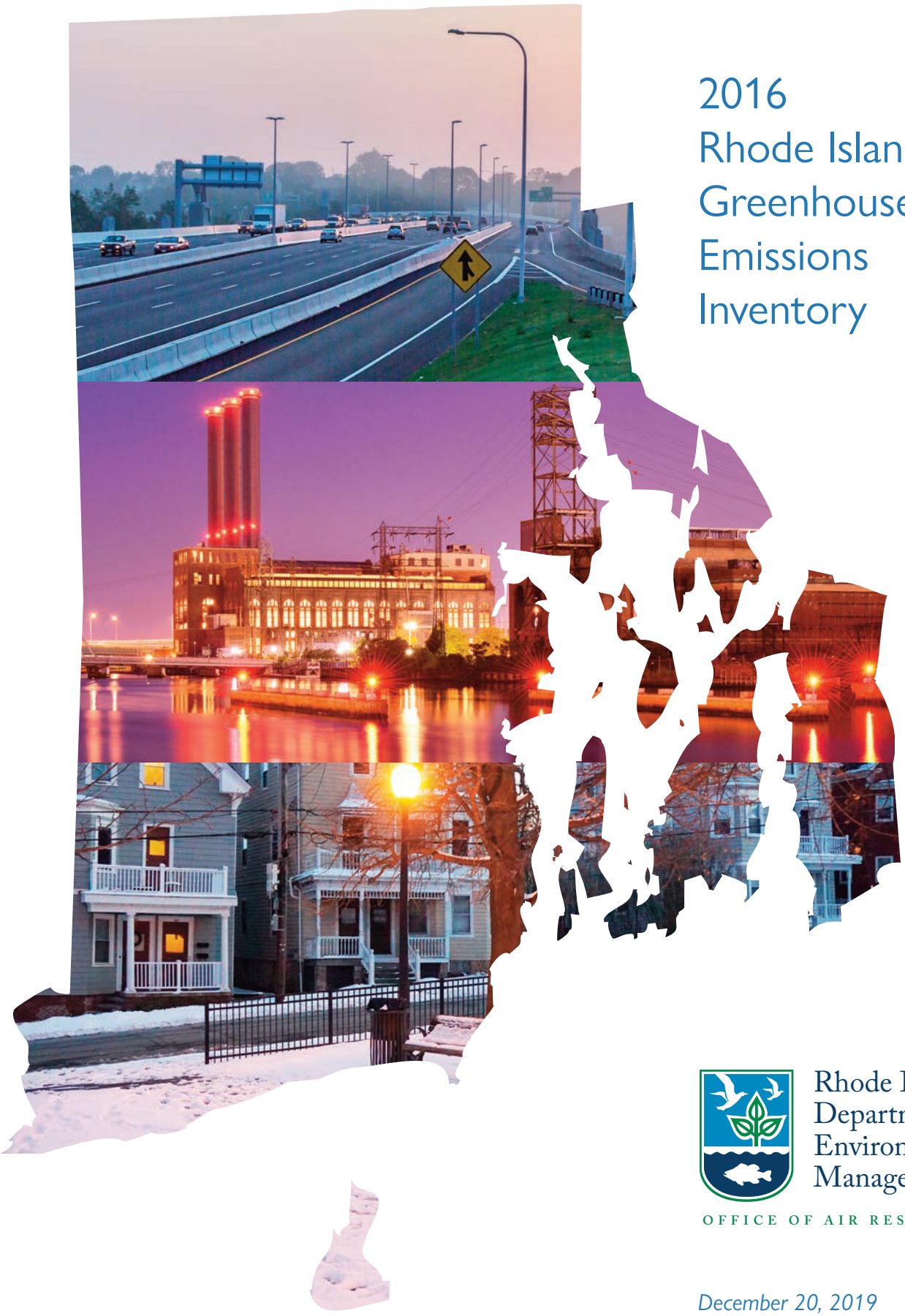

2016 Rhode Island Greenhouse Gas Emissions Inventory

Rhode Island Department of Environmental Management

OFFICE OF AIR RESOURCES

December 20, 2019

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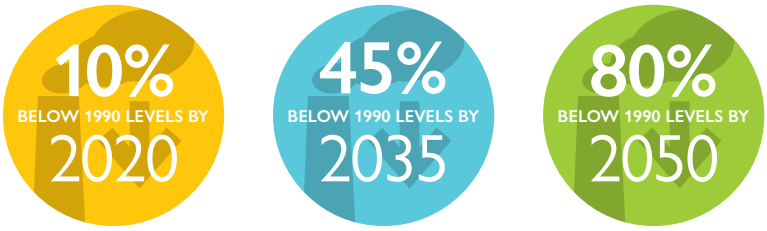
Executive Summary

Increasing atmospheric concentration of greenhouse gases (GHG) caused by emissions from human activities is leading to global climate change. To understand Rhode Island's contribution to climate change we must understand the contributions of Rhode Island and Rhode Islanders to global emissions of greenhouse gases. This update provides an overview of Rhode Island GHG emissions from 1990 to 2016, the most recent year for which full data are available.[1] The statewide GHG emissions inventory is an important tool for tracking Rhode Island's progress towards the targets set by the 2014 Resilient Rhode Island Act.[2]

In accordance with the provisions of the Rhode Island Generals Laws §42-6.2-2(2), the Rhode Island Executive Coordinating Council (EC4) produced the "EC4 Greenhouse Gas Emissions Reduction Plan" in December 2016. The plan included strategies, programs, and actions to meet the targets for GHG emissions reduction as established in the Resilient Rhode Island Act.

2014 Resilient Rhode Island Act GHG Emissions Reduction Targets



Per the statute, the EC4 provided the following recommendations for state agencies to monitor progress on an ongoing basis:[3]

1. Monitor progress using a triennial schedule of GHG reductions based on the Resilient Rhode Island GHG targets.
2. DEM will develop a triennial GHG emissions inventory for Rhode Island and report on progress towards meeting Resilient Rhode Island GHG targets.
3. DEM will evaluate the possibility of meeting higher targets through cost-effective measures in the triennial report.

The information in this update provides a comprehensive view of GHG emissions in Rhode Island. It can be used to evaluate Rhode Island's GHG emissions, discuss where the emissions are coming from, and determine whether they are increasing or decreasing over time. External factor analysis (i.e. fuel prices, population, economics, etc.) that impact GHG emissions are excluded from this update.

Key Findings:

- Achieved 2020 GHG Emissions Reduction Target.
- Rhode Island's 2016 total GHG emissions were 11.02 million metric tons carbon dioxide equivalent ($MMTCO_2e$).
- Rhode Island's 2016 total emissions have decreased 1.46 $MMTCO_2e$ (-11.67%) from the 1990 baseline of 12.48 $MMTCO_2e$.
- In 2016, Rhode Island's largest contributors of GHG emissions by sector:
  - Transportation at 36%
  - Electricity Consumption at 26%
  - Residential Heating at 17%

[1] The Rhode Island Department of Environmental Management (RIDEM) greenhouse gas inventory relies in part on U.S. EPA State Inventory Tool (SIT), 2016-year full data available.
[2] For additional information, go to: http://StateofRhodeIslandResilientRhodeIslandAct
[3] For additional information, go to: http://climatechange.ri.gov/ec4GHGReductionPlan2016

Working Towards GHG Reduction

Greenhouse gases (GHG) trap heat in the atmosphere causing a temperature increase known as global warming. The most common GHGs are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. GHGs primarily from fossil fuel combustion create a multitude of problems ranging from a decrease in air quality to an increase in extreme weather events. A GHG inventory provides an estimate of statewide GHG emissions and trends from which strategies and policies can be developed to reduce these emissions. The Resilient Rhode Island Act (2014) created reduction targets and established a council to assess climate change impacts in Rhode Island. The Executive Climate Change Coordinating Council (EC4) discusses climate issues in Rhode Island and develops strategies to address undesired impacts.

The Inventory Process

Like many other states that regularly preform economy-wide GHG emissions inventories, Rhode Island relies heavily on the U.S. Environmental Protection Agency's State Inventory Tool (SIT).[4] The tool is an interactive top-down spreadsheet model designed to help states develop GHG emissions inventories.

The SIT consists of 11 modules which calculate sector-by-sector GHG emissions based on numerous state-level data sets, including energy-related data provided by the U.S. Energy Information Administration (EIA). The U.S. Environmental Protection Agency (EPA) recommends that states employ their own data when these are likely to be more robust than the tool's default data.

The SIT estimates GHG emissions by applying pollutant-specific emission factors to Rhode Island activity data. EPA updates the SIT annually with the latest activity data. If needed, any updates to emission factors and/or Global Warming Potentials (GWP) are made as well.

Global Warming Potentials (GWP)
Allows for comparisons of the global warming impact of different gases. Specifically, it is a measure of how much energy the emissions of 1 ton of gas will absorb over a given period of time, relative to the emissions of 1 tons of carbon dioxide (CO_2).

Emissions Factor
An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.

Source: United States Environmental Protection Agency

GHG emissions are typically converted to a unit of measure called carbon dioxide equivalent (CO_2e) based on their GWP that allows for better comparison of the impact of different GHGs. These conversions are completed within the SIT. For this 2016 GHG emissions inventory, the SIT uses the GWPs from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). Table 1 below illustrates the differences in GWP of different gases between the AR4 and the IPCC's Second Assessment Report (used in RI's initial 1990 & 2010 GHG Inventories).[5]

Table 1: Global Warming Potential Factors for Greenhouse Gases

Greenhouse Gases (100 YR)	Global Warming Potential (SAR)	Global Warming Potential (AR4)
Carbon dioxide (CO_2)	1	1
Methane (CH_4)	21	25
Nitrous oxide (N_2O)	310	298
Hydrofluorocarbons (HFCs)	140-11,700	12-14,800
Perfluorocarbons (PFCs)	6,500-9,200	7,390-12,200
Sulfur hexafluoride (SF_6)	23,900	22,800

[4] For additional information, go to: **https://www.epa.gov/StateInventoryProjectionTool**
[5] For additional information, go to: **https://www.ipcc.ch/reports/**

In 2013, the Northeast States for Coordinated Air Use Management (NESCAUM) conducted the first GHG emissions inventory to determine a 1990 baseline and 2010 emissions inventory. The 1990 baseline and 2010 emissions totals used in this inventory came from the 2016 GHG Reduction Plan (see pages 51 and 52 for detailed information). Since then, the Office of Air Resources has completed a GHG emissions inventory annually. As mentioned above, the SIT is preloaded with default data or States can input more state-specific data if available. As Table 2 shows, RIDEM has completed inventories for years 2011-2016. However, inventory years 2011, 2012, and 2015 were default runs. In other words, the emissions for these three years were estimated using primarily default data in the SIT. Inventory years 2013, 2014 and 2016 were non-default runs. In these years, state-specific data was utilized to obtain the most robust emissions estimates. In addition, for all years (2011-2016), RIDEM chose to use reported data to EPA's Facility Level Information on Greenhouse gases Tool (FLIGHT) for two sectors: emissions from natural gas distribution and solid waste. For the natural gas distribution sector, the SIT does not contain certain values needed to estimate emissions and National Grid reports its emissions from natural gas distribution in Rhode Island directly to EPA. The report includes emissions associated with distribution mains, services, and metering regulated stations. The SIT apportions national data as well as makes certain assumptions based on landfills in general, therefore, RIDEM chose to use the emission reported by the RI Resource Recovery Corporation for the Central Landfill for the solid waste sector in lieu of the SIT. The Land Use, Land Use Change and Forestry (LULUCF) sector has not been estimated in this update or any recent inventory. The SIT has been unreliable for estimating emissions and/or sequestration of emissions for this sector and no alternative methodology has been developed. When a reliable methodology becomes available, RIDEM anticipates including the LULUCF sector in future inventories.

Table 2: Rhode Island Total Annual GHG Emissions ($MMTCO_2e$)

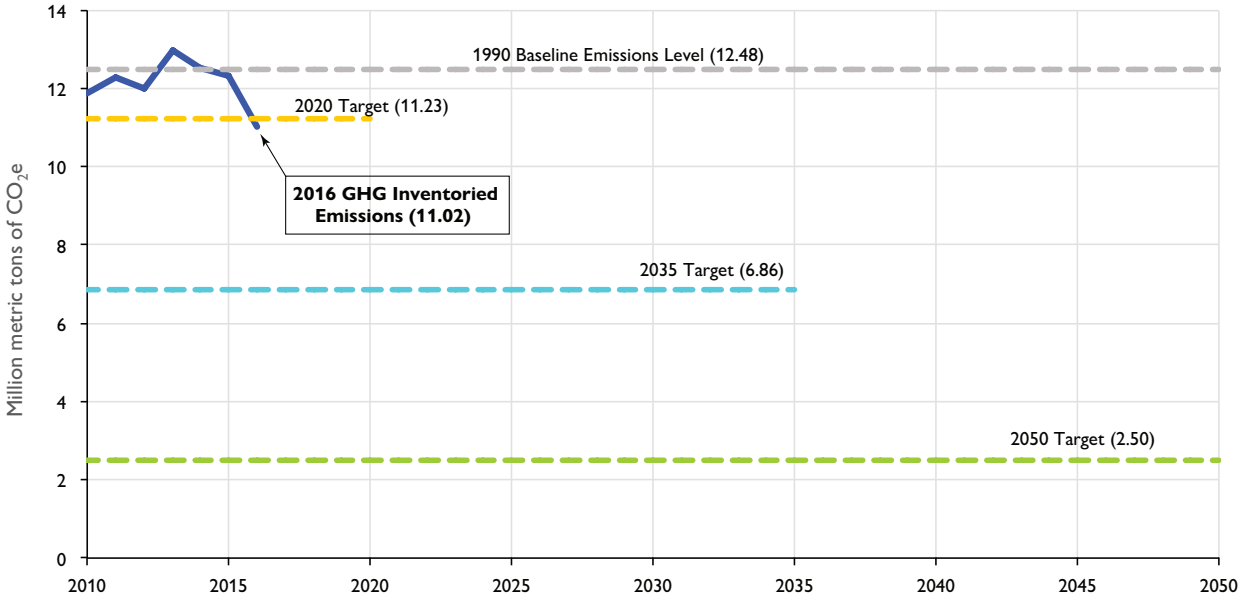
Rhode Island Greenhouse Gas Emissions Inventory								
	1990	2010	2011	2012	2013	2014	2015	2016
Model Run Type (Default or Non-Default)	Non-Default	Non-Default	Default	Default	Non-Default	Non-Default	Default	Non-Default
Energy	**3.12**	**2.44**	**3.53**	**3.53**	**3.69**	**3.42**	**3.37**	**3.00**
Electricity Consumption	*2.82*	*2.29*	*3.38*	*3.38*	*3.52*	*3.25*	*3.21*	*2.84*
Natural Gas Distribution	*0.30*	*0.15*	*0.15*	*0.15*	*0.17*	*0.17*	*0.16*	*0.15*
Residential Heating	**2.37**	**2.24**	**2.15**	**2.08**	**2.27**	**2.34**	**2.46**	**1.84**
Commercial Heating	**1.15**	**0.92**	**0.87**	**0.79**	**0.91**	**1.13**	**1.00**	**0.86**
Transportation	**4.97**	**4.79**	**4.40**	**4.19**	**4.59**	**4.25**	**4.09**	**3.94**
Aviation	*0.33*	*0.27*	*0.31*	*0.29*	*0.29*	*0.30*	*0.28*	*0.30*
Highway Vehicles	*4.37*	*3.70*	*3.76*	*3.61*	*4.09*	*3.62*	*3.66*	*3.62*
Nonroad Sources	*0.24*	*0.33*	*0.31*	*0.27*	*0.19*	*0.30*	*0.12*	*0.00*
Lubricants	*0.03*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*	*0.02*
Industrial	**0.81**	**1.04**	**1.06**	**1.05**	**1.24**	**1.14**	**1.12**	**1.14**
Industrial Heating	*0.71*	*0.61*	*0.56*	*0.54*	*0.67*	*0.57*	*0.59*	*0.61*
Industrial Processes	*0.09*	*0.43*	*0.50*	*0.51*	*0.56*	*0.57*	*0.53*	*0.53*
Agriculture	**0.04**	**0.02**	**0.05**	**0.04**	**0.03**	**0.05**	**0.05**	**0.04**
Waste	**0.31**	**0.47**	**0.22**	**0.33**	**0.25**	**0.21**	**0.22**	**0.20**
Solid Waste	*0.23*	*0.39*	*0.11*	*0.21*	*0.15*	*0.10*	*0.10*	*0.09*
Wastewater	*0.08*	*0.08*	*0.11*	*0.11*	*0.11*	*0.11*	*0.12*	*0.11*
Land Use, Land Use Change, and Forestry (LULUCF)	**-0.29**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
TOTAL (Million Metric Tons $MMTCO_2e$)	**12.48***	**11.86***	**12.28**	**12.01**	**12.98**	**12.54**	**12.31**	**11.02**

*1990 & 2010 Data has been adjusted as done in the Rhode Island Greenhouse Gas Reduction Plan, December 2016. http://climatechange.ri.gov/documents/ec4-ghg-emissions-reduction-plan-final-draft-2016-12-29-clean.pdf

2016 Statewide GHG Emissions Inventory Results

In 2016, total Rhode Island GHG emissions were 11.02 million metric tons carbon dioxide equivalent ($MMTCO_2e$) as shown in Table 2 and Figure 1. This is a decrease of 1.46 $MMTCO_2e$ (11.7%) from the 1990 baseline of 12.48 $MMTCO_2e$. As seen in Figure 1 below, the 2016 GHG emissions are below the 2020 GHG target of 11.23 $MMTCO_2e$.

Figure 1: Rhode Island 2016 GHG Emissions and Reduction Targets



Detailed information on the inventory process can be found in each major sector highlighted specifically, the transportation, electricity consumption and residential heating sectors within this update.

2016 GHG Emissions Inventory Results by Sector

The majority of GHG emissions in Rhode Island in 2016 were from the transportation sector (36%), followed by emissions from the electricity consumption sector (26%), and residential heating sector (17%) as shown in Figure 2. The "other" category includes agriculture, waste and natural gas distribution.

Figure 2: 2016 GHG Emissions by Sector

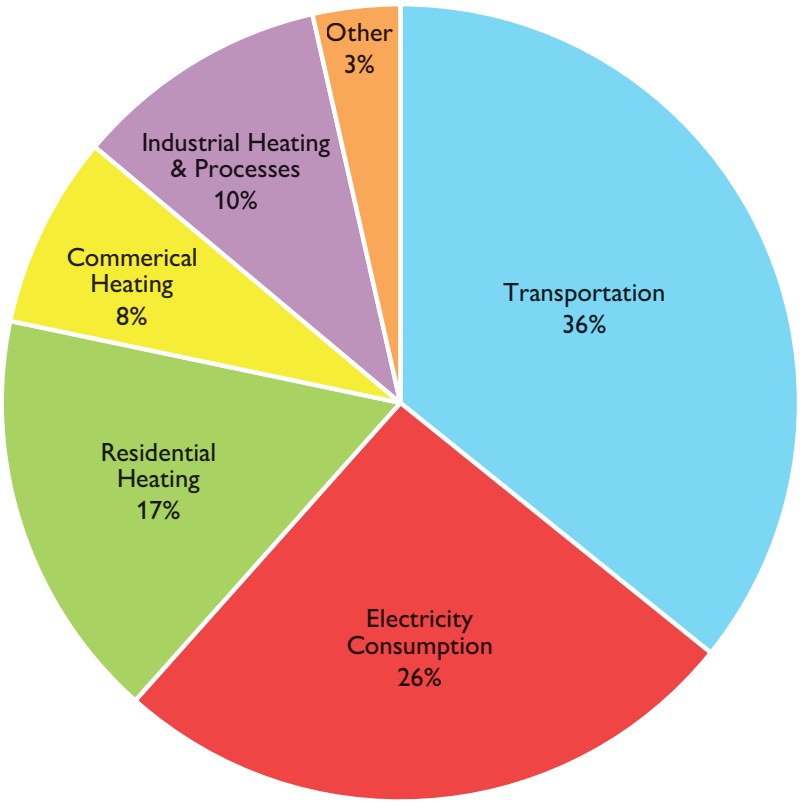


Table 3 below compares the change in sectors from the baseline year 1990 and 2016. Both the electricity consumption and industrial heating & processes sectors have trended upward from 1990. Emissions from the industrial sector have increased approximately 41% from 1990 to 2016. Although this increase may appear significant, the change between 1990 (0.81 $MMTCO_2e$) and 2016 (1.14 $MMTCO_2e$) is relatively small. The increase in the electricity consumption sector is discussed in further detail within the electricity consumption section.

Table 3: Rhode Island Greenhouse Gas Emissions Changes 1990-2016

Sector	Change in $MMTCO_2e$	Percent Change	Trend
Transportation	-1.03	-20.7%	↓
Electricity Consumption	0.02	0.7%	↑
Residential Heating	-0.53	-22.4%	↓
Industrial Heating & Processes	0.33	40.7%	↑
Commercial Heating	-0.29	-25.2%	↓
Other *(Agriculture, Waste and Natural Gas Distribution)*	-0.26	-40.0%	↓
Total	-1.46	-11.7%	↓

Transportation Sector

Trends

In 2016, the transportation sector continues to be the largest source of GHG emissions in the state, 36%, as seen in Figure 2. GHG emissions from transportation decreased 0.15 $MMTCO_2e$ (3.67%) from the previous year. Most of the GHG emissions are coming from passenger vehicles as seen in Figure 3.

While there has been a 20% reduction in GHG emissions since 1990, further reductions are critical to meeting the State's 2035 and 2050 targets. Much like other Northeast states, vehicle miles traveled (VMT) continues to trend up, as seen in Figure 4.[6] This makes it challenging for the improved fuel efficiencies of modern-day vehicles to affect total transportation GHG emissions. Increased deployment of zero-emission vehicles across all vehicle sizes, but specifically passenger vehicles, will be required to meet RI's targets, as well as a reduction in personal vehicle miles traveled.

Figure 3: 2016 Vehicle Population Breakdown

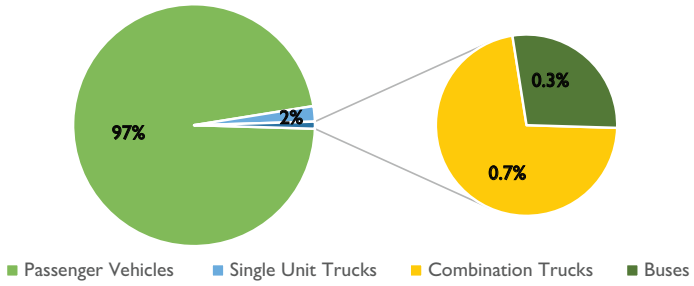
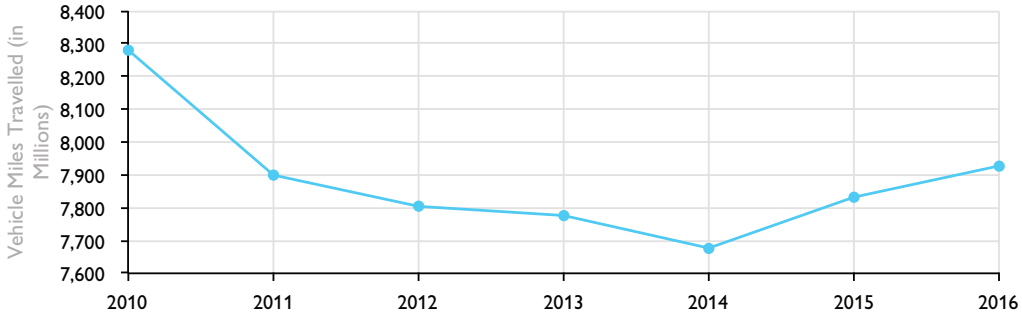
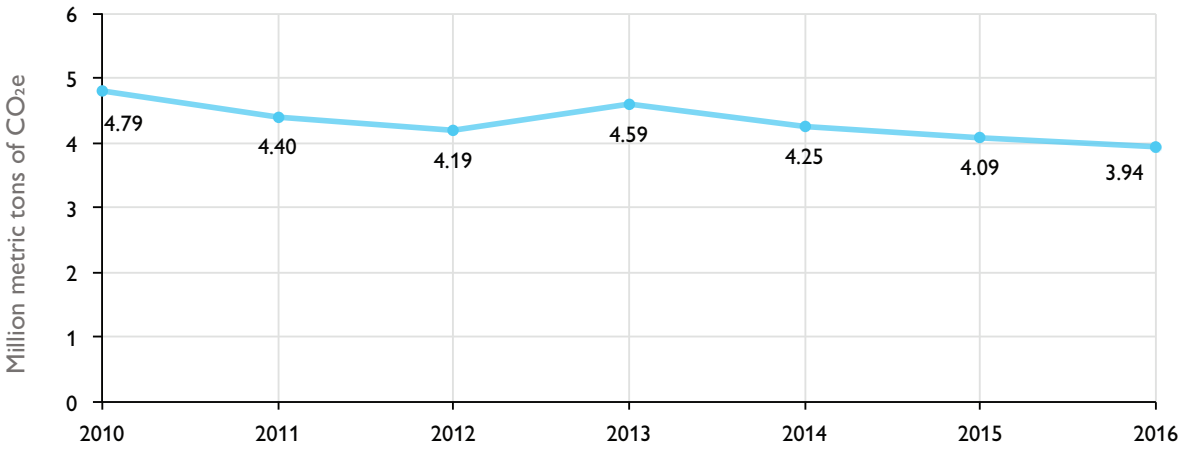


Figure 4: Rhode Island VMT Trends



[6] For additional information, go to: **https://www.fhwa.dot.gov/**

Figure 5: Rhode Island Transportation GHG Emissions 2010-2016



Transportation Sector Methodology

A range of tools is available to calculate GHG emissions from the transportation sector. These tools vary significantly in their capabilities. EPA recommends the SIT and the Motor Vehicle Emissions Simulator (MOVES)[7] for statewide emissions inventories.

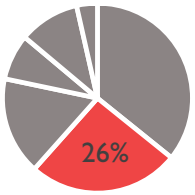
The SIT uses a "top-down" approach to calculate CO_2 emissions from transportation, starting with fuel consumption and VMT. This approach uses data on fuel sales within each state as a proxy for fuel consumption. The major shortcoming of this method is a lack of detail. Drivers do not always use their vehicles in the same state that they purchase fuel. As a result, fuel sales may not provide an accurate estimate of fuel consumption at the state level. Data on fuel sales also does not provide information on different types of on-road vehicles.

MOVES is an all-in-one program that converts all GHG emissions to CO_2e using a "bottom-up" approach. VMT and vehicle data determines fuel consumption and emissions produced. The tool includes a great deal of opportunity for user-supplied inputs and simplifies analysis at different levels of geography (e.g. nation, county). For the purposes of state GHG inventories, EPA recommends county level inputs requiring the user to supply local, state and county data. Inputs to MOVES includes data on vehicle population, vehicle age, average speed distribution, meteorological data, I/M program details, road type distribution, and VMT. The model simulates vehicle drive cycles for the defined time period and geographical area specified. Data from all five Rhode Island counties are summed to produce a transportation sector inventory.

Although MOVES provides the strongest and most up-to-date methods for analyzing the GHG impacts of on-road vehicles, the tool is not the best option for state inventories to address every potential GHG analysis component (e.g. non-road modes, lubricants, and aviation). As a result, the SIT tool is used to determine the non-road and lubricant associated emissions of the transportation sector. Some examples of non-road emission sources are boats, locomotives, tractors, construction and snowmobiles (gasoline only). For aviation related GHG emissions, as required by the Permanent Air Quality Monitoring Act (Rhode Island General Laws 1-7-6),[8] the Rhode Island Airport Corporation (RIAC) provides an annual inventory of GHG pollutants associated with the State's primary airport, T.F. Green Airport, to RIDEM. This 2016 GHG emissions inventory update used the data provided in the 2016 Air Emissions Inventory submitted to RIDEM's Office of Air Resources by RIAC.

[7] For additional information, go to: **https://www.epa.gov/moves**

[8] For additional information, go to: **http://StateofRhodeIslandStatute/PermanentAirQualityAct**

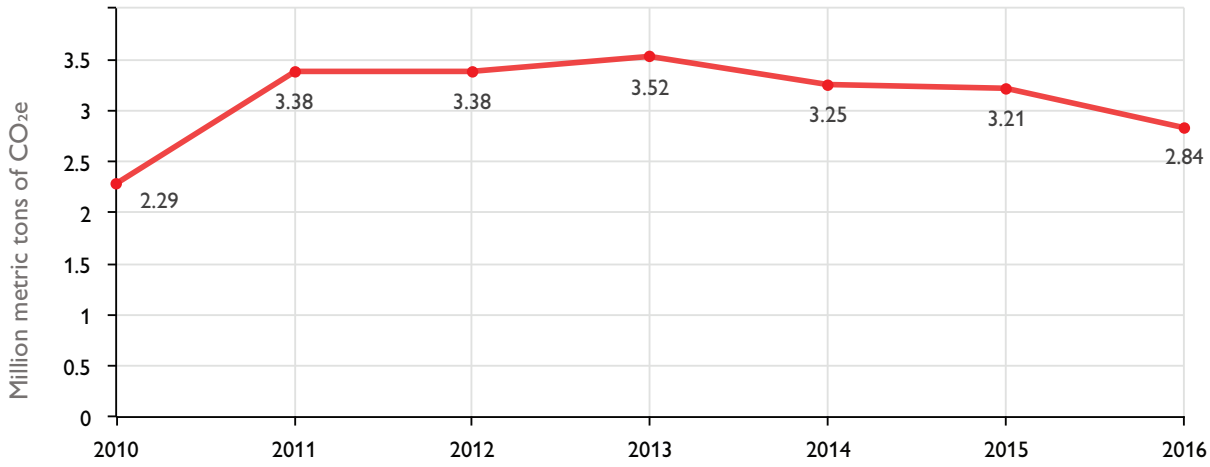


Electricity Consumption Sector

Trends

In 2016, the electricity consumption sector continues to be the second largest source of GHG emissions in the state, 26%, as seen in Figure 2. Electricity consumption emissions have increased slightly from 1990 whereas the other top emission sources, transportation and residential heating, have trended downward (refer to Table 3). It should be noted that the 1990 baseline inventory did not include three of the five power plants in Rhode Island. The RI State Energy Center, Manchester Street Power Station and Tiverton Power started operation between 1995 and 2002. The 2010 emissions of 2.29 $MMCO_2e$ is the GHG emissions estimate from the 2016 RI GHG Reduction Plan. As Figure 6 below shows, the emissions from the electric sector have remained relatively flat averaging 3.30 $MMTCO_2e$ for last five years (2011-2015). However, in 2016, emissions from electricity consumption dropped by 0.37 $MMTCO_2e$ (-11.50%) to 2.84 $MMTCO_2e$. This decline in emissions from 2015 to 2016 is attributed to Rhode Island's ambitious energy efficiency measures as well as using an improved emission accounting methodology. Rhode Island has consistently scored in the top five in the nation for energy efficiency as ranked by the American Council for an Energy-Efficient Economy.[9] In 2016, RI ranked fourth and in 2019 RI tied for third with Vermont. These scores reflect RI's commitment to energy efficiency as a means to reducing emissions in this sector.

Figure 6: *Rhode Island Electricity Consumption GHG Emissions 2010-2016*



[9] For additional information, go to: **https://aceee.org/state-policy/scorecard**

Electricity Consumption Sector Methodology

The SIT has been used to estimate electricity consumption-based GHG emissions from the electric power sector. In an effort to continuously improve RI's GHG emissions inventory, it is recognized that renewable energy is playing a larger role in RI's energy portfolio. As a national leader in energy policy, RI's ambitious Renewable Energy Standard (RES) requires that an increasing amount of renewable power be sold each year (38% by 2035).[10] Since the RES requires increasing amounts of renewable energy (RE), it is possible that the SIT methodology would have caused an increasingly less accurate GHG emissions inventory over time.

For this 2016 emissions inventory update, the electric sector GHG emissions inventory methodology has been revised and aligns with RI's neighboring states, Massachusetts (MA) and Connecticut (CT). This method for estimating GHG emissions from electricity consumption accounts for emission reductions from Renewable Energy Certificates (RECs) purchased and/or sold by Rhode Island retail electricity sellers. RECs are counted in the state in which they are settled (retired) and not where they are minted (generated). Utilizing the New England Power Pool Generation Information System (NEPOOL GIS) data, RIDEM accounted for the total number of RECs used for in-state RES compliance. These RECs were "credited" to Rhode Island thereby reducing the total emissions associated with energy needed to meet statewide electric demand. This inventory update is the first time RI has accounted for RECs in estimating electricity consumption GHG emissions.

In 2016, RI was a net importer of electricity.[11] RI's demand for electricity exceeded its generation. This inventory assumes that CO_2 emissions from RI's power plants are attributed to Rhode Islanders energy demand. The additional electricity consumed by RI is imported from other New England states that are net exporters of energy. This inventory uses RI-specific generation and annual electricity load data from the Independent System Operator, New England (ISO-NE) to determine an imported emissions estimate. In years that New England receives net imports of electricity from adjacent control areas (NY, NB and Quebec), the associated emissions from this imported energy is included as well. If pumped hydro has been used, the megawatt hours of losses and associated emissions are calculated. The total energy consumed is multiplied by emission factors consistent with the MA methodology to obtain emissions from RI's electricity consumption.

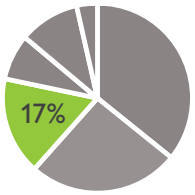
Consumption vs. Generation Accounting

GHG emissions from the electric power sector can be estimated by using either a consumption-based or a generation-based accounting methodology. Generation-based accounting is the total of GHG emissions from the combustion of fossil fuels at power plants located within RI, whereas GHG emissions associated with electricity used within the state is referred to as consumption-based. In 2016, RI imported approximately 20% of electricity from outside the state (1,637 Gigawatt hours). A consumption-based approach is used in this inventory captures the emissions of this imported electricity. In addition, a generation-based method may not fully account for GHG emission reductions achieved through energy efficiency programs and/or give appropriate credit for electricity obtained from renewable energy sources. Electricity in RI is obtained from a regional (New England) transmission grid and the majority of New England states including neighboring states of MA and CT utilize consumption-based accounting to estimate GHG emissions from this sector. In February of 2016, the EC4 formally adopted the consumption-based accounting methodology for use in the 2016 RI GHG Emissions Reduction Plan.[12]

[10] For additional information, go to: **http://StateofRhodeIslandStatute/RenewableEnergyStandard**

[11] For additional information, go to: **https://www.iso-ne.com/EnergyLoadandDemandReport**

[12] "Memo Re: Electricity Generation vs. Consumption GHG accounting approaches" prepared by Paul Miller to Liz Stone and Danny Musher, January 8, 2016 – **http://www.dem.ri.gov/programs/air/documents/ghg-memo.pdf**

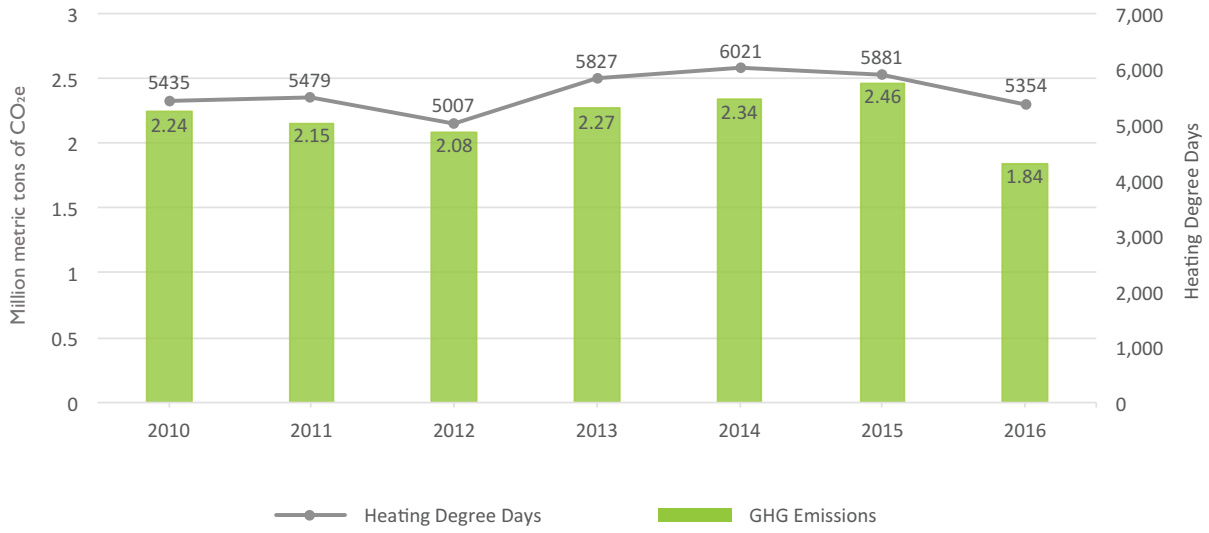


Residential Heating Sector

Trends

The residential heating sector emitted 1.84 million metric tons of CO_2e accounting for 17% of Rhode Island's GHG emissions in 2016. Rhode Island has experienced a decrease in emissions from the residential heating sector, most notably a 22.4% decrease in GHG emissions since 1990. Major fuels used to heat Rhode Island homes include natural gas and distillate fuel oil.[13] 53% of homes use natural gas[14] and approximately 31% of homes use distillate fuel oil.[15] Electricity and other miscellaneous fuels[16] account for the remaining approximately 16%.[17] Heating fuels produce different amounts of GHG emissions because "dirtier" fuels produce more emissions.

Figure 7: Rhode Island Residential Heating GHG Emissions and Heating Degree Days 2010-2016[18]



[13] Also commonly referred to as #2 fuel oil or home heating oil.

[14] Natural gas emits about 20-30% less CO_2 than oil. For additional information, go to: **https://www.eia.gov/energyexplained/natural-gas**

[15] For additional information, go to: **https://www.eia.gov/state/RIStateEnergyProfile**

[16] Miscellaneous fuels include propane, kerosene, wood, solar and geothermal sources.

[17] For additional information, go to: **https://www.eia.gov/state/seds/2016**

[18] For additional information, go to: **https://www.NOAA/HeatingDegreeDays**

Distillate fuel oil plays a central role in heating approximately one-third of Rhode Island homes. However, over the course of the past century, consumption of delivered fuels in Rhode Island, New England and across the U.S. have declined steadily.[19] Market economics, public initiatives, increases in heating equipment efficiencies, advancements in control technologies, building improvements, and alternative fuel options (particularly, natural gas conversions) have all contributed to a trend in reduced consumption of distillate fuel and other delivered fuels. Further information about the decline in distillate fuel consumption is provided in the "Factors Impacting Heating Emissions" section.

Temperature changes from year to year play a large factor in emissions from the heating sector. For example, during a mild winter, lower fuel consumption for space heating can be expected. This reduction in fossil fuel use results in lower emissions. Heating degree days alleviate the variability of temperature by determining the weather's impact on fuel consumption. Figure 7 shows the relationship between residential heating emissions and heating degree days.[20] Additional information about heating degree days is provided below.

Factors Impacting Heating Emissions

Rhode Island's weather provides a level of uncertainty for heating emissions because colder temperatures require more energy to keep residents comfortable inside their homes. Cold winters demand more heat, and likely result in increased fuel usage and GHG emissions. Wintertime possesses a variability for Rhode Island's GHG emissions; an attempt to mitigate this uncertainty with heating degree days determines if Rhode Island's change in heating emissions is a result of temperature change, energy efficiency or other factors (such as fuel consumption).

Heating degree days are used to normalize emissions associated with fuel use and differences in weather. Heating degree days are calculated by subtracting the average daily temperatures from a baseline temperature of 65°F; 65°F is when neither air conditioning nor heating are required to maintain a comfortable temperature.[21] The concept of heating degree days is tricky because there can be multiple heating degree days in a 24-hour period. Heating degree days provide useful information about the intensity of winter and the fuel usage required to provide adequate heat. Assuming all variables are identical from year to year, a 10% increase in heating degree days should experience a 10% increase in heating emissions. A 24-hour temperature average greater than the baseline temperature (65°F) results in 0 heating degree days because heating units will not be turned on.[22]

Rhode Island's residential heating sector emitted 2.46 MMTCO$_2$e in 2015 and 1.84 MMTCO$_2$e in 2016. There were 5,881 heating degree days in 2015 and 5,354 heating degree days in 2016. The warmer winter of 2016 experienced a 9% decrease in heating degree days and a 25% decrease in GHG emissions. Weather alone did not contribute to a 25% decrease in GHG emissions from 2015 to 2016. Further emissions reductions are likely a result of decreased fuel consumption and increased energy efficiency.

[19] For additional information, go to: **https://www.eia.gov/state/seds/2016**
[20] For additional information, go to: **https://www.NOAA/HeatingDegreeDays**
[21] For additional information, go to: **https://www.weather.gov/key/climate_heat_cool**
[22] For additional information, go to: **https://www.weather.gov/key/climate_heat_cool**

U.S. consumption of distillate fuel use in heating has declined from 28% in 1985 to 11% in 2015 (the most recent year with sales data to end-use consumers).[23] This trend is even more prominent on the East Coast, and for our purposes, Rhode Island. The Rhode Island distillate fuel consumption drastically decreased from 17,289 Billion Btu in 2015 to 10,912 Billion Btu in 2016. Emission reductions from distillate fuel accounts for a 0.47 $MMTCO_2e$ decrease from the residential heating sector, responsible for a 19% drop in residential heat GHG emissions. Since 1990, distillate fuel oil use has decreased from residential heating, but distillate fuel usage for highway transportation has continued to increase. As residents shift away from distillate fuel to heat their homes, it makes sense that Rhode Island will see a decrease in emissions from the heating sector. Lastly, like all heating fuels during a warm winter, consumption decreases. Reductions in fuel usage in 2016 may be attributed to the warmer than average winter; however, distillate fuel experienced unprecedented drops in consumption from 2015 to 2016. There is no singular reason for emissions to drop as they have. Purchasing trends, energy efficiency improvements, and warmer than average weather may have all played a role in the reduction of heating emissions.

Heating Degree Day Calculation

February 2nd, 2016

25%
Drop in CO_2e
2016

24-hour temperature average: 22°F

Baseline temperature: 65°F

24-hour average temperature (22°F) is colder than the baseline (65°F), therefore, heating degree days

65°F – 22°F = 43 heating degree days on February 2nd, 2016

Calculate for 365 days in a year, sum of all heating degree days equals annual heating degree days

Residential Heating Sector Methodology

Residential heating emissions are estimated using the SIT's Fossil Fuel Combustion module and the Stationary Combustion module. EIA collects fuel consumption data throughout the United States by requiring mandatory surveys for all companies that deliver natural gas to consumers or transport natural gas across state lines. In Rhode Island, National Grid is responsible to report natural gas consumption data to the EIA via Form EIA-176.[24] Distillate fuel, propane, and kerosene are other fuels used to heat RI homes. These are deliverable fuels because they must be delivered to your house for use. Consumption estimates for deliverable fuels are estimated by EIA. Fuel consumption data is a key component in order to estimate emissions. The SIT estimates Rhode Island's 2016 residential heating emissions to be 1.84 million metric tons of CO_2e.

Rhode Island enacted the Biodiesel Heating Oil Act of 2013 to require the mixing of biodiesel in heating oil.[25] Biodiesel is a renewable fuel made from waste such as plant oils, cooking oils and animal fats. Biofuel can be mixed with conventional heating oil to create different blends of oil. For example, a B5 blend contains 5% biodiesel and a B50 blend contains 50% biodiesel. B5 is the minimum blend required in Rhode Island as outlined in the Biodiesel Heating Oil Act of 2013. Biodiesel reduces GHG emissions in Rhode Island because biodiesel burns 85% cleaner than conventional oil.[26] Currently, biodiesel is not included in the emissions inventory due to a lack of state-level data on biofuel consumption. Residential heating emissions may be overestimated because this inventory's calculations do not include the use of blended biofuels. Adjustments and improvements to accurately represent biofuel may be considered in future inventories to create a more detailed emissions calculation.

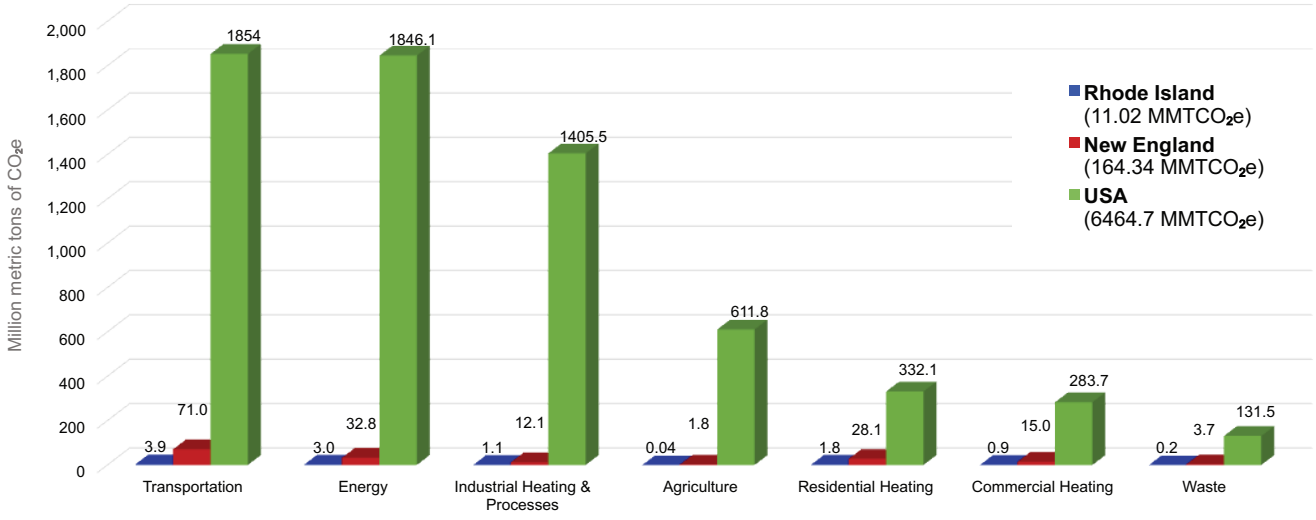
[23] For additional information, go to: https://www.eia.gov/DistillateFuelInventories
[24] For additional information, go to: https://www.eia.gov/NaturalGasReporting
[25] For additional information, go to: http://StateofRhodeIsland-BiodieselHeatingOilActof2013
[26] For additional information, go to: http://www.rilin.state.ri.us/pressrelease

Trends by Sector: Rhode Island, New England and the United States

Rhode Island is one of the Nation's lowest GHG emitters behind Vermont and the District of Columbia.[27] Vast differences including population, electricity prices, climate and fuel options creates a large variability in a state's GHG emissions. Rhode Island emits approximately 11 $MMTCO_2e$, only 0.17% of the 6464.70 $MMTCO_2e$ the United States is responsible for emitting in 2016. The three largest sectors of GHG emissions on a national level are transportation, energy, and industrial heating and processes. The three largest sectors in Rhode Island are transportation, energy, and residential heating. These sectors are also the largest emitters in New England. In comparison to national averages, residential heating produces a large proportion of emissions in New England due to the colder than average climate.

Per capita consumption is important to determine how well Rhode Islander's utilize their resources. Per capita consumption is the amount of emissions produced by one person on average in a year.[21] On average each Rhode Islander produces 10.43 metric tons of CO_2e in a given year. The average United States citizen produces 20.15 metric tons of CO_2e in a given year.[28] Rhode Island is a small piece of the puzzle; however, continuous improvements to heating systems, renewable energy, and transportation will help achieve the reduction targets mapped out in the Resilient Rhode Island Act.

Figure 8: Rhode Island, New England, & U.S. Greenhouse Gas Emissions 2016



ME & NH Greenhouse Gas Emissions data collected from 2015 inventories. All other New England data compiled from 2016 inventories. National Greenhouse Gas Emissions data collected from EPA. Methodologies to calculate sector totals may vary in different states.

[27] For additional information, go to: **https://www.eia.gov/environment/CO2EmissionByState2005-2016**

[28] For additional information, go to: **https://www.census.gov/quickfacts**

Going Forward

Rhode Island must stay diligent to further reduce our carbon footprint in all sectors to meet the state's 2035 and 2050 reduction targets. To do so, Rhode Island has enacted programs and policies to limit emissions and push the state towards a cleaner future.

On July 8, 2019, Rhode Island's Governor, Gina Raimondo, signed executive order 19-06 highlighting the urgency to transform the heating sector to protect against climate change. The executive order establishes the commitment to reduce emissions in the heating sector while limiting impacts to ratepayer costs, public health and the environment. The Division of Public Utilities and Carriers (DPUC) and the Office of Energy Resources (OER) have been tasked with providing the Governor with heating sector recommendations by 2020.

Rhode Island has also been selected to receive assistance from the National Governors Association (NGA) to integrate electric vehicle measures, to modernize the electrical grid, and to electrify the heating sector. NGA staff, with the help of the U.S. Department of Energy, will provide financial and technical support to lead Rhode Island towards a clean electrical grid.

The Office of Energy Resources has developed a pilot program to save energy and reduce costs in Rhode Island communities. The Achieving Community Efficiency Program (ACE), launched in Spring 2019, has been tasked with reducing energy usage and associated costs in the Towns of Warren, South Kingstown and North Providence and the public-school systems of Barrington, Scituate and North Providence.

The State of Rhode Island stays committed to upholding the Paris Agreement by pursuing ways to limit the temperature increase from rising 2°C above pre-industrial levels. By 2050, the United States pledged to reduce greenhouse gas emissions by 80% of 2005 levels. Executive Order 17-10 outlines the action Rhode Island must take to protect itself from temperature increase, coastal changes, and severe weather events.

Transportation and Climate Initiative (TCI)[29]

Rhode Island continues efforts to reduce GHG pollution from transportation through the TCI regional low-carbon transportation policy. The TCI policy would work by setting a cap on GHG emissions from cars, trucks, buses and other modes of transportation in the region. The cap would lower each year, meaning less and less pollution would be allowed. Regulated entities would have to purchase allowances at auction for each ton of carbon they emit. Proceeds from the sale of carbon allowances would go toward state projects that further reduce transportation emissions, such as program to boost cleaner public transit.

Zero-Emission Vehicle MOU (ZEV)[30]

In 2013, the Multi-State ZEV Task Force was formed when the governors of eight states signed a Memorandum of Understanding committing to a coordinated action to support successful implementation of state ZEV programs. Transportation electrification is essential to achieving near and long-term GHG reduction goals.

In 2015, Rhode Island released a state specific ZEV Action Plan identifying key actions necessary to promote the responsible growth of the ZEV market in Rhode Island. The state's Lead by Example Program focuses on increasing ZEVs in the state, municipal, and other public fleets.

The state also rolled out new regulatory framework for its electric system as part of the Rhode Island Power Sector Transformation.[31] As an important part of transitioning the transportation sector to vehicle electrification and lowering GHG emissions, the grid will be modernized and investments in electric vehicle infrastructure will be made.

[29] For additional information, go to: https://www.TCI.org/RegionalPolicyDesignProcess2019
[30] For additional information, go to: https://www.nescaum.org/ZEVs
[31] For additional information, go to: http://www.ripuc.org/utilityinfo/electric/PST

Regional Greenhouse Gas Initiative (RGGI)[32]

A significant portion of RIDEM's work has focused on reducing GHG emissions. Since the program's inception in 2009, Rhode Island has participated in the Regional Greenhouse Gas Initiative ("RGGI"), the nation's first market-based regulatory program to reduce carbon dioxide emissions ("CO_2") from the electric sector. RGGI establishes a regional cap on CO_2 emissions from power plants, which declines over time, and by issuing a limited number of tradable allowances. Tradable allowances provide market flexibility for states and emitting power plants to set their own compliance path. Proceeds from the allowance auctions are returned to participating states. Rhode Island's auction proceeds (approximately $70 million to date) are invested in clean energy and other consumer benefit programs including energy efficiency.

These energy efficiency investments reduce demand for electricity which in turn reduces power plant emissions. Power sector carbon pollution in the RGGI region has declined significantly over the past decade. The RGGI states have experienced more than 50% reduction in power sector carbon pollution since 2005. In December of 2017, the RGGI states committed to further reducing the regional cap on CO_2 emissions an additional 30% by 2030. In part due to the funds from RGGI, Rhode Island is one of the top states in the nation when it comes to energy efficiency.

National Grid Northeast 80x50 Pathway[33]

In June 2018, National Grid, one of the nation's largest investor-owned utilities, released the "Northeast 80x50 Pathway," a blue-print for drastically reducing greenhouse gas emissions 80% below 1990 levels by 2050. National Grid's goal is consistent with the states they serve - New York, Massachusetts, and Rhode Island. The Northeast 80x50 Pathway includes in-depth modeling and analysis addressing the three most carbon-intensive sectors in the Northeast - transportation, power generation, and heating.

Conclusion and Future Considerations

This inventory provides a snapshot of 2016 GHG emissions in Rhode Island and an analysis of the three largest emitting sectors in the state. Every three years, RIDEM's Office of Air Resources will update the GHG emissions inventory data. Through this effort of identifying key emissions sources and benchmarking progress, RIDEM will provide the foundational information needed to develop and implement targeted and strategic actions for meeting GHG reduction targets. In the next data update, we will strive to improve by using the most recent science and coordinate GHG emissions accounting methodologies with other bordering states.

[32] For additional information, go to: **http://www.dem.ri.gov/RGGI**
[33] For additional information, go to: **https://www.nationalgridus/80x50-White-Paper**