Connecticut Department of Energy and Environmental Protection

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

GC3 Analysis, Data, and Metrics Working Group Meeting

May 5, 2016
1:00 — 3:00 p.m.

Connecticut Department of Energy and Environmental Protection

Agenda

2:00	Welcome
2:05	Natural gas electric generation mix now and into the future *Katie Dykes, Deputy Commissioner for Energy and Tracy Babbidge, Bureau Chief*
2:30	Opportunities for interaction between the State Comprehensive Energy Strategy and the GC3 climate change mitigation analysis *Katie Dykes, Deputy Commissioner for Energy and Tracy Babbidge, Bureau Chief*
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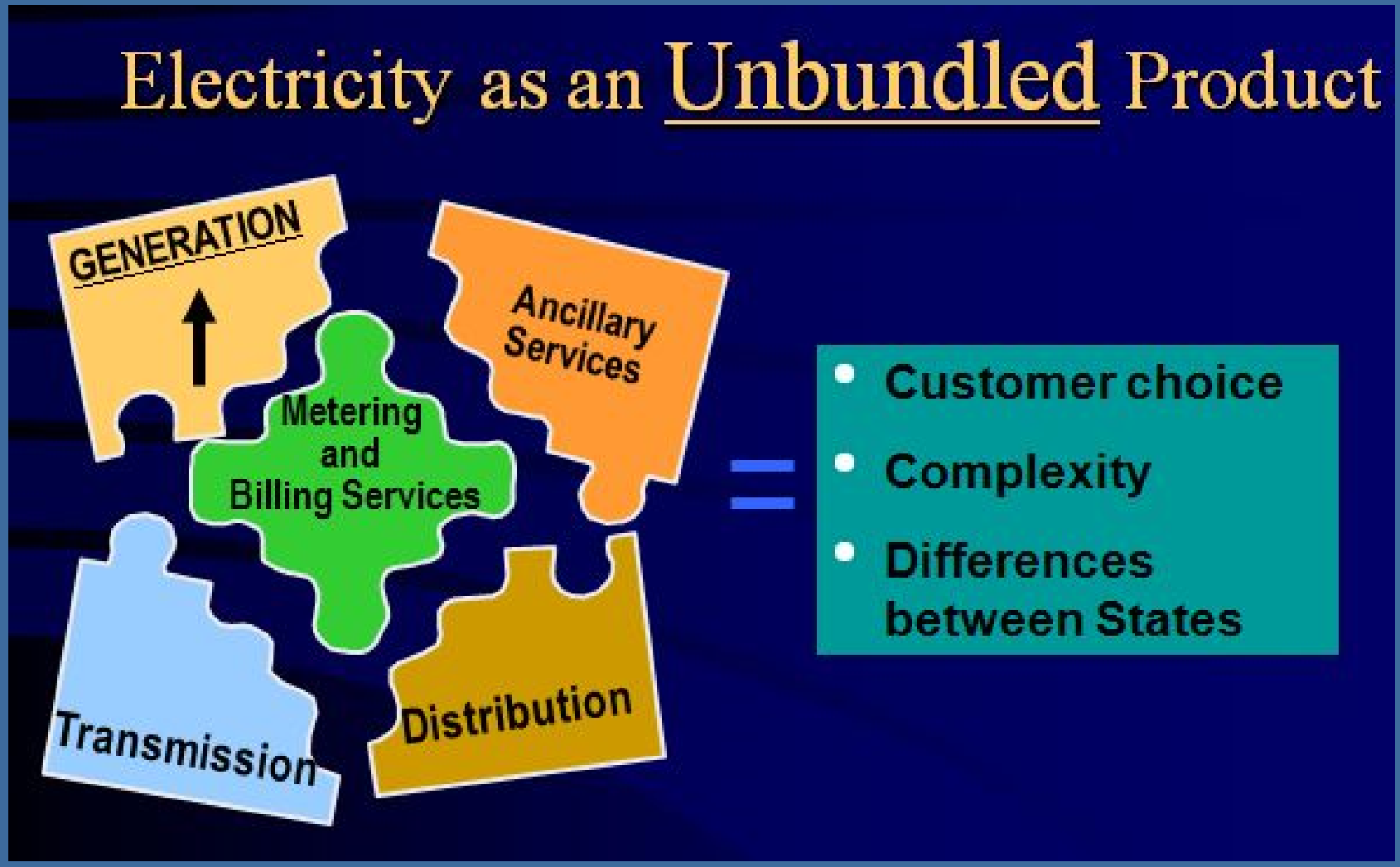
Energy Market:
Drivers and Developments

May 5, 2016
Deputy Commissioner Katie Dykes
GC3 ADM Working Group Meeting

Connecticut Department of Energy and Environmental Protection

Evolution of the Energy Markets

1900 1978 1990 2000 2016



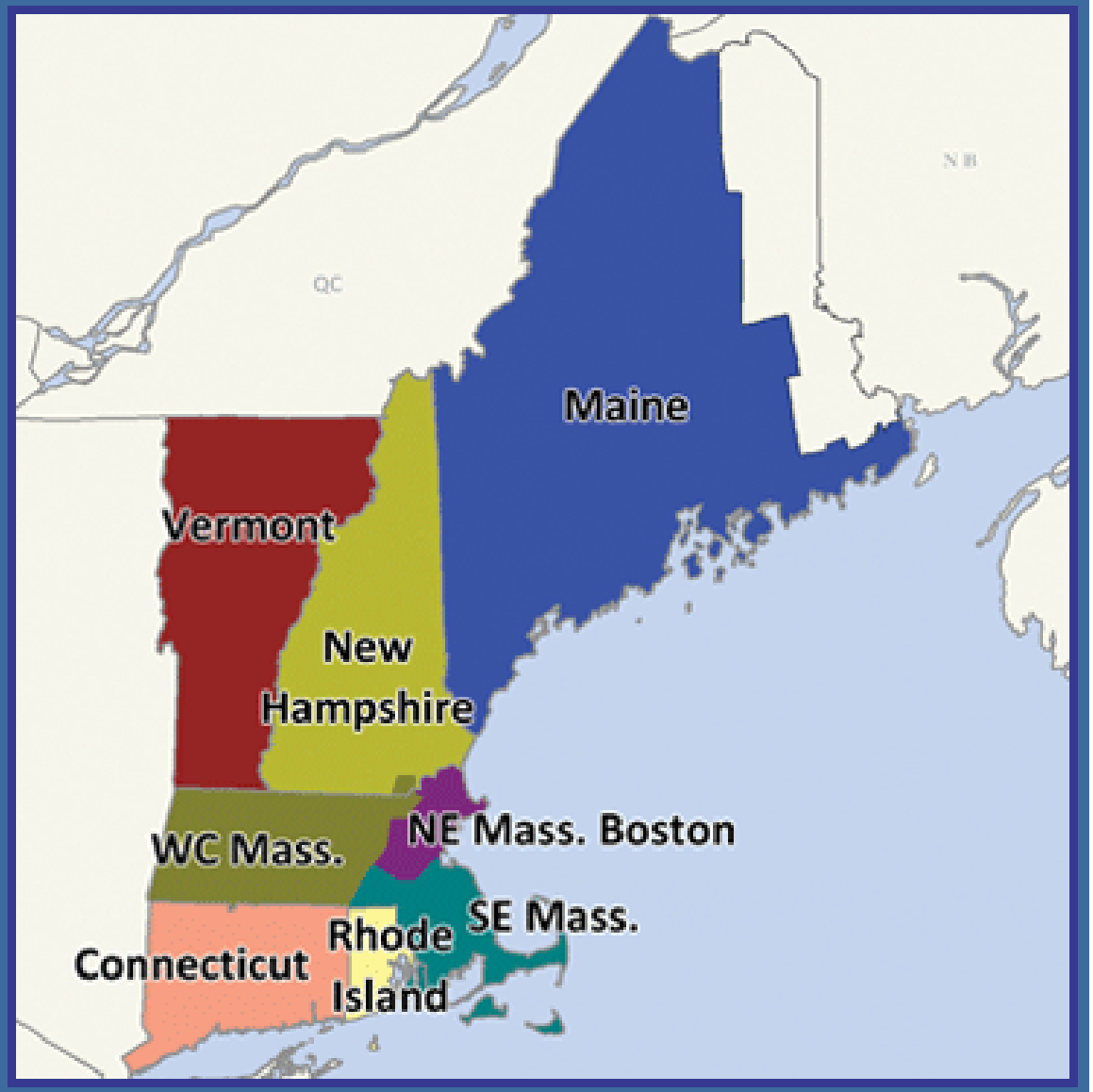
Vertically Integrated Monopolies→Deregulation/Restructuring→Regional ISO-NE Markets

ISO-NE Wholesale Markets

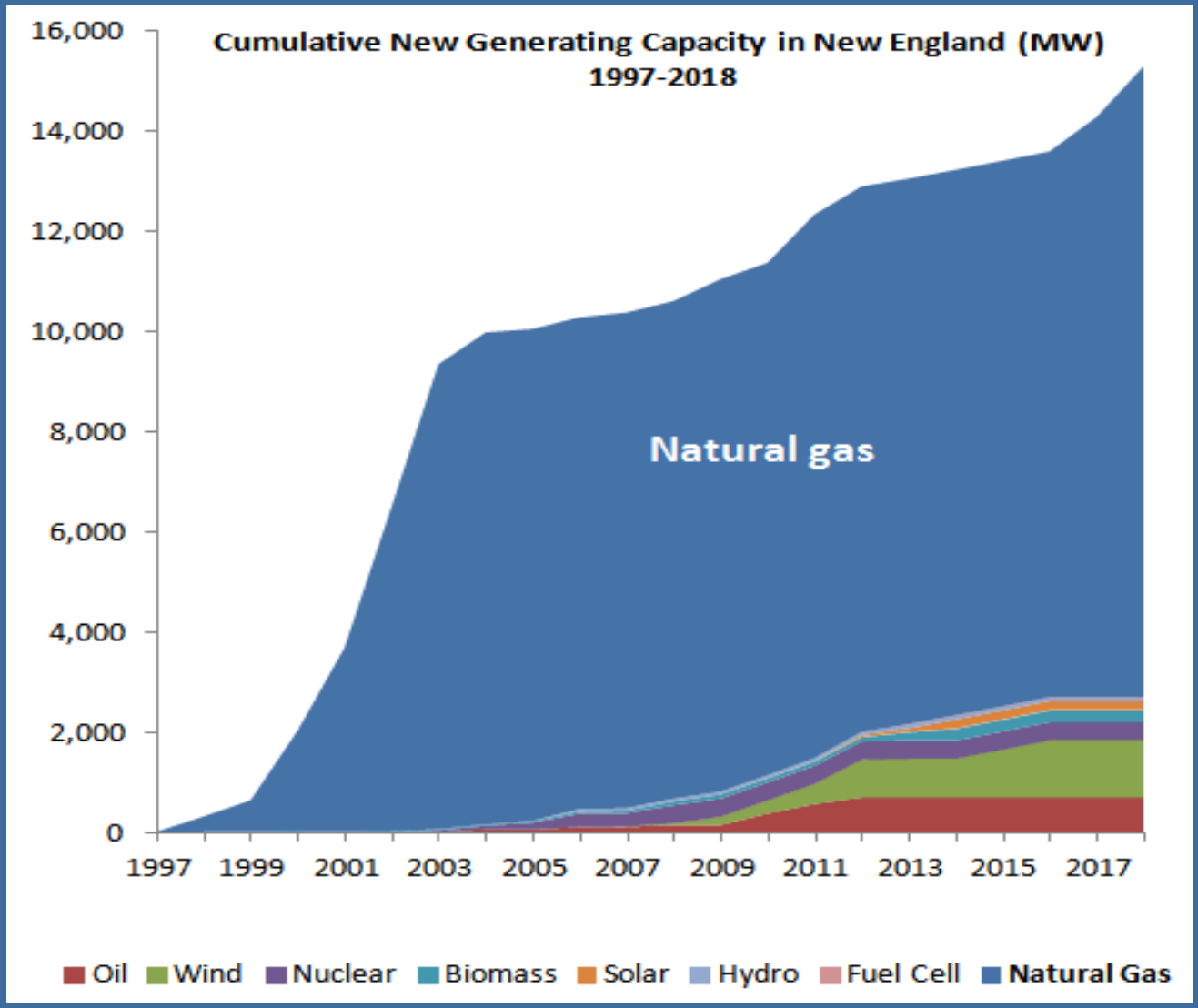
Forward Capacity Market (FCM): Three-year forward market that commits "capacity" resources to meet system resource-adequacy needs

Energy Market: Daily market for wholesale customers to buy and sell electric "energy

Ancillary Markets: Reserves and regulation provide support for system operations

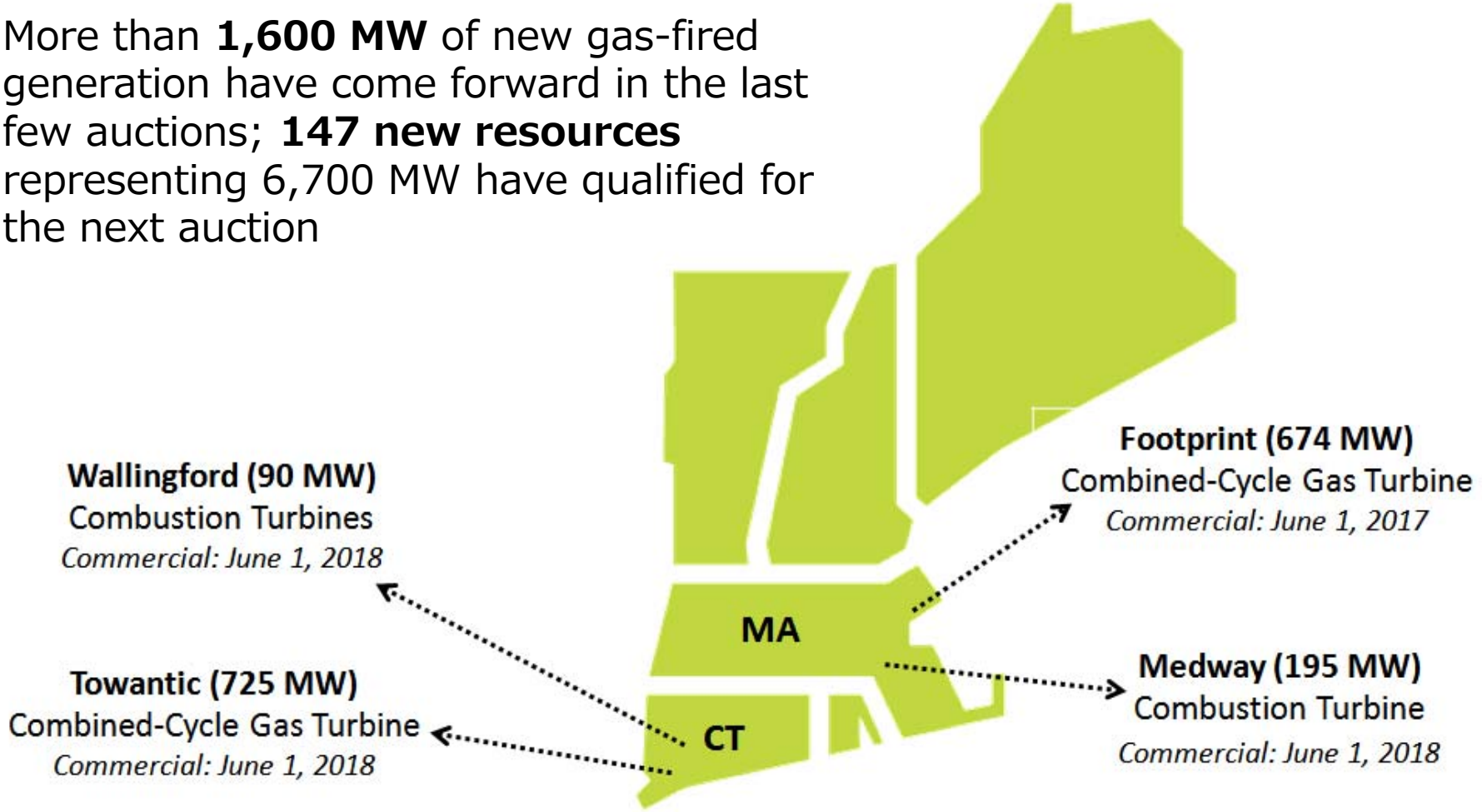


Transformation of Region's Resource Mix



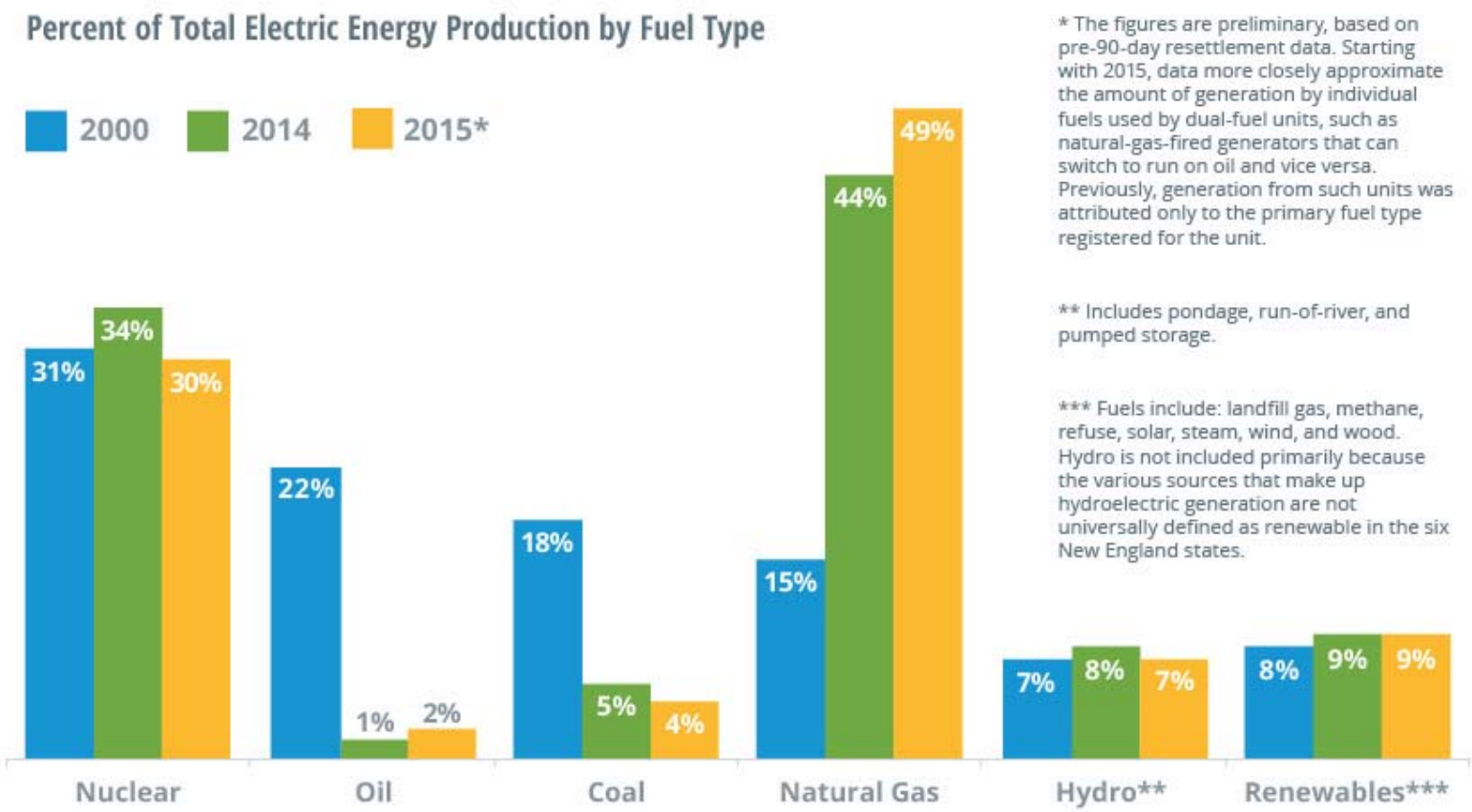
New Natural Gas Generation is Clearing in the Capacity Market

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



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



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%**

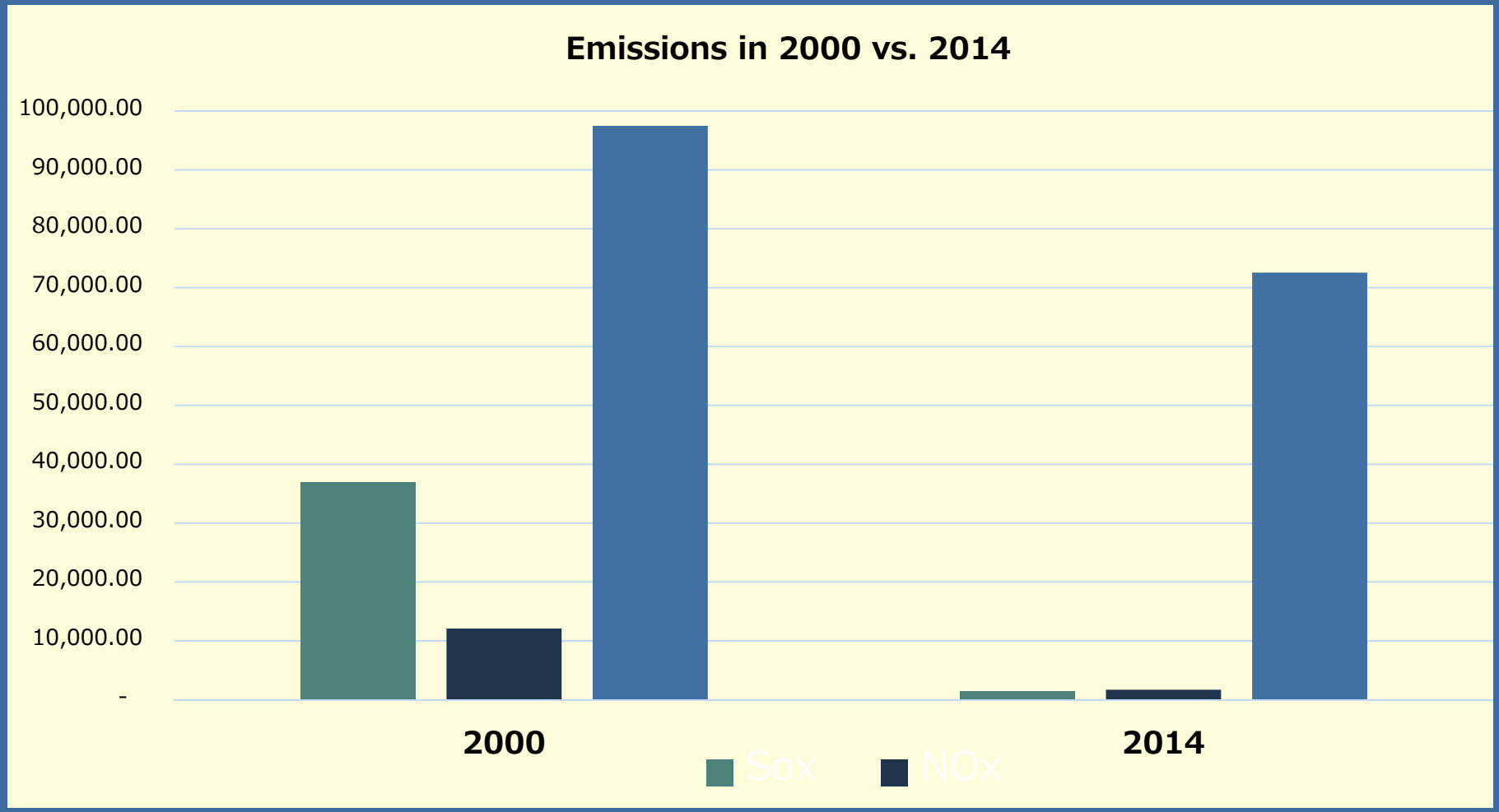
Reduction in Average Emission Rates (lb/MWh)

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

Connecticut's Emission Reduction Story

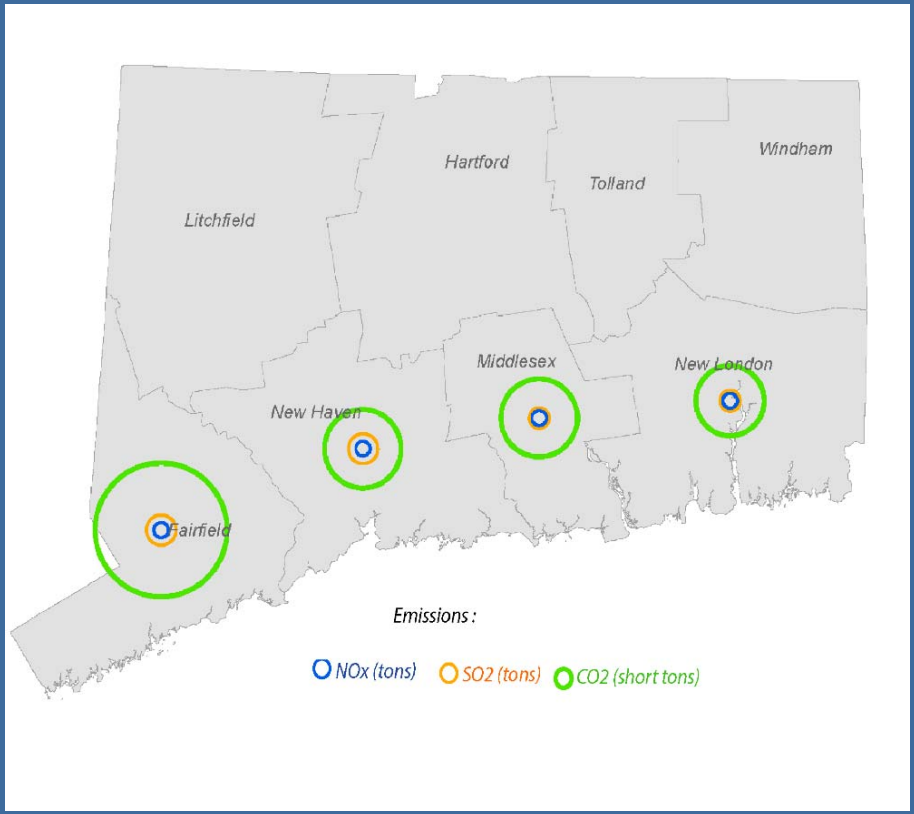
96% reduction in SOx, 86% reduction in NOx, and 26% reduction in CO2!



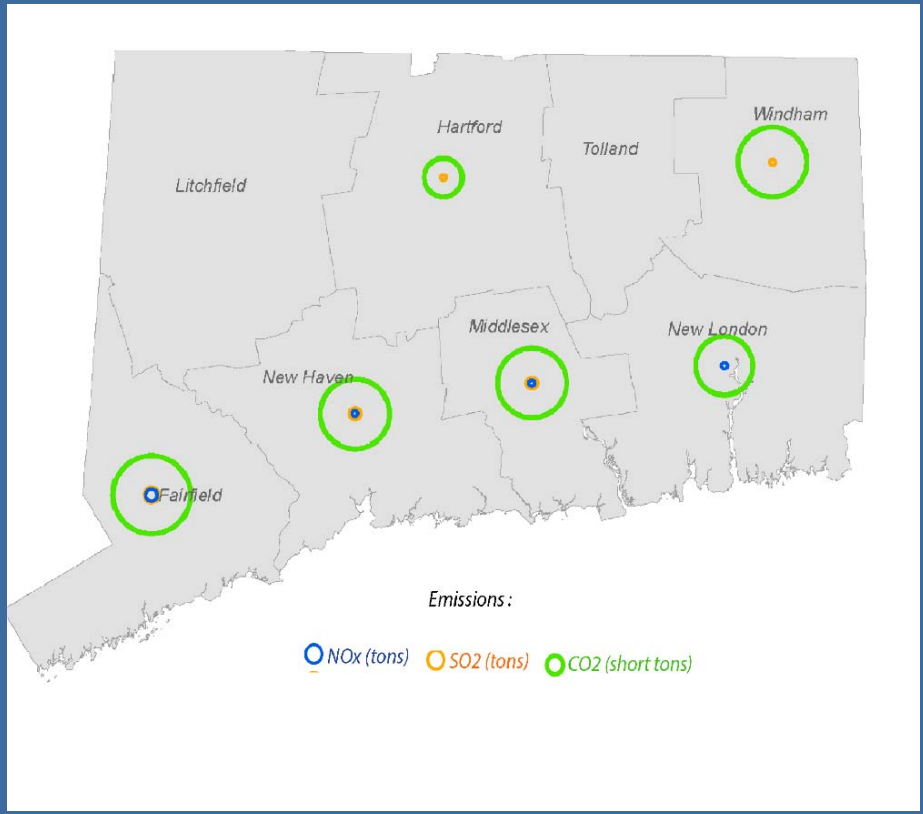
*CO2 emission shown in as 100s of tons, all else in tons

More to the Emissions Story

2000



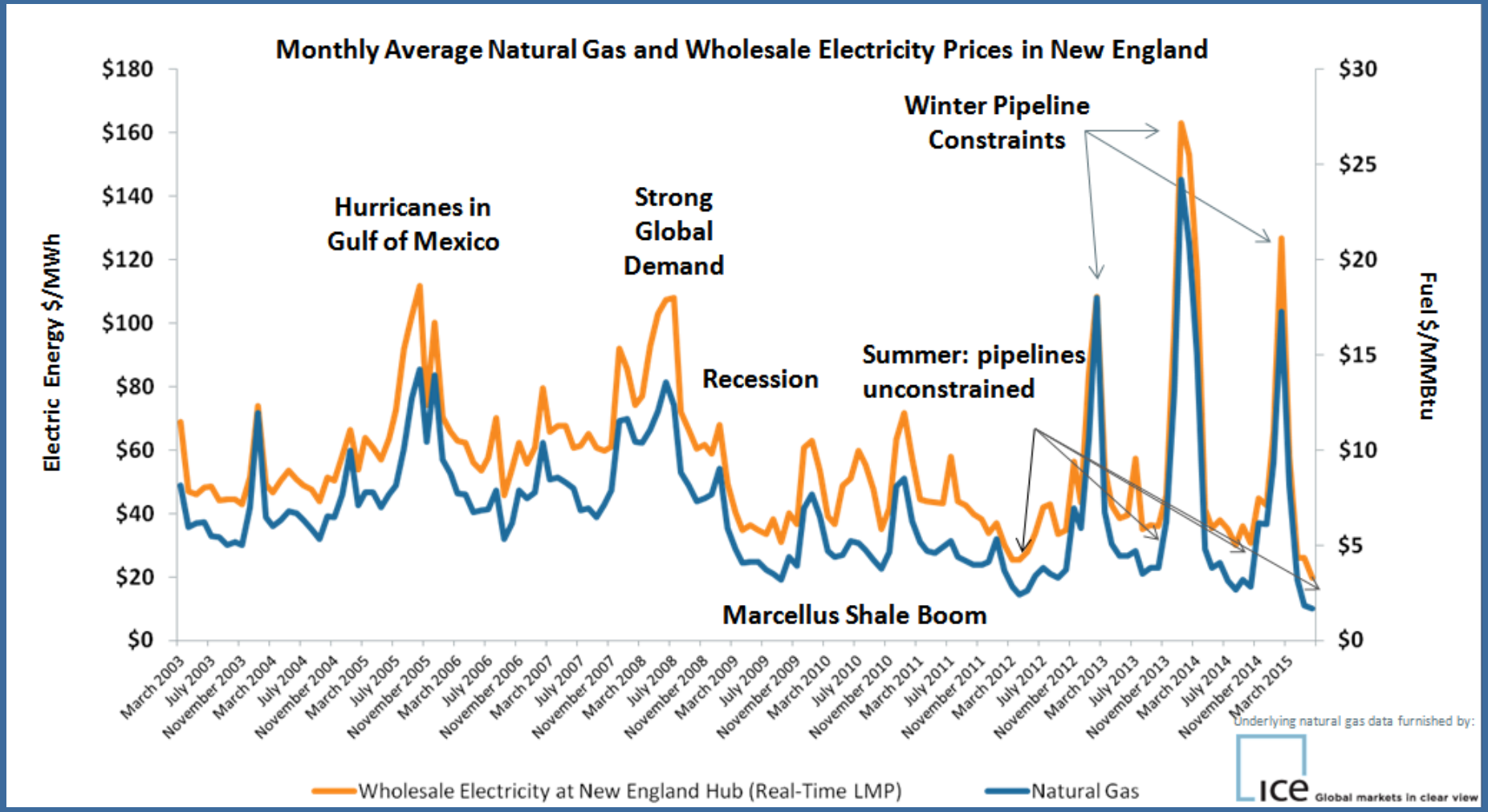
2014



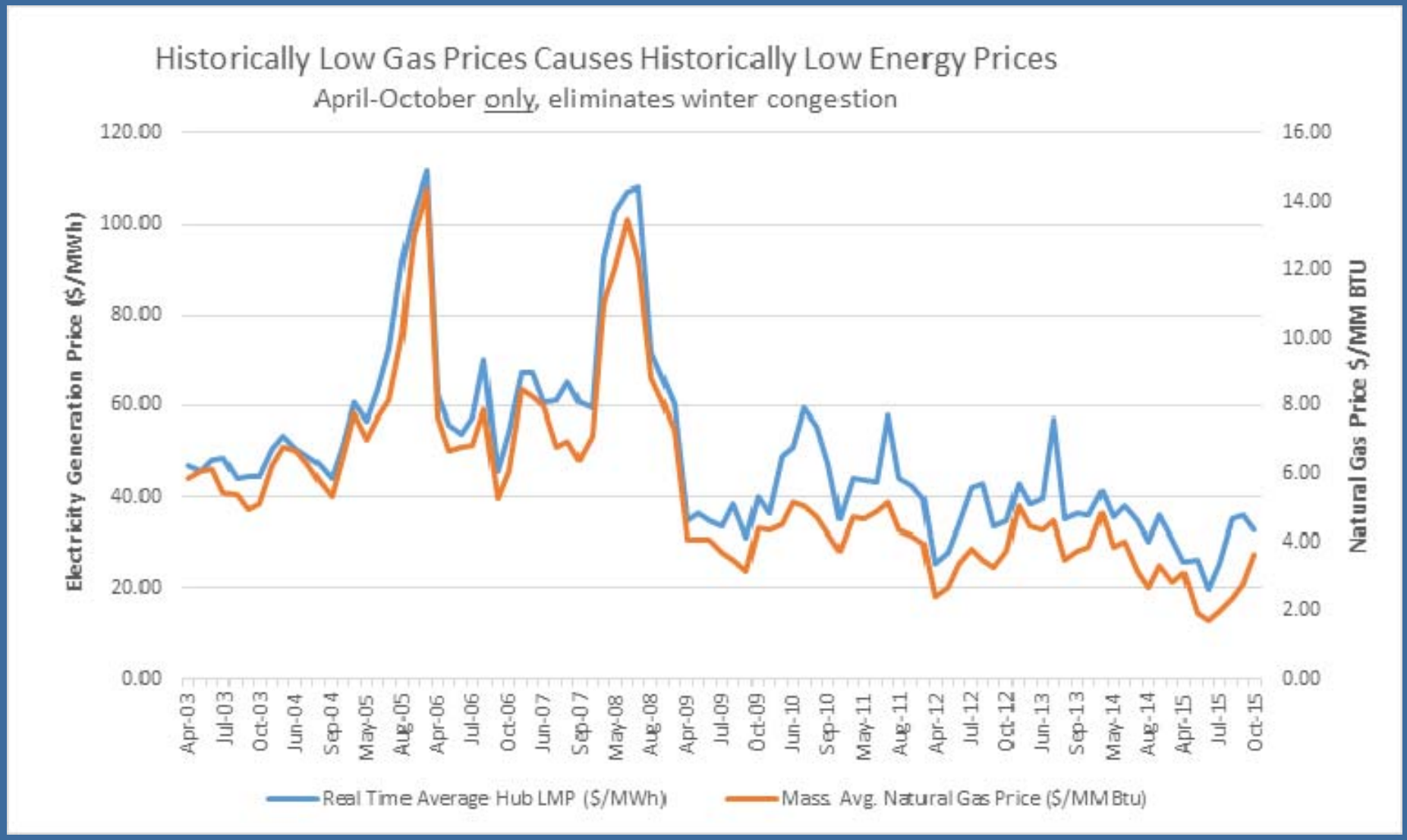
The size of the circles represents the relative amount of pollutant emitted. In our urban areas, we significantly reduced emissions of NOx and Sox, the pollutants that have relatively immediate and acute adverse health impacts on Connecticut residents.

Natural Gas and Wholesale Electricity Prices Are Linked

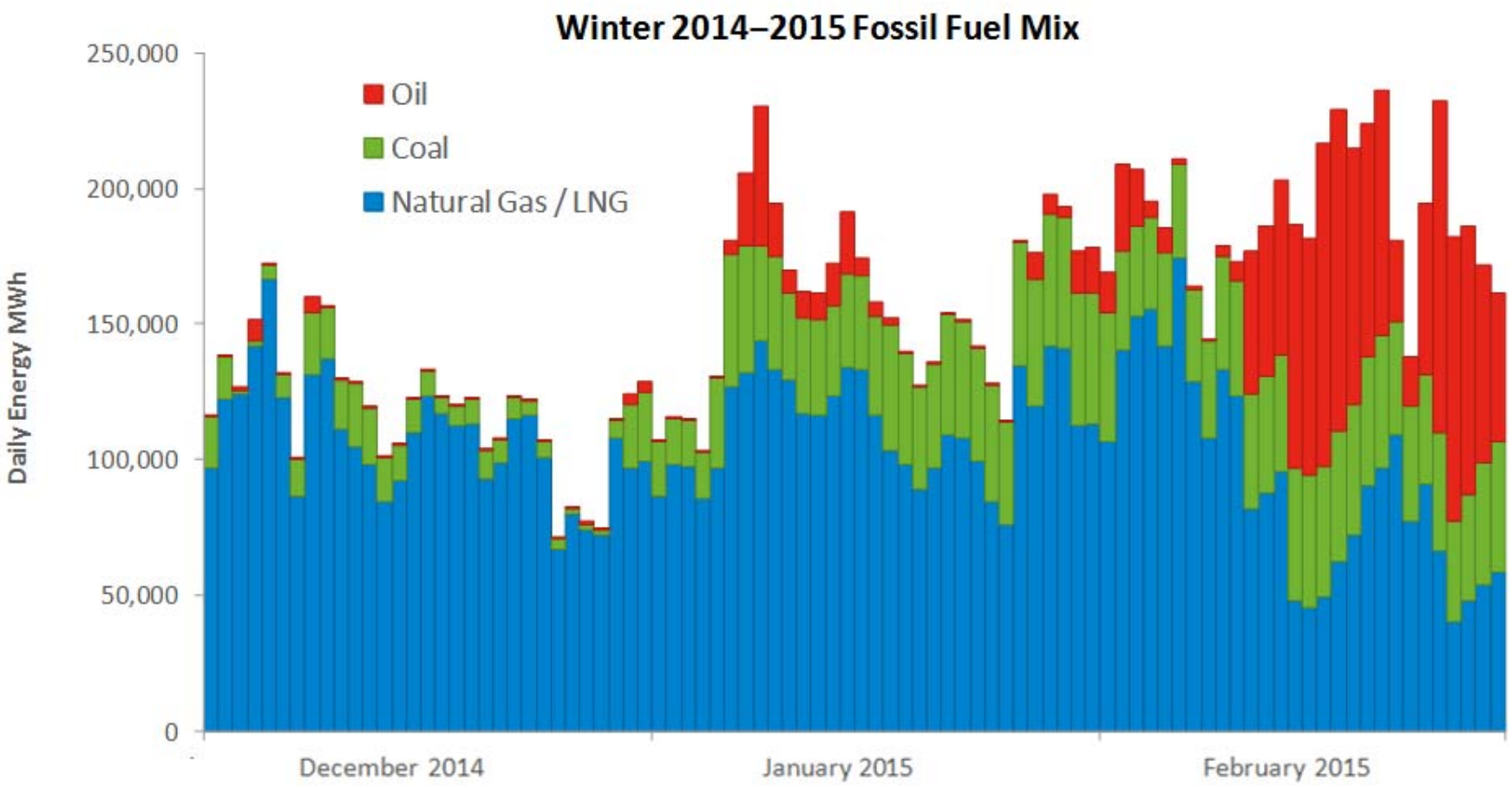
With natural gas the primary fuel used to produce electricity, natural-gas-fired power plants typically set the price for wholesale electricity



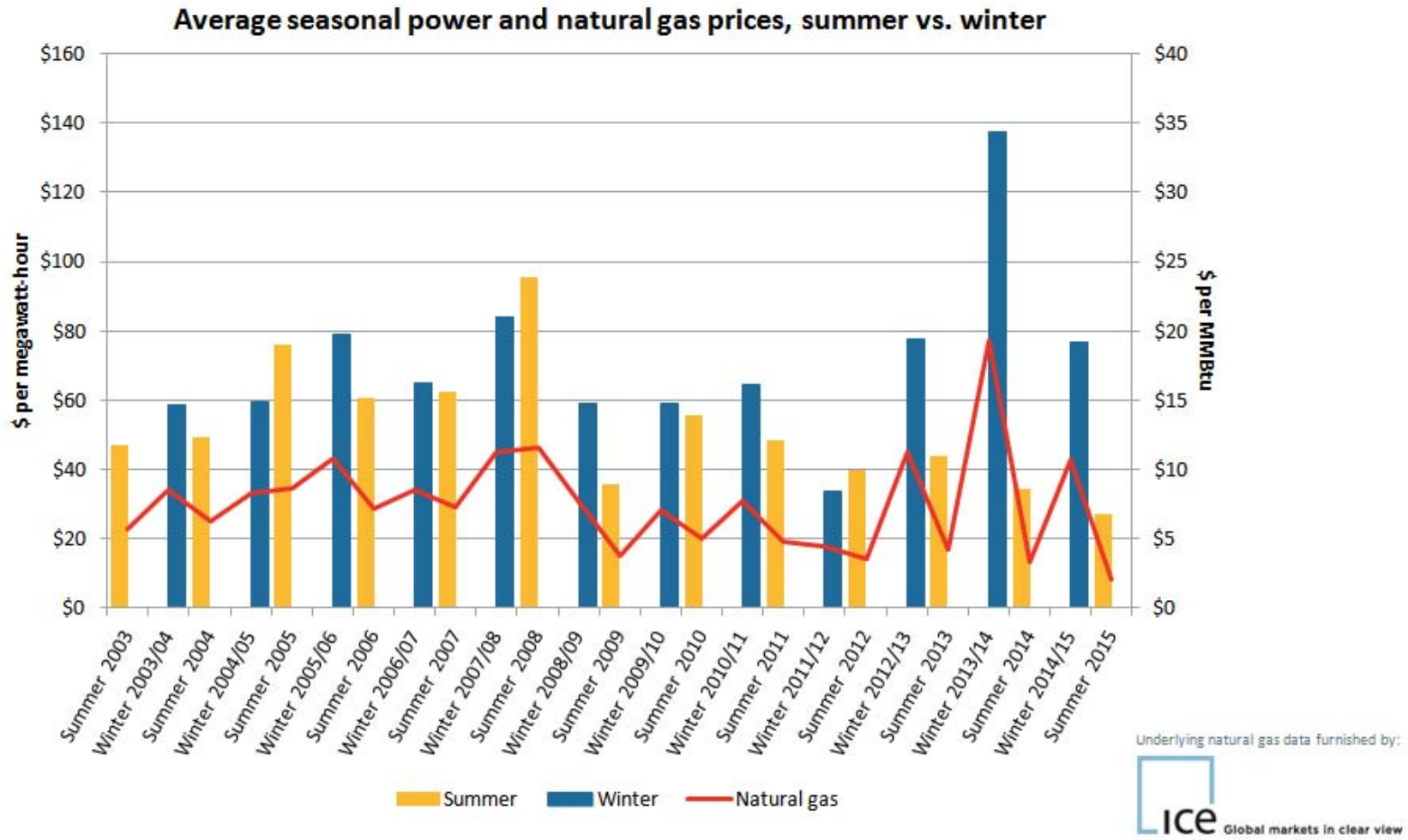
Natural Gas Causing Lower Energy Market Prices



New England Shifts to Coal and Oil in the Winter



Winter v. Summer Power Prices



Generator Retirements

New England Shifts to Coal and Oil in the Winter

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)

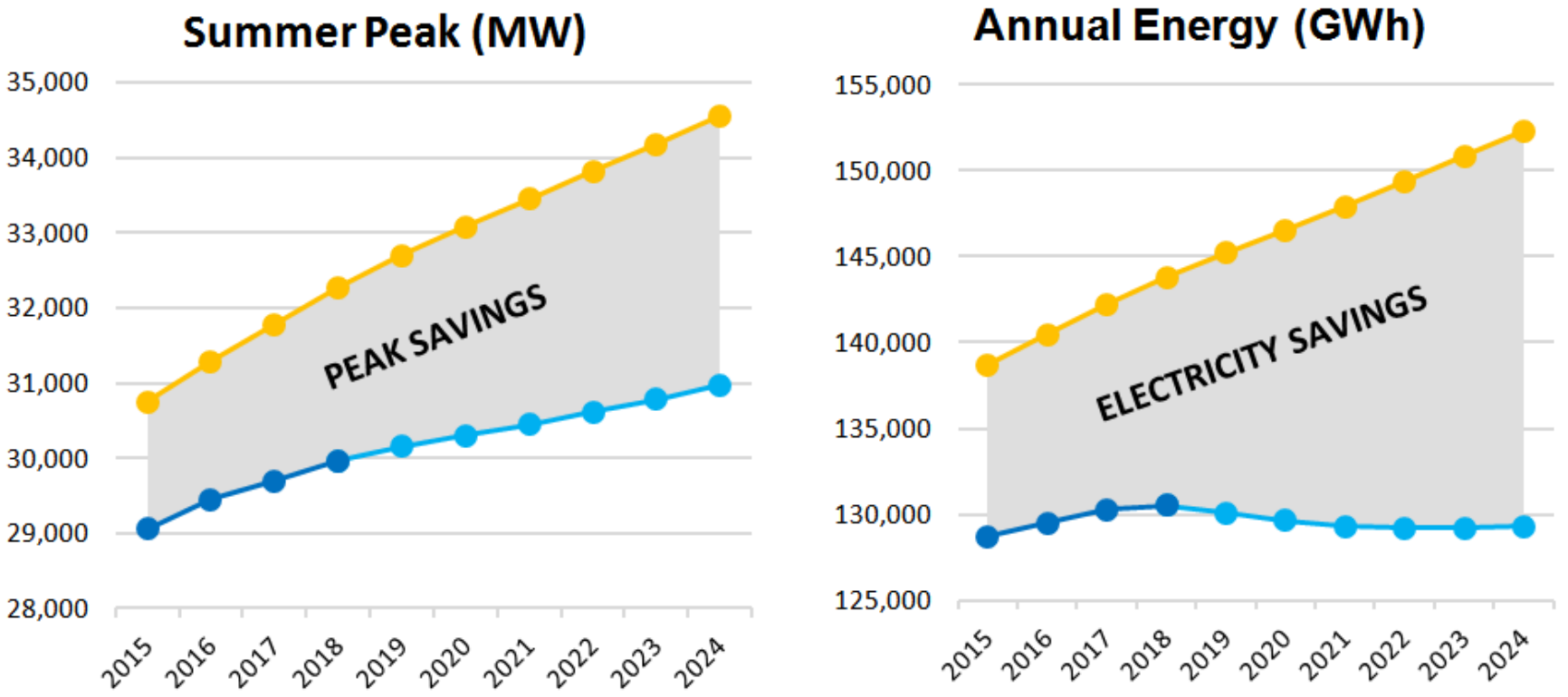
Brayton Point Station (1,535 MW)
- 4 units (coal & oil)

Mount Tom Station (143 MW)
- 1 unit (coal)

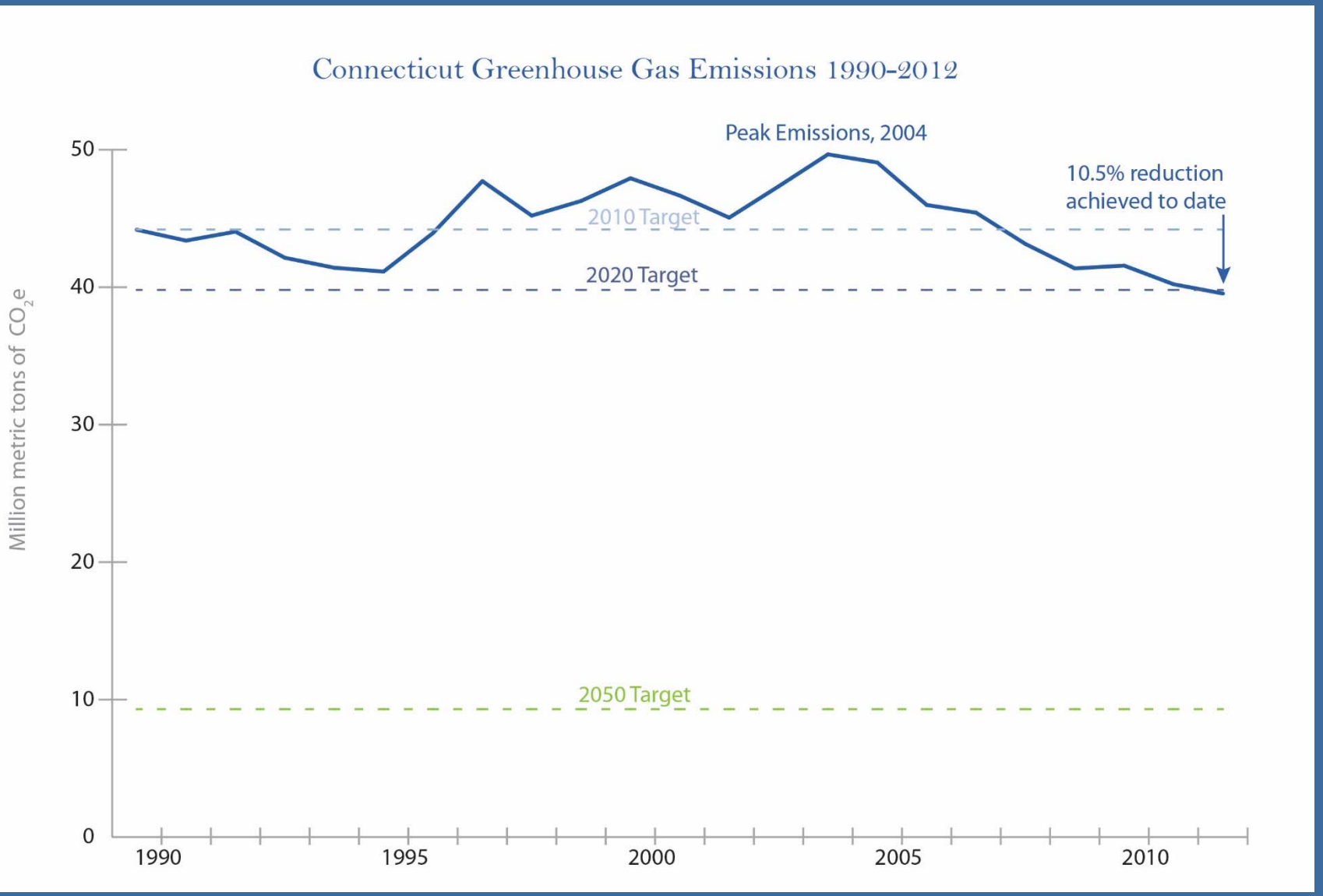
Pilgrim Nuclear Power Station (677 MW)
- 1 unit (nuclear)

Additional retirements are looming

Energy Efficiency Is Slowing Peak Demand Growth and Flattening Energy Use

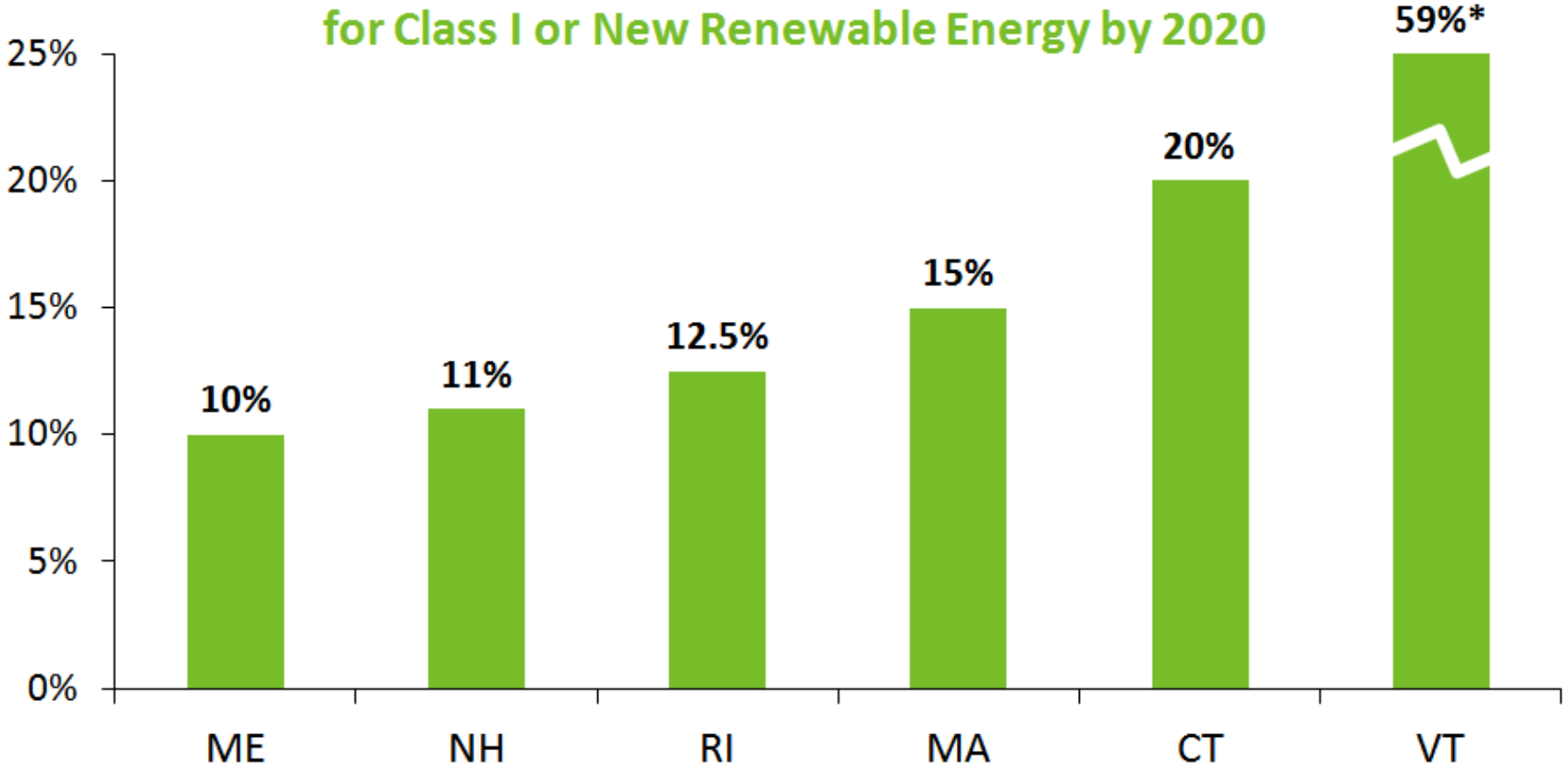


Source: Final ISO New England EE Forecast for 2019-2024 (April 2015)



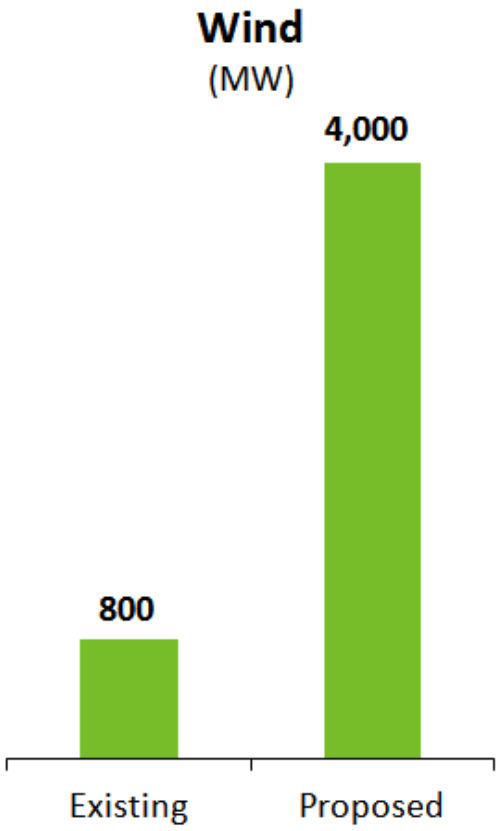
Statewide, Connecticut achieved a 10.5 percent reduction in greenhouse gas emissions between 1990 and 2012.

State Policy Requirements Drive Proposals for Renewable Energy

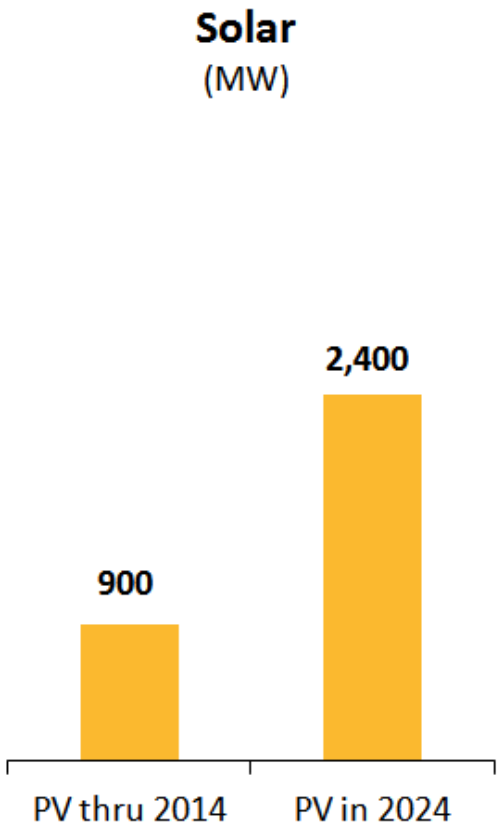


* State Renewable Portfolio Standards (RPS) promote the development of renewable energy resources by requiring electricity providers (electric distribution companies and competitive suppliers) to serve a minimum percentage of their retail load using renewable energy. Vermont's new Renewable Energy Standard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

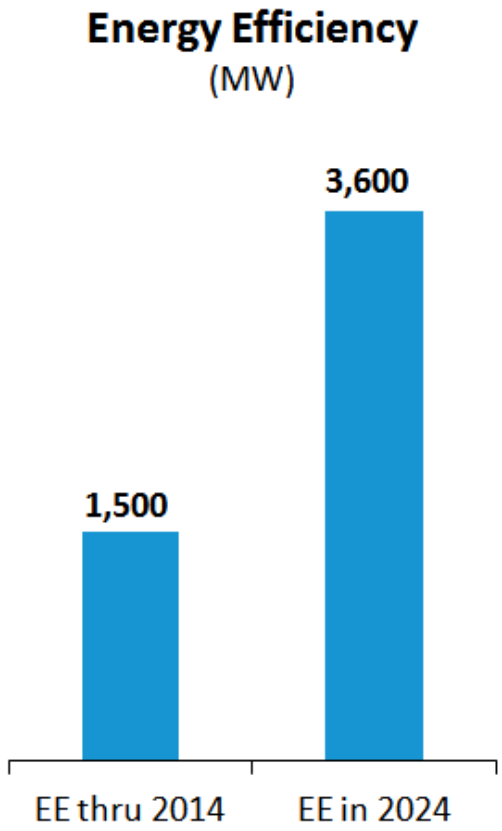
Renewable and EE Resources Are Trending Up



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



2015 ISO-NE Solar PV Forecast, nameplate capacity, based on state policies.



2015 CELT Report, EE through 2014 includes EE resources participating in the Forward Capacity Market (FCM). EE in 2024 includes an ISO-NE forecast of incremental EE beyond the FCM.

State Public Policy
Interactions with the Market

"Cleaner, Cheaper, More Reliable"
2013 CES & 2014 IRP

- Air Regulations
- Siting of in-state Generation, Transmission, Gas Infrastructure
- Procurement of Natural Gas Resources
- Regional Greenhouse Gas Initiative
- Renewable Portfolio Standard
  - Long-term contracts
- Conservation & Load Management Plans
- Smart Meters, Time-Varying Rates
- Incentives for Behind-the-meter Generation

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

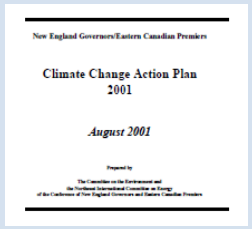
Connecticut climate action

CT signs *NEG/ECP 2001 Climate Change Action Plan*

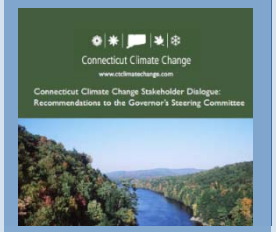
2005 CT Climate Change Action Plan

CT is one of 11 states to launch the Transportation & Climate Initiative

Governor Malloy issues Executive Order 46 establishing the Governor's Council on Climate Change (GC3)



2001

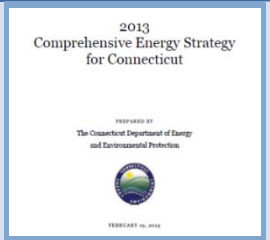


2004

2005

2008

2010



2013

Executive Order 46

2015

9-month stakeholder dialogue process develops *2004 Connecticut Stakeholder Recommendations*

An Act Concerning Climate Change (Public Act 04-252) sets GHG goals that align with NEG/ECP regional goals

CT Global Warming Solutions Act (Public Act 08-98) reaffirms commitment to GHG targets for 2020 and 2050

CT and other northeastern states participate in first auction of Regional Greenhouse Gas Initiative (RGGI), the nation's first carbon cap-and-trade program.

2013 Comprehensive Energy Strategy

Review timeline details

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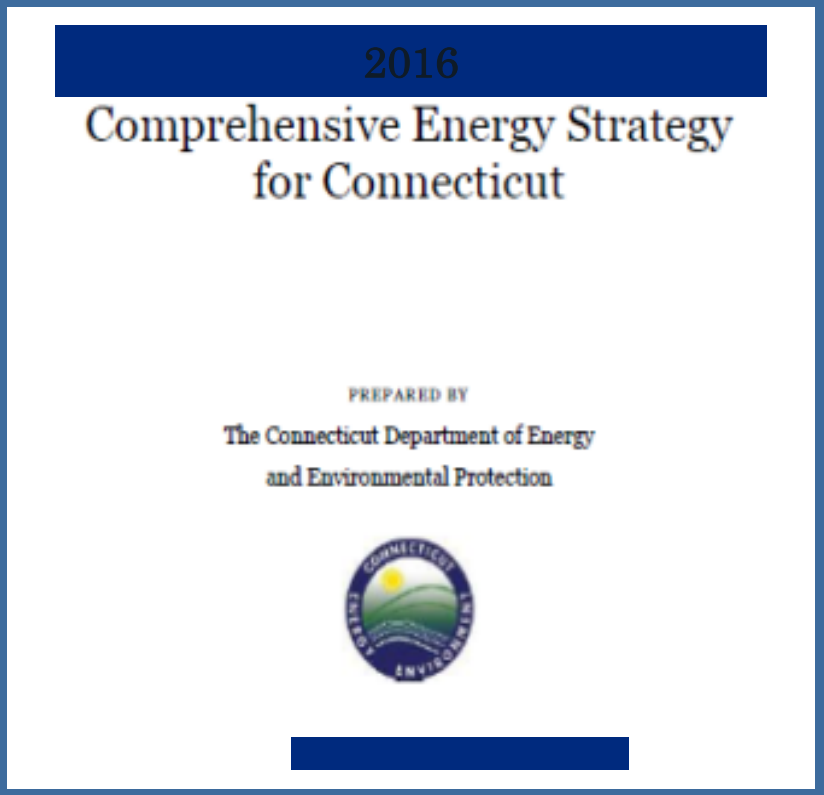
Comprehensive Energy Strategy: Timeline



May 2016-Public Scoping Meeting

October 2016-Draft CES

November 2016-Technical Meetings

December 2016-Public hearings

January 2017-Finalize CES

Major Segments Covered

Residential Buildings & Equipment

- Mainstreaming of Efficient and Weatherized Homes
- Decarbonizing heating fuels

Commercial & Industrial Buildings & Processes

- Segmentation
- Customization of Approach

Electric Power Generation

- Affordable electricity for families and businesses
- Deployment & Integration of Clean Energy Resources

Transportation

- Moving People (Advanced Vehicle Technology, Advanced Alternative Fuels, Responsible Growth, Transit Oriented Development)
- Moving Goods (Freight, Ports, Aviation)

Developing Low-Cost Renewable Generation

2013 CT's Comprehensive Energy Strategy (CES) Goals

Develop low-cost renewable electric generation to make the electricity sector more diverse, affordable, and reliable, while also meeting the State's commitment to reducing the environmental impacts from electricity generation.

Proposed Methods for accomplishing these goals in the 2013 CES

Connecticut's Green Bank Residential Solar Investment Program (RSIP)

- *Public Act 11-80 required the Connecticut Green Bank to deploy 30 MW of Residential Solar; recent legislation permits the deployment of an additional 300 MW.*

LREC/ZREC, Public Act 11-80, Sections 107 and 110

- *Required the development of a Low Emissions and Zero Emissions Renewable Energy Credit Program to buy down the cost of RECs through a reverse auction process.*

Utility Scale Renewable Energy Procurement, Public Act 11-80, Section 127

- *Allowed DEEP to require the EDCs to enter into long-term PPAs in the procurement of renewable energy generation through a competitive bidding process.*

Utility Scale Renewable Energy Procurement, Public Act 13-303, Section 6

- *Allowed DEEP to require the EDCs to enter into long-term PPAs in the procurement of renewable energy generation. through a competitive bidding process.*

Deploying Distributed Generation: Looking Ahead

Procurements Currently Underway

Public Act 15-303, Section 7

- Procure 5% of Class 1 generation

Public Act 15-107, Section B and C, Large Scale and Small Scale Clean Energy Procurement

- Requires DEEP to Procure large and small scale Class I and III energy resources for electric generation, including energy storage and transmission. DEEP can procure up to 10% of the Connecticut EDC load of the aforementioned resources.
- These procurements will allow the State to meet its clean energy goals and improve winter reliability.

Meet our Global Warming Solutions Act Goals by 2050

- Clean energy must be expanded beyond our 2020 RPS goals in order to meet our Global Warming Solutions Act goals in reducing our greenhouse gas emissions by 80% by 2050.
- Retain non-emitting energy resources, such as nuclear generation.

Utilize the Most Cost-Effective Options for Procuring Clean Energy Generation

- Implement innovative mechanisms to reduce the reliance of subsidies for clean energy electric generation
- Promote programs and procurements that will yield the most cost-effective clean energy sources of generation.
- Balance the procurement of in-state and out-of-state resources to minimize the impact on ratepayers.

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Hypothetical:
Building Future Scenarios in LEAP

Demonstration of using LEAP with groupings of technologies/measures to achieve CT's 80% goal

Purpose of Hypothetical

- Initiate your thinking on bundling technologies & measures into scenarios, along with their trade-offs
- Give sense of scale and pace of GHG reductions over the 2050 planning horizon
- Show an example in LEAP of “front loading” GHG reductions
- Keep in mind -- This is a hypothetical to illustrate scenario development. It isn’t real.

Hypothetical Scenario Elements: Efficiency and Conservation
(Faster Implementation 2015 – 2030)

- Vehicle miles traveled (light - duty cars & trucks) reduced 10% by 2050 from smart growth practices
- CT EE programs for natural gas and electricity increase 5x by 2030 and 10x by 2050

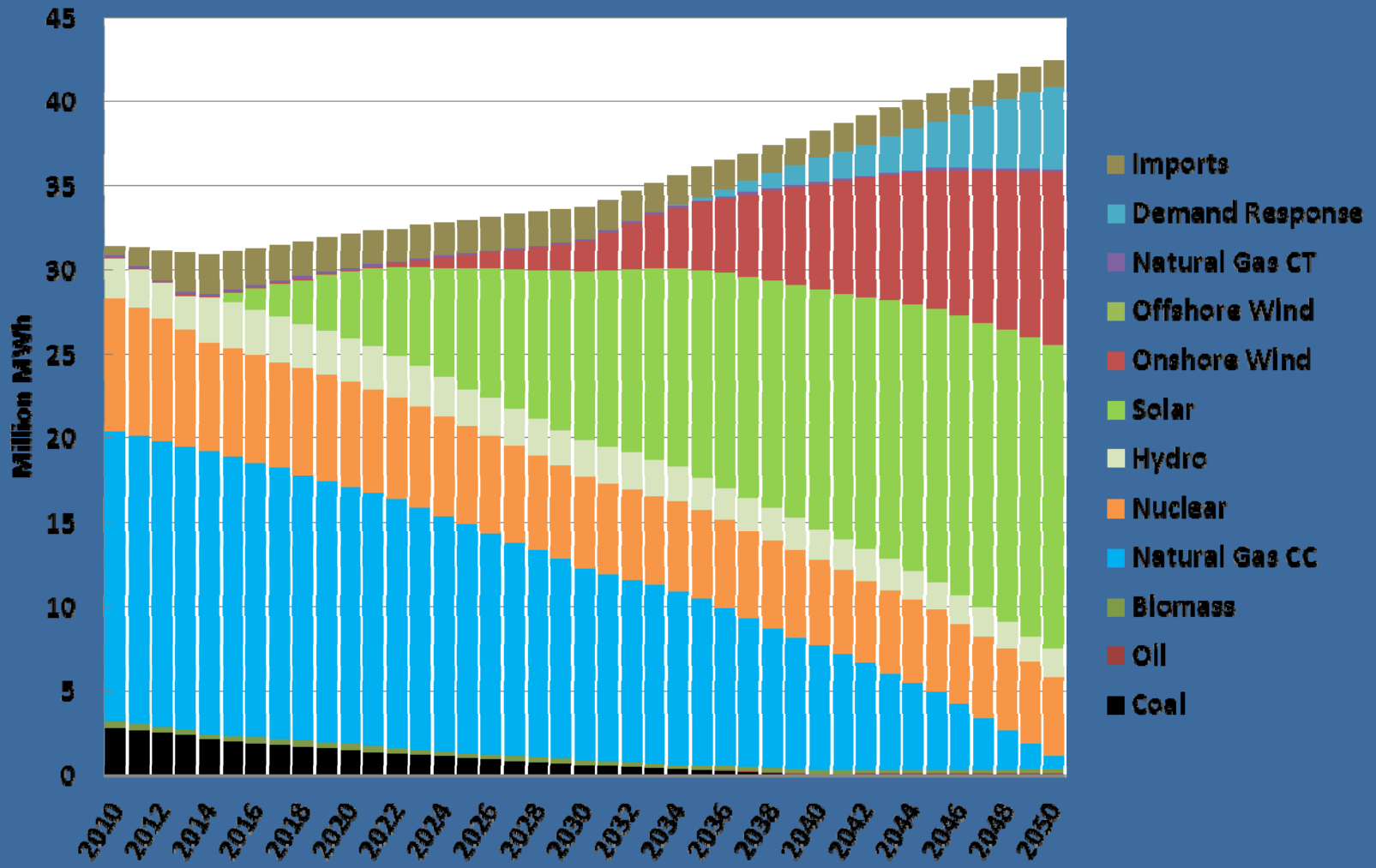
Hypothetical Scenario Elements: Fuel Switching
(Faster Implementation 2015 – 2030)

- Space heating: oil furnaces / radiators along with gas radiators phased out by 2050; replaced by air and ground source heat pumps
  - Res – 40% by 2030
- Water heating: gas and oil water heaters phased out by 2050; replaced by solar thermal water heaters
  - Com – 50% by 2030
- Transportation:
  - 90% of light - duty cars and trucks electric by 2050
  - 80% of commercial trucks and transit busses electric by 2050
  - 60% of short haul trucks electric by 2050
  - Electricity replaces diesel in passenger and freight rail by 2050

Hypothetical Scenario Elements: Decarbonize Electricity

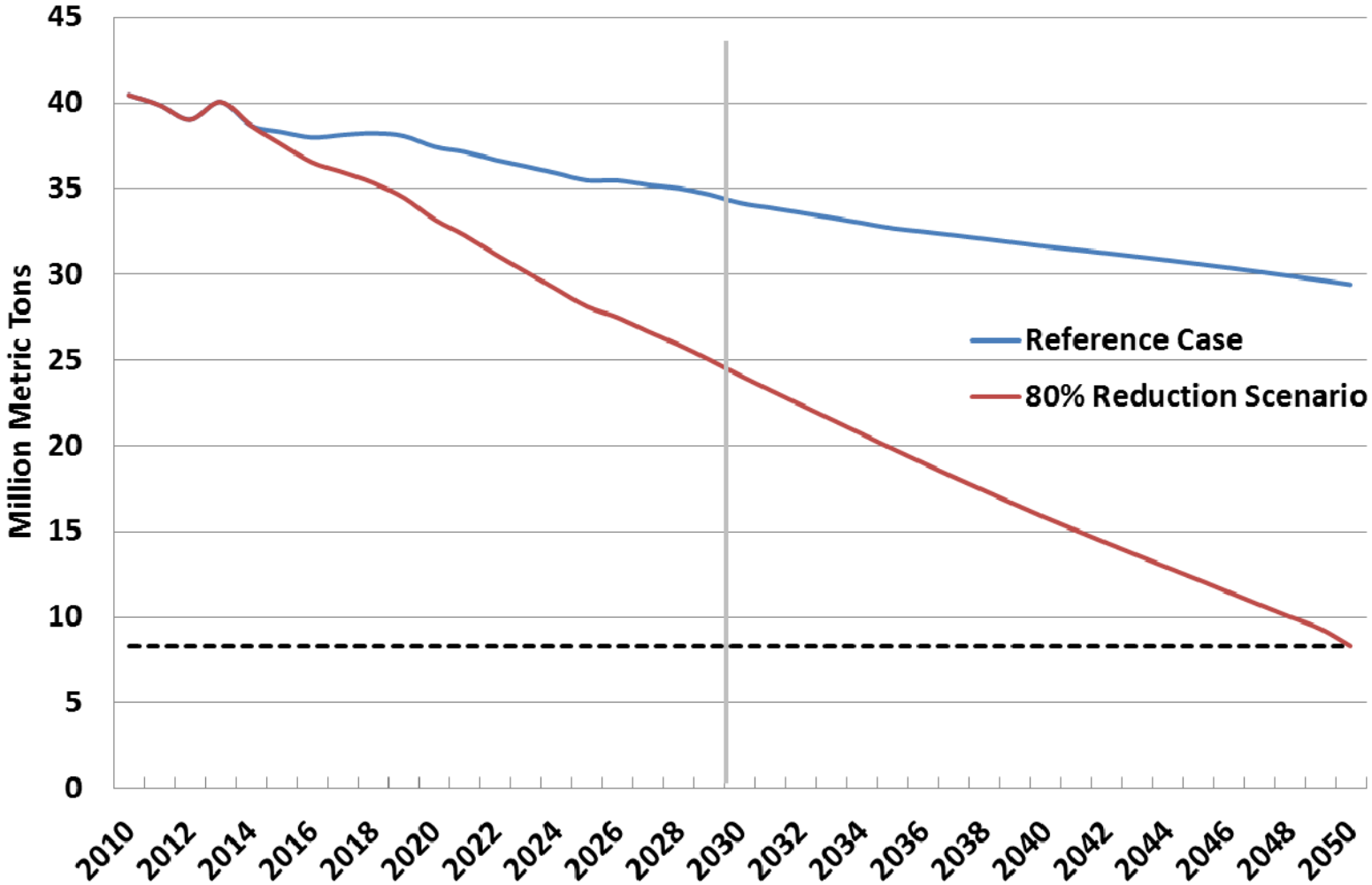
- No new gas plants built after 2020
- Increased electric load from vehicle charging and electric heating is met by a mix of solar, onshore wind and demand response

Hypothetical Electricity Generation by Source



- No new gas plants built after 2020
- Increased load between 2015 and 2050 is met by additional solar PV, Onshore Wind, and Demand Response

Hypothetical Economy-Wide GHG Trends



- Faster reductions in the 2050 – 2030 timeframe
- 42% below 2001 by 2030
- 80% is achieved if aggressively pursuing all key technologies and measures

Electric Sector Barriers and Opportunities

Barriers

- Natural gas generation plays a dominant role in forward capacity market.
- State regulatory levers to change fuel mix are limited.
- Still waiting for breakthrough technologies (battery storage)
- Build out of renewables cannot happen overnight.

Opportunities

- Price of renewables continues to decline.
- Use of long-term contracts for clean energy (Three-state RFP)
- Move to a decentralized smart electric grid – “grid modernization”
- Grid modernization pilot project including battery storage
- In-state programs to support deployment of renewables (RSIP, SHREC, CPACE, LREC, ZREC)

Summary

- Demonstrated a hypothetical bundle of technologies and measures in LEAP
- Illustrated LEAP's ability to simulate non-straight line GHG reductions through faster implementation
- Showed example of possible fuel shifts in one energy sector (electricity)
- Indicates need for aggressive penetration levels across all energy sectors for multiple technologies and measures

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