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Offshore Wind Transmission:

AN ANALYSIS OF NEW ENGLAND AND NEW YORK OFFSHORE WIND INTEGRATION

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Presenting today

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Johannes (Hannes) Pfeifenberger, a Principal at The Brattle Group, is an economist with a background in electrical engineering and over twenty-five years of experience in wholesale power market design, renewable energy, electricity storage, and transmission. He also is a Senior Fellow at Boston University's Institute of Sustainable Energy (BU-ISE), a Visiting Scholar at MIT's Center for Energy and Environmental Policy Research (CEEPR), and serves as an advisor to research initiatives by the Lawrence Berkeley National Laboratory's (LBNL's) Energy Analysis and Environmental Impacts Division and the US Department of Energy's (DOE's) Grid Modernization Lab Consortium.

Most recently, Mr. Pfeifenberger evaluated offshore wind transmission options in New York State and New England, discussed role of offshore wind in economy-wide decarbonization on a panel organized by the Atlantic Council, and presented on offshore wind development trends, transmission needs, and renewable integration challenges at a number of industry meetings, including the Harvard Electricity Policy Group.

Mr. Pfeifenberger received an M.A. in Economics and Finance from Brandeis University's International Business School and an M.S. and B.S. ("Diplom Ingenieur") in Power Engineering and Energy Economics from the University of Technology in Vienna, Austria.

Motivation: Substantial off-shore wind development planned in northeast

Thousands of MW of new clean resources will need to be built to achieve decarbonization goals in New York and New England—including substantial offshore wind beyond current commitments.

A key policy challenge is **ensuring a pathway to enable the lowest-cost solutions** for delivering new clean energy from source to population centers

Region	Already Contracted	Total Committed	Potentially Needed
New England	3,112 MW	5,900 MW	25-40,000 MW by 2050
New York	4,316 MW	9,000 MW	10-25,000 MW by 2040

Mid-Atlantic states account for another 15,000 MW of OSW commitments

Sources:

Brattle Study of NE by Jurgen Weiss and Michael Hagerty, "Achieving 80% GHG Reduction in New England by 2050," September 2019.
Brattle Study for NYISO by Roger Lueken et al., "New York's Evolution to a Zero Emission Power System: Modeling Operations and Investment Through 2040." May 18, 2020. E3, "Electric Reliability under Deep Decarbonization in New England," August 4, 2020. E3, "Pathways to Deep Decarbonization in New York State," June 24, 2020. https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind/Focus-Areas/NY-Offshore-Wind-Projects. Initial Report on New York Power Grid Study, January 19, 2021.

Project scope and approach

In separate studies of New England and New York, we examined approaches to developing offshore transmission and associated onshore grid upgrades to reach stated offshore wind (OSW) development goals

We examined two alternatives:

1. The **"generator lead line" approach:** developers develop incremental amounts of OSW generation with project-specific generator lead lines (GLLs)
2. An alternative **"planned" approach:** Offshore transmission and onshore grid upgrades are planned to minimize overall risks and costs of achieving offshore wind and clean energy goals

The following slides provide an overview of the planned grid approach and summarize results from our two studies

Summary: the benefits of a <u>planned</u> offshore transmission approach

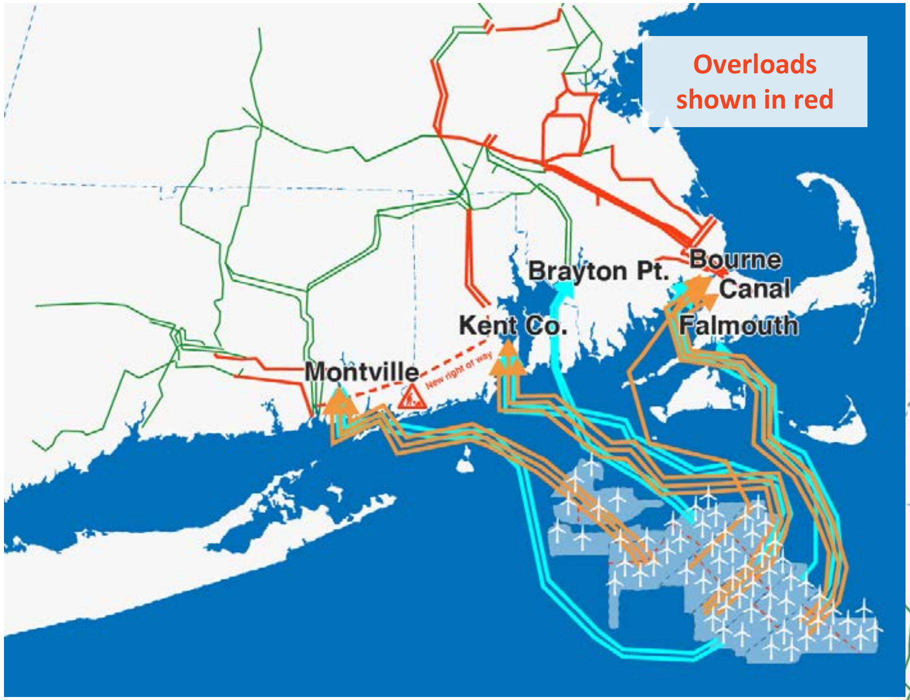
We find results that are qualitatively similar for New England and New York …

Elements we examine	A planned approach shows…
Total onshore + offshore transmission costs • **Onshore transmission upgrade costs** (more risk) • **Offshore transmission costs** (less risk)	Lower overall costs in both NE & NY • Substantially lower onshore costs • Slightly higher offshore costs
Losses over offshore transmission	Reduced losses
Impact to fisheries and environment	Substantially lower impacts
Effect on generation & transmission competition	Increased competition
Utilization of constrained landing points	Improved landing point utilization
Enabling third-party customers	Improved third-party participation

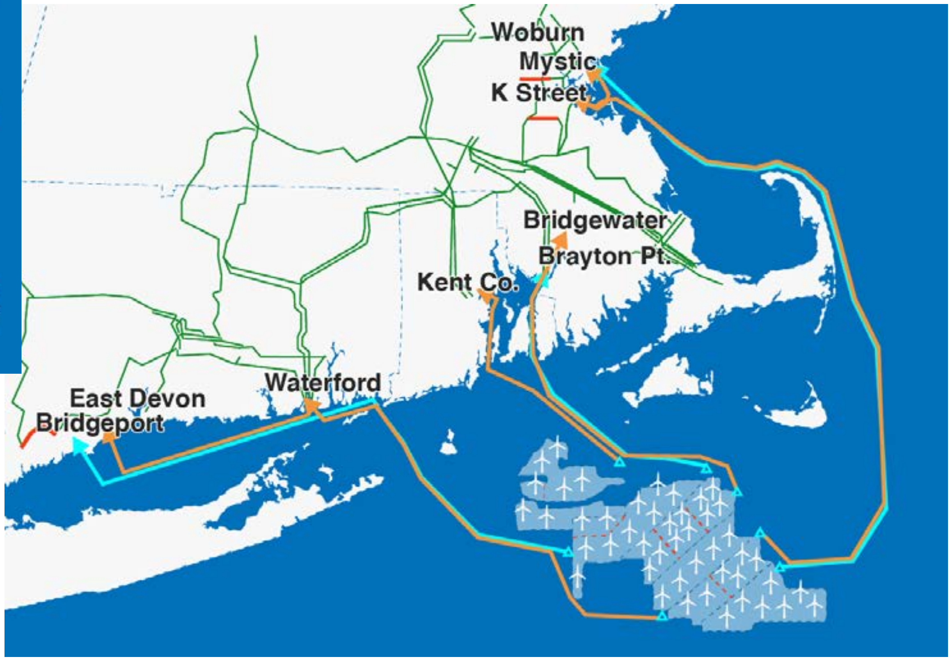
Overview of the Planned Grid Concept

Summary of two transmission approaches studied in New England (~8,400 MW OSW)

Current GLL Approach

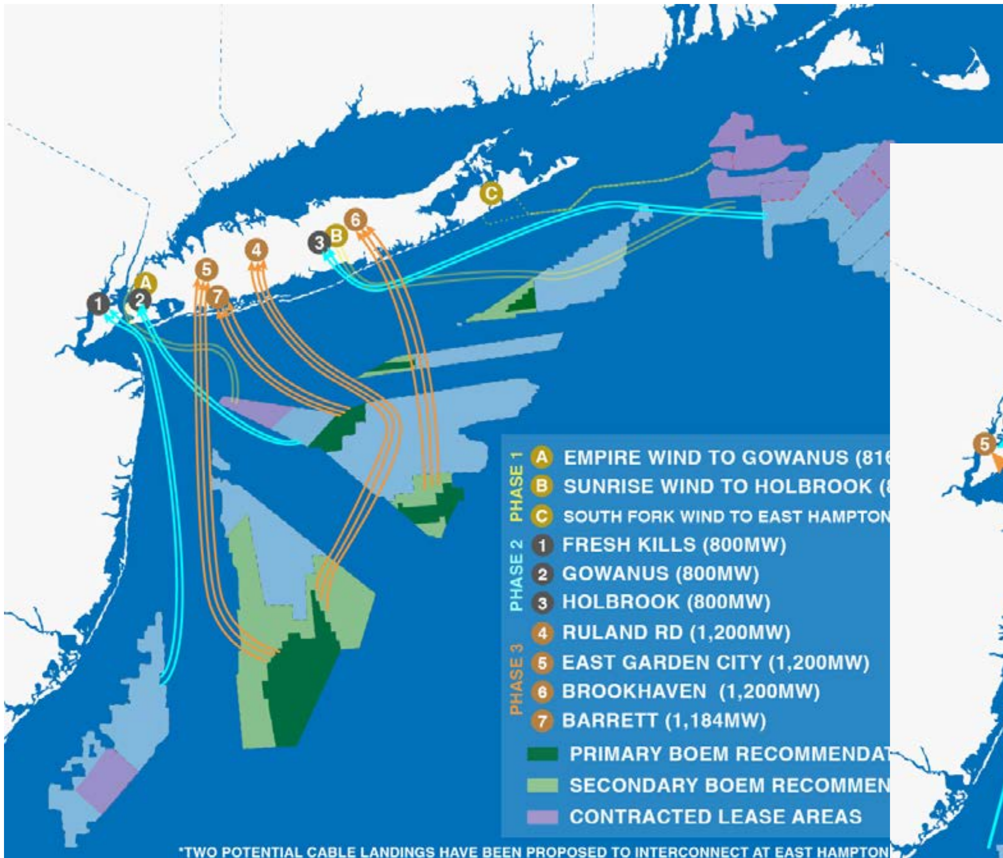


Planned Approach

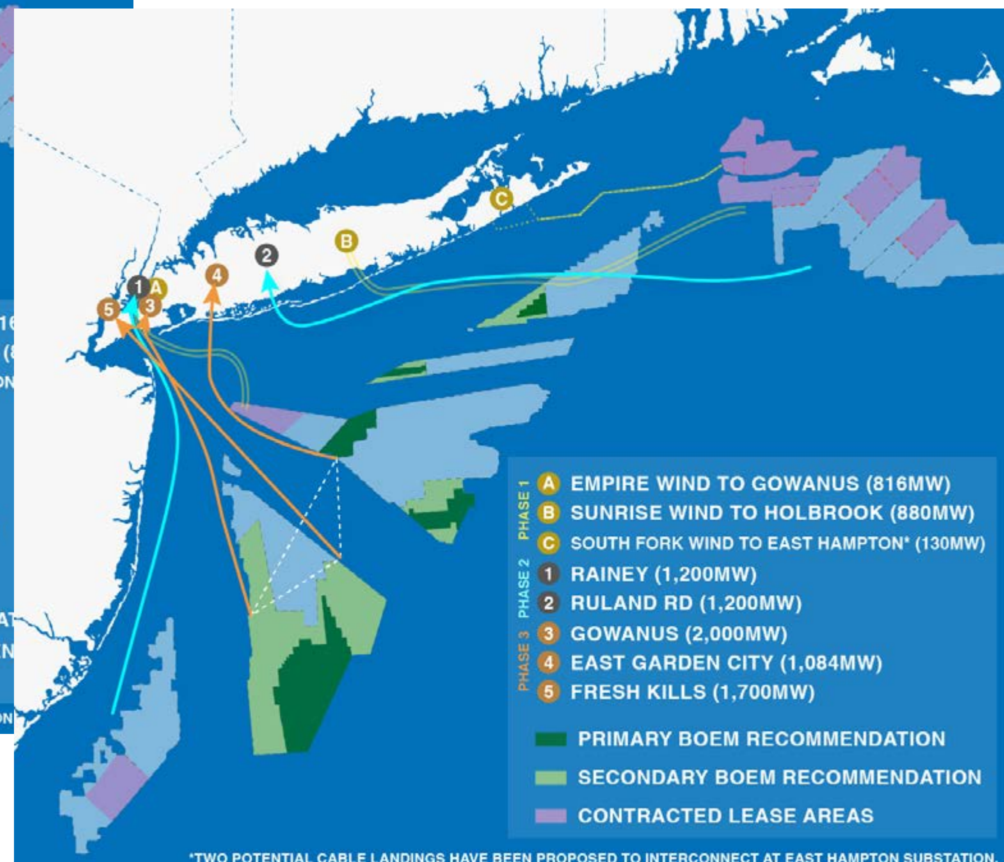


Summary of two transmission approaches studied in NY (9,000 MW OSW)

Current GLL Approach



Planned Approach



Note: Phase 1 is already contracted using HVAC cables. NYSERDA since has provisionally awarded two additional projects for 2490 MW, interconnecting into the Astoria (using HVDC) and Barrett substations.

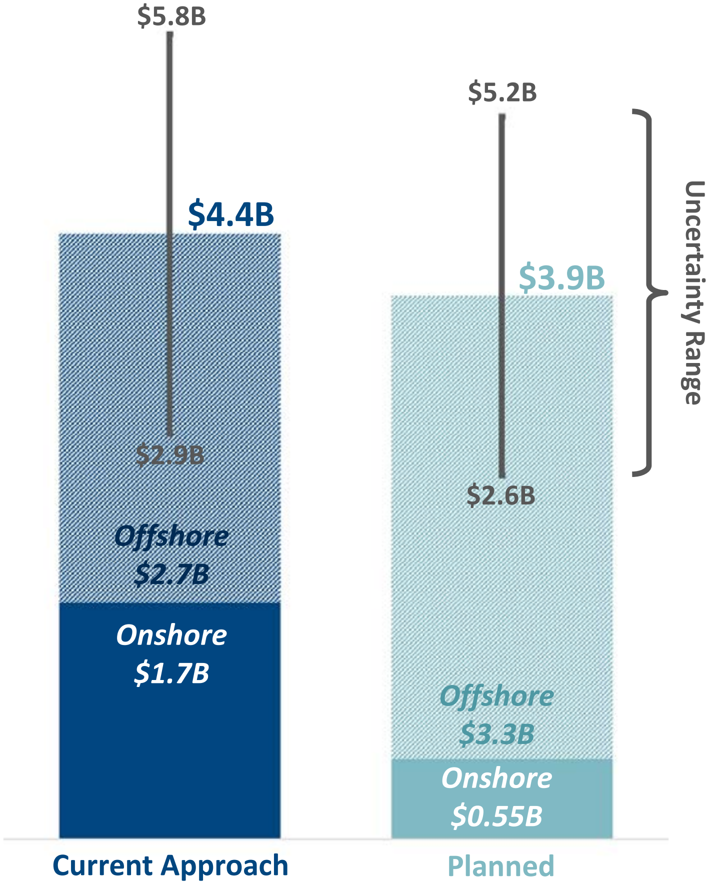
Benefits of a Planned Grid

Total costs of transmission are expected to be lower under a planned approach

Even including the more costly offshore transmission equipment, total costs of onshore upgrades plus offshore transmission are estimated to be lower under a planned than the current GLL approach in both New England and New York

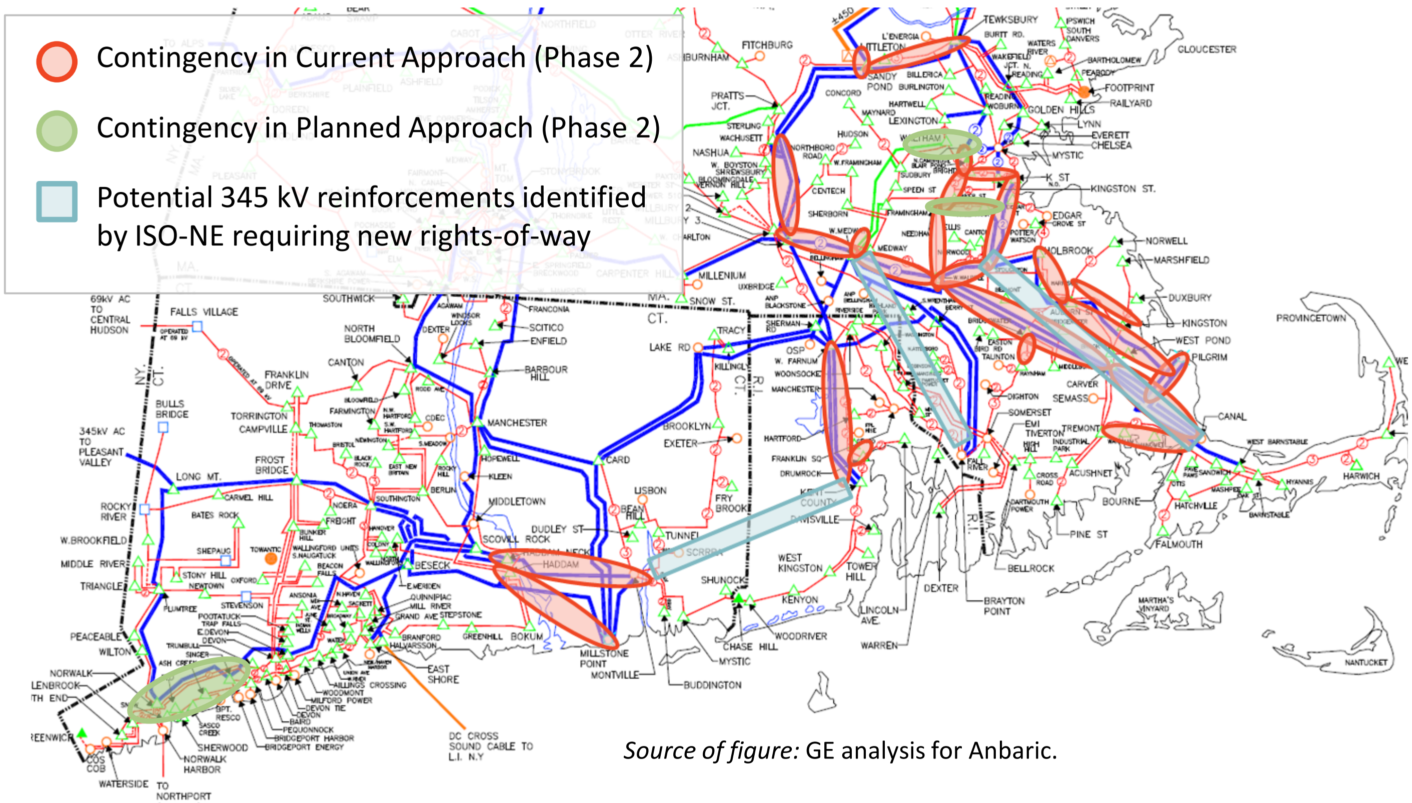
The planned approach to building offshore transmission can enable significant long-term cost savings and avoid some of the higher risks associated with onshore upgrades

Comparison of Total Onshore Plus Offshore Transmission Costs in New England
(Evaluated for next 3,600 MW OSW)



Planning ahead avoids onshore transmission upgrades that otherwise would be needed

Already selected projects connecting to Cape Cod face up to <u>$787 million</u> in onshore transmission upgrades,* and continuing this approach for even the next 3600 MW of procurements could lead to an <u>additional $1.7 billion</u> in onshore upgrades.



Source of figure: GE analysis for Anbaric.

Planned off-shore transmission can significantly reduce the necessary onshore upgrades.

Given the difficulty of permitting and building new onshore trans-mission, a planned approach also reduces the risk of cost overruns and delays

* ISO-NE's Feasibility Study for interconnecting three projects totaling 2,400 MW to Cape Cod (QP 828)

Reduced impacts to fisheries, coastal communities, and the marine environment

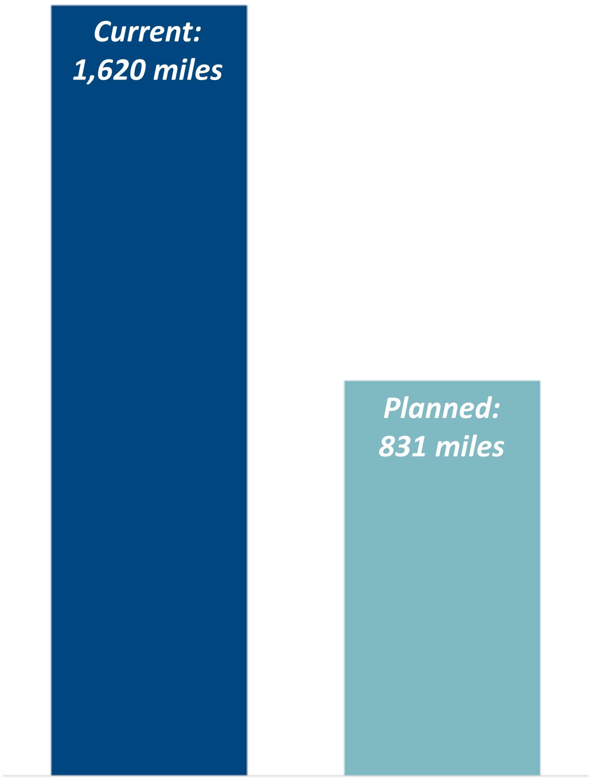
Better planning can **reduce the cumulative effects of offshore transmission on fisheries, coastal communities, and the marine environment**

Fewer cables results in **less disruption and impacts on the marine and coastal environment**

Minimizing the number of offshore platforms, cabling, seabed disturbance, and cables landing at the coast **reduces impacts on existing ocean uses and marine/coastal environments** to the greatest practical extent

Comparison of Total Length of Undersea Transmission Under GLL and Planned Approaches in NE

(Excluding Already-Contracted Projects)



Increased competition among OSW generation developers

Competition among developers of OSW generation would be enhanced, yielding a range of potential cost savings

Minimum savings → **Higher potential savings**

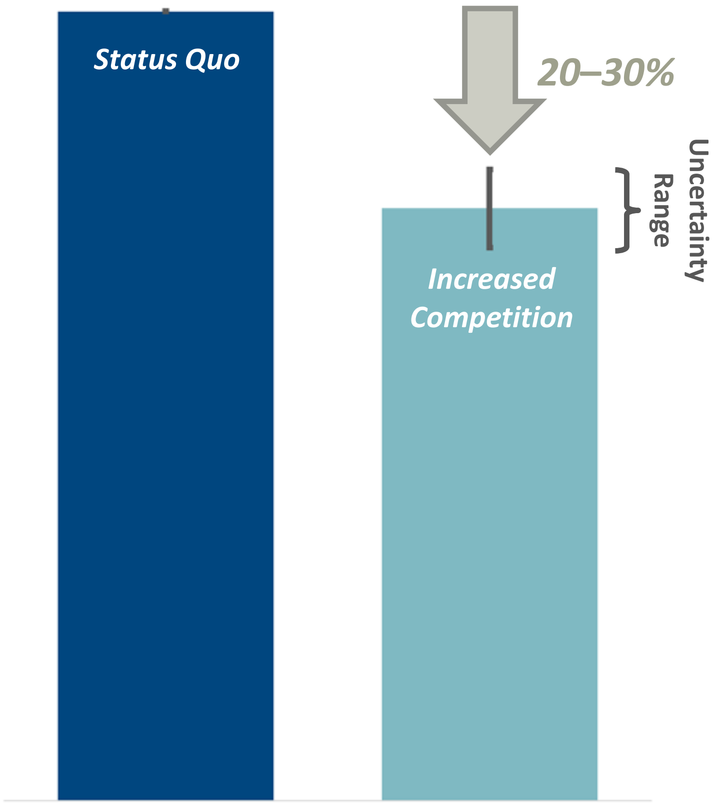
Minimum savings	Higher potential savings
The planned, competitive approach would simplify a major strategic decision for developers	**Ultimately, it could increase participation and competition in OSW solicitations.**
Today, developers must bid before they have accurate information about their transmission upgrade costs. Removing these risks from the offshore generation procurement should lead to lower bids because of the reduced risk premium alone	In Europe, planned transmission approaches have enhanced head-to-head competition leading to **zero-subsidy bids** in recent procurements (see case study details in appendix) We anticipate more willing bidders and more competition with increased access to transmission (though overall still limited by number of leaseholders)

Increased competition among offshore <u>transmission</u> developers

Offshore transmission developers would compete to build planned transmission. This direct competition would put downward pressure on costs to ratepayers (further lowering costs beyond that described on previous slides)

- Studies of <u>onshore</u> transmission indicate that competitive procurement enables “significant innovation and cost savings of 20–30%” relative to the costs incurred by incumbent transmission companies; the costs of conducting the competitive processes are small compared to the savings*
- Studies of <u>offshore</u> transmission costs in the U.K. similarly indicate that competition across independent offshore transmission owners reduced costs 20–30% compared to generator-owned transmission (driven by lower operating costs and financing costs from improved allocation of risk and reduced risk premium)**

Anticipated Cost Impact of Competition to Develop Offshore Transmission



Issues Unique to New York

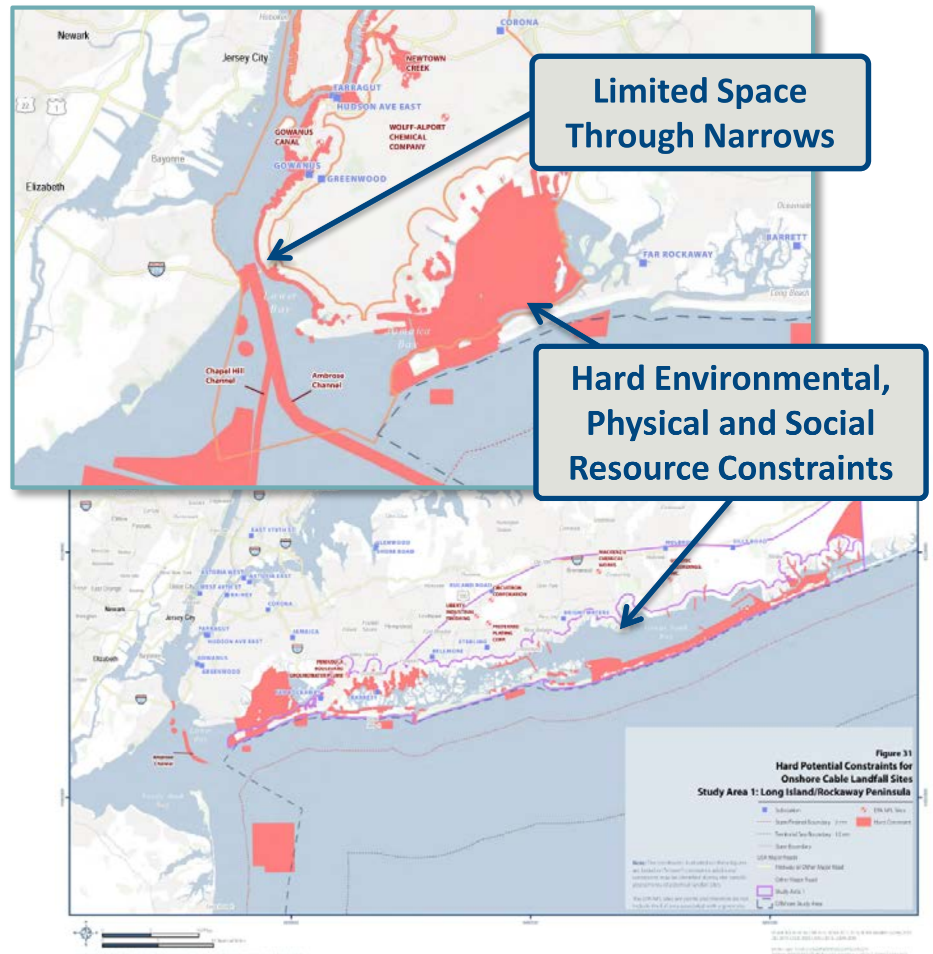
Constrained access routes require efficient offshore transmission to meet goals at low cost

There are a limited number of robust POIs for connecting offshore wind to the onshore grid and limited access routes to these POIs

If each OSW project builds a separate GLL to the onshore transmission system, **viable landing sites and cabling routes will become constrained. A planned transmission approach can make better use of the limited landing sites**

The clearest example of this is the cable approach route through the **<u>Narrows</u>** to reach POIs in New York Harbor

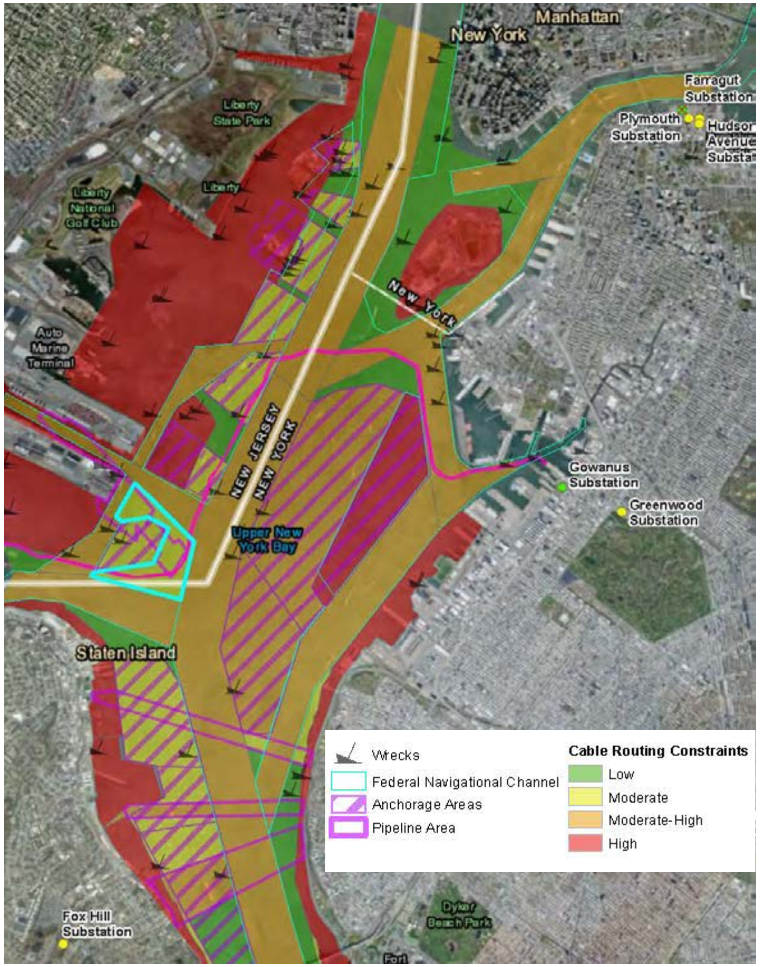
Landing Limitations along NY Coast



Narrows likely has space for only four cables, suggesting maximizing utility of route is key

- **Major constraints to routing through the Narrows and the Upper Bay** are physical width of suitable seabed, federal navigation projects (FNPs) (channels and anchorages), cable spacing requirements, and competing uses
  - All potential routes are heavily constrained by navigational aspects in the Upper Bay: primarily the inner harbor anchorages and federal navigational channels
- In The Narrows and Upper Bay of NYC harbor, **maximal transmission capacity in the available space may be achieved most efficiently by using HVDC technology** to connect clusters of OSW farms to a grid that has been extended offshore
- Given the constraints in the Upper Bay, it is likely **four routes could access NY Harbor**
- Not utilizing Narrows effectively **risks limiting ability to cost-effectively route OSW transmission into New York City** and meet climate goals without large costs

NY Harbor Route Constraints



Source: Analysis of Narrows constraints by Intertec (see Appendix C for details).

Future curtailments can be high and thus require planners’ attention

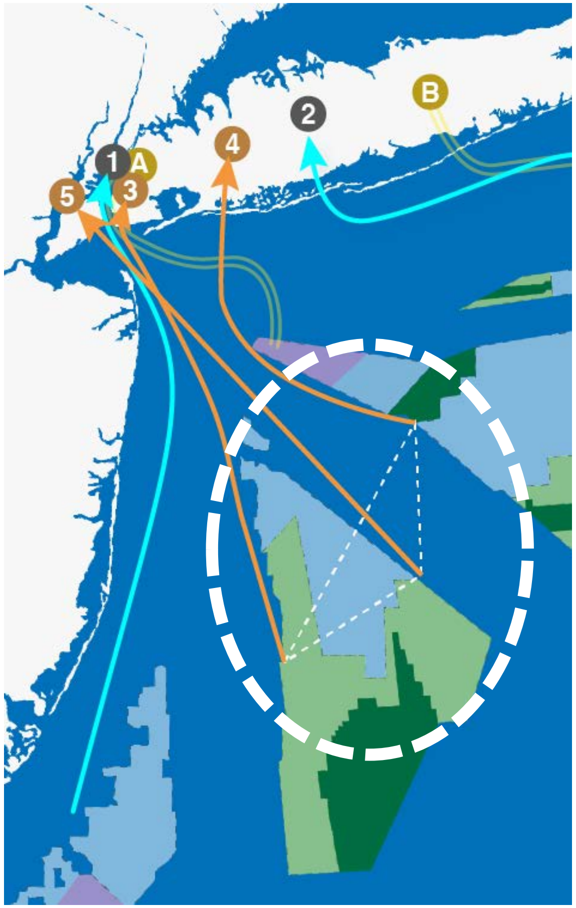
Anbaric’s preliminary analyses indicate high curtailment (~18%) if more than 1/3 of 9,000 MW of OSW is connected to Long Island

The risk of high curtailments can be addressed under a planned approach by:

- Further planning analysis to optimize to optimize the transmission configuration to reduce curtailments
- Integrated planning of NY’s 3,000 MW storage goal with offshore transmission
- Future networking of HVDC cables into an offshore grid to move OSW injections to less congested POIs (which also reduces risks from transmission outages)

The Jan 2021 NY Power Grid Study identifies need for significant storage and recommends that the state create the option to pursue a similar “meshed” network approach

DC Technology Enables Potential Future Offshore Networking in the NY Bight



*may be higher due to must-run units

Recommendations

We recommend a planned approach to offshore transmission

Utilizing GLLs has distinct disadvantages over planned offshore transmission

- Poor use of limited onshore POIs
- Increased seabed disturbance
- Reduced competition for transmission and off-shore wind generation
- Higher onshore transmission upgrade costs and higher overall costs in the long run

A planned approach is necessary to support the large scale of states' OSW goals:

- Reduce number of cables and landing points
- Reduce the need for onshore transmission upgrades (by optimally selecting interconnection points and storage deployment)
- Create options to evolve towards a meshed offshore grid
- Use solicitations for OSW transmission needs (e.g., 7500 MW by NJ BPU)

Mitigating risk with separate generation and transmission development

- The current GLL approach places development of generation and offshore transmission under a single developer, but leaves onshore upgrades with incumbent (onshore) transmission owners
  - This approach reduces coordination risk between OSW and offshore transmission, but there remains project-on-project risk related to the completion of onshore upgrades
- The planned offshore grid model can also address individual project-on-project risk through:
  - Strong performance and completion incentives (rewards or penalties) for both transmission and generation developers to meet project deadlines
  - Allowing generation developer to participate in transmission procurement, with the condition that the transmission will be open access
  - Staggered transmission and generation project completion timelines (e.g., scheduling transmission project completion before generation)
- If initially relying on GLL, build in options to later interconnect these lines into a meshed grid

Additional Reading

Pfeifenberger et al, Initial Report on the New York Power Grid Study, prepared for NYPSC, January 19. 2021.

Pfeifenberger, "Transmission Cost Allocation: Principles, Methodologies, and Recommendations," prepared for OMS, Nov 16, 2020.

Pfeifenberger, Ruiz, Van Horn, "The Value of Diversifying Uncertain Renewable Generation through the Transmission System," BU-ISE, October 14, 2020.

Pfeifenberger, Newell, Graf and Spokas, "Offshore Wind Transmission: An Analysis of Options for New York", prepared for Anbaric, August 2020.

Pfeifenberger, Newell, and Graf, "Offshore Transmission in New England: The Benefits of a Better-Planned Grid," prepared for Anbaric, May 2020.

Tsuchida and Ruiz, "Innovation in Transmission Operation with Advanced Technologies," T&D World, December 19, 2019.

Pfeifenberger, "Cost Savings Offered by Competition in Electric Transmission," Power Markets Today Webinar, December 11, 2019.

Pfeifenberger, "Improving Transmission Planning: Benefits, Risks, and Cost Allocation," MGA-OMS Ninth Annual Transmission Summit, Nov 6, 2019.

Chang, Pfeifenberger, Sheilendranath, Hagerty, Levin, and Jiang, "Cost Savings Offered by Competition in Electric Transmission: Experience to Date and the Potential for Additional Customer Value," April 2019. "Response to Concentric Energy Advisors' Report on Competitive Transmission," August 2019.

Ruiz, "Transmission Topology Optimization: Application in Operations, Markets, and Planning Decision Making," May 2019.

Chang and Pfeifenberger, "Well-Planned Electric Transmission Saves Customer Costs: Improved Transmission Planning is Key to the Transition to a Carbon-Constrained Future," WIRES and The Brattle Group, June 2016.

Newell et al. "Benefit-Cost Analysis of Proposed New York AC Transmission Upgrades," on behalf of NYISO and DPS Staff, September 15, 2015.

Pfeifenberger, Chang, and Sheilendranath, "Toward More Effective Transmission Planning: Addressing the Costs and Risks of an Insufficiently Flexible Electricity Grid," WIRES and The Brattle Group, April 2015.

Chang, Pfeifenberger, Hagerty, "The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments," on behalf of WIRES, July 2013.

Chang, Pfeifenberger, Newell, Tsuchida, Hagerty, "Recommendations for Enhancing ERCOT's Long-Term Transmission Planning Process," October 2013.

Pfeifenberger and Hou, "Seams Cost Allocation: A Flexible Framework to Support Interregional Transmission Planning," on behalf of SPP, April 2012.

Pfeifenberger, Hou, "Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada," on behalf of WIRES, May 2011.

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