Seeking a Landing Point

TRANSMISSION NEEDS FOR U.S OFFSHORE WIND GENERATION

PRESENTED TO

Offshore WINDPOWER Conference
Washington, DC

PRESENTED BY

Michael Hagerty

Co-authors: J. Pfeifenberger, J. Chang, A. Sheilendranath

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Agenda

Background

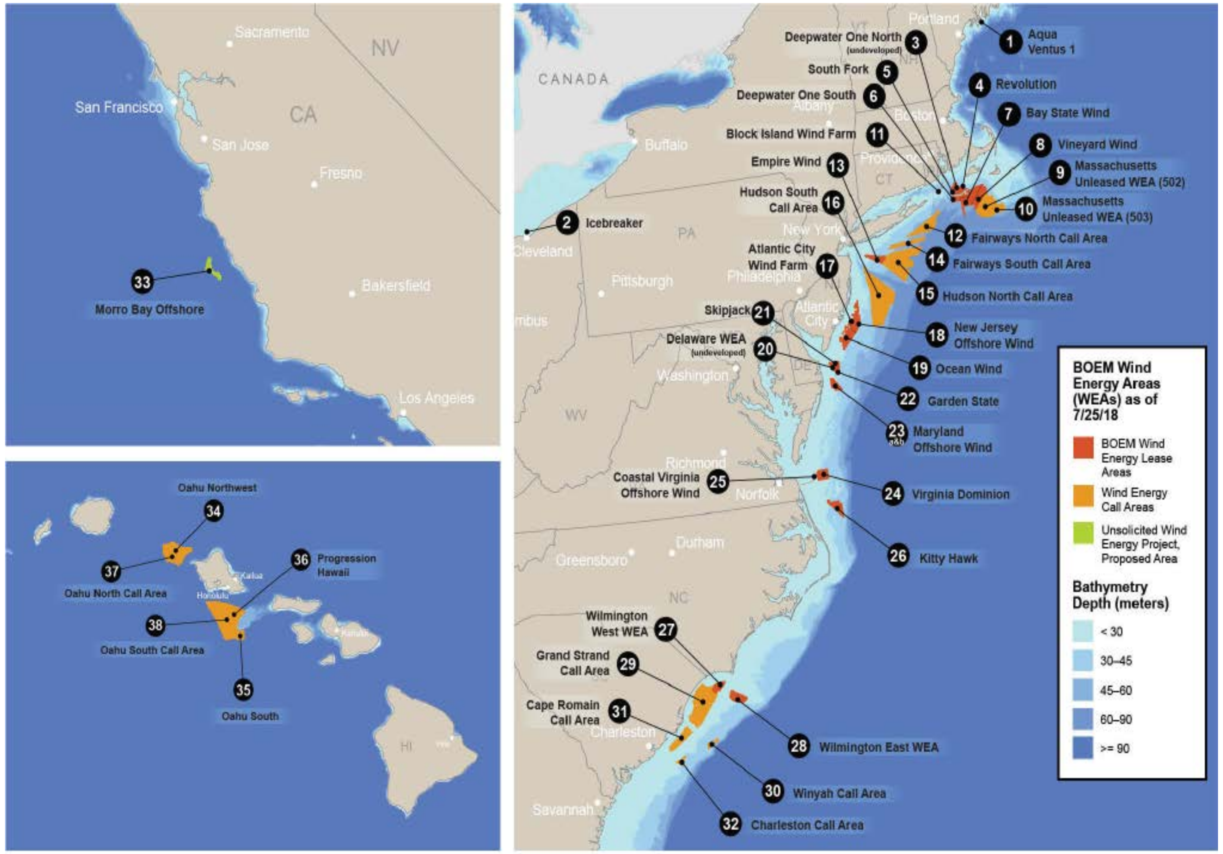
Scale of Offshore Wind Transmission Needs

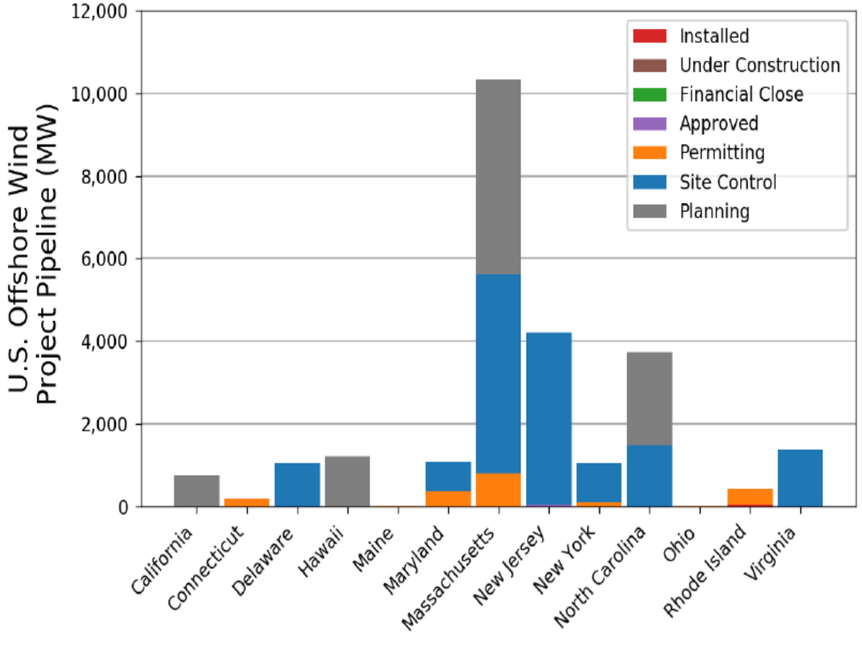
Gen-Ties versus Offshore Grids

Takeaways

Currently Proposed U.S. Offshore Wind Projects

- 5 projects selected for near-term development (1,900 MW), in MA, CT, RI, MD and NY
- 18 projects with site control (14,585 MW), mostly in Mid-Atlantic and New England
- 28 projects "under development" (25,435 MW)





U.S. Project Pipeline by State as of June 2018

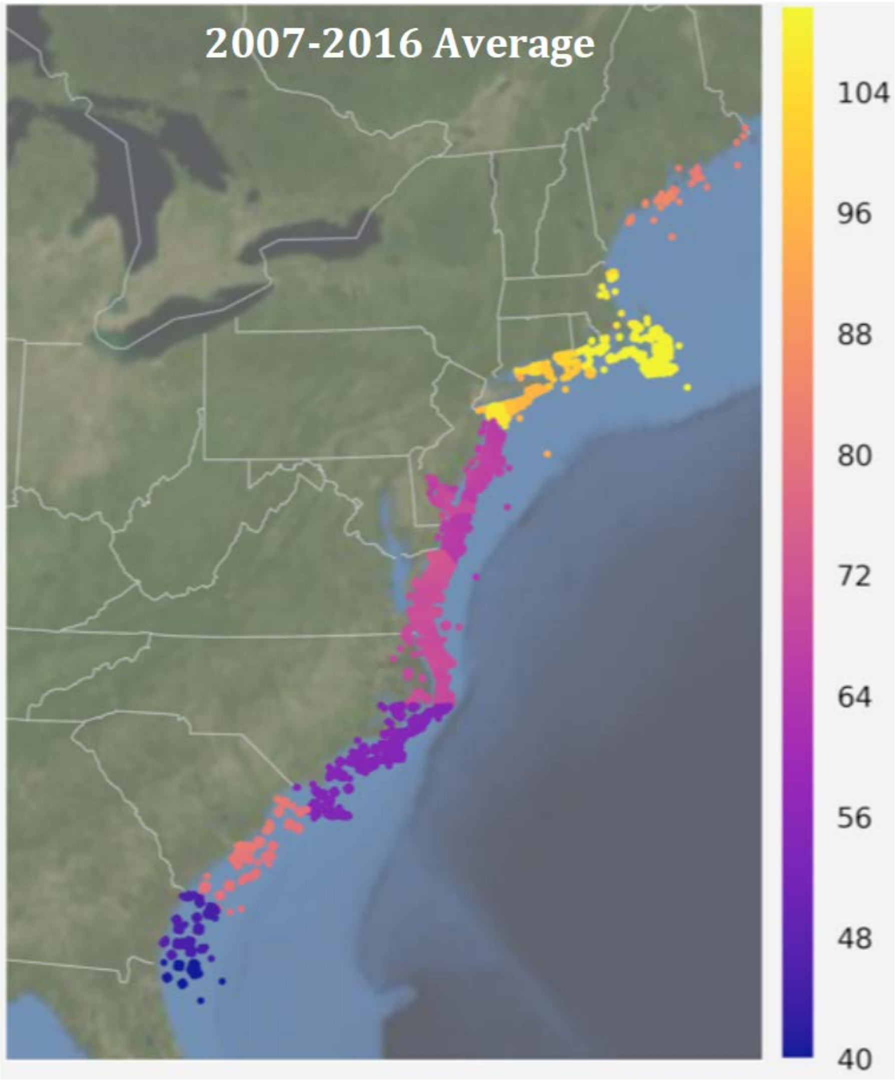
Source: Beiter, Musial, et al. 2018. *2017 Offshore Wind Technologies Market Update. Figure "U.S. Offshore Wind Lease and Call Areas"; Figure " U.S. Project Pipeline by States as of June 2018"*

Market Value of Offshore Wind in the U.S.

LBNL estimated the total market value of offshore wind generation based on historical market prices for energy, capacity, and RECs:

- Highest value in New England at $110/MWh
- New York: $100/MWh
- Mid-Atlantic (PJM): $70/MWh
- South of PJM: $40-55/MWh

Total costs of Vineyard Wind (MA) is likely in the $70 – 85/MWh range, after accounting for the capacity market value



Source: LBNL (2018). Estimating the Value of Offshore Wind Along the United States' Eastern Coast
http://eta-publications.lbl.gov/sites/default/files/offshore_erl_lbnl_format_final.pdf

Implications for Offshore Transmission

U.S. offshore wind development will require substantial offshore transmission infrastructure

- The 8,000 MW of committed off-shore wind development in MA, NY and NJ will require about 600-1,200 miles of offshore transmission plus onshore reinforcements
  - To integrate 8,000 MW with single 220kV HVAC gen-ties for every 400 MW of wind plants (30-60 miles offshore) would require 20 landing points with associated onshore grid interconnections reinforcements
  - Ørsted estimated that transmission can be 15%-20% of total off-shore wind capex.
  - Siemens estimated the cost-based cross-over point from AC to DC technology to be around more than 300-400 MW and more than 60 miles
- Integrating 15,000-24,000 MW of already proposed offshore wind plants will almost certainly require the development of some (networked) offshore grids and approximately 3,000 miles of offshore transmission lines

Sources: Sunny Gupta (2018). "Developer's Perspective on Transmission", Orsted, p. 9. Kevin Pearce (2018). "Transmission Solutions for the U.S. Offshore Wind Market Global Transmission Offshore Wind Conference", Siemens, p. 5.

Offshore Transmission Needs for Current Procurement Goals

MA, RI, CT: 40 to 90+ miles from interconnections with on-shore grid

	State	Owner	Approximate Total Cable Route Length (Miles)	Approximate Land Cable Route Length[32]	Approximate Submarine Cable Route Length	Substation Improvement for a 1,000 MW Project	Proximity of Potential Converter Station Parcel	Rank
Brayton Point	MA	National Grid	45 – 95	<1	45 – 95	$10M	Close	Tier 1
Canal	MA	NSTAR	60 – 100	10	50 – 90	$2.5M	Close	Tier 1
Kent County	RI	National Grid	51 – 96	1	40 – 95	$2.5M	Close	Tier 1
Carver	MA	NSTAR	65 – 105	20	45 – 85	$2.5M	Not Close	Tier 2
Oak Street	MA	NSTAR	50 – 60	10	45 – 60	$2.5M	Not Close	Tier 2
Millstone	CT	Northeast Utilities	60 – 120	<1	60 – 120	$2.5M	Close	Tier 3
Montville	CT	Northeast Utilities	65 – 130	<1	65 - 130	$2.5M	Close	Tier 3

Sources: Northeast Offshore Wind Regional Market Characterization (2017) https://www.northeastwindcenter.org/wp-content/uploads/Northeast-Offshore-Wind-Regional-Market-Characterization.pdf ESS Group (2014) Offshore Wind Transmission Study: Final Report http://files.masscec.com/research/MassCECOSWTransmissionStudy.pdf

New York: wind energy area located 14-30 miles offshore

- Limited by shipping lanes emanating from New York City
- Limited interconnection opportunities with on-shore grid

New Jersey: wind areas in southern NJ, approx. 17 miles from shore

- Beyond Oyster Creek, the onshore grid in southern NJ is fairly weak, likely requiring
  - (1) significant reinforcements of the on-shore grid at local landing points or
  - (2) build off-shore connections to more robust but more distant landing points (e.g., in northern NJ)

Offshore Gen-Ties vs. Offshore Grids

Advantages of gen-ties to interconnect individual offshore wind plants:

- Offshore wind plant and transmission can be developed, financed, and constructed in parallel by individual companies
- Developers may be more likely to seek out low-cost alternatives
- Development of individual wind plants does not depend on common offshore transmission infrastructure becoming available in time
- More cost effective for limited wind development and short distances

Advantages of offshore grids to integrate multiple offshore wind plants:

- More cost effective for large-scale developments that are far offshore or in locations with onshore limitations (few landing points, sensitive shoreline)
- Reduced risk that gen-ties for initial wind plants inefficiently use up available rights-of-ways, blocking subsequent developments
- Better coordination with and reinforcement of onshore grid
- Added offshore redundancy due to meshed configuration
- Open access to enable more competition between wind developers
- Competition between experienced transmission developers

Choosing between Gen-Ties and Offshore Grids?

Factors favoring offshore grids to serve multiple wind plants

- **Large size of total commitment with sizable individual steps**
  - Greater than 1,400 MW and procured within a few years?
- Several plants close to each other but long distances from shore or from sufficiently-robust onshore transmission nodes
  - Greater than 40 miles?
- **More efficient use of right-of-way**
  - Few landing points with robust on-shore transmission
  - Difficult permitting of landing points and onshore interconnection study process
- Network benefit (offshore redundancy and reinforcement of on-shore grid)
- Create level playing-field for wind developers through open access to hubs
- Create competition between experienced offshore transmission developers

Factors favoring gen-ties to individual offshore wind plants

- Modest total development and small incremental steps
  - 200-400 MW plants only?
- Modest distance from shore
  - Less than 40 miles?
- Long distance between offshore locations to be interconnected
- Many landing points with robust on-shore transmission infrastructure
  - 4-8 for every 1,600 MW of total development?
- Easy permitting of landing points and interconnection study process
- Wind developers have significant offshore transmission experience

Takeaways

U.S poised to make significant investments in offshore wind in the next decade that are close to major load centers and higher-priced power markets

- 30 MW installed
- 4,000 MW on-deck
- 9,000 MW of existing state-level commitments by 2030
- 25,000 MW of proposed projects

This scale will likely require 600-1,000 miles (up to 3,000 miles) of offshore transmission infrastructure to integrate proposed projects

- **Gen-ties** to individual offshore wind plants that are within 30 miles from shore (and far from other plants) can be cost effective
- **Offshore grids** with open access can offer significant cost and competitive advantages for interconnecting large amounts of wind generation

PRESENTED BY

Michael Hagerty

Senior Associate, Washington, DC
+1.202.419.3323
michael.hagerty@brattle.com

Michael Hagerty is a Senior Associate with over 5 years of consulting experience in electricity wholesale market design, transmission planning and development, renewable and climate policy analysis, and strategic planning for utility companies. Michael has analyzed approaches to improving long-term transmission planning considering a wider-range of benefits of transmission, and analyzing those benefits for a set of proposed transmission portfolios. In addition, Michael has focused on analyzing opportunities and challenges of existing and proposed renewable energy and climate policies, including the EPA’s Clean Power Plan (CPP), state-level Renewable Portfolio Standards (RPS), and California’s GHG cap-and-trade market.

Mr. Hagerty holds an M.S. from the Massachusetts Institute of Technology and an B.S. in Chemical Engineering from the University of Notre Dame

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