CITY OF TORONTO

2022 SECTOR-BASED EMISSIONS INVENTORY

TORONTO

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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

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 are an estimate of all GHG emissions[1] that occur within Toronto for the sectors of stationary energy, transportation, waste, industrial processes and product use. The estimate also includes emissions from certain activities that occur outside Toronto, including emissions from the use of electricity, steam, and/or heating/cooling supplied by grids which cross city boundaries, and emissions from fuel use in waste collection vehicles travelling to waste disposal sites outside of city boundaries. Community-wide emissions are currently estimated using the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC), version 1.1[2].
Consumption-based emissions inventory	A consumption-based emissions inventory (CBEI) is a calculation of all GHG emissions 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 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.

[1] The GPC requires cities to report, as possible, on the seven sources of GHG emissions currently required for most national GHG inventory reporting under the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). Toronto currently reports on CO_2, CH_4 and N_2O emissions.

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

Term	Definition
Fossil (natural) gas	Fossil (natural) gas is a naturally occurring gas comprised primarily of methane and other hydrocarbons. It is used as a source of energy for heating, cooking and in the production of electricity[3]. In Toronto's previous sector-based emissions inventory reports, emissions related to fossil (natural) gas were reported as emissions from "natural gas".
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).
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 into the atmosphere is equivalent to the amount taken out of the atmosphere.
Sector-based emissions inventory	A sector-based emissions inventory (SBEI) measures 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 during a given time (typically one year).

The values reported annually in Toronto's sector-based emissions 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 2022 sector-based emissions inventory. Values may not add up to totals due to rounding.

[3] https://www.cer-rec.gc.ca/en/data-analysis/glossary/index.html

KEY FINDINGS

In 2022, Toronto's community-wide greenhouse gas (GHG) emissions were 15.5 megatonnes (MT) of carbon dioxide equivalent (CO_2e), a five per cent increase over the 14.8 MT CO_2e emitted in 2021. Emissions were 36 per cent lower than 1990 levels. In comparison to 2019 (pre-pandemic), Toronto's emissions were four per cent lower in 2022. The sources that contributed the largest percentage of emissions in Toronto were fossil (natural) gas heating in residential buildings and gasoline combustion in passenger vehicles, which represented 29 per cent and 23 per cent of Toronto's community-wide emissions respectively.

NET ZERO BY 2040

The sector-based emissions inventory is Toronto's main tool for measuring community-wide and corporate-wide progress towards net zero. The 2022 inventory results, although increasing slightly in emissions community-wide, remain generally consistent with an overall downward trend in emissions over time; however, it is clear that the current pace of emissions reductions is unlikely to meet the City's 2025 emissions target. A 2.1 MT CO_2e reduction in annual emissions would be required to meet the 2025 target and Toronto is not moving at this pace. This 2.1 MT reduction would be equivalent to removing 58 per cent (650,887) of gas-powered cars from the road[4], or converting 83 per cent (413,416) of single-family homes from fossil (natural) gas heating to electric heat pumps[5]. More than ever, alignment in actions to reach Toronto's future emissions targets (65 per cent reduction from 1990 levels by 2030, and net zero by 2040) must be made across all levels of government, the private sector and individuals in order to achieve significant emissions reduction progress. Whether action is taken in the near-term will determine if Toronto can achieve its net zero by 2040 target.

Buildings remained the primary source of GHG emissions in Toronto in 2022, accounting for 56 per cent of community-wide emissions, a slight increase in emissions share from 55 per cent in 2021. The largest source of these emissions was fossil (natural) gas heating in residential buildings, accounting for 29 per cent of community-wide emissions in 2022. Fossil (natural) gas emissions from residential buildings have remained relatively stable since 1990.

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

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 2022. This was about the same emissions share as in 2021. These emissions were mostly attributable to gasoline used in passenger cars and trucks, accounting for 23 per cent of community-wide emissions in 2022. In 2022, the total kilometres travelled by commercial and heavy vehicles rose seven per cent and emissions from these vehicle classes likewise rose seven per cent. The total emissions from passenger cars and trucks increased by three per cent.

Waste sector emissions, primarily from landfills, were the third largest source of GHG emissions in Toronto, accounting for roughly nine per cent of community-wide emissions in 2022. This was about one per cent lower than in 2021.

In 2022, the City of Toronto's corporate emissions from City-owned buildings, vehicle fleets, waste, and water supply and wastewater treament were 0.83MT, accounting for about five per cent of Toronto's community-wide emissions. Corporate emissions increased four per cent since 2021, from 0.80 MT. These emissions were 13 per cent below 2008 levels and it will require a concerted effort to reach the 2030 target of a 65 per cent GHG emissions reduction from 2008 levels. Corporate emissions were roughly equally distributed across the buildings, transportation, and water & wastewater sectors in 2022. Although emissions sources are equal across these sectors, the City has existing policies and processes, such as the corporate carbon budget, enabling immediate action to reduce buildings and transportation emissions. Supported by these tools, the City aims to reduce its use of fossil fuels to heat City- and TCHC-owned buildings (fossil (natural) gas) and power fleet vehicles (diesel and gasoline).

1 BACKGROUND

1.1 Toronto's sector-based emissions inventory

The City's TransformTO Net Zero Strategy (NZS)[6] 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 for 2025 and 2030. 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 2022 sector-based emissions inventory (SBEI) presents the quantity and sources of Toronto's emissions during the year 2022. It tracks the City's progress towards meeting its GHG emissions reduction targets. It also informs City-led climate programs and initiatives, such as the Toronto Carbon Accountability System[7] and TransformTO NZS. The SBEI provides the main benchmark against which the success of these initiatives and other emissions reduction 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 discloses 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 enables the City to be transparent on its progress to reduce GHG emissions. For the fifth year in a row, the City of Toronto was recognized on the 2023 CDP Cities "A" List for its leadership and transparency on climate action[8]. Toronto was one of 119 cities globally to receive an "A" rating.

The City relies on Environment Canada's National Inventory Report (NIR)[9] as a primary source for emission factors used to calculate 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 2022 emission factors were released in 2024). When completing its annual emissions inventory, the City updates its previously reported annual emissions estimates using the latest (revised) emission factors for previous inventory years, as published in the NIR.

[6] https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-235849.pdf
[7] https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-235864.pdf
[8] Due to delays by CDP, the 2024 CDP Cities "A" List was yet not released at the time this inventory was published.
[9] https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/inventory.html

1.2 City-led GHG emissions reduction actions in Toronto

This SBEI provides opportunities to understand the city-wide impacts of individual and collective actions from citizens, businesses, visitors, and all 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 activities undertaken by the City to support, enable, or achieve emissions reductions include:

- **Fossil (natural) gas use in buildings**
  Fossil (natural) gas usage for heating buildings is the largest source of Toronto's emissions. To address this, the City has a comprehensive strategy to reduce building emissions: the Net Zero Existing Buildings Strategy[10]. This strategy outlines nine key policy actions that the City will take to accelerate the uptake of retrofits by home and building owners, while maximizing potential benefits and minimizing potential harms to building owners and tenants[11].

- **Electricity emission factor**
  As seen in this report, electricity emissions increased by eight per cent in 2022 as a direct result of increased fossil (natural) gas power generation. When fossil (natural) gas is burned to generate electricity, GHG emissions increase – specifically, the "emission factor" for electricity generated in Ontario (i.e. the amount of GHG emissions relative to one unit of electricity generated, or tonnes of CO_2e per kilowatt hour generated) increases. The City cannot directly control how electricity is generated as this is under provincial jurisdiction. However, the City actively supports, advocates and partners with the provincial and federal governments to decarbonize the provincial electricity grid, promote energy conservation and enable local distributed renewable energy generation.

[10] https://www.toronto.ca/wp-content/uploads/2021/10/907c-Net-Zero-Existing-Buildings-Strategy-2021.pdf
[11] https://www.toronto.ca/services-payments/water-environment/net-zero-homes-buildings/key-city-strategies-for-net-zero-buildings/

• **Gasoline emissions from passenger vehicles**
Gasoline usage for transportation is the second largest source of Toronto's sector-based emissions. Among other activities, the City is expanding cycling and pedestrian infrastructure[12], including rolling out new and upgrading existing cycling routes[13], installing bicycle parking and implementing a bicycle-sharing system at or near TTC stations. Toronto's Vision Zero Road Safety Plan[14], a comprehensive action plan focused on eliminating traffic related fatalities and serious injuries on Toronto's streets adopted in 2017 and continually updated[15], is related and complementary to these initiatives. To further address emissions from transportation, the City passed a bylaw in 2023 mandating all vehicles-for-hire (VFH) operating in the city must be zero-emission by 2031[16,17].

• **Methane emissions from solid waste management**
Methane emissions from existing and closed landfill sites and organics processing facilities (anaerobic digestion facilities) are a key driver of emissions, and some of the largest producers of biogas and landfill gas in Ontario. Toronto's Solid Waste Management Services Division (SWMS) is harnessing the green energy potential of these gases by upgrading its biogas and landfill gas to renewable natural gas (RNG)[18]. RNG produced through biogas upgrading can be blended with the fossil (natural) gas that the City buys to create a lower-carbon fuel blend to be used across the organization, instead of traditional fossil (natural) gas. The fuel blend is used to power City vehicles and heat City-owned facilities. Two biogas upgrading facilities are now online at the Dufferin and Disco Road Organic Processing Facilities, with a combined annual RNG output of 6.3 million cubic metres of RNG[19]. By 2028, the City will have installed RNG infrastructure at the currently active Green Lane Landfill, which is expected to produce approximately 24.7 million cubic metres of RNG per year.

[12] https://www.toronto.ca/services-payments/streets-parking-transportation/cycling-in-toronto/torontos-cycling-infrastructure/, https://secure.toronto.ca/council/agenda-item.do?item=2024.IE14.3
[13] https://www.toronto.ca/wp-content/uploads/2024/05/8fea-2023-Toronto-Cycling-Year-in-Review.pdf
[14] https://www.toronto.ca/services-payments/streets-parking-transportation/road-safety/vision-zero/
[15] https://secure.toronto.ca/council/agenda-item.do?item=2023.IE7.4
[16] https://www.toronto.ca/legdocs/mmis/2023/ec/bgrd/backgroundfile-239119.pdf, https://secure.toronto.ca/council/agenda-item.do?item=2023.EC6.6
[17] There are ongoing policy and emissions modelling efforts at the City of Toronto examining the efficacy of zero-emission vehicle (ZEV) policies on reducing community-wide GHG emissions, including on the federal Light-Duty Zero Emission Vehicle Mandate (https://www.canada.ca/en/environment-climate-change/news/2023/12/canadas-electric-vehicle-availability-standard-regulated-targets-for-zero-emission-vehicles.html). Modelling efforts will help inform future policy decisions at the municipal level related to ZEVs. Further information on the modelling is available here: https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/local-emissions-for-net-zero-modelling-suite/
[18] https://www.toronto.ca/services-payments/recycling-organics-garbage/solid-waste-facilities/renewable-natural-gas/; https://secure.toronto.ca/council/agenda-item.do?item=2020.IE14.7
[19] The City used 155.2 million cubic metres of fossil (natural) gas in 2022.

The City, like other municipal governments across Ontario, has limited tools to reduce GHG emissions generated within Toronto's territorial boundary (**Figure 1**). Approximately five per cent of GHG emissions are the direct responsibility and under the direct control of the City of Toronto government (see Section 3.1 for further details). Corporate emissions include those from City-owned buildings and vehicle fleets, and to a certain extent[20] municipal waste and wastewater management. The City is taking action to reduce its corporate emissions through established programs and major policy achievements[21] such as:

- The Corporate Real Estate Management Net Zero Carbon Plan[22] for City-owned buildings
- Enhancing sustainable procurement policies[23]
- Greening City[24] and TTC fleets[25] through the Sustainable City of Toronto Fleets Plan[26]
- Application of the Toronto Green Standard V4 for City buildings, which in 2022 has mandated that all new City-owned buildings be net zero[27]
    - For example, as of 2024, construction is 75 per cent complete on the City's first net zero energy and emissions community recreation facility, the North East Scarborough Community and Child Care Centre[28]. 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.
    - Since 2022, the Toronto Green Standard has mandated that all new City-owned buildings will be net zero.
- Implementing the Single-use and Takeaway Items Reduction Strategy, including amendments to the Single-Use and Takeaway Items Bylaw[29]

[20] Waste and wastewater management emissions are connected to the volume (and, for waste, composition) of waste and wastewater produced by the community. The City controls waste and wastewater management options and infrastructure, given the waste and wastewater produced in the community.
[21] https://secure.toronto.ca/council/agenda-item.do?item=2024.IE12.3
[22] https://secure.toronto.ca/council/agenda-item.do?item=2021.IE23.2
[23] https://secure.toronto.ca/council/agenda-item.do?item=2024.GG12.18, https://www.toronto.ca/legdocs/mmis/2024/gg/bgrd/backgroundfile-245309.pdf
[24] https://secure.toronto.ca/council/agenda-item.do?item=2023.IE3.5
[25] https://www.ttc.ca/riding-the-ttc/TTC-Green-Initiatives/
[26] https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-235807.pdf
[27] https://www.toronto.ca/city-government/planning-development/official-plan-guidelines/toronto-green-standard/toronto-green-standard-version-4/city-agency-corporation-division-owned-facilities-version-4/
[28] https://www.toronto.ca/city-government/planning-development/construction-new-facilities/new-parks-facilities/north-east-scarborough-community-and-child-care-centre/
[29] https://secure.toronto.ca/council/agenda-item.do?item=2024.IE13.6

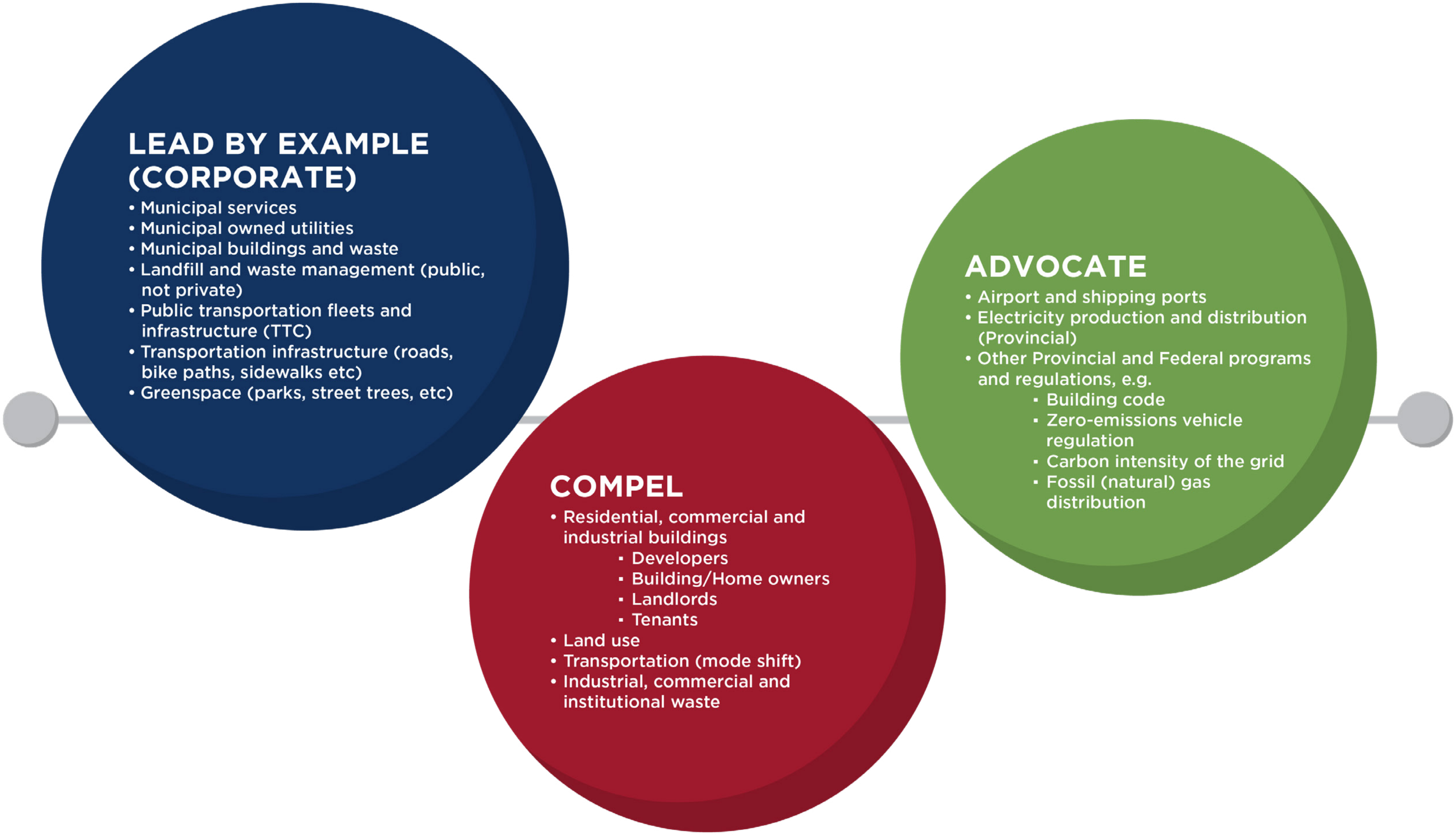


Figure 1: Understanding the City's authority, influence and advocacy related to GHG emissions sources

1.3 Emerging issue: Increasing electricity generation emissions in Ontario

Electricity generation is outside of municipal control and is under provincial jurisdiction (**Figure 1**). Electricity generation directly impacts emissions associated with electricity usage in the city. Ontario's electricity is supplied by nuclear, fossil (natural) gas, hydroelectricity (hydro) and renewables. Most of the electricity produced in Ontario is generated at nuclear and hydro plants, which produce low levels of GHG emissions. Beginning in 2021, the amount of fossil (natural) gas used to generate electricity increased substantially from previous years, which increased total emissions from electricity usage in Toronto. In 2021, 25 per cent more fossil (natural) gas was used to generate electricity province-wide than during 2020; a further 25 per cent more fossil (natural) gas was used in 2022 than during 2021[30]. Annual electricity usage in Toronto increased a negligible 1.6 per cent in 2022 while emissions from Toronto's electricity usage increased eight per cent, attributable to an increase in fossil (natural) gas-generated electricity province-wide[31].

An example of increasing fossil (natural) gas electricity generation is occurring at the Portlands Energy Centre (PEC), the fossil (natural) gas electrical generating station located in Toronto. PEC's electricity generation increased 88 per cent from 2020 to 2021, and then remained stable in 2022[32].

Photo Credit: Ryan Walker & Vid Ingelevics

[30] https://www.ieso.ca/en/Power-Data/Data-Directory
[31] https://data-donnees.az.ec.gc.ca/data/substances/monitor/canada-s-official-greenhouse-gas-inventory/C-Tables-Electricity-Canada-Provinces-Territories/?lang=en, Table A13-7: Electricity Generation and GHG Emission Details for Ontario
[32] The increase in 2021 also represented 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, as calculated using data from IESO. https://ieso.ca/en/Power-Data/Data-Directory

Looking to the future, the emission factor for electricity generated in Ontario (i.e. the amount of GHG emissions relative to one unit of electricity generated, or tonnes of CO_2e per kilowatt hour generated) is projected to increase even more because of greater fossil (natural) gas use at PEC and other fossil (natural) gas electricity generating stations[33]. It is important that Toronto be aware that as electricity emissions increase alongside usage (e.g. fuel switching to electricity for space heating and vehicle power), efforts to reduce emissions from fossil (natural) gas may be undermined if the grid continues to be carbon intensive.

The Net Zero Strategy asserts that the backbone of a net zero Toronto must be an emissions-free electricity grid that both delivers energy more efficiently to address the demands of an increasing population and increasing electricity consumption by buildings and vehicles, while remaining a stable, reliable power source during extreme weather events[34]. With this objective in mind, Toronto has established direction on municipal renewable energy programs[35] that will increase local renewable energy generation to contribute to a resilient, carbon-free grid, including:

- Working with Toronto's local utility, Toronto Hydro, to increase the number of and ease of installing solar and battery storage projects on City-owned lands[36],
- Encouraging and facilitating larger scale heat exchange projects[37],
- Developing corporate standards for solar and battery storage installation on City assets, and frameworks to facilitate renewable thermal energy infrastructure under City land assets and heat exchange infrastructure on the Lake Ontario lakebed.

[33] Toronto Atmospheric Fund, 2024. https://taf.ca/publications/ontario-electricity-emissions-factors-2024/
[34] https://www.toronto.ca/wp-content/uploads/2024/03/95d3-Attachment-1-Annual-TransformTO-Net-Zero-Progress-and-Accountability-Report.pdf
[35] https://secure.toronto.ca/council/agenda-item.do?item=2023.IE9.7
[36] Key changes have been implemented. See Toronto Hydro Climate Action: 2023 Year-End Status Report, page 11: https://www.torontohydro.com/documents/20143/193303016/climate-action-2023-year-end-status-report.pdf
[37] Including the City's first renewable energy district, the Etobicoke Civic Center Project, in collaboration with Enwave (https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-240803.pdf) and first wastewater energy project, in collaboration with Noventa Energy Partners (https://secure.toronto.ca/council/agenda-item.do?item=2022.MM47.61)

2 CITY OF TORONTO COMMUNITY EMISSIONS

2.1 Status of Toronto's GHG emissions and progress to targets

Figure 2 shows that community-wide emissions have decreased since 1990 and the City achieved its 2020 emissions reduction target, however, community-wide emissions then increased in 2021 and 2022. Following the unprecedented impacts of the COVID-19 pandemic in 2020 and 2021 on activities that are responsible for GHG emissions, 2022 was the most representative year since 2019 demonstrating Toronto's annual GHG emissions under "normal" conditions. The City's 2025 target of a 45 per cent emissions reduction from 1990 levels is likely not feasible given the current emissions level and required trajectory over time: a 2.1 MT reduction in annual emissions would be required to achieve the 2025 target, which equates to removing 58 per cent (650,887) of gas-powered cars from the road[38] or 83 per cent (413,416) of all fossil (natural) gas-heated single-family homes switching from fossil (natural) gas furnaces to electric heat pumps[39]. The scale of these fuel switches is not likely achievable within the timeframe of the 2025 target.

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

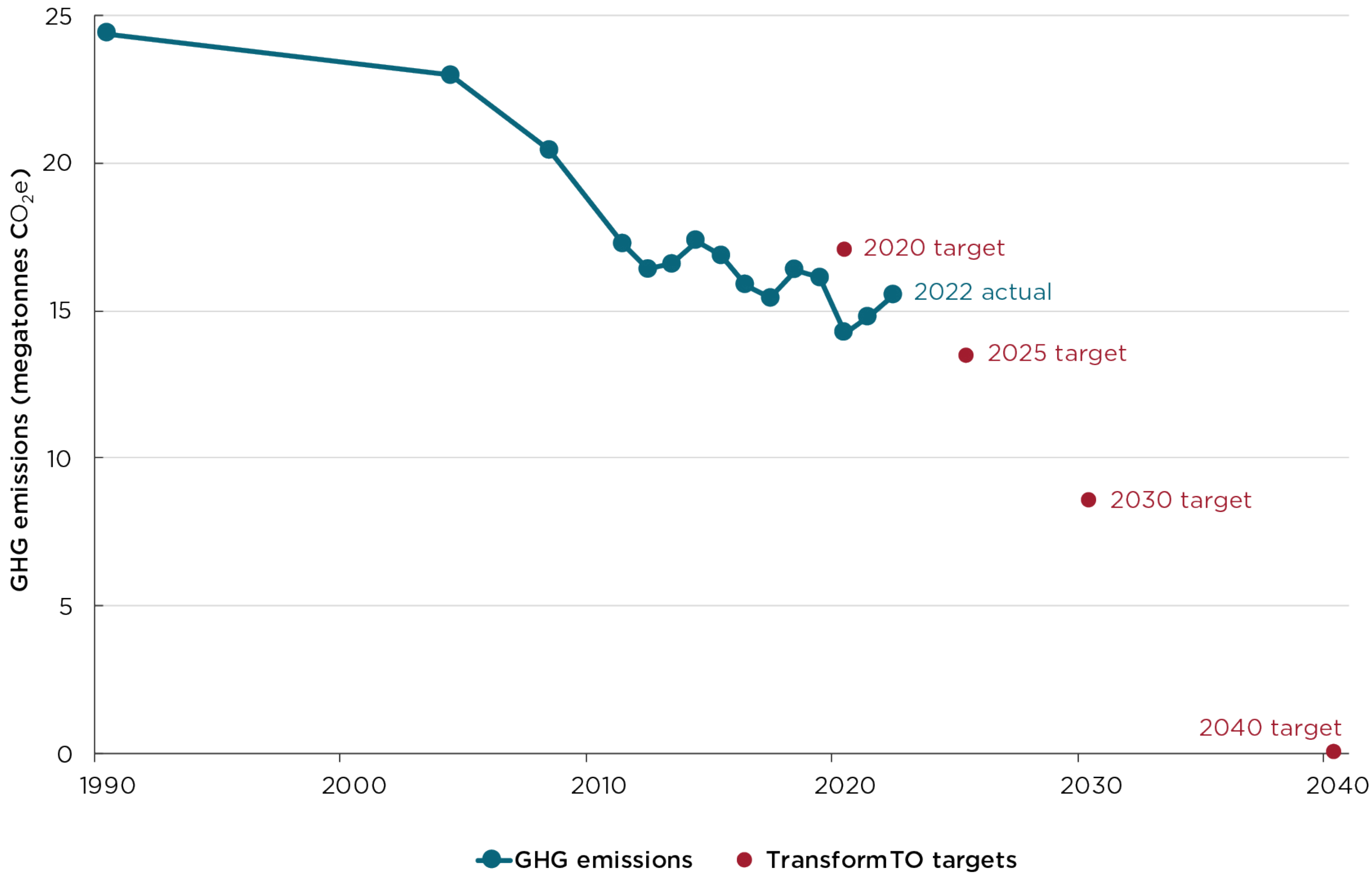


Figure 2: Toronto's GHG emissions and Council-approved GHG emissions targets

All years for which the City has complete annual community-wide emissions data are included as data points (dots) on **Figure 2**. Due to data availability limitations, the City does not have complete annual data for 1991 to 2003, 2005 to 2007, or 2009 to 2010. Straight lines connecting data points that are more than one year apart do not depict the interannual emissions trajectory over those time periods.

Table 1 displays the Council-adopted community-wide GHG emissions targets and the City's GHG reduction progress as of 2022. As a whole, Toronto needs to cut its annual emissions by roughly 7.0 MT to meet the City's 2030 target of a 65 per cent emissions reduction below 1990 levels.

Table 1: Council-adopted community-wide GHG emissions targets and 2022 status

Year	Percentage GHG reduction target from 1990 baseline	Absolute GHG emissions target (MT CO_2e)[a]	Progress as of 2022
2020	30 per cent	17.1 MT	The City achieved its 2020 GHG reduction target. In 2020[b], Toronto's community-wide emissions were 14.3 MT, which is 42 per cent lower than in 1990.
2022	N/A	N/A	In 2022 Toronto's community-wide emissions were 15.5 MT, which is a 5 per cent increase from 2021. This remains below the 2020 reduction target and is 36 per cent lower than 1990.
2025	45 per cent	13.4 MT	To reach this target, annual emissions need to be reduced by 2.1 MT from 2022 levels. This is unlikely to be achieved given the current pace of emissions reductions as compared to the required trajectory.
2030	65 per cent	8.5 MT	Toronto must reduce annual emissions by about 7.0 MT from 2022 levels to meet the 2030 target. Toronto's annual emissions must be rapidly reduced to make significant progress towards this target.
2040	Net zero	Net zero	15.5 MT in annual emissions must be eliminated from 2022 levels to meet the 2040 target. Whether action is taken in the near-term will determine if Toronto can achieve this target.

Notes:
a Emissions target calculated relative to 1990 baseline emissions of 24.4 MT.
b Although 2020 was an irregular year due to the COVID-19 pandemic, note that the City's 2019 community-wide GHG emissions were 34 per cent lower than 1990 levels, achieving the 30 per cent reduction target set for 2020 one year early.

2.2 Population, economic growth and GHG emissions

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

Figure 3 shows the trends in Toronto's GHG emissions, energy use, population and gross domestic product (GDP, used as an indicator of economic prosperity) over time since 2008. In 2022, all of these indicators increased. The increase in population was relatively small (two per cent) compared with changes in the other three indicators.

Decoupling is defined by the IPCC as economic growth which is no longer strongly associated with the consumption of fossil fuels[40]. Starting in 2016, Toronto's GDP and population began to grow at a faster rate than GHG emissions. This is called relative decoupling, where both economic growth and emissions increase but at different rates, with GDP rising at a faster rate[41]. In 2020, it appeared that GHG emissions in Toronto had demonstrated absolute decoupling from economic prosperity, population and energy use. Absolute decoupling is defined as increased economic growth and decreased emissions from fossil fuel use, with the two becoming independent of each other[42]. For Toronto to become an economically prosperous, net zero city, economic prosperity must absolutely decouple from GHG emissions.

However, 2020 was an abnormal year due to the COVID-19 pandemic, and the absolute decoupling observed was likely a result of broad COVID-19 impacts across society. In 2021 and 2022, both GDP and GHG emissions increased (by nine per cent and five percent, respectively, in 2022), while population increased by two per cent year-over-year in 2022. This pattern shows that Toronto is still following a relative decoupling trend.

[40] https://www.ipcc.ch/sr15/chapter/glossary/
[41] Ibid.
[42] Ibid.

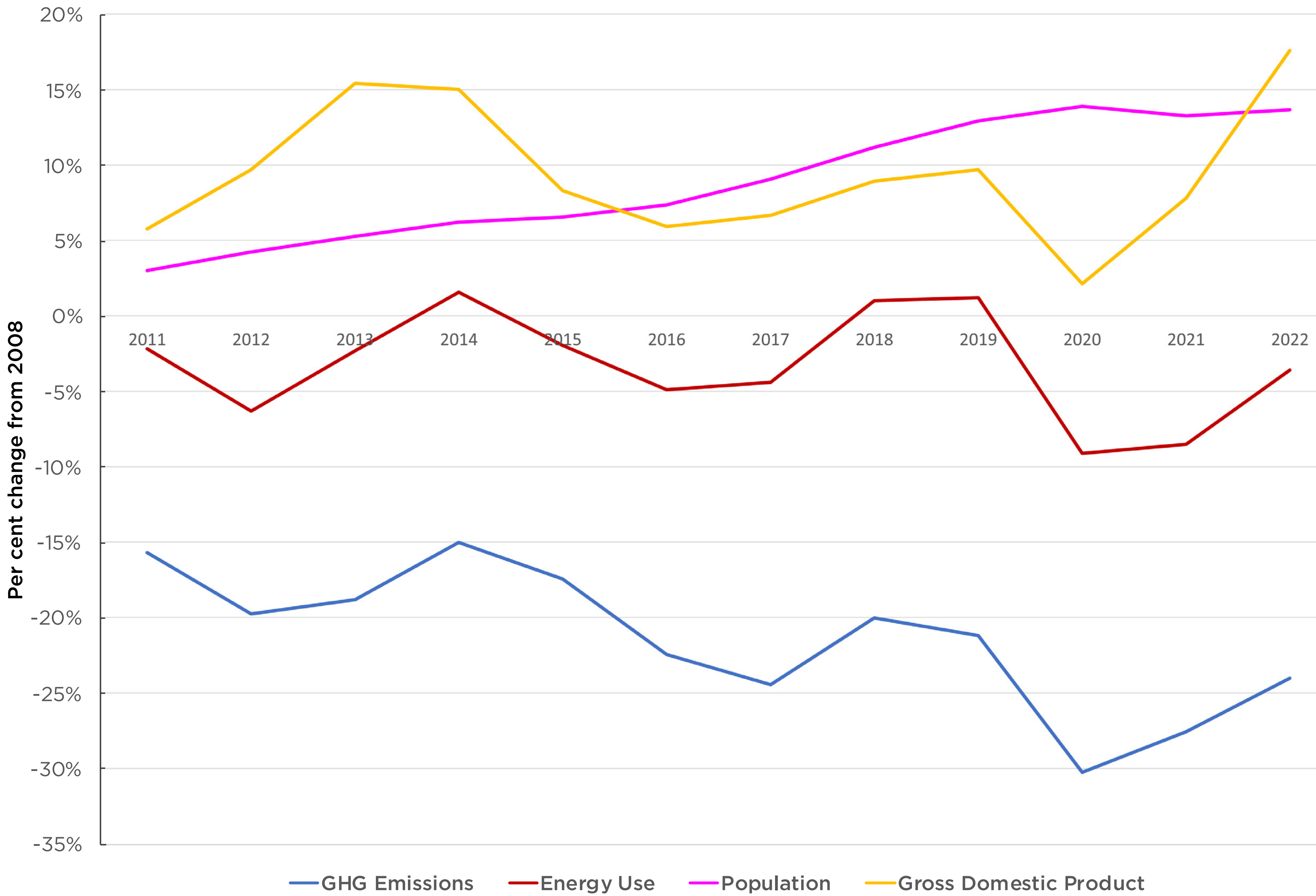


Figure 3: Energy, GHG emissions and economic indicators (per cent change from 2008 baseline)

2.3 Sector-level findings summary

Figure 4 presents the proportion each sector contributed to total annual emissions in 2022, while **Figure 5** shows the year-over-year changes in sectoral emissions from 1990 to 2022 .

- **Buildings:** In 2022, buildings sector emissions were 8.7 MT, representing 56 per cent of overall community-wide emissions, with most of those emissions attributable to fossil (natural) gas used for space and water heating. This was a slight increase from 2021 (8.2 MT emissions from buildings), likely due to the cooler 2022 winter (please see Appendix D: Heating and cooling degree days).
- **Transportation:** 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:** 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 2.5.

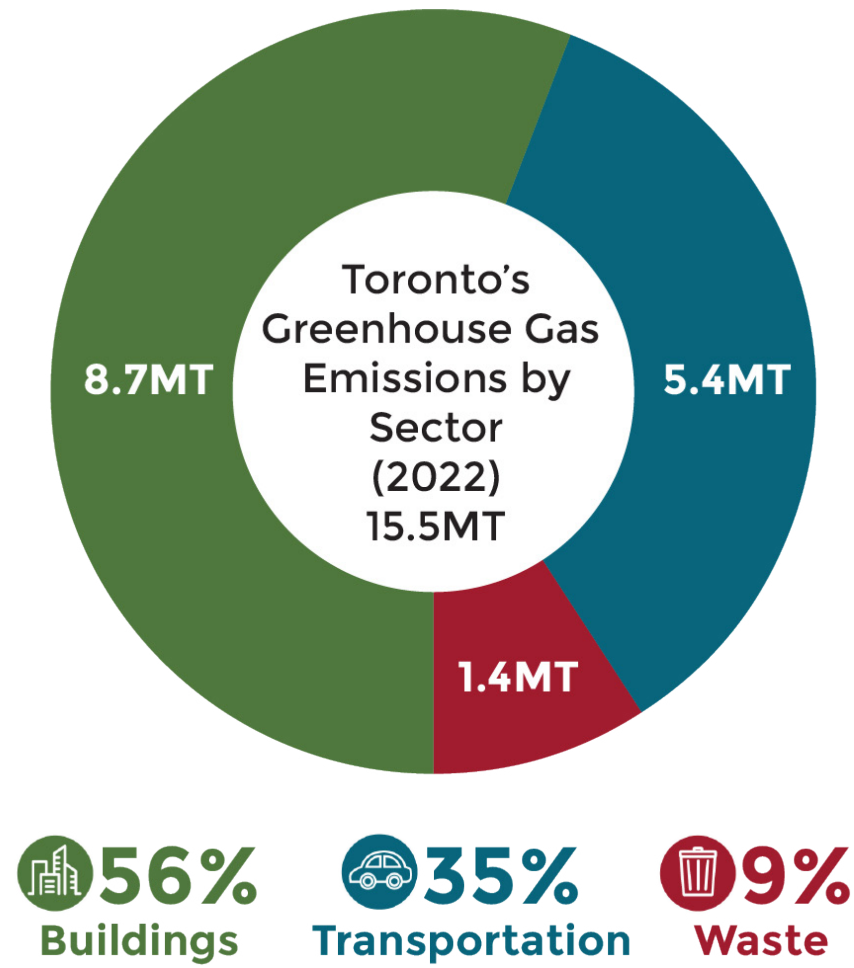


Figure 4: Toronto's percentage breakdown of community-wide GHG emissions by sector (2022)

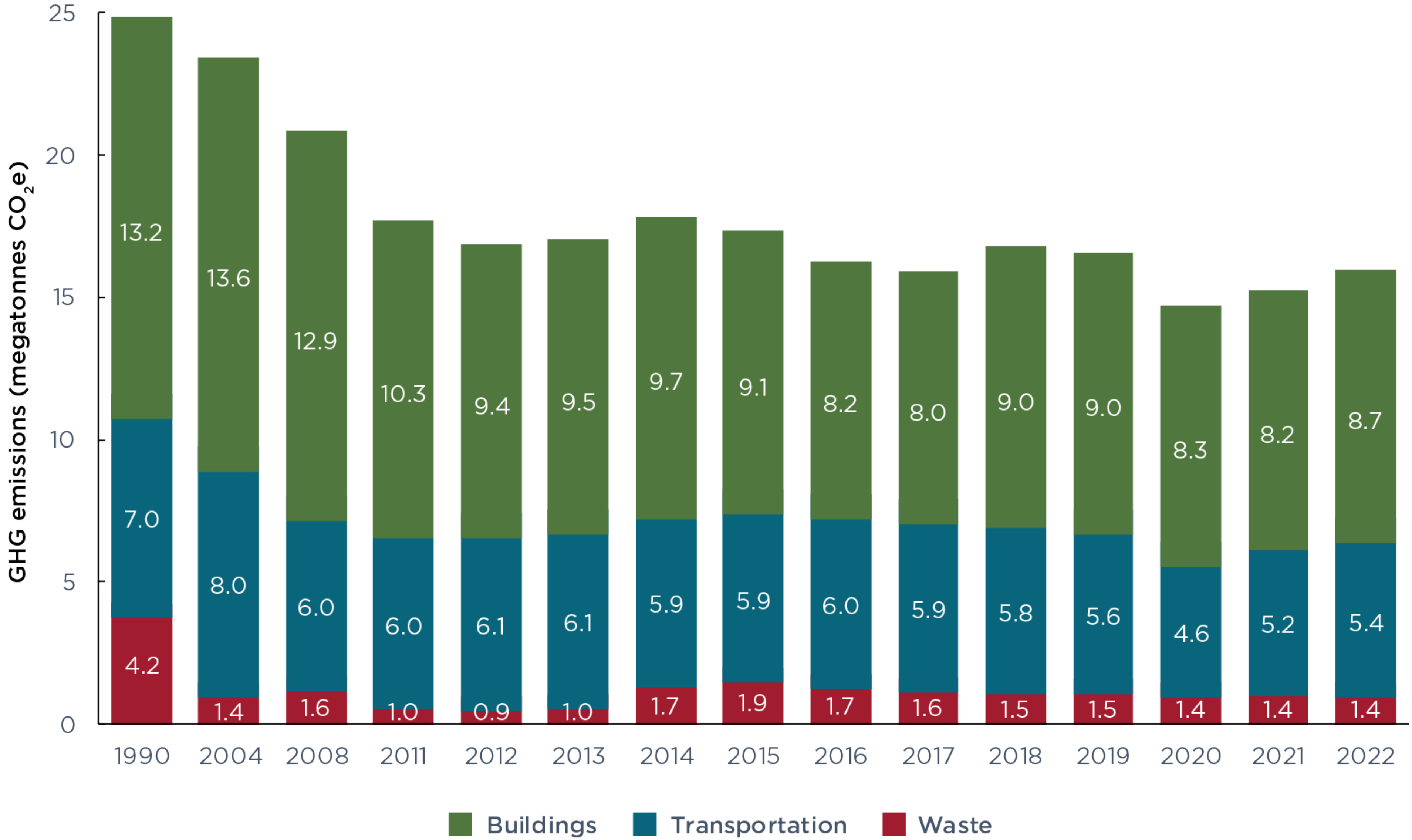


Figure 5: Toronto's year-over-year community-wide GHG emissions by sector

Figure 6 presents a Sankey diagram, a data visualisation tool that illustrates the proportion of emissions by sector (left column of the diagram) and source (middle and right columns). The thickness of each coloured link shown flowing from left to right is proportional to the quantity of GHG emissions represented. Thicker links indicate more emissions, thinner links indicate less emissions. Reading the diagram from the left side, Toronto's total community-wide GHG emissions (15.5 MT) are divided into the sectors of buildings, transportation and waste (left column). Moving to the center column, each sector's emissions are then shown by their component categories; for example, buildings is divided into commercial, industrial and residential, the three categories of buildings included in the inventory.

In the right column, these categories are further divided into specific emissions sources; to continue our example for buildings, the emissions sources are electricity and fossil (natural) gas. Individually, fossil (natural) gas heating in residential buildings (4.5 MT) and gasoline combustion in passenger vehicles (3.6 MT) contributed the largest percentage of emissions to the community-wide emissions total. Residential fossil (natural) gas use represents 29 per cent of Toronto's sector-based emissions. Passenger vehicle gasoline use accounts for 23 per cent. The Sankey diagram (**Figure 6**) demonstrates that two basic daily activities many people carry out, heating homes with fossil (natural) gas and getting around the city in a gasoline-fueled car, are the top two sources of emissions.

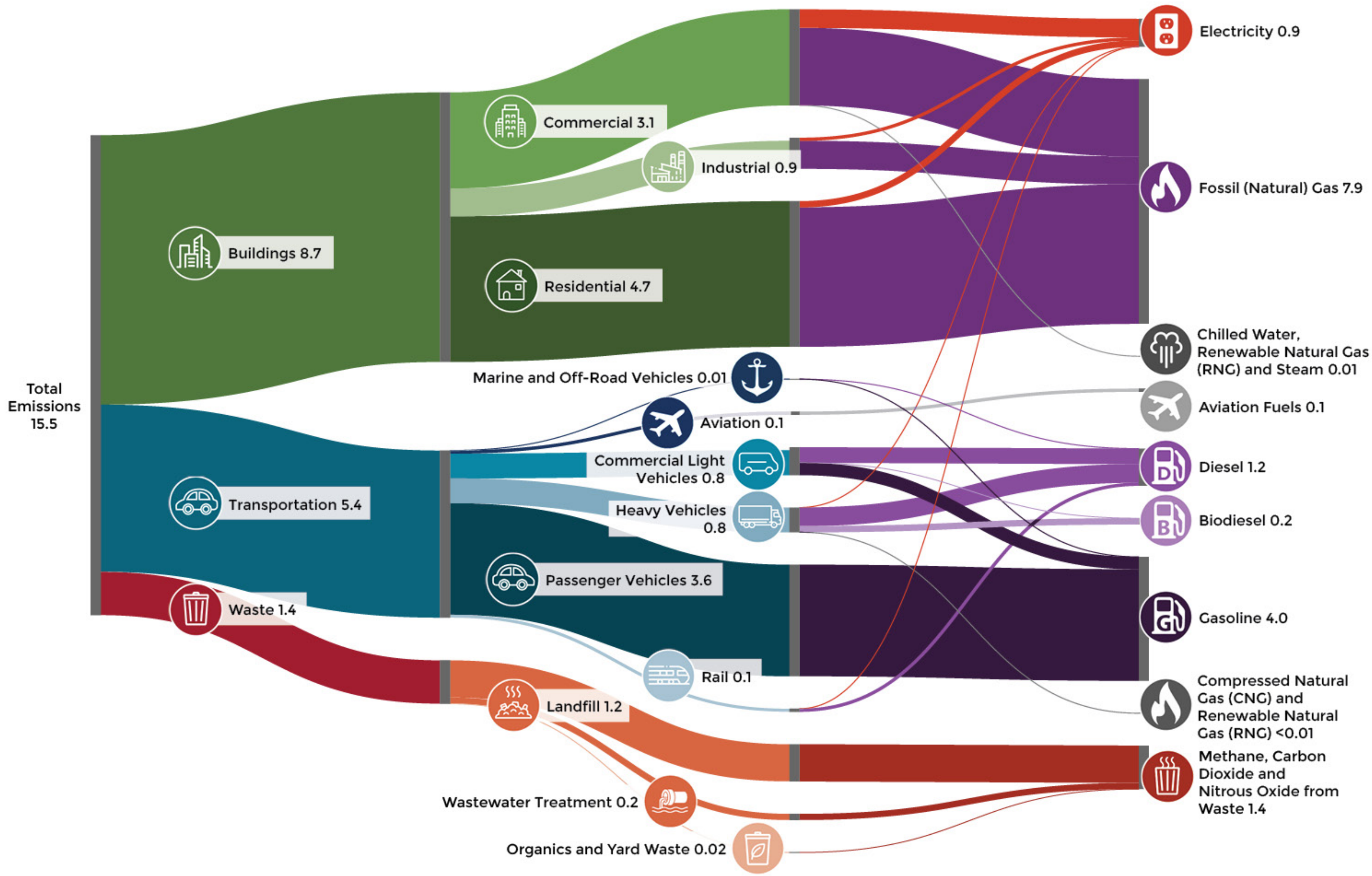


Figure 6: Sankey diagram of Toronto's community-wide emissions (MT) by sector and emissions source (2022)

2.4 Key drivers of community-wide GHG emissions

Toronto's community-wide emissions are driven by several main sources, as shown in **Figure 7**.

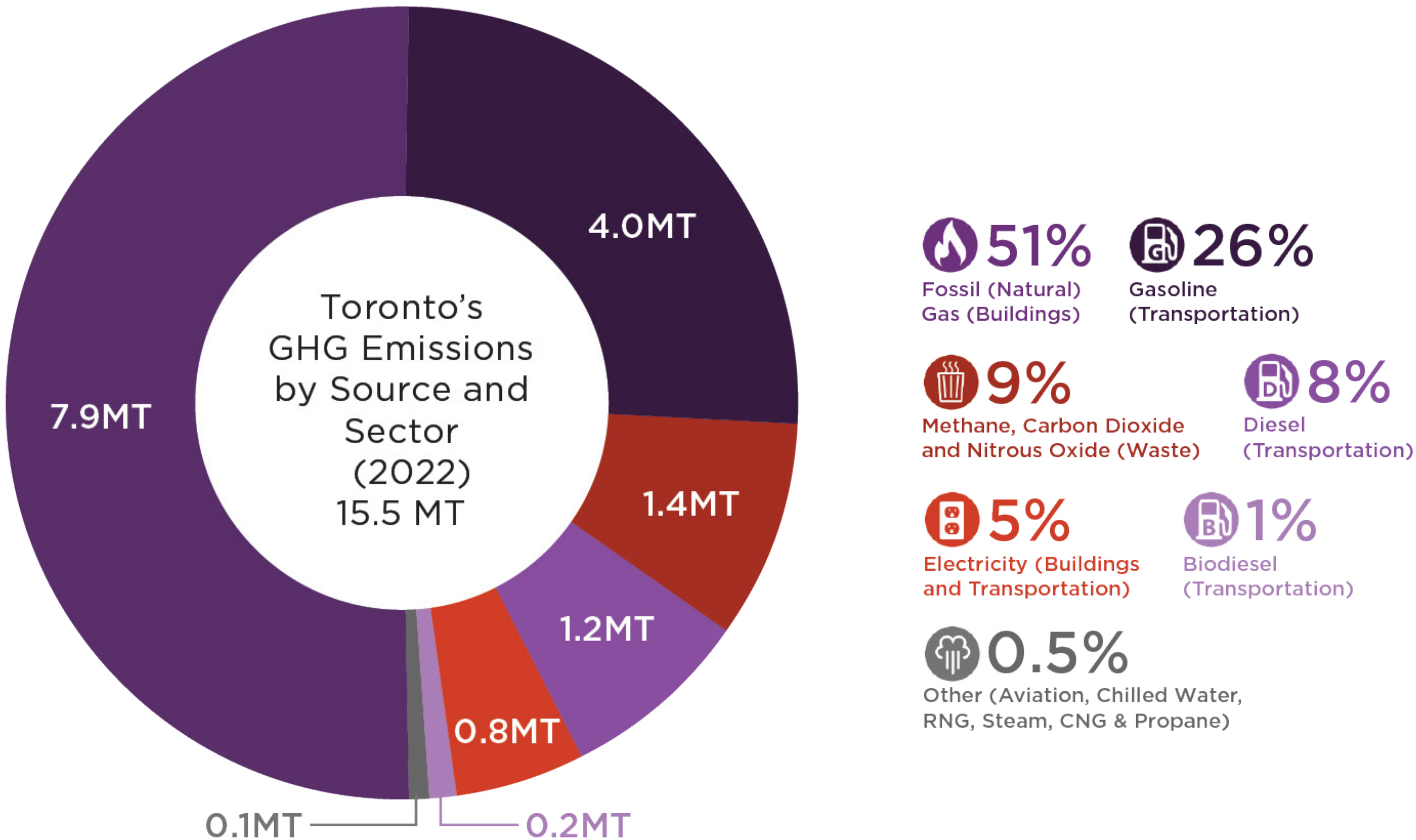


Figure 7: Key drivers of community-wide GHG emissions (2022) expressed in MT and per cent of total emissions[43]

[43] In previous SBEI reports, "diesel" and "biodiesel" emissions were reported as part of "Other". Total may not sum due to rounding.

The key drivers of community-wide emissions include:

1. **Fossil (natural) gas**. Fossil (natural) gas consumption to heat buildings continued to be the largest source of community-wide GHG emissions in 2022 at 7.9 MT, accounting for 51 per cent of all emissions. This was six per cent more than 2021. Fluctuations in fossil (natural) gas and electricity consumption are sensitive to weather conditions, with more fossil (natural) gas used to heat homes and buildings during colder winters and more electricity used to cool these spaces during hotter summers. The increase in fossil (natural) gas use in 2022 was due to a slightly cooler winter than the previous year, translating into more fossil (natural) gas use for heating and more emissions. Across the building types in the inventory, fossil (natural) gas usage in residential buildings was the largest single source of emissions, accounting for 29 per cent of community-wide emissions.
2. **Gasoline.** Gasoline used for passenger cars and trucks accounted for 23 per cent of community-wide GHG emissions. It was the second largest source of emissions at 3.6 MT. This was a slight increase from 2021 (3.5 MT).
3. **Methane, carbon dioxide, and nitrous oxide (CH_4, CO_2 & N_2O) from waste.** Waste emissions from methane, carbon dioxide and nitrous oxide were 1.4 MT in 2022, making up 9 per cent of total community-wide emissions. Waste emissions remained stable from 2021 to 2022. Most methane emissions not associated with fossil (natural) gas consumption originate from City-managed landfills, both closed and operating, where methane gas is released to the atmosphere through the soil landfill cap. The City's largest open and closed landfills operate continuous landfill gas collection and flaring systems that destroy methane, significantly reducing emissions. Wastewater treatment accounted for 13 per cent and organics and yard waste processing accounted for an additional two per cent of methane emissions in the 1.4 MT waste emissions total. Further discussion of the nature of these waste emissions, which do not arise from burning fossil fuels for energy production, is provided in Section 2.5.3.
4. **Diesel[44].** Diesel use accounted for 1.2 MT of emissions in 2022, or 8 per cent of community-wide emissions. The majority (1.1 MT) of these emissions were from commercial light and heavy diesel-fuelled trucks travelling on Toronto's roads.
5. **Electricity.** Emissions from electricity consumption increased by eight per cent even though electricity usage increased by nearly two per cent in 2022 compared to 2021 (see Section 2.5.1, **Table 3**). This was due to the provincial power grid using more fossil (natural) gas to generate electricity than in 2021, increasing the emissions per unit of electricity delivered to Toronto customers as a result of decisions made at the provincial level.
6. **Biodiesel from corporate transportation[45].** The City tracks biodiesel use in corporate vehicles including TTC buses, on- and off-road vehicles, and marine vessels. Biodiesel use by privately owned vehicles is not included in the emissions inventory. Corporate biodiesel use accounted for 0.2 MT or one per cent of community-wide emissions in 2022. Nearly all of this (99 per cent) was from TTC buses, which have replaced diesel fuel use with biodiesel as part of TTC's sustainability initiatives.

[44] "Diesel" emissions were reported as part of "Other" in this section of previous SBEI reports.
[45] "Biodiesel" emissions were reported as part of "Other" in this section of previous SBEI reports.

7. **Other.** Other sources of emissions in Toronto, including aviation fuels, chilled water, renewable natural gas (RNG), steam, compressed natural gas (CNG) and propane, accounted for 0.1 MT or 0.5 per cent of community-wide emissions. Aviation fuel emissions reported in the inventory are limited to fuel in airplanes filled at Billy Bishop Toronto City Airport on Toronto Island. This amount is an overestimate, as a portion of the fuel in airplanes leaving the airport is burned outside the SBEI's geographic boundary (the City of Toronto municipal boundary)[46]. Apart from aviation fuels, emissions sources in this category reflect only corporate (City of Toronto government) use, as data on community use of RNG, steam, CNG and propane is not available.

Further details on key drivers of Toronto's GHG emissions, described in the context of their respective emissions sectors, are provided in Section 2.5.

[46] Aviation fuel use at Toronto Pearson International Airport is discussed in Section 2.5.2.

2.5 Details on GHG emissions by sector

As shown in **Figure 8**, overall emissions have declined since 1990 and, in 2022, Toronto's emissions were 36 per cent lower than 1990. Emissions increased five per cent from 2021, when total emissions were 39 per cent lower than 1990 levels. While there is an overall downward trend in emissions by sector over time (**Figure 8**), the current pace of emissions reductions is unlikely to meet the City's 2025 total emissions target (solid line shown on **Figure 8**). Annual emissions need to be reduced by 2.1 MT (compared to 2022 levels) to reach the 2025 target of 13.4 MT. A 2.1 MT reduction in emissions equates to removing 58 per cent (650,887) of gas-powered cars from the road or converting 83 per cent (413,416) of single-family homes from fossil (natural) gas heating to electric heat pumps. Given the rapid pace and scale of change required to meet the 2025 emissions target of a 45 per cent reduction, and the knowledge that policy and programmatic interventions occurring during the 2023 and 2024 years are still in early stages of implementation, the 2025 goal is unlikely to be achieved. Keeping in mind that the 2030 emissions target (a 65 per cent reduction) is only five years beyond the 2025 target, Toronto would need to decrease its annual emissions much more rapidly than it has in past years to make notable progress.

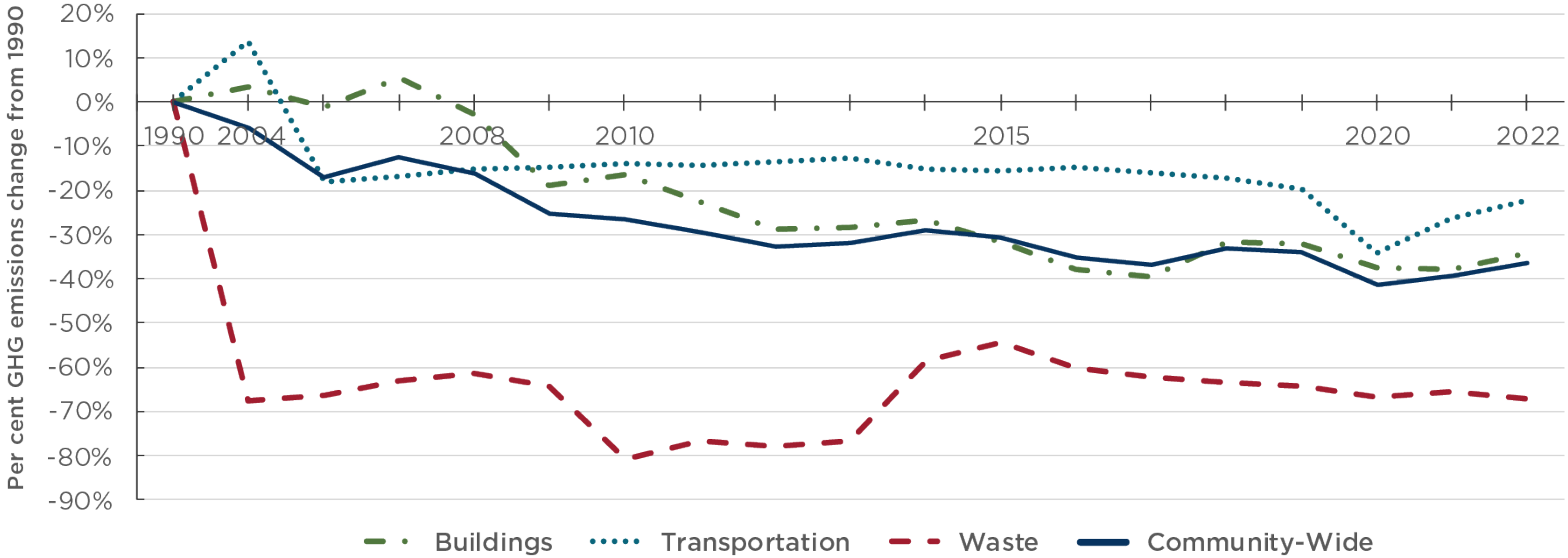


Figure 8: Annual per cent change in emissions by sector relative to 1990 baseline[47]

[47] Annual waste emissions decreased substantially from 1990 to 2004. This was largely because methane emissions from landfill waste naturally decrease over time once landfills close, and three of the City's four landfills closed during this time period (Brock West, Beare Road and Thackeray Landfills). At the landfill that was open in 1990 and remained open through 2004 (Keele Valley Landfill), methane collection systems were enhanced to increase the methane collection rate from 23 to 73 per cent, reducing its annual emissions by 2004. The City's current landfill, Green Lane Landfill, was acquired in 2008.

City of Toronto emissions monitoring and action planning through modelling

To monitor and project near-term emissions reduction progress in support of its TransformTO Net Zero Strategy, the City of Toronto has developed LENZ (Local Emissions for Net Zero), an open-source suite of energy system and GHG emissions modelling tools[48]. The suite is designed to model action plans to support deep decarbonization across all sectors and achieving net-zero emissions by 2040. LENZ enables the City to test and evaluate various climate policies and actions, as well as assess their associated financial feasibility. LENZ can model net-zero pathways and optimizes the cost of energy technologies and fuels for activities like building heating and lighting, transportation, and waste processing. By using LENZ to simulate different actions (such as building retrofit implementation, bikeshare program attributes, or electric bus adoption) and scenarios (such as business-as-usual, net-zero by 2040), the City can make informed decisions about its climate and energy-related policies, and adjust its strategies as needed to achieve its emissions goals.

48 https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/local-emissions-for-net-zero-modelling-suite/

2.5.1 Buildings

In 2022, emissions from residential, commercial and industrial buildings accounted for approximately 8.7 MT of Toronto's total inventory, making buildings the largest source of emissions at roughly 56 per cent of community-wide emissions. The previous year, in 2021, building emissions were 8.2 MT and accounted for 55 per cent.

Figure 9 breaks down the emissions contribution of each building type for 2022 – residential (54 per cent), commercial and institutional (35 per cent), and industrial[49] (11 per cent). **Figure 10** shows the proportion of building emissions from the two main energy forms – electricity and fossil (natural) gas – and how this proportion has changed over time, by building type, from 1990 to 2022. While the trend in overall emissions is decreasing over time, this is largely due to a decrease in commercial and industrial electricity emissions and industrial fossil (natural) gas usage. **Figure 10** shows that the largest sources of buildings emissions, residential and commercial fossil (natural) gas usage, have stayed at mostly the same level since 1990.

Figure 11 highlights the large proportion of building GHG emissions that come from fossil (natural) gas. Residential fossil (natural) gas usage accounted for 29 per cent of community-wide emissions. In 2022, emissions from fossil (natural) gas in buildings were approximately ten times greater than emissions from electricity. Further, the proportion of fossil (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 (multi-unit residential).

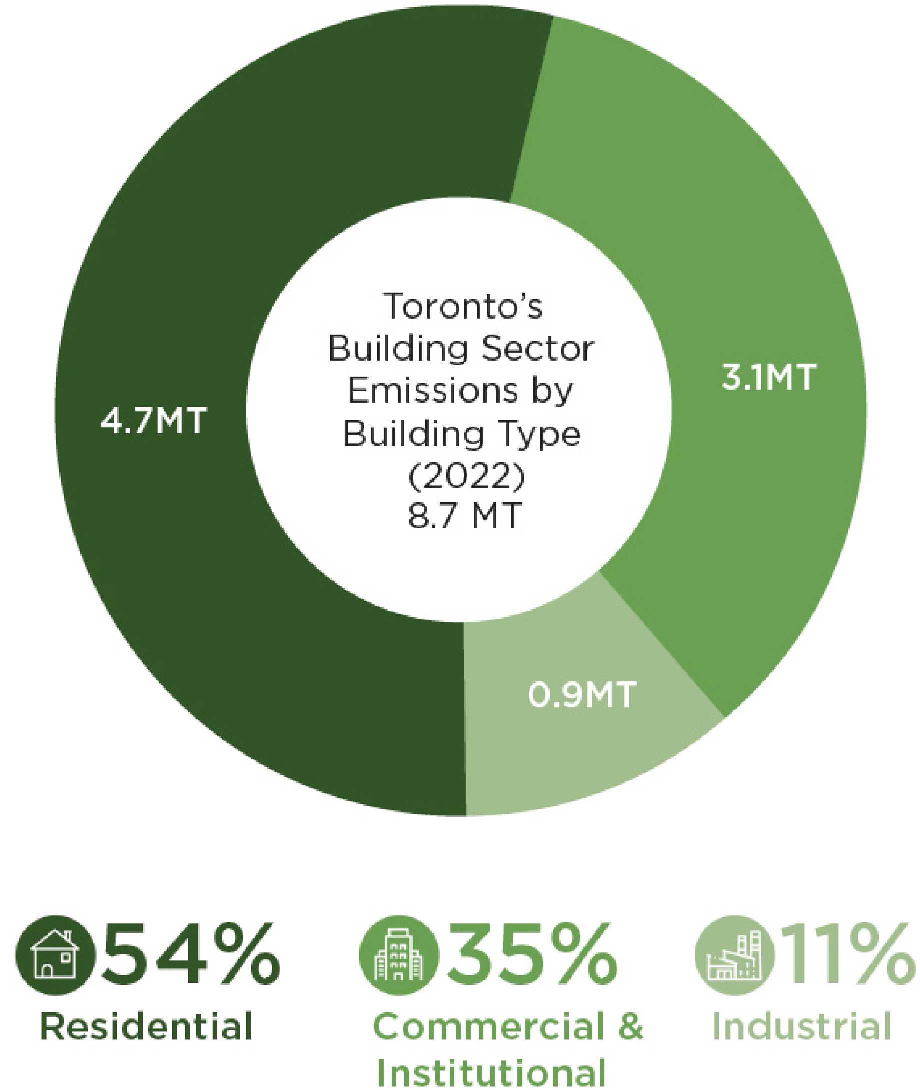


Figure 9: Percentage breakdown of GHG emissions by building type (2022)

[49] Industrial emissions include emissions from heating and cooling industrial buildings.

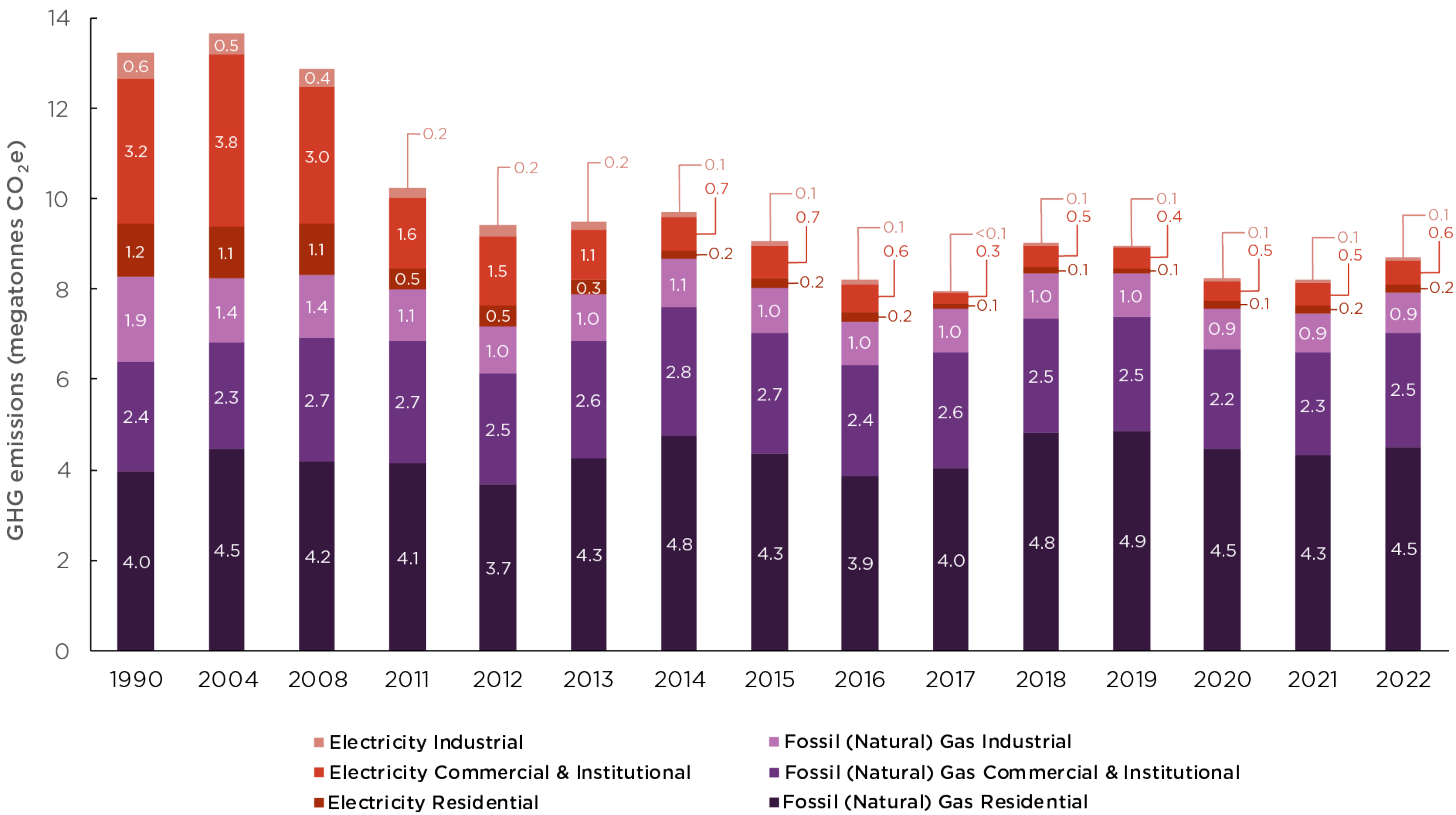


Figure 10: Buildings GHG emissions by energy form from 1990 to 2022

Relative to 2021, residential buildings' fossil (natural) gas consumption in 2022 increased by five per cent, while industrial buildings' fossil (natural) gas usage increased by one per cent (**Table 2**). The increase in fossil (natural) gas consumption was primarily due to cooler winter weather that increased the demand for space heating. For more information on how weather affects fluctuations in fossil (natural) gas consumption, please refer to Appendix D: Heating and cooling degree days. Aside from weather conditions, changes in fossil (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 fossil (natural) gas use in 2022. Commercial and institutional fossil (natural) gas usage increased by ten per cent in 2021, likely due to a rebound in business activities in the latter half of 2021 as pre-pandemic activities resumed.

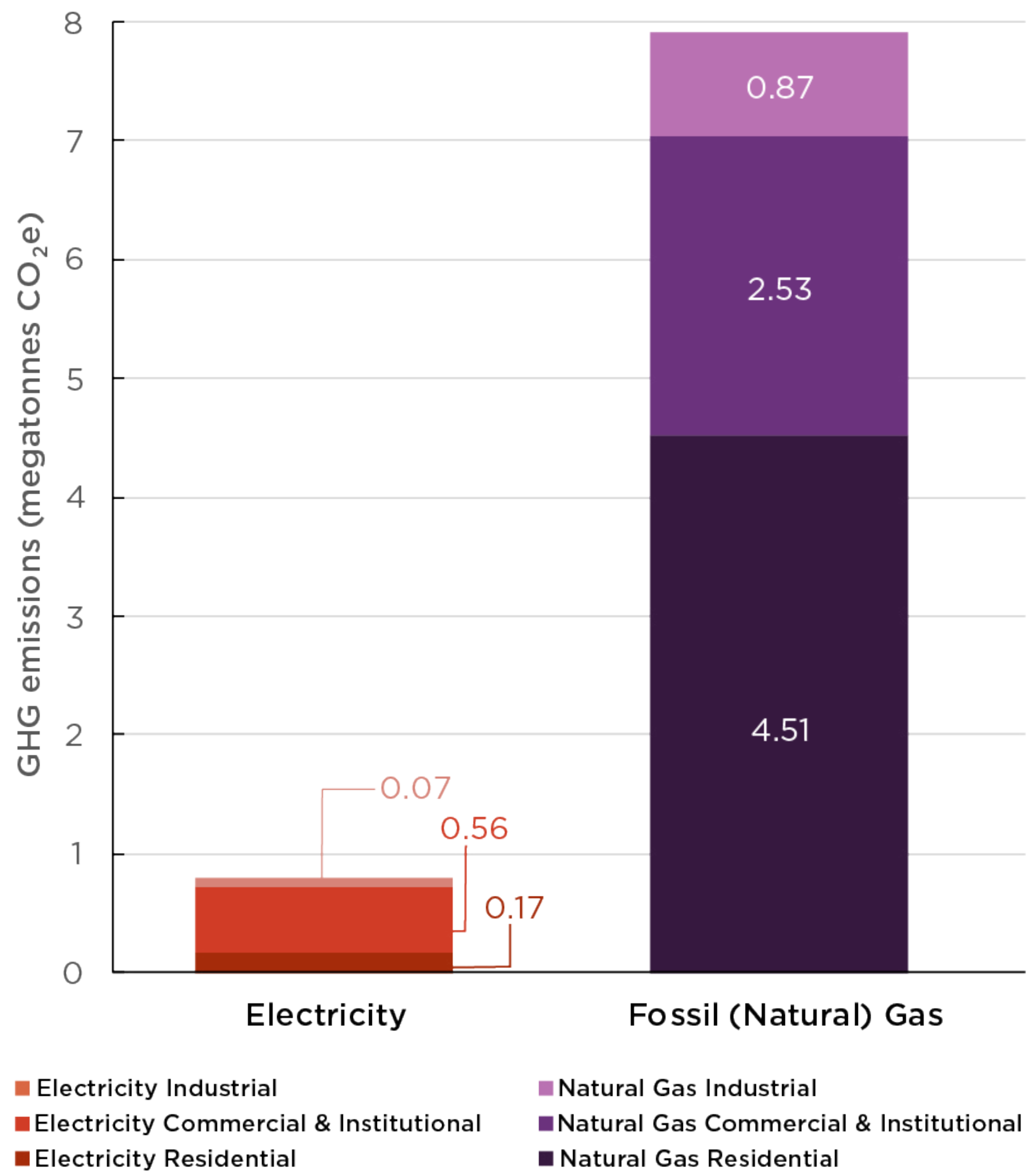


Figure 11: Buildings GHG emissions by energy form (2022)

Table 2: Fossil (natural) gas consumption by building type (2021 to 2022)

Building type	Fossil (natural) gas (millions m³)		Per cent change
	2021	2022	
Residential	2,229	2,336	5%
Commercial & institutional	1,185	1,307	10%
Industrial	445	450	1%
Total (all building types)	3,860	4,093	6%

Buildings sector electricity consumption has not changed much in the past few years. As shown in **Table 3**, residential electricity usage in 2022 decreased by one per cent from 2021. Commercial & institutional and industrial electricity usage increased slightly.

Table 3: Electricity consumption by building type (2021 to 2022)

Building Category	Electricity (GWh)		Per cent change
	2021	2022	
Residential	5,092	5,034	-1%
Commercial & institutional	16,127	16,466	2%
Industrial	1,923	1,989	3%
Total (all building types)	23,142	23,489	1%

2.5.2 Transportation

Transportation emissions in 2022 were approximately 5.4 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 97 per cent of all transportation emissions. The largest portion of transportation emissions was attributed to gasoline-powered passenger vehicles, accounting for 23 per cent of 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. VFH contribute four to six per cent of total transportation emissions[50].

Gasoline use in transportation across all vehicle types included in the inventory accounted for 26 per cent of total community-wide emissions.

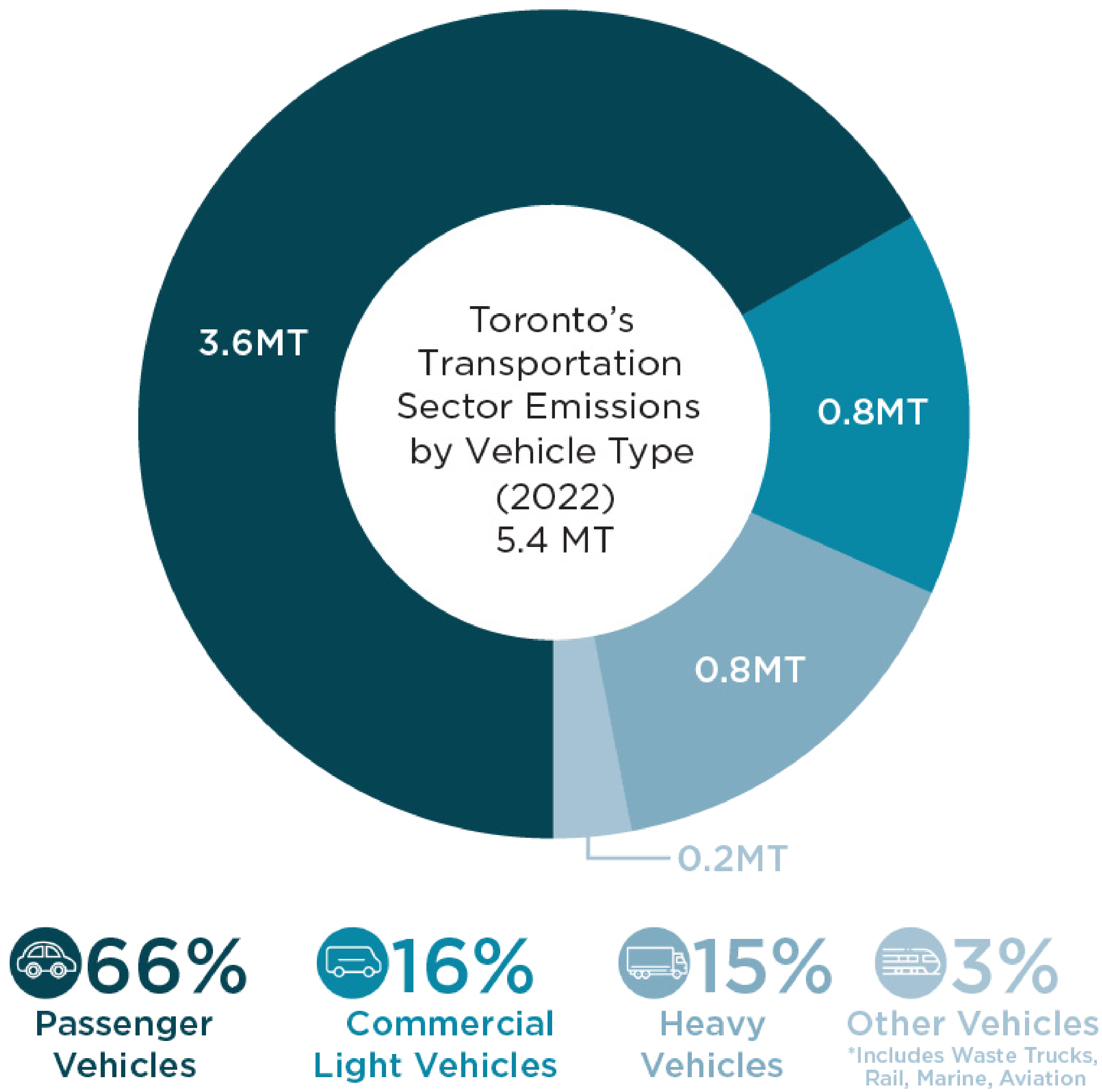


Figure 12: Percentage of GHG emissions by vehicle type (2022)

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

Other vehicles

In **Figure 12**, the “Other Vehicles” category includes Toronto Transit Commission (TTC) rail emissions from electricity used to power streetcars and subways. TTC 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 diesel emissions within the city boundary, which made up 1.1 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 to fill aircraft at Billy Bishop Toronto City Airport on Toronto Island, which accounted for 1.4 per cent of total transportation emissions[51]. The aviation fuels emissions value is an overestimate, as a portion of the fuel in airplanes leaving the airport is burned outside the City of Toronto municipal boundary.

[51] Billy Bishop Toronto City Airport resumed operating in September 2021 after an 18 month pause due to the COVID-19 pandemic. Aviation emissions in the inventory are therefore much higher in 2022 than in 2021. https://www.flightglobal.com/strategy/porter-restarts-service-after-18-month-shutdown/145380.article

Transportation emissions excluded from inventory

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. Note that this airport is located outside of Toronto's city boundary. The emissions from marine vessels associated with cargo transport and personal use were also not captured due to data availability limitations.

Estimating transportation emissions

The City employs a transportation emissions model, created by the University of Toronto, to simulate traffic in the city and estimate its associated emissions[52]. As presented in **Figure 13**, the model shows that Vehicle Kilometres Travelled (VKT) for passenger vehicles[53] increased from 2006 until 2019, decreased in 2020 due to COVID-19 travel restrictions, and then increased in 2021 and 2022. Before the COVID-19 pandemic in 2020, passenger vehicle emissions were decreasing, especially from 2013 to 2019, despite the increasing VKT during the same time period. The reduction during that period primarily reflects improvements in vehicle fuel efficiency and a gradual uptake of electric vehicles (EVs) in Toronto[54]. Both VKT and vehicle transportation emissions decreased substantially in 2020 due to pandemic-related travel restrictions and public health measures. Upon the COVID-19 restrictions being lifted, VKT and emissions began to rise, and continued increasing in 2022. In 2022, vehicle emissions across all vehicle classes increased by four per cent and VKT by seven per cent.

Similarly, the VKT and associated emissions from commercial and heavy vehicles[55] were stable from 2006 to 2019, followed by COVID-19 pandemic-related declines in 2020, and subsequent increases beginning in 2021. In 2022, commercial and heavy vehicle VKT rose seven per cent and associated emissions likewise rose seven per cent.

[52] Note that the model does not estimate vehicle kilometres traveled by electric vehicles (EVs) at this time.
[53] In Figure 13, "passenger vehicles" includes non-commercial passenger cars and trucks fueled by gasoline.
[54] The number of registered passenger electric vehicles in Toronto increased by 44 per cent in 2022 from 2021, however, the total number of registered passenger EVs in Toronto remained quite low (1.7 per cent of registered passenger vehicles) in 2022.
[55] In Figure 13, "commercial and heavy vehicles" includes a mix of gasoline- and diesel-fueled vehicles.

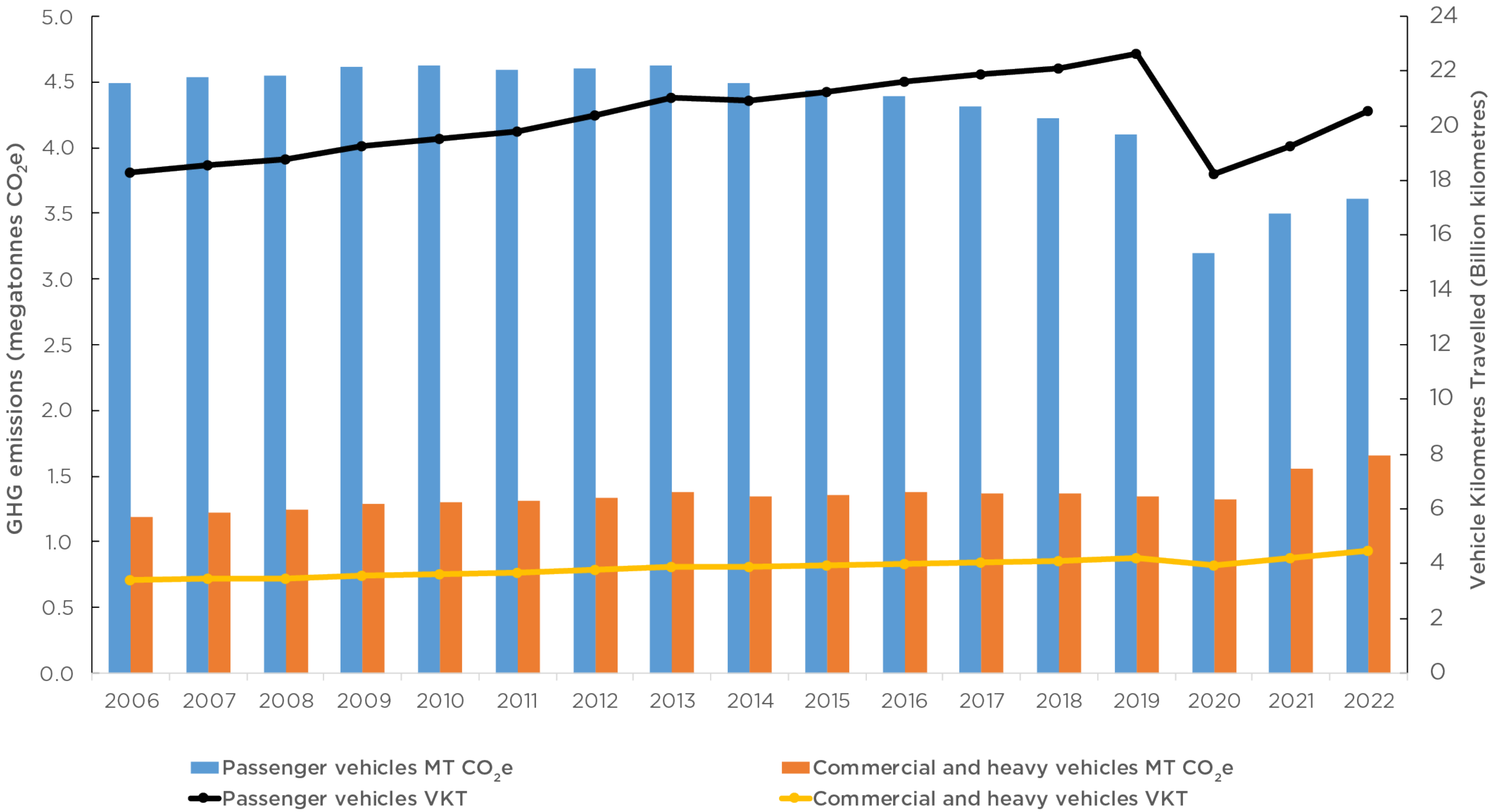


Figure 13: Annual GHG emissions from on-road transportation and associated Vehicle Kilometres Travelled (VKT)

2.5.3 Waste

Community-wide waste emissions account for emissions from landfills, organics processing, and yard waste processing facilities, as well as wastewater treatment. Waste emissions in 2022 were approximately 1.4 MT, accounting for nine per cent of the community-wide inventory. This is a significantly smaller share than the emissions from the buildings and transportation sectors. The total represents a decrease of about 0.1 MT since 2021. Community-wide waste emissions in 2022 were 67 per cent lower than in 1990. Roughly 86 per cent of emissions from the waste sector were landfill emissions, which include emissions estimated from waste disposal in both public and private landfills. The remaining waste emissions are composed of 0.17 MT from wastewater treatment processes (13 per cent), and 0.02 MT from organics and yard waste (two per cent)[56].

Estimated emissions from landfills are composed of 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.5 Community-wide waste sector for more information on how the City calculates waste emissions.

[56] Values may not sum due to rounding.

3 CITY OF TORONTO CORPORATE EMISSIONS

3.1 Status of corporate emissions and progress to targets

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

In 2022, corporate emissions were 0.83 MT (five per cent of Toronto's community-wide emissions). The City's corporate emissions increased four per cent from 2021 and remained a stable share of community-wide emissions between 2021 and 2022.

The City's first corporate GHG emissions reduction target is a 65 per cent reduction from a 2008 baseline by 2030, followed by net zero by 2040[57]. In 2022, corporate emissions were only 13 per cent below 2008 levels, and are not trending downward over time. To reach its 2030 corporate emissions target, the City is using tools such as a corporate carbon budget[58] to more actively manage its own emissions. Although emissions sources are roughly equal across the sectors of buildings, transportation and water & wastewater, the City has existing policies and processes enabling immediate action to reduce buildings and transportation emissions. Supported by policies such as the Net Zero Carbon Plan[59] and the Sustainable City of Toronto Fleets Plan[60], the City will develop more specific plans in the near-term in alignment with the corporate carbon budget process to reduce its use of fossil fuels for heating City and TCHC-owned buildings (fossil (natural) gas and powering fleet vehicles (diesel and gasoline).

[57] https://secure.toronto.ca/council/agenda-item.do?item=2021.IE26.16
[58] https://secure.toronto.ca/council/agenda-item.do?item=2023.IE3.4 and https://www.toronto.ca/legdocs/mmis/2024/bu/bgrd/backgroundfile-242067.pdf
[59] https://secure.toronto.ca/council/agenda-item.do?item=2021.IE23.2 and https://www.toronto.ca/wp-content/uploads/2022/09/9624-City-of-Toronto-Corporate-Real-Estate-Management-Net-Zero-Carbon-Plan-September-2022.pdf
[60] https://www.toronto.ca/city-government/accountability-operations-customer-service/long-term-vision-plans-and-strategies/green-fleet-plan/

Though waste and water and wastewater treatment are significant emissions sources[61], these sectors differ from the buildings and transportation sectors in that they comprise two major types of emissions: emissions from energy use, mainly through fossil fuel consumption to power water & wastewater treatment facilities, and emissions from waste treatment processes, arising as by-products of waste and water management processes at landfills, organic waste processing facilities, and water & wastewater treatment facilities. The second type of emissions, known as "process emissions," make up the majority of waste and water and wastewater emissions and are not driven by fossil fuel use but rather are by-products of a treatment process. Therefore, measures to mitigate process emissions are different than measures that would target buildings energy use or transportation emissions.

[61] Water and wastewater emissions increased in this 2022 inventory for the years 2019 to 2022 due to an emissions estimation methodology change at Toronto's wastewater treatment plants, resulting in an increase in the reported process emissions estimate. Further detail is provided in Section 3.2.1.

3.2 Key drivers of corporate GHG emissions

Figure 14 shows the breakdown of corporate emissions by sector in 2022. Buildings, the largest source of corporate emissions, accounted for 37 per cent, followed by transportation emissions at 32 per cent and water & wastewater emissions[62] at 27 per cent, and finally waste emissions at four per cent. **Figure 15** shows that 2022 corporate emissions rebounded nearly to 2019 pre-pandemic levels, and corporate emissions since 2020 are trending upwards.

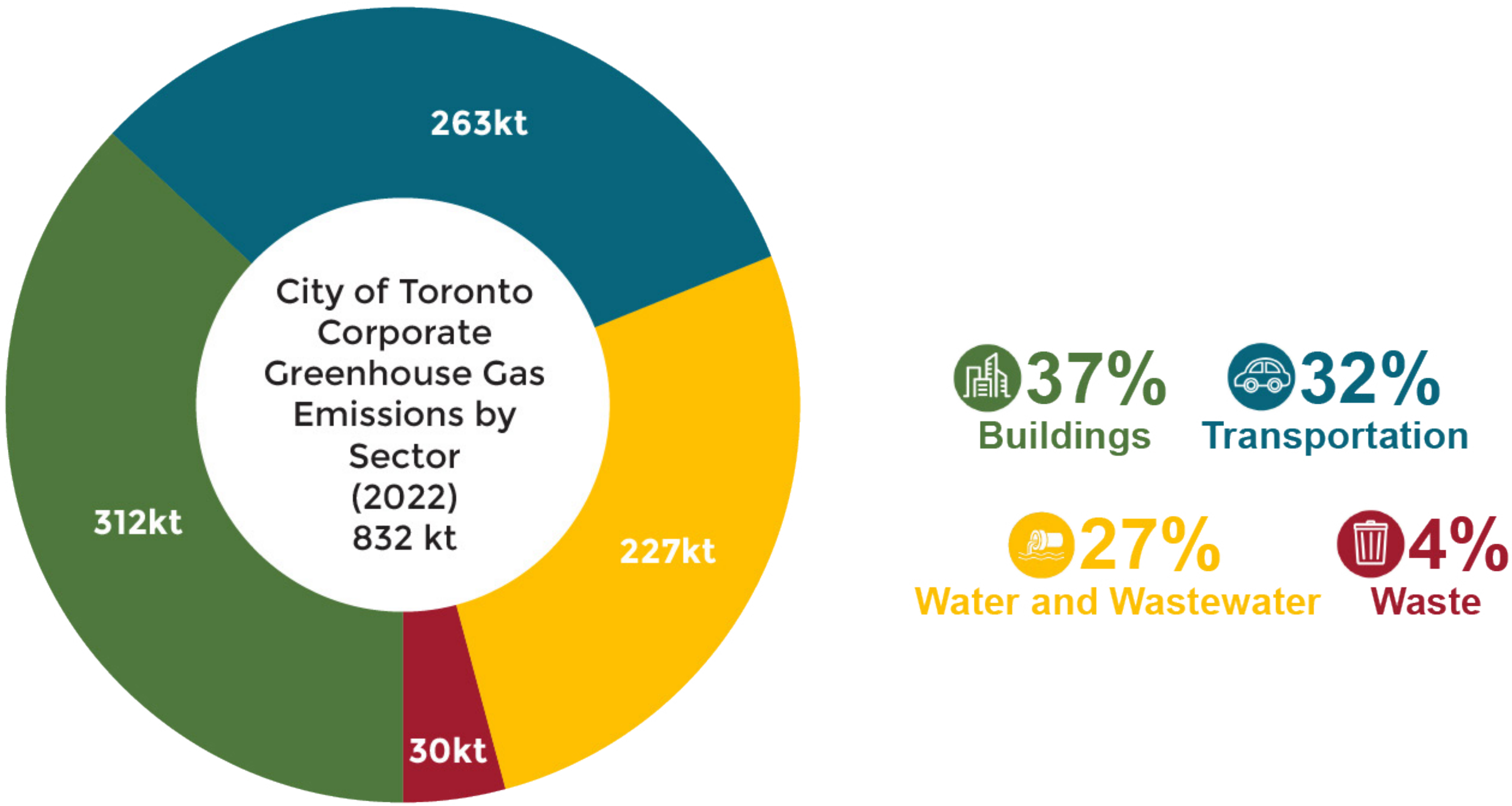


Figure 14: City of Toronto's percentage breakdown of corporate GHG emissions by sector (2022)

[62] Corporate "water and wastewater" sector emissions were reported in the "waste" sector in previous SBEI reports. Sectors are defined differently in the corporate versus community emissions report sections and associated figures. Therefore, for example, Figure 14: City of Toronto's percentage breakdown of corporate GHG emissions by sector (2022) cannot be directly compared to Figure 4 Toronto's percentage breakdown of community-wide GHG emissions by sector (2022).

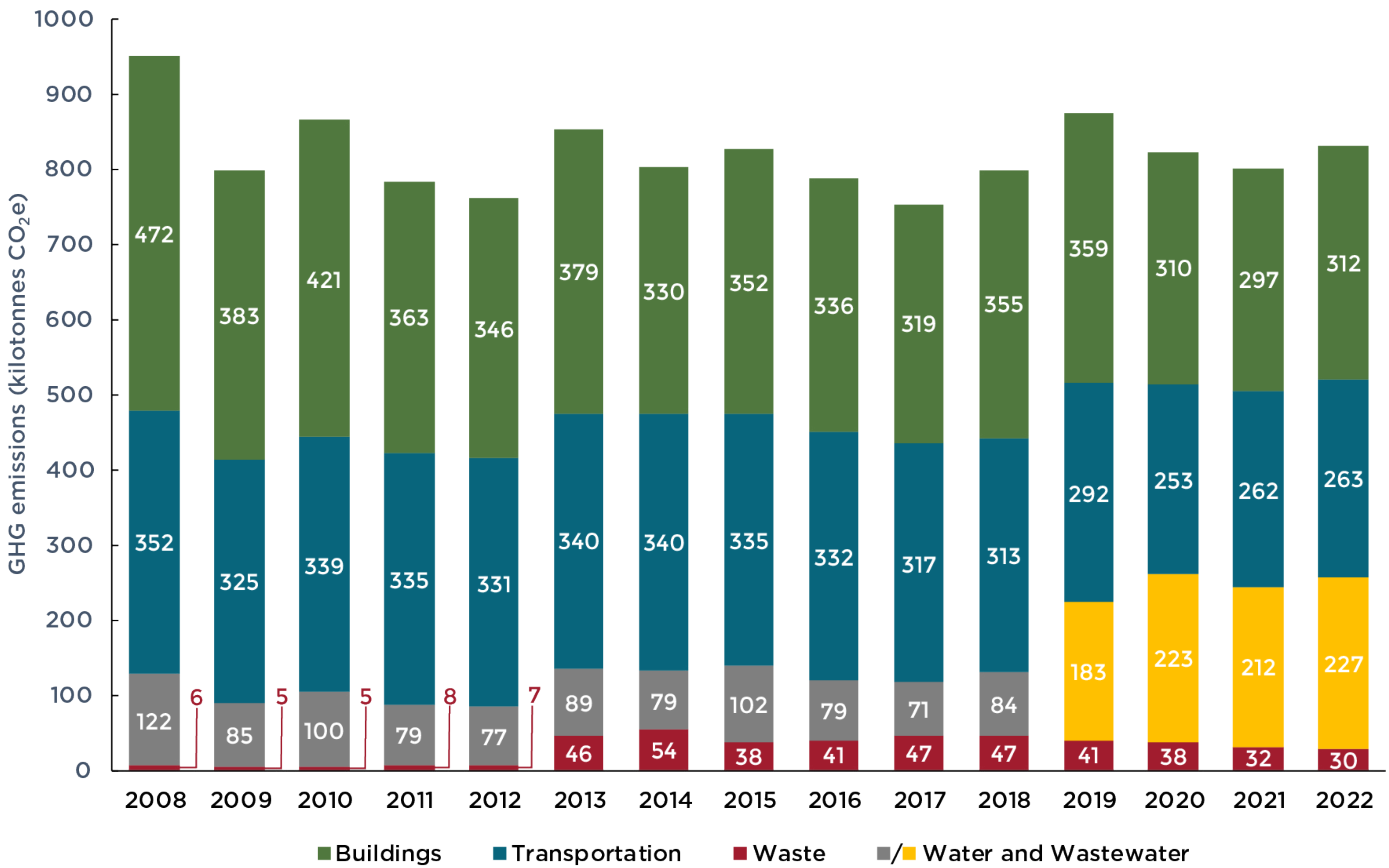


Figure 15: City of Toronto's year-over-year corporate GHG emissions by sector[63]

[63] "Water and wastewater" sector emissions were reported in the "waste" sector in previous SBEI reports. Wastewater treatment emissions, a component of "water and wastewater" sector emissions, are estimated using two different methods for the periods of 2008 to 2018 and 2019 onward. This is indicated by the different colours on Figure 15 (grey for 2008 to 2018 and yellow for 2019 to 2022). The 2019 emissions increase of 99 kt reported in the water and wastewater sector was not due to an actual increase in emissions from wastewater treatment. The larger estimates from 2019 onward were caused by changes to the emissions estimation methodology only. See Section 3.2.1 for further details.

Figure 16 depicts the sources contributing to emissions at the corporate level in 2022, and demonstrates that the corporation's use of fossil (natural) gas for space heating and predominantly fossil fuel-derived vehicle fuels[64] were primary sources of corporate emissions[65]. Fossil (natural gas) consumption (used primarily for space heating facilities, including housing) comprised 36 per cent of all corporate emissions and accounted for the largest single source of emissions. Emissions from fossil (natural) gas were four per cent higher than in 2021, primarily due to cooler winter weather that increased the demand for space heating.

Biodiesel use by corporate vehicles accounted for 23 per cent of corporate emissions, followed by process emissions from wastewater treatment at 21 per cent. Emissions from electricity use by buildings, water supply and treatment, and TTC vehicles accounted for eight per cent. Corporate gasoline use accounted for four per cent of corporate emissions, waste treatment process emissions likewise accounted for four per cent, and diesel use accounted for three per cent. Finally, other emissions sources (chilled water, steam, compressed natural gas (CNG), renewable natural gas (RNG), and propane) accounted for one per cent of corporate emissions.

[64] Biodiesel.
[65] Process emissions associated with wastewater management are likewise a major source of corporate emissions. As discussed in Section 2.5.3, process emissions are managed differently than fossil fuel-driven emissions sources.

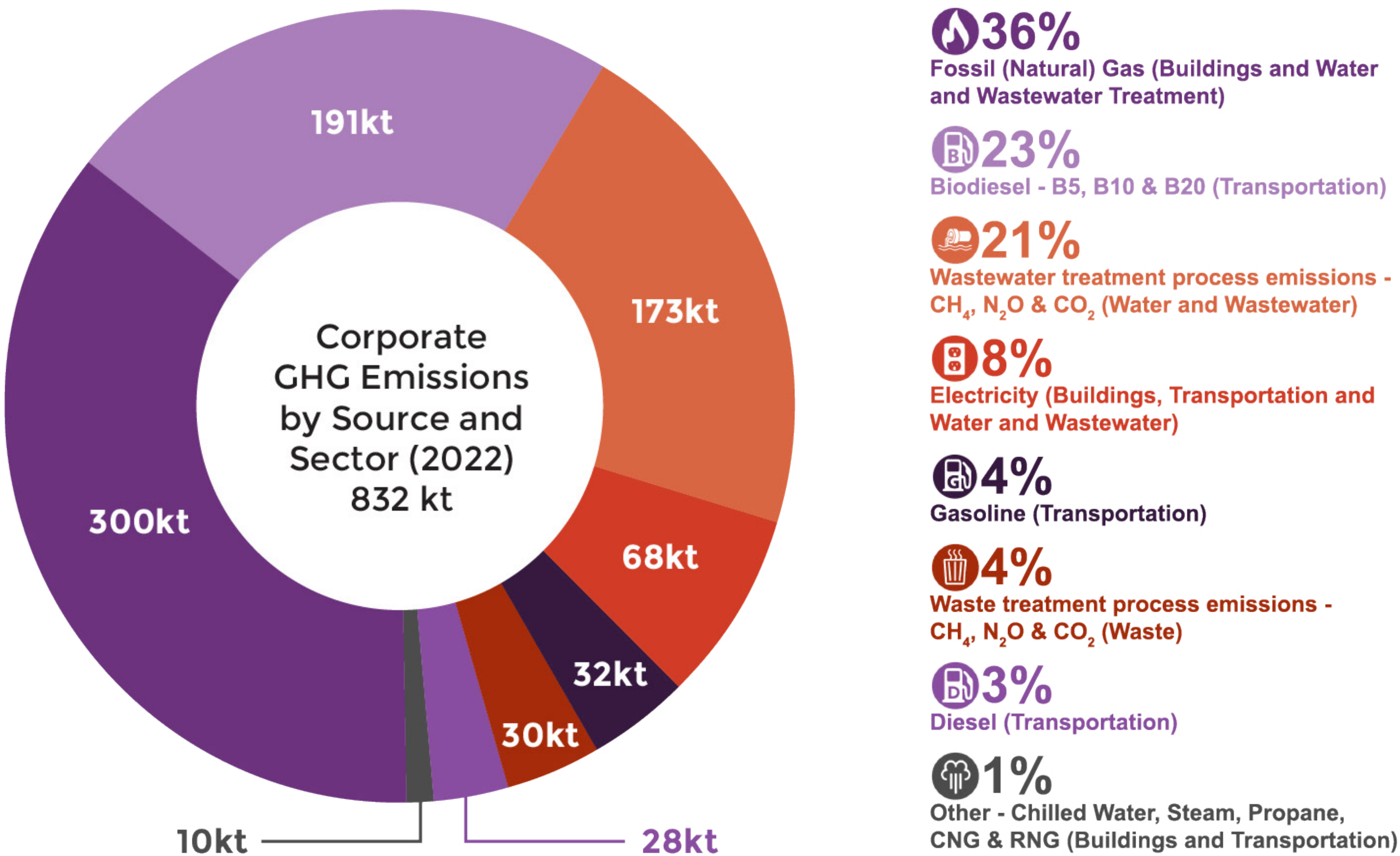


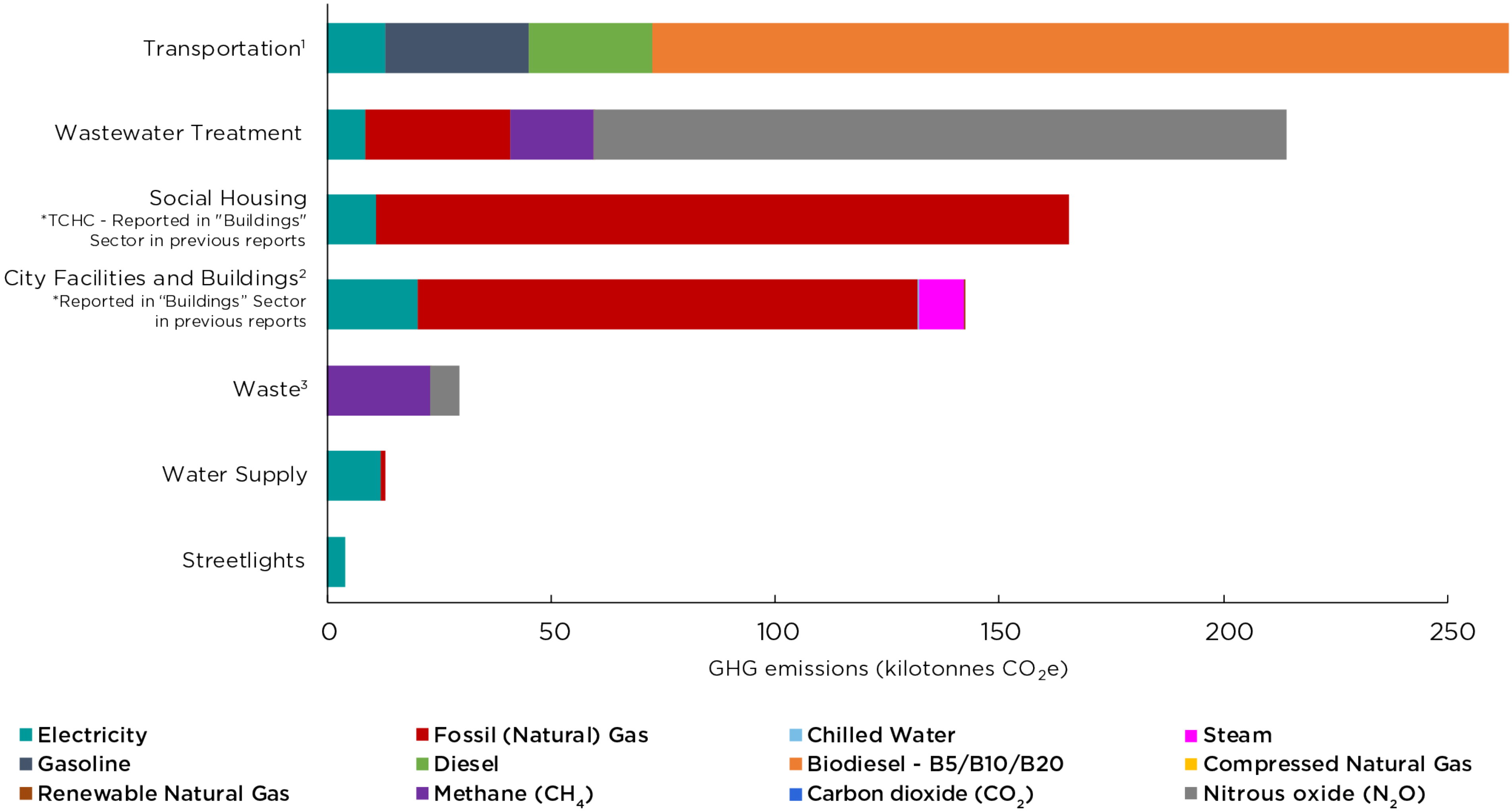
Figure 16: City of Toronto's corporate GHG emissions by source and sector (2022)

These emissions are presented in another manner, by detailed corporate subsector, in **Figure 17**. Figure 17 shows that City of Toronto government facilities and buildings (non-TCHC) accounted for 17 per cent of corporate emissions, while TCHC housing accounted for 20 per cent of corporate emissions, with the majority of these emissions (97 per cent) coming from fossil (natural) gas consumption.

Within the corporate transportation sector, diesel and biodiesel emissions accounted for 83 per cent of emissions, while gasoline emissions represented 13 per cent. Biodiesel emissions from TTC buses were 72 per cent of corporate transportation emissions.[66] Diesel fuel use (including biodiesel) from the combined fleets of TTC, EMS, Fire, Police Services, and the City's corporate fleet resulted in 26 per cent of corporate emissions.

Nitrous oxide (produced through waste and wastewater treatment processes) accounted for 19 per cent of corporate emissions, followed by electricity at eight percent, methane (produced through waste and wastewater treatment processes) at five per cent, and gasoline at four per cent.

[66] At the beginning of 2018, the TTC changed its fuel source for all buses from diesel to biodiesel.



Notes

[1] Compressed Natural Gas and Renewable Natural Gas are included in Transportation but the values are too small to be visible at this scale

[2] Chilled Water and Renewable Natural Gas are included in City Facilities and Buildings but the values are too small to be visible at this scale

[3] CO_2 is included in Waste but the value is too small to be visible at this scale

Figure 17: City of Toronto's corporate GHG emissions by corporate subsector (2022)

3.2.1 Changes to wastewater treatment emissions estimation methodology

Toronto's corporate waste emissions reported here have increased substantially since the previous (2021) SBEI report was published. This is primarily due to a change in wastewater[67] treatment emissions estimation methods used by Toronto Water, applied from 2019 onward. The reason for the large increase was a change in the approach used to estimate nitrous oxide (N_2O) emitted from secondary treatment (called "process N_2O"), a process that occurs at Toronto's three wastewater treatment plants. Process N_2O emissions occur as a by-product of the treatment process, and (unlike most other emissions sources reported in the SBEI) are not a result of fossil fuel combustion for energy production.

The jump in reported emissions was not caused by an actual increase in emissions from wastewater treatment. The larger estimates were caused by changes to the calculation methodologies used to estimate and report emissions. As calculation methods are updated over time, emissions can be reported more accurately. In this case, the best method for estimating process N_2O was previously a population-based approach. For this 2022 SBEI report, process N_2O was estimated using a newer approach based on influent nitrogen[68]. This effectively caused a 35 to 40 times increase in the emission factor, the amount of N_2O released per unit of wastewater treated.

[67] Wastewater is used water. It includes substances such as human waste, food scraps, oils, soaps and chemicals. In homes, this includes water from sinks, showers, bathtubs, toilets, washing machines and dishwashers. Businesses and industries also contribute their share of used water that must be cleaned. Wastewater also includes storm runoff. https://www.usgs.gov/special-topics/water-science-school/science/wastewater-treatment-water-use
[68] https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/5_Volume5/19R_V5_6_Ch06_Wastewater.pdf

3.2.2 Other sources of corporate emissions increases in 2022

Corporate emissions increased about four per cent in 2022 over 2021. Apart from the methodology changes explained in Section 3.2.1, other major sources of corporate emissions increases are detailed here.

TTC garage fossil (natural) gas use

Toronto Transit Commission's garages used more fossil (natural) gas for space heating during 2022 than 2021, resulting in an 18 per cent increase in emissions (approximately four kilotonnes (kt) year-over-year. Fossil (natural) gas use in garages fluctuates with outdoor temperatures, and the winter of 2022 was colder than 2021. These emissions were only six per cent higher (less than two kt) in 2022 than in 2019, a similarly cold year to 2022. Therefore, this year-over-year increase is considered within the normal, weather-dependent range of fossil (natural) gas use at TTC garages.

TTC bus biodiesel use

Emissions from TTC buses' use of B20 biodiesel[69], a fuel blend containing 20 per cent biodiesel and 80 per cent diesel from fossil sources, increased by 94 per cent (3.3 kt) in 2022 over 2021. Similarly, emissions from B10 biodiesel, a fuel blend containing ten per cent biodiesel and 90 per cent diesel from fossil sources, increased by 46 per cent (1.6 kt) in 2022. The TTC stopped using conventional diesel fuel (100 per cent diesel from fossil sources) in its buses and switched to using B5 biodiesel (five per cent biodiesel, 95 per cent diesel from fossil sources) at the beginning of 2018. In 2021, TTC buses began using a combination of B5, B10 and B20 biodiesel, with the portions of B10 and B20 (relative to B5) increasing further in 2022. Fuel blend emission factors (GHG emissions per litre of fuel used) are lower for fuel blends with higher percentages of biodiesel; emissions are lower per litre of B20 biodiesel used than B10, and even lower than B5. When TTC buses use greater amounts of B20 and B10 biodiesel instead of opting for B5 biodiesel, emissions are lower per litre of fuel. However, in 2022, TTC buses used about three million more litres of biodiesel than in 2021 (across all biodiesel fuel blends), resulting in emissions from TTC buses.

TTC is targeting an all-electric bus fleet by 2040[70], and the use of biodiesel as a lower-emissions fuel option is understood to support this transition in the interim to a zero emission passenger fleet.

[69] https://natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/alternative-fuels/biofuels/biodiesel/3509
[70] https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-235807.pdf

TTC subway and streetcar electricity use

Emissions from TTC subway and streetcar electricity use increased by 11 per cent in 2022 over 2021, and electricity use increased by five per cent. Beyond this higher electricity usage, emissions increased in part due to greater fossil (natural) gas power generation at the provincial level, reflecting the challenge of reaching emissions reduction targets while the municipality relies on a provincial electricity system that includes fossil fuel-generated power. Overall, TTC subway and streetcar are an almost “emissions-free” public transit mode.

Toronto Water electricity use for water treatment and supply

Emissions from electricity used to power water treatment and supply processes increased by ten per cent in 2022 over 2021, and electricity use increased by four per cent. Similar to electricity emissions increases across the corporation, emissions increased in part due to greater fossil (natural) gas power generation at the provincial level.

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 during one year 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.

Complementary to the SBEI, the consumption-based emissions inventory (CBEI)[71] estimates the total GHG emissions associated with producing, processing, transporting, using and disposing goods and services consumed by a particular community or entity in a given time frame (typically one year). Similar to calculations that estimate a household's carbon footprint, a consumption-based emissions inventory focuses on consumers. The emissions associated with purchases of goods and services by Toronto residents, such as food at the grocery store, consumer goods purchased at a store or online, larger items like personal vehicles, and services like medical treatments received, 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 where the products or services are manufactured or delivered from (see **Figure 18**). These emissions occurring outside of Toronto are captured in a CBEI. This differs from an SBEI, which mainly accounts for emissions from activities occurring within the geographic boundary of Toronto.

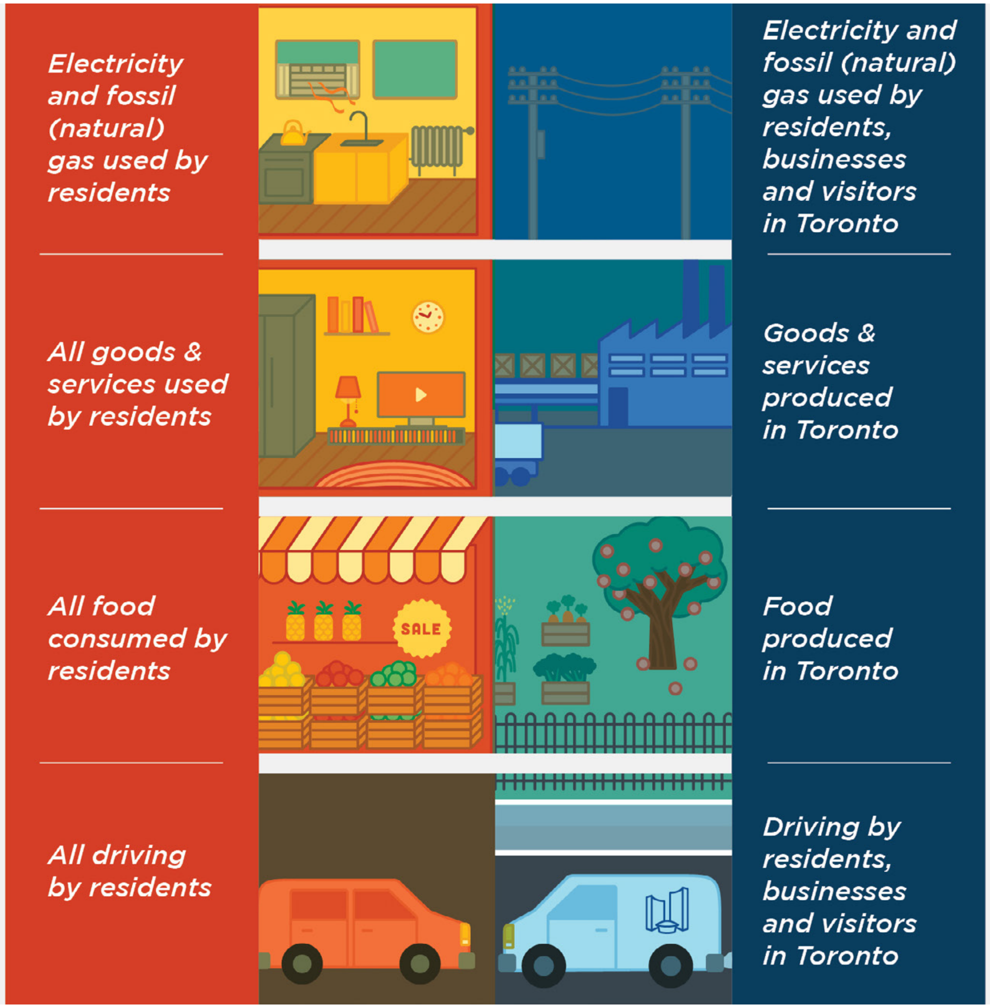
[71] https://www.toronto.ca/legdocs/mmis/2023/ie/bgrd/backgroundfile-239071.pdf

CBEI vs. SBEI: What's the difference?

Toronto's CBEI and SBEI are complementary and partially overlapping. The examples below illustrate some of the key differences between the two.

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.



Sector-Based Emissions Inventory (SBEI)

Toronto's SBEI measures greenhouse gas emissions occurring 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 18: Graphical representation of sector-based versus consumption-based GHG emissions inventories

The complementary and overlapping nature of the SBEI and CBEI provide the City with opportunities to identify major emissions sources driven by local activities. The emissions sources can be targeted for reduction, whether the emissions occur locally or globally. For example, in both inventories, transportation (specifically gasoline consumption) and fossil (natural) gas use in buildings are the two largest sources of emissions[72]. By supporting efforts to reduce and eventually eliminate emissions from fossil (natural) gas and gasoline, Toronto would be able to reach its sector-based emissions targets while also reducing the consumption-based emissions total. This support can be provided in part through municipal policies that enable engagement in non-automobile, low carbon transportation modes (like walking, cycling and taking transit), and that reduce fossil (natural) gas usage by supporting low emissions space heating option installation (like electric heat pumps). Further detail on the potential sector-based emissions impacts of reducing consumption-based emissions can be found in Toronto's CBEI.

[72] The full results of Toronto's CBEI are available at https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/transformto/torontos-consumption-based-emissions-inventory/

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 Greenhouse Gas Emission Inventories (GPC), version 1.1[73]. 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[74].

This sector-based GHG emissions inventory is based on the BASIC level of GHG emissions reporting, as defined by the GPC. BASIC level includes scope 1[75], 2 and 3 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 2022 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.

[73] https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities
[74] 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/
[75] Emissions accounted for in Toronto's inventory that are labeled as Scope 1 do not include any fugitive emissions from refrigerants.

Table 4: Toronto's BASIC 1990 (baseline year) and 2022 (current reporting year) community-wide GHG emissions

Sector	Emission sources	1990 GHG Emissions (tCO_2e)[a]	2022 GHG Emissions (tCO_2e)[a]
Stationary energy	Residential buildings (Scope 1, 2, & 3)	5,134,821	4,642,616
	Commercial and institutional buildings and facilities (Scope 1, 2, & 3)	5,632,007	3,068,357
	Manufacturing industries and construction (Scope 1, 2, & 3)	2,447,289	931,257
	Fugitive emissions from oil and fossil (natural) gas systems (Scope 1)	0	73,018
Transportation	On-road transportation (Scope 1, 2 & 3)	7,008,360	5,287,616
	Railways (Scope 1 & 2)	0	73,607
	Waterborne navigation (Scope 1 & 2)	0	1,157
	Aviation (Scope 3)	0	74,484
	Off-road transportation (Scope 1 & 3)	0	7,459
Waste	Solid waste generated in the city (Scope 1 & 3)	4,171,771	1,170,376
	Biological waste generated in the city (Scope 1 & 3)	0	21,911
	Wastewater generated in the city (Scope 1)	0	173,141
Total GHG emissions		24,394,249	15,525,000
Change in GHG emissions from the baseline year (1990)			-8,869,249
Total population		2,362,928	2,985,228
Total per capita GHG emissions (tCO_2e / capita)		10.32	5.20
Change in GHG emissions per capita from the baseline year (1990)			-49.62%
Percent change in GHG emissions from baseline year (1990)			-36.36%
Energy use (GJ)		0	365,122,043
Total per capita energy use (GJ / capita)			122.31

Notes

[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 Toronto's sector-based emissions inventory

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

In summary, Toronto's sector-based emissions 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 fossil (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 public landfills constitute most of Toronto's waste emissions. In addition, there is a portion of emissions from organics and yard waste processing, and wastewater treatment processes. Emissions from privately managed waste are estimated within the total waste emissions value.

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)[76] 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[77]. Toronto was one of 119 cities globally to receive an "A" rating.

[76] https://www.cdp.net/en/scores
[77] At the time of publication, the 2024 CDP results have not been released.

APPENDIX C: METHODOLOGY

The purpose of Appendix C is to provide a high-level overview of the City's methodology to estimate its annual sector-based 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 mentioned at the beginning of this report, the values reported annually in Toronto's sector-based emissions 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 2022 sector-based emissions 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[78]. The GWP measures how much a particular gas contributes to global warming relative to carbon dioxide (CO_2). It is used to convert tonnes of GHG to tonnes of carbon dioxide equivalent (CO_2e) and 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
Carbon dioxide (CO_2)	1
Methane (CH_4)	34
Nitrous oxide (N_2O)	298

[78] 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 fossil (natural) gas consumption
- GWh of electricity consumption
- Volume of gasoline used
- Kilometres driven
- Tonnes of solid waste sent to landfill

An emission factor is a measure of the mass of GHG emissions relative to a unit of activity. As discussed in Section 1.1, the City relies on Environment Canada's National Inventory Report (NIR)[79] as the primary source for emission factors. Typically, Environment Canada releases the NIR two years after a given calendar year (i.e. the 2022 emission factors were released in 2024). The City also updates its previously reported annual emissions estimates when compiling the latest inventory upon revised emission factors becoming available for previous inventory years.

C.3 Community-wide buildings sector

Buildings sector emissions result primarily from fossil (natural) gas and electricity use. For both of these energy forms, emissions are calculated by multiplying activity data (e.g. fossil (natural) gas and electricity consumption data) by their corresponding emission 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

Fossil (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 emission factor, which is in tonnes of carbon dioxide equivalent per cubic metre (CO_2e per m^3). The City multiplies this factor by total fossil (natural) gas consumption (cubic metres, m^3) to generate the total fugitive emissions.

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

- 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 fossil (natural) gas and electricity consumption activity data.

- The number of single-family homes required to convert to energy efficient homes either by building envelope retrofits or fuel switching from fossil (natural) gas heating to electric heat pumps to reduce emissions by 2.1 MT by 2025 (reduction required to meet Toronto's 2025 annual community-wide emissions target) was calculated by the following:

A. 2022 Single-family fossil (natural) gas emissions	2,541,944 tCO_2e Source: Enbridge Gas Residential Consumption x NIR Emission Factor
B. 2022 Single-family fossil (natural) gas customers	498,491 Source: Enbridge Gas Residential Customer Counts
C. Emissions per single-family customer	5.10 tCO_2e (A/B)
D. Amount of GHG emissions reduction needed by 2025	2,108,163 tCO_2e
E. Number of single-family fossil (natural) gas customers needed to reach net zero	**413,416 or 83 per cent (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 2.5.2, most on-road transportation emissions are estimated using a model developed by the University of Toronto, the Traffic Emissions Prediction Scheme (TEPs)[80]. 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. Estimated electricity used by TTC subway trains and above-ground streetcars

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

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 Toronto Pearson International Airport are not captured in the City's annual inventory due to current constraints in acquiring data. The airport is also located within the municipal boundary of Mississauga (outside of Toronto), outside the geographic scope of the SBEI.
- 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 sources.

[80] https://teps.ca/

- 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. These estimates are used to determine the percentage of system-wide fuel used by GO Trains and UP Express within Toronto alone. This percentage is 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 biodiesel vehicles emission factors.
- 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 unidentified 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 three categories:

- City-owned landfill sites
- Private landfill sites
- Organic and yard waste processing facilities

The City manages five landfill sites which are accounted for in Toronto's sector-based emissions inventory, but only two of which (Beare Road and Thackeray) exists within Toronto's geographic boundary. Further, of the five sites, only one facility (Green Lane) is an operating landfill. The rest are closed, meaning that waste generated in the present inventory reporting year is only transported to 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 generation and flaring 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 landfill emissions are calculated by subtracting the gas flared/destroyed (measured) from the amount of gas produced at the landfill (modelled).

The method to estimate privately managed waste in Toronto's annual sector-based inventory was developed because 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 emissions estimate 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 Toronto's municipally managed waste (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 using the total tonnage of collected green bin organics from the City's two facilities and private processing facilities located outside the City's boundary, and applying an emissions estimation formula and emission factors recommended by the GPC Protocol. Leaf & yard waste emissions are estimated for private facilities where the City sends this waste, likewise using an emissions estimation formula and emission factors recommended by the GPC Protocol[81].

Carbon dioxide emissions from the decomposition of biomass in landfill waste are not reported as they are considered of biogenic origin, which is a type of emissions excluded from the inventory results per the GPC Protocol.

Waste collection vehicles' emissions are captured under transportation sector emissions, not waste sector emissions.

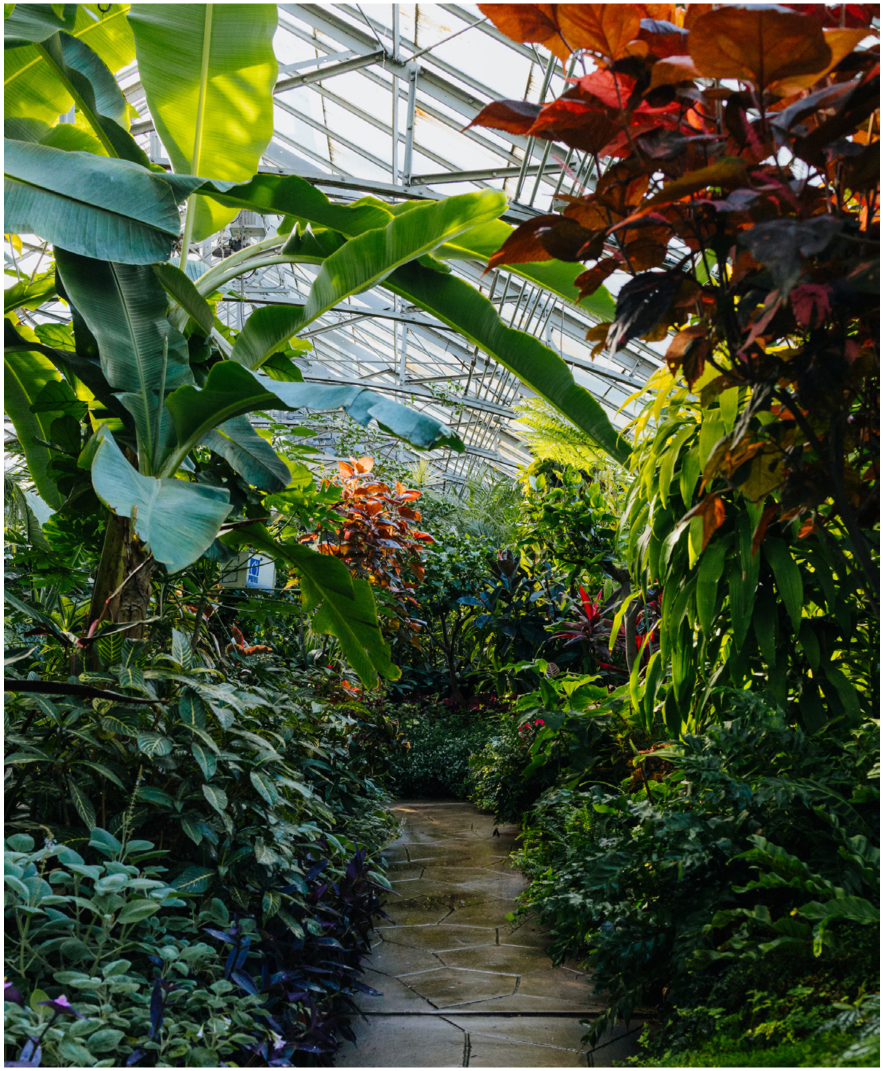
[81] See Appendix B.1 Global Protocol for Community-Scale GHG Emissions Inventories (GPC Protocol).

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 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 fossil (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 (as is done for community-wide electricity emissions).
- The electricity use of Bike Path (lighting), Signal (traffic signals) and Streetlights are also managed and monitored in EnergyCAP.
- The City's Fleet Services Division (FSD) manages all of the City's corporate marine, off-road and on-road transportation fuel consumption. The FSD receives fuel consumption activity data 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. The activity data are multiplied by the corresponding NIR emission factors based on the vehicle types.
- The City estimates corporate waste emissions based on the percentage of total waste transported to Green Lane that is attributable to corporate operations, as measured by annual corporate waste tonnage received at Green Lane. This percentage is applied to the total emissions from annual waste transported to Green Lane.
- To estimate transportation-related emissions for corporate waste sent to Green Lane, the City applies this same percentage to the litres of fuel consumed by all long haul trucks travelling to Green Lane. This provides an estimate of corporate waste-related transportation emissions outside the City boundary.

- Electricity and fossil (natural) gas use by City water supply and treatment and wastewater treatment facilities is reported in the corporate water and wastewater treatment sector.[82]
- Municipal wastewater is treated anaerobically at the City's four wastewater treatment plants. The City's water engineers calculate the annual carbon dioxide, methane and nitrous oxide emissions attributed to the wastewater treatment at these plants. Wastewater treatment process emissions are reported in the corporate water and wastewater treatment sector.
- For details on estimating corporate emissions associated with the City's waste and organics processing facilities, please see Appendix C.5 Community-wide waste sector.



[82] A small amount of electricity and fossil (natural) gas use emissions at water and wastewater treatment buildings resulting from building heating, cooling, and electricity use that are not associated with industrial processes are reported in the corporate buildings sector. However, the remaining (majority of) emissions reported for electricity and fossil (natural) gas use at water and wastewater treatment buildings is a combination of building function- and industrial process-related emissions, and it is not currently possible to separate and report these emissions in each the buildings and water and wastewater sectors.

APPENDIX D: HEATING AND COOLING DEGREE DAYS

Fluctuations in fossil (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, while CDD 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 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[83] shows that both Toronto's winter and summer were slightly cooler in 2022 than in 2021. **Figure 19** further shows that Toronto's 2022 HDD was about average compared with the city's 25-year HDD average, which means building heating needs were average in 2022. In contrast, Toronto's 2022 CDD was 13 per cent higher than the city's 25-year CDD average, but slightly lower than 2021, which means air conditioning needs were lower in 2022 than the previous year (despite being above average). This implies that Toronto experienced an average winter and a warmer summer in 2022 compared to recent years.

[83] Datasets gathered from Environment and Climate Change Canada, 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 to 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%
2021	3,340	464	-5.01%	-6.26%
2022	**3,676**	**434**	**10.06%**	**-6.47%**

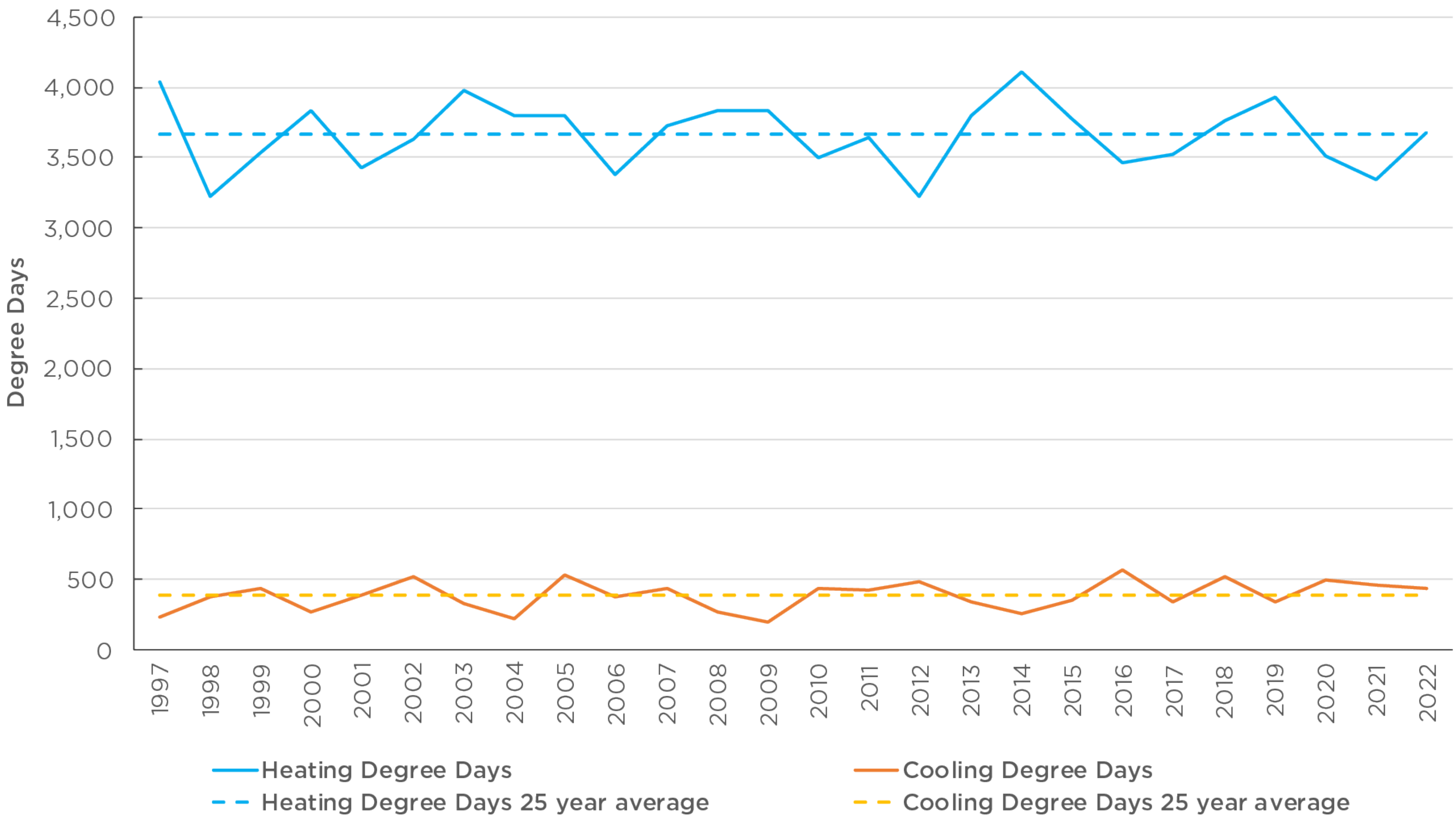
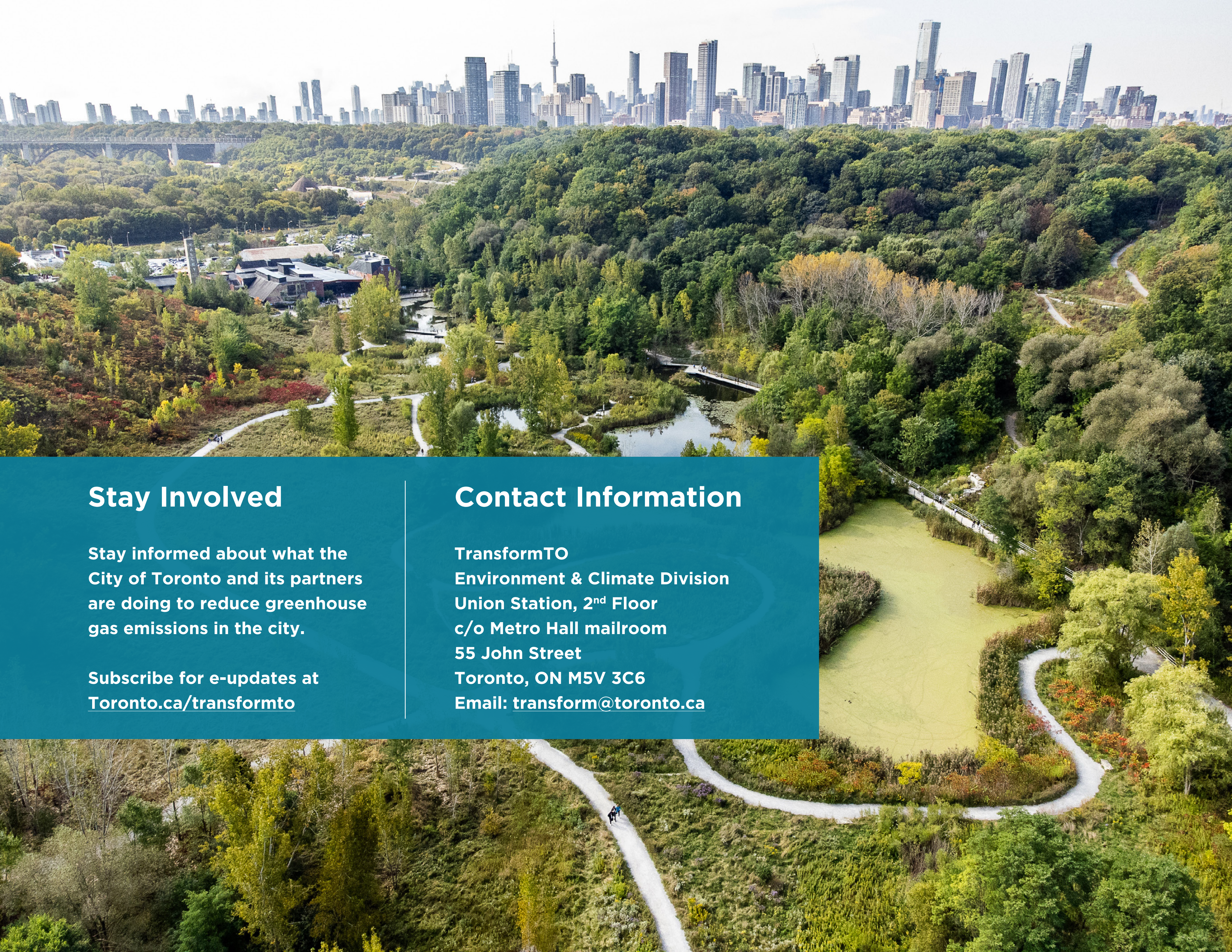


Figure 19: Annual Heating Degree Days (HDD) and Cooling Degree Days (CDD) in Toronto



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

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