



**FRESH
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Climate Solutions

2023 COMMUNITY-WIDE AND MUNICIPAL GREENHOUSE GAS INVENTORIES

City of Columbia, Missouri

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OUR STATEMENT

Information contained in this report has been compiled and computed from sources believed to be credible. Application of the data is strictly at the discretion and the responsibility of the reader. Fresh Coast Climate Solutions is not liable for any loss or damage arising from the use of the information in this document.

OVERVIEW & APPROACH

The City of Columbia, Missouri commissioned Fresh Coast Climate Solutions in March of 2024 to conduct the 2023 community-wide and municipal greenhouse gas (GHG) inventories for the City of Columbia. Standard operating procedures based on the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions and the Local Government Operations (LGO) Protocol were utilized for the 2023 inventories, both developed by ICLEI- Local Governments for Sustainability USA. The procedures used for the 2023 inventories are consistent with the procedures that had been used to conduct the GHG inventories for calendar years 2015-2022.

The 2023 inventories were completed in ClearPath by ICLEI and the results were built into a Power BI dashboard. A review was conducted for both the community-wide and municipal inventories to identify drivers of changes in emissions between calendar year 2022 and 2023 inventories.

COMMUNITY-WIDE GHG INVENTORY RESULTS

Scope & Boundaries

The community-wide GHG inventory includes scope 1 GHG emissions emitted within City of Columbia city limits and scope 2 GHG emissions from electricity consumed within City of Columbia city limits. Sources of scope 1 emissions include natural gas combusted within the City of Columbia, the University of Missouri's combined heat and steam powerplant, the Columbia Energy Center, the Municipal Power Plant, transportation within city limits, the City of Columbia's landfill, and the treatment of community wastewater.

Summary

The total for 2023 community-wide scope 1 and 2 greenhouse gas emissions was 2.2 million metric tons of carbon dioxide equivalent (CO₂e). This is an 8% decrease from 2015 GHG emissions, and a 4% decrease from 2022 emissions.

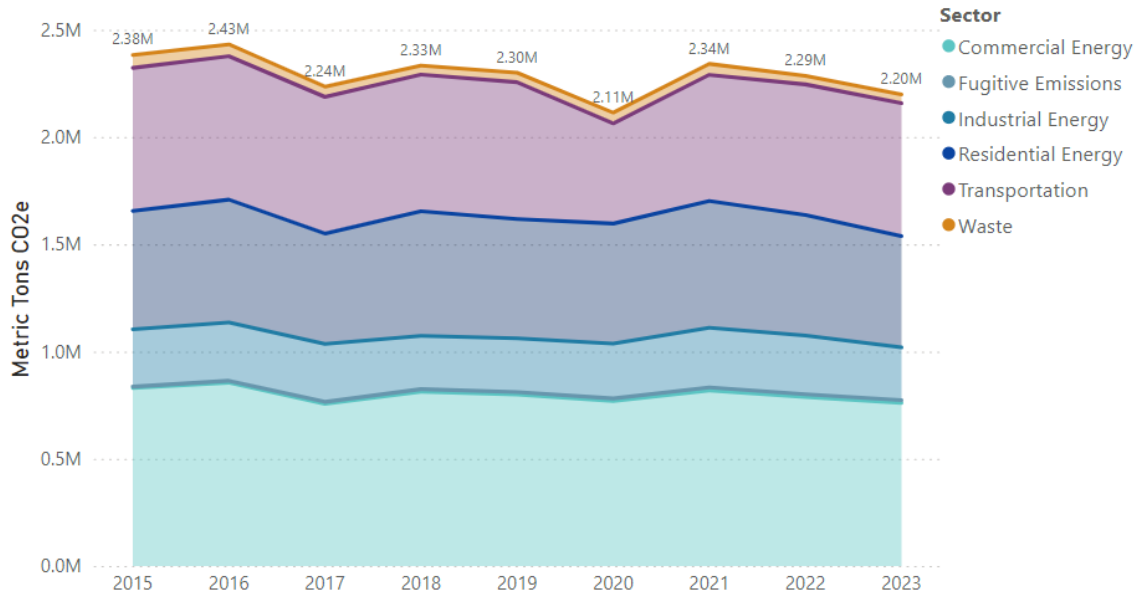


Figure 1. 2015-2023 City of Columbia, Missouri community-wide GHG emissions by sector

Inventory Analysis

Contribution by Sector

The energy sector is the largest contributor of GHG emissions, at 70% of the total inventory. GHG emission percentages by sector are shown in Figure 2. In 2023, commercial energy was responsible for 35% of GHG emissions, followed by residential energy at 24%, and industrial energy at 11%. Community transportation emissions made up 28% of the inventory and waste emissions made up only 2%. These results are proportional to previous years' inventories, as shown in Figure 1.

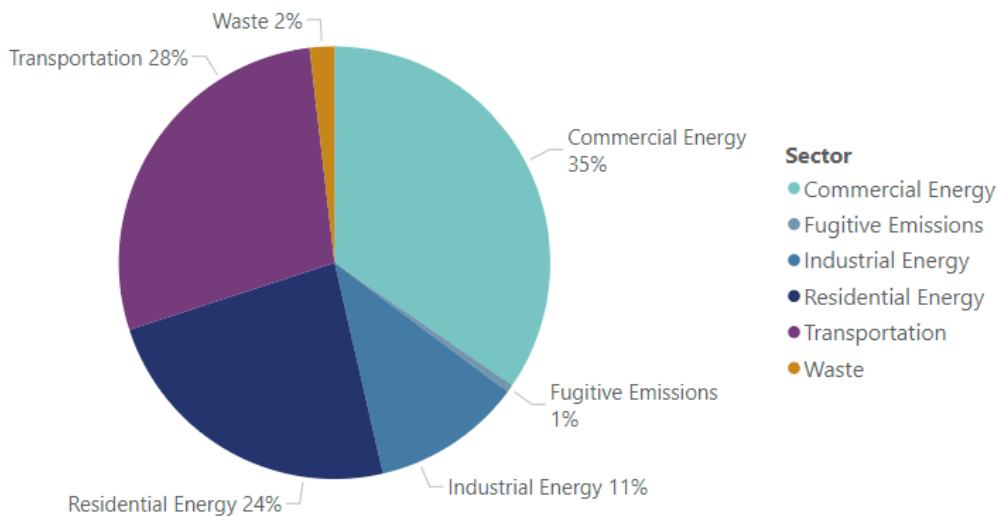


Figure 2. 2023 City of Columbia, Missouri community-wide GHG emissions percentages by sector



GHG Inventory Trend: 2022 to 2023

The decrease in GHG emissions between 2022 and 2023 of 87.8k metric tons of CO₂e, or 4% was mainly driven by an increase in renewable energy in the City of Columbia's electricity grid. Renewable energy made up 22% of electricity provided by the City of Columbia Electric Utility in 2023, up from 18% in 2022. The City of Columbia Electric Utility's weighted emissions factor, which includes all utilities that electricity is purchased from, decreased by 4% from 1,729 lbs CO₂e/MWh in 2022 to 1,663 lbs CO₂e/MWh in 2023.

Another primary driver for the reduction in emissions was the reduced need for climate control due to milder weather. An analysis was conducted to compare the number of heating degree days and cooling degree days in 2022 and 2023. Using historic weather data from NOAA collected at the Columbia Regional Airport, it was found that 2023 had 8% less cooling degree days than 2022, and 18% less heating degree days than 2022. A correlation in energy consumption trends was observed. Electricity provided by the City of Columbia Electric Utility decreased by 4% between 2022 and 2023, and natural gas consumption decreased by 6% between the two years.

Community transportation GHG emissions increased due to a 2% rise in vehicle miles traveled (VMT) between 2022 and 2023. This is based on data provided by Google's Environmental Insights Explorer. Share of VMT by fuel type, as well as vehicle efficiency, are modeled as the same for the two inventory years.

Wastewater GHG emissions also increased between 2022 and 2023 by 15%. 2023 BOD5 from influent increased from 18.8k in 2022 to 19.4k in 2023, and the percent removed in primary treatment decreased from 92% to 91%. Each percentage point removed in primary treatment has a large impact on GHG emissions. More detailed information on changes in activity data and GHG emissions can be found in Appendix 1.

Per Capita GHG Emissions

Based on American Community Survey (ACS) 1-year estimates, the City of Columbia, Missouri's population has grown at an average of 1.1% per year between 2015 and 2022. The population grew by 1.3% between 2021 and 2022. This value is modeled as the estimated population growth between 2022 and 2023. As Columbia's population has grown, the community-wide GHG emissions have decreased from 20 metric tons CO₂e/capita in 2015 to an estimated 16.9 metric tons CO₂e/capita in 2023. This represents an estimated 16% decrease in per capita GHG emissions from the 2015 baseline.

MUNICIPAL GHG INVENTORY RESULTS

Scope & Boundaries

The City of Columbia's municipal GHG inventory is compiled in two ways. The first compilation includes municipal operations only, which focuses on GHG emissions from the day-to-day operations of City government. This inventory most clearly reflects the impact of the City of Columbia's organizational sustainability efforts.



The second inventory includes municipal operations, as outlined above, as well as community power generation (the Municipal Power Plant and Columbia Energy Center), community landfill waste, and community wastewater treatment. This compilation is more heavily influenced by changes in community population size and activity.

The municipal inventories include a combination of scope 1, 2, and 3 emissions. Sources of scope 1 GHG emissions include buildings & facilities natural gas consumption, combusted fuel from the vehicle and transit fleet, electric power production, wastewater treatment, solid waste, and fugitive emissions from natural gas. Sources of scope 2 GHG emissions include electricity consumed by buildings, streetlights and traffic signals, and electric vehicles. The only source of scope 3 GHG emissions is employee commuting. Scope 3 emissions from purchased goods are not included in the inventory.

Summary- Municipal Operations Only

The total for 2023 municipal operations GHG emissions was 49.2k metric tons of CO₂e. This is 8% below 2022 emissions and 17% lower than 2015 GHG emissions.

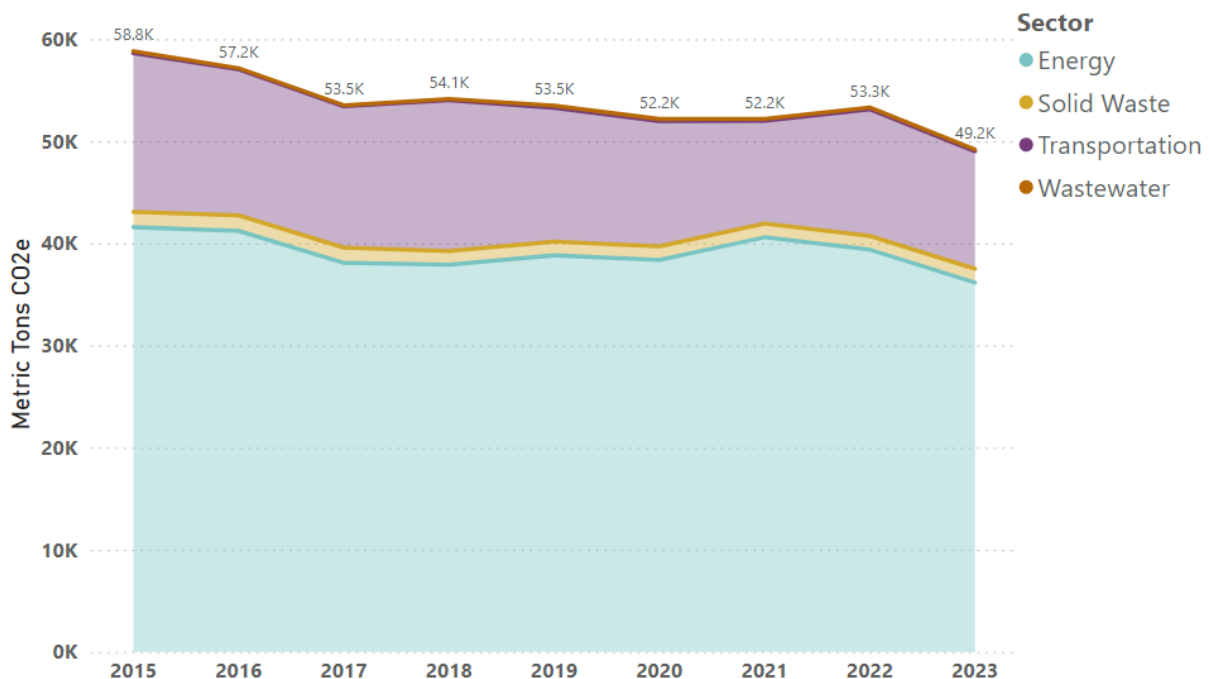


Figure 3. City of Columbia municipal operations only GHG emissions 2015-2023

Inventory Analysis - Municipal Operations Only

The municipal operations GHG inventory's emissions by sector mirrors that of the community-wide GHG inventory. Energy accounts for nearly three quarters (74%) of GHG emissions, transportation accounts for almost a quarter of emissions (23%), and waste and wastewater combined account for 3%.



GHG emissions from buildings & facilities energy consumption decreased by 11% between 2022 and 2023. Known drivers of this change include milder weather in 2023 than in 2022 and an increase in renewable energy in the City of Columbia Utility's electricity.

Transportation is another sector with decreased GHG emissions between 2022 and 2023 (7.3% decrease). Vehicle fleet GHG emissions decreased by 11% and transit fleet GHG emissions decreased by 8%. A decrease in diesel consumption drove the change in vehicle fleet GHG emissions. Similarly, added electric buses led to a reduction in transit fleet diesel consumption. City fleet staff reported fuel consumption data with low confidence in data quality, which may have influenced the results of the municipal transportation sector.

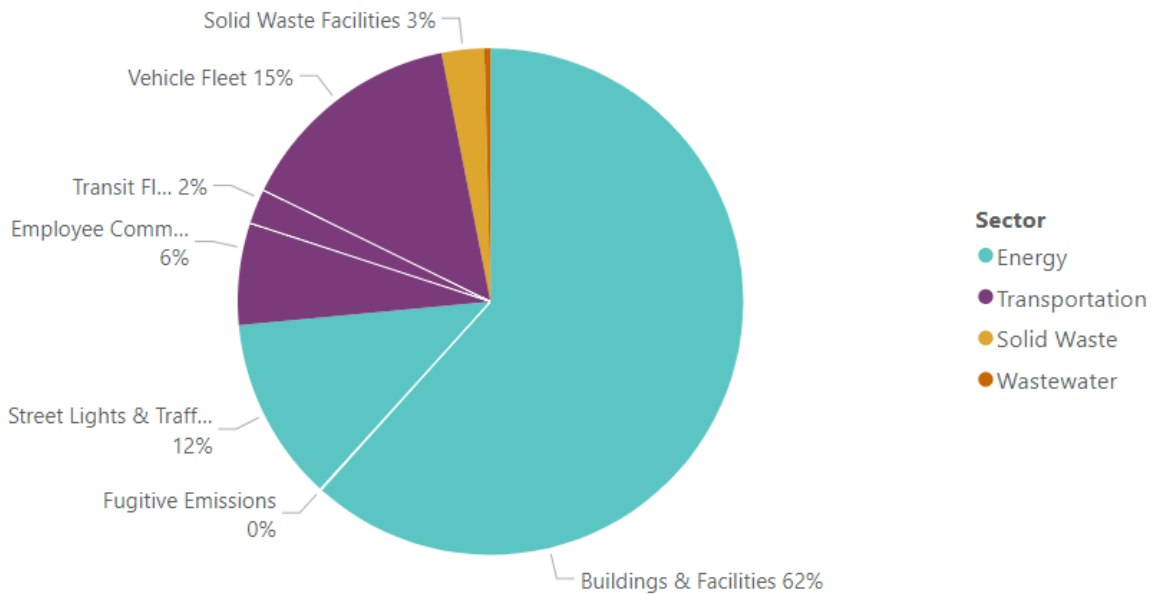


Figure 4. 2023 City of Columbia municipal operations only GHG emissions by sector/source

Summary - Municipal Operations + Community Waste, Wastewater, & Local Power Generation

The total for the City of Columbia's 2023 municipal GHG inventory, inclusive of community waste, wastewater, and local power generation, was 105.1k metric tons of CO₂e. This is 17% below 2022 emissions, and 37% lower than 2015 GHG emissions.

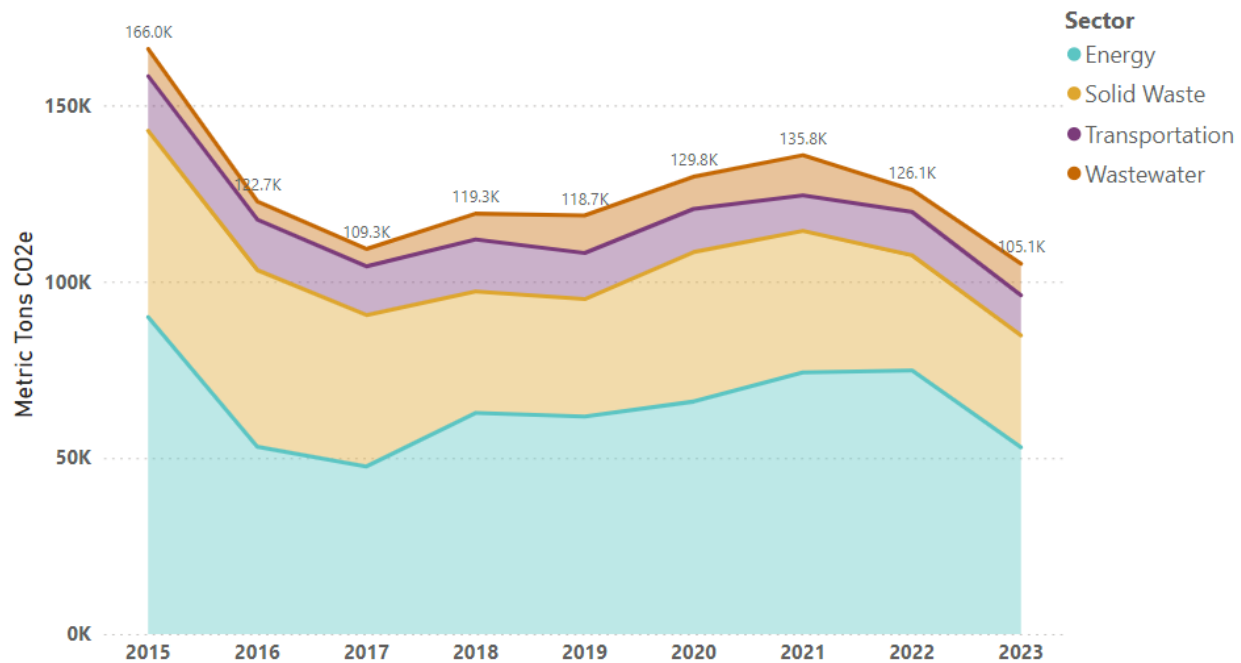


Figure 5. City of Columbia municipal GHG emissions, inclusive of community waste, wastewater, & local power generation

Inventory Analysis - Municipal Operations + Community Waste, Wastewater, & Local Power Generation

As seen in Figure 5, the energy sector is the largest contributor to GHG emissions. However, with the inclusion of community waste, wastewater, and local power generation, the municipal GHG inventory varies from year to year. For this reason, it is difficult to identify true trends in activity or efforts to reduce GHG emissions.

The largest change from 2022 to 2023 took place in the energy sector, driven by a decrease of 53% in GHG emissions from community power generation. 2023 energy sector GHG emissions were comprised of 57% buildings and facilities, 32% local power generation, and 11% streetlights and traffic signals. Local power generation, which includes the Municipal Power Plant and the Columbia Energy Center, made up 22% of the City of Columbia Electric Utility's electricity in 2023. The megawatt hours generated locally by the City of Columbia Electric Utility varies from year to year, and though it is generally a small percentage of total city-wide electricity consumption, it has a large impact on the municipal GHG inventory. Therefore, large fluctuations in local power generation annually result in the observed fluctuations in total municipal energy emissions. See Table 1 for local power generation GHG emissions and percentage of total municipal inventory by year.



Table 1. Local power generation GHG emissions and percentage of municipal inventory by inventory year

Year	CO ₂ e	Percent of Municipal Inventory
2015	48,319	29%
2016	11,863	10%
2017	9,476	9%
2018	24,802	21%
2019	22,914	19%
2020	27,599	21%
2021	33,622	25%
2022	35,644	28%
2023	16,793	16%

GHG emissions from solid waste facilities also fluctuate from year to year but have generally decreased since the 2015 baseline. In 2023, solid waste facilities accounted for 30% of the full municipal GHG inventory. Solid waste (landfill) GHG emissions in 2023 were 40% lower than the 2015 baseline and 2% lower than 2022 solid waste emissions.

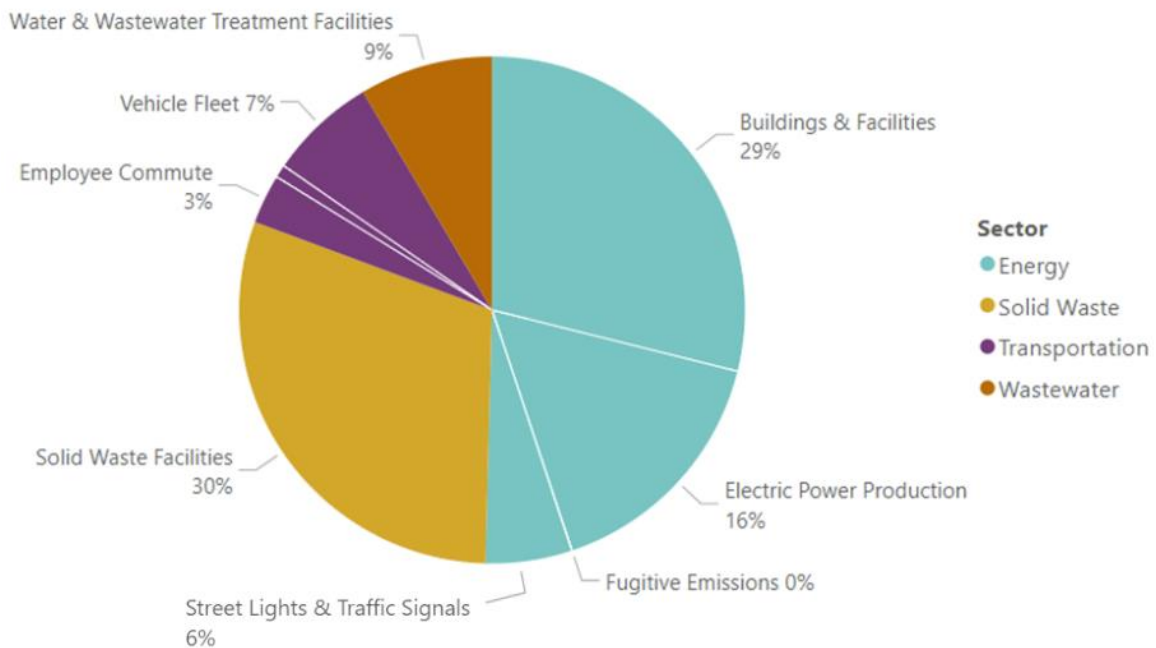


Figure 6. 2023 City of Columbia municipal GHG emissions, inclusive of community waste, wastewater, & local power generation by sector/source



RECOMMENDED INQUIRIES

This report documents the findings of the City of Columbia's community-wide and municipal GHG emissions inventories. Large scale drivers of change, such as weather impact or changes in activity, are noted. However, further investigation into other potential causes of activity changes may help the City of Columbia further understand trends in GHG emissions. The following are recommended:

1. Community wastewater GHG emissions: understand the cause of year-to-year fluctuations in wastewater treatment emissions, specifically the annual percentage removed.
2. Municipal building energy: look for correlations between individual building energy efficiency improvements and decrease in weather normalized energy consumption.
3. Municipal transportation: specifically, diesel consumption decreased for the municipal vehicle fleet. Work to understand potential decreases in vehicle fleet VMT or other changes in types of vehicles used and investigate idling data for changes between 2022 and 2023.
4. Community power generation: the inventory for municipal operations plus community waste, wastewater, & local power generation is greatly impacted by community power generation GHG emissions. The GHG emissions from community power generation decreased by 53% between 2022 and 2023. Investigate the cause of this decrease, and/or the likely fluctuation of this value in future years.



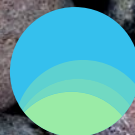
APPENDIX

APPENDIX A.1

Appendix Table 1. Community-wide GHG emissions changes 2022 to 2023

Sector	Category	Source	% Change in Consumption	% Change in GHG Emissions	Explanation
Energy	Residential	Natural Gas	-9.5%	-9.77%	Warmer winter
Energy	Residential	City of Columbia Electricity	-4.7%	-8.30%	Cooler summer, increase in renewable energy
Energy	Residential	Boone Electric Electricity	-0.7%	-0.73%	Lower energy consumption
Energy	Commercial	Natural Gas	-4.5%	-4.47%	Warmer winter
Energy	Commercial	City of Columbia Electricity	-0.3%	-4.12%	Cooler summer, increase in renewable energy
Energy	Commercial	Boone Electric Electricity	0.8%	0.79%	Increase in electricity consumption
Energy	Commercial	Mizzou	-3.4%	-0.17%	
Energy	Industrial	Natural Gas	-2.5%	-2.48%	Warmer winter
Energy	Industrial	City of Columbia Electricity	-6.9%	-10.43%	Cooler summer, more renewable energy, and slight decrease in percent of City of Columbia energy used by industrial sector
Energy	Industrial	Boone Electric Electricity	1.3%	1.35%	
Waste	Solid Waste	Landfill		-2.45%	
Water & Wastewater				14.51%	2023 BOD5 from influent increased from 18,795 in 2022 to 19,425 in 2023, and % removed in primary treatment decreased from 92% to 91%. Each % point removed in primary treatment has a large impact on GHG emissions
				-5.92%	Fugitive Emissions from Natural Gas Warmer winter
Transportation				1.57%	VMT increased by 1.8%. This could be explained by increase in population, and/or slight uptick in VMT as people may have driven more post covid in 2023 than in 2022

APPENDIX A.2



Appendix Table 2. Municipal operations only GHG emission changes 2022 to 2023

Sector	Category	% Change in GHG Emissions	Explanation
Energy	Buildings & Facilities	-11.1%	Cooler summer, warmer winter, more renewable energy. Look for improvements in energy efficiency
Energy	Street Lights & Traffic Signals	-5.7%	Increase in W&L renewable energy
Energy	Fugitive Emissions	-8.9%	Decrease in natural gas consumption (warmer winter)
Solid Waste	Solid Waste Facilities	0.0%	This is an estimate
Transportation	Vehicle Fleet	-10.6%	Decrease in diesel consumption
Transportation	Employee Commute	1.6%	Increase in employees
Transportation	Transit Fleet	-8.3%	Added electric buses reduced diesel consumption
Wastewater	Water & Wastewater Treatment Facilities	0.0%	This is an estimate