City of Cambridge

2019 Community-wide GHG Emissions Inventory

September 2022

Introduction

The City of Cambridge set a goal to become carbon neutral no later than 2050. To track progress on reaching this goal, community-wide greenhouse gas (GHG) inventories are completed approximately every five years.

This report describes the most recent inventory, reflecting 2019 data, including:

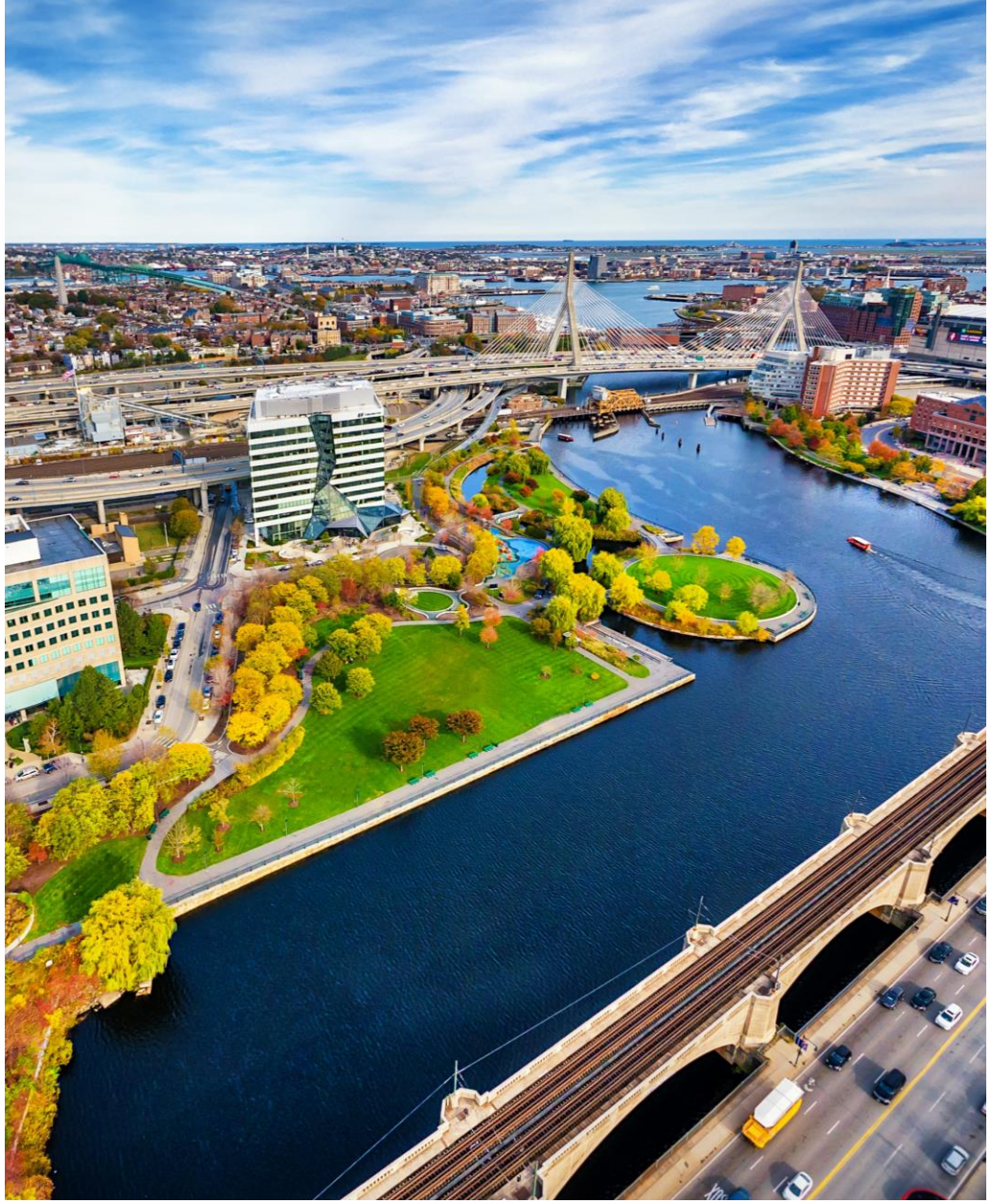
- **An overview of Cambridge's community-wide GHG emissions inventory**
- **2019 inventory results and 2012-2019 trendline**

Understanding Cambridge's Community-wide GHG Inventory

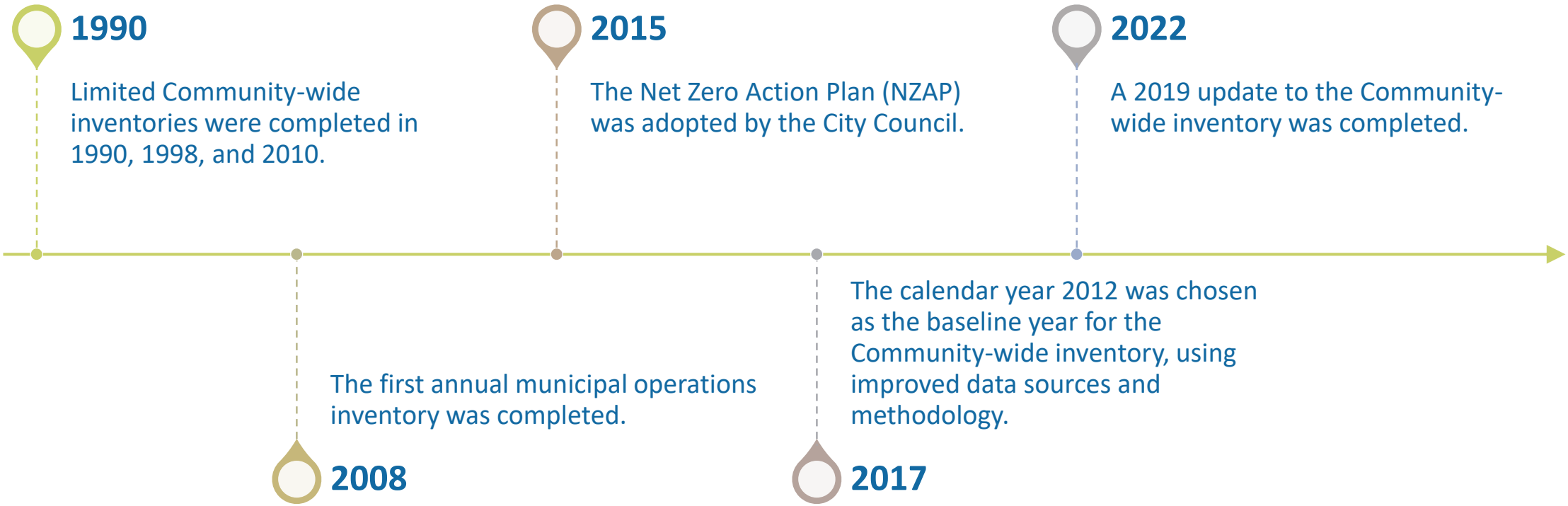
Inventory Purpose

The purpose of Cambridge's 2019 Community-wide GHG Emissions Inventory is to:

1. Identify current sources of carbon dioxide (CO_2) and other GHGs generated in Cambridge
2. Quantify GHG emissions from community-wide activities
3. Compare 2019 emissions to the 2012 baseline and observe trends
4. Use the information to evaluate the impact of existing policies and programs aimed at reducing emissions and reaching the City's carbon neutral goals



Inventory History



Inventory Background

The City of Cambridge has joined the **Global Covenant of Mayors (GCoM)**, a global network of thousands of cities that are also committed to reducing GHG emissions from city-level activities.

As a GCoM signatory, **Cambridge commits to conducting regular GHG inventories to evaluate progress and accelerate climate and energy initiates** that lead to a low-emission and climate-resilient future.

What is a Community-Wide GHG Emissions Inventory?

Conceptual sketch of the upgraded Central Utilities Plant at MIT, as viewed from Albany Street
Credit: MIT/Ellenzweig.

GHG emissions inventories are developed to help community leaders and members understand how and in what quantities their activities generate GHG emissions. GHG emissions associated with Cambridge activities can result from sources within the City's boundaries as well as outside the City's boundaries.

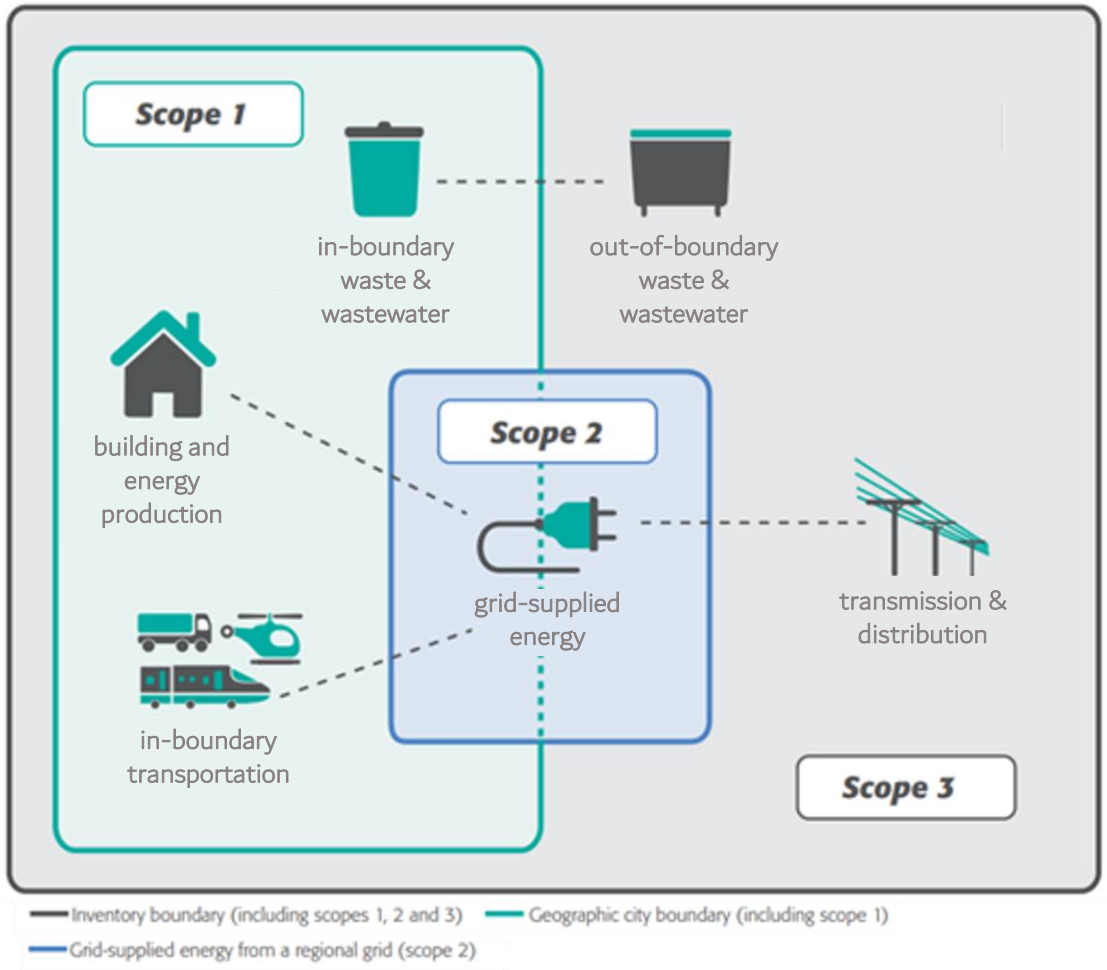
To distinguish GHG emissions, they are typically categorized as either Scope 1, Scope 2, or Scope 3.

Sources and Boundaries of Community-Based GHG Emissions

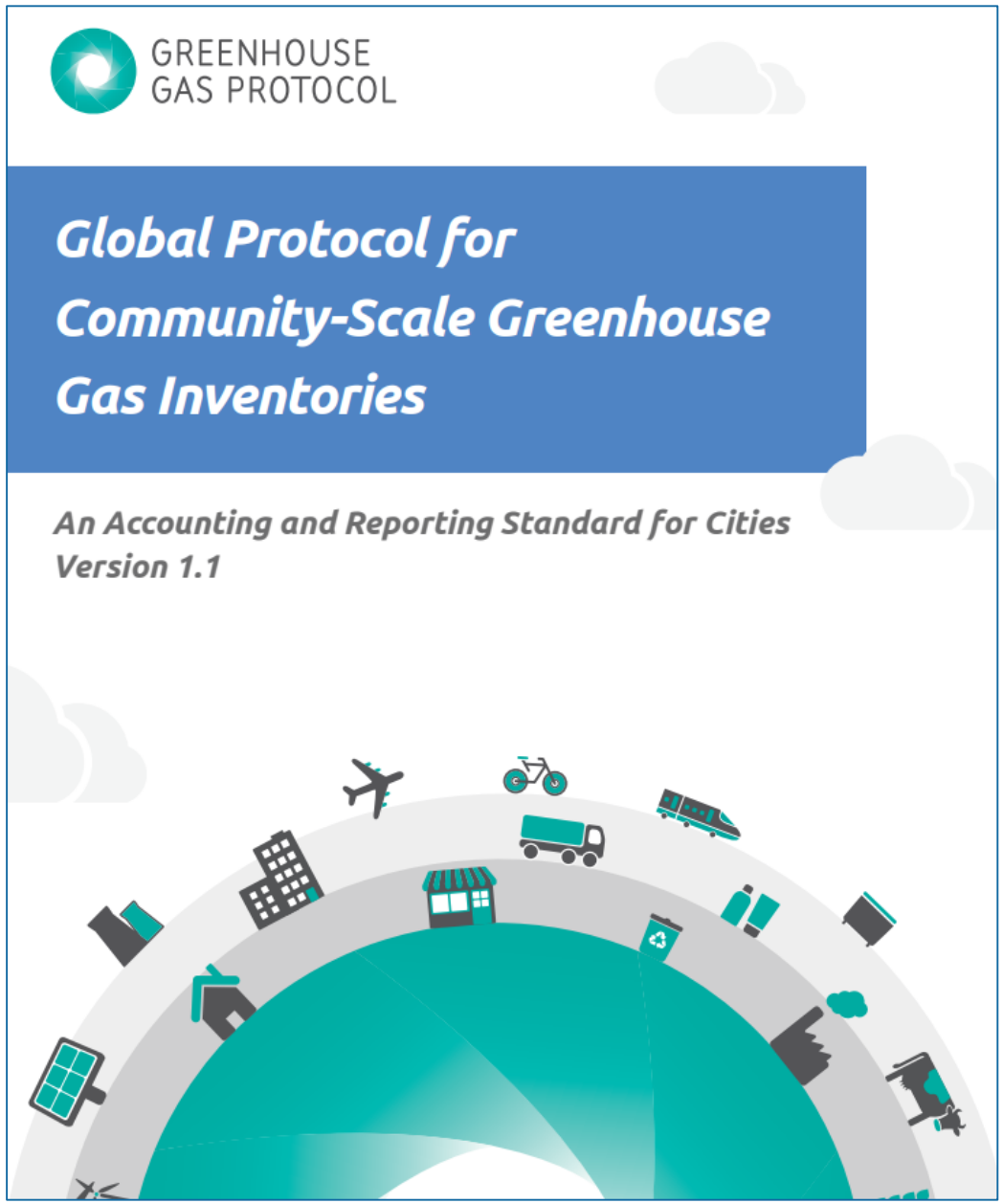
Scope 1: GHG emissions from sources located within the City, such as gasoline consumed by cars and natural gas used to heat buildings.

Scope 2: GHG emissions associated with electricity supplied by the grid to power buildings and motorized modes of transport.

Scope 3: GHG emissions occurring outside of the City limits resulting from activities taking place within the City (for example, treatment of the City's waste outside of Cambridge).



Graphic modified from the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories.



Cambridge's 2019 Community-wide GHG Emissions Inventory follows the **Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC).** The GPC is a compliance requirement for the Global Covenant of Mayors for Climate and Energy (GCoM) commitment.

Like the 2012 Community-wide GHG Emissions Inventory, the 2019 update accounts for Scope 1, 2, and 3 GHG emissions from the Stationary Energy (Buildings and Energy Production), Transportation, and Waste Sector, as required by the GPC reporting framework.

Buildings and Energy Production Sub-Sectors Included in Cambridge GHG Inventory

Building and Energy Sector	Scope 1	Scope 2	Scope 3
Residential – Natural Gas / Fuel Oil Use	X		
Residential – Electricity Use		X	
Commercial – Natural Gas / Fuel Oil Use	X		
Commercial – Electricity Use		X	
Manufacturing and Construction – Fuel Use (Including Vehicles)	X		
Manufacturing and Construction – Electricity Use		X	
Energy Producing Facilities (Multiple Fuels)	X		
Electricity Distribution System Losses			X
Fugitive Emissions* from Oil and Natural Gas Systems	X		

*Unintended leaks of gasses or vapors

X = Included in inventory

= Located within the City

= Electricity supplied by the grid

= Located outside of City limits

Transportation Sub-Sectors Included in Cambridge GHG Inventory

Transportation Sector	Scope 1	Scope 2	Scope 3
Vehicle Travel On-road – Fuel Use	X		
Vehicle Travel On-road – Electricity Use		X	
Public Transit – Fuel Use	X		
Public Transit – Electricity Use		X	
Electricity Distribution System Losses			X

X = Included in inventory

= Located within the City

= Electricity supplied by the grid

= Located outside of City limits

Waste Sub-Sectors Included in Cambridge GHG Inventory

Waste Sector	Scope 1	Scope 2	Scope 3
Solid Waste – Landfill Disposal			X
Solid Waste – Biological Treatment			X
Solid Waste – Incineration			X
Wastewater Treatment			X

X = Included in inventory

= Located within the City

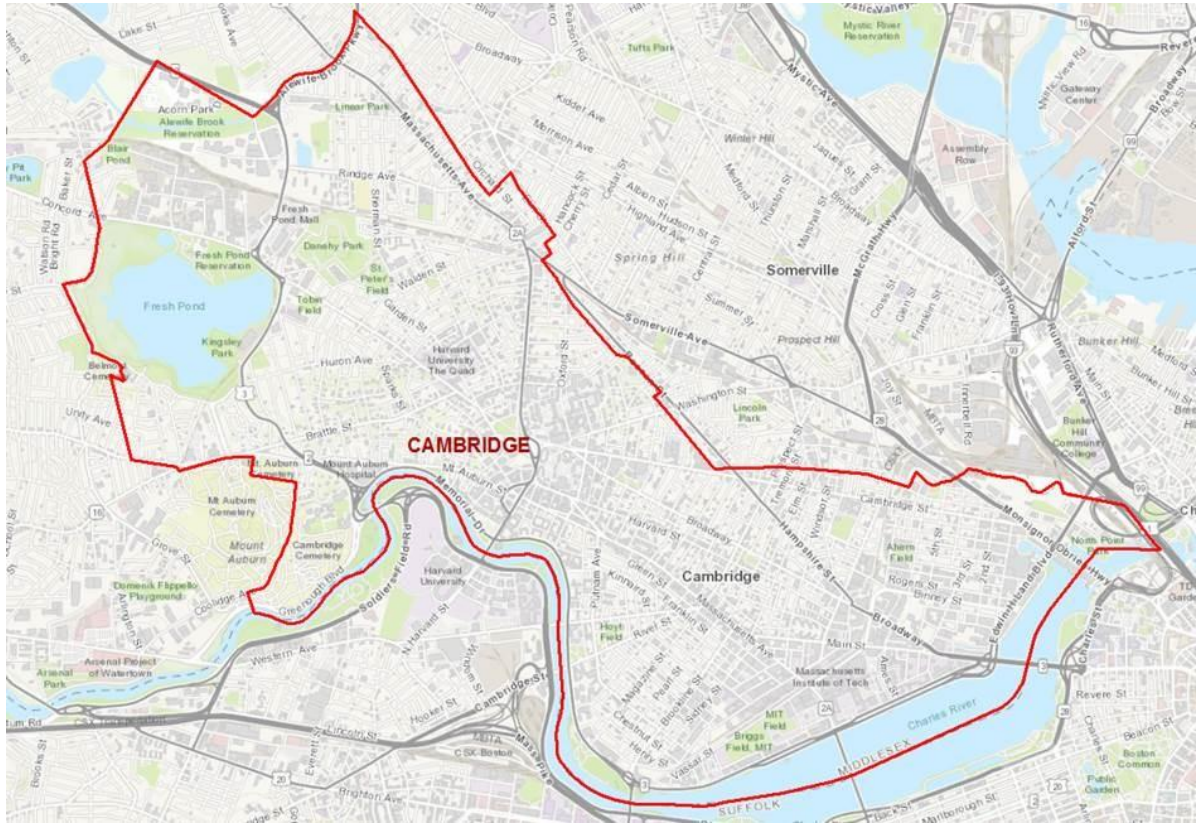
= Electricity supplied by the grid

= Located outside of City limits

Inventory Boundary and Time Period

Consistent with the 2012 community-wide inventory, the 2019 update uses the administrative boundary of the City of Cambridge as its geographic boundary.

As a signatory to the Compact of Mayors, the City is committed to updating its Community-wide GHG Emissions Inventory every 5 years. Calendar Year 2019 was used as the reporting year because this was the latest year of complete data that was not skewed by the COVID pandemic.



Total Land Area = 6.4 sq. mi.

How GHG Emissions Are Calculated:

The basic equation for calculating GHG emissions is:

- **Activity data** refers to measurements of energy use or other GHG emissions-generating processes, such as fuel consumption, electricity consumption, vehicle miles traveled, and tons of waste generated.
- **Emission factors** are used to convert activity data into amounts of emissions generated by the activity (for example, pounds of carbon dioxide per megawatt hour of electricity).
- Emissions are reported using the unit of **metric tons of carbon dioxide equivalent (MT CO_2e).**

2019 Community-wide GHG Emissions Inventory Results

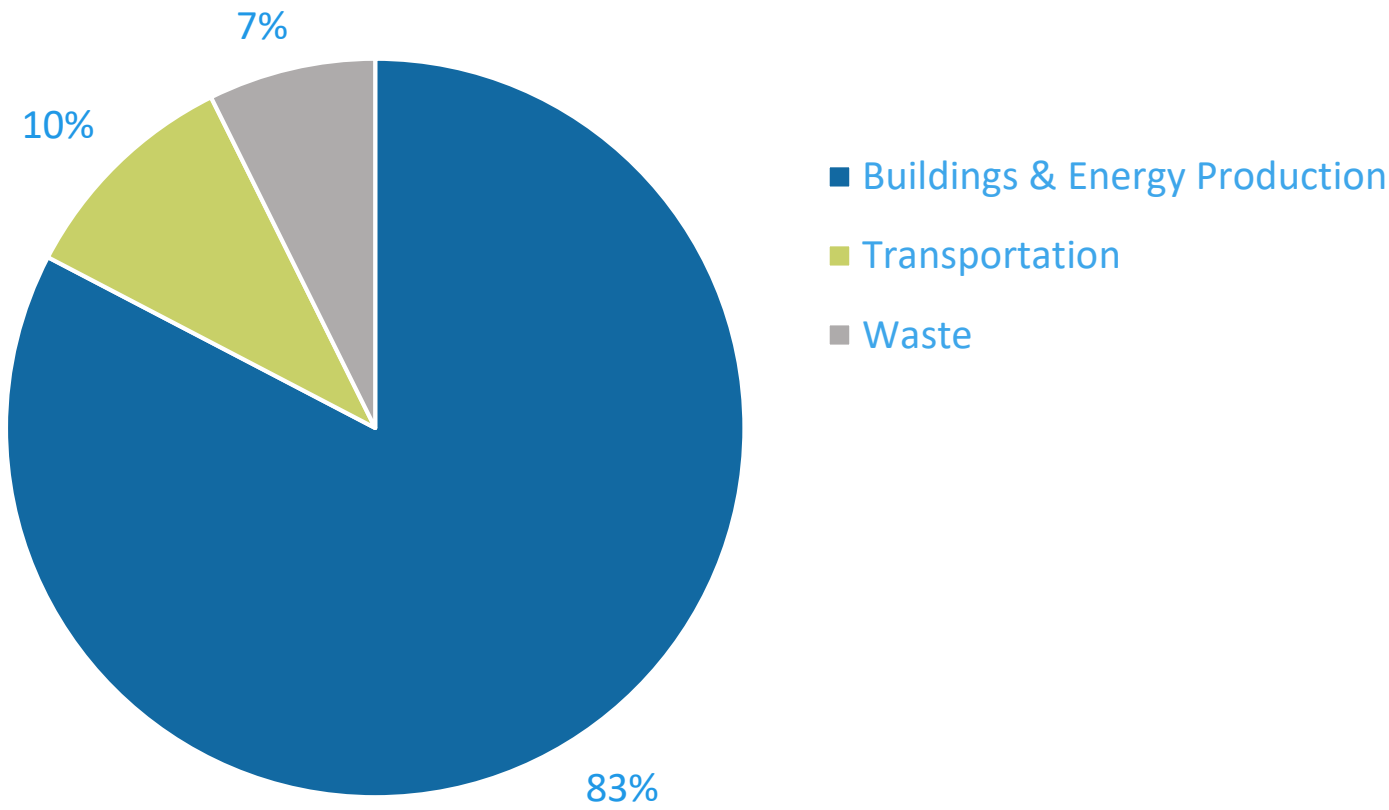
2019 Community-wide GHG Emissions by Sector

Total emissions for calendar year 2019 were estimated to be **1,413,026** metric tons of carbon dioxide equivalent (MT CO_2e).

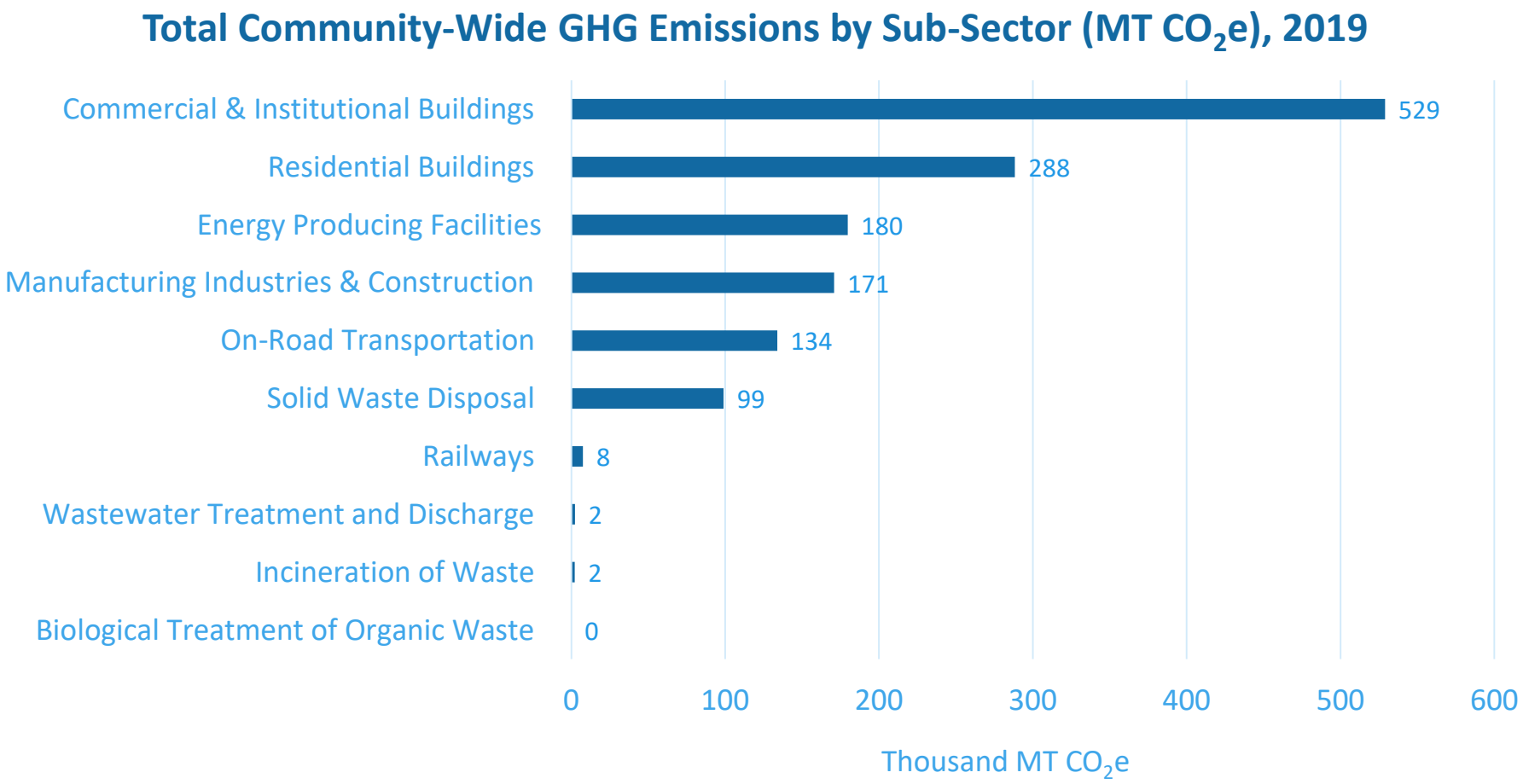
Emissions from the Buildings and Energy Production sector were responsible for 82.7 percent of this total, followed by the Transportation sector at roughly 10 percent and the Waste Sector at 7.3 percent.

89 percent of total 2019 emissions can be directly attributed to the City as Scope 1 and 2 emissions, while 11 percent of emissions are associated City activities but are considered Scope 3 emissions because they occur outside of City limits.

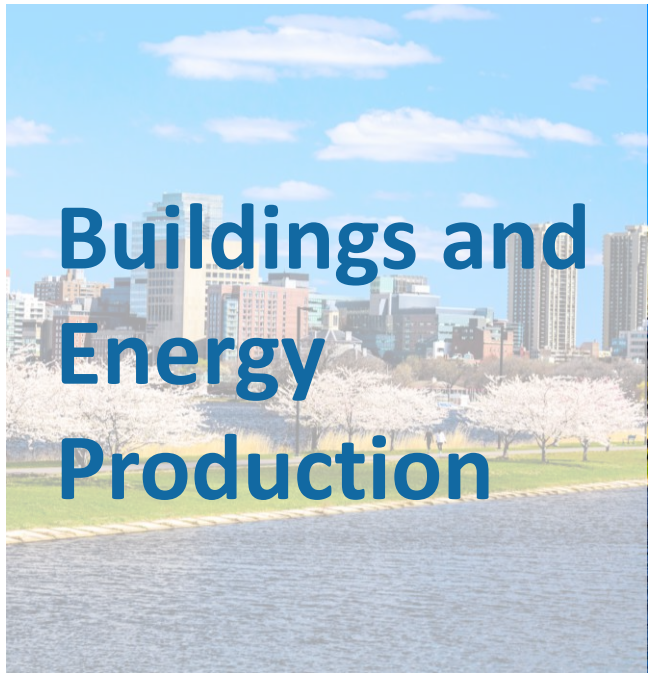
Total Community-Wide GHG Emissions by Sector (MT CO_2e), 2019



2019 Community-wide GHG Emissions by Sub-Sector

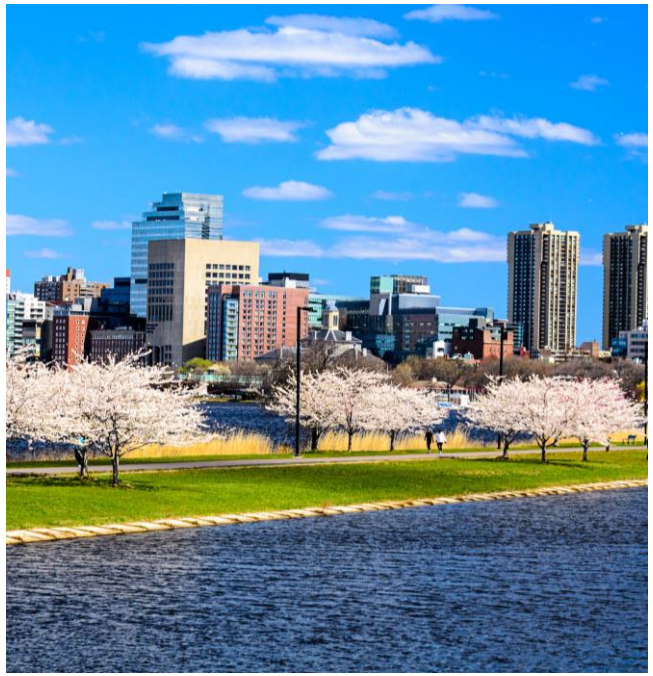


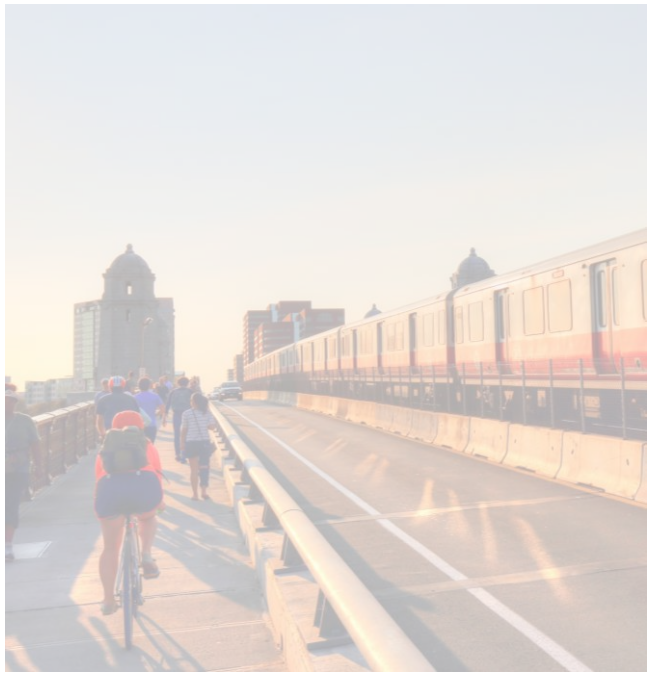
In 2019, the largest source of emissions in the City of Cambridge was **Commercial and Institutional Buildings** (37.4%), followed by Residential Buildings (20.4%) and Energy Producing Facilities (12.7%).



GHG emissions from City activities are classified into three **sectors**: Buildings and Energy Production (also referred to as Stationary Energy), Transportation, and Waste.

Emissions from these sectors are divided into **sub-sectors** and **sub-categories** for additional levels of categorization. Sub-sectors and sub-categories improve inventory detail and help identify actions and policies to target the highest sources of emissions.





Emissions associated with the **Buildings and Energy Production sector** result from the use of electricity, natural gas, fuel oil, and other energy sources within the City's boundaries.

Buildings and Energy Production – Activity Data

In 2019:

- Residents and businesses consumed:
  - **1.65 billion kWh** of electricity
  - **73.5 million Therms** of natural gas
  - **3.1 million gallons** of fuel oil.
- Electricity transmission & distribution losses were estimated to be **150,615,903 kWh**.
- Natural gas distribution system losses were estimated to be **441,043 Therms**.
- Emissions data for **Energy Producing Facilities** were gathered directly from publicly available reports provided by the U.S. EPA.

Electricity generation in Massachusetts is made up of a mix of natural gas, nuclear, coal, hydroelectric, and other renewable sources. The consumption of these fuel sources releases CO_2, CH_4, and N_2O to varying extents.

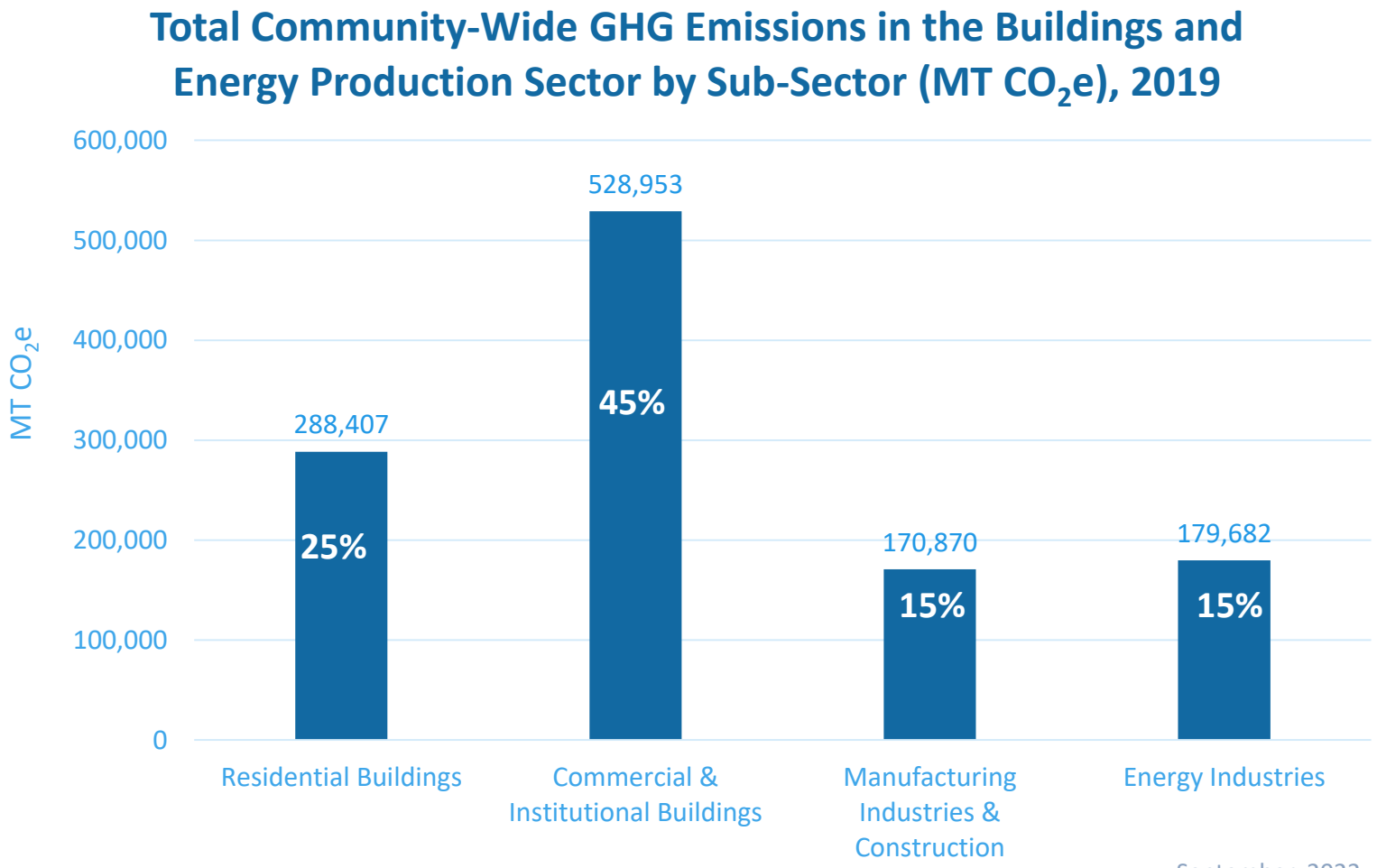
Natural gas is used for space heating, water heating equipment, and co-generation stations in Cambridge. The burning of natural gas primarily releases CO_2 emissions.

Natural gas leaks, called "fugitive emissions," release methane (CH_4) into the atmosphere, a GHG with global warming potential that is approximately 28 times greater than CO_2.

Energy Producing Facilities in Cambridge include four large electricity and steam generation facilities: The Kendall Co-Generation Station, the Massachusetts Institute of Technology (MIT) Central Utilities Plant, the Harvard University Blackstone Plant, and the Biogen Idec Plant.

Buildings and Energy Production – 2019 Inventory Results

At **45%**, Commercial & Institutional Buildings generated the greatest share of GHG emissions within the Buildings and Energy Production sector in 2019, followed by Residential Buildings at **25%**. This is primarily due to Cambridge's high density of education, research, and commercial activity.



Buildings and Energy Production – 2019 Inventory Results

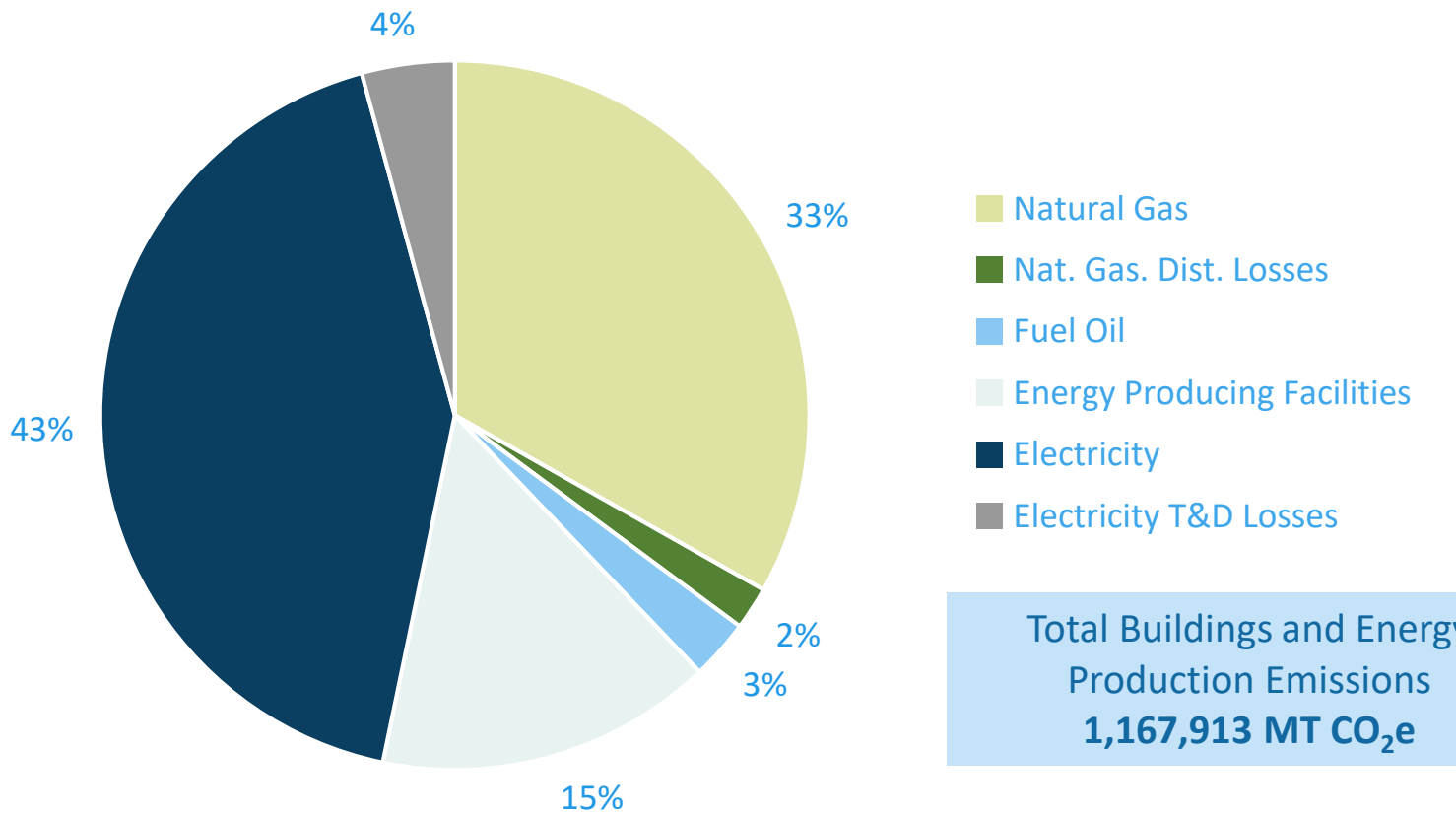
In this sector:

Scope 1 sources, including natural gas, natural gas distribution losses, fuel oil, and energy producing facilities, accounted for 53% of emissions.

Scope 2 emissions from purchased electricity accounted for 43% of emissions.

Scope 3 emissions from electricity transmission & distribution losses accounted for 4% of emissions.

Total Community-Wide GHG Emissions in the Buildings and Energy Production Sector by Source (MT CO_2e), 2019



Total Buildings and Energy Production Emissions
1,167,913 MT CO_2e

Buildings and Energy Production – 2012-2019 Comparison

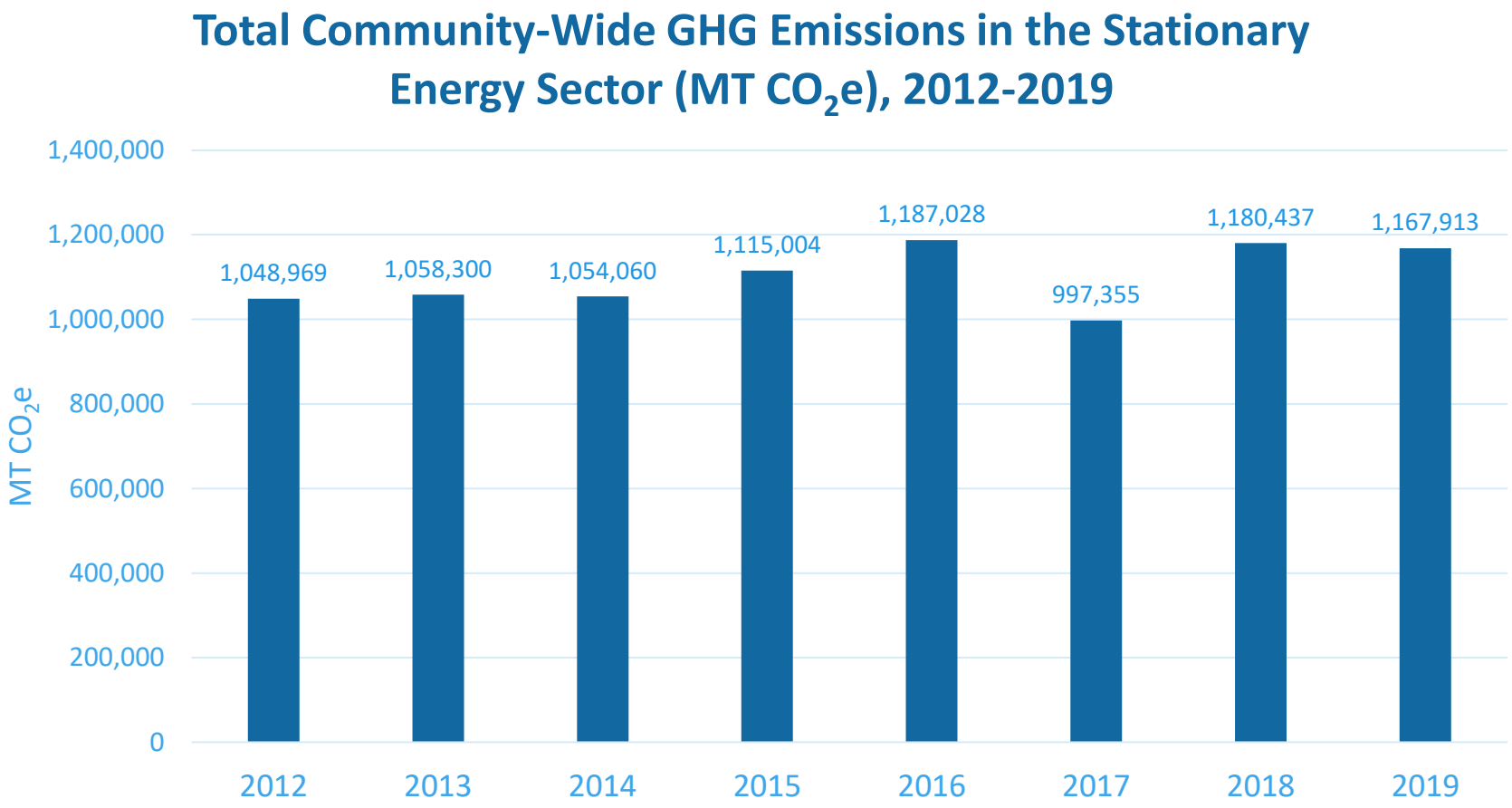
It is estimated that Buildings and Energy Production emissions increased **11%** between 2012 to 2019. This is likely due to increased growth in the City of Cambridge, including the construction of **commercial and institutional buildings** (which can be energy-intensive), as well as residential buildings.

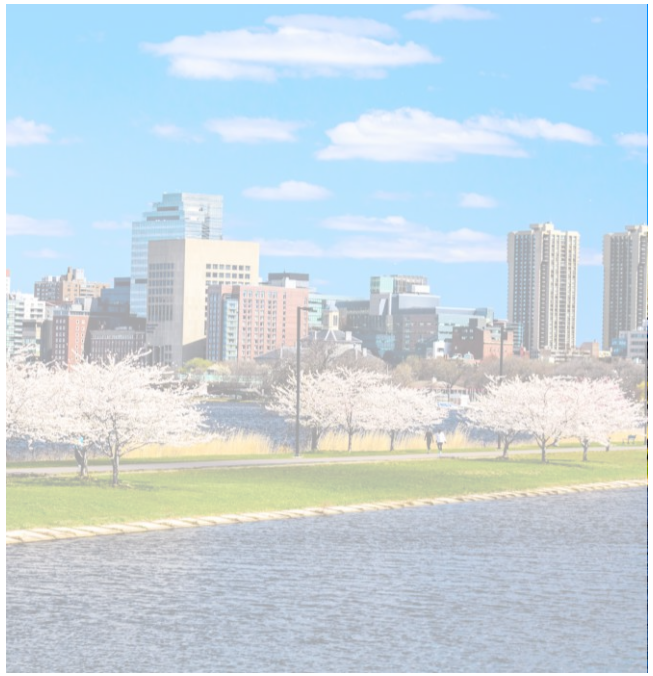
Sub-Sector	2012 Emissions (MT CO_2e)	2019 Emissions (MT CO_2e)	Change
Residential Buildings	264,858	288,407	+ 9 %
Commercial & Institutional Buildings	410,178	528,953	+ 29 %
Manufacturing Industries & Construction	179,026	170,870	- 5 %
Energy Industry	194,907	179,682	- 8 %
Total Buildings and Energy Production Sector Emissions	**1,048,969**	**1,167,913**	**+ 11 %**

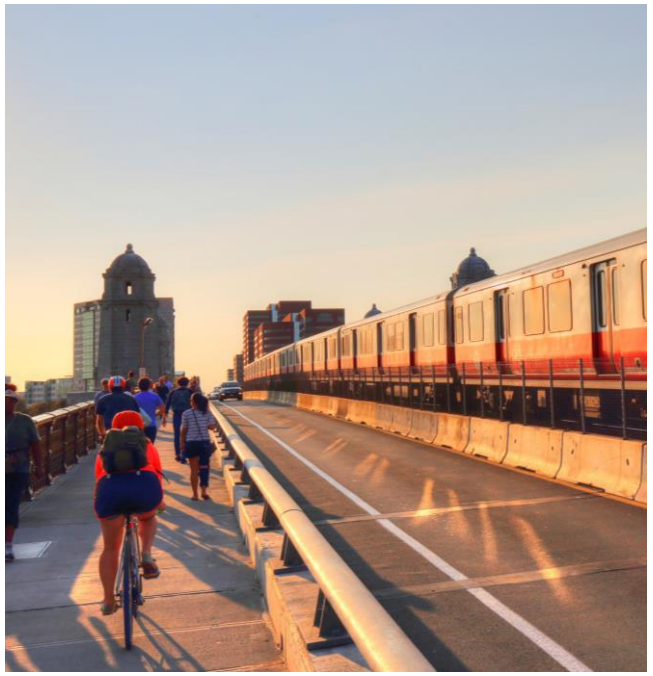
Buildings and Energy Production – 2012-2019 Comparison

Buildings and Energy Production emissions peaked in 2016 and began to decline in 2017.

Between 2012 and 2019, an increase in new energy-intensive buildings in the City of Cambridge was balanced by city-wide improvements in energy efficiency.







Transportation sector emissions are a combination of on-road vehicle activity and rail travel. On-road vehicle activity includes both personal and commercial vehicles registered to the City, as well as buses and trackless trolleys traveling on the streets of Cambridge. Rail travel includes the portion of the Fitchburg Line (Commuter Rail) and the Red and Green lines operating within the City's boundary.

Transportation Sector – Activity Data

In 2019:

- Private passenger and commercial vehicles consumed **14,343,897 gallons** of gasoline and **193,668 gallons** of diesel. Private electric vehicles used **372,942 kWh**.
- Public electric vehicle charging stations in Cambridge consumed **1,903,629 kWh**.
- Trackless Trolleys consumed **2,798,370 kWh** of electricity.
- MBTA buses operating in Cambridge consumed **216,610 gallons** of bio-diesel and **9,157 MMBtu** of CNG.
- Rail transit within City boundaries consumed **107,107 gallons** of diesel and **21,292,491 kWh** of electricity.

The consumption of fossil fuels like **gasoline** and **diesel** releases CO_2, CH_4, N_2O, and other more immediate pollutants, such as black carbon, into the atmosphere.

Electric vehicles provide a cleaner method of transportation, especially when the electricity is generated from renewable fuel sources like solar energy.

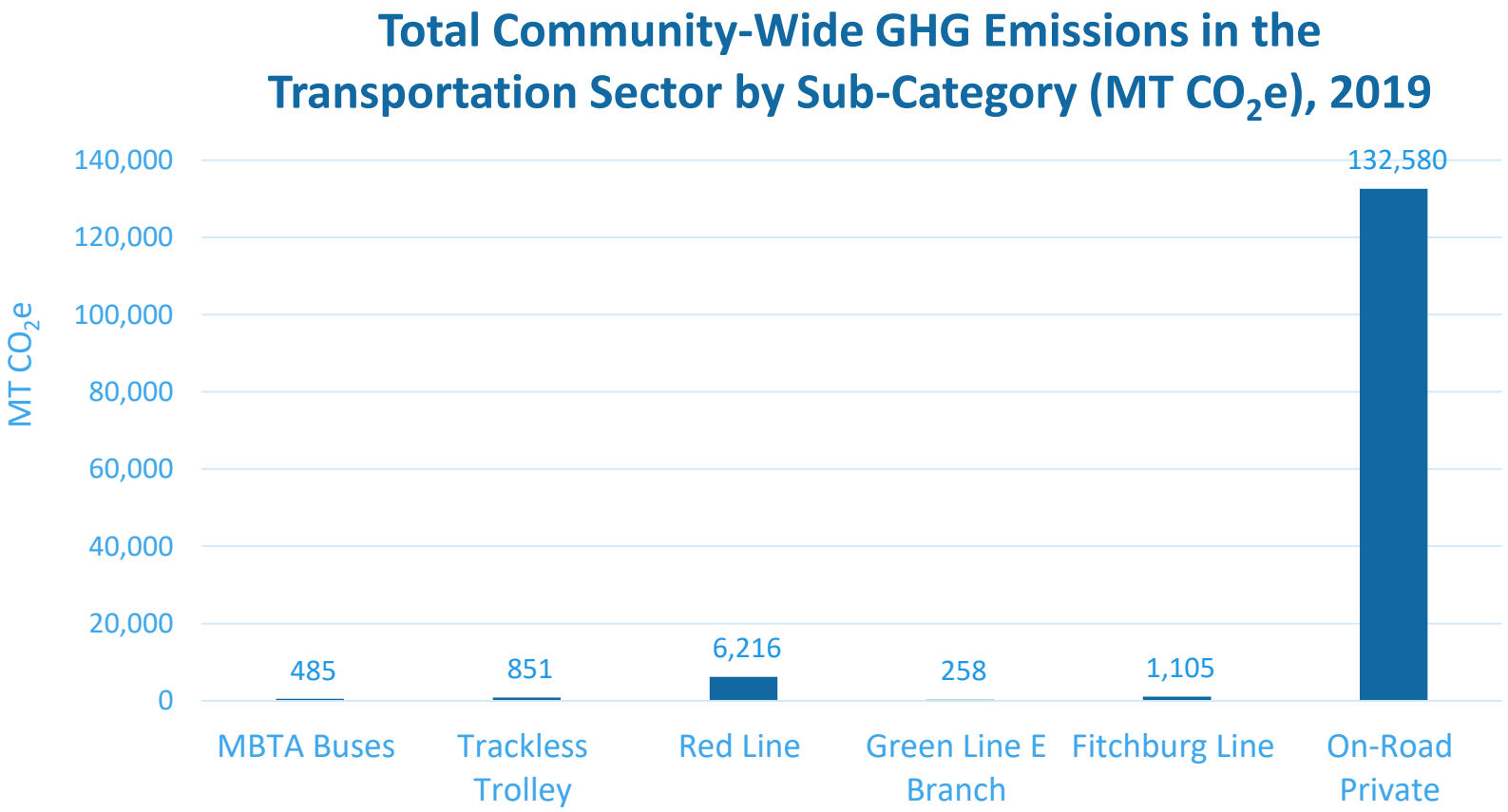
MBTA buses operating in Cambridge switched from diesel to bio-diesel in 2012. This inventory assumes bio-diesel production is carbon neutral.

Rail transit includes the MBTA Red Line, MBTA Green Line (E Branch), and Fitchburg Commuter Rail. The Red and Green Lines run on 100 percent electricity, while the Fitchburg Commuter Rail runs on diesel.

Transportation Sector – 2019 Inventory Results

Private On-road Transportation represents the greatest source of emissions for the transportation sector in Cambridge.

It is estimated that private transportation was the source of **93.7%** of total transportation sector emissions in 2019.



Transportation Sector – 2019 Inventory Results

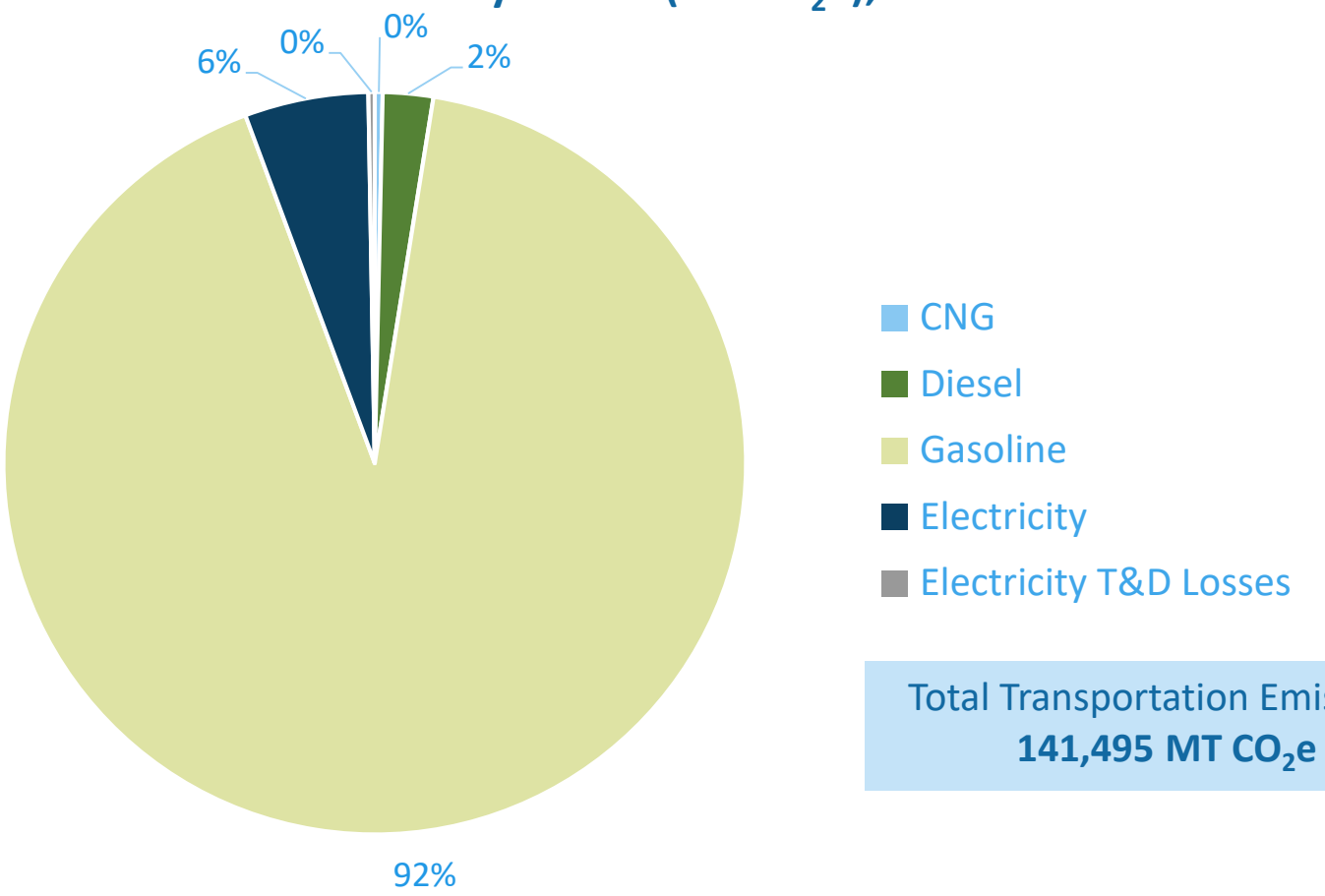
GHG emissions in the Transportation sector are produced from the consumption of fuels used to power on-road transportation and rail travel.

Scope 1 emissions from gasoline, diesel, and CNG accounted for 94% of emissions.

Scope 2 emissions from purchased electricity used to power electric vehicles, trackless trolleys, and light rail accounted for 0.05% of emissions.

Scope 3 emissions from electricity transmission & distribution losses accounted for 0.003% of emissions.

Total Community-Wide GHG Emissions in the Transportation Sector by Source (MT CO_2e), 2019



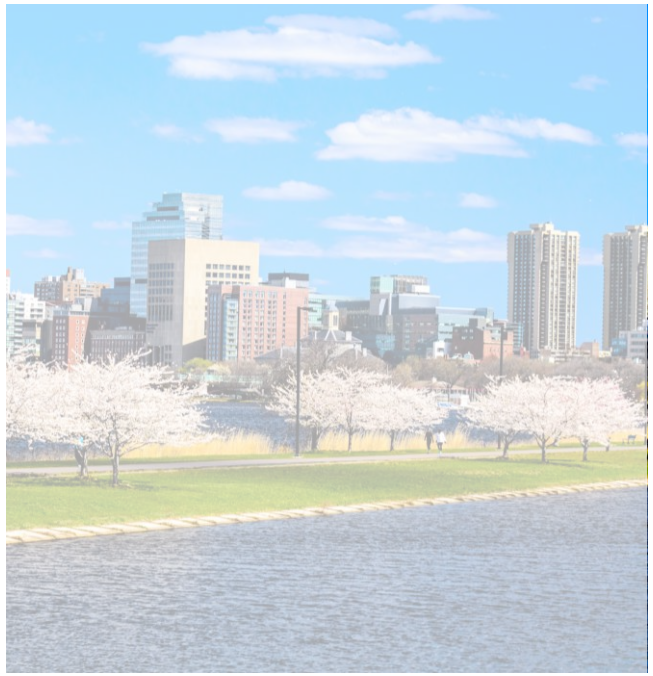
Total Transportation Emissions
141,495 MT CO_2e

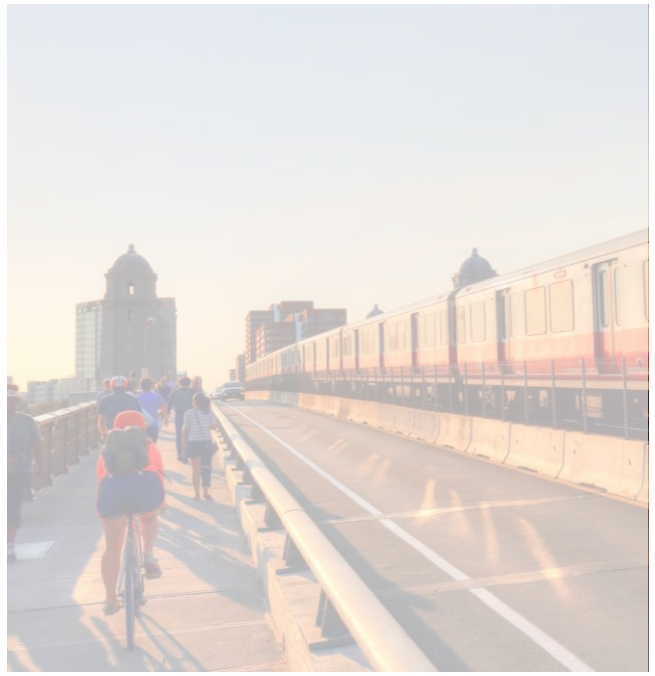
Transportation – 2012-2019 Comparison

It is estimated that Transportation sector emissions have decreased roughly **13%** from 2012 to 2019. This reduction is primarily driven by **buses** and **on-road private transportation**.* Since 2012, MBTA has replaced diesel fuel with bio-diesel alternatives. Reductions in on-road transportation emissions were likely driven by an improvement in vehicle fuel efficiencies.

Sub-Sector	Sub-Category	2012 Emissions (MT CO_2e)	2019 Emissions (MT CO_2e)	Change
Private Transportation	On-Road Private	149,815	132,580	- 12 %
Public Transportation	MBTA Buses	3,061	485	- 84 %
	Trackless Trolley	1,118	851	- 24 %
	Red Line (Subway Heavy Rail)	7,088	6,216	- 12 %
	Green Line E Branch (Light Rail)	310	258	- 17 %
	Fitchburg Line (Commuter Heavy Rail)	967	1,105	+ 14 %
Total Transportation Sector Emissions		**162,359**	**141,495**	**- 13 %**

*Despite the larger percentage reduction in estimated emissions from buses, the reduction from on-road private transportation drove the overall reduction in emissions because it is the source of over 90% of emissions. The drop in emissions for Trackless Trolleys, the Red Line, and the Green Line has less of an impact in overall Transportation sector emissions.





Waste sector emissions are generated from solid waste disposal at landfills, the biological treatment of organic waste (for example, composting or using bacteria to make biogas), the incineration of waste, and wastewater treatment.

Waste Sector – 2019 Activity Data

In 2019:

- Residents and businesses generated an estimated **147,599 tons** of trash.
- Approximately 59,040 tons of municipal solid waste were **landfilled** (40%) and 88,560 tons (60%) were **incinerated**.
- Residents generated an estimated **1,756 tons of organics** that were municipally collected and then treated by bacteria at a facility in Charlestown to create either methane or fertilizer.
- An estimated **6,414,760 gallons** of wastewater was generated per day by the City's **116,632 residents** and treated at the Deer Island Wastewater Treatment Plant in the Boston Harbor.

Municipal solid waste (i.e., trash or garbage) is generated by residents and visitors, businesses, public entities, and other organizations in the community.

Landfilled waste results in methane emissions as organic materials decompose in the anaerobic (non-oxygen) environment of a landfill.

Incineration of waste results in CO_2, CH_4, and N_2O emissions as the waste is burned. Incinerated waste in Massachusetts is used to produce energy.

Anaerobic digestion is the process through which bacteria break down organic matter in the absence of oxygen, creating biogas in the form of methane that can be used for energy.

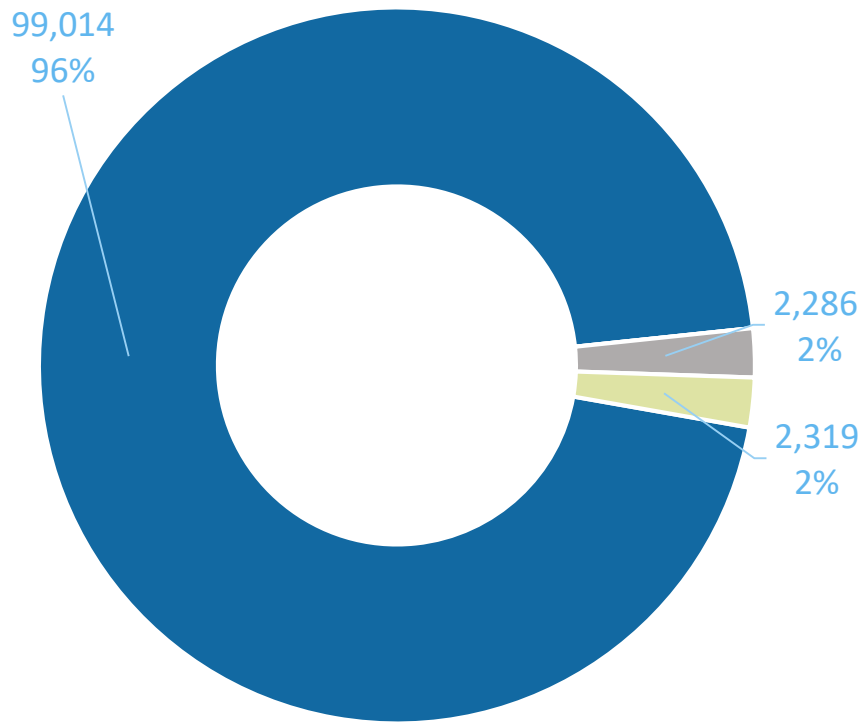
Wastewater treatment results in process and fugitive emissions of methane and/or nitrogen oxide (N_2O).

Waste Sector – 2019 Inventory Results

Solid Waste Disposal generated **96%** of all waste sector emissions in 2019, at an estimated 99,014 MT CO_2e.

This is primarily due to the high global warming potential of methane, a greenhouse gas over 28x more potent than CO_2. Methane is emitted from the decomposition of waste in landfills.

Total Community-Wide GHG Emissions in the Waste Sector by Sub-Sector (MT CO_2e), 2019



Total Waste Emissions
103,619 MT CO_2e

Waste Sector – 2012-2019 Comparison

It is estimated that Waste sector emissions have increased by **8%** from 2012 to 2019. This increase is primarily due to an alternative accounting approach used for 2019 that more accurately reflects solid waste collections from commercial buildings and large multi-family residences by private haulers.

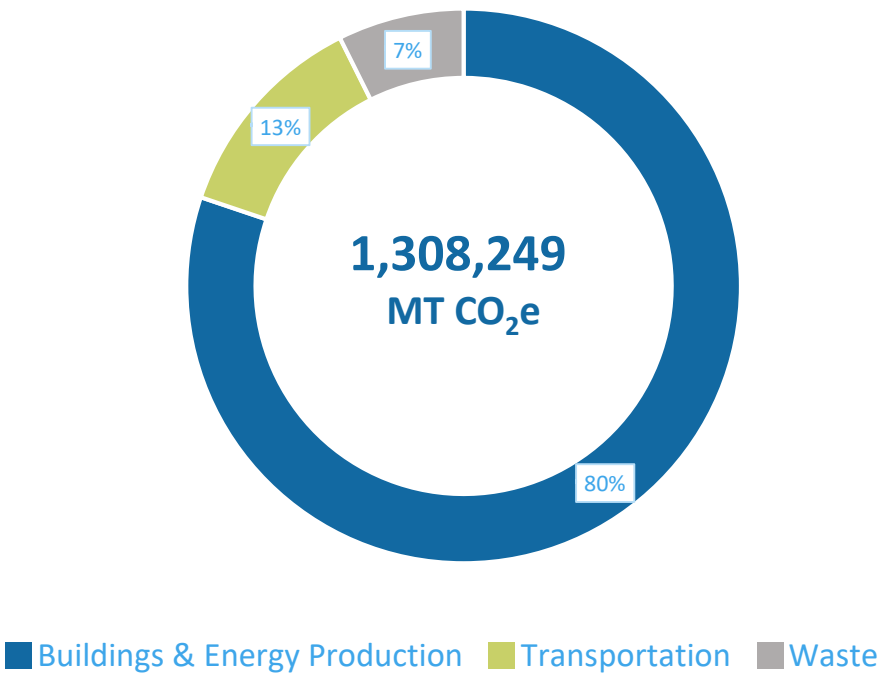
Cambridge's **Organics Diversion Program** was not fully implemented until 2018. This waste stream did not generate emissions in 2019, as all materials are sent to an anaerobic digestion facility in North Andover that recovers 100% of methane gases.

Sub-Sector	2012 Emissions (MT CO_2e)	2019 Emissions (MT CO_2e)	Change
Solid Waste Disposal	92,051	99,014	+ 8 %
Incineration	2,145	2,286	+ 7 %
Wastewater Treatment and Discharge	2,146	2,319	+ 8 %
Total Waste Sector Emissions	**96,342**	**103,619**	**+ 8 %**

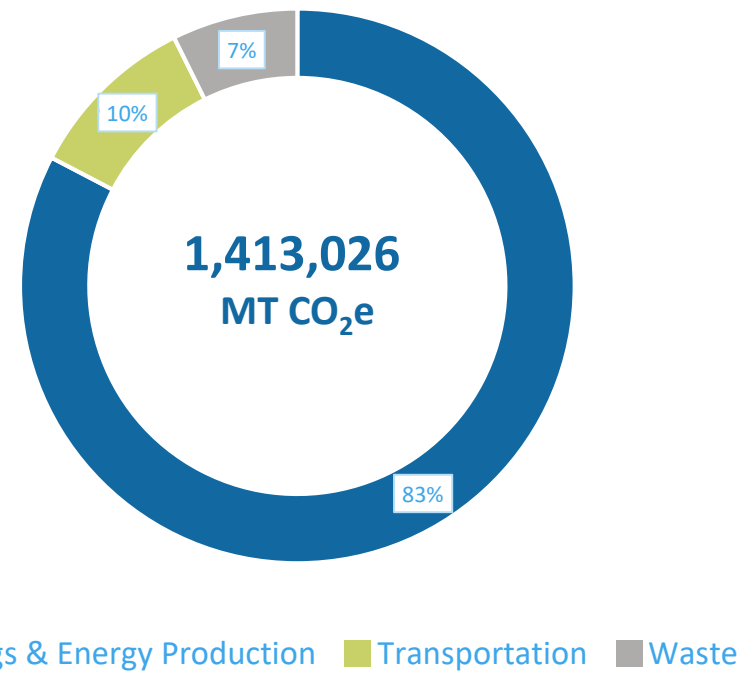
Comparing 2019 Inventory Results to the 2012 Baseline

2012-2019 Community-wide GHG Emissions Inventories Comparison

2012 Community-wide GHG Emissions



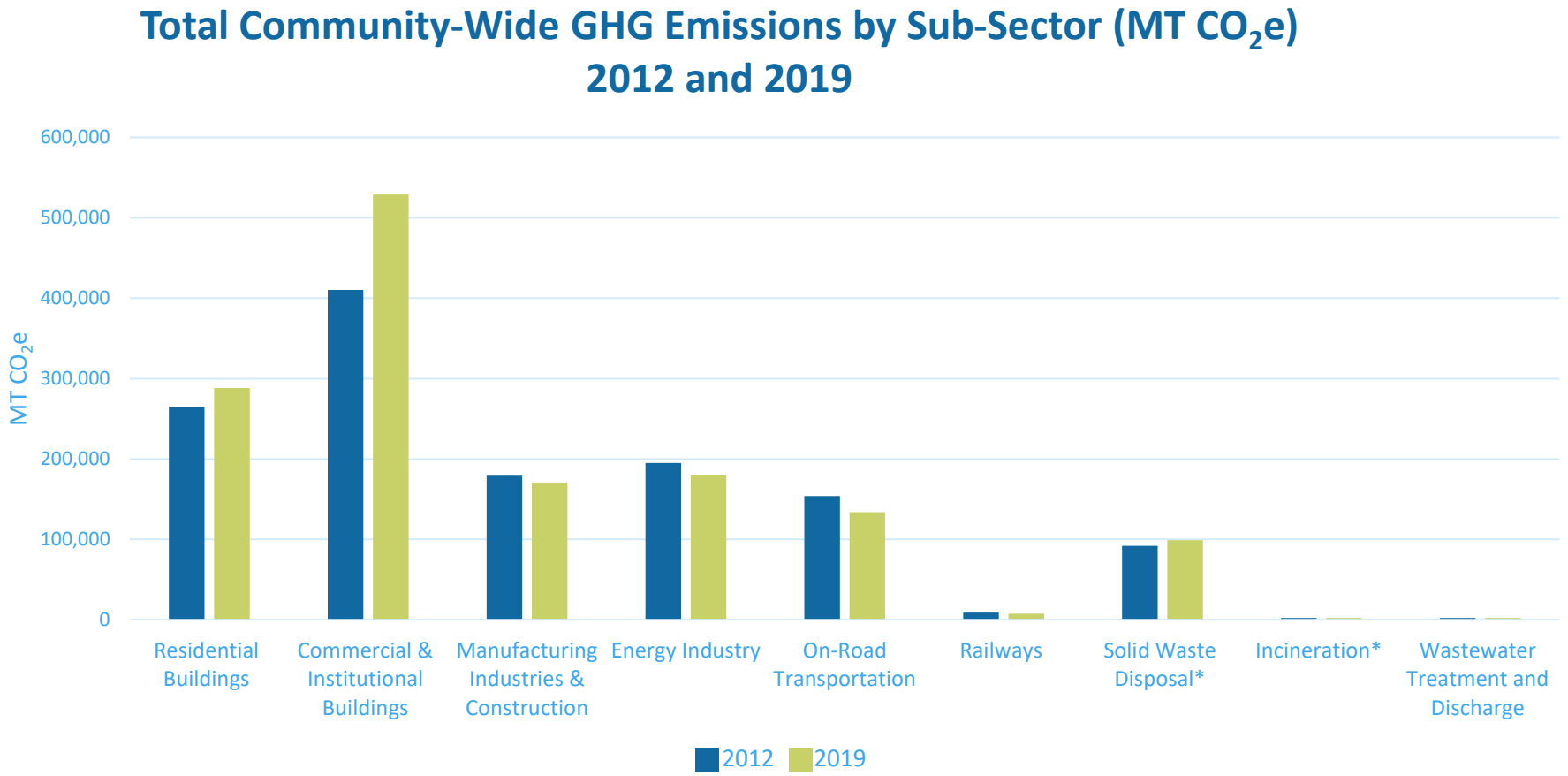
2019 Community-wide GHG Emissions



2012-2019 Community-wide GHG Emissions Inventories Comparison

Between 2012 and 2019, increases in GHG emissions were primarily caused by new construction of **Residential Buildings** (+9%) and **Commercial and Institutional Buildings** (+29%).

*Waste emissions from Solid Waste Disposal and Incineration increased from 2012 to 2019 due to an alternative accounting approach employed for 2019 that more accurately reflects solid waste collections from commercial buildings and large multi-family residences by private haulers.



2012-2019 Community-wide GHG Emissions Inventories Comparison

Sector	Sub-Sector	2012 Emissions (MT CO2e)	2019 Emissions (MT CO2e)	2019 Percentage	Sub-Sector Percent Change	Sector Percent Change
Buildings and Energy	Residential Buildings	264,858	288,407	20%	+ 9 %	**+ 11 %**
	Commercial & Institutional Buildings	410,178	528,953	37%	+ 29 %	
	Manufacturing Industries & Construction	179,026	170,870	12%	- 5 %	
	Energy Industry	194,907	179,682	13%	- 8 %	
Transportation	On-Road Transportation	153,993	133,916	9%	- 13 %	- 13 %
	Railways	8,945	7,579	1%	- 15 %	
Waste	Solid Waste Disposal*	92,051	99,014	7%	+ 8 %	+ 8 %
	Incineration*	2,145	2,286	0%	+ 7 %	
	Wastewater Treatment and Discharge	2,146	2,319	0%	+ 8 %	
Total Emissions		**1,308,249**	**1,413,026**		**+ 8 %**	**+ 8 %**

*Waste emissions from Solid Waste Disposal and Incineration increased from 2012 to 2019 due to an alternative accounting approach employed for 2019 that more accurately reflects solid waste collections from commercial buildings and large multi-family residences by private haulers.

Thank You