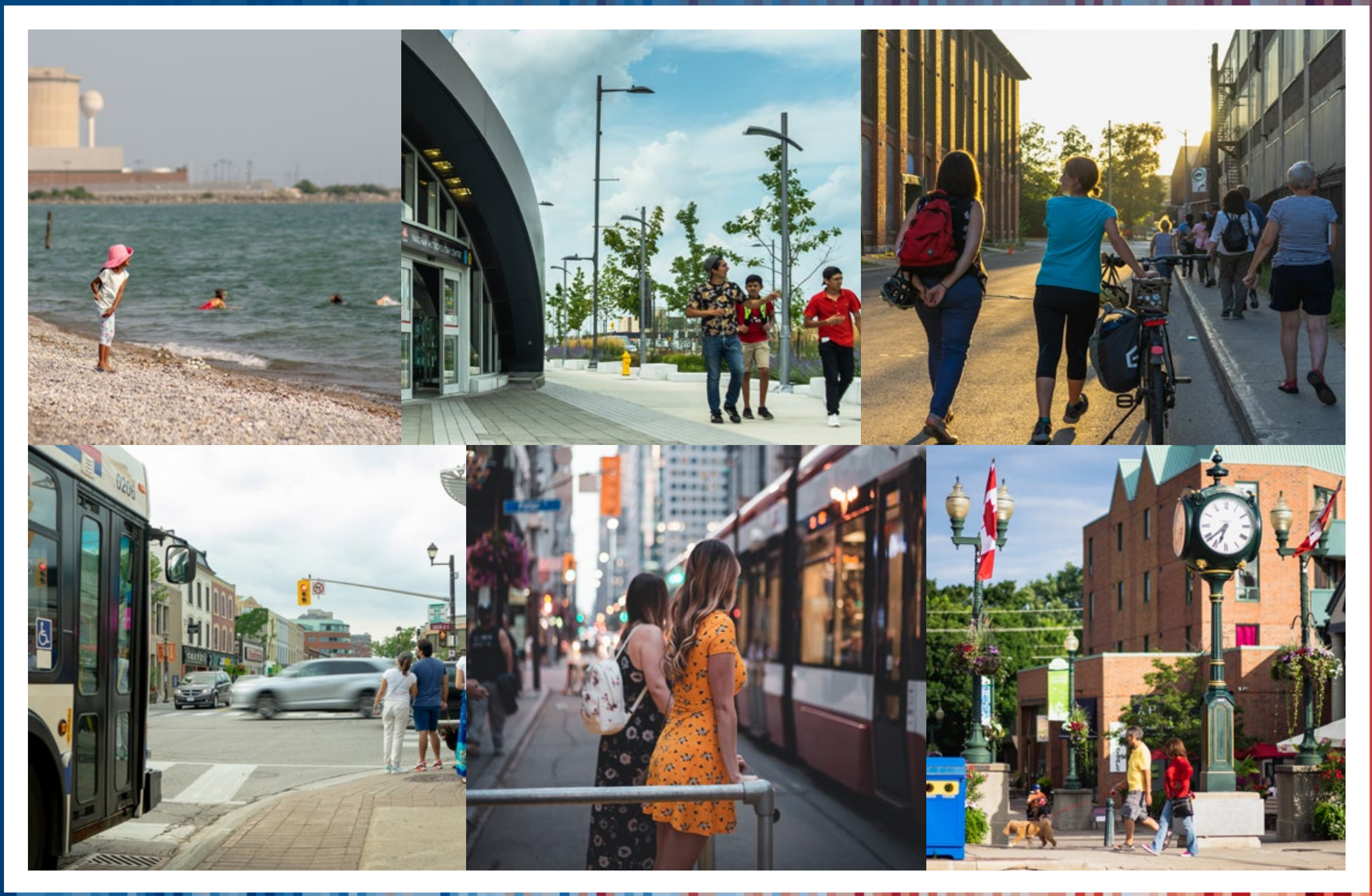
TAF The Atmospheric Fund

Carbon Emissions Inventory for the GTHA

2019 EDITION: THREE YEARS OF DATA AND REGIONAL PROFILES



A Strong Foundation for Regional Climate Action

The foundation of high-impact climate action is a thorough understanding of the major sources of carbon emissions and how they are changing across time and space. Despite longstanding recognition of the climate imperative, many stakeholders across the Greater Toronto and Hamilton Area (GTHA) still struggle to access accurate, timely, and regionally specific emissions data. With that in mind, we launched the carbon emissions inventory for the GTHA last year, and we hope that this 2019 edition contributes further to building a strong foundation for regional climate action.

The 2019 edition reports on carbon emissions from 2015-17, and covers the major sources across the region including buildings, transportation, industry, waste and agriculture. Due largely to limitations in available data, this inventory does not cover Scope 3 emissions — emissions associated with goods and services consumed in the region but produced elsewhere. The inventory generally follows the guidelines established in the Global Protocol for Community-Scale Greenhouse Gas Emissions. We've used the latest regionally specific primary data sources as far as possible. We have made improvements in our methodology since the last edition, and have retroactively adjusted previously published data to ensure the comparability of the reported emissions over time.

By necessity, emissions inventories are always backwards looking. This report covers emissions up to the end of 2017, which is not so long ago in some ways and yet a world apart in others. For example, in 2017 no major jurisdiction in Canada had declared a climate emergency; fast forward two years, and most municipalities in the GTHA, along with the Government of Canada, have declared climate emergencies. Likewise, this inventory predates the dramatic changes in provincial climate policies and programs heralded by the provincial election of 2018. Data is not yet available to determine how these and other notable developments change our emissions profile. Nevertheless, we must look backward in order to chart the way forward.

There is a large gap between GTHA climate goals and actions

The GTHA is among the most successful and prosperous urban regions in the world. I firmly believe that we have the talent, the financial capital, and the public support needed to be world leaders in climate action. Yet there is a yawning gap between our ambitious climate commitments and the scale of climate action on the ground. During the three years covered by this report, emissions fell at an average annualized rate of 1.7%; no small accomplishment considering the regional population grew by nearly a quarter million over this timeframe. However, transitioning to carbon neutrality by 2050 requires achieving average annual reductions of seven per cent — four times the pace we have been setting — even as the region continues to grow.

The good news is that there are success stories to be found in every corner of the GTHA – trailblazing initiatives that are reducing emissions while building a healthier, more prosperous and more resilient region. We've highlighted a sample of them in this report. We need to get better at replicating and scaling proven successes, while continuing to invest in bold new ideas that can be brought to scale in future years. And above all else, we must honour our climate declarations and targets by acting with urgency and commitment befitting a deepening planetary emergency.

Bryan Purcell
VP, Policy and Programs, The Atmospheric Fund (TAF)

Inventory Overview

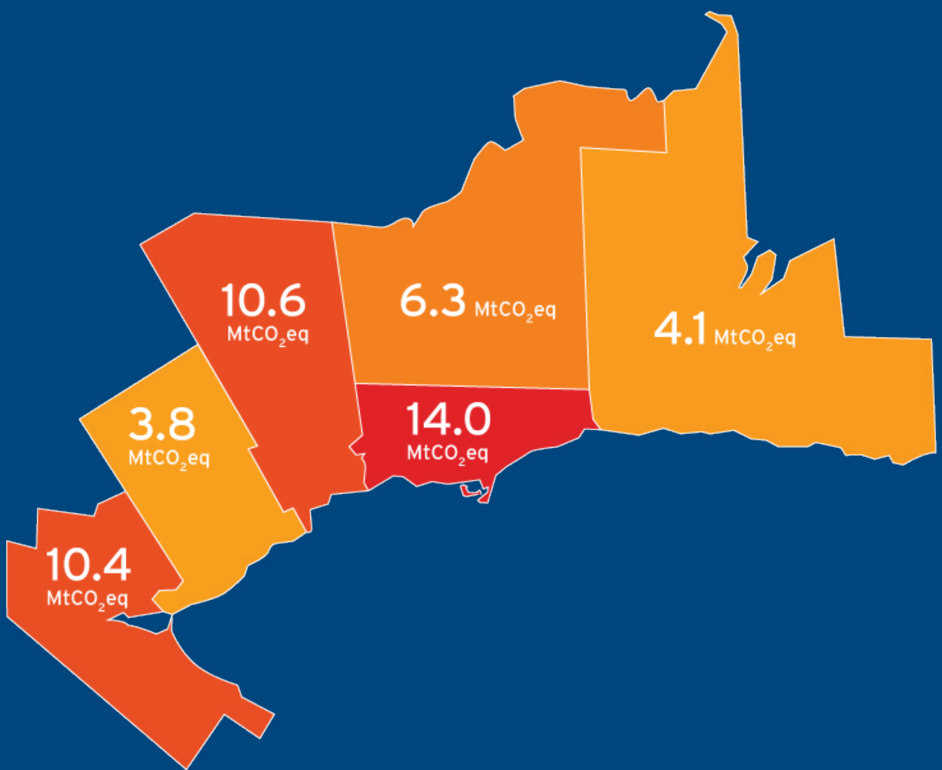


Figure 1: Carbon emissions by municipality in 2017

49.2 megatonnes

CO_2eq emitted in 2017

41%

of Ontario's total carbon emissions in 2017

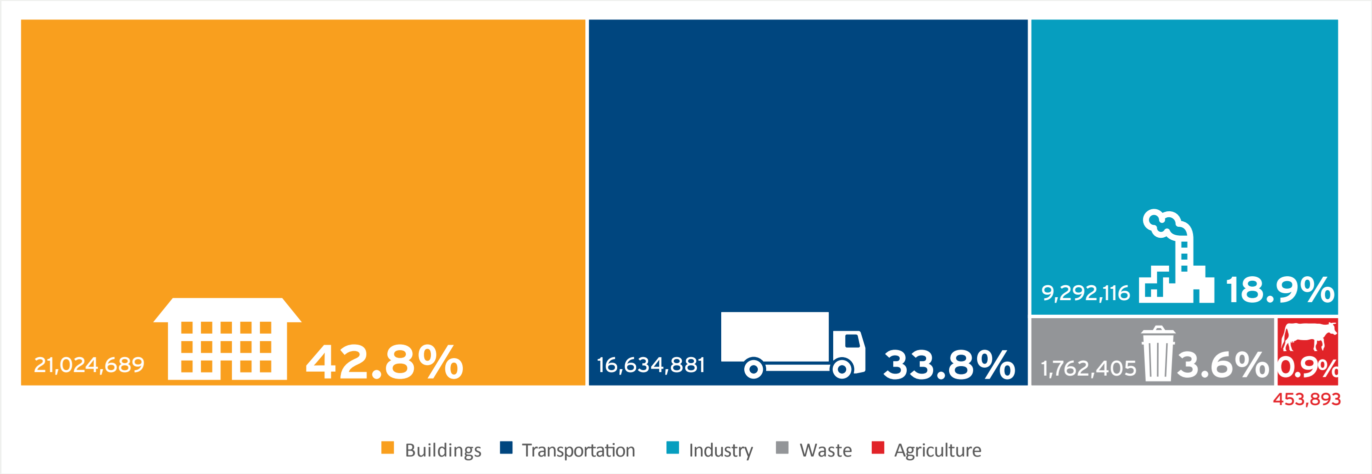


Figure 2: Carbon emissions by sector in 2017, in tonnes of carbon dioxide equivalents, or tCO_2eq

Carbon Emissions by Sector

Carbon emissions in the GTHA hit 49.2 million tonnes, or megatonnes,in 2017 continuing the upward trend that's been occuring for the past century, as illustrated with the 'warming stripes' seen on this report's cover.

This emissions quantity represents the GTHA's Scope 1 and 2 emissions — also known as direct emissions (such as burning gasoline in a vehicle) and indirect emissions from the generation of electricity (such as burning natural gas to generate electricity). The 49.2 megatonnes emitted by the GTHA annually does not account for Scope 3 emissions, which are any other indirect emissions such as the mining and refining of fossil fuels or the emissions from producing imported goods. The region's Scope 3 emissions are significant, but they are not included in this inventory due to data constraints and methodological complexities. See Appendix A for a more detailed methodological breakdown.

BUILDINGS AND TRANSPORTATION ARE THE GTHA'S TWO LARGEST SOURCES OF EMISSIONS

77%

of GTHA carbon emissions are from the buildings and transportation sectors

Buildings and transportation are the largest emitting sectors in every municipality in the GTHA, except Hamilton where industry is the most significant. The emissions from the buildings and transportation sectors are from the use of three fossil fuels; most building sector emissions are from natural gas used for space and water heating, and transportation emissions are from diesel and gasoline.

Emissions profiles are similar across regions

Most GTHA municipalities follow similar trends in the sectors responsible for their emissions. Industry in Hamilton and agriculture in Durham are some of the only deviations from the regional trends in emissions by sector. The similar emissions profiles of many GTHA municipalities highlights the importance of collaboration across the region to implement climate solutions.

GTHA EMISSIONS DEMONSTRATE THE NEED TO ACT REGIONALLY

Jobs, transportation, housing, and manufacturing have impacts that span municipal boundaries throughout the GTHA. Looking at the emissions data for each municipality on an individual basis doesn't capture this regional complexity. For example, between 50 and 57.4 per cent of GTHA residents in each region commute for more than 30 minutes to work, indicating that many are living in one municipality and working in another (City of Toronto, 2017). Further, Hamilton's individual emissions profile shows very high per capita emissions due to its industrial activity — but products from the industrial facilities are being used across the GTHA and beyond, not only in Hamilton.

None of the municipalities in the GTHA function independently. We operate as a region, and our climate policies and programs must reflect that. Because many municipalities have similar emissions profiles, reduction measures could be applied region-wide in many cases, and collaboration on climate plans is needed to identify these opportunities.

Because the population of GTHA municipalities and regions varies greatly, considering per capita emissions provides important opportunities for comparing regions (Figure 4) and easily seeing similarities. Municipalities with higher per capita emissions in a particular sector can still look to other parts of the region for strategies that have been proven to work in that sector.

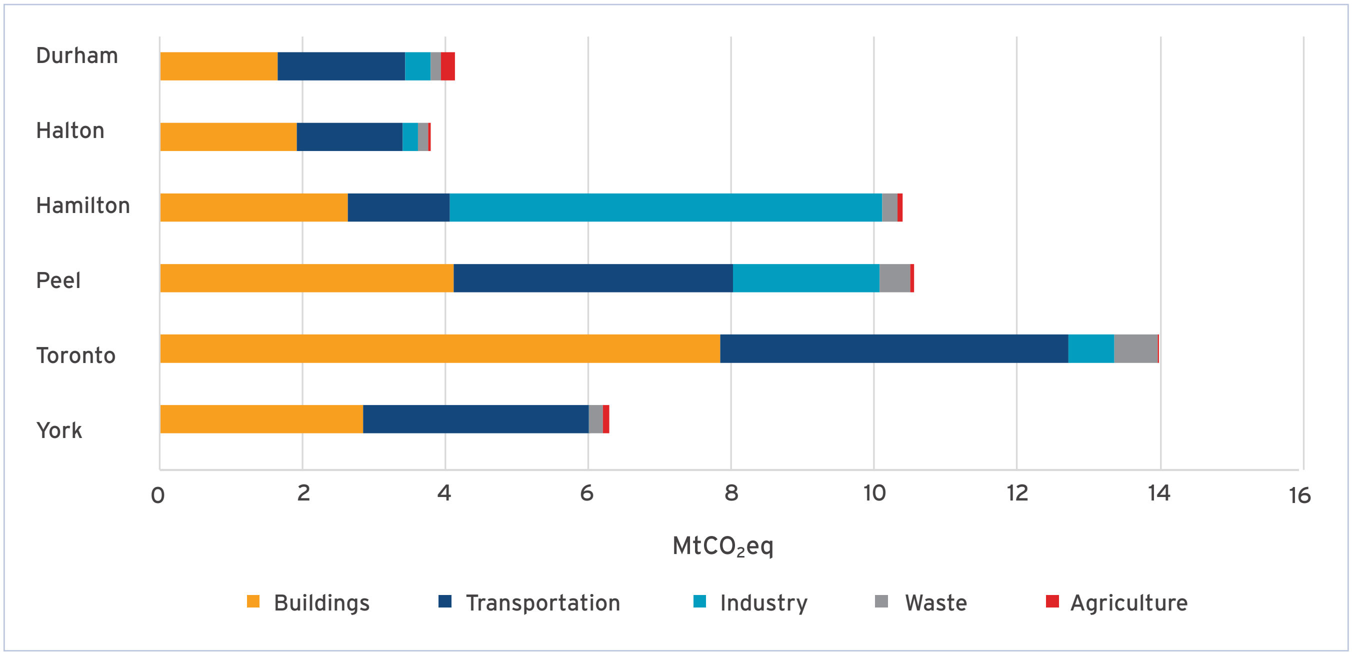


Figure 3: Carbon emissions by municipality and by sector for 2017

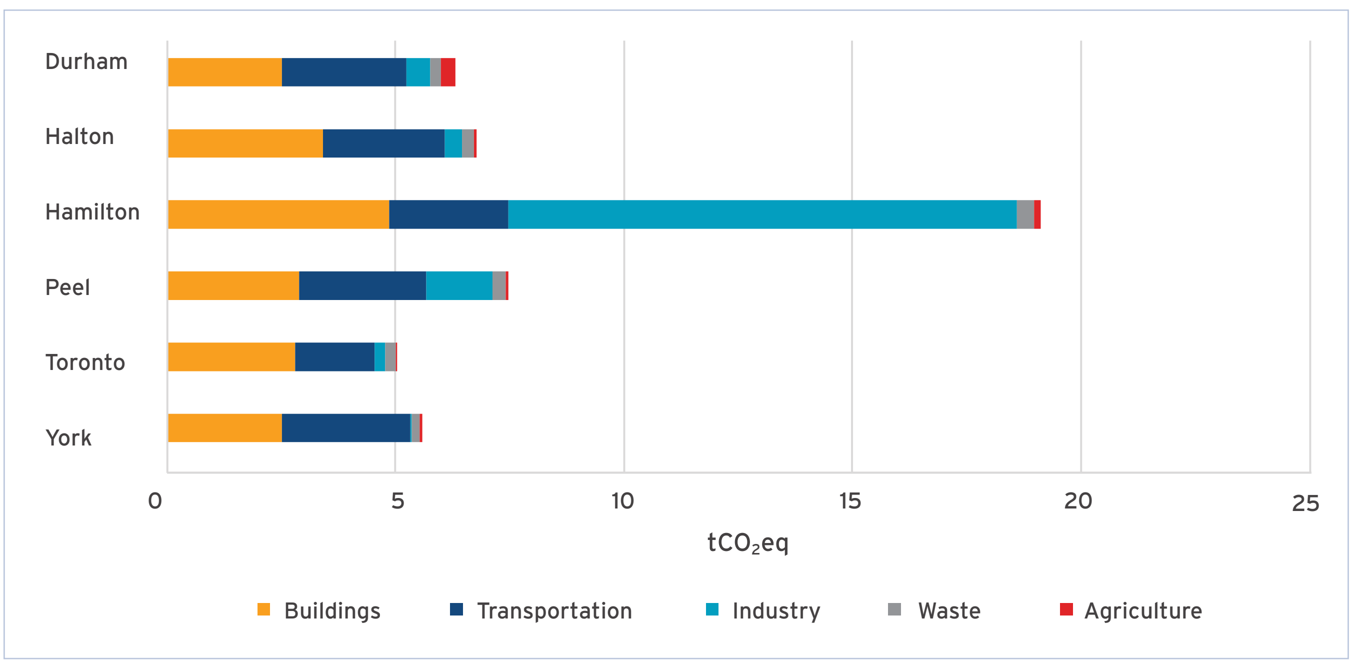


Figure 4: Per capita carbon emissions by municipality and by sector for 2017

2015-2017 Reflections

EMISSIONS FELL SLIGHTLY BETWEEN 2015 AND 2017

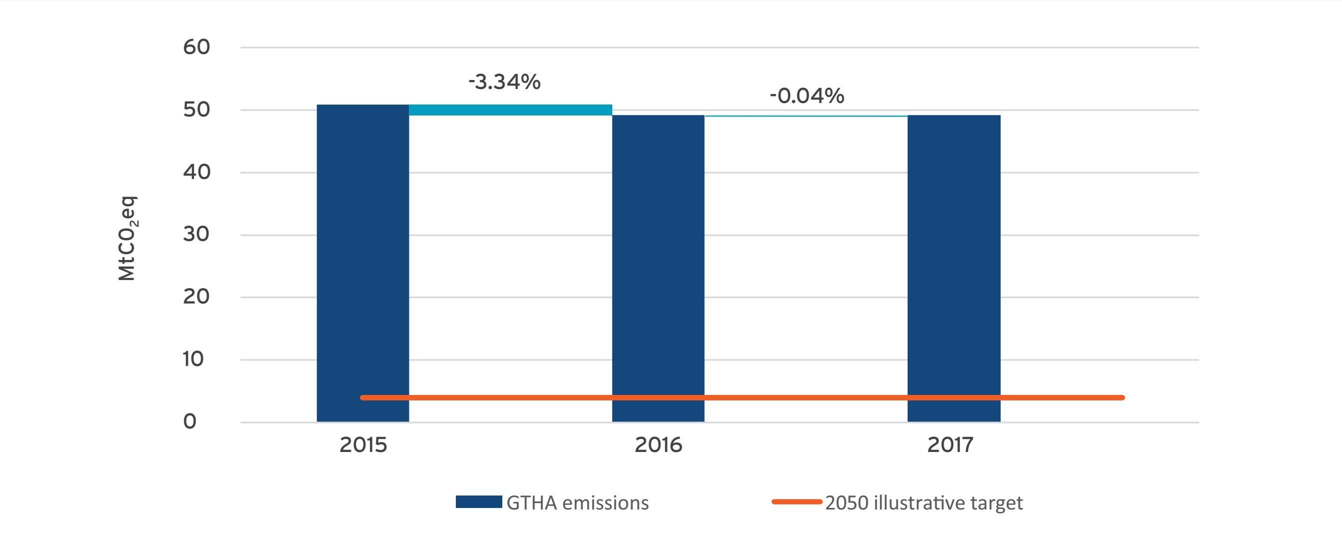


Figure 5: 2015 to 2017 carbon emissions shown against the illustrative emissions level that region must get down to in order to reach carbon neutrality - the 2050 target currently being considered by some jurisdictions

Emissions in the GTHA fell 3.3 per cent between 2015 and 2016, then remained flat between 2016 and 2017.[i] These results are despite a population growth of 3.1 per cent (over 200,000 people) over this time, and are supported by the fact that per capita emissions fell by 4.4 per cent between 2015 and 2016, and by 1.9 per cent between 2016 and 2017. While these reductions represent positive progress, the pace of emissions reductions needs to increase substantially — to an average annual reduction of seven per cent — to reach carbon neutrality by 2050.

1.7%

average annual reduction in carbon emissions from 2015 to 2017

Emissions must be reduced at four times this pace to achieve carbon neutrality by 2050.

> "Halton region declared a climate emergency because we recognize how urgently we need to respond to the climate crisis, and that single municipalities can't do it alone. We need all hands on deck."
>
> **Councillor Jane Fogal** | Halton Regional Council

[i] Appendix A and B for further explanations of our methodology including why the methods and data we used in this inventory may give results that differ from other inventories compiled by GTHA regions and municipalities.

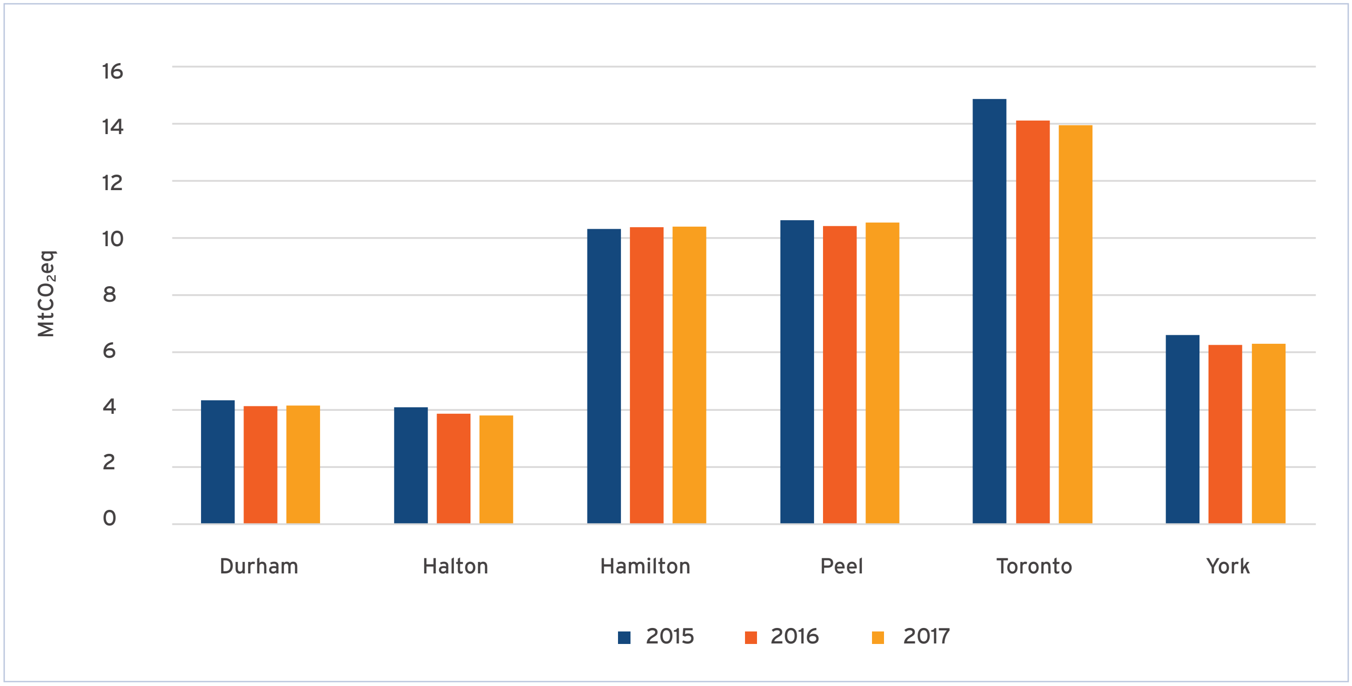


Figure 6: Change in carbon emissions from 2015 to 2017

The 2015 to 2017 progress in the GTHA should be celebrated with caution. Changes in weather, including a warmer winter in 2016 that lowered heating energy use, are responsible for some of the reductions. A year with a colder winter could cause emissions from natural gas for heating buildings to increase again, as could changes in the sources for Ontario's electricity supply, which is expected to get more carbon intensive again in the coming years.

Three years of emissions data is not enough to establish trends or extrapolate to create forecasts. Updating this inventory annually will help us identify trends over time, and better inform emissions reduction work.

"Keeping track of emissions over time and reporting on progress are central to creating emissions reductions strategies."

Councillor Mike Layton | Toronto City Council

TRANSPORTATION EMISSIONS INCREASED, EVEN ON A PER CAPITA BASIS

Transportation emissions increased by four per cent between 2015 and 2017. This sector contributes one-third of region-wide emissions, so increases in transportation emissions have a noticeable effect on overall GTHA emissions.

In every GTHA region, transportation emissions increased between 2015 and 2017. Of course, population in every region also increased over this time, but not by enough to explain some of the transportation emissions increases. Per capita transportation emissions also increased in many parts of the GTHA, and one per cent in the region as a whole.

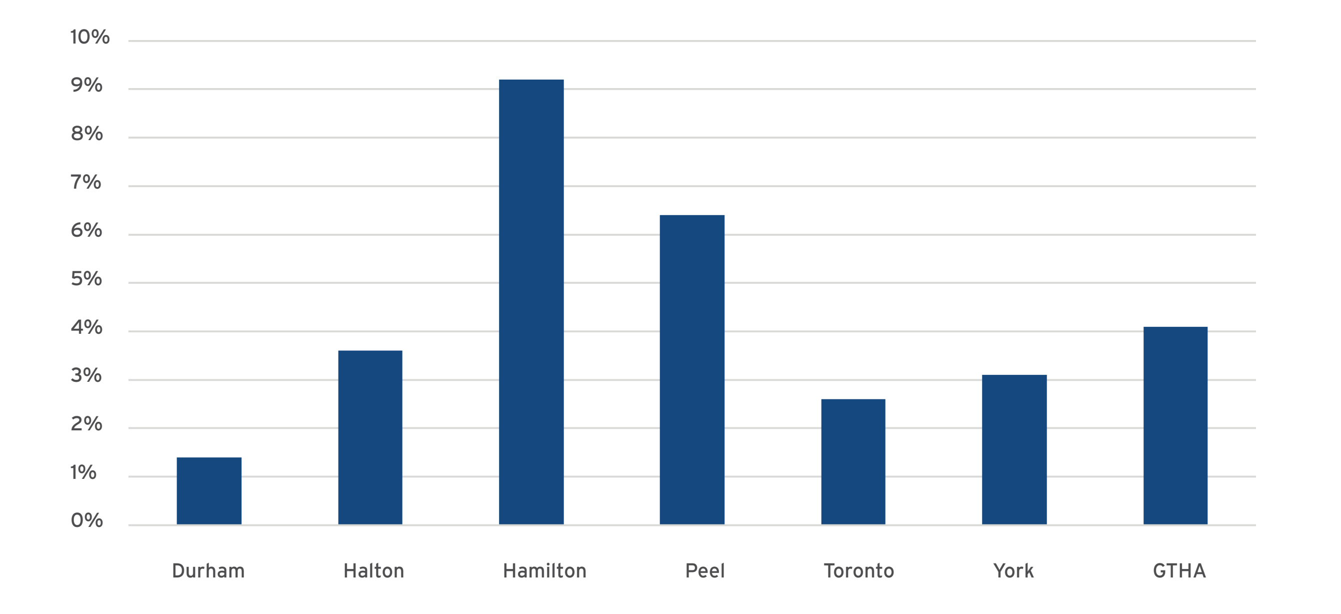
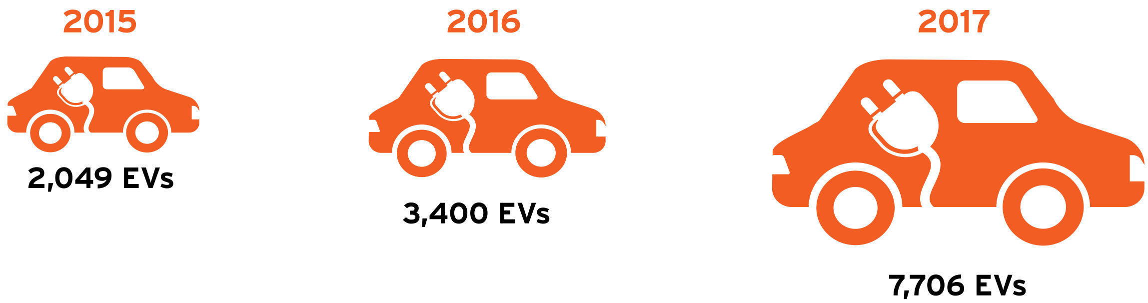


Figure 7: Increase in transportation emissions from 2015 to 2017

1%
increase in per capita transportation emissions across the GTHA

This data demonstrates that improvements in fuel efficiency and adoption of electric vehicles are not currently rapid enough to offset growth in transportation emissions. Despite improvements in those areas, there have been increases in the number of vehicles and mileage driven, increases in fuel consumption caused by more traffic congestion, and significant increases in the market share of larger vehicles like SUVs or pickup trucks (in 2017, 61 per cent of new car sales in Canada were SUVs or pickup trucks, the highest share in the world [International Energy Agency]). Accelerated action is needed to break the upward trend in transport emissions.



The EV adoption in Ontario increased significantly from 2015 to 2017. But despite growth in sales, electric vehicles still represented less than 0.5 per cent of vehicles on the road in the GTHA in 2017. EV sales, and electrification of freight and public transit fleets offer huge room for growth in reducing emissions from transportation if adoption grows.

Since 2017, the most recent year we have emissions data for, the growth of EV sales slowed in part due to the 2018 cancellation of Ontario's Electric and Hydrogen Vehicle Incentive Program. As demonstrated in other provinces with higher EV adoption like B.C. and Quebec (where EVs represent 15 per cent and 10 per cent of new vehicles sold, respectively), consumer incentives and better charging infrastructure are equally vital in order to get and sustain mass EV adoption. Without incentives and infrastructure improvements supporting their uptake, EVs are unlikely to lead to substantial reductions in transportation emissions in future editions of this inventory.

> "To reduce transportation emissions we need to look outwards and connect the suburbs more effectively, which means the whole region will need to work together."
>
> **Marianne Hatzopoulou**
> University of Toronto Associate Professor

BUILDINGS EMISSIONS CHANGED SIGNIFICANTLY FROM YEAR TO YEAR

Buildings are the largest source of emissions in the GTHA, but their contribution to the region's total emissions varies based on many factors. In 2015, buildings contributed 23.6 MtCO_2eq. This number fell to 21.7 MtCO_2eq in 2016, and 21.0 MtCO_2eq in 2017. Building sector emissions come primarily (94.5 per cent) from natural gas consumed on-site for space and water heating, as well as a small share (5.5 per cent) associated with electricity generated using natural gas.[ii] There is significant year-to-year variability in building sector emissions, with similar trends across all GTHA regions.

First, electricity emissions are a tiny portion of overall emissions. They decreased by over 50 per cent in 2017 due to reduced demand and as Ontario's electricity supply got cleaner. Electricity emissions could become more significant in the future if, as expected, the supply of Ontario's electricity generation moves towards more carbon-intensive sources like natural gas, and if the GTHA sees large increases in electrification of heating and transportation.

Natural gas consumption responds to changes in winter weather

Natural gas emissions fell between 2015 and 2016 but increased between 2016 and 2017 (Table 1).

About 70 per cent of the natural gas consumed in each GTHA region is used for space heating, so the weather influences consumption of this resource. Normalizing emissions to account for weather illustrates that much of the change in natural gas emissions from year to year was weather related and the changes are not as significant as they first appear (Table 2). See Appendix B for a full description of the weather normalization methodology.

> "A strong Clean Fuel Standard, including a building decarbonization pathway supported by utilities, is an important part of accelerating emission reductions."
>
> **Chris Wray**
> Director of Government & Industry Relations at Alectra Utilities.

[ii] See Appendix D

	Change in emissions	
	2015-2016	**2016-2017**
Durham	-8.50%	3.70%
Halton	-11.50%	0.60%
Hamilton	-2.70%	-0.90%
Peel	-7.40%	3.90%
Toronto	-9.60%	4.00%
York	-10.30%	5.60%
GTHA	**-8.50%**	**3.20%**

Table 1: Yearly variation in carbon emissions from natural gas, 2015-2017

	Change in normalized emissions	
	2015-2016	**2016-2017**
Durham	-3.50%	2.60%
Halton	-6.30%	-0.40%
Hamilton	2.00%	-1.80%
Peel	-2.20%	2.90%
Toronto	-4.20%	2.80%
York	-4.90%	4.50%
GTHA	**-3.30%**	**2.10%**

Table 2: Yearly variation in weather normalized carbon emissions from natural gas, 2015-2017

SCALABLE SOLUTIONS FOR BUILDINGS AND TRANSPORTATION

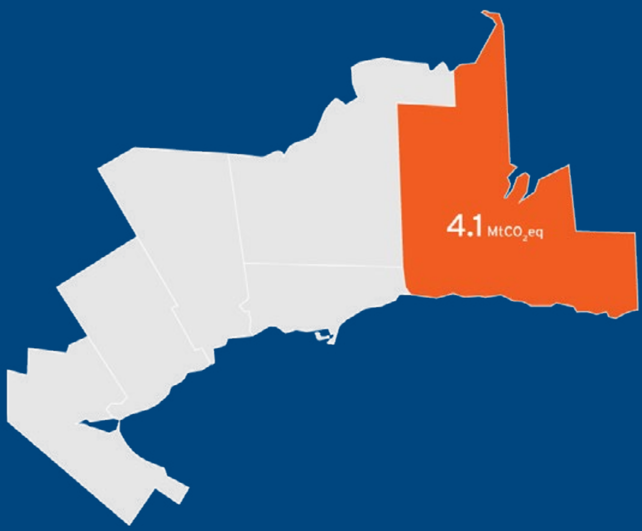
The Clean Fuel Standard

As a major part of the Government of Canada's climate strategy, the Clean Fuel Standard (CFS) has the potential to reduce national carbon emissions by 30 megatonnes per year by 2030. This policy will include carbon intensity reduction standards for gaseous, liquid, and solid fossil fuels, incentivizing the development of cleaner fuel technologies and low-carbon alternatives.

As industries adapt over time, these standards will become increasingly stringent, prompting fuel importers and suppliers to switch to lower carbon fuels and energy sources such as ethanol, biodiesel and even electricity. This approach will allow the market to determine an optimal combination of low carbon solutions that meet the carbon intensity requirements, as opposed to enforced specific solutions for the market. Overall, the CFS is expected to play a catalytic role in leading Canada on a path towards a low-carbon economy.

REGIONAL PROFILE
Durham

The Regional Municipality of 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 (2017): 656,331
Land Area: 2,524 km^2
Population Density: 260 people per km^2
GTHA emissions: 8 per cent
GTHA population: 9 per cent

2015	2016	2017
4.3 Mt	4.1 Mt	4.1 Mt

Durham has high agricultural emissions and low waste emissions

Agricultural emissions in Durham are higher than anywhere else in the GTHA. But with over seven million residents in the GTHA, Durham's agriculture only produces a small fraction of what it takes to sustain the region. So, Durham's higher agricultural emissions only represent a small part of the agricultural emissions that actually go into feeding the GHTA.[iii]

Durham has one of the highest waste diversion rates in Ontario. This reduces the quantity of emissions from waste, as does the waste-to-energy incinerator in Durham.

Despite these notable regional characteristics, as in the rest of the GTHA most of Durham's emissions are from the transportation and buildings sectors.

[iii] We hope to incorporate Scope 3 emissions, which consider the emissions from goods and services imported into the region, in future editions of this inventory. They are not incorporated into this edition due to data availability constraints.

Durham

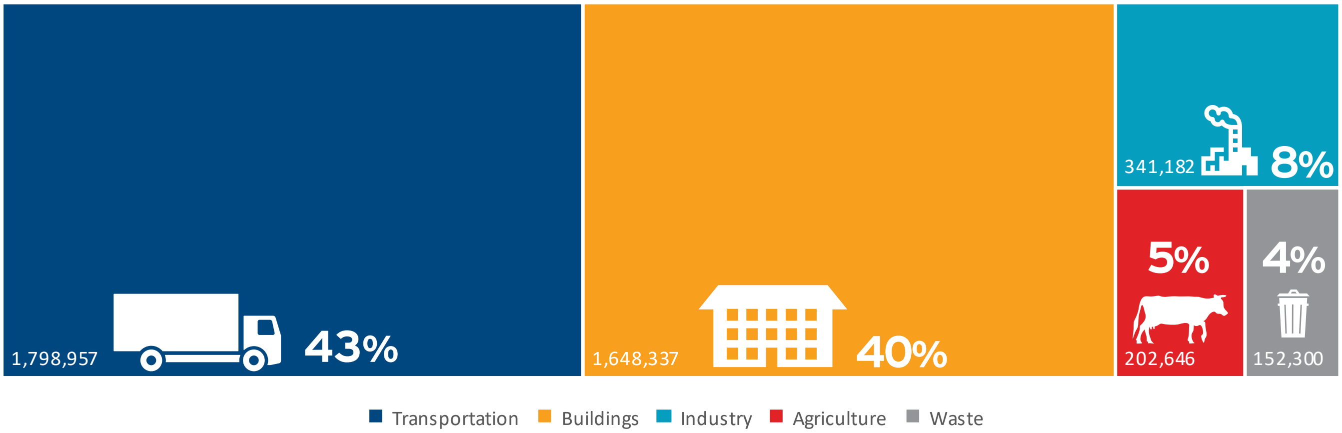


Figure 8: Durham's 2017 carbon emissions by sector, in tCO_2eq

Durham's Pathway to Carbon Neutrality

Durham has the lowest population density of the GTHA regions, and Durham residents have the highest percentage of long distance commutes (22.4 per cent spend more than an hour each way to get to work [City of Toronto, 2017]), some using the GO train but most taking their car (in the GTHA, about 80 per cent of commutes are made by car). Investments in public transit and electrification of transportation need to take density and travel patterns into consideration.

Residential buildings in Durham are predominantly single-family homes, so building retrofit policies and programs need to prioritize these buildings to improve their efficiency.

To achieve carbon neutrality, Durham's strategy will need to include local measures to address emissions from agriculture. On the other hand, by working regionally, with other GTHA jurisdictions with similar building and transport considerations, such as York, highly applicable solutions can be rapidly tested and scaled.

SCALABLE SOLUTION FROM DURHAM, FOR THE GTHA

Waste Emissions Reductions

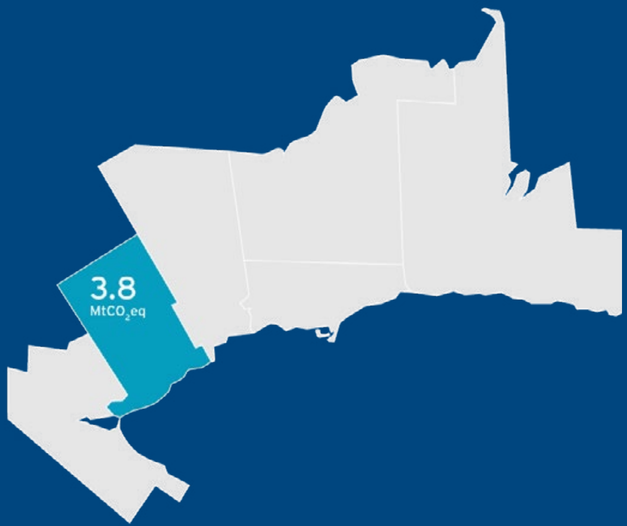
Durham achieved a 65 per cent waste diversion in 2017 – the third best rate in Ontario and higher than any other GTHA municipality (Durham Region, 2018). Sustaining this strong rate will help the region to achieve carbon neutrality.

Durham is also home to a waste-to-energy plant that reduces landfill emissions by processing 140,000 tonnes of residential garbage from Durham and York each year (Durham York Energy Centre, A). The electricity generated from this process powers about 10,000 homes.

Though waste is only responsible for about four per cent of GTHA emissions, getting to carbon neutrality will require addressing waste diversion rates in all GTHA municipalities, and Durham is a leader in this area.

REGIONAL PROFILE
Halton

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



Population (2017): 560,435
Land area: 964 km^2
Population Density: 581 people per km^2
GTHA emissions: 8 per cent
GTHA population: 8 per cent

2015 4.1 Mt

2016 3.9 Mt

2017 3.8 Mt

Halton has high natural gas emissions

Halton has the highest per capita emissions in the GTHA when industry sources are excluded. This is despite the fact that Halton's per capita transportation emissions are at the GTHA median, and the region's percentage of long car-based commutes is not as high as in Durham or York.

Natural gas — captured in the buildings sector data — is responsible for a large portion of Halton's emissions. This natural gas is primarily used for water and space heating, so the warmer winter (with less heating demand) in 2017 is partially responsible for the large overall decrease in emissions that Halton is showing from 2015 to 2017 (see page 10 for more about weather impacts on building emissions).

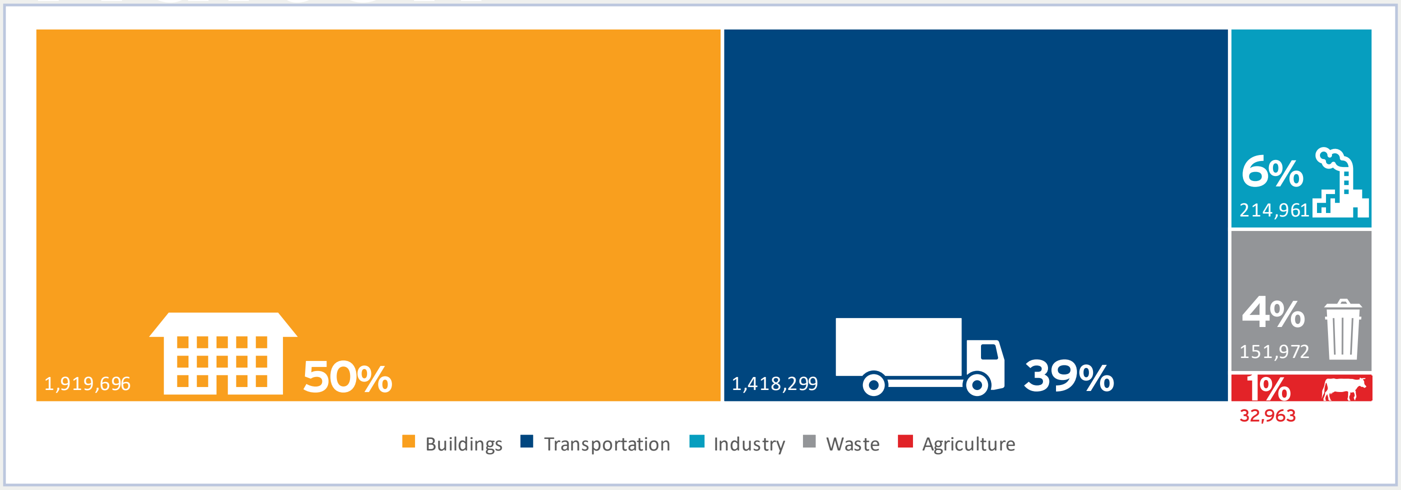


Figure 9: Halton's 2017 carbon emissions by sector, in tCO_2eq

Halton's Pathway to Carbon Neutrality

All the municipalities in Halton declared a climate emergency in 2019, suggesting that the region plans to accelerate climate action.

Halton's emissions from natural gas are high compared to most other parts of the GTHA. Although this is due in part to industrial consumption of natural gas, undertaking energy efficiency retrofits will have to be a critical part of Halton's plan to reach carbon neutrality. Further, green standards for new buildings should be developed to ensure that the region can continue to grow while still reducing emissions.

SCALABLE SOLUTION FROM HALTON, FOR THE GTHA

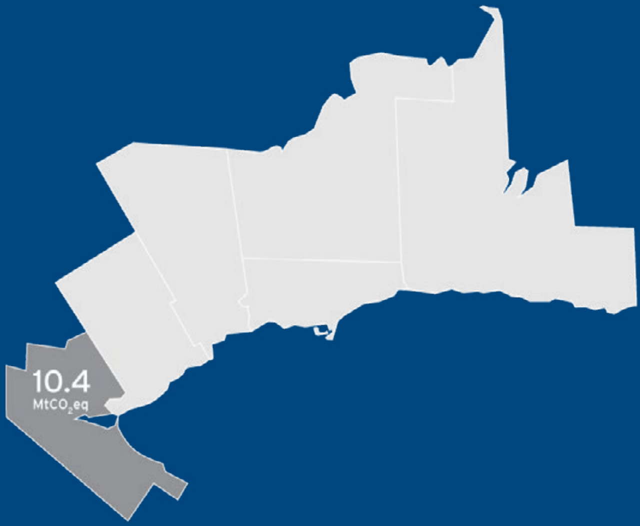
Financing Emissions Reductions

Oakville-based company BerQ RNG produces renewable natural gas from Ontario's food waste. In 2019, TAF invested $1.15 million in a 15-year project with BerQ to install and operate new refining equipment. Not only will this investment reduce carbon emissions by displacing fossil fuels, it will demonstrate the business case for renewable natural gas.

This project has the potential to influence policy and lead to wider GTHA uptake of renewable natural gas technology. Climate solutions that can be applied across the GTHA make for exciting investment opportunities that can accelerate the pace of emissions reductions.

REGIONAL PROFILE

Hamilton



Population (2017): 543,917
Land area: 481 km^2
Population Density: 1,132 people per km^2
GTHA emissions: 21 per cent
GTHA population: 9 per cent

2015	2016	2017
10.3 Mt	10.4 Mt	10.4 Mt

Home to GTHA industry, and industrial emissions

The industrial emissions in The City of Hamilton give it the largest per capita emissions in the GTHA, at 19.1 tCO_2eq per capita compared to an average of 6.9 tCO_2eq per capita for the whole region. Industrial emissions are also increasing: in 2017 they were 145,244 tCO_2eq higher than in 2015.

However, in other sectors, Hamilton has lower than GTHA average per capita emissions. Its per capita emissions from transportation are only 2.6 tCO_2eq, whereas nearby regions like Peel have 2.8 tCO_2eq per capita transportation emissions.

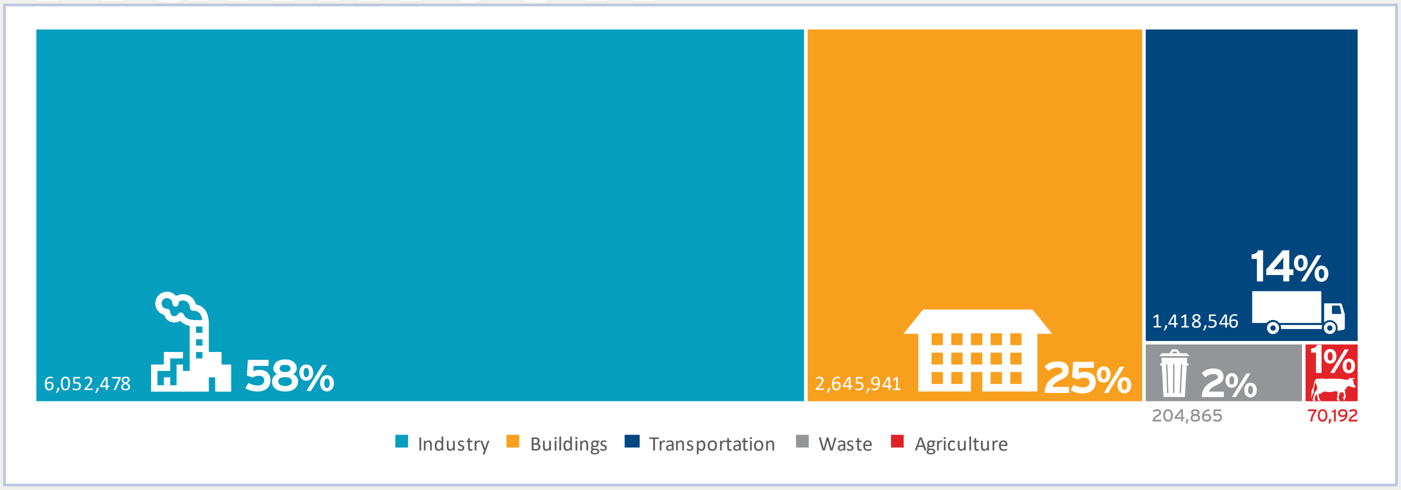


Figure 10: Hamilton's 2017 carbon emissions by sector, in tCO_2eq

Hamilton's Pathway to Carbon Neutrality

Industrial emissions in Hamilton will need to be tackled if the city is to reach carbon neutrality, but this is an area with a lot of potential for reductions. Single projects and initiatives can make a significant impact in the industrial sector, because the emissions are concentrated in a small number of facilities.

Hamilton's population density, which is high compared to some other GTHA municipalities, may make it easier to achieve modal shifts in transportation and reduce emissions from this sector. With support from TAF, Environment Hamilton is collaborating with multiple sectors to increase public transit uptake and accessibility within Hamilton, to shift behaviour and reduce transportation emissions further.

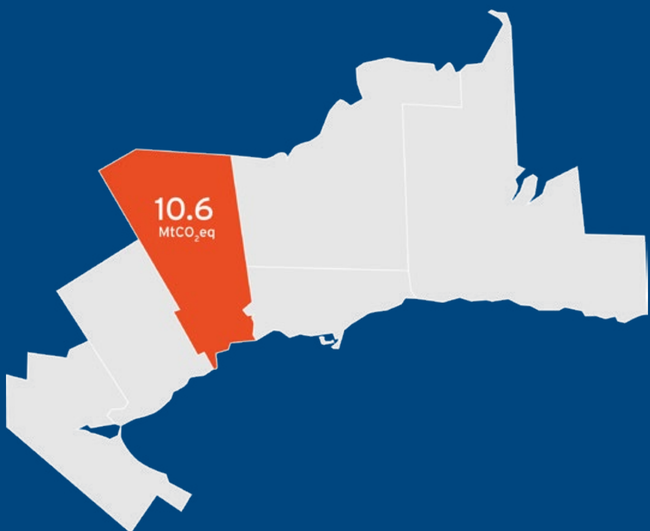
SCALABLE SOLUTION FROM HAMILTON, FOR THE GTHA

Opportunities in Industry

Partnership will be central to tackling industrial emissions, and ensuring a just transition for industry workers and their families. The Hamilton Chamber of Commerce, with the support of a TAF grant, is advancing the reduction of emissions through recovery of industrial waste heat. The chamber is conducting a project that will map out the sources of waste heat along Hamilton's industrial waterfront, which could lead to implementation of waste-heat to energy applications that will reduce industrial emissions.

REGIONAL PROFILE
Peel

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



Population (2017): 1,413,639
Land area: 1,247 km^2
Population Density: 1,134 people per km^2
GTHA emissions: 21 per cent
GTHA population: 20 per cent

2015 10.7 Mt
2016 10.4 Mt
2017 10.6 Mt

Transportation emissions rose in Peel

Peel is an above-average per capita emitter in the GTHA, with 7.5 tCO_2eq per capita compared to the GTHA average of 6.9 tCO_2eq.

Transportation emissions, as a percentage of Peel's emissions, overall and per capita, have climbed from 2015 to 2017. Alongside York, Peel's per capita transportation emissions are the highest in the GTHA at 2.8 tCO_2eq.

Although the rise of transportation emissions is the most notable result in Peel, buildings are still the most significant emitter in the region as is the case in many other parts of the GHTA.

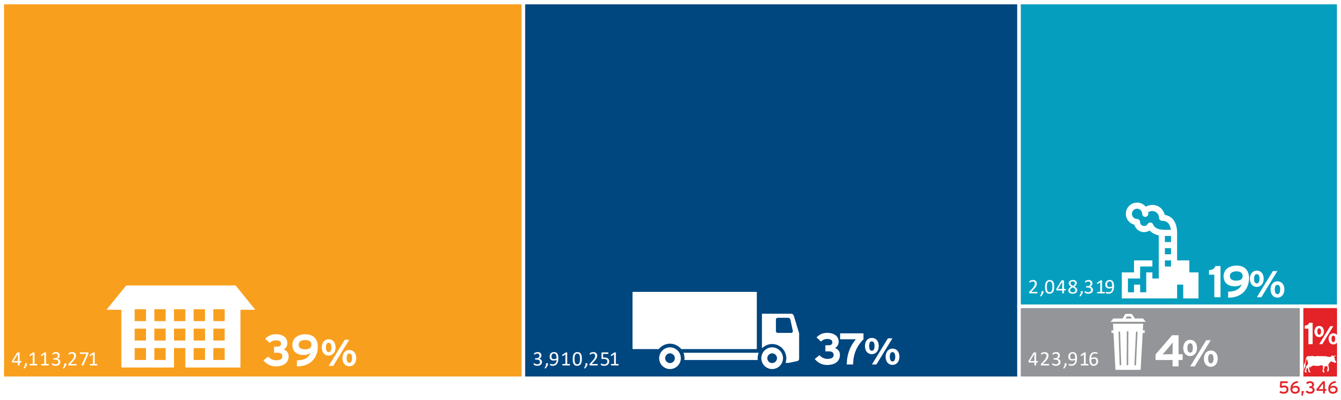


Figure 11: Peel's 2017 carbon emissions by sector, in tCO_2eq

Peel's Pathway to Carbon Neutrality

Peel has higher per capita emissions from transportation than Hamilton does, even though the population densities of these regions are similar. 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.

In October 2019, Peel adopted a master plan to address climate change which seeks to integrate climate into regional decision making.

> "An effective community climate plan requires input and collaboration from many different stakeholders including the Town, Region of Peel, conservation authorities, utilities, public and private sector stakeholders across the GTHA, as well as residents."
>
> **Allie Service**
> Climate Change Specialist
> for the Town of Caledon.

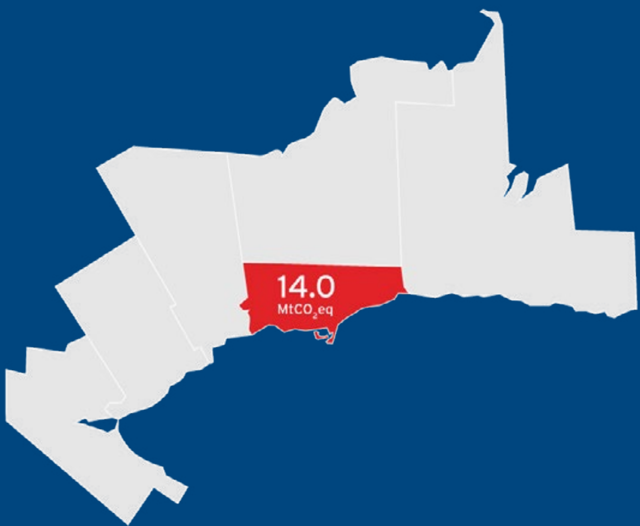
SCALABLE SOLUTION FROM PEEL, FOR THE GTHA

Climate Policies

With the help of a 2017 grant from TAF, Peel is reducing transportation emissions from delivery vehicles. By working with businesses to shift deliveries from peak hours to off-peak hours throughout the region, emissions are reduced, and air quality and commuter's quality of life is improved by less congestion on major roadways at peak times while maintaining a high quality level of on-time delivery service.

Solutions like the off-peak delivery pilot don't require new technology, just new approaches, partnerships and priorities that leverage the multiple benefits of emissions-reducing behaviours. And, the great success of projects like this pilot can lead to similar solutions being applied in other parts of the GHTA.

REGIONAL PROFILE
Toronto



Population (2017): 2,790,371
Land area: 630 km^2
Population Density: 4,428 people per km^2
GTHA emissions: 28 per cent
GTHA population: 39 per cent

2015 14.9 Mt | **2016** 14.1 Mt | **2017** 14.0 Mt [iv]

The City of Toronto: higher density, lower transportation emissions

Though Toronto has the lowest per capita emissions of any municipality in the GTHA, the per capita emissions from buildings are in line with other parts of the region. 56 per cent of Toronto's emissions are from buildings, including residential, commercial, industry, and institutional buildings.

Toronto's high population density — nearly four times higher than Peel, the next densest region in the GTHA — results in significantly lower per capita transportation emissions.

[iv] 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.

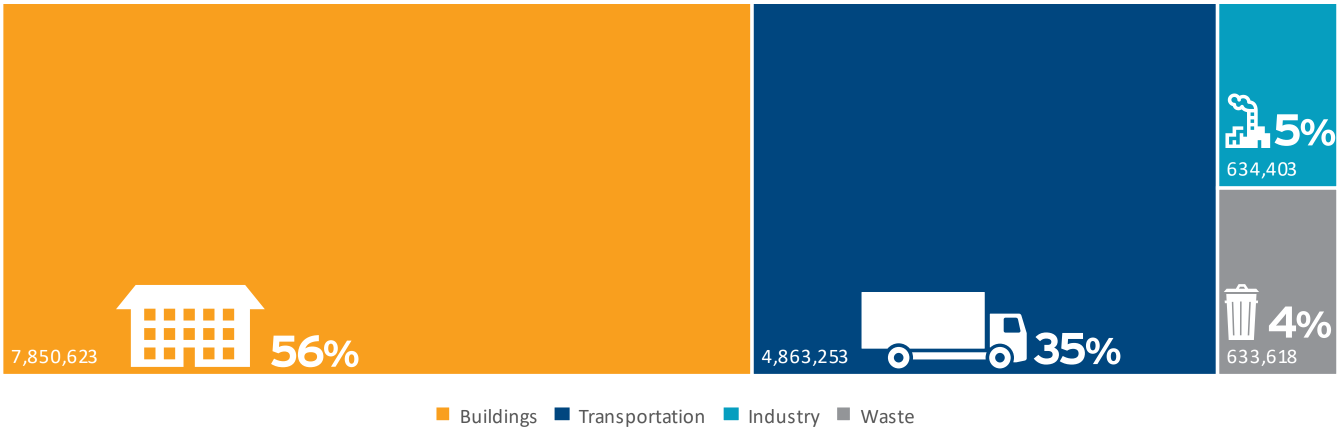


Figure 12: Toronto's 2017 carbon emissions by sector, in tCO_2eq

Toronto's Pathway to Carbon Neutrality

Natural gas (most of it used for building heating) is responsible for more than half of Toronto's emissions. While some GTHA municipalities have mainly single-family homes, Toronto has a high proportion of multi-unit residential buildings, at 64 per cent. So, retrofit policies and programs need to focus on multi-unit residential buildings to make the largest impact on the housing stock.

Although Toronto already has the lowest per capita emissions from transportation in the region, achieving carbon neutrality will still require significant changes to Toronto's transportation. Critically, the changes must include shifting to electric vehicles for both passenger and freight transit, and supporting that shift with city planning. Lowering per capita emissions from transportation further can be achieved through investing in public transit, which creates a modal shift.

SCALABLE SOLUTION FROM TORONTO, FOR THE GTHA

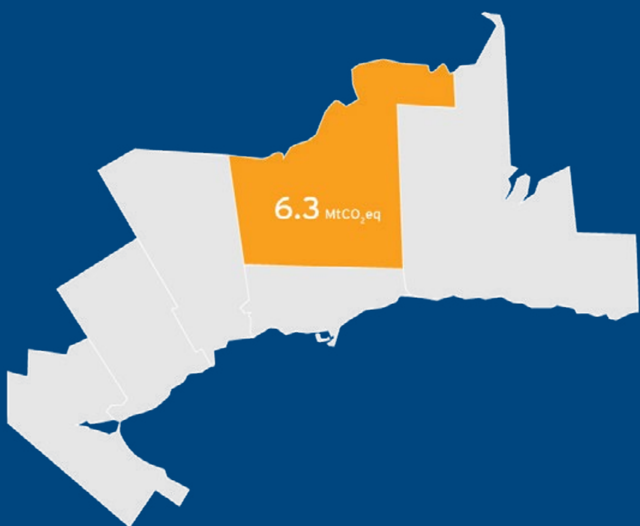
Standards That Work

Through the Toronto Green Standard and the Zero Emissions Building Framework for Toronto, new private and city-owned buildings are required to meet environmental and efficiency standards in order to receive planning approval. As of 2017, 1,500 new buildings were built in line with the required standards for energy efficiency and emissions reductions.

Toronto is one of the fastest growing cities in North America. Policies like the Toronto Green Standard have allowed the population of the city to grow without increasing its emissions between 2015 and 2017, and these standards can be adopted by other GTHA regions to instantly create a clear pathway to improving the long-term efficiency of all new buildings.

REGIONAL PROFILE
York

The Regional Municipality of 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 (2017): 1,124,748
Land area: 1,762 km^2
Population Density: 638 people per km^2
GTHA emissions: 13 per cent
GTHA population: 16 per cent

2015 6.6 Mt | **2016** 6.3 Mt | **2017** 6.3 Mt

York's transportation emissions are among the GHTA's highest

York's emissions from buildings, industry, and waste are among the lowest in the GTHA on a per capita basis. Industry emissions for York are low enough that they do not appear in the region's sectoral breakdown (Figure 13).

In contrast, York's transportation emissions are the highest per capita in the GTHA, tied with Peel. Transportation emissions in York have climbed from 2015 to 2017 and the share of York's overall emissions that come from transportation have also increased from 46 per cent to 50 per cent.

York

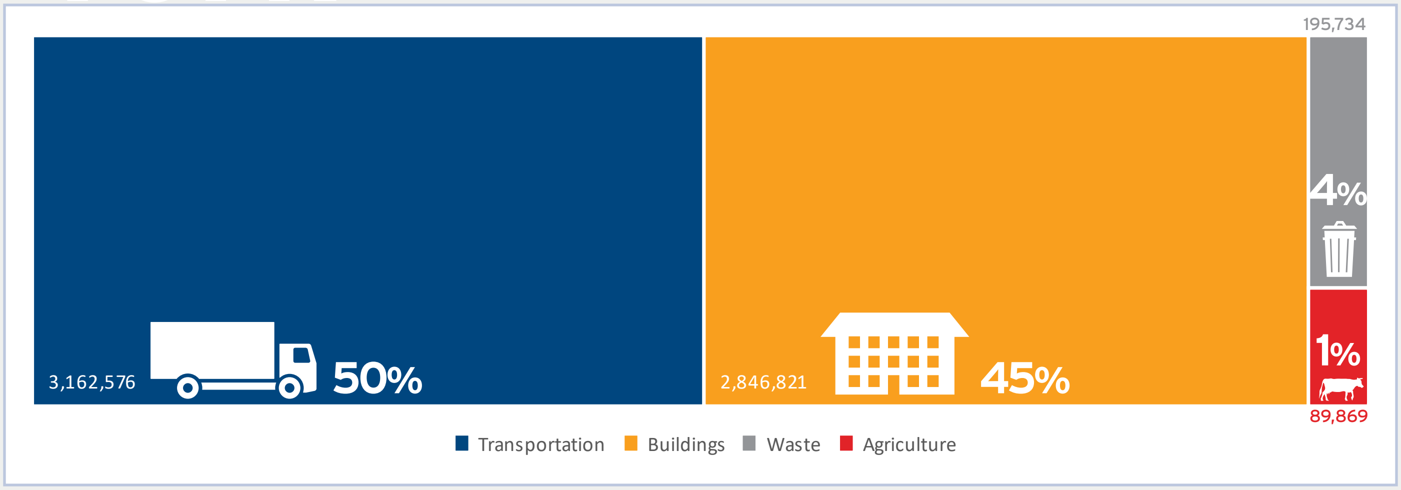


Figure 13: York's 2017 carbon emissions by sector, in tCO_2eq

York's Pathway to Carbon Neutrality

York's population density is below the GTHA average, and only 18 per cent of homes are multi-unit residential buildings. This low density makes the region's high transportation emissions unsurprising. Improving urban planning to reduce commutes and travel times would allow for substantial reductions in transportation emissions.

York has a transportation master plan that seeks to address York's mobility needs through multiple measures. Increasing the connectedness of their public transit system is a priority, ideally including fare integration and improved networking with neighbouring municipalities and regions. Supporting active transportation and non-car options is also a critical part of the plan.

SCALABLE SOLUTION FROM YORK, FOR THE GTHA

Developing Best Practices

The City of Markham is working with Mattamy Homes and Enwave to design the largest net-zero neighbourhood in Ontario. Supported by a TAF grant, the project will create 400 homes that are anchored by a district geothermal heating system.

This Markham neighbourhood will prove the case for geothermal community energy systems across the GTHA. The lessons learned from the project in Markham can be applied elsewhere in the region and beyond to accelerate the uptake of this low-carbon solution.

Creating a Carbon-Neutral GTHA

49.2 million tonnes of carbon =

10.4 million **passenger vehicles off the road for one year,** or 87 per cent of all the passenger vehicles in Ontario. In order to achieve the necessary reductions, the electrification of transportation will need to accelerate: in 2017, only 7,706 new vehicles sold in Ontario were electric, representing less than one per cent of total Ontario vehicle sales (Statistics Canada, 2019).

5.9 million **single family homes' energy use for one year.** That's more than double the number of dwellings in the GTHA. Deep retrofits to all existing buildings in the GTHA will be necessary for the region to reach carbon neutrality by 2050. We can't simply stop using energy to heat our homes and power our appliances, so efficiency needs to be improved drastically and transitions to lower-carbon sources of energy for heating will be critical.

24.4 million tonnes **of coal burned.** Ontario has already phased out coal – as the result of collaboration between the province, its regions, and municipalities. Just like the coal phase-out required regions to work together, none of the GTHA municipalities can achieve carbon neutrality alone. This challenge will require mobilization of low-carbon policies, programs, and technologies on an unprecedented scale, which will require municipalities to work together in new ways.

813 million **tree seedlings grown for 10 years sequester this amount of carbon.** In both rural and urban areas, trees and greenspace are important parts of healthy and vibrant neighbourhoods.

Achieving a carbon-neutral GTHA by 2050 requires eliminating most of the 49.2 million tonnes emitted annually, and offsetting emissions that can't be eliminated.

This challenge requires integrated solutions that will touch on all facets of everyday life, and bring societal and economic benefits along with environmental ones. In the face of the climate emergency, it is time to accelerate the implementation of proven solutions at scale, while concurrently innovating new low-carbon solutions. TAF's consistent and robust emissions inventory for every year will help provide support for these solutions, and an effective way of tracking their progress.

Appendix A – Methodology

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). This carbon emissions inventory includes Scope 1 and 2 emissions. We will continue to improve our methodology over time.

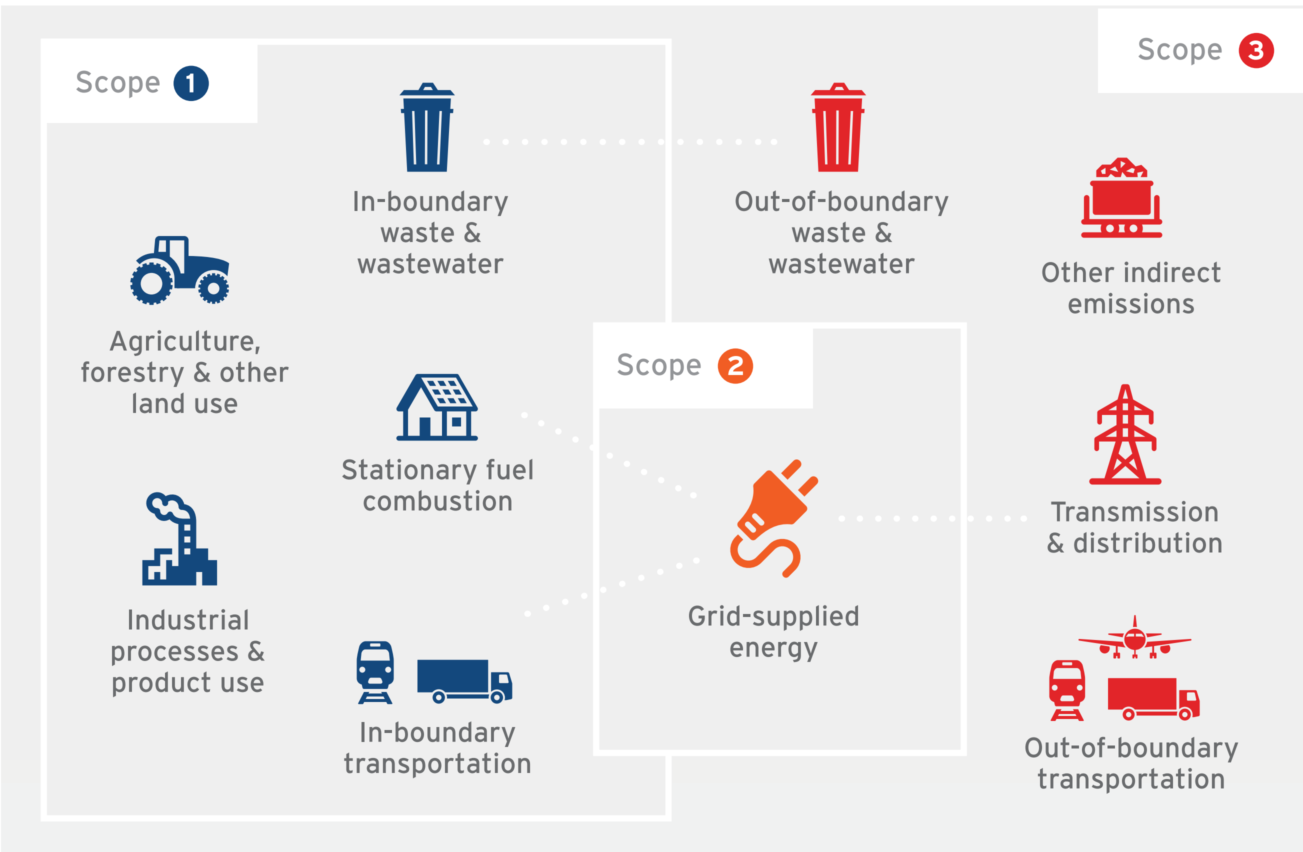


Figure 14: Definition of Scope 1, 2, and 3 emissions sources

As mentioned in the report, our results in this inventory may differ from results in inventories published by individual municipalities. 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. 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.

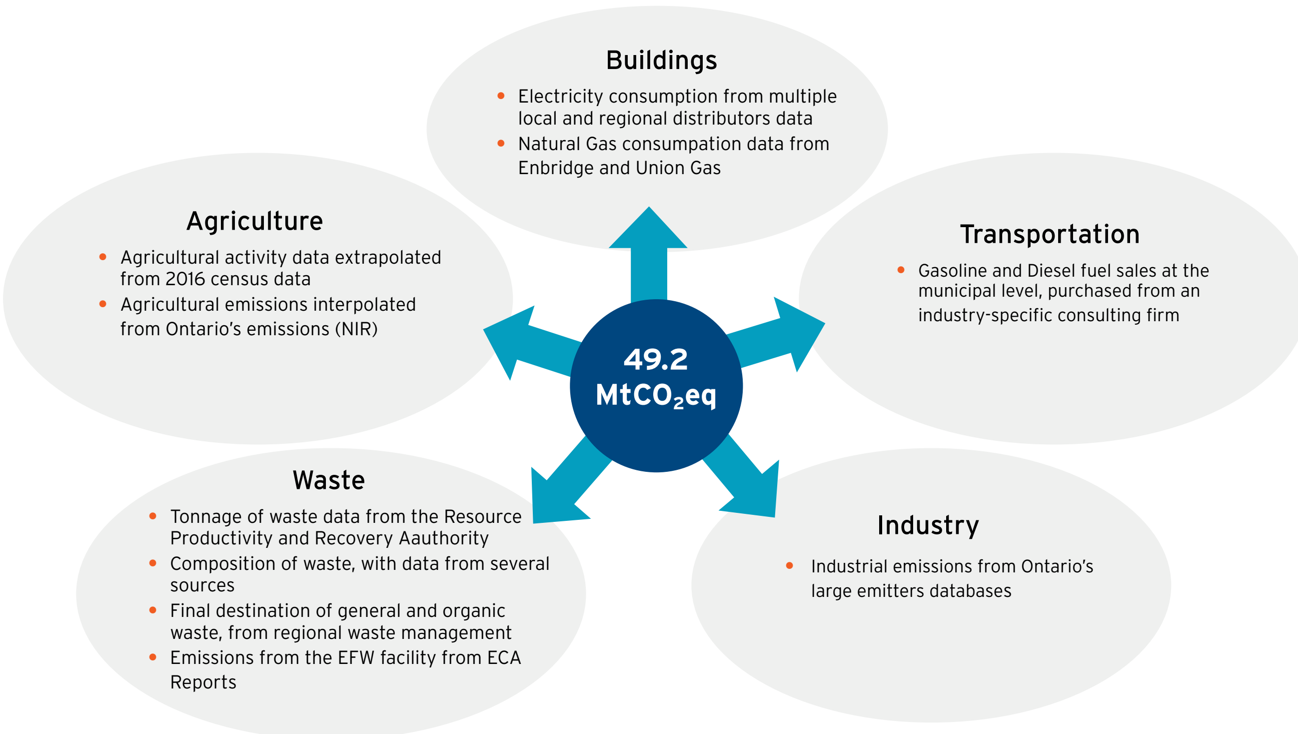


Figure 15: Overview of the sources of emissions used to develop this inventory

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 refer to them as "Buildings" in this document to make the concept more relatable. According to Natural Resources Canada's Comprehensive Energy Use Database, 89.2 per cent of residential energy use and 94.9 per cent of commercial/institutional energy use comes from these two energy sources. 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, or coal emissions as we determined they make up a tiny portion of the emissions in buildings in the GTHA and we could not obtain reliable data.

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 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.

The natural gas and electricity consumption values were multiplied by emissions factors from Canada's National Inventory Report, 0.001899 tCO_2eq/m^3 of natural gas and 0.00002 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 per cent 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 45 per cent of Ontario's total consumption (an expected value based on population and economic activity), our diesel data accounts only for 15 per cent of the province's consumption. 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 five per cent of gasoline sold to be from a renewable source so it was assumed that five per cent of gasoline sales were ethanol with a 34 per cent reduction in emissions (United States Environmental Protection Agency, 2014; Government of Ontario, 2016). Similarly, due to the Greener Diesel regulation, two per cent of diesel sales were assumed to be bio-based with a 30 per cent reduction in emissions (Ministry of the Environment and Climate Change, 2015).

Fuel sales occurring in each 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.

Top-Tier Municipality	Gasoline Emissions (tCO_2eq)	Diesel Emissions (tCO_2eq)	Total Fuel Emissions (tCO_2eq)
Durham	1,688,911	110,046	1,798,957
Halton	1,333,415	147,884	1,481,299
Hamilton	1,321,269	97,276	1,418,546
Peel	3,539,903	370,348	3,910,251
Toronto	4,507,139	356,113	4,863,253
York	2,874,245	288,330	3,162,576

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

Lower-Tier Municipality	Gasoline Emissions (tCO_2eq)	Diesel Emissions (tCO_2eq)	Total Fuel Emissions (tCO_2eq)
Ajax and Pickering	612,683	37,578	650,261
Aurora	207,348	16,205	223,553
Brampton	1,415,590	113,962	1,529,552
Burlington	440,133	36,223	476,356
Caledon (only Bolton)	83,134	11,747	94,881
Clarington (only Bowmanville)	122,737	10,121	132,858
Halton Hills (only Georgetown and Hornby)	165,355	52,325	217,679
King (only Nobleton)	17,269	2,012	19,282
Markham	2,306,232	245,782	2,552,014
Milton	248,986	24,259	273,245
Mississauga	2,023,911	242,626	2,266,537
Newmarket	360,666	26,343	387,009
Oakville	478,941	35,078	514,019
Oshawa and Whitby	834,552	49,023	883,575
Scugog (only Port Perry)	69,686	6,733	76,419
Uxbridge	49,253	6,591	55,844

Table 4: Transportation fuel emissions by lower-tier municipality in the GTHA

Waste

We used the methane commitment approach to calculate emissions from waste. Using this method, the 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). 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, 1.5583 tonnes of non-residential waste were disposed of in 2016 (Statistics Canada, 2017).

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. Table 5 summarizes the data available to TAF.

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 per cent, as suggested by the United States Environmental Protection Agency. Canada's National Inventory report estimates a reduction of emission of about 38 per cent 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). The OX, F, DOC_f, and MF values use the appropriately recommended values of 0.1, 0.5, 0.6, and 1, respectively (ICLEI, WRI, $C_4$0, 2014).

The GTHA has one energy-from-waste facility, the Durham York Energy Centre. In 2017 the facility emitted 70,078 tCO_2eq (Environment and Climate Change Canada, 2017). 25 per cent of the facility's capacity is used to process York waste while the remaining 75 per cent is used to process Durham waste. We used these proportions in our emissions analysis (Durham York Energy Centre, B). In 2017, the facility generated 114,412 MWh of electricity, of which 98,578 MWh were exported to the grid[v].

We also included CH_4 and N_2O emissions from organic waste treatment, both aerobic and anaerobic. Organic waste data was obtained from the Resource Productivity & Recovery Authority (RPRA). 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 CH_4/kg waste and 0.3 g N_2O / kg waste for aerobic digestion (composting) and 1 g CH_4/kg waste and 0 g N_2O /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.

[v] https://www.durhamyorkwaste.ca/Assets/Documents/FacilityOperationsReports/2017/Reports/DYEC_2017_Annual_OP_RPT_ACC.pdf

Source	Sector	Year	Methane Generation Potential (L_0) (tCH_4 per tWaste)	DOC	DOC Category: 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 5: Waste composition data sources and values

Agriculture

We arrived at 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 2017 greenhouse gas emissions reporting by large emitters (>25,000 tCO_2eq/year and smaller emitters that report voluntarily) (Government of Ontario, 2017). 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 emitters, data reporting does not disaggregate the sources of emissions.

Appendix B – Recalculation

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, we're recalculated the emissions total for 2015 that we published last year. Figure 16 and Table 6 show the changes in emissions caused by this update.

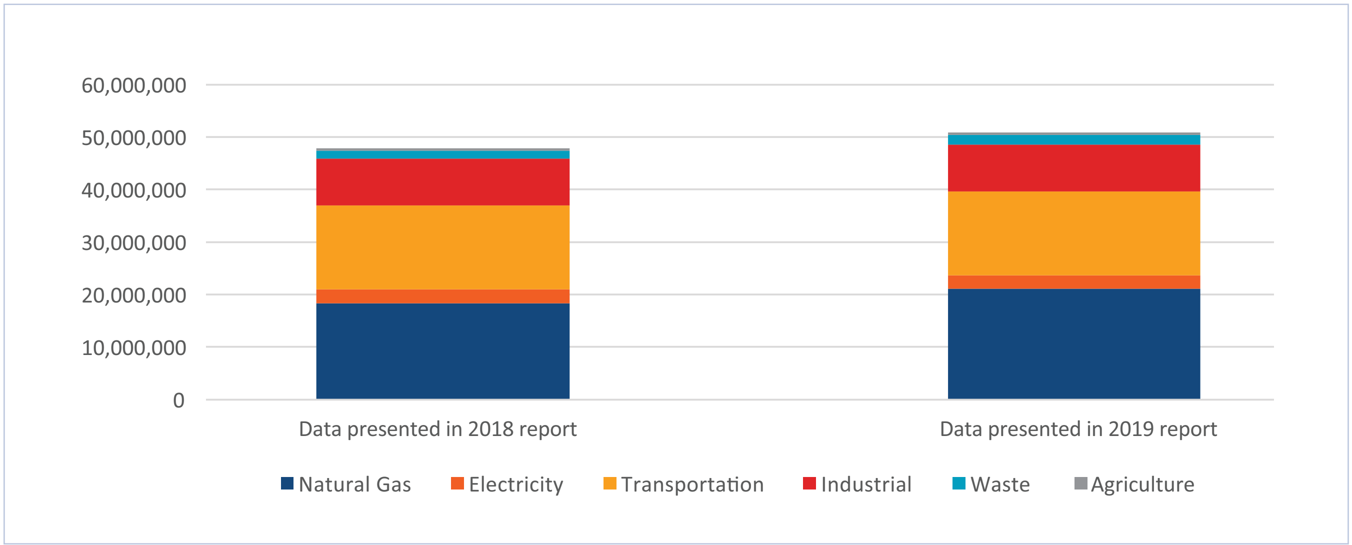


Figure 16: 2015 emissions, as reported in the 2018 report and as recalculated for this 2019 report

	2018 Report	Recalculated	Difference	Change %
Agricultural	460,893	461,362	469	0.1%
Electricity	2,613,159	2,559,235	-53,924	-2.1%
Industrial	8,901,305	8,958,152	56,847	0.6%
Natural Gas	18,362,494	21,049,448	2,686,954	14.6%
Transportation	15,986,751	15,986,751	0	0.0%
Waste	1,489,191	1,851,698	362,507	24.3%
2015 Emissions	**47,813,793**	**50,866,646**	**3,052,853**	**6.4%**

Table 6: Comparison of calculations for 2015 emissions

The following changes were made for each sector:

Natural gas: Additional information has been gathered for large consumers' natural gas consumption in Halton and Hamilton.

Electricity: Consumption data for some municipalities have been updated after review. Methodology employed to estimate electricity consumption in Durham has been changed to ensure consistency in the comparison between years.

Transportation: No changes.

Industrial: New facilities have been added in Hamilton, and cogeneration facilities have been removed because their emissions are already considered within the natural gas consumption data.

Waste: The methodology has been updated and organic waste emissions have been added to the results. Data for waste sent to the incineration facility was projected in the original quantification and has been updated with actual data reported from the energy-from-waste facility.

Agriculture: Ontario's agriculture emissions have been revised with the latest NIR report data.

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[vi]. 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 7).

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

Table 7: The number of heating degree days in the GTHA for 2015-2017

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

Table 8: The change in heating degree days between 2015 and 2017

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

[vi] 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 dependent on high temperatures in summer) doesn't allow for normalization of its consumption based on CDDs.

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

Natural Gas Use for Space Heating	
Commercial	77%
Industrial	42%
Residential	72%

Table 9: Natural gas used for heating by building type

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

	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				**67%**

Table 10: The relationship between building type and natural gas used 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 11. Normalization has a significant effect on the calculated change in natural gas emissions between 2015 and 2017.

[vii] https://www.oeb.ca/sites/default/files/uploads/ICF_Report_Gas_Conservation_Potential_Study.pdf

[viii] Those values are obtained from the data provided by the utilities, but its lack of granularity doesn't allow one to be completely certain about the accuracy of those percentages.

	Emissions			Normalized Emissions		
	2015	2016	2017	2015	2016	2017
Durham	1,653,306	1,512,345	1,567,710	1,576,925	1,521,946	1,562,036
Halton	2,052,527	1,816,493	1,827,502	1,952,142	1,828,701	1,820,501
Hamilton	2,653,362	2,580,736	2,557,542	2,545,010	2,595,218	2,549,361
Peel	4,028,241	3,729,888	3,875,923	3,839,101	3,753,953	3,861,668
Toronto	7,839,606	7,084,041	7,364,888	7,446,443	7,132,860	7,335,043
York	2,822,406	2,531,537	2,673,059	2,680,150	2,549,071	2,662,505
GTHA	**21,049,448**	**19,255,041**	**19,866,624**	**20,039,772**	**19,381,955**	**19,791,978**

Table 11: The emissions and weather normalized emissions for each GTHA region

	Change in Emissions		Change in Normalized Emissions	
	2015-2016	2016-2017	2015-2016	2016-2017
Durham	-8.5%	3.7%	-3.5%	2.6%
Halton	-11.5%	0.6%	-6.3%	-0.4%
Hamilton	-2.7%	-0.9%	2.0%	-1.8%
Peel	-7.4%	3.9%	-2.2%	2.9%
Toronto	-9.6%	4.0%	-4.2%	2.8%
York	-10.3%	5.6%	-4.9%	4.5%
GTHA	**-8.5%**	**3.2%**	**-3.3%**	**2.1%**

Table 12: The weather normalization effect on annual changes in emissions

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 - Results

2017

Municipality	Emissions by Sector (tCO_2eq)					
	Buildings	Transportation	Industrial	Waste	Agricultural	2017 Emissions
Durham	1,648,337	1,798,957	341,182	152,300	202,646	4,143,423
Halton	1,919,696	1,481,299	214,961	151,972	32,963	3,800,892
Hamilton	2,645,941	1,418,546	6,052,478	204,865	70,192	10,392,022
Peel	4,113,271	3,910,251	2,048,319	423,916	56,346	10,552,102
Toronto	7,850,623	4,863,253	634,403	633,618	1,877	13,983,774
York	2,846,821	3,162,576	773	195,734	89,869	6,295,772
GTHA	**21,024,689**	**16,634,881**	**9,292,116**	**1,762,405**	**453,893**	**49,167,985**

Table 13: Emissions by municipality and sector

Municipality	Emissions					
	Buildings	Transportation	Industrial	Waste	Agricultural	Total
Durham	40%	43%	8%	4%	5%	100%
Halton	51%	39%	6%	4%	1%	100%
Hamilton	25%	14%	58%	2%	1%	100%
Peel	39%	37%	19%	4%	1%	100%
Toronto	56%	35%	5%	5%	0%	100%
York	45%	50%	0%	3%	1%	100%
GTHA	**43%**	**34%**	**19%**	**4%**	**1%**	**100%**

Table 14: Relative emissions by municipality and sector

Municipality	Emissions per Capita (tCO_2eq)							
	2017 Population	Buildings	Transportation	Industrial	Waste	Agricultural	Total	Total, Excluding Industrial
Durham	656,331	2.5	2.7	0.5	0.2	0.3	6.3	5.79
Halton	560,435	3.4	2.6	0.4	0.3	0.1	6.8	6.40
Hamilton	543,917	4.9	2.6	11.1	0.4	0.1	19.1	7.98
Peel	1,413,639	2.9	2.8	1.4	0.3	0.0	7.5	6.02
Toronto	2,790,371	2.8	1.7	0.2	0.2	0.0	5.0	4.78
York	1,124,748	2.5	2.8	0.0	0.2	0.1	5.6	5.60
GTHA	**7,089,441**	**3.0**	**2.3**	**1.3**	**0.2**	**0.1**	**6.9**	**5.62**

Table 15: Per capita emissions by municipality and sector

Municipality	Buildings Emissions per Capita (tCO_2eq)	
	Natural Gas	Electricity
Durham	2.4	0.12
Halton	3.3	0.16
Hamilton	4.7	0.16
Peel	2.7	0.17
Toronto	2.6	0.17
York	2.4	0.15
GTHA	**2.8**	**0.16**

Table 16: Per capita emissions by municipality for natural gas and electricity consumption

Municipality	Transportation Emissions per Capita (tCO_2eq)	2017 Land Area (km^2)	2017 Population	Population Density ($population/km^2$)
Durham	2.7	2,523.80	656,331.0	260
Halton	2.6	964.05	560,435.0	581
Hamilton	2.6	480.60	543,917.0	1,132
Peel	2.8	1,246.95	1,413,639.0	1,134
Toronto	1.7	630.20	2,790,371.0	4,428
York	2.8	1,762.13	1,124,748.0	638
GTHA	**2.3**	**7,607.73**	**7,089,441.0**	**932**

Table 17: Per capita emissions, population and land area by municipality

	Natural Gas	Electricity	Total
GTHA Total Emissions	19,866,624	1,158,064	21,024,689
GTHA Total Emissions (%)	94.5%	5.5%	100%

Table 18: Total GTHA emissions for natural gas and electricity consumption

References

City of Toronto. (2015, August 15). Technical Memorandum No. 1 Current System Summary. Retrieved 2019, from https://www.toronto.ca/wp-content/uploads/2017/10/967e-SW_Technical-Memo-No-1-FINAL-AODA.pdf

City of Toronto. (2017, December 5). 2016 Census: education, labour, journey to work, language of work, mobility and migration. Retrieved 2019, from the City of Toronto: https://www.toronto.ca/wp-content/uploads/2017/12/94ce-2016-Census-Backgrounder-Education-Labour-Journey-to-work-Language-Mobility-Migration.pdf

Durham Region. (2018). Waste Management Annual Report. Retrieved 2019, from Durham York Energy Centre: https://www.durhamyorkwaste.ca/Assets/PublicOutreach/2019EnvironmentalAssessment/40038_DR_WASTE_AR_ACCESSIBLE_J2019_FINAL.pdf

Durham York Energy Centre, A. (n.d.) About Durham-York Energy Centre. Retrieved 2019, from Durham York Energy Centre: https://www.durhamyorkwaste.ca/Home/Home.aspx

Durham York Energy Centre, B. (n.d.). *Quick Technical Facts About the DYEC*. Retrieved 2019, from Durham York Energy Centre: https://www.durhamyorkwaste.ca/Home/QuickFacts.aspx

Environment and Climate Change Canada. (2017). *Facility and GHG Information.* Retrieved 2019, from Environment and Climate Change Canada: http://www.ec.gc.ca/ges-ghg/donnees-data/index.cfm?do=facility_info&lang=en&ghg_id=G10805&year=2015

Environment and Climate Change Canada. (2019). National Inventory Report 1990 – 2017: Greenhouse Gas Sources and Sinks in Canada. Retrieved 2019, from the Government of Canada: http://publications.gc.ca/collections/collection_2019/eccc/En81-4-1-2017-eng.pdf

FleetCarma. (2018). Electric vehicles sales update Q3 2018, Canada. Retrieved 2019 from FleetCarma: https://www.fleetcarma.com/electric-vehicles-sales-update-q3-2018-canada/

Government of Canada. (2019). *National Inventory Submissions 2019.* Retrieved 2019, from United Nations Framework Convention on Climate Change: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php

Government of Ontario. (2016, September 13). *Ethanol in gasoline.* Retrieved 2019, from Ontario: https://www.ontario.ca/page/ethanol-gasoline

Government of Ontario. (2017). *Greenhouse gas emissions reporting by facility.* Retrieved 2019, from Ontario: https://www.ontario.ca/data/greenhouse-gas-emissions-reporting-facility

ICLEI, WRI, C40. (2014, December 8). *The Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC)*. Retrieved 2019, from ICLEI - Local Governments for Sustainability: https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

The International Energy Agency. (2018). *Fuel Economy in Major Car Markets, Country database for Canada.* Retrieved 2019, from The International Energy Agency: https://www.iea.org/topics/transport/gfei/#controls

Kelleher, M., Christina, S., & Torrie, R. (2015, November). *Greenhouse Gas Emissions and the Ontario Waste Management Industry.* Retrieved 2019, from Ontario Waste Management Association: http://www.owma.org/articles/greenhouse-gas-emissions-and-the-ontario-waste-management-industry

Ministry of the Environment and Climate Change. (2015, December). *Guide and Director's Directions - Renewable Fuel Content Requirements for Petroleum Diesel Fuel*. Retrieved 2019, from Ministry of the Environment and Climate Change: http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2015/012-4413_FinalGuide.pdf

Mohareb, E. (2012). *Quantifying the Transition to Low-Carbon Cities* . Retrieved 2019, from T-Space: https://tspace.library.utoronto.ca/bitstream/1807/32774/6/Mohareb_Eugene_201206_PhD_thesis.pdf

Resource Productivity & Recovery Authority. (2016). *Datacall*. Retrieved 2019, from Resource Productivity & Recovery Authority: https://www.rpra.ca/wp-content/uploads/2016-Residential-Diversion-Rates.pdf

Statistics Canada. (2017). *Disposal of waste, by source, Canada, provinces and territories.* Retrieved 2019, from Statistics Canada: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1530041&&pattern=&stByVal=1&p1=1&p2=31&tabMode=dataTable&csid=

Statistics Canada. (2019). Table 20-10-0002-01, New motor vehicle sales, by type of vehicle. Retrieved 2019, from Statistics Canada: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010000201&pickMembers%5B0%5D=1.7

Toronto Environmental Alliance. (2016, February). *Reports: Zero Waste Toronto & Organics First.* Retrieved 2019, from Toronto Environmental Alliance: http://www.torontoenvironment.org/zerowaste

United States Environmental Protection Agency. (n.d.). *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks.* Retrieved 2019, from United States Environmental Protection Agency: https://archive.epa.gov/epawaste/conserve/tools/warm/pdfs/chapter1.pdf

United States Environmental Protection Agency. (2014, April 4). *Emission Factors for Greenhouse Gas Inventories.* Retrieved 2019, from United States Environmental Protection Agency: https://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

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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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Image: Toronto's warming stripes from 1841 to 2017