2015 Connecticut Greenhouse Gas Emissions Inventory

This summary provides an overview of the state's greenhouse gas (GHG) emissions from 1990 to 2015, the most recent year for which full data are available.[1] Electric sector 2016 emissions data is also reported. 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 2050.[2,3]

Mid-term GHG Reduction Target

As directed in Excutive Order 46, the Governor's Council on Climate Change (GC3) conducted a thorough analysis of mitigation scenarios to reduce state-wide GHG emission and made a recommendation to set a mid-term reduction target of 45 percent below 2001 levels by 2030.

The GC3's mid-term reduction target recommendation was adopted by the Connecticut General Assembly when it passed An Act Concerning Climate Change Planning and Resiliency (Public Act 18-82). The consensus 2030 target was signed into law by Governor Malloy on June 20, 2018.

Inventory Methodology

A federal standard for economy-wide GHG accounting does not currently exist. In the absence of a federal standard, Connecticut 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, Connecticut relies heavily on the U.S. Environmental Protection Agency's 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 CT), including energy-related data provided by the Energy Information Administration. EPA recommends that states employ their own data when these are likely to be more reliable than the tool's default figures. CT's inventory uses SIT default data, with three exceptions. First, beginning with the 2013 inventory, CT has drawn on solid-waste data collected by the Department of Energy and Environmental Protection's municipal waste program. Second, because SIT data on land use, land use change, and forestry appear unreliable, they have not been included in the state's recent inventories. The state aims to develop an alternative means to estimate GHG impacts of land use and forestry for use in preparing future inventories. Third, this analysis continues to present both a consumption and generation based accounting approach for the electricity sector.

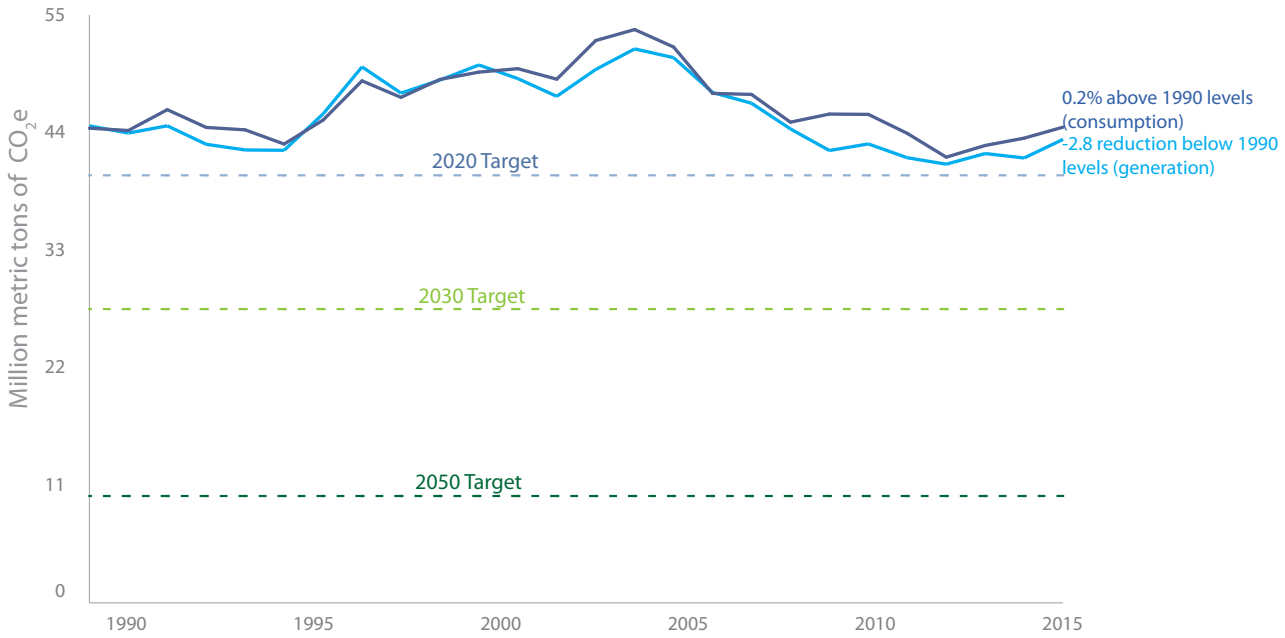
Based on best practices among states reporting state-wide GHG emissions, and reflecting the regional nature of the electric grid, the consumption-based accounting for the electric power sector was first applied in the 2013 inventory analysis. In prior GHG inventories, emissions from the electric power sector had been based

1 The Department of Energy and Environmental Protection (DEEP) greenhouse gas inventory relies in part on emissions data from U.S. EPA's

2 Public Act 08-98, An Act Concerning Connecticut Global Warming Solutions, https://www.cga.ct.gov/2008/ACT/PA/2008PA-00098-R00HB-05600-PA.htm

3 Public Act 18-82, An Act Concerning Climate change Planning and Resiliency, https://www.cga.ct.gov/asp/cgabillstatus/cgabillstatus.asp?selBillType=Bill&which_year=2018&bill_num=7

Connecticut Statewide Greenhouse Gas Emissions 1990-2015
Comparison of Electricty Sector Generation and Consumption-based Accounting



* Targets shown in this graph utilize the consumption-based approach 1990 baseline of 44.4 $MMTCO_2e$. The generation-based approach 1990 baseline is 44.6 $MMTCO_2e$.

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.

2015 GHG Emissions

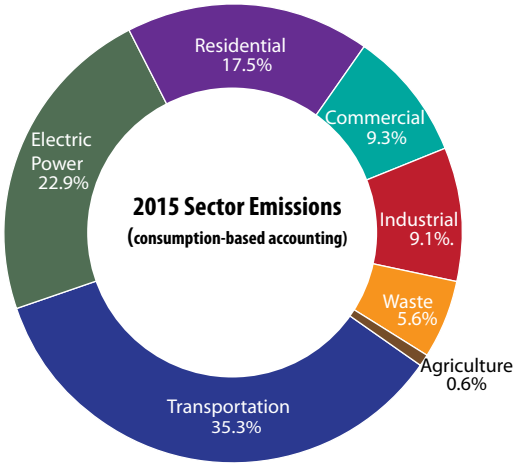
Using the consumption-based accounting approach for electricity, Connecticut's economy-wide GHG emissions in 2015 were 44.5 million metric tons (MMT) of carbon dioxide equivalent (CO_2e), 0.2 percent above 1990 levels and 10.9 percent below 2001 levels.[4] In comparison, emissions using the generation-based accounting approach were 43.4 MMT CO2e, 2.8 percent below 1990 levels and 11.6 percent below 2001 levels (Figure 1).

When compared to 2014, emissions rose by 0.8 MMT. This uptick in GHG emissions is correlated with the extreme winter weather that occurred in 2015. For much of the Northeastern U.S., the months of January-March 2015 were the coldest on record leading to increased energy consumption for heating and natural gas constraints for electricity generation. This susceptibility to weather extremes illustrates the challenges we face in the coming years as we seek to imple-

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	2010	2015
Transportation	15.6	17.8	16.1	15.4
Electric Power				
Consumption	11.9	12.3	12.0	10.2
Generation	12.1	11.4	9.2	9.0
Residential	8.3	8.5	7.7	7.8
Industrial	3.2	4.4	3.9	4.2
Commercial	3.8	4.3	3.4	4.3
Waste	1.3	2.3	2.4	2.5
Agriculture	0.3	0.3	0.3	0.3
Consumption-based Accounting Total	**44.4**	**50.0**	**45.7**	**44.5**
Generation-base Accounting Total	**44.6**	**49.0**	**42.9**	**43.4**
Consumption-based Accounting 0.2% above 1990 levels 11% below 2001 levels				
Generation-based Accounting 3% below 1990 levels 12% below 2001 levels				



ment actions to drive down emissions.

The transportation sector continues to be the single largest source of emissions in the state, contributing 35 percent, principally from the use of fossil fuels in passenger cars and light-duty trucks. These emissions have remained mostly stagnant since 1990, dropping by only 1.5 percent. 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 emissions reductions in the transportation sector. Significantly reducing transportation emissions in the coming decades will require continued improvements in vehicle fuel economy for all class sizes, increased deployment of zero-emission vehicles, and through the utilization of strategies that reduce vehicle miles traveled.

Connecticut's largest reduction since 1990 has occurred in the electric power sector —14.5 percent under consumption-based accounting and 25.4 percent under generation-based accounting. This reduction correlates with state and regional policies and programs that encourage investment in energy efficiency in homes and businesses, a shift from dirtier fossil fuels such as coil 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.

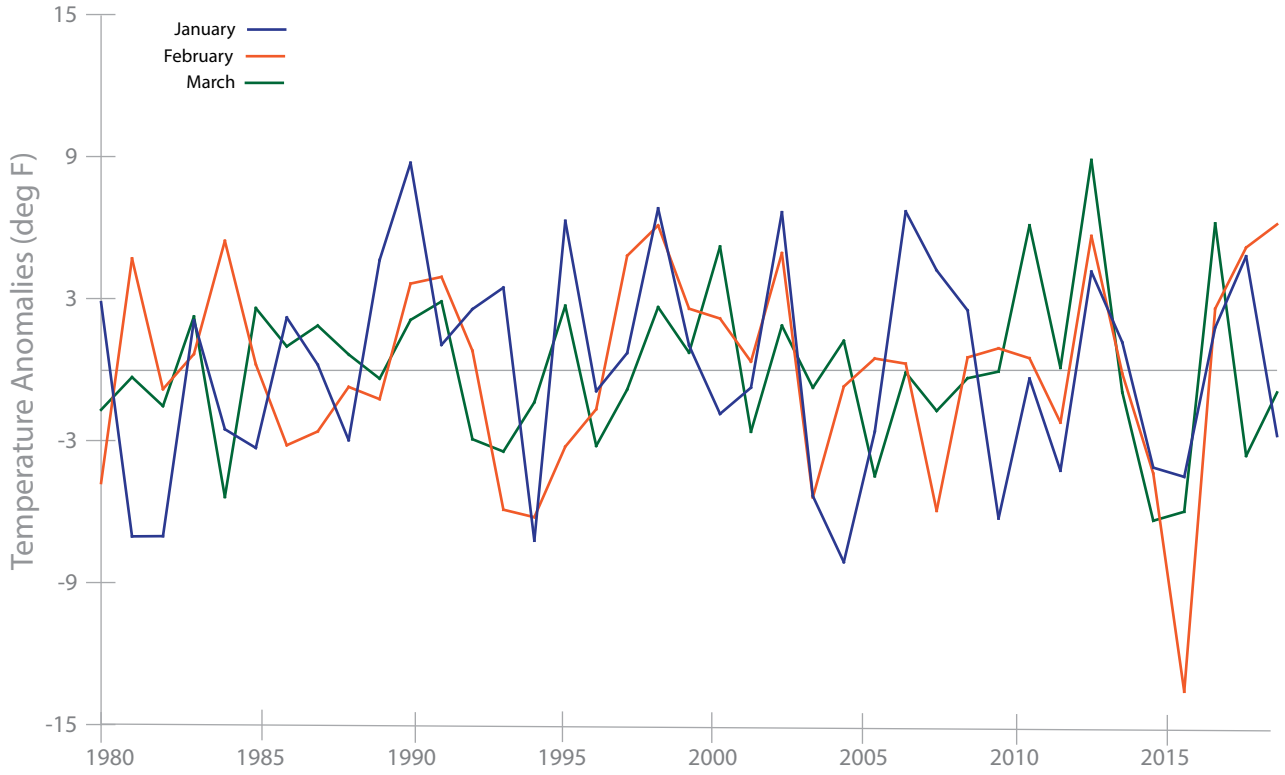
Effects of Extereme Weather Events

January through March 2015 temperatures were well below average (Figure 3). Winter 2015 was one of the coldest on record for much of the Northeast US, particularly February. Record-breaking snow depths were also observed during this winter, but as a whole, monthly precipitation averages were slightly below normal.

In late December and early January, an intense cold front originating along the US west coast, moved across the continent. Temperatures across the Northeast plummeted. This was followed by a "polar vortex" or a stalled/slow moving trough of a Rossby wave over the Northeastern US in mid/late January through mid-February. Typical conditions of a stalled polar vortex are cold and dry with strong winds. During this period, temperatures across the Northeast region were significantly below average. For many cities in Connecticut, this was the coldest February on record, and with a 16.10F average temperature, the state average was record setting as well.

The conditions created by the "polar vortex", and warmer than average Northern Atlantic sea surface temperature from a mild El Nino phase (and subsequently a warm Northern Atlantic Oscillation phase) in the winter of 2014/2015, helped spur 2 large snow events. These low pressure, high moisture systems developed along the east coast and were pulled into the polar vortex, resulting in intense snow storms on January 26-27th and February 14-15th. As these systems moved eastward off the coast, days following the snow storms were anomalously cold.

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/).

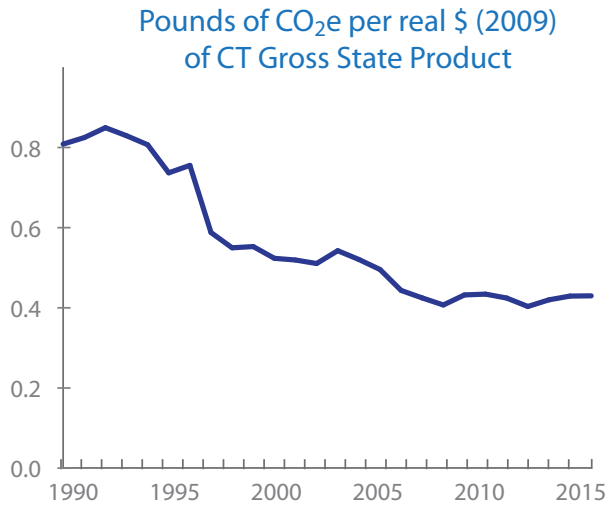
For Connecticut over 78% of energy demand is met through use of natural gas, and demand for natural gas is highest when the weather is coldest. According to ISO-NE in mid/late February 2015, demand in the Northeast was the highest in recorded history. In the ISO-NE region, over 50% of the electricity generated is from natural gas-fueled resources. When demand is high, residential thermal customers are guaranteed natural gas supply, but there is little left in the pipeline for electric generation needs. To ensure electric reliability, GHG intensive oil and coal electric generating units are called upon to satisfy the regions electric needs.

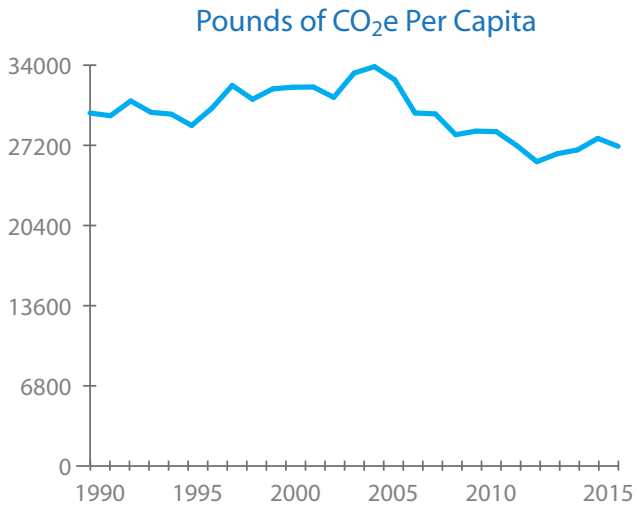
The lowest monthly percentages of natural-gas-fired generation in 2015 for New England were in January, February, and March. These are also the months during which coal- and oil-fired generation had a larger contribution. While nuclear and natural gas were the dominant fuels used to produce power in winter 2015, oil and coal resources were a large part of the fuel mix. This was especially true during February, the coldest month.

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). With January-March 2015 being much colder than average, and a larger percentage of GHG intensive fuels used, overall CO_2 emissions for the state of Connecticut (and throughout the New England region) were higher. These type of extreme cold winter events have a significant impact on regional GHG emissions.

Economy and Demographics

Overall trends in the inventory demonstrate that the carbon intensity of Connecticut's economy has declined — falling 60 percent from 1990 to 2015, 0.387 lbsCO_2e/$ (USD 2015, Figure 4). 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 7 percent between 1990 and 2015.





Electric Sector 2016 Emissions

Preliminary data for 2016 show that electric sector emissions are down by almost 9 percent compared to 2015. This decline is largely due to a reduction in overall consumption and warmer winter conditions. According to ISO-NE, in 2016 net energy load and system generation decreased by 2.0% and 2.2%, respectively, and imports into the region were 1% lower than in 2015. Further, 2016 Connecticut winter temperatures were 5-6 degrees Fahrenheit above average.

For 2016, energy consumption and emissions from the electric sector are both down from 2015 values. Since 1990, emission reductions were achieved even when energy consumption has not significantly changed.

GHG Emission Reduction Strategies Currently Underway

Connecticut is implementing a suite of complementary strategies to ensure that the state is on a course to achieve its near-term 2020 reduction goal. The range of GHG reduction actions include direct regulations, monetary and non-monetary incentives, market-based mechanisms, and recognition for voluntary actions.

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

duce emissions beyond 2020.

2017 Comprehensive Energy Strategy

Connecticut will need to continue to scale investments that drive down GHG emissions in order to meet the ambitious requirements of the Global Warming Solutions Act, both in the near- and long-term (2020 and 2050), particularly in light of the updated 2013 Summary showing an uptick in 2013 emissions. The 2016 Comprehensive Energy Strategy will evaluate GHG mitigation options on all of these time horizons, and will emphasize any additional near term strategies that may be needed to ensure compliance with the 2020 goal.

Energy Efficiency

The Connecticut Energy Efficiency Fund supports a variety of programs that provide financial incentives to help Connecticut consumers reduce the amount of energy used in their homes and businesses. Investment in energy efficiency programs has doubled since 2013, implementing a key recommendation of the 2013 Comprehensive Energy Strategy. At this increased level of investment, expected lifetime GHG reductions from the state's energy efficiency programs will be 3.2 $MMTCO_2e$.

Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR)

Through the CHEAPR program, DEEP offers rebates of up to $5,000 for Connecticut residents who purchase or lease a new eligible battery electric, plug-in hybrid electric, or fuel cell electric vehicle. In just over a year's time, these rebates have supported purchases of more than 750 vehicles.[7]

Zero Emission Vehicle (ZEV) Memorandum of Understanding

Connecticut is one of seven states committed to putting 3.3 million ZEVs on the road by 2025. Connecticut is implementing the steps laid out in the Multi-State Action Plan which focuses on developing ZEV infrastructure and supporting policies, codes, and standards to advance the deployment

of ZEVs. With the implementation of the revised travel provision, ZEV sales in Connecticut and other New England states are expected to increase beginning in 2017.[8]

Renewable Portfolio Standard (RPS)

The Malloy Administration has embraced the use of open, competitive procurements of renewables and large-scale hydropower through long-term contracts as the best way to secure investment in new clean generation at the least cost to the state's ratepayers. A new, 20 MW solar facility in Sprague, CT, that was contracted under Section 6 of Public Act 13-303 is expected to come online in January 2017. Currently, DEEP is considering more than 100 bids submitted in two historic RFPs for clean energy projects of different size classes that could be selected for long-term contracts pursuant to Public Acts 13-303 and 15-107. Under those statutes, CT DEEP has the authority to contract for up to 4,250 GWh, or approximately 15% of the state's electricity demand, from clean energy resources. Bid selections are expected in the fall of 2016, and winning projects must be online by 2020.

Rooftop Solar Deployment

The Connecticut Green Bank, established in 2011, has pioneered multiple programs to expand the deployment of rooftop solar photovoltaics (PV) in Connecticut, while driving down installed costs and ratepayer incentives. A program goal of installing 30 MW of rooftop solar PV under the Residential Solar Incentive Program was met in 2015, 8 years early. Public Act 15-194 requires the Connecticut Green Bank to offer incentives to support the deployment of 300 MW of residential solar by 2022. The Green Bank is partnering with the state's electric utilities in the Solar Homes Renewable Energy Credit program to enable purchase of long-term contracts for Renewable Energy Credits produced from a homeowners' solar system, making solar more accessible and affordable to ratepayers throughout the state.

Shared Clean Energy Facilities

Public Act 15-113 requires DEEP to establish a two-year pilot program for shared clean energy facilities, including solar, fuel cells, geothermal, hydroelectric and other renewables. Multiple customers will be able to contract a percentage or set amount of the electricity produced from these facilities. Projects selected in this pilot program must be online by 2019.