1990–2021

Connecticut Greenhouse Gas Emissions Inventory

Connecticut Department of
Energy & Environmental Protection

April 2023

Contents

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Abbreviations

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AR6 – Sixth Assessment Report

B

BTU – British Thermal Unit

C

CO2e – Carbon-dioxide Equivalent

CES – Comprehensive Energy Strategy

CMMS – Comprehensive Materials Management Strategy

CTDOT – Connecticut Department of Transportation

CHEAPR – Connecticut Hydrogen and Electric Automobile Purchase Rebate

D

DEEP – Department of Energy and Environmental Protection

E

e-bike – Electric Bicycle

EDC – Electric Distribution Companies

EIA – Energy Information Administration

G

GWP – Global Warming Potential

GWSA – Global Warming Solutions Act

GC3 – Governor's Council on Climate Change

GHG – Greenhouse Gas

H

HVAC – Heating Ventilation and Air Conditioning

HES – Home Energy Solutions

I

IRA – Inflation Reduction Act

IIJA – Infrastructure Investment and Jobs Act

IPCC – Intergovernmental Panel on Climate Change

L

LDVs – light duty passenger vehicles

M

MIRA – Materials Innovation and Recycling Authority

MHDs – Medium and Heavy-duty Vehicles

MMT – Million Metric Ton

MSW – Municipal Solid Waste

N

NWL – Natural and Working Lands

P

PURA – Public Utilities Regulation Authority

R

REC – Renewable Energy Certificate

RPS – Renewable Portfolio Standard

S

SED – State Energy Data System

SIT – State Inventory Tool

V

VMT – Vehicle Miles Traveled

Introduction

For over two decades, Connecticut has been a U.S. leader in addressing climate change. A key part of that effort is reducing greenhouse gas (GHG) emissions and tracking those reductions.

Through the state's Greenhouse Gas Emissions Inventory, first published in 2003, the Department of Energy and Environmental Protection (DEEP) provides a report card on 30 years of GHG emissions in the state, from 1990 to 2020, and tracks progress toward the state's statutory GHG emission-reduction targets.[1] This report also contains a preliminary estimate of 2021 GHG emissions. While this inventory analyzes statewide GHG emissions, we recognize the negative impacts of climate change and air pollution are often concentrated in Connecticut's most overburdened communities. When implementing policies and programs to reduce GHG emissions, we must accordingly place environmental and climate justice at the center of those strategies and work to prioritize solutions that reverse historic harms.

For over two decades, Connecticut has been a U.S. leader in addressing climate change. A key part of that effort is reducing greenhouse gas (GHG) emissions and tracking those reductions.

The main takeaways from the report are that as of 2021: transportation remains the top emitter in the state and has not decreased significantly from 1990 levels; residential heating has replaced the electric sector as the second-largest emitter in the state; and electric-sector emissions continue to decrease. While Connecticut has met its initial goal for 2020 emissions set by Connecticut statutes, further sharp reductions are needed to meet the medium- and longer-term goals. The report concludes by identifying a range of potential policy options to further mitigate GHG emissions and impacts. These options include, for example, updating state statutes to adopt sector sub-targets; adopting a net-zero energy building code; increasing the tree canopy in urban settings; adding standards for vehicles; pursuing alternative fuels where electrification is not practical; and identifying more policies as part of the state's forthcoming Comprehensive Energy Strategy.

[1] Connecticut's greenhouse gas inventory relies heavily on data sets compiled by the U.S. EPA and released annually in its State Inventory Tool (SIT). The latest SIT was released in 2023 and contains data necessary to produce this inventory through 2020. Some data are available for 2021 and have been used with SIT calculators to produce a preliminary estimate of 2021 GHG emissions. Complete data for 2021 are expected by mid-2023.

The state first set targets in its **2008 Global Warming Solutions Act[2] (GWSA), Connecticut Public Act 08-98**, which established a mandate to reduce statewide GHG emissions 10 percent below 1990 levels by 2020 and 80 percent below 2001 levels by 2050. In 2018, to guide progress toward the 2050 target, the GWSA was amended by Public Act No. 18-82 to add a medium-term target of 45 percent emissions reductions below the 2001 level by 2030. In 2022, the Connecticut Legislature codified Governor Lamont's Executive Order 3 with the passage of Public Act No. 22-5, requiring Connecticut's electrical grid to be carbon free by 2040.

In this inventory, first published in 2003, the Department of Energy and Environmental Protection (DEEP) provides a report card on 30 years of GHG emissions in the state, from 1990 to 2020, and tracks progress toward the statutory GHG emission-reduction targets.

Note on baselines used in this report:

To quantify progress in reducing GHG emissions, Connecticut's 2008 Global Warming Solutions Act established emission reduction goals relative to a baseline year of 1990. 1990 was the first publication year of the Intergovernmental Panel on Climate Change's (IPCC's) assessment report and the baseline year against which the IPCC projected future global warming without coordinated government commitments.

In 2001, the New England Governors and Eastern Canadian Premiers **agreed to a regional Climate Action Plan** to reduce GHG emissions to 1990 levels by 2010, 10 percent below 1990 levels by 2020, and 75-85 percent below 2001 levels by 2050. Based on these commitments, Connecticut added a goal of 80 percent emissions reductions from a 2001 baseline to the state's GWSA.

(Another baseline referenced in this report is GHG emissions from the year 2005. In 2021, the Biden administration established 2005 as the baseline year for which to reduce GHG emissions by 50-52 percent by 2030, because 2005 was the year when nationwide emissions were near their peak.)

In 2021 and 2022, the Intergovernmental Panel on Climate Change (IPCC) released a series of papers as part of its **sixth assessment report** (AR6) about the physical and economic impacts of climate change; **in 2023, a synthesis report summarizing the AR6 findings was released.** The IPCC found that in order to limit global warming to 1.5-2.0° C by the end of the 21st century, immediate and dramatic cuts must be made to greenhouse gas (GHG) emissions, and that worldwide carbon dioxide (CO2) **emissions must be accelerated by the 2030s**. (See **Figure SPM.4.**)

In parallel, the federal government has invested substantially in climate and energy through two major bills: the **Infrastructure Investment and Jobs Act (IIJA)** and the **Inflation Reduction Act (IRA)**. Together, these laws are expected to reduce nationwide emissions to 30-43 percent below 2005 levels by 2030.[3] Although this reduction is significant progress, it does not yet meet President Biden's goal of a 50-52 percent reduction by 2030 from 2005[4], and additional state action will be needed to complement the IIJA and IRA and ensure Connecticut meets its statutory goal of a 45 percent reduction from 2001 by 2030.

[2] Connecticut Public Act 08-98
[3] https://crsreports.congress.gov/product/pdf/R/R47385
[4] https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/

Current energy costs, largely driven by fossil fuel price volatility, also continue to overburden Connecticut businesses and residents. While IIJA and IRA investments will improve the economics of cost-saving and carbon-reducing technologies such as all-electric heat pumps and electric vehicles, policy and programmatic changes are needed in Connecticut to maximize the benefits of federal funding opportunities and reduce carbon emissions in line with State and global climate goals.

This report shows that strong policies are specifically needed to strengthen Connecticut's emission reduction planning and regulatory authority, align Connecticut's climate commitments with national and international goals, support carbon negative technologies and practices, and rapidly accelerate carbon reductions from the buildings and transportation sectors.

Inventory Highlights

Connecticut met its statutory target of 10 percent emissions reductions below 1990 levels as of Jan. 1, 2020. In 2019, Connecticut had economy-wide emissions of 38.6 million metric tons (MMT) of carbon-dioxide equivalent (CO_2e) — a decrease of 13.9 percent from 1990 levels.

Top sectors: The transportation, electricity, and residential sectors continue to account for nearly three quarters of Connecticut's GHG emissions. Transportation remains the largest source of emissions, but the residential sector replaced the electric power sector as the second-largest emitter.

Transportation: Except for the COVID-19 pandemic-induced dip in emissions for the years 2020-2021, transportation emissions remain near their 1990 levels, despite significant improvements in automobile fuel economy over the past 3 decades. Improvements in fuel economy have reduced emissions per mile traveled, but those reductions have been offset by an increase in the overall number of miles driven.

DEEP currently estimates emissions for 2021 totaled 34.7 $MMTCO_2e$ — a 22 percent decrease from the 1990 baseline, but a 6 percent increase from the previous year (2020).

Residential: As of January 1, 2020, residential sector emissions had dropped 10 percent since 1990. However, to set the pace of reductions needed to meet the 2030 GWSA targets, deeper reductions in emissions must be achieved through retrofits of Connecticut's older housing stock.

Electricity: In 2021, electricity consumption emissions continued to drop, falling in that year below the commercial sector. Connecticut must substantially accelerate emission reductions outside of the electricity consumption sector – especially in the building and transportation sectors – if it is to meet the 2030 and 2050 statutory targets.

2019-2021 GHG Emissions

In 2019, Connecticut emitted 39.3 MMTCO2e of greenhouse gases. This amount is 13.9 percent lower than in 1990. Emissions reached a low of 32.7 MMTCO2e in 2020 — due to the effects of the global COVID-19 pandemic — and rebounded to an estimated and still anomalous low of 34.7 MMTCO2e in 2021 as the economy began reopening. Connecticut's emissions peaked in 2004 at nearly 53 MMTCO2e and since have been declining 0.9 MMTCO2e a year on average.

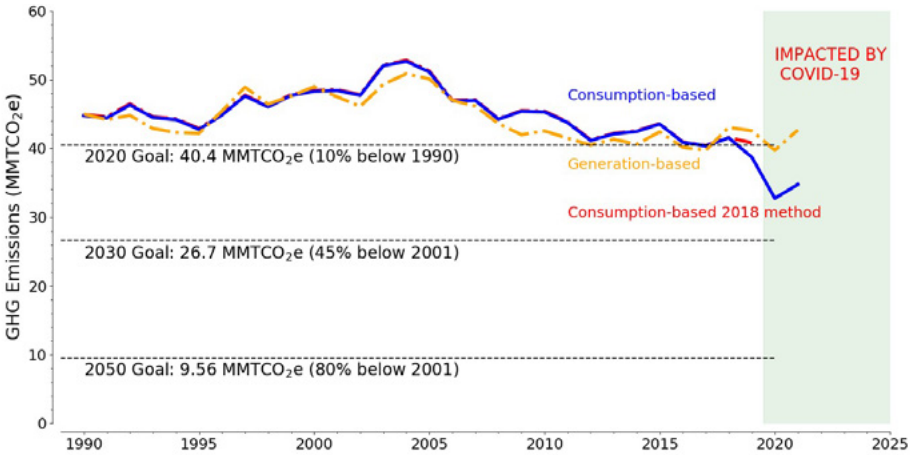

FIGURE 1: *Total economy-wide GHG emissions from Connecticut, 1990–2021. Economy-wide results are depicted based on revised consumption-based accounting for the electric power sector (blue), 2018's consumption-based methodology (red), and a generation-based calculation (yellow). Also shown are the state's statutory emissions-reduction goals for 2020, 2030, and 2050. The 2020 goal was met in 2019.*

Emission reductions in recent years have been achieved primarily in the electricity sector, with an average annual reduction of 1.1 MMTCO2e each year since 2015. While Connecticut met the GWSA's 2020 goal, the state will need to significantly accelerate annual reductions in other sectors to be on track to meet the 2030 GWSA goal. From 2019 to 2030, the state must achieve an average annual reduction of 1.1 MMTCO2e in order to meet the medium-term goal.

Figure 1 shows economy-wide emissions for 1990-2021. (2020 is the most recent year for which complete results are available.) It shows three distinct emissions totals, based on three different methodologies to tabulate emissions in the Electric Power sector:

1. Consumption-based. Electricity emissions from consumption of electricity in Connecticut. (See the addendum to the **2018 GHG inventory** and in an October 2021 **public meeting**, and the **appendix of this document** for more detail.) Here, the emissions calculation integrates Connecticut's Renewable Portfolio Standard (RPS)[5] profile into the emissions calculation. The RPS profile treats biogenic fuels as carbon neutral. After removing each state's RPS claims from the ISO-NE system wide generation and emissions, a regional emission factor is calculated. The regional emission factor is then used to compute Connecticut's GHG emissions from the portion of its electricity consumption that the RPS does not account for.
2. Generation-based. Emissions from electricity generated in Connecticut. This was the methodology DEEP used prior to the 2013 GHG inventory. This number comes from the Energy Information Administration's **(EIA) State Electricity Profile**.
3. Consumption-based 2018 method. Emissions associated with consumption of electricity in Connecticut, where the regional emission factor is used to compute all emissions, and biogenic emissions are included in the reported total. DEEP used this methodology to calculate electric-sector consumption based GHG emissions for 2013-2018.

[5] Renewable Portfolio Standards Overview (ct.gov)

(Further details on the computation of electric sector emissions are provided below.)

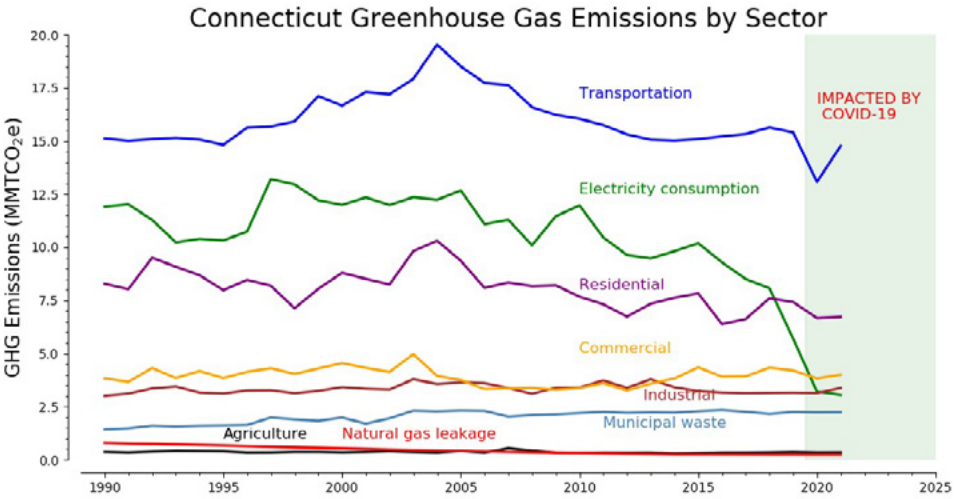

FIGURE 2: *GHG emissions for Connecticut broken down by economic sector.*

Transportation remains the largest emitter, twice as high as residential emissions. Transportation emissions also remain at 1990 levels. Electric power was third, behind residential, in 2019. While accounting for only a quarter of the state's emissions in 2019, the commercial, industrial, and waste management sectors also present challenges to the state's reduction goals.

A Note on 2020-2021 GHG Emissions

In early 2023, the EPA updated its State Inventory Tool (SIT), which provides the data for most results in this inventory, to include 2020 data. Additionally, it made available incomplete data from 2021 for the largest emitting sectors. Emission factors from the SIT support a preliminary estimate of GHG emissions through 2021 here, which DEEP will update when complete data become available.

This inventory reports emissions for two years impacted by the COVID-19 pandemic. The economic shutdown beginning in March 2020 and lasting until COVID-19 vaccines were widely available in 2021 drove the GHG emissions reductions seen in 2020-2021, mainly due to state residents sharply reducing their driving. GHG emissions for 2020 were 32.7 MMTCO2e, a decrease of 27 percent from 1990. In 2021, with the scaling back of COVID-19 related shutdowns, emissions began to rebound to pre-pandemic levels. Inferences about future trends in GHG emissions should not be made based on these years.

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Transportation Sector

In 2019, Connecticut's transportation sector emitted 15.4 MMTCO2e. This sector accounts for approximately 39 percent of the state's total emission profile and exceeds the total emissions from the next two highest emitters, combustion in individual residences and consumption of electricity, combined (see Figure 3 and Table 1). Gasoline is responsible for 77 percent of the transportation emissions in 2019, adding 11.3 MMTCO2e, as shown in Figure 4. Emissions from distillate fuel-powered vehicles add another 2.1 MMTCO2e. These medium to heavy duty vehicles will be difficult to electrify so development of alternative fuels such as Connecticut's participation in a regional pursuit of a clean hydrogen hub in the northeast is vital.

Most of the state's reduction in GHG emissions for 2020 and 2021 directly resulted from reduced personal driving during the pandemic. With increased fuel economy standards in effect since 1990, the carbon footprint of each individual mile driven has fallen substantially. So far, however, as Figure 5 shows, increasing vehicle miles traveled (VMT) in the state have offset all of those gains in efficiency. As a result, transportation sector emissions actually increased between 1990 and 2019 before decreasing during the COVID-19 pandemic.

Preliminary estimates for 2021 suggest that transportation sector emissions are returning to pre-pandemic levels. Reductions in the transportation sector are a critical component of any strategy the state employs toward meeting the 2030 and 2050 reduction goals.

FIGURE 3: *Relative contribution of each economic sector to GHG emissions in 2019. Transportation alone is responsible for approximately the same GHG emissions as the residential and electricity consumption sectors combined. The top three emission sectors account for about three-fourths of the state's 2019 emissions.*

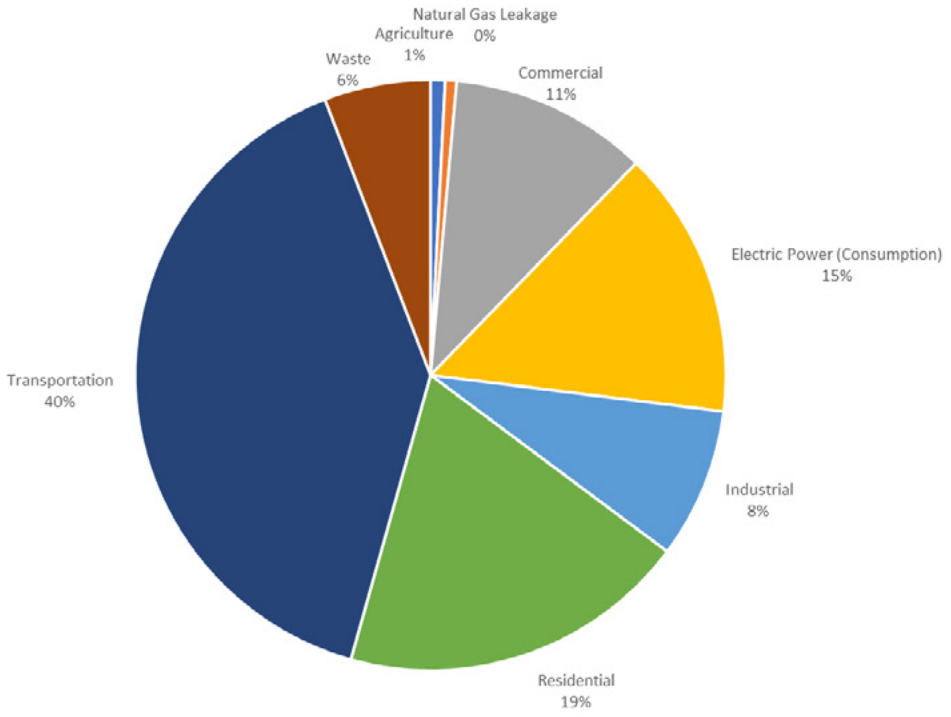


TABLE 1: Statewide Greenhouse Gas Emissions for Select Years

Sector Emissions (MMTCO2e)	1990	2001	2004	2019	2020	2021 (est.)
Agriculture	0.38	0.37	0.34	0.37	0.35	0.35
Natural Gas Leakage	0.79	0.51	0.43	0.24	0.24	0.24
Commercial	3.8	4.3	3.9	4.20	3.82	4.00
Electric Power (Consumption)	11.9	12.3	12.2	5.69	3.20	3.04
Industrial	3.0	3.3	3.6	3.15	3.13	3.38
Residential	8.3	8.5	10.3	7.41	6.67	6.72
Transportation	15.1	17.3	19.5	15.40	13.07	14.77
Waste	1.4	1.7	2.3	2.25	2.23	2.24
Total	**44.7**	**48.4**	**52.6**	**38.71**	**32.71**	**34.74**

The Governor's Council on Climate Change (GC3), in 2018 and 2021 reports, estimated that for Connecticut to reach its 2030 emissions target, roughly half a million light-duty electric vehicles (EVs) must replace internal combustion vehicles. **In 2021, approximately 78,000 EVs, plug-in hybrids, or hybrid vehicles were registered in Connecticut.** Compared to the 2.5 million gasoline-powered light duty vehicles in service, EVs are still relatively rare.

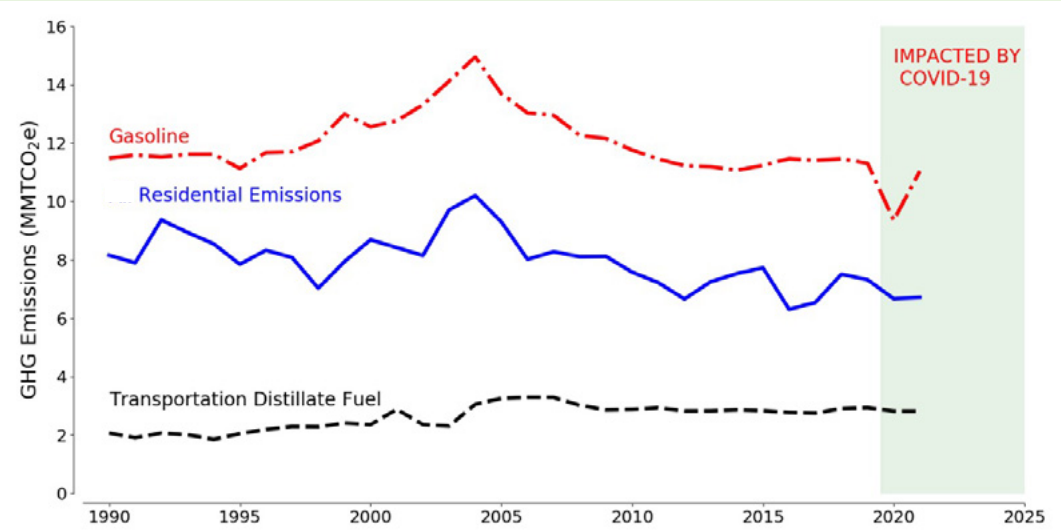


FIGURE 4: *Transportation related GHG emissions compared to the second most carbon intense sector. Emissions from gasoline consumption stubbornly remain at 1990 levels and higher than residential sector emissions by about 50 percent.*

The U.S. Department of Transportation has awarded Connecticut $52 million in funding to expand its EV charging infrastructure. With the IRA providing further economic incentives for individuals who purchase an EV, the carbon emitted per each mile traveled is likely to continue declining. This support is coupled with the Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR) program, which provides a standard rebate of $2,250 toward the purchase or lease of a new EV and up to $9,500 for a fuel cell electric vehicle for income qualified buyers. If Connecticut continues to follow the emissions standards of California for light-duty vehicles, the sale of new internal combustion cars and trucks will be **phased out by 2035**.

The Biden administration had committed to having EV sales make up **one-half of car sales by 2030**, however, an April 2023 announcement from the EPA proposed new tailpipe emission standards that would **require up to two-thirds of all new vehicles sold in the United States to be all-electric by 2032**. Such a market transformation would significantly reduce emissions from the transportation sector. However, a concern is that improvements in vehicle longevity have resulted in an average age of light duty vehicles in operation in the United States of 12.1 years, meaning that non-electric vehicles sold today are lasting longer and will be a large source of emissions well into the future.

Challenges in meeting 2030 goals Connecticut is still not on track to meet the 29 percent reduction of transportation sector emissions from 2014 levels that the **GC3 determined** is crucial to meet the GWSA 2030 goal. With transportation emissions rising slightly since 2014, the state will face difficulties meeting this target. Policies to encourage reduction in total VMT are essential for the state's climate goals.

Governor Lamont's **Executive Order 21-3** directs the Connecticut Department of Transportation (CTDOT) to set a VMT reduction target for 2030 and to develop a plan of investment to reach that target. CTDOT put forward a **goal and strategies** document in 2022, which set a goal of reducing VMT per person by **5 percent from the 2019 baseline by 2030**. This is equivalent to 1.21 fewer miles per person each day and 433.17 fewer per person miles each year. This means that in 2030, daily person miles would be 23.07. The CTDOT set forth a set of strategies it controls that can influence VMT reductions. These strategies are: increase Active Transportation/Complete Streets infrastructure in areas of urban/dense residential/commercial development; increase in transit frequency; increase in transit access; continue to assist/partner with municipalities who are pursuing transit-oriented development; and a Trip Reduction Program

(e.g., employer-based programs). However, the CTDOT goals and strategies document acknowledged their actions by their agency alone cannot achieve a VMT reduction target stating:

"In Connecticut, local towns and municipalities largely determine local land use patterns through zoning. Areas that are zoned for single family residential development spread destinations further apart, forcing longer vehicle trips and making it challenging to access destinations by walking, biking, or transit. *In Connecticut, 90.6 percent of land is zoned for single family residential development* [emphasis added] as of right and just 2.2 percent is zoned for four or more housing units without a public hearing.

This prevents the construction of dense, mixed-use development that allows for shorter vehicle trips and lower VMT. Zoning codes that require large amounts of parking for residential or commercial buildings encourage vehicle ownership and vehicle trips. To reduce VMT rate of growth, *municipalities would need to consider amending zoning laws to allow denser development, particularly near their downtown centers* [emphasis added]."

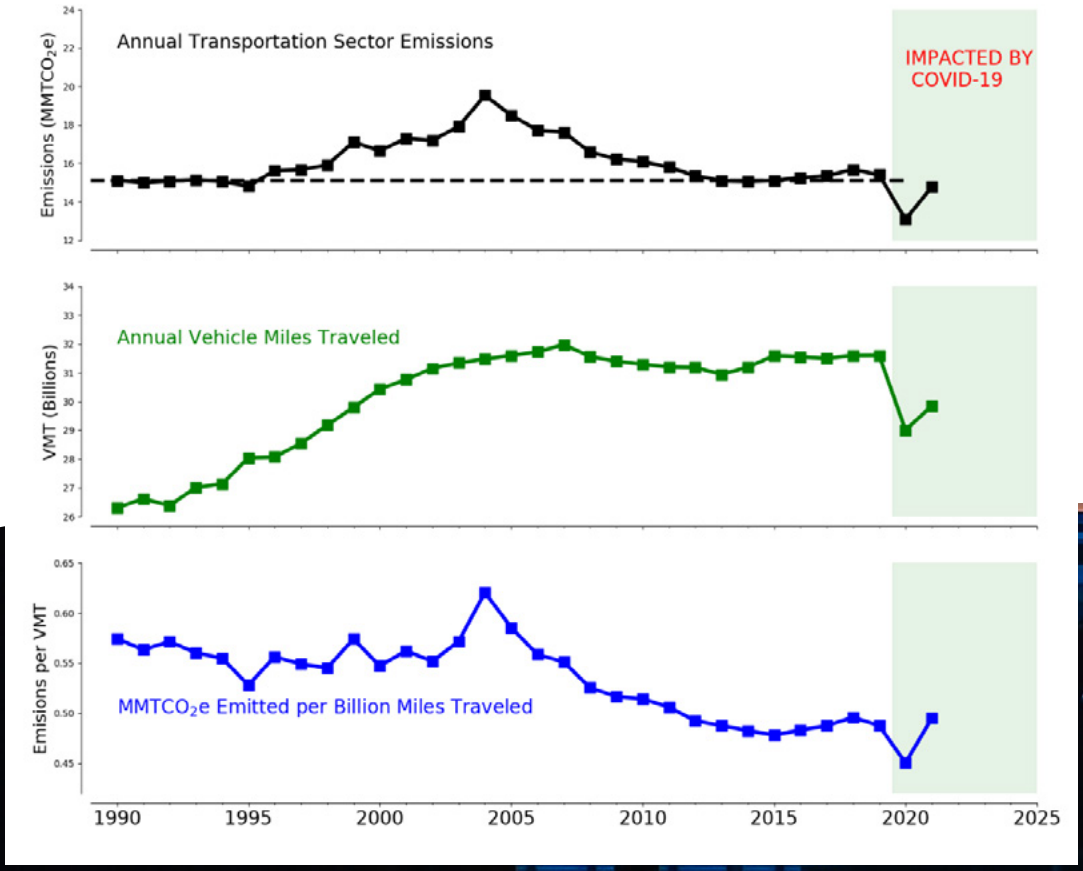


FIGURE 5: *Top: total transportation sector GHG emissions, 1990–2021. The horizontal dashed line depicts 1990 emissions. Middle: annual vehicle miles traveled (VMT), 1990–2021. Bottom: GHG emissions per vehicle mile traveled in CT, 1990–2021. Improvements in average fuel economy have been offset by increase in VMT. Source: CT DOT.*

Residential Sector

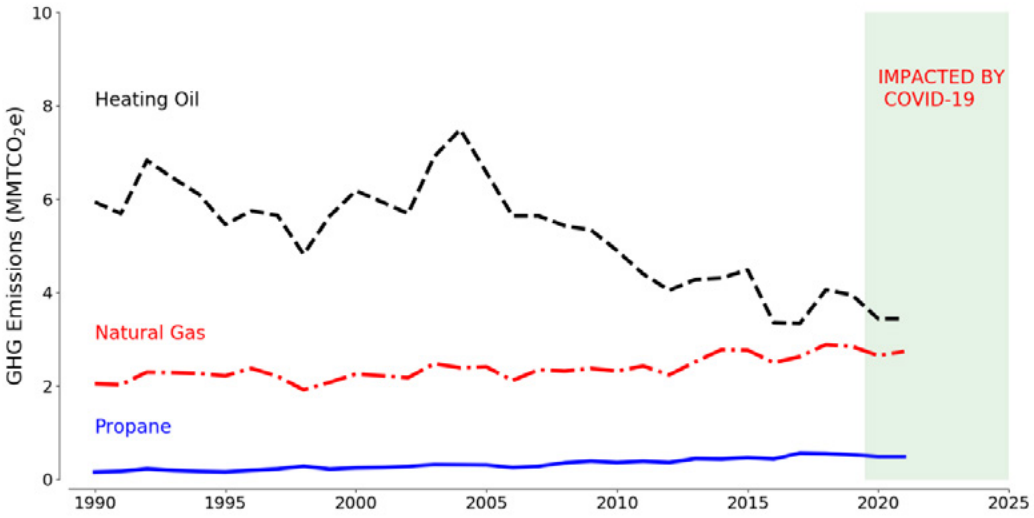


FIGURE 6: *Residential GHG emissions from delivered fuels (Heating oil: Black, and Propane: Blue) compared with natural gas service (Red). Heating oil is responsible for over 60 percent of residential emissions in 2019, despite serving less than half of CT households. The fraction of emissions from heating oil has been steadily declining since 1990, but this is largely due to customers switching to natural gas heat.*

In 2019, emissions from the residential sector surpassed those from electricity for the first time since this inventory has been produced, and now make up about a fifth of Connecticut's total economy-wide emissions. Most residential sector emissions originate from oil, propane, and natural gas used for heating; however, some emissions remain from fossil fuel use in cooking, heating water, and drying clothes.

Delivered fossil fuels such as propane and heating oil account for 61 percent of residential sector emissions in the state. (See Figure 6.) These two fuels serve approximately 43 percent of Connecticut homes for space heating.[7] Residential sector natural gas emissions have risen by 50 percent since 1990 and make up about 40 percent of home emissions while serving 35 percent of homes. However, with the Public Utilities Regulation Authority (PURA) **decision** in April 2022 ending incentives for expansion of natural gas service, conversions from oil to natural gas in existing housing stock are likely to slow down. The other major source

[6] American Community Survey Table B25040|HOUSE HEATING FUEL

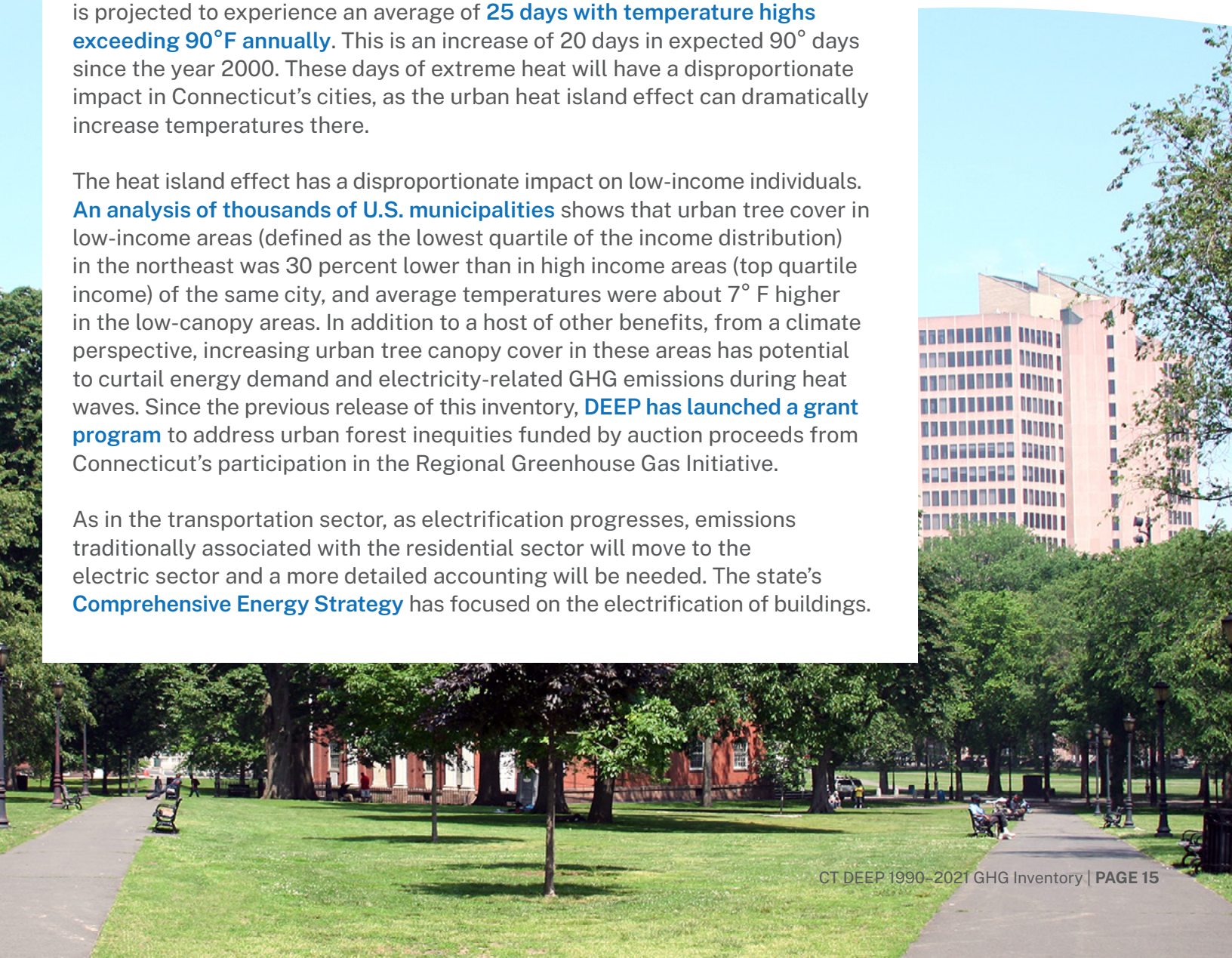
of home heating is electricity, at 18 percent of households. This covers electric heating from heat pumps as well as electric resistance heating. Emissions from this source are already accounted for in the electricity sector. Emissions from home electricity use are expected to continue decreasing as Connecticut achieves its **2040 zero-carbon electricity supply goal**.

A 2020 **EIA survey** indicates that 41 percent of Connecticut housing units currently rely on electrically heated hot water while natural gas, propane, and heating oil account for 58 percent of household water heating. **More than 70 percent** of Connecticut households utilize an electric range, cooktop, or oven for cooking. Most electric heating, hot water heating, and cooking comes in the form of inefficient electric resistance, in which electric energy is converted directly to heat. Replacing these electric resistance technologies, as well as less efficient fossil-fuel-based technologies, with heat pumps, heat pump water heaters, and induction ranges and cooktops provides a potential windfall of energy savings. Supporting building owners, renters, and contractors in learning about these potential energy savings and enabling new construction to minimize annual net energy use will be critical to reducing building emissions.

Another opportunity to reduce emissions from residential energy demand is expanding urban tree canopy cover, as called for in the 2021 GC3 report. The average number of cooling degree days the state experiences has been steadily increasing for decades (Figure 7), and by 2050 Connecticut is projected to experience an average of **25 days with temperature highs exceeding 90°F annually**. This is an increase of 20 days in expected 90° days since the year 2000. These days of extreme heat will have a disproportionate impact in Connecticut's cities, as the urban heat island effect can dramatically increase temperatures there.

The heat island effect has a disproportionate impact on low-income individuals. **An analysis of thousands of U.S. municipalities** shows that urban tree cover in low-income areas (defined as the lowest quartile of the income distribution) in the northeast was 30 percent lower than in high income areas (top quartile income) of the same city, and average temperatures were about 7° F higher in the low-canopy areas. In addition to a host of other benefits, from a climate perspective, increasing urban tree canopy cover in these areas has potential to curtail energy demand and electricity-related GHG emissions during heat waves. Since the previous release of this inventory, **DEEP has launched a grant program** to address urban forest inequities funded by auction proceeds from Connecticut's participation in the Regional Greenhouse Gas Initiative.

As in the transportation sector, as electrification progresses, emissions traditionally associated with the residential sector will move to the electric sector and a more detailed accounting will be needed. The state's **Comprehensive Energy Strategy** has focused on the electrification of buildings.



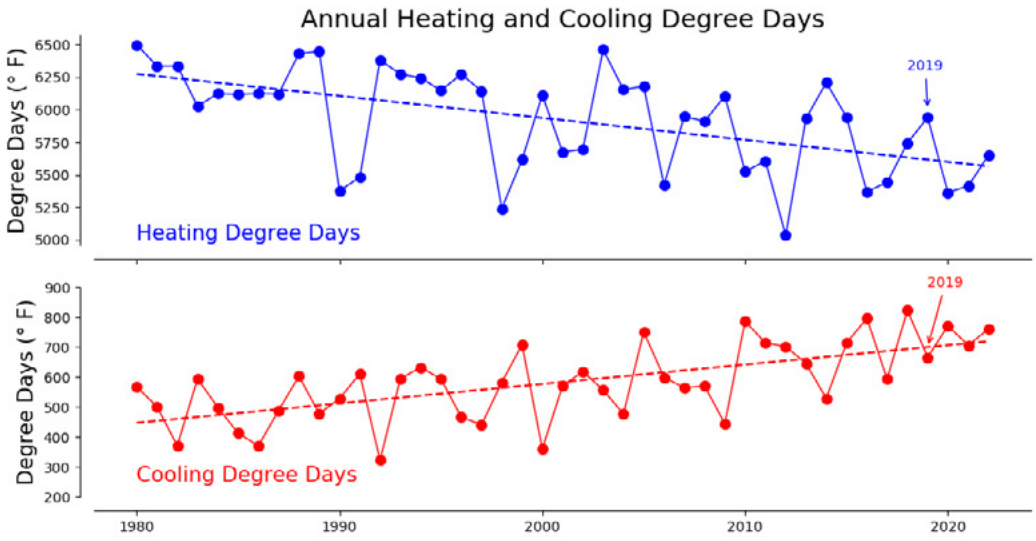


FIGURE 7: *Heating degree days (top panel: blue) and cooling degree days (bottom panel: red), 1990–2022. The summer of 2019 was milder than in 2018, but still in line with the 40-year trend. While heating degree days are on a steady decline, note that the scale for heating degree days surpasses cooling degree days by ~ a factor of ten. Therefore, winter heating will remain a significant source of the state's energy demand in the coming decades. In addition to mitigation by improving grid resiliency, increases in urban tree canopy cover can mitigate the increase in summer cooling degree days. Urban tree cover can lower the temperature in the surrounding environment by several degrees. Source: NOAA National Centers for Environmental information, Climate at a Glance.*

Heating degree days and cooling degree days are defined relative to a temperature average of 65°F. The concept of heating and cooling degree days builds in the assumption that an outside temperature of 65°F results in little to no energy being used to heat or cool indoor spaces.

Degree days are calculated by taking the difference between the daily average temperature and 65°F. For example, a summer day with a low temperature of 70°F and a high of 80°F would have an average temperature of 75°F. Cooling would be required for indoor spaces and this day would result in 10 cooling degree days (75°F-65°F). A winter day with a low of 20°F and a high of 40°F would likewise have an average temperature of 30°F and result in 35 heating degree days (65°F-30°F).

Electrical Power Sector

Connecticut generated more electricity than it consumed in 2019-2021, resulting in the state exporting power to the rest of New England and New York. Emissions associated with all of the electric power generated within the state continue to rise, as power generators in other parts of New England retire. This increase is happening even while emissions from Connecticut's overall electricity consumption are falling, because Connecticut is part of a regional electric system, and power generated within our state is not necessarily consumed in-state. In 2019, 2020, and 2021, in-state electric generation emitted 9.5, 10.2, and 11.0 MMTCO2e respectively. For the three years, consumption of electricity in Connecticut resulted in 5.7, 3.2, and 3.0 MMTCO2e in GHG emissions. Decisions on siting of new power plants are made with regional infrastructure in mind, and electricity intended for consumption in one location may be more efficiently generated elsewhere.

Emissions associated with electricity generated in-state but not consumed in-state should be included in the GHG inventories of the state where the electricity was purchased. Note that most of the other inventory emissions counted toward the GWSA goal are tabulated at the point of emission, with the primary exception being the electric sector.

In 2019, non-biogenic emissions due to electricity consumption were down 47 percent from 1990 levels. The calculation of electric sector emissions was performed differently than in previous years to more accurately reflect the state's RPS. In this calculation, Renewable Energy Certificates (RECs) that are retired in Connecticut are treated as consumed in the state and the corresponding energy is deducted from the state's total energy consumption. The calculation is likewise performed for every state in the region from data sourced from ISO-NE and the EIA. Once the RECs are removed, the emissions from the remaining energy consumption are calculated from regionwide emission factor in MMTCO2e emitted per megawatt hour of electricity consumed.

Commercial and Industrial Sectors

The combustion of natural gas contributes over three-quarters of commercial emissions. (See Figure 8.) The industrial sector presents a unique challenge for decarbonization: only 55 percent of its CO2e emissions are in the form of CO2 emitted from the combustion of fossil fuels (See Figure 9). The industrial processes that contribute the other 45 percent are from high global warming potential gases (GWP) used in semiconductor manufacturing and in Ozone Depleting Substance substitutes such as HFCs and other refrigerants. While low GWP refrigerants are being developed and HFCs are being phased out of production, the state must avoid releasing these high GWP refrigerants into the atmosphere throughout installation, maintenance, and disposal of equipment currently using them. Another common industrial greenhouse gas is the Sulfur Hexafluoride (SF6) used in high voltage relay switches to protect the electric power distribution system. **Development of SF6 circuit breaker alternatives is underway**, and adoption of these technologies will be essential in meeting the GWSA's medium term goals. Connecticut's emissions of these gases are based on national data and apportioned by the state's population.

As the commercial and industrial sectors begin to comprise a larger fraction of Connecticut's GHG emissions, better resolution data about the state's consumption of these industrial gases will be needed to aid in reducing emissions. Reporting from the state's electric distribution companies (EDCs) regarding the number of assets that use SF6 and estimated leakage rates would be vital toward ensuring data quality.

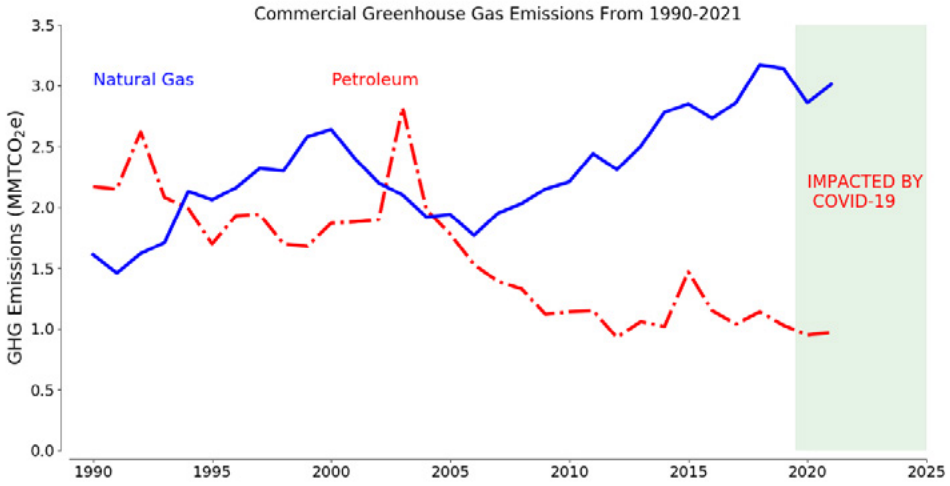


FIGURE 8: *The commercial sector is one part of the economy where emissions have increased since 1990. While throughout the 1990s, natural gas and petroleum products contributed roughly the same amount to the state's emissions budget, in 2019 the state's fuel use profile had changed enough that natural gas contributed at a rate of 3 to 1 in GHG emissions.*

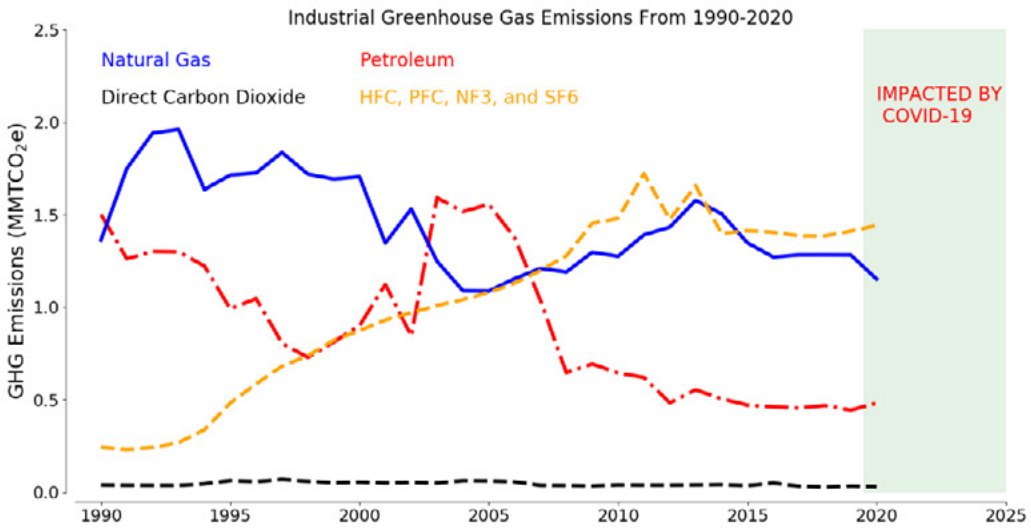
Waste

GHG emissions associated with the treatment of wastewater as well as municipal solid waste (MSW) slightly declined in 2019; however, they have increased since 1990. Overall, emissions from wastewater treatment have not moved much in the past three decades. About 80 percent of the GHG emissions from the waste sector come from solid waste, much of it already baked in due to outgassing related to the breakdown of previous landfilling. Some GHG emissions associated with this sector are accounted for under the electricity sector calculation with the combustion of trash to generate electricity. With the closing of the Materials Innovation and Recycling Authority (MIRA) waste to energy facility in July 2022, it is estimated that about 860,000 tons per year, or 40 percent of MSW generated in the state requiring disposal, are being exported to other states, traveling an average of 407 miles, primarily to landfills. DEEP estimates that the increase in exports alone will contribute an additional 100,000-150,000 MTCO2e. Before the MIRA facility closed, approximately 17 percent of total MSW generated was exported for out of state disposal.

The General Assembly has established a solid waste management group which began meeting in August 2022 in order to plan both long-term and short-term waste management strategies. In January 2023, DEEP released a **draft amendment** to the state's Comprehensive Materials Management Strategy (CMMS) to address the impacts of the MIRA facility's closure and regain self-sufficiency – the ability to manage MSW disposal within Connecticut's borders.

The Draft CMMS Amendment proposes two key MSW diversion strategies: 1) implementing extended producer responsibility (EPR) for packaging materials and 2) significantly ramping up collection and processing of source separated food scraps, which make up 22 percent of the waste stream. DEEP estimates that these two strategies could reduce the amount of MSW exported for disposal by 385,000 tons per year, while also reducing emissions by 475,000-515,000 MTCO2e. The remaining tonnage exported would have to be addressed through new in-state waste disposal infrastructure in order for Connecticut to regain self-sufficiency.

FIGURE 9: *GHG emissions due to industrial processes. Non-combustion GHG emissions from industrial processes are challenging to reduce or eliminate.*



Agriculture and Natural Gas Leakage

These sectors' modest contributions to the statewide emission total reflect the fact the inventory focuses primarily on emissions occurring within Connecticut. Emissions associated with growing and processing most of the food consumed in Connecticut and with mining and processing natural gas occur outside the state.

Natural and Working Lands and Negative Emissions

While this inventory provides a framework to tabulate the GHG emissions from all of Connecticut's economic activity, it does not provide a way to estimate or understand the various carbon sinks throughout the state that could aid in removing CO2 from the atmosphere. The natural and working lands (NWLs) sector includes forests and woodlands, grasslands and shrublands, croplands and rangelands, wetlands and urban green spaces. NWLs can store carbon in plants and soils in these landscapes and can therefore be a net carbon sink, resulting in negative emissions. Protecting NWLs is critical to limiting global warming to 1.5 degrees Celsius; the IPCC report identifies no path to net-zero emissions by 2050 without carbon removal provided by this resource.

Connecticut's forests cover approximately **60 percent** of the state's land area. Forests can sequester **4-40 tons CO2 per year per hectare**. Another even more efficient carbon sink includes the State's tidal and coastal wetlands, which cover a **minimum of 14 percent** of the state's land. It is estimated that, globally, wetlands contain **20-30 percent of global soil carbon** while covering less than 8 percent of the land. NWLs, in addition to serving as carbon sinks, are also a source of emissions. While nationally managed forests and other lands areas are a net sink, the inventory has not yet accounted for whether this is the case for Connecticut. Wildfires, insect infestations, extreme storms and other weather events, and land-use changes can lead to NWLs emitting more carbon than is sequestered.[8]

Governor Lamont's **Executive Order 21-3** directs DEEP to "evaluate the feasibility and reliability of monitoring and reporting on negative carbon emissions from Connecticut's forests as part of the greenhouse gas inventory report required by the GWSA." It also directs the Department of Agriculture to evaluate the resources needed to "maximize mitigation potential through carbon storage and sequestration" on working lands. Until 2009, the SIT Land Use Change module was used to estimate negative emissions that could be attributed to carbon sinks, but the calculations year to year have been inconsistent and that module is no longer used in preparing the GHG inventory.

Connecticut is a participant in the U.S. Climate Alliance's Natural and Working Lands Workgroup, which is engaged in a process to improve methods for determining the carbon flux into and out of NWLs. DEEP is also engaged in a process to implement various GIS mapping tools to estimate tree cover in areas of interest and develop a methodology to estimate carbon sequestration in the state. The Connecticut Department of Agriculture is administering the Climate Smart Agriculture and Forestry grants, which support climate-protective agricultural practices for soil health, improved nitrogen management, improved livestock waste

[8] US Climate Alliance_2022 NWL State Guide Natural and Working Lands and Climate Action (squarespace.com)

management systems, enhanced grazing land management, improved agroforestry, forestry, and upland wildlife habitat, and restored disturbed lands. Models show these practices can provide quantifiable reductions in GHG emissions and/or increases in carbon sequestration, according to the USDA Natural Resource and Conservation Service.

Policy Recommendations to Further Mitigate GHG Emissions and Impacts

As described above, Connecticut has made progress toward meeting its GWSA goals, but more remains to be done. This section details policies that the state can pursue to continue reducing its emissions.

Update the GWSA to make targets more ambitious, adopt sector sub-targets, and grant regulatory authority

Connecticut's current suite of approaches to reduce GHG emissions is not keeping the state on track to meet the 2030 and 2050 targets established in the GWSA. Without substantial changes to emission trajectories in non-electric power sectors, Connecticut is unlikely to meet these targets. Additional programs, regulations, and incentives are needed to ensure the state fulfills its longstanding climate change mitigation objectives.

In response to the escalating climate crisis, neighboring states have made their climate goals and initiatives more aggressive. In 2021, Massachusetts updated its Global Warming Solutions Act to require the state to reduce emissions 50 percent from 1990 levels by 2030 and 85 percent by 2050 and embrace a new goal: bringing the commonwealth to net-zero GHG emissions by 2050.[9] Under Massachusetts law, these provisions are legally enforceable. That same year, Rhode Island enacted the Act on Climate, which requires the state to reduce emissions 45 percent from 1990 levels by 2030 and 80 percent by 2040 to reach net-zero by 2050. The act made achievement of those reductions legally enforceable and, accordingly, authorized all state agencies and entities to promulgate rules and regulations necessary to reduce GHG emissions.[10] The State of New York also is developing plans to achieve net-zero emissions by 2050, with an 85 percent reduction in gross GHG emissions by that time.[11]

Connecticut should update its GWSA targets and timeline to align with those of our neighboring states and grant DEEP the regulatory authority to set and enforce GHG reduction targets in sub-sectors of the economy. Regulations proposed under this authority would remain subject to legislative review through the joint bipartisan legislative Regulatory Review Committee.

Requires legislative authorization

[9] MA Decarbonization Roadmap | Mass.gov
[10] RI Gen L §42-6.2, 2021 Act on Climate, webserver.rilin.state.ri.us/Statutes/TITLE42/42-6.2/INDEX.htm.
[11] New York State Climate Action Council Finalizes Scoping Plan to Advance Nation-leading Climate Law - NYSERDA

Increase tree canopy in urban settings

Trees can help mitigate the impacts of climate change and urban heat island effect, which can cause cities such as Hartford to be up to 19° F warmer than surrounding areas.[12] Research suggests than a minimum canopy cover of 40 percent is needed to significantly reduce temperatures;[13] but in Bridgeport and Hartford, urban tree cover is just 20 percent and 26 percent, respectively.[14] Even in New Haven, which has relatively dense tree cover (38 percent), low-income neighborhoods have just 23 percent. Across Connecticut's urban environments, disparities between income, temperature, and tree canopy cover are among the highest in the nation.[15] Establishing a goal to increase urban tree canopy by at least 5 percent in environmental justice residential neighborhoods by 2040 could provide substantial benefits to vulnerable communities. Any such policies would be supported by the $500,000 in American Rescue Plan Act funding for urban tree canopy that is in the governor's budget, plus potentially bridge funding to additional federal dollars.

Requires legislative authorization

Require reporting of building energy consumption to prospective renters and buyers

Connecticut residents, on average, spend **at least $156/month on electricity and $76/month for heating oil or $39/month for natural gas**.[16] These are some of the highest energy rates in the nation. Currently **nine states and the District of Columbia** require some form of energy-use disclosure during real estate transactions. States that authorize such disclosures can employ the Department of Energy **Home Energy Score**, which is available to households participating in the Home Energy Solutions (HES) and HES-Income Eligible programs. This score rates the energy efficiency of a home relative to others by taking into account factors such as structure and insulation as well as heating, cooling, and hot water systems. It also provides an estimate of the home's annual energy cost, much like the estimated cost labels found on appliances. Requiring disclosure of the Home Energy Score or developing a similar home energy efficiency score and requiring its disclosure during real estate transactions in Connecticut would motivate property owners to perform energy saving retrofits and HVAC upgrades before placing their properties up for sale or rent.

Requires legislative authorization or regulatory authority

Continue adopting additional standards for light-, medium-, and heavy-duty vehicles

Public Act 22-25 authorizes the Department to adopt California's emission standards for medium- and heavy-duty vehicles (MHDs). The Department is in the process of adopting the regulations necessary to reduce MHD emissions of oxides of nitrogen by over 90 percent and set a path for electrification of 30 percent of the MHD fleet by 2030. Connecticut also follows California's standards for light-duty passenger vehicles (LDVs). Connecticut is developing regulations to adopt California's standards, as did

[12] Climate Central. Hartford Climate at a Glance, https://www.climatecentral.org/news/urban-heat-islands-threaten-us-health-17919

[13] Ziter CD, Pedersen, EJ, Kucharik, CJ, Turner, MG (2019) Scale-dependent interactions between tree canopy cover and impervious surfaces reduce daytime urban heat during summer. PNAS 116(15).

[14] Pelletier K. O'Neil-Dunne J. Spatial Analysis Laboratory, University of Vermont.

[15] McDonald RI, Biswas T, Sachar C, Housman I, Boucher TM, Balk D, et al. (2021) The tree cover and temperature disparity in US urbanized areas: Quantifying the association with income across 5,723 communities. PLoS ONE 16(4): e0249715

[16] These costs represent annual costs spread evenly across all 12 months. However, energy costs related to heating naturally increase during the winter months and can result in monthly energy bills in the hundreds of dollars, which can make it more difficult for many residents to make ends meet. DEEP supports efforts to help residents spread those costs evenly across the entire year to provide greater economic stability.

Massachusetts and New York, to phase out the sale of new gasoline- and diesel-powered cars by 2035. If adopted this year, as expected, the MHD and LDV rules will require manufacturers to begin delivering cleaner vehicles for sale in Connecticut beginning with the 2027 model year. By 2040, implementation of the LDV standards could reduce GHG well-to-wheels emissions by 39.5 MMT, and the MHD rules could provide annual GHG emissions reductions of 1.48 MMT.

Beyond light-, medium-, and heavy-duty vehicles, the Department also expects to explore options for encouraging carbon reductions in off-road and non-road sectors.

Adopt a net-zero energy building code

As the carbon intensity of the region's electricity grid declines, combustion of fossil fuels in Connecticut buildings accounts for a larger share of economywide emissions – 29 percent in 2018 and approximately 31 percent in 2021. **Over 80 percent of U.S. households and commercial buildings are heated with fossil fuels;** and together combustion and electricity use for heating, ventilation, and air conditioning account for 60 percent of U.S. building energy consumption. Although the vast majority of Connecticut buildings that will exist in 2050 have already been built, improving the energy efficiency and carbon intensity of newly constructed buildings and buildings that undergo major renovation represents a prime opportunity to green the state's building stock. This work can be done more thoroughly and often at less expense during construction and renovation than it can during more conventional retrofitting of existing buildings; and incorporating efficiency and sustainably from the outset locks in savings for decades.

For these reasons, enabling municipalities to adopt a net-zero energy building code would deliver cost-effective reductions in building emissions and operating costs in Connecticut. States that have granted municipalities this authority include Massachusetts, New York, Maine, Vermont, the District of Columbia, and Maryland. This change would require legislative authorization. Alternatively, if the legislature were to grant state agencies regulatory authority to mitigate GHG emissions, Connecticut could revise the energy code adoption process to more quickly achieve net-zero energy, although the regulations would still be subject to legislative review through the Regulatory Review Committee.

Requires legislative authorization or regulatory authority

Pursue alternative fuels where electrification is not practical

Some end uses will prove difficult to decarbonize, including heavy-duty vehicles, long-distance shipping, and aviation. Substituting alternative fuels with a lower carbon content may serve as an interim or even long-term strategy. **Connecticut along with neighboring states** is currently involved in pursuing one of the regional hydrogen hubs funded as part of the **IIJA**. A transition to clean hydrogen fuel for applications, where this is practical, is another tool for the state to make progress toward the 2050 emissions target in sectors that are challenging to electrify or otherwise decarbonize. As with other alternative fuels, there are critical differences between methods used to produce hydrogen, and Connecticut should develop a framework that aligns with the state's GHG reduction targets under the GWSA and ensure positive emission and environmental outcomes.

Requires legislative authorization or regulatory authority

Improve Bicycle and Pedestrian Infrastructure

Under the CHEAPR program, Connecticut residents will be eligible, beginning in mid-2023, for a **$500 rebate toward the purchase of an electric bicycle** (e-bike). Low- to moderate-income residents and residents of environmental justice communities will be eligible for an additional $1,000 voucher to be applied at the point of sale. CHEAPR's e-bike incentive could lead to a dramatic increase in the number of e-bikes in our communities – and steps are needed to prepare the built environment to safely accommodate this increase. Because most trips are under 6 miles, many trips could conceivably be accomplished via e-bike. In order to do so today, however, a cyclist must typically use the same path as high-speed vehicular traffic on at least some portion of most trips. The University of Connecticut's **Crash Data Repository** indicates that from January 1, 2020, to August 31, 2022, **89 bicycle-involved crashes** in Connecticut resulted in either a fatality or serious injury, which is nearly 9 percent of all crashes that involved a bicycle. This is in stark contrast to the 1.6 percent of all crashes that result in serious injury or a fatality during the same period. That is, crashes involving bikes were far more likely to involve serious injury or fatality.

To encourage increased use of e-bikes and improve biker safety, all levels of government should coordinate investments in protected bike lanes separated from motor-vehicle traffic lanes. Similarly, state and local government should also build sidewalks in areas where they do not currently exist and assess the safety of intersections between these modes of transportation. **Doing so may also have the benefit of increasing safety not only for bikers but for motorists and pedestrians.**

Implement strategies to meet the target of 5 percent VMT reduction by 2030

The CTDOT adopted five strategies that are within its control and that were determined to decrease VMT in pursuit of the 5 percent per-person VMT reduction by 2030 target, especially when combined with land use strategies that encourage denser development. These are:

1. Increase in Active Transportation/Complete Streets infrastructure in areas of urban/dense residential/commercial development. Note that Active Transportation and Complete Streets projects will continue to be implemented in other locations outside of urban core areas, but the primary purposes in such other locations will be less related to VMT reduction, and instead be focused on safety and mobility.
2. Increase in transit frequency.
3. Increase in transit access.
4. Continue to assist and partner with municipalities that are pursuing Transit-Oriented Development.
5. Trip Reduction Program.

Additionally, the following strategies would also reduce vehicle miles traveled:

- Parking Management, including eliminating residential parking minimums, adding fees to parking.
- Increase residential density.
- Increase job density.
- Build medium-high intensity mixed-use Transit-Oriented Development (TOD).

Implementation of the above strategies is not exclusively the purview of state government. Local governments must make planning and zoning changes that would allow these development patterns.

Take advantage of incentives to expand consumer awareness and adoption of renewable thermal and low-carbon technology

In 2022, due to the Russian invasion of Ukraine, the global petroleum and natural gas markets experienced extreme volatility that has taken a year to stabilize. This has led to a severe affordability crisis for homes in Connecticut that heat with natural gas, as well as skyrocketing electricity rates as roughly half of ISO-NE's electricity is generated by natural gas fired power-plants. This has exposed yet another major vulnerability in the resilience and reliability of our home heating infrastructure that must be addressed immediately. The Inflation Reduction Act provides direct savings and subsidies for households to make energy efficiency upgrades. Some of the savings available to consumers include:

- Up to a 30 percent federal tax credit for energy efficiency improvements such as insulation upgrades, air-source heat pump installation, heat pump water heater installation, and door and window upgrades.
- Direct rebates for electrification of appliances and required service panel upgrades.
- Up to 30 percent tax federal credit toward installation of rooftop solar systems or a geothermal heat pump.

In addition to direct subsidies available to all consumers, the IRA provides grants for state energy offices to implement the HOME Rebates Program to provide rebates to income-eligible consumers as well as funding for direct rebates of up to 100 percent for low- to moderate-income households that install energy efficient appliances through the High-Energy Electric Home Rebate Act. DEEP will partner with community leaders to raise awareness of the rebates and tax incentives available to low- to moderate-income households through the IRA and in order to decrease pressure on natural gas as a fuel for both home heating and electricity generation needs.

Pursue grants available through the IRA

The IRA allocates $3 billion to the Federal Housing Administration toward neighborhood access and equity grants. Connecticut should pursue funding to address urban heat islands and increase urban tree canopy cover. The state should also pursue grant funding available through the IRA to address the state's persistently poor air quality.

Other policies being considered in DEEP's next comprehensive energy strategy

DEEP's ongoing Comprehensive Energy Strategy (CES) development process, described above, is exploring a number of decarbonization policies to help reduce emissions from buildings and thermal end uses. Policies being analyzed for costs, benefits, and equity impacts include:

- **Building performance standards:** In urban areas, large commercial and multifamily buildings can play an outsized role in local energy use and GHG emissions. Many of these buildings in Connecticut were also constructed under historic, less stringent energy codes, which suggests that energy efficiency retrofits may be possible. By tracking and reporting energy use and GHG emissions from large buildings, and providing incentives and programs to encourage improvement over time, Connecticut could encourage carbon emission reductions in existing buildings while helping to improve air quality in urban environments.

- **A clean heat standard and/or program:** The majority of thermal energy used in Connecticut is currently provided by fossil fuels. However, less carbon intense alternatives such as all-electric heat pumps and certain biofuels are commercially available. Clean heat standards, as proposed or implemented in other states like Vermont and Oregon, create a standard and market for "clean heat credits" similar to existing renewable energy credits used in electricity markets. By establishing a clean heat credit market based on GHG savings from less carbon-intensive heating alternatives, clean heat standards and/or programs can drive substantial emission reductions in residential, commercial, and industrial sectors.

- **Launching a future of natural gas planning docket** through Connecticut's Public Utilities Regulatory Authority: Other states such as Massachusetts and Rhode Island, both of which have GHG regulatory authority, have launched studies and dockets focused on planning for the future of the natural gas system. As currently built and operating, natural gas distribution systems are misaligned with long-term GHG emission reduction targets. However, careful planning could help avoid negative outcomes for ratepayers during the clean energy transition.

The policy concepts outlined above have been successfully implemented in other jurisdictions but need to be carefully evaluated within the Connecticut context. Stakeholder engagement is also critical to determining if such policies are appropriate for Connecticut. Through subsequent CES stakeholder meetings, DEEP aims to establish a robust list of policy recommendations that could be recommended to the legislature as regulations and/or legislative amendments.

Conclusion

This report provides a snapshot of Connecticut's Greenhouse Gas Emissions Inventory for the years 1990-2021. The past few years represent a unique moment in history marked by widescale behavioral changes, resulting in unprecedented year-to-year GHG reductions. Moving forward, stakeholders and policymakers should cautiously consider these factors when drawing inferences about future trends in GHG emissions from Connecticut's energy usage. It is reasonable to assume emissions in certain sectors, like transportation, will continue to rise in subsequent near-term inventories and more closely resemble pre-pandemic levels.

Of course, this unique moment in history also represents a critical opportunity to evaluate those behavioral changes and assess legislative and regulatory changes that can provide the greatest emissions reduction benefits while also aligning with other public policy goals. Those goals include environmental and climate justice, public health and safety improvements, reduced energy burdens and lower utility costs, economic development, climate resiliency, energy reliability, and supply diversification. To that end, this report has identified several potential policy reforms.

DEEP looks forward to working with all parties to meet the requirements of the Global Warming Solutions Act and effectively address the mounting climate crisis.

Appendix

Biogenic Emissions and Electricity Sector Methodology

On October 26, 2021, DEEP held a public meeting to solicit comments on a proposed methodology change in GHG emissions accounting in the Electricity Sector. This change was implemented for the 2019-2021 inventory report. The reason behind this methodology change is to move the accounting more in line with international standards and peer states in treating biogenic emissions as neutral for purposes of compliance with GWSA goals. The steps in the new methodology are as follows:

1. Credit each state with electricity from RECs retired there and account for the corresponding non-biogenic emissions.
2. Using appropriate emission factors, determine the carbon dioxide equivalent (CO2e) from electricity generated from all non-biogenic fuels consumed within the ISO-NE region and from electricity imported into ISO-NE.
3. Determine the CO2e associated with emission of methane (CH4) and nitrous oxide (N2O) associated with biogenic fuels used to generate electricity and add this to the regional total, in line with international protocols.
4. Determine CO2e emissions associated with RECs retired in Connecticut and subtract the emissions and electricity from the ISO-NE regional mix.
5. Credit Connecticut with its share of electricity and associated environmental attributes generated at the Millstone facility.
6. For Connecticut's remaining electricity consumption, determine the associated emissions via a calculated regional emission factor.

This new methodology is an attempt to address three issues:

1. Connecticut's RPS profile contains a significant fraction of biomass. Because DEEP's methodology in the past failed to properly credit each state with its own RECs, the remaining system mix reflected generation and emissions not associated with the point of consumption.
2. All environmental attributes from the Millstone plant would otherwise become part of the system mix.
3. In the transportation sector, although emissions from combustion of ethanol blended with gasoline were properly excluded from totals for comparison with GWSA goals, the agency did not provide an estimate of those emissions. At the same time, biogenic emissions resulting from electricity generation were improperly included in the reported emission values counted against the GWSA goals.

The new methodology requires the reporting of biogenic CO2e in the GHG inventory that are not counted against the GWSA targets. For the electricity consumption sector, Table 2 displays the total amount of electric power generated in the state's RPS profile, as well as the total GHG emissions generated. In total Connecticut's RPS profile for electricity generation emitted ~ 5.2 MMTCO2e in 2019. Most emission sources, however, are biogenic in origin with the major exception being the non-biogenic portion of trash to energy emissions estimated at around 50 percent. Using the non-biogenic emissions as well as all of the CO2e emissions from methane and N2O adds approximately 1.1 MMTCO2e to be counted against the GWSA goals. Combining the 1.1 MMTCO2e with the state's remaining electric emissions as figured from the regional emission factor results in 5.69 MMTCO2e cited earlier in this report. Absent any adjustment for biogenic origins, the full electricity sector emissions would be 9.8 MMTCO2e for 2019.

This seeming spike over previous years is an artifact of the methodology changed in order to accurately reflect the RPS profile of each state in the region when computing the regional emission factor. As shown in Figure 1, had 2018's methodology been employed in 2019, electricity sector emissions would be reported at 7.9 MMTCO2e, a slight decrease from the previous year. In addition to the 5.7 MMTCO2e due to biofuels in 2019, biogenic emissions due to electricity consumed in Connecticut in 2020 and 2021 are 2.3 and 3.6 MMTCO2e.

A similar adjustment is necessary to the reported emissions figures for the transportation sector. Most of the gasoline sold in Connecticut comes in a 10 percent ethanol blend. In 2019 Connecticut consumed 12,492 billion British Thermal Units (BTU) combusting ethanol blended with gasoline. Ethanol has a CO2 emission factor of 68.4 kilograms of CO2 per million BTU as well as 1.1 grams of methane and 0.11 grams of N2O per million BTU. Employing these emission factors and AR5 100-year global warming potential (GWP) values result in the ethanol blend adding another 0.86 MMTCO2e emissions that are not counted against the GWSA goals. For 2020 and 2021, ethanol emissions not counted against the GWSA goals amount to approximately 0.71 and 0.79 MMTCO2e. In addition to the transportation sector, there is some ethanol use in the commercial and industrial sectors. Connecticut burned 335 billion BTU in the commercial sector and 141 billion BTU in the industrial sector in 2019. This results in an additional 0.02 and 0.01 MMTCO2e of biogenic emissions from each of those sectors, with similar results for 2020 and 2021.

TABLE 2: Electricity generation and GHG emissions from Connecticut's 2019 RPS profile

RPS Fuel Source	Energy for use in CT (MWh)	Emitted (lbs CO2)	Emitted CH4 (lb CO2e)	N2O (lb Co2e)
Biogas	-	-	-	-
Biomass	1,655,784	4,726,620,786	9,070,274.43	54,058,836
Coal	-	-	-	-
Diesel	-	-	-	-
Digester Gas	11,446	14,530,664	22,325	52,391
Energy Storage	-	-	-	-
Fuel cell	598,111	-	-	-
Hydroelectric/Hydropower	424,388	-	-	-
Hydrokinetic	-	-	-	-
Jet	-	-	-	-
Landfill Gas	384,800	536,896,846	824,885	1,935,798
Municipal solid waste	-	-	-	-
Natural gas	148,526	126,708,179	59,689	71,150
Nuclear	4,201,895	-	-	-
Oil	-	-	-	-
Solar Photovoltaic	586,045	-	-	-
Trash-to-energy	1,077,156	4,189,001,228	31,417,509	49,932,895
Wind	815,940	-	-	-
Wood	656,984	1,947,114,694	3,736,467	22,269,346
Total	**10,561,025**	**11,540,872,397**	**45,131,150**	**128,320,415**

Another source of biogenic GHG emissions in Connecticut's energy profile is biodiesel that is blended into both home heating fuel and motor vehicle fuel. The Energy Information Administration provides estimates for biodiesel consumption for each state through the State Energy Data System (SEDS). For 2019, SEDS estimates that Connecticut consumed 1.1 trillion BTU of biodiesel in total. Using the EPA emission factor of 78.8 kg of CO2 emitted per million BTU, Connecticut's biodiesel consumption is responsible for 0.08 MMTCO2e of the state's total emissions for 2019.

portal.ct.gov/DEEP