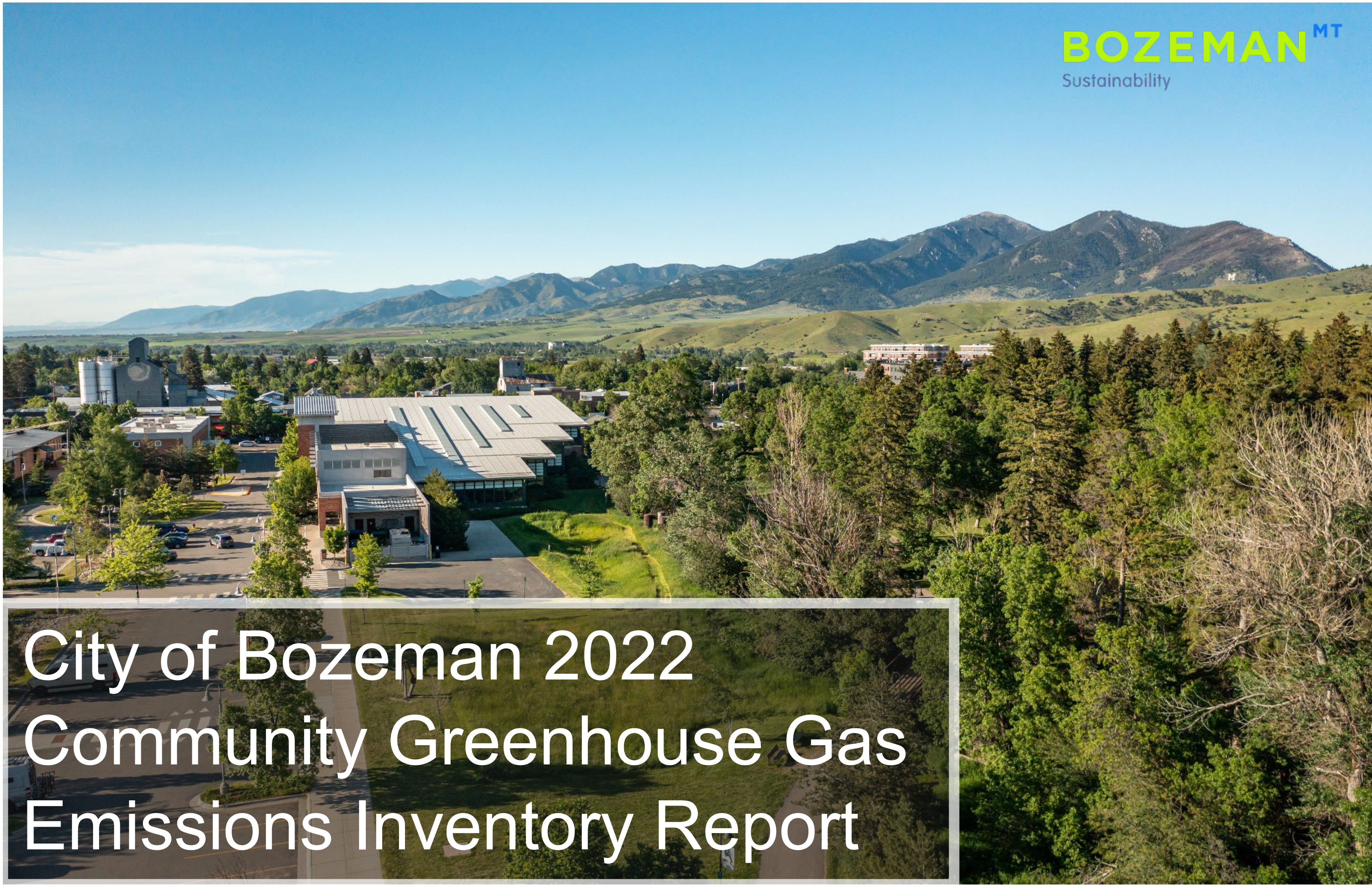

City of Bozeman 2022 Community Greenhouse Gas Emissions Inventory Report

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Introduction

The City of Bozeman began tracking community greenhouse gas (GHG) emissions in 2008 and since 2016 has performed a Global Protocol Community-scale (GPC) compliant greenhouse gas emissions inventory on a bi-annual basis to monitor and inform progress on climate action. With guidance from the International Council for Local Environmental Initiatives (ICLEI) over time, the emission inventories have allowed Bozeman to understand GHG emission sources, trends, and drivers of change within four sectors – stationary energy, transportation, waste, and industrial processes.

Using the 2008 inventory as a baseline year, the Bozeman Climate Plan was adopted in 2020, laying out ambitious climate goals including a 26% reduction in GHG emissions by 2025, 100% clean electricity by 2030, and carbon neutrality by 2050. As Bozeman continues to grow, the bi-annual GHG emissions inventory helps to inform the progress the community is making toward the Bozeman Climate Plan goals, recognize reduction opportunities, and support further climate action on an individual and local level.

The GHG emissions inventory assesses community-scale emissions within Bozeman's city limits (Figure 1.) as the physical boundary, helping to determine the scope of emissions by source and activity.

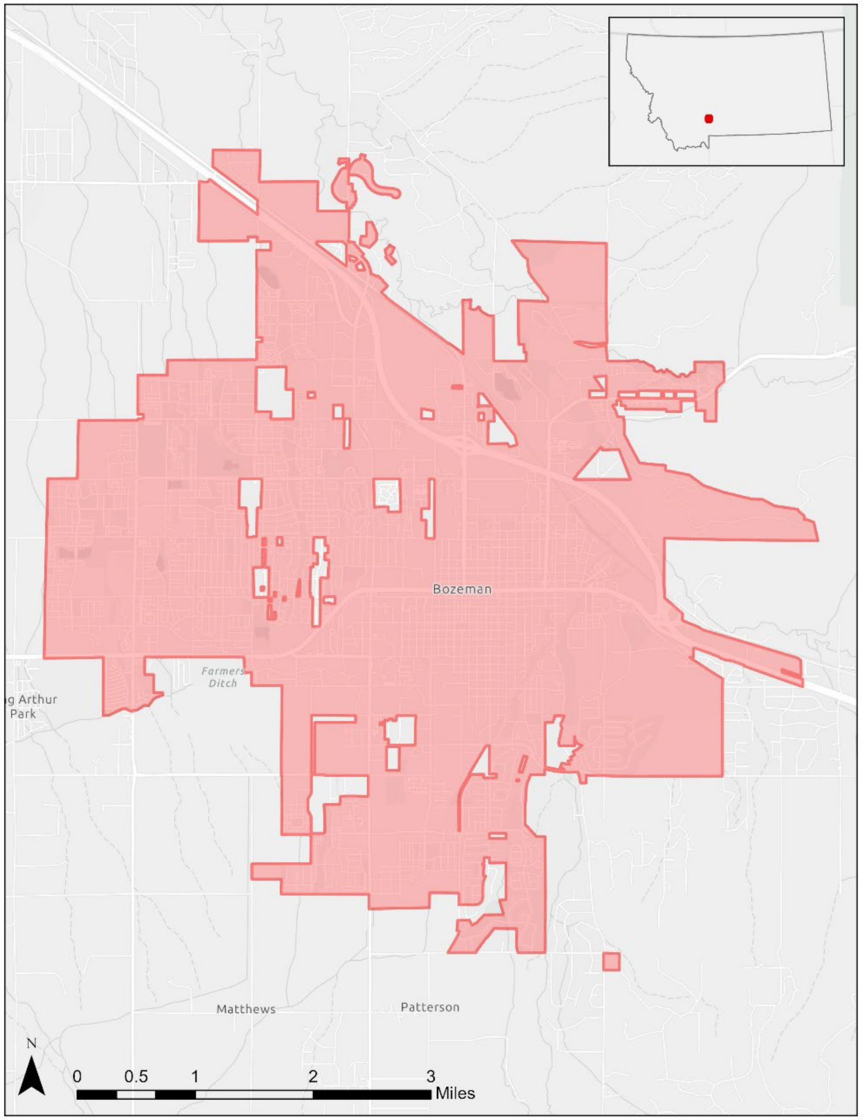

Figure 1. 2022 Bozeman City Limits

Overview of 2022 Emissions

Bozeman's 2022 GHG emissions totaled 687,194 metric tons of carbon dioxide equivalent (mt CO_2e) inclusive of all GHG emissions generated in Bozeman from building energy use (stationary energy), transportation, and waste.

In 2022, building stationary energy emissions were the largest contributor to Bozeman's GHG emissions, accounting for 52% of total emissions, with commercial and industrial buildings responsible for 29% and residential buildings for 23%. Transportation emissions account for 37% of total emissions. Waste and wastewater processes contributed 10% of total emissions. Industrial process emissions contributed 1% of total emissions.

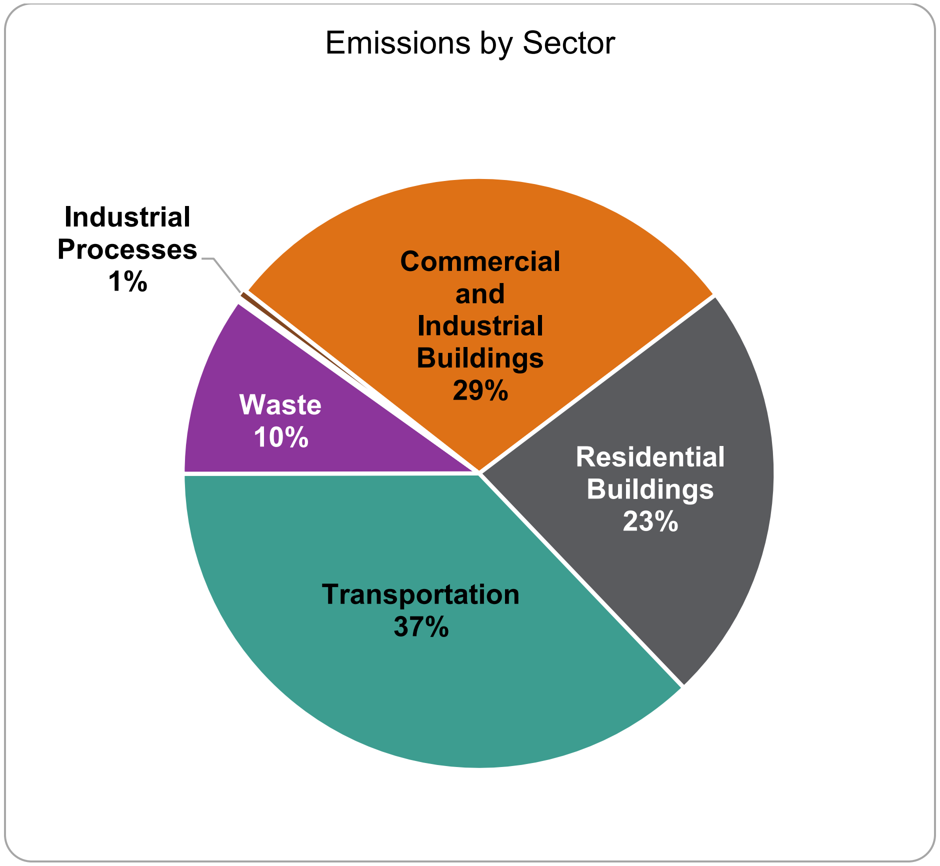

Figure 2. 2022 GHG emissions by sector.

Bozeman's overall greenhouse gas emissions have increased 19% from 2020 and 31% from the 2008 baseline year. Per capita emissions have increased 13% from 2020 and decreased 17% from the 2008 baseline year. A contributing factor to Bozeman's increased overall emissions is rapid population growth; Bozeman's population has increased by 57% from 2008 to 2022 and continues to increase at a rate of approximately 4% per year. See Figure 3.

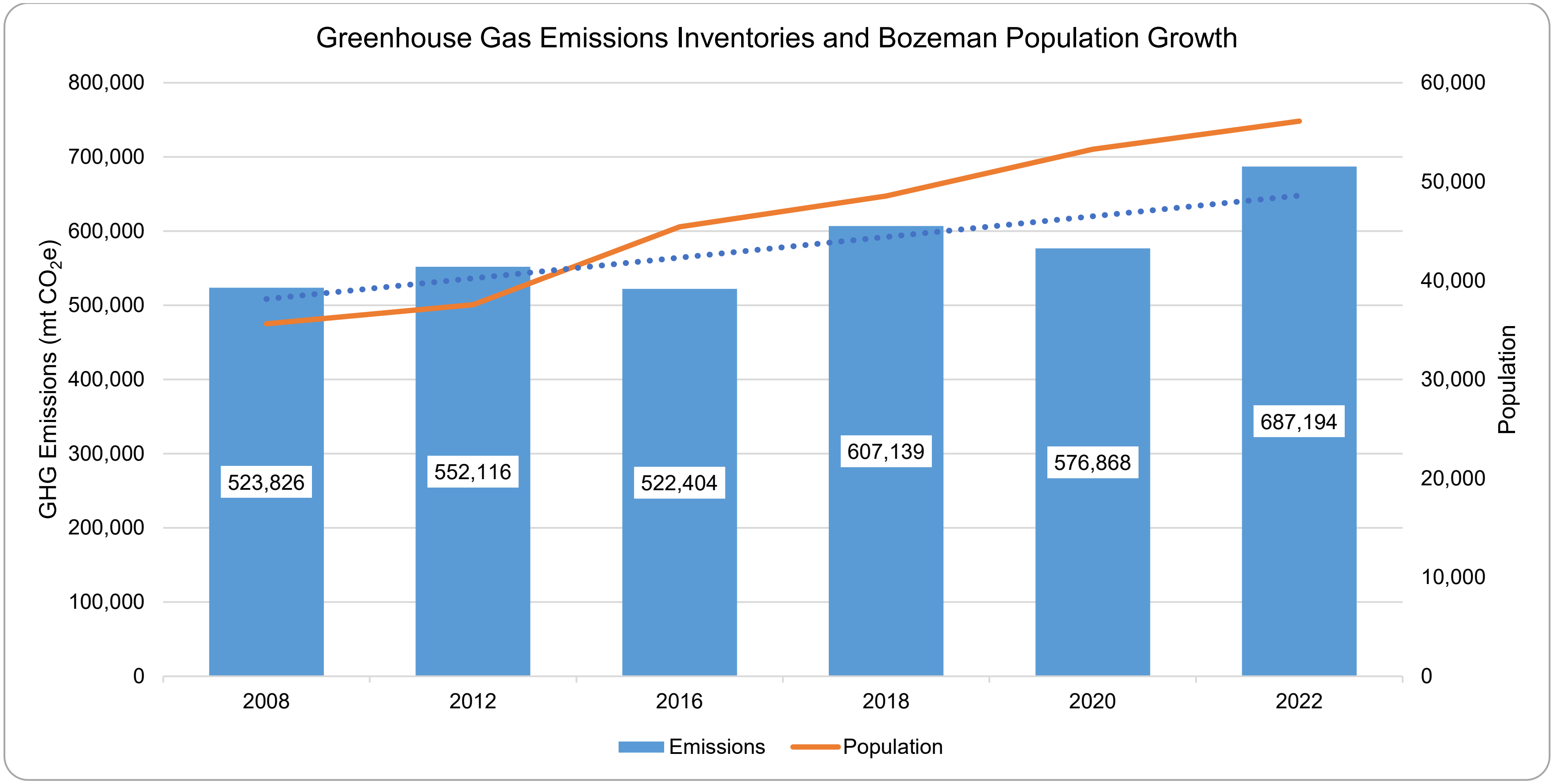

Figure 3. Annual GHG emissions for the City of Bozeman with emissions trend line and population growth.

Additional data has been made available since the 2020 GHG emissions inventory resulting in a more accurate accounting of Bozeman's overall emissions for both 2020 and 2022. With the integration of improved data sets in the waste and transportation sectors, the 2020 inventory final reporting figure has increased 5% from the previously reported 548,746 mt CO_2e to 576,868 mt CO_2e. By continuing to refine the process and data sources used in the greenhouse gas emissions inventory the City of Bozeman can help ensure the most accurate reporting of community-scale emissions.

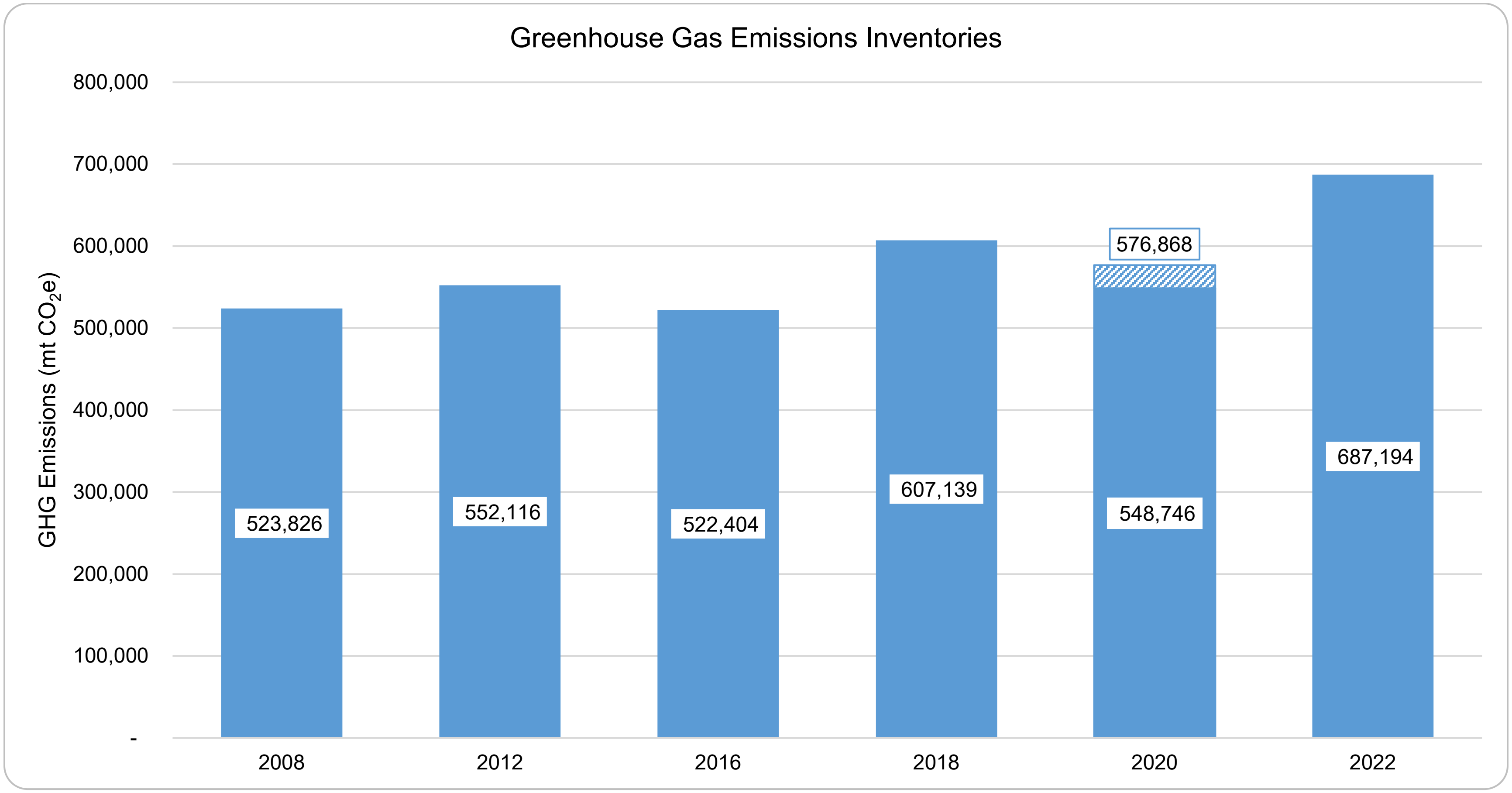

Figure 4. Revised GHG emissions inventory figure for 2020.

Per capita emissions show a decreasing trend while the population continues to increase at rates that have exceeded the growth projection modeling used to establish climate goals in the 2020 Climate Plan. Decreasing per capita emissions is indicative of individuals reducing their greenhouse gas emitting activities. Although overall emissions have increased for Bozeman the current community actions are trending in the right direction.

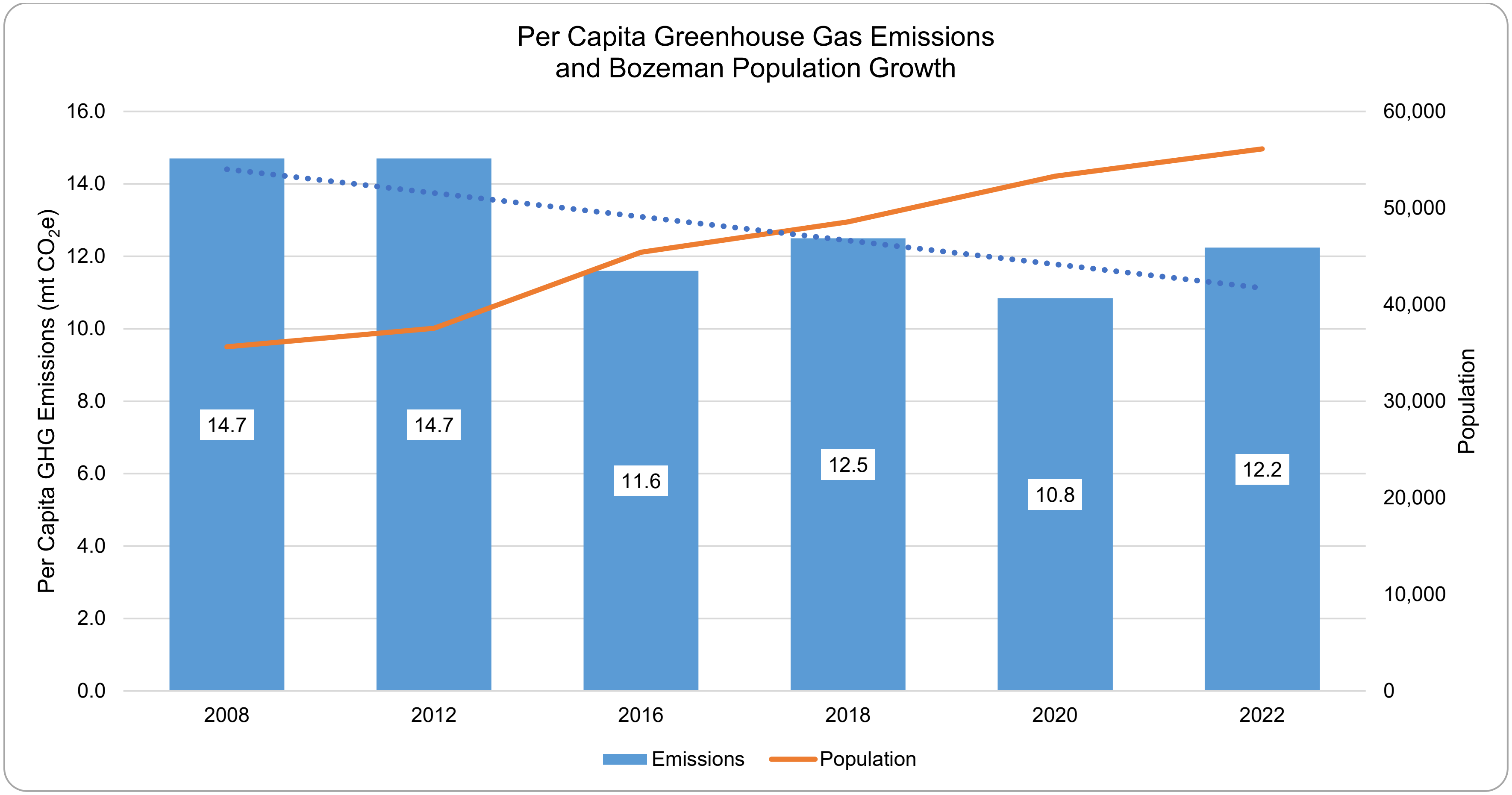

Figure 5. Annual per capita GHG emissions with per capita emissions trend line and population growth.

Emissions by Scope

Emissions are broadly categorized by sector, scope, and source. When calculating emissions by scope each source is examined on the point of emissions release in relation to the city boundary.

Scope 1 emissions include greenhouse gas sources that are emitted within the city boundary, such as the usage of natural gas, vehicle activity, and waste processes.

Scope 2 emissions include the use of grid-supplied fuels such as electricity that are sourced from outside of the city boundary but are used within the city boundary.

Scope 3 emissions include all other greenhouse gas emissions that occur outside the city boundary as a result of activities within the city, such as landfilled waste.

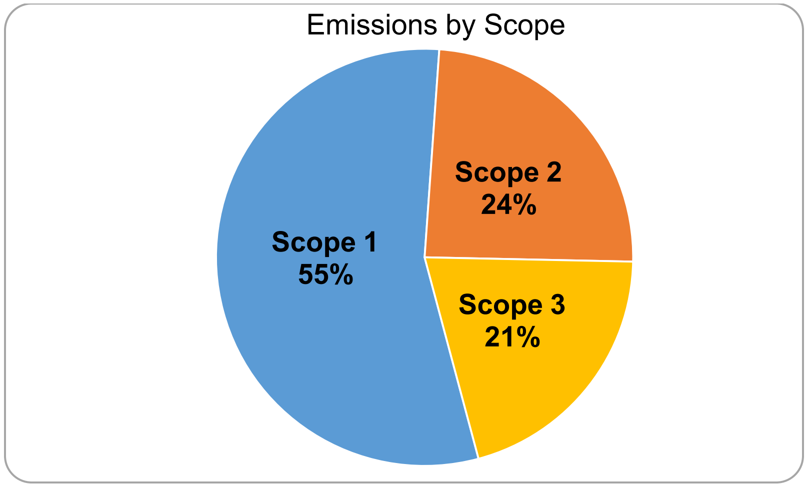

Figure 6. 2022 GHG emissions by scope.

Scope 1 emissions accounted for 55% of Bozeman's total emissions (379,966 mt CO_2e). On-road vehicle activity was the largest contributor to scope 1 emissions followed by commercial and residential natural gas use.

Scope 2 emissions made up 24% of total emissions (166,332 mt CO_2e), which are attributed to grid-supplied energy usage for commercial and residential buildings. A small portion would also be attributed to the grid-supplied energy used to charge electric vehicles.

Scope 3 emissions accounted for 21% of total emissions (140,896 mt CO_2e), half of which is from aviation emissions. The other half is largely attributed to waste and wastewater treatment, the transportation of waste outside the city's boundary, as well as transmission and distribution (T&D) losses associated with grid-supplied electricity.

Transmission and Distribution Losses

Transmission and distribution loss is the estimated quantity of electricity lost to inefficiencies in the utility grid. Northwestern Energy has estimated a T&D loss rate of 6.27% resulting in the loss of 25,230,387 kWh in the process of supplying Bozeman with electricity. The total emissions from these losses are 11,102 mt CO_2e and comprise 3% of overall emissions.

Emissions by Sector and Source

The community-scale greenhouse gas inventory for the City of Bozeman is broken into four sectors with various contributing sources: building stationary energy, transportation, waste and waste processes, and industrial processes.

Stationary energy includes emissions from commercial and residential building utility usage, propane and diesel combustion, and T&D losses.

Transportation includes emissions from off-road and on-road gas and diesel fuel combustion, aviation, transit, electric vehicles, and T&D losses associated with electric vehicles.

Waste and waste processes include emissions from the transportation, collection, and processing of waste, and emissions released from landfilled organic materials.

Industrial processes include emissions from refrigerant leaks in building heating, ventilation, and air conditioning (HVAC) systems.

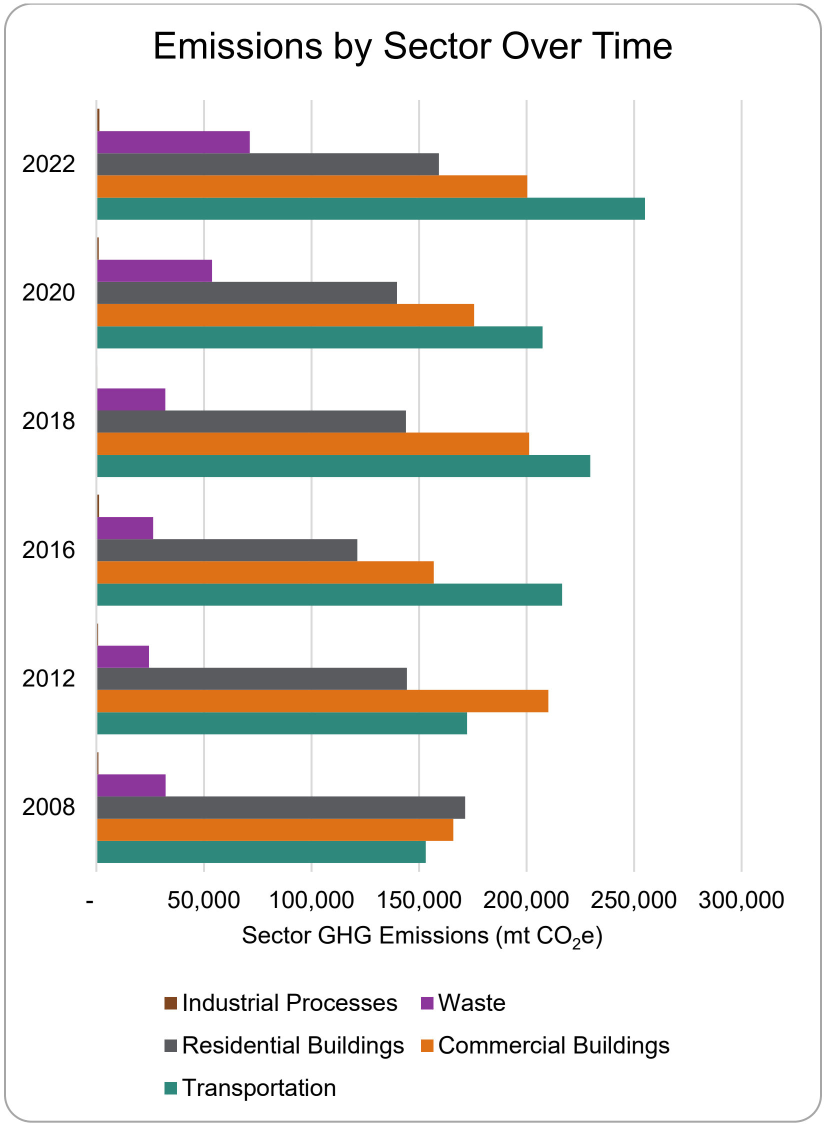

Figure 7. Annual GHG emissions by sector.

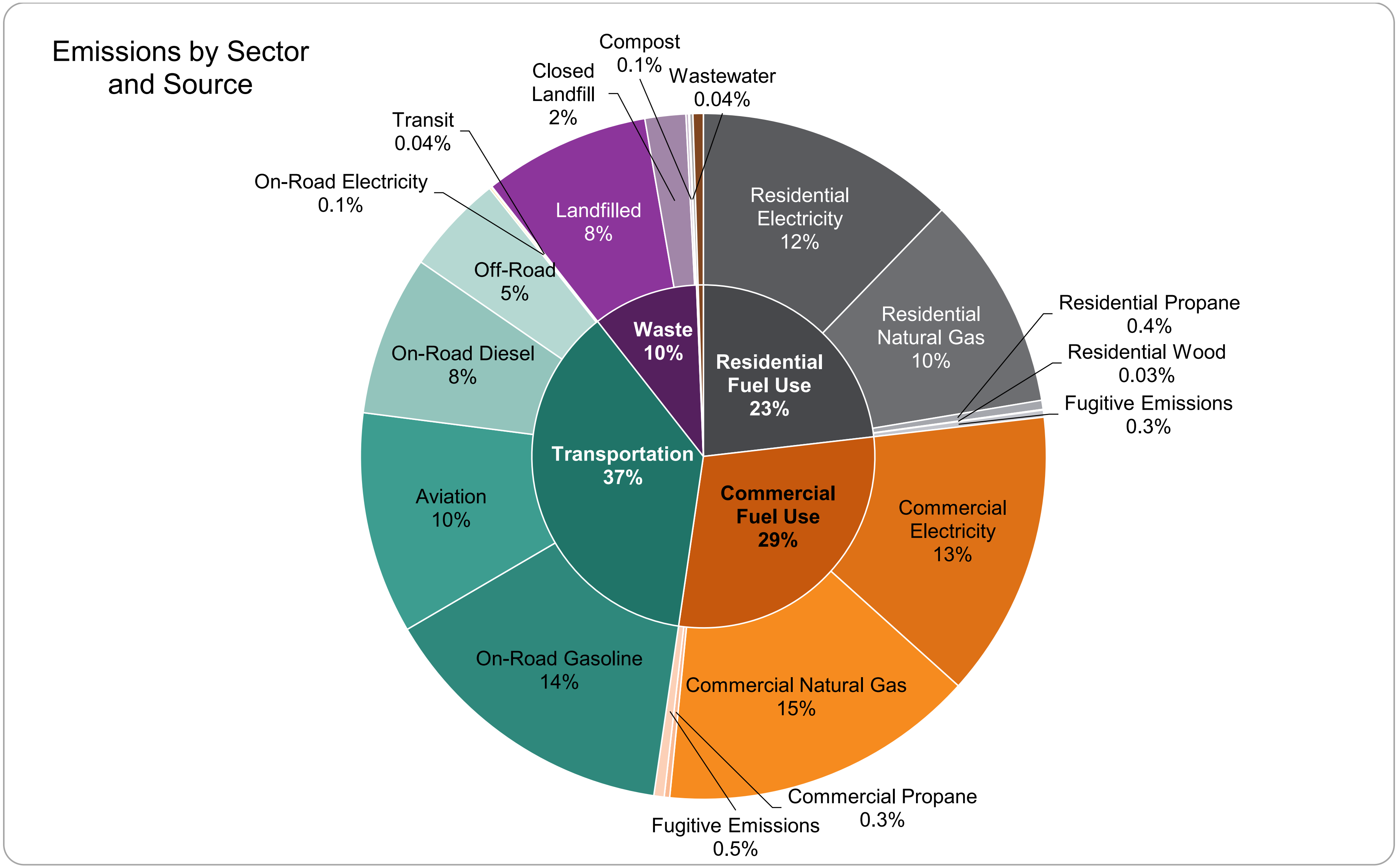

Figure 8. 2022 GHG emissions by percent sector and source.

Table 1. 2022 greenhouse gas emissions by sector, source, scope, and percent total.

Stationary Energy			
Fuel Usage	**Scope**	**GHG Emissions (mt CO_2e)**	**Percent**
Commercial and Industrial Natural Gas	1	102,424	15%
Commercial and Industrial Stationary Diesel	1	0	0%
Commercial and Industrial Propane	1	1,773	0.3%
Residential Propane	1	2,940	0.4%
Residential Natural Gas	1	69,722	10%
Residential Wood	1	222	0.03%
Electricity	**Scope**	**GHG Emissions (mt CO_2e)**	
Commercial and Industrial Grid-Supplied Electricity	2	86,904	13%
Residential Grid-Supplied Electricity	2	78,792	11%
Commercial and Industrial T&D Losses	3	5,823	1%
Residential T&D Losses	3	5,279	1%
Fugitive Emissions	**Scope**	**GHG Emissions (mt CO_2e)**	
Commercial and Industrial	1	3,329	0.5%
Residential	1	2,266	0.3%
Total Stationary Energy		**359,475**	52%

Transportation			
On-Road Vehicles	**Scope**	**GHG Emissions (mt CO_2e)**	
Emissions from fuel combustion on-road transportation occurring in the city	1	150,023	22%
Emissions from grid-supplied energy consumed in the city for on-road transportation	2	635	0.1%
EVs T&D Losses	3	43	0.01%
Off-Road	**Scope**	**GHG Emissions (mt CO_2e)**	
Off-road fuel use	1	32,224	5%
Transit	**Scope**	**GHG Emissions (mt CO_2e)**	
Transit activities within the city (buses)	1	288	0.04%
Aviation	**Scope**	**GHG Emissions (mt CO_2e)**	
Transboundary aviation	3	71,830	10%
Total Transportation		**255,043**	37%

Waste			
Community Solid Waste	**Scope**	**GHG Emissions (mt CO_2e)**	
Landfilled waste treated outside the City	3	53,888	8%
Composted waste treated inside the City	1	188	0.03%
Composted waste treated outside the City	3	693	0.1%
Emissions from closed landfill	1	13,201	2%
Wastewater Treatment and Discharge	**Scope**	**GHG Emissions (mt CO_2e)**	
Wastewater Generated and Treated in City	1	298	0.04%
Total Waste		**68,268**	10%

Industrial Processes and Product Use			
Refrigerant Leakage	**Scope**	**GHG Emissions (mt CO_2e)**	
Emissions from leaked refrigerants in the City	1	1,068	0.2%
Total Refrigerants		**1,068**	0.2%

Other Scope 3			
Other Scope 3	**Scope**	**GHG Emissions (mt CO_2e)**	
Emissions from transport, collection, and processing of waste	3	3,341	0.5%
Total Other Scope 3		**3,341**	0.5%

Stationary Energy

Bozeman's largest emissions contributor is from stationary energy sources, comprising 52% of the total greenhouse gas emissions for the 2022 inventory (359,475 mt CO_2e), a 14% increase from 2020.

The stationary energy sector includes emissions from building utility use, primarily from electricity and natural gas usage, as well as other fuel sources such as propane, stationary diesel, wood, and T&D losses. Fugitive emissions are also included in the stationary energy sector to account for the natural gas sourcing, transport, and leakage.

Overall, electricity use accounted for 49% of stationary energy emissions, including T&D losses (176,798 mt CO_2e). Natural gas use also accounted for 49% of stationary energy emissions, including fugitive emissions (177,741 mt CO_2e).

Commercial and industrial buildings make up 53% of the total stationary energy emissions (191,101 mt CO_2e), a 14% increase from 2020. The increase in commercial and industrial buildings was largely predicted following the lifting of COVID-19 pandemic restrictions and the return to office spaces, industrial buildings, and academic institutions.

Residential buildings make up 42% of total stationary energy emissions (151,677 mt CO_2e) and were also observed to have a 14% increase from 2020. Fugitive emissions and T&D losses make up the remaining 5% of total stationary energy emissions (16,697 mt CO_2e).

In 2022, Bozeman commercial and residential buildings used 376,572,945 kWh of electricity and 32,366,316 therms of natural gas.

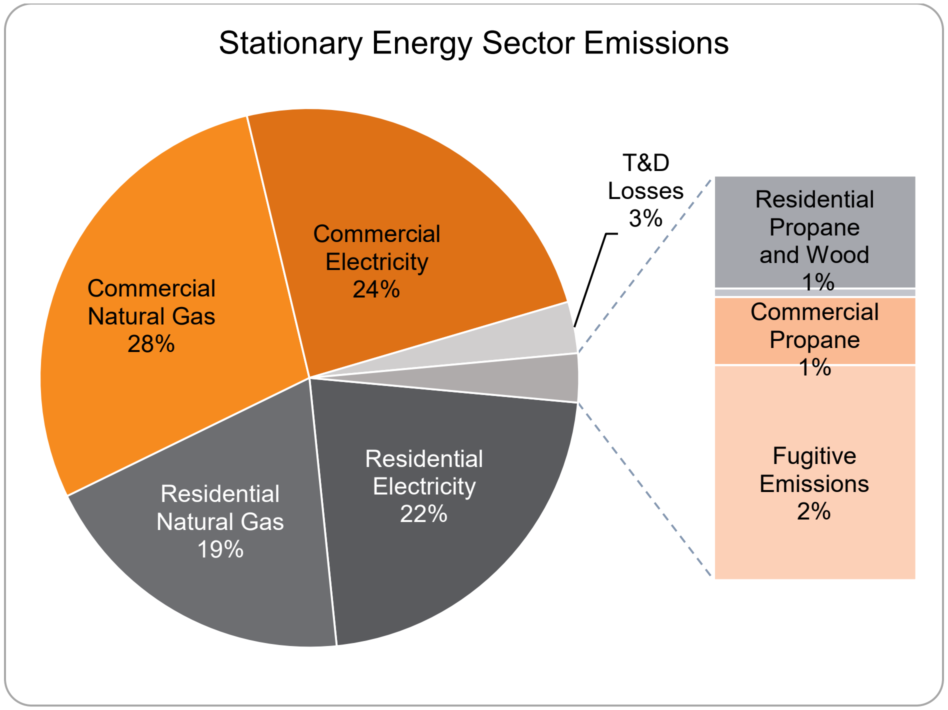

Figure 9. Stationary energy sector GHG emissions detail.

Transportation

Transportation sector emissions are the second largest source of Bozeman's greenhouse gas emissions and comprise 37% of the total emissions for 2022 (255,043 mt CO_2e), an overall 23% increase from 2020.

On-road vehicles are the largest contributing factor of greenhouse gas sources for the transportation sector. On-road gasoline vehicles make up 39% of the total transportation emissions (98,093 mt CO_2e), diesel on-road vehicles, make up 20% (51,931 mt CO_2e), public transit contributed 0.11% (288 mt CO_2e), and electric vehicles along with T&D losses make up 0.2% of transportation emissions (678 mt CO_2e).

Aviation emissions make up 28% of total transportation sector emissions (71,830 mt CO_2e), an 80% increase from 2020 aviation emissions, this could largely be attributed to the lifting of COVID-19 related travel restrictions as well as an increase in population and tourism in Bozeman.

Off-road emissions contributed 13% of total transportation emissions (32,224 mt CO_2e). Off-road emissions include fuel combustion from agricultural equipment, private aviation such as medical helicopters and aerial surveys, boating, commercial and industrial equipment, construction equipment, lawn and garden equipment, and recreational equipment such as snowmobiles and ATVs.

In 2022, people drove 315,922,851 miles in Bozeman, a measure provided by the Montana Department of Transportation of Vehicle Miles Traveled (VMT) using a model based on road miles and vehicle counts.

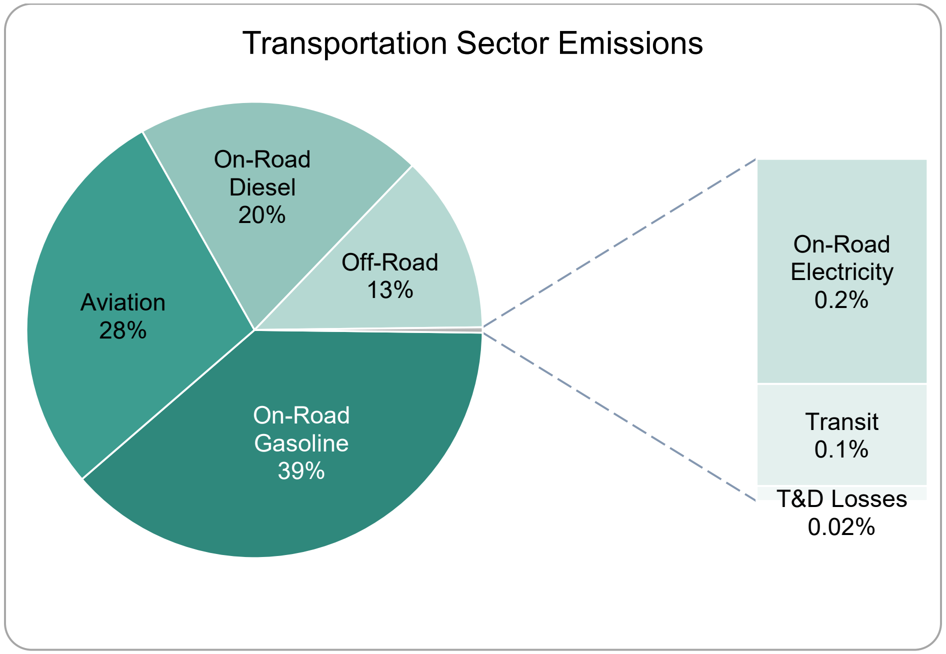

Figure 10. Transportation sector GHG emissions detail.

Transportation – Aviation

Although Bozeman does not have an airport within city limits the Bozeman-Yellowstone International Airport (BZN), located only a few miles from the center of town, serves as the air travel hub for the community. Because the emissions from air travel occur outside of city limits, these emissions are considered Scope 3. They are calculated based on ICLEI guidance, using the percentage of passengers that begin their travel from Bozeman as an indicator of the amount of jet fuel and aviation gasoline attributable to the community.

In 2022, BZN had a total of 2,264,424 passengers taking flights in and out of the airport, 42% of those passengers began their travel from BZN. It's estimated that a total of 7,350,936 gallons of jet fuel and aviation gasoline were used to accommodate that travel, resulting in the emissions of 71,830 mt CO_2e, making up 10% of Bozeman's total greenhouse gas emissions.

Aviation emissions stand out in the overall 2022 GHG emissions inventory due to the rate of increase from 2020. Prior to 2020, air travel was steadily increasing at BZN, following similar national trends. In 2020, air travel decreased nationally by 58%, and at BZN by 43%, largely due to travel restrictions associated with the COVID-19 pandemic.

Between 2020 and 2022, national air travel steadily increased to near pre-pandemic levels, while BZN exceeded pre-pandemic travel by 44%, see Figure 10. While these figures refer to all air travel in and out of BZN and are not entirely attributable to Bozeman, the rate of increased air travel to the region is notable for overall emissions intensity for the Bozeman community.

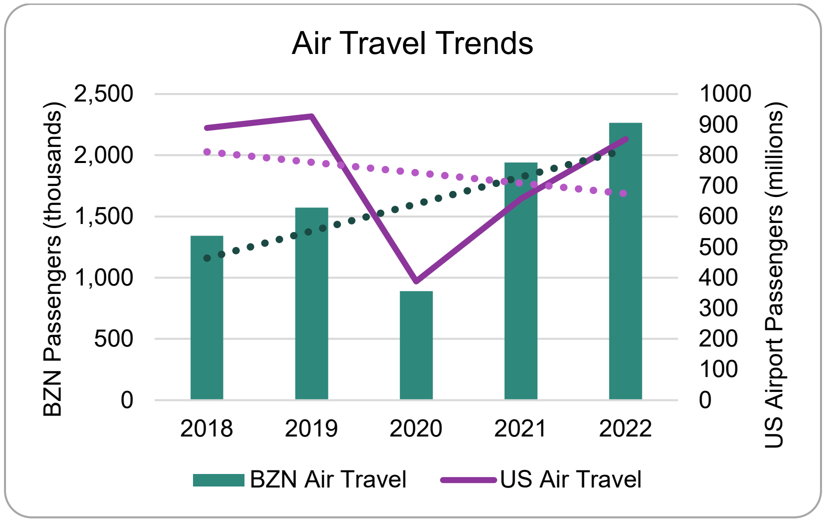

Figure 11.Air travel at BZN and total US airports with linear trend lines showing a rate of return to travel following 2020 (US Dept. of Transportation – Bureau of Transportation Statistics).

Waste and Wastewater

Waste and wastewater processes account for 10% of total greenhouse gas emissions (68,268 mt CO_2e), an overall 33% increase from 2020.

Most of the waste produced in Bozeman is collected and transported to the Logan Landfill, this waste is a mix of solid waste and compostable material. Solid waste refers to everything that is not composted or recycled and mostly consists of Municipal Solid Waste (MSW), which is household waste such as food scraps, and non-recyclable paper and plastic. In 2022, Bozeman's solid waste included 67% MSW and totaled 50,844 tons of landfilled waste, a 61% increase from 2020 when MSW totaled 31,547 tons.

Solid waste also describes other discarded materials such as tires, e-waste, and construction waste. Generally, organic materials have a higher global warming potential when landfilled compared to recycling or composting.

Solid waste contributed 79% of total waste-related emissions (53,888 mt CO_2e), a 49% increase from 2020, largely due to the increase in MSW. The second largest source of greenhouse gas waste emissions comes from the closed Story Mill Landfill in Bozeman. The closed landfill continues to emit methane from previously landfilled organic material. This methane is captured, flared, and converted to CO_2 before it is emitted into the atmosphere, resulting in a 19% contribution to total waste emissions (13,201 mt CO_2e).

Wastewater treatment contributed 0.4% of total waste emissions (298 mt CO_2e) and is primarily impacted by the volume and concentration of wastewater. A small portion of the waste generated in Bozeman comprised of food scraps and other green waste is composted within the city. Composted materials contributed 1% of total waste-related emissions (881 mt CO_2e).

In 2022, the community of Bozeman threw away 75,999 tons of material. Fortunately, 8,760 tons of waste were composted, and 2,078 tons were recycled, avoiding 5,835 mt CO_2e in emissions.

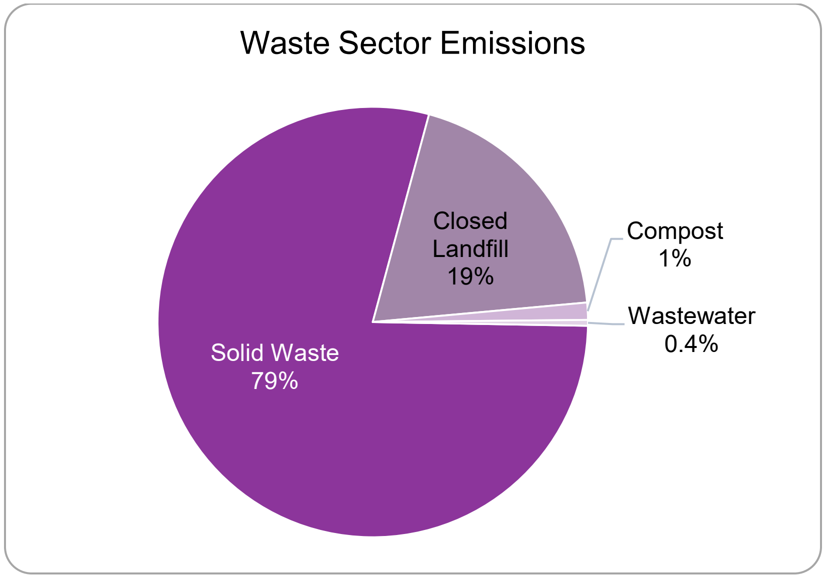

Figure 12. Waste and wastewater sector GHG emissions detail.

Solid Waste – Construction Waste

Emissions calculations for solid waste are based on assumptions regarding the types and amounts of materials discarded. Logan Landfill provides data on the weight of broadly categorized types of waste received which is then normalized for the population of Bozeman, however, detailed waste characterization is not available. Assumptions regarding the composition of waste categories are designated based on regional waste characterization studies and guidelines from the Environmental Protection Agency (EPA) to estimate greenhouse gas emissions associated with various materials.

Light construction waste, such as dimensional lumber, metal, glass, and other composite materials made up 26% of all waste the Logan Landfill received in 2022, heavy construction waste, such as concrete and pavement made up 1.5%. Based on regional and EPA waste characterization studies, for Bozeman's greenhouse gas emissions inventory in 2022, it was assumed that 8% of light construction waste is comprised of dimensional lumber. As an organic material, dimensional lumber has a higher global warming potential than the rest of the material that would typically be found in light construction waste, and when landfilled emits more methane emissions during anaerobic decomposition.

This method of accounting for the overall percentage of dimensional lumber is new to the 2022 Bozeman greenhouse gas emissions inventory and more accurately describes and accounts for the emissions associated with light construction materials.

Industrial Processes + Other Scope 3

Industrial processes and industrial product use, along with other scope 3 emissions contributed 0.7% to Bozeman's total greenhouse gas emissions (4,409 mt CO_2e).

Industrial product use refers to the emissions that result from refrigerant leaks in building HVAC systems. These emissions are estimated using the assumption that 25% of the commercial square footage in Bozeman is refrigerated and that, based on the International Panel on Climate Change (IPCC) methodology, there is a leakage rate of 5%. Refrigerant leaks contributed 0.2% to overall emissions (1,068 mt CO_2e).

The other scope 3 emissions that are not accounted for elsewhere in the inventory come from the transport of solid waste to the Logan Landfill outside of Bozeman's city limits. Waste transport accounts for 0.5% of overall emissions (3,341 mt CO_2e).

Drivers of Greenhouse Gas Emission Changes

During the COVID-19 pandemic greenhouse gas emissions for the City of Bozeman were generally reduced across several sectors due to factors including reduced travel, less commercial energy usage, and a mild winter. The uncharacteristic circumstances experienced during 2020 make the greenhouse gas emissions inventory unusual to compare to subsequent years. The ICLEI Contribution Analysis is a tool that helps communities better understand the sources of emissions driving observed changes between inventory years, see Figure 12.

While Bozeman experienced a reduction in overall greenhouse gas emissions in 2020, there was a subsequent population increase that exceeded the growth projections of previous climate modeling by the City of Bozeman. The results of the 2022 emissions inventory reflect rapid population growth, coupled with a return to a new normal outside of a global pandemic.

The largest contributing factor to the increase in greenhouse gas emissions is air travel. Air travel decreased nationwide in 2020 and has seen a steady increase annually, returning to near pre-pandemic levels. While Bozeman's air travel has followed the national trend of reduced passengers in 2020 the rate at which air travel has increased in Bozeman following the pandemic exceeds national trends, see Figure 10.

The second largest contributing factor is increased waste generation per person. The quantity of Municipal Solid Waste (MSW), which includes organic material that produces methane in a landfill, increased by 61% from 2020 to 2022. An increase of 61% for Bozeman is not proportionate to population growth but rather indicative of each person contributing more waste to the Logan Landfill.

Other contributing factors include more extreme seasonal weather, an increase in vehicle miles traveled (VMT) per person, as well as the use of less efficient vehicles. Energy use increased per household coupled with a change in the electricity fuel mix. Job growth within the city increased, however, the amount of heating fuel used per employee decreased, reflecting greater commercial building efficiency and the potential impacts of more people working from home.

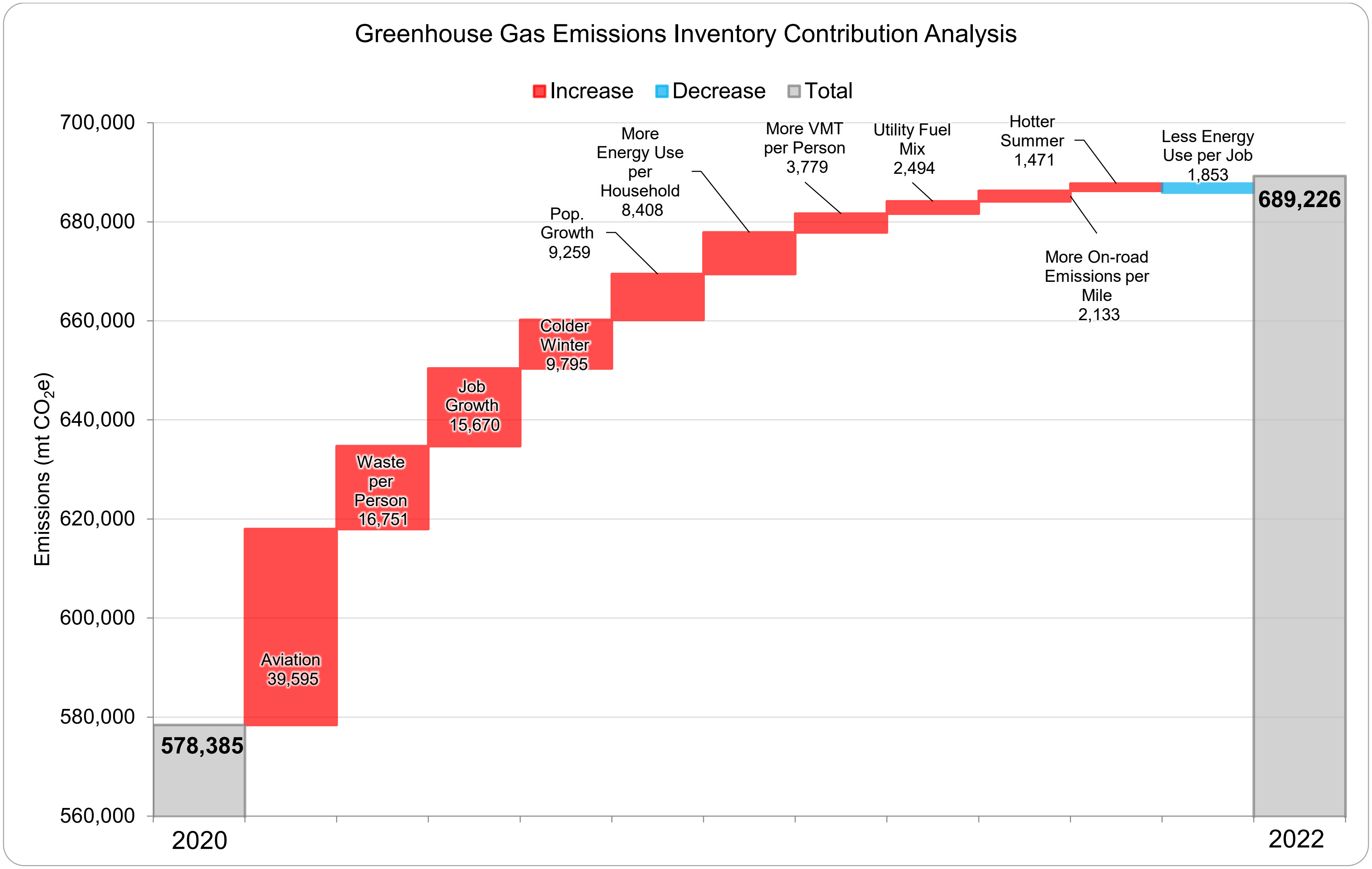

Figure 13. ICLEI Contribution Analysis results show sources of greenhouse gas emissions increases and decreases between 2020 and 2022.

Drivers of Greenhouse Gas Emissions Changes

Table 2. ICLEI Contribution Analysis tool detailed table.

Contribution	Emissions (mt CO_2e)
Aviation	39,595
Waste Generation per Person	16,751
Growth in Employment	15,670
Colder Winter	9,795
Growth in Population	9,259
Increased Energy Use Per Household	8,408
Increased VMT per Person	3,779
Electricity and Heating Fuels Mix	2,494
Increase On-road Emissions per Mile	2,133
Hotter Summer	1,471
Decreased Commercial Energy Use per Job	-1,853

By integrating weather data, utility usage data, and population growth for 2020 through 2022 the drivers of change between the two emissions inventories can present themselves at a more granular level.

Some factors, such as hotter summers and colder winters which can increase the amount of heating and cooling energy used, can be further outside the sphere of individual control.

Other factors, such as air travel, waste generation, and vehicle miles traveled, are GHG-emitting activities that can be mitigated through the actions of each person in the community. It also highlights opportunities for leaders at the federal, state, and local levels to support climate solutions in these areas.

Per Capita Emissions

Bozeman's per capita emissions increased 13% between 2020 and 2022 from 10.8 mt CO_2e per person to 12.2 mt CO_2e per person, an increase that follows a global trend of reduced emissions per person during the COVID-19 pandemic largely due to reduced travel.

While per capita emissions increased from 2020 to 2022 there was a 17% reduction from the 2008 baseline year, during that time Bozeman's population has more than doubled in size. Because emissions per person have continued to decrease from the 2008 baseline year, the overall effects of a rapidly increasing population have not resulted in a proportional increase in overall greenhouse gas emissions for Bozeman, see Figure 3. Bozeman's per capita emissions are 15% lower than the national average, although remaining nearly two and a half times the international average.

Table 3. Per capita greenhouse gas emissions intensities for Bozeman, the U.S., and internationally.

Per Capita Emissions (mt CO_2e)			
	2008	2020	2022
Bozeman	14.7	10.8	12.2
National	18.8	13.5	14.4
International	4.7	4.5	4.7

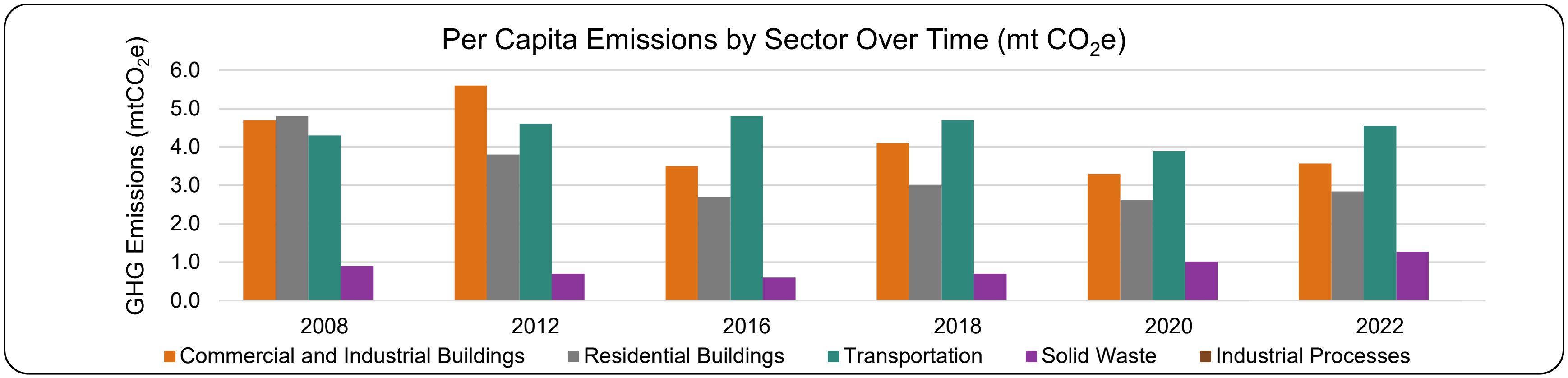

Figure 14. Per capita GHG emissions by sector.

Bozeman Climate Plan Goals

Bozeman has ambitious climate goals that were established with the adoption of the 2020 Bozeman Climate Plan. While the 2022 greenhouse gas emissions inventory is not aligned with the Climate Plan Reduction Pathway, significant progress can be made toward the 2025 goal of a 26% reduction in greenhouse gas emissions from the 2008 baseline year by implementing the Actions detailed in the Climate Plan.

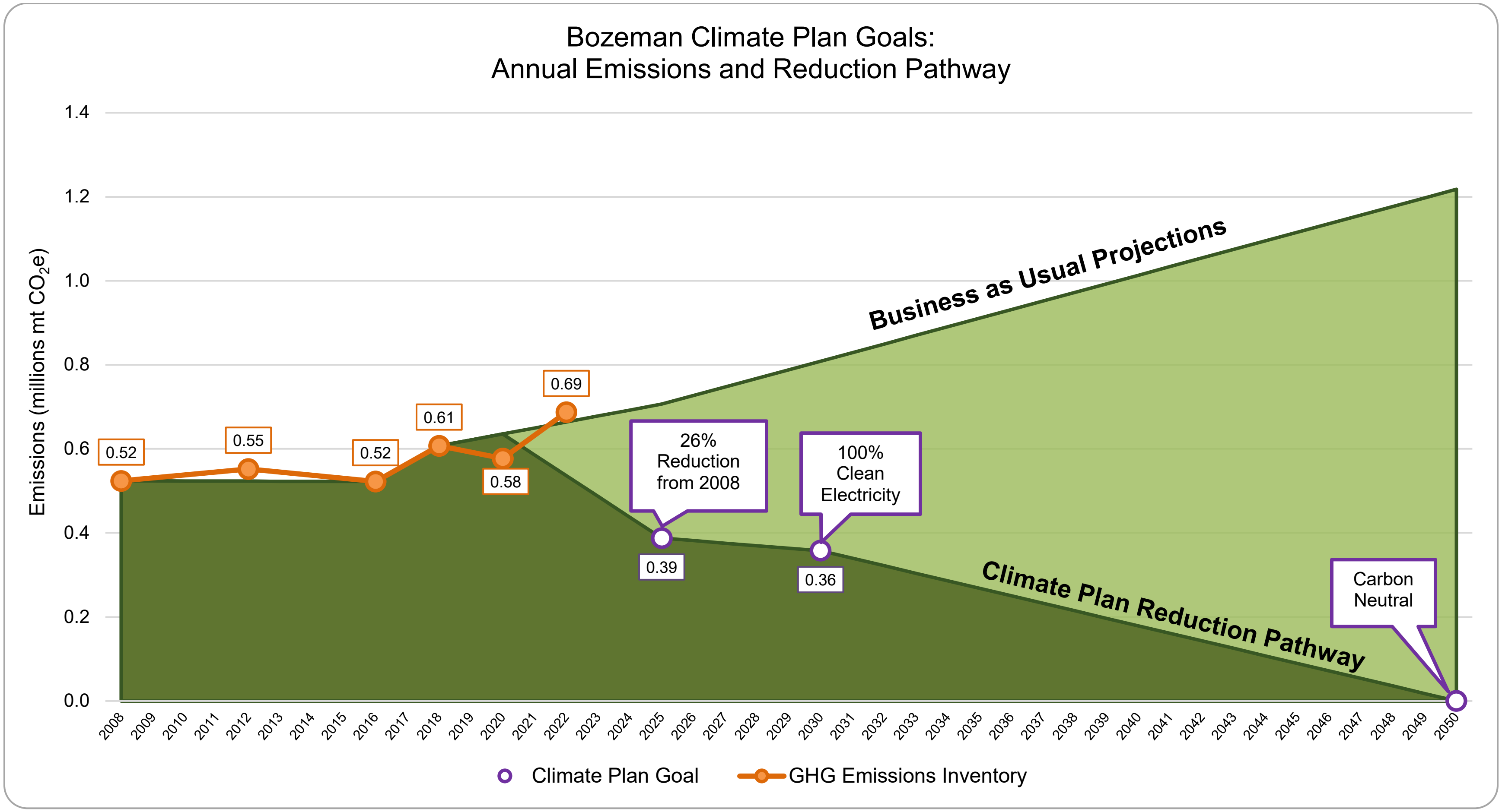

Figure 15. Climate Plan reduction pathway and business as usual GHG emission projections

Summary

Bozeman's 2022 greenhouse gas emissions inventory highlights the areas of progress, both on an individual level and as a community, and the areas where further emissions reduction opportunities exist. Emissions observed in 2022 reflect the return to a new normal following the COVID-19 pandemic in 2020, one in which people are traveling more, returning to office spaces and other institutions, and the desire for outdoor activity and open spaces have driven a rise in population and tourism for mountain towns across the West.

The increase in overall GHG emissions between 2020 and 2022 was anticipated and driven primarily by the transportation and waste sectors. Although commercial and residential building energy usage has fluctuated over time, the building energy sector has seen the largest per capita decrease since 2008, indicating that each person within the community uses less energy in their homes and places of work or study, and that buildings are being constructed to be more energy efficient. Per capita emissions in the waste sector are the most notable increase from the baseline year, encouraging the development of waste reduction opportunities on a municipal and individual level.

Accelerating the implementation of solutions and actions laid out in the 2020 Climate Plan can help Bozeman come closer to reaching the community climate goals established for 2025, 2030, and 2050. Continuing to monitor community-scale GHG emissions helps build an understanding of where policy, partnerships, and individual action can enhance community efforts that support our climate goals.

Appendix A: Data Sources

Emissions Source	Data Source	Were Emissions Estimated or Calculated?
Building Electricity Use	NorthWestern Energy	Calculated
Building Natural Gas Use	NorthWestern Energy	Calculated
Building Propane Use	US Census ACS House heating Fuel Survey data, Bozeman commercial square footage data, CBECS data, and US EIA unit conversions	Estimated
Building Stationary Diesel Use	US Census ACS House heating Fuel Survey data, Bozeman commercial square footage data, CBECS data, and US EIA unit conversions	Estimated
Fugitive Emissions from Natural Gas Leakage	GPC Protocol default leakage rate	Calculated
Transmission & Distribution Losses	NorthWestern Energy loss rate	Calculated
Vehicle Miles Traveled	City of Bozeman and MT DOT	Calculated
Vehicle Registrations	EPA State Inventory Tool Mobile Combustion Module	Calculated
Electric Vehicle Registrations	Atlas EV Dashboard	Calculated
EV Transmission & Distribution Losses	NorthWestern Energy loss rate	Calculated
Transit Fuel Use	Human Resources Development Council	Calculated
Aviation Fuel Use	Bozeman/Yellowstone International Airport	Calculated
Waste and compost tonnage	Gallatin County Solid Waste, City of Bozeman	Calculated
Closed landfill emissions	Estimated emissions depreciation rate via ICLEI	Estimated
Waste transport, collection, and processing emissions	GPC Protocol methodology	Calculated
Wastewater	City of Bozeman data for Bozeman WRF	Calculated
Refrigerant Leaks	Commercial square footage and IPCC methodology	Estimated
NorthWestern Energy Electric Emissions Factor	NorthWestern Energy	N/A

Appendix B: Emissions Factor

Stationary Energy Emission Factors—Electricity & Natural Gas				
Emission Source	**GHG**	**Value**	**Unit**	**Source**
Electricity	CO_2	0.419	mt CO_2/MWh	Northwestern Energy's EEI-ESG Template
	CH_4	0.00003	mt CH_4/MWh	EPA's eGrid 2022
	N_2O	0.000004	mt N_2O/MWh	
Natural Gas	CO_2	0.0053	mt CO_2/therm	2013 ICLEI US Community Protocol: Appendix C
	CH_4	0.0000005	mt CH_4/therm	
	N_2O	0.00000001	mt N_2O/therm	
Stationary Diesel	CO_2	0.01	mt CO_2/gallon	
	CH_4	0.0000004	mt CH_4/gallon	
	N_2O	0.0000001	mt N_2O/gallon	
Propane	CO_2	0.006	mt CO_2/gallon	
	CH_4	0.000001	mt CH_4/gallon	
	N_2O	0.0000001	mt N_2O/gallon	

Transportation Emission Factors—Ethanol, Gasoline, and Diesel				
Emission Source	**GHG**	**Value**	**Unit**	**Source**
Gasoline	CO_2	0.00878	mt CO_2/gal	EPA Estimates
	CH_4	Varies by vehicle	g/mile	
	N_2O			
Diesel	CO_2	0.01	mt CO_2/gal	
	CH_4	Varies by vehicle	g/mile	
	N_2O			
Ethanol	CO_2	0.006	mt CO_2/gal	
	CH_4	Varies by vehicle	g/mile	
	N_2O			
Transit Emission Factors				
Emission Source	**GHG**	**Value**	**Unit**	**Source**
Diesel	CO_2	0.01	mt CO_2/gal	EPA Estimates
	CH_4	0.001	g CH_4/mile	
	N_2O	0.0015	g N_2O/mile	
Aviation Emission Factors				
Emission Source	**GHG**	**Value**	**Unit**	**Source**
Jet fuel	CO_2	9.75	Kg CO_2/gal	Per guidance from ICLEI on emissions factors used in the ClearPath tool.
	CH_4	0.41	g CH_4/gal	
	N_2O	0.08	g N_2O/gal	
Aviation Gasoline	CO_2	8.31	kg CO_2/gal	Per guidance from ICLEI on emissions factors used in the ClearPath tool.
	CH_4	0.36	g CH_4/gal	
	N_2O	0.07	g N_2O/gal	

Waste Emission Factors				
Emission Source	**GHG**	**Value**	**Unit**	**Source**
Municipal Solid Waste	CH_4	Varies by waste type	mt CH_4/ ton waste	2013 ICLEI US Community Protocol, Appendix E
Recycled Waste	CH_4	Varies by waste type	mt CH_4/ ton waste	2014 ICLEI US Community Protocol, Appendix E
	N_2O		mt N_2O/ wet short ton waste	
Composted Waste	CH_4	0.00047	mt CH_4/ ton waste	EPA Waste Reduction Model (WARM) Documentation
	N_2O	0.00022	mt N_2O/ ton waste	
	CH_4	0.00018	mt CH_4/ ton waste	
	N_2O	0.00013	mt N_2O/ ton waste	
Wastewater	CH_4	Varies by treatment	Varies	2013 ICLEI US Community Protocol, Appendix F
	N_2O			