Ann Arbor 2019 Community-Wide Greenhouse Gas Inventory Report

V1.0 Published October 2020

For more information contact:

| Thea Yagerlener, Energy Analyst, tyagerlener@a2gov.org

A2ZERO

EQUITABLE • SUSTAINABLE • TRANSFORMATIVE

Table of Contents

Executive Summary

Emission Trends

In 2019, the expanded Ann Arbor community-wide greenhouse gas (GHG) emission inventory found community GHG emissions totaling **2.1 million metric tons of carbon dioxide equivalent**. The sectors included in the inventory are:

Buildings	Residential, commercial, and institutional buildings accounted for **68%** of community-wide emissions, with 41% of emissions from the use of natural gas, 59% from the use of electricity, and 0.2% from other fuels.
Transportation	Passenger, commercial, transit, rail, and aviation transportation accounted for **30%** of community-wide emissions, with 75% of emissions from the use of gasoline, 24% from the use of diesel and biodiesel, and just under 1% from the use of other fuels.
Solid Waste	Municipal solid waste, the City-operated sealed landfill, and composted waste accounted for **2%** of community-wide emissions, with 45% of these emissions from municipal solid waste, 53% from the City-operated sealed landfill, and 2% from other sources.
Wastewater Treatment	Emissions from the treatment of wastewater accounted for **0.05%** of community-wide emissions.

2019 community-wide emissions were **20%** below 2000 levels. These changes are estimated based on the simple Ann Arbor community-wide GHG inventory, which does not include all emission sources currently estimated due to historic data availability and consistency.[1] Changes in each sector since 2000 are:

Buildings	Decreased by 22%, representing over 85% of the emissions reductions
Transportation	Decreased by 16%, representing, representing 15% of emissions reductions
Solid Waste	Increased by 29%, having minimal impact on overall community emissions

Since 2000, Ann Arbor's population increased 5% and the economy grew 15%. During this time, emissions per capita decreased 4%.

Emissions Reduction Drivers

Looking at the level of activity and emission factors informs where emission reductions largely came from:

Cleaner Grid	Emissions from the use of electricity represents 40% of total emissions. In 2000, DTE's electricity grid was sourced 77% from coal, compared to 59% in 2019, largely displaced by natural gas, nuclear, and renewables. This resulted in a 30% lower carbon intensity per unit of energy produced.
Vehicle Efficiency Improvements	The vehicle miles traveled in passenger and commercial vehicles has not changed significantly, but on average, vehicles on the road are 17% more efficient compared to those in 2000.

[1] Wastewater treatment process emissions are not included in the simple inventory.

Introduction

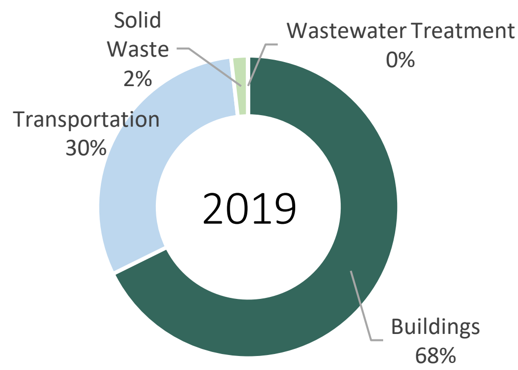


Figure 1: *Overview of 2019 emissions by sector*

The Ann Arbor community-wide Greenhouse Gas (GHG) Inventory illustrates our progress to date on emission reductions, and informs the [A^2ZERO Living Carbon Neutrality Plan]. Our inventory annually monitors GHG emissions associated with sources and activities in Ann Arbor to frame where we need the most action. Based on the emissions profile of the community, much of the A^2ZERO Plan's seven strategies focus on reducing emissions related with the electricity and fossil fuels consumed in our buildings and vehicles, as well as moving towards a circular economy.

The A^2ZERO Plan puts forward seven strategies for our community to achieve a just transition to carbon neutrality, community-wide, by the year 2030. These strategies were created with input from thousands of Ann Arborites and informed by the community-wide GHG inventory. Those strategies are:

1. Power our electric grid with 100% renewable energy;
2. Switch our appliances and vehicles from fossil fuels to electric;
3. Significantly improve the energy efficiency in our buildings;
4. Reduce the miles we travel in our vehicles by at least 50%;
5. Change the way we use, reuse, and dispose of materials;
6. Enhance the resilience of our people and our place; and
7. Cross-cutting actions

The A^2ZERO Plan also addresses emissions not yet captured in this inventory that go beyond the requirements of standard protocols – such as those associated with the food, goods, and services our community consumes, or long-range transportation. The A^2ZERO Plan estimates the emissions reduction of each action related to emission levels calculated in our community-wide GHG inventories. Even for those emission activities that we don't yet have an estimate for, the A^2ZERO Plan recognizes it is critical for our community to take action.

To achieve carbon neutrality, the entire Ann Arbor community must eliminate 2.1 million metric tons of carbon dioxide equivalent emissions annually – the emission levels estimated for the community in 2019. To date, emissions have reduced 20% compared to 2000 levels, roughly 1% per year. These emission reductions have come from changes to the electric grid, largely through the phasing out of coal and the transition to natural gas, and from efficiency improvements in vehicles. The Ann Arbor community will not reach the 2030 goal of community-wide carbon neutrality at the current pace of action – not even by 2090. The A^2ZERO Plan provides strategies and timelines to rapidly and aggressively reduce emissions to achieve our 2030 goal.

The community-wide GHG inventory illustrates trends in emission reductions since 2000. It also allows us to understand emission drivers in Ann Arbor, which is used to inform and design programs that will have the most impact on emission levels. This report reviews these long-term trends and evaluates current emission levels to better inform City and community climate planning, action, prioritization, and implementation.

Inventory Details

The protocols, assumptions, and data used impact the emission levels estimated. The methodology used is discussed below, along with a statement on expected accuracy and an explanation of the different versions of the inventory presented.

Methodology

The Ann Arbor GHG inventory is completed in accordance with the ICLEI – Local Governments for Sustainability US Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (Community Protocol). The Community Protocol provides recommendations and data sources specifically relevant to the United States. For more information on the specific methodology, assumptions, and data sources used, see the 2020 City of Ann Arbor Community-Wide Greenhouse Gas Inventory Guide and accompanying worksheet.

The inventory is completed on an annual basis and reported to the Carbon Disclosure Project (CDP) to benchmark our performance with cities around the world. The City of Ann Arbor was one of 150 global cities to a receive an "A" score from the CDP in 2019 for assessing climate risk, tracking emissions, working towards an ambitious reduction target through a robust adaptation and mitigation strategy, and for reporting this information publicly. The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories Accounting and Reporting Standard for Cities is used when reporting to the CDP, as required by the Global Covenant of Mayors (formerly the Compact of Mayors).[2]

The City's inventory accounts for three greenhouse gas: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These greenhouse gases represent 97% of emissions in the United States. Fluorinated gases are not estimated based on data availability but are synthetic and powerful greenhouse gases that are addressed in the A^2ZERO Plan.

Accuracy

The inventory is completed using data derived from aggregated, modeled, and/or scaled data. Some data sources are not updated on an annual basis, and therefore comparison of consecutive years may not represent actual changes in emission levels. Regardless, the City aims for a 5% accuracy in each year of estimation (I.e., accurately capturing at least 95% of emissions).

Inventory Versions

The community-wide greenhouse gas inventory was estimated for the year 2000 in 2007. Since then, more data associated with emission sources is available and inventory protocols have been updated. To maintain the ability to observe long term trends in emission amounts, a **Simple Inventory** is completed each year, which only includes emissions sources that can be estimated with historically available data. In 2015 and the following years, the City began conducting an **Expanded Inventory** to provide a more comprehensive understanding of emissions associated with Ann Arbor. **Table 1** summarizes the different emission sources included in the Simple and the Expanded inventory.

[2] The GPC protocol is slightly different than the ICLEI protocol for estimating emissions for solid waste and waste water. The values for these emissions reported to the CDP are different than presented here. These emissions are collectively less than 3% of total emissions, and within the goal of 5% accuracy.

The **Expanded Inventory** includes additional emission sources and represents 17% more emissions than the **Simple Inventory.** The largest additional emission source accounted for in the **Expanded Inventory** is commuting patterns, representing over 85% of the additional emissions.

Table 1: *Simple and Expanded Inventory Comparison*

Emission Source	**Simple Inventory**	**Expanded Inventory**
Electricity used in buildings	•	•
Transmission and distribution losses	•	•
Natural gas used in buildings	•	•
Local fugitive natural gas leaks		•
Additional stationary energy emission sources		•
Local passenger and commercial vehicles	•	•
Commuting passenger vehicles		•
Rail and aviation		•
Generated solid waste	•	•
Additional solid waste emission sources		•
Wastewater processing		•

Emission Trends – Simple Inventory

The **Simple Inventory** compares recent emission estimates to previous baseline years. It includes emissions associated with residential, commercial, and university (institutional) buildings, local transportation, and waste.

Simple Inventory emission levels in 2000 were 2.26 million metric tons of carbon dioxide equivalent (MT CO_2e), and 1.8 million MT CO_2e in 2019. From 2000 to 2019 emissions have decreased by 20%, roughly 1% per year. Weather fluctuations impact emissions, resulting in small changes between consecutive years. When averaging emission reductions over 2017, 2018, and 2019, emissions have decreased 16% since 2000. ***Figure 2*** shows the trends in emission levels broken out by sector since 2000. ***Figure 3*** summarizes the changes in emission levels since 2000 attributed to each sector.

Buildings represent the majority of emission reductions. From 2000 to 2019, reductions in residential building emissions represent 22% of total reductions. The combined total of commercial and institutional buildings emissions reductions represent 65% of total reductions.[3] Local transportation emissions represent 15% of total reductions. Emissions associated with waste increased slightly since 2000, equaling 2% of emission reductions.

[3] Since 2000, some properties have changed sectors from commercial to institutional. ***Figure 2*** illustrates how the commercial building sector emissions have decreased while the institutional building sector increased.

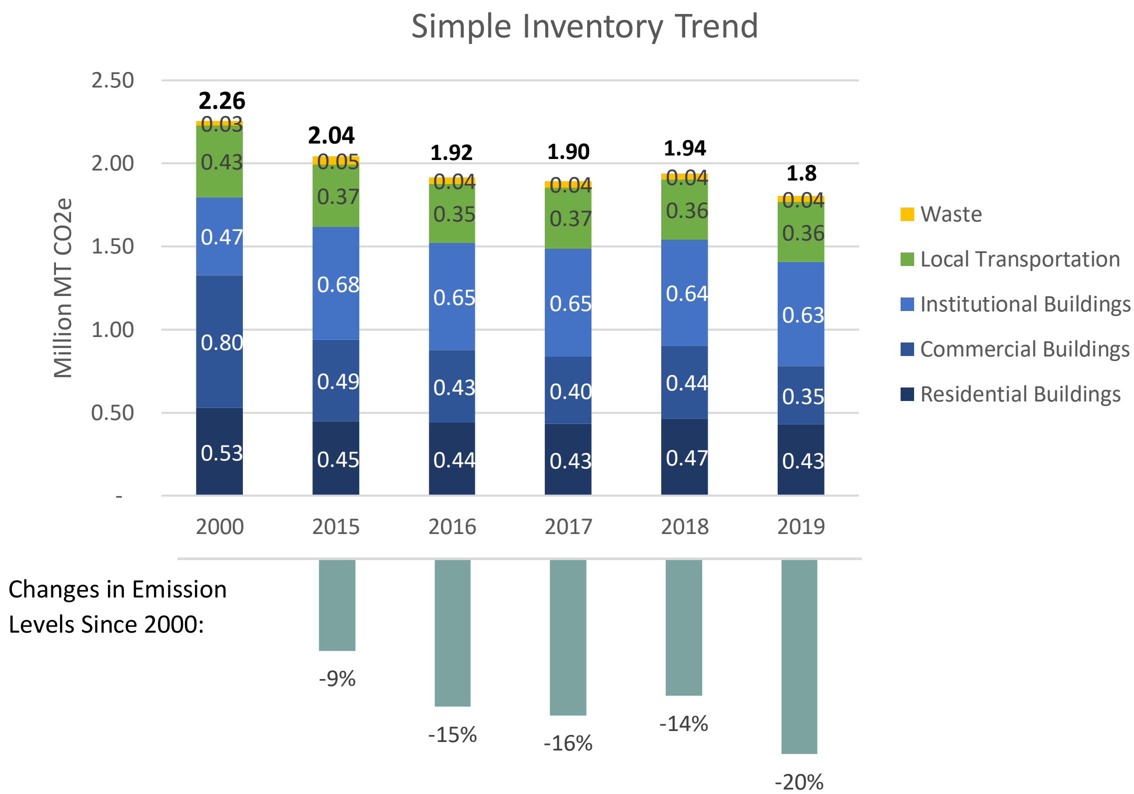


Figure 2: *Changes in emission levels since 2000, illustrated by sector*

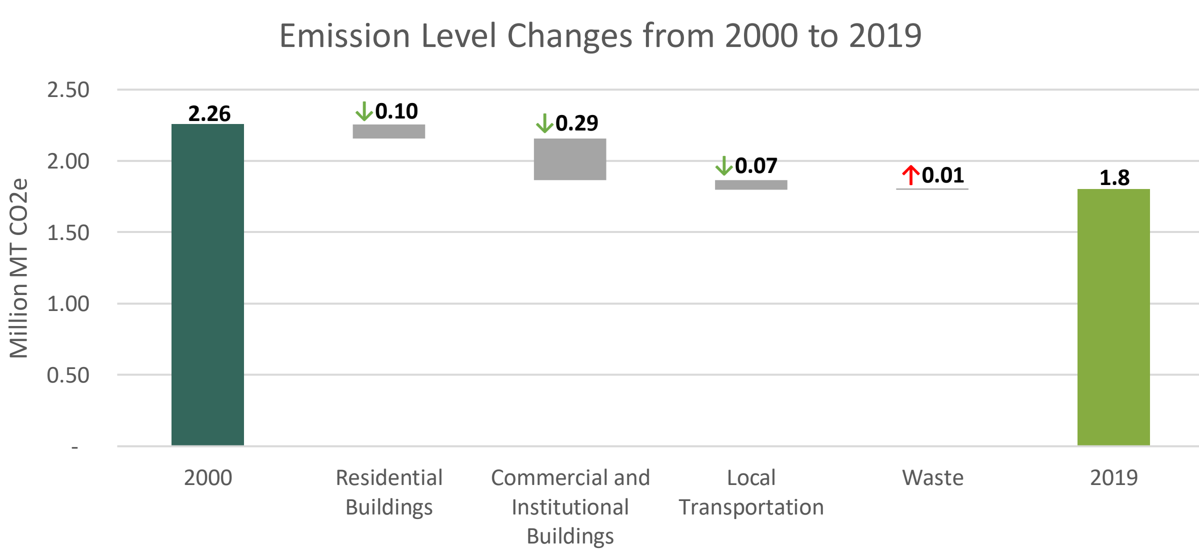


Figure 3: *Emission level changes by sector from 2000 to 2019*

Population and GDP Trends

Ann Arbor has grown since 2000, both in terms of population and GDP. ***Figure 4*** illustrates changes in the Ann Arbor population, GDP, and emissions since 2000. After recovering from the 2008 recession, change in population and GDP have been positive while emissions have decreased, showing that emission reductions are not mutually exclusive with healthy growth. In addition, emissions have decreased more than the population increased, meaning that per-capita emissions have decreased as well.

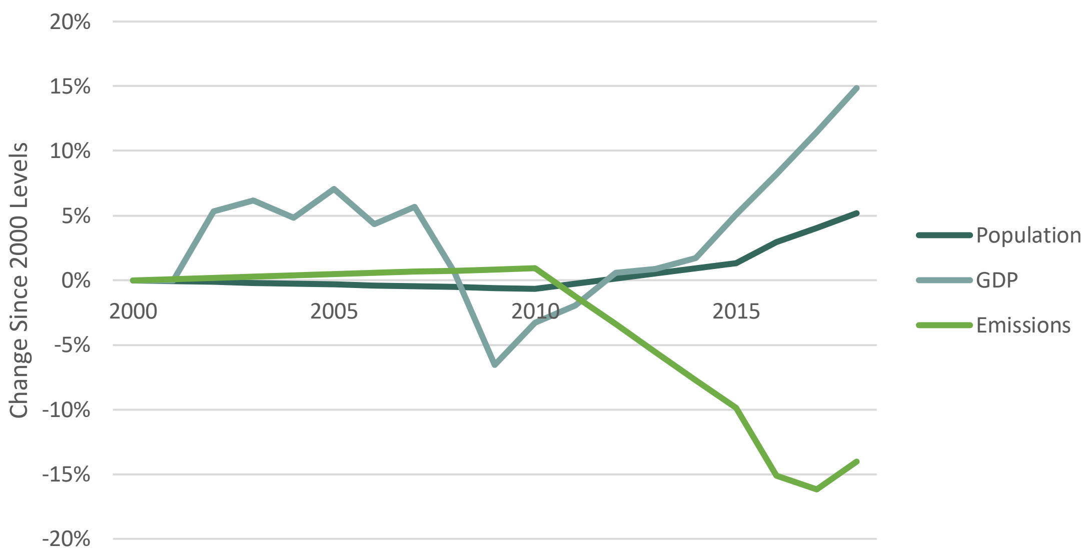


Figure 4: *Percent change in Ann Arbor population, gross domestic product, and emission levels since 2000*

Emission Drivers

Reductions in emissions since 2000 can be attributed to two drivers – a less carbon intense electricity grid and efficiency improvements in light-duty vehicles. Changes to fuel sources used to generate electricity for the region represent 85% of total emission reductions. Improvements in vehicle efficiency represent 15% of emission reductions.[4]

These emission drivers represent change at the regional (grid) or national (vehicle efficiency) scale. The aggregate rate of change of emission since 2000 has been a 1% decrease each year. The A^{2}ZERO Plan lays out intentional and specific actions our community can take to achieve our community-wide goal of carbon neutrality by 2030, requiring a much more rapid rate of change.

Cleaner Grid

Emissions from the use of electricity represents 40% of total emissions. In 2000, DTE's electricity grid was sourced 77% from coal, compared to 59% in 2019, largely displaced by natural gas, nuclear, and renewables, resulting in a

[4] These values add to over 100% due to the increase in waste emission levels equal to 2% of emission reductions.

30% lower carbon intensity per unit of energy produced. ***Figure 5*** illustrates that many of these changes have occurred in the last five years – coal represented 10% more of DTE's fuel mix in 2015 than in 2019.[5]

Currently, the coal-dominated grid is more carbon intensive than natural gas used in buildings. As the Ann Arbor community moves towards carbon neutrality, however, we will need to transition away from natural gas to renewable electricity.

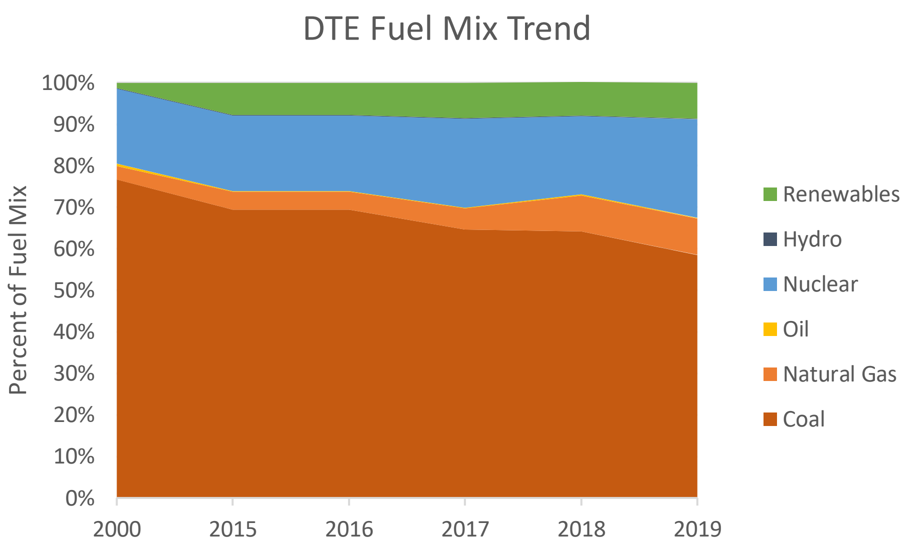


Figure 5: *Composition of DTE's fuel mix since 2000*

Vehicle Efficiency Improvements

Between 2000 and 2019, the miles traveled in passenger and commercial vehicles only changed by 2%. Accounting for average miles per gallon and age, vehicles on the road are on average 17% more efficient than in 2000.

[5] DTE does purchase approximately a sixth of their electricity portfolio and the regional grid is used as a proxy for the fuel mix of those purchases. Additionally, renewable energy credits are not currently included in the inventory to comply with the US Community Protocol.

Emission Trends – Expanded Inventory

The **Expanded Inventory** provides more detail and more emission sources for 2014 onward. This allows for more insight into factors affecting the magnitude of emissions. It also considers additional emission sources, resulting in a higher total emission level that the **Simple Inventory.** These emission sources also occurred in 2000, but data is not available to estimate an accurate magnitude of emissions in 2000 and between 2000 and 2014.

The largest additional emission source considered in the **Expanded Inventory** is that associated with the full range of commuting. In the **Simple Inventory,** only the portion of vehicle trips contained within Ann Arbor's boundary are estimated. Including the full range of the commute adds 15% more emissions to the total, while all remaining additional emission sources (other transportation, waste, and upstream emissions) account for 2% of emissions.

As discussed above, emission reductions are currently largely driven by the displacement of coal in the fuel mix used to generate electricity by DTE. While there are year-to-year fluctuations in emission levels due to weather variations, the general trend since 2015 is a roughly 2% decrease in emissions each year. In order to reach carbon neutrality by 2030, emissions must be reduced at a rate nearly four times the current pace. For more information on proposed actions and their estimated impact on emissions, see the A^2ZERO Carbon Neutrality Living Plan.

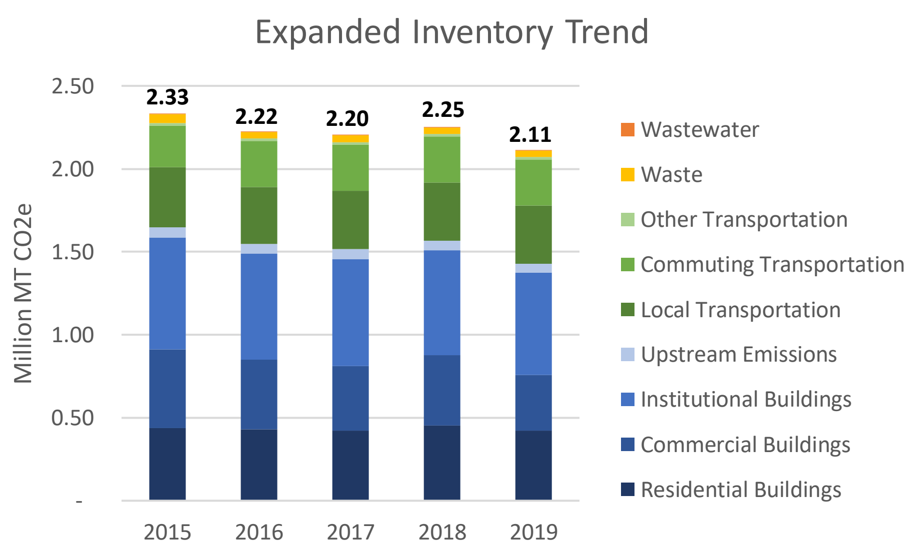


Figure 6: *Expanded inventory emission trends since 2015*

Sector Summary

The expanded inventory provides year-to-year monitoring of emission levels. ***Table 2*** summarizes the sectors and sub-sectors included in the inventory and provides the emission sources for each and their scope.

Table 2: *Expanded Inventory Sectors and Sub-Sectors*

Sector	Sub-Sector	Sources (Scope)
Buildings (Stationary Energy)	Residential Buildings	Natural Gas (1), Propane (1), Electricity (2)
	Commercial Buildings	Natural Gas (1), Electricity (2)
	Institutional Buildings (University of Michigan)	Natural Gas (1), Propane (1), Fuel Oil (1), Electricity (2)
Transportation	Local Transportation	Passenger Vehicles (1), Commercial Vehicles (2)
	Commuting Vehicles	Commuting Vehicles (3)
	Local Bus Transit	Bus Transit (1)
	Local Rail	Passenger Rail (1), Freight Rail (1)
	Local Aviation	Municipal Airport Fuel Consumption (1)
Waste	Landfilled Waste	Landfilled Waste (3)
	Composted Waste	Composted Waste (1)
	Closed City Landfill	Closed City Landfill (1)
Wastewater Treatment	Wastewater Treatment	Treatment of Ann Arbor Population Wastewater (1)
Upstream Emissions	Transmission and Distribution Losses	Transmission and Distribution Losses (3)
	Local Fugitive Methane Leaks	Local Fugitive Methane Leaks (1)

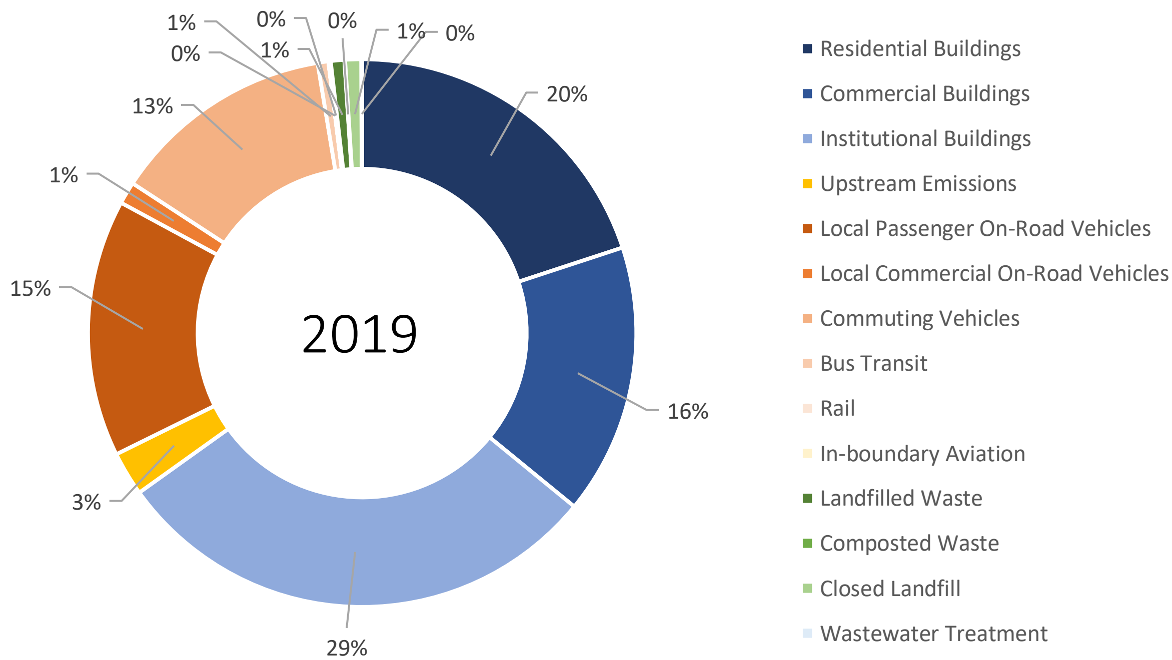


Figure 7: *Expanded inventory emissions by sector in 2019*

Buildings

Buildings account for 1.37 million MT CO_2e and represent 65% of greenhouse gas emissions emitted in 2019. Emissions from buildings decreased 22% since 2000, largely due to a cleaner grid. Institutional buildings represent the largest single emission source, nearly equivalent to local and commuting transportation emissions combined.

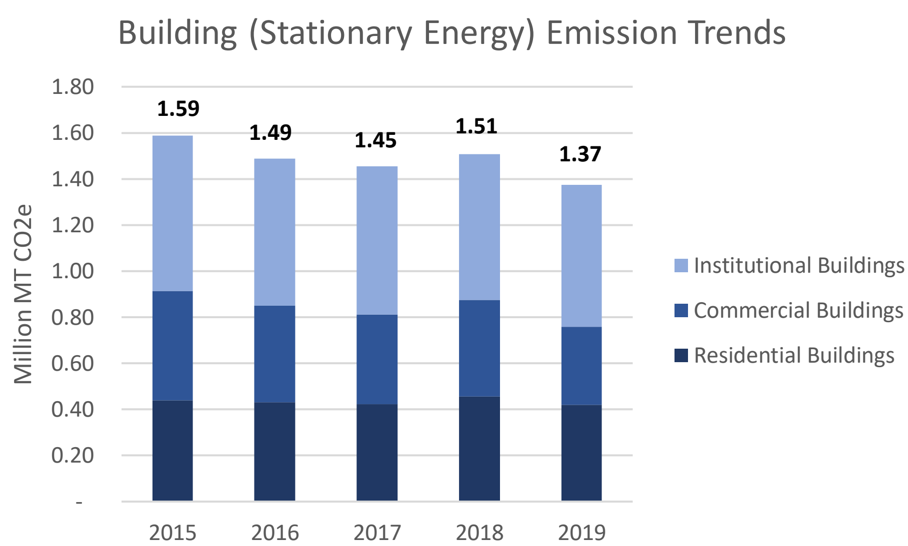


Figure 8: *Building emission levels since 2015*

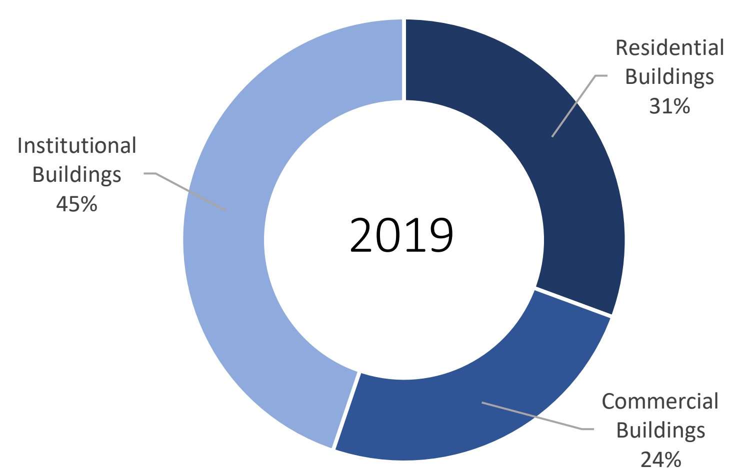


Figure 9: *Building emission composition in 2019*

Residential Buildings

Residential buildings account for 0.42 million MT CO_2e, or 20% of total greenhouse gas emissions. Emissions from residential buildings decreased 19% since 2000, largely due to a cleaner grid. Some emission reductions are due to a lower consumption of natural gas, down 13% since 2000. Use of electricity in residential buildings increased 9% since 2000, so it is unclear if se reductions are due to energy efficiency improvements, or an increased use of electricity for heating replacing natural gas; approximately 20% of housing units in Ann Arbor use electricity for heat. Since 2015, the general trend in residential building emissions has been steady.

Residential building emissions equally come from electricity and natural gas, with a negligible amount attributed to propane used for heating. Propane used for cooking may not be fully captured in the inventory. The majority of energy consumed in homes comes from natural gas, but the coal-dominated grid is currently more carbon intensive than natural gas used to heat homes and cook, resulting in nearly equal emission levels.

Year-to-year changes in emission levels can be attributed to a strong correlation of natural gas use to heating degree days (a measure of how much temperatures were below 65 deg F in a single year). ***Figure 13*** illustrates this correlation of residential natural gas consumption alongside the number of heating degree days each year compared to a 30-year average. Electricity is less strongly correlated to cooling degree days (a measure of how much temperatures were above 65 deg F in a single year) – nationally, only [16% of electricity consumed in homes] is used for space cooling.

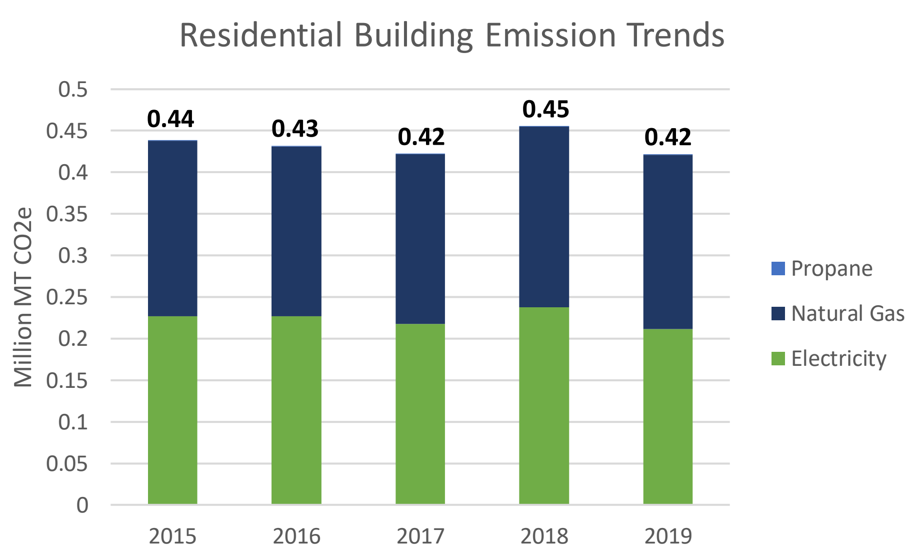


Figure 10: *Residential building emission levels since 2015*

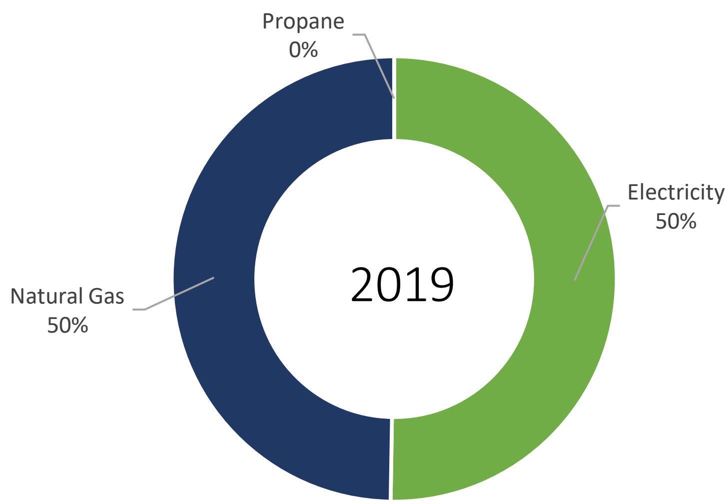


***Figure 11**: Composition of residential building emissions in 2019*

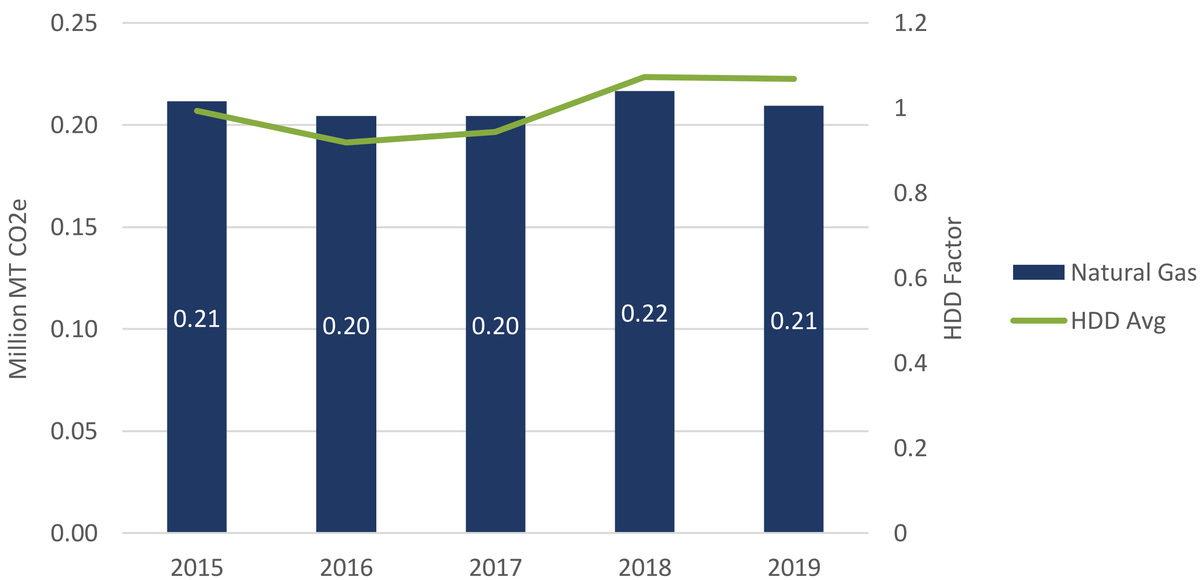


***Figure 13**: Natural gas use in residential buildings compared to the average heating degree day factor*

Commercial Buildings

Commercial buildings, including commercial and limited industrial buildings, account for 0.34 million MT CO_2e or 16% of total emissions in 2019. This is a decrease of 23% since 2000.

Emissions associated with commercial buildings primarily come from the use of electricity. The use of electricity is strongly correlated to hotter years with more cooling degree days, meaning that a significant amount of electricity is used for space cooling. ***Figure 17*** illustrates this trend comparing electricity use to the cooling degree day factor. The use of natural gas is not correlated to colder years with more heating degree days in commercial buildings.

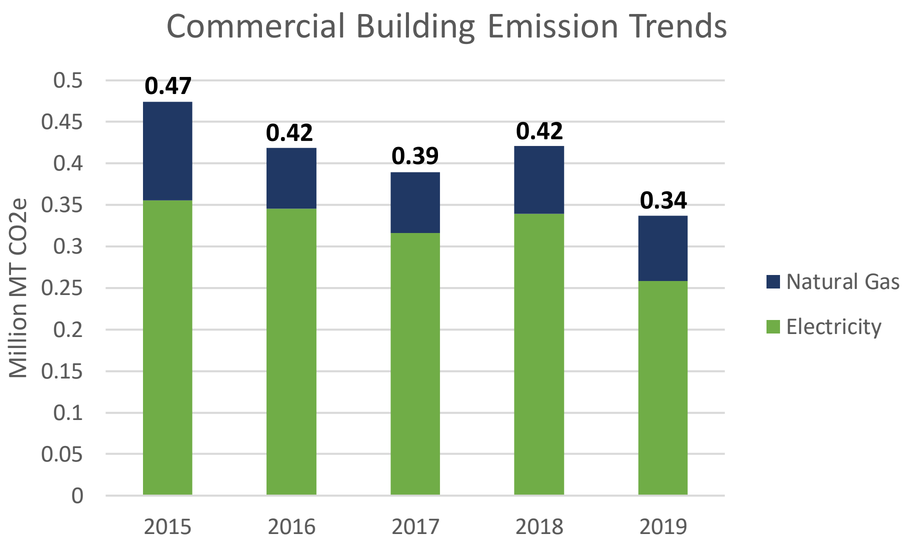


***Figure 15**: Commercial building emission levels since 2015*

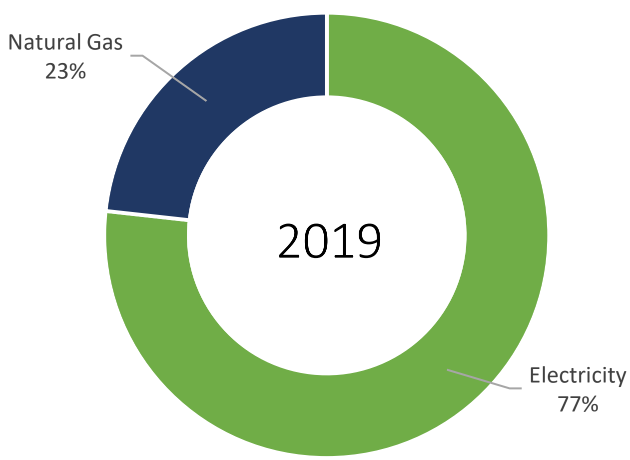


***Figure 16**: Composition of commercial building emission levels in 2019*

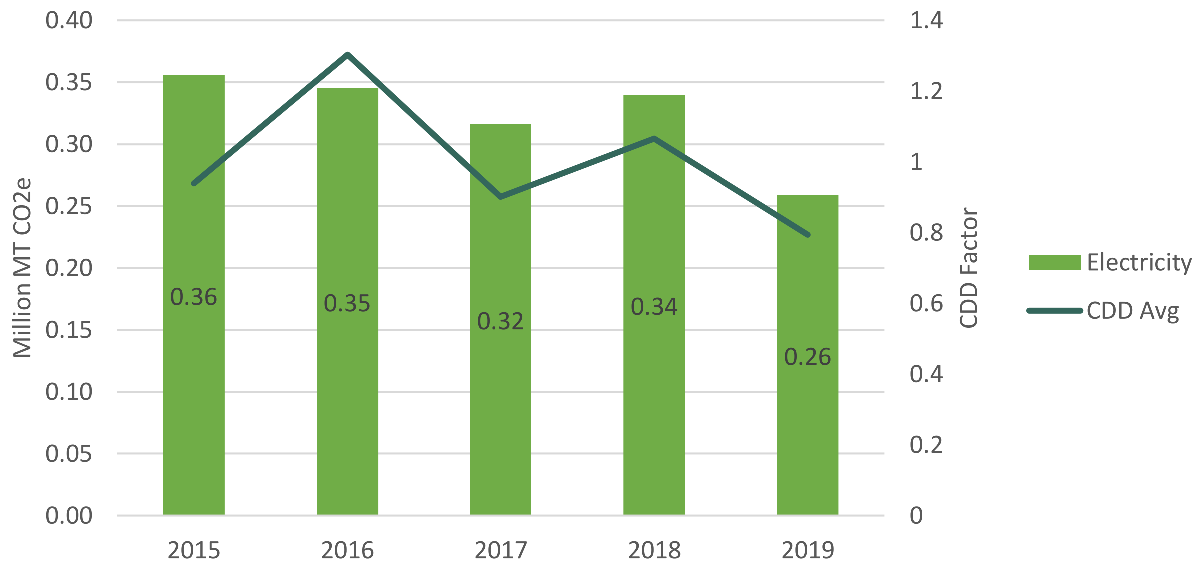


Figure 17*: Electricity use in commercial buildings compared to average cooling degree day factor*

Institutional Buildings

Institutional buildings, or buildings associated with the University of Michigan, account for 0.64 million MT CO_2e, representing 29% of total emissions. Since 2015, institutional building emissions have decreased 8%. This decrease is primarily due to a decrease in natural gas use beginning in 2015. Use of electricity and natural gas in institutional buildings is inversely correlated to cooling and heating degree days, meaning that the use of electricity and natural gas is unrelated to how hot or cold a given year is.

Institutional building emissions are primarily from the use of electricity and natural gas. Natural gas emissions reported here represent those from combustion in buildings as well as those emitted from electricity generation at the University of Michigan's Central Power Plant. Natural gas emissions associated with electricity production represent approximately 15% of natural gas emissions.

The University of Michigan Ann Arbor Campus has grown 32% since 2004. While this sub-sector evaluates emissions only associated with University of Michigan buildings, the University of Michigan's Office of Campus Sustainability prepares an annual organizational greenhouse gas inventory that also includes campus transportation. ***Figure 20*** compares percent change in the Ann Arbor campus population and the emissions reported by the Office of Campus Sustainability. While the campus population has grown, emissions started to decrease around 2011. Emissions per capita for the Ann Arbor campus population have decreased 5% since 2015 despite a 10% increase in campus population.

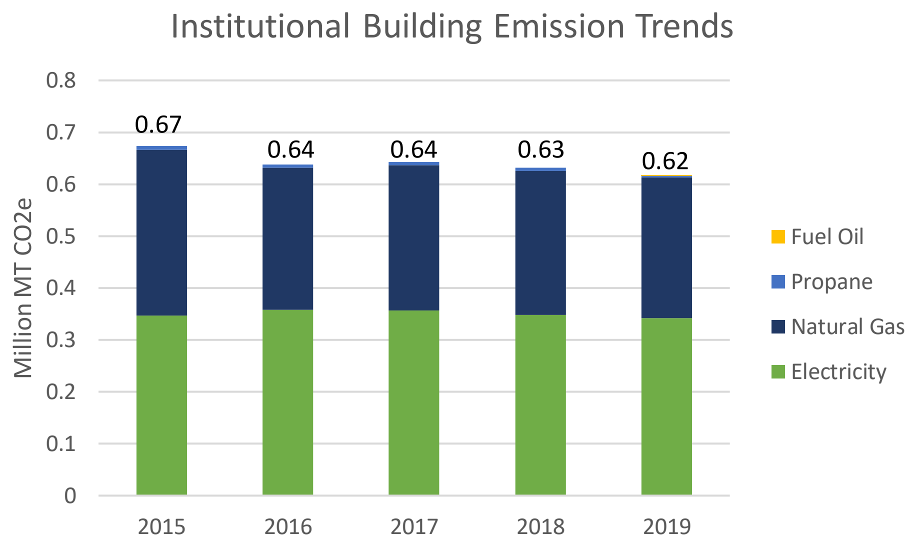


***Figure 18**: Institutional building emission trends since 2015*

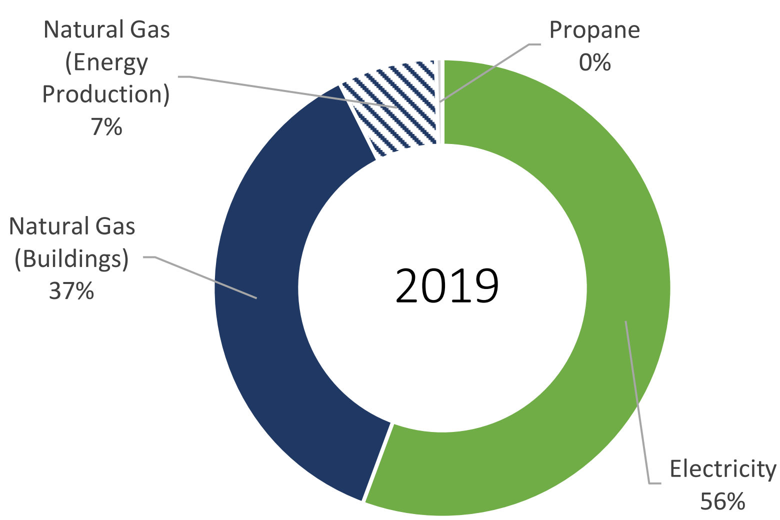


***Figure 19**: Composition of institutional building emissions in 2019*

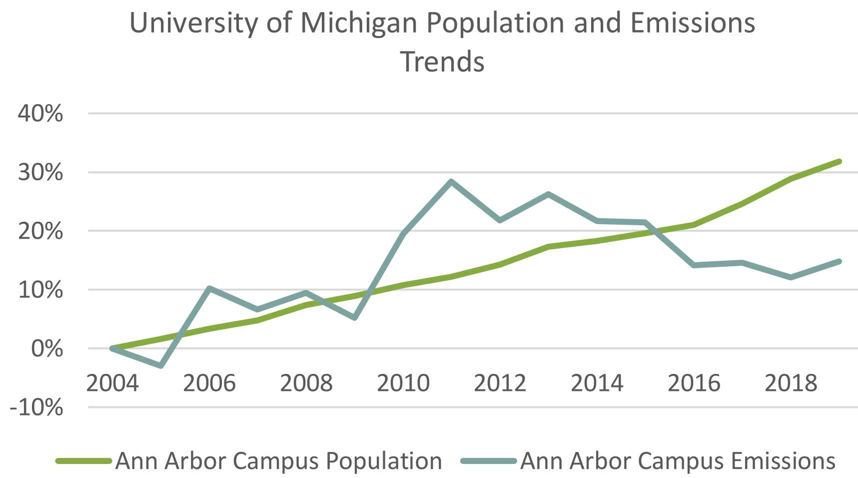


Figure 20*: Percent change in University of Michigan Ann Arbor campus population and emissions since 2004.*

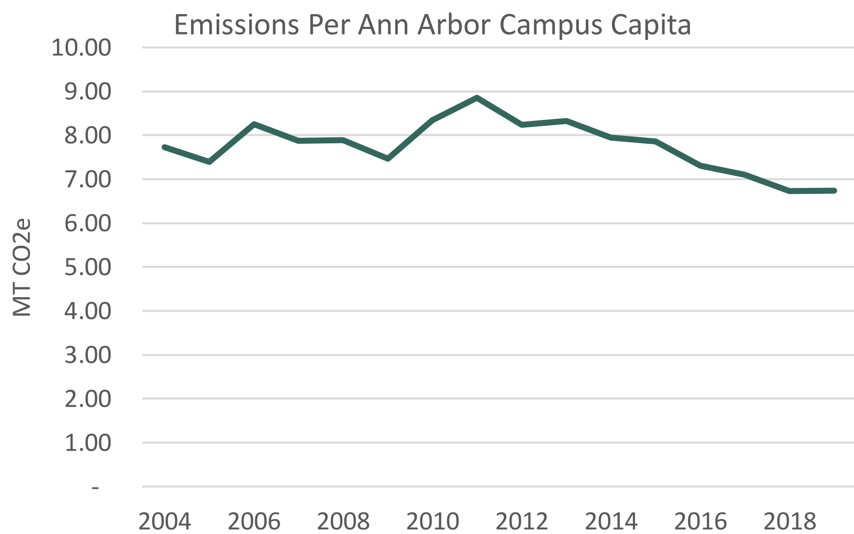


Figure 21*: University of Michigan emissions per capita – Ann Arbor campus population*

Transportation

Transportation accounts of 0.64 million MT CO_2e, representing 30% of total emissions. Transportation emissions include local passenger and commercial transportation, commuting patterns, and local buses, rail, and aviation. It should be noted that non-local (scope 3) buses, rail, and aviation trips and non-commuting long-distance passenger vehicle trips associated with the Ann Arbor community are not currently estimated.

Emission levels for transportation have been steady since 2015. Activity data for commuting is not available every year, and modeled data used for local transportation may not be fully updated every year. Buses, rail, and aviation emission levels are estimated from fuel consumption on an annual basis but represent less than 1% of total emissions.

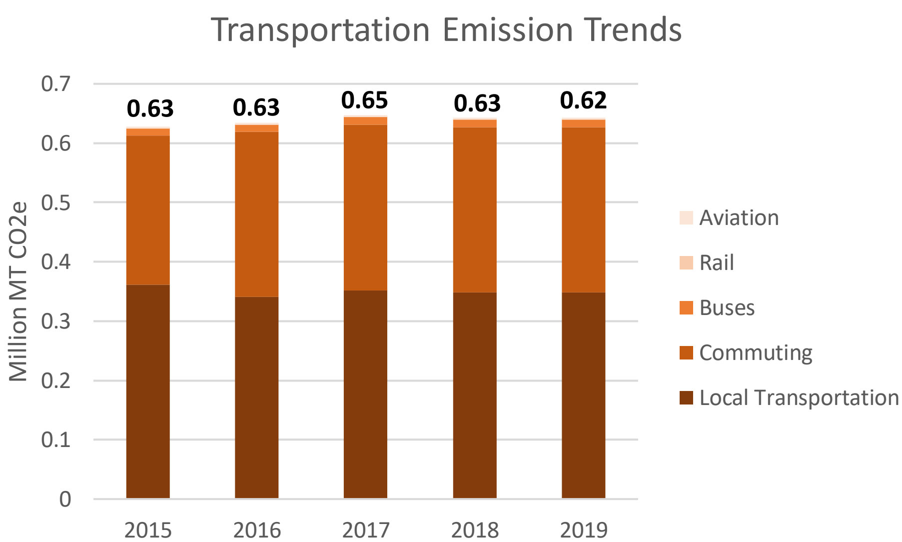


***Figure 22**: Transportation emission levels since 2015*

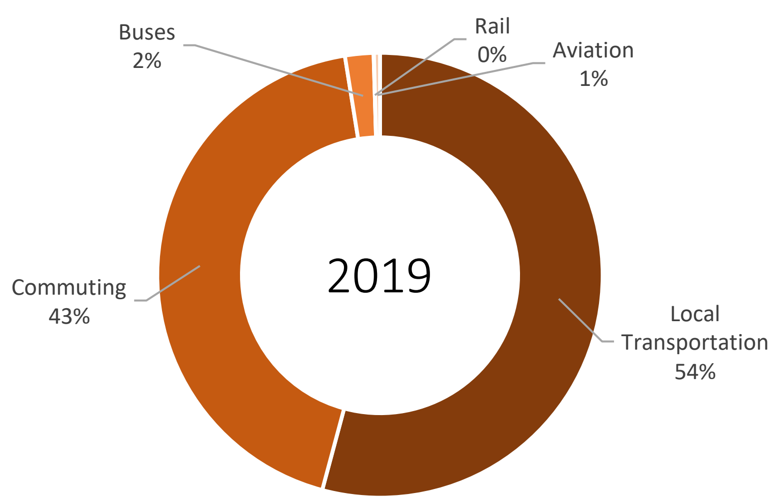
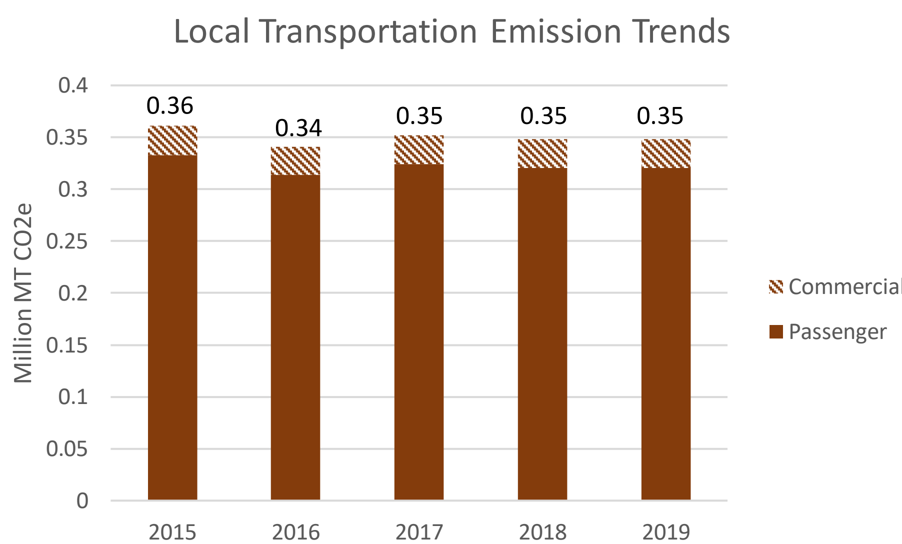


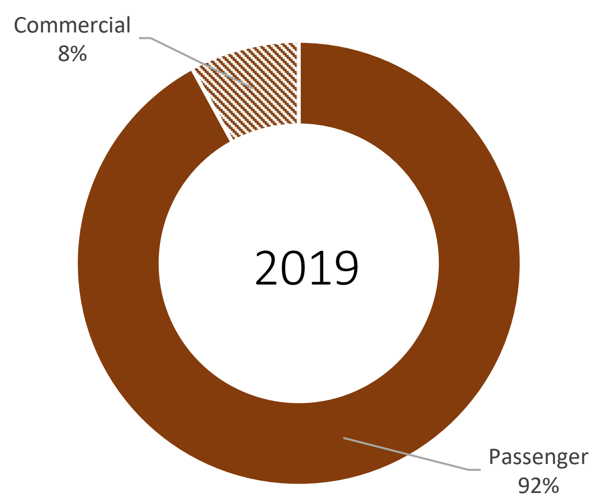
***Figure 23**: Composition of transportation emissions in 2019*

Local Transportation

Local transportation accounts for 0.35 million MT CO_2e, representing 17% of total emissions. Local transportation accounts for passenger and commercial vehicle trips that begin, end, or are fully contained in the City of Ann Arbor. Since 2000, local transportation emissions have decreased 16%. Between 2000 and 2019, the miles traveled in passenger and commercial vehicles only changed by 2%. Across different vehicle types and accounting for the average age of vehicles on the road, vehicles on the road are on average 17% more efficient than they were in 2000. Since 2015, emissions associated with local transportation have remained steady.

Passenger vehicles represent most local transportation emissions. This emission distribution is based on vehicle registration data for Washtenaw County, and commercial vehicles traveling within Ann Arbor may not be registered within Washtenaw County.



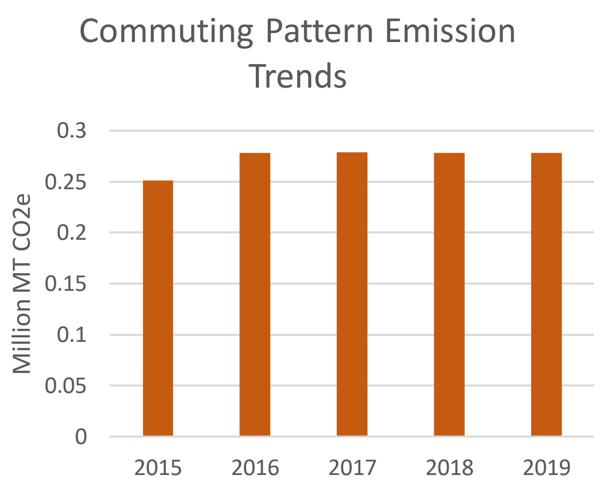


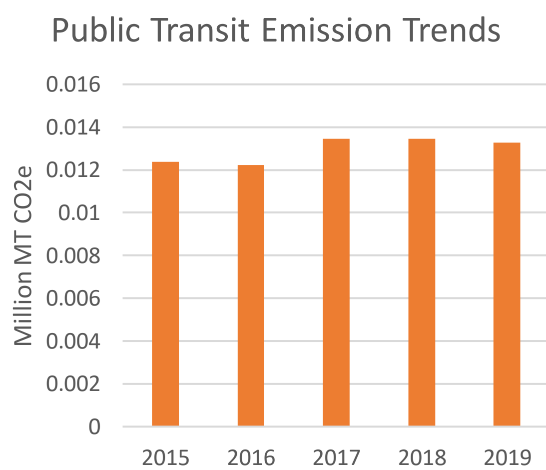
***Figures 24 and 25**: Local transportation emission levels since 2015 and composition of local transportation emissions in 2019*

Commuting Patterns

Commuting vehicles account for 0.28 million MT CO_2e, representing 13% of total emissions. Commuting patterns were not able to be estimated for 2000, so a comparison is not available. In addition, commuting pattern data is available every six years, so year-to-year changes are not available. Since 2015, commuting emissions have increased 11%. Commuting pattern emissions account for alternative commutes, such as car pooling or working virtually. Commuting patterns only account for workers traveling within Southeast Michigan, and avoids double counting with local transportation emission estimates.

Public Transportation





Figures 26 and 27*: Commuting transportation emission levels since 2015 and public transit emission level trends since 2015*

Public transportation accounts for .013 million MT CO_2e, representing 1% of total emissions. Public transportation emissions currently account for the Ann Arbor Area Transportation Authority (AAATA) and the University of Michigan (UM) public buses. Since 2015, emissions from buses have increased 11%, largely due to increased total consumption of fuels. The use of biodiesel has increased for both the AAATA and UM, with a decrease in non-biodiesel fuels.

Rail

Local passenger and freight rail accounts for 136 MT CO_2e, representing 0.01% of total emissions. Data is not available to estimate long-term trends in rail emissions since 2000. Additionally, annual activity data is not available for passenger and freight rail in Ann Arbor, so trends since 2015 are not available.

Municipal Airport

The Ann Arbor Municipal Airport accounts for 2,800 MT CO_2e, representing 0.1% of total emissions. Activity data is based on fuel consumed at the airport, although not all that fuel is consumed in Ann Arbor. Like rail emission data, no long-term or short-term data is currently available.

Waste

Solid waste accounts for 0.038 million MT CO_2e, representing 2% of total emissions. Estimates for waste emissions are associated with solid waste generated in Ann Arbor, the closed landfill in Ann Arbor, and organically treated, or composted waste. Since 2015, waste emissions have decreased by 35%.

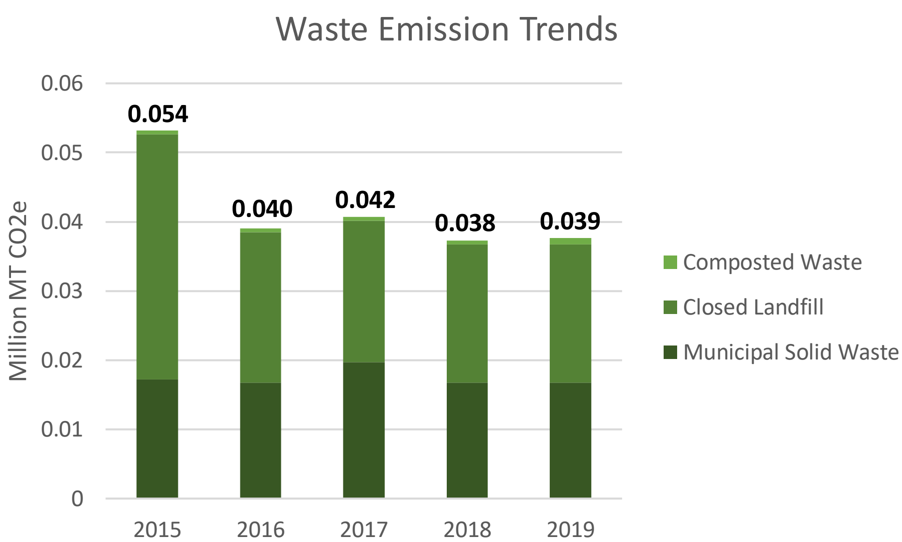


***Figure 28**: Waste emission levels since 2015*

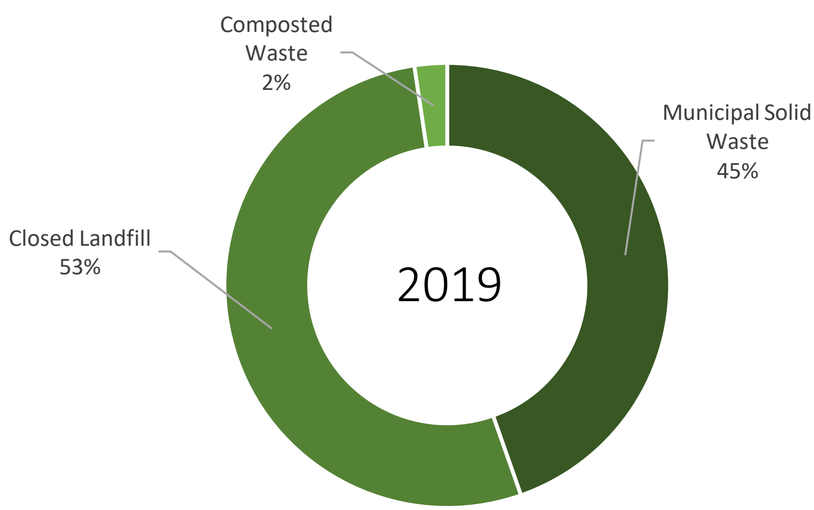


***Figure 29**: Composition of waste emissions in 2019*

Landfilled Waste

Landfilled waste generated in Ann Arbor accounts for .016 million MT CO_2e, representing 0.8% of total emissions. Landfilled waste emissions have decreased 29% since 2000. Landfilled waste emissions attribute the full lifetime of emissions of waste landfilled in 2019, rather than tracking these emissions to each consecutive year (I.e., the year in which the emissions occur). Due to the frequency of new data on waste characterization, the emission factor for landfilled waste remains constant since 2015 and landfilled emissions have remained constant since 2015.

Waste treatment emissions represent the fugitive emissions from organic waste decomposing anaerobically. Process emissions account for the equipment and operation of the landfill itself.

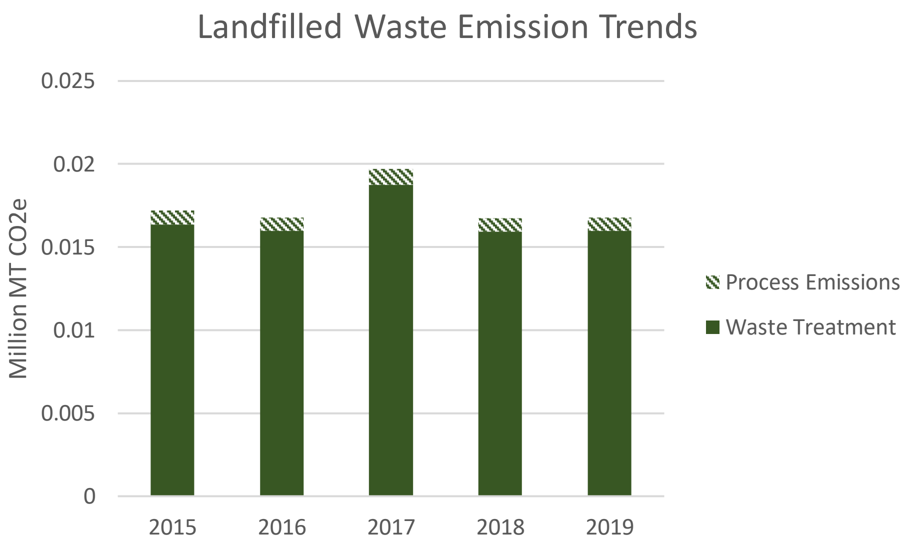


***Figure 30**: Landfilled waste emission levels since 2015*

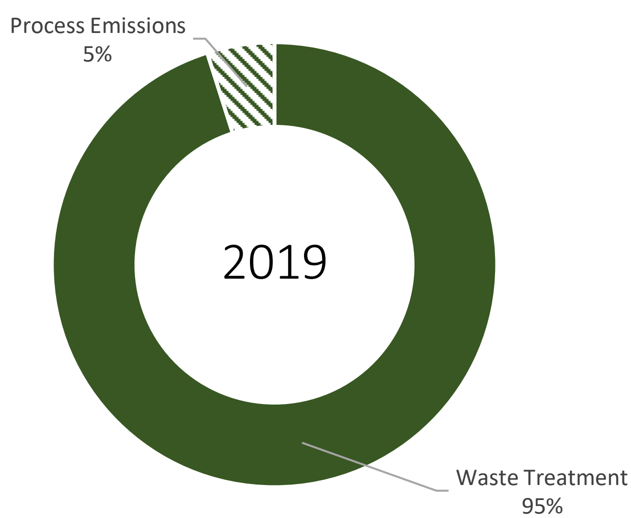


***Figure 31**: Composition of landfilled waste emissions in 2019*

Composted Waste

Composted waste accounts for 891 MT CO_2e, representing 0.04% of total emissions. Well-managed composted waste processing results in very low fugitive emissions. Emissions associated with composted waste also highlight avoided emissions by diverting organic materials from landfills. Six times as many emissions would have occurred had these organics been landfilled.

Closed Landfill

The closed City landfill accounts for 0.019 million MT CO_2e, representing 0.9% of total emissions. Unlike landfilled waste, annual emissions from fugitive emissions are estimated for each year of operations, rather than attributing emissions from waste to the year they were landfilled. This is largely because the closed landfill is within the scope of City operations, and annual emissions are more easily addressed. In addition, emissions associated with the closed landfill are modeled, and methodologies to collect data and estimate fugitive emissions have changed over the last 20 years. Since 2015, closed landfilled emissions have decreased 66%, attributed to a spike in emissions in 2015. This large decrease may be due to previous operations of flaring gas, annual repairs, or updates in data collection.

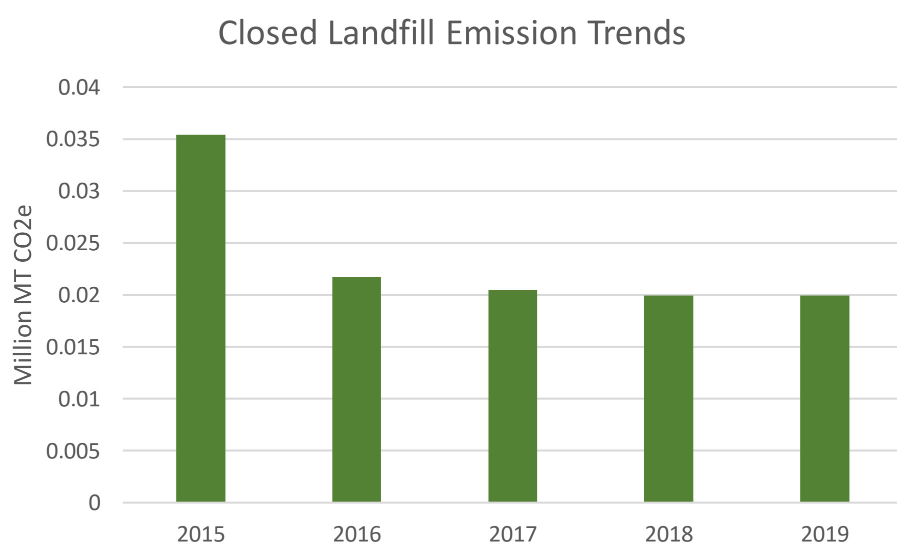


***Figure 32**: Closed landfill emission trends since 2015*

Wastewater Treatment

Wastewater treatment accounts for 1,000 MT CO_2e, representing 0.05% of total emissions. Wastewater treatment emissions are estimated using factors based on the specific processes used by the City of Ann Arbor to treat wastewater, and the population of Ann Arbor.

Upstream Emissions

The expanded inventory includes emissions associated with the use of electricity and natural gas, specifically transmission and distribution losses of electricity and fugitive methane emissions from local natural gas delivery. These emissions were 0.055 million MT CO2e in 2015, representing 3% of total emissions. These emissions have decreased 10% since 2015 due to a higher consumption of natural gas in 2015 and a decrease in electricity consumption in commercial buildings in 2019.

Upstream methane emissions occur as well, though these are not currently included in the inventory. [Studies estimate leakage rates from 1 to 12 percent](), with an average leak rate of 4.52 percent, or 0.27 million MT CO2e – 12% of emissions if added to the expanded inventory. While methane leakage rates are dependent on many factors and hard to accurately estimate, it is important to recognize the magnitude of these emissions as the A^{2}ZERO Plan provides strategies to shift away from natural gas used in our buildings and instead rely on electricity powered by renewable energy.

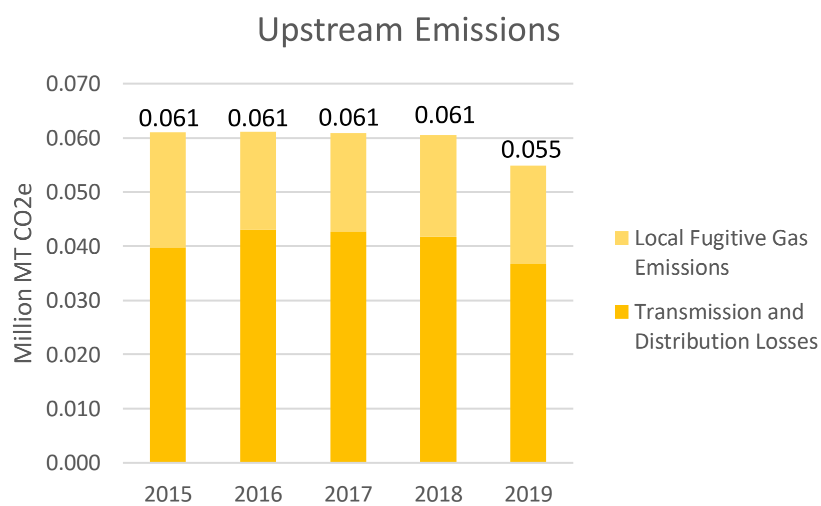


***Figure 33**: Upstream emission level trends since 2015*

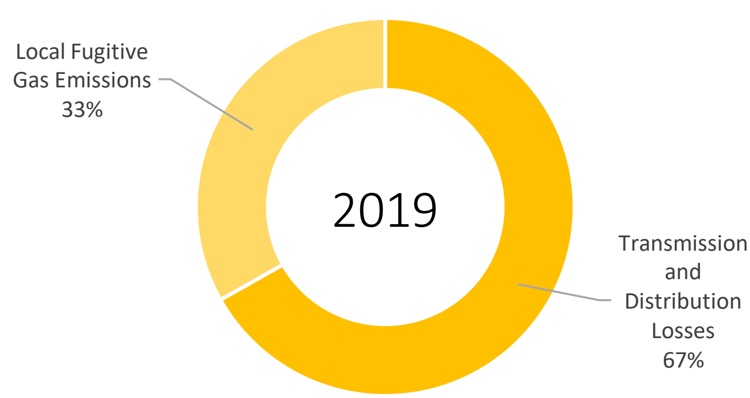


***Figure 34**: Composition of upstream emissions in 2019*

Closing

This report looked at the long-term community-wide trends illustrated by the **simple inventory** to understand what progress has been made to date on our community's emission reduction goals. Ann Arbor has achieved a 20% reduction in emissions since 2000 due to a portion of coal generation being replaced by less carbon-intensive electricity sources, as well as improvements in vehicle efficiency.

The report presented the 2019 **expanded inventory in order** to understand a more comprehensive view of our community's emissions, as well as to provide insight into year-to-year changes and understand where our emissions come from.

In the future, we aim to develop an **expanded+ inventory** to include consumption-based emissions, like those associated with community consumed food, goods, and services, as well as including additional transportation sources like travel, and renewable energy credits and offsets. The City has committed to participating in an ICLEI cohort of other cities working to develop similar information.

Conducting a regular greenhouse gas inventory is important to understanding the magnitude of emissions associated with our community, to finding strategic opportunities to achieve reductions, to celebrate successes, and to continually inform our programs and priorities If you would like to understand your personal carbon footprint, you can estimate it with Berkeley's CoolClimate Calculator, and explore how your behaviors contribute to our community's greenhouse gas emissions.

Ann Arbor has the intellect, the human power, the resources, and the skills needed to move climate action and sustainability forward. What is currently missing is the will, and what is lacking is time. Join us as we combat the most significant crisis of our era. Together we can avoid the unmanageable, manage the unavoidable, and create a more equitable and just society for all.