2017 Connecticut Greenhouse Gas Emissions Inventory

This summary provides an overview of Connecticut's greenhouse gas (GHG) emissions from 1990 to 2017, the most recent year for which full data are available.[1] The statewide GHG emission inventory is an important tool for tracking Connecticut's progress toward the goals set by the Global Warming Solutions Act and An Act Concerning Climate Change Planning and Resiliency. These statutory requirements set targets of reducing GHG emissions 10 percent below 1990 levels by 2020, 45 and 80 percent below 2001 levels by 2030 and 2050 respectively.[2,3]

Inventory Methodology

A federal standard for economy-wide GHG accounting does not currently exist. In the absence of a federal standard, the Connecticut Department of Energy & Environmental Protection (DEEP) is committed to continuous improvement of its accounting methodology. This includes identifying improvements in both the quality of data and methods utilized to calculate annual GHG emissions.

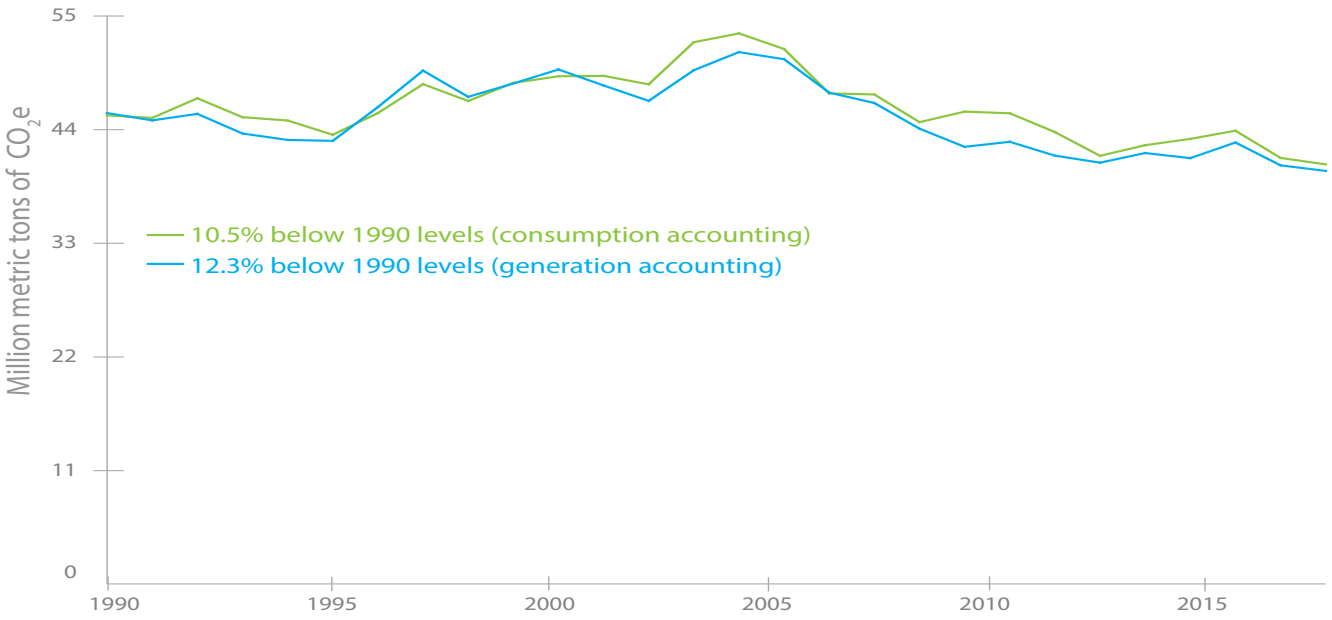
Like several states across the country that regularly perform economy-wide GHG inventories, DEEP relies heavily on the U.S. Environmental Protection Agency's (EPA) State Inventory Tool (SIT). The tool calculates sector-by-sector GHG emissions based on numerous state-level data sets (e.g., number of gallons of fuel oil sold in Connectitcut), including energy-related data provided by the Energy Information Administration (EIA). EPA recommends that states employ their own data when these are likely to be more reliable than the tool's default figures. DEEP's inventory uses SIT default data, with two exceptions. First, because SIT data on land use, land use change, and forestry appear unreliable, they have not been included in the state's recent inventori es. DEEP aims to develop an alternative means to estimate GHG impacts of land use and forestry for use in preparing future inventories. Second, this analysis continues to present both a consumption and generation based accounting approach for the electricity sector.

Based on best practices among states reporting state-wide GHG emissions, and reflecting the regional nature of the electric grid, the consumption-based accounting for the electric power sector was first applied in the 2013 inventory analysis. In prior GHG inventories, emissions from the electric power sector had been based entirely on direct emissions from generation of electricity by power plants operating within state boundaries. A consumption-based approach calculates emissions based on Connecticut's share of electricity consumption in New England, using the emissions profile of the regional electric grid's generation fuel mix.

Specifically, the consumption-based approach for the electricity sector uses the annual electricity load data from the Independent System Operator, New England (ISO-NE). We then account for emissions from Renewable Energy Certificates (RECs) purchased/sold by Connecticut retail electricity sellers, and megawatt hours of losses (and associated emissions) due to pumped hydro. And finally, the total energy consumed is multiplied by the regional New England emission factor to obtain emissions associated with the State's energy consumption. The New England emission factor takes into account the regional fuel mix as well as the associated GHG emissions from each power source for any particular year.

New to the inventory analysis is the inclusion of emissions from transmission and distribution leagage of natural gas. Emissions from the natural gas transmission system were calculated using the EPA SIT Natural Gas and Oil Module.

Connecticut Statewide Greenhouse Gas Emissions 1990-2017
Comparison of Electricty Sector Generation and Consumption-based Accounting



* Targets shown in this graph utilize the consumption-based approach 1990 baseline of 45.2 MMT CO_2e. The generation-based approach 1990 baseline is 45.6 MMT CO_2e.

Emissions from natural gas distribution systems were calculated based on Connecticut Public Utilities Regulatory Authority (PURA), the EIA, and Pipeline and Hazardous Materials Safety Administration (PHMSA) data. Emissions were not calculated for the following sources: natural gas production, natural gas flaring, and oil.

2017 GHG Emissions

Using the consumption-based accounting approach for electricity, **Connecticut's economy-wide GHG emissions in 2017 were 40.6 million metric tons (MMT) of carbon dioxide equivalent (CO_2e), 10.5 percent below 1990 levels and 17.4 percent below 2001 levels**.[4] In comparison, emissions using the generation-based accounting approach were 40 MMT CO_2e, 12.3 percent below 1990 levels and 17.1 percent below 2001 levels.

The transportation sector continues to be the single largest source of emissions in the state, contributing 38 percent, principally from the use of fossil fuels in passenger cars and light-duty trucks. Dropping 0.8 percent since 1990 and 13 percent since 2001, further transportation emission reductions are critical to meeting the State's targets. And, although national fuel economy standards have improved vehicle efficiency, the number of vehicle miles driven in Connecticut have increased, which is likely the contributing factor for not attaining greater emission reductions in the transportation sector. Significantly reducing transportation emissions in the coming decades will require continued improvements in vehicle fuel economy and GHG emission standards for all class sizes, increased deployment of zero-emission vehicles, and strategies that reduce vehicle miles traveled.

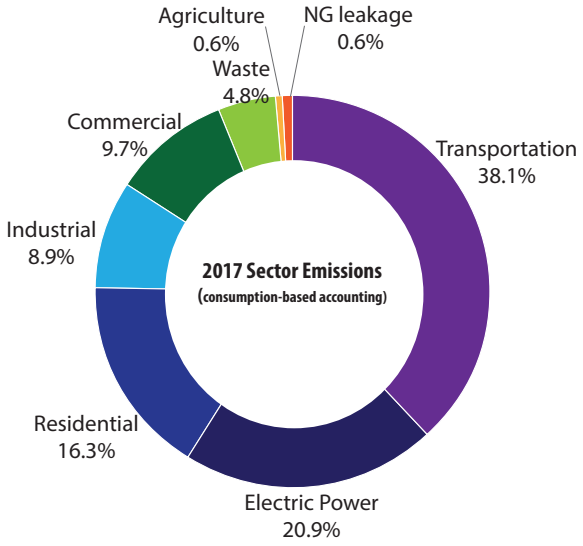
Electric sector emissions are down 29 percent from 1990 and 31 percent from 2001. This reduction correlates with state and regional policies and programs that encourage investment in energy efficiency in homes and

4 Emissions are reported in terms of carbon dioxide equivalence (CO2e). Carbon dioxide is the primary GHG. Emissions of other GHGs are expressed on the basis of their potential to contribute to global warming, relative to carbon dioxide's potential.

Connecticut Emissions by Sector ($MMTCO_2e$)

	1990	2001	2016	2017
Transportation	15.6	17.8	15.4	15.5
Electric Power				
Consumption	11.9	12.3	9.3	9.3
Generation	12.1	11.4	8.6	8.6
Residential	8.3	8.5	6.4	6.6
Industrial	3.2	3.7	3.6	3.6
Commercial	3.8	4.3	3.9	4.0
Waste	1.4	1.7	2.03	1.97
Agriculture	0.35	0.33	0.25	0.24
NG leakage	0.75	0.47	0.26	0.24
Generation-base Accounting Total	**45.6**	**48.2**	**40.5**	**40.0**
Consumption-based Accounting Total	**45.3**	**49.2**	**41.2**	**40.6**

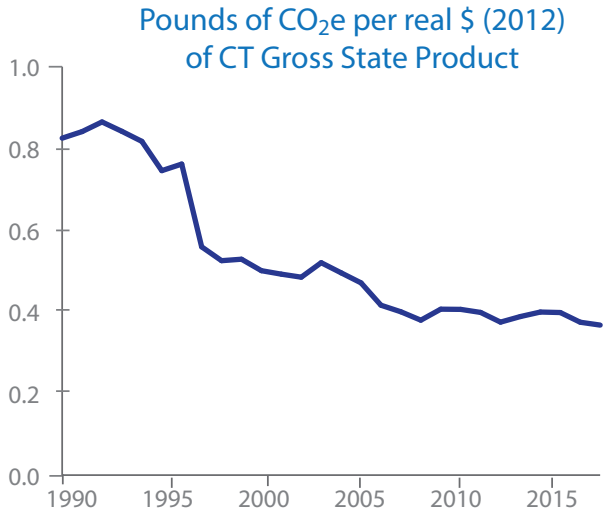
Consumption-based Accounting
10.5% below 1990 levels
17.4% below 2001 levels

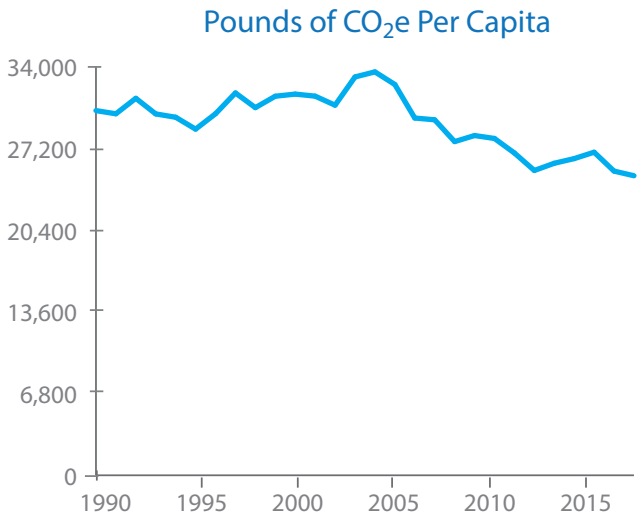


businesses, a shift from dirtier fossil fuels such as coal and oil to natural gas, and increased deployment of renewable energy sources. Additional emissions reductions in this sector will come from further reducing reliance on oil and coal during periods of peak electricity demand, continual expansion of renewable energy, and mainstreaming of energy efficiency in homes, businesses, and industry.

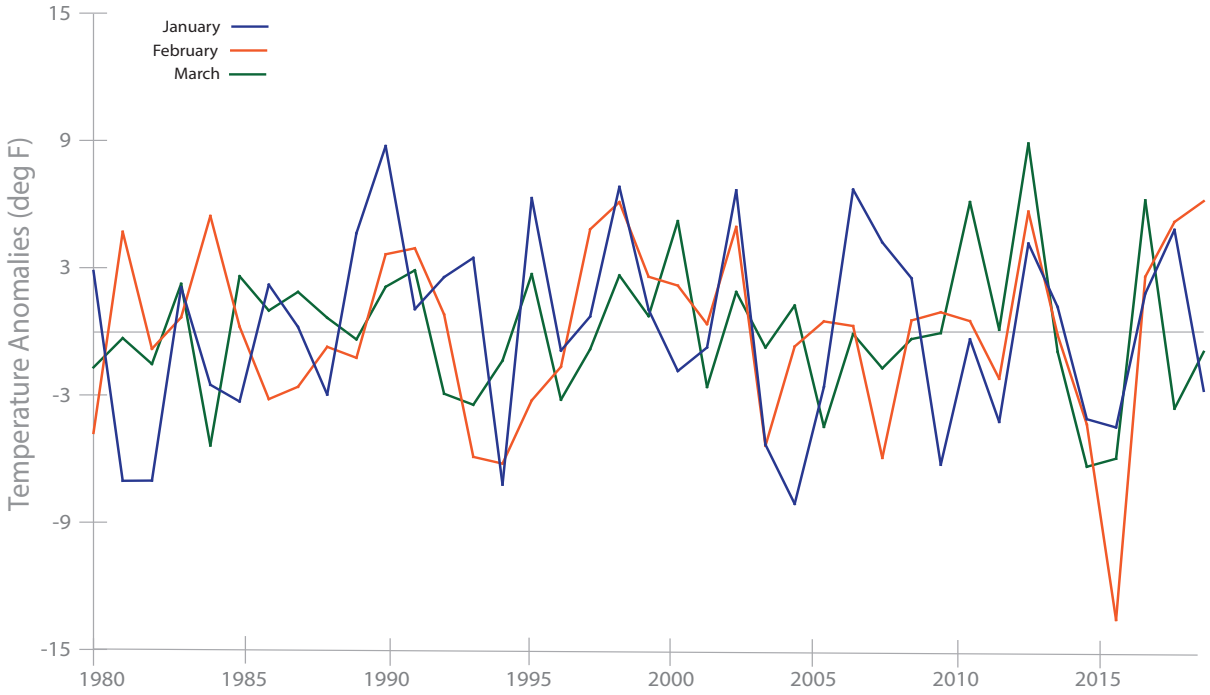
Economy and Demographics

Overall trends in the inventory demonstrate that the carbon intensity of Connecticut's economy has declined — falling 55 percent from 1990 to 2017, 0.39 pounds of CO_2e per dollar (USD 2012). This demonstrates significant long-term decoupling of economic growth and carbon pollution. In addition to this, Connecticut's per capita emissions are among the lowest in the country and have declined 18 percent between 1990 and 2017.





Connecticut monthly temperature anomaly from 1980-2018 for January, February, and March



Temperature anomaly is the departure of detrended monthly means from 1980-2018 climatology in degrees Fahrenheit. Source: NOAA statewide Climate at a Glance (https://www.ncdc.noaa.gov/cag/).

Effects of Extreme Weather Events

Temperatures from January through March 2017 were well above average. Additionally, annual heating degree days (HDD) for 2017 was the second lowest on record (lowest in 2012). However, a record-breaking, late December 2017 cold snap resulted in more fuel consumption (than in 2016) for thermal use in the commercial and residential sectors.

In the ISO-NE region, over 50% of electricity generation is from natural gas-fueled re-sources. During extreme cold winter events, demand for natural gas to meet heating needs is high resulting in less natural gas pipeline capacity for electric generators. To ensure electric reliability, GHG intensive oil and coal electric generating units are called up-on to satisfy the regions electric needs.

The emission factors for coal and oil (205-214 and 161-210 CO_2 lb/MMBtu, respectively) are higher than emission factors for natural gas (177 CO_2 lb/MMBtu). When a larger percentage of GHG intensive fuels are used, overall carbon emissions for the New England region will be higher. Extreme winter events have a signif-icant impact on regional GHG emissions in both the electric and building sectors. Ramping up measures such as building efficiency improve-ments for the commercial and residential buildings will help to ensure Connecticut achieves its ambitious reduction targets.

Building a Low Carbon Future for Connecticut

Connecticut is implementing a suite of comple-mentary strategies to ensure that the state is on a course to achieve its mandatory GHG reduction targets. The range of GHG reduction actions include direct regulations, monetary and non-monetary incentives, market-based mechanisms, and recognition for voluntary actions.

The Governor's Council on Climate Change (GC3) examined the effectiveness of existing policies and regulations designed to reduce greenhouse gas emissions and identified new strategies to ensure the state meets it's statutory targets. The Council submitted its recommendations on December 18, 2018 when it released the report Building a Low Carbon Future for Connecticut: Achieving a 45% GHG Reduction by 2030.

The recommendations in the report build upon the successful policies and measures the State has implemented to date, proposes strengthening existing programs, and recommends pursuing new strategies to ensure Connecticut is on a sustainable path to reach its mid- and long-term GHG emission- reduction targets. The recommendations underscore that there is no single solution, instead, they offer a balanced mix of strategies that allow for flexibility and mid-course adjustments as technologies improve and costs change over time. Moreover, the recommendations outlined in the report are guided by the following key conclusions which emerged from the analysis of reduction pathways and include:

Beneficial Electrification: To achieve deep decarbonization across all sectors, electrification of energy end uses is essential. This will require shifting away from utilizing fossil fuels to power transportation and building thermal loads to electric technologies that have no direct emissions. Widespread deployment of electric technologies such as electric vehicles and heat pumps will be a primary means to achieve deep economy-wide reductions.

Zero-Carbon Electricity Generation: As Connecticut moves to electrify energy end uses, it will see increased demand in electricity and a simultaneous shifting of emissions away from the building and transportation sectors to the electric sector. While electricity generation has become increasingly cleaner over the past 15 years, we will need to continue to decarbonize the electric grid – achieving 84 percent carbon-free electric generation by 2050.

Energy Efficiency: Cost-effective energy efficiency measures are essential in the early years to drive down energy consumption and GHG emissions from fossil fuels. However, in the long term, as the electric-grid decarbonizes, the marginal impact of efficiency leads to less potent reductions in carbon emissions. Nevertheless, in the long run energy efficiency measures will help reduce the extent of increased electricity demand and avoid the costs of developing unnecessary generation and transmission/ distribution capacity.

Scale and Pace of Change: The scale and pace of change needed to achieve Connecticut's emission- reduction targets require immediate and consistent action. Moreover, action across all sectors of the economy is necessary, in part because of interactive effects between them.

Economic Impacts: Meeting Connecticut's near- and long-term GHG emission reduction targets will have a small net positive economic impact.

Legislators, state agencies, municipalities, businesses, non-profit organizations, and residents must work together if Connecticut is to meet its emission-reduction goals. Legislative support is necessary to research, draft, and enact policy that places the State on a downward trajectory. State agencies will be responsible for establishing the proper regulatory framework and programs to enforce the State's environmental policy agenda. Home rule enables municipalities to lead by example in: adopting modern, efficient, and sustainable

building codes; transitioning their vehicle fleets to zero-emission vehicles; and sharing resources to help residents and businesses achieve energy savings and emission reductions. Businesses can advance climate leadership by investing in renewable energy, deploying low-carbon technologies, sustainably sourcing resources, and developing transformative solutions. Non-profit organizations can contribute to policymaking processes by advocating for equitable outcomes. Connecticut's residents will be critical to adopting the technologies and behaviors necessary to reduce emissions and supporting progressive climate action.

The strategies and suite of recommendations presented in the report serve as foundational steps to put Connecticut on track to actualize these objectives. Additional actions, beyond those proposed in the report, will need to be regularly evaluated and integrated into state and local planning efforts and acted upon by public and private entities alike.