REALITY CHECK

Carbon Emissions Inventory for the Greater Toronto and Hamilton Area 2018

TAF The Atmospheric Fund

FEBRUARY 2021

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Foreword

This year's regional emissions inventory provides a much-needed reality check, illustrating that in the four years following Ontario's coal phase out, emissions are slowly increasing across the GTHA.

The purpose of publishing an annual emissions inventory is to help policy- and decision-makers better understand the quantity and sources of carbon emissions in their jurisdictions. While our annual inventory report for the Greater Toronto and Hamilton Area is, by necessity, backward looking (this year's results are from 2018), they provide consistent access to data for players across the region to measure and influence the scope, speed, and direction of climate actions.

If previous reports raised alarm bells, the 2018 data is a code red, with emissions increasing across all regions and nearly all sources. This was led by a stunning 57% increase in emissions from electricity generation. While 2018 may feel like ancient history as we grapple with the current social and economic shocks of a global pandemic, any blips in emissions in 2020 and 2021 are not expected to affect the trajectory of our carbon problem. In fact, without dramatic and immediate intervention, emissions will get worse.

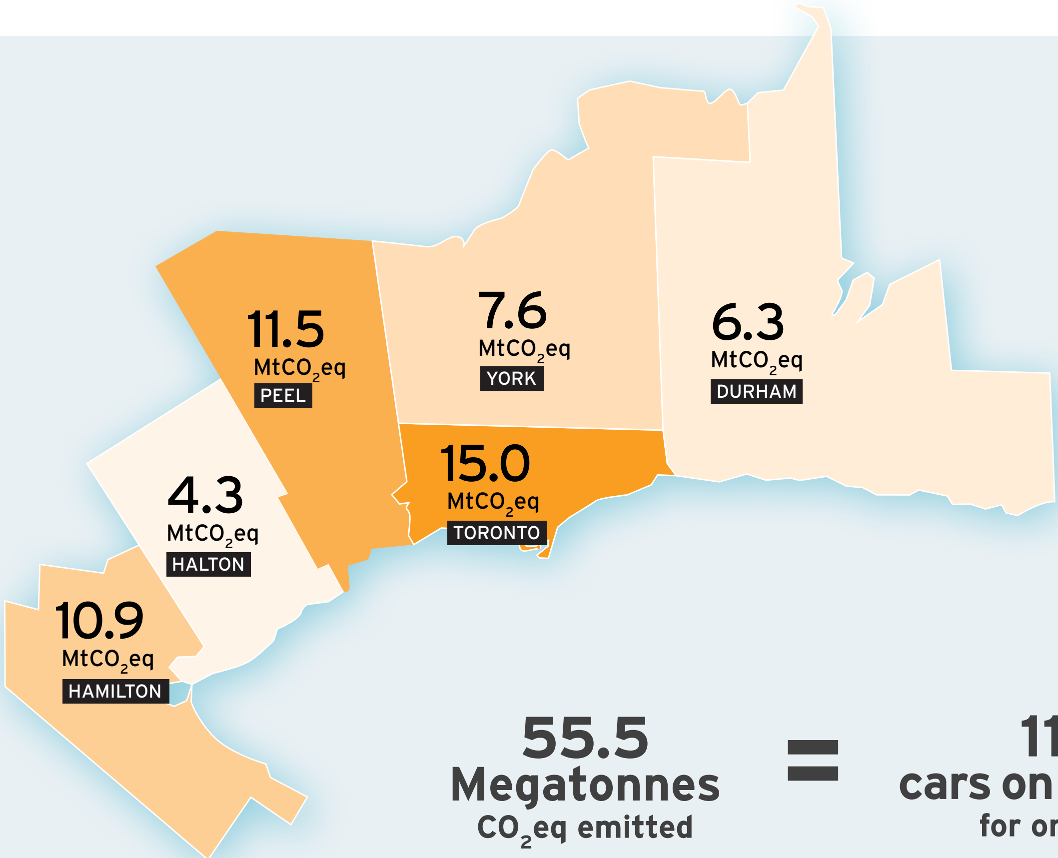
We are not short on worthy announcements and plans at all levels of government. Declarations of climate emergencies and new climate plans have continued to proliferate across the GTHA this year. In November 2020, the federal government introduced the Canadian Net-Zero Emissions Accountability Act, legislating 2030 and 2050 targets. But we are not tracking to meet any of these targets. **Beyond announcements and planning, faster implementation and deeper investment is needed and must be based on robust emissions data.**

Achieving our climate targets will require significant reductions every year from now until we achieve net-zero. We know we can achieve this scale of transformation because we have done it before; in the decade between 2005 and 2014, Ontario's emissions fell nearly 19%, primarily due to the coal phase out. Getting to zero will take this level of systems change across all sectors, from retrofitting all our homes and commercial buildings, to electrifying vehicles, to phasing out natural gas (also known as fossil gas).

You will also find optimism and ambition in this report. Many GTHA players are showing leadership with innovative programs and solutions on the pathway to net-zero. We have highlighted these success stories and opportunities along the way to show what is possible. These are just a few of the many ways carbon reduction can create opportunity, from better health to a prosperous clean economy.

Bryan Purcell
VP Policy & Programs

2018 Carbon Emissions
in the GTHA



44%
of Ontario's total carbon emissions from GTHA

▲ **Emissions increased 5.2%**

55.5 Megatonnes CO_2eq emitted = **11 M cars on the road** for one year

Figure 1: Total emissions by upper tier municipality

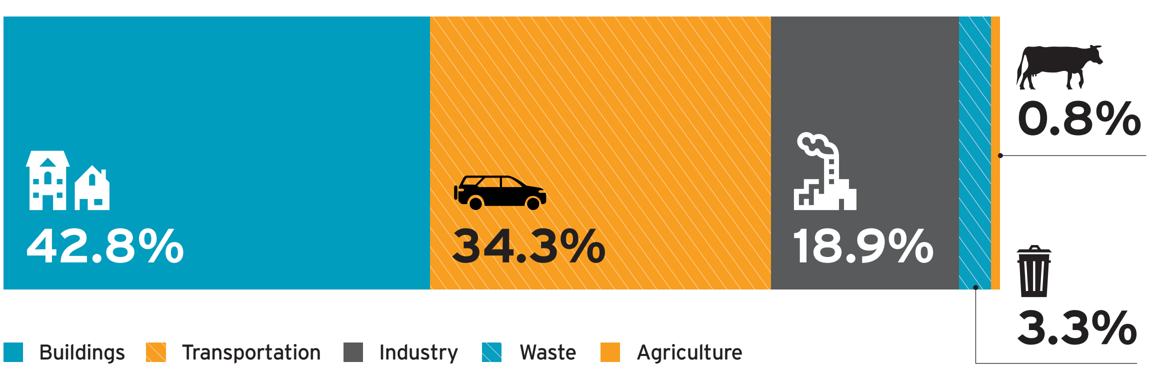


Figure 2: Total emissions by sector in 2018 in $MtCO_2eq$

#GTHAemissions

Summary

CARBON EMISSIONS IN THE GREATER TORONTO AND HAMILTON AREA

Overall emissions increased **5.2%** in 2018

Total carbon emissions in the Greater Toronto and Hamilton Area (GTHA) increased 5.2% in 2018, reaching 56 Mt CO_2eq. The overall trend shows that progress in reducing emissions stalled after Ontario's coal phase out and have even gone into reverse, with 2018 emissions higher than in 2015.

Year-over-year variability has been largely driven by fluctuations in weather, and any impacts from policy and programs have been offset by population increase. There was a slight increase in emissions even when adjusting the data for weather and population growth. With emissions clearly trending upward, **it is clear we are not on track to achieve the deep carbon reduction necessary to reach the 2030 and 2050 climate targets needed to curb dangerous climate change.** Getting on track requires annual emissions reductions of at least 7%, and each year we fail to hit that pace means going even faster in the years ahead.

So, where are the emissions coming from?

- **Natural gas** (40%) and electricity (3%) from consumption in homes, offices, etc., increased in 2018.
- Increased electricity consumption results in a dirtier supply, causing a staggering 57% increase in emissions from **electricity** in 2018.
- Road **transportation** (34%) from gasoline and diesel combustion increased with more cars, trucks, and SUVs on the road, travelling more kilometres.
- A smaller portion from **industry** (19%), **waste** (3%) and **agriculture** (1%) held mostly steady.

Buildings and transportation are the two biggest emitters

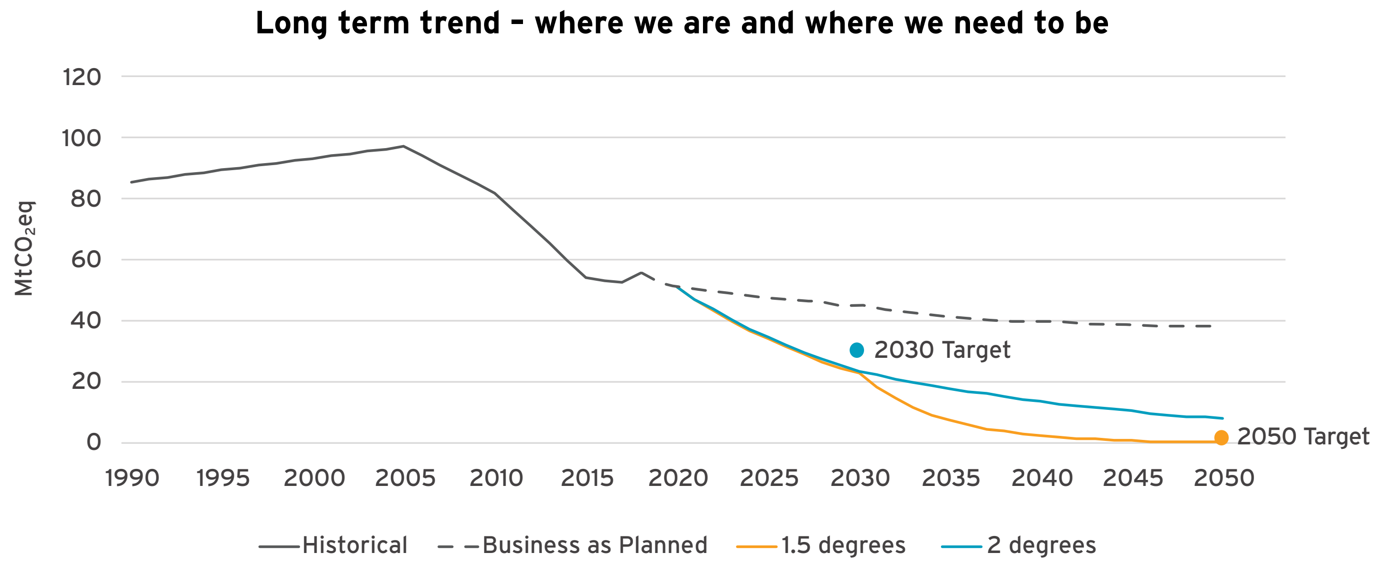


Figure 3: GTHA carbon emission reductions and forecast scenarios.[1]

1 Based on a method developed by Sustainability Solutions Group to align with C40's 1.5 degree pathways. 2030 target extrapolated to the GTHA from TransformTO modelling.

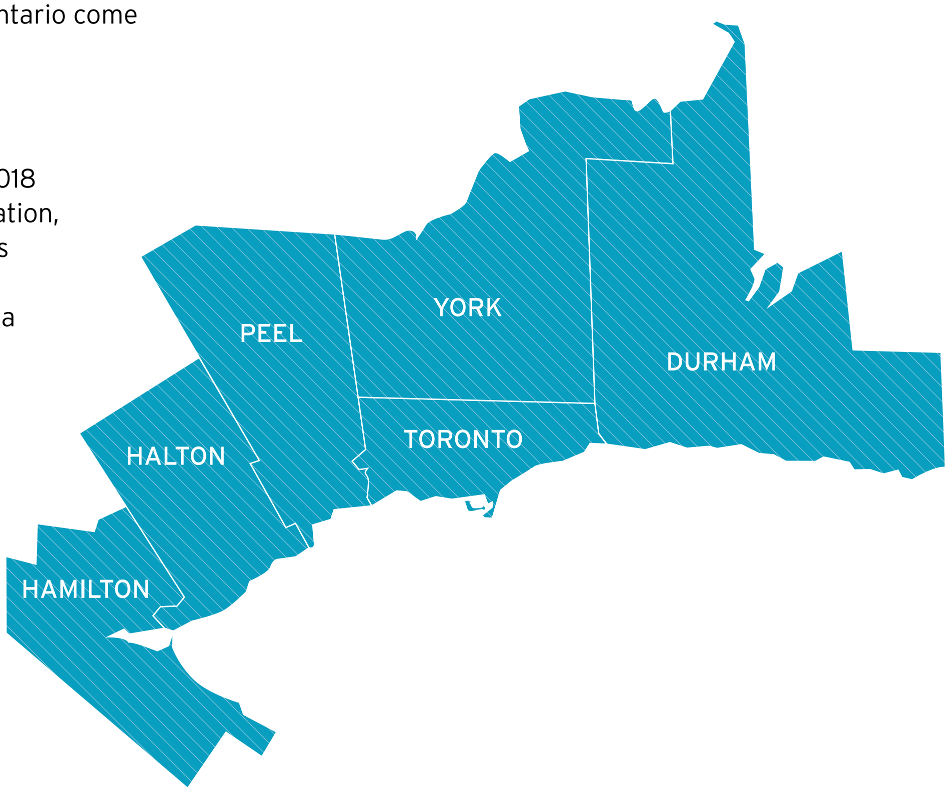
ABOUT THE GTHA

The Greater Toronto and Hamilton Area (GTHA) in Canada includes the city of Toronto, the city of Hamilton, and the regional municipalities of Halton, Peel, York, and Durham. This contiguous urban region of around 8,244.42-square kilometre is home to a population of about 7.4 million. It is Canada's commercial, distribution, and financial core. Almost half of the emissions in the province of Ontario come from this region.

What emissions are counted?

The 55.5 Mt CO_2eq of carbon emitted in 2018 represent the GTHA's buildings, transportation, industry, waste, and agriculture. It includes Scope 1 and Scope 2 emissions only (from direct actions such as burning gasoline in a vehicle and indirect emissions from the generation of electricity). We currently do not account for Scope 3 (indirect emissions from upstream activities such as the mining and refining of fossil fuels, or the emissions from imported goods) due to data constraints and methodological complexities. As access to data improves, TAF will research and analyze more sources of Scope 3 emissions. See Appendix A for more detail on methodology.

The GTHA is the **second-largest financial centre** in North America



Carbon Emissions by Sector

Buildings (which use natural gas for space and water heating and electricity) and transportation (which use gasoline and diesel) are the largest emitting sectors in every municipality in the GTHA, with the exception of Hamilton where industrial emissions (mainly from steel and other manufacturing) are the largest. Waste and agriculture are less significant across the mostly urban and suburban region, but still offer opportunity for progress on emission reduction.

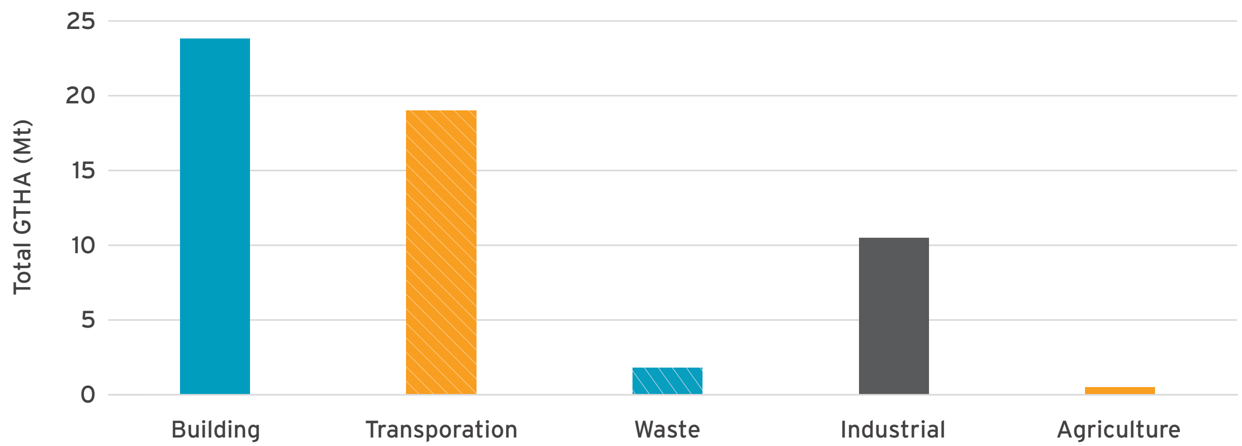


Figure 4: Total emissions in the GTHA by sector

EMISSIONS PROFILES ARE SIMILAR ACROSS THE REGION

When we segment the sources of emissions by region, most GTHA municipalities have similar emissions profiles. Industry in Hamilton and agriculture in Durham are some of the only deviations from the regional similarities. This highlights the value of collaboration across the region to implement climate solutions.

Every region shows a similar increase in natural gas emissions of around 10%, except for Hamilton, where the large portion of natural gas consumed by industry is less sensitive to weather changes.

Transportation shows a more varied regional profile, some up, some down, but overall region-wide emissions increased by almost 1%.

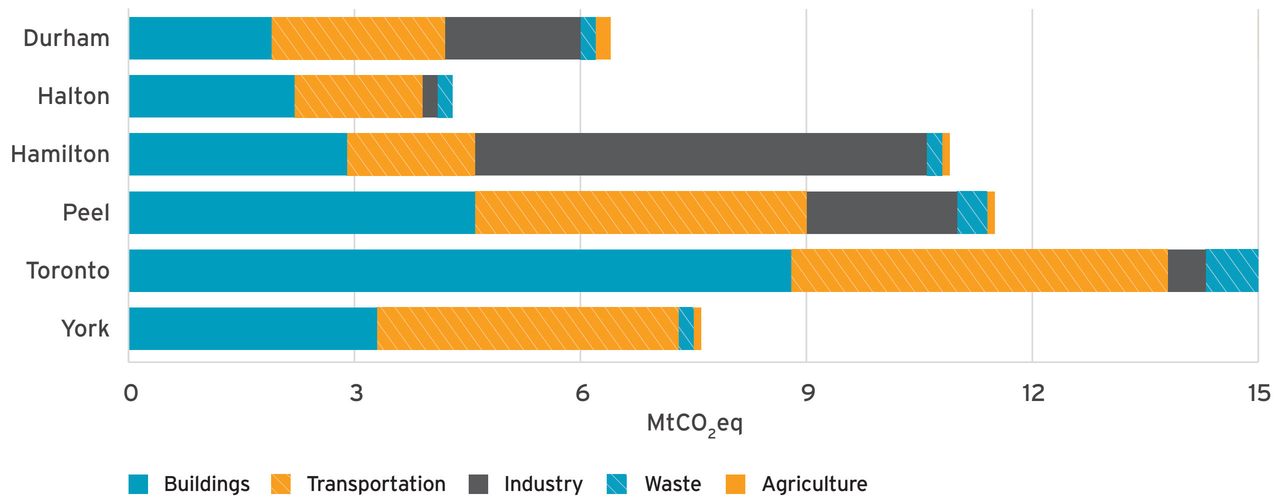


Figure 5: Emissions by municipality and sector

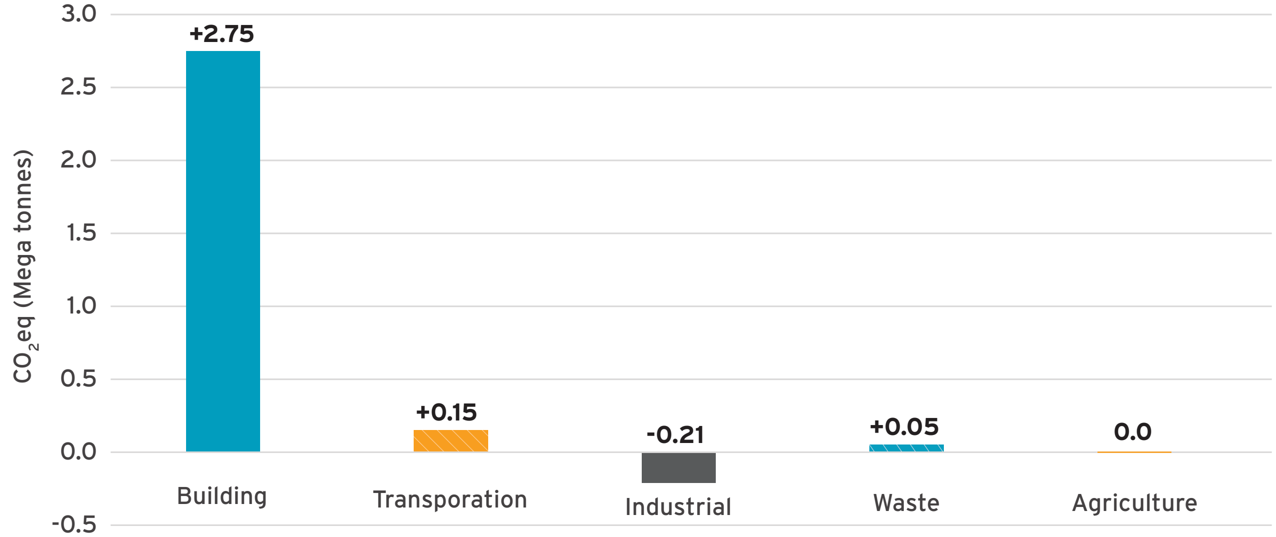


Figure 6: Change by sector in total emissions from 2017 to 2018

BUILDINGS AND ELECTRICITY

Natural gas

Emissions from buildings (43%) come primarily from:

- Natural gas (92.4%) consumed on-site for space and water heating,
- Electricity (7.6%) associated with electricity generated using natural gas.

Natural gas is a fossil fuel (methane) and it is the most significant source of emissions in the GTHA and Ontario. In 2018 natural gas increased about 10.6%, or 2Mt CO_2eq. Achieving net zero by 2050 will require phasing out virtually all natural gas from both heating and power production.

Our per capita natural gas emissions are **increasing** even when adjusted for population growth and weather.

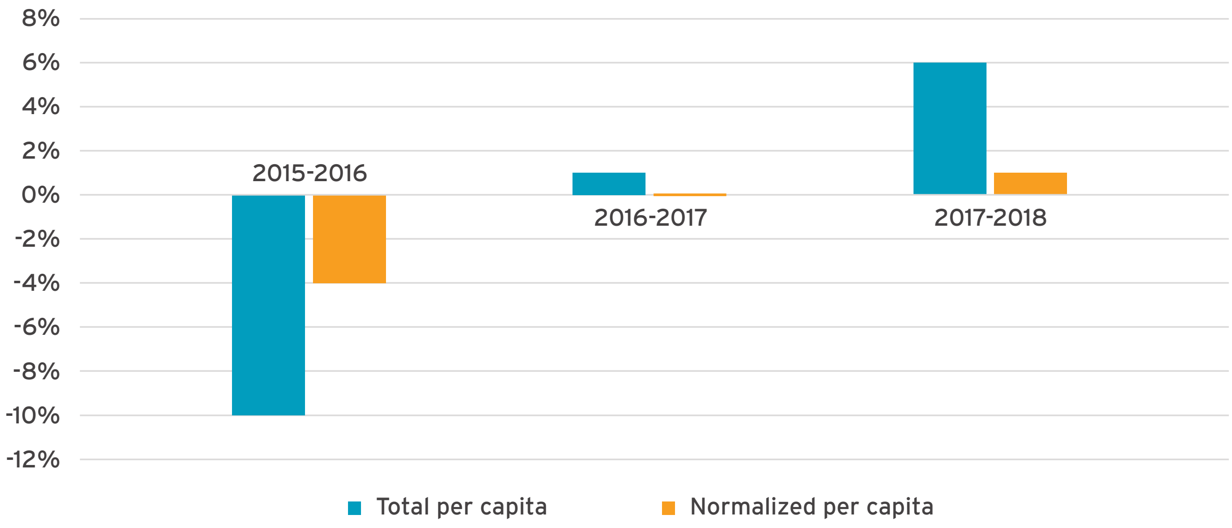


Figure 7: Change in emissions per capita GTHA total vs normalized natural gas

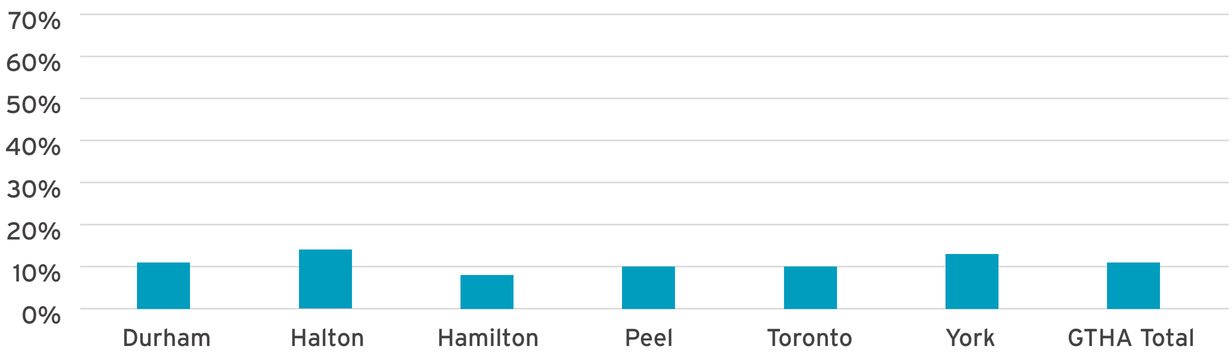


Figure 8: Change in natural gas emissions 2017-2018

Electricity

The electricity supply is getting **dirtier**.

Although electricity is a small portion of GTHA emissions (3%), the increase over 2017 correlates with a very high increase in emissions. While Ontario has relatively clean baseload electricity generation, any increase in demand beyond the baseload is met disproportionately by burning natural gas, which is increasingly sourced from U.S. fracked gas[1]. As a result, the 4.8% increase in consumption in 2018 resulted in a staggering 57% increase in emissions.

This problem is about to get worse unless action is taken. Based on provincial models, electricity emissions are expected to triple over the next few years as natural gas generation supplies an ever-higher share of production. Nuclear refurbishments are scheduled later in the decade, and while they are offline, electricity supply will be filled by natural gas plants.

More electrification of heating in buildings and increased adoption of electric vehicles is key to reducing emissions and will thus increase demand. This emphasizes the overwhelming importance and urgency of accelerating electricity conservation, renewable energy generation, energy storage, and peak shifting.

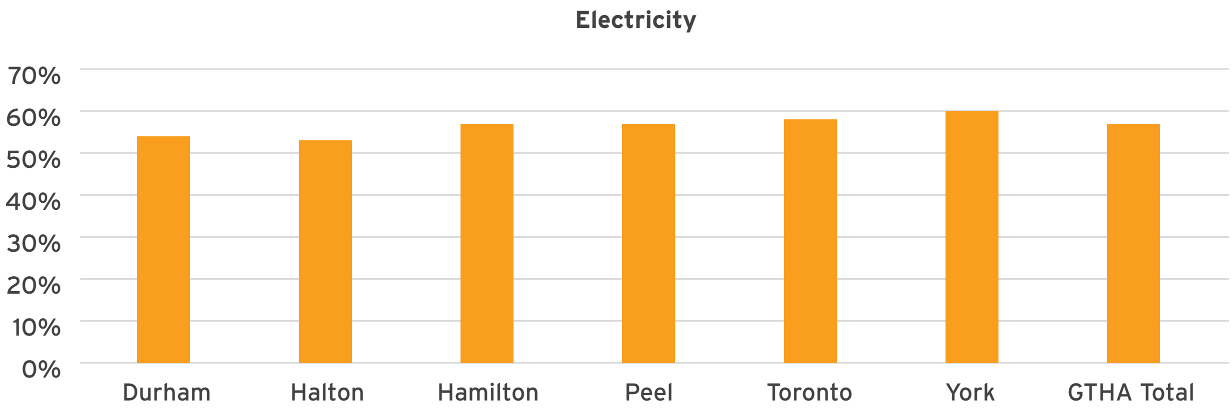


Figure 9: Change in electricity emissions 2017-2018

4.8% increase in electricity consumption resulted in a **57% increase in emissions**.

1 According to the NIR, 83% of the Natural Gas consumed in Ontario in 2018 came from the US, consistent with a constant increase since the year 2000, when less than 5% of Ontario's NG was imported.

POLICY SPOTLIGHT: CHAMPIONING GREEN DEVELOPMENT STANDARDS

In 2020 the Town of Whitby adopted The Whitby Green Development Standard following their declaration of a climate emergency. Without adopting this regulation, new buildings in Whitby alone would have consumed its entire carbon budget by 2050.

Green Development Standards (GDS) are beginning to take root across the GTHA after Toronto's adoption in 2011. With mandatory efficiency standards, these regulations can prevent massive emissions increases from new development associated with population growth.

Green development standards ensure all new housing is healthy, affordable, and low-carbon. Mandatory carbon emissions targets guarantee:

- Buildings have better envelopes (e.g. walls, windows, and roofs), which result in long-lasting energy savings and enhanced resiliency.
- Lower overall energy use and affordability for owners and operators.
- Integration of lower carbon fuels while allowing flexibility to use natural gas if overall targets are met.

To ensure green standards are effective, they should include performance targets, predictable timelines, and industry input and support. To achieve near zero emissions in new construction, the GTHA must embrace Green Development Standards. Municipalities can apply to TAF through our grants program for funding to pursue developing or implementing a green standard.

> "Whitby's population is expected to grow by more than 40% over the next 11 years. We need to lead by example to ensure design and construction of buildings supports greenhouse gas reduction and healthy, sustainable, communities."
>
> **Whitby Mayor Don Mitchell**

TRANSPORTATION

78% of transportation emissions come from personal vehicles.

Transportation emissions come primarily from:

- Gasoline from personal vehicles (78%)
- Diesel and gasoline from light and heavy-duty commercial trucks (22%)
- Transit and aviation (not counted due to data constraints, see note on Scope 3)

This sector contributes one third of region-wide emissions, so increases have a noticeable effect on total GTHA emissions. Transportation emissions overall have been growing at 1-2% every year, despite cleaner fuels and more efficient vehicles. This can likely be attributed to a combination of an increase in the number of personal vehicles, a continuing trend to larger vehicles, increasing sprawl resulting in more kilometers travelled, and increased goods movement.

Transportation emissions per capita did fall slightly in 2018, even with the growth in population. The Toronto trend illustrates that you can have population growth and stable or falling transport emissions if growth is concentrated in existing neighbourhoods with good transit access.

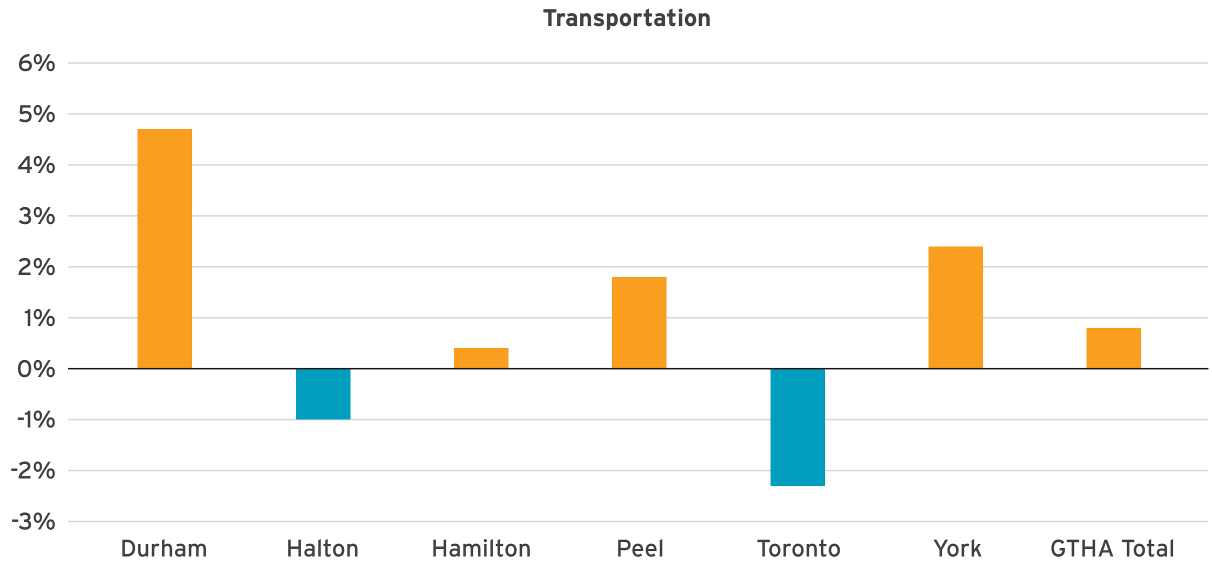


Figure 10: Change in transportation emissions 2017-2018

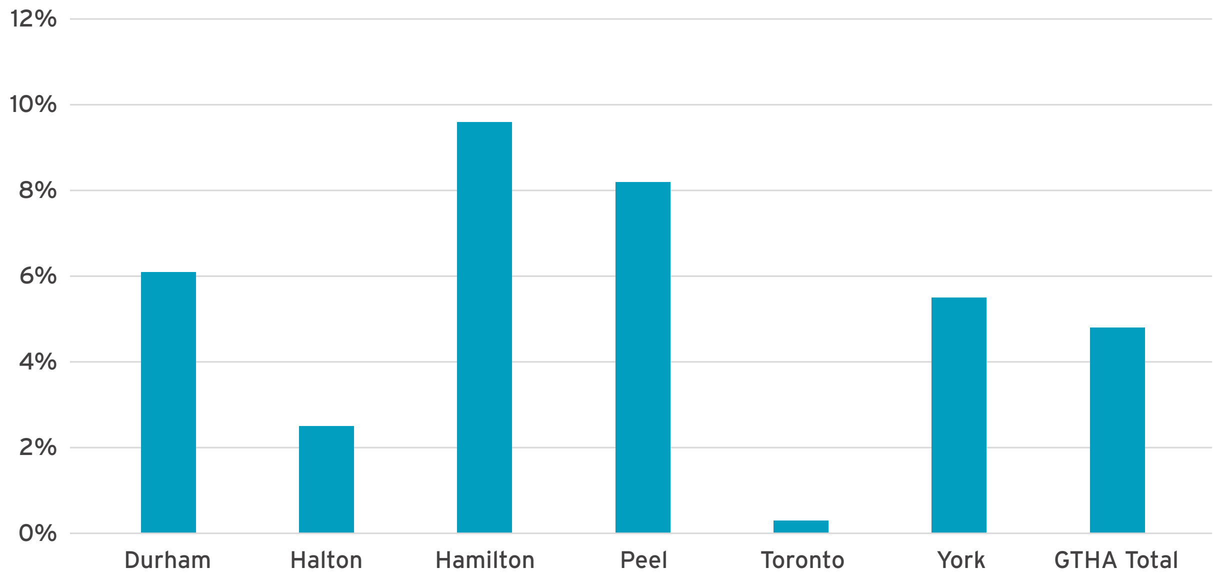


Figure 11: Trend in transportation emissions increase over four years 2015 to 2018

Photo by CHUTTERSNAP on Unsplash

POLICY SPOTLIGHT: EVS AND EV CHARGING INFRASTRUCTURE

The electrification of our transportation sector is vital to decarbonizing our society. All municipalities across the GTHA include electrification of transportation as an important part of meeting their targets. However, without comprehensive planning and supports, municipalities face barriers to electrifying transit systems or encouraging broad adoption of electric vehicles, for example. We have identified three policy solutions from all levels of government needed to tackle these challenges:

A Federal ZEV mandate
A pan-Canadian requirement to gradually increase the market share of Zero-Emissions Vehicles (ZEVs) would effectively address vehicle supply issues and get Canada on track for its ZEV sales targets (30% by 2030, 100% by 2040). A national mandate would be more effective than a patchwork of provincial mandates, and would provide the policy certainty needed to justify local investment in charging infrastructure.

Municipal Actions
Municipalities have jurisdiction over many actions needed to decarbonize transportation, such as zoning and by-laws that impact density, EV charging requirements within standards for new buildings, and electrifying municipal fleets and transit. Federal and Provincial support through funding and leadership is key to enabling these transitions.

Clean Fuel Standard
The newly introduced Clean Fuel Standard is aimed at reducing the carbon intensity of transportation fuels and moving towards emerging low carbon alternatives. This regulation has the potential to increase the implementation of EV charging stations and support the growth of advanced bio-fuels across Canada providing new fuel alternatives for multiple sectors.

INDUSTRY

Most industrial emissions come from:

- Steel and other manufacturing in Hamilton (55% of total Hamilton's emissions),
- Bowmanville Cement Plant in Durham (24% of total Durham's emissions),
- Mississauga Cement Plant in Peel (9% of total Peel's emissions).

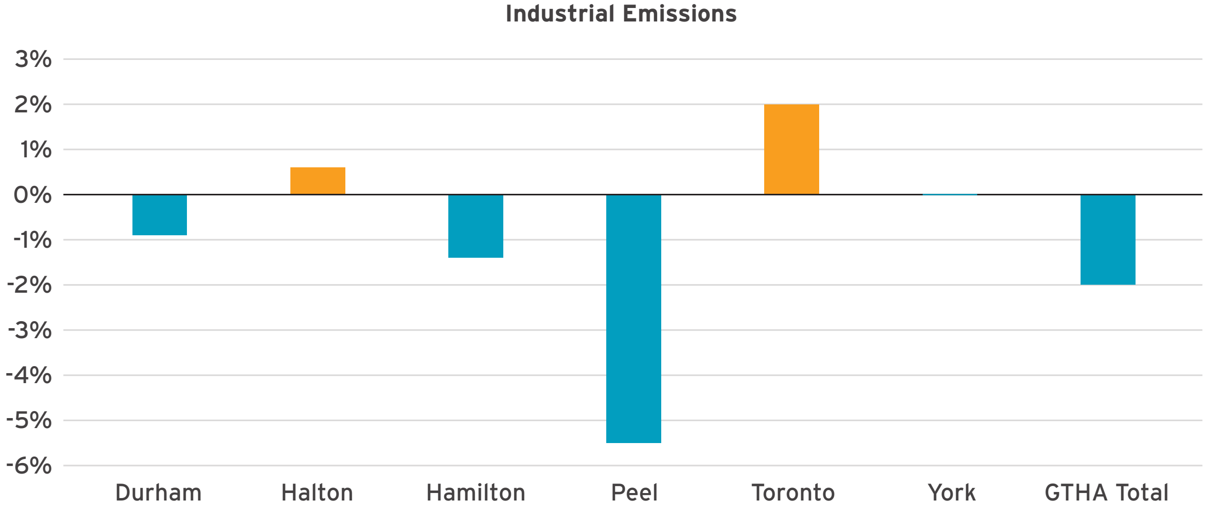


Figure 12: Change in industrial emissions 2017-2018

WASTE AND AGRICULTURE

Waste emissions (3%) come from methane produced from the organic material in landfills and a small portion from waste transportation. Waste is the least reliable and comparable source of emissions in our inventory due to data and methodology limitations, but we can also see an increase in most of the regions.

Emissions from agriculture (1%) are almost negligible. See Regional Profile of Durham for more details on agriculture.

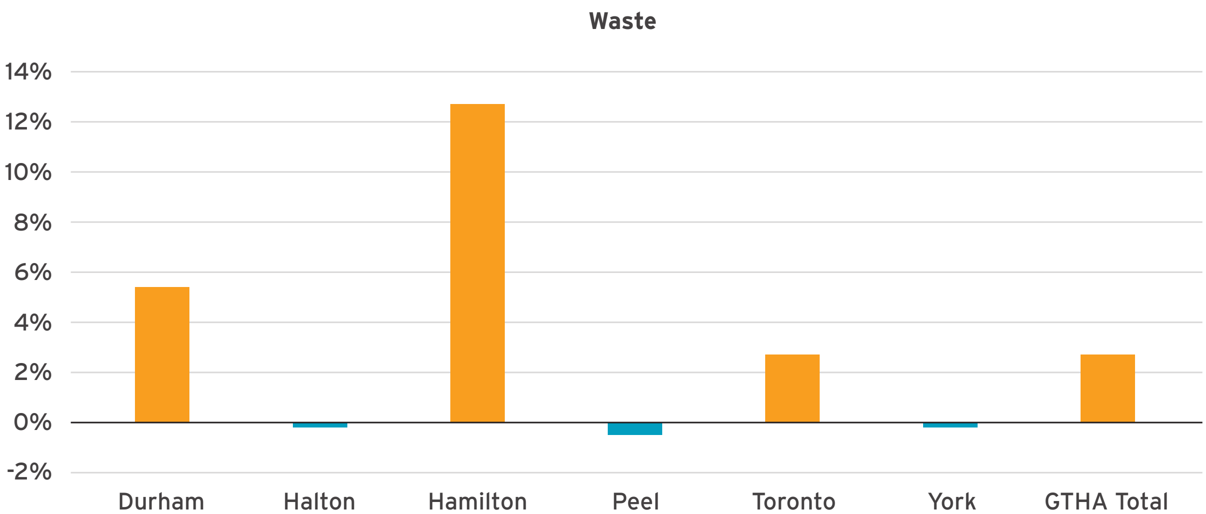


Figure 13: Change in waste emissions 2017-2018

HOW DOES POPULATION AFFECT EMISSIONS?

We need to pick up the pace of carbon reduction to offset population growth

An increase in emissions this year can largely be tied to the population growth of over 313,000 people. Per capita emissions increased by only 0.7%, compared to the absolute emissions increase of 5.2%. Most of the region experienced similar increases per capita with the exceptions of Peel and Hamilton, with slight decreases. Long term stability in electricity and gas usage (despite year over year fluctuations due to weather) shows us that increases in energy efficiency have been just barely sufficient to offset demand growth from new homes and buildings. In the transportation sector, efficiency is not improving fast enough to offset population growth. The strong link to population growth in the two largest sources (buildings and transportation) shows the importance of accelerating the transition to near-zero new construction and electric vehicles.

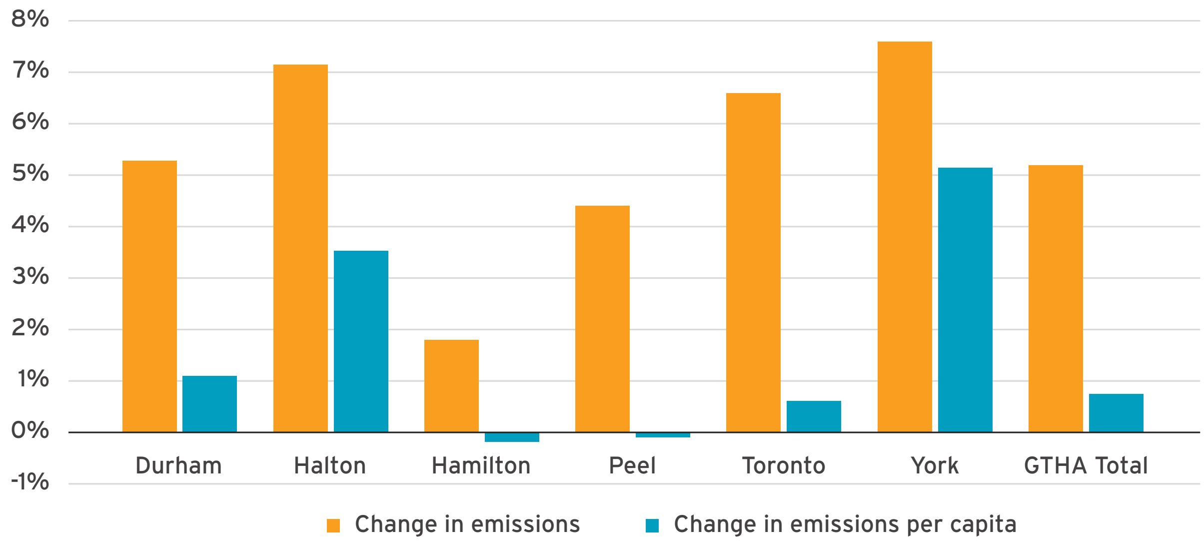


Figure 14: Total Change in emissions and per capita emissions from 2017 to 2018

Regional Profile

Durham

Durham is home to the cities of Oshawa and Pickering, the towns of Whitby and Ajax, the Municipality of Clarington, and the Townships of Scugog, Uxbridge, and Brock.

Population (2018): 683,600
Land Area: 2,524 km^2

GTHA emissions: 11 per cent
GTHA population: 9 per cent

2015	2016	2017	2018
6.1 Mt	6.1 Mt	6.0 Mt	6.3 Mt

Figure 15: Durham has high agricultural and low waste emissions

Profile at a glance:

- 45% of total agriculture emissions in the GTHA come from Durham.
- 1.5 Mt CO_2eq of emissions come from St. Mary Bowmanville cement plant, a significant source in the region.
- Durham has one of the highest waste diversion rates in Ontario. This reduces emissions from waste, as does the waste-to-energy incinerator in Durham.
- Residential buildings in Durham are predominantly single-family homes, so building retrofit policies and programs need to prioritize these buildings to improve their efficiency. In 2020, TAF provided a grant to the region to develop a residential retrofit program and plan.

Regional Profile

Halton

Halton is home to the City of Burlington, and the towns of Oakville, Milton, and Halton Hills.

Population (2018): 580,000
Land Area: 964 km²

GTHA emissions: 8 per cent
GTHA population: 8 per cent

2015	2016	2017	2018
4.3 Mt	4.1 Mt	4.0 Mt	4.3 Mt

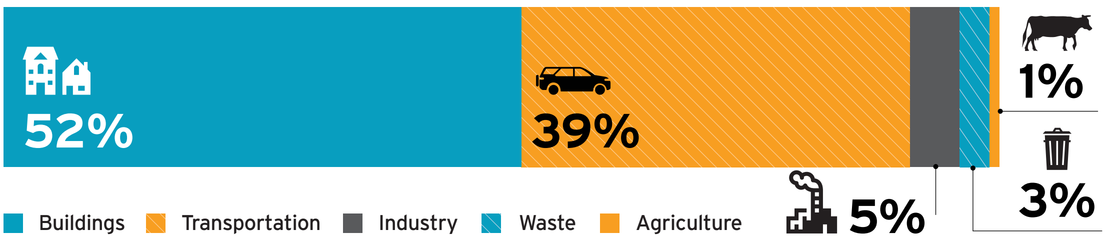


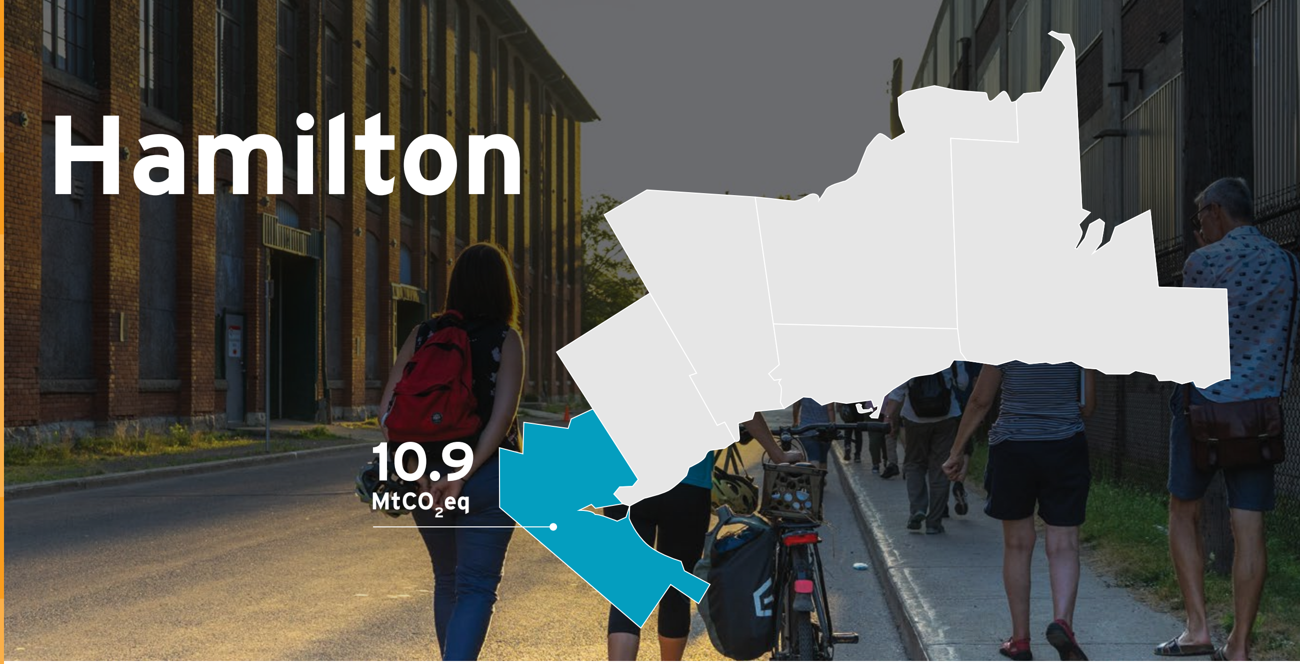
Figure 16: Halton has the highest natural gas emissions in the region

Profile at a glance:

- When industry sources are excluded, Halton has the highest per capita emissions in the GTHA, even though Halton's per capita transportation emissions are at the GTHA median, and the region's percentage of long commutes is not as high as in Durham or York.
- 48.5% of Halton's emissions come from natural gas, so green development standards for new buildings and accelerating deep retrofits for existing buildings are both essential to reaching targets.
- In 2020, TAF provided grants to:
  - Town of Halton Hills to develop Green Development Standards training workshops.
  - Mohawk College and the Bay Area Climate Council to develop a home retrofit program (this grant spans both Hamilton and Halton).

Regional Profile

Hamilton



Population (2018): 554,697
Land Area: 481 km²

GTHA emissions: 19 per cent
GTHA population: 7 per cent

2015	2016	2017	2018
10.6 Mt	10.6 Mt	10.7 Mt	10.9 Mt

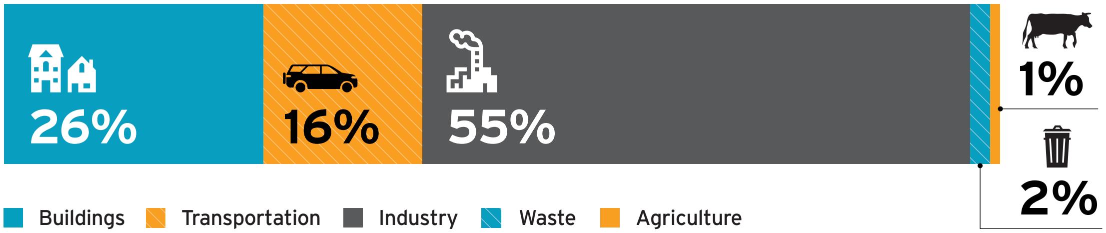


Figure 17: Hamilton is home to GTHA industry and industrial emissions

Profile at a glance:

- Hamilton has the largest per capita emissions in the GTHA, at 19.6 tCO_2eq per capita compared to a regional average of 7.5 tCO_2eq.
- 55% of Hamilton emissions are from industry. Although industrial emissions slightly decreased in 2018, they are still the largest source in the city. Single projects and initiatives to tackle industrial emissions can make a significant impact because the emissions are concentrated in a small number of facilities. In 2020, TAF provided a grant to Hamilton Chamber of Commerce to identify opportunities for industrial waste heat recovery.
- Hamilton's population density is high compared to some other GTHA municipalities, which is a great opportunity to support modal shift and transit investment to reduce emissions from transportation.

Regional Profile

Peel

Peel is home to the cities of Brampton and Mississauga, and the Town of Caledon.

Population (2018): 1,477,200
Land Area: 1,247 km²

GTHA emissions: 21 per cent
GTHA population: 20 per cent

2015	2016	2017	2018
11.0 Mt	10.9 Mt	11.0 Mt	11.5 Mt

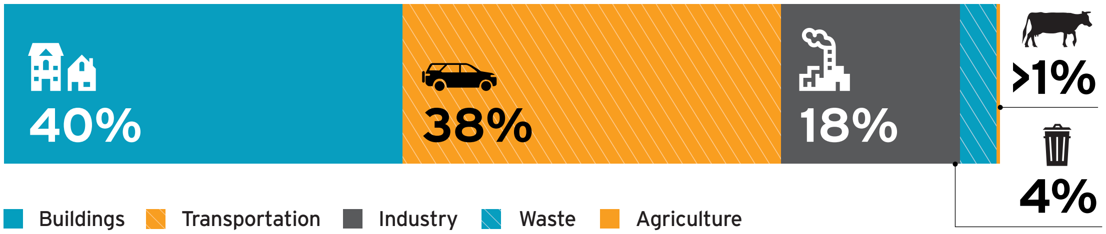


Figure 18: Transportation emissions are rising

Profile at a glance:

- Transportation emissions in Peel have increased 8.2% since 2015. However, per capita emission remained constant.
- The growing density of Brampton, Caledon, and Mississauga presents great opportunities for investing in public transit both within the region's municipalities, and between them.
- One of Peel's most innovative solutions to tackle transportation emissions includes a plan to introduce hydrogen buses, in partnership with a cement plant to generate the hydrogen.
- Given Peel's high density and growth, there is also opportunity for low-carbon district energy. In 2020, TAF provided a grant to the City of Mississauga to demonstrate the feasibility of building a renewable district energy system in downtown Mississauga.

Regional Profile

Toronto

Photo by Matthew Henry on Unsplash

Population (2018): 2,956,000
Land Area: 630 km²

GTHA emissions: 27 per cent
GTHA population: 40 per cent

2015	2016	2017	2018
15.0 Mt	14.2 Mt	14.1 Mt[2]	15.0 Mt

Figure 19: Higher density, lower transportation emissions

Profile at a glance:

- 59% of Toronto's emissions are from natural gas in buildings, including residential, commercial, industry, and institutional buildings.
- 64% of Toronto's homes are multi-residential buildings, so this provides the opportunity to retrofit a large share of the housing stock with a relatively small number of projects.
- While a large share of Toronto's housing stock is multi-residential, single family emissions are higher, so energy efficiency must be addressed in this sector as well.
- Toronto's much higher population density than the rest of the region results in the lowest per capita emissions from transportation. Even so, achieving carbon neutrality will require significant changes to Toronto's transportation, including more active transportation like cycling and walking, electrification of all vehicles, and investment in transit.

2 See Appendix A for a description of our methodology, including why the methods and data we used in this inventory give different results from other inventories compiled by GTHA regions and municipalities.

Regional Profile

York

York is home to the towns of Aurora, East Gwillimbury, Georgina, Newmarket, and Whitchurch-Stouffville, as well as the Township of King and the cities of Markham, Richmond Hill, and Vaughan.

Population (2018): 1,151,000
Land Area: 1,762 km^2

GTHA emissions: 14 per cent
GTHA population: 16 per cent

2015	2016	2017	2018
7.3 Mt	7.0 Mt	7.0 Mt	7.6 Mt

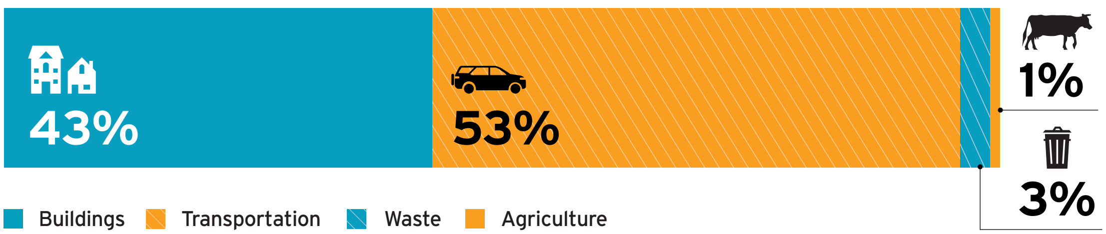


Figure 20: York's transportation emissions are among the GHTA's highest

Profile at a glance:

- York's emissions from buildings, industry, and waste are among the lowest in the GTHA on a per capita basis, yet transportation emissions per capita are the highest.
- Transportation emissions in York have climbed 5.5% from 2015 to 2018.
- Only 18% of homes in York are multi-unit residential buildings. The lower-than-average density results in higher transportation emissions. Improving urban planning to reduce commutes and travel times would allow for substantial reductions in transportation emissions.

Diving Deeper with Methodology

Adjusting for weather does not affect the overall picture

Natural gas consumption is the main driver of changes in emissions year over year. Because gas consumption is highly affected by the weather, we have developed a model that removes the impact of weather on consumption so that we are analyzing trends rather than blips. This gives us a more accurate picture of the data and should allow us to understand if energy efficiency or similar initiatives are having the desired impacts. See Appendix B for a full description of the weather normalization methodology.

	2015-2016	2016-2017	2017-2018
Durham	-8.5%	3.7%	11.0%
Halton	-11.5%	0.6%	13.9%
Hamilton	-2.7%	-0.9%	7.6%
Peel	-7.4%	3.9%	10.1%
Toronto	-9.6%	4.0%	10.1%
York	-10.3%	5.6%	12.7%
GTHA Total	**-8.5%**	**3.2%**	**10.6%**

Table 1: Changes in emissions from natural gas (not weather-normalized)

	2015-2016	2016-2017	2017-2018
Durham	-3.5%	2.6%	5.8%
Halton	-6.3%	-0.4%	8.5%
Hamilton	2.0%	-1.8%	2.5%
Peel	-2.2%	2.9%	4.9%
Toronto	-4.2%	2.8%	4.9%
York	-4.9%	4.5%	7.3%
GTHA Total	**-3.3%**	**2.1%**	**5.3%**

Table 2: Weather-normalized changes in emissions from natural gas

Even after weather normalization, the last two years show an increase in natural gas emissions, which is an unsustainable trend. It is clear that efficiency programs are not offsetting the growth of gas consumption.

Quantification Spotlight: Carbon Data Network

Improving municipal inventories to make them as accurate and accessible as possible is challenging for a few reasons. The use of different methodologies affects our ability to compare data sources. And access to primary data can be complicated, time consuming, and expensive. Similar challenges apply to climate action planning and reporting.

To overcome these challenges, TAF initiated a community of practice for municipalities, utilities, and practitioners in the field of greenhouse gas emission quantification. Through the Carbon Data Network (CDN) we share methodologies and resources to create better data and more efficient outcomes.

Our objectives are:

- Gain a better understanding of available methodologies to allow for more meaningful comparisons between inventories from different jurisdictions.
- Improve access to more granular data to enable better tracking of progress over time of specific interventions.
- Increase efficiency of data gathering to allow practitioners to dedicate more time to implement and monitor climate solutions.

Contact Juan Sotes at juan@taf.ca for more for information.

What do the last four years tell us?

TAF has been aggregating the data from all six GTHA municipalities to create a comprehensive regional picture since 2015. We now have four years of data to compare. Is there a trend? Yes. Emissions are slowly increasing across the board. While weather causes variation in natural gas consumption, emissions have increased since 2015. Transportation emissions are decreasing slightly per capita, but not enough to offset growth in population, increasing almost 5% since 2015.

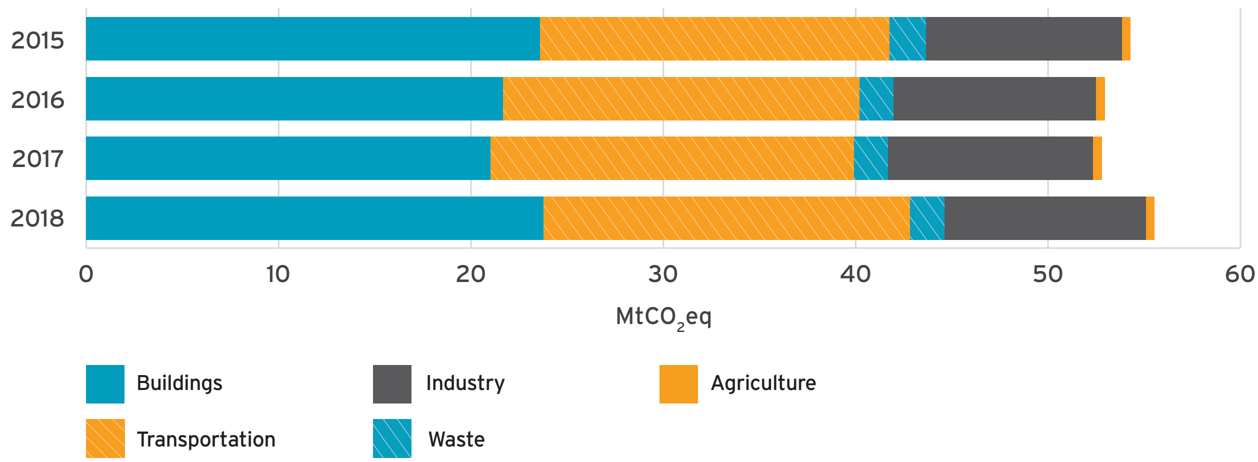
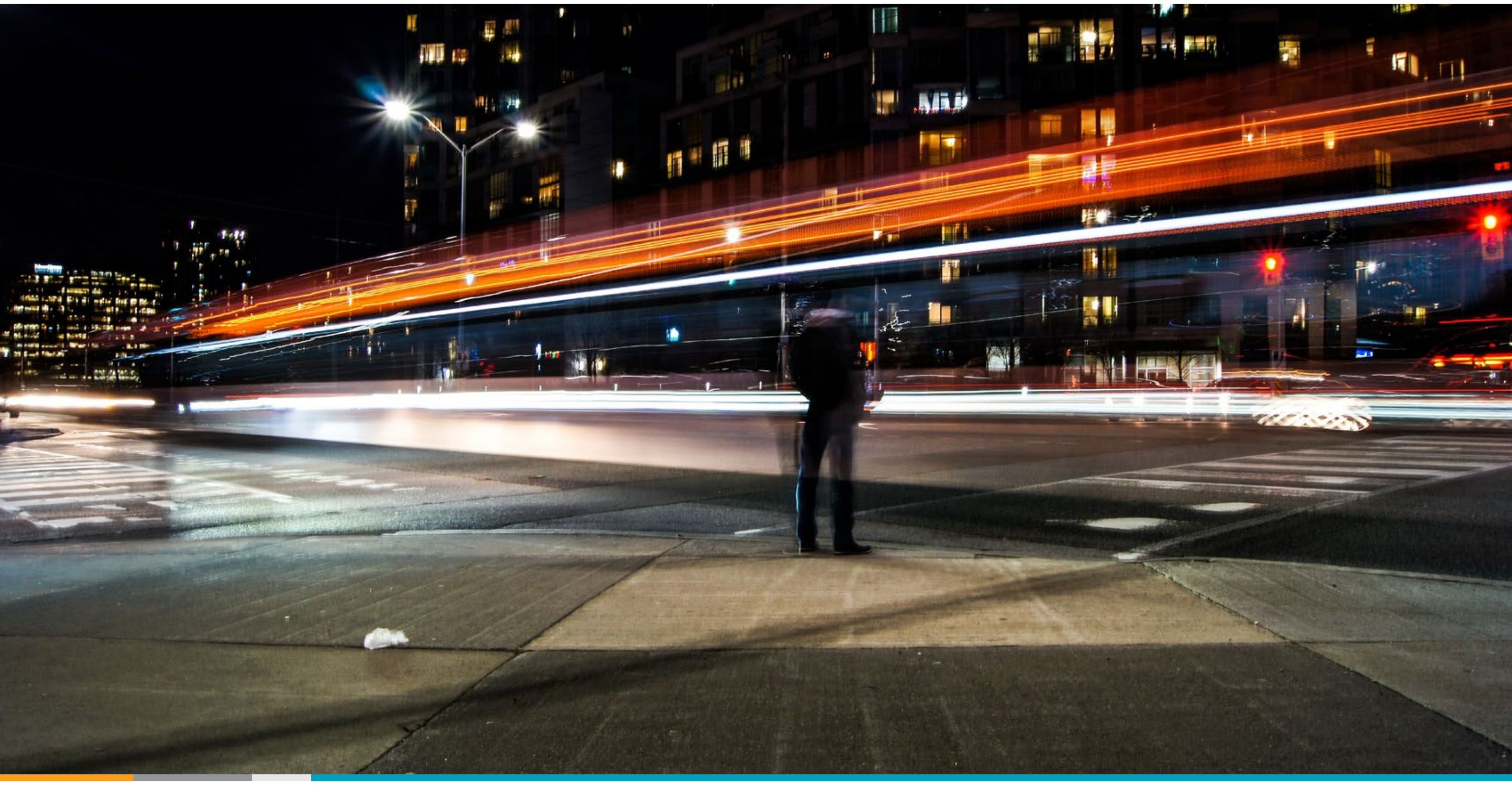


Figure 21: Total carbon emissions in the GTHA from all sectors 2015-2018

Photo by Ahsan Avi on Unsplash



Conclusion

Photo by Daniel Novykov on Unsplash

Getting to net-zero in the GTHA

Achieving a net-zero GTHA by 2050 requires eliminating most of the 56 million tonnes emitted annually and offsetting the emissions that cannot be eliminated. In the face of the climate emergency and COVID recovery, it is time to accelerate the implementation of proven solutions at scale, making all facets of everyday life low- and zero-carbon to support multiple social and economic benefits along with the environmental outcomes. Consistent and robust annual emissions inventories will support development and deployment of solutions and provide the opportunity to track progress and celebrate wins. As the 2018 data clearly show, stronger action is needed from all levels of government, businesses, and citizens to curb emissions. Each jurisdiction and each stakeholder have its part to play.

THREE ENABLING POLICY SOLUTIONS

MUNICIPAL

All new buildings should be built to **near zero standards**. As consumption increase is tied to population growth, standards for new development (green development standards) are critical.

MUNICIPAL, PROVINCIAL

Accelerate deeper retrofits in all existing buildings, in the short term to be driven by incentives and voluntary conservation programs, and transitioning rapidly to mandatory standards.

FEDERAL, PROVINCIAL, MUNICIPAL

We need to **electrify heating and transportation**, at the same time we **decarbonize electricity production**. This requires utilities to ramp up electricity conservation, storage, demand response, and renewable generation. along with public and private investment.

APPENDIX A

Methodology and Sources

In general, we followed the guidelines in the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories and attempted to use as many primary sources of data as possible (ICLEI, WRI, C40, 2014). The regional inventory includes scope 1 and 2 emissions. We will continue to improve our methodology over time.

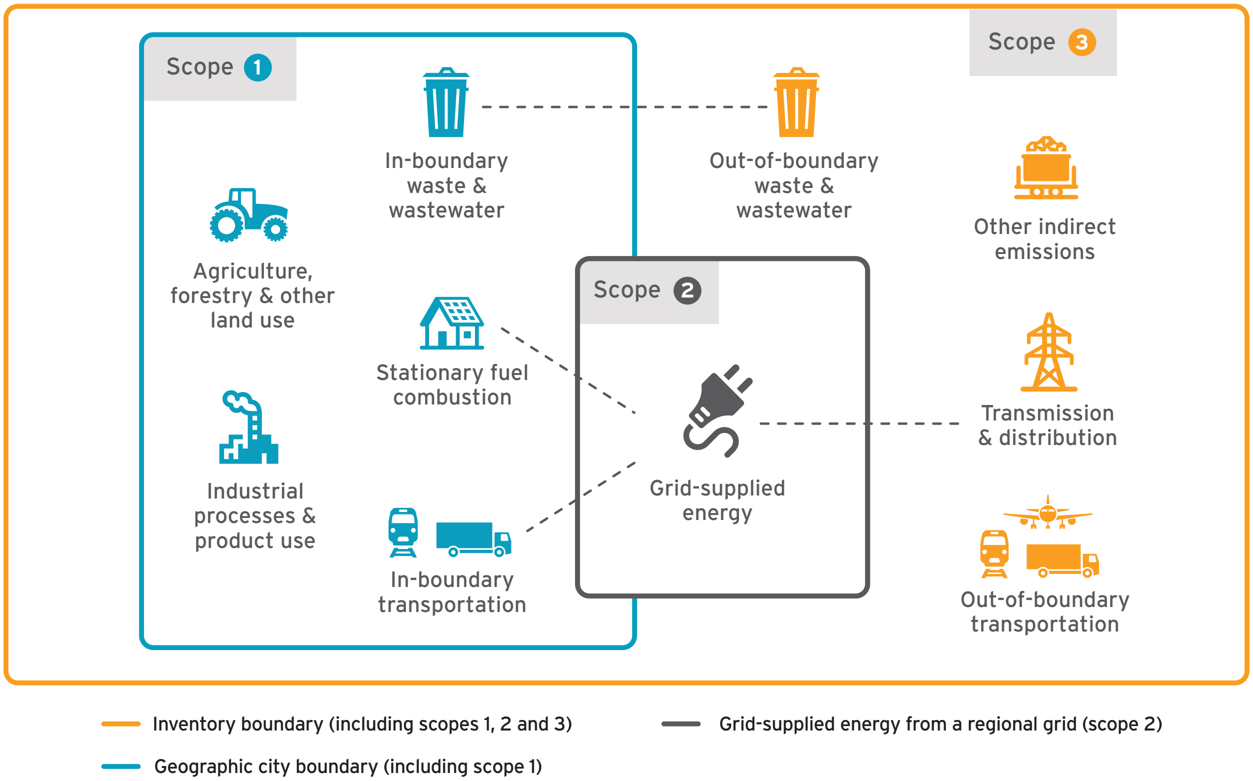


Figure 22: Definition of scope 1, 2, and 3 emissions sources

As mentioned in the report, our results in this inventory may differ from results in the emissions inventories published by individual municipalities or specific regions. This is due to differences in data sources and methodologies. For example, our approach for estimating transportation and waste emissions is different from the approach taken by the City of Toronto for the TransformTO project, which explains the discrepancies in the results. Further, our methodology is affected by the availability of comparable data from every GTHA region.

Results from emissions inventories are conditioned by the methodology employed, information available and assumptions made, in a complex process which sometimes doesn't provide an optimal solution. One solution is not necessarily better than another, so comparing results from two different inventories is usually misleading.

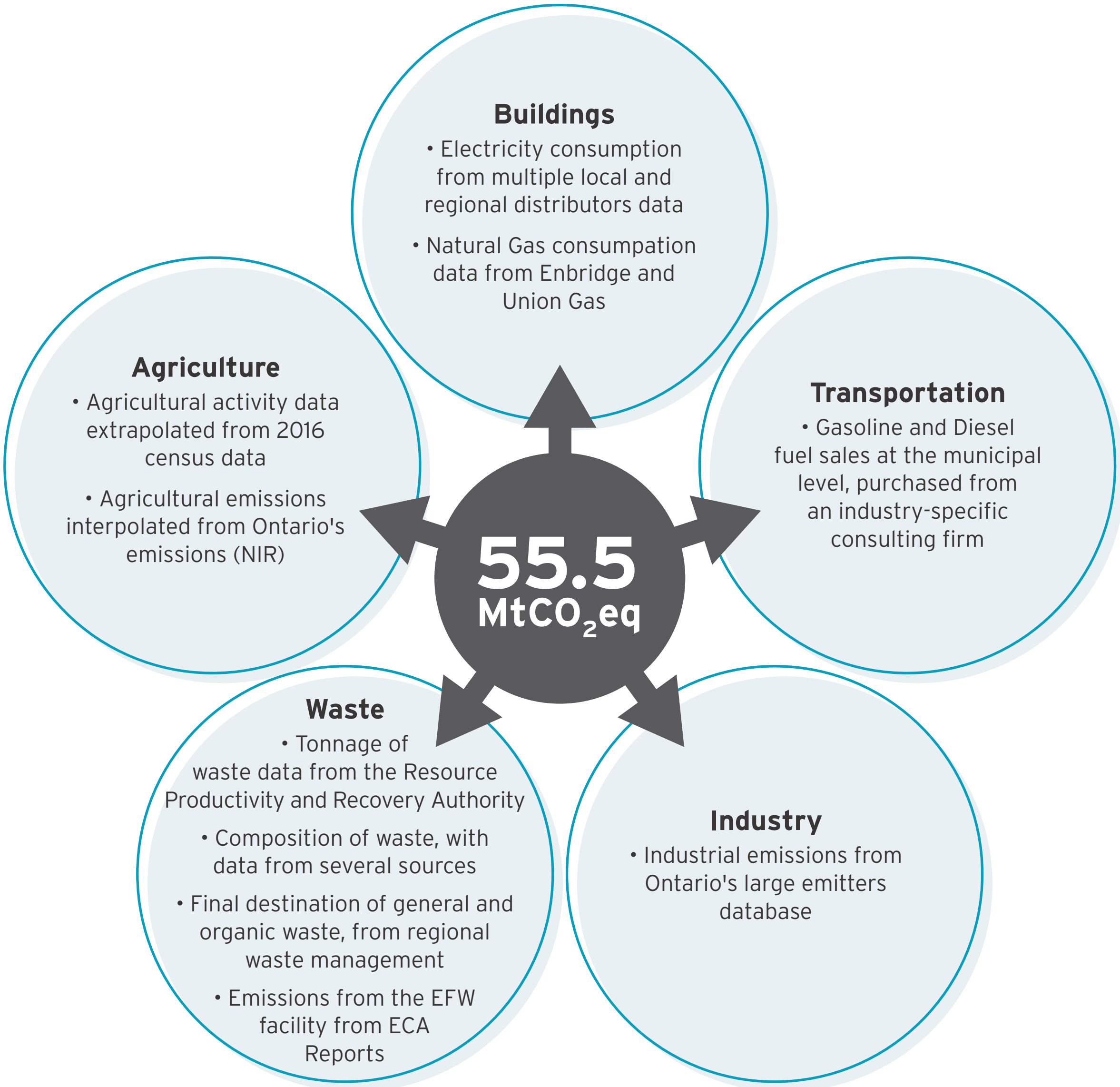


Figure 23: Overview of the sources of emissions used to compile this inventory

Buildings

Natural gas and electricity consumption are the two main sources of emissions from buildings in the GTHA. These sources typically fall under the umbrella term of "Stationary Energy" but we will refer to them as "Buildings" in this document to make the concept more relatable. According to Natural Resources Canada's Comprehensive Energy Use Database, 83.8% of residential energy use and 93.3% of commercial/ institutional energy use comes from these two energy sources[3]. Cities likely use an even higher proportion of energy use from natural gas and electricity, given that these services have long been available and easily accessible in urban areas. We did not calculate propane, heating oil, wood, and coal emissions as we estimated that they make up an insignificant portion of the emissions in buildings in the GTHA and could not easily obtain reliable data on their emissions.

We obtained natural gas consumption data from Enbridge and Union Gas. We did not account for leakage of natural gas during local distribution and upstream emissions from the mining and refinement of natural gas.

We obtained electricity data from the Ontario Energy Board's Reporting and Record Keeping Requirements (RRR), and local distribution companies (LDC). The RRR reports electricity distribution by LDC, with some LDCs

3 https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=com&juris=ca&rn=1&page=0

providing electricity to more than one municipality. Electricity consumption for some small municipalities was interpolated based on a strong correlation between historic population and consumption values for the GTHA. Municipalities with interpolated electricity consumption are Caledon, Georgina, Whitchurch-Stouffville, East Gwillimbury, and Scugog.

Electricity consumption could include sources that are not associated with buildings such as EV charging, street lighting, or transit operations. We did not disaggregate those sources due to inconsistencies in available data across the region. Further, we did not consider electricity imports and exports in this inventory, but Ontario exports significantly more electricity than it imports, particularly to jurisdictions with greater emissions intensity such as New York and Michigan.

The natural gas and electricity consumption values were multiplied by emissions factors from Canada's National Inventory Report, 0.001888 tCO_2eq/m^3 of natural gas and 0.00003 tCO_2eq/kWh, respectively.

Transportation

We calculated transportation emissions using gasoline and diesel fuel sales data from Kent Group Limited. Kent Group Limited's coverage is about 99% of public gas stations in the GTHA. Diesel fuel from bulk contracts and cardlock sales is not included in this dataset, underestimating diesel emissions in the region; while gasoline sales in the GTHA account for 42% of Ontario's total consumption (an expected value based on population and economic activity), our diesel data accounts only for 10% of the province's consumption[4]. This value has not been extrapolated because retail diesel trends are not typically correlated with retail gasoline trends, increasing the uncertainty associated with any possible estimation. The transportation emissions data doesn't account for private sales, railway, marine, transit, or local aviation emissions.

Ontario's renewable fuel standard requires at least 5% of gasoline sold to be from a renewable source so it was assumed that 5% of gasoline sales were ethanol with a 34% reduction in emissions (United States Environmental Protection Agency, 2014; Government of Ontario, 2016). Similarly, due to the Greener Diesel regulation, 4% of diesel sales were assumed to be bio-based with a 30% reduction in emissions (Ministry of the Environment and Climate Change, 2017).

Fuel sales occurring in each top-tier municipality were allocated to that municipality's emissions inventory. We took this approach for simplicity. A reasonable alternative method would be to attribute the emissions to the municipality in which the fuel is consumed. We analyzed the Tomorrow Survey origin-destination data from 2016 to identify the potential difference an alternative methodology might make, but the effect of including the origin-destination variable is negligible in the overall results for each region.

The tables below show emissions by municipality and emissions split between gasoline and diesel.

Top-Tier Municipality	Gasoline Emissions (tCO_2eq)	Diesel emission (tCO_2eq)	Total Fuel Emissions (tCO_2eq)
Durham	1,975,773	141,394	2,117,167
Halton	1,392,791	156,106	1,548,897
Hamilton	1,472,182	128,761	1,600,943
Peel	3,668,933	376,631	4,045,564
Toronto	4,288,026	347,046	4,635,072
York	3,379,024	335,153	3,714,176
GTHA Total	**16,176,729**	**1,485,091**	**17,661,819**

Table 3: Transportation fuel emissions by top-tier municipality in the GTHA

4 https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2310006601&pickMembers%5B0%5D=1.7&cubeTimeFrame.startYear=2015&cubeTimeFrame.endYear=2019&referencePeriods=20150101%2C20190101

The fuel sales data accounts for 90% of total transportation emissions in the GTHA including gasoline passenger cars and trucks, gasoline commercial vans and pick up trucks, and diesel light commercial trucks. It however, excludes the diesel heavy commercial truck emissions which accounts for 7% of transportation emissions (the remaining is associated with the transit emissions) (Ref: The TEPs Model developed by University of Toronto estimates that heavy freight accounts for 7% of transportation emissions). We multiplied the fuel sales emission by 1.08 to account for heavy commercial truck in the GTHA transportation emissions.

Waste

We used the methane commitment approach to calculate emissions from waste. Using this method, the estimated lifetime emissions of waste disposed in a given year is attributed entirely to that year even though the emissions will occur over many years (ICLEI, WRI, C40, 2014). Waste emissions are attributed to the municipality that produced the waste, not where waste is disposed of. Captured and flared methane is considered biogenic methane and estimated to be net zero emissions. The formulas for this method can be found in the Greenhouse Gas Protocol for Community-Scale Emissions Inventories.

The methane commitment method requires two main points of data: Waste tonnage disposed of in landfill, and the degradable organic carbon (DOC) portion of the waste. Residential waste tonnage was obtained from the Resource Productivity & Recovery Authority (RPRA) (Resource Productivity & Recovery Authority, 2016). Data is provided by municipality or upper-tier municipality. Commercial and industrial waste tonnage is extrapolated from the RPRA data using Statistics Canada CANSIM Table 153-0041 which showed for every tonne of residential waste disposed 1.53 tonnes of non-residential waste were disposed of in 2018 (Statistics Canada, 2018).

DOC values were calculated by using standard factors for each type of waste disposed of requiring waste audit/composition data to be available. Assumptions were made when 'other' was listed as a category in the waste audit. The following table summarizes the data available to TAF:

					DOC CATEGORY					
Source	**Sector**	**Year**	**Methane Generation Potential (LO) (tCH4 per tWaste)**	**DOC**	**Food (A)**	**Garden/ Plant (B)**	**Paper (C)**	**Wood (D)**	**Textiles (E)**	**Industrial Waste (F)**
Toronto Environmental Alliance (Toronto Environmental Alliance, 2016)	Single Family	2015	0.054	0.1619	0.41	N/A	0.2	N/A	0.06	0.04
Toronto Environmental Alliance (Toronto Environmental Alliance, 2016)	Multi-family	2015	0.064	0.1926	0.54	N/A	0.24	N/A	0.04	0.04
Torrie Smith Associates (2017)	Non-residential	2014	0.070	0.2114	0.22	0.02	0.35	0.08	N/A	N/A

Table 4: Waste composition data sources and values

For the residential sector, we used the waste composition provided by the Toronto Environmental Alliance to calculate the DOC as the data was collected in 2015, a year that is covered by the inventory. The single family and multi-family compositions were weighted based on the proportion of each building type in the GTHA to create one single DOC value that could be applied across the region for residential waste.

The non-residential waste composition was provided by Torrie Smith Associates and Kelleher Environmental as supplemental data to their report on Greenhouse Gas Emissions and the Ontario Waste Management Industry (Kelleher, Christina, & Torrie, 2015).

The efficiency of landfill gas recovered is assumed to be 75%, as suggested by the US EPA (United States Environmental Protection Agency). Canada's National Inventory report estimates a reduction of emission of about 38% from landfill gas recovery but the percentage in the GTHA is presumed to be much higher than that based on the quantity of methane the region's landfills capture, hence our use of the US EPA's value (Government of Canada, 2019). OX, F, DOCf, and MF values use the appropriately recommended values of 0.1, 0.5, 0.6, and 1, respectively (ICLEI, WRI, C40, 2014).

The GTHA has two energy-from-waste facilities, the Durham York Energy Centre and Peel region's Emerald Energy from Waste Inc. In 2018, the Durham York Energy Centre facility emitted 72,811 TCO_2eq (Environment and Climate Change Canada, 2017). 21% of the facility's capacity is used to process York Region waste while the remaining 79% is used to process Durham Region waste. We used these proportions in our emissions analysis (Durham York Energy Centre). In 2018, the facility generated 102,192 MWh of electricity of which 85,412 MWh were exported to the grid[5]. The Emerald facility's emission is accounted in industrial emissions due to the lack of information on the amount of waste sent to incineration.

We also included CH4 and N2O emissions from organic waste treatment, both aerobic and anaerobic. Organic waste data was obtained from the Resource Productivity & Recovery Authority (RPRA) (Resource Productivity & Recovery Authority, 2016). The type of organic waste processing was determined by reviewing the waste management plans of each region and through direct consultation with waste management areas. The emission factors applied are 4 g CH4/kg waste and 0.3 g N2O /kg waste for aerobic digestion (composting) and 1 g CH4/kg waste and 0 g N2O /kg waste for anaerobic digestion.

We assumed zero emissions from wastewater since the methane in digester gas is biogenic, which is either flared or used to offset the natural gas required by the plant in heating or processes. A credit is not calculated for the digester gas used to offset natural gas use, because the avoided natural gas use is already excluded from the natural gas consumption values. We did not account for the emissions from the end-uses of wastewater sludge.

Agriculture

We estimated agricultural emissions by proportioning Ontario's agricultural emissions in Canada's National Inventory Report based on Statistics Canada's Census of Agriculture. Livestock emissions were proportioned based on the head count of cattle and emissions from manure management, and agriculture soils were proportioned based on area of farm land.

We did not include resource inputs like the manufacturing of fertilizer. Additionally, we did not calculate emissions from land use change or forestry activities due to insufficient data.

Industrial

We took the industrial emissions from Ontario's 2018 greenhouse gas emissions reporting by large emitters (>25,000 tCO_2eq/year and smaller emitters that report voluntarily) (Government of Ontario, 2018). We assumed the emissions from power generating facilities were already included in the electricity grid emissions and combined heat and power plants' emissions were captured by the natural gas consumption data, thus we excluded those two sources. By excluding these two sectors, most of the remaining emissions should be from industrial processes. However, some natural gas emissions may be double counted as the large emitter's data reporting does not disaggregate the sources of emissions.

5 https://cleanairpartnership.sharepoint.com/sites/TowerWise/Shared%20Documents/P_PUBLIC/GHG%20Quantification/After%20Sep2018/GHG%20Quantification/Emission%20Inventory/Data/Waste/2018/2018_DYEC_Annual_RPT.pdf

APPENDIX B

Annual Comparison

In order to make meaningful comparisons between different years, it is necessary to ensure consistency in the data set and methodology over time. Given that some sources of data have been added and specific methods have been refined, the emissions inventory results for 2015, 2016 and 2017 have been recalculated.

	RECALCULATED EMISSIONS			PERCENTAGE CHANGE		
	2015	2016	2017	2015	2016	2017
Natural gas	1,049,448	19,255,041	19,866,624	0.0%	0.0%	0.0%
Electricity	2,541,076	2,414,155	1,141,201	-0.6%	1.6%	-1.3%
Transportation	18,163,156	18,508,291	18,891,421	13.6%	13.5%	13.6%
Waste	1,876,358	1,768,428	1,762,405	1.3%	0.0%	0.0%
Industrial	10,196,112	10,528,461	10,683,265	13.8%	17.2%	15.0%
Agriculture	460,893	469,239	453,893	0.3%	0.0%	0.0%
Total GTHA	**54,287,043**	**52,943,615**	**52,798,810**	**6.7%**	**7.7%**	**7.4%**

Table 5: The recalculated emissions inventory results for 2015, 2016 and 2017

The following changes were made for each sector:

Natural gas
No changes

Electricity
Toronto Hydro's electricity data already included Transmission loss and we applied NIR transmission loss on top of Toronto Hydro's data. We corrected these values and recalculated the emissions.

Transportation
Heavy commercial trucks emissions are added. In addition, municipal boundary of Kent fuel sale is changed so some of the surveyed sites are re-allocated to other regions due to change in the boundaries.

Industrial
New facilities have been added and cogeneration facilities have been removed because their emissions are already considered within the natural gas consumption data. Missing facilities in last year reports were added (Durham's Bowmanville cement facility).

Waste
No changes

Agriculture
No changes

APPENDIX C

Weather Normalization

Natural gas and electricity consumption are very sensitive to weather conditions. In the GTHA, natural gas is commonly used as a fuel for space and water heating in the residential and commercial sectors, therefore there is a direct correlation between the daily temperature and natural gas consumption.

In order to address this variable and make more meaningful comparisons between years, we used a weather normalization method. Weather normalization is achieved by calculating a normalization factor which compares a given year's total heating degree days (HDD) against a 30-year average.

An HDD is calculated by taking the difference between the average temperature of any given day and 18°C[6]. For example, if the average temperature of one day is 10°C, this will account for 8 HDD. When this is done for every day of the year, it provides a total value of HDD (Table 6).

	Heating Degree Days (18°C)
2015	3,769.00
2016	3,464.00
2017	3,518.00
2018	3,765.00
Average 1981-2010	**3,498.20**

Table 6: The heating degree days varied between 2015 and 2018

The change in HDD for the years covered by this inventory is outlined below in Table 7.

	Change % in HDD
2015 - 2016	-8.09%
2016 - 2017	1.56%
2017 - 2018	7.02%

Table 7: The change in heating degree days between 2015 and 2018

There was a significant reduction in the number of HDDs between 2015 and 2016, and this should be reflected in the normalized values for natural gas consumption.

Weather normalization also requires estimating the fraction of natural gas used for heating. A report[7] from the OEB provides the following values:

Natural gas use for space heating	
Commercial	77%
Industrial	42%
Residential	72%

Table 8: The amount of natural gas used for heating varies by building type

To estimate the fraction of natural gas used for heating in each region, we applied approximate[8] values for the proportion of residential, industrial and commercial natural gas consumption.

6 If the average temperature is above 18°C, what is calculated are the Cooling Degree Days (CDD). The granularity of electricity data (the energy source dependant of high temperatures in summer) doesn't allow to carry the same exercise in order to normalize its consumption based on CDDs.

7 https://www.oeb.ca/sites/default/files/uploads/ICF_Report_Gas_Conservation_Potential_Study.pdf

8 Those values are obtained from the data provided by the utilities, but its granularity doesn't allow to be completely certain about the accuracy of those fractions.

	NATURAL GAS USE			Average Use for Space Heating
	Residential	Commercial	Industrial	
Durham	51%	20%	29%	64%
Halton (Burlington data only)	47%	33%	21%	68%
Hamilton	25%	21%	54%	57%
Peel	44%	29%	27%	65%
Toronto	53%	34%	13%	70%
York	60%	29%	11%	70%
GTHA Total				**67%**

Table 9: The type of buildings in each GTHA region determines the average use of natural gas for space heating

The fraction of natural gas use that is weather normalized corresponds with the average proportion of natural gas used for space heating. This fraction is divided by the yearly HDD and multiplied by the 30-year average. The normalization results are outlined in Table 12.

	EMISSIONS				NORMALIZED EMISSIONS			
	2015	2016	2017	2018	2015	2016	2017	2018
Durham	1,653,306	1,512,345	1,567,710	1,740,681	1,576,925	1,521,946	1,562,036	1,651,869
Halton	2,052,527	1,816,493	1,827,502	2,082,247	1,952,142	1,828,701	1,820,501	1,976,007
Hamilton	2,653,362	2,580,736	2,557,542	2,752,540	2,545,010	2,595,218	2,549,361	2,612,101
Peel	4,028,241	3,729,888	3,875,923	4,269,091	3,839,101	3,753,953	3,861,668	4,051,276
Toronto	7,839,606	7,084,041	7,364,888	8,109,214	7,446,443	7,132,860	7,335,043	7,695,470
York	2,822,406	2,531,537	2,673,059	3,011,555	2,680,150	2,549,071	2,662,505	2,857,900
GTHA Total	**21,049,448**	**19,255,041**	**19,866,624**	**21,965,327**	**20,039,772**	**19,381,955**	**19,791,978**	**20,844,623**

Table 10: The emissions and weather normalized emissions for each GTHA region

As shown on page 32, normalization has a significant effect on the calculated change in natural gas emissions between 2015 and 2018.

	CHANGE IN EMISSIONS			CHANGE IN NORMALIZED EMISSIONS		
	Total 2015-2016	Total 2016-2017	Total 2017-2018	Normalized 2015-2016	Normalized 2016-2017	Normalized 2017-2018
Durham	-9.6%	2.0%	6.6%	-4.6%	1.0%	1.5%
Halton	-13.0%	-1.5%	10.1%	-7.9%	-2.6%	4.9%
Hamilton	-3.4%	-2.2%	5.5%	1.3%	-3.0%	0.5%
Peel	-8.5%	1.6%	5.4%	-3.4%	0.5%	0.4%
Toronto	-10.4%	1.8%	3.9%	-5.0%	0.7%	-1.0%
York	-11.6%	4.2%	10.1%	-6.2%	3.1%	4.9%
GTHA Total	**-9.5%**	**1.2%**	**5.9%**	**-4.3%**	**0.2%**	**0.9%**

Table 11: The weather normalization altered the quantity by which natural gas emissions increased or decreased per capita

Even after normalization, the data still shows similar trends in all GTHA regions for the increase or decrease in natural gas emissions between 2015 and 2017. This implies that the current method for normalization doesn't completely avoid the influence of weather in the comparison – it is very unlikely that all regions would have the same trends in their natural gas consumption if weather was not an influencing factor. There is still uncertainty associated with the normalization data, and there are known problems with the method. However, we still consider the normalization results to enable a better comparison between years of emissions data.

APPENDIX D

Municipality and Sector Summary Tables

2018

	EMISSIONS BY SECTOR (tCO_2eq)					
	Buildings	**Transportation**	**Industrial**	**Waste**	**Agricultural**	**2018 Emissions**
Durham	1,873,838	2,282,227	1,799,096	160,515	205,905	6,321,581
Halton	2,222,945	1,669,653	216,256	151,681	32,028	4,292,563
Hamilton	2,891,034	1,725,757	5,956,184	230,921	71,144	10,875,040
Peel	4,640,035	4,360,967	2,017,687	421,834	55,479	11,496,002
Toronto	8,849,614	4,996,434	483,895	650,590	1,930	14,982,463
York	3,284,230	4,003,743	773	195,311	89,425	7,573,482
GTHA Total	**23,761,696**	**19,038,781**	**10,473,891**	**1,810,852**	**455,911**	**55,541,131**

Table 12: Absolute Emissions by Municipality and Sector

	EMISSIONS AS % OF TOTAL					
	Buildings	**Transportation**	**Industrial**	**Waste**	**Agricultural**	**Total**
Durham	30%	36%	28%	3%	3%	100%
Halton	52%	39%	5%	4%	1%	100%
Hamilton	27%	16%	55%	2%	1%	100%
Peel	40%	38%	18%	4%	0%	100%
Toronto	59%	33%	3%	4%	0%	100%
York	43%	53%	0%	3%	1%	100%
GTHA Total	**43%**	**34%**	**19%**	**3%**	**1%**	**100%**

Table 13: Relative Emissions by Municipality and Sector

	PER CAPITA						
	Buildings	Transportation	Industrial	Waste	Agricultural	Total	Total Excluding Industrial
Durham	2.74	3.34	2.63	0.23	0.30	9.25	6.62
Halton	3.83	2.88	0.37	0.26	0.06	7.40	7.03
Hamilton	5.21	3.11	10.74	0.42	0.13	19.61	8.87
Peel	3.14	2.95	1.37	0.29	0.04	7.78	6.42
Toronto	2.99	1.69	0.16	0.22	0.00	5.07	4.90
York	2.85	3.48	0.00	0.17	0.08	6.58	6.58
GTHA Total	**3.21**	**2.57**	**1.41**	**0.24**	**0.06**	**7.50**	**6.09**

Table 14: Per Capita Emissions by Municipality and Sector

	PER CAPITA	
	Natural Gas	Electricity
Durham	2.55	0.19
Halton	3.59	0.24
Hamilton	4.96	0.25
Peel	2.89	0.25
Toronto	2.74	0.25
York	2.62	0.24
GTHA Total	**2.97**	**0.24**

Table 15: Per Capita Emissions by Municipality for Natural Gas and Electricity Consumption

	Transportation per capita (tCO_2eq)	2016 Land Area (km^2)	2018 Population	Population Density (ppl/km^2)
Durham	3.34	2,524	683,600	271
Halton	2.88	964	580,000	602
Hamilton	3.11	481	554,697	1,154
Peel	2.95	1,247	1,477,200	1,185
Toronto	1.69	630	2,956,024	4,691
York	3.48	1,762	1,151,000	653
GTHA Total	**2.57**	**7,608**	**7,402,521**	**973**

Table 16: Per Capita Emissions, Population and Land Area by Municipality

	Natural Gas	Electricity	Total
GTHA Total Emissions	**21,965,327**	**1,796,368**	**23,761,696**
GTHA Total Emissions	**92.4%**	**7.6%**	**100.0%**

Table 17: Total GTHA Emissions for Natural Gas and Electricity Consumption

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Acknowledgments

This report has been made possible in part thanks to the data and advice from:

- Alectra Utilities
- British Columbia Ministry of Energy, Mines, and Petroleum Resources
- British Columbia Ministry of Environment and Climate Change Strategy
- City of Hamilton
- City of Toronto
- Clean Air Council
- Durham York Energy Centre
- Elexicon Energy
- Enbridge Gas
- Environmental Commissioner of Ontario
- Friends of the Greenbelt Foundation
- ICLEI
- Ontario Ministry of the Environment and Climate Change
- Region of Durham
- Region of Halton
- Region of Peel
- Region of York
- Resource Productivity and Recovery Authority
- Toronto and Region Conservation Authority
- Torrie Smith Associates
- Union Gas
- University of Toronto

About The Atmospheric Fund

The Atmospheric Fund (TAF) is a regional climate agency that invests in low-carbon solutions for the Greater Toronto and Hamilton Area and helps scale them up for broad implementation. We are experienced leaders and collaborate with stakeholders in the private, public and non-profit sectors who have ideas and opportunities for reducing carbon emissions. Supported by endowment funds, we advance the most promising concepts by investing, providing grants, influencing policies and running programs. We're particularly interested in ideas that offer benefits in addition to carbon reduction such as improving people's health, creating local jobs, boosting urban resiliency, and contributing to a fair society.

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