

2019 SAN FRANCISCO SECTOR-BASED GREENHOUSE GAS EMISSIONS INVENTORY AT A GLANCE

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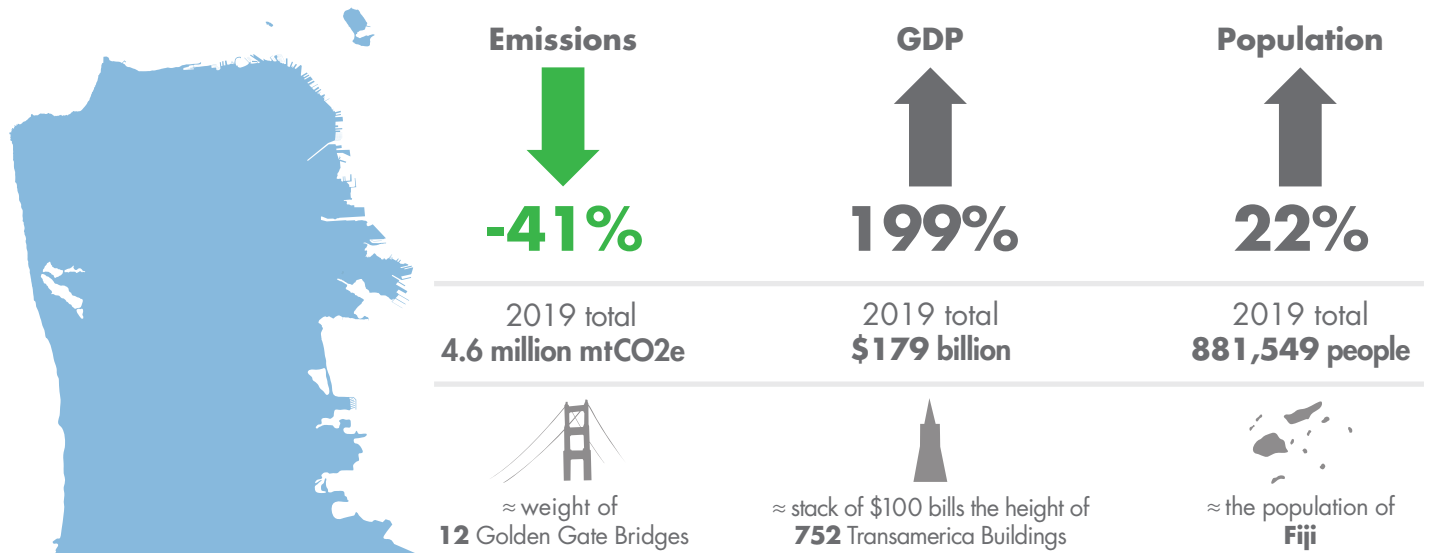
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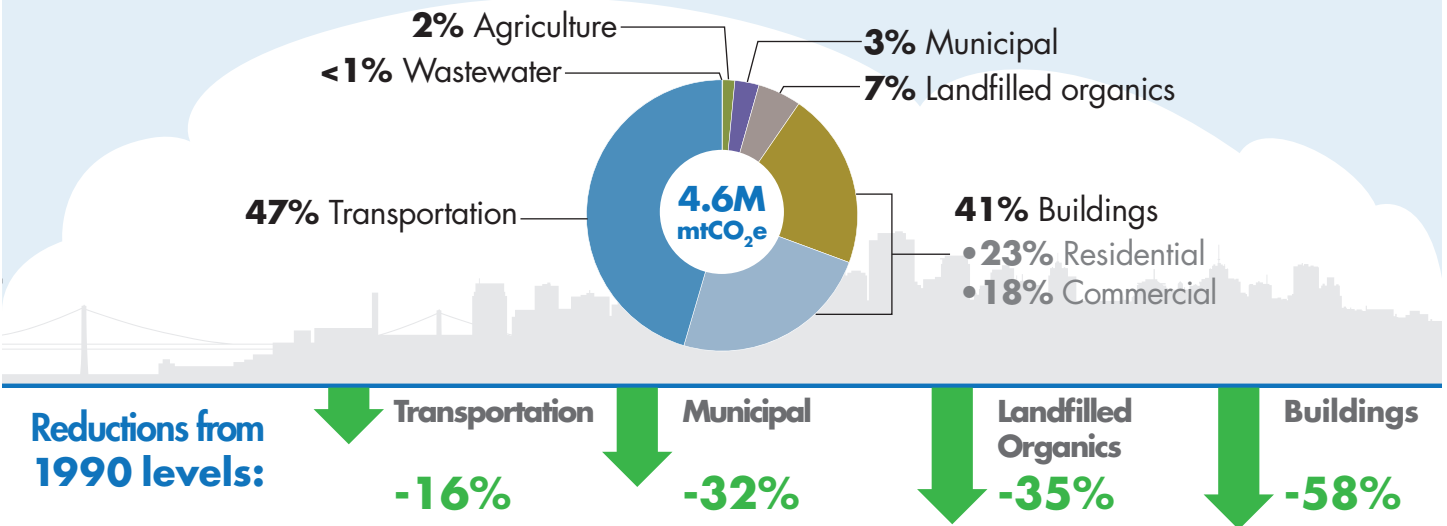
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1990-2019 San Francisco trends



2019 San Francisco emissions by sector



San Francisco per capita emissions



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EMISSIONS OVERVIEW

EMISSIONS TRENDS

In 2019, San Francisco's community-wide greenhouse gas (GHG) emissions totaled 4.6 million mtCO₂e (Fig. 1). This total is 41% below emissions levels in 1990. These reductions came despite a 22% increase in population and a near-tripling of economic output from \$59.7 billion in 1990 to \$178.5 billion in 2019. As a result, San Francisco's emissions per capita was 5.21 mtCO₂e/person in 2019, about half of the 11 mtCO₂e/person seen in 1990.

2019 emissions were 420,000 mtCO₂e (8%) lower than in 2018. Building emissions fell 285,000 mtCO₂e (13%) between 2018 and 2019, driven by lower emissions from San Francisco's grid-supplied electricity. This was the largest contributor to the community-wide drop in emissions. The Transportation sector saw a 116,000 mtCO₂e (5%) drop in emissions, led by reductions in emissions from cars and trucks on the road.

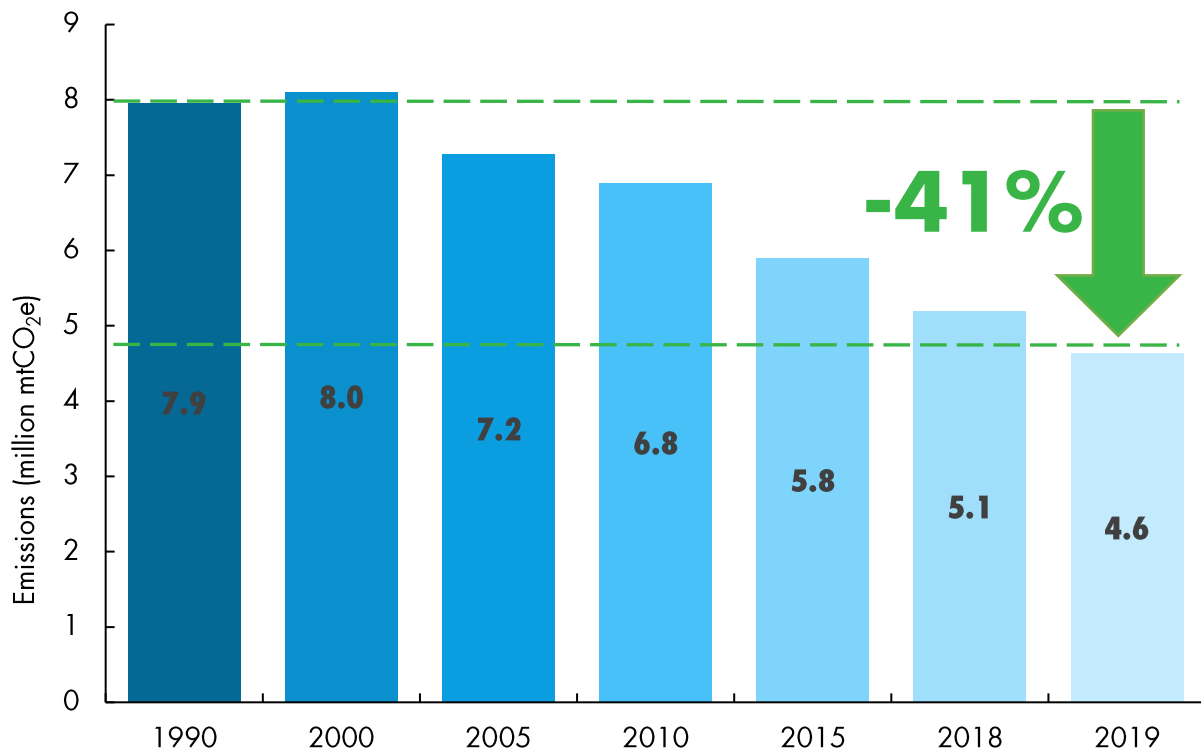


Figure 1. San Francisco's GHG Emissions from Inventory Year 1990 to 2019.

Emissions are categorized into seven sectors in the 2019 inventory (Fig. 2):

- The **Residential Buildings** sector accounts for 23% of the city's emissions. Within the sector, 96% of emissions come from natural gas, 2% from electricity, and 2% from other fuels.
- The **Commercial Buildings** sector accounts for 18% of the city's emissions. Within the sector, 85% of emissions come from natural gas, 8% from steam, and 7% from electricity.
- The **Transportation** sector accounts for 47% of the city's emissions. Within the sector, 72% of emissions come from passenger vehicles, 19% from Maritime Ships and Boats¹ (non-ferry), 6% from off-road equipment, and 3% from public transportation².
- The **Landfilled Organics** sector accounts for 7% of the city's emissions³.
- The **Municipal** sector accounts for 3% of the city's emissions. This includes facilities and fleet, and nearly all emissions come from natural gas and vehicle fuel use.
- The **Agriculture** sector accounts for 2% of the city's emissions.⁴
- The **Wastewater** sector accounts for <1% of the city's emissions.⁵

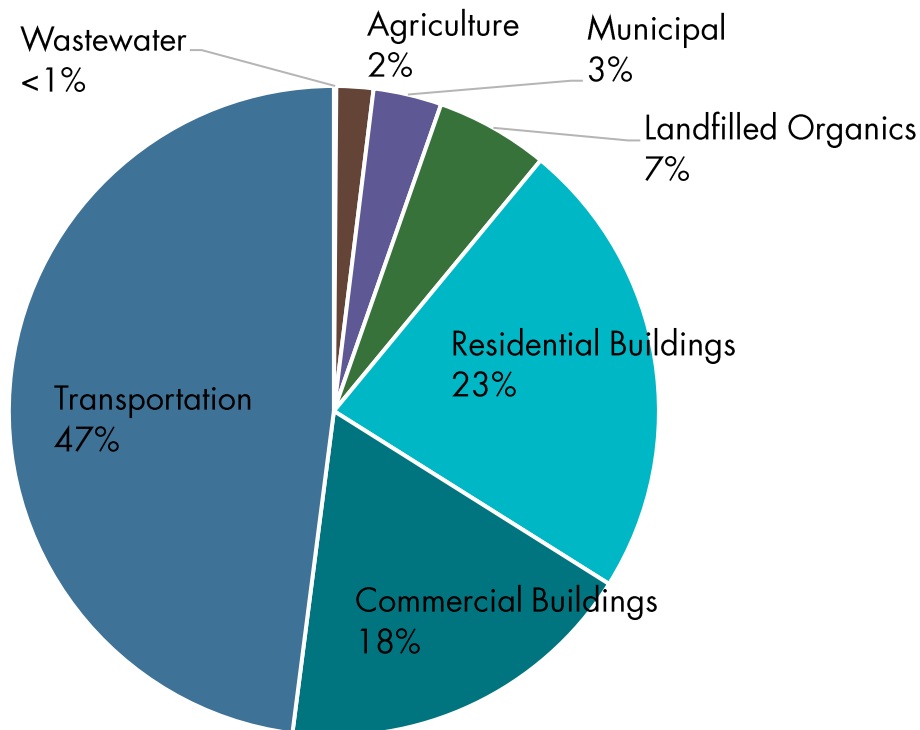


Figure 2. San Francisco 2019 emissions by sector

¹ Maritime ships and boats consist of ships and boats within 24 nautical miles.

² Public transportation consists of Muni, BART, Caltrain (rail and buses), commuter ferries, and other buses (including Golden Gate Transit).

³ Emissions from Landfilled Organics, previously known as the Waste sector, occur when disposed organics break down (decompose) in a landfill and produce methane.

⁴ Agriculture sector is a relatively new sector tracked starting in inventory year 2016. These emissions are allocated to the city proportionally from BAAQMD's regional inventory.

⁵ Wastewater sector is a relatively new sector tracked starting in inventory year 2016.

In 2019, San Francisco successfully reduced emissions to 41% below 1990 levels from 7.9 million⁶ mtCO₂e to 4.6 million mtCO₂e (Fig. 1). Emissions fell in the top five of the seven sectors tracked:

Sector	2019 Emissions compared to 1990 levels
Residential Buildings	47% decline
Commercial Buildings	67% decline
Transportation	16% decline
Landfilled Organics	35% decline
Municipal	32% decline
Agriculture	9% increase
Wastewater	26% increase

Since 1990, San Francisco's GHG inventories have been calculated and reported in accordance with the ICLEI U.S. Community Protocol (USCP) for Accounting and Reporting of Greenhouse Gas Emissions. The methodology and sectors tracked were third-party verified in inventory year 2012. All subsequent inventories were completed according to the guidance of the verifiers. In 2015, the City began reporting its emissions to C40 to comply with a newer protocol to report emissions referred to as the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC). GPC incorporated new emission categories to track. Furthermore, while ICLEI protocols are used to calculate GHG emissions, GPC serves as a framework to unify San Francisco's inventory protocols with other cities and publicly disclose emissions to the global community.

EMISSIONS REDUCTION DRIVERS

Reductions in emissions can be attributed to a variety of factors, such as the implementation of innovative technologies, policies, and programs. Annual emissions may also vary with changes in the weather. The main drivers of the emission reductions observed between 1990 and 2019 are illustrated below. This 2021 report reflects inventory year 2019; it does not reflect inventory year 2020, which will likely be impacted by the COVID-19 pandemic.

- **A cleaner electric grid for all of San Francisco.** City-owned buildings have been powered by 100% GHG-free electricity since 2012, and the power mix available to other customers has become significantly cleaner since 1990. CleanPowerSF, San Francisco's Community Choice Aggregation program, has expanded its clean energy portfolio and customer base while reinvesting ratepayer funds in local renewable energy resources. By the end of 2019, the program more than tripled the number of customers served compared to 2018, serving 380,000 customers by the end of the year. CleanPowerSF served 47% of the City's electricity load in 2019. Of the electricity served by CleanPowerSF and PG&E (San Francisco's investor-owned utility), 83% came from renewable resources in 2019.⁷
- **A scale-up in energy efficiency programs** that helped curtail demand for electricity and natural gas. In 2019, San Francisco's Energy Watch program saved San Francisco commercial and multifamily properties a total of 680,000 kWh across 31 projects and an average of \$4,400 in bill savings each. This translates to a GHG emissions reduction of 162 mtCO_{2e}, or the equivalent of removing 35 passenger vehicles from the road for a year.
- **Progressive green building codes** which ensure new construction is built to the highest standards for energy, water, and other key environmental performance metrics. Local green building code requirements contributed 149 million square feet in commercial buildings becoming LEED certified by the end of 2019. This includes 67 city-owned buildings and interiors that were LEED certified between 2004 and 2018, totaling 9.37 million square feet.

Impact of Weather on Emissions

It is important to differentiate between long-term emissions reductions driven by new technologies, policies, and programs and short-term reductions due to changes in factors such as the weather. Weather can affect usage patterns. For example, warmer temperatures compared to a previous year can drive down the use of natural gas. Understanding how weather impacts emission levels is important because there are likely to be short-term, year-to-year variations in emissions as San Francisco continues to make progress towards longer-term reduction targets.

⁷California's cleaner grid is driven at the state level through the Renewable Portfolio Standards (RPS), which sets a goal of 33% renewable energy by 2020 and 50% by 2030.

- **Cleaner fuels** which helped decouple transportation emissions from growth. Between 1990 and 2019 commuting into and out of the city increased alongside the City's growing economy. Even with an additional 340 million vehicle miles added to San Francisco roads between 1990 and 2019, vehicle emissions declined 22%, due to State and local efforts to reduce the carbon intensity⁸ of vehicle fuels.
- **A switch to renewable diesel** by which the City reduced emissions from SF MUNI buses and municipal fleet vehicles. Diesel consumption across the city fleet has been halved since 2015 when this transition began. Commuter ferries also began the switch to renewable diesel in 2017, further reducing carbon emissions in the Transportation sector. Renewable diesel is an interim fuel that will be phased out as transportation modes shift toward electrification. Renewable diesel consumption currently makes up less than 1% of transportation emissions.

⁸ Carbon intensity is the amount of carbon emitted per unit of energy used.

SECTOR SUMMARY

Below is an in-depth analysis of San Francisco's emissions trends since 1990 in the Residential Buildings, Commercial Buildings, Transportation, Landfilled Organics, Municipal, Agriculture, and Wastewater sectors.

RESIDENTIAL BUILDINGS

In 2019, emissions from the Residential sector totaled 1.05 million mtCO₂e, accounting for 23% of San Francisco's GHG emissions (Fig. 3). Emissions from the Residential sector have declined 47% since 1990 (Fig. 4). This was driven primarily by a cleaner electrical grid, improved energy codes, and city-wide energy efficiency programs. Residential sector emissions are generated from fossil fuels used to heat household spaces, provide hot water, dry clothes, and cook. Emissions from the Residential sector result primarily from natural gas use (96%), followed by electricity use (2%) and other fuel consumption (2%) (Fig. 5). Emissions from electricity are much lower than those from natural gas because of San Francisco's push to increase its renewable energy portfolio.

Between inventory years 2018 and 2019, Residential Buildings sector emissions fell by 8%. This came as San Francisco customers saw an increased supply of low-carbon electricity, resulting in a 50% decrease in Residential Building electricity emissions year-over-year. Many residential customers received electricity from CleanPowerSF in 2019: CleanPowerSF served more than 66% of residential customer load in 2019, compared to less than 20% in 2018. Residential sector emissions should continue to trend downward over time.

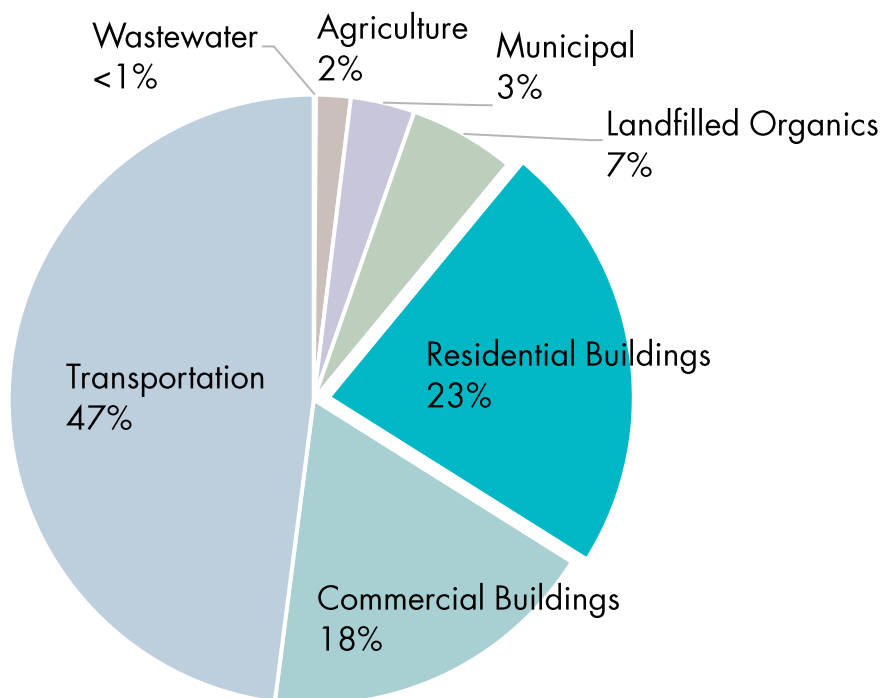


Figure 3. 2019 Residential sector emissions.

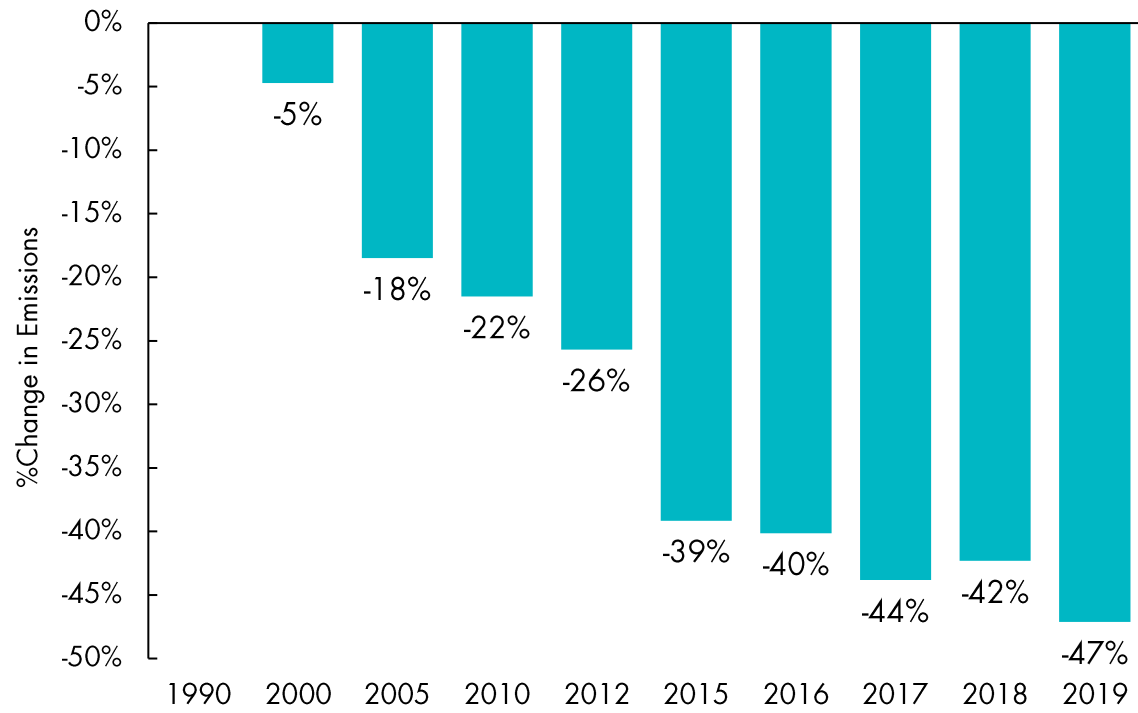


Figure 4. 2019 Residential sector emissions compared to 1990.

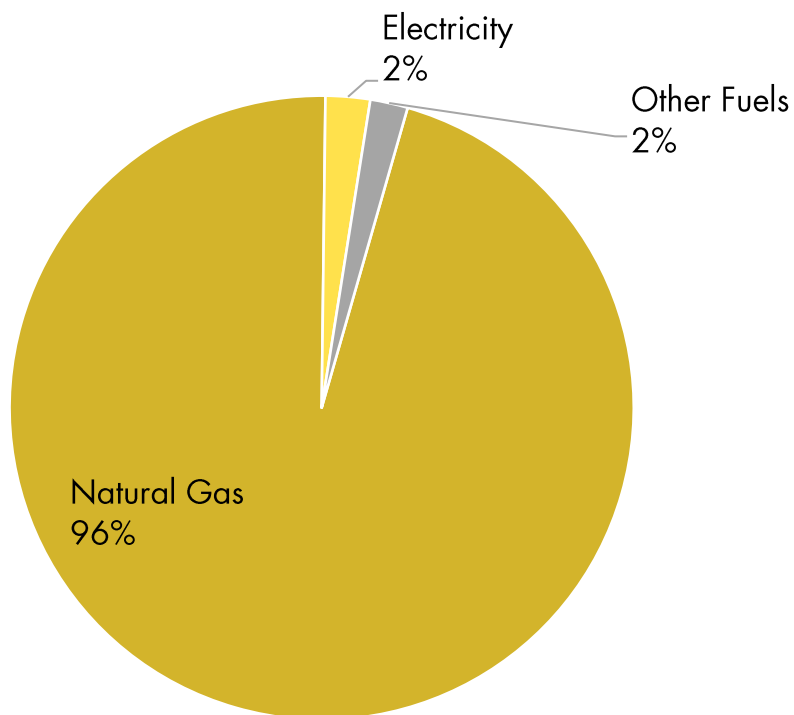


Figure 5. 2019 Residential sector emissions by commodity.

COMMERCIAL BUILDINGS

In 2019, emissions from the Commercial⁹ sector totaled 831,000 mtCO₂e, accounting for 18% of San Francisco's GHG emissions (Fig. 6). This includes commercial and industrial, direct access, district, and steam loop customers.¹⁰ Emissions from the Commercial sector have declined 67% since 1990 (Figure 7). As in the Residential sector, this decrease in emissions was mainly due to a combination of a cleaner electrical grid, improved energy codes, and city-wide energy efficiency programs. Generating and distributing steam in a centralized manner through the downtown district steam loop is more efficient than generating steam in individual buildings. While this efficiency has helped reduce emissions, the steam loop is a historic system that may be replaced as the City transitions to a carbon-free solution. Commercial natural gas use was responsible for the largest share of emissions (85%), followed by steam (8%) and electricity (7%) (Fig. 8). As in the residential sector, emissions from electricity usage make up a relatively small portion of sector emissions due to San Francisco's increasingly renewable and low- and zero-carbon electricity generation mix.

Between inventory years 2018 and 2019, Commercial Buildings sector emissions dropped by 19% from over 1 million mtCO₂e to 831,000 mtCO₂e, due largely to a drop in electricity emissions. This was driven by an increased supply of low-carbon electricity to San Francisco's Commercial customers from PG&E and CleanPowerSF, the two largest electricity load-serving entities for Commercial Buildings.

⁹ The commercial sector includes the Industrial sector because of California's Data Privacy Aggregation rules, which causes the two sectors to be combined. The Industrial sector is reported as part of the Commercial sector as there are more commercial buildings than industrial buildings in San Francisco.

¹⁰ Direct Access is electricity usage for customers for whom PG&E provides transmission and distribution services, but not electricity generation (Commercial, Industrial, as well as Residential). District electricity includes accounts such as BART, School Districts, Hospital Districts, Water or Sewer Districts, Fire Districts, Junior College Districts, District Fairs, Public Utility Districts, Community Service Districts, Cemetery Districts, Mosquito Abatement Districts, and/or Park Districts. The steam loop is powered by natural gas use and serves only commercial and municipal customers in the downtown core.

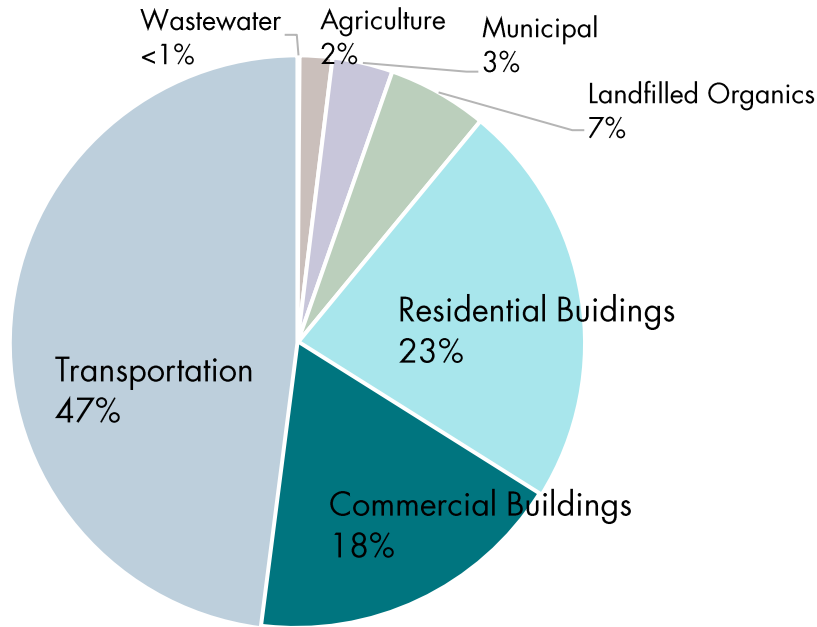


Figure 6. 2019 Commercial sector emissions.

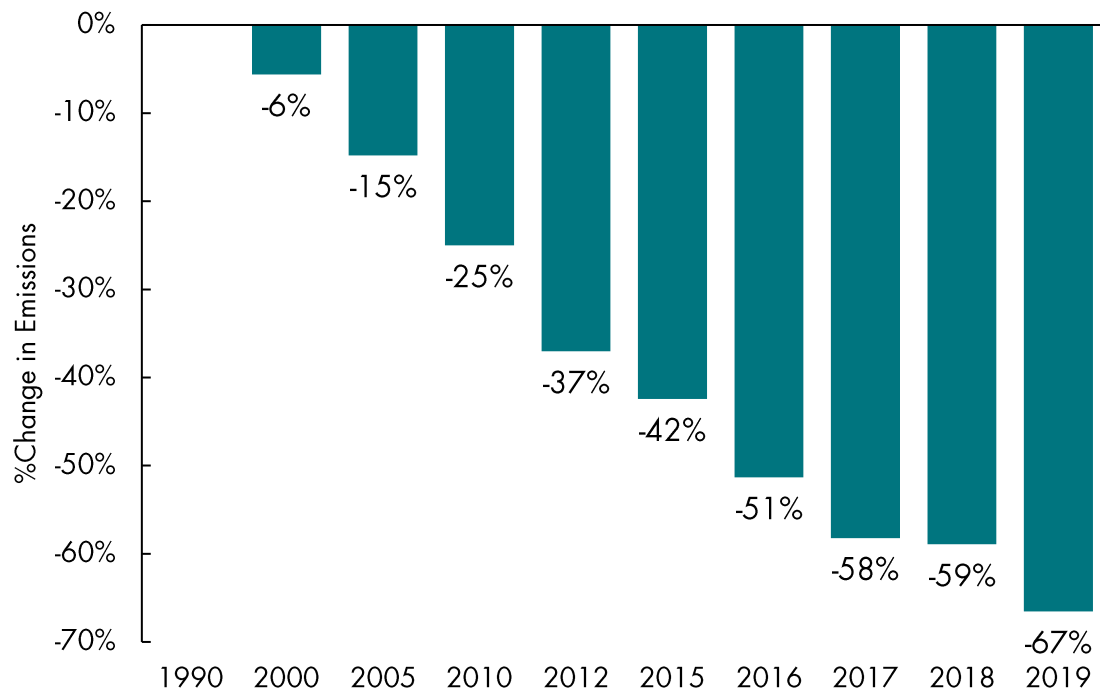


Figure 7. Commercial sector emissions changes compared to 1990 levels.

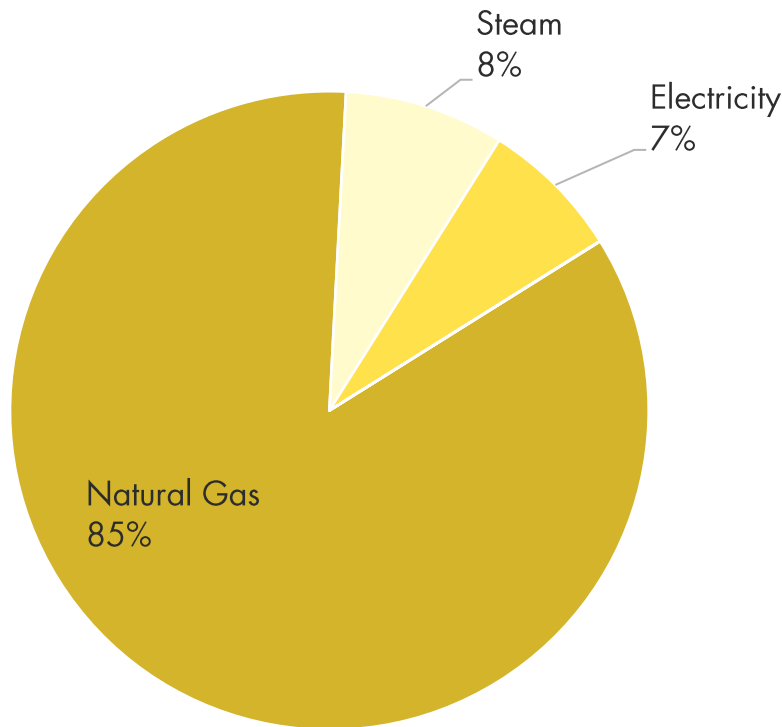


Figure 8. 2019 Commercial sector emissions by commodity.

TRANSPORTATION

In 2019, emissions in the Transportation sector totaled 2.20 million mtCO₂e, accounting for 47% of San Francisco's GHG emissions (Fig. 9). Emissions from the Transportation sector have declined 16% below 1990 levels mainly due to higher fuel efficiency standards and cleaner vehicle fuels mandated by the State of California (Fig. 10). Emissions from public transportation (e.g. MUNI, Commuter Ferries) have fallen as diesel consumption has been replaced by renewable diesel since 2016. Gasoline used by the Transportation sector was responsible for the largest share of emissions (72%), followed by diesel (21%), other fuels (6%), electricity (1%), and renewable diesel (<1%)¹¹ (Fig. 11). Broken down by vehicle type, privately-owned passenger vehicles¹² were responsible for 72% of emissions at 1.59 million mtCO₂e (Fig. 12)¹³. Maritime Ships and Boats accounted for 19% of emissions, and Off-Road Equipment accounted for 6% of emissions. Public Transportation accounted for the remaining 3% of emissions.

Transportation sector emissions decreased from 2.32 million to 2.20 million mtCO₂e (2% decrease) between inventory years 2018 and 2019. Car and truck VMTs – primarily generated by driving to work, school, etc. – is the largest contributor to emissions for the sector and declined 4%. Emissions from diesel for ships and boats also fell 2% with a drop in usage. Emissions from MUNI buses remained

¹¹ Includes trace amount of emissions from the CH₄ and N₂O portion of renewable diesel.

¹² Consists of private vehicles such as cars and light duty trucks.

¹³ Gasoline consumed makes up all of passenger vehicle emissions.

low as the fleet used no conventional diesel for the second year in a row, replaced by renewable diesel¹⁴ consumption.

Transportation Network Companies (TNCs), also referred to as ride-sharing companies, represent a growing source and share of transportation emissions in San Francisco with its specific impacts unknown due to a lack of data. The California Air Resources Board's 2018 emissions profile¹⁵ concluded that TNC vehicles produce nearly 50% more emissions per passenger mile than other automobiles. The San Francisco County Transportation Authority's analysis of TNCs in 2017 found that TNCs represent roughly 15%¹⁶ of all vehicle trips within the City. San Francisco recognizes that TNCs play a role in our transportation emissions and the City is working to incorporate their impacts into future emissions inventories.

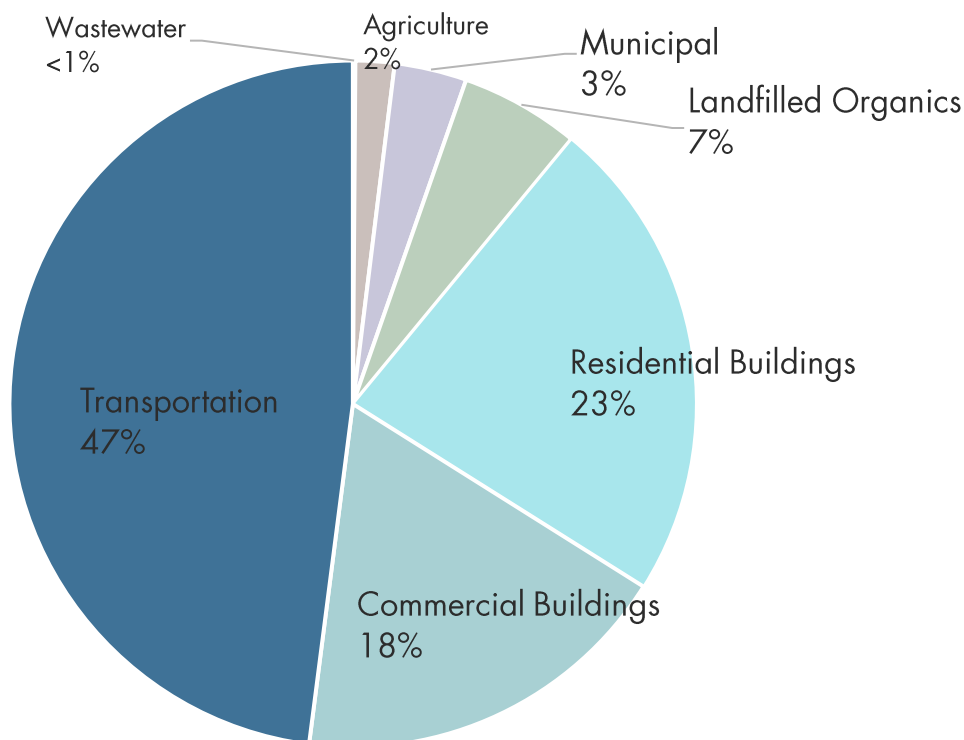


Figure 9. 2019 Transportation sector emissions.

¹⁴ Renewable diesel used in San Francisco comes from renewable resources such as tallow, used cooking oils, and ethanol byproducts.

¹⁵ California Air Resources Board, "2018 base year Emissions Inventory Report", December 2019, <https://ww2.arb.ca.gov/sites/default/files/2019->

¹⁶ San Francisco County Transportation Authority, "TNCs Today", June 2017, <https://www.sfcta.org/projects/tncs-today>

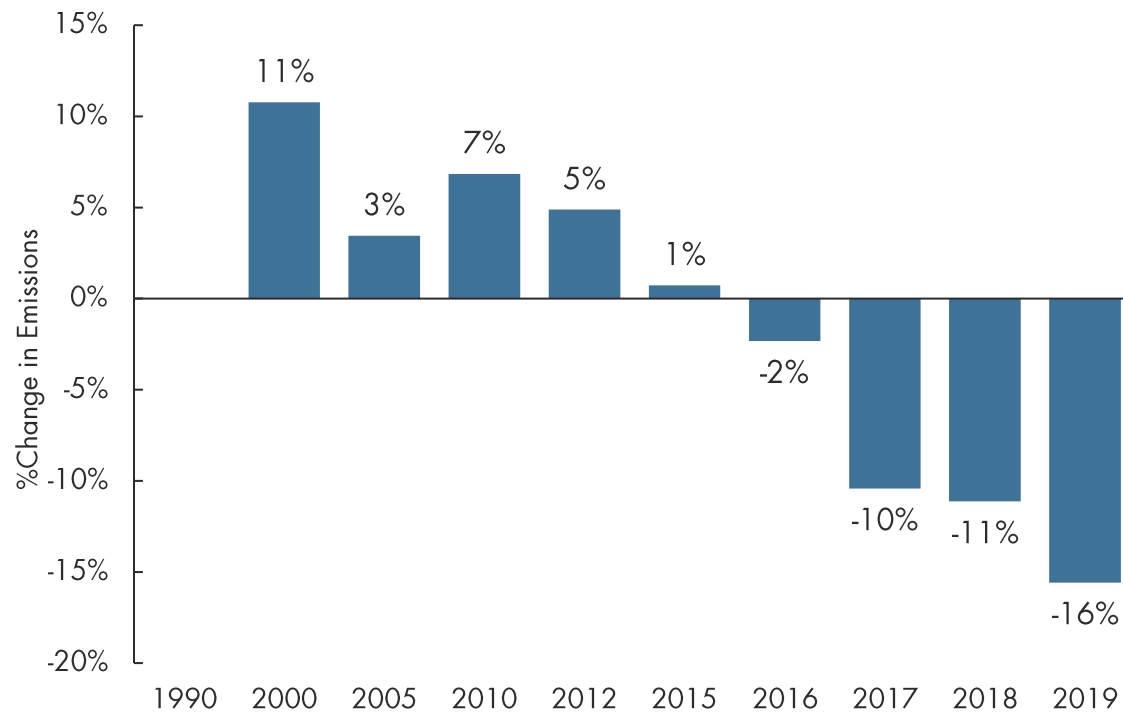


Figure 10. 2019 Transportation sector emissions changes compared to 1990 levels.

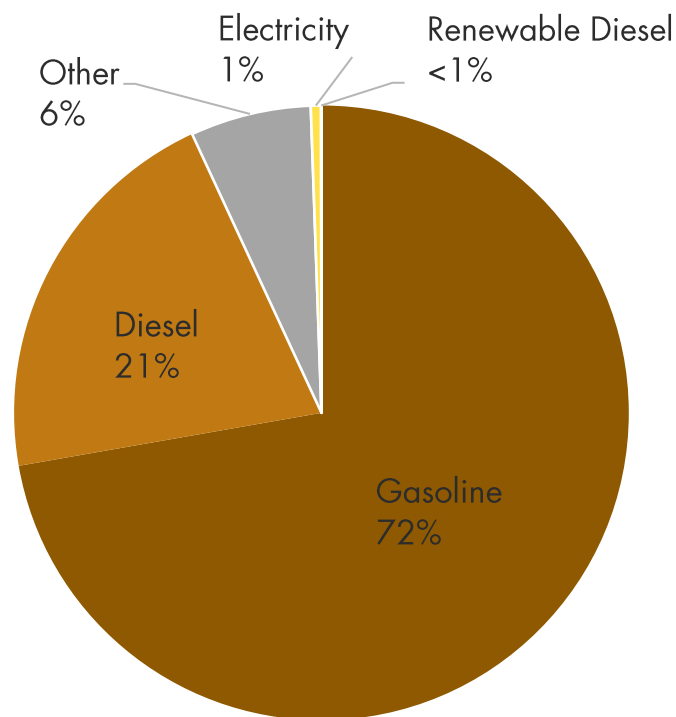


Figure 11. 2019 Transportation sector emissions by commodity.

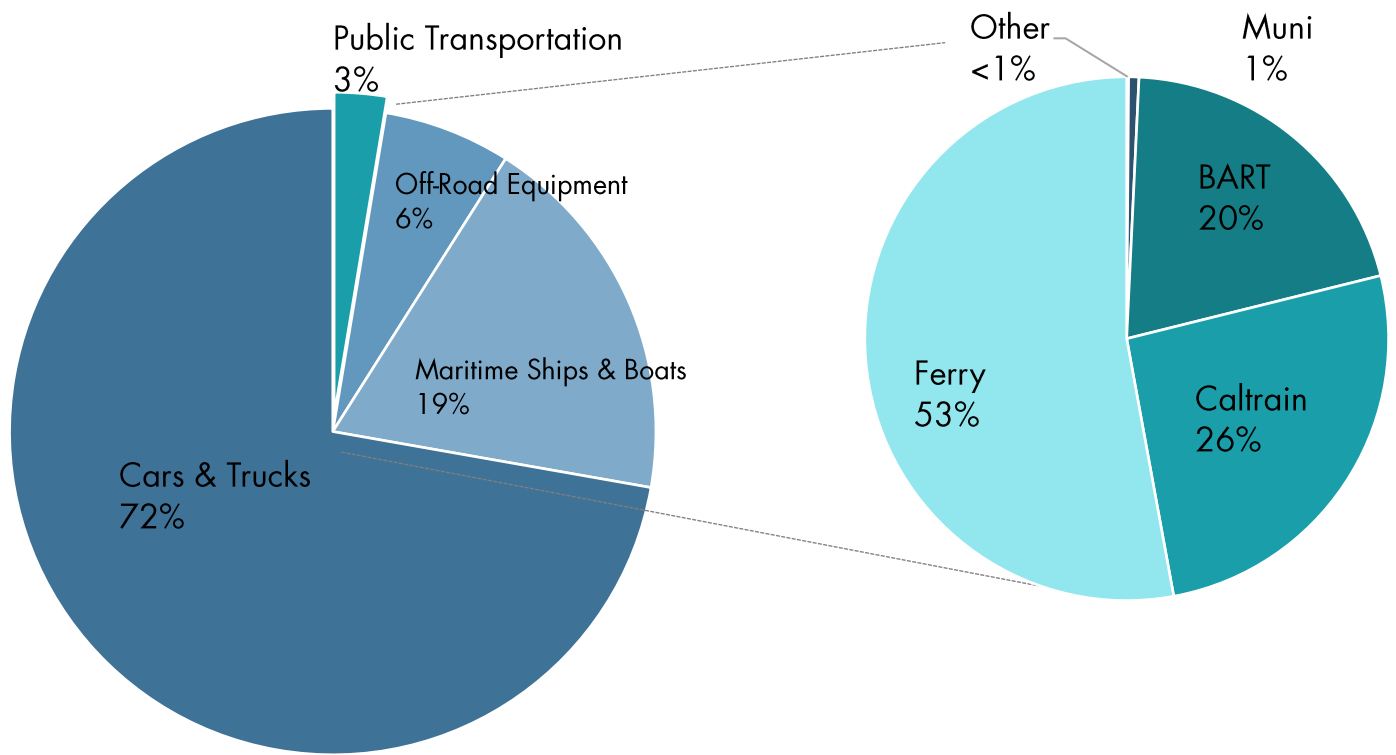


Figure 12. 2019 Transportation emissions by sub-sector.

LANDFILLED ORGANICS

In 2019, emissions from landfilled organics¹⁷ totaled 308,000 mtCO₂e, accounting for 7% of San Francisco's GHG emissions (Fig. 13). Organic materials sent to landfill decompose and release methane emissions to the atmosphere. Emissions from Landfilled Organics have declined 45% below 1990 levels due to improved resource recovery in the City (Fig. 14).

Emissions from Landfilled Organics fell 6% between inventory years 2018 and 2019. This change was due to a corresponding decline in the tonnage of organics sent to the landfill. This was a reversal of a rising emissions trend that began in 2012. Over the last decade, the city's economic and population growth had resulted in higher rates of organics disposed to landfill and driven a construction and demolition¹⁸ boom, resulting in an increase in discarded organic and inorganic material sent to landfill. Emissions from landfilled organics disposal per capita have decreased 46% from 1990 levels, from 65 to 29 mtCO₂e per person in 2019.

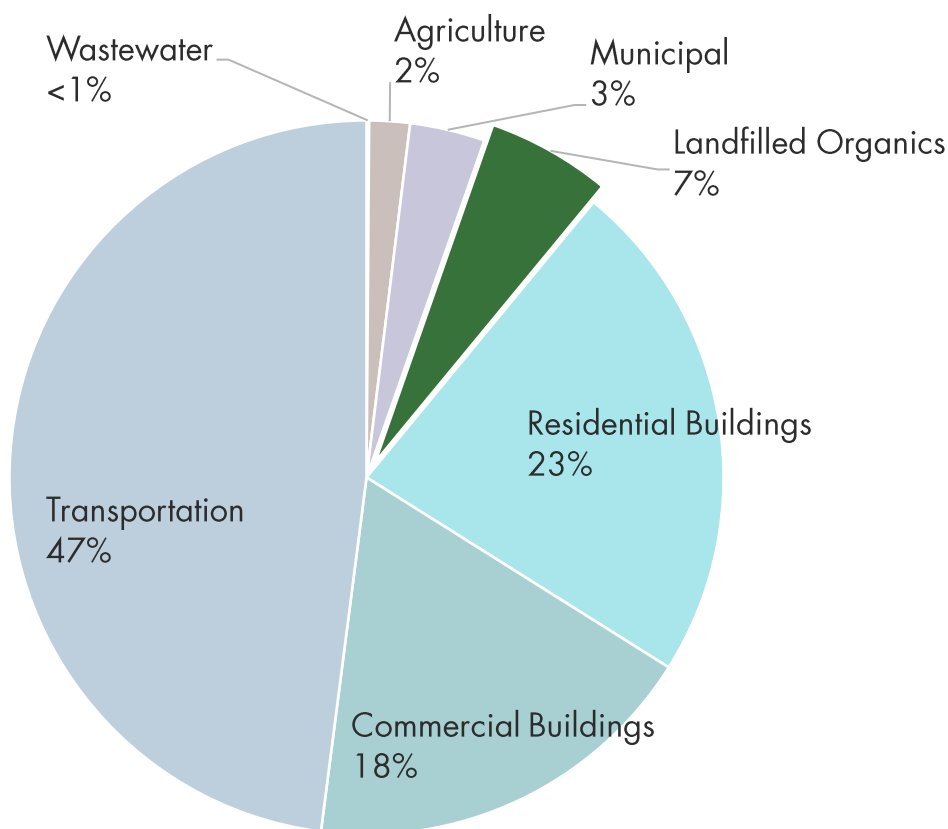


Figure 13. 2019 Landfilled Organics emissions.

¹⁷ Referred to as the Waste sector in previous inventory years.

¹⁸ Construction and Demolition is a mixture of inorganic materials such as concrete, metals and glass as well as organic materials such as wood and cardboard. Organic materials decompose in landfills and release methane.

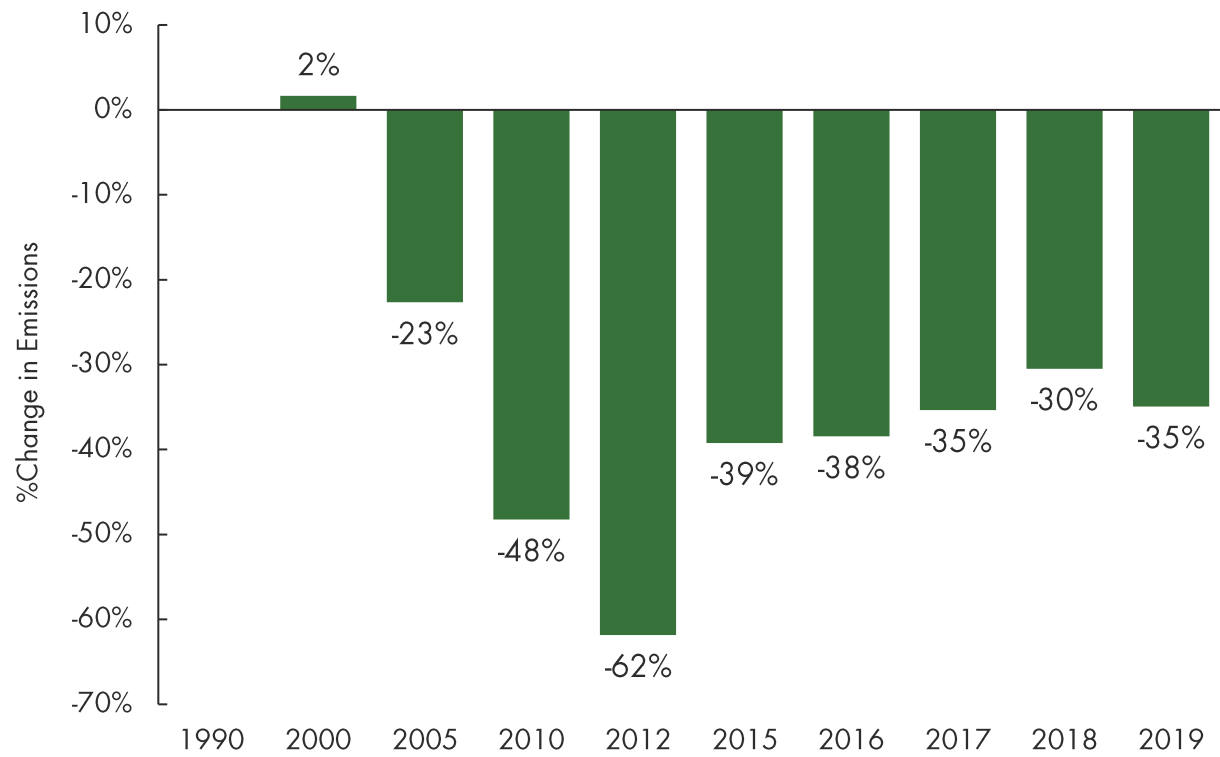


Figure 14. Landfilled Organics emissions changes compared to 1990 levels.

MUNICIPAL

In 2019, emissions from the Municipal sector totaled 156,000 mtCO₂e, accounting for 3% of San Francisco's total emissions (Fig. 15). Emissions in the Municipal sector¹⁹ were generated from city-owned buildings (86%) and the City's fleet of non-revenue vehicles²⁰ (14%). Municipal sector emissions declined 31% below 1990 levels. The steepest decline occurred between 2010 and 2012 when all city-owned buildings began to fully source 100% GHG-free electricity²¹ generated from San Francisco Public Utilities Commission's Hetch-Hetchy hydroelectric dam (Fig. 16). As a result, natural gas consumption makes up nearly 100% of the emissions in Municipal buildings (Fig. 17).

Municipal building emissions are driven by natural gas use. Municipal building emissions rose by 0.5% from 133,000 mtCO₂e to 134,000 between inventory years 2018 and 2019 but have fallen by 31% since 1990. Municipal energy efficiency projects, programs, and energy code improvements helped reduce emissions. The City continues to improve its efforts to make municipal buildings more efficient with 67 LEED buildings, totaling 9.37 million square feet, certified from 2004 to 2018.

Municipal fleet emissions fell by 7% between inventory years 2018 and 2019. This was driven by a drop in gasoline consumption, which made up 91% of total non-revenue fleet emissions (Fig. 18). Emissions from diesel use have continued to decline with the rollout of renewable diesel which began in fiscal year 2016. Specifically, diesel consumption in 2019 was a tenth of what it was in 1990, contributing to a 36% drop in fleet emissions compared to 1990 levels. Moving forward, the City will push further city fleet emissions reductions with continued efforts to transition diesel vehicles to renewable diesel, the City Fleet Zero Emissions Vehicles Ordinance, and the EV Readiness Ordinance to target emissions from gasoline consumption. A more detailed analysis of Municipal emissions can be found in the latest SF Municipal Progress Report on Climate and Sustainability²².

¹⁹ The majority of energy data for the municipal sector is obtained directly from PG&E.

²⁰ Since 2009, city-owned fleet emissions were categorized and tracked within the Municipal sector. Non-revenue vehicles are all operations vehicles that do not generate revenue, specifically, all vehicles excluding MUNI bus and light rail vehicles that collect fares from riders.

²¹ City-owned buildings have been sourcing hydropower since the 1970's with very little generation coming from carbon-intense sources. Starting in fiscal year 2011, the SFPUC began providing power content labels to the CPUC in which all hydropower since has been verified 100% GHG-free electric power.

²² https://sfenvironment.org/sites/default/files/fliers/files/sfe_municipal_progress_report_19.pdf

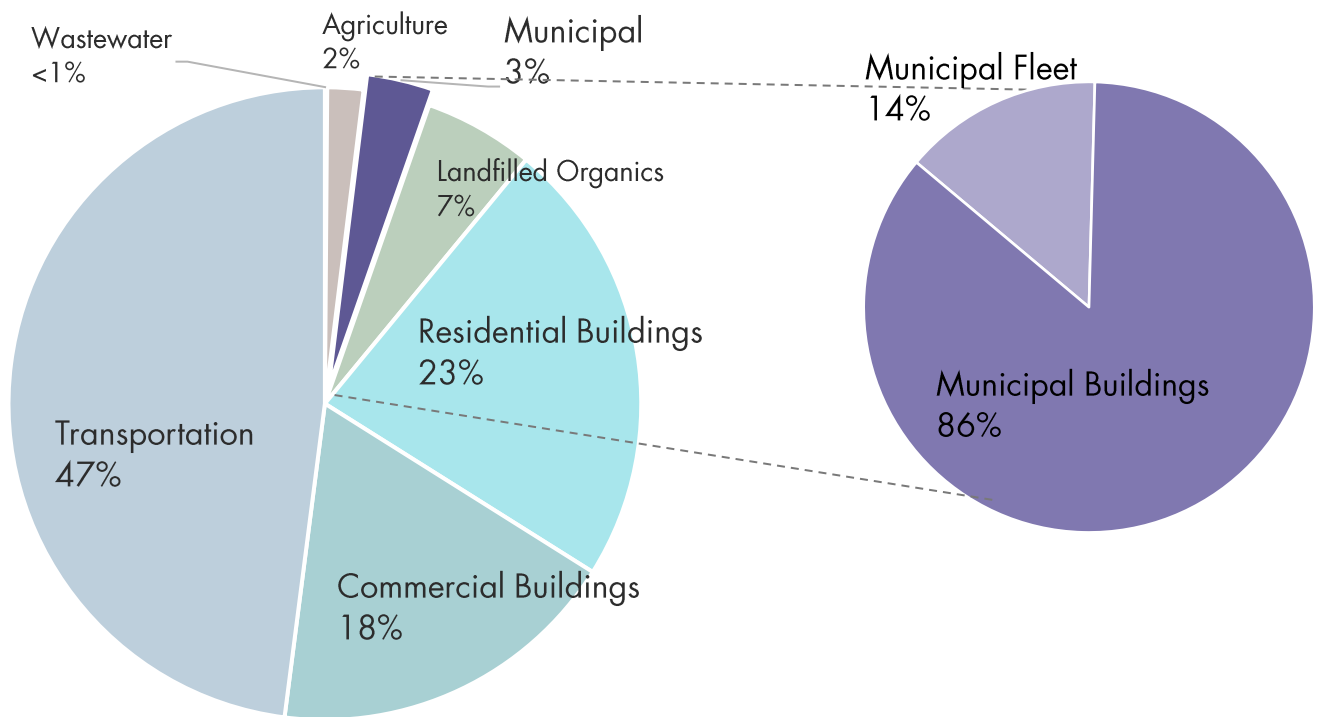


Figure 15. 2019 Municipal sector emissions.

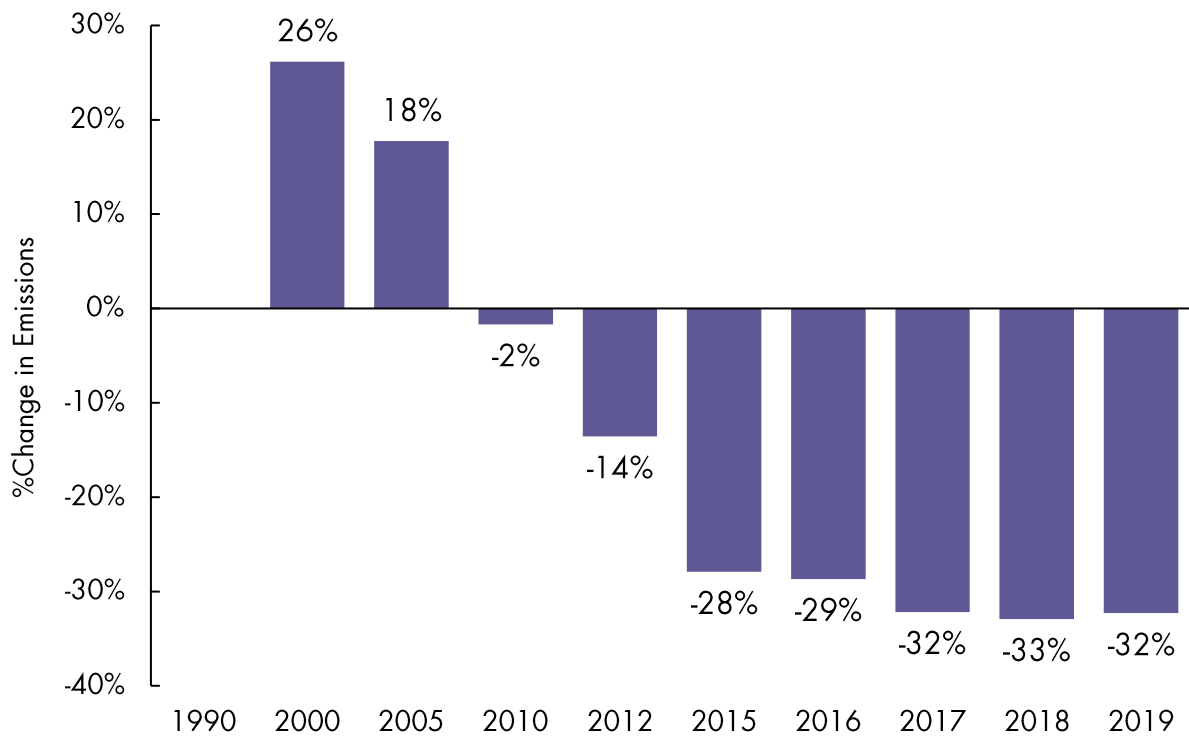


Figure 16. Municipal sector emissions changes compared to 1990 levels.

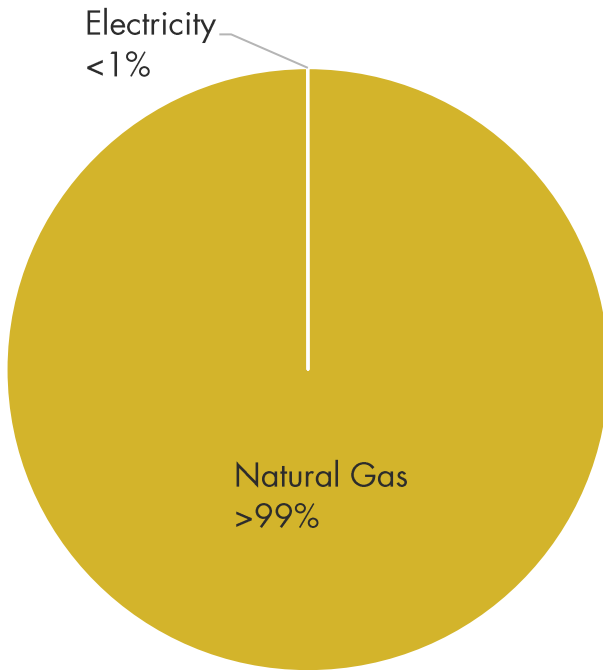


Figure 17. 2019 Municipal buildings emissions share by commodity.

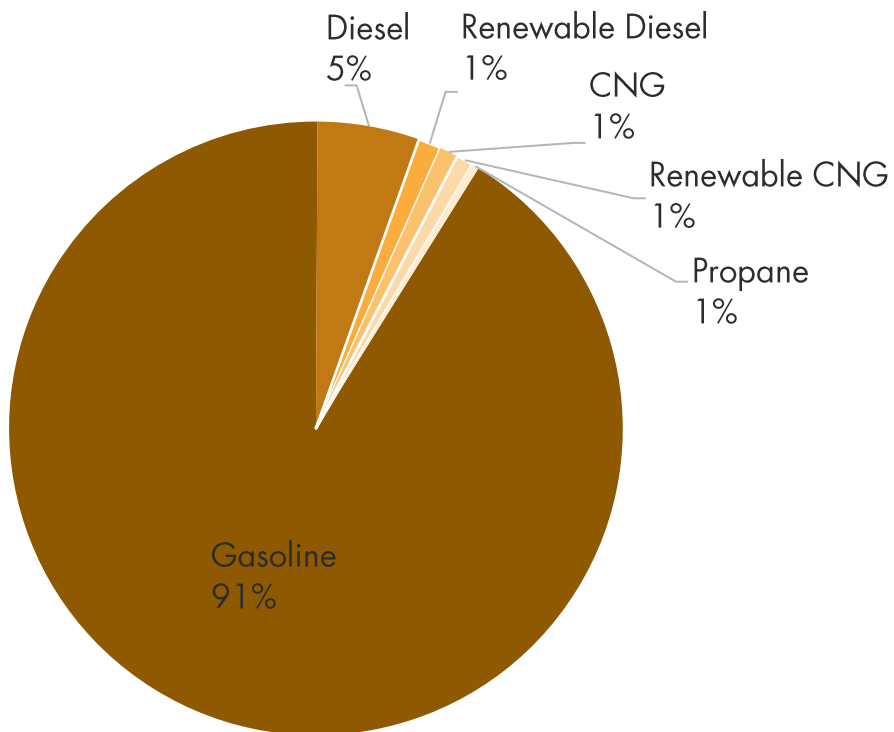


Figure 18. 2019 Municipal non-revenue fleet emissions share by commodity.

AGRICULTURE

In 2019, emissions in the Agriculture sector totaled 84,000 mtCO₂e, accounting for 2% of San Francisco's GHG emissions (Fig. 19). Emissions from the Agriculture sector have increased 9% from 1990 levels (Fig. 20) and are generated mostly from animal waste with the remaining share from managing urban soils.²³

Emissions from the Agriculture sector were little changed between inventory years 2018 and 2019, rising 350 mtCO₂e (<1%) year-over-year. This sector represents a small fraction of San Francisco's emissions and is not a major driver of emissions trends. As such, no further analysis was conducted on the trends impacting this sector at this time.

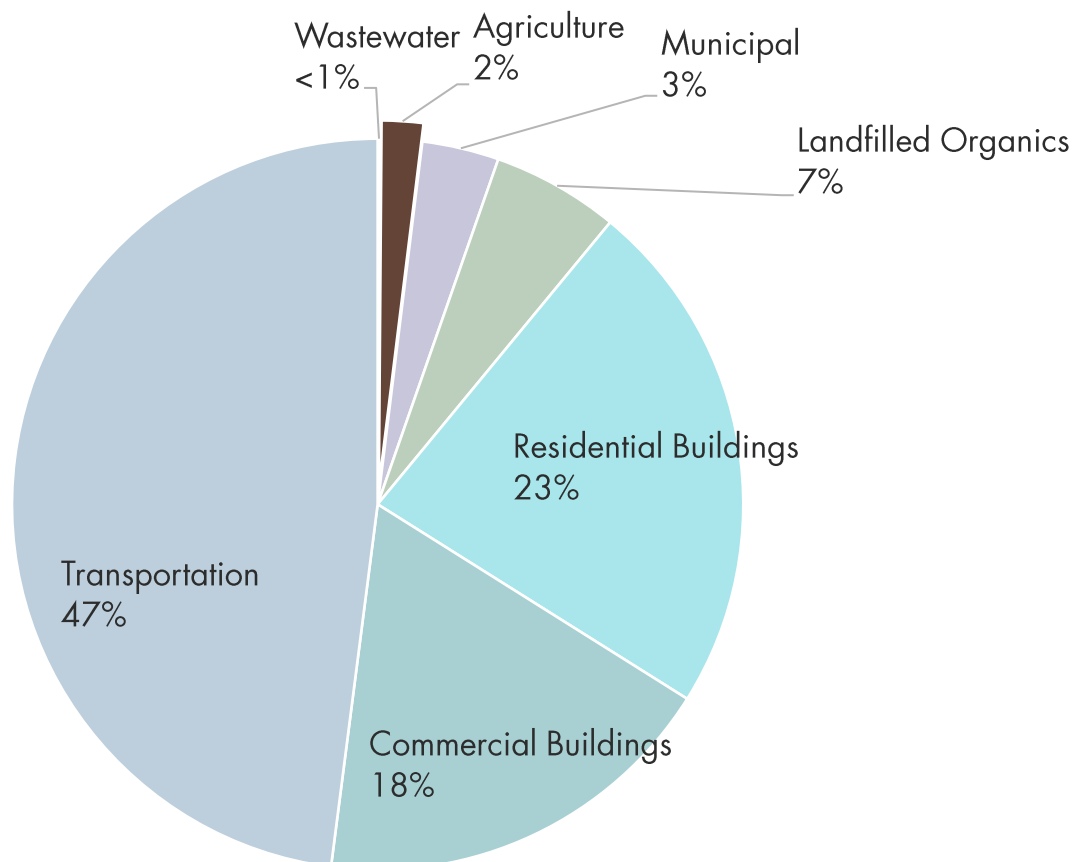


Figure 19. 2019 Agriculture sector emissions.

²³ Emissions in the agricultural sector are allocated to the city proportionally from BAAQMD's regional inventory.

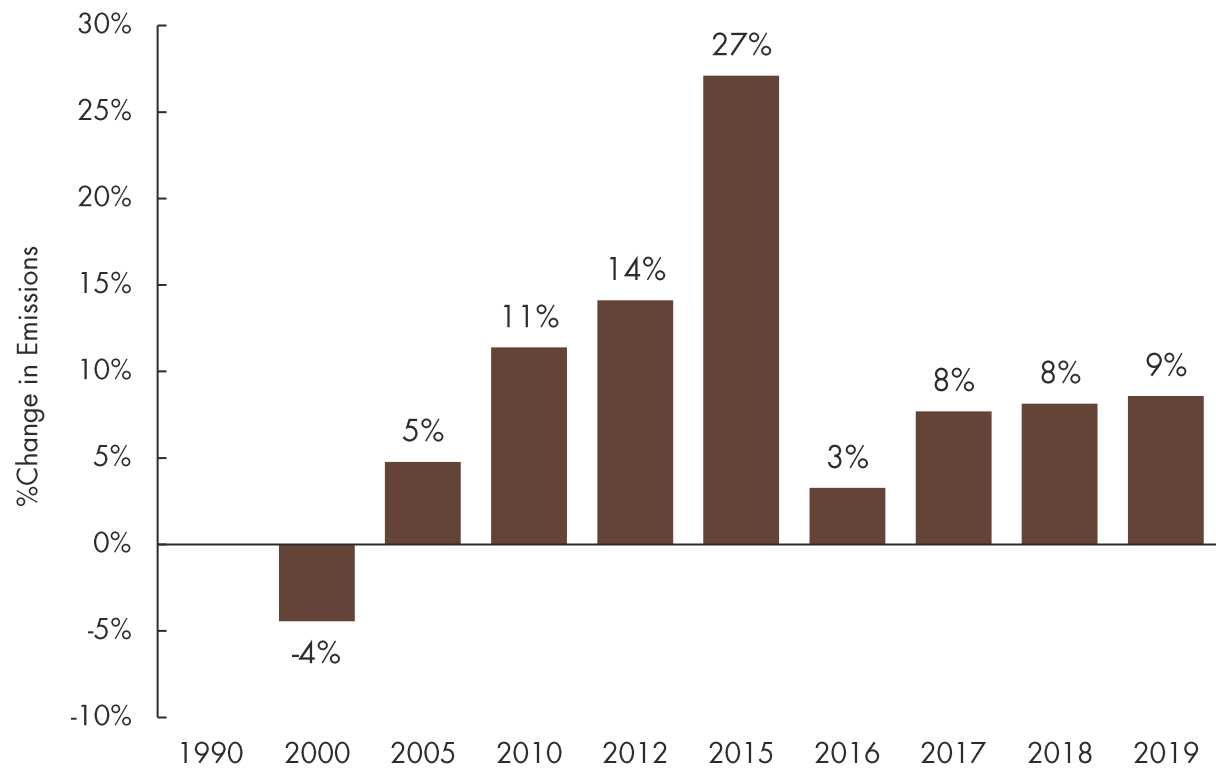


Figure 20. 2019 Agriculture sector emissions changes compared to 1990 levels.

WASTEWATER

In 2019, emissions in the Wastewater sector totaled 5,400 mtCO₂e, accounting for just one tenth of a percent of San Francisco's GHG emissions (Fig. 21). Emissions from the Wastewater sector have increased 26% from 1990 levels mainly due to a 22% increase in population, which increases the volume of wastewater treated at the City's water pollution control plants (Fig. 22).

Wastewater sector emissions occur mainly from fugitive emissions, or emissions that are released as effluent is discharged to a body of water. The remaining emissions occur from the energy used in treating wastewater, other processes associated with the treatment, and gases released during the digestion stage. Fugitive nitrogen emissions were responsible for the largest share of wastewater emissions (81%) followed by process nitrogen emissions (17%) and reuse of captured digester gas to power the treatment plant (2%).

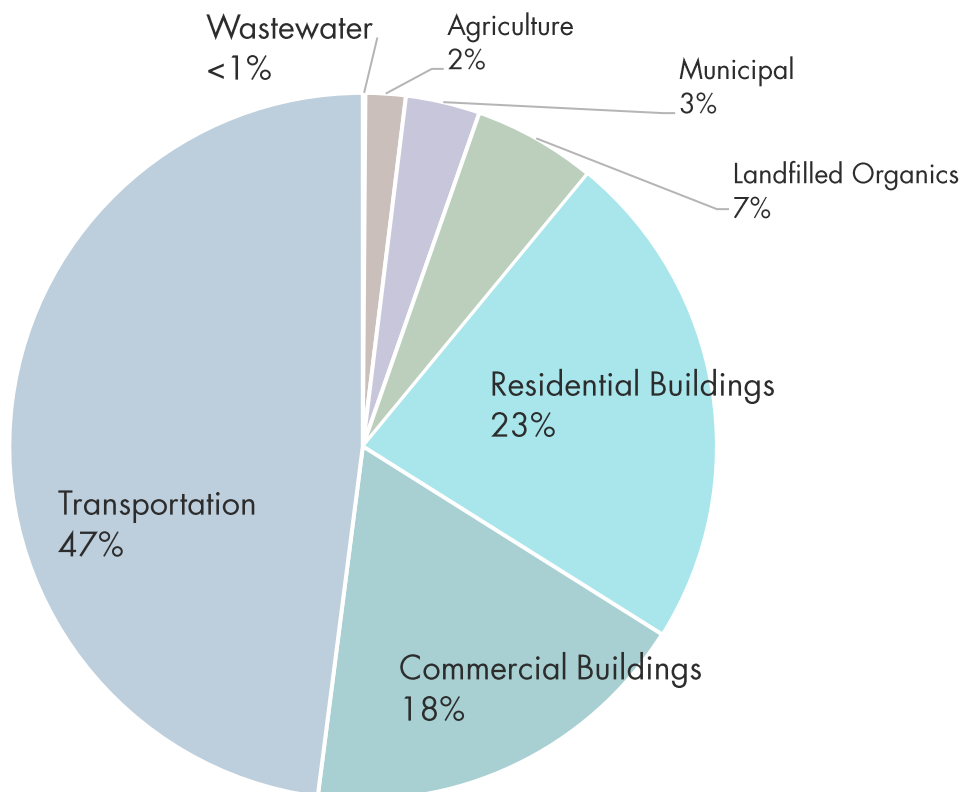


Figure 21. 2018 Wastewater sector emissions.

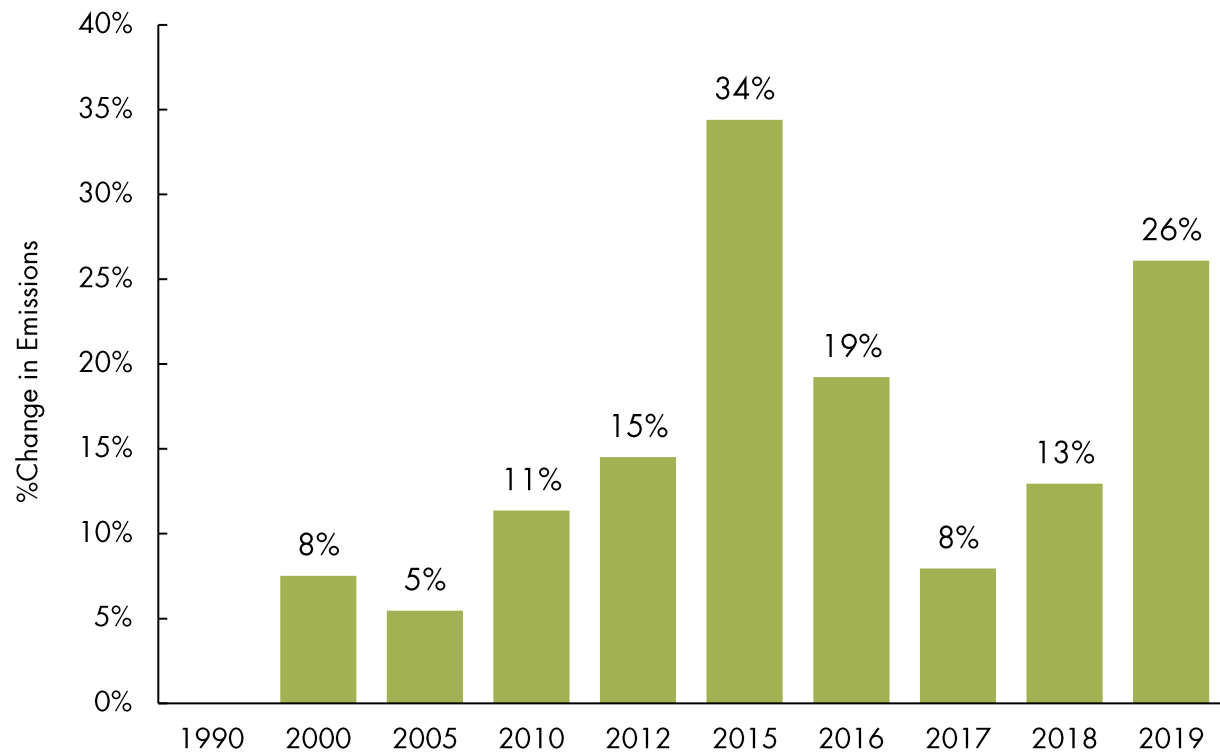


Figure 22. Wastewater sector emissions changes compared to 1990 levels.