CITY OF LAKEWOOD'S 2021 GREENHOUSE GAS EMISSIONS INVENTORY SUMMARY REPORT

Report completed July 2023

City of Lakewood Sustainability Division

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Executive Summary

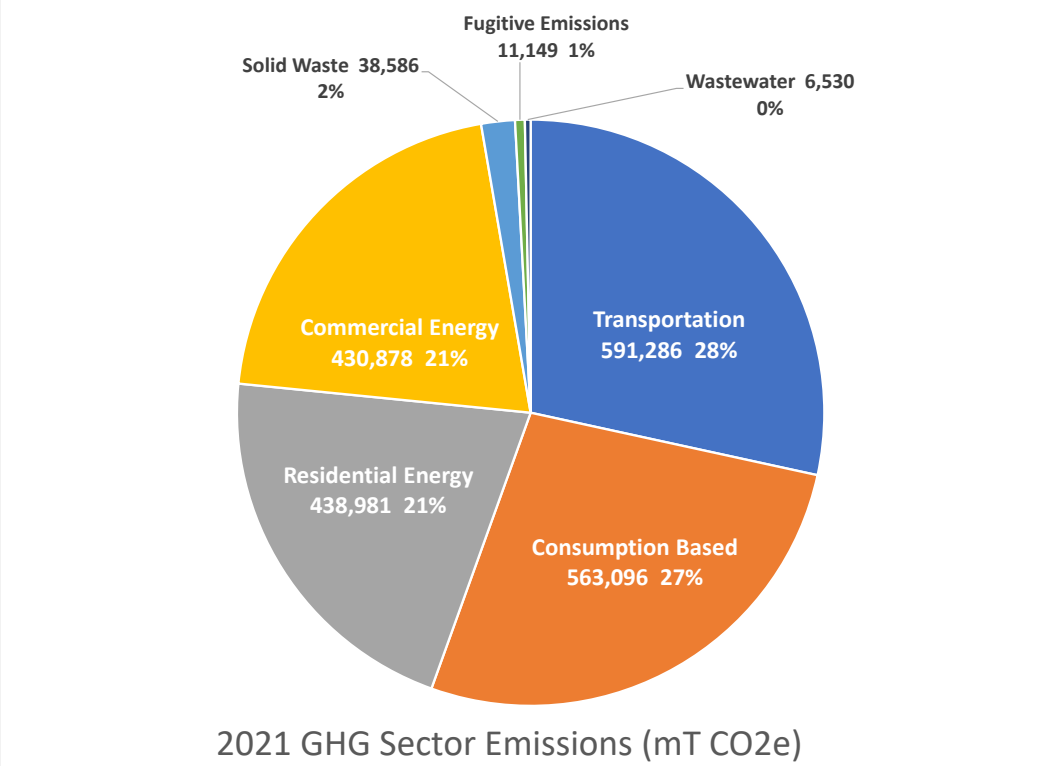
This report presents data from the City of Lakewood's 2021 Greenhouse Gas Inventory. The inventory was completed in accordance with the Global Protocol for Community-Scale GHG Emissions (GPC) and included BASIC level emissions, in addition to selected BASIC+ level emissions.

The City of Lakewood's adopted 2015 Sustainability Plan includes two GHG reduction targets:

1. Reduce communitywide GHG emissions by 20% below 2007 levels by 2025.
2. Reduce communitywide GHG emissions by 50% below 2007 levels by 2050.

Since adoption of the Sustainability Plan and in alignment with the city's commitment to the Global Covenant of Mayors (GCoM) for Climate & Energy and other climate programs, a Science-Based Target (SBT) and additional GHG emissions reductions goals were developed for Lakewood, including a goal of reducing communitywide GHG emissions by 60.7% below 2018 levels by 2030.

The 2021 Lakewood GHG inventory calculated a total emission value of 2,080,506 metric tons of CO_2 equivalence (mT CO_2e). Transportation (which includes gasoline and diesel-powered vehicles, public transit, and air travel) was the largest sector contributor, representing 28.4% of overall emissions. Consumption-based emissions contributed 27.1% of overall emissions. Energy use in residential buildings and energy use in commercial and industrial (C&I) buildings represented 21.1% and 20.7% of overall emissions, respectively.



2021 GHG Sector Emissions (mT CO2e)

Between 2007 and 2021, overall GHG emissions in Lakewood decreased by 15%. Excluding consumption-based GHG emissions, Lakewood's emissions decreased by 22% between 2007 and 2021. The decrease is primarily influenced by reduced emissions from electricity use and transportation. Since 2007, the mix of energy sources that supply Xcel Energy's electric grid has incorporated increasing amounts of renewable energy sources (wind and solar), resulting in lower carbon emissions factors. Total vehicle miles traveled (VMT) decreased in 2021 compared to 2007.

Sector	Emissions (mT CO_2e)		% Change 2007-2021
	2007	2021	
Buildings	1,228,916	881,009	-28%
Transportation*	688,082	591,286	-14%
Waste**	21,096	45,116	114%
Consumption-Based	509,652	563,096	10%
Total with Consumption-Based	2,447,746	2,080,506	-15%
Total without Consumption-Based	1,938,094	1,517,410	-22%

The 2021 GHG inventory results demonstrate that although emissions continue to decrease in Lakewood over time, a considerable amount of progress must still be made to meet the climate goals developed for the community. Data will continue to be collected and evaluated to measure progress and to determine and prioritize a list of high-impact action items that will accelerate the decarbonization of communitywide activities.

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Definitions of Terms

BASIC Emissions: Emissions that are included as part of GPC's standard protocol, including stationary energy, in-boundary transportation, and community-generated waste emissions.

BASIC+ Emissions: Established by GPC, emissions that include BASIC emission sources, as well as transboundary transportation; energy transmission and distribution losses; industrial processes and product use; and agriculture, forestry and other land uses.

CDP: A non-for-profit organization that runs the global disclosure systems for entities to manager their environmental impacts, including GHG reporting and disclosure.

Consumption-Based Emissions: Carbon emissions associated with goods and services consumed by a community. They include both direct and direct emissions from household consumption, such as the products and food the people buy and the services they utilize. They are considered Non-GPC Scope 3 emissions that are not required to be reported per GPC protocol.

Fugitive Emissions: Emissions from leaks and losses associated with natural gas transport distribution within the city.

Global Protocol for Community-Scale GHG Emissions (GPC): A well-established protocol and framework created to assist cities in accounting and reporting their GHG emissions.

Greenhouse Gases: Gases that trap heat and solar radiation in the planet's atmosphere. The most significant contributions to climate change are the burning of fossil fuels, which introduce large amounts of carbon dioxide (CO_2), methane (CH4), and other GHGs into the atmosphere. Collectively, these gases intensify the natural greenhouse effect, causing global average surface and lower atmospheric temperatures to rise.

Greenhouse Gas Inventory: An accounting and list of carbon emissions within a defined boundary over a specified period.

ICLEI: Local Governments for Sustainability, a global network of local and regional governments committed to sustainable urban development.

Scope 1 Emissions: GHG emissions from sources located within the city boundary, including natural gas, propane, and diesel used for building energy and fuel combustion for on-road vehicles.

Scope 2 Emissions: GHG emissions from the use of grid-supplied electricity for building energy and light rail within the city boundary.

Scope 3 Emissions: GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary, including waste disposal, wastewater treatment, potable water distribution, and consumption-based emissions.

Stationary Energy: Energy used for consumption outside of transportation, including electricity and natural gas use.

Vehicle Miles Traveled (VMT): Number of miles traveled by a motor vehicle over a specific period.

List of Acronyms

C&I	Commercial and Industrial
CDD	Cooling Degree Day
DIA	Denver International Airport
DRCOG	Denver Regional Council of Governments
FTE	Full-time Employee
GCoM	Global Covenant of Mayors
GHG	Greenhouse Gas
HDD	Heating Degree Day
IPCC	Intergovernmental Panel on Climate Change
kWh	kilowatt hours
mT CO_2e	metric tons of CO_2 equivalence
SBT	Science-Based Target
VMT	Vehicle Miles Traveled

1. Why a Greenhouse Gas Emission Inventory Matters

Greenhouse gas (GHG) emissions inventories provide Lakewood leaders, community members, and city staff with information necessary to understand the existing state of carbon emissions and inform decisions on where to focus climate mitigation efforts.

Naturally occurring gases dispersed in the atmosphere impact the Earth's climate by trapping solar radiation. This phenomenon is known as the greenhouse effect. Overwhelming scientific evidence clearly shows that human activities are increasing the concentration of GHGs and changing the global climate. The most significant contributions to climate change are the burning of fossil fuels for transportation and building energy and the breakdown of waste, which introduce large amounts of carbon dioxide (CO_2), methane (CH_4), and other GHGs[1] into the atmosphere. Collectively, these gases intensify the natural greenhouse effect, causing global average surface and lower atmospheric temperatures to rise.

Air temperatures have increased 2°F since 1900 in Colorado, creating increasingly hotter and drier conditions.[2] All 20 of the largest wildfires in state history have occurred since 2001. Local impacts of increasing temperatures due to climate change include the following:

- Average air temperatures expected to increase by 2.5° F by 2025 and 4° F by 2050.[3]
- Seasonal shifts in precipitation.
- Reductions in available water.
- Increase in the number of days that exceed 90 degrees and 100 degrees.
- More severe storms and flooding and more extreme wildfires.
- Increase in heat related illnesses and poor air quality.
- Increase in pine beetle and related tree-killing outbreaks.

Colorado's ecosystems, public health and safety, and economic viability (particularly tourism and agriculture industries) are at risk, and Colorado residents, businesses, and municipal operations will be impacted. A GHG inventory assesses a community's contribution to global climate change and informs community policies and programs that will reduce GHG emissions.

2. What We Can Learn from a GHG Inventory

The United Nations estimates that cities produce more than 60% of all GHG emissions, making cities a critical participant and partner in the sustainability movement.[4] In 2016, 196 parties including the United States, adopted the Paris Agreement, an international treaty with a goal of

[1] The GHGs include: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, nitrogen trifluoride, and sulfur hexafluoride.
[2] https://wwa.colorado.edu/sites/default/files/2021-06/ColoRiver_StateOfScience_WWA_2020_FullReport_hi-res.pdf
[3] https://cwcb.colorado.gov/focus-areas/hazards/climate
[4] https://www.un.org/en/climatechange/climate-solutions/cities-pollution

limiting the global temperature warming to 1.5°C above preindustrial levels. In 2023, the Intergovernmental Panel on Climate Change (IPCC) released the Climate Change 2023: Synthesis Report, which reiterated that the 1.5°C limit is still achievable, but immediate critical action must be taken to reduce global GHG emissions and mitigate the negative impacts of climate change.[5]

Lakewood's GHG inventory provides a picture of carbon emissions created by the activities of Lakewood residents, businesses, institutions, and industries. By comparing inventories over time, Lakewood can track the success of existing and future climate change related policies and programs.

3. Science-Based Target and Emissions Reduction Goals

The City of Lakewood's adopted 2015 Sustainability Plan includes two GHG reduction targets:

1. Reduce communitywide GHG emissions by 20% below 2007 levels by 2025.
2. Reduce communitywide GHG emissions by 50% below 2007 levels by 2050.

Since adoption of the Sustainability Plan, Science-Based Targets (SBTs) have been widely accepted as the standard best practice to determine a community's fair share of emissions reductions to meet the goals of the Paris Agreement. Communities that are most responsible for global emissions are also responsible for reducing GHG emissions at faster rates compared to developing communities.

In alignment with the city's commitment to the Global Covenant of Mayors (GCoM) for Climate & Energy and other climate programs, a SBT and additional GHG emissions reductions goals were developed for Lakewood:

1. Reduce communitywide GHG emissions by 60.7% below 2018 levels by 2030.
2. Achieve net zero GHG emissions by 2050.

Progress toward Lakewood's sustainability goals and GHG emission reduction targets are provided annually to City Council and the community through the Sustainability Plan Annual Reports. Lakewood also demonstrates accountability to the global community by annually reporting its GHG inventory results to CDP, a global platform used by cities and companies to disclose environmental data. This report also fulfills the reporting requirements for GCoM participation.

4. Inventory Methodology

The 2021 Lakewood GHG inventory uses the approach and methods provided by Global Protocol for Community-Scale GHG Emissions (GPC), which defines what categories of emissions must be

[5] https://www.ipcc.ch/report/sixth-assessment-report-cycle/

reported and how, providing a consistent structure to enable better comparisons among different cities.[6] There are two reporting levels for the community framework:

> **BASIC**: The BASIC methodology covers stationary energy, in-boundary transportation, and community-generated waste.
>
> **BASIC+:** The BASIC+ level includes BASIC emission sources, as well as transboundary transportation; energy transmission and distribution losses; industrial processes and product use; and agriculture, forestry and other land uses.

Based on available data, Lakewood has chosen the BASIC reporting level, which is consistent with many other cities to date. To ensure consistency with previous inventories, the 2021 inventory includes additional BASIC+ sources.

The GPC defines emission scopes by whether emissions occur within the city boundary or outside the city boundary, whereas BASIC emission scopes are defined as follows:

- **Scope 1:** GHG emissions from sources located within the city boundary including:
  - Energy and transportation fuel combustion.
  - Fugitive emissions (emissions from leaks and losses associated with natural gas transport distribution within the city).
  - Solid waste treated within the city.
  - Wastewater treated within the city.
- **Scope 2:** GHG emissions from the use of grid-supplied electricity, heat, steam and cooling within the city boundary.
- **Scope 3**: GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary including:
  - Solid waste treated outside the city.
  - Wastewater treated outside the city.

Transboundary aviation, airline travel from Denver International Airport (DIA) attributed to Lakewood, was recorded as a BASIC+ Scope 3 emission source.

Non-GPC Scope 3 emissions (consumption-based) include GHG emissions that are not required to be reported per GPC protocol but may help cities better understand GHG emissions that result from consumption-based activities. Consumption-based emissions are carbon emissions associated with goods and services consumed by a community. They include both direct and direct emissions from household consumption, such as the products and food the people buy and the services they utilize.

For Lakewood, a few select consumption-based emission sources were originally calculated in the 2007 inventory and were calculated again for subsequent inventory updates to support comparisons.

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[6] https://ghgprotocol.org/ghg-protocol-cities

These sources were selected because of their established methodology and locally available data, and they include:

- Treating drinking water supply.
- Cement use.
- Food consumption.

With the exception of electricity and natural gas emission factors, the GPC protocol uses the most up-to-date emission factors based on ICLEI's "U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions," Version 1.2, July 2019. Electricity and natural gas emission factors are sourced from Xcel Energy's Annual Community Report.[7]

For the 2021 GHG Inventory, the following methodology changes were made when estimating emissions:

- On-road Transportation: Google Environmental Insights Explorer was used to estimate total vehicle miles traveled (VMT) instead of using modeled data from the Denver Regional Council of Governments (DRCOG).
- Residential and Commercial Energy: propane estimates from AmeriGas were extrapolated using industry data.
- Potable Water Supply: US Community Protocol Appendix F was used to estimate kilowatt-hours of electricity per million gallons delivered to Lakewood from Denver Water.
- Commercial Solid Waste: the average waste generated per business from the City and County of Denver was used instead of assuming commercial dumpster size and frequency of service.
- Food Consumption: USDA Food Consumption method was used (average calories consumed) instead of dollars spent on food.

5. 2021 Emissions Analysis

The 2021 Lakewood GHG inventory calculated a total emission value of 2,080,506 metric tons of CO_2 equivalence (mT CO_2e) and a total BASIC emission value of 1,310,699 mT CO_2e. Table 1 presents a summary of 2021 emissions based on scope and sector. Table 2 provides additional details about emissions sources within each sector. Figure 1 shows total emissions and percentage of overall emissions by sector.

Transportation (which includes gasoline and diesel-powered vehicles, public transit, and air travel)

[7] https://www.xcelenergy.com/community_energy_reports

was the largest contributor to Lakewood's total emissions in 2021, contributing 28.4% of overall emissions. Energy use in residential buildings and energy use in commercial and industrial (C&I) buildings represented 21.1% and 20.7% of overall emissions, respectively. Consumption-based emissions contributed 27.1% of overall emissions. The remainder of emissions come from the solid waste sector, process and fugitive emissions, and wastewater treatment. Table 1 shows that most BASIC emissions came from the energy and transportation sectors, representing 97% of total BASIC emissions.

Table 1. Total and BASIC Emissions (mT CO_2e)

Sector	Scope 1	Scope 2	Scope 3	BASIC Emissions	Total Emissions
Stationary Energy	354,024	526,984		881,009	881,009
Transportation	382,638	1,936	206,711	384,574	591,286
Solid Waste			38,586	38,586	38,586
Wastewater			6,530	6,530	6,530
Consumption-Based			563,096		563,096
Total	**736,663**	**528,921**	**814,923**	**1,310,699**	**2,080,506**

Note: Totals may not equal sum of sectors due to rounding.

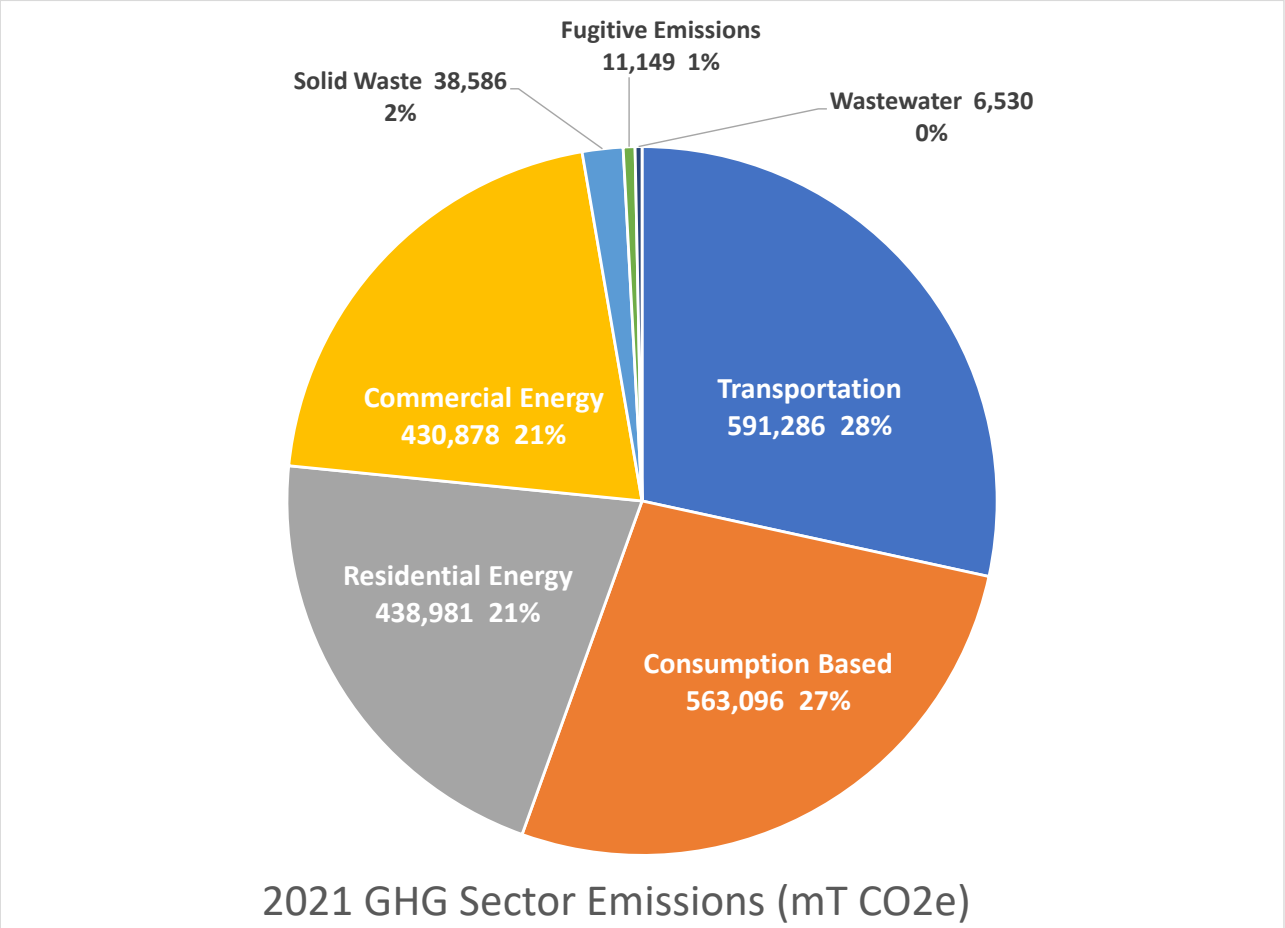
Sources required for BASIC & BASIC+ reporting
Sources required for BASIC+ reporting only
Sources included in Other Scope 3

Table 2. 2021 Detailed Emissions

Sector	Type	Emissions (mT CO_2e)	
Stationary Energy	Commercial Energy (Natural Gas, Propane, Diesel)	138,208	881,009
	Residential Energy (Natural Gas, Propane)	204,667	
	Process & Fugitive Emissions (Natural Gas)	11,149	
	Commercial Energy (Electricity)	292,670	
	Residential Energy (Electricity)	234,314	
Transportation	On Road Transportation	382,638	591,286
	Light Rail	1,936	
	Aviation	206,711	
Solid Waste	Commercial	20,847	38,586
	Residential	17,734	
	Compost	5	
Wastewater	Wastewater Treatment	6,530	6,530
Consumption-Based	Cement	137,104	563,096
	Food	423,837	
	Potable Water Distribution	2,155	
	TOTAL	**2,080,506**	

Note: Totals may not equal sum of sectors due to rounding.

Figure 1. Total Emissions by Sector



6. Inventory Comparisons

Between 2007 and 2021, overall GHG emissions in Lakewood decreased by 15%. Excluding consumption-based GHG emissions, Lakewood's emissions decreased by 22% between 2007 and 2021. Total BASIC emissions decreased by 27% between 2007 and 2021. Table 3 compares sector and overall emissions for the four communitywide GHG inventories that have been completed.

While the energy associated with the building sector remained the greatest contributor of Lakewood's emissions in 2021, these values have decreased since 2007 by 28%. This is primarily due to increased renewable energy sources incorporated into Xcel Energy's electricity grid. Total emissions (both including Consumption-Based and BASIC emissions) continue to decrease over time. Since 2018, transportation emissions decreased, while waste and consumption-based emissions increased. Additional analysis is described in Section 7 Factors Influencing Emissions.

Table 3. Comparison Between GHG Inventories

Sector	Emissions (mT CO_2e)				% Change 2007-2021
	2007	2015	2018	2021	
Buildings	1,228,916	1,099,381	970,036	881,009	-28%
Transportation*	688,082	650,148	722,936	591,286	-14%
Waste**	21,096	22,047	30,599	45,116	114%
Consumption-Based	509,652	619,782	563,216	563,096	10%
Total with Consumption-Based	2,447,746	2,391,358	2,286,787	2,080,506	-15%
Total without Consumption-Based	1,938,094	1,771,577	1,723,571	1,517,410	-22%
Total BASIC	1,806,359	1,652,223	1,480,115	1,310,699	-27%

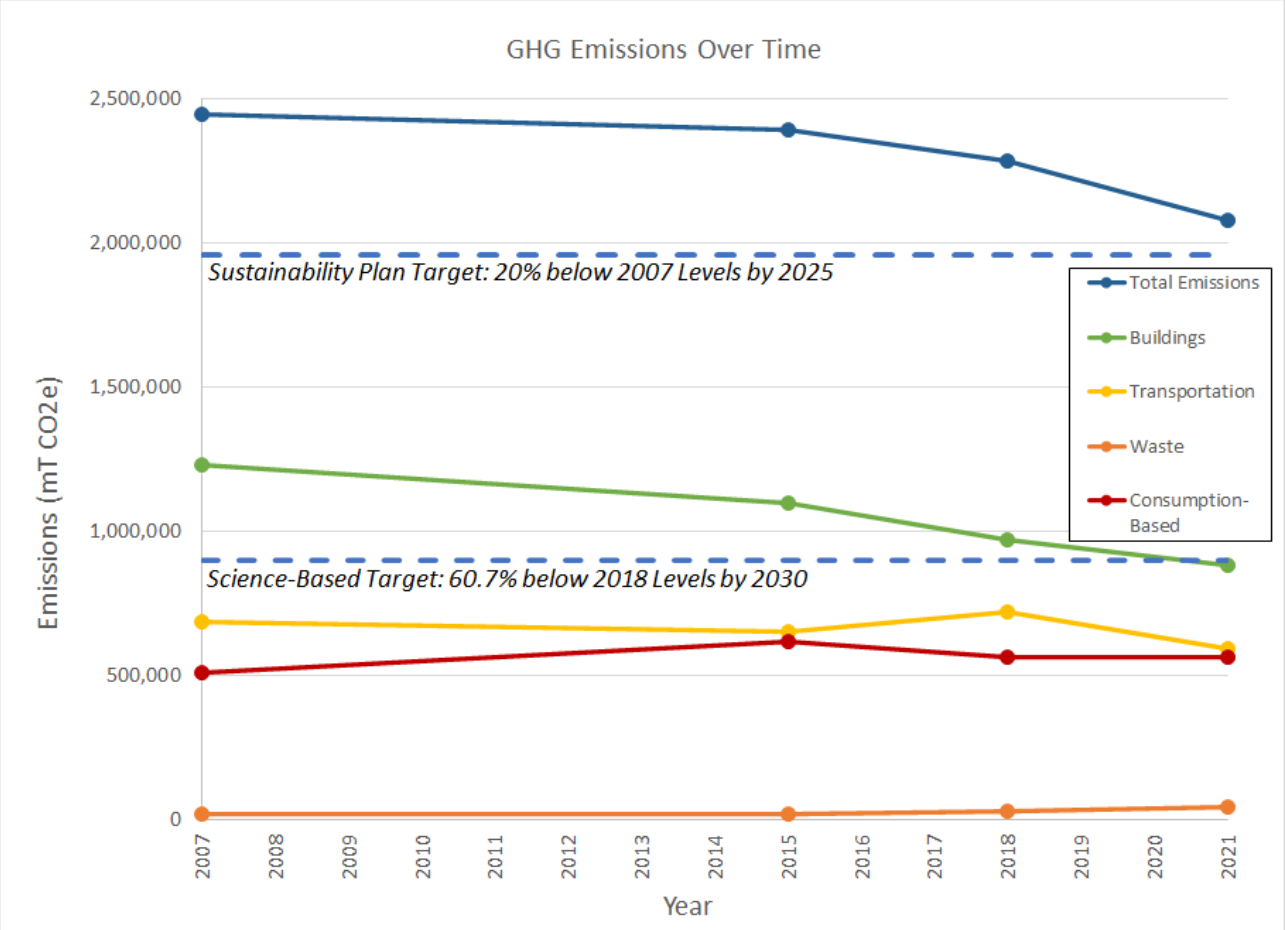
** In 2021, Google Environmental Insights Explorer was used to estimate total vehicle miles traveled (VMT) instead of using modeled data from the Denver Regional Council of Governments (DRCOG) as in previous inventories.*

*** In 2021, commercial solid waste was determined using the average waste generated per business from the City and County of Denver, instead of assuming commercial dumpster size and frequency of service as in previous inventories.*

Figure 2 shows the changes in sector emissions over time, as well as how total emissions compare to the city's Sustainability Plan GHG target and Science-Based Target. The Sustainability Plan target will likely be achieved by 2025 due to the planned incorporation of additional renewable energy, as described in Xcel Energy's Clean Energy Plan.[8] The Science-Based Target will be more challenging to achieve unless additional high impact action items are incorporated into the community's emissions related activities (see Section 8 Next Steps).

[8] https://co.my.xcelenergy.com/s/environment/clean-energy-plan

Figure 2. Sector Emissions Over Time



7. Factors Influencing Emissions

Emissions are a product of emission factors and activity data. Emission factors can be changed through large system-side modifications, such as using cleaner fuel sources. Activity data is influenced by community indicators (i.e., population, economic growth, etc.) and consumption and generation behaviors. These behaviors can be positively affected through programs, policies, and education, which are identified in the Sustainability Plan. The following is an overview of the drivers that may have affected the GHG emissions between 2007 and 2021.

7.1. Community Indicator Trends

Between 2007 and 2021, Lakewood experienced growth in population, number of households, and number of jobs (see Table 4). Population and job growth can affect GHG emissions due to changes in energy and water use, transportation patterns, waste production, and household consumption. While Lakewood's population has increased over time, the overall GHG emissions have decreased.

Table 4. Changes in Community Indicators

Indicator	2007	2015	2018	2021
Population	143,109	152,597	151,411	155,608
% Change Population Since 2007	-	6.6%	5.8%	8.7%
Households	60,017	61,986	64,734	67,598
Number of Jobs	66,483	73,255	82,506	86,247

7.2. Electricity Carbon Emissions Factor Trends

Colorado's Renewable Energy Standard requires Xcel Energy to increase the efficiency of its operations and source increasing amounts of energy from low- to zero-carbon sources (i.e. renewable energy, recycled energy, etc.). As a result, the mix of energy sources that supply Xcel Energy's electric grid changes every year, and the resulting electricity carbon emission factor decreases every year. Table 5 shows how the electricity carbon emissions factor has changed since 2007. Based on data from Xcel Energy, electricity emission factors decreased 43% from 2007 to 2021. Xcel Energy's natural gas emission factor does not change annually because the composition of natural gas delivered to Lakewood does not change. Natural gas combustion has a specific carbon emissions factor. Natural gas emissions can only be reduced by lowering overall consumption.

Table 5. Changes in Electricity Carbon Emissions Factor

	Units	2007	2015	2018	2021	% Change 2007-2021
Electricity carbon emissions factor	mT CO_2e/MWh	0.839	0.676	0.552	0.477	-43%

The electricity carbon emissions factor has a significant impact on the city's emissions, as a major portion of any reduction in electricity-generated emissions is attributable to the reduced emission factor. The reduced emission factor may result in reductions in electricity-generated emissions, even when electricity use increased.

7.3. Building Energy Use Trends

Table 6 presents communitywide total electricity and natural gas data for inventory years. Electricity use has decreased, and natural gas use has increased slightly since 2007. The

percent change between 2007 and 2021 for both energy fuels is less than the population growth percent change shown in Table 4.

Table 6. Changes in Community Energy Activity Data

Energy Activity	Units	2007	2015	2018	2021	% Change 2007-2021
Total electricity	kWh	1,110,369,000	1,135,815,439	1,126,103,980	1,097,187,216	-1.2%
Total natural gas	therms	62,599,210	59,704,114	62,589,021	64,263,720	2.7%

7.3.1. Residential Energy Use

Table 7 presents residential energy activity data for inventory years. Residential electricity use increased in 2021 compared to 2007, while natural gas use remained steady. The percent change for both fuels is less than the population growth during the same period (+8.7%). On a per capita basis, residential electricity and natural gas have decreased since 2007. This may be attributed to increased efficiency of lighting and space conditioning over time. Residential energy emissions per person have decreased significantly due to the lower carbon emissions factor associated with the city's electricity grid, as shown in Table 5.

Table 7. Changes in Residential Energy Activity Data

Energy Activity	Units	2007	2015	2018	2021	% Change 2007-2021
Residential electricity	kWh	460,547,000	452,426,346	466,040,714	487,847,842	5.9%
Residential natural gas	therms	38,243,940	36,253,504	37,552,227	38,466,713	0.6%
Residential Energy Emissions per person	mT CO_2e/person	4.0	3.3	3.0	2.8	-29.3%
Residential Electricity per person	kWh/person	3,218	2,965	3,078	3,135	-2.6%
Residential Natural Gas per person	therms/person	267	238	248	247	-7.5%

7.3.2. Commercial & Industrial Energy Use

Table 8 presents commercial and industrial energy activity data for inventory years. In 2021, commercial and industrial electricity and natural gas use was 56% and 40% of total communitywide use, respectively. Commercial and industrial electricity and natural gas decreased by 27.7% and 18.4%, respectively, per full-time employee (FTE). Commercial energy use may have been lower in 2021 due to decreased business activity and increased remote work due to the COVID pandemic. Energy emissions per FTE have decreased significantly due to the lower carbon emissions factor associated with the city's electricity grid, as shown in Table 5.

Table 8. Changes in Commercial Energy Metrics Per Capita

Energy Activity	Units	2007	2015	2018	2021	% Change 2007-2021
C&I electricity	kWh	649,822,000	683,389,093	660,063,266	609,339,374	-6.2%
C&I natural gas	therms	24,355,270	23,450,610	25,036,794	25,797,007	5.9%
C&I Energy Emissions per FTE	mT CO_2e/FTE	9.7	8.0	6.1	5.0	-48.7%
C&I Electricity per FTE	kWh/FTE	9,774	9,329	8,000	7,065	-27.7%
C&I Natural Gas per FTE	therms/FTE	366	320	303	299	-18.4%

Note: Actual % Change may differ than using values in table due to rounding.

7.3.3. Weather Normalized Energy Use

Table 9 presents weather normalized energy use data. Weather normalized energy use accounts for the amount of energy use that would have been consumed under average climate conditions. Some years may be colder or warmer than previous ones, requiring various amounts of heating and cooling. Weather normalization adjusts energy use to allow for a comparison of different years as if they all had a normal weather period. The weather normalization process considers the number of Heating Degree Days (HDD) and Cooling Degree Days (CDD). HDD and CDD are roughly proportional to the energy used for heating and cooling a building.[9]

Lakewood experienced a slight decrease in electricity consumption between 2007 and 2021, despite an 111% increase in days needed to cool buildings. The residential electricity per person per CDD decreased by 54%, and the commercial electricity per employee per CDD decreased by 66%, indicating that building operations have become more efficient in electricity usage. Both residential and commercial natural gas use per FTE per HDD increased despite the number of HDD decreasing since 2007. Considering that both population and number of jobs have increased since 2007, electricity use efficiency has increased significantly on a per capita basis.

[9] A Heating Degree Day (HDD) and Cooling Degree Day (CDD) are calculated by taking the difference between the average daily temperature and the balance point temperature. The balance point temperature is the average daily outside temperature at which a building maintains a comfortable indoor temperature without heating or cooling (60°F was used as the balance point temperature to determine local HDD and CDD). When the average daily temperature is above the balance point temperature, the result is cooling degree days (i.e., you need to cool the building to maintain the balance point temperature). When the average daily temperature is below the balance point temperature the result is heating degree days (i.e., you need to heat the building to maintain the balance point temperature).

Table 9. Weather Normalized Energy Use Per Capita

Weather Normalized Energy Use per Person / FTE	Units	2007	2015	2018	2021	% Change 2007-2021
Cooling Degree Days (CDD)	CDD	784	1,514	1,684	1,656	111.2%
Heating Degree Days (HDD)	HDD	5,687	4,291	4,465	4,100	-27.9%
Residential Electricity per person per CDD	kWh/person/CDD	4.1	2.0	1.8	1.9	-53.9%
Residential Natural Gas per person per HDD	therms/person/CDD	0.047	0.055	0.056	0.060	28.3%
C&I Electricity per FTE per CDD	kwh/FTE/HDD	12.5	6.2	4.8	4.3	-65.8%
C&E Natural Gas per FTE per HDD	therms/FTE/HDD	0.064	0.075	0.068	0.073	13.3%

Note: Actual % Change may differ than using values in table due to rounding.

7.4. Transportation Trends

As shown in Table 3, emissions from transportation decreased 14% between 2007 and 2021. The transportation value includes vehicle travel from on-road gasoline and diesel vehicles, public transit, and airline travel from DIA. The emissions represent only the portion that is attributed to Lakewood activity. For example, airline activity and emissions only include the portion attributed to Lakewood passengers, not all passengers traveling from DIA. Emission data is based on several factors: emission factors, fuel efficiencies, vehicle miles traveled, and vehicle type distribution by vehicle fuel. The emission factors for gasoline, diesel, and jet fuel are not expected to change significantly each year, which suggests that changes in transportation emissions are a result of changes in activity data.

Table 10 presents transportation activity data for inventory years. Compared to the 2007 baseline, all metrics decreased in 2021 except aviation jet fuel consumed. Compared to 2018, all metrics decreased in 2021 except diesel based on-road transportation. The decrease may be reflective of the impact of the COVID pandemic on transportation behaviors and travel restrictions. Residents operating passenger vehicles generally drove less in 2021, with many working from home or in remote locations instead of traditional office settings. Additionally, the methodology for transportation activity has changed the past few inventory years, which may influence comparison of activity data over time.[10]

[10] The 2007 inventory used a VMT value produced by the Denver Regional Council of Governments (DRCOG) demand model, while the 2018 inventory used a figure for per-capita VMT, also provided by DRCOG. The 2021 inventory used VMT data from Google's Environmental Insights Explorer. To determine VMT, Google applied privacy filters, aggregation and anonymization techniques, and inference models to data derived from Google's proprietary location history data.

Table 10. Transportation Activity Data

Transportation Type	Units	2007	2015	2018	2021	% Change 2007-2021
On-Road Transportation – Gasoline*	Vehicle Miles Traveled	1,002,420,104	929,926,828	1,053,152,004	673,906,582	-32.8%
On-Road Transportation – Diesel*	Vehicle Miles Traveled	101,236,314	107,894,860	40,792,267	69,795,142	-31.1%
Public Transit (Bus)	Gallons Diesel	187,868	298,497	378,714	165,774	-11.8%
Railways	kWh	N/A	3,291,810	14,110,143	4,033,820	N/A
Aviation	Gallons Jet Fuel	13,751,269	12,458,843	25,174,908	21,130,171	53.7%

** In 2021, Google Environmental Insights Explorer was used to estimate total vehicle miles traveled (VMT) instead of using modeled data from the Denver Regional Council of Governments (DRCOG) as in previous inventories.*

7.5. Waste Trends

Emission data related to municipal waste is based on the amount of waste generated, waste characterization, and emission factors. The same assumptions of waste generation per household and per business were applied for both inventories; therefore, estimated waste emissions increased in proportion to the increase in number of households and number of businesses.

Table 11 presents waste activity data for inventory years. There was a significant increase in nonresidential landfill waste in 2021, potentially due to changes in how this amount was quantified (see Section 4 Inventory Methodology). Improved tracking of solid waste collection would allow a more informative comparison of solid waste emissions between inventories in the future. Wastewater treatment emissions are a function of the population served, and the increase in associated emissions matched the increase in Lakewood's population.

Table 11. Waste Activity Data

Waste Type	Units	2007	2015	2018	2021	% Change 2007-2021
Landfill Waste (Total)	Tons	87,185	90,817	116,966	172,064	97.4%
Landfill Waste (Residential)	Tons	68,659	70,912	68,316	79,090	15.2%
Landfill Waste (Non-Residential)*	Tons	18,525	19,905	48,649	92,974	401.9%
Wastewater Population Served	People	143,109	152,597	151,511	155,608	8.7%

** In 2021, commercial solid waste was determined using the average waste generated per business from the City*

and County of Denver, instead of assuming commercial dumpster size and frequency of service as in previous inventories.

7.6. Consumption-based Trends

All inventories include consumption-based emissions, covering the categories of cement usage, food usage, and drinking water treatment. The consumption-based emissions increased by 10% from 2007 to 2021 (see Table 3); however, considerable caution should be taken in interpreting this result. The methodology used for these emissions is based on national consumption trends rather than data on local consumption. In addition, the method does not distinguish between changes in spending because of food price changes and changes in the amount or types of food consumed (i.e. local produce, less meat consumption). There are several services and goods that are not currently included as part of consumption-based emissions, as noted in Section 4. Examples of communities with consumption-based GHG inventories include the State of Oregon and the San Francisco, California.

8. Next Steps

The 2021 GHG inventory results demonstrate that although emissions continue to decrease in Lakewood over time, a considerable amount of progress must still be made to meet the SBTs developed for the community. Data will continue to be collected and evaluated to measure progress toward the city's goals and to determine and prioritize a list of high-impact action items that will accelerate the decarbonization of communitywide activities.

Strategies to decrease communitywide GHG emissions may include:

- increasing building energy efficiency through programs and policies, such as benchmarking and performance standards of the existing built environment,
- ensuring new development minimizes carbon impact,
- expanding building electrification,
- increasing the amount of locally generated renewable energy,
- adding carbon sequestration strategies such as increasing tree canopy,
- providing education about consumption-based emissions and the need for a circular economy,
- reducing VMT, and
- increasing electric vehicle adoption and public transit to reduce transportation emissions.

The city will also continue to inventory and report GHG emissions in Lakewood on a regular basis to both the community and organizations like CDP to ensure that programs, planning, and policy are effective toward decreasing carbon emissions. Potential future data collection projects include detailed inventories of consumption-based emissions, local government operations, and neighborhood-scale activity and emissions.

APPENDIX A
DETAILED GHG EMISSIONS DATA

Scope	BASIC	Specific Sectors	GHG Emissions (mT CO_2e)			
			2007	2015	2018	2021
1	Yes	On-Road Transportation	556,347	528,557	476,672	382,638
1	Yes	Commercial Energy (Natural Gas, Propane, Diesel)	129,537	124,726	133,707	138,208
1	Yes	Residential Energy (Natural Gas, Propane)	203,406	192,820	199,751	204,667
1	Yes	Fugitive Emissions (Natural Gas)	10,386	9,906	10,859	11,149
2	Yes	Light Rail	-	2,237	2,808	1,936
2	Yes	Commercial Energy (Electricity)	518,273	464,449	367,007	292,670
2	Yes	Residential Energy (Electricity)	367,314	307,481	258,712	234,314
3	No	Aviation	131,735	119,354	243,456	206,711
3	Yes	Solid Waste	18,174	18,931	27,507	38,586
3	No	Consumption-Based (Potable Water Distribution)	882	1,007	4,353	2,155
3	Yes	Wastewater Treatment	2,922	3,116	3,092	6,530
3	No	Consumption-Based (Food, Cement)	508,770	618,775	558,863	560,941

Scope	GHG Emissions (mT CO_2e)			
	2007	2015	2018	2021
Scope 1	899,676	856,008	820,990	736,663
Scope 2	885,587	774,167	628,527	528,921
Scope 3	662,483	761,183	837,271	814,923
TOTAL	2,447,746	2,391,358	2,286,787	2,080,506

Note: Totals may not equal sum of sectors due to rounding.