Managing New England's Fuel-Security Risk During the Rapid Transformation of the Region's Power System

Pierce Atwood's Second Annual

Energy Infrastructure Symposium

Gordon van Welie

PRESIDENT & CEO

New England Has Embarked on a Journey

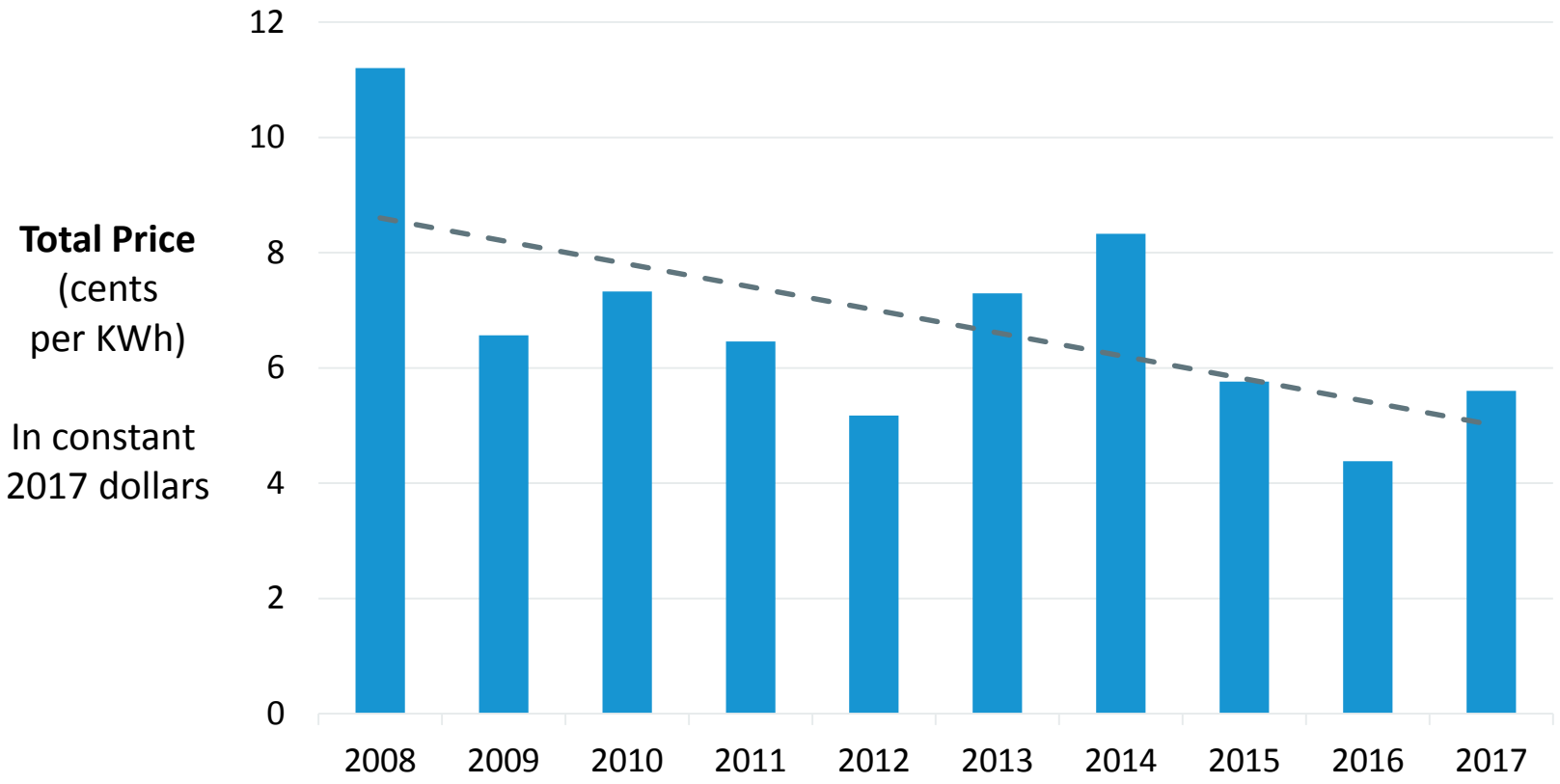
From restructuring the wholesale power industry to decarbonizing the economy

- In the late 1990s, New England restructured its wholesale power industry with three key principles in mind
  - **Competition** between buyers and sellers yields prices that reflect a resource's true operating costs
  - **Efficiency and transparency** spur innovation and investment in new technologies
  - **Investment risk** shifts from consumers to private investors

- Today, and for decades to come, New England will be focused on decarbonizing the economy
  - **Reducing carbon emissions** from the electricity sector and, in time, the transportation and buildings sectors
  - **Greening the grid** with more renewable energy sources to meet decarbonization goals

Competition Fosters Lower Market Prices Over Time

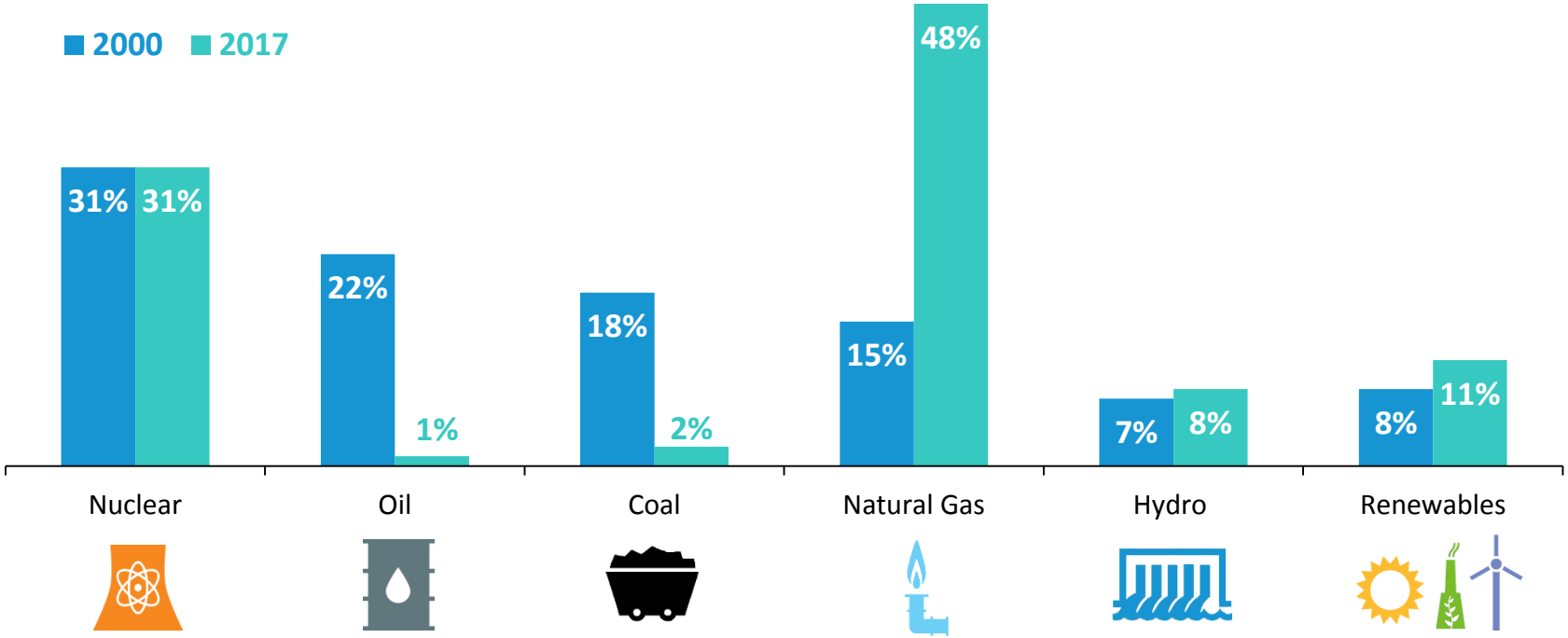
New England's total wholesale electricity market price has declined over the past decade, but faces continued volatility due to natural gas price spikes in winter



Notes: *Total wholesale market price includes all capacity, energy, and ancillary service market charges in the ISO-administered markets, including RTO costs, expressed per kilowatt-hour (kWh) of real-time load.* Sources: *U.S. Bureau of Labor Statistics (inflation data) and ISO-NE (market data).*

New England Has Seen Dramatic Changes in the Energy Mix: *From Coal and Oil to Natural Gas*

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

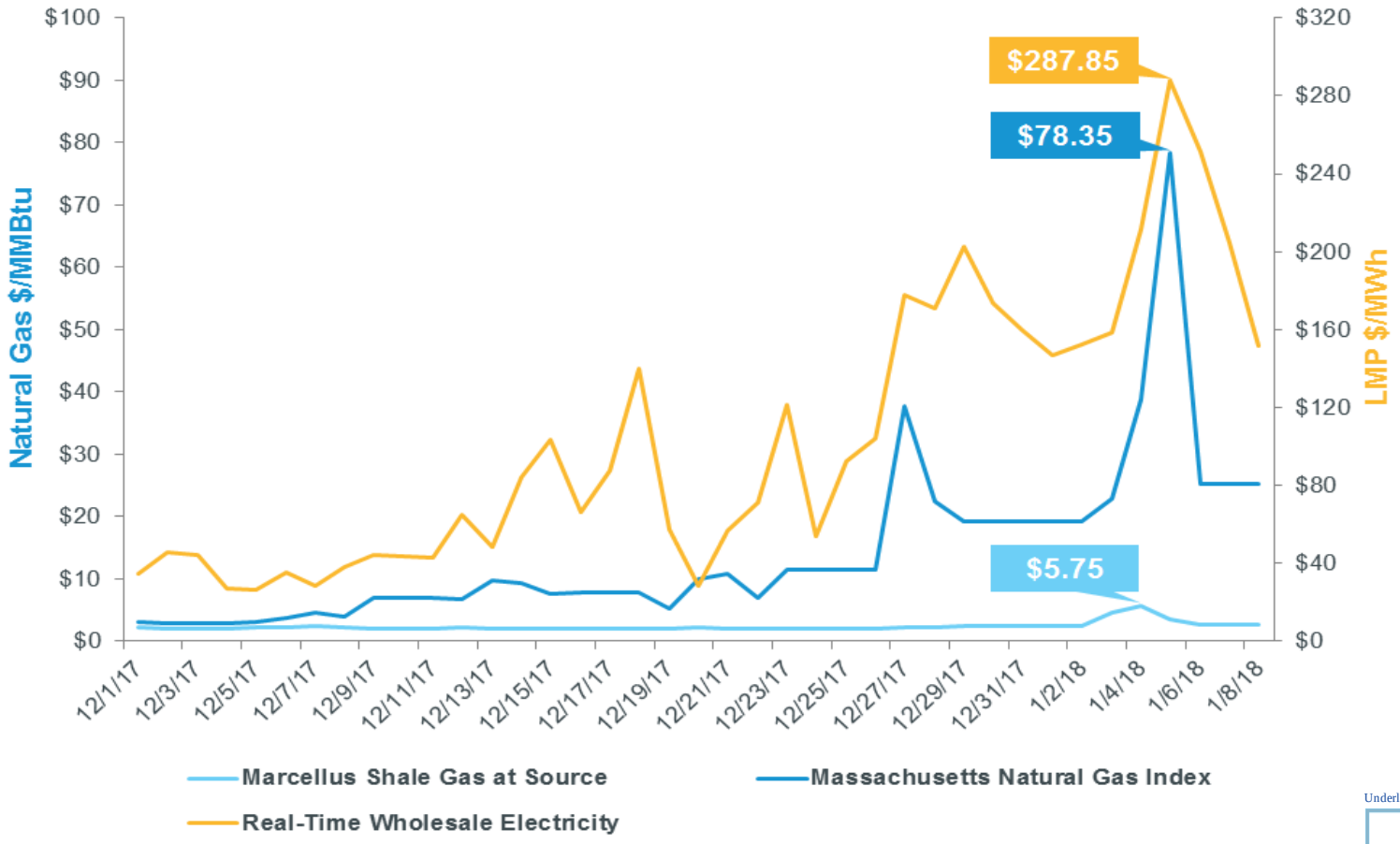


Source: ISO New England Net Energy and Peak Load by Source
Renewables include landfill gas, biomass, other biomass gas, wind, solar, municipal solid waste, and miscellaneous fuels.
This data represents electric generation within New England; it does not include imports or behind-the-meter (BTM) resources,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

Frigid Cold Drove Up Regional Demand for Natural Gas

This led to spikes in natural gas prices, which then led to spikes in wholesale electricity prices; with natural gas at a premium, oil generation became economic

Cold Weather Period Prices for Natural Gas and Wholesale Electricity



Underlying natural gas data furnished by:

ice Global markets in clear view

Since 2013, More Than 4,600 MW of Generation Have Retired or Announced Plans for Retirement in the Coming Years

- More than **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

Winter Fuel-Security Observations

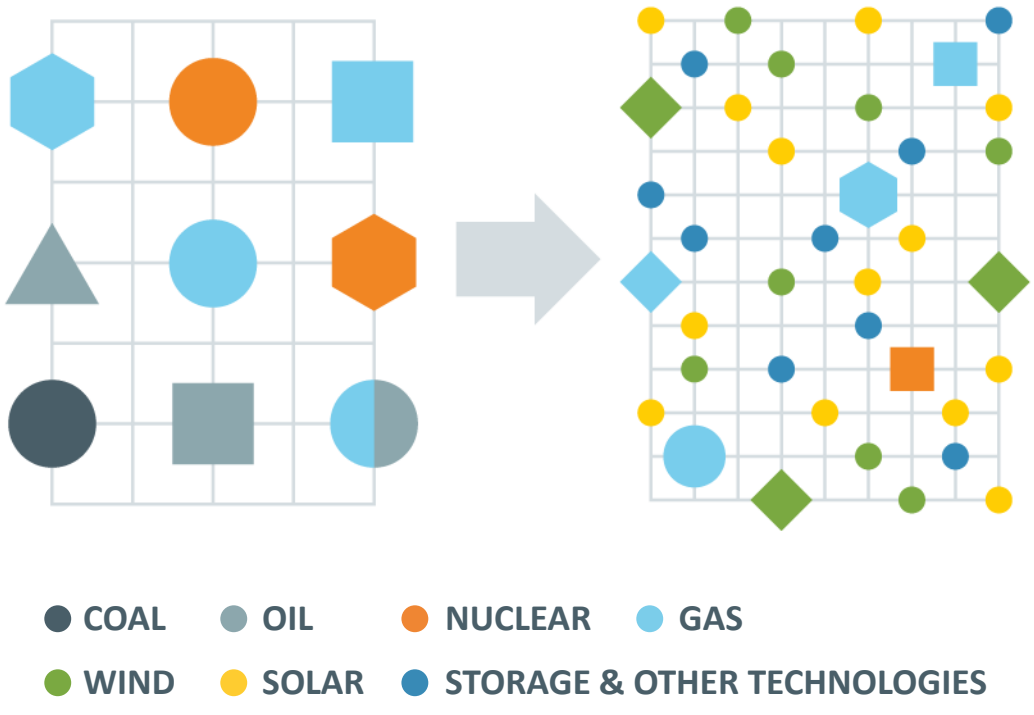
- New England is trending toward a **riskier fuel-security profile**
- The **operational risk** is a **lack of energy** during cold weather
- **The region is likely to remain exposed to winter energy limitations for the foreseeable future** – and the region will become more dependent on large volumes of LNG
- **Coordinating the timing of exit and entry of resources will be very challenging** – state-sponsored renewable resources will reduce energy market revenues over time, which will lead existing resources to require more capacity revenues to continue operation
- **Premature loss of existing non-pipeline-gas units will greatly exacerbate operational risks** – Exelon's plans to retire the Mystic units in 2022 accelerate discussions on fuel security

A Hybrid Grid Is Emerging in New England

There are two dimensions to this transition, happening simultaneously

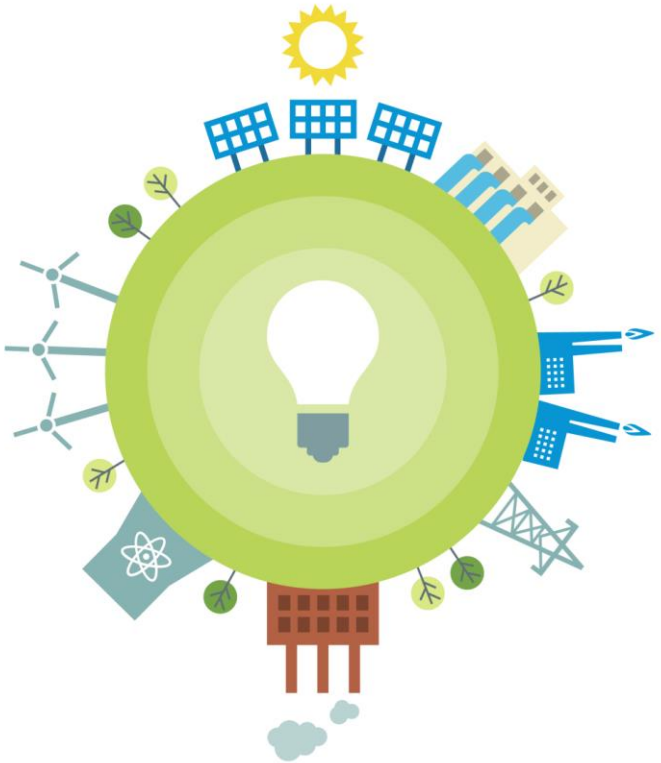
1. **A shift from conventional generation to renewable energy**

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

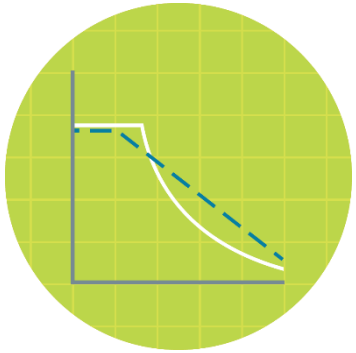


The Road to Decarbonization Presents Operational and Market-Design Challenges

- Maintaining reliable power system operations becomes **more complex** with the shift to greater intermittent and distributed energy resources
- Decarbonization efforts, market economics, and a structural gap between the business model for wholesale generators and the investment model for regional fuel infrastructure have led to **concerns about energy shortfalls** during cold weather periods that add an additional layer of **complexity**

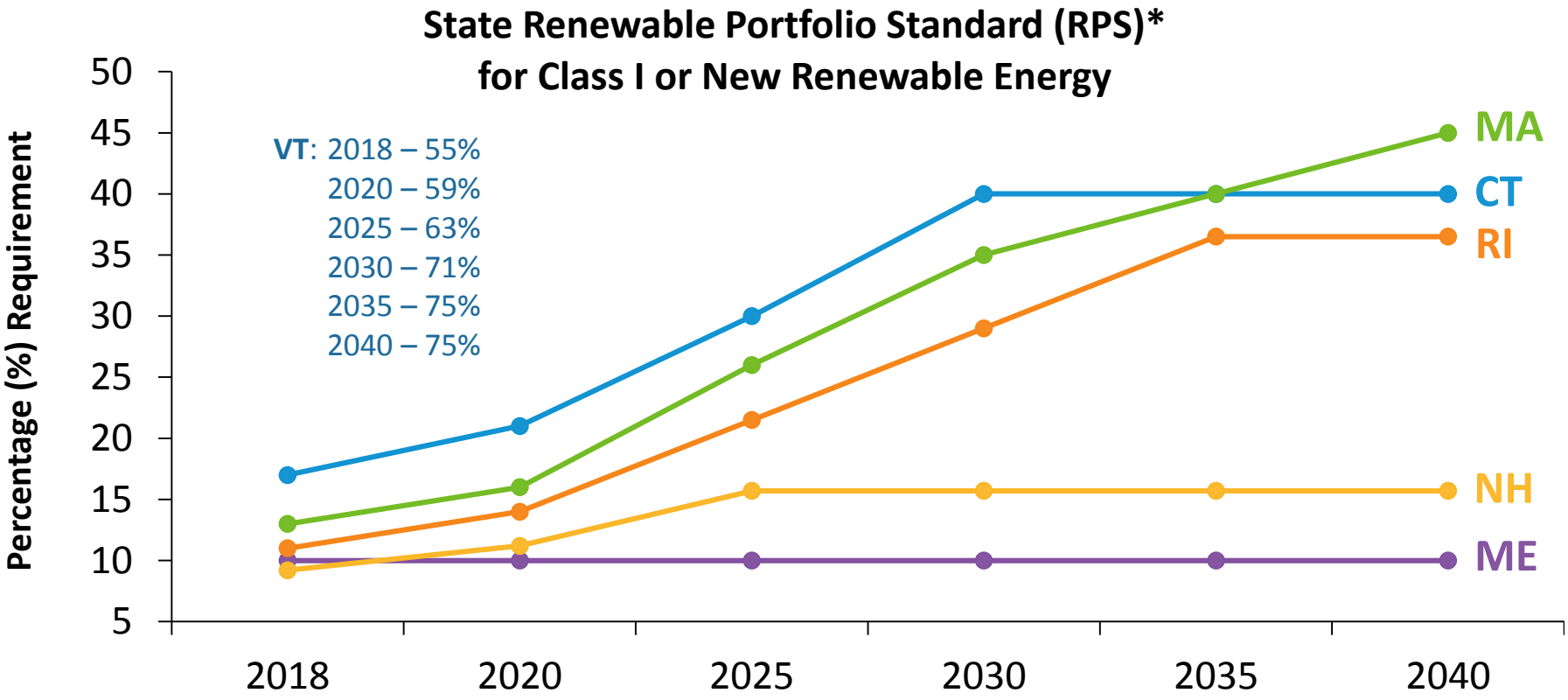


The Road to Decarbonization Presents Operational and Market-Design Challenges, *continued*



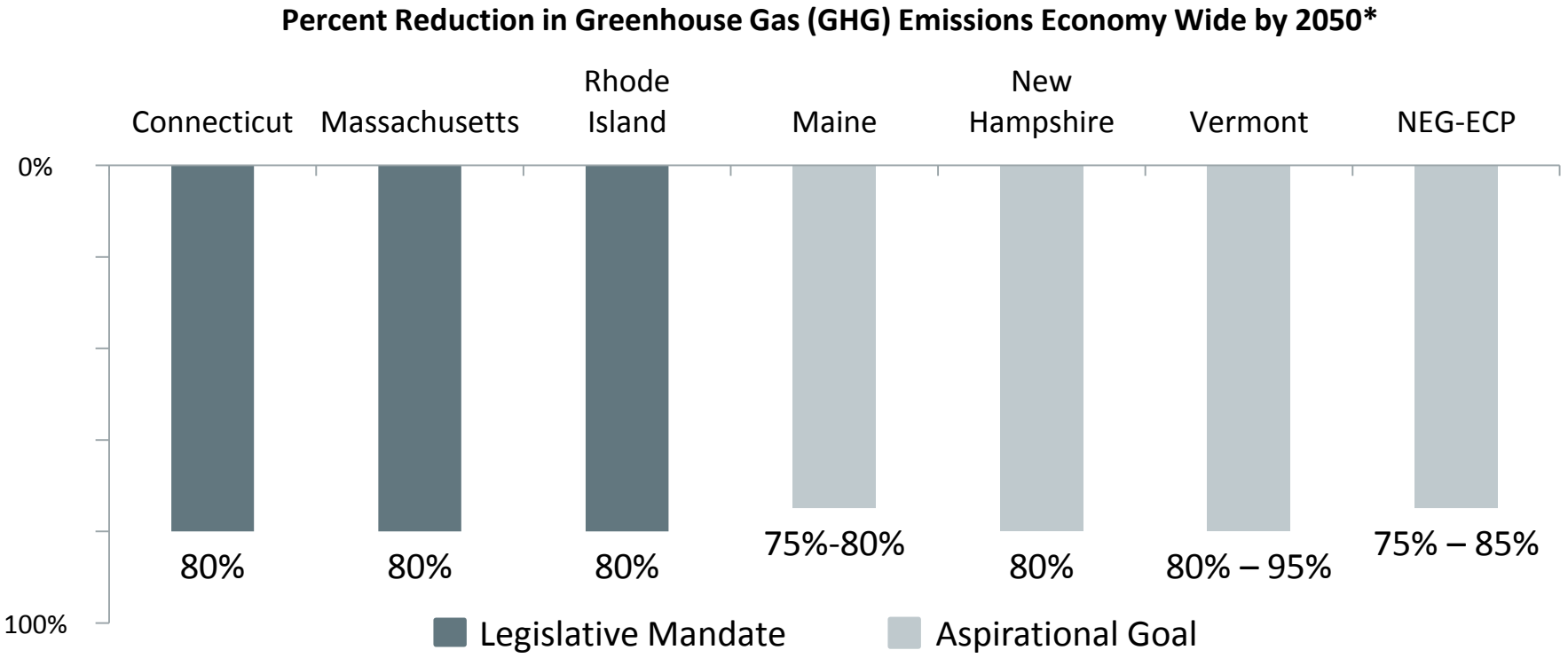
- These forces are imposing significant stress on the **wholesale market construct**, in particular, the Forward Capacity Market, which is a vital revenue stream for resources needed for regional reliability
- Capacity market revenues **complement** energy market revenues, which face significant future reductions with increasing penetrations of renewable resources capable of producing zero (or even negative) marginal cost energy
- Improvements to the wholesale markets will be required in the next several years to ensure that necessary **reliability services** are appropriately compensated

As the Generation Fleet Turns Over, the New England States Seek to Influence the Future Resource Mix



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 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 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.

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).

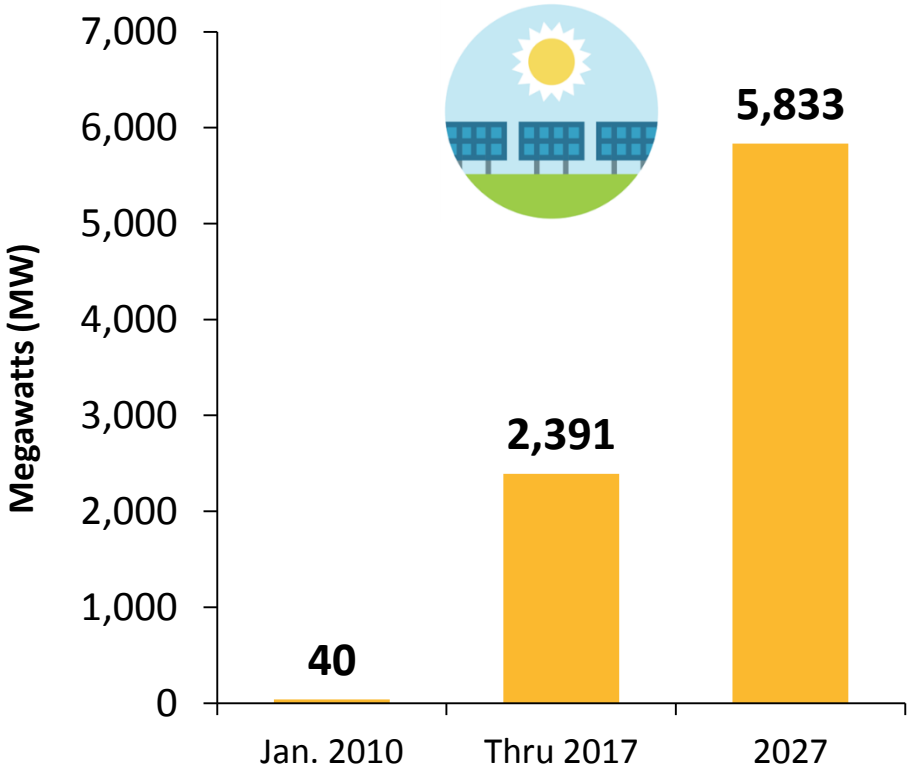
* MA, RI, NH, and VT use a 1990 baseline year for emissions reductions. CT and the NEG-ECP use a 2001 baseline. ME specifies reductions below 2003 levels that *may* be required "in the long term." For more information, see the following ISO Newswire article: http://isonewswire.com/updates/2017/3/1/the-new-england-states-have-an-ongoing-framework-for-reducin.html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

New England Has Seen Significant Growth in Solar PV, and More Is on the Way

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**

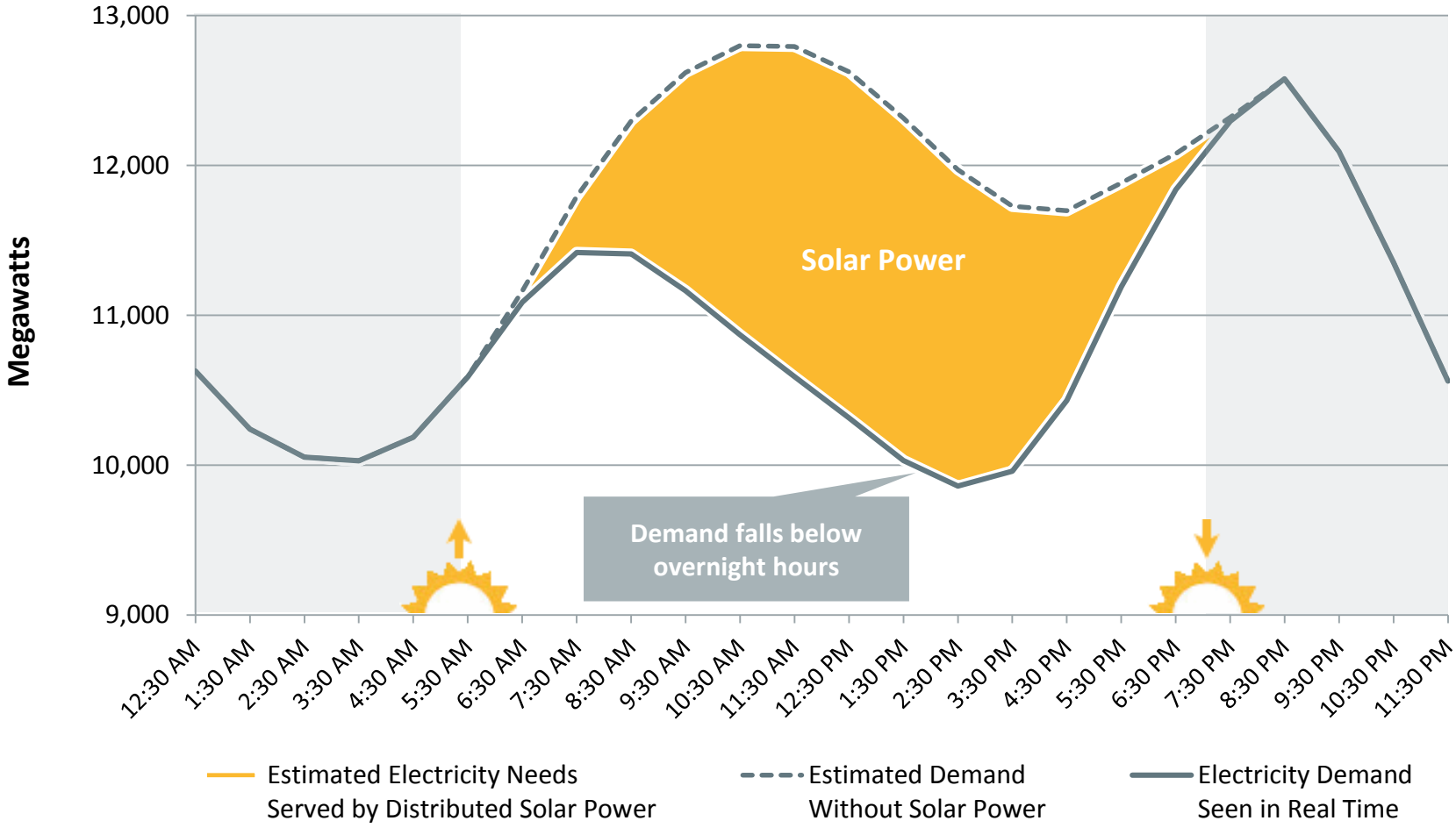
Cumulative Growth in Solar PV through 2027 (MW_{ac})



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 (March 2018); MW values are AC nameplate.

Behind-the-Meter (BTM) Solar Is Having a Significant Impact on Electricity Demand in New England

At 1:30 p.m. on April 21, 2018, BTM solar reduced grid demand by more than 2,300 MW



Growing Provision of Long-Term, Above-Market Contracts to Clean Energy Resources

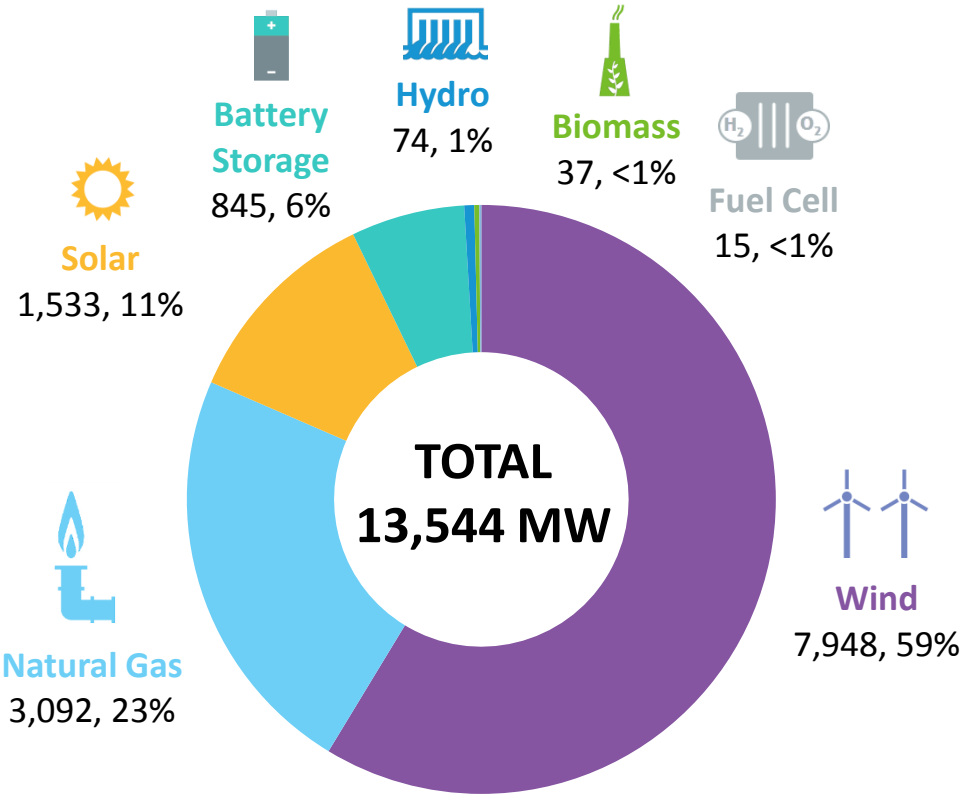
- The states are seeking to develop (or retain) more than 5,000 MW of clean energy resources through large-scale procurement efforts to meet public policy goals

State(s)	State Procurement Initiatives for Large-Scale Clean Energy Resources	Resources Eligible/Procured	Target MW (nameplate)
MA, CT, RI	2015 Multi-State Clean Energy RFP	Solar, Wind	390 MW
MA	2017 Section 83D Clean Energy RFP	Hydro Import	Approx. 1,200 MW (9,554,000 MWh)
MA RI	2017 Section 83C Offshore Wind RFP	Offshore Wind	1,600 MW (MA) 400 MW (RI)
CT	2018 Renewable Energy RFP	Offshore Wind, Fuel Cells, Anaerobic Digestion	254 MW
CT	2018 Zero-Carbon Resources RFP	Nuclear, Hydro, Class I Renewables, Energy Storage	Approx. 1,400 MW (12,000,000 MWh)
RI	2018 Renewable Energy RFP	Solar, Wind, Biomass, Small Hydro, Fuel Cells and Other Eligible Resources	400 MW

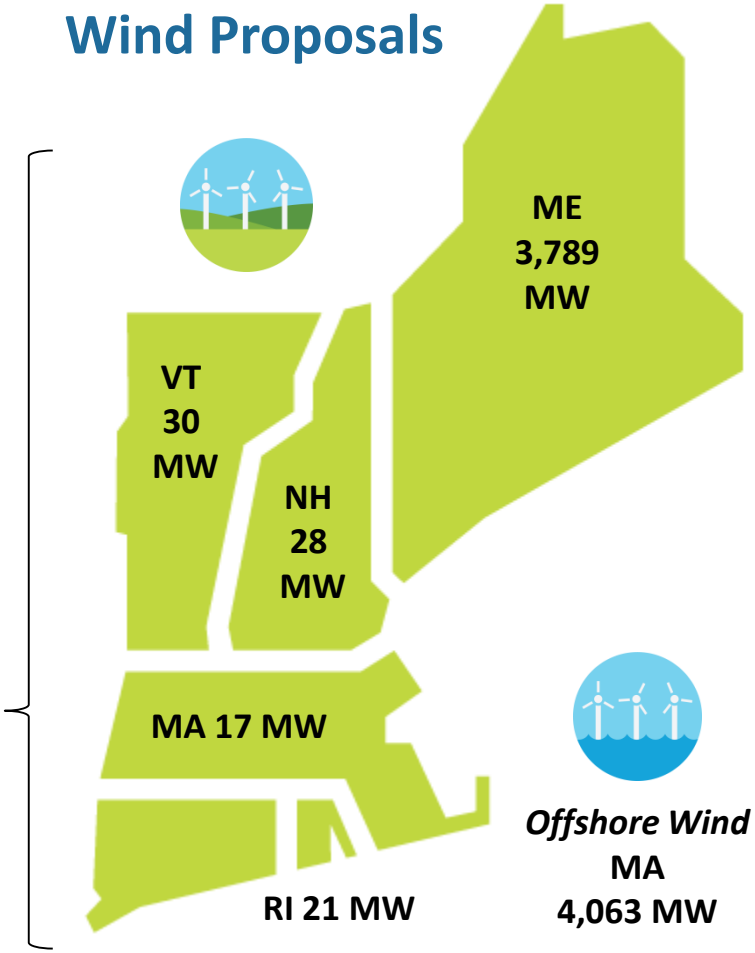
Note: Nameplate megawatts (MW) may be higher than qualified Forward Capacity Market (FCM) capacity MW.

Wind Power and Other Forms of Clean Energy Dominate New Resource Proposals in the ISO Queue

Proposals by Type



Wind Proposals



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

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

Where Are We Heading as a Region?

What market improvements will be needed to incent appropriate investment decisions and ensure necessary reliability services are compensated?

- Energy market prices will continue to face **downward pressure** as more renewable resources connect to the system, further challenging non-gas resources
- Given the system's evolving resource mix and fuel delivery infrastructure, the region faces heightened risks to meeting demand for electricity during New England's cold winter period
  - ***What market incentives are necessary to minimize these risks?***

Relevant Timeframes for Investment Decisions

1. Longer, Forward Commitments for Energy Infrastructure
2. Shorter, Forward Signals to Obtain and Maintain Energy Supplies and Inventories; Recognizing Seasonal Logistical Constraints such as Winter Refueling
3. Shorter, Near-Term Signals to Incentivize Management and Optimal Use of Energy Inventories

Questions