City of Vaughan's 2024 Municipal Energy Plan

June 2024

VAUGHAN

Presented to:

Vaughan Municipal Energy Plan Revision Project Team

Presented by:

Sustainability Solutions Group (SSG)

Designed by SSG

June 2024

VAUGHAN

SSG

Acknowledgments

Land Acknowledgement

We respectfully acknowledge that the City of Vaughan is situated in the Territory and Treaty 13 lands of the Mississaugas of the Credit First Nation. We also recognize the traditional territory of the Huron-Wendat and the Haudenosaunee. The City of Vaughan is currently home to many First Nations, Métis, and Inuit people today. As representatives of the people of the City of Vaughan, we are grateful to have the opportunity to work and live in this territory.

Project Team Acknowledgement

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We also acknowledge many members of the community and City of Vaughan staff for their input, guidance, and support.

Ancillary Reports

- **Ancillary Report:** Vaughan's Current Practices for Decreasing Community Energy Use and Emissions
- **Ancillary Report:** Data, Methods and Assumptions Manual
- **Ancillary Report:** Financial Analysis
- **Ancillary Report:** Engagement Plan and Engagement Summary

Contents

Abbreviations

BAU: Business-as-usual scenario

BAP: Business-as-planned scenario

CDD: Cooling Degree Day

EV: Electric Vehicle

GHG: Greenhouse Gas

GJ: Gigajoule

HDD: Heating Degree Day

IPCC: Intergovernmental Panel on Climate Change

kWh: Kilowatt-hour

$ktCO_2e$: Kilotonnes of Carbon Dioxide Equivalents

MEP: Municipal Energy Plan (2016 and 2023)

MEPR: Municipal Energy Plan Revision

$MtCO_2e$: Megatonnes of Carbon Dioxide Equivalents

MW: Megawatt

OPR: Official Plan Review

O&M: Operations and Maintenance

PJ: Petajoule

PPA: Power Purchase Agreements

PV: Photovoltaic

RNG: Renewable Natural Gas

tCO_2e: Tonnes of Carbon Dioxide Equivalents

UNFCCC: United Nations Framework Convention on Climate Change

A glossary of terms can be found in Appendix B.

Units

GHG emissions

1 $MtCO_2e$ = 1,000,000 tCO_2e

One megatonne of carbon dioxide equivalents ($MtCO_2e$) is equal to one million tonnes of carbon dioxide equivalents (tCO_2e).

Energy

1 MJ = 0.0001 GJ

1 TJ = 1,000 GJ

1 PJ = 1,000,000 GJ

1 GJ = 278 kWh

1 MWh = 1,000 kWh

1 GWh = 1,000,000 kWh

Disclaimer

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Message from Mayor Steven Del Duca

Over the past decade, the City of Vaughan has demonstrated strong leadership in the fight against climate change, and the updated Municipal Energy Plan will continue to guide our efforts. It plots a path toward a greener future and provides recommendations that will allow our city to reduce greenhouse gas emissions, while also generating a positive economic return and thousands of jobs – it's a win-win.

The plan includes an implementation framework that outlines the actions we need to take in six key areas to reach our goals. It's ambitious but achievable. We need to do our part to ensure we're building a brighter, cleaner Vaughan for future generations. We will continue working with residents, businesses, industry professionals and other levels of government to achieve this.

I want to thank all the City staff who contributed to this report. Your hard work is evident on every single page, and we are grateful for your efforts.

Thank you for all you do.

Sincerely,

Steven Del Duca

Mayor

Key Insights

The 2024 Municipal Energy Plan (MEP) provides guidance and recommendations for the City of Vaughan (City) to reach its greenhouse gas emissions reduction targets and build a low-carbon economy and resilient city. The MEP is rooted in the local context and work already underway through current programs and initiatives, and accounts for projected population growth. This plan will enable the City to take a leadership role in addressing climate change and promoting a sustainable future for its community. The entire Vaughan community, as well as regional, provincial, and federal organizations, will have to collaborate to implement the plan and make it a success.

1

Vaughan can reach net-zero emissions by 2050 with actions in six key sectors.

The City has set a target to reach 2-3 tonnes of greenhouse gas emissions per capita by 2030 and net-zero emissions by 2050 at the latest. Six low-carbon pillars, or areas of action, can contribute to reducing emissions in these sectors:

- Retrofitting existing buildings,
- Building net-zero new construction,
- Generating renewable energy,
- Reducing vehicle emissions,
- Increasing active transportation and transit use, and
- Reducing waste emissions.

2

The Implementation Framework outlines key actions the City can take to get the plan off the ground.

The City's Ancillary Report: Implementation Framework report outlines the actions required for each low-carbon pillar. Using the Implementation Framework, the City can begin planning how to implement actions over the next five years.

3

Low-carbon actions will make Vaughan wealthier.

The cumulative, incremental expenditures and undiscounted savings of a low-carbon actions have a capital investment of $11 billion, and the savings, avoided cost of carbon, and revenue have a total of $11.42 billion. After discounting at 3%, the capital investments have a net present value of $7.67 billion across various sectors in the community. These investments are offset by the cost savings related to avoided energy, carbon pricing, maintenance and operations, and increased revenue generation. This means that implementing the low-carbon pathway will yield a net return (financial return) of $6.37 billion across the community.

4

This plan will generate thousands of jobs.

Implementing the MEP will also generate job growth in Vaughan. Specifically, more than 59,423 person-years of employment are expected to be created between 2024 and 2050. This is equal to an annual average of 2,285 full-time-equivalent jobs above the jobs that would be created in the business-as-planned scenario.

5

Climate action can transform Vaughan into a more equitable place to live.

In the context of climate planning, equity refers to the fairness and justice in the distribution of resources and opportunities to ensure that climate change does not disproportionately impact or increase the vulnerability of community members. To prioritize equity, the project team engaged with and incorporated the perspectives of interested and affected communities in developing climate actions and implementation policies that can contribute to increased equity in Vaughan.

Introduction

A Time for Action

The planet is heating up. Our natural, economic, and social systems are suffering. In 2022, the Intergovernmental Panel on Climate Change (IPCC) provided a dire warning about the impact global climate change will have on people and our planet. The Panel urged governments to take action to limit global warming to 1.5 degrees Celsius (°C) above pre-industrial levels. Reaching this target will allow humanity to avoid the most harmful impacts of climate change. However, it will require unprecedented changes to global energy systems, including vast changes to buildings, land use, transportation, and waste systems.

Limiting the most catastrophic impacts of climate change is still possible, if we act now.[1] Local governments and communities can continue being catalysts for change, using their local expertise, commitment to community, and place-based action to reduce emissions.

Vaughan's Response

Vaughan has set a target to reach 2-3 tonnes of greenhouse gas emissions per capita by 2030 and net-zero emissions by 2050 at the latest. To meet these targets, Vaughan will need to eliminate 0.86 megatonnes of CO_2 equivalent emissions ($MtCO_2e$) by 2030 and 2.6 $MtCO_2e$ by 2050.

In June 2019, in response to the IPCC's 2018 assessment and intensifying climate emergency, Vaughan City Council endorsed a City of Vaughan Climate Emergency Declaration. The Declaration recognizes the IPCC's assessment that urgent and transformative action needs to occur between now and 2030 to limit the average global temperature increase to 1.5°C, with aggressive actions required to meet the target of net-zero emissions by 2050.

The Municipal Energy Plan Revision (MEPR), the process undertaken to update the 2016 Municipal Energy Plan (MEP) with a 2024 MEP, is a directive resulting from the Declaration and the 2018-2022 Council's "Environmental Stewardship" strategic priority which included the directive to build a low-carbon economy and resilient city. The 2024 MEP measures the size of the challenge in Vaughan and provides guidance and recommendations for the City to reach its greenhouse gas (GHG) emissions reduction targets. It is rooted in Vaughan's unique local context, including the work already being done through the City's planning efforts and current programs and initiatives, and accounts for the population and job growth expected in the community.

[1] Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte et al.]. (2021). Climate Change 2021: The Physical Science Basis. Cambridge University Press, Cambridge, United Kingdom. In Press.

What Is a Climate Emergency Declaration?

A climate emergency declaration is used by governments to signal the dire and urgent need to respond to the climate crisis. As of 2024, climate emergencies have been declared by 2,356 jurisdictions in 40 countries, representing over one billion citizens.[2]

Climate Action Opportunities in a Growing City

For the past 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 (Figure 1). With this transformation comes challenges but also great opportunities for climate action as the residential, commercial, industrial, and transportation sectors shift their energy use. Transit-supported intensification and higher-density mixed-use forms of development are planned to accommodate future growth. Prioritizing the development of higher-density mixed-use developments within close proximity to transit nodes or corridors supports more walkable and bikeable neighbourhoods and decreases reliance on cars. Many new buildings will need to be built to accommodate population and job growth, offering the opportunity to build with emissions reductions and energy efficiency in mind.

[2] Climate Emergency Declaration. (2024). "Climate Emergency Declarations in 549 Councils Cover 65 Million Citizens - Climate Emergency Declaration." Climate Emergency Declaration. Accessed May 2024. https://climateemergencydeclaration.org/climate-emergency-declarations-cover-15-million-citizens/.

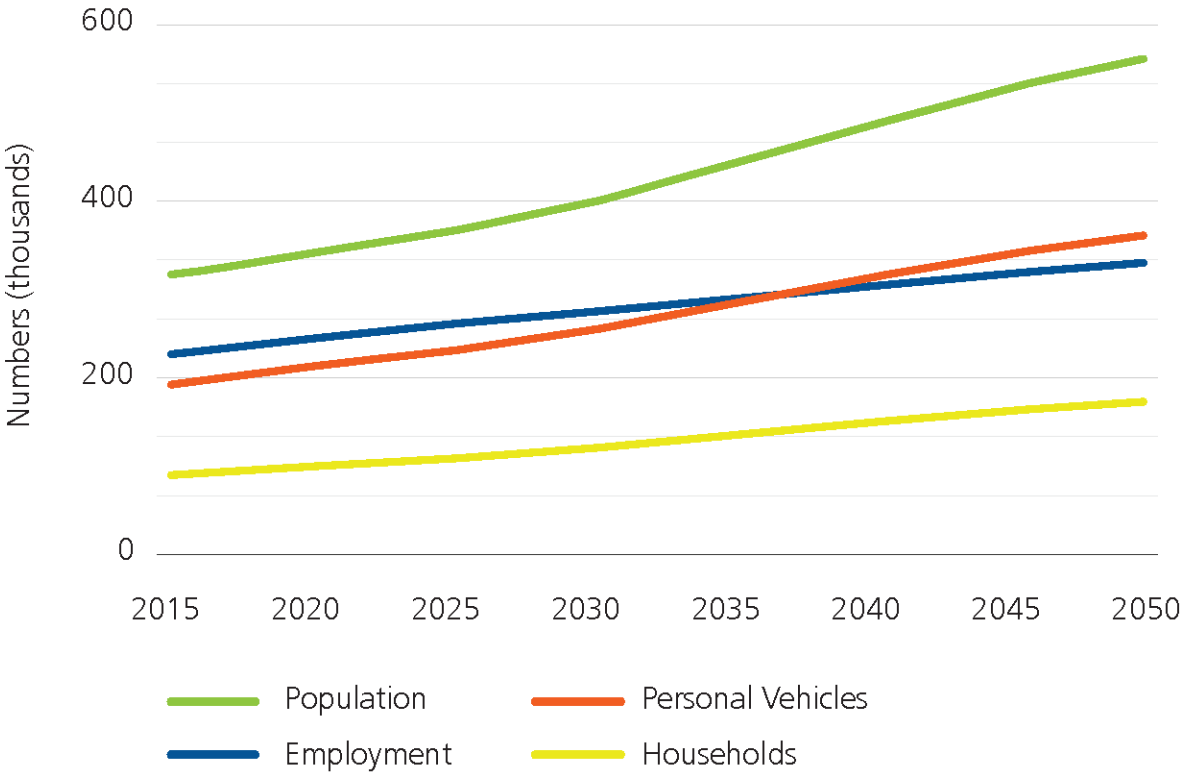


Figure 1. Projected population, personal vehicles, number of households, and employment (in full-time equivalent person-years) from 2016-2050.

Vaughan's Official Plan Review

The City is conducting a comprehensive Official Plan Review (OPR) for Vaughan, which will establish updated planning decisions for the city's growth and protection of existing neighbourhood characteristics, to contribute to Vaughan's environmental integrity and provide different transportation options. The OPR is being conducted to better meet the needs of current and future citizens, workers, and visitors, and to conform with new provincial policies and plans such as the Planning Act, A Place to Grow: Growth Plan for the Greater Golden Horseshoe, and the Greenbelt Plan.

The timeline and goals of the OPR overlap with those of the MEPR. Thus, the OPR offers an opportunity to develop policies to support the updated MEP. The OPR is guided by principles such as environmental sustainability, social responsibility, and economic development to plan for complete communities and guide the city's growth for the next 30 years and beyond. As part of the MEPR, current and proposed Official Plan policies were reviewed to assess whether they align with the emissions reduction target, and recommendations were made to increase alignment where necessary.

What are complete communities?

Complete communities prioritize transit-oriented and mixed-use development practices, which aim to establish neighbourhoods where residents can live, work, and conveniently access essential amenities without the need to travel extensively.

The Climate Change Experience in Vaughan

Vaughan is already experiencing the impacts of climate change. The mean temperature in Vaughan increased by more than 1°C between 1950 and 2022.[3] The city has experienced significant flooding,[4] numerous heat waves, and air quality issues from forest fires in other parts of the province. These climate hazards are projected to increase in severity over the coming years and decades. More extreme weather events will accompany these changes, including more intense rain and snowfall events, flash floods, high winds, and stronger hurricanes.

Residents' experiences with climate change also impact energy use trends. For example, an increase in extreme heat events and the number of cooling degree days[5] (CDDs) and heating degree days[6] (HDDs) in a year is an indicator of the heating and cooling demand of buildings (known as thermal conditioning), which directly influences energy consumption and therefore GHG emissions. While HDDs are declining and will continue to decline in Vaughan due to warming weather, CDDs will continue to increase as hot days and nights encourage a greater use of air conditioning (Figure 2).

[3] Climate Atlas of Canada. (2020). Municipality Toronto. Annual Mean Temperature (RCP 8.5). Accessed May 2024: https://climateatlas.ca/data/city/458/annual_meantemp_null_85/line

[4] Global News. (August 9, 2011). Heavy rain causes flooding in Vaughan. https://globalnews.ca/news/142991/heavy-rain-causes-flooding-in-vaughan/

[5] CDDs are used to provide an indication of the amount of air conditioning required to maintain comfortable indoor conditions. Over the selected measurement timeframe (e.g. monthly, annually etc) when the daily outdoor temperatures exceed the temperature threshold of 18°C, the CDDs are accumulated. A larger number of CDD means that there is a greater need for air conditioning.

[6] HDDs are used to provide an estimate of the amount of heating required to maintain a comfortable indoor conditions. Over the selected measurement timeframe (e.g. monthly, annually etc) when the daily outdoor temperature is less than the temperature threshold of 18°C, the HDDs are accumulated. A larger number of HDD means that there is a greater need for heating.

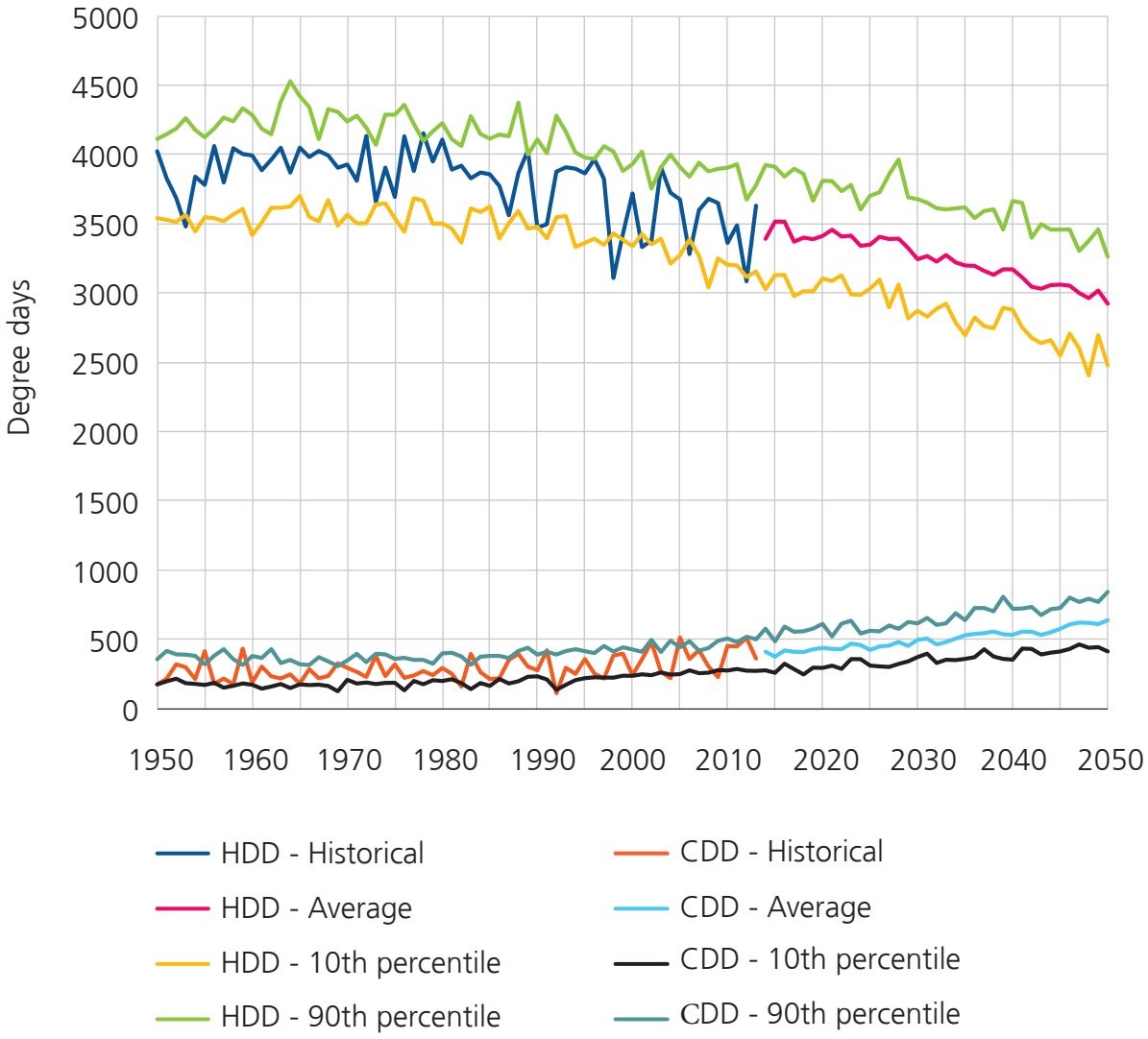


Figure 2. Heating degree days and cooling degree days for Vaughan, projected out to 2050 (IPCC AR5 RCP 8.5).[7] *Historical data are shown until 2013. The projection is an average of the results of several models. Ten and ninety percentiles of the results from these simulations are also included.*

Based on the current global trajectory, climate change in Vaughan is far from over. Yearly precipitation is expected to increase from a historical average of 793 mm (1976 - 2005) to 845 mm by 2050 (IPCC AR5 RCP 8.5).[8] This increase may not seem large, but a predicted increase in heavy rain days could lead to floods. As well, the precipitation increases are expected in the winter and spring, which could lead to more mixed precipitation (e.g., hail, slush) events due to temperatures hovering around 0°C. By 2050, mean annual temperature

[7] Climate Atlas of Canada. (2020). Toronto Municipality. Heating Degree Days (RCP 8.5) and Cooling Degree Days (RCP 8.5). Accessed May 2024: https://climateatlas.ca/data/city/458/hdd_2030_85/line; https://climateatlas.ca/data/city/458/cooldd_2030_85/line

[8] Climate Atlas of Canada.(2020). Toronto Municipality. Annual Precipitation (RCP 8.5). Accessed May 2024: https://climateatlas.ca/data/city/458/annual_precip_2030_85/line

is projected to rise by another 2°C, and the number of extremely hot days (greater than 30°C) are expected to increase from an average of 12 days per year to an average of 30 days per year. Additionally, by 2050, average heatwave length is expected to double to 11 days, compared to 2013, increasing the risk of adverse health impacts, environmental concerns, and crop failures.

Demonstrating Commitment

Besides the MEPR, the City has taken other steps to address climate change in the community. The City released its first MEP in 2016 and provided Vaughan with an emissions reduction action plan aligned with the City's participation in the Partners for Climate Protection program, a national program for municipalities focused on reducing emissions. The MEP 2016 replaced the City's climate change action plan, and aligned with Green Directions Vaughan, and the Community Sustainability Plan.

The City has also addressed climate change across many of its plans and operational decisions. The City's current Official Plan has a goal dedicated to establishing Vaughan as a green and sustainable community, which involves minimizing energy use and encouraging the use of alternative transportation options. Many of Vaughan's secondary plans carry this work forward, including the Vaughan Metropolitan Centre Secondary Plan which addresses creating a mixed-use, higher-density community and a more walkable and bikeable neighbourhood.

The City is also developing a new Transportation Master Plan and has established the plan's guiding principles. The Vaughan Transportation Plan will include a multi-modal approach to moving Vaughan's citizens, and support the reduction of environmental impacts and transportation-related GHG emissions.

Additionally, the City has a Corporate Energy Management Plan. This plan includes proposed conservation and energy efficiency measures, cost and savings estimates, an implementation plan, and energy consumption and GHG emissions reduction targets. The City reports annually on metrics set out in the plan and on energy use in municipally owned and operated facilities via a public report.

This list is not exhaustive. To learn more about the City's current practices aimed at decreasing energy use and emissions across the community, please see Ancillary Report: Data, Methods and Assumptions Manual and the Ancillary Report: Current Practices for Decreasing Community Energy Use and Emissions.

The MEPR is a comprehensive revision of the 2016 MEP, and will ultimately replace it with the 2024 MEP, to align with the increased expectations for reducing emissions as outlined in city-wide plans and with plans, including the OPR, that have been updated since the MEP was first created. The updated MEP provides guidance and recommendations for Vaughan to reach its GHG emissions reduction targets, and build a low-carbon economy and resilient city. It is rooted in the local context and work already being completed through current programs and initiatives.

Vaughan's Sustainability Metrics Program

Updated in 2022, Vaughan's Sustainability Metrics Program (SMP) guides and measures how well new development performs in terms of sustainability by providing a menu of metrics (called the Sustainability Metrics and Thresholds) that applicants can apply to their development application. These metrics support reducing emissions in buildings, increasing active transportation and transit use and reducing transportation emissions, increasing waste diversion and infrastructure, and generating renewable energy. Additionally, the metrics support the development of community well-being and natural heritage.

As of Q1 2023, the updated set of Sustainability Metrics and Thresholds will be implemented for all development in Vaughan. Development located within Intensification Areas will be required to meet the applicable Silver Threshold Scores, and applications located elsewhere in the city will be required to meet the applicable Bronze Threshold Scores. Following the launch of the program, the City staff will examine requiring higher Threshold Scores and integrating climate change performance to advance the success of the SMP.

Community Input

As part of the MEPR, members of the community members, City staff, members of the Building Industry and Land Development Association (BILD) - York Chapter, and other interested and affected parties were engaged through a series of engagement events. The City invited the broader public to participate in two workshops to learn more about the MEPR and share feedback. Participants provided insights on what they felt should be included in the plan and how they felt the plan could and should be implemented in the community. A community survey was also conducted to identify opportunities and challenges for implementing the plan. Additionally, the City held a workshop with BILD – York Chapter to inform key members of the building industry about the project, and to provide them with an opportunity to share their insights on the low-carbon actions and potential options for implementing those actions.

Staff and stakeholders met with the project team in a series of workshops to learn about the MEP development process and climate action planning. They also provided feedback on the modelling assumptions, low-carbon actions, and Implementation Framework.

What We Heard

SSG and the City's Project Management team gathered feedback from 79 members of the public, including representatives from the construction, building, and consulting industries, community members, non-profit organizations, and equity-denied community members. Engagement participants shared their perspectives on climate action and lived experiences with climate change, opportunities and barriers, and different supports to assist community members in implementing climate actions. SSG used a thematic analysis to analyse the qualitative feedback received from the engagement process. This was completed to share common patterns among the feedback, and provides a compressed analysis of key concerns, challenges and opportunities expressed by different stakeholder groups. The following recommendations were developed based on the thematic analysis, and were used to inform the MEP:

1. The City should leverage and expand financial, employment, and transit support for all community members, with priority given to equity-denied and vulnerable community members.
2. The City should adopt an equity lens to ensure climate actions are developed to support equity-seeking and vulnerable community members. This includes directly working with equity-seeking and vulnerable community members throughout projects to address potential co-harms and enhance co-benefits.
3. The City should encourage mixed-use and compact development to enhance access to community amenities and facilitate less travel. In addition, the City should invest in active transportation infrastructure to encourage walking and cycling between destinations.
4. The City should work to raise the community's awareness of climate change and climate actions by providing education on these topics. The City should recruit community champions and encourage greater participation in climate planning events.

Informed by this input, the MEP is designed to streamline the implementation of the GHG reduction measures identified in this document and to maximize co-benefits. Our Ancillary Report: Engagement Plan and Summary provides a thematic analysis of all the feedback gathered from engagement with interested and affected parties.


EARTH HOUR
CHANGE
CHANGE
CLIMATE
CHANGE

Energy and Emissions in Vaughan

The city's current energy use and associated emissions (the baseline), and the potential energy use and emissions trajectory resulting from demographic changes and changes in practices, policies, and legislation is used to understand the size of Vaughan's challenge to reach the community's net-zero target by 2050 (the business-as-usual and business-as-planned scenarios).

A low-carbon scenario identifies actions that are locally viable and can reduce the current expected emissions by decreasing energy use and moving to low-carbon energy sources.

What is Scenario Modelling?

Scenario modelling examines potential energy and emissions trajectories based on observed historical data; assumptions about the impact of current policies, regulations, legislation, and practices (e.g., the federal electric vehicle target); and assumptions about future conditions (e.g., population growth, the types of housing people will live in).

As scenario models tend to examine complex issues impacted by multiple, interdependent, and unpredictable factors, they do not attempt to predict the future. Rather, these models are explorative. They are also transparent about the assumptions that are made, and about the factors that could change the modelled outcomes. Therefore, scenario models provide an internally consistent view of the future that is plausible.

The CityInSight model was used for Vaughan's energy-use and emissions scenarios. The model is a stocks and flows model, meaning it tracks energy-using assets and their associated emissions over time and space based on observed historical data, locally provided demographic projections, and relevant policies. Refer to the Ancillary Report: Data, Methods, and Assumptions Manual for more information about the model and the assumptions.

Baseline Energy Use and Emissions

A quantitative assessment of Vaughan's baseline energy use and resulting emissions was completed for 2016. The 2016 baseline year was used due to the availability of robust census data and other community data. Based on observed data—including utility data, transportation and fuel use data, and waste data—Vaughan's baseline energy use was estimated to be 51 million gigajoules (GJ). The resulting emissions in 2016 were estimated to be nearly 2.7 megatonnes of carbon dioxide equivalents ($MtCO_2e$). Based on Vaughan's 2016 population, this is 161 GJ of energy use per capita (or per person) and 8.4 tonnes of carbon dioxide equivalents (tCO_2e) per capita.

Vaughan's per capita GHG emissions in the 2016 baseline year (8.4 tCO_2e) were significantly below the average Canadian per capita GHG emissions (18.6 tCO_2e)[9] but significantly higher than the community's 2030 target of 2-3 tCO_2e per capita (Figure 3). Based on the business-as-usual scenario the 2024 per capita emissions were projected to be 7.4 tCO_2e per capita.

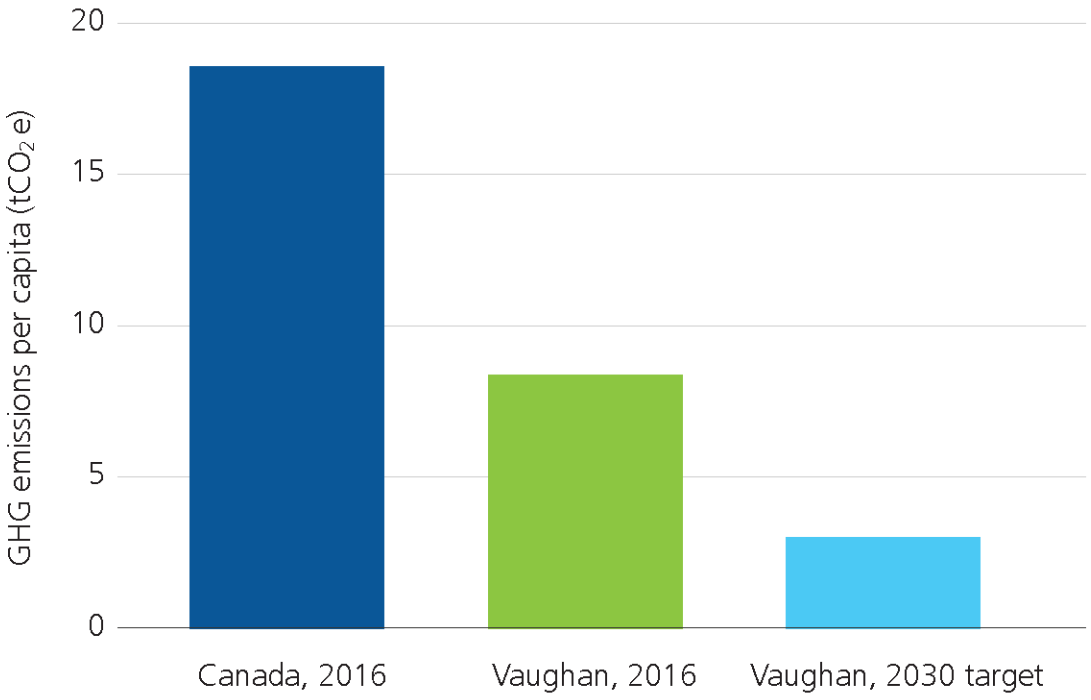


Figure 3. Per capita emissions comparisons.

[9] Statistics Canada. (2016). Greenhouse gas emissions in Canada. Table 38-10-0097-01. Accessed May 2024: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810009701

Business-As-Planned Energy Use and Emissions

A business-as-usual (BAU) scenario was also developed for Vaughan in CityInSight, an energy-use and emissions scenario model. This scenario illustrates expected energy use and emissions in Vaughan if the City, other levels of government, and other sectors do not implement the energy and emissions-reducing measures they have committed to. In this scenario, energy use is projected to increase from the baseline by 13% by 2050 from 51 to 58 million GJ. Emissions are expected to increase by 11% by 2050 from nearly 2.7 to 3 $MtCO_2e$ (equivalent to 2,662,140 $ktCO_2e$ and 3,019,132 $ktCO_2e$).

To further understand the size of the challenge to reach Vaughan's 2050 net-zero target, a business-as-planned (BAP) scenario was developed to provide insights into future emissions resulting from current policy decisions and practices within the community.

The BAP scenario estimates the energy use and resulting emissions in Vaughan between the baseline year (2016) and net-zero target year (2050). The scenario is based on projects and initiatives that are underway or approved with dedicated funding, and legislation and regulations at the provincial and federal levels. For example, a BAP scenario accounts for planned changes in transportation infrastructure and expected shifts in mode share, the percentage of trips made using different types of transportation, resulting from infrastructure additions. It also includes projected increases in the grid emissions factor of electricity based on current provincial policy and an increase in electric vehicle uptake based on the federal light-duty electric vehicle target.

In the BAP scenario, energy use is expected to decrease from the baseline by 16% by 2050 (from 51 to 43 million GJ). Emissions are expected to decrease by 30% from nearly 2.7 to 1.9 $MtCO_2e$ (equivalent to 2,662,140 $ktCO_2e$ and 1,944,812 $ktCO_2e$) (Figure 4). Because the population in Vaughan is expected to grow at a rapid rate, per capita emissions are expected to decrease by 58% (from 8.4 to 3.5 tCO_2e).

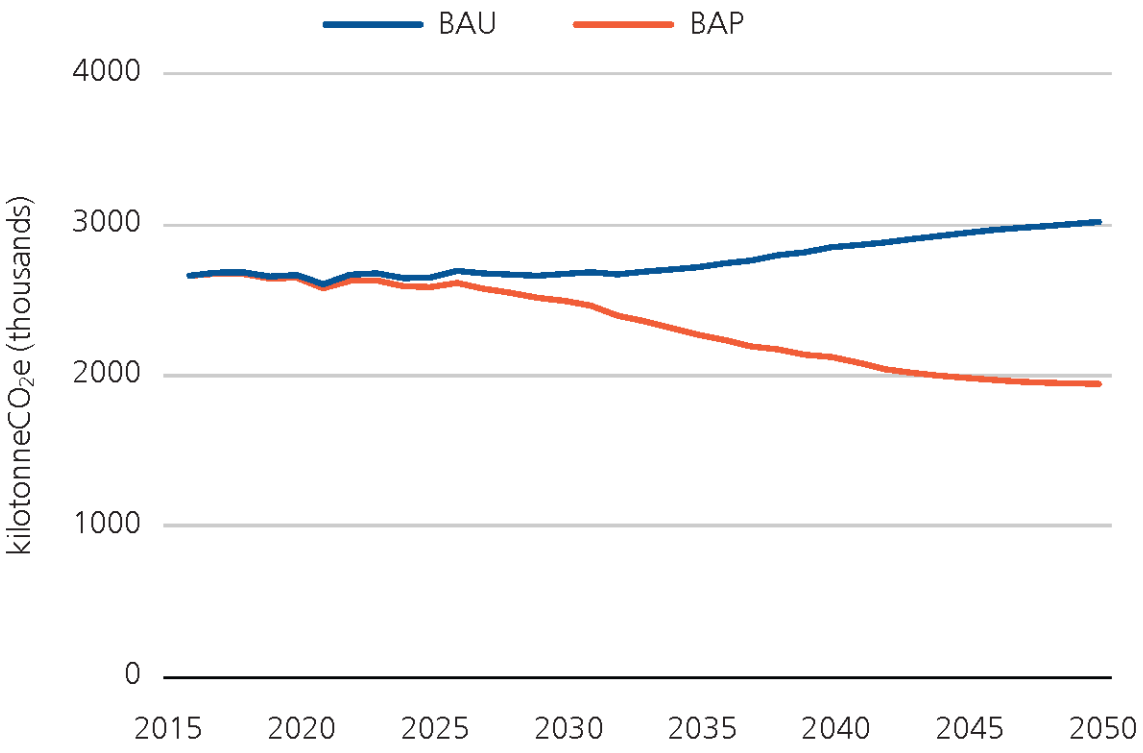


Figure 4. A comparison between 2016 baseline emissions, 2050 business-as-planned emissions, and 2050 business-as-usual emissions in Vaughan.

The BAP scenario predicts that, by 2050, buildings will have produced most of the projected emissions in Vaughan (Figure 5). Of the total community emissions, 35% are projected to come from residential buildings, 24% from commercial and institutional buildings, and just over 6% from industrial buildings. Emissions from transportation would make up nearly a quarter of community emissions, while emissions from waste would make up over 5%.

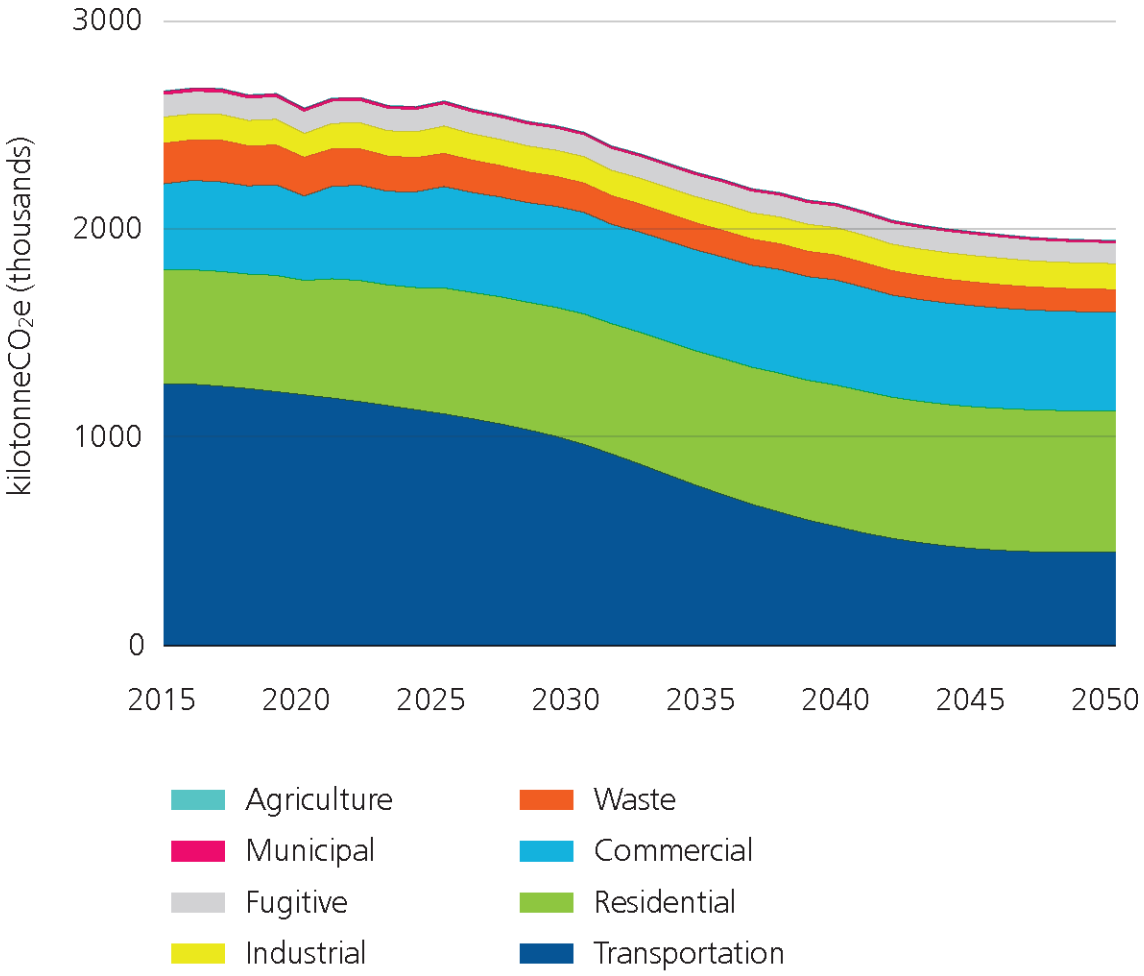


Figure 5. Projected emissions by sector between 2016 and 2050 in the business-as-planned scenario in Vaughan.

Regarding projected energy sources in 2050, natural gas is expected to make up 42% of community emissions, mostly due to its use in buildings (Figure 6). Electricity use from the grid would make up over a quarter of emissions, also largely due to its use in buildings but also in power electric vehicles. Diesel is projected to make up 14% of emissions, from its use in medium- and heavy-duty vehicles, while gasoline would make up less than 2% of emissions as it is displaced by electric vehicles. Non-energy emissions, which include waste and fugitive emissions,[10] would make up nearly 11% of community emissions.

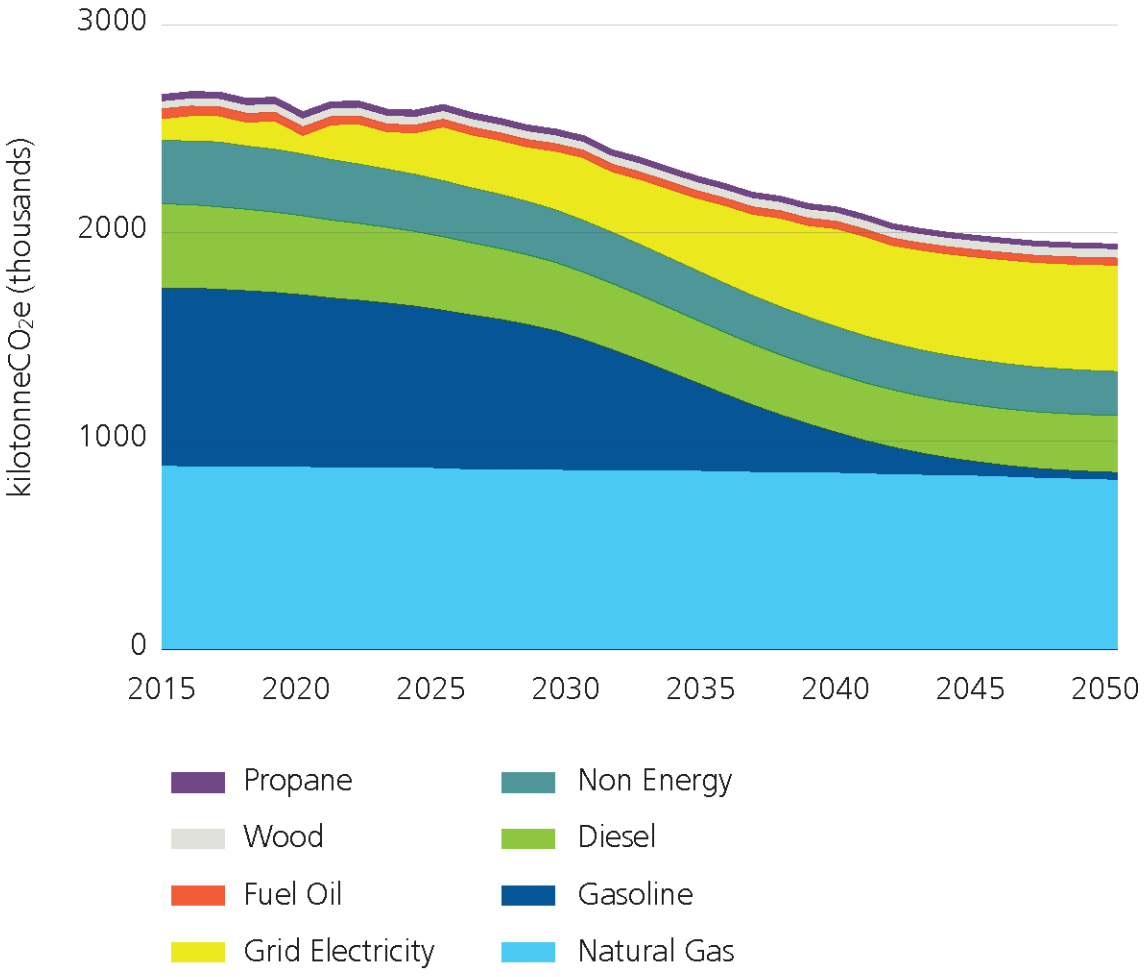


Figure 6. Emissions by fuel type between 2016 and 2050 in the business-as-planned scenario in Vaughan.

[10] Fugitive emissions are the accidental greenhouse gas emissions released from equipment, storage tanks, pipelines, or other sources.

While overall emissions reductions show that there is a modest decrease between 2016 and 2050, this does not reflect all the work being done within the community to decrease emissions. Over the course of the BAP scenario, per capita emissions are projected to decrease by over half, from 8.4 to 3.5 tCO_2e per person (Figure 7).

The overall emissions trajectory shows that although emissions per person are expected to decrease significantly under current policies and practices, increased population and employment in Vaughan will outstrip per capita emissions resulting in an overall increase in emissions. This means further action must be taken to meet net-zero emissions by 2050.

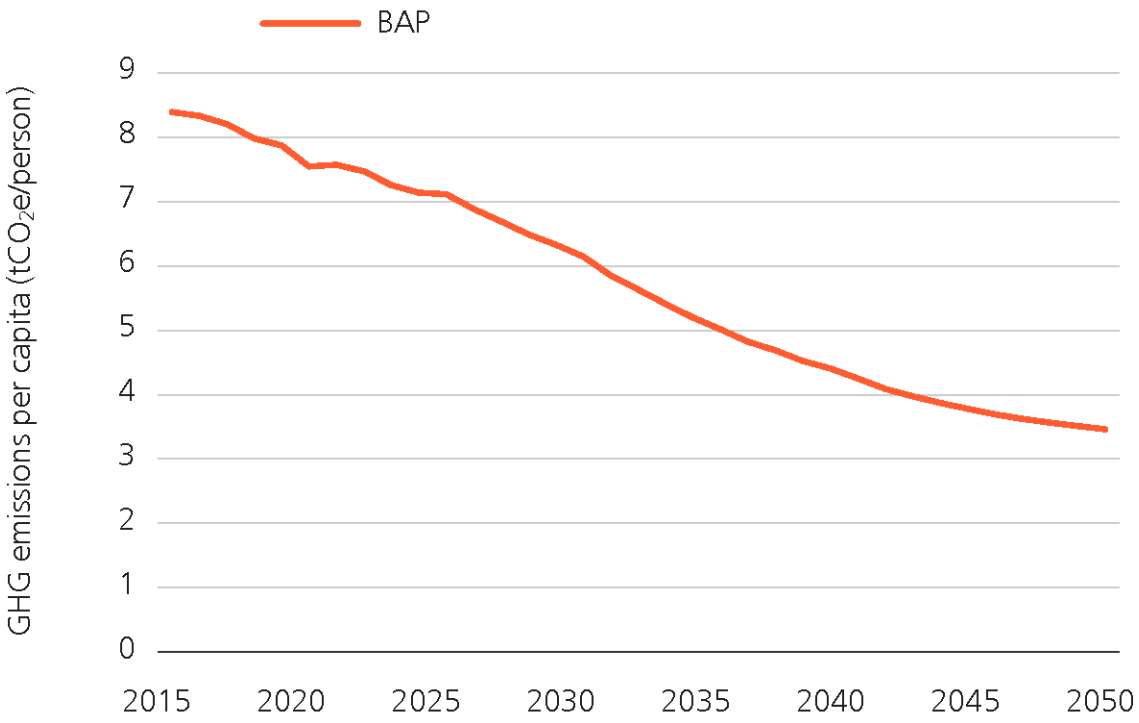


Figure 7. Per capita emissions trajectory in the business-as-planned scenario in Vaughan.

Imagining a Low-Carbon Vaughan

The BAP scenario makes Vaughan's efforts to reduce community GHG emissions obvious, especially when compared to the BAU scenario. It also highlights where additional work is needed to reach the net-zero target in Vaughan—specifically, action is required in the buildings, transportation, and waste sectors to achieve this goal.

Six low-carbon pillars, or areas of action, can contribute to reducing emissions in these sectors include: building retrofits and net-zero new construction for the buildings sector, generating renewable energy for both the buildings and transportation sectors, reducing vehicle emissions and increasing active transportation and transit use in the transportation sector, and reducing waste emissions.

What Is the Difference Between a BAP Scenario and Low-Carbon Scenario?

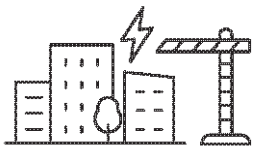
A **BAP scenario** for carbon emissions reductions is a projection of the City's expected emissions levels if it continues with its current policies and practices, and assumes no additional policy or climate action intervention. This scenario serves as a benchmark, or starting point, against which the City can measure the effectiveness of its emissions reduction efforts. It includes projections for energy consumption, emissions from transportation and industrial processes, and other sources of carbon emissions. The projections are based on locally available data including utility use records, transportation data, demographic data, and population and employment change forecasts. The BAP scenario also considers local, provincial, and federal policies, such as the federal electric vehicle target. This scenario essentially describes the size of the emissions reduction challenge the City faces, and can be used to set emissions reduction targets and track progress toward achieving them.

A **low-carbon scenario** is a projected future state in which the amount of carbon emissions is reduced to mitigate the effects of climate change. This scenario can be achieved through a combination of measures such as increasing the use of clean energy sources, improving energy efficiency, and reducing overall fossil fuel consumption. A low-carbon scenario helps evaluate the effectiveness of different policy options for reducing emissions and informing decisions about how to achieve a low-carbon future.

Vaughan's Low-Carbon Pillars

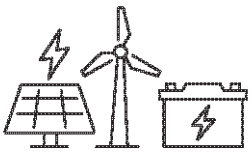
Retrofitting Buildings

In 2016, energy use in buildings accounted for nearly half of GHG emissions in Vaughan. Building emissions result from heating, cooling, and lighting spaces, and running appliances and equipment. These emissions come from all types of buildings in the community, including homes, schools, offices, stores, and industrial spaces. To make buildings more efficient, they can be retrofitted by replacing windows and doors, increasing insulation, replacing weatherstripping, and replacing inefficient heating systems with more efficient technologies such as heat pumps. In turn, these retrofitted buildings use less energy overall, whether the energy comes from a renewable source or not. This decreases emissions from the baseline and the amount of renewables required later to meet community needs.



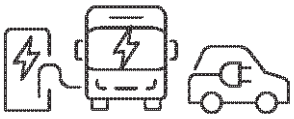
Building Net-Zero New Construction

Buildings and the systems within them, such as heating and cooling systems, are long-lasting assets. However, they can also be significant sources of GHG emissions depending on how efficient they are and what types of energy they use to operate. A net-zero building is one that is designed and constructed in an energy efficient way. For example, a net-zero energy building is one in which the energy demand is met by on-site (or near-site) renewable energy, and a net-zero energy ready building is designed and constructed in the same manner as a net-zero energy building but does not yet have on-site renewable energy. Constructing new buildings that do not meet net-zero standards creates an emissions burden now that will last well into the future unless costly retrofits are completed to meet the GHG reduction target before the buildings' systems are due to be renewed. Net-zero buildings eliminate that burden throughout the building's lifecycle, right from the beginning. The upfront capital cost of more efficient construction is typically more than offset by utility savings over time.



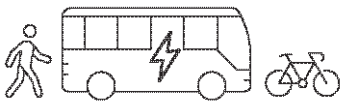
Generating Renewable Energy

Renewable energy systems ensure that our buildings and transportation sectors can operate emissions-free. Currently, in Vaughan, a mix of natural gas, electricity (most of it not emissions-free), gasoline, and diesel power day-to-day activities. By 2050, electricity will largely replace gasoline as more people adopt electric vehicles for personal use. Natural gas and electricity will still play large roles in powering the community but need to be replaced by renewable energy sources such as wind, solar, and renewable natural gas to reduce emissions. As technologies and consumer products evolve, new energy sources such as green hydrogen may also come online. While the cost of renewables is decreasing year-over-year, efficiency measures such as retrofitting buildings and building net-zero construction will still contribute to their viability for widespread use.



Reducing Vehicle Emissions

Vehicle emissions result from travel in personal and commercial fleet vehicles, the movement of goods, and mass transportation such as transit. Emissions from vehicles are expected to decrease drastically in the business-as-planned scenario from 2016 to 2050 (from 1.2 to less than 0.5 $MtCO_2e$), mostly due to an increased uptake in electric vehicles, SUVs, and small trucks in line with federal policy. Electric vehicles are emissions-free if they are charged using infrastructure connected to renewable (e.g., solar, wind) energy sources. However, even if they are emitting, their motors are significantly more efficient than those of gasoline and diesel vehicles, decreasing the amount of energy they require to operate. New technologies are also being refined for medium- and heavy-duty vehicles to become non-emitting, but no target date for their uptake is currently outlined at the federal level.



Increasing Active Transportation and Transit Use

Active transportation (e.g., cycling, walking) and transit (e.g., bus) use can help reduce transportation emissions when single-occupancy vehicle trips. Well-thought-out active transportation and transit networks and supportive programming, operations, and maintenance can help decrease congestion, promote active and healthy lifestyles, and complement urban intensification and mixed-use developments while decreasing emissions. The City continues to develop and expand active transportation and transit networks in Vaughan while the community experiences rapid population growth and urbanization that requires attention to transportation modes within, and in and out of, the community. The City of Vaughan and York Region share responsibility for municipal services within Vaughan, with York Region managing transit use. Thus, expanding transit in Vaughan will require collaboration and alignment with York Region's policies.

Reducing Waste Emissions

Waste releases emissions, mostly methane, over time as it decomposes. Vaughan has a plan in place to significantly divert waste in the coming years. However, even as per capita waste decreases, the growing population means overall waste will continue to increase. With a strong residential diversion program in place, the City is positioned to turn its attention to the non-residential sector in Vaughan to decrease waste going to landfills.

Vaughan's Low-Carbon Pathway

A low-carbon pathway offers a strategic approach to reduce GHG emissions by identifying a series of actions that aim to minimize carbon-intensive activities. The objective of a low-carbon pathway is to achieve substantial emissions reductions within a specified timeframe, while also mitigating the impacts of climate change and promoting a more resilient future.

Vaughan's low-carbon pathway shows what actions need to be taken, over what timeframe, and in what sequence to balance the priorities of reducing GHG emissions, financial and technological feasibility, and maximizing co-benefits while minimizing co-harms. The pathway was built through community engagement and energy and emissions modelling.

The resulting low-carbon pathway reaches nearly net-zero emissions by 2050 (Figure 8 and Figure 9). This scenario projects that the transportation sector will still produce emissions due to the replacement of heavy trucks only starting in 2035 when low emissions options are expected to be widely available. However, the scenario does not assume that trucks will be retired before the end of their lifecycle, so some will be replaced with low-emission vehicles after 2050. In the buildings sector, small amounts of emissions are expected to remain from natural gas as current projected renewable natural gas (RNG) is maximized and buildings and processes that are difficult to convert to other energy sources will still remain and exceed the total availability of RNG. It is likely that new technologies, and potentially even new fuel sources, will address these remaining emissions before 2050. Additionally, the scenario projects that the waste sector will also continue to produce emissions. Emissions decreases in this sector are largely due to diversion efforts. However, because Vaughan does not operate the landfills where remaining waste is deposited, it does not have the authority to capture methane, resulting in the continued emissions in the sector.

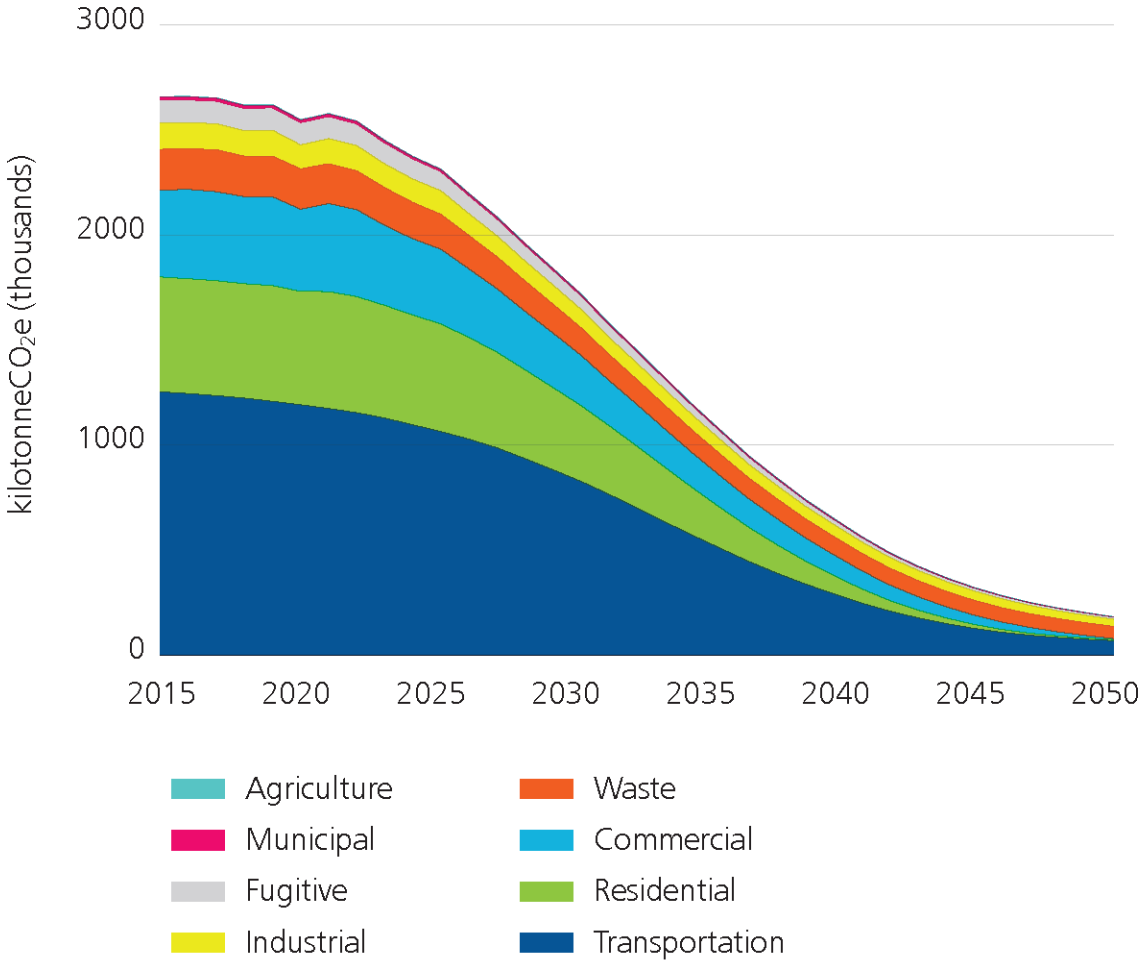


Figure 8. Projected emissions by sector between 2016 and 2050 in the low-carbon scenario in Vaughan.

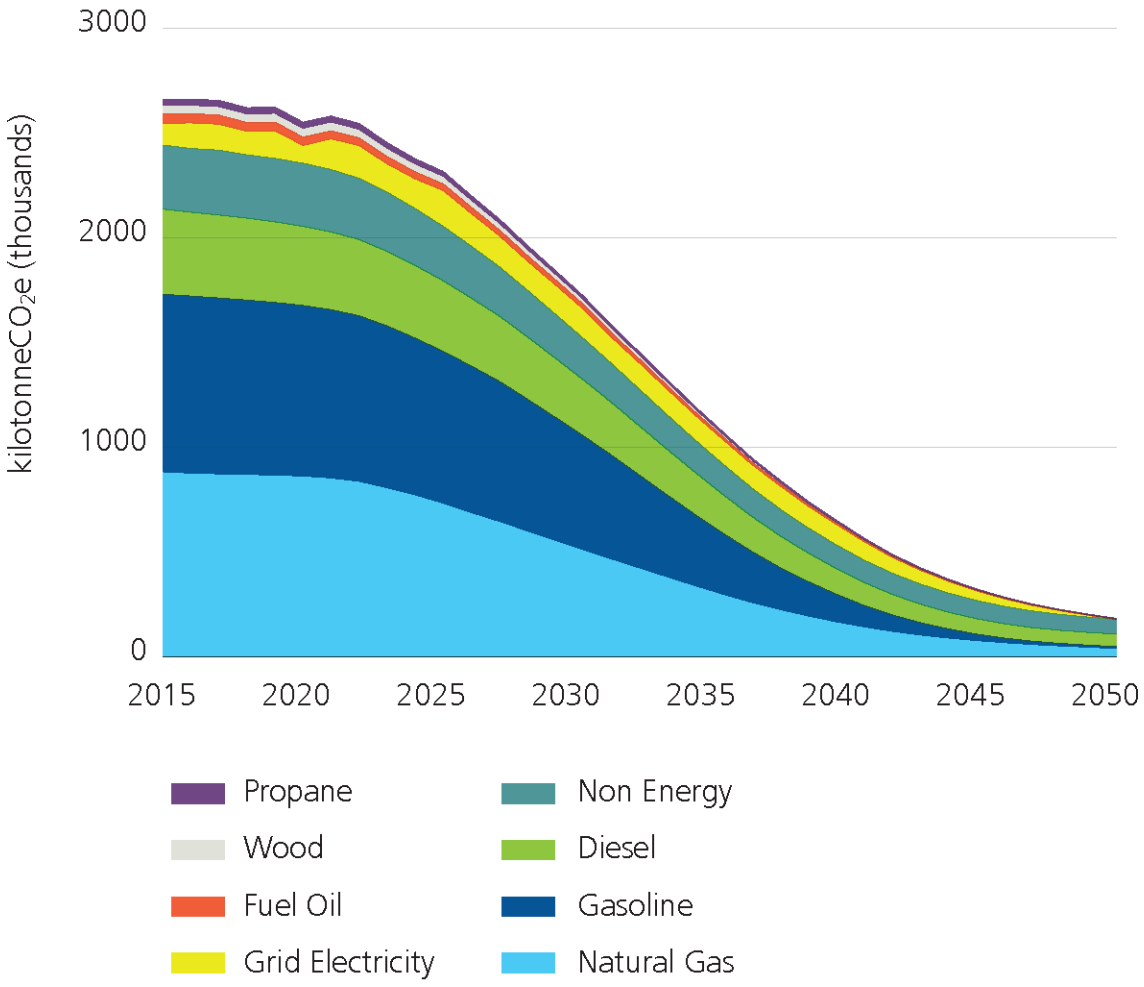


Figure 9. Projected emissions by fuel type between 2016 and 2050 in the low-carbon scenario in Vaughan.

The low-carbon scenario reduces per capita GHG emissions to 3.3 tonnes per person by 2030 and 0.3 tonnes per person by 2050 (Figure 10). These figures are slightly above the targets of 2-3 tCO_2e per capita by 2030 and net-zero emissions by 2050. This is largely because the low-carbon scenario assumes some gas vehicles will have a lifespan past 2050. Additionally, the need for natural gas in some buildings is beyond the expected RNG supply, although this could change over time.

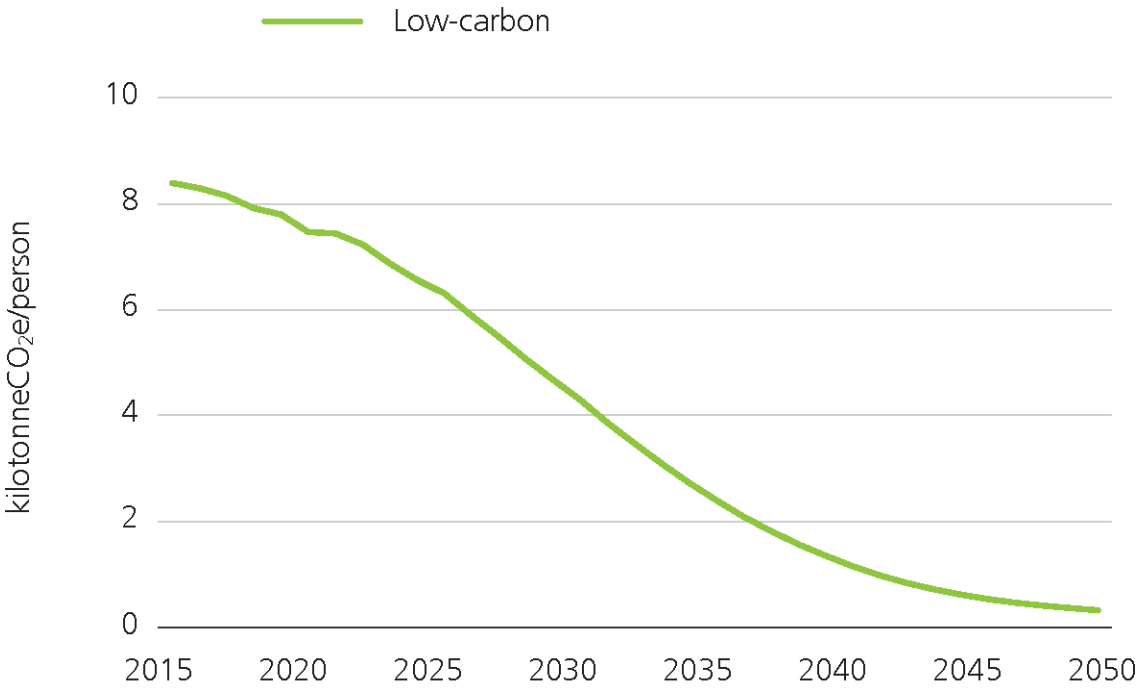


Figure 10. Projected emissions per capita between 2018 and 2050 in the low-carbon scenario in Vaughan.

The low-carbon scenario is ambitious, but it focuses heavily on what is feasible in Vaughan. For example:

- Vehicles are not retired early because of the burden it would have on individuals with low or fixed incomes. Most municipalities do not offer incentives on low emissions vehicles because they cannot guarantee the emissions savings will stay in their jurisdiction. Thus, any requirement to have a low-emissions vehicle through regulations, or the phase out of gas stations, etc. can have a negative impact on equity.
- Renewable energy sources within Vaughan are limited. In the low-carbon scenario, renewable energy is placed on rooftops and on parking lots. However, following consultation with City staff and the community, no ground-based (wind and solar) farms are located within Vaughan due to the city's rapid urbanization and the importance of leaving natural areas intact. Instead, power purchase agreements are identified as a potential solution for clean electricity.

Power Purchase Agreements

A power purchase agreement (PPA) is an agreement between a seller (the owner of renewable energy infrastructure, which could be a private business, the utility, the City, a cooperative of residents, or another third party) and the buyer (the City, utility, or ratepayer). The agreement often aims to increase the availability of renewable energy in an area where renewable energy assets cannot be built at the required scale or price. A PPA can be beneficial for both the seller, who receives incentives for generating renewable energy, and the buyer, who can purchase renewable energy at a lower rate than is possible through other arrangements.

- Waste diversion is prioritized over methane capture at landfills. This is because the City of Vaughan and York Region have committed to increasing diversion rates. Diverting waste at the source (e.g., households, businesses) through purchasing less, reusing, and recycling can decrease the burden at the end of a product lifecycle. The City does not operate landfills and uses shared landfills for residential waste, while commercial and institutional entities find their own private waste disposal sources. Thus, it is challenging for the City to have influence over what happens at the landfill.
- Ambient geothermal district energy is an option for increasing local energy generation. This will need to be further explored during the secondary planning stages of development. Vaughan is rapidly urbanizing and new blocks of land are being developed, presenting an opportunity to develop highly efficient shared heating and cooling systems for buildings in newly developing areas where there is high density and/or mixed building uses that require a high demand for heating and cooling.

Geothermal District Energy Systems

Ambient geothermal district energy systems include heat pumps in individual buildings and underground pipes that circulate water. Heat is exchanged via the ambient loop that connects all the buildings within the system. Ambient geothermal systems are very efficient because they operate at temperatures similar to the ground temperature, whether heating or cooling is required. Because of this, little energy is lost to the surrounding ground and little insulation is required to prevent loss. As well, the same pipe system can simultaneously provide heating and cooling, creating system efficiencies. Companies in Vaughan are exploring the viability of offering ambient geothermal systems in future markets.

Co-Benefits of a Low-Carbon Vaughan

The low-carbon scenario offers Vaughan more than just a net-zero future; it provides a suite of co-benefits associated with improved health outcomes, prosperity, opportunities for equity enhancement, and climate resilience. The IPCC defines co-benefits as "the positive effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on overall social welfare. Co-benefits are often subject to uncertainty and depend on local circumstances and implementation practices, among other factors."[11] Not all co-benefits are equal. One set of criteria by which to assess the co-benefits of initiatives and actions to reduce GHG emissions follows:[12]

- **Synergies:** Many low-carbon actions have multiple socio-economic benefits, including improving transit, energy efficiency, and compact urban design.
- **Costs:** The cost of early action is generally lower than that of later action, particularly because delayed action involves ongoing investments in infrastructure, activities, and utilities (e.g., renewable energy infrastructure, transit, energy efficiency) that are higher emitting than low-carbon solutions.
- **Urgency:** Some actions are associated with a higher degree of urgency to avoid loss of inertia on action already taken, lock-in effects,[13] irreversible outcomes, or deferred costs that become even more elevated due to deferment. Some low-carbon actions require time to realize their effects, making immediate implementation paramount.
- **Longevity:** Related to urgency, the longevity of investment decisions locks society into their effects for decades, if not centuries.
- **Distribution effects:** Low-carbon actions have different impacts on different population subsets including income groups, generations (including future generations), and ethnicities.

[11] Intergovernmental Panel on Climate Change. (2014). Annex II: Glossary [Agard, J., et al.] Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1762.

[12] Adapted from: Fay, Marianne; Hallegatte, Stephane; Vogt-Schilb, Adrien; Rozenberg, Julie; Narloch, Ulf; Kerr, Tom. 2015. Decarbonizing Development: Three Steps to a Zero-Carbon Future. Climate Change and Development;. © Washington, DC: World Bank. http://hdl.handle.net/10986/21842

[13] Lock-in effect refers to the implementation of a strategy or action (e.g., building upgrades, land use) that improves performance of an object or activity in the short term but is prohibitive to future change. As an example, where quick building retrofits are undertaken, no additional improvements in the equipment installed can be expected over the course of its lifetime without considerable additional expense. In this way, lower energy reduction levels can be locked in for a long period.

Air Quality and Health Benefits

Combusting fossil fuels for energy use releases air pollutants (e.g., sulphur dioxide, nitrogen oxides [NOx], particulate matter, carbon monoxide [CO], volatile organic compounds [VOC]) and can create ground-level ozone. These pollutants impact human health as they are breathed in during regular daily activities. For example, air pollution from traffic is linked to neurological disorders, bronchitis, asthma, and other respiratory illnesses. Often, low-income residents experience the impacts of air pollution to a greater extent compared to other residents, due to proximity to pollution sites, lack of indoor air filtration, and comorbidities. While a quantitative assessment of impact has not been conducted for Vaughan, in nearby Toronto, Toronto Public Health estimates that air pollution causes 1,300 premature deaths and 3,550 hospitalizations for heart and lung disease in that city each year.[14] A U.S.-based study of light-duty vehicle electrification in large metropolitan areas estimated that the health cost savings of eliminating fine particulate matter emissions from tailpipe pollution is between US$0.02 and US$0.12 per mile.[15] These health cost savings, when compared to those associated with a conventional vehicle, present a clear case for electrification in urban areas.

Indoors, natural gas stoves and fireplaces are shown to contribute to negative health impacts, especially for children.[16] Replacing these with electric units over time can further decrease negative health outcomes and associated human and financial costs.

Retrofitting existing buildings can also reduce indoor air pollutants (i.e., NOx, CO, and VOCs), reduce mold and dampness, and improve the thermal comfort of buildings. These changes can lead to health benefits such as reduced risk of cancer and cardiovascular, endocrine, respiratory, and cardiopulmonary illnesses.[17,18] Evidence also suggests that these improvements contribute to better mental health outcomes.[19]

By 2050, the low-carbon scenario projects a significant reduction in local fossil fuel combustion compared to the BAP scenario as vehicles and buildings are moved away from using fossil fuels, primarily from switching vehicles and building heating systems to electric sources.

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[14] City of Toronto. (2017). Avoiding the TRAP: Traffic-Related Air Pollution in Toronto and Options for Reducing Exposure. Technical Report. https://www.toronto.ca/legdocs/mmis/2017/pe/bgrd/backgroundfile-108667.pdf

[15] Choma, E. F., Evans, J. S., Hammitt, J. K., Gómez-Ibáñez, J. A., & Spengler, J. D. (2020). Assessing the health impacts of electric vehicles through air pollution in the United States. Environment International, 144, 106015.

[16] Seals, B. & Karasner, A. (2020). Gas Stoves: Health and Air Quality Impacts and Solutions. https://rmi.org/insight/gas-stoves-pollution-health

[17] Wu, F., Jacobs, D., Mitchell, C., Miller, D., & Karol, M. H. (2007). Improving Indoor Environmental Quality for Public Health: Impediments and Policy Recommendations. Environmental Health Perspectives, 115(6), 953–957. https://doi.org/10.1289/ehp.8986.

[18] Barton, A., Basham M., Foy C., Buckingham, K., & Somerville, M., on behalf of the Torbay Healthy Housing Group. (2007). The Watcombe Housing Study: the short term effect of improving housing conditions on the health of residents. Journal of Epidemiol Community Health, 61(9), 771e7.

[19] Bonnefoy, X. (2007). Inadequate housing and health: An overview. International Journal of Environment and Pollution, 30(3/4), 411. doi: 10.1504/IJEP.2007.014819

Active Transportation and Health Benefits

Vaughan is already planning to expand its active transportation network. Doing so using the most climate positive scenario identified by the City will not only lead to the greatest GHG reduction benefit but also to the greatest health outcomes for its residents. Evidence shows increased active transportation and routine physical exercise can lead to improvements in mental health.[20] A study of 828 workers in Portland, Oregon, found that those who travel by car or transit in heavily congested areas are less happy with their commutes than their counterparts who walk or bike.[21] Increasing walking and biking is one of the most significant ways to improve a community's public physical health. Health benefits from routine physical exercise include reductions in rates of diabetes, cancer, and heart-related illnesses.[22]

Equity

In the low-carbon scenario, increased equity is possible but not guaranteed. Equity is a broad term that encompasses fairness for many different demographics across many different situations, so the low-carbon scenario can only contribute to, not create, equity. In the context of climate planning, equity refers to the fairness and justice in the distribution of resources and opportunities to ensure that climate change does not disproportionately impact or increase the vulnerability of different population groups. The MEPR prioritized equity by engaging with and incorporating the perspectives of interested and affected communities in the development of climate actions and implementation policies. Some areas where the low-carbon scenario can contribute to equity are intergenerational equity, income inequality, global equity, and climate resilience.

Intergenerational Equity

As the impacts of climate change increase in frequency, duration, and severity, younger generations, and generations yet to be born, are and will be increasingly affected by the impacts of, and shoulder the responsibility for, reducing emissions generated by systems created by older and past generations. Addressing emissions in the short-term decreases that inequitable burden.

[20] Sampasa Kanyinga, H., Colman, I., Hamilton, H. A., & Chaput, J. P. (2020). Outdoor physical activity, compliance with the physical activity, screen time, and sleep duration recommendations, and excess weight among adolescents. Obesity Science & Practice, 6(2), 196–206.

[21] Smith, O. (March 1, 2017). "Commute Well-Being Differences by Mode: Evidence from Portland, Oregon, USA." Journal of Transport & Health, 4, 246–54. https://doi.org/10.1016/j.jth.2016.08.005.

[22] Canadian Society for Exercise Physiology. (2019). Canadian 24-Hour Movement Guidelines. Canadian Society for Exercise Physiology. https://csepguidelines.ca/

Income Inequality

We often hear that it is "expensive to be poor," and that is true in the low-carbon transition unless an effort is made to decrease the financial burden for individuals and families living on low incomes. For example, as the transition from fossil fuels to cleaner energy sources progresses, individuals still using fossil fuels will feel the impact of covering the fixed costs of those systems in the prices they pay for energy. In addition, those still using fossil fuels will be increasingly impacted by the rising carbon tax. If a person cannot transition due to the upfront cost, it could mean an increase in their ongoing costs. However, if individuals and families living on a low income are supported to make their homes and vehicles more efficient and transition away from fossil fuels, they could gain utility and fuel savings. The City and other levels of government must play a role in this and ensure that support is accessible for low-income earners. For example, instant rebates and other time-of-purchase financial supports may be more useful than post-purchase rebates.

Access to transit and active transportation can also increase equity. For individuals who do not own a vehicle, especially those who cannot own a vehicle due to cost, access to transit and active transportation increases the ability to get to services, appointments, activities, and employment. This is only possible if robust transit and active transportation networks are connected to both areas within the community where lower-income earners reside and to areas with employment opportunities and services.

Individuals living on low and fixed incomes are also more vulnerable to climate risks than wealthier individuals due to factors such as higher rates of comorbidities; limited access to transportation to flee during climate-related events; lack of air conditioning during heat-related events; and a lack of money for alternative accommodations, to prepare for climate-related events, or to repair or restore their dwellings after an event.

Global Equity

Globally, climate change is currently having a disproportionate impact on poorer nations, which experience more climate-related events and resulting mortality rates than wealthier nations. At the same time, many of these disproportionately impacted countries have contributed less than their wealthier counterparts to the increased use of fossil fuels that have led to the current climate crisis. Led by C40 Cities Climate Leadership Group (C40), many cities, including Vaughan, have set GHG reduction targets that acknowledge that cities in wealthier countries must act more rapidly to reduce emissions than cities struggling with widespread poverty.

Climate Resilience

Some actions that support reducing emissions can also increase a city's capacity to adapt to climate change impacts. Some of the key resilience co-benefits associated with Vaughan's low-carbon scenario include:

- Safer buildings during extreme weather events (e.g., flooding, extreme heat/cold) due to older buildings being retrofitted;
- Decreased impacts of power outages due to homes being fitted with renewable energy and storage systems;
- Decreased impacts of power outages on homes that are connected to district energy systems;
- Decreased stress on water and wastewater systems due to retrofits and more stringent efficiency standards for new buildings; and
- Increased back-up power from electric vehicles.

Economic Prosperity

The local economy will benefit from implementing the low-carbon scenario. Retrofitting buildings, installing renewable energy, and expanding the construction of active transportation networks all help to create jobs that can be held locally. Decreased utility and fuel costs can also reduce household and business costs, which offsets capital investments in low-carbon assets over time. All of these factors can be built into an economic strategy to encourage residents to buy locally to ensure more money stays within the community.


EXIT
Thornhill Room
2024 Earth Hour
VAUGHAN TOGETHER
FOR A GREENER FUTURE
City Hall
MAPLE
CORTELLUCCI
2024 Earth Hour
York Hill
P.E.S.
TAKEACT
CLIMAT
IS RE
"We are diverse
we are one"
St Agnes of Assisi
selected works from the
corporate art collection

Capturing an Economic Opportunity

Transitioning to a low-carbon economy will require investments in all community sectors from residents, businesses, institutions, the City of Vaughan, and other levels of government. The investments need to begin now and continue out to 2050. While the need for capital is high, the paybacks of the investments are higher, especially if they happen in the short term. The cumulative, undiscounted incremental expenditures and savings, have a capital investment of $11 billion, and savings, avoided cost of carbon, and revenue have a total of $11.42 billion.

After discounting at 3%[23], the capital investments in the low carbon actions have a net present value of $7.67 billion, and the savings, avoided cost of carbon, and revenue have a total return of $ 6.37 billion by the end of 2050.

This expected net return is based on revenue generation (valued at $726 million) and savings in operations and maintenance ($171 million), energy costs ($10.5 billion), and carbon taxes ($2.6 billion), all at a 3% discount rate. The overall investment across the community amounts to $7.5 billion (Figure 11, next page).

[23]< The discount rate is the baseline growth value an investor places on their investment dollar. An investor considers a project to be financially beneficial if it generates a real rate of return equal to or greater than their discount rate. 3% is the social discount rate recommended by the Treasury Board of Canada. A social discount rate is recommended for instances where a regulatory proposal primarily affects private consumption of goods and services, and a regulatory proposal's impacts occur over the long term (50 years or more).

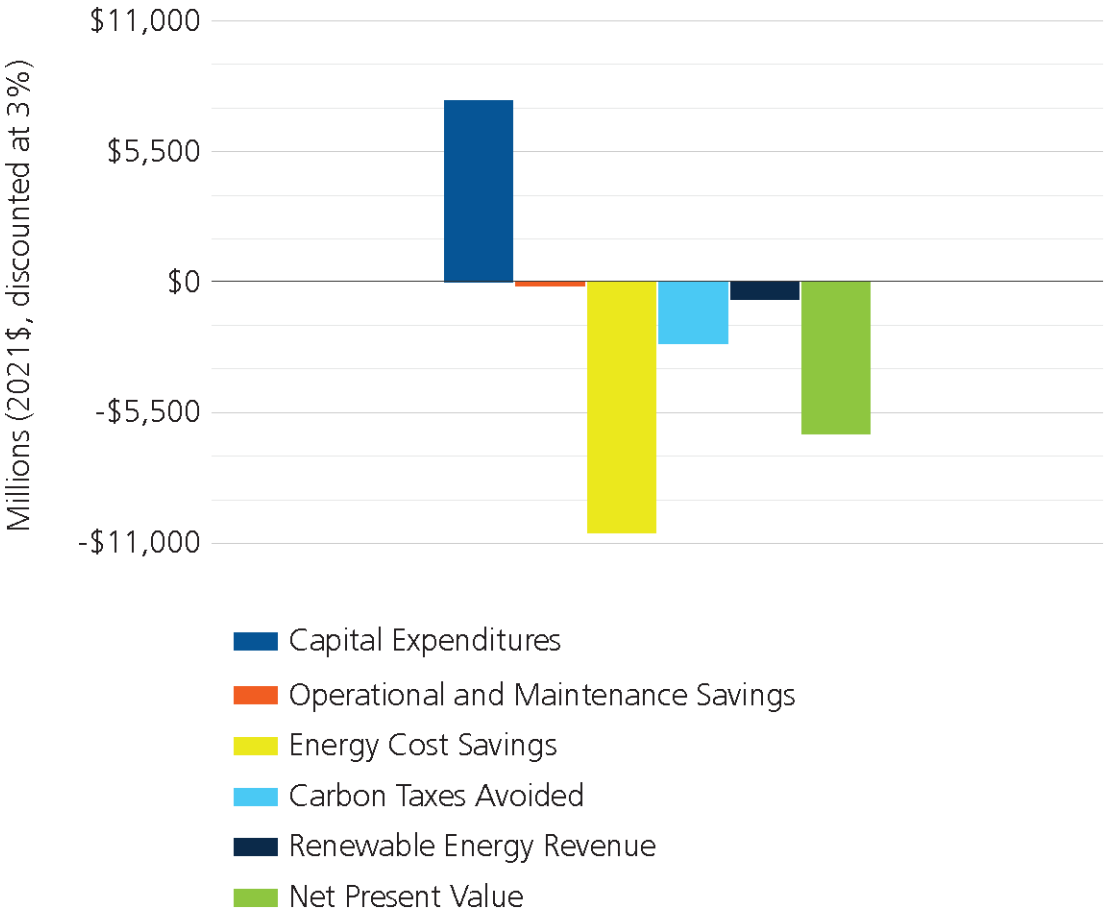

Figure 11. Projected net investments and returns between 2024 and 2050 resulting from the low-carbon scenario.

Transitioning to a low- or zero-carbon economy is expected to impact labour markets in four main ways: additional jobs will be created in emerging sectors, some employment will be shifted (e.g., from fossil fuels to renewables), certain jobs will be reduced or eliminated, and many existing jobs will be transformed and redefined. Specifically, more than 59,423 person-years of employment between 2024 and 2050. This equates to an average of 2,285 full-time equivalent jobs annually across all sectors. These jobs are primarily created by expanding transit, investing in residential retrofits, and investing in commercial and industrial retrofits

The financial analysis is developed at the low-carbon pathway level, meaning it represents total costs across the community and does not allocate costs or savings specifically to the municipality or other sectors or investors, although it does assign costs to current asset owners. Actual costs to the municipality are dependent on third-party funding available for actions the municipality will take directly (e.g., in its own buildings and fleets) and the degree to which the municipal government chooses to invest in certain actions and incentivize other sectors. Implementing the MEP requires investigating all financial tools available to the

municipal government and other community stakeholders including individuals, businesses, and other levels of government. The financial analysis does not include incentives and rebates currently available to residents and businesses through local, provincial, and federal programs.

Financial Scenario Limitations

The financial scenario is a current best-guess estimated cost of implementing the MEP, but it is very sensitive to change. For example, if a new technology is introduced that causes individuals to make currently unexpected changes to reduce emissions, this might change the scenario's financials.

The financial scenario is also sensitive to changes in energy prices. As seen in recent years, energy prices can fluctuate widely based on global events such as pandemics and wars. These events cannot be reliably predicted, but could greatly impact the financial scenario. For example, if the change in natural gas prices were to increase while electricity prices remained stable, or vice versa, the price of the scenario would change drastically and may push individuals and governments to make different choices about energy sources.

To achieve the emissions reductions targets, all of the MEP actions need to be implemented. When other funding from other levels of government have already been considered or applied, it makes sense for the City to intervene and provide financial support for actions that do not have a payback that is attractive to individual residents or businesses. When there is a clear and timely financial payback for community members, the City's role is to educate and support using non-financial mechanisms. The MEP Implementation Framework provides initial recommendations on how the City can use both financial and non-financial mechanisms to support its residents and community sectors to take action.

For a more detailed financial analysis, please review the Ancillary Report: Financial Analysis.

Starting the Journey to Net-Zero Emissions

New Choices on the Horizon

Enbridge is piloting hybrid heating programs and incentives. The current program involves an incentive for residents to install an electric air-source heat pump in their home while keeping their natural gas furnace as a secondary heating source. Residents can switch between the two systems, via controls, to maximize savings or GHG reductions. A preliminary assessment shows that this program reduces but does not eliminate GHGs. In the future, the hybrid system could eliminate household GHGs if the availability of affordable RNG increases. This could lead to a decrease in costs for households to transition to clean energy, given that they would be keeping a current heating source. However, depending on when RNG availability increases, it could shift when emissions reductions are achieved. Regardless, building retrofits that decrease energy needs, while increasing efficiency and the comfort of the home, are still recommended.

The MEP is an ambitious plan that spans every sector of the community to achieve net-zero emissions by 2050. It relies on a whole-city approach in which staff members and departments advance the MEP's objectives and targets to meet the City's long-term target. While climate action is essential, not all the required changes can happen at once. Over the next year, the City can take the following key steps to set the foundation that will ensure climate action remains a priority for it and the broader community.

1

Adopt a carbon budget

A global carbon budget is the maximum amount of GHG emissions that can be emitted world-wide without increasing the global average temperature above 1.5°C. Increasingly, municipalities across Canada are adopting a municipal carbon budget. A carbon budget is a tool to transform municipal GHG emission targets into funded and measurable actions across the city. As such, a carbon budget is a management system to align the City's plans and expenditures (operating and capital) with its GHG reduction targets. Implementing a carbon budget will support the City of Vaughan and the community in:

- Achieving the GHG emissions reduction targets by implementing a new management system that integrates GHG emissions impacts into City decision-making processes;
- Aligning expenditures and investments with GHG targets and building capacity and expertise across the organization; and
- Providing transparent accountability by publishing an Annual Carbon Budget Report and a GHG Inventory.

2

Dedicate staff to manage the MEP implementation

Implementing the MEP will require a concerted effort by city staff and departments. Dedicating staff to oversee coordinating the MEP's implementation will ensure the City is on track to meet its interim 2030 reduction goal, while planning ahead to create future programs that will ensure net-zero emissions by 2050. It is recommended that the City, dedicate one staff member to oversee the implementation of the MEP's Implementation Framework, and develop an annual work plan identifying activities, budgets and schedules to achieve each implementation action. In addition, establishing a cross-departmental working group of City staff to:

- Discuss the allocation of the Implementation Framework into departmental work plans;
- Identify internal operational and capital funding opportunities for each implementation mechanism;
- Determine the City's role in each action and identify internal lead departments;
- Adaptively respond to changes in implementation mechanisms, external funding opportunities, and technological developments; and
- Engage external project leads, sponsors, and supports.

3

Apply an equity lens

Applying an equity lens assessment to climate change mitigation and resilience projects and programs is a first step to ensure that intergenerational equity, income inequality, global equity, and climate resilience are considered in policies, programs, and initiatives. This action can be further enhanced through continued collaboration and information sharing about climate change with community grassroots organizations and nonprofit organizations in a way that builds trust with the City.

As these foundational pieces are put into place, the City can plan how to operationalize the implementation actions outlined in Appendix A: Implementation Framework over the next five years. But climate action is not just about the actions the community takes today; it is also about the legacy it leaves for future generations. Committing to meaningful actions in the fight against climate change is required, and this plan represents an important step in that direction. With collaboration and a shared sense of purpose, the City of Vaughan can achieve its net-zero emissions by 2050 target.


Thornhill Room
2024 Earth Hour
St. Gabriel
C.E.S.
2024 Earth Hour
Glenn Gould
P.E.S.

Appendix A: Implementation Framework

Context

The purpose of the following short-term Implementation Framework (Framework) is to actively guide progress on the low-carbon pathway outlined in the 2024 MEP between 2024 and 2030.

The direction of the low-carbon pathway is driven by the target of net-zero emissions by 2050. However, the specific strategies to achieve this target is influenced by several factors, including:

- Input from the Municipal Energy Plan Revision (MEPR) Project Advisory Committee,
- Input from the community via community workshops and survey responses,
- Input from the development and construction industry via a sector specific workshop,
- Research on best practices,
- Consultant experience from other projects.

Partnerships are critical to the success of the MEP. Although this Framework outlines City-led initiatives, the City will need to leverage resources and leadership from various community partners, including industry, businesses, utilities, and institutions. Additionally, securing funding, resources, and enabling policies from higher levels of government and municipal partners will be vital in achieving the targets set by the MEP.

How the Guide is Organized

The Framework is divided into the following three sections:

Section 1: Governance and Administration details the governance structures and administrative processes required to successfully implement the low-carbon pillars.

Section 2: Low-Carbon Pillars details the actions across the six focus areas identified in the MEP. It is important to note that actions within each focus area are interconnected and mutually reinforce one another, as there is considerable overlap between the programs, initiatives, policies, and infrastructure recommendations. These six focus areas are:

1. Retrofitting buildings;
2. Building net-zero new construction;
3. Generating renewable energy;
4. Reducing vehicle emissions;
5. Increasing active transportation and transit use; and
6. Reducing waste emissions.

Section 3: Funding Opportunities provides a summary of potential funding opportunities the City and community members can access to fund the actions.

Key Definitions

Each low-carbon pillar is divided into the Action Overview and Detailed Sub-Actions. The Action Overview section details the action, the 2050 modelled low carbon targets, the GHG impact, and the modelled investment. The Detailed Sub-Actions provides a description of the implementation mechanism, the internal impact, the city's role, the implementation timeframe, and tracking metrics. Due to the overlap in interested and affected parties[24], a summary of these has been provided for each low-carbon pillar.

Action Overview

Action: The title of the action that helps achieve the Low-Carbon Pillar in the MEP's low-carbon pathway.

2050 Modelled Low Carbon Target: A description of the low-carbon pathway's 2050 modelled target related to the action.

Total Modelled Investment: The estimated funding required across all sectors between 2024 and 2030 to implement the actions. The investment does not include the savings from avoided carbon tax, energy savings, operation and maintenance, and revenue generation. The investment costs can be provided by a variety of sources, such as funding opportunities identified in the Section 3. This is a high-level estimate that may change with further study and action refinement.

Detailed Sub-Actions

Sub-Action: A brief description of the programs, initiatives, policies, and infrastructure required to implement each action. These are further expanded upon in the table below.

MECHANISM	DEFINITION
Policy	A policy developed by the Municipality, and approved by Council.
Program	An ongoing effort by the Municipality, with staff and financing to support the effort.
Initiative	A study or project, undertaken by the Municipality, private sector, not-for-profit sector, or other sectors, individually or collaboratively, with a specific focus, that is implemented for a set time period.
Infrastructure	Investment in physical infrastructure by the municipality or private sector, not-for-profit sector, or other sectors, individually or collaboratively.
Advocacy	An activity undertaken by the Municipality that demonstrates leadership and/or feasibility to the community.
Education	An activity undertaken by the Municipality to raise awareness and increase knowledge within the community.

Internal Impact: Summarizes the anticipated internal impacts of each sub-action. These

[24] Organizations that have a vested interest in these actions and should be engaged and/or informed during implementation.

include resources to initiate the action; internal communications and engagement fees; and anticipated costs to be incurred by the City to implement City-led initiatives, such as consulting fees to complete feasibility studies. This is an initial estimate, subject to change as additional investments may be necessary following further study and refinement of actions. In addition, many of the initial steps of the actions are to investigate opportunities and begin planning for specific implementation mechanisms. As opportunities are investigated, the City will better understand what additional investments need to be made into programs, which can be integrated into the City's annual budget review process.

Project Lead, Sponsors, and Support: Highlights the City's role as either the project lead, project sponsor, or project support.

- **Project Lead:** Organization responsible for executing and overseeing the sub-action from initiation to completion. The project lead's primary role is to manage project activities, resources, and risks. They act as the central point of communication for the action.
- **Project Sponsor:** Organization required to champion the action. They will need to be engaged to ensure the action is implemented, and may be responsible for providing funding.
- **Project Support:** Organization with a range of roles and functions that assist the project lead and the project sponsor in various aspects of the action.

Tracking Metrics: The method and measurement unit for measuring the impact of the action taken. All metrics should be analyzed on an annual basis for those actions that are being actively implemented.

Section 1: Governance and Administration

This first section of Vaughan's Implementation Framework focuses on building internal capacity to efficiently implement the actions associated with the Low-Carbon Pillars. The City's Climate Change team within the Policy Planning and Special Programs department will be responsible for overseeing and planning the implementation of the 2024 MEP. The Governance and Administration actions lay out the important first steps to determine the City's level of involvement for each action and lead departments, launching the monitoring and evaluation framework, and engaging community members.

Action A: Incorporate climate change mitigation into all corporate decision-making and planning in current and future processes

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	TRACKING METRIC(S)
A.1 Initiative: Provide training and workshops to City staff on climate change mitigation and adaptation.	Staff time	Percent of staff completed training
A.2 Policy: Develop carbon budget to integrate climate mitigation into the City's budgeting process, and require that administrative/staff reports to Council include an assessment of greenhouse gas emission impacts.	Staff time	Carbon budget is adopted by Council in 2024 Corporate carbon budget is implemented in 2026 Community carbon budget is implemented in 2028

Action B: Develop and implement a community wide education campaign on climate mitigation

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	TRACKING METRIC(S)
B.1 Initiative: Define climate vulnerable populations in alignment with the City of Vaughan's Diversity, Equity and Inclusion Strategy, and with support from the Anti-Hate, Diversity, and Inclusion Advisory Committee.	Staff time	Climate vulnerable populations defined and identified Published in Diversity, Inclusion, and Equity materials
B.2 Education: Publish a toolkit and/or guidance for private businesses and organizations to follow based on the City's GHG reduction experience.	Staff time	Toolkit published
B.3 Initiative: Develop a communications strategy for the implementation of MEP that includes a baseline assessment of community member's climate change knowledge and identifies education needs.	Staff time	Communications reach

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	TRACKING METRIC(S)
B.4 Education: Develop proactive education and information campaigns with partners that the public trusts and who can distribute information (libraries, non-profits, businesses, radio stations, etc.). Identify partners who can assist the City in engaging with vulnerable populations (Action B.1).	Staff time	Number of partners engaged Communications reach

Action C: Monitor and report on climate change mitigation

How will the City monitor progress?

Monitoring and evaluating the City's progress towards its GHG emission targets and Framework will allow the City to adaptively manage the plan and respond to advancements in technology and resources. GHG emission targets can be tracked by completing an annual GHG inventory in accordance with the GHG Protocol for Community-Scale (GPC) GHG Inventories and updating the modelling for the baseline and three scenarios (BAU, BAP, and low-carbon) during the 5-year update of the MEP. Completing an annual GHG inventory and disclosing to the Carbon Disclosure Project (CDP) will provide insights into the progress made towards achieving the 2030 GHG targets. As the largest disclosure program, the CDP offers a standardized and transparent approach for all sectors to measure and manage their climate action. The 5-year MEP update provides a more detailed means to track GHG emissions reductions and projections, and will allow the City to identify additional actions to reach the net-zero emissions by 2050 target. The Implementation Framework identifies six actions to monitor the MEP progress. In addition, the carbon budget (Action A.3) will be an important tool for the City to monitor the GHG impacts of corporate capital and operating projects.

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	TRACKING METRIC(S)
C.1 Program: Establish a cross-departmental working group of City staff to:[25] • Discuss the allocation of the Implementation Framework into departmental work plans; • Identify internal operational and capital funding opportunities for each implementation mechanism; • Determine the City's role in each action and identify internal lead departments; • Adaptively respond to changes in implementation mechanisms, external funding opportunities, and technological developments; and • Engage external project leads, sponsors, and supports.	Staff time	Working group participants identified Working group convened Quarterly meetings hosted
C.2 Program: Dedicate one staff member to oversee the implementation of the MEP's Implementation Framework, and develop an annual work plan identifying activities, budgets and schedules to achieve each implementation action.	1 FTE salary and compensation benefits	Annual workplan developed and reviewed
C.3 Program: Track, update, and share annual progress on the MEP's implementation. The annual progress reporting can include reporting on the progress of the Implementation Framework's tracking metrics, investigating opportunities to update implementation actions in response to changes in technology and resources.	Staff time	Implementation report complete
C.4 Program: Complete an annual GHG inventory according to the GPC GHG Inventories, and submit annual reporting to the CDP.	Staff time Consulting fees for annual GHG emissions inventory (if used): $10,000 - $20,000 per inventory	Annual GHG inventory completed Annual CDP submission completed

[25] Once the cross-departmental working group is established, the City can either invite community members (including youth) to attend quarterly meetings or develop an MEP Community Working Group. Community participation will be key to building partnerships and identifying project champions.

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	TRACKING METRIC(S)
C.5 Program: Assign staff person to track and manage funding applications for monitoring and reporting.	Staff time	Number of annual funding applications submitted
C.6 Initiative: Review and update MEP every five years.	Staff time $50,000 in modelling fees, plus additional consulting fees to develop Plan and Framework	MEP update completed

Section 2: Low-Carbon Pillars

Section 2 is designed to generate momentum for Vaughan's low-carbon pillars by identifying actions and supporting sub-actions to decrease emissions. The Framework is designed to be a living document, as circumstances evolve (e.g., community champions are identified, funding becomes available, technologies change), the Implementation Framework should be updated to reflect new opportunities and advancements.

Pillar 1: Retrofitting Buildings

Building emissions result from heating, cooling, and lighting spaces, and running appliances and equipment. These emissions come from all types of buildings in the community, including homes, schools, offices, stores, and industrial spaces. The most cost-effective approach is to first maximize energy efficiency before incorporating renewable energy sources or fuel switching. This approach improves energy efficiency in homes and buildings, reduces energy costs, and enables significant emissions reductions as the power grid becomes cleaner. To make buildings more efficient, they can be retrofitted by replacing windows and doors, increasing insulation, replacing weather stripping, and replacing inefficient heating systems with more efficient technologies such as heat pumps or hybrid heating systems. In turn, these retrofitted buildings use less energy overall, whether the energy comes from a renewable source or not. This decreases emissions from the baseline and the amount of renewable energy required later to meet community needs. The following interested and affected parties have been identified to support the implementation of the retrofitting buildings actions:

- Alectra Utilities
- Enbridge Gas
- TransPower Utility Contractors
- Local developers (e.g., Building Industry and Land Development [BILD] York Region Chapter)
- Local construction companies (e.g., Residential Construction Council of Ontario [RESCON] can be a resource for beginning engagement with local construction companies)
- Post-secondary education institutions
- Ontario Landlords Association
- Local manufacturers and trades associations
- Canada Green Building Council
- Ontario Government
- Canada-Ontario Housing Benefit (COHB)
- Housing Services Corporation
- Clean Air Partnership
- The Atmospheric Fund

- Toronto and Region Conservation Authority (TRCA)
- At-risk and affordable housing groups (e.g., Local Diversity and Immigration Partnership Council)
- Vaughan Chamber of Commerce

Building On Success: The City's Decarbonization Efforts

The City of Vaughan has already successfully implemented several initiatives to support the decarbonization of existing buildings. These include:

1. Collaborating with the Toronto and Region Conservation Authority (TRCA) to implement a Sustainable Neighbourhood Action Program (SNAP) in a neighbourhood in Thornhill. Council approved the Thornhill SNAP Action Plan in September 2021, which included a Residential Retrofit Program.
2. Conducting an outreach study with commercial building owners to raise awareness of the Government of Ontario's Reporting of Energy Consumption and Water Use Regulation, which requires commercial buildings to annually report on energy-use.
3. The City of Vaughan's Corporate Energy Management Plan outlines proposed conservation and energy efficiency measures, cost and savings estimates, an implementation plan, and energy consumptions and GHG emissions reduction targets for municipally owned and operated facilities.

Action 1.1 Develop retrofit program for residential and ICI buildings

What is a deep retrofit?

A deep retrofit program is designed to improve the energy efficiency of a building and as a result improve building quality. These programs are designed to overhaul all systems of the building, such as replacing existing HVAC systems with electric heat pumps, replacing the roof, and maximizing solar gain through reconfiguring windows. A deep retrofit typically reduces a building's energy consumption by 50% or more. Further reductions in energy consumption can be achieved through minor retrofits such as insulation improvements and installation of LEDs.

However, retrofitting buildings one by one will not suffice to meet Vaughan's targets, and bulk retrofits will be required to retrofit several housing units at one time. Energiesprong, a Dutch public-private partnership, has pioneered a semi-industrialized net-zero energy retrofit package and applied this approach to approximately 5,000 low- and mid-rise multifamily retrofits, with roughly another 100,000 units of multifamily demand aggregated across Europe. Similar projects are underway in Edmonton, and the City of Seattle has developed an Energy Efficiency as a Service (EEaS) contract mechanism to transform deep retrofits into power purchase agreements. Conducting a feasibility study through a pilot bulk retrofit program can help tailor and refine the approach to suit Vaughan's local conditions.

Action 1.1 Overview

ACTION 1.1 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	All residential, and institutional, commercial and industrial (ICI) buildings are retrofitted to achieve a 50% reduction in thermal energy and 10% reduction in electrical savings using the following schedule: • By 2040, 70% of the existing buildings are retrofitted; and • By 2050, 100% of the existing buildings are retrofitted.
MODELLED INVESTMENT (2024 -2030):	Residential: $14 million ICI: $29.5 million Note: retrofitting building performance and fuel switching investments were modelled together.

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
Residential Buildings			
1.1.1 Program: Implement the Home Energy Retrofit (similar to a Property Assessed Clean Energy [PACE]) program based on the recommendations of the Local Improvement Charges (LIC) study.	Staff time Consulting firm fees to develop a Home Energy Retrofit feasibility study (if used): approx. $130,000	Project Lead	Home Energy Retrofit program implemented
1.1.2 Program: Using the City of Vaughan Study Report for a Home Energy Retrofit Program conduct feasibility study to investigate an incentive program to conduct bulk energy retrofits and provide larger incentives for lower-income housing dwellers and individuals earning less than 80% of the average household income. Note: Integrate with Action 1.1.1	Staff time Consulting firm fees to develop feasibility study (if used): approx. $130,000	Project Lead	Feasibility study completed
1.1.3 Initiative/Program: Investigate opportunity to expand the SNAP to another neighbourhood across Vaughan and implement Residential Retrofit Program in low-income housing and vulnerable populations. Note: integrate with Actions 1.1.1 and 1.1.2.	Staff time	Project Lead Note: include the TRCA as a co-lead or project sponsor.	SNAP program expanded
1.1.4 Program/Initiative: Investigate additional financing opportunities for residents to make retrofits and potentially stack with the City of Vaughan's Home Energy Retrofit Program.	Staff time	Project Lead	Research completed
1.1.5 Education: Clearly communicate and promote existing programs and incentive stacking opportunities that residents can take advantage of through federal, provincial, regional, utility, and other local government programs.	Staff time Internal digital communications fees	Project Lead	Number of education techniques used Number of people reached through education efforts

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
1.1.6 Education: Educate residents on the opportunities and pathways to reach net-zero based on their home. This includes building awareness of the different types of energy retrofits that can be completed in their homes, the benefits of energy retrofits and heat pumps, qualified energy auditors and local contractors that can conduct energy retrofits. Note: integrate with Action 1.1.5	Staff time Internal digital communications fees	Project Lead	Number of education techniques used Number of people reached through education efforts
1.1.7 Advocacy: Advocate the Provincial and Federal government, construction industry, and local post-secondary education institutions, including trades schools to develop a labour and training strategy to meet building retrofit targets.	Staff time	Project Support Note: potential project leads include the CAP and TAF.	Advocacy completed
ICI Buildings			
1.1.8 Program: Investigate opportunity to develop a Commercial Property Assessed Clean Energy (C-PACE) program or expand the Home Energy Retrofit Program to include ICI buildings. Note: Integrate with Action 1.1.1	Staff time Consulting firm fees to develop a Commercial Energy Retrofit feasibility study (if used): approx. $130,000	Project Lead	Home Energy Retrofit program implemented

Action 1.2 Implement retrofit schedule for municipal buildings as identified in the Corporate Energy Management Plan

Action 1.2 Overview

ACTION 1.2 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	All municipal buildings are retrofitted to achieve the long-term goal of eliminating GHG emissions associated with building operations by 2050 using the following schedule: • By 2024, building energy consumption is reduced by 9%, and natural gas consumption is reduced by 10%, relative to the 2017 levels; and • By 2030, building energy consumption is reduced by 14%, and natural gas consumption is reduced by 37%, relative to the 2017 levels.
MODELLED INVESTMENT (2024 -2030):	Not modelled

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
1.2.1 Policy: Undertake review of Corporate Energy Management Plan to develop strategy for achieving net-zero emissions and provide guidance on investments for all departments. Consider integrating into the City's Asset Management Plan so replacements and cost estimates reflect energy reduction needs. Note: the corporate carbon budget (Action A.2) provides a decision-making tool to analyze corporate capital and operations investments based on an annual GHG surplus or deficit.	Staff time Consulting firm fees to complete review of the Corporate Energy Management Plan (if used): approx. $130,000	Project Lead	Number of buildings retrofitted

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
1.2.2 Program: Implement a revolving energy fund that directs cost savings generated from retrofits to future low-carbon investments. Revolving funds, or Green Revolving Funds (GRF), provide a unique opportunity to pay forward the success of efficiency projects into future projects. A green revolving fund finances projects by tracking utility savings, fuel savings, or other cost savings associated with efficiency upgrades, and paying those savings back into a common fund. GRFs should reduce resource consumption or reduce emissions, and produce savings from operations.	Staff time Capital and operating funding to launch GRF	Project Lead	GRF launched Number of projects financed through GRF

Action 1.3 Develop retrofit program for electric heat pumps and water heaters for all residential and non-residential buildings

Action 1.3 Overview

ACTION 1.3 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	By 2050, all residential and non-residential buildings are retrofitted with electric heat pumps and water heaters using the following schedule: • By 2040, 70% of the existing buildings are retrofitted; and • By 2050, 100% of the existing buildings are retrofitted.
MODELLED INVESTMENT (2024 -2030):	Residential: $14 million ICI: $29.5 million Note: retrofitting building performance and fuel switching were investments were modelled together.

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
1.3.1 Program: Identify eligible households and implement a targeted program for installing hybrid heating, heat pumps, and electric water heaters in lower-income or at-risk households (e.g., senior centers, support housing), alongside measures that increase efficiency. For example, explore a program to connect heat pump manufacturers and installers with lower-income households to discount the incentive of the heat pump at the time of purchase.[26]	Staff time	Project Lead Potential Project Support: York Region	List of eligible households identified Partnerships established (i.e., manufacturers, installers, or private funders) to fund program The annual number of heat pumps and electric water heaters installed at lower income or at-risk houses
1.3.2 Program: Develop an interim program to support hybrid heating systems for residents. A hybrid heating system is comprised of an electric heat pump with smart controls and a natural gas furnace.	Staff time	Project Lead Potential Project Support: York Region	Program launched Number of hybrid heating systems installed
1.3.3 Program: Develop fuel-switching programs for all buildings. A fuel switching program that includes the installation of hybrid heating, air or ground-source heat pumps, and electric water heaters can be combined with building retrofits, or carried out as a separate program. This program will increase energy efficiency in homes and buildings, decrease energy costs, and enable deep emissions reductions as the grid becomes cleaner. The installation and maintenance of heat pumps creates local jobs and stimulates local businesses.	Staff Time	Project Lead Potential Project Support: York Region	Number of heat pumps and electric water heaters installed Number of building with heat pumps and electric water heaters

[26] Programs supporting eligible homes that meet income qualification requirements provide rebate coverage based on the number of people living in the home and the income level, for example the CleanBC program provides up to 95% of the upgrade costs. The approximate installation cost for a residential heat pump ranges from $15,000 to $32,000, if following a similar rebate coverage based on number of people living in the home and income level the program should anticipate to cover up to 95% of the eligible installation costs.

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
1.3.4 Education/Initiative: Develop and implement a communications and engagement plan to educate the community about the benefits and feasibility of hybrid heating, electric heat pumps and water heaters, and federal, provincial, and regional rebates and grant programs. For example, engagement events and campaigns can include open houses hosted at locations with electric heat pumps and water heaters, speaker-series and educational webinars, and social media campaigns.	Staff time Communications fees	Project Lead	Communication and engagement plan developed and implemented Number of campaigns developed and number of engagement events hosted Number of community members reached (e.g., website visits, social media campaign reach)

Pillar 2: Building Net-Zero New Construction

Planning for net-zero homes is essential in the coming decade, but there are advantages to taking action earlier. With expected significant growth in Vaughan, encouraging net-zero new construction now will result in fewer buildings contributing to GHG emissions in the community and reduce the need for future retrofits. Choices made today regarding buildings and building systems will have a lasting impact on emissions for decades to come, either increasing or decreasing the burden on future generations. Increasing the proportion of net-zero builds over time will also help prepare the workforce for industry-wide changes by 2030. The following interested and affected parties have been identified to support the implementation of the net-zero construction:

- Alectra Utilities
- Enbridge Gas
- TransPower Utility Contractors
- Local developers (e.g., Building Industry and Land Development [BILD] York Region Chapter)
- Local construction companies (e.g., Residential Construction Council of Ontario [RESCON] can be a resource for beginning engagement with local construction companies)
- Post-secondary education institutions
- Ontario Landlords Association
- Local manufacturers and trades associations
- Canada Green Building Council
- Ontario Government

- Canada-Ontario Housing Benefit (COHB)
- Housing Services Corporation
- Clean Air Partnership
- The Atmospheric Fund
- Toronto and Region Conservation Authority (TRCA)
- At-risk and affordable housing groups (e.g., Local Diversity and Immigration Partnership Council)
- Vaughan Chamber of Commerce

Building On Success: The City's Sustainability Metrics Program

Vaughan has implemented a Sustainability Metrics Program (SMP) as part of the development application review process. The SMP provides developers with a menu of Sustainability Metrics and Thresholds. Currently, development applications in Vaughan, such as Site Plans, Draft Plans of Subdivision, and Block Plans, are required to meet a minimum threshold score based on sustainability actions in mobility and transportation, energy efficiency, green space, and occupant well-being.

The SMP's IB-12: Building Energy Efficiency, Greenhouse Gas Reduction, and Resilience metric promotes buildings that are designed to be energy-efficient with reduced operating costs and greenhouse gas emissions associated with building operations, while improving the thermal comfort of occupants and enhancing building resilience. To achieve an excellent or exceptional level of performance, buildings must be constructed to near-net zero emissions or achieve Canadian Home Builders Association's Net Zero Homes or Passive House certification.

Discussions with the building sector throughout the project revealed a need for clear regulations, policies, and by-laws that would impact the sector, as well as transparent and advanced communications whenever possible. The City's low-carbon pathway aligns with the Sustainability Metrics Program, however early adoption of Net Zero Energy Ready (NZER) and Net Zero Energy (NZE) building performance can be promoted through additional developer incentives, such as development charge rebates.

Action 2.1 All new residential construction is net-zero ready in accordance with the CHBA Net Zero Home Labelling Program or Passive House Standards, and all new ICI buildings are built to achieve net-zero by 2050

Action 2.1 Overview

ACTION 2.1 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	By 2050, all new residential buildings are designed and constructed in accordance with the CHBA Net Zero Energy Labelling Program or Passive House Canada. By 2050, all new commercial and industrial buildings achieve a 50% energy improvement, and office and retail buildings achieve a Greenhouse Gas Intensity (GHGI) target of 15 kgCO2/m2/year by 2030, and 5 kgCO2/m2/year by 2050.
MODELLED INVESTMENT (2024 -2030):	Residential: $3.86 million ICI: $149.7 million

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
2.1.1 Program: Investigate and implement an incentive program to encourage the adoption of the SMP higher energy performance standards.	Staff time	Project Lead Potential project supports: City of Brampton, Town of Richmondhill, City of Markham, York Region, and The Atmospheric Fund	Incentives study completed Incentive program funded and implemented for energy performance standards The number of development applications approved using the higher performance standards in the SMP
2.1.2 Education: Educate developers, planners, and builders on the SMP and opportunities to achieve higher performance standards.	Staff time Internal communications fees	Project Lead	Education materials developed Number of developers, planners, and builders engaged

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
2.1.3 Advocacy: Identify organizations to advocate for training and micro-credential programs for skilled tradespeople to increase their knowledge and skills around efficient building practices.	Staff time	Project Lead	At least one project sponsor, support, or partnership identified Increase number of training and micro-credential programs available regarding efficient building practices

Action 2.2 All new municipal construction is net-zero ready and Passive House certified

Detailed Sub-Actions

ACTION 2.2 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	As of 2023, all new municipal buildings are designed and constructed to achieve NZER, and by 2030, all new municipal buildings are designed and constructed to achieve Passive House certification.
MODELLED INVESTMENT (2024 -2030):	Not modelled

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
2.2.1 Policy: Adopt a policy that commits the City to constructing all new municipal facilities to meet NZER and Passive House standards. Note: the corporate carbon budget (Action A.2) provides a decision-making tool to analyze corporate capital and operations investments based on an annual GHG surplus or deficit.	Staff time	Project Lead	Policy is adopted

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
2.2.2 Initiative/Education: Conduct public engagement to share progress on the City's new net-zero construction, host public demonstrations, and share information on the results.	Staff time Internal communications fees	Project Lead	Number of communication actions completed Number of community members reached (e.g., website visits, social media campaign reach)

Pillar 3: Generating Renewable Energy

Renewable energy generation plays a significant role in reducing GHG emissions. Coupling renewable energy generation with energy efficiency improvements will offset some of the challenges with meeting the current energy demands with renewable energy. Since Vaughan does not have local community-scale renewable energy generation, in order to meet the renewable energy targets Vaughan will need to:

1. Implement supportive programs, policy frameworks, external funding, and labour and training strategies to facilitate large-scale rooftop solar PV installations, similar to building retrofits.
2. Promote large-scale ground-mount solar photovoltaics (PV) installations in parking lots. A community-scale funding model could be explored, where community members who invest in the project distribute the costs of installation, operation, and maintenance, ensuring the generation of low-emission energy.
3. Conduct feasibility studies to explore the installation of district energy systems in new high-density and mixed-use neighbourhoods. This will provide an energy-efficient solution for heating buildings in these areas.

Immediate efforts are needed to establish programs for new builds and make rooftop solar PV an attractive option for retrofits. New build installations could be coupled with developer incentives for NZER and NZE buildings under the SMP. Additionally, by implementing solar PV installations on municipal buildings, the City can demonstrate its commitment to renewable energy and provide transparency on feasibility, cost, and outcomes. The following interested and affected parties have been identified to support the implementation of the generating renewable energy actions:

- Alectra Utilities
- Enbridge Gas
- TransPower Utility Contractors
- Local developers (e.g., Building Industry and Land Development [BILD] York Region Chapter)
- Local construction companies (e.g., Residential Construction Council of Ontario

[RESCON] can be a resource for beginning engagement with local construction companies)

- Post-secondary education institutions (e.g., Ontario Tech University, Durham College Geothermal Field and Energy Innovation Centre, Trent University)
- Ontario Landlords Association
- Local manufacturers and trades association
- Canada Green Building Council
- Ontario Government
- Windfall Ecology Centre
- Canada-Ontario Housing Benefit (COHB)
- Housing Services Corporation
- Clean Air Partnership
- The Atmospheric Fund
- At-risk and affordable housing groups (e.g., Local Diversity and Immigration Partnership Council)

Action 3.1 Increase local renewable energy generation through installing rooftop solar photovoltaics and ground-mount solar photovoltaics

Action 3.1 Overview

ACTION 3.1 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	By 2050, Vaughan will increase renewable energy generation by achieving the following installation capacities: • 23 MW capacity installed using greenfield solar farms; • 1970 MW capacity installed on available rooftops; and • Ground mount PV installed in 50% of existing parking lots.
MODELLED INVESTMENT (2024 -2030):	$20.42 million

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
3.1.1 Infrastructure: Develop plan for community-scale solar farms on greenfield sites and ground mount solar in existing parking lots. Determine how the municipality can best contribute to the development of local solar farms and installation in existing parking lots (e.g. as an investor, providing land in-kind or at reduced cost, acting as a promoter).	Staff time	Project Lead	Plan completed First solar farm installed First ground mount PV installed
3.1.2 Program/Initiative: Create an inventory of all programs, funding, and support mechanisms available to building owners in Vaughan to add solar PVs to rooftop and parking lots and analyze opportunities and gaps.	Staff time	Project Lead	Inventory of opportunities and gaps completed Inventory is used to support the implementation of Actions 3.1.3 and 3.1.5
3.1.3 Education: Educate building owners on programs, funding, and support mechanisms available to install solar PVs, and of the feasibility of these installations in Vaughan.	Staff time Internal communications fees	Project lead	Number of education programs completed on an annual basis Number of building owners engaged with on an annual basis
3.1.4 Program: Investigate funding and financing tools (i.e., the Home Energy Retrofit Program) to add rooftop solar PVs to residential and ICI buildings. Determine the City's role and identify required partners.	Staff time Potential feasibility study fees are identified in Action 1.1.1[27]	Project Lead	Financing and funding tools investigated Tools presented to Council and City's role identified

[27] The FCM grant provides up to $175,000 in eligible costs for municipalities to assess options for a local home-energy upgrade financing program.

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
3.1.5 Program/Infrastructure: Undertake study of existing municipal building assets to determine solar PV potential and use as a pilot to install solar PVs. Note: the City of Vaughan participated in the Feed-In-Tariff (FIT) program and identified buildings for solar installations, Action 3.1.5 builds on the work completed as part of the FIT.	Staff time Consulting firm fees to develop costing study and plan (if used): approx. $75,000 - $150,000	Project Lead	FIT program results reviewed Feasibility study completed First solar PV installed
3.1.6 Policy/Initiative: Complete a study to determine the areas throughout the City that are best suitable for a district energy, and wastewater heat recovery. Based on study, investigate partnership with private sector firm to develop district energy system in one new high-density and mixed-use neighbourhood.	Staff time Consulting firm fees to develop feasibility study: $60,000[28]	Project Lead	Study completed Private sector partner identified

Pillar 4: Reducing Vehicle Emissions

To meet or exceed Federal targets of achieving 100% electric sales for personal and light-duty vehicles by 2035, the City needs to develop and implement a strategy to transition to low-emission vehicles. For example, the lack of electric vehicle charging infrastructure remains a significant barrier to local EV adoption. Establishing a local charging network that involves multiple partners is crucial to encourage wider adoption of electric vehicles. Immediate actions are required to ensure that the necessary infrastructure is in place to support the rapid growth of EVs as prices decrease, supply increases, and the Federal target deadline approaches. The following interested and affected parties have been identified to support the implementation of the reducing vehicle emissions actions:

- York Region Transit
- Toronto Transit Commission
- Metrolinx
- Brampton Transit
- Community members
- Local businesses and institutions
- Local dealerships
- Ontario Trucking Association

[28] The FCM provides up to $175,000 for municipalities to assess energy recovery or district energy.

- Ontario Government
- Durham Region
- Post-secondary institutions
- Electric Vehicle Society
- Plug'n Drive
- Electric Mobility Canada
- Non-profit organizations
- The Atmospheric Fund
- Clean Air Partnership
- Electric Vehicle Society

Building On Success: The City's Actions To Reduce Vehicle Emissions

The City of Vaughan has already successfully implemented several initiatives to reduce vehicle emissions. These include:

1. The City has installed electric vehicle charging stations at multiple City buildings and is seeking grants to further expand charging infrastructure;
2. The City is developing an EV Strategy to identify potential locations for charging stations, explore funding opportunities, and address technical requirements;
3. The Sustainable Metrics Program includes low-emission vehicle parking spots; and
4. The City's MoveSmart Mobility Management Study does indicate that a Heavy Traffic and Truck Routing Plan will be completed in 2026 to manage heavy vehicle and truck transport traffic throughout the community.
5. In addition, in 2019 the York Region Council approved the procurement of six electric buses. The pilot will be used to assess the technology and evaluate requirements to further electricity the York Region Transit.

Action 4.1 Advocate for the electrification of regional transit systems

Action 4.1 Overview

ACTION 4.1 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	Starting in 2030, all new transit asset purchases are zero emissions and all transit vehicles are electric by 2040.
MODELLED INVESTMENT (2024 -2030):	Not modelled

Detailed Sub-Action

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
4.1.1 Advocacy: Host regular meetings with all transit operators within York Region to discuss their electrification strategies and advocate for meeting the MEP targets for transit electrification.	Staff time	Project Lead (advocacy) Project Co-Leads (implementation): York Region, Toronto Transit Commission, Metrolinx, and Brampton Transit	York Region engaged through advocacy program Regular meetings hosted (quarterly, or annually) Number of transit vehicles electrified on an annual basis

Action 4.2 Electrify municipal fleet as per the Green Fleet Strategy

Action 4.2 Overview

ACTION 4.2 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	Beginning in 2024, all new light and medium duty vehicles and equipment purchases are electric, and beginning in 2030, all new heavy-duty vehicle and equipment purchases are electric.
MODELLED INVESTMENT (2024 -2030):	$2.25 million

Detailed Sub-Action

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
4.2.1. Program: Implement the City of Vaughan's Green Fleet Strategy as per the timeline and targets.	Staff time	Project Lead	Number of fleet vehicles electrified

Action 4.3 Electrify personal and commercial vehicles

Action 4.3 Overview

ACTION 4.3 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	Beginning in 2024, all new light and medium duty vehicles and equipment purchases are electric, and beginning in 2030, all new heavy-duty vehicle and equipment purchases are electric.
MODELLED INVESTMENT (2024 -2030):	$178.66 million

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
4.3.1 Program/Policy: Investigate incentives for the Sustainability Metrics Program to encourage all residential and commercial buildings and parking lots are equipped with electric vehicle charging stations.	Staff time	Project Lead	Incentives study completed Number of new development with EV charging
4.3.2 Program/Initiative: Create an inventory of all programs, funding, and support mechanisms available for in-home electric vehicle infrastructure installations and purchases.	Staff time	Project Lead Project Support: Clean Air Partnership	Inventory complete
4.3.3 Education: Educate community members about the feasibility of purchasing electric vehicles in Vaughan.	Staff time Internal communications fees	Project Lead	Number of community members reached (e.g., website visits, social media campaign reach)

Action 4.4: Electrify commercial vehicles

Action 4.4 Overview

ACTION 4.4 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	Beginning in 2024, all new light and medium duty vehicles and equipment purchases are electric, and beginning in 2030, all new heavy-duty vehicle and equipment purchases are electric.
MODELLED INVESTMENT (2024 -2030):	$175.02 million

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
4.4.1 Policy: Support the development of refuelling stations for zero emissions medium- and heavy-duty vehicles through investigating and developing zoning ordinances.	Staff time	Project Lead	Zoning ordinance implemented
4.4.2 Initiative: Identify partners to collaborate on annual research on industry trends for the deployment of green hydrogen and electric vehicle infrastructure in the ICI sector.	Staff time	Project Lead Project Sponsor and Support: TBC based on partner identification	ICI partners identified Annual research on industry trends completed
4.4.3 Education: Educate commercial vehicle owners annually on industry trends for the deployment of green hydrogen and electric vehicle infrastructure.	Staff time Internal communications fees	Project Lead	Annual communication reach to ICI sector on industry trends update

Pillar 5: Increasing Active Transportation and Transit Use

Efforts to increase transit use, walking, and cycling are crucial for reducing transportation emissions and offer additional benefits for health and community well-being. The City plays a leading role in implementing programs and initiatives that support transit and active transportation, contributing to a more inclusive and less car-dependent community. As a local municipality, Vaughan is not directly responsible for delivering transit services, however, the City provides guidance on transit planning matters to transit agencies such as York Region Transit (YRT), the Toronto Transit Commission (TTC), Metrolinx, and Brampton Transit. Similar

to the electrification of transit systems, the City will need to advocate that its partners expand transit services in the Region. The following interested and affected parties have been identified to support the implementation of the active transportation and transit expansion actions:

- York Region Transit
- Toronto Transit Commission
- Metrolinx
- BILD York Region
- RESCON
- Ontario Traffic Council
- Local businesses
- Landlords
- Post-secondary institutions
- Non-profit organizations
- The Atmospheric Fund
- Clean Air Partnership

Building On Success: The City's Actions To Increase Active Transportation

The City already has several projects underway to increase active transportation use, these include:

1. The Vaughan Transportation Plan (2023), with guiding principles to reduce environmental impacts and monitor transportation-related GHG emissions as a key indicator of progress. The Plan adopts a multi-modal approach to support residents in increasing their active transportation use.
2. Pedestrian and Bicycle Master Plan (2020), which provided 75 recommendations to enhance safety, infrastructure, connectivity, and awareness for pedestrian and bicycle travel. A key outcome of this plan is the formalization of the Active Transportation Implementation Framework, which integrates pedestrian and cycling facilities into all capital and development projects.
3. The MoveSmart Mobility Management Strategy, which identifies short-term projects and programs to enhance safety and promote sustainable mobility.
4. The Parking Strategy, which considers opportunities for bike-sharing.
5. The Sustainability Metrics program assigns points to new developments that incorporate traffic calming measures on residential and non-residential streets, provide pedestrian connectivity to schools, proximity to transit routes, proximity to bikeways, and include bicycle parking on-site. Additionally, all new developments undergo reviews to ensure the inclusion of pedestrian and cycling facilities, trails, and transportation demand management measures during the development application process.

Action 5.1 Advocate for transit expansion

Action 5.1 Overview

ACTION 5.1 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	By 2050, travel within the city of a distance less than 5km is completed by using transit (10% of travel), walking (16%), and biking (2%). Travel between 5 and 15 km is completed using transit (10%), and biking (2%). Travel that is greater than 15km in distance is completed using transit (25%).
MODELLED INVESTMENT (2024 -2030):	$205.85 million

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
5.1.1 Program: Advocate York Region to undertake a pilot for free transit by determining populations to offer free transit and time frames in which to offer free transit. The City will need to determine roles in providing free transit (e.g. advocacy, financing, education, campaign, feasibility assessment).	Staff time	Project Lead (advocacy)	York Region engaged through advocacy program Pilot launched Transit ridership
5.1.2 Program: Advocate York Region to undertake study to increase frequency of transit across the Region.	Staff time	Project Lead (advocacy)	York Region engaged through advocacy program Study completed Transit ridership
5.1.3 Education: Use education, advocacy and promotional support to increase the number of employers that offer commute option programs and subsidized transit passes for their employees.	Staff time	Project Lead	Communications reach Employer participation

Action 5.2 Increase active transportation

Action 5.2 Overview

ACTION 5.2 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	By 2050, travel less than 5km is completed using transit (10%), walking (16%), biking (2%), travel between 5 and 15 km is completed using transit (10%), biking (2%), and travel greater than 15 km is completed using transit (25%).
MODELLED INVESTMENT (2024 -2030):	Not modelled

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
5.2.1 Infrastructure: Fully implement the infrastructure outlined in the City of Vaughan's Pedestrian and Bicycle Master Plan, and MoveSmart Mobility Management Strategy.	Staff time Capital funding as identified in Master Plan and Mobility Management Strategy	Project Lead	Number of projects completed annually Mode share
5.2.2 Program/Policy: Complete Parking Strategy, and implement initiatives to increase bike share opportunities.	Staff time Capital funding required	Project Lead	Parking Strategy adopted Mode share
5.2.3 Initiative: Investigate incentives to encourage developers to implement traffic calming measures, pedestrian connectivity, and proximity to multi-modal networks in the SMP.	Staff time Incentives funding required	Project Lead	Study completed Number of developments achieving Silver or higher threshold in active transportation and transit
5.2.4 Education: Promote active transportation and educate residents on the benefits. Promote new routes and trails and programs and initiatives.	Staff time	Project Lead	Communications

5.3 Decrease vehicle kilometers travelled

Action 5.3 Overview

ACTION 5.3 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	By 2030, light duty VKT decreases 10% beyond decreases from mode share changes, and medium and heavy-duty VKT decrease by 5%.
MODELLED INVESTMENT (2024 -2030):	Not modelled

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
5.3.1 Education: Complete annual commuter survey for City staff to track home-to-work trips and calculate the GHG emission reductions and additional co-benefits as a result of hybrid work schedules.	Staff time	Project Lead	Annual commuter survey completed and GHG emissions calculated
5.3.2 Education/Advocacy: Using the results from 5.2.1, develop education and promotion campaigns to highlight the annual GHG emissions saved by the City and other co-benefits tracked in the survey as a way to promote other businesses to continue or adopt hybrid remote policies.	Staff time	Project Lead	Communications reach Number of businesses engaged

Pillar 6: Reducing Waste Emissions

Forty-seven percent of respondents in the community survey reported difficulty in reducing their household waste. One mechanism to address this issue is to increase education and awareness regarding waste diversion and reduction opportunities. These efforts can include social media campaigns, outreach events, newsletter updates, and educational programs that focus on recycling and composting (e.g., providing education stickers for household bins). In addition, the City will need to support and take a leading role in working with the York Region Environment Department and other community partners to implement additional programs and initiatives.[29]

The following interested and affected parties have been identified to support the implementation of waste initiatives:

- Local businesses
- York Region
- Local municipalities
- Non-profit organizations
- National Zero Waste Council
- Canadian Circular Cities and Regions Initiatives
- Vaughan Chamber of Commerce (for engaging with small businesses)
- Toronto Region Conservation Authority (TRCA)

[29]< The top initiatives and programs selected among survey respondents were community reuse centers, increased support for reuse programs, and a green procurement strategy.

Building On Success: The City's Actions To Reduce Waste

Vaughan already offers residential recycling and composting programs and has also adopted York Region's SM4RT Living Plan. This Plan includes a long-term waste reduction goal to decrease and recycle an additional bag of garbage per week per household by 2031, as well as to reduce food waste through changes in purchasing and consumption habits. In addition, York Region provides drop-off centers for garbage, recycling, yard waste, electronics, and other items

Action 6.1 Increase residential and ICI diversion rates and decrease per capita waste across all sectors

Action 6.1 Overview

ACTION 6.1 OVERVIEW	
2050 MODELLED LOW CARBON TARGET:	By 2031, the residential sector diversion rates increase by 15% over the business-as-planned (BAP) rates.[30] The ICI sector diversion recycling rates increase by 50% by 2030 and 75% by 2050, and the organics rates increase to 50% by 2030 and 90% by 2050. The waste per capita decreases by 20% by 2031 and 30% by 2050.
MODELLED INVESTMENT (2024 -2030):	Not modelled

Detailed Sub-Actions

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
6.1.1. Program: Work with community partners to support reuse programming and events that encourage repairing products, or donation events.	Staff time	Project Support Potential Project Leads: York Region, TRCA, and Vaughan Libraries	Number of community partners contacted Number of annual programming and events

[30] The BAP 2031 rate is to achieve a reduction of one bag of garbage per week per household.

IMPLEMENTATION MECHANISM	INTERNAL IMPACT	CITY'S ROLE	TRACKING METRIC(S)
6.1.2 Education: Educate residents and local businesses on waste diversion and reduction opportunities, including organic and recycling.	Staff time	Project Lead Potential Project Leads: York Region, TRCA, and Vaughan Libraries	Number of education campaigns Communications reach
6.1.3 Program/Initiative: Convene a circular economy roundtable to investigate the creation of circular economy initiatives. The Green Municipal Fund provides a seven-step model for developing such an initiative.	Staff time	Project Lead Potential project sponsors include: York Region, TRCA, and Vaughan Libraries	Roundtable created Seven-step model followed to identify a circular economy community initiative

Section 3: Funding Opportunities

The MEP's financial analysis (Ancillary Report: Financial Analysis) estimates the total funding required across all sectors in the community to implement the actions and meet the modelled low-carbon pathway. The Implementation Framework includes estimates of the investment costs across all sectors for each action, however the investments are not solely borne by the City. One of the key roles of the City will be to apply for funding and grant opportunities to fund either City-led initiatives or further fund community initiatives. There are several financial tools that can be used at the municipal level to facilitate climate action, including:

1. Federation of Canadian Municipalities (FCM): The FCM is an advocacy group that offers grants and loans for municipal projects related to climate mitigation, resilience, and environmental projects.
2. Incentive Programs: Incentives programs provide building owners with non-repayable sums of money (directly or as a rebate) to purchase efficient appliances and products, or to perform energy audits or retrofitting.
3. Revolving Loan Funds: Revolving funds, or green revolving funds and community revolving funds, provide a unique opportunity to pay for future projects using the savings achieved through efficiency improvements.

Investigating all financial tools available to the City will be critical, as capital costs or upfront investments are considered a primary barrier to climate action. The following section provides a summary of potential funding opportunities available to the City and community members to implement the MEP's Implementation Framework.

Funding Opportunities: Retrofitting and New Construction

SOURCE	FUNDING OPPORTUNITIES
Government of Canada	• Greener Homes Loans Program: As of 2024 the program is not accepting new applicants, however, low to median income homeowners who were heating their homes with oil and have already installed a heat pump as part of the Canada Greener Homes Grant on or after January 1st, 2023, may be eligible for up to $5,000 in additional grant funding under the Oil to Heat Pump Affordability (OHPA) program. • Deep Retrofit Accelerator Initiative: Provides funding to organizations that help building owners in the development of deep retrofits in commercial, institutional, and mid- or high-rise multi-unit residential buildings. • Greener Neighbourhoods Pilot Program:Provides funding to pilot the Energiespring aggregated deep energy retrofit model in low-rise housing. • Implementation Readiness Fund: Provides funding for activities and investments that increase the readiness to deploy GHG emissions reduction projects and remove barriers to low-carbon technology adoption and 2030 climate mitigation action. • Oil to Heat Pump Affordability (OHPA) program: Provides funding for low to median income homeowners. • Low Carbon Economy Fund: Provides between $1 million up to $25 million in funding for eligible municipal project expenditures.
Ontario Government	• Save on Energy Program: Supports residents in lower energy use during peak times.
Municipal Government	• Revolving Loan Funds provide an opportunity for municipalities to pay for future projects using savings achieved through energy efficiency improvements.

SOURCE	FUNDING OPPORTUNITIES
Federation of Canadian Municipalities (FCM)	• Green Municipal Fund: Provides funding for local governments and non-profit organizations to retrofit public buildings to improve energy performance. • Community Efficiency Financing Program: Provides funding for low-rise residential properties, such as PACE.[31] • Feasibility Study: Provides funding to conduct feasibility studies to assess options for a local home-energy upgrade financing program. • Capital Program: Provides a loan or credit enhancement for local home-energy upgrade financing program. • Pilot Project: Provides funding for retrofitting or new construction of sustainable affordable housing.
Canada Infrastructure Bank	• Building Retrofits Initiative: Provides financing for energy retrofits projects, the program is available to both public sector and private sector.
Private investments	• Private investments include investments from individual homeowners and business owners to complete building retrofits, and private sector financing into retrofit programs such as the PACE programs.

Funding Opportunities: Renewable Energy

SOURCE	FUNDING OPPORTUNITIES
Government of Canada	• Greener Homes Loans Program: As of 2024 the program is not accepting new applicants, however, low to median income homeowners who were heating their homes with oil and have already installed a heat pump as part of the Canada Greener Homes Grant on or after January 1st, 2023, may be eligible for up to $5,000 in additional grant funding under the Oil to Heat Pump Affordability (OHPA) program. • Low Carbon Economy Fund: Provides funding for non-profit organizations, Indigenous recipients, and public sector to implement projects that deploy proven, low-carbon technologies. • Canadian Renewable and Conservation Expenses (open to businesses): Provides guidance on clean energy generation and energy conservation project development activities, the cost of which qualifies as Canadian renewable and conservation expense (CRCE) or businesses. • Investment Tax Credit (beginning in 2023 this refundable incentive will cover up to 30% of the capital cost investment).
Ontario Government	• Net-metering program: Supports residents and municipalities to fund renewable energy programs.

[31] PACE programming can be financed through the municipality, private investment or a third party such as a Community Revolving Loan Fund, or Local Improvement Charge (LIC).

SOURCE	FUNDING OPPORTUNITIES
Municipal Government	• Revolving Loan Funds provide an opportunity for municipalities to pay for future projects using savings achieved through energy efficiency improvements.
Federation of Canadian Municipalities (FCM)	• Feasibility Study: Provides up to $175,000 to assess energy recovery or district energy. • Community Efficiency Financing Program: Provides funding for low-rise residential properties, such as PACE.
Canada Infrastructure Bank	• Clean Power Initiative: Provides financing for renewable, district energy systems, energy storage, etc., projects.
Private investments	• Private investments include investments from individual homeowners and business owners to complete solar installations, and private sector financing could be explored for PACE programs.

Funding Opportunities: Transportation

SOURCE	FUNDING OPPORTUNITIES
Government of Canada	• Zero Emission Vehicle Infrastructure Program: Provides funding for the deployment of electric vehicle (EV) chargers and hydrogen refuelling stations. • Incentives for Zero Emission Vehicles Program: Provides point-of-sale incentives for eligible consumers (subject to funding availability) who buy or lease an eligible zero emission vehicles. • Active Transportation Fund: Provides funding to support the expansion and enhancement of active transportation infrastructure. • Zero Emission Transit Fund: Provides planning and capital funding for zero emission transit programs.
Federation of Canadian Municipalities (FCM)	• Green Municipal Fund: Provides funding support for studies, capital projects, and pilot projects related to transit electrification and expansion. • Green Municipal Fund: Provides funding support for studies, capital projects, and pilot projects related to transportation networks and commuting. • FCM GMF Pilot Project: provides up to $500,000 in funding to reduce fossil fuel use in municipal fleets.
Other funding sources	• The Atmospheric Fund's EV Station Fund provides organizations with rebates of up to 50% of EV charging station installation cost.
Private investments	• Private investments include investments from community members and businesses to purchase electric vehicles and charging infrastructure.

Funding Opportunities: Waste

SOURCE	FUNDING OPPORTUNITIES
Government of Canada	• Innovative Solutions Canada: Provides funding streams related to the circular economy, research, and technology development. • Low Carbon Economy Challenge: Federal cost share program to implement low-carbon technologies that align with Canada's net-zero emissions by 2050 goal. • Smart Cities Challenge: Provides funding for municipalities, local or regional governments, and Indigenous communities to adopt smart cities approaches. • Strategic Innovation Fund: Provides investments to all economic sectors to support the Canadian innovation network.
Federation of Canadian Municipalities (FCM)	• Circular Cities and Regions Initiative: Provides support, guidance, and peer-to-peer exchange to support local governments in circular economy initiatives.

Appendix B: Glossary

Air-source heat pump: A building heating technology that transfers heat from the outside air to heat or cool a building using a refrigeration system and process.

Baseline: The starting year for energy or emissions projections.

Building envelope: A building envelope is any building component (e.g., windows, doors, insulation) that physically separates the interior and exterior of a building and shields the inside space from elements such as heat, cold, and precipitation.

Carbon budget: This term refers to three concepts: (1) an assessment of carbon-cycle sources and sinks on a global level through the synthesis of evidence for fossil-fuel and cement emissions, land-use change emissions, ocean and land CO_2 sinks, and the resulting atmospheric CO_2 growth rate. This is referred to as the global carbon budget; (2) the estimated cumulative amount of global carbon dioxide emissions that is predicted to limit global surface temperature to a given level above a reference period, taking into account global surface temperature contributions of other greenhouse gases and climate forcers; and (3) the distribution of the carbon budget defined under (2) to the regional, national, or sub-national level based on considerations of equity, costs, or efficiency.

Clean energy: Energy derived from renewable, zero-emissions sources.

Climate adaptation: Any initiative or action in response to actual or projected climate change impacts which reduce the effects of climate change on built, natural, and social systems.

Climate mitigation: Any policy, regulation, infrastructure, or other project-based measures that contributes to the reduction of greenhouse gas concentrations in the atmosphere.

Carbon dioxide (CO_2): A naturally occurring gas and a by-product of burning fossil fuels (e.g., oil, gas, coal), of burning biomass, of land-use changes, and of industrial processes (e.g., cement production). CO_2 is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a global warming potential of one.

Carbon dioxide equivalent (**CO_2e):** A standardized measurement of greenhouse gases based on the warming potential of given gases compared with carbon dioxide.

Co-benefits: Benefits that are additional to the primary objective of the climate plan. In this case, the primary objectives are energy efficiency and emissions reductions, and co-benefits include job creation, enhanced equity, and better air and water quality.

Cooling degree days: The number of degrees that a day's average temperature is above 18°C, requiring cooling.

Decarbonization: The process by which countries, individuals, or other entities aim to achieve a zero-fossil-carbon existence. Typically refers to a reduction of the carbon emissions associated with electricity, industry, and transport.

Deep building retrofits: A whole-building analysis and construction process minimizing

building energy use by 50% or more compared to the baseline energy use.

Density: A measurement of the population per unit area.

District energy systems: A network of hot and cold water pipes that are used to heat and cool connected buildings more efficiently than if each building had its own heating/cooling systems.

Energy efficiency: Using less energy to perform the same task.

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 (H2O), 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 several entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Besides CO_2, N_2O, and CH_4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Green hydrogen: Hydrogen generated by surplus renewable electricity using electrolysis, which can then be combusted.

Ground-source heat pump: A building heating technology that transfers heat stored in the earth at a somewhat stable temperature into a building when it requires heating, and transfers heat out of a building into the ground when it needs cooling. Also referred to as a geothermal heat pump.

Heating degree days: Number of degrees that a day's average temperature is below 18°C, requiring heating.

Intensification: Refers to land-use intensification and describes developing an area at a higher building density (units/sq km) than currently exists through development, redevelopment, infill, building expansion, and building conversion.

Lock-in: A situation in which the future development of a system—including infrastructure, technologies, investments, institutions, and behavioural norms—is determined or constrained ("locked in") by historic developments.

Low emissions: A term used to comparatively describe technologies and processes that produce much fewer greenhouse gas emissions than current conventional technologies and processes. There is no standard threshold for low emissions.

Net-zero emissions: Net-zero emissions are achieved when human-caused emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net-zero emissions depends on the climate metric (e.g., global warming potential, global temperature change potential) chosen to compare emissions of different gases, as well as

on the time horizon chosen.

Paris Agreement: The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in December 2015, in Paris, France, at the 21st session of the Conference of the Parties (COP) to the UNFCCC. The agreement, adopted by 196 Parties to the UNFCCC, entered into force on 4 November 2016 and as of May 2018, it had 195 Signatories and was ratified by 177 Parties. One of the goals of the Paris Agreement is "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change." Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change.

Pathway: The temporal evolution of natural and/or human systems toward a future state. Pathway concepts range from sets of quantitative and qualitative scenarios or narratives of potential futures to solution-oriented decision-making processes to achieve desirable societal goals. Pathway approaches typically focus on biophysical, techno-economic, and/or socio-behavioural trajectories and involve various dynamics, goals, and actors across different scales.

Renewable energy: Energy that is derived from a source that is not depleted when used or is regularly replenished, such as wind or solar energy. Renewable energy is commonly used interchangeably with "clean energy" and is understood to be derived from zero- or low-emissions energy sources.

Renewable natural gas: Methane captured from bacterial decomposition of sewage, manure, waste, plant crops, or other organic waste products. It can be used as a natural gas replacement.

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 potential implications of developments and actions.

Solar farm: A large-scale or centralized solar installation where photovoltaic panels are used to harvest the sun's energy. Solar farms are typically connected to the electricity grid, and energy from the farm is delivered to consumers as part of that system.

Solar photovoltaic technologies: Technologies that produce electricity from solar radiation.

Wind farm: A large-scale or centralized group of wind turbines that are used to harvest the energy from wind. Wind farms are typically connected to the electricity grid, and energy from wind farms is delivered to consumers as part of that system.


VAUGHAN