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Year 2019 Southeast Michigan Regional Greenhouse Gas Emissions Inventory Report

SEMCOG | SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS

Table of Contents

Executive Summary 1
Introduction 2
Climate Change Overview 3
Regional Overview 5
2019 Emissions Inventory 8
Emissions by Sector 17
Emissions Projections and Reduction Scenario 25
Community Level Emissions 29
Conclusion 30
References 31
Appendix A: Acronyms and Abbreviations 36
Appendix B: Detailed Emissions Results 38
Appendix C: Detailed GHG Inventory Methodology 41
Appendix D: County Level GHG Summaries 50

Executive Summary

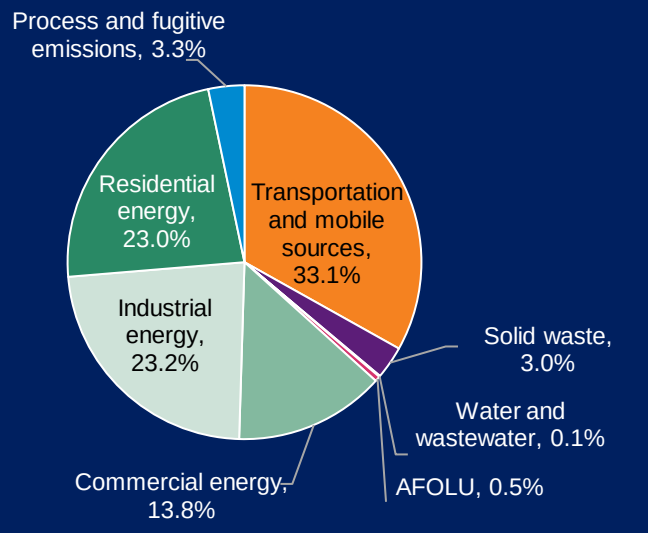
The Year 2019 Regional Greenhouse Gas Emissions Inventory (GHGI) for Southeast Michigan, commissioned by the Michigan Department of Transportation (MDOT) for SEMCOG, the Southeast Michigan Council of Governments , provides a summary of greenhouse gas (GHG) emissions generated within the region during 2019. The inventory was designed to comply with the Global Protocol for Community-scale Greenhouse Gas Emissions Inventories (GPC) BASIC requirements.

The GHGI provides a summary of emissions for the seven-county region in Southeast Michigan, which includes Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties *(see map to the right)*.

GHGs, which trap heat in the atmosphere, significantly contribute to climate change. The work of the GHGI helps Southeast Michigan to build an understanding of the region's contributions to GHG emissions, actively plan for climate change, and strengthen resilience to anticipated climate impacts. The inventory report is the first step toward efforts to reduce emissions, as it identifies major sources of GHG emissions and provides information on emissions trends over time.

The 2019 inventory shows that about 63% of the region's GHG emissions come from the stationary energy sector, which includes all fossil fuels used in the creation of electricity and natural gas consumption that heats homes and businesses. Transportation accounts for 33% of the region's GHG emissions, and solid waste, wastewater, and agriculture, forestry, and other land use (AFOLU) emissions account for most of the remaining 4 percent. Methodology and breakdowns of total and per capita emissions for each of the region's seven counties and the City of Detroit are available within the report.

FIGURE 1. 2019 Regionwide GHG Emissions by Sector



Note: AFOLU stands for agriculture, forestry, and other land use.

Introduction

The 2019 Southeast Michigan Regional Greenhouse Gas Emissions Inventory Report is the 2019 baseline greenhouse gas emissions inventory summary report for the Southeast Michigan region. SEMCOG developed this baseline inventory to establish a framework for future regional climate action planning. The baseline inventory will support future development of policies and actions, estimation of emissions reductions, and prioritization of regional climate initiatives. Additionally, the baseline inventory will support compliance with new regulatory requirements, leverage opportunities for future funding, and support capacity building at the local level.

This GHG inventory report includes the necessary data, methodology, and resources to participate in and contribute to the ongoing process of reducing emissions in the region. It outlines the data collected and analysis conducted to develop the baseline GHG inventory at the regional and county levels while also ensuring the analysis is at a scale useful for summary results at the local level.

The GHG inventory quantified emission sources in 2019 across six distinct sectors within the seven-county SEMCOG region. This inventory uses the basic-level approach and methods provided by the Global Protocol for Community-scale Greenhouse Gas Inventories.

MI Healthy Climate Plan

The MI Healthy Climate Plan, published in April 2022, outlines the State of Michigan's strategy to address climate change. The plan aims to protect public health by addressing air quality, extreme weather events, and vector-borne diseases. This collaborative effort between government, communities, and businesses outlines six primary goals:

1. Commit to environmental justice and pursue a just transition
2. Clean the electric grid
3. Electrify vehicles and increase public transit
4. Repair and decarbonize homes and businesses
5. Drive clean innovation in industry
6. Protect Michigan’s land and water

Each of these goals has quantitative targets, and the State intends to leverage federal funding to the maximum extent possible to achieve these goals (Michigan Department of Environment, Great Lakes, and Energy 2022). Understanding the State’s goals when it comes to climate change requires some upfront knowledge about GHGs, atmospheric measurements, and the intersections of these aspects with public health, which are provided in the following sections.

Climate Change Overview

Climate change has advanced as GHG levels emitted into the atmosphere have increased. The most recent update from the Intergovernmental Panel on Climate Change (IPCC) succinctly outlines the latest trends:

> Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850–1900 in 2011–2020. Global greenhouse gas emissions have continued to increase over 2010–2019, with unequal historical and ongoing contributions arising from unsustainable energy use, land use and land-use change, lifestyles, and patterns of consumption and production across regions, between and within countries, and between individuals (*high confidence*). Human-caused climate change is already affecting many weather and climate extremes in every region across the globe.
>
> This has led to widespread adverse impacts on food and water security, human health, and on economies and society and related losses and damages to nature and people (*high confidence*). Vulnerable communities who have historically contributed the least to current climate change are disproportionately affected (*high confidence*). (IPCC 2023, 42)

Greenhouse Gases

GHGs are substances in the Earth's atmosphere that trap heat by allowing sunlight to enter the atmosphere but prevent heat from Earth's surface from escaping. The primary GHGs include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), fluorinated gases, and water vapor. While water vapor is a significant greenhouse gas, human activities have a more direct influence on the concentrations of CO2, CH4, and N2O. According to the United States Environmental Protection Agency (EPA), the most significant GHGs contributing to climate change are (EPA 2023c):

- CO2: Emitted through burning fossil fuels (coal, oil, and natural gas), deforestation, and certain industrial processes
- CH4: Emitted during the production and transport of coal, oil, and natural gas; also released by livestock and other agricultural practices
- N2O: Released from agricultural and industrial activities as well as the combustion of fossil fuels and solid waste

Global Warming Potential

Global warming potential (GWP) is a measure of how much heat a GHG traps in the atmosphere over a specific period, usually 100 years, compared to CO2. The larger the GWP, the more that a given

gas warms the earth compared to CO2. GWP helps in comparing the relative impact of different gases on global warming by providing a common unit of measure (EPA n.d.). To accurately reflect the relative strength of each gas and quantify the total emissions impact of many types of gases, GWP is used to convert all to a single unit of carbon dioxide equivalent (CO2e). CO2e is a common representation of the GWP of various gases if they were all CO2.

- CO2: Used as the baseline with a GWP of 1.
- CH4: Has a GWP of about 25 over 100 years, meaning it has 25 times the warming potential of CO2.
- N2O: Has a GWP of about 298 over 100 years.

TABLE 1. GWP Values

Greenhouse Gas (GHG)	Global Warming Potential (GWP)
CO2	1
CH4	25
N2O	298

Source: IPCC 2014

Public Health Impacts

Alongside this understanding of GHGs and their effects on climate change, the usefulness of a GHG inventory and execution of MI Healthy Climate goals also hinge on understanding the significant intersections of climate change, air quality, and public health. Simply, burning fossil fuels (e.g., for energy production and transportation) releases GHGs, which in turn lead to a warmer planet as they insulate the atmosphere over long stretches of time. Emissions from burning fossil fuels also include air pollutants like particulate matter, nitrogen oxides, and sulfur dioxide, which have immediate adverse effects on air quality (EPA 2023d).

Research shows rising temperatures and decreased air quality (both indoor and outdoor) contribute to a host of events that directly impact public health, including:

- More frequent and severe heatwaves, which lead to heat-related illnesses
- Changes in precipitation patterns, which result in floods and droughts that affect water quality and quantity, food security, and waterborne disease spread
- Proliferation of vector-borne diseases as the geographic distribution of disease-carrying organisms, like mosquitos, changes due to climate shifts (Centers for Disease Control and Prevention 2022)
- More frequent wildfires, which pollute the air and can worsen respiratory illnesses like asthma, chronic obstructive pulmonary disease (COPD), and bronchitis
- Earlier and longer springs and summers, which can increase people's exposure to pollen and other airborne allergens and in turn lead to more allergy-related illnesses (EPA 2023a)

Regional Overview

Regional Characteristics

The seven-county region includes Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties and covers over 4,598 square miles. The region includes over 200 communities and had a population of nearly 4.8 million people in 2019. Wayne County, which includes the City of Detroit, is the region's most populous county, with 1.7 million residents in 2019. SEMCOG projects that the region's total population will reach 5.1 million by 2050 (SEMCOG 2023) as shown in Table 2.

TABLE 2. Southeast Michigan Populations, Projections, and Changes, 2010, 2019, and 2050

Jurisdiction	Population		Percentage Change, 2010–2019	2050 Population Projection	Projected Percentage Change, 2019–2050
	2010	2019			
City of Detroit	711,910	670,052	**-5.90%**	632,328	**-5.63%**
Livingston	180,972	191,995	**6.10%**	238,137	**24.03%**
Macomb	841,126	873,972	**3.10%**	962,485	**10.13%**
Monroe	151,932	150,500	**-0.90%**	160,611	**6.72%**
Oakland	1,203,012	1,257,584	**4.50%**	1,387,838	**10.36%**
St. Clair	162,789	159,128	**-2.20%**	163,144	**2.52%**
Washtenaw	345,290	367,601	**6.50%**	421,412	**14.64%**
Wayne	1,815,734	1,749,343	**-3.70%**	1,804,908	**3.18%**
SEMCOG Region	**4,700,855**	**4,750,123**	**1.00%**	**5,138,535**	**8.18%**

Note: Totals reconcile upon removal of City of Detroit because it is included in Wayne County.
Source: U.S. Census Bureau 2010 and 2019a, SEMCOG Community Profiles

Regional Implications of Climate Change

Climate change will have dramatic impacts worldwide, including measurable effects in Southeast Michigan. According to experts at the Great Lakes Integrated Climate Assessment (GLISA), some expected changes include (GLISA 2019):

1. **Temperature increases:** Climate change is expected to lead to higher average temperatures in the region, potentially affecting ecosystems, agriculture, and overall quality of life.
2. **Changing precipitation patterns:** Southeast Michigan may experience alterations in precipitation patterns, including more intense storms and altered snowfall patterns, which can impact water resources and infrastructure.
3. **Increased frequency of extreme weather events:** Climate change is associated with an increase in extreme weather events, such as heatwaves, heavy rainfall, and storms. These events can have significant implications for infrastructure, public health, and emergency response systems.
4. **Rising sea levels:** While southeastern Michigan is not directly on an oceanic coast, rising sea levels globally can indirectly impact the Great Lakes, affecting water levels and coastal areas.
5. **Impacts on agriculture:** Changes in temperature and precipitation patterns can affect crop yields and the agricultural sector. Farmers may need to adapt to new conditions or consider alternative crops.
6. **Ecological changes:** Climate change can lead to shifts in ecosystems, affecting plant and animal species. Some species may struggle to adapt, leading to changes in biodiversity and ecosystem services.
7. **Water quality and availability:** Changes in precipitation patterns and temperature can impact water quality and availability in the Great Lakes region, affecting drinking water sources and ecosystems.
8. **Health risks:** Increased temperatures and changes in weather patterns can pose health risks, including heat-related illnesses, the spread of vector-borne diseases, and respiratory issues related to air quality changes.

Climate and Weather Trends in Southeast Michigan

Scientific consensus shows that Southeast Michigan has experienced an increase in average annual temperature as well as more frequent and more intense heat waves and storms (GLISA 2019).

- The 30-year average annual temperature increased for Detroit by 1.4°F from the period 1961–1990 to the period 1981–2010.
- From 1959 to 2011, average overnight temperatures on hot, dry days warmed 4.3°F.
- The number of days per year with a high temperature above 90°F is projected to increase from 15 at present to between 36 and 72 by the end of the century.
- Southeast Michigan has seen an 11% increase in total annual precipitation from the 1961–1990 average to the 1981–2010 average.

- In the *Southeast Michigan Current and Future Precipitation* Report, an increase of approximately 57% is projected for the average region rainfall value typically used in stormwater design (a 10-year, 24-hour storm event). Based on the average prediction, a storm with a 1% chance of happening annually today will have a 10% likelihood of annually happening by 2050.
- Most climate projection models predict the trend of increased frequency and intensity of rainfall events.
- With warmer temperatures, more precipitation will fall in the form of rain rather than snow.
- Extreme precipitation events have become more frequent and more intense. Most models project that these trends will continue.

2019 Emissions Inventory

Scopes and Sectors

Southeast Michigan has been an active region for climate action planning, with the cities of Ann Arbor, Detroit, Ferndale, and others leading efforts to measure and mitigate the impacts of climate change. This inventory report is a key component of regional efforts to reduce emissions, as it highlights the sources of the majority of GHG emissions and identifies trends and opportunities for reduction strategies.

The inventory was conducted in compliance with the methods provided by the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) and includes emissions from the following sectors:

- **Stationary energy emissions**: Emissions from residential buildings, commercial and industrial buildings and facilities, manufacturing industries, energy industries, and fugitive emissions from oil and natural gas systems
- **Industrial process emissions**: Emissions from the chemical or physical transformation of materials and fugitive emissions from oil and natural gas systems
- **Transportation emissions**: Emissions from on-road transportation, railways, waterborne navigation (intraregional), and off-road transportation (e.g., construction equipment)
- **Waste emissions**: Emissions from the disposal of solid waste generated in the region, biological treatment of waste generated in the region, and treatment of wastewater generated in the region
- **Agriculture, forestry, and other land use (AFOLU) emissions:** Emissions associated with livestock-enteric fermentation and manure management and agricultural production

To distinguish amongst emissions, the GPC groups emissions into three categories based on where they occur: scope one, scope two, or scope three emissions (Table 3).

TABLE 3. Scopes Definitions for GHG Inventories

Scope	Definition
Scope one	GHG emissions from sources located within the regional or jurisdiction boundary
Scope two	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam, and/or cooling within the regional or jurisdiction boundary
Scope three	All other GHG emissions that occur outside the regional or jurisdiction boundary as a result of activities taking place within the boundary

Source: WRI, ICLEI, and C40 Cities 2021

Methodology

This section provides a high-level overview of the methodology used to produce this inventory. For a more detailed discussion on methodology and data sources, see Appendix C.

Global Protocol for Community-scale Greenhouse Gas Inventories

The World Resources Institute (WRI), C40 Cities Climate Leadership Group (C40 Cities), and ICLEI—Local Governments for Sustainability (ICLEI) partnered to create the Global Protocol for Community-scale Greenhouse Gas Inventories (GPC 1.1) (WRI, C40 Cities, and ICLEI 2021). The GPC represents an international standard in guidance to help local governments develop community GHG emissions inventories, and it :

- Establishes reporting requirements for all community GHG emissions inventories,
- Provides detailed accounting guidance for quantifying GHG emissions associated with a range of emission sources and community activities, and
- Provides several reporting frameworks to help local governments customize their community GHG inventory reports based on their local goals and capacities.

In 2022, WRI, C40 Cities, and ICLEI released *The Supplemental Guidance for Forests and Trees* to consistently identify, calculate, and report on GHG emissions and removals by forests and trees within a community's boundaries (WRI, C40 Cities, and ICLEI 2022). WRI guidance is aligned with the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* and Appendix J of the *U.S. Community Protocol* (USCP) (IPCC 2019; Birdsey et al. 2019).

This report includes emissions from the following categories, in accordance with the GPC BASIC framework (some sources are optional under the GPC BASIC level):[1]

[1] The BASIC level covers scope one and scope two emissions from stationary energy and transportation, as well as scope one and scope three emissions from waste. BASIC+ involves more challenging data collection and calculation processes and includes emissions from industrial processes and product use (IPPU) and AFOLU and transboundary transportation.

FIGURE 2. GHG Inventory Sectors

Stationary energy is the use of electricity, natural gas, and non-utility fuels in residential, commercial, and industrial buildings, including furnaces, generators, or other stationary combustion equipment.

Transportation and mobile source emissions include on-road passenger and freight motor vehicle travel, public transportation, freight and passenger rail, off-road vehicles and equipment, and waterborne shipping in and out of ports in the region.

Waste and Wastewater Treatment involves emissions from solid waste disposal through composting, landfills, or incineration and water/ wastewater treatment processes.

Industrial Process and Fugitive emissions related to physical and chemical transformations of raw materials and fugitive emissions that occur through natural gas leakage and oil production wells.

Agriculture, Forestry, and Land Use (AFLOU) involve emissions as well as carbon sequestration from forests, crops, and other vegetation as well as livestock and manure management.

Some communities within the region have already completed GHG inventories. Use of the GPC ensures that the regional inventory will be largely comparable with these individual community inventories. However, the base year for those inventories may be different and some optional emissions sources included in the regional inventory may not be included in the community inventories (or vice versa). Additionally, some estimation methods may be different.

Quantification Methods

GHG emissions were quantified through two distinct approaches, measurement-based and calculation-based methodologies:

Measurement-based methodologies refer to the direct measurement of GHG emissions (from a monitoring system) emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility.

Calculation-based methodologies calculate estimated emissions using activity data and emission factors. To calculate emissions accordingly, this basic equation is used:

Activity data x Emission factor = Emissions

Most emission sources in this inventory were quantified using calculation-based methodologies. Activity data refer to the relevant measurement of energy use or other GHG-generating processes, such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled.

Known emission factors were used to convert energy usage or other activity data into associated quantities of emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g., lbs. CO2/kWh of electricity). For this inventory, calculations were made using ICLEI's ClearPath tool, an online software platform for completing GHG inventories, forecasts, climate action plans, and monitoring (ICLEI n.d.). The data presented in this report is based on the most recent available data from ICLEI.

Future Data Recommendations

The data sources obtained for this inventory cover most emissions in the region. However, some sources were omitted due to lack of available data. SEMCOG staff and community planners should consider developing the following data sources for future inventories:

- Emissions from septic systems: The data needed is the population or number of households in each county relying on septic systems.
- Agricultural emissions from fertilizer use: It is difficult to obtain this data at the community level, but researchers may be able to adapt a method from state inventories.

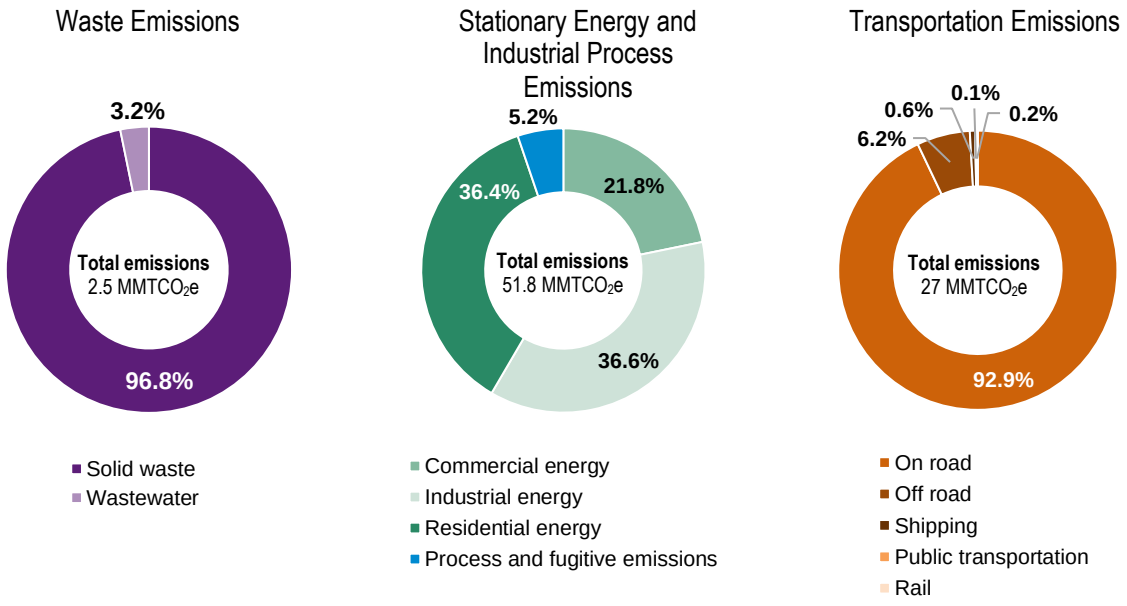
Overall Emissions and Summary Results

Summary of Results

In 2019, the SEMCOG region emitted approximately 81,856,404 metric tons of carbon dioxide equivalent (MTCO2e). The inventory shows that about 63% of the region's GHG emissions came from the stationary energy sector, which includes all emissions generated from the commercial, industrial, and residential energy sectors and process and fugitive emissions. Transportation accounts for 33% of the region's GHG emissions, and solid waste, wastewater, and AFOLU emissions account for the remaining 4%. Further breakdown of the waste, stationary energy, process and transportation emissions are available in Figure 3.

Further breakdowns by sector and jurisdiction are available in Figures 4-6 and Tables 4 and 5Additionally County Level summaries were created and are included in Appendix D.

FIGURE 3. 2019 Regionwide GHG Emissions Within Each Sector



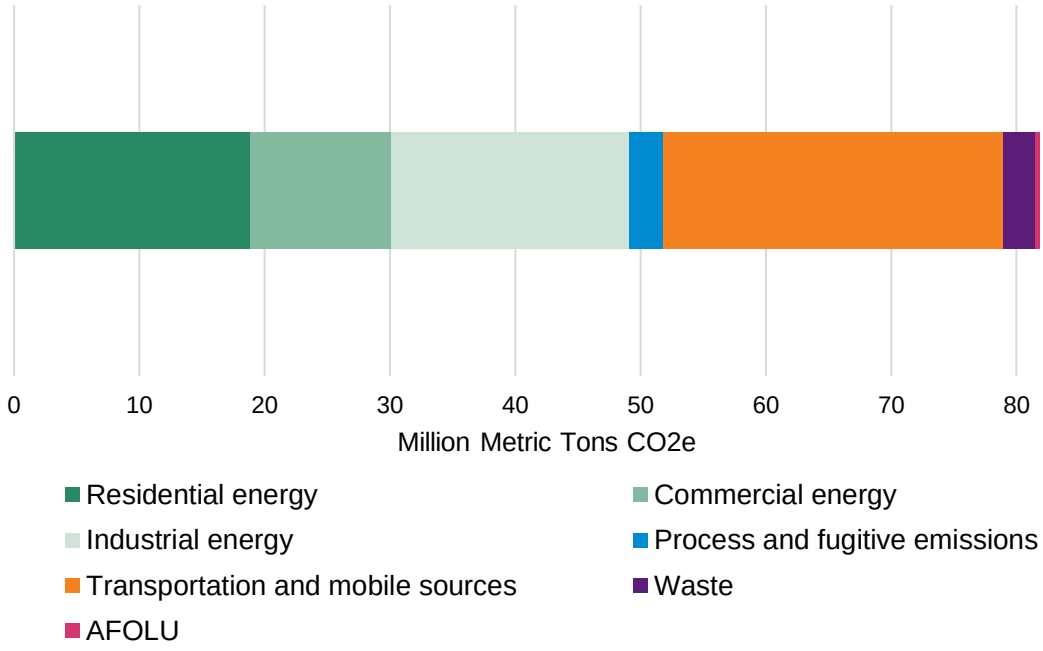
Source: ICLEI ClearPath data

TABLE 4. 2019 Regional Emissions by Sector (MTCO2e)

Sector	Total Emissions ($MTCO_2e$)	Percent of Total
Stationary energy	**49,120,435**	**60.01%**
Industrial energy	18,989,739	23.20%
Residential energy	18,846,455	23.02%
Commercial energy	11,284,241	13.79%
Process and fugitive emissions	**2,695,788**	**3.29%**
Transportation and mobile sources	**27,107,314**	**33.12%**
Waste	**2,538,223**	**3.10%**
Solid waste	2,456,456	3.00%
Water and wastewater	81,767	0.10%
AFOLU	**394,644**	**0.48%**
Total	**81,856,404**	**100.00%**

Source: ICLEI ClearPath data

FIGURE 4. 2019 Regional Emissions by Sector



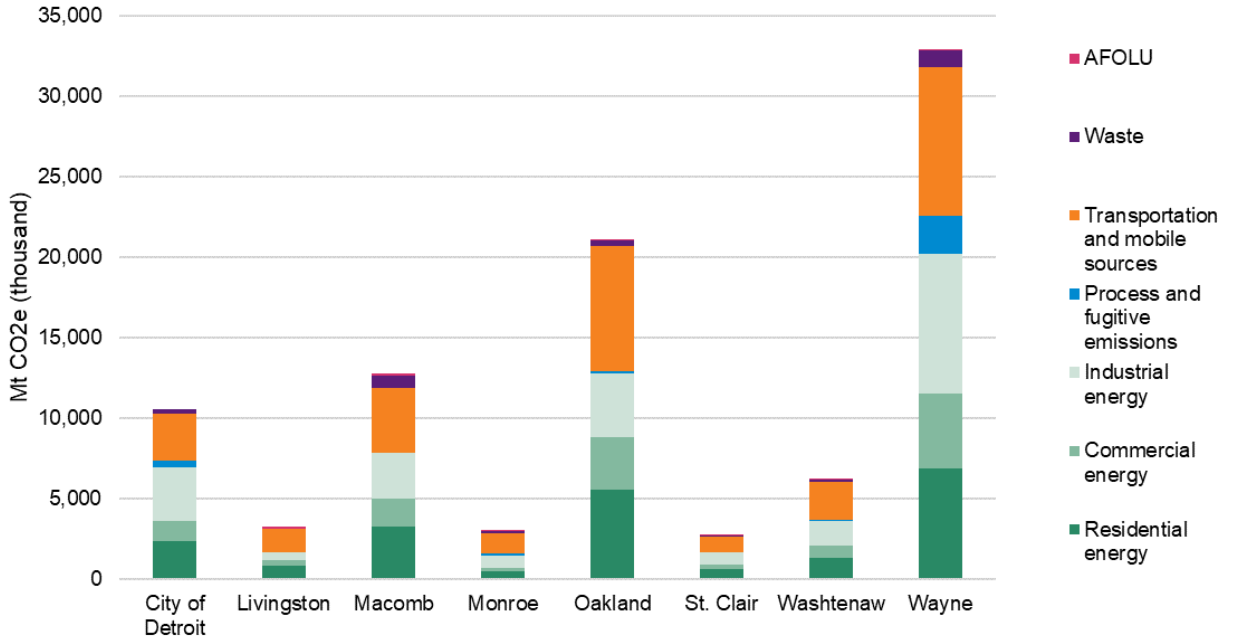
Source: ICLEI ClearPath data

TABLE 5. 2019 Emissions by Sector and Jurisdiction (MTCO2e)

Sector	City of Detroit	Livingston	Macomb	Monroe	Oakland	St. Clair	Washtenaw	Wayne*	SEMCOG Region
Stationary energy	**6,923,416**	**1,627,979**	**7,859,053**	**1,420,140**	**12,743,507**	**1,670,318**	**3,579,060**	**20,220,378**	**49,120,435**
Industrial energy	3,351,225	463,648	2,870,787	715,406	3,921,878	789,407	1,511,026	8,717,587	18,989,739
Residential energy	2,341,503	833,959	3,212,201	462,303	5,566,615	567,820	1,325,758	6,877,799	18,846,455
Commercial energy	1,230,688	330,372	1,776,065	242,431	3,255,014	313,091	742,276	4,624,992	11,284,241
Process and fugitive	**394,929**	**16,002**	**381**	**148,637**	**137,364**	**3,408**	**61,417**	**2,328,579**	**2,695,788**
Transportation and mobile sources	**2,933,271**	**1,428,305**	**4,029,380**	**1,240,099**	**7,783,151**	**958,001**	**2,399,760**	**9,268,618**	**27,107,314**
Waste	**264,452**	**29,336**	**767,408**	**126,005**	**358,918**	**87,891**	**98,247**	**1,070,418**	**2,538,223**
Solid waste	248,722	29,336	750,808	125,730	336,306	87,891	91,849	1,034,536	2,456,456
Wastewater	15,730	0	16,600	275	22,612	0	6,398	35,882	81,767
AFOLU	**0**	**175669**	**77690**	**10252**	**1492**	**43065**	**83672**	**2804**	**394644**
Total MTCO2e	**10,516,068**	**3,277,291**	**12,733,912**	**2,945,133**	**21,024,432**	**2,762,683**	**6,222,156**	**32,890,797**	**81,856,404**

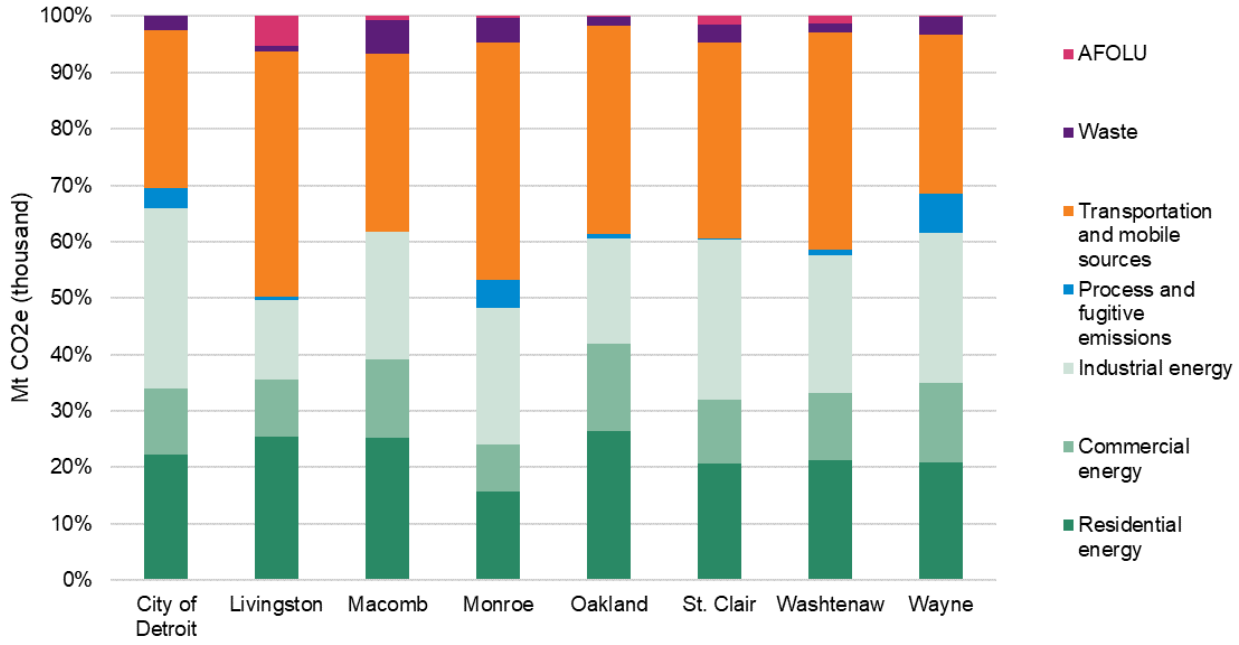
Source: ICLEI ClearPath data, *Wayne County including Detroit

FIGURE 5. 2019 Regional Emissions by Jurisdiction and Sector (MTCO2e)



Source: ICLEI ClearPath data, Note Wayne County includes the City of Detroit

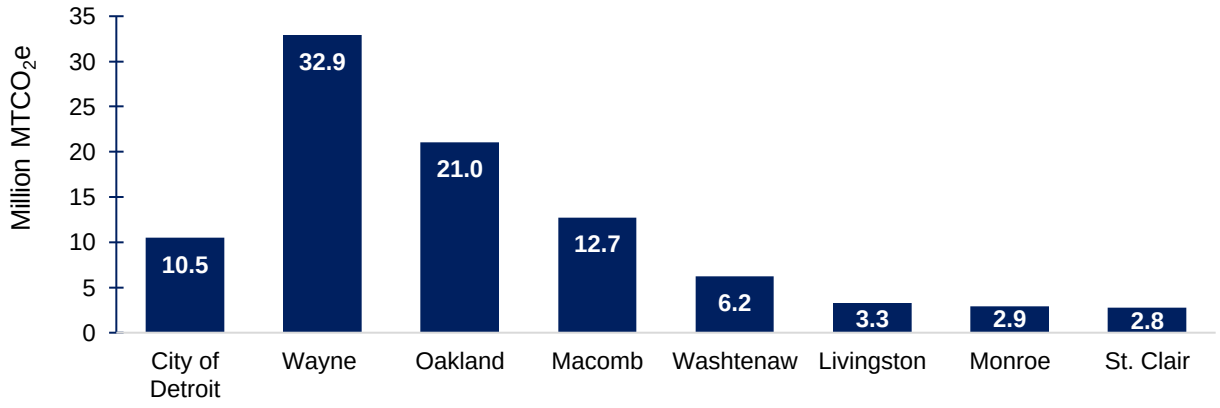
FIGURE 6. 2019 Regional Emissions by Jurisdiction and Sector as Percent of Total



Source: ICLEI ClearPath data; *Wayne County including Detroit

In 2019, Wayne County, which includes the City of Detroit, accounted for the greatest share of regional emissions (about 43%), followed by Oakland County, Macomb County, Washtenaw County, Livingston County, Monroe County, and St. Clair County, in that order. Figure 7 below shows emissions by county.

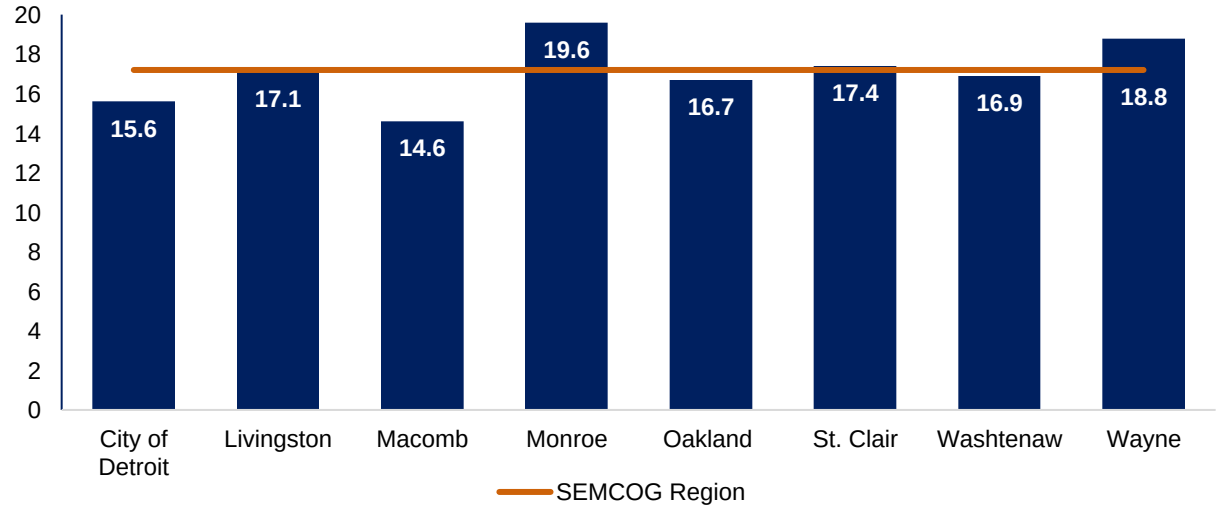
FIGURE 7. 2019 Regional Emissions by Jurisdiction (Million MTCO2e)



Source: ICLEI ClearPath data; *Wayne County including Detroit

Per capita emissions for the region were 17.2 MTCO2e per person in 2019. Monroe County had the highest emissions per capita (19.6 MTCO2e/person) of any county, while Macomb County had the lowest emissions per capita (14.6 MTCO2e/person). Figure 8 shows per capita emissions by county.

FIGURE 8. 2019 Per Capita Emissions by Jurisdiction (MTCO2e/Person)



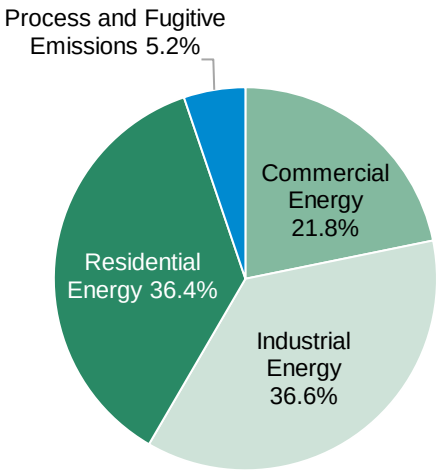
Source: PSC analysis of ICLEI ClearPath data; U.S. Census Bureau 2019a; *Wayne County including Detroit

Emissions by Sector

Stationary Energy and Industrial Process Emissions

Emissions from the stationary energy sector represent the largest source of emissions in the region, accounting for 63.3% of total emissions. This sector is divided into four subsectors: commercial energy, industrial energy, residential energy, and process and fugitive emissions. The largest portion of emissions are from industrial energy (36.6%), followed by residential energy (36.4%), commercial energy (21.8%), and process and fugitive emissions (5.2%). Figure 9 shows the breakout of stationary energy emissions by subsector. The following sections of this report provide additional information on emissions from each subsector.

FIGURE 9. 2019 Stationary Energy Emissions by Subsector



Note: Percentages may not sum due to rounding.
Source: ICLEI ClearPath data

Residential Energy

Emissions from the residential energy subsector include indirect emissions from electricity use and direct emissions from natural gas consumption and other fuels (e.g., propane and distillate fuel oil) for residential buildings. In 2019, residential energy emissions from natural gas consumption accounted for 51.5% of emissions, and electricity use accounted for 47% of emissions. Table 6 presents emissions from residential buildings by county and energy source.

TABLE 6. 2019 Emissions from Residential Buildings by County and Energy Source (MTCO2e)

County	Electricity	Natural Gas	Other Fuel	Total
City of Detroit	852,647	1,428,623	6,443	**2,287,713**
Livingston	419,163	366,356	48,440	**833,959**
Macomb	1,644,236	1,532,603	35,361	**3,212,200**
Monroe	328,453	10,9411	24,439	**462,303**
Oakland	2,525,328	2,986,935	54,351	**5,566,614**
St. Clair	345,784	182,254	39,781	**567,819**
Washtenaw	650,247	640,637	34,874	**1,325,758**
Wayne (incl. Detroit)	2,939,942	3,896,220	41,637	**6,877,799**
SEMCOG Region	**8,853,154**	**9,714,417**	**278,884**	**18,846,452**

Source: ICLEI ClearPath data Note: Totals may not sum due to rounding.

Commercial Energy

Emissions from the commercial energy subsector include indirect emissions from electricity use and direct emissions from natural gas consumption and other fuels (e.g., propane and distillate fuel oil) for commercial buildings and facilities. In 2019, commercial energy emissions from electricity use accounted for 56.5% of emissions, and natural gas consumption accounted for 38.3% of emissions. Table 7 presents emissions from commercial buildings and facilities by county and energy source.

TABLE 7. 2019 Emissions from Commercial Buildings by Jurisdiction and Energy Source (MTCO2e)

County	Electricity	Natural Gas	Other Fuel	Total
City of Detroit	786,500	345,040	99,150	**1,230,690**
Livingston	206,775	103,268	20,328	**330,371**
Macomb	1,167,956	514,940	93,169	**1,776,065**
Monroe	175,967	55,465	10,998	**242,430**
Oakland	1,907,508	1,094,167	253,338	**3,255,013**
St. Clair	197,979	101,849	13,262	**313,090**
Washtenaw	488,204	179,166	74,906	**742,276**
Wayne (incl. Detroit)	2,230,617	2,269,201	125,175	**4,624,993**
SEMCOG Region	**6,375,005**	**4,318,055**	**591,178**	**11,284,238**

Source: ICLEI ClearPath data, Note: Totals may not sum due to rounding.

Industrial Energy

Emissions from the industrial energy subsector include indirect emissions from electricity use and direct emissions from natural gas consumption and other fuels (e.g., propane and distillate fuel oil) for industrial buildings and facilities. In 2019, industrial energy emissions from electricity use accounted for 61.2% of emissions, and natural gas consumption accounted for 14.2% of emissions. Table 8 presents emissions from industrial buildings and facilities by county and energy source.

TABLE 8. 2019 Emissions from Industrial Buildings by Jurisdiction and Energy Source (MTCO2e)

County	Electricity	Natural Gas	Other Fuel	Total
City of Detroit	1,752,344	1,210,473	388,408	**3,351,225**
Livingston	258,061	15,078	190,508	**463,647**
Macomb	1,712,510	154,569	1,003,865	**2,870,944**
Monroe	538,692	45,021	131,687	**715,400**
Oakland	2,291,970	110,036	1,519,814	**3,921,820**
St. Clair	499,985	139,861	149,555	**789,401**
Washtenaw	803,381	389,840	317,792	**1,511,013**
Wayne (incl. Detroit)	5,510,073	1,847,670	1,359, 770	**8,717, 513**
SEMCOG Region	**11,614,672**	**2,702,074**	**4,672,991**	**18,989,737**

Source: ICLEI ClearPath data, Note: Totals may not sum due to rounding.

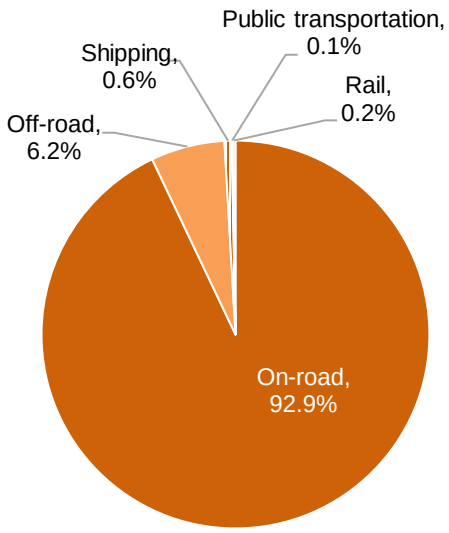
Industrial Process and Fugitive Emissions

Process and fugitive emissions include emissions that occur during the extraction, transformation, and transportation of fossil fuels. Emissions related to other industrial processes like refining petroleum or hydrogen production are included in this sector. Data is available through the EPA- FLIGHT. These facilities are required to report annual data about GHG emissions to EPA as part of the Greenhouse Gas Reporting Program (GHGRP) In 2019, process and fugitive emissions accounted for approximately 5.2% of emissions from the stationary energy sector.

Transportation Emissions

Emissions from the transportation sector represent the second largest source of emissions in Southeast Michigan, accounting for 33.1% of total emissions. The transportation sector reflects emissions from all transportation occurring within the region's geographical boundary and includes all modes of transportation that require the use of synthetic energy sources, such as gasoline, diesel fuel, and electricity. This sector is divided into five subsectors: on-road transportation, off-road transportation, shipping, rail, and public transportation. The vast majority of transportation emissions are from on-road transportation (92.9%), followed by off-road transportation (6.2%), shipping (0.6%), rail (0.2%), and public transportation (0.1%). Figure 10 shows the breakout of transportation emissions by subsector.

FIGURE 10. 2019 Transportation Emissions by Subsector



Source: ICLEI ClearPath data

TABLE 9. 2019 Transportation Emissions by Jurisdiction and Fuel Type (MTCO2e)

County	Gasoline	Diesel	Other	Total
City of Detroit	1,966,663	696,886	269,722	**2,933,271**
Livingston	1,012,647	336,500	79,158	**1,428,305**
Macomb	2,796,744	939,413	293,223	**4,029,380**
Monroe	846,865	281,977	111,256	**1,240,098**
Oakland	5,417,385	1,811,610	554,153	**7,783,148**
St. Clair	635,682	210,207	112,112	**958,001**
Washtenaw	1,699,528	578,735	121,498	**2,399,761**
Wayne (incl. Detroit)	6,430,749	2,191,762	646,106	**9,268,617**
SEMCOG Region	**18,839,600**	**6,350,203**	**1,917,510**	**27,107,313**

Note: Totals may not sum due to rounding.
Source: ICLEI ClearPath data

Waste Emissions

The waste sector accounts for 3.1% of emissions in Southeast Michigan. Waste sector emissions include emissions generated during the management and treatment of solid waste and wastewater in the region. Most waste emissions are from the disposal of solid waste (96.8%). Emissions from water and wastewater account for 3.2% of emissions from the waste sector and only occur in Macomb, Monroe, Oakland, Wayne, and Washtenaw Counties. This data represents over 90% of the permitted wastewater treatment plants within the region. Data related to wastewater treatment was not available for all jurisdictions for this report. Table 10 shows waste emissions by county and waste type.

TABLE 10. 2019 Waste Emissions by Jurisdiction and Waste Type (MTCO2e)

County	Solid Waste	Water and Wastewater	Total
City of Detroit	248,722	15,730	**264,452**
Livingston	29,336	0	**29,336**
Macomb	750,808	16,600	**767,408**
Monroe	125,730	276	**126,006**
Oakland	336,306	22,613	**358,919**
St. Clair	87,891	0	**87,891**
Washtenaw	91,849	6,398	**98,247**
Wayne (incl. Detroit)	1,034,536	35,882	**1,070,418**
SEMCOG Region	**2,456,456**	**81,767**	**2,538,223**

Note: Totals may not sum due to rounding.
Source: ICLEI ClearPath data

Municipal Solid Waste

In 2019, the region generated about 3.7 million tons of solid waste sent to a landfill for disposal, resulting in emissions of approximately 1,448,801 MTCO2e. Table 11 summarizes the amount of municipal solid waste (MSW) generated and landfilled in the region by county.

TABLE 11. 2019 Tons of MSW Generated and Landfilled by County

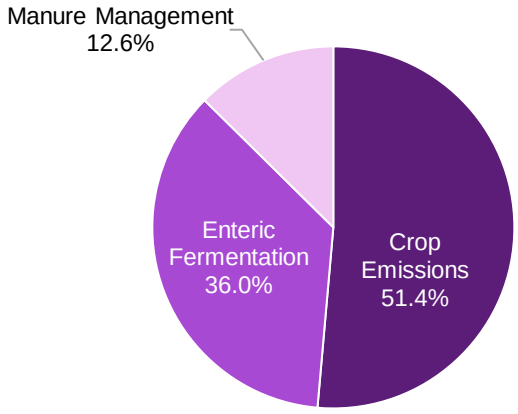
County	Generated in county, exported outside SEMCOG region	Generated in county, exported to another SEMCOG county	Generated and landfilled in county	Imported from outside SEMCOG region
Livingston	50,284	21,640	0	0
Macomb	23	84,745	397,305	1,360,842
Monroe	0	140,804	16,722	149,696
Oakland	12,553	462,996	414,063	2,027
St. Clair	3	0	145,020	66,602
Washtenaw	5,244	70,319	143,482	2,214
Wayne	45	469,367	1,106,164	948,596

Source: ICLEI ClearPath Tool; Wayne County including Detroit

Agriculture, Forestry, and Other Land Use Emissions

Emissions from the AFOLU sector include emissions that occur through livestock-enteric fermentation and manure management and agricultural production. In 2019, AFOLU emissions accounted for less than 1% of total regional emissions. About half of AFOLU emissions are from crop emissions (51.4%), followed by enteric fermentation (36%), and manure management (12.6%). Figure 11 shows the breakout of AFOLU emissions by subsector.

FIGURE 11. 2019 AFOLU Emissions by Subsector



Source: ICLEI ClearPath data

TABLE 12. 2019 AFOLU Emissions by County and Source (MTCO2e)

County	Enteric Fermentation	Manure Management	Crop Emissions	Total

Livingston	22,371	10,669	35,802	**68,842**
Macomb	10,893	3,595	63,203	**77,691**
Monroe	8,286	1,833	133	**10,252**
Oakland	1,199	134	159	**1,492**
St. Clair	24,732	6,885	11,448	**43,065**
Washtenaw	35,123	12,934	35,616	**83,673**
Wayne	1,093	121	1,590	**2,804**
SEMCOG Region	**103,697**	**36,171**	**147,951**	**287,819**

Note: Totals may not sum due to rounding.
Source: ICLEI ClearPath data; Wayne County including Detroit

Emissions and carbon removed or sequestered from the atmosphere were calculated using ICLEI's LEARN tool. Calculation of forest and tree emissions and removals requires land cover and canopy data from two years. For forests, data for the years 2013 to 2019 were used, and for trees outside of forests data for the years 2011 to 2016 (the only two years of data available in the LEARN tool) were used. These totals represent an emissions reduction as shown in Table 13.

TABLE 13. Carbon Sequestration by County (MTCO2e)

County	Carbon Sequestration
Livingston	22,371
Macomb	10,893
Monroe	8,286
Oakland	1,199
St. Clair	24,732
Washtenaw	35,123
Wayne	1,093
SEMCOG Region	**103,697**

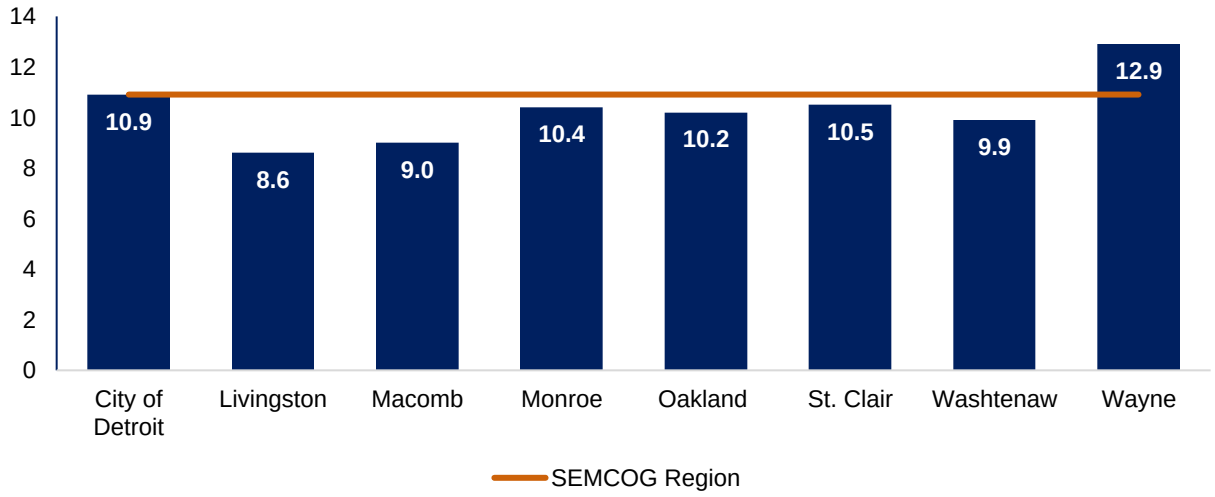
Note: Totals may not sum due to rounding; Wayne County including Detroit.
Source: ICLEI LEARN Tool

Per Capita Emissions by Sector

Per capita measurement is a direct way to compare various geographic boundaries for emissions contributions and to track performance of reduction strategies. The following figures provide comparisons of per capita emissions for the stationary energy, transportation, and waste sectors for each county, the City of Detroit, and the SEMCOG region.

Stationary Energy Emissions

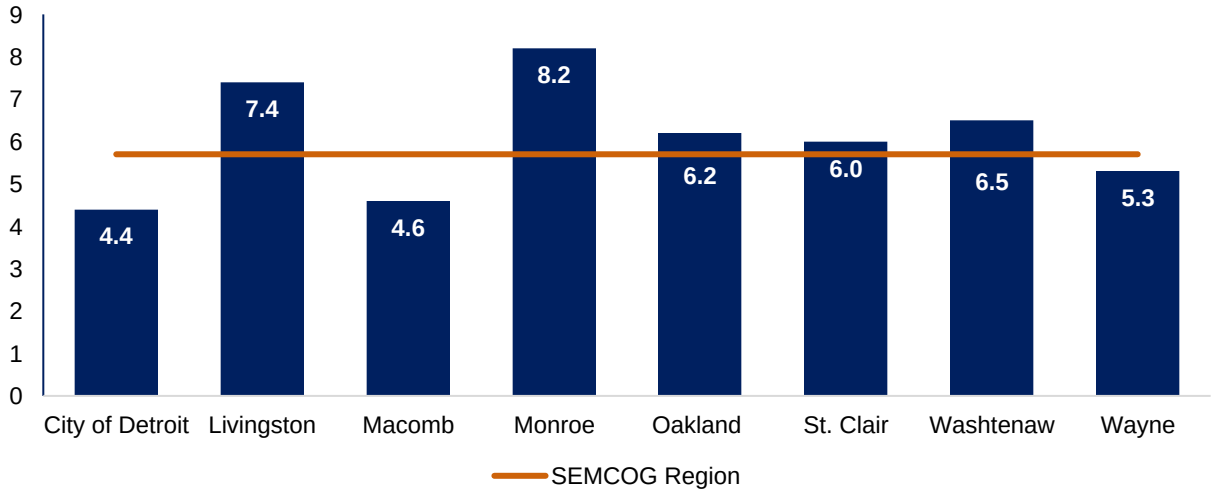
FIGURE 12. 2019 Per Capita Stationary Emissions by Jurisdiction (MTCO2e/Person)



Source: PSC analysis of ICLEI ClearPath data; U.S. Census Bureau 2019a; Wayne County including Detroit

Transportation Emissions

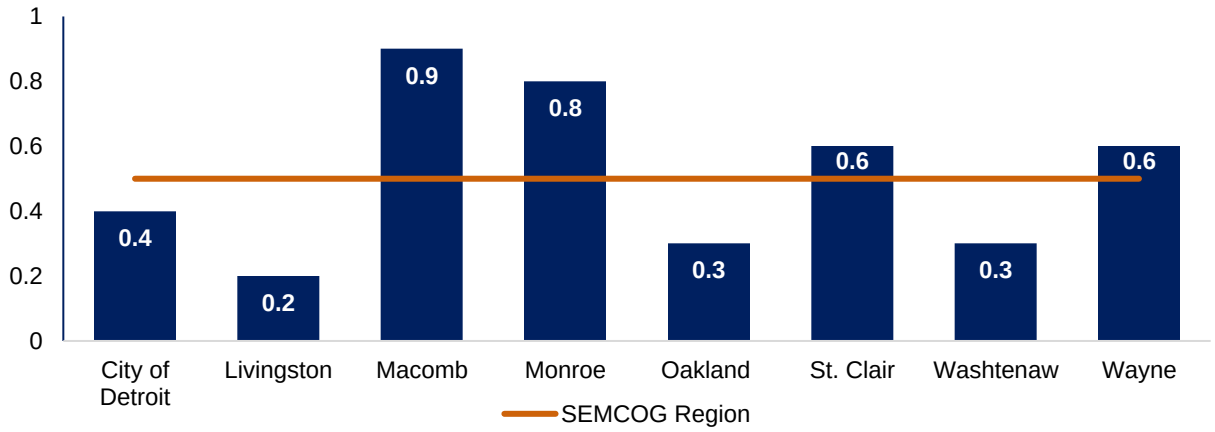
FIGURE 13. 2019 Per Capita Transportation Emissions by Jurisdiction (MTCO2e/Person)



Source: PSC analysis of ICLEI ClearPath data; U.S. Census Bureau 2019a; Wayne County including Detroit

Waste Emissions

FIGURE 14. 2019 Per Capita Waste Emissions by Jurisdiction (MTCO2e/Person)

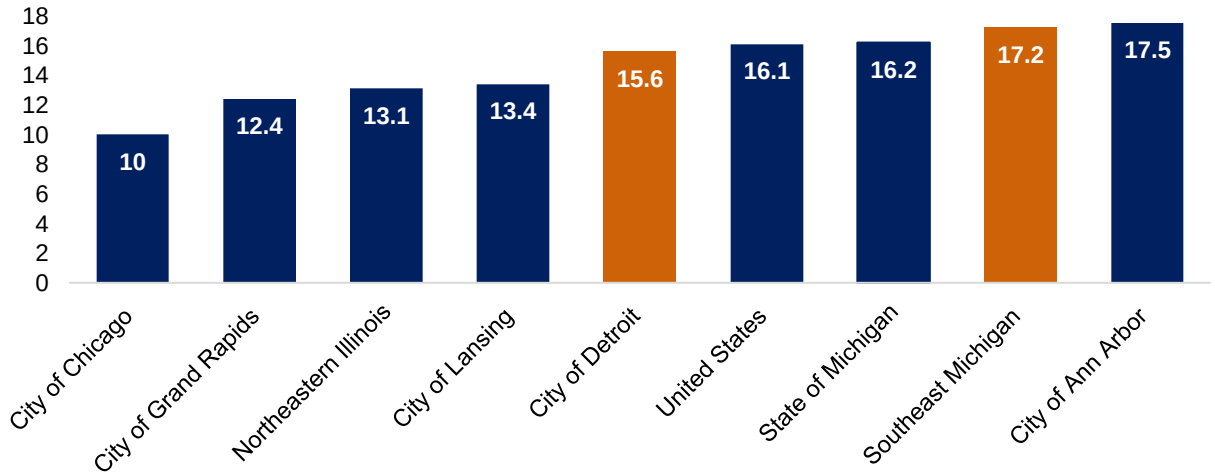


Source: PSC analysis of ICLEI ClearPath data; U.S. Census Bureau 2019a; Wayne County including Detroit

Per Capita Comparisons

For the purposes of comparison, Figure 15 shows per capita emissions for Southeast Michigan, the City of Detroit, and other areas in 2019.

FIGURE 15. 2019 Per Capita Emissions for Southeast Michigan, City of Detroit, and Other Areas (MTCO2e/Person)



Note: Because the methodologies used to develop these estimates vary, strict comparisons may not be appropriate.
Source: City of Ann Arbor 2020; City of Grand Rapids 2023; City of Lansing 2022; CMAP 2023; Climate Watch n.d.[2]

[2] Converted from short tons CO2e (tCO2e) per capita to metric tons (MTCO2e) per capita by multiplying by 0.9071847 (e.g., 17.72 x 0.9071847 = 16.1) (EIA 2023)

Emissions Projections and Reduction Scenario

Following data collection and analysis, several strategies for reducing GHG emissions in the region were explored. Regional strategies set the framework for future climate action planning, and every county and individual community must consider the unique local geographic and demographic factors that influence decision making for sector-specific strategies. See Appendix D for a list of suggested reduction strategies organized by sector.

Projected emissions and reductions for the region were modeled under two scenarios to show how emissions from the region may change in the future. The first is a forecast, or business-as-usual (BAU) model, to demonstrate emission trends if all contributing activities continue along their current trajectory. The second is an 80% reduction goal scenario based on the long-term goals of the reduction plan. Figures 16 and 17 show the remaining emissions in each sector under the scenarios.

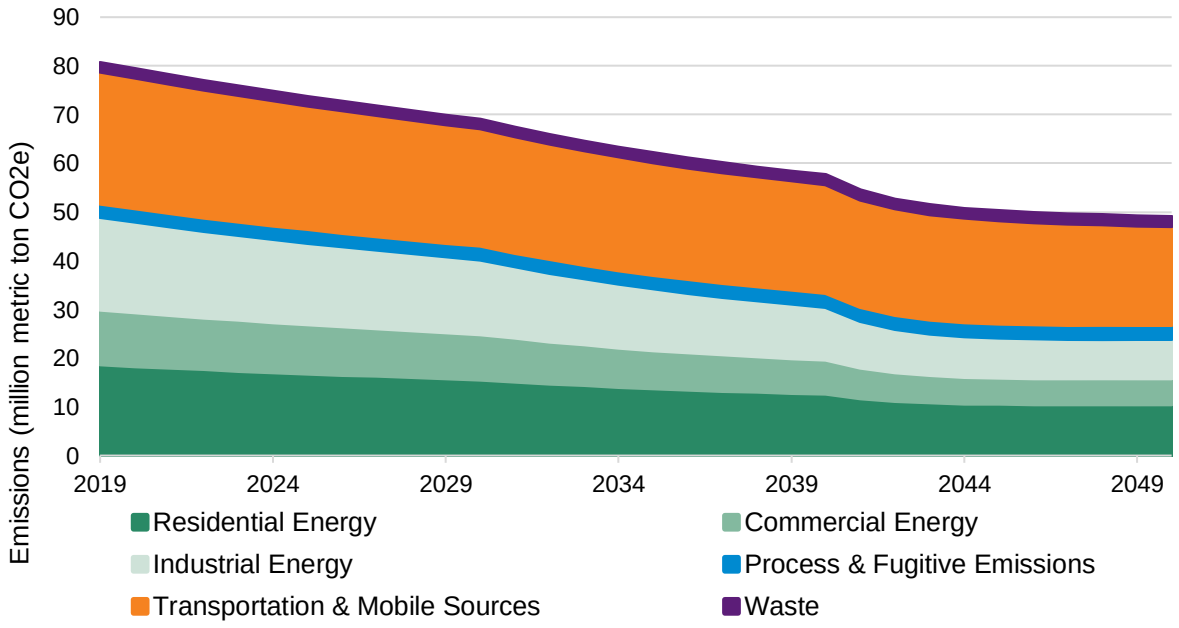
Scenario one: Original Forecast (BAU)

- Incorporates SEMCOG's population and jobs forecasts.
- Includes energy emissions reductions due to public utility net zero emissions goals and expected increases in federal fuel economy standards. The on-road transportation emissions intensity is decreased by expected by Federal CAFE fuel economy standard.
- Assumes no change in emissions per capita from 2019 through 2050 for other sectors.
- Results in following approximate emissions reductions:
    - 14% overall emissions reduction by 2030 and 44% overall emissions reduction by 2050
    - 18% energy emissions reduction by 2030 and 53% energy emissions reduction by 2050
    - 11% transportation emissions reduction by 2030 and 25% transportation emissions reduction by 2050

Scenario two: 80% Reduction Goal

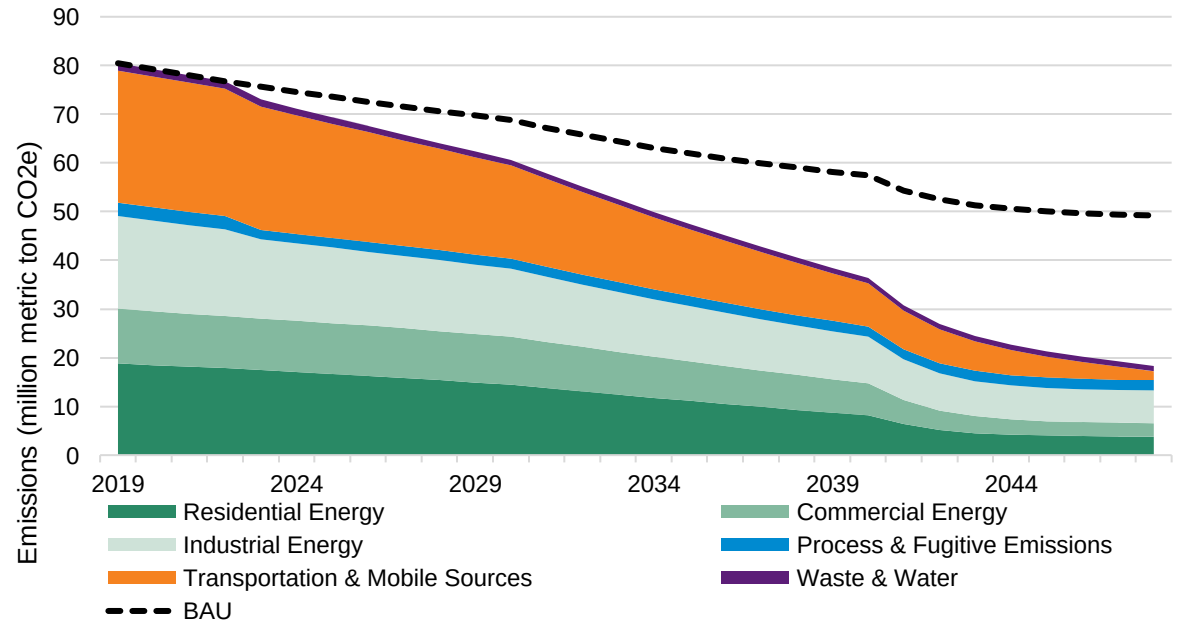
- Incorporates the assumptions in the BAU forecast, including SEMCOG's population and jobs forecasts.
- Assumes the region will achieve an 80% emissions reduction modeled using several high-level actions as described in the following section.
- Results in following approximate emissions reductions:
    - 25% overall emissions reduction by 2030 and 80% overall emissions reduction by 2050
    - 23% energy emissions reduction by 2030 and 71% energy emissions reduction by 2050
    - 29% transportation emissions reduction by 2030 and 99% transportation emissions reduction by 2050

FIGURE 16. Business as Usual Emission Projections by Sector



Source: ICLEI ClearPath data

FIGURE 17. 80% Emissions Reduction Scenario Projections by Sector



Source: ICLEI ClearPath data

80% Reduction Scenario Results

A preliminary scenario for regionwide emissions reductions is presented using high-level actions that could be achieved in two stages: activities from now to 2030 and from 2030 to 2050. The following seven categories of actions were analyzed and included in the preliminary scenario.

Vehicle Miles Traveled (VMT) Reduction

VMT per capita is reduced 10% by 2030 and 20% by 2050. Strategies to achieve this include strategically improved transit service, transit-oriented development, and commuting incentive programs.

Electric Vehicle (EV) Adoption

- 15% of on-road gasoline vehicles are electric by 2030 and 91.5% are electric in 2050 (EVAdoption n.d.). Local actions to promote this are consumer education and charging infrastructure, including charging for multifamily buildings.
- 15% of on-road diesel vehicles are electric by 2030, and 91.5% are electric in 2050.

Local action to promote this could include electrification of local government vehicles and conversations with other institutional and private fleet operators; and deployment of additional charging infrastructure.

Clean Electricity

Utilities in the region reduce emission intensity by 80% by 2030 and to net zero by 2050. This would be achieved through utility actions—local governments in the region can advocate for supportive policies (State or otherwise). Example emissions reduction targets of local utilities:

- Consumers Energy: 60% emissions reduction by 2025, net zero emissions by 2040 (Consumers Energy 2021)
- DTE: 50% emissions reduction by 2028, 80% reduction by 2040, net zero emissions by 2050 (DTE Energy 2021)

Building Electrification

- 40% of communitywide commercial square footage is converted to heat pump heating by 2030, and 100% is converted by 2050.
- 40% of communitywide housing units are converted to heat pump heating by 2030, and 100% are converted by 2050.

Actions to promote this would include consumer education, contractor education, and financial incentives.

Building Efficiency

- 5% of households receive an efficiency retrofit each year through 2030, with 20% energy savings for each retrofitted household. No additional retrofits modeled after 2030.
- 5% of commercial building space receives energy efficiency retrofits each year through 2030, with 20% energy savings for the buildings receiving the retrofits. No additional retrofits modeled after 2030.

Actions to promote this would include consumer education, contractor education, and financial incentives.

Green Industry

- 50% of the region's steel industry converts to electric arc furnaces, green hydrogen, or other carbon-free energy by 2030, and 100% converts by 2050.
- 15% of industrial natural gas and oil use shifts to industrial heat pumps (this shift is completed by 2030).

These changes will require cooperation between industry, local agencies, and state and federal government to identify and pursue opportunities. Federal grants, loans and tax credits are available to help industries implement heat pumps (Hoffmeister and Elliott 2023).

Solid Waste

- 30% of organic waste (e.g., food waste, yard waste, and paper) currently going to landfills is diverted to recycling or composting by 2030, and 40% is diverted by 2040.

Table 14 breaks these actions down by net reduction (million MTCO2e) and level of impact.

TABLE 14. Preliminary Scenario Strategies with the Corresponding Net Reduction (MTCO2e) and Level of Impact

Strategy	2030	2050	Impact Level
Clean electricity	20.8	28.8	**Very high**
Electric vehicle adoption	3.1	16.9	**High**
Building electrification	2.5	8.7	**High**
Green industry	2.4	5.7	**High**
VMT reduction	1.8	2.5	**Medium**
Building efficiency	0.8	0.8	**Low**
Solid waste	0.5	0.7	**Low**

Community-Level Emissions

In addition to breaking down the GHGI data by region and county, simplified community-specific emission profiles for all the communities within the Southeast Michigan boundary (i.e., cities, townships, and villages) were developed. The community data was formatted in such a way that it can be easily integrated into the Community Profiles available on SEMCOG's website. Emissions estimates for each community were developed by downscaling the county-level GHG emissions inventory results based on either percentage of county population or percentage of county jobs in relevant sectors (such as manufacturing), as is most appropriate for each emissions-generating activity. On-road transportation data was broken down using a location-based analysis of VMT. Table 15 below shows the estimated community emissions and basis of the estimates for each sector.

TABLE 15. Estimated Community Emissions by Sector

Estimated Community Emissions	Basis of Estimate
Residential electricity	Households
Residential fuels	Households
Commercial electricity	Jobs (excluding manufacturing)
Commercial fuels	Jobs (excluding manufacturing)
Industrial electricity	Manufacturing jobs
Industrial fuels	Manufacturing jobs
Process and fugitive	Manufacturing jobs
On-road gasoline	Location-Based Data Analysis of VMT
On-road diesel	Freight demand jobs (e.g., jobs in manufacturing, wholesale trade, retail trade, transportation, and warehousing)
Solid waste	Population
Water and wastewater	Population
Agriculture	Jobs in agriculture, forestry, fishing, and hunting

Conclusion

The 2019 regional greenhouse gas emissions inventory can help local governments throughout Southeast Michigan make decisions about where to prioritize the development of GHG emission reduction strategies. While additional information such as cost per metric ton of reduction is helpful, focusing on those areas that contribute significantly to the region's overall GHG footprint can be a starting point for policies, programs, and projects that can support Southeast Michigan's leadership in addressing the causes and impacts of climate change.

SEMCOG expects to update the regional inventory approximately every five years moving forward. In future iterations, the community-level emissions data will also be updated. As new methods for measuring and collecting data become available, every effort will be made to incorporate the best resources and techniques with reviewing progress towards emissions reductions goals included in the Mi Healthy Climate Plan.

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Appendix A: Acronyms and Abbreviations

AFOLU	Agriculture, forestry, and other land uses
AIP	Aging in Place
BAU	Business as usual
CH4	Methane
CO2	Carbon dioxide
CO2e	Carbon dioxide equivalent
EGLE	Michigan Department of Environment, Great Lakes, and Energy
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
EV	Electric vehicle
FHWA	U.S. Federal Highway Administration
FLIGHT	EPA Facility Level Information on GreenHouse Gases Tool
FTA	U.S. Department of Transportation Federal Transit Administration
GHG	Greenhouse gas
GHGI	Greenhouse gas emissions inventory
GLISA	Great Lakes Integrated Climate Assessment
GLWA	Great Lakes Water Authority
GPC	Global Protocol for Community-scale Greenhouse Gas Emission Inventories
GWP	Global warming potential
H2O	Water
kWh	Kilowatt hour
ICLEI	International Council for Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
LEARN	U.S. Community Protocol's Land Emissions and Removals Navigator tool
MDOT	Michigan Department of Transportation
MMBtu	One million British thermal units
MPO	Metropolitan planning organization
MPSC	Michigan Public Service Commission
MSW	Municipal solid waste
MT	Metric tons
MWh	Megawatt hour
N2O	Nitrous oxide
NEI	National Emissions Inventory
NEVI	National Electric Vehicle Infrastructure Formula Program
NTD	FTA's National Transit Database

PSC	Public Sector Consultants
SEMCOG	Southeast Michigan Council of Governments
SHVUA	South Huron Valley Utility Authority
SIT	EPA State Inventory Tool
USCP	U.S. Community Protocol
USDA	U.S. Department of Agriculture
VMT	Vehicle miles traveled
WDS	EGLE Waste Data System
WRI	World Resources Institute
YCUA	Ypsilanti Community Utilities Authority

Appendix B: Detailed Emissions Results

This appendix presents emissions by sector and gas for Southeast Michigan, each of the region's seven counties, and the City of Detroit.

TABLE B1. 2019 Emissions for Southeast Michigan by Sector and Gas (Metric Tons)

Sector	CO2	CH4	N2O	Total CO2e
Stationary energy	48,813,880	20,243	541	**51,816,223**
Transportation and mobile sources	26,924,244	1,468	536	**27,107,314**
Waste	0	51,777	320	**2,538,223**
Agriculture, forestry, and other land uses	0	4,834	575	**394,644**
Total	**75,738,124**	**78,322**	**1,972**	**81,856,404**

TABLE B2. 2019 Emissions for the City of Detroit by Sector and Gas (Metric Tons)

Sector	CO2	CH4	N2O	Total CO2e
Stationary energy	6,888,519	1,065	56	**7,318,345**
Transportation and mobile sources	2,717,936	89	55	**2,933,271**
Waste	0	8,881	60	**264,452**
Agriculture, forestry, and other land uses	0	0	0	**0**
Total	**9,606,455**	**10,035**	**171**	**10,516,068**

TABLE B3. 2019 Emissions for Livingston County by Sector and Gas (Metric Tons)

Sector	CO2	CH4	N2O	Total CO2e
Stationary energy	1,616,931	776	19	**1,643,981**
Transportation and mobile sources	1,418,600	72	29	**1,428,305**
Waste	0	1,048	0	**29,336**
Agriculture, forestry, and other land uses	0	1,133	140	**175,669**
Total	**3,035,531**	**3,029**	**188**	**3,277,291**

TABLE B4. 2019 Emissions for Macomb County by Sector and Gas (Metric Tons)

Sector	CO2	CH4	N2O	Total CO2e
Stationary energy	7,805,620	1,019	96	**7,859,434**
Transportation and mobile sources	4,001,814	232	80	**4,029,380**
Waste	0	7,036	63	**767,408**
Agriculture, forestry, and other land uses	0	501	240	**77,690**
Total	**11,807,434**	**8,788**	**479**	**12,733,912**

TABLE B5. 2019 Emissions for Monroe County by Sector and Gas (Metric Tons)

Sector	CO2	CH4	N2O	Total CO2e
Stationary energy	1,410,682	2,753	18	**1,568,777**
Transportation and mobile sources	1,231,888	61	25	**1,240,099**
Waste	0	4,510	1	**126,005**
Agriculture, forestry, and other land uses	0	354	1	**10,252**
Total	**2,642,570**	**7,678**	**45**	**2,945,133**

TABLE B6. 2019 Emissions for Oakland County by Sector and Gas (Metric Tons)

Sector	CO2	CH4	N2O	Total CO2e
Stationary energy	12,653,774	6,691	147	**12,880,871**
Transportation and mobile sources	7,729,504	453	154	**7,783,151**
Waste	0	13,280	88	**358,918**
Agriculture, forestry, and other land uses	0	47	1	**1,492**
Total	**20,383,278**	**20,471**	**390**	**21,024,432**

TABLE B7. 2019 Emissions for St. Clair County by Sector and Gas (Metric Tons)

Sector	CO2	CH4	N2O	Total CO2e
Stationary energy	1,660,021	235	19	**1,673,726**
Transportation and mobile sources	951,401	58	19	**958,001**
Waste	0	3,305	1	**87,891**
Agriculture, forestry, and other land uses	0	1,098	47	**43,065**
Total	**2,611,422**	**4,696**	**86**	**2,762,683**

TABLE B8. 2019 Emissions for Washtenaw County by Sector and Gas (Metric Tons)

Sector	CO2	CH4	N2O	Total CO2e
Stationary energy	3,555,325	2,470	49	**3,640,477**
Transportation and mobile sources	2,383,715	121	48	**2,399,760**
Waste	0	3,438	17	**98,247**
Agriculture, forestry, and other land uses	0	1,658	141	**83,672**
Total	**5,939,040**	**7,687**	**255**	**6,222,156**

TABLE B9. 2019 Emissions for Wayne County by Sector and Gas (Metric Tons)

Sector	CO2	CH4	N2O	Total CO2e
Stationary energy	20,110,913	6,308	197	**22,548,957**
Transportation and mobile sources	9,207,321	473	181	**9,268,618**
Waste	0	36,981	158	**1,070,418**
Agriculture, forestry, and other land uses	0	43	6	**2,804**
Total	**29,318,234**	**43,805**	**542**	**32,890,797**

Appendix C: Detailed GHG Inventory Methodology

The following sections describe the methods used to collect and analyze data that supported the GHG inventory.

Residential, Commercial, and Industrial Energy Use

Utility-provided Energy Use Data

Data on electricity use and/or natural gas use, as applicable, was categorized as residential, commercial, or industrial and provided by the following utilities:

- DTE Energy
- Consumers Energy

Electricity usage for Wyandotte Municipal Service Commission and the Village of Chelsea was obtained from EIA Sales to Ultimate Customers data (EIA n.d.a). Because the service of each utility is completely within the county where they are located, no further estimation was needed.

Consumers Energy and DTE Energy provided CO2/MWh emissions factors for electricity, which were used for energy use from those providers in combination with CH4 and N2O emissions factors from the EPA's Emissions and Generation Resource Integrated Database (eGRID) (EPA 2021a). For the City of Wyandotte and Village of Chelsea, eGRID emissions factors were used for CO2, CH4, and N2O.

Estimated Natural Gas Usage

Michigan Gas Utilities and SEMCO Energy Gas Company did not provide data, so an estimation approach was applied.

Total gas sales for each utility were obtained from the EIA form 176 Natural Gas Annual Respondent Query System (EIA 2023). Because each utility provides service to areas both inside and outside the SEMCOG region, it was necessary to estimate the percentage of each utility's total sales within the region. To do this, the number of townships served by each utility was counted visually from the Michigan Public Service Commission (MSPC) Natural Gas Service Area Map (MPSC 2011).

In some cases, a township is served by multiple utilities; in such cases, the township was assigned to whichever utility appeared to have the largest area of the township. The total gas sales for each utility were then allocated to SEMCOG counties based on the percentage of total townships served by the utilities in that county.

Residential Nonutility Fuel Use

The number of households in each county using propane and fuel oil as their primary heating fuel was obtained from the U.S. Census Bureau American Community Survey One-year Estimates Subject

Tables, Physical Housing Characteristics for Occupied Housing Units (U.S. Census Bureau 2019b). Reported natural gas usage and number of residential customers in each county from Consumers Energy was used to calculate the average heating MMBtu per household in each county. This was used to estimate residential propane and fuel oil use for each county.

Commercial and Industrial Nonutility Fuel Use

Statewide commercial usage of fuel oil, propane, and wood was allocated based on job counts for each county, totaling the job categories listed under commercial in Table C1 below. Job counts were provided by SEMCOG. Statewide commercial usage of each fuel was obtained from the EIA State Energy Data System (SEDS), and usage per job was calculated by dividing the statewide usage by the number of statewide jobs in the commercial categories (EIA n.d.b). The number of statewide job counts was obtained from the U.S. Census OnTheMap tool (U.S. Census Bureau n.d.). Industrial residual and distillate fuel oil, propane, wood, still gas, petroleum coke, and coal were allocated using the same method with the industrial job categories.

TABLE C1. Job categories used to estimate nonutility fuel usage

Commercial	Industrial
Information	Agriculture, forestry, fishing and hunting
Finance and insurance	Mining, quarrying, and oil and gas extraction
Real estate and rental and leasing	Utilities
Professional, scientific, and technical services	Construction
Management of companies and enterprises	Manufacturing
Administration and support, waste management and remediation	Wholesale trade
Educational services	Retail trade
Healthcare and social assistance	Transportation and warehousing
Arts, entertainment, and recreation	
Accommodation and food services	
Other services (excluding public administration)	
Public administration	

Transportation

On-road Vehicles

On-road daily VMT was produced from SEMCOG's travel demand model. The regional annual total VMT from the Federal Highway Performance Monitoring Program (HPMS) was divided by the regional daily total from the travel demand model to produce a conversion from daily to annual VMT. This conversion was applied to the daily VMT for each county; this approach ensures that the regional annual total matches the annual total from HPMS.

VMT was broken into miles traveled using gasoline and diesel based on ICLEI's defaults of 9.4% diesel and 90.6% gasoline, which come from the EPA's State Inventory Tool (SIT) (EPA 2024) (Table C2). Defaults were used, rather than local vehicle registration data, because commercial vehicles are typically driven much higher mileage per vehicle than passenger vehicles, so the count of vehicles is not a good indicator of VMT breakdown. In addition, freight vehicles, particularly long-haul trucks, making trips into and out of the region are frequently registered outside the region, often in a different state.

TABLE C2. On-road Vehicle Miles Traveled by Fuel Type

	Annual VMT (Origin to Destination)	Gasoline VMT (90.6%)	Diesel VMT (9.4%)
Detroit	5,036,116,933	4,562,721,941	473,394,992
Wayne	15,829,408,000	14,341,443,648	1,487,964,352
Oakland	13,083,863,000	11,853,979,878	1,229,883,122
Macomb	6,784,653,000	6,146,895,618	637,757,382
Washtenaw	4,179,755,724	3,786,858,686	392,897,038
Monroe	2,036,500,000	1,845,069,000	191,431,000
St. Clair	1,518,162,000	1,375,454,772	142,707,228
Livingston	2,430,280,000	2,201,833,680	228,446,320
Regional	**45,636,216,000**	**41,346,411,696**	**4,289,804,304**

Source: SEMCOG 2024a; EPA 2024

VMT was assigned by percentage to different vehicle types:

- Diesel VMT was assigned to vehicle types based on the following defaults: 88.2% heavy truck, 8.3% light truck, and 3.5% passenger car. As with gasoline VMT, these are ICLEI defaults taken from EPA's SIT.
- Gasoline VMT was assigned to vehicle types based on vehicle registration data by county, which was provided by SEMCOG (see Table C3). Vehicle body types in the registration data were assigned to categories matching those used in ClearPath. Since this assignment is within passenger vehicles, vehicle count is a good proxy for VMT breakdown.

TABLE C3. Percentage of Gasoline VMT by Vehicle Type for Each County

	Detroit	Livingston	Macomb	Monroe	Oakland	St. Clair	Washtenaw	Wayne
Passenger car	50.4%	34.0%	36.6%	34.4%	37.8%	33.3%	41.8%	43.5%
Light truck	47.9%	61.5%	60.4%	60.6%	61.6%	61.9%	55.0%	56.1%
Motorcycle	1.3%	3.7%	2.6%	4.3%	2.4%	3.9%	2.7%	2.4%
Heavy truck	0.3%	0.7%	0.4%	0.7%	0.5%	0.8%	0.5%	0.4%

Source: SEMCOG 2024b

Public Transportation

Fuel usage data was obtained from the U.S. Federal Transit Administration (FTA) for the following transit agencies:

- Enterprise Rideshare
- Blue Water Area Transit
- Lake Erie Transit
- Detroit Transportation Corporation (rail)
- QLINE Detroit

In addition, data on vehicle revenue miles from the FTA's National Transit Database were collected for the following transit agencies (FTA 2023):

- City of Detroit
- Ann Arbor Area Transportation Authority
- University of Michigan Parking and Transportation Services
- Detroit Transportation Corporation (bus)
- Livingston County Board of Commissioners

Data was not available for the Suburban Mobility Authority for Regional Transit at the time of data collection for this report. Revenue miles were converted to gallons of fuel based on a default of 17.9 miles per gallon from the Federal Highway Administration (FHWA)'s Table of Annual Vehicle Distance Traveled in Miles and Related Data (see value for "Light Duty Vehicles Long WB") (FHWA 2024).

Equation used: Gallons fuel = Revenue miles / 17.9

Rail

- For freight rail, the MDOT provided ton miles and an average efficiency of 500 ton miles/gallon. This was used to calculate gallons of diesel fuel used.
- For passenger rail, gallons of diesel fuel for each route were obtained from MDOT. Fuel use was allocated to each county based on the percentage of the total route track miles in each county (see Table C4).

TABLE C4. Allocated Passenger Rail Fuel Use by County

County, Route	Route Track Miles	County Track Miles	Percentage of Route	2019 Fuel for Route	County Fuel Use (Gallons)
Washtenaw, Wolverine	304	35	11.5%	805,555	92,745
Wayne, Wolverine	304	30	9.9%	805,555	79,496
Oakland, Wolverine	304	15	4.9%	805,555	39,748
St. Clair, Blue Water	319	25	7.8%	416,972	32,678

Source: MDOT 2024

Waterborne Transportation

Data on vessel movements (ships entering and leaving port) and total tonnage of freight for the ports of Detroit, Monroe, Marine City, Marysville, and Port Huron were obtained from the U.S. Army Corps of Engineers Waterborne Commerce Statistics Center Ports and Waterways Page (see Table C5). Marine emissions are accounted for based on the port's area of authority and status of incoming or outgoing. Factors for fuel use of vessels during cruise, reduced speed, and maneuvering (see Tables C6 and C7) were applied to the tonnage of number of trips to calculate emissions, which were directly entered into ClearPath.

TABLE C5. Number of Vessels and Freight Tonnage for Ports in Region in 2019

Port	Detroit	Marine City	Monroe	Marysville	Port Huron
Total vessels (inbound + outbound)	841	158	239	81	55
Liquid tanker vessels	22	0	43	0	0
Tonnage of freight	5,694,217	1,037,063	1,656,927	720,561	76,197

TABLE C6. Full-power Fuel Usage and Emissions Factors for Marine Vessels

Ship type	Fuel consumption (metric tons/day) at full power
Solid bulk	20.186 + 0.00049 * gross tonnage
Liquid bulk	14.685 + 0.00079 * gross tonnage
GHG	**Emissions (g/kg fuel)**
CO2	3,188
CH4	0.23
N2O	0.08

Source: Jun, Gillenwater, and Barbour 2023

TABLE C7. Factors Used for Adjusting from Full-power Fuel Use Factor for Marine Vessels

Mode	Time in Mode (Minutes) per Inbound or Outbound Trip	Load Factor (Percentage of Full Power)
Cruise	30	80%
Reduced speed	31	33%
Maneuvering	30	12%

Source: SEMCOG 2022

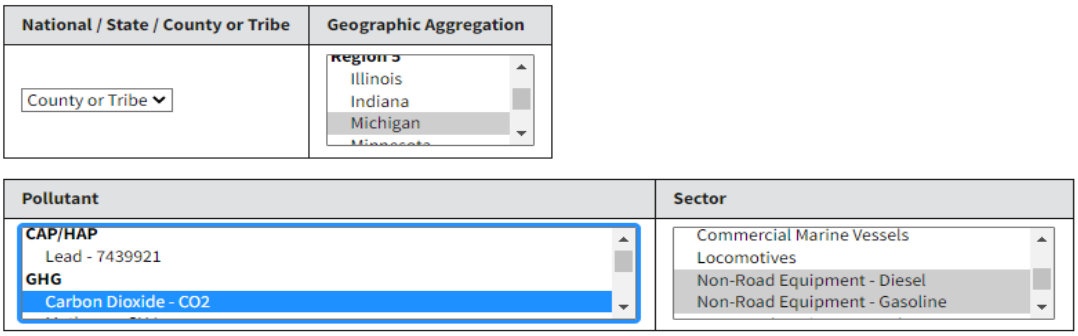
Data was not available on ferry operations; these emissions are de minimis and are not included.

Off-road/Mobile Equipment

Data was entered by county from the EPA's 2017 National Emissions Inventory (NEI) (EPA 2021b). CO2 emissions from the NEI are pulled for "Nonroad Equipment—Diesel and "Nonroad Equipment—Gasoline" (see Figure C1). NEI data is updated on a three-year cycle, with approximately a three-year delay (data for 2023 is expected to be available in 2026). As of June 2023, data for 2020 had been released, but not in a query-able format.

Air travel was not included because it was assumed to be scope three.

FIGURE C1. NEI Query Settings



Solid Waste

Landfilled Waste

Waste generation for each county was obtained from the *Fiscal Year 2019 Annual Report of Solid Waste Landfilled in Michigan* (EGLE 2020). This data includes the amount of waste by origin county and location of the landfill. This data was summed into the amount for each county that was both generated and landfilled within that county; the amount generated in that county and exported to another SEMCOG county; the amount generated in that county and exported outside the region; and the amount imported and landfilled in that county. For the regional inventory, there would be double counting between waste exported to another county in the region and imported waste (waste exported from one county would also show up as imported to another county). To avoid this, all 'waste imported' entries are marked as information only in the regional inventory. The double counting issue does not arise with individual county inventories, so imported waste entries are not marked as information only in those (this means if waste emissions from each county inventory were added together, the total is more than the regional total waste emissions).

Waste was converted from volume to mass units using an EPA conversion factor of 550 lbs./cubic yard (EPA 2016). For municipal solid waste, waste composition was used from the *2016 Economic Impact Potential and Characterization of Municipal Solid Waste in Michigan* report (Schoonmaker et al. 2016). For Detroit, Wayne County waste generation was downscaled based on population.

Equation used: Tons waste = cubic yards * 550/2000

Compost

Cubic yards of material brought to composting sites in each county were obtained from the EGLE Waste Data System (EGLE n.d.). The assumption was used that the material originated in that county. Cubic yards were converted to tons using a volume-to-weight conversion factor of 0.175 tons/cubic yard (New Hampshire Department of Environmental Services 2006). For Detroit, Wayne County compost tonnage was downscaled based on population.

Equation used: Tons composted = cubic yards composted * 0.175

Water/Wastewater

Wastewater Treatment Process Emissions

Data on wastewater treatment processes was provided by the following wastewater utilities:

- Ypsilanti Community Utilities Authority (YCUA)
- South Huron Valley Utility Authority (SHVUA)
- Monroe Metro Sewer Authority
- Downriver Utility Wastewater Authority
- City of Ann Arbor
- Great Lakes Water Authority (GLWA)

Process N2O emissions and effluent discharge N2O emissions were calculated for each facility based on the data provided (depending on the data provided, either daily nitrogen (N) load in effluent discharge or population was used). In addition, YCUA and GLWA reported combustion of wastewater solids, and emissions were calculated from the data provided. Since GLWA serves multiple counties, tons of biosolids were allocated to each county based on the portion of the total population served by GLWA that reside in that county.

Emissions were not calculated for the remaining utilities that did not provide data.

Process and Fugitive Emissions

Process Emissions from Industrial Facilities

Process emissions from large emitters were obtained from the EPA Facility-Level Information on Greenhouse Gases Tool (FLIGHT) (EPA 2023b).

Fugitive Emissions from Oil and Gas Production

- Gas production emissions are estimated using an emissions factor of 4.1 metric tons (MT) CH4/year. The emissions factor comes from the EPA's SIT. A total of four producing gas wells were identified in the region in 2019.
- Oil production emissions were estimated using an emissions factor of 0.3477 MT CH4 per 1,000 barrels of oil produced. The emissions factor comes from the EPA's SIT.

Data on gas production wells and oil production was supplied by EGLE's Oil, Gas, and Minerals Division.

Fugitive Emissions from Natural Gas Distribution

Fugitive emissions from natural gas distribution were calculated using the total gas usage in each county (including usage provided by utilities and estimated usage as described above). A default leakage rate of 0.3% was applied to this total usage.

Agriculture, Forestry, and Other Land Use

Livestock-enteric Fermentation and Manure Management

CH4 emissions from enteric fermentation were calculated using factors from the EPA's SIT. The number of livestock of different types by county were obtained from the USDA Census of Agriculture for 2017 (USDA 2019). [3] Enteric fermentation emissions were calculated for dairy cows, beef cows, heifer stockers, sheep, and swine. Manure management emissions were calculated for dairy cows, beef cows, heifer stockers, sheep, swine, and chickens. [4]

Agricultural Production

N2O emissions from crop residues and legumes were calculated using factors from the EPA's SIT. Production of crops by county was obtained from the USDA Census of Agriculture for 2017 (USDA 2019). Emissions were calculated from the following crops based on availability of data and emissions factors: corn (grain), oats, soybeans, wheat, and beans (dry edible).

Forests and Trees

Emissions and carbon removed from the atmosphere were calculated using ICLEI's Land Emissions and Removals Navigator (LEARN) tool. Calculation of forest and tree emissions and removals requires land cover and canopy data from two years. For forests, the time period of 2013 to 2019 was used, and for trees outside of forests, the time period of 2011 to 2016 (the only two years of data available in the LEARN tool) was used.

[3] The agricultural census is conducted every five years.

[4] Enteric fermentation does not occur in chickens.

Appendix D: County-Level GHG Summaries

Livingston County

2019 County Emissions Summary

This county emissions summary was developed as part of the 2019 Regional Greenhouse Gas Emissions Inventory (GHGI) for the Southeast Michigan Council of Governments (SEMCOG). It is intended to help decision makers understand key greenhouse gas (GHG) emissions sources in Livingston County and provide communities with information needed to begin developing GHG emissions reduction strategies. More details on the methods and data sources used to produce this summary will be available in the full report on SEMCOG's website.

Community Characteristics

Population*	**191,995**
Jobs (full- and part-time)**	**94,929**
Median household income*	**$85,512**
Share of owner-occupied housing units*	**85%**
Land area (acres)**	**374,639**
Tree coverage (percentage of land area)**	**43.9%**
Impervious surfaces (percentage of land area)**	**6.4%**

Data sources: *2019 American Community Survey One-year Estimates; **SEMCOG Community Profiles

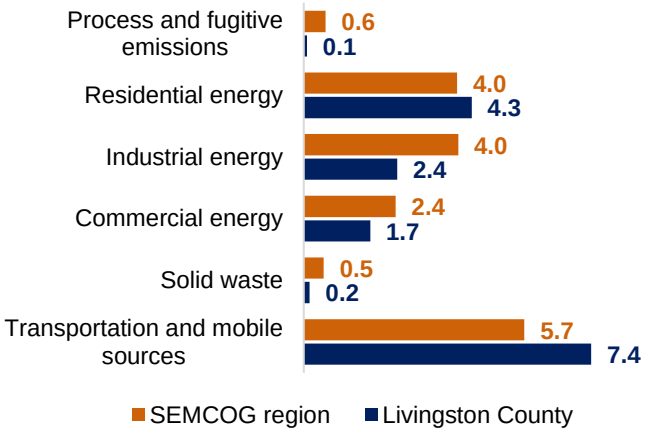
Emissions Summary

2019 Emissions Summary ($MTCO_2e$)

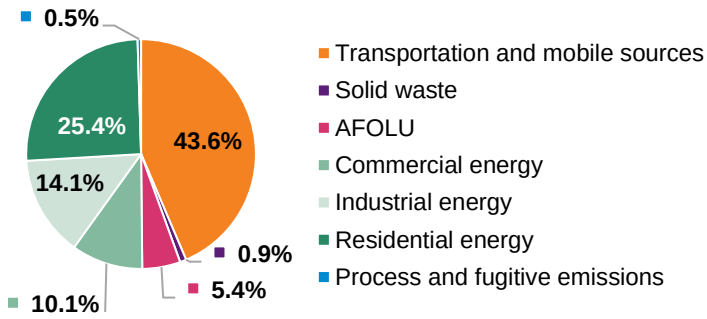
Transportation and mobile sources	**1,428,305**
Solid waste	**29,336**
Water and wastewater	**0**
AFOLU	**175,669**
Commercial energy	**330,372**
Industrial energy	**463,648**
Residential energy	**833,959**
Process and fugitive emissions	**16,002**

AFOLU = agriculture, forestry, and other land uses
$MTCO_2e$ = metric tons of carbon dioxide equivalent

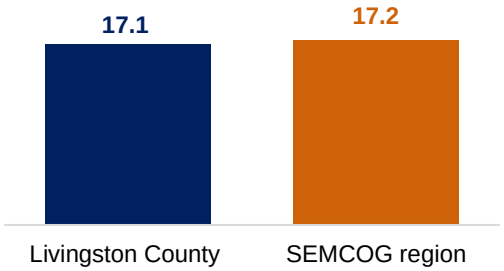
2019 Per-capita Emissions ($MTCO_2e$/Person)



2019 Regional Emissions by Sector ($MTCO_2e$)

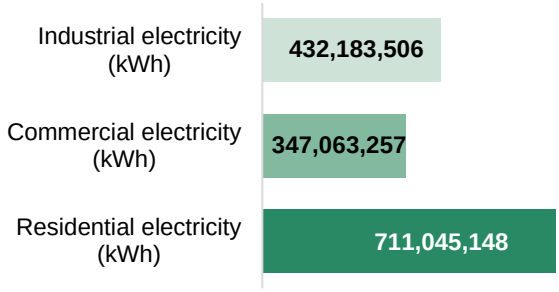


2019 Overall Per-capita Emissions ($MTCO_2e$/Person)



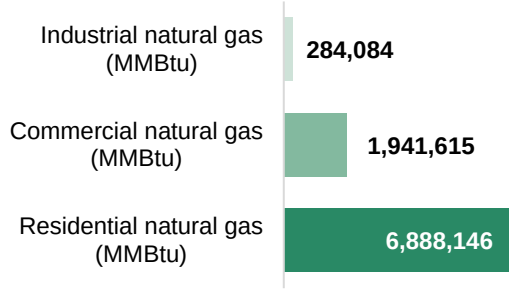
Energy Characteristics

2019 Electricity Energy Consumption



kWh = kilowatt hours

2019 Natural Gas Consumption



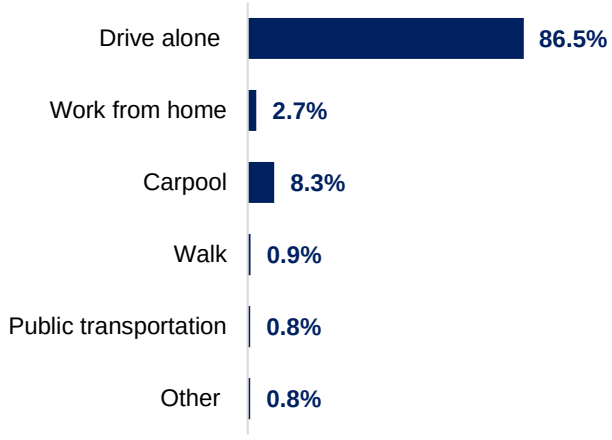
MMBtu = million British thermal units

2019 Per-capita Energy Consumption

	Livingston County	SEMCOG Region
Residential electricity (kWh/person)	3,703	3,110
Commercial electricity (kWh/person)	1,808	2,236
Industrial electricity (kWh/person)	2,251	4,065
Residential natural gas (MMBtu/person)	36	38
Commercial natural gas (MMBtu/person)	10	17
Industrial natural gas (MMBtu/person)	1	11

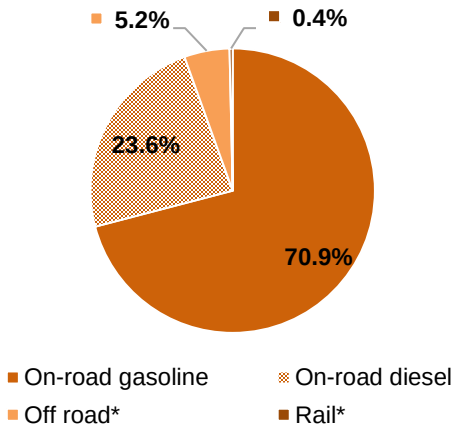
Transportation Characteristics

Mode of Travel to Work



Note: Totals may not sum due to rounding
Data source: 2019 American Community Survey Five-year Estimates

2019 Transportation Fuel Emissions



*Mixed fuel sources

Data source: PSC Analysis of ICLEI (Local Governments for Sustainability) data

Macomb County

2019 County Emissions Summary

This county emissions summary was developed as part of the 2019 Regional Greenhouse Gas Emissions Inventory (GHGI) for the Southeast Michigan Council of Governments (SEMCOG). It is intended to help decision makers understand key greenhouse gas (GHG) emissions sources in Macomb County and provide communities with information needed to begin developing GHG emissions reduction strategies. More details on the methods and data sources used to produce this summary will be available in the full report on SEMCOG's website.

Community Characteristics

Population*	**873,972**
Jobs (full- and part-time)**	**459,397**
Median household income*	**$64,947**
Share of owner-occupied housing units*	**74.2%**
Land area (acres)**	**309,777**
Tree coverage (percentage of land area)**	**25.3%**
Impervious surfaces (percentage of land area)**	**22.2%**

Data sources: *2019 American Community Survey One-year Estimates; **SEMCOG Community Profiles

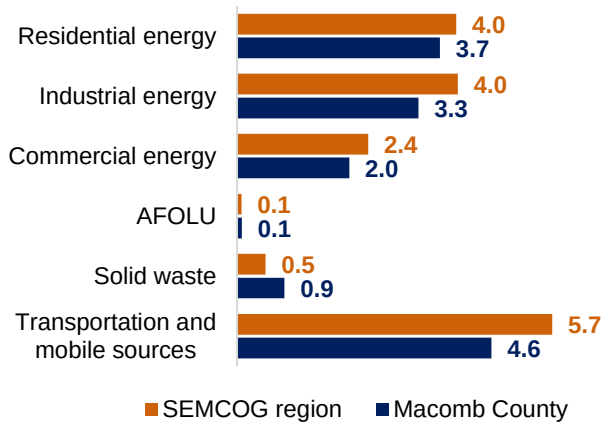
Emissions Summary

2019 Emissions Summary ($MTCO_2e$)

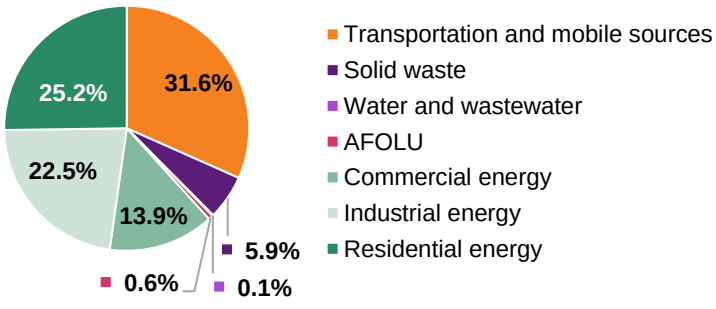
Transportation and mobile sources	**4,029,380**
Solid waste	**750,808**
Water and wastewater	**16,600**
AFOLU	**77,690**
Commercial energy	**1,776,065**
Industrial energy	**2,870,787**
Residential energy	**3,212,201**
Process and fugitive emissions	**381**

AFOLU = agriculture, forestry, and other land uses
$MTCO_2e$ = metric tons of carbon dioxide equivalent

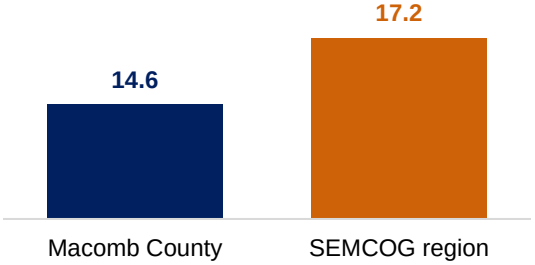
2019 Per-capita Emissions ($MTCO_2e$/Person)



2019 Energy Emissions ($MTCO_2e$)

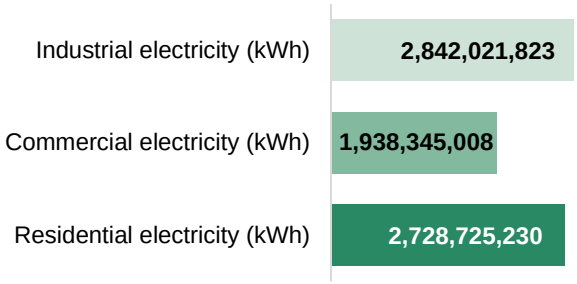


2019 Overall Per-capita Emissions ($MTCO_2e$/Person)



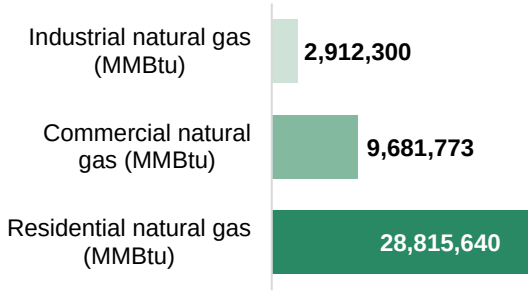
Energy Characteristics

2019 Electricity Energy Consumption



kWh = kilowatt hours

2019 Natural Gas Consumption



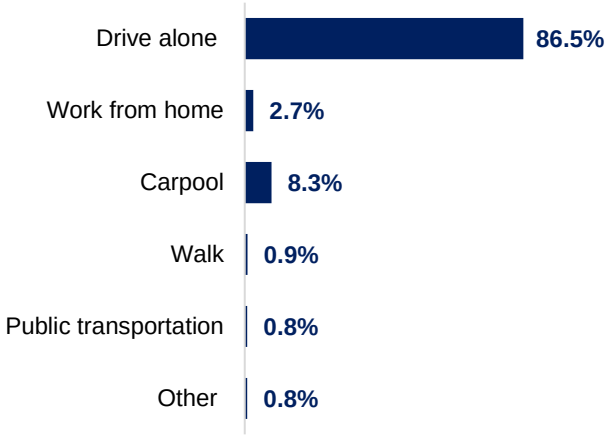
MMBtu = million British thermal units

2019 Per-capita Energy Consumption

	Macomb County	SEMCOG Region
Residential electricity (kWh/person)	3,122	3,110
Commercial electricity (kWh/person)	2,218	2,236
Industrial electricity (kWh/person)	3,252	4,065
Residential natural gas (MMBtu/person)	33	38
Commercial natural gas (MMBtu/person)	11	17
Industrial natural gas (MMBtu/person)	3	11

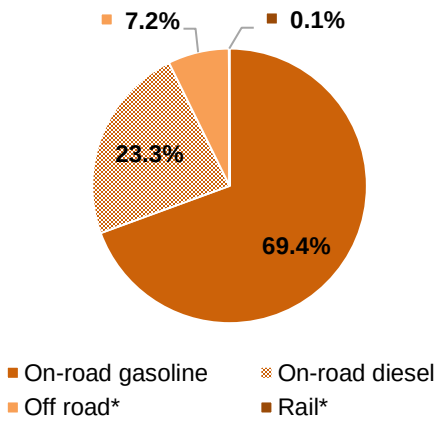
Transportation Characteristics

Mode of Travel to Work



Note: Totals may not sum due to rounding
Data source: 2019 American Community Survey Five-year Estimates

2019 Transportation Fuel Emissions



*Mixed fuel sources

Data source: PSC Analysis of ICLEI (Local Governments for Sustainability) data

Monroe County

2019 County Emissions Summary

This county emissions summary was developed as part of the 2019 Regional Greenhouse Gas Emissions Inventory (GHGI) for the Southeast Michigan Council of Governments (SEMCOG). It is intended to help decision makers understand key greenhouse gas (GHG) emissions sources in Monroe County and provide communities with information needed to begin developing GHG emissions reduction strategies. More details on the methods and data sources used to produce this summary will be available in the full report on SEMCOG's website.

Community Characteristics

Population*	**150,500**
Jobs (full- and part-time)**	**56,696**
Median household income*	**$62,839**
Share of owner-occupied housing units*	**78.1%**
Land area (acres)**	**356,830**
Tree coverage (percentage of land area)**	**20.6%**
Impervious surfaces (percentage of land area)**	**5.8%**

Data sources: *2019 American Community Survey One-year Estimates; **SEMCOG Community Profiles

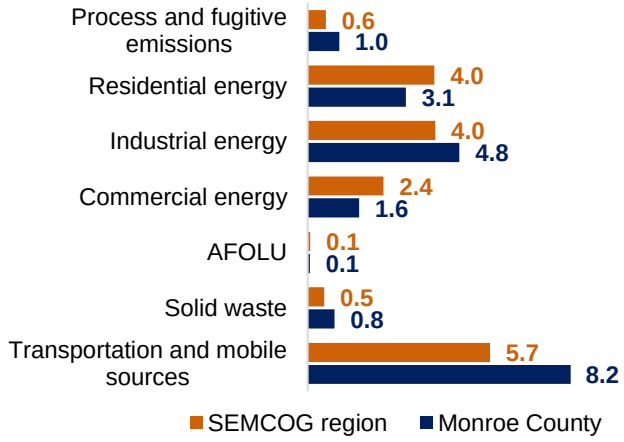
Emissions Summary

2019 Emissions Summary ($MTCO_2e$)

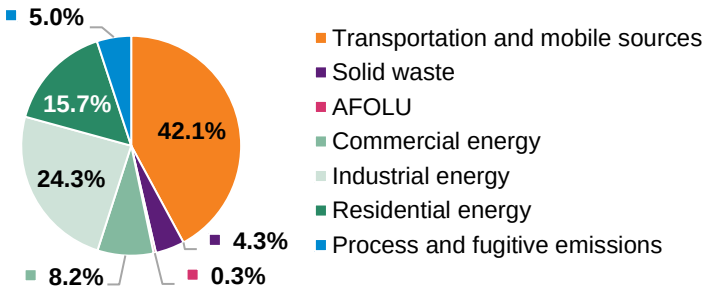
Transportation and mobile sources	**1,240,099**
Solid waste	**125,730**
Water and wastewater	**275**
AFOLU	**10,252**
Commercial energy	**242,431**
Industrial energy	**715,406**
Residential energy	**462,303**
Process and fugitive emissions	**148,637**

AFOLU = agriculture, forestry, and other land uses
$MTCO_2e$ = metric tons of carbon dioxide equivalent

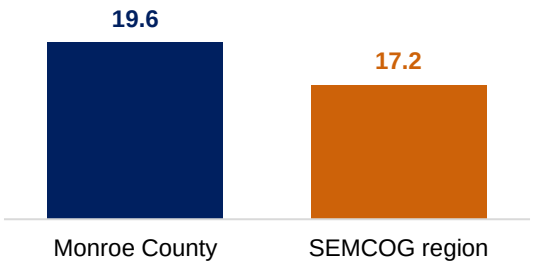
2019 Per-capita Emissions ($MTCO_2e$/Person)



2019 Regional Emissions by Sector ($MTCO_2e$)

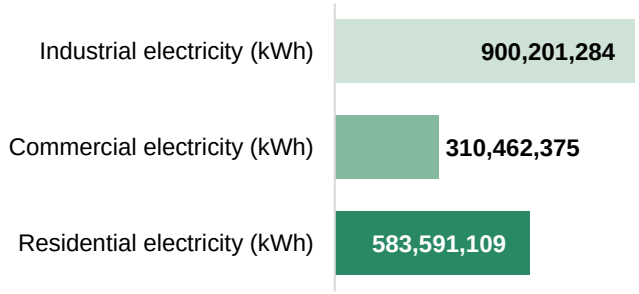


2019 Overall Per-capita Emissions ($MTCO_2e$/Person)



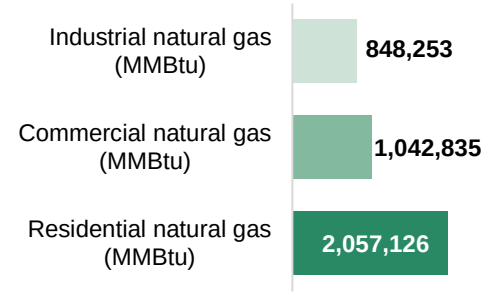
Energy Characteristics

2019 Electricity Energy Consumption



kWh = kilowatt hours

2019 Natural Gas Consumption



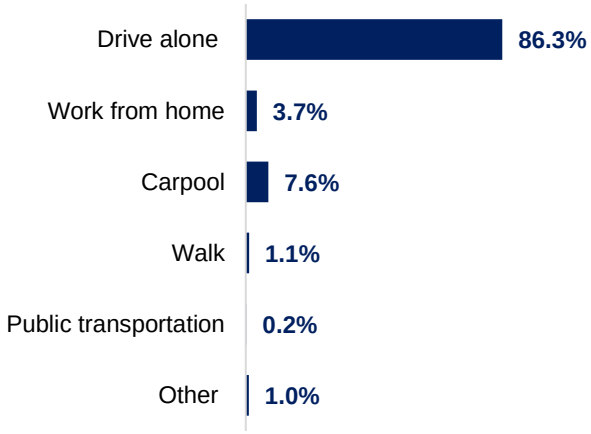
MMBtu = million British thermal units

2019 Per-capita Energy Consumption

	Monroe County	SEMCOG Region
Residential electricity (kWh/person)	3,878	3,110
Commercial electricity (kWh/person)	2,063	2,236
Industrial electricity (kWh/person)	5,981	4,065
Residential natural gas (MMBtu/person)	14	38
Commercial natural gas (MMBtu/person)	7	17
Industrial natural gas (MMBtu/person)	6	11

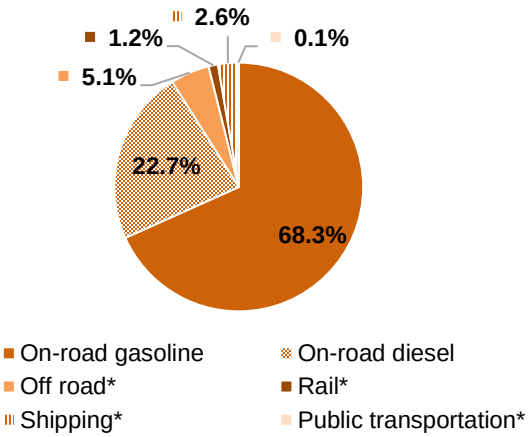
Transportation Characteristics

Mode of Travel to Work



Note: Totals may not sum due to rounding
Data source: 2019 American Community Survey Five-year Estimates

2019 Transportation Fuel Emissions



*Mixed fuel sources

Data source: PSC Analysis of ICLEI (Local Governments for Sustainability) data

Oakland County

2019 County Emissions Summary

This county emissions summary was developed as part of the 2019 Regional Greenhouse Gas Emissions Inventory (GHGI) for the Southeast Michigan Council of Governments (SEMCOG). It is intended to help decision makers understand key greenhouse gas (GHG) emissions sources in Oakland County and provide communities with information needed to begin developing GHG emissions reduction strategies. More details on the methods and data sources used to produce this summary will be available in the full report on SEMCOG's website.

Community Characteristics

Population*	**1,257,584**
Jobs (full- and part-time)**	**1,023,765**
Median household income*	**$81,190**
Share of owner-occupied housing units*	**71.7%**
Land area (acres)**	**580,583.2**
Tree coverage (percentage of land area)**	**40.0%**
Impervious surfaces (percentage of land area)**	**19.2%**

Data sources: *2019 American Community Survey One-year Estimates; **SEMCOG Community Profiles

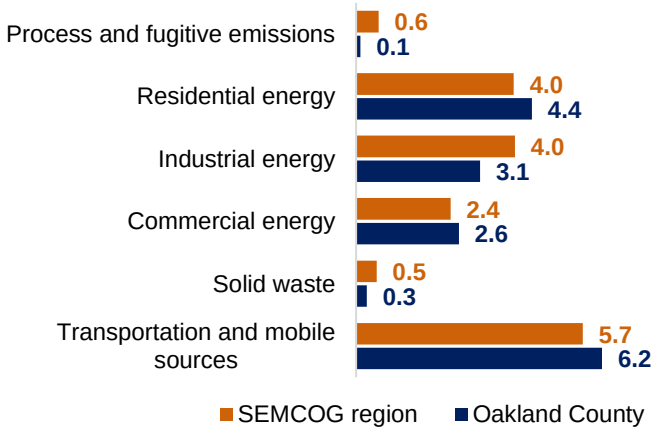
Emissions Summary

2019 Emissions Summary ($MTCO_2e$)

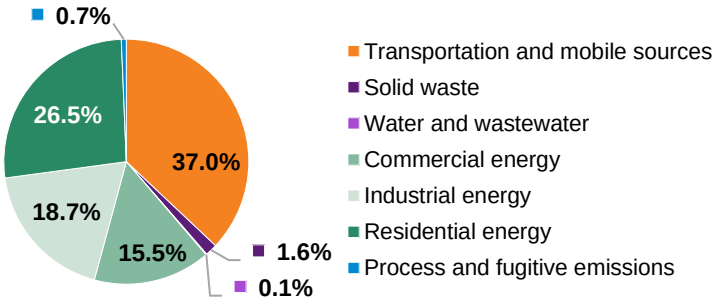
Transportation and mobile sources	**7,783,151**
Solid waste	**336,306**
Water and wastewater	**22,612**
AFOLU	**1,492**
Commercial energy	**3,255,014**
Industrial energy	**3,921,878**
Residential energy	**5,566,615**
Process and fugitive emissions	**137,364**

AFOLU = agriculture, forestry, and other land uses
$MTCO_2e$ = metric tons of carbon dioxide equivalent

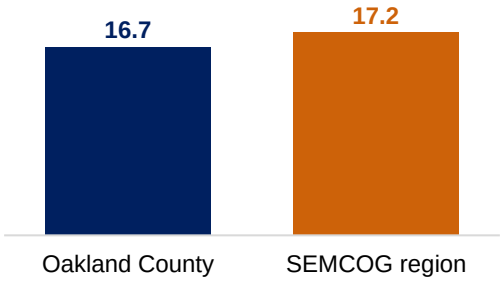
2019 Per-capita Emissions ($MTCO_2e$/Person)



2019 Regional Emissions by Sector ($MTCO_2e$)

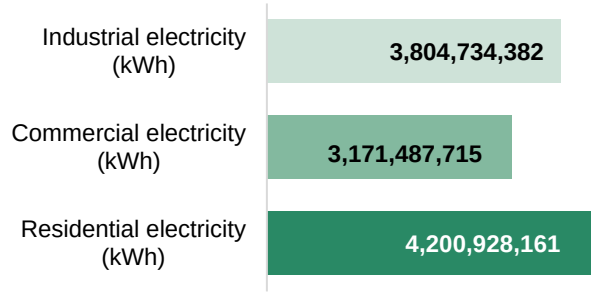


2019 Overall Per-capita Emissions ($MTCO_2e$/Person)



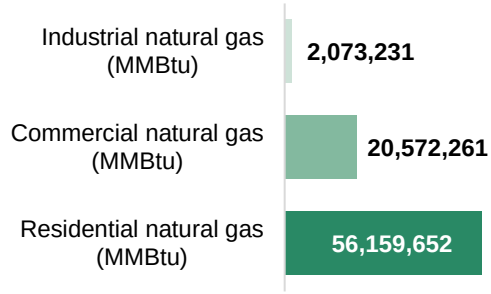
Energy Characteristics

2019 Electricity Energy Consumption



kWh = kilowatt hours

2019 Natural Gas Consumption



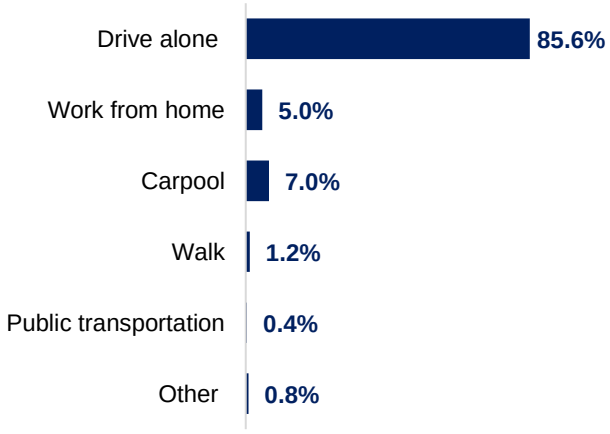
MMBtu = million British thermal units

2019 Per-capita Energy Consumption

	Oakland County	SEMCOG Region
Residential electricity (kWh/person)	3,340	3,110
Commercial electricity (kWh/person)	2,522	2,236
Industrial electricity (kWh/person)	3,025	4,065
Residential natural gas (MMBtu/person)	45	38
Commercial natural gas (MMBtu/person)	16	17
Industrial natural gas (MMBtu/person)	2	11

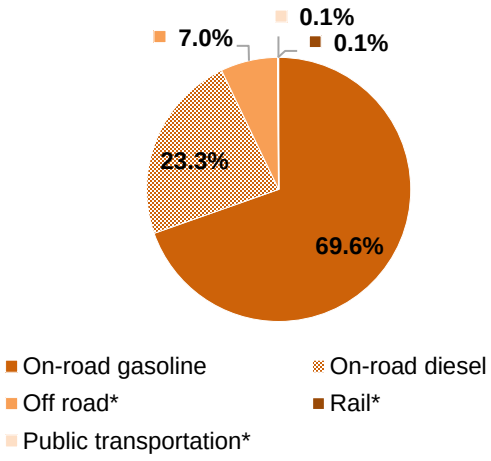
Transportation Characteristics

Mode of Travel to Work



Note: Totals may not sum due to rounding
Data source: 2019 American Community Survey Five-year Estimates

2019 Transportation Fuel Emissions



*Mixed fuel sources

Data source: PSC Analysis of ICLEI (Local Governments for Sustainability) data

Oakland County

2019 County Emissions Summary

This county emissions summary was developed as part of the 2019 Regional Greenhouse Gas Emissions Inventory (GHGI) for the Southeast Michigan Council of Governments (SEMCOG). It is intended to help decision makers understand key greenhouse gas (GHG) emissions sources in Oakland County and provide communities with information needed to begin developing GHG emissions reduction strategies. More details on the methods and data sources used to produce this summary will be available in the full report on SEMCOG's website.

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Median household income*	**$81,190**
Share of owner-occupied housing units*	**71.7%**
Land area (acres)**	**580,583.2**
Tree coverage (percentage of land area)**	**40.0%**
Impervious surfaces (percentage of land area)**	**19.2%**

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Water and wastewater	**22,612**
AFOLU	**1,492**
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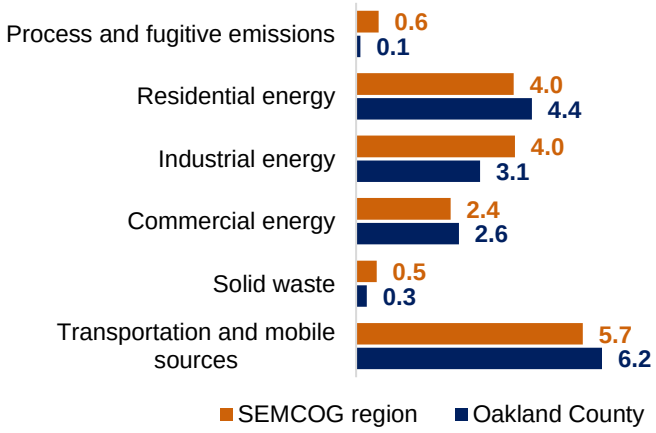
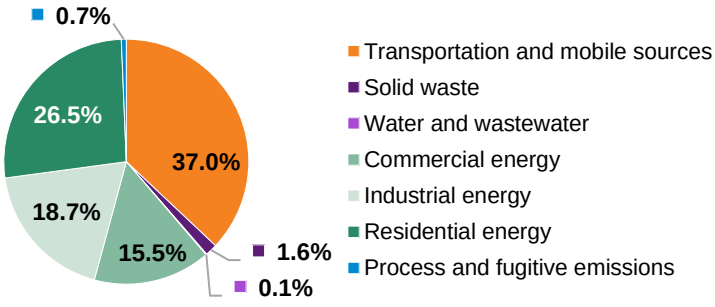
Industrial energy	**3,921,878**
Residential energy	**5,566,615**
Process and fugitive emissions	**137,364**

AFOLU = agriculture, forestry, and other land uses
$MTCO_2e$ = metric tons of carbon dioxide equivalent

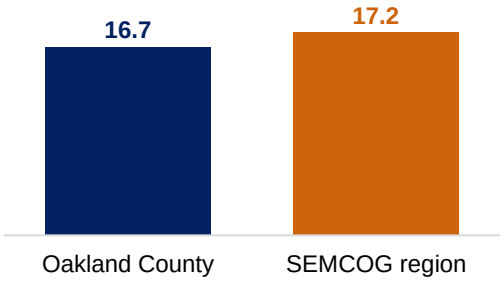
2019 Per-capita Emissions ($MTCO_2e$/Person)



2019 Regional Emissions by Sector ($MTCO_2e$)

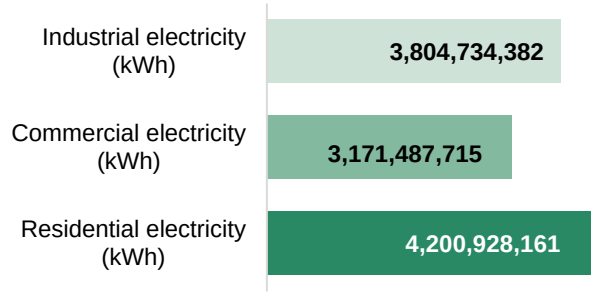


2019 Overall Per-capita Emissions ($MTCO_2e$/Person)



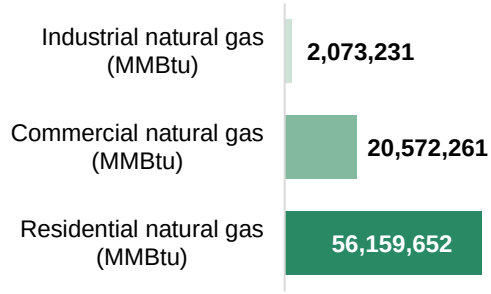
Energy Characteristics

2019 Electricity Energy Consumption



kWh = kilowatt hours

2019 Natural Gas Consumption



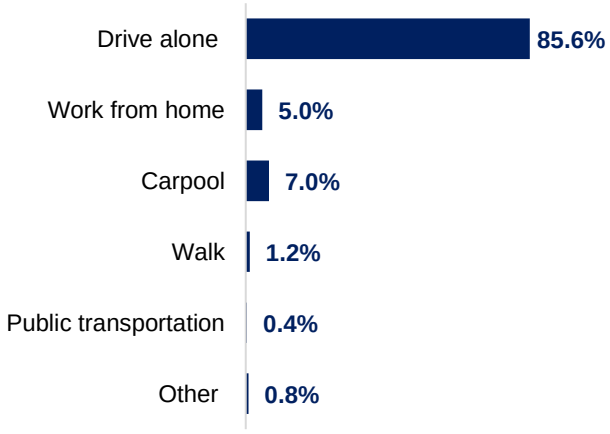
MMBtu = million British thermal units

2019 Per-capita Energy Consumption

	Oakland County	SEMCOG Region
Residential electricity (kWh/person)	3,340	3,110
Commercial electricity (kWh/person)	2,522	2,236
Industrial electricity (kWh/person)	3,025	4,065
Residential natural gas (MMBtu/person)	45	38
Commercial natural gas (MMBtu/person)	16	17
Industrial natural gas (MMBtu/person)	2	11

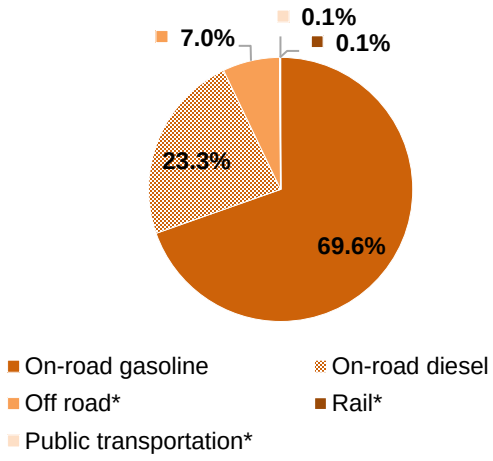
Transportation Characteristics

Mode of Travel to Work



Note: Totals may not sum due to rounding
Data source: 2019 American Community Survey Five-year Estimates

2019 Transportation Fuel Emissions



*Mixed fuel sources

Data source: PSC Analysis of ICLEI (Local Governments for Sustainability) data

Washtenaw County

2019 County Emissions Summary

This county emissions summary was developed as part of the 2019 Regional Greenhouse Gas Emissions Inventory (GHGI) for the Southeast Michigan Council of Governments (SEMCOG). It is intended to help decision makers understand key greenhouse gas (GHG) emissions sources in Washtenaw County and provide communities with information needed to begin developing GHG emissions reduction strategies. More details on the methods and data sources used to produce this summary will be available in the full report on SEMCOG's website.

Community Characteristics

Population*	**367,601**
Jobs (full- and part-time)**	**278,176**
Median household income*	**$76,576**
Share of owner-occupied housing units*	**62.5%**
Land area (acres)**	**462,370**
Tree coverage (percentage of land area)**	**35.5%**
Impervious surfaces (percentage of land area)**	**7.3%**

Data sources: *2019 American Community Survey One-year Estimates; **SEMCOG Community Profiles

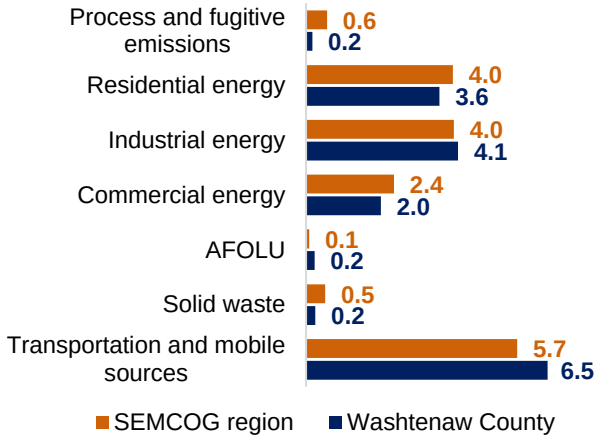
Emissions Summary

2019 Emissions Summary ($MTCO_2e$)

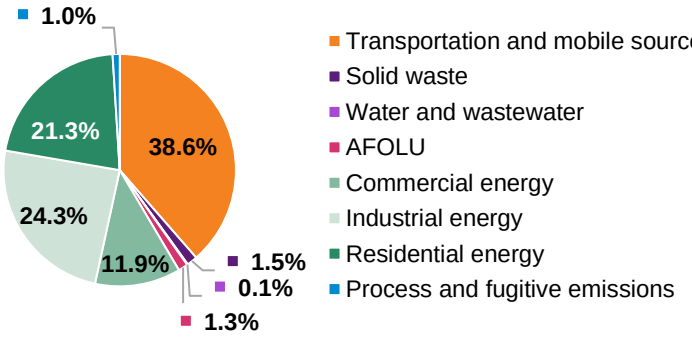
Transportation and mobile sources	**2,399,760**
Solid waste	**91,849**
Water and wastewater	**6,398**
AFOLU	**83,672**
Commercial energy	**742,276**
Industrial energy	**1,511,026**
Residential energy	**1,325,758**
Process and fugitive emissions	**61,417**

AFOLU = agriculture, forestry, and other land uses
$MTCO_2e$ = metric tons of carbon dioxide equivalent

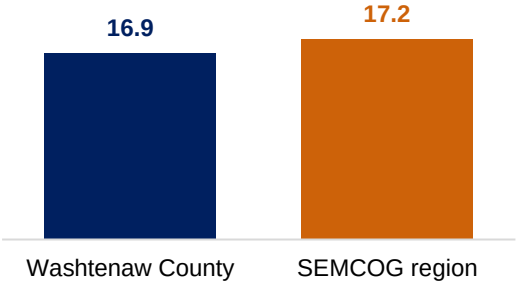
2019 Per-capita Emissions ($MTCO_2e$/Person)



2019 Regional Emissions by Sector ($MTCO_2e$)

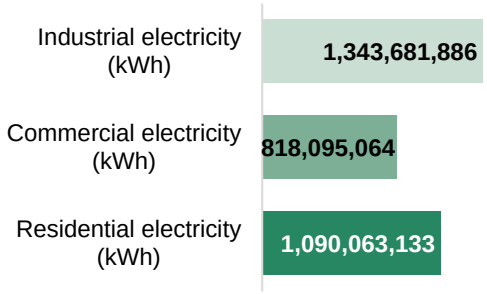


2019 Overall Per-capita Emissions ($MTCO_2e$/Person)



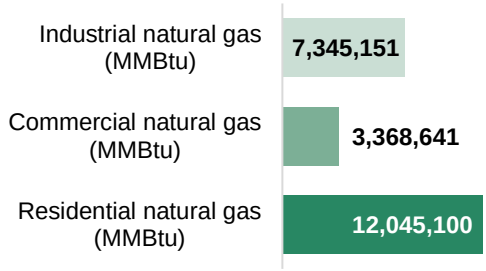
Energy Characteristics

2019 Electricity Energy Consumption



kWh = kilowatt hours

2019 Natural Gas Consumption



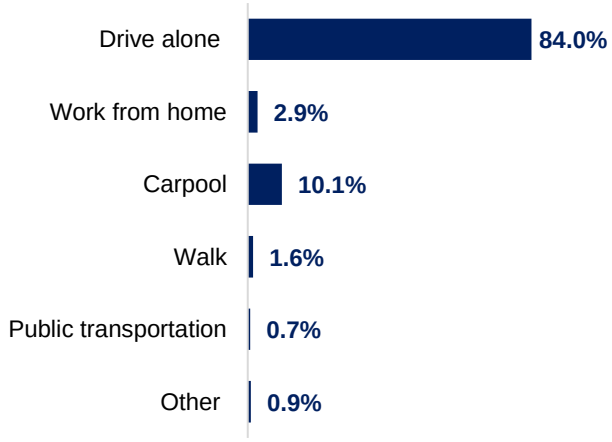
MMBtu = million British thermal units

2019 Per-capita Energy Consumption

	Washtenaw County	SEMCOG Region
Residential electricity (kWh/person)	2,965	3,110
Commercial electricity (kWh/person)	2,225	2,236
Industrial electricity (kWh/person)	3,655	4,065
Residential natural gas (MMBtu/person)	33	38
Commercial natural gas (MMBtu/person)	9	17
Industrial natural gas (MMBtu/person)	20	11

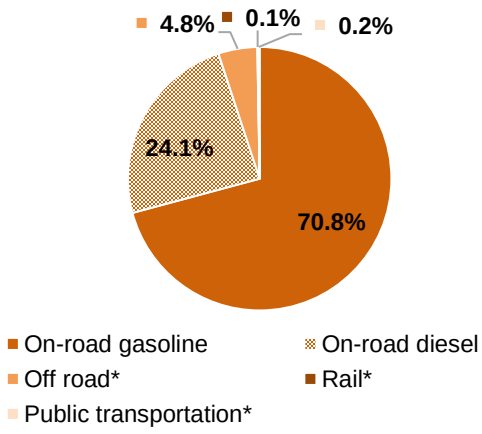
Transportation Characteristics

Mode of Travel to Work



Note: Totals may not sum due to rounding
Data source: 2019 American Community Survey Five-year Estimates

2019 Transportation Fuel Emissions



*Mixed fuel sources

Data source: PSC Analysis of ICLEI (Local Governments for Sustainability) data

Wayne County

2019 County Emissions Summary

This county emissions summary was developed as part of the 2019 Regional Greenhouse Gas Emissions Inventory (GHGI) for the Southeast Michigan Council of Governments (SEMCOG). It is intended to help decision makers understand key greenhouse gas (GHG) emissions sources in Wayne County and provide communities with information needed to begin developing GHG emissions reduction strategies. More details on the methods and data sources used to produce this summary will be available in the full report on SEMCOG's website.

Community Characteristics

Population*	**1,749,343**
Jobs (full- and part-time)**	**982,165**
Median household income*	**$50,753**
Share of owner-occupied housing units*	**62.5%**
Land area (acres)***	**395,050.8**
Tree coverage (percentage of land area)***	**25.2%**
Impervious surfaces (percentage of land area)***	**33.7%**

Data sources: *2019 American Community Survey One-year Estimates; **SEMCOG Community Profiles

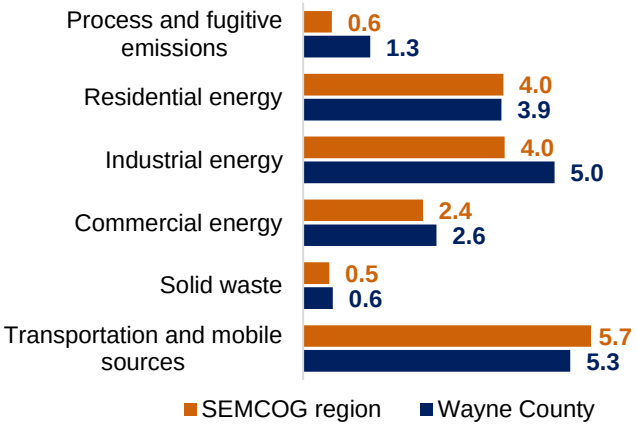
Emissions Summary

2019 Emissions Summary ($MTCO_2e$)

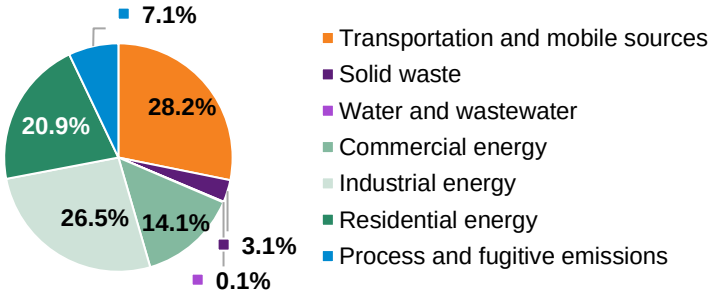
Transportation and mobile sources	**9,268,618**
Solid waste	**1,034,536**
Water and wastewater	**35,882**
AFOLU	**2,804**
Commercial energy	**4,624,992**
Industrial energy	**8,717,587**
Residential energy	**6,877,799**
Process and fugitive emissions	**2,328,579**

AFOLU = agriculture, forestry, and other land uses
$MTCO_2e$ = metric tons of carbon dioxide equivalent

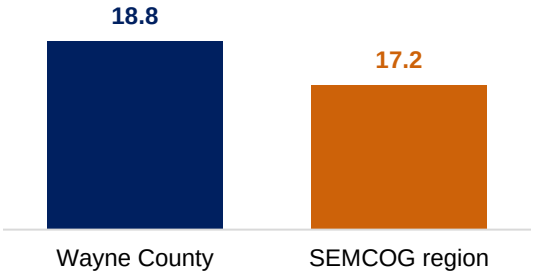
2019 Per-capita Emissions ($MTCO_2e$/Person)



2019 Regional Emissions by Sector ($MTCO_2e$)

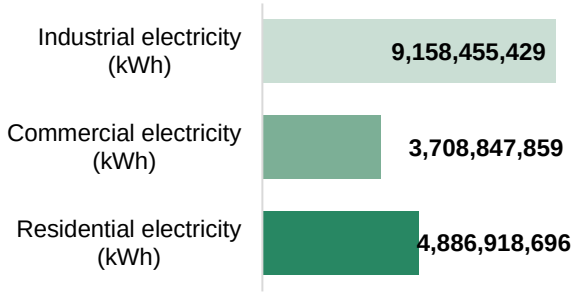


2019 Overall Per-capita Emissions ($MTCO_2e$/Person)



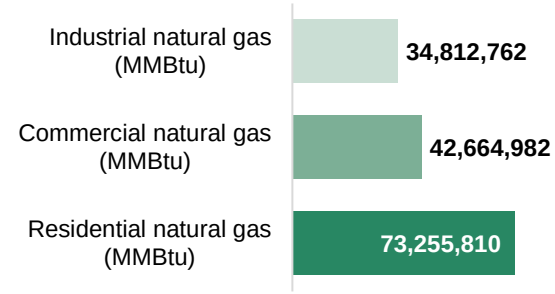
Energy Characteristics

2019 Electricity Energy Consumption



kWh = kilowatt hours

2019 Natural Gas Consumption



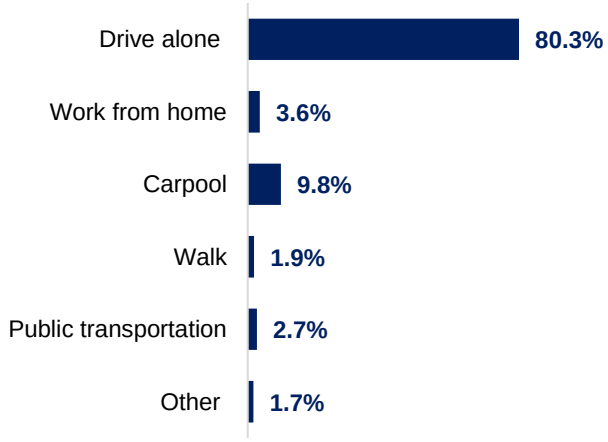
MMBtu = million British thermal units

2019 Per-capita Energy Consumption

	Wayne County	SEMCOG Region
Residential electricity (kWh/person)	2,794	3,110
Commercial electricity (kWh/person)	2,120	2,236
Industrial electricity (kWh/person)	5,235	4,065
Residential natural gas (MMBtu/person)	42	38
Commercial natural gas (MMBtu/person)	24	17
Industrial natural gas (MMBtu/person)	20	11

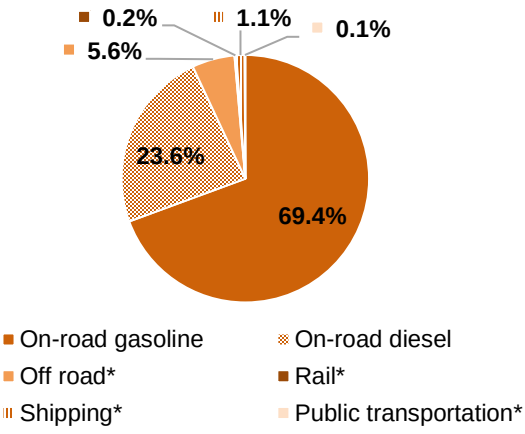
Transportation Characteristics

Mode of Travel to Work



Note: Totals may not sum due to rounding
Data source: 2019 American Community Survey Five-year Estimates

2019 Transportation Fuel Emissions



*Mixed fuel sources

Data source: PSC Analysis of ICLEI (Local Governments for Sustainability) data

SEMCOG Officers
2023-2024

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