APPENDIX C: Reference Scenario Modelling Results

July 2021

Purpose of this Document

This document reports the energy use and greenhouse gas (GHG) emissions for the Town of Halton Hills in a reference scenario by 2030 scenario (Part 1). The model results are shown in comparison to the Town's 2016 base year energy use and GHG emissions. The data and series of assumptions that make up the reference scenario, as well as the modelling methods are outlined in Part 2.

Disclaimer

Reasonable skill, care and diligence has been exercised to assess the information acquired during the preparation of this analysis, but no guarantees or warranties are made regarding the accuracy or completeness of this information. This document, the information it contains, the information and basis on which it relies, and the associated factors are subject to changes that are beyond the control of the author. The information provided by others is believed to be accurate but has not been verified.

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Glossary

Base Year: the starting year for energy or emissions projections.

Carbon dioxide equivalent (CO2e): a measure for describing the global warming potential of a greenhouse gas using the equivalent amount or concentration of carbon dioxide (CO2) as a reference. CO2e is commonly expressed as million metric tonnes of carbon dioxide equivalent (MtCO2e).

Cooling degree days (CDD): the number of degrees that a day's average temperature is above 18^{o}C, requiring cooling.

District energy: Energy generation within the municipal boundary that serves more than one building.

Emissions: In this report, the term 'emissions' refers exclusively to greenhouse gas emissions, measured in metric tonnes (tCO2e), unless otherwise indicated.

Electric vehicles (EVs): an umbrella term describing a variety of vehicle types that use electricity as their primary fuel source for propulsion or as a means to improve the efficiency of a conventional internal combustion engine.

Greenhouse gases (GHG): gases that trap heat in the atmosphere by absorbing and emitting solar radiation, causing a greenhouse effect that unnaturally warms the atmosphere. The main GHGs are water vapor, carbon dioxide, methane, nitrous oxide, and ozone.

Heating Degrees Days (HDD): number of degrees that a day's average temperature is below 18^{o}C, requiring heating.

Local electricity: Electricity produced within the municipal boundary and sold to the electricity system operator or used behind the meter.

Reference scenario: a scenario illustrating energy use and greenhouse gas emissions which aims to reflect current and planned policies and actions that are likely to be implemented.

Renewable Natural Gas (RNG): Biogas resulting from the decomposition of organic matter under anaerobic conditions that has been upgraded for use in place of fossil natural gas.

Sankey: a diagram illustrating the flow of energy through a system, from its initial sources to points of consumption.

Vehicle kilometres travelled (VKT): distance traveled by vehicles within a defined region over a specified time period.

Units of Measurement:

To compare fuels on an equivalent basis, all energy is reported primarily as petajoules (PJ) or sometimes as gigajoules (GJ) (a PJ is a million GJ). Greenhouse gas emissions are primarily characterized as Kilotonnes or megatonnes of carbon dioxide equivalents ($ktCO_2e$ or $MtCO_2e$) (a Mt is a thousand kt).

- An average house uses about 100GJ of energy in a year
- 100 liters of gasoline produces about 3.5 GJ
- A kilowatt-hour is .0036 GJ
- A terawatt-hour is 3.6 PJ
- Burning 50,000 tonnes of wood produces 1 PJ
- A typical passenger vehicle emits about 4.7 metric tons of carbon dioxide per year.*

*Data provided by United States Environmental Protection Agency

GHG emissions	Energy
1 mtCO2 = 1,000,000 tCO2e 1 ktCO2e = 1,000 tCO2e 1 tCO2e = 1,000 kgCO2e 1 kgCO2e = 1,000 gCO2e	1 PJ = 1,000,000,000 J 1 GJ = 1,000,000 J 1 MJ = 0.001 GJ 1 TJ = 1,000 GJ 1 PJ = 1,000,000 GJ

1. Introduction

The Low-Carbon Transition Strategy (LCTS) will chart a course for the Town of Halton Hills to reach net-zero emissions by 2030. The LCTS will be developed by evaluating future emission reduction scenarios using CityInSight, a spatial energy and emissions simulation model developed by SSG and whatIf? Technologies.

Scenario analysis projects alternate stories about how the world could unfold based on possible future pathways. Scenario planning is a technique used to inform decision-making by exploring how combinations of alternate policies, economic mechanisms, and investments could impact society and the economy.

Once we have developed a base year energy and emissions model for the town, two emissions scenarios will be evaluated to develop the LCTS: first, a reference scenario and, then a net-zero scenario.

The reference scenario reflects current activities and trends that generate emissions in the Town of Halton Hills, and projects what emissions could look like over time if little additional action is taken to reduce emissions. The net-zero scenario then explores the energy and emissions implications of a suite of actions to reduce the emissions identified in the reference scenario. The net-zero scenario will then inform the LCTS.

This report summarizes the technical modelling results for the base year and reference scenario. The report provides a brief overview of the modelling process and key assumptions used to develop the reference scenario. It ends with a summary of the reference scenario modelling results from the base year (2016) to 2030.

2. 2016 Base Year

The modelling projections for both the reference and the net-zero scenarios are built on a base year energy and emissions model produced for the Town. The base year model represents energy use and processes that generate emissions in the Town of Halton Hills.

Emissions come from three main sources:

- The consumption of carbon-based fuels for energy, which emit greenhouse gases during their combustion. This includes a range of activities that occur in Halton Hills, including building heating, cooling and plug loads transportation; as well as industrial processes.
- Emissions generated from decomposing organic waste and its treatment, and decomposing organic waste in wastewater treatment.
- The incidental release of emissions (methane) from the natural gas system, referred to as fugitive emissions.

The base year is developed based on observed data in Halton Hills, including census data, energy consumption from utilities and observed transportation studies. The base year is 2016 because the most recent Census data is from 2016. Where more current data is available, it is used to calibrate the model projections between 2016-2019.

2.1 Geographic Scope

The GHG accounting framework in CityInSight applies the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC Protocol). The geographic boundary of the Town of Halton Hills is the inventory boundary. Further details on the modelling scope is outlined in Part 2.

3. Reference Scenario Assumptions

The reference scenario represents the Town of Halton Hills' energy and emissions projected to 2030 based on ongoing trends and planned initiatives. This scenario is made up of a suite of assumptions applied to the energy and emissions model for the Town of Halton Hills. The assumptions relate to energy and waste systems that drive emissions and include:

- Population growth
- New building construction
- Transit system expansion and its corresponding fuel type
- Personal use vehicles counts and fuel efficiency
- Waste and waste diversion rates

The activities included in the reference scenario are described below. A full list of assumptions applied in the reference scenario model are described in Part 2 of this report.

3.1 Population and Households

The population of Halton Hills is anticipated to increase by 45% by 2030, from 63,000 in 2016 to nearly 92,000, according to Town projections.[1] This captures the development at Vision Georgetown.

Employment is projected to rise by 20%, with just under 40,000 jobs in the Town by 2030 (up from 33,000 in 2016). The smaller relative employment growth projections is indicative of the fact that many residents are currently and projected to continue to commute to work in neighbouring communities, including Toronto.

Population, households and employment are shown in Figure 1. A growing population and employment base translates to more homes, more commercial floor area and more vehicles—all of which influence emissions.

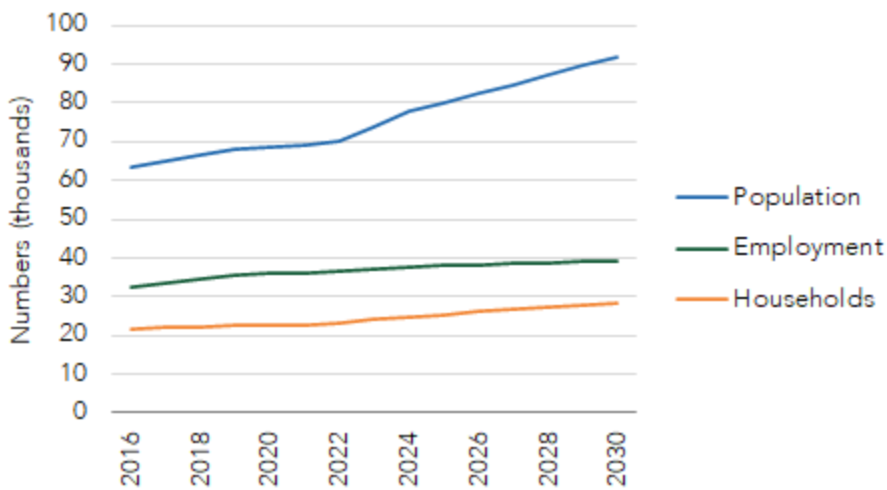

Figure 1. Projected changes in population, vehicles, employment and households, 2016-2030.

3.2 Climate Change

Halton Hills is projected to experience a decline in heating needs and an increase in cooling needs for its buildings as a result of climate change. This is reflected in heating and cooling degree days—the extent to which heating (below 18°C) and cooling (above 18°C) is required. By 2030, heating degree days are projected to decline to 3,573 (from 3,882), and cooling degree days are projected to increase to 405 (from 331).[2]

3.3 Buildings

New Construction

The Halton Hills Green Development Standard (GDS) has been in place since 2014, and uses a point-based system to encourage sustainable design in new construction. Theoretically, GDS energy performance points

[1] Environics Analytics. (2019). Demo Stats 2019.
[2] Climate Atlas of Canada. (n.d.). RCP8.5 BCCAqv2 downscaled climate data from Pacific Climate Impacts Consortium.

results in buildings that are 5-20% more efficient than the 2012 Ontario Building Code (OBC).[3] An updated GDS is currently in development, and is expected to advocate for 15% better energy performance than the newest iteration of the OBC (2020).

In the reference scenario, it is assumed that between 2016 and 2030, 25% of new buildings are constructed to meet the GDS Standards applicable at the time of construction. The remaining 75% of new buildings are constructed to meet the OBC standards required at the time of construction. Since OBC 2012, it is assumed that the code is updated every five years to require improved energy performance of 10%.[4]

Existing Buildings

The energy performance of municipal buildings is expected to improve as initiatives in the Town's Corporate Energy Plan are implemented.[5] The energy consumption by facility is anticipated to fall by 43%, averaged across 12 of the Town's facilities.

The energy performance of non-municipal existing buildings is assumed to remain unchanged, for two reasons:

- There are no targeted retrofit programs for buildings in Halton Hills.
- Any gains from building renovations or heating system replacements that occur may be offset by increasing plug loads.

Across the whole residential building stock (non-municipal new and existing), this translates to about a 12.5% reduction in energy consumption by 2021, 14% reduction by 2026, and a 10% reduction by 2030. For the new non-residential building stock, there is a 10% improvement in energy performance every five years.

3.4 Local Energy Generation

Existing grid-connected renewable electricity generation is assumed to remain in operation, with contract extensions beyond their current end dates.[6] This includes 4.08 MW of rooftop solar, as well as 0.5 MW of ground mount solar PV.[7] This also includes small solar PV installations on municipal corporate buildings.

While there is a planned district energy system in the Vision Georgetown development, it is not expected to be operational until 2035—beyond the time scope of the reference projection.

3.5 Transit

The reference scenario accounts for an increase in transit trips and transit vehicle kilometres travelled (VKT) from Metrolinx's GO train Kitchener Line expansion. Beginning in 2025, transit trips will increase according to

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[3] Arup. (2017). Vision Georgetown Energy Master Plan.
[4] Environmental Commissioner of Ontario. (2016). Conservation: Let's Get Serious 2015-2016.
[5] Town of Halton Hills. (2019). 2020-2025 Corporate Energy Plan.
[6] IESO. (March 2020). IESO Active Contracted Generation List (as of March 2020). Retrieved from: www.ieso.ca/Power-Data/Supply-Overview/Transmission-Connected-Generation
[7] It should be noted that the Halton Hills Generating Station, a 641 MW natural gas fired electricity generating station is not included in either the base year or the reference projection. This is because its emissions impact is captured in Ontario's grid emissions factor. For more details, see Part 2 Section 7.

Table 1. Transit VKT is assumed to be five times higher than base year VKT, based on the increasing frequency of transit service.

Table 1. Transit trip increase for GO Train Kitchener expansion.[8]

	2016	2025
Acton	121 daily trips	220 daily trips
Georgetown	618 daily trips	643 daily trips

While the Town is also anticipating an expansion of the local Universal Access Service, this is incorporated into personal vehicle trips because the service closely resembles taxi activities.[9]

Neither the GO expansion, nor the Universal Access Service, is assumed to be electric.

3.6 Transportation Mode Share

The reference scenario assumes that the transit and active mode shares identified in the Town's Transportation Master Plan (TMP) are achieved.[10] In addition, the GO Train expansion is assumed to exceed this transit mode share identified in the TMP. The assumed 2030 modeshare is shown in Table 2.

Table 2. Reference scenario mode share in 2016 (observed) and 2030 (projected).

	2016	2030
Personal use automobiles	88.90%	83.54%
Transit	4.95%	10.77%
School bus	2.29%	2.52%
Walk	3.36%	2.74%
Bike	0.50%	0.43%

3.7 Vehicles

A portion of personal vehicle stock in Halton Hills is assumed to be replaced with electric vehicles, starting at 0% of new vehicle sales in 2016 and up to 14% of new vehicle sales by 2030.[11] New vehicles are incorporated into

[8]Metrolinx. (2019). Kitchener go expansion initial business case. Retrieved from: www.metrolinx.com/en/regionalplanning/projectevaluation/benefitscases/2019-11-14-Kitchener-Mid-Term-Service-Expansion-IBC-Update-FINAL.pdf
[9] Town of Halton Hills. (2019). Transit Service Strategy. Prepared by WSP.
[10] Town of Halton Hills. (2011). Transportation Master Plan.
[11] Axsen, J., Wolinetz, M. (2018). Reaching 30% plug-in vehicle sales by 2030: Modeling incentive and sales mandate strategies in Canada.Transportation Research Part D: Transport and Environment, 65, 596-617.

the model with new population growth, as well as through replacement at the end of vehicle life. The assumption reflects the underlying increase in EV purchases.

The reference scenario assumes that commercial vehicles are not replaced with an electric counterpart.

New internal combustion engine vehicles are assumed to have the fuel economy of their manufacturing year, according to Canadian regulations.[12] Regulations schedule vehicle efficiency improvements for the upcoming decade.

3.8 Municipal Fleets

The reference scenario assumes that there will be no significant changes to municipal fleet vehicles, other than replacements at the end of vehicle life.

3.9 Waste and Wastewater

Waste generation in Halton Hills is assumed to remain constant at the base year level of 1,250 kg/household/year.[13] The base year waste diversion rate is 57.4%.[14] As a result of Halton Region policies, Halton Hills is expected to reach a 70% waste diversion rate by 2025. After 2025, the diversion rate stays constant at 70%. Increasing the diversion rate reduces the amount of organic waste sent to landfill.

Currently, waste is landfilled outside the Halton Hills boundary. A landfill gas capture system captures a portion of emissions produced from decomposing organic waste; once captured, some gas is flared, directly releasing carbon dioxide into the atmosphere. The remaining gas is combusted to produce electricity. There are no expected changes to how waste is treated in the reference scenario.[15]

There are two wastewater treatment plants within the Town boundary. Wastewater systems consume various fuels, and also produce emissions from the decomposition of organic waste in sewage. Wastewater emissions are projected to increase with population growth.

3.10 Industry

The model accounts for energy consumption at industrial facilities. The industrial sector is expected to grow as broader local employment grows between 2016 and 2030.

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12 *SOR/2010-201. Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations. Available from: laws-lois.justice.gc.ca. SOR/2018-98. Regulations Amending the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations and other Regulations Made Under the Canadian Environmental Protection Act, 1999. Available from: pollution-waste.canada.ca*
13 Halton Region. (2011). Solid Waste Management Strategy.
14 Resource Productivity and Recovery Authority. (n.d.). 2016 Residential Waste Diversion Rates by Municipal Program.
15 Waste treatment occurs outside of Halton Hills' boundaries, and is therefore a scope 3 emission. The electricity produced from the combustion of landfill gas is not included in the Town's inventory as it is under the control of Oakville Hydro. For details on scope, see Part 2 of this report.

3.11 Agriculture

Agriculture emissions in the model relate to emissions associated with methane emissions from livestock, not energy use on farms. There are no anticipated changes to agriculture emissions in Halton Hills.

4. Base Year Scenario Results

4.1 Base Year Energy, 2016

In 2016, 8.3 PJ of energy were consumed for activities within the Town of Halton Hills. About 80% of energy consumption is from fossil fuels.[16]

The breakdown of fuel uses varies by sector (Figure 2). Building-related sectors (residential, commercial, municipal and industrial) use many of the same fuels, albeit in different proportions. Natural gas is the dominant fuel consumed in residential, commercial, industrial and municipal sectors, mostly for space heating and industrial purposes. Grid electricity is also used in buildings, primarily for cooling and plug loads. A range of other fuels are also used within the Halton Hills boundary, including fuel oil, wood and propane; this is generally in rural areas without access to natural gas for heating, and in industrial processes.

Energy consumption in the transportations sector is made up mostly of gasoline, and to a lesser extent diesel.

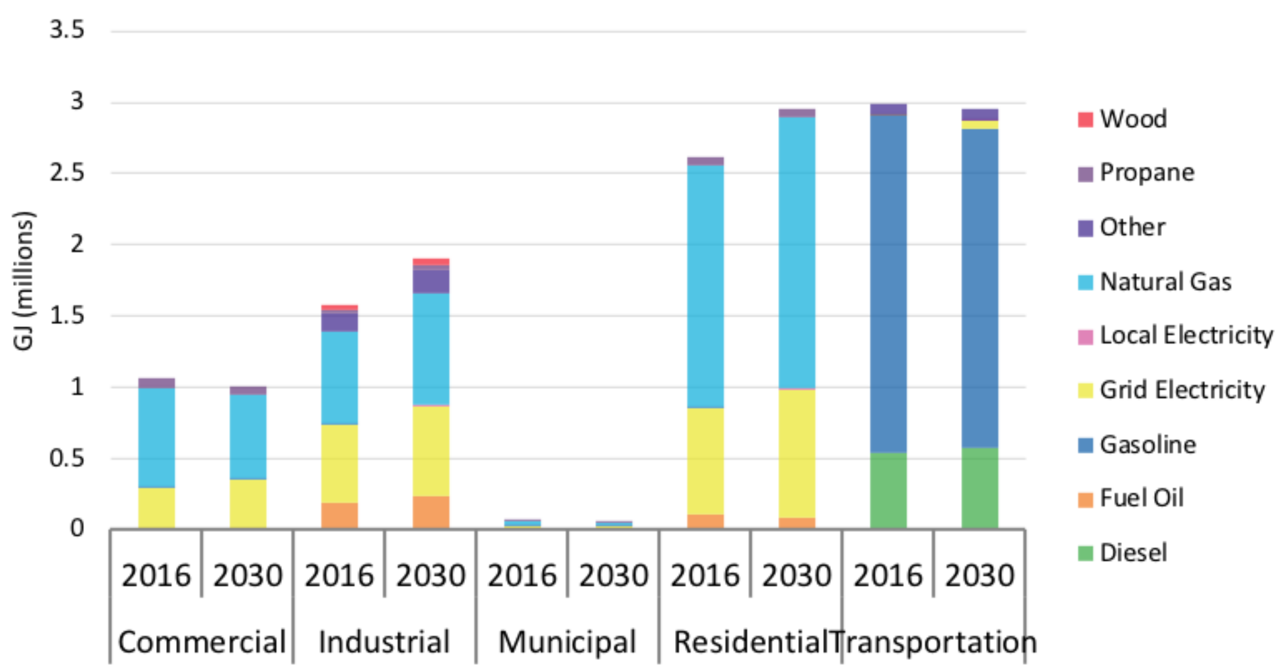


Figure 2. Energy consumption by fuel and by sector in 2016 and in a 2030 reference scenario.

As shown in Figure 3, building energy consumption is highest in areas with dense commercial, residential or industrial activity. This includes Georgetown, followed by zones in Acton, and zones along Highway 401. For transportation energy consumption in particular, zones surrounding the core of Georgetown have the highest

[16] This excludes all electrical energy and the combustion of wood biomass for energy.

VKT (Figure 4). This is likely because these areas have a greater population than the more rural regions, but are not within walking or cycling distance to their end locations.

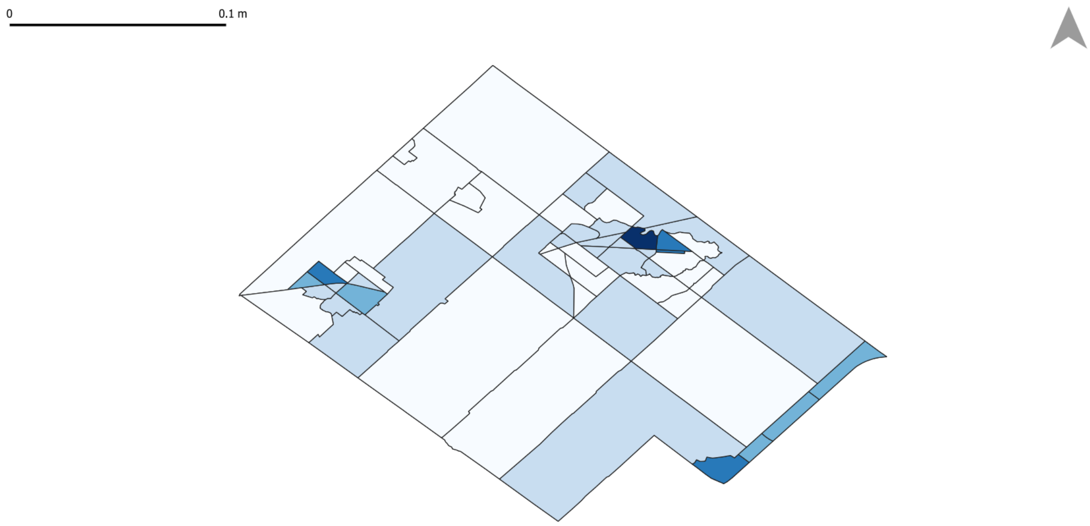


Figure 3. Total building energy consumption by zone, 2016 (GJ).

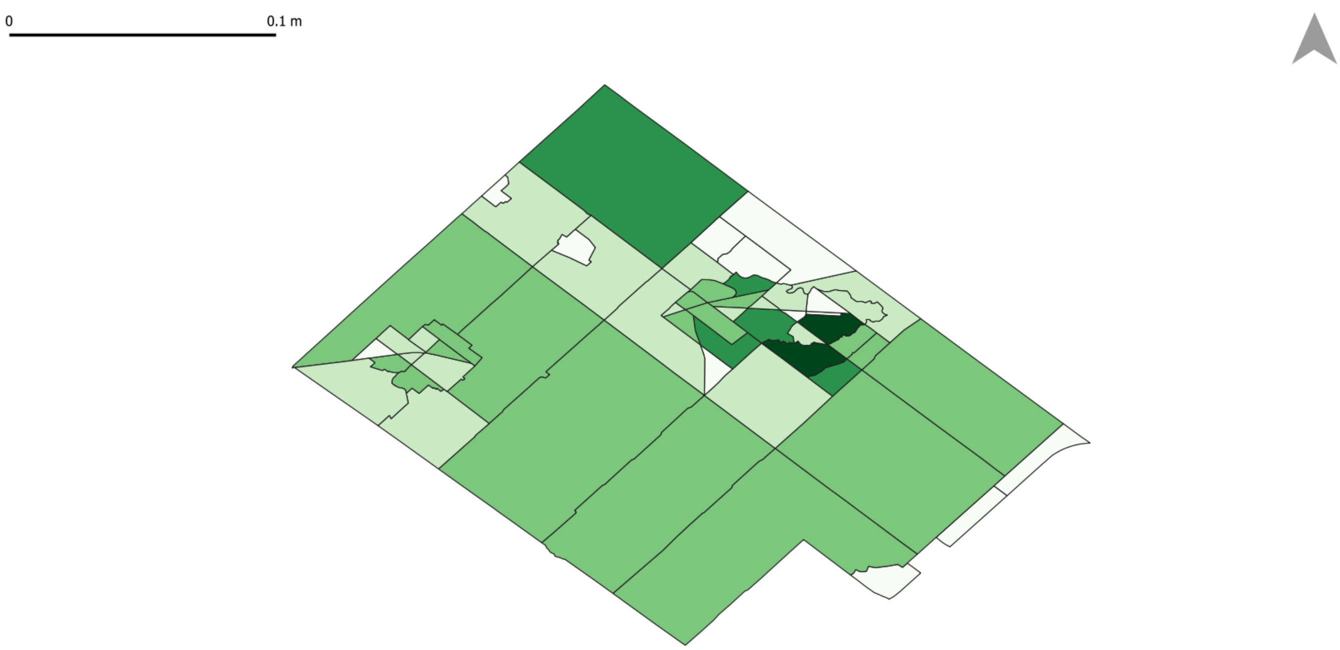


Figure 4. Personal use automobile VKT, 2016. VKT are associated with the zone where the trip originates.

4.2 Base Year Emissions, 2016

The above-noted energy activities—in addition to non-energy related emissions (i.e., waste, agricultural and fugitive emissions)—generate 457 kt CO2e of greenhouse gas emissions in 2016. This translates to about 7.2 tCO2e per person, including industrial emissions.

Per capita emissions in Halton Hills are higher than per capita emissions in the Greater Toronto and Hamilton Area as a whole (6.9 tCO2e/person), with per capita emissions in the City of Toronto at 5.5 tCO2e/person, and 7.9 tCO2e/person in the Region of Peel.[17] Compared to other municipalities in Canada with differing energy systems, Halton Hills per capita emissions are somewhere in the middle, with the City of Courtenay, BC emissions at 4.2 tCO2e/person, and emissions in the Halifax Regional Municipality are 13 tCO2e/person (this latter is high due to electricity generation from fossil fuels).

Emissions by sector are shown in Figure 5. The transportation sector is the largest energy consumer and makes up the largest share of emissions, at 49% of Halton Hills' total emissions.[18] This greater share of emissions from transportation reflects the greater emissions intensity of transportation fuels over those used in buildings—particularly grid electricity.

The second largest contributor to emissions is the residential sector (at 22% of total emissions). This is mostly from natural gas use, which is the primary source of building space and water heating in the Town of Halton Hills.

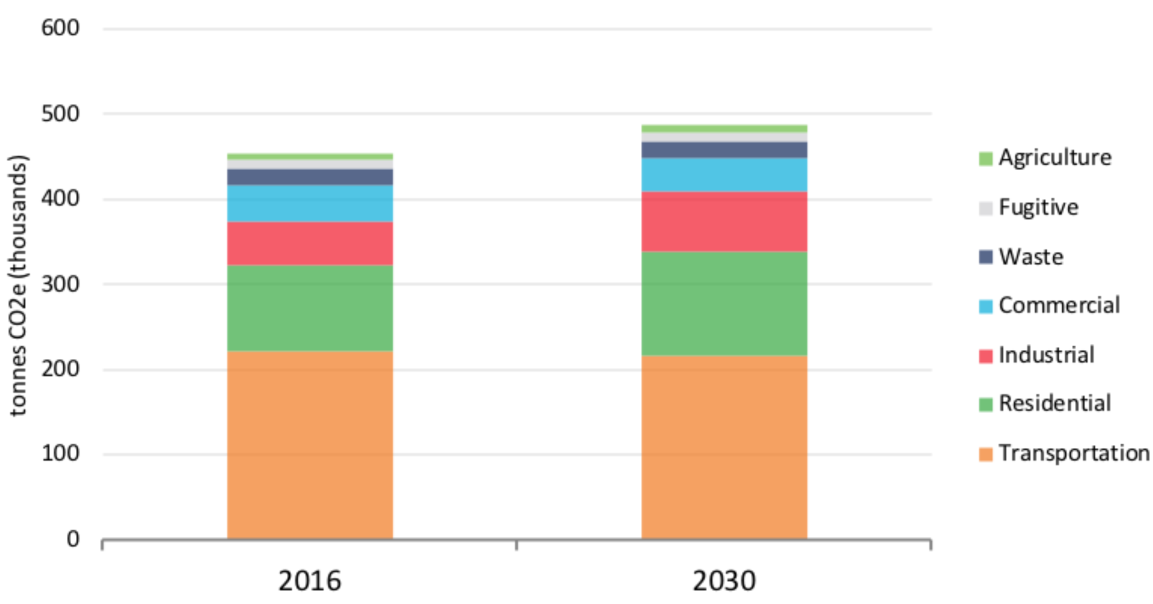


Figure 5. Town of Halton Hills emissions profile by sector in 2016 and in a 2030 reference scenario.

[17] The Atmospheric Fund. (2018). Keeping Track: 2015 Carbon Emissions in the Greater Toronto and Hamilton Area. Retrieved from: taf.ca/wp-content/uploads/2018/09/TAF_GTHA_Emissions_Inventory_Report_2018-Final.pdf.

[18] This value includes both on-road and off-road transportation.

As shown in Figure 6, emissions are the highest in the zone adjacent to Highway 401—an area with concentrated commercial, industrial and warehouse activities. This points to the intensity of emissions generated from industrial activities. Emissions are also generated in both the central and peripheral zones of Georgetown.

Emissions by sector are summarized in Figure 6.

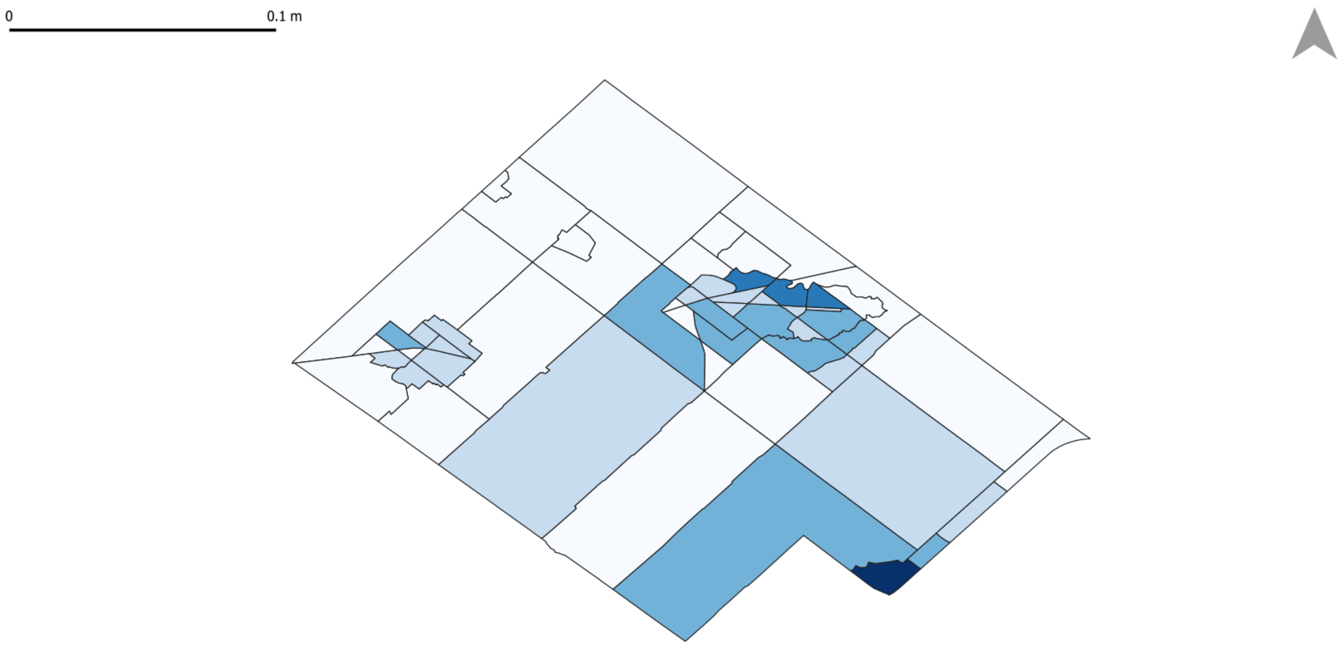


Figure 6. Emissions by zone, 2016 (tco2e).

5. Reference Scenario Results

5.1 Total Energy and Emissions, 2016-2030

In the reference scenario, total energy consumption increases by 6%, from 8.3 PJ in 2016 to 8.8 PJ in 2030.

The share of fuel consumption remains fairly constant in the Town's reference scenario. Natural gas remains the most consumed fuel in Halton Hills. There is a small decline in gasoline consumption and an increase in electricity from the uptake of electric vehicles.

Although total energy consumption increases slightly through to 2030, energy consumption per capita declines by 27%, from 132 GJ per person in 2016 to 97 GJ per person in 2030 (Figure 9). This is because increasing energy consumption related to population growth is being offset by improved vehicle efficiency, reductions in vehicle mode share, and building energy performance improvements.

The resulting emissions pattern is similar, with a 7% increase, from 457 ktCO2e to 489 ktCO2e. Per capita emissions also decline from 7.2 tCO2e per person, to 5.3 tCO2e.

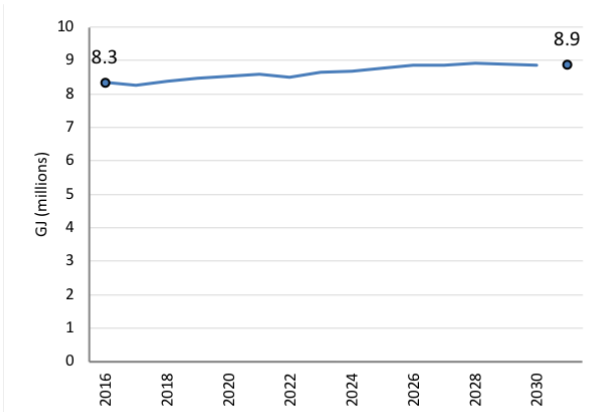
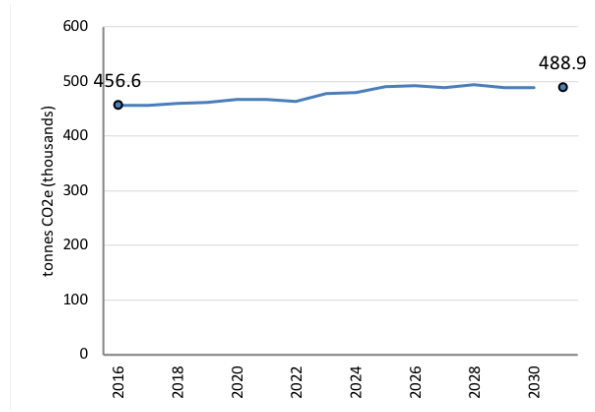
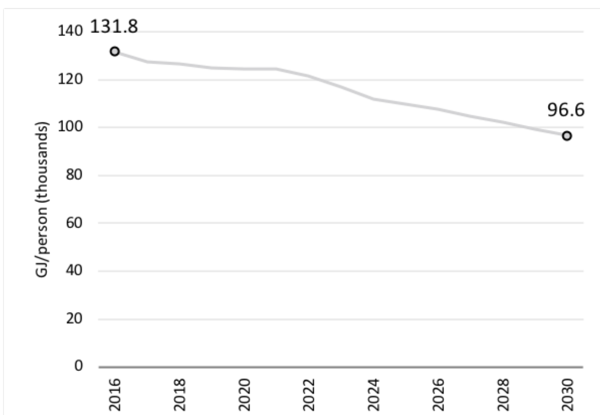
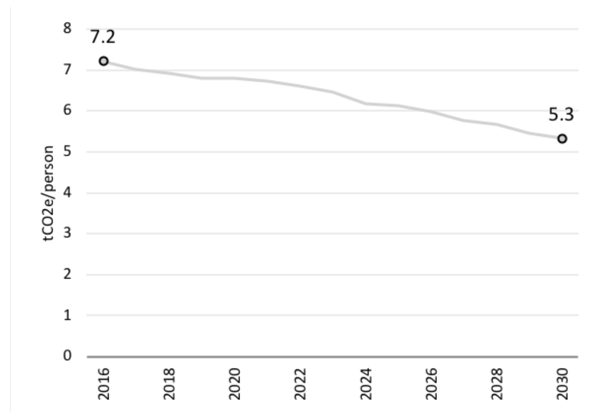
	Energy	Emissions
Total		
Per capita		

Figure 7. Total and per capita change in energy and emissions, 2016-2030.

The relative share of emissions from each sector varies only slightly from 2016 to 2030 (Figure 8). Sector trends are discussed in more detail below. This emissions growth is driven by population and employment growth projections, which outweigh any projected efficiency improvements and electrification.

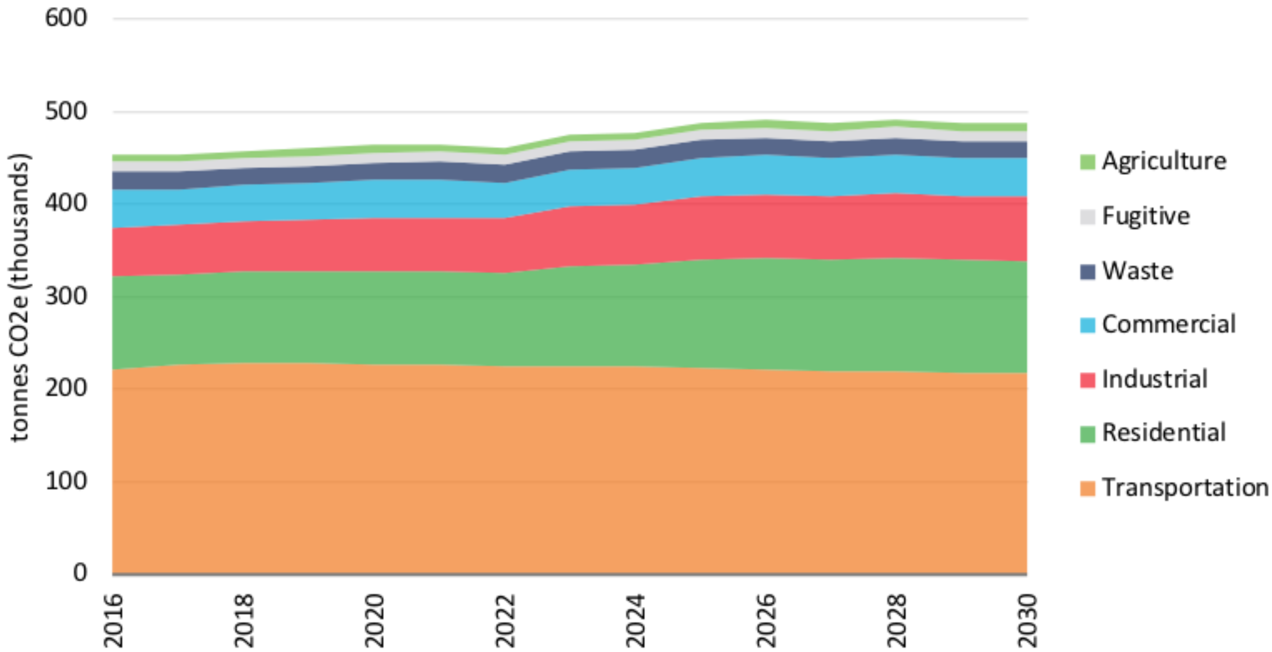


Figure 8. Emissions by sector, 2016-2030.

Similar to the base year, emissions are highest from zones in Georgetown, adjacent to Highway 401, and to a lesser extent in Acton (Figure 9).

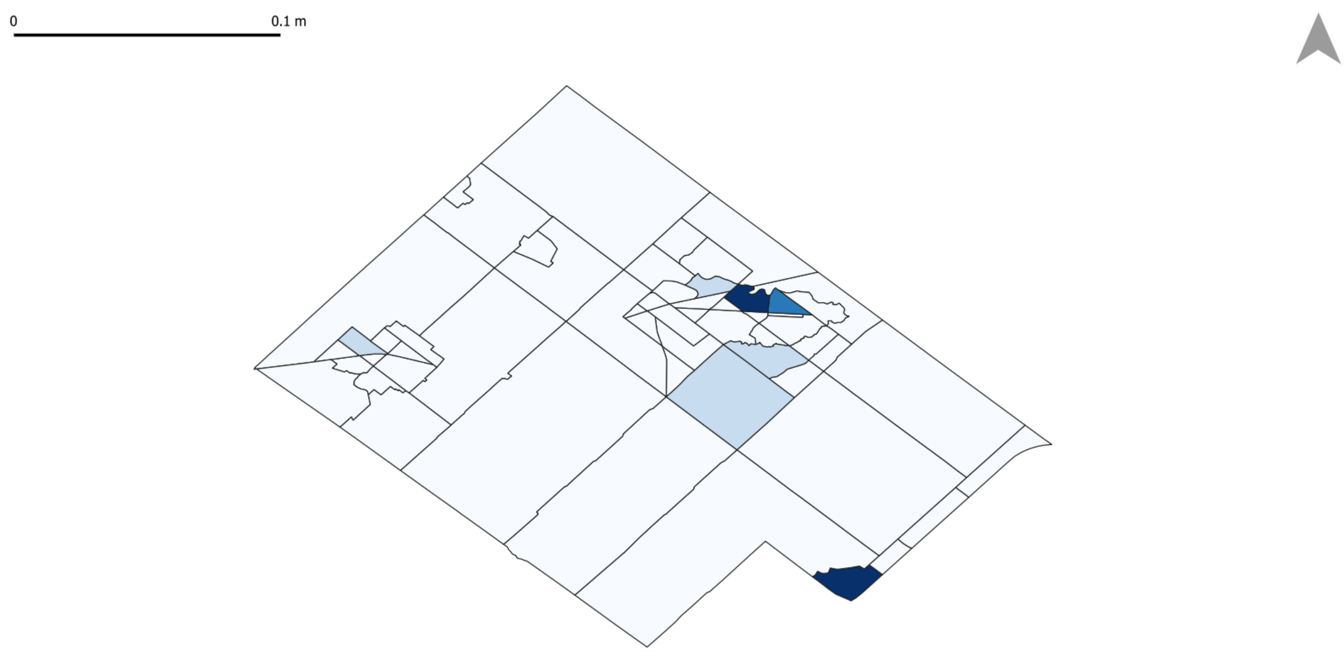


Figure 9. Emissions by zone, 2030.

5.2 Energy and Emissions, 2016-2030

Buildings

Space heating and industrial processes use the most energy, in 2016 and in 2030 (Figure 10). The industrial and residential sectors see increasing energy consumption between 2016 and 2030. The fact that the commercial sector experiences a decline is indicative of the relatively small projected employment growth over the period versus population growth, combined with projected improvements in energy efficiency.

Most of the energy demand is met by natural gas, particularly in the residential sector, but electricity and fuel oil are also used in the residential, commercial and industrial sectors (Figure 11).

Municipal buildings represent the smallest square footage, and in turn use comparatively less total energy than other building sectors. Their projected decline in energy use is due to the Town corporation's energy efficiency targets.

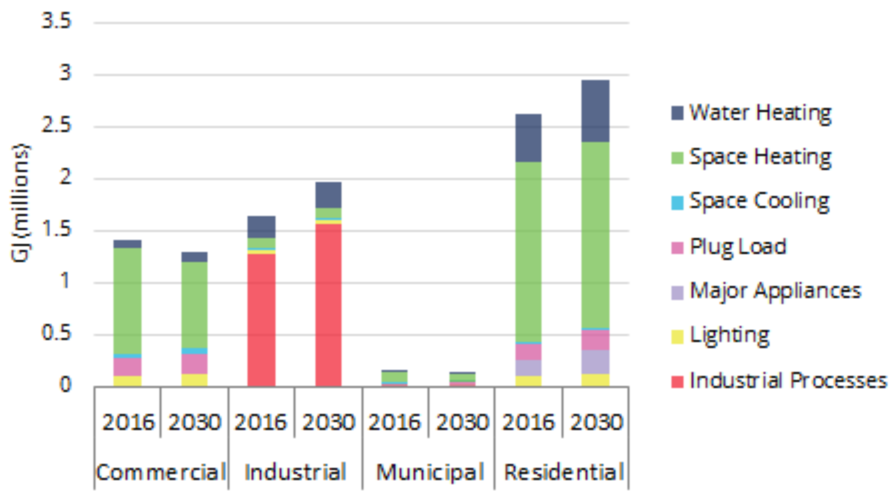


Figure 10. Energy consumption by sector and end use, 2016 and 2030.

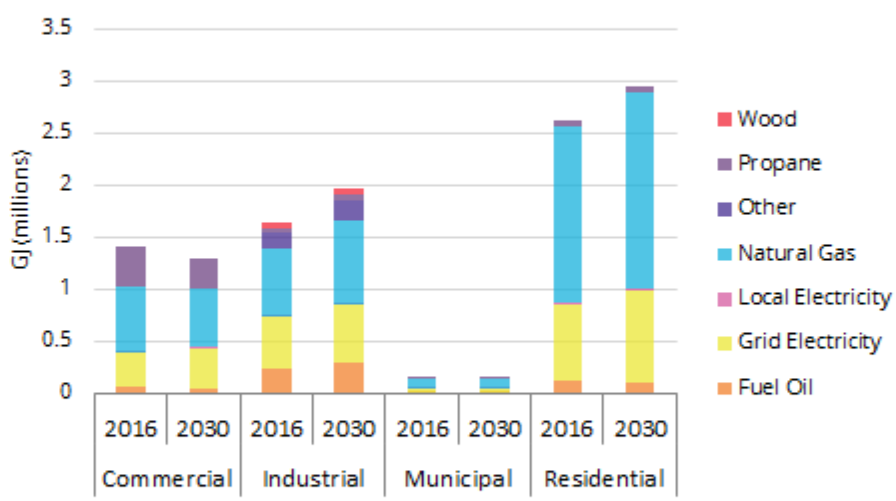


Figure 11. Energy consumption by sector and by fuel, 2016 and 2030.

This energy consumption pattern results in a similar emissions profile in both 2016 and 2030, where space heating and industrial processes are the largest contributors to emissions from buildings (Figure 12). The industrial sector sees the largest growth in emissions by 2030 (+38%), driven in part by sector growth related to employment projections, and its large reliance on carbon-intensive fuel oil. Emissions from the residential sector are also growing (+20%). Emissions from municipal buildings decline by 29%, and emissions from commercial buildings decline by 5% in the reference scenario.

Natural gas is the largest contributor to building emissions in 2016 and 2030 (Figure 13). Fuel oil is responsible for over half of industrial building emissions. Grid-supplied electricity has a lower emissions profile than other fuels, so its relative contribution to Halton Hills' emissions profile is smaller.

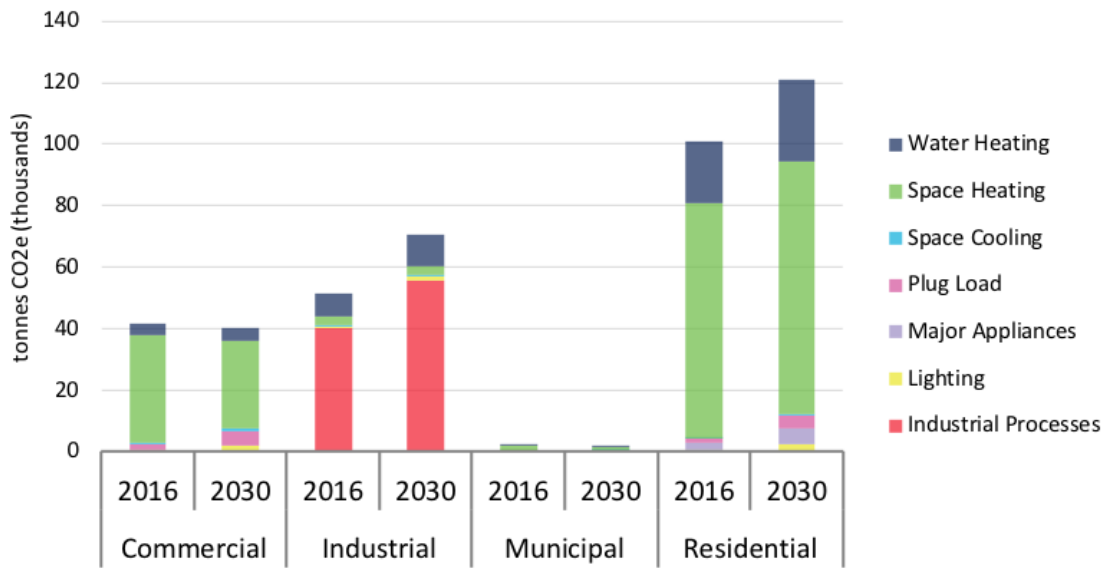


Figure 12. Building emissions by sector and by end use, 2016 and 2030.

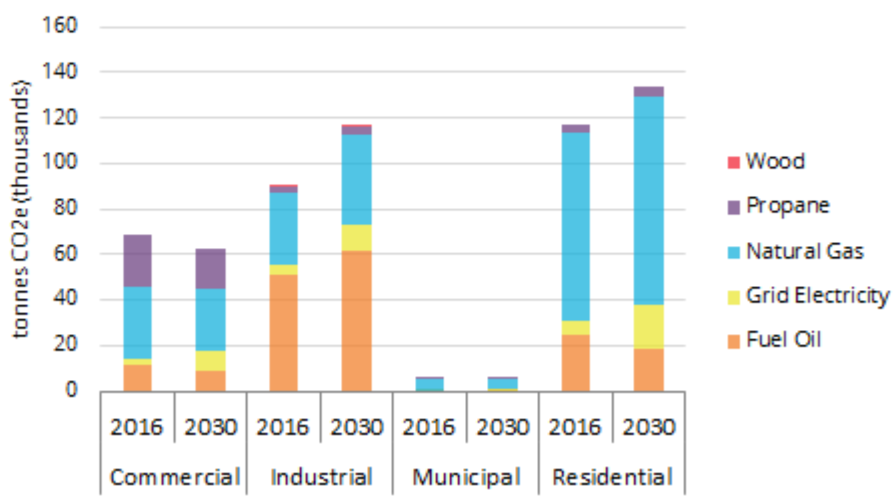


Figure 13. Building emissions by sector and by fuel.

5.3 Transportation

Transportation energy consumption remains dominated by personal use vehicles by the year 2030. Annual vehicle kilometres travelled (VKT) by personal use vehicles increases by nearly 0.2 billion between 2016 and 2030, increasing for trips within Halton Hills and for trips that leave or enter the Halton Hills boundary (Figure 14). Much of this growth in VKT is likely due to population increase in the Vision Georgetown development;[19] as shown in Figure 15, the Vision Georgetown zone has the highest VKT in all of Halton Hills in 2030.

This increase in automobile VKT is also accompanied by an increase in trips by other modes, most notably an increase in transit trips (Figure 16). In 2016, transit made up 5% of all trips; in 2030, transit makes up 11% of trips.

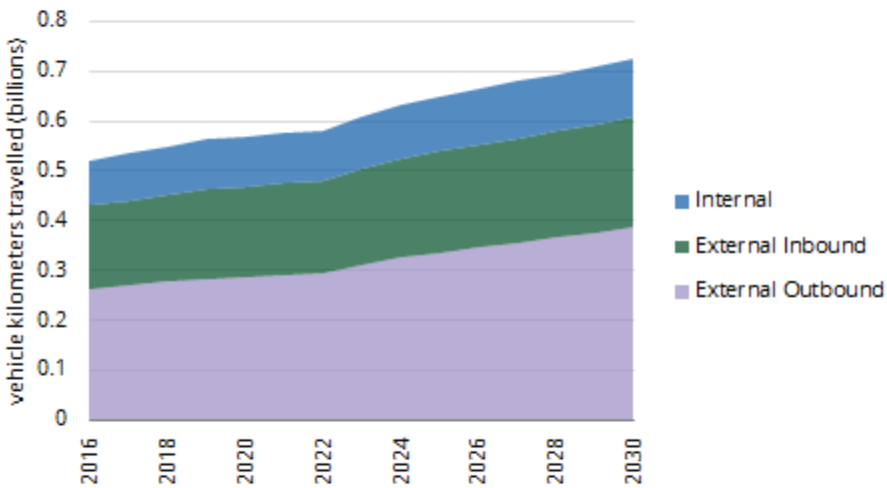


Figure 14. Personal use automobile VKT, 2016-2030.

[19] VKT is allocated to the zone of trip origin.

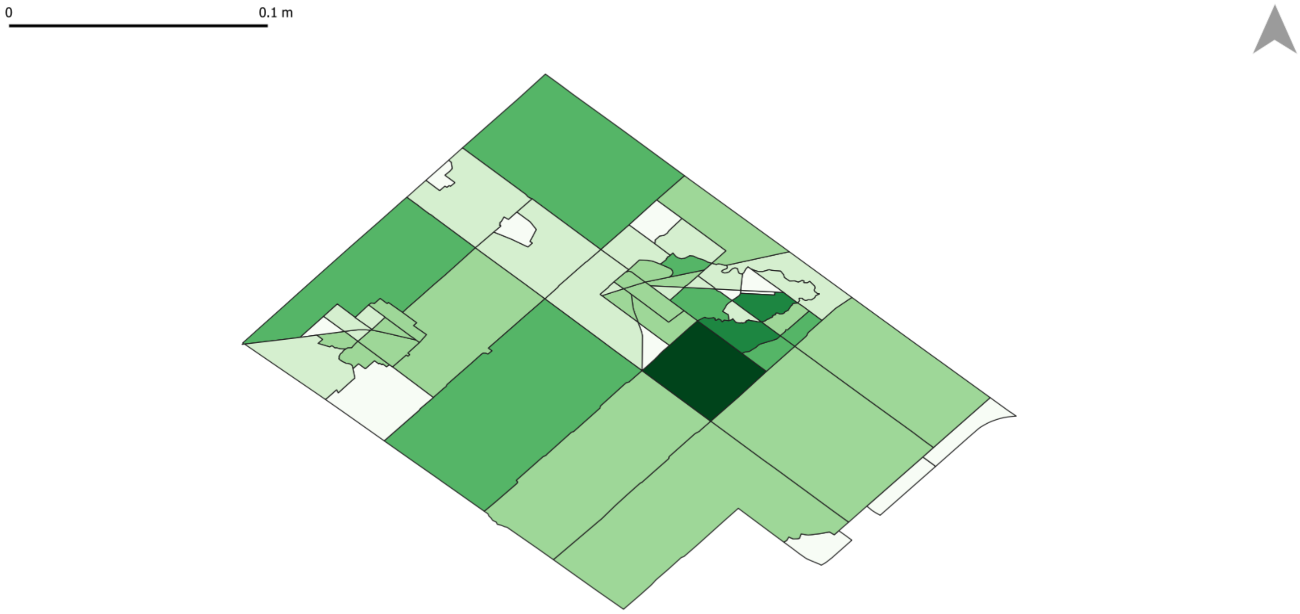


Figure 15. Map of VKT by zone, 2030.

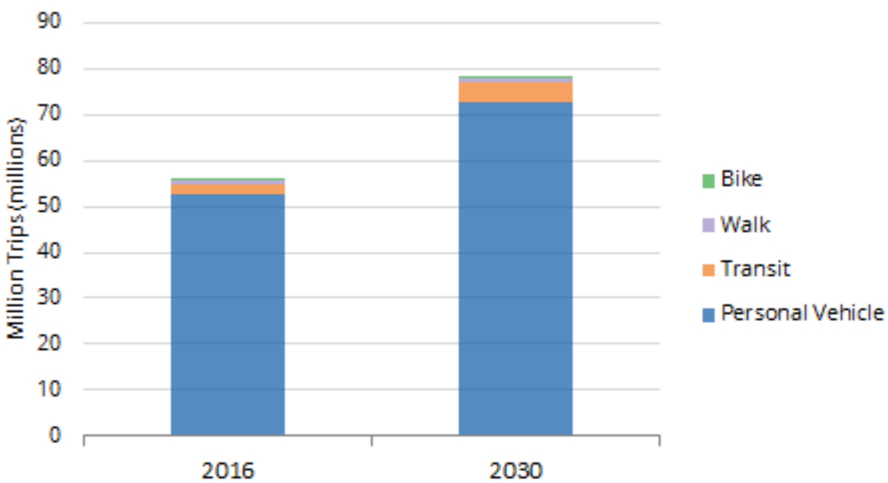


Figure 16. Number of trips by mode, 2016 and 2030.

In the base year, cars make up the largest segment of transportation fuel consumption, using predominantly gasoline (Figure 17). By 2030, light trucks will become the largest fuel consumers in 2030, reflecting trends in increasing truck market share. In 2030, electricity is projected to represent less than 1% of fuels consumed in the car and light truck classes, and is not consumed at all in heavy truck or urban bus classes.

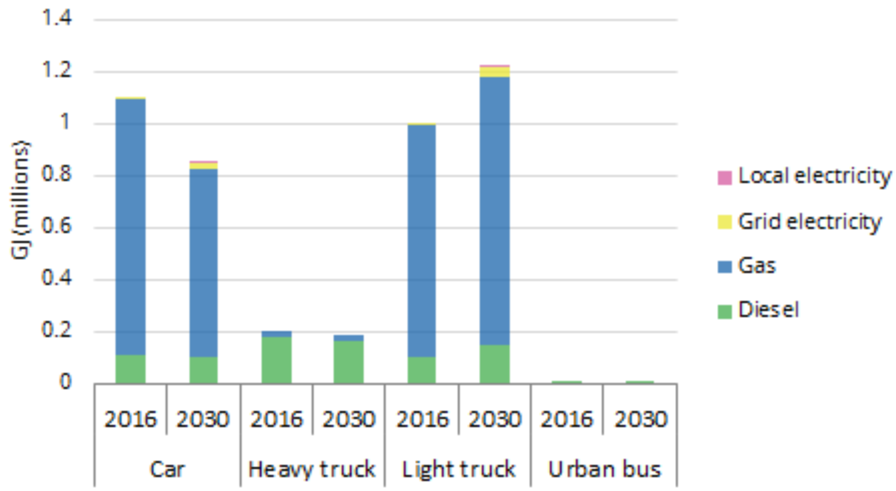


Figure 17. Energy consumption fuel vehicle class and fuel, in 2016 and 2030.

In both 2016 and 2030, emissions are predominantly from gasoline use. Emissions decline slightly by 4 ktCO2e (Figure 19). The decline is likely due to increasing use of electric vehicles for personal vehicle trips and increasing efficiency of combustion engine vehicles.

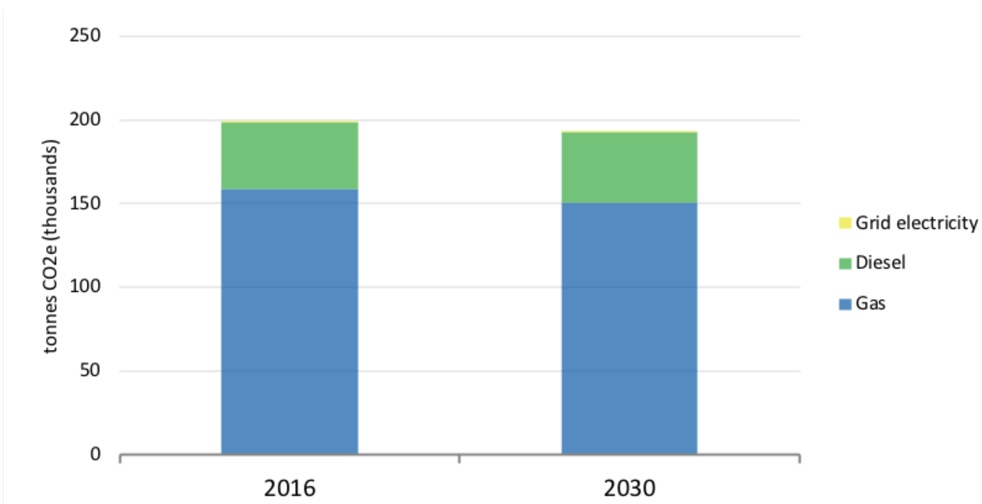


Figure 18. Transportation emissions by fuel, in 2016 and 2030.

5.4 Waste and Wastewater

Waste emissions decline slightly between 2016 and 2030 (Figure 19). This decline reflects an increasing organic waste diversion rate, which outweighs the projected increase in organic waste generation from a growing population.

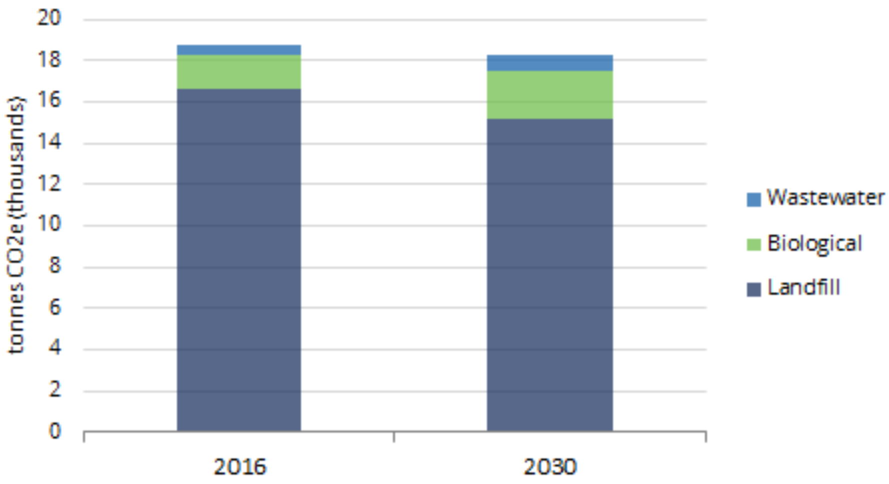


Figure 19. Waste and wastewater emissions, 2016 and 2030.

5.5 Other

The Reference Scenario also accounts for methane emissions from agricultural livestock. Agriculture makes up 2% of total emissions in Halton Hills. These emissions are expected to remain constant between 2016 and 2030.

6. Conclusions and Next Steps

Total emissions in the Town of Halton Hills are projected to marginally increase if no additional interventions are made. In the reference scenario, emissions from residential and industrial buildings increase, while all other sectors see small declines in emissions. Generally, total emissions increase is the result of its projected population growth, although per capita emissions do decline consistently between 2016 and 2030 from small gains in energy and waste efficiency. If no further action is taken, the Town is estimated to be 489 ktCO2e over its net-zero emissions target in the year 2030.

Ambitious action will be needed to reach its emissions reduction target. As transportation and residential buildings are the largest contributors to emissions, these sectors should be the focus of action, although emissions will need to be addressed in all sectors to achieve net zero emissions by 2030. These ambitious actions to reduce emissions will be modelled in the net-zero scenario.

Reference Scenario Results Summary Tables

Table A1. Energy by Sector (GJ).

Sector	2016	%	2030	%
Commercial	1,071,601	13%	1,011,348	11%
Industrial	1,584,413	19%	1,909,620	22%
Municipal	72,446	1%	48,324	1%
Residential	2,620,586	31%	2,953,881	33%
Transportation	2,992,639	36%	2,950,082	33%
Total	8,341,685	100%	8,873,255	100%

Table A2. Energy consumption by fuel (GJ).

Fuel	2016	%	2030	%
Diesel	537,183	6%	572,641	6%
Fuel Oil	313,369	4%	330,815	4%
Gasoline	2,369,554	28%	2,244,737	25%
Grid Electricity	1,601,633	19%	1,955,460	22%
Local Electricity	18,058	0%	24,283	0%
Natural Gas	3,081,390	37%	3,296,448	37%
Other	214,901	3%	242,000	3%
Propane	168,676	2%	160,996	2%
Wood	36,920	0%	45,874	1%
Total	8,341,685	100%	8,873,255	100%

Table A3. Energy by end-use (GJ).

End Use	2016	%	2030	%
Industrial Processes	1,207,854	14%	1,503,644	17%
Lighting	250,545	3%	284,616	3%
Major Appliances	167,168	2%	227,029	3%

Plug Load	336,133	4%	409,628	5%
Space Cooling	80,262	1%	101,118	1%
Space Heating	2,562,879	31%	2,470,512	28%
Transportation	2,992,639	36%	2,950,082	33%
Water Heating	744,205	9%	926,626	10%
Total	8,341,685	100%	8,873,255	100%

Table A4. Energy by sector and fuel (GJ).

Sector	year	Diesel	Fuel Oil	Gasoline	Grid Elec.	Local Elec.	Natural Gas	Other	Propane	Wood
Commercial	**2016**	0	9,819	0	287,343	3,240	697,954	0	73,246	0
	2030	0	8,880	0	345,546	4,291	594,114	0	58,516	0
Industrial	**2016**	0	188,430	0	547,351	6,171	645,006	129,035	31,499	36,920
	2030	0	234,356	0	634,603	7,881	787,522	160,328	39,057	45,874
Municipal	**2016**	0	340	0	28,775	324	40,101	0	2,906	0
	2030	0	288	0	23,551	292	22,623	0	1,571	0
Residential	**2016**	0	114,780	0	738,128	8,322	1,698,330	0	61,025	0
	2030	0	87,290	0	901,356	11,193	1,892,189	0	61,852	0
Transportat-ion	**2016**	537,183	0	2,369,554	37	0	0	85,865	0	0
	2030	572,641	0	2,244,737	50,405	626	0	81,673	0	0

Table A5. Fuel by on-road vehicle class (GJ).

Vehicle	year	Diesel	Gas	Grid electricity	Local electricity
Car	**2016**	107,235	1,029,532	20	0
	2030	102,205	756,560	18,230	226
Heavy truck	**2016**	179,821	24,908	0	0
	2030	168,806	23,417	0	0
Light truck	**2016**	316	0	0	0
	2030	1,580	0	0	0

Urban bus	2016	99,887	931,044	17	0
	2030	150,947	1,075,676	32,175	400

Table A6. Emissions by sector (tCO2e).

Sector	2016	%	2030	%
Agriculture	8,083	2%	8,083	2%
Commercial	41,721	9%	40,414	8%
Fugitive	10,754	2%	11,014	2%
Industrial	51,683	11%	70,846	14%
Municipal	2,411	1%	1,714	0%
Residential	101,151	22%	121,085	25%
Transportation	221,704	49%	217,032	44%
Waste	19,064	4%	18,667	4%
Total	456,571	100%	488,856	100%

Table A7. Emissions by fuel (tCO2e).

Fuel	2016	%	2030	%
Diesel	39,613	9%	42,180	9%
Fuel Oil	22,291	5%	23,538	5%
Gasoline	158,853	35%	150,551	31%
Grid Electricity	14,330	3%	41,230	8%
Jet Fuel	23,238	5%	23,238	5%
Natural Gas	149,970	33%	160,436	33%
Non Energy	37,900	8%	37,764	8%
Propane	10,317	2%	9,847	2%
Wood	58	0%	72	0%
Total	456,571	100%	488,856	100%