ISO New England Regional Electricity Outlook

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

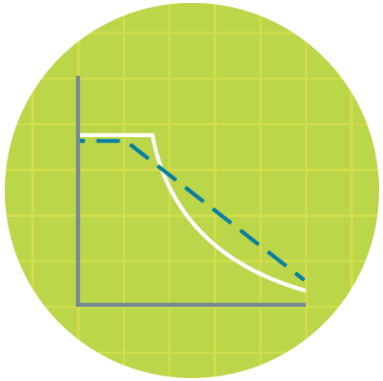
ISO New England Performs Three Critical Roles to Ensure Reliable Electricity at Competitive Prices

Grid Operation

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

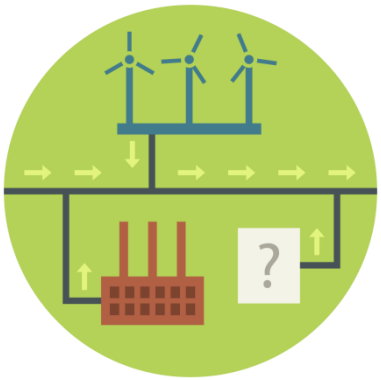
Market Administration

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



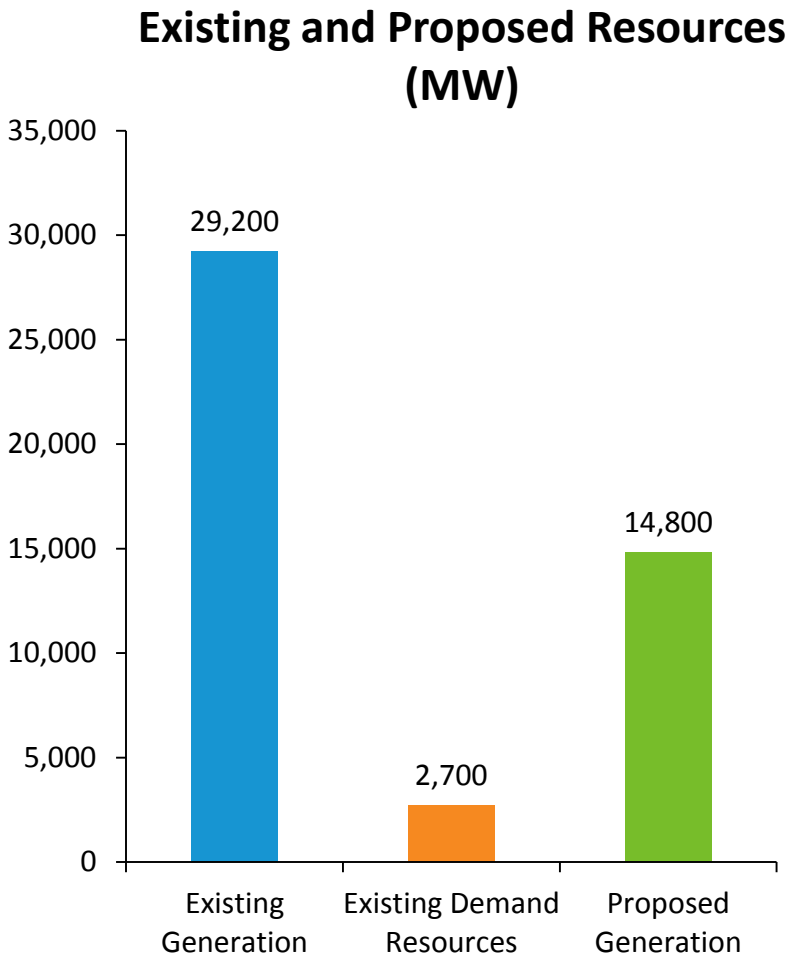
Power System Planning

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



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

- **350** generators in the region
- **29,200 MW** of generating capacity
- **14,800 MW** of proposed generation in the ISO Queue
  - Mostly wind and natural gas
- **4,600 MW** of generation has retired or will retire in the next few years
- **400 MW** of active demand response and **2,300 MW** of energy efficiency with Capacity Supply Obligations in the Forward Capacity Market (FCM)*

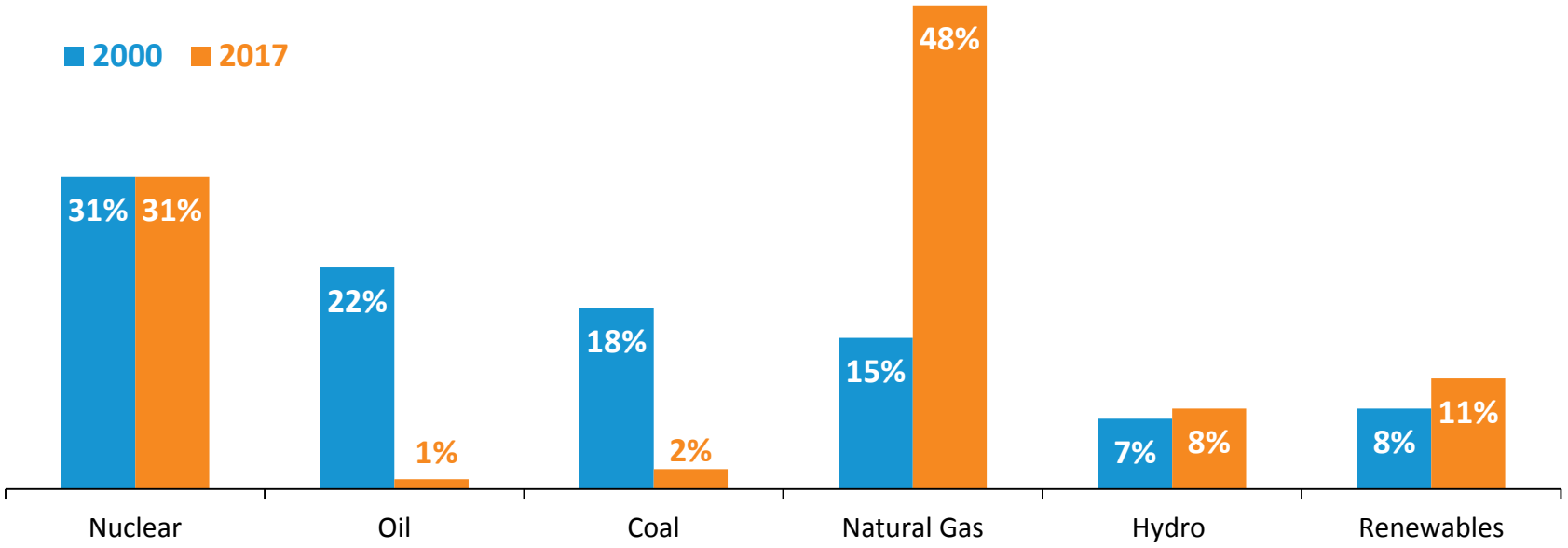


* In the FCM, demand-reduction resources are treated as capacity resources.

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

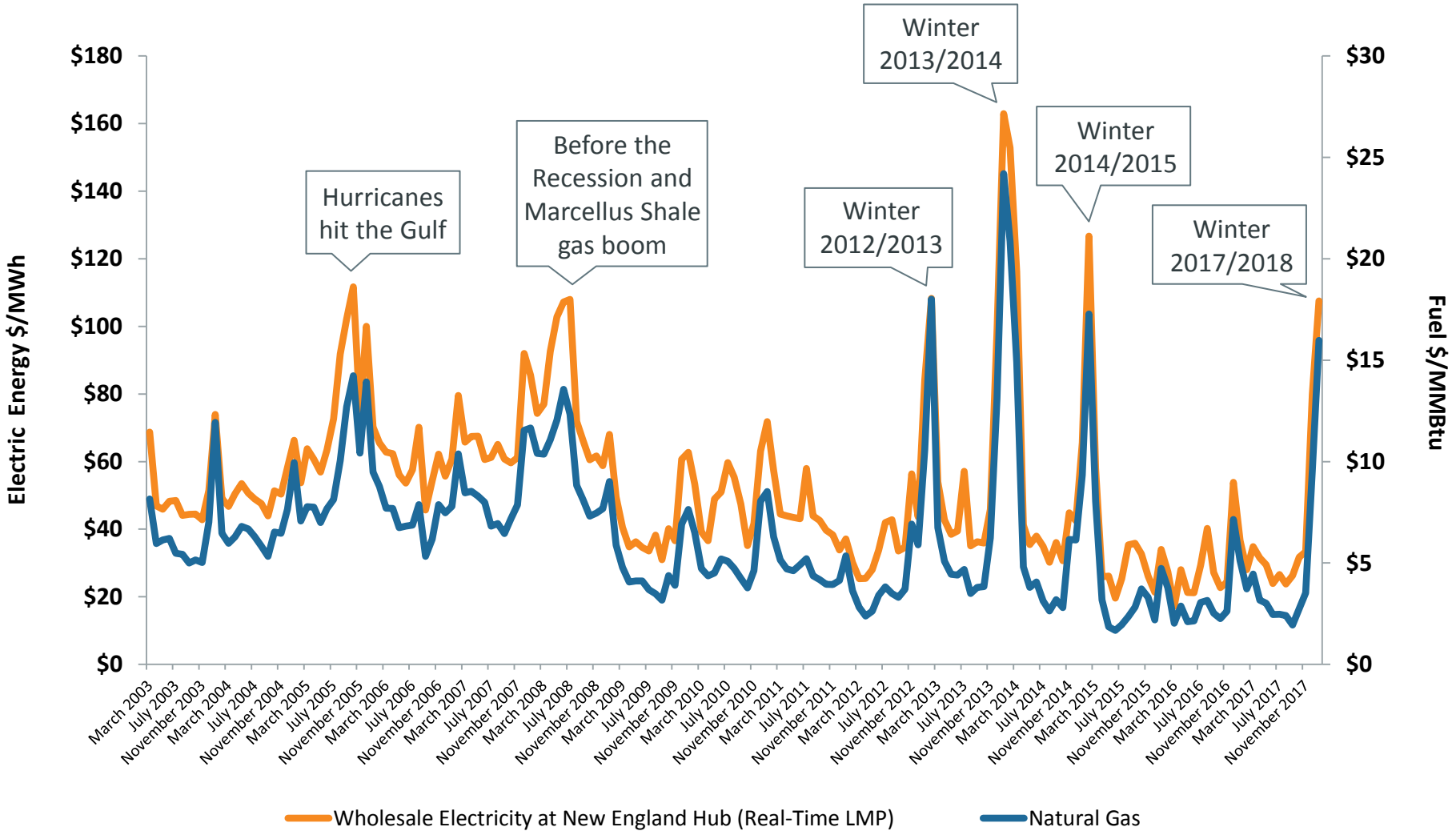
Percent of Total **Electric Energy** Production by Fuel Type
(2000 vs. 2017)



Source: ISO New England Net Energy and Peak Load by Source
Renewables include landfill gas, biomass, other biomass gas, wind, solar, municipal solid waste, and miscellaneous fuels

Natural Gas and Wholesale Electricity Prices Are Linked

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



The Region Has Lost—*and Is at Risk of Losing*—Substantial Non-Gas Resources

Major Generator Retirements:

- **Salem Harbor Station (749 MW)**
  - 4 units (coal & oil)
- **Norwalk Harbor Station (342 MW)**
  - 3 units (oil)
- **Mount Tom Station (143 MW)**
  - 1 unit (coal)
- **Vermont Yankee Station (604 MW)**
  - 1 unit (nuclear)
- **Brayton Point Station (1,535 MW)**
  - 4 units (coal & oil)
- **Pilgrim Nuclear Power Station (677 MW)**
  - 1 unit (nuclear)
- **Bridgeport Harbor Station (564 MW)**
  - 2 units (coal & oil)
- *Additional retirements are looming*

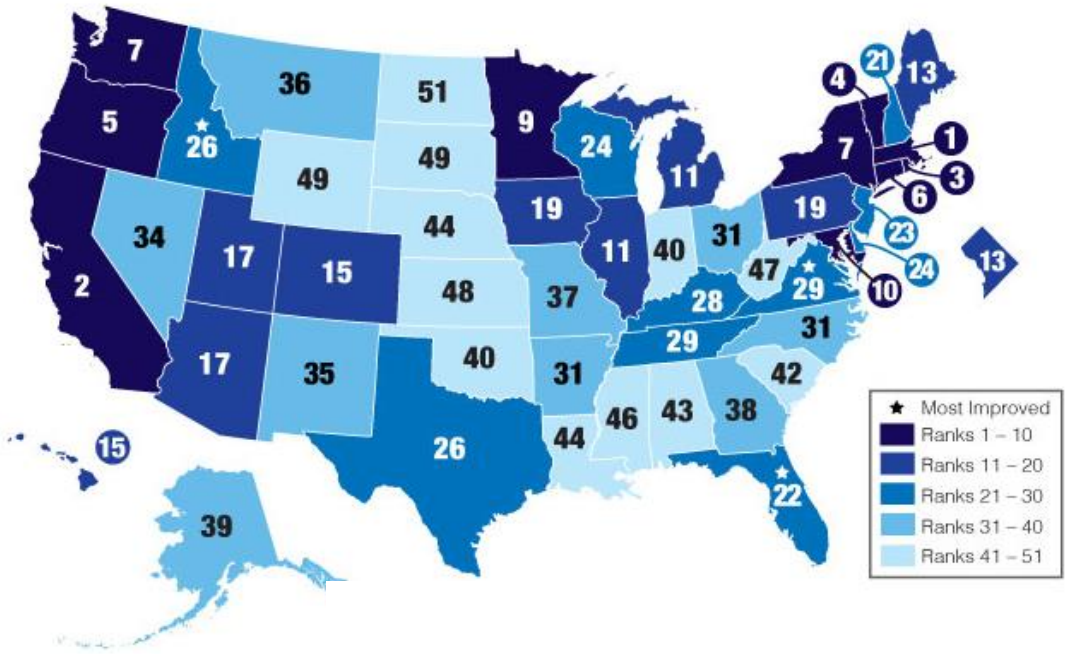
Energy Efficiency and Behind-the-Meter Solar Impact Peak Demand and Overall Electricity Use

- **7.1 million** retail electricity customers drive the demand for electricity in New England (14.7 million population)
- Region's all-time summer peak demand set on August 2, 2006 at **28,130 MW**
- Region's all-time winter peak demand set on January 15, 2004 at **22,818 MW**
- The annual growth rates for summer *peak* demand and *overall* electricity use are **0.1%** and **-0.6%**, respectively, when energy efficiency and behind-the-meter solar are factored into the forecast

Note: Without energy efficiency and solar, the region's peak demand is forecasted to grow 1% 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.

Energy Efficiency Is a Priority for State Policymakers

2017 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 6
- Maine 13
- New Hampshire 21

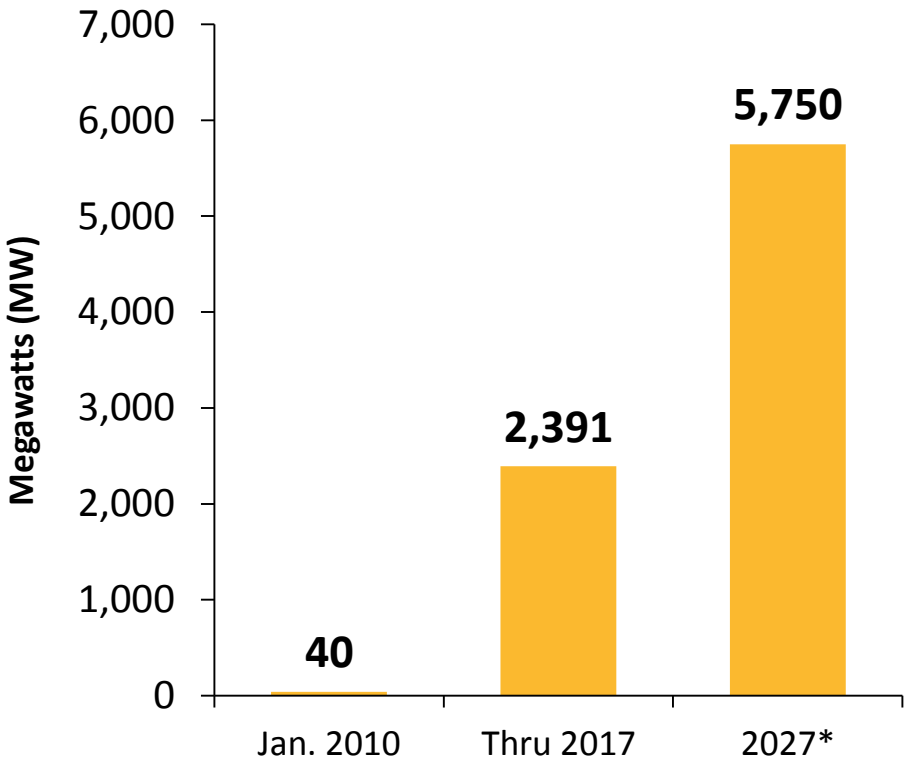
- Billions spent over the past few years and more on the horizon
  - Nearly $4.5 billion invested from 2010 to 2015
  - ISO estimates $7.2 billion to be invested in EE from 2021 to 2026

ISO New England Forecasts Strong Growth in Solar PV

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

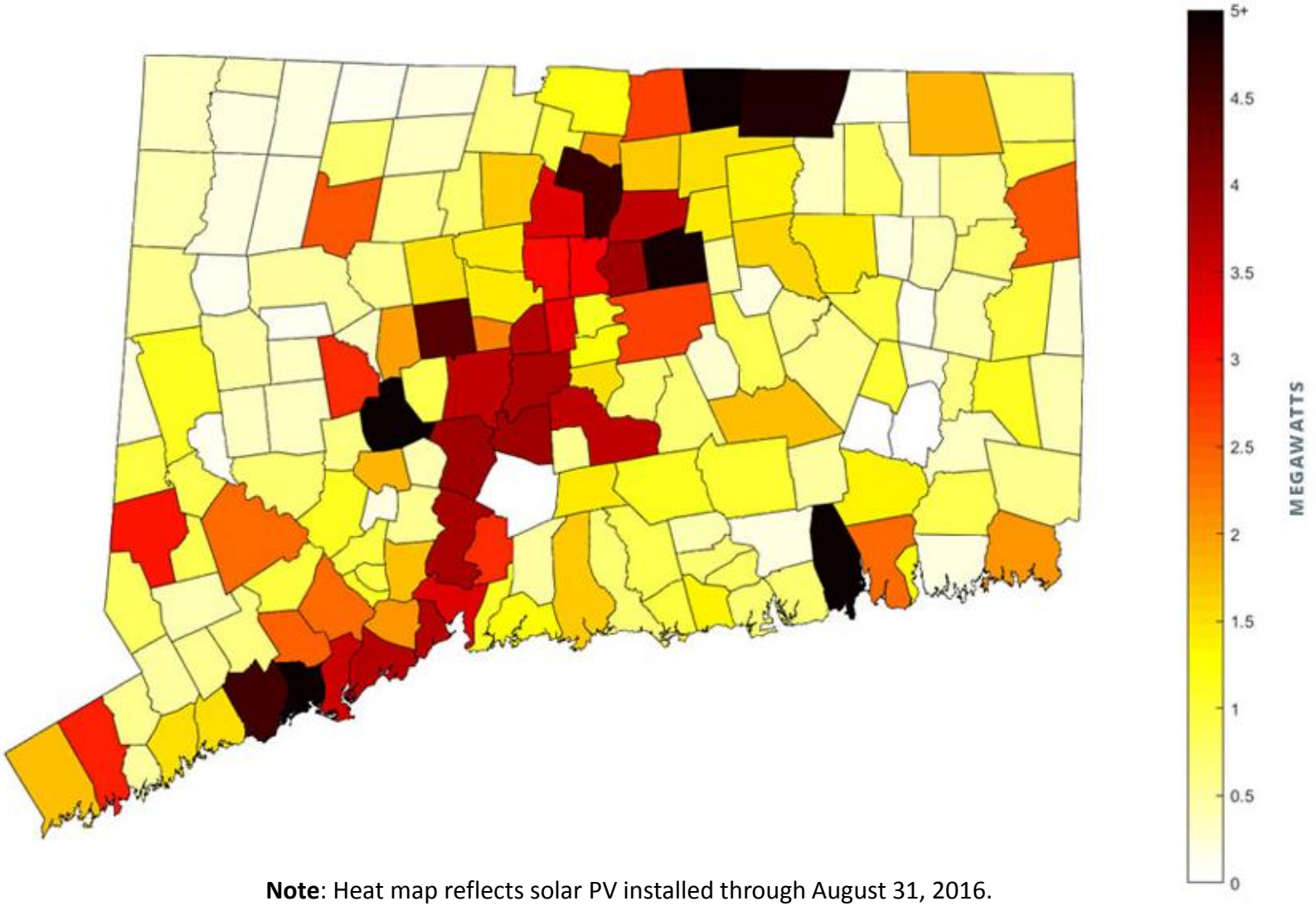
State	Installed Capacity (MW_{ac})	No. of Installations
Connecticut	365.6	29,512
Massachusetts	1,602.3	78,047
Maine	33.5	3,598
New Hampshire	69.7	7,330
Rhode Island	62.2	4,148
Vermont	257.2	9,773
New England	**2,390.5**	**132,408**

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



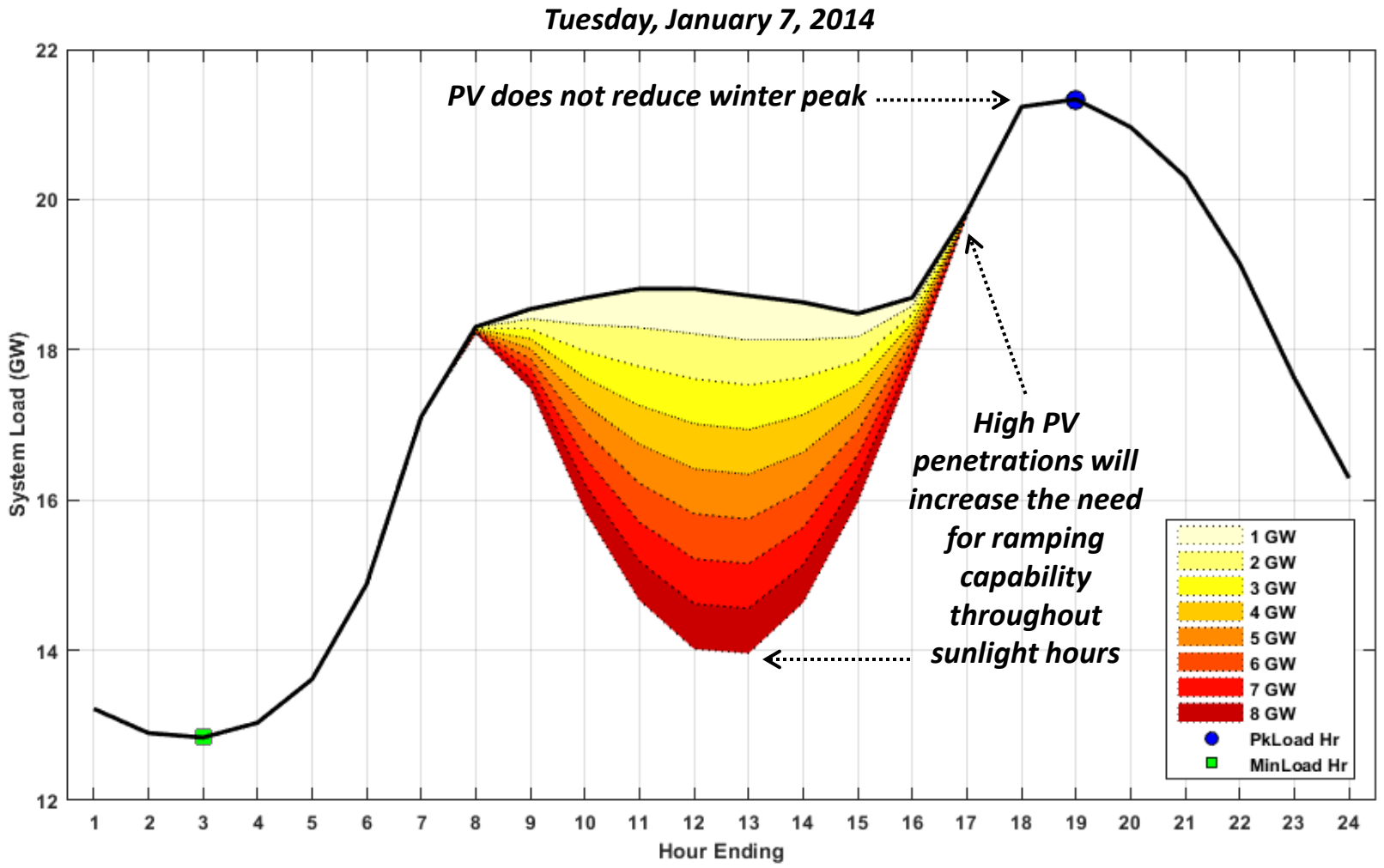
Note: The bar chart reflects the ISO's projections for nameplate capacity from PV resources participating in the region's wholesale electricity markets, as well as those connected "behind the meter." *Source: Draft 2018 PV Forecast (February 2018); MW values are AC nameplate.

Connecticut Installed Solar PV "Heat Map"

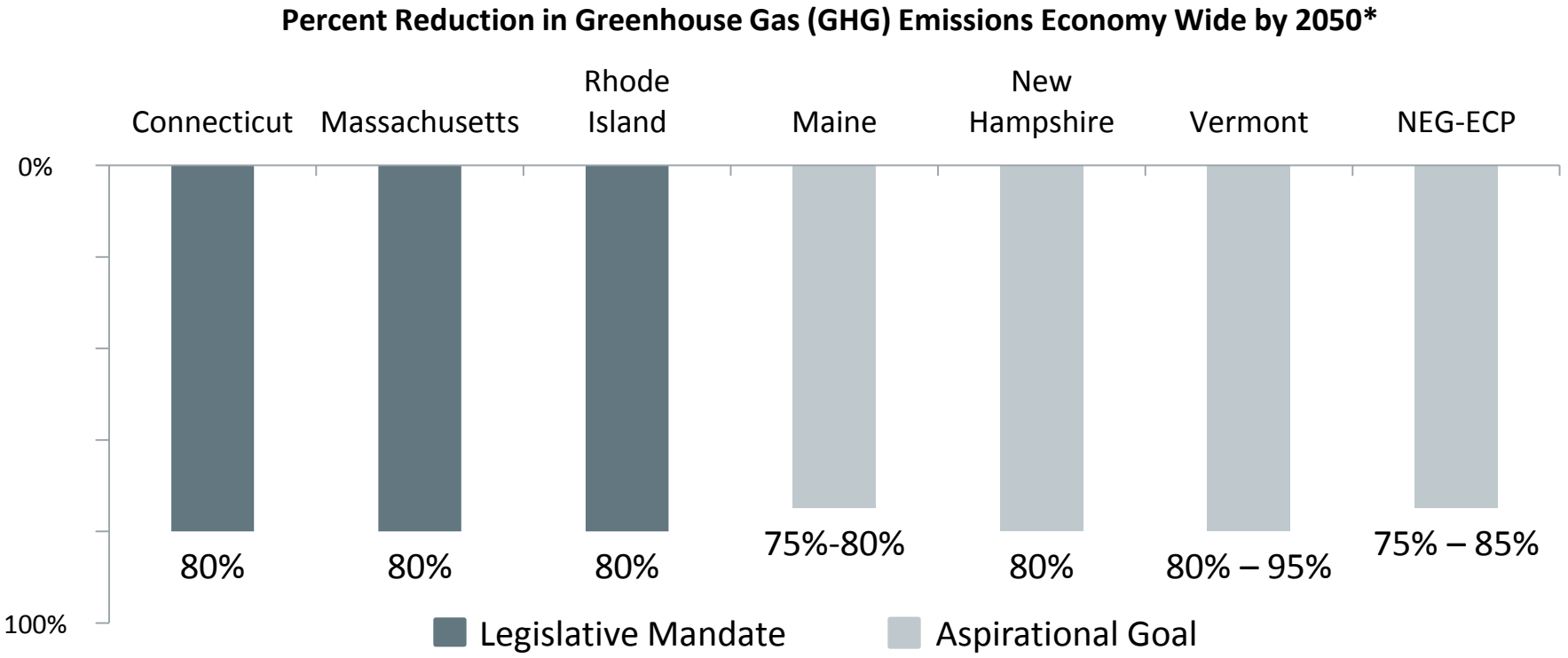


Note: Heat map reflects solar PV installed through August 31, 2016.

Deep Load Reductions During Winter Daylight Hours Result in Steep Ramp Into the Evening Peak



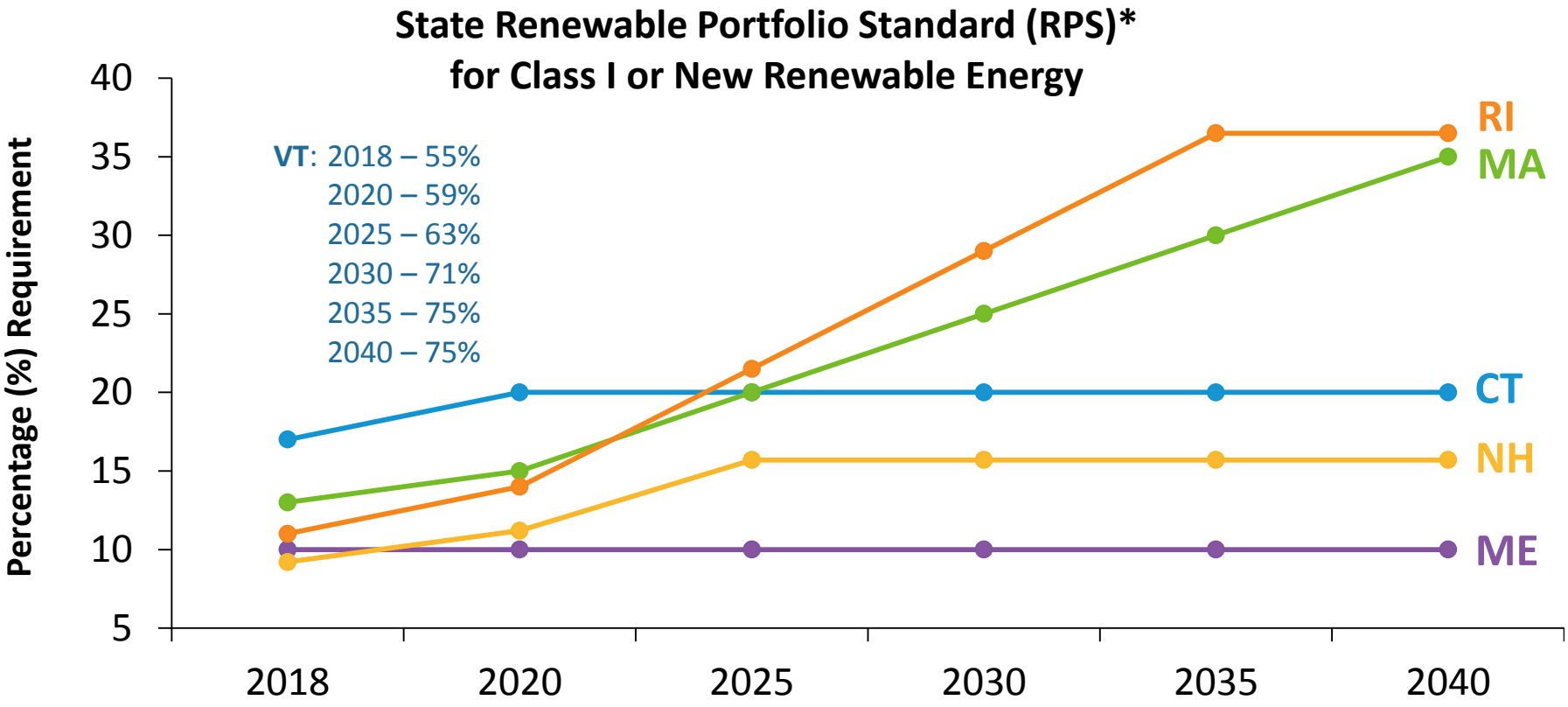
States Have Set Goals for Reductions in Greenhouse Gas Emissions: *Some Mandated, Some Aspirational*



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.

State Policy Requirements Drive Proposals for Renewable Energy



Notes: Connecticut's Class I RPS requirement plateaus at 20% in 2020. Maine's Class I RPS requirement plateaus at 10% in 2017 and expires in 2022 (but has been held constant in this chart for illustrative purposes). Massachusetts' Class I RPS requirement increases by 1% each year after 2020 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.

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, December 2017 (draft)

ISO New England Is Focused on Developing Solutions to Today's Grid Challenges

Integrating Markets and Public Policy

Accommodating the states' clean energy goals while maintaining competitively based capacity pricing for other resources

Addressing Fuel Security

Ensuring the region's generators have adequate fuel to produce electricity, particularly in the wintertime

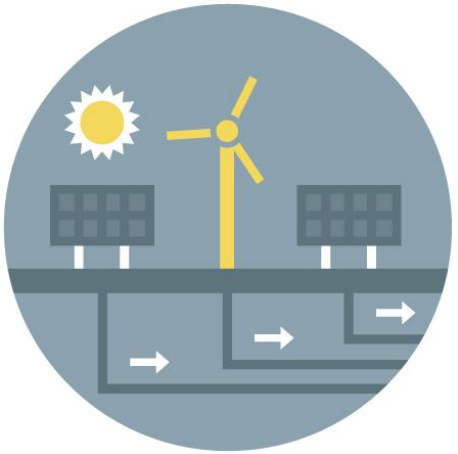
The Forward Capacity Market Is Attracting New Resources Amid Retirements

Demand Resources

energy-efficiency and active demand response resources

Natural Gas Resources

efficient and fast-starting gas resources, many with dual-fuel capability

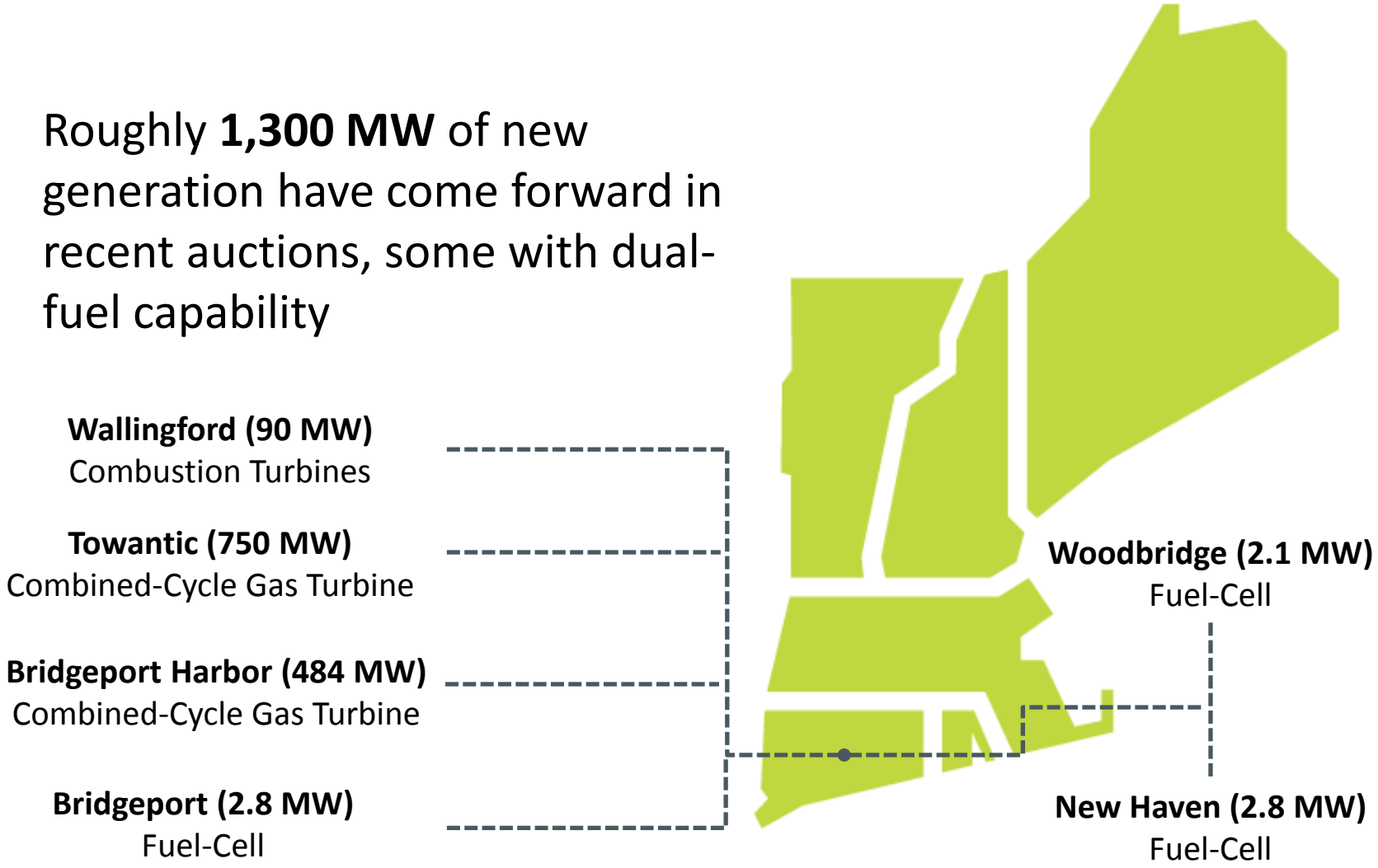


Renewable Resources

onshore and offshore wind, solar photovoltaics, and fuel cells

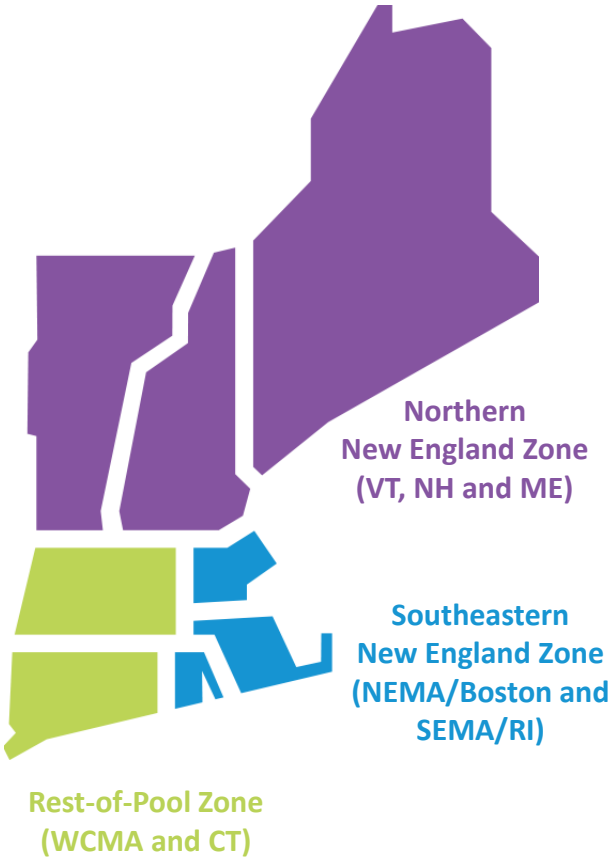
Recent Auctions Bring Forward New Generation in CT

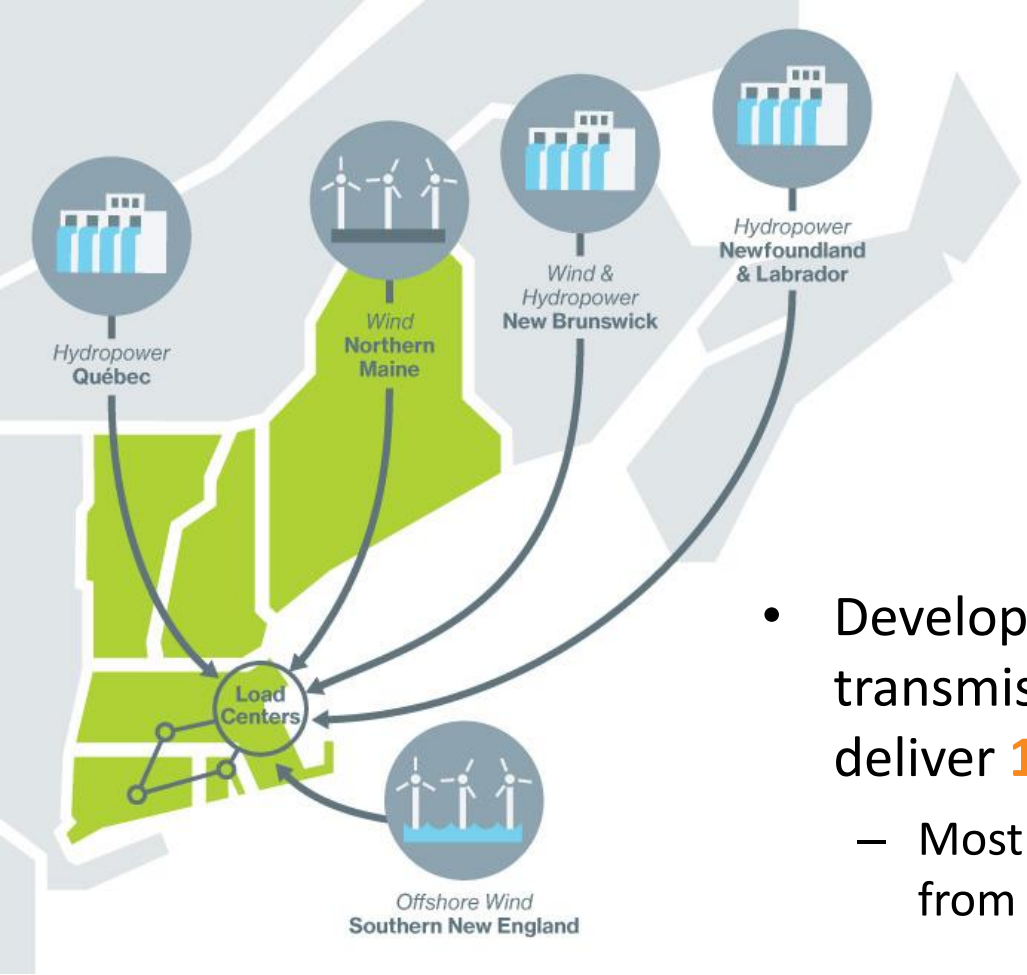
- Roughly **1,300 MW** of new generation have come forward in recent auctions, some with dual-fuel capability



Forward Capacity Auction #12 at a Glance

- **FCA #12** procured the resources needed to meet the demand for electricity, plus reserve requirements, during the **June 1, 2021 to May 31, 2022** capacity commitment period
- The ISO modeled **three** capacity zones in FCA #12
- Final results will be filed with FERC later this month
- Next auction will take place **February 2019** for resources needed in 2022-2023.





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

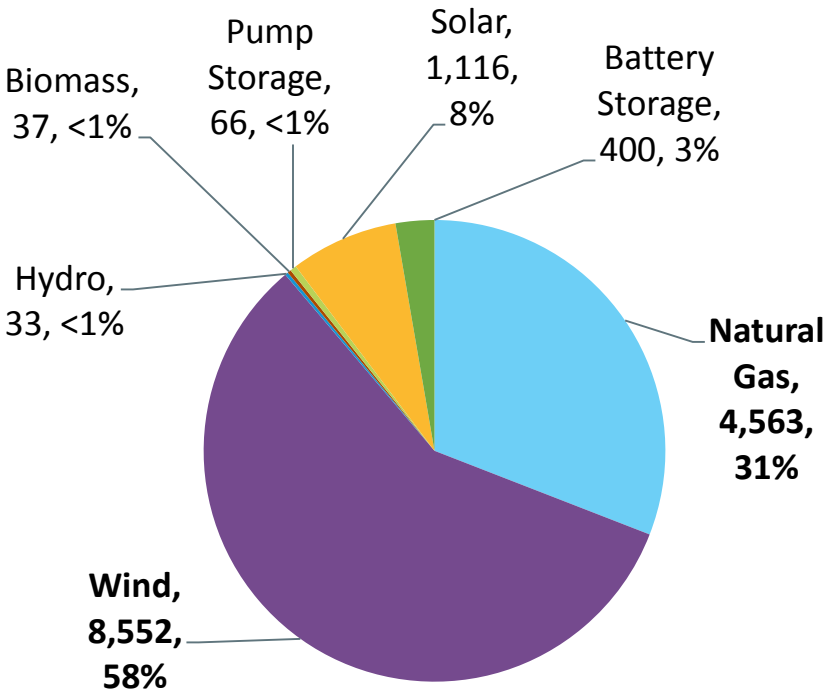
- Developers are proposing **20+** elective transmission upgrades (ETUs) to help deliver **16,500+ MW** of clean energy
  - Mostly Canadian hydro and onshore wind from northern New England
- Wind projects make up **58%** of proposed new power resources, but most are remote
- Massachusetts has plans to contract for **1,600 MW** of offshore wind

Source: ISO Interconnection Queue (January 2018)

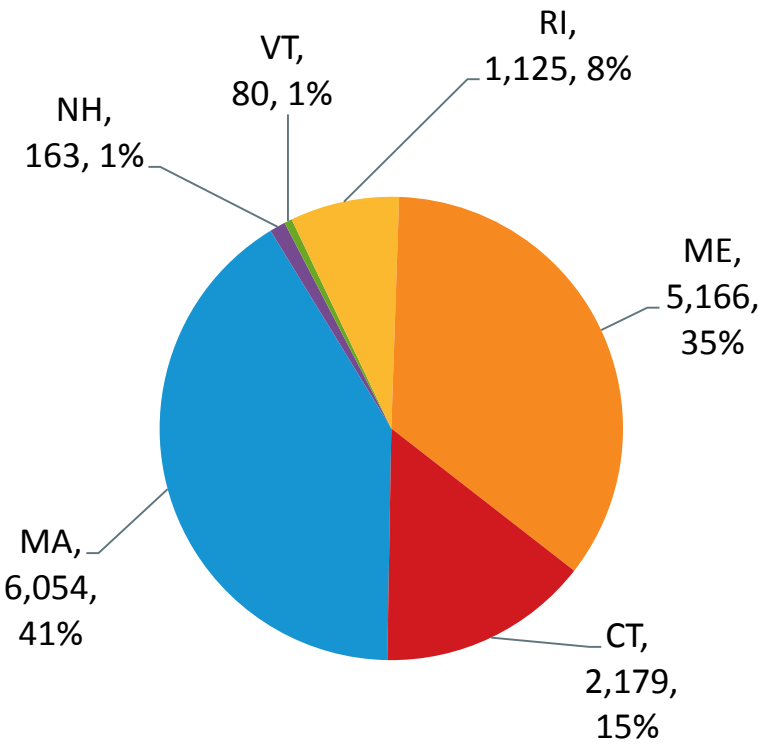
Wind Power and Natural Gas Dominate New Resource Proposals in the ISO Interconnection Queue

Approximately 14,800 MW

By Type



By State



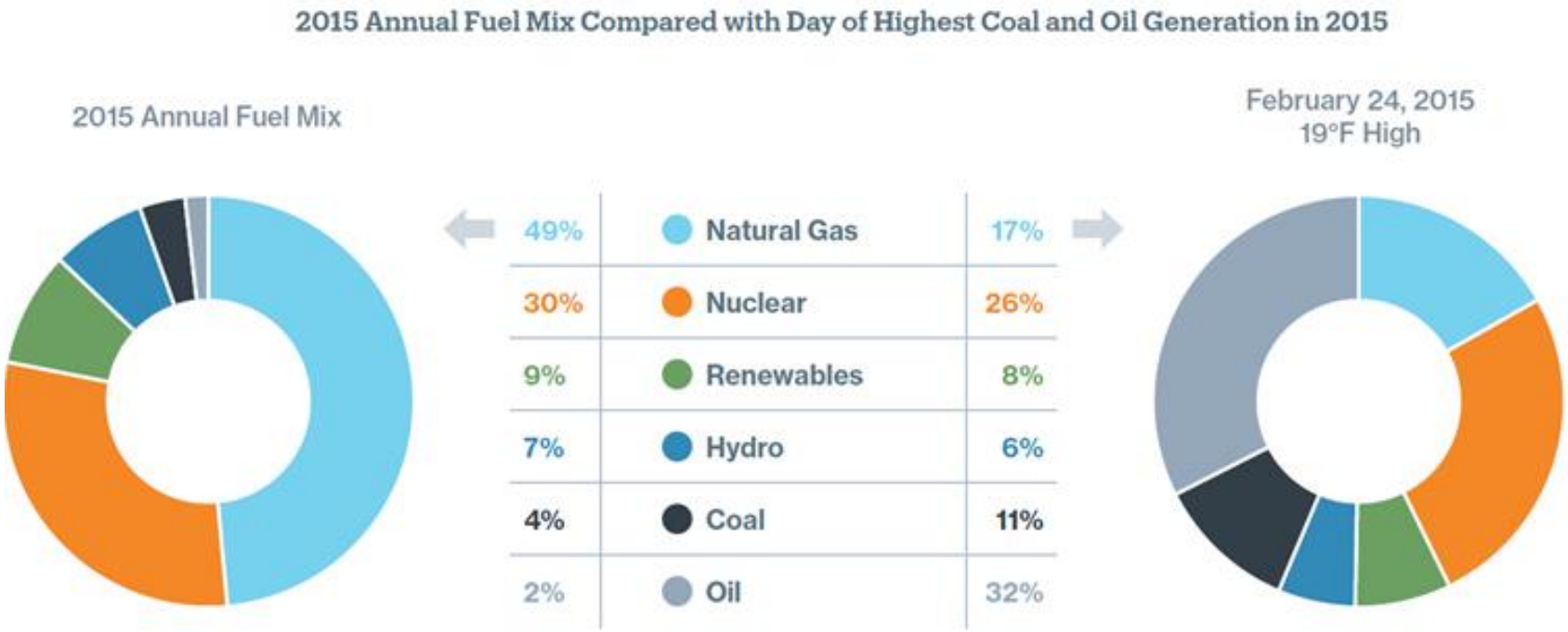
Note: Some natural gas proposals include dual-fuel units (oil); some wind and solar proposals include battery storage; megawatts represent nameplate capacity ratings; megawatts have been rounded for each proposal.

Source: ISO Generator Interconnection Queue (January 2018)
FERC and Non-FERC Jurisdictional Proposals

ISO New England Publishes *Operational Fuel-Security Analysis*

- The goal of the study is to understand future effects of trends **already affecting** power system operations
- The analysis examines more than 20 cases of generating resource and fuel-mix combinations during the 2024-2025 winter, and quantifies each case's **fuel security risk**
  - *i.e.,* the number and duration of energy shortfalls that could occur and that would require implementation of emergency procedures to maintain reliability
- The study assumed **no additional natural gas pipeline capacity** to serve generators would be added during the timeframe of the study

Generation Mix Changes on Cold Days



Source: ISO New England, 2000-2015 Net Energy and Peak Load by Source and Daily Generation by Fuel Type 2015

OFSA Outages of Key Facilities Scenarios

These scenarios assessed the effects of a winter-long outage of each of four major energy facilities on the reliability of the power system

- All outage scenarios increased the Dual-Fuel Oil Tank Fills from the two used in the reference case to three
  - Start the season full and refill twice during the winter season for combined cycle power plants, while fast-start units replenished continuously

- Winter-long outages were each modeled in both the reference case and the combination scenario of maximum renewables and maximum retirements for:
  - Millstone
  - Canaport
  - Distrigas
  - A compressor station on a gas pipeline

- This results in eight total outage scenarios, which are illustrated in the following slides

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**
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Questions