Meeting of the Governor's Council on Climate Change (GC3)

September 8, 2016

Connecticut Department of Energy and Environmental Protection

Agenda

1:00	Welcome and Announcements *DEEP Commissioner Klee*
1:05	Review and discuss updated scenarios and setting a mid-term target(s) *Paul Miller and Jason Rudokas, NESCAUM* *DEEP Commissioner Klee*
2:20	Review updated 2013 GHG Inventory *Keri Enright-Kato, CT DEEP*
2:30	Public Comments

Reference Case & Mitigation Wedge Input Assumptions

Introduction

- The purpose of this presentation is to document the input assumptions that went into the 35%, 45% and 55% GHG mitigation wedges.

- This is another way to foster discussion and get feedback on future scenarios to consider.

Penetration Rates and Assumptions Associated with Mitigation Wedges

Rates & assumptions for following scenarios:

1. 80% GHG reduction by 2050 relative to 2001 levels.

2. Evaluation of three alternative interim 2030 targets:
   - 35%
   - 45%
   - 55%

Reference Case Assumptions for Nuclear

- Pilgrim retires in 2019 and replaced with natural gas
- Seabrook granted a 20-year license renewal in 2030 and operates through 2050
- Millstone 2 and 3 retire in 2035 and 2045 respectively and are replaced with natural gas

State Electric Energy Efficiency Programs

- Energy efficiency forecast is based on ISO-NE 2016 CELT.

- CELT incorporates CT-specific program spending and savings data into its forecast through the ISO-NE EE working group.

	2015	2030	2050
Energy Savings (GWh)	2,460	6,540	9,510

Behind-the-Meter(BTM) Solar

Low BTM: ISO-NE PV growth forecast cut in half.

Medium BTM: ISO-NE growth forecast extrapolated based on 2020 – 2025 growth rate.

High BTM: Geostellar estimate of 650k households with rooftops suitable for PV install systems by 2050.

(MW)	2015	2030	2050
Low	185	870	1,150
Medium	185	1,075	3,325
High	185	1,160	4,875

Clean Grid

- Assumes clean generation resources begin to replace natural gas after 2025.
- By 2050:
  - Natural Gas = 5% of Generation
  - Renewables = 75% of Generation

Resource Type	Capacity Factor	Capital Cost – ($/kw)	Technical Potential – (GW)
Utility-scale Solar	21%	$3,800	825
BTM Solar	21%	$4,000	23
Onshore Wind	34%	$2,200	17
Offshore Wind	44%	$6,200	363
Imported Hydro	37%		

Technical Potential is for New England.
Source: Lopez, A. et al. (2012). "U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis." NREL/TP-6A20-51946. Golden, CO: National Renewable Energy Laboratory.

Electrification of Passenger Vehicles

	2015	2030	2050
35% below 2001 levels by 2030			
# of ZEVs	2,902	462,149	2,184,529
% of Fleet	.1%	20%	79%
% of Sales	.8%	60%	54%
45% below 2001 levels by 2030			
# of ZEVs	2,902	875,650	2,184,529
% of Fleet	.1%	38%	79%
% of Sales	.8%	87%	32%
55% below 2001 levels by 2030			
# of ZEVs	2,902	1,532,388	2,184,529
% of Fleet	.1%	67%	79%
% of Sales	.8%	200%	13%

- In 55% scenario ZEV sales are more than LDV sales forecast
- More aggressive ZEV targets lead to relaxed sales numbers in later years
- ZEV penetration rate is a key sensitivity
- Yearly ZEV sales of 25% would attain 80% of fleet by 2050

Residential Renewable Thermal

	2015	2030	2050
35% below 2001 levels by 2030			
# of Devices	2,934	171,186	847,293
% of Thermal load	.3%	18%	87%
# of Change Outs /yr.		11,400 (.7%)	33,800 (3%)
45% below 2001 levels by 2030			
# of Devices	2934	376,896	847,293
% of Thermal load	.3%	39%	87%
# of Change Outs /yr.		25,100 (1.7%)	23,500 (1.6%)
55% below 2001 levels by 2030			
# of Devices	2934	579,840	847,293
% of Thermal load	.3%	60%	87%
# of Change Outs /yr.		38,656 (2.6%)	13,373 (.9%)

- For this scenario renewable thermal refers to air and ground source heat pumps.
- # of Change outs per year is the # of conventional units that would need to be replaced each year in the 2015-2030 and 2030-2050 periods.

Commercial Renewable Thermal

	2015	2030	2050
35% below 2001 levels by 2030			
Sq. ft. Heated by ASHP & GSHP	111,981	3,561,796	27,963,354
% of Heated Sq. ft.	.3%	10%	69%
45% below 2001 levels by 2030			
Sq. ft. Heated by ASHP & GSHP	111,981	13,891,003	27,963,354
% of Heated Sq. ft.	.3%	39%	69%
55% below 2001 levels by 2030			
Sq. ft. Heated by ASHP & GSHP	111,981	19,375,200	27,963,354
% of Heated Sq. ft.	.3%	60%	69%

- For this scenario renewable thermal refers to air and ground source heat pumps.
- Percentages represent the % of heated floor space provided by heat pumps.

Heavy-duty Vehicle Electrification

- Table presents penetration of electric heavy-duty vehicle technologies used to meet 80% GHG reduction target.
- This wedge represents 8% of total GHG reductions by 2050.
- This wedge also has local air pollution Co-benefits.

	2015	2030	2050
Light Commercial Trucks and Transit Buses	<.01%	30%	80%
School Busses & Refuse Trucks	<.01%	30%	95%
Single Unit Short Haul Trucks	<.01%	35%	90%

Electrification of Passenger and Freight Rail

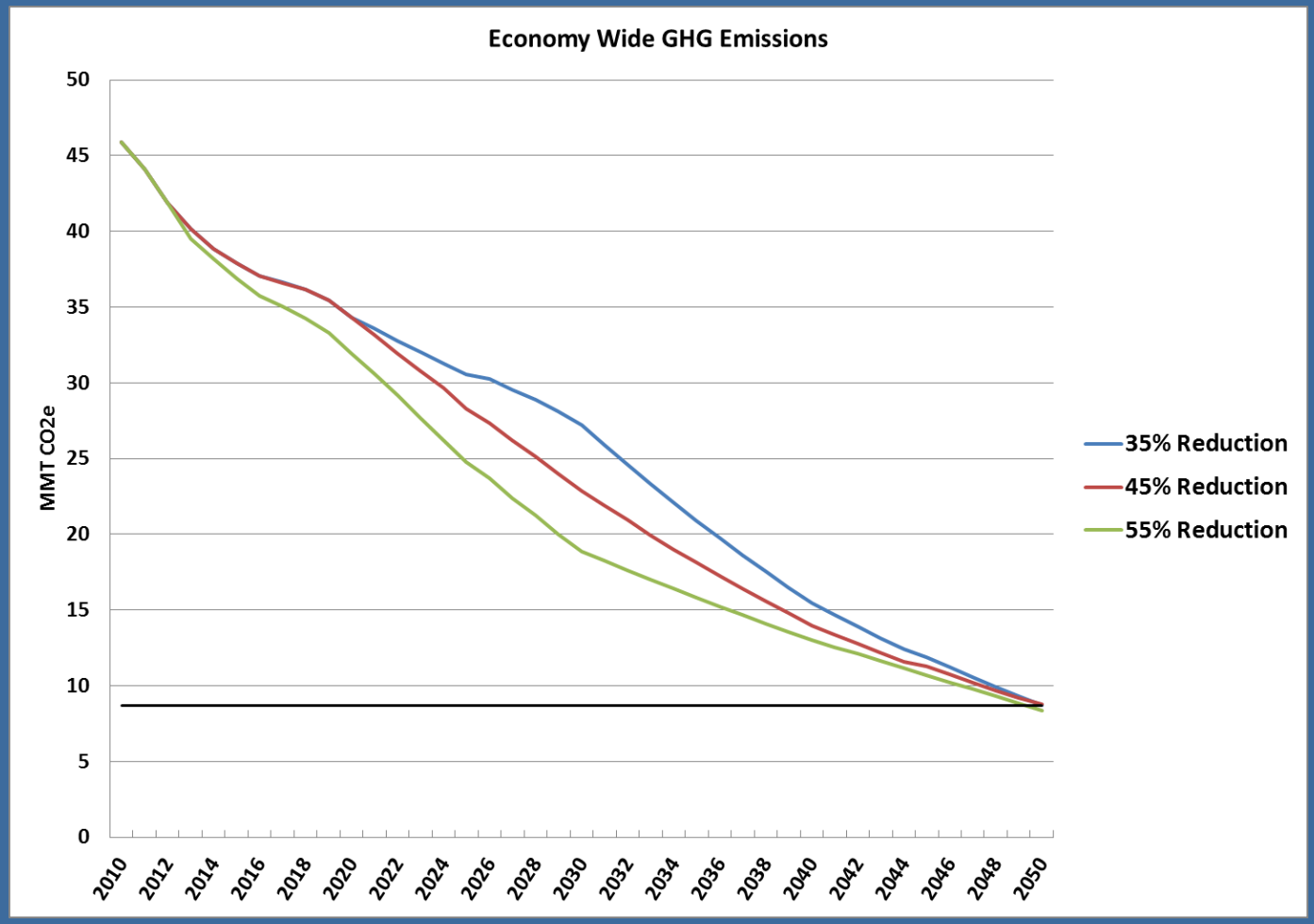
- The table below presents the penetration of electric rail technologies used to meet the 80% GHG reduction target.

- This wedge represents 5% of the total GHG reduction potential through 2050.

	2030	2050
Passenger	45%	95%
Freight	45%	95%

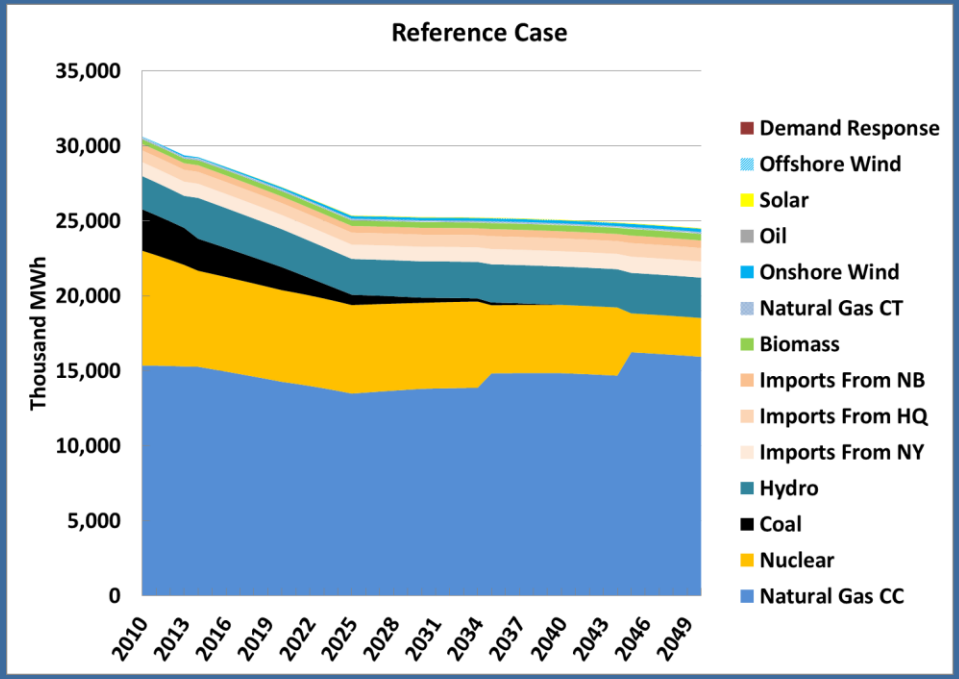
Additional Scenario Analysis

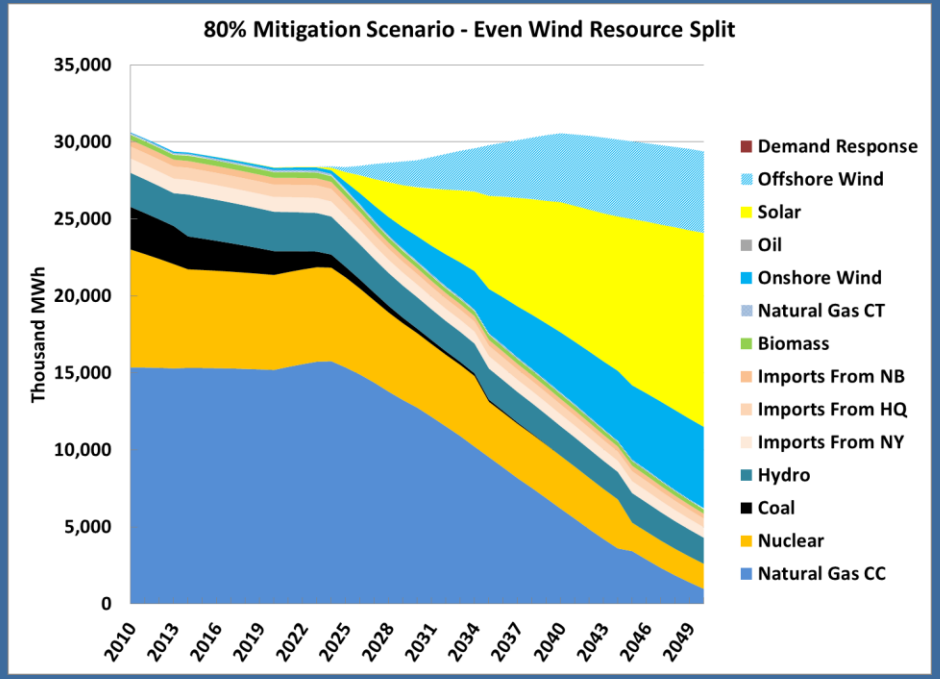
Alternative 2030 Target Trends



- Technology penetration rates focused on residential & commercial thermal loads and zero emission vehicles
- 8 MMT difference in 2030 between 35 and 55 percent scenarios

Renewable Generation Sensitivity
Even Wind Resource Split (45% Scenario)



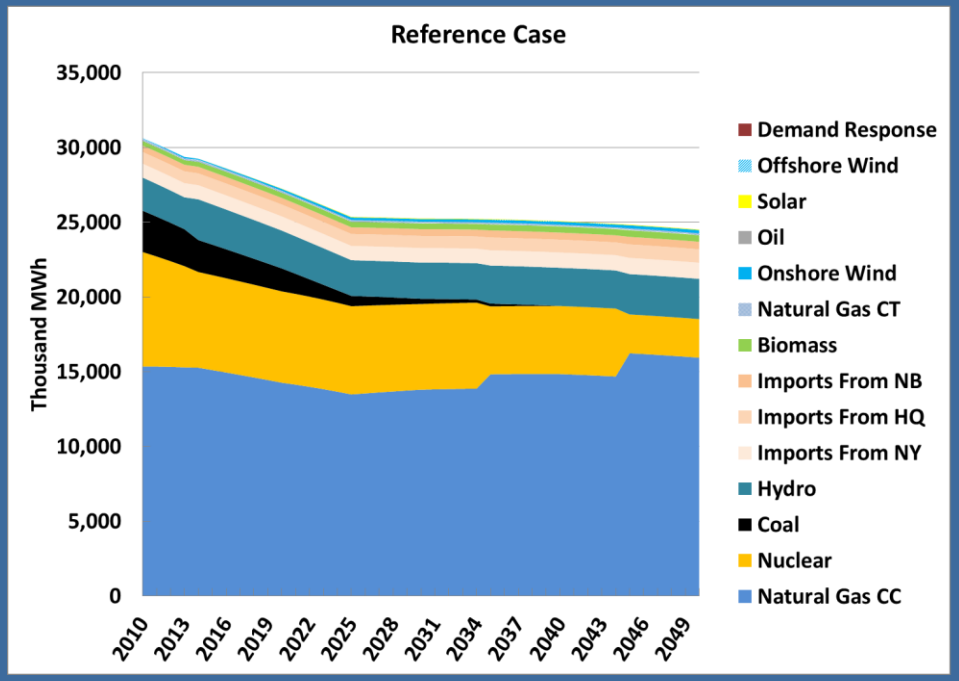


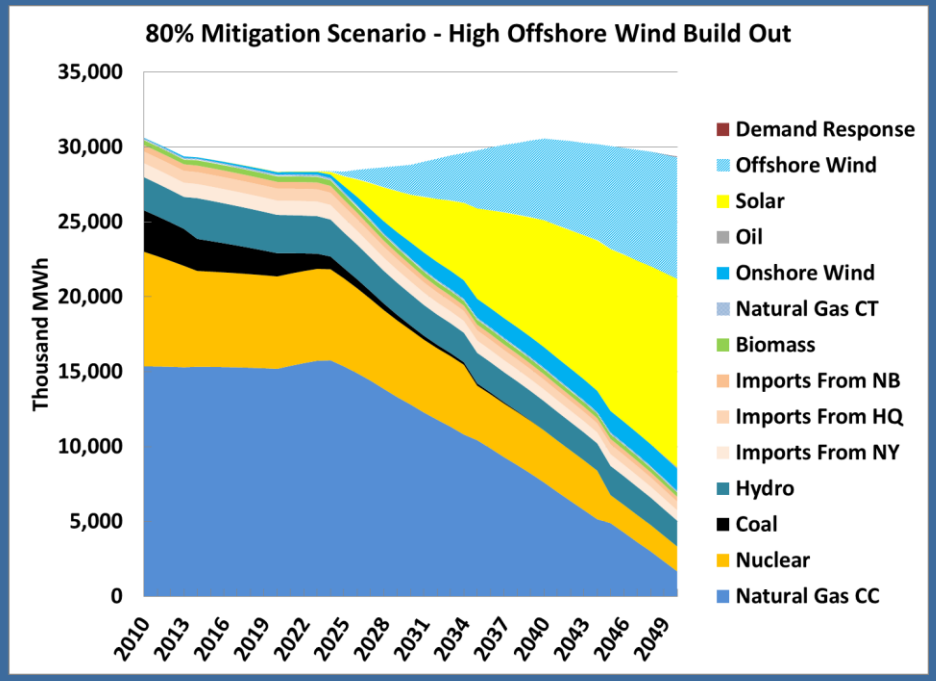
Overall renewable generation represents 75% of total generation by 2050

- Utility-scale solar = 40%
- Onshore wind = 17.5%
- Offshore wind = 17.5%

Levelized cost of energy is 23% to 26% higher than reference case

Renewable Generation Sensitivity
Offshore Wind Build Out (45% Scenario)





Overall renewable generation represents 75% of total generation by 2050

- Utility-scale solar = 40%
- Onshore wind = 5%
- Offshore wind = 30%

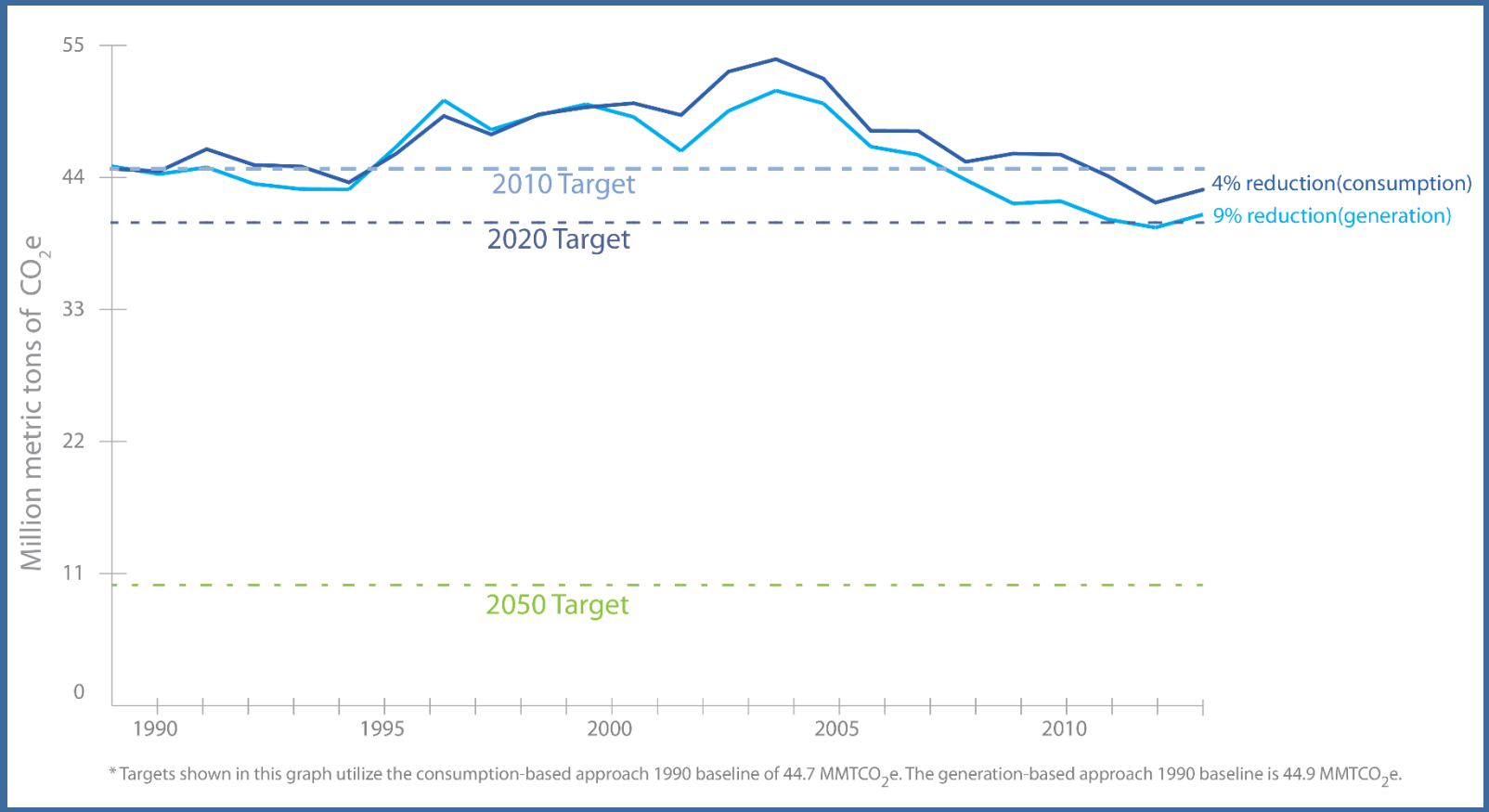
Levelized cost of energy is 27% to 33% higher than reference

2013 GHG Inventory Update

Connecticut Department of Energy and Environmental Protection

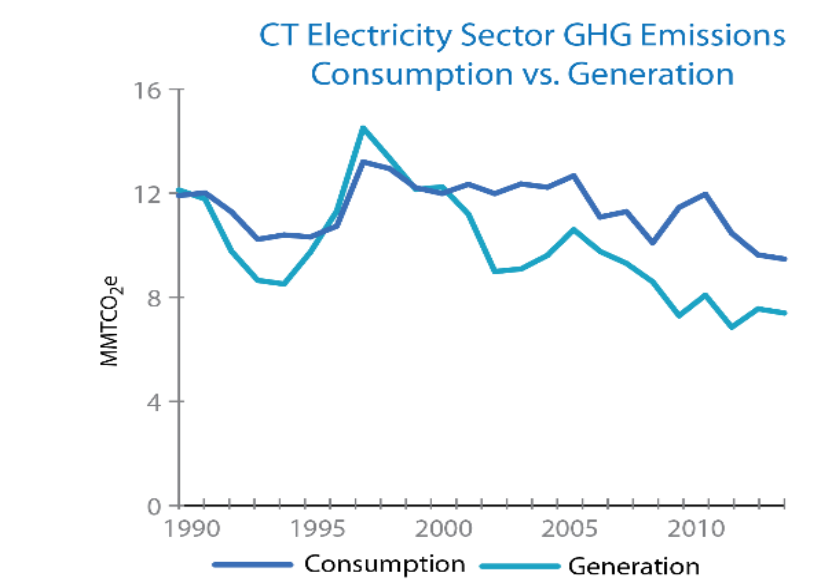
CT Economy-wide GHG Emissions 1990-2013

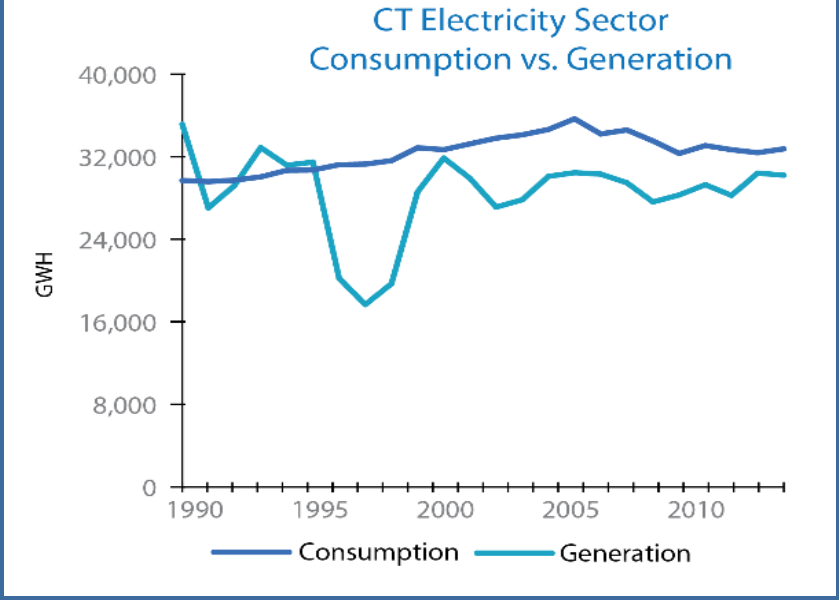
Comparison of Electricity Sector Generation- and Consumption-based Accounting



Utilizing the consumption-based approach for the electricity sector, Connecticut's economy-wide GHG emissions in 2013 were 43 $MMTCO_2e$. In comparison, using the generation-based approach emissions were 41 $MMTCO_2e$.

Emissions for both accounting approaches are closely paralleled, with peak emissions occurring in 2004 and an overall downward trend to 2013.





These two graphs represent a comparison of GHG emissions and GWH using a consumption-and generation-based accounting approaches. The generation-based approach indicates lower carbon emissions than the consumption-based approach, reflecting the fact that power plants operating within Connecticut have a "cleaner" generation mix than the region as a whole.

The consumption-based approach reflects significant historical and ongoing change in the mix of fuels used to generate electricity in New England. It also has the potential to better align Connecticut's GHG inventory with actions the state has taken and can take to reduce emissions by investing in energy efficiency within our borders, and increasing generation of electricity from renewable energy sources both within the state and regionally through policies such as the Renewable Portfolio Standard and long-term contracting.

Further refinement of this approach will be necessary going forward, to ensure that a consumption-based approach can accurately account for the benefits of direct ratepayer investments in clean energy generation and/or transmission that may be made outside of Connecticut, without double-counting investments directly attributable to other states in the region.

GHG Emission Reduction Strategies Currently Underway

The following programs, strategies, and policy initiatives are just a few examples of current efforts driving the state's emissions down between now and 2020. These initiatives offer a foundational framework to build upon as additional strategies are developed to further reduce emissions beyond 2020.

Energy Efficiency: Investment in energy efficiency programs have doubled since 2013. At this increased level of investment, expected lifetime GHG reductions from the state's energy efficiency programs will be 3.2 $MMTCO_2e$.

Zero Emission Vehicle Memorandum of Understanding (ZEV MOU): Connecticut is one of seven states committed to putting 3.3 million ZEVs on the road by 2025.

Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR): CHEAPR rebates provide up to $5,000 for Connecticut residents who purchase or lease a new eligible battery electric, plug-in hybrid electric or fuel cell electric vehicle. In just over a year's time, these rebates have supported purchases of more than 750 vehicles.

Competitive Regional Procurements for Grid-Scale Clean Energy: A new, 20 MW solar facility in Sprague, CT that was contracted under Section 6 of Public Act 13-303 is expected to come online in January 2017. CT DEEP is also currently considering more than 100 bids submitted in two historic RFPs for clean energy projects of different size classes that could be selected for long-term contracts pursuant to Public Acts 13-303 and 15-107. Under those statutes, CT DEEP has the authority to contract for up to 4,250 GWh, or approximately 15% of the state's electricity demand, from clean energy resources.

Accelerating Rooftop Solar Deployment: The Connecticut Green Bank has pioneered multiple programs to expand the deployment of rooftop solar photovoltaics (PV) in Connecticut, while driving down installed costs and ratepayer incentives. A program goal of installing 30 MW of rooftop solar PV under the Residential Solar Incentive Program was met in 2015, 8 years early. Public Act 15-194 requires the Connecticut Green Bank to offer incentives to support the deployment of 300 MW of residential solar by 2022.

Shared Clean Energy Facilities: A pilot program for shared clean energy facilities (SCEF) will enable multiple customers to contract a percentage or set amount of the electricity produced from these facilities. Projects selected in this pilot program must be online by 2019.

Clean Energy Communities: The Clean Energy Communities program encourages and supports municipal efforts to promote and adopt energy efficiency strategies and clean energy technologies

2016 Comprehensive Energy Strategy (CES): The 2016 Comprehensive Energy Strategy will evaluate GHG mitigation options for near-, mid-, and long-term time horizons. The strategy will provide emphasis on any additional near term strategies that may be needed to ensure compliance with the 2020 goal.

Public Comments