



State of the Grid: 2016

ISO on Background

Gordon van Welie

PRESIDENT & CEO, ISO NEW ENGLAND INC.



About the *ISO on Background Series*

- Informal opportunity for media to learn more about trends affecting New England's electricity industry
- Hosted by ISO New England senior management
- **Content is on the record**
- Please hold questions until the Q&A session at the end of the presentation
- Presentation and remarks will be posted at www.iso-ne.com>About Us>News and Media>Press Releases



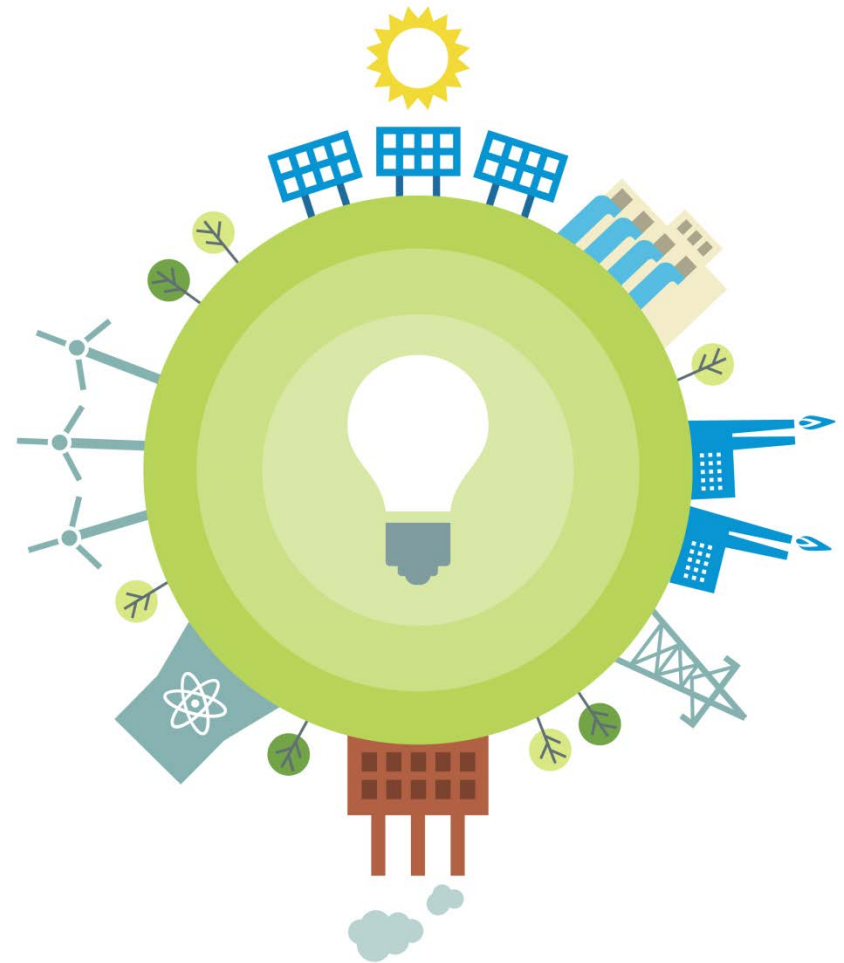
Agenda

- 10:30 -10:40 a.m. **Welcome and Introductions**
Ellen Foley, director, Corporate Communications
- 10:40 a.m. -11:30 a.m. **State of the Grid: 2016**
Gordon van Welie, president and CEO
- 11:30 a.m. – 12:00 p.m. **Question-and-Answer Session**



Overview of Presentation

- About ISO New England
- State of the Grid
 - Setting the Stage
 - 2015 Highlights
 - Preparing for the Hybrid Grid
 - Conclusions
- Questions and Answers



ABOUT ISO NEW ENGLAND



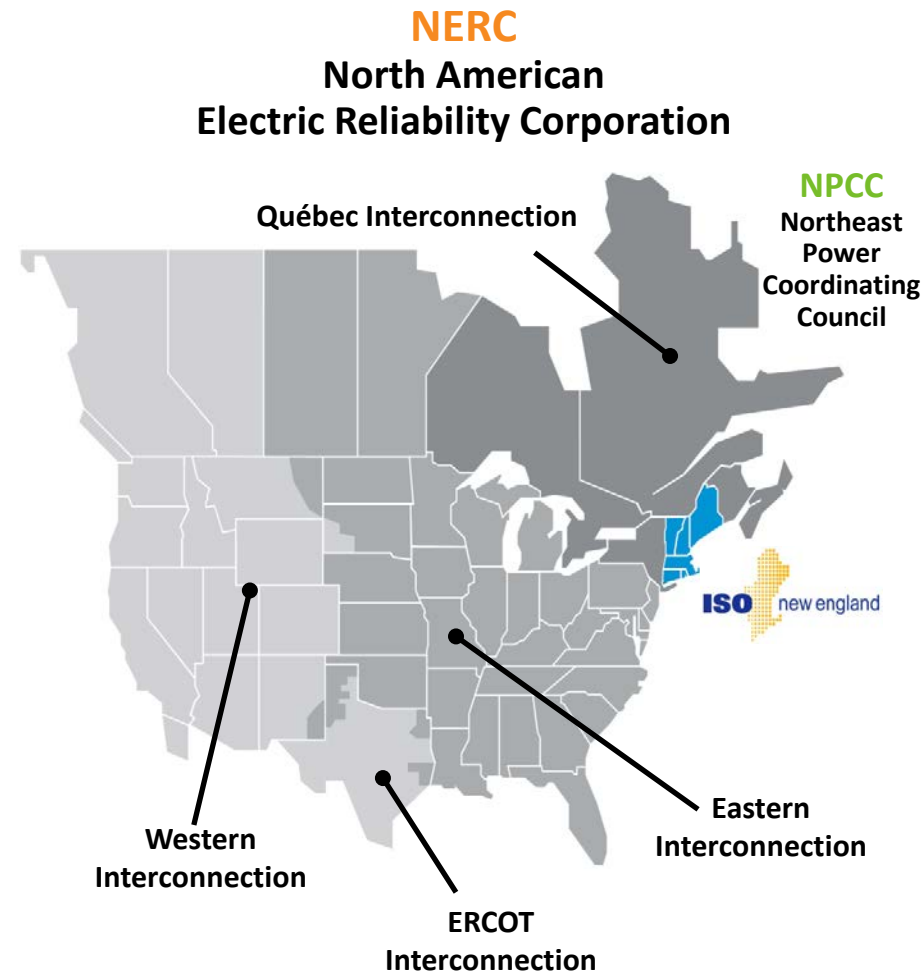
Two Decades of Experience Overseeing the Region's Restructured Electric Power System

- **ISO New England's three core responsibilities** include:
 - Operating the regional power system
 - Administering the region's competitive wholesale electricity markets
 - Planning for the regional power system
- **Regulated** by the Federal Energy Regulatory Commission (FERC)
- **Independent** of companies in the marketplace
- **ISO-NE does not:**
 - Buy or sell power
 - Own generation or transmission equipment
 - Have any involvement in the natural gas industry
 - Take any position on any pipeline or elective transmission project proposal



Snapshot of New England's Power System and Wholesale Electricity Markets

- Resources & consumer demand:
 - 350 generators; 31,000 MW of generating capacity
 - 600 MW of demand response & 1,700 MW of energy efficiency
 - 15,000 MW of new generation since 1997
 - All-time peak demand: 28,130 MW on August 2, 2006
- Transmission system:
 - 8,600 miles of high-voltage transmission lines
 - \$7.4 billion invested since 2002 to improve reliability
 - 13 transmission ties to neighboring power systems (NY & Canada)
- Markets:
 - Energy: daily market for electricity
 - Capacity: annual forward auction for long-term resource availability; obligation for one year or seven years for new resources
 - Ancillary services: daily market for real-time reliability services

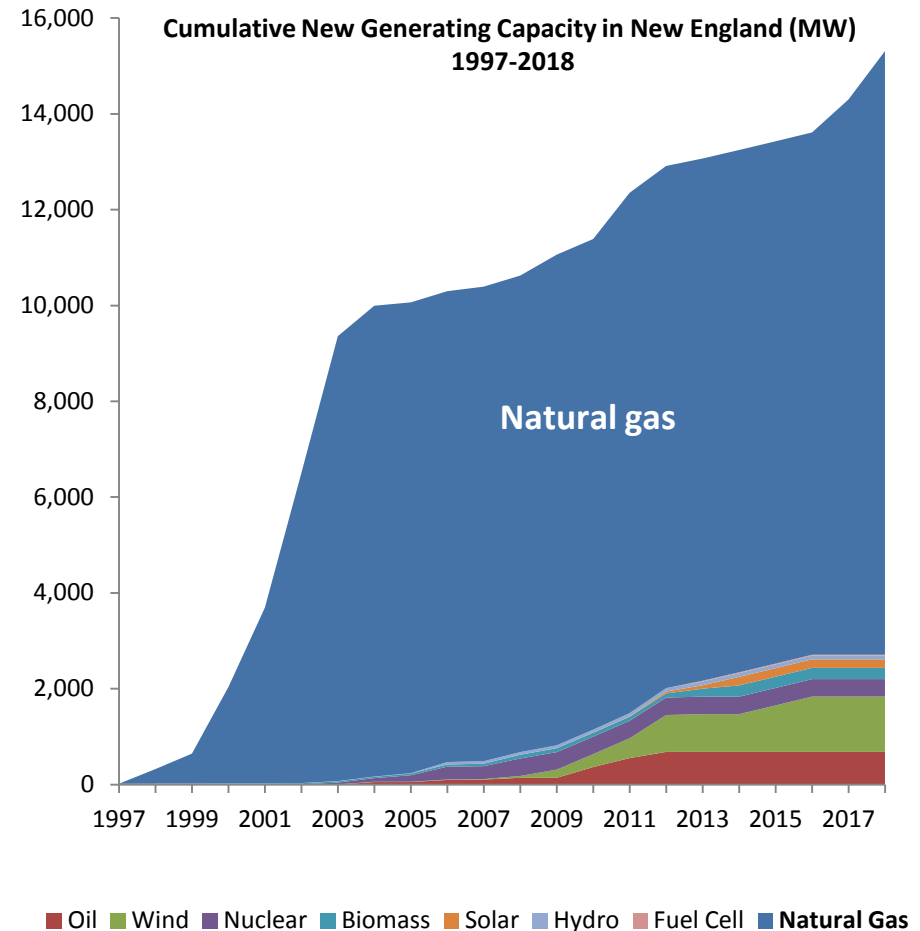


STATE OF THE GRID: SETTING THE STAGE



Transformation of Region's Resource Mix Continues

- **Low natural gas prices**
 - Gas is the most economic fuel for new, conventional resources
 - 80% of new capacity since 1997 runs on natural gas
 - Nearly 65% of all proposed new generation would use natural gas
 - Demand for natural gas is rising
 - Gas pipelines are constrained during high demand periods, particularly winter
 - Creates grid reliability concerns and price volatility
- **Low prices are putting financial pressure on coal, oil and nuclear baseload generators; some are retiring**



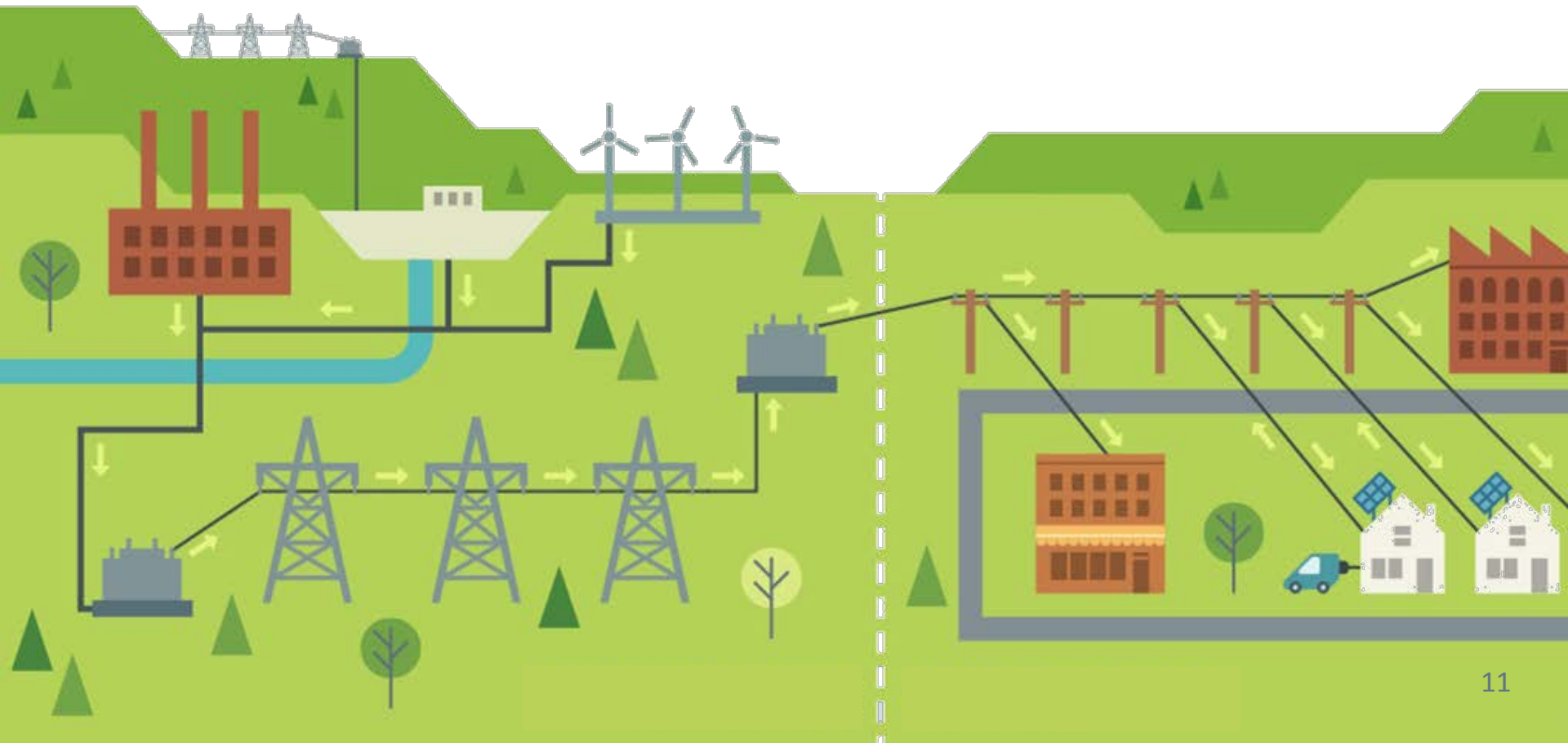
Shift to Cleaner Energy Sources Continues

- **State policies drive renewable resource development**
 - Mostly large-scale wind and behind-the-meter solar
 - Other, fast & flexible resources will be needed to balance intermittent resources' variable output
 - New transmission needed to bring wind farms' energy from their remote locations to population centers
- **Distributed generation and the “hybrid” grid**
 - A significant portion of New England’s future grid could be “behind-the-meter” (solar facilities on distribution system)
 - That will change how much and when power is used by consumers



Electric Grid Will Look Very Different in the Near Future

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



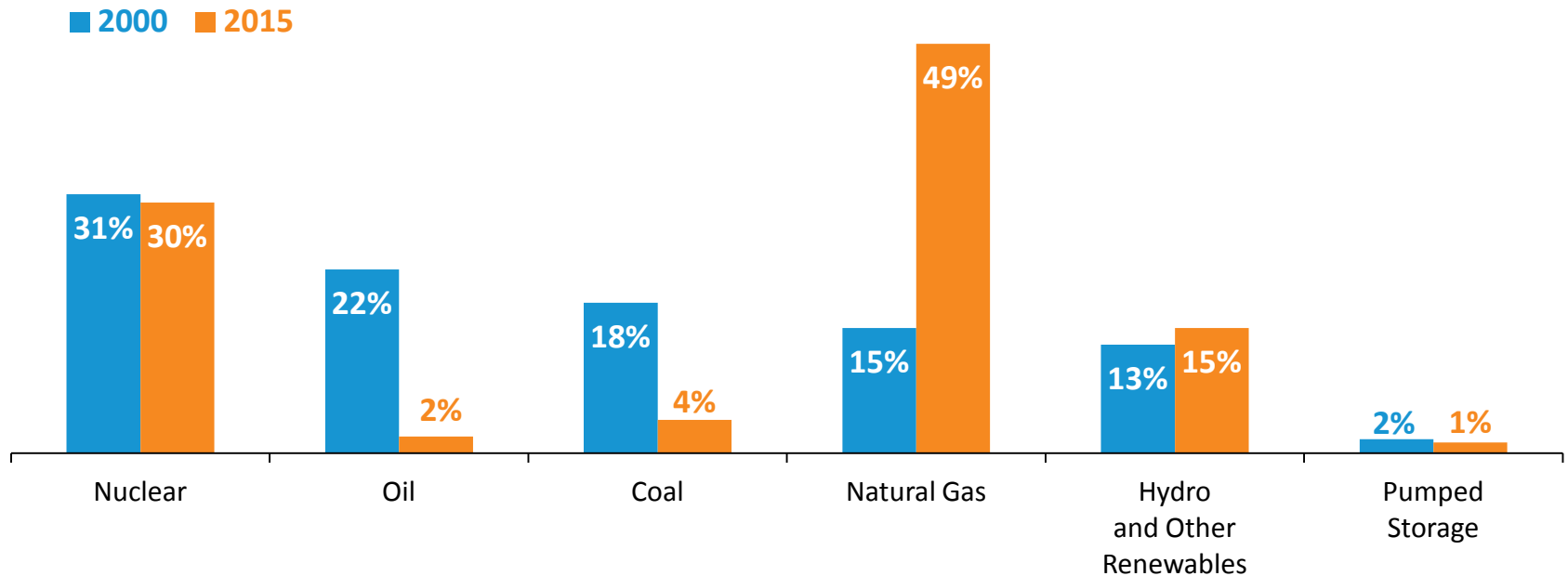
STATE OF THE GRID: 2015 HIGHLIGHTS



Natural Gas Used Most Often to Generate Region's Power

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)

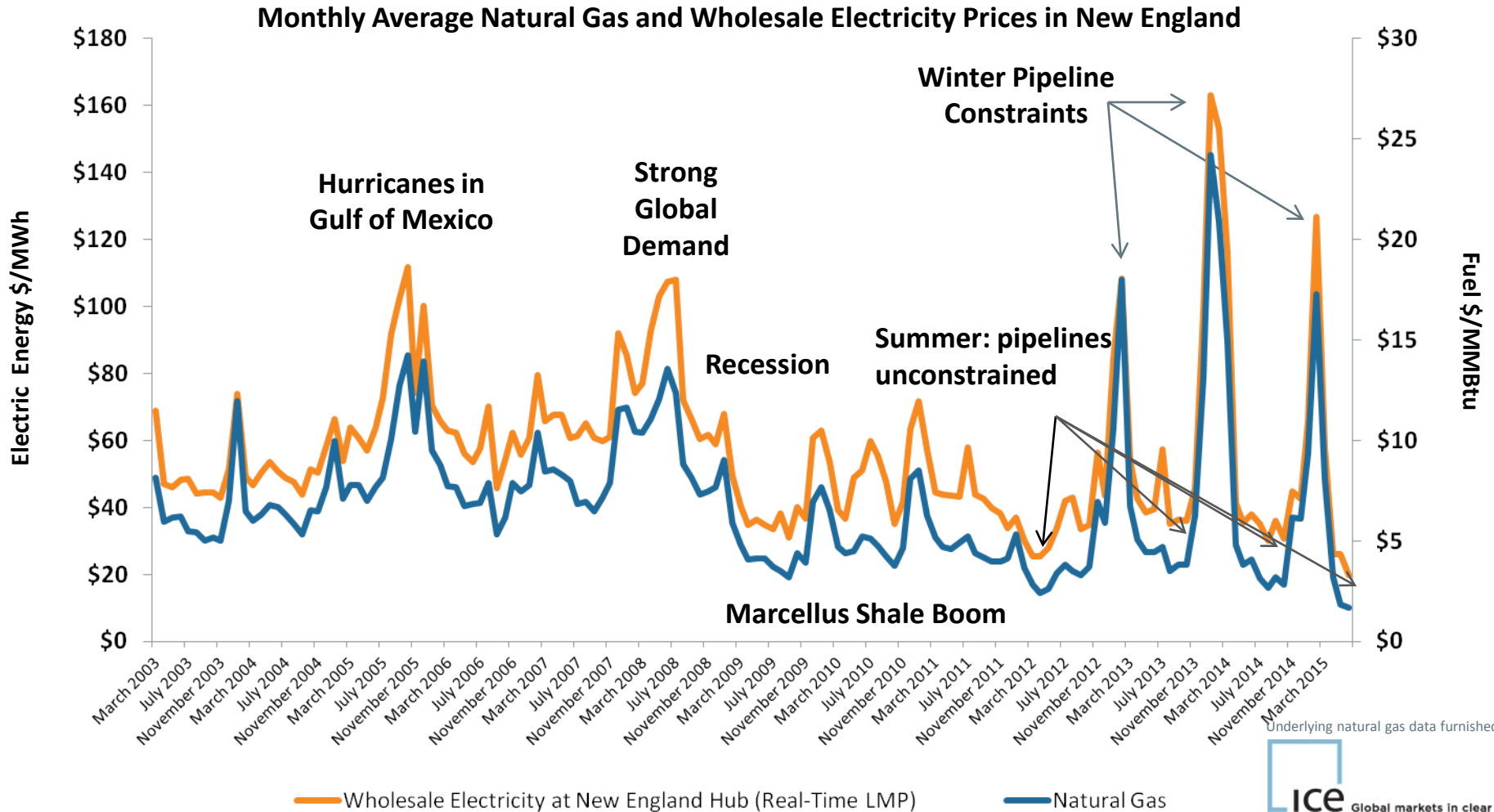


Source: ISO New England [Net Energy and Peak Load by Source](#)

Other renewables include landfill gas, biomass, other biomass gas, wind, solar, municipal solid waste, and miscellaneous fuels

Natural Gas and Wholesale Electricity Prices Are Linked

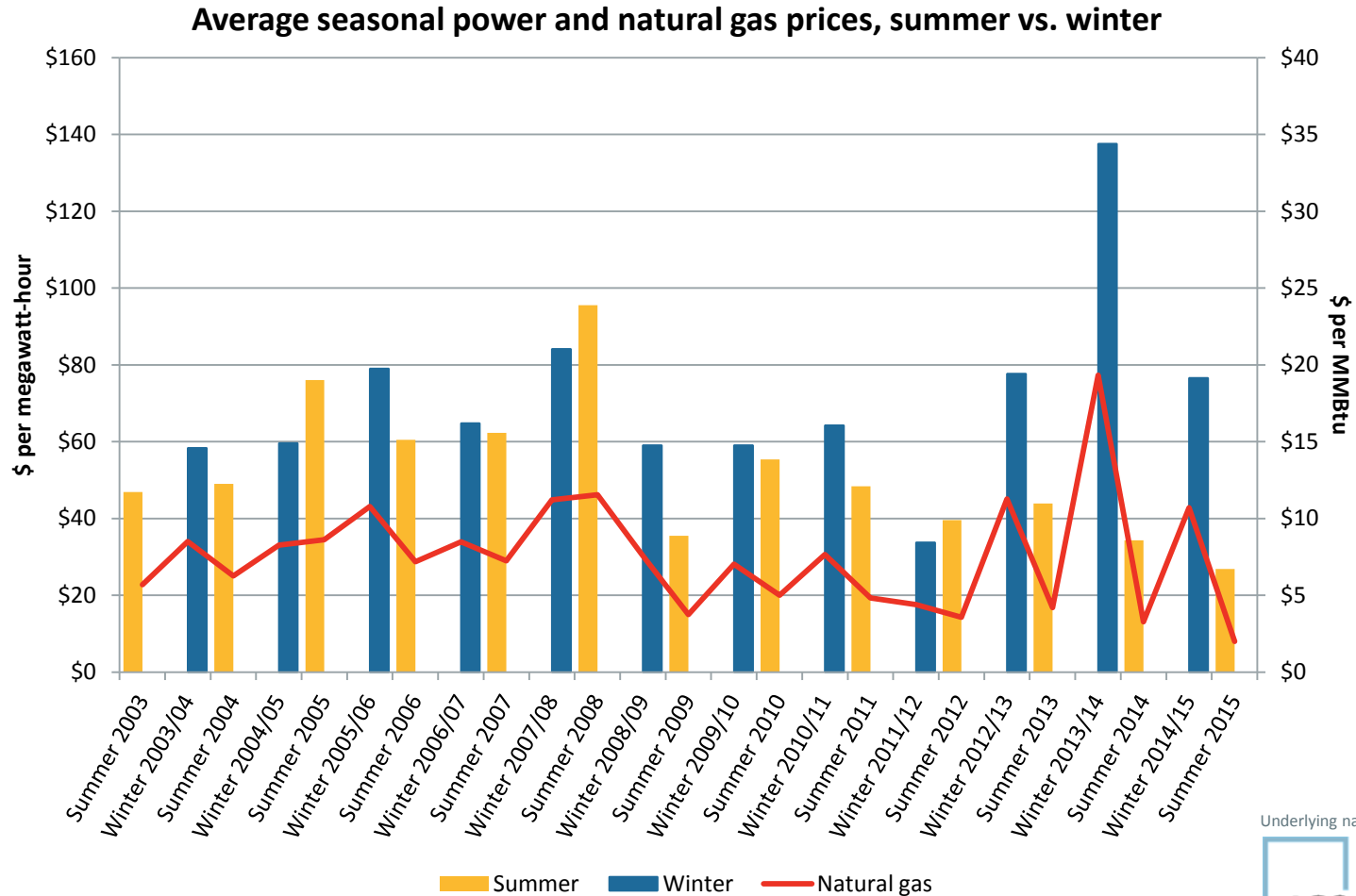
With natural gas the primary fuel used to produce electricity, natural-gas-fired power plants typically set the price for wholesale electricity



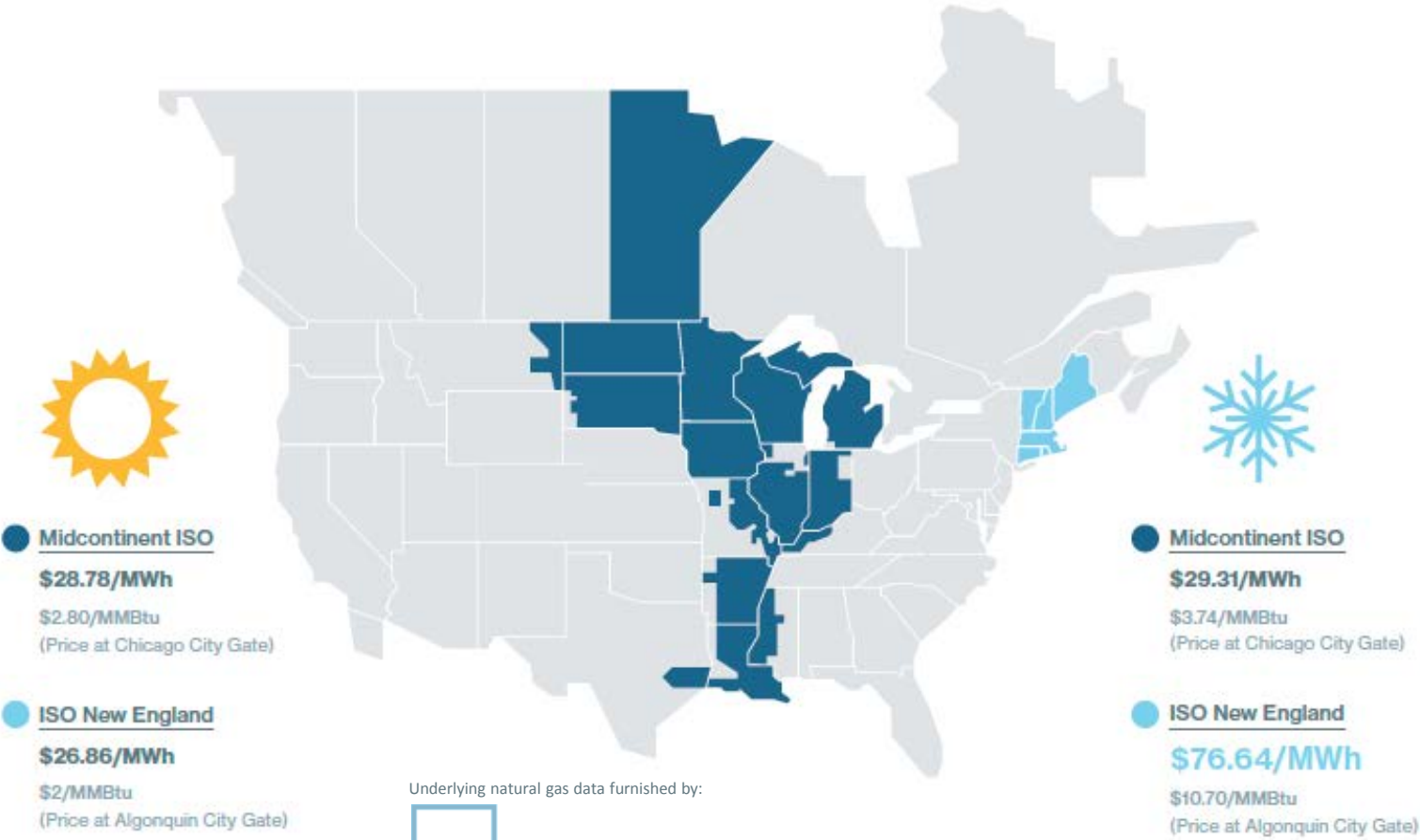
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Winter vs. Summer Prices: With Pipeline Constraints, the Price Spread is Growing

When pipelines are unconstrained, generators can access low-priced natural gas



When Pipelines are Unconstrained: New England's Wholesale Prices are Competitive with Other Regions

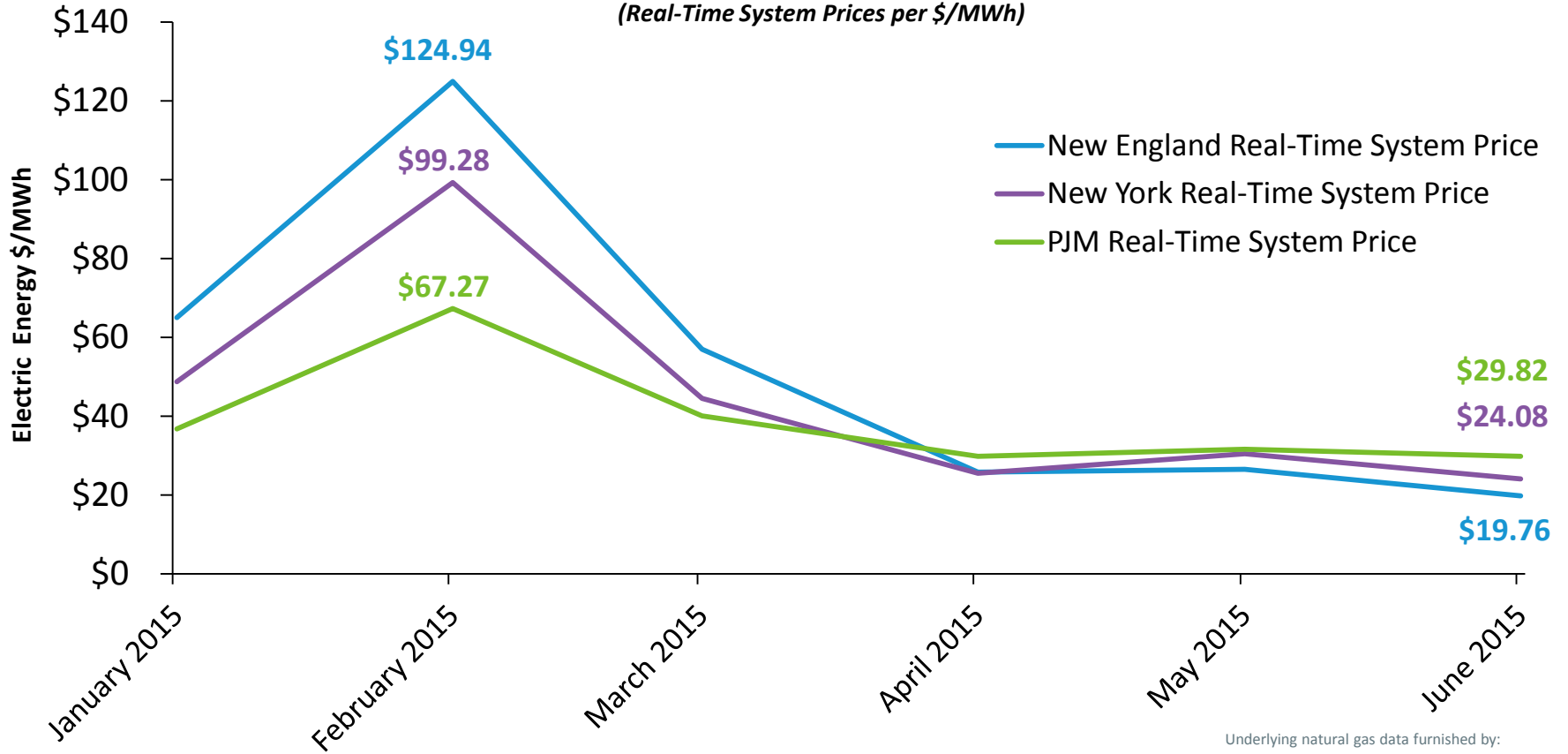


Underlying natural gas data furnished by:



When Pipelines are Unconstrained: New England's Wholesale Power Prices are Competitive with Other Regions

Monthly Average Wholesale Electricity Prices for New England, New York, and PJM
January 2015 – June 2015
(Real-Time System Prices per \$/MWh)



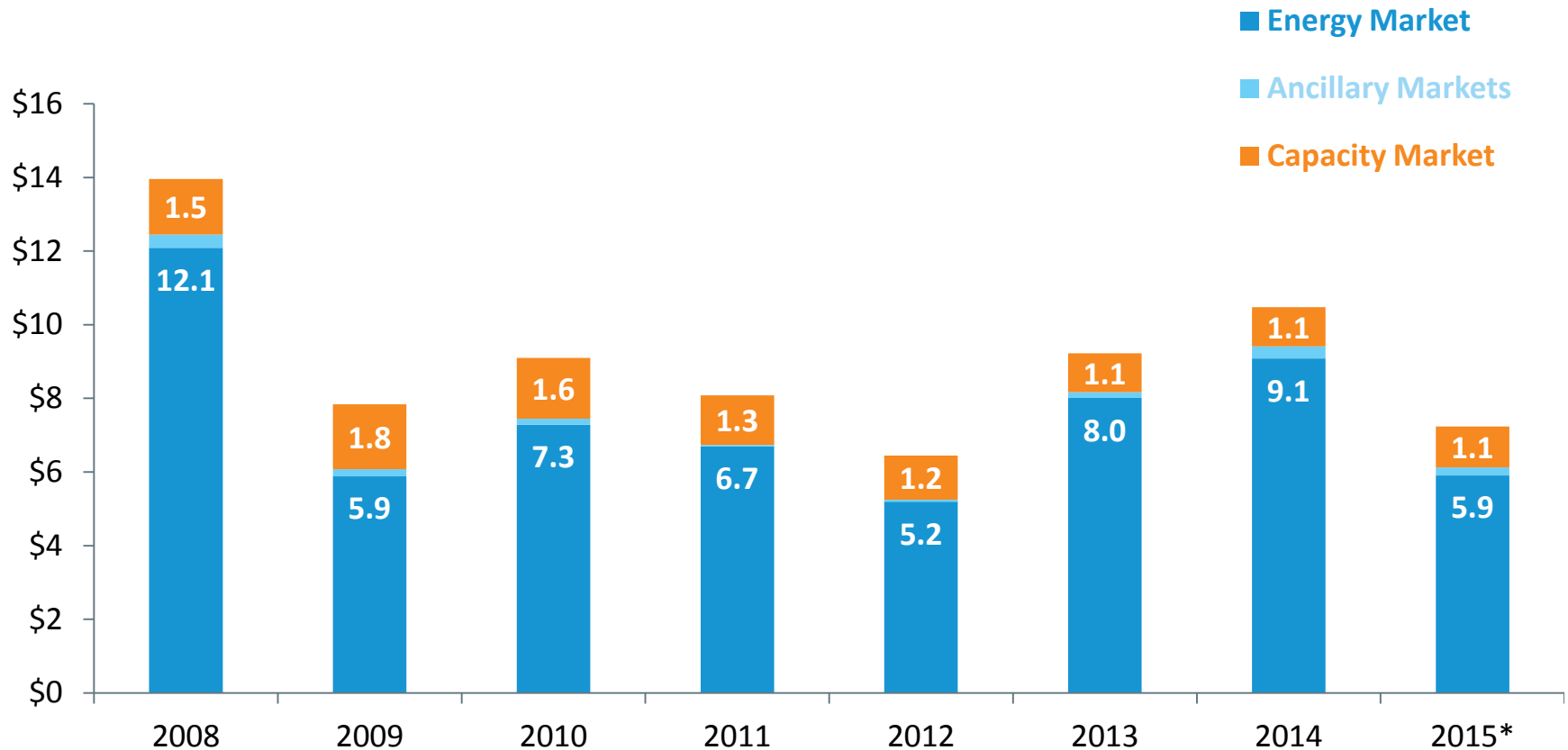
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Wholesale Electricity Costs Reflect Market Conditions

Total annual wholesale market costs have ranged from \$6 billion to \$14 billion

Annual Value of Wholesale Electricity Markets
(in billions)



* Preliminary data subject to reconciliation.

Putting Competitive Wholesale Markets to Work for New England

- Markets reveal a resource's **true operating cost**
 - Fuel is the primary driver of operating costs
 - The dollar value of New England's energy markets fell from 2008 to 2012 as low-cost natural gas displaced older, fossil fuel-fired units
- Gas-fired generators are becoming **more efficient**
 - Improvements in technology have made newer generators more economic than older generators
- Region has invested in **cleaner technologies** ahead of much of the rest of the country and has seen regional air emissions decline significantly over the past decade



Power Plant Emissions Have Declined with Changes in the Fuel Mix



Reduction in Aggregate Emissions (ktons/yr)

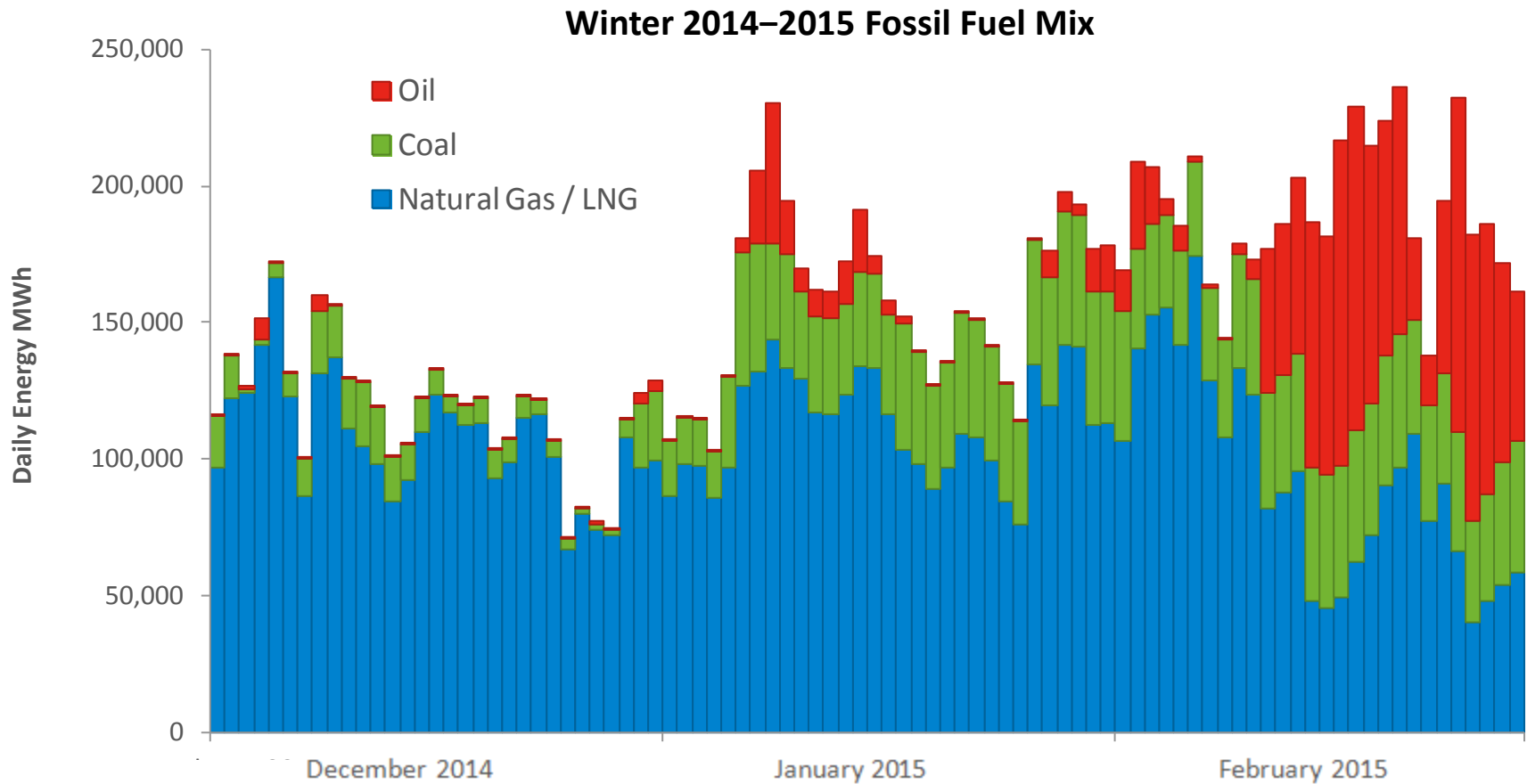
Year	NO _x	SO ₂	CO ₂
2001	59.73	200.01	52,991
2014	20.49	11.68	39,317
% Reduction, 2001–2014	↓ 66%	↓ 94%	↓ 26%

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%

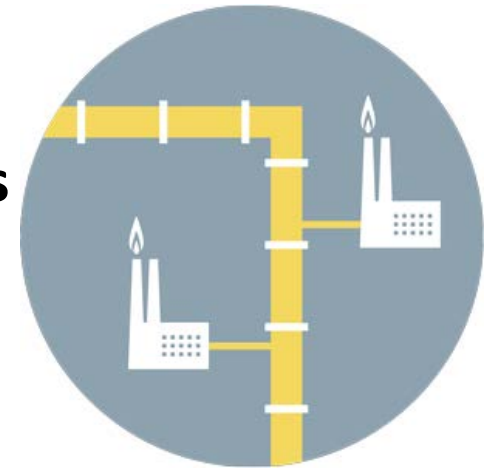
Source: [2014 ISO New England Electric Generator Air Emissions Report](#), January 2016

New England Shifts to Coal and Oil in the Winter



Winter Operations Highlight Natural Gas Pipeline Constraints as a Continuing Reliability Challenge

- Close to half—**13,650 MW, or 44%**—of the total generating capacity in New England uses natural gas as its primary fuel
- 2015/16 winter outlook identifies up to **4,220 MW** of natural gas-fired generation at risk of not being able to get fuel when needed
- To address continuing concerns about natural gas pipeline constraints, the ISO will administer **Winter Reliability Programs** until 2018 to help improve fuel security and protect power system reliability



Winter 2015/2016 So Far

December 1, 2015 through January 18, 2016

- Mildest December since at least 1960
 - Even milder than December 2014
 - Lowest December energy usage since 2003 (10,160 GWh)
 - Second-lowest wholesale power price at \$21.35 per megawatt-hour
 - June 2015 was lowest, at \$19.61/MWh
- Beginning of January was also mild
- When weather is mild:
 - Natural gas demand is lower
 - Pipelines are less constrained
 - Prices of natural gas and electricity fall

12/1 thru 1/18	Winter 13/14	Winter 14/15	Winter 15/16
Ave monthly temp (°F)	29.1	30.7	37.9
Total energy consumption (GWh)	18,339	17,818	16,470
Peak demand (MW)	21,448	20,556	19,227
Date of peak and temp	12/17/13 15°F	1/8/15 20°F	1/5/16 22°F
Ave. real-time energy price (\$/MWh)	\$105.66	\$53.27	\$26.01
Ave. natural gas price (\$/MMBtu)	\$13.58	\$7.36	\$3.22
Total value of energy market (billions)	\$2.024	\$1.038	\$0.464

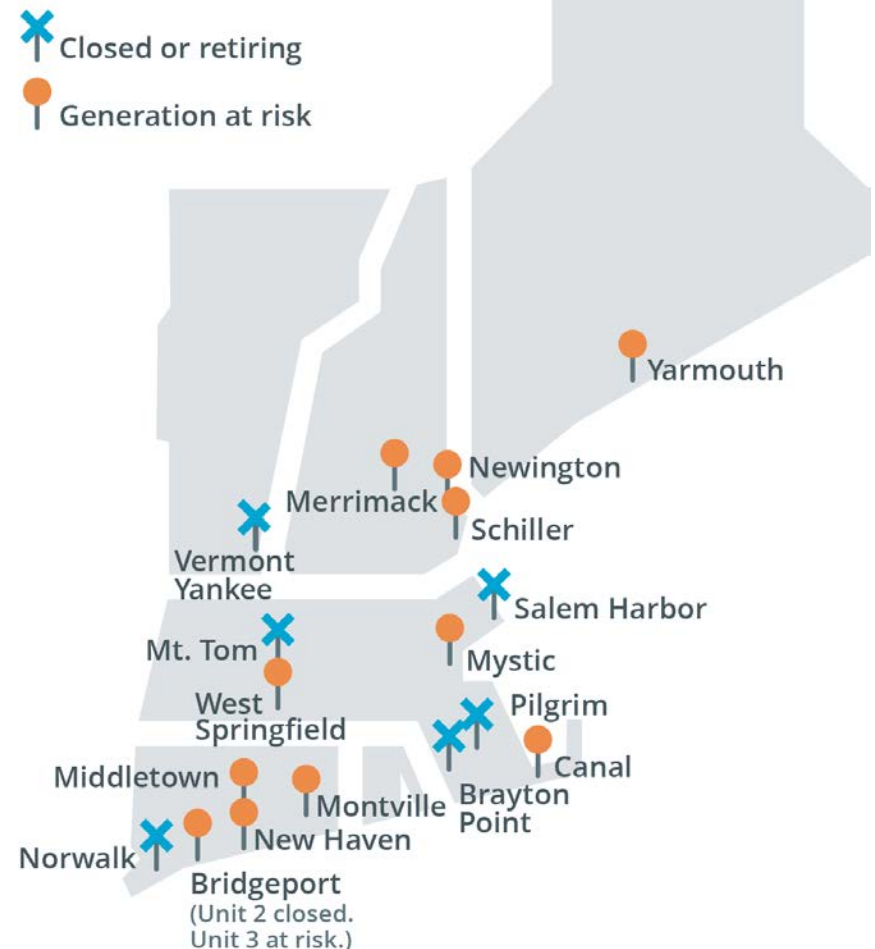
Underlying natural gas data furnished by:



More Than 4,200 MW of Generation Have Retired or Will Retire in Less Than Five Years

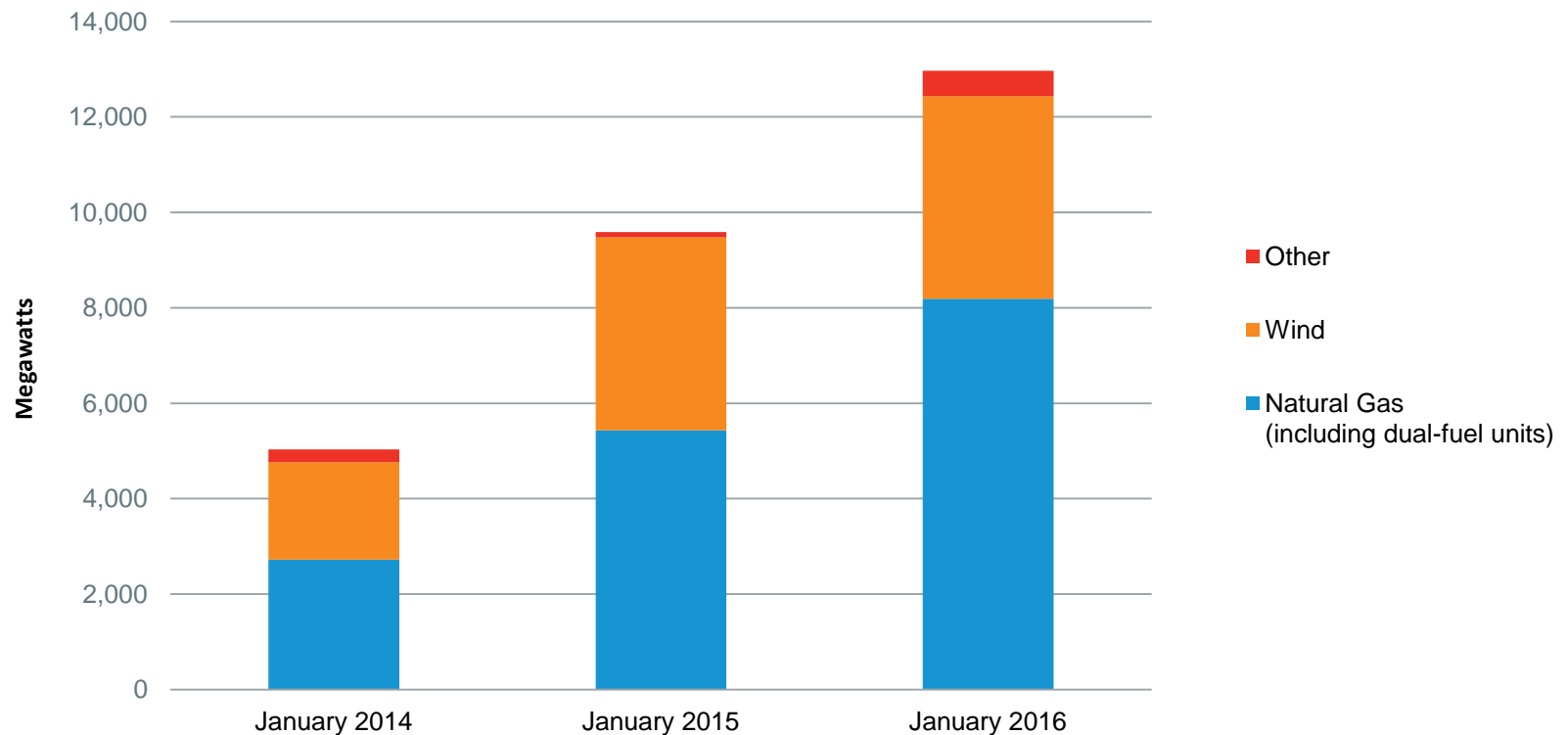
Major Generator Retirements:

- **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*



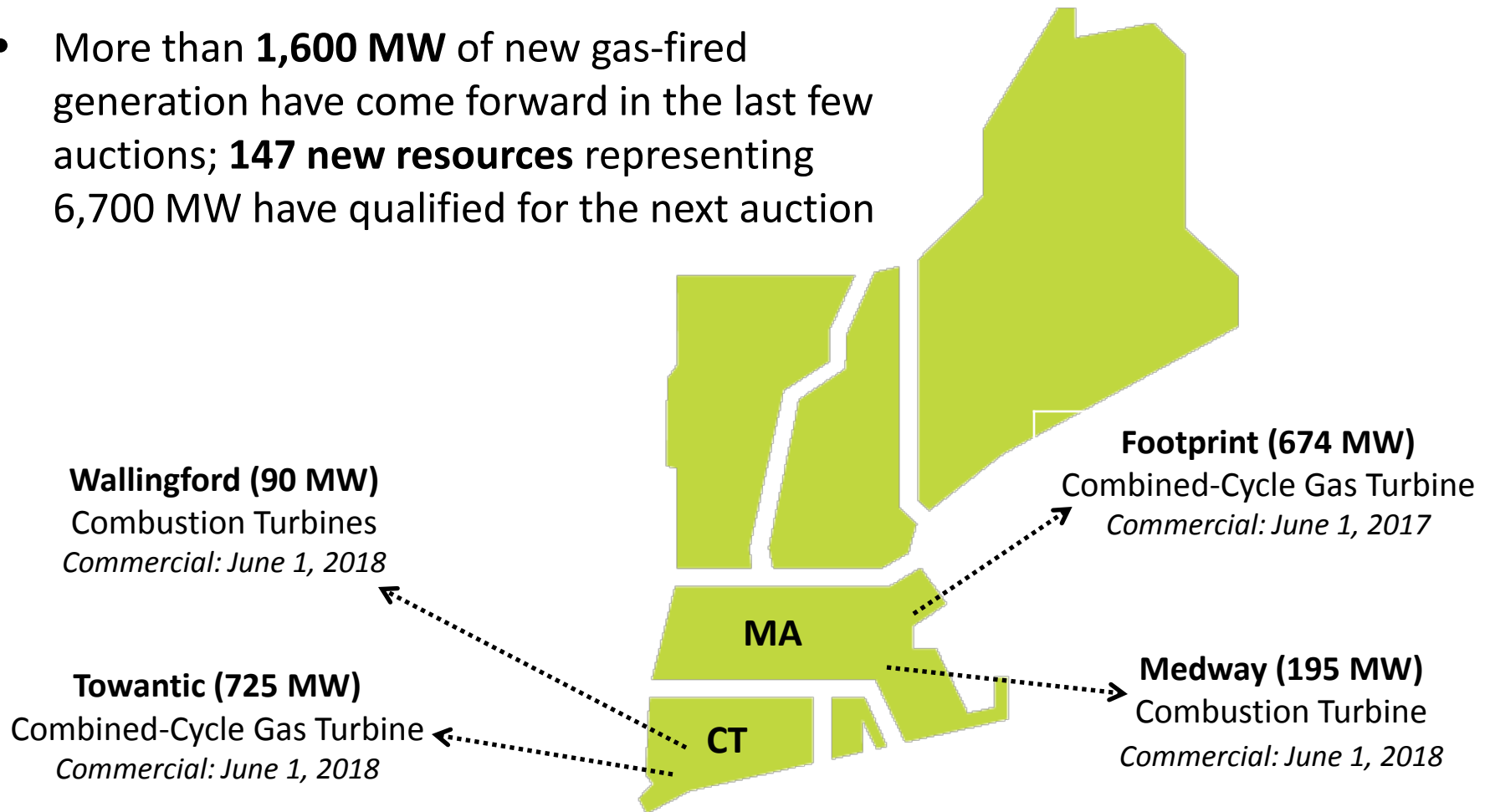
Generator Retirements and Higher Capacity Prices Signal the Need for New Supply Resources

Proposed Capacity in ISO's Generator Interconnection Queue



Forward Capacity Market Is Attracting Efficient and Fast-Starting Resources

- More than **1,600 MW** of new gas-fired generation have come forward in the last few auctions; **147 new resources** representing 6,700 MW have qualified for the next auction



STATE OF THE GRID: PREPARING FOR THE HYBRID GRID



Market Enhancements Are Providing Benefits

- Provide proper signals to market participants to improve their resource's performance, retire, or build new resources
- Price signals promoting investment, reflecting fundamentals
 - Guiding New England's transition through a gas and renewables system
 - Attracting new entry, at competitive, transparent prices
- Benefits of well-designed capacity and energy markets
 - Greater return on investments for resources that perform reliably
 - Simpler, more predictable capacity market design
 - Promotes flexibility, innovation, and cost-effective development



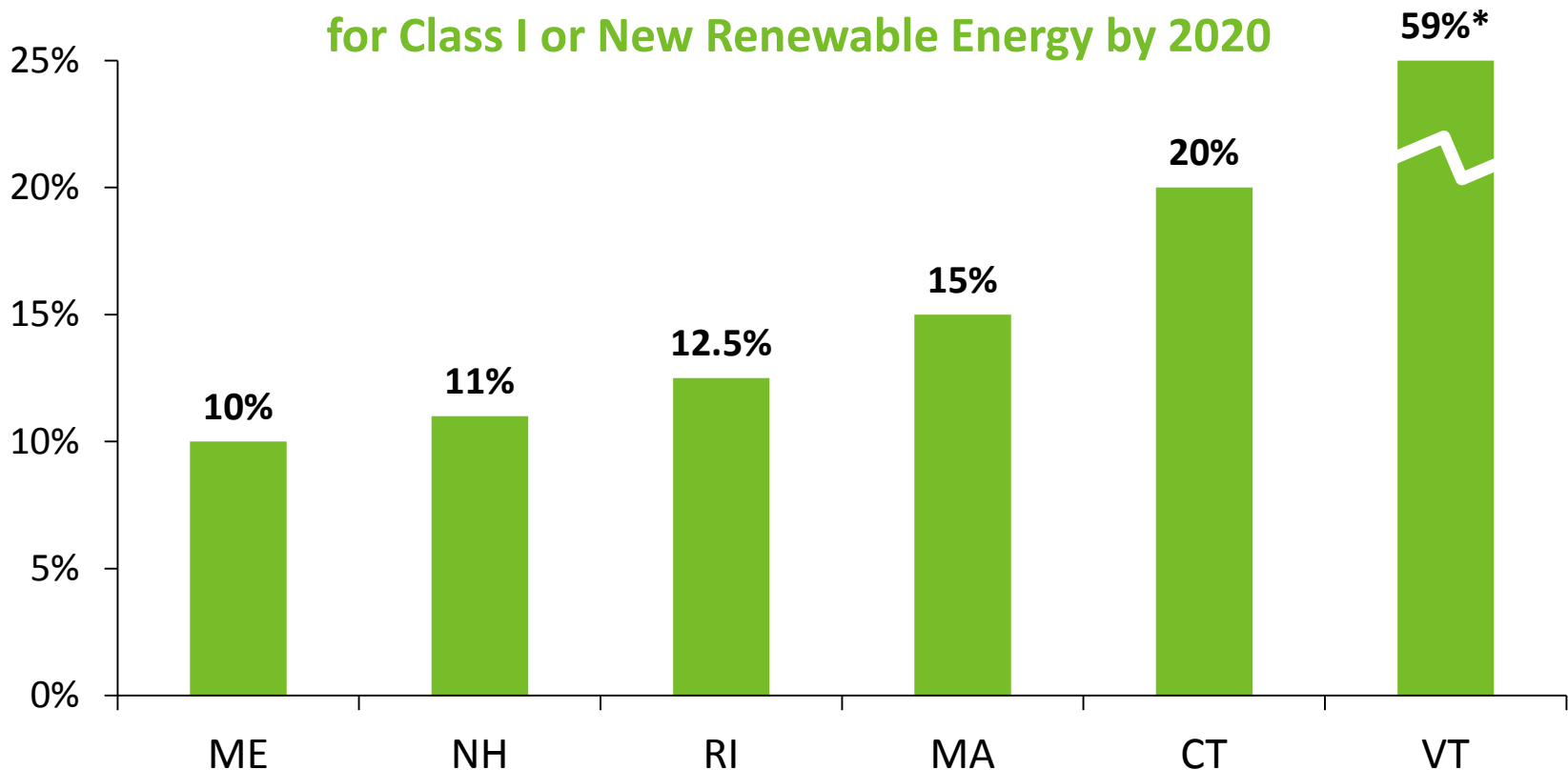
Market Changes Allow Variable Resources to More Effectively Participate in the Wholesale Markets

- **Negative offer price:** allows generators like wind resources the opportunity to operate during low-load conditions when their output otherwise might be curtailed
- **Do-not-exceed dispatch order:** allows the ISO to better manage transmission congestion to maximize the use of low-cost renewable resources and alleviate the need for curtailments
- **Elective transmission upgrade rules:** contain options for strengthening electrically weak portions of the grid to help integrate distant resources like wind



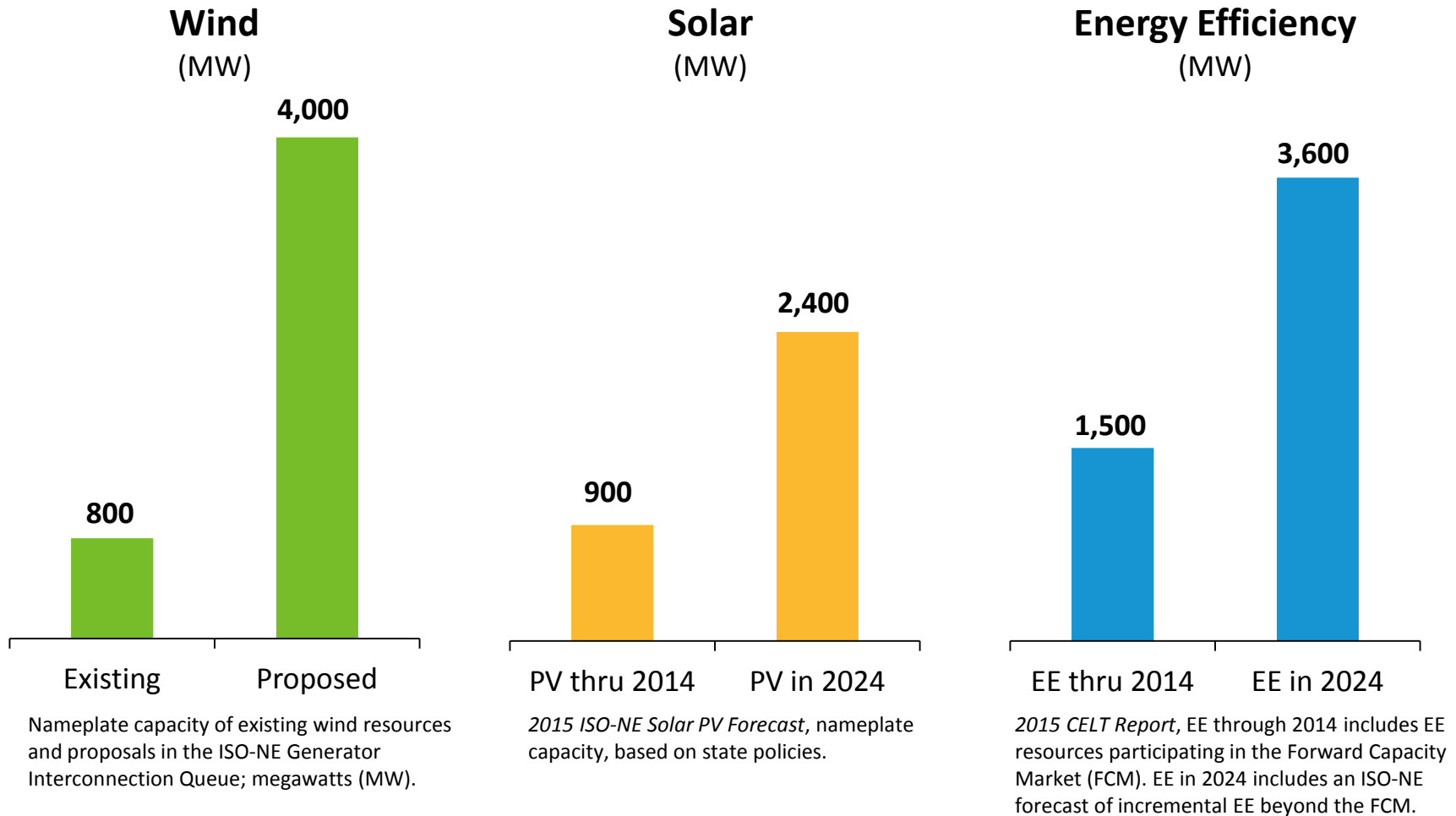
State Policy Requirements Drive Proposals for Renewable Energy

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

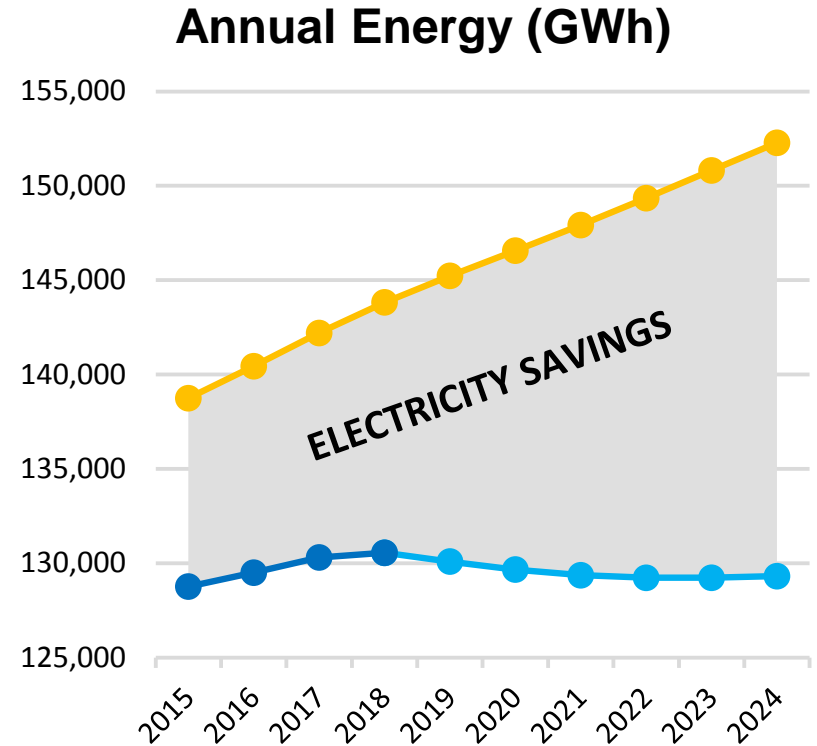
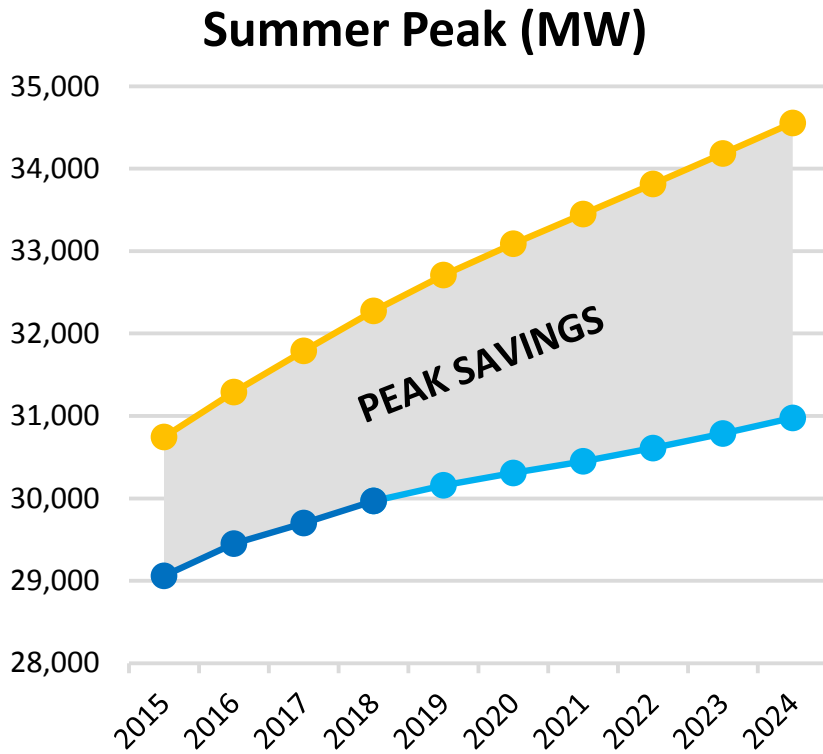


* State Renewable Portfolio Standards (RPS) promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Vermont's new Renewable Energy Standard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

Renewable and EE Resources Are Trending Up



Energy Efficiency Is Slowing Peak Demand Growth and Flattening Energy Use



The gross forecast of peak demand and energy use



The forecast minus the impact of EE participating in the Forward Capacity Market (FCM) to date

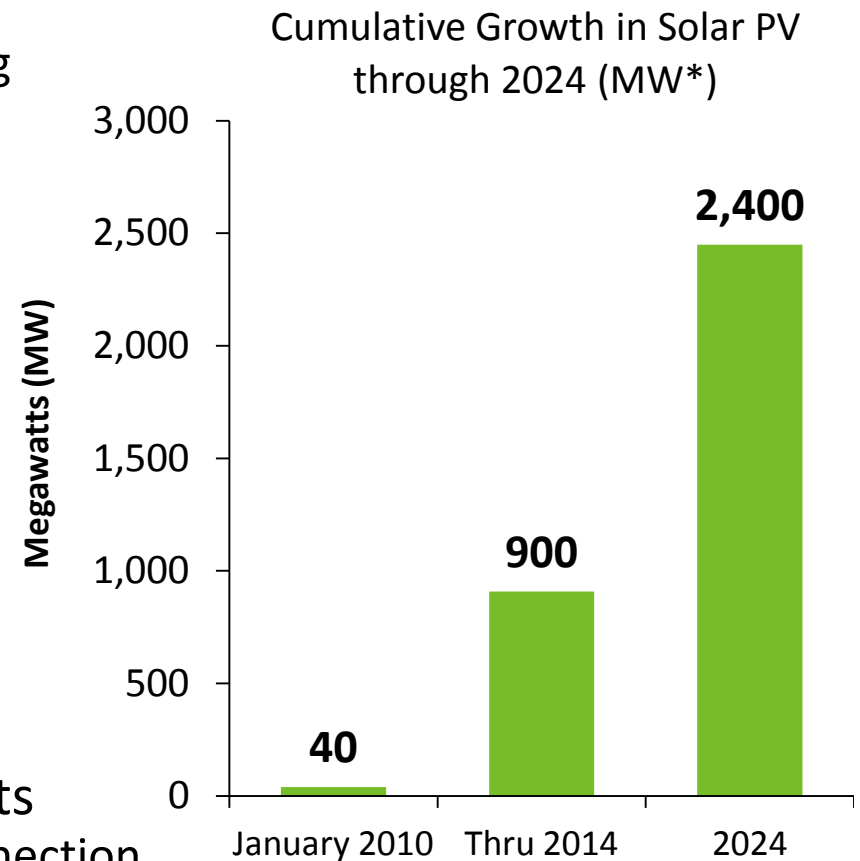


The forecast minus anticipated EE growth beyond FCM years

Source: [Final ISO New England EE Forecast for 2019-2024](#) (April 2015)

The ISO is Leading Efforts to Account for Solar Resources Connected to the Distribution System

- Long-term solar forecast
 - Tracking historical growth; predicting solar development 10 years ahead
 - Used in transmission planning and market needs assessments
 - In 2015, PV forecast used for first time in Installed Capacity Requirement time, reducing 2019/2020 need by 390 MW
- Short-term solar forecast
 - ISO creates daily forecasts of solar PV production to improve daily load forecasts
- Interconnection rules improvements
 - ISO is helping develop new interconnection standards to reduce reliability concerns

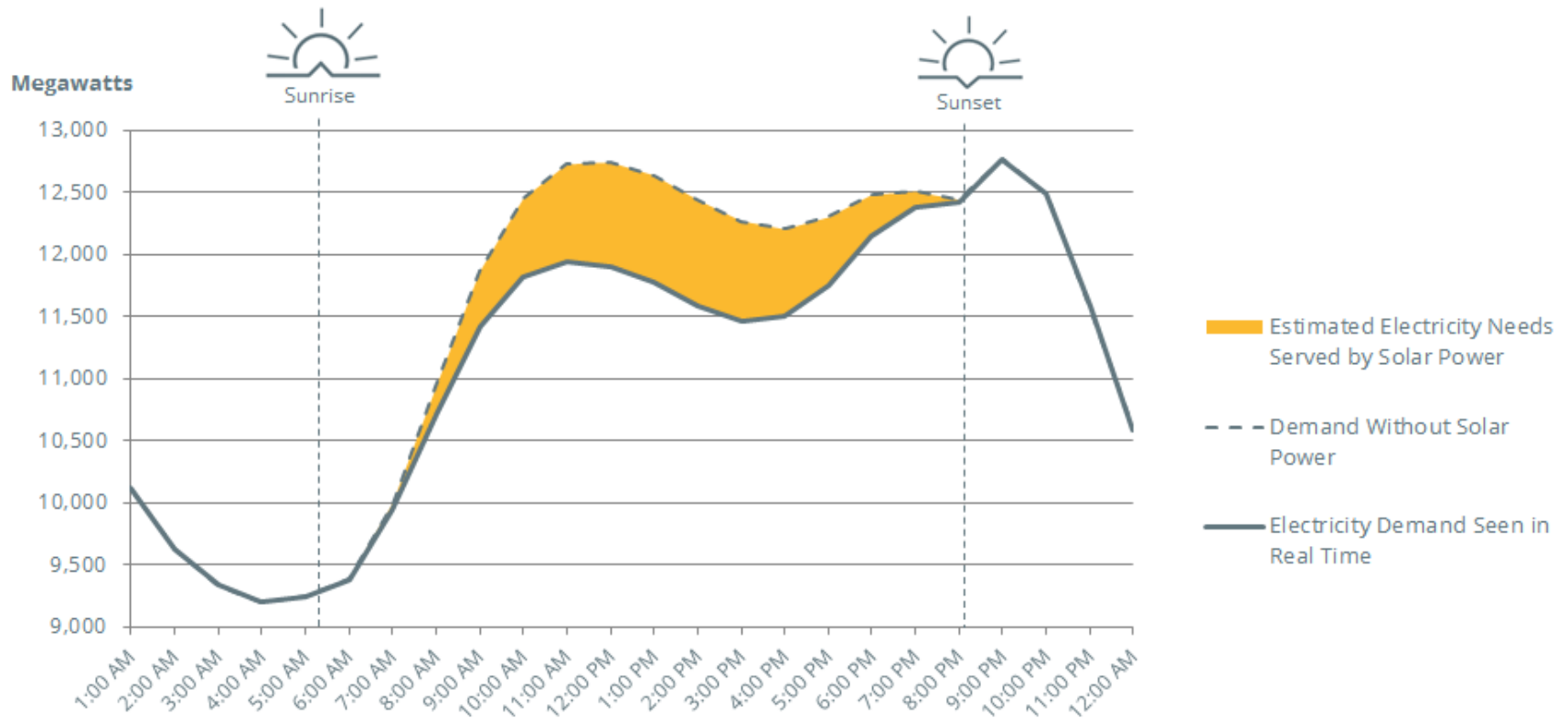


Source: [Final PV Forecast](#) (April 2015); Note: MW values are AC nameplate

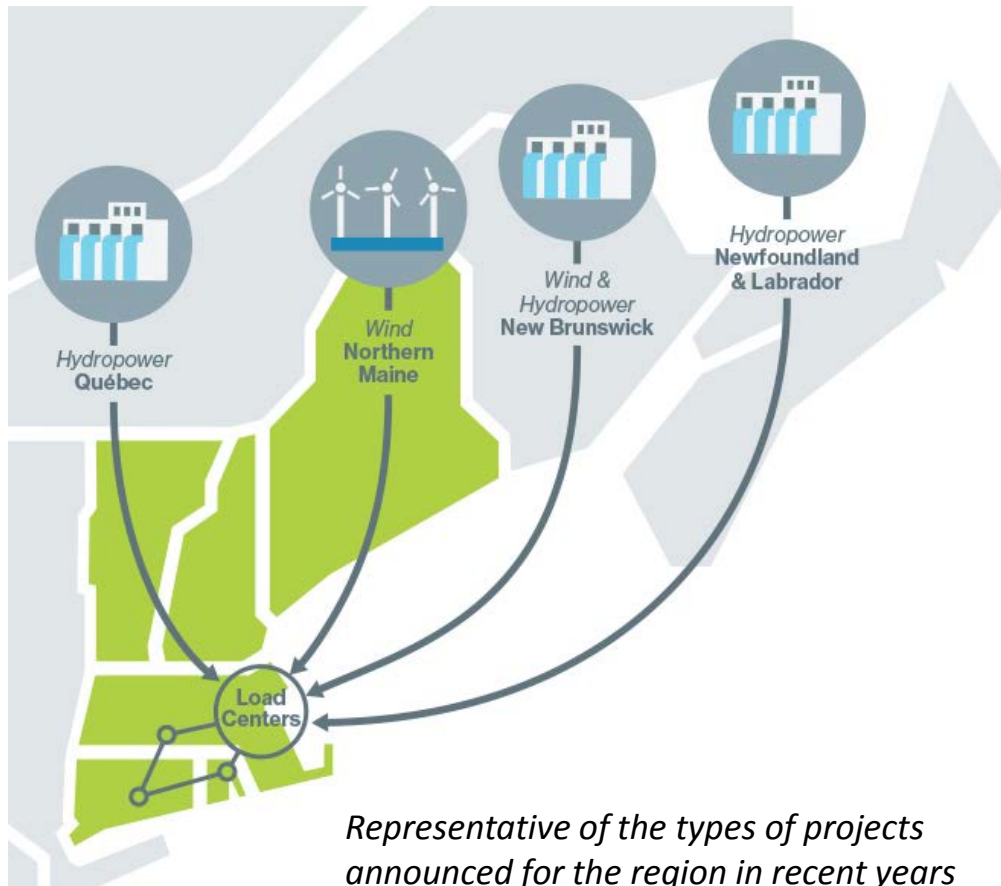
Solar Power's Effect on Hourly Electricity Demand

May 23, 2015

Solar Power's Effect on Regional Electricity Demand
May 23, 2015



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



- 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
- These merchant projects seek to address public policy goals, not reliability needs

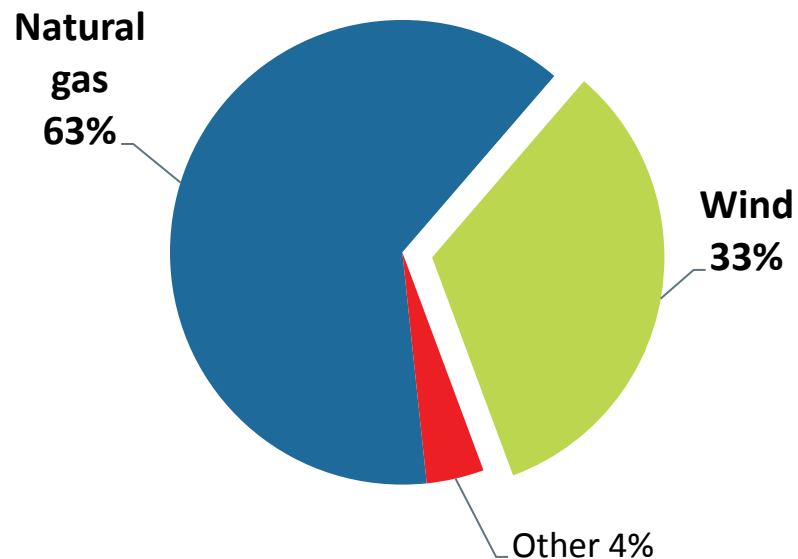
Source: ISO Interconnection Queue (January 2016)

<http://www.iso-ne.com/system-planning/transmission-planning/interconnection-request-queue>

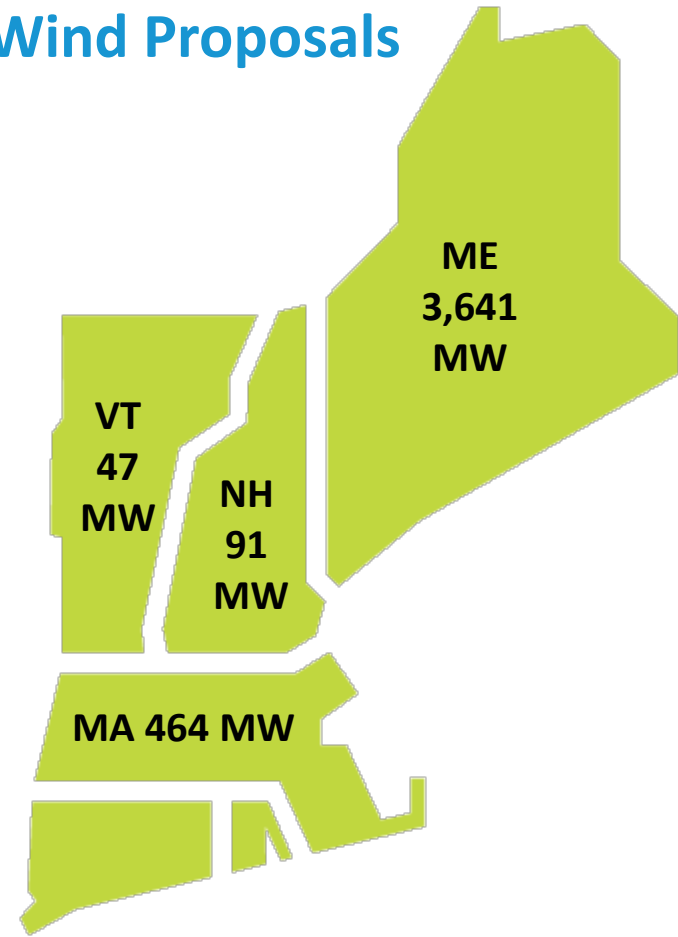
Infrastructure Will Be Needed to Deliver Energy from Proposed Resources

All Proposed Generation

Developers are proposing to build 13,000 MW of generation, including nearly 8,200 MW of gas-fired generation and more than 4,200 MW of wind



Wind Proposals



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

STATE OF THE GRID: CONCLUSIONS



Conclusions

- **Competitive wholesale electricity markets** have resulted in significant efficiencies & have driven billions of dollars of investment in New England's power system
- **New England's generation fleet is changing rapidly** – the use of natural gas for power generation is increasing dramatically; older, fossil-fired units are retiring; and renewables and demand-side resources are growing
- **New England needs additional energy infrastructure** – rising demand for natural gas drives the need for additional natural gas infrastructure; increasing wind development in remote areas will require additional transmission; and growing levels of variable generation will require a fleet of flexible resources to successfully integrate
- **Wholesale power prices are directly related to natural gas prices** – when natural gas pipelines are unconstrained, natural gas and wholesale power prices drop
- **ISO New England has taken major steps** to address these challenges to reliability through financial incentives provided in the wholesale market and in changes to transmission planning processes, and will continue to work with regional stakeholders to help manage the continuing transition in the regional resource mix

Questions



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