City of Boulder's 2019 Municipal Greenhouse Gas Emissions Inventory Summary Report

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INTRODUCTION

The City of Boulder (City/Boulder) has committed to reducing greenhouse gas (GHG) emissions by establishing aggressive programs, policies, and goals to reduce community GHG emissions by at least 15 percent by 2020 and 80 percent by 2050 (from a 2005 baseline). In support of this effort, Boulder is proactively reducing the environmental impact of city operations.

Boulder performed its first municipal GHG inventory in 2008. Starting in 2011, annual inventories have been completed to continue tracking the City of Boulder's progress toward municipal climate action goals, which includes a 50 percent reduction in municipal emissions from 2008 levels by 2020 and an 80 percent reduction in municipal emissions from 2008 levels by 2030.

The 2019 municipal GHG inventory was developed using The Climate Registry's *Local Government Operations Protocol*[1] (LGOP) framework and the results of Boulder's municipal GHG inventory have been entered into the ICLEI-Local Governments for Sustainability (ICLEI) ClearPath tracking system.[2] The inventory considers emissions generated from activities within the operational control of the City of Boulder. 'Operational control' is defined as those operations, facilities, or sources that are wholly owned by the City of Boulder, as well as those in which the City of Boulder has full authority to introduce and implement operational health, safety, and environmental policies.[3]

Table 1 includes an overview of all the sources that are included in the 2019 inventory, classified by scope.

Table 1. Emissions included in the inventory by scope.

Scope 1	Scope 2	Scope 3
GHG emissions from sources located within the city boundary. For the city of Boulder this includes: • Stationary fuel used in buildings and facilities including natural gas, propane, diesel, and biodiesel • Vehicle fleet and equipment fuel use including gasoline, ethanol, diesel, and biodiesel • Wastewater treatment by city-owned facility • Refrigerants	**GHG emissions occurring as a result of the use of grid-supplied electricity, heat, steam, and/or cooling within the boundary. For the city of Boulder this includes:** • Grid-supplied electricity used in buildings, facilities, and vehicle fleet	**All other GHG emissions that occur outside the boundary as a result of activities taking place within the city boundary. For the city of Boulder this includes:** • Employee commuting fuel use including diesel and gasoline • Business travel (on-road) fuel use including gasoline • Business travel (aviation) • Solid waste and compost • Consumption-based including asphalt, cement, paper, food, fertilizer, and computers

[1] For more information on the Local Government Operations Protocol please see http://www.theclimateregistry.org/tools-resources/reporting-protocols/local-goverment-operations-protocol/.
[2] For more information in ICLEI's ClearPath tool please see http://icleiusa.org/clearpath/.
[3] For more information on operational control, please see https://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

As defined by the LGOP, the inventory includes emissions from building and on-site energy use (i.e., electricity, natural gas, propane, etc.), municipal fleet operations, employee commuting and business travel, waste generation, community wastewater processing, and refrigerant use in buildings. Additionally, the inventory includes emissions generated from consumption-based behavior within city operations, namely the consumption of asphalt, cement, paper, food, computers, and fertilizer. Finally, Boulder was interested in understanding their avoided emissions from activities such as recycling, composting, and renewable energy (i.e., on-site solar and hydro generation). These activities are not included in the standard LGOP reporting and are therefore reported as information-only.

Emission reductions are evident with every GHG inventory, and since 2008, Boulder has reduced its municipal GHG emissions by 40 percent. By staying on track and continuing to push forward with sustainability initiatives including renewable energy, alternative transportation, and zero waste, the ability to meet the 2020 goal of a 50 percent reduction in emissions since 2008 is within reach.

The following is a high-level review of the 2019 GHG inventory and how the emissions compare to past GHG inventories.

Key Findings From 2019 Inventory

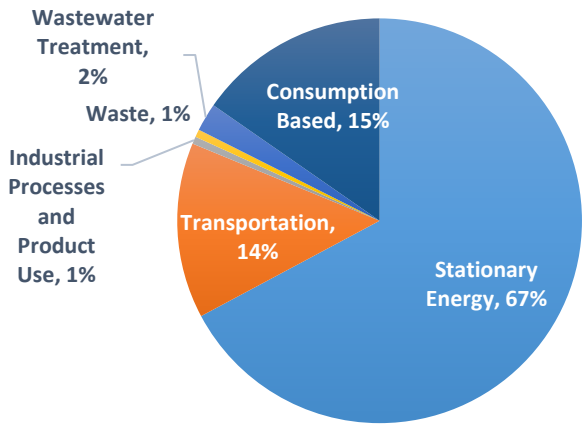


Figure 1: City of Boulder municipal emissions by sector (mt CO_2e), 2019.

In 2019, Boulder's municipal operations generated a total of 28,651 metric tons of carbon dioxide equivalent (mt CO_2e). At 67 percent of total emissions (i.e., 19,251 mt CO_2e), the stationary energy sector made up the largest share of the city's operational emissions, followed by consumption-based emissions at 15 percent (4,393 mt CO_2e) and transportation emissions at 14 percent (4,021 mt CO_2e). The remaining four percent of emissions were generated from wastewater treatment (two percent), solid waste (one percent), and the use of industrial processes and products (i.e., refrigerant use, one percent). The percentage of emissions by sector is shown in Figure 1.

In terms of emissions by source, electricity was the highest source at 51 percent of the total emissions (14,595 mt CO_2e). These emissions include those from grid-supplied electricity (i.e., electricity used in streetlights, facilities, water transport, and wastewater treatment) and those associated with emissions from grid-supplied electricity consumed in the city for on-road transportation (i.e., electric vehicles in the municipal vehicle fleet and used for employee commuting). The next highest source of emissions was associated with natural gas usage from facilities at almost 16 percent (4,432 mt CO_2e). Transportation

activities related to city operations, including the use of gasoline, diesel, ethanol, propane, and biodiesel in the municipal fleet and employee commuting and business travel, together accounted for 14 percent of municipal emissions (4,139 mt CO_2e), with gasoline accounting for the majority of that share at 2,580 mt CO_2e. For consumption-based emissions by source, asphalt and cement used in city operations, including from the building of roads and other infrastructure, together accounted for 13 percent of overall municipal emissions (3,723 mt CO_2e). See Figure 2 and Table 2 for details on all emissions by source.

Figure 2: Municipal emissions by source (mt CO_2e), 2019.

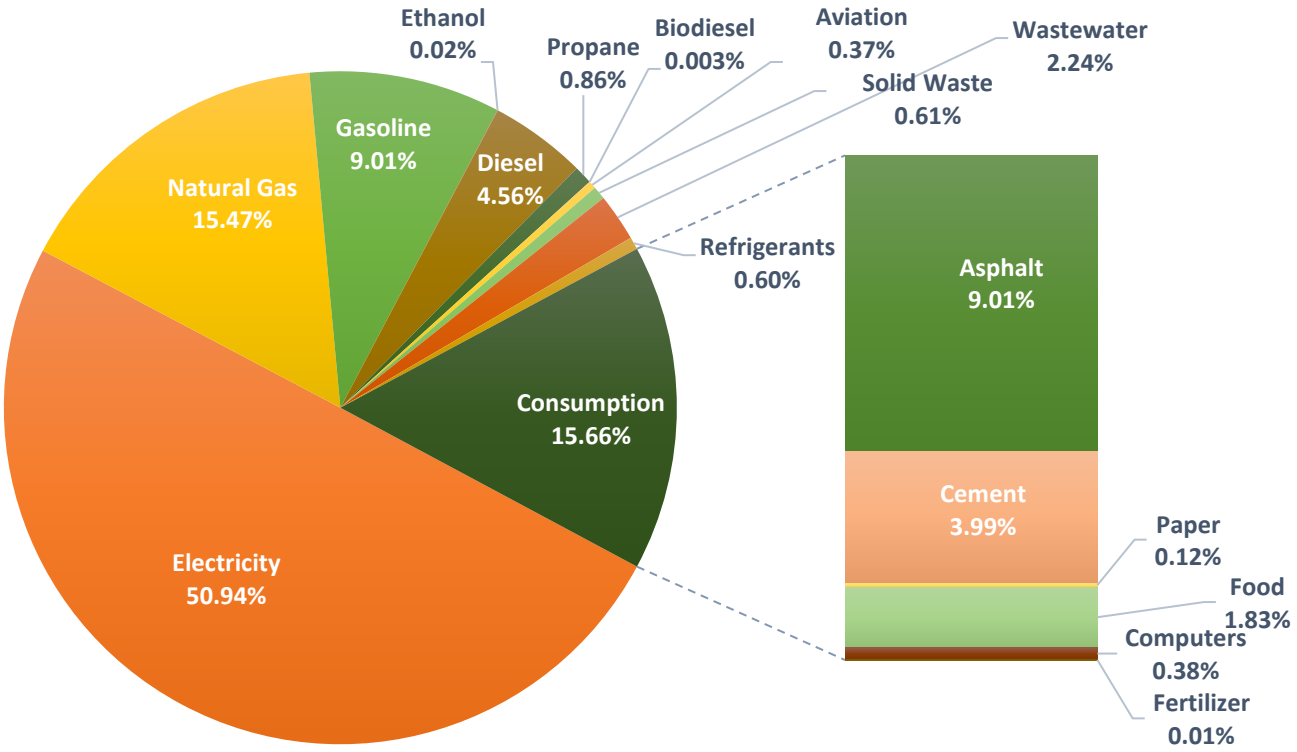


Table 2: Municipal emissions by source detail (mt CO_2e), 2019.

Emission Source	Emissions (mt CO_2e)	% of Total
Electricity	14,595	50.94%
Natural Gas	4,432	15.47%
Gasoline	2,580	9.01%
Ethanol	5	0.02%
Diesel	1,306	4.56%
Propane	247	0.86%
Biodiesel	1	0.00%
Aviation	105	0.37%
Solid Waste	176	0.61%
Wastewater	642	2.24%
Refrigerants	168	0.58%
Asphalt	2,581	9.01%
Cement	1,142	3.99%
Paper	34	0.12%
Food	525	1.83%
Computers	108	0.38%
Fertilizer	3	0.01%
Total	28,651	100%

Stationary energy and transportation comprise most of the municipal emissions in the city.

Within the stationary energy sector, the leading source of emissions from municipal operations is from electricity use in municipal facilities at 31 percent (6,012 mt CO_2e), followed by municipal utility buildings (i.e., Public Works Utilities and water and wastewater treatment facilities) at 30 percent (5,850 mt CO_2e). Stationary fuel use in municipal buildings comprised 17 percent (3,180 mt CO_2e) of total emissions, followed by electricity for streetlights at 14 percent (2,697 mt CO_2e) of stationary energy emissions. Refer to Table 3.

Table 3. Stationary energy emissions detail (mt CO_2e), 2019.

Emission Source	Emissions (mt CO_2e)	% of Total
Utilities Electricity	5,850	30%
Facilities Electricity	6,012	31%
Facilities Stationary Fuel	3,180	17%
Streetlights Electricity	2,697	14%
Utilities Stationary Fuel	1,253	7%
Water Transport Stationary Fuel	258	1%
Wastewater Treatment Stationary Fuel	0.44	0.002%
Total	19,251	100%

In May of 2019, the lease for Boulder Community Health, the local hospital, ended, and the hospital and accompanying pavilion building became part of the city's operational emissions inventory as the city took over operational control of these buildings. As this site was not included in prior years' inventories, this represented an additional load that was not included in past emissions analyses. However, the increase in energy use associated with this site was offset by reductions in energy use across other city facilities.

Multiple energy efficiency projects and renovations were implemented that helped to reduce energy use in city buildings in 2019. These projects included renovations at two Open Space and Mountain Parks facilities at the 75th Street Annex location, process optimization at the Water Resource Recovery Facility, and retrofits and consolidation of staff at the 55th Street Hub location for Open Space and Mountain Parks.

Within the transportation sector, employee commuting resulted in 46 percent (1,852 mt CO_2e) of emissions and municipal-owned vehicles comprised 42 percent (1,692 mt CO_2e) of emissions. The remainder of the transportation emissions included municipal-owned equipment at nine percent (362 mt CO_2e), airline business travel at almost three percent (105 mt CO_2e), and on-road business travel at less than one-quarter of one percent (9 mt CO_2e). Refer to Table 4.

Table 4. Transportation emissions detail (mt CO_2e), 2019.

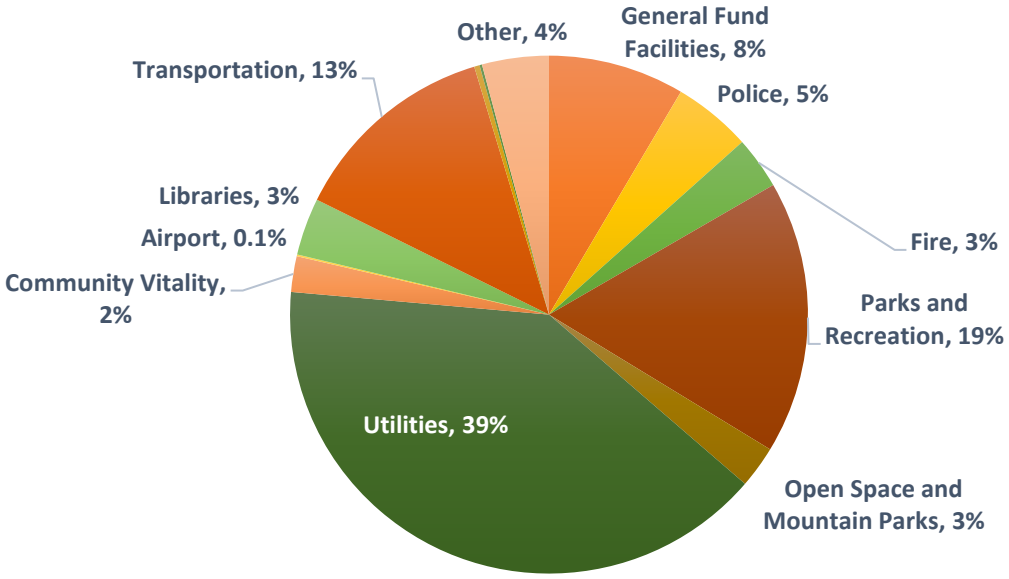
Emission Source	Emissions (mt CO_2e)	% of Total
Employee Commuting	1,852	46%
Municipal Owned Vehicles	1,692	42%
Municipal Owned Equipment	362	9%
Airline Business Travel	105	3%
On-Road Business Travel	9	0.23%
Total	4,021	100%

Boulder made multiple updates to the fleet vehicle fueling procedures in 2019 that resulted in greater use of biodiesel as compared to regular diesel fuel. Specifically, the location of the biodiesel and diesel fueling tanks were re-arranged such that the biodiesel tank became easier to access. Additionally, expanded on-site biodiesel fueling capacity was developed and the combination of these efforts resulted in a significant increase in the use of biodiesel for fleet vehicles in 2019. This increase was accompanied by a reduction in standard diesel and unleaded fuel use for fleet vehicles. The city also increased the share of fleet vehicles that are electric in 2019.

In 2019 the city continued to promote the use of public transit, carpooling, and telework programs to help address and reduce the emissions generated by employee commuting. As an updated employee commute survey was not completed in 2019, the actual employee commute activity and associated emissions were assumed to remain unchanged from the 2018 values.

Stationary energy and vehicle fleet emissions can be attributed to various departments within the city's operations. When analyzing emissions by department, utilities produced the highest amount of emissions at 39 percent (8,296 mt CO_2e), with parks and recreation second highest at 19 percent (4,124 mt CO_2e). See Figure 3 for details on all emissions by department.

Figure 3: Municipal stationary energy and vehicle fleet emissions by department (mt CO_2e), 2019.



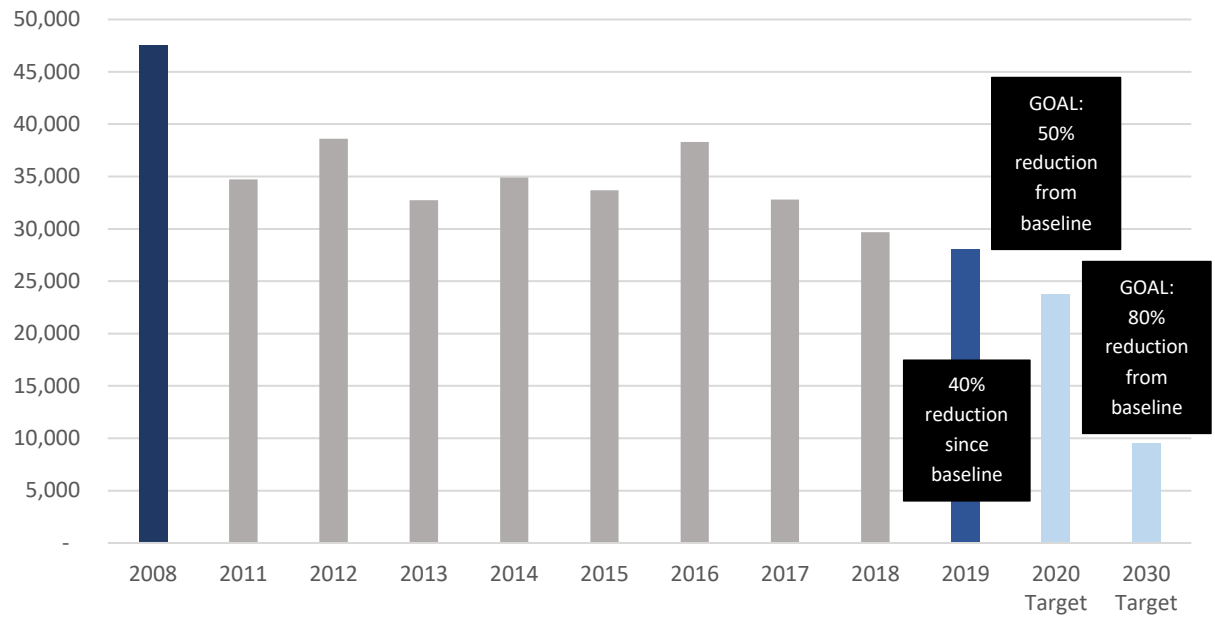
Emissions Trends

Boulder has been tracking emissions produced by city operations since 2008; the city has developed an emissions inventory for every year between 2008 and 2019 except for the years 2009 and 2010. These inventories have helped Boulder understand trends in the city's operational activities and emissions and identify key areas to focus on when developing programs and policies to reduce emissions. The following is an overview of the emissions trends for the inventories from 2008 to 2019.

Total Emission Trends

The City of Boulder has set a goal of reducing its municipal emissions by 50 percent by 2020 and 80 percent by 2030 using a 2008 baseline. Since 2008, emissions have reduced by an overall average of five percent per year. As shown in Figure 4, the city of Boulder has reduced its municipal emissions by 40 percent from the 2008 baseline, which puts the city on track to meet its 2020 GHG reduction target of 50 percent.

Figure 4. Total annual emissions (mt CO_2e) 2008-2019 and 2020/2030 targets.

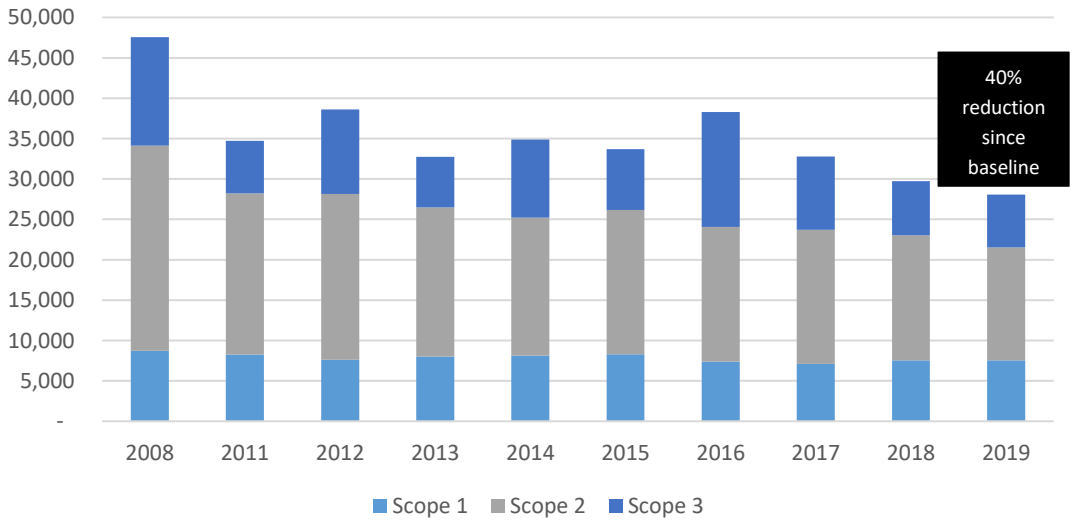


Emission Trends by Scope

Since 2008, except for a few years, emissions have been declining. Between 2018 and 2019 total emissions reduced by four percent with the largest reduction coming from Scope 3 emissions (see Figure 5).

Comparing emissions by scope is important as each scope presents a different level of controllability. For example, Scope 1 emissions are direct emissions from owned or controlled sources (e.g., fuel used in buildings and fleet vehicles). Scope 2 emissions primarily consists of grid-supplied electricity and Scope 3 emissions are other indirect emissions (e.g., consumption-based sources).

Figure 5. Emissions by scope (mt CO_2e), 2008-2019.

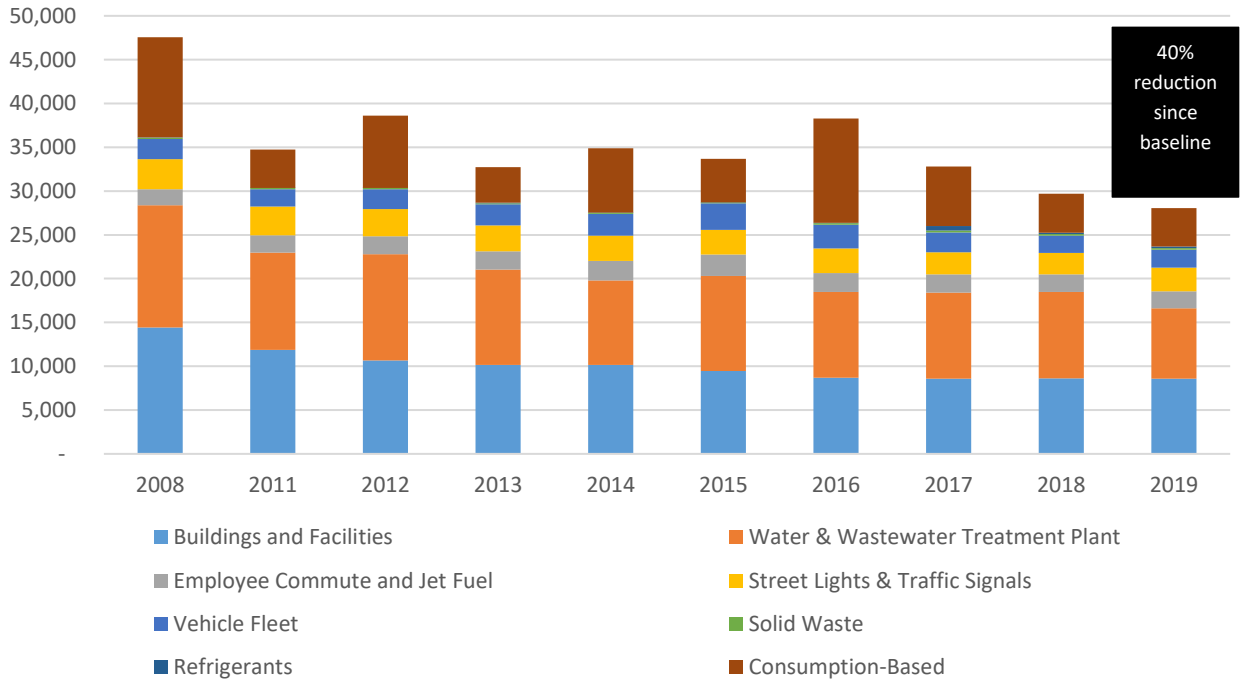


The inventory also estimated Scope 3 emissions resulting from well-to-wheel activities, which include emissions from extracting and transporting the primary fuel source to the point at which it is used in the vehicle. Well-to-wheel activities produce 1,582 mt CO_2e, resulting in a total emissions value of 30,233 mt CO_2e.

Emission Trends by Sector

Table 5 and Figure 6 highlight the trends in emissions by sector from 2008 to 2019. The largest reductions since 2008 (by percent reduced) were from consumption-based sources, wastewater/water treatment, and buildings and facilities emissions (which reduced by 62 percent, 43 percent, and 36 percent respectively), followed by streetlights and traffic signals and vehicle fleet (which reduced by 21 percent and 10 percent, respectively).

Figure 6. Emissions by sector (mt CO_2e), 2008-2019.



The most significant variability in emissions over the years is within the consumption-based sector. Emissions from consumption-based sources, including the use of asphalt and concrete, can vary significantly year-to-year based on community growth and related infrastructure needs (i.e., these emissions increase significantly in years when the city is investing in large infrastructure projects and other investments like computers/hardware).

Table 5. Emissions by sector (mt CO_2e), 2008, 2018, and 2019.

Sector	2008	2018	2019	% Change (2008-2019)	% Change (2018-2019)
Stationary Energy—*Water & Wastewater Treatment Plant*	13,939	9,839	8,004	-43%	-19%
Stationary Energy—*Buildings and Facilities*	14,440	8,629	9,192	-36%	7%
Stationary Energy—*Streetlights & Traffic Signals*	3,425	2,445	2,697	-21%	10%
Consumption-Based	11,445	4,459	4,393	-62%	-1%
Employee Commute and Business Travel (including jet fuel)	1,833	2,027	1,967	7%	-3%
Vehicle Fleet	2,292	1,969	2,054	-10%	4%
Solid Waste	148	196	176	19%	-10%
Refrigerants	34	124	168	398%	35%
Totals	***47,554***	***29,688***	***28,651***	***-40%***	***-3%***
mt-CO_2e per employee	38.92	23.27	21.59	-46%	-7%
mt-CO_2e per square foot	0.017	0.014	0.010	-43%	-30%
mt-CO_2e per capita	0.55	0.25	0.24	-56%	-2%

The following sectors have increased their emissions since 2008: 1) refrigerants; 2) solid waste; and 3) employee commute and business travel.

The large increase from refrigerant emissions is based on a more accurate estimation of refrigerant use than occurred in the city's earlier inventories. Even with this increase, refrigerants still only make up less than one percent of the city's total 2019 emissions.

The city has experienced a decrease of ten percent in emissions from solid waste from 2018 to 2019; however, the city has seen an overall increase in solid waste emissions of 19 percent between 2008 and 2019. The overall increase is largely based on additional city employees and the inclusion of compost in inventories, which was not included in the 2008 inventory.

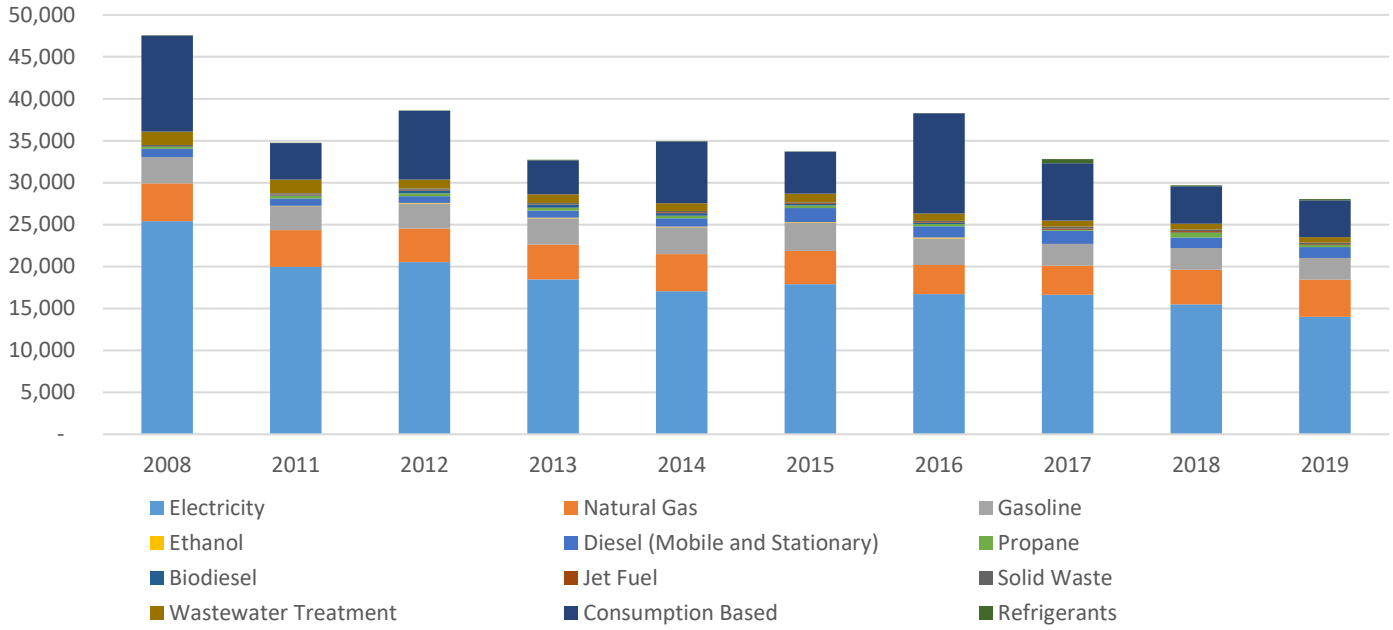
The city experienced a substantial decrease in the amount of business travel recorded both via air travel and reimbursed mileage in personal vehicles from 2018 to 2019 (air travel decreased by 29 percent and the total miles for vehicle reimbursements decreased by approximately 59 percent). Boulder did not complete an updated employee commute survey in 2019, so employee commute activity is assumed to have remained the same from 2018 to 2019. Overall emissions have decreased for employees commuting by three percent from 2018 to 2019, but emissions from employee commuting have increased by seven percent between 2008 and 2019.

Emissions Trends by Source

As shown in Figure 7, emissions over the years can be largely attributed to the following sources: electricity, natural gas, gasoline, and consumption-based items. Emissions from all these sources have decreased since the 2008 baseline based on decisions and policies made by the city and, in the case of

reduced electricity emissions, the 'greening' of Xcel Energy's electricity grid that supplies power to Boulder.

Figure 7. Emissions by source (mt CO_2e), 2008-2019.



Additional information related to trends from 2008 to 2018 for the primary emission sources mentioned above is provided in Figure 8. The emissions by source for 2008, 2018, and 2019 are provided in Table 6.

Figure 8. Primary GHG emission source annual trends (mt CO_2e), 2008-2019.

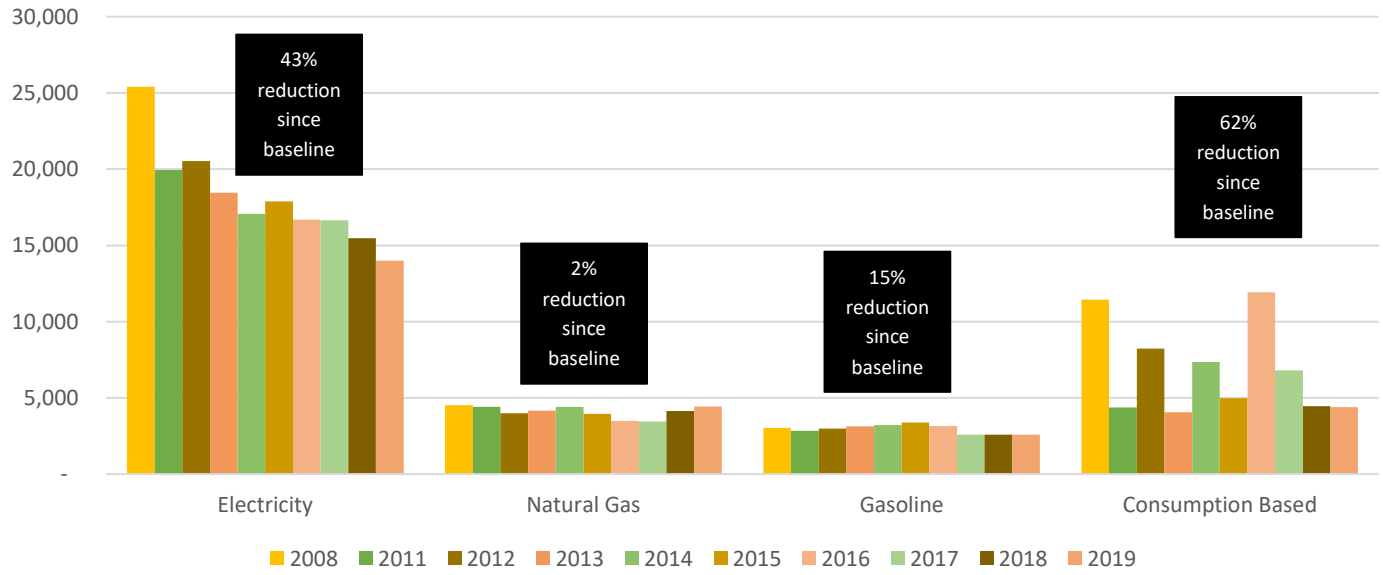


Table 6. Emissions by source (mt CO_2e), 2008, 2018, and 2019.

Source	2008	2018	2019	% Change (2008-2019)	% Change (2018-2019)
Electricity	25,409	15,482	14,595	-43%	-6%
Natural Gas	4,520	4,141	4,432	-2%	7%
Gasoline	3,025	2,590	2,580	-15%	0%
Ethanol	35	5	5	-86%	-4%
Diesel (Mobile and Stationary)	1,026	1,234	1,306	27%	6%
Propane	292	604	247	-16%	-59%
Biodiesel	12	1	1	-94%	-29%
Jet Fuel	30	150	105	248%	-30%
Solid Waste	148	196	176	19%	-10%
Wastewater Treatment	1,579	704	642	-59%	-9%
Consumption Based	11,445	4,459	4,393	-62%	-1%
Refrigerants	34	124	168	398%	35%
Totals	***47,554***	***29,690***	***28,057***	***-40%***	***-4%***

As seen in Table 6, emissions from refrigerants have seen the largest increase of all sources since 2008 (398 percent). This significant increase in emissions from refrigerants is largely due to improved tracking of refrigerant use over the years; it should be noted that refrigerant emissions vary significantly from year to year.

In addition to changes in emissions from efficiencies and growth, nearly every year the city's reporting also becomes more detailed and granular.

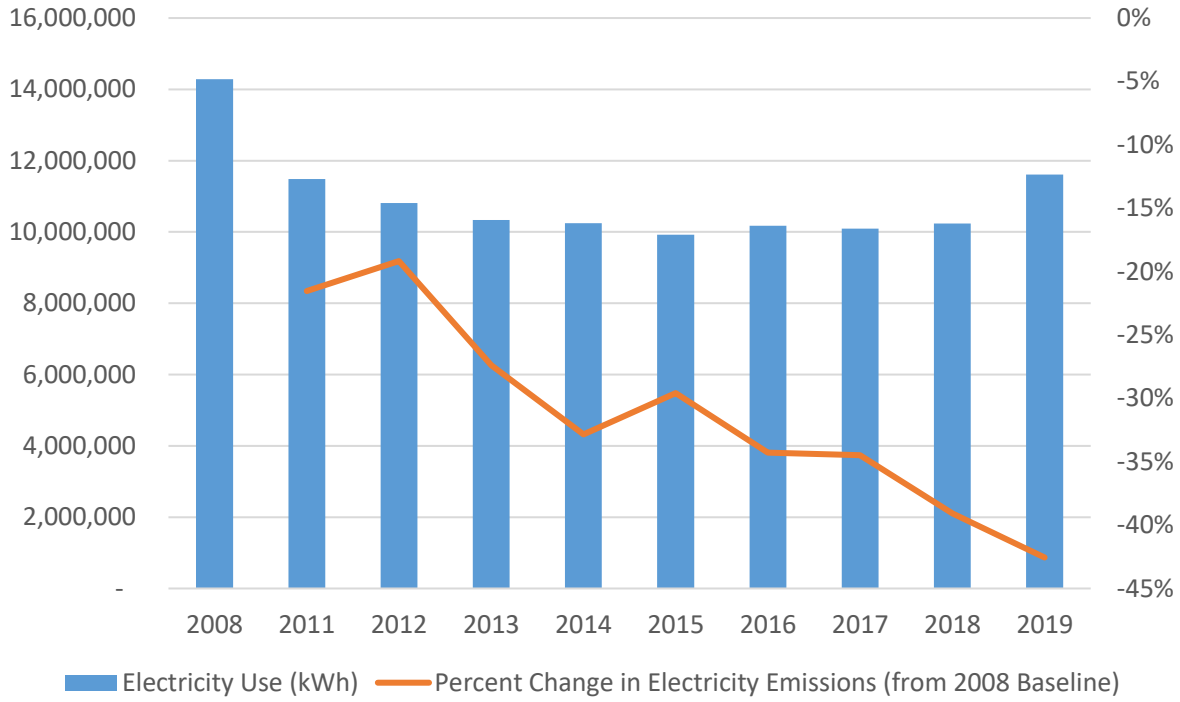
Trends in Electricity Emissions and Usage

Electricity use comprises a significant source of emissions, and it is noteworthy to point out observable trends between usage and emissions. The large decreases in emissions from the building and facilities have been largely driven by energy efficiency and renewable energy.

The City of Boulder has reduced its electricity consumption by 17 percent between 2008 and 2019. This reduction is in large part attributed to an energy performance contract on 66 city facilities between 2010 and 2013. The project reduced GHG emissions in those buildings by 24 percent while adding over two megawatts of solar to city facilities and the 75th Street wastewater treatment plant.[4] Refer to Figure 9.

[4] For more information see: https://bouldercolorado.gov/public-works/energy-efficiency-upgrades-at-city-facilities-energy-performance-contract

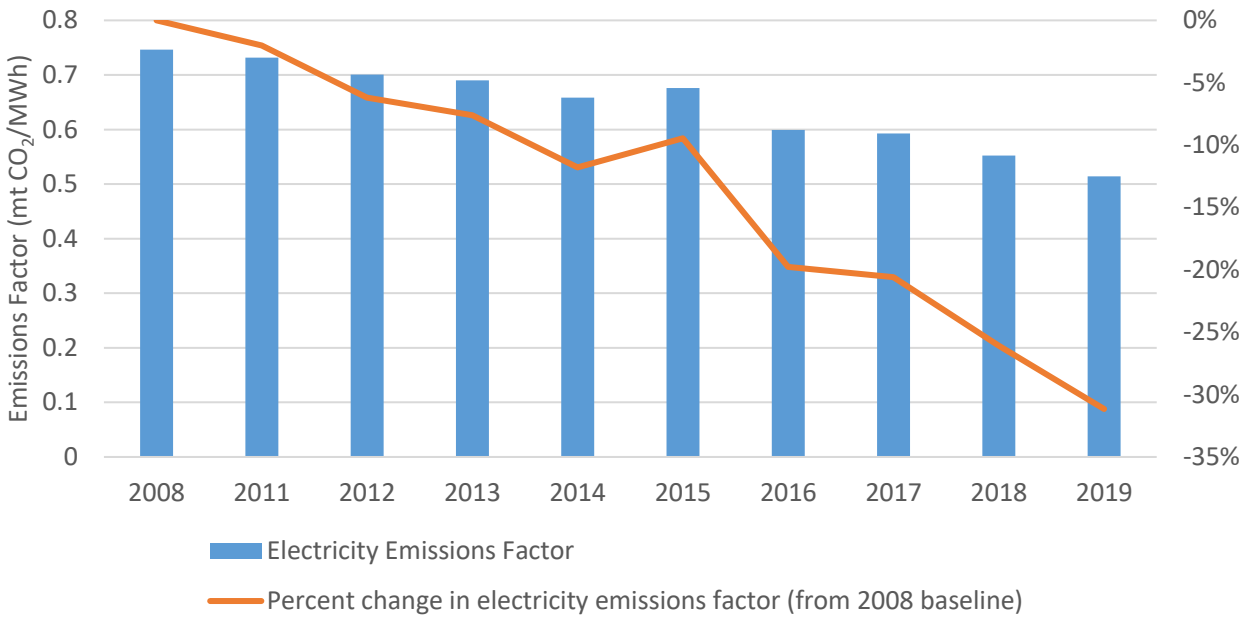
Figure 9. Total electricity use and percent change in electricity emissions from the 2008 baseline (2011-2019).



The city installed a 1.6 megawatt (MW) solar array at the 63rd Street Waster Treatment Plant in 2019, which resulted in significant reductions in electricity use from the grid for the city's Water and Wastewater Treatment facilities. Additionally, the city authorized agreements that will add 2.75 MW of solar capacity across 14 different city-owned properties. While those solar installations were not yet completed and energized in 2019, it can be presumed that these installations will result in further grid electricity use reductions in future years after these systems come online.

GHG emissions also continue to decrease because of the increased use of renewable energy by Xcel Energy, the city of Boulder's electricity provider, and by city residents and businesses. Xcel Energy has announced plans to reduce emissions from the electricity it supplies to Colorado customers by 80 percent by 2030 and to become a carbon-neutral utility by 2050. Therefore, the City of Boulder can anticipate that the emissions associated with each kilowatt-hour of electricity consumed will continue to trend downwards over the coming years. Figure 10 shows the overall change in the electricity emissions factor between 2008 and 2019, as well as the percent change in the emissions factor from the 2008 baseline.

Figure 10: Electricity emissions factor and percent change in electricity emissions factor from the 2008 baseline.



CONCLUSION

The City of Boulder has made significant progress towards its goal of reducing emissions from municipal operations by 50 percent from 2008 levels by 2020. Having already reduced operational emissions by 40 percent as compared to the 2008 baseline, the city's work also puts it on track towards meeting the 2030 goal of an 80 percent reduction in emissions from 2008. Together, the city's work to: 1) reduce fleet vehicle fuel use and replace fuels with less carbon-intensive options; 2) mitigate energy use in city-owned facilities and buildings; and 3) procure greater amounts of renewable energy for city facilities, have been the largest drivers of the city's emission reductions to date. By continuing to improve upon building energy efficiency gains, increasing the amount of solar that is deployed to city facilities, and addressing opportunities for efficiency in the city's fleet, Boulder is likely to meet its emission reduction goals and continue to serve its residents and community in an environmentally and fiscally responsible manner.

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