The State of Wind Energy in New England

"Everyone Knows Its Windy – The State of Wind Energy"

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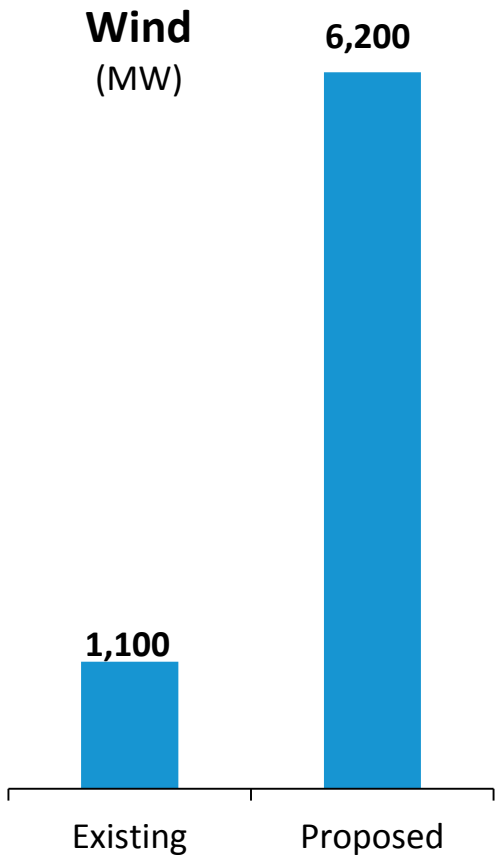
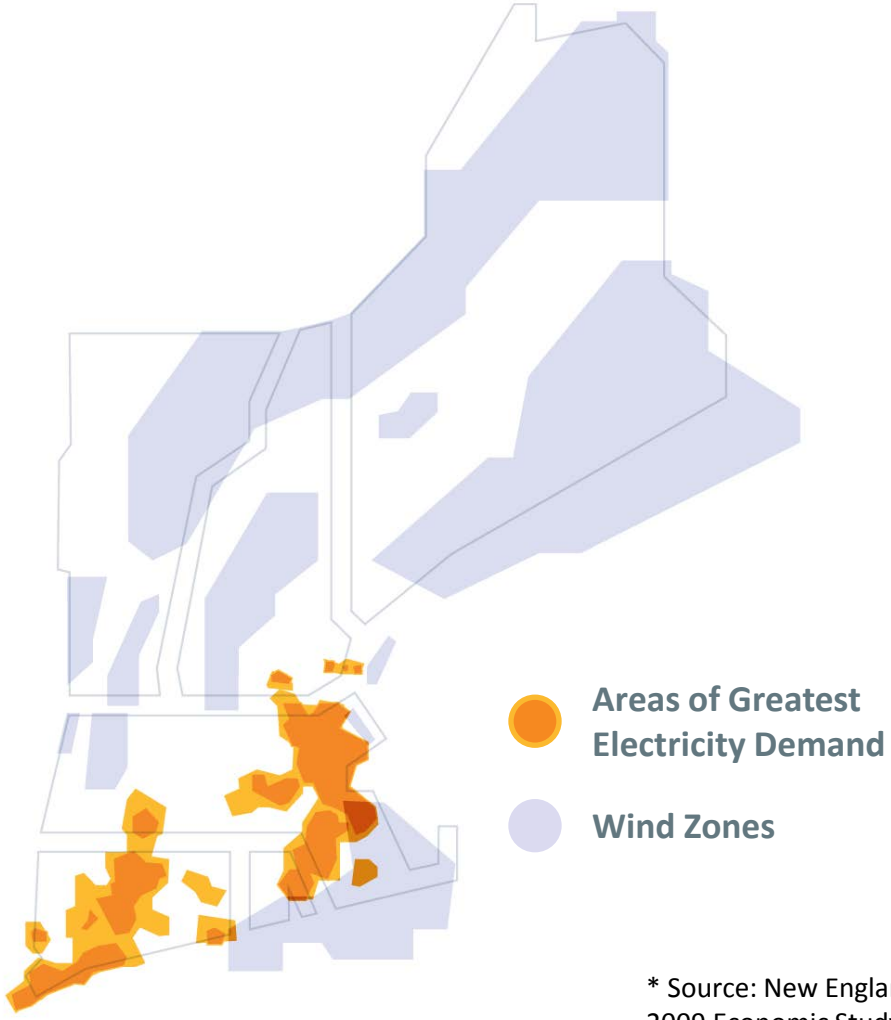
Wind Power Has Emerged in New England, With Significantly More Interest from Developers

- Renewable portfolio standards and other public policies have helped stimulate wind development
- Over 1,100 MW of large scale wind have begun commercial operations over the past few years
- The ISO has implemented wind power forecasting and enhanced opportunities for wind resources to offer into the energy market



Nameplate capacity of existing wind resources and proposals in the ISO-NE Generator Interconnection Queue; megawatts (MW).

New England Has Significant Wind Potential But Additional Transmission is Needed



- Population and electric demand are concentrated along the coast in central and southern New England
- **12,000 MW** of onshore and offshore wind potential*
- Transmission will be required to connect potential wind resources to load centers in New England

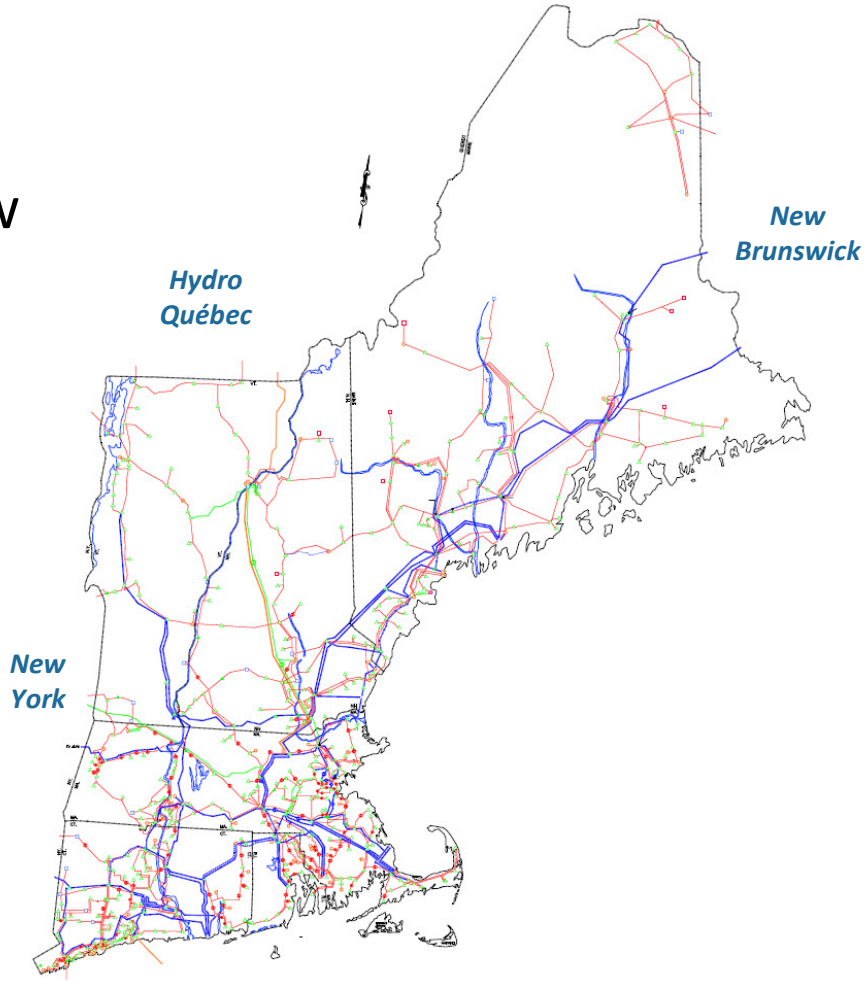
* Source: New England 2030 Power System Study, Report to the New England Governors, 2009 Economic Study: Scenario Analysis of Renewable Resource Development (February 2010)

Massachusetts Sets Timeline For Off-Shore Wind

- Off-shore wind-related legislation passed into law last year in Massachusetts
- Draft RFP for off-shore wind to be finalized by June 30, 2017
- No less than 400 MW but up to 1,600 MW of aggregate nameplate off-shore capacity
- Bids will include costs for both generator lead lines and optional additional capacity
- For delivery by June 2027

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

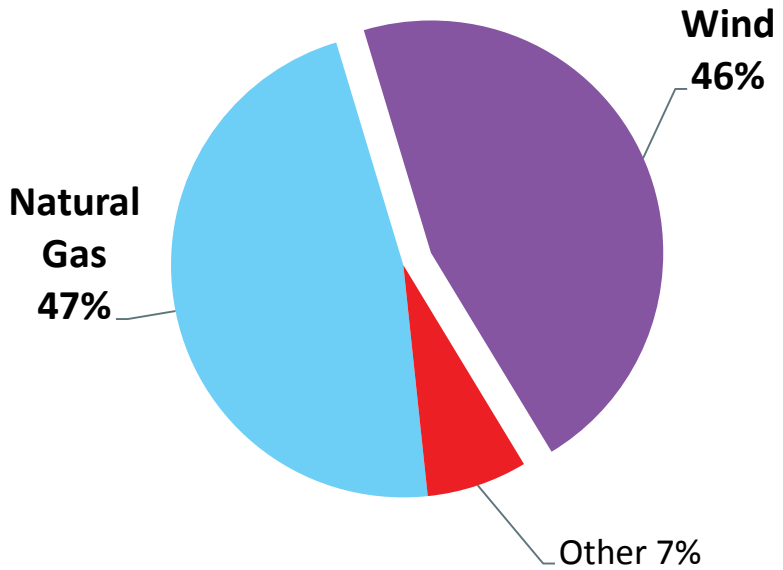
- 9,000 miles of high-voltage transmission lines (≥115 kV)
- Wind generators in northern New England have connected and are seeking to connect to remote areas that are electrically weak
- Developers have proposed multiple transmission projects to access renewables
- The system is more developed in central and southern New England because that is where the load is concentrated



Infrastructure Will Be Needed to Deliver Energy from Proposed Resources

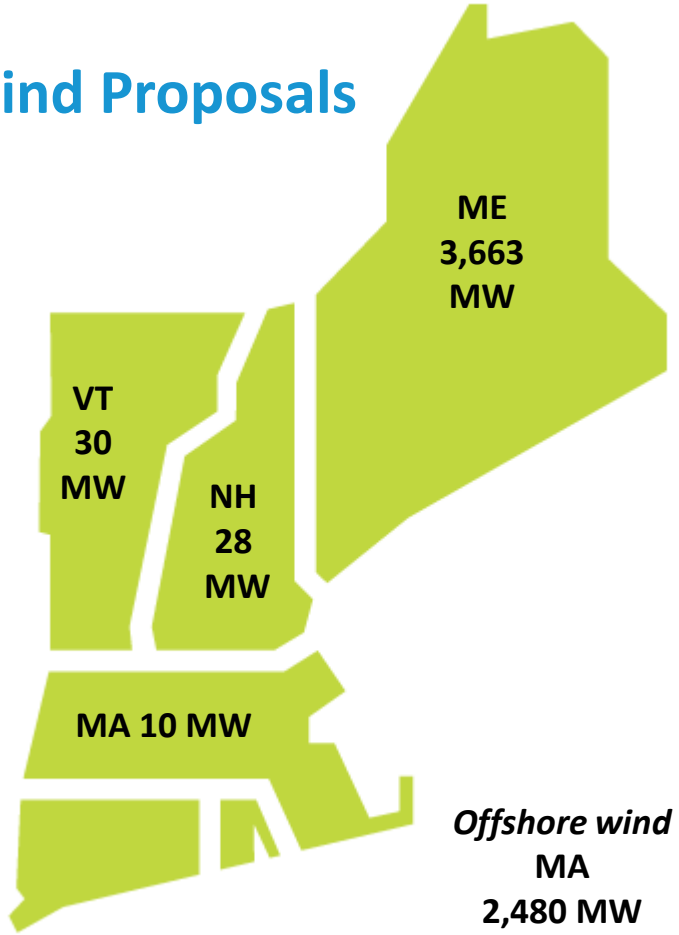
All Proposed Generation

Developers are proposing to build roughly 13,650 MW of generation, including nearly 6,400 MW of gas-fired generation and more than 6,200 MW of wind



Source: ISO Generator Interconnection Queue (May 1, 2017)
FERC Jurisdictional Proposals Only; Nameplate Capacity Ratings

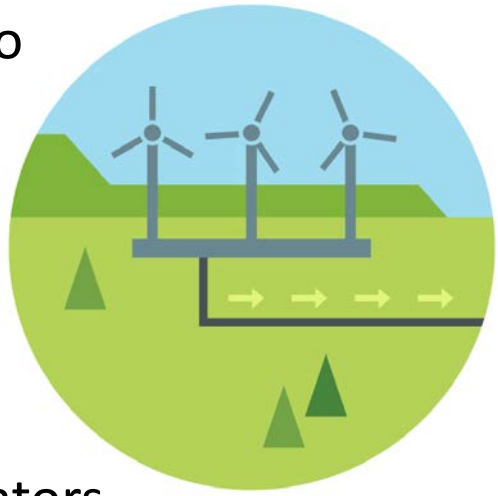
Wind Proposals



Source: ISO Generator Interconnection Queue (May 1, 2017)
FERC Jurisdictional Proposals; Nameplate Capacity Ratings

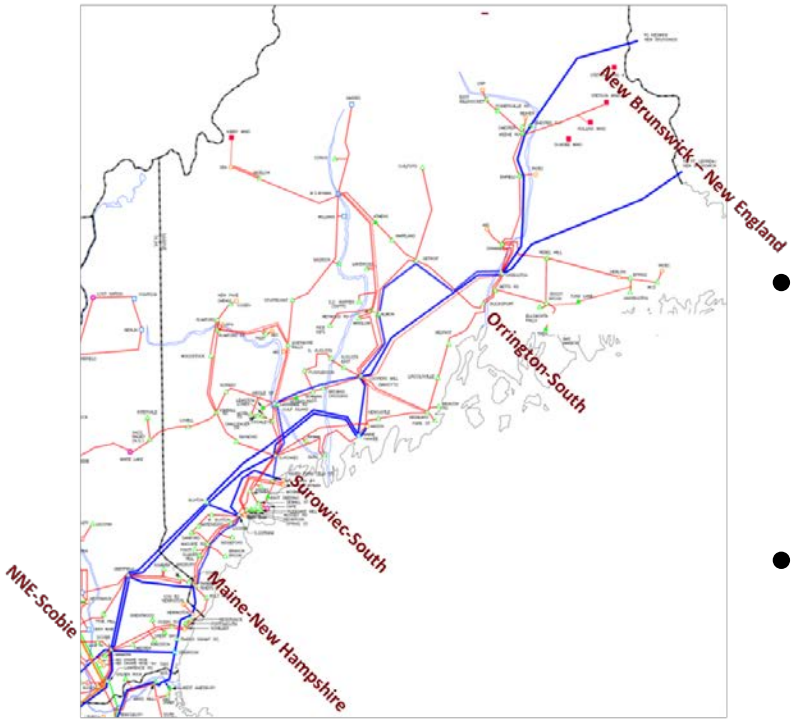
Challenges for *On-Shore* Wind in Northern New England

- Wind technology provides limited transmission system support
  - Although technologies are improving, wind does not provide significant system voltage/reactive or stability support
- Resources seek to connect in a marginal manner to weak parts of the system, often where there are local and regional constraints
  - Poor voltage and stability performance
  - Extremely high reactive power losses



- First-in wind generators have exhausted limited existing system margins, resulting in more significant system upgrades for subsequent generators
- Wind interconnecting as an energy resource competes for transmission use based on bid price
  - In some areas of the system, wind competes with wind and other renewable resources, sometimes with the same owner

Background: Clustering In the Interconnection Process



Transmission Interface Constraints in Maine*

- The ISO is able to process generator interconnection requests in a timely manner throughout most of the region
  - On average, system impact studies are completed within a year of request
- Transmission constraints in northern and western Maine, however, have resulted in a backlog for requests to connect in those areas
- Clustering of interconnection requests is not currently an option under the ISO tariff, unlike with other ISOs/RTOs
  - In the past, some developers and stakeholders were hesitant to move toward clustering
- Proposal to be filed with FERC when commission has a quorum

* Source: 2016 Maine Resource Integration Study, Scope of Work, Presentation to Planning Advisory Committee, March 2016

Addressing the Backlog of Wind Proposals In the Interconnection Queue in Maine

- In 2015, the ISO began a two-phase discussion with stakeholders to address the factors contributing to the Maine queue backlog

First Phase	Second Phase

• Queue improvements were approved by FERC in April 2016
• Improvements designed to make wind and other inverter-based generator projects more "study-ready"
  • Reactive performance requirements for wind generators
  • New technical data requirements for wind and inverter-based generators
	• Interconnection process improvements focusing on how to address identified infrastructure issues
	• Clustering methodology improvements worked through stakeholder process
	• Maine Resource Integration Study underway

With Stakeholder Feedback and Support the ISO Has Developed An Approach to Cluster Study Wind Projects

- Provide a mechanism to expedite interconnection processing in circumstances where the ISO determines that a backlog would be likely to persist with the continued application of the serial queue process
- A cluster approach will be triggered by the ISO's identification of the following circumstances in the queue
  1. There must be a backlog of two or more requests in the same part of the regional transmission system, and
  2. The ISO must have identified that none of the applicable interconnection requests will be able to interconnect, either on an individual basis or as a cluster, without incurring "significant transmission upgrades"

Choices at the Beginning of the Phase 2 Study

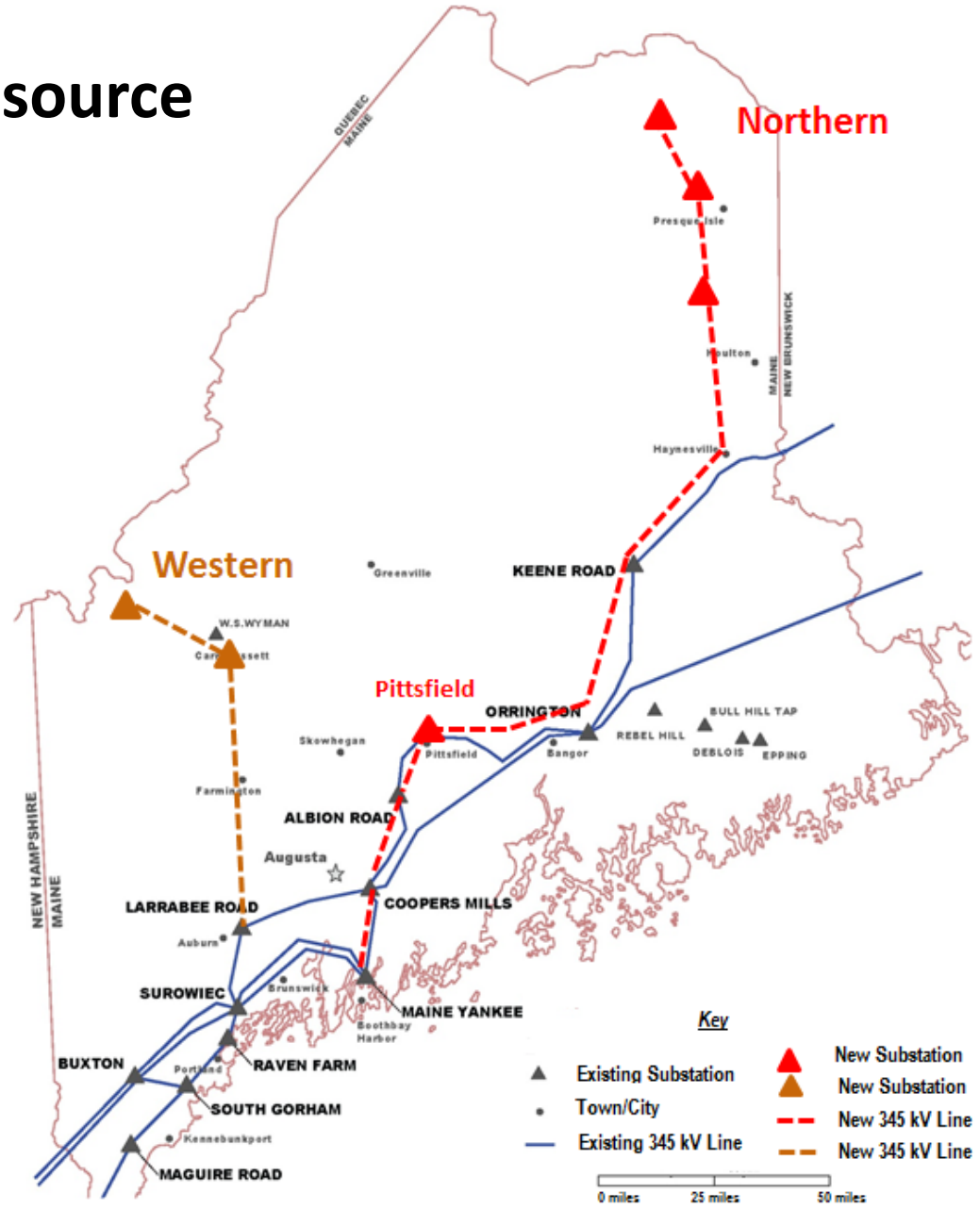
- All eligible interconnection requests that are located in the same electrical part of the transmission system will be identified in the Phase 1 Cluster Enabling Transmission Upgrades (CETU) Regional Planning Study
- By the cluster entry deadline, eligible projects will have the following choices:
    1. Enter the cluster
    2. Move to the bottom of the queue in the same relative queue order as other eligible projects that make this choice (no new $50,000 Interconnection Request deposit)
    3. Withdraw the Interconnection Request, and receive a refund of the unspent portion of the $50,000 IR deposit

ISO Proposal: Upgrade Cost Allocation

- Direct allocation of direct-connect costs
  - *Example:* generator lead that would connect generator to the CETU
- CETUs will be allocated to each cluster project using a distribution factor methodology
- Network upgrades (other than the CETU(s)) will be allocated to each cluster project using a distribution factor methodology
- All upgrade costs paid by interconnection customers
  - No regional or local rate-payer support for interconnection upgrades
- Late-comer provision allows for headroom reimbursement by projects that interconnect after the original CETU funding

Scope of 2016 Maine Resource Integration Study

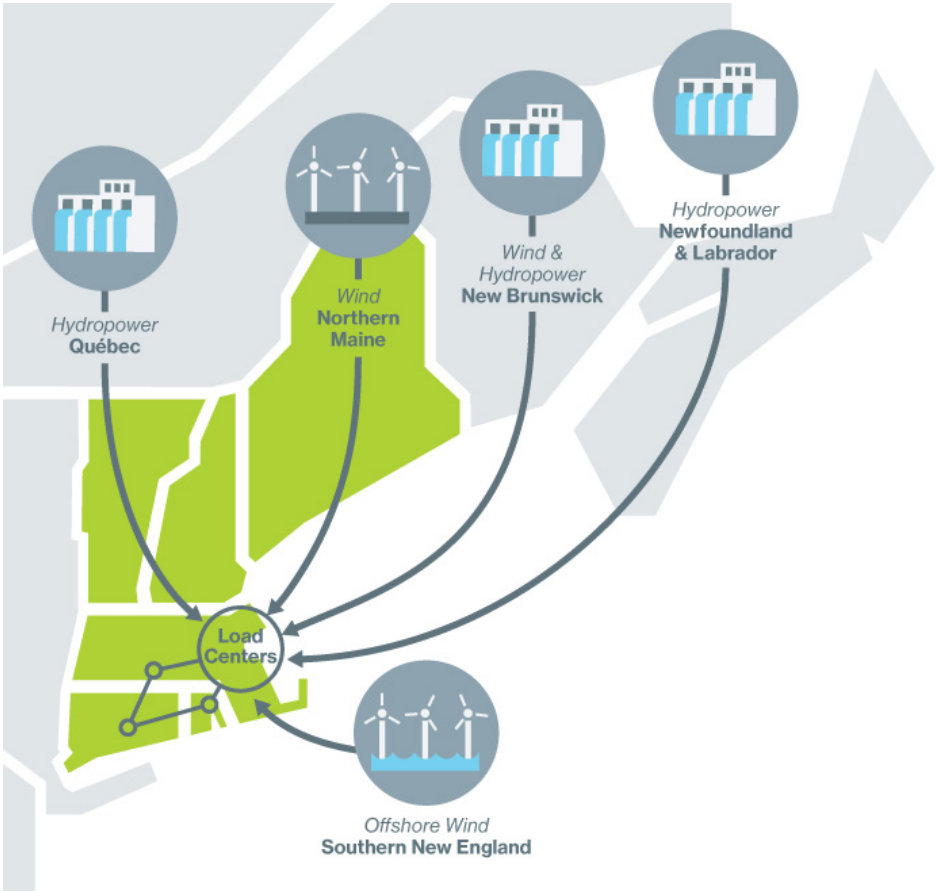
- Analyze new 345 kV transmission in parallel with the existing network
- Study seeks to connect the areas with the largest quantity of requested new wind generation interconnections
- Evaluations include interconnecting with, or bypassing, existing lines and substations



The ISO Is Improving the Ability of Intermittent Resources to Participate in the Wholesale Markets

- ✓ **Flexibility to Offer Negative Prices**
  - Allows generators, like wind, the opportunity to operate during low-load conditions when they otherwise might be curtailed
- ✓ **Updated Elective Transmission Upgrade (ETU) Rules**
  - Improve the interconnection study process for ETUs and ensure these resources are able to deliver capacity and energy into the wholesale electricity markets
- ✓ **Flexibility to Operate Up to a Certain Level**
  - Allows the ISO to better manage transmission congestion in a way that will maximize the use of low-cost renewable resources and alleviate the need for curtailments
  - Known as “Do-not-Exceed Dispatch Order”

Developers Are Proposing to Move Renewable Energy to New England Load Centers



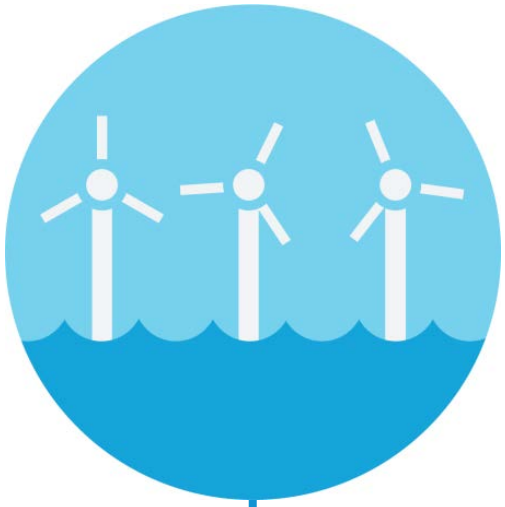
Map is representative of the types of projects announced for the region in recent years

- As of **May 1, 2017**, seventeen elective transmission projects had been proposed in the ISO Interconnection Queue, totaling more than **14,000 MW** of potential transfer capability, including:
  - **Large-scale hydro** resources from eastern Canada, and
  - **Onshore wind** resources from northern New England
- Projects seek to address public policy goals, not reliability needs
- In addition, **offshore wind** resources are emerging in southern New England

Source: ISO Interconnection Queue (May 1, 2017)

Recently Announced Retirements Offer Reasonable Interconnection Spots For Southern Off-shore Wind

- Robust transmission system in southern New England can allow wind power to flow throughout the system



Closing Thoughts

- New England has abundant wind potential and state policy initiatives have the potential to stimulate investment in infrastructure to integrate wind power resources
- Significant transmission investment would be needed to interconnect large-scale wind power in northern New England
- Connecting wind near strong parts of the power system can help reduce transmission bottlenecks
- Clustering proposal is designed to expedite development of wind resources in constrained areas

Questions