

***Preliminary Discussion Document – Does not document conclusions and opinions of the CEAB Members***

# **Connecticut Energy Advisory Board Analytical Findings Briefing**

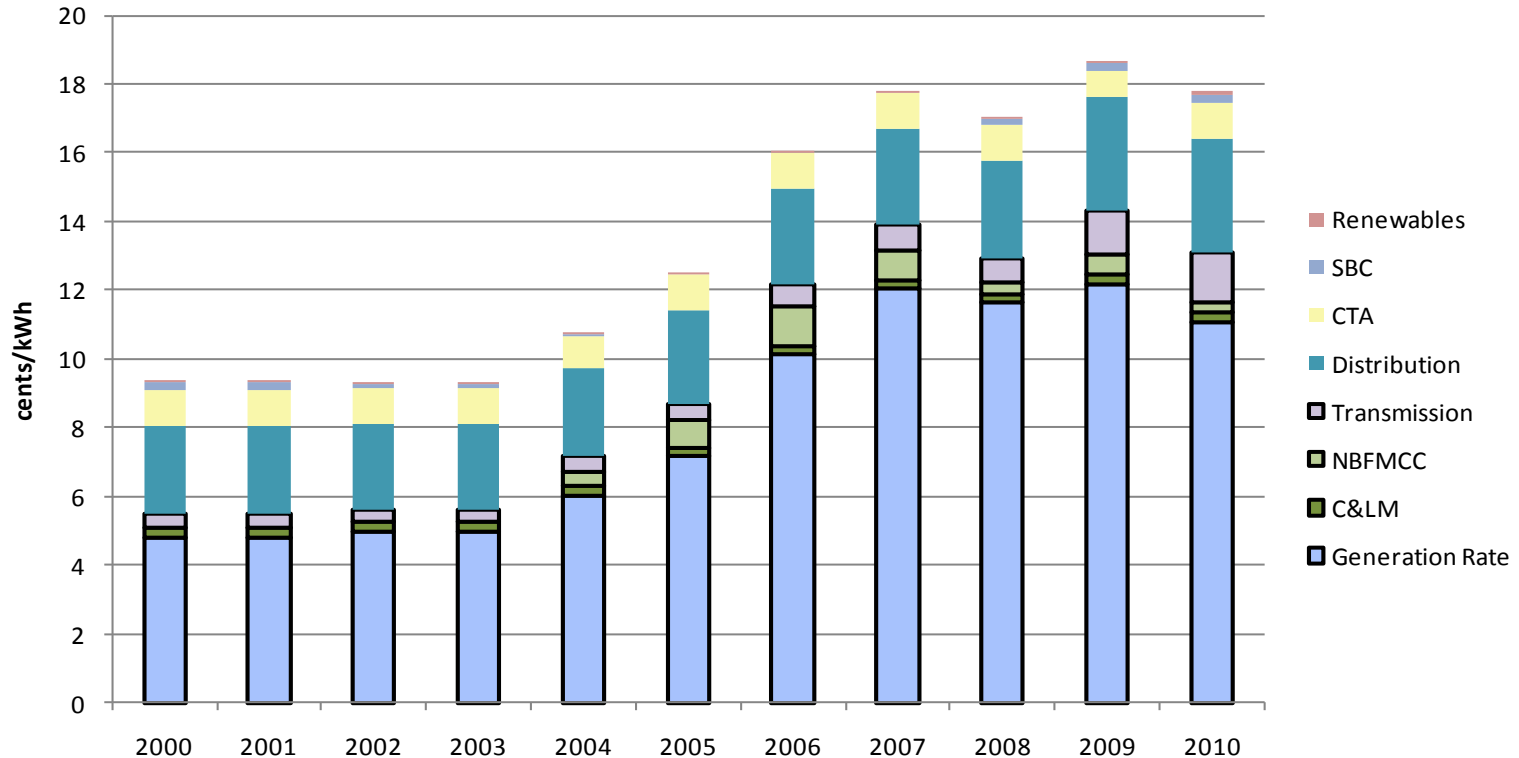
April 9, 2010

## *What we want to accomplish today*

- Briefing on the Key Analytics and Findings
  - Cost Analysis
  - Environmental Analysis
  - Reliability Analysis
  - bPortfolio Results

# Historical Connecticut Electric Rates

## CT Light and Power's Historical Electric Rate in CT



CTA (Competitive Transition Assessment) – The component of electric utility retail customer bills assessed to allow utilities to recover Stranded Costs

SBC (Systems Benefits Charge) –public policy costs such as generation decommissioning and displaced worker protection costs

NBFMCC (Non-Bypassable Federally Mandated Congestion Charges)

# Components of Power Costs

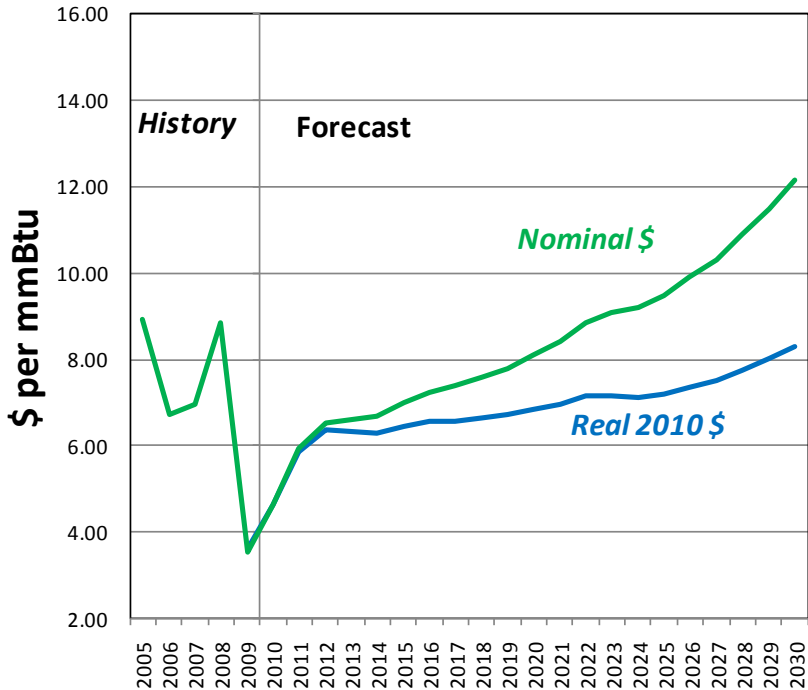
- **Energy Costs** - include the fuel, variable O&M, and any emission allowance costs that go into the ISO-NE energy market to contribute to a market clearing energy price (MCP)
- **Capacity Costs** - The costs associated with the capacity an Load Serving Entity, as charged by ISO-NE, resulting from the Forward Capacity Market
- Renewable Energy Costs to meet CT RPS (**REC**)
- The **Regional Network Service** rate under the ISO-NE for Transmission
- Additional **Transmission costs associated with** the large scale development of significant amounts of **renewable generation**

## ***Reference Case – Key Assumptions***

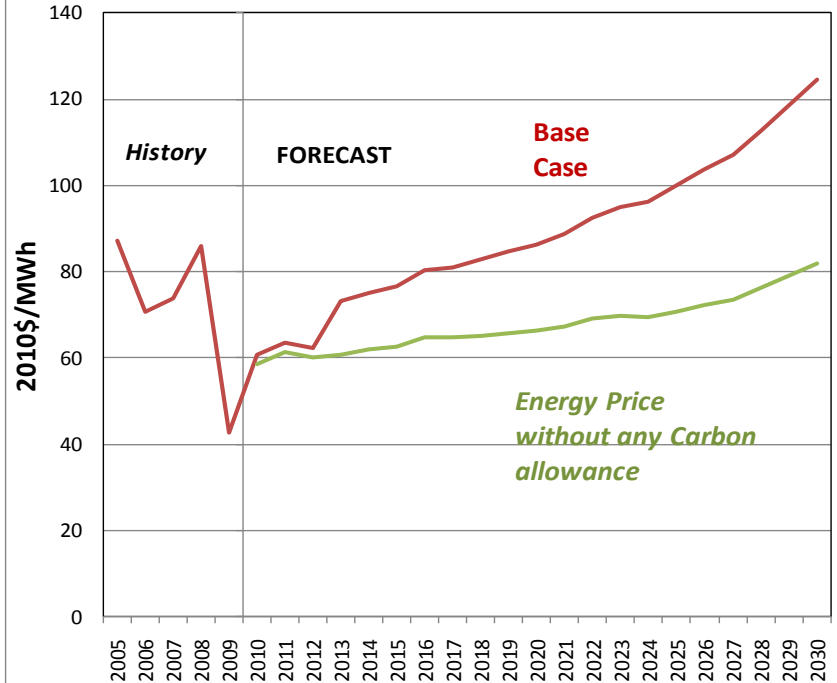
- Delivered Natural gas prices (2010 dollars)
  - \$7.00/MMBtu in 2010 increasing to \$9.00/MMBtu by 2030
- Connecticut's RPS target of 20% by 2020 is met – regional solution.
  - Current RPS policy remains in effect through 2030
- Carbon - Assumes Waxman Markey in 2013; EIA middle carbon case
- 1,500 MW of retirements (between 2013 and 2016) (EDC analysis)
- NO<sub>x</sub> prices benchmarked to EDC analysis
- CL&M - extended EDC reference case (2020 to 2030)
  - energy savings from ECMB potential study conducted by KEMA

# Natural Gas & Connecticut Market Energy Prices

## Henry Hub Spot Price \$/mmBtu



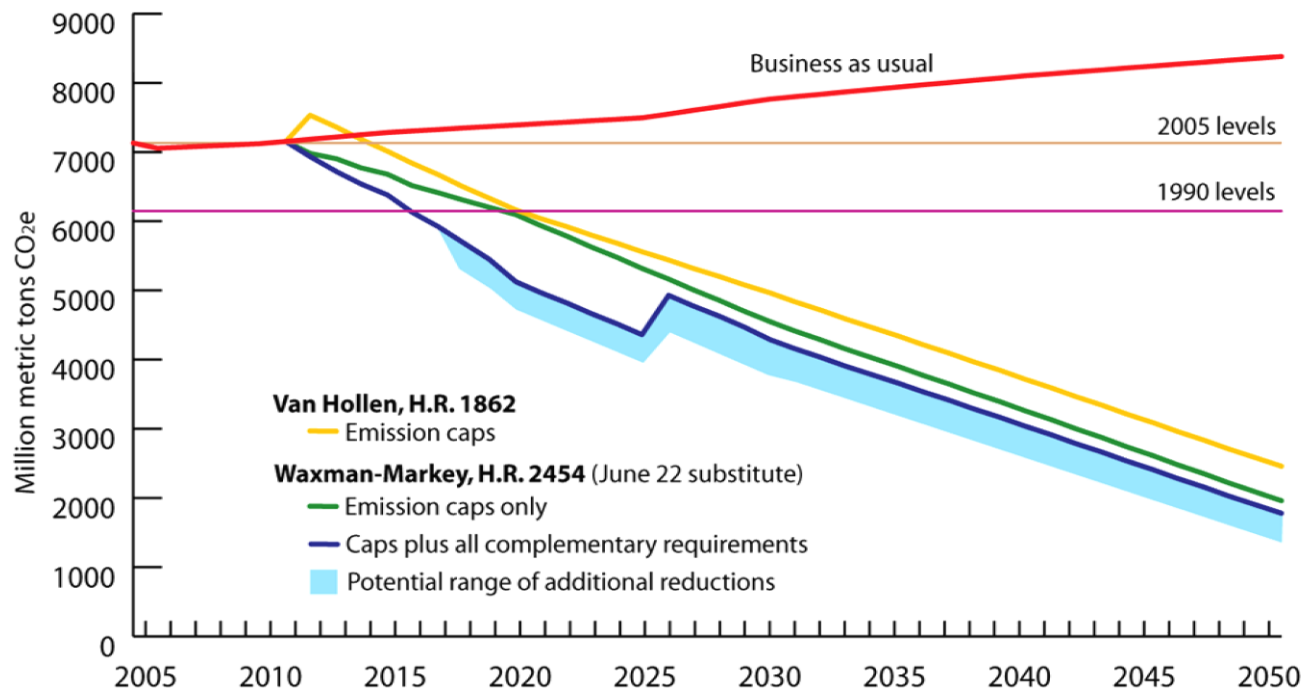
## Central Connecticut Zone Prices - 2010 \$/MWh



# Federal Proposals for GHG Reductions

Emission Reductions Under Cap-and-Trade Proposals in the 111th Congress, 2005-2050

June 25, 2009

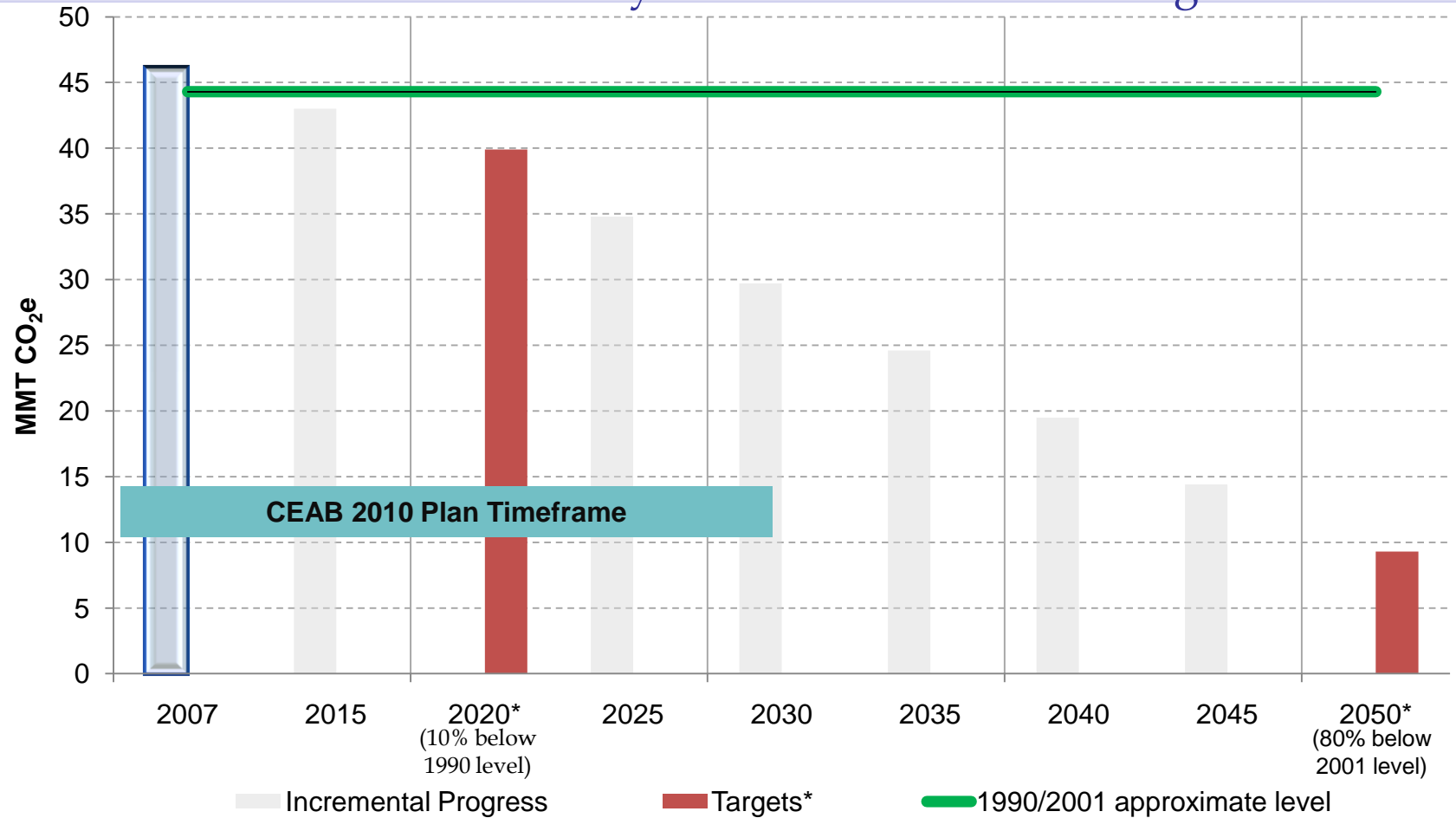


WORLD RESOURCES INSTITUTE

For a full discussion of underlying methodology, assumptions and references, please see <http://www.wri.org/usclimatetargets>.

# 2008 Global Warming Solutions Act

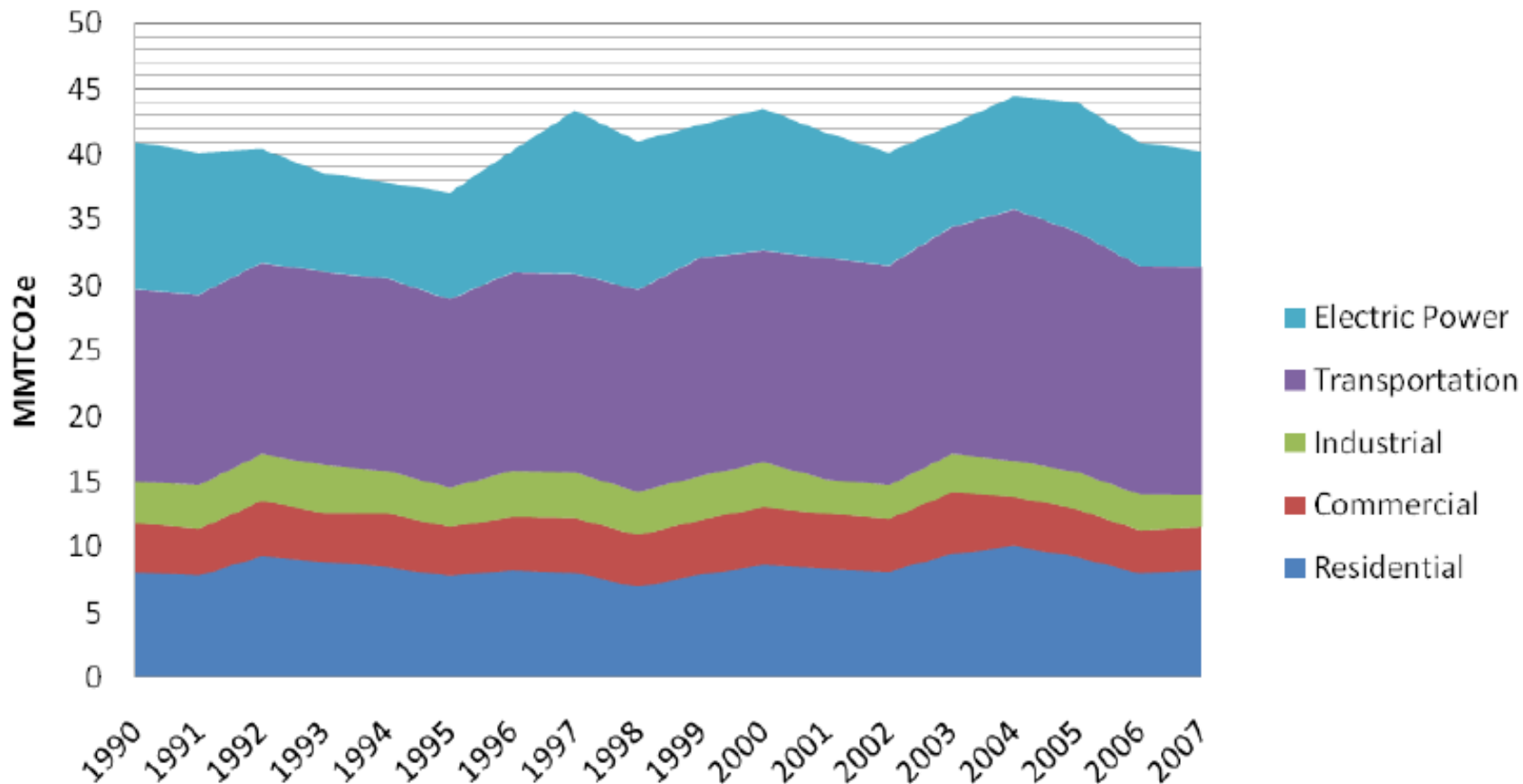
## •Connecticut Economy-wide GHG Emission Targets\*



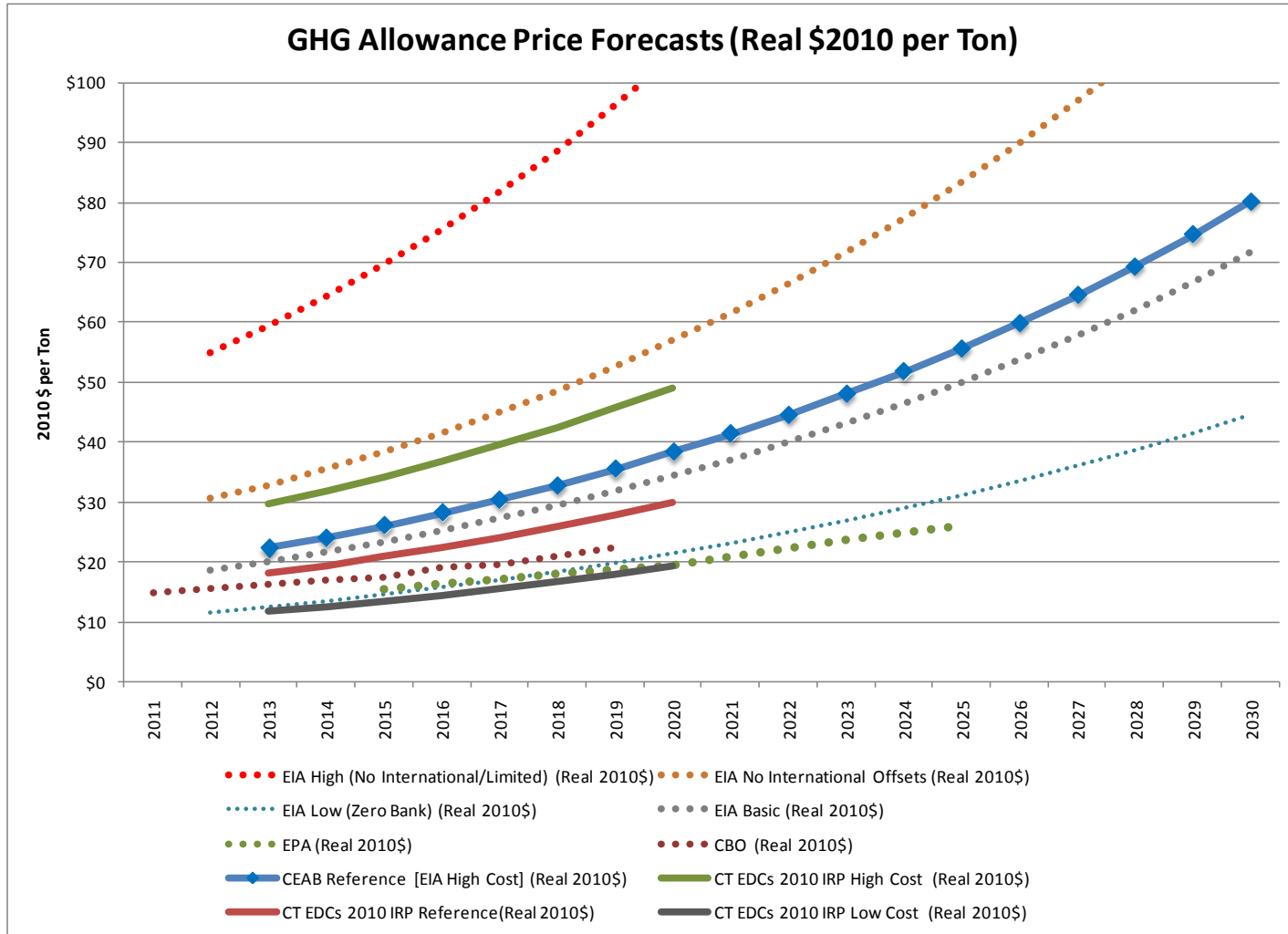
\* Targets are legislatively mandated for Connecticut (PA 08-98)

# Historical CT CO<sub>2</sub> Emissions

Fossil fuel Combustion CO<sub>2</sub> by Sector 1990 - 2007

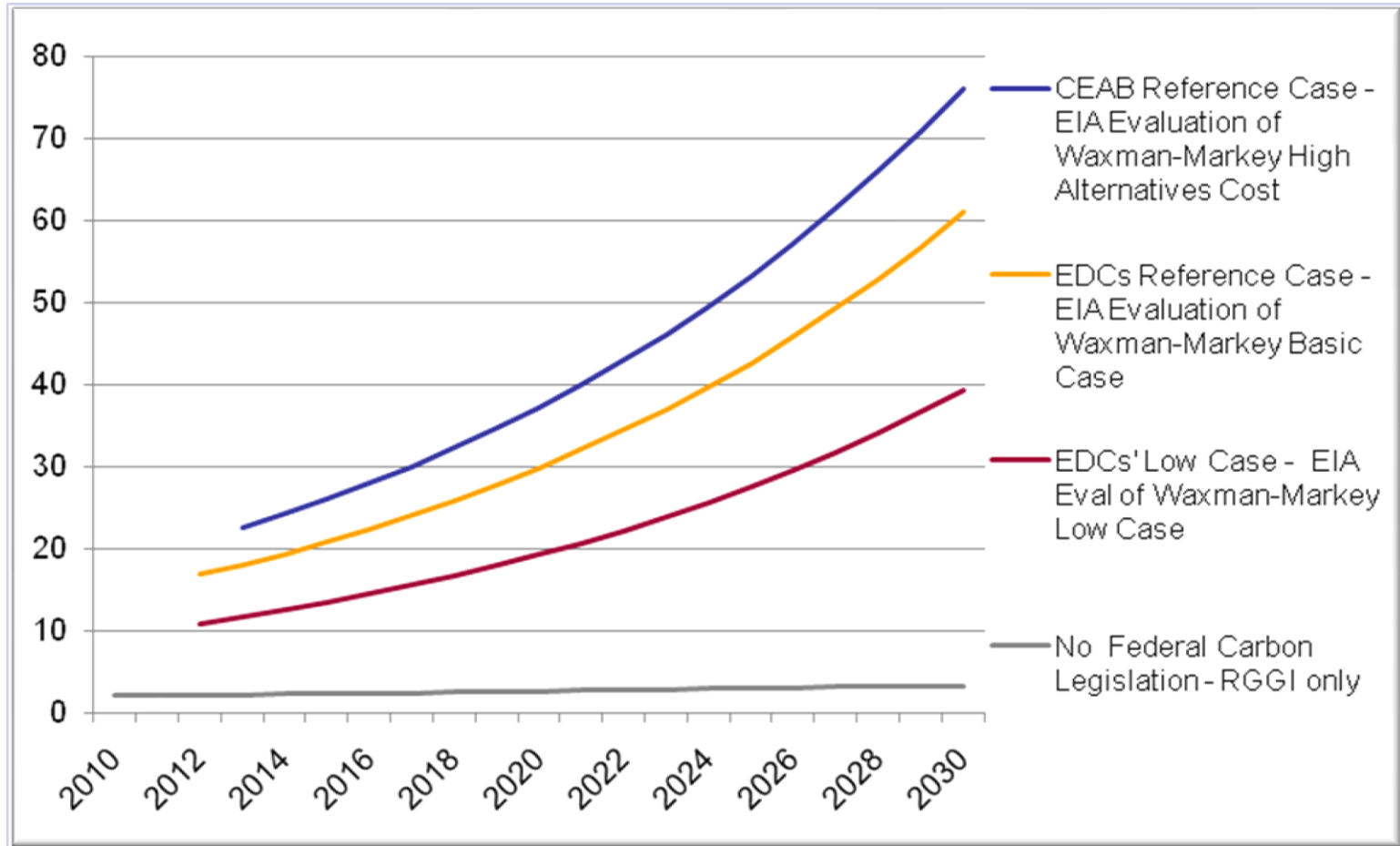


# Comparison of Carbon Price Forecasts



# Cost Implications – Sensitivities

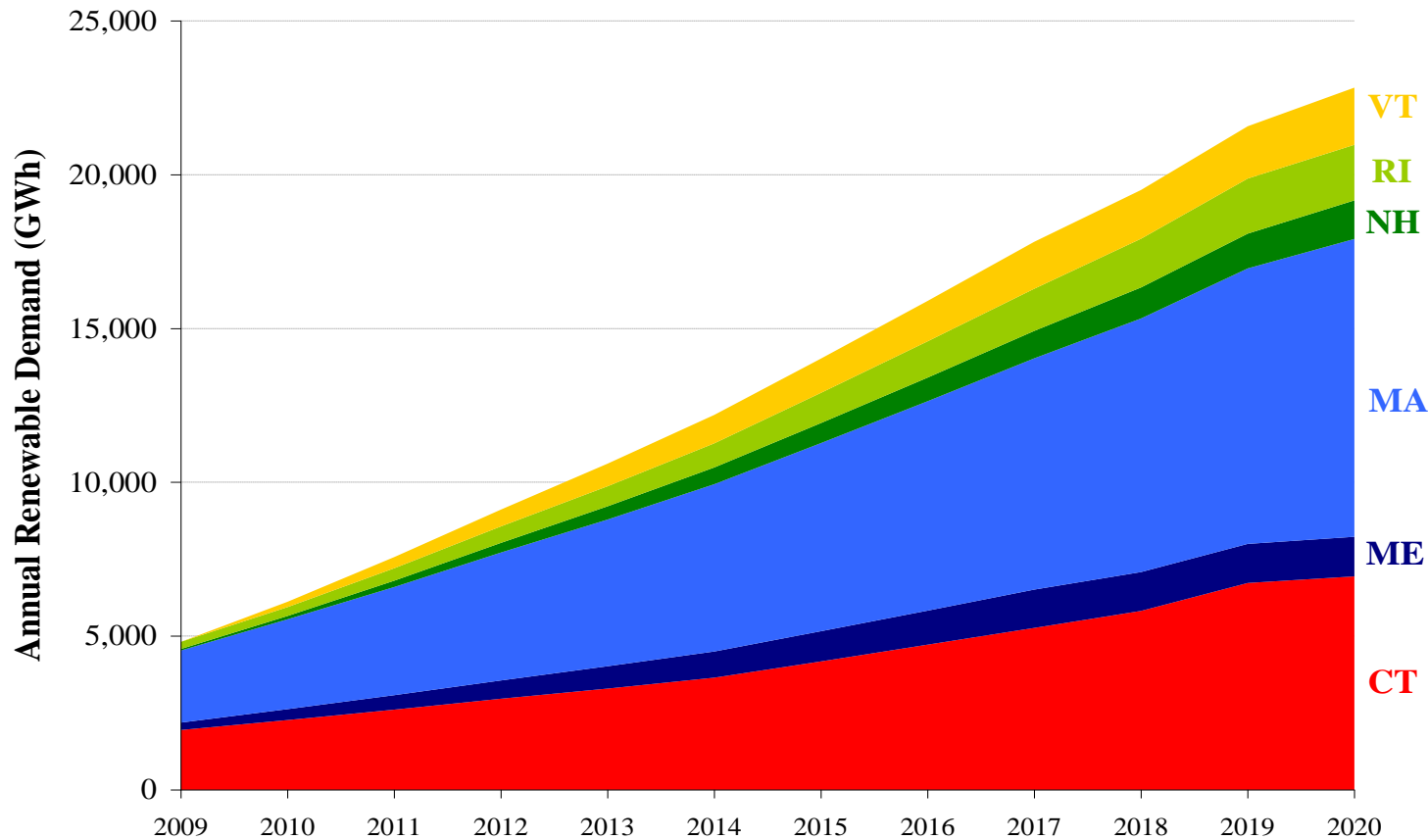
## Carbon Allowance Price Outlooks Used In Analysis



# Key Cost Drivers – Renewable Policy

## Increasing Renewable Energy Requirements

New England Class I Renewable Demand to 2020



## Connecticut has the most aggressive RPS policy in the region

### New England RPS Targets to 2020

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
<b>CT Class I</b>	<b>7.0%</b>	<b>8.0%</b>	<b>9.0%</b>	<b>10.0%</b>	<b>11.0%</b>	<b>12.5%</b>	<b>14.0%</b>	<b>15.5%</b>	<b>17.0%</b>	<b>19.5%</b>	<b>20.0%</b>
<b>ME Class I</b>	<b>3.0%</b>	<b>4.0%</b>	<b>5.0%</b>	<b>6.0%</b>	<b>7.0%</b>	<b>8.0%</b>	<b>9.0%</b>	<b>10.0%</b>	<b>10.0%</b>	<b>10.0%</b>	<b>10.0%</b>
<b>MA Class I</b>	<b>5.0%</b>	<b>6.0%</b>	<b>7.0%</b>	<b>8.0%</b>	<b>9.0%</b>	<b>10.0%</b>	<b>11.0%</b>	<b>12.0%</b>	<b>13.0%</b>	<b>14.0%</b>	<b>15.0%</b>
<b>NH Class I &amp; II</b>	<b>1.0%</b>	<b>2.1%</b>	<b>3.2%</b>	<b>4.2%</b>	<b>5.3%</b>	<b>6.3%</b>	<b>7.3%</b>	<b>8.3%</b>	<b>9.3%</b>	<b>10.3%</b>	<b>11.3%</b>
<b>RI</b>	<b>2.5%</b>	<b>3.5%</b>	<b>4.5%</b>	<b>5.5%</b>	<b>6.5%</b>	<b>8.0%</b>	<b>9.5%</b>	<b>11.0%</b>	<b>12.5%</b>	<b>14.0%</b>	<b>14.0%</b>

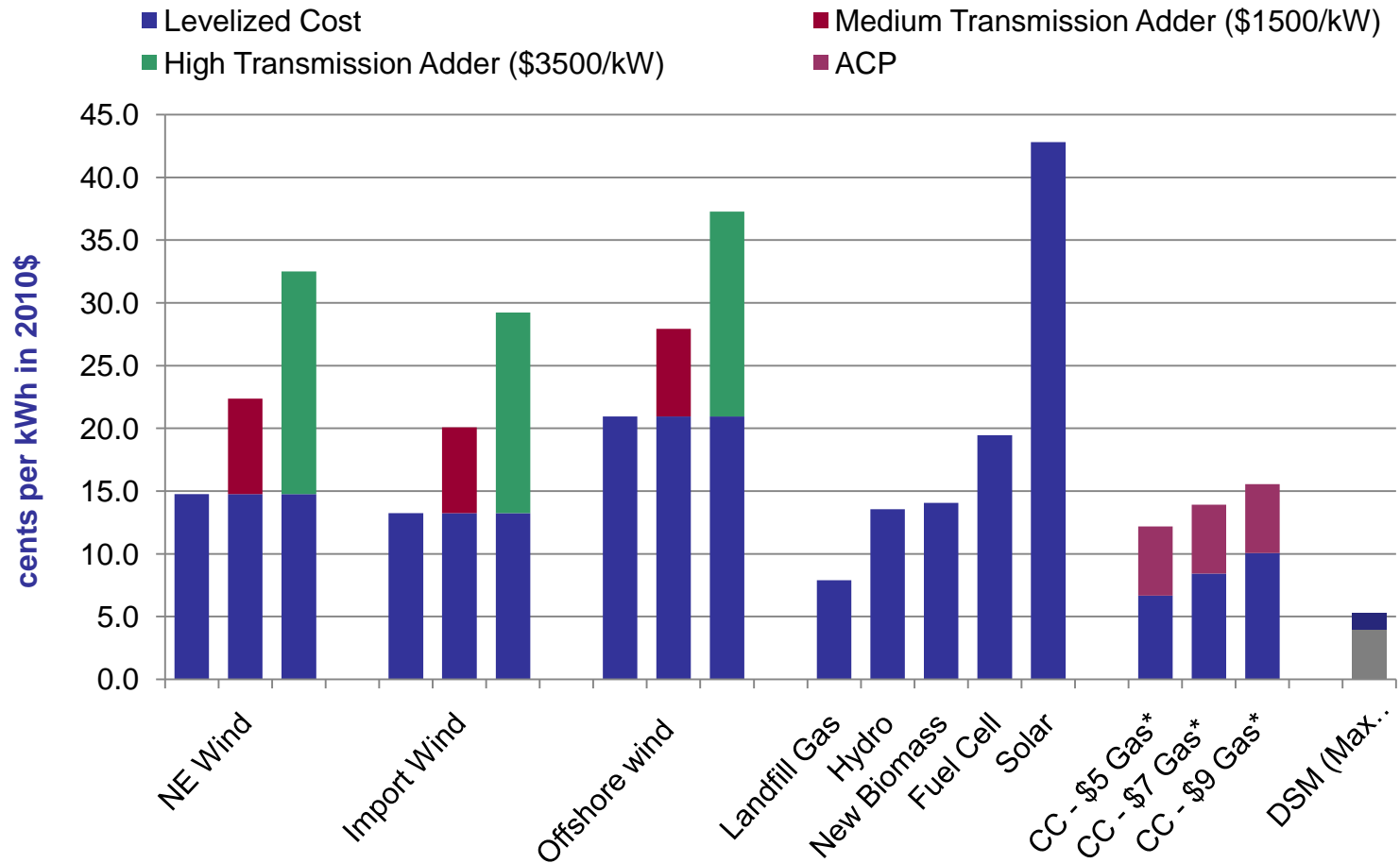
## Renewable Build-out – Reference Case

Connecticut	2009	2013	2015	2020	2030
LFG	9	36	38	38	38
Wind	0	0	0	0	0
Hydro	3	4.3	4	14	14
Biomass/Biofuels	0	102	102	139	139
Offshore Wind	0	0	0	0	0
Fuel Cells	3	45	45	45	45
Solar PV	4	24	35	66	196
Tidal	0	0	0	0	0
CT Total	20	211	224	301	432
ISO-NE					
LFG	127	41	46	46	46
Wind (incl. imports)	218	126	720	1,916	3,141
Hydro	51	27	36	83	83
Biomass/Biofuels	492	195	266	624	708
Offshore Wind	0	0	150	400	878
Fuel Cells	3	45	45	45	45
Solar PV	7	128	212	672	1178
Tidal		0	0	22	22
NE Total	898	562	1475	3808	6101

Note: 2013, 2015, 2020, 2030 show build-out incremental to 2009

# Key Cost Drivers – Renewable Policy

## 20-Year Levelized Cost of Renewable Technologies (2020 without PTC/ITC)



\*

## ISO-NE Estimates for Added Transmission for Wind

# Transmission for 5,500 MW of Wind

- Potential transmission to connect 4,000 MW of offshore and 1,500 MW of near-shore onshore wind
- New transmission paths
  - New 345 kV line from Maine to Connecticut
  - New HVDC underwater cable from Maine to Boston
- Local loops to collect wind in Maine
- Preliminary cost estimate: \$6 billion



# *Key Cost Implications –Renewable Policy*

## Various Strategies on Meeting Connecticut's RPS requirements

### 1. Regional Renewable Strategy

- ❑ High investment costs outside Connecticut \$13B for NE, CT Share \$4.3B
- ❑ Likely Substantial Transmission Investment \$10B for NE, CT Share \$3.5B
- ❑ REC Prices may exceed 4 cents per KWH by 2020

### 2. In State Renewable Promotion

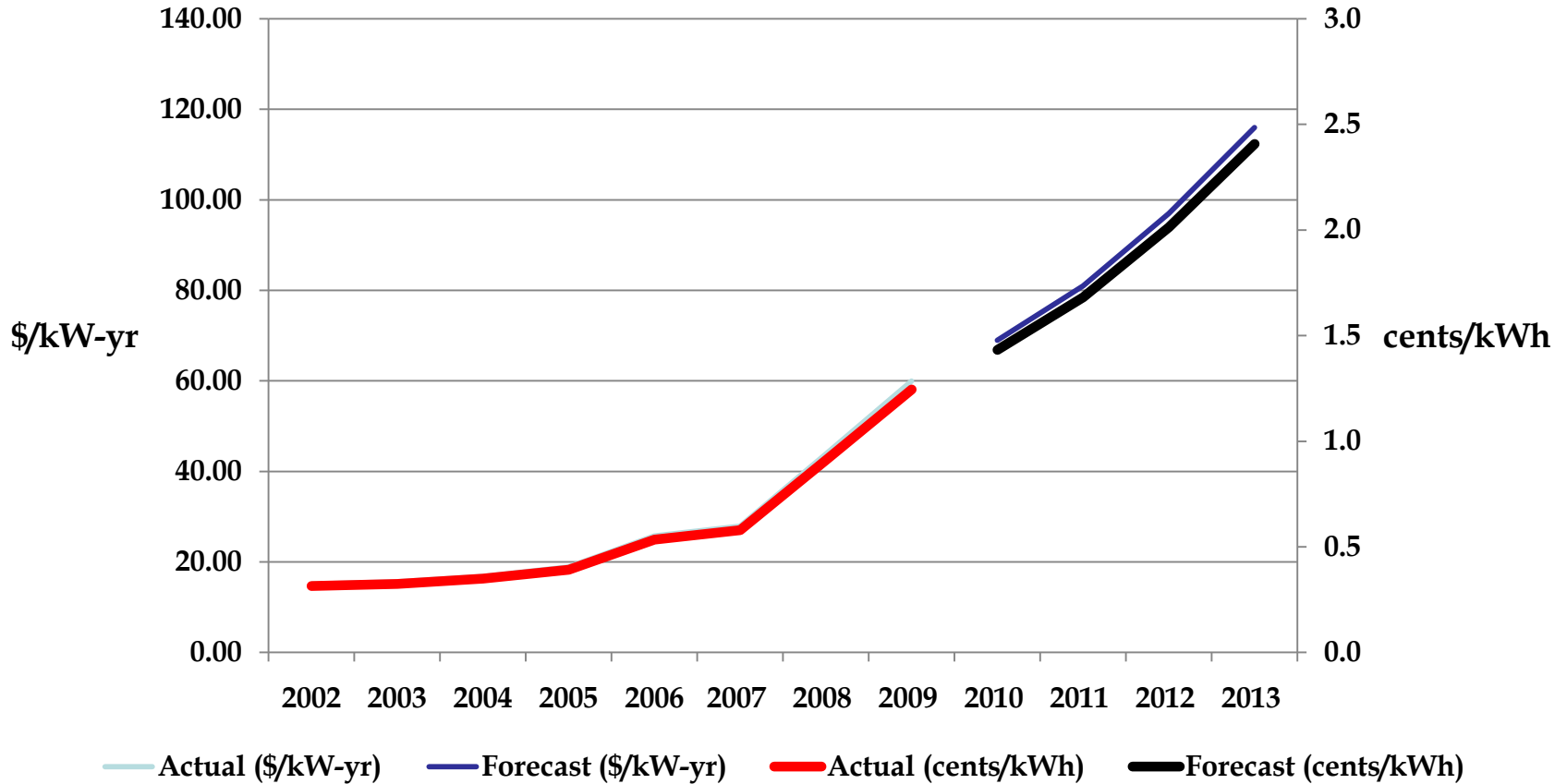
- ❑ High investment costs inside CT Share \$4B
- ❑ May reduce transmission costs
- ❑ Estimated to carry costs well in excess of regional RECs

### 3. Expand RPS definition to include EE and CHP more directly

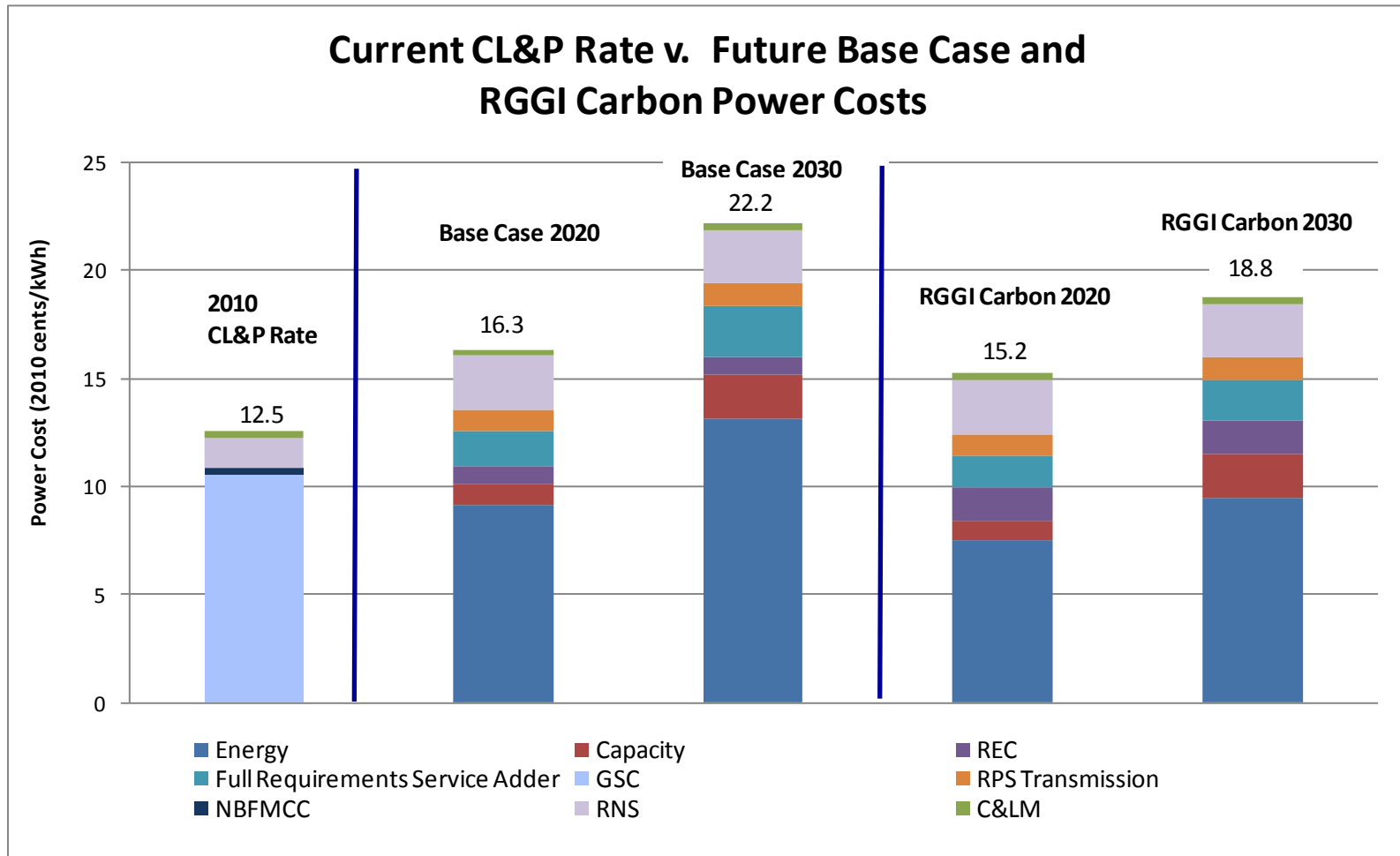
- ❑ A-ACE EE Eliminated \$3B of investment costs
- ❑ Promotes the most cost effect, non-emitting resources

# Regional Transmission Service Costs

## \$9 Billion investment in Transmission 2002 - 2013



# Power Cost Implications – Base Case



# Cost Implications of Base Case Components

There are several drivers pushing the price higher

## Estimated Breakdown of the anticipated Power Rate Increases from today

	2020		2030	
	Cents/kWH	% of Total	Cents/kWH	% of Total
Energy*	(0.9)	-24%	0.7	7%
Carbon Allowance*	1.8	47%	4	41%
Capacity*	0.2	5%	1.3	13%
RPS Compliance*	0.6	16%	0.6	6%
Regional Network Service	1.1	29%	1.1	11%
RE Related Transmission	1	26%	1	10%
Other	0	0%	1	10%
<b>Total</b>	<b>3.8</b>	<b>100%</b>	<b>9.7</b>	<b>100%</b>

\* Energy, Capacity, Carbon Allowance, and RPS Compliance Costs are part of a bundled full requirement service solicitation that also effectively includes three year forward market prices that have been built into prices competitively bid by winning bidders. Thus the market energy price in current rates is estimated to be higher than the energy price in 2020

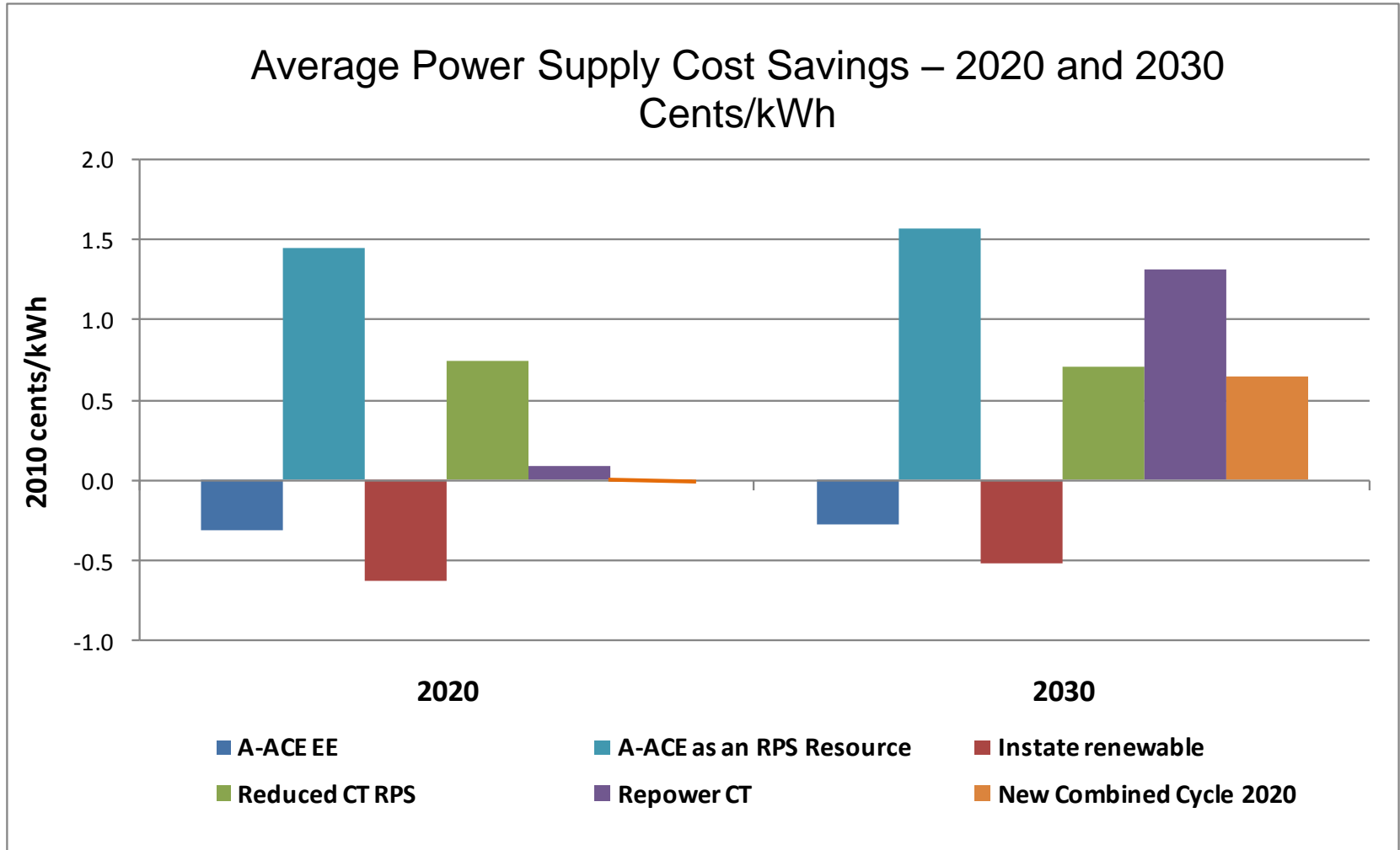
## ***Sensitivities – External Factors***

- **Carbon Allowance Price Outlook.** In addition to reference CO2 allowance prices, several cases were assessed with three lower price forecasts
- **Unit Retirements.** Three cases were studied where the Connecticut coal units were retired by 2020
- **Alternative Natural Gas Prices.** A low natural gas and a high natural gas price case were each studied for the base case set of resources
- **Resource Contingencies.** The potential resource adequacy implications were studied for key elements of the base case resource plan, including the potential for the NEEWS transmission project components not going forward

# ***Sensitivities – Resource Options***

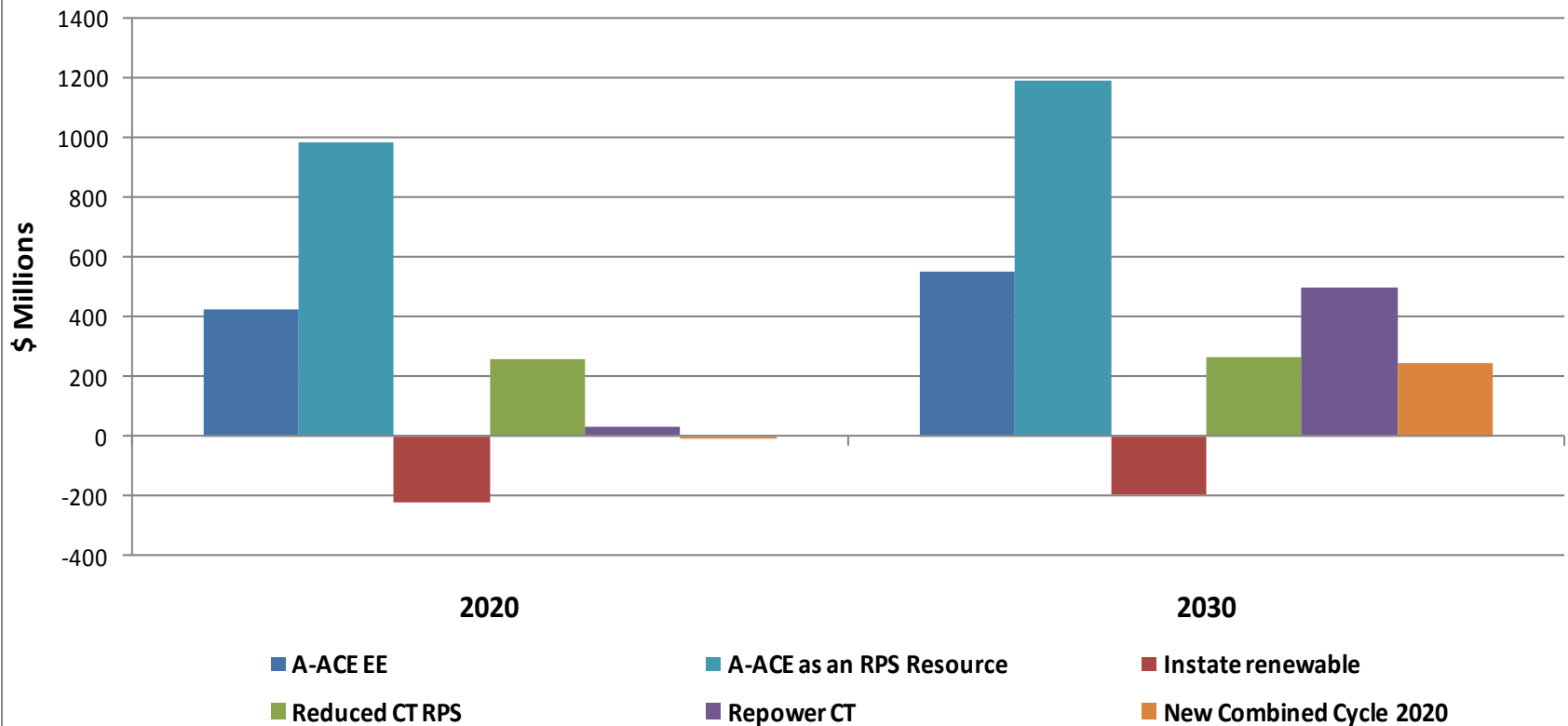
- **A-ACE**
- **A-ACE as a Renewable Resource**
- **In-State Renewables**
- **Reduced RPS.** RPS of 11.4 percent by 2020.
- **Repowering Initiative.** Repowering of 5 CT sites by 2020 (2,400 MW)
- **Combined Cycle.** Adds two 600 MW efficient CCs (7,000 Btu/kWh) in 2020 and 2022

# Cost Implications – Resource Portfolios

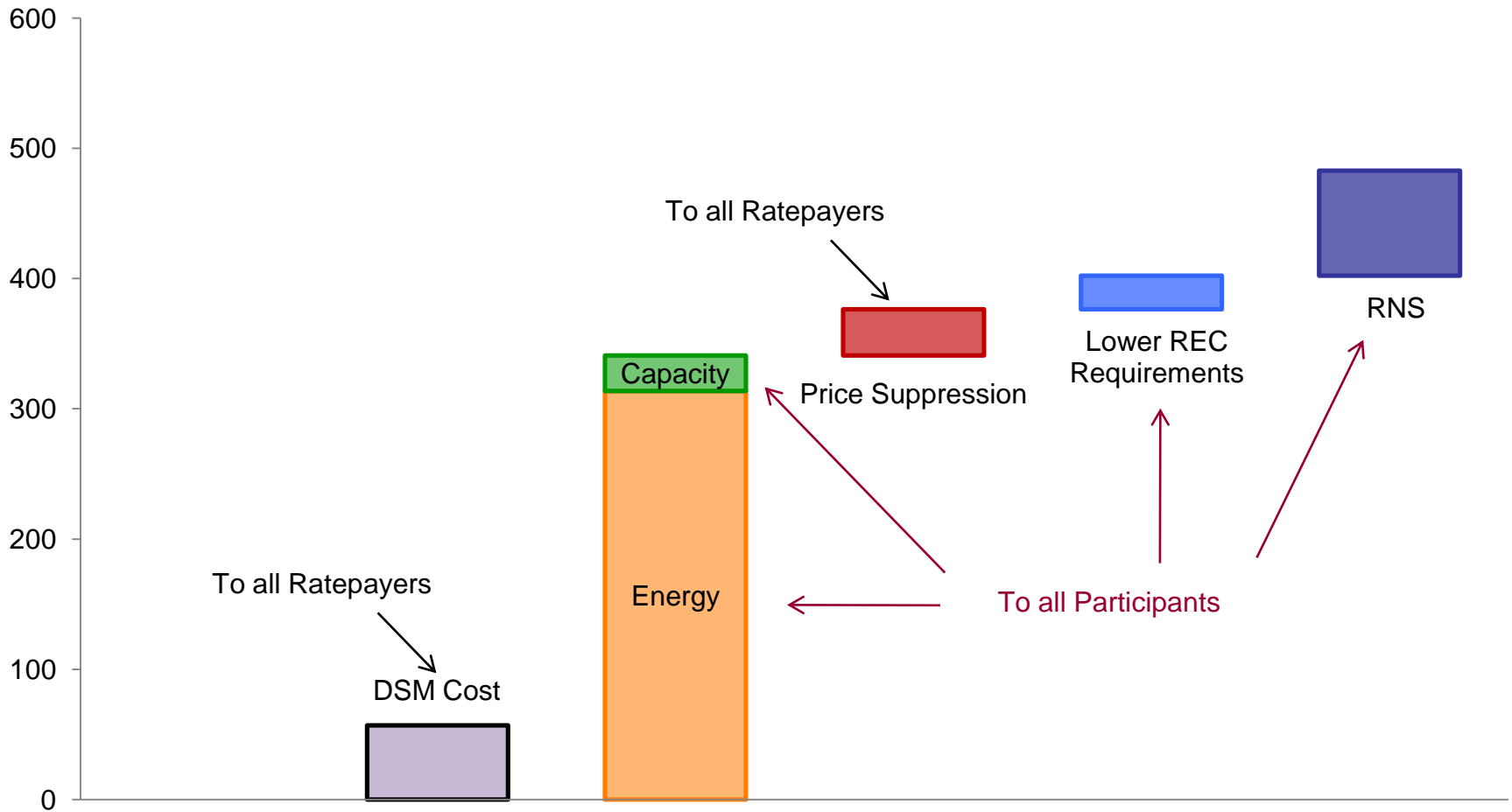


# Portfolio Cost Implications – Resource Sensitivities

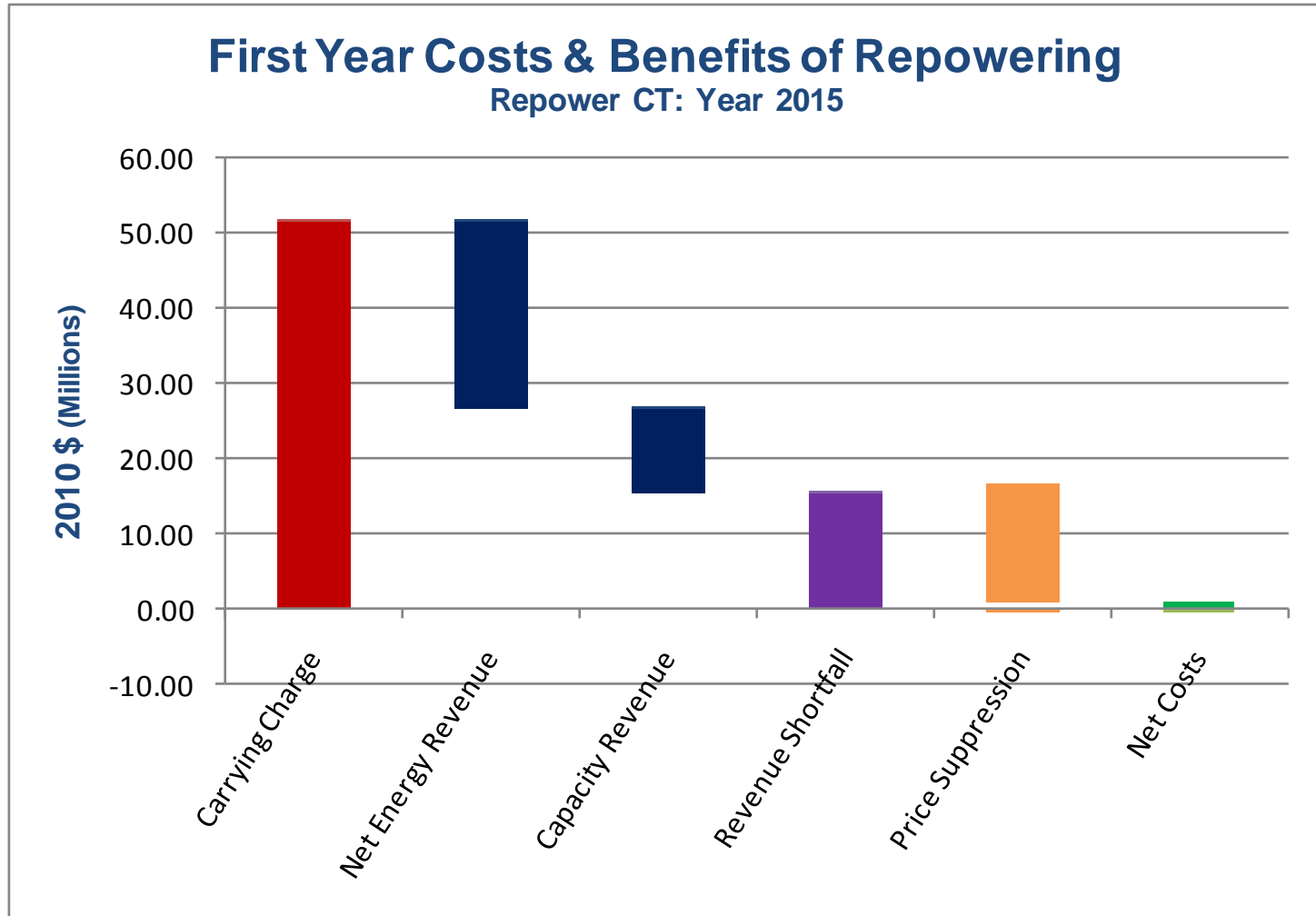
## 2020 and 2030 Resource Savings



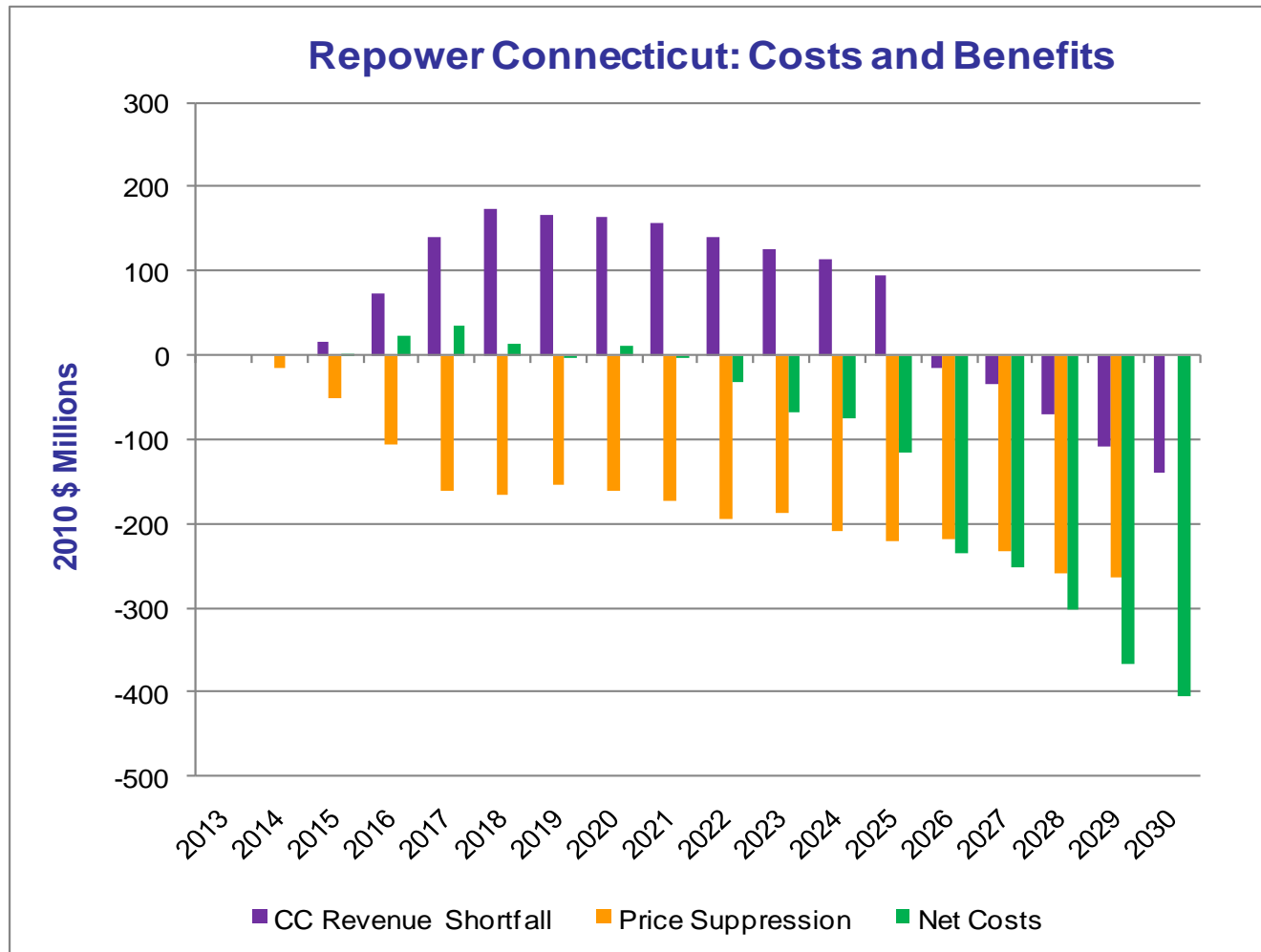
# Cost Implications – Expanded C&LM Programs



# Cost Implications – Repowering/Combined Cycles



# Cost Implications– Repowering /Combined Cycles



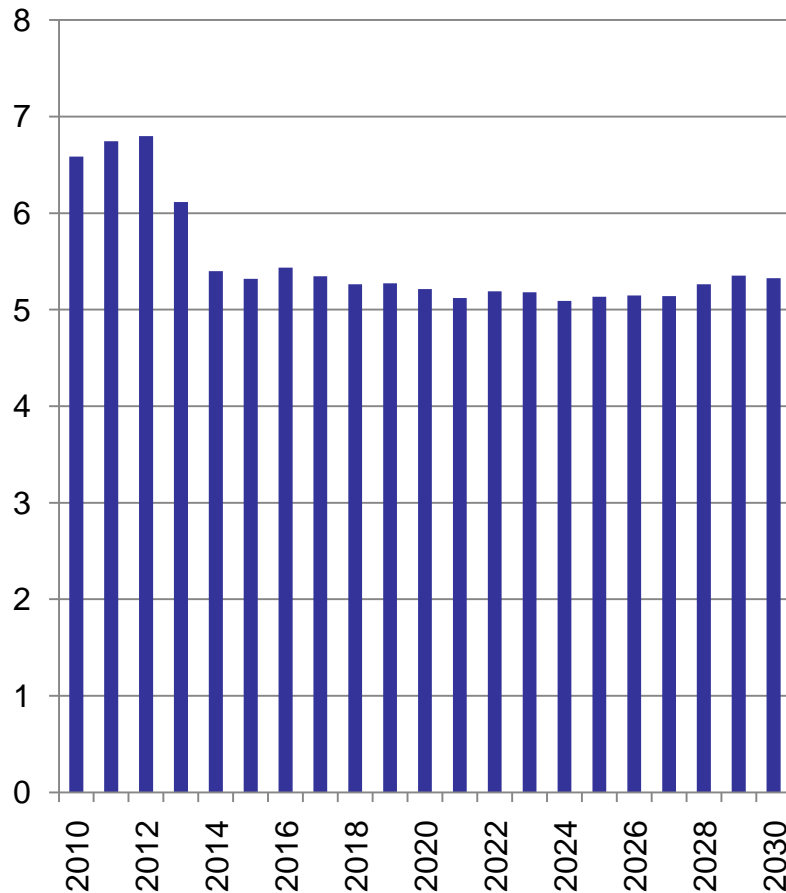
# ***Environmental Implications - Base Case***

## **KEY FACTORS AFFECTING CO<sub>2</sub> and NO<sub>x</sub> EMISSIONS**

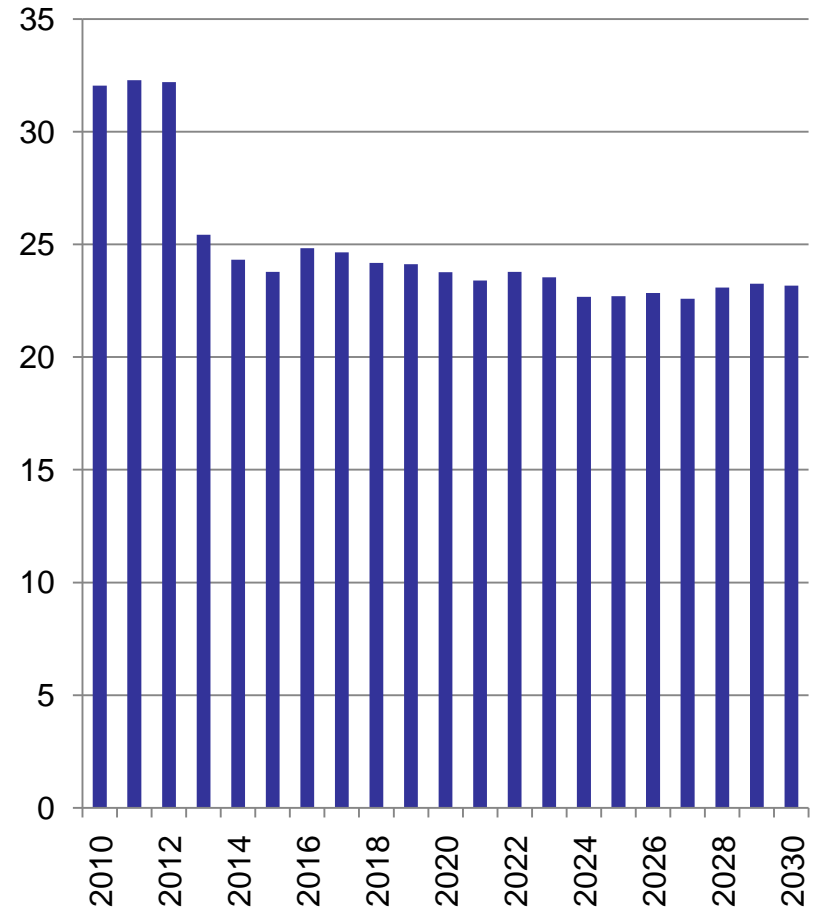
- Retirements remove NO<sub>x</sub> emissions on HEDD
- SCR and/or Scrubber retrofits reduce NO<sub>x</sub> emission rates
- Reduced oil/gas steam generation in CT due to:
  - planned gas and renewable generation additions in Connecticut
  - Energy Efficiency and Renewable Energy
- Federal legislation on carbon adds cost to carbon emitting resources

# Environmental Implications - Base Case

CT NOx emissions (thousand tons)

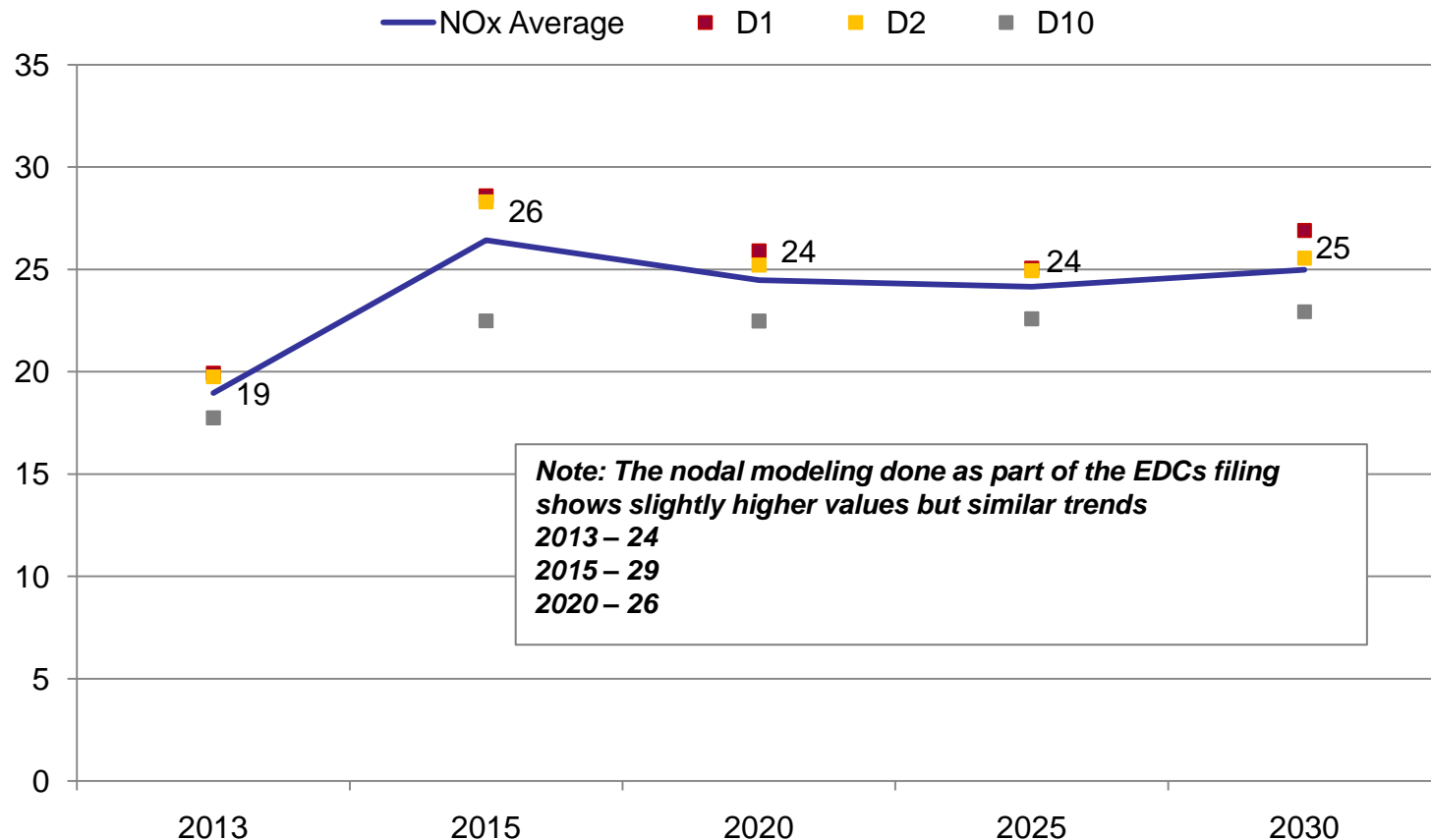


NE NOx emissions (thousand tons)



# Environmental Implications - Base Case

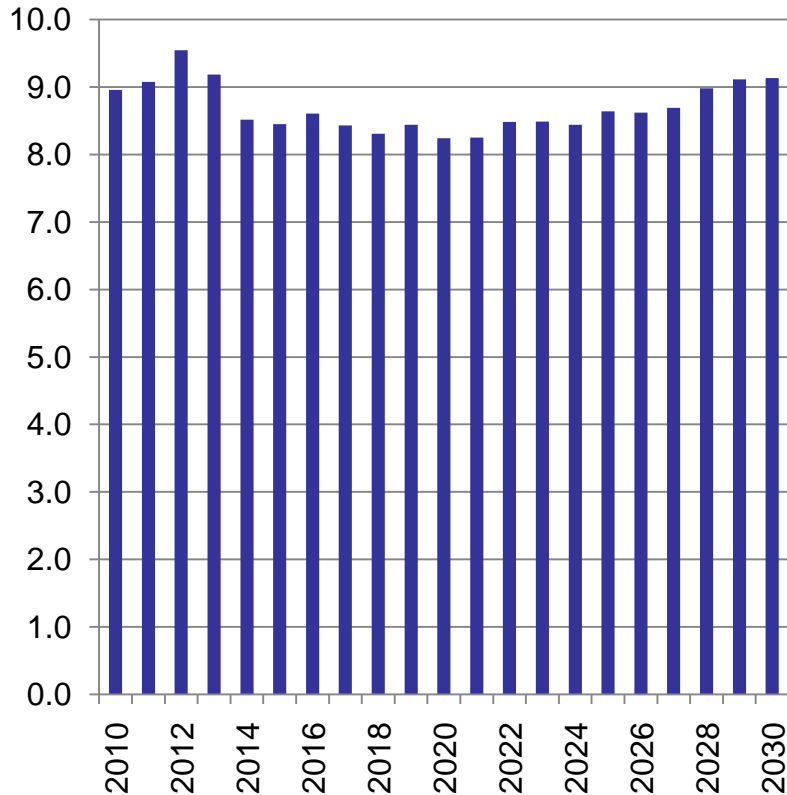
## HEDD NOx Emissions 10-Day Average (tons per day)



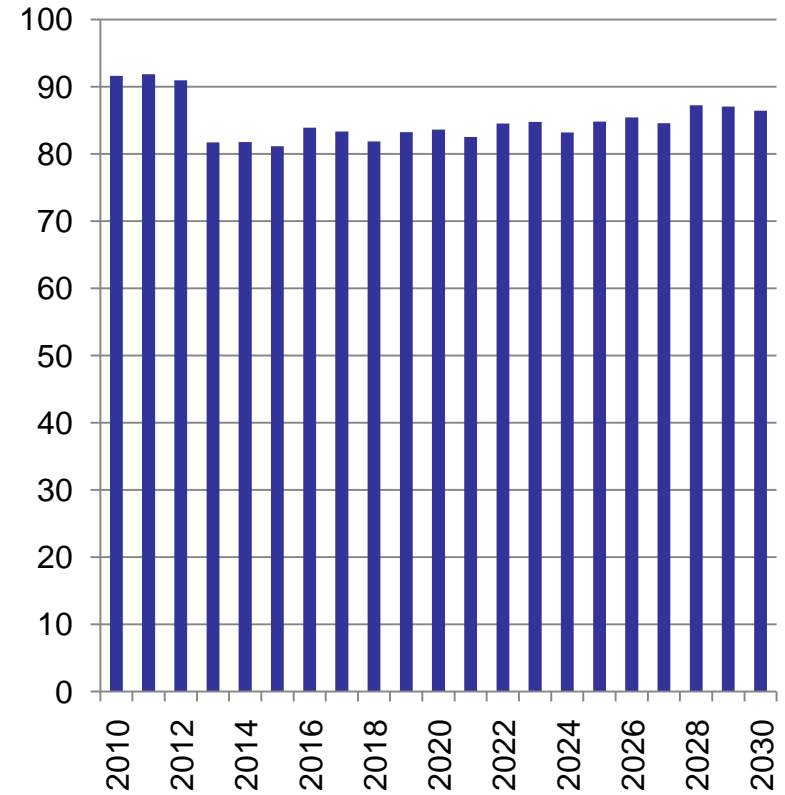
NOTE: Connecticut has agreed to a NOx reduction of 11.7 tons per day from current target of 42.7 tons/day

# Environmental Implications - Base Case

### CT CO2 Emissions (million tons)

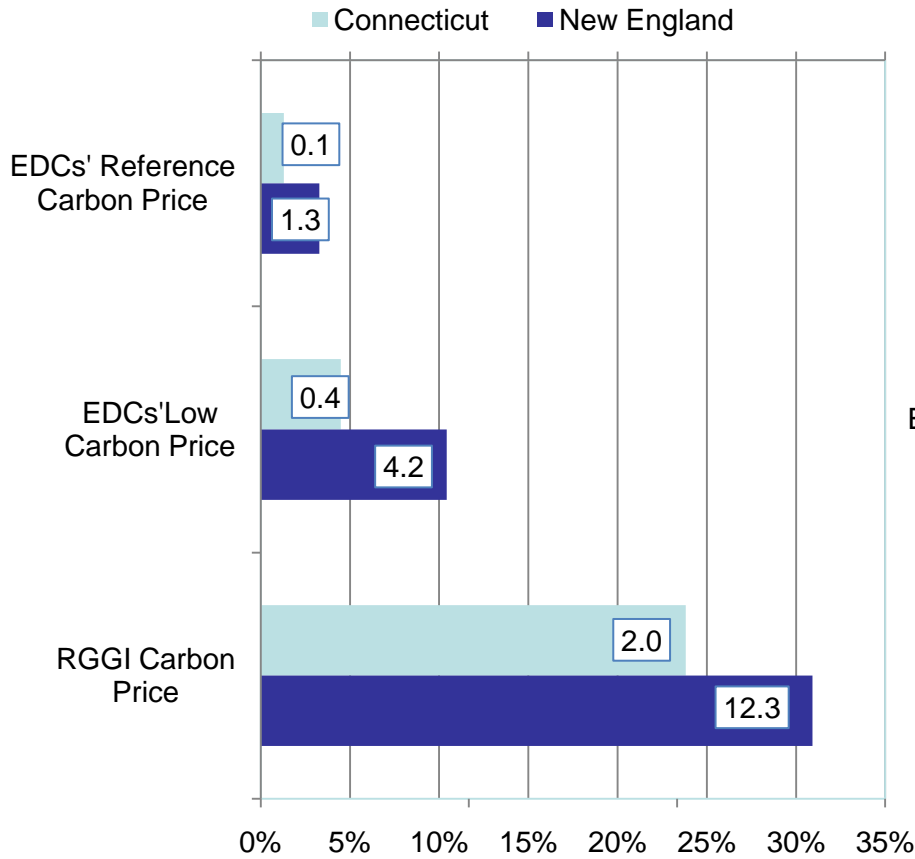


### New England CO2 Emissions (million tons)

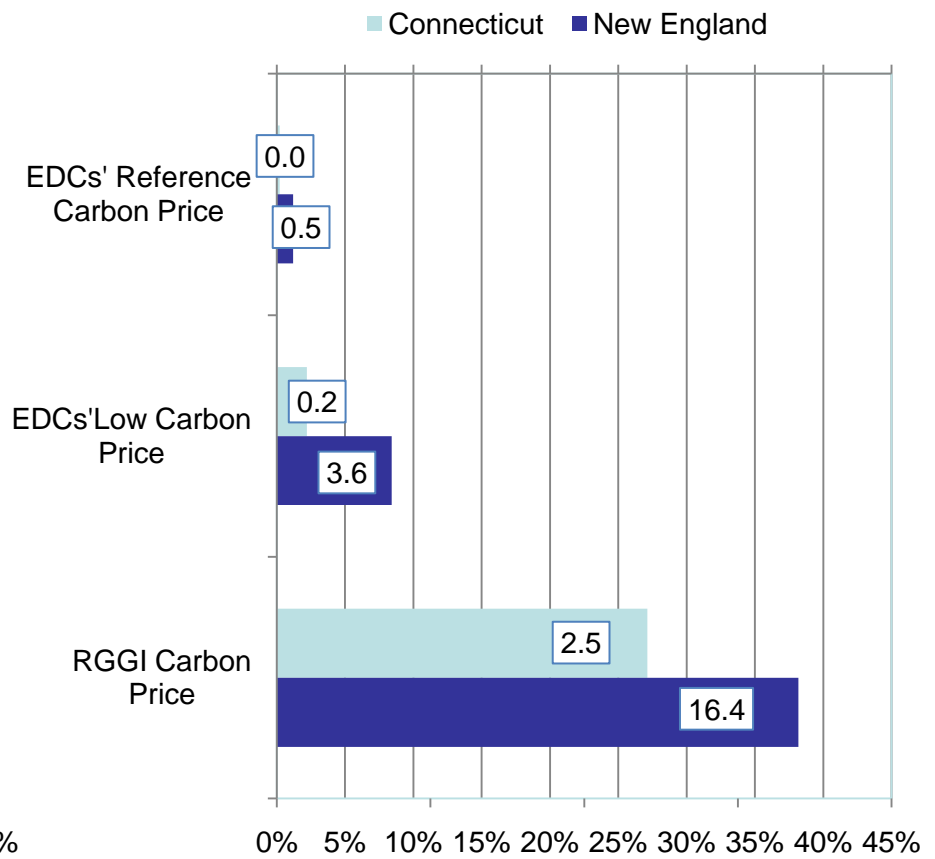


# Environmental Implications - Sensitivities

**CO2 Emissions % Change from Base Case, 2020**  
Emissions Level Increase in millions tons



**CO2 Emissions % Change from Base Case, 2030**  
Emissions Level Increase in millions tons



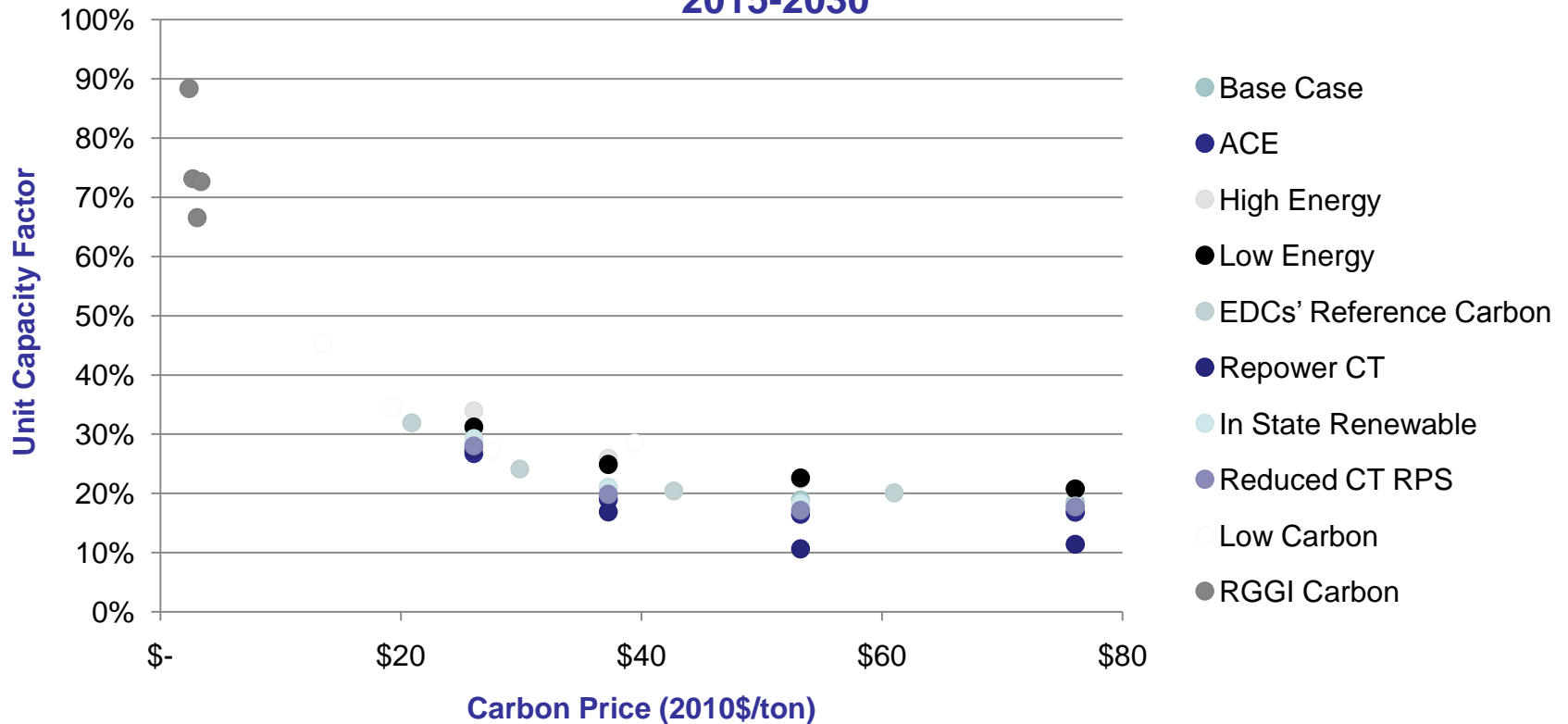
Base Case Emissions Level (millions tons): CT = 8.24 NE = 39.83

Base Case Emissions Level (millions tons): CT = 9.13 NE = 42.91

# Environmental Implications - Sensitivities

Coal vs. Gas Generation dispatch price as Carbon Allowance Prices

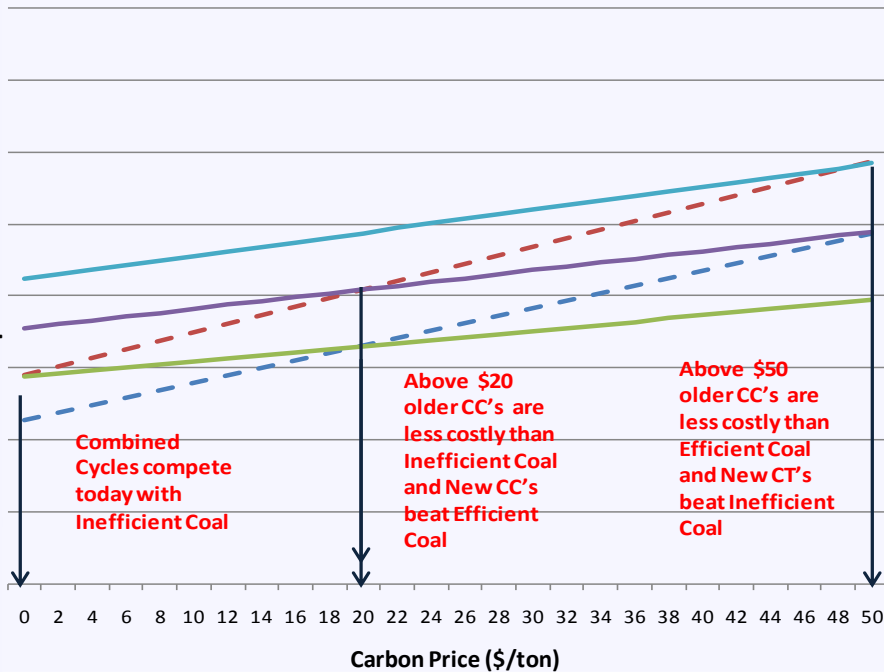
**Efficient Coal Plant  
Unit Capacity Factor v. Carbon Price  
2015-2030**



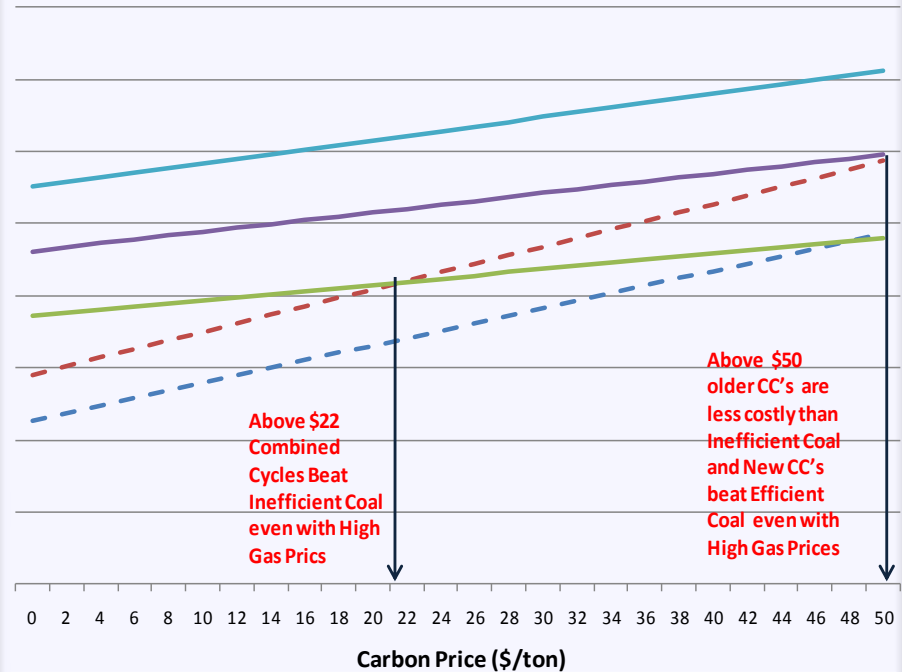
# Environmental Implications - Sensitivities

## Coal vs. Gas Generation dispatch price as Carbon Allowance Prices

Reference Gas \$7.00/MMBtu \$2010



High Gas Price \$2010

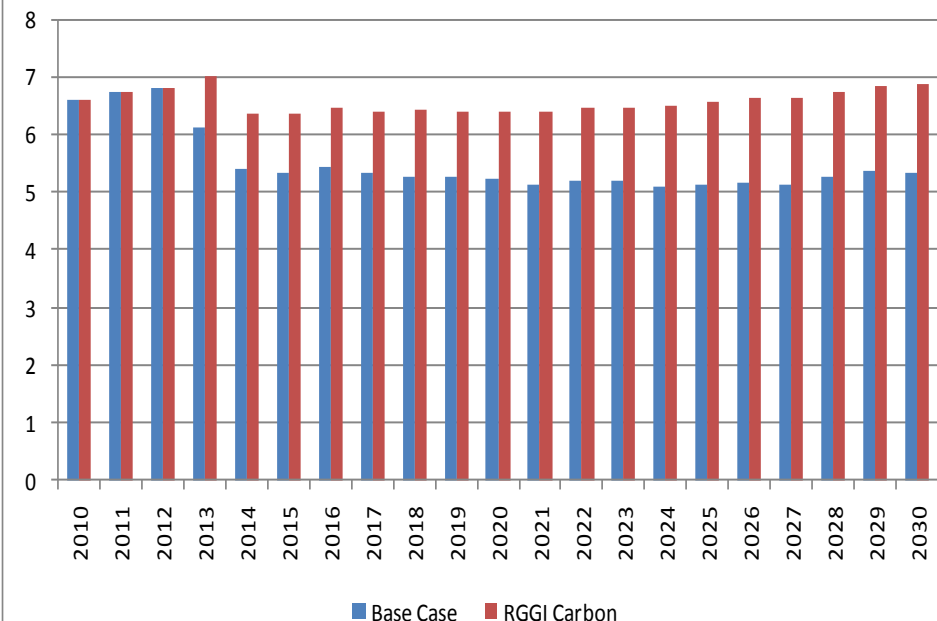


Key: — Efficient Coal Steam    - - Inefficient Coal Steam    — Efficient Gas CC    — Inefficient Gas CC    — Combustion Turbine (CT)

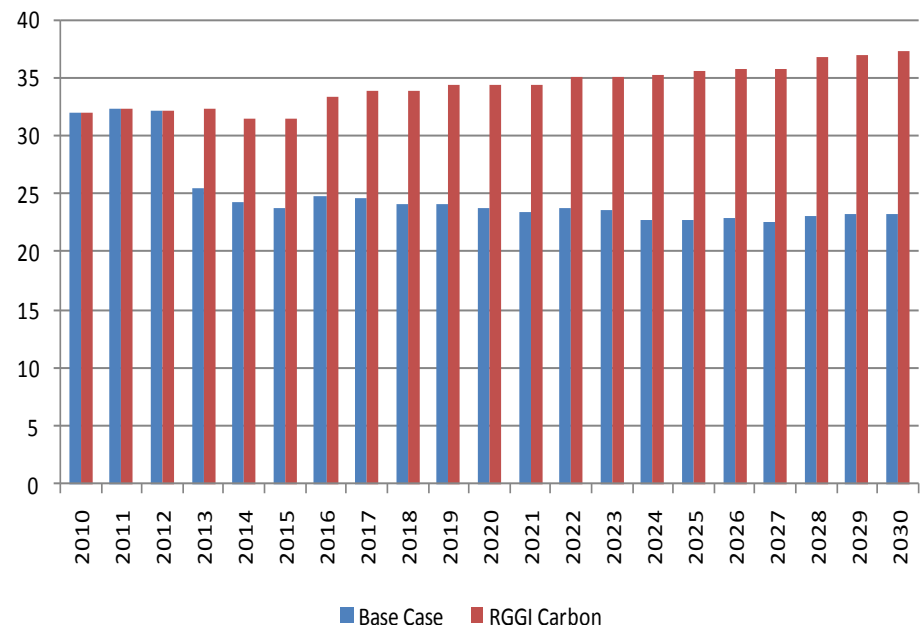
# Environmental Implications – NOx

Impact of CEAB Reference NOx Price compared with a RGGI only Outlook

CT NOx emissions (thousand tons)



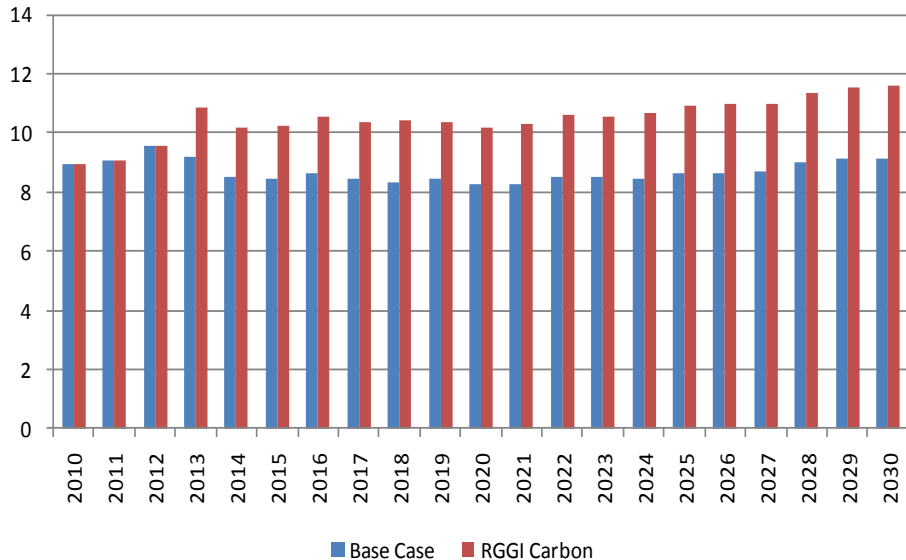
NE NOx emissions (thousand tons)



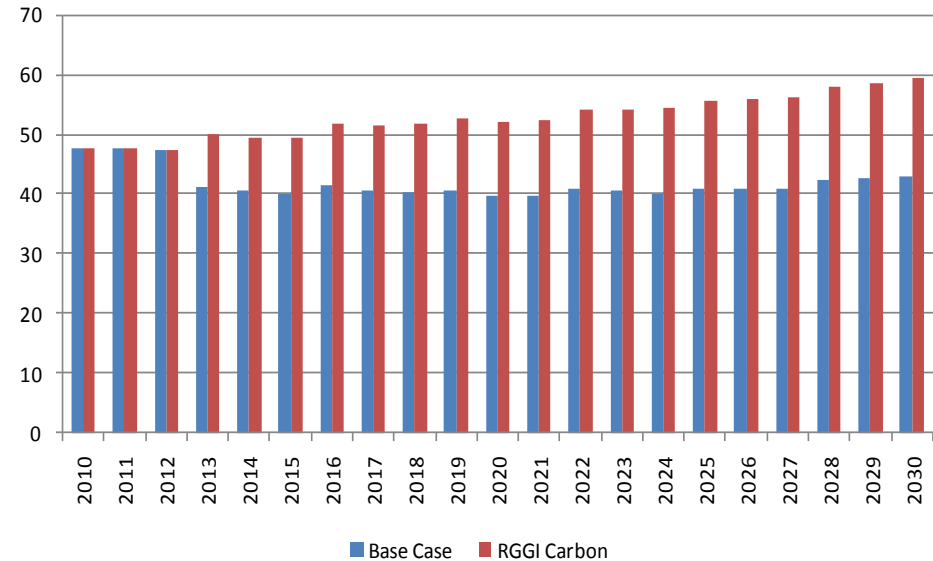
# Environmental Implications – CO2

Impact of CEAB Reference CO2 Price compared with a RGGI only Outlook

CT CO2 emissions (million tons)

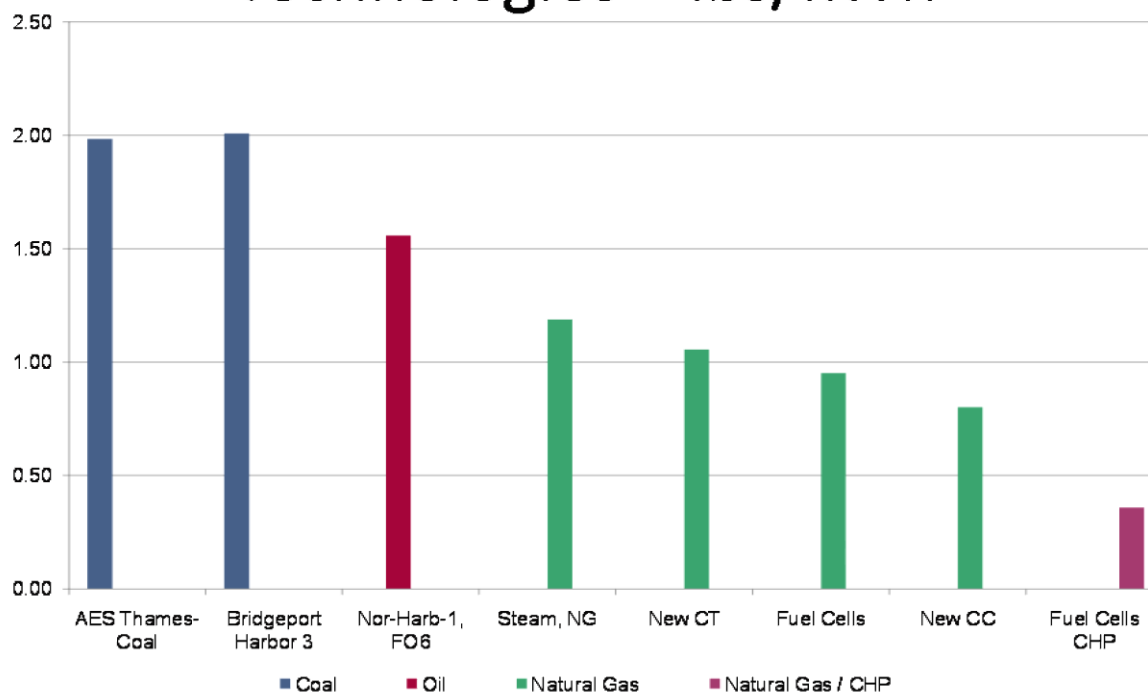


NE CO2 emissions (million tons)



# Environmental Implications – Resource Portfolios

## CO2 Emissions for Generating Technologies – lbs/kWh

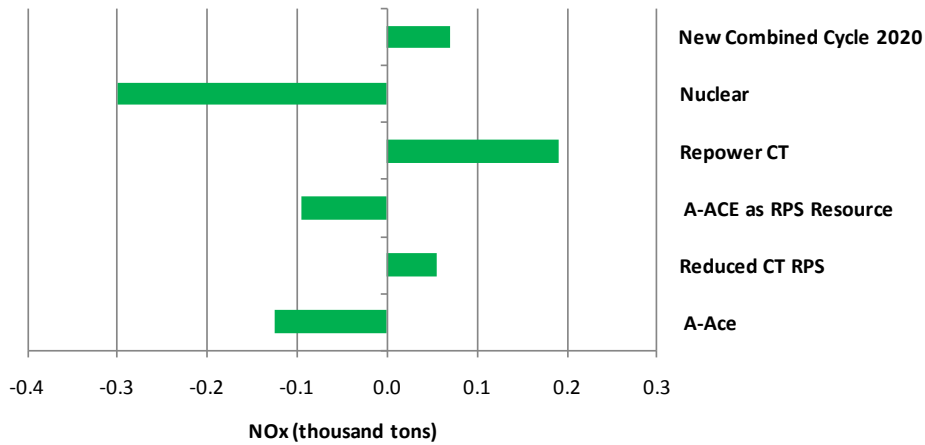


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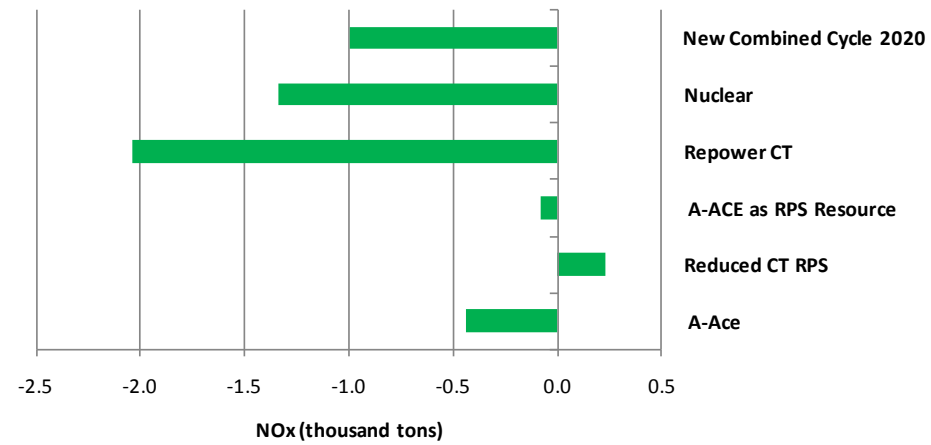
Preliminary - For Discussion Purposes Only

# Environmental Implications - Sensitivities

**Difference in CT NOx Emissions between Base Case and Sensitivity Cases**

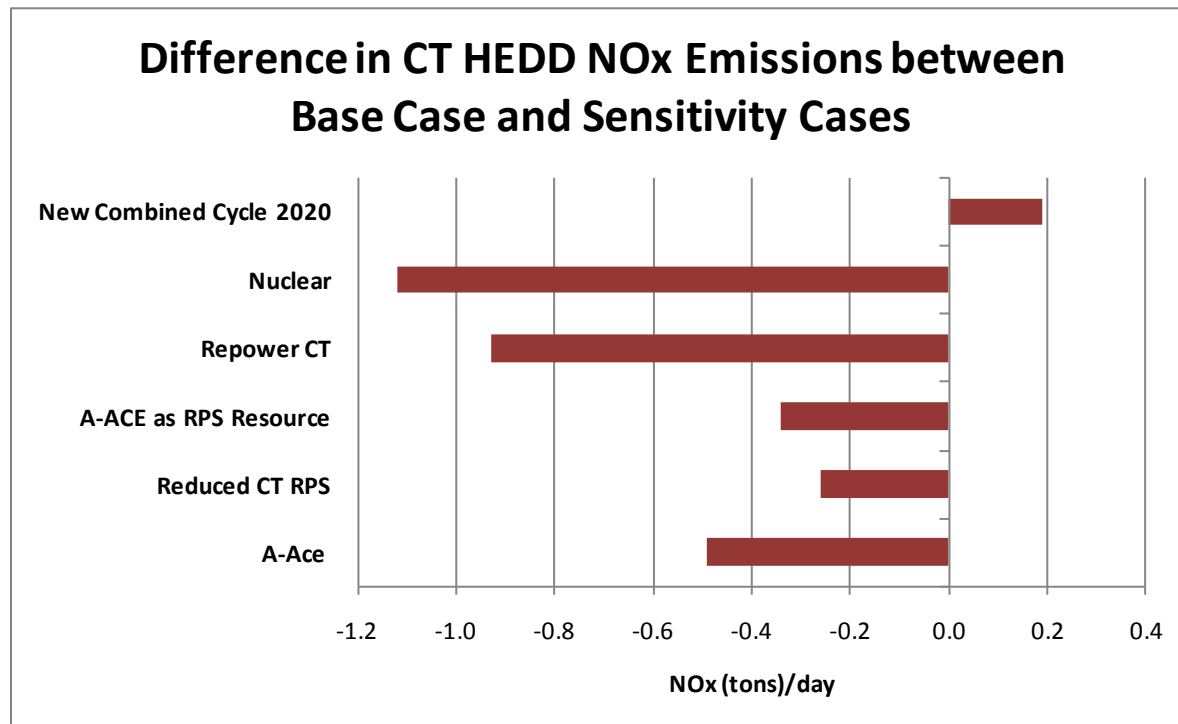


**Difference in NE NOx Emissions between Base Case and Sensitivity Cases**

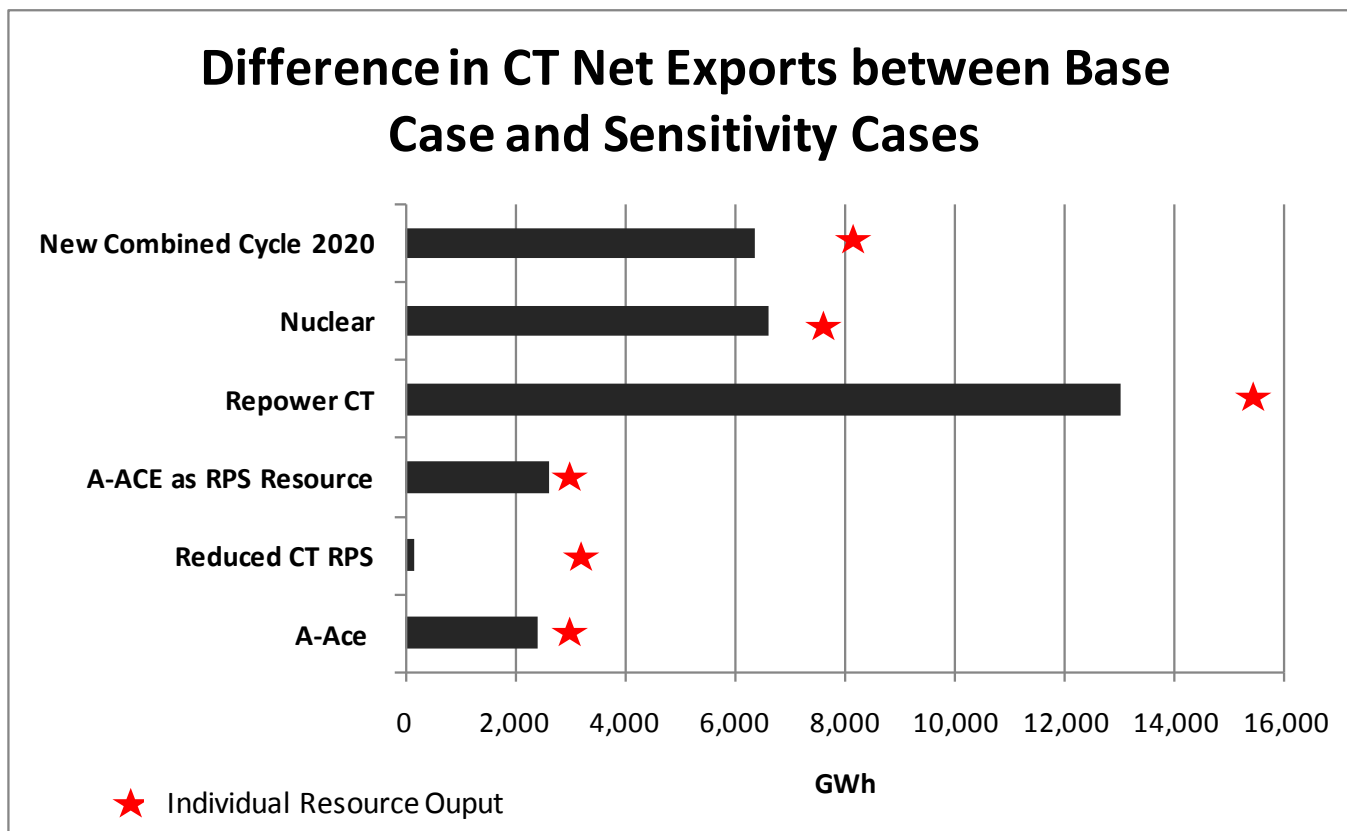


# Environmental Implications - Sensitivities

2030 Results

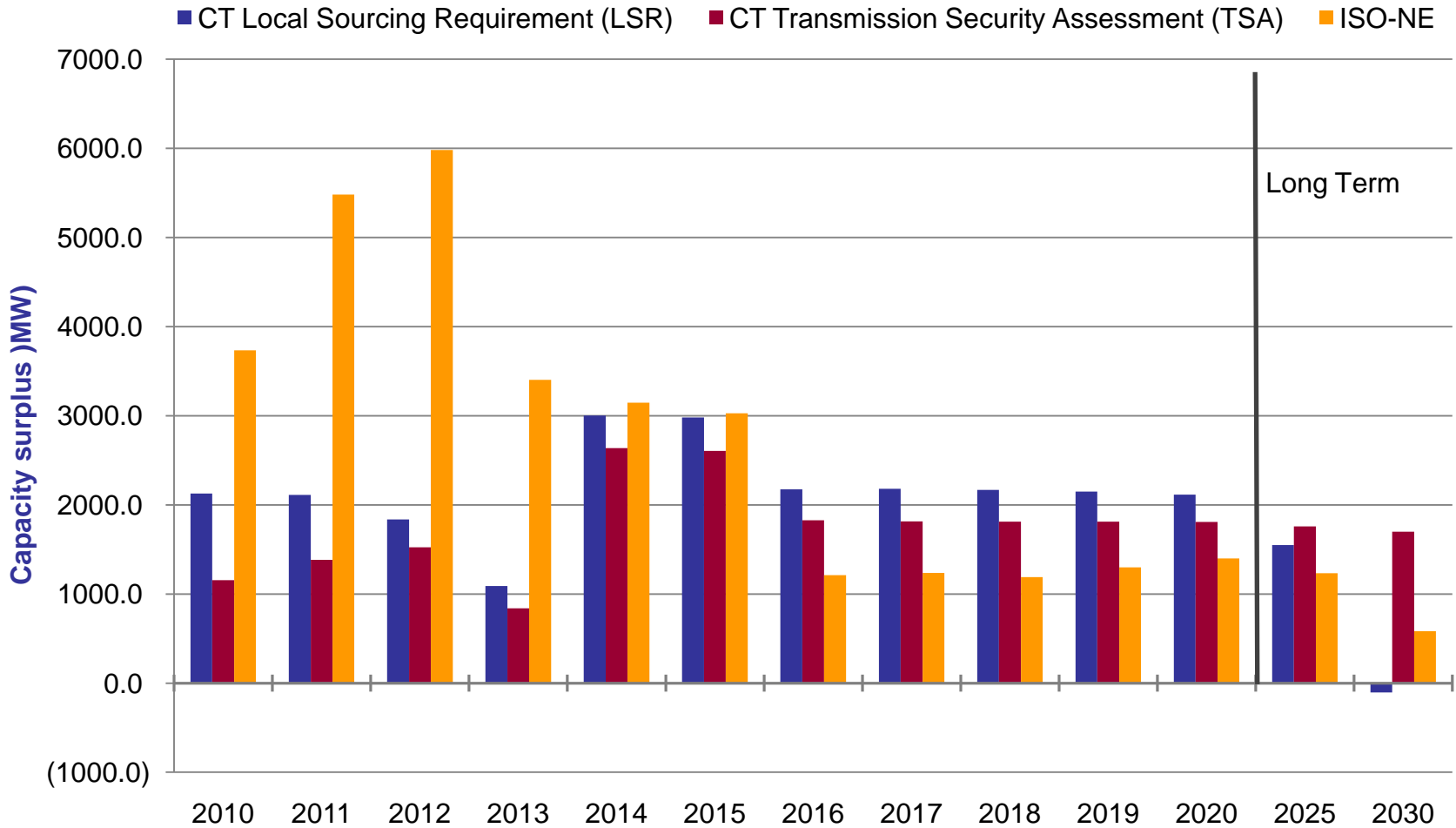


# Environmental Implications – Resource Portfolios



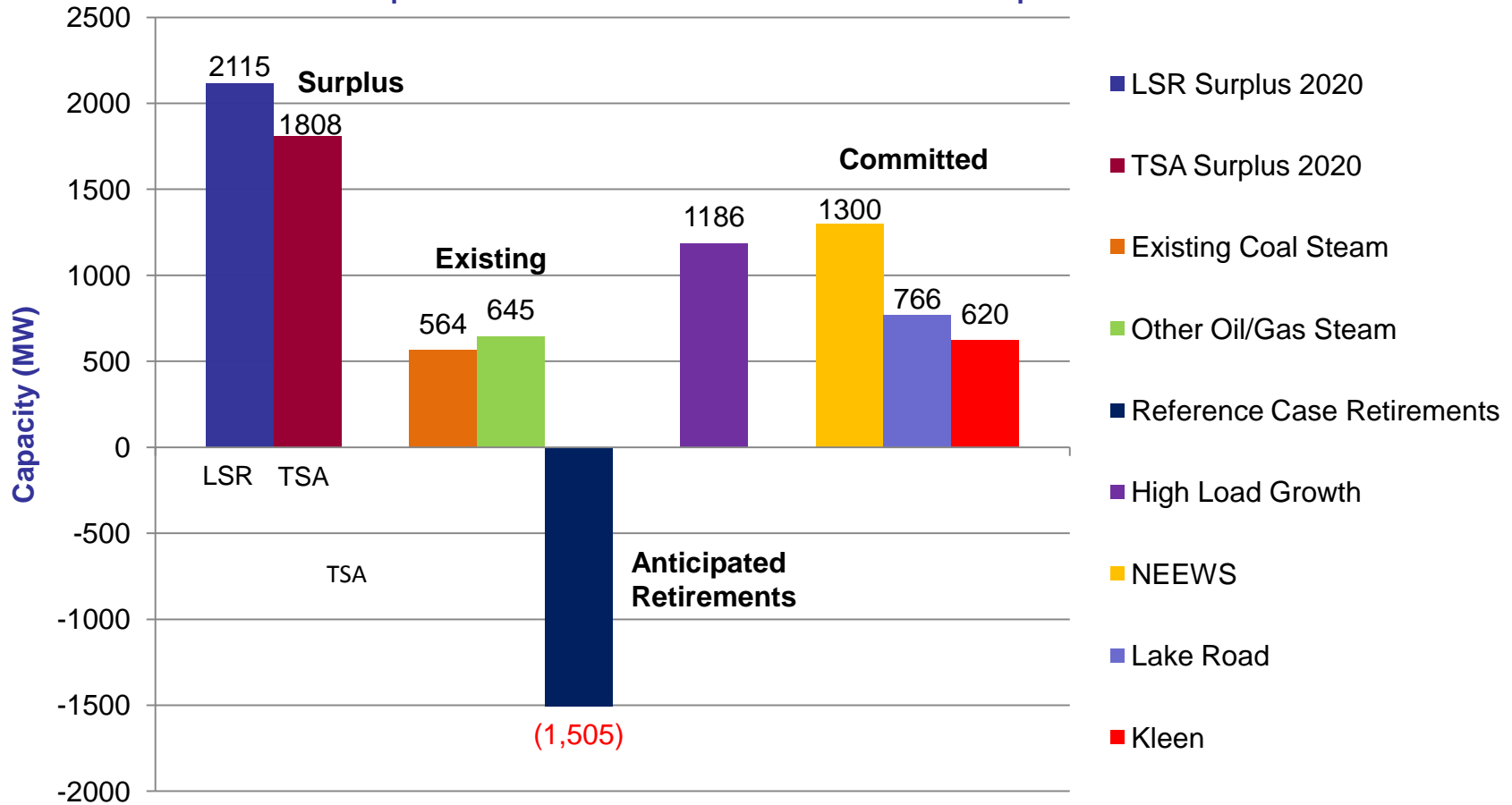
# Reliability Implications - Base Case

## Connecticut TSA Capacity Surplus



# Reliability Implications - Sensitivities

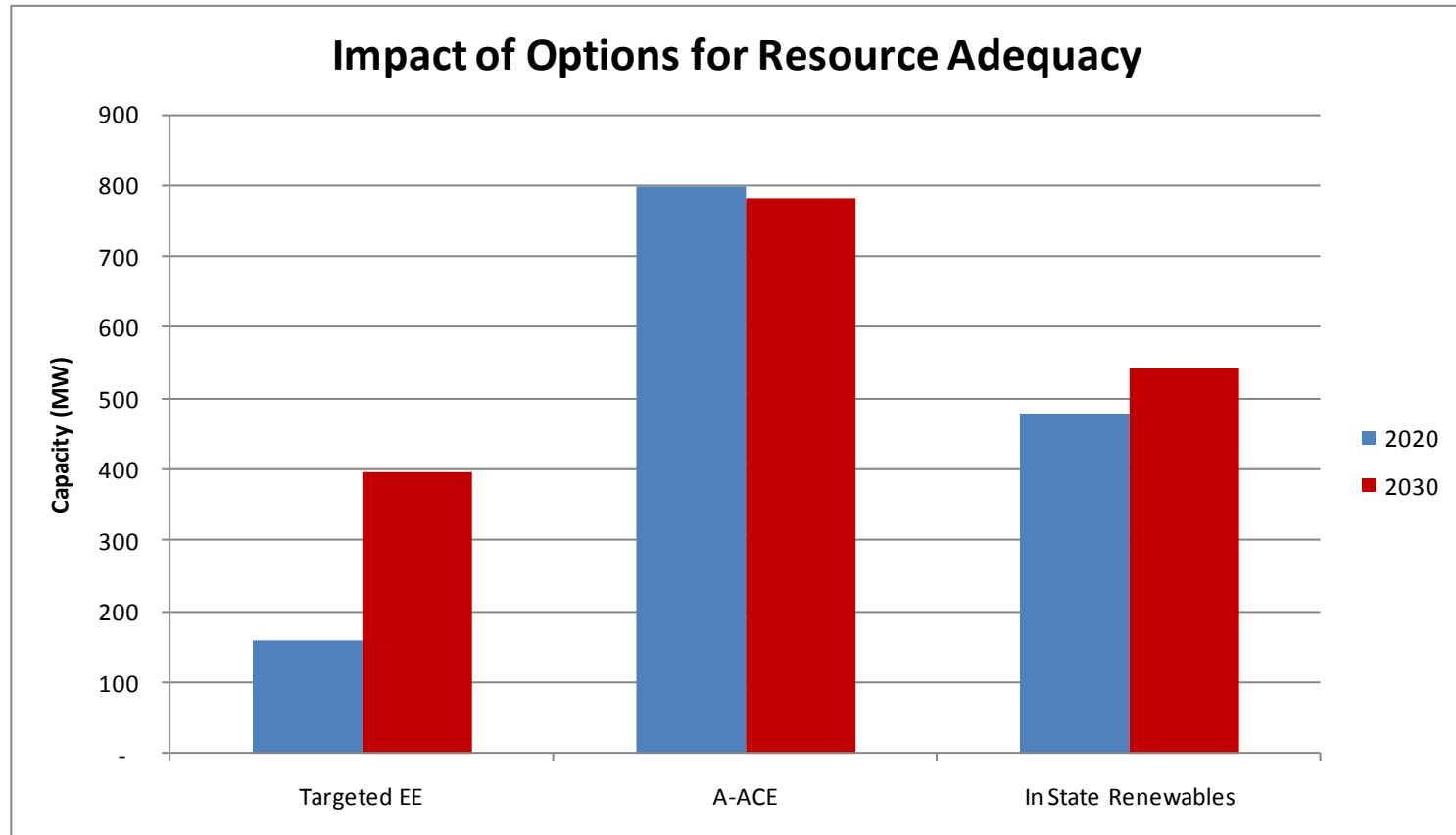
Resource Contingencies: Existing & Committed Resource Changes as compared to CT Reference Case Surplus in 2020



# Reliability Implications - Estimated Capacity Increases

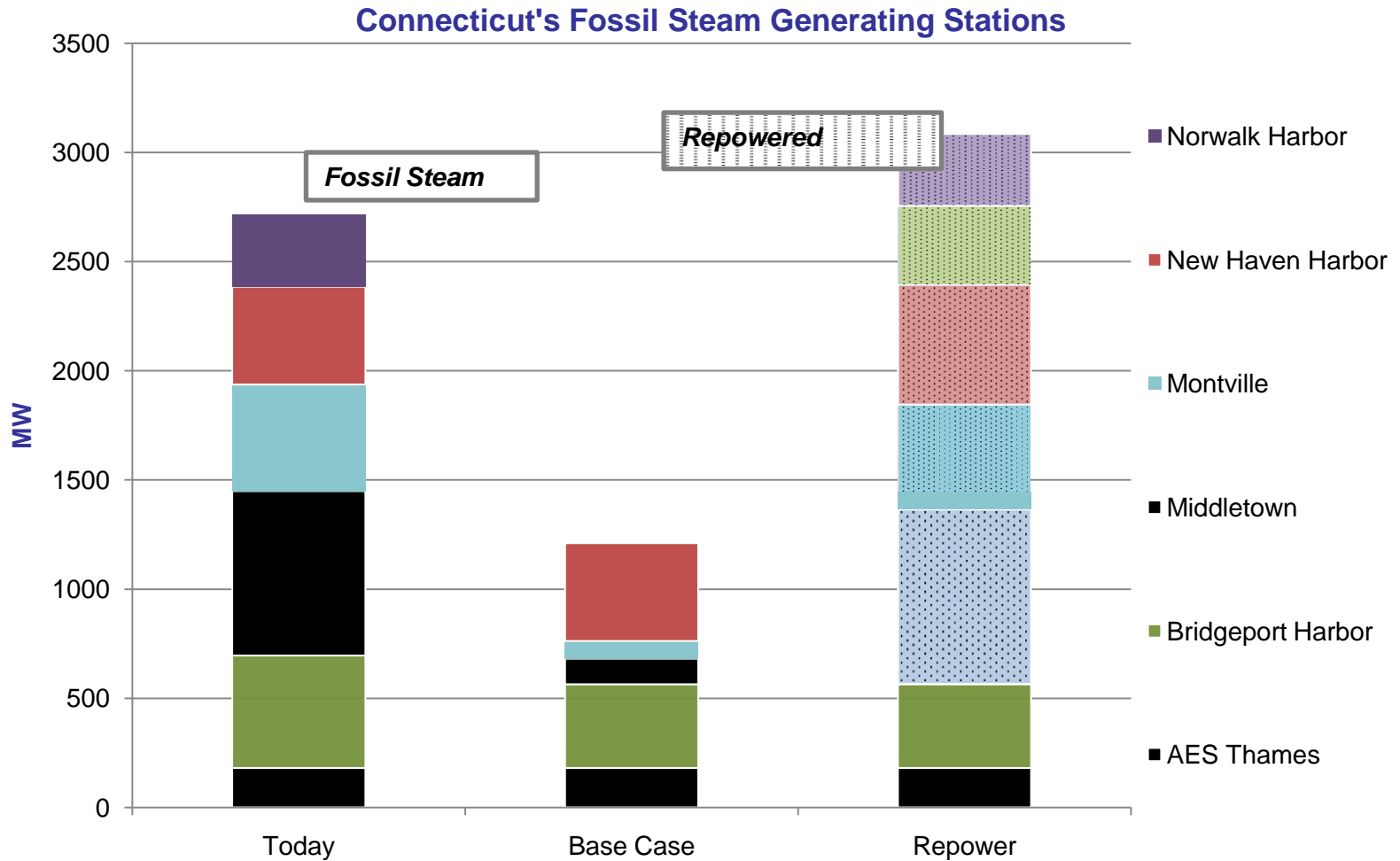
<i>Connecticut</i>				<i>New England</i>			
	<b>Reference Energy Efficiency</b>	<b>Demand Response</b>	<b>RPS Capacity</b>	<b>Energy Efficiency</b>	<b>Demand Response</b>	<b>RPS Capacity</b>	
2015	145	436	125	457	1,876	2,036	
2020	330	436	225	1,596	2,206	2,579	
2030	640	571	225	2,054	2,536	2,748	

# Reliability Implications – Energy Efficiency and Renewables



Option Capacity shown as incremental to Base  
Case: 330 MW in 2020 and 640 MW in 2030

# Reliability Implications – Repowering



## ***Portfolio Takeaways: Maximize ACE***

- ACE is lowest cost resource option today and will be to greater degree in the future
- Provides quantifiable environmental benefits
- Provides price suppression benefits as well as transmission and REC savings
- ACE reduces Connecticut RPS requirement by reducing energy and peak demand
- Even with RGGI carbon prices, ACE still provides measurable benefits
- Strong stakeholder support

## ***Portfolio Takeaways: Revisit RPS/Less near-term focus on Renewable Development***

- Regional approach required to cost effectively comply with Connecticut's RPS
- Regional approach still costly: \$13.6 billion capital investment plus estimated \$10 billion in transmission costs will have large rate impact
- Most of minimal environmental benefit is outside of CT
- Going slow will enable monitoring of regional transmission developments as well potential future renewable cost reductions

## ***Portfolio Takeaways: Targeted Development of Natural Gas Generation***

- One or two repowering projects by 2020 with new efficient gas-fired combined cycle generation provide effective replacement capacity
- Projects provide significant price suppression benefits
  - Even with RPS compliance, A-ACE, and modest retirements
  - Added Value as contingency resource
- Options could incorporate renewables or CHP
- Many existing CT sites are in good locations for transmission and load
- Need to monitor pace of retirements, NEEWS, federal greenhouse gas regulation, and the timing on need for capacity