ISO New England Overview and Regional Update

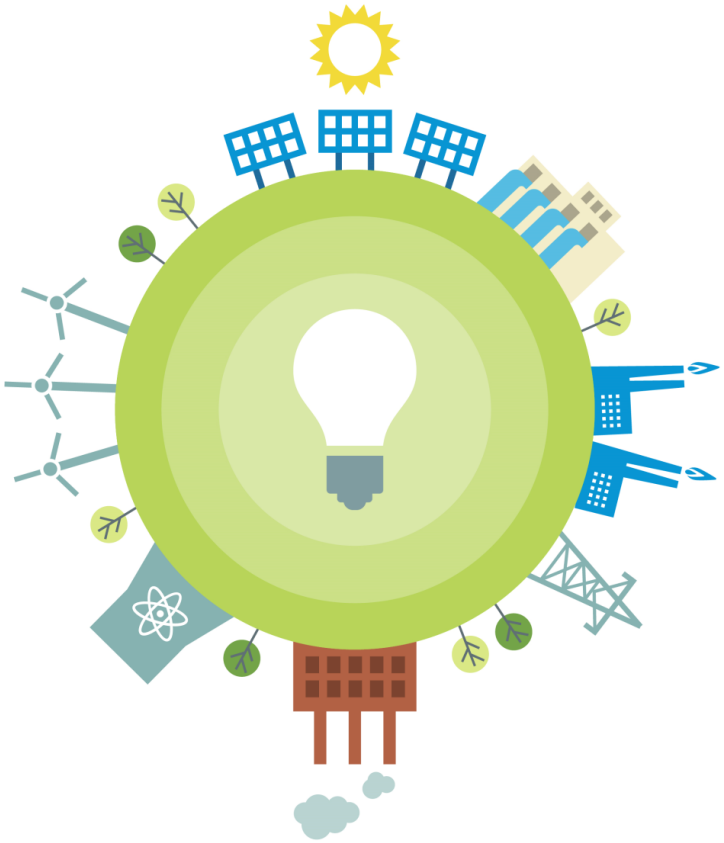
Vermont House Committee on Energy and Technology

Eric Johnson and Molly Connors

EXTERNAL AFFAIRS

Overview of Presentation

- About ISO New England
- Electric Grid At-a-Glance
- Strategic Planning
- Resource Developments
- Transmission Developments



ISO New England (ISO) Has Two Decades of Experience Overseeing the Region's Restructured Electric Power System

- **Regulated** by the Federal Energy Regulatory Commission
- **Reliability Coordinator** for New England under the North American Electric Reliability Corporation
- **Independent** of companies in the marketplace and **neutral** on technology

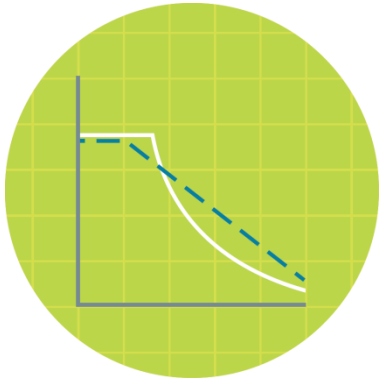
ISO New England Performs Three Critical Roles to Ensure Reliable Electricity at Competitive Prices

Grid Operation

Coordinate and direct the flow of electricity over the region's high-voltage transmission system

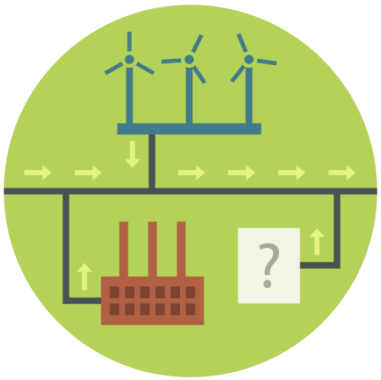
Market Administration

Design, run, and oversee the markets where wholesale electricity is bought and sold

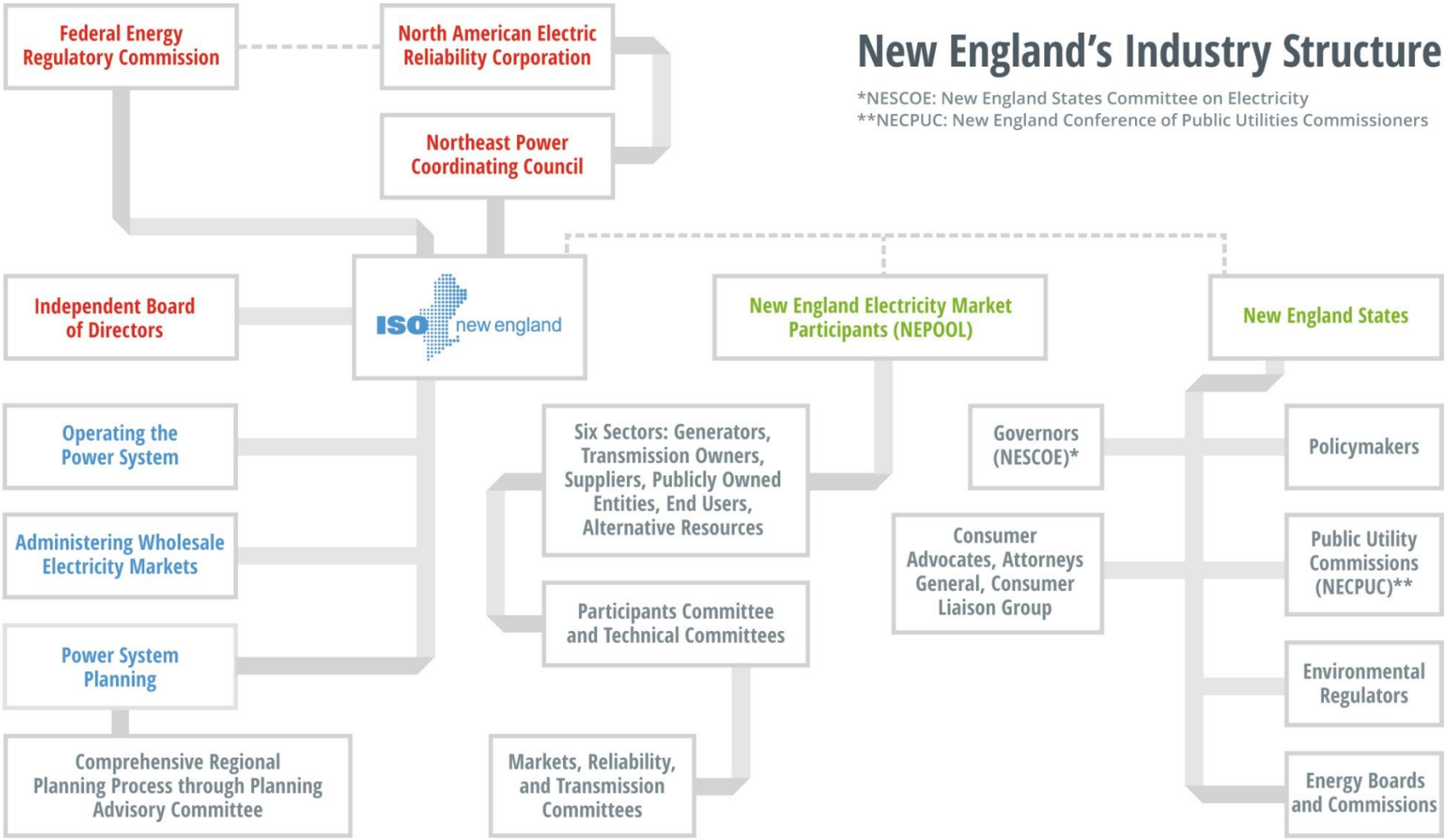


Power System Planning

Study, analyze, and plan to make sure New England's electricity needs will be met over the next 10 years



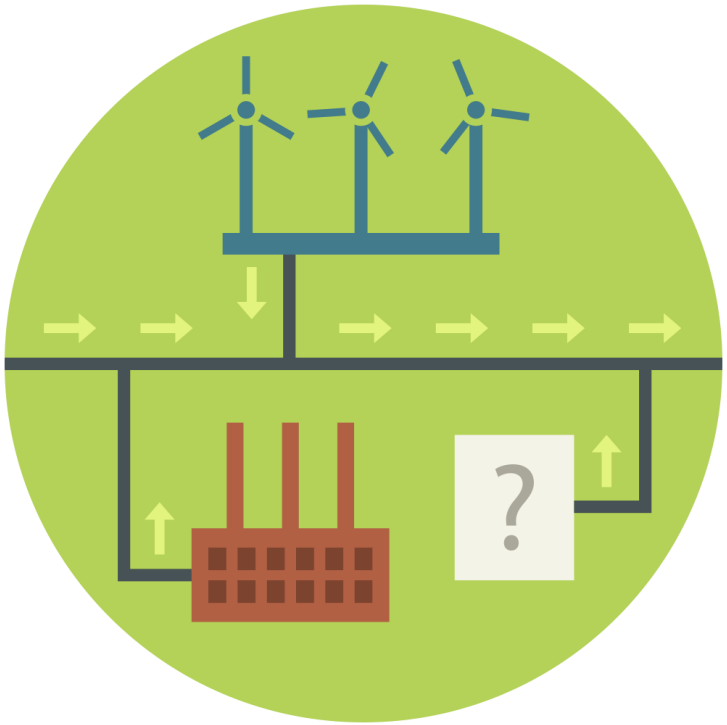
Numerous Entities Including an Independent Board Provide Oversight of and Input on ISO's Responsibilities



ISO New England Keeps Power Flowing Across the Region Every Minute of Every Day

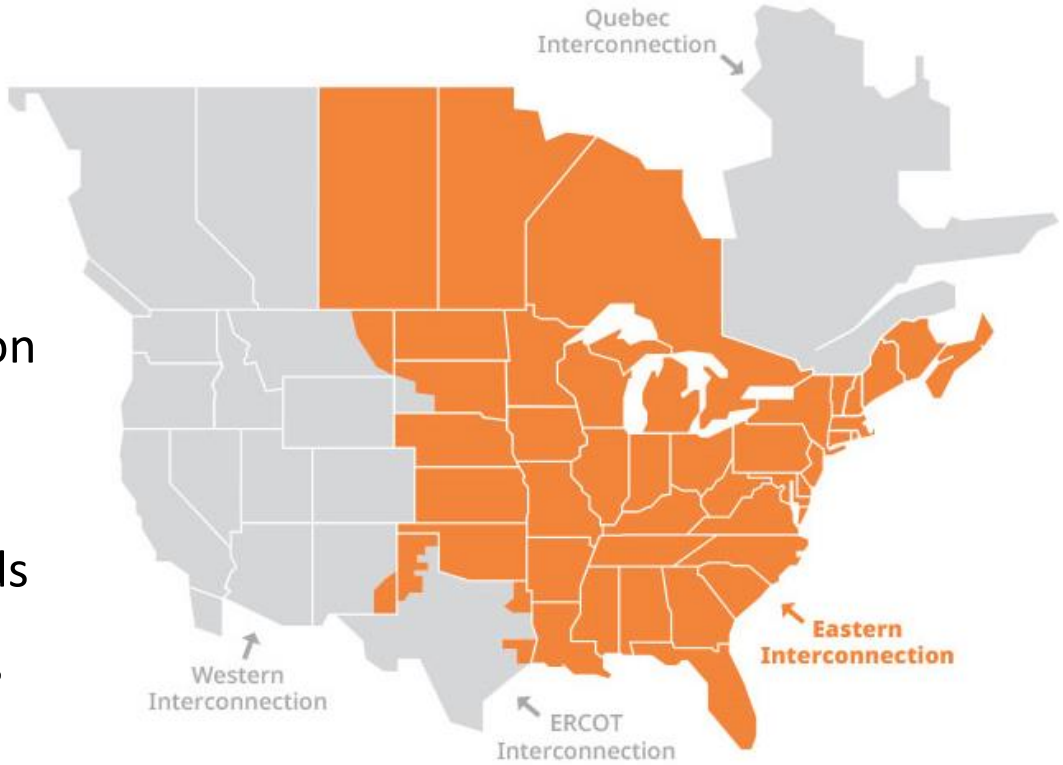
ISO New England Manages Regional Power System Planning to Meet Future Electricity Needs

- Manage regional power system planning in accordance with mandatory reliability standards
- Administer requests for interconnection of generation and regional transmission system access
- Conduct transmission system needs assessments
- Plan regional transmission system to provide regional network service
- Develop Regional System Plan (RSP) with a ten-year planning horizon



New England's Power Grid Is Part of a Larger Electric Power System

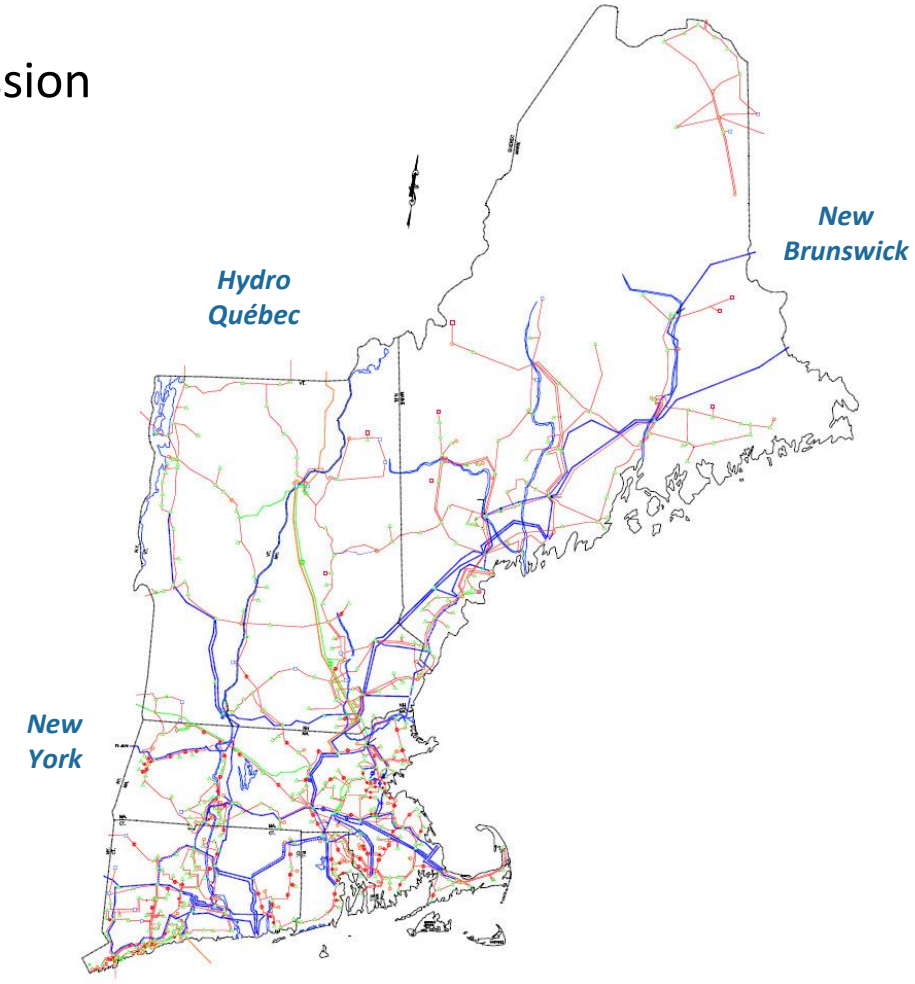
- Part of the **Eastern Interconnection**, one of four large power grids in North America
  - Interconnected through primarily alternating current (AC) transmission
- Tied to **Québec** only through direct current (DC) transmission
- 2003 blackout ushered in wide-area monitoring and **mandatory** reliability standards
- Subject to reliability standards set by **NERC** and **NPCC***



* North American Electric Reliability Corporation (NERC) and Northeast Power Coordinating Council (NPCC)

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

- **9,000 miles** of high-voltage transmission lines (115 kV and above)
- **13 transmission interconnections** to power systems in New York and Eastern Canada
- **17%** of region's energy needs met by imports in 2017
- **$10.6 billion** invested to strengthen transmission system reliability since 2002; **$1.7 billion** planned
- Developers have proposed multiple transmission projects to access **non-carbon-emitting resources** inside and outside the region



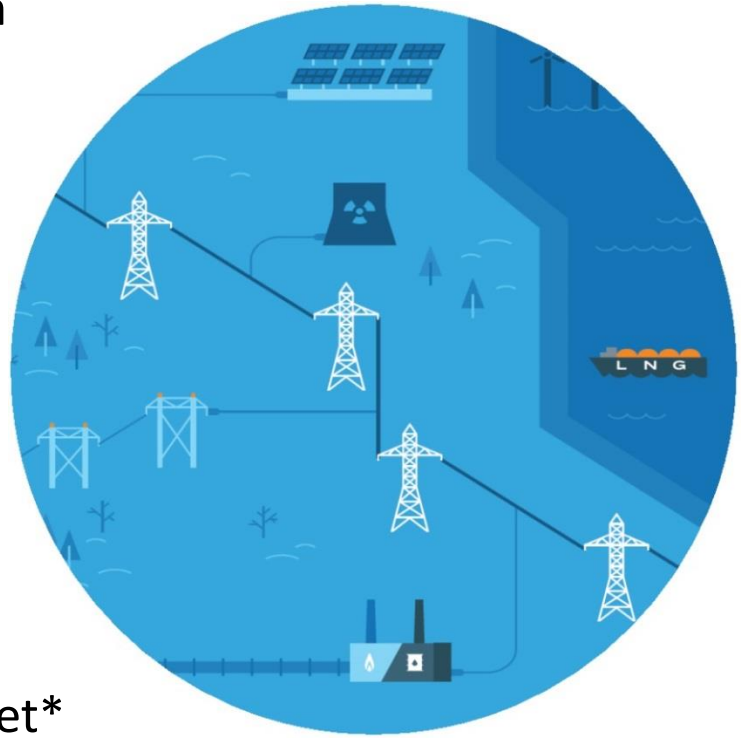
Demand Patterns Are Changing

- **7.2 million** retail electricity customers drive the demand for electricity in New England (14.8 million population)
  - Region's all-time summer peak demand: **28,130 MW** on August 2, 2006
  - Region's all-time winter peak demand: **22,818 MW** on January 15, 2004
- Energy efficiency (EE) and behind-the-meter (BTM) solar are **reducing** peak demand growth and overall electricity use over the next ten years
  - **-0.2%** annual growth rate for summer peak demand (with EE and BTM solar)
  - **-0.9%** annual growth rate for overall electricity use (with EE and BTM solar)
- BTM solar is **shifting** peak demand later in the day in the summertime

Note: Without energy efficiency and solar, the region's peak demand is forecasted to grow 0.8% annually and the region's overall electricity demand is forecasted to grow 0.9% annually. Summer peak demand is based on the "90/10" forecast for extreme summer weather.

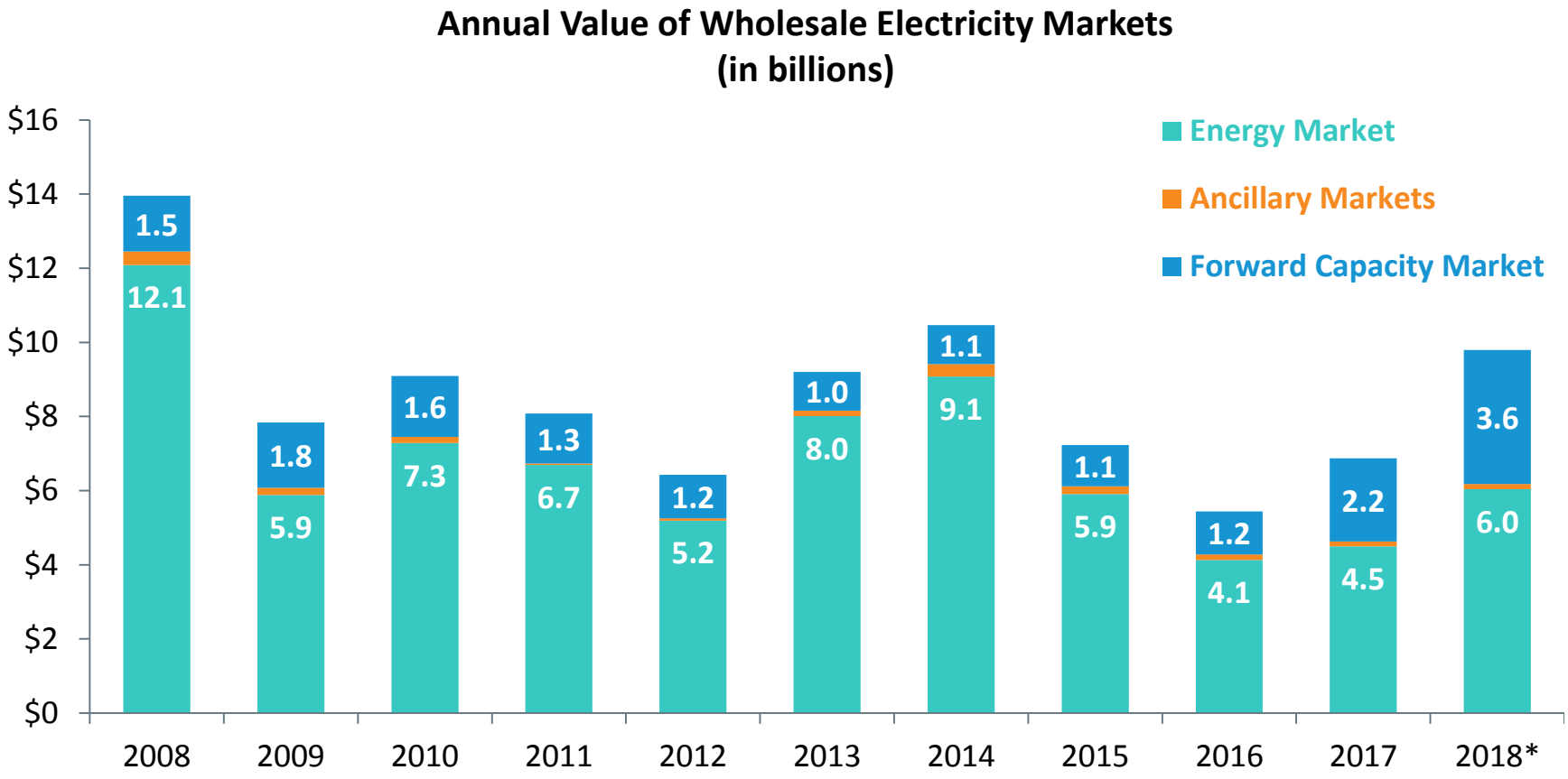
Generation and Demand Resources Are Used to Meet New England's Energy Needs

- **350** dispatchable generators in the region
- **31,000 MW** of generating capacity
- **20,600 MW** of proposed generation in the ISO Queue
  - Mostly wind and natural gas
- **5,200 MW** of generation have retired or will retire in the next few years
- **400 MW** of active demand response and **2,500 MW** of energy efficiency with obligations in the Forward Capacity Market*
  - Effective June 1, 2018, demand resources have further opportunities in the wholesale markets



* In the Forward Capacity Market, demand-reduction resources are treated as capacity resources.

Energy Market Values Vary with Fuel Prices While Capacity Market Values Vary with Changes in Supply

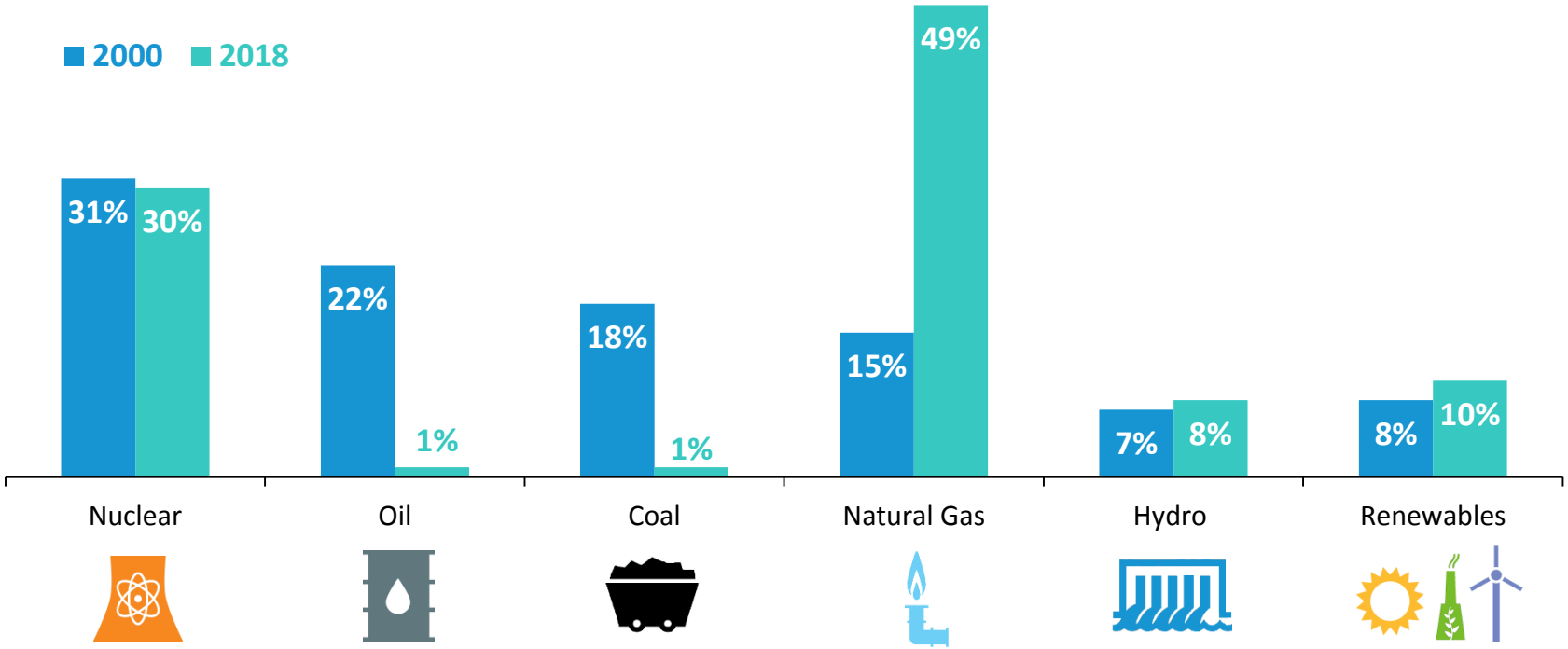


Source: 2017 Report of the Consumer Liaison Group; *2018 data is preliminary and subject to resettlement
Note: Forward Capacity Market values shown are based on auctions held roughly three years prior to each calendar year.

Dramatic Changes in the Energy Mix

The fuels used to produce the region's electric energy have shifted as a result of economic and environmental factors

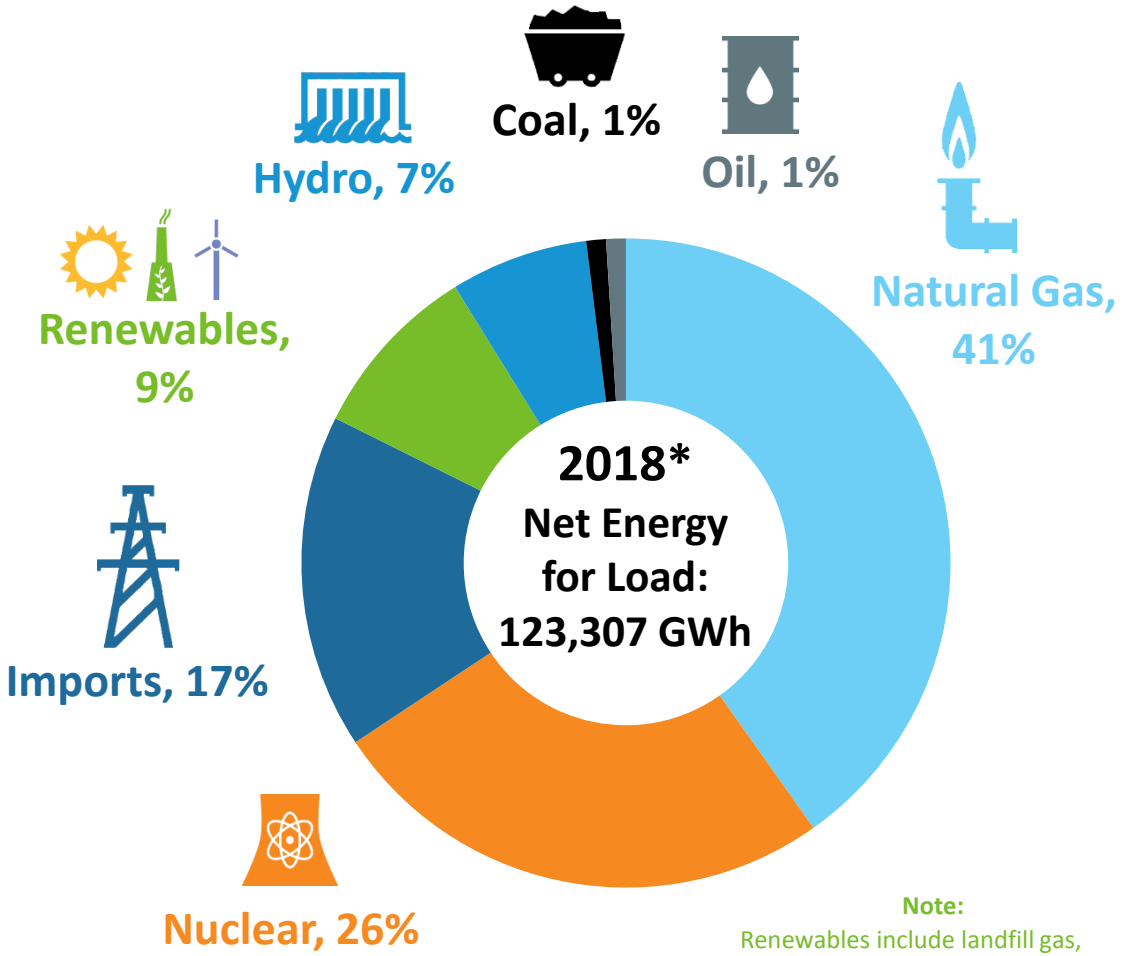
Percent of Total **Electric Energy** Production by Fuel Type
(2000 vs. 2018)



Source: ISO New England Net Energy and Peak Load by Source
Renewables include landfill gas, biomass, other biomass gas, wind, grid-scale solar, municipal solid waste, and miscellaneous fuels.
This data represents electric generation within New England; it does not include imports or behind-the-meter (BTM) resources, such as BTM solar.

Lower-Emitting Sources of Energy Supply Most of New England's Electricity

- In 2018, most of the region's energy needs were met by natural gas, nuclear, imported electricity (mostly hydropower from Eastern Canada), renewables, and other low- or non-carbon-emitting resources
- Region is transitioning away from older coal and oil resources

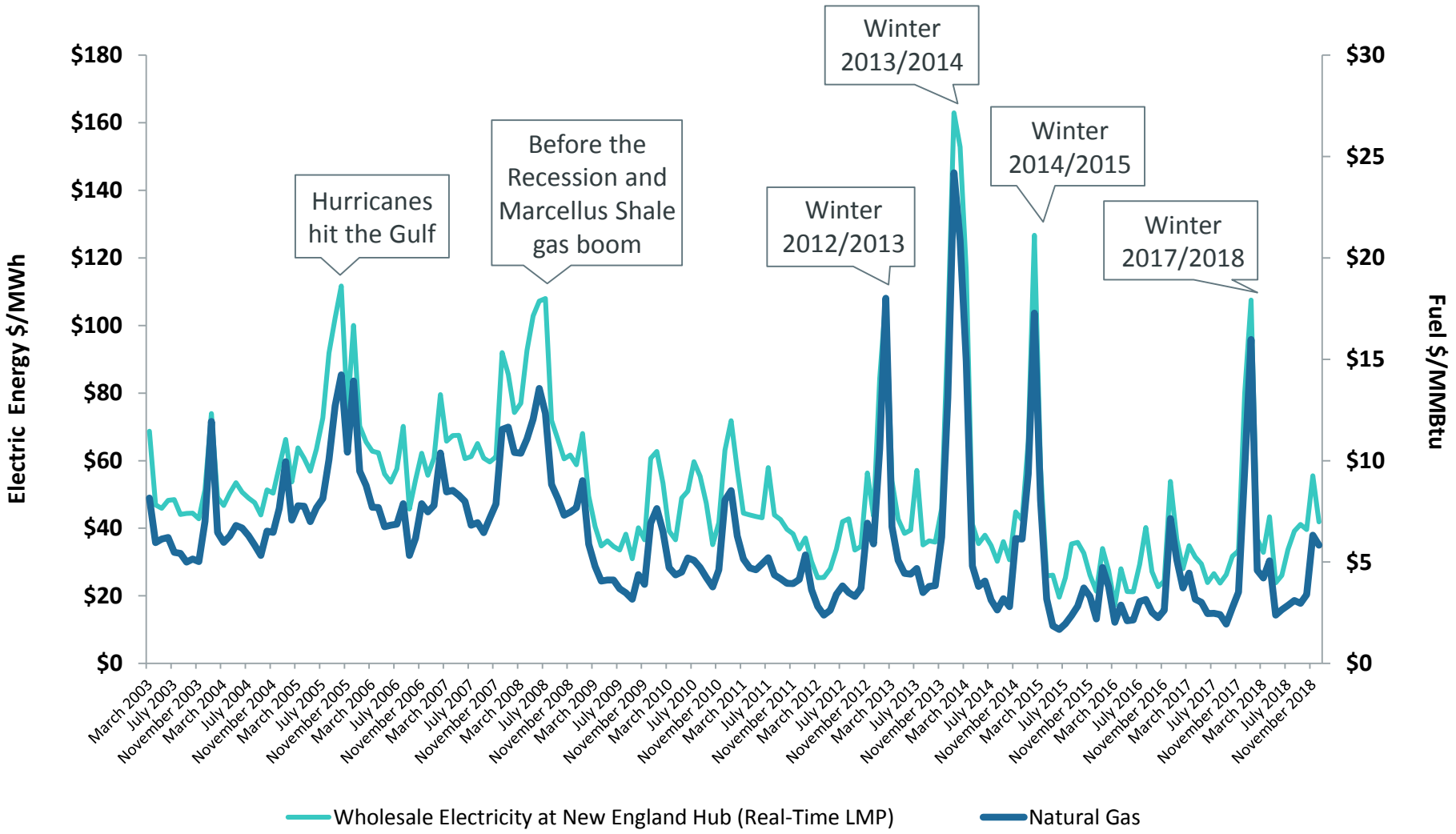


Note:
Renewables include landfill gas, biomass, other biomass gas, wind, grid-scale solar, municipal solid waste, and miscellaneous fuels.

* Data is preliminary and subject to resettlement

Natural Gas and Wholesale Electricity Prices Are Linked

Monthly average natural gas and wholesale electricity prices at the New England hub

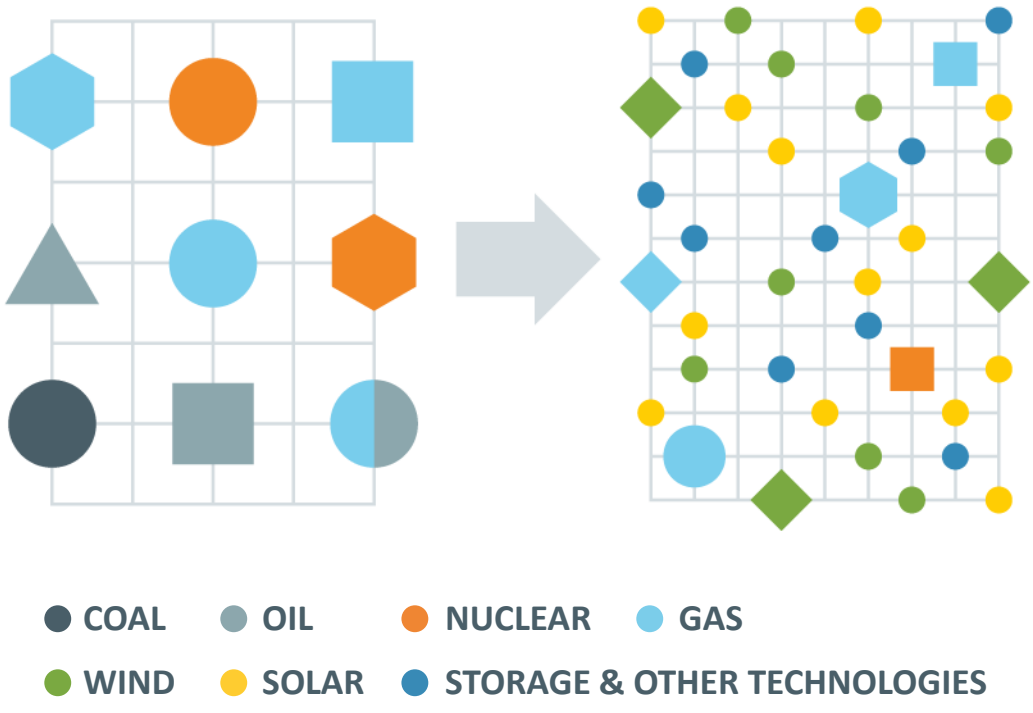


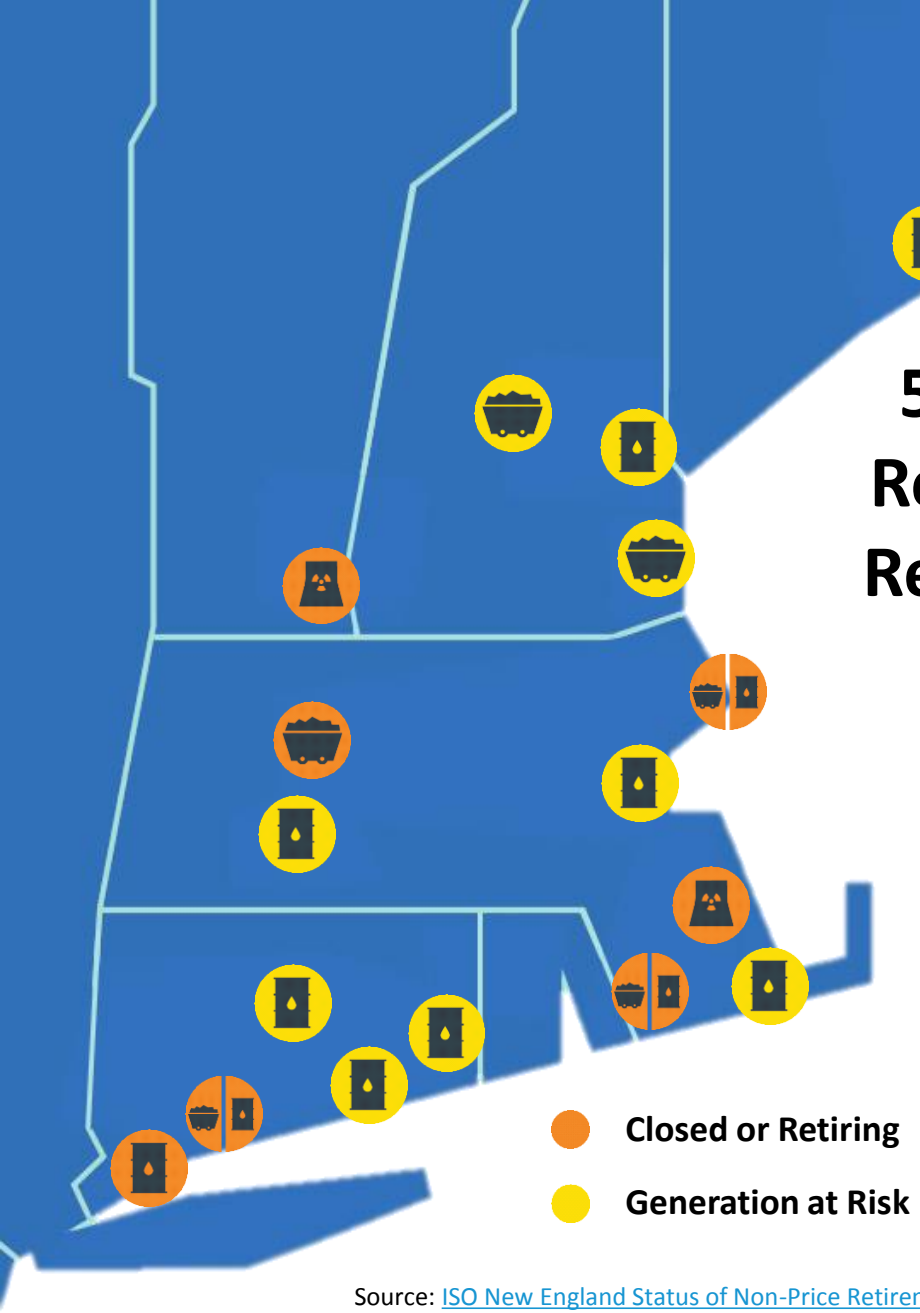
We Are Moving Toward a Hybrid Grid

There are two dimensions to this transition, happening simultaneously

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

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





Since 2013, More Than 5,200 MW of Generation Have Retired or Announced Plans for Retirement in the Coming Years

- Include predominantly coal, oil, and nuclear resources
- Another **5,000 MW** of remaining coal and oil are at risk of retirement
- These resources have played an **important** role in recent winters when natural gas supply is constrained in New England

Source: ISO New England Status of Non-Price Retirement Requests and Retirement De-list Bids; August 17, 2018

Power Plant Emissions Have Declined with Changes in the Fuel Mix

Reduction in Aggregate Emissions (ktons/yr)

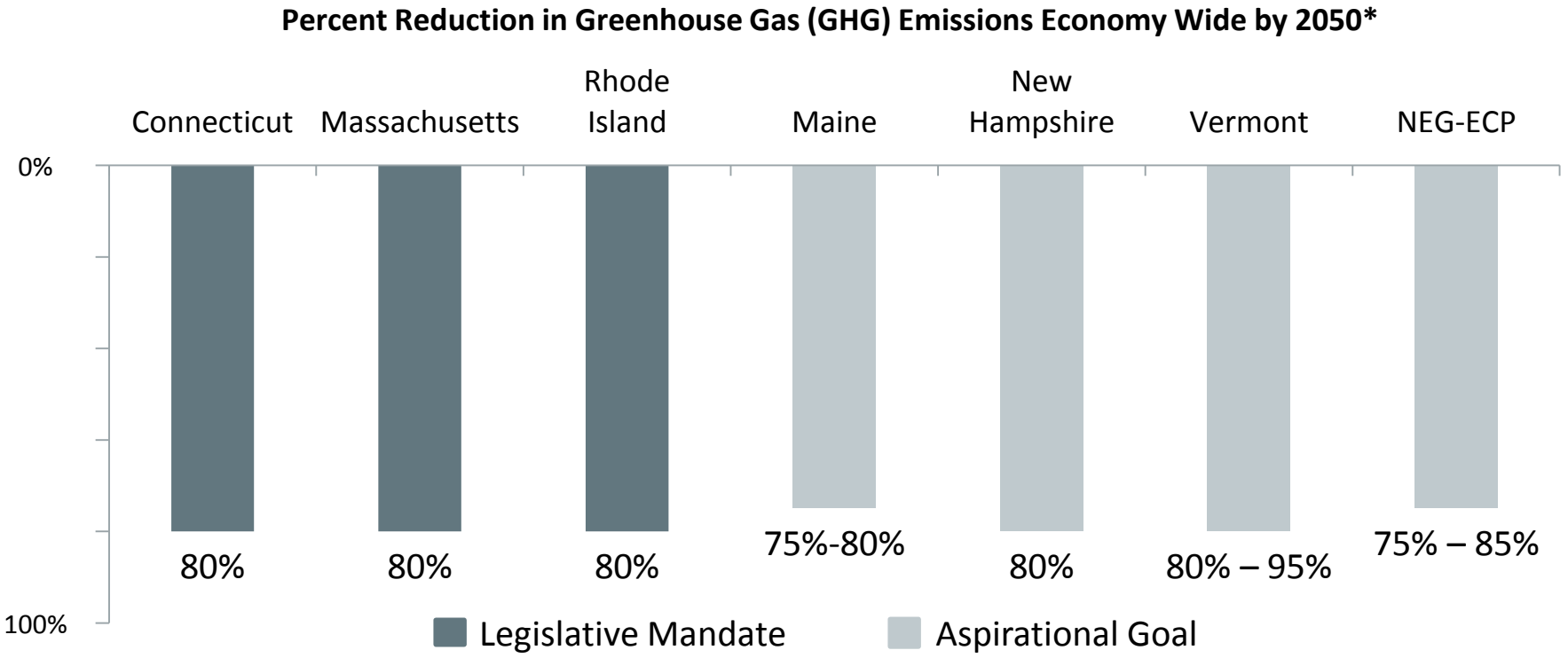
Year	NO_x	SO_2	CO_2
2001	59.73	200.01	52,991
2016	16.27	4.47	37,467
% Reduction, 2001–2016	**⬇ 73%**	**⬇ 98%**	**⬇ 29%**

Reduction in Average Emission Rates (lb/MWh)

Year	NO_x	SO_2	CO_2
1999	1.36	4.52	1,009
2016	0.31	0.08	710
% Reduction, 1999–2016	**⬇77%**	**⬇ 98%**	**⬇ 30%**

Source: 2016 ISO New England Electric Generator Air Emissions Report, January 2018

States Have Set Goals for Reductions in Greenhouse Gas Emissions: *Some Mandated, Some Aspirational*

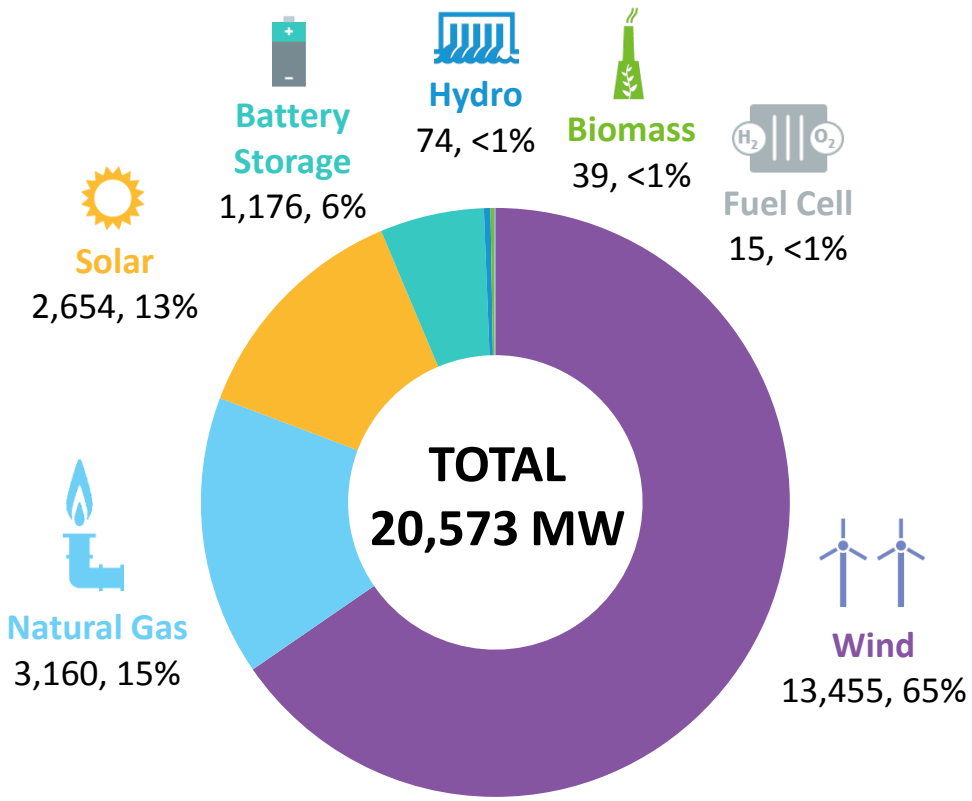


The New England states are promoting GHG reductions on a state-by-state basis, and at the regional level, through a combination of legislative mandates (e.g., CT, MA, RI) and aspirational, non-binding goals (e.g., ME, NH, VT and the New England Governors and Eastern Canadian Premiers).

* MA, RI, NH, and VT use a 1990 baseline year for emissions reductions. CT and the NEG-ECP use a 2001 baseline. ME specifies reductions below 2003 levels that *may* be required "in the long term." For more information, see the following ISO Newswire article: http://isonewswire.com/updates/2017/3/1/the-new-england-states-have-an-ongoing-framework-for-reducin.html.

Wind Power Dominates New Resource Proposals in the ISO Generator Interconnection Queue

Proposals by Type



Note: Some natural gas proposals include dual-fuel units (oil); some natural gas, wind, and solar proposals include battery storage; megawatts represent nameplate capacity ratings; megawatts have been rounded.

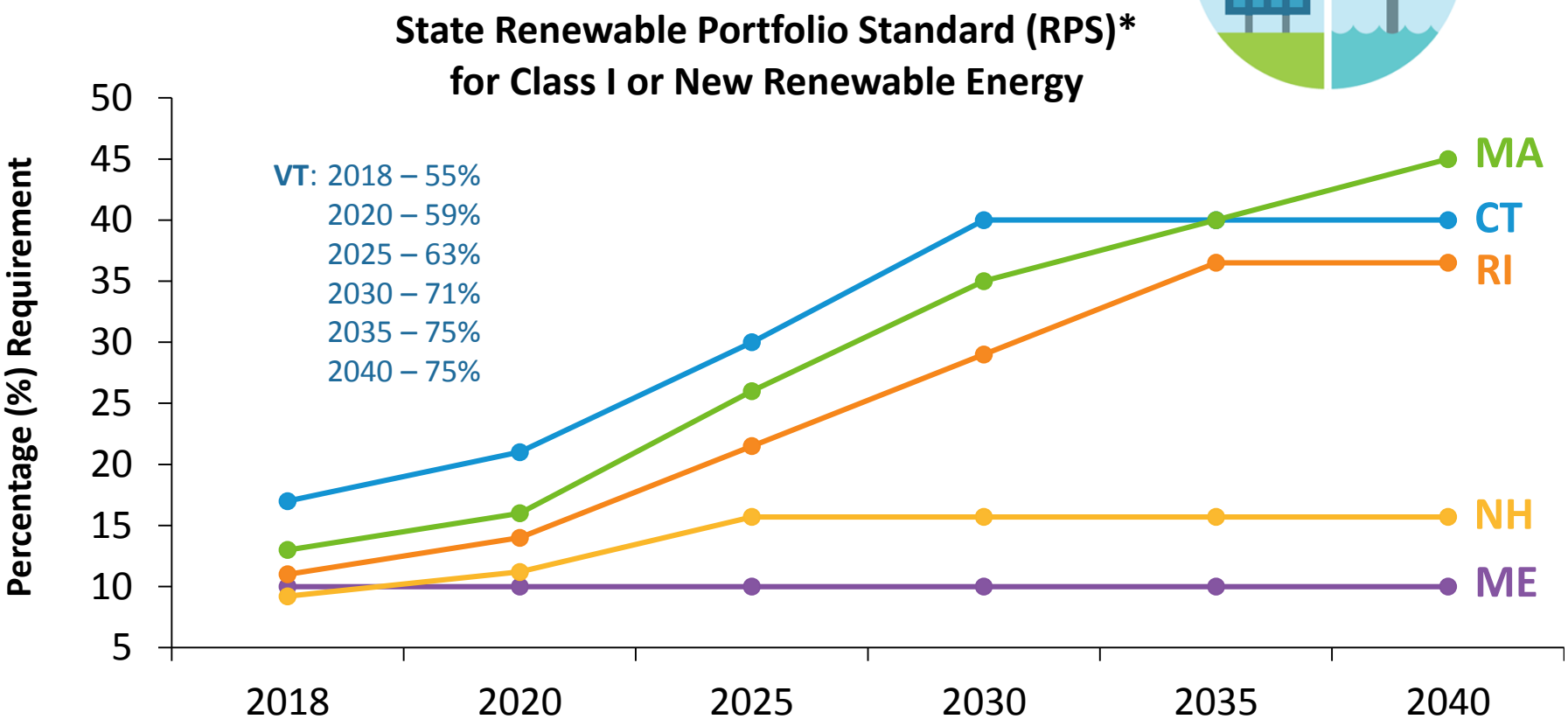
Proposals by State

State	Megawatts (MW)
Massachusetts	10,426
Maine	4,578
Connecticut	3,682
Rhode Island	1,366
New Hampshire	302
Vermont	218
Total	**20,573**

Source: ISO Generator Interconnection Queue (January 2019) FERC and Non-FERC Jurisdictional Proposals

Renewable Energy Is on the Rise

State policy requirements are a major driver

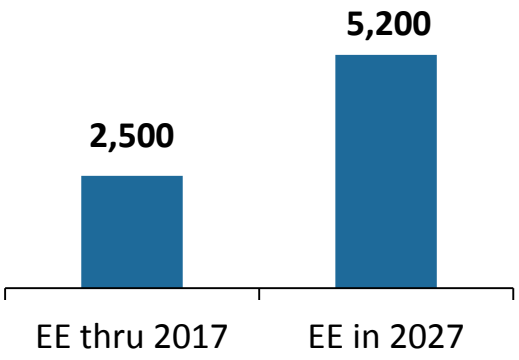


Notes: State RPS requirements promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Connecticut's Class I RPS requirement plateaus at 40% in 2030. Maine's Class I RPS requirement plateaued at 10% in 2017 and is set to expire in 2022 (but has been held constant for illustrative purposes). Massachusetts' Class I RPS requirement increases by 2% each year between 2020 and 2030, reverting back to 1% each year thereafter, with no stated expiration date. New Hampshire's percentages include the requirements for both Class I and Class II resources (Class II resources are new solar technologies beginning operation after January 1, 2006). New Hampshire's Class I and Class II RPS requirements plateau at 15.7% in 2025. Rhode Island's requirement for 'new' renewable energy plateaus at 36.5% in 2035. Vermont's 'total renewable energy' requirement plateaus at 75% in 2032; it recognizes all forms of new and existing renewable energy and is unique in classifying large-scale hydropower as renewable.

Energy-Efficiency and Renewable Resources Are Trending Up in New England

Energy Efficiency

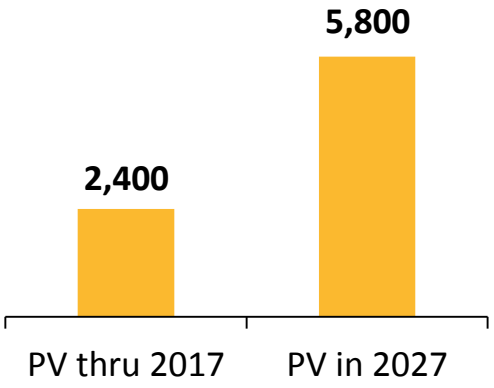
(MW)



Final 2018 CELT Report, EE through 2017 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2027 includes an ISO-NE forecast of incremental EE beyond the FCM.

Solar

(MW)



Final 2018 ISO-NE PV Forecast, AC nameplate capacity from PV resources participating in the region's wholesale electricity markets, as well as those connected "behind the meter."

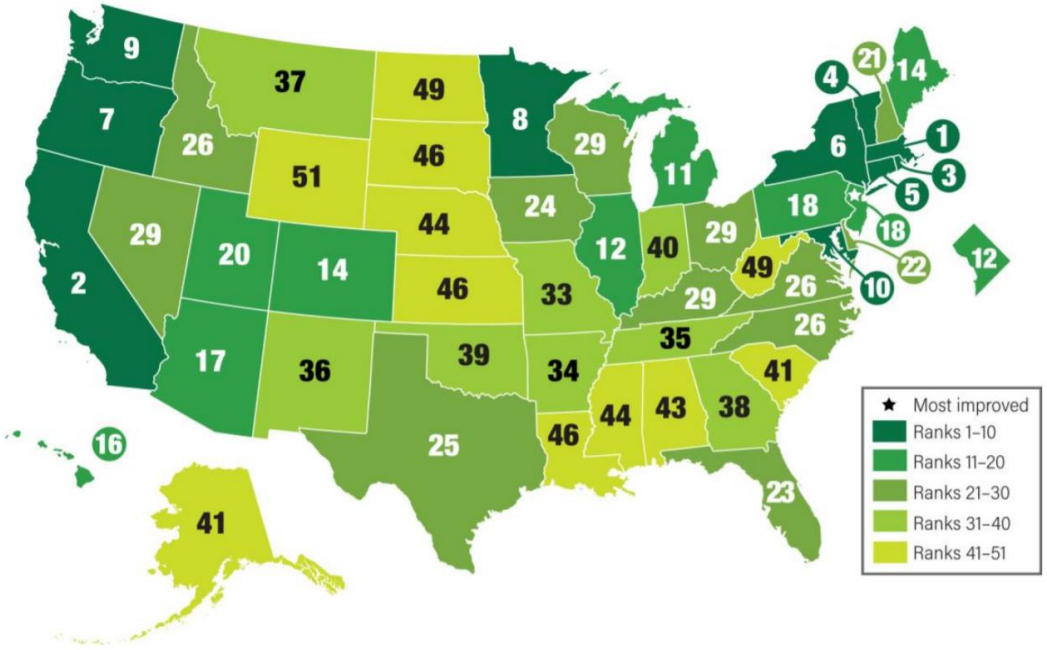
Wind

(MW)

Nameplate capacity of existing wind resources and proposals in the ISO-NE Generator Interconnection Queue; some wind proposals include battery storage.

Energy Efficiency Is a Priority for State Policymakers

2018 State Energy-Efficiency Scorecard



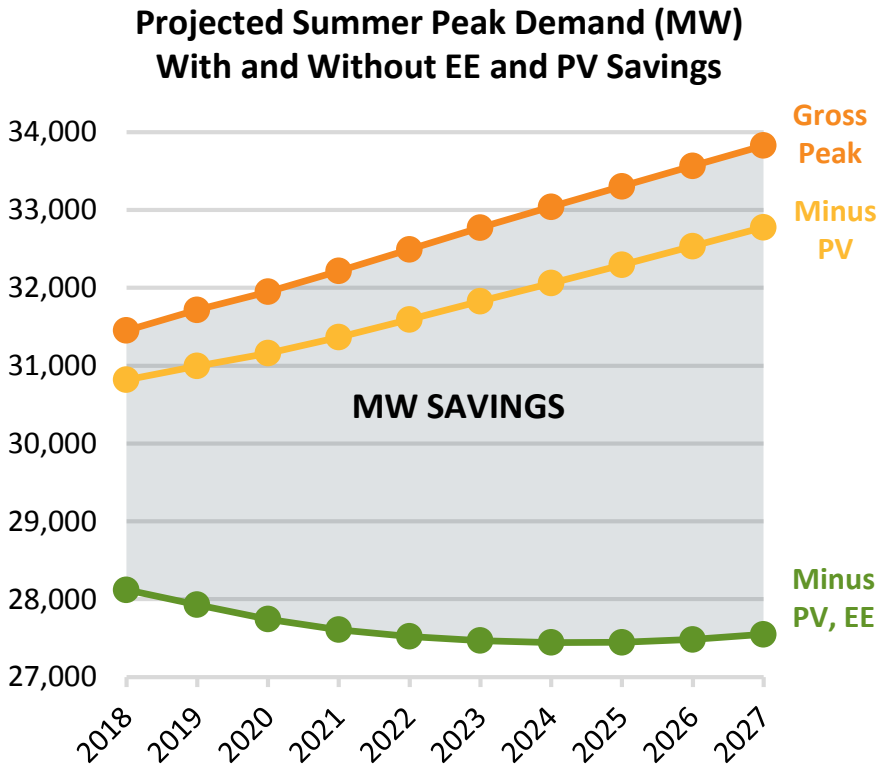
Source: American Council for an Energy-Efficient Economy

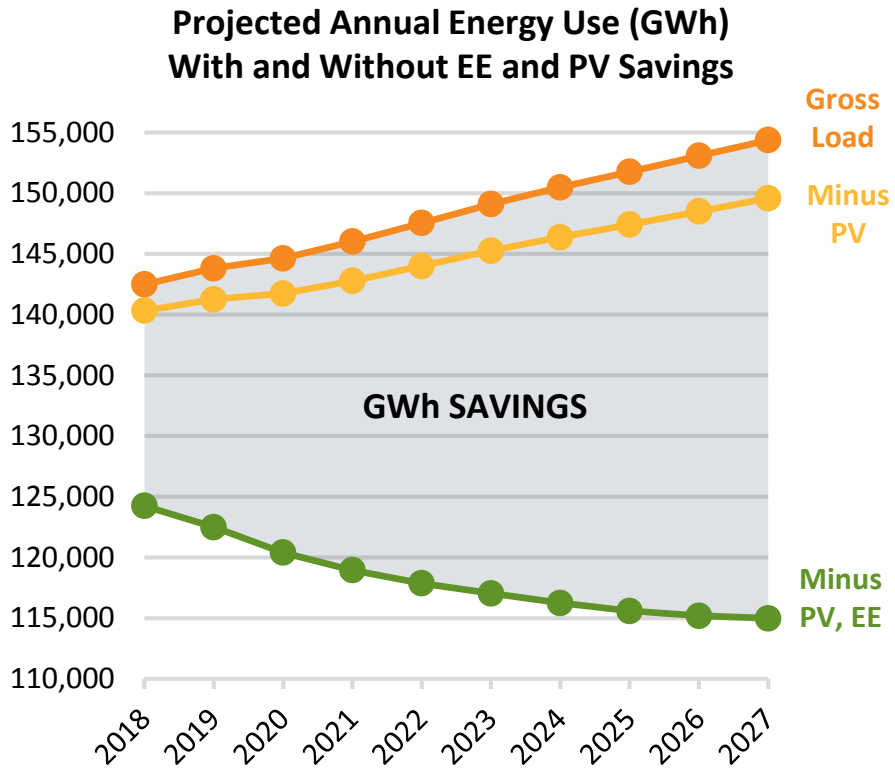
Ranking of state EE efforts by the *American Council for an Energy-Efficient Economy*:

- Massachusetts 1
- Rhode Island 3
- Vermont 4
- Connecticut 5
- Maine 14
- New Hampshire 21

- Billions spent over the past few years and more on the horizon
  - Nearly $4.9 billion invested from 2011 to 2016
  - ISO estimates $10.5 billion to be invested in EE from 2019 to 2027

Energy Efficiency and Behind-the-Meter Solar Are Reducing Peak Demand and Annual Energy Use





- The gross peak and load forecast
- The gross peak and load forecast minus existing and anticipated "behind-the-meter" (BTM) solar PV resources
- The gross peak and load forecast minus existing and anticipated BTM solar PV and energy efficiency

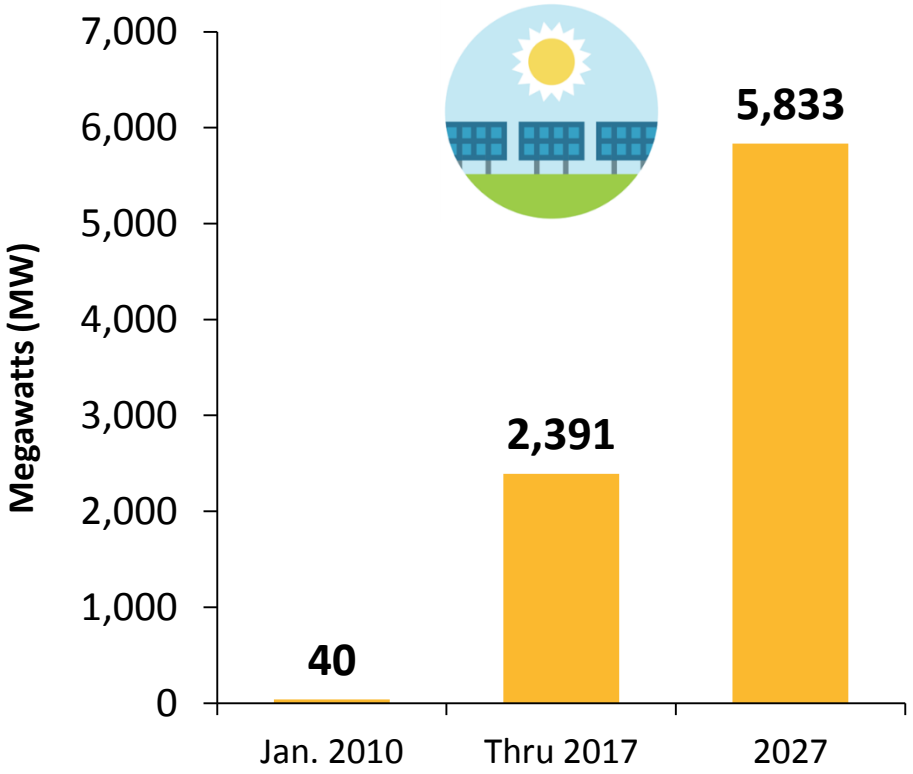
Note: Summer peak demand is based on the "90/10" forecast, which accounts for the possibility of extreme summer weather (temperatures of about 94° F).
Source: ISO New England 2018-2027 Forecast Report of Capacity, Energy, Loads, and Transmission (2018 CELT Report) (May 2018)

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

December 2017 Solar PV Installed Capacity (MW_{ac})

State	Installed Capacity (MW_{ac})	No. of Installations
Connecticut	365.6	29,512
Massachusetts	1,602.3	78,047
Maine	33.5	3,598
New Hampshire	69.7	7,330
Rhode Island	62.2	4,148
Vermont	257.2	9,773
New England	**2,390.5**	**132,408**

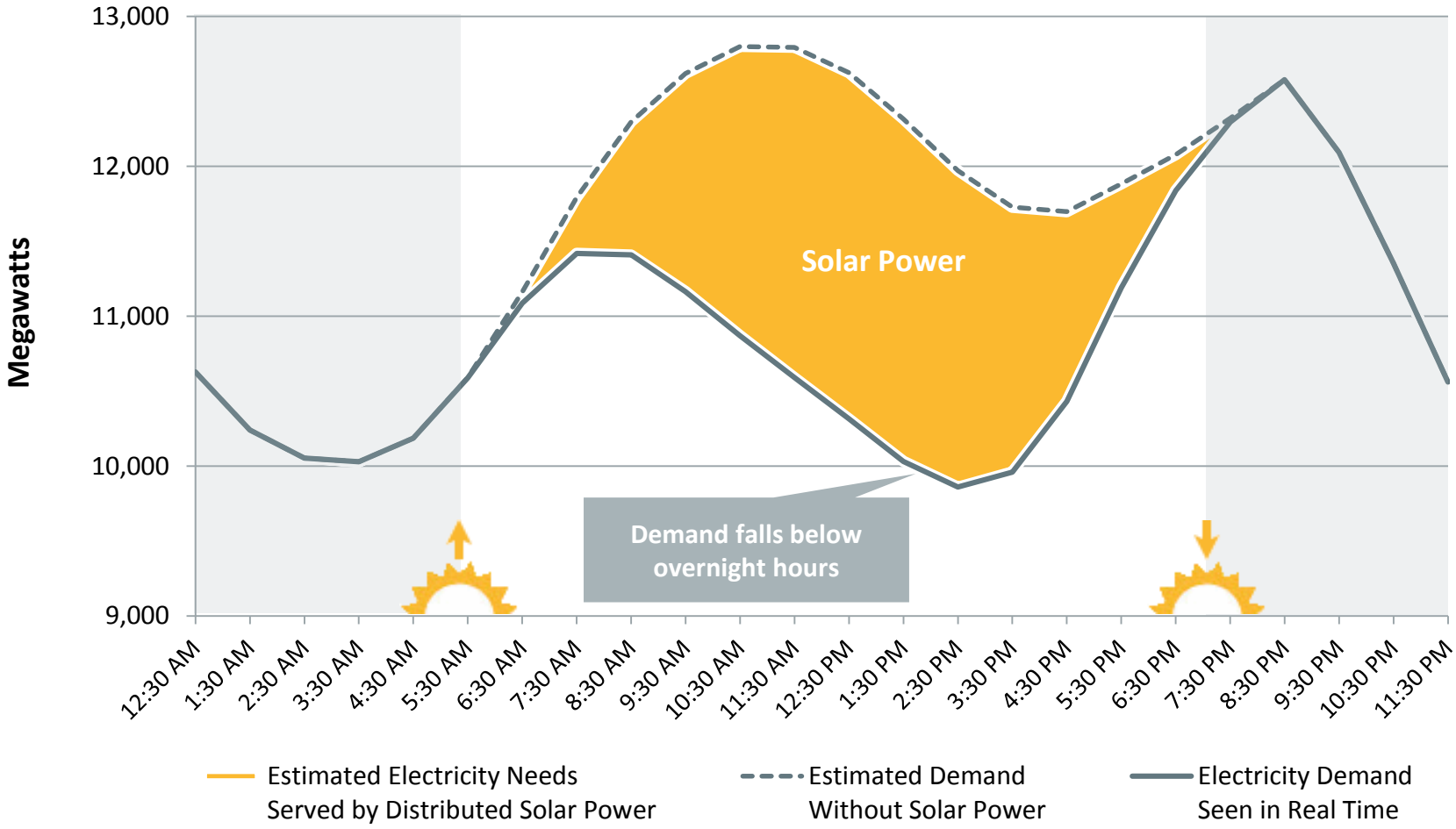
Cumulative Growth in Solar PV through 2027 (MW_{ac})



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." Source: Final 2018 PV Forecast (May 2018); MW values are AC nameplate.

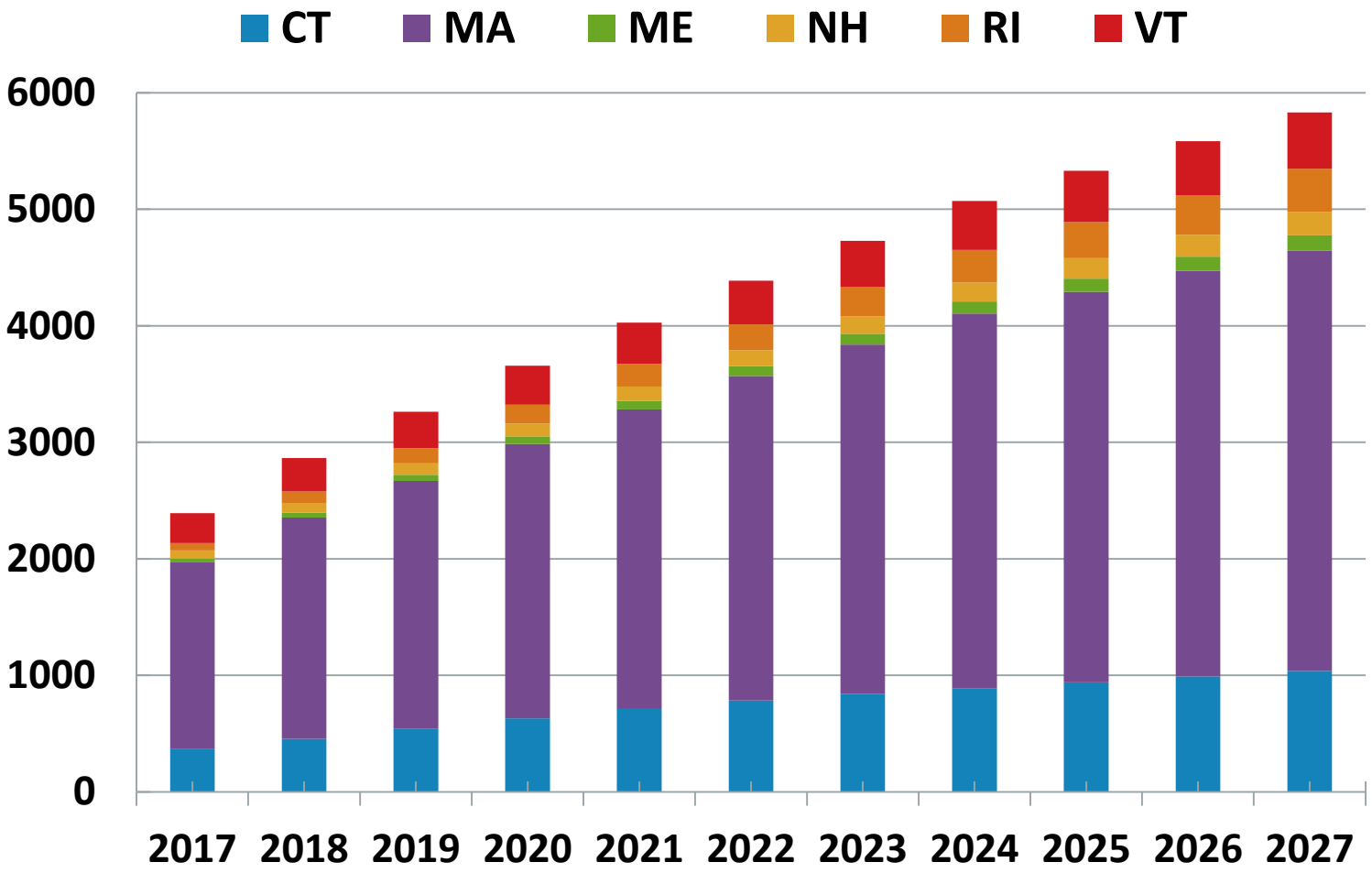
Historic Dip in Midday Demand with Record-High Solar Power Output on April 21, 2018

At 1:30 p.m., behind-the-meter solar reduced grid demand by more than 2,300 MW



Final 2018 PV Forecast

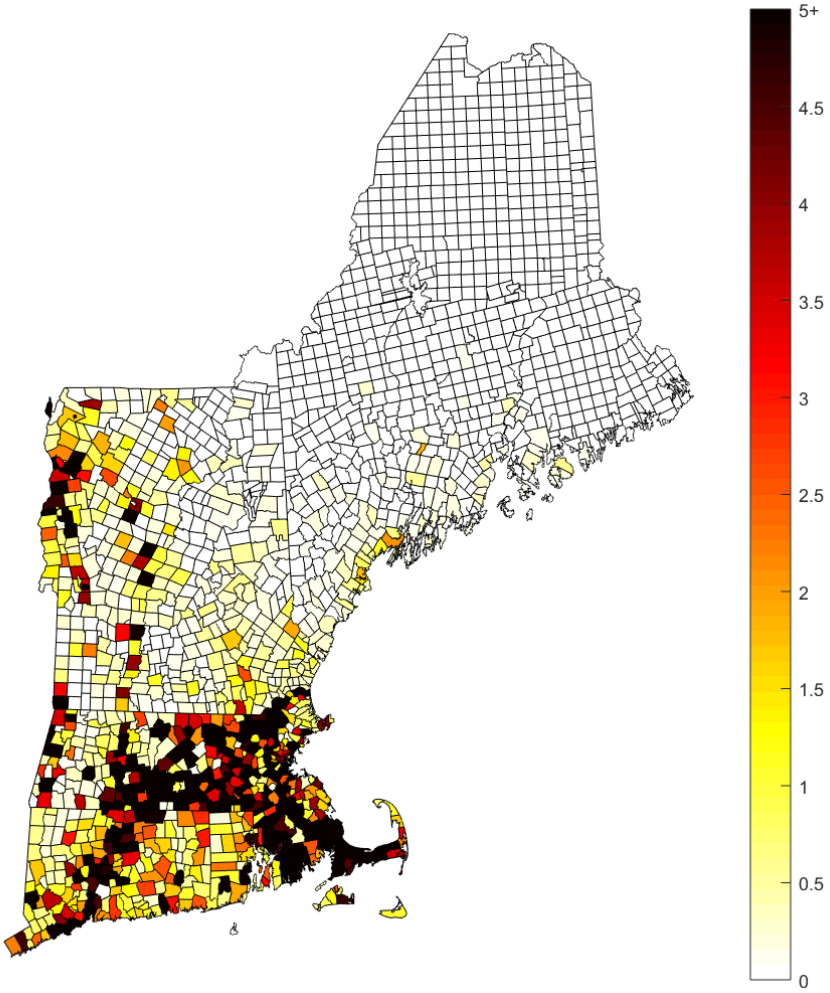
Cumulative Nameplate Installed, MW_{ac}



Source: Final 2018 PV Forecast. Available at https://www.iso-ne.com/static-assets/documents/2018/03/a03-2018-pv-forecast.pdf (March 2018)

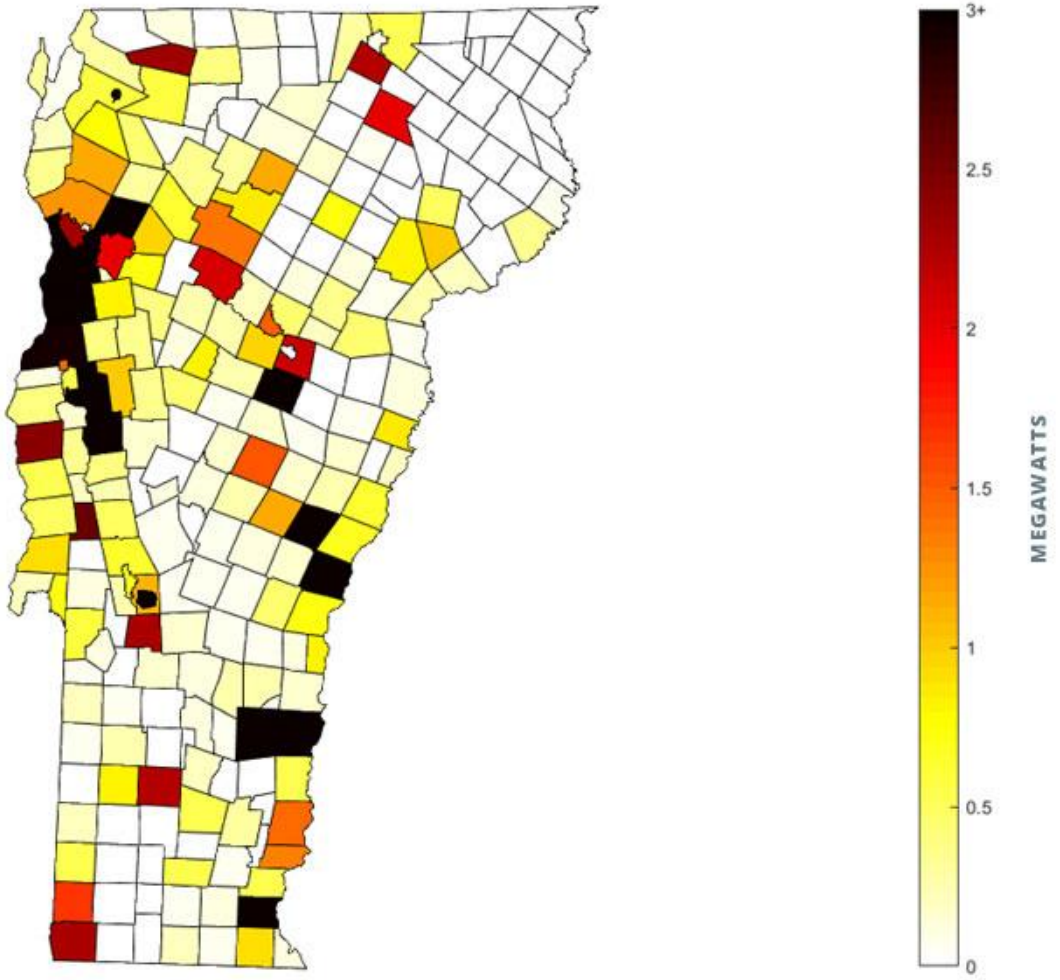
State Installed Solar PV “Heat Maps”

- Understanding the spatial distribution of existing solar PV resources will be critical to the ISO’s ongoing integration activities within both System Planning and System Operations
- Based on the data provided by distribution owners, the ISO has aggregated the installed nameplate capacity by town within each state, and generated heat maps showing the results



Note: Heat map reflects solar PV installed through December 2017.

Vermont Installed Solar PV “Heat Map”



Note: Heat map reflects solar PV installed through December 2017.

New Energy Storage Technologies Are Coming On Line

- **20 MW** of grid-scale battery storage projects have come on line since late 2015
- Nearly **1,200 MW** of grid-scale energy storage projects are requesting interconnection
- New England has a successful history of operating the region's two large pumped-storage facilities, which can supply **1,800 MW** of power within 10 minutes for up to 7 hours

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

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

- Developers are proposing more than **15** elective transmission upgrades (ETUs) to help deliver nearly **14,000 MW** of clean energy to New England load centers
  - Mostly Canadian hydro and onshore wind from northern New England
- Wind projects make up **65%** of proposed new power resources in the ISO Queue, but many are remote

Source: ISO Interconnection Queue (January 2019)

Upcoming Opportunities for Engagement

Consumer Liaison Group

- **March 14, June 13**, **September 5,** and **December 5** (Locations vary)
- Meeting agendas, presentations, and summaries will be posted on the CLG webpage
- Each state has representation on the group's coordinating committee

Regional System Plan Public Meeting

- **Thursday, September 12** (Logistical details to follow)

Vermont System Planning Committee

- ISO staff attend and **provide regional updates** regularly

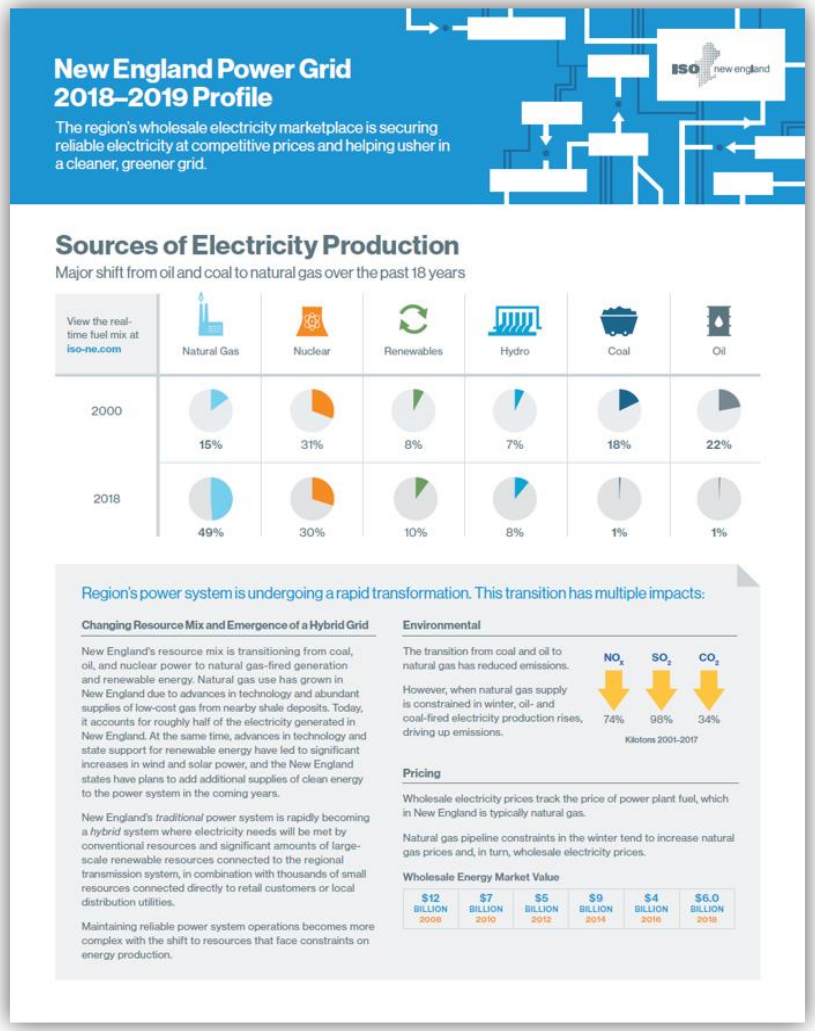
ISO-NE Reports and Resources

Available Now:

- Updated State and Regional Profiles

Coming Soon:

- 2019 Regional Electricity Outlook (REO)
  - A summary of the current state of the grid, issues affecting its future, and ISO actions to ensure a modern, reliable power system
- **Consumer Liaison Group Annual Report**
- **Energy-Efficiency** and **Solar Photovoltaic** Forecasts
  - Scheduled for release by May 1, 2019 in the annual Capacity, Energy, Load and Transmission (CELT) Report



FOR MORE INFORMATION…

Subscribe to the *ISO Newswire*

ISO Newswire is your source for regular news about ISO New England and the wholesale electricity industry within the six-state region

Log on to ISO Express

ISO Express provides real-time data on New England's wholesale electricity markets and power system operations

Follow the ISO on Twitter

@isonewengland

Follow the ISO on LinkedIn

@iso-new-england

Download the ISO to Go App

ISO to Go is a free mobile application that puts real-time wholesale electricity pricing and power grid information in the palm of your hand

GET IT ON Google Play

Download on the App Store

Questions