FEBRUARY 5, 2019 | HARTFORD, CT

ISO New England Overview and Regional Update

Connecticut General Assembly

Energy and Technology Committee

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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

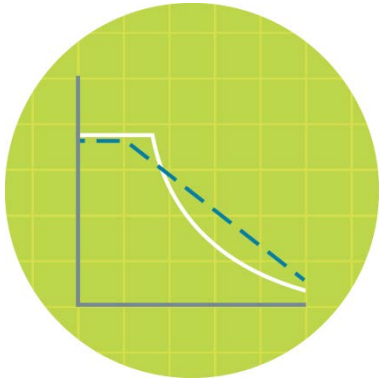
ISO New England Performs Three Critical Roles to Ensure Reliable Electricity at Competitive Prices

Grid Operation

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

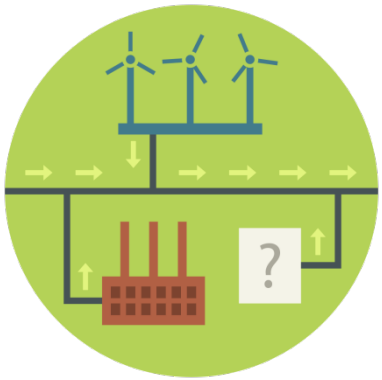
Market Administration

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



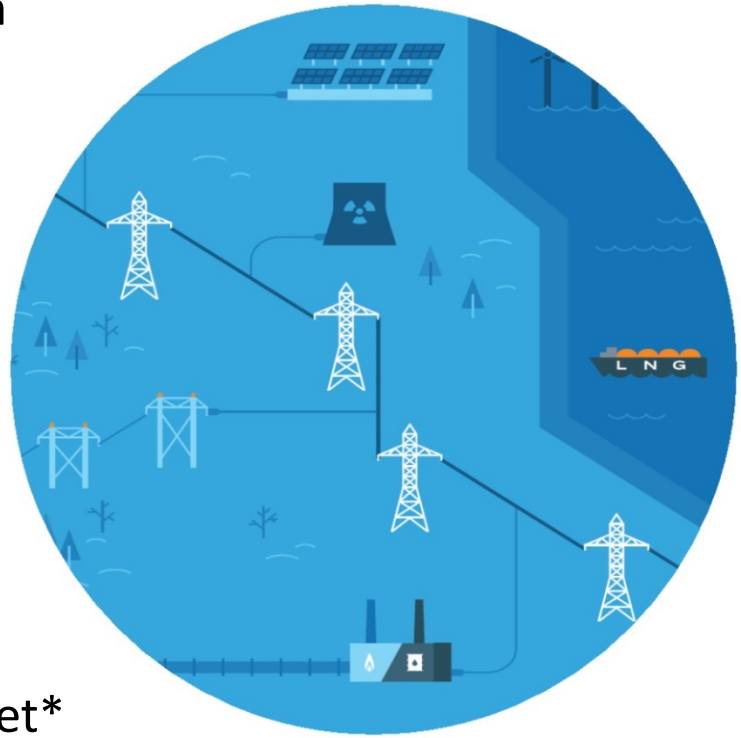
Power System Planning

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



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

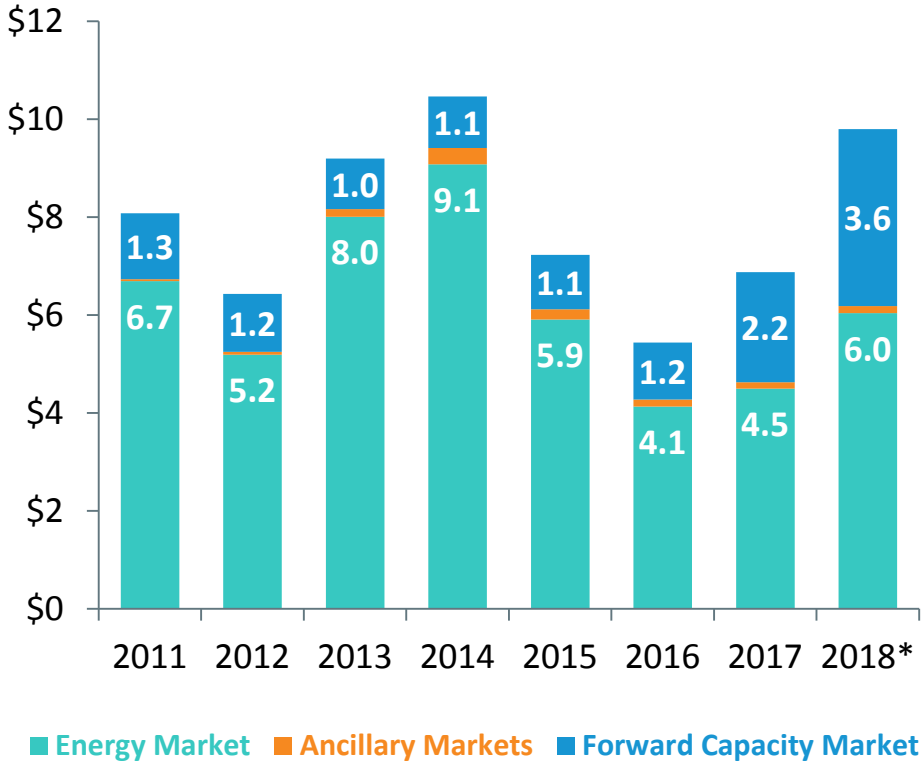


* In the Forward Capacity Market, demand-reduction resources are treated as capacity resources.

Many Resources Compete to Supply Electricity in New England's Wholesale Markets

- Close to **500** buyers and sellers in the markets
- **$9.8 billion** traded in wholesale electricity markets in 2018
  - **$6.0 billion** in energy markets
    - Increased costs driven by **cold weather** and higher wholesale electric energy prices in January
  - **$3.8 billion** in capacity and ancillary services markets
    - Increased costs driven by resource **retirements** and higher clearing prices in Forward Capacity Market
- Extensive analysis and reporting of market results

Annual Value of Wholesale Electricity Markets (in billions)



* Data is preliminary and subject to resettlement

Demand Patterns Are Changing

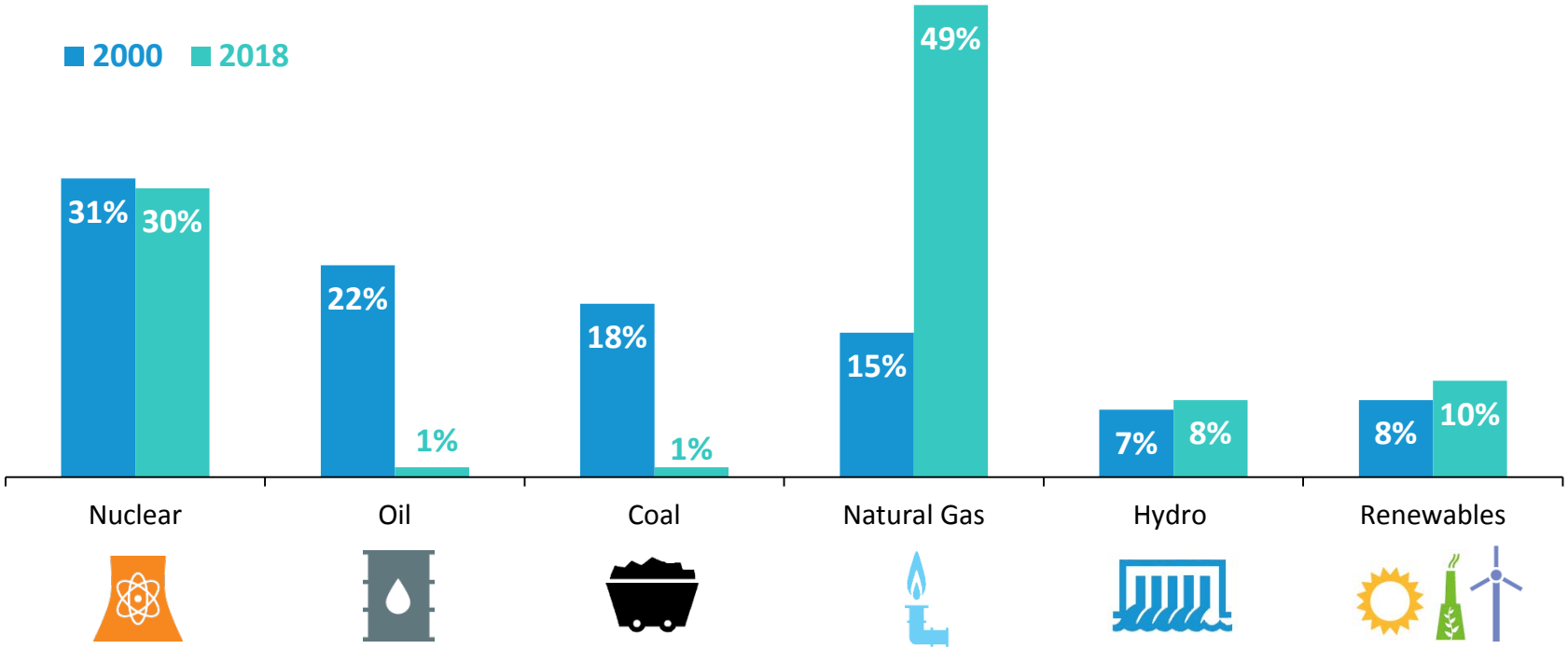
- **7.2 million** retail electricity customers drive the demand for electricity in New England (14.8 million population)
  - Region's all-time summer peak demand: **28,130 MW** on August 2, 2006
  - Region's all-time winter peak demand: **22,818 MW** on January 15, 2004
- Energy efficiency (EE) and behind-the-meter (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.

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

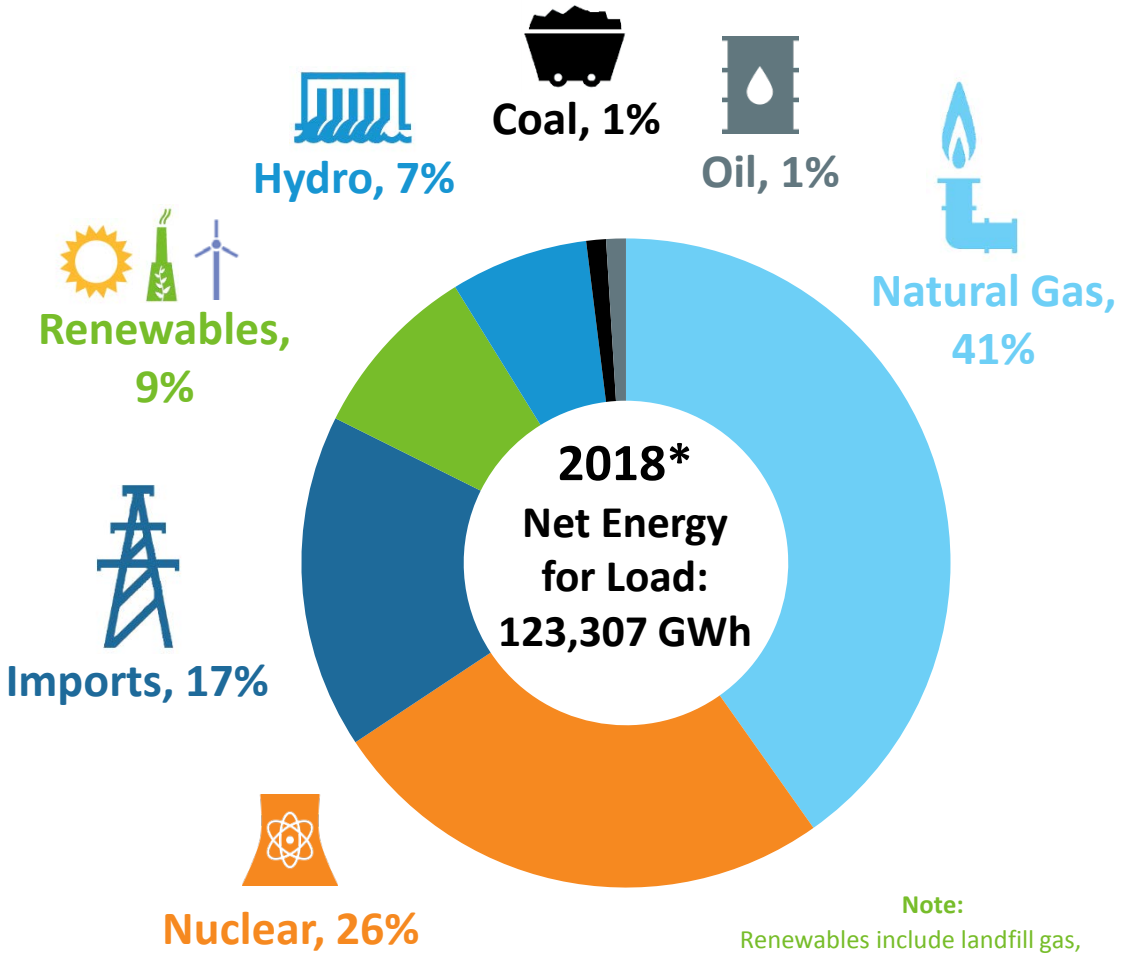
Percent of Total **Electric Energy** Production by Fuel Type
(2000 vs. 2018)



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.

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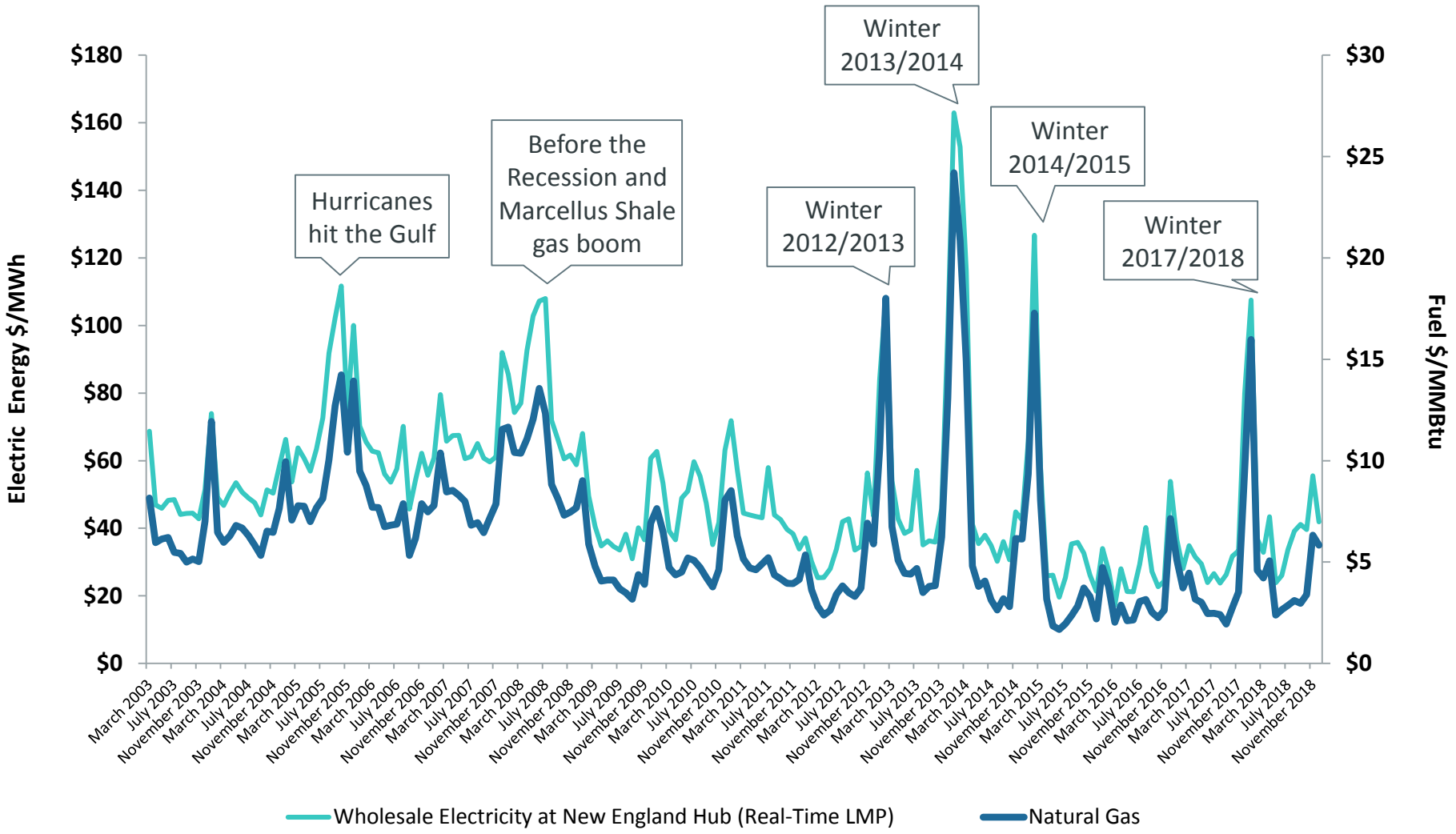
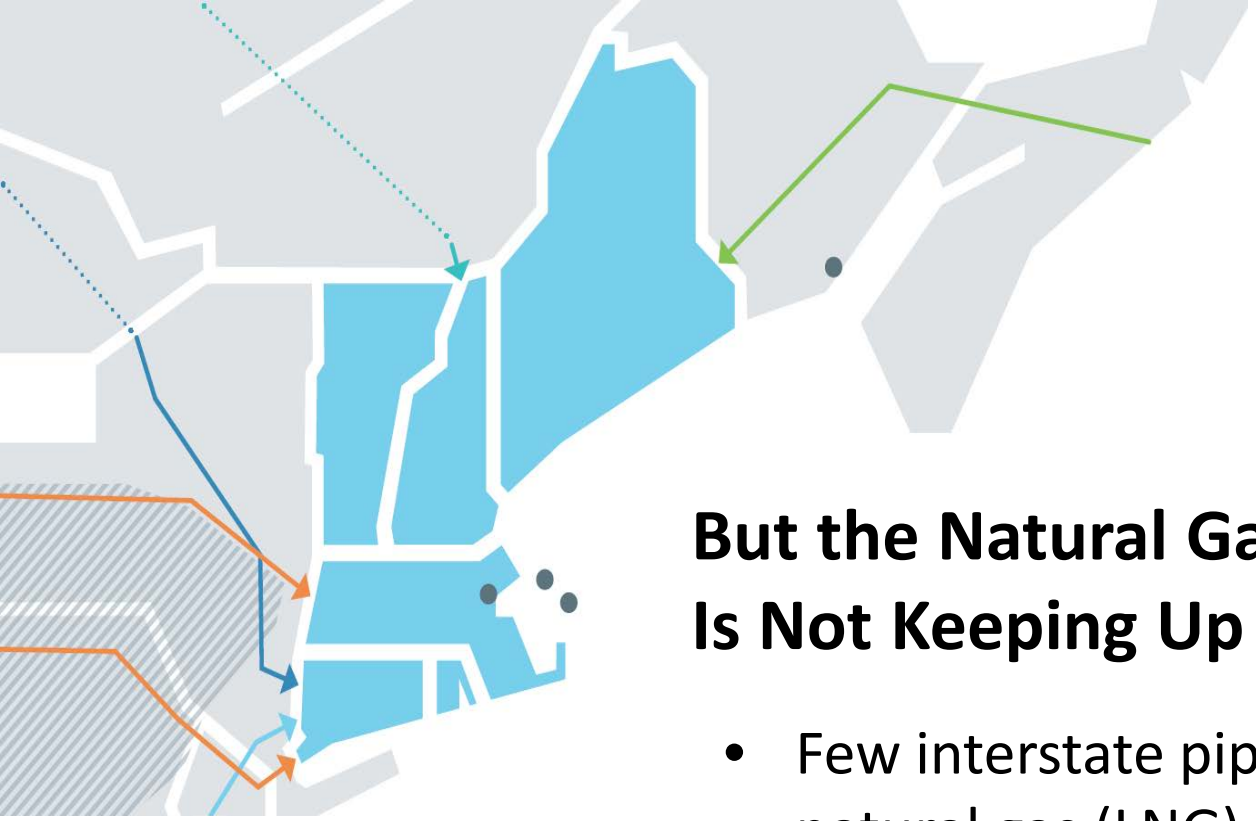
Natural Gas and Wholesale Electricity Prices Are Linked

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





Pipelines

LNG facilities

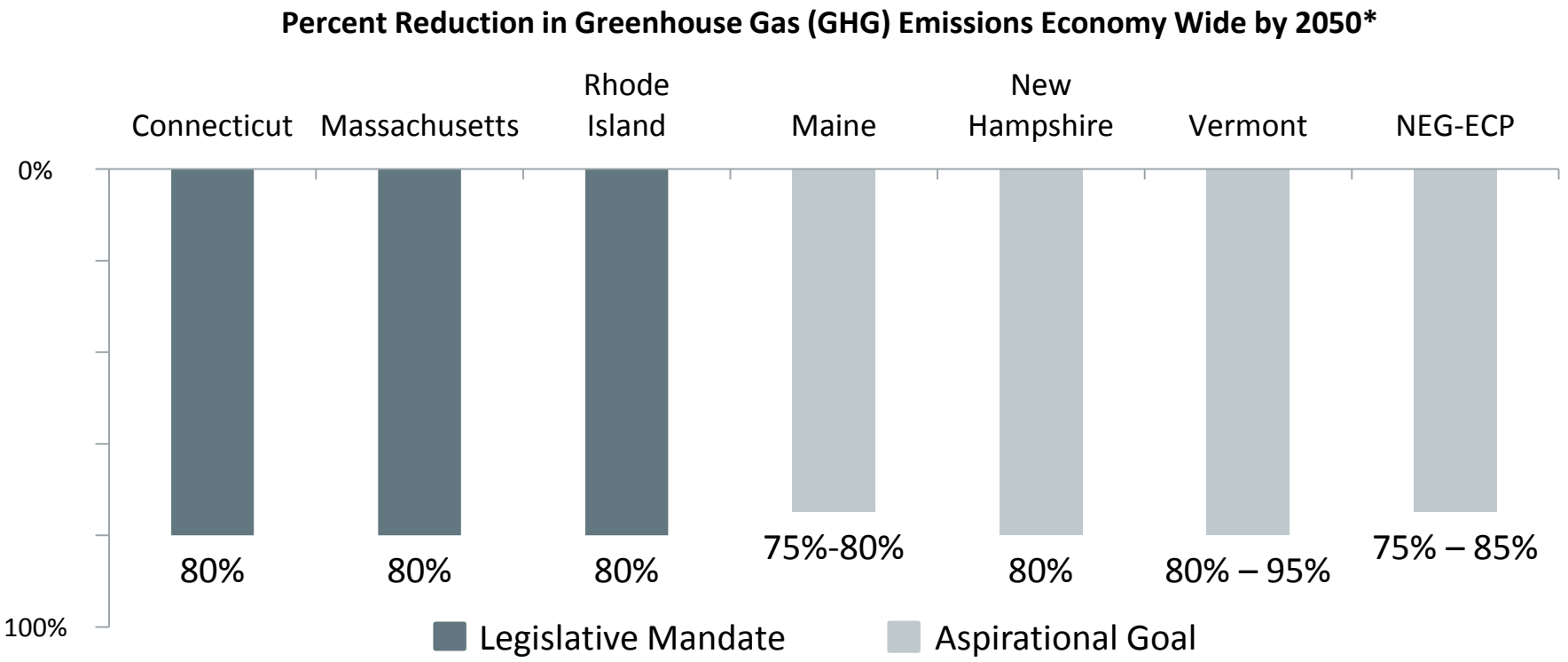
Marcellus shale

Source: ISO New England

But the Natural Gas Delivery System Is Not Keeping Up with Demand

- Few interstate pipelines and liquefied natural gas (LNG) delivery points
- Regional pipelines are:
  - Built to serve heating demand, not power generation
  - Running at or near maximum capacity during winter

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

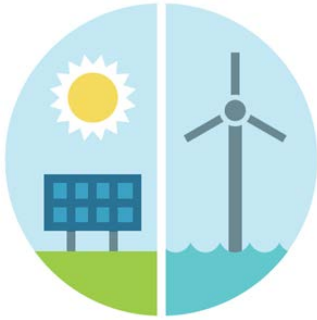


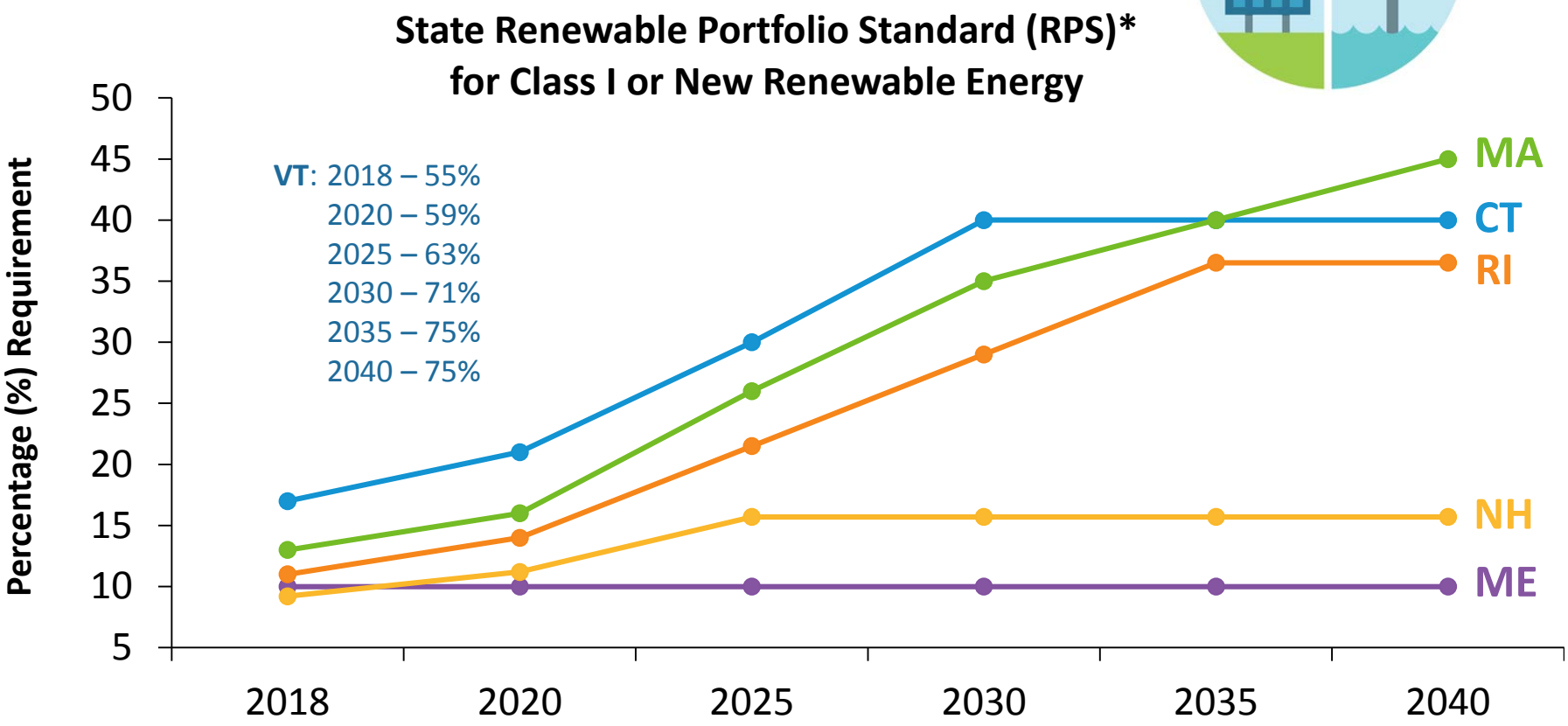
The New England states are promoting GHG reductions on a state-by-state basis, and at the regional level, through a combination of legislative mandates (e.g., CT, MA, RI) and aspirational, non-binding goals (e.g., ME, NH, VT and the New England Governors and Eastern Canadian Premiers).

* 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.

Renewable Energy Is on the Rise

State policy requirements are a major driver

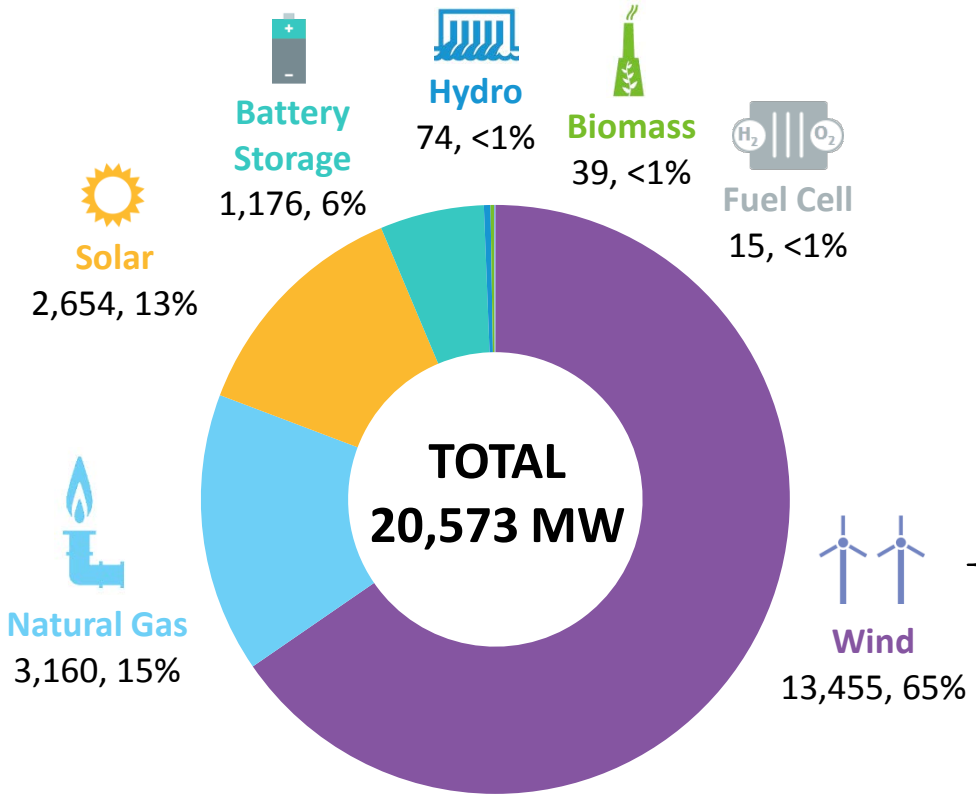




Notes: State RPS requirements promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Connecticut's Class I RPS requirement plateaus 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.

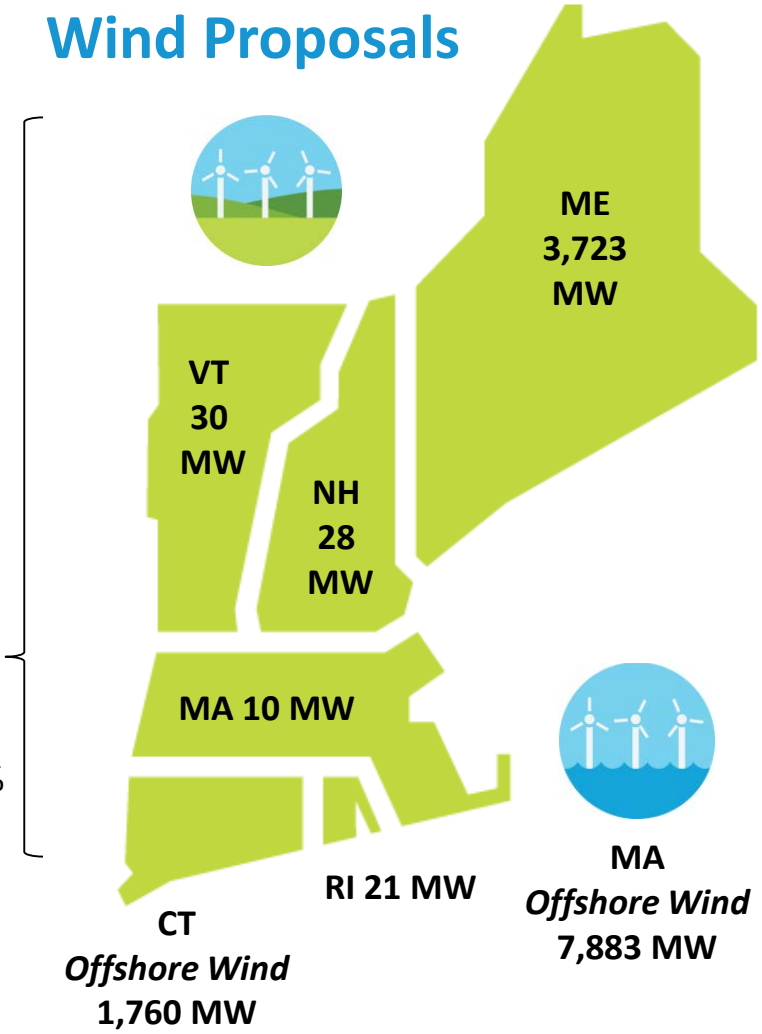
Wind Power Now Comprises Two Thirds of New Resource Proposals in the ISO Interconnection Queue

All Proposed Generation



Source: ISO Generator Interconnection Queue (January 2019)
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.

Wind Proposals



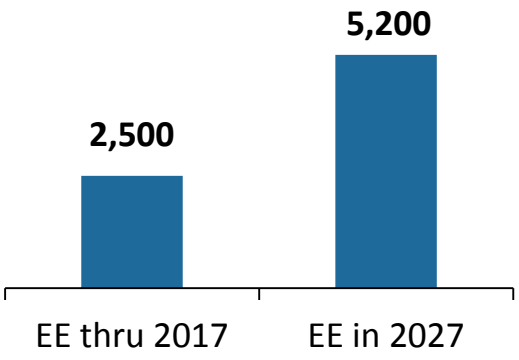
New Energy Storage Technologies Are Coming On Line

- **20 MW** of grid-scale battery storage projects have come on line since late 2015
- Nearly **1,200 MW** of grid-scale stand-alone 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

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

Energy Efficiency

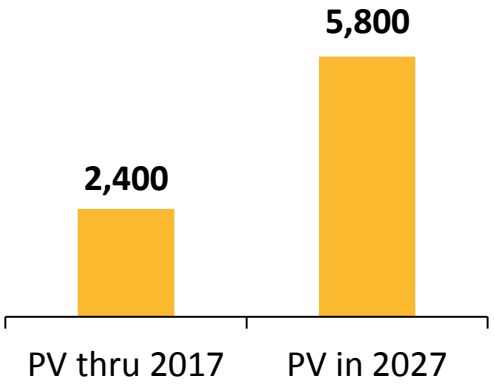
(MW)



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

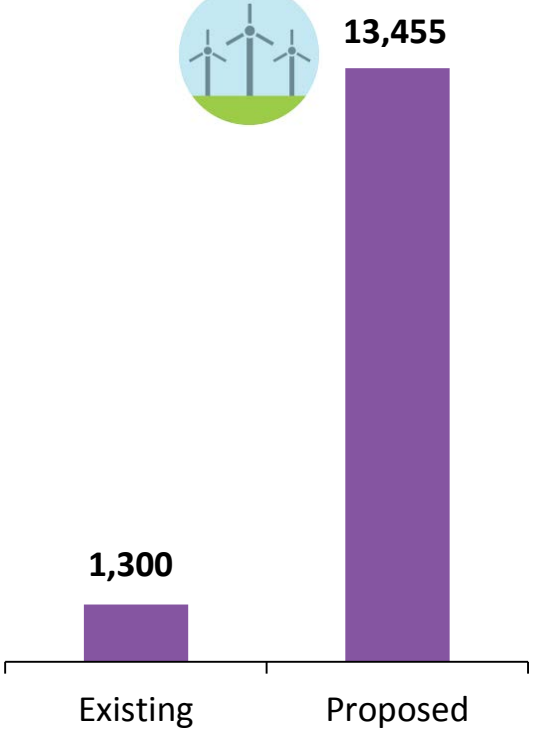
(MW)



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

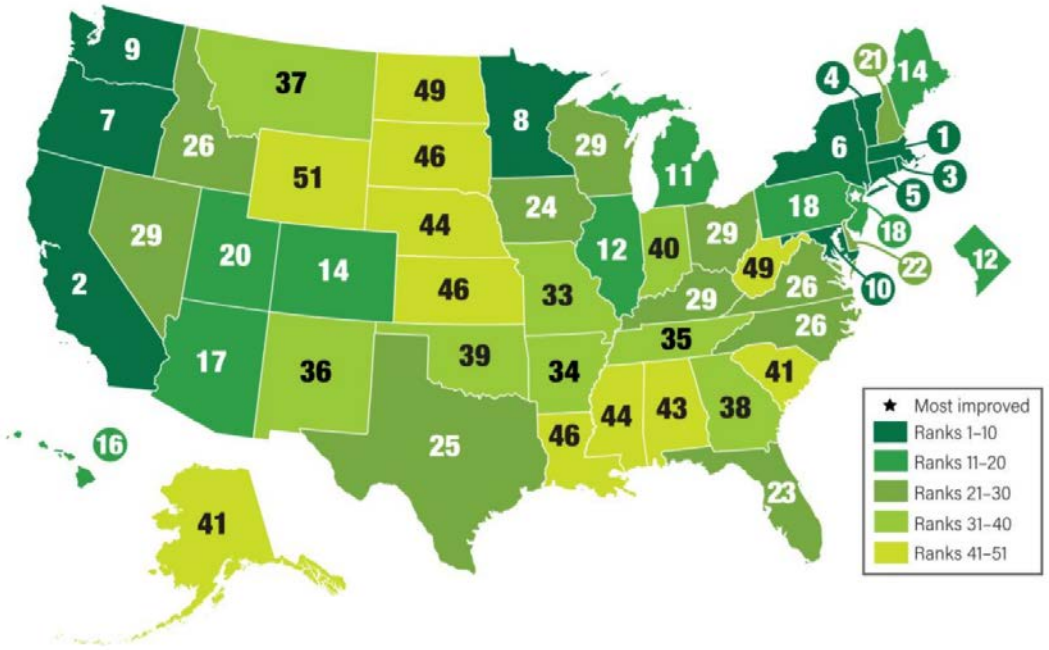
(MW)



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

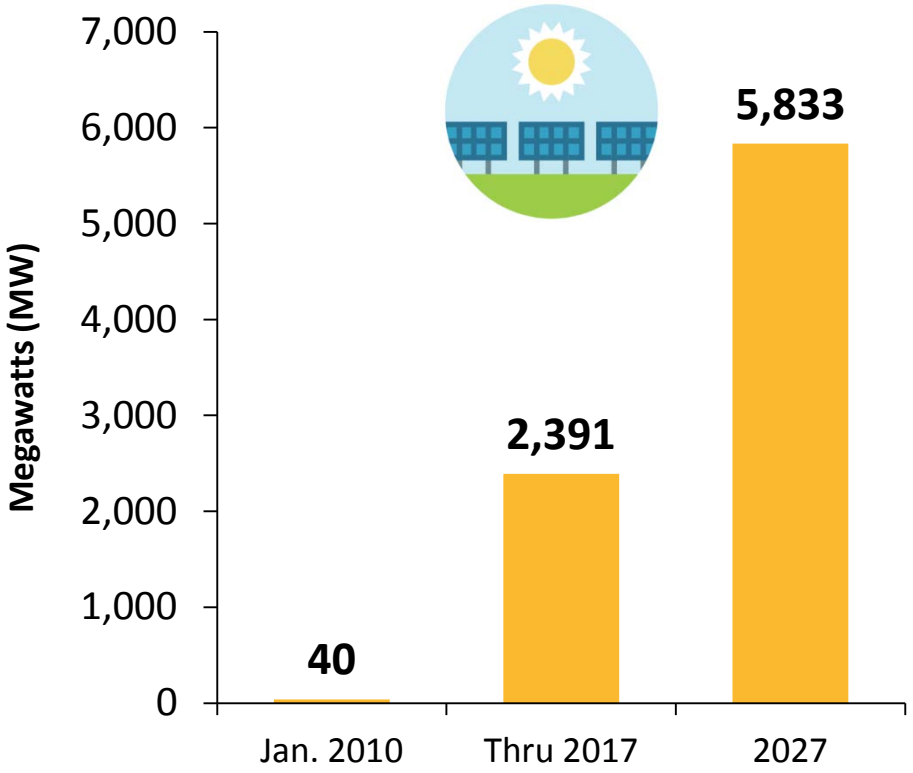
- Billions spent over the past few years and more on the horizon
  - Nearly $4.9 billion invested from 2011 to 2016
  - ISO estimates $10.5 billion to be invested in EE from 2019 to 2027

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

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

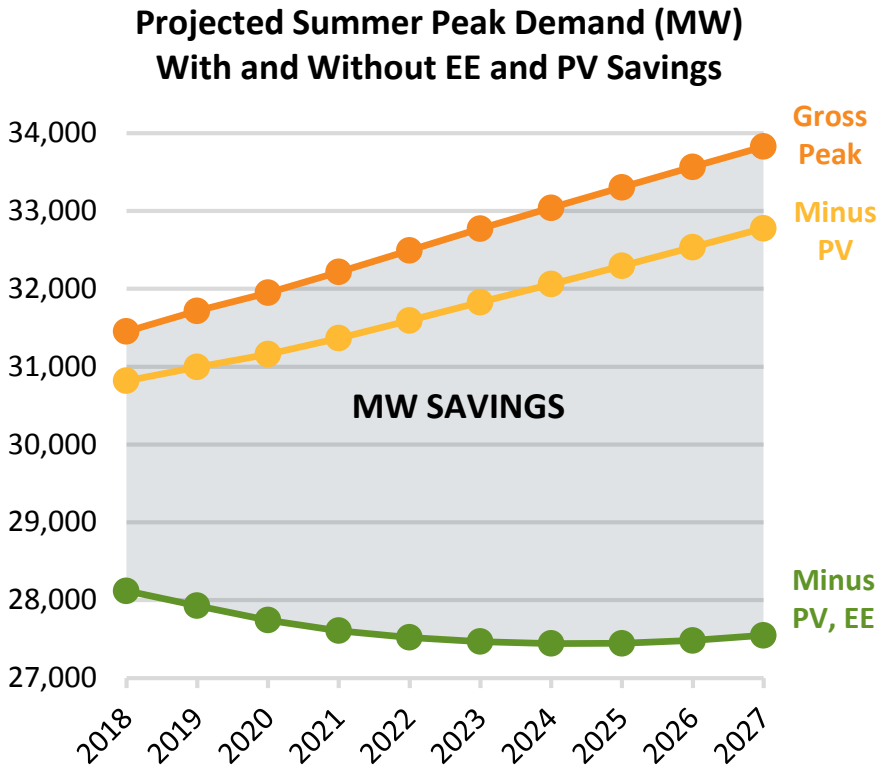
State	Installed Capacity (MW_{ac})	No. of Installations
Connecticut	365.6	29,512
Massachusetts	1,602.3	78,047
Maine	33.5	3,598
New Hampshire	69.7	7,330
Rhode Island	62.2	4,148
Vermont	257.2	9,773
New England	**2,390.5**	**132,408**

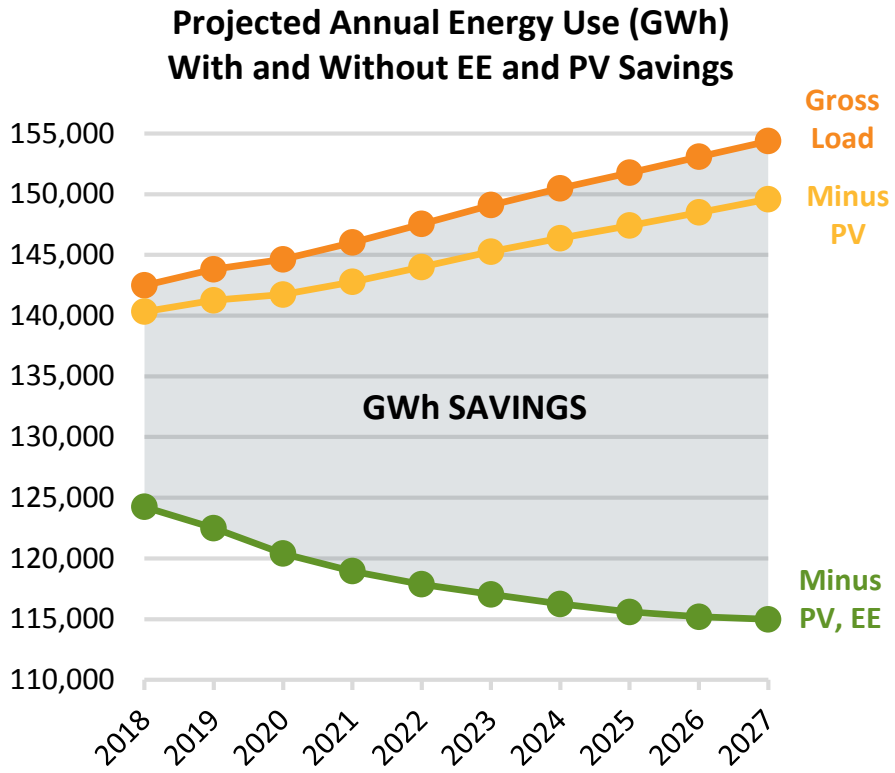
Cumulative Growth in Solar PV through 2027 (MW_{ac})



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.

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



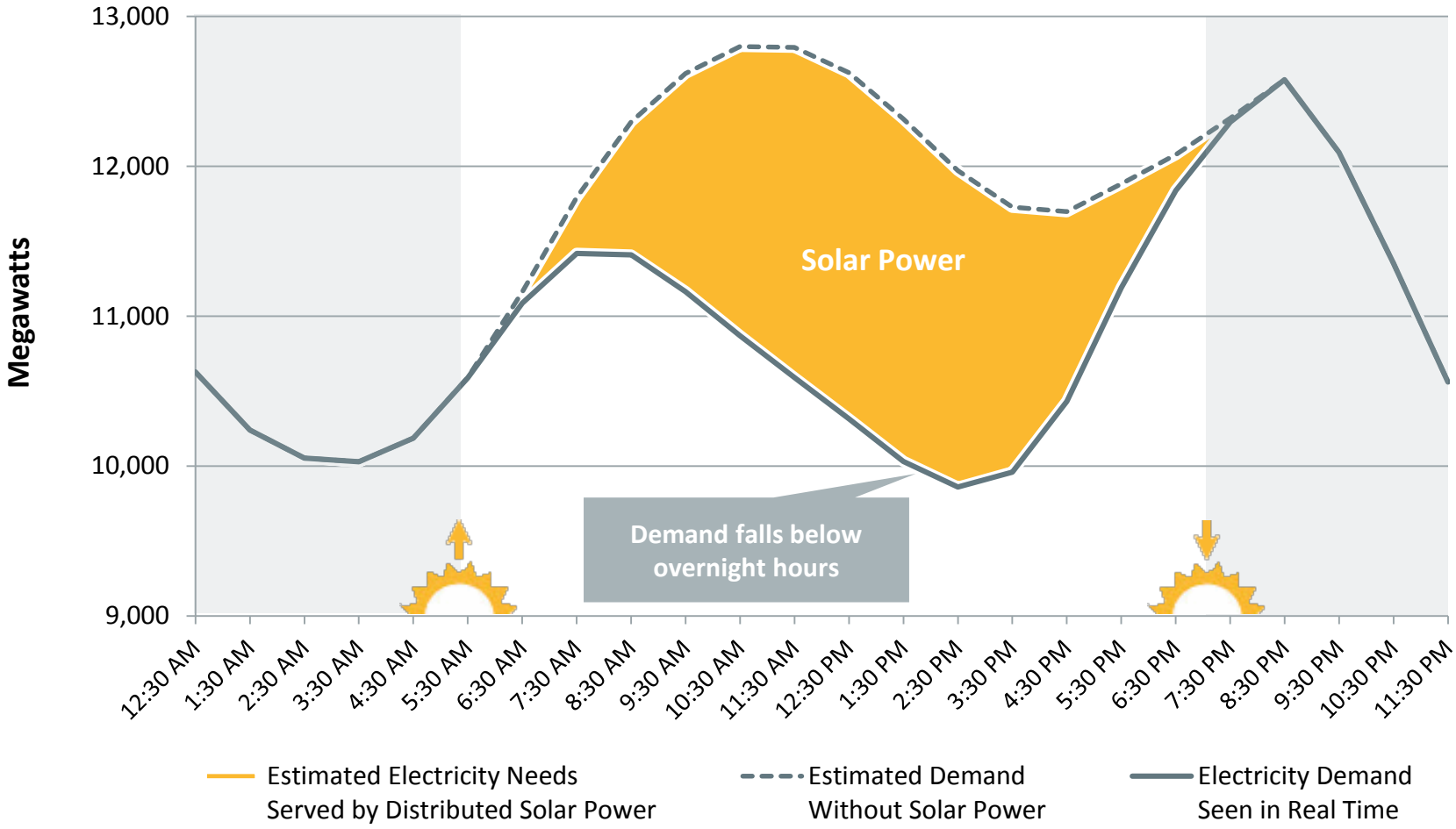


- The gross peak and load forecast
- The gross peak and load forecast minus existing and anticipated "behind-the-meter" (BTM) solar PV resources
- The gross peak and load forecast minus existing and anticipated BTM solar PV and energy efficiency

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)

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



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 new resource proposals in the ISO Generator Interconnection 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)

Questions