City of Toronto

2020 Sector-Based Greenhouse Gas Emissions Inventory

TORONTO

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Glossary

Term	Definition
Activity data	Activity data refers to the data associated with an activity that leads to GHG emissions.
Baseline	The reference year against which annual emissions reductions/increases are measured over time.
Community-wide GHG emissions	Community-wide emissions include all GHG emissions within Toronto that can currently be estimated or measured by the City of Toronto.
Consumption-based emissions inventory	A consumption-based emissions inventory (CBEI) is a calculation of all GHGs associated with producing, transporting, using, and disposing of waste, products, and services consumed by a particular community or entity in a given time (typically one year).
Corporate-wide GHG emissions	Corporate-wide emissions account for emissions generated only by local government activities. Corporate emissions are included in community-wide emissions.
Carbon dioxide equivalent (CO_2e)	A unit that allows emissions of different greenhouse gases (such as carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]) to be expressed as a single unit of measurement.
Cooling Degree Days (CDD)	Cooling Degree Day (CDD) is a quantitative index used to estimate the energy demand needed to cool a home or business in a given time (typically one year).
Emission factor	An emission factor is a measure of the mass of GHG emissions relative to a unit of activity.
Greenhouse gases (GHGs)	Compound gases that trap heat and emit longwave radiation in the atmosphere causing the greenhouse effect.
Gigawatt hour (GWh)	A GWh is a unit of energy representing one billion watt hours and is equivalent to one million kilowatt hours. Gigawatt hours are often used as a measure of the output of large electric power stations.
Global Warming Potential (GWP)	GWP measures how much a particular GHG contributes to global warming relative to carbon dioxide (CO_2). It is used to convert tonnes of a GHG to tonnes of carbon dioxide equivalent (CO_2e) to express total emissions using a common unit.
Heating Degree Days (HDD)	Heating Degree Day (HDD) is a quantitative index used to estimate the energy demand needed to heat a home or business in a given time (typically one year).
Megatonnes (MT)	A megatonne, abbreviated as MT, is a metric unit equivalent to 1 million (10^6) tonnes.
Net zero	A balance between the amount of greenhouse gases released and the amount taken out of the atmosphere.
Sector-based emissions inventory	Sector-based emissions inventories measure GHGs attributable to emissions-generating activities taking place within the geographic boundary of the city, as well as some indirect emissions from waste produced in the city, and transmission of electricity into the city boundary in a given time (typically one year).

The values reported annually in Toronto's sector-based GHG inventory report may not match those in previously published inventories. Updates to various datasets occur throughout each year including after the publication of past inventories. The values reported here are the most up-to-date as of the publication of this 2020 sector-based GHG inventory.

Artist: Amir Akbari | Photo by: Ian Pereira

This report contains photos of local art created through the StreetARToronto ('StART') program. For 11 years, StART has helped instigate and provide space for individual and community expressions to come alive through street art, using the art itself as the catalyst to bring communities together, stimulate discussion and advance diversity, equity and inclusion. StreetARToronto is an initiative of the City of Toronto, Transportation Services Division.

Key Findings

In 2020, Toronto's community-wide greenhouse gas (GHG) emissions were 14 megatonnes (MT) of carbon dioxide equivalent (CO_2e), which is 43 per cent lower than in 1990. Community-wide emissions decreased by nearly 13 per cent compared to 2019 when Toronto emitted 16 MT CO_2e. Decreased transportation activities were the main contributor to the city's emissions reduction as many Toronto residents were required to either work or learn from home.

Global GHG emissions plunged by roughly 2.4 billion tonnes in 2020, a seven per cent drop from 2019 and the largest decline on record, triggered by worldwide COVID-19 restrictions[1]. In Toronto, this translated to an 13 per cent community-wide GHG emissions reduction from 2019 levels. The transportation sector saw the most dramatic decrease in emissions in Toronto, decreasing by about one fifth from 2019 to 2020. As COVID-19 economic recovery efforts gain momentum, GHG emissions are expected to approach pre-pandemic levels in subsequent years.

Toronto exceeded its 2020 target of a 30 per cent reduction in GHG emissions from a 1990 baseline. In 2020, Toronto's emissions were 43 per cent lower than in 1990 but since this is an anomaly year due to the COVID-19 pandemic, emissions are expected to approach pre-pandemic levels in subsequent years. Ambitious climate actions and programs are still required from the City to stay on track if its next interim target of 45 percent GHG emissions reduction by 2025, from 1990 levels, is to be achieved. Further, these efforts will need to be scaled up to reach 65 per cent reduction by 2030 and net zero by 2040.

Buildings sector emissions were the primary source of GHG emissions in Toronto, accounting for 58 per cent of community-wide emissions in 2020. This is an increase in share of two per cent over 2019. Natural gas, used mostly for space and water heating, continued to be the largest source of buildings sector emissions in Toronto, accounting for 54 per cent of community-wide emissions in 2020.

Transportation sector emissions were the second largest source of GHG emissions in Toronto, totaling 33 per cent of community-wide emissions (a small decrease from 35 per cent in 2019). These emissions were mostly attributable to gasoline used in passenger cars and trucks, accounting for 25 per cent of community-wide emissions in 2020.

Waste sector emissions, primarily from landfills, comprised roughly nine per cent of community-wide emissions in 2020.

The City of Toronto's corporate emissions, or local government emissions, decreased by roughly 15 per cent compared to 2019 and continued to account for about five per cent of community-wide emissions.

[1] https://www.cnbc.com/2020/12/11/covid-record-drop-global-carbon-emissions-2020.html

1 Background

The City of Toronto's (the City) 2020 sector-based greenhouse gas (GHG) emissions inventory presents the quantity and sources of Toronto's emissions over the year. It provides opportunities for the City to track its progress towards meeting its GHG emissions reduction targets. It also helps to inform City-led climate programs and initiatives, as well as provides benchmarks against which the success of these activities can be measured.

The City relies on Environment Canada's National Inventory Report (NIR)[2] as a primary source of its emission factors which is necessary in calculating GHG emissions (please refer to Appendix B: Methodology for more information). Typically, Environment Canada releases the NIR two years after a given calendar year (i.e. the 2020 emission factors were released in 2022). The City updates its previously reported annual emissions estimates when compiling its latest inventory using revised emission factors, including those from previous inventory years.

The City, just like other municipal governments, does not have full control over all GHG emissions generated within Toronto's territorial boundary; it can influence community-wide emissions through the prioritization of strategies that are actionable at a municipal level. Some examples include:

- The City issuing building permits and development approvals for projects that meet sustainable building design, as required by the Toronto Green Standard[3].
- The City's local transit agency, the Toronto Transit Commission (TTC), acquiring a zero-emissions bus fleet that will continue to deliver safe and reliable transportation service for Toronto residents[4].

Primarily, the City uses this sector-based GHG inventory as a tool to be transparent with its progress in reducing GHG emissions and also to provide opportunities to understand the impacts of individual and collective actions from citizens, businesses, visitors, and other levels of government as we work together in addressing the climate crisis and meeting Toronto's future GHG reduction targets, as outlined in the TransformTO Net Zero Strategy (NZS)[5].

On December 15, 2021, Toronto City Council adopted the NZS to reduce community-wide GHG emissions in Toronto to net zero by 2040 – 10 years earlier than initially proposed. This Strategy establishes new and accelerated actions to drive down community-wide emissions, and sets the trajectory needed to reach net zero by 2040.

As shown in Figure 1, though community-wide emissions have decreased since 1990 and the City exceeded its 2020 emissions reduction target, emissions have not decreased significantly in recent years. Though emissions were lower in 2020 than in 2019, in large part due to the COVID-19 pandemic, emissions are expected to approach pre-pandemic levels in subsequent years. In 2020, Toronto's community-wide emissions were 43 per cent lower than in 1990 but since this is an anomaly year due to the COVID-19 pandemic, ambitious climate actions and programs are still required from the City to stay on track of its 2025 target of a 45 per cent emissions reduction from 1990 levels. Further, as detailed in Table 1 below, Toronto still needs to cut its emissions by roughly 5.3 MT to meet the City's 2030 target of a 65 per cent emissions reduction below 1990 levels.

2 https://publications.gc.ca/site/eng/9.506002/publication.html
3 https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/
4 https://www.ttc.ca/riding-the-ttc/TTC-Green-Initiatives/
5 https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/

Table 1: Council-adopted GHG emissions targets and 2020 status

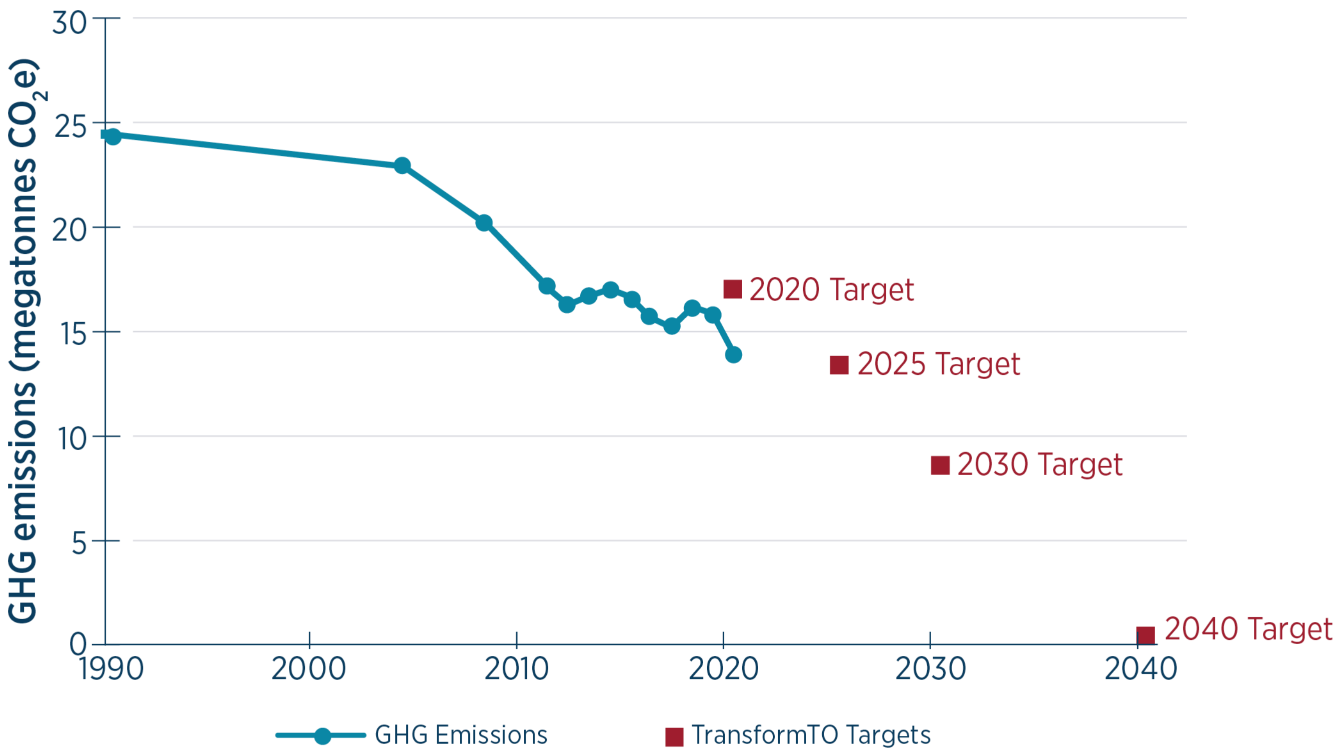
Year	GHG reduction target from 1990 baseline	GHG emissions target (MT CO_2e)[a]	Progress as of 2020
2020	30 per cent	17.3 MT	The City exceeded its 2020 GHG reduction target. In 2020[b], Toronto's community-wide emissions were 14 MT, which is 43 per cent lower than in 1990.
2025	45 per cent	13.6 MT	To be determined.
2030	65 per cent	8.6 MT	Toronto must reduce annual emissions by about 5.3 MT within 10 years to meet the 2030 target. Toronto must rapidly increase its current annual emissions reduction rate.
2040	Net zero	Net zero	14 MT must be eliminated to meet the 2040 target.

Notes:

[a] Emissions target calculated relative to a 1990 baseline emissions of 24.7 MT.

[b] Although 2020 is an anomaly year due to the COVID-19 pandemic, it must be noted that the City's 2019 community-wide GHG emissions were 35 per cent lower from 1990 levels.

Figure 1: Toronto's GHG emissions and Council-approved GHG emissions targets[6]



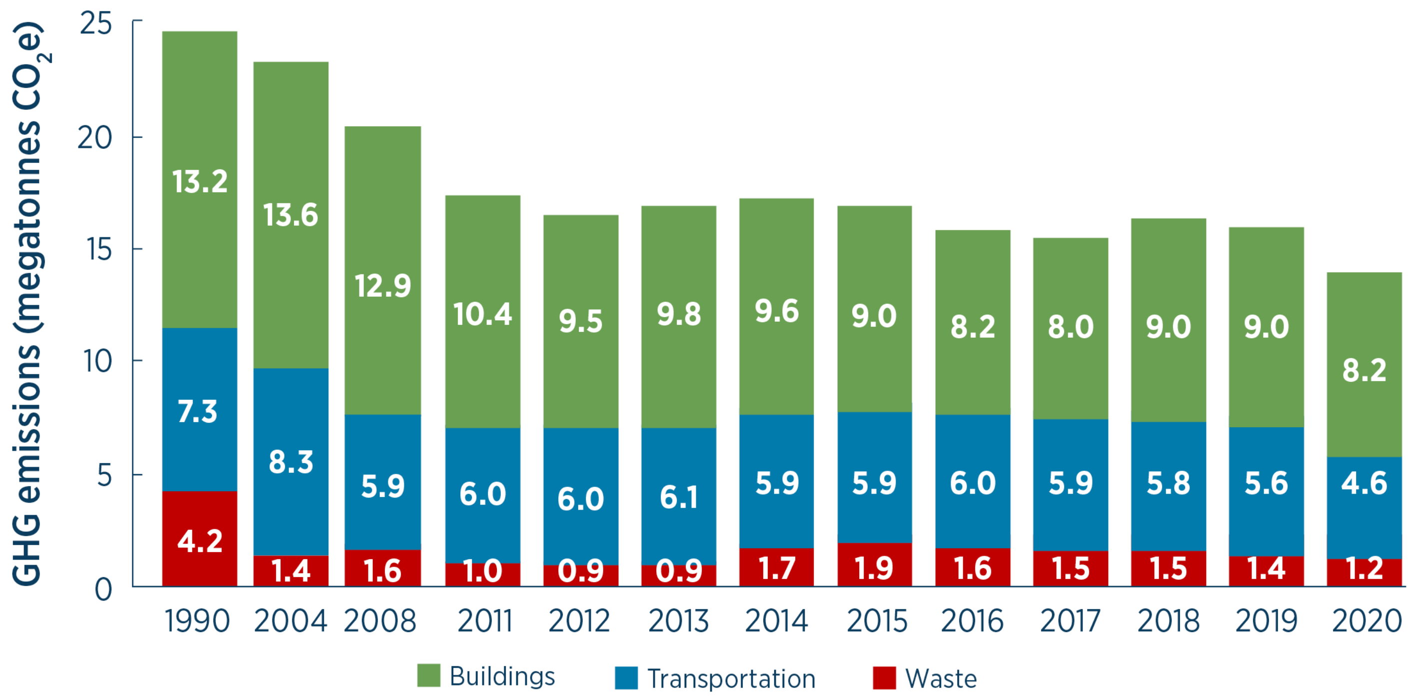
[6] 2020 is an anomaly year. As COVID-19 economic recovery efforts gain momentum, GHG emissions are expected to approach pre-pandemic levels in subsequent years.

Figure 2 shows the year-over-year changes in sectoral emissions from 1990 to 2020, while Figure 3 presents the breakdown of emissions by sector for 2020. In 2020, building sector emissions accounted for 58 per cent of overall community-wide emissions, with most of those emissions attributable to natural gas used for space and water heating. Transportation emissions accounted for 33 per cent of overall community-wide emissions, with most of those emissions coming from gasoline used in passenger cars and trucks. Waste sector emissions, which include emissions from landfills, organics and yard waste, and wastewater treatment processes, were nine per cent of overall community-wide emissions. More details on GHG emissions by sector are provided in Section 3.3.

The COVID-19 pandemic played a significant role in reducing GHG emissions in 2020. Global GHG emissions plunged by roughly 2.4 billion tonnes in 2020, a seven per cent drop from 2019 and the largest decline on record, triggered by worldwide COVID-19 restrictions[7]. In Toronto, this translated to an 13 per cent community-wide GHG emissions reduction from 2019 levels and transportation sector emissions saw the most dramatic decrease. In particular, transportation emissions were reduced by 19 per cent in 2020 due to COVID-19 travel restrictions and associated closures of businesses and educational institutions, among others. In comparison, Toronto's transportation emissions were roughly three per cent lower from 2018 levels.

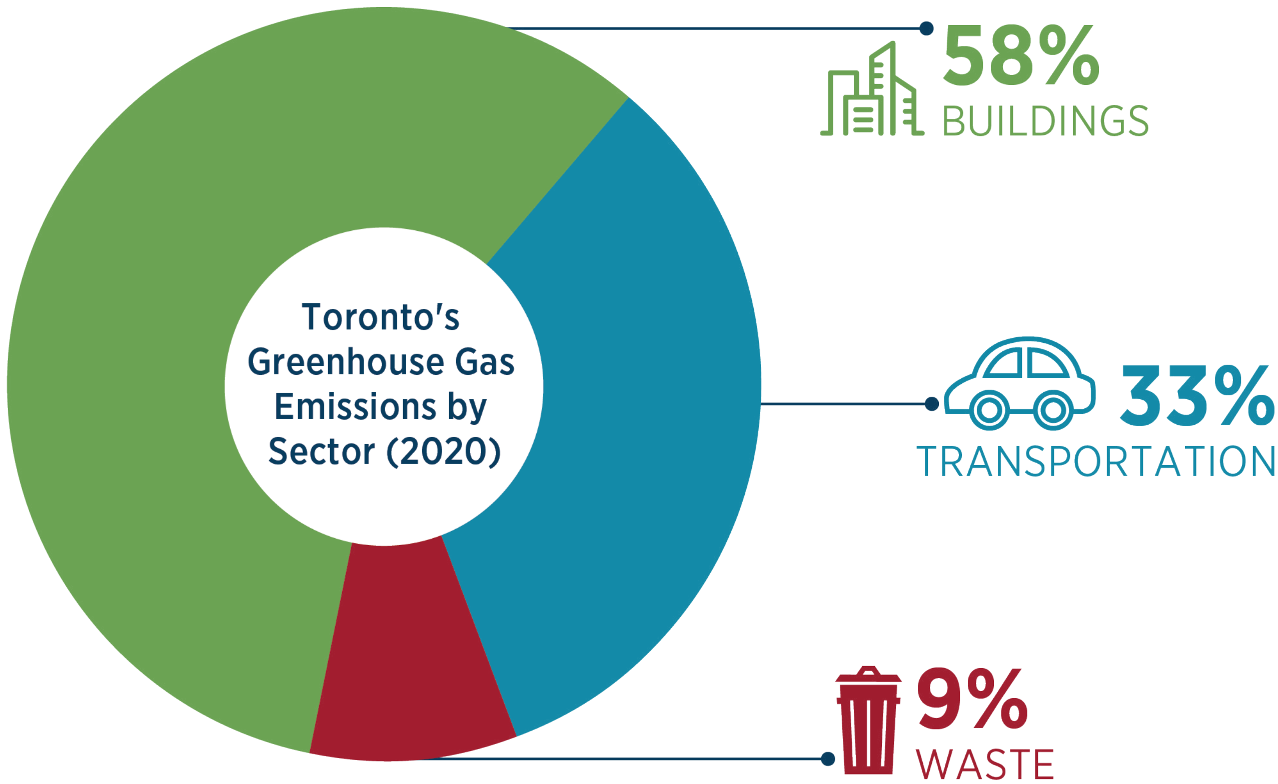
As COVID-19 economic recovery efforts gain momentum, it is expected that the GHG emissions in Toronto will increase from 2020 levels, beginning in 2021. The City will continue to track progress on GHG emissions reductions through annual sector-based inventories and continue to develop policies to drive down emissions going forward.

Figure 2: Toronto's year-over-year community-wide GHG emissions by sector



7 https://www.cnbc.com/2020/12/11/covid-record-drop-global-carbon-emissions-2020.html

Figure 3: Toronto's percentage breakdown of community-wide GHG emissions by sector (2020)



Artist: Spudbomb with Kreecha | Photo by: Ian Pereira

2 Sector-based versus consumption-based emissions inventories

Sector-based and consumption-based GHG emissions inventories are complementary tools the City will soon be using to present a robust analysis of GHG emissions sources generated in Toronto. This report presents the results of Toronto's sector-based GHG emissions inventory, which is commonly reported by cities. Toronto will release its first consumption-based inventory in 2023. It will track GHG emissions associated with producing, transporting, using, and disposing of waste, products, and services consumed in Toronto in a given time (typically one year).

The following section describes the differences between the two inventory approaches to help readers understand the scope of this report versus the forthcoming consumption-based GHG inventory report.

In 2018, the C40 Cities Climate Leadership Group[8] published a report[9] on the consumption-based emissions of 79 cities around the world. As shown in Table 2, both sector-based GHG inventories and consumption-based GHG inventories include GHG emissions that result from waste, household use of fuels and electricity, as well as goods and services produced and consumed in a city. The sector-based GHG inventory also includes GHG emissions resulting from goods and services produced in the city but consumed elsewhere or by those who are not residents of Toronto. Conversely, consumption-based GHG inventories exclude GHG emissions from goods and services produced in Toronto that are exported from the city for consumption elsewhere, or consumed in Toronto by those who are not residents. However, unlike the sector-based inventory, the consumption-based inventory includes GHG emissions from goods and services produced elsewhere but consumed by city residents (i.e. the lifecycle emissions of these goods and services – those associated with the raw materials, manufacture, distribution, retail, and disposal of goods and services).

Through the TransformTO NZS short-term implementation plan[10], Toronto City Council directed City staff to report on consumption-based GHG emissions and identify short- and long-term consumption-based GHG reduction targets across different consumption categories. The City expects to release its first consumption-based GHG emissions inventory report by the second quarter of 2023.

[8] C40 Cities is a group of 97 cities around the world that represents one twelfth of the world's population and one quarter of the global economy. It is a global network of mayors taking urgent action to confront the climate crisis and create a future where everyone can thrive. For more information, see https://www.c40.org/.

[9] https://resourcecentre.c40.org/resources/consumption-based-ghg-emissions

[10] https://www.toronto.ca/legdocs/mmis/2021/ie/bgrd/backgroundfile-173757.pdf

Table 2: Sector-based versus consumption-based GHG emissions inventory

	Sector-based	Consumption-based
What's included:	• Emissions that occur **inside** the city of Toronto boundary, including emissions generated by residents and non-residents in Toronto.* • Waste-related emissions occurring **outside** Toronto as a result of waste generated within Toronto. • Emissions from electricity transmission into Toronto from **outside** Toronto. *Examples include emissions from gasoline used by any vehicle that travels within Toronto's boundary, and emissions from natural gas used to heat any building in Toronto.	• Emissions that occur **inside** and **outside** the city of Toronto boundary resulting from the consumption of goods and services by Toronto residents.** • Waste-related emissions occurring **outside** Toronto as a result of waste generated within Toronto. • Emissions from electricity transmission into Toronto from **outside** Toronto. ** Examples of emissions that occur **inside** Toronto are emissions from gasoline used in Torontonians' vehicles **inside** the city, and from energy used in Toronto households. Examples of emissions that occur **outside** Toronto include emissions from Toronto residents' consumption of food, products, and services that are grown or manufactured **outside** of Toronto, and the emissions associated with Toronto residents' travel **outside** of Toronto.
What's excluded:	• Emissions that occur **outside** the city of Toronto boundary (except as noted above). For example, emissions that occur **outside** Toronto associated with growing food that is consumed by Toronto residents.	• Emissions that occur **inside** the city of Toronto boundary resulting from the consumption of goods and services by non-Toronto residents. • Emissions that occur **inside** the city of Toronto's boundary resulting from the consumption of goods & services **outside** of the city boundary. i.e., emissions from product manufacturing **inside** Toronto where the products are shipped for consumption **outside** Toronto.

3 City of Toronto community emissions

The City's sector-based GHG inventory includes community-wide emissions that can currently be estimated or measured by the City, including corporate emissions from local government operations. See City of Toronto corporate (local government) emissions in Section 4 for further details on corporate emissions estimates.

Section 3 of this document provides details of Toronto's community-wide sector-based GHG emissions for the 2020 calendar year.

3.1 Key drivers of GHG emissions

Figure 4: Key drivers of community-wide GHG emissions (2020) expressed in MT and per cent of total emissions

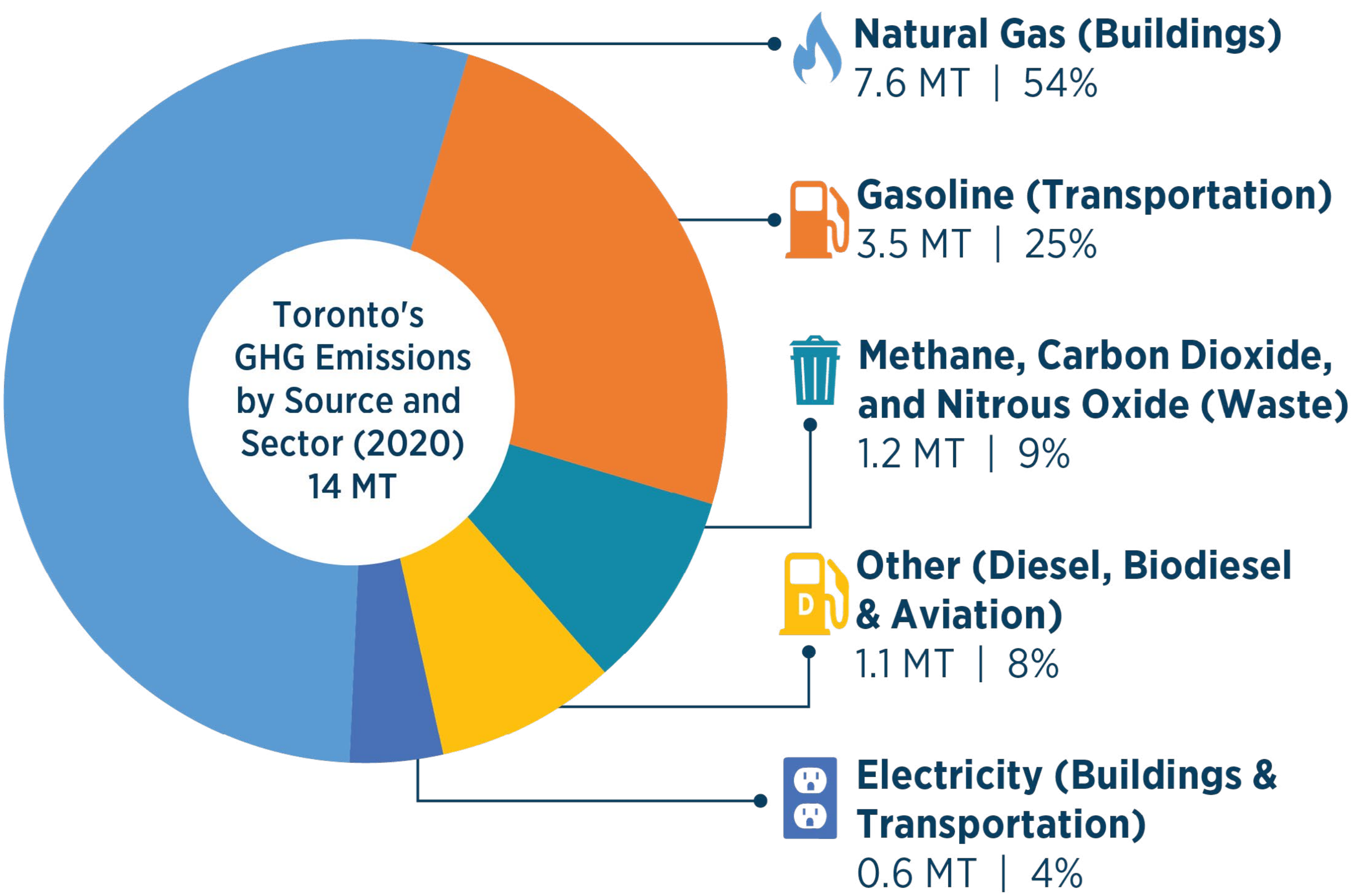


Figure 4 provides a snapshot of key drivers of GHG emissions in Toronto, including:

1. **Natural gas.** Natural gas consumption to heat buildings continued to be the largest source of community-wide GHG emissions in 2020 at approximately 7.6 MT, accounting for about 54 per cent of all emissions. Most of this natural gas is used for space and water heating. Compared to 2019, emissions from natural gas decreased by about nine per cent due to warmer winter and autumn weather that reduced the demand for space heating. For more information on how weather affects fluctuations in natural gas consumption, refer to Appendix C: Heating and cooling degree days.

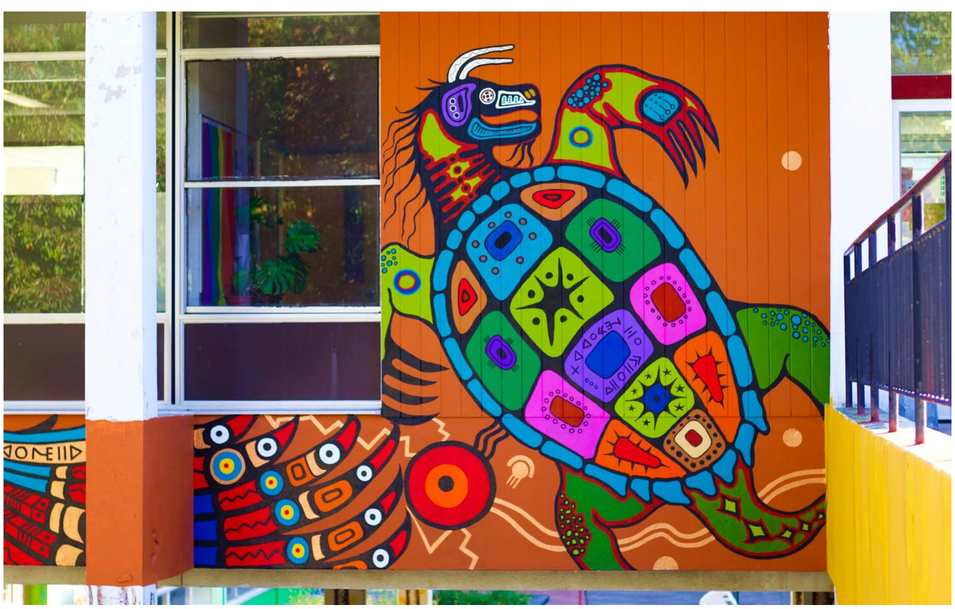
2. **Gasoline.** Gasoline used for passenger cars and trucks accounted for almost 25 per cent of community-wide GHG emissions in Toronto. It is the second largest emissions source at approximately 3.5 MT.

3. **Methane, carbon dioxide, and nitrous oxide from waste.** Emissions from methane, carbon dioxide, and nitrous oxide were 1.2 MT in 2020 making up about nine per cent of total emissions. Most methane emissions not associated with natural gas consumption originate from City-managed landfills, both closed and operating, where methane gas is released directly to the atmosphere as fugitive emissions. Operating and largest closed landfills have continuous active gas collection and flaring of methane which significantly reduces methane released to the atmosphere and therefore emissions. Wastewater treatment and organics and yard waste processing are other sources of methane emissions, which accounted for only 0.03 MT of the 1.2 MT total. Emissions from all of these sources decreased by about 11 per cent in 2020.

4. **Electricity.** Emissions from electricity were measured at approximately 0.57 MT, a decrease of eight per cent compared with 2019. Although there was an overall decrease in Toronto's 2020 electricity emissions and an overall decrease in electricity consumption, it should be noted that residential electricity consumption increased by roughly six per cent due to a major shift towards work- and learn-from-home setups resulting from COVID-19 (see Section 3.3.1 and Table 4 for more information).

5. **Others.** Other sources of emissions in Toronto do not have a significant impact as compared to the first four sources named here. These other sources include diesel, biodiesel, and aviation fuels.

Further details on key drivers of GHG emissions in Toronto are provided in Section 3.3.



Artist: Philip Cote with Red Urban Nation Collective | Photo by: Trey Robinson

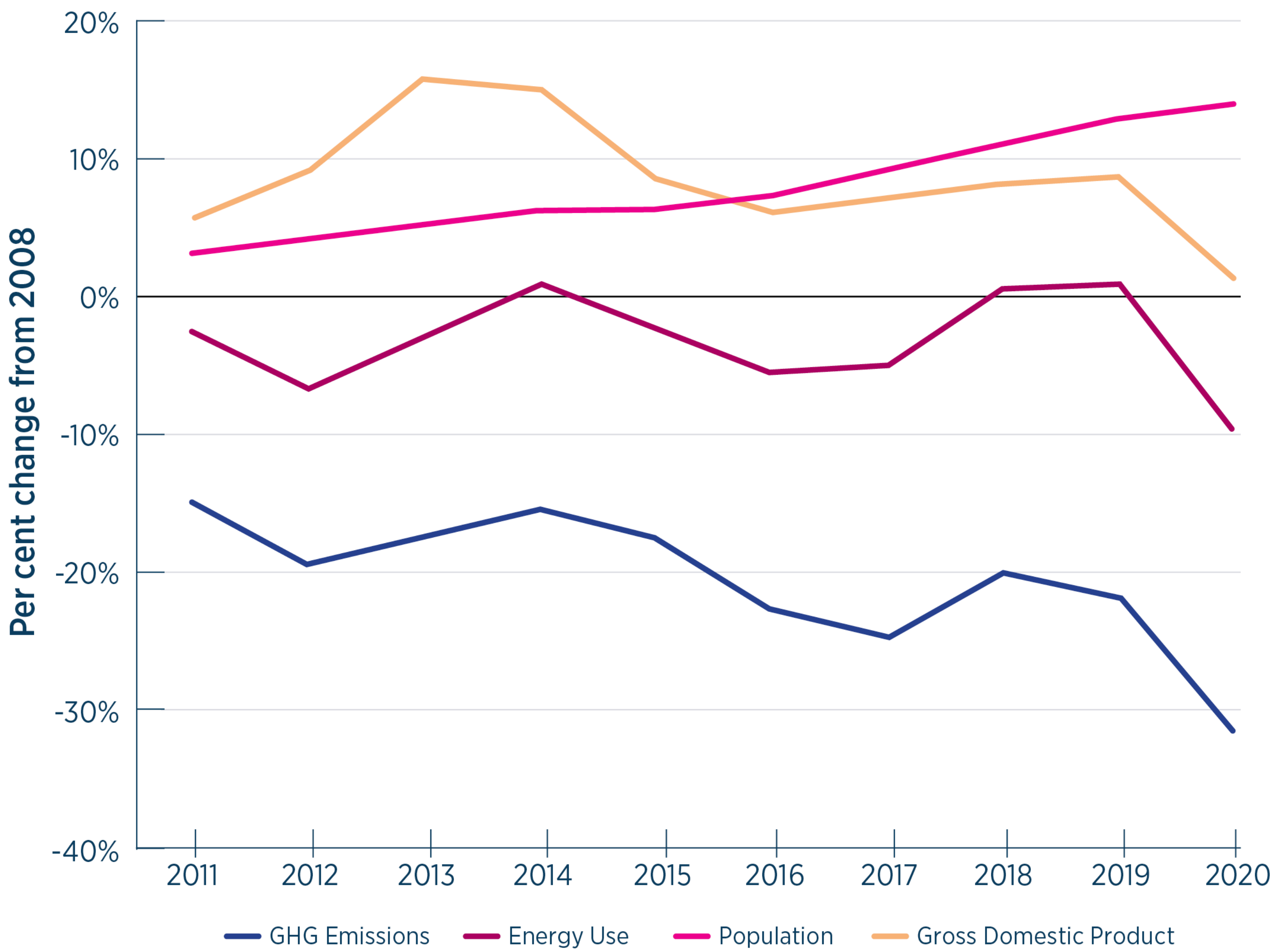
3.2 Population, economic growth, and GHG emissions

Understanding the relationship between factors such as population, economic growth, and GHG emissions is important as they are indicative of a city's well-being and resilience.

Figure 5 shows that GHG emissions in Toronto have de-coupled from economic prosperity (as measured by gross domestic product (GDP)), population, and energy use. Before the COVID-19 pandemic in 2020, community-wide emissions were generally decreasing even as population and GDP rose, indicating that Toronto was on the path to a low-carbon future. However, public health measures that imposed restrictions on the movement of people and business operations during 2020 impacted Toronto's GDP, particularly stemming from impacts to businesses that involve physical interactions with customers (such as the food industry, retail trade, tourism, and transportation services, among others).

Similarly, before the COVID-19 pandemic, energy use was fairly stable since 2011 despite an increase in population and GDP. In 2020, the observed reduction in energy use can be correlated with the decline in GDP as many existing businesses were closed for extended periods.

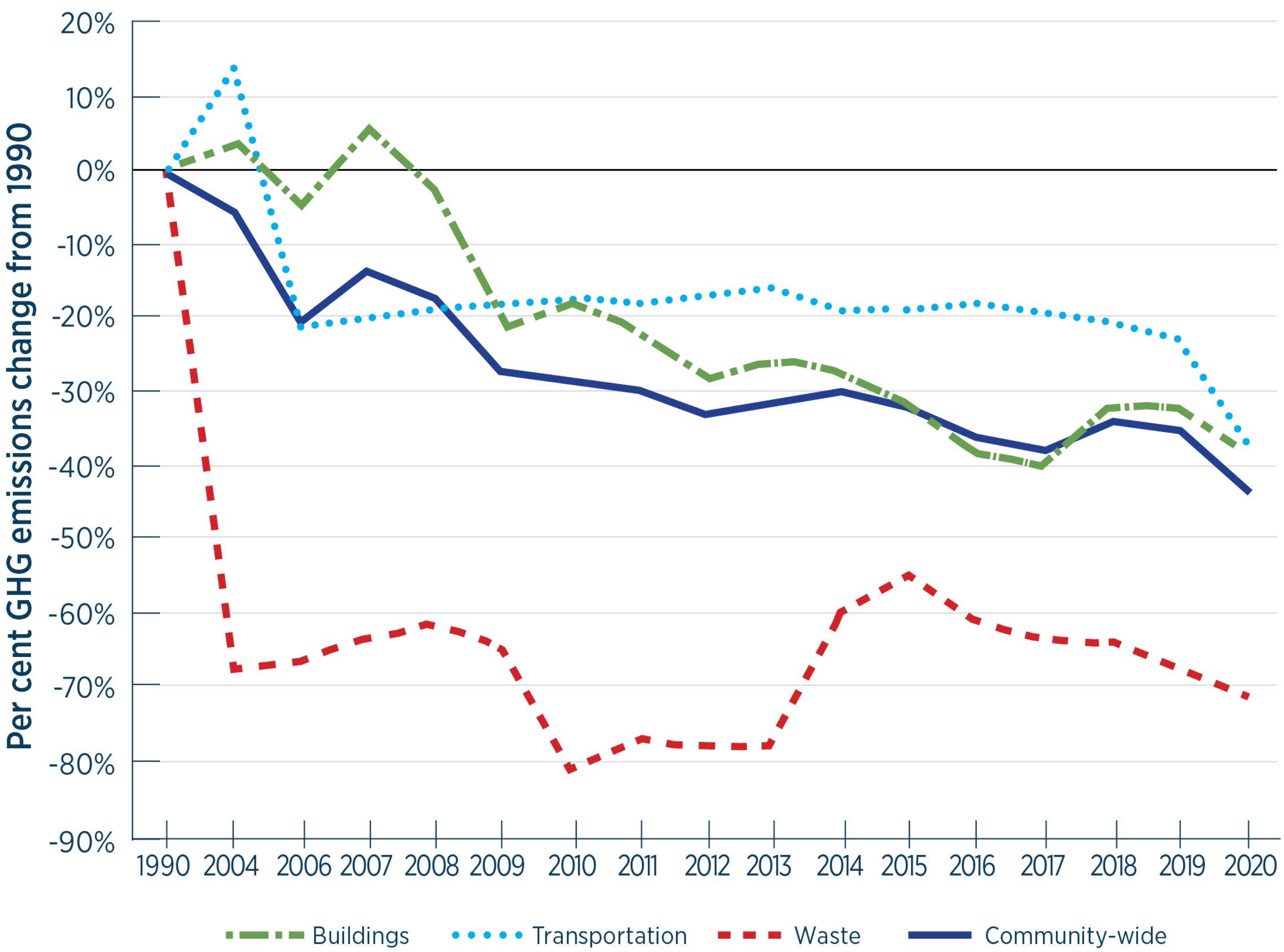
Figure 5: Energy, GHG emissions, and economic indicators (per cent change from 2008 baseline)



3.3 Details on GHG emissions by sector

As shown in Figure 6, Toronto achieved an overall decline in emissions in 2020 relative to 1990 baseline GHG emissions. However, Figure 6 also demonstrates that Toronto's emissions – examined by individual sectors or community-wide – are not declining consistently year over year.

Figure 6: Annual per cent change in emissions by sector relative to 1990 baseline

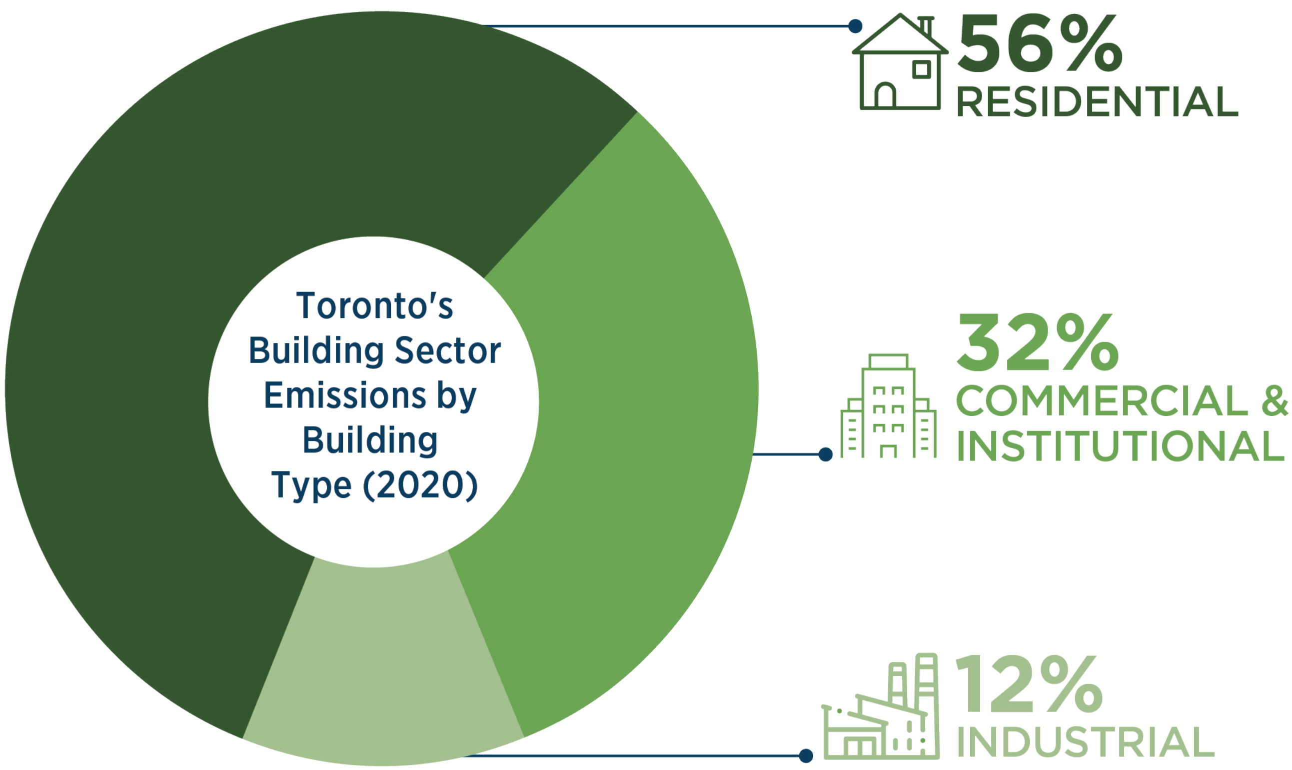


3.3.1 Buildings

In 2020, emissions from residential, commercial, and industrial buildings accounted for approximately 8.2 MT of the city's total inventory, making buildings the largest source of emissions at roughly 58 per cent of community-wide emissions. Compared to 2019, overall building emissions decreased by about nine per cent.

Figure 7 breaks down the emissions contribution of each building type – residential, commercial/institutional, and industrial[11]. Figure 8, on the other hand, shows the proportion of emissions coming from the two main energy forms – electricity and natural gas – by building type. Natural gas is primarily used for heating during the winter months. In 2020, the contribution of emissions from natural gas in buildings was approximately 13 times greater than emissions contributed from electricity. Further, the proportion of natural gas emissions from single-family homes was higher than from multi-unit residential buildings (MURB), at 56 per cent (single-family) compared to 44 per cent (MURB)[12].

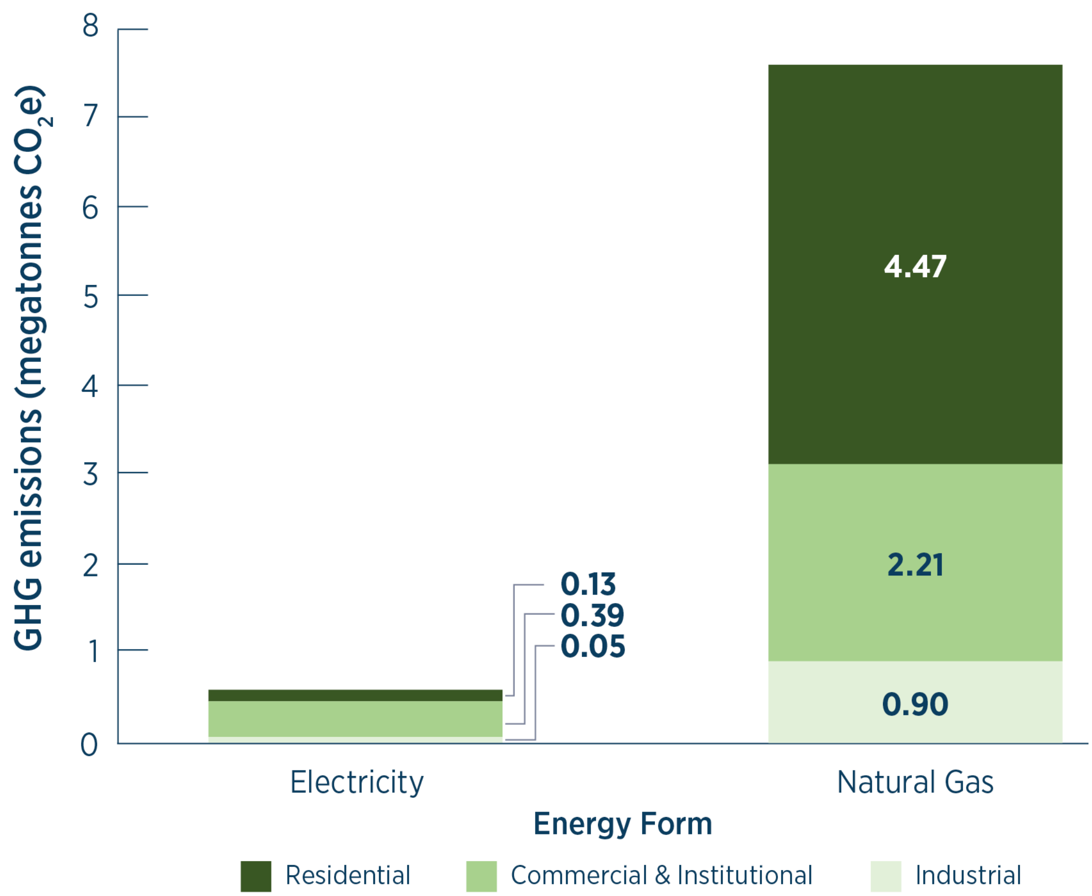
Figure 7: Percentage of buildings sector GHG emissions by building type (2020)



[11] Industrial emissions include emissions from heating and cooling industrial buildings, as well as process emissions.

[12] According to Municipal Property Assessment Corporation (MPAC) data obtained for the years 2016 and 2020, single-family floor space increased by two per cent while multi-unit residential floor space increased by roughly eight per cent over the four-year period. As well, within the MURB sub-category, floor space for rental apartments increased by about three per cent from 2016 to 2020 whereas residential condominium space increased by almost 13 per cent.

Figure 8: Buildings GHG emissions by energy form (2020)



Relative to 2019, natural gas emissions from residential buildings decreased by about eight per cent, and by roughly 12 per cent and eight per cent for commercial & institutional and industrial buildings, respectively (Table 3). The decrease in natural gas consumption was due to warmer winter and autumn weather that reduced the demand for space heating. For more information on how weather affects fluctuations in natural gas consumption, please refer to Appendix C: Heating and cooling degree days. It must be noted that, aside from weather conditions, a decrease in natural gas consumption may have partly been driven by improved building efficiency, though more data would be needed to confirm whether measures to enhance building performance affected total natural gas use in 2020.

Table 3: Per cent change in natural gas consumption between 2019 and 2020

Building type	2019 natural gas use (millions m^3)	2020 natural gas use (millions m^3)	Per cent change
Residential	2,494	2,288	-8
Commercial & Institutional	1,277	1,129	-12
Industrial	500	462	-8

The COVID-19 pandemic also impacted building sector emissions, especially for electricity consumption. As shown in Table 4, residential electricity usage in 2020 increased by roughly six per cent, since many businesses and workplaces (i.e. commercial & institutional, and industrial buildings) were closed and most people worked and learned from home.

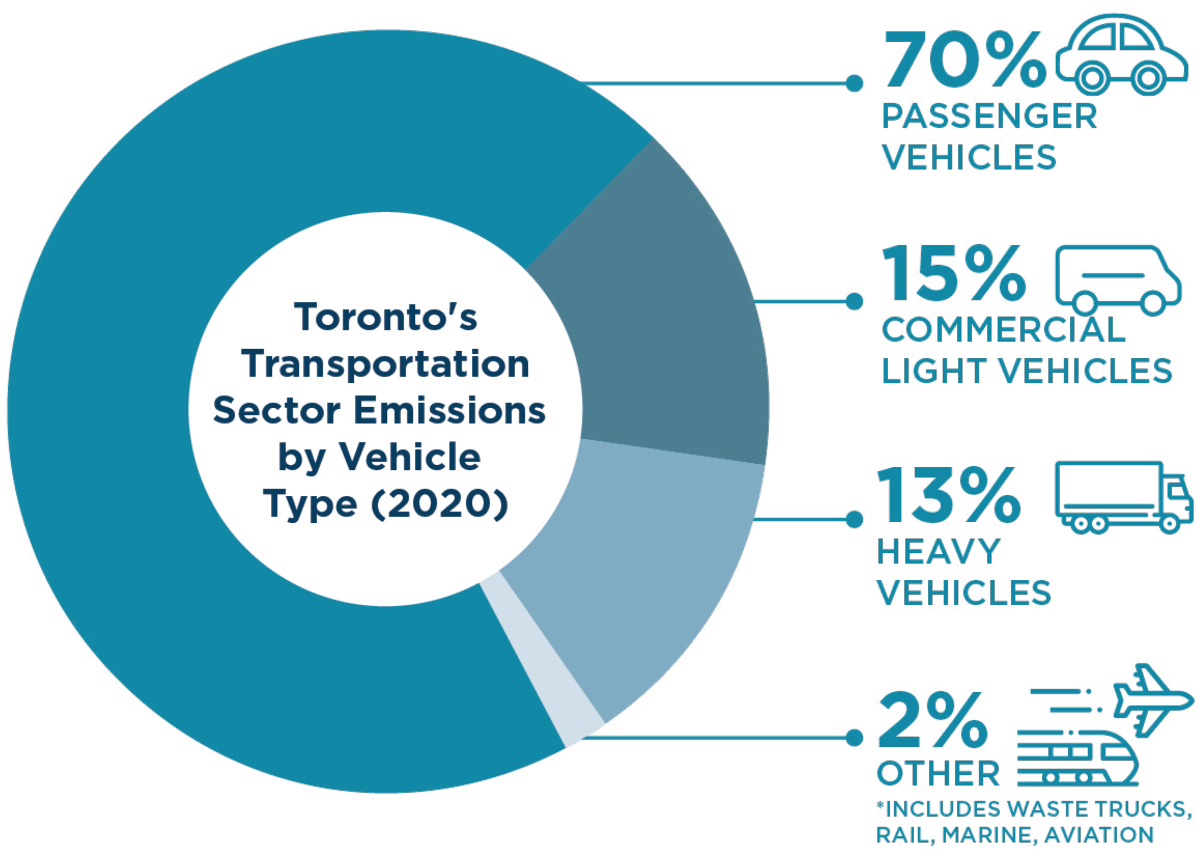
Table 4: Per cent change in electricity consumption between 2019 and 2020

Building type	2019 electricity use (GWh)	2020 electricity use (GWh)	Per cent change
Residential	4,920	5,199	+ 6
Commercial & Institutional	17,496	16,318	- 7
Industrial	2,247	2,098	- 7

3.3.2 Transportation

Transportation emissions in 2020 were approximately 4.6 MT, accounting for 33 per cent of the community-wide inventory. As shown in Figure 9, on-road vehicle emissions from passenger vehicles, commercial light vehicles, and heavy vehicles dominated the emissions profile, accounting for approximately 98 per cent of all transportation emissions. The largest portion of on-road emissions, approximately 70 per cent of all transportation emissions, was attributed to passenger vehicles. As compared to 2019, transportation emissions from passenger vehicles decreased by 22 per cent while heavy trucks increased by roughly 29 per cent.

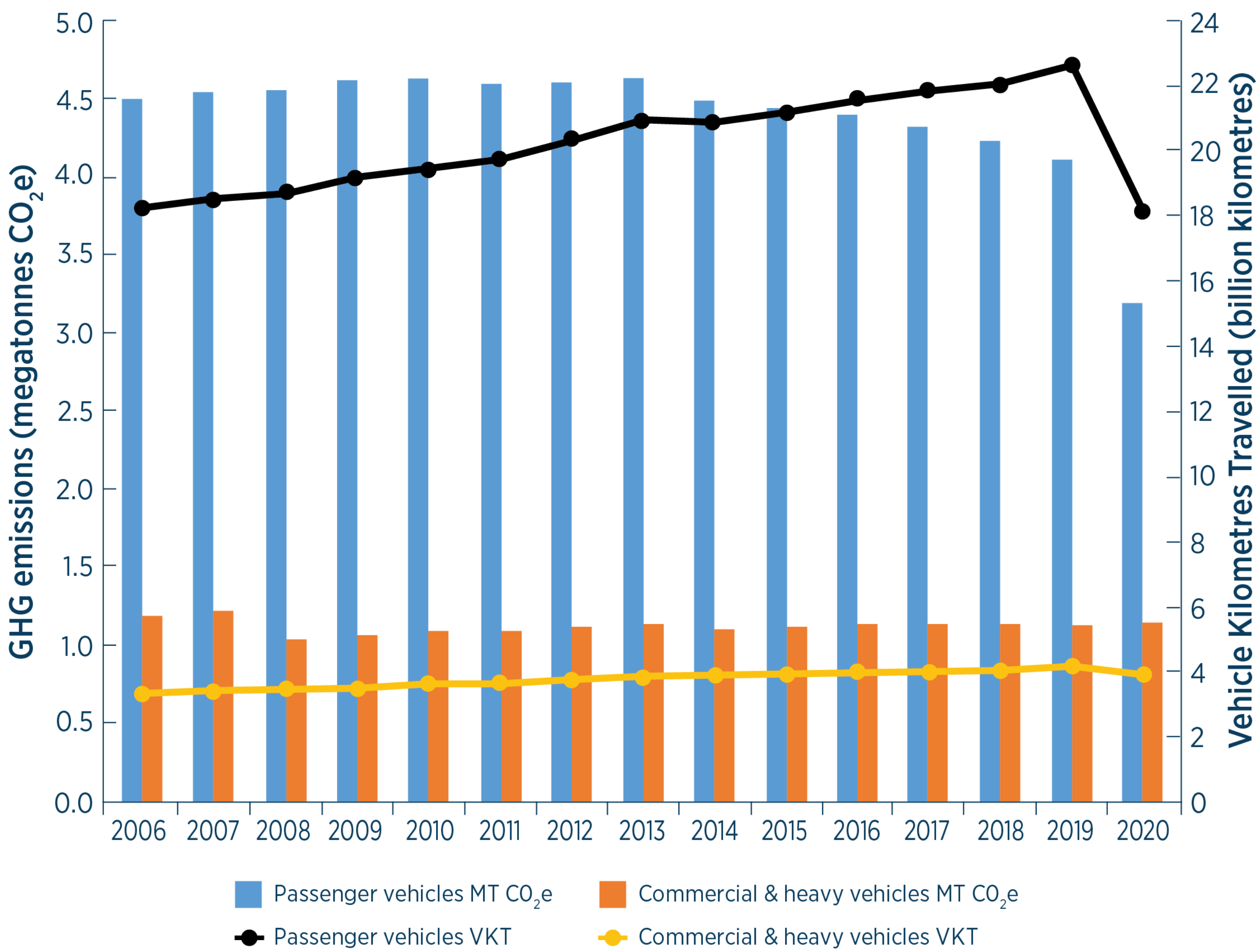
Figure 9: Percentage of transportation sector GHG emissions by vehicle type (2020)



In Figure 9, the Other Vehicles category includes Toronto Transit Commission (TTC) rail emissions from electricity used to power streetcars and subways. In total, these emissions accounted for only 0.2 per cent of all transportation emissions, making TTC subways and streetcars an almost "emissions-free" public transit mode. Also in this category are the GO and UP commuter rail, which mainly captured diesel emissions within the city boundary, and together make up 0.85 per cent of total transportation emissions. Marine emissions reporting in the inventory was limited and captured only the fuel used by the City's marine fleet (e.g. Toronto Island Ferry, Toronto Police, Emergency Medical Services (EMS), and Fire vessels), totalling 0.02 per cent of all transportation emissions. Similarly, emissions from aviation included only aviation fuel used at Billy Bishop Toronto City Airport on Toronto Island, which accounted for 0.01 per cent of total transportation emissions.

The GHG emissions associated with Toronto residents' extensive air travel to and from Toronto Pearson International Airport were not captured in this inventory due to constraints in acquiring data. Another gap resulting from data availability limitations was emissions from marine vessels associated with cargo transport and personal use. These emissions were not accounted for in this inventory.

Figure 10: Annual GHG emissions from on-road transportation and associated Vehicle Kilometres Travelled (VKT)



The City employs a transportation emissions model, created by the University of Toronto, to simulate traffic in the city and estimate its associated emissions. As presented in Figure 10, the model shows that Vehicle Kilometres Travelled (VKT) for passenger vehicles[13] increased from 2006 until 2019, and then a significant VKT decrease occurred in 2020 due to COVID-19 travel restrictions. Before the COVID-19 pandemic in 2020, passenger vehicle emissions were decreasing, especially from 2013 to 2019, despite the increasing VKT in the same time period. The reduction during that period primarily reflects improvements in vehicle fuel efficiency and a gradual uptake of electric vehicles in Toronto. However, the significant decrease in 2020 in terms of both VKT and transportation emissions was heavily influenced by travel restrictions and public health measures imposed due to the COVID-19 pandemic.

Similarly, the VKT and associated emissions from commercial and heavy vehicles[14] were stable from 2006 to 2019, but the COVID-19 pandemic travel restrictions resulted to an emissions increase for heavy trucks (roughly 29 per cent between 2019 and 2020), which is part of the commercial and heavy vehicles category in Figure 10..

As a fuel, gasoline accounted for about 25 per cent of total community-wide emissions.

3.3.3 Waste

Waste emissions in 2020 were approximately 1.2 MT, accounting for about nine per cent of the community-wide inventory – far less than the contributions of the buildings and transportation sectors. This is a reduction of about 0.15 MT since 2019. Community-wide waste emissions in 2020 were 71 per cent lower than in 1990. Roughly 0.9 MT of emissions from the waste sector were landfill emissions, which include emissions estimated from waste disposal in private landfills, with the remaining small portion, about 0.03 MT, originated from organics, yard waste, and wastewater treatment processes.

Waste emissions from landfills accounted for methane, nitrous oxide, and carbon dioxide emissions, and captured GHGs originating from all landfills, open and closed, within and outside the city's boundary. Please refer to Appendix B: Methodology for more information on how the City is calculating emissions from waste.

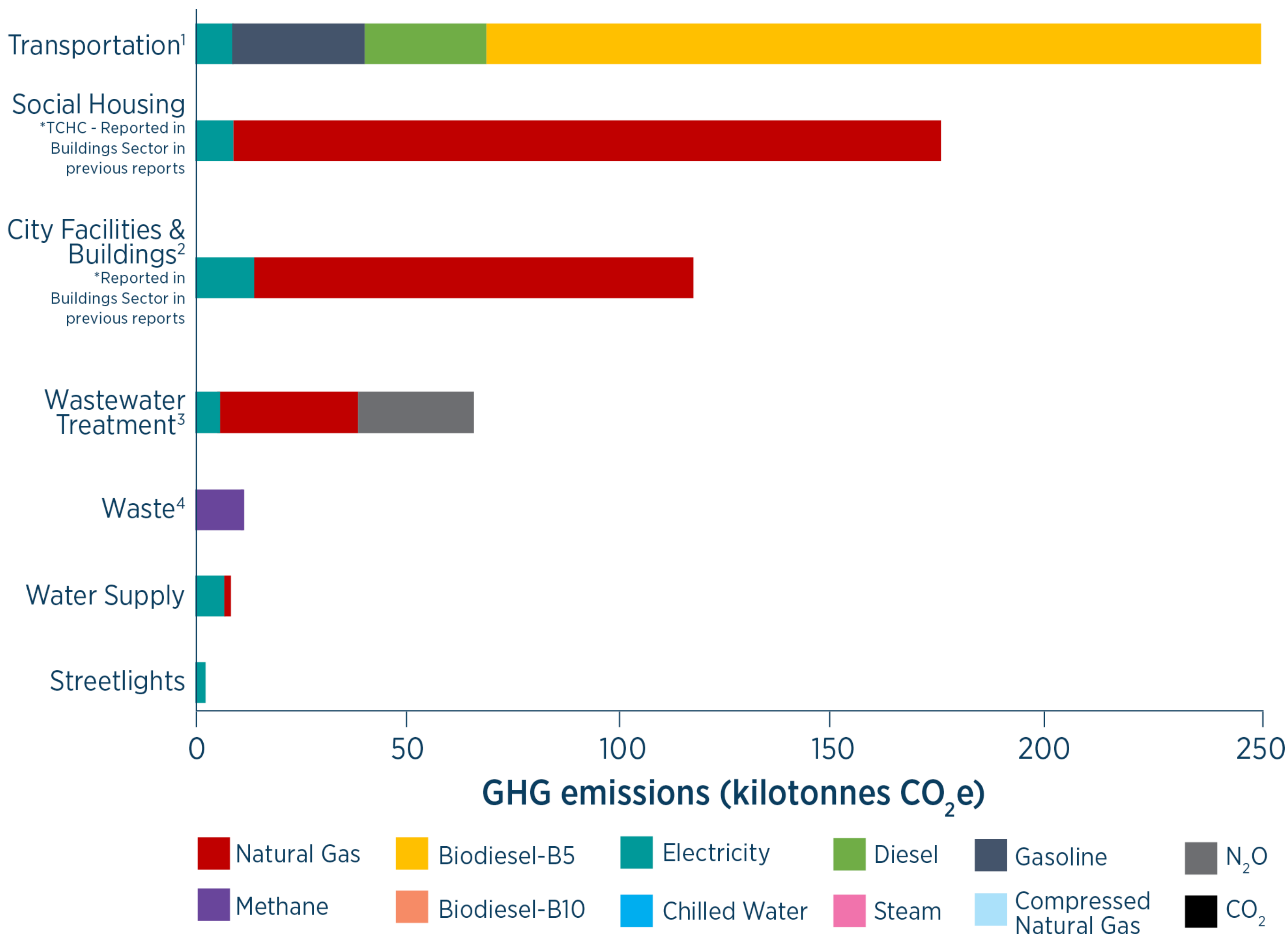
[13] In Figure 10, "passenger vehicles" includes cars and trucks fueled by gasoline.
[14] In Figure 10, "commercial and heavy vehicles" includes a mix of gasoline- and diesel-fueled vehicles.

4 City of Toronto corporate emissions

The City of Toronto's corporate (or local government) emissions are calculated based on the energy used in all municipal buildings (offices, community recreation centres, Toronto Community Housing Corporation (TCHC) housing), vehicle fleets including Toronto Transit Commission (TTC) transit vehicles, waste, water supply, and wastewater treatment, as well as streetlights.

In 2020, corporate emissions were 0.63 MT, which was about five per cent of Toronto's community-wide emissions. The City's corporate emissions decreased by nearly 15 per cent from 2019 but remained a stable share of community-wide emissions between 2019 and 2020.

Figure 11: City of Toronto corporate GHG emissions (2020)



Notes:

1 Biodiesel-B10 and Compressed Natural Gas values are included in Transportation but are too small to be visible at this scale

2 Chilled Water and Steam values are included in City Facilities and Buildings but are too small to be visible at this scale

3 Methane values are included in Wastewater Treatment but are too small to be visible at this scale

4 CO_2 & N_2O values are included in Waste but are too small to be visible at this scale

Figure 11 shows key sources of corporate emissions at the City. Transportation emissions were the largest source of emissions at roughly 0.25 MT, followed by social housing, and City facilities and buildings at 0.18 MT and 0.12 MT, respectively. Within transportation, diesel and biodiesel emissions accounted for about 84 per cent of corporate transportation emissions, while gasoline emissions represented approximately 12 per cent. Biodiesel emissions from TTC buses were approximately 71 per cent. In 2018, the TTC changed its fuel source for all buses from diesel to biodiesel. Fuel use dropped from 83 million litres in 2019 to 69 million litres in 2020, which was primarily due to COVID-19 restrictions imposed on City-related operations. Regardless of the reduced TTC bus operations in 2020, emissions per litre of biodiesel fuel are lower than for diesel; therefore, TTC bus emissions in 2020 were lower by about 0.04 MT than if TTC buses still used diesel fuel.

Natural gas consumption comprised approximately 48 per cent of all corporate emissions. Diesel fuels (including biodiesel) from the combined fleets of TTC, EMS, Fire, Police Services, and the City's corporate fleet resulted in about 33 per cent of corporate emissions. Electricity accounted for about eight percent of corporate emissions, followed by gasoline at roughly five per cent and nitrous oxide (produced through waste and wastewater treatment) at about four per cent.

Artist: Jieun Kim | Photo by: Al Loha

Appendix A: Disclosures

A.1 Global Protocol for Community-Scale GHG Emissions Inventories (GPC Protocol)

Toronto's community-wide emissions are calculated and reported as per the guidance in the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), version 1.1[15]. The GPC provides a robust framework for accounting and reporting community-wide GHG emissions to support climate action planning. Use of the GPC is also required to uphold Toronto's commitment as a signatory of the Global Covenant of Mayors for Climate and Energy[16].

This sector-based GHG emissions inventory is based on the BASIC level of GHG emissions reporting. As defined by the GPC, the BASIC level includes scope 1 and 2 emissions from the stationary energy and transportation sectors, as well as scope 1 and 3 emissions from the waste sector. A summary of Toronto's 2020 GHG emissions aligned with the BASIC reporting sectors is shown in Table 5, reported in tonnes of carbon dioxide equivalent (tCO_2e). Please refer to Table 6 for definitions of emissions scopes, as per the GPC.

Artist: Essencia Collective and Misha Hunter | Photo by: Essencia Collective

15 https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

16 The Global Covenant of Mayors for Climate and Energy (GCoM) is a group of over 10,000 cities that share a long-term vision to combat climate change, and work towards a low-emission and climate-resilient future. More information can be found at: https://www.globalcovenantofmayors.org/

Table 5: Toronto's BASIC 1990 (baseline year) and 2020 (current reporting year) community-wide GHG emissions

Sector	Emission sources	1990 GHG Emissions (tCO_2e)[a]	2020 GHG Emissions (tCO_2e)[a]
Stationary energy	Residential buildings (Scope 1, 2, & 3)	5,134,821	4,546,707
	Commercial and institutional buildings and facilities (Scope 1, 2, & 3)	5,632,007	2,575,758
	Manufacturing industries and construction (Scope 1, 2, & 3)	2,447,289	944,100
	Fugitive emissions from oil and natural gas systems (Scope 1)	0	85,880
Transportation	On-road transportation (Scope 1 & 3)	7,293,440	4,531,086
	Railways (Scope 1 & 2)	0	48,358
	Waterborne navigation (Scope 1 & 3)	0	1,078
	Aviation (Scope 3)	0	366
	Off-road transportation (Scope 1 & 3)	0	7,432
Waste	Solid waste generated in the city (Scope 1 & 3)	4,171,771	1,178,746
	Biological waste generated in the city (Scope 1 & 3)	0	6,746
	Wastewater generated in the city (Scope 1)	0	27,359
Total GHG emissions		24,679,328	13,953,616
Change in GHG emissions from the baseline year (1990)			-10,725,713
Total per capita GHG emissions (tCO_2e / capita)		10.50	4.67
Change in GHG emissions per capita from the baseline year (1990)			-56%
Percent change in GHG emissions from baseline year (1990)			-43%
Energy Use (GJ)		0	343,473,583
Total per capita Energy Use (GJ / capita)			114.84

Note:

[a] Emissions noted as zero (0) tCO_2e in 1990 were not accounted for in the 1990 baseline estimate for a variety of reasons, such as lack of data availability.

Table 6: Scope definitions for city inventories

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

In summary, Toronto's sector-based GHG inventory consists of direct and indirect GHG emissions from three dominant sectors – buildings, transportation, and waste:

- **Energy use of buildings** is used to calculate the emissions produced from the consumption of natural gas and electricity.

- **Transportation emissions** represent emissions from on-road passenger vehicles, heavy trucks, and buses as well as from commuter rail and some marine and aviation navigation. Freight rail emissions are not accounted for in this inventory, as reliable data for these emissions sources is currently not available. Identifying emissions sources from all transportation modes continues to be a methodological challenge. Due to the number of different authorities and private businesses that may contribute to transportation emissions, as well as the varying levels of voluntary, sometimes proprietary versus regulated reporting, this section of the inventory presents the best data available at the time of collection.

- **Waste emissions** (primarily methane but also nitrous oxide and carbon dioxide) originating in landfills constitute most of Toronto's waste emissions. In addition, there is a small portion of emissions from organics and yard waste, and wastewater treatment processes. Emissions from privately managed waste are estimated.

A.2 Toronto's "A List" score on GHG accounting and action reporting

As a Global Covenant of Mayors signatory, Toronto discloses its sector-based GHG emissions inventory and its climate mitigation and adaptation actions annually to the Carbon Disclosure Project (CDP)[17] to share Toronto's progress and benchmark against other cities facing similar challenges.

For the fourth year in a row, the City of Toronto is recognized on the 2022 Carbon Disclosure Project (CDP) Cities "A" List for its leadership and transparency on climate action. Toronto was one of 122 cities globally to receive an "A" rating.

17 https://www.cdp.net/en/scores

Appendix B: Methodology

The purpose of Appendix B is to provide a high-level overview of the methodology followed by the City to estimate its annual sector-based GHG emissions, in alignment with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. For more detailed methodology information, please email the City using the contact information provided at the end of this document.

As previously mentioned at the beginning of this report, the values reported annually in Toronto's sector-based GHG inventory report do not exactly match those in previous inventories because of updates to various datasets that occur over time, including after the publication of past inventories. The values reported here are the most up-to-date as of the publication of this 2020 sector-based GHG inventory.

B.1 Global Warming Potential (GWP)

GHGs released into the atmosphere have different warming effects depending on the unique qualities of each gas. To enable comparisons of the global warming impacts of different GHGs, the concept of Global Warming Potential (GWP) was developed[18]. The GWP measures how much a particular gas contributes to global warming relative to CO_2 and is used to convert tonnes of GHG to tonnes of carbon dioxide equivalent (CO_2e) to calculate total emissions across multiple GHGs using a common unit. The larger the GWP, the more a given gas warms the earth's atmosphere relative to CO_2 over a given time period. The time period usually used to establish GWPs is 100 years. The GWPs used by the City of Toronto are listed in Table 7.

Table 7 Global Warming Potential (GWP) of major GHGs

GHG	GWP
Carbon dioxide (CO_2)	1
Methane (CH_4)	34
Nitrous oxide (N_2O)	298

B.2 Activity data and emission factors

The City uses the following equation, as prescribed by the GPC protocol, to estimate GHG emissions:

GHG emissions = Activity data x Emission factor

Activity data refers to the data associated with an activity that leads to GHG emissions. Examples of activity data are:

- Volume of natural gas consumption
- GWh of electricity consumption
- Volume of gas used
- Kilometres driven
- Tonnes of solid waste sent to landfill

18 https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

An emission factor, on the other hand, is a measure of the mass of GHG emissions relative to a unit of activity. As discussed in Section 1, the City relies on Environment Canada's National Inventory Report (NIR)[19] as a primary source of its emission factors. Typically, Environment Canada releases the NIR two years after a given calendar year (i.e. the 2020 emission factors were released in 2022). The City updates its previously reported annual emissions estimates when compiling its latest inventory upon revised emission factors becoming available for previous inventory years.

B.3 Community-wide buildings sector

Buildings sector emissions result primarily from natural gas and electricity use. For both of these energy forms, emissions are calculated by multiplying activity data (e.g. natural gas and electricity consumption data) by their corresponding emissions factors, and are broken down into the following building type categories (as shown in Figure 7 and Figure 8 of this inventory):

- Residential buildings (single-family and multi-unit residential buildings (MURBs))
- Commercial and institutional buildings
- Industrial buildings

Natural gas consumption data are provided to the City by Enbridge Gas, while electricity consumption data are provided by Toronto Hydro.

Additional Notes:

- Every year, Enbridge Gas provides the City with a gas distribution fugitive emissions factor, which is in tonnes of carbon dioxide equivalent per cubic metre (CO_2e per m^3). The City multiplies this factor by the total natural gas consumption (cubic metres, m^3) to generate the total fugitive emissions.

- Emissions associated with electricity transmission loss are estimated using the electricity generation and GHG emission details for Ontario provided annually in the NIR. Specifically, a transmission loss factor is estimated by subtracting the generation intensity (grams of carbon dioxide equivalent per kilowatt hour (g CO_2e per kWh)) from the consumption intensity (g CO_2e per kWh), and then applying that factor to the total buildings sector natural gas and electricity consumption activity data.

B.4 Community-wide transportation sector

Transportation sector emissions in Toronto are classified primarily into the following sub-categories (as shown in Figure 9 of the inventory):

- Passenger vehicles
- Commercial light vehicles
- Heavy vehicles
- Other vehicles (including waste trucks, rail, marine, and aviation)

19 https://publications.gc.ca/site/eng/9.506002/publication.html

Most of Toronto's transportation sector emissions come from on-road transportation. As discussed in Section 3.3.2, most on-road transportation emissions are estimated using a model developed by the University of Toronto, the Traffic Emissions Prediction Scheme (TEPs)[20]. The model was created in Matlab® and has two separate modules:

1. TEPs – I, designed for traffic volume prediction
2. TEPs – II, designed for traffic emissions prediction

TEPs – I estimates an Average Annual Daily Traffic (AADT) value, which is subsequently fed into TEPs – II to estimate traffic emissions associated with the AADT.

Emissions from off-road vehicles & equipment in Toronto are calculated by multiplying the litres of fuel used (reported by the City of Toronto Fleet Services Division) by emission factors for energy mobile combustion sources (provided annually by the NIR).

Emissions from rail are calculated from three main sources:

1. Litres of diesel fuel supplied by Metrolinx for GO Train
2. Litres of diesel fuel supplied by Metrolinx for UP Express
3. Electricity consumption used by TTC subway trains and above-ground streetcars

These activity data are then multiplied by emission factors from the NIR to produce the emissions estimate for transportation by rail.

Additional notes:

- Emissions from aviation represent the monthly litres of fuel pumped into aircraft at Billy Bishop Toronto City Airport during a given year. This fuel consumption is then multiplied by the emission factors for energy-mobile combustion sources.

- Emissions associated with the Toronto Pearson International Airport are not captured in the City's annual inventory due to current constraints in acquiring data, noting that the airport is located within the municipal boundary of Mississauga (outside of Toronto).

- Due to data limitations, emissions from marine transportation only capture City-owned fleet marine vehicles. Specifically, emissions from these vehicles are estimated by using the litres of fuel (reported by the City of Toronto Fleet Services Division) multiplied by emission factors for energy mobile combustion.

- Using Geographic Information System (GIS) mapping and system route information, the number of kilometres travelled by GO Trains and UP Express trains within Toronto territorial boundaries versus the system-wide GO Train and UP Express routes are estimated to determine the percentage of system-wide fuel used by GO Trains and UP Express within Toronto alone. This percentage is then multiplied by the total litres of diesel fuel used annually by GO Trains and UP Express trains (fuel data supplied by Metrolinx). Due to data constraints, VIA Rail and CN/CP Rail are not captured in the City's inventory.

- Emissions from the TTC Bus Fleet are estimated using litres of fuel (supplied by the City's Fleet Services Division), multiplied by the heavy-duty B5 diesel vehicles emission factor.

20 https://teps.ca/

- The City accounts for the emissions from the litres of fuel used by waste trucks to transport publicly-managed waste to landfill sites. This fuel consumption is then multiplied by the emission factors for energy-mobile combustion sources.
- The City also estimates the litres of fuel used by private waste trucks to transport privately-collected waste to unknown landfills outside the city boundary. This fuel consumption is then multiplied by the emission factors for energy-mobile combustion sources.

B.5 Community-wide waste sector

The waste sector accounts for emissions from waste generated inside Toronto's city boundaries, and waste managed and treated at City-owned facilities inside and outside of the city boundaries. Emissions from the waste sector are broken down into four categories:

- City-owned landfill sites
- Private landfill sites
- Organic processing facilities
- Wastewater treatment plants

The City manages five landfill sites, all of which are accounted for in Toronto's sector-based GHG emissions inventory, but only one of which (Beare Road) exists within Toronto's geographical boundary. Further, of the five sites, only one facility (Green Lane) is an open landfill. The rest are closed, meaning that waste produced in the present inventory reporting year is only for Green Lane.

Methane emissions from landfills continue for several decades (or sometimes even centuries) after waste disposal. Waste disposed of in a given year thereby contributes to GHG emissions in that year and subsequent years. Likewise, methane emissions released from an open landfill in any given year include emissions from waste disposed of that year, as well as from waste disposed of in prior years. To account for these methane emissions, the City uses these two approaches:

1. For Beare Road and Thackeray landfill sites, emissions are calculated using the Scholl-Canyon First Order of Decay (FOD) model which is based on the tonnage of waste deposited into the landfill over its lifetime.

2. For Green Lane, Keele Valley, and Brock West landfill sites, landfill gas rate meter reading data are collected and are used, together with an industry–standard model for landfill emissions, by an external consultant for the City. The model estimates the amount of gas generated by the landfill(s); the sites operators collect gas measurements at the flares. The estimated emissions from the landfills are calculated by subtracting the gas flared/destroyed from the amount of gas produced at the landfill (modelled).

Regarding the method to estimate privately managed waste in Toronto's annual sector-based inventory, the City does not have access to data on the tonnage of waste or emissions attributable to waste collected by private firms and sent to unknown landfill locations. To provide an estimate of emissions associated with this privately managed waste, the City uses Ontario's provincial estimate for the amount of waste managed by municipalities as compared to the amount of waste managed privately. The most recently published ratio (2016) states that 40 per cent of waste is managed municipally, and 60 per cent is managed privately. As the City does not have information on the composition of this privately managed waste, the landfill gas collection efficiency of the receiving landfills, or these landfills' locations, the City currently assumes the following:

- Privately managed waste has the same composition as the waste the City sends to Green Lane landfill (the only currently open landfill receiving municipally-managed waste from Toronto).
- The receiving landfills have the same landfill gas collection efficiency as Green Lane landfill.
- To estimate emissions from privately managed waste, the City applies the provincial ratio by assuming the emissions from the landfill currently receiving municipally-managed waste from Toronto (Green Lane) are equivalent to 40 per cent of the total community-wide waste emissions. The City calculates the remaining 60 per cent of emissions, which the City assumes to be the emissions attributable to privately-managed waste.

Emissions from the City's organics processing facilities are calculated by taking into account the total tonnage of collected green bin organics and leaf and yard waste from the City's two facilities and applying an emissions estimate formula and emission factors recommended by the GPC Protocol.

Municipal wastewater is treated anaerobically, meaning that both methane and nitrous oxide are accounted for, and all wastewater is treated at the City's four wastewater treatment plants. The City's water engineers calculate the annual methane and nitrous oxide emissions attributed to the wastewater treatment at these plants.

Carbon dioxide 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 the transportation sector emissions.

B.6 Corporate emissions

Generally, the City follows the same principle described previously in calculating community-wide emissions (as per the GPC Protocol), with some additional notes below:

- Most of the City's corporate activity data, specifically energy consumption, is managed by the Corporate Real Estate Management (CREM) Division. CREM monitors the utility bills of all City-owned buildings, facilities, yards, etc. through an energy management software called EnergyCAP. EnergyCAP also includes utility bill information from Toronto Community Housing (TCHC), the largest social housing provider in Canada and the second largest in North America. TCHC is owned by the City of Toronto.
- To calculate natural gas and electricity emissions, the City applies the same emission factors used in the community-wide inventory, obtained from the NIR. For steam and chilled water, the City uses emission factors from EnWave (the City's district energy supplier).
- Electricity emissions are handled slightly differently for corporate and community emissions. Specifically, the electricity consumption data provided by CREM already incorporates transmission losses. The City uses this value directly and multiplies it with the appropriate NIR emission factor, and does not perform a separate transmission loss emissions calculation step.

- The electricity consumption for Bike Path, Signal, and Streetlights is also managed and monitored in EnergyCAP.

- The City's Fleet Services Division (FSD) manages all the City's corporate marine, off-road and on-road transportation fuel consumption. The FSD receives activity data (fuel consumption in particular) from the following City agencies: Toronto Transit Commission (TTC), Toronto Police Service, Toronto Fire Services, Toronto Paramedic Services, TCHC, Exhibition Place, Toronto Zoo, Toronto Parking Authority, and Toronto Public Library. These activity data are then multiplied by the corresponding appropriate NIR emission factors based on the vehicle types.

- The City estimates litres of fuel used by corporate waste trucks using the percentage of community versus corporate waste that is transported to Green Lane. The City uses this same percentage to estimate corporate waste emissions.

- For corporate emissions associated with the City's wastewater and organics processing facilities, please see Appendix B.5 Community-wide waste sector.

Appendix C: Heating and cooling degree days

Fluctuations in natural gas and electricity consumption are sensitive to weather conditions, specifically expressed in terms of Heating Degree Days (HDD) or Cooling Degree Days (CDD). HDD is a quantitative index used to estimate the energy demand needed to heat a home or business. Cooling CDD, on the other hand, is a quantitative index used to estimate the energy demand needed to cool a home or business.

HDD is equal to the number of degrees Celsius (°C) a given day's mean temperature is below 18°C. For example, if the daily mean temperature is 12°C, the HDD value for that day is equal to 6 HDD. If the daily mean temperature is above 18°C, the HDD value for that day is set to zero. When this exercise is performed every day of the year, it provides a total value of HDD for a given year.

CDD follows a similar calculation process as HDD, except it refers to the number of degrees Celsius a given day's mean temperature is above (instead of below) 18°C. At this temperature, people inside a building no longer want the building heated, but instead begin to consider cooling the building.

A high number of degree days (HDD and/or CDD) generally results in higher levels of energy use for space heating or cooling.

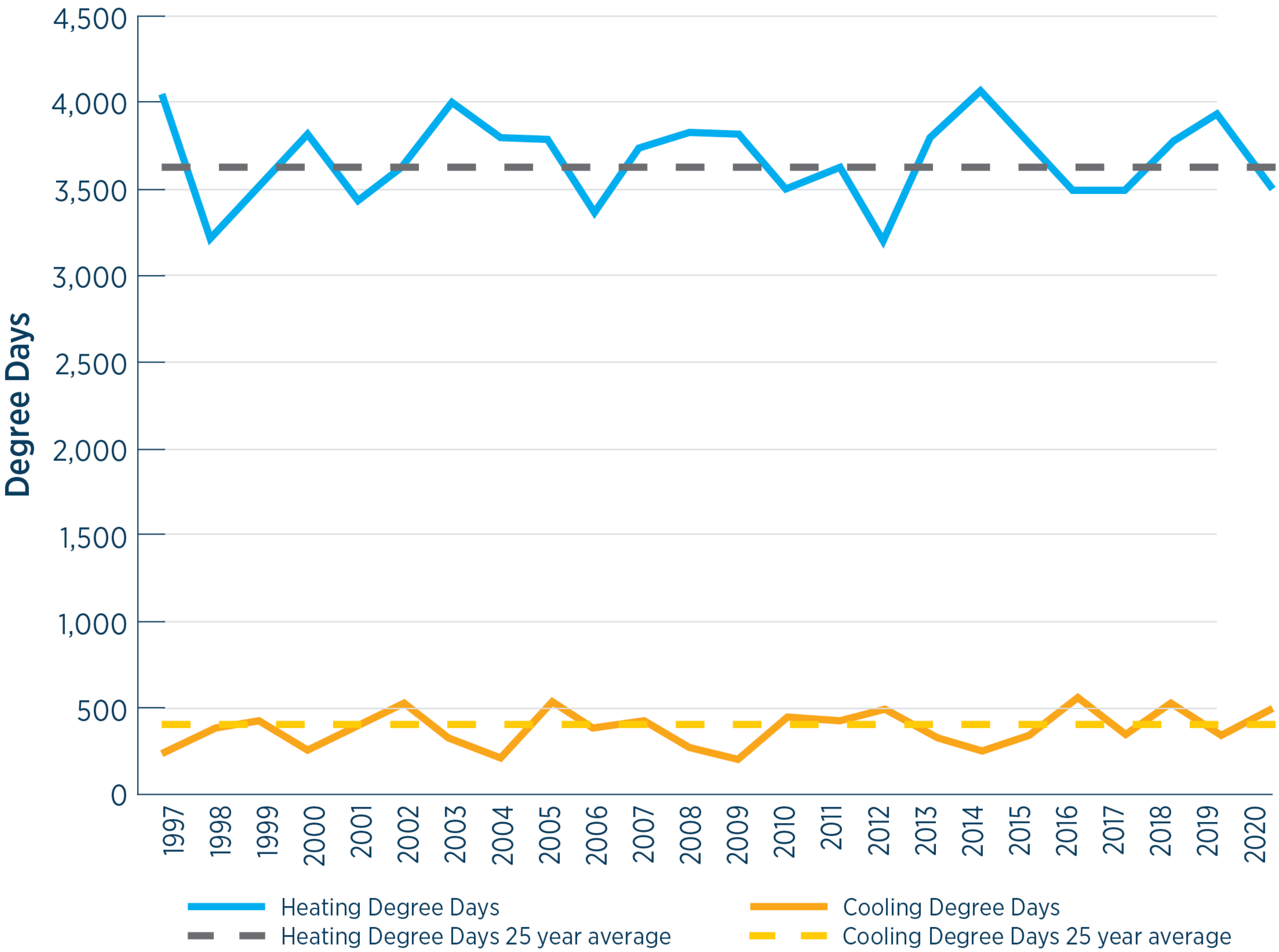
Table 8[21] shows that Toronto's winter and summer in 2020 were warmer as compared to 2019. Figure 12 further shows that Toronto's 2020 HDD was lower than the city's 25-year HDD average, which means building heating needs were lower in 2020. In contrast, Toronto's 2020 CDD was higher than the city's 25-year CDD average, which means air conditioning needs were higher in 2020. This implies that Toronto experienced a hotter and longer summer in 2020 than the historical average.

21 Datasets were gathered from Environment and Climate Change Canada, please see: https://toronto.weatherstats.ca/charts/hdd-yearly.html and https://toronto.weatherstats.ca/charts/cdd-yearly.html

Table 8: Annual Heating Degree Days (HDD) and Cooling Degree Days (CDD) in Toronto (1990-2022)

Year	Heating Degree Days	Cooling Degree Days	Heating difference from the previous year	Cooling difference from the previous year
1997	4,036	236		
1998	3,225	373	-20.09%	58.05%
1999	3,541	438	9.80%	17.43%
2000	3,829	263	8.13%	-39.95%
2001	3,422	389	-10.63%	47.91%
2002	3,633	515	6.17%	32.39%
2003	3,984	324	9.66%	-37.09%
2004	3,801	226	-4.59%	-30.25%
2005	3,797	533	-0.11%	135.84%
2006	3,383	380	-10.90%	-28.71%
2007	3,721	433	9.99%	13.95%
2008	3,839	273	3.17%	-36.95%
2009	3,838	197	-0.03%	-27.84%
2010	3,504	437	-8.70%	121.83%
2011	3,649	425	4.14%	-2.75%
2012	3,219	480	-11.78%	12.94%
2013	3,797	337	17.96%	-29.79%
2014	4,106	262	8.14%	-22.26%
2015	3,769	349	-8.21%	33.21%
2016	3,464	564	-8.09%	61.60%
2017	3,518	345	1.56%	-38.83%
2018	3,765	516	7.02%	49.57%
2019	3,929	340	4.36%	-34.11%
2020	**3,516**	**495**	**-10.51%**	**45.59%**

Figure 12: Annual Heating Degree Days (HDD) and Cooling Degree Days (CDD) in Toronto



Stay Involved

Stay informed about what the City of Toronto and its partners are doing to reduce greenhouse gas emissions in the city.

Subscribe for e-updates at Toronto.ca/transformto.

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