The Ongoing Transformation of New England's Power System

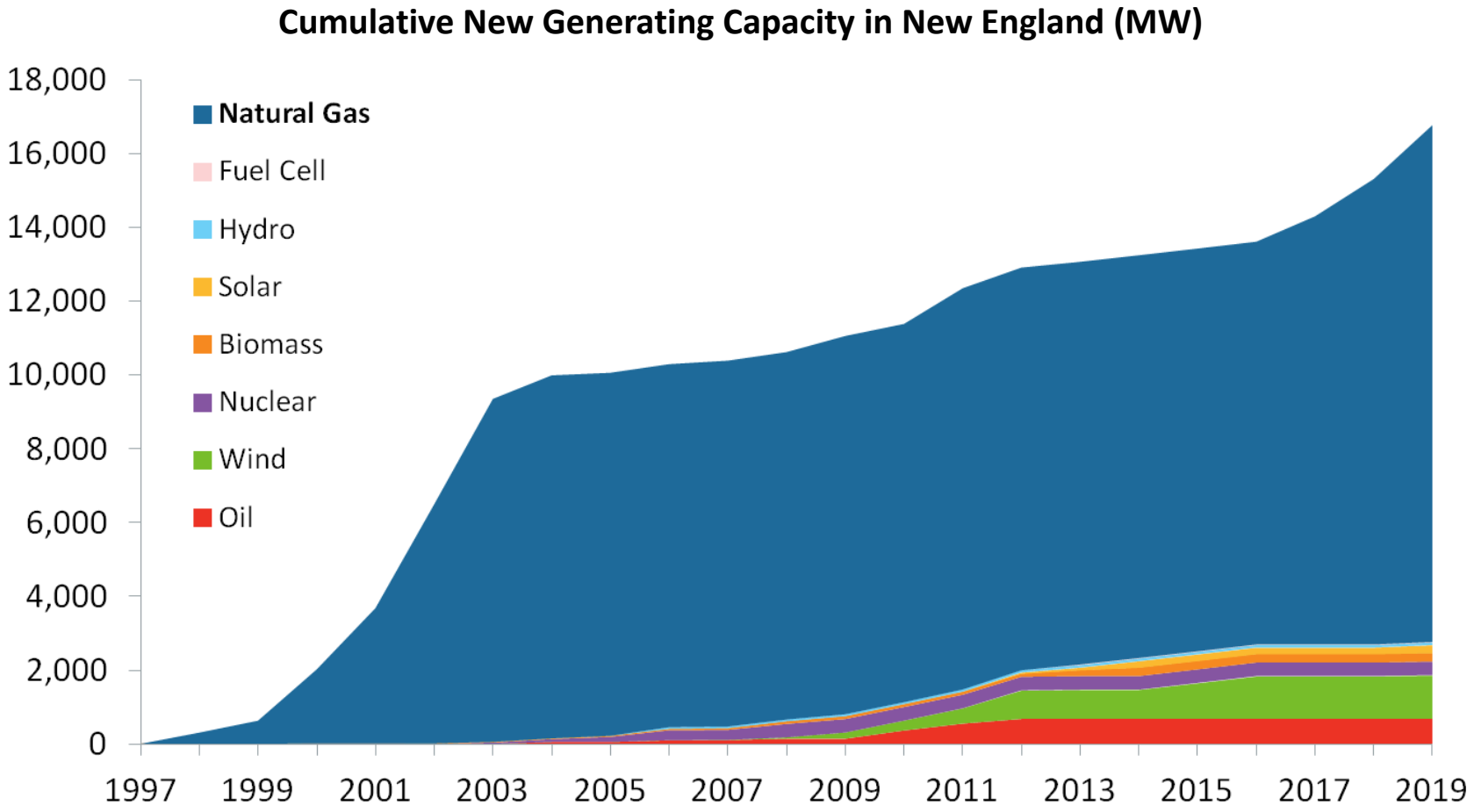
US Department of Energy

2016 Quadrennial Energy Review

Stephen J. Rourke

VICE PRESIDENT, SYSTEM PLANNING

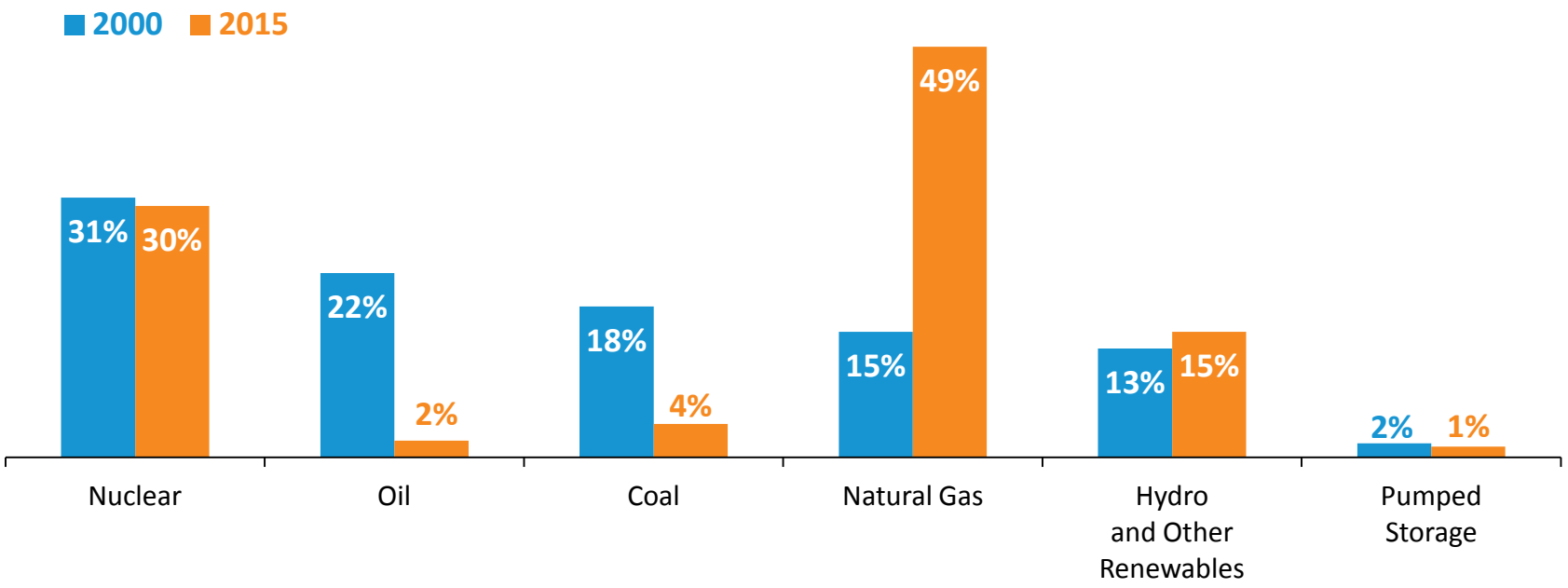
Natural Gas Is the Dominant Fuel Source for New Generating Capacity in New England



Note: New generating capacity for years 2016 – 2019 includes resources clearing in recent Forward Capacity Auctions

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. 2015)



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

Power Plant Emissions Have Declined with Changes in the Fuel Mix

Reduction in Aggregate Emissions (ktons/yr)

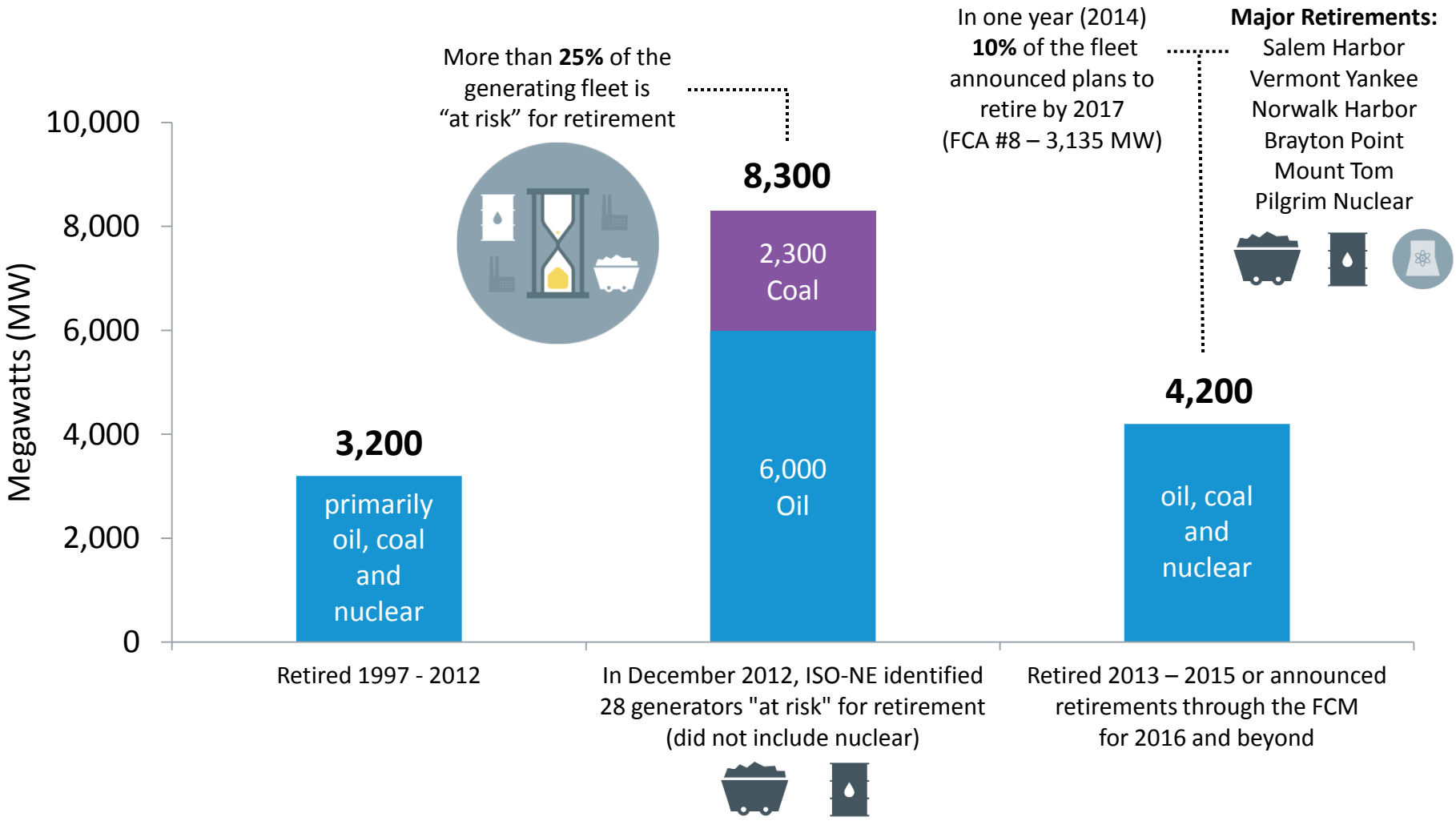
Year	NO_x	SO_2	CO_2
2001	59.73	200.01	52,991
2014	20.49	11.68	39,317
% Reduction, 2001–2014	**⬇ 66%**	**⬇ 94%**	**⬇ 26%**

Reduction in Average Emission Rates (lb/MWh)

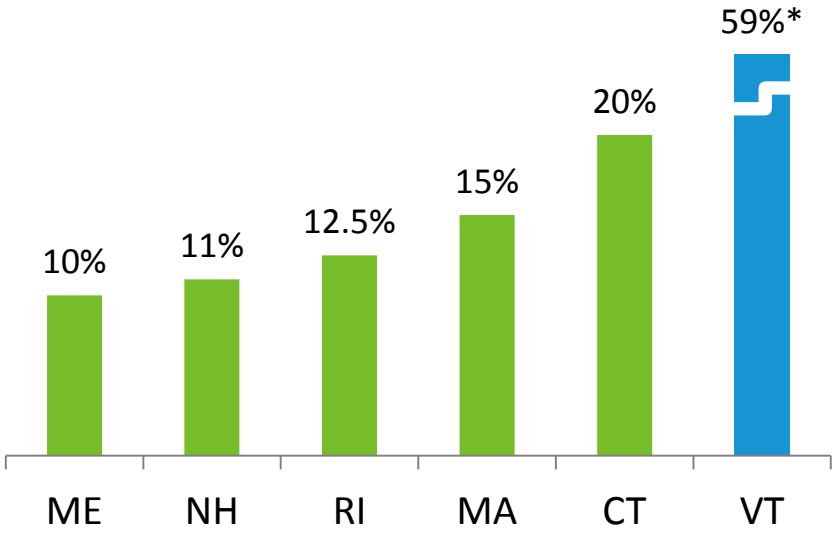
Year	NO_x	SO_2	CO_2
1999	1.36	4.52	1,009
2014	0.38	0.22	726
% Reduction, 1999–2014	**⬇72%**	**⬇ 95%**	**⬇ 28%**

Source: 2014 ISO New England Electric Generator Air Emissions Report, January 2016

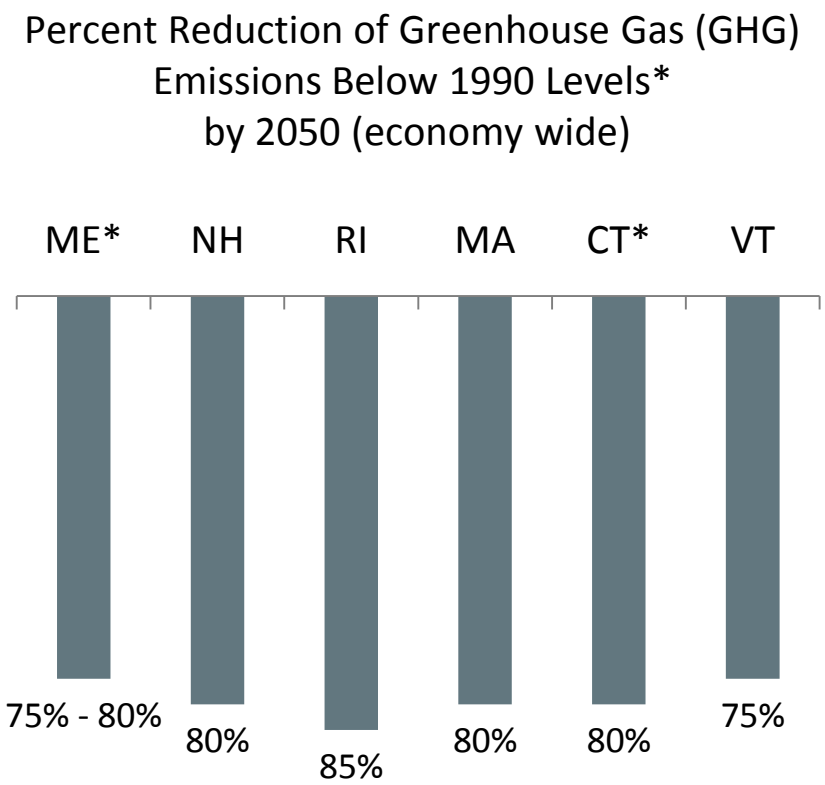
More Than 4,200 MW of Non-Gas Generation Have Recently Retired or Announced Plans to Retire



States Have Set Goals to *Increase* Renewable Energy and *Reduce* Greenhouse Gas Emissions



State Renewable Portfolio Standard (RPS) for Class I or New Renewable Energy by 2020

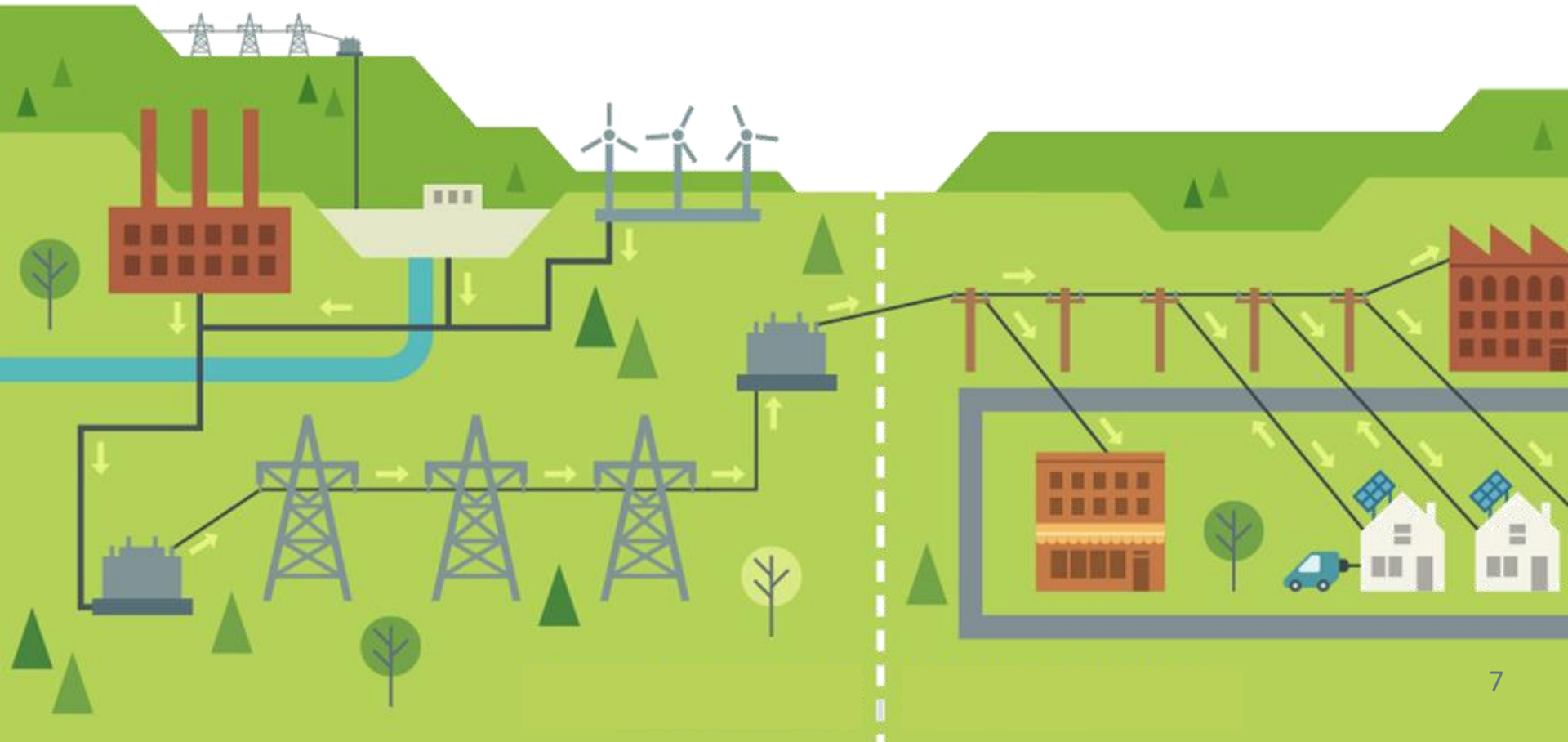


* Vermont's standard recognizes all forms of renewable energy, and is unique in classifying large-scale hydro as renewable.

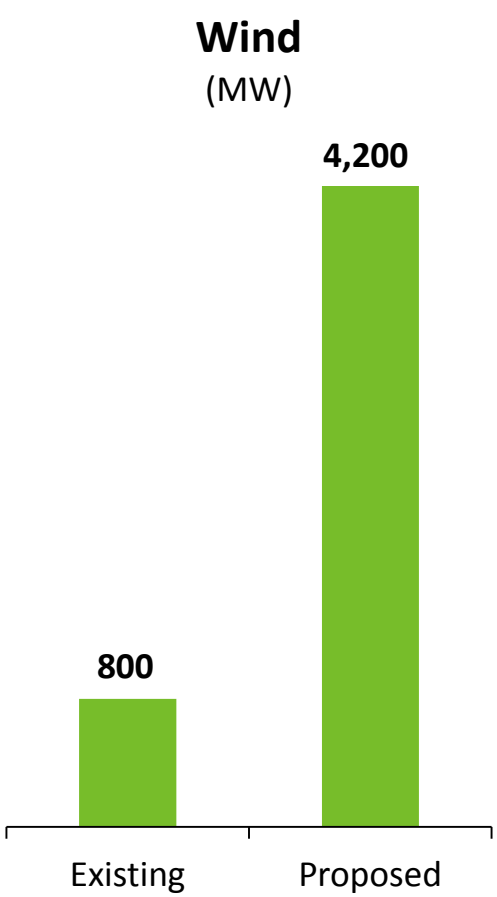
* Connecticut's goal is tied to 2001 levels. Maine's goal is tied to 2003 levels.

Electric Grid Will Look Very Different in 5 to 10 Years

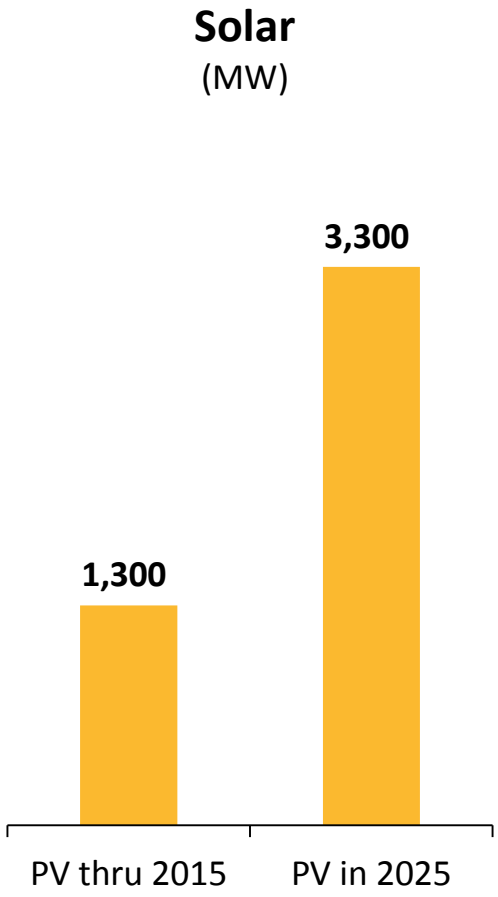
"Hybrid" grid with grid-connected and distributed resources, and a continued shift toward natural gas and renewable energy



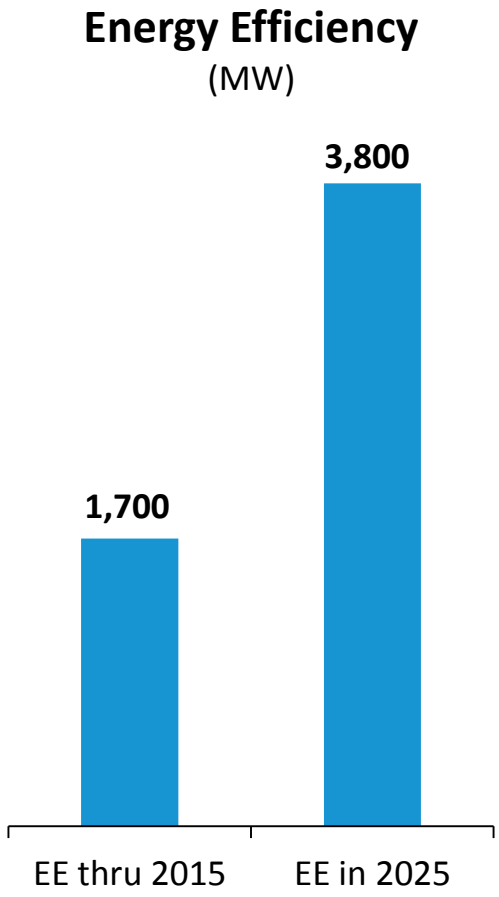
Renewable and EE Resources Are Trending Up



Nameplate capacity of existing wind resources and proposals in the ISO-NE Generator Interconnection Queue; megawatts (MW).

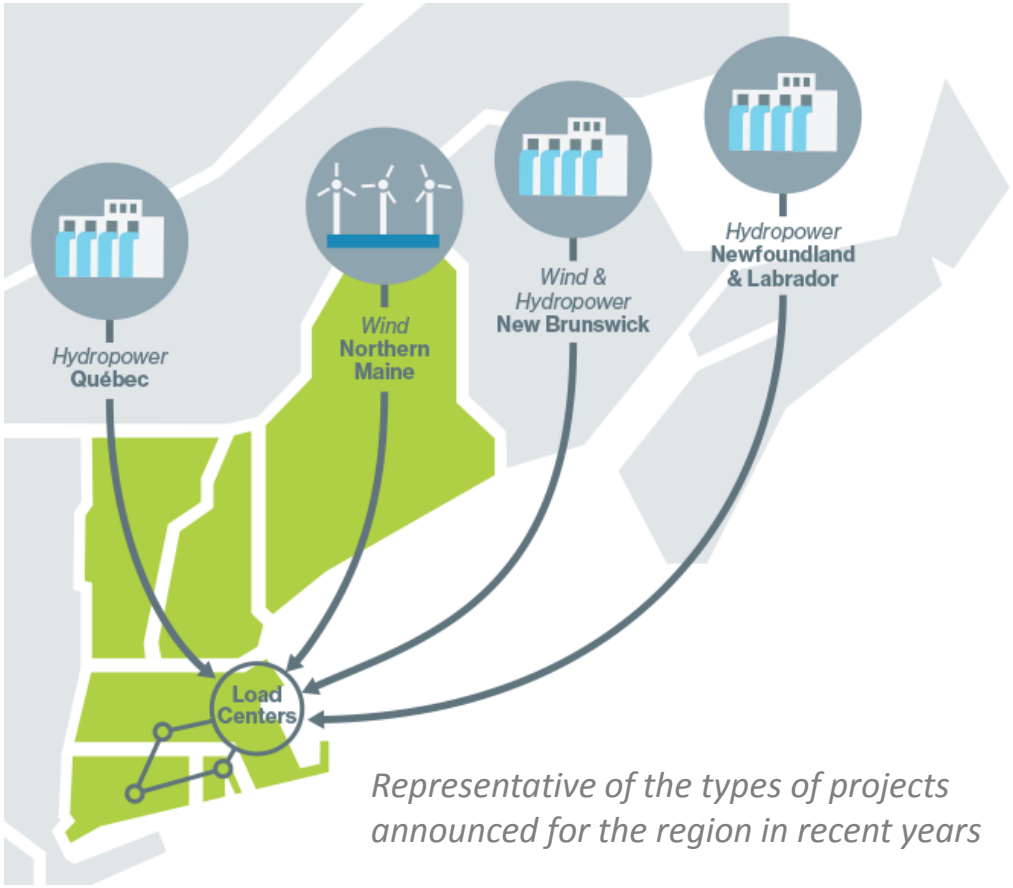


2016 ISO-NE Solar PV Forecast, nameplate capacity, based on state policies.



2016 CELT Report (preliminary), EE through 2015 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2025 includes an ISO-NE forecast of incremental EE beyond the FCM.

Transmission Developers Are Proposing to Move Renewable Energy to New England Load Centers



Representative of the types of projects announced for the region in recent years

- As of **January 1, 2016**, eleven elective transmission projects had been proposed in the ISO Interconnection Queue, totaling more than **7,000 MW** of potential transfer capability
  - Primarily large-scale **hydro** resources from eastern Canada and **wind** resources from northern New England and New York
- Some of these projects are participating in the CT, MA, RI Clean Energy RFP
- These projects seek to address public policy goals, not reliability needs; but could be a factor in planning for public policy under FERC Order 1000

Source: ISO Interconnection Queue (January 2016)
http://www.iso-ne.com/system-planning/transmission-planning/interconnection-request-queue

The ISO Is Improving the Ability of Intermittent Resources to Participate in the Wholesale Markets

- ✓ **Flexibility to Offer Negative Prices**
  - Allows generators, like wind, the opportunity to operate during low-load conditions when they otherwise might be curtailed
- ✓ **Updated Elective Transmission Upgrade (ETU) Rules**
  - Improve the interconnection study process for ETUs and ensure these resources are able to deliver capacity and energy into the wholesale electricity markets
- ○ **Flexibility to Operate Up to a Certain Level**
  - Allows the ISO to better manage transmission congestion in a way that will maximize the use of low-cost renewable resources and alleviate the need for curtailments (effective May 2016)
  - Known as "Do-not-Exceed Dispatch Order"

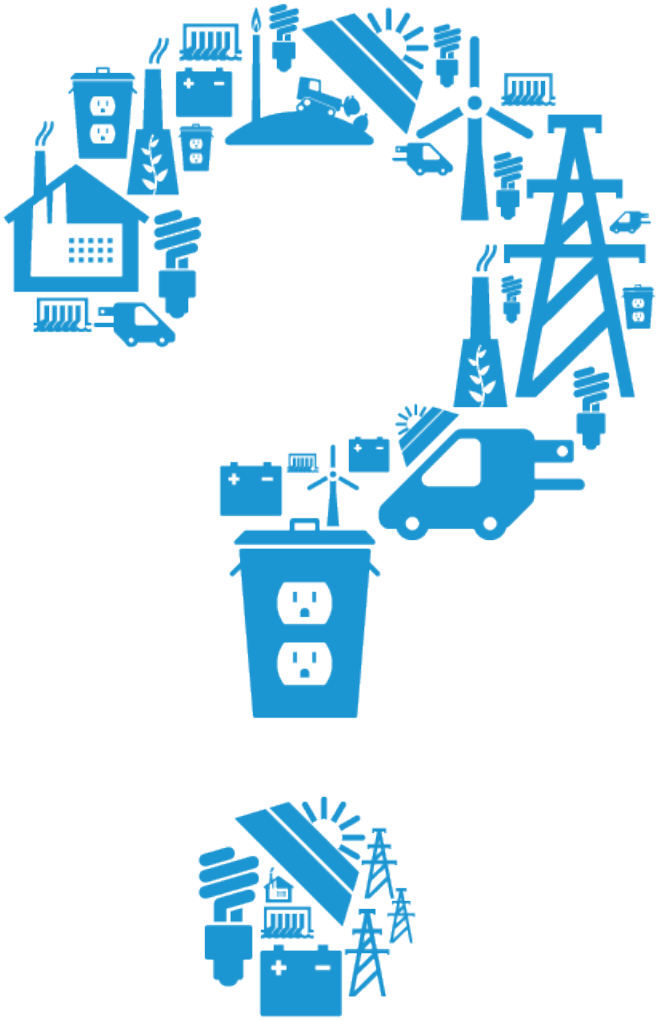
Conclusions

- New England is transitioning to a system with *decreasing* amounts of traditional resources (coal, oil, nuclear) and *increasing* amounts of renewable energy
- In the coming years, New England's "hybrid" electric grid will include growing levels of wind, solar, and energy efficiency resources
  - New England policymakers continue to encourage investment in low- and non-carbon energy
- Transmission investment will be required to incorporate large amounts of remote renewable resources
- The ISO is working with stakeholders to enable the successful integration of variable energy resources

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
- 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

Questions



Prepared Statement for Stephen J. Rourke
Vice President, System Planning, ISO New England
US Department of Energy -- Quadrennial Energy Review Meeting
Marriott Long Wharf, Boston, MA
April 15, 2016

Good Morning. My name is Steve Rourke, and I am the Vice President for System Planning for ISO New England.

First, I want to welcome and thank Secretary Moniz, Dr. Holdren, and all of the US Department of Energy staff involved in the QER effort. I know that Secretary Moniz took the time to speak at a QER stakeholder meeting in New England in 2014 as well. We very much appreciate the attention DOE is giving to our region and the discussion of the natural gas pipeline constraints that DOE included in the first version of the QER released in 2015.

The ISO has three primary responsibilities: Reliable operation of the bulk power system, administering New England's wholesale energy markets, and long-term planning for a rapidly evolving regional power system.

In New England, we have been operating organized wholesale markets since the late 1990s, and most of the new generators that have been built are natural gas-fired power plants. Nearly 13,000 MW of new natural gas fired resources have been installed across the region.

The domestic shale gas revolution has certainly had a tremendous impact on our region. However, New England's investment in natural gas infrastructure has not kept pace with power generation and we experience significant reliability, economic and environmental risks because of the constraints on the pipelines. As I mentioned, DOE highlighted the reliability and economic impacts of these constraints in the 2015 QER. New England is going to need additional infrastructure to meet increasing demand for natural gas.

Consequently, New England has experienced a major transformation in how electricity is produced and delivered in the region. As this chart indicates, our power plant fleet is experiencing rapid change. In 2000, coal- and oil-fired resources represented 40% of the electricity generated in New England. Last year,

those two resource types (combined) produced 6%. We have seen one nuclear plant already retire with another nuclear facility set to retire in the coming years. During that same period, our reliance on natural gas has grown substantially – nearly half of our electricity is produced by natural gas-fired power plants.

As my next slide illustrates, that shift in generation resources from oil and coal to natural gas has resulted in significant reductions in NO_X, SO_2, and carbon dioxide during a similar time period.

Since 2013, New England has seen the retirement of approximately 4,200 MW of nuclear, coal, and oil resources. This is only part of a number of "at-risk" plants that the ISO highlighted in 2012 as likely to retire in the next decade given their age and fuel type. To offset those retirements, since 2013 our Forward Capacity Market has incentivized 4,700 MW of new capacity resources to come forward. However, we anticipate that New England could experience an additional 6,000 MW of retirements that have yet to be announced, so we are very much in the midst of this regional transition.

So when these retirements occur, what takes their place? As we are seeing this change through our wholesale markets, policymakers are setting aggressive statutory goals to increase the amount of renewable and low-carbon energy on the system as well as mandating reductions in greenhouse gas emissions.

This is moving New England to a "hybrid grid" that will combine large power-system resources supplying the regional system with smaller ones supplying consumers directly.

As Slide 8 demonstrates, the ISO forecasts a dramatic growth in weather-dependent, renewable power-system resources (like wind and solar) and energy-efficiency measures. Our preliminary 2016 forecasts estimate a growth in solar from 1,300 MW to 3,300 MW in the next decade and over a doubling of energy efficiency resources from 1,700 MW to 3,800 MW. There are over 4,000 MW of wind projects in our study queue.

In order to meet these goals, New England will need an investment in transmission to bring remote hydro and wind resources closer to load centers. Our interconnection queue includes a number of elective, merchant projects to

address this need, and additional transmission investment will be important to meeting renewable energy goals in New England.

We have also worked with New England states and stakeholders to make it easier for variable resources to participate in wholesale markets. We are engaged in an ongoing dialogue with our stakeholders about how markets can work to accomplish the New England states' policy requirements.

In some ways we are the vanguard of change in the electric industry. New England is experiencing change at a significant depth and pace. And we appreciate the US Department of Energy shining a light on these critical regional issues.

Thank you.