2021 SECTOR-BASED EMISSIONS INVENTORY

TORONTO

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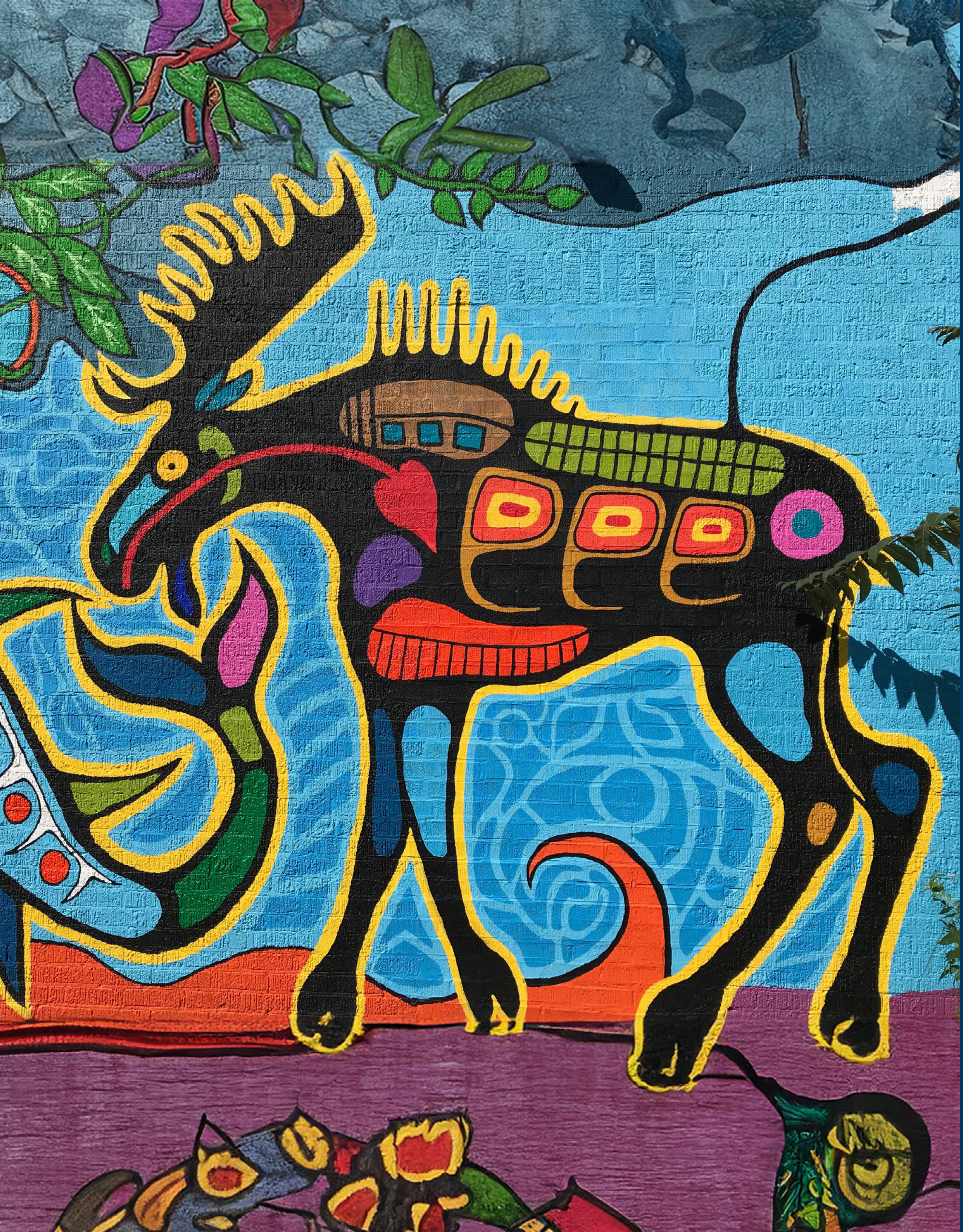
FIGURES

TABLES



LAND ACKNOWLEDGEMENT

The City acknowledges that all facets of its work are carried out on the traditional territories of many nations, including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee, and the Wendat peoples and is now home to many diverse First Nations, Inuit, and Métis peoples. These territories are currently covered by Treaty 13 with the Mississaugas of the Credit and the Williams Treaties signed with multiple Mississaugas and Chippewa bands. We are eternally grateful for Indigenous stewardship of these lands and waters.

Gchi Miigwetch, Niawen, Marsi, Nakummesuak, Quannamiik

Artist: Phillip Cote

This report contains photos of local art created through the StreetARToronto ('StART') program. For 12 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.

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's geographical boundary 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, and using 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 Days (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 global warming, also called the greenhouse effect. The three GHGs measured in Toronto are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).
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), which has a GWP of 1. GWP is used to convert tonnes of GHGs, like methane, to tonnes of carbon dioxide equivalent (CO_2e) to express total emissions using a common unit. For details see Appendix C.1 Global Warming Potential (GWP).

GLOSSARY

Term	Definition
Heating Degree Days (HDD)	Heating Degree Days (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	Occurs when the amount of greenhouse gases released is equivalent to 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 2021 sector-based GHG inventory.

KEY FINDINGS

In 2021, Toronto's community-wide greenhouse gas (GHG) emissions were 14.5 megatonnes (MT) of carbon dioxide equivalent (CO_2e), a four per cent increase over the 14 MT CO_2e emitted in 2020. Emissions were 41 per cent less than 1990 levels. In comparison to 2019 (pre-pandemic), Toronto's 2021 and 2020 emissions were 9 per cent and 13 per cent lower, respectively.

The sources that contribute the largest percentage of emissions in Toronto are natural gas heating in residential buildings (30 per cent of Toronto's community-wide emissions) and gasoline combustion in passenger vehicles (24 per cent of emissions).

COVID-19 lockdowns continued during first half of 2021 and schools remained closed to in-person learning until fall 2021. This means that the emissions increase in 2021 represents six months of a resumption of pre-pandemic activity. This upward trend in emissions is expected to continue into 2022 when activity returns to pre-pandemic levels.

Toronto must continue to scale up its GHG reduction programs and initiatives to reach its interim targets and net zero by 2040. Toronto's next target, its 2025 target of a 45 per cent GHG emissions reduction from 1990 levels, is at risk if the upward trend in GHG emissions continues. In order to reach this goal, Toronto's 2021 emissions need to be reduced by 1.0 MT, which equates to removing 28 per cent or 293,643 gas powered cars off the road[1] or 40 per cent (200,751) of single-family homes converted to energy-efficient homes either through building envelope retrofits or fuel switching from natural gas heating to electric heat pumps[2]. Reaching this level of reduction may be particularly challenging given that emissions increased with the resumption of pre-pandemic activity in the second half of 2021. Toronto must continue to scale up its GHG reduction programs and initiatives to reach its interim targets and net zero by 2040.

[1] As calculated using https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/calculator/ghg-calculator.cfm
[2] See Appendix C.3 Community-wide buildings sector for calculation

KEY FINDINGS

Emissions from buildings remained the primary source of GHGs in Toronto in 2021, accounting for 56 per cent of community-wide emissions, a slight decrease in emissions from 58 per cent in 2020. The largest source of these emissions is from natural gas heating in residential buildings, accounting for 30 per cent of community-wide emissions in 2021.

Waste sector emissions, primarily from landfills, were the third largest source of GHG emissions in Toronto, roughly nine per cent of community-wide emissions in 2021. This remained stable compared to 2020.

Transportation sector emissions continued to be the second largest source of GHG emissions in Toronto, accounting for 35 per cent of community-wide emissions in 2021. This is an increase in share from 33 per cent in 2020. These emissions were mostly attributable to gasoline used in passenger cars and trucks, accounting for 27 per cent of community-wide emissions in 2021. Of note is the 17 per cent increase in emissions from commercial and heavy vehicles, but a negligible increase in vehicle kilometres travelled, due to an increase in commercial and heavy vehicles on local roads. Driving along local roads leads to more stops and starts, which increases emissions.[3]

In 2021, the City of Toronto's corporate emissions from City-owned buildings, fleets and waste, were 0.67 MT, which was about five per cent of Toronto's community wide emissions as it was in 2020. While emissions remained a stable share of community-wide emissions, they increased by four percent from 0.63 MT in 2020. The City, just like other municipal governments, does not have full control over all GHG emissions generated within Toronto's territorial boundary.

[3] There is insufficient data to determine the reason for the observed increase in Commercial Vehicles on local roads, but preliminary data suggests an increase in the average number of daily trips taken by vehicles involved in last-mile deliveries (Kouchakzadeh and Roorda, 2021, https://rb.gy/mr9qmh). These vehicles travel on local roads to deliver to properties, leading to stopping and starting and consequently increased emissions.

1 BACKGROUND

The City's TransformTO Net Zero Strategy (NZS)[4] aims to create a future Toronto that is zero-carbon, equitable, healthy, prosperous and resilient. To achieve this, the City of Toronto (the City) set an ambitious target to reduce community-wide greenhouse gas (GHG) emissions to net zero by 2040, with interim targets shown in Table 1. These targets are set in order to meet the global, science-based pathways to achieve the Paris Agreement 1.5 °C goal, as determined by the Intergovernmental Panel on Climate Change (IPCC).

The City of Toronto's 2021 sector-based emissions inventory (SBEI) presents the quantity and sources of Toronto's emissions for the year 2021. 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, such as the Toronto Carbon Accountability System[5] and TransformTO NZS, as well as provide benchmarks against which the success of these activities can be measured.

This report also fulfils one of the requirements the City has as a Global Covenant of Mayors signatory. The City of Toronto has been disclosing its GHG emissions inventory and its climate mitigation and adaptation actions annually to the Carbon Disclosure Project (CDP) to share Toronto's progress and benchmark against other cities facing similar challenges. Disclosing GHG emissions annually allows the City to be transparent with its progress in reducing GHG emissions.

For the fifth year in a row, the City of Toronto is recognized on the 2023 CDP Cities "A" List for its leadership and transparency on climate action. Toronto was one of 119 cities globally to receive an "A" rating.

The City relies on Environment Canada's National Inventory Report (NIR)[6] as a primary source of its emission factors which is necessary in calculating GHG emissions (please refer to Appendix C: Methodology for more information). Typically, Environment Canada releases the NIR two years after a given calendar year (i.e. the 2021 emission factors were released in 2023). The City updates its previously reported annual emissions estimates when compiling its latest inventory using revised emission factors, including those from previous inventory years.

[4] https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-235849.pdf
[5] https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-235864.pdf
[6] https://publications.gc.ca/site/eng/9.506002/publication.html

The SBEI also provides 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 NZS. Examples of sector specific emission reduction activities include:

- **NATURAL GAS USE IN BUILDINGS**
  Natural gas usage for heating buildings is the largest source of emissions. To address this, the City has a comprehensive strategy to reduce building emissions: the Net Zero Existing Buildings Strategy[7].

- **ELECTRICITY USAGE**
  As seen in this report, emissions from electricity increased because of an increase in use of natural gas power generation. When electricity is generated by natural gas, emissions increase because burning natural gas creates GHGs. The City cannot directly control how electricity is generated as it is under provincial jurisdiction but the City is actively supporting, advocating to and partnering with provincial and federal governments and agencies, to decarbonize the provincial electricity grid, promote energy conservation and enable local renewable energy generation.

- **GASOLINE FROM PASSENGER VEHICLES**
  Emissions from gasoline usage for transportation is the second largest source of sector-based emissions. Among other activities, the City is expanding cycling and pedestrian infrastructure, including the rollout of cycling routes, bicycle parking and a bicycle-sharing system at or near TTC stations[8]. These activities also support reducing consumption-based emissions (Appendix A).

[7] https://www.toronto.ca/wp-content/uploads/2021/10/907c-Net-Zero-Existing-Buildings-Strategy-2021.pdf
[8] https://www.toronto.ca/services-payments/streets-parking-transportation/cycling-in-toronto/cycling-pedestrian-projects/cycling-network-plan/

It should be noted that the City, just like other municipal governments, does not have full control over all GHG emissions generated within Toronto's territorial boundary (Figure 1). Approximately five percent of GHG emissions are the direct responsibility of, and under the direct control of, the City of Toronto government, which primarily includes City-owned buildings and vehicle fleets. The City is taking action to reduce Toronto's corporate emissions through established programs and major policy achievements[9] such as:

- The Corporate Real Estate Management Net Zero Carbon Plan for City-owned buildings
- Greening City and TTC fleets
- Enhancing sustainable procurement policies
- Application of the Toronto Green Standard V4 for City buildings:
    - o For example, in 2022, construction began on what will be the City of Toronto's first net zero energy and emissions community recreation facility, the North East Scarborough Community and Child Care Centre[10]. The building's leading-edge design uses innovative strategies to eliminate the use of fossil fuels, reduce overall energy consumption and incorporate on-site renewable energy systems. It will be 100 per cent electricity powered through a mix of solar photovoltaic panels on its roof and facade, as well as a parking lot canopy. Going forward, all new City-owned buildings will be net zero.

[9] https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-235849.pdf
[10] https://www.toronto.ca/city-government/planning-development/construction-new-facilities/new-parks-facilities/north-east-scarborough-community-and-child-care-centre/

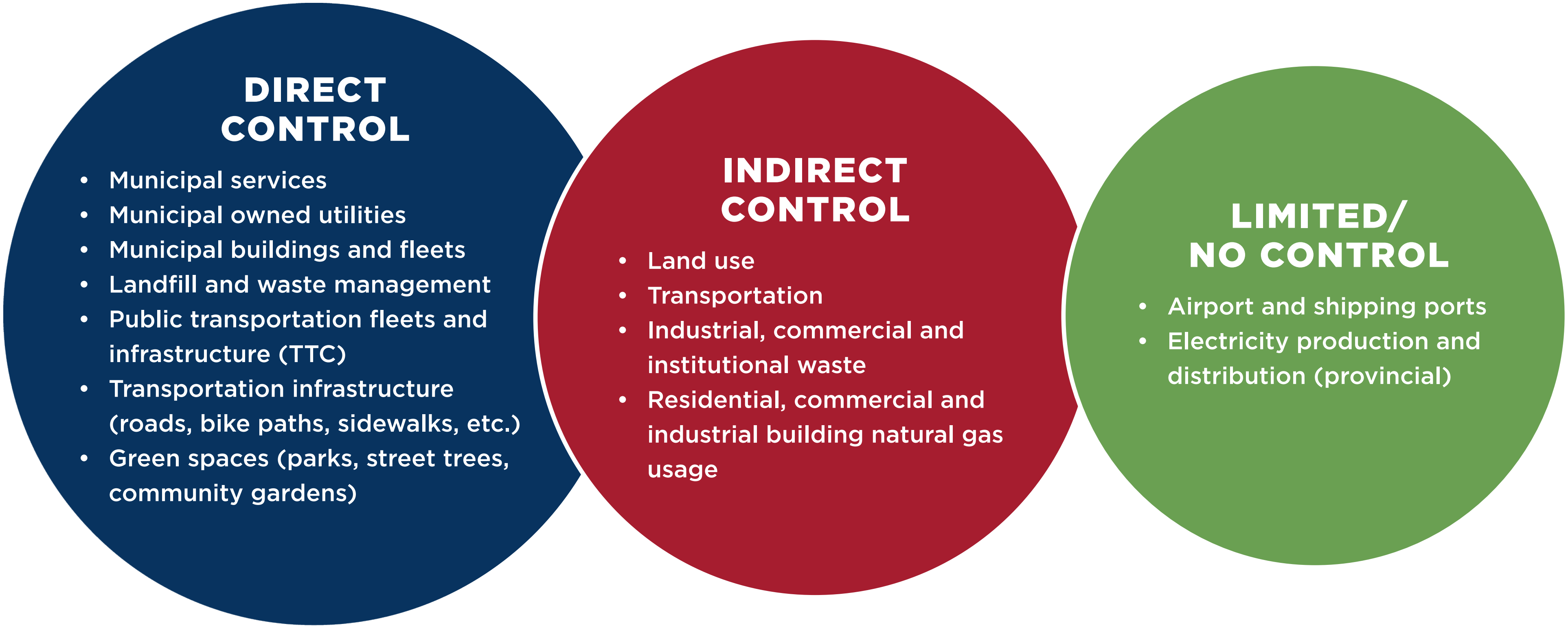


Figure 1: Municipal spheres of influence over GHG emission sources

As noted in Figure 1, electricity generation is outside of municipal control and under provincial jurisdiction. How electricity is generated greatly impacts emissions from electricity usage. Ontario's electricity is supplied by nuclear, natural gas, hydro and renewables. Most of the electricity produced in Ontario is generated at nuclear and hydro plants, which produce low levels of GHG emissions. However, in 2021 the amount of natural gas used to generate electricity increased from previous years which increased emissions from electricity usage.

As shown in Figure 2, though community-wide emissions have decreased since 1990 and the City exceeded its 2020 emissions reduction target, emissions increased in 2021. It should be noted that while Toronto's emissions increased from 2020, it was an anomaly year due to COVID-19 restrictions. The year 2021 was also an anomaly as the activities in 2021 only represent half a year of resumption of pre-pandemic activity. Ambitious climate actions and programs are required from the City to get back on track to meet its 2025 target of a 45 per cent emissions reduction from 1990 levels. A 1.0 MT reduction in emissions

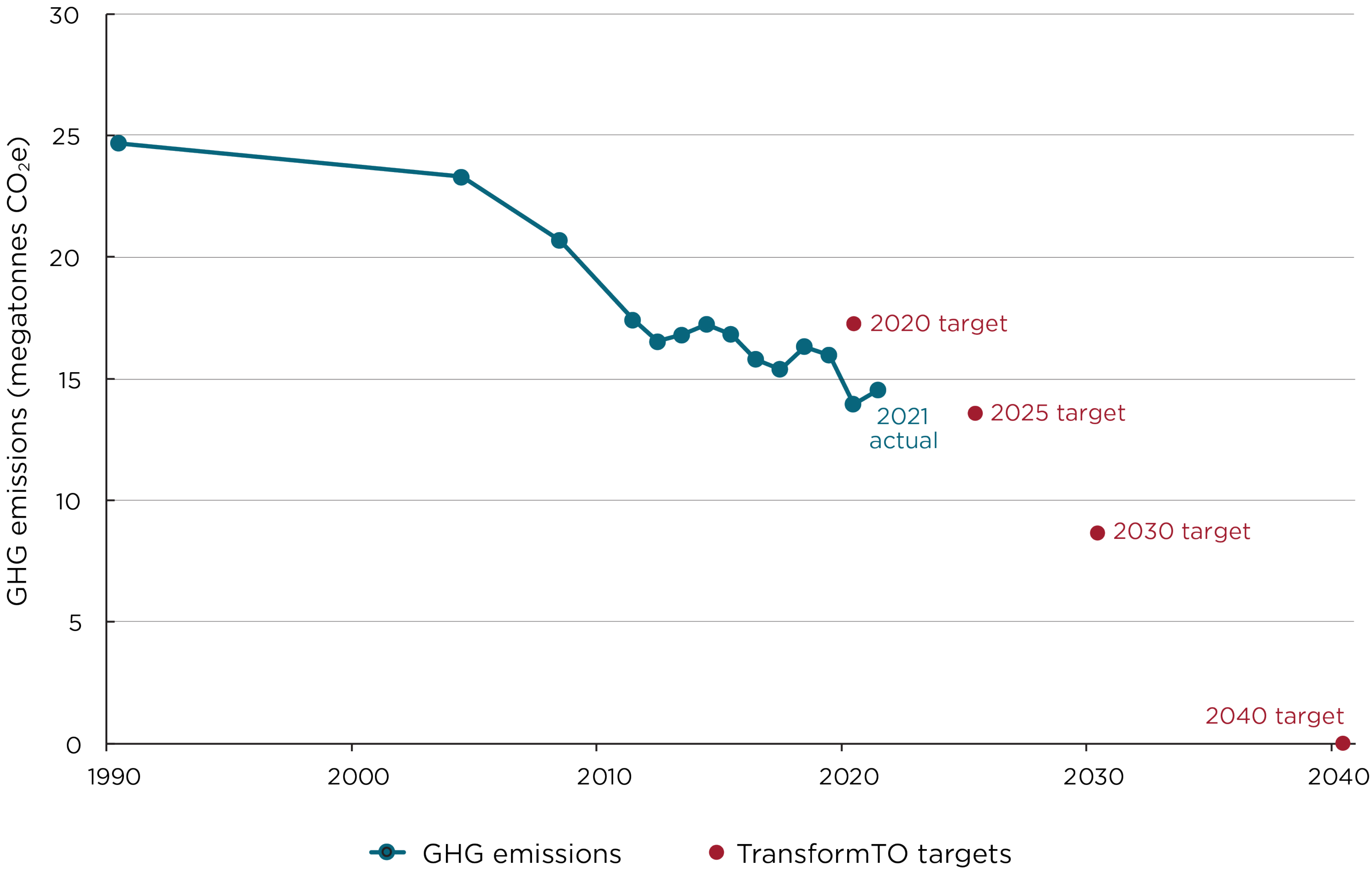


Figure 2: Toronto's GHG emissions and Council-approved GHG emissions targets

equates to removing 28 per cent or 293,643 gas powered cars off the road[11] or 40 per cent (200,751) of all natural gas heated single-family homes switching from natural gas furnaces to heat pumps[12]. Reaching this level of reduction may be particularly challenging given that emissions increased with the resumption of pre-pandemic activity in the second half of 2021.

Further, as detailed in Table 1, Toronto now needs to cut its emissions by roughly 5.9 MT to meet the City's 2030 target of a 65 per cent emissions reduction below 1990 levels.

Energy output from the Portlands Energy Centre, the natural gas electrical generating station in Toronto, jumped to 1,600 GWh in 2021 accounting for an 88 per cent increase from 2020 and a 60 per cent increase compared with the annual average of 1,000 GWh (annual average calculated for years 2010 to 2019) in previous years[a]. This is reflected in the ten per cent increase in emissions from electricity usage reported in the 2021 sector-based emissions inventory.

[a] https://www.ieso.ca/en/Power-Data/Data-Directory

[11] As calculated using https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/calculator/ghg-calculator.cfm
[12] See Appendix C.3 Community-wide buildings sector for calculation

Table 1: Council-adopted GHG emissions targets and 2021 status

Year	GHG reduction target from 1990 baseline	GHG emissions target (MT CO_2e)[a]	Progress as of 2021
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.
2021	N/A	N/A	In 2021 Toronto's community-wide emissions were 14.5 MT, which is a 4 per cent increase from 2020. It is still below the 2020 reduction target and is 41 per cent lower than in 1990.
2025	45 per cent	13.6 MT	To reach this target, emissions need to be reduced by 1.0 MT from 2021 levels.
2030	65 per cent	8.6 MT	Toronto must reduce annual emissions by about 5.9 MT from 2021 levels meet the 2030 target. Toronto must rapidly increase its current annual emissions reduction rate.
2040	Net zero	Net zero	14.5 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.

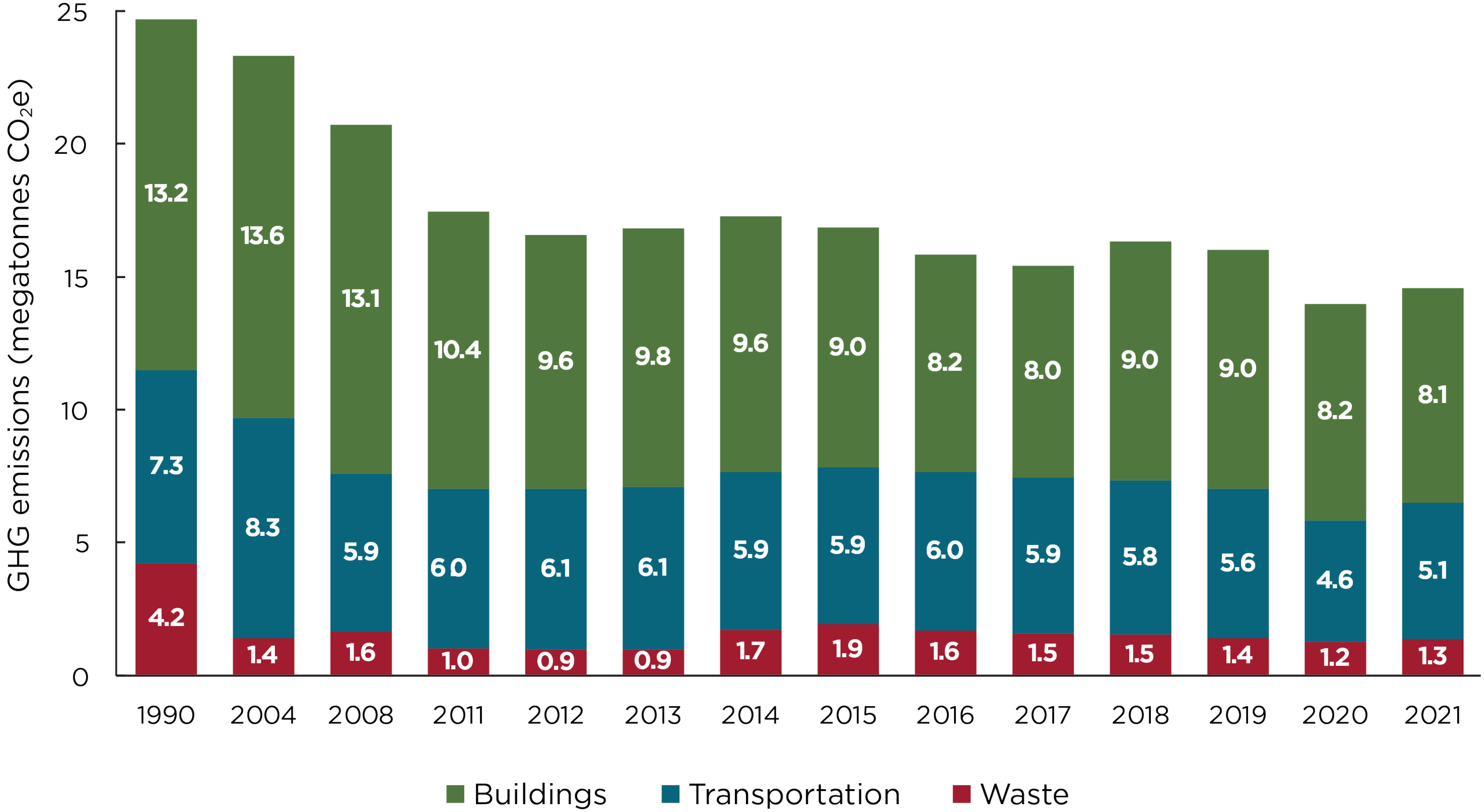


Figure 3: Toronto's year-over-year community-wide GHG emissions by sector

Figure 3 shows the year-over-year changes in sectoral emissions from 1990 to 2021, while Figure 4 presents the proportion the sectors contribute to the total emissions for 2021. In 2021, building sector emissions were 8.1 MT representing 56 per cent of overall community-wide emissions, with most of those emissions attributable to natural gas used for space and water heating. This is a slight decrease from 2020 (8.2 MT emissions from buildings) likely due to the milder 2021 winter (please see Appendix D: Heating and cooling degree days). Transportation emissions accounted for 35 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 processing, and wastewater treatment processes, were nine per cent of overall community-wide emissions. More details on GHG emissions by sector are provided in Section 2.

The COVID-19 pandemic continued to play a significant role in the first half of 2021. Despite this, emissions rose by four per cent, driven largely by the increase in transportation in the second half of 2021. Toronto's rise in emissions is mirrored in a global GHG emissions increase to a total of 34.9 gigatons in 2021, a five per cent increase from 2020[13]. As COVID-19 economic recovery efforts gain momentum, it is expected that the GHG emissions in Toronto will continue to increase in 2022. 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.

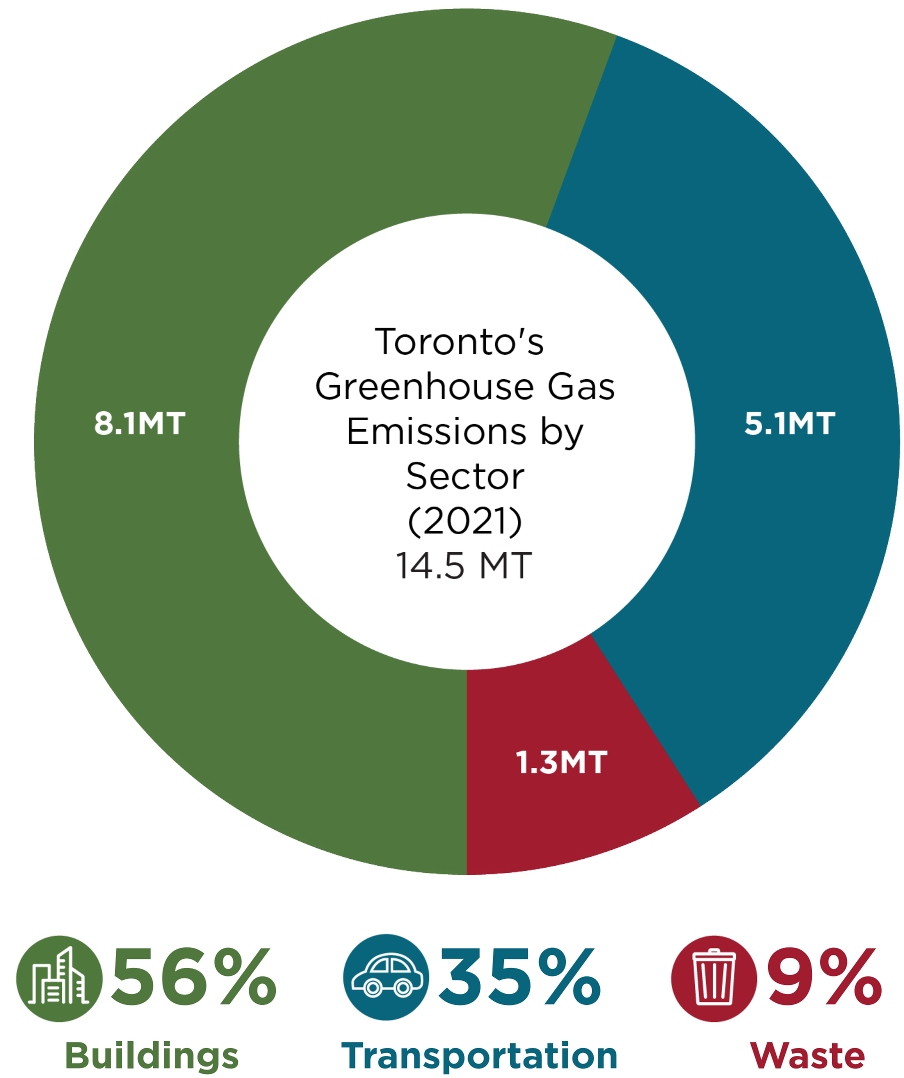


Figure 4: Toronto's percentage breakdown of community-wide GHG emissions by sector (2021)

[13] https://www.nature.com/articles/s43017-022-00285-w

Figure 5 is a Sankey diagram which is a data visualisation tool that illustrates the proportion of emissions by sector and source and gives an overview of how the many pieces of data presented in this report fit together. The width of the pathways is proportional to the quantity represented, thereby showing the overall breakdown of emissions from buildings, transportation and waste. The total GHG emissions are divided into the sectors of buildings, transportation and waste. Each of these are then broken down into various categories, for example buildings, is divided into industrial, commercial and residential. From there, these categories are sub-divided into the sources of emissions, which in the case of buildings, are electricity and natural gas. The two pathways that contribute to the largest percentage of emissions are from natural gas heating in residential buildings and gasoline combustion in passenger vehicles. The first path indicates that 30 per cent of Toronto's sector-based emissions are from natural gas heating in residential buildings. The second path accounts for 24 per cent of emissions coming from gasoline combustion in passenger vehicles. It becomes clear from the Sankey diagram that two of the most basic daily activities that most people carry out, staying warm and getting around, are the top two sources of emissions.

Artists: Odinamaad, Chief Lady Bird, Dave Monday Oguorie and Philip Cote

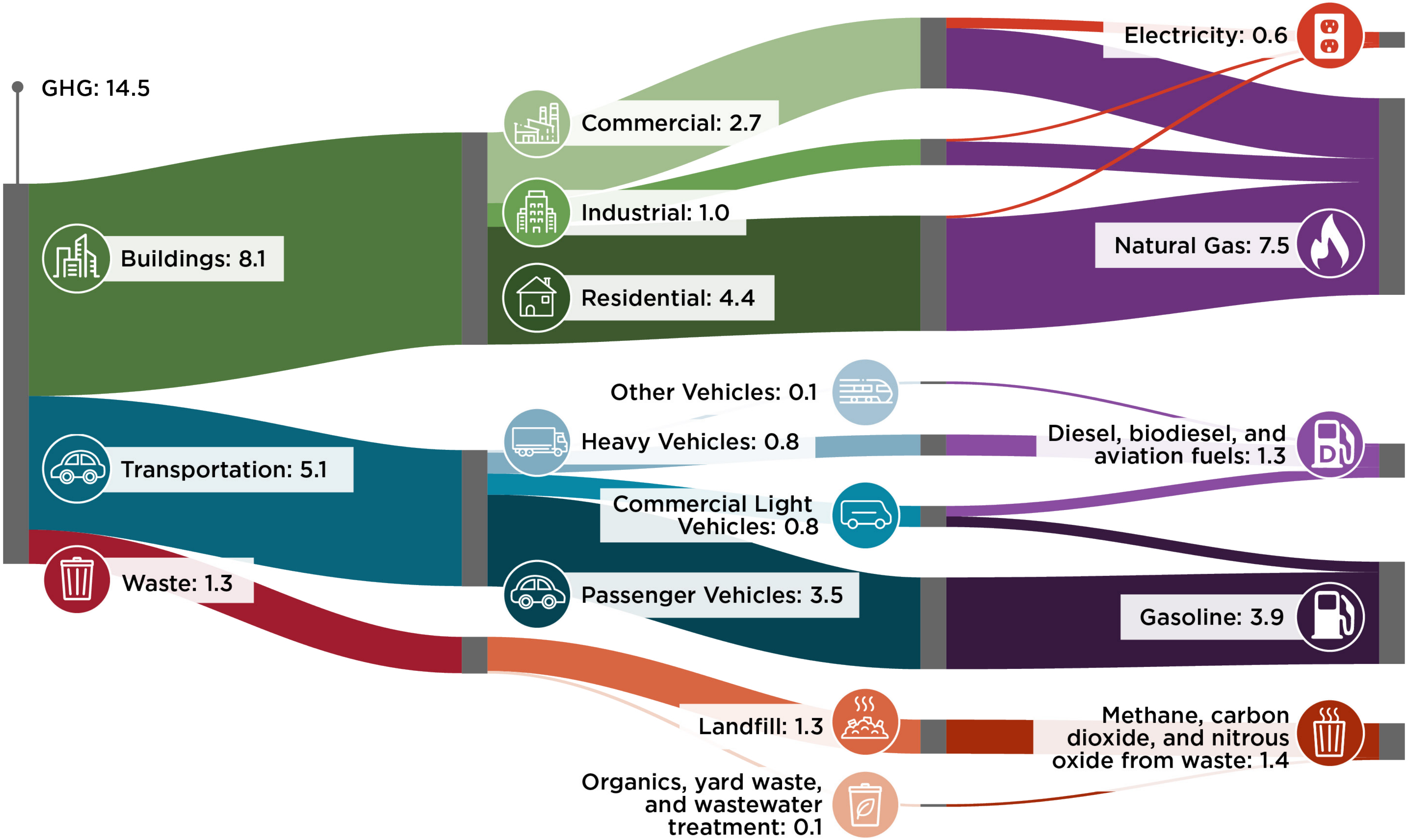


Figure 5: Toronto GHG sector emissions Sankey diagram expressed in MT

2.1 KEY DRIVERS OF GHG EMISSIONS

The City's annual 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 3 for further detail on corporate emissions estimates.

Section 2 of this document provides details of Toronto's community-wide sector-based GHG emissions for the 2021 calendar year.

Figure 6 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 2021 at approximately 7.5 MT, accounting for about 51 per cent of all emissions. This is one per cent less than 2020. This slight decrease is due to a slightly warmer winter, which requires less building heating. Natural gas usage in residential buildings was the largest single source of emissions, accounting for 30 per cent of community-wide emissions.

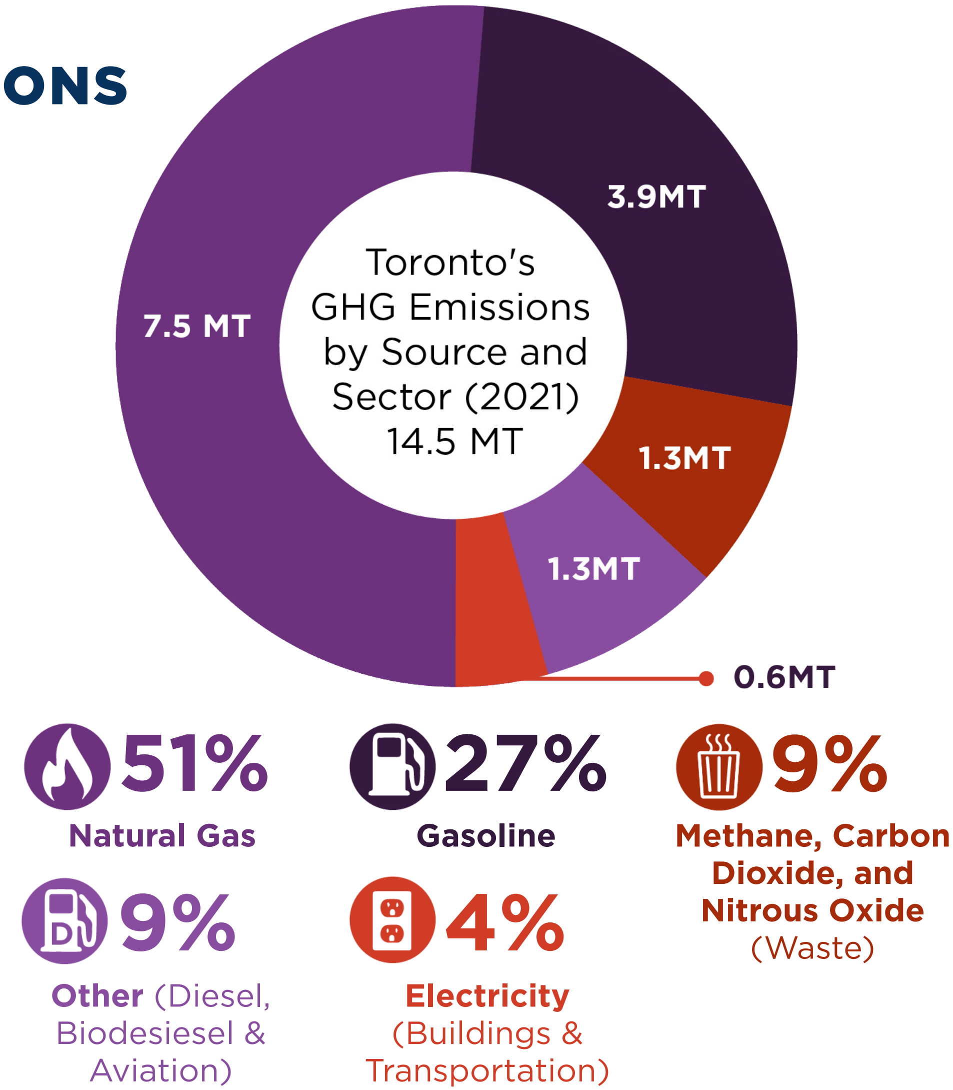


Figure 6: Key drivers of community-wide GHG emissions (2021) expressed in MT and per cent of total emissions

2. **Gasoline.** Gasoline used for passenger cars and trucks accounted for 27 per cent of community-wide GHG emissions in Toronto. It is the second largest source of emissions source at approximately 3.9 MT. This is an increase from 2020 due to a resumption of pre-pandemic activity in the second half of 2021.

3. **Methane, carbon dioxide, and nitrous oxide from waste.** Emissions from methane, carbon dioxide, and nitrous oxide were 1.3 MT in 2021 making up about 9 per cent of total emissions. The 2021 waste emissions slightly increased from 2020 emissions which were 1.2 MT. 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 through leaks or when burned by landfill gas flares. The City's largest open and closed landfills operate continuous landfill gas collection and flaring systems, which destroy methane and significantly reduce emissions. Wastewater treatment accounted for two per cent of the waste emissions, while organics and yard waste processing accounted for an additional two per cent of methane emissions in the 1.3 MT total.

4. **Electricity.** Emissions from electricity consumption increased by ten per cent even though usage decreased by two per cent in 2021 compared to 2020 (see Section 2.3.1 and Table 3). This is due to the provincial power grid, specifically Portland Energy Centre, using more natural gas to generate electricity than in 2020.

5. **Others.** Separately, the other sources of emissions in Toronto, such as diesel, biodiesel, and aviation fuels do not have a significant impact as compared to the first four sources described above. The combined total of emissions from other sources is 1.3 MT accounting for 9 per cent of emissions.

Further details on key drivers of GHG emissions in Toronto are provided in Section 2.3.

2.2 POPULATION, ECONOMIC GROWTH, AND GHG EMISSIONS

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

Figure 7 shows that GHG emissions in Toronto have increased along with economic prosperity, as measured by gross domestic product (GDP), while the population decreased slightly and energy use remained stable. Before the COVID-19 pandemic in 2020, community-wide emissions were decreasing even as population and GDP rose, indicating that Toronto was on the path to decoupling emissions. Decoupling is defined by the IPCC 'as economic growth which is no longer strongly associated with the consumption of fossil fuels'[14].

Starting in 2016, the GDP and population began to grow at a faster rate the GHG emissions. This is called relative decoupling where both economic growth and emissions both increase but at different rates, with the GDP rising at a faster rate. In 2020 it appeared that GHG emissions in Toronto had absolutely decoupled from economic prosperity population, and energy use. Absolute decoupling is increased economic growth and decreased emissions, with the two becoming independent of each other. In order for Toronto to realise the NZS of a prosperous, net zero city, economic prosperity must be absolutely decoupled from emissions.

However, in 2021 both the GDP and GHGs increased, by six per cent and four percent respectively. This trend shows that Toronto is still following a relative decoupling trend.

[14] https://www.ipcc.ch/sr15/chapter/glossary/

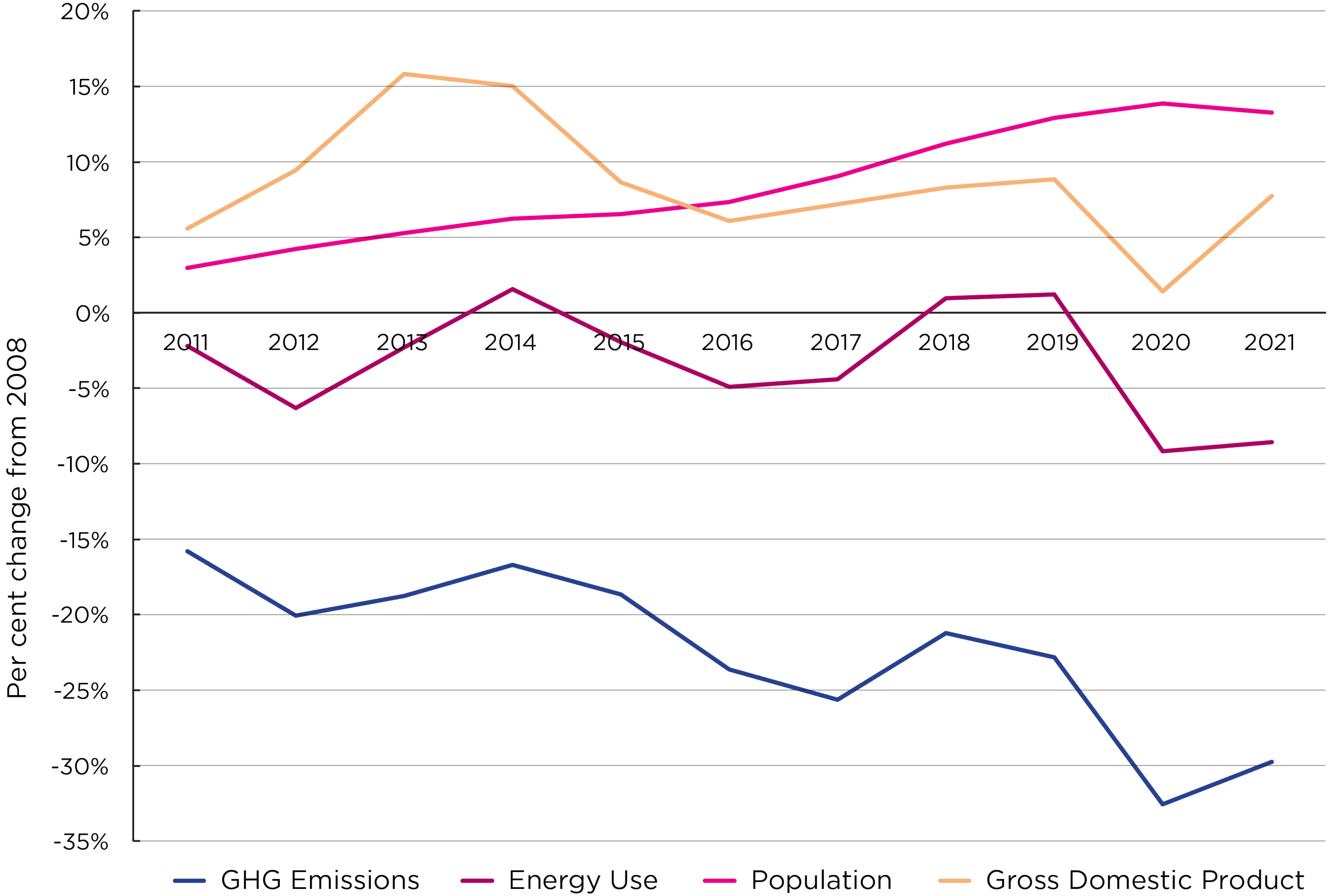


Figure 7: Energy, GHG emissions, and economic indicators (per cent change from 2008 baseline)

2.3 **DETAILS ON GHG EMISSIONS BY SECTOR**

As shown in Figure 8, overall emissions have been declining since 1990 and in 2021, Toronto's emissions were 41 per cent lower than in 1990. This an increase in four per cent from 2020 which was 43 per cent lower than 1990 levels. Additionally, while there is an overall downward trend in emissions in the sectors (Figure 8), it does not appear to be sufficient to meet the targets set out by the City. For example, emissions need to be reduced by 1.0 MT (compared to 2021 levels) to reach the 2025 target of 13.6 MT. A 1.0 MT reduction in emissions equates to removing 28 per cent or 293,643 gas powered cars off the road or 40 per cent (200,751) of single family homes converted to energy efficient homes either by buildings envelope retrofit or fuel switching from natural gas heating to electric heat pumps. This type of large behaviour change would require bold actions by residents, businesses and the City in each sector.

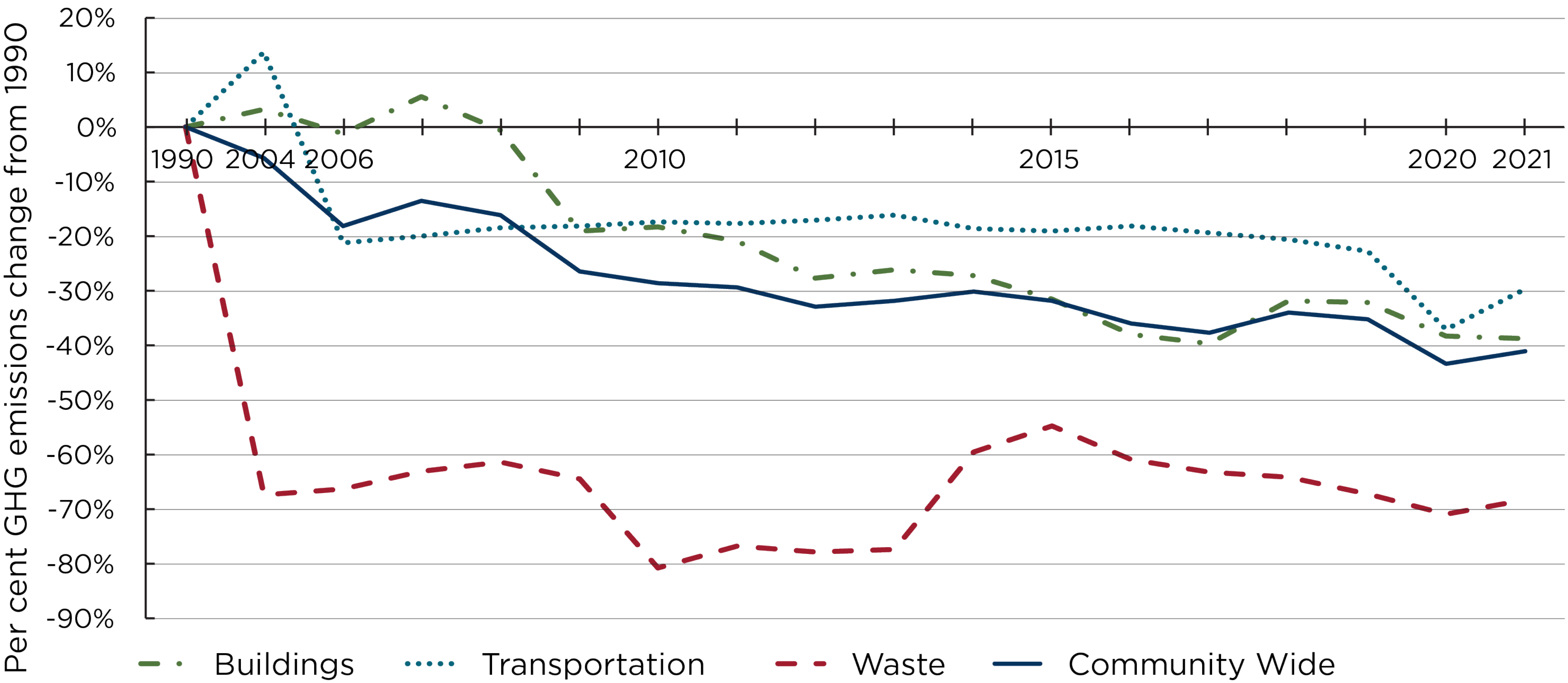
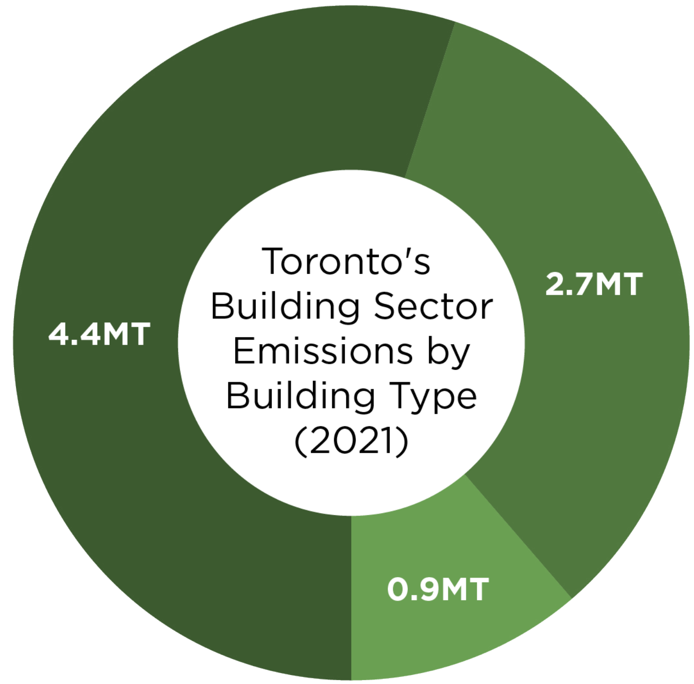


Figure 8: Annual per cent change in emissions by sector relative to 1990 baseline

2.3.1 DETAILS ON GHG EMISSIONS BY SECTOR

In 2021, emissions from residential, commercial, and industrial buildings accounted for approximately 8.1 MT of the city's total inventory, making buildings the largest source of emissions at roughly 56 per cent of community-wide emissions. In 2020, building emissions were 8.2 MT and accounted for 58 per cent.

Figure 9 breaks down the emissions contribution of each building type for 2021– residential (55 per cent), commercial/institutional (34 per sent), and industrial[15] (11 per cent). Figure 10 on the other hand, shows the proportion of emissions coming from the two main energy forms – electricity and natural gas – and how it has changed over time by building type from 1990 to 2021. While the trend in emissions is decreasing over the years this is largely due to decrease in commercial and industrial electricity emissions and natural gas usage. Figure 11 shows that the largest source of emissions, residential natural gas usage, has stayed mostly at the same level since 1990. Figure 11 highlights the large proportion of emissions that come from natural gas, in particular residential usage which accounts for 30 per cent of the community-wide GHG emissions. In 2021, the contribution of emissions from natural gas in buildings is approximately 12 times greater than emissions contributed from electricity. Further, the proportion of natural gas emissions from single-family homes is higher than from multi-unit residential buildings (MURB), at 56 per cent (single-family) compared to 44 per cent (multi-unit residential)[16].



55% Residential

34% Commercial & Institutional

11% Industrial

Figure 9: Percentage breakdown of GHG emissions by building type (2021)

[15] Industrial emissions include emissions from heating and cooling industrial buildings, as well as process emissions.
[16] 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.

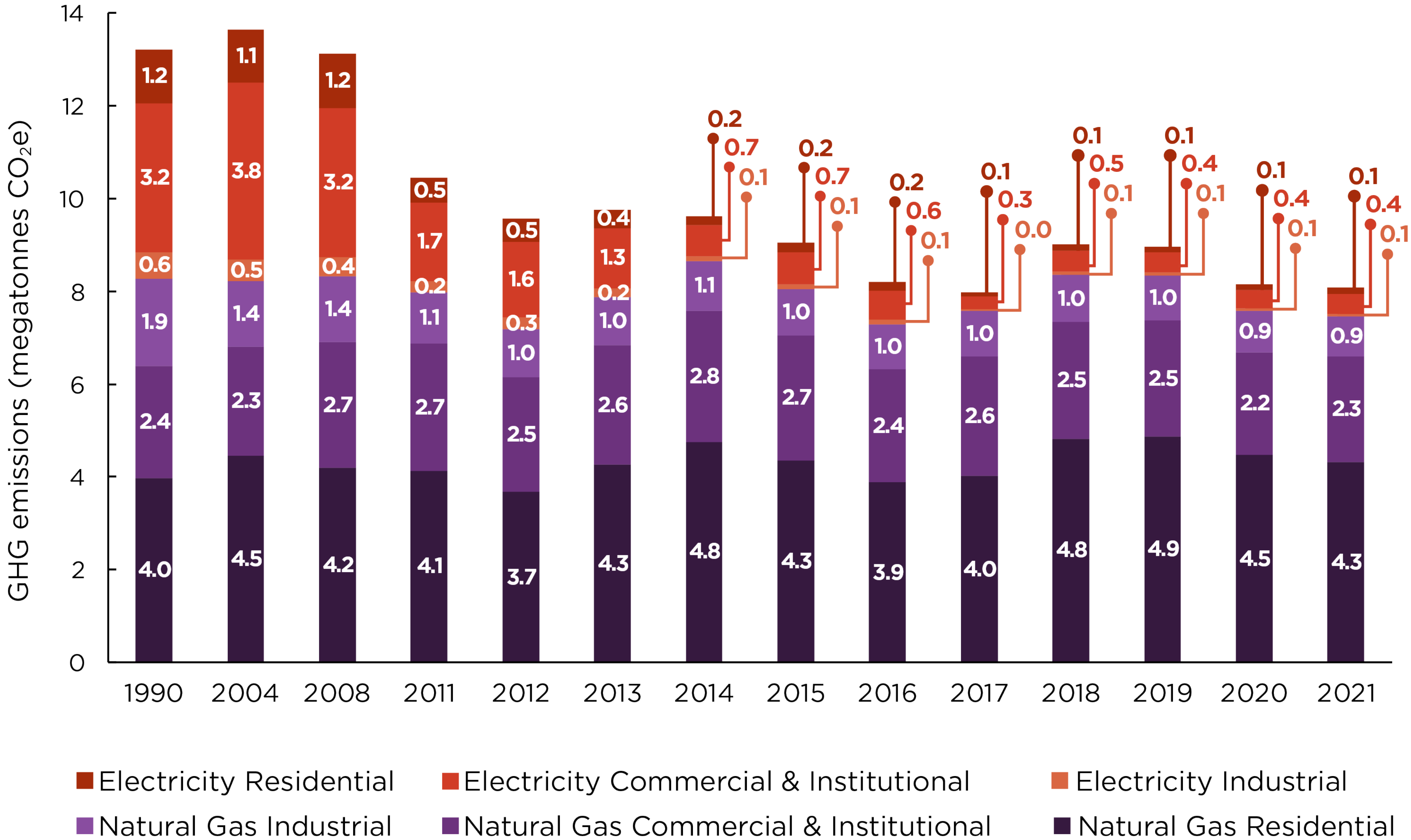


Figure 10: Buildings GHG emissions by energy form from 1990 to 2021

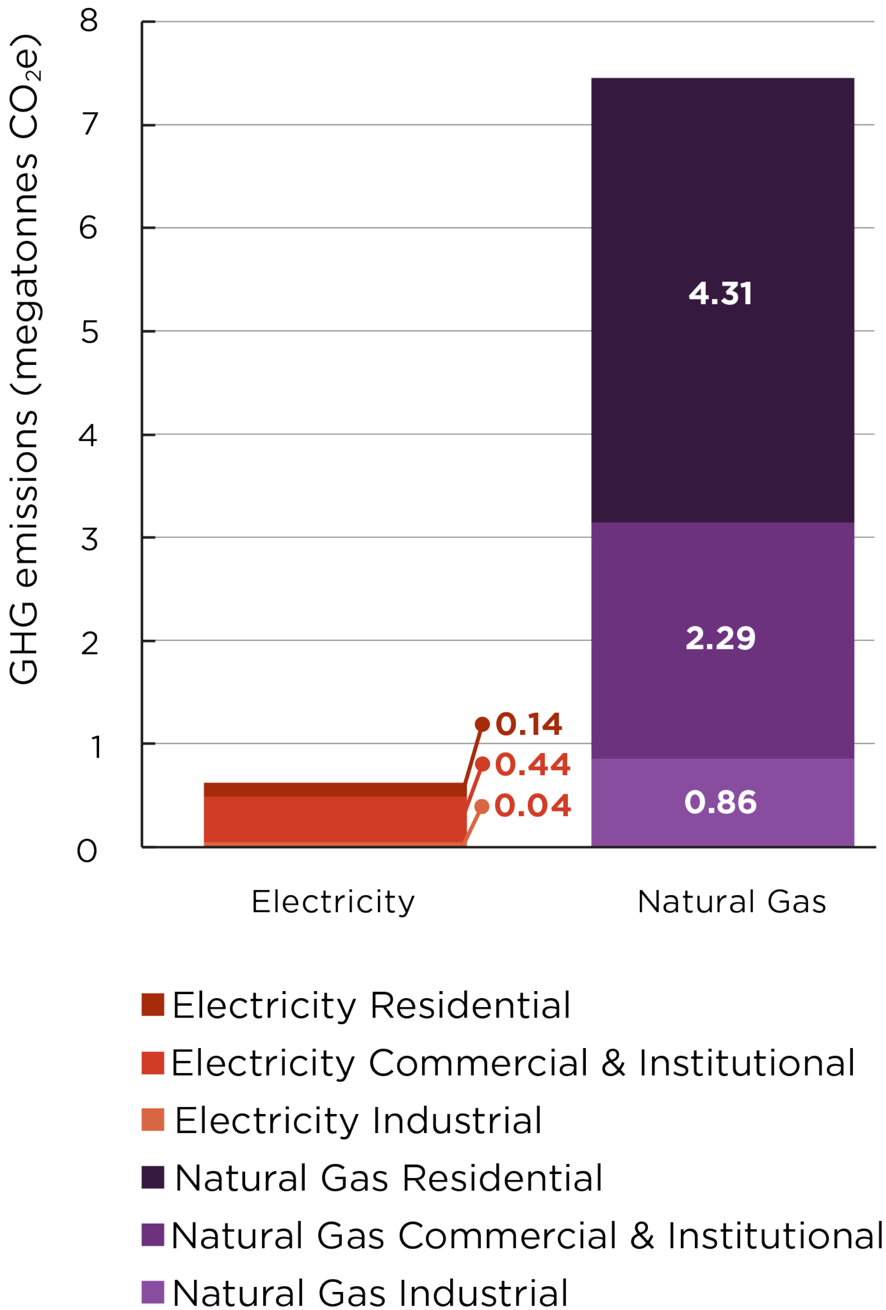


Figure 11: Buildings GHG emissions by energy form (2021)

Relative to 2020, natural gas consumption from residential buildings decreased by about four per cent, while industrial buildings natural gas usage decreased by five percent (Table 2). The decrease in natural gas consumption was primarily 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 D: 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 2021. Commercial and institutional natural gas usage increased by four per cent in 2021, likely due to a rebound in business activities in the latter half of 2021 as pre-pandemic activities resumed.

Artist: Emilia Jajus

Table 2: Natural gas consumption by building type for 2020 and 2021

Building type	2020 natural gas (millions m^3)	2021 natural gas (millions m^3)	Per cent change
Residential	2,314	2,229	-4%
Commercial & institutional	1,142	1,185	4%
Industrial	467	445	-5%
Total	3,922	3,860	-2%

Table 3: Electricity consumption by building type for 2020 and 2021

Building Category	2020 electricity (GWh)	2021 electricity (GWh)	Per cent change
Residential	5,199	5,092	-2%
Commercial & institutional	16,317	16,127	-1%
Industrial	2,098	1,923	-8%
Total	23,615	23,142	-2%

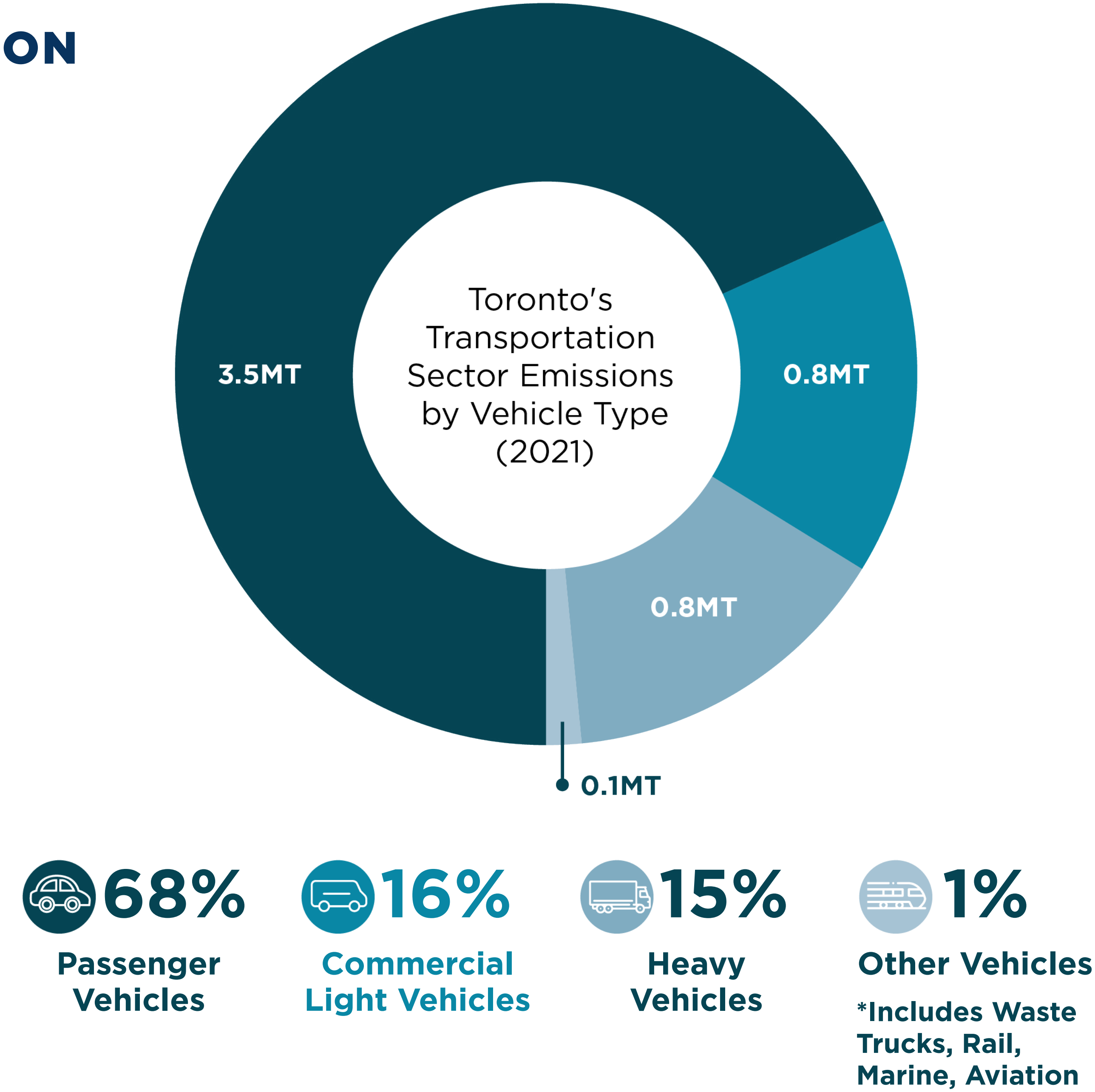
The COVID-19 pandemic also impacted building sector electricity consumption. As shown in Table 3, residential electricity usage in 2021 decreased by two per cent from 2020. Interestingly, commercial, institutional and industrial electricity usage decreased in 2021 from both 2020 and 2019 even though GDP increased during this time (see Figure 10). Due to the limitations of the data, it is unclear if this represents improvements in energy efficiencies realized in commercial and industrial processes or other changes.

How electricity is generated greatly impacts emissions from electricity usage. Ontario's electricity is supplied by nuclear, natural gas, hydro and renewables. Most of the electricity produced in Ontario is generated at nuclear and hydro plants, which produce low levels of GHG emissions. However, in 2021 the amount of natural gas used to generate electricity from the Portlands Energy Centre increased by 88 per cent from the from previous years which increased emissions from electricity[17] usage.

[17] https://www.ieso.ca/en/Power-Data/Data-Directory

2.3.2 **TRANSPORTATION**

Transportation emissions in 2021 were approximately 5.1 MT, accounting for 35 per cent of the community-wide inventory. As shown in Figure 12 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 transportation emissions were attributed to gasoline powered passenger vehicles accounting for 24 per cent of the total community-wide emissions. Included in passenger vehicles are vehicles for hire (VFH) which encompasses taxicabs, limousines, and private transportation companies such as Lyft and Uber and contributes 4-6 per cent of total transportation emissions[18].



[18] https://www.toronto.ca/legdocs/mmis/2023/ec/bgrd/backgroundfile-239119.pdf

Figure 12: Percentage of GHG emissions by vehicle type (2021)

In Figure 12, 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 0.1 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 0.9 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.

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 13, the model shows that Vehicle Kilometres Travelled (VKT) for passenger vehicles[19] increased from 2006 until 2019, decreased in 2020 due to COVID-19 travel restrictions and then increased by roughly six per cent in 2021. Before the COVID-19 pandemic in 2020, passenger vehicle emissions were decreasing, especially from 2013 to 2019, despite the increasing VKT at 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. Once the COVID-19 restrictions were lifted in the latter half of 2021, VKT and emissions rose by six per cent.

Similarly, the VKT and associated emissions from commercial and heavy vehicles[20] were stable from 2006 to 2019, but the COVID-19 pandemic travel restrictions also resulted in a drop in these values in 2020. Of note is the 17 per cent increase in emissions from commercial and heavy vehicles but a negligible increase in vehicle kilometres travelled. Traffic data shows that this is due to an increase in commercial and heavy vehicles on local roads. Driving along local roads leads to more stops and starts, which increases emissions.[21]

As a fuel, gasoline accounts for about 27 per cent of total community-wide emissions.

[19] In Figure 13 "passenger vehicles" includes cars and trucks fueled by gasoline.

[20] In Figure 13 "commercial and heavy vehicles" includes a mix of gasoline- and diesel-fueled vehicles.

[21] There is insufficient data to determine the reason for the observed increase in Commercial Vehicles on local roads, but preliminary data suggests an increase in the average number of daily trips taken by vehicles involved in last-mile deliveries (Kouchakzadeh and Roorda, 2021, https://rb.gy/mr9qmh). These vehicles travel on local roads to deliver to properties, leading to stopping and starting and consequently increased emissions.

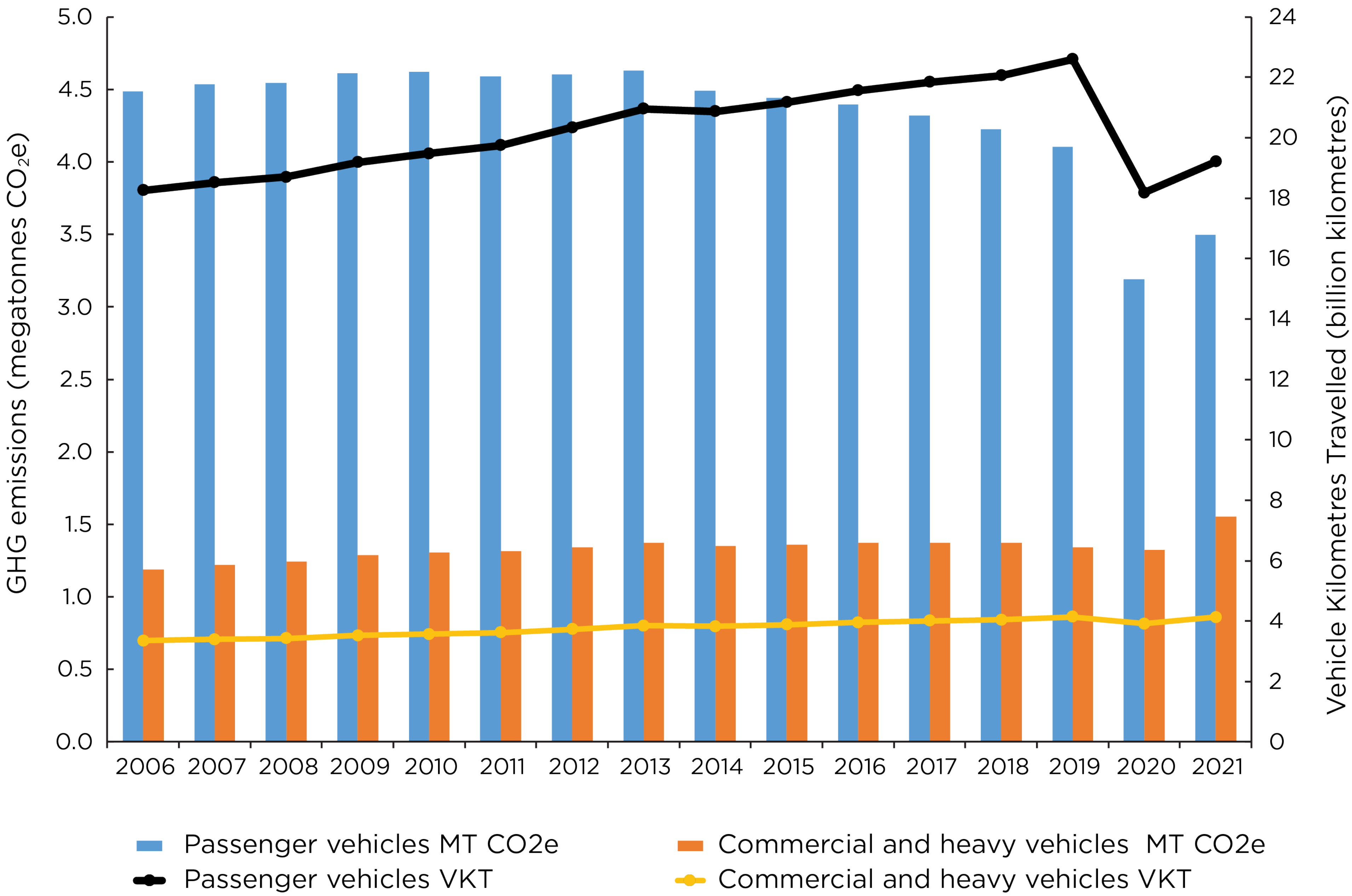


Figure 13: Annual GHG emissions from on-road transportation and associated Vehicle Kilometres Travelled (VKT)

2.3.3 **WASTE**

Artists: University of Toronto collaboration

Waste emissions in 2021 were approximately 1.3 MT, accounting for about nine per cent of the community-wide inventory and is significantly less than the contributions of the buildings and transportation sectors. This is an increase of about 0.1 MT since 2020. Community-wide waste emissions in 2021 were 68 per cent lower than in 1990. Roughly 96 per cent of emissions from the waste sector were landfill emissions, which include emissions estimated from waste disposal in private landfills. The remaining four per cent of emissions is composed of about 0.029 MT from organics and yard waste (two per cent), and 0.026 MT (two per cent) from wastewater treatment processes.

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

CITY OF TORONTO

3 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 treatment, as well as streetlights.

In 2021, corporate emissions were 0.67 MT, which was about five per cent of Toronto's community-wide emissions. The City's corporate emissions increased by four per cent from 2020 but remained a stable share of community-wide emissions between 2020 and 2021.

Figure 14 shows key sources of corporate emissions at the City. Buildings accounted for 43 per cent, the largest source of corporate emissions, followed by transportation emissions at 40 per cent and waste emissions accounting for 17 per cent. Figure 15 shows the downward trend of the emissions from corporate buildings and transportation. It should be noted that corporate transportation emissions increased by six per cent from 2020 due to the lifting of COVID-19 restrictions in the second half of 2021.

As seen in Figure 16, natural gas consumption used primarily for space heating facilities including housing, comprised approximately 43 per cent of all corporate emissions, six per cent lower than 2020 and accounted for the largest single source of emissions. Separately, the City of Toronto buildings accounted for 18 per cent of emissions, while TCHC accounted for 25 per cent of corporate emissions.

Within transportation, diesel and biodiesel emissions accounted for about 83 per cent of corporate transportation emissions, while gasoline emissions represented approximately 13 per cent. Biodiesel emissions from TTC buses were approximately 68 per cent. In 2018, the TTC changed its fuel source for all buses from diesel to biodiesel. Fuel use increased from 69 million litres in 2020 to 71 million litres, which was primarily due to lifting of COVID-19 restrictions imposed on City-related operations in the second half of 2021.

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, methane (produced through waste and wastewater treatment) at about six per cent.

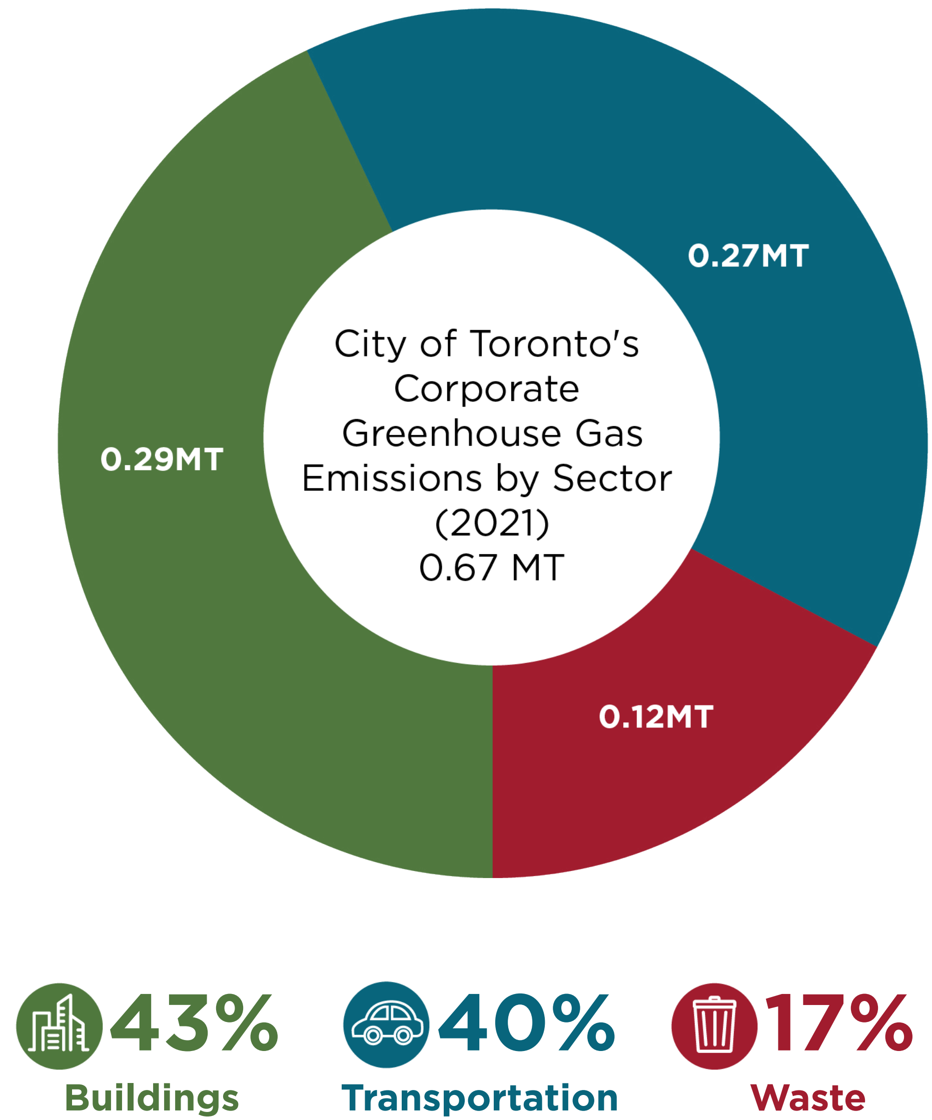


Figure 14: City of Toronto's percentage breakdown of Corporate GHG emissions by sector (2021)

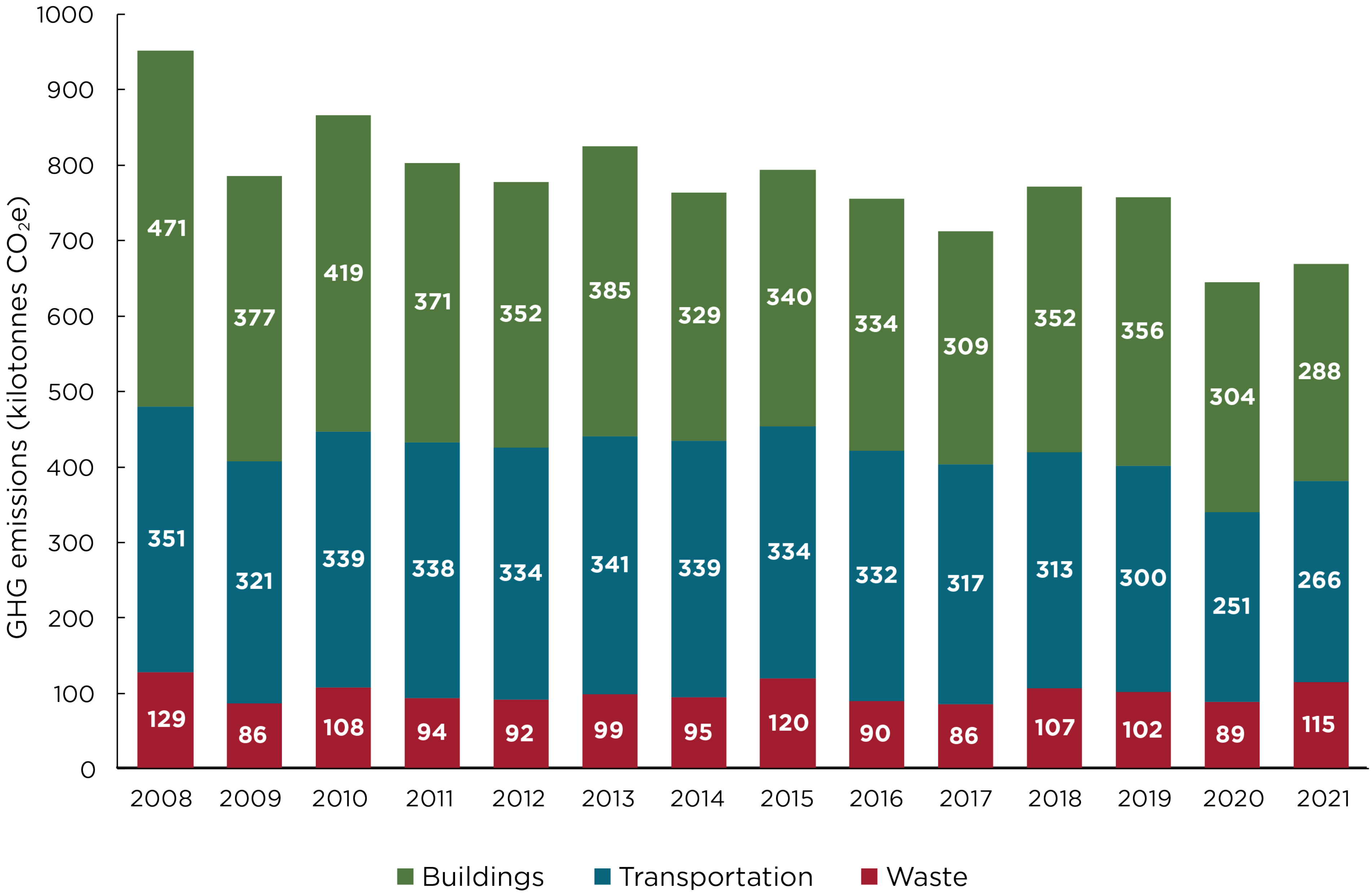


Figure 15: City of Toronto's year-over-year corporate GHG emissions by sector

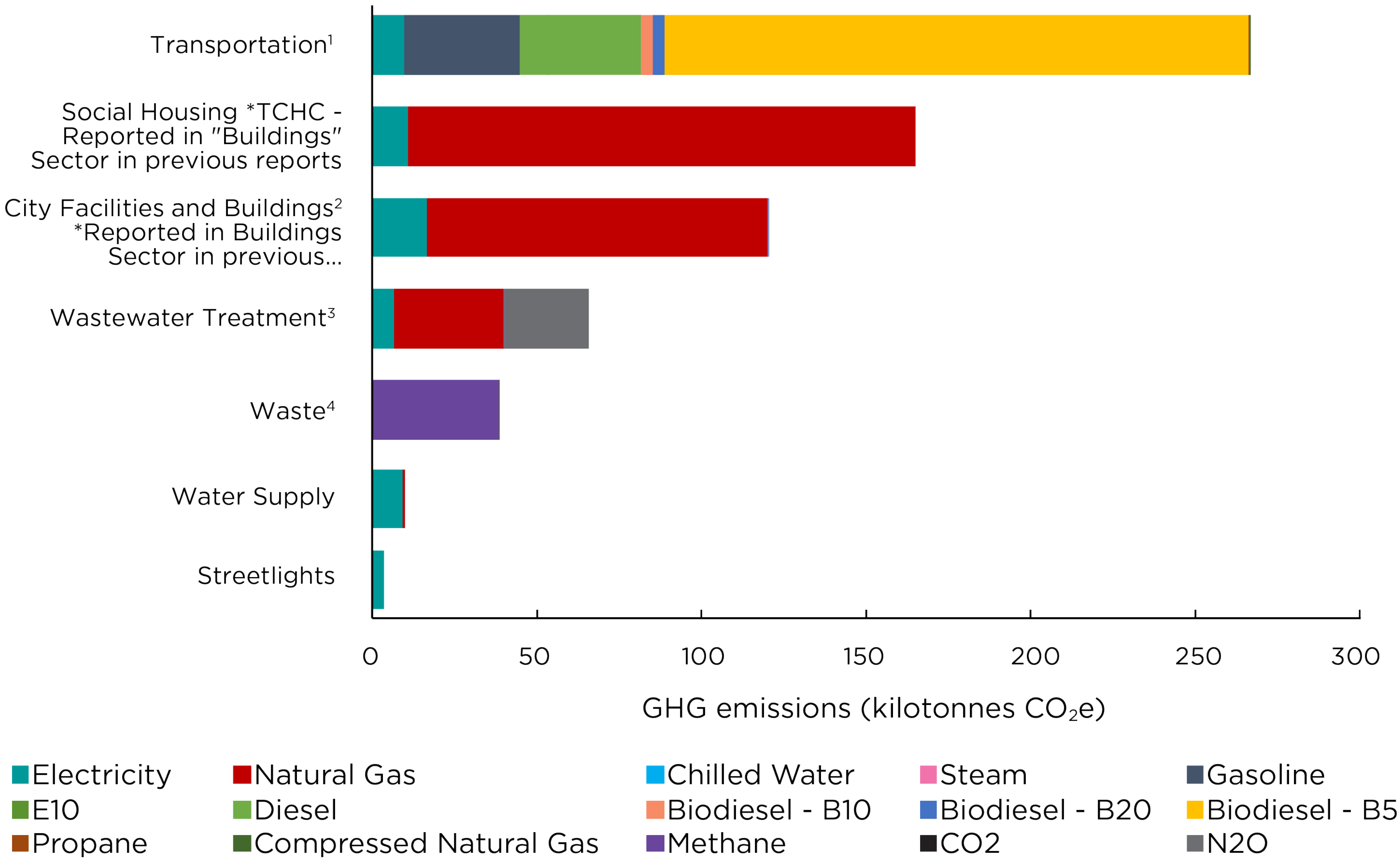


Figure 16: City of Toronto corporate GHG emissions by sector (2021)

[1] Biodiesel - B10 and Compressed Natural Gas values are shown at the end of the Transportation sector
[2] Chilled Water and Steam values are included in City Facilities and Buildings but are too small to be visible at the 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 thie scale

APPENDIX A
Sector-based versus consumption-based emissions inventories

The Sector-Based Emissions Inventory (SBEI) measures the GHGs attributable to emissions generated from 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 year.

Complementary to the SBEI, the consumption-based emissions inventory (CBEI)[22] estimates the total GHG emissions associated with producing, processing, transporting, using and disposing of goods and services consumed by a particular community or entity in a given time frame (e.g., typically one year). Similar to calculations that estimate a household's carbon footprint, a consumption-based emissions inventory focus on consumers. The emissions associated from the purchases of goods and services by Toronto residents, such as the food on grocery store shelves, consumer goods purchased at a store or online, along with larger items like personal vehicles, are all captured by a CBEI. Typically, for these products and services, the majority of GHG emissions are generated outside of Toronto's geographic boundary because many of them are not produced in Toronto (see Figure 17).

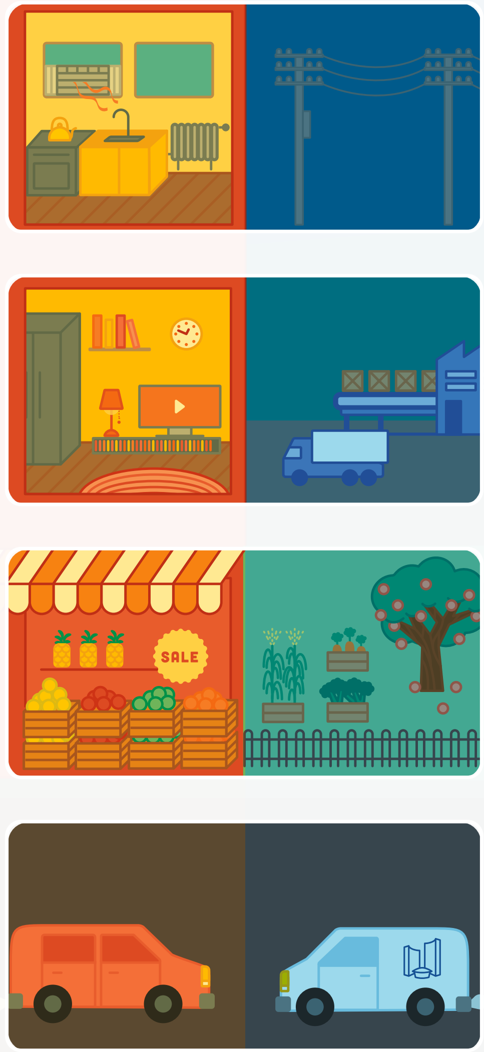
Artist: Chrissy Kuiack

[22] https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-239071.pdf

CBEI VS SBEI: WHAT'S THE DIFFERENCE?

Consumption-based Emissions Inventory (CBEI)

The community-wide CBEI estimates the total greenhouse gas emissions associated with producing, transporting, and using everything consumed by Toronto residents. These emissions can occur inside and outside of city limits.



CBEI	SBEI
Electricity & natural gas used by residents	Electricity & natural gas used by residents, businesses, and visitors in Toronto
All goods & services used by residents	Goods & services produced in Toronto
All food consumed by residents	Food produced in Toronto
All driving by residents	Driving by residents, businesses and visitors in toronto

Sector-based Emissions Inventory (SBEI)

Toronto's SBEI measures greenhouse gas emissions occuring due to activities taking place within Toronto city limits, by businesses. visitors, and residents. Most of these emissions occur locally, but emissions from waste and electricity may occur elsewhere.

Figure 17: Graphical representation of sector-based versus consumption-based GHG emissions inventory

The complementary and overlapping nature of the SBEI and CBEI provide the City with opportunities to align emission reduction activities. For example, in both inventories, transportation (specifically gasoline consumption) and natural gas usage are the two largest sources of emissions (for the full CBEI results, visit Toronto's 2019 Consumption-Based Greenhouse Gas Emissions Inventory). By supporting efforts to reduce and/or eliminate emissions from natural gas and gasoline, Toronto would be able to reach the sector-based goals while also reducing the consumption-based footprint. This can be partly achieved by residents and businesses increasing actions that support non-automobile low carbon transportation modes like walking, cycling and taking transit, along with reducing natural gas usage by using low carbon space heating options, like heat pumps.

APPENDIX B
Disclosures

B.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 GHG Greenhouse Gas Emission Inventories (GPC), version 1.1[23]. 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[24].

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 2021 GHG emissions aligned with the BASIC reporting sectors is shown in Table 4, reported in tonnes of carbon dioxide equivalent (tCO_2e). Please refer to Table 5 for definitions of emissions scopes, as per the GPC.

[23] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

[24] 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 4: Toronto's BASIC 1990 (baseline year) and 2021 (current reporting year) community-wide GHG emissions

Sector	Emission sources	1990 GHG Emissions (tCO_2e)[a]	2021 GHG Emissions (tCO_2e)[a]
Stationary energy	Residential buildings (Scope 1,2, & 3)	5,134,821	4,395,915
	Commercial and institutional buildings and facilities (Scope 1,2, & 3)	5,632,007	2,699,446
	Manufacturing industries and construction (Scope 1,2, & 3)	2,447,289	904,438
	Fugitive emissions from oil and natural gas systems (Scope 1)	0	86,221
Transportation	On-road transportation (Scope 1, 2 & 3)	7,293,440	5,049,564
	Railways (Scope 1 & 2)	0	56,258
	Waterborne navigation (Scope 1 & 2)	0	1,214
	Aviation (Scope 3)	0	405
	Off-road transportation (Scope 1 & 3)	0	20,499
Waste	Solid waste generated in the city (Scope 1 & 3)	4,171,771	1,263,716
	Biological waste generated in the city (Scope 1 & 3)	0	28,521
	Wastewater generated in the city (Scope 1)	0	25,911
Total GHG emissions		24,679,328	14,532,109
Change in GHG emissions from the baseline year (1990)			-10,147,220
Total Population		2,349,931	2,974,293
Total per capita GHG emissions (tCO_2e / capita)		10.50	4.89
Change in GHG emissions per capita from the baseline year (1990)			-53.48%
Percent change in GHG emissions from base year (1990)			-41.12%
Energy Use (GJ)		0	346,270,604
Total per capita Energy Use (GJ / capita)			116.42

[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 5: 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, vehicles, for hire, commercial and 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 Toronto's waste emissions. In addition, there is a small portion of emissions from organics and yard waste processing, and wastewater treatment processes. Emissions from privately managed waste are estimated.

B.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)[25] to share Toronto's progress and benchmark against other cities facing similar challenges.

For the fifth year in a row, the City of Toronto is recognized on the 2023 Carbon Disclosure Project (CDP) Cities "A" List for its leadership and transparency on climate action. Toronto was one of 119 cities globally to receive an "A" rating.

[25] https://www.cdp.net/en/scores

APPENDIX C
Methodology

The purpose of Appendix C 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 GHG 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.

C.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[26]. 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 6.

Table 6: Global Warming Potential (GWP) of major GHGs

GHG	GWP
CO_2	1
CH_4	34
N_2O	298

[26] https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

C.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

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)[27] as a primary source of its emission factors. Typically, Environment Canada releases the NIR two years after a given calendar year (i.e. the 2021 emission factors were released in 2023). The City updates its previously reported annual emissions estimates when compiling its latest inventory upon revised emission factors becoming available for previous inventory years.

Artist: Pam Lostracco

[27] https://publications.gc.ca/site/eng/9.506002/publication.html

C.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 9):

- 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/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.
- Number of single family homes required to convert to energy efficient homes either by buildings envelope retrofit or fuel switching from natural gas heating to electric heat pumps needed to reduce emissions by 1.0 MT by 2025 was calculated by the following:

A. 2021 Single family natural gas emissions	2,377,539 Source: Enbridge Gas Residential Consumption x NIR Emission Factor
B. 2021 Single family natural gas customers	497,970 Source: Enbridge Gas Residential Customer Counts
C. Emissions per single family customers	4.77 (A/B)
D. Amount GHG reduction needed by 2025	958,478
E. Number of single family natural gas customers needed to reach net zero	200,751 or 40% (D/C)

C.4 COMMUNITY-WIDE TRANSPORTATION SECTOR

Transportation sector emissions in Toronto are classified primarily into the following sub-categories (as shown in Figure 12 of the inventory):

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

Most of Toronto's transportation sector emissions come from on-road transportation. As discussed in Section 2.3.2, most on-road transportation emissions are estimated using a model developed by the University of Toronto, the Traffic Emissions Prediction Scheme (TEPs)[28]. 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 and 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.

[28] https://teps.ca/

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.
- 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.

C.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 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 operating 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 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 emissions estimate formula and emission factors recommended by the GPC Protocol.

C.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 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 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 C.5 Community-wide waste sector.

APPENDIX D
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 7[29] shows that in 2021 Toronto's winter was warmer and summer was slightly cooler compared to 2020. Figure 18 further shows that Toronto's 2021 HDD was lower than the city's 25-year HDD average, which means building heating needs were lower in 2021. In contrast, Toronto's 2021 CDD was higher than the city's 25-year CDD average, but slightly lower than 2020, which means air conditioning needs were lower in 2021. This implies that Toronto experienced a warmer winter and a hotter and longer summer in 2021 than historically.

[29] 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 7: Annual Heating Degree Days (HDD) and Cooling Degree Days (CDD) in Toronto (1990-2021)

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%
2021	3,340	464	-5.01%	-6.26%

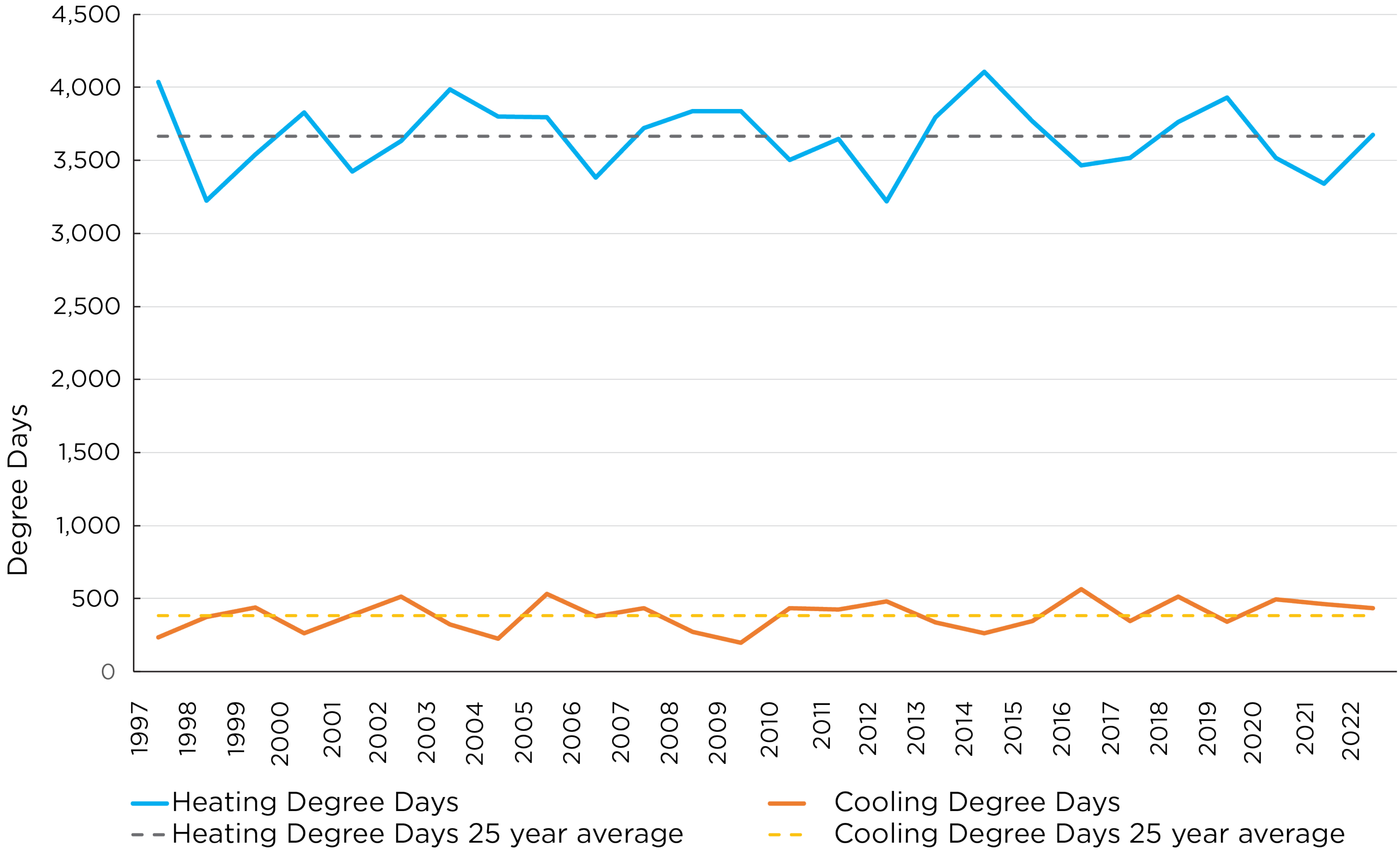


Figure 18: Annual Heating Degree Days (HDD) and Cooling Degree Days (CDD) in Toronto

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