Attachment 2

City of Vaughan Carbon Budget

Recommendations for Implementing a Carbon Budget and Framework

VAUGHAN SSG

Table of Contents

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This report was prepared in June 2024 to introduce the carbon budget concept and provide recommendations for how it can be implemented into a framework for the City of Vaughan.

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Executive Summary

In 2019, the City's Mayor and the members of the City Council unanimously passed a Member's Resolution to declare a climate emergency in the City of Vaughan. The carbon budget responds to this declaration by providing the City with a systematic way to reduce greenhouse gas (GHG) emissions, ensure policies and programs do not lock in further emissions, and maximize social and financial opportunities resulting from the energy transition.

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. This document provides guidance on establishing a carbon budget and management framework for the City of Vaughan (the City) that aligns with the low-carbon scenario set out in the Municipal Energy Plan (MEP). The recommended implementation 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.

Context

In 2019, the Mayor and the members of the City Council unanimously passed a Member's Resolution to declare a climate emergency in the City of Vaughan (the City). This declaration reaffirmed the City's commitment to climate action and directed that Vaughan staff continue the planned update of the MEP. The updated 2024 MEP established a low-carbon scenario to achieve the City's climate target of reaching 2–3 tonnes of GHG emissions per capita by 2030 and net-zero emissions by 2050, at the latest. Vaughan's target aligns with the C40 Cities Climate Leadership Group (C40)[1] approach of Convergence and Contraction. The C40 and the International Panel on Climate Change (IPCC) recommend, by 2030, all cities converge on a maximum emissions rate of 2.9 tonnes carbon dioxide equivalent (tCO2e) per person,[2] and from 2030 onwards, cities reduce their emissions to net zero by 2050.[3]

> "Human activity has already caused 1.2°C of warming since pre-industrial times. The time lag between emitting GHGs and their effect on climate means that we are guaranteed some additional warming. Without an immediate, large-scale reduction in GHG emissions, it will be impossible to limit global heating to 1.5°C." – C40[4]

The MEP's Implementation Framework provides a concise and comprehensive guide (zero to five years) that enables the City to efficiently transition from climate planning to climate action. Achieving the City's GHG targets will require a whole-city approach that is as much about change management as it is about technical solutions.

Implementing a carbon budget is one of the first policies the City can undertake to achieve the Governance and Administration action of incorporating climate change mitigation into all corporate decision-making and planning processes (as outlined in the MEP's Implementation Framework). When implemented, the carbon budget framework is a tool to incorporate climate considerations into the City's decision-making processes, ensuring accountability is distributed across the organization rather than concentrated within a single department.

This report details the process for setting the City's annual carbon budget for 2025 to 2030 and provides the recommended framework for the City to implement the carbon budget throughout its capital and operating decision-making processes.

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[1] C40 is a group of 96 cities representing one twelfth of the world's population and one quarter of the global economy.

[2] During the first iteration of C40's carbon budget, cities are required to converge their per capita emissions rate of 3.2 tonnes per person by 2030 and decrease until 2050 when the per capita emissions rates for all cities would need to reach 0 tonnes per capita. However, as of 2020, the recommended per capita emissions are 2.9 tCO2e per capita by 2030.

[3] Arup et al., "How Cities Will Get the Job Done," Deadline 2020: How Cities Will Get the Job Done, 2016, https://www.c40.org/wp-content/uploads/2021/07/Deadline_2020.pdf.

[4] "C40 Knowledge Community," n.d., https://www.c40knowledgehub.org/s/article/1-5-C-Cities-the-why-what-and-how-of-urban-climate-leadership?language=en_US.

Understanding the Carbon Budget

A carbon budget uses two dimensions to mainstream accountability and action across all municipal departments, both of which are adapted to the local context and scale. The first dimension provides the mechanism for setting the cumulative and annual carbon emissions limit (such as a target), and the second dimension establishes a management framework for embedding GHG emissions decisions throughout the organization.

Carbon budget frameworks can be implemented at different scales, from a corporate-level scope focusing on emissions municipalities have direct control over to a community-wide scope that encompasses all emissions within the municipal boundaries. Some municipalities choose to implement the climate budget framework rather than the carbon budget framework.

The carbon budget concept and its use as a management framework is fairly new. Since 2017, municipalities around the world have started to implement the carbon budget framework. However, there is no correct method or standardized approach to operationalize the carbon budget. In Canada, the first municipal carbon budget framework was introduced in Edmonton, Alberta, in 2021, with the first carbon budget report released in 2022.

What is a Carbon Budget?

In 2017, C40 published a report assessing the C40 cities' contribution to the UN Climate Change Conference (COP21) Paris Agreement's target of limiting climate change to 1.5°C to 2.0°C.[5] The report highlights the use of carbon budgets as a communication tool to represent how much carbon the world had left to emit before exceeding the desired global temperature increases. Oslo, Norway, is one of the cities turning the Paris Agreement into action. Its climate budget gave rise to the creation of city-specific carbon budgets, which are used as tools to incorporate GHG emissions reductions into municipal decision-making processes and to communicate the urgency of these required reductions by placing them at the forefront of the financial budgeting process (Figure 1, next page).

[5] Anne Hidalgo and Mark Watts, "C40 Annual Report 2017," 2017, https://www.c40.org/wp-content/uploads/2024/01/C40-2017-Annual-Report-ORIGINAL_compressed.pdf.

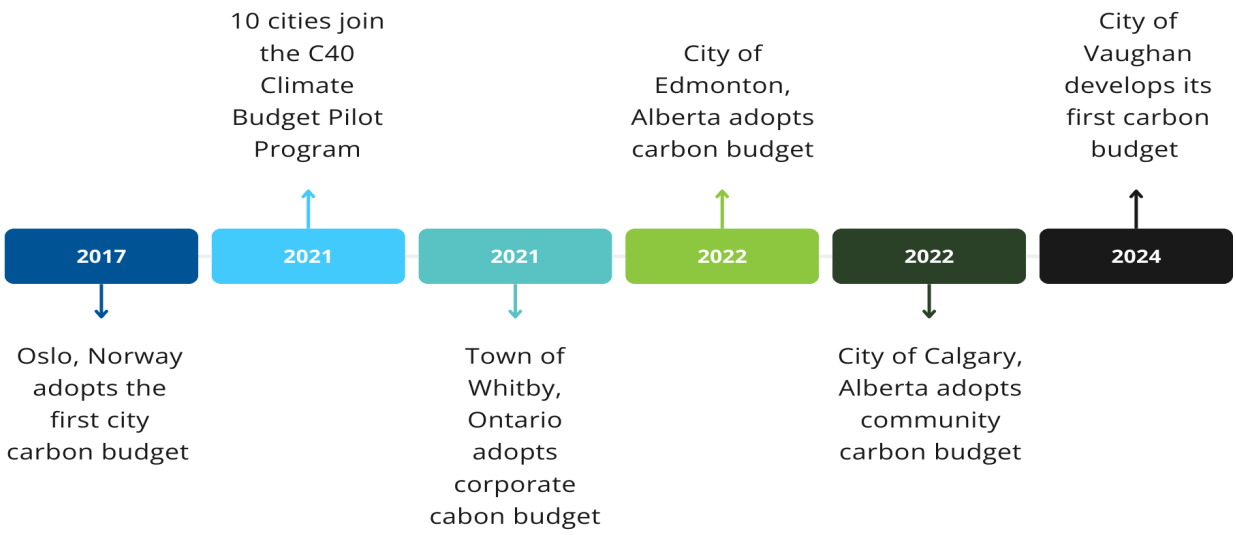

Figure 1. Key carbon budget implementation milestones.

Oslo: The First City Carbon Budget Approach

Oslo, Norway, is one of the most energy-efficient cities in the world. With a population of just under 700,000 and a virtually carbon-free hydroelectricity-based electric grid, Oslo's per capita emissions rate is 1.2 tCO2e/person —one of the lowest in the world. Over half the city's emissions are produced by road transport and another 25% are from the city's waste incineration and energy supply facilities.

In 2017, Oslo pioneered the carbon budget (referred to as the "climate budget" by the City of Oslo) and began using it in local government climate mitigation planning. Despite the city's anticipated population growth throughout the next decade, Oslo is pursuing a climate budget that would reduce emissions by 90% by 2030 (or 95% relative to the 1990 levels).

Oslo's Department of Environment and Transport (the City's climate agency) oversees the City's climate action programs; however, the responsibility and management of the climate budget resides in the financial services department. In addition, using the climate budget as the first chapter of the financial budget created an effective strategy to bring the climate budget and lens to all financial decisions and priorities. The progress is reported on the same three-year timeframe as the financial reporting and an online climate barometer is used to track real-time reductions using 14 indicators.

Oslo's success spurred the development of climate and carbon budgets across multiple regions. Since 2021, C40 has been working with cities to pilot the development and implementation of climate budgets. Led by the City of Oslo, the pilot includes Barcelona, Berlin, Los Angeles, Milan, Montreal, Mumbai, Stockholm, Paris, Rio de Janeiro, and Tshwane.[6]

[6] "C40 Knowledge Community." n.d. Www.c40knowledgehub.org. https://www.c40knowledgehub.org/s/article/Climate-budgets-why-your-city-needs-one?language=en_US.

HOW DO MUNICIPALITIES SET A CARBON BUDGET?

The first step in developing a corporate and community carbon budget is identifying the cumulative emissions that can be released within a timeframe in order to stay within the IPCC and C40's target to limit global warming to 1.5°C. The limit on emissions can be calculated on an annual basis or as a cumulative total between the baseline year (in Vaughan's case, 2016) and the net-zero target year. This approach underscores the importance of establishing a viable low-carbon scenario in which annual emissions are continually reduced over time to ensure compliance within the cumulative limits.

Carbon budgeting is driven by emission limits, which are comparable to spending limits in a financial budget. The key difference between a carbon budget and a financial budget is that financial budgets can be adjusted to reflect growing demands and increasing populations, whereas a carbon budget is fixed. Similar to financial planning on a fixed income, a carbon budget is balanced when GHG emissions ("expenditures") are at or below the target. When applied to capital and operating expenditures, the carbon budget is an additional tool that decision-makers can use during the approval process because it explains the emissions surplus or deficit caused by a project.

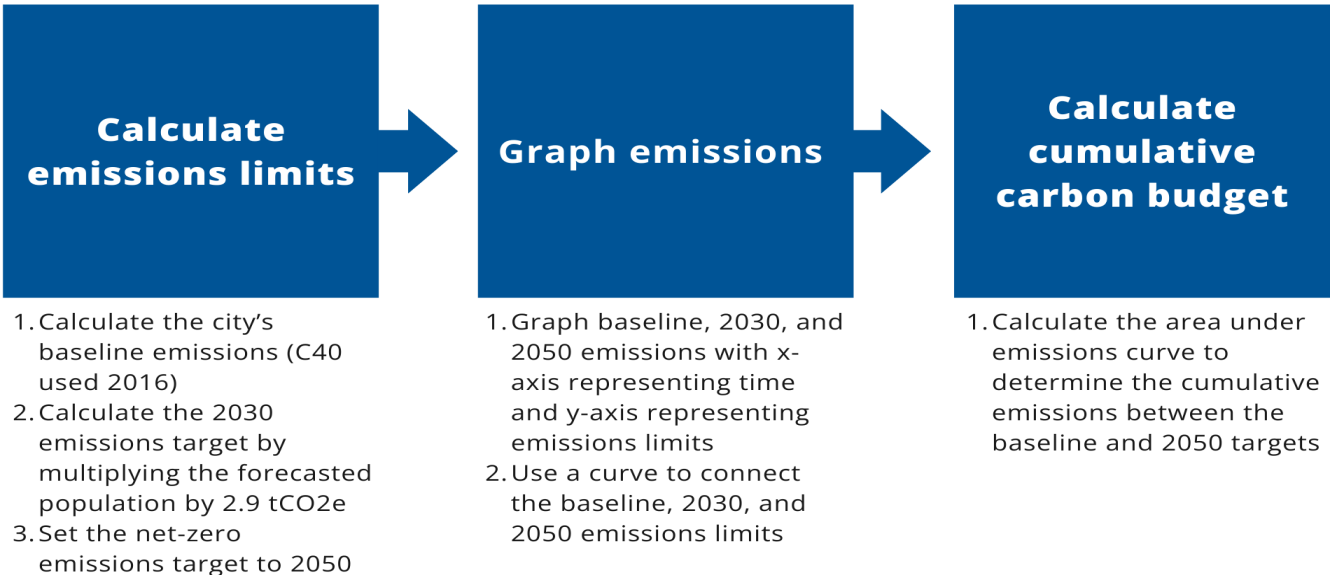

Figure 2. C40 approach for calculating fair-share city carbon budgets.

Setting Emission Limits: The C40's Convergence and Contraction Methodology

C40 used a three-step approach to identify emission limits for its member cities. The methodology can be used for cities who are not C40 member cities, such as Vaughan, to develop fair-share distributions of the global carbon budgets. The following section outlines how the C40 developed a carbon budget and city-specific carbon budgets.

Step 1: Calculating the global carbon budgets

In 2016, the C40 determined the global carbon budget to stay within 1.5°C and 2°C of warming. Based on data from the IPCC and a 66% chance of limiting global temperature rises to 1.5°C and 2°C, the global carbon budgets are 387 gigatons of CO2e (GtCO2e) and 1,037 GtCO2e, respectively.

Step 2: Calculating a city's fair-portion of the global carbon budget

Using the Convergence and Contraction approach, C40 allocated a fair-share portion of the global carbon budget to each member city. This approach assigns cities to one of four groups depending on whether they have high or light emissions and high or low gross domestic product (GDP). Those with high emissions and high GDP are required to reduce their emissions fastest, while cities with low emissions and low GDP are permitted to increase their emissions until 2030.

Figure 2 (previous page) summarizes the C40 approach for calculating the fair-share portion of the global carbon budget for each member city.

Step 3: Comparing the C40 carbon budget to the global carbon budget

To ensure that the Vaughan's carbon budget was realistic relative to current patterns, it was compared to the global budget identified in Step 1. Based on C40 methodologies, C40 cities were granted a total of 22 GtCO2e, or 6% of the remaining global budget. In 2016, the C40 cities emitted a total of 2.5 GtCO2e, or 5% of the total global emissions for that year. These similar proportions suggest that assigning this portion of the total remaining global carbon budget to cities who are not C40 member cities would result in a fair-share distribution of the global carbon budget.

What is a Carbon Budget Framework?

With a carbon emissions limit established, the second mechanism is to develop a multi-year framework that allows the carbon budget to be operationalized alongside more conventional and familiar fiscal budgets.

At the beginning of the budget cycle, project proposals requesting capital and operational budgets will include estimated GHG emissions that would result from the project. Using the estimated project-level GHG emissions, City staff and leadership are able to compare the total emissions to the carbon budget in order to strategize how to stay within the budget. Once projects are underway or completed, consistent monitoring and reporting using carbon accounting methods track the carbon budget status.

WHAT IS CARBON ACCOUNTING?

Carbon accounting is the process of quantifying the number of GHGs produced directly or indirectly by an organization's activities within a set of boundaries, providing the organization with a better understanding of their climate impacts. The project-level GHG emissions are typically reported in the form of a GHG inventory that provides a snapshot of energy use and associated emissions over a given period of time.

In the context of the carbon budget framework, GHG inventories can be evaluated against the total carbon budget at the end of each budget cycle to determine if the City has stayed within or exceeded its allocated budget.

WHY IMPLEMENT A CARBON BUDGET FRAMEWORK?

Proactive GHG Emissions Management

The carbon budget framework will allow Vaughan to make decisions to avoid significant emissions before committing to the GHG emitting initiatives. This transitions Vaughan away from the current GHG management processes, which focus on mitigating GHG emissions associated with initiatives after they have been committed to and are in operation.

Managing Cumulative Emissions to Ensure Emissions Trajectories Are Decreased

The carbon budget framework aligns with the science of climate change—it is the cumulative emissions to the atmosphere that will determine the extent of climate change. The carbon budget framework recognizes that cumulative emissions will determine the extent of global warming, and it reflects this by setting a limit on the cumulative emissions between the present and the target year.

Tying Into Financial Accounting

The carbon budget framework is comparable to Vaughan's capital and operating financial management, and the familiarity provides simplicity and allows for easy implementation across all the City's municipal departments. By setting an emissions ceiling and devising strategies to adhere to this limit, carbon budgeting is analogous to financial planning while specifically addressing emissions management.

Providing Accountability to the Climate Actions

The carbon budget framework provides a direct link between decision-making and Vaughan's climate targets identified in the MEP, ensuring there is accountability for meeting these climate targets.

Transparent Reporting and Monitoring

When combined with effective emissions monitoring, the framework provides the mechanism to consistently report on progress towards reaching climate targets on a year-to-year basis while ensuring the transparency and feedback needed to make periodic adjustments to the emissions budget.

How Does the Framework Overcome Challenges of Climate Action?

These characteristics (outlined above) will allow Vaughan to overcome three key challenges commonly associated with climate planning.

1. Mobilization: Typically, climate action plans are implemented by a sustainability or climate team, which is small relative to the scale of the climate challenge; however, the carbon budget provides a framework to engage the entire municipal staff and local organizations and businesses. This mainstreams climate action across all departments and community

organizations, making it easier to mobilize action.

2. Alignment: Achieving GHG targets requires organizational transformation; however, historically, municipalities have had minimal linkages between capital and operating projects and climate targets. This presents a temporal disconnect between the decisions being made today and the net-zero target in 2050. While only six years away, the 2030 target is still outside the consideration of many municipal projects. The carbon budget's annual reporting brings the climate target in alignment with the standard decision-making timeframe of governments.
3. Inertia: Decarbonization actions and policies require transformative changes across all sectors; however, it is the municipal government's role to provide community services. This creates a system of business-as-usual that can be at odds with climate goals. The carbon budget provides guidance to municipalities to manage this risk, from the perspective of their operations and from the perspective of the community. Without this guidance, governments and communities are prone to making or enabling investments that will need to be undone or retrofitted in the future, imposing heavy financial costs due to retrofits and limiting the opportunity to invest in other climate projects in the future.

HOW DOES THE CARBON BUDGET DIFFER FROM OTHER MUNICIPAL ACCOUNTABILITY TOOLS?

Municipalities have access to a host of tools and resources to integrate climate considerations into their decision-making process to promote sustainability and mitigate climate change impacts.

Climate Lens

A climate lens is a strategic approach used to evaluate the potential climate impacts of policies, projects, and decisions, and how they contribute to or detract from the municipality's climate objectives. Municipalities can incorporate a climate lens through dedicated sections in staff reports to council or by integrating climate change considerations into municipal plans. A climate lens can be qualitative or quantitative, whereas the carbon budget framework provides a mechanism for quantifying climate impacts. The two tools can be integrated together within municipal processes for better accountability and to reduce the risk of missed emissions reduction opportunities.

Climate Budget

Similar to the carbon budget, the climate budget integrates GHG emissions into budget deliberations. However, where the carbon budget sets a cap on cumulative emissions, with each department estimating emissions for their projects and operations, the climate budget focuses on funding actions that will result in significant GHG reductions. However, by not considering the overall emissions impact, there is a higher likelihood of missing opportunities for reduction.

Task Force on Climate-Related Financial Disclosures (TCFD)

The TCFD provides a framework for organizations to disclose their climate-related financial risks and opportunities. The TCFD core recommendations focus on governance, strategy, risk management, and metrics and targets through the phases of "maturity", "getting started", "evolving", and "highly integrated".

Following the TCFD's disbandment in November 2023, the International Sustainability Standards Board (ISSB) has assumed the TCFD's responsibility of monitoring climate-related disclosures. On June 26, 2023, the ISSB released its first two IFRS Sustainability Disclosure Standards.

1. IFRS S1 General Requirements for Disclosure of Sustainability-Related Financial Information lays out the general requirements for disclosing sustainability-related financial information.
2. IFRS S2 Climate-Related Disclosures focuses on climate-related disclosures.

Both standards fully incorporate the TCFD recommendations.

The Process

In partnership with the Norwegian municipalities of Oslo, Hamer, and Trondheim, the C40 has developed a four-step manual to guide municipalities in preparing and implementing a carbon budget.[7] The following section summarizes how the four steps were adapted to Vaughan's context.

STEP 1: SETTING THE STAGE FOR THE CARBON BUDGET

The first step prepares the municipality to develop and implement the carbon budget by adopting political resolutions to support the carbon budget, setting emission targets, and identifying champions. The preliminary work for Vaughan's carbon budget was undertaken during the review of the MEP and included the following steps:

1. The City adopted a Science-Based Target to reduce emissions to between 2 and 3 tonnes per capita by 2030 and achieve net-zero emissions by 2050, at the latest.
2. The MEP's Implementation Framework identified the carbon budget as a key action to achieve Vaughan's climate targets.
3. The Environmental Sustainability department engaged with representatives from the City's Finance department to begin the process of preparing the carbon budget as part of the City's budgeting process.

STEP 2: CALCULATING THE GREENHOUSE GAS EMISSION IMPACTS

The second step involves developing the baseline GHG emission, modelling emission trajectories, and setting the emissions limit. The MEP review modelled the baseline emissions (2016) and developed three scenarios: business-as-usual (BAU), business-as-planned (BAP), and low-carbon. Through the review process, the MEP's low-carbon scenario was selected as the preferred pathway to achieve the City's GHG emissions targets.

Vaughan's cumulative and annual emissions limits for the carbon budget were developed using the C40 Convergence and Contraction methodology, and they align with the trajectories from the low-carbon scenario (See Section 3: Vaughan's Emissions Limits).

STEP 3: CREATING THE CARBON BUDGET MANAGEMENT FRAMEWORK

The third step involves preparing the carbon budget's management framework. The framework uses the climate targets, baseline emissions and emissions trajectories, and roles and responsibilities for integrating the carbon budget into the City's financial budgeting processes.

Carbon budget frameworks can be implemented at different scales, from a corporate-level scope focusing on emissions municipalities have direct control over to a community-wide scope that encompasses all emissions within the municipal boundaries. Some municipalities choose to implement the climate budget framework rather than the carbon budget framework. Table 1 (next page) summarizes the different approaches.

[7] "C40 Knowledge Community," n.d., https://www.c40knowledgehub.org/s/article/Manual-for-climate-budgets-as-a-governance-tool?language=en_US.

Table 1. Strategies for implementing carbon budgets.

APPROACH	DESCRIPTION	EXAMPLES
Corporate operations	A carbon budget is established for corporate operations. The carbon budget can be annual or aligned with multi-year capital or operating budgets. The carbon budget can also be scaled down to individual departments or divisions.	Town of Whitby, Ontario, Canada Regional Municipality of Durham, Ontario, Canada
Climate action plan	A carbon budget is calculated based on the City's initiatives and programs in the climate action plan only.	City of Oslo, Norway City of Saskatoon, Saskatchewan, Canada City of Montreal, Quebec, Canada
City operations and policies	A carbon budget is identified for the community, and investments, expenditures, policies, and programs by the City are tracked against that carbon budget.	City of Edmonton, Alberta, Canada
Comprehensive community	A carbon budget is identified for the community. Expenditures and policies by the City, households, businesses and other organizations in the community are tracked against the carbon budget.	City of Calgary, Alberta, Canada United Kingdom (national-level framework)

STEP 4: REPORTING AND EVALUATION

The fourth and final step involves reporting the GHG impacts of the City's projects and evaluating the carbon budget on an annual basis.

Recommendations for Vaughan's corporate carbon budget reporting is detailed in Section 4: Vaughan's Carbon Budget Management Framework.

Vaughan's Emissions Limits

Moving from the MEP's BAP scenario[8] to the low-carbon scenario will require a new approach to integrating GHG reductions into the City's decision-making processes. The City will need to control and influence certain decisions within the community, but many decisions that influence GHG emissions will be outside the City's control or input. As such, the City's phased approach focuses on first establishing a corporate carbon budget to address capital and operating expenditures. Once the management framework is implemented and the City is familiar with conducting carbon budgeting for municipal decision-making processes, the community actions can be incorporated into the carbon budgeting process.

This report provides the corporate and community-wide emissions limits, the management framework for implementing the corporate carbon budget, and preliminary guidance for implementing a community-wide carbon budget. The corporate carbon budget's emission limits were calculated using a proportion of the municipal emissions from the total community emissions for each year. During the 2016 baseline, the municipality's emissions accounted for approximately 0.6% of the total community emissions. Assuming this proportion stays the same in the short term, the carbon budgets for corporate operations were calculated as 0.6% of the community emissions limits.

Vaughan's Cumulative Emissions

Vaughan's cumulative emissions were identified using the MEP's low-carbon scenario. As illustrated in Figure 3 (next page), Vaughan's low-carbon scenario is very different from the BAP scenario, which will see emissions decrease by only 23% by 2050, relative to the 2016 baseline. The low-carbon scenario reduces per capita GHG emissions to 3.3 tonnes per person by 2030 and to 0.3 tonnes per person by 2050.

[8] The BAP scenario models the energy use and resulting emissions in Vaughan based on initiatives that are underway or approved with dedicated funding and legislations and regulations at the provincial and federal levels.

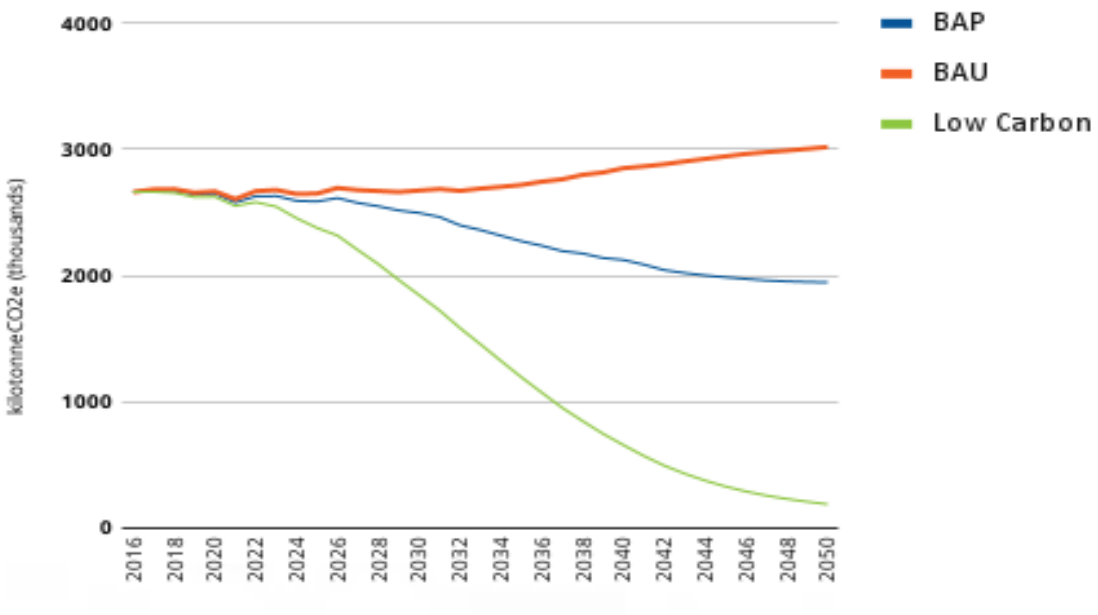

Figure 3. Emissions trajectory of the low-carbon scenario recommended in the Municipal Energy Plan versus emissions trajectory in the business-as-planned and business-as-usual scenarios.

While Vaughan's climate targets are within the recommended C40 per capita convergence of 2.9 tCO2e, the low-carbon scenario results in 2030 emissions above the C40 cities' target. As a result, there is a gap between the fair-share carbon budget and the low-carbon scenario. However, climate action is not a static process. As circumstances evolve (e.g., community champions are identified, funding becomes available, technologies change), additional GHG reduction measures can be added to reflect these new opportunities and further reduce GHG emissions to meet the fair-share carbon budget. Table 2 (below) summarizes the low-carbon scenario's cumulative emissions.

Table 2. Vaughan's community-wide and corporate cumulative emissions between the baseline, implementation year, and 2050.

	CUMULATIVE EMISSIONS BETWEEN BASELINE YEAR (2016) AND NET-ZERO TARGET (2050)	CUMULATIVE EMISSIONS BETWEEN IMPLEMENTATION YEAR (2024) AND NET-ZERO TARGET (2050)
Community-wide emissions	54 MtCO2e	30 MtCO2e
Corporate emissions	0.324 MtCO2e	0.18 MtCO2e

Vaughan's Annual Carbon Budget

The annual carbon budgets for Vaughan were calculated to guide decision-making during the remaining two years of the 2023–2026 and the entire four years of the 2027–2030 financial budgeting periods. The assumption is that the carbon budget would be used starting in 2025, meaning that the allowable community-wide emissions limits between implementing the carbon budget and 2030 are equal to 12.79 MtCO2e. Table 3 summarizes the annual corporate and community-wide carbon budgets between 2025 and 2030.

Table 3. Vaughan's corporate and community-wide annual carbon budgets from 2025 to 2030.

BUDGETING YEAR	2025	2026	2027	2028	2029	2030
Community-wide carbon budget (MtCO2e)	2.38	2.32	2.20	2.09	1.96	1.84
Corporate carbon budget (MtCO2e)9	0.014	0.014	0.013	0.012	0.012	0.011

[9] During the 2016 baseline, the City's emissions accounted for approximately 0.6% of the total community emissions. Assuming this proportion stays the same in the short term, the carbon budgets for corporate operations were calculated as 0.6% of the community-wide carbon budget.

Vaughan's Carbon Budget Management Framework

The management framework for Vaughan's corporate carbon budget is designed to be implemented through a phased approach, with a long-term goal to incorporate a community carbon budget framework. The management framework has been designed to meet the following carbon accounting objectives:

1. Implement a mechanism to manage carbon emissions from municipal operations and assets.
2. Align operating and capital budgets, processes, decisions, and priorities with the carbon budget.
3. Highlight trade-offs and synergies for financial and GHG decisions.
4. Track municipal initiatives, actions, and policies and the impact on the broader community's carbon budget.
5. Provide an accountability framework.
6. Enable transparent reporting.
7. Build carbon literacy in the municipal government.

The carbon budget framework will be an integral part of Vaughan's ongoing operational and capital budgeting processes under the MEP. The City will begin implementation with a corporate-level carbon budget framework focusing on high-investment capital projects, which will be expanded to include all corporate emissions. As the city staff gains expertise in the process, the City will reassess its resources and capacity to introduce a community-wide carbon budget framework within the next five years.

Establishing the Framework

In 2017, Council endorsed the Financial Sustainability Guiding Principles, which represent responsible fiscal management and provide a conceptual approach to decision-making to address short-term and long-term financial impacts. The carbon budget is the third pillar of Vaughan's budget, alongside the capital budget and the operating budget.

Figure 4 (next page) summarizes how the carbon budget framework supports Vaughan's Financial Sustainability Guiding Principles.

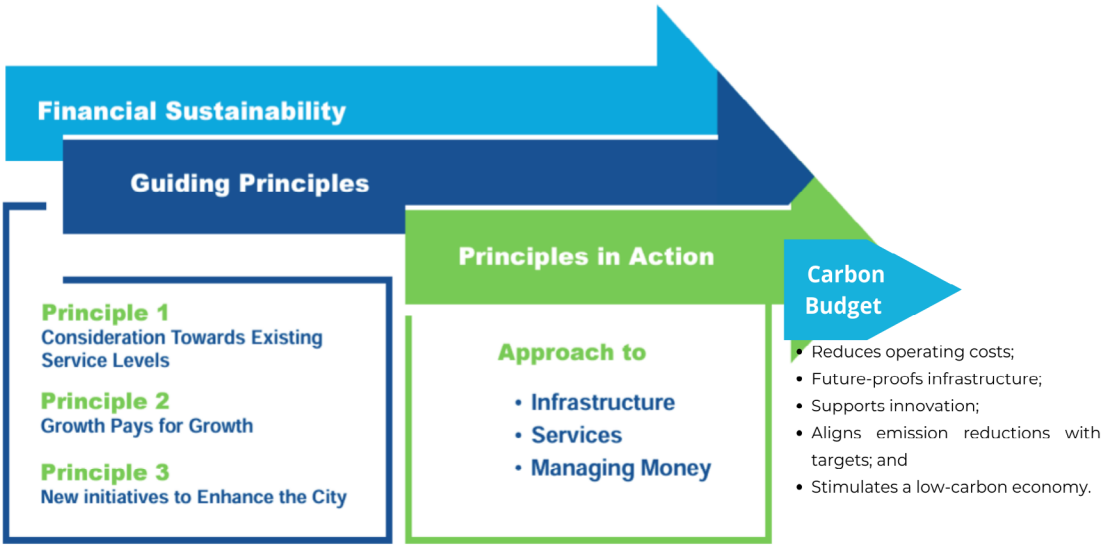

Figure 4. Integration between the City's Financial Sustainability Guiding Principles and the carbon budget outcomes (image adapted from the City of Vaughan's 2024 Budget and the 2025–2026 Financial Plan).

THE CONCEPT

The corporate carbon budget quantifies emissions derived from three distinct streams: capital projects, operating expenditures, and policies that impact the broader community. Once the carbon budget is expanded to include community-wide emissions limits, it will quantify emissions derived from GHG reduction projects by external organizations. Table 4 summarizes the four carbon budget streams.

Table 4. The four carbon budget framework streams.

STREAM	DESCRIPTION
Capital	Analysis of the GHG impact of proposed capital investments by Vaughan. The GHG quantification will be conducted by the Policy Planning and Special Programs department and used to prioritize capital expenditures through the financial budgeting process.
Operating	Analysis of the GHG impact of operating expenditures by Vaughan. Since many operating expenditures relate to personnel or other ongoing expenses, their GHG impact will be less significant than that of capital expenditures. The impact of Vaughan's investment portfolio could be included in this stream.
Policy	Analysis of the GHG impact of transportation, land use, industry, energy, and buildings policies implemented by Vaughan, resulting in GHG emissions from community activities.
External	The external stream is a mechanism for other organizations, including other levels of government, businesses, public sector organizations (schools, health authorities), non-profits, to register GHG emission reduction efforts as part of Vaughan's overall carbon budget.

TOOLS AND RESOURCES

Six tools and resources support the implementation of Vaughan's carbon budget and management framework:

1. Carbon Budget Strategy (this report provides the basis for the strategy): The document that guides the implementation of the carbon budget for Vaughan, including identifying timelines and roles and responsibilities.
2. GHG Calculator for Municipal Projects Tool: Prepared by SSG, the GHG Calculator is a Microsoft Add-On Excel Tool used for calculating the project-level GHG impact of the projects and policies and compiling the total GHG impact to determine the carbon surplus and deficit.
3. Aggregation Worksheet: A document that aggregates all the GHG impacts of projects and policies using the output from the GHG Calculator for Municipal Projects Tool. This worksheet can be used to compare the annual GHG emissions against the annual carbon budget.
4. GHG Actions Form (and Climate Lens): A form that departments can fill out to describe the GHG impact of the projects. Since Vaughan does not currently have a climate lens, it is recommended the City develop both a climate lens and GHG Actions From.
5. Carbon Budget Report: An annual report that compares the annual carbon budget against the carbon budget target and describes progress and challenges.
6. Annual GHG Inventory: An annual inventory of the previous year's GHG emissions.

GOVERNANCE FRAMEWORK

Implementing the carbon budget will require the continuation of existing roles, as well as the creation of new or revised roles and responsibilities, as outlined in Table 5 (next page). It is recommended that the Environmental Sustainability team within the Policy Planning and Special Programs department lead the implementation of the carbon budget. However, a new line of communication needs to be established between the Environmental Sustainability team and Finance staff, as the Finance department should have in-depth knowledge of the carbon budget process and its integration with the financial planning process. During the first two years of implementation, the departments will need to collaborate closely to build capacity across the organization to fully implement the corporate carbon budget tools. This process will include:

- Training staff for specific responsibilities and steps;
- Training for existing staff to bolster capacity to complete GHG quantification
- Updating internal documents to include GHG quantification reporting (e.g., climate lens) and an Annual Carbon Budget Report;
- Establishing liaisons between the Environmental Sustainability Team and the Finance department; and
- Updating online resources and corporate-wide tools.

Table 5. Key responsibilities in administering the carbon budget's management framework.

GROUP	RESPONSIBILITIES AND APPLICABLE TOOLS	RESOURCES
City of Vaughan Council	Carbon Budget Report • Review and approve annual carbon budget.	Briefing on the overall carbon budget framework and how to interpret the carbon budget reports in decision-making processes.
Committee of a Whole	Carbon Budget Report • Review, assess, and advise Council and Senior Leadership Team on annual report.	Briefing on the overall carbon budget framework and how to interpret the carbon budget reports in decision-making processes.
Senior Leadership Team (SLT)	Supporting the carbon budget implementation • Champion the carbon budget by providing leadership; • Coordinate with the Environmental Sustainability Team; • Act as an administrative resource for programs/departments; • Provide transparency on the progress to the organization and the community; • Evaluate the impact of GHG reduction decisions on other municipal priorities (e.g., job growth, economic growth, stability, etc.); and • Evaluate the financial implications at the corporate level. Carbon Budget Report • Review and present the report with the Finance Department and Environmental Sustainability Team to the Committee of a Whole/Council and • If required, support the preparation of the Carbon Budget Report.	Briefing on the overall carbon budget framework and how to interpret the carbon budget reports in decision-making processes.

GROUP	RESPONSIBILITIES AND APPLICABLE TOOLS	RESOURCES
Finance Department	Implementation Support • Ensure processes under the management framework remain aligned with the business planning and budgeting processes and the municipality's financial framework, long-term financial outlook, policies, procedures, and requirements; • Evaluate the impact of GHG reduction decisions on other municipal priorities (e.g., job growth, economic growth, stability, etc.); • Evaluate the financial implications at the corporate level; and • Liaise with the Environmental Sustainability Team to support implementation of the carbon budget and management framework. GHG Actions Form and Climate Lens • Update project budget forms with recommended GHG Actions Form and climate lens form. Carbon Budget Report • Support the Environmental Sustainability Team in preparing the Annual Carbon Budget Report; and • Integrate the Annual Carbon Budget Report into the annual Budget and Financial Plan.	Training on carbon budget framework and all its tools for calculations and reporting.

GROUP	RESPONSIBILITIES AND APPLICABLE TOOLS	RESOURCES
Environmental Sustainability Team	Implementation Support • If necessary, propose additional actions to achieve the carbon budget based on available funding, longer-term asset/financial strategies, and current year and proposed forecasts; • Support the Finance department in analyzing the impact of GHG reduction decisions on other municipal priorities (e.g., job growth, economic growth, stability, etc.); • Coordinate/facilitate the assessment of cross-program or multi-program initiatives; and • Provide training, resources, and support to all staff involved in the carbon-budgeting process. Carbon Budget Strategy • Prepare Carbon Budget Strategy; • Review annually and provide necessary updates; • Communicate policy updates to the Finance Team; • Support the Finance department in preparing the GHG Actions and climate lens forms; and • Lead implementation of the carbon budget and management framework. GHG Quantification Tool • Complete project-level GHG quantification on behalf of each department; • Beginning in 2027, support each department in completing GHG quantification and review project-level GHG quantification on behalf of each department; and • Compile project-level GHG quantification into an Aggregation Worksheet to determine the carbon surplus and deficit.	Training on carbon budget framework and all its tools for calculations and reporting.

GROUP	RESPONSIBILITIES AND APPLICABLE TOOLS	RESOURCES
Managers	Implementation Support • Implement Council-approved actions and directions. GHG Quantification Tool • Beginning in 2027, quantify GHG impacts of program initiatives and projects and submit to the Environmental Sustainability Team for review. GHG Actions Form and Climate Lens • Complete climate lens section and submit to the Environmental Sustainability Team for quantification; and • With support from the Environmental Sustainability Team update the GHG Actions Form with the results of the GHG quantification.	Briefing on carbon budget framework. Training on all its tools for project-level calculations.
Departmental Staff/ Program Leads	GHG Quantification Tool • Beginning in 2027, quantify GHG impacts of program initiatives and projects and submit to the Environmental Sustainability Team for review. GHG Actions Form and Climate Lens • Complete climate lens section and submit to the Environmental Sustainability Team for quantification; and • With support from the Environmental Sustainability Team update the GHG Actions Form with the results of the GHG quantification.	Briefing on carbon budget framework. Training on all its tools for project-level calculations.

IMPLEMENTING THE CARBON BUDGET INTO VAUGHAN'S FINANCIAL PLANNING PROCESSES

Implementing the City's carbon budget and framework required four distinct GHG quantification activities:

1. Annual Carbon Budget: Quantification and establishment of the carbon budget. The annual carbon budget limits have been prepared in this report, however, the Environmental Sustainability Team will be responsible for reviewing and updating annually.
2. Project-Level GHG Quantification: The project manager(s) within the Environmental Sustainability Team uses (use) the GHG Calculator for Municipal Projects to calculate project-level GHG emissions of capital and operating expenditures (Appendix A). The

project manager(s) within the Environmental Sustainability Team compiles (compile) all the project-level GHG quantification results into an Aggregation Worksheet to compare against the annual carbon budget target (e.g., emissions limits).

3. Carbon Budget Report: The Environmental Sustainability Team and the Finance Team co-develop the Carbon Budget Report using the outputs from the GHG quantification and aggregation. The Carbon Budget Report is presented alongside the capital and operating budgets as a forward-looking perspective of GHG emissions. The Carbon Budget Report identifies whether a carbon surplus or deficit will be achieved based on the approved projects, and adjustments to or cancellation of proposals can be made to stay within the financial and carbon budget limits during municipal budget deliberation.
4. Annual GHG Inventory: The project manager(s) within the Environmental Sustainability Team prepares (prepare) the annual community-wide GHG inventory to illustrate how Vaughan performed against its carbon budget and emission reduction targets.

The following section details how each carbon budget step and tool is integrated into the City's existing financial planning processes (Figure 5). The City's corporate carbon budgeting framework is a management system approach designed to incorporate GHG emission targets into capital and operating expenditures using five key outputs:

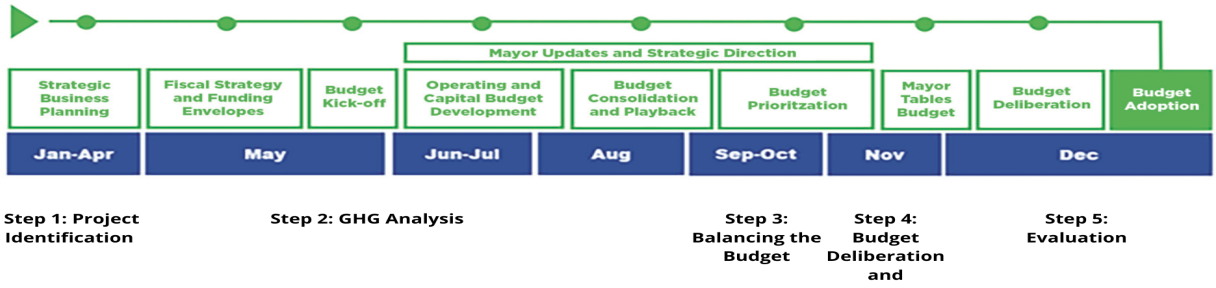

Figure 5. Implementation of the carbon budget management framework into the City of Vaughan's annual budget process (image adapted from the City of Vaughan's 2024 Budget and 2025–2026 Financial Plan).

STEP 1: PROJECT IDENTIFICATION

Overview

Timeframe	• January to April
Leads	• Departmental managers and staff
Carbon Budget Tools	• Climate lens
Outputs	• Each department identifies the GHG emission impact resulting from the project in the climate lens • Departmental project lists are compiled and submitted to the Environmental Sustainability Team for GHG quantification

Description

From January to April, each department completes their annual strategic business planning to identify projects and plans that support the City's Master Plans, Studies, and Capital Plans. During this phase, departments will compile a list of potential projects and policies to submit

to the Environmental Sustainability Team for GHG quantification. In addition, the Environmental Sustainability Team will be responsible for notifying departments of the MEP Implementation Framework's projects that are related to their department's work plan.

For each project, apply the climate lens to identify if there will be any resulting GHG emissions impacts. While not all project proposals will have emissions impacts, this step reduces the risk of missing out on opportunities for emissions reductions and ensures that projects with a GHG impact will be quantified during Step 2.

STEP 2: GHG ANALYSIS

Overview

Timeframe	• May to July
Leads	• Environmental Sustainability Team • Finance department (support)
Carbon Budget Tools	• GHG Quantification Tool • GHG Action Form (and Climate Lens)
Outputs	• Project-level GHG quantification is completed for each department • Climate lens is updated to include GHG quantification, using the GHG Action Form

Description

Key elements of the carbon budgeting process are the quantification of GHG impacts and the completion of an analysis to determine whether there is a surplus or deficit. These processes will be integrated into the City's operating and budget development process between May and July.

Project-Level GHG Quantification

For projects with GHG emissions impacts identified in the climate lens, the Environmental Sustainability Team will be responsible for quantifying the project-level GHG emissions expected to be eliminated or added, relative to the business-as-usual scenario. Depending on the project size and complexity, different tools may be used as long as the tool adheres to standard GHG accounting methodologies. Analysis results are summarized into a GHG Action Form (similar to a budget request form) and submitted to the finance department. Figure 6 (next page) illustrates a decision tree that can guide which protocol or method to use.

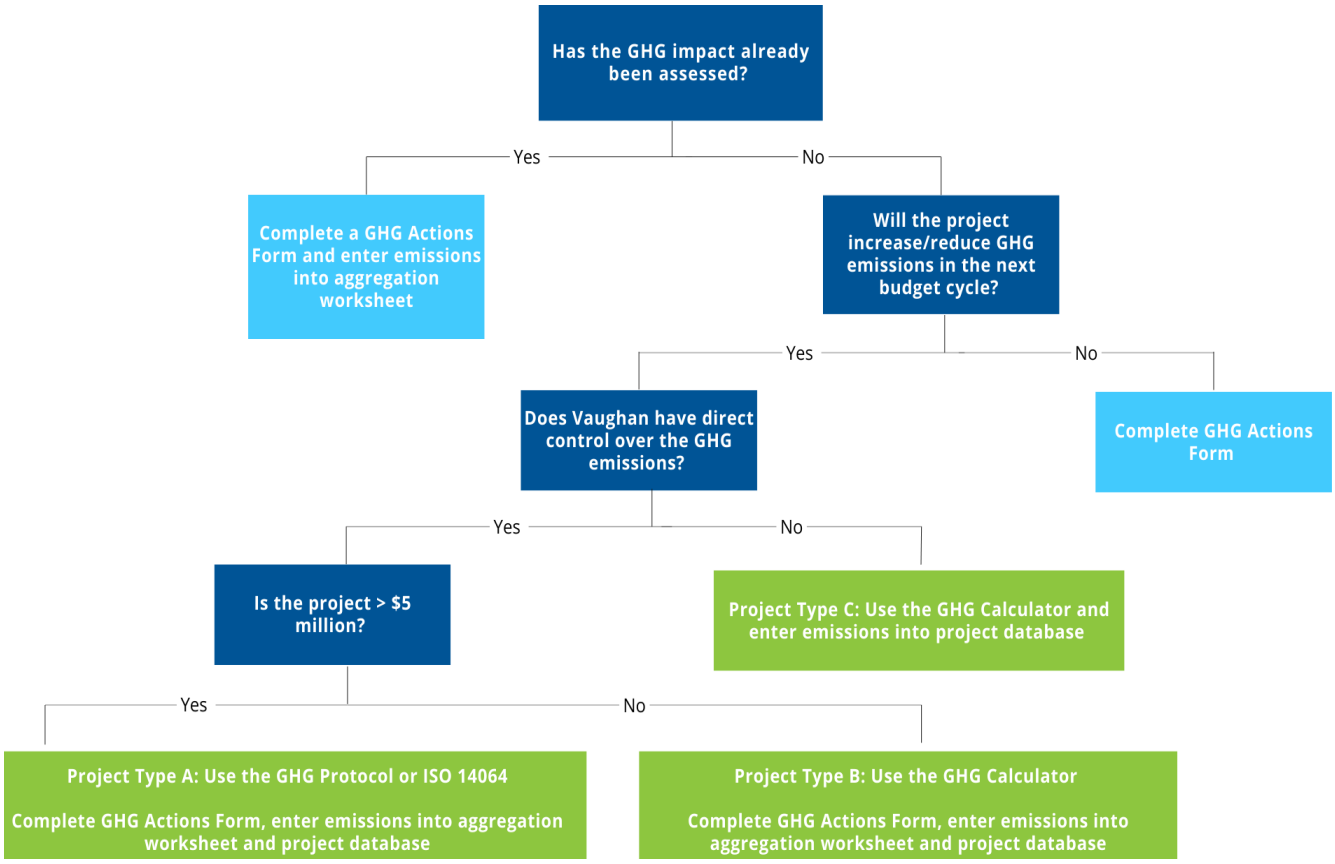

Figure 6. Carbon accounting decision tree for GHG projects (adapted from the City of Edmonton).

As the City gains experience with quantification, the decision tree would likely evolve. The review by the Environmental Sustainability Team is a quality-control step prior to submitting results into the aggregation worksheet or project database. For major projects that require investments above a certain threshold (e.g. above $5 million), a higher level of scrutiny is applied using third-party standardized approaches or standards (such as the International Organization for Standardization 14064 or GHG Protocol); however, other projects apply a simpler approach through the GHG Calculator for Municipal Projects Tool.

As the Environmental Sustainability Team builds internal capacity and familiarizes themselves with the GHG quantification procedures, they will be responsible for training other departmental staff and program leads in the procedures. It is recommended that each department complete the project-level GHG quantification beginning of the 2028 budget cycle. At this stage, the Environmental Sustainability Team will be responsible for acting as a quality-control by reviewing each GHG quantification and aggregating all project-level quantifications into the Aggregation Worksheet. This transition aligns with the full implementation of the carbon budget across the municipal portfolio, which will allow the Environmental Sustainability Team to allocate their resources towards compiling all the project-level GHG emissions into a spreadsheet for analysis and preparing the Annual Carbon Budget Report.

Aggregating the GHG Quantifications

Similar to financial budgets, the aggregated total is evaluated in comparison with the allocated budget to determine whether the City will be in a deficit or surplus for the budget cycle. Using the project-level GHG quantification results, the Environmental Sustainability Team will compile the GHG quantification results into a spreadsheet (e.g., Aggregation Worksheet). The preliminary

budget will be reviewed with the Finance department.

STEP 3: BALANCING THE BUDGET

Overview

Timeframe	• September to October
Leads	• Senior Leadership Team
Carbon Budget Tools	• Aggregation Worksheet • Annual Carbon Budget Report
Outputs	• Preliminary carbon budget is reviewed and the budget is balanced based on the City's ranking framework, Council priorities, and GHG impacts

Description

The Environmental Sustainability Team and Finance departments present the results of the preliminary carbon budget to inform the Senior Leadership Team of the GHG surplus or deficit. The preliminary budget will undergo the formal budgeting process, including a presentation to Council, a public hearing, and ultimately, a decision by Council.

GHG reductions would be one of the criteria in the priority-based process—other criteria would depend on the City's priorities, like fiscal responsibility and service-level commitments. Criteria weighting can be determined by policy, stakeholder engagement, or Council direction. In a deficit situation, trade-offs between criteria will see some projects adjusted, redesigned, or deferred to ensure that the City remains within its carbon and fiscal budget allocations.

At the end of the budget deliberation process, which typically takes place from September to October each year, a final budget will be approved by Council for implementation.

STEP 4: BUDGET DELIBERATION AND EXECUTION

Overview

Timeframe	• September to October
Leads	• Environmental Sustainability Team • Finance department (support) • Committee of a Whole, Mayor, and Members of Council (reviewers and approvers)
Carbon Budget Tools	• Carbon Budget Report
Outputs	• A Carbon Budget Report is prepared and presented to the City's Committee of a Whole and Council

Description

The City will present the Annual Carbon Budget Report of the proposed projects to the Committee of a Whole, the Mayor's Table, and Council. The results feed into the City's budget deliberation in November, which includes presentations to the Mayor and Members of Council.

STEP 5: EVALUATION

Overview

Timeframe	• Ongoing
Leads	• Environmental Sustainability Team
Carbon Budget Tools	• Annual Carbon Budget Report • GHG Inventory Tool
Outputs	• An annual GHG inventory is compiled

Description

Following approval, funds are allocated according to the approved budget and City staff executes planned activities and projects. Deviations from a planned budget may occur due to a number of factors, such as unexpected funding shortfalls, unforeseen expenses, policy adjustments, and external factors. It is important for department heads and project managers to monitor and adjust accordingly.

Reporting is a key component of the carbon budgeting process. The Annual Carbon Budget Report and the GHG Inventory Report describe whether the municipality is in a surplus or deficit position and provide accountability for Council and the public.

As actions are implemented, their impacts on GHG emissions are evaluated and tracked annually, either through direct measurement of energy or emissions or via key performance indicators. Annual GHG inventories help assess whether emissions are within the carbon budget, the magnitude of any carbon deficit, and the effectiveness of implemented actions. Like the financial budgeting process, supplemental adjustments are made annually based on continuous reporting and evaluation.

Integrating the Community Carbon Budget

Several municipalities have elected to initially implement a carbon budget solely for municipal operations, with the intention of expanding to the broader community emissions in subsequent phases. However, due to the City of Vaughan's 2030 target of 2–3 tCO2e per capita, it is recommended that the City expand the carbon budget to include community emissions in Q1, 2027. As identified in Figure 6, external emissions that the City does not have a direct control over the GHG emissions would not be quantified using the GHG Calculator. However, these emissions would be tracked and reported using the Annual Carbon Budget and project database.

The annual community-wide GHG inventory will track community progress towards the 2030 target; to support tracking, the City would need to build or purchase a tool that allows other entities to report on their emissions reduction projects so they can be tracked in the Annual Carbon Budget Report. For example, the Climate Smart[10] software enables businesses to measure, reduce, and report on their corporate carbon footprint by providing training and resources, and Kausal[11] provides community collaboration software to track progress. The City of Vaughan could adopt a similar program to allow local entities to self-report their GHG emissions,

[10] Information on the Climate Smart program is available here: https://commercial.bmo.com/en/ca/we-can-help/climate-smart/.

[11] Information on Kausal is available here: https://kausal.tech/solutions/collaborate

which would reduce the resourcing requirements of city staff, as the GHG quantification would be completed through the self-reporting software.

Next Steps

Where possible, carbon budget framework timelines should align with financial accounting timelines to ensure clarity and continuity.

- The first priority is to establish a carbon budget strategy with roles, responsibilities, and timelines, thereby formalizing the incorporation of a GHG management framework that aligns organizational decision-making with GHG targets.
- The City will need to develop the GHG Actions Form and climate lens, to prepare for the first carbon budget workflow in the 2025 budget.
- The City will build resources, tools, and staff capacity to ensure that the organization as a whole (and project managers in particular) is equipped and ready to undertake its first carbon budget workflow for inclusion in the 2025 budget.
- In the short term, the City needs to focus on quantifying the impacts of actions that result in high corporate investments. Actions in this category include that lock-in patterns of GHG emissions (i.e., road construction) are irreversible (i.e., building codes) or result in higher costs if action is delayed (i.e., deployment of retrofits). GHG emissions for some actions with these characteristics are already being quantified because they involve federal investments.
- Following this effort, the next target is to deliver a full Carbon Budget Report for corporate emissions in the 2027 financial budgeting period.
- Within the next five years, with the knowledge and experience gained from the corporate framework, the City will expand the carbon budget framework to capture emissions from the community to align with Vaughan's corporate and community GHG emissions targets.

Figure 7 (next page) summarizes the recommended implementation phases, and the following sections detail the concept, governance framework, roles and responsibilities, and implementation steps for incorporating carbon budgeting into Vaughan's existing financial processes.

YEAR 1 Q3 - Q4, 2024	YEAR 2 Q1 - Q4, 2025	YEAR 3 Q1 - Q4, 2026	YEAR 4 Q1 - Q4, 2027	2028 - 2030
Formally adopt annual carbon budgets and management framework, and establish the Carbon Budget Strategy Complete GHG quantification training Pilot carbon budget workflow for one major capital project Update relevant financial documents to include climate lens and GHG quantification results, and prepare template for annual Carbon Budget Report Identify departments to participate in Year 2 pilot	Pilot carbon budget management framework's workflow into multiple departments for at least one project per department It is recommended to pilot with Corporate Fleet and Facilities Management	Incorporate carbon budget management framework into annual budgeting process for all capital and operating projects Update the the annual "Budget Book" to include the Carbon Budget Report as part of the Budget Summary Section Complete GHG quantification training for all departmental; Project Managers Begin exploring implementation of community-wide carbon budget	Departmental staff are responsible for completing project-level GHG quantification Carbon budget management framework is integrated into all capital and operating projects Pilot community carbon budget is launched	Continue full implementation and reporting for corporate and community carbon budget management frameworks

Figure 7. Recommended implementation phases.

The corporate carbon budget will further enhance the implementation of the MEP and will highlight Vaughan as a leader in climate action. The organizational change process will require staff time, support, training, and new processes to be efficiently implemented; however, implementing the carbon budget will also produce the following benefits:

- Simplicity: Aligns with financial systems, providing a familiar approach to planning used in local governments;
- Temporal Scope: Provides a multi-year framework for tracking GHG emissions over all aspects of corporate capital, operating, and policy decisions, and it can be further applied to community activities;
- Alignment: Integrates into the existing capital and operating decision-making frameworks of a local government, allowing investments, costs, and benefits to be assessed over multiple years;
- Accountability: Allocates climate action across all municipal departments, while at the same time allowing managers to manage their team's share of the budget and to identify priorities for action that fit best with their team's mission and objectives; and
- Transparency: When combined with emissions monitoring (as identified in Vaughan's MEP), it provides a transparent framework to measure progress towards the climate targets.

This structured approach ensures that Vaughan's strategies for reducing GHG emissions are integrated seamlessly with financial planning, enhancing the effectiveness and accountability of the City's climate actions.

Appendix A: Greenhouse Gas Quantification Manual

GHG Quantification Resources

It is recommended the City uses the SSG GHG Calculator for Municipal Projects for projects with a budget of less than $5 million (Table 1A). For projects with a budget exceeding $5 million, the City should explore using the GHG Protocol or ISO 14064.

Table 1A. Recommended quantification tool.

DOCUMENT	USE CASE	GUIDANCE
SSG (2023). GHG Calculator for Municipal Projects	Designed for typical municipal projects and policies. Useful for quick, preliminary GHG quantifications.	Microsoft Office Add-in for Excel. Estimates project GHG emissions with formulas and emission factors embedded within the tool.

Protocols

The Greenhouse Gas Protocol (GHG Protocol), the internationally accepted GHG accounting and reporting standards and tools, outlines six principles for project-level GHG quantification:

1. Relevance: The data and GHG quantification procedures most appropriate to the project should be selected. The levels of accuracy and uncertainty associated with the quantification process should reflect the intended use of the data and the objectives of the project.
2. Completeness: All relevant GHG emissions and removals should be included, along with information to support criteria and procedures.
3. Consistency: All data, methods, criteria, and assumptions should be applied consistently to ensure meaningful comparisons between the baseline and the project scenario.
4. Accuracy: Estimates and calculations should be unbiased, and uncertainties should be reduced as far as practical. Calculations should be conducted in a manner that minimizes uncertainty.
5. Transparency: All assumptions, methods, calculations, and associated uncertainties should be explained to allow the intended users to make decisions with reasonable confidence.
6. Conservativeness: Where there are uncertainties, the values used to quantify GHG emissions should err on the side of underestimating potential reductions.

Actions Categories

As the City gains experience with quantification, it is expected that the decision-making process regarding GHG impacts will evolve. It is recommended that during early implementation, the Environmental Sustainability Team's project manager(s) leads (lead) the project-level GHG emissions on behalf of departmental managers, staff, and program leads. As internal capacity builds and the corporate carbon budget expands to include all capital and operating projects, the quantification process will transition to be completed by each departmental manager, staff, and/or program lead. At this point, the Environmental Sustainability Team's project manager would act as a quality-control step prior to submitting the results to the project's climate lens

and Annual Carbon Budget Report. For major projects, a third-party verification could also be beneficial.

Boundary

The boundary defines the scope of the GHG analysis and is the geographic boundary of the city of Vaughan, unless otherwise specified. GHG emissions will be reported according to the accounting framework for cities (Figure 1A and Table 1B), which includes:

- Direct Emissions: Emissions or removals from GHG sources or sinks that are owned or controlled by the City. At the GHG inventory level, direct emissions are also commonly referenced as Scope 1 emissions, such as emissions from in-boundary transportation and stationary fuel combustion.
- Indirect Emissions: Emissions or removals that are of consequence to the project but occur at GHG sources or sinks not owned or controlled by the City. For example, reduced electricity consumption might be considered a secondary effect in some infrastructure projects. Indirect emissions can include Scope 2 emissions as well as some Scope 3 emissions, as defined under the GHG Protocol, such as emissions from grid-supplied energy, transmission and distribution, and out-of-boundary transportation.

Table 1B. Emissions scope definitions.

SCOPE	DEFINITION
1	All GHG emissions from sources located within the City boundary.
2	All GHG emissions occurring as a consequence of using grid-supplied electricity, heat, steam, and/or cooling within the city boundary.
3	All other GHG emissions that occur outside the Town boundary as a result of activities taking place within the City boundary.

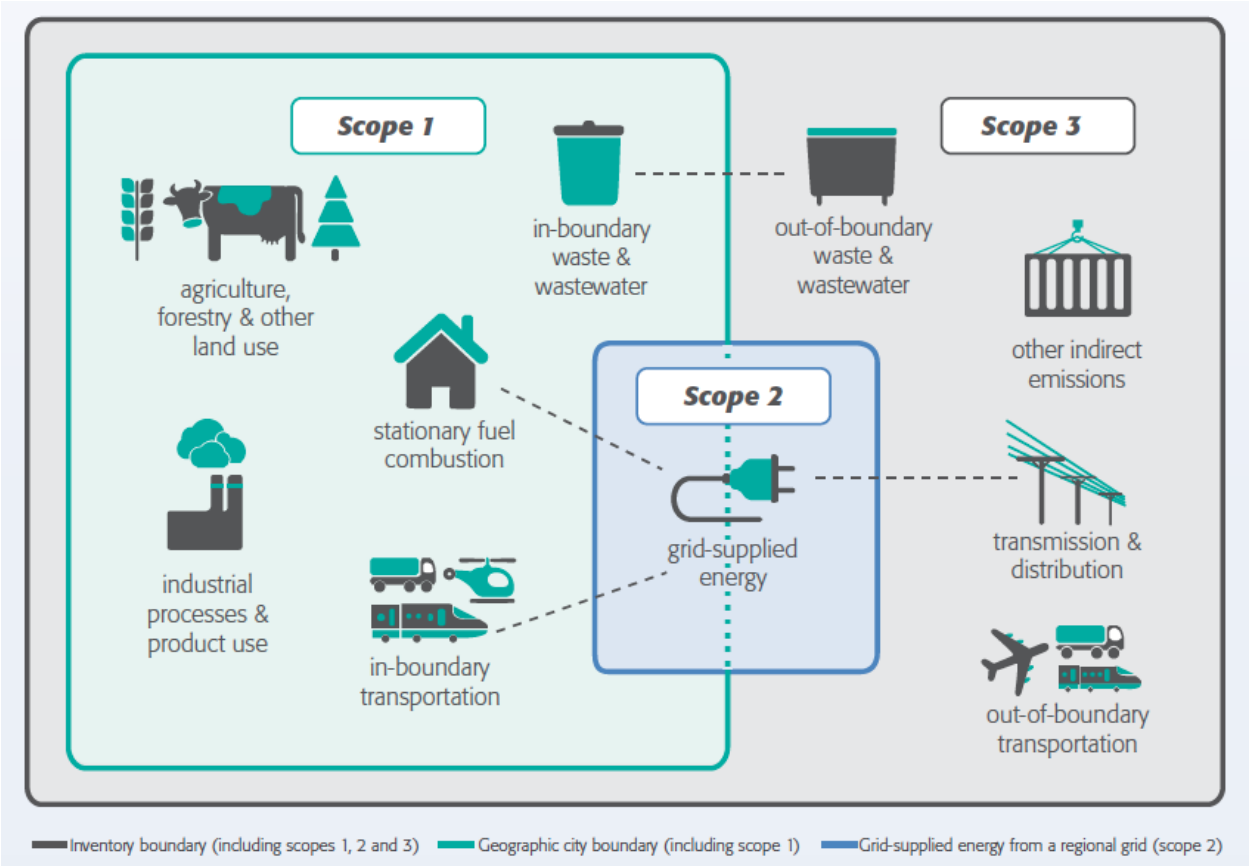

Figure 1A. Illustration of scope for a city's GHG calculation.

Greenhouse Gases

Mitigation assessments will consider the same greenhouse gases tracked through Canada's National Inventory Report. Specific gases can be excluded if deemed insignificant and appropriately rationalized through the assessment report. Emissions must be converted into CO2 equivalent (CO2e) using the Global Warming Potentials (GWP) identified in the most up-to-date version of Canada's National Inventory Report and reported in tonnes (t), kilotonnes (kt), or megatonnes (Mt):

- The GWP of CO2 = 1
- The GWP of CH4 = 28
- The GWP of NOC = 325

For projects that result in reductions or releases of CH4, Chartered Professional Accountants' (CPA) guidance on accounting for the short-term impacts should be reported:

- GWP (100 year) of 28 based on the IPCC's Fifth Assessment Report;
- GWP (20 year) of 85 based on the IPCC's Fifth Assessment Report and to match the more risk-relevant time horizon of 20 years; and
- Further, where relevant, hydrochlorofluorocarbons (HCFCs) should also be included, for example, if they are being used as refrigerants.

The Basic Formula

The quantification strategies are designed to provide GHG estimates for a source or activity because of an expenditure or action taken by the City of Vaughan. The general equation for emissions quantification is as follows:

GHG emissions = [source metric] x [emissions factors] x [GWP]

This calculation is used when:

- The source metric is the unit of measure of the source of emissions. For example, in the case of transportation, the source metric is vehicle kilometres travelled. For building energy use, it is the energy intensity or energy consumption per square metre of building space;
- The emissions factor is the rate at which emissions are generated per unit of source metric. In the case of a vehicle, it is kgCO2 per kilometre travelled; and/or
- The GWP is the factor that converts different greenhouse gasses to their carbon dioxide equivalent.

GHG Emissions Reductions

There are three types of GHG reduction categories (Table 1C). Reductions are calculated by subtracting GHG emissions resulting from a low-carbon action from GHG emissions in a reference or BAU case. For example, in order to identify the impact of the purchase of an electric car, GHG emissions resulting from the electric carbon are subtracted from GHG emissions created with a gasoline car, with the gasoline car representing the reference case. The general equation for GHG reduction quantifications is as follows:

GHG Reduction = [reference case] - [low-carbon case]

This calculation is used when:

- GHG reduction is the GHG emissions avoided as a result of the action taken or policy implemented;
- Reference case is the calculation of GHG emissions if current practice continues; and
- Low-carbon case is the calculation of GHG emissions when the action or policy is implemented.

Table 1C. Types of GHG emissions reductions.

REDUCTION CATEGORIES	DESCRIPTION
Avoided GHG emissions	The activity that generates the emissions is avoided. For example, a vehicular trip is replaced by a transit trip or a walking trip, avoiding the GHG emissions resulting from that vehicle.
Fewer created GHG emissions	The same activity is undertaken but with a strategy that generates fewer GHG emissions. For example, a more energy efficient vehicle is used or a more energy efficient boiler is installed.
Sequestration of emissions	Carbon emissions are embedded in a structure that can hold the emissions, preventing them from being released into the atmosphere. Planting trees is an example of biological sequestration. Carbon capture and storage injects emissions underground, an example of physical sequestration.

Appendix B: GHG Actions Form

The following is a recommended Climate Lens and GHG Actions Form:

Project Number:		
Project Name:		
Proposed by:		
Department:		
Estimated Project Planning and Design Phase Timing:	Start:	End:
Estimated Project Execution Phase Timing:	Start:	End:
Estimated Operational Date		

Climate Lens:

- Does this proposal move the City of Vaughan closer to its emissions reduction targets in line with Municipal Energy Plan (2024)?

Carbon Budget:

	2025	2026	2027	2028	2029	2030
Projected Energy Use						
Projected Emissions						

Description of GHG Impacts