MARCH 13, 2020 | BOSTON, MA

Transmission System Needs for a Decarbonized Electric System

New England Restructuring Roundtable

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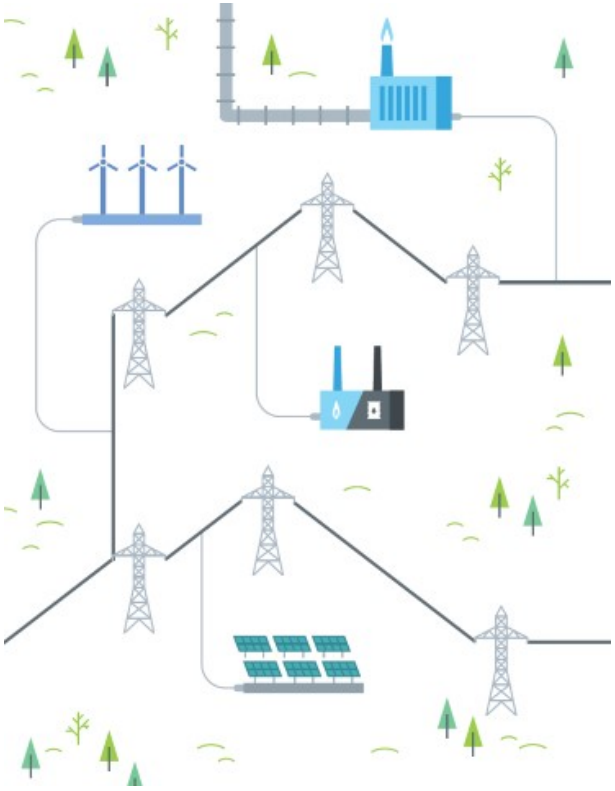
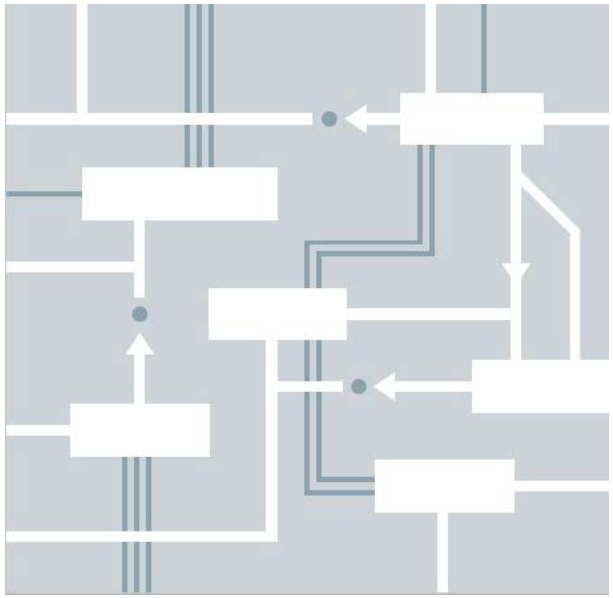
Key Themes

- Regional transmission investment to date has yielded a robust, reliable system for current use patterns
- Integration of renewables and storage may significantly change transmission system flows
- Renewables and increased electrification will require changed planning assumptions and add new stresses



Three Transmission-Related Questions for Envisioning a Fully Decarbonized Electric System

- How does transmission planning work **today**?
- What **transmission infrastructure** do we need to build to support a fully decarbonized electric grid?
- What **process** do we need to put in place to get there?

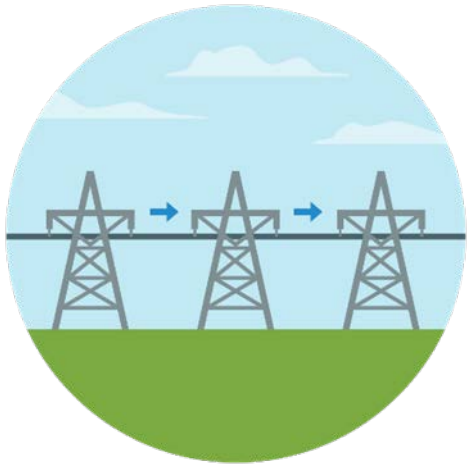


Major Types of Transmission Development

- **Transmission Needed for *Reliability***
  - *Historically*, the ISO has worked with Transmission Owners (TOs) to *plan* transmission solutions to solve reliability needs
    - **$10.9 billion** invested to date to strengthen transmission system reliability since 2002 (e.g., Greater Boston, Southeast Massachusetts, Southwest Connecticut, Maine Power Reliability Program); an additional **$1.5 billion** is planned (ISO Transmission Project List)
  - *Today*, the ISO works with TOs to *plan* transmission solutions that are time-sensitive (i.e., needs arise within three years); the ISO *issues* a competitive solicitation (RFP) for transmission solutions that are not time-sensitive and then *evaluates* proposals submitted in response to the RFP (e.g., Boston Area)
  - *New England has a regional cost-sharing arrangement for reliability projects*
- Stakeholders have opportunities to be involved in the planning process through the Planning Advisory Committee ("PAC")
- The ISO's role is to select a project that provides a cost-effective and comprehensive solution to the reliability need

Competition for Transmission Solutions in Boston

- In December 2019, the ISO issued an RFP for competitive transmission solutions to reliability needs in the Boston Area
- Reliability needs are driven by the anticipated retirement of the Mystic Generating Station
- Eight Qualified Transmission Project Sponsors (QTPS) submitted 36 proposals
  - Mix of AC and HVDC proposals
  - Costs range from $49M to $745M
  - In-service dates range from March 2023 to December 2026
- The ISO is evaluating proposals and will review results with the PAC



Major Types of Transmission Development, *cont.*

- **Transmission to Achieve Objectives *Other than Reliability***
  - Developers are proposing large-scale transmission projects to deliver clean energy in response to state RFPs
    - Roughly 15 proposals would deliver 11,000 MW of new supply (ISO Interconnection Queue)
  - Known as Elective Transmission Upgrades (ETUs) in the ISO Tariff
  - Costs are born by developers, who have required long-term contracts
- The ISO's role is to ensure that the interconnecting transmission project does not have an adverse impact on system reliability
- *This is a primary mechanism for state-sponsored projects to expand access to clean energy resources* (e.g., Massachusetts solicitation for clean energy resources and the New England Clean Energy Connect project)
  - While a collection of states could also potentially fund an upgrade, this has not yet happened

Lines represent types of ETUs private developers have proposed in recent years

Developers Are Proposing Large-Scale Transmission Projects to Deliver Clean Energy to Load Centers

- Developers are proposing roughly **15** elective transmission upgrades (ETUs) to help deliver about **11,000 MW** of clean energy to New England load centers
- Wind projects make up roughly **68%** of new resource proposals in the ISO Generator Interconnection Queue, but some are remote and require transmission
- Most are waiting on a long-term contract

Source: ISO Interconnection Queue (January 2020)

Transmission Planning for Public Policy

- **FERC initiated this mechanism through Order 1000**
  - Created a role for the ISO in planning to meet public policy objectives
  - The ISO initiates the process every three years (2017, 2020)
  - Mapped out in ISO-NE *Transmission Planning Process Guide*
- The New England states, NESCOE, and stakeholders can provide input
- The ISO is evaluating two recent submissions
- The planning mechanism exists, but the states have concerns about cost allocation
- The process in 2017 did not result in a transmission project; the 2020 process is ongoing

ISO New England Performs Economic Studies to Inform Policymakers and Stakeholders

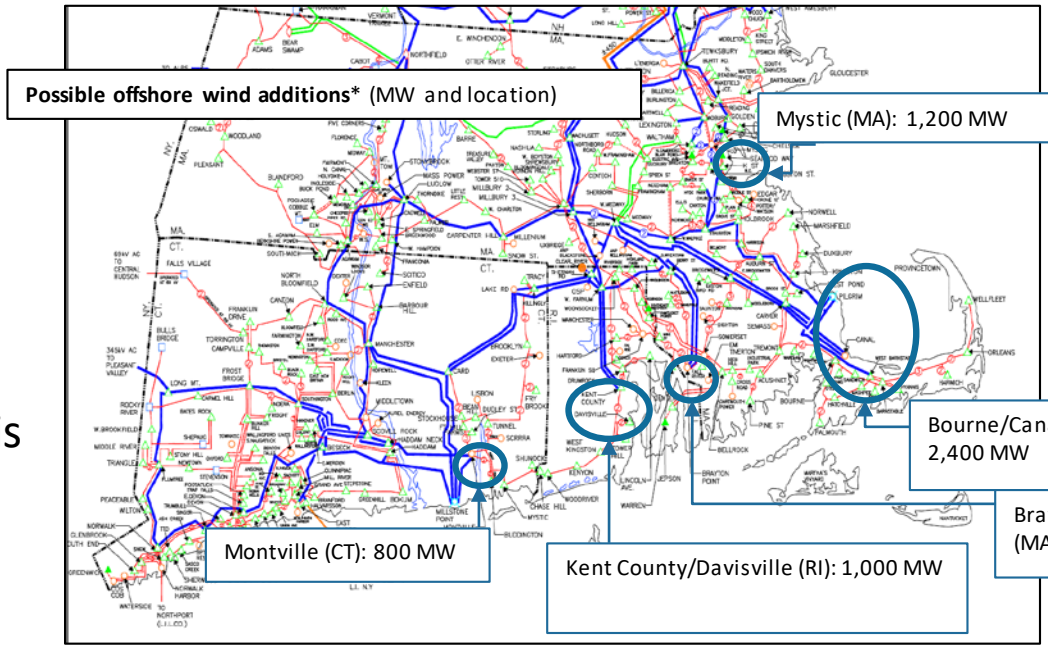
Three studies were requested in 2019: two on offshore wind, one on transmission

Requester	Purpose of Request
New England States Committee on Electricity (NESCOE)	Impacts on transmission system and wholesale market of increasing penetrations of offshore wind resources ***Preliminary results show no major new transmission is needed for up to 7,000 MW of new offshore wind***
Anbaric Development Partners (Anbaric)	Impacts on energy market prices, air emissions, and regional fuel security of large penetrations of offshore wind resources ***Preliminary results are similar to NESCOE***
Renew Northeast (RENEW)	Economic impact of conceptual increases in hourly operating limits on the Orrington-South interface from conceptual transmission upgrades in Maine ***Results are pending***

Potential Interconnection Points for Offshore Wind

Considered in economic studies for NESCOE and Anbaric

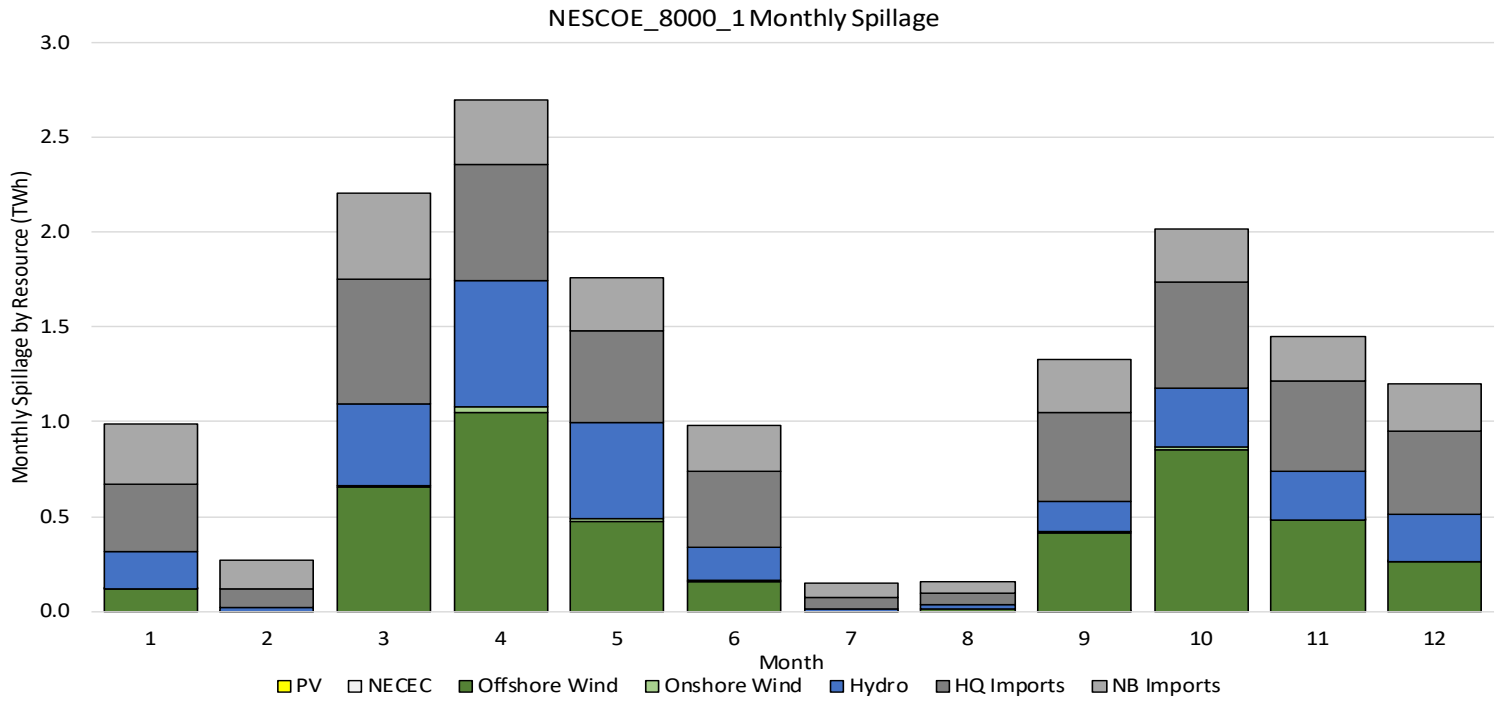
- Based on the currently expected transmission system for 2030, the ISO anticipates that **approx. 7,000 MW** of offshore wind additions have the potential to avoid major additional 345 kV reinforcements*
- The transmission system is modeled using 2030 internal transmission-interface transfer capabilities
- Assumes FCA #13 retirements have occurred, including Mystic 8 & 9



*Some 345 kV reinforcement/expansion may still be needed for this scenario. This anticipation is preliminary (system impact studies have not been completed for all of these MW). This anticipates minimal interconnection at nameplate levels and capacity interconnection at intermittent capacity values – does not anticipate all of the MW being able to run simultaneously at nameplate levels at all times on the system.

2019 NESCOE Economic Study: Modeling Offshore Wind Interconnections in Southern New England

- The rate of spillage increases as offshore wind buildout increases. In the 8,000 MW scenario studies, with no retirements of the current generation fleet, spillage is attributed to oversupply
- Energy spillage varies significantly by month (from 0.15 terawatt-hours (TWh) in July up to 2.69 TWh in April) depending on the interaction of wind, solar, and the monthly load profile



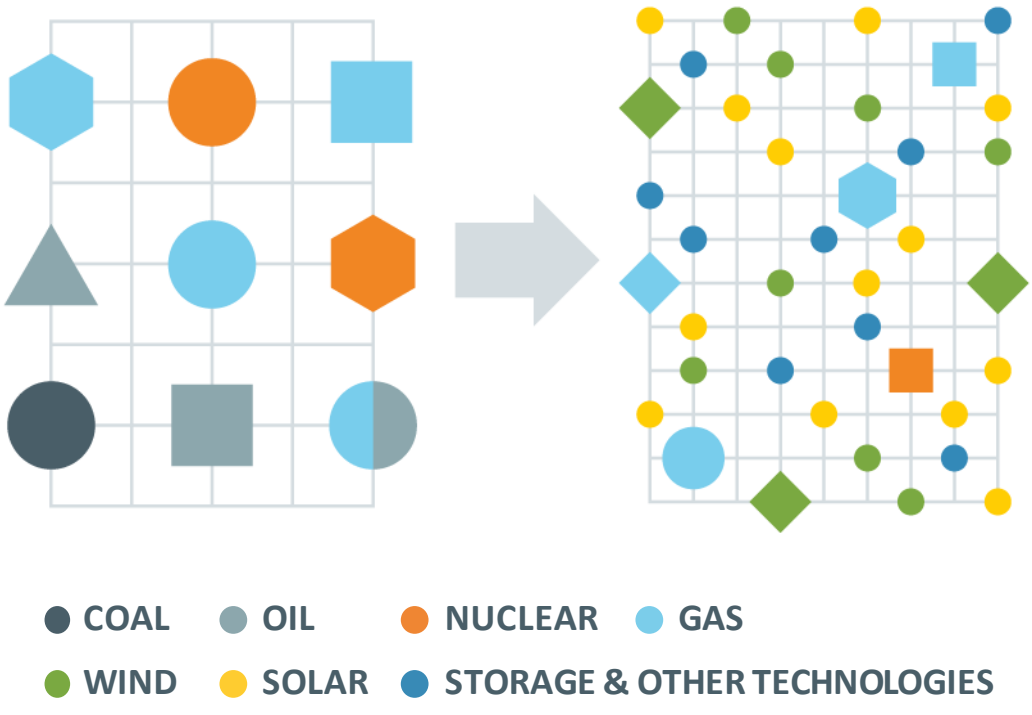
Curtailment of specific resources is driven by the threshold prices and order. This model uses the 2015 weather year to shape the 2030 wind, solar, and load profiles. If a different weather year is used, the results would differ.

New England Is Moving Toward a Hybrid Grid

There are two dimensions to the transition, happening simultaneously…

1. **A shift from conventional generation to renewable energy**

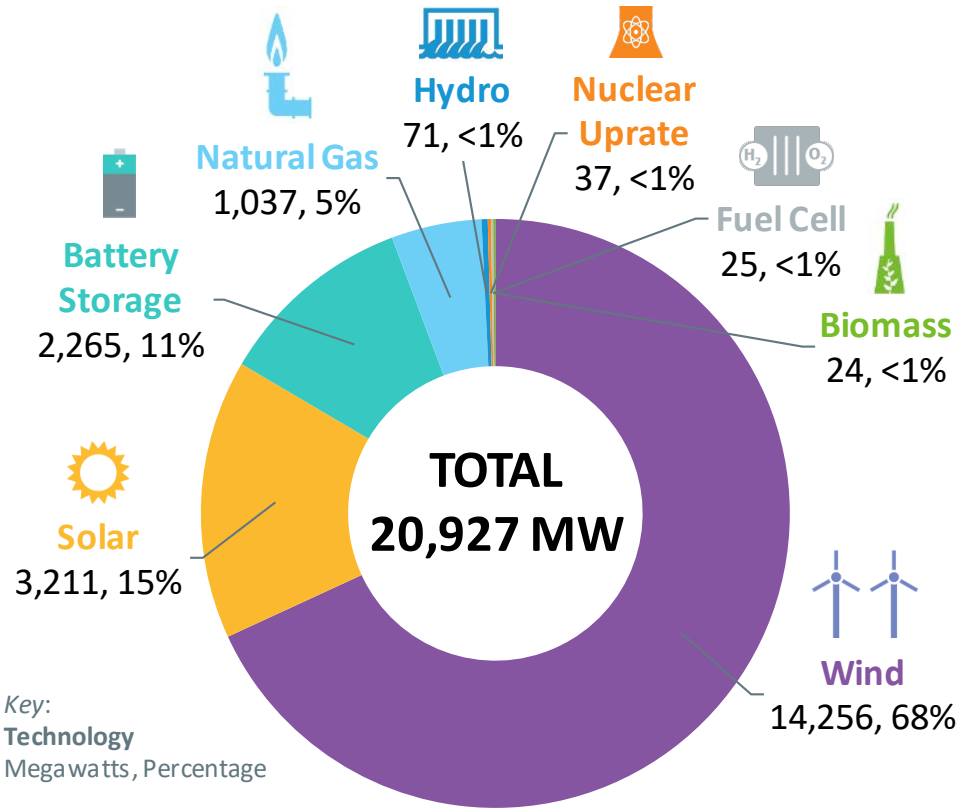
2. **A shift from centrally dispatched generation to distributed energy resources**



*Maintaining reliable power system operations becomes **more complex** with the shift to greater resources that face constraints on energy production*

Wind Power Comprises Two Thirds of New Resource Proposals in the ISO Interconnection Queue

All Proposed Resources



Source: ISO Generator Interconnection Queue (January 2020)
FERC and Non-FERC Jurisdictional Proposals; Nameplate Capacity Ratings
Note: Some natural gas proposals include dual-fuel units (with oil backup).
Some natural gas, wind, and solar proposals include battery storage.

Proposals by State

(all proposed resources)

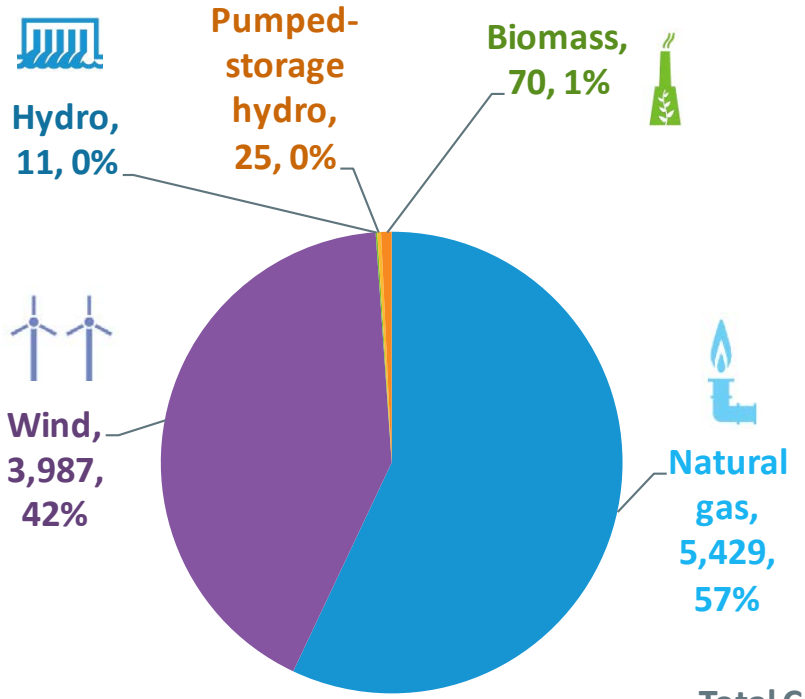
State	Megawatts (MW)
Massachusetts	11,243
Connecticut	5,591
Maine	1,988
Rhode Island	1,453
New Hampshire	506
Vermont	145
Total	**20,927**

Source: ISO Generator Interconnection Queue (January 2020)
FERC and Non-FERC Jurisdictional Proposals

The ISO Interconnection Queue: *Looking Back to 2015*

Natural gas was the primary fuel, and the total queue was half of 2020

All Proposed Resources

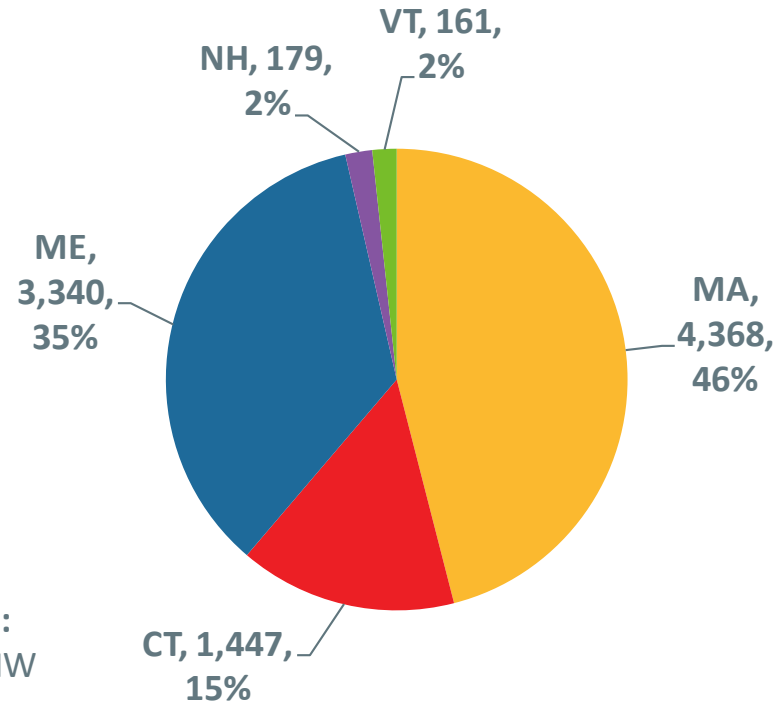


Key:
Technology, Megawatts, Percentage

Total Capacity:
Approx. 9,500 MW

Note: Some natural gas include dual-fuel units (oil)

Proposals By State



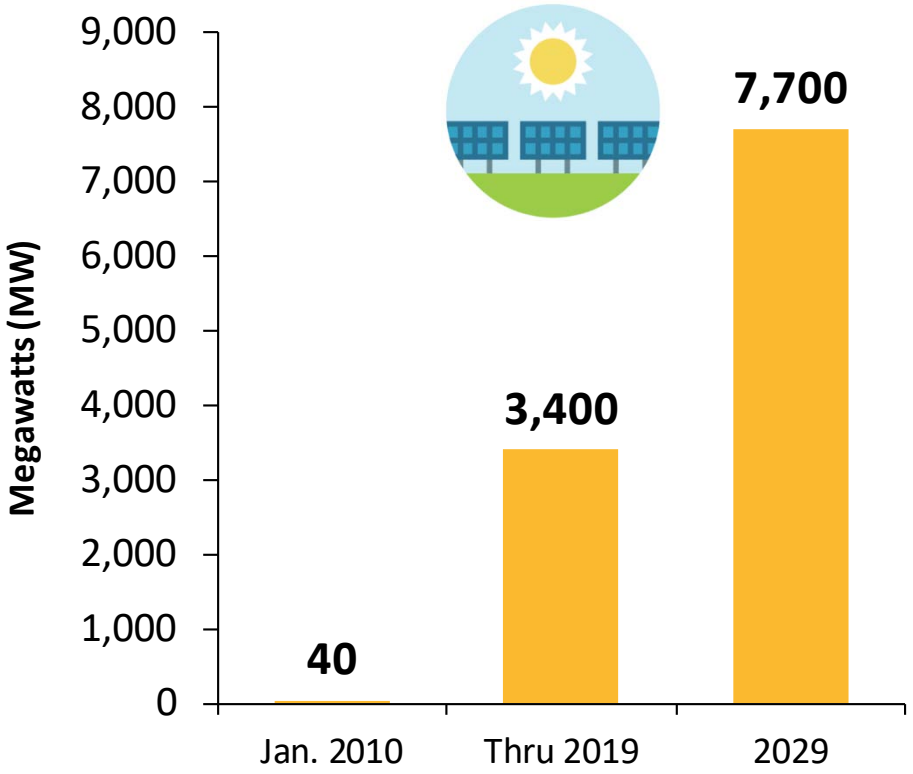
Source: ISO Generator Interconnection Queue (January 2015)
FERC Jurisdictional Proposals Only

ISO New England Forecasts Strong Growth in Solar Photovoltaic (PV) Resources

December 2019 Solar PV Installed Capacity (MW_{ac})

State	Installed Capacity (MW_{ac})	No. of Installations
Massachusetts	2,180.45	102,381
Connecticut	566.53	44,514
Vermont	364.24	13,863
New Hampshire	105.24	9,587
Rhode Island	159.75	7,776
Maine	56.32	5,387
New England	**3,432.53**	**183,508**

Cumulative Growth in Solar PV through 2029 (MW_{ac})



Note: The bar chart reflects the ISO's projections for nameplate capacity from PV resources participating in the region's wholesale electricity markets, as well as those connected "behind the meter." The forecast does not include forward-looking PV projects > 5 MW in nameplate capacity. Source: Draft 2020 PV Forecast (Feb. 2020); MW values are AC nameplate.

What Will the Transmission System Look Like in a Fully Decarbonized Electricity System?

- How will the region accommodate the next wave of large-scale renewable energy deployment after using up the initial points of interconnection (i.e., generator retirement sites)?
- Should the region proceed with ad hoc interconnection studies to integrate renewables or consider proactive plans to integrate renewable energy on a larger scale?
- How would transmission costs be allocated for transmission expansion to support grid-scale renewable generation?
  - ISO's cluster study methodology facilitates this, but developers haven't signed on
- How will the distribution systems evolve to accommodate growth of distributed resources and electrification of transportation and heating sectors?
  - Ongoing Western Massachusetts cluster study has enabled interconnection, but is also revealing limits to growth

Questions