Connecticut Department of Energy and Environmental Protection

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

Agenda

• Welcome and introduction	1:00 p.m.
• Housekeeping	1:05
• **Presentation**	1:10
• Public comments	1:40

- During presentation, please use **Chat** feature to:
  - ask a quick clarifying question, if needed
  - indicate technical difficulties or address administrative issues
- Please do not use **Chat** feature to make substantive statements for public record – save those for Public Comment period
- To signal your intention to offer a Public Comment, use **Raise Hand** feature at any time
- Session is being recorded
- Slides will be available on DEEP Greenhouse Gas Inventory web page (https://portal.ct.gov/DEEP/Climate-Change/CT-Greenhouse-Gas-Inventory-Reports)

Calculation of Electric Sector Greenhouse Gas Emissions in Connecticut

10/26/2021

Michael Malmrose

Connecticut Department of Energy and Environmental Protection

A. Background: Electric sector
B. Accounting methodologies
   - Based on generation
   - Based on consumption
   - Methodology currently employed in Connecticut
C. Renewable Portfolio Standards
D. Role of Millstone
E. Proposed new methodology
F. Emissions from biomass combustion

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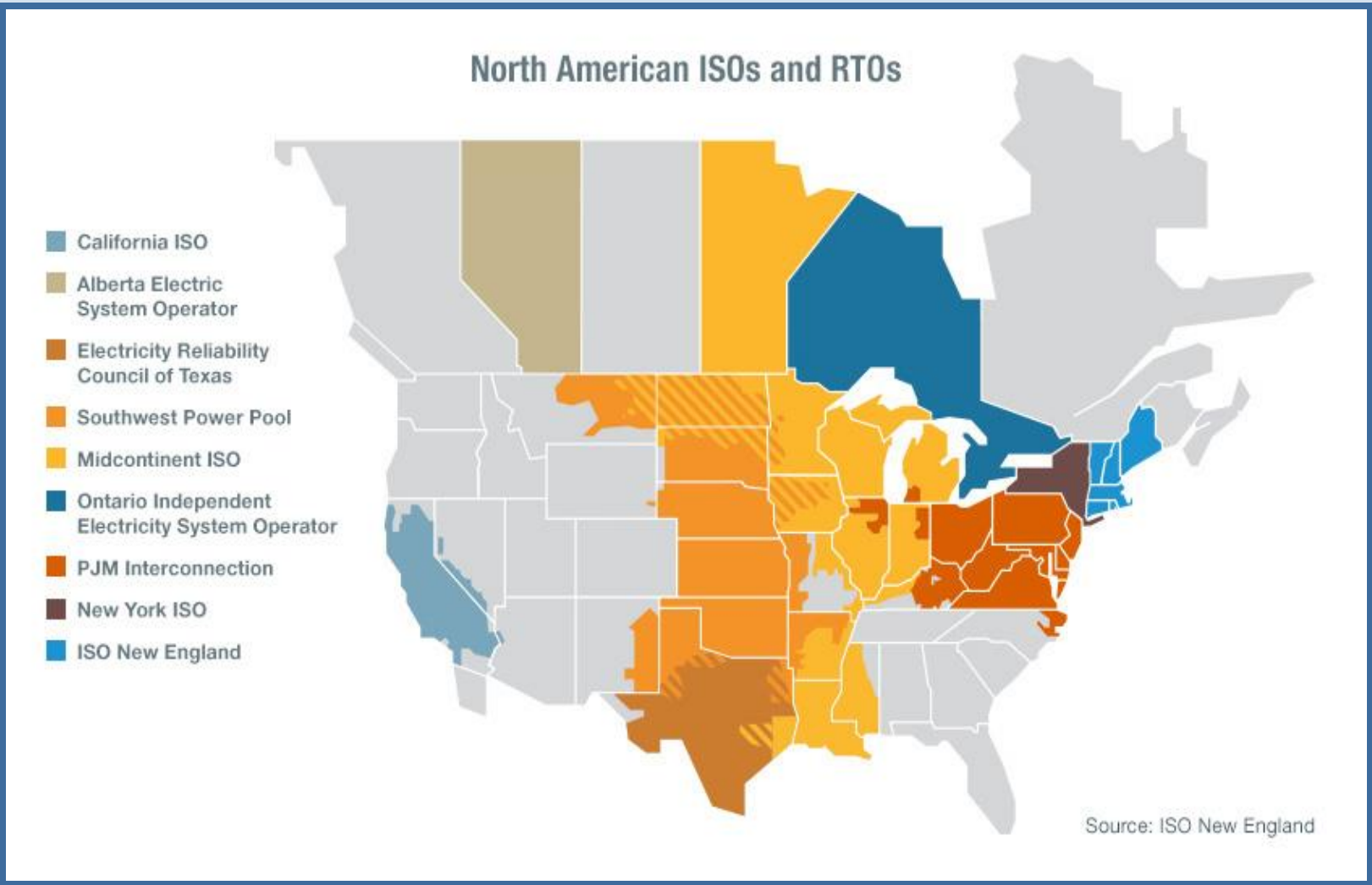
Electricity is generated for regional transmission



Sources of Electricity for ISO New England

- In-region generation
- Behind-the-meter generation
- Imports from other ISOs

	GWH (a)	% OF GENERATION	% OF NEL
Total Generation (b)	94,945	100.0%	81.24%
Gas	49,793	52.44%	42.60%
Nuclear	25,580	26.94%	21.89%
Renewables	11,507	12.12%	9.85%
Wind	3,613	3.81%	3.09%
Refuse	3,013	3.17%	2.58%
Wood	2,315	2.44%	1.98%
Solar	2,079	2.19%	1.78%
Landfill Gas	448	0.47%	0.38%
Methane	39	0.04%	0.03%
Steam	0	0.0%	0.0%
Hydro (c)	7,728	8.14%	6.61%
Coal	147	0.15%	0.13%
Oil	147	0.15%	0.13%
Price-Responsive Demand	15	0.02%	0.01%
Other (d)	27	0.03%	0.02%
Net Flow over External Ties (e)	23,531		20.13%
Québec	13,969		
New Brunswick	2,491		
New York	7,070		
Pumping Load (f)	-1,601		-1.37%
Net Energy for Load (g)	116,875		100.00%

(a) GWh stands for gigawatt-hour.

(b) As of January 2016, this chart approximates the amount of generation by individual fuels used by dual-fuel units, such as natural-gas-fired generators that can switch to run on oil and vice versa. Previously, the report attributed generation from such units only to the primary fuel type registered for the unit. The new reporting flows from changes related to the Energy Market Offer Flexibility Project implemented December 2014. See the notes in the Net Energy and Peak Load by Source Report for more details.

(c) Hydro is not included in the renewables category primarily because the various sources that make up hydroelectric generation (i.e., conventional hydroelectric, run-of-river, pumped storage) are not universally defined as renewable in the six New England states.

(d) "Other" represents resources using a fuel type that does not fall into any of the existing categories. Other may include new technologies or new fuel types that come onto the system but are not yet of sufficient quantity to have their own category.

(e) Tie lines are transmission lines that connect two balancing authority areas. A positive value indicates a net import; a negative value represents a net export.

(f) The energy used to operate pumped storage plants.

(g) Generation
+ net interchange
- pumping load.

[Resource Mix (iso-ne.com)]

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Generation-based Accounting

Calculate emissions based on electricity generated in CT

Data obtained directly from EIA

This is not the number counted toward the GWSA goals – merely provided for comparison

Connecticut Electricity Profile 2018

Table 1. 2018 Summary statistics (Connecticut)

Item	Value	Rank
Primary energy source		**Natural gas**
Net summer capacity (megawatts)	**9,833**	**35**
Electric utilities	161	46
IPP & CHP	9,672	11
Net generation (megawatthours)	**39,453,552**	**36**
Electric utilities	108,940	47
IPP & CHP	39,344,611	12
Emissions		
Sulfur dioxide (short tons)	972	47
Nitrogen oxide (short tons)	6,668	43
Carbon dioxide (thousand metric tons)	9,591	40
Sulfur dioxide (lbs/MWh)	0.0	47
Nitrogen oxide (lbs/MWh)	0.3	45
Carbon dioxide (lbs/MWh)	535	42
Total retail sales (megawatthours)	**28,833,925**	**37**
Full service provider sales	13,799,045	41
Energy-only provider sales	15,034,880	9
Direct use (megawatthours)	**1,007,910**	**27**
Average retail price (cents/kWh)	**18.41**	**4**

Sources: U.S. Energy Information Administration, Form EIA-860, *Annual Electric Generator Report*, U.S. Energy Information Administration, Form EIA-861, *Annual Electric Power Industry Report*, U.S. Energy Information Administration, Form EIA-923, *Power Plant Operations Report* and predecessor forms.

Consumption-based accounting

- A state that imports its electricity but would also want to track its emissions based on consumption may take a different approach.
- Consumption-based emissions are usually not done in GHG inventories for practical reasons: data usually does not exist to do the job reliably. For electricity, however, consumption-based accounting is more feasible.
- In addition to in-state emissions, GHG emissions for imported electricity also would need to be determined.
- If electricity is imported from different locations, an emission factor for each location needs to be independently calculated; then the amount of electricity imported from each source needs to be determined.
- Emissions from in-state generation can then be added to emissions from imported electricity.
- Emissions from consumption of this mix of in-state and imported electricity can be calculated.

Connecticut's current methodology

- Determine total emissions from region, including imports
- Determine load for entire region
- Use ratio (emissions/load) to determine regional emission factor
- Multiply regional emission factor by CT load

Let's take a closer look at a couple of steps …

Regional emission factor

Plant State	Census Region	NERC Region	NAICS Code	EIA Sector Number	Sector Name	Reported Prime Mover	Reported Fuel Type Code	AER Fuel Type Code	Physical Unit Label	Total Fuel Consumption Quantity	Electric Fuel Consumption Quantity	Total Fuel Consumption MMBtu	Elec Fuel Consumption MMBtu	Net Generation (Megawatthours)	YEAR	Exclude mmBtu from CO2 calculations, because Part 75 CO2	Unit HEAT RATES – electric (MMBTU/MWh)	CHP NG Heat Rate
						natural gas	NG	NG		136,075,125	135,273,910	139,855,932	139,031,814	18,934,667		108,720,965	139,031,814	18,934,67
						sludge waste	SLW	ORW		0	0	0	0	0		0	0	
						non-biogenic component of municipal solid waste	MSN	OTH		642,784	642,784	9,056,660	9,056,660	464,733		0	9,056,660	464,7
						other	OTH	OTH		0	0	0	0	0		0	0	
						tire derived fuel	TDF	OTH		0	0	0	0	0		0	0	
						petroleum coke	PC	PC		0	0	0	0	0		0	0	
						residual petroleum	RFO	RFO		311,514	311,514	1,926,200	1,926,200	157,183		1,926,200	1,926,200	157,1
						jet fuel	JF	WOO		730	730	4,380	4,380	284		0	4,380	2
						kerosene	KER	WOO		61,066	61,066	342,270	342,270	24,839		126,872	337,482	24,8
						waste oil	WO	WOO		0	0	0	0	0		0	0	
						gaseous propane	PG	OOG		0	0	0	0	0		0	0	
	Biogenic fuels					landfill gas	LFG	MLG		266,063	266,063	128,628	128,628	10,150		34,800	128,628	10,1
						biogenic component of municipal solid waste	MSB	MLG		1,142,714	1,142,714	9,426,257	9,426,257	483,698		0	9,426,257	483,6
						black liquor	BLQ	WWW		0	0	0	0	0		0	0	
						wood/wood waste solids	WDS	WWW		342,812	342,812	3,153,870	3,153,870	260,871		3,153,870	3,153,870	260,8

Determine CO_2 emissions from generation for each state from EIA data on fuel consumption, heat generated from consumption, and electricity generated from that heat

Repeat for each state

CT electricity consumption emissions based on region-wide generation and imports

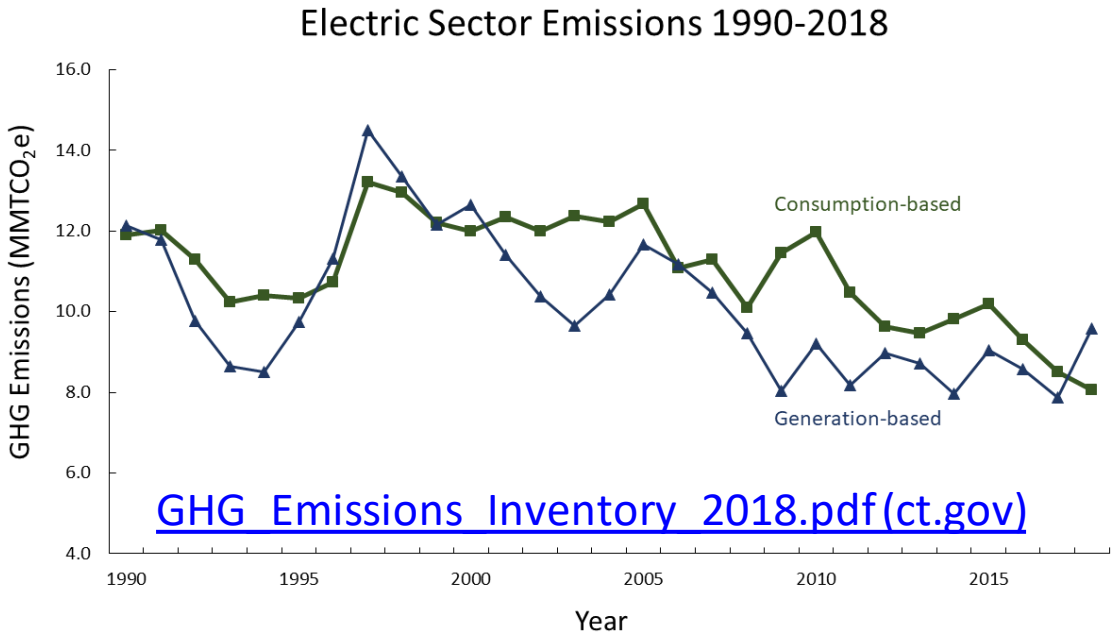
	New England							
	Total NE Generation [except N. ME] (MWh)	NE Load [except N. ME] (MWh)	NE Hydro Pumping Load (MWh)	Total NE Load (MWh)	Actual Imports (MWh)	NE GHG Emissions Associated with Load (lb)	Regional Non-Biogenic GHG Emission Factor (lb/MWh)	Consumption Non-Biogenic Emissions based on NE Average GHG Emission Factor (lb)
2018	104,525,062	123,445,145	2,615,917	126,061,062	21,536,000	56,507,136,321	448	14,035,197,322

CT electricity consumption emissions based on region-wide generation and imports

	New England							
	Total NE Generation [except N. ME] (MWh)	NE Load [except N. ME] (MWh)	NE Hydro Pumping Load (MWh)	Total NE Load (MWh)	Actual Imports (MWh)	NE GHG Emissions Associated with Load (lb)	Regional Biogenic CO2 Emission Factor (lb/MWh)	CT Electricity Consumption Biogenic CO2 Emissions based on NE Average GHG Emission Factor (lb)
2018	104,525,062	123,445,145	2,615,917	126,061,062	21,536,000	17,212,080,740	137	4,275,122,847

Perform similar calculations for each state in region, including emissions from imported electricity. Emissions for each individual state can then be recovered by multiplying that state's load by the region-wide emission factor.

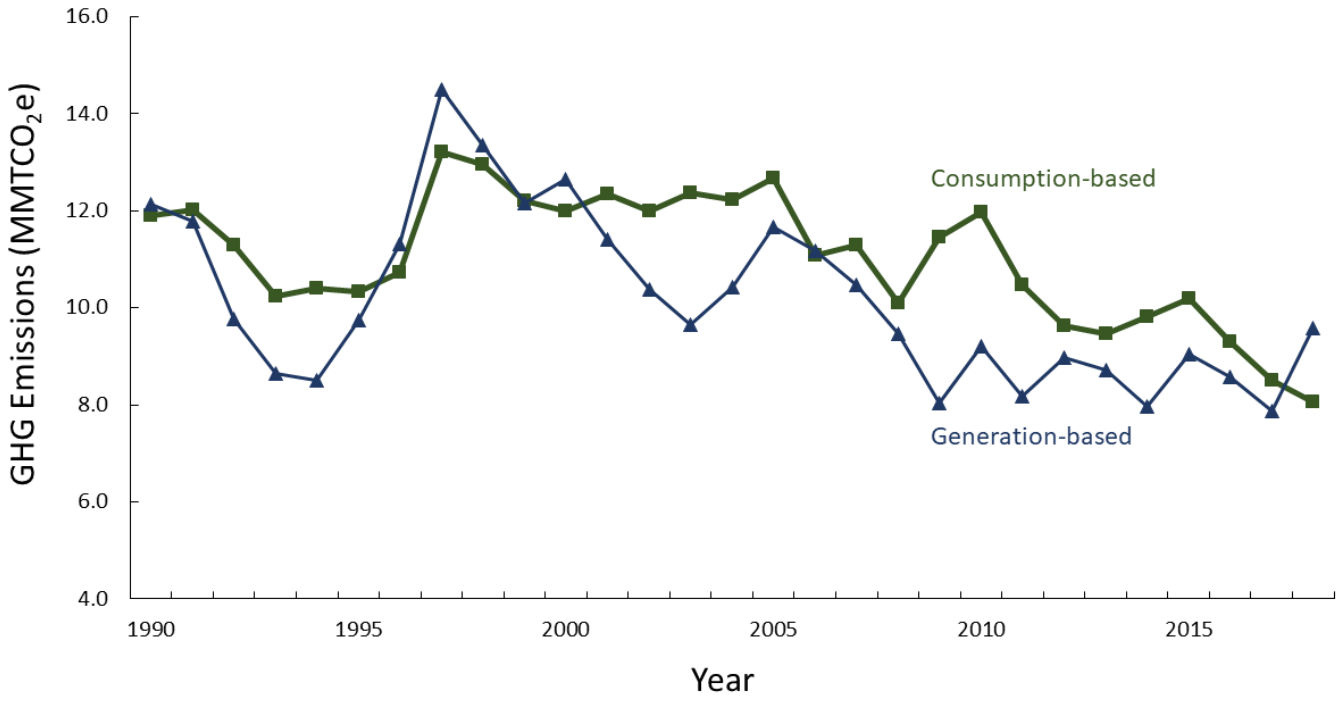
Results for CT



Statewide Emissions in MMTCO2e (Select Yrs)

YEAR	1990	2001	2004	2017	2018
Transportation	15.6	17.8	19.9	15.5	15.8
Electric Power					
Consumption	11.9	12.3	12.2	8.5	8.1
Generation	12.1	11.4	10.4	7.9	9.6
Residential	8.3	8.5	10.3	6.6	7.6
Industrial	3.2	3.7	4.0	3.6	3.8
Commercial	3.8	4.3	3.9	4.0	4.3
Municipal waste	1.6	1.7	4.4	2.0	2.1
Agriculture	0.38	0.33	0.35	0.24	0.32
Natural gas leakage	0.75	0.47	0.40	0.24	0.24
Generation based total	45.7	48.2	53.7	40.0	43.7
Consumption based total	45.5	49.2	55.5	40.6	42.2

Consumption-based accounting:
7% below 1990 levels | 14% below 2001 levels



- Since 2013, state has procured 710 MW of grid-scale solar generation capacity, 1,100 MW of offshore wind capacity, and 10.6 MW of hydrogen fuel cell capacity
- In 2018, state entered long-term contract with Millstone Nuclear facility to purchase 9 Million MWh of zero-carbon energy (16 million MWh of environmental attributes) annually, 2019-2029
- IRP estimates 90% of CT demand will be supplied by zero-carbon generation by 2025 (assuming all contracted attributes are retained); and it outlines pathways to zero-carbon electricity by 2040

Electricity-consumption emissions have declined markedly since 2010 as fossil-fueled generation has gotten cleaner and more zero-carbon generation has come on line

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Renewable Portfolio Standard

- **New England Power Pool Generation Information System** (NEPOOL GIS) tracks renewable energy certificates (RECs) for generation and load produced in region
- NEPOOL GIS has more than 2,700 account holders and 80,000 generators
- RECs generated for 8 million Megawatt hours in Q1 2021
- Certificates can be retired in states other than those where they are generated
- Ideally, a REC and any associated emissions would be accounted for by the state that retires the REC

- State policy requires electric providers to offset a certain percentage of demand by purchasing RECs

- REC tiers
  - **Class I** includes Solar, Wind, Fuel Cells, etc.
  - **Class II** includes trash-to-energy facilities
  - **Class III** includes waste heat recovery systems

[Renewable Portfolio Standards Overview (ct.gov)]

Required Annual Renewable Energy Percentages:

Year	Class I	Class II or Class I (add'l)	Class III	Total
2018	17.0%	4.0%	4.0%	25.0%
2019	19.5%	4.0%	4.0%	27.5%
2020	21.0%	4.0%	4.0%	29.0%
2021	22.5%	4.0%	4.0%	30.5%
2022	24%	4.0%	5.0%	33%
2023	26%	4.0%	5.0%	35%
2024	28%	4.0%	5.0%	37%
2025	30%	4.0%	4.0%	38%
2026	32%	4.0%	4.0%	40%
2027	34%	4.0%	4.0%	42%
2028	36%	4.0%	4.0%	44%
2029	38%	4.0%	4.0%	46%
2030	40%	4.0%	4.0%	48%

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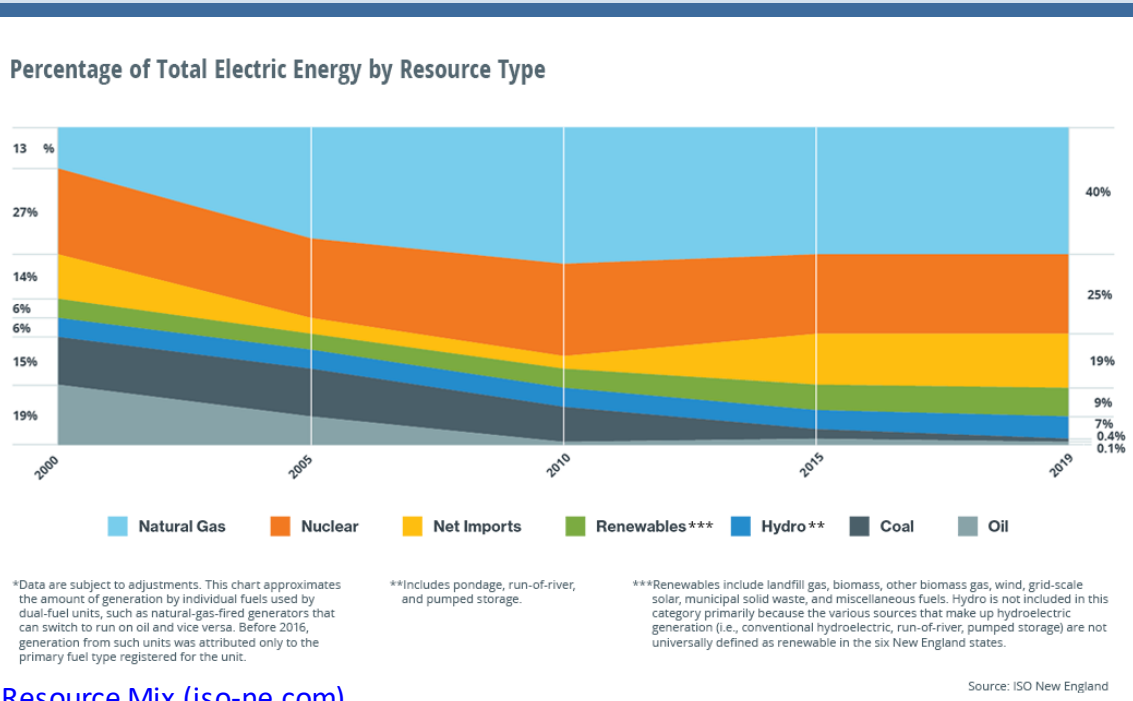
Importance of Millstone in 2020s and beyond

Prior to agreement between EDCs and Dominion, Millstone was in danger of early retirement

Millstone early retirement put New England at risk for rolling blackouts and brownouts during coldest days of year

Regional GHG emissions could have risen approximately 20% if Millstone had to be replaced with generators powered by fossil fuels

2020-CT-DEEP-Draft-Integrated-Resources-Plan-in-Accordance-with-CGS-16a-3a.pdf



[Resource Mix (iso-ne.com)]

It would be difficult to replace nuclear power with natural gas generators during extreme cold, because natural gas becomes less available for electricity generation during such conditions

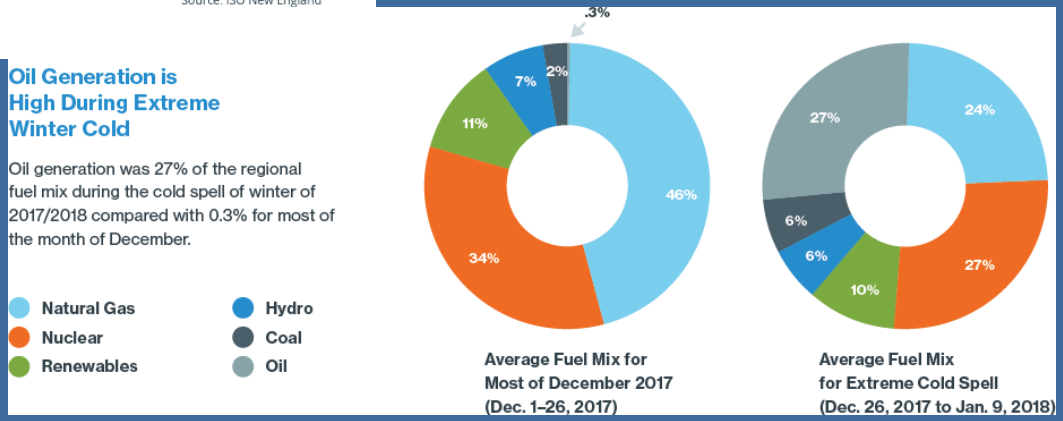


Table 1: Percentage of Millstone's Output Each EDC Must Purchase by Year (Rounded)

Year	Eversource	United Illuminating
2019	40%	10%
2020	44%	11%
2021	41%	10%
2022	42%	10%
2023	44%	11%
2024	41%	10%
2025	42%	10%
2026	44%	11%
2027	41%	10%
2028	42%	10%
2029	44%	11%

Millstone Power Procurement (ct.gov)

Contract for approximately 9 million MWh through 2029 (36% of EDC load) 2020-Connecticut-Integrated-Resources-Plan-10-7-2021.pdf

- Millstone is licensed to continue operating beyond expiration of current purchasing contract
- Unit 2 licensed until 2035, Unit 3 until 2045
- IRP: "The retention of Millstone beyond 2029 is a critical factor in how much more and how quickly Connecticut needs to procure new clean energy additions"
- Currently, ratepayer contract is only mechanism preventing Millstone retirement

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Proposed New Methodology

Initial steps

1. For each state in ISO-NE, calculate energy from RPS and associated emissions. This will be subtracted from each state's total load.
2. Remove all RPS generation and emissions from system mix.
3. Calculate new regional emission factor for emissions not associated with RPSs.
4. Multiply CT's remaining load by new regional emission factor to obtain electric sector emissions.

	Regional EF
Total (Settled/Reserved)(MWh)	5,676,852
CT Load including pumping (MWh)	31,292,145
RECs-Load Difference (MWh)	25,615,293
Emission factor (lb/MWh)	479
Difference * regional EF (lbs)	12,263,954,331
TOTAL Settled & Load (lbs)	22,551,252,891
MMTCO2e	10.22908841

Two issues still must be addressed

Large amount of emissions associated with biomass in CT's RPS profile (1.1 million MWh from wood) – *Discussion coming toward end of presentation*

All of Millstone's generation still in the regional pot. GHG reduction associated with Millstone contract not reflected in the inventory – *Let's look more closely*

Treat Millstone like a REC

	Scenario 1 Regional EF	Scenario 2 MillstoneAdjust
Total (Settled/Reserved)(MWh)	5,676,852	22,558,344
CT Load including pumping (MWh)	31,292,145	31,292,145
RECs-Load Difference (MWh)	25,615,293	8,733,801
Emission factor (lb/MWh)	479	568
Difference * regional EF (lbs)	12,263,954,331	4,961,098,041
TOTAL Settled & Load (lbs)	22,551,252,891	15,248,396,601
MMTCO2e	**10.22908841**	**6.916564578**

CT is not entitled to entirety of Millstone output

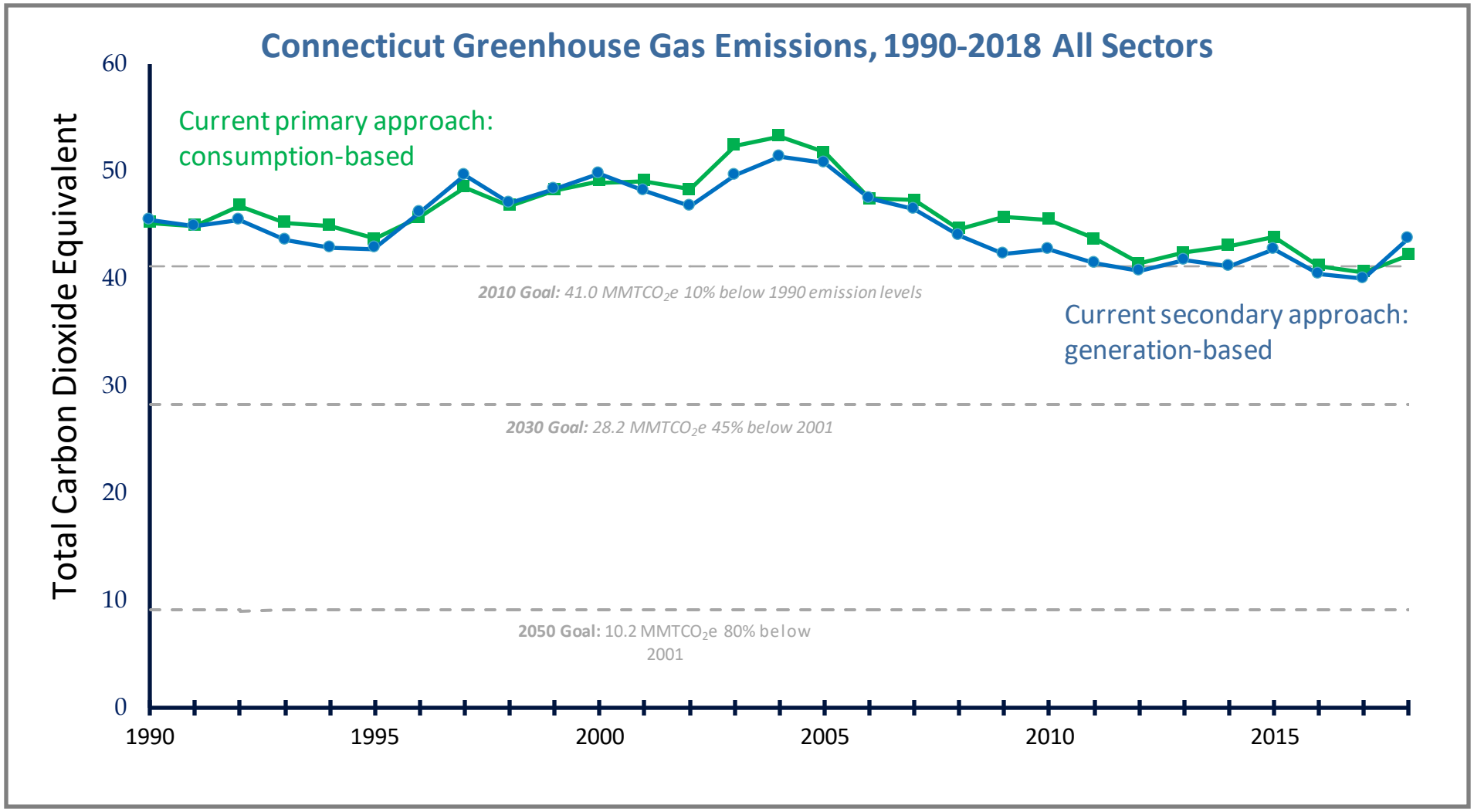
Consider two "bookend" scenarios

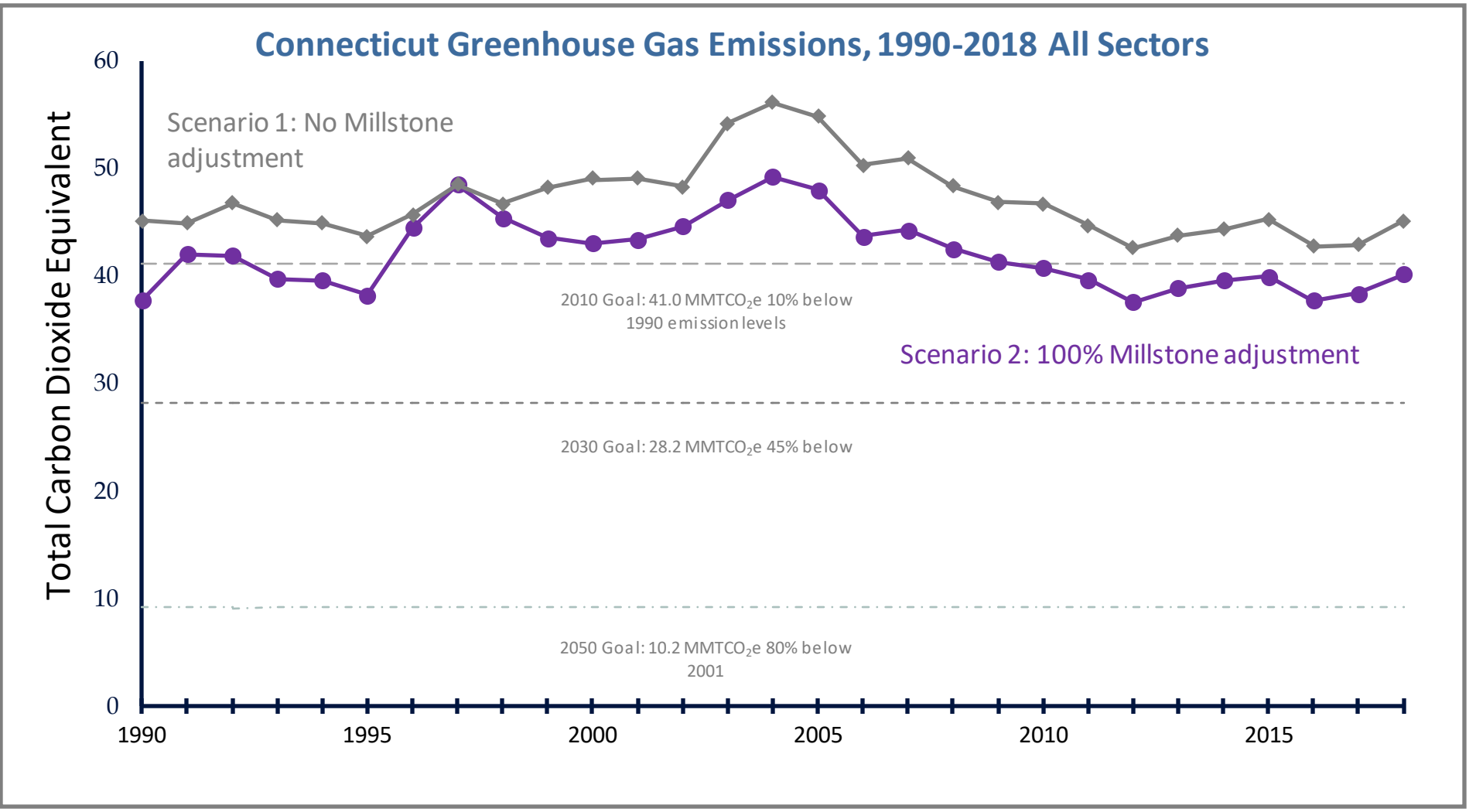
Scenario 1

- CT takes no credit for Millstone

Scenario 2

- CT takes full credit for Millstone
- This would make regional grid 'dirtier,' but CT would draw less from it
- If CT had taken credit for entire Millstone generation in 2018, consumption-based emissions would have been down by 1.1 $MMTCO_2e$


Connecticut Greenhouse Gas Emissions, 1990-2018 All Sectors
Total Carbon Dioxide Equivalent
60
50
40
30
20
10
0
1990
1995
2000
2005
2010
2015
Current primary approach: consumption-based
Current secondary approach: generation-based
2010 Goal: 41.0 MMTCO2e 10% below 1990 emission levels
2030 Goal: 28.2 MMTCO2e 45% below 2001
2050 Goal: 10.2 MMTCO2e 80% below 2001



Proposed approach: For 2019-2029, claim GHG credit for environmental corresponding to % of Millstone generation acquired and retained by Eversource and UI

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Addressing biomass emissions

- In calculating regional emission factor for electricity, we currently treat emissions from combustion of biogenic fuels (wood, biogenic component of municipal solid waste, methane captured from landfills, etc.) like emissions from fossil fuels
- This differs from other sections of the inventory, where biofuels are treated as carbon neutral – e.g., 10% ethanol blend in gasoline
- This also is inconsistent with methods used by other states – and with international norms

- Internationally, CO_2 emissions from biomass combustion are not counted against emissions goals – under the reasoning that equivalent CO_2 was sequestered while fuel's biological feedstock was growing (other GHGs emitted during combustion [e.g., N_20] are counted, however)
  - CO_2 emissions should be calculated and presented as addendum
- ***Proposed solution:*** align with international norm
- This will somewhat reduce electricity emissions from 1990 forward – and make 2020, 2030, and 2050 targets under GWSA somewhat more stringent

Questions?

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Public comments

To offer a **verbal comment**, use **Raise Hand** function

Written comments:

- Submit to DEEP.EnergyBureau@ct.gov
- *Deadline:* November 9, 2021
- *Subject line:* "Electricity-sector greenhouse gas emissions written comments"
- All materials submitted will be posted on DEEP website

Slides will be available on DEEP Greenhouse Gas Inventory web page (https://portal.ct.gov/DEEP/Climate-Change/CT-Greenhouse-Gas-Inventory-Reports)