2018 SAN FRANCISCO GEOGRAPHIC GREENHOUSE GAS EMISSIONS INVENTORY AT A GLANCE

By San Francisco Department of Environment, Climate Program

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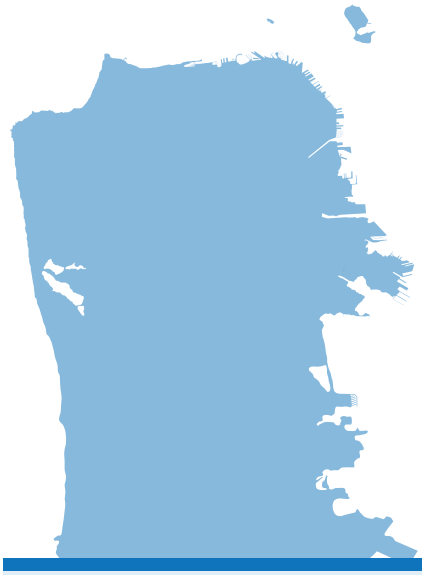
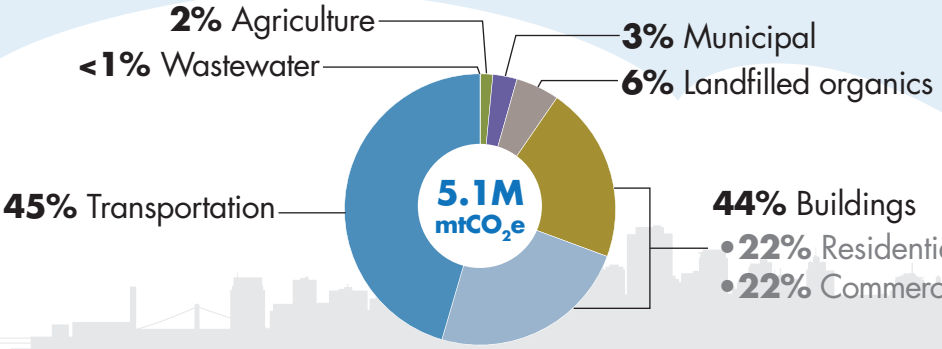
1990-2018 San Francisco trends



Emissions	GDP	Population
-35%	172%	22%
2018 total **5.1 million mtCO2e**	2018 total **$163 billion**	2018 total **883,305 people**
≈ weight of **14** Golden Gate Bridges	≈ stack of $100 bills the height of **684** Transamerica Buildings	≈ the population of **Fiji**

2018 San Francisco emissions by sector



Reductions from 1990 levels:

Transportation	Municipal	Landfilled Organics	Buildings
-11%	-31%	-30%	-51%

San Francisco per capita emissions

EMISSIONS OVERVIEW

EMISSIONS TRENDS

In 2018, San Francisco's community-wide greenhouse gas (GHG) emissions, totaled 5.14 million $mtCO_2e$ (Fig.1). The seven sectors tracked in the 2018 inventory include:

- The **Residential Buildings** sector, which accounted for 22% of the city's carbon footprint, with 88% of its emissions from the use of natural gas, 10% from electricity, and 2% from other fuels (Fig. 2).
- The **Commercial Buildings** sector, which accounted for 22% of the city's carbon footprint, with 76% of its emissions from the use of natural gas, 18% from electricity, and 6% from steam.
- The **Transportation** sector, which accounted for 45% of the city's carbon footprint, with 72% from passenger vehicles, 18% from Maritime Ships and Boats[1] (non-ferry), 6% from off-road equipment, and 4% from public transportation[2].
- The **Landfilled Organics** sector, which accounted for 6% of the city's carbon footprint[3].
- The **Municipal** sector, including facilities and fleet, which accounted for 3% of the city's carbon footprint, with nearly all emissions from natural gas and vehicle fuel use.
- The **Agriculture** sector, which accounted for just over 1% of the city's carbon footprint[4].
- The **Wastewater** sector, which accounted for less than 1% of the city's carbon footprint.[4]

In 2018, San Francisco successfully reduced emissions 35% below 1990 levels to 5.14 million $mtCO_2e$ (Fig. 1). Declines occurred across the top five of the seven sectors tracked.

- The Residential sector declined 43%
- The Commercial sector declined 55%
- The Transportation sector declined 11%
- The Landfilled Organics sector declined 30%
- The Municipal sector declined 31%
- The Agriculture sector increased 8%
- The Wastewater sector increased 13%

Emission reductions were achieved even though San Francisco's population increased 22% and the economy grew 172% during the same time period. In 2018, San Francisco's emissions per capita were 5.82 $mtCO_2e$ compared to 10.99 $mtCO_2e$ in 1990, a 47% decline.

[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] In alignment with the GPC Framework, San Francisco added the Agriculture and Wastewater sectors to its reporting in inventory year 2016.

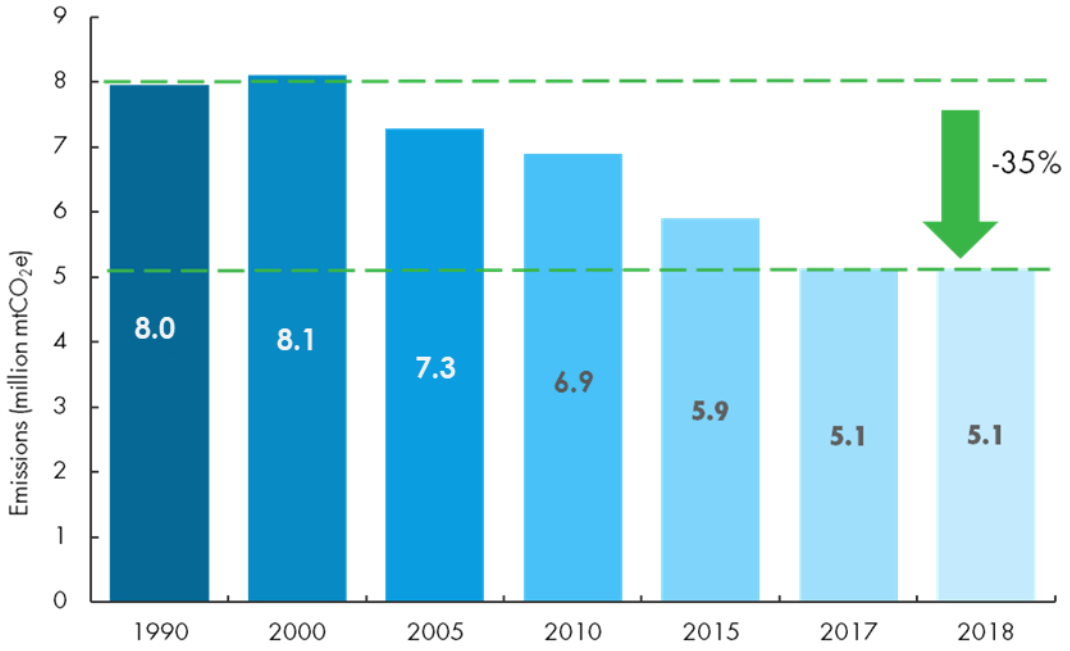


Figure 1. San Francisco's GHG emissions from inventory year 1990 to 2018.

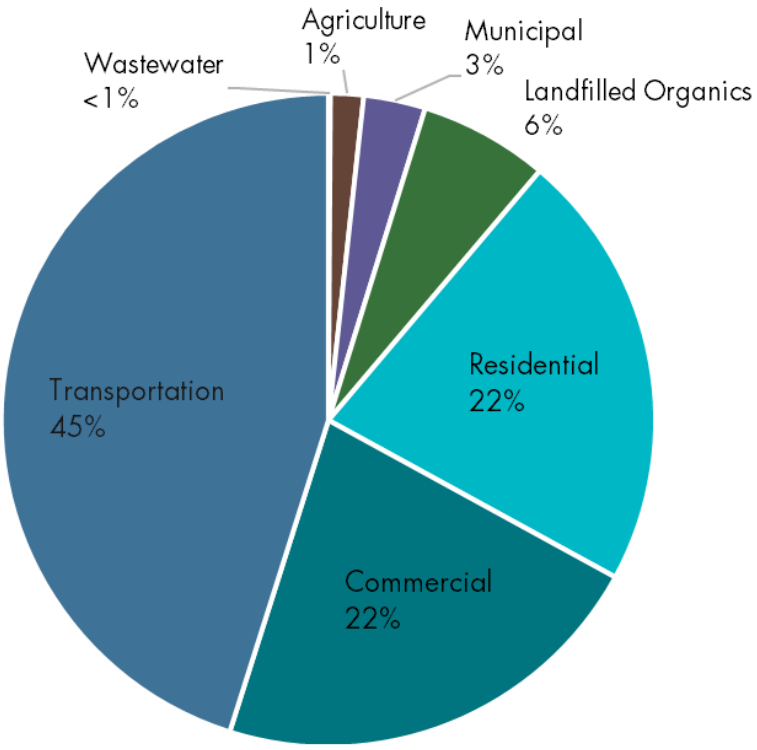


Figure 2. 2018 emissions by sector.

EMISSIONS REDUCTION DRIVERS

Reductions in emissions can be attributed to a variety of factors, including the implementation of innovative technologies, policies, and programs, as well as changes in the weather. The main drivers of the emission reductions observed between 1990 to 2018 were:

- **The electric grid has become cleaner for all of San Francisco** in the last few years. City-owned buildings use 100% GHG-free electricity, and the private sector to receives a continually cleaner[5] power mix. CleanPowerSF and PG&E supplied San Francisco's electric grid with 69% renewables, growing 8% from the previous year. Since 2016, **CleanPowerSF,** San Francisco's Community Choice Aggregation program, has increased its renewables portfolio and expanded its customer base while reinvesting ratepayer funds locally in new renewable energy facilities. In 2018, the program reached 39% more customers than the year before, and in 2020 nearly all San Francisco residents will have access to power from CleanPowerSF.
- **A scale-up in energy efficiency programs** helped stem demand for electricity and natural gas. During 2018, San Francisco's Energy Watch program saved 417 San Francisco commercial and multifamily properties a total of 5.5 million kWh, which is an average of $1,990 in annual utility costs per property. It also reduced total GHG emissions by 1,057 $mtCO_2e$ tons, an equivalent to removing 226 passenger vehicles from the road.
- **Progressive green building codes** ensured new construction was built to the highest standards for energy, water, and other key environmental performance metrics. Local green building code requirements contributed 122 million square feet of LEED certified space between 2004 and 2017 in commercial buildings. In addition, the City had 56 city-owned buildings and interiors LEED certified between 2004 and 2017, totaling 7.65 million square feet.
- **Cleaner fuels helped decouple transportation emissions from growth.** Between 1990 and 2018 commuting into and out of the city increased along with a booming economy. Even with an additional 533.8 million vehicle miles traveled (VMT) added to San Francisco roads between 1990 and 2018,

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. 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.

[5]California'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.

vehicle emissions from cars and trucks declined 18.5%, primarily due to State efforts to reduce the carbon intensity[6] of vehicle fuels.

- By **switching to renewable diesel[7]**, the city reduced emissions from SF MUNI buses and municipal fleet vehicles by 49% between 2016 and 2018 while fuel use for these vehicles remained constant. Commuter ferries also began the switch to renewable diesel in 2017, further reducing carbon emissions in the Transportation sector. Transportation emissions reductions will continue in the coming years as more on road vehicles and ferries switch to renewable diesel.

[6] Carbon intensity is the amount of carbon per unit of energy used.

[7] Renewable Diesel is made up of nonpetroleum renewable resources derived from agricultural waste products.

SECTOR SUMMARY

San Francisco inventories are completed in accordance with the ICLEI[8] 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. The 2018 inventory was completed according to the guidance of the verifiers. In 2015, the City began reporting its emissions to C40[9] to improve its GHG emissions inventory by using a newer protocol to estimate emissions referred to as the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC). GPC is a global framework that standardizes the inventory process for cities worldwide. The next section of this report provides an in-depth analysis of 2018 emissions trends since 1990 in the Residential Buildings, Commercial Buildings, Transportation, Landfilled Organics, Municipal, Agriculture, and Wastewater sectors.

RESIDENTIAL BUILDINGS

In 2018, emissions from the Residential sector totaled 1.12 million mtCO_2e accounting for 22% of San Francisco's GHG emissions (Fig. 3). Emissions from the Residential sector have declined 43% below 1990 levels mainly due to a combination of a cleaner electrical grid, improved energy codes, and continual implementation of city-wide energy efficiency programs (Fig. 5). Residential sector emissions come from natural gas combustion to heat household spaces, provide hot water and cook as well as the fossil fuel-based electricity provided by utilities used to power electric appliances. Emissions from the Residential sector are mainly generated from natural gas use (88%) followed by electricity (10%) and other fuels (2%). Emissions from electricity are much lower than those from natural gas because of San Francisco's push to increase its renewable electricity portfolio (Fig. 4).

Between inventory year 2017 and 2018 Residential sector emissions increased by 1%. This increase could be due to the colder year San Francisco experienced resulting in increased indoor heating use. With continued improvements in building efficiency, expanded enrollment of customers in CleanPowerSF, Residential sector emissions should continue to trend downward over time. Additionally, aggressively moving to transition away from natural gas use in new and existing buildings will drive emissions down significantly.

[8] International Council for Local Environmental Initiatives

[9] C40 is a network of the world's largest cities committed to addressing climate change in a collaborative, measurable, and meaningful way. https://www.c40.org/

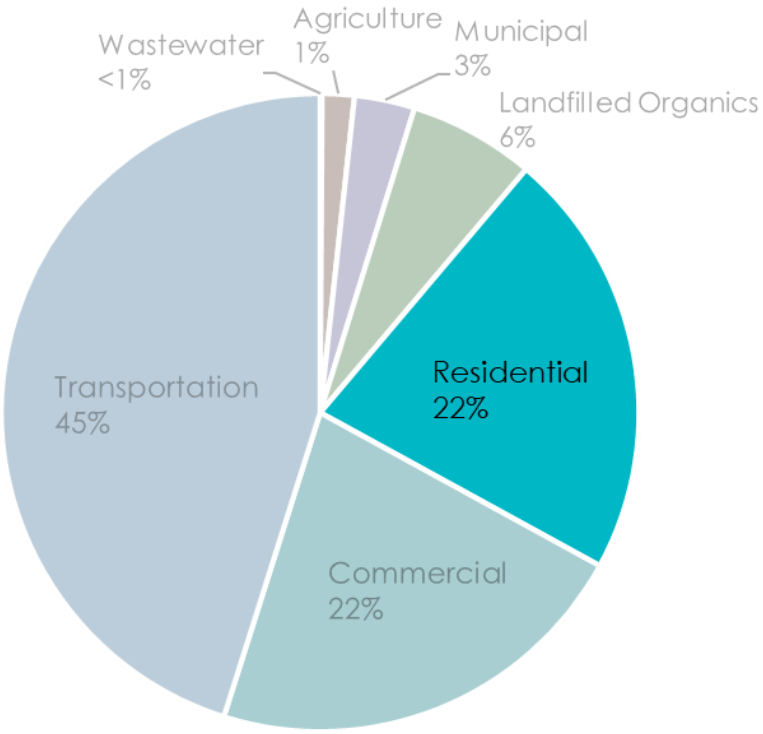


Figure 3. 2018 Residential sector emissions.

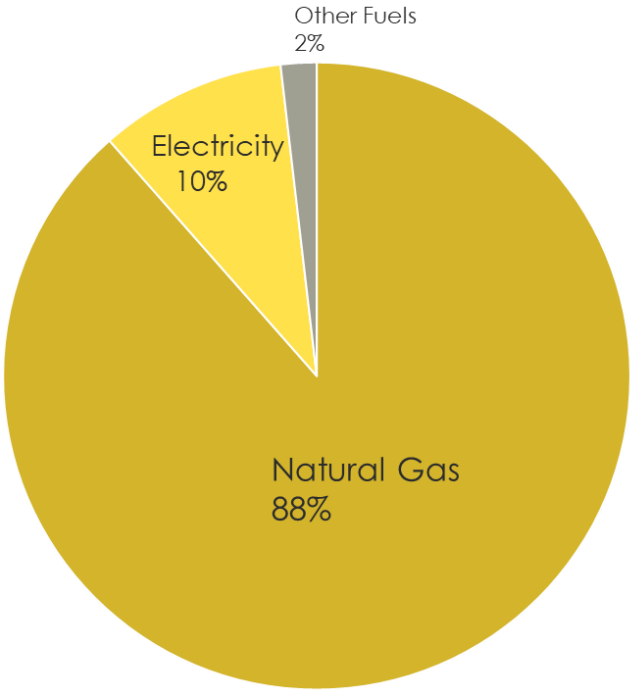


Figure 4. 2018 Residential sector emissions by commodity.

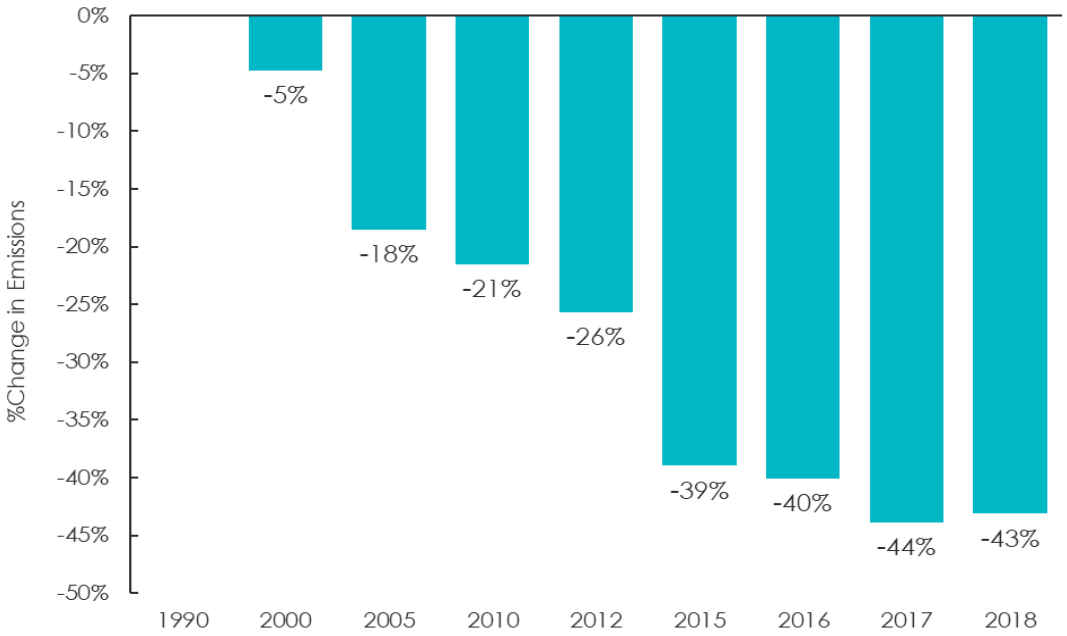


Figure 5. Residential sector emissions changes compared to 1990 levels.

COMMERCIAL BUILDINGS

In 2018, emissions from the Commercial[10] sector (including commercial and industrial, direct access, district, and steam loop customers[11]) totaled 1.13 million $mtCO_2e$ accounting for 22% of San Francisco's GHG emissions (Fig. 6). Emissions from the Commercial sector declined 55% below 1990 levels. Similar to the Residential sector, the decrease in emissions was mainly due to a combination of a cleaner electrical grid, improved energy codes, and the continual implementation of city-wide energy efficiency programs. Furthermore, the completion of the downtown district steam loop contributed to more efficient building operations and thus lowered emissions (Fig. 7). Commercial sector natural gas use was responsible for the largest share of emissions (76%) compared to electricity (18%) and steam (6%) (Fig. 8).

Emissions between 2017 and 2018 stagnated around 1.13 million $mtCO_2e$ (0.8% decrease) (Fig. 7). With continued improvements in building efficiency and enrollment of customers in CleanPowerSF, emissions in the Commercial sector should continue to trend downward over time. However, despite San Francisco's electric grid including more renewable

[10] 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.
[11] 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.

power, increased natural gas use in Commercial buildings prevents larger emissions reductions from taking root. As with the Residential sector, aggressively moving to transition away from natural gas use in new and existing buildings will drive down emissions.

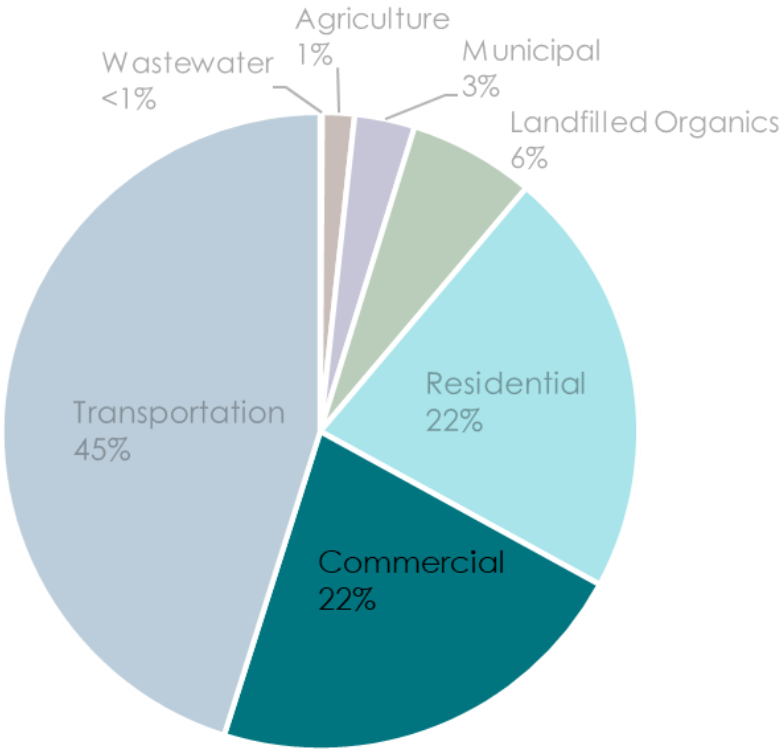


Figure 6. 2018 Commercial sector emissions.

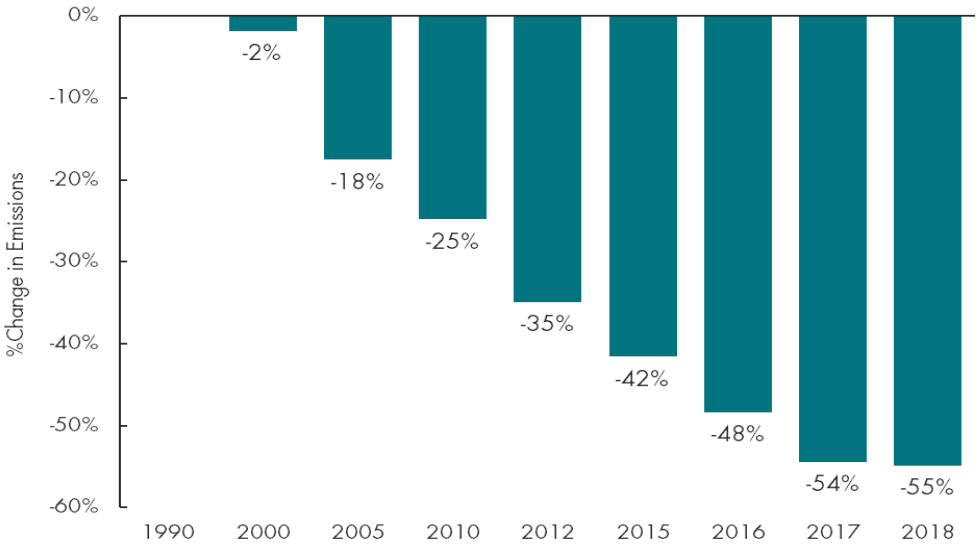


Figure 7. Commercial sector emissions changes compared to 1990 levels.

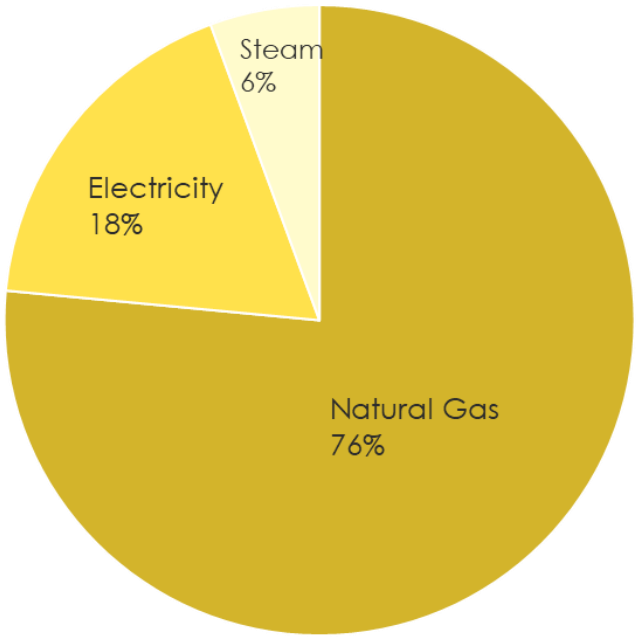


Figure 8. 2018 Commercial sector emissions by commodity.

TRANSPORTATION

In 2018, emissions in the Transportation sector totaled 2.32 million $mtCO_2e$, accounting for 45% of San Francisco's GHG emissions (Fig. 9). Emissions from the Transportation sector have declined 11% below 1990 levels mainly due to higher fuel efficiency standards and cleaner vehicle fuels mandated by the State of California (Fig. 10). Gasoline used by the Transportation sector makes up the largest share of emissions (72%) compared to diesel (20%), other fuels (6%), electricity (2%), and renewable diesel (<1%)[12] (Fig. 11). Passenger vehicles[13] were responsible for 72%[14] of Transportation sector emissions totaling 1.66 million $mtCO_2e$ (Fig. 12). Maritime Ships and Boats accounted for 18% of emissions (421 thousand $mtCO_2e$), while Off-road Equipment accounted for 6% of emissions (143 thousand mtCO2e). Public Transportation made up the remaining 4% (93.5 thousand $mtCO_2e$). San Francisco's public transit fleet realized significant emissions reductions from MUNI buses switching to renewable diesel and light rail services using 100% GHG-free electricity. From 2017 to 2018, all MUNI buses switched to renewable diesel while commuter ferries continued to make this fuel switch. As a result, renewable diesel usage increased by 62% leading to a sharp decline in diesel usage.

Transportation sector emissions decreased from 2.34 to 2.32 million $mtCO_2e$ (8% decrease) between inventory year 2017 and 2018 despite increases in population,

[12] Includes trace amount of emissions from the CH_4 and N_2O portion of renewable diesel.

[13] Consists of private vehicles such as cars and light duty trucks.

[14] Gasoline consumed makes up all of passenger vehicle emissions.

economic growth, and the number of passenger vehicle miles traveled (VMT). The slight decrease in emissions can be attributed to a variety of factors. The state succeeded in reducing vehicle fuel carbon intensity with vehicle emissions declining 0.3%, while passenger and commercial VMT into and out of the city increased 2% in 2018. Furthermore, public transportation ridership increased from 2017 to 2018, indicating that people are choosing more sustainable modes of transportation to get to and throughout the city. By switching to electricity and renewable diesel[15], MUNI bus emissions have declined 37% between 2017 and 2018, down to a total of 470 $mtCO_2e$. Because ferries are switching diesel for renewable diesel, their emissions will also continue to decline.

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 profile[16] concluded that TNC vehicles produce nearly 50% more emissions per passenger mile than other automobiles, and the SF County Transportation Authority's analysis of TNCs in 2017 found that TNCs represent roughly 15%[17] of all vehicle trips within the city. San Francisco recognizes that TNCs play a role in our transportation emissions and is working to incorporate their impacts into future emissions inventories.

[15] Renewable diesel used in San Francisco comes from renewable resources such as tallow, used cooking oils, and ethanol byproducts.
[16] California Air Resourced Board, "2018 base year Emissions Inventory Report", December 2019, https://ww2.arb.ca.gov/sites/default/files/2019-12/SB%201014%20-%20Base%20year%20Emissions%20Inventory_December_2019.pdf?utm_medium=email&utm_source=govdelivery
[17] San Francisco County Transportation Authority, "TNCs Today", June 2017, https://www.sfcta.org/sites/default/files/2019-02/TNCs_Today_112917_0.pdf

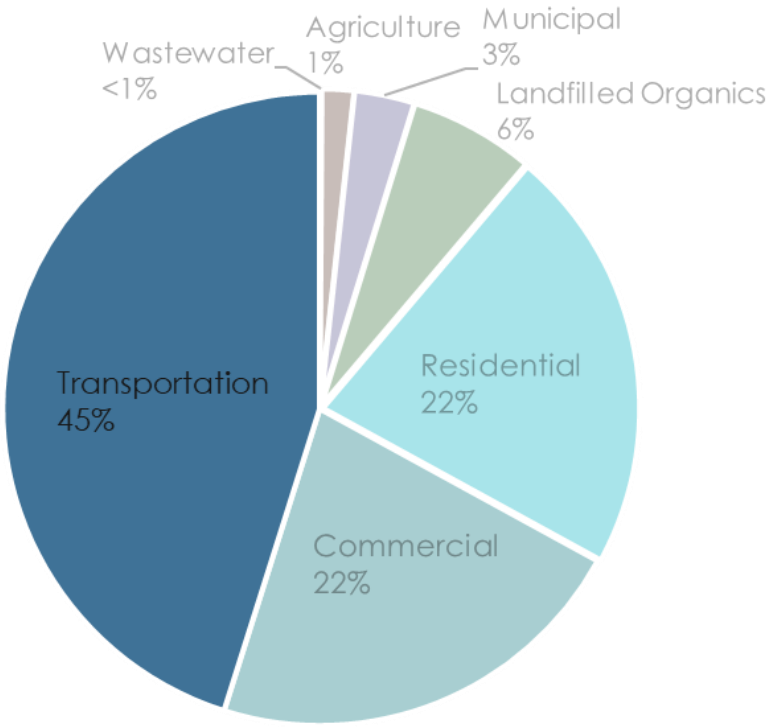


Figure 9. 2018 Transportation sector emissions.

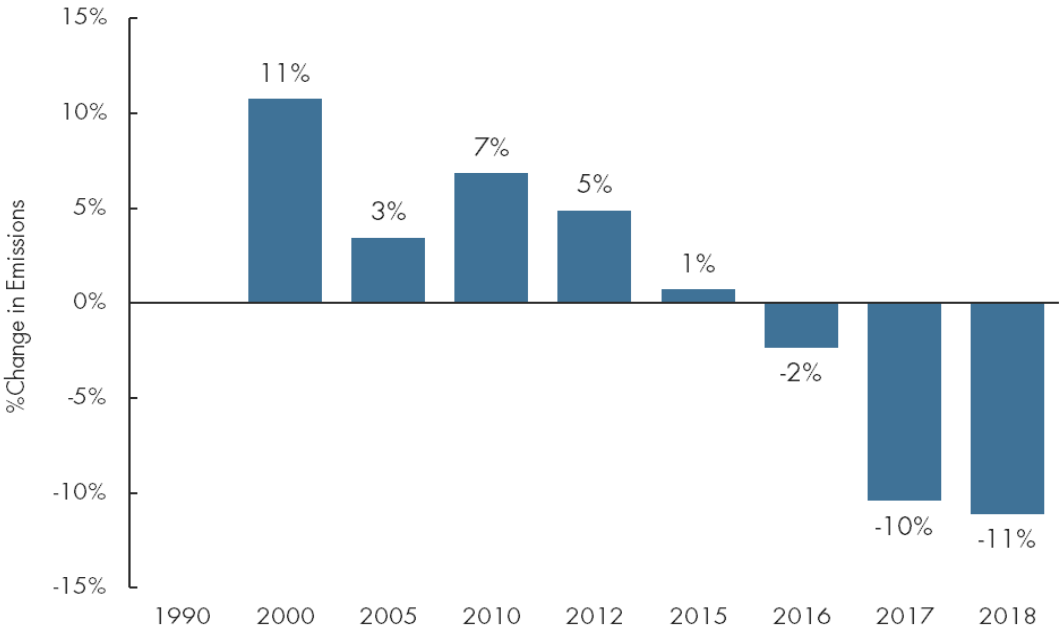


Figure 10. Transportation sector emissions changes compared to 1990.

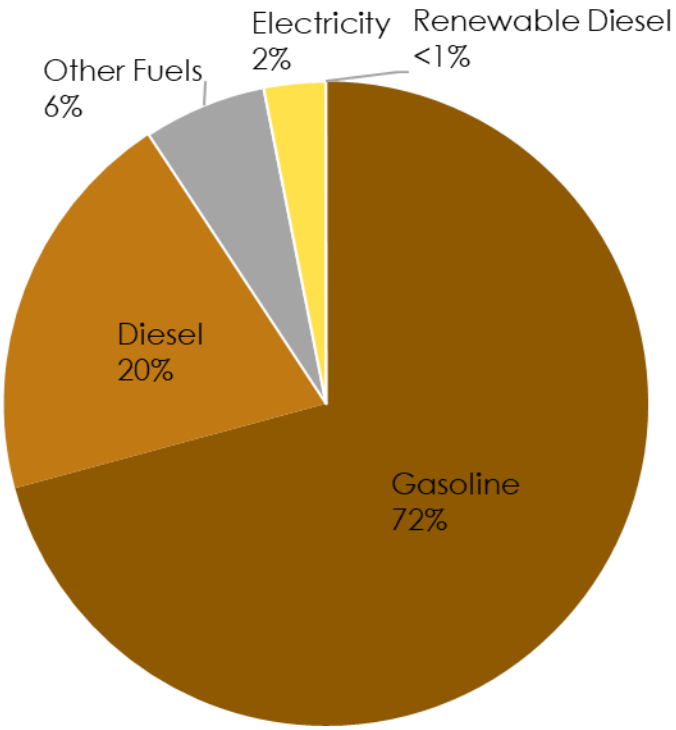


Figure 11. 2018 Transportation sector emissions by commodity.

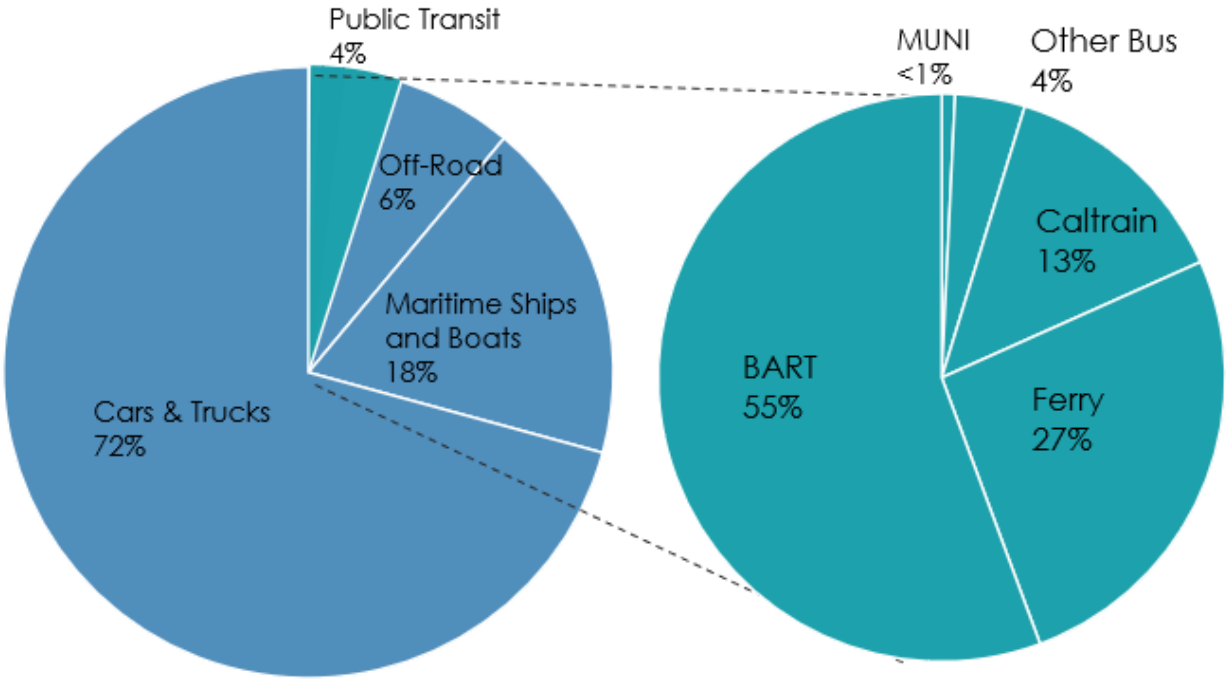


Figure 12. 2018 Transportation emissions by sub-sector.

LANDFILLED ORGANICS

In 2018, emissions from Landfilled Organics[18] totaled 329 thousand $mtCO_2e$, accounting for 6% of San Francisco's GHG emissions (Fig. 13). Emissions occur when organic materials sent to landfill decompose and release methane to the atmosphere. Emissions from Landfilled Organics have declined 30% below 1990 levels due to successful resource recovery in the city (Fig. 14).

Emissions from Landfilled Organics increased 7.5% between inventory year 2017 and 2018. The city's economic growth and population increase has resulted in higher rates of organics disposed to landfill. The construction and demolition[19] boom have also resulted in an increase of discarded organic and inorganic materials sent to landfill. Even with this increase in discarded materials, the tonnage of disposed materials has decreased 1.6% from 1990 levels. Emissions from Landfilled Organics disposal per capita has decreased 43% from 1990 levels.

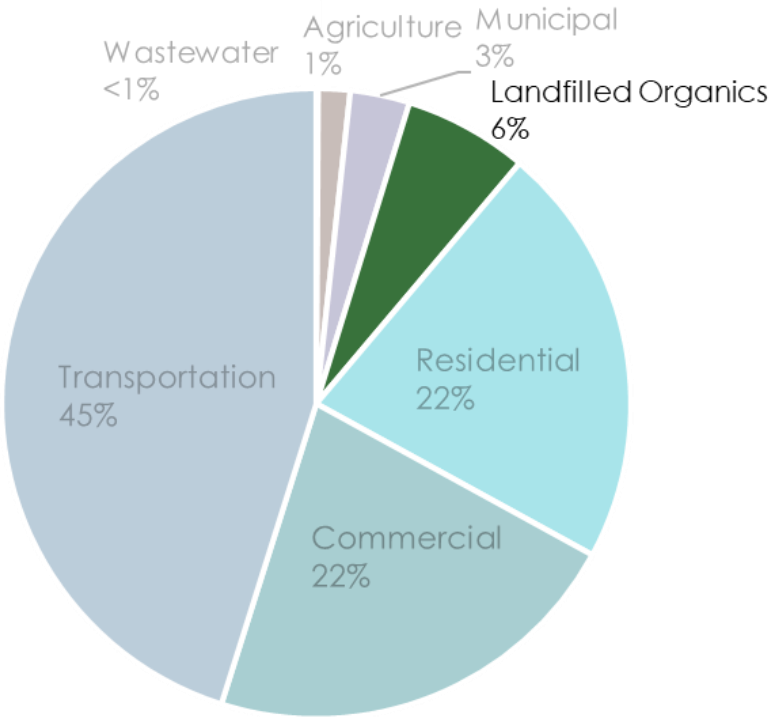


Figure 13. 2018 Landfilled Organics emissions.

[18] Referred to as the Waste sector during previous inventory years.

[19] Construction and demolition is a mixture of inorganic (inert) 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.

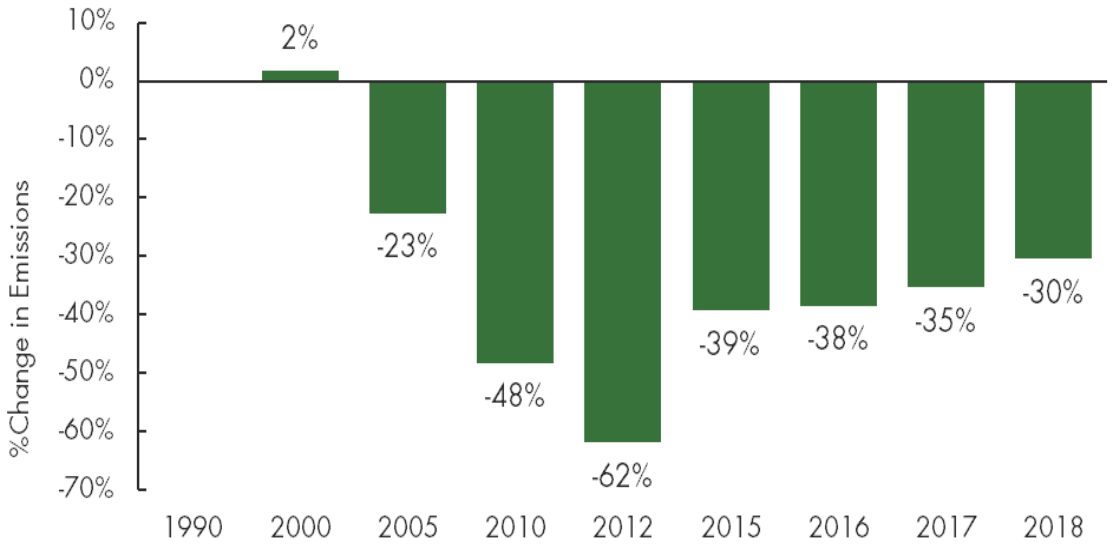


Figure 14. Landfilled Organics emissions changes compared to 1990 levels.

MUNICIPAL

In 2018, emissions in the Municipal sector[20], were generated from the operation of city-owned buildings (85%) and non-revenue vehicles[21] (15%), totaling 157 thousand $mtCO_2e$ and accounting for 3% of San Francisco's total emissions (Fig. 15). Emissions from San Francisco's Municipal sector declined 31% below 1990 levels with the steepest declines between 2010 to 2012 due in large part to all city-owned buildings fully sourcing GHG-free electricity[22] generated from San Francisco Public Utilities Commission's Hetch-Hetchy hydroelectric dam (Fig.16). As a result, natural gas accounts for nearly 100% of the emissions in Municipal buildings, totaling 108 thousand $mtCO_2e$ (Fig. 17).

Municipal building emissions are driven by natural gas use. The colder weather in 2018 may have increased the use of gas-powered heating appliances, causing natural gas use in Municipal buildings to increase 0.5% between inventory year 2017 and 2018. Municipal energy efficiency projects, programs, and energy code improvements served to temper emissions increases. The City continues to improve its efforts to green municipal buildings with 64 LEED buildings, totaling 8.42 million square feet, certified from 2004 to 2018.

[20] The majority of energy data for the municipal sector is obtained directly from PG&E.
[21] Since 2015, city-owned fleet emissions were categorized and tracked within the Municipal sector.
[22] City owned buildings have been sourcing hydro power since the 1970's with very little generation coming from carbon intense sources. Starting fiscal year 2011, the SFPUC begun providing power content labels to the CPUC in which all hydro power since has been verified 100% GHG free electric power.

Municipal fleet emissions remained constant between 2017 and 2018. Municipal fleet emissions generated from gasoline use made up 91% of total non-revenue fleet emissions (Fig. 18). Emissions from diesel use have continued to decline with the roll out of renewable diesel, which began during fiscal year 2016. Moving forward, San Francisco can push further city fleet emissions reductions with: (1) ongoing efforts to transition diesel vehicles to renewable diesel, (2) implementing the City Fleet Zero Emissions Vehicles Ordinance[23], and (3) implementing the EV Readiness Ordinance [24]. A more detailed analysis of Municipal Emissions can be found in the latest SF Municipal Progress Report on Climate and Sustainability[25].

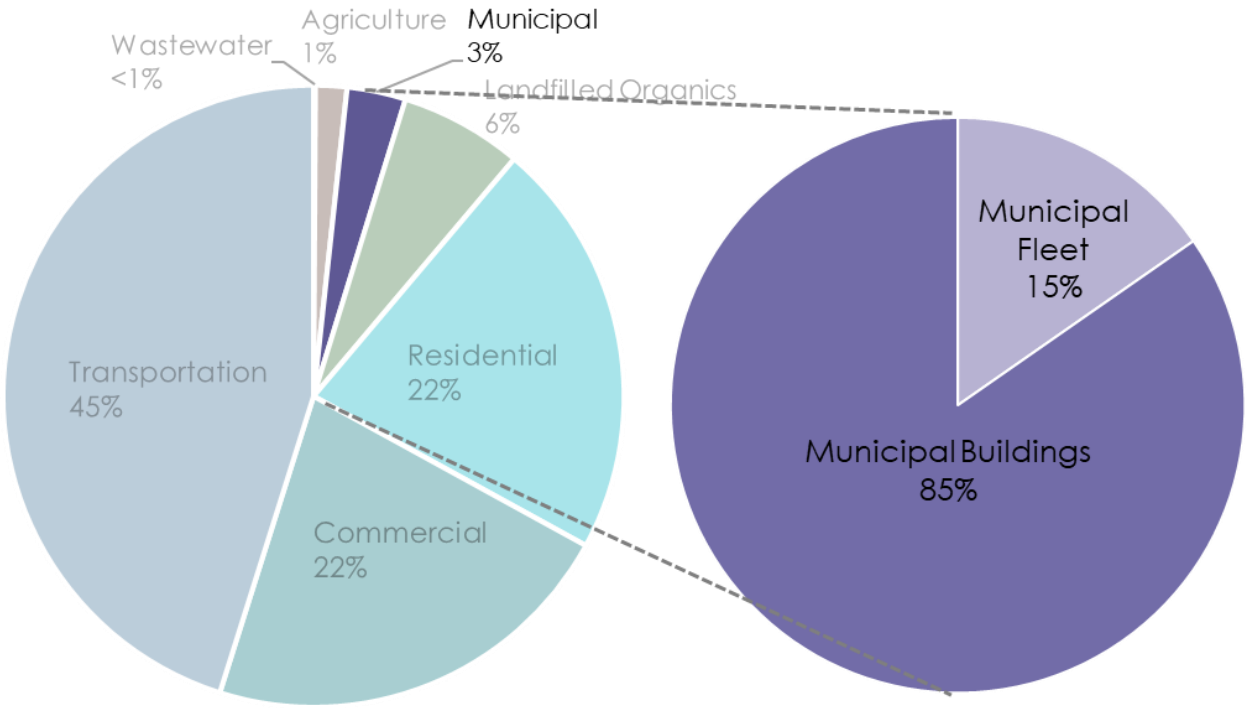


Figure 15. 2018 Municipal sector emissions.

[23] Requires all light duty passenger vehicles in the City fleet to be Zero Emission Vehicles by Dec 31st, 2022. http://www.cleancitiessf.com/bevs

[24] Requires new residential, commercial, and municipal buildings and major renovations to have sufficient EV infrastructure. http://www.cleancitiessf.com/bevs

[25] sfenvironment.org/sites/default/fliers/files/sfe_municipal_progress_report_19.pdf

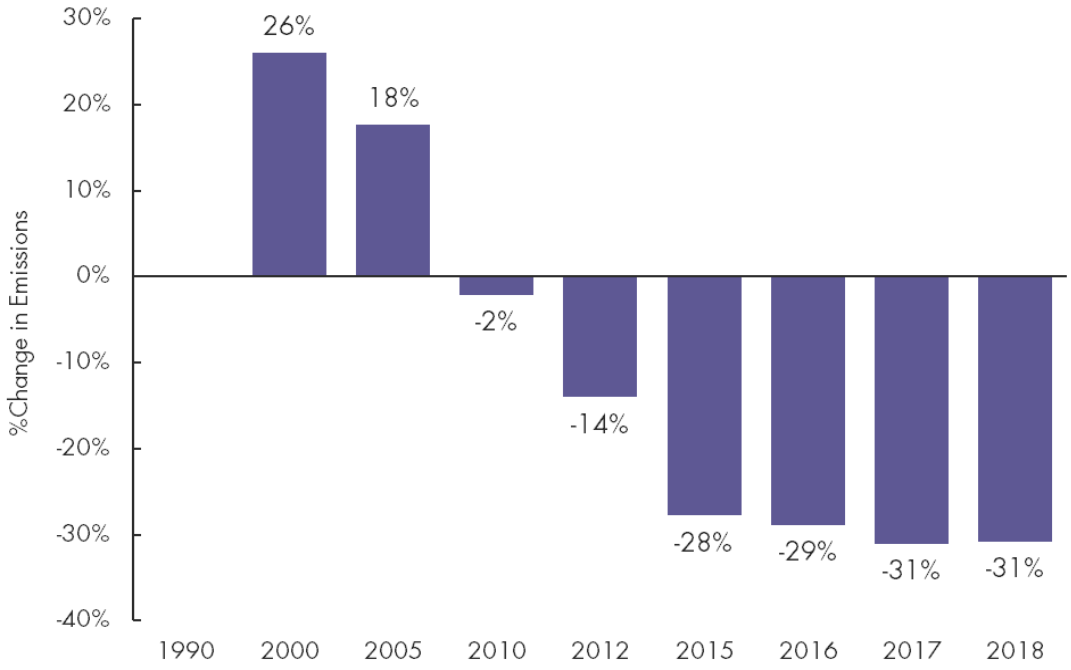


Figure 16. Municipal sector emissions changes compared to 1990 levels.

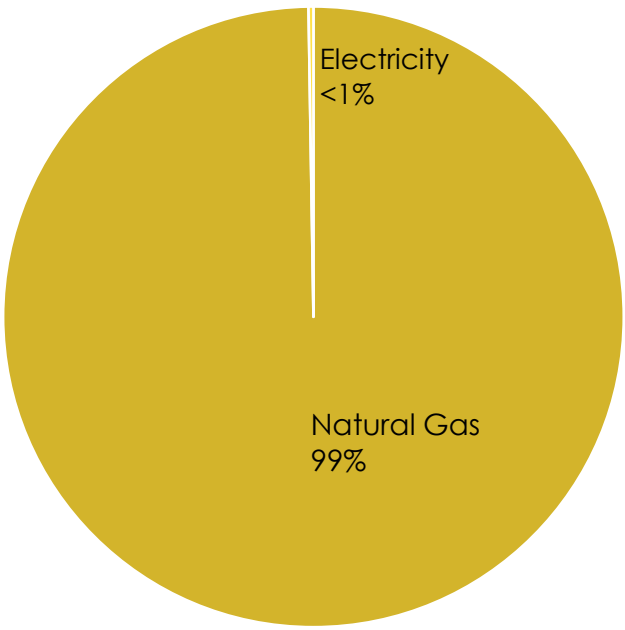


Figure 17. 2018 Municipal buildings emissions share by commodity.

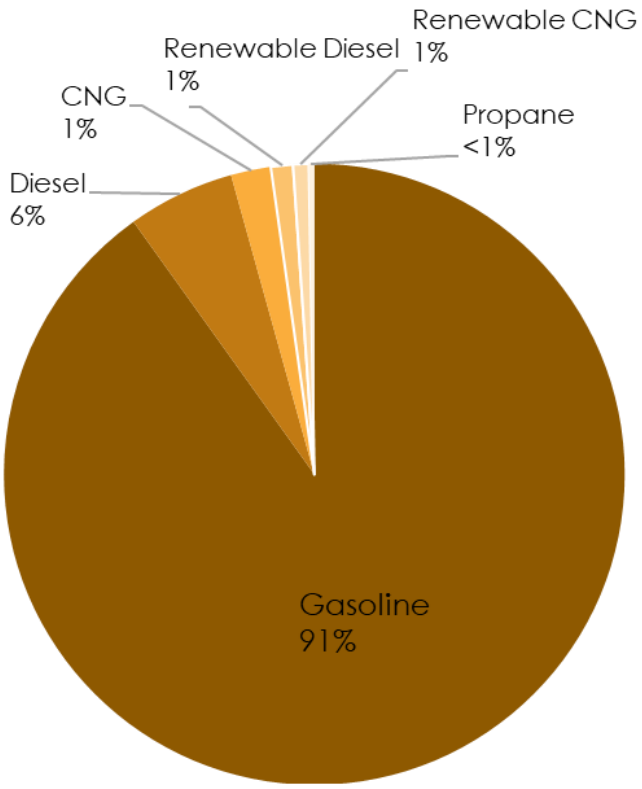


Figure 18. 2018 Municipal non-revenue fleet emissions share by commodity.

AGRICULTURE

In 2018, emissions in the Agriculture sector totaled 84,000 $mtCO_2e$ accounting for only 1% of San Francisco's GHG emissions (Fig. 19). Emissions from the Agriculture sector have increased 8% from 1990 levels (Fig. 20) and are generated mostly from domestic and wild animal waste with the remaining share from managing urban soils.

Between inventory years 2017 and 2018, the Agriculture sector increased 0.4%. Emissions from this sector represent a small fraction of San Francisco's emissions and, thus, further analysis of this increase was not conducted.

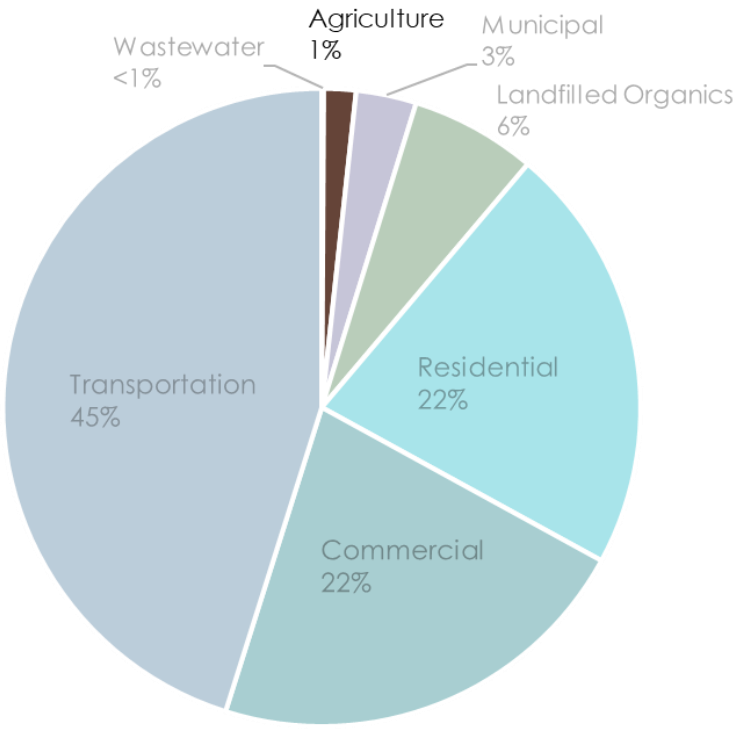


Figure 19. 2018 Agriculture sector emissions.

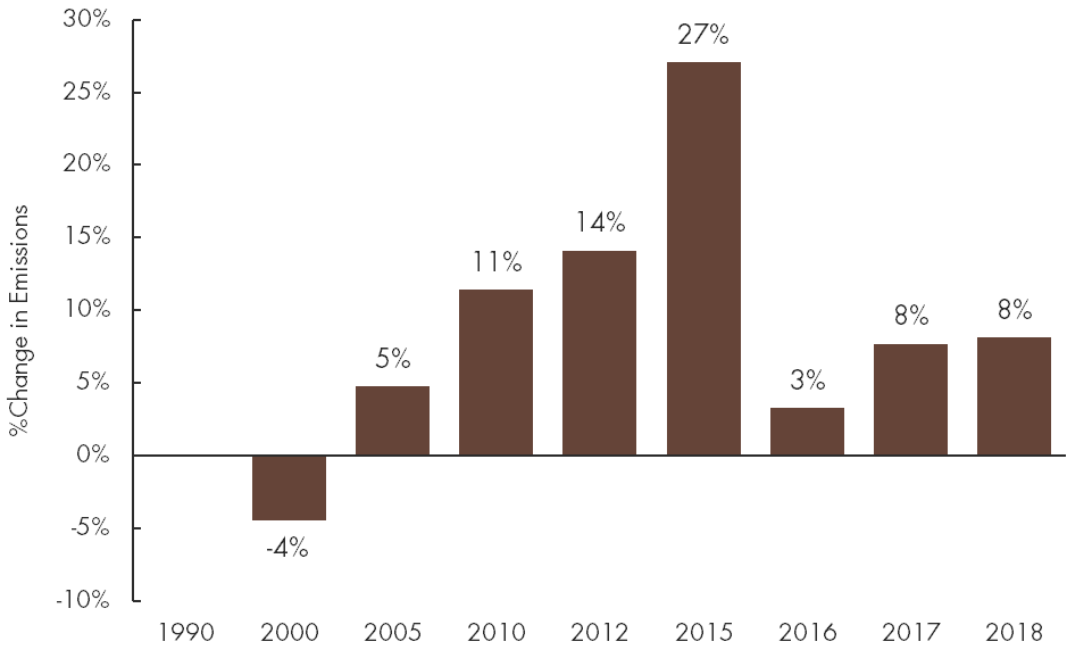


Figure 20. Agriculture sector emissions changes compared to 1990 levels.

WASTEWATER

In 2018, emissions in the Wastewater sector totaled 6.6 thousand $mtCO_2e$ accounting for less than 1% of San Francisco's GHG emissions (Fig. 21). Emissions from the Wastewater sector have increased 13% 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 sources[26], while the remaining portions occur from the energy used to treat 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 (79%) compared to process nitrogen emissions (19%) and reuse of captured digester gas to power the treatment plant (2%).

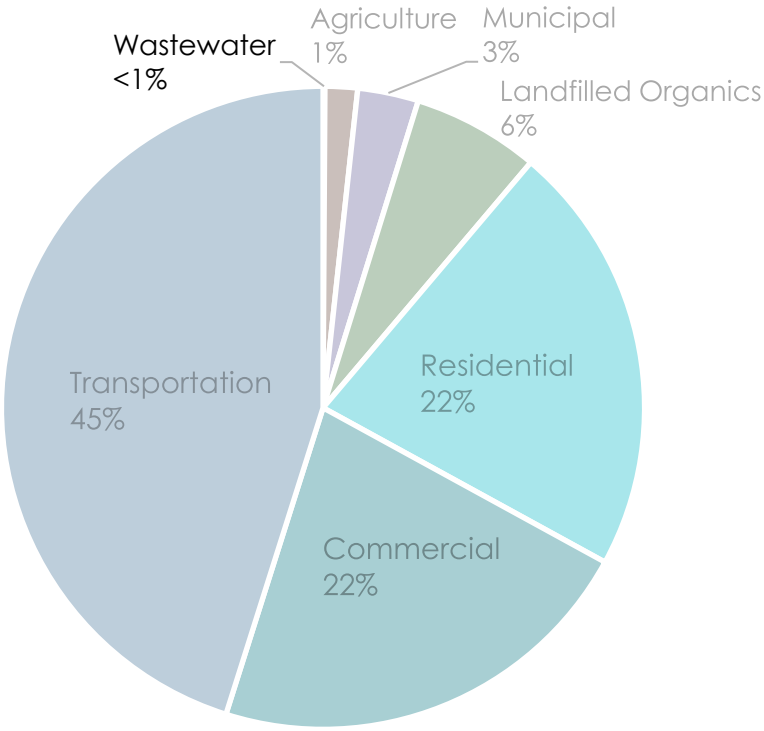


Figure 21. 2018 Wastewater sector emissions.

[26] Fugitive emissions are unintended Nitrous Oxide releases from the effluent discharged to a body of water.

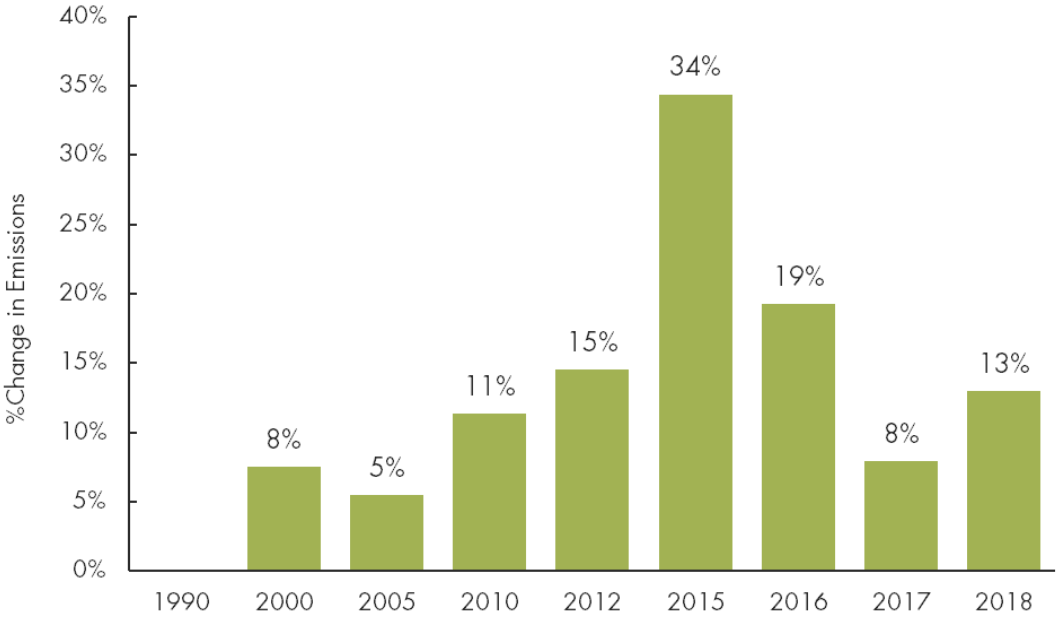


Figure 22. Wastewater sector emissions changes compared to 1990 levels.