

Town of Caroline, New York: Greenhouse Gas Emissions Inventory: A comparison of 2013 and 2018

Compiled by:
Cornell Cooperative Extension of Tompkins County
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Introduction

This comparison of 2018 greenhouse gas (GHG) emissions in the Town of Caroline, New York, from a baseline year of 2013, serves as a preliminary step in creating strategies to reduce GHG emissions. It is important for local government to understand their town's emission levels and their impacts as it allows them to prioritize actions when creating a local Climate Action Plan to mitigate the effect of these emissions.

This information was compiled per the guidance and assistance of the NYS Climate Smart Communities Greenhouse Gas Inventory Guide for Government Operations. This guide was developed to provide detailed guidance on procedures on how to collect the municipal energy usage and emissions data. It also advises on what specific data is needed to calculate the government operations total greenhouse gas emissions. This guide was used in conjunction with the EPA Government Operations GHG calculation tool which provides the specific requirements to calculate total emissions.

This Greenhouse Gas Inventory was prepared as a component of the Town of Caroline's participation in the Climate Smart Communities program of the New York State Department of Environmental Conservation. The inventory was prepared by Osamu Tsuda (CCE Tompkins), Climate Smart Communities Specialist on behalf of the Town of Caroline and under the guidance of Terrance Carroll, Clean Energy Communities coordinator in Tompkins County.

Communities that have been certified as Climate Smart Communities are committed to reducing GHG emissions and improving climate resilience, which allows them to reduce long-term costs and adapt to a changing climate.

Greenhouse Gas Emission and Energy Use in New York State

Greenhouse gases are gases that trap heat in the Earth's atmosphere when they accumulate in high concentrations. Common greenhouse gases include carbon dioxide, methane, nitrous oxide, and fluorinated gases, which are synthetic gases produced by industrial processes. These gases are released into the atmosphere through everyday

activities of all kinds which eventually lead to changing weather patterns and thus climate change.

Some gases have a greater impact on the atmosphere than others, but together, these gases combine to “thicken the Earth’s blanket” and change climatic conditions. For example, methane gas has a higher warming effect on the atmosphere than carbon dioxide but dissipates more quickly. Some of these gases, such as water vapor, carbon dioxide, and methane, occur naturally in small percentages, and help the atmosphere retain enough heat to sustain life. This balance is disrupted, however, by greenhouse gas emissions from human activity, which cause the atmosphere to retain more energy from the sun than it normally would. This seemingly small change in the atmosphere’s composition has already led to big changes in temperature and weather all over the world.

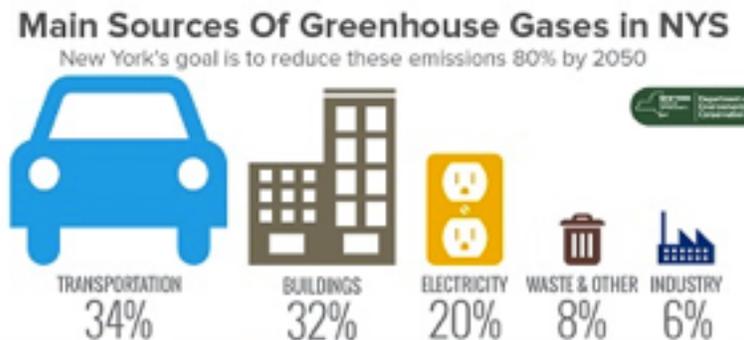


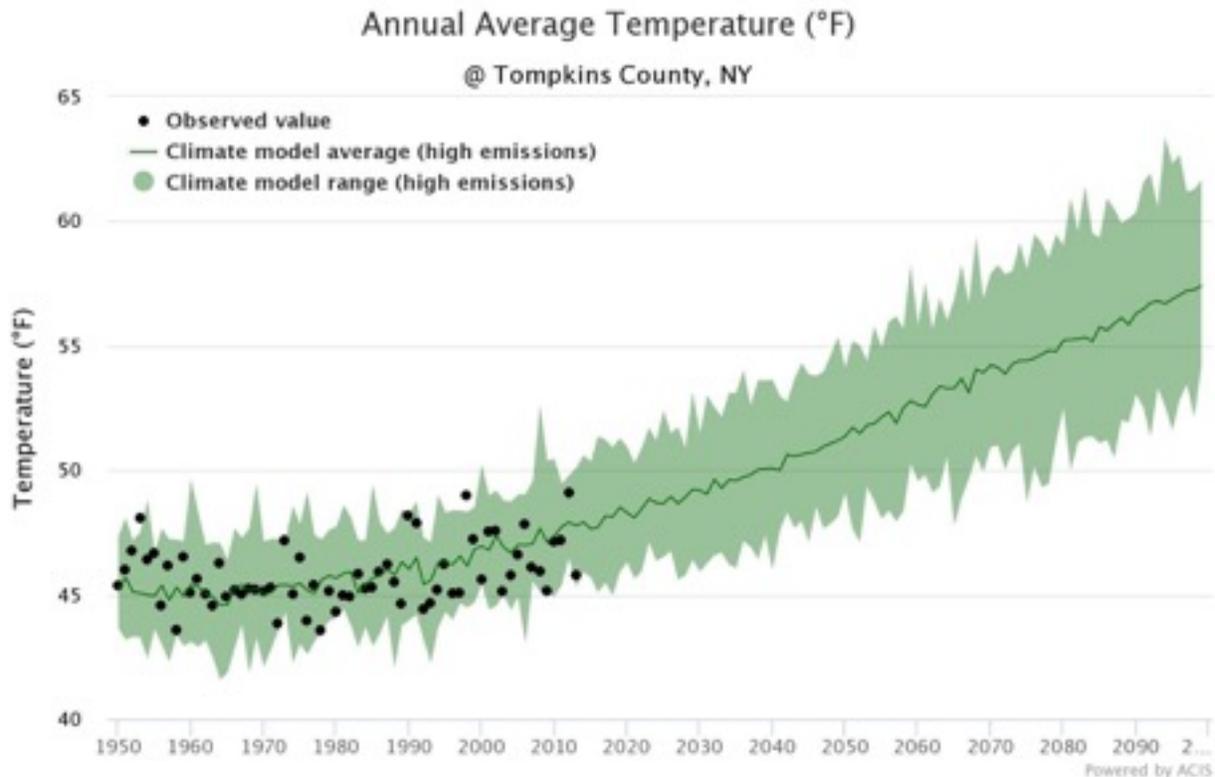
Image source: New York Department of Environmental Conservation http://www.dec.ny.gov/images/administration_images/ghgsrscsm.jpg

Greenhouse gas emissions in New York State come mostly from transportation (34%). This includes all travel of people and goods by cars, trucks, ships, airplanes, trains, and other vehicles. Greenhouse gases in the state are also largely produced by the industrial sector from the manufacturing processes that create the goods and raw materials that we use in our everyday lives. Residential and commercial activity contributes emissions as well, mostly through heating, cooking, wastewater management, and refrigerant leaks. While greenhouse gasses are most commonly associated with urban areas, agricultural lands, which are primarily located in rural areas also emit GHGs through soil management practices which releases nitrous oxide into the atmosphere. These agricultural activities include the use of synthetic and organic fertilizers, growing nitrogen-fixing crops, and various irrigation processes. Livestock also contribute to GHG emissions, as their natural digestive processes produce methane. This however could be mitigated through proper management of livestock waste.

A variety of research, including New York’s Climate Aid report (2011, 2014) and the National Climate Assessment (2014), has shown that impacts of climate change have already begun to occur in New York State. Climate change manifests as changes in temperature, precipitation, sea levels, seasonal changes, and severe weather events.

These changes have direct effects on the health of humans, animals and plants in New York State.

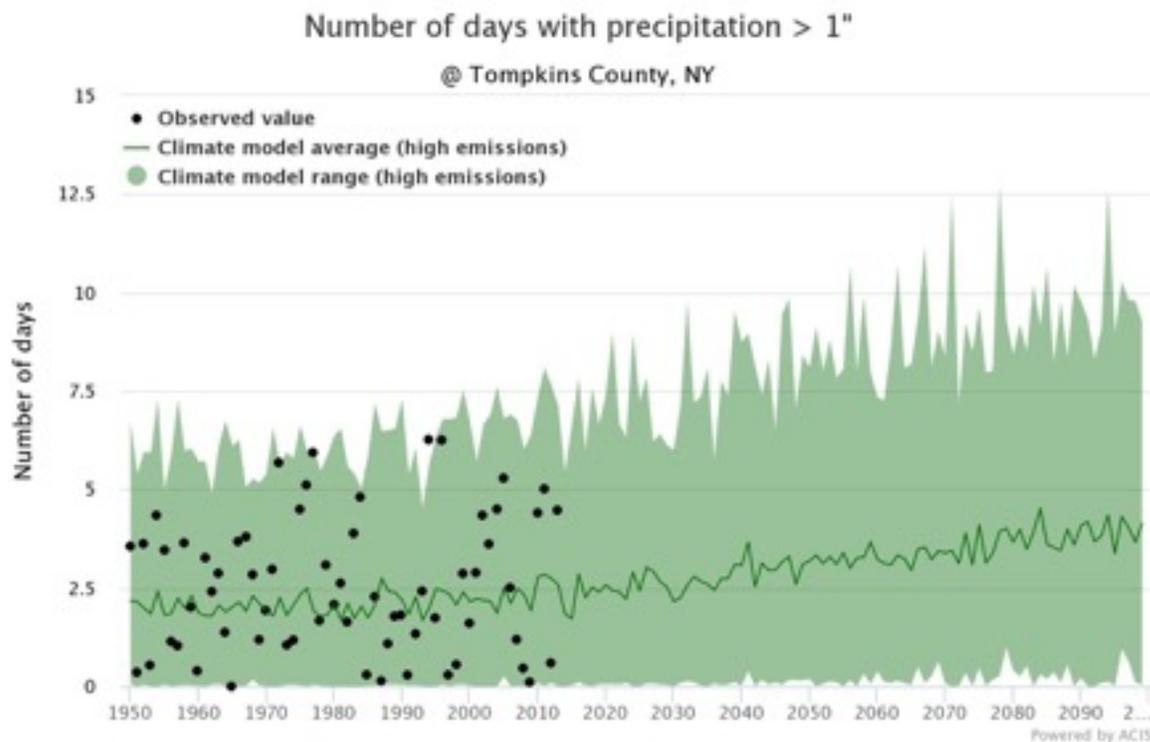
Since 1970, the average annual temperature has risen by 2.4°F in New York State. Average winter temperatures have increased by over 4.4°F. Climate change has also resulted in increased precipitation in the winter, and less in the summer. The chart below from Climate Smart Farming depicts county-specific annual temperature



projections. Climate change also includes climactic events beyond global warming, namely an increase in severe weather events, such as superstorms and hurricanes. Between 1958 and 2010, the number of very heavy precipitation events increased by over 70% in the United States. New York’s coastal areas have seen a sea level rise of over a foot since 1900. Sea level rise is a result of climate change, which causes warmer temperatures that melt polar caps, glaciers, and land-based ice. Sea level rise is especially imminent in New York State, where the rate of rise (1.2 inches per decade) is nearly twice as high as the global rate (0.7 inches per decade). The chart on the following page from Climate Smart Farming depicts county-specific projections. Additionally, climate change has also resulted in variation in seasonal patterns. In New York State, for example, spring begins a week earlier than it once did. The first leaf date in autumn is, correspondingly, over a week late.

While coastal flooding and sea level rise is a major problem, for most of New York State, inland flooding due to extreme weather poses an even greater threat to communities. According to the DEC, a large portion of Upstate NY will experience

increased precipitation. This not only includes rainfall, but snow as well, as the Finger Lakes' regional weather can be significantly influenced by the major lakes (i.e. Lake Ontario). As a result of this increased precipitation, runoff will continue to increase, which will not only lead to flooding, but potential contamination of existing waterbodies. According to the US EPA, runoff is a major factor to the contamination of large waterbodies, eventually leading to algal bloom, which is a green-colored cyanobacteria that creates a toxic environment to aquatic organisms as well as humans, thus posing a threat to the entire community. This phenomenon is a major issue throughout fresh-water waterbodies in New York State and many findings have shown that while there are many factors that lead to increased algal bloom, increased runoffs which contain contaminants and fertilizers from developed lands and surfaces have significantly contributed to this problem. While this might seem like an indirect link to climate change, it is important to make the connection that all of this can be linked back to greenhouse gas emissions.



Once greenhouse gases are emitted into the atmosphere, they can linger for decades or even centuries, even if emissions are reduced in the future. It is important to understand how greenhouse gas emission are affecting our region in order to create strategies to reduce future greenhouse gas emissions and most importantly, protecting ourselves from the changing climate. Modeling has projected that climate change will continue in New York State. The region will experience more precipitation, more variability in precipitation, and warmer temperatures. By 2020, average precipitation will

increase by up to 8%, compared to the 1971-2000 period, and annual average temperatures will increase by 3°F.

Climate change also negatively impacts the availability of clean air, water, and food supplies. Changing environmental conditions in New York State also help insects, such as mosquitoes and ticks, spread infectious diseases such as West Nile virus and Lyme disease. Human health is also affected directly by the changing climate, especially those, like the elderly and children, who are already vulnerable. This can be caused by things such as increased pollen production, ground-level ozone formation, or the presence of other forms of air pollution. All of these factors exacerbate asthma, allergies, and other respiratory conditions.

In summary, greenhouse gas emissions and the climate change that they cause have already begun to affect the health and sustainability of communities in New York State. These negative effects can be partially mitigated, however, by reducing greenhouse gas emissions and the activities that create them. This Greenhouse Gas Inventory for the Town of Caroline, New York, serves as a first step in taking action to plan for a healthier and more environmentally responsible town that may be enjoyed for generations to come.

Methodology

The calculations in this report were performed using the Climate Smart Communities Local Government Greenhouse Gas Accounting Tool, provided by the New York State Department of Environmental Conservation. The tool is based on the Local Government Operations Protocol, which serves as a national standard for municipal greenhouse gas inventories across the country. Buildings emissions data for the Town of Caroline was collected from the New York State Electric and Gas Corporation (NYSEG) over a 12-month period while vehicle emissions data was gathered through municipal gas consumption logs and the town vehicle inventory.

The government operations Greenhouse Gas Inventory is required to create designated departments that divides the electricity consumption into specific uses and consumption. In the case for the Town of Caroline, this energy consumption has been divided into three departments: Town Hall, Highway/ DPW, and Streetlights. The Town Hall specifically refers to the energy consumption of the town hall and town court located in Slaterville NY. Whereas the Highway/ DPW specifically refers to the highway and public work facilities and equipment (vehicles) which are shared by both departments. And finally, the streetlights category refers to all streetlights located throughout the township (i.e. primarily Brooktondale, Slaterville, and Speedsville).

Stationary Combustion of Fossil Fuels: Natural Consumption in Municipal Buildings

The use of natural gas in municipal facilities has slightly increased in the period between 2013 and 2018. In the Town Hall, yearly natural gas usage increased from 214 million BTUs to 289 million BTUs, an approximately 35% increase. As for the Highway/DPW, the consumption rose from 277 to 451 million BTUs between 2013 and 2018, around a 62 % increase in consumption. In total, natural gas use in these municipal facilities increased by 51%, or a total of 249 million BTUs of natural gas. As for the town hall, most to all of the natural gas is used by the town court building, since the town hall is heated using a geothermal system. However, as the town court also convert to geothermal, there is expected to be a major reduction in natural gas used. In terms of the highway and DPW, all buildings are heated by natural gas, which is why the Highway has a significantly higher energy consumption rate. A note on units: A BTU, or British Thermal Unit, measures thermal energy, and is a standard measure of natural gas usage.

2013 v. 2018 Municipal Building Fuel and Energy Consumption (million BTU)				
Building	2013 Natural Gas Energy Use	2018 Natural Gas Energy Use	2013 v. 2018 Use Difference	2013 v. 2018 Use Percent Change
Town Hall	214	289	75	35%
Highway/DPW	277	451	174	62%
Streetlights	0	0		0%
Total Stationary Combustion Energy Use	491	740	↑249	↑51%

The combustion and use of natural gas results in the release of carbon dioxide into the atmosphere. The Town of Caroline’s emissions from municipal buildings have been calculated below in metric tons of CO₂ equivalent (MT CO₂E). This unit converts other greenhouse gases into the amount of CO₂ that would have the same impact on global climate change in order to standardize and measure harmful emissions. The yearly carbon dioxide equivalent emissions of these buildings have increased in the period between 2013 and 2018, corresponding with the increase in the amount of natural gas used.

2013 v. 2018 GHG Emissions from Natural Gas by Municipal Building (MT CO ₂ E)				
Building	2013 CO ₂ Emissions	2018 CO ₂ Emissions	2013 v. 2018 Emission Difference	2013 v. 2018 Emission Percent Change
Town Hall	11	16	5	45%
Highway/ DPW	15	25	10	66.67%
Streetlights	0	0	0	0%
Total Stationary Combustion Emissions	26	41	↑15	↑57%

In general, as there is an overall increase in consumption of natural gas, it is important to note that the winter of 2018 was significantly colder than 2013. For example, in 2013 between January and May, the average temperature was approximately 37 F whereas in 2018 the temperature was approximately 35 F. While this might not sound too significant, these lower temperatures likely contributed to the increase in fuel consumption. Finally, it might also be worth considering changes in operation hours, as this change can also increase consumption of gas.

Electricity Consumption in Municipal Buildings

Overall electricity consumption in municipal buildings in the Town of Caroline has decreased between the period between 2013 and 2018. Between 2013 and 2018, the Town Hall managed to decrease its energy use by 1,894 kWh or 24%, while the Highway/ DPW and Streetlights also decreased, but at a more modest level, 1,068 kWh or 4.9% and 1568 kWh or 3.8%, respectively. In total, municipal buildings in the Town of Caroline consumed 4530 fewer kilowatt hours of electricity in 2018, compared to 2013. This was a total reduction of 6.4%.

2013 v. 2018 Electrical Consumption by Municipal Building (kWh)				
Building	2013 Electrical Use	2018 Electrical Use	2013 v. 2018 Electrical Use Difference	2013 v. 2018 Electrical Use Percent Change
Town Hall	7,907	6,013	-1,894	-24.0%

Highway/DPW	21,741	20,673	-1,068	-4.9%
Streetlights	41,780	40,212	-1,568	-3.8%
Total Electrical Consumption	71,428	66,898	↓4,530	↓6.4%

The reduction of electrical consumption in this period resulted in a reduction of greenhouse gas emissions from electricity. Between 2013 and 2018, greenhouse gas emissions from electricity use in the Town Hall decreased by 0.59 metric tons of CO₂ equivalent, or 42.1%. As for the Highway/DPW buildings, yearly electricity consumption was reduced by 0.88 metric tons of CO₂ equivalent between 2013 and 2018, a decrease of 24.1%. Similarly, the streetlights had a decrease of 1.97 metric tons which resulted in a 27.7% reduction. In total, electricity uses in municipal buildings produced 27.7% less, or 3.44 fewer metric tons of CO₂ equivalent in 2018, compared to 2013.

2013 v. 2018 GHG Emissions from Electricity by Municipal Building (MT CO ₂ E)				
Building	2013 CO ₂ Emissions	2018 CO ₂ Emissions	2013 v. 2018 Emission Difference	2013 v. 2018 Emission Percent Change
Town Hall	1.40	0.81	-0.59	-42.1%
HWY/DPW	3.66	2.78	-0.88	-24%
Streetlights	7.37	5.40	-1.97	26.7%
Total Electrical Consumption	12.43	8.99	↓3.44	↓27.7%

While there is no single answer to the significant decrease in overall electricity consumption between 2013 and 2018, one potential answer might be the overall technological upgrades between 2013 and 2018. While the change might be insignificant, the cumulative effect could have a larger impact on the electricity consumption. Such changes include installation of LED lighting as well as computer and mechanical upgrades. Other factors to consider might be different operational hours which would lead to the reduction of lighting and usage of power, thus leading to a decrease in energy usage.

Mobile Combustion of Fossil Fuels: Municipal Vehicle Fleet Consumption

As of 2018, the mobile fleet in the Town of Caroline consists of 23 vehicles, all of which consume diesel fuel. For the year of 2013, there are unfortunately no official records of mobile fuel consumption. Thus, the fuel consumption is based on an estimate that was calculated based on current consumption and using the historical records that were provided by the USEPA. Based on this information in 2013, the municipal vehicle

fleet in the Town of Caroline used a total of 3091 million British Thermal Units (MMBtu) of energy, from 22,386 gallons of fossil fuel. By 2018, with reduction in the number of vehicles and renewal of old vehicles with new ones, fossil fuel use decreased by approximately 15%. In 2018, the fleet’s fossil fuel consumption decreased by 205 MMBtu to 2886 MMBtu. The fleet used 20,898 gallons of fossil fuel.

2013 v. 2018 Vehicle Fossil Fuel Use by Type (MMBtu)	
Year	Total Diesel Fuel Consumption
2013	3091
2018	2886

The slight decrease in fleet updates and reduction of the fleet size by 2 vehicles naturally led to a decrease in greenhouse gas emissions from fossil fuel use in the fleet. Between 2013 and 2018, carbon dioxide emissions increased by 90 MT CO₂E, from 604 MT CO₂E to 694 MT CO₂E, a 14.9% overall increase in emissions.

2013 v. 2018 GHG Emissions from Municipal Vehicle Fleet (MT CO ₂ E)			
2013 CO ₂ Emissions	2018 CO ₂ Emissions	2013 v. 2018 Emission Difference	2013 v. 2018 Emission Percent Change
229	213	↓16	↓6.9%

Town Wastewater and Solid Waste Operations

The Town of Caroline is one of three municipalities within Tompkins County that does not have any wastewater or water treatment infrastructure or services, according to the Countywide Inter-Municipal Water and Sewer Feasibility Study for Tompkins County. This is primarily because the town is sparsely populated and does not have a large enough urban center to need a municipal facility. As a result, each structure within the town has its own private septic system and wells.

In addition to wastewater treatment, the town does not have any municipal landfills and pays a third-party service for solid waste collection. Per the guidelines of the Climate Smart Communities, Caroline does not need to include additional information for wastewater and solid waste emissions. While this might be the case, in the future the town might consider measuring its GHG contributions based on the amount of wastewater and solid waste generated by the township.

Summary: GHG Emissions in the Town of Caroline, New York

2013 v. 2018 GHG Emission Source (MT CO ₂ E)				
Year	Stationary Combustion	Electricity	Mobile Combustion	Total
2013	26.12	12.43	229	267.55
2018	40.10	9.19	213	262.29
% Change in Emissions	↑53.5%	↓26.1%	↑14.7%	↓1.0%

In total, the greenhouse gas emissions generated by municipal government in the Town of Caroline seem to have decreased by approximately 1%. This number should be considered as an estimate (but capturing at least 95% of the town’s GHG emissions) since it can be very difficult to capture every source of greenhouse gas emission involved in local government operations. Additionally, it is important to remember that waste disposal and treatment are also factors that are not considered in this inventory, solely because the disposal and treatment facility do not exist within the township. And finally, it is important to note that this inventory only estimates emissions created by the town government and does not take into account the greenhouse gas emissions generated by residents and businesses located within the township.

As Caroline is currently on track to implement sustainability measures such as installing new energy efficient technology in municipal buildings (i.e. geothermal) and opening new EV charging stations, this will cut the overall MT CO₂E. By the town being proactive and slowly implementing additional sustainability measures over time, the municipality will continue to see a decline in overall emissions, not just for municipal operations, but also for the entire community.

Conclusions: Impacts and Further Action

In 2018, the Town of Caroline created 266.99 metric tons of carbon dioxide equivalent. This is approximately equivalent to driving 57 average passenger cars for an entire year. Alternatively, it is equivalent to 3.5 gas tankers worth of gasoline.

The Town of Caroline has taken several concrete steps to help reduce their greenhouse gas emissions. These actions have included installing an EV charging station, geothermal

Gross Emissions by Department



Gross Emissions by Department



heating system within the town hall as well as solar system, upgrading the existing fleet to more fuel-efficient vehicles as well as upgrading internal lighting to LEDs. The town is also expected to install a new geothermal heating system in the existing town court, which is currently heated by gas.

Further reductions in emissions could come from upgrades to heating and cooling systems throughout all municipal buildings, such as installing air source heat pumps or geothermal in the Highway and DPW office. Another action that could significantly reduce overall emissions is upgrading the existing fleet to electric and or hybrid vehicles, which could cut the mobile emissions by at least half. As depicted in the above pie graph, the highway and vehicle emissions accounts for over 80% of the municipal operational emissions, and any reduction in fleet emissions would drastically decrease overall GHG emissions. Because the town has developed a fleet inventory, that information could be used as a baseline to assess how the town can move forward to make their fleet more efficient over time. While there are many ways to reduce energy consumption/ emissions, one other significant action the town could take is to change building operation hours to reduce overall energy usage. While most buildings are open during the day to take advantage of the natural light, there are times when the buildings can change operations according to the season to better utilize the sunlight and warmer weather.

2013 Summary Consumption and Emission					
Source	Electricity (kWh)	MTCO ₂ E from Kwh	Natural Gas (Therms)	MtCo ₂ E from NG	Total MT Co ₂ E
Town Hall	7,907	1.40	2218.7	11	12.4
Highway/DPW	20,741	3.66	2871.9	15	18.66
Streetlights	41,780	7.37	0	0	7.37

2018 Summary Consumption and Emission					
Source	Electricity (kWh)	MTCO ₂ E from Kwh	Natural Gas (Therms)	MtCo ₂ E from NG	Total MT Co ₂ E
Town Hall	6,013	0.81	2949.9	16	16.81
Highway/DPW	20,673	2.78	4601.2	25	27.78
Streetlights	40,212	5.40	0	0	5.40

There are also a variety of energy-conscious actions that municipal employees can take to reduce their contribution to greenhouse gas emissions. Opting for alternative modes of transportation, such as carpooling, or biking or walking in warmer months not only drastically reduces automobile emissions but can also have benefits for

personal health and wellbeing. Turning off and unplugging computers and other electronics, such as microwaves, coffee makers, printers, etc. when not in use reduces electricity consumption as well, as these things consume electricity even when they are not in use.

Though solid waste was not taken into consideration in this inventory, smart recycling practices throughout the town can drastically reduce the overall carbon footprint. If the average American household were to divert half of its garbage to recycling, they would save 2,400 pounds of CO₂ per year. In fact, for every 10% of waste reduction, 1,200 pounds of CO_{2e} are avoided.

In terms of wastewater, which is also excluded in this inventory, while the town does not have its own sewage treatment plant, considering how to reduce municipal wastewater can be another significant factor which decreases the overall emissions. One example for attempts to reduce wastewater is installing water efficiency fixtures, low water volume flushing toilets, and having rainwater storage tanks.

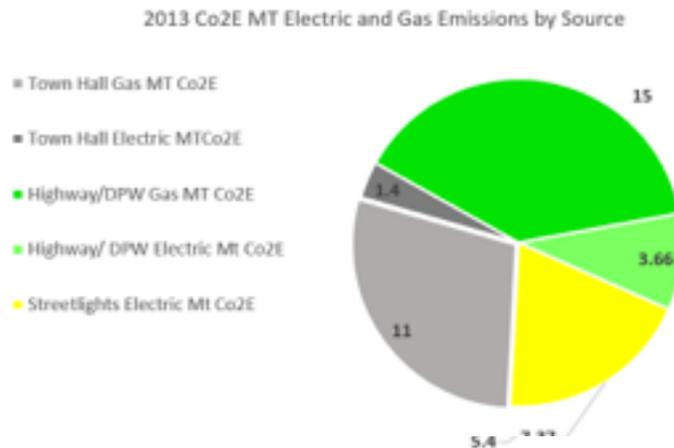
As mentioned above, the Town of Caroline has already begun the process of increasing its use of renewable and energy-efficient technology such as geothermal heating, solar panels, EV charging stations, and internal/ external LED lights. Further actions such as expanding solar technology use throughout all municipal buildings and replacing the current fleet with all electric or hybrid vehicles are just some of the efforts that the town can implement and see a major decrease in overall greenhouse gas emissions in government operations.

For Questions Regarding this Greenhouse Gas Inventory

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Sources and Further Information

Energy Star: LED Lighting and Energy Savings
<https://www.energystar.gov/homepage?s=footer>

United States Environmental Protection Agency: Greenhouse Gas Overview
<https://www.epa.gov/ghgemissions/overview-greenhouse-gases>

US EPA Historical Emissions and Fuel Economy Calculator:
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