Results of the 2019 Community and Corporate Greenhouse Gas (GHG) Inventories

Executive Summary

Greenhouse gas (GHG) inventories provide a snapshot of energy use and associated emissions over a given period within the buildings, transportation, waste, and agriculture sectors. Emissions are reported in tonnes of equivalent carbon dioxide emissions (tonnes of CO_2e), which are calculated based on carbon dioxide (CO_2), methane (CH_4), and nitrogen oxide (N_2O) emissions. Inventories follow the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), which offers a consistent and robust accounting methodology that allows for comparison around the world. They are based on five principles in order to represent a true account of emissions: relevance, completeness, consistency, transparency, and accuracy.

The City of Ottawa undertakes two types of greenhouse gas (GHG) emissions inventories on an annual basis: community inventories and corporate inventories. The latest inventory results are for the 2019 calendar year.

Community inventories manage and track emissions associated with people who live within the geographic boundaries of the city of Ottawa and are broken down into four sectors:

- *Buildings* – includes emissions from residential, commercial, institutional, and industrial buildings; streetlights; and fugitive emissions
- *Transportation* – includes emissions from on-road, aviation, rail, and off-road transportation
- *Waste* – includes emissions from solid waste and wastewater treatment
- *Agriculture* – includes emissions from crop production and livestock operations

Between 2012 and 2019, community emissions decreased 12 per cent; however total emissions increased slightly from 2018 and have remained relatively flat since 2016. Per capita emissions dropped from 7.4 tCO_2e per person in 2012 to 6.1 tCO_2e per person in 2019. This decline in emissions remains primarily attributable to the provincial phase out of coal plants and a significant reduction in emissions from electricity generation.

Roughly 90 per cent of community emissions are attributable to the buildings and transportation sectors, a trend that has been consistent since 2012. Waste and agriculture sectors make up the other 10 per cent of emissions. Natural gas consumption was the largest contributing source of emissions, accounting for 38 per cent of total community emissions. Gasoline and diesel consumption were the second and third largest contributors, accounting for 26 per cent and 11 per cent, respectively.

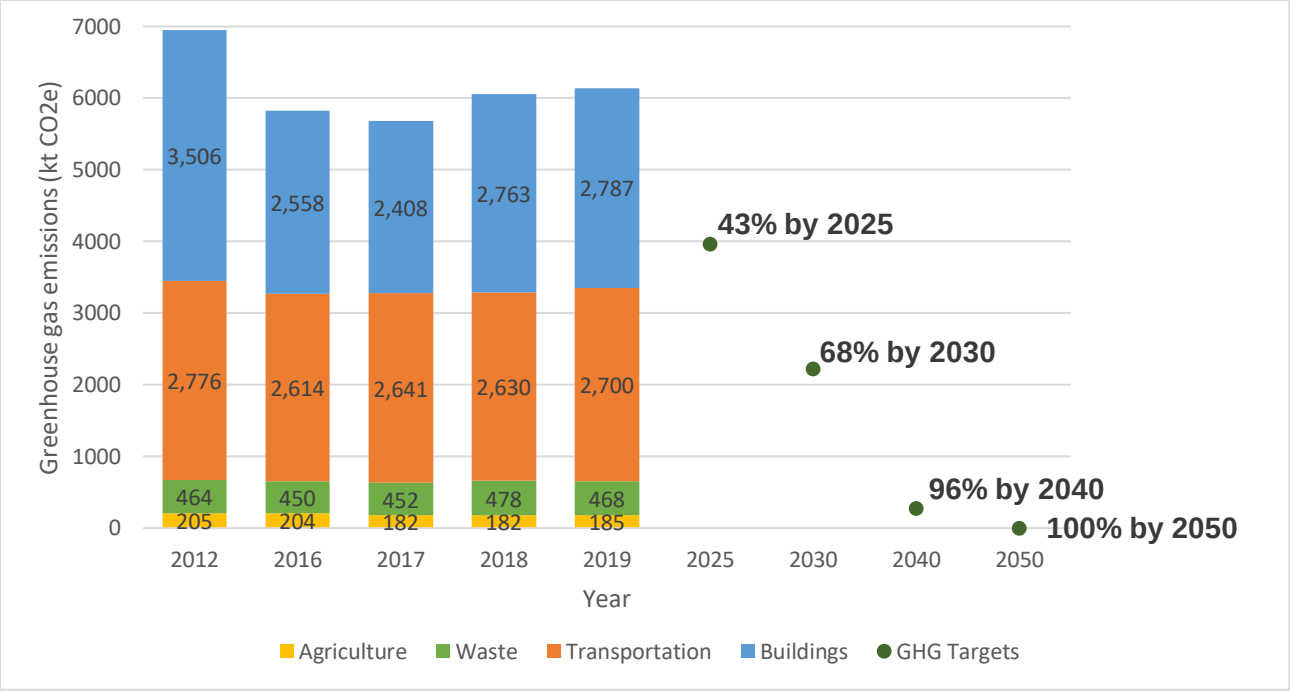

Figure 1: Annual Community GHG Emissions by Sector, 2012 and 2016-2019

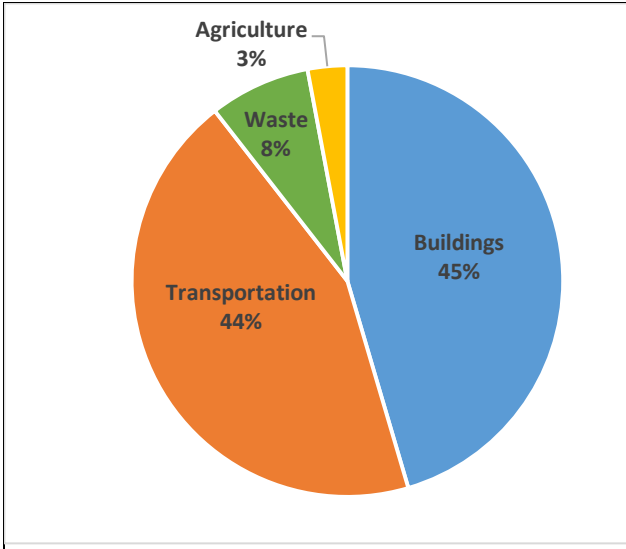

Figure 2: Community GHG Emissions by Sector (2019)

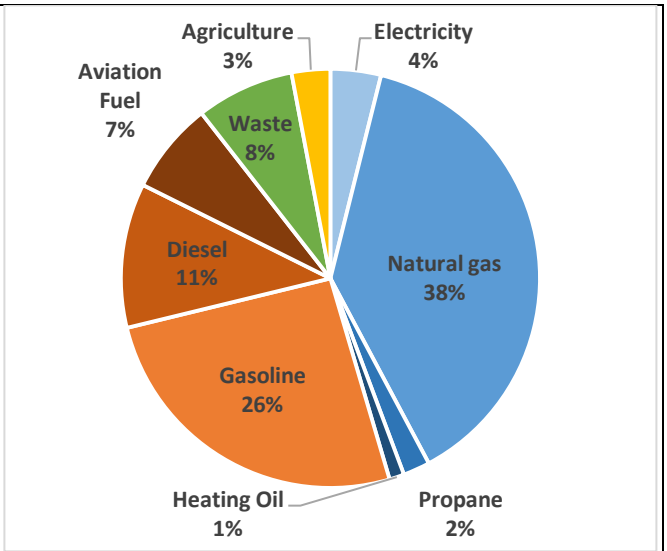

Figure 3: Community GHG Emissions by Source (2019)

Corporate inventories are used to track emissions under municipal operational control within the corporate organizational structure and are broken down into four sectors:

- *Facilities* – includes buildings, streetlights, traffic lights, and light rail transit (stations and trains)
- *Fleet* – includes municipal, transit, and police fleets

- *Solid waste* – includes emissions from the Trail Road Waste Facility
- *Wastewater treatment* – includes emissions from the treatment of wastewater at Robert O. Pickard Environmental Centre

Between 2012 and 2019, corporate emissions decreased by 34 per cent, currently exceeding the short-term target to reduce emissions by 30 per cent below 2012 baseline levels by 2025. This decrease in emissions remains primarily due to the significant decline in emissions in the solid waste sector, which can be attributed to the considerable efficiencies made at the Trail Road Waste Facility. The provincial phase out of coal plants and a significant reduction in emissions associated with electricity generation also contributed to a decrease in total corporate emissions. The largest contributing sector to total corporate emissions was fleet, accounting for 63 per cent of total corporate emissions of which 48 per cent was attributed to transit fleet. Directly related, diesel consumption was the largest contributing source of emissions, accounting for 55 per cent of total corporate emissions. Corporate emissions accounted for roughly 4 per cent of total community emissions in 2019.

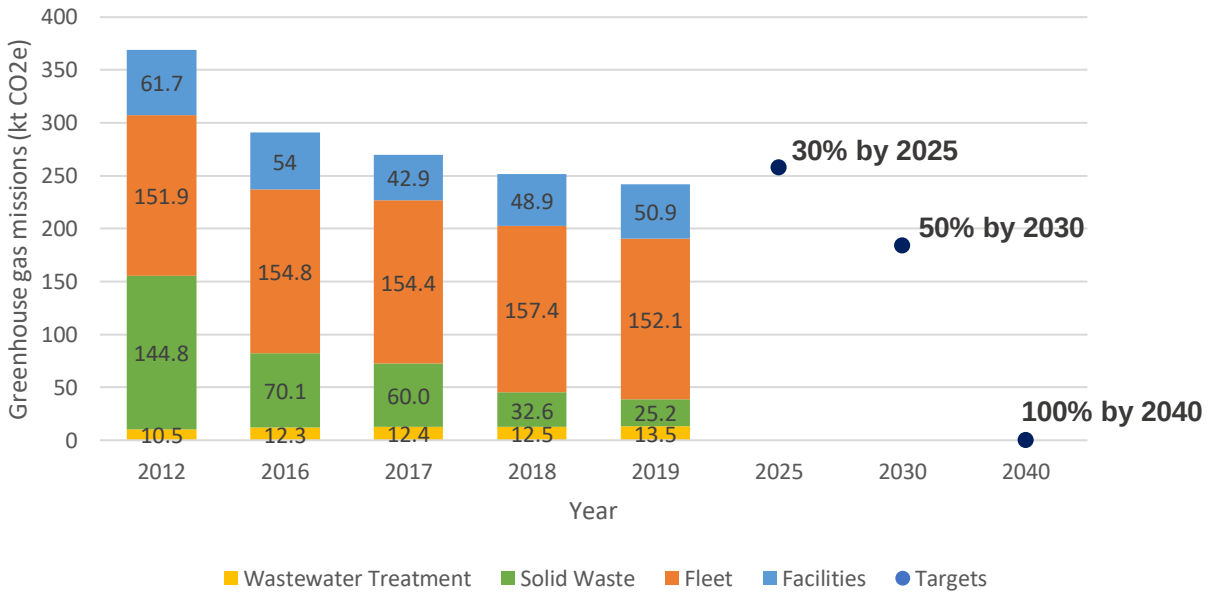

Figure 4: Annual Corporate GHG Emissions by Sector Since 2012

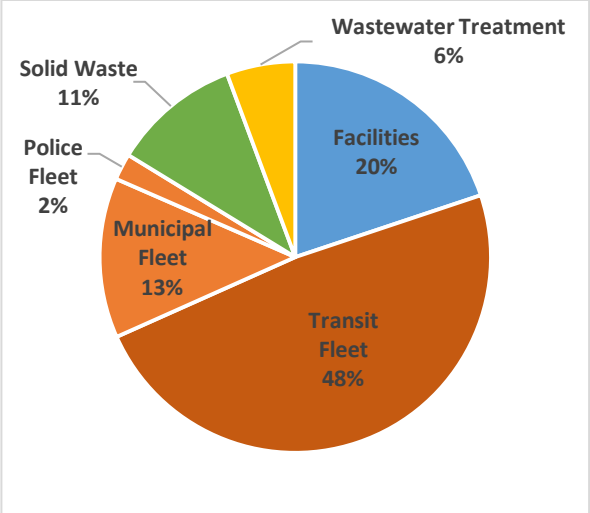

Figure 5: Corporate GHG Emissions by Sector (2019)

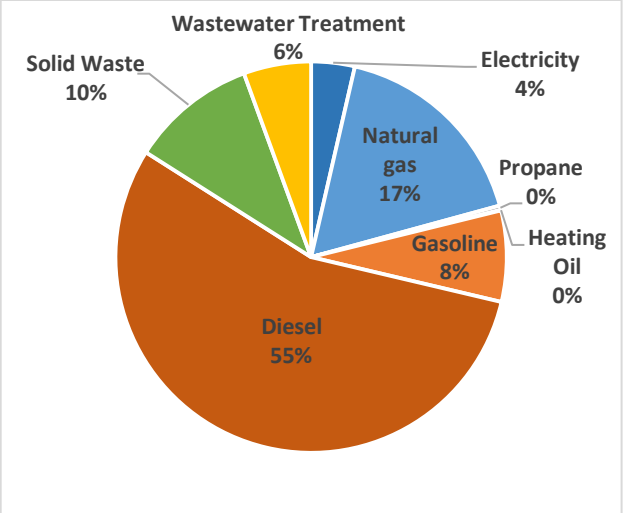

Figure 6: Corporate GHG Emissions by Source (2019)

Looking ahead, staff will:

- Review the GHG inventory methodology and assumptions for 2012 and 2016-2019 to ensure consistency and transparency and update where required;
- Complete the 2020 GHG inventory and, if required, revise the 2012 baseline and 2016-2020 GHG inventories based on the above review;
- Make the 2012 and 2016-2019 GHG inventory results available on the City's Open Data platform;
- Review the GHG inventory methodology and assumptions as part of the five-year update of the Climate Change Master Plan in 2025.

1. Introduction

Greenhouse gas (GHG) inventories provide a snapshot of energy use and associated emissions over a given period within the buildings, transportation, waste, and agriculture sectors, and are based on the best data available at the time. Variables such as population, weather, regulatory and technology changes, price and availability of energy, and consumer behaviours can all influence emissions, but are not considered in the inventory calculations. Emissions are reported in tonnes of equivalent carbon dioxide emissions (tonnes of CO_2e), which are calculated based on carbon dioxide (CO_2), methane (CH_4), and nitrogen oxide (N_2O) emissions. Inventories follow the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), which offers a consistent and robust accounting methodology that allows for comparison around the world. They are based on five principles in order to represent a true account of emissions: relevance, completeness, consistency, transparency, and accuracy.

The City of Ottawa (the City) undertakes two types of greenhouse gas (GHG) emissions inventories: community inventories and corporate inventories.

Community inventories manage and track emissions associated with people who live within the geographic boundaries of the city of Ottawa. Data collection and analysis is typically more resource intensive than corporate inventories, often requiring the use of data and assumptions from other organizations. Data from City departments, local and provincial utilities, Statistics Canada, Natural Resources Canada, and Environment Canada was collected for the community inventory.

The community inventory is broken down into four sectors:

- *Buildings* – includes emissions from residential, commercial, institutional, and industrial buildings; streetlights; and fugitive emissions
- *Transportation* – includes emissions from on-road, aviation, rail, and off-road transportation
- *Waste* – includes emissions from solid waste and wastewater treatment
- *Agriculture* – includes emissions from crop production and livestock operations

Corporate inventories are used to track emissions under municipal operational control within the corporate organizational structure. These inventories are generally considered to be more precise than community inventories as municipalities have more direct control over their emissions and access to reliable data. Data used to calculate corporate emissions came from observed data from City departments.

The corporate inventory is broken down into four sectors:

- *Facilities* – includes buildings, streetlights, traffic lights, and light rail network (stations and trains)
- *Fleet* – includes municipal, transit, and police fleets
- *Solid waste* – includes emissions from the Trail Road Waste Facility

- *Wastewater treatment* – includes emissions from the treatment of wastewater at Robert O. Pickard Environmental Centre

Historically, the City completed GHG inventories every four years. Starting in 2019, community and corporate inventories are to be undertaken on an annual basis. The latest inventory results are for the 2019 calendar year. Additionally, the City is a member of three different programs that work towards greater emission reductions: Federation of Canadian Municipalities' Partners for Protection Program, Global Covenant of Mayors for Climate and Energy, and EnviroCentre's Carbon 613 Program. To learn more about these programs, refer to Annex A.

2. GHG Emission Reduction Targets

In January 2020, Council approved short, mid and long-term GHG emission reduction targets as part of the Climate Change Master Plan to reduce community emissions by 100% by 2050 and corporate emissions by 100% by 2040 (Figures 7 and 8). These targets align with the Intergovernmental Panel on Climate Change's target to limit global warming increases to 1.5 degrees Celsius.

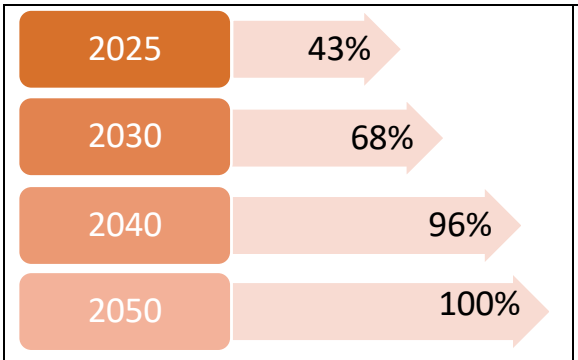

Figure 7: Short, Mid and Long-term Community Targets to Reach 100% by 2050 Target

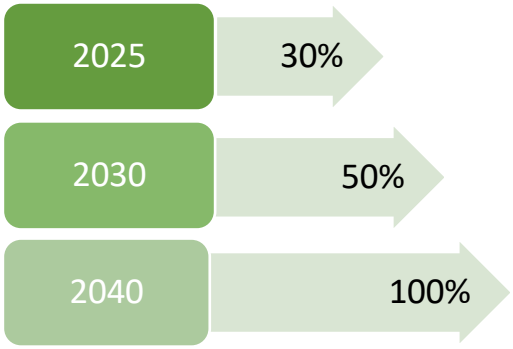

Figure 8 Short, Mid and Long-term Corporate Targets to Reach 100% by 2040 Target

3. Population Growth, Employment and Weather

Population growth and the number of employed residents factor into GHG inventories. Ottawa's population has been steadily growing over the years, increasing by 1.5 per cent between 2018 and 2019 and 7.6 per cent since 2012.

Table 1: Population of Ottawa[1]

	2012	2016	2017	2018	2019
Population	935,255	968,580	979,173	991,429	1,006,211

[1] City of Ottawa Annual Development Reports.

Similarly, Ottawa's employment has been steadily growing over the years, increasing by 5.8 per cent between 2018 and 2019 and by 9.5 per cent since 2012.

Table 2: Employed Residents in Ottawa[2]

	2012	2016	2017	2018	2019
Employed Residents	539,100	543,400	546,700	557,600	590,100

Weather plays a factor in how much energy is consumed in a given year. Heating and cooling degree days are used to indicate how much energy is required to heat or cool a building. Colder weather can also impact vehicle fuel consumption which is higher in colder conditions. Heating degree days (HDD) are equal to the number of degrees Celsius a given day's mean temperature is less than 18ºC. For example, if the daily mean temperature is 10ºC, then the HDD value for the day is 8ºC. The HDD value for the day is zero if the mean temperature is above 18ºC. The opposite is applied for cooling degree days (CDD) whereby CDD are equal to the number of degrees Celsius where a given day's mean temperature is above 18ºC and zero if less than 18ºC. Figure 9 highlights the annual HDD and CDD since 2012.

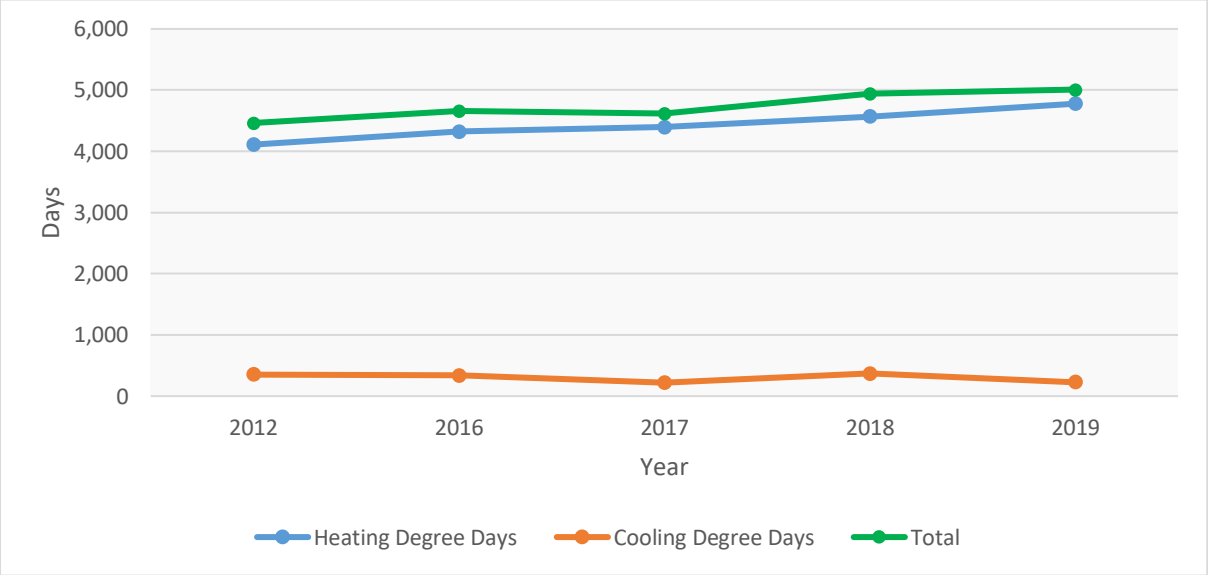

Figure 9: Annual Heating and Cooling Degree Days in Ottawa (2012-2019)[3]

4. Community Inventory Results (2019)

The 2019 community inventories are based on emissions from activities within the geographic boundary of the city of Ottawa for a 12-month period from January 1, 2019 to December 31, 2019. Between 2012 and 2019, community emissions dropped 12 per cent; however total emissions increased slightly from 2018 and remained relatively flat since

[2] Ibid.
[3] Ottawa (Kanata-Orléans) www.ottawa.weatherstats.ca

2016. Additionally, per capita emissions dropped from 7.4 tCO_2e per person in 2012 to 6.1 tCO_2e per person in 2019. This decline in emissions remains primarily attributable to the provincial phase out of coal plants and a significant reduction in emissions from electricity generation.

Roughly 90 per cent of community emissions are attributable to the buildings and transportation sectors, a trend that has been consistent since 2012. The waste and agriculture sectors make up the other 10 per cent of emissions. Natural gas consumption was the largest contributing source of emissions, accounting for 38 per cent of total community emissions. Gasoline and diesel consumption were the second and third largest contributors, accounting for 26 per cent and 11 per cent, respectively.

The following tables and figures provide an overview of the community inventory results by sector, emissions source, and energy use, as well as indicates what percent contribution the sector is making towards achieving the GHG emission reduction targets. Please note that some results may not add up exactly due to rounding. A more detailed overview of each of the four sectors (buildings, transportation, waste, and agriculture) is outlined in the following sections. For the full list of data sources and the calculation methodology behind the results, refer to Annex B and Annex C, respectively.

Of note, there were revisions made to some of the previous inventories. These include:

- Emissions from electricity were recalculated for 2018 to account for the availability of the 2018 electricity emission factors which were unavailable at the time the inventory was calculated.
- The wastewater treatment sector was recalculated for the 2012 and 2016-2018 inventory years for accuracy.

Table 3: Annual Community GHG Emissions by Sector Since 2012

Sector	GHG emissions (tonnes of CO_2e) ('000s)					Change between 2012 and 2019 (%)	Contribution to achieving GHG targets (%)
	2012	2016	2017	2018	2019		
Buildings	3,506	2,558	2,408	2,763	2,787	-20%	-10%
Transportation	2,776	2,614	2,641	2,630	2,700	-3%	-1%
Waste	464	450	452	478	468	1%	0%
Agriculture	205	204	182	182	185	-10%	0%
Total	**6,951**	**5,826**	**5,681**	**6,053**	**6,140**	**-12%**	**-12%**

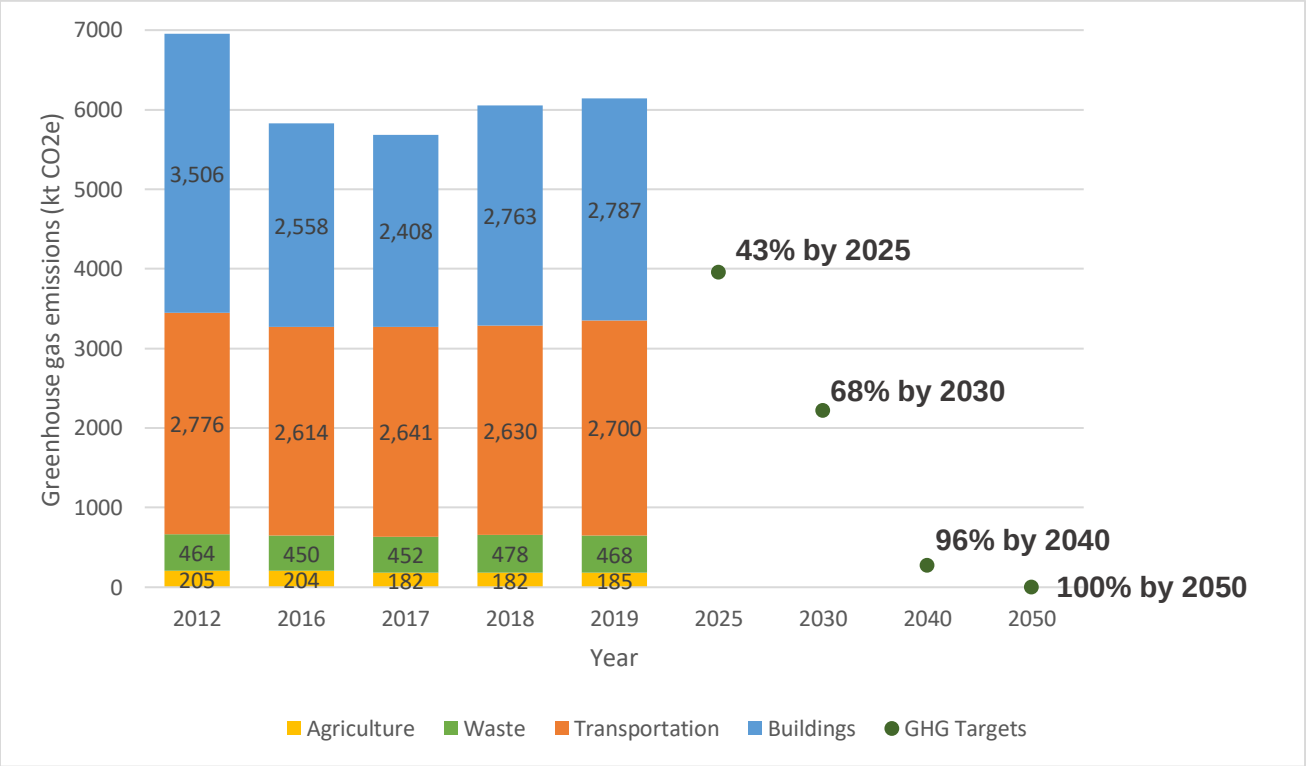

Figure 10: Annual Community GHG Emissions by Sector, 2012 and 2016-2019

Table 4: Annual Community Energy and GHG Emissions by Source (2019)

Energy and Emissions Source	Gigajoules ('000s)	GHG emissions (tonnes of CO_2e) ('000s)
Electricity	27,149	239
Natural gas	48,268	2,351
Propane	2.1	127
Heating Oil	1.0	70
Gasoline	23,868	1,580
Diesel	10,010	684
Aviation Fuel	6,303	435
Solid Waste	N/A	432
Wastewater Treatment	N/A	36
Agriculture	N/A	185

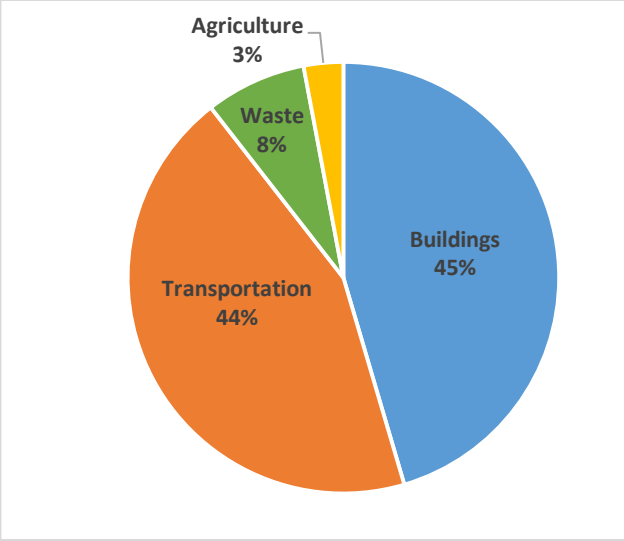

Figure 11: Community GHG Emissions by Sector (2019)

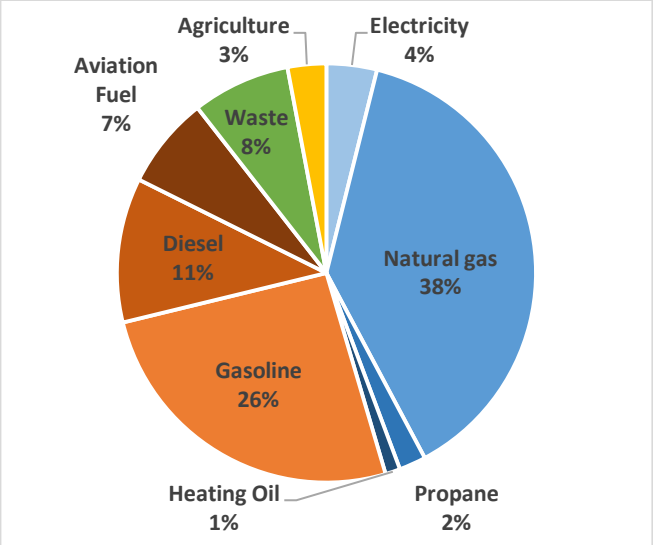

Figure 12: Community GHG Emissions by Source (2019)

Buildings Sector

The buildings sector accounts for emissions generated through the combustion of fossil fuels (electricity, natural gas, propane, and heating oil) created in the process of generating, delivering, and consuming forms of energy. Energy is primarily consumed for space heating, cooling, appliances, and lighting in residential, apartment, industrial, commercial, and institutional buildings. The transmission and distribution losses from grid-supplied electricity are also included in the emissions totals.

In 2019, the buildings sector accounted for 45 per cent of total community emissions, the same as 2018. Between 2012 and 2019, there was a 20 per cent drop in emissions within the buildings sector. The decline in emissions remains primarily attributable to the provincial phase out of coal plants (the last one decomissioned in 2014) and Ontario having one of the cleanest electricity systems in North America. However, emissions from provincial electricity generation are starting to increase as a result of increased production from natural-gas fired electricity generation due to an increased demand and reduced nuclear production. Despite that, emissions from electricity consumption remain far below emissions associated with the consumption of fossil fuels such as natural gas or propane[4].

Breaking it down by sub-sector, there was little difference in the total emissions generated between residential buildings and institutional, commercial, and industrial (ICI) buildings

[4] Independent Electricity Systems Operator. *Annual Planning Outlook: A view of Ontario's electricity system needs.* January 2020. https://www.ieso.ca/en/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook

in 2019. Natural gas was the biggest source of emissions within the buildings sector, accounting for 84 per cent of total sector emissions.

As Figure 9 indicates, 2019 had the highest combined number of HDD days since 2012, contributing to an increase in natural gas consumption. Alternatively, the decrease in the number of CDD days contributed to a decrease in electricity consumption from previous years.

Table 5: Emissions from Buildings – By Sub-Sector

Sub-Sector	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Residential Buildings	1,718	1,376	1,390	-5%
Industrial, Commercial, and Institutional Buildings[5]	1,788	1,387	1,398	-6%

Table 6: Emissions from Buildings – By Source

Emissions Source	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Electricity	828	252	239	-10%
Natural Gas	2,026	2,301	2,351	5%
Propane	146	123	127	0%
Heating Oil	110	87	70	-1%

Transportation Sector

The transportation sector includes emissions from the mobile combustion of gasoline and diesel and is broken down into the following sub-sectors:

- On-road transportation
- Aviation
- Rail
- Off-road transportation

Gasoline consumption is attributed to on-road transportation only. Emissions from electric vehicles are captured under the buildings sector.

In 2019, the transportation sector accounted for 44 per cent of total community emissions, the same as in 2018. Between 2012 and 2019, emissions decreased by 3 per cent within

[5] Prior to the 2019 GHG inventory, natural gas emissions from apartments were captured under Industrial, Commercial, and Institutional Buildings. Starting in the 2019 inventory, natural gas emissions from apartments were captured under Residential Buildings. This was due to a change in how account classes are categorized.

the transportation sector. On-road transportation was the highest emitting sub-sector in 2019, contributing roughly 72 per cent of emissions within the transportation sector, while gasoline consumption accounted for roughly 59 per cent of total sector emissions. Despite that, there was a small decrease in on-road transportation emissions due to the provincial government regulatory requirement to increase renewable energy content in gasoline and diesel.

Table 7: Emissions from Transportation – By Sub-Sector

Sub-Sector	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
On-Road Transportation	2,172	1,942	1,948	-3%
Aviation	317	378	435	2%
Rail	101	101	99	0%
Off-Road Transportation[6]	186	214	217	0%

Table 8: Emissions from Transportation – By Source

Emissions Source	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Gasoline	1,579	1,574	1,580	0%
Diesel	880	678	684	-3%
Aviation Fuel	317	378	435	2%

Waste Sector

The waste sector includes emissions from solid waste in private and public landfills and emissions from wastewater treatment and septic tanks.

In 2019, the waste sector accounted for 8 per cent of total community emissions. Between 2012 and 2019, the waste sector increased by 1 per cent due to very small increases in emissions from both solid waste and wastewater treatment.

Table 9: Emissions from Waste – By Sub-Sector

Sub-Sector	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Solid Waste	430	442	432	0%
Wastewater Treatment	28	32	32	0%

[6] Per Natural Resources Canada, off-road transportation includes vehicles not registered for on-road such as ATVs and snowmobiles.

Agriculture Sector

Emissions from agricultural practices are only tracked through the community inventory and include emissions from the biological processes involved in agricultural production. The main sources include agricultural soils, enteric fermentation[7] in ruminant animals and manure management.

In 2019, the agricultural sector accounted for 3 per cent of total community emissions, the smallest percentage of all sectors. Between 2012 and 2019, agricultural emissions decreased by 11 per cent. However, there is low confidence in these results as it is based on census data in which the latest census data was for 2016.

Table 10: Emissions from Waste – By Sector

Sector	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Agriculture	205	182	185	0%

5. Corporate Inventory Results (2019)

The 2019 corporate inventory calculated emissions from municipal operations within the corporate organizational framework for a 12-month period from January 1, 2019 to December 31, 2019.

Between 2012 and 2019, corporate emissions decreased by 34 per cent, currently exceeding the short-term target to reduce emissions by 30 per cent below 2012 baseline levels by 2025. This decrease in emissions remains primarily due to the significant decline in emissions in the solid waste sector, which can be attributed to the considerable efficiencies made at the Trail Road Waste Facility. The provincial phase out of coal plants and a significant reduction in emissions associated with electricity generation also contributed to a decrease in total corporate emissions.

Similar to previous inventory years, the largest contributing sector to total corporate emissions was the fleet sector, accounting for 63 per cent of total corporate emissions of which the transit fleet was responsible for 48 per cent. Directly related, diesel consumption was the largest contributing emission source, accounting for 55 per cent of total corporate emissions. Corporate emissions accounted for roughly 4 per cent of total community emissions in 2019.

The following tables and figures provide an overview of the corporate inventory results by sector, emissions source, and energy use, as well as indicates what percent contribution

[7] Enteric fermentation occurs in the rumen (stomach) of certain animals (cattle, sheep) as part of their digestive processes. Typically this process results in methane emissions releases as eructation (burping) or flatulence. These emissions are sometimes controlled or reduced through changes in diet for ruminant animals.

the sector is making towards achieving the GHG emission reduction targets. Please note that some results may not add up exactly due to rounding. A more detailed overview of each of the four sectors (facilities, fleet, solid waste, and wastewater treatment) is outlined in the following sections. For the full list of data sources and the inventory calculation methodology, refer to Annex B and Annex C, respectively.

Of note, there were revisions made to some of the previously completed inventories. These include:

- Emissions from electricity were recalculated for 2018 to account for the availability of the 2018 electricity emission factors which were unavailable at the time the inventory was calculated.
- The solid waste sector was recalculated to include emissions from the Nepean landfill.
- The wastewater treatment sector was recalculated for the 2012 and 2016-2018 inventory years for accuracy.

Table 11: Annual Corporate GHG Emissions by Sector Since 2012

Sector	GHG Emissions (tonnes of CO_2e) ('000s)					Change between 2012 and 2019 (%)	Contribution to achieving GHG targets (%)
	2012	2016	2017	2018	2019		
Facilities	61.7	54.0	42.9	48.9	50.9	-23%	-3%
Fleet	151.9	154.8	154.4	157.4	152.1	0%	0%
Solid Waste	144.8	70.1	60.0	32.6	25.2	-83%	-32%
Wastewater treatment	10.5	12.3	12.4	12.5	13.5	29%	1%
Total	**368.9**	**291.2**	**269.8**	**251.4**	**241.7**	**-34%**	**-34%**

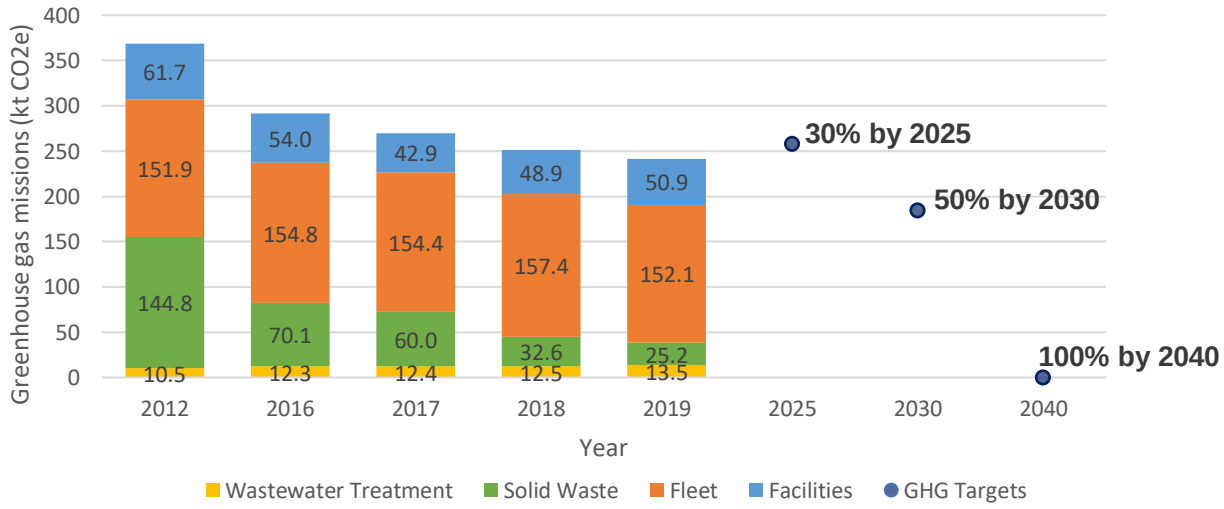

Figure 13: Annual Corporate GHG Emissions by Sector (2012 and 2016-2019)

Table 12: Total Corporate Energy Use and GHG Emissions by Source (2019)

Energy and Emissions Source	Gigajoules ('000s)	GHG emissions (tonnes of CO_2e) ('000s)
Electricity	1,079.9	8.7
Natural gas	852.8	41.5
Propane	14.1	0.9
Heating Oil	1.1	0.08
Gasoline	273.4	18.2
Diesel	1,840.4	133.7
Solid Waste	N/A	25.2
Wastewater Treatment	N/A	13.5

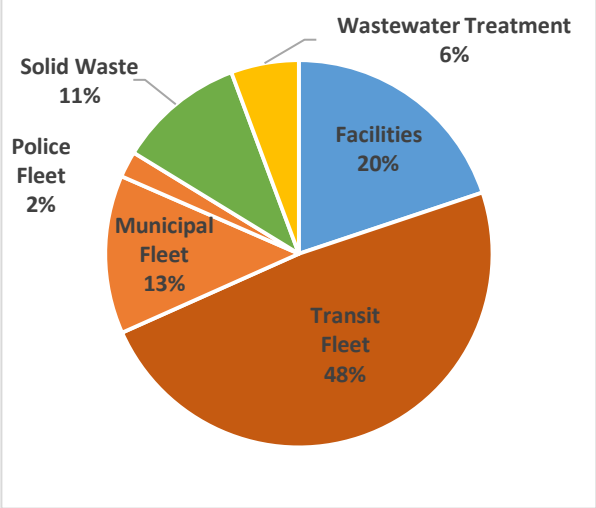

Figure 14: Corporate GHG Emissions by Sector (2019)

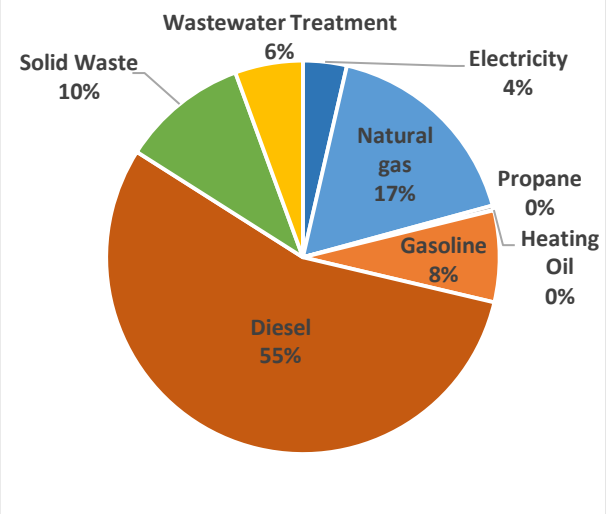

Figure 15: Corporate GHG Emissions by Source (2019)

Facilities Sector

Emissions from facilities includes emissions from buildings, pumping stations, streetlights and traffic lights. Electricity consumption for the operation of the light rail transit network, including stations and trains, is also captured under facilities for the first time in 2019. A summary of energy usage by City facilities is posted to the City of Ottawa's website on an annual basis as mandated by Ontario's Electricity Act.

In 2019, municipal facilities accounted for 20 per cent of total corporate emissions. Between 2012 and 2019, there was a 23 per cent drop in emissions from facilities. The decline in emissions remains primarily attributable to the provincial phase out of coal plants and a reduction in GHG emissions associated with electricity generation.

In 2012, the subset of City buildings that are under the operational control of facility operation services had a total area of 712,000 m^2. That grew to 749,237 m^2 as of 2019, an increase of roughly 5.2 per cent. Additionally, the higher combined number of HDD and CDDs contributed to the greater demand for energy to heat buildings in 2019. Despite these two factors, the overall Building Energy Performance Index in 2019 for these buildings fell to 313.0 from 368.0 in 2012. That represents a decrease in energy intensity of 15 per cent in seven years.

Table 13: Emissions from Facilities – By Source

Emissions Source	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Electricity	30.5	8.3	8.7	-9%
Natural Gas	30.7	39.9	41.5	4%
Propane	0.3	0.6	0.6	0%
Heating Oil	0.2	0.07	0.08	0%

Fleet Sector

Fleet emissions are generated from the mobile combustion of fossil fuels (gasoline, diesel, and propane) from corporate fleet vehicles. Corporate fleet vehicles are broken down by:

- Municipal fleet, which includes service areas such as by-law, solid waste, paramedics, fire, roads, etc.
- Transit fleet, which includes OC Transpo, O-Train (diesel trains), and Para Transpo.
- Police fleet

Electricity used to power electric vehicles and the light rail transit network trains is captured under the facilities sector.

In 2019, fleet emissions accounted for 63 per cent of total corporate emissions, of which transit fleet accounted for 48 per cent, municipal fleet accounted for 13 per cent and police fleet accounted for 2 per cent. Diesel consumption accounted for roughly 55 per cent of total corporate emissions.

For the first time since 2012, emissions from conventional buses decreased. This is primarily due to the introduction of light rail transit in Ottawa with the launch of O-Train Line 1 and an associated decrease in diesel fuel consumption. Overall diesel fuel consumption by buses in 2019 decreased by 6 per cent compared to 2018. For the period that the LRT was operational in 2019 between October and December and bus service was reduced, diesel consumption decreased 15 per cent compared to the same period in 2018 and system-wide ridership went up. It should also be noted that due to operational

issues in the first months of O-Train Line 1, additional buses were deployed to replace and supplement train service when necessary.

Table 14: Emissions from Fleet - By Sub-Sector

Sub-Sector	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Transit Fleet	116.8	121.7	115.3	0%
Municipal Fleet	29.5	30.5	31.5	1%
Police Fleet	5.6	5.2	5.2	0%

Table 15: Emissions from Fleet – By Source

Emissions Source	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Gasoline	14.7	17.5	18.2	1%
Diesel	131.5	139.9	133.8	1%
Propane	0.3	0.3	0.3	0%

Solid Waste Sector

The solid waste sector includes emissions from the Trail Road Waste Facility (currently operational) and the Nepean landfill (closed), both under municipal operations control. In addition to landfill operations, three flares and six landfill gas fuelled generator sets are operated on site at the Trail Road Waste Facility. The City annually reports on emissions from the Trail Road Waste Facility in accordance with Ontario Regulation 390/18: Greenhouse Gas Emissions: Quantification, Reporting and Verification, which are made publicly available on the Provincial government's website. Emissions from privately owned landfills and facilities are accounted for within the community inventory. Emissions from solid waste collection vehicles are tracked under the corporate municipal fleet.

In 2019, the solid waste sector accounted for 11 per cent of total corporate emissions. Between 2012 and 2019, emissions from the Trail Road Waste Facility decreased by 83 per cent. The significant reduction in emissions can be attributed to the efficiencies made at the Trail Road Waste Facility, where a 90.9 per cent landfill gas collection efficiency rate was observed as a result of the landfill gas capture system in place. However, starting in 2021, it is expected that the City will observe an increase in emissions at the Trail Road Waste Facility given the increasing amount of waste in place and due to operations moving into an active waste cell (an uncapped portion of the landfill open to precipitation). Moisture is the largest driver in the waste decomposition process and therefore landfill gas generation, and an active cell will not realize the same landfill gas collection efficiency as the recently closed cells with final cover which have full infrastructure coverage and vacuum. Additionally, the Trail Road Waste Facility is required to recirculate leachate for

up to five years per cell in order to reduce the contaminating lifespan of the landfill per Trail Road Waste Facility's Environmental Assessment, which will also accelerate GHG generation.

Table 16: Emissions from Solid Waste – By Source

Emissions Source	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Solid Waste	144.8	32.6	25.2	-32%

Wastewater Treatment Sector

Emissions for wastewater treatment are estimated based on data collected from the Robert O. Pickard Environmental Centre, Ottawa's wastewater treatment facility.

The reported emissions account for N_2O only and do not include energy-derived emissions, which are accounted for as part of corporate facilities. The wastewater treatment sector was responsible a small percentage of corporate emissions in 2019, accounting for 6 per cent of the total. Although wastewater emissions increased by 29 per cent since 2012, this is due to normal year-to-year variation in the treatment process. It is expected that emissions will increase each year proportionate with population growth. In addition, the current treatment process results in the minimum emission rate. Enhanced treatment to remove ammonia will cause a net increase in the emission rate.

Table 17: Emissions from Wastewater Treatment – By Source

Emissions Source	GHG emissions (tonnes of CO_2e) ('000s)			Contribution to achieving GHG targets (%)
	2012	2018	2019	
Wastewater treatment	10.5	12.5	13.5	1%

6. Next Steps

Looking ahead, staff will:

- Review the GHG inventory methodology and assumptions for 2012 and 2016-2019 to ensure consistency and transparency and update where required;
- Complete the 2020 GHG inventory and, if required, revise the 2012 baseline and 2016-2020 GHG inventories based on the above review;
- Make the 2012 and 2016-2019 GHG inventory results available on the City's Open Data platform;
- Review the GHG inventory methodology and assumptions as part of the five-year update of the Climate Change Master Plan in 2025.

ANNEX A – GHG EMISSIONS PROGRAMS

Federation of Canadian Municipalities' Partners for Climate Protection Program

Since 1997, the City has been a member of the Federation of Canadian Municipalities' Partners for Climate Protection (PCP) program. It is a network of Canadian municipalities committed to reducing GHG emissions and acting on climate change with over 350 municipalities taking part.

The PCP program comprises five "milestones" used to guide municipalities to reduce their GHG emissions. The milestone included creating an emissions baseline, setting reduction targets, and developing an action plan. In 2012, the City completed all five milestones.

Global Covenant of Mayors for Climate and Energy

In April 2016, Mayor Jim Watson formally committed the City to join the Compact of Mayors, now called the Global Covenant of Mayors for Climate and Energy (GCoM). GCoM is described as "the world's largest coalition of mayors promoting and supporting voluntary action to combat climate change and move to a low-carbon economy". Cities participating in the initiative have up to three years to meet a series of requirements to fully comply, including setting a greenhouse gas reduction target, tracking progress in meeting said target, and preparing for the impacts of climate change. The City is undertaking to fulfill all these requirements.

In 2019, it was announced that the City of Ottawa was one of 25 successful municipal applicants to participate in the first cohort to participate in GCoM's Showcase Cities pilot project in Canada. The purpose of Showcase Cities is to provide intensive support to help municipalities reduce their GHG emissions and adapt to climate change over the course of one year. The program is to conclude by the end of 2020.

EnviroCentre's Carbon 613 Program

In June 2016, the City joined EnviroCentre's Carbon 613 program. Carbon 613 is described as a "made-in-Ottawa, target-based sustainability program for businesses". The City joined as both a program catalyser and a program member. As part of its membership, the City commits to setting a GHG reduction target, and to tracking and reporting out on the corporation's annual emissions. The City is also a part of the Carbon 613 Advisory Council.

ANNEX B – DATA SOURCES

Global Warming Potential (GWP) values

GHG emissions are not created equally and each has its own lifespan and heat-trapping potential. GWPs measure how much a GHG contributes to global warming relative to CO_2 and are used to convert tonnes of GHG to tonnes of carbon dioxide equivalent (CO_2e) to calculate total emissions using a common unit. The higher the GWP, the higher the warming capacity. Both the community and corporate GHG inventories calculated emissions using the GWPs from the IPCC's Fourth Assessment Report.

Table 18: IPCC's Fourth Assessment Report GWPs

GHG	Global Warming Potential
CO_2	1
CH_4	25
N_2O	298

Emission Factors

Emission factors are applied to convert activity data into GHG emissions. Of note, the emissions factors for the 2019 calendar year were unavailable at the time of completing the 2019 inventory. Typically, Environment Canada releases the National Inventory Report two years after a given calendar year (for example, the 2016 emission factors were released in 2018). The 2019 inventory will be revised when the 2019 emissions factors become available, where required.

Table 19: Ontario Emission Factors

Emission Source	CO_2	CH_4	N_2O	CO_2e	Data Source
Electricity	-	-	-	28.998 g/kWh	Environment Canada National Inventory Report 1990-2018, Part 3, Table A13-7 + Hydro Ottawa and Hydro One local renewable energy generation data
Natural Gas	1,888 g/m^3	0.037 g/m^3	0.035 g/m^3	-	Environment Canada National Inventory Report 1990-2018, Part 2, Table A6.1-1 and Table A6.1-2
Propane	1,515 g/L	0.027 g/L	0.108 g/L	-	Environment Canada National Inventory Report 1990-2018, Part 2, Table A6.1-3
Heating Oil	2,753 g/L	0.026 g/L	0.031 g/L	-	Environment Canada National Inventory Report 1990-2018, Part 2, Table A6.1-4
Gasoline	2,307 g/L	0.14 g/L	0.022 g/L	-	Environment Canada National Inventory Report 1990-2018, Part 2, Table A6.1-13
Diesel	2,681 g/L	0.11 g/L	0.151 g/L	-	Environment Canada National Inventory Report 1990-2018, Part 2, Table A6.1-13

Energy Conversion Factors

Energy conversion factors are specific coefficients used to convert different energy sources into a common unit, in this case gigajoules.

Table 20: Energy Conversion Factors[8]

Fuel Type	Conversion Factor
Electricity	0.0036 GJ/kWh
Natural Gas	0.039 GJ/m^3
Propane	0.025 GJ/L
Heating Oil	0.039 GJ/L
Gasoline	0.035 GJ/L
Diesel	0.039 GJ/L

Population and Employment Data Sources

Population and employment data are sourced from the City of Ottawa's Annual Development Reports.

Community Data Sources

The community inventory was calculated based on the best available data at the time of reporting. Data used to calculate community emissions included City departments, utilities, Statistics Canada, Natural Resources Canada, and Environment Canada.

Table 21: Community Inventory Data Sources

Emissions Source	Data	Data Quality
Electricity	Hydro Ottawa annual electricity consumption	High
	Hydro One annual electricity consumption	High
Natural Gas	Enbridge annual natural consumption	High
Propane / Heating Oil	Natural Resources Canada National Energy Database; Residential and Commercial; Table 1: Secondary Energy Use and GHG Emissions By Energy Source (Modelled Data)	Low
Gasoline	Kent Group Inc. annual fuel sales	High
Diesel	Kent Group Inc. annual fuel sales	Medium
	Statistics Canada's Supply and Demand of Primary and Secondary Energy Sources, Annual (Modelled Data)	Low
	Natural Resources Canada National Energy Database; Transportation Sector (Modelled Data)	Low
	City of Ottawa O-Train annual consumption data	High

[8] Statistics Canada. Report on Energy Supply and Demand in Canada, 2017 Preliminary. May 29, 2019. Page 131. https://www150.statcan.gc.ca/n1/en/pub/57-003-x/57-003-x2019002-eng.pdf?st=unFh7uHv

Emissions Source	Data	Data Quality
Aviation Fuel	Natural Resources Canada National Energy Database; Transportation Sector (Modelled Data)	Low
Solid Waste	Resource Productivity & Recovery Authority (RPRA) residential waste data (Modelled Data)	Medium
	City of Ottawa ICI sector data (Modelled Data)	Low
Wastewater	City of Ottawa Robert O. Pickard Environmental Centre annual data	High
Agriculture	Statistics Canada 2016 Census of Agriculture (Modelled Data)	Low

Corporate Data Sources

Six departments within the City of Ottawa are responsible for the data collected for inclusion in the corporate inventory. As the City has mostly direct control over its municipal operations, the quality of the data is considered high.

ANNEX C – METHODOLOGY

Emissions Scope

Under the GPC, emissions are separated into three categories to identify which emissions are generated from within the city boundary and outside the city boundary.

Table 22: Scopes definitions for city inventories[9]

Scope	Definition
Scope 1	GHG emissions from sources located within the city boundary
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam, and/or cooling within the city boundary.
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary.

The community and corporate GHG inventories calculate Scope 1 and Scope 2 emissions.

Community GHG Inventory Methodology

a) Buildings Sector

Emissions for the buildings sector are calculated by multiplying fuel and electricity consumption activity data by their corresponding emission factors and are broken down into the following sub-sectors:

- Residential buildings
- Commercial and institutional buildings and facilities (includes apartment buildings)
- Manufacturing industries and construction.

For all sub-sectors, emissions from natural gas are calculated using local Enbridge Gas consumption data and emissions from electricity usage are calculated using Hydro Ottawa and Hydro One usage data. Emissions from propane and heating oil are calculated using Statistics Canada energy data for Ontario prorated by population to estimate use within Ottawa.

Assumptions and Notes:

- The emission factor for electricity was calculated by accounting for the local renewable energy generation within the provincial generation intensity factor.
- Until 2018, apartment account classes for natural gas were included under the ICI building sub-sector. Starting in 2019, apartment account classes were captured under residential building sub-sector.

[9] Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories.

b) Transportation Sector

The transportation sector calculated emissions from the mobile combustion of gasoline and diesel and is broken down into the following sub-sectors:

- On-road transportation
- Railways
- Aviation
- Off-road transportation

For on-road transportation, emissions from gasoline consumption are calculated using annual retail fuel sales data provided by Kent Group Inc. Emissions from diesel consumptions are calculated using a combination of:

- Fuel sales data provided by Kent Group Inc; and
- Modelled data based on Statistics Canada data prorated to local levels using population data.

Assumptions and Notes:

- Gasoline and diesel fuel sales data was converted to simulate induced activity data to represent cross-boundary trips. An induced activity reduction percentage of 15.6 per cent was applied for gasoline and 0.7 per cent for diesel, both of which were sourced from the City's Energy Evolution's Business As Planned model.
- It is assumed that the data provided by Kent Group Inc underrepresents diesel fuel sales as it does not include fuel sales of private fleets.
- It was assumed that the ethanol content of gasoline was 5.5 per cent by volume based on Ontario Regulation 535/05: Ethanol in Gasoline.
- It was assumed that the renewable content of diesel was 4 per cent by volume based on Ontario Regulation 97/14: Greener Diesel – Renewable Fuel Content Requirements for Petroleum Diesel Fuel.
- CO_2 emissions from combustion of biofuels are not reported as they are considered of biogenic origin and therefore excluded from the inventory results.
- Electricity used to power electric vehicles is captured under the building sector.

Emissions from gasoline and diesel consumption for aviation, railways, and off-road transportation were calculated using National Resources Canada's National Energy Database energy use data for Ontario prorated to the local level using population data. Emissions from railway transportation also included diesel consumption from the O-Train.

Assumptions and Notes:

- The most recent version of the National Energy Databased was for 2017. It is assumed that later inventories will be updated when more recent data is available, where required.

c) Waste Sector

Emissions from the waste sector can be broken down into two sub-sectors:

- Solid Waste
- Wastewater treatment

Solid waste includes emissions from waste generated inside the city boundaries and are calculated using a first order of decay method. Both residential waste and ICI waste data were accounted for in the emission calculations.

In Ottawa, municipal wastewater is treated anaerobically, meaning that both CH_4 and N_2O are accounted for, and all wastewater (except for septic tanks) is treated at the Robert O. Pickard Environmental Centre centralized wastewater treatment plant. The methodology for accounting for emissions from the wastewater treatment plant can be found under the Corporate GHG Inventory Methodology. Community inventories also include emissions from septic tanks.

Assumptions and Notes:

- CO_2 emissions from the decomposition of biomass are not reported as they are considered of biogenic origin and are therefore excluded from the inventory results.
- It is assumed that the ICI sector waste is landfilled within the city boundary.
- It is assumed that septic tanks are in rural areas only.

d) Agriculture Sector

Agriculture is included in the community inventory only and includes emissions from agricultural land use and livestock operations. Emissions are calculated using provincial Statistics Canada data for crop production and livestock operations prorated to Ottawa based on population.

Assumptions and Notes:

- The most recent data available from Statistics Canada for agriculture processes was for 2016. Data will be updated when more current data is available.

Corporate GHG Inventory Methodology

a) Facilities Sector

This section of the corporate inventory seeks to quantify the emissions related to electricity, natural gas, propane and heating oil consumption of corporate facilities. Corporate facilities include all corporate buildings, streetlights, and traffic lights.

Electricity is used in corporate buildings for lighting, building controls, electronics, heating and other uses. Streetlights, traffic lights and road flashers also consume electricity. Natural gas, propane and heating oil is primarily used for space heating purposes in corporate buildings.

Assumptions and Notes:

- The emission factor for electricity was calculated by accounting for the local renewable energy generation within the provincial generation intensity factor.

b) Fleet Sector

The fleet sector calculated emissions by multiplying the City's gasoline, diesel and propane purchases by their corresponding emission factor. Emissions are tracked within the following sub-sectors:

- Municipal fleet, which includes service areas such as by-law, solid waste, paramedics, fire, roads, etc.
- Transit fleet, which includes OC Transpo, O-Train (diesel trains), and Para Transpo.
- Police fleet

Assumptions and Notes:

- It was assumed that the ethanol content of gasoline was 10 per cent by volume based on data provided by City departments.
- It was assumed that the renewable content of diesel was 4 per cent by volume based on Ontario Regulation 97/14: Greener Diesel – Renewable Fuel Content Requirements for Petroleum Diesel Fuel
- Electricity used to power electric vehicles and the light rail transit network trains is captured under the facilities sector.

c) Solid Waste Sector

Emissions from the Trail Road Waste Facility and Nepean landfill are calculated by using the reported annual values that are submitted to the Province in accordance with O. Reg. 390/18. The City retains Dillon Consulting and Comcor to meet the reporting requirements. The reported annual values are calculated using a methodology which uses a reported methane generation rate and estimates the emissions from fugitive uncollected landfill gas, and landfill gas combustion from the landfill flare and reciprocating engines on site.

Assumption and Notes

- CO_2 emissions from the decomposition of biomass are not reported as they are considered of biogenic origin and are therefore excluded from the inventory results.
- Emissions associated with the waste collection vehicles are captured under Fleet.

d) Wastewater Treatment Sector

The City controls the Robert O. Picard Environmental Centre centralized wastewater treatment plant. Any City related sewage not connected into the municipal wastewater

service is assumed to be treated in localized septic systems. Since the City does not have operational control over localized septic systems, septic systems are excluded from the corporate control. Wastewater emissions accounted for under this section can be allocated in three major categories:

- *Stationary CH_4 emissions*: include emissions from incomplete combustion of digester gas at a centralized wastewater treatment plant.
- *Process CH_4 emissions*: include emissions from anaerobic and facultative treatment lagoons and poorly operated aerobic wastewater plants. As the city does not use lagoons as part of their treatment methods, these emissions are not accounted for. The City facilities also meets regulatory systems and is not considered to be a poorly operated aerobic wastewater plant, therefore emissions resulting from poor operations are not accounted for.
- *Process N_2O emissions:* include emissions resulting from nitrification/denitrification in centralized wastewater treatment plant and effluent discharged into receiving aquatic environment.

Wastewater emissions were calculated using the methodology outlined in Chapter 10 of The Climate Registry's *Local Government Operations Protocol*.

Assumption and Notes

- CO_2 emissions from the decomposition of biomass are not reported as they are considered of biogenic origin and are therefore excluded from the inventory results.