

Emporia, Virginia Community Greenhouse Gas Inventory

George Mason University – Local Climate Action Planning Initiative
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Introduction

The City of Emporia is located in the middle of Greensville County, Virginia with a population of 5,481. Local government officials have requested that an inventory be taken of greenhouse gas emissions from the year 2022. Partnering with ICLEI Local Governments for Sustainability, George Mason University has undertaken the process of collaborating with local government officials to compile greenhouse gas emissions data, and present it for the benefit of the City of Emporia. The following Community greenhouse gas inventory includes detailed reports of each sector and its emissions.

What is a Community Greenhouse Gas (GHG) Inventory?

A Community greenhouse gas (GHG) inventory is a systematic and comprehensive assessment of all GHG emissions produced within a specific community or geographic area. This inventory provides a detailed account of the sources and amounts of greenhouse gasses released into the atmosphere as a result of human activities within the community of Emporia.

Key elements of a Community GHG inventory include:

1. **Emission Sources** - Electricity, Transportation, Solid Waste, Water and Wastewater, AFOLU (Agriculture, Forestry, and Other Land Use), Fugitive Emissions, and Grid Loss. Note, as per ICLEI guidelines AFOLU is not included in the emissions total. The record is for information only.
2. **Greenhouse Gasses** - Measurement of different types of greenhouse gasses such as carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and refrigerants. Each gas contributes to climate change with varying potential. Carbon dioxide equivalent (CO₂e) is often used to convert methane, nitrous oxide and other greenhouse gasses to an equivalent warming potential of carbon dioxide to more easily compare emissions.
3. **Data Collection** - Where the data comes from such as vehicle miles traveled, reports from utility companies, and other relevant factors.
4. **Inventory Period** - The time frame in which the inventory is taking place.

Total Emissions

Emporia's total greenhouse gas emissions in 2022 are estimated to be 135,704 metric tons of carbon dioxide equivalent (CO₂e). Emission estimates were taken from internal municipal departments and external sources, such as Dominion Energy. Emissions data was categorized into the following: Residential Energy, Commercial Energy, Industrial Energy, Transportation, Solid Waste, Water and Wastewater, AFOLU (Agriculture, Forest, and Land Use), and Grid Loss.

Per capita emissions for Emporia are about 24.76 metric tons of CO₂e. While this is higher than the US average of 16, it is important to keep in mind that a large source of Emporia's emissions comes from transportation due to the intersection of highways 58 and 301. It's also important to note that per capita emissions tend to be lower for urban areas and higher for rural ones. For a comparison with other

municipalities of varying sizes:

	Martinsville, VA	Henry County, VA	Danville, VA	Charlottesville, VA	Carlisle, PA	Boone, NC
Population	13,517	50,248	42,215	45,672	20,144	18,036
Total Emissions	169,561	809,664	660,900	362,192	241,000	230,799
Per Capita Emissions	12.54	16.11	15.66	7.93	11.96	12.8

Emissions by Sector

Figures 1 and 2 illustrate how total emissions of 135,704 are divided into sectors. The sectors are:

- Residential Energy – 12,072 CO2e
- Commercial Energy – 12,970 CO2e
- Transportation – 52,197 CO2e
- Industrial Energy – 46,884 CO2e
- Solid Waste – 8,079 CO2e
- Water and Wastewater - 542 CO2e
- Grid Loss – 2,960 CO2e

The majority of emissions fall under the energy and transportation sectors, which is typical for the US.

Figure 1, Emissions by Sector

CO2e By Category

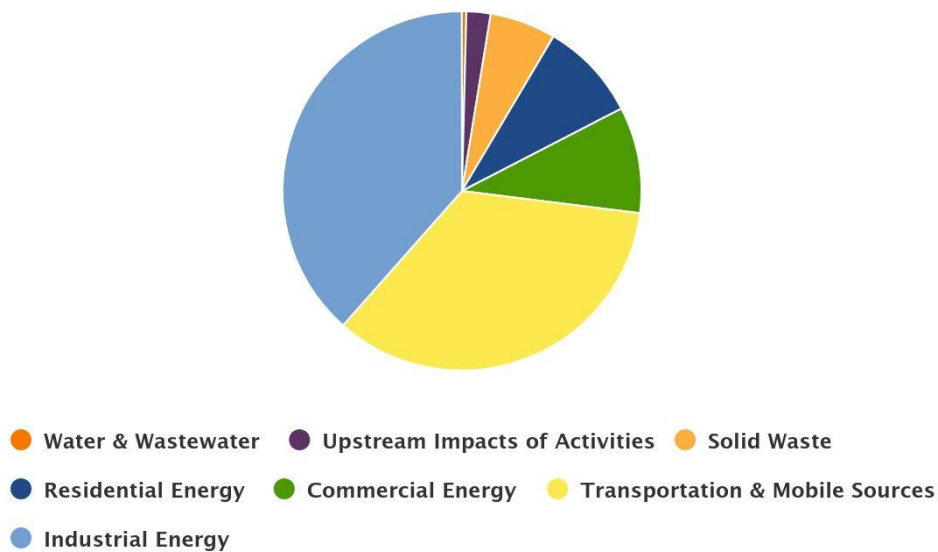
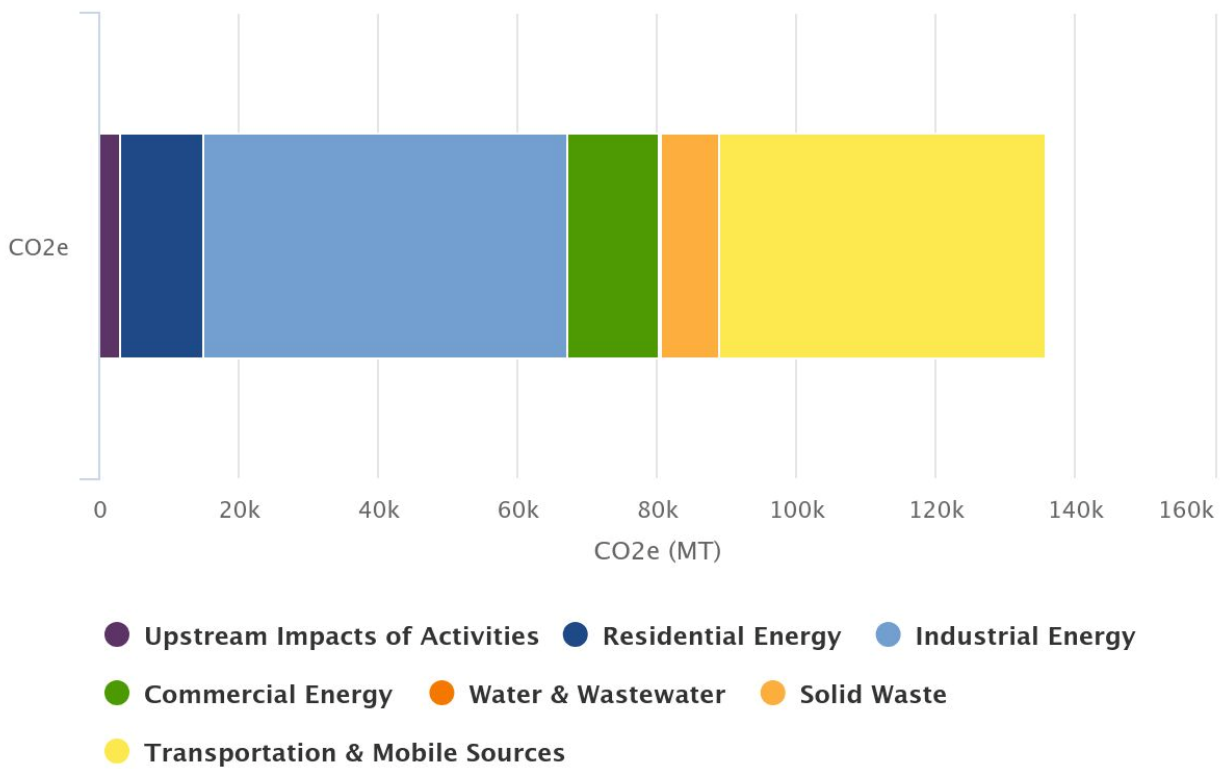


Figure 2, Emissions by Sector

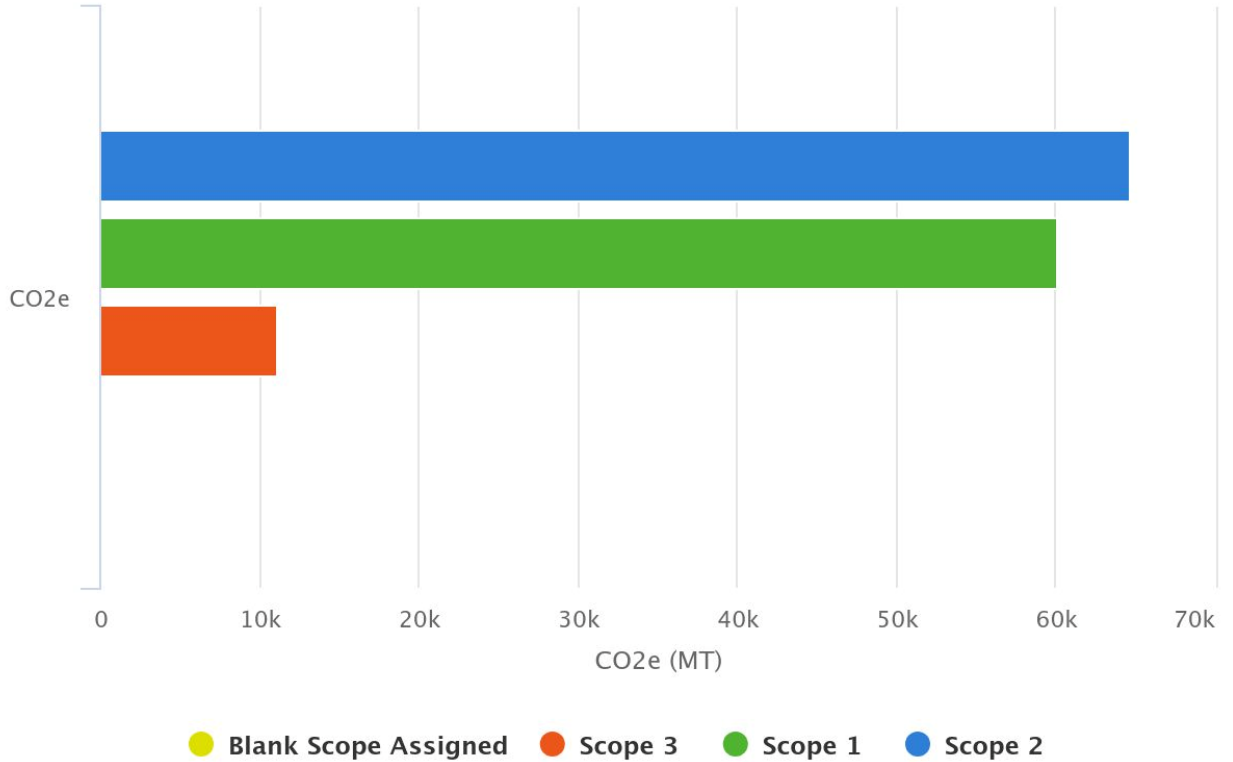


Inventory by Scope

Greenhouse gas emissions can also be divided up into scope 1, 2, or 3. Figure 3 represents Emporia's emissions divided by scope.

- Scope 1 emissions are directly made by an entity.
 - Ex: Transportation, since it takes place within Emporia's borders
 - Scope 1 emissions – 64,595 CO2e
- Scope 2 are emissions that an entity indirectly makes and are primarily from purchasing energy.
 - Ex: Energy purchased for heating and cooling homes.
 - Scope 2 emissions – 60,072 CO2e
- Scope 3 are emissions an entity is indirectly responsible for, but result from its activities
 - Ex: Solid waste produced by residents and sent to a landfill outside of Emporia's boundaries
 - Scope 3 emissions - 11,039 CO2e

Figure 3, Emissions by Scope



Residential Energy

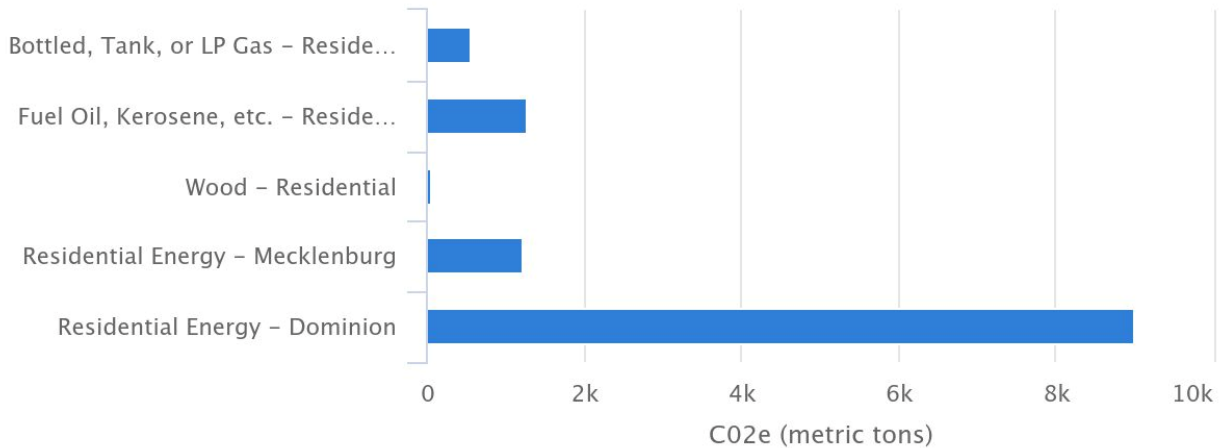
Emissions from residential energy come from the Energy Information Administration and utility providers Dominion and Mecklenburg. These reports allowed us to estimate the 2022 emissions for the residential energy sector for Emporia. Residential emissions are also divided up by type allowing for a more accurate emissions estimate. The categories are:

1. Bottled, Tank, or LP Gas Residential - For Bottled, Tank or LP Gas, the total emissions are 546 metric tons of CO₂e. This was measured by using EIA's Virginia Non-liquid fuels consumption 2022 data and the US Census Bureau's House Heating Fuel (B25040) Index for Emporia, VA.
2. Fuel Oil and Kerosene Residential - For Fuel Oil and Kerosene, total emissions are 1,260 metric tons of CO₂e. This was measured by using EIA's Virginia Non-liquid fuels consumption 2021 data and the US Census Bureau's House Heating Fuel (B25040) Index for Emporia, VA.
3. Wood Residential - For Wood, total emissions are 50 metric tons of CO₂e. This was measured by using EIA's Virginia Non-liquid fuels consumption 2021 data and the US Census Bureau's House Heating Fuel (B25040) Index for Emporia, VA.
4. Residential Electricity (Dominion) - The electricity used totaled 8,990 metric tons of CO₂e emitted. This number was calculated from data obtained from Dominion.
5. Residential Electricity (Mecklenburg) - The electricity used totaled 1,226 metric tons of CO₂e emitted. This number was calculated from data obtained from Mecklenburg.

Total emissions for the entire residential energy sector are 12,072 metric tons of CO₂e.

Figure 4, Emissions from Residential Energy

CO2e By Record



Commercial Energy

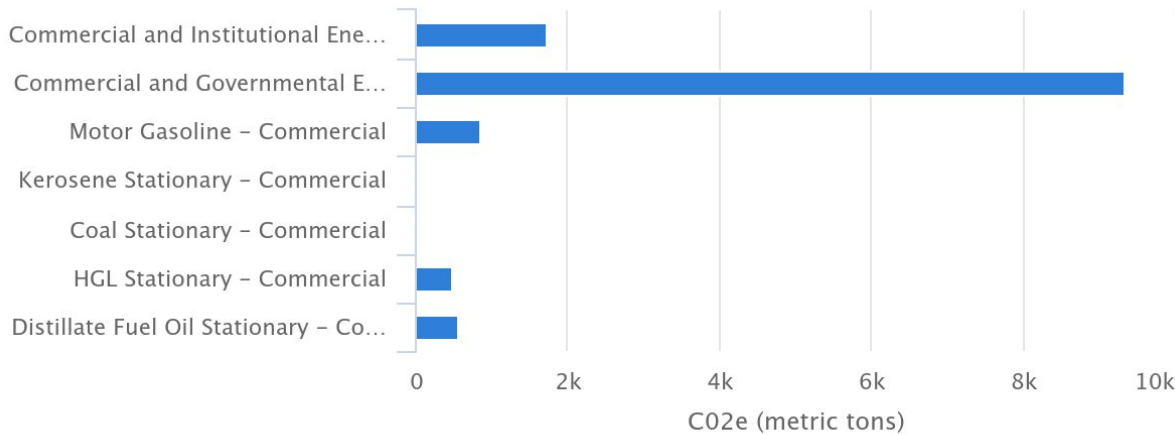
Emissions from commercial energy were calculated from 2021 US Census data, data from the Energy Information Administration, and utility providers Dominion and Mecklenburg. These reports allowed us to estimate the emissions for the commercial energy sector for the year 2022 Emporia. Commercial emissions are also divided up by type, allowing for a more accurate emissions estimate. The categories are:

1. Commercial and Institutional Electricity Use (Mecklenburg) - Electricity use is estimated to be 1,712 metric tons of CO2e. Data for this was provided by Mecklenburg.
2. Commercial and Governmental Electricity Use (Dominion) - Electricity use is estimated to be 9,330 metric tons of CO2e. Data for this was provided by Dominion.
3. Commercial Motor Gasoline - The stationary motor gasoline represented 860 metric tons of CO2e. The US Census Bureau's "OnTheMap" and EIA's "Commercial Sector Energy Consumption Estimates" tools were used to estimate fuel usage by number of jobs in the Commercial Sector in Emporia.
4. Commercial Distillate Fuel Oil - The same method was used for distillate fuel oil for a total of 567 metric tons of CO2e.
5. Commercial HGL - The same method was used for HGL for a total of 447 metric tons of CO2e.
6. Commercial Kerosene - The same method was used for kerosene for a total of 6 metric tons of CO2e.
7. Commercial Coal Use - Since anthracite and bituminous coal are the types of coal used the most in the region, we averaged their emission factors. Otherwise, the same method was used for a total of 18 metric tons of CO2e.

In total, the emissions resulting from commercial electric consumption are 12,970 Metric Tons of CO2e.

Figure 5, Emissions from Commercial Energy

CO2e By Record



Industrial Energy

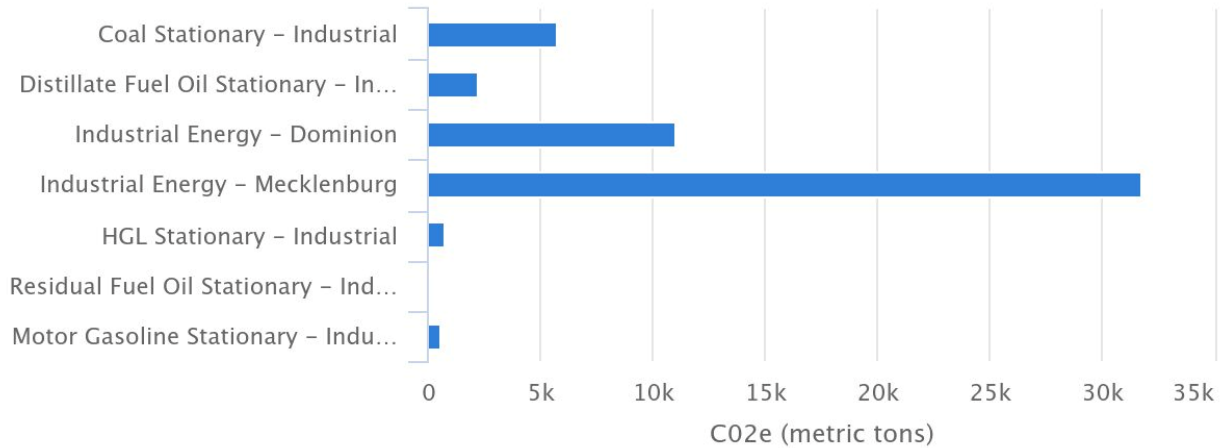
Emissions from industrial energy were calculated from 2021 US Census data, data from the Energy Information Administration, and utility providers Dominion and Mecklenburg. These reports allowed us to estimate the emissions for the industrial energy sector for the year 2022 for Emporia. Industrial emissions are also divided up by type, allowing for a more accurate emissions estimate. The categories are:

1. Industrial Electricity Use (Mecklenburg) - Electricity use is estimated to be 31,793 metric tons of CO2e. Data for this was provided by Mecklenburg.
2. Industrial Electricity Use (Dominion) - Electricity use is estimated to be 11,008 metric tons of CO2e. Data for this was provided by Dominion.
3. Industrial Motor Gasoline - The stationary motor gasoline emissions totaled 550 metric tons of CO2e. The US Census Bureau's "OnTheMap" and EIA's "Industrial Sector Energy Consumption Estimates" tools were used to estimate fuel usage by number of jobs in the Industrial Sector in Emporia.
4. Industrial Distillate Fuel Oil - The same method was used for distillate fuel oil for a total of 2,225 metric tons of CO2e.
5. Industrial HGL - The same method was used for HGL for a total of 773 metric tons of CO2e
6. Industrial Residual Fuel Oil - The same method was used for residual fuel oil for a total of 114 metric tons of CO2e.
7. Industrial Coal Use - Since anthracite and bituminous coal are the types of coal used the most in the region, we averaged their emission factors. Otherwise, the same method was used for a total of 5,736 metric tons of CO2e.

As a result of all these calculations, we found that in total, the emissions resulting from the industrial electric consumption represented 52,199 Metric Tons of CO2e

Figure 6, Emissions from Industrial Energy

CO2e By Record



Transportation

Emissions from transportation were calculated from the Department of Transportation's "Vehicle Miles Traveled" report. This report estimates the miles traveled for the year 2022 for each municipality in Virginia. Vehicles miles traveled are also divided up by vehicle type allowing for a more accurate emissions estimate since vehicles can be divided up into categories which use different emissions factors and fuel sets. The categories are:

1. Passenger (Gas) - Includes motorcycles, cars, 2 axles 4 tires, and 2 axles 6 tires
2. Passenger (Diesel) - Includes busses
3. Freight (Diesel) - Includes 3 axle single unit trucks, 4 or more axle single unit trucks, 4 axle or fewer single trailers, 5 axle single trailers, 6 or more axle single trailers, 5 axle or fewer multi-trailers

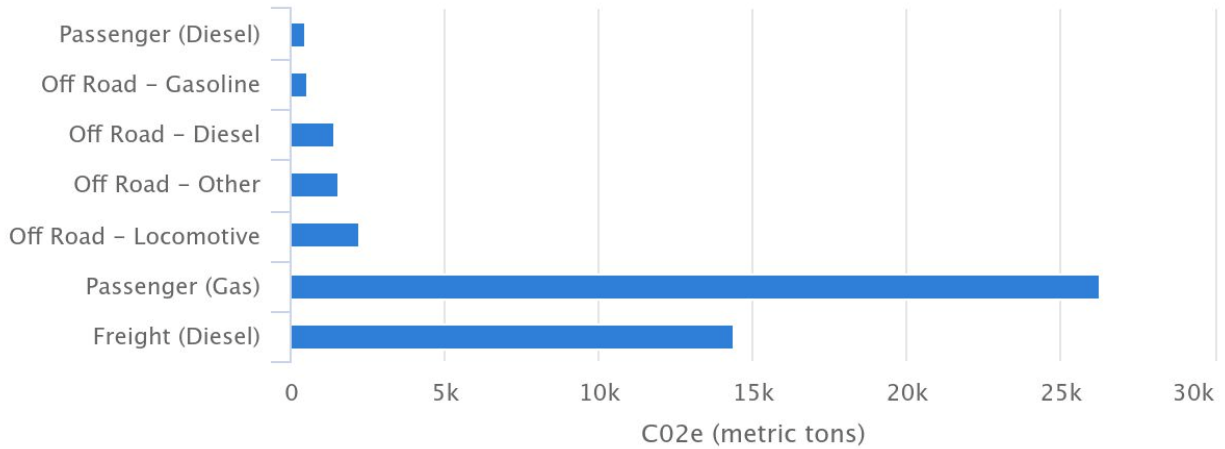
Emissions resulting from vehicle miles travelled in metric tons of CO2e of 26,317 for passenger (gas), 481 for passenger (diesel), and 14,367 freight (diesel) for total emissions of 41,165.

Additional emissions for Off-Road Transportation were calculated from the EPA's National Emissions Inventory Data tool. Emissions data was provided for the following categories by type of GHG emission: Gas, Diesel, Other, and Locomotive. Emissions by category (CO2e) were 515 for gas, 1,394 for diesel, 1,556 for other, and 2,256 for locomotive for total emissions of 5,721.

Total emissions for the entire transportation sector are 46,886 metric tons of CO2e.

Figure 7, Emissions from Transportation

CO2e By Record



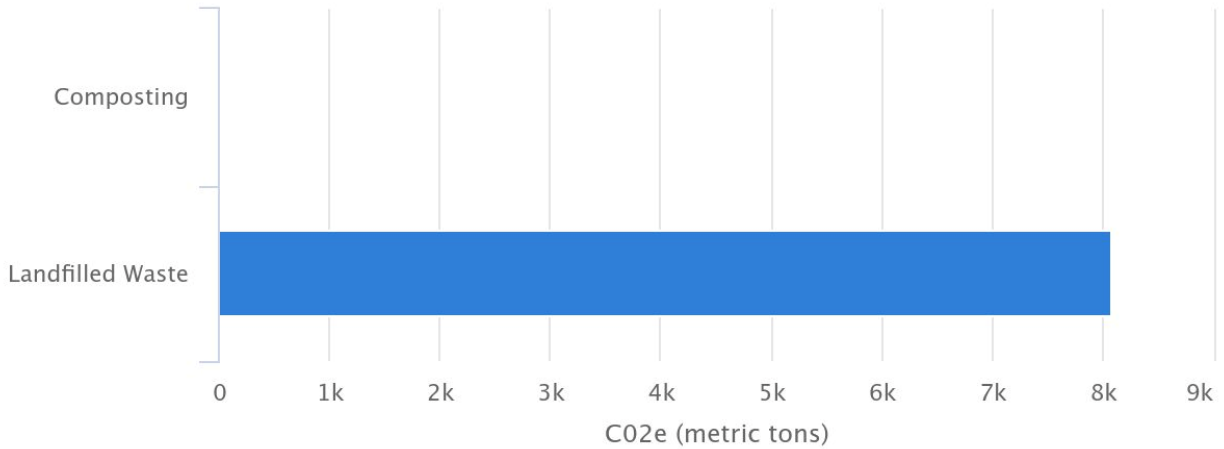
Solid Waste

Emissions from solid waste were calculated using the data supplied by Emporia officials, which represented the raw tonnage of landfilled. There were no reports of flared or combusted waste, meaning there is no documentation of methane (CH₄) gas being captured or burned, which leaves the majority of gases isolated to the landfilled waste. Moisture content for the landfill was also categorized as wet due to above average rainfall in the area.

With a total of 4,947.5 tons sent to an off-site landfill in Greenville County, this is classified as a Scope 3 Emission and resulted in 8,079 metric tons of CO₂e. Since no waste characterization was provided, 100% MSW (Mixed Waste) was used. Figure 8 shows solid waste emissions represented in metric tons of CO₂e.

Figure 8, Emissions from Solid Waste

CO₂e By Record



Water and Wastewater

Emissions for water and wastewater were calculated based on data collected from the City of Emporia. This data contains the amount of electricity used for the calendar year 2022 (in kWh) and the total population served.

For potable water treatment in the year 2022, approximately 748,800 kWh of electricity was used. The amount of potable water delivered for residents and businesses of Emporia was 302.628 mil. gal. The total population served by the potable water treatment plant was 5522.

For wastewater treatment in the year 2022, approximately 1,091,792 kWh of electricity was used. No nitrification or flaring of digester gas occurs.

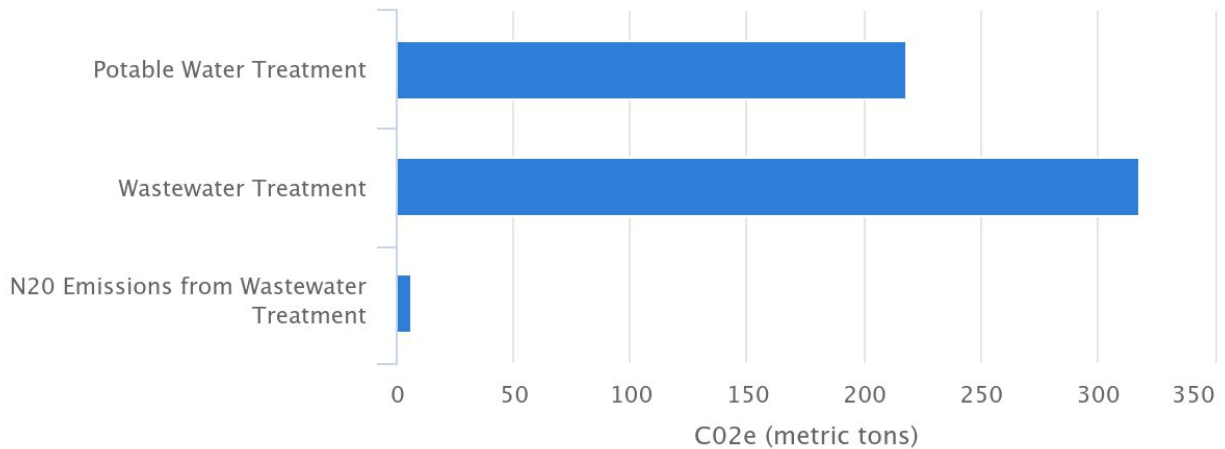
Per record, after converting to quantity of CO₂e emissions, this breaks down to:

- Potable Water Treatment — 218 metric tons CO₂e
- Wastewater Treatment — 318 metric tons CO₂e
- N₂O Emissions from wastewater treatment — 6 metric tons CO₂e

This amounts to a total of 542 CO₂e for Water and Wastewater.

Figure 9, Emissions from Water and Wastewater

CO₂e By Record



AFOLU

AFOLU stands for Agriculture, Forestry, and Other Land Use. For Emporia, only forestry contributes a sizable amount of greenhouse gas emissions. Forests act as greenhouse gas sinks as they absorb carbon from the atmosphere and can reduce emissions in a given area. As forests are converted to grassland, settlement, or other features, their ability to sequester carbon reduces.

Data from this section is not included in the overall emissions total and is designated as information only per ICLEI recommendations. While it is important to keep track of the amount of GHG reduced by forests, this inventory is only concerned with total emissions.

Emissions and Reductions from forest use were calculated through the LEARN tool from ICLEI which uses a land cover matrix and forest characteristics to estimate the annual loss or gain of forests in a specified area.

Emissions for this sector total 757.51 metric tons of CO₂e and are broken down as follows:

- Forest to Grassland – 170.56 CO₂e
- Forest to Settlement – 312.07 CO₂e
- Forest Disturbances – 274.88 CO₂e

Reductions for this sector total -8,408.65 metric tons of CO₂e and are broken down as follows:

- Undisturbed Forests - -6,215.1 CO₂e
- Trees Outside Forests - -1,821.6 CO₂e
- Non-Forest to Forest - -371.95 CO₂e

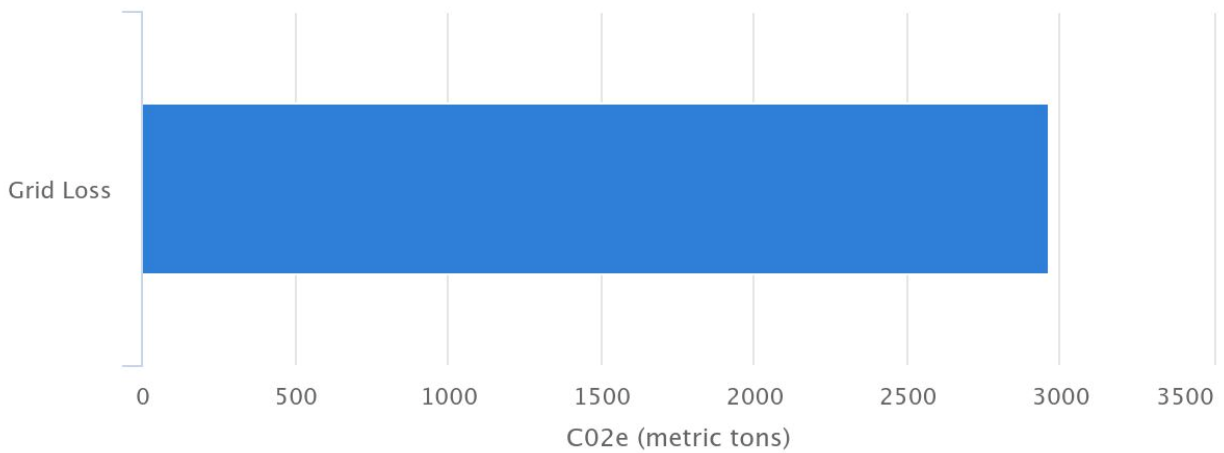
Net reductions for AFOLU are -7,651.14 metric tons of CO₂e

Grid Loss

Grid loss is the naturally occurring energy loss during the transmission of electricity. The Environmental Protection Agency's grid loss summary table estimates 4.5% of energy is lost in the region which contains the city of Emporia. Using ICLEI's internal calculator, total electricity usage within the city of Emporia of 225,537,144 kWh (Residential – 35,966,350, Commercial – 38,877,425, and Industrial – 150,693,369), and a grid loss factor of 4.5%, grid loss for Emporia is 2,690 metric tons of CO₂e.

Figure 10, Emissions from Grid Loss

CO₂e By Record



Data Sources and References

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