



# Regional Update

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*New Hampshire House Science, Technology  
& Energy Committee, Orientation*

**Eric Johnson, Gregory Wade**

EXTERNAL AFFAIRS, ISO NEW ENGLAND



# Overview of Presentation

- About ISO New England
- Electric Grid At-a-Glance
- Major Responsibilities
- Strategic Planning
- Resource Developments
- Transmission Developments
- Appendix: Background Information



# About ISO New England

- **Regulated by** the Federal Energy Regulatory Commission (FERC)
- **Reliability coordinator** for New England under the North American Electric Reliability Corporation (NERC)
- Nearly two decades of experience **overseeing** New England's restructured electric power system
- **Independent** of companies doing business in the marketplace



# 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

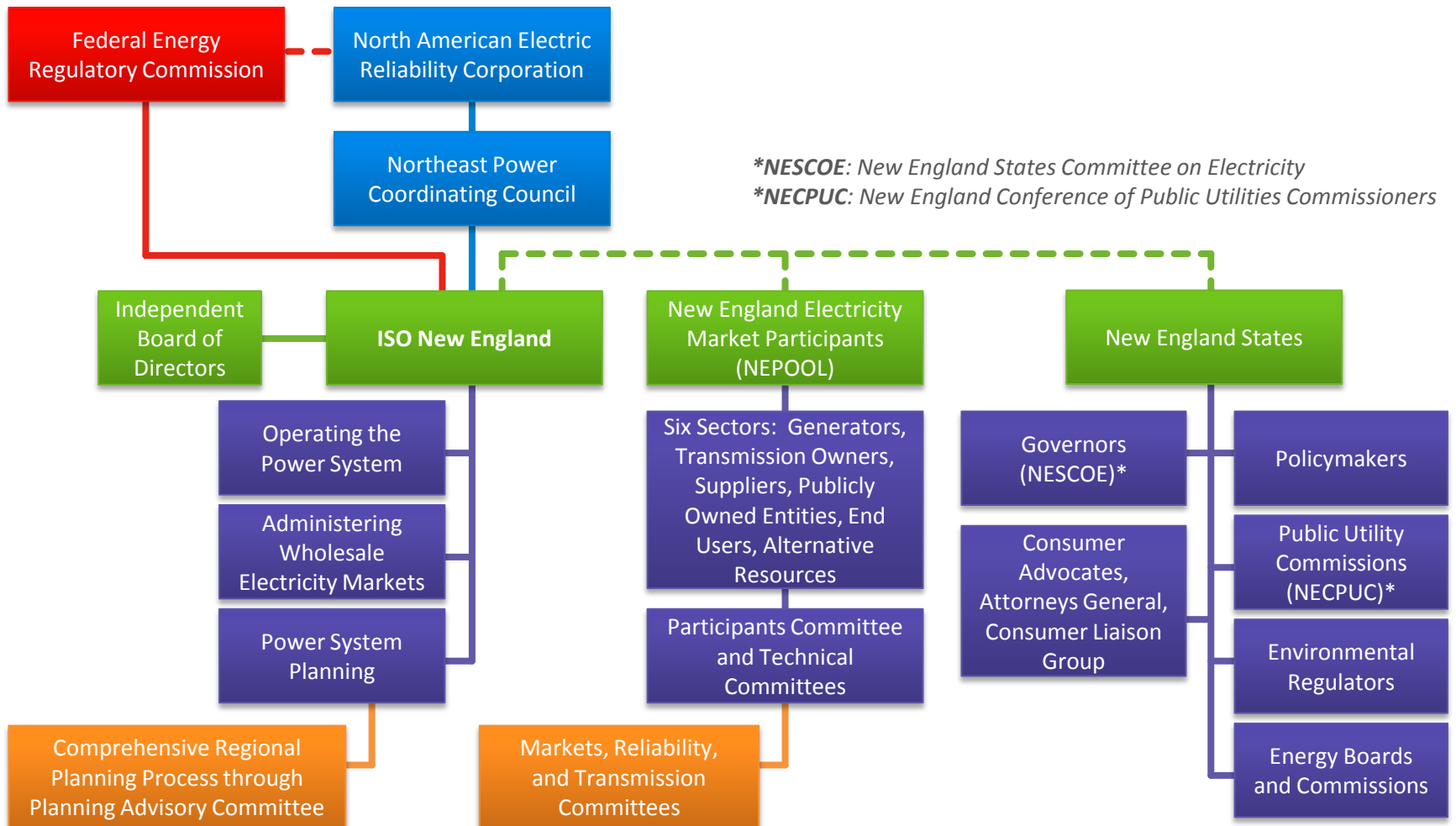
Managing comprehensive regional power **system planning**

Developing and administering the region's competitive **wholesale electricity markets**



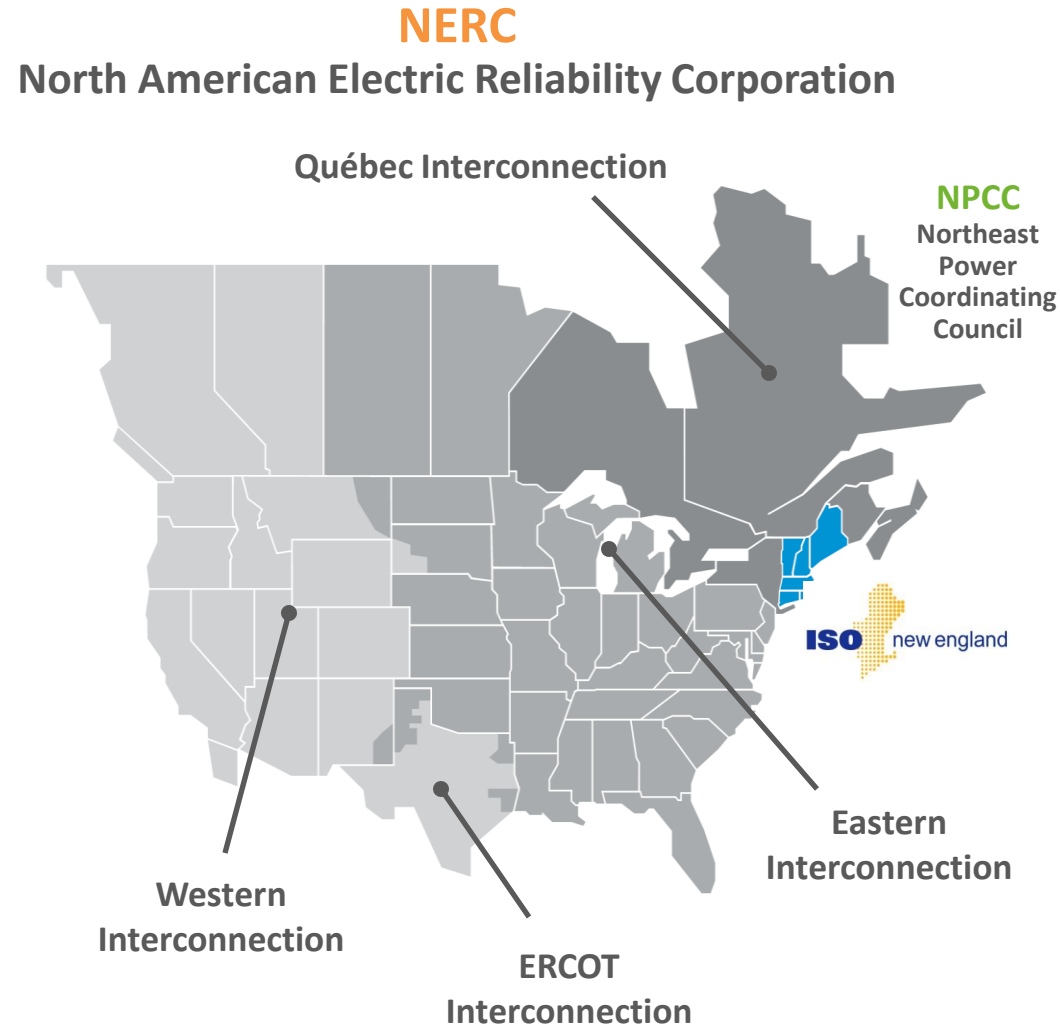
# Federal Entities and an Independent Board Provide Oversight of ISO's Responsibilities

*Robust stakeholder process for states and market participants informs ISO-NE*



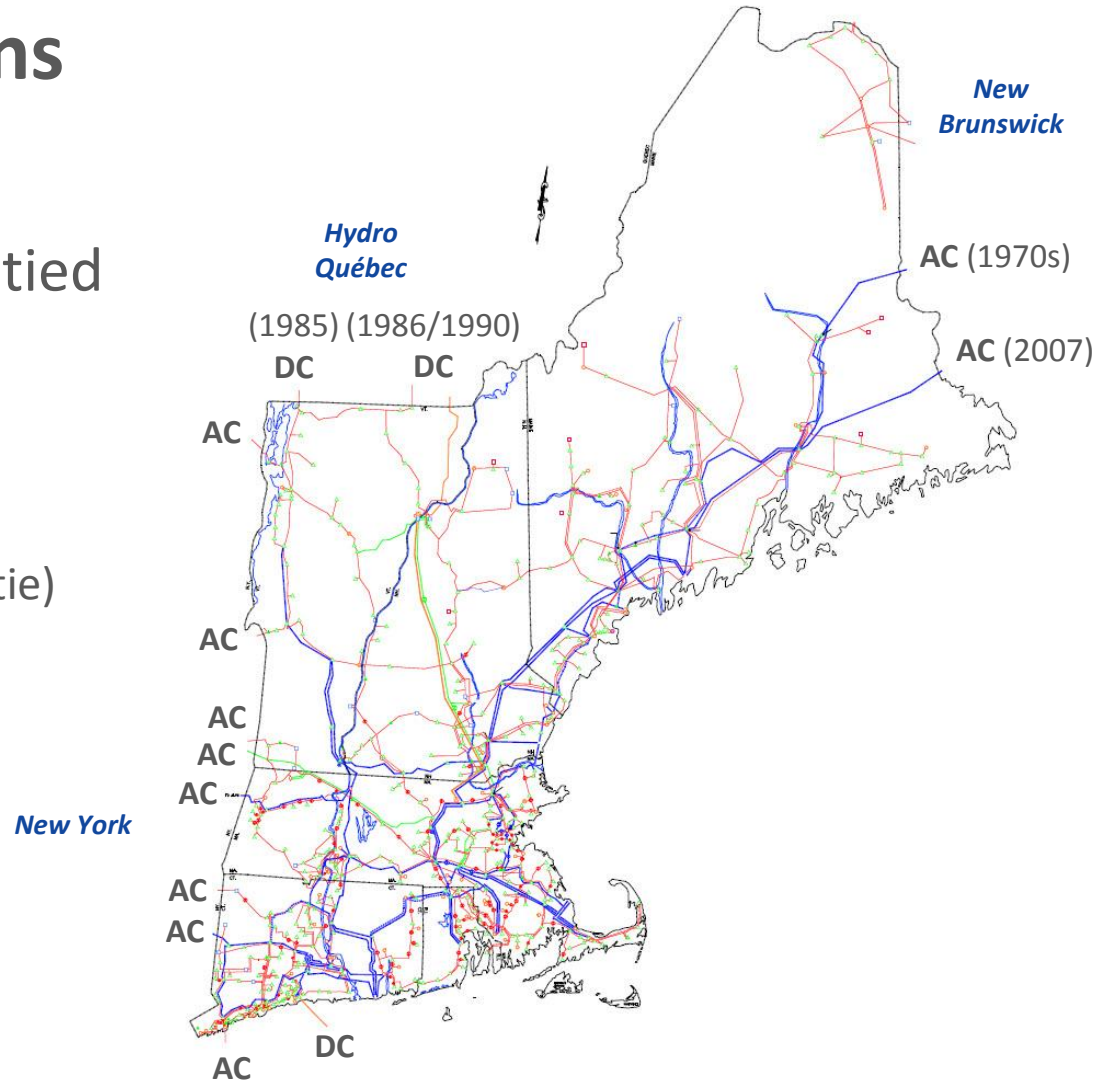
# ISO New England is Part of a Larger Electric Power System

- 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 Quebec only through direct-current (DC) transmission
- 2003 Blackout ushered in wide-area monitoring and mandatory reliability standards



# New England has Multiple Ties to Neighboring Regions

- Transmission system is tied to neighboring power systems in the U.S. and Eastern Canada:
  - New York (8 AC ties, 1 DC tie)
  - Hydro Québec (2 DC ties)
  - New Brunswick (2 AC ties)



Note: AC stands for Alternating Current and DC stands for Direct Current

# New England's Energy Use at a Glance

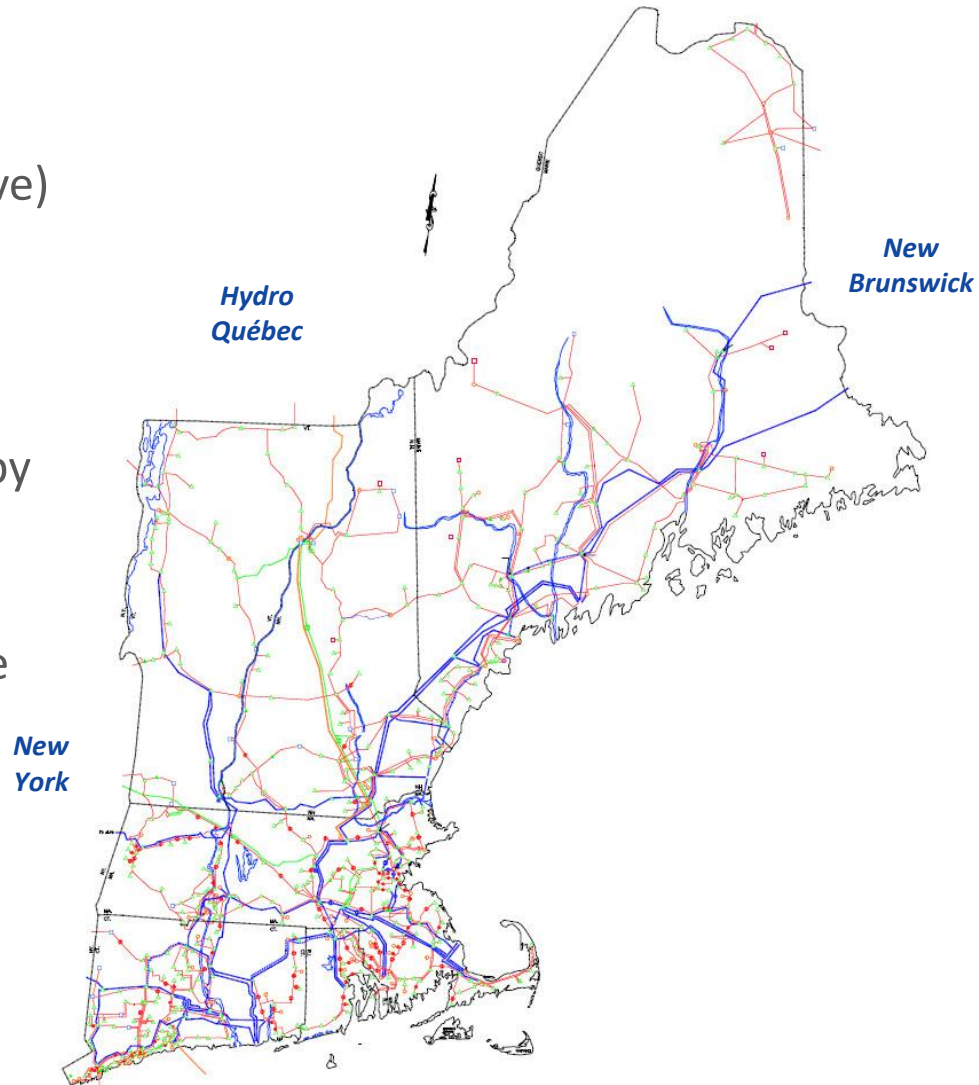
- **6.5 million** households and businesses;  
**14 million** population
- **28,130 MW** all-time summer peak demand set on August 2, 2006
- **22,818 MW** all-time winter peak demand set on January 15, 2004
- Region's *peak* demand forecasted to grow **1.3%** annually
- Region's *overall* electricity demand forecasted to grow **1.0%** annually
- Energy efficiency slows growth in peak demand and flattens overall electricity demand





# New England's Transmission Grid at a Glance

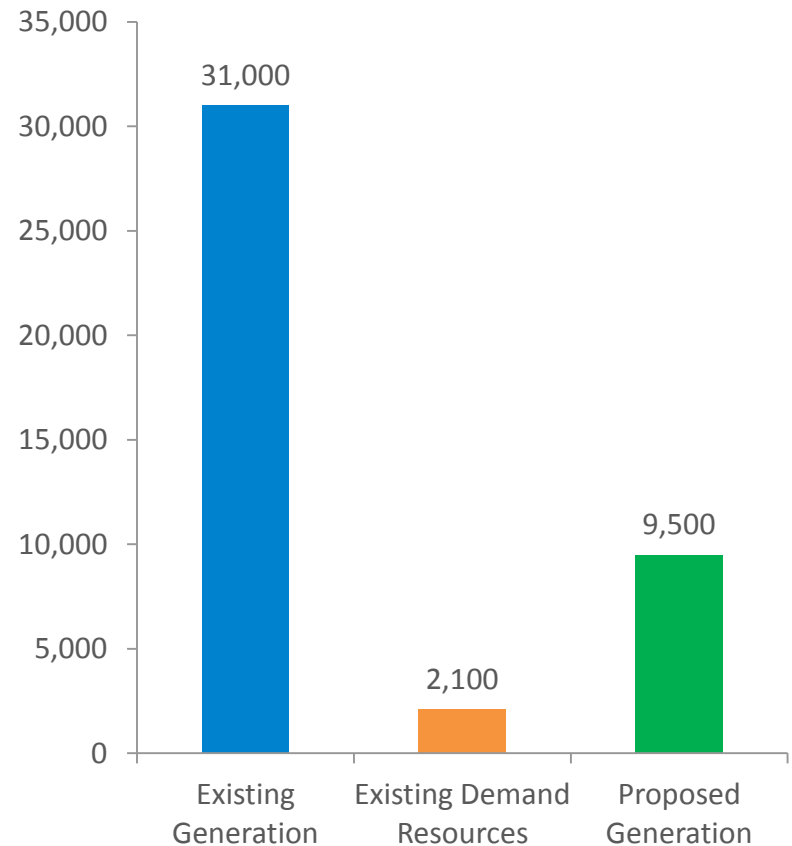
- **8,500 miles** of high-voltage transmission lines (115 kV and above)
- **13 transmission interconnections** to power systems in New York and Eastern Canada
- **16%** of region's energy needs met by imports in 2014
- **\$7 billion** invested to strengthen transmission system reliability since 2002; **\$4.5 billion** planned
- Developers propose multiple transmission projects to access non-carbon-emitting resources



# New England's Generation and Demand Resources at a Glance

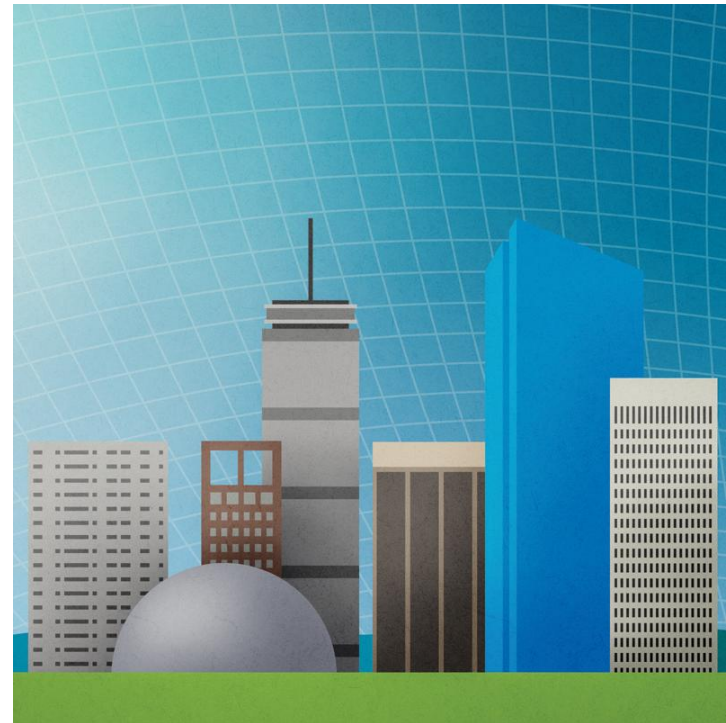
- **350** generators in the region
- **31,000 MW** of generating capacity
- **9,500 MW** of proposed generation
- **3,500 MW** of generation capacity retiring over the next five years
- **700 MW** of active demand response and **1,400 MW** of energy efficiency with capacity supply obligations

Existing and Future Resources (MW)



# New England's Wholesale Markets at a Glance

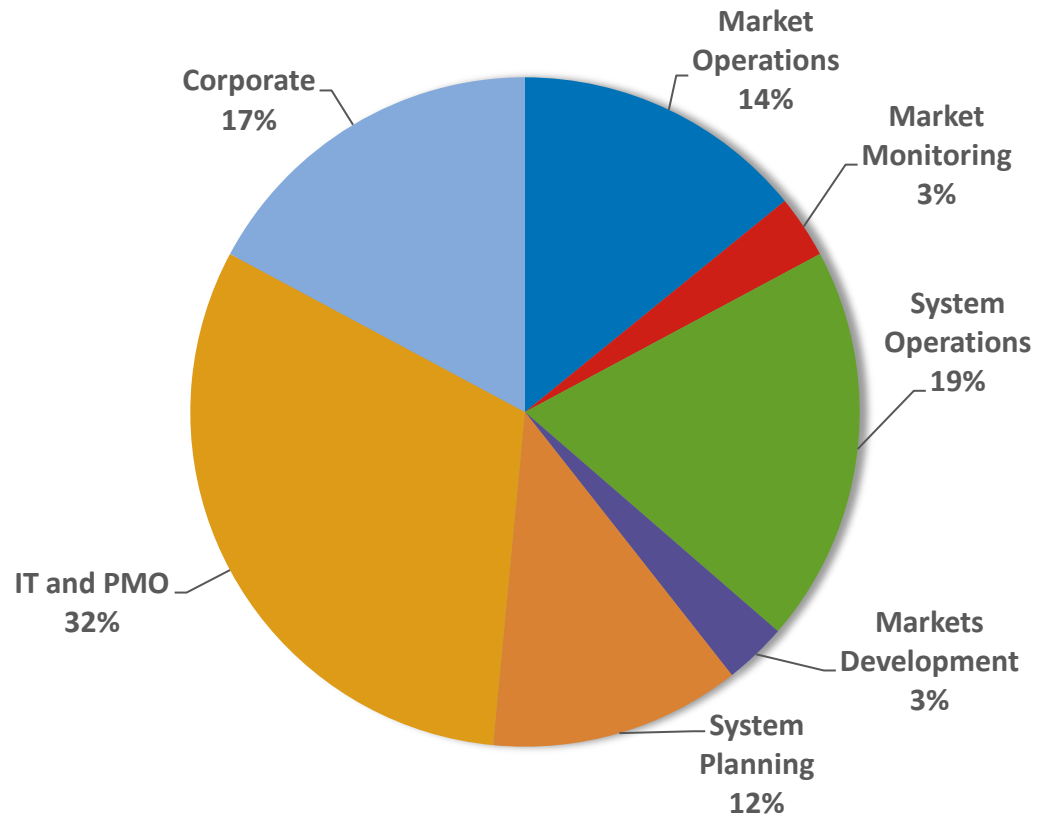
- More than **400** buyers and sellers in the markets
- **\$9.2 billion** traded in wholesale electricity markets in 2013
  - **\$8 billion** in energy markets
  - **\$1.2 billion** in capacity and ancillary services markets
- Forward and spot markets
- Prices vary by time and location, and by changes in demand and available resources
- Extensive analysis and reporting of market results



# ISO New England's Workforce at a Glance

- Key technical roles:

- Engineers
- Operators
- Analysts
- Economists
- Forecasters
- Trainers

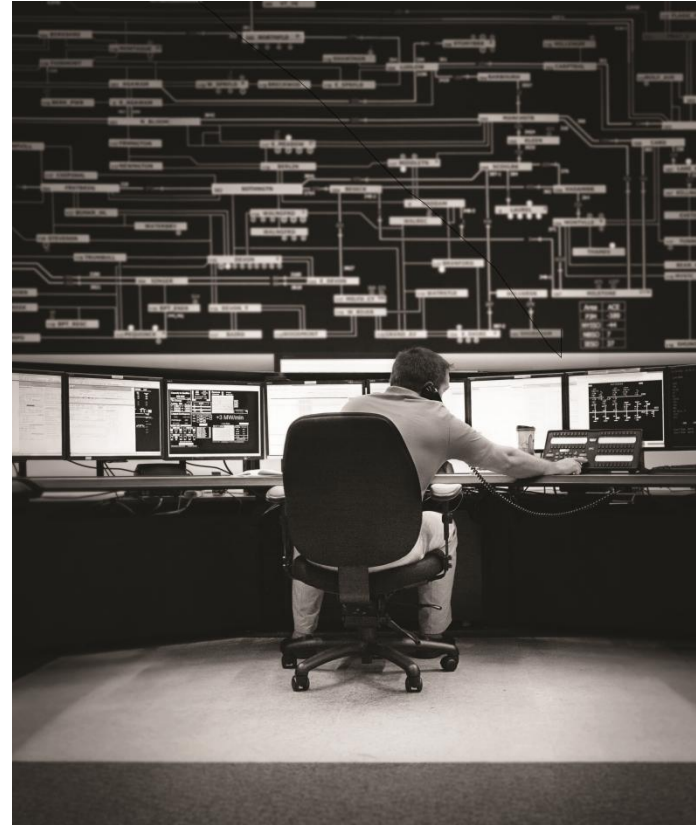


Corporate: Finance, HR, Communications, External Affairs, and Legal; IT and PMO: Information Technology and Program Management Office

# Major Responsibility: Operations

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

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



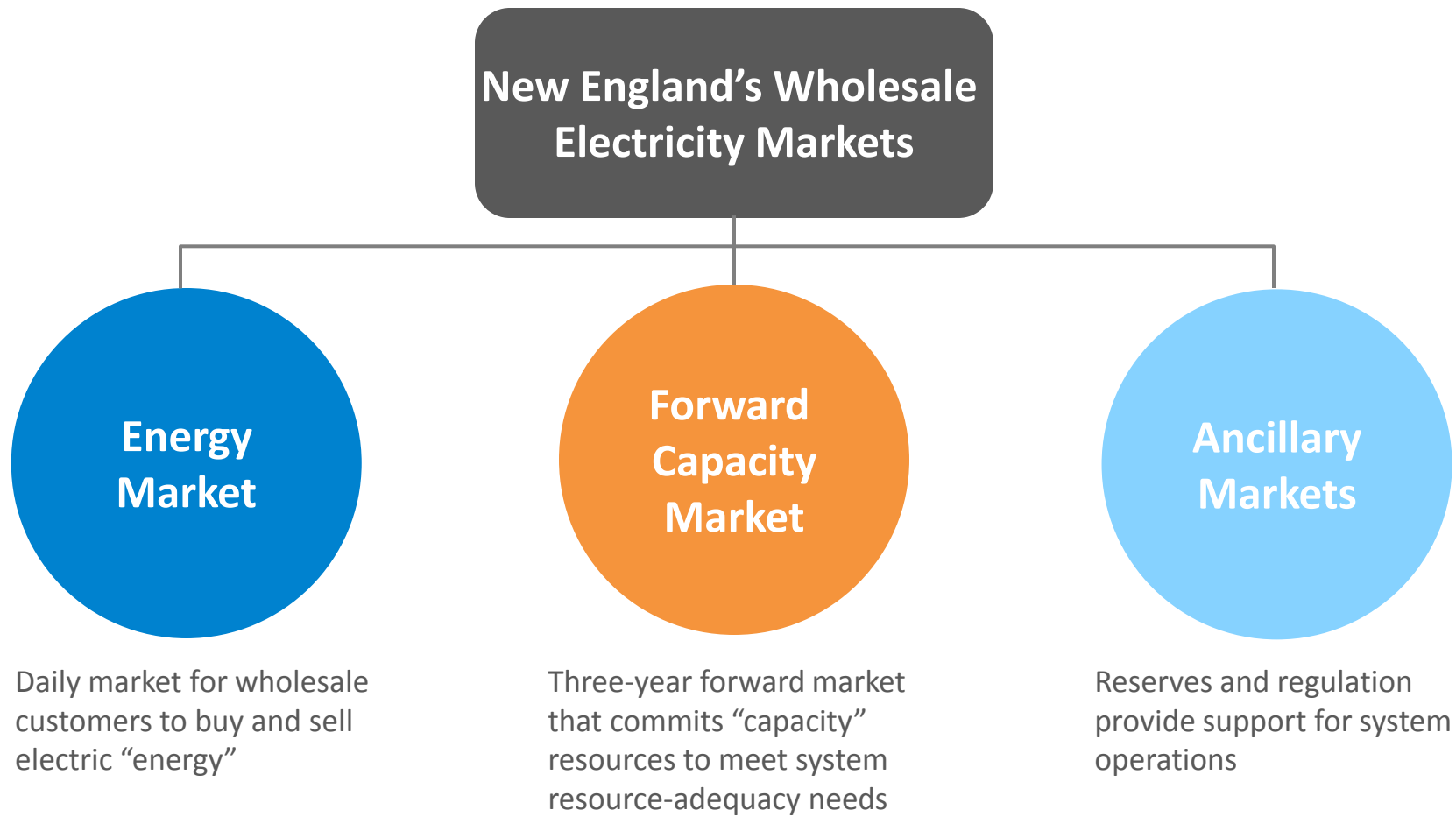
# ISO New England Follows Best Practices to Address Cybersecurity Risks

- Physical and cyber security are a top priority for the ISO
- 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 II)



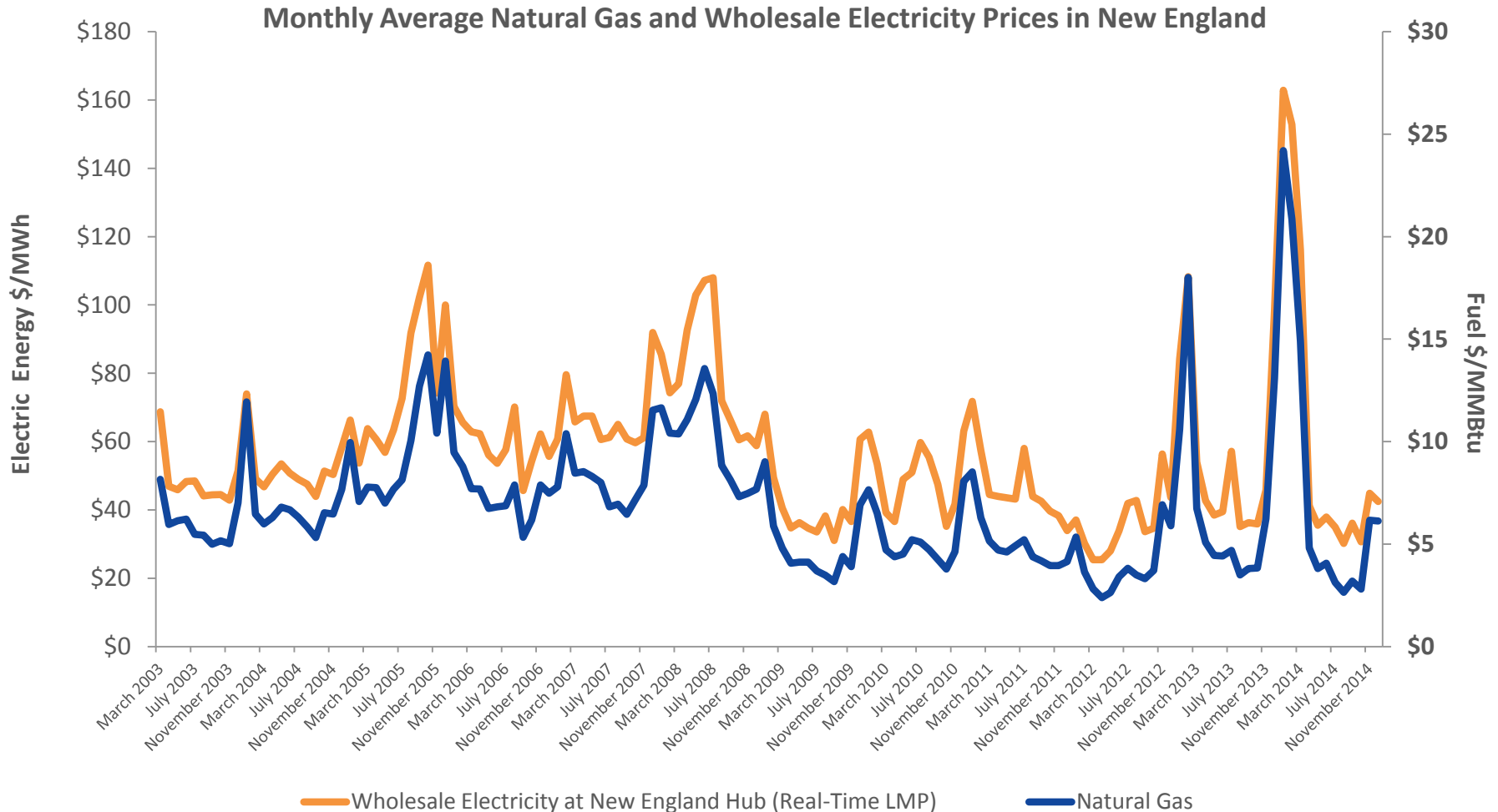
# Major Responsibility: Markets

*Developing and administering the region's competitive wholesale electricity markets*



# Natural Gas and Wholesale Electricity Prices are Linked

*Because of New England's heavy reliance on natural gas as a fuel source, natural gas typically sets the price for wholesale electricity*

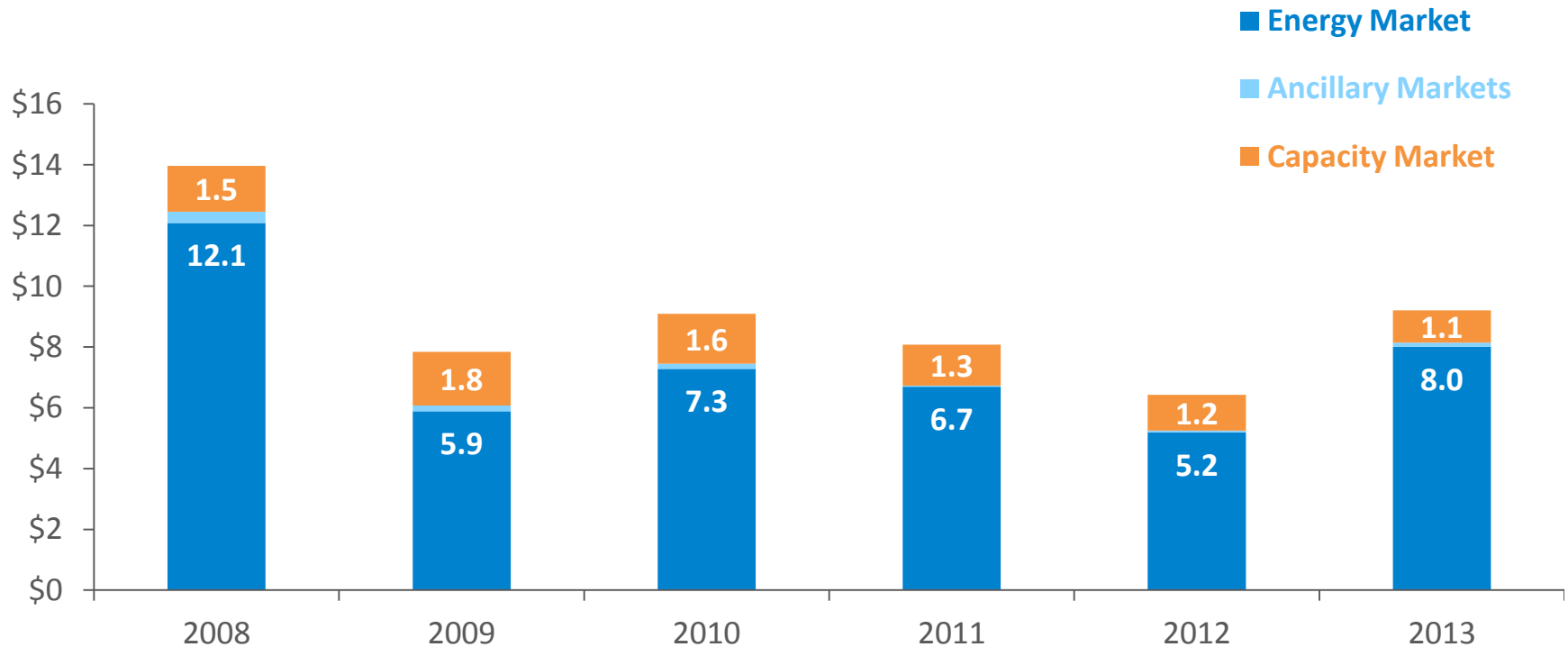




# Total Value of Markets Varies with Fuel Costs

*Annual wholesale market costs have ranged from \$6 billion to \$14 billion*

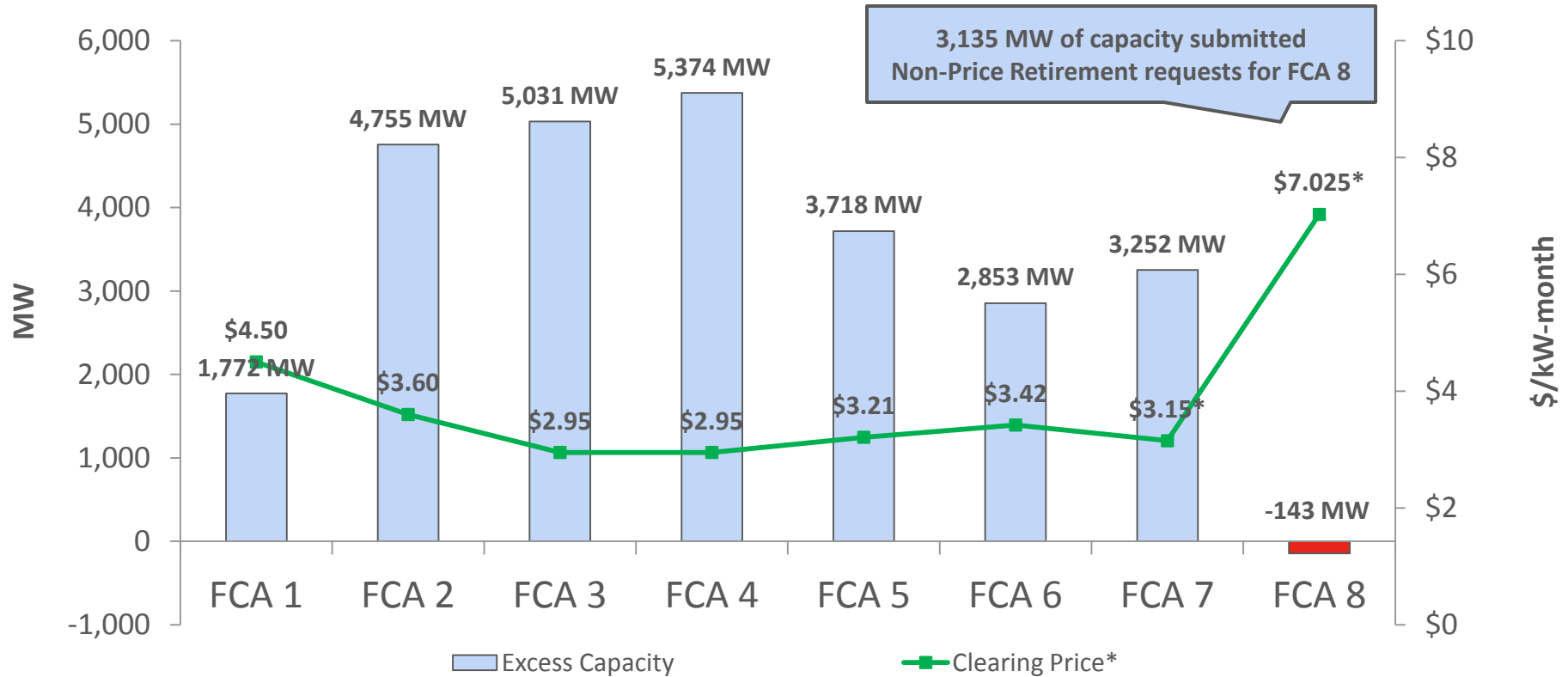
Annual Value of Wholesale Electricity Markets  
(in billions)



Source: [2013 Report of the Consumer Liaison Group, Appendix C](#)

# Capacity Prices Vary with Changes in Supply

Capacity Surplus or Deficit (MW) Against Auction Clearing Prices (\$/kWh-month)



\* Prices cleared at the floor price in the first seven auctions due to excess capacity; therefore, resources were paid a slightly lower prorated price. The clearing price in NEMA/Boston was \$14.999/kWh-month for FCA 7 (new capacity received \$14.999/kWh-month and existing capacity received an administrative price of \$6.66/kWh-month). The clearing price in FCA 8 was \$15.00/kWh-month (new capacity in all zones and existing capacity in NEMA/Boston received \$15.00/kWh-month and existing capacity in all other zones received an administrative price of \$7.025/kWh-month).

# Major Responsibility: Planning

*Managing comprehensive regional power system planning*

- 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 annual Regional System Plan (RSP) with a ten year planning horizon



# ISO New England's Strategic Planning Initiative

*Focused on developing solutions to the region's top reliability risks*

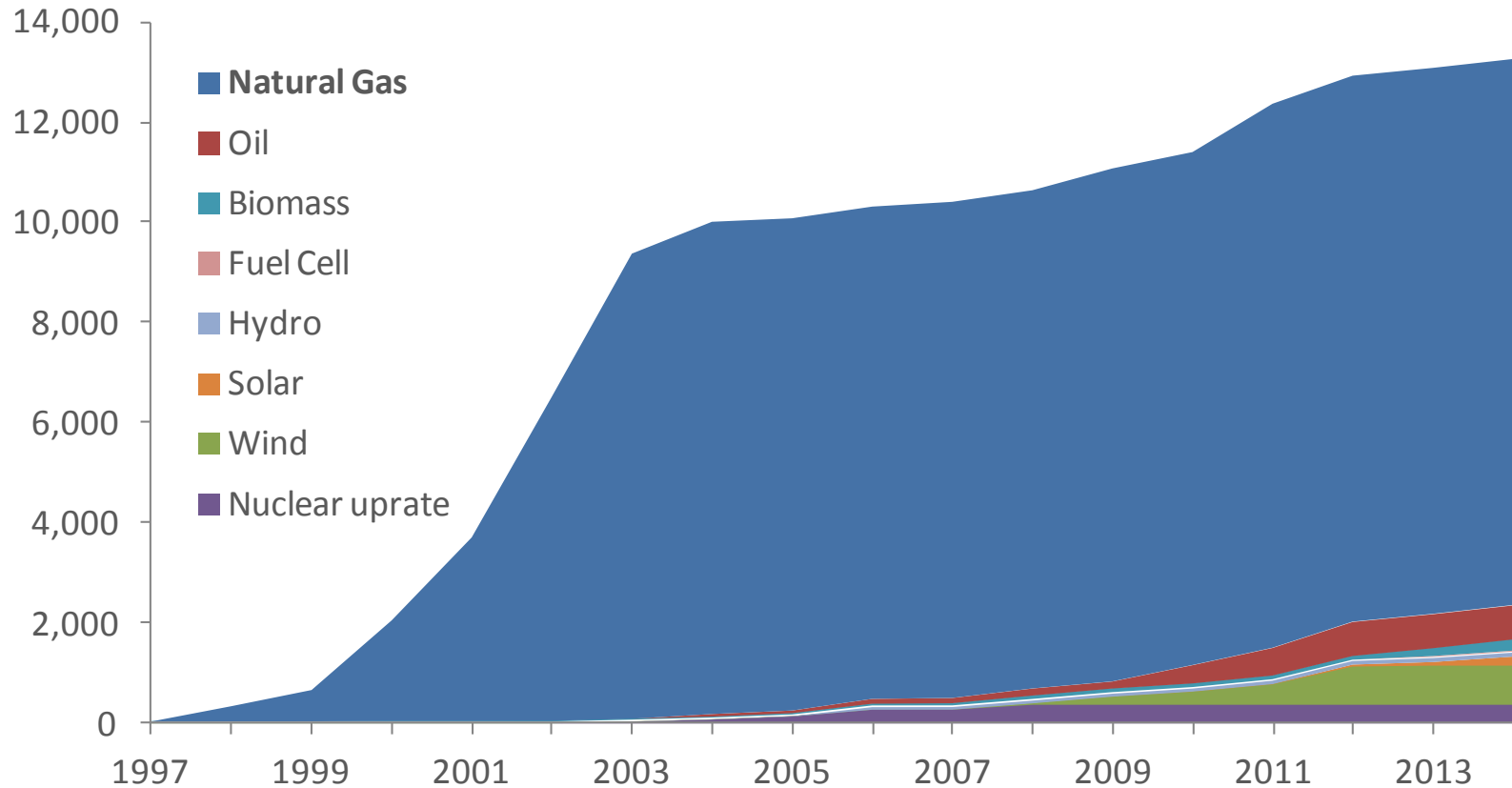
## Reliability requires a flexible, high-performance fleet:

- Natural Gas Dependency
  - “Just-in-time” fuel delivery presents an immediate risk to reliability
- Power Plant Retirements
  - New England will need new ways to meet peak demand as aging plants close
- Renewable Resource Integration
  - Balancing variable generation with reliability will require changes in system operations



# Region Has Not Developed Gas Pipeline Infrastructure to Keep Pace With Growth of Gas-fired Generation

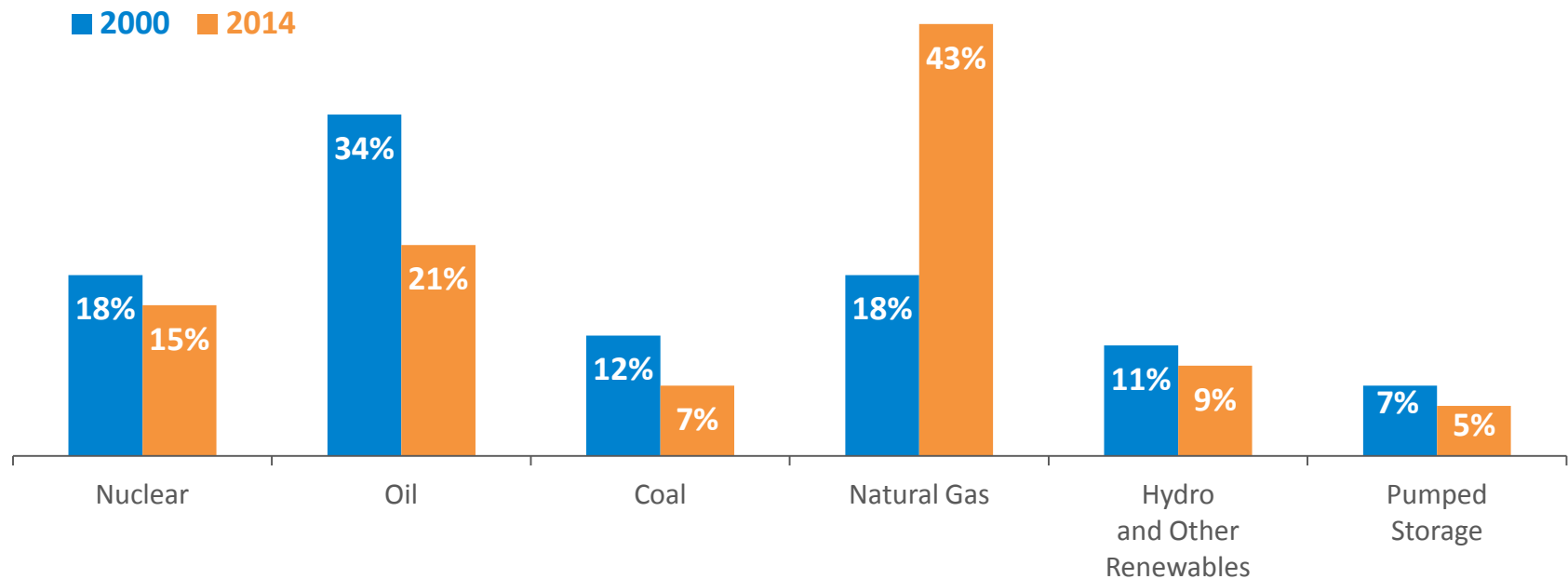
Cumulative New Generating Capacity in New England (MW)



# Dramatic Changes in Power System Resources

*The resources making up the region's installed generating capacity have shifted from nuclear, oil and coal to natural gas*

Percent of Total System **Capacity** by Fuel Type  
(2000 vs. 2014)

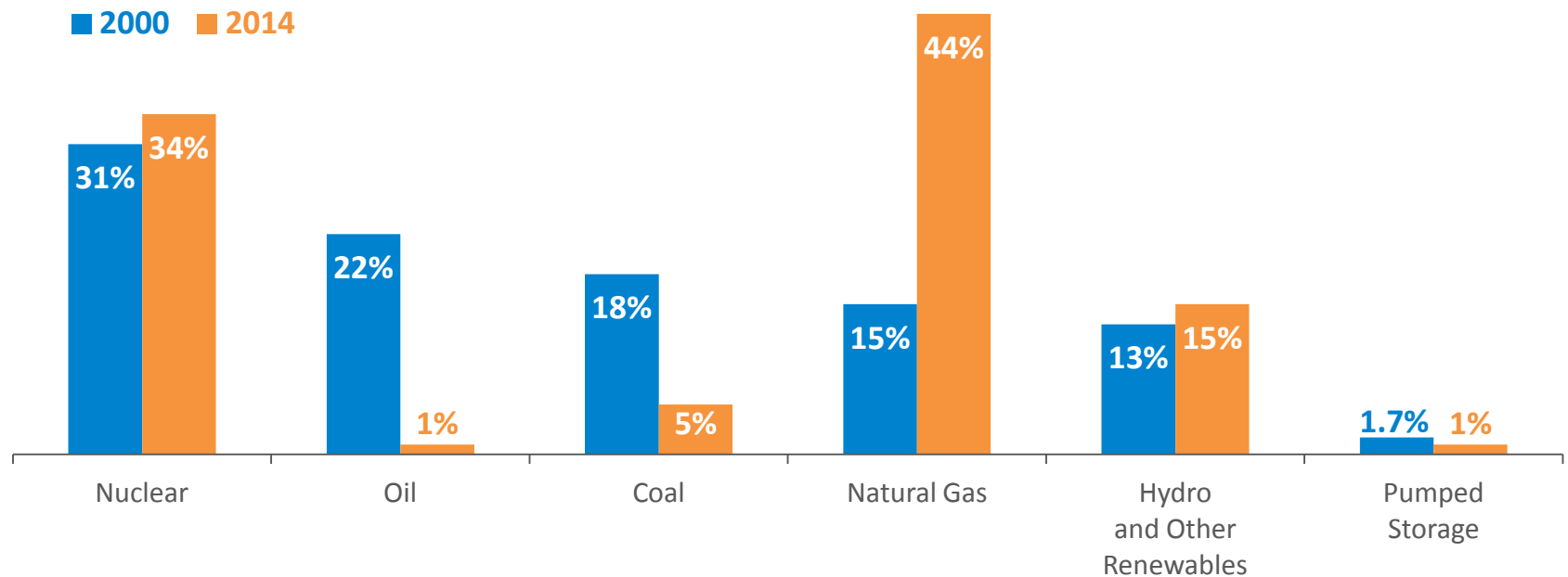


Source: [2014 CELT Report](#), Summer Seasonal Claimed Capability (SCC) Capacity

# Dramatic Changes in the Energy Mix

*The fuels used to produce New England's electric energy have shifted as a result of economic and environmental factors*

Percent of Total **Electric Energy** Production by Fuel Type  
(2000 vs. 2014)



Source: ISO New England [Net Energy and Peak Load by Source](#)

# Power Plant Emissions have Declined with Changes in the Fuel Mix

*Reduction in Aggregate Emissions (ktons/yr)*

Year	NO <sub>x</sub>	SO <sub>2</sub>	CO <sub>2</sub>
2001	59.73	200.01	52,991
2013	20.32	18.04	40,901
<b>% Reduction, 2001–2013</b>	<b>↓ 66%</b>	<b>↓ 91%</b>	<b>↓ 23%</b>

*Reduction in Average Emission Rates (lb/MWh)*

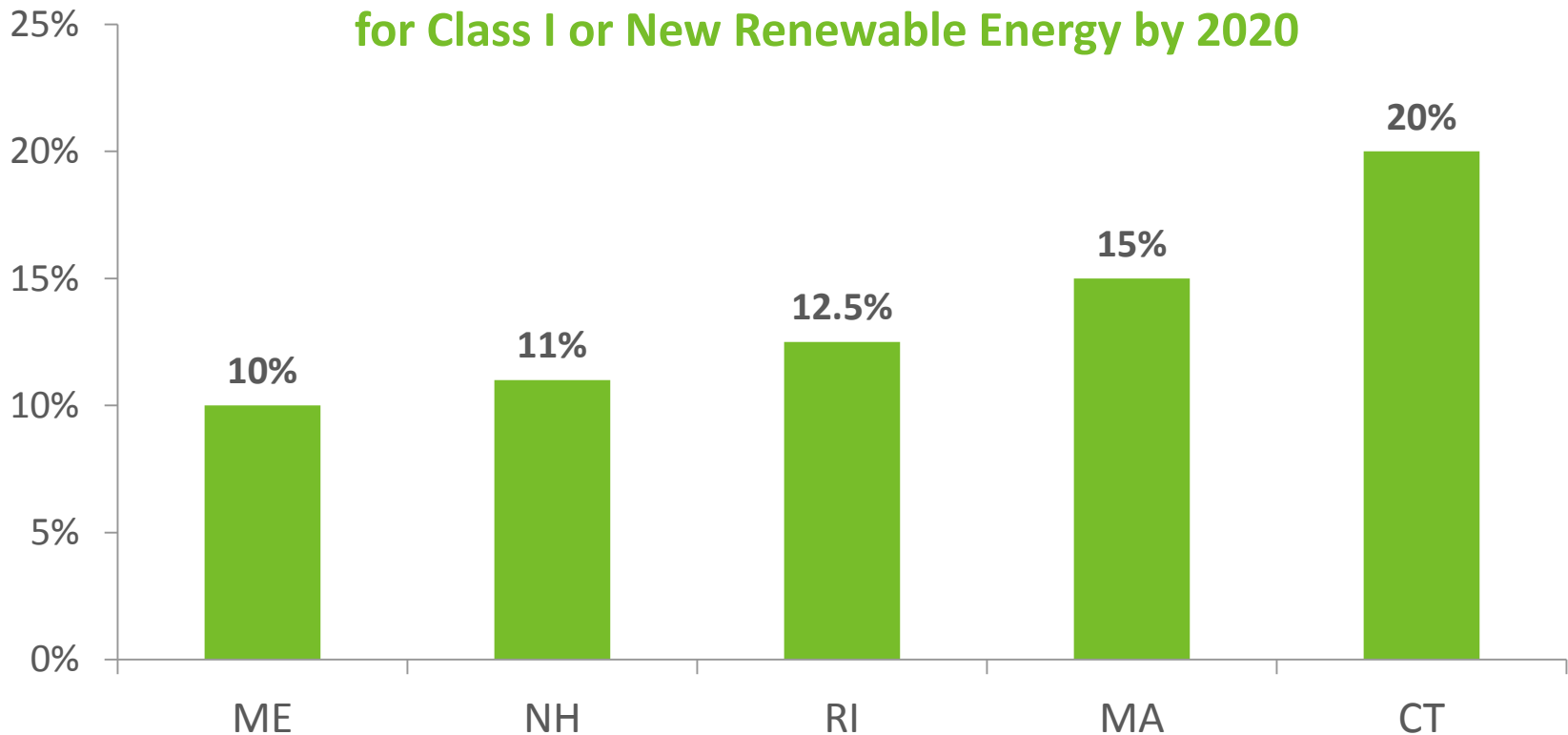
Year	NO <sub>x</sub>	SO <sub>2</sub>	CO <sub>2</sub>
1999	1.36	4.52	1,009
2013	0.36	0.32	730
<b>% Reduction, 1999–2013</b>	<b>↓74%</b>	<b>↓ 93%</b>	<b>↓ 28%</b>

Source: [2013 ISO New England Electric Generator Air Emissions Report](#), December 2014



# State Requirements Drive Proposals for Renewable Energy

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

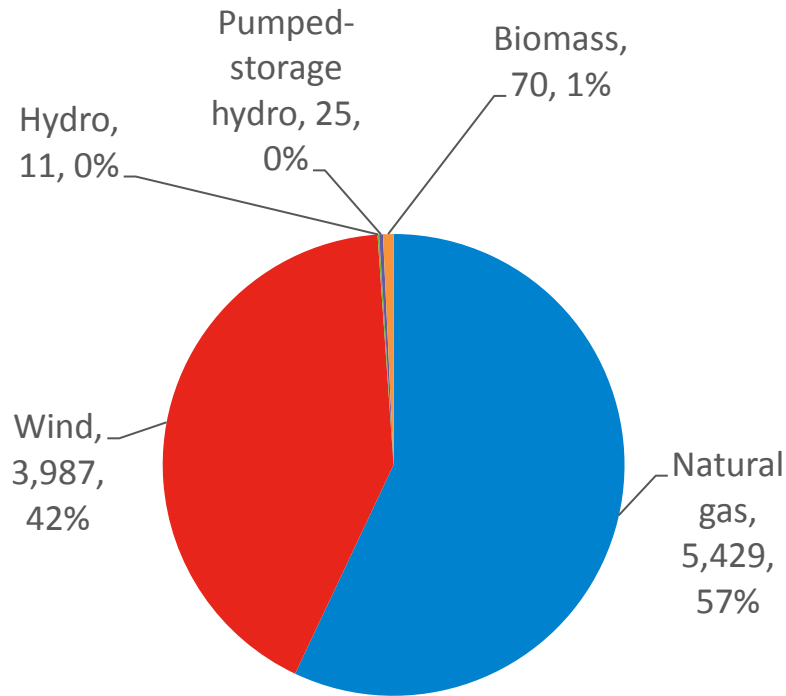


\* State Renewable Portfolio Standards (RPS) promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Vermont does not have a formal RPS program. It relies on a program known as 'Sustainably Priced Energy Enterprise Development' (SPEED) to promote renewable energy development in the state.

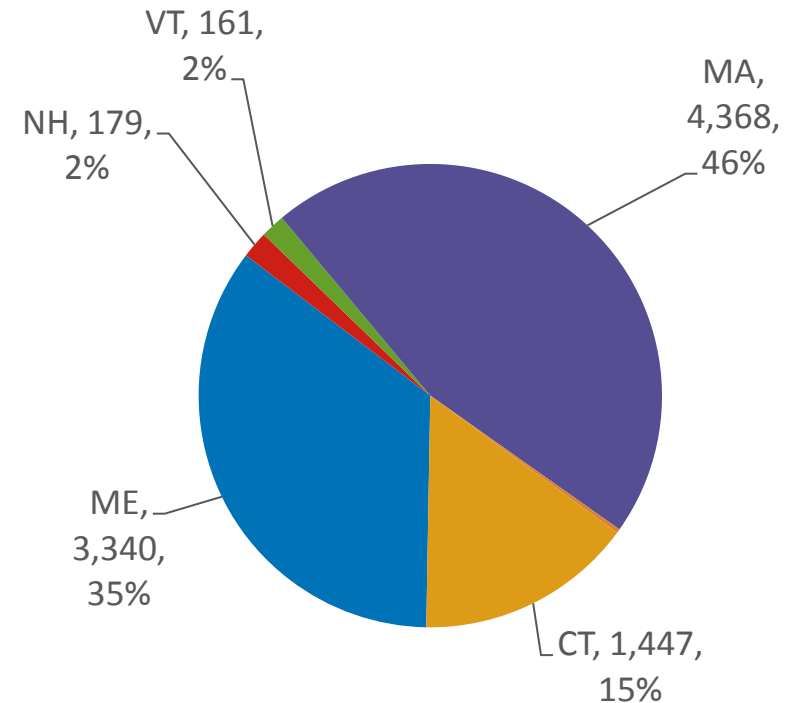
# Generator Proposals in the ISO Queue

*Approximately 9,500 MW*

## By Type



## By State



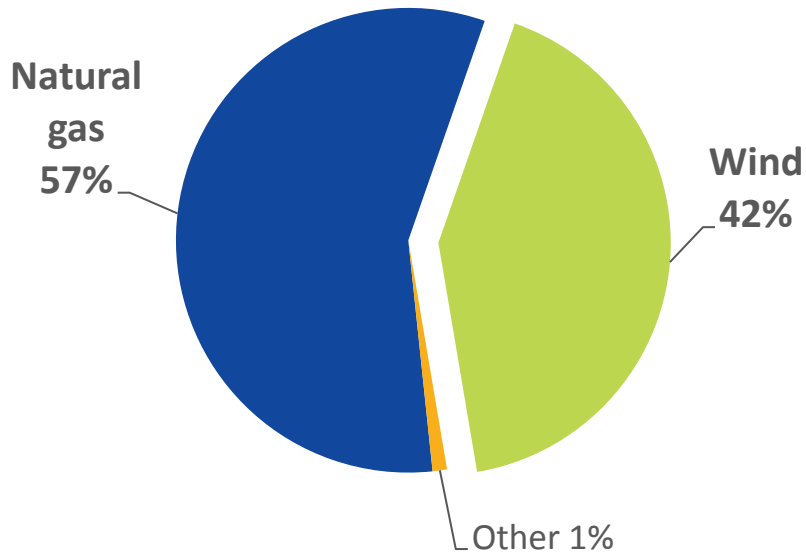
Note: Some natural gas include dual-fuel units (oil)

Source: ISO Generator Interconnection Queue (January 2015)  
FERC Jurisdictional Proposals Only

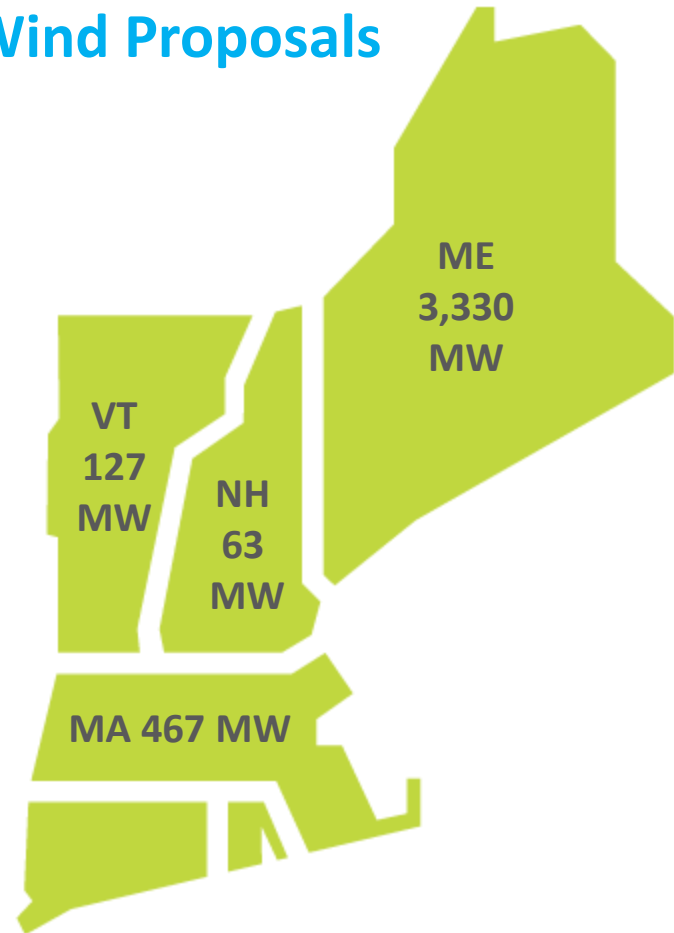
# Proposed Generation Is Primarily Gas and Wind

## All Proposed Generation

Developers propose >5 GW of gas-fired generation and approximately 4 GW wind; wind is mostly onshore in northern New England and offshore in southern New England

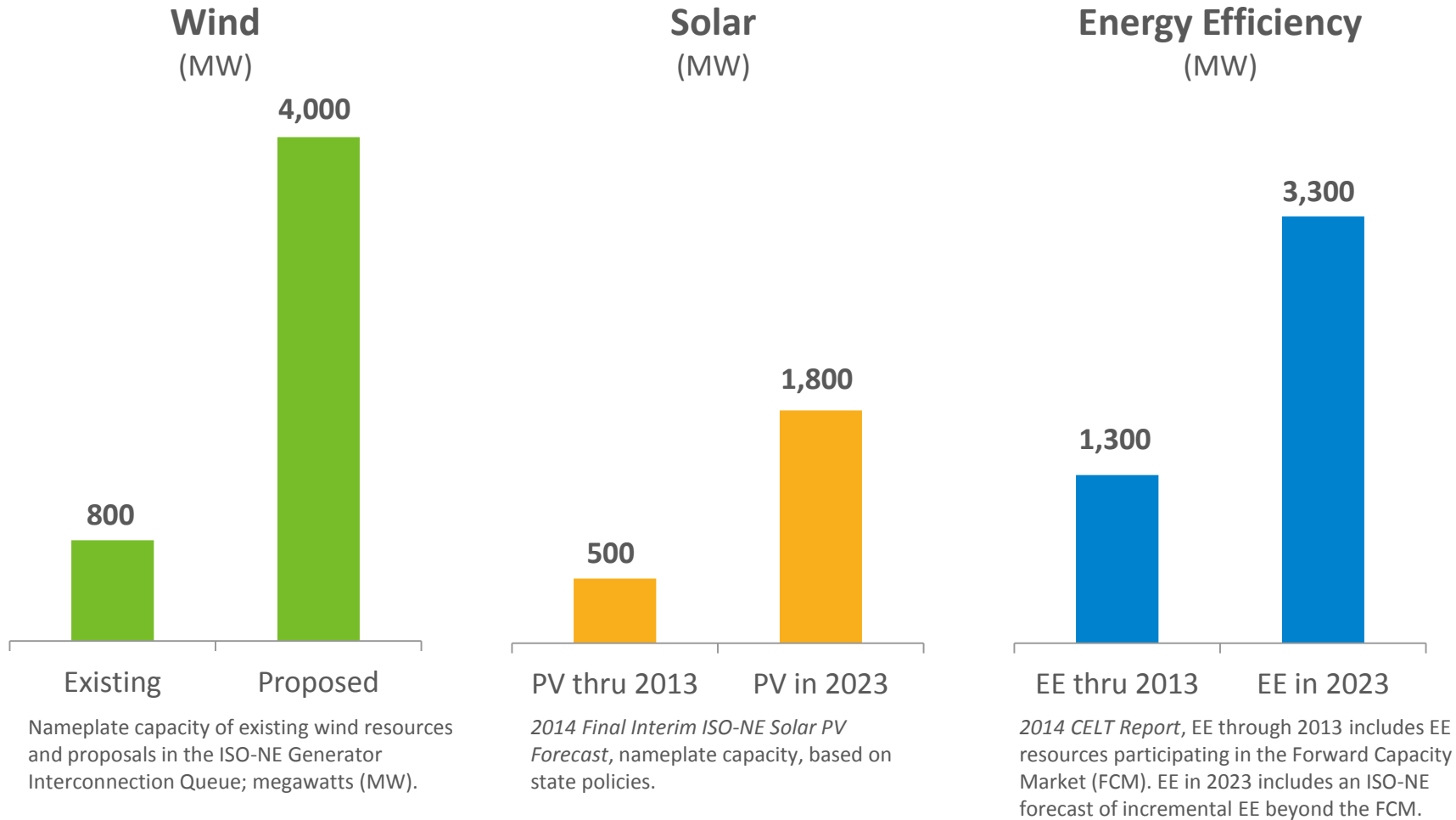


## Wind Proposals



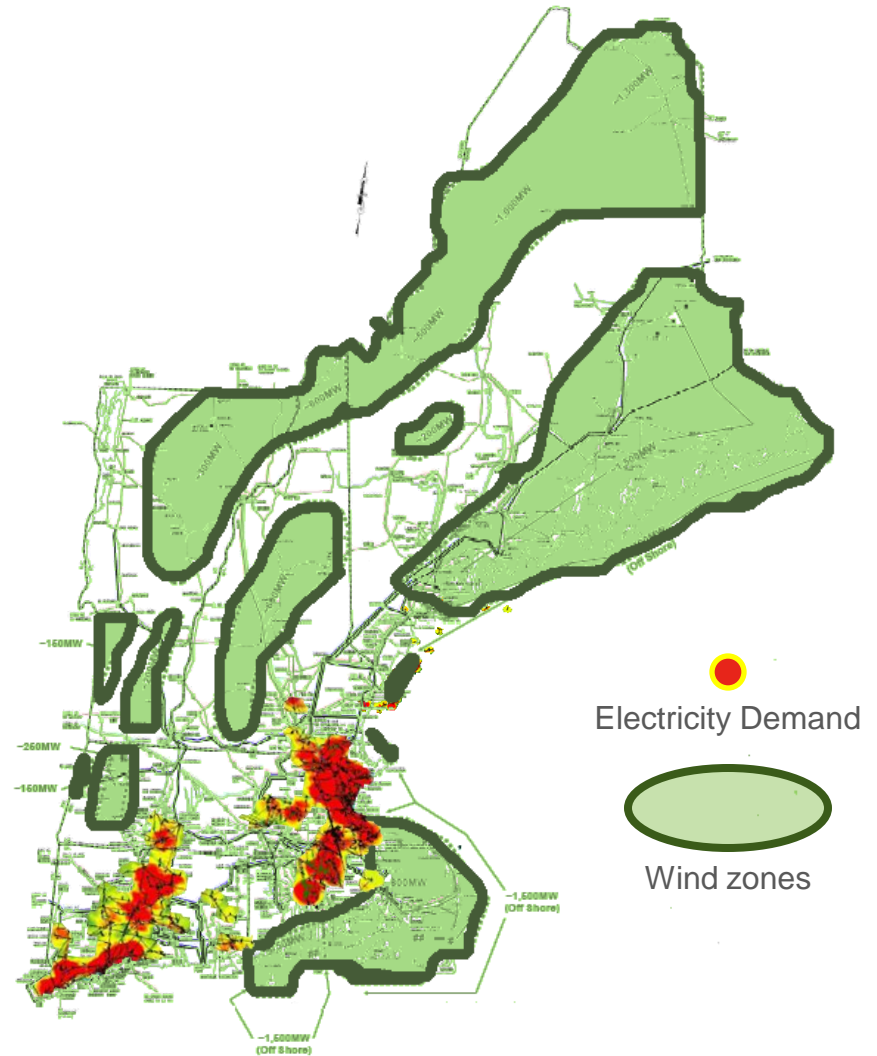
Source: ISO Generator Interconnection Queue (January 2015)  
FERC Jurisdictional Proposals Only

# Renewable and EE Resources Are Trending Up



# New England has Significant Wind Potential

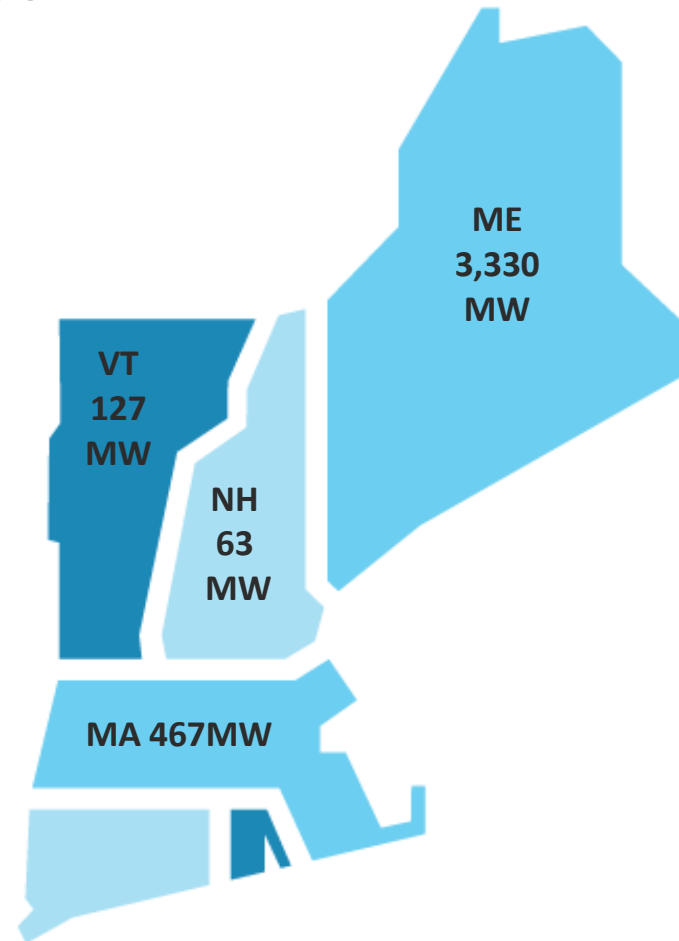
- Population and electric demand are concentrated along the coast in central and southern New England
- 12,000 MW of onshore and offshore wind potential
  - Preliminary screening eliminated wind sites near urban areas and sensitive geographic locations (e.g., Appalachian Trail)
- Transmission will be required to connect potential wind resources to load centers in New England



# On- and Off-shore Wind is Being Proposed

*Represents almost half of proposed generation*

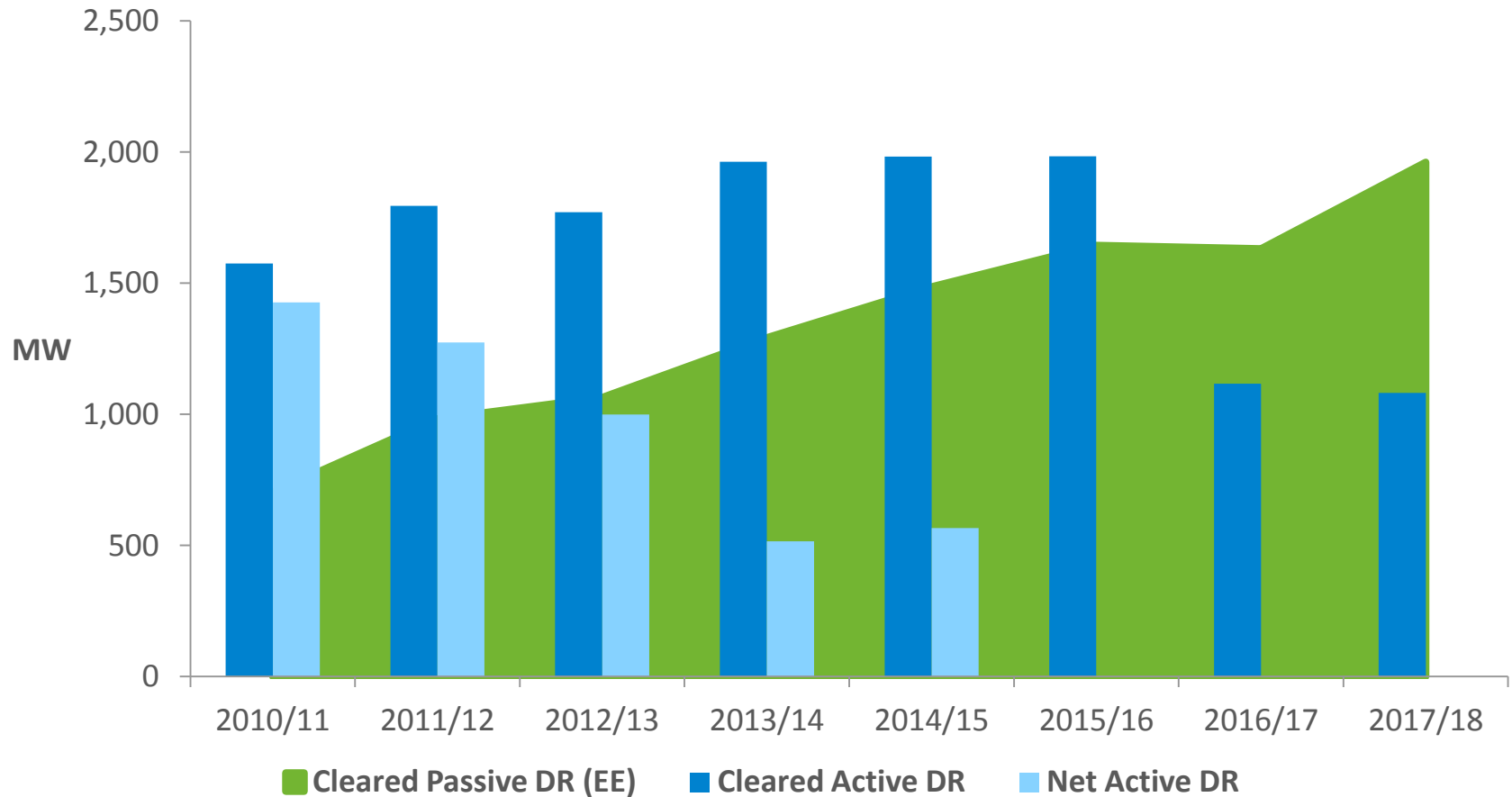
- Almost 4,000 MW of wind proposed
- Majority of wind development proposals in Maine and northern New England
- Offshore projects proposed in Maine, Massachusetts and Rhode Island



Source: ISO Generator Interconnection Queue (January 2015)  
FERC Jurisdictional Proposals Only

# FCM Has Attracted Significant Demand Resources

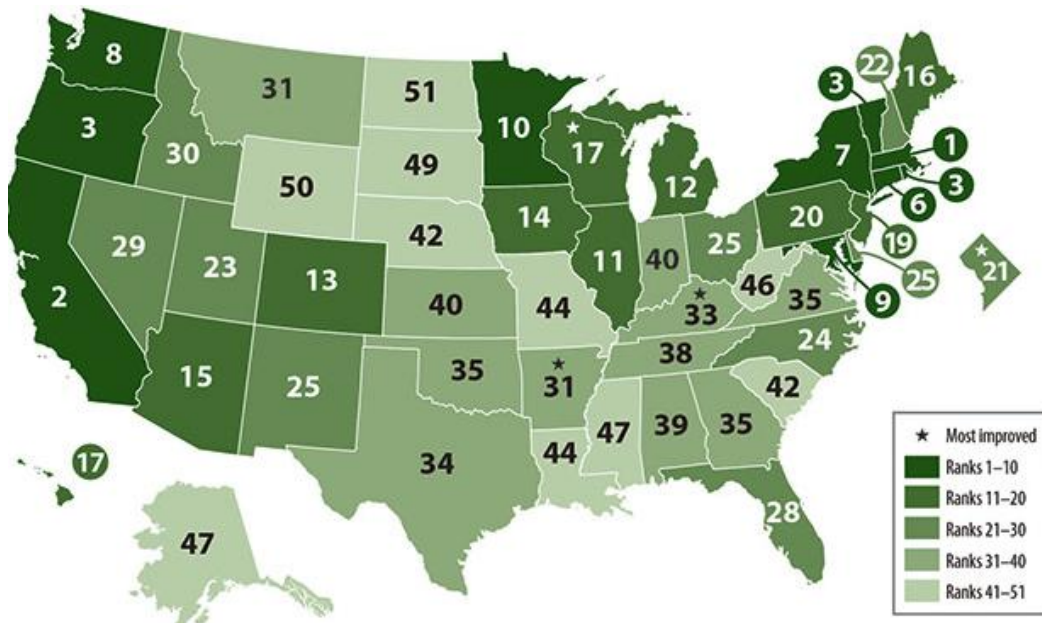
*EE is growing, but a lot of "Active" DR has dropped out*



**Notes:** *Cleared Active DR* represents Real-Time DR and RT Emergency Generation that cleared in the primary auction. *Net Active DR* represents Active DR remaining at the start of commitment period, net of resources that shed Capacity Supply Obligations after the primary auction.

# Energy Efficiency is a Priority for New England

2014 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 3
- Connecticut 6
- Maine 16
- New Hampshire 22

- Billions spent over the past few years and more on the horizon
  - Approximately \$2.3 billion invested from 2009 to 2012
  - ISO estimates \$6.3 billion to be invested in EE from 2017 to 2023

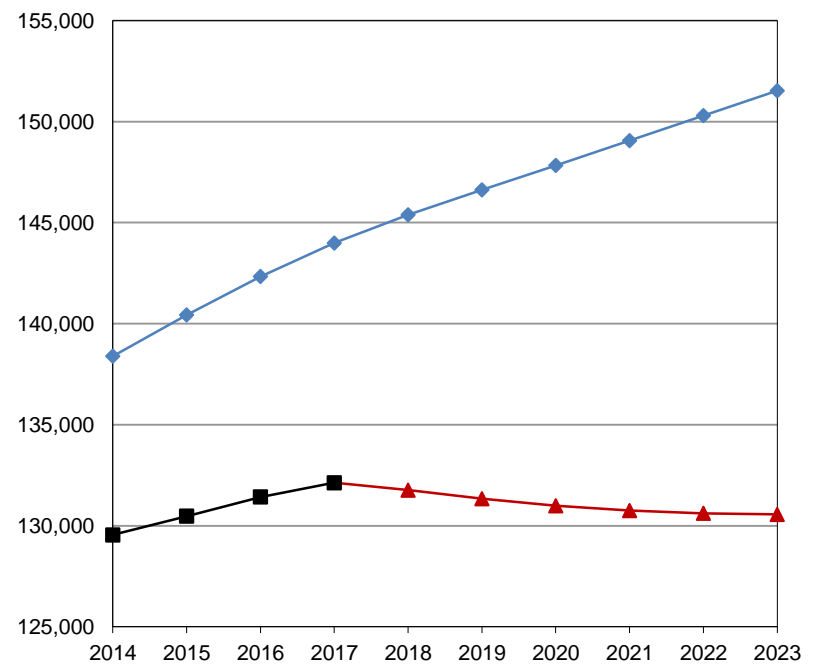
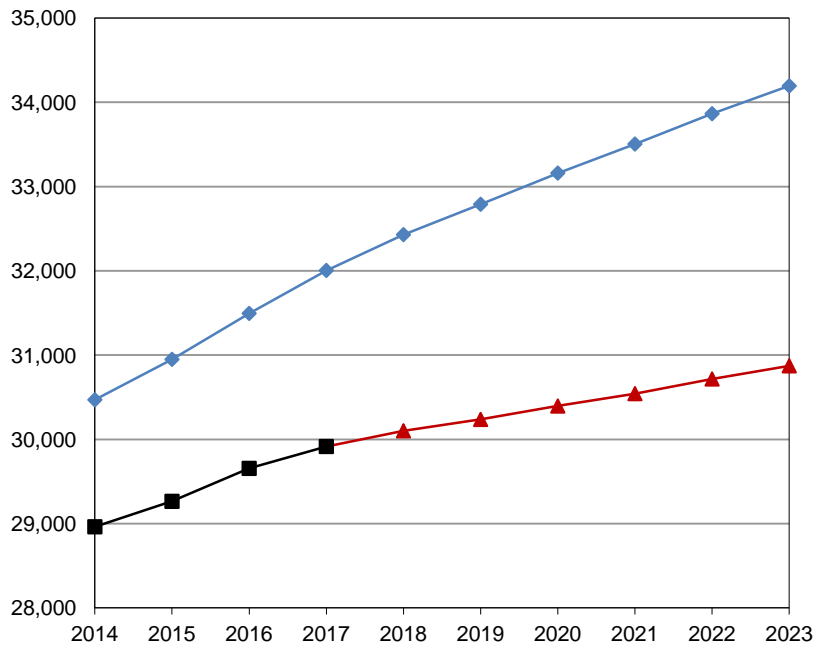


# EE Affects New England's Electricity Consumption

*Peak demand growth is lower; energy use is flat*

## New England: Summer 90/10 Peak (MW)

## New England: Annual Energy Use (GWh)



—◆— RSP14    —▲— RSP14-FCM-EEF    —■— RSP14-FCM

—◆— RSP14    —▲— RSP14-FCM-EEF    —■— RSP14-FCM

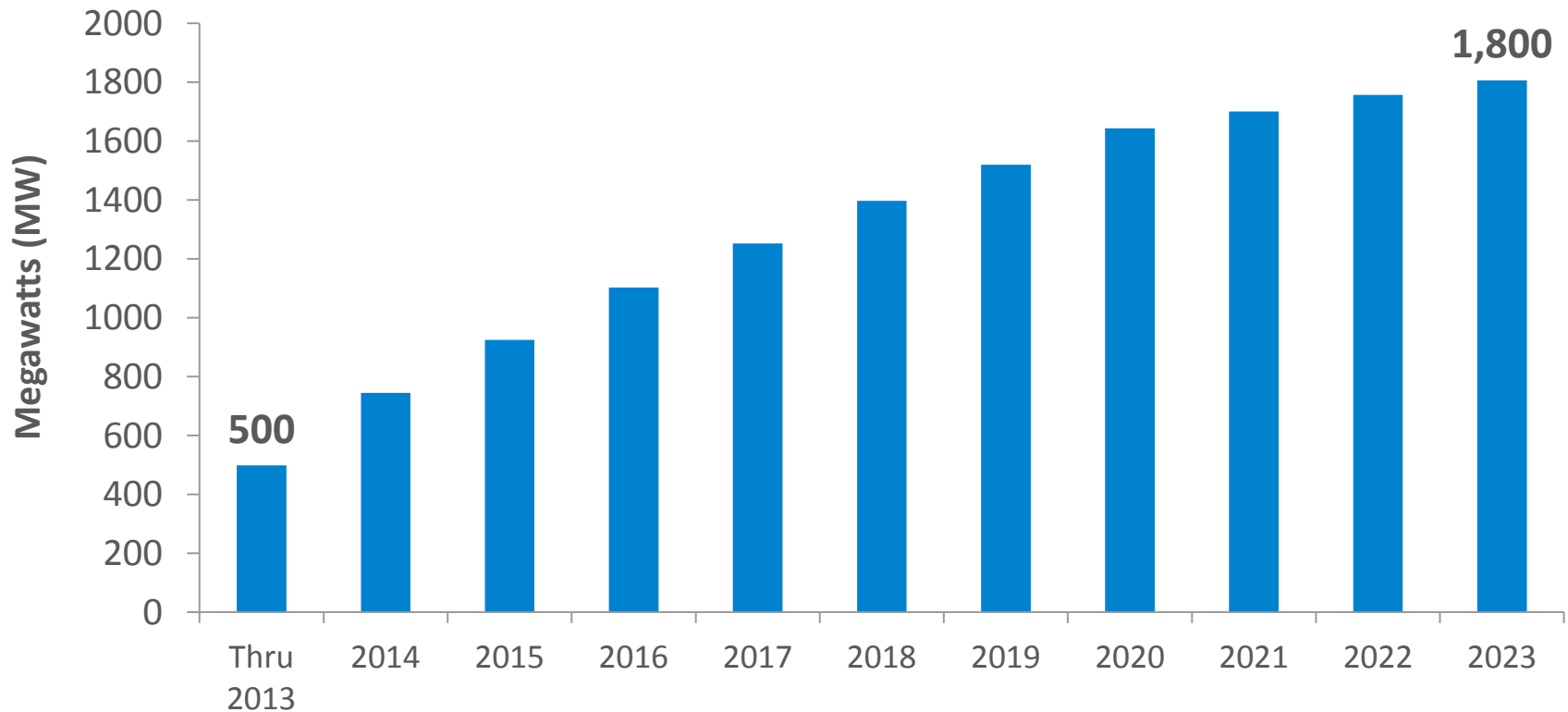
Source: [Final ISO New England EE Forecast for 2018-2023](#) (April 2014)

# ISO New England Developed a Distributed Generation Forecast

- The ISO began an initiative in September 2013, working with the states and regional utilities, to forecast long-term incremental DG growth in New England
- The ISO created a regional Distributed Generation Forecast Working Group (DGFWG) to collect data on DG policies and implementation from the states and regional utilities
- DGFWG assisted the ISO in developing a forecast methodology
- DGFWG focused on the following types of DG resources
  - Under 5 MW
  - Connected to the distribution system
  - Not visible to the ISO directly
  - Focused on solar PV, the largest DG component
- The ISO's April 2014 interim DG forecast shows steady growth in solar PV through 2023
  - Interim forecast is based on state policy goals for DG

# ISO's Interim DG Forecast Shows Growth in Solar PV through 2023

## Cumulative Growth in Solar PV through 2023



Source: [Final Interim PV Forecast](#) (April 2014); Note: MW values are AC nameplate

# Resource Shift Creates Reliability Challenges

- **ISO New England** is increasingly reliant on resources with uncertain performance and availability
  - **Intermittent resource growth** with inherently uncertain output
  - **Natural gas resources** lack fuel storage and rely on “just-in-time” fuel
  - **Coal, oil-steam fleet** is being displaced by more efficient resources
- ISO estimates **up to 8,300 MW of non-gas-fired generation is “at risk” for retirement by 2020** (28 older oil and coal units)
  - If all retire, ISO estimates 6,300 MW of new or repowered capacity will be needed in the region
- More than **3,500 MW of generation are retiring over the next five years**
  - Source: Status of Non-Price Retirement Requests; November 21, 2014

# Resources Assumed to be “At Risk” of Retirement

Unit	Unit Type	MW Maximum Assumed	In-service Date	Age in 2020	Unit	Unit Type	MW Maximum Assumed	In-service Date	Age in 2020
BRAYTON POINT 1	Coal	261	01-Aug-63	57	MONTVILLE 6	Oil	418	01-Jul-71	49
BRAYTON POINT 2	Coal	258	01-Jul-64	56	MOUNT TOM 1	Coal	159	01-Jun-60	60
BRAYTON POINT 3	Coal	643	01-Jul-69	51	MYSTIC 7 GT	Oil	615	01-Jun-75	45
BRAYTON POINT 4	Oil	458	01-Dec-74	46	NEW HAVEN HBR	Oil	483	01-Aug-75	45
BRIDGEPORT HBR 2	Oil	190	01-Aug-61	59	NEWINGTON 1	Oil	424	01-Jun-74	46
BRIDGEPORT HBR 3	Coal	401	01-Aug-68	52	NORWALK HBR 1	Oil	173	01-Jan-60	60
CANAL 1	Oil	597	01-Jul-68	52	NORWALK HBR 2	Oil	179	01-Jan-63	57
CANAL 2	Oil	599	01-Feb-76	44	SCHILLER 4	Coal	51	01-Apr-52	68
MERRIMACK 1	Coal	121	01-Dec-60	60	SCHILLER 6	Coal	51	01-Jul-57	63
MERRIMACK 2	Coal	343	30-Apr-68	52	W. SPRINGFIELD 3	Oil	111	01-Jan-57	63
MIDDLETOWN 2	Oil	123	01-Jan-58	62	YARMOUTH 1	Oil	56	01-Jan-57	63
MIDDLETOWN 3	Oil	248	01-Jan-64	56	YARMOUTH 2	Oil	56	01-Jan-58	62
MIDDLETOWN 4	Oil	415	01-Jun-73	47	YARMOUTH 3	Oil	122	01-Jul-65	55
MONTVILLE 5	Oil	85	01-Jan-54	66	YARMOUTH 4	Oil	632	01-Dec-78	42

**TOTAL 8,281 MW**

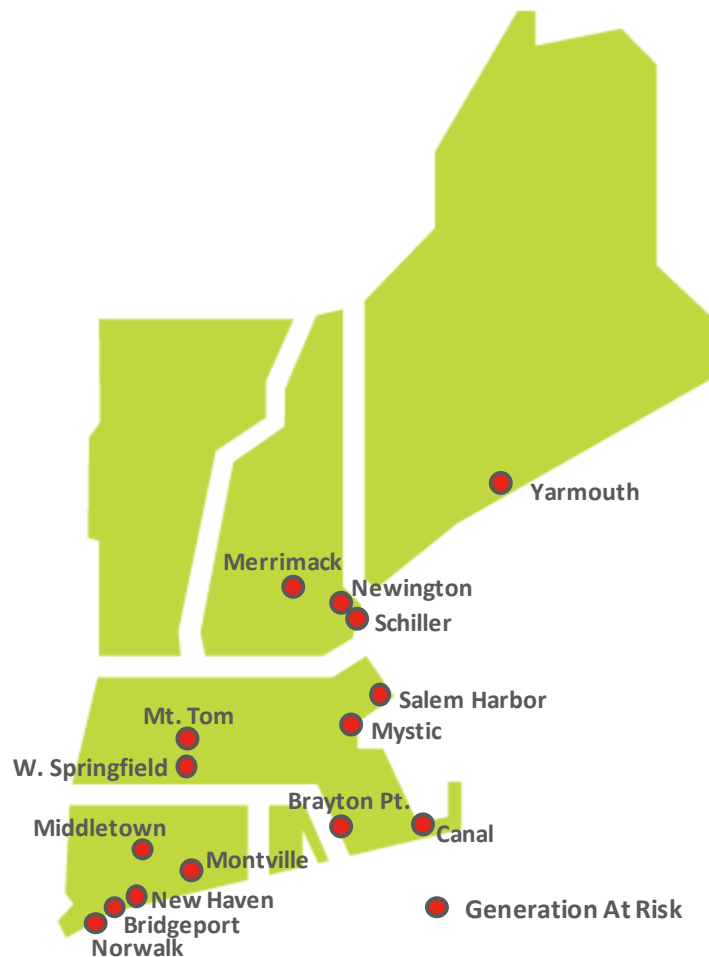
Source: Strategic Transmission Analysis, [Generator Retirements Study](#), December 2012



# Region Is Losing Non-Gas Resources

## Major Retirements Underway:

- 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)
- *Additional retirements are looming*



Source: *Generator Retirement Study*, ISO New England, 2012.

# Generator Non-Price Retirement Requests

*More than 3,500 MW of generation are retiring over the next five years*

## Major Retirements Underway:

- **Salem Harbor Station (749 MW)**
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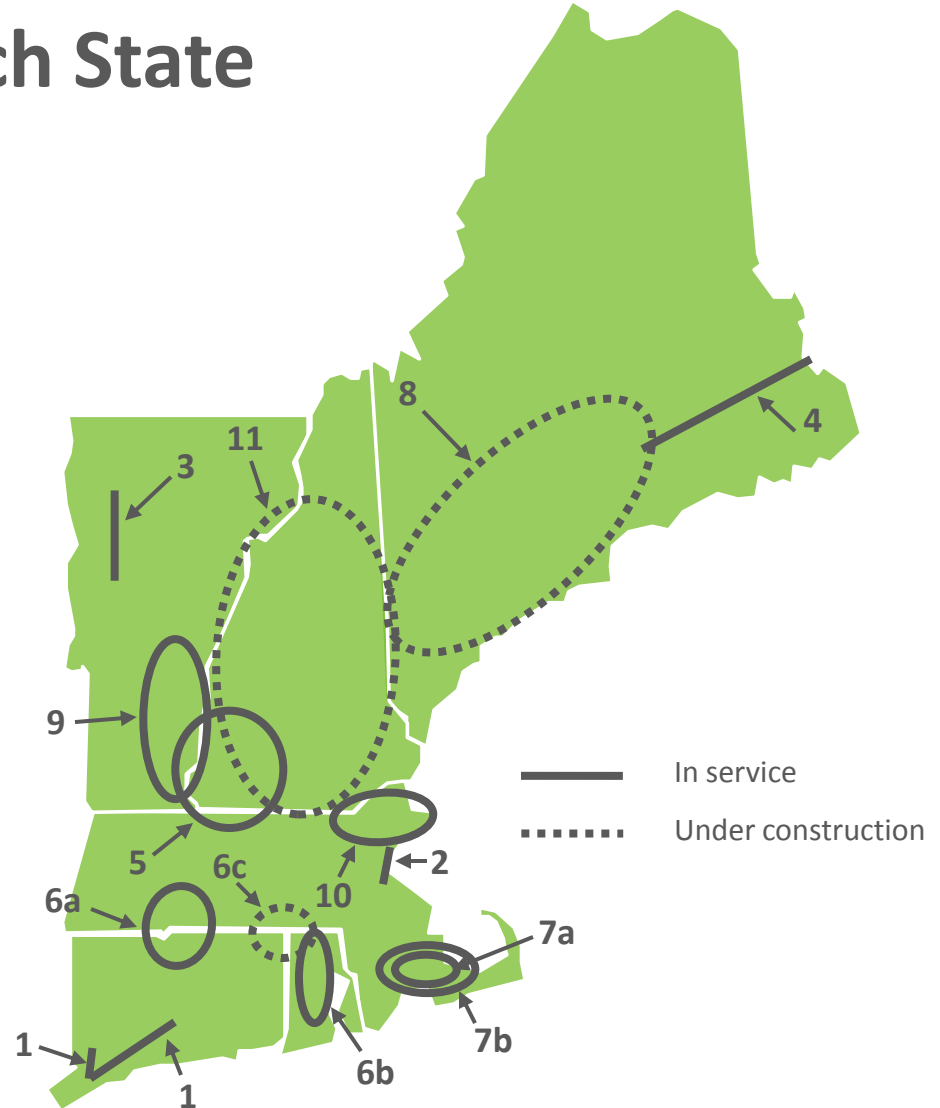
Total MW Retiring in New England*	
Connecticut	354 MW
Maine	35 MW
Massachusetts	2,502 MW
New Hampshire	5 MW
Rhode Island	13 MW
Vermont	634 MW
<b>Total</b>	<b>3,543 MW</b>

\*Megawatts based on relevant Forward Capacity Auction (FCA) summer qualified capacity (NOTE: total includes full and partial generator Non-Price Retirement (NPR) requests for Capacity Commitment Period (CCP) 2014-2015 through CCP 2018-2019; does not include NPRs for demand response (DR) resources)

Source: Status of Non-Price Retirement Requests; November 21, 2014

# Transmission Projects to Maintain Reliability Have Progressed in Each State

1. Southwest CT Phases I & II
2. Boston NSTAR 345 kV Project, Phases I & II
3. Northwest Vermont
4. Northeast Reliability Interconnect
5. Monadnock Area
6. New England East-West Solution
  - a. Greater Springfield Reliability Project
  - b. Rhode Island Reliability Project
  - c. Interstate Reliability Project
7. Southeast Massachusetts
  - a. Short-term upgrades
  - b. Long-term Lower SEMA Project
8. Maine Power Reliability Program
9. Vermont Southern Loop
10. Merrimack Valley/North Shore Reliability
11. New Hampshire/Vermont Upgrades

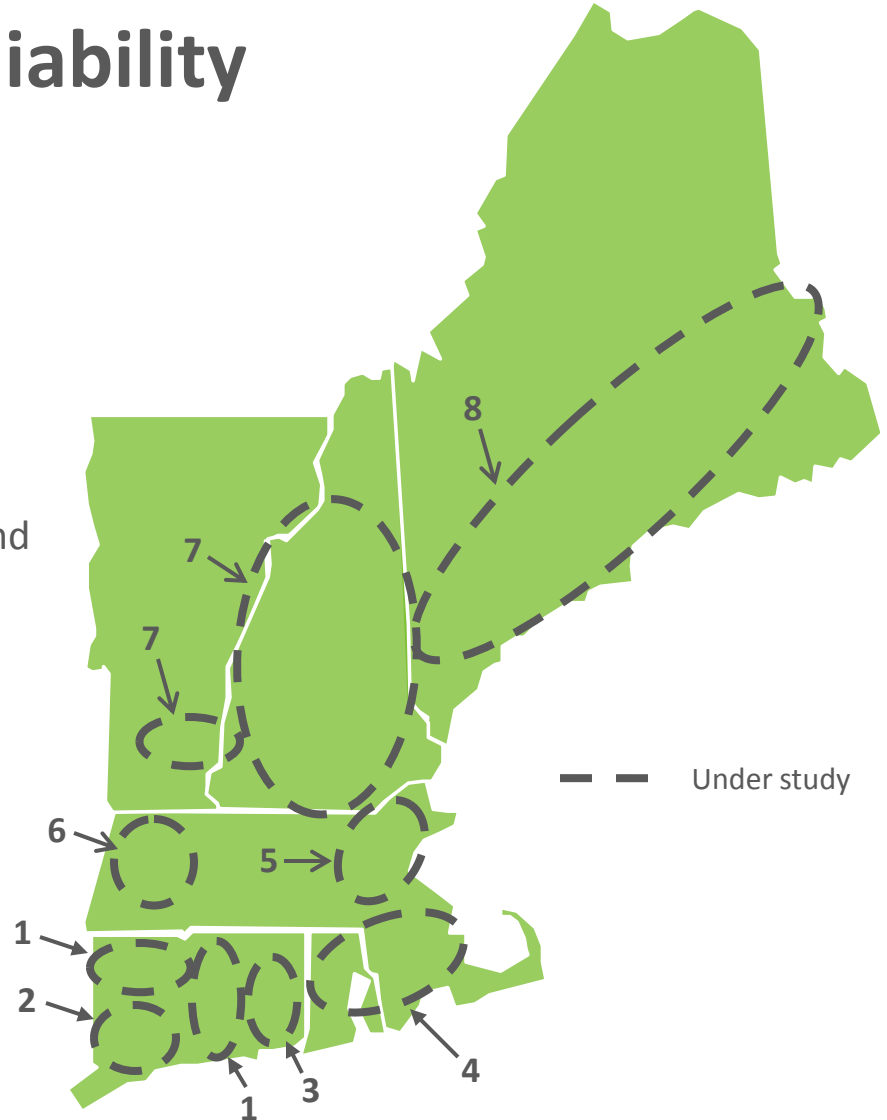


Source: RSP Transmission Project Listing, October 2014; (does not include "concept" projects)



# ISO Continuously Studies Transmission System Needs to Maintain Reliability

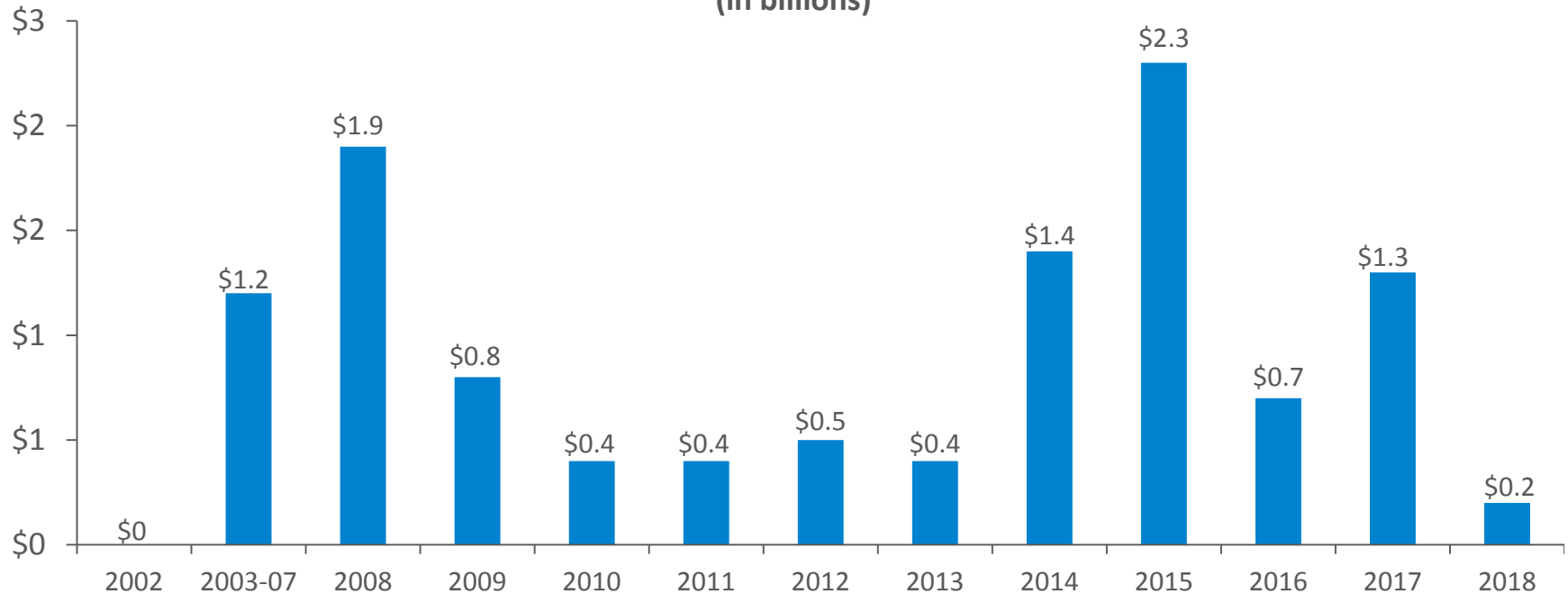
1. Greater Hartford and Central Connecticut
2. Southwest Connecticut
3. Eastern Connecticut
4. Southeast Massachusetts and Rhode Island
5. Greater Boston
6. Pittsfield and Greenfield
7. New Hampshire and Vermont
8. Maine



Source: ISO New England Key Study Areas at <http://www.iso-ne.com/system-planning/key-study-areas>

# New Transmission Investment in New England

**Annual Investment in Transmission to Maintain Reliability**  
(in billions)

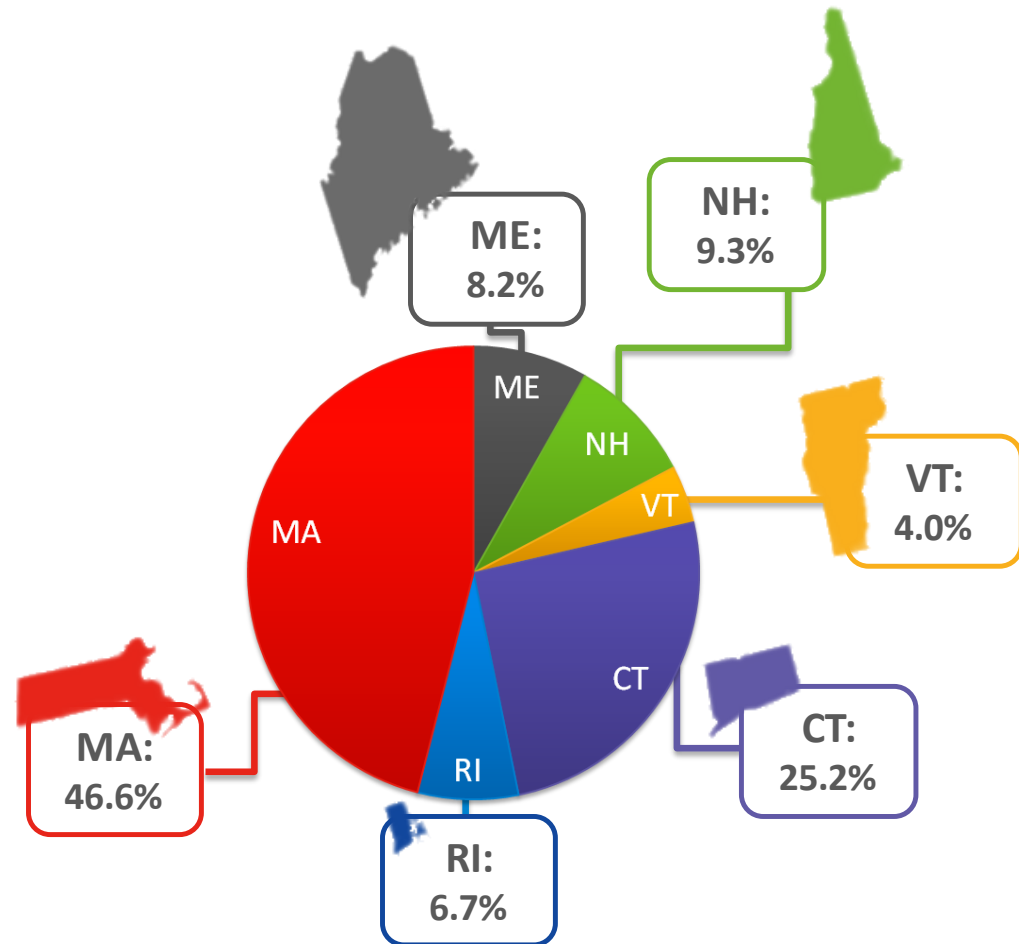


<b>Cumulative Investment through 2014</b>	<b>\$7.0 billion</b>
<b>Estimated Future Investment through 2018</b>	<b>\$4.5 billion</b>

Source: ISO New England RSP Transmission Project Listing, October 2014  
Estimated future investment includes projects under construction, planned and proposed

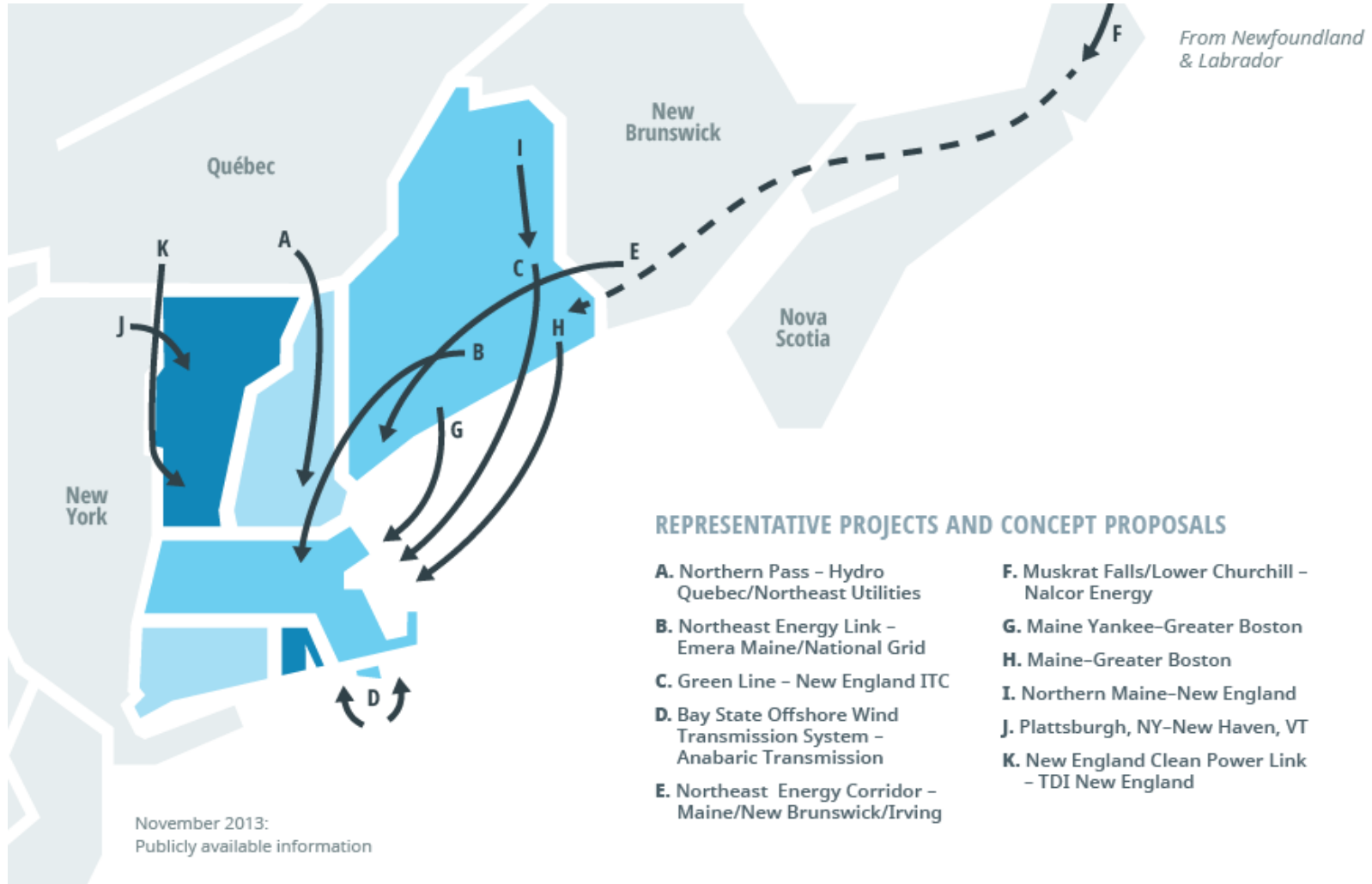
# How are Transmission Costs Allocated?

- The New England electric grid is a tightly interconnected system; each state shares in the benefits of reliability upgrades
- The amount of electricity demand in an area determines its share of the cost of new or upgraded transmission facilities needed for reliability



Source: 2013 Network Load by State

# On- and Off-shore Transmission Proposals are Vying to Move Renewable Energy to New England Load Centers



Note: These projects are NOT reliability projects, but ISO New England’s role is to ensure the reliable interconnection of these types of projects.

# U.S. Department of Energy Is Examining New England's Energy Infrastructure Challenges

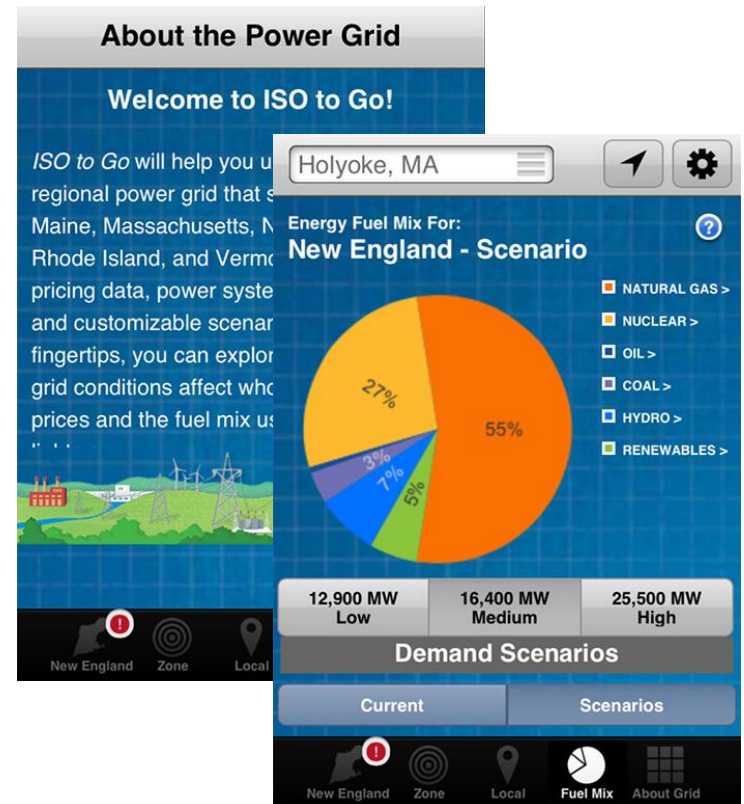
- U.S. Department of Energy (DOE) is studying energy infrastructure challenges as part of its Quadrennial Energy Review (QER)
- ISO-NE has worked extensively with DOE throughout 2014 to articulate New England's challenges
  - ISO-NE has highlighted the region's increasing reliance on natural gas-fired resources and the need for additional energy infrastructure
- DOE's initial report is expected in February 2015 (focused on transmission, storage, and distribution of energy)



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# Questions

