City of Bath:
2019 Climate Action Plan

2018 Greenhouse Gas Emissions and Energy Use Inventory and Recommended Climate Action Plan

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I. Climate Change Background

Climate change has become a global crisis affecting communities around the world. Individuals, businesses, and government agencies are becoming more aware of the consequences of our decisions and are setting stricter goals for our future. Throughout history, the Earth's climate has always been experiencing periods of high and low atmospheric carbon dioxide levels. However, prior to human civilization, most of the earth's climate variations have been due to slight orbital variations altering the amount of solar energy received by the Earth, or by natural disasters such as volcanic eruptions. The Intergovernmental Panel on Climate Change (IPCC), an intergovernmental body of the United Nations committed to providing an objective, scientific view on climate change stated in their most recent report:

"Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century."[1]

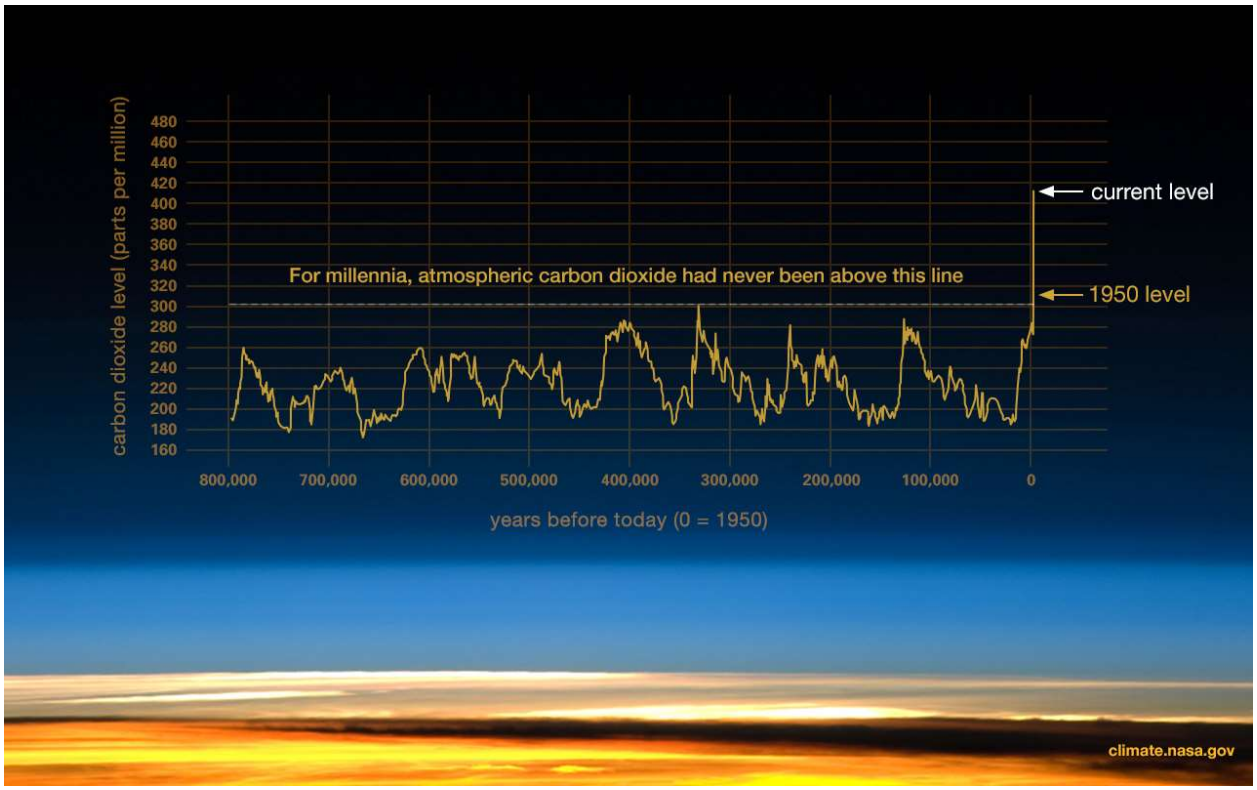


Figure 1. *Data from the past 800,000 years on atmospheric carbon dioxide concentrations in parts per million (ppm) based on ice core data. The high and low dips in CO_2 values show the cycle of ice ages (low CO_2 levels) and warmer interglacial periods (higher levels of CO_2). The highest previous CO_2 concentration was around 300ppm, 350,000 years ago. In 2017, the average level was 405ppm. This graph shows that CO_2 levels have been on the rise ever since the industrial revolution. Climate.nasa.gov,(Credit: Luthi, D., et al.. 2008; Etheridge, D.M., et al. 2010; Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO_2 record.)*[2,3]

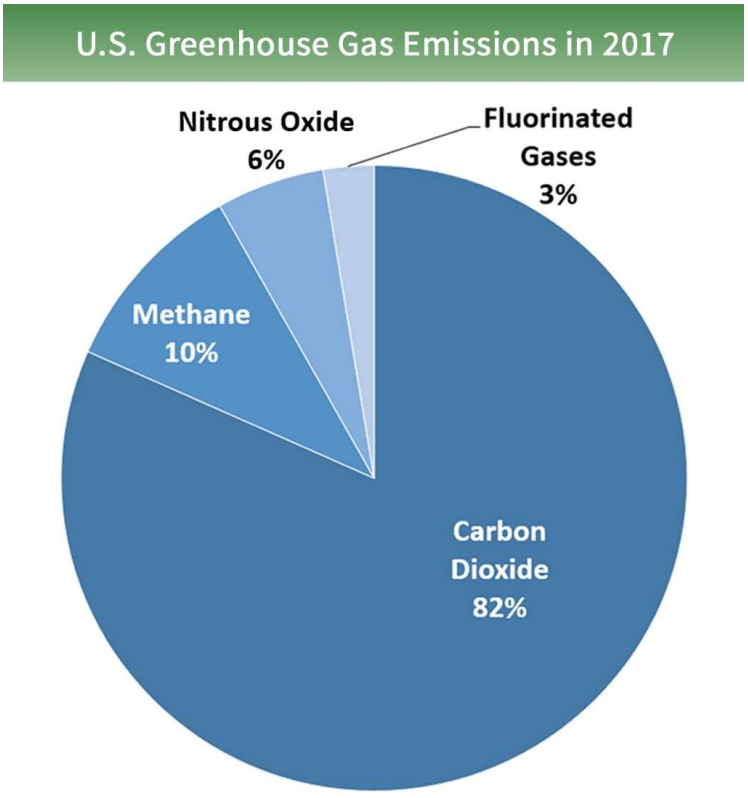
Scientists are attributing the severe effects of global warming to human activities that increase the amount of greenhouse gases found in the atmosphere. The greenhouse gas effect is the process that occurs when the combustion of fossil fuels like coal, oil, and gas release high amounts of carbon dioxide and other greenhouse gases into the atmosphere, and these gases trap heat coming from the sun causing the earth to heat up. The main greenhouse gases are as follows: carbon dioxide, methane, nitrous oxide, water vapor, ozone, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. For the purposes of this report, only carbon dioxide, methane, and nitrous oxide were accounted for. The following definitions are based off information from NASA and the EPA.[4,5]

Carbon Dioxide (CO_2): Carbon dioxide enters the atmosphere through the burning of fossil fuels such as coal, oil, and natural gas, and through other human activities such as deforestation and land use changes. Atmospheric carbon dioxide can be absorbed by plants and trees as part of the carbon cycle, therefore removing it from its hazardous role in the atmosphere. For reference, about 200 pounds of CO_2 are produced per 1 MMBtu of coal, 160 pounds of CO_2 are produced per 1 MMBtu of distillate fuel oil, and 117 pounds of CO_2 are produced per 1 MMBtu of natural gas.[6]

Methane (CH_4): Methane is mostly emitted during the generation and transportation of coal, oil, and natural gas. Other causes of methane emissions include livestock and agricultural practices, as well as the breakdown of organic waste in landfills. Methane is a much more potent greenhouse gas than carbon dioxide, but it is much less abundant in the atmosphere. Releasing 1kg of CH_4 into the atmosphere is equivalent to 25kg of CO_2.[7]

Nitrous Oxide (N_2O): Nitrous Oxide is mostly released through agricultural practices, as well as through fuel combustion, industrial practices, and wastewater management. Releasing 1kg of N_2O into the atmosphere is equivalent to 298kg of CO_2.[8]

All greenhouse gas emissions in this report are compared in terms of carbon dioxide equivalents (CO_2e). Since all fuels release different combinations of greenhouse gases, carbon dioxide equivalents are a way to standardize units when portraying the global warming affect of a specific activity. The burning of a certain fossil fuel may release carbon dioxide, methane, and nitrous oxide, and combining those into one standard unit makes it easier to understand and compare.



U.S. Environmental Protection Agency (2019). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017

Figure 2. *Chart comparing relative abundance of greenhouse gases in the atmosphere as a result of emissions in the U.S. Total emissions in 2017 were 6,457 Million Metric Tons of CO_2e. Data from the EPA's "Inventory of U.S. Greenhouse Gase Emissions and Sinks: 1990-2017."*[9]

1.) Climate Change - Affects on Maine

Climate change has been, and will continue to be, a severe threat to the coastal and mountainous regions of Maine. As a state that prides itself on its natural beauty and depends on its natural resources and wildlife to sustain its economy and provide jobs, Maine must continue implementing climate adaptation and mitigation strategies. The following list discusses a fraction of the changes Maine is experiencing as a result of climate change.[10,11]

- Rising sea level erodes beaches and wetlands, and increases the severity of coastal damage from storms. Tidal wetlands are extremely vulnerable to climate changes because of their low elevations, and shoreline development prevents them from migrating towards areas of higher elevation. These wetlands provide habitats for species such as the osprey, heron, and many fish. Losing these coastal wetlands means harming ecosystems and local food chains.
- Many Maine ecosystems are experiencing new disruptions because of climate threats. Rising temperatures are causing deer populations to increase, simultaneously causing a decline in forest underbrush which provides a place of safety for many animals. Warmer temperatures are also allowing invasive species to expand their range and destroy habitats.
- As ocean acidity rises, lobsters and shellfish lose their ability to properly build shells. Many fish species are also migrating northward to maintain a normal temperature range greatly affecting the seafood market in Maine.
- Warmer weather is increasing the occurrence of insect born disease and respiratory health problems. As the weather stays warmer for longer periods of time, tick season also becomes extended. Higher temperatures also amplify ground-level ozone contributing to respiratory problems like asthma.
- Warmer weather affects the quintessential snowy Maine winter and the local economies that depend on it.
- 90% of Maine is covered in forests and forestry provides over 19,000 jobs for Mainers. Suitable climate conditions for these forests are expected to decline greatly impacting the industries that rely on these forests.

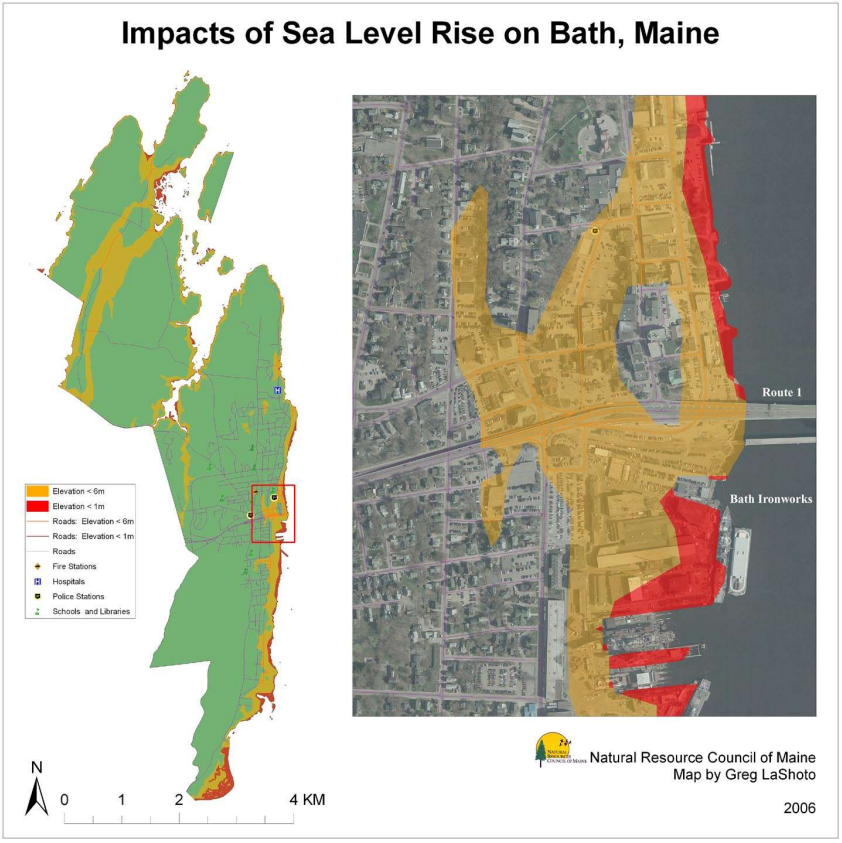


Figure 3. *Bath is listed as one of the top 20 Maine towns affected by sea-level rise by the Natural Resources Council of Maine. The impact on Bath is shown on the map below. Red shows elevation <1m, yellow shows elevation <6m. Map found on bangordailynews.com and was created by Greg LaShoto[12].*

II. Executive Summary

This study was created for the City of Bath through collaboration with Bowdoin College's Environmental Studies Fellowship Program. The study used a software called ClearPath, which is provided by *ICLEI: Local Governments for Sustainability*, and is designed for greenhouse gas emissions inventory on the local level. The software used a baseline year of 2018 for calculating all emissions and energy use within the government and community as a whole. Energy use and emissions were determined by entering data such as annual fuel use and type, building square footage, annual vehicle miles traveled within Bath, etc. Data was obtained through talking to City departments and employees, state agencies such as the Maine Department of Transportation and Maine Department of Environmental Protection, local companies such as Central Maine Power, City of Bath budgets from the Finance Department, and average household energy use determined by U.S. Census data from the 2018 Population Estimate. The software computes this data into total energy use and emissions, and provides preliminary graphs and charts. With this data, the City can determine which areas create the most emissions and use the most energy, and where the City should focus its energy for the next ten years.

The original City of Bath Climate Action Plan was created as an alternative to the signing of the U.S. Mayor's Agreement for Climate Protection in hope that the goals and reduction strategies would be more feasible and achievable for the City of Bath. This updated report is based off the same theory.

All recommendations made in this report are general measures the government and community can take. With the data and methods outlined in this report, the City will be able to maximize energy efficiency while minimizing emissions.

III. Research Summary

Data for the greenhouse gas emissions inventory were gathered from several different sources at community, municipal, and statewide levels for the baseline year 2018. The data collected were then entered into the ClearPath inventorying software provided by *ICLEI: Local Governments for Sustainability*. This software calculates the total energy consumption in MMBtu (Million British Thermal Units) and the greenhouse gas emissions in metric tonnes of carbon dioxide equivalents (CO_2e). Energy use information is plugged into the software, which then uses the global warming potential of each greenhouse gas to calculate the average amount of CO_2e produced by the mixture of greenhouse gases in each type of energy use. The software calculates emissions in tonnes of carbon dioxide equivalents since CO_2 is the most common greenhouse gas, although it is not the most potent.

The analysis portion of the inventory is divided into the Community Track and the Government Track. The Community section accounts for the total emissions from the entire city while the Government sections only accounts for emissions from municipally managed sources. It is important to note that government emissions are included in the community section, but analyzing government emissions separately gives the municipality more leadership and responsibility in reducing the City's emissions. The year 2018 was used since it was the most recent year from which the most complete and reliable data was available. In some cases Fiscal Year (FY) 17-18 was used, and in a few special instances earlier years were used because there was no complete data for 2018.

1.) Community Analysis:

The ClearPath software breaks the community track into six main sections: Residential Energy, Commercial Energy, Industrial Energy, Transportation and Mobile Sources, Solid Waste, and Waste and Wastewater. Other sections such as Agriculture, Process and Fugitive Emissions, Upstream Impacts of Activities, and Consumption Based were also available but not used for the purpose of this inventory.

Data collected for the ***Residential*** sector included Bath's total electricity usage in kilowatt hours (kWh), as provided by Central Maine Power (CMP); heating fuel use in gallons calculated by using data on the types of household heating fuel used in Bath, as provided by the U.S. Census; and statewide average consumption per household for Maine, as provided by the Energy Information Administration (EIA). Liquid Propane (LP) gas and fuel oil/kerosene were the two most popular residential house heating fuels in 2017 (2018 data was not yet available). "All other fuels" was the third highest, and was assumed to encompass wood, wood chips, and pellets. Since the EIA data was based on consumption estimates for the state of Maine, U.S. Census data on the entire state of Maine was used to calculate the average fuel consumption per household. This number was then multiplied by the number of households in Bath that used each type of heating fuel.

Total Residential Sector Energy Consumption: 463,354 MMBtu

Total CO_2 Equivalents: 28,174 MT

Data collected for the ***Commercial*** sector included the total electricity use provided by CMP and estimated heating fuel use calculated using state averages, also provided by the EIA. Information regarding all commercial buildings in Bath was obtained through the Assessor's Office. Commercial buildings were then split up by fuel type and building usage. Based on these two factors, the annual fuel usage for these buildings was calculated using the specific fuel's average energy intensity factor per square foot in the New England region (provided by the EIA).

Total Commercial Sector Energy Consumption: 234,486 MMBtu

Total CO_2 Equivalents: 12,442 MT

Data collected for the ***Industrial*** sector included total electricity provided by CMP and heating fuel use calculated using the average energy intensity per square foot provided by the EIA. Bath Iron Works (BIW) accounts for the majority of industrial emissions and their emissions were reported directly from the Maine Department of Environmental Protection (MDEP). Since emissions were reported directly, BIW's energy use from fuel consumption was not included. The total industrial sector energy consumption seen below is a result of overall industrial electricity usage and fuel consumption in industrial properties excluding BIW. The total industrial electricity usage provided by CMP included BIW and the other few industrial properties in Bath (Gagne Foods, Custom Composite Technologies, Kennebec Company). The exact electricity attributable to BIW was not available. However, BIW's fuel usage emissions accounted for 99% of the industrial fuel use emissions.

Total Industrial Sector Energy Consumption: 338,581 MMBtu

Total CO_2 Equivalents: 30,965 MT

Data collected for the ***Transportation*** sector included the total vehicle-miles traveled – or "VMT" - inside the city based on traffic survey estimates provided by the Maine Department of Transportation (MDOT). This includes travel by vehicles passing through the city, but does not include travel by Bath residents outside of the city. Denise Cormier at the MDEP was able to compile a list of registered vehicles in Bath for the year 2018, and Ed Beckwith at the MDOT was able to provide the annual vehicle miles traveled within Bath during 2018. Based on this data, total VMT for each vehicle type in Bath was able to be calculated.

Total Transportation Sector Energy Consumption: 259,455 MMBtu

Total CO_2 Equivalents: 17,749 MT

Data collected for the ***Solid Waste*** sector included the total amount of waste (in tons) coming from Bath and contained in the Bath Landfill, as well as the total amount of compost collected by Garbage to Garden. Emissions associated with the landfill were found by using a few different calculators provided by ICLEI. One calculator helped compute downstream landfill emissions from landfill destined waste generated by the community. This calculator estimates all future methane emissions from the tons of waste sent to the landfill in 2018. Another calculator estimated the emissions that resulted from the flaring of landfill gas. A final calculator computed emissions associated with the use of landfill equipment.

Total Solid Waste Energy Consumption: 2,983 MMBtu

Total CO_2 Equivalents: 3,181 MT

Data collected for the ***Water and Wastewater*** sector included the heating and electricity usage at the treatment plant and its pump stations. Energy use from the Bath Water District was included in the community track since its operations are not controlled by the City. Bath Water District provided an estimate of how much of their electricity and water was being used in only Bath since they serve a much larger community. The calculators provided by ICLEI calculated emissions associated with the supply of potable water, private septic systems, N_2O emissions from the effluent, and overall emissions from the use of WWTP equipment.

Total *Water and Wastewater* Energy Consumption: 7319 MMBtu

Total CO_2 Equivalents: 379 MT

2.) Government Analysis:

The ClearPath software breaks the government track into seven main sections: Buildings and Facilities, Street Lights and Traffic Signals, Vehicle Fleet, Transit Fleet, Employee Commute, Solid Waste Facilities, and Water and Wastewater Treatment Facilities. Other sections such as Electric Power Production and Process and Fugitive Emissions were also available but not used for the purpose of this inventory.

Data collected for the ***Buildings and Facilities*** sector included total electricity and fuel usage for buildings owned and operated by the City of Bath. Total municipal electricity usage was provided by CMP, and fuel types and usage were provided by the Office of Finance.

Total Buildings and Facilities Energy Consumption: 14,691 MMBtu

Total CO_2 Equivalents: 814 MT

Data collected for the ***Vehicle Fleet*** sector included the total gallons of gasoline and diesel fuel used by City-owned vehicles. This information was provided by the Public Works Department, who maintains the municipal fuel storage. Average VMT for each vehicle was calculated by multiplying each vehicle's annual fuel usage by the vehicle's average MPG.

Total Vehicle Fleet Energy Consumption: 7,645 MMBtu

Total CO_2 Equivalents: 639 MT

Data collected for the ***Transit Fleet*** sector included the total gallons of gasoline and diesel fuel used by the two City buses and trolley. This information was provided by the Public Works Department and Maintenance Department. Emissions from the *Transit Fleet* are included in the *Vehicle Fleet* category on all future graphs and charts.

Total Transit Fleet Energy Consumption: 852 MMBtu

Total CO_2 Equivalents: 60 MT

Data collected for the ***Employee Commute*** sector included the total annual vehicle-miles traveled to and from work by City employees in each department. Type of car was not accounted for.

Total Employee Commute Energy Consumption: 2,043 MMBtu

Total CO_2 Equivalents: 145 MT

Data collected for the ***Streetlights*** sector included the total energy use for the 645 CMP- owned City streetlights. Number of streetlights and total electricity usage was provided by CMP.

Total Streetlight Energy Consumption: 1,252 MMBtu

Total CO_2 Equivalents: 145 MT

Data for the ***Solid Waste*** sector included the total tons of waste produced in Bath and entering the Bath Landfill. Because the landfill is owned and operated by the City, methane emissions from decaying waste were calculated in the government track. Data regarding the Bath Landfill was provided by the Public Works Department. The calculators provided under the solid waste section in the government and community tracks are slightly different. As a result, there is a discrepancy between the way in which solid waste emissions are calculated and the final emissions.

Total Waste Energy Consumption: 5,814 MMBtu

Total CO_2 Equivalents: 3,062 MT

Data for the ***Water and Wastewater*** sector included the electricity and heating fuel used at the treatment facility and pump stations within Bath, as well as nitrogen emissions from naturally occurring nitrification/denitrification and effluent discharge to the river. Energy use from the Bath Water District is not included in the government inventory since their operations are not controlled by the City.

Total Water and Wastewater Energy Consumption: 4,936 MMBtu

Total CO_2 Equivalents: 376 MT

IV. Data Results and Analysis

This section outlines the results of the inventory in more specific detail. It is important to note that the data presented in this report are estimates and that the precision of these estimates is limited by the following:

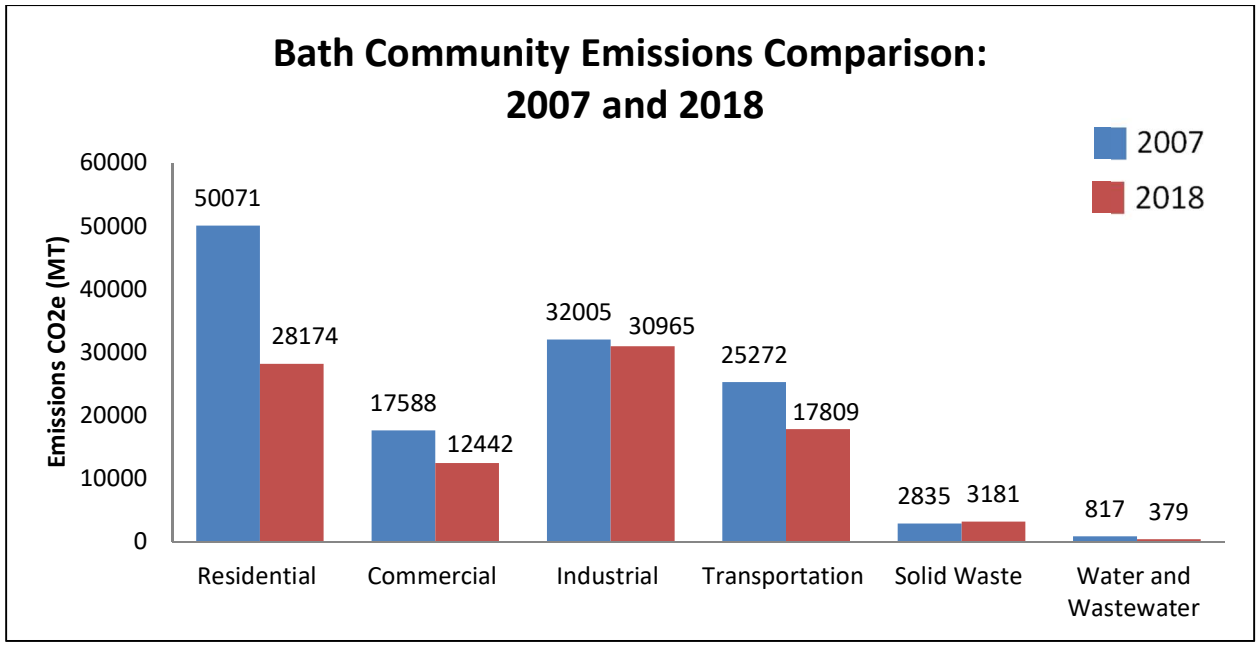
1. In some cases, important data were not attainable for a variety of reasons. Some organizations were not able to disclose energy use information because of strict protocol or the limited time available to obtain necessary data.
2. Not all greenhouse gases were accounted for in this inventory. Carbon dioxide, methane, and nitrous oxide are the most abundant and easiest to collect data on because of their direct relationship with human activities. Emissions from perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs) are difficult to calculate because the use of chemicals that release them are not well recorded.
3. The data collected varies between being regional/state averages and specific to Bath. Data specific to Bath were used whenever possible and state averages and estimations were used to fill in the blanks. For example, the electricity usage was obtained through information from Central Maine Power and invoices from the Finance Department that were all specific to Bath. On the other hand, heating fuel consumption for the community track was estimated using the average fuel use per square foot of buildings in the Northeast.
4. The time periods for which the data were collected varied based on the availability of information. Most data were compiled from the 2018 calendar year or 2017-18 fiscal year. Data from the census were based on their 2018 population estimate as of July 1, 2018. Occasional data were used from earlier years only if that was the most recent option.
5. Human error must always be taken into account. Gathering data on the collection end is extremely difficult, and transferring that information to another party to analyze and report may very well include some sort of human error or miscalculation.
6. This inventory and report is an update to the *City of Bath Energy Inventory and Climate Action Plan* created in 2008. Although the main reason for conducting this inventory ten years later was for the purpose of comparing 2007 to 2018 emissions levels, it is important to note the factors that complicate the comparison:
    a. *ICLEI – Local Governments for Sustainability* provided the software for both inventories, but over the ten years there have been many updates as to how information is recorded and presented.
    b. Precise steps and methods were not always included in the 2008 report making it difficult to standardize collection techniques over the ten years.
    c. Graphs and charts created by the software are not the same and do not present information in the same way between the two years.

Despite the many deficiencies and difficulties, the data presented in this report represents the most recent, available, and complete data to the best knowledge of all parties involved.

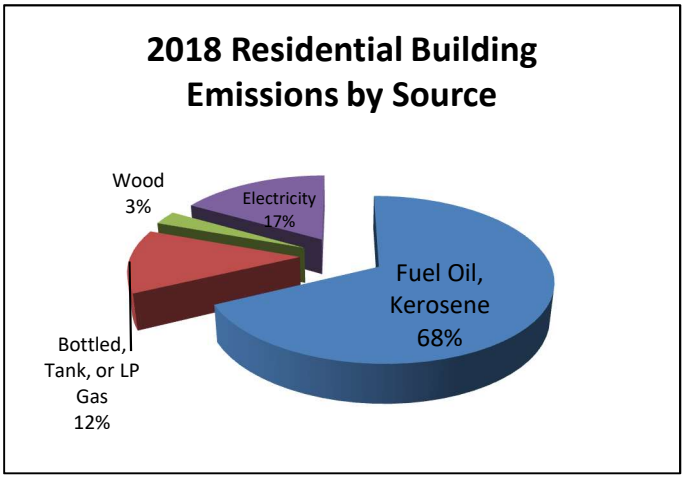
1.) Community Emissions and Energy Use

The Community Track accounts for the emissions and energy use for the entire City of Bath. This includes all emissions from the government, heating and electricity use in residential, commercial, and industrial buildings, fuel use from transportation within the community, and emissions associated with the landfill and water and wastewater treatment facilities.

In 2018, Bath emitted **92,950 MT of CO_2e**, and consumed **1,306,178 MMBtu** of energy. The Community Track analysis provides a good estimate of the total emissions released by the City of Bath, however it is less precise than the analysis of the government track because the community inventory relies more on regional and state averages, and therefore may be less accurate. Overall, the entire Bath community saw a 27% reduction from 2007 emission values. (In 2007, Bath emitted 127,772 metric tonnes of CO_2e and consumed 1,284,423 MMBtu of energy.)



Residential

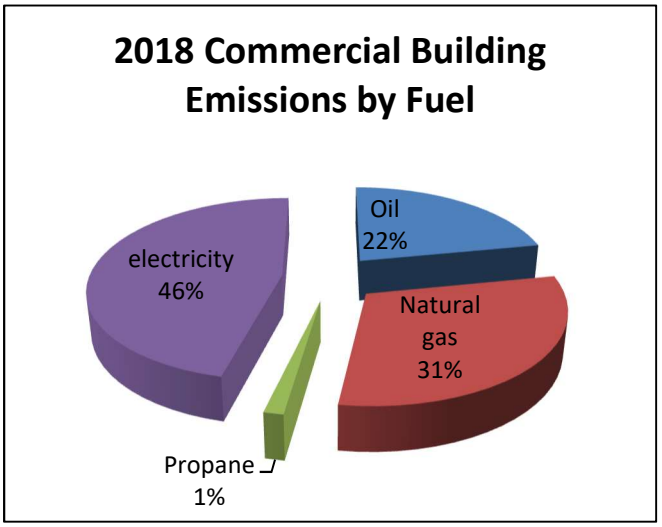


In 2018, Bath residents emitted approximately 28,174 MT of CO_2e, accounting for 31% of the total emissions from the City. The residential sector also consumed 463,354 MMBtu of energy, accounting for 36% of overall City consumption. The residential sector was the second largest contributor to Bath's overall community emissions falling right behind the industrial sector.

The U.S. Census estimates Bath's 2018 population to be 8,329 (as of July 1, 2018), which is a 185-person decrease from the 8,514 estimate in the 2010 census. The 2013-2017 American Community Survey 5-Year Estimates provided data on the number of Bath residential buildings using which type of heating fuel in 2017. The residential heating fuels were: utility gas; bottled, tank or LP gas; electricity; fuel oil, kerosene, etc; all other fuels; and no fuels used. The top three heating fuels were fuel oil/kerosene (68% of residential building emissions), LP gas (12%), and all other fuels which were assumed to be wood, wood chips, and pellets (3%). Electricity use emitted 4,771 MT of CO_2e and consumed 106,515 MMBtu of energy. There are some residential homes in Bath that have their own solar panels and are contributing to the offset of carbon emissions, however that information was not able to be obtained and recorded in this report.

Commercial

According to the U.S. Census' 2012 Survey of Business Owners, they are 1,147 companies within the City of Bath. Commercial businesses accounted for 12,442 MT of CO_2e, 13% of the City's total. The commercial sector consumed 234,486 MMBtu of energy, 18% of total City consumption. The municipal government's building emissions are contained in the commercial sector and account for 8% of the total commercial building emissions.



Industrial

The emissions from the industrial sector amounted to 30,695 MT of CO_2e, accounting for 34% of all community emissions. Industries (excluding BIW) consumed 338,581 MMBtu of energy, 27% of City energy use. Bath Iron Works is the largest industrial emitter in the Bath, accounting for 99% of emissions from fuel use within the industrial sector. Because BIW's emissions were received directly from the MDEP in terms of MT of CO_2, methane, and nitrous oxide, BIW's energy usage was not able to be calculated since there was no data on fuel type and fuel usage. The industrial electricity usage provided by CMP includes BIW and all other industrial properties (Gagne Foods, Custom Composite Technologies, Kennebec Company) making it difficult to separate just BIW's electricity usage.

Transportation

Transportation within the City produced 17,749 MT of CO_2e, accounting for 19% of the total community emissions. The transportation sector also consumed 259,455 MMBtu of energy, 20% of total City energy consumption. Gasoline fueled cars accounted for 96% of these emissions, diesel 3%, and hybrid 1%. These calculations account for transportation within the City boundaries and do not include travel outside of the City of Bath.

Water and Wastewater Treatment

Operating the Water Pollution Control Facility and pumping stations resulted in 379 MT of CO_2e, accounting for less than 1% of the overall City emissions. The plant consumed 7,319 MMBtu of energy, accounting for 1% of government energy use. Emissions associated with the Bath Water District were included in the community sector. Because the Bath Water District serves surrounding towns in addition to Bath, and the water treatment plant is not in Bath itself, emissions were difficult to calculate. However, it is important to still include these emissions since Bath is using a portion of the water that is treated at the facility. The Bath Water District was able to provide an estimate of the amount of electricity used for the City of Bath, as well as the volume of water that is sent to Bath. Emissions from supplying potable water accounted for 109 MT of CO_2e. Emissions from private septic systems were also included in this section, but were very minimal in comparison to all other emissions.

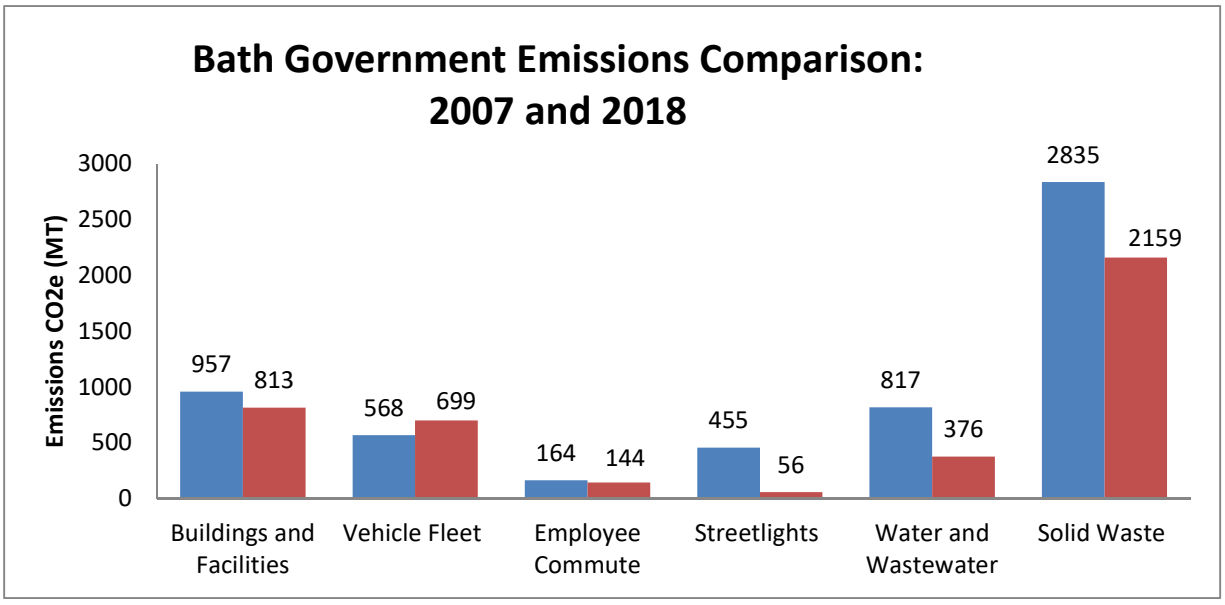
Solid Waste

Emissions from solid waste within the community sector accounted for 3,181 MT of CO_2e, 3% of the total community emissions. The calculators provided under the solid waste section in the government and community tracks are slightly different. As a result, there is a bit of discrepancy between the way in which solid waste emissions are calculated and the final emissions. Methane from decaying solid waste is the biggest emitter of greenhouse gases at the landfill. The landfill currently flares its gas, reducing emissions significantly. The City has looked into harnessing the landfill's gas to create renewable energy, but this project was not economically feasible for the city at the time.

2.) Government Emissions and Energy Use

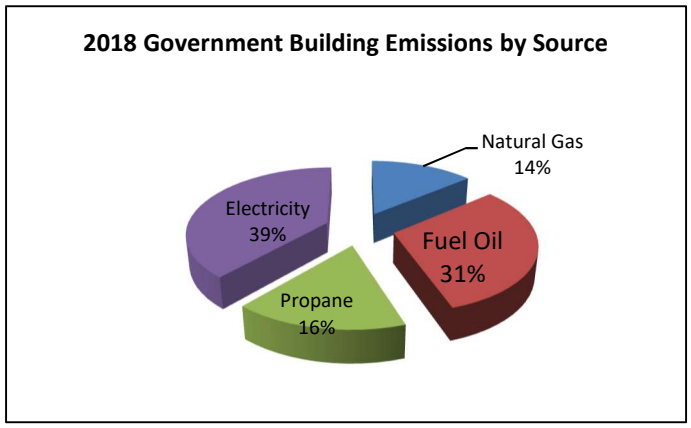
The Governmental Analysis accounts for the emissions and energy use from all operations of the municipal government. This includes electricity and heating fuel use in all municipal buildings, gasoline and diesel fuel use by the City's vehicle fleet, fuel use from City employee commuting, electricity for streetlights, electricity for water and waste management, and process emissions and methane emissions from the Bath Landfill. The municipal buildings included in this inventory are: City Hall, Public Works Department, Fire Department, Cemetery (office and garage), Police Department, Landfill, Water Pollution Control Facility, Recreation Department, Train Station, 2 Town Landing, Armory, and Lambert Park Community Center.

In 2018, the City of Bath government was responsible for emitting **4,251 MT of CO_2e,** 4.6% of the total Bath community emissions. The City government also consumed **38,470 MMBtu of energy**, 3% of the total Bath Community energy consumption. Overall, the City of Bath government saw a 27% reduction from 2007 emissions values (excluding Bath School data in 2007). With the Bath School emissions included in the 2007 data, the City of Bath government saw a 49% reduction from 2007 emissions values. In 2007, the Bath government emitted 5,796 metric tonnes of CO_2e excluding Bath Schools, and 8,408 metric tonnes of CO_2e including Bath Schools. The City also consumed 63,573 MMBtu of energy.



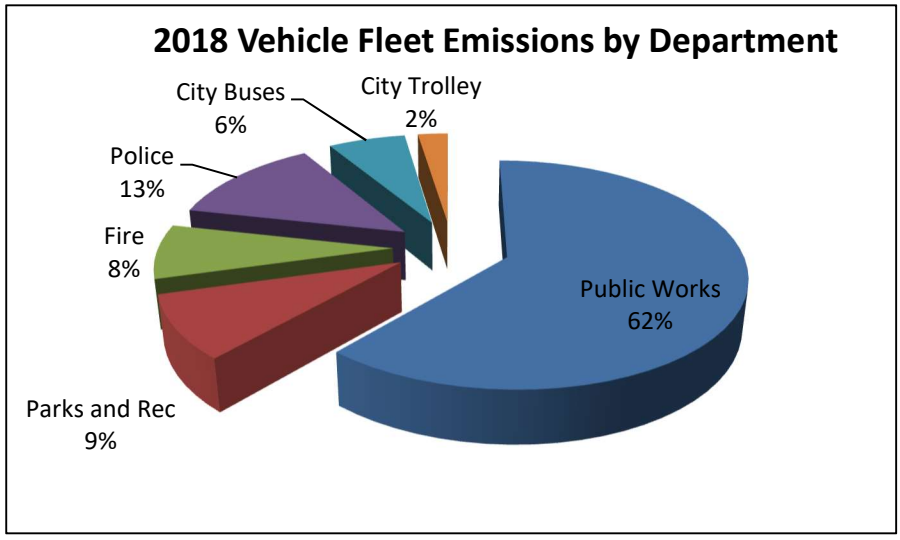
Note: Bath School emissions were subtracted from 2007 values for comparison purposes because the Bath Schools are now a part of RSU1 and included in the community track only.

Buildings and Facilities



Emissions from the government buildings amounted to **814 MT of CO_2e** and accounted for approximately 19% of the total municipal emissions. Buildings were the second highest emitter in the government track, falling behind the landfill. Buildings used 14,691 MMBtu of energy, approximately 39% of the total community consumption. Within the buildings, electricity was the most significant source, accounting for 39% of emissions. Fuel oil was second highest, accounting for 31% of emissions. Natural gas and propane together accounted for the remaining 30% of government building emissions. The Bath Schools were included in the *Buildings and Facilities* section of the government track in the 2008 report, but are included in the community section of the 2018 report since they are now a part of RSU1. As a result of this, the emissions associated with the *Buildings and Facilities* section of the 2008 report are much higher. In some cases, Bath school emissions were subtracted from 2007 values in the government track to perform more accurate comparisons.

Vehicle Fleet (Including Transit Fleet)



Bath's municipal vehicle fleet is comprised of vehicles from the following departments: Public Works, Parks and Recreation, Police, and Fire. Although the ClearPath software inventories the City's vehicle and transit fleet in two separate sections, they are combined into one section in all graphs found in this report. The City's vehicle and transit fleet together produced 699 MT of CO_2e emissions, accounting for 17% of the total government emissions. The fleet consumed 8,497 MMBtu of energy, 23% of the total government consumption. The biggest emitter within the City's vehicle fleet was the Public Works Department, emitting 431 MT of CO2e, accounting for 62% of total government vehicle emissions. Gasoline fuel contributed to 65% of emissions with diesel contributing to the other 37%. School buses were included in the *Vehicle Fleet* section of the government track in the 2008 report, but are included in the community section of the 2018 report since they are now a part of RSU1.

Employee Commute

Employee commuting by municipal workers produced 144 MT of CO_2e, accounting for 3% of total government emissions. Commuting consumed 2,043 MMBtu of energy, accounting for 6% of the total government energy consumption. Calculations were based off average City of Bath employee commute mileage data.

Streetlights

Streetlights in the city produced 56 MT of CO_2e, accounting for 1% of the total emissions. Powering the lights consumed 1,252 MMBtu of energy and accounted for 3% of government energy consumption. Streetlight emissions were substantially lower in 2018 than in 2007. The reasoning for this is still unknown, but there have been some changes that are responsible for a portion of the drastic decrease. All of the City's downtown streetlights are now LEDs. In 2007, the streetlights provided by CMP were mercury vapor bulbs which lose about 50% of their light upward. Over the past ten years there has been a transition to the use of high pressure systems and cut-off fixtures which retain more light and are therefore more efficient.

Water and Wastewater Treatment

Operating the Water Treatment Control Facility and pumping stations resulted in 376 MT of CO_2e, accounting for 9% of the total government emissions. The plant consumed 4,936 MMBtu of energy, accounting for 13% of government energy use.

Solid Waste

The Bath Landfill was the largest emitter within the government, releasing 2,159 MT of CO_2e, accounting for 51% of the government emissions. The landfill consumed 5,815 MMBtu of energy which accounted for 16% of total government energy use. Emissions and energy from transporting the waste was not accounted for.

V. Achievements

The Bath Government, Bath Schools, businesses, and residents in the community have all taken steps to address energy use and lower emissions values since 2007 levels. The City of Bath has implemented a number of conservation measures over the years and some departments have done significant building renovations with energy efficiency in mind. As energy costs rise and concerns about climate change drastically increase, many individuals are making personal changes in their daily lives to address energy issues. The following list gives an overview of the many actions that have been taken since the 2007-2008 Climate Action Report.

1.) Community Achievements

Residential

Although it is difficult to attain data on steps residents have taken to reduce their emissions, the residential sector saw a large decrease in emissions from 2007 values. Data from the U.S. Census showed that more residents are using alternative heating sources, and some residents have installed personal solar panels on their homes. Over the past ten years, residents have been making more conscious decisions about saving energy through the better insulation in their homes, more energy efficient appliances, conscientious water usage, etc.

Commercial

Currently, 13 businesses within the City of Bath use Garbage to Garden for composting, and many have switched to natural gas or electricity for heating. As a part of the community track, the Bath Schools have also made many changes to reduce their emissions.

- Morse High School replaced all windows with double panes to reduce the amount of heat being lost, all lighting was switched from T-12 to T-8 fixtures, heating controls were automated for better control and efficiency, and single stream recycling was implemented in 2009.
- Bath Middle School replaced all lighting from T-12 to T-8 fixtures and T-5 fixtures in the gym, in 2017 all lighting was upgraded to LEDs, heating controls were update to natural gas in 2019, and single stream recycling started in 2009.
- Dike Newell School replaced all T-12 fixtures with T-8 fixtures, heating controls were replaced in 2010, heat is currently being upgraded from steam to a hot water system, and single stream recycling was implemented in 2009.
- Fisher Mitchell School got a new boiler in 2017, heating controls were updated in 2010, lighting switched from T-12 to T-8 in 2009 and then to LEDs in 2016, a new hot water boiler was installed in 2016, and single stream recycling began in 2009. Parking lots at all schools have installed LED lights.
- RSU1 has reported that fuel usage, as well as electrical costs, have dropped significantly over the past ten years.

Industrial

BIW accounts for close to 99% percent of industrial emissions, and they have been taking many steps to reduce their emissions despite increasing in size since 2007. Through their partnership with Efficiency Maine, Bath Iron Works is in the midst of a multi-year program to replace metal halide and high pressure sodium lighting with more efficient LEDs for use in temporary fixtures on ships under construction, and for fixed lighting at its several production buildings leading to a significant reduction in electricity use.

Transportation

The transportation sector saw a large reduction in emissions largely due to the growing popularity of hybrid and electric vehicles. Over the past ten years, many cars have also seen increasingly better mileage per gallon of fuel. The City still continues to provide a bus service throughout the city as a way to decrease individual car emissions. Sidewalks were added to North Street and Congress Street, Whiskeag Trail was built for biking and hiking, and bike lanes have been added to many streets.

Solid Waste

Currently, 160 households within the City of Bath use Garbage to Garden for composting. With single stream recycling and curbside pickup, it is extremely easy for residents to recycle at their homes. Both composting and recycling substantially reduce the amount of solid waste that would otherwise go to the landfill.

Water

Bath Water District has done a lot to decrease their emissions. Electric motors that are variable frequency driven are used at the plant, lighting upgrades are constantly happening to keep up with the most efficient lighting, a project to increase insulation is currently taking place, solar panels are used at a couple remote sites on tanks as backup options, and the office building in Bath is fueled by natural gas.

2.) Government Achievements

Buildings

As suggested in the 2008 plan, many municipal buildings had energy audits completed in 2011 to address the ways in which buildings could be reducing their emissions. As a result of these audits, City Hall, the Police Department, and the Train Station all switched to natural gas, and insulation/window updates took place in many municipal buildings. Lighting in all municipal buildings has progressively become more and more LEDs, and controls and thermostats have been installed in buildings for better heating control.

Streetlights

As mentioned before, the streetlight sector saw a substantial reduction from 2007 levels, but the exact reasoning for this drastic reduction is still unclear. All downtown streetlights within the City have been upgraded to LEDs. In 2007, CMP still used mercury vapor bulbs which lost 50% of the light upwards. The transition to high pressure systems and cut off fixtures have allowed for more efficient electricity generation.

Vehicle Fleet

The municipal vehicle fleet saw the lowest improvement out of all the government sectors. The 2008 report suggested the use of hybrid vehicles for the police fleet. The City looked into this option, but hybrid cars are not able to perform the tasks police vehicles must be able to do. As technology continues to improve, hybrid municipal fleet vehicles may become a feasible option again.

Solid Waste

The City has continued to put an emphasis on recycling with single stream recycling bins in all City offices. Compost has also become more popular within the City. City Hall has its own compost bin, and the City partners with Garbage to Garden during Bath Heritage Days where 90% of the generated waste

during the festival was put toward compost or recycling this past year. The landfill has also upgraded to a more energy efficient compactor.

Water and Wastewater Treatment

The Water Pollution Control Facility has seen many upgrades over the past 10 years at the plant and its pumping stations. One of the larger pump stations which used high energy motors has been upgraded to more energy efficient motors. Many lights have been changed to fluorescents and all parking lots lights are LEDs. There is a new high efficiency boiler that has the ability to take natural gas if needed, new efficient aeration blowers were installed and the office uses seven heat pumps. On “high demand” days when CMP increases their electricity cost and generation, the WPCF shuts down all electricity usage and only uses a generator. Although the generator still has its own emissions, this method decreases the overall amount of electricity CMP has to generate. A new storm water separation project was implemented to decrease the amount of treatment rainwater must go through after every storm. Storm water is now separated from sewage water so that during big rain events, the abundance of storm water does not have to go through the same extensive treatment process as the sewage water.

VI. Action Plan – Next Steps

Through the greenhouse gas emissions inventory, it is clear which areas produce the most emissions and consume the most energy, and which areas should be top priorities for the next ten years. This section concentrates on possible reduction strategies for the future, and is divided into government and community sections. It is important to note that some of these strategies are the same as the ones mentioned in the 2007-2008 Climate Action Plan. There were many recommended measures that the government looked into, but was not able to follow through with for a variety of reasons. These recommendations have been included in this plan in the hope that they will become possible in the next ten years as technologies become more advanced and available.

1.) Recommended Measures for the Community

Recommendations for the community sector are harder to enforce because it is up to individual citizens to take action. The City and other organizations should work together to share information with the public and to create educational campaigns so that Bath residents are aware of their impact on the environment, the choices they have, and alternative options. As more energy-related funding becomes available from state and federal sources, the City might serve as a conduit for loans, grants, services, and information.

Residential

The residential sector accounts for 30% of the City's emissions, the second largest emitter behind the industrial sector, and 36% of overall energy consumption. Within the residential sector, it is up to individual citizens to take initiative and reduce their own carbon footprint. Some residents have already become leaders in terms of using alternative energy and have purchased solar panels for their home. The largest emitter within the residential sector is the use of heating fuel oil. Residential emissions could be lowered by turning toward natural gas, electric heating pumps, better insulation, and of course alternative sources such as solar. Emissions associated with electricity use can be reduced by purchasing all LED lights, energy efficient appliances, and by shutting off appliances when not in use.

Commercial

It is advised that businesses follow the same guidelines as outlined in the residential section above. Electricity is the biggest emitter within the commercial sector, and switching to LEDs and the use of natural light whenever possible can have large impacts on the emissions related to electricity use. It is also advised that more commercial buildings switch to natural gas as it becomes more available. The commercial sector also includes emissions from the Bath Schools. 77% of the Bath School emissions come from the use of heating fuel oil. As a large emitter within the City, it is advised that the schools switch to natural gas when available, as well as begin to look into alternative energy sources for the future. The schools are a great place to promote sustainable practices and educate residents about our impact on the environment. The younger generation is the hope for the future, and providing resources and education at this age is extremely important.

Transportation

Transportation accounted for 19% of overall Bath emissions. 96% of those emissions came from the use of gasoline. Increasing the number of residents driving hybrid and electric vehicles would decrease emissions substantially. Incentivizing the use of these vehicles with more charging stations around town, as well as special parking could increase the number of residents that invest in these structural changes. Public transportation is also available and should be utilized more frequently. There are two city-run

buses that have regular routes and schedules within the City. Finally, through increased sidewalk and bike lane construction, walking and biking should become more utilized forms of transportation for shorter distances. Economic incentives for walking/biking to work or to shop could be a possible option for private businesses or the city as a whole.

Solid Waste

Residents have done a great job incorporating the use of compost in their everyday lives over the past ten years. Currently, 160 residents within the City use Garbage to Garden for composting. Increasing that number would have immense impacts on the amount of waste being transported to the landfill. If Bath were to double the number of residents that use compost from 160 to 320, the City of Bath could divert 3,600 tons of organic waste from entering the landfill over the next ten years.

Water and Wastewater

Pledging to never use plastic water bottles and installing more water stations around the downtown would limit the amount of waste associated with buying these bottles. The Bath Water District is providing clean, local water that has very minimal transportation costs. Increasing the use of water provided by the BWD instead of buying plastic water bottles and jugs would have huge benefits in terms of emission reductions. Not only are plastic water bottles increasing the amount of plastic in the City, but they are also adding to the emissions associated with producing and transporting these bottles. Water from the BWD is just as clean with a substantially smaller carbon footprint.

2.) Recommended Measures for Bath Government

Buildings and Facilities

Municipal buildings accounted for 19% of government emissions and 39% of government energy use. In the building analysis, electricity accounted for 39% and fuel oil accounted for 31% of those emissions. There are several ways to address electricity and fuel use within the city.

- Continue to update all municipal lights to LEDs
- As the natural gas lines expand within Bath, continue to increase the number of municipal buildings using natural gas. This means that any municipal building heating upgrades should be selected with the ability to take in natural gas.
- Perform a cost-benefit analysis of using solar energy in municipal buildings. Options for this could include investing in solar panels directly on municipal buildings, or investing in a solar farm that would allow the City to receive offset credits.
- Transition the Public Works equipment fleet to natural gas, hybrid, or electric as technology allows.
- Use of alternative materials to pave streets to turn away from fossil-fuel based asphalt as technology allows.

Streetlights

The reasoning for why streetlight emissions decreased at such an alarming rate is still unclear. However, based on this data, streetlights accounted for only 1% government emissions. Despite being the smallest

emitter within the government track, switching all streetlights to LEDs would allow for large energy savings.

Municipal Vehicle Fleet

Bath's municipal vehicle and transit fleet produced 17% of the total government emissions and was the only section that saw a slight increase from 2007 values. All city vehicles today are powered by gasoline or diesel. Looking into hybrid or electric vehicles for the municipal fleet should be considered as technologies become more advanced.

Employee Commute

The employee commute accounted for 6% of total government emissions. Although it is hard to reduce these emissions since employees are able to use whatever mode of transportation they chose, the City could consider implementing an incentive program to encourage government employees to walk, bike, carpool, or use more forms of public transportation for their daily commute.

Waste

Operating the Bath Landfill accounted for 51% of all government emissions, and 16% of government energy use. In 2008, the City began burning landfill gases to minimize the amount being released into the atmosphere, and this process is still being continued today. The City discussed the option of harnessing landfill gas to use as energy, but the costs associated with this project were not feasible at the time. This suggestion should still remain an option in case it becomes more attainable in the next ten years. Other options for reducing emissions associated with solid waste within the City include:

- A broader acceptance and use of composting city-wide to reduce the tons of organic waste being transported to the landfill
- Opening of a solar farm on the south facing slopes once the landfill has closed
- Continue using the flare to reduce methane and other greenhouse gases that escape into the atmosphere

Water and Wastewater Treatment

Water and wastewater treatment accounted for 9% of government emissions and 13% of government energy use. This includes all emissions associated with operations at the Bath Water Pollution Control Facility. Steps to reduce emissions at the WPCF include:

- Continue the transition to all LEDs at the plant
- Invest in new dewatering equipment that is able to draw more water out of the biosolids, subsequently reducing the amount of biosolids going to the landfill
- Consider the use of an anaerobic digester that will reduce sludge production by 40-60%, subsequently reducing the amount going to the landfill. This method produces a biogas consisting of methane, carbon dioxide, and other gases which can then be used as fuel.
- Continue updating all pump stations to increase efficiency and effectiveness of cleaning the water.

VII. Final Conclusions

Change starts at the local level, and the City of Bath has the opportunity to become a leader in climate action. This report gives the City of Bath Government and citizens the information needed to take action and commit to reduce energy consumption and overall emissions. All recommendations in this report are suggestions based off the 2007-2008 Bath Climate Action Plan, as well as results from the greenhouse gas inventory process.

Large, structural changes may be associated with some upfront costs, but most of these measures will see a timely return and will save money in the long-term. As technologies advance, the possibility of investing in large-scale changes will hopefully become more available and feasible for the City and community.

The 2007-2008 Climate Action Plan set a 2% reduction goal per year for an overall 20% reduction in emissions by the year 2018. Based on the data in this year's inventory, the City and community of Bath saw a 27-28% reduction in emissions from 2007 values. Based on this data, and the expectation that the City of Bath and its residents will continue to reduce energy use and make climate change a prominent issue, this plan recommends that the City attempt to reduce emissions by 40% from 2018 levels by the year 2030.

City of Bath Resolution on Energy Conservation and Climate Protection

WHEREAS, A scientific consensus has arisen that a continual release of greenhouse gases into the atmosphere will have a profound effect on the earth's climate, including rising sea levels, melting of Arctic ice sheets, extreme temperature changes, habitat disruption, human health concerns, and overall climate disruption; and

WHEREAS, Energy consumption, specifically the burning of fossil fuels, such as coal, oil, and gas, are one of the largest emitters of U.S. greenhouse gas emissions; and,

WHEREAS, State and local governments have an immense influence on their community's energy consumption by exercising key powers over land use, transportation, building construction, waste management, and protection of green space; and,

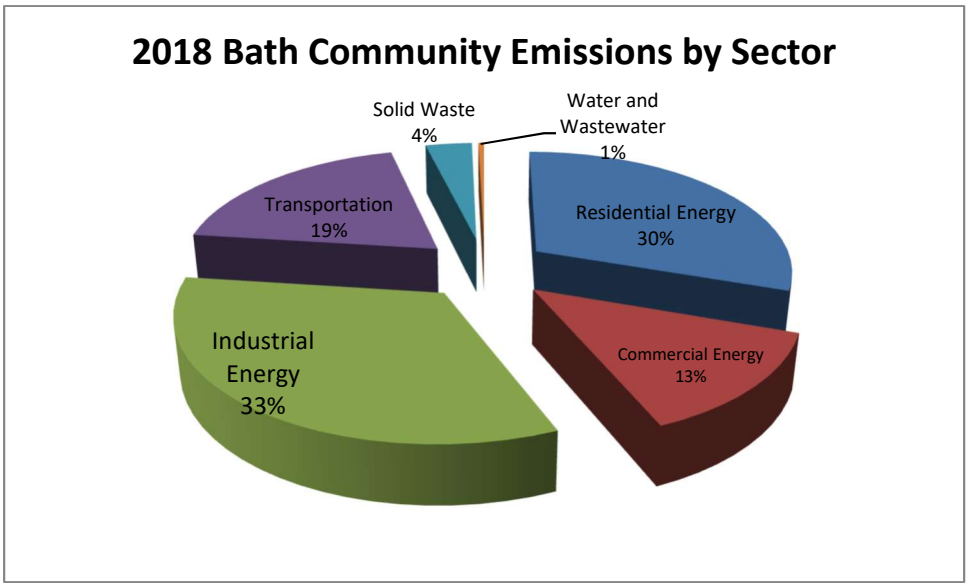
WHEREAS, State and local governments throughout the nation and the world are reducing climate change pollutants through national and local programs and resolutions that provide economic and quality of life benefits such as reduced traffic congestion, improved transportation choices, economic development and job creation through energy conservation strategies that provide economic and environmental incentives for the City government, its businesses, and its citizens;

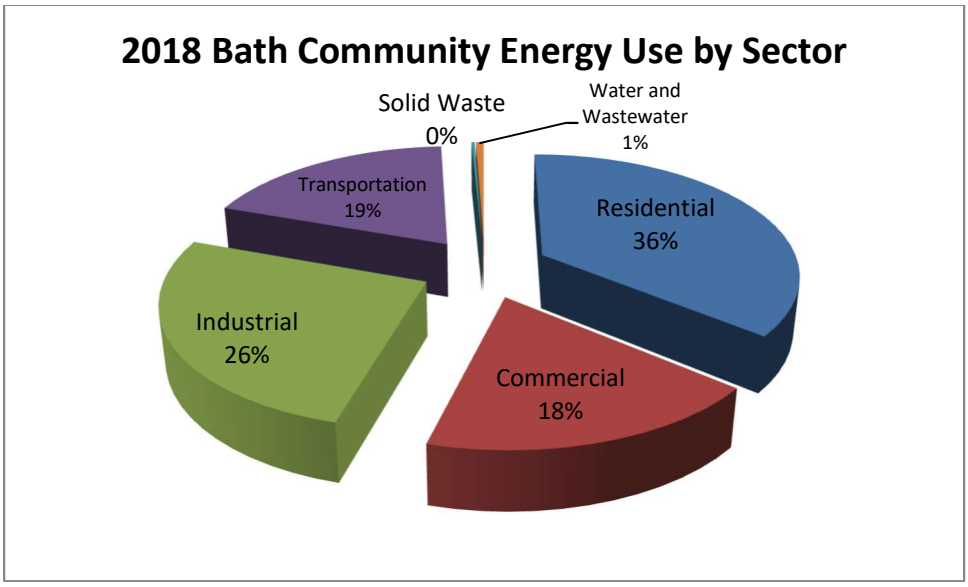
NOW, THEREFORE, BE IT RESOLVED that the City of Bath pledges to take a leadership role to minimize the City's energy use and emissions and maximize efficiency and sustainability through the following measures:

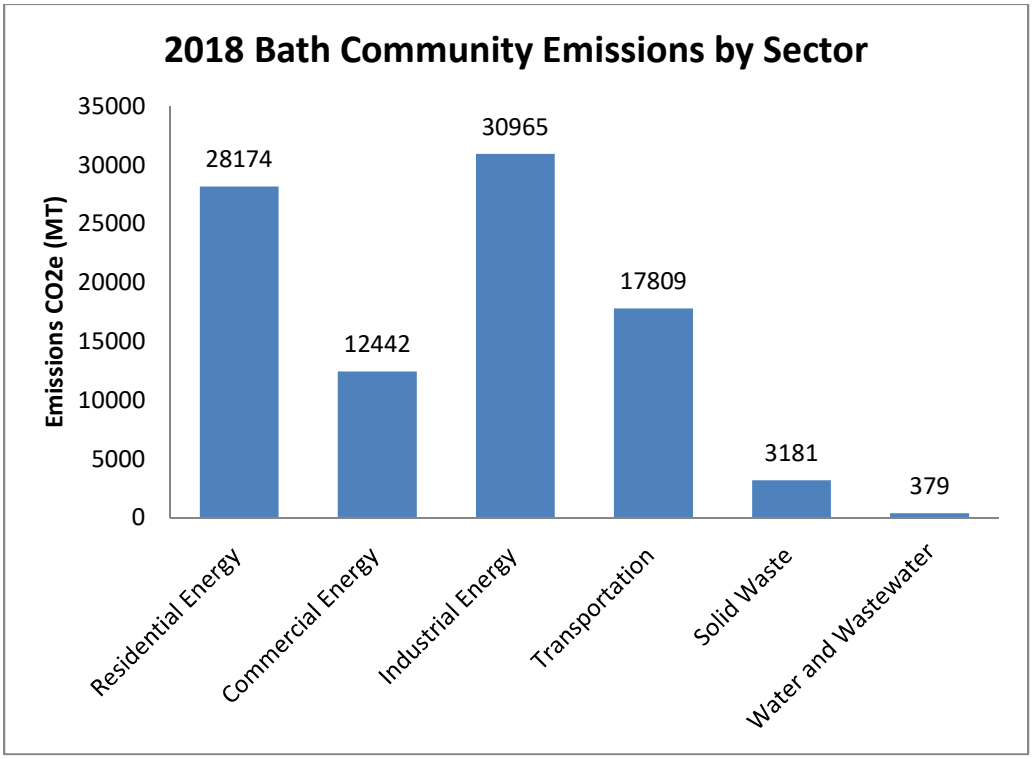
1. Reduce overall City emissions by at least 40% from 2018 values by the year 2030.
2. Support public education on structural and lifestyle changes that must take place in order for the City to make meaningful strides in energy reduction.
3. Maintain and expand a healthy tree population within the City, as well as preservation and expansion of green space.
4. Increase composting and recycling rates within City buildings, businesses and private households, to decrease waste sent to the landfill.
5. All City funded new construction and renovations should meet the U.S. Green Building Council's LEED certification program.
6. Convert all City streetlights to LEDs.
7. Continue exploring alternative energy sources including the use of biofuels, hybrid vehicle fleets as technology advances, landfill gas recovery system, natural gas, and solar energy.
8. Incentivize the use of alternative transportation by continuing to make the City walkable and bikeable with the addition of sidewalks and bike lanes wherever needed.
9. Adjust City ordinances, codes, and policies to make sustainable, energy efficient lifestyles more attainable.
10. Explore the use of tax credits and financial incentives as they become more available at the state and federal level.

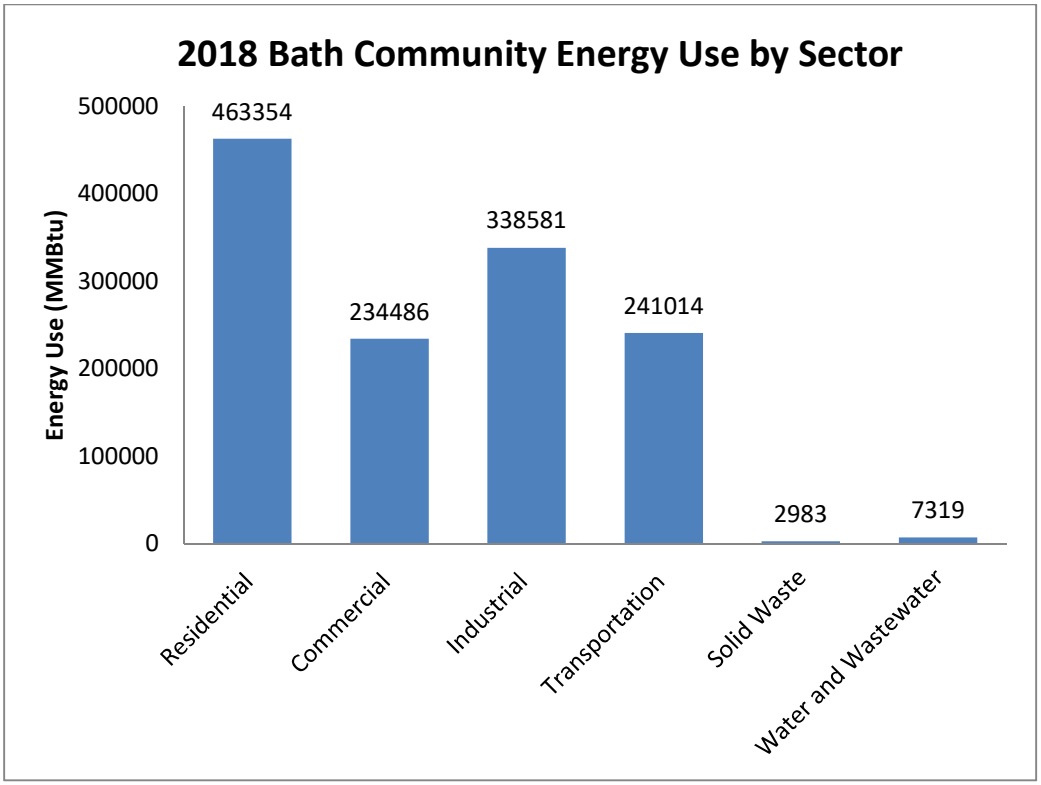
Appendix 2: Charts and Graphs

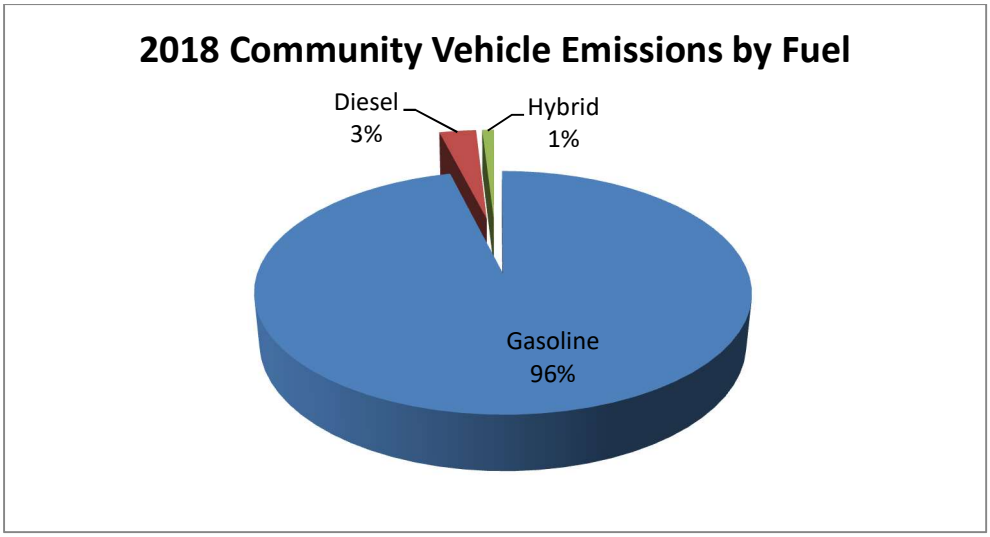
1.) Community Sector

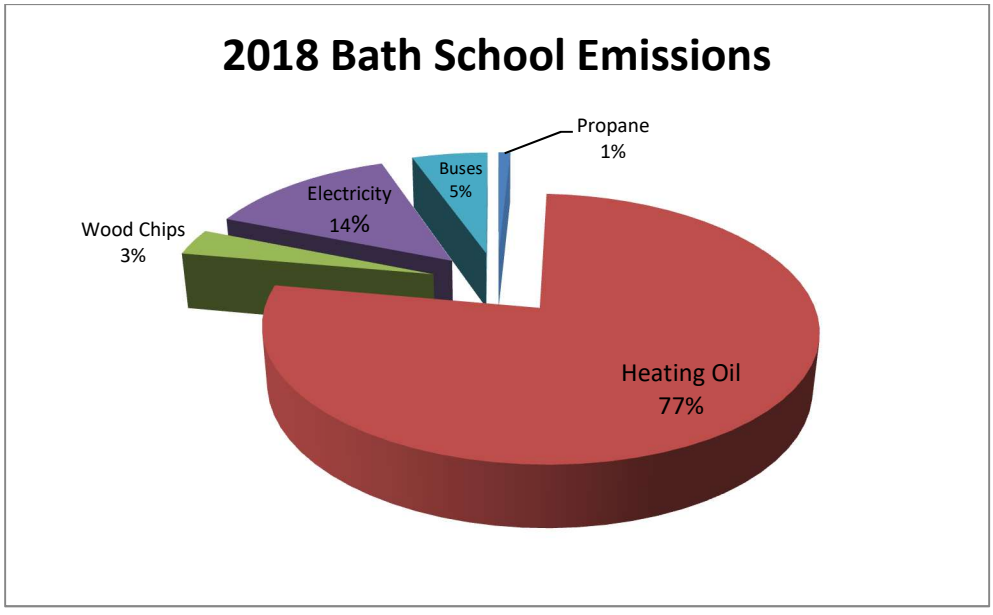




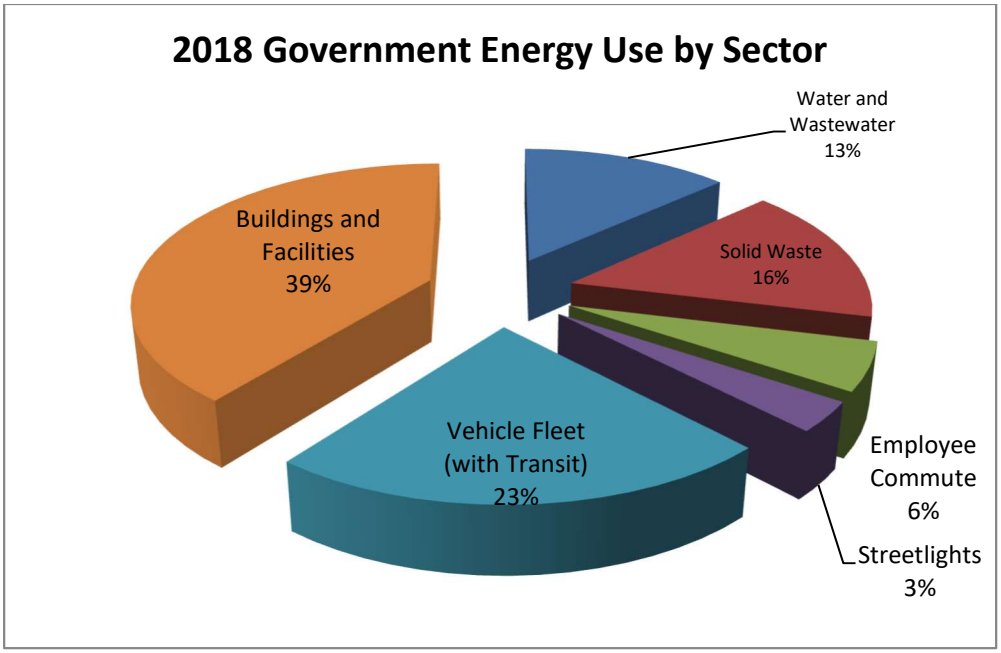

2018 Bath Community Emissions by Sector
Emissions CO2e (MT)
35000
30000
25000
20000
15000
10000
5000
0
28174
12442
30965
17809
3181
379
Residential Energy
Commercial Energy
Industrial Energy
Transportation
Solid Waste
Water and Wastewater

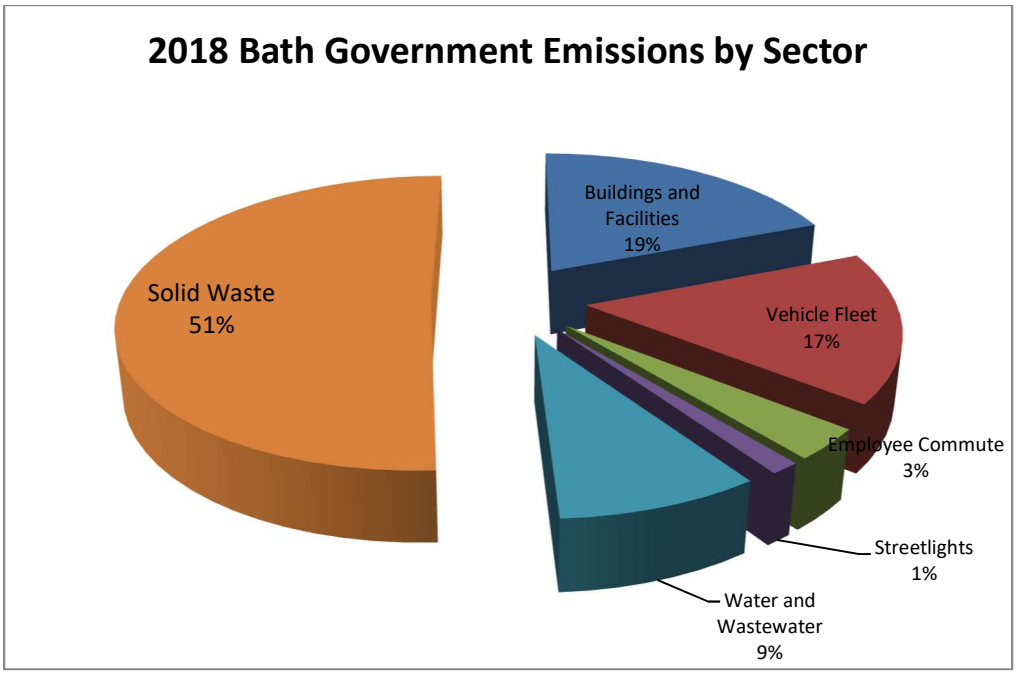

2018 Bath Community Energy Use by Sector
Energy Use (MMBtu)
500000
400000
300000
200000
100000
0
463354
234486
338581
241014
2983
7319
Residential
Commercial
Industrial
Transportation
Solid Waste
Water and Wastewater

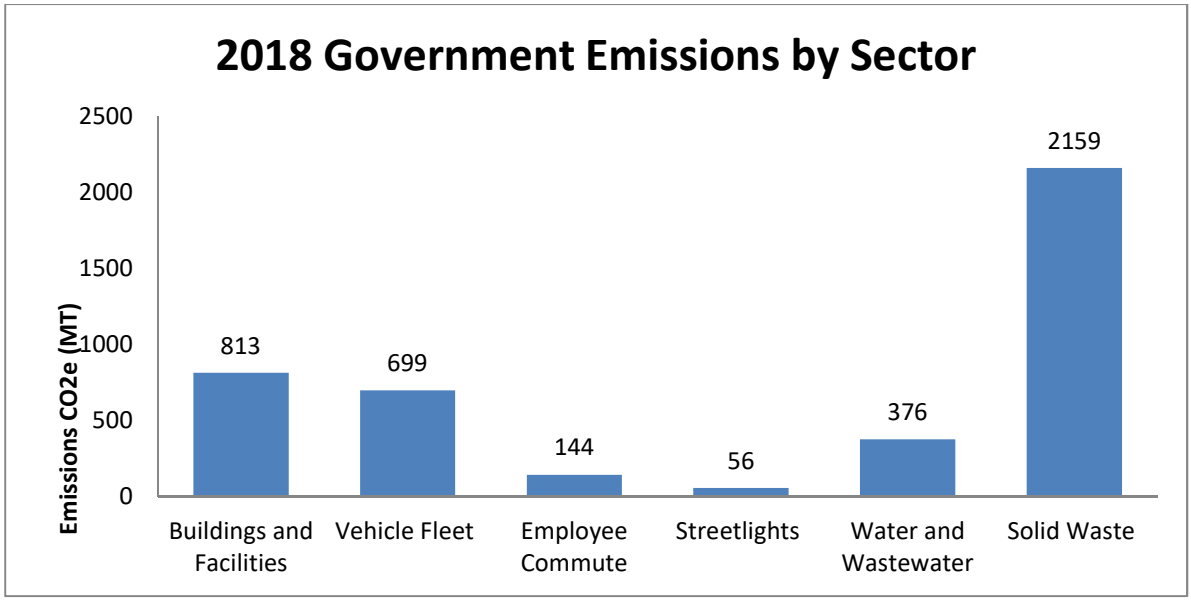

2018 Community Vehicle Emissions by Fuel
Diesel
3%
Hybrid
1%
Gasoline
96%

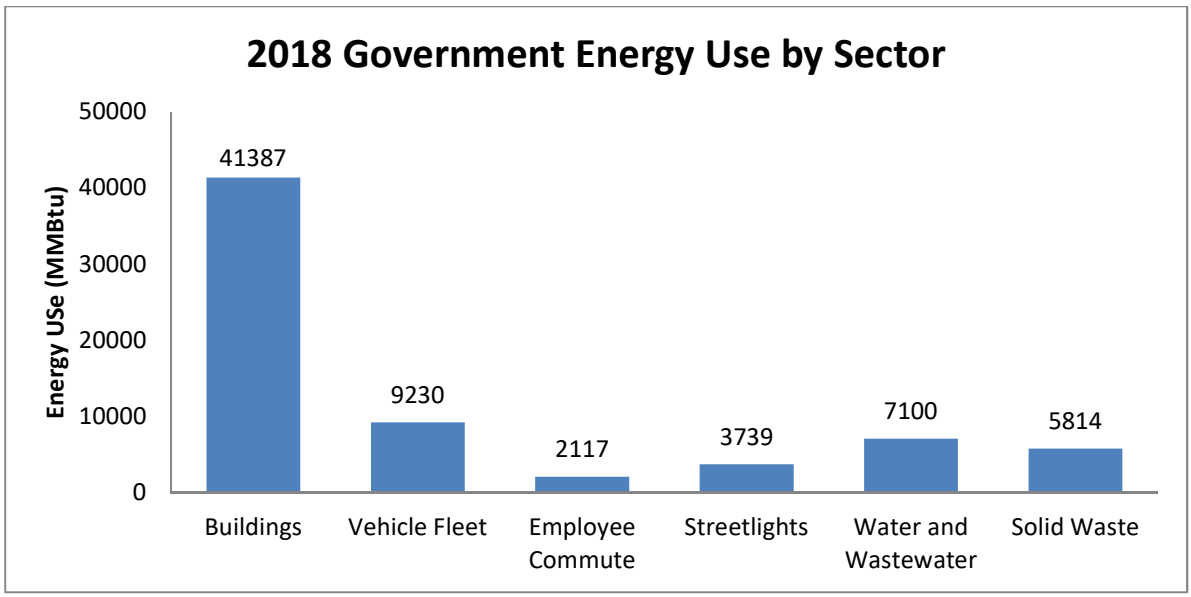

2018 Bath School Emissions
Propane
1%
Buses
5%
Electricity
14%
Wood Chips
3%
Heating Oil
77%

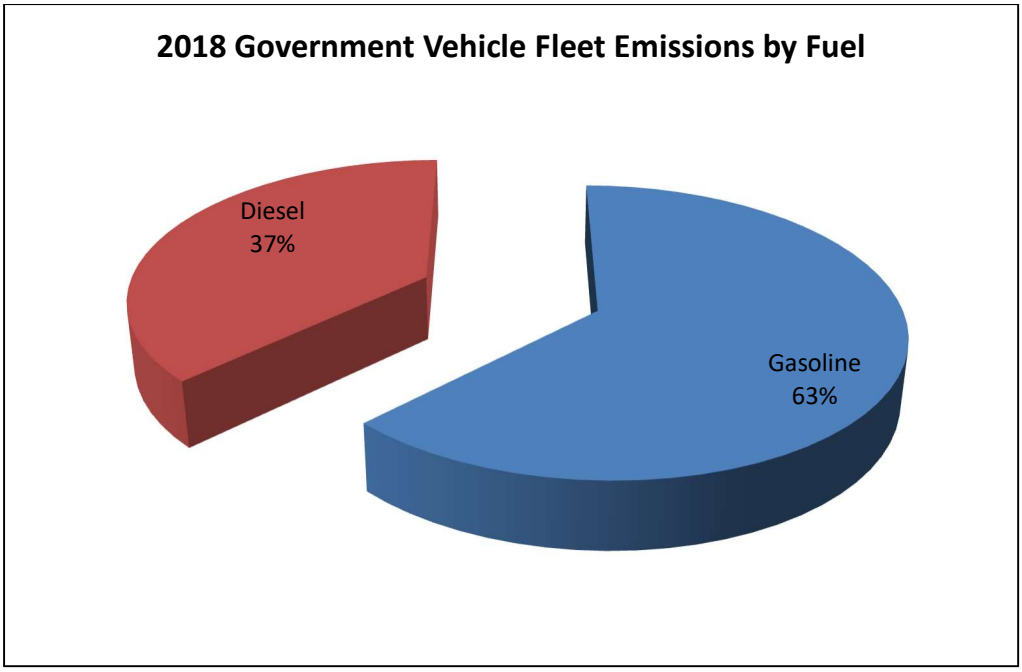
2.) Government Sector

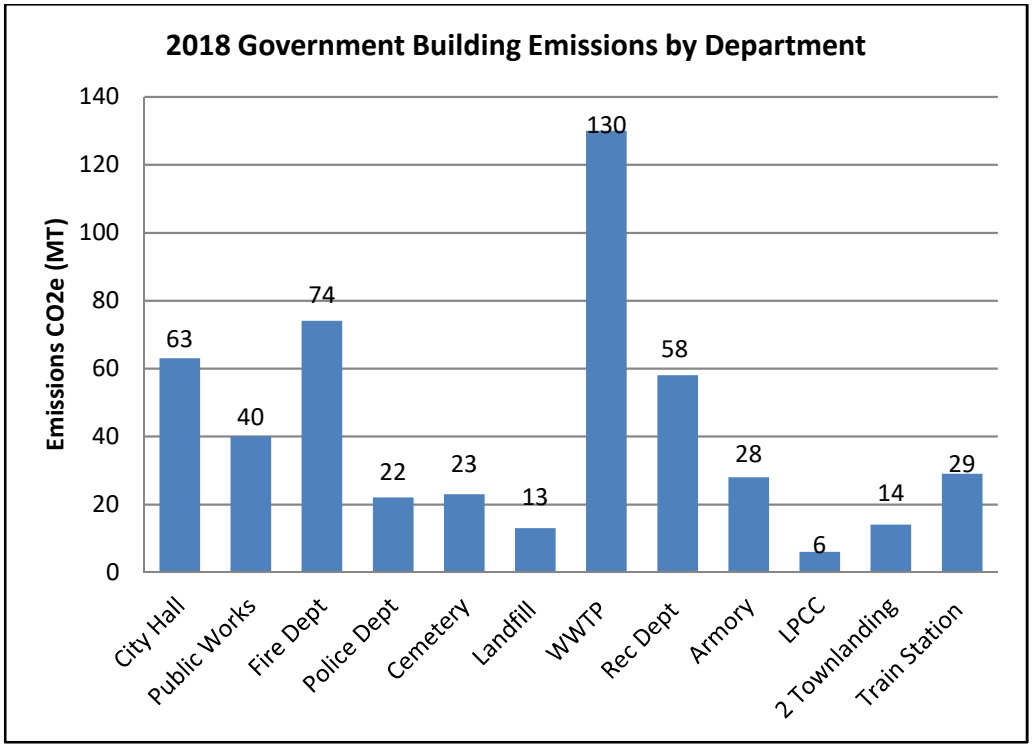





2018 Government Emissions by Sector
Emissions CO2e (MT)
2500
2000
1500
1000
500
0
813
699
144
56
376
2159
Buildings and Facilities
Vehicle Fleet
Employee Commute
Streetlights
Water and Wastewater
Solid Waste


2018 Government Energy Use by Sector
Energy USe (MMBtu)
50000
40000
30000
20000
10000
0
41387
9230
2117
3739
7100
5814
Buildings
Vehicle Fleet
Employee Commute
Streetlights
Water and Wastewater
Solid Waste


2018 Government Vehicle Fleet Emissions by Fuel
Diesel
37%
Gasoline
63%


2018 Government Building Emissions by Department
Emissions CO2e (MT)
140
120
100
80
60
40
20
0
63
40
74
22
23
13
130
58
28
6
14
29
City Hall
Public Works
Fire Dept
Police Dept
Cemetery
Landfill
WWTP
Rec Dept
Armory
LPCC
2 Townlanding
Train Station

Appendix 3: Summary Reports

1.) Bath Community Detailed Summary Report

Sector	Emissions (CO_2e)	Energy (MMBtu)
Residential Sector		
Electricity	4771	106515
Fuel Oil, Kerosene	19393	260455
Bottled, Tank, or LP Gas	3618	56904
Wood	787	39480
Commercial Sector		
Electricity	4967	129400
Fuel Oil	2356	50463
Natural Gas	3265	58280
Propane	150	236
Industrial Sector		
Electricity	15130	337804
BIW	15778	n/a
Fuel Oil	58	777
Transportation		
Diesel	514	6769
Gasoline	17008	241872
Hybrid	164	2291
Electric	0.024	0.5
Solid Waste		
Compost	13	n/a
Landfill Process Emissions	165	n/a
Flaring Emissions	15	2983
Waste Emissions	2988	n/a
Water and Wastewater		
Emissions from Potable Water	109	2440
Private Septic Systems	4	n/a
Nitrfication/Denitrification	19	n/a
Nitrogen from Effluent Discharge	28	n/a
Electricity	219	4879
Fuel Oil	24	321
Propane	106	1709

2.) Bath Government Detailed Summary Report

Sector	Emissions (CO2e)	Energy (MMBtu)
Buildings and Facilities		
Electricity	314	7011
Fuel Oil	252	3379
Natural Gas	113	2131
Propane	135	2170
Streetlights		
Electricity	56	1252
Vehicle Fleet		
Diesel	261	2368
Gasoline	439	4602
Employee Commute		
Gasoline	145	2043
Solid Waste		
Electricity	21	475
Propane	146	2356
Total Waste	1976	n/a
Flaring Emissions	15	2983
Methane Emissions	903	n/a
Water and Wastewater		
Electricity	219	4879
Nitrification/Denitrification	19	n/a
Fuel Oil	4	57
Propane	106	1709
Nitrogen Effluent	28	n/a

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