ISO New England Overview and Regional Update

House Science, Technology and Energy Committee

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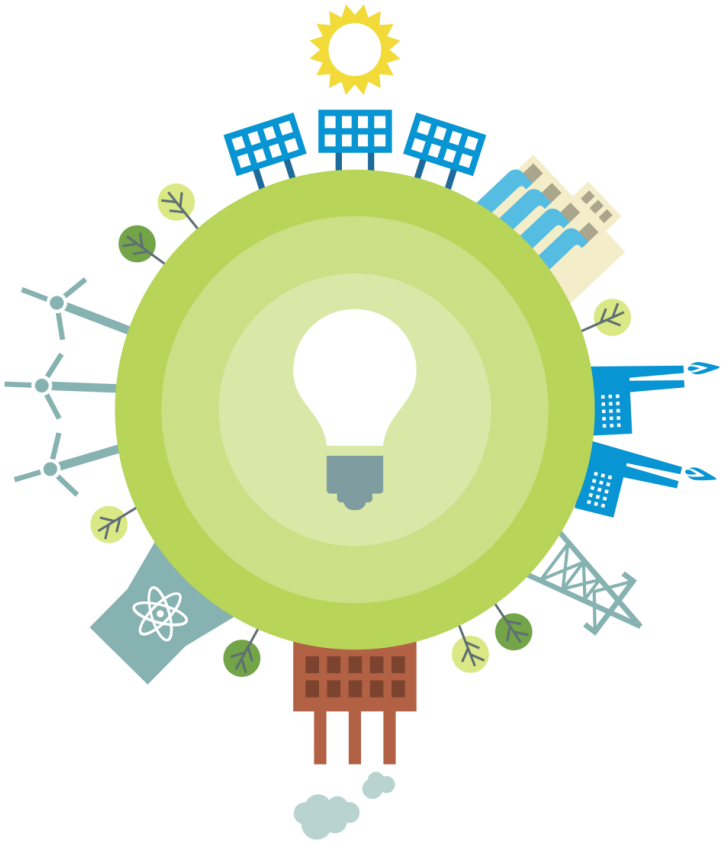
EXTERNAL AFFAIRS

Overview of Presentation

- About ISO New England
- Electric Grid At-a-Glance
- Major Responsibilities
- Strategic Planning
- Resource Developments
- Transmission Developments
- Consumer Liaison Group



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

Reliability Is the Core of ISO New England's Mission

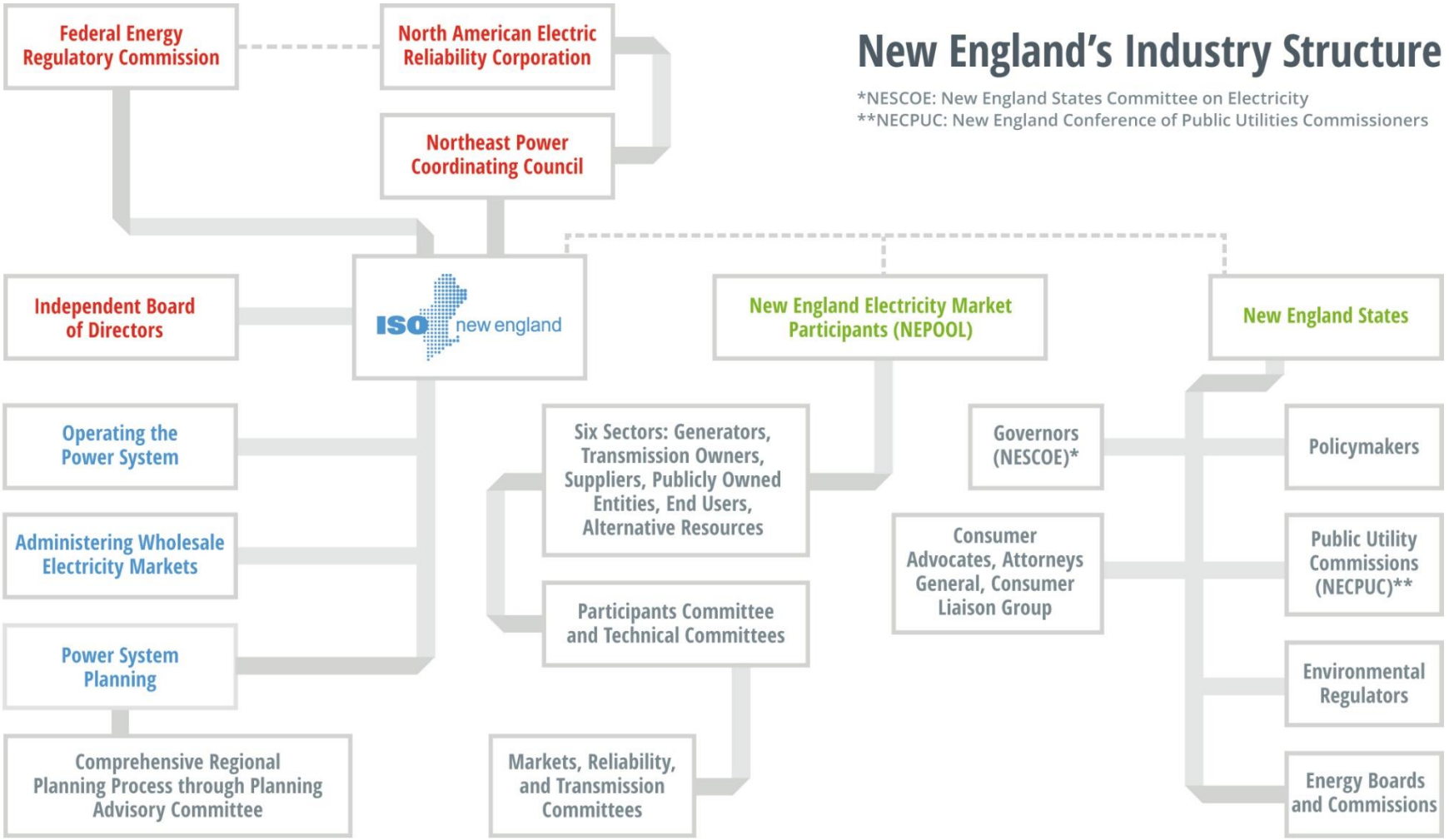
Fulfilled by three interconnected and interdependent responsibilities

Overseeing the day-to-day operation of New England's electric power generation and transmission system

Managing comprehensive regional power system planning

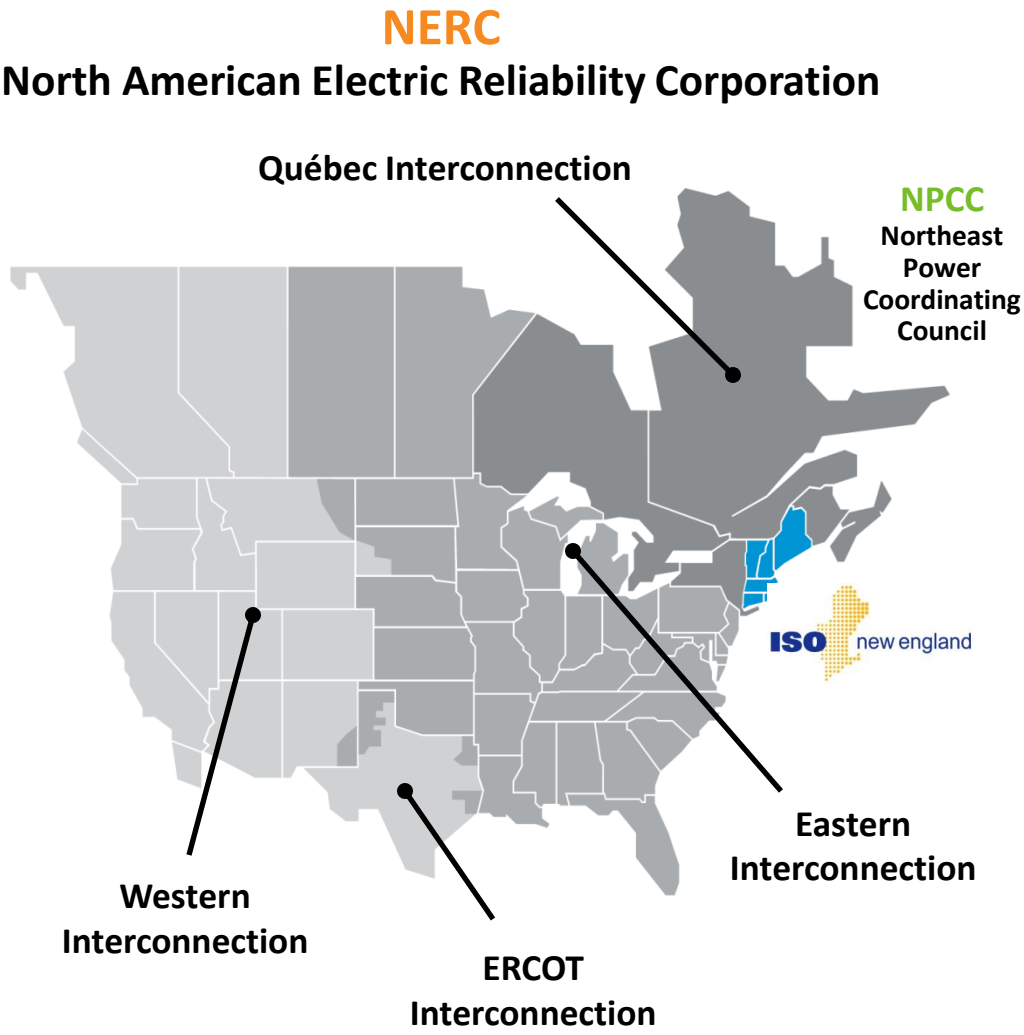
Developing and administering the region's competitive wholesale electricity markets

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



ISO New England Is Part of a Larger Electric Power System

- Eastern Interconnection spans from Rocky Mountains to East Coast and Canadian Maritimes
  - Primarily alternating-current (AC) transmission
  - New England linked to rest of Eastern Interconnection via transmission ties to New York and New Brunswick
- Tied to Québec only through direct-current (DC) transmission
- 2003 Blackout ushered in wide-area monitoring and mandatory reliability standards



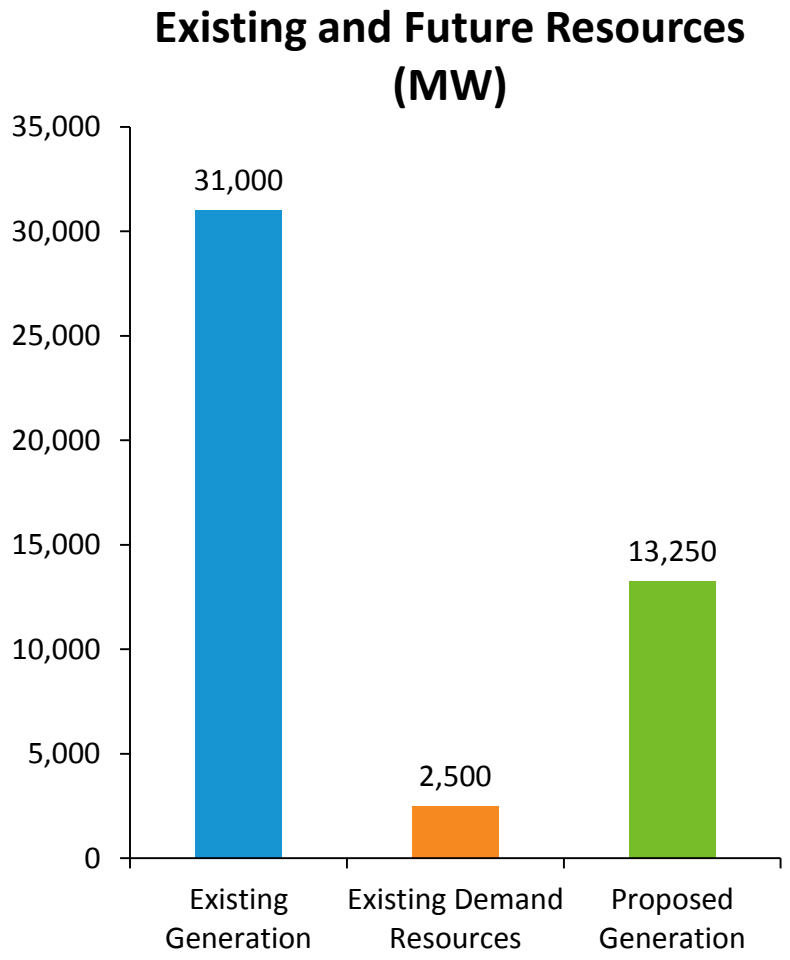
Overall Electricity Demand Is Flattening Due to Energy Efficiency and Behind-the-Meter Solar

- **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**
- Energy efficiency and behind-the-meter solar slow the growth in summer *peak* demand to **0.3%** annually and flatten the growth in *overall* electricity demand to **-0.2%** annually

Note: Without energy efficiency and solar, the region's peak demand is forecasted to grow 1.1% annually and the region's overall electricity demand is forecasted to grow 1.0% annually. Summer peak demand is based on the "90/10" forecast for extreme summer weather.

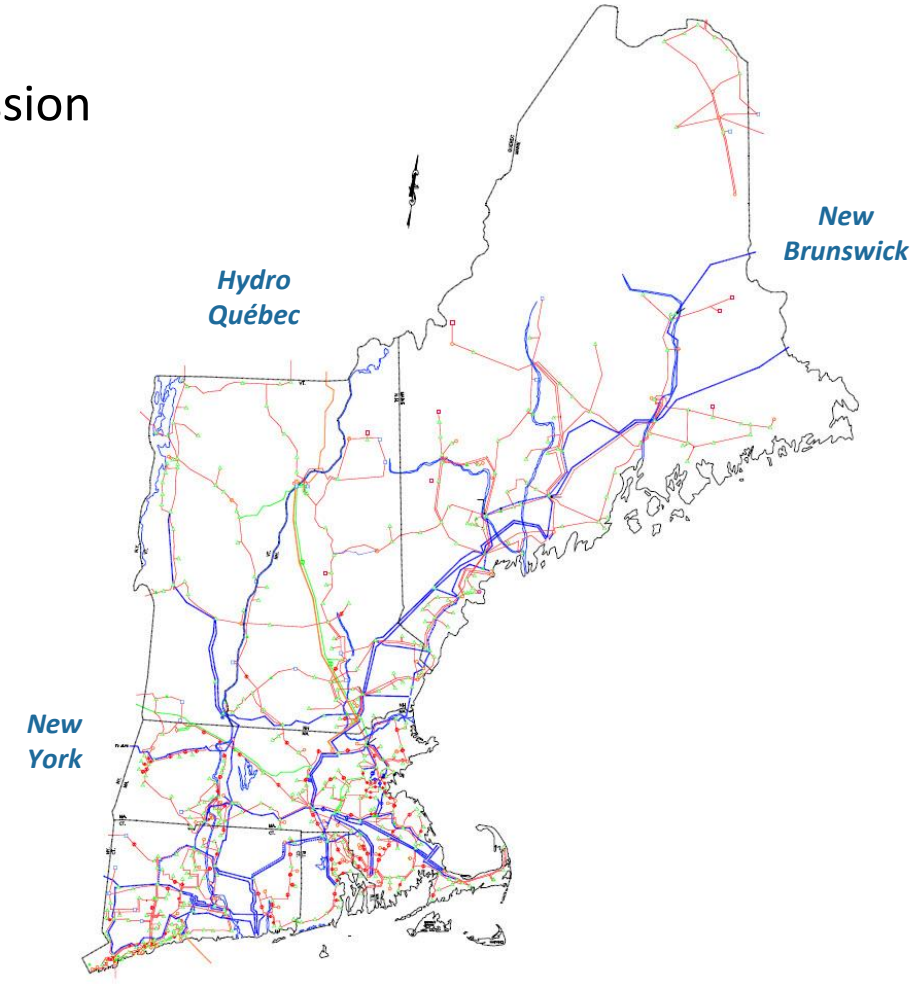
A Range of Generation and Demand Resources Are Used to Meet New England's Energy Needs

- **350** generators in the region
- **31,000 MW** of generating capacity
- **13,250 MW** of proposed generation in the ISO Queue
  - Mostly natural gas and wind
- **4,200 MW** of generation has retired or will retire in the next five years
- **600 MW** of active demand response and **1,900 MW** of energy efficiency with capacity supply obligations



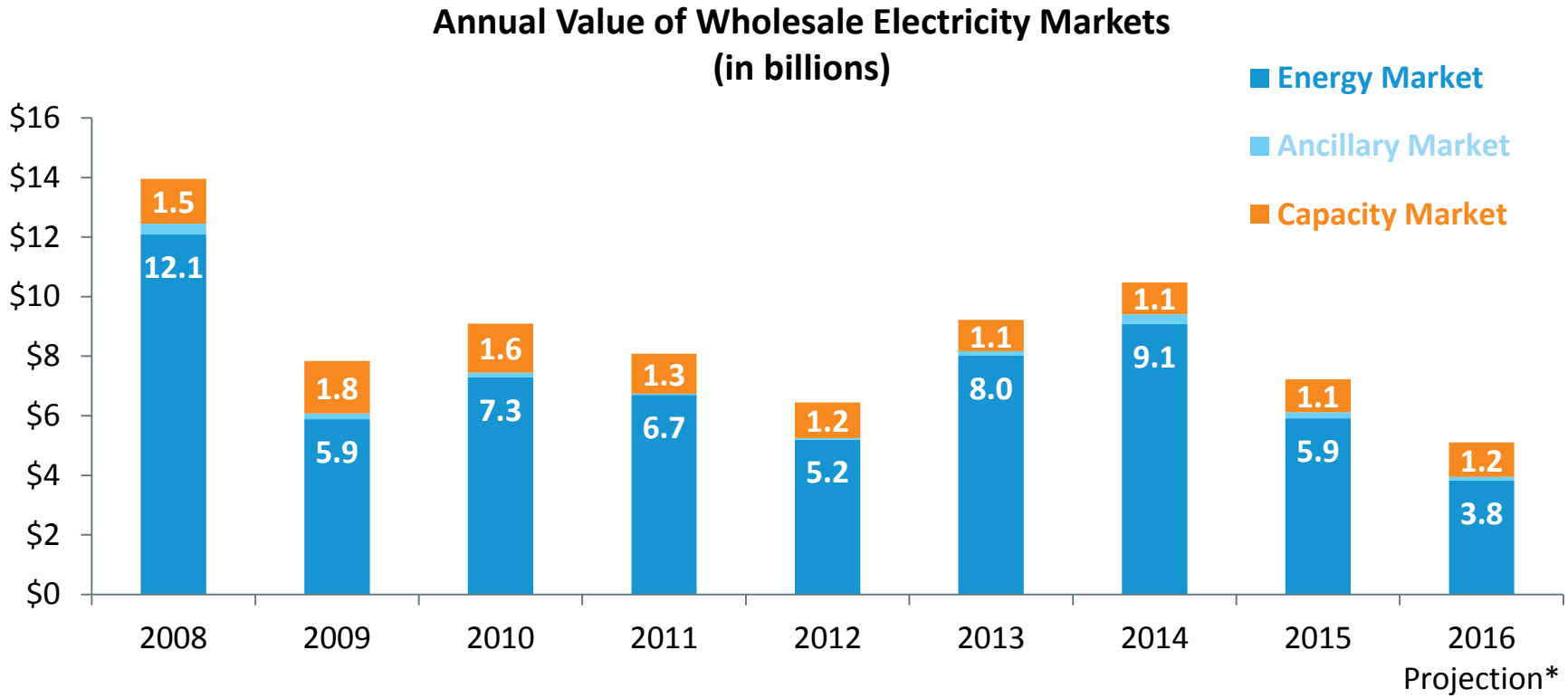
New England's Transmission Grid Is the Interstate Highway System for Electricity

- **9,000 miles** of high-voltage transmission lines (115 kV and above)
- **13 transmission interconnections** to power systems in New York and Eastern Canada
- **16%** of region's energy needs met by imports in 2015
- **$8 billion** invested to strengthen transmission system reliability since 2002; **$4 billion** planned
- Developers have proposed multiple transmission projects to access non-carbon-emitting resources



New England's Wholesale Electricity Markets Produce Low Prices When the Region's Fuel Infrastructure Is *Unconstrained*

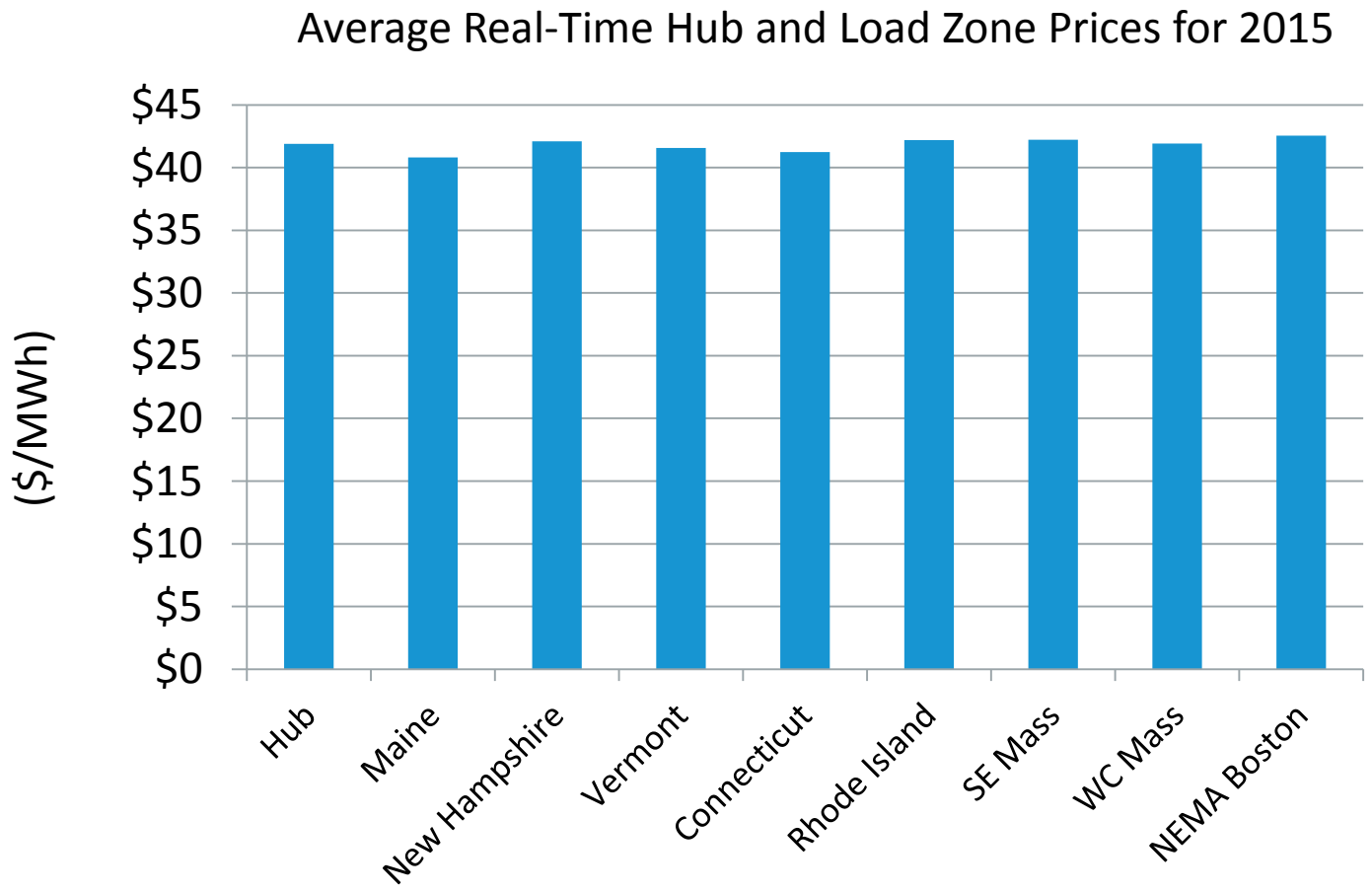
Electric transmission investments allow the region to access the most economic resources



Source: 2015 Report of the Consumer Liaison Group

The 2016 projection is the sum of preliminary 2016 January-September actuals and the October-December projected values. The October-December projections were derived as follows: on average, over the last five years (2011-2015), the value of the Energy Market and the Ancillary Market accrued over the first three quarters of the year was approximately 79.43% and 72.78% of the annual total for the respective market. These percentages were applied to the totals from the first three quarters of 2016 to produce the October-December projections for these markets. The Capacity Market values reflect the October 2016 value held constant for the remainder of the year. This projection is for illustrative purposes only. Data are preliminary and subject to reconciliation.

Wholesale Electricity Prices Are Relatively Constant Across the Region



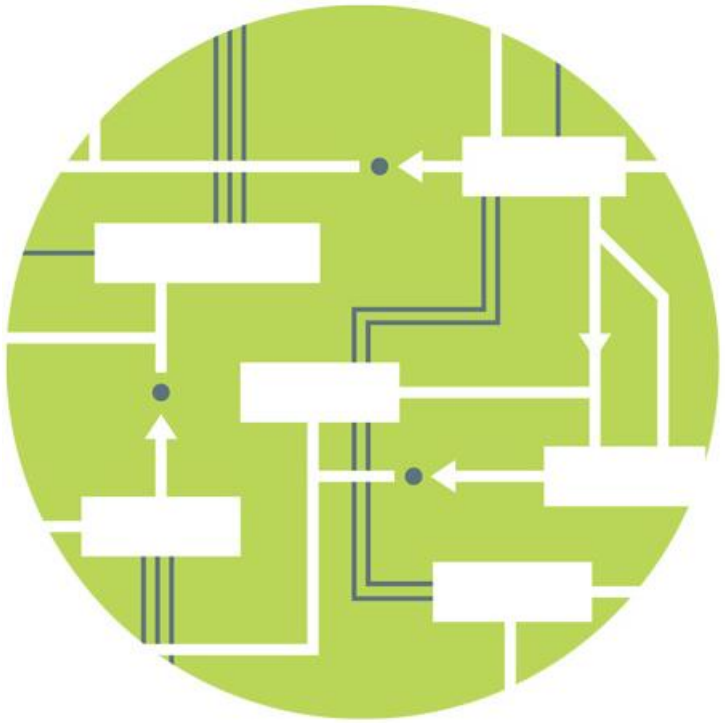
Source: ISO New England *2015 Annual Markets Report*, May 25, 2016

Ensuring Reliable Power System Operations Is a Major Responsibility

- Maintain minute-to-minute reliable operation of region's generation and transmission system
- Perform centralized dispatch of the lowest-priced resources
- Coordinate and schedule maintenance outages
- Coordinate operations with neighboring power systems

Managing Comprehensive Regional Power System Planning Is a Major Responsibility

- 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



ISO New England Adheres to Mandatory Reliability Standards That Address Cybersecurity

- Safeguarding physical and cyber security is a **top priority** for ISO New England
- The nine Independent System Operators and Regional Transmission Organizations (ISOs/RTOs) in North America are subject to **mandatory** NERC Critical Infrastructure Protection (CIP) reliability standards that address cybersecurity
- The ISO is actively engaged in NERC grid security exercises that test the readiness of the electricity subsector to respond to physical and cybersecurity threats (e.g., **GridEx III**)

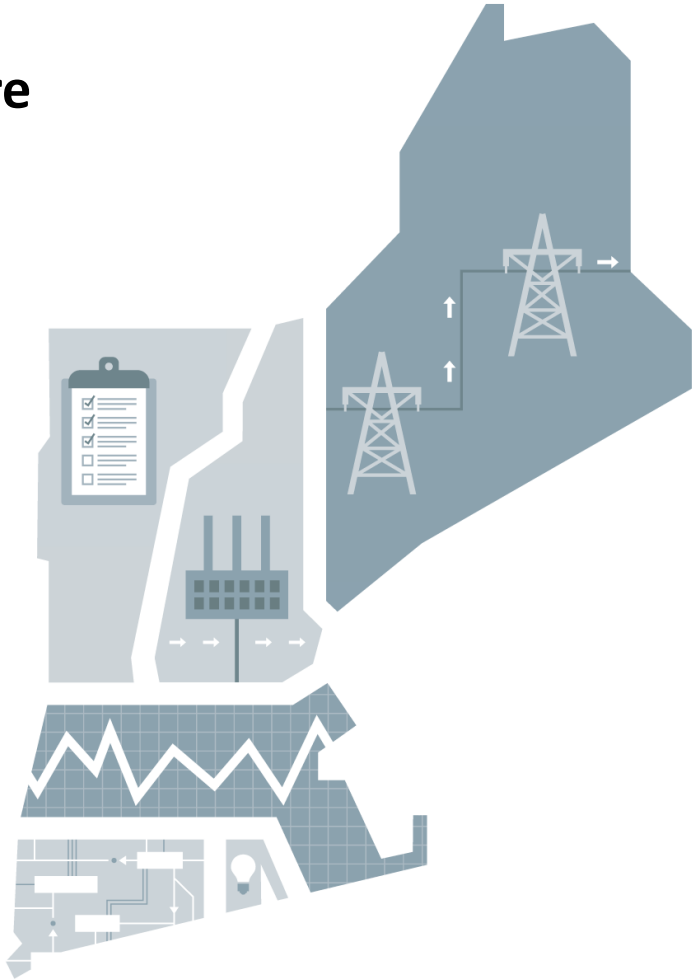
Note: The North American Electric Reliability Corporation (NERC) develops and enforces mandatory standards to ensure reliability of the bulk power system in North America.

ISO New England Has Initiated Round-the-Clock Cybersecurity Monitoring

- To be able to **detect**, **withstand**, and **recover** from a cyber attack, the ISO has implemented an extensive system of process controls, advanced detection and response systems, and redundancy measures to protect the ISO New England network
- Building on existing tools, the ISO launched the 24/7 Security Operations Center in late 2015 to provide **round-the-clock cybersecurity monitoring** of the ISO New England network

ISO New England Is Focused on Developing Solutions to the Region's Top Reliability Risks

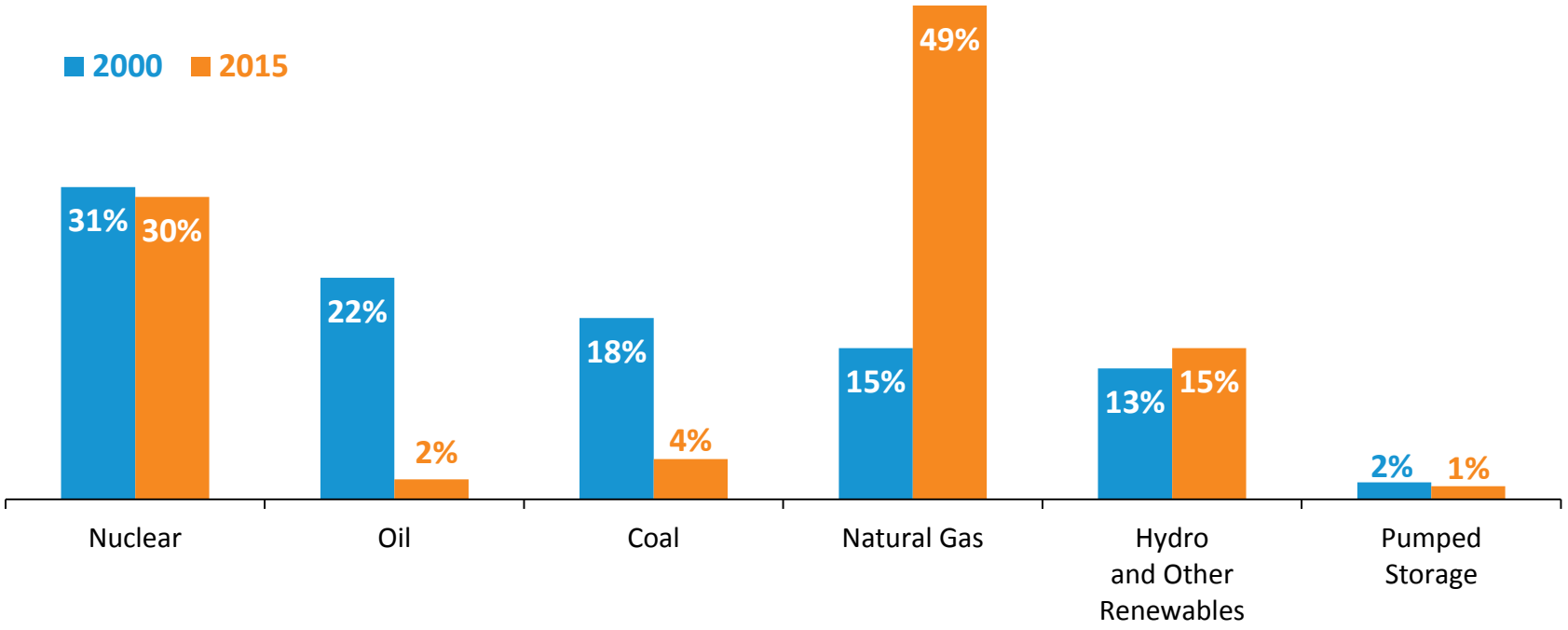
- **Inadequate Natural Gas Infrastructure**
  - New England is challenged to meet electricity demands with existing natural gas infrastructure, particularly during the winter
- **Power Plant Retirements**
  - New England will need new ways to meet peak demand as aging plants close
- **Renewable Resource Integration**
  - Maintaining reliability as increasing levels of distributed generation and intermittent resources come online



New England Has Seen Dramatic Changes in the Energy Mix

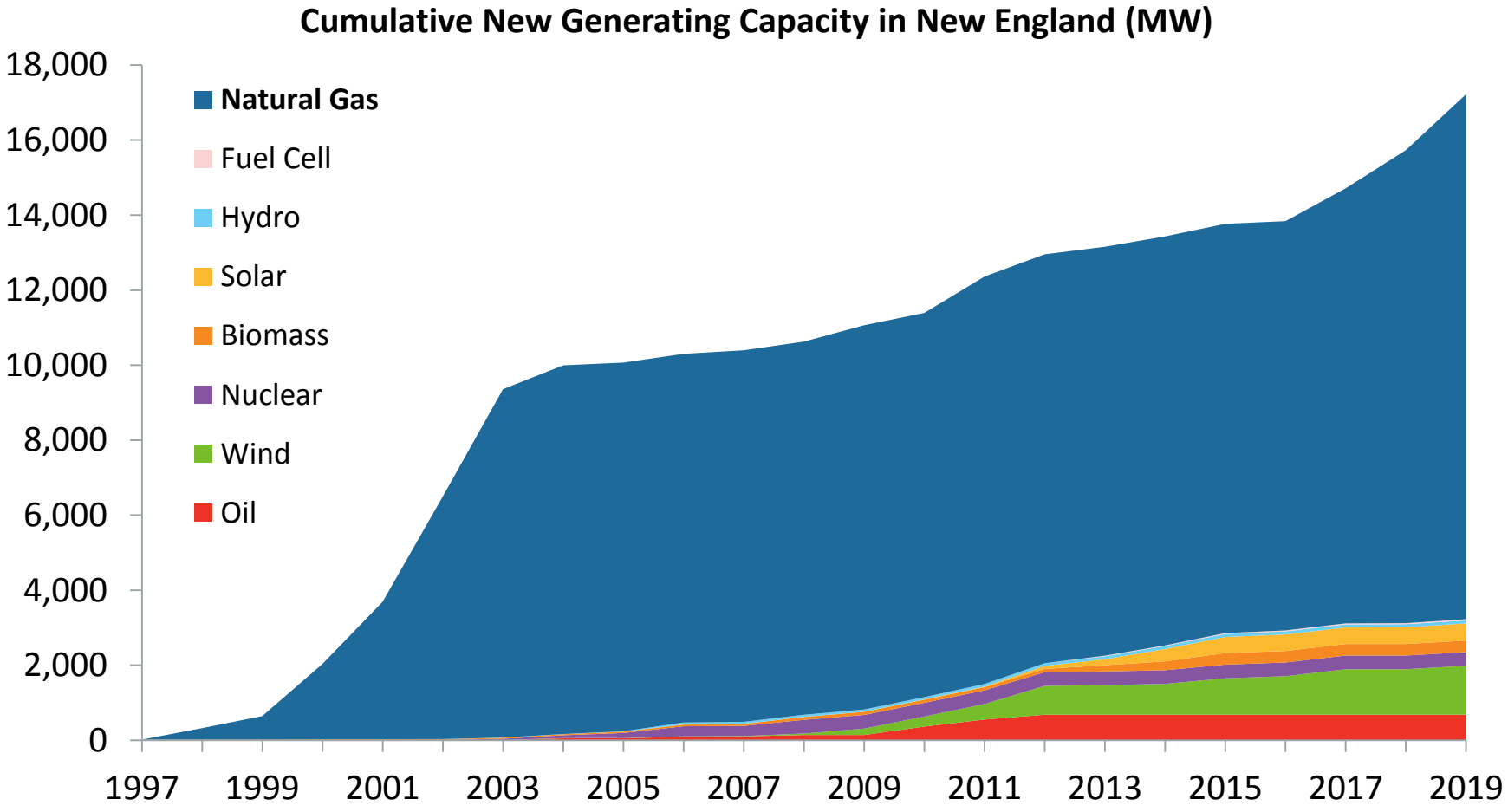
The fuels used to produce the region's electric energy have shifted as a result of economic and environmental factors

Percent of Total **Electric Energy** Production by Fuel Type
(2000 vs. 2015)



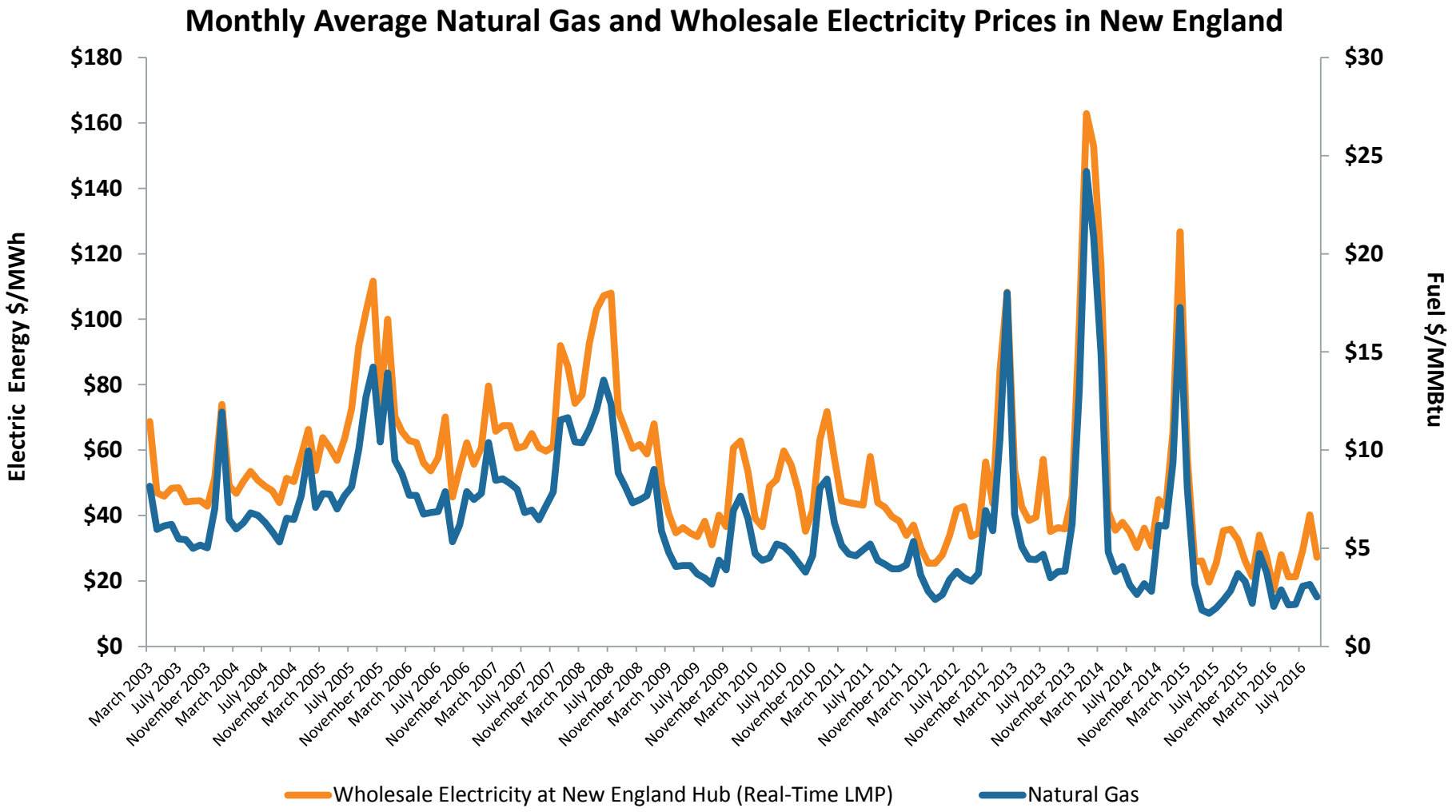
Source: ISO New England Net Energy and Peak Load by Source
Other renewables include landfill gas, biomass, other biomass gas, wind, solar, municipal solid waste, and miscellaneous fuels

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.

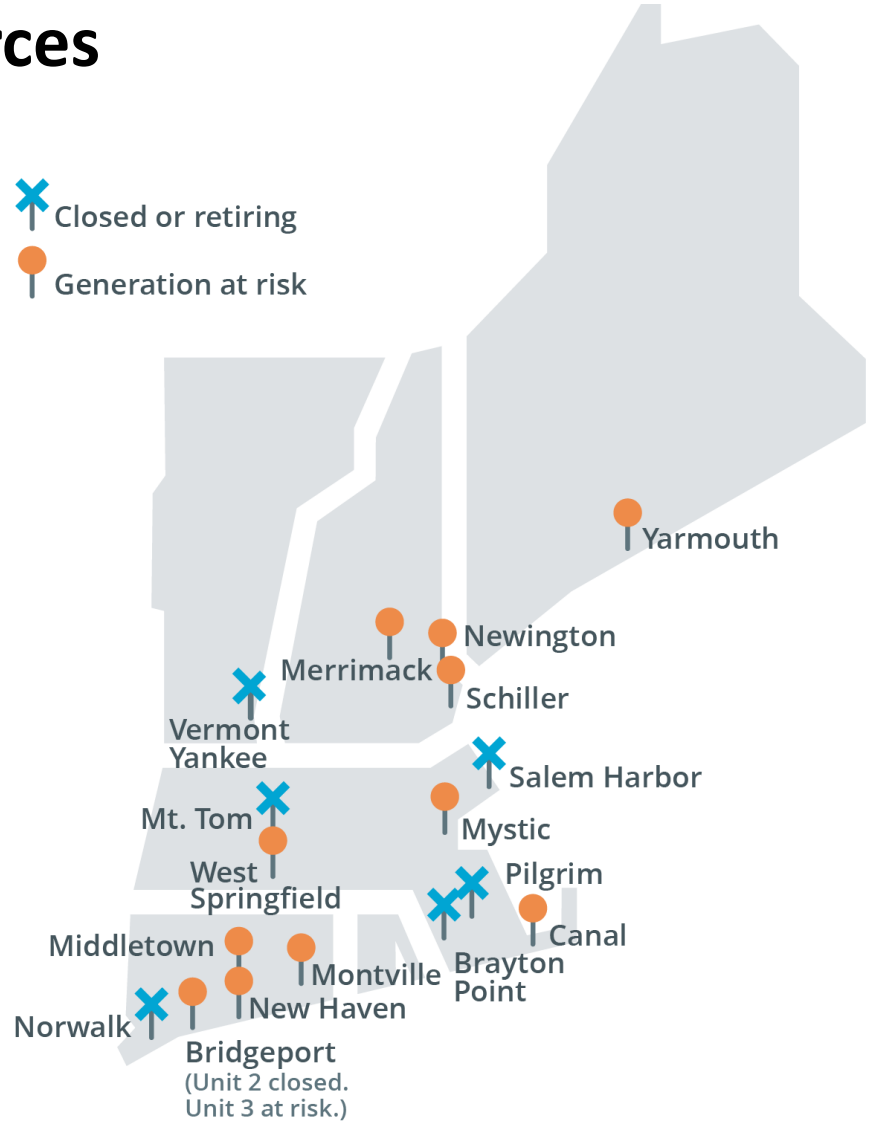
Natural Gas and Wholesale Electricity Prices Are Linked



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



Power Plant Emissions Have Declined with Changes in the Fuel Mix

Reduction in Aggregate Emissions (ktons/yr)

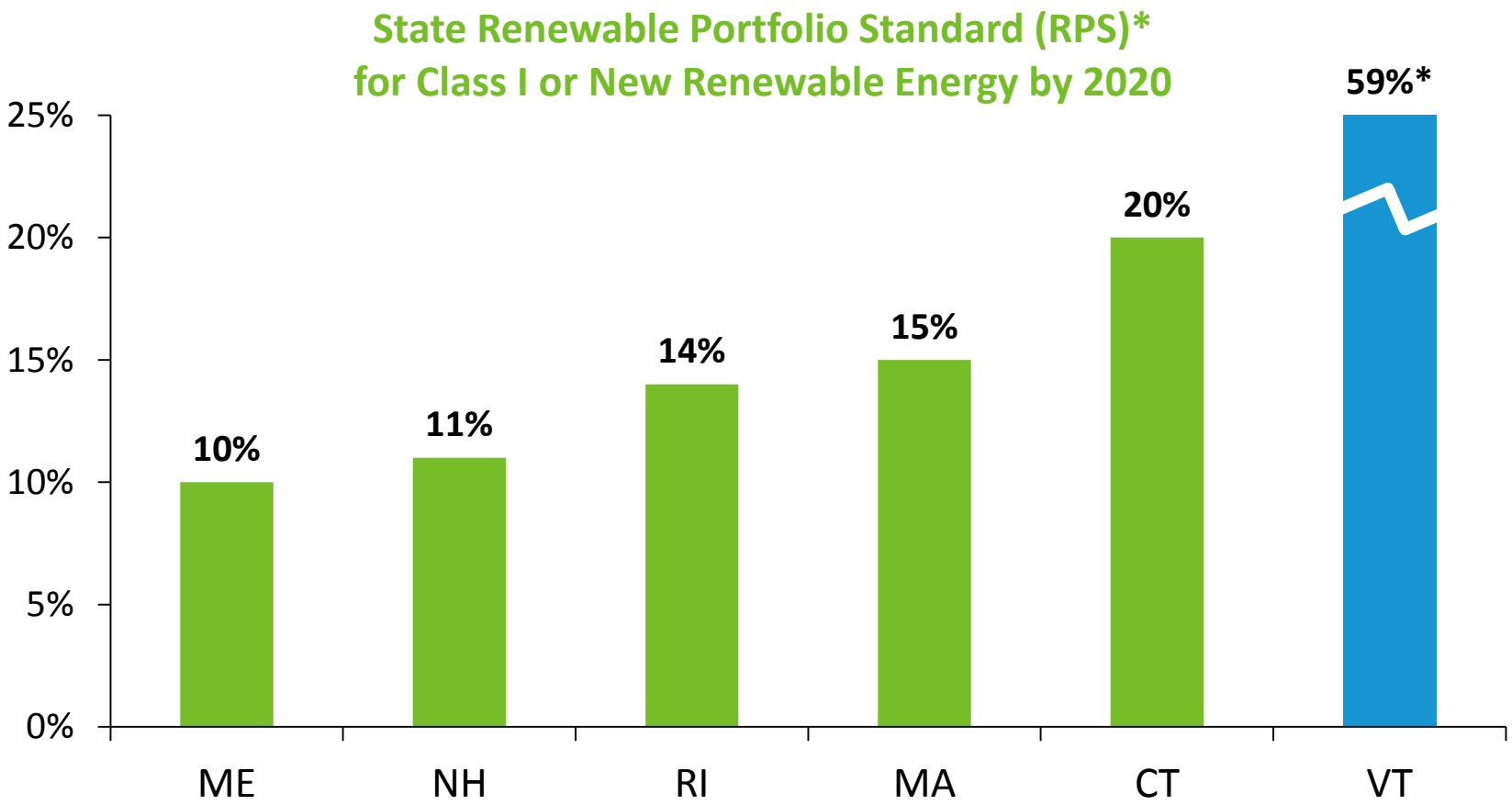
Year	NO_x	SO_2	CO_2
2001	59.73	200.01	52,991
2014	20.49	11.68	39,317
% Reduction, 2001–2014	**⬇ 66%**	**⬇ 94%**	**⬇ 26%**

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

State Policy Requirements Drive Proposals for Renewable Energy

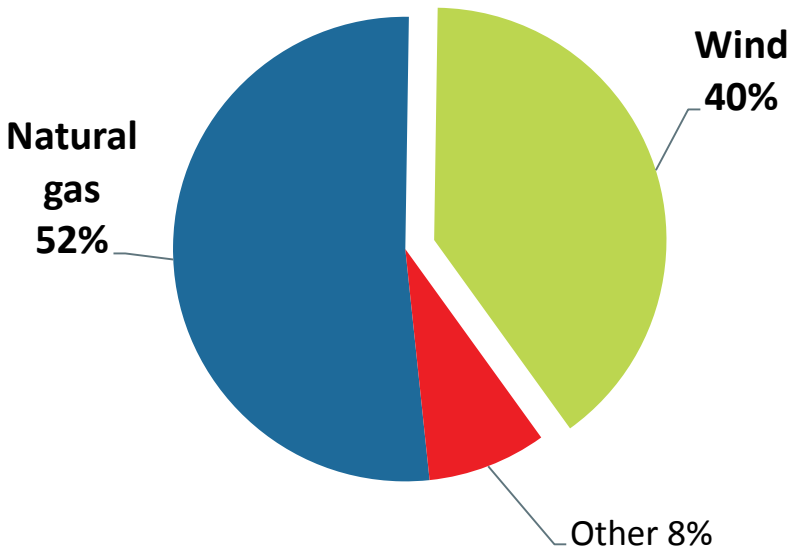


* State Renewable Portfolio Standards (RPS) promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Vermont's Renewable Energy Standard has a 'total renewable energy' requirement (reflected above), which recognizes all forms of new and existing renewable energy, and is unique in classifying large-scale hydropower as renewable.

Infrastructure Will Be Needed to Deliver Energy from Proposed Resources

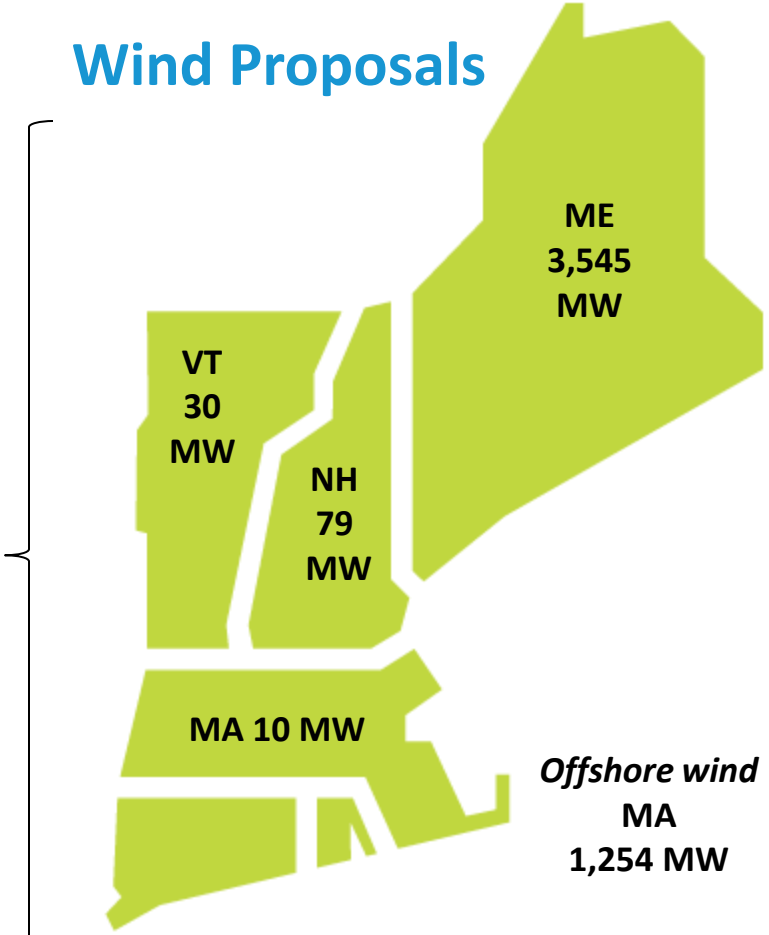
All Proposed Generation

Developers are proposing to build nearly 12,400 MW of generation, including over 6,400 MW of gas-fired generation and more than 4,900 MW of wind



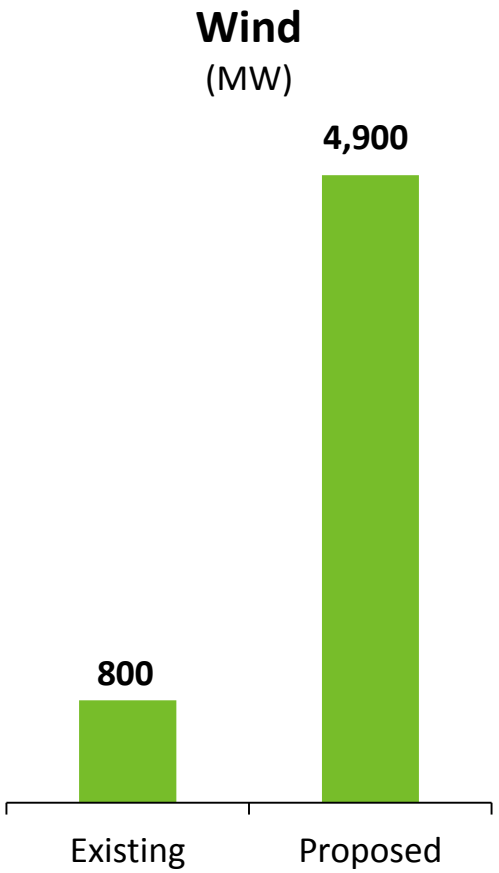
Source: ISO Generator Interconnection Queue (November 2016)
FERC Jurisdictional Proposals Only

Wind Proposals

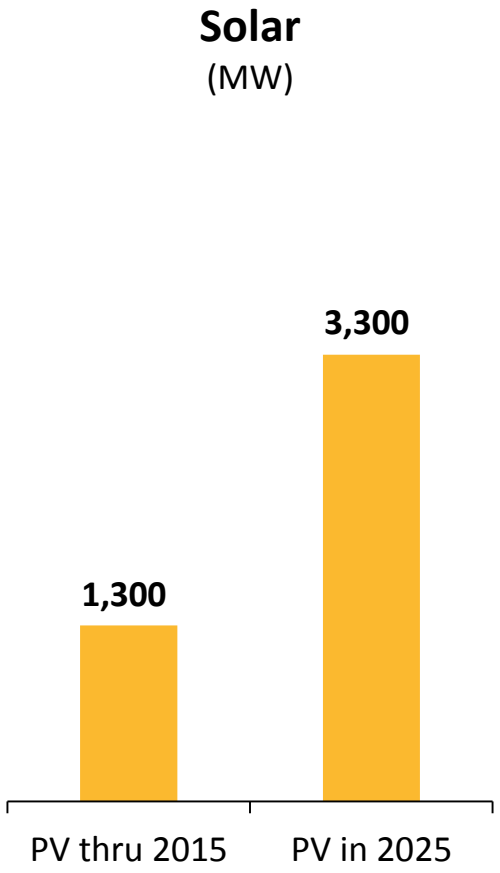


Source: ISO Generator Interconnection Queue (November 2016)
FERC Jurisdictional Proposals

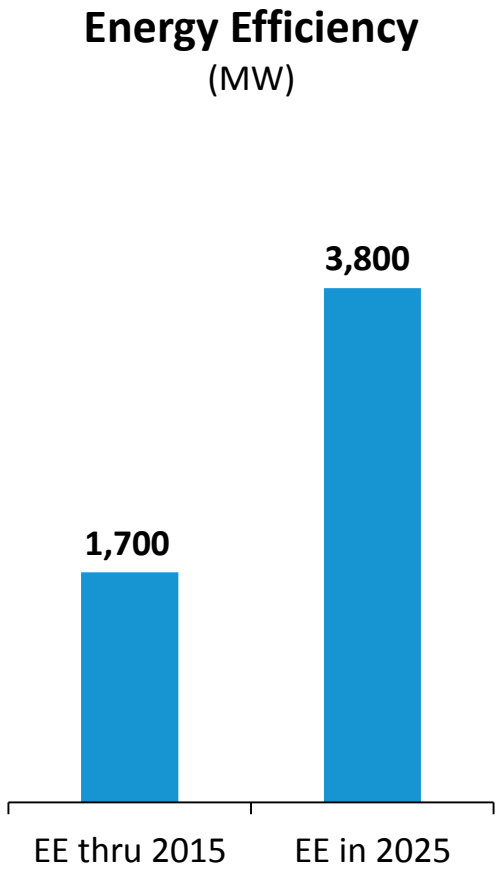
Renewable and EE Resources Are Trending Up



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



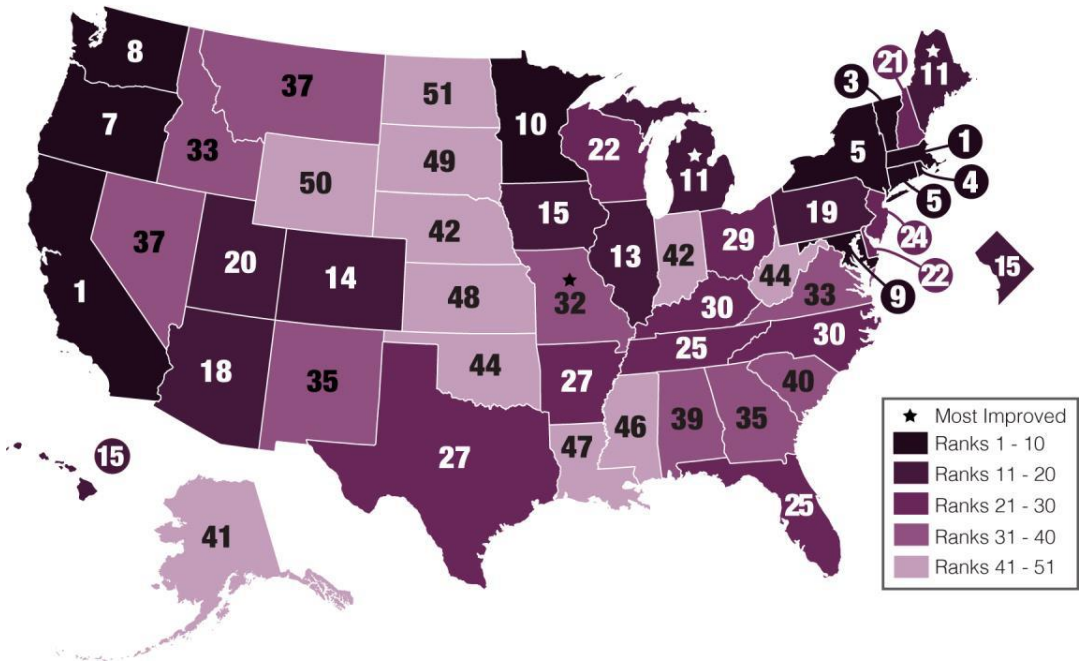
Final 2016 ISO-NE PV Forecast, AC nameplate capacity from PV resources participating in the region's wholesale electricity markets, as well as those connected "behind the meter."



2016 CELT Report, 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.

Energy Efficiency Is a Priority for State Policymakers

2016 State Energy-Efficiency Scorecard



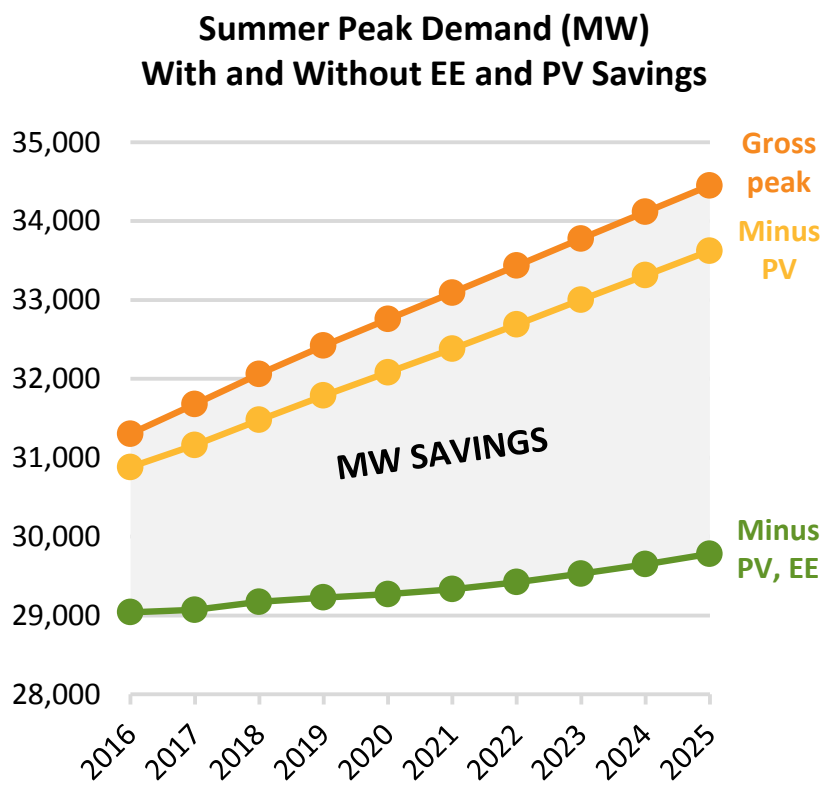
Source: American Council for an Energy-Efficient Economy

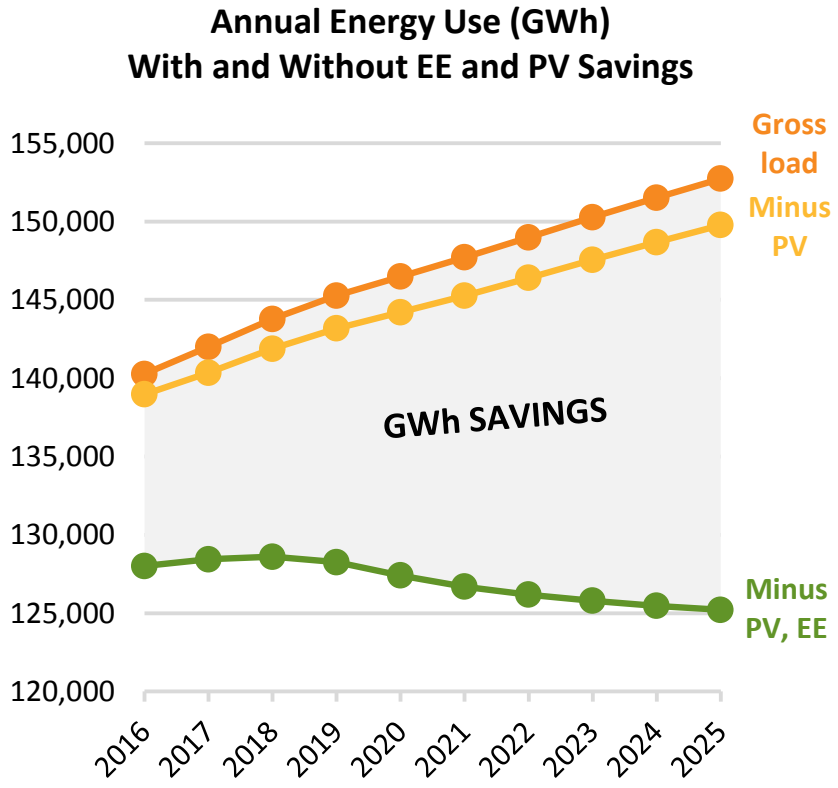
Ranking of state EE efforts by the *American Council for an Energy-Efficient Economy*:

- Massachusetts 1
- Vermont 3
- Rhode Island 4
- Connecticut 5
- Maine 11
- New Hampshire 21

- Billions spent over the past few years and more on the horizon
  - Nearly $4 billion invested from 2009 to 2014
  - ISO estimates $6.6 billion to be invested in EE from 2020 to 2025

Energy Efficiency and Solar PV Are Slowing Peak Demand Growth and Flattening Energy Use





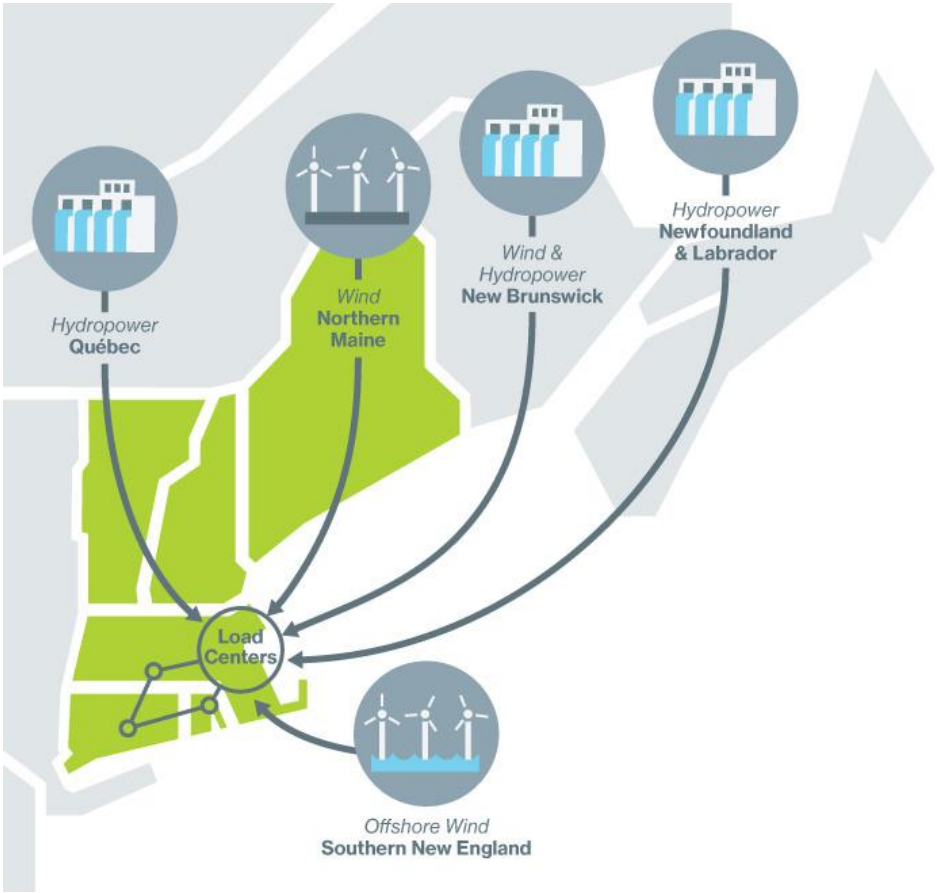
The gross peak and load forecast

The gross peak and load forecast minus forecasted "behind-the-meter" (BTM) solar PV resources

The gross peak and load forecast minus forecasted BTM solar PV, minus energy-efficiency (EE) resources in the Forward Capacity Market 2016-2019 and forecasted EE 2020-2025

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: Final ISO New England Energy-Efficiency Forecast 2020-2025 and Final 2016 Solar PV Forecast Details (May 2016)

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



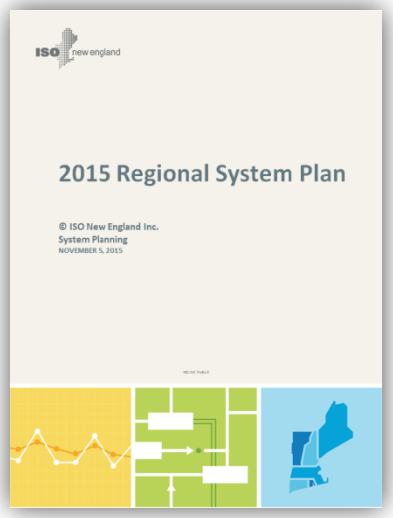
Map is representative of the types of projects announced for the region in recent years

- As of **November 1, 2016**, fifteen elective transmission projects had been proposed in the ISO Interconnection Queue, totaling more than **9,000 MW** of potential transfer capability, including:
  - **Large-scale hydro** resources from eastern Canada, and
  - **Onshore wind** resources from northern New England
- Projects seek to address public policy goals, not reliability needs
- In addition, **offshore wind** resources are emerging in southern New England

Source: ISO Interconnection Queue (November 2016)

Overview of Transmission Planning

- As the **Regional Transmission Organization**, the ISO is required to identify transmission infrastructure solutions that are essential for maintaining power system reliability in New England
- Through an **open stakeholder process**, the ISO is responsible for the development of long-range plans to address future system needs over the ten-year planning horizon
  - Summarized in a **Regional System Plan (RSP)**
- The transmission planning process is governed by a **FERC-approved tariff**
- The transmission planning process has been revised to comply with the Federal Energy Regulatory Commission's (FERC) **Order 1000**



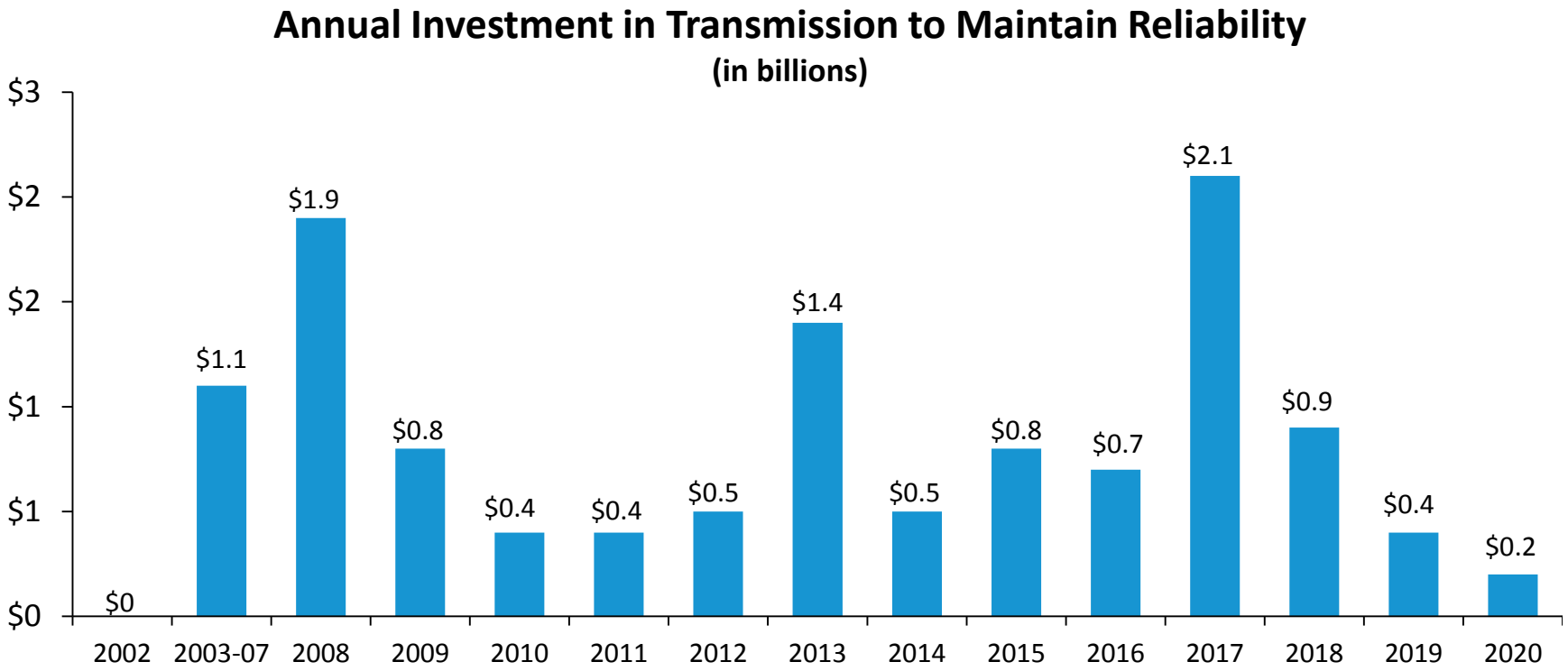
Transmission Projects to Maintain Reliability Have Progressed throughout New England

Major 345 kV Projects

- Southwest Connecticut Reliability Project, Phases 1 & 2
- Boston 345 kV Transmission Reliability Project, Phases 1 & 2
- Northwest Vermont Reliability Project, and Vermont Southern Loop Project
- New England East-West Solution
  - Greater Springfield Reliability Project
  - Rhode Island Reliability Project
  - Interstate Reliability Project
- Southeast Massachusetts
  - Short-term Lower SEMA Upgrades
  - Long-term Lower SEMA Project
- Maine Power Reliability Program
- Greater Boston Project

Source: RSP Transmission Project List, October 2016; RSP Transmission Project List also includes 115kV projects

Region Has Made Major Investments in Transmission Infrastructure to Ensure a Reliable Electric Grid



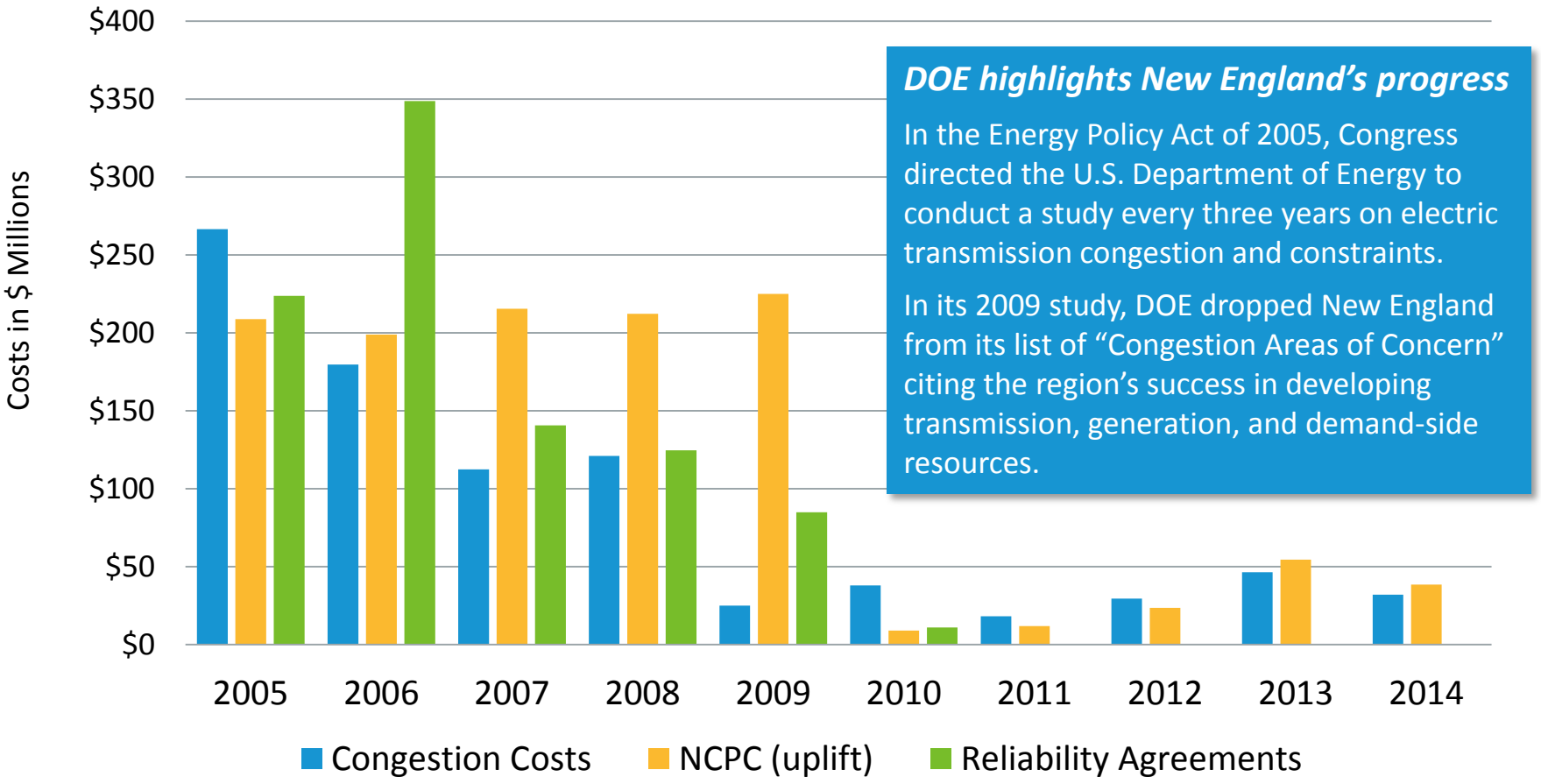
Cumulative Investment through October 2016	$8.02 billion
Estimated Future Investment through 2020	$4.07 billion

Source: ISO New England RSP Transmission Project Listing, October 2016
Estimated future investment includes projects under construction, planned and proposed

Transmission Provides Benefits Beyond Reliability

- **Transmission has reduced or eliminated out-of-market costs:**
  - Reliability agreements with certain generators that were needed to provide transmission support in weak areas of the electric grid
    - These often were older, less-efficient generating resources
  - Uplift charges to run specific generators to meet local reliability needs
- **The markets are increasingly competitive:** Easing transmission constraints into import-constrained areas has enabled the ISO to dispatch the most economic resources throughout the region to meet customer demands for electricity
- **Transmission congestion has been nearly eliminated**
- **Transmission facilitates resource transformation:** Transmission upgrades have allowed older, less-efficient resources to retire, which helps the states achieve their environmental objectives

Transmission and Resource Developments Have Reduced Energy and Reliability Costs



DOE highlights New England's progress

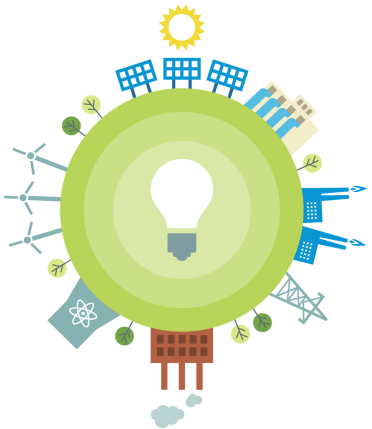
In the Energy Policy Act of 2005, Congress directed the U.S. Department of Energy to conduct a study every three years on electric transmission congestion and constraints.

In its 2009 study, DOE dropped New England from its list of "Congestion Areas of Concern" citing the region's success in developing transmission, generation, and demand-side resources.

Sources: Regional System Plans, ISO-NE Annual Markets Reports

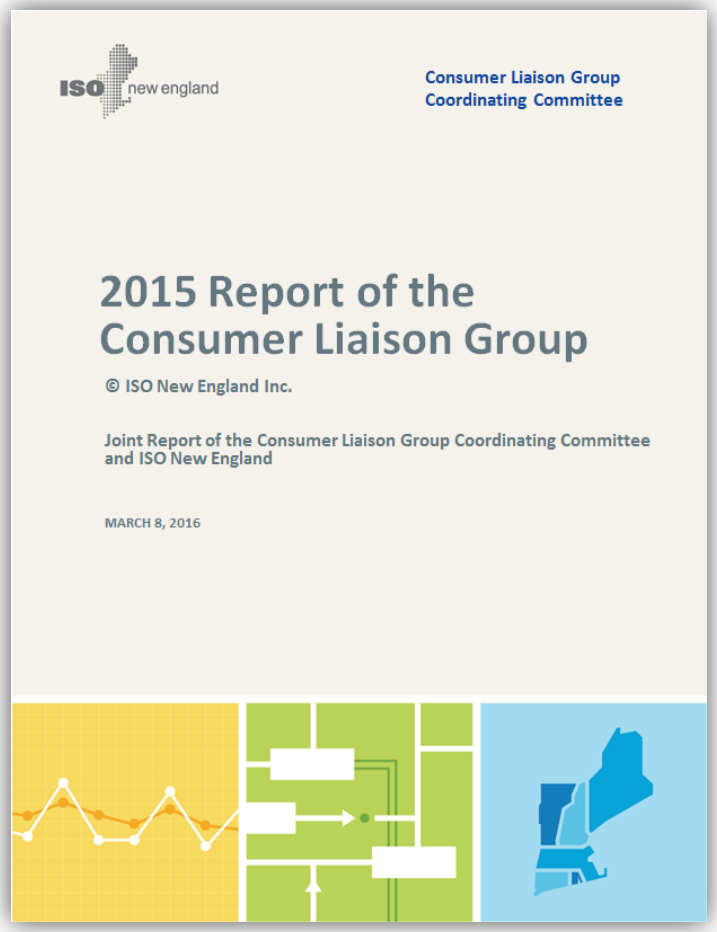
Consumers Have Opportunities to Engage Through the Consumer Liaison Group

- The Consumer Liaison Group (CLG) is a forum for sharing information between ISO New England (ISO) and those who ultimately use and pay for electricity in New England
- Through this forum, the ISO develops a better understanding of consumer issues, needs, and concerns relative to the electric power system and its costs
- Similarly, consumers and their representatives gain a better understanding of regional electricity issues



CLG Website Offers Many Information Resources for Consumers

- The *2015 Report of the Consumer Liaison Group* summarizes the activities of the CLG in 2015, the 2016 report will likely be published in March:
  - http://www.iso-ne.com/committees/industry-collaborations/consumer-liaison
- The CLG will next meet on March 2 in Boston, MA



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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- 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