COLUMBUS GREENHOUSE GAS INVENTORY

SUSTAINABLE COLUMBUS
ANDREW J. GINTHER, MAYOR

2023

Prepared for:
City of Columbus, Office of Sustainability

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2023 CITY OF COLUMBUS GREENHOUSE GAS INVENTORY

Introduction

The City of Columbus recognizes the impact of climate change on the economic well-being of the region and quality of life for residents. As a member of the Global Covenant of Mayors, the City of Columbus is actively engaged in mitigating and adapting to the effects of climate change. Per the requirements of the Global Covenant of Mayors, Columbus has committed to and developed inventorying its annual greenhouse gas (GHG) emissions since 2017 and setting targets for future year emissions through publishing its first climate action and adaptation plan in December of 2021. This plan will be updated in 2025. The City of Columbus asked the Mid-Ohio Regional Planning Commission (MORPC), whose staff has extensive experience in the energy sector and developing GHG inventories, to complete the 2023 city operations and community-scale GHG inventory.

Greenhouse Gas Inventory Tool

The 2023 GHG inventory was conducted using the ICLEI-USA ClearPath tool.[1] ClearPath includes tracks to inventory both local government operations and community-scale GHG emissions. Results from each track are presented in the following sections. Each track is consistent with widely accepted US-based protocols, the Local Government Operations Protocol, and the US Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. ICLEI-USA's ClearPath tool is provided as a recommended resource for all members of the Global Covenant of Mayors. It includes inventory, forecast, planning, and monitoring modules.

The ClearPath tool relies on user-defined factor sets to analyze emissions that occur within a specific geography. In some instances, national averages are used when more locally specific data are not available. Of particular note, the emissions resulting from the electricity grid rely on a factor set provided by the US Environmental Protection Agency (US EPA). The Emissions & Generation Resource Integrated Database (eGRID) provides sub-region emission factors for even years on a two-year lag cycle (for example, emission rates for 2020 were provided in 2022). For odd years, the previous year's emission rates will be used as a place holder, as will be the case for even years if the GHG Inventory is produced prior to the release of updated data. If data provided in previous inventories are updated, the notation will appear below. For the Columbus GHG Inventory, the emissions factor set for Reliability First Corporation West (RFCW, the sub-region that includes Columbus) is used to analyze emissions. More information on eGRID can be found on the US EPA's website.[2]

[1] ICLEI USA: icleiusa.org/clearpath/.(Accessed July 9, 2024)
[2] US EPA: epa.gov/energy/emissions-generation-resource-integrated-database-egrid. (Accessed July 9, 2024)

Changes in Model or Methodology

The methodology utilized in the 2023 GHG Inventory is the same as in the 2022 GHG Inventory unless mentioned in this section. Significant changes to the model or methodology are noted below:

- As was the case for the 2022 inventory, due to the publication of the Columbus Climate Action Plan in December 2021, all government operations emissions comparisons now use 2013 as the baseline year, rather than the Green Memo 2005 reference.

- In this year's inventory, for the first time since 2018, the major natural gas utility provided a breakdown by sector of natural gas consumption. From 2018-2022, calculations were made based on the total sum of natural gas consumption. For this year's inventory, the true consumption by sector from the major natural gas utility will clearly be seen among the three sectors: residential, commercial, and industrial, most notably with increases in industrial power consumption.

- In January 2023, the US EPA updated eGRID values for RFCW (eGRID 2002). These updated values are lower than eGRID 2022 by 4.4%. Coal generation decreased by 11.8% in the RFCW subregion, which accounts for a much higher portion of the fuel mix. More detailed information is included in Appendix A.

- As was the case for the 2022 inventory, in the transportation sector, the vehicle mix—heavy trucks, light trucks, motorcycles, and passenger vehicles— has been updated using calculations derived from the local vehicle miles traveled (VMT) data and methodology provided by MORPC paired with the national default vehicle fuel efficiency and emissions factors provided by the US EPA (2020 values are the most recent available). This updated methodology provides a reliable vehicle mix that is on the road throughout the City of Columbus and Central Ohio. While the MPG affects both the city and community-scale inventories, the fuel vehicle mix only affects the community-scale inventory.

- After completing this report, it was discovered that the 2013 Community-Scale baseline inventory had been misrepresented. Specifically, Industrial Scope 2 emissions were not fully captured and are, therefore, absent from this report. Additionally, the entire 2013 Community-Scale baseline inventory was updated to more accurately reflect the true emissions for that year. However, these corrections are not reflected in this report, but will be incorporated into next year's report.

Greenhouse Gases

The following greenhouse gases are included in City of Columbus inventories:

- Carbon Dioxide (CO_2e)
- Methane (CH_4)
- Nitrous Oxide (N_2O)

These three gases are used to calculate a total carbon dioxide equivalent (CO_2e) value for City of Columbus emissions. In order to do so, ClearPath uses global warming potential (GWP) values for both methane and nitrous oxide. The GWP allows for the non-CO_2 gases to be presented in common terms that indicate the relative strength of their greenhouse effect in the atmosphere. ClearPath utilizes GWP values presented in Assessment Reports from the Intergovernmental Panel on Climate Change (IPCC). The GWPs are updated in each new Assessment Report from the IPCC. GWP values from the Second Assessment Report were used for the 2005

government operations inventory. Both government and community inventories from 2013-2017 used GWPs from the Fourth Assessment Report. GWP values available in the Fifth Assessment Report are used for the 2018 through 2022 GHG Inventories. And this year's inventory, 2023, used GWP values in the new Sixth Assessment Report.[3]

Sectors Included

The following sectors are included in the 2023 GHG inventories

Table 1. Sectors – Government Operations Inventory

Sectors – Community – Scale Inventory
Buildings and Facilities – Electricity Use
Buildings and Facilities – Natural Gas Use
Solid Waste Facilities – Refuse Collection
Streetlights and Traffic Signals – Electricity Use
Vehicle Fleet – On Road Fuel Use
Vehicle Fleet – Off Road Fuel Use
Water and Wastewater Treatment Facilities – Electricity Use
Water and Wastewater Treatment Facilities – Combustion of Digester Gas
Water and Wastewater Treatment Facilities – Flaring of Digester Gas
Water and Wastewater Treatment Facilities – Natural Gas Use

Table 2. Sectors – Community-Scale Inventory

Sectors – Community-Scale Inventory
Biological Treatment of Biosolids
Biological Treatment of Yard Waste and Woody Material
Commercial and Industrial Energy – Electricity Use
Commercial and Industrial Energy – Natural Gas Use
Fugitive Emissions from Natural Gas Distribution
Municipal Solid Waste
Residential Energy – Electricity Use
Residential Energy – Natural Gas Use
Transportation – Aviation Fuel Use
Transportation – Off Road Fuel Use
Transportation – On Road Fuel Use
Transportation – Public Transit Fuel Use
Transportation – Rail Fuel Use
Water and Wastewater Treatment Facilities – Combustion of Digester Gas
Water and Wastewater Treatment Facilities – Electricity Use
Water and Wastewater Treatment Facilities – Flaring of Digester Gas
Water and Wastewater Treatment Facilities – Natural Gas Use

[3] IPCC Sixth Assessment Report: ipcc.ch/assessment-report/ar6/ (Accessed July 9, 2024)

2023 Government Operations Emissions

Captured in Figures 1 and 2 and Tables 3 and 4 below, government operations contributed 306,649 metric tons of CO2e in 2023. This represents a decrease of 1.7% in total emissions from 2022. The Columbus Climate Action Plan (CAP) utilizes 2013 as the baseline year for all metrics and goals. When considering the total emissions from government operations since 2013, the year in which annual inventories began, the negative trend—decreasing emissions—that had been seen through 2015 leveled off. Between 2016-2020, the emissions ebbed and flowed—increased and decreased— without a real trend materializing, until the past two years; since 2020, emissions have decreased by 7.2%, continuing to decrease with 2023 Government Operations being the lowest ever.

Overall, 2023 emissions compared to 2022 emissions have decreased, both in total emissions and emissions per capita. The biggest increase seen from this year to last year is in Vehicle Fleet, by nearly 10,000 MT CO2e or an increase of 46.3%. This resembles a continual increase seen in Transportation of the Community-Scale inventory. Compared to 2013 in Government Operations, emissions have decreased nearly 13.8%. On a per capita basis, which offers a levelized view of the City's efficiency in providing services, government operations created 0.336 metric tons of CO2e per person in 2023, a 23.9% decrease per capita from 2013.

Figure 1. Government Operations – Annual Total Emissions | 2013 - 2023

CITY OF COLUMBUS

Government Operations CO2e Emissions

Annual Total Emissions in Metric Tons of CO2e | 2013 - 2023

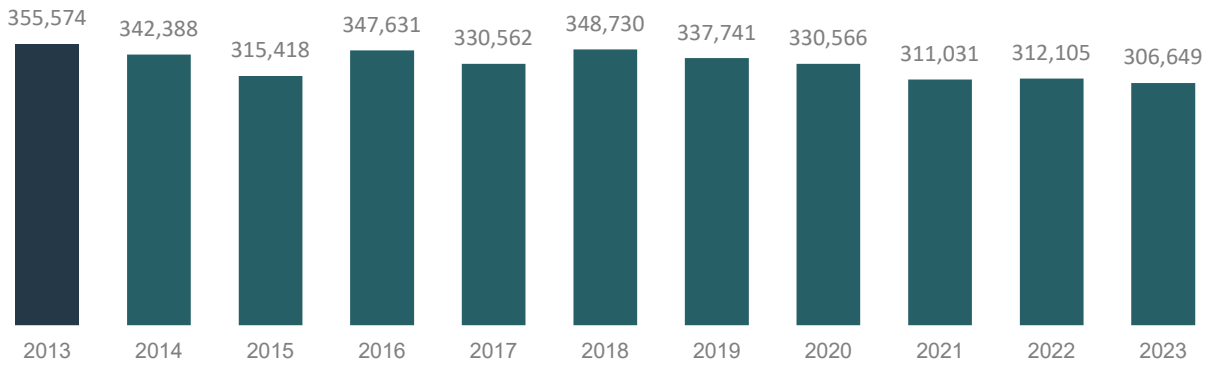


Table 3. Government Operations – Annual Emissions by Sector

Government Operations	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Buildings & Facilities	76,431	87,309	79,818	88,451	81,284	86,011	75,347	63,071	61,829	67,325	69,100
Streetlights & Traffic Signals	26,749	32,442	31,788	30,471	21,616	25,265	18,733	23,587	17,966	21,571	15,643
Vehicle Fleet	30,281	29,459	26,184	23,587	22,564	23,473	23,445	20,141	19,649	19,549	28,609
Solid Waste Facilities	97,218	98,597	102,290	108,272	110,308	111,721	122,917	133,148	130,287	117,856	105,163
Water & Wastewater Treatment Facilities	124,895	94,582	75,337	96,851	94,790	102,259	97,300	90,619	81,300	85,804	88,134
Total Emissions (Metric tons CO_2e)	355,574	342,388	315,418	347,631	330,562	348,730	337,741	330,566	311,031	312,105	306,649

Figure 2. Government Operations – Emissions Per Capita | 2013 - 2023

CITY OF COLUMBUS

Government Operations CO2e Emissions

Annual Metric Tons of CO2e Per Capita | 2013 – 2023

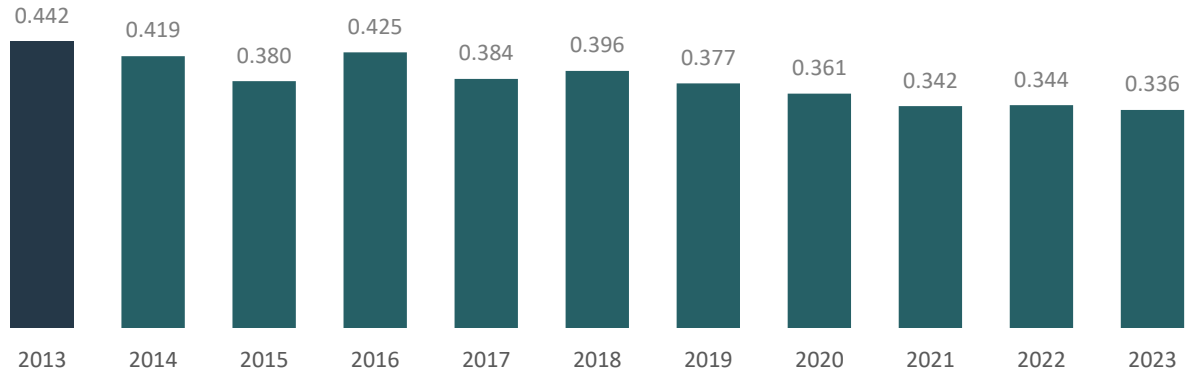


Table 4. Government Operations – Annual Emissions Per Capita

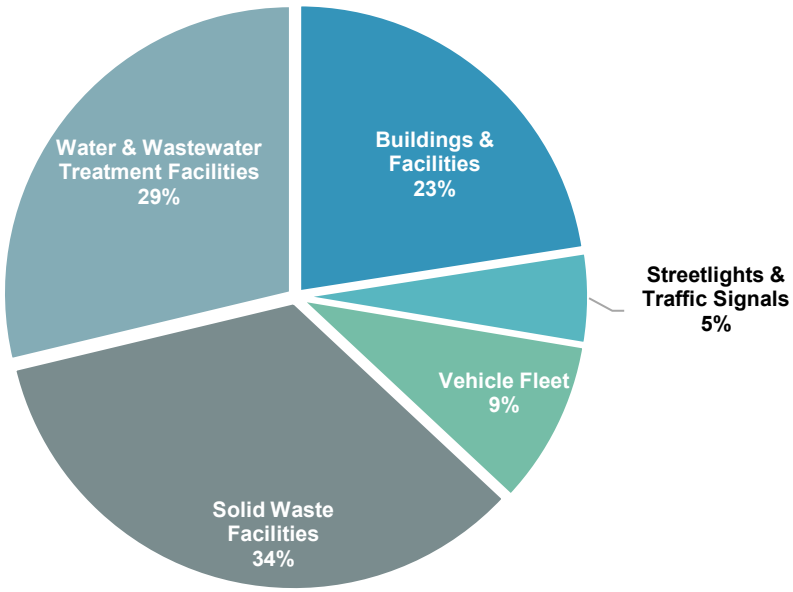
Government Operations	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Population	805,348	817,383	829,690	818,912	861,141	880,828	895,877	914,850	909,686	908,386	912,274
Buildings & Facilities	0.095	0.107	0.096	0.108	0.094	0.098	0.084	0.069	0.068	0.074	0.076
Streetlights & Traffic Signals	0.033	0.040	0.038	0.037	0.025	0.029	0.021	0.026	0.020	0.024	0.017
Vehicle Fleet	0.038	0.036	0.032	0.029	0.026	0.027	0.026	0.022	0.022	0.022	0.031
Solid Waste Facilities	0.121	0.121	0.123	0.132	0.128	0.127	0.137	0.146	0.143	0.130	0.115
Water & Wastewater Treatment Facilities	0.155	0.116	0.091	0.118	0.110	0.116	0.109	0.099	0.089	0.094	0.097
Total Emissions per Capita (Metric tons CO_2e)	0.442	0.419	0.380	0.425	0.384	0.396	0.377	0.361	0.342	0.344	0.336

Sector-Relative Emissions Contributions

Emissions are relative to the fuel being consumed directly, the primary fuel mix of the electricity consumed, and the processes that occur during operations. Providing for a city's water and waste needs are often the greatest contributors to emissions when looking at government operations alone. Both services are the two largest emitters—at 29% and 34%, respectively—as seen in Figure 3. Despite a lower energy use intensity and minimal emission byproducts of operations, city-owned buildings and facilities were still responsible for nearly a quarter of emissions—at 23%—from city government operations. As City of Columbus fleets are primarily reliant on gasoline and diesel as fuel sources, fleet vehicles saw the biggest increase from 2022, moving from 6% to 9 % in 2023. And streetlights and traffic signals accounted for only 5% in 2023, down from 7% of total city government operation emissions. Overall, 2023 total emissions decreased by almost 6,000 MT CO2e, or 1.7%, from 2022.

Figure 3. Government Operations – Sector Percentage of Total Annual Emissions | 2023

CITY OF COLUMBUS
Government Operations CO2e Emissions
Sector Percentage of Total | 2023



Sector Emission Contributions Between 2013 and 2023

As seen in Table 5, nearly all sectors analyzed produced fewer total emissions in 2023 than in 2013. Only solid waste facilities produced more CO2e emissions in 2023 than in 2013, most of which can be accounted for in population growth.

Table 5. Government Operations – Percent Change in Emissions from 2013

Government Operations	Percent Change in Total Emissions 2013 - 2023	Percent Change in Emissions per Capita 2013 - 2023
Buildings & Facilities	-9.6%	-20.2%
Streetlights & Traffic Signals	-41.5%	-48.4%
Vehicle Fleet	-5.5%	-16.6%
Solid Waste Facilities	8.2%	-4.5%
Water & Wastewater Treatment Facilities	-29.4%	-37.7%
Total Emissions (Metric tons CO_2e)	**-13.8%**	**-23.9%**

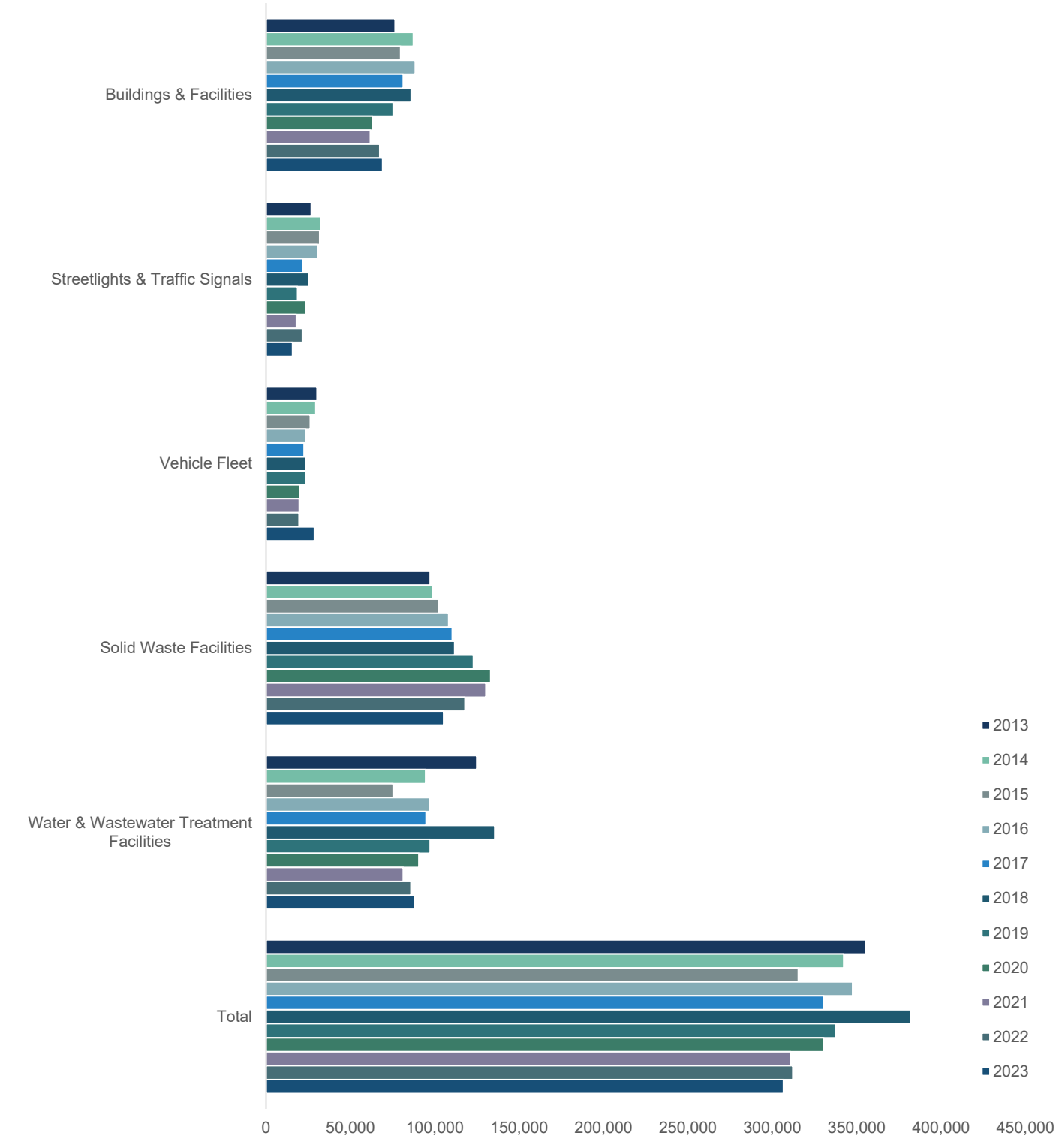
Annual emissions data for each sector are provided below in Figure 4, accompanied by the sector breakdown by percentage in Figure 5. Both are set against the baseline year 2013 for comparison purposes, noted in dark blue in Figure 4.

Figure 4. Government Operations – Annual Sector Contributions | 2013 - 2023[4]

CITY OF COLUMBUS

Government Operations CO2e Emissions

Annual Sector Contributions in Metric Tons CO2e | 2013 - 2023



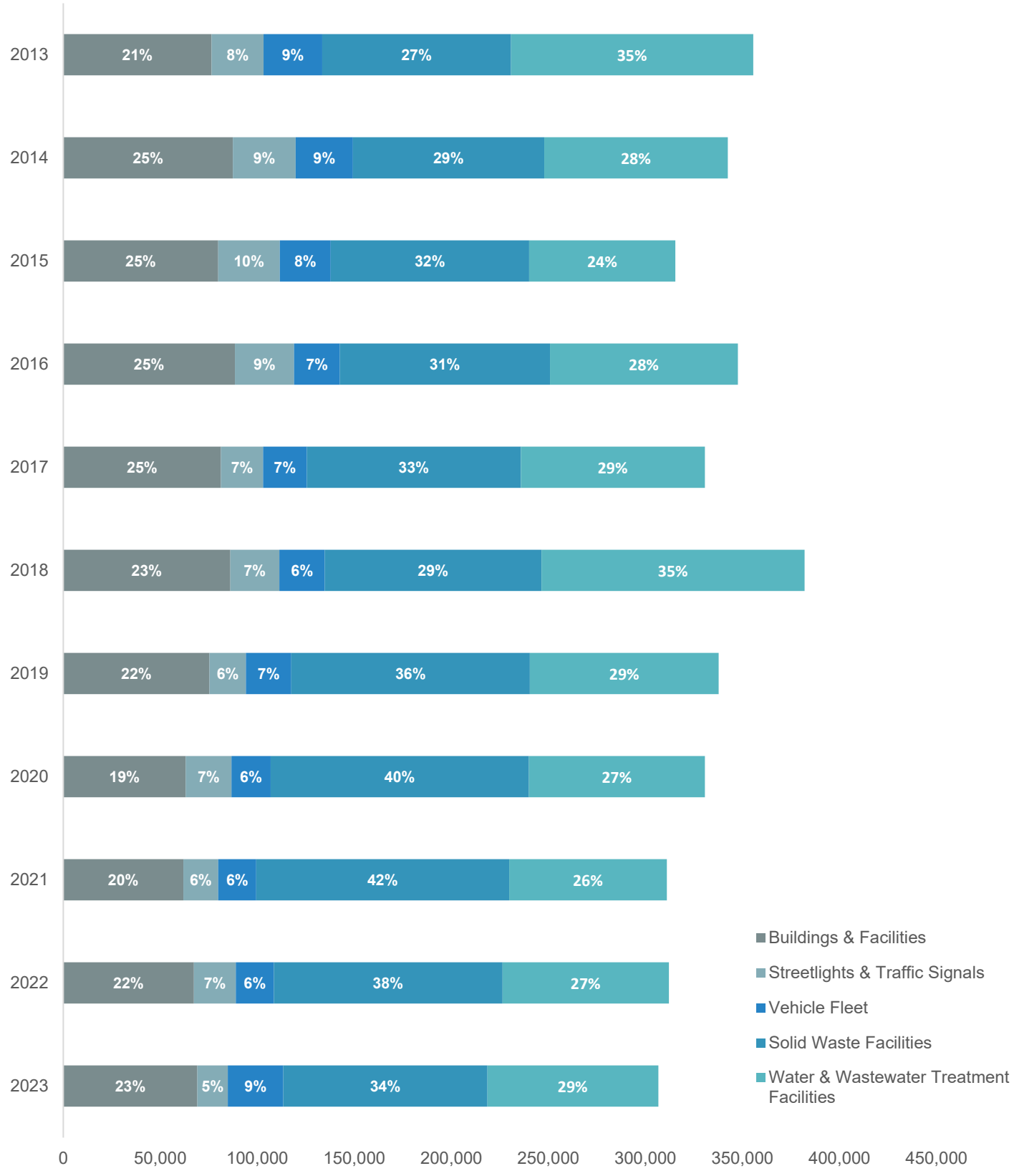
[4] Emissions from energy use at Waste and Wastewater Treatment Facilities was included in Buildings and Facilities in 2016. This methodology was corrected beginning in the 2017 City of Columbus Greenhouse Gas Inventory.

Figure 5. Government Operations – Percentage of Total Emissions by Sector | 2013 - 2023

CITY OF COLUMBUS

Government Operations CO2e Emissions

Total Emissions by Sector Percentage in Metric Tons CO2e | 2013 - 2023



Below in Figures 6-10 are annual emissions data for each individual sector from 2013-2023 with a three-year moving average trend line. The baseline year of 2013 is noted in dark blue. These figures better highlight the changes seen both between this year and last year, as well as the general trend for each sector since 2013, smoothing out any outlier years, most notably in the spikes seen in Figure 8 in 2023 Vehicle Fleet emissions and Figure 10 in 2018 Water and Wastewater Treatment emissions.

Figure 6. Government Operations – Annual Building and Facilities Contributions | 2013 - 2023

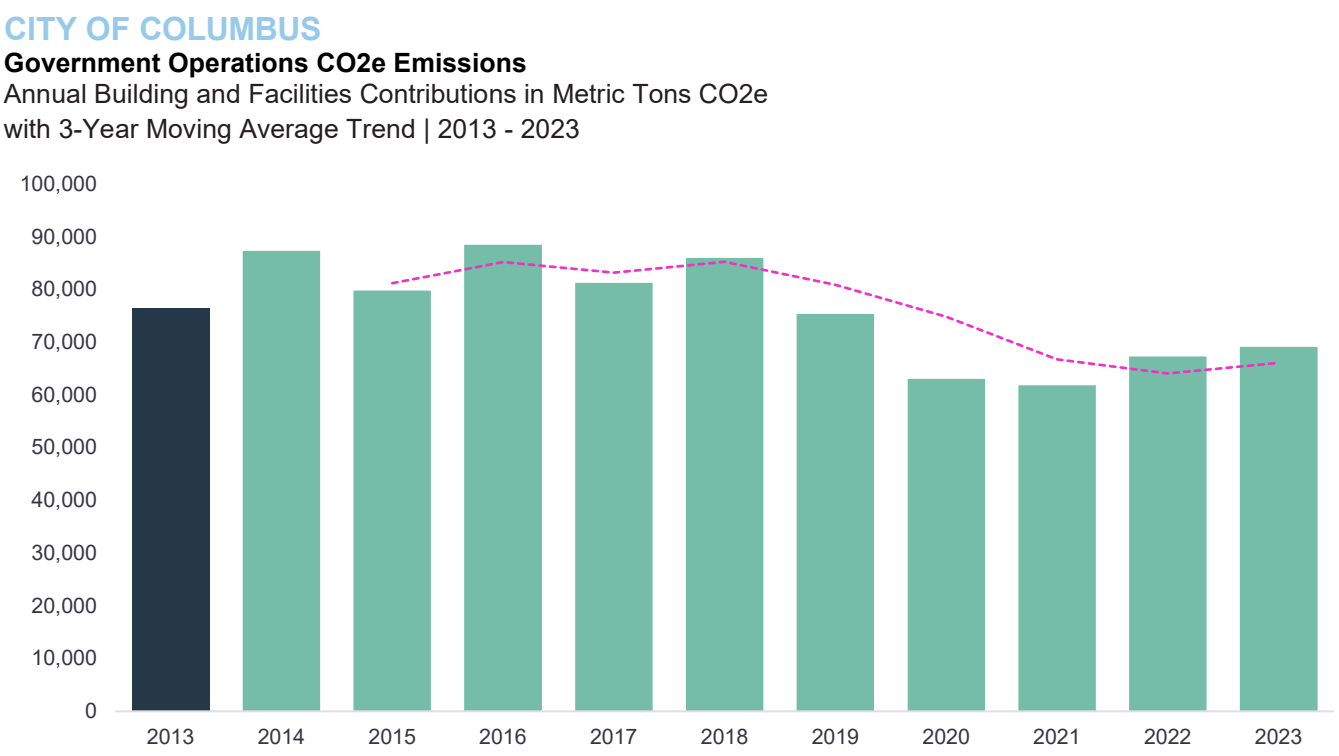


Figure 7. Government Operations – Annual Streetlight and Traffic Signals Contributions | 2013 - 2023

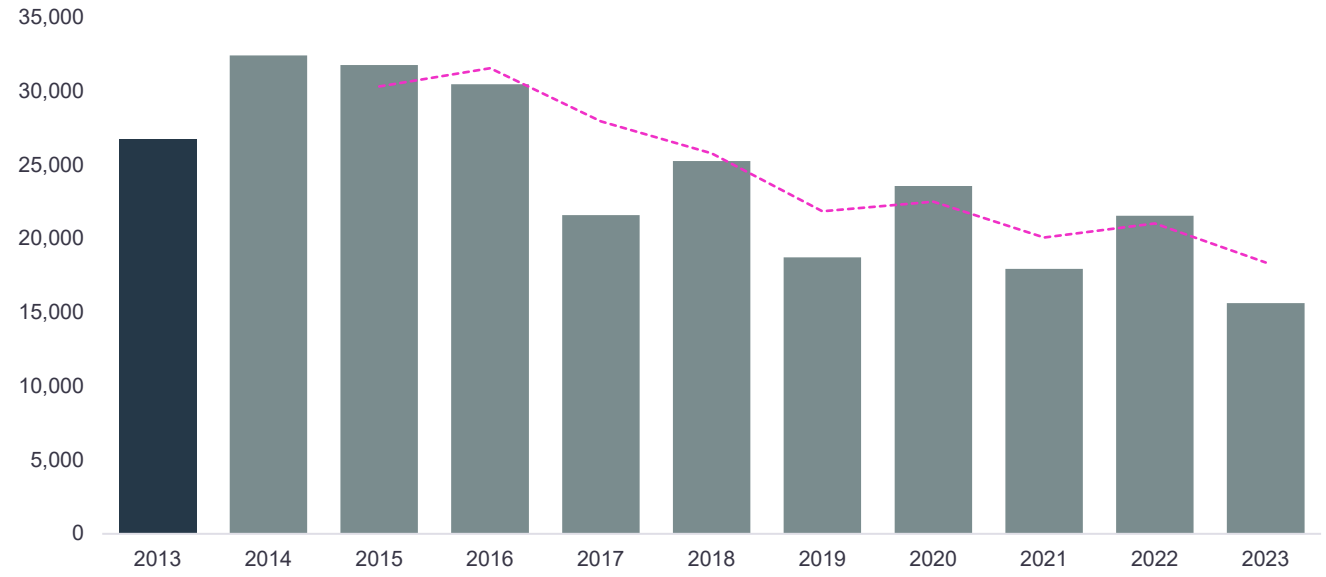


Figure 8. Government Operations – Annual Fleet Vehicle Contributions | 2013- 2023

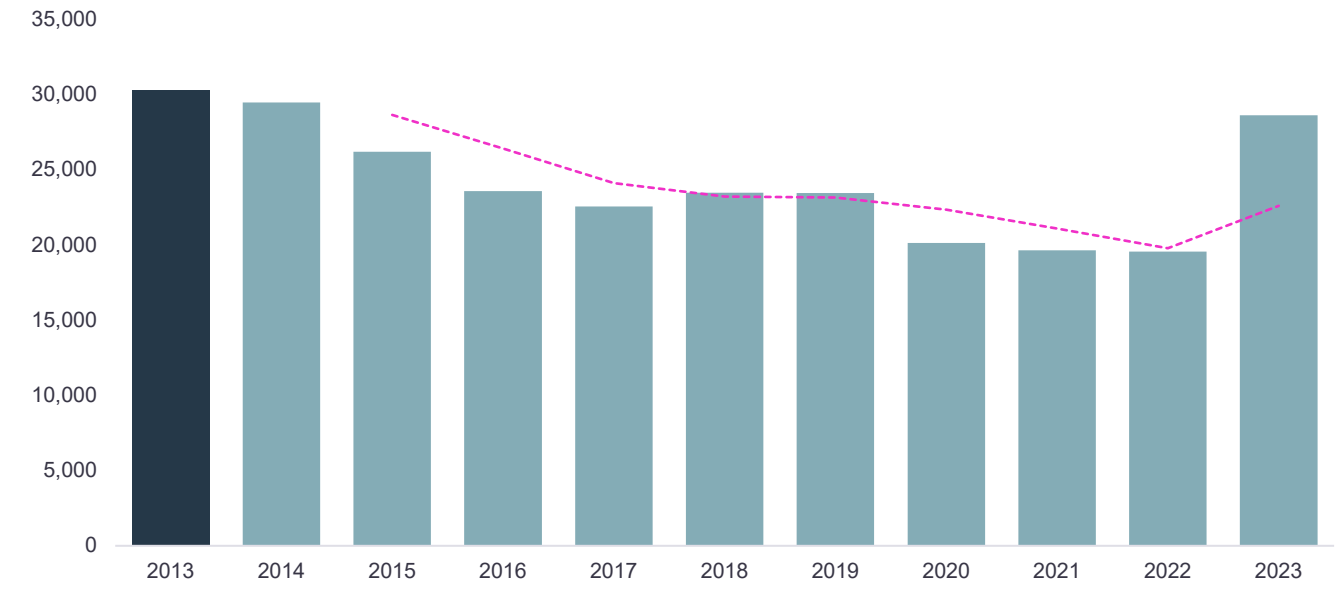


Figure 9. Government Operations – Annual Solid Waste Facilities Contributions | 2013 - 2023

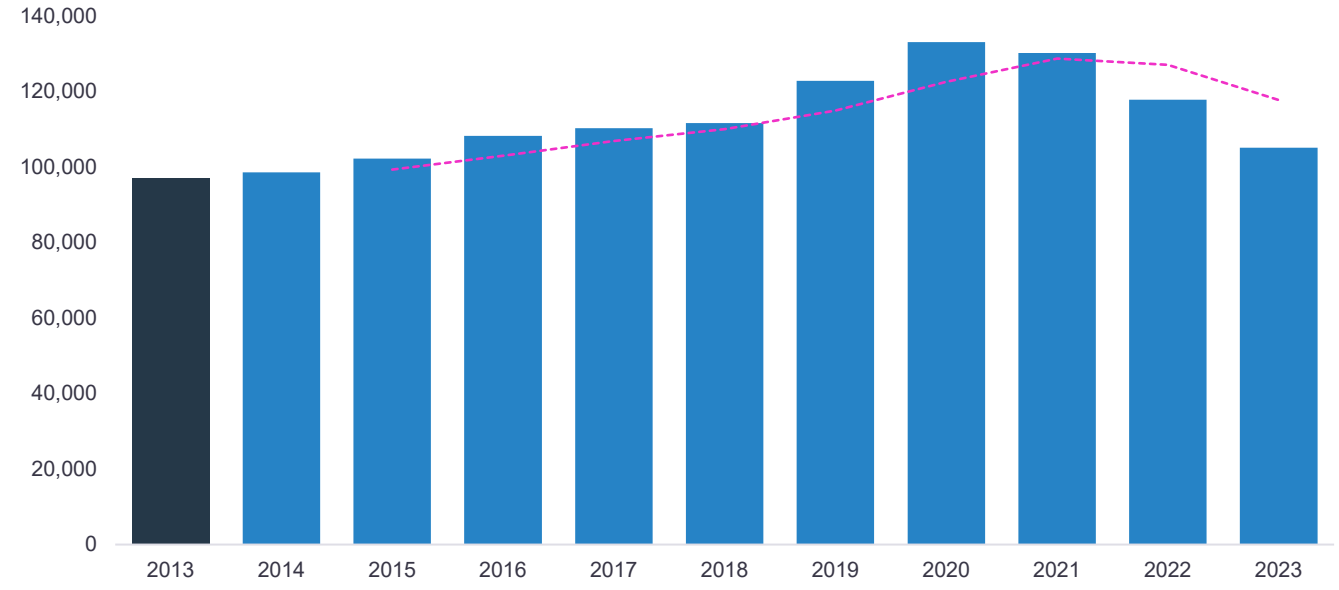
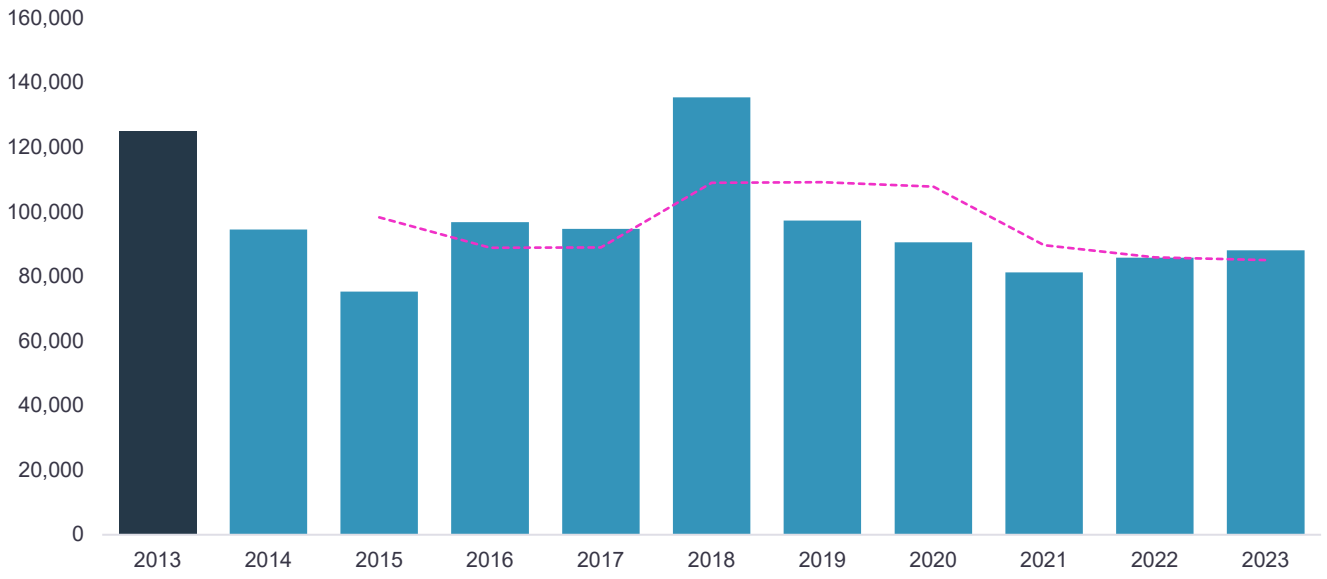


Figure 10. Government Operations – Annual Water and Wastewater Treatment Facilities Contributions | 2013 - 2023

Government Operations CO2e Emissions

Annual Water and Wastewater Treatment Facilities Contributions in Metric Tons CO2e with 3-Year Moving Average Trend | 2013 - 2023

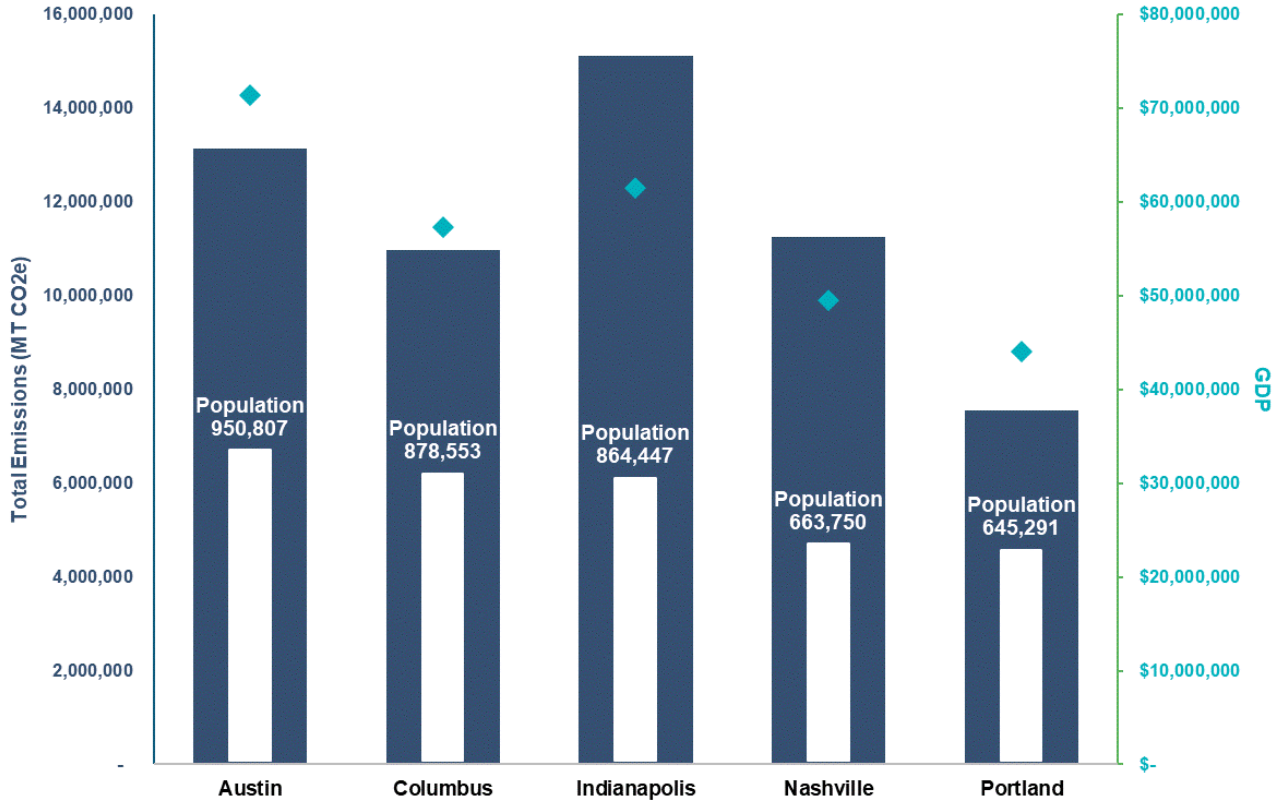


2023 Community-Scale Emissions

Globally, cities conduct their own greenhouse gas inventories and report their emissions and baseline data to various entities, similar to this and past reports. Methodologies used and the type of gases analyzed may vary from city to city based on a variety of factors. City of Columbus annually reports to the CDP, one of a few international clearinghouses for climate and sustainability reporting, along the CDP-ICLEI Track. Figure 11 highlights five similar cities, based on population (white bar) and GDP (light blue diamond), that regularly report their emissions to the CDP. [5],[6] The dark blue bar indicates each city's total community-scale emissions in 2019, the most recent year all cities reported.[7] Relative to other cities, Columbus fares well both in total emissions and emissions per capita, only behind Portland in both.

Figure 11. Cross-City Community-Scale Comparison – 2019 Total Emissions

2019 Total Emissions
Total Emissions v. Population v. GDP



Community-scale activities contributed 10,700,559 metric tons of CO2e in 2023. This represents a 1.6% increase from 2022, as reflected below in Figure 11 and Table 6. The 2021 Columbus Climate Action Plan (CAP) utilizes 2013 as the baseline for community-scale emissions. The Growth Scenarios calculated in the Columbus CAP forecast that with no further action to mitigate emissions, the city is projected to see a 20% increase in emissions

[5] US Census Bureau: ***2019: ACS 5-Year Estimates Detailed Tables***. (Accessed October 3, 2023)
[6] US Bureau of Economic Analysis: ***2019: CAGDP1 County and MSA gross domestic product (GDP) summary.*** (Accessed October 3, 2023)
[7] CDP: ***CDP Cities, States and Regions Open Data Portal.*** (Accessed October 3, 2023)

by 2030 and 39% increase by 2050 compared to the 2013 baseline. The measures with direct GHG impacts within the Columbus Climate Action Plan are modeled to bring emissions down to the 2030 and 2050 targets. Sustainable Columbus is in the process of creating a system to demonstrate how the activity toward actions outlined in the CAP relates to the progress made toward overall reduction targets as measured in the annual inventories.[8]

In the City of Columbus community-wide GHG inventory, from 2013-2018, emissions rose and fell without a clear trend with emissions oscillating between 11 and 12 million metric tons of CO2e per year. From 2018 to 2020, there was a 14% reduction in emissions, decreasing substantially each year. While there has been a general downward trend in total emissions from 2014 to 2021, there was a significant uptick of 9.4% seen in 2022 compared to 2021, which plateaued some over the past year from 2022 to 2023 increasing by only 1.6%. In 2023 every sector except two—residential energy and solid waste—increased between a little over 2% by up to almost 32% in the industrial sector compared to 2022. As noted in the "Changes in Methodology" on p.6, the large spike in the industrial sector is largely due to the major natural gas utility reporting true consumption by sector. Residential decreased by slightly more than 11% and solid waste by 1.5%.

It is also important to note that population increased over 13% from 2013-2023, as seen below in Figure 12 and Table 7. In this time, total community-wide emissions decreased by 5%. On a per capita basis in 2023, the community of Columbus created 11.73 metric tons of CO2e per person, a 1.2% increase in the per capita emissions from 2022. In 2023, the population upticked to 912,274, moving closer to the largest population of 914,850 seen in 2020. With slight increases in emissions in 2023, the overall total emissions are nearing to pre-pandemic levels seen in 2019—only 2.4% below—and even further below 2013 by 5%. Furthermore, when factoring in population, the per capita emissions are down by 16.1% from 2013.

[8] City of Columbus: ***2021 Columbus Climate Action Plan.*** (Accessed October 3, 2023)

Figure 12. Community-Scale – Annual Total Emissions | 2013 – 2023

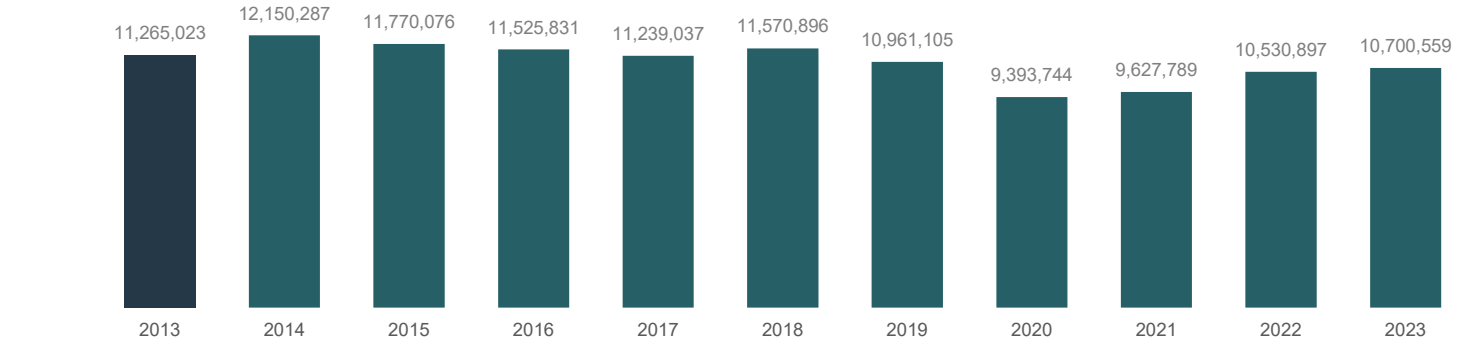


Table 6. Community-Scale – Annual Total Emissions by Sector | 2013 - 2023

Sector	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Residential Energy	2,641,935	3,020,841	2,700,722	2,614,721	2,423,504	2,763,887	2,492,497	2,406,417	2,178,011	2,206,771	1,957,279
Commercial Energy	4,883,764	4,640,654	4,216,227	4,170,874	3,748,313	3,573,927	3,343,330	2,759,194	2,340,597	2,993,514	3,079,165
Industrial Energy	287,152	713,266	657,967	626,048	611,877	371,757	347,443	139,625	366,358	390,086	514,566
Transportation	3,015,878	3,365,275	3,796,842	3,696,430	4,029,621	4,373,857	4,292,211	3,615,510	4,271,031	4,442,566	4,638,166
Solid Waste	249,007	249,877	244,372	263,633	275,496	332,321	304,904	307,564	310,579	330,910	326,053
Fugitive Emissions	59,171	63,481	57,928	56,682	55,435	52,887	83,420	74,815	79,913	81,199	97,150
Water/Wastewater	128,116	96,893	96,017	97,444	94,790	102,259	97,300	90,619	81,300	85,851	88,180
Total Emissions (Metric tons CO_2e)	**11,265,023**	**12,150,287**	**11,770,076**	**11,525,831**	**11,239,037**	**11,570,896**	**10,961,105**	**9,393,744**	**9,627,789**	**10,530,897**	**10,700,559**

Figure 13. Community-Scale – Annual Emissions Per Capita | 2013 - 2023

CITY OF COLUMBUS

Community-Scale CO2e Emissions

Annual Metric Tons of CO2e Per Capita | 2013 - 2023

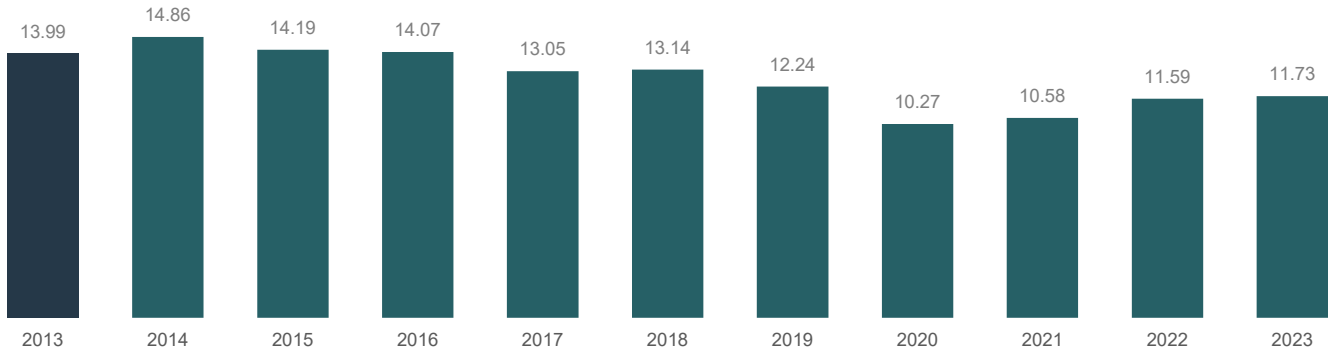


Table 7. Community-Scale – Annual Emissions Per Capita | 2013 - 2023

Sector	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Population	805,348	817,383	829,690	818,912	861,141	880,828	895,877	914,850	909,686	908,386	912,274
Residential Energy	3.28	3.70	3.26	3.19	2.81	3.14	2.78	2.63	2.39	2.43	2.15
Commercial Energy	6.06	5.68	5.08	5.09	4.35	4.06	3.73	3.02	2.57	3.30	3.38
Industrial Energy	0.36	0.87	0.79	0.76	0.71	0.42	0.39	0.15	0.40	0.43	0.56
Transportation	3.74	4.12	4.58	4.51	4.68	4.97	4.79	3.95	4.70	4.89	5.08
Solid Waste	0.31	0.31	0.29	0.32	0.32	0.38	0.34	0.34	0.34	0.36	0.36
Fugitive Emissions	0.07	0.08	0.07	0.07	0.06	0.06	0.09	0.08	0.09	0.09	0.11
Water/Wastewater	0.16	0.12	0.12	0.12	0.11	0.12	0.11	0.10	0.09	0.09	0.10
Total Emissions	**13.99**	**14.86**	**14.19**	**14.07**	**13.05**	**13.14**	**12.24**	**10.27**	**10.58**	**11.59**	**11.73**

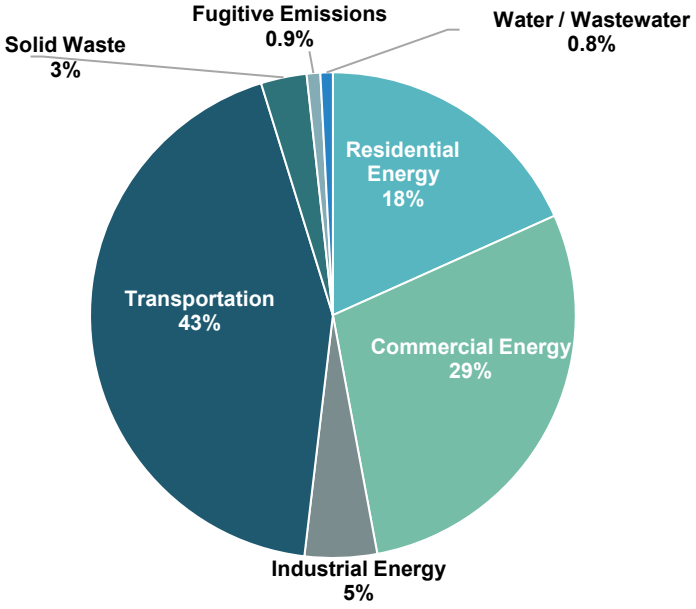
Sector-Relative Emissions Contributions

Since 2017, the transportation sector accounts for the greatest portion of emissions on a community-wide basis, 43% in 2023. ***The 2023: ACS 1-Year Estimates Subject Tables*** note that in 2023, 69.2% of Americans commuted via single-occupancy vehicles,[9] a slight increase of 1.9% seen from 2022, yet still well below pre-pandemic levels of 75.9% in 2019. Within the Columbus Metropolitan Statistical Area (MSA), 71.2% of commuters traveled via single-occupancy vehicles, a slight increase of 1.5% from 2022, but even further below 2019 levels of 81.6% of Columbus MSA commuters. Even with these recent decreases, population is back on the rise and with expected continued growth, this leads to increased congestion and commute times. Increasing vehicle efficiency and adoption of fuel-efficient and alternative fuel vehicles is not expected to offset the increase in vehicles on the road, at least not currently. In the Community-Scale 2023 inventory, compared to 2022, there was a 4.4% increase in transportation emissions, and, for the second year in a row, the highest total emissions in this sector since conducting greenhouse gas inventories.

As is typical of similar-sized cities in the United States, as noted below in Figure 14, commercial and residential sectors made up the next two largest contributors to emissions in the City of Columbus, 29% and 18%, respectively. In 2023, compared to 2022, there was a large decrease in emissions from the residential sector at 11.3%, whereas in the industrial sector, there was a significant increase in emissions by nearly 32%, as noted in the previous section. Even when looking at commercial and industrial sectors combined over the same period, illustrating a more accurate analysis of the data,[10] there is a 6.2% increase. And both solid waste and water services made up nearly 4% of emissions, with the remaining emissions, a little less than 1%, being accounted for by process and fugitive emissions.

Figure 14. Community-Scale – Sector Percentage of Total Emissions | 2023

CITY OF COLUMBUS
Community-Scale CO2e Emissions
Sector Percentage of Total | 2023



[9] US Census Bureau: "***2023: ACS 1-Year Estimates Subject Tables.***" (Accessed July 9, 2024)
[10] Until this year, the major natural gas utility had not broken-down consumption by sector. To see how previous year's commercial and industrial sectors compare to this year's, there is a historical consumption of the commercial and industrial sectors is to combine them (C&I), as seen in Table 8. This analysis was first conducted in the 2021 inventory.

Sector Emission Contributions Between 2013 and 2023

Columbus is experiencing an uptick in emissions; while still below, emissions are on an upward swing moving closer to 2013 levels. The City's population has grown a little over 13% since 2013, while the metropolitan statistical area for Columbus experienced an 28.3% growth in gross domestic product over the same 10-year period.[11,12] Total emissions in 2023 are still below 2019 pre-pandemic levels, by 2.4%. Total emissions have decreased from the baseline year of 2013 by 5%, and by 16.1% based on emissions per capita, as depicted in Table 8.

Table 8. Community-Scale – Percent Change in Emissions From 2013

Sector		Percent Change in Total Emissions 2013 to 2023		Percent Change in Emissions Per Capita 2013 to 2023	
Residential Energy		-25.9%		-34.6%	
Commercial (C) Energy	C&I Energy Combined	-37.0%	-30.5%	-44.3%	-38.6%
Industrial (I) Energy		79.2%		58.2%	
Transportation		53.8%		35.8%	
Solid Waste		30.9%		15.6%	
Fugitive Emissions		64.2%		44.9%	
Water/Wastewater		-31.2%		-39.2%	
Total Emissions		**-5.0%**		**-16.1%**	

Across community sectors compared to 2022, 2023 total emissions increased in every sector except residential and solid waste. The sectorial increases ranged anywhere between 2 – 31.9%, with the largest being industrial energy—to some degree related due to the change in reporting from the major natural gas utility. Residential and solid waste decreased by 11.3% and 1.5%, respectively. When analyzing 2023 to pre-pandemic 2019, residential, commercial, and water/wastewater all, individually, decreased between almost 7.9 – 21.5%. However, industrial, solid waste, and transportation increased in total emissions by 48.1%, 16.5%, and 8.1% respectively, with the largest gross increase seen in transportation.

Fugitive emissions are a function of the quantity of natural gas used in the analysis area. Fugitive emissions substantially increased by 19.6% from 2022, due to an increase in natural gas use—the highest since 2017.

In 2023, residential energy use emissions decreased by 11.3% from 2022. The largest change in power consumption is in the industrial sector. Overall, the industrial sector increased by nearly 32%. A large amount could be directly linked to natural gas consumption within this sector, due to a change in reporting by the major natural gas utility, as outlined on p.6; natural gas increased by almost a third from 2022 and an increase of almost 50 times from 2020 levels. From 2018-2022, calculations were made based on the total sum of natural gas consumption. Due to some methodological refinements, the consumption levels seen in 2021 and 2022 were more pragmatic based on sector; however, even with this more sensible methodology used last year, natural gas consumption is up a little over 2.5 times from 2022. As noted in red, commercial and industrial (C&I) energy use emissions, collectively, have decreased since 2015; however, the last two years C&I energy use emissions have increased from year to year—25% from 2021 to 2022 and 6.2% from 2022 to 2023. Even with this two-year spike, C&I total emissions have decreased by 30.5% since 2013.

While total emissions from water and wastewater facilities also increased by a little more than 2% from 2022, since 2013, they are down by 31.2% due to less coal being utilized to generate electricity in the region.

Annual emissions data for each sector are provided below in Figure 15, accompanied by the sector breakdown by

[11] According to the US Bureau of Economic Analysis, ***"CAGDP1 County and MSA gross domestic product (GDP) summary"*** (accessed July 9, 2024).
[12] The US Bureau of Economic Analysis revised its data, chained to 2017 dollars.

percentage in Figure 16. Both are set against the benchmarking year 2013 for comparison purposes, noted in dark blue in Figure 15.

Figure 15. Community-Scale – Annual Sector Emission Contributions | 2013 - 2023

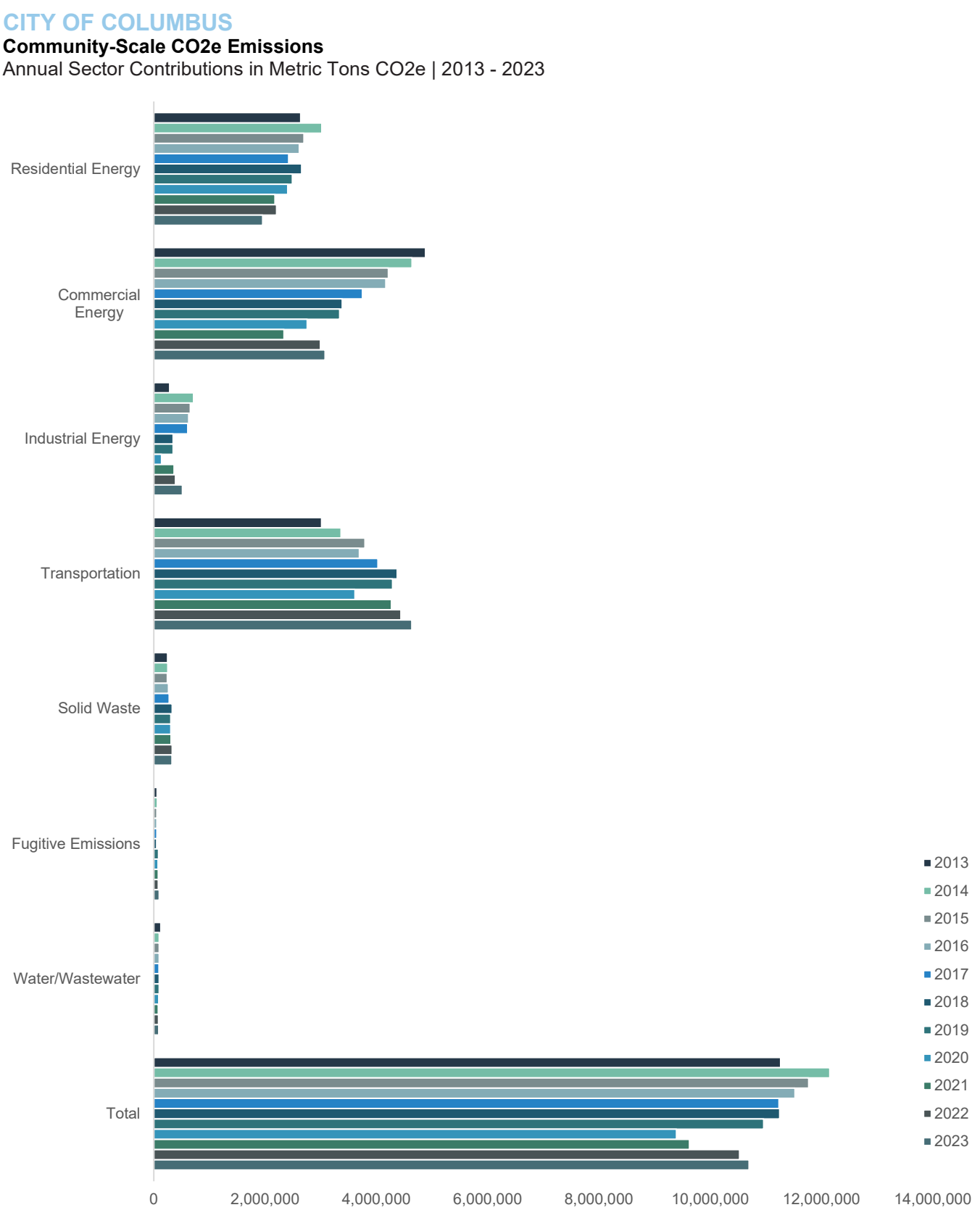
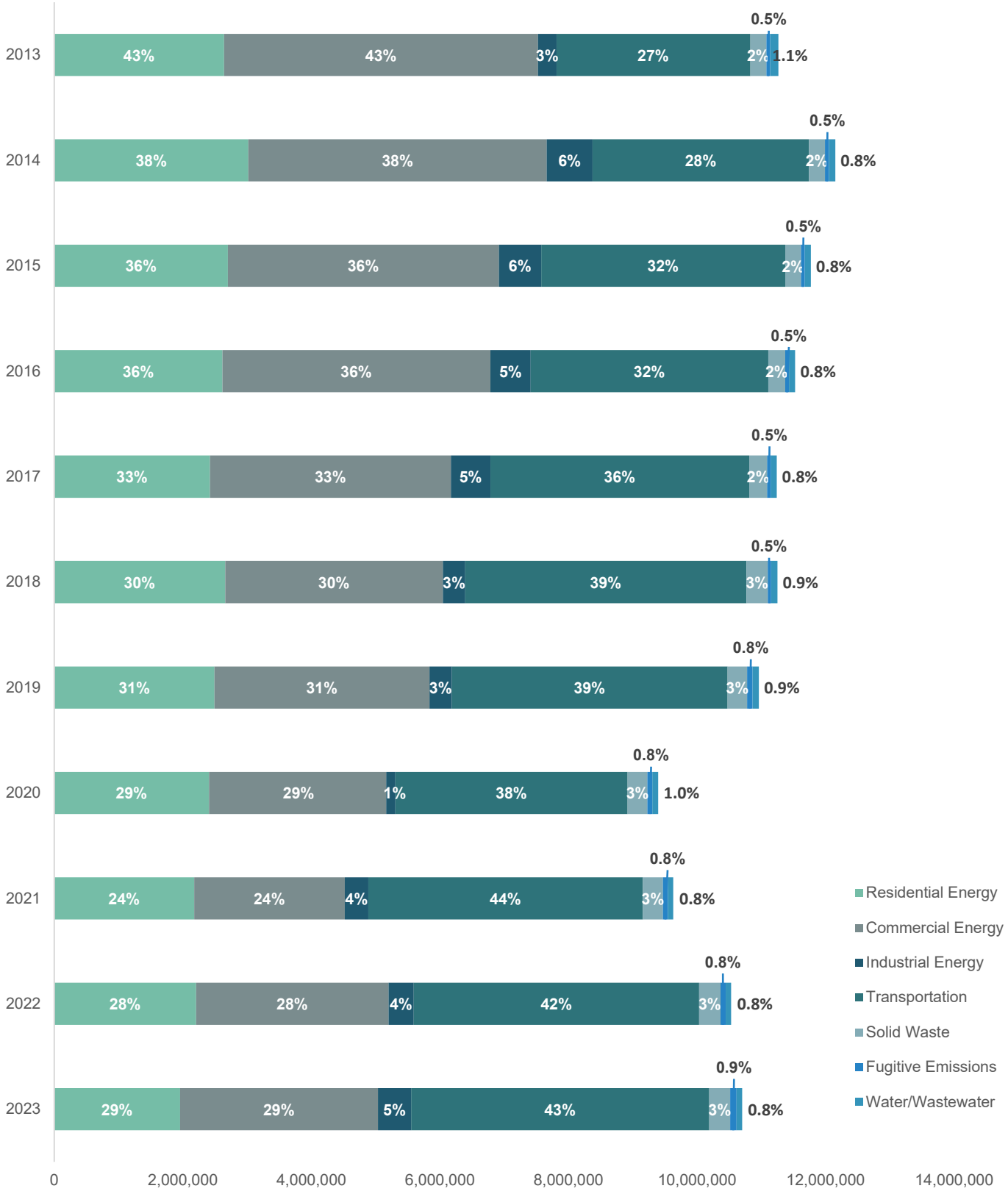


Figure 16. Community-Scale – Percentage of Total Emissions by Sector | 2013 - 2023

CITY OF COLUMBUS

Community-Scale CO2e Emissions

Total Emissions by Sector Percentage and in Metric Tons CO2e | 2013 - 2023



Below in Figures 17-23 are annual emissions data for each individual sector from 2013-2023 with a three-year moving average trend line. The benchmark year of 2013 is noted in dark blue. These figures better highlight the changes seen both between this year and last year, as well as the general trend for each sector since 2013, smoothing out any outlier years.

Figure 17. Community-Scale – Annual Residential Sector Contributions | 2013 - 2023

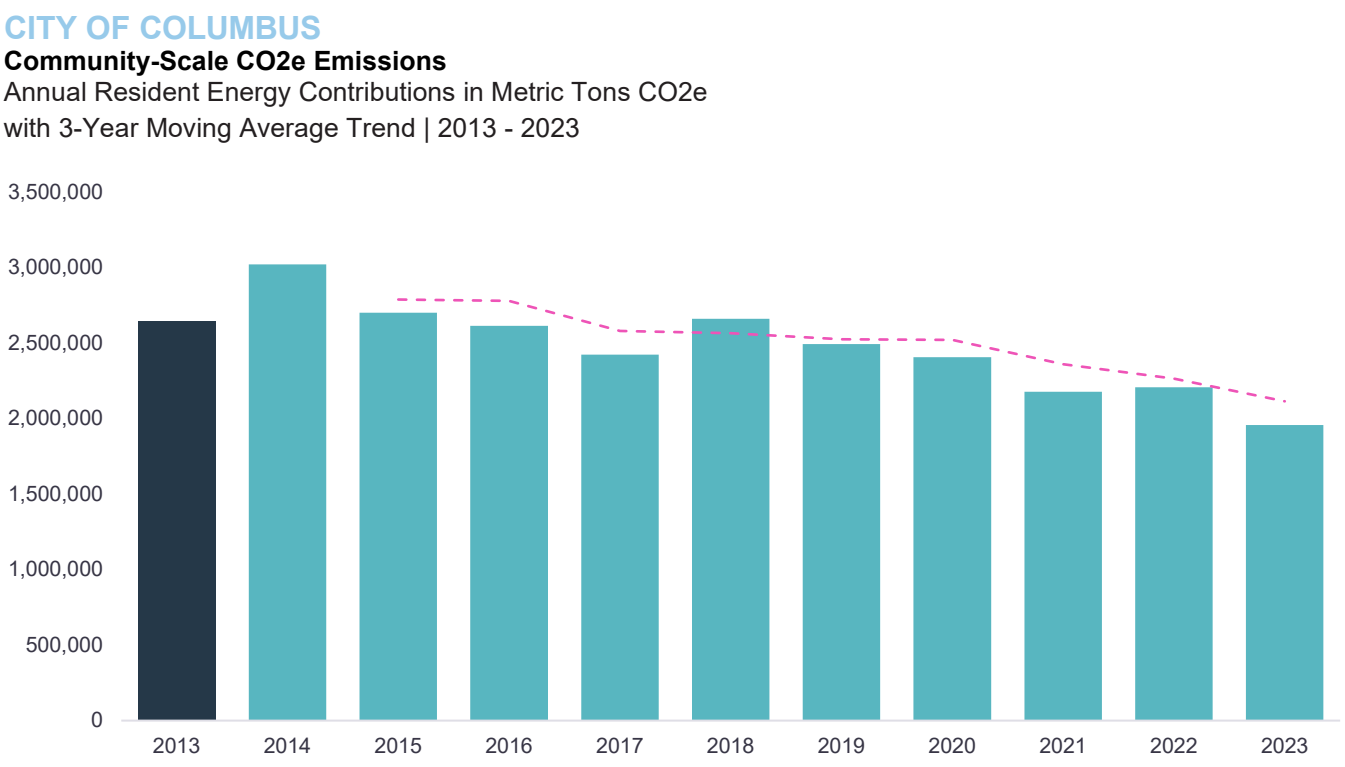


Figure 18. Community-Scale – Annual Commercial Sector Contributions | 2013 - 2023

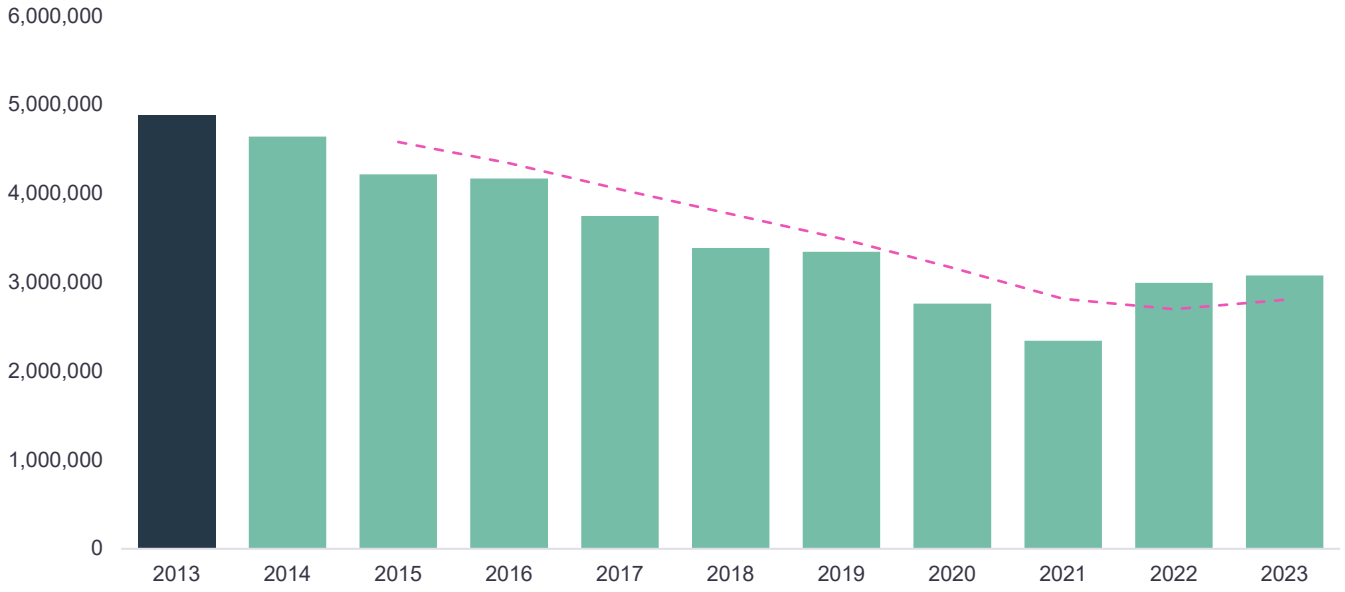


Figure 19. Community-Scale – Annual Industrial Sector Contributions | 2013 - 2023

CITY OF COLUMBUS

Community-Scale CO2e Emissions

Annual Industrial Energy Contributions in Metric Tons CO2e
with 3-Year Moving Average Trend | 2013 - 2023

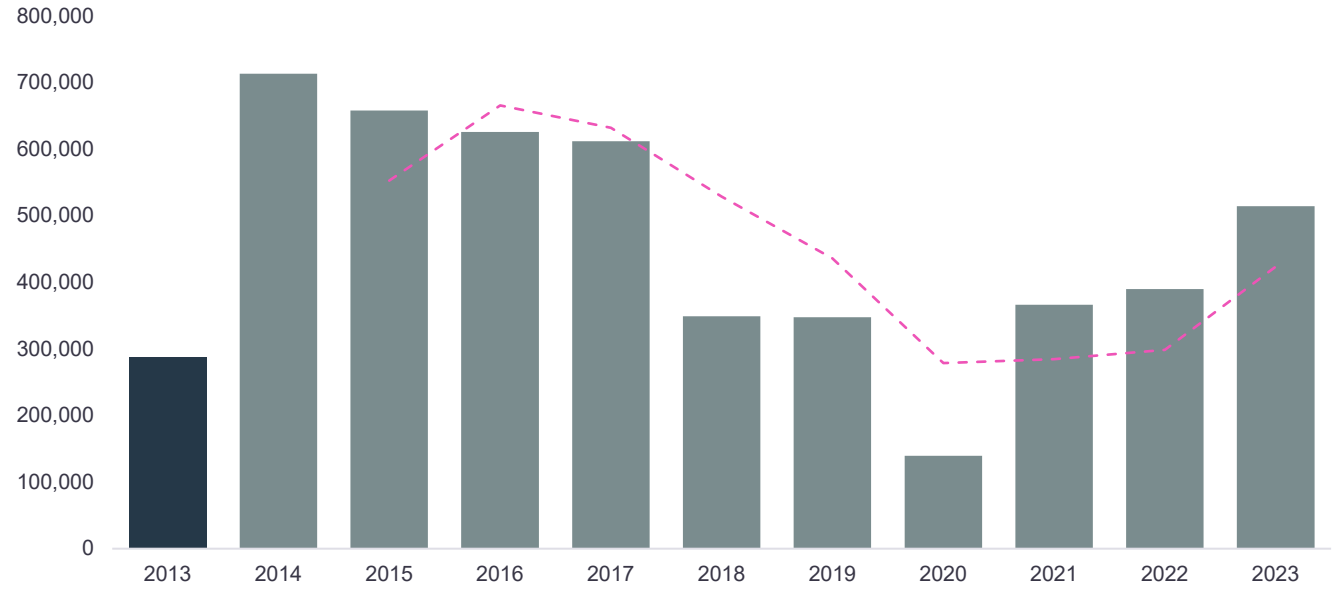


Figure 20. Community-Scale – Annual Transportation Sector Contributions | 2013 - 2023

CITY OF COLUMBUS

Community-Scale CO2e Emissions

Annual Transportation Contributions in Metric Tons CO2e
with 3-Year Moving Average Trend | 2013 - 2023

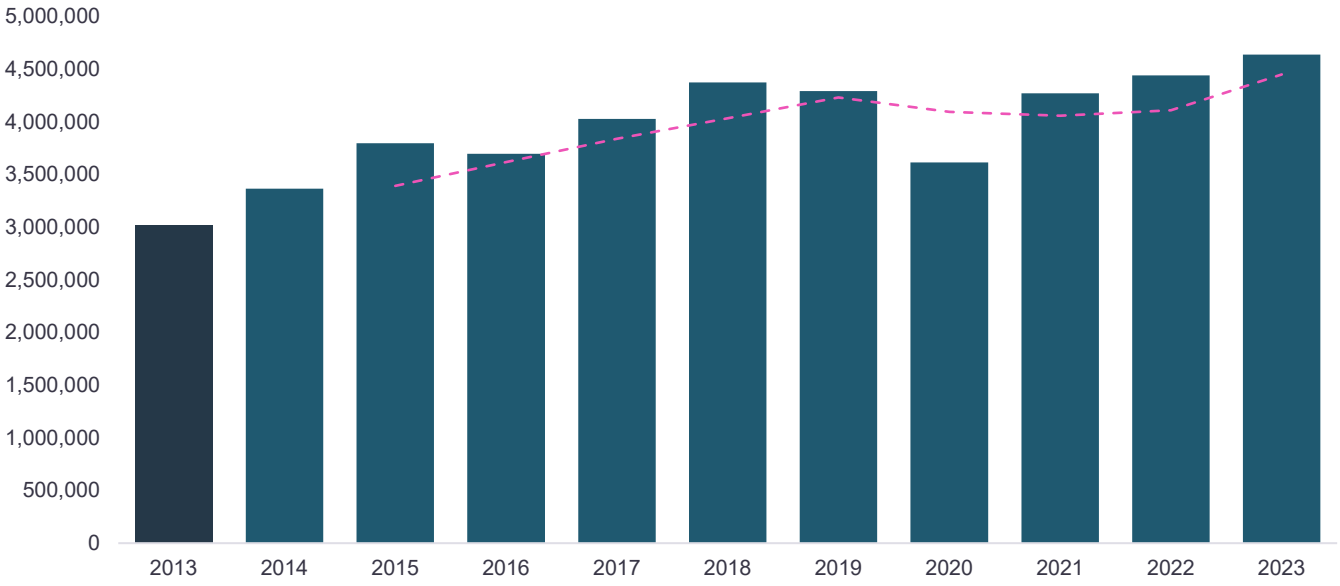


Figure 21. Community-Scale – Annual Solid Waste Sector Contributions | 2013 - 2023

CITY OF COLUMBUS

Community-Scale CO2e Emissions

Annual Solid Waste Contributions in Metric Tons CO2e
with 3-Year Moving Average Trend | 2013 - 2023

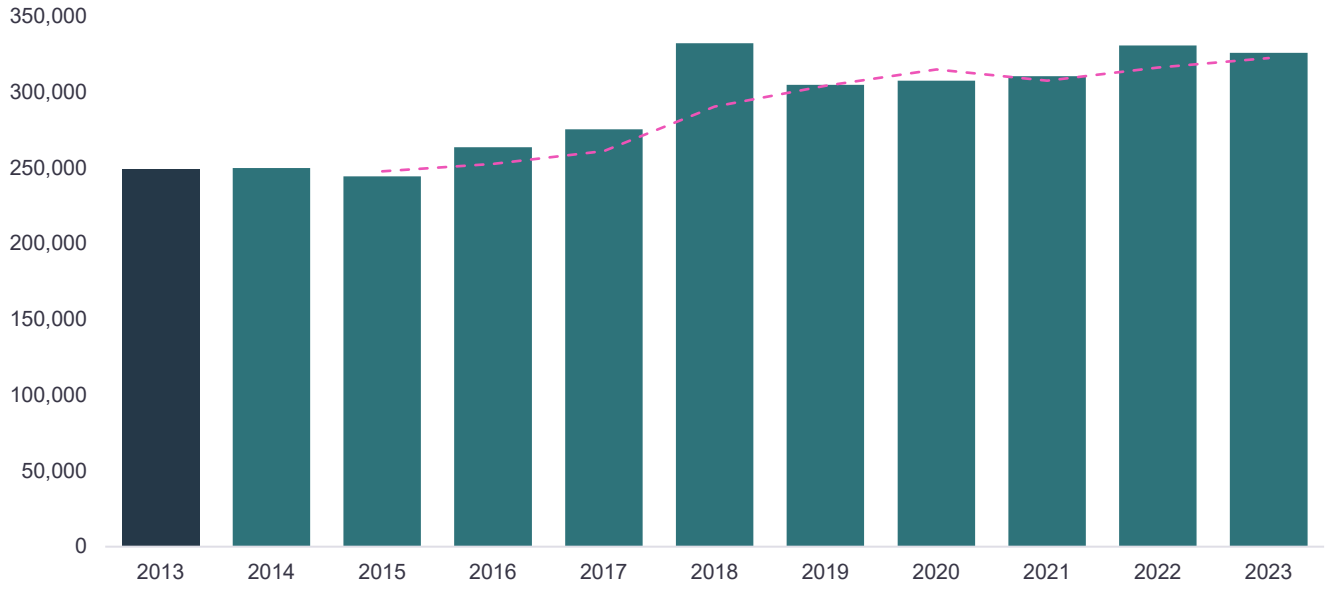


Figure 22. Community-Scale – Annual Fugitive Emissions Contributions | 2013 - 2023

CITY OF COLUMBUS

Community-Scale CO2e Emissions

Annual Fugitive Emissions Contributions in Metric Tons CO2e
with 3-Year Moving Average Trend | 2013 - 2023

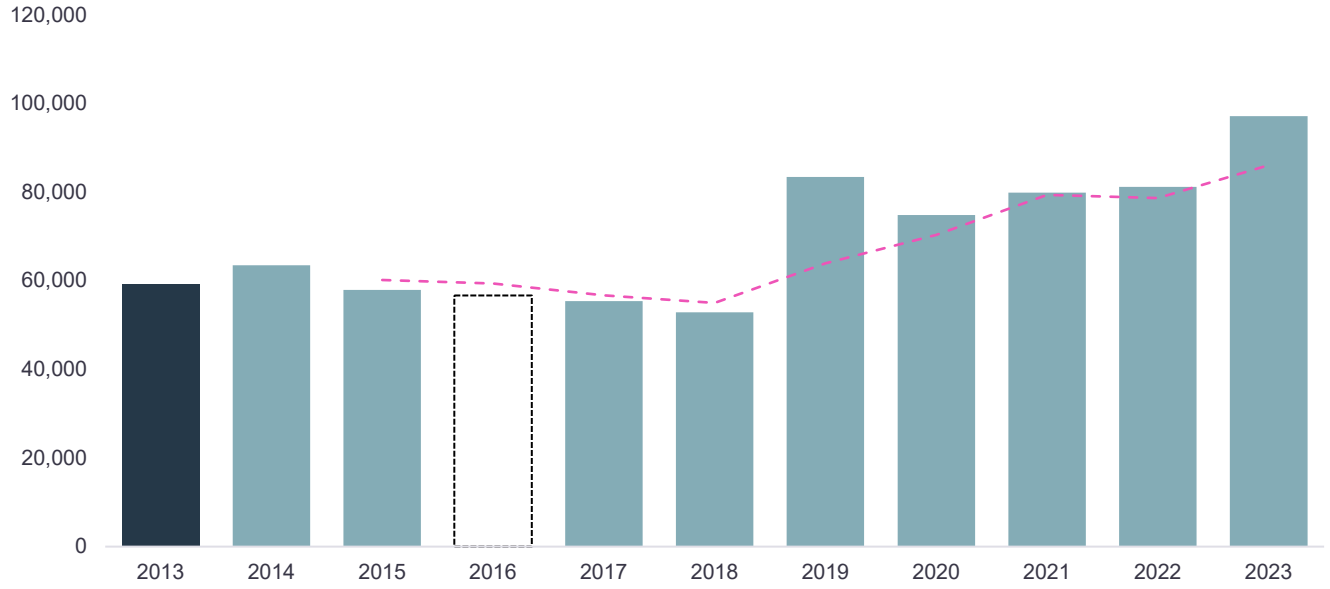
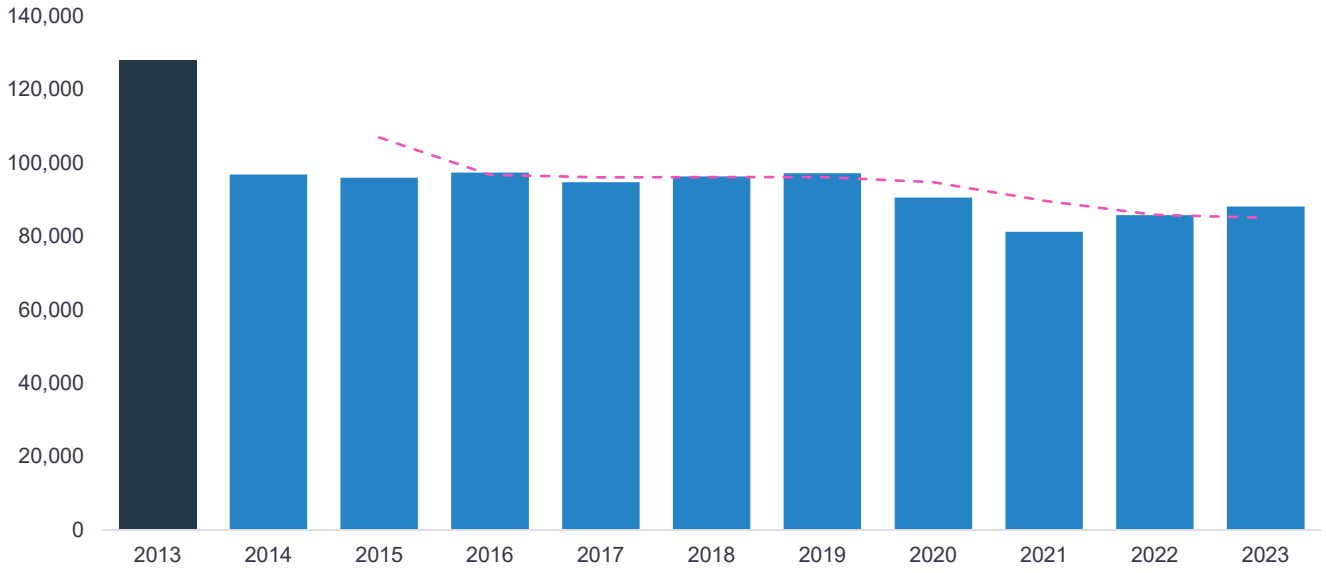


Figure 23. Community-Scale – Annual Water and Wastewater Sector Contributions | 2013 - 2023

CITY OF COLUMBUS

Community-Scale CO2e Emissions

Annual Water and Wastewater Treatment Contributions in Metric Tons CO2e
with 3-Year Moving Average Trend | 2013 - 2023



Appendix A – Inputs

Energy Consumption and Waste Values

Government Operations Inputs	Unit	2016	2017	2018	2019	2020	2021	2022	2023
Aviation - Helicopter	Gallons	61,708	100,154	111,161	118,244	64,024	60,988	80,354	61,018
City Fleet Biodiesel (off road)	Gallons	-	93,886	95,908	170,324	130,196	100,847	293,050	80,994
City Fleet Biodiesel (on road)	Gallons	0	470,960	353,342	459,112	324,762	267,172	111,346	758,400
City Fleet CNG (off road)	Gallons	-	672	1,510	11,616	16,512	6,668	3,231	97
City Fleet CNG (on road)	Gallons	476,151	562,787	658,932	750,904	863,167	906,003	901,508	876,901
City Fleet Diesel (off road)	Gallons	-	2,928	9,033	9,070	17,313	26,611	293,050	65,152
City Fleet Diesel (on road)	Gallons	868,701	300,396	966,559	246,845	237,226	276,312	231,757	258,660
City Fleet E85 (off road)	Gallons	-	-	-	446	-	-	-	-
City Fleet E85 (on road)	Gallons	2,060	5,190	0	8,755	4,004	1,163	-	-
City Fleet EVs (on road)	kWh	n/a	n/a	34,850	34,850	121,835	470,259	214,212	225,333
City Fleet Gasoline (off road)	Gallons	-	5,842	4,444	26,657	31,217	21,984	293,050	4,032
City Fleet Gasoline (on road)	Gallons	1,569,238	1,402,088	918,043	1,547,154	1,394,834	1,364,318	1,365,000	1,789,064
City Fleet Propane (off road)	Gallons	-	-	15,716	19,146	15,580	16,973	16,935	15,356
Destruction Efficiency – Jackson Pike & Southerly	Percent	-	99%	99%	99%	99%	99%	99%	99%
Electric	kWh	107,802,332	104,989,940	90,052,367	88,680,470	86,887,794	97,455,182	93,978,348	109,138,651
Gas Composition – Jackson Pike	% Methane	-	65%	62%	61%	61%	61%	61%	61%
Gas Composition – Southerly	% Methane	-	56%	56%	63%	63%	63%	63%	63%
Gas Production – Jackson Pike	scf/day	-	1,000,000	810,000	932,918	917,846	907,001	825,023	806,064
Gas Production – Southerly	scf/day	-	700,000	700,000	882,767	1,143,037	1,123,029	1,165,331	1,020,293
Heat Content – Jackson Pike	Btu/scf	-	580	570	588	588	588	588	588
Heat Content – Southerly	Btu/scf	-	512	512	554	554	577	584	584
Municipal Solid Waste Generation (Landfill Total)	Tons	320,807	326,839	331,027	325,178	352,242	344,677	311,790	302,841
Natural Gas	MMBtu	276,538	407,557	656,413	528,845	389,895	339,205	422,315	363,126
Streetlights and Signals – Electricity - DPU	kWh	42,520,846	38,069,976	44,058,418	35,181,696	48,412,050	39,984,663	45,186,091	34,290,796
Wastewater Treatment Plants – Electricity	kWh	75,205,564	92,829,836	98,662,456	97,313,001	94,829,970	91,405,025	87,958,794	98,157,258
Wastewater Treatment Plants – Natural Gas	MMBtu	66,640	75,325	67,778	109,264	101,564	101,564	110,136	108,800
Water Treatment Plants – Electricity	kWh	58,228,740	60,707,038	67,114,035	68,130,723	69,370,103	66,982,970	69,158,497	72,553,932
Water Treatment Plants – Natural Gas	MMBtu	36,523	31,681	51,733	21,294	49,603	41,244	46,944	43,127

Community-Scale Inputs	Unit	2016	2017	2018	2019	2020	2021	2022	2023
Aviation – Airport, gasoline	Gallons	84,767	54,479	75,315	81,903	89,568	99,517	104,715	141,785
Aviation – Airport, kerosene jet fuel	Gallons	59,713,628	68,362,002	73,251,020	81,766,923	53,560,625	84,189,599	77,389,896	70,906,507
Aviation – Helicopter (kerosene jet fuel)	Gallons	61,708	100,154	111,161	118,244	64,024	60,988	80,354	61,018
Commercial Electric Usage – DPU	kWh	130,435,929	106,813,606	113,923,918	113,998,160	82,783,991	111,032,869	116,373,383	119,350,000
Commercial Natural Gas Usage	MMBtu	13,831,531	14,529,943	10,040,435	9,649,676	6,550,352	9,581,980	9,736,234	14,317,239
Commercial/Industrial Electric Usage – AEP	kWh	5,332,567,481	5,134,004,677	5,241,305,315	5,077,234,606	3,741,204,447	4,811,760,557	4,930,291,625	4,817,754,840
Destruction Efficiency – Jackson Pike & Southerly	Percent	-	99%	99%	99%	99%	99%	99%	99%
Freight Rail, Diesel	Gallons	-	9,910,732	2,119,594	2,242,506	2,205,206	2,442,340	2,575,629	2,800,818
Gas Composition – Jackson Pike	% Methane	-	65%	62%	61%	61%	61%	61%	61%
Gas Composition – Southerly	% Methane	-	56%	56%	63%	63%	63%	63%	63%
Gas Production – Jackson Pike	scf/day	-	1,000,000	810,000	932,918	917,846	907,001	825,023	806,064
Gas Production – Southerly	scf/day	-	700,000	700,000	882,767	1,143,037	1,123,029	1,165,331	1,020,293
Heat Content – Jackson Pike	Btu/scf	-	580	570	588	588	588	588	588
Heat Content – Southerly	scf/day	-	512	512	554	554	577	584	584
Industrial Electric Usage – DPU	kWh	587,071,546	613,696,855	639,762,013	639,841,221	109,530,729	622,180,746	632,373,495	628,981,000
Industrial Natural Gas Usage	MMBtu	4,839,784	4,963,302	161,932	127,198	87,319	1,635,415	1,661,742	4,288,830
On Road, Freight, Diesel	Miles	259,715,974	262,722,228	464,442,498	400,590,749	376,257,919	407,500,363	360,690,518	413,519,084
On Road, Freight, Gasoline	Miles	6,659,384	6,736,467	11,908,782	26,721,204	9,647,639	10,448,727	55,608,042	16,280,279
On Road, Passenger, Diesel	Miles	22,156,496	22,494,699	23,578,100	28,092,665	19,467,848	21,923,288	104,622,233	127,591,449
On Road, Passenger, Gasoline	Miles	7,363,342,017	7,475,738,443	7,835,788,415	7,934,217,355	6,469,814,775	7,285,839,350	7,660,963,007	8,389,613,836
Paratransit Buses, Diesel	Gallons	339,773	346,180	340,861	308,109	225,537	208,618	102,608	85,657
Paratransit Buses, Gasoline	Gallons	34,127	30,258	28,302	27,259	10,670	31,656	112,937	136,322
Residential Electric Usage – AEP	kWh	2,776,284,947	2,675,953,721	2,890,640,718	2,701,175,306	2,770,146,643	2,819,054,398	2,677,280,847	2,692,463,653
Residential Electric Usage – DPU	kWh	66,851,275	66,621,085	78,522,037	80,561,233	946,904,053	91,296,975	92,845,984	94,139,000
Residential Natural Gas Usage	MMBtu	15,549,233	15,710,210	20,280,912	19,014,639	19,109,712	16,363,597	16,627,024	12,899,504
Transit Buses, CNG	Gallons	1,497,898	1,779,363	2,061,696	2,232,396	1,745,451	2,460,280	2,373,594	2,471,404
Transit Buses, Diesel	Gallons	2,012,291	1,950,033	1,907,288	1,730,300	1,166,032	843,806	455,110	238,912
Wastewater Treatment Plants – Electricity – DPU	kWh	75,205,564	92,829,836	98,662,456	97,313,001	94,829,970	91,405,025	87,958,794	98,157,258
Wastewater Treatment Plants - Natural Gas	MMBtu	66,640	75,325	67,778	109,264	101,564	101,564	110,136	108,800
Water Treatment Plants – Electricity – DPU	kWh	58,228,740	60,707,038	67,114,035	68,130,723	69,370,103	66,982,970	69,158,497	72,553,932
Water Treatment Plants – Natural Gas	MMBtu	36,523	31,681	51,733	21,294	49,603	41,244	46,944	43,127

Emission Rates from eGRID[13]

Government Operations					
Analysis Year	Name	Region	CO_2 lbs/MWh	CH_4 lbs/GWh	N_2O lbs/GWh
2013	EPA eGRID 2010 Proxy for 2013	RFCW	1503.5	18.2	24.8
2014	EPA eGRID 2010 Proxy for 2014	RFCW	1503.5	18.2	24.8
2015	EPA eGRID 2012 Proxy for 2015	RFCW	1379.5	17.1	21.7
2016	EPA eGRID 2014 Proxy for 2016	RFCW	1497.1	161.3	23.7
2017	EPA eGRID 2016 Proxy for 2017	RFCW	1243.4	108	19
2018	EPA eGRID 2016 Proxy for 2018	RFCW	1243.4	108	19
2019	EPA eGRID 2018 Proxy for 2019	RFCW	1166.1	117	17
2020	EPA eGRID 2018v2 Proxy for 2019	RFCW	1068	99	14
2021	EPA eGRID 2020 Proxy for 2021	RFCW	985	86	12
2022	EPA eGRID 2021 Proxy for 2022	RFCW	1046.1	95	14
2023	EPA eGRID 2022 Proxy for 2023	RFCW	1000.1	87	12

Community-Scale					
Analysis Year	Name	Region	CO_2 lbs/MWh	CH_4 lbs/GWh	N_2O lbs/GWh
2013	EPA eGRID 2010 Proxy for 2013	RFCW	1503.5	18.2	24.8
2014	EPA eGRID 2010 Proxy for 2014	RFCW	1503.5	18.2	24.8
2015	EPA eGRID 2012 Proxy for 2015	RFCW	1379.5	17.1	21.7
2016	EPA eGRID 2014 Proxy for 2016	RFCW	1497.1	161.3	23.7
2017	EPA eGRID 2016 Proxy for 2017	RFCW	1243.4	108	19
2018	EPA eGRID 2016 Proxy for 2018	RFCW	1243.4	108	19
2019	EPA eGRID 2018 Proxy for 2019	RFCW	1166.1	117	17
2020	EPA eGRID 2018v2 Proxy for 2019	RFCW	1068	99	14
2021	EPA eGRID 2020 Proxy for 2021	RFCW	985	86	12
2022	EPA eGRID 2021 Proxy for 2022	RFCW	1046.1	95	14
2023	EPA eGRID 2022 Proxy for 2023	RFCW	1000.1	87	12

Whereas all values are stated to come from EPA's eGRID value tables, it should be noted that EPA eGRID 2014 values noted in the tables above are not accurate. Documentation does not exist as to why there is a discrepancy, although EPA eGRID value tables note a V2, which could mean that the values for 2014 were updated after the greenhouse gas inventory for 2014 was conducted. Reliability First Corporation West (or RFCW) is the correct region to use for this analysis. The 2023 updated values are lower than eGRID 2022 by 4.4%. The biggest reason for this drop was the overall decrease in coal generation by nearly 12% from the previous year in the RFCW subregion; and, therefore, a decrease in CO2, CH4, and N2O.

[13] US EPA eGRID Summary Tables 2022: https://www.epa.gov/system/files/documents/2024-01/egrid2022_summary_tables.pdf (Accessed July 9, 2024)

Appendix B

Progress Towards the Climate Action Plan Emissions Reduction Goals by 2030 and 2050

Renewable Energy Credits (RECs), commonly known as offsets, are an important mechanism utilized by cities and communities to help reach emission reduction goals while in-boundary renewable energy resources are being built out. RECs are not factored into a greenhouse gas inventory. To estimate the impacts of RECs, one would reduce total emissions reported in an inventory by the emissions reductions associated with RECs purchased in the same year. In December of 2021, the City of Columbus published their first-ever Climate Action Plan (CAP). In the CAP, the City set a community-wide emissions reduction target of 45% by 2030 and 100% by 2050, utilizing 2013 as the baseline year. From 2013-2021, the City's population grew nearly 13%, making an absolute emissions reduction more difficult to achieve. The tables below present progress towards achieving the 45% by 2030 and 100% by 2050 goals in both absolute and per capita terms; per capita in order to capture the levelized impacts of emission reduction activities. Inclusive of RECs, but without factoring in population growth, the City of Columbus has achieved 31.2% of its 2030 CAP emissions target and 14.1% of its 2050 CAP emissions target. When adjusting for population growth based on emissions per capita, the City has achieved 53.6% of its 2030 CAP emissions target and 24.1% of its 2050 CAP emissions target, again, inclusive of emissions offset by the purchase of RECs.

Climate Action Plan Emissions Reduction Goals		
Absolute Emissions	**2030**	**2050**
2013 Emissions Benchmark (metric tonnes)	11,265,023	11,265,023
Emissions Reduction Goal	45%	100%
Emissions Goal Absolute Reduction (metric tonnes)	5,069,260	11,265,023
Emissions Goal Target (metric tonnes)	6,195,763	0
2023 Emissions (metric tonnes)	10,700,559	10,700,559
2023 RECs Offset (metric tonnes)	250,001	250,001
2023 City of Columbus Aggregation Program RECs Offset (metric tonnes)	768,289	768,289
2023 Emissions including RECs (metric tonnes)	9,682,269	9,682,269
Percent of Target Achieved	**31.2%**	**14.1%**

Per Capita	**2030**	**2050**
2013 Population	805,348	805,348
2013 Emissions per Capita Benchmark (metric tonnes)	13.99	13.99
2023 Population	912,274	912,274
2023 Emissions per Capita (metric tonnes)	11.69	11.73
2023 Emissions per Capita inclusive of RECS (metric tonnes)	10.61	10.61
Per Capita Goal Absolute Reduction (metric tonnes)	6.29	13.99
Per Capita Goal Target	7.69	0.00
Percent of Target Achieved	**53.6%**	**24.1%**

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