City of Rochester 2019 Community & Municipal GHG Inventories

MARCH 2023

Image Credit: Communications Bureau, City of Rochester NY

Malik D. Evans, Mayor

City of Rochester, NY
Rochester City Council

Acknowledgements

City of Rochester, NY
Malik D. Evans, Mayor
Rochester City Council

City of Rochester Mayor's Office

Malik D. Evans, Mayor

Rochester City Council

Miguel A. Meléndez, Jr., President (At-Large)

Mary Lupien, Vice President (East District)

Mitch Gruber (At-Large)

Willie J. Lightfoot (At-Large)

Stanley Martin (At-Large)

Kim Smith (At-Large)

LaShay D. Harris, South District

Michael A. Patterson, Northeast District

Jose Peo, Northwest District

City of Rochester, Department of Environmental Services

Richard Perrin, AICP, Commissioner

Prepared by:

City of Rochester Office of Energy and Sustainability
Anne Spaulding, Manager, Division of Environmental Quality
Shalini Beath, Energy & Sustainability Manager

Kim Lundgren Associates, Inc.
Mike Steinhoff, Director of Climate Analysis
Andrew Pettit, GHG Analysis Manager
Kate Galbo, Climate Action Planning Manager

This project has been funded in part by The Climate Smart Community Grant Program, Title 15 of the Environmental Protection Fund through the NYS Department of Environmental Conservation.

Contents

EXECUTIVE SUMMARY

This report summarizes the City of Rochester's 2019 greenhouse gas (GHG) emissions for municipal operations and community activities to better understand key sources of emissions and drive action towards climate mitigation opportunities.

The City of Rochester completed its initial Municipal GHG Inventory in 2011, using 2008 as the baseline year and its initial Community GHG Inventory in 2017, using 2010 as the baseline year. This inventory covers calendar year 2019. As such, the Community GHG Inventory compares data from 2010 to 2019, while the Municipal GHG Inventory compares data from 2008 to 2019. This inventory reports emission estimates in a format compliant with generally accepted guidance and reporting requirements such as the Local Government Operation Protocol, CDP, and the Global Covenant of Mayors.

This GHG inventory assesses emissions by sector (e.g., Buildings, Transportation, Solid Waste) and by source (e.g., electricity, natural gas). The highest sources of emissions from both Rochester's community activities and municipal operations were the energy used in buildings and the fossil fuels burned for transportation. Other sources included waste generation, non-road transportation, wastewater treatment, and energy use for water treatment and delivery.

Between 2010 and 2019, the emissions from Rochester's community activities decreased by 10%, from 2,192,640 $MTCO_2e$ to 1,975,264 $MTCO_2e$. The emissions from Rochester's municipal operations were 22,264 $MTCO_2e$ in 2019, a 33% decrease from emissions in 2008 at 33,039 $MTCO_2e$.

2019 GHG Emissions

Community GHG Emissions
1,975,264 $MTCO_2e$

Municipal GHG Emissions
22,264 $MTCO_2e$

Figure 1: Rochester Community Emissions by Sector, 2019[1]

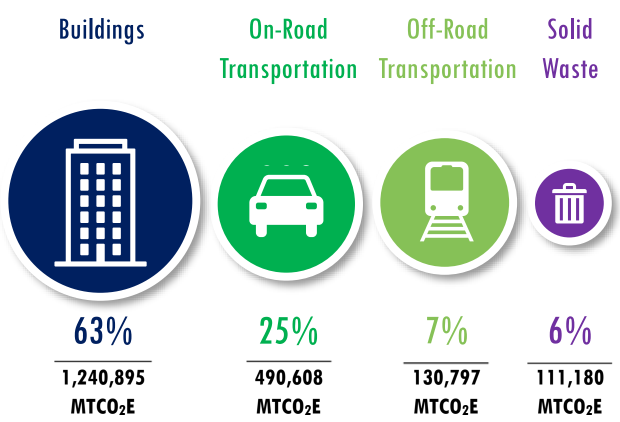
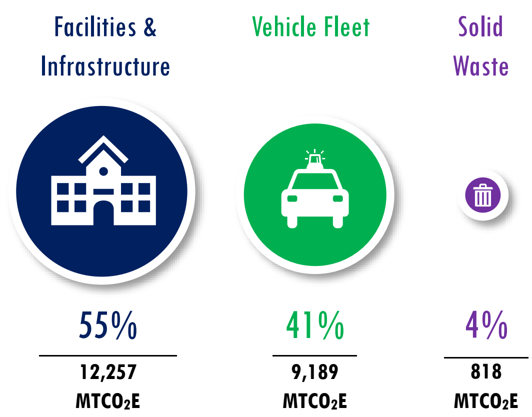


Figure 2: Rochester Municipal Emissions by Sector, 2019



[1] Percentages may not total 100 due to rounding.

INTRODUCTION

This report was developed for the Department of Environmental Services within the City of Rochester, New York in support of the City's strong commitment to sustainability.

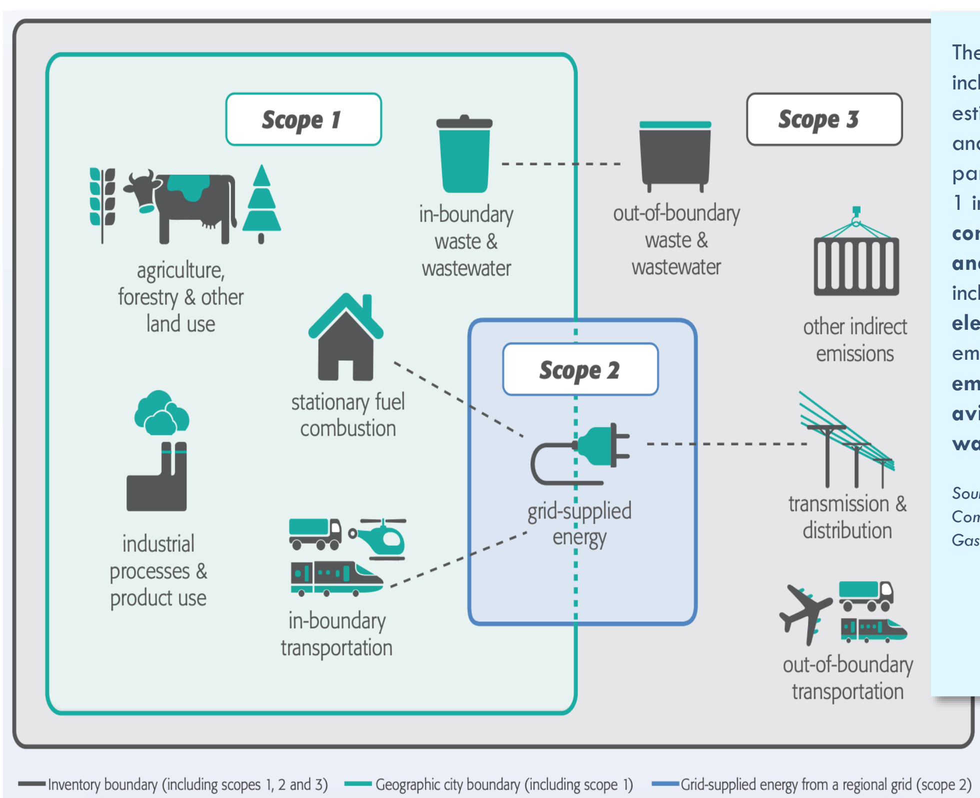
GHGs are naturally occurring compounds that accumulate in the atmosphere, trapping heat and regulating the Earth's temperature. However, when fossil fuels (like natural gas, coal, and gasoline) are burned or when materials in landfills decompose, the level of GHGs in the atmosphere increases and heat that would normally escape into space is trapped and reflected to earth. This "*Greenhouse Effect*" has caused an increase in the global average temperature as well as more local extreme weather events and climate hazards already being experienced in New York and Rochester.

This GHG emissions inventory includes three primary GHGs—carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)—organized by sector and source. GHGs are typically reported in units of CO_2 equivalents, or CO_2e. This accounting convention normalizes the relative amount of warming produced by different gases with the use of global warming potential (GWP) multipliers. For the non-CO_2 gases, CH_4 and N_2O, calculations use GWP values from the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report assessed over a 100-year time horizon.

The data used to generate regional GHG emissions estimates were drawn from local and national sources that capture and report activity data from multiple sectors across the city. For more information about specific data sources, please refer to the **Methodology** section at the end of this report. Figure 3: GHG Inventory Scope Diagram, GPC

The City of Rochester includes emission estimates for Scope 1 and 2 sources and partial Scope 3. Scope 1 includes fuel combustion in buildings and vehicles. Scope 2 includes purchased electricity. Scope 3 emissions include indirect emissions such as aviation, waste & wastewater.

Figure 3: GHG Inventory Scope Diagram, GPC



The City of Rochester includes emission estimates for Scope 1 and 2 sources and partial Scope 3. Scope 1 includes **fuel combustion in buildings and vehicles.** Scope 2 includes **purchased electricity.** Scope 3 emissions include **indirect emissions such as aviation, waste & wastewater.**

Source: The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)c

Source: The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)

MUNICIPAL GHG EMISSIONS

The GHG emissions presented in this section were generated from all City of Rochester government operations. These activities include governmental buildings' energy use, municipal vehicle fleet use, employee commuting, and waste disposal from government buildings.

Overview

Rochester's total municipal GHG emissions decreased 33% from 2008 to 2019. The largest category of municipal emissions came from Facilities & Infrastructure (55%) followed by Vehicle Fleets (41%). Solid Waste had the smallest amount of emissions at only 4% of municipal emissions. Although gasoline and diesel used in fleet vehicles are the two largest contributors to GHG emissions, the collective energy required to power buildings and facilities, sourced from electricity, natural gas, steam, and propane, make up a larger proportion of total emissions.

Figure 4: Rochester Municipal Emissions, 2019

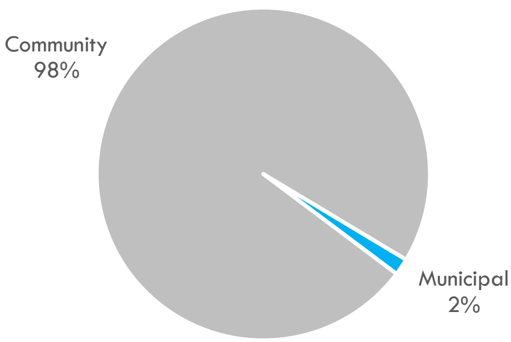
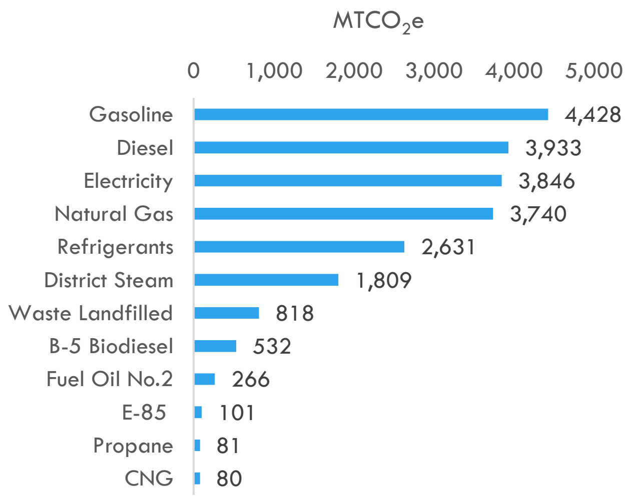


Figure 5: Rochester Municipal Emissions by Sector, 2019

Figure 6: Rochester Municipal Emissions by Source, 2019



Year	Total Emissions ($MTCO_2e$)	
2008	33,039	↓
2019	22,264	33%

Facilities & Infrastructure

The GHG emissions presented in this section were generated from the energy used in Rochester's municipal buildings, water delivery and port facilities, and streetlights & traffic signals.

Overview

The City of Rochester's Municipal Facilities & Infrastructure emissions account for 55% of municipal emissions. This category is broken into municipal buildings, water delivery facilities, port facilities, and streetlights and traffic signals. In 2019, municipal buildings produced 8,165 $MTCO_2e$ (79%), streetlights and traffic signals produced 1,143 $MTCO_2e$ (11%), and water delivery and port facilities produced 766 and 270 $MTCO_2e$ respectively (10%). Refrigerants and district steam energy added nearly the same amount of GHGs as electricity use in all facilities in 2019 (2,517 $MTCO_2e$).

Figure 7: Municipal Facilities & Infrastructure Emissions, 2019

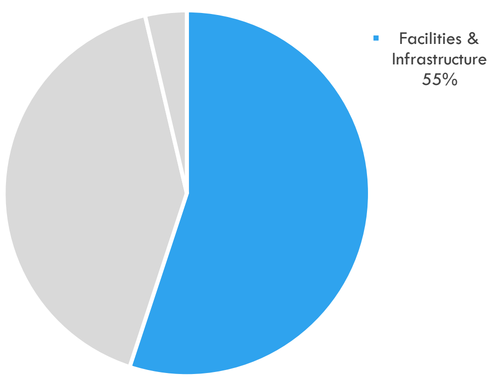
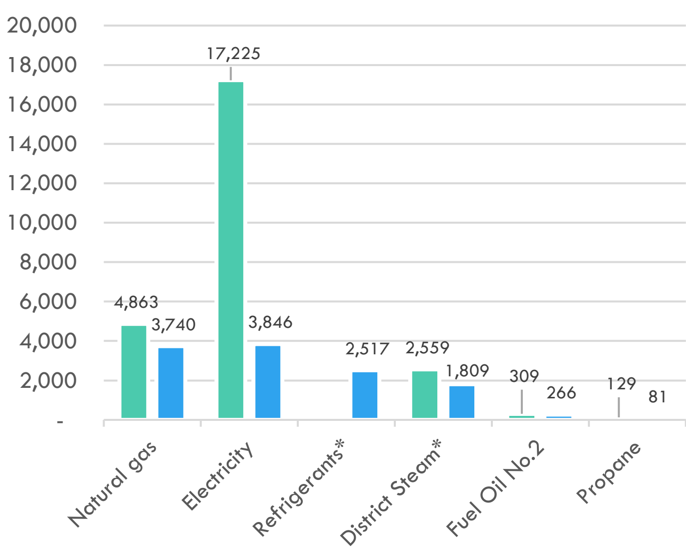


Table 1: Municipal Facilities & Infrastructure Emissions, 2008 & 2019

Sector	2008 $MTCO_2e$	2019 $MTCO_2e$	% Change
Municipal Buildings	13,161	8,165	↓38%
Streetlights & Traffic Signals	5,808	1,143	↓80%
Water Delivery Facilities	1,944	766	↓61%
Port Facilities	307	270	↓12%

Figure 8: Municipal Buildings Emissions by Source, 2019



* Refrigerants and District Steam were not included in 2008 total reported emissions, though district steam was estimated.

As illustrated in Figure 8, the largest differences in the source of GHGs is from electricity related emissions which affect all of the buildings and facility types. Much of this reduction is attributable to cleaner electricity supply that was available in 2019 as opposed to 2008.

However, the City of Rochester has demonstrated effective investments in efficiency that have reduced the consumption of electricity by 78%. Direct use of fossil fuels has also decreased by 23% in natural gas, 14% in fuel oil, and 37% in propane. These trends have put Rochester's municipal operations on a solid pathway to eliminating the use of fossil fuels and resulting GHGs from its operations.

Leading by Example

The City of Rochester has made significant progress in reducing emissions from municipal facilities and infrastructure due to a number of successful initiatives that aim to reduce energy use and source municipal energy from renewable energy sources.

Spotlight

Municipal Facility Energy Performance

The City has participated in the U.S. Department of Energy's Better Buildings Challenge (BBC) since 2012. BBC participants strive to decrease portfolio-wide source energy use intensity (EUI) and to increase the percent improvement compared to a set baseline. Rochester's portfolio consists of 77 buildings and more than 4 million square feet. Through 2019, Rochester decreased its EUI by 27%, exceeding its goal of a 20% EUI reduction from a 2009 baseline by 2022. Energy savings have been achieved primarily through performing lighting upgrades at properties including City Hall, municipal garages, central maintenance facilities, and libraries. In addition, LED street lighting upgrades and the renovation of buildings and building systems with newer, more efficient designs have contributed to the overall performance improvement.

Spotlight

Solar Field on Former Landfill

The City worked with a solar developer to construct a 2 mega-Watt solar field on the City's former Emerson Street Landfill. The power generated at the solar field is remote net metered to City Hall and the City's Mt. Read Blvd. Operations Center. Since December 2017, the solar field has produced approximately 13 giga-Watts of electricity, displacing 5,624 MTCO2e, equivalent to the greenhouse gas emissions from 1,200 passenger vehicles driven for one year or the burning of 31 railcars of coal.

Spotlight

Climate Smart Community and Clean Energy Community Designations

The City of Rochester has been designated as both a NYSDEC Climate Smart Community and a NYSERDA Clean Energy Community. These designations demonstrate the City's commitment to taking action to reduce greenhouse gas emissions both in its own operations and community-wide. Actions taken to earn these designations include developing climate action plans, installing public electric vehicle charging stations, and implementing a Community Choice Aggregation program

Spotlight

Electric Fleet Vehicles

To reduce dependence on fossil fuels, the City has begun to incorporate electric vehicles into its fleet. These vehicles are currently in use by various City departments, including Parking Violations, the Water Bureau and general City pool cars. An analysis of the City's fleet is underway to identify best uses of EVs in the fleet and to prioritize the addition of electric vehicles where most appropriate.

Vehicle Fleet

The GHG emissions presented in this section were generated from the fuel used by City of Rochester's vehicle fleet.

Overview

Rochester's vehicle fleet fuel use and emissions are broken down by fuel type, which includes gasoline, diesel, E-85, B-5 biodiesel, CNG and electricity, and by vehicle type, which includes passenger cars, light trucks, heavy trucks and equipment. Municipal vehicles generated 9,189 MTCO$_2$e in 2019. Emissions from the vehicle fleet were largely flat from 2008 which totaled 9,107 MTCO$_2$e, when the only fuels used were either gasoline or diesel. This may be due in part to better record keeping for fuel use among non-road equipment, which is a significant part of the total, balanced by more efficient passenger vehicles in the fleet. While a small part of the fleet in 2019, the newest additions to the City's fleet in electric vehicles added approximately 1 MTCO$_2$e to the total footprint. We hope to see this value both stay low even as electric models take a larger share of the fleet, powered with progressively cleaner electricity each year.

Figure 9: Municipal Vehicle Emissions, 2019

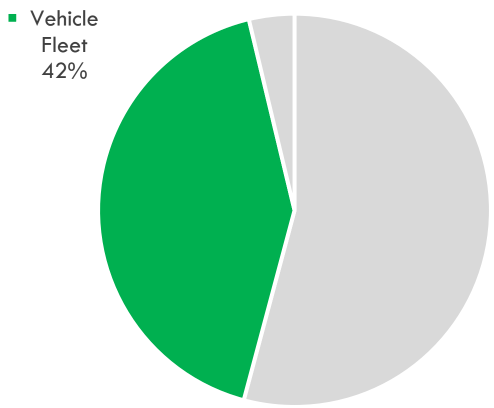
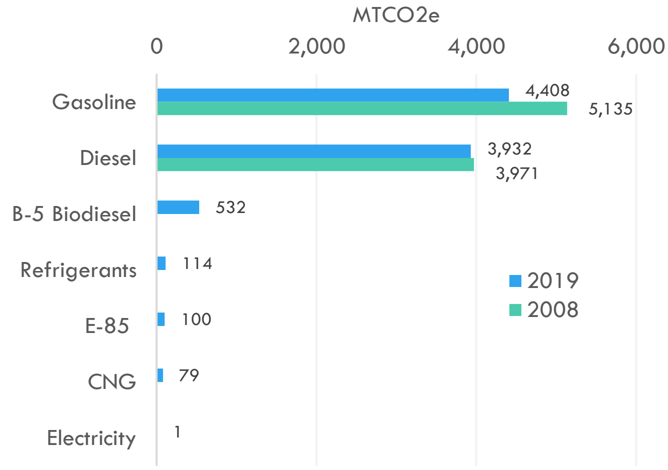


Figure 10: Municipal Vehicle Emissions by Source, 2019



Majority of vehicle GHG emissions (48%) come from use of gasoline at 4,428 MTCO$_2$e. Use of diesel makes up 43% of GHG emissions at 3,933 MTCO$_2$e. Emissions from the use of E-85, B-5 biodiesel, CNG, and refrigerants make up approximately 9% of GHG emissions.

Figure 11: Fleet and Equipment GHGs by Vehicle Type (MTCO$_2$e), 2019

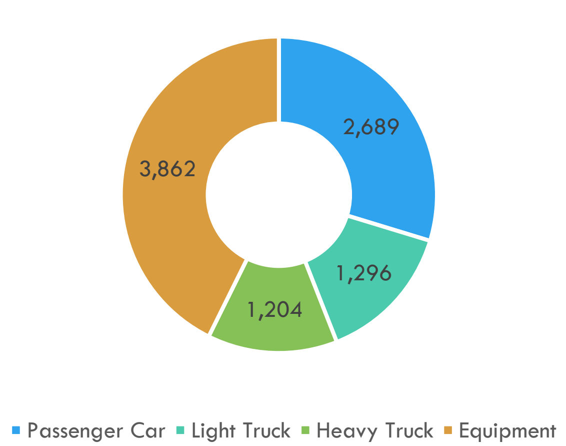


Image Credit: City of Rochester NY

COMMUNITY GHG EMISSIONS

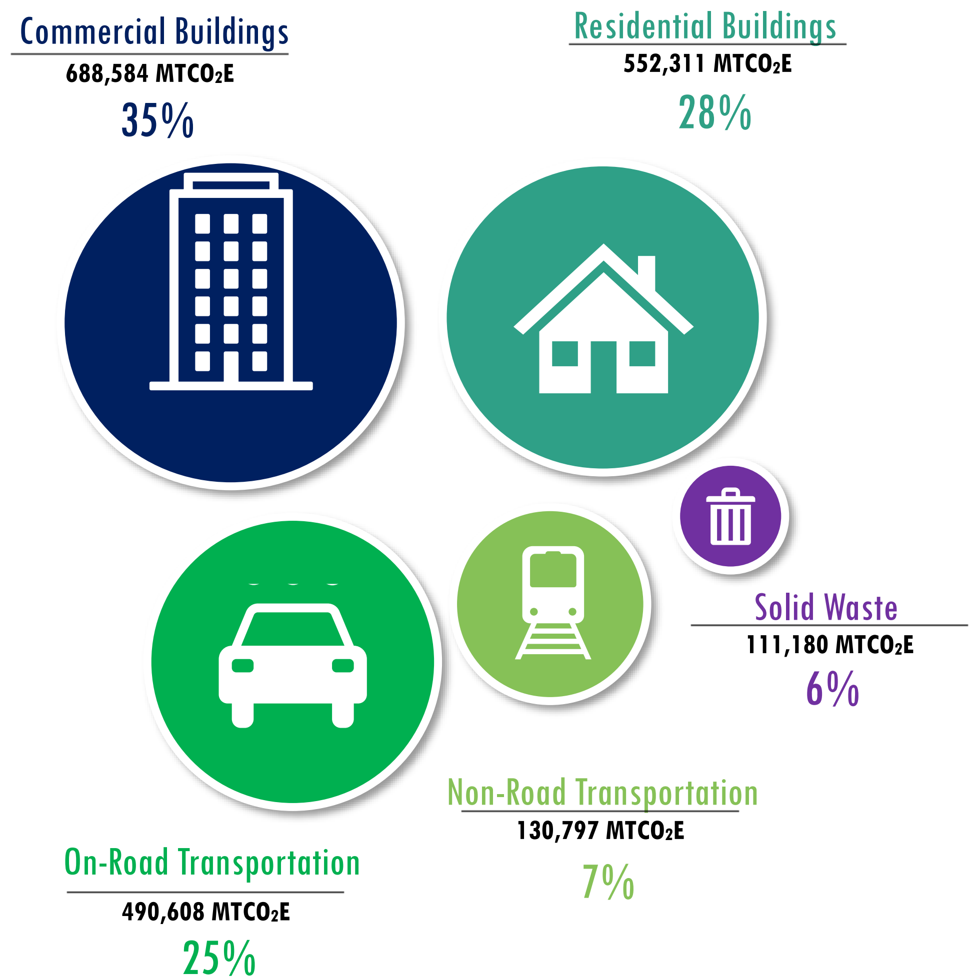
The community GHG emissions data was generated from community activities that take place within the geographic boundary of the City of Rochester. These activities include residential and commercial energy use, public and personal transportation, and waste disposal, among others.

Overview

In 2019, the City of Rochester's community activities generated 1,975,264 $MTCO_2e$. This was a 10% reduction in overall emissions from the City's 2010 community emissions. This community GHG inventory assesses emissions by ***sector***—which includes Residential and Commercial Buildings, On-Road and Non-Road Transportation, Solid Waste, Wastewater Treatment, and Water Treatment and Delivery—and by ***source***, such as natural gas or electricity.

The majority of the City of Rochester's community wide emissions come from residential (28%) and commercial buildings (35%) and on-road transportation (25%). Non-road transportation and solid waste cumulatively contribute approximately 13% of overall emissions. Other sources included wastewater treatment and energy use for water treatment and delivery. Each of these additional sectors contributed less than 1% of overall emissions.

Figure 12: City of Rochester Community Emission by Sector, 2019[2]



[2] Percentages may not total 100 due to rounding.

Community Trends

Community activities change over time and therefore the GHG emissions associated with those activities change as well. According to the U.S. Census Bureau, the City of Rochester grew by 0.36% between 2010 and 2019.

Figure 13: Rochester Community GHG Indicators, 2010 to 2019

Overall GHG Emissions ($MTCO_2e$)

2010	2,192,640	↓
2019	1,975,264	10%

Overall GHG Emissions per Capita ($MTCO_2e$ per person)

2010	10.4	↓
2019	9.4	10%

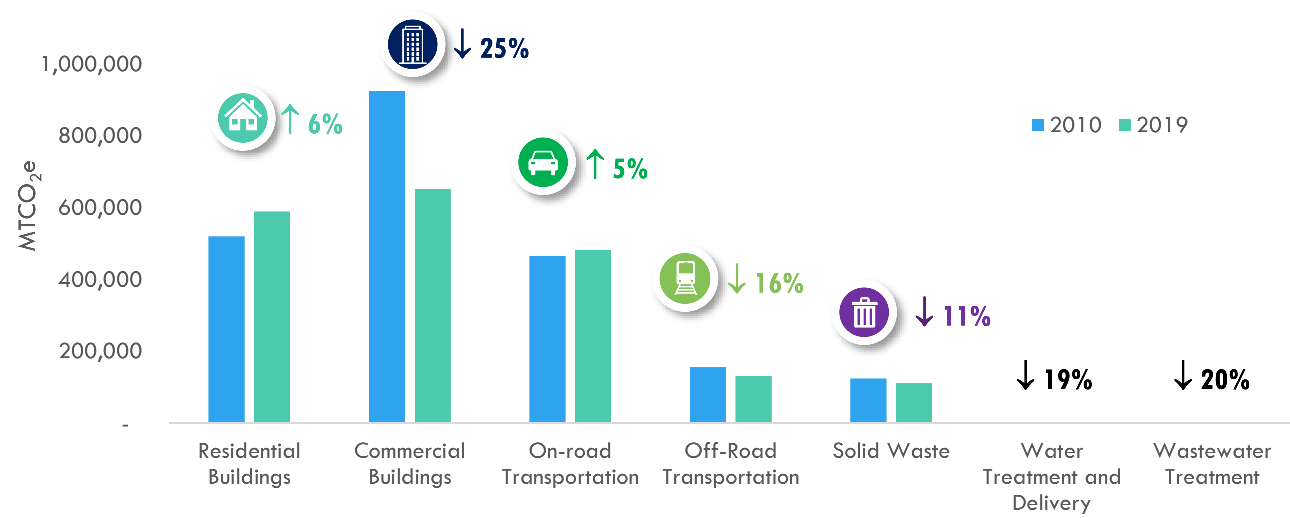
Light-Duty Vehicle Miles Traveled (VMT per Capita)

2010	5,456	↓
2019	5,042	8%

Residential Waste Landfilled per Capita (Lbs. per person)

2010	857	↓
2019	488	43%

Figure 14: Rochester Community GHG Emissions Trends, 2010 & 2019



Buildings

The GHG emissions presented in this section were generated from the energy use in residential and commercial buildings within the geographic boundary of the City of Rochester.

Overview

Overall, Rochester's total building emissions decreased by 14% from 1,444,105 $MTCO_2e$ in 2010 to 1,240,895 $MTCO_2e$ 2019. Residential building emissions, which made up 28% of total community-wide emissions in 2019, increased by 6% from 2010 to 2019. Commercial buildings, which made up 35% of total community-wide emissions in 2019, decreased 25% from 2010 to 2019 leading to a net overall decrease in building energy.

Figure 15: Building Emissions (%) by sector

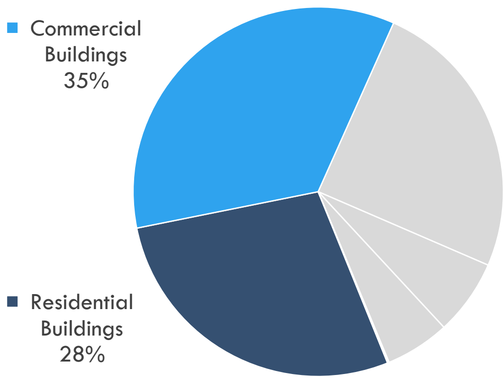
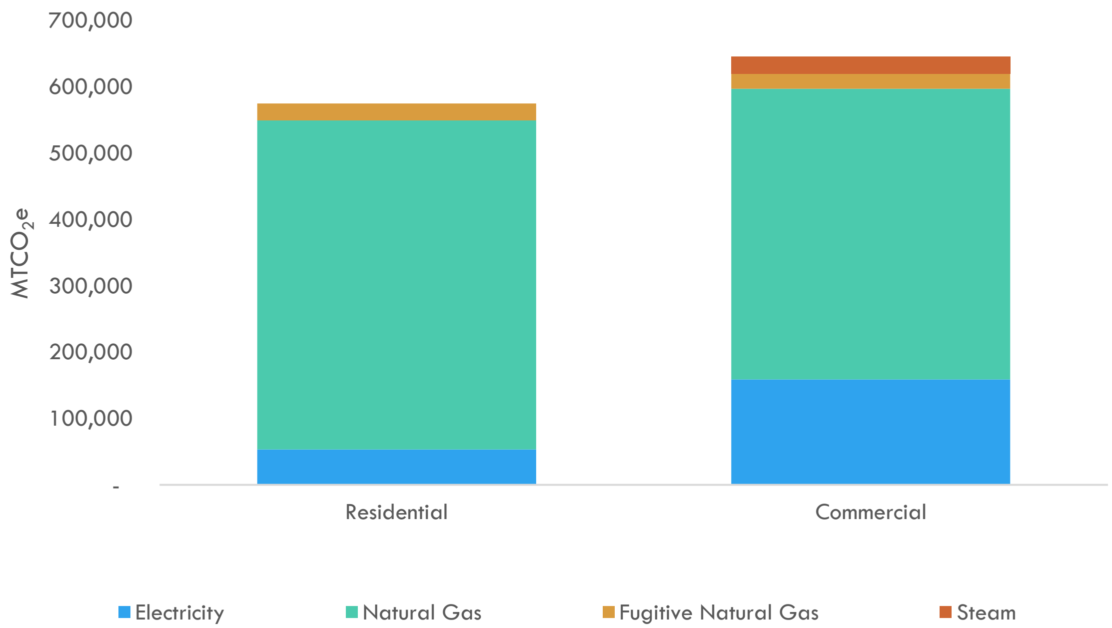


Table 2: Building Emissions, 2010-2019 (MTCO2e)

Year	Residential ($MTCO_2e$)	
2010	520,103	↑
2019	552,311	6%
Year	**Commercial ($MTCO_2e$)**	
2010	924,002	↓
2019	688,584	25%
Year	**Total Buildings ($MTCO_2e$)**	
2010	1,444,105	↓
2019	1,240,895	14%

Figure 16: 2019 Building Emissions by Building Type (Sector) and Source



Electricity (Source)

Electricity related greenhouse gases from Rochester's buildings are down approximately 84% from 2010. The reasons for this include a mix of factors, but the dominant cause is a reduction in the carbon intensity of the electricity supply. This has allowed emissions to fall from residential buildings despite a small increase in electricity used while both GHGs and electricity use fell among commercial buildings. This trend is an encouraging sign as the shift to electrification will drive more electricity use in the coming years, but emissions can still be decreasing as more renewable sources are added to generate the power used in a variety of applications.

Table 3: Building Electricity Emissions & Consumption, 2010-2019

	Year	Residential ($MTCO_2e$)		Commercial ($MTCO_2e$)		Total Buildings ($MTCO_2e$)	
GHGs	2010	124,424	↓ 80%	255,646	↓ 47%	522,507	↓ 84%
	2019	53,359		158,899		212,257	
	Year	**Residential (MWh)**		**Commercial (MWh)**		**Total Buildings (MWh)**	
Use	2010	500,219	↑ 1%	1,592,322	↓ 6%	2,092,542	↓ 4%
	2019	504,206		1,501,496		2,005,702	

Natural Gas (Source)

Emissions sourced from natural gas consumption increased by 13% between 2010 and 2019. The rise in consumption within the residential sector was particularly significant, while overall natural gas use in the commercial facilities decreased slightly. A complete explanation of these changes is not readily apparent, although some of this change can be accounted for.

Table 4: Building Natural Gas Emissions, 2010-2019

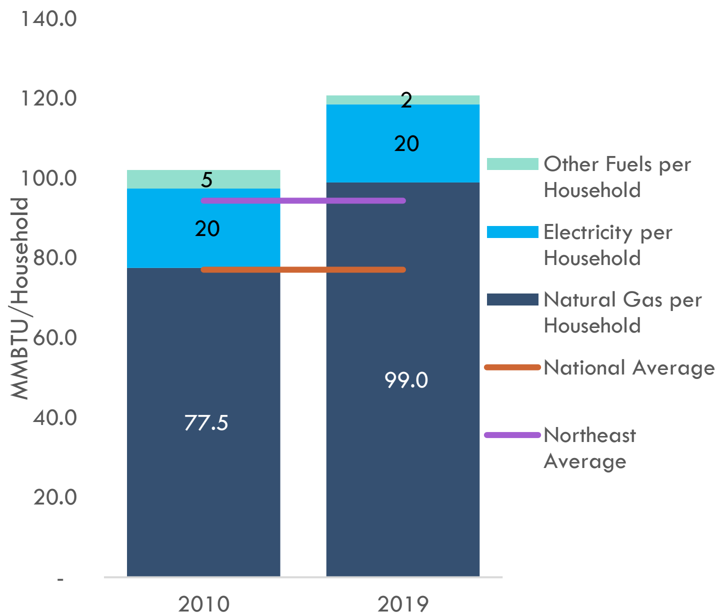
Year	Residential ($MTCO_2e$)		Commercial ($MTCO_2e$)		Total Buildings ($MTCO_2e$)	
2010	353,462	↑ 26%	486,506	↓ 3%	823,789	↑ 13%
2019	460,853		473,585		934,438	

Since natural gas use in residential buildings is primarily used for space and water heating, it is particularly sensitive to fluctuations in the weather from one year to another. It was slightly cooler in 2019 than 2010, with 2.5% more Heating Degree Days over the calendar year. Some increase in gas use is expected, however not as much as was observed. One source of uncertainty includes potential differences in how data from RG&E was aggregated by customer class in 2010 versus the standard for how this data will be aggregated and reported going forward in the NYSERDA Utility Data Registry, which was the data source for this inventory. Another trend that explains some of this trend is a shift in heating fuels from fuel oil to natural gas, particularly in older, inefficient housing, but specific attribution of this shift is not possible as fuel oil use is estimated in both inventories.

Residential Buildings (Sector)

Overall, the number of houses in Rochester increased by 2% from 2010 and 2019 and residential energy use increased by 21%. Energy use per household, which is above both the national and Northeast average, increased by 18% from 102 to 121 MMBTU per Household. The most significant increase in energy use per household is the increase of natural gas per household, which increased from 78 MMBTU in 2010 to 99 MMBTU in 2019.

Figure 17: Residential Energy User per Household, 2010-2019



Average for a Single Family Detached Home (MMBtu per Household)

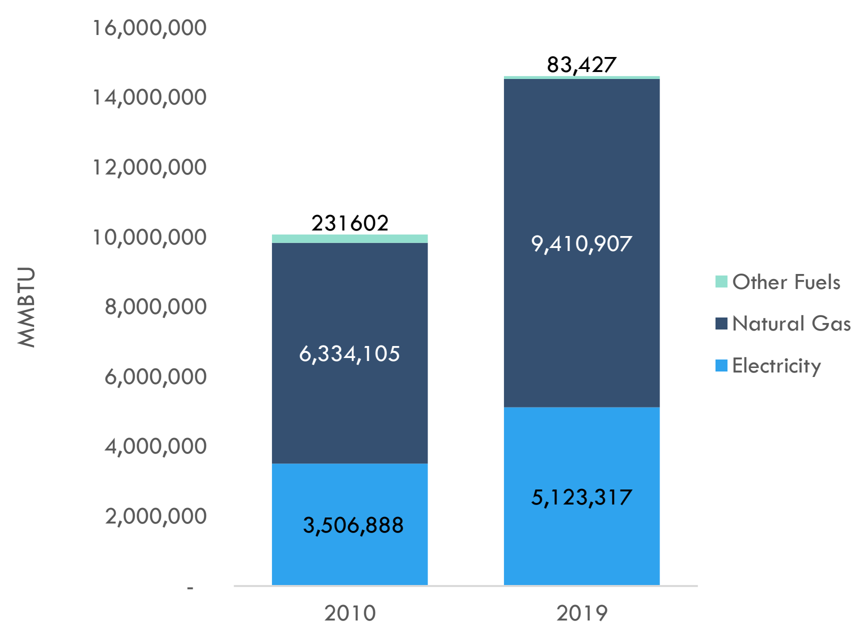
U.S.	Northeast
77.1	94.4

EIA Residential Energy Consumption Survey, 2015.
https://www.eia.gov/consumption/residential/data/2015/

Commercial Buildings (Sector)

Energy use in commercial buildings increased by 45% between 2010 and 2019. Energy sourced from natural gas makes up the largest percentage of commercial energy use and increased by 49% between 2010 and 2019. Energy sourced from other fuels, including fuel oil and propane, decreased by 64% between 2010 and 2019. While commercial energy use increased during this time period, emissions decreased by 3% due to reduction in carbon intensity of energy supply.

Figure 18: Commercial Energy Use by Source, 2010-2019



Transportation

The GHG emissions presented in this section includes personal and commercial vehicle use, public transportation, aviation, boating, and freight hauling within the geographic boundary of Rochester.

Overview

On-road transportation emissions, which made up 25% of transportation emissions in 2019, have increased 5% from 2010 to 2019. Combined non-road transportation made up 7% of recorded transportation emissions in 2019 at 130,797 MTCO$_2$e. The increase in emissions from on-road transportation is likely due to the slight increase in population. Modes of on-road transportation with the highest emissions in 2019 were passenger cars (403,851 MTCO$_2$e) and heavy trucks (69,479 MTCO$_2$e), while transit busses had significantly fewer emissions (16,999 MTCO$_2$e) and electric vehicles produced a very small amount (279 MTCO$_2$e). Modes of non-road transportation with the highest emissions in 2019 were airline travel (126,234 MTCO$_2$e) and rail travel (3,696 MTCO$_2$e), with waterborne travel contributing very little (867 MTCO$_2$e). The most carbon intensive travel mode was internal combustion engine cars at 0.40 kg CO2e/mile, followed by Amtrak at 0.14 kg CO2e/mile and electric vehicles at 0.03 kg CO2e/mile.

Figure 19: Transportation Emissions, 2019

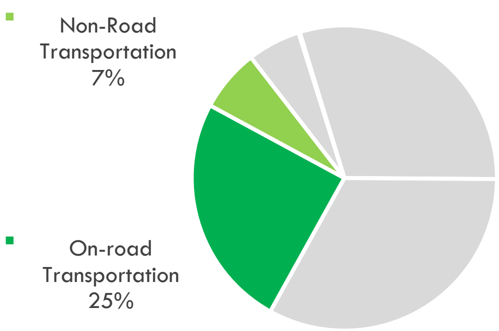


Table 5: Transportation Emissions, 2010-2019

Year	On-Road (MTCO$_2$e)	
2010	465,051	↑
2019	490,608	5%
Year	**Vehicle Miles Traveled**	
2010	1,066 Million	↑
2019	1,079 Million	1%

From 2010 to 2019, total vehicle miles traveled on roads within Rochester rose by 1%. Estimates of GHGs from 2010 to 2019 rose by 5% due to a combination of methodology changes, including updated and more conservative on-road fuel economy values for 2019.

Figure 20: On-Road Transportation Emissions by Mode, 2019

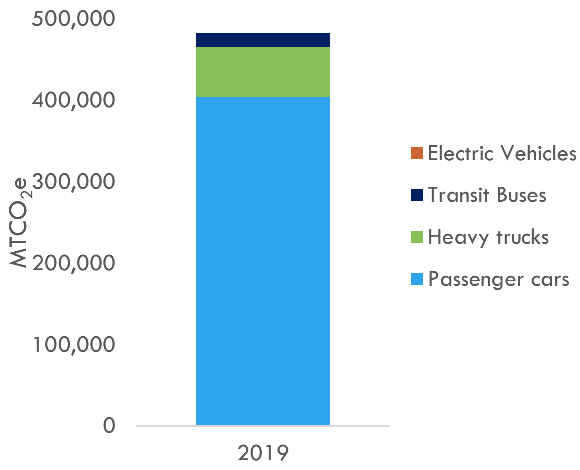
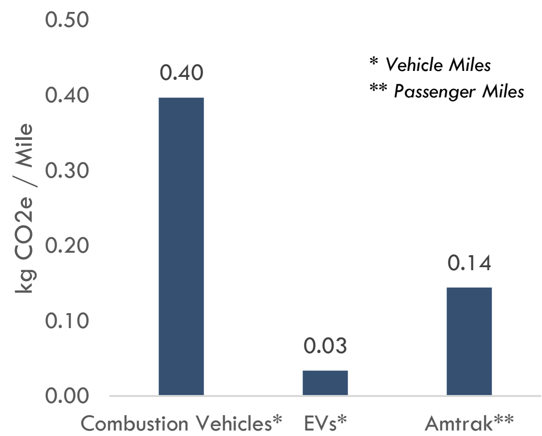


Figure 21: Carbon Intensity of Travel Modes



Waste, Wastewater Treatment, & Water Delivery

The GHG emissions data presented in this section resulted from residential and commercial solid waste landfilled or composted, process and fugitive emissions from wastewater treatment, and from the energy used in potable water treatment & delivery.

Overview

Solid waste emissions in the form of methane are generated from the decay of organic matter in a landfill environment. These emissions make up the majority of Rochester's GHGs that are not related to building energy or transportation. Wastewater emissions are from nitrous oxide which is a by-product of all modern wastewater treatment processes. Lastly, emissions from water treatment and delivery are generated by the energy, typically electricity, used to move and supply drinking water to residents and businesses within the city. Much of the reductions observed for the water and wastewater sectors are as a result of lower carbon electricity supply.

Figure 22: Other Emissions, 2019

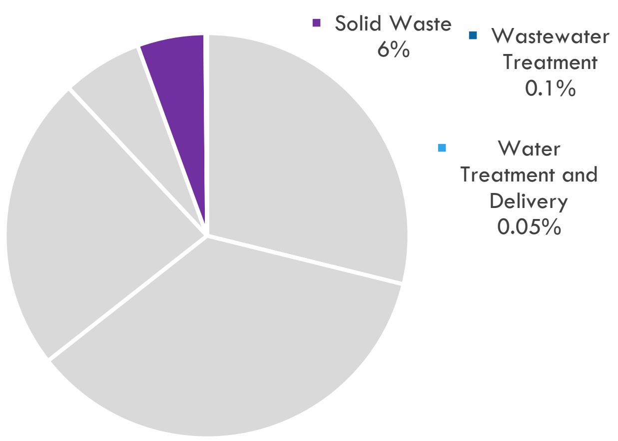
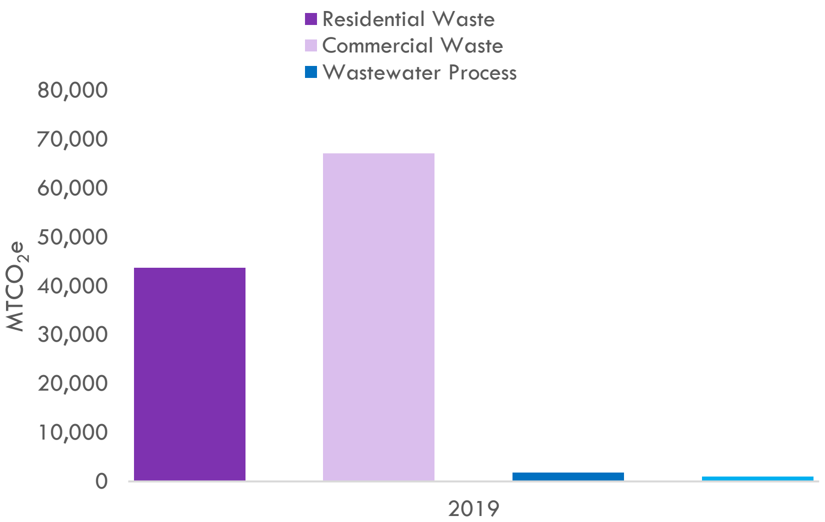


Table 6: Other Emissions ($MTCO_2e$), 2010-2019

Year	Solid Waste	
2010	124,413*	↓
2019	111,180	11%
Year	**Wastewater**	
2010	2,223	↓
2019	1,785	20%
Year	**Water Treatment & Delivery**	
2010	1,210	↓
2019	979	19%

Figure 23: Emissions from Waste & Water Activities, 2019



Solid waste related emissions dominate among non-transportation and building related emissions. It is also a sector that is challenging to track with high levels of detail. The City of Rochester municipal collection provides residential services to residential households of four units or fewer and a small number of commercial and multi-family properties. Waste related emissions included in past inventories have been limited to only that portion of the community. For this inventory, solid waste generation from commercial facilities was estimated based on employment data within Rochester and typical waste generation rates for different industries. For comparison purposes, 2010 emissions from solid waste were scaled by the ratio of residential to commercial waste established for 2019.

Wastewater treatment emissions are down from 2010 as a result of using the latest global warming potential multiplier for N_2O which was reduced to 286 from 310 MT CO_2e per MT N_2O. Emissions associated with potable water treatment and delivery are down primarily as a result of lower carbon electricity used to perform those functions. Note that emissions from potable water treatment and delivery are information items and not included in community-wide totals to avoid double counting.

Image Credit: City of Rochester NY

LOOKING FORWARD

The City of Rochester remains committed to reducing its contribution to climate change since the City signed the U.S. Conference of Mayor's Climate Protection Agreement in 2007. Since then, significant progress has been made to achieve GHG emissions reductions. This inventory illustrates that Rochester has achieved a 33% reduction in municipal emissions and a 10% reduction in community-wide emissions. Rochester has shown that it is possible to reduce emissions during a short time frame.

This inventory shows that the City has made great progress in reducing municipal emissions, which can be attributed to a variety of municipal sustainability efforts such as LED lighting upgrades, the solar field at the former Emerson Street Landfill and numerous smaller conservation actions that add up to big changes. Although community emissions have not reduced as quickly, Rochester did see significant reductions from its commercial buildings and water distribution and wastewater treatment infrastructure. A substantial challenge lies ahead in Rochester and many communities to transform the way that we heat homes, buildings, and transportation with carbon-free electricity.

Looking forward, the City of Rochester will use 2019 as a new benchmark from which to track progress toward our GHG emissions goals. As the City continues to update and implement the *Rochester Climate Action Plan* which was prepared in 2017, bigger initiatives will come into play to help drive deep reductions in greenhouse gases. Both at the state level through the New York Climate Leadership and Community Protection Act and from the federal Inflation Reduction Act of 2022, Rochester is well positioned to accelerate progress and maintain a leadership position in the transition to a climate-friendly and resilient community.

MUNICIPAL METHODOLOGY

The data used to generate regional GHG emissions estimates were drawn from sources that capture activity data from multiple departments and datasets across the city of Rochester's municipal operations. This inventory uses 100-year horizon Global Warming Potential values from the IPCC 5th Assessment Report. Except where noted, this inventory follows methods and emissions factors sourced from the Local Government Operations Protocol[3].

Energy

Electricity

Data Sources

Data Provider	Year(s)	Data Type	Categorization
City of Rochester Portfolio Manager Records	2019	Electricity Consumption	By facility
City of Rochester Building Services Division	2019	Electricity Consumption	By facility
eGRID emission factors NYUP Region[4]	2019	Emission Factors	EPA eGRID: NEWE CH_4 and N_2O Factors.

Methodology

- Collect activity data from Portfolio Manager Reports & other City of Rochester internal billing records for miscellaneous utility accounts.
- Multiply electricity consumption by eGRID emission factors to estimate emissions.

Natural Gas, Fuel Oil, & Steam

Data Sources

Data Provider	Year(s)	Data Type	Categorization
City of Rochester Portfolio Manager Records	2019	Fuel Consumption	By facility
City of Rochester Building Services Division	2019	Fuel Consumption	By facility
U.S. EPA's Emission Factors for Greenhouse Gas Inventories[5]	2019	Emission Factors	By fuel type for natural gas, fuel oil, diesel.

Methodology

- Collect activity data from Portfolio Manager Reports.
- Multiple consumption by EPA emission factors.

[3] https://ww2.arb.ca.gov/local-government-operations-protocol-greenhouse-gas-assessments
[4] https://www.epa.gov/egrid/power-profiler#/
[5] https://www.epa.gov/climateleadership/ghg-emission-factors-hub

Vehicle Fleet

Gasoline, Diesel, B-5 Biodiesel, E-85, CNG, Electricity

Data Sources:

Data Provider	Year	Data Type	Categorization
City of Rochester Fleet Management	2019	Fuel Use	By fuel type and vehicle type
U.S. Department of Energy's Alternative Fuel Data Center, Average Fuel Economy of Major Vehicle Categories[6]	2019	Average MPG (fuel efficiency) by Vehicle Type.	National
U.S. EPA's Emission Factors for Greenhouse Gas Inventories[7]	2021	Emission factors by vehicle type and amount of fuel consumed.	National

Methodology:

- Collect fuel use data and vehicle miles traveled from City of Rochester Fleet Management Software.
- Estimates of CNG in terms of gallon gasoline equivalent were converted to standard cubic feet based on energy densities of fuel types.
- Calculate CO_2 on the basis of fuel volumes.
- Biogenic portions CO2 was estimated by 15% of e85 ethanol and 5% of B5 biodiesel. These values are reported separate from fossil emissions.
- Fuel use data was not associated with specific vehicle types, for simplicity all gasoline was considered to be used by passenger vehicles and diesel by heavy trucks.
- Fuel use by equipment was identified by vehicles reporting operating hours rather than miles traveled.
- Calculate CH4 and N2O with VMT based emission factors for each vehicle and fuel type combination.
- Municipal EV consumption was obtained from charging stations within municipal facilities. This may be incomplete if vehicles charged in other locations and may include charging of non-municipal vehicles.
- Electricity consumption associated with EVs was subtracted from the aggregated municipal building electricity consumption to avoid double counting.

Solid Waste

Landfilled Waste – Methane Commitment

Data Sources:

Data Provider	Year	Data Type	Categorization
NY Department of Environmental Conservation	N/A	Population and Municipal Solid Waste Composition Calculator[8]	Material type distribution
US EPA WARM Model Documentation[9]	N/A	Methane Generation Potential	N/A

[6] https://www.afdc.energy.gov/data/categories/fuel-consumption-and-efficiency https://afdc.energy.gov/data/10310
[7] https://www.epa.gov/climateleadership/ghg-emission-factors-hub
[8] https://www.dec.ny.gov/chemical/48208.html
[9] https://www.epa.gov/warm/documentation-chapters-greenhouse-gas-emission-energy-and-economic-factors-used-waste

Methodology:

- Solid waste generation by municipal facilities used City of Rochester internal estimates of waste generation from waste collection service schedules.
- Tonnage of degradable waste types were estimated using the composition percentages for commercial facilities from the NYDEC Population and Municipal Solid Waste Calculator.
- Methane generation potential by waste type was calculated from generation potential and average landfill gas collection rates from EPA WARM model documentation, Management Practices Chapters exhibits 6-7 and 6-11.

Refrigerants

Fugitive Emissions from Building Air Conditioning Systems

Data Sources:

Data Provider	Year	Data Type	Categorization
City of Rochester Portfolio Manager Records	2019	Building Gross Floor Area	By Building
California Air Resources Board, High Global Warming Potential Gases Emissions Inventory, Technical Support Document.[10]	2016	Default refrigerant charge and leakage rates for building air conditioning systems.	By cooling system size

Methodology:

- Cooling system sizes for each building was estimated from building area data contained in EPA Portfolio Manager records, multiplied by 0.0016 tons of cooling per square foot of space. Buildings were classified as having <200, 200-2,000, or 2,000+ ton cooling systems.
- Assign average refrigerant charge and annual leakage rates using California Air Resources Board defaults.
- Convert pounds of leaked refrigerants to $MTCO_2e$ using 5th Assessment Global Warming Potentials.
- Building cooling systems assumed to use R141a.

Fugitive Emissions from Vehicle Air Conditioning Systems

Data Sources:

Data Provider	Year	Data Type	Categorization
City of Rochester Fleet Management	2019	Vehicle Count	N/A
California Air Resources Board, High Global Warming Potential Gases Emissions Inventory, Technical Support Document.[11]	2016	Default refrigerant charge and leakage rates for vehicle air conditioning systems.	N/A

Methodology:

- Obtain a count of vehicles from the Fleet Management Software data export used in fuel consumption calculations.

[10] https://ww3.arb.ca.gov/cc/inventory/slcp/doc/hfc_inventory_tsd_20160411.pdf
[11] https://ww3.arb.ca.gov/cc/inventory/slcp/doc/hfc_inventory_tsd_20160411.pdf

- Assign average refrigerant charge and annual leakage rates using California Air Resources Board defaults.
- Convert pounds of leaked refrigerants to $MTCO_2e$ using 5th Assessment Global Warming Potentials.
- Building cooling systems assumed to use R134a.

COMMUNITY METHODOLOGY

The data used to generate regional GHG emissions estimates were drawn from sources that capture activity data from multiple sectors across the City of Rochester. This inventory uses 100-year horizon Global Warming Potential values from the IPCC 5th Assessment Report. Except where noted, this inventory follows methods and emissions factors sourced from the US Community Protocol[12] and aligns with the reporting conventions defined by the Global Protocol for Community Scale Emissions Inventories (GPC).[13]

Energy

Electricity

Data Sources

Data Provider	Year(s)	Data Type	Categorization
NYSERDA, Utility Energy Registry[14]	2019	Electricity Consumption	Community wide consumption by customer class data provided by power utilities in the region. Residential and Commercial.
eGRID emission factors NYUP Region[15]	2019	Emission Factors	EPA eGRID: NYUP CO_2, CH_4 and N_2O Factors.

Methodology

- Collect activity data from the Utility Energy Registry database.
- Subtract the estimated electricity used for electric vehicles from residential and commercial electricity consumption.
    - *Assumption: Half of the total electric vehicle electricity consumption came from residents' homes and half came from commercial buildings.*
- Multiply electricity consumption by eGRID emission factors to estimate emissions.

Natural Gas

Data Sources

Data Provider	Year(s)	Data Type	Categorization
NYSERDA, Utility Energy Registry[16]	2019	Natural Gas Consumption	Community wide consumption by customer class data provided by power utilities in the region. Residential and Commercial.
U.S. EPA's Emission Factors for Greenhouse Gas Inventories[17]	2019	Emission Factors	Residential, Commercial
US EPA Facility Level GHG report	2019	Natural Gas Consumption at point sources	By Facility

Methodology

[12] https://icleiusa.org/us-community-protocol/
[13] https://ghgprotocol.org/greenhouse-gas-protocol-accountingreporting-standard-cities
[14] https://utilityregistry.org/app/#/
[15] https://www.epa.gov/system/files/documents/2022-01/egrid2020_summary_tables.pdf
[16] https://utilityregistry.org/app/#/
[17] https://www.epa.gov/climateleadership/ghg-emission-factors-hub

- Obtain gas consumption data from Utility Energy Registry database.
- Multiple natural gas consumption by EPA emission factors.

Notes

Additional natural gas consumption is used for energy production within the City of Rochester. This includes the generation of steam distributed by Rochester District Heating and in Combined Heat and Power applications at the Red-Rochester industrial facility and University of Rochester. These items are included in Rochester's official disclosure figures but are excluded from assessment of the progress towards meeting the Climate Action Plan targets as they were also excluded from the original scope of that plan. Some uncertainty exists whether these large sources are included in aggregate energy consumption reported in the NYSERDA Utility Registry, but due to the size of these sources compared to consumption throughout the wider community, it is assumed that these users are additional to the consumption contained in reports from the Utility Registry.

Steam

Data Sources

Data Provider	Year(s)	Data Type	Categorization
Rochester District Heating	2019	Quantity of Delivered Steam	All Commercial
US EPA Facility Level GHG report	2019	Consumption of gas at Rochester District Heating	By Facility

Methodology

- Calculate emissions factor for delivered steam based on an assumed 80% system efficiency according to the method for allocating emissions from Combined Heat and Power from the Climate Registry General Reporting Protocol Advance Methods.[18]
- Multiply customer delivered steam by calculated emissions factor.
- Calculate T&D losses as the difference between total gas use and delivered energy.

Notes

Full consumption of natural gas at the RDH facility is included as an information item under GPC reference number I.4.1.

Fugitive Natural Gas

Data Sources

Data Provider	Year(s)	Data Type	Categorization
NYSERDA, Utility Energy Registry[19]	2019	Residential and Commercial Natural Gas Consumption	Community wide consumption by customer class data provided by power utilities in the region.
Urban Sustainability Directors Network Methane Accounting tool[20]	N/A	Local distribution system leakage rate	Rochester Gas and Electric.

[18] https://www.theclimateregistry.org/protocols/GRP-V3-Advanced-Methods.pdf
[19] https://utilityregistry.org/app/#/
[20] https://www.usdn.org/public/page/31/Energy#MethaneAccounting

Methodology

- Identify estimated regional natural gas leakage rates by region and utility provider.
- Multiple leakage rate (0.0000098 MT CH_4 per therm) by residential and commercial natural gas consumption.
- Multiple estimated leakage by global warming potential for methane.

Liquified Petroleum Gas (LPG), Distillate Fuel Oil, or Wood

Data Sources

Data Provider	Year(s)	Data Type	Categorization
American Community Survey, U.S. Census Bureau, 5-Year Estimates Data Profile, DP04 Selected Housing Characteristics[21]	2019	Estimated number & percentage of homes in the City of Rochester categorized by the primary home heating fuel type.	Residential
US EIA Residential Energy Consumption Survey[22]	2020	Heating fuel intensities for homes heated with fuel oil and bottled gas	Residential
US EIA Commercial Building Energy Consumption Survey[23]	2018	Estimated building area using fuel oil for heat	Commercial
US EIA Commercial Building Energy Consumption Survey	2018	Average fuel intensity for commercial buildings utilizing fuel oil	Commercial

Methodology:

Residential

- Estimate total number of households using natural gas, fuel oil, propane, and wood for heating from the ACS.
- Calculate heating energy per household based on the natural gas usage from the Utility Registry and the household county in the ACS.
- Multiply total heating energy per household by the number of homes heated by fuel oil.
- Multiply consumption estimates by EPA emission factors.

Commercial

- Determine the energy fuel mix for the commercial subsector for Monroe County in 2010 was
- Calculate the ratio of the amount of fuel oil & other heating fuels consumed in 2010 versus natural gas.
- Multiply that ratio by the 2019 natural gas consumption to estimate 2019 fuel oil consumption.
- Multiply consumption estimates by EPA emission factors.

Notes

In the future it would be beneficial for the City of Rochester track combustion fuels used in properties through permitting processes or other mechanisms. While there are fields for this information in the assessor records for residential properties, values did not appear to accurately reflect current status. Commercial properties lack a field for tracking fuels used all together.

---

[21] https://data.census.gov/cedsci/table?tid=ACSDP5Y2020.DP04&g=0400000US36_1600000US3663000&hidePreview=true
[22] https://www.eia.gov/consumption/residential/data/2020/
[23] https://www.eia.gov/consumption/commercial/data/2018/pdf/CBECS_2018_Building_Characteristics_Flipbook.pdf

On-road Transportation

Passenger Vehicles – Gasoline & Diesel

Data Sources:

Data Provider	Year	Data Type	Categorization
Genesee Transportation Council	2019	Modeled VMT by vehicle type	Community-wide
Genesee Transportation Council	2019	Default vehicle mix values from HPMS classification.	Regional
U.S. Department of Energy's Alternative Fuel Data Center, Average Fuel Economy of Major Vehicle Categories[24]	2019	Average MPG (fuel efficiency) by Vehicle Type.	By Fuel and Vehicle Classification
U.S. EPA's Emission Factors for Greenhouse Gas Inventories[25]	2019	Emission factors for fuel combustion (CO_2) and distance traveled (CH_4 and N_2O)	By Fuel and vehicle type classification.

Methodology:

- Genesee Transportation Council provided on-road 2019 Annual Average Daily Traffic (AADT), and seasonal adjustment factors for road segments clipped to Rochester boundaries from the 2015 version of the regional transportation demand model.
- Vehicle class distribution which was sourced from Highways Performance Monitoring System distribution for the region.
- Fuel type assignments were made on the basis of vehicle classification assuming that all passenger vehicles use gasoline and heavy-duty vehicles use diesel.
- Divide total VMT for each fuel and vehicle classification by corresponding fuel economy to estimate total fuel consumption.
- Multiply fuel consumption by corresponding emissions factor for CO_2.
- Multiply mileage by corresponding mile-based factors for CH_4 and N_2O.

Passenger Vehicles – Electric

Data Sources:

Data Provider	Year	Data Type	Categorization
U.S. Department of Energy's Alternative Fuel Data Center, Electricity Sources and Emissions Tool[26]	2019	Electric vehicle kWh consumption per mile traveled	National
Atlas Public Policy, EValuateNY, March 2022[27]	2019	Estimated % of registered vehicles in state	State
eGRID emission factors NYUP Region[28]	2019	Emission Factors	EPA eGRID: NYUP CO_2, CH_4 and N_2O Factors.

[24] https://www.afdc.energy.gov/data/categories/fuel-consumption-and-efficiency https://afdc.energy.gov/data/10310
[25] https://www.epa.gov/climateleadership/ghg-emission-factors-hub
[26] https://afdc.energy.gov/vehicles/electric_emissions_sources.html
[27] https://atlaspolicy.com/evaluateny/
[28] https://www.epa.gov/system/files/documents/2022-01/egrid2020_summary_tables.pdf

Methodology:

- Multiply estimated VMT for gasoline passenger vehicles by the estimated NY state EV adoption rate to calculate an estimate VMT for EVs.
    - *Assumption: All EV's replace gasoline passenger vehicles, not light duty trucks, or diesel-powered vehicles.*
- Subtract mileage from gasoline passenger vehicle VMT to avoid double counting.
- Multiply estimated VMT by DOE's national average kWh/mile value to calculate total kWh consumed by EV's.
- Subtract half of estimated EV kWh use from both residential and commercial building electricity consumption to avoid double counting.
    - *Assumption: Half of EV kWh use is consumed from residential buildings and the other half is consumed from commercial buildings.*
- Multiply electricity consumption by eGRID emission factors to estimate emissions.

Transit

Data Sources:

Data Provider	Year	Data Type	Categorization
US Bureau of Transportation National Transit Database. Regional Transit Service - Monroe County, dba: RTS Monroe (MB) and RTS Access (DR).[29]	2019	Gasoline, Diesel, & Electricity Consumption	Community-wide

Methodology:

- Sum fuel consumption from data collected.
- Multiply Transit fuel consumption by EPA emission factors to estimate emissions.

Non-road Transportation

Aviation

Data Sources:

Data Provider	Year	Data Type	Categorization
U.S. Department of Transportation, Federal Aviation Administration, Air Passenger Statistics[30]	2019	Enplanements at U.S Airports	By Airport
U.S. Department of Transportation, Office of Aviation Analysis, Domestic Airline Fares Consumption Report[31]	2019	Average Distance per Trip & Quarterly Passenger counts	By Airport
U.S. Travel Association, Answer Sheet[32]	2019	Average Residential vs. Commercial flight trip split	National

[29] https://www.transit.dot.gov/ntd/transit-agency-profiles
[30] https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/media/cy20-all-enplanements.pdf
[31] https://www.transportation.gov/policy/aviation-policy/domestic-airline-consumer-airfare-report
[32] https://www.ustravel.org/answersheet

Methodology:

- Multiply Rochester airport's total enplanements by U.S. Travel's Residential and Commercial split to calculate residential and commercial enplanements.
- Multiply the quarterly average distance per trip by the quarterly passenger amount from the Domestic Fares consumption Report to calculate quarterly passenger miles travels. Sum the quarterly passenger miles traveled and divide by total passengers to calculate an average mileage per trip.
- Multiply the average mileage per trip by the residential and commercial enplanements to estimate total air miles traveled for each sector.
- Multiply commuter mileage estimates by EPA emission factors.

Railways

Data Sources:

Data Provider	Year	Data Type	Categorization
U.S. Department of Transportation Bureau of Transportation Statistics, Amtrak Rail Profile[33]	2019	Ridership, Average commuter mileage	Commuter Rail
Rail Passengers Association[34]	2019	Amtrak Service in Rochester, NY	Inbound Boardings

Methodology:

- Multiply 2019 Inbound boardings by average commuter rail mileage to estimate total passenger miles.
- Multiply commuter mileage estimates by EPA emission factors.

Waterborne

Data Sources:

Data Provider	Year	Data Type	Categorization
Google Maps	N/A	Count of Boats and Boat Slips	N/A
Sea Grant New York, Recreational Boating Survey	2003	Average Fuel Expenses per boater	N/A
US Energy Information Administration[35]	2003	Average price of gasoline	N/A

Methodology:

- Count boats and boat slips on Rochester side of port area.
- Estimate total fuel use by average fuel expense and price of gasoline from New York Recreational Boating Survey.
- Calculate Emissions with standard fuel combustion emissions factors.

---

[33] https://www.bts.gov/content/rail-profile
[34] https://www.railpassengers.org/site/assets/files/2402/roc.pdf
[35] https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=emm_epm0_pte_nus_dpg&f=a

Solid Waste

Landfilled Waste – Methane Commitment

Data Sources:

Data Provider	Year	Data Type	Categorization
City of Rochester, Solid Waste Management Division	2019	Tonnages of Waste Landfilled	Residential & Commercial Waste
CalRecycle 2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California[36]	2014	Average Commercial Solid Waste Generation Rates per Employee	By industry/NAICS Code
US Census On the Map, Employment Profile[37]	2019	Rochester Employment	By industry/NAICS Code
NY Department of Environment and Conservation[38]	2019	Waste Characterization	By Residential and Commercial
US EPA WARM Model Documentation[39]	N/A	Methane Generation Potential	N/A

Methodology:

- Total residential waste collection was provided by City of Rochester Solid Waste Management Division.
- Commercial generation was estimated based on local employment levels and average solid waste disposal rates for commercial establishments.
- Tonnage of degradable/methane generating waste types was determined by multiplying disposed waste by characterization values from the DEP Calculator.
- Methane generation potential by waste type was calculated from generation potential and gas collection rates from EPA WARM model documentation. Average gas collection efficiency values assume moderately aggressive landfill gas collection and average moisture conditions. Landfill gas emissions rate were calculated using 1 – [gas collection efficiency].

Composted Waste

Data Sources:

Data Provider	Year	Data Type	Categorization
City of Rochester, Solid Waste Management Division	2019	Tonnages of Waste Collected	Leaves & Yard Waste (Residential)
Impact Earth and Community Composting	2019	Waste Composted	Food Scraps
Global Protocol for Community Scale Emissions Inventories[40]	N/A	Emissions factors for Biological Treatment	N/A

Methodology:

- Calculate emissions using standard factors for composted waste of leaves, yard waste, and food scraps.

[36] https://www2.calrecycle.ca.gov/WasteCharacterization/PubExtracts/2014/GenSummary.pdf
[37] https://onthemap.ces.census.gov/
[38] https://www.dec.ny.gov/chemical/48208.html
[39] https://www.epa.gov/warm/documentation-chapters-greenhouse-gas-emission-energy-and-economic-factors-used-waste
[40] https://ghgprotocol.org/sites/default/files/standards/GPC_Full_MASTER_RW_v7.pdf

- Calculate N_2O and CH_4 emissions from composting. All CO_2 is omitted in this case as it is biogenic.

Water Treatment and Delivery

Data Sources:

Data Provider	Year	Data Type	Categorization
City of Rochester Water Bureau, 2021 Water Quality Report[41]	2020	Average daily delivery of water	Community-wide
U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. Appendix F: Wastewater and Water Emission Activities and Sources, July 2013.[42]	2019	Energy Intensity Defaults for Water Treatment & Delivery	National
eGRID emission factors NYUP Region[43]	2019	Emission Factors	EPA eGRID: NYUP CO_2, CH_4 and N_2O Factors.

Methodology:

- Extrapolate 2009 and 2019 annual water consumption using the 2005 and 2020 values collected from data sources.
- Calculate a total energy intensity for water use by summing the mid-point energy intensities from the range of values for extraction, conveyance, treatment, and distribution of surface water from the U.S. Community Protocol.
- Multiply estimates annual consumption by the calculated energy intensity to determine the total electricity used for water treatment and distribution.
- Multiply electricity consumption by eGRID & ISO emission factors to estimate emissions.
- Note that emissions associated with the energy used to treat and supply potable water are based on estimates of the energy use of facilities inside Rochester city limits which are included in other areas. Results from this section are not included in overall totals to avoid double counting and should be considered an information item.

Wastewater

Data Sources:

Data Provider	Year	Data Type	Categorization
U.S. Census Bureau, Quickfacts[44]	2019	Population	By City or Census Designated place
U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. Appendix F: Wastewater and Water Emission Activities and Sources[45]	N/A	Standard methods for nitrogen from nitrification/denitrification treatments and effluent discharge.	National

Methodology:

[41] https://www.cityofrochester.gov/waterquality/
[42] https://static1.squarespace.com/static/5d1e51dd2a98da000183bc20/t/5db5c0f84f74010ee4dac41a/1572192509182/Appendix+F+-+Wastewater+and+Water+Emission+Activities+and+Sources+-+U.S.+Community+Protocol.pdf
[43] https://www.epa.gov/system/files/documents/2022-01/egrid2020_summary_tables.pdf
[44] https://www.census.gov/quickfacts/rochestercitynewyork
[45] https://static1.squarespace.com/static/5d1e51dd2a98da000183bc20/t/5db5c0f84f74010ee4dac41a/1572192509182/Appendix+F+-+Wastewater+and+Water+Emission+Activities+and+Sources+-+U.S.+Community+Protocol.pdf

- Populations contributing to advanced wastewater treatment plants in each jurisdiction were sourced from the US Census.
- Populations were applied to standard methods for nitrogen from nitrification/denitrification treatments and effluent discharge.

DATA TABLES

Table 7: Rochester Municipal GHG Emissions by Sector and Source ($MTCO_2e$), 2019

GHG Emissions Source	2019
Municipal Buildings	**11,114**
Natural gas	3,740
Electricity	2,702
Fuel Oil No.2	266
District Steam	1,809
Propane	81
Refrigerants	2,517
Solid Waste	**818**
Waste Landfilled	818
Streetlights and Traffic Signals	**1,143**
Electricity	1,143
Vehicle Fleet	**9,189**
Diesel	3,933
Gasoline	4,428
CNG	80
E-85	101
B-5 Biodiesel	532
Electric Vehicles	1
Refrigerants	114
Grand Total	**22,264**

Table 8: City of Rochester Community GHG Emissions by Sector and Source ($MTCO_2e$), 2019

GHG Emissions Source	2019
Residential Buildings	**552,311**
Natural Gas	460,853
Electricity	53,359
Fugitive Natural Gas	23,818
Fuel Oil	12,377
Propane	1,905
Commercial Buildings	**688,584**
Natural Gas	473,585
Electricity	158,899
Steam	26,270
Fugitive Natural Gas	24,476
Propane	4,752
Fuel Oil	602
On-Road Transportation	**490,608**
Gasoline	403,851
Diesel	69,479
Transit	16,999
Electric	279
Non-Road Transportation	**130,797**
Aviation	126,234
Railways	3,696
Waterborne	867
Solid Waste	**111,180**
MSW Landfilled	110,785
Composted	395
Water Treatment and Delivery*	**979**
Wastewater Treatment	**1,785**
Total	**1,975,264**

***Information item, not included in total**