Context & Greenhouse Gas Inventory Report

Prepared for the City of Vaughan Municipal Energy Plan Revision

April 2022

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Units of Measurement in this Analysis

GHG emissions	Energy
1 ktCO2e = 1,000 tCO2e	**1 PJ = 1,000,000 GJ**
One kilotonne (kt) of carbon dioxide equivalent (CO_2e) is equal to one thousand tonnes (t) of CO_2e.	One petajoule is equal to one million gigajoules.

To compare fuels on an equivalent basis, all energy is reported as units of energy content, primarily as petajoules (PJ), or sometimes as gigajoules (GJ). Emissions are characterized as kilotonnes of carbon dioxide equivalent ($ktCO_2e$). These measures can be characterized as follows:

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

Data provided by the United States Environmental Protection Agency

Contents

SECTION ONE

An Introduction to Vaughan

Municipal Energy Plan Revision

The City of Vaughan is conducting a comprehensive Municipal Energy Plan (MEP) Revision to provide a low-carbon transition strategy for the city. The plan will inform the Official Plan Review, underway to update the Vaughan Official Plan 2010. The updated Official Plan will guide the City's growth and development up to the year 2051.

The MEP revision builds on Vaughan's previous and ongoing environmental initiatives, including *Green Directions Vaughan (2019)*, the *2016 Municipal Energy Plan,* and the *Sustainability Metrics* program.

The MEP revision is identified as a specific action in the Climate Emergency Declaration endorsed by Council in June 2019. The plan aligns with the target set out in Council declaration to reach 2 to 3 tonnes of carbon dioxide equivalent tonnes (tCO2e) of GHG emissions per person by 2030 and net-zero by 2050.

About Vaughan

Vaughan is a city located in York Region, a part of the Greater Toronto Area, and the Greater Golden Horseshoe area of southern Ontario.

For the last 35 years, Vaughan has been one of Canada's fastest-growing municipalities. This trend is expected to continue until at least the 2051 planning horizon.

The city will continue to transition from a primarily suburban environment to an urban context, placing increasingly greater reliance on transit-supportive **intensification** and higher **density**, mixed-use forms of development to accommodate its growth.

Vaughan's transformation to an urban municipality will shift the nature of energy use in its residential, commercial, industrial, and transportation sectors.

Density is the number of people or jobs per unit of land, and **intensification** is an increase in density.

Community Demographics (2016)

Demographics are an important consideration in understanding current energy use and emissions.

With regard to the greenhouse gas (GHG) emission baseline, demographic data allows for measuring energy use and emissions per capita, which is useful for comparing communities and jurisdictions.

Understanding the projected demographic changes allows for predicting how energy use and emission patterns may change over time, while taking into account current policies and practices.

Population

317,176

Households

88,741

Personal vehicles

192,404

Full-time equivalent jobs*

226,896

* Located in Vaughan

SECTION TWO

Developing a Greenhouse Gas Emissions Inventory

What is a Greenhouse Gas Inventory?

GHG inventories identify the major sources of GHG emissions within a defined scope.

For Vaughan, community-wide emissions are defined within the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) BASIC+ scope.

The BASIC+ scope includes emissions from sources including stationary fuel combustion (e.g. energy for use in buildings), transportation, waste, wastewater, industrial processes, and agriculture and forestry activities.

Inventories can serve as a baseline to help communities evaluate the sources and scale of current emissions, and to develop an action plan to reduce them.

They can also serve as a check-in if a reduction target and action plan have already been developed.

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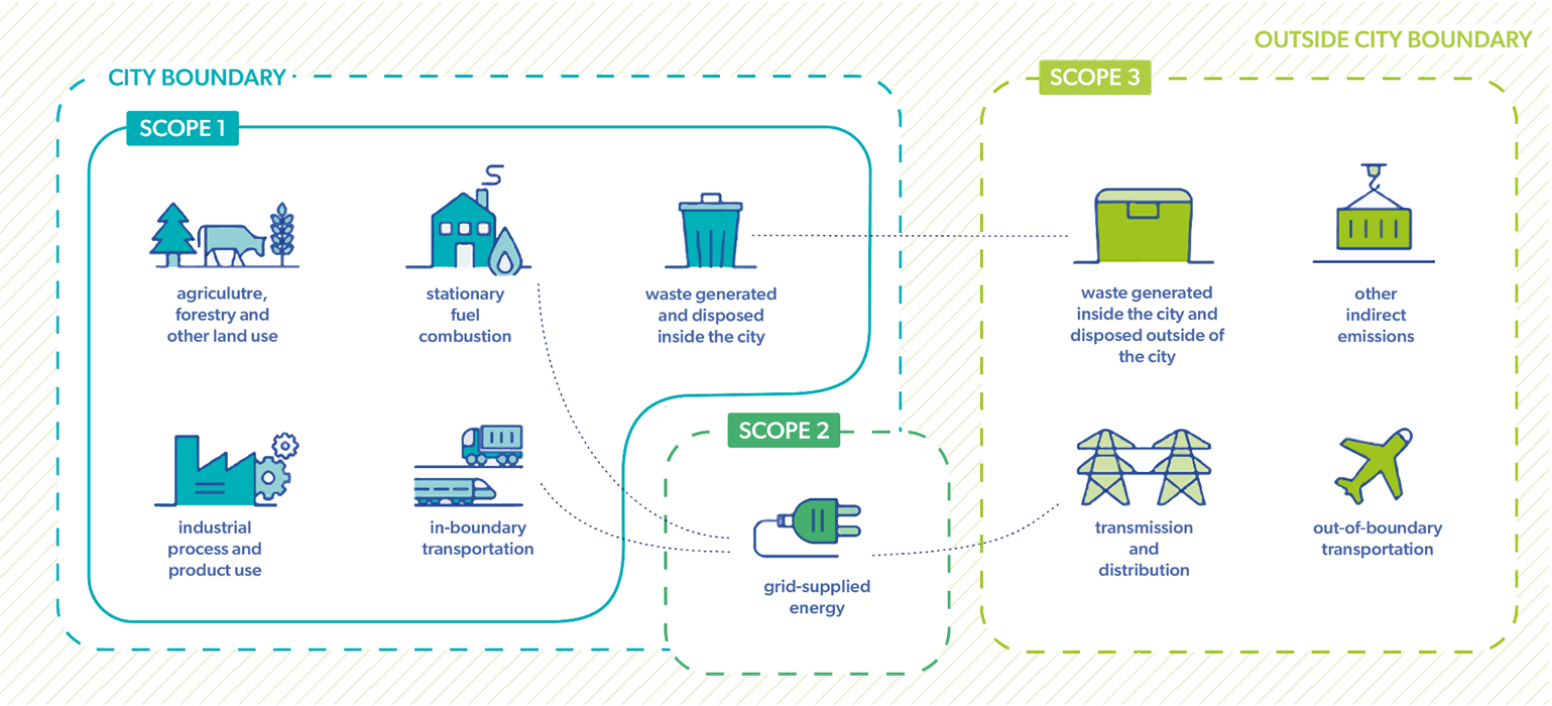
BASIC+ Emissions Accounting



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Greenhouse Gas Inventory - Key Outcomes

Analyzing the 2016 baseline inventory for the City of Vaughan is instrumental in understanding the nature of its recent energy use and the resulting community emission patterns and sources.

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Key Outcomes

The GHG inventory results, as well as the review of local context and best practices, allow the City and the MEP Revision consultants to develop two scenarios:

Business-as-planned scenario: A time-bound and spatial scenario that identifies how energy and emissions may change over time, based on the current and planned policies and practices and the projected demographic changes.

Low-carbon scenario: A time-bound and spatial scenario that identifies actions that will lead to a low-carbon future, typically based on a goal determined by the community.

SECTION THREE

Community Energy Consumption

Overview

Community Energy Use, 2016

Total Community Energy Use

~50,000,000 GJ or ~50 PJ

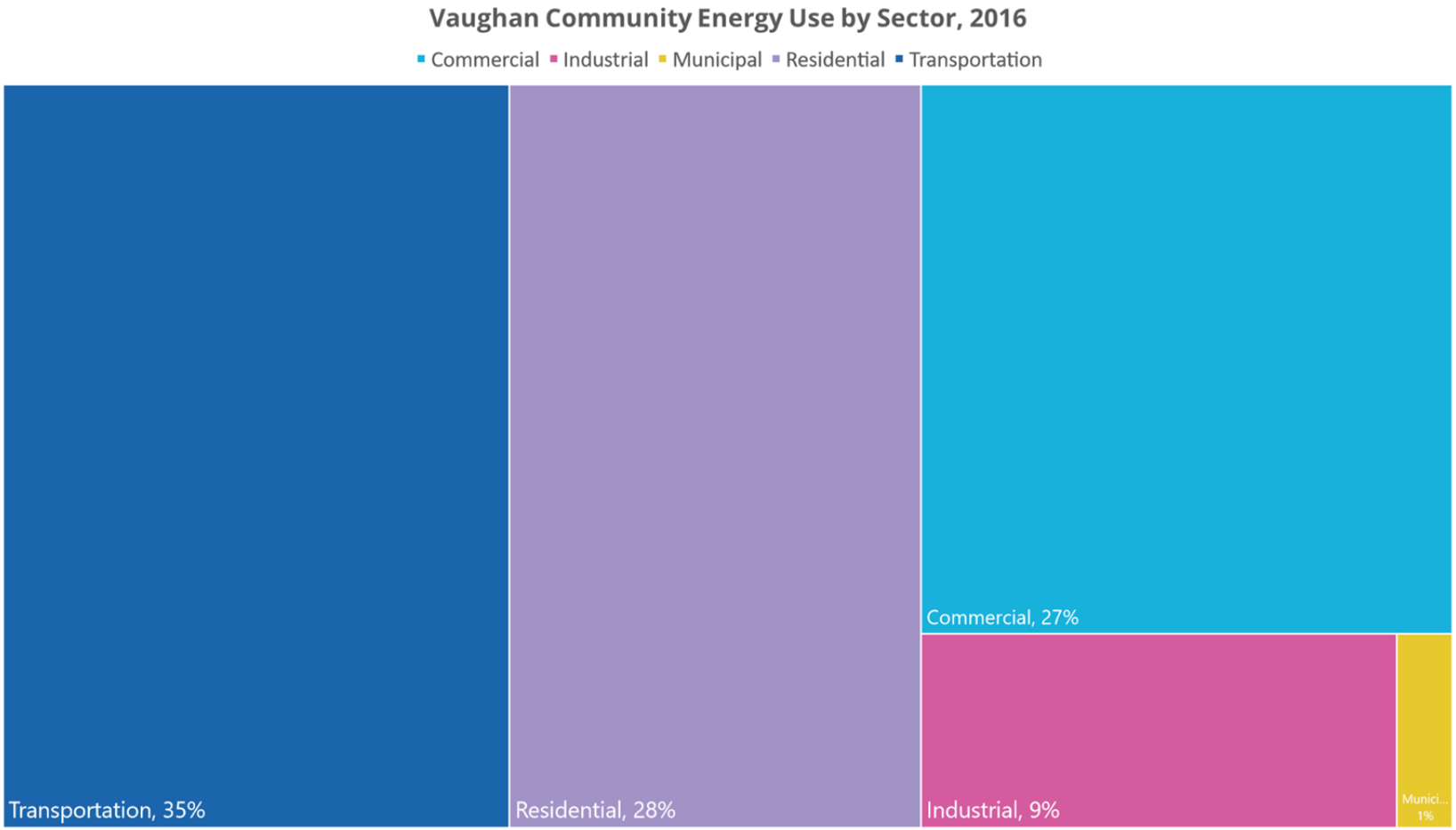
Community Energy Use Per Capita

158 GJ/person

Total community energy use is equivalent to taking nearly 3,400 tourist tours to space in a modern space rocket.

Figure 1

Total Community Energy Use by Sector, 2016


Vaughan Community Energy Use by Sector, 2016
Commercial
Industrial
Municipal
Residential
Transportation
Transportation, 35%
Residential, 28%
Commercial, 27%
Industrial, 9%
Munici...
1%

Community Energy Use

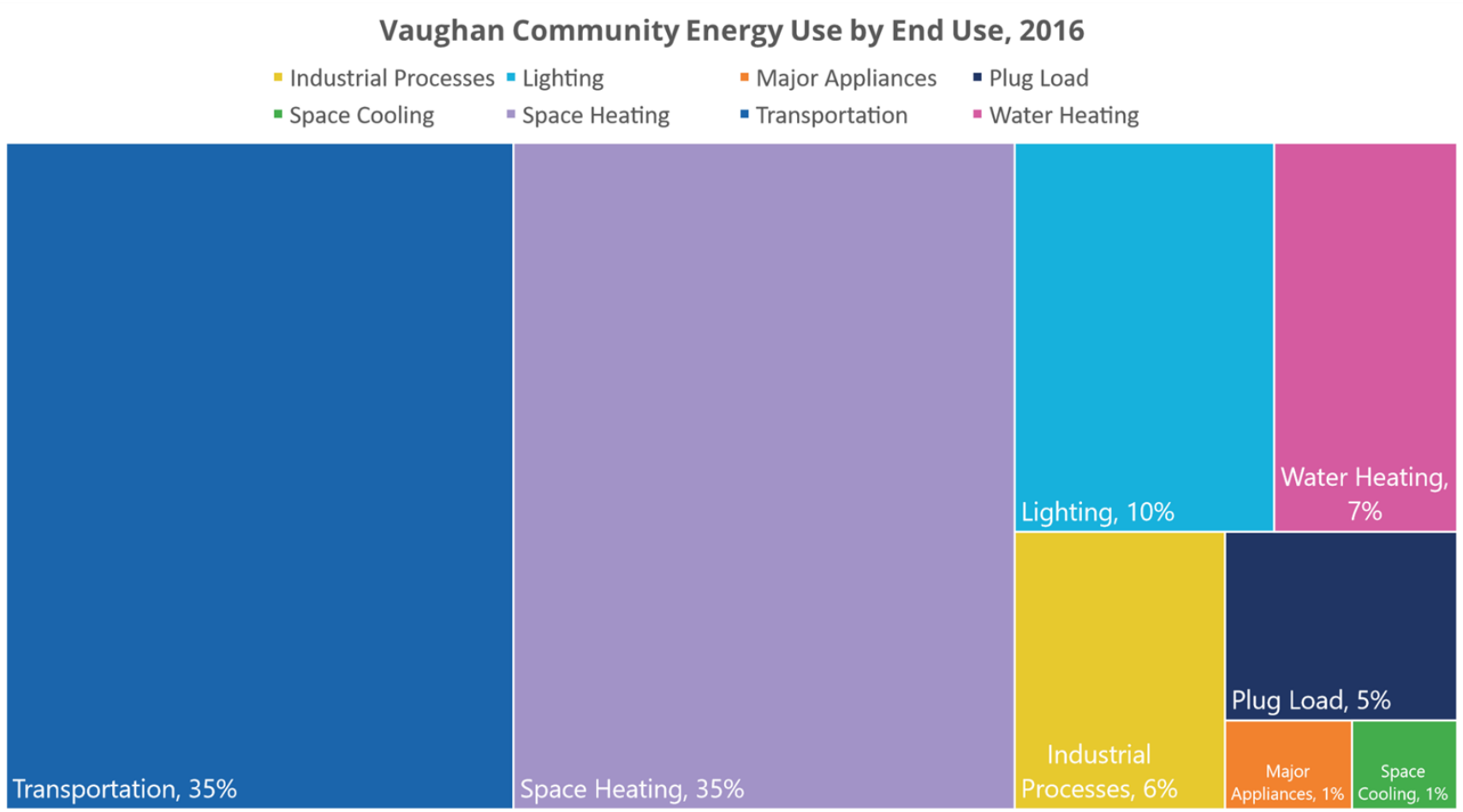
Total energy consumption in Vaughan was approximately **50 PJ** in 2016.

Taken together, **the top three energy-consuming sectors—residential, commercial, and transportation—accounted for 90% of total energy use**.

Municipal energy use, which includes operation of municipal buildings and facilities such as arenas and pools, and city fleet vehicles such as snow plows and parks and recreation services vehicles, made up 1% of total energy use in the community. The City of Vaughan has direct control over this energy use.

Figure 2

Total Community Energy Use by End Use, 2016


Vaughan Community Energy Use by End Use, 2016
Industrial Processes
Lighting
Major Appliances
Plug Load
Space Cooling
Space Heating
Transportation
Water Heating
Transportation, 35%
Space Heating, 35%
Lighting, 10%
Water Heating, 7%
Industrial Processes, 6%
Plug Load, 5%
Major Appliances, 1%
Space Cooling, 1%

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Community Energy Use by End Use

Activities that largely occur in buildings, including space heating, lighting, water heating, industrial processes, plug load, major appliance use, and space cooling **accounted for 65% of energy use in Vaughan in 2016.**

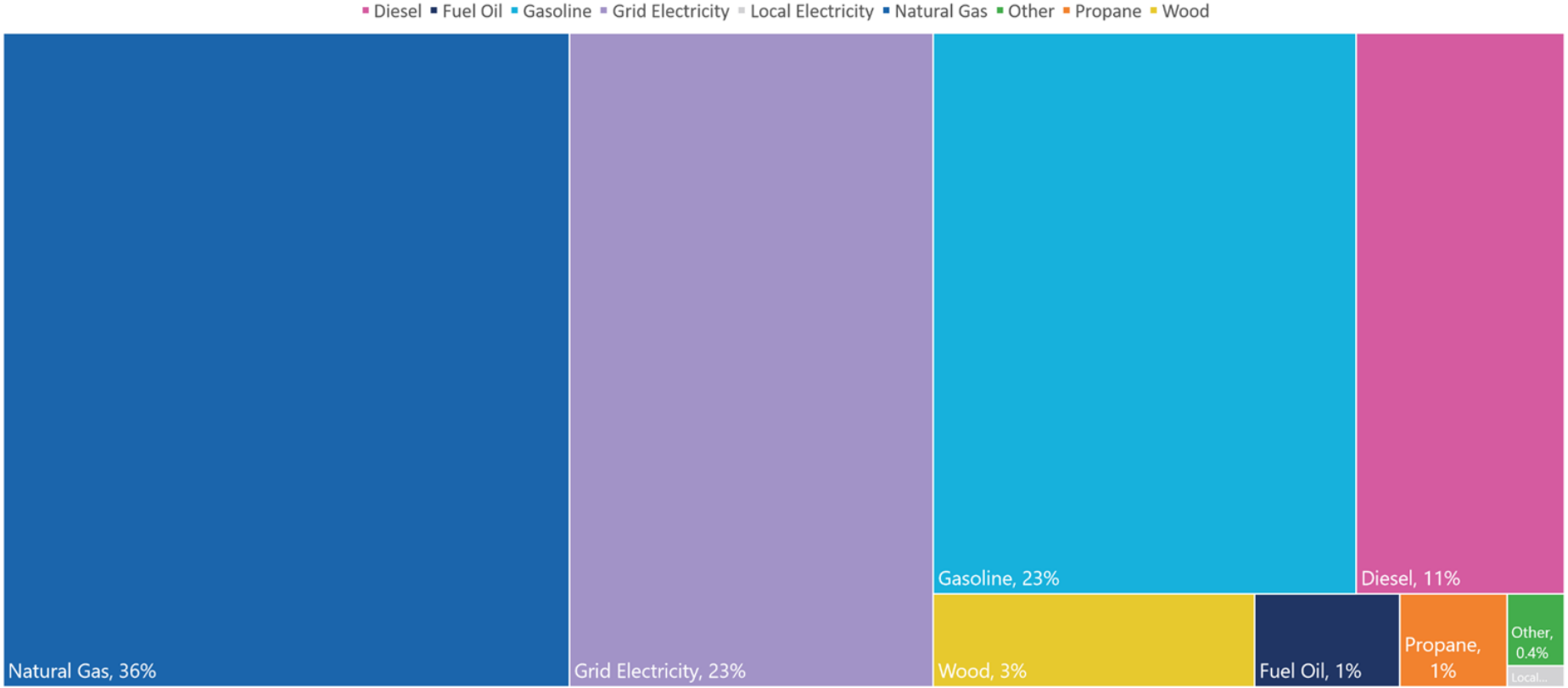
Space heating stands out as a major source of energy use at 35% of total community energy use.

The remaining **35% of energy use results from transportation.**

Figure 3

Community Energy Use by Fuel Type, 2016

Vaughan Community Energy Use by Fuel Type, 2016



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Community Energy Use by Fuel Type

Vaughan was powered mostly by natural gas in 2016, with over one-third (18.1 PJ) of community energy use coming from this source. It was mostly used for heating buildings and water, and for powering appliances.

Grid electricity use was also significant, making up nearly a quarter of energy use in the community. It was mostly used in buildings for lighting, plug load, heating, cooling, and appliance use.

Gasoline contributed to 23% of community energy use, while diesel contributed 11%.

Wood, propane, fuel oil, and local electricity from renewables contributed marginally to overall community energy use.

SECTION FOUR

Community Greenhouse Gas Emissions

Overview

Community Greenhouse Gas Emissions, 2016

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Total Community GHG Emissions

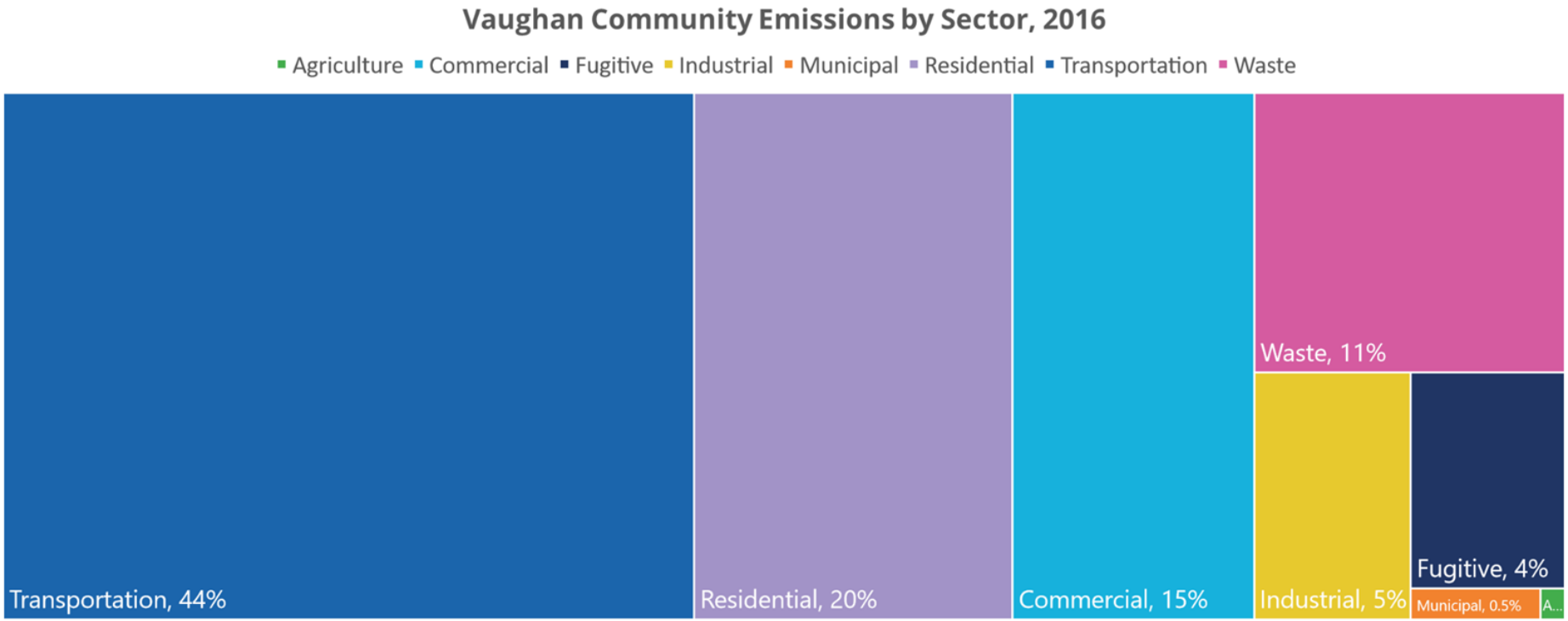
~2690 $ktCO_2e$

Community GHG Emissions Per Capita

~8.5 tCO_2e/person

GRAPH 5

Community Greenhouse Gas Emissions by Sector, 2016


Vaughan Community Emissions by Sector, 2016
Agriculture
Commercial
Fugitive
Industrial
Municipal
Residential
Transportation
Waste
Transportation, 44%
Residential, 20%
Commercial, 15%
Waste, 11%
Industrial, 5%
Fugitive, 4%
Municipal, 0.5%
A...

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Community Emissions by Sector

Vaughan's total community emissions in 2016 were approximately **2,690 ktCO_2e.**

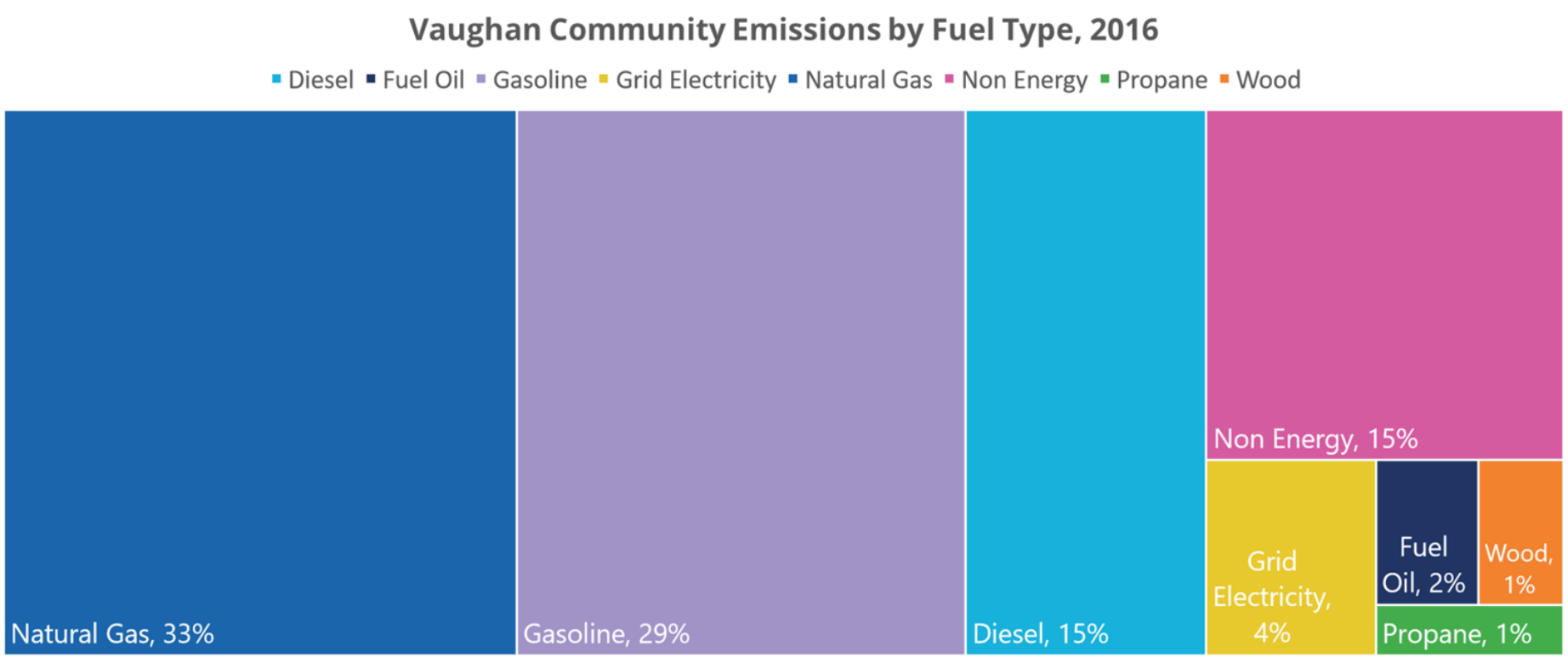
The largest source of emissions in Vaughan is the transportation sector, at 44% of total community emissions. This outsizes the 35% of total community energy use from this sector.

The residential, commercial, and waste sectors are also significant sources of emissions, totalling 20%, 15%, and 11% of community emissions, respectively.

Fugitive emissions make up 4% of total community emissions and result largely from methane escape as natural gas is transported and distributed.

GRAPH 6

Community Emissions by Fuel Type, 2016


Vaughan Community Emissions by Fuel Type, 2016
Diesel
Fuel Oil
Gasoline
Grid Electricity
Natural Gas
Non Energy
Propane
Wood
Natural Gas, 33%
Gasoline, 29%
Diesel, 15%
Non Energy, 15%
Grid Electricity, 4%
Fuel Oil, 2%
Wood, 1%
Propane, 1%

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Community Emissions by Source

Natural gas use accounts for one-third of community emissions, aligning with the 36% of community energy use allocated to natural gas.

Grid electricity, on the other hand, makes up 4% of emissions, while accounting for 23% of community energy use. This means that it has a lower overall emissions factor than natural gas.

Gasoline and diesel account for 29% and 15% of emissions, respectively, which is slightly more than their corresponding energy use, at 23% and 11%.

Waste is a non-energy source of emissions in the community, making up a notable share of community emissions at 11%.

SECTION FIVE

Greenhouse Gas Inventory Summary & Context Review

Vaughan's communities are constantly growing and changing. Vaughan is one of the fastest growing cities in Canada with a population of 341,600 people and 240,100 jobs in 2021. Vaughan will be home to 570,400 people by 2051 and total employment will grow to 351,500 jobs.

With this growth Vaughan will continue to urbanize.

Vaughan's urban transition will require higher-density, mixed-used forms and transit-supportive intensification to accommodate future growth

This will shift how the community uses energy, and present opportunities—as well as barriers—to achieving its low-carbon emission goals.

A recommendation in the Declaration endorsed by Council states that the planned update of the MEP should identify strategies that will reduce the community's GHG emissions to 2-3 t CO_2e per capita by 2030.

In June 2019, Vaughan City Council endorsed a City of Vaughan Climate Emergency Declaration.

The declaration recognizes the determination of the Intergovernmental Panel on Climate Change that urgent and transformative action needs to occur between now and 2030 to limit the average global temperature increase to 1.5°C.

Additionally, the Declaration recognizes the C40 Cities' determination that to remain within the 1.5°C threshold, their average per capita emissions need to be reduced to 2.9 tCO_2e per capita by 2030.

The C40 target is now being adopted by local governments outside the C40 group to match the ambition of these leading global cities.

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Vaughan's 2030 target aligns with a fair-share carbon budget target, the global best practice for GHG emission reductions.

A fair-share carbon budget target approach emphasizes a greater responsibility of wealthy nations and their local communities to reduce emissions in the short term, due to: their relative wealth; equity concerns around development opportunities for less wealthy nations and their capacity to respond to the current climate crisis; and a recognition that wealthier places have disproportionately contributed to and benefitted from activities that have led to the current climate crisis.

Fair-share targets aim to ensure wealthier countries and jurisdictions reach 2.9 tCO2e per capita by 2030 or earlier.

Growing cities need to address emissions from today's assets and infrastructure, as well as those that will be built for or come along with a growing population.

In 2016, Vaughan's emissions were approximately 8.5 tonnes of CO_2e per person. This is lower than the average national and provincial per capita emissions.

The gap between Vaughan's current emissions and its 2030 target, combined with the city's projected growth, presents both an opportunity and a challenge.

The community must address emissions from current assets, including buildings and vehicles in the city, as well as the new assets that come along with and need to be built for a growing population, including buildings and transportation infrastructure.

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A significant proportion of Vaughan's 2016 energy use and emissions came from existing buildings. Since many of them will still be there in 2050, measures must be taken to reduce, and then eliminate or offset, the ongoing emissions from the operation of these buildings to meet Vaughan's emission reduction target.

The City of Vaughan has conducted a study report on the use of Local Improvement Charges to provide financing to private property owners for energy-related projects and to incentivize the deep retrofit of many of the 80,000 existing single-detached dwellings in Vaughan. The implementation of this project is currently on hold.

As part of a Sustainable Neighbourhood Action Program in Thornhill, the City of Vaughan and the Toronto and Region Conservation Authority are exploring a community-scale building retrofit program. Funding is currently being sought.

Existing buildings are a major source of emissions that typically require deep retrofits to eliminate ongoing emissions.

Vaughan is taking steps to reduce, though not yet eliminate, emissions resulting from the operation of new buildings.

Buildings are long-lasting assets. Therefore, cities must consider the future operating emissions of new buildings being constructed today and in the future.

Updated in 2022, Vaughan's Sustainability Metrics program sets sustainability goals for new development in Vaughan to encourage green development standards. The program allocated points for sustainable practices that are incorporated into new developments, many of which reduce building emissions.

As of Q1 2023, the updated set of Sustainability Metrics and thresholds will be implemented for all development. Development located within Intensification Areas will be required to meet the proposed Silver threshold and applications located elsewhere in the city will be required to meet the Bronze threshold scores. City staff will examine requiring higher Threshold Scores and integrating climate change performance to advance the success of the Sustainability Metrics Program.

Vaughan's planning practices have been instrumental in addressing energy-use and emissions in the community.

The Vaughan Official Plan 2010 contains policy that encourages low-carbon and energy efficient communities. Vaughan requires community energy plans for development in New Community Areas, Intensification Areas, and undeveloped Employment Areas to reduce community energy demands and provide, where feasible, renewable energy options.

Vaughan also requires energy plans to accompany new block plans and developments. The City-Wide Urban Design Guidelines (2018) address sustainable design and building performance standards.

The transportation sector was the most significant source of emissions in Vaughan in 2016, mostly resulting from use of personal vehicles.

Since the 2016 baseline year, Vaughan, York Region, and the Toronto Transit Commission (TTC) have introduced several new transit options since 2016, including the rapid transit expansion along Highway 7, TTC Line 1 and the Yonge North Subway Extension being expanded into Vaughan, and the construction of a transit hub in the Vaughan Metropolitan Area. Vaughan has also continued to invest in active transportation expansion.

Vaughan is encouraging transit use and active transportation, but emissions related to transportation remain high.

Additional unfunded plans have been put forth to expand transit services, add active transportation infrastructure, enhance active transportation safety, and reduce emissions from local deliveries.

The Sustainability Metrics program, Urban Design guidelines and the Vaughan Metropolitan Centre secondary plan all highlight the need for development focused on transit and active transportation.

Vaughan and its partners have created several additional plans and targets to increase transit ridership and active transportation.

Natural gas has a higher emission factor in Vaughan than electricity, and this should be considered in future emission reduction planning.

Natural gas use in Vaughan accounts for 36% of energy use and 33% of emissions, while electricity makes up 23% of energy use and only 4% of emissions.

No funded plans are currently in place to reduce emissions from natural gas or increase the use of electricity in the community.

The waste sector, including solid waste, combustion of solid waste, composting, and wastewater accounted for 11% of emissions in the community in 2016.

The residential diversion rate in Vaughan is high, with approximately two-thirds of household waste being diverted away from the landfill through the recycling and composting programs. Diversion from industrial, commercial, and institutional waste sources is estimated to be much lower, at around 3%.

Overall, the community's diversion rate stood at approximately 22%. An additional 11% of waste was combusted to create energy, meaning that the remaining two-thirds of solid waste in Vaughan was landfilled.

Emissions from waste in Vaughan result largely from decaying materials producing methane in the landfills.

The 2016 GHG energy use and emission inventory sets a baseline for understanding the scope and context of the opportunities and challenges Vaughan faces in reaching its emission targets.

The next step in the MEP revision process is to develop a business-as-planned scenario to demonstrate projected energy use and emissions in Vaughan between 2016 and 2050, based on policies and practices currently in place or adopted and expected to occur during the timeframe.

Once the business-as-planned scenario has been developed, a low-carbon scenario should be created to identify actions and strategies to help Vaughan reach its goals.

Developing the low-carbon scenario requires an understanding of both local context from direct experience and best practices from other jurisdictions.

APPENDIX A

Reference Guide

Abbreviations

GHG: greenhouse gas

GJ: gigajoule

PJ: petajoule

tCO_2e: tonnes of carbon dioxide equivalent

$ktCO_2e$: kilotonnes of carbon dioxide equivalent

Data Sources

For the baseline year, many model inputs come from calibrating the model with real energy datasets. This includes real building and transportation fuel data, data on population, housing stock and vehicle stock etc. Datasets come from reliable sources including the City of Vaughan, York Region, and Statistics Canada.

Other assumptions come from underlying relationships between energy stocks and flows identified through research, like the fuel efficiency of personal vehicles, and the efficiency of solar PV.

The geographic boundary of the modelling assessment was the municipal boundary of the City of Vaughan. The model will used Vaughan's 184 traffic zones to assign energy use and greenhouse gas emissions spatially.

Glossary

Baseline: The starting year for energy or emission projections.

CO_2e: Carbon dioxide equivalent, a standardized measurement of greenhouse gases based on the warming potential of given gases compared with carbon dioxide.

Greenhouse gas (GHG): Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) are the primary GHGs in the Earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Scenario: A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g. rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are used to provide a view of the implications of developments and actions