2016 Connecticut Greenhouse Gas Emissions Inventory

This summary provides an overview of Connecticut's greenhouse gas (GHG) emissions from 1990 to 2016, 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]

Mid-term GHG Reduction Target

As directed in Executive Order 46, the Governor's Council on Climate Change (GC3) conducted a thorough analysis of mitigation scenarios to reduce state-wide GHG emissions 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 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 inventories. The state 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
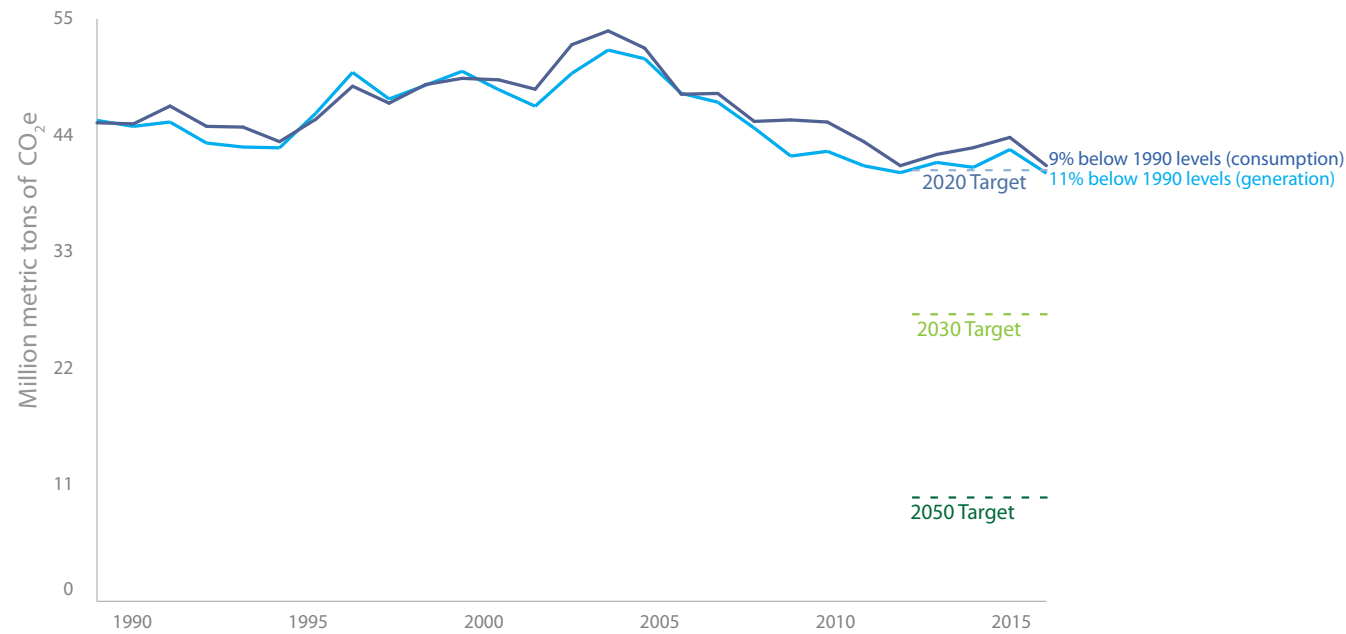
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1 The Department of Energy and Environmental Protection (DEEP) greenhouse gas inventory relies in part on emissions data from U.S. EPA's

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 1990-2016
Comparison of Electricty Sector Generation and Consumption-based Accounting

9% below 1990 levels (consumption)
11% below 1990 levels (generation)
2020 Target

2030 Target

2050 Target

Million metric tons of CO_2e

* 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 45.4 MMT CO_2e.

Connecticut Emissions by Sector (MMTCO$_2$e)

	1990	2001	2015	2016
Transportation	15.6	17.8	15.4	15.5
Electric Power				
Consumption	11.9	12.3	10.2	9.3
Generation	12.1	11.4	9.0	8.6
Residential	8.3	8.5	7.8	6.4
Industrial	3.2	4.4	4.2	3.9
Commercial	3.8	4.3	4.3	3.9
Waste	2.0	1.5	1.86	1.85
Agriculture	0.35	0.33	0.25	0.25
Consumption-based Accounting Total	**45.2**	**50.0**	**43.8**	**41.1**
Generation-base Accounting Total	**45.4**	**49.0**	**43.8**	**40.4**
Consumption-based Accounting **9% below 1990 levels** **16.5% below 2001 levels**				
Generation-based Accounting **11% below 1990 levels** **16.3% below 2001 levels**				

2016 Sector Emissions
(consumption-based accounting)

Residential 15.5%
Commercial 9.5%
Industrial 9.5%.
Waste 4.5%
Agriculture 0.6%
Transportation 38%
Electric Power 23%

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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.
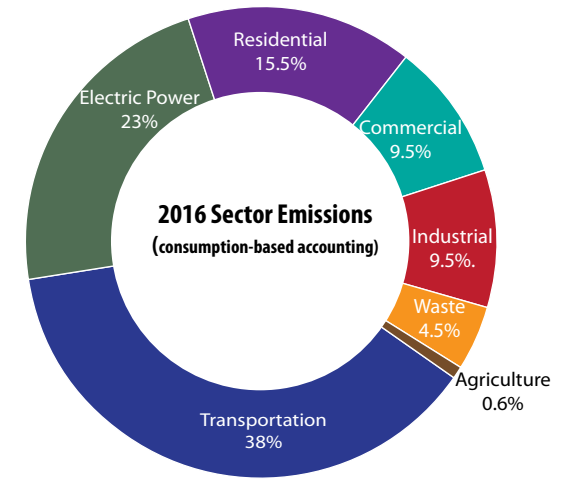
2016 GHG Emissions

Using the consumption-based accounting approach for electricity, **Connecticut's economy-wide GHG emissions in 2016 were 41 million metric tons (MMT) of carbon dioxide equivalent (CO$_2$e), 9 percent below 1990 levels and 16 percent below 2001 levels**.[4] In comparison, emissions using the generation-based accounting approach were 40 MMT CO$_2$e, 11 percent below 1990 levels and 16 percent below 2001 levels.

Relative to 2015, emissions in 2016 dropped by almost 3 MMT CO$_2$e. This decline is largely due to reductions in overall energy consumption and an extreme temperature difference between 2015 and 2016 — in Connecticut, winter 2016 temperatures were 5-6°F above average, whereas, across much of the Northeast, the months of January-March 2015 were the coldest on record, leading to increased

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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.

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energy consumption for heating and natural gas constraints for electricity generation. This susceptibility to weather extremes illustrates the challenge the state faces in the coming years as it seeks to implement actions that drive emissions downward.

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 0.3 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.

Connecticut's largest reduction has occurred in the electric sector — down 22 percent from 1990 and 24.7 percent from 2001. 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 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.
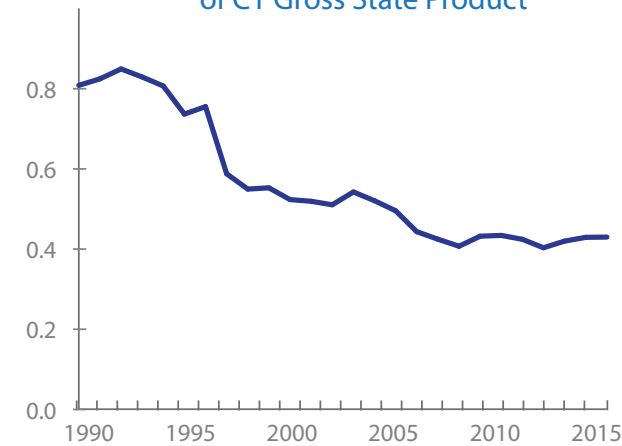
Effects of Extreme Weather Events

Temperatures from January through March 2016 were well above average. The warm winter resulted in less fuel consumption for thermal use in both the commercial and residential sectors— commercial and residential sector emissions were 3.9 and 6.4 MMT, respectively. In contrast, winter 2015 was one of the coldest on record for much of the Northeast, particularly February. 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-to-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 16.1°F average temperature, the state average was record setting as well.
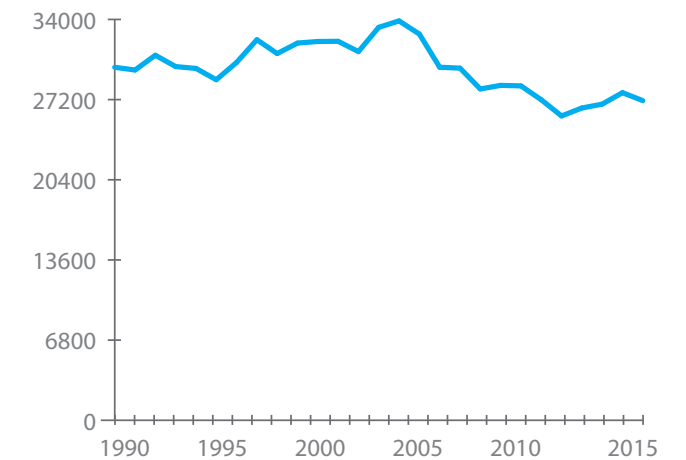
In the ISO-NE region, over 50% of electricity generation is from natural gas-fueled resources. During extreme cold winter events, demand for natural gas to meet heating needs is high. As a result, this leaves very little to no natural gas pipeline capacity for electric generators. To ensure electric reliability, GHG intensive oil and coal electric generating units are called upon 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

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

January
February
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/).

Pounds of CO_2e per real \$ (2009) of CT Gross State Product

of GHG intensive fuels are used, overall carbon emissions for the New England region will be higher. Extreme winter events have a significant impact on regional GHG emissions in both the electric and building sectors. Ramping up measures such as building envelop improvements for the commercial and residential buildings will help to ensure Connecticut achieves its ambitious reduction targets.

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 2016, 0.39 pounds of CO_2e per dollar (USD 2009). 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 16 percent between 1990 and 2016.

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 mandatory GHG

Pounds of CO_2e Per Capita

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 following programs, strategies, and policy initiatives are just a few examples of current efforts driving down the state's emissions. These initiatives offer a foundational framework to build upon as additional strategies are developed to meet the State's 2030 and 2050 targets.

2018 Comprehensive Energy Strategy

The 2018 Comprehensive Energy Strategy made recommendations on eight key strategies aimed at reducing emissions across all sectors, reducing the cost of energy for all consumers in Connecticut, and improving energy security and reliability. These recommendations included: ensuring sustainable funding for energy efficiency; increasing the amount of energy generated from zero carbon resources; reducing transportation emissions by accelerating the adoption of zero-emissions vehicles; and modernizing the grid to enable integration of distributed energy resources.
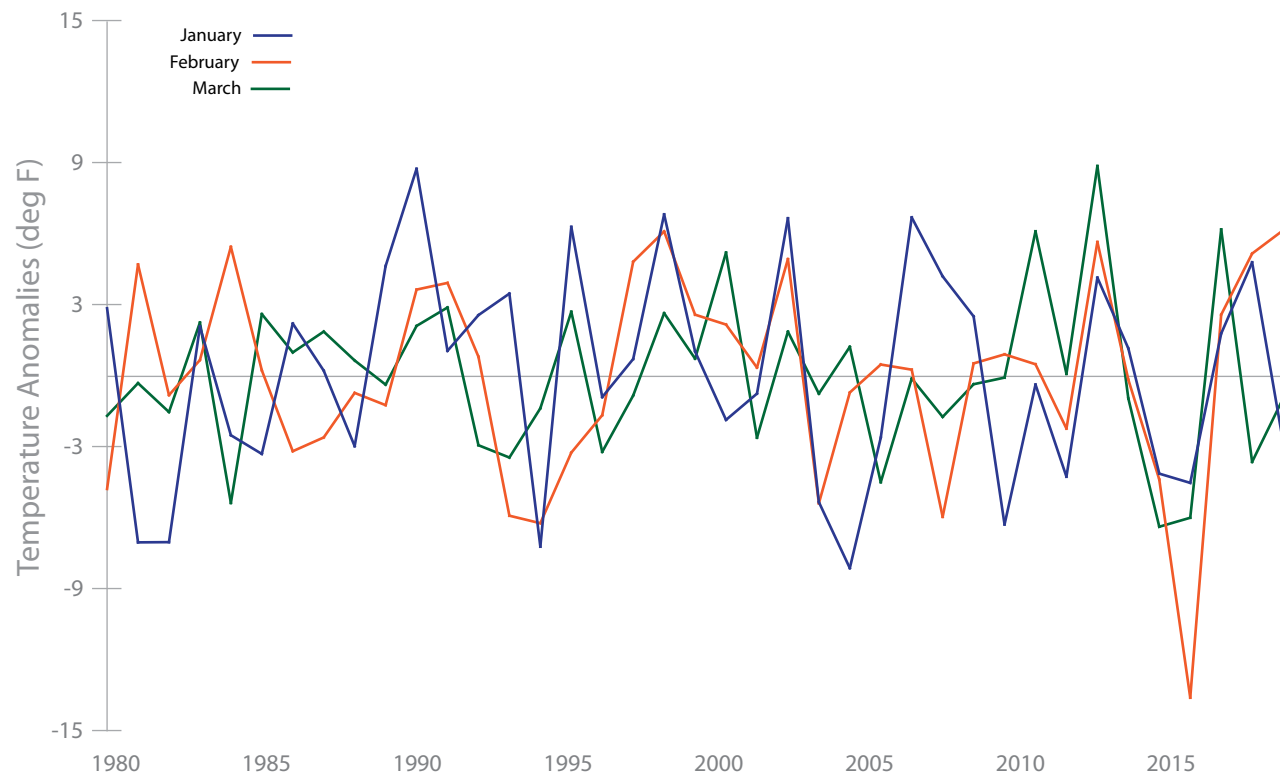
Regional Greenhouse Gas Initiative (RGGI)

In partnership with the other New England states, Delaware, Maryland and New York. RGGI is the nation's first market-based, regulatory cap-and-invest program to reduce greenhouse gas emissions from large fossil fueled power plants. Collectively, the RGGI states have cut carbon pollution from the power sector 45 percent since 2005, while at the same time the region's per-capita GDP has continued to grow. From 2008-2017, Connecticut has received a total of $187 million in proceeds from RGGI auctions. More than 90 percent of these proceeds are invested in energy efficiency projects and clean and renewable energy programs that are harnessing market forces and competition to scale clean energy deployment and increase energy efficiency at the lowest cost. Connecticut's proceed investments during 2017 alone are expected to achieve a lifetime benefit of 95,000 tons of avoided CO_2 and nearly $31.5 million energy bill savings.

Energy Efficiency

Energy efficiency investments are forecasted growth in overall energy demand and in peak demand, while increasing the productivity of Connecticut's businesses. The utility administrated Conservation and Load Management (C&LM) Plan plays a vital role in reducing emissions and increasing economic activity in the state. Every $1 invested in businesses and homes in Connecticut through utility-administered energy efficiency programs generates $7 into the Connecticut Economy. The energy efficiency investments made in 2017 are estimated to increase the Gross State Product by approximately $1.4 billion. This continued return on investment demonstrates that energy efficiency programs are a powerful economic catalyst: they reduce customer costs, generate jobs, and make the state's businesses more competitive.

The lifetime energy savings achieved through C&LM programs in 2017 resulted in 4.2 billion kilowatt hours reduced; 97.8 million CCF (centum cubic feet) of natural gas saved; 29.3 million gallons of fuel oil and propane reduced; and avoided annual emissions of 236,789 tons of CO_2 (2.8 million tons of CO_2 over their lifetime).

Renewable Portfolio Standard (RPS)

In June 2018, Governor Malloy signed *An Act Concerning Connecticut's Energy Future* into law, expanding the RPS from 20 percent class I renewable sources by 2020 to 40 percent class I aources by 2030. To ensure the state meets its ambitious RPS targets, Connecticut has launched new initiatives that harness market forces to boost the supply of low-cost, in-state renewables. Small-scale (up to 1-2 megawatts) renewable distributed generation projects can compete for long-term power purchase agreements that Connecticut's electric distribution companies are required to offer through reverse auctions. These projects support local economic development and also reduce local electricity consumption.

Competitive Regional Procurements for Grid-Scale Clean Energy

Connecticut 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. In 2016, the Connecticut Department of Energy and Environmental Protection (DEEP) selected, and the Public Utilities Regulatory Authority approved, large scale clean energy resources totaling over 400 MW shared with Massachusetts and Rhode Island and smaller scale clean energy resources, including an energy efficiency proposal, for over 400 MW for long-term contracts pursuant to Public Acts 13-303 and 15-107. Under those statutes, DEEP has the authority to contract for up to 4,250 gigawatt hours, or approximately 15 percent of the state's electricity demand, from clean energy resources. And in 2018, DEEP selected over 250 MW of additional clean energy projects, including 200 MWs of offshore wind.

Lead by Example

As part of a broader effort to model environmentally preferable practices, since 2013, the inter-agency team of DEEP, the Department of Administrative Services, the Attorney General's Office, the Office of the Treasurer, the Office of Policy and Management, the Connecticut Green Bank, the utility companies, and others, have advanced the "Lead by Example" energy management programs, including customized initiatives and financing mechanisms to reduce energy use in state buildings. DEEP has developed an implementation pathway to reduce energy costs from state buildings by collecting, analyzing, and benchmarking energy consumption, conducting investment grade energy audits to identify energy saving opportunities, and pursuing financing mechanisms for implementing energy efficiency measures across all state agencies

Shared Clean Energy Facilities

In 2015, the General Assembly authorized development of a pilot program to develop up to 6 MW of community clean energy statewide to increase access to renewables for customers who cannot participate in rooftop solar. In June 2017, DEEP selected three projects to participate in the pilot program at a direct cost that is cheaper than rooftop solar. The projects are expected to come online before 2020. In addition to this, *An Act Concerning Connecticut's Energy Future* provided authorization to procure up to 25 MW per year from shared clean energy facilities with a particular emphasis on reaching low- to- moderate-income customers.

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. Between 2014 and 2017 electric vehicle registration have risen 181 percent.

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.

The Connecticut Green Bank

Established in 2011, the CT Green Bank has pioneered multiple programs to expand the deployment of rooftop solar photovoltaics (PV) in Connecticut, while driving down installed costs and ratepayer incentives. The CT Green Bank has employed its model of leveraging limited state funding to attract private capital and investment in clean energy to ramp up the deployment of renewables and energy efficiency throughout Connecticut. Public Act 15-194 requires the CT Green Bank to offer incentives to support the deployment of 300 MW of residential solar by 2022. The CT Green Bank is partnering with the state's electric utilities in the Solar Homes Renewable Energy Credit (SHREC) program to enable purchase

long-term contracts for Renewable Energy Credits produced from a homeowner's solar systems, making solar more accessible and affordable to ratepayers throughout the state. In addition to this the CT Green Bank's Commercial Property Assessed Clean Energy (C-PACE) is an innovative program that is helping commercial, industrial and multi-family property owners access affordable, long-term financing for smart energy upgrades to their buildings. C-PACE allows building owners to finance qualifying energy efficiency and clean energy improvements through a voluntary assessment on their property tax bill. Property owners pay for the improvements over time through this additional charge on their property tax bill, and the repayment obligation transfers automatically to the next owner if the property is sold. Capital provided under the C-PACE program is secured by a lien on the property, so low-interest capital can be raised from the private sector.