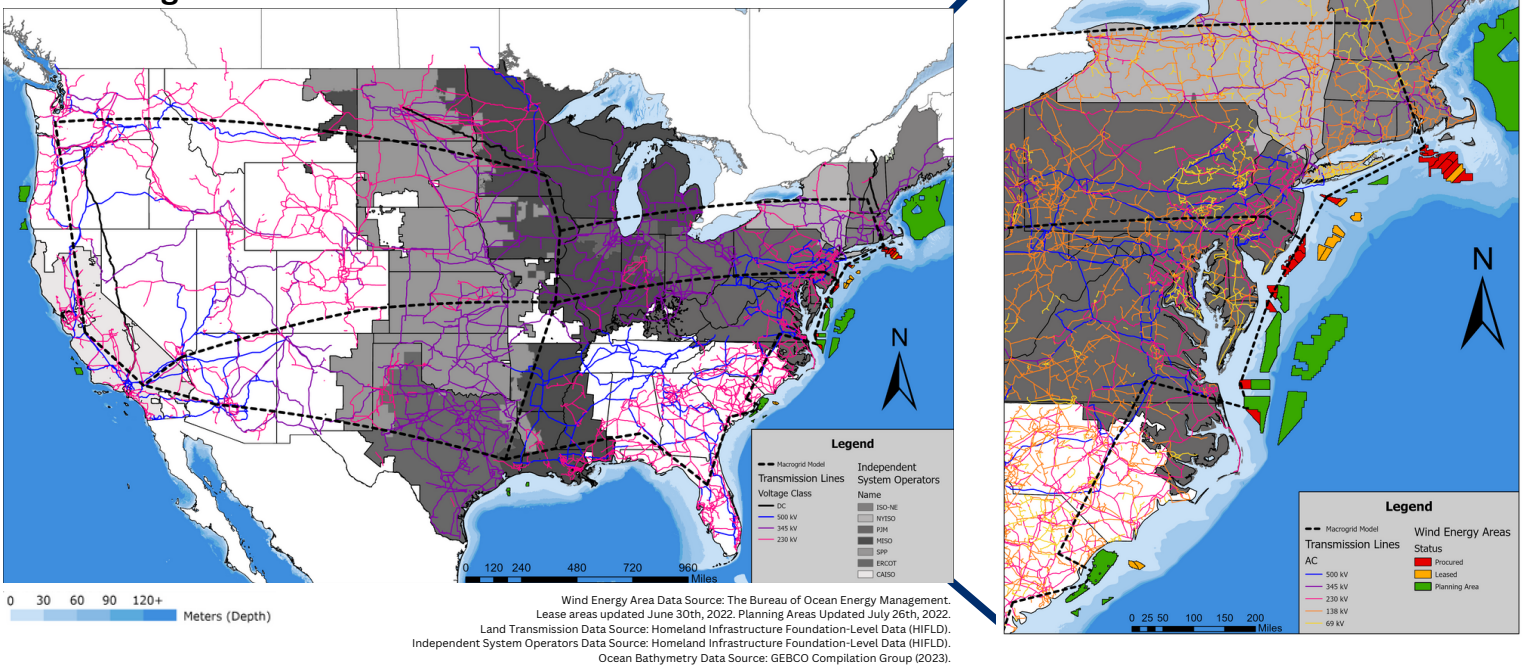
June 2023

East Coast Offshore Wind Transmission

Exploring the technology/policy interface for an 85 GW offshore/onshore transmission system

This brochure reflects the tools and capabilities this team has developed over the past two years. We will be refining the results of this work over the coming months.

The Macrogrid Model



Wind Energy Area Data Source: The Bureau of Ocean Energy Management.
Lease areas updated June 30th, 2022. Planning Areas Updated July 26th, 2022.
Land Transmission Data Source: Homeland Infrastructure Foundation-Level Data (HIFLD).
Independent System Operators Data Source: Homeland Infrastructure Foundation-Level Data (HIFLD).
Ocean Bathymetry Data Source: GEBCO Compilation Group (2023).

OFFSHORE WIND TRANSMISSION AND THE ENERGY TRANSITION

The planning and commissioning of large offshore wind farms off the U.S. East Coast, coupled with unprecedented investments in renewable energy resources, creates significant value in building High Voltage Direct Current (HVDC) transmission in the form of a national macrogrid. The East Coast offshore wind transmission backbone could become the first leg of this new macrogrid, unlocking the U.S. manufacturing and supply chain capabilities needed to transition our energy system.

- Macrogrid's ultra-high capacity enables efficient long-distance, interregional energy transfer
- Multi-regional sharing of electricity and grid services allows least-cost reliable and resilient decarbonization of the nation's electric systems
- Interplay between onshore / offshore wind power and the HVDC macrogrid
- 30-year outlook considers significant wind and solar generation potential in the U.S. and variations in electricity consumption across the multiple time zones
- This project has developed three models to help decisionmakers investigate the role of East Coast offshore wind in the U.S. energy transition:
  - 176-bus macrogrid model
  - 722-bus coordinated expansion planning (CEP) model
  - 93,520-bus full Eastern Interconnect power-flow model and POI optimizer

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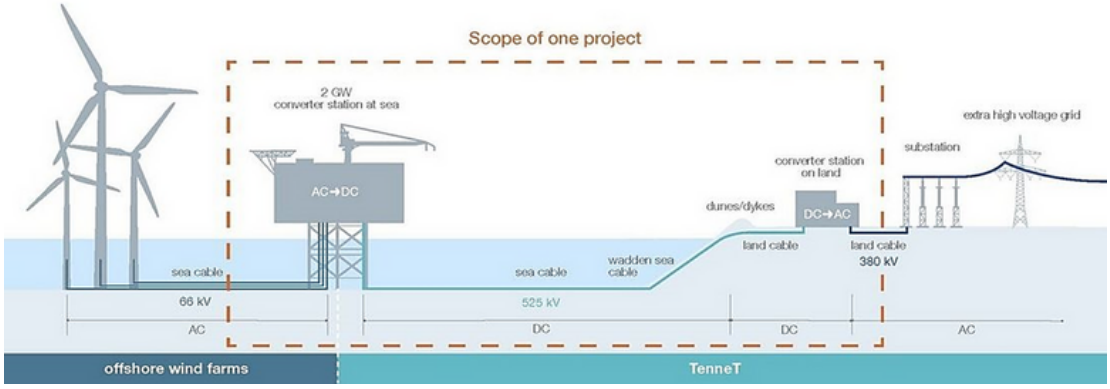
IOWA STATE UNIVERSITY
Department of Electrical and Computer Engineering

Tufts UNIVERSITY

Transmission Backbone: HVDC Technology

TenneT 2GW System

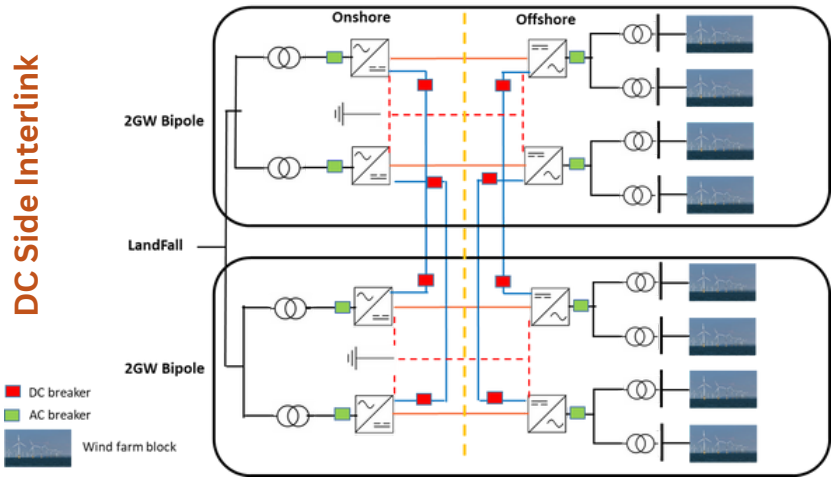


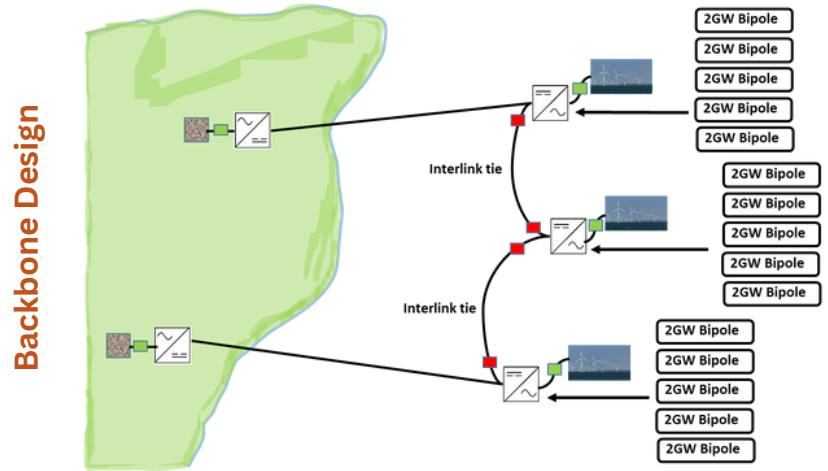
The proposed TenneT 2GW HVDC grid model standardizes the layout for onshore/offshore HVDC substations. This system informs the recommended HVDC system design.

RECOMMENDED DESIGN

- **Topology**: Starting point for U.S. offshore grid should be a back-bone design
- **Voltage**: North American grid should be planned for 525kV instead of 325kV
- **HVDC links**: Bipole is a more promising solution than monopolar
- **Offshore platforms** should be standardized, TenneT 2GW standard could be helpful
- **Converters**: Voltage Source VSC-HVDC technology should be utilized in onshore/offshore converter stations and platforms

Connecting HVDC Transmission



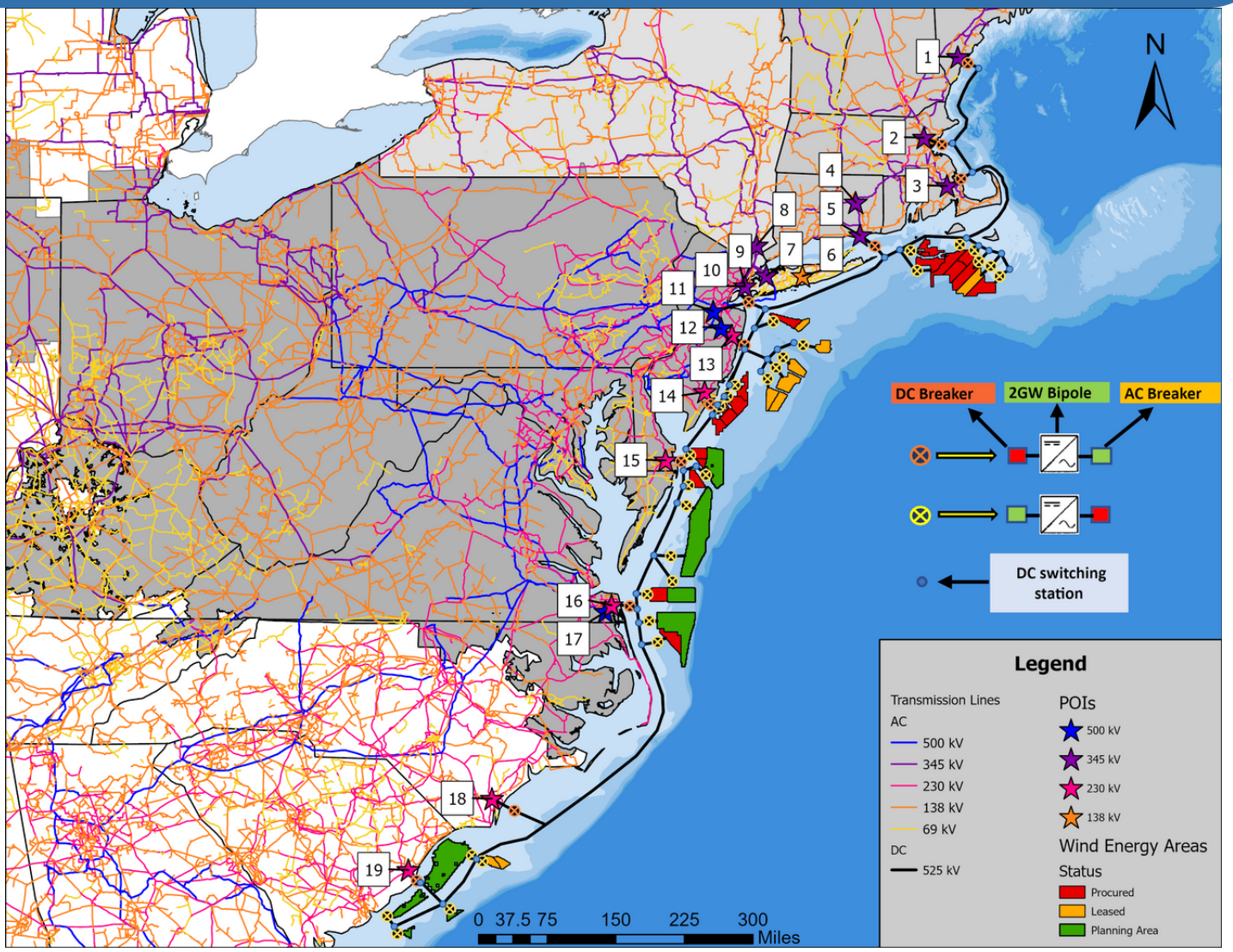


LOOKING AHEAD:

- Initiate full-scale multi-vendor, multi-purpose, multi-terminal HVDC network pilot
- Create new tools and modeling approaches for integrated AC/DC system studies
- Develop DC switchgear
- Anticipate spare bay and space requirements
- **Cost allocation in case of multi-state involvement would be cumbersome. This demands national energy policy for all stakeholders (FERC, NERC, DOE, ISOs, RTOs) engagement and coordination**

76 GW Offshore Wind Study

PRELIMINARY 76 GW OFFSHORE HVDC BACKBONE



POI Identification

POI		kV	State	Capacity (MW)
ISO-NE				
1	Maguire Road	345	ME	4000
2	Woburn	345	MA	4000
3	Carver	345	MA	4000
4	Card Street	345	CT	4000
5	Millstone	345	CT	4000
	Total			**20000**
NYISO				
6	Holbrook	138	NY	2000
7	Shore Road	345	NY	4000
8	Millwood	345	NY	6000
9	Farragut East	345	NY	4000
10	Farragut West	345	NY	4000
	Total			**20000**
PJM				
11	Deans	500	NJ	6000
12	Smithburg	500	NJ	6000
13	Larrabee	230	NJ	4000
14	Cardiff	230	NJ	4000
15	Indian River	230	DE	2000
16	Landstown	230	VA	4000
17	Fentress	500	VA	4000
	Total			**30000**
South				
18	Sutton	230	NC	2000
19	Winyah	230	SC	4000
	Total			**6000**
EAST COAST				**76000**

Putting 76 GW in Context

Complementary to the Department of Energy's Atlantic Offshore Wind Transmission Study, this project investigates an integrated offshore-onshore grid with fewer landing points, lower environmental impact, and reinforced POIs with capacities up to 6 GW.

As we work toward studying 200-300 GW injections, currently planned OSW projects accounting for approximately 5-10% of the overall goal are not included. This simplification centers our project on understanding the prevailing local and regional power flows within the Eastern Interconnect.

Scaling from 30 GW to 85 GW for this milestone, we discovered the need for a new system perspective at around 76 GW, beyond which a controllable transmission backbone offers important benefits to system reliability.

Regional Coordination and Policy

POLICY CONSIDERATIONS

- Anticipating realistic timelines: assume at least 10 years to plan and build after BOEM approval
- Building common technological knowledge and expectations
- Focusing on community development and environmental justice
- Developing technical standards compatible with the existing system
- Creating regional frameworks
  - Transferring power among regions
  - Costing the transfer among RTOs and markets
  - Considering diversity of resources among regions and impacts of local constraints
- Advancing the labor pool and skill set development

NEXT STEPS:

Offshore Wind Governance for Public Interest

- **Develop** appropriate Governance structures to facilitate deployment within an environmental justice framework
- **Devise** a collaborative stakeholder and partnership where private and public sector roles operate distinctly
- **Deploy** appropriate technology and at faster speed
- **Rationalize** regional efficient energy markets

RECENT DEVELOPMENTS

On June 16th 2023, the New England states, New York, and New Jersey submitted a request to the DOE for a new interregional transmission planning process in the Northeast led by the DOE . With a focus on system reliability and transition to a clean energy system, we expect this process will become more robust.

TRANSMISSION COORDINATION IN THE US

In the 1940s, a significant drought reduced hydropower in the Northwest and increased a regional drive to link the Northwest and Southwest HVDC systems. Combined with energy shortage concerns in the Northwest and California and a federal interest in a connected power grid for national defense, the Pacific Intertie was born.

The construction of the NW/SW intertie was driven by:

- **Federal support** through the Bureau of Reclamation and Federal Power Commission
- **Active presence** of the Bonneville Power Administration
- **Regional drive** to share power generation and alleviate energy shortages
- **Formal plan** for a federally constructed intertie that served as a "yardstick" and motivated non-federal parties to participate in meaningful negotiations

Acknowledgement and Disclaimer:
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