THE CITY OF BARRIE

Corporate Net-Zero Strategy

2025 - 2050

Prepared by:

ENERGY MANAGEMENT BRANCH

Executive Summary

The City of Barrie's Net-Zero Strategy (NZ0 Strategy) is a comprehensive plan designed to achieve net-zero greenhouse gas (GHG) emissions from its corporate operations by 2050. Created in response to the City's 2019 Climate Emergency declaration, the strategy builds on more than two decades of climate action, including Barrie's involvement in the Partners for Climate Protection Program since 2001 and the adoption of the Community Energy and GHG Emission Reduction Plan in 2022. The NZ0 Strategy emphasizes an asset management framework, focusing on transitioning to low-carbon alternatives as assets reach the end of their useful life. Developed using a bottom-up approach, the strategy analyzes the City's operations at the asset level to project future GHG emissions, relying on data and evidence to guide decision-making and set a clear path toward emissions reduction.

'Net-zero emissions' means balancing GHG emissions to zero by reducing as much as possible first, then removing the remaining emissions from the atmosphere.

The City aims to achieve net-zero emissions by 2050, in alignment with global climate goals and the Paris Agreement. "Net-zero emissions" refers to balancing greenhouse gas (GHG) emissions to zero by first reducing them and then removing any remaining emissions from the atmosphere. At the global and national levels, a carbon budget has been set to limit emissions and keep average global temperature rise below 1.5°C, and the City's plan strives to meet these same objectives.

Undertaking a robust bottom-up approach the 2025 plan will not fully align with these objectives, due to existing technological limitations, as well as current operational and financial constraints. However, by developing the NZ0 Strategy through a bottom-up methodology, the City is able to fully understand and assess current constraints while taking practical and achievable steps toward its net-zero aspirations now. In this context, the NZ0 Strategy offers a clear, evidence-based pathway forward that is ready for immediate implementation.

The NZ0 Strategy establishes a solid foundation for integrating net-zero practices across the organization, while fostering the development of the knowledge, structures, and capacities necessary to accelerate the transition in the future. This approach will ultimately enable the City to expand its ability to meet its long-term net-zero targets.

The NZ0 Strategy also acts as an update under Ontario Regulation 25/23 (formerly On. Reg 507/18) which mandates public sector entities in Ontario to report annually on energy consumption and GHG emissions from buildings, as well as update their Conservation and Energy Demand Management Plans (CDM) every five years. Further details have been included within the Appendix of this report to highlight the required updates from the City's 2019 CDM plan and also provide a summary of projected future intensity metrics, a requirement outlined from the City's previous plan.

WHERE ARE WE TODAY?

The City of Barrie's Net-Zero Strategy follows established municipal accounting protocols, including the Partners for Climate Protection (PCP) Protocol and the Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC). These protocols provide a standardized approach for quantifying and reporting greenhouse gas (GHG) emissions at the municipal level. The strategy's emissions inventory includes two primary categories: Scope 1 and Scope 2 emissions.

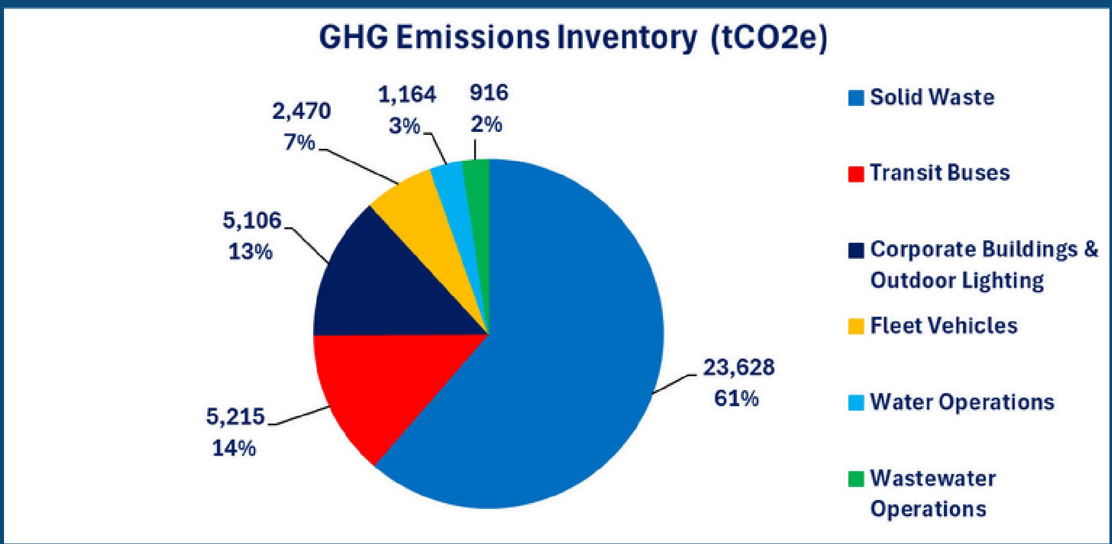
- **SCOPE 1** GHG emissions resulting from on-site fossil fuel combustion, such as natural gas, biogas, and propane in facilities and diesel and gasoline to power vehicles. Scope 1 GHG emissions also includes methane produced from the decomposition of solid waste.
- **SCOPE 2** GHG emissions that occur outside of the City's boundary as a result of the generation and distribution of electricity utilized by the City.
- **SCOPE 3** GHG emissions resulting from activities considered outside of the City's operational control, including from embodied carbon in the supply chain, process and fugitive emissions from wastewater treatment, and contractor travel.

At present, the inventory excludes Scope 3 emissions, which arise from activities outside the City's direct control, such as supply chains, contractor travel, or employee commuting. While some Scope 3 sources were analyzed during the strategy's development, they were excluded from the current inventory due to uncertainties in data accuracy and gaps in available information. As the strategy evolves, future updates to the GHG emissions inventory will focus on addressing these gaps. The City plans to prioritize actions to improve data collection and accuracy, with the goal of including Scope 3 emissions in future iterations of the inventory.

The NZ0 Strategy establishes 2022 as its baseline year, with the City generating a total of 38,500 tonnes of CO_2e emissions. The largest share of these emissions, 61 percent, comes from the decomposition of solid waste, which includes all waste produced by the community. The remaining emissions from City operations are mainly attributed to energy use across various sources, with total energy consumption in 2022 amounting to 100,270 MWh.

38,500

Tonnes GHG Emissions in 2022



WHERE WILL WE BE TOMORROW?

A business-as-usual (BAU) GHG emission pathway projects future emissions based on current trends, practices, and known plans, assuming no significant changes in policies, technologies, or behaviours. It serves as a reference scenario, offering a forecast of what emissions would look like if the City continues its existing activities without implementing new measures to reduce emissions.

40,100

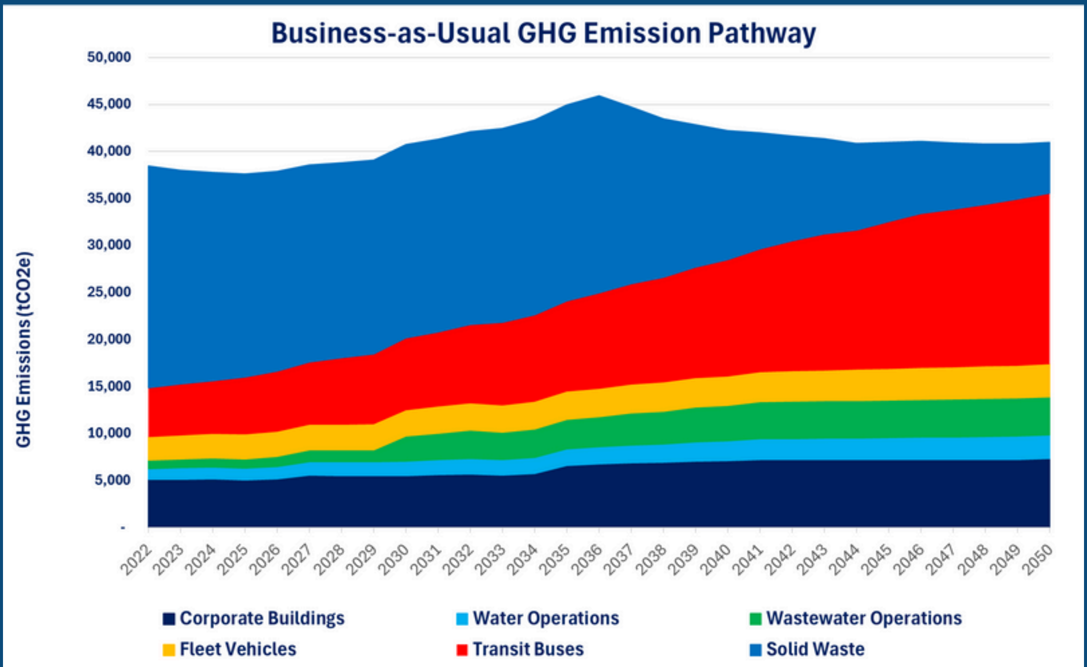
Tonnes GHG Emissions by 2050

For the Corporation, the BAU pathway predicts a 6% increase in emissions, which would result in a total of 40,100 tonnes of CO_2e by 2050. This projection reflects the continued reliance on current systems and operations without any transformative changes to address climate goals.

- The Corporation's GHG emissions from energy consumption are mainly driven by increased transit service to support population growth and rising ridership. However, it is important to note, that transit will be key in reducing the Community's overall emissions under both pathways.

- The GHG emission trend is also significantly influenced by accounting protocols for solid waste emissions. Under the BAU Pathway, the City-owned landfill is assumed to be to closed in 2035 and that waste will be exported outside the City's boundary which impacts how GHG emissions from the community's waste is reported.

- Water and Wastewater Operations will experience higher GHG emissions due to increased energy demand from population growth. Additionally, Wastewater Operations will see a significant rise in electricity usage as upgrades to meet stricter effluent standards are implemented.



WHERE COULD WE BE TOMORROW?

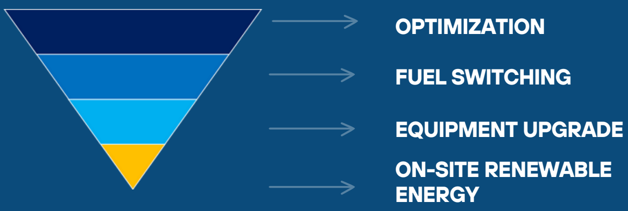
The NZ0 Pathway enables the City to reduce GHG emissions by 53 percent from the baseline by 2050, resulting in remaining emissions of 18,200 tCO_2e. Strategies for each Operational Group were identified and thoroughly evaluated to determine the total possible reductions, considering both current and anticipated technological advancements.

18,200

Tonnes GHG Emissions by 2050

Furthermore, the strategies are grouped into broader categories, as illustrated in the pyramid diagrams below. This tiered structure provides a clear, logical order of operations, balancing both GHG emission reduction with financial priorities. By organizing strategies in this way, the approach ensures consistent and coordinated implementation across all operational groups, aligning each step with the Corporation's overall net-zero objectives.

Operational Group Strategies



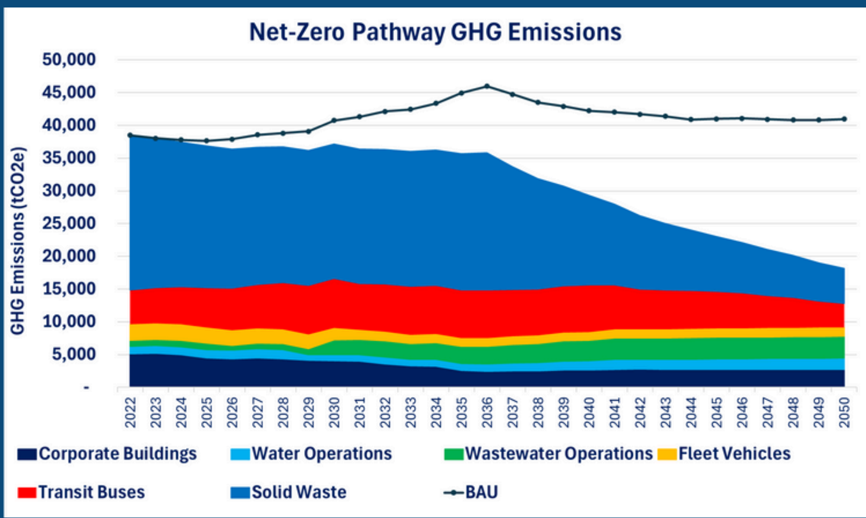
Corporate-Wide Strategies

Under the NZ0 Pathway, GHG emissions from all reported sources would result in a decrease of GHG emissions of 53 percent below the 2022 baseline. This reduction is achieved through a combination of energy efficiency improvements, the adoption of renewable energy, and the gradual transition to low-carbon technologies in key operational areas. The NZ0 Pathway demonstrates the potential reduction in GHG emissions based on the specific strategies identified for each operational group. It illustrates the impact of internal measures and actions, showing what can be achieved within each operational area before broader corporate-wide strategies are applied to address any remaining emissions.

-53%

Reduction below baseline by 2022

- Transit bus fleet is converted to battery electric models.
- Heating in buildings is transitioned from natural gas to electric.
- Solid Waste emissions follow the same pathway as the BAU.

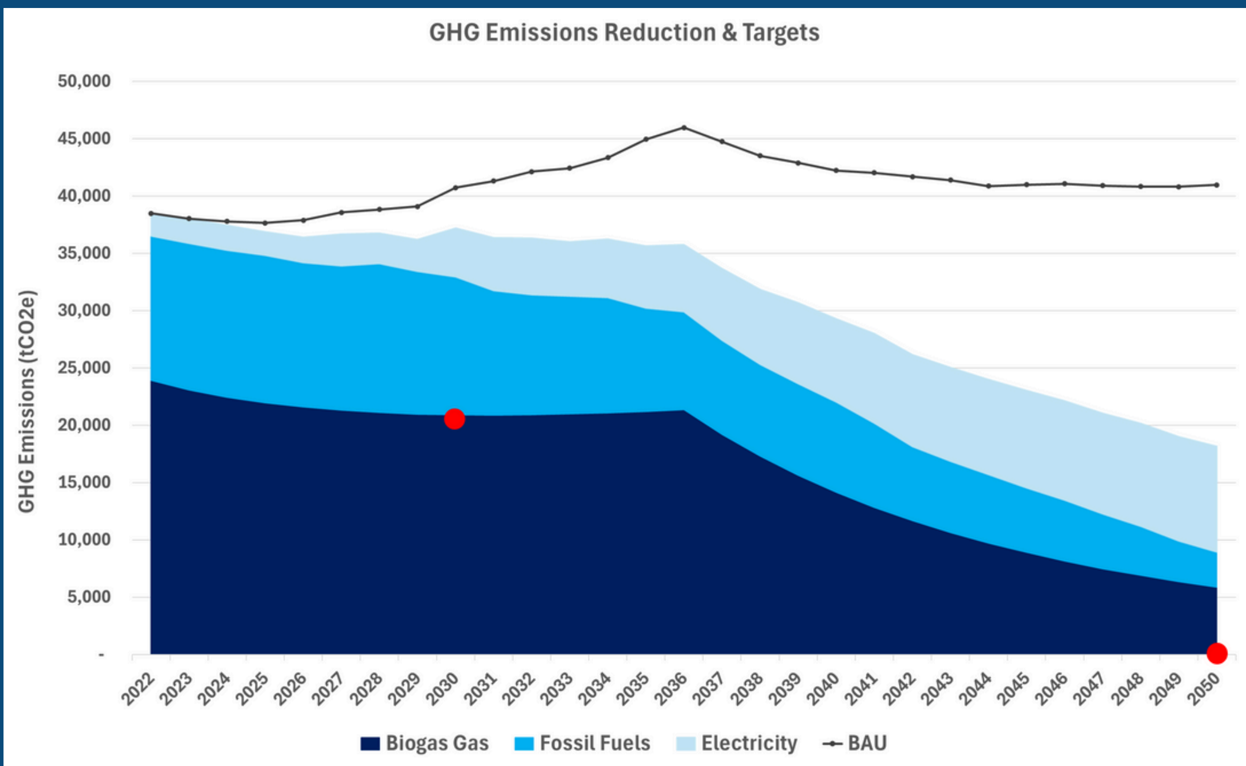


WHAT ABOUT THE REMAINING EMISSIONS?

The NZ0 Pathway moves the City on a pathway towards net-zero emissions by 2050. Developed utilizing a bottom-up approach, current constraints can be recognized and assessed in order to take practical and achievable steps on a NZ0 Pathway. The graph below shows the projected trajectory of remaining emissions by energy source compared to the BAU pathway. The light blue area represents emissions from electricity consumption from the Ontario grid. Renewable Solar PV electricity can serve as method to mitigate these emissions, reducing these emissions to zero, and reduce the overall remaining emissions outlined by 50 percent by 2050.

The other two segments on the graph include remaining fossil fuels and biogas emissions which should first be offset through nature-based solutions, such as carbon sequestration, and then, if necessary, through carbon offsets.

The two red dots on the graph represent the recommended GHG reduction targets as specified by the international scientific community. At 2030, this would mean a reduction in GHG emissions from the baseline of 45 percent, or 21,000 tonnes CO2e, and reaching zero by 2050.



HOW TO ENSURE SUCCESS?

The effective implementation of the NZ0 Strategy across City departments will necessitate a comprehensive range of activities and strategies. Key actions essential to achieving the plan's objectives include proposed modifications to the City’s capital planning and renewal processes, with a particular focus on prioritizing low-carbon alternatives. Additionally, integrating NZ0 objectives into existing planning documents during routine updates is crucial to ensuring alignment with the strategy’s long-term goals. Moreover, a commitment to ongoing improvement in data monitoring, as well as the establishment of standardized reporting structures and frequencies, has been identified as central to the successful execution of the 2025 NZ0 Strategy.

1 Capital Planning & Renewal

→ Net-zero objectives will be integrated into the City’s capital planning and renewal framework, with a focus on an inclusion and evaluation of low-carbon alternatives. Low-carbon options that demonstrate a life cycle payback will be incorporated as standard business-as-usual solutions. Conversely, where substantial initial capital investment is required without a projected return on investment, such items will be explicitly highlighted for Council's consideration.

2 Plan Governance & Integration

→ The NZ0 Strategy will be executed through a collaborative effort between the EMB and the Operational Groups, ensuring alignment with the City’s net-zero goals. Each group will be guided by an annual carbon budget, informed by the NZ0 Pathway, to help track progress. Successful implementation will be supported by integrating net-zero strategies into existing policies, ensuring consistent and effective execution across all departments.

3 Data Monitoring & Plan Reporting

→ Data monitoring and plan reporting will support the asset-based approach by emphasizing evidence-driven decision-making, emphasizing the reliance on data to guide planning and actions. Regular progress updates will maintain momentum, recognize successes, and identify areas for improvement, ensuring continuous progress toward long-term goals.

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About the Strategy

HOW THE STRATEGY WAS DEVELOPED

The Corporate Net-Zero Strategy (NZ0 Strategy) was created in response to the City's commitment to meaningful climate action, following its declaration of a Climate Emergency in 2019, alongside over 500 other municipalities across Canada.

Developed by the Energy Management Branch (EMB), the NZ0 Strategy builds on more than a decade of energy management initiatives. It focuses on energy efficiency and operational cost savings through the City's established energy management framework, integrates with the City's asset management approach, and embeds GHG emission reduction into decision-making across the organization.

The strategy was shaped through extensive consultations with internal working groups, composed of City staff who shared their expertise on operational areas that influence the City's GHG emissions. The working groups were made up of the staff from the following departments and branches:

- **Corporate Asset Management**
- **Corporate Facility Services**
- **Energy Management**
- **Facility Planning & Development**
- **Parks and Forestry**
- **Parks Planning**
- **Recreation and Culture Services**
- **Transit and Parking Strategy**
- **Waste Management and Environmental Sustainability**
- **Wastewater Operations**
- **Water Operations**

HOW THIS REPORT IS STRUCTURED

This report contains ten main sections to guide the reader from an introduction and background on net-zero GHG emission planning, the approach the City is taking to plan a pathway to net-zero emissions by 2050, the strategies selected to reduce emissions across the corporation, and the immediate steps the City will take to implement the NZ0 Strategy. The following is a summary of the ten main sections of this document:

- **Net-Zero Background** introduces concepts of net-zero GHG emission planning and provides a summary of the current landscape of climate mitigation.
- **Climate Action at the City** provides an overview of the history of climate mitigation action at the City.
- **Developing the Strategy** outlines the process by which the NZ0 Strategy was developed by staff at the City.
- **Baseline Inventory** summarizes the GHG emissions inventory for 2022, the baseline year for the NZ0 Strategy, as well as the City's energy use and energy cost profile in 2022.
- **Business-as-Usual Pathway** provides a summary of the modelling undertaken to project the GHG emissions, energy use, and energy cost from the baseline year to 2050.
- **Approach to Net-Zero** covers the overarching principles the City will draw on in its approach to reaching net-zero operational emissions by 2050.
- **Strategies by Operational Group** reviews the business-as-usual GHG emission projection, the key actions required to move towards net-zero, the impact on capital budgets and operating costs, and resulting net-zero pathway projection for each operational group.
- **Corporate-Wide Strategies** summarizes the strategic priorities for corporate-wide actions that will influence the corporate net-balance of emissions though have no quantifiable impact at the writing of this report.
- **Net-Zero Pathway** provides a summation of the reduction pathway outlined for each operational group to show the overall reduction in GHG emissions for the Corporation from the baseline to 2050.
- **Strategy Implementation** outlines the principles for how the City intends to implement the NZ0 Strategy and the immediate next steps to move forward on the net-zero pathway.

Net-Zero Background

'Net-zero emissions' refers to the balance achieved when human-caused emissions are reduced to zero, or any remaining emissions are offset through the enhancement of natural carbon sinks or the use of carbon capture technologies.

The concept of net-zero GHG emissions was first introduced internationally in 2015 with the signing of the Paris Agreement by UNFCCC member nations. This landmark agreement emphasized the urgent need to limit average global temperature rise to no more than 1.5°C above pre-industrial levels to avoid catastrophic climate consequences. To meet this target, it called for global GHG emissions to be reduced by 45 percent from 2005 levels by 2030, with the goal of reaching net-zero emissions by 2050.

'Net-zero emissions' means balancing GHG emissions to zero by reducing them first, then removing the remaining emissions from the atmosphere.

Since 2015, governments at national, regional, and municipal levels, as well as multinational corporations and private-sector entities, have increasingly committed to net-zero emissions targets. Today, more than 90 percent of the global economy is covered by jurisdictions with net-zero targets, typically set between 2050 and 2070. In June 2021, Canada enshrined its commitment to net-zero emissions by 2050 through the passage of the Net-Zero Emissions Accountability Act.

In 2019, the City of Barrie joined over 500 Canadian municipalities in declaring a climate emergency. This declaration marked a critical step in committing the City to climate action that matches the scale of the crisis, setting a target for net-zero emissions in City operations by 2050. For the broader community, the City developed the Community Energy and GHG Emission Reduction Plan, which was adopted by council in 2022. Created through extensive public and stakeholder engagement, this plan established a net-zero target for the community and outlined key actions for the City to help residents and businesses transition to a low-carbon future.

Climate Action at the City

The City has a long-standing commitment to climate action. In 2001, it joined the Partners for Climate Protection Program (PCP), a municipal climate initiative launched in 1994 by the Federation of Canadian Municipalities (FCM) and ICLEI-Canada. Since then, the City has taken significant steps, completing its first climate action plan in 2006, establishing an energy management branch in 2013, and developing a climate adaptation strategy in 2017. In 2019, the City declared a climate emergency and has since installed nearly 30 km of new bike lanes (2020), and launched a circular economy strategy in 2022. These efforts, alongside other initiatives, demonstrate the City's ongoing commitment to sustainability, environmental stewardship, and continuous improvement. The infographic below highlights some of the City's key achievements in climate action since joining the PCP program in 2001.

2001 — **CLIMATE MITIGATION NETWORK**
City joins FCM & ICLEI Canada's Partners for Climate Protection Program

2006 — **CLIMATE PLAN & GHG INVENTORY**
Completion of the first Community and Corporate GHG Emissions Reduction Plan

2012 — **FIRST ENERGY MANAGEMENT PLAN**
Completion of the first Conservation and Energy Demand Management Plan

2013 — **ENERGY MANAGEMENT BRANCH**
The City's Energy Management Branch established

2016 — **CLIMATE ADAPTATION NETWORK**
City joins ICLEI Building Adaptive and Resilient Communities program

2017 — **CLIMATE ADAPTATION STRATEGY**
City's Climate Adaptation Strategy and Implementation Plan appoved

2019 — **CLIMATE EMERGENCY DECLARATION**
Council declares a climate emergency, joining over 500 other municipalities

2020 — **BICYCLE INFRASTRUCTURE**
Addition of new bike lanes, urban shoulders, sidewalks, and trails

2021 — **FLEET ELECTRIFICATION**
Council endorses converting transit buses and fleet vehicles to electric models

2022 — **CIRCULAR ECONOMY STRATEGY**
The Circular Economy Strategy is completed and approved

2022 — **COMMUNITY ENERGY & GHG REDUCTION PLAN**
City's Community Energy and GHG Emissions Reduction Plan approved

2023 — **ELECTRIFY BARRIE PROGRAM**
Electrify Barrie program to support the adoption of EVs is established

2023 — **NET-ZERO FEASIBILITY STUDIES**
Completion of net-zero feasibility studies on eleven of the City's largest buildings

2025 — **CORPORATE NET-ZERO STRATEGY**
Completion of the NZ0 Strategy to manage GHG emissions across City-wide operations

Developing the Strategy

The Corporate Net-Zero Strategy was developed using a 'bottom-up' method, where GHG emission reductions were mapped based on the impact of each individual strategy. This approach contrasts with a 'top-down' method, which typically sets a target without detailing how specific strategies will contribute to achieving it.

The City's approach relies on evidence-based, quantitative analysis of low-carbon measures. While more time-consuming, this method ensures greater accountability and provides more reliable data. This approach was undertaken by the EMB and utilized for each Operational Group, following the process outlined in the graphic adjacent.

PHASE 1
Planning & Data Collection

- Assemble Operational Groups
- Define Scope of Emission Sources
- Collect & Analyze Data

PHASE 2
Characterization of Current State

- Establish GHG Inventory for each Operational Group
- Develop a BAU Pathway for each Operational Group
- Solicit Feedback

PHASE 3
Evidence-Based Pathway Development

- Identfiy and Analyze Low Carbon Measures
- Evaluate Capital Cost & Operational Savings
- Solicit Feedback

NET-ZERO BUILDING PATHWAY FEASIBILITY STUDY

In 2023, the Energy Management Branch (EMB) secured funding to conduct a feasibility study on nine of the City's largest energy-consuming and GHG-emitting facilities, with the goal of identifying the optimal pathway to net-zero emissions for each. This funding enabled the EMB to hire an engineering firm to carry out the studies, which included comprehensive site visits, reviews of previous Facility Condition Assessments (FCA), analysis of Building Automation Systems, energy and utility audits, and workshops with building supervisors, operators, and the energy management team.

The feasibility studies assessed the capital costs of low-carbon equipment compared to the existing systems at each facility, as well as the potential savings in operational energy costs from installing more energy-efficient, low-carbon alternatives. The findings strongly recommended an asset management approach to achieve net-zero emissions in most facilities. This approach focuses on replacing equipment with low-carbon alternatives at the end of its useful life to maximize the initial capital investment, rather than hastening the transition to low-carbon solutions before the equipment's end of life.

Building on the expertise and findings from the engineering firm, EMB staff conducted an analysis of the remaining City-owned facilities to determine a net-zero pathway, primarily through a fuel-switching and asset management approach. The results of the feasibility study enabled the EMB to develop a comprehensive and robust net-zero pathway for corporate buildings. This pathway provides detailed, equipment-level insights and offers a thorough analysis that can inform decision-making for facility upgrades and equipment renewals going forward that draws on both a strong energy management and low-carbon approach.

Accounting for GHG Emissions

The City's corporate GHG emission inventory follows established accounting protocols utilized by the municipal sector, including the Partners for Climate Protection (PCP) Protocol and the Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC). A key tenet of municipal GHG accounting is the principle of operational control, meaning any activities where the City has direct operational control must be included within the inventory. As such, the inventory includes all sources of Scope 1 and Scope 2 emissions required under the PCP Protocol where the City has operational control and excludes Scope 3 and other optional emission sources.

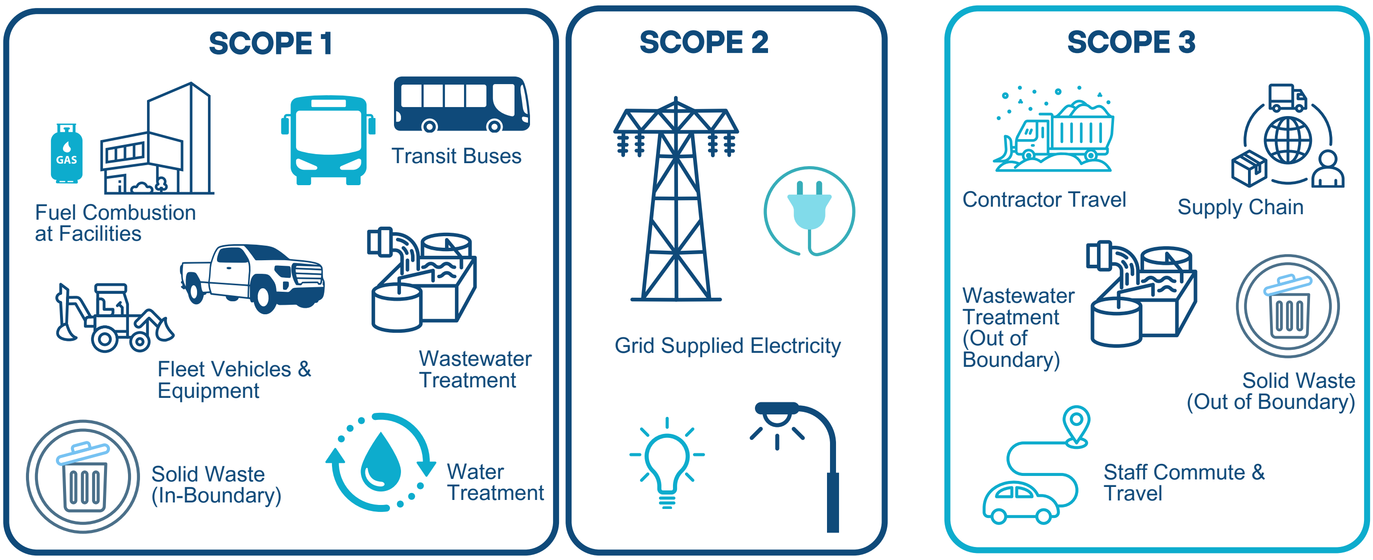
In the development of the 2022 inventory, staff investigated and analyzed optional emissions sources, including employee travel, contractor travel, fugitive and process emissions from wastewater treatment, and embodied carbon in supply chains. However, these emission sources were excluded from the 2022 inventory either due to incomplete data or to low levels of certainty with available data and methodologies. These emission sources will require further investigation, monitoring, and data acquisition in order to be included within future inventories.

GHG EMISSION SOURCES, ACCORDING TO SCOPE

→ **SCOPE 1** GHG emissions resulting from on-site fossil fuel combustion, such as natural gas, biogas, and propane in facilities and diesel and gasoline to power vehicles. Scope 1 GHG emissions also includes methane produced from the decomposition of solid waste.

→ **SCOPE 2** GHG emissions that occur outside of the City's boundary as a result of the generation and distribution of electricity utilized by the City.

→ **SCOPE 3** GHG emissions resulting from activities considered outside of the City's operational control (out-of-boundary), including from embodied carbon in the supply chain, process and fugitive emissions from wastewater treatment, and contractor travel.



**The above diagram illustrates how various GHG emission sources are delineated by municipal GHG emission protocols as a reference, and not necessarily what has been included within the City's 2050 inventory. Note, in-boundary refers to activities where the Corporation has operational control, out-of-boundary refers to upstream and downstream Scope 3 emission sources.*

Baseline Inventory

GHG Emissions (2022)

The NZ0 Strategy adopts 2022 as the baseline year, as it provides the most complete data, while earlier years lacked full data sets for all sources. Furthermore, the COVID-19 pandemic significantly impacted emissions in 2020 and 2021, making those years unrepresentative of typical conditions and unsuitable for establishing a baseline. The following section outlines the business-as-usual pathway, which combines both actual and modeled activity data for 2023 and 2024.

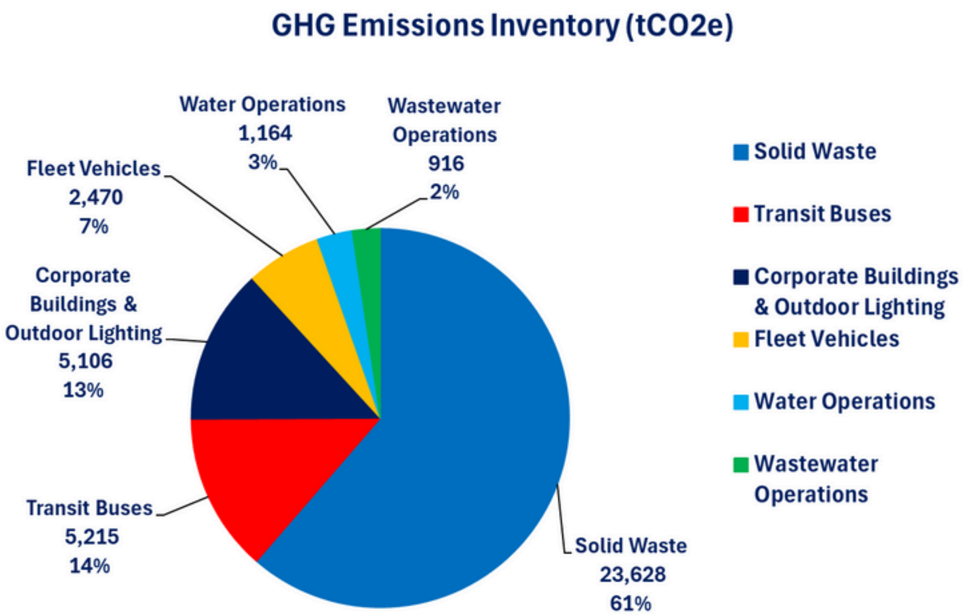
38,500

Tonnes GHG Emissions CO_2e

In line with the PCP Protocol, which recommends disaggregating GHG emissions into specific key sectors, the City's inventory organizes emissions into six categories: corporate buildings and outdoor lighting, Water Operations, Wastewater Operations, fleet vehicles and equipment, transit buses, and solid waste. In addition to GHG emissions, this report also includes an inventory of energy use and energy costs for each sector.

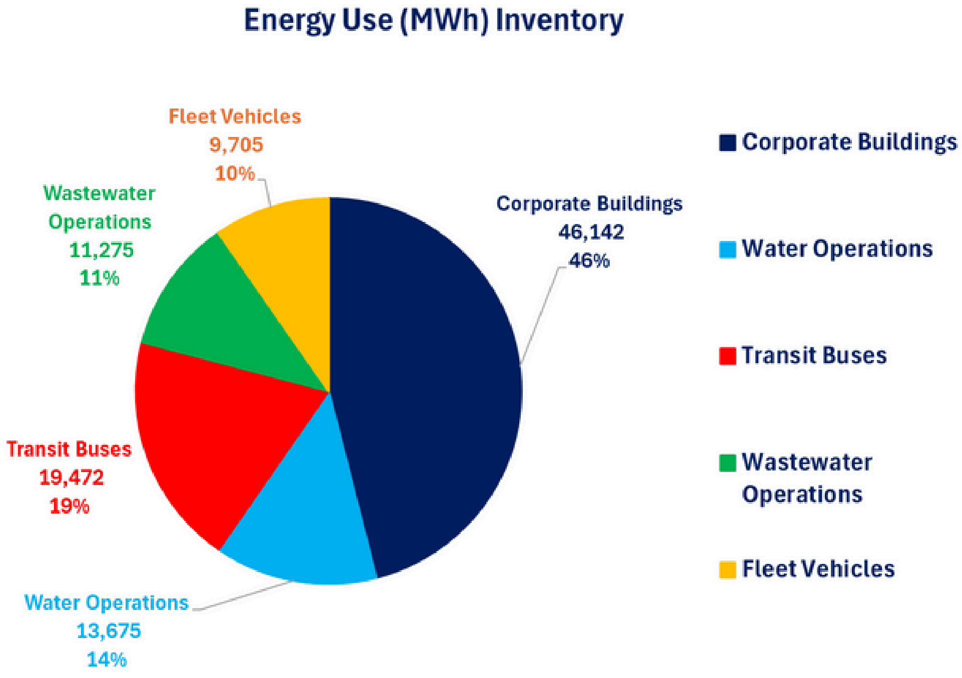
In 2022, the City’s operations generated a total of 38,500 tonnes of CO_2e GHG emissions and represents roughly 4 percent of the community’s overall GHG emissions. The largest source of these emissions, accounting for 61 percent of the total (23,630 tonnes CO_2e), comes from solid waste deposited at the Barrie Landfill. It is important to note that this figure includes solid waste generated by the community, not just that produced by the City itself. According to the PCP Protocol, all emissions from solid waste must be included in the inventory if the municipality has operational control of the landfill and it is not contracted to a third party.

- **39% of the emissions (14,870 tCO_2e) result from the Corporation’s activities.**
- **61% of emissions (23,630 tCO_2e) result from the community landfill.**
- **5% (2008 tCO_2e) of emissions are from electricity.**
- **33% (12,570 tCO_2e) of emissions are from fossil fuels.**
- **4% (210 tCO_2e) of emissions are from streetlighting and traffic signals; included under Corporate Buildings**



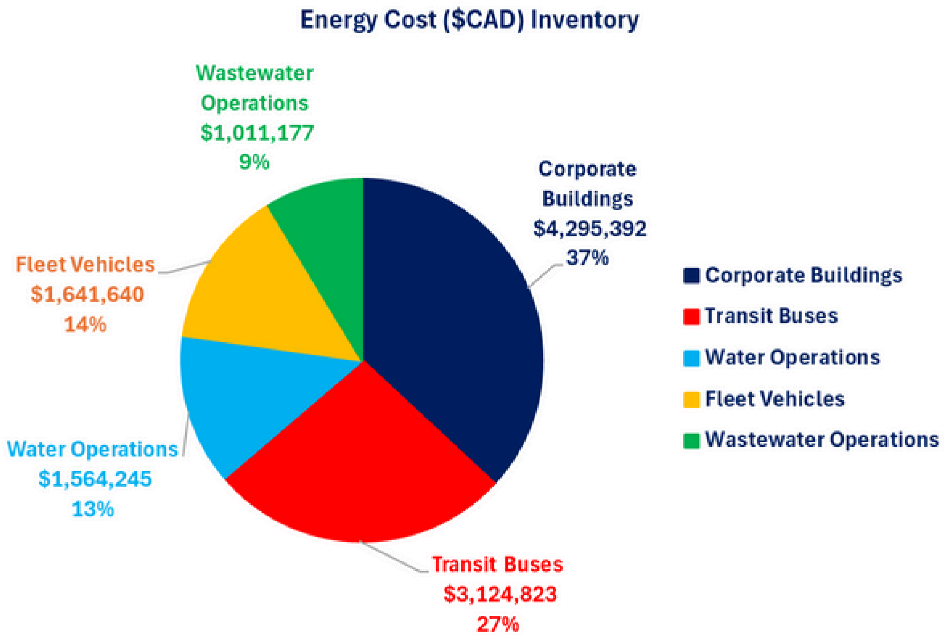
Energy Use Profile (2022)

- Total energy use was 100,270 megawatt hours (MWh equivalent) in 2022.
- Natural gas and propane are utilized to heat and power facilities.
- Gasoline and diesel power the City's fleet vehicles and transit buses.
- Biogas is used to power the co-generation system at the WwTF.



Energy Cost Profile (2022)

- Total energy cost was $11.6 million in 2022.
- 37% of energy cost ($4.3 million) from corporate facilities.
- 27% of energy cost ($3.1 million) to power transit buses.



Business-as-Usual Pathway

The Business-as-Usual (BAU) pathway presented below illustrates the projected percent increas in energy consumption, energy costs, and GHG emissions relative to the baseline inventory of 2022.

ENERGY USE

In 2022, the corporation utilized 100,300 MWh of energy to power facilities and vehicles. As City services expand, energy use could increase by 98% resulting in 198,600 MWh annual energy by 2050.

2030	2040	2050
35%	70%	98%

ENERGY COST

In 2022, $12 million was spent by the City on energy. As energy use and utility prices increase over time, the annual amount spent on energy could increase by 217%, resulting in $37 million annual energy expenditure by 2050.

2030	2040	2050
58%	139%	217%

GHG EMISSIONS

In 2022, emissions from all sources totaled 38,500 tCO_2e, with a projected increase of 6% by 2050. Note, for energy sources only, emissions are projected to increase by 140% by 2050.

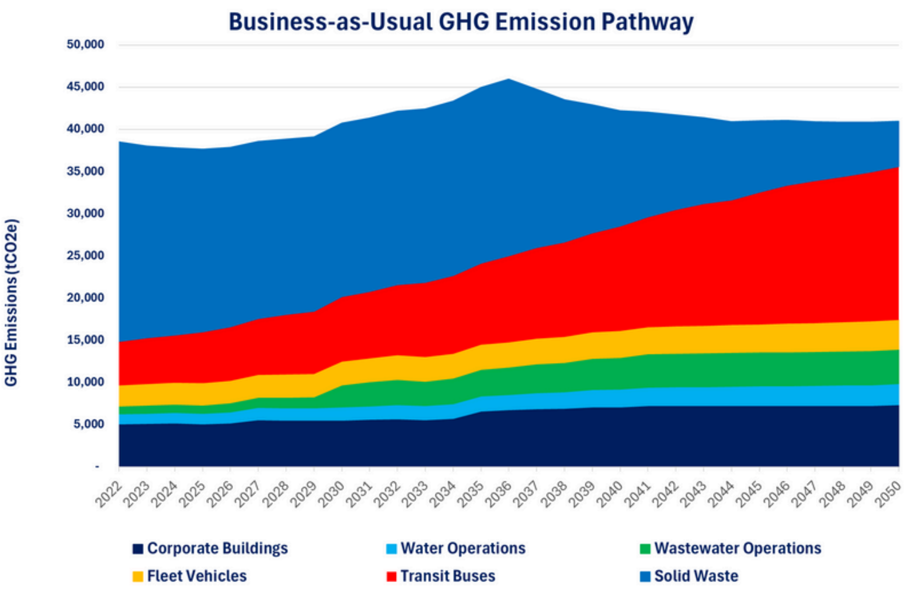
2030	2040	2050
6%	10%	6%

BAU Pathway - GHG Emissions

A business-as-usual (BAU) GHG emission pathway represents a projection of future GHG emissions based on current trends and plans, assuming no significant changes in policies, technologies, or behaviors. It serves as a baseline scenario to estimate future emissions if existing conditions and activities continue unchanged. The BAU pathway modelled for the Corporation's GHG emissions projects an increase in emissions of 6 percent (41,000 tonnes CO_2e).

41,000

Tonnes CO_2e in 2022



% Increase C02e	
Year	**2050**
Solid Waste	-77%
Transit Buses	248%
Fleet Vehicles	41%
Wastewater Operations	344%
Water Operations	116%
Corporate Buildings	44%
Total	**6%**

KEY DRIVERS OF GHG EMISSION GROWTH

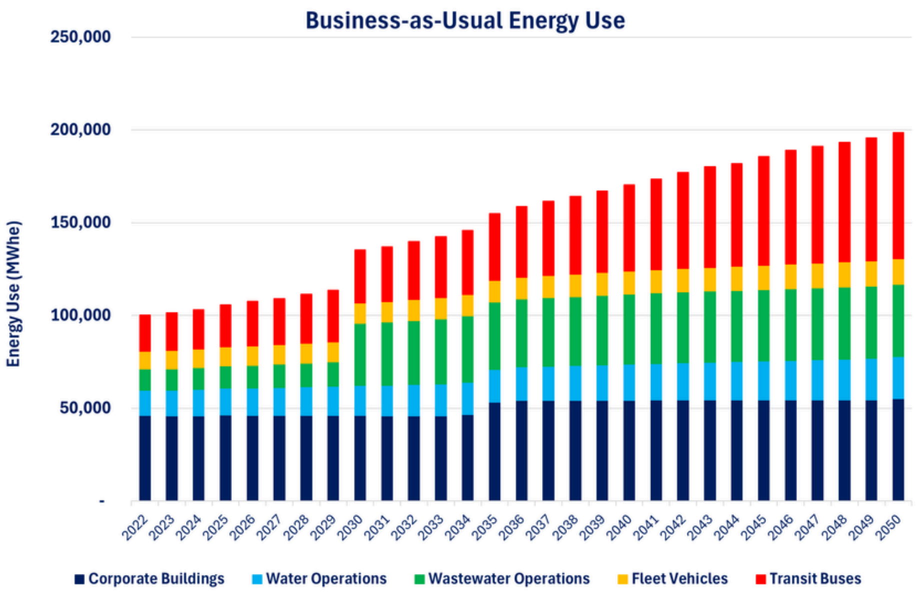
- The overall GHG emission trend is significantly influenced by accounting protocols for solid waste emissions. Since the City-owned landfill is scheduled to close in 2035, responsibility for accounting for the community's solid waste emissions will shift to another jurisdiction, rather than being reduced as it appears in the City's projected BAU pathway.
- GHG emissions from transit buses are projected to rise significantly, increasing from 14% of the City's total emissions in 2022 to 44% by 2050. This rise is primarily driven by the need for a larger transit fleet to accommodate increased ridership and population growth.
- GHG emissions from Wastewater Operations are expected to rise significantly due to planned upgrades to processing infrastructure, aimed at meeting stricter Provincial effluent treatment requirements.
- The primary driver of the increase in GHG emissions from Water Operations is the rising demand for water treatment and distribution to support the community's projected population.
- The primary factors driving growth in GHG emissions from Corporate Buildings are the construction of new facilities, facility expansions, and the increased GHG intensity of the electricity grid.

BAU Pathway - Energy Demand Increase

98%

Increase in energy use by 2050

The BAU Pathway for energy use projects future energy demand based on current consumption patterns, expected service growth, and ongoing energy management practices. Energy use from facilities at the landfill is included under Corporate Buildings, as there is no dedicated energy infrastructure for biogas generation at the site. As a result, Solid Waste is not part of this section. For the other Operational Groups, energy consumption is expected to rise, with varying rates of increase across each group. Overall, total energy use across the organization is projected to increase by 98 percent under the BAU Pathway.



% Increase Energy Use	
Year	**2050**
Transit Buses	248%
Fleet Vehicles	43%
Wastewater Operations	246%
Water Operations	66%
Corporate Buildings	19%
Total	**98%**

KEY DRIVERS OF ENERGY USE

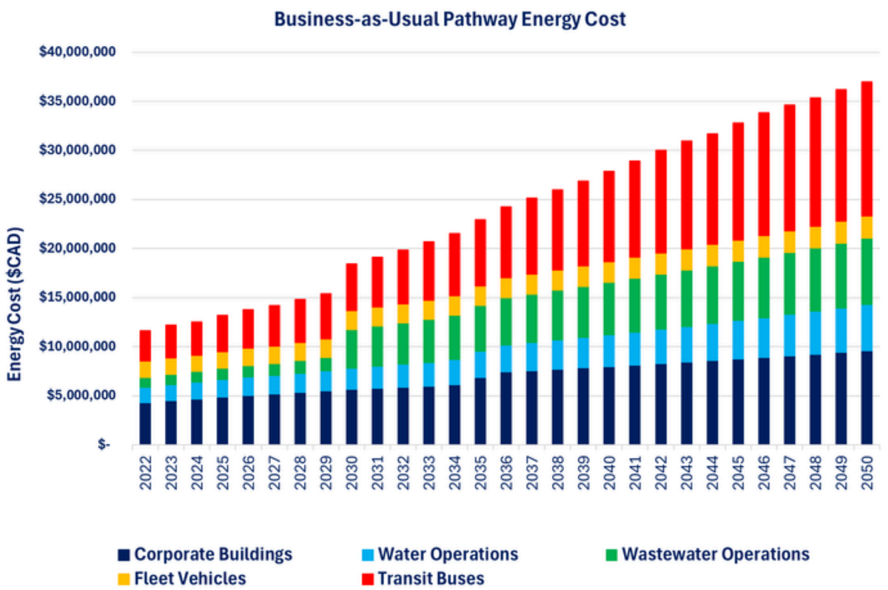
- The transit fleet is a key driver of the City's overall energy use increase over time. To accommodate a growing population and a projected increase in overall ridership, the fleet is expected to expand from 65 buses currently in use to roughly 200 buses by 2050. This will lead to a corresponding increase in fuel consumption from roughly 2 million liters in 2022 to 6.8 million liters in 2050, resulting in a 248 percent rise in energy consumption over this period.
- The City's fleet energy use is projected to increase as the fleet expands to support growing services across departments to meet community needs. Currently, the fleet and off-road equipment consume approximately 1 million litres of fuel annually, and this is expected to rise to 1.4 million litres by 2050.
- The energy consumption at the City's Wastewater Treatment Facility is expected to rise significantly due to two main factors. First, major upgrades to the processing infrastructure are planned to meet stricter Provincial effluent treatment requirements. At the time of developing this report, the assumed completion date was 2030. Second, the growing population will drive increased demand for wastewater treatment services.
- The primary factor driving the increase in energy use from Water Operations is the growing demand for water treatment and distribution to accommodate the community's projected population growth.
- The primary driver of increased energy use in Corporate Buildings is the construction of new facilities.

BAU Pathway - Operational Cost Increase

The BAU Pathway for energy costs aligns with projected energy demand and factors in future utility and fuel prices, accounting for regional demand and inflation. The model estimates energy costs for each Operational Group by applying projected commodity price increases to projected energy demand. By 2050, annual energy costs are projected to increase from approximately $12 million to $37 million.

217%

Increase in energy costs by 2050



% Increase Energy Cost	
Year	**2050**
Transit Buses	339%
Fleet Vehicles	37%
Wastewater Operations	567%
Water Operations	201%
Corporate Buildings	122%
Total	**217%**

KEY DRIVERS OF ENERGY COST

- As the commodity prices of diesel and gasoline are projected to rise, the cost to power the City's vehicle fleet and transit buses is expected to increase accordingly.
- Energy costs for Wastewater Operations are expected to rise significantly, primarily due to the increased energy demand at the Wastewater Treatment Facility (WwTF) in 2030, driven by the need to meet stricter Provincial effluent treatment requirements. Once the necessary infrastructure upgrades are in place, energy costs will increase from approximately $1 million in 2022 to $4 million in 2030. As the population grows, this figure is projected to further rise to $6 million by 2050.
- The increase in energy costs for Water Operations is primarily driven by the growing energy demand to support population growth, along with rising utility price projected.
- The increase in energy costs for Corporate Buildings is driven by the addition of new facilities and projected rises in utility prices.

Approach to Net-Zero

Through consultations with each of the Operational Groups, actions were identified to transition operations to low-carbon options, considering factors such as technical feasibility, suitability, community service needs, and financial priorities. These actions were categorized based on the level of initial capital investment required and their impact on GHG emissions. The NZ0 Strategy proposes a tiered approach, in which these actions are implemented in a structured, step-by-step process.

This tiered framework ensures a logical and consistent order of operations, balancing GHG emission reduction with financial priorities. Organizing the strategies in this manner, the approach facilitates coordinated implementation across all Operational Groups, ensuring alignment with the Corporation's overall net-zero objectives. Additionally, it is recommended that two separate tiered approaches be developed: one for the Operational Groups and one for the Corporation as a whole. The following section outlines the various steps and actions associated with each.

OPTIMIZATION

The first step, Optimization, focuses on ensuring existing systems and processes operate at maximum efficiency. Optimization is prioritized as the first step across all operational groups because it requires minimal initial investment while delivering reductions in GHG emissions.

For facilities, optimization may include commissioning equipment to ensure proper function or programming building automation systems (BAS) to match energy needs during occupancy and unoccupancy periods. While at Barrie's landfill site, optimization may focus on maximizing the efficiency of the gas capture system to reduce the amount of methane (CH_4) emitted to the atmosphere.

The remaining steps for the operational groups align with the City's existing asset management framework. This means the recommended timeline for implementing these steps is based on the lifecycle of individual assets, with replacements occurring only when assets reach the end of their useful life or as part of a larger capital upgrade. This approach applies to all types of assets, including HVAC equipment, fleet vehicles, or solar panels, unless a compelling business case justifies replacing the equipment earlier.

FUEL SWITCHING

The second step in achieving net-zero emissions is Fuel Switching, which involves transitioning to low-carbon energy sources. For buildings, this could mean replacing natural gas boilers with electric heat pumps, which are more efficient and have significantly lower GHG emissions. Before developing the NZ0 Strategy, a third-party engineering firm conducted an alternative fuel study, assessing both hydrogen and electric vehicles. The study recommended that the City focus on electric models for its fleet. Therefore, fuel switching for the City's fleet and transit buses involves replacing gas-powered vehicles with electric models.

EQUIPMENT UPGRADES

The third strategic step in this approach is upgrading equipment to more energy-efficient models. While this may not involve a fuel switch, it offers significant potential for reducing overall energy consumption. However, it could also result in continued use of higher-intensity fuel options until the next asset replacement cycle. As a result, upgrading equipment was prioritized as the third step, following fuel switching, as it contributes to energy efficiency, though it may not deliver the same level of GHG reductions.

RENEWABLE ENERGY

The fourth step toward net-zero emissions for the Operational Groups is the installation of on-site renewable energy systems. This may include solar photovoltaic (PV) panels on facility rooftops or the installation of co-generation systems where feasible. In line with the asset management framework, rooftop PV systems, for example, would not be installed or replaced until the next scheduled roof replacement, coordinating management across asset classes to avoid unnecessary retrofit costs. The NZ0 Strategy follows a core energy management principle: reduce energy consumption first, then consider on-site energy production, ensuring systems are appropriately sized to meet actual needs and optimize cost savings. As such, on-site renewable energy is the final strategic step for the Operational Groups.

> The Corporate-Wide Strategies were developed to address any remaining GHG emissions once the actions implemented by each Operational Group have been completed.

CORPORATE-WIDE STRATEGIES

The second set of strategies, the ‘Corporate-Wide Strategies’, focus on addressing the remaining corporate-wide GHG emissions after implementing the Operational Group Strategies. The Corporate-Wide Strategies begin with installing a large-scale off-site renewable energy system to power the City's remaining electricity needs. This strategy is prioritized because though there would be a significant initial investment required, the energy generated would offset operating costs and provide long-term financial benefits.

The next strategy is Sequestration, which involves enhancing the City’s existing natural assets and planting additional trees on City-owned property. Trees absorb carbon dioxide, helping to draw carbon from the atmosphere while providing a myriad of other community benefits in parks and natural areas.

The final strategy is purchasing carbon offsets, which should only be considered as a last resort. These offsets offer no direct financial, environmental, or social benefit to the City or community and should be used only after all other options have been exhausted.

The following section visually outlines the City's approach to its NZ0 Strategy, depicting the tiered steps for both the Operational Groups and the Corporate-Wide Strategies that address remaining GHG emissions. The next two sections of this report will summarize the internal analysis conducted to develop a modeled NZ0 pathway based on this approach.

Operational Group Strategies

STRATEGY PRIORITIZATION PYRAMID

OPTIMIZATION
Ensuring current systems and processes are running at their greatest efficiency to reduce energy use.

FUEL SWITCHING
Fuel switching to replace high emission intensity energy sources with lower-emission alternatives, such as switching a heating system from natural gas to electricity or replacing a gasoline vehicle with an electric model.

EQUIPMENT UPGRADES
Upgrading existing equipment by replacing outdated models with newer, more energy-efficient alternatives at equipment end of life to reduce energy use.

ON-SITE RENEWABLE ENERGY
Generating on-site renewable energy at City-owned facilities by installing rooftop solar photovoltaic panels where feasible, and utilizing biogas captured on-site at the landfill and wastewater facility.

Corporate-Wide Strategies

STRATEGY PRIORITIZATION PYRAMID

OFF-SITE RENEWABLE ENERGY

Generating renewable energy through the installation of a large, solar PV field on a city-owned property to offset the grid-supplied electricity remaining after the first of set of actions have been implemented.

SEQUESTRATION

Enhancing natural assets and planting trees on City-owned properties to increase carbon sequestered (carbon captured) from the atmosphere through plant photosynthesis.

CARBON OFFSETS

Purchasing emission offset credits from other governments or entities to offset the City’s remaining emissions by investing in activities that create carbon sinks elsewhere.

Strategies by Operational Group

LOW-CARBON STRATEGIES DEVELOPED FOR EACH OPERATIONAL GROUP

The following section outlines the activities within each Operational Group that influence GHG emissions, along with the key drivers of change under the BAU Pathway. It also summarizes the low-carbon strategies for each group, highlighting their impact on GHG emission reductions, operational cost savings, and incremental capital costs under the NZ0 Pathway. This section is organized by operational group: Corporate Buildings, Water Operations, Wastewater Operations, Fleet Vehicles, Transit Buses, and Solid Waste.

OPERATIONAL GROUPS

Corporate Buildings

The City operates and manages a diverse portfolio of over 40 facilities, all of which are essential to supporting both administrative functions and a wide range of services for the community. These facilities include community centers, recreational spaces, emergency service stations, cultural institutions, libraries, environmental services, park buildings, and various administrative offices. Additionally, the City is responsible for maintaining and operating streetlighting, traffic signals, as well as lighting for parks, sports fields, and outdoor courts, which contribute to the safety and accessibility of public spaces.

The Corporate Building section of the NZ0 Strategy outlines the energy consumption, operational energy costs, and GHG emissions associated with these facilities. In addition, the City also manages wastewater and water facilities, however these are not included in the Corporate Buildings section due to their distinct operational characteristics. These facilities are addressed in detail in the following two sections of the report.

BASELINE GHG EMISSIONS

In 2022, the energy required to power the City's buildings totaled 46,000 MWh, which represents approximately 46 percent of the City's total energy consumption. This significant portion highlights the essential energy demand of the City's buildings in supporting administrative functions and providing services to the community. The total energy cost to power these buildings was around $4.3 million, accounting for approximately 37 percent of the City's total energy cost.

5,100

Tonnes CO_2e emissions in 2022

The operation of these buildings resulted in 5,100 tonnes of CO_2e in GHG emissions, which were directly linked to the energy consumed for heating, cooling, and powering various systems within these facilities. The GHG emissions are driven by the fuel sources used to generate energy, including electricity, natural gas, and propane. These energy sources have varying GHG emission intensities, with natural gas and propane being significantly more GHG-intensive compared to the Ontario electrical grid.

BAU Pathway - GHG Emissions

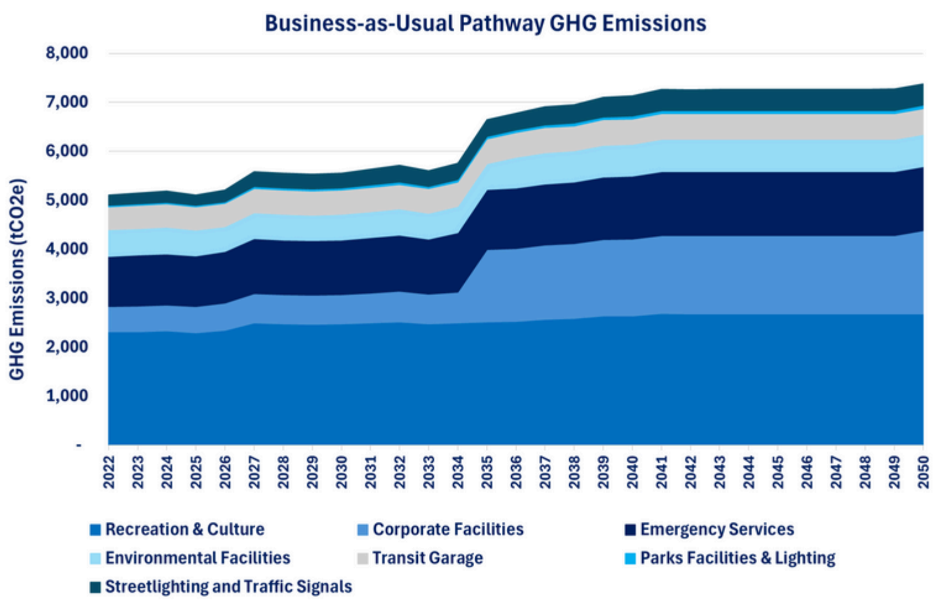
The BAU Pathway for Corporate Buildings projects a 19 percent increase in energy consumption by 2050, which would result in a corresponding 122 percent rise in operational energy costs. Starting from the baseline year of 2022, the total GHG emissions from the City's corporate buildings were 5,100 tonnes CO_2e. This figure is expected to increase by 45 percent by 2050, reaching a projected total of 7,400 tonnes CO_2e. The energy utilized at existing facilities is not expected to increase over time, as these facilities are not expanding and their day-to-day operations are not projected to change significantly. However, the BAU pathway anticipates an overall increase in energy consumption due to the addition of new facilities needed to meet the growing demands of the community. Additionally, new streetlighting and traffic signals will be required as development expands in the City's south end.

45%

Increase in GHG emissions by 2050

BUSINESS-AS-USUAL TRENDS

- Under the BAU Pathway, the total energy consumption of Corporate Buildings is projected to increase by 19 percent due to the expansion of the City's facility portfolio, driven by growing community service needs.
- GHG emissions from the City's corporate facilities are projected to increase by 229 percent, primarily due to higher energy usage following the revitalization of the City's Operations Center necessary to enhance service for the community.
- The addition of streetlighting and traffic signals in new development areas is expected to increase electricity demand for these assets by 24 percent by 2050, resulting in a 110 percent increase in GHG emissions compared to the baseline.
- The planned expansion of parks facilities and park lighting will energy consumption overall for parks infrastructure, with corresponding GHG emissions projected to increase by 143 percent.



% Increase C02e	
Year	**2050**
Streetlighting	110%
Parks Facilities	143%
Transit Garage	12%
Environmental Facilities	22%
Emergency Services	27%
Corporate Facilities	229%
Recreation & Culture	16%
Corporate Buildings BAU	**45%**

NZ0 Pathway - GHG Emissions

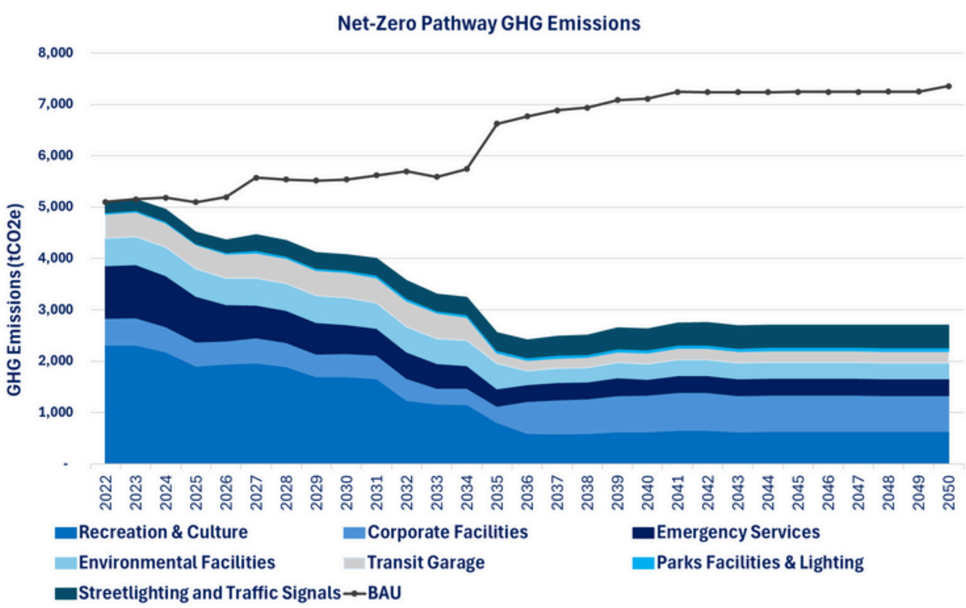
The NZ0 Pathway for Corporate Buildings projects a 22 percent reduction in energy consumption by 2050 compared to the baseline year. This decline in energy use will be driven by the implementation of energy-efficient technologies and strategies across the City's buildings. However, with utility and fuel prices projected to rise due to inflation, the operational energy costs for Corporate Buildings are expected to increase by 59 percent. Despite this, the increase in costs under the NZ0 Pathway is roughly half of the projected rise in energy costs under the BAU Pathway, indicating more efficient energy management. In 2022, GHG emissions from Corporate Buildings totaled 5,100 tonnes CO_2e. By 2050, under the NZ0 Pathway, this is projected to drop to 2,700 tonnes CO_2e. This reduction is even more significant when compared to the projected emissions under the BAU Pathway, which are expected to reach 7,400 tonnes CO_2e by 2050.

-47%

Decrease in GHG emissions by 2050

NET-ZERO TRENDS

- Under the NZ0 Pathway, total energy consumption for Corporate Buildings is projected to decrease by 22 percent, despite the addition of new facilities. This reduction will result from energy-efficient measures across both existing and new buildings.
- Net-zero new buildings will greatly reduce energy consumption and GHG emissions across Corporate Buildings. Additionally, upgrading large energy-intensive systems to low-carbon alternatives, particularly in recreation facilities, will further drive energy reductions.
- At Corporate Facilities, GHG emissions are projected to increase by 39 percent, a significant reduction compared to the 229 percent increase projected under the BAU Pathway.
- The installation of on-site solar PV is expected to reduce GHG emissions by 160 tonnes CO_2e annually by 2030, and by 650 tonnes CO_2e annually by 2050.



% Change C02e	
Year	**2050**
BAU	44%
Streetlighting	110%
Parks Facilities	143%
Transit Garage	-52%
Environmental Facilities	-43%
Emergency Services	-68%
Corporate Facilities	34%
Recreation & Culture	-73%
Corporate Buildings NZ0	**-47%**

Corporate Buildings - Key Strategies

OPTIMIZATION

EQUIPMENT UPGRADES

FUEL SWITCHING

ON-SITE RENEWABLE ENERGY

OPTIMIZATION

Ensuring energy systems operate at peak performance involves recommissioning, regular maintenance, and calibration to meet the needs of building occupants effectively. This includes optimizing HVAC systems across all facilities, as well as addressing specific operational needs at certain sites. For example, pool pumping systems must be optimized, and air and humidity levels in pools and ice rinks need to be carefully balanced to maintain operational quality, occupant comfort, and energy efficiency.

FUEL SWITCHING

Undertaking an asset management approach, replacing natural gas and propane powered equipment at its end of useful life to electric alternatives. Additionally, the strategy includes implementing a policy to ensure that all new facilities are developed to meet net-zero standards. This involves designing and constructing buildings that are energy-efficient, use renewable energy sources, and incorporate sustainable materials and technologies. A key component of this policy is the prioritization of electric HVAC systems, which are more energy-efficient and have a lower carbon footprint compared to traditional heating and cooling systems that rely on fossil fuels.

EQUIPMENT UPGRADES

Replacing equipment at its end of useful life with newer, more efficient models. This includes upgrading to higher efficiency motors, compressors, fans, and right-sizing equipment. Additionally, optimizing processes to recover thermal energy and reuse it to reduce thermal loads elsewhere. For example, heat recovery ventilators (HRVs) can capture heat from exhaust air and use it to preheat incoming fresh air, reducing the need for additional heating and lowering energy consumption. Additional, equipment upgrades include replacing traditional outdoor lighting with LED fixtures, which are more energy-efficient and have a longer lifespan.

ON-SITE RENEWABLE ENERGY

Installing rooftop solar PV panels where feasible. Installation should occur following roof replacement rather than before, on facilities with large rooftops space to ensure installation is economically feasible, and following the end of any existing contracts with local utilities that currently have rooftop solar PV installation on City facilities. Additionally, on-site ground mount solar PV installation where the City holds private access, and brownfields that could support installations. The projected total potential energy generation from on-site solar PV is estimated to reach 28,800 MWh by 2050.

RECREATIONAL FACILTIES

The City offers a wide range of recreational and cultural facilities for its residents, including the Allandale Recreation Centre, East Bayfield Community Centre, Peggy Hill Community Centre, and Sadlon Arena, among others. Managing the energy needs of these facilities is a complex task, particularly for those that feature ice rinks and swimming pools. As part of the City's Net-Zero Strategy, external consultants were brought in to conduct feasibility studies on achieving net-zero emissions for several of these recreation and community centres.

45%

Corporate Buildings GHG emissions

ICE RINKS

Energy management in ice rinks is a complex process that requires careful control of both ice and air temperatures. The ice needs to remain between -4°C and -6°C, while the indoor air is kept at 10°C to 12°C to ensure the comfort of skaters and spectators. Humidity control is equally important, as high humidity can damage the ice and necessitate energy-intensive dehumidification. Traditionally, ice resurfacers powered by natural gas or propane have been used, consuming large amounts of energy from high GHG-emitting sources. However, electric ice resurfacers are now available as a more sustainable alternative. Additionally, ice rinks are typically flooded with hot water, which requires significant energy. While cold-water flooding can produce ice surfaces of comparable quality, many users still prefer the traditional hot-water flooding, despite its higher energy consumption and associated GHG emissions. While these factors can be complex, there are numerous opportunities to optimize energy management in ice rinks by transitioning to more energy-efficient and low-carbon equipment and processes.

SWIMMING POOLS

Energy management in swimming pools is complex, primarily due to the need to balance comfort, water quality, and operational efficiency. To maintain water temperatures between 26°C to 29°C, pools require continuous heating, which can be highly energy-intensive, especially during colder months when heating demand is higher. In addition to temperature control, pools must manage humidity levels to prevent moisture buildup, which could damage the facility and promote mold growth. To address this, ventilation and dehumidification systems are employed, further increasing energy consumption. A significant portion of energy usage also comes from the filtration and circulation system, which operates 24/7 to ensure water quality, hygiene, and safety for swimmers. When features such as hot tubs, water slides, or diving pools are added, the energy demands increase further, making efficient energy management even more challenging. These factors collectively highlight the complexity of optimizing energy use in swimming pool facilities.

PARKS FACILITIES & LIGHTING

The City's parks are integral to community life, offering a diverse range of recreational activities. To maintain functional and safe spaces for residents to enjoy the City's park amenities during the evening, outdoor lighting illuminates sports fields, tennis and pickleball courts, skating rinks, parking lots and pathways. Amenities in the City's parks require energy throughout the day including washrooms, splashpads, and other park features. Though parks represent a small fraction of the City's overall energy needs, the energy required for park operations is projected to increase from 580,000 kWh to 725,000 kWh by 2050 due to planned park expansions. Implementing energy savings projects where applicable will reduce overall costs which can be utilized elsewhere to support the maintenance and expansion of the City's parks and natural areas.

1%

Corporate Buildings GHG emissions ↑

ENERGY USE IN PARKS

Parks facilities account for less than 1 percent of the City's GHG emissions, as the energy required to power parks facilities and outdoor lighting is minimal compared to other energy needs in the City. Additionally, the City's parks are powered entirely by grid-supplied electricity, which, although not net-zero, is significantly less GHG emission-intensive than other energy sources. To achieve net-zero, on-site renewable energy has the potential to meet the energy needs of parks facilities. Rooftop and ground-mounted solar PV installations could be installed; however, installation must be done without disrupting the current use or aesthetics of park spaces. Further assessment is needed to ensure these installations align with the City's requirements and the expectations of the public. As such, while on-site solar PV has not been included in the quantifiable aspects of this plan, it is strongly recommended as a strategy for the City's parks moving forward.

PARKS NET-ZERO STRATEGIES

The energy consumption and GHG emissions for park operations in 2022 are included in the Corporate Buildings section of this report. Strategies like energy efficiency and on-site renewable energy, applied to Corporate Buildings, will also be used at park facilities to manage future energy demand and reduce GHG emissions. Additionally, the City's parks contribute to GHG mitigation through carbon sequestration, which is addressed in the Corporate-Wide Strategy section of the plan.

- Installation of solar photovoltaic panels at parks where applicable to power park buildings, outdoor recreational lighting, and other park features.
- Explore emerging solar PV technologies for innovative applications on building facades, walkways, pathways, and roads.
- Integrate energy efficiency and low-carbon technologies as well as increasing naturalization and lower maintenance areas into future park designs and master plans.
- Ensure solar PV installations preserve the park's natural aesthetics and infrastructure without disrupting recreational activities.

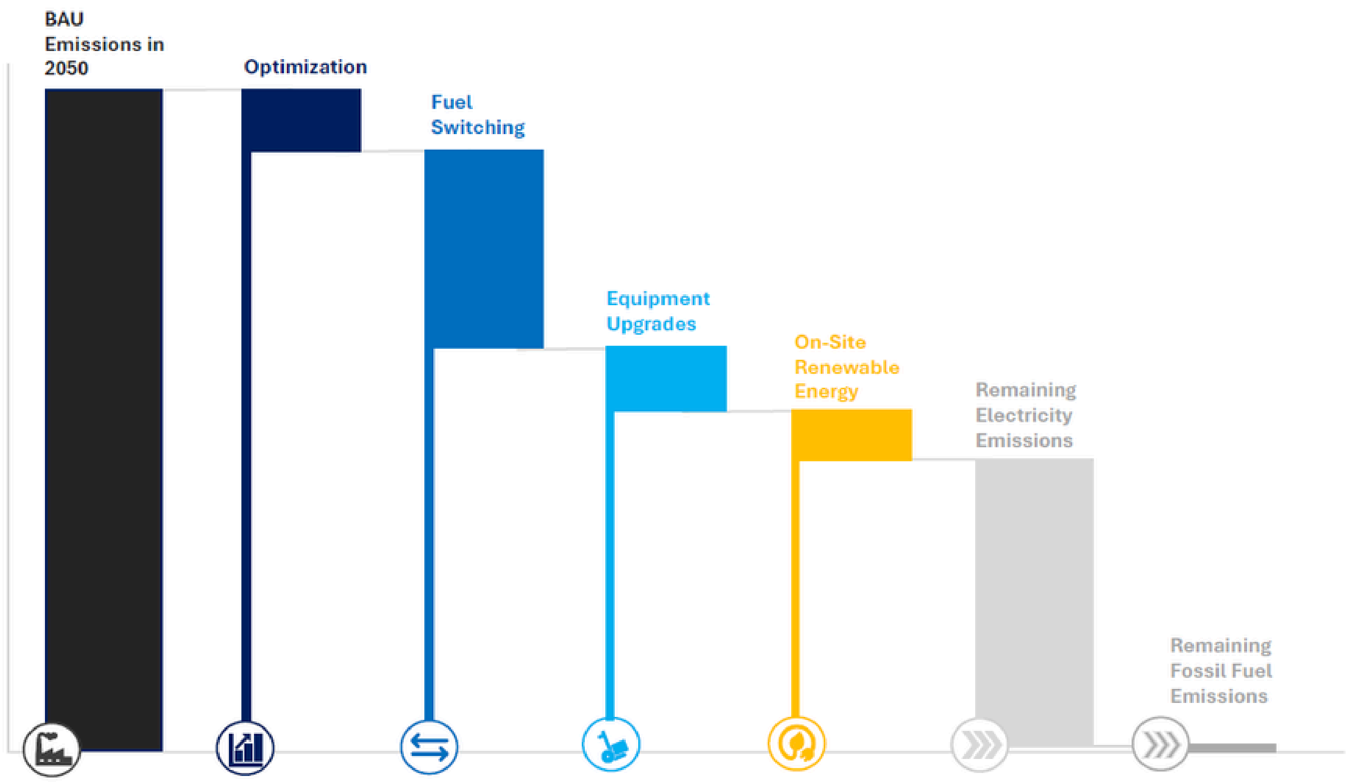
GHG Emission Reduction

The GHG emission reductions achievable under the NZ0 Pathway were determined through several feasibility studies conducted for the City's largest GHG-emitting buildings. These studies involved comprehensive site visits by an external engineering firm, reviews of previous Facility Condition Assessments (FCA), analysis of Building Automation Systems, energy and utility audits, and workshops with building supervisors, operators, and the energy management team. The studies assessed the capital costs of low-carbon equipment compared to existing systems and evaluated potential savings in operational energy costs from implementing energy-efficient, low-carbon alternatives.

Additionally, two recreational facilities, featuring a swimming pool and ice rink, were selected for a net-zero facilities assessment conducted by a non-profit organization specializing in municipal energy efficiency. These facilities were part of a larger municipal cohort, enabling lessons learned to be shared with other Ontario municipalities undertaking similar net-zero initiatives. For smaller facilities, City staff conducted analyses to evaluate the energy and GHG reduction potential of fuel-switching measures.

Through these efforts, valuable lessons were learned in developing a feasible pathway to net-zero for the City's buildings. A comprehensive list of potential actions was identified for each facility, which has been grouped into several categories outlined in the beginning of this plan. The following graph illustrates the relative impact of these actions on the GHG emissions from Corporate Buildings and the remaining emissions from electricity and fossil fuels.

RELATIVE GHG EMISSION REDUCTION



Operational Energy Cost Savings

Under the BAU Pathway, the operational cost of energy for the City's buildings is projected to rise by 122 percent, reaching approximately $9.5 million annually by 2050. The primary drivers of this increase are the additional energy required to power new facilities and the rising costs of utilities and fuel due to inflation. In contrast, under the NZ0 Pathway, the projected increase is 60 percent above the baseline, reaching approximately $7 million annually by 2050.

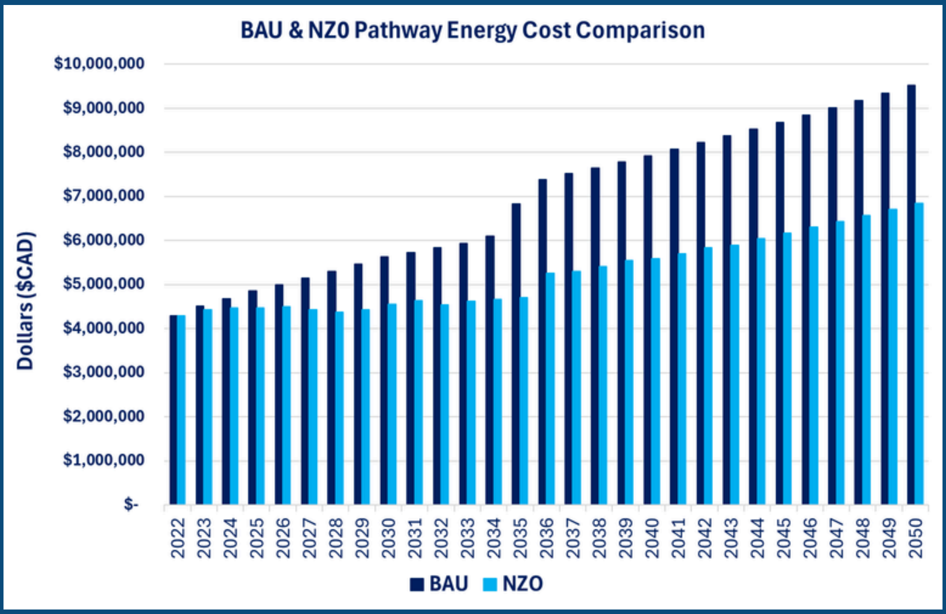
60%

Increase in energy cost at 2050

This smaller increase is attributed to the enhanced energy efficiency measures recommended for the City's facilities in the NZ0 Pathway. By following the NZ0 Pathway, the City would realize a cost savings of $2.5 million annually compared to the BAU Pathway, demonstrating the financial benefits of energy efficiency and low-carbon strategies.

NET-ZERO COST SAVING TRENDS

- The total cumulative operation energy cost reduction for the NZ0 Pathway compared to the BAU Pathway is $49 million.
- Under both the BAU and NZ0 Pathways, utility and fuel costs are a key driver for the increase in operational energy costs for Corporate Buildings due to the projected rising cost of these commodities.
- While operational energy costs increase under the NZ0 Pathway, the rise is less than in the BAU Pathway due to the implementation of energy-saving measures. By 2050, energy use under the BAU Pathway is projected to reach 55,090 megawatt-hours, while under the NZ0 Pathway, total energy use is projected to be 35,888 megawatt-hours.
- The strategies driving a reduction in energy costs under the NZ0 Pathway are optimization, equipment upgrades, and on-site renewable energy. While fuel switching provides energy reduction benefits, transitioning to low-carbon technologies does not necessarily lead to significant energy cost savings.

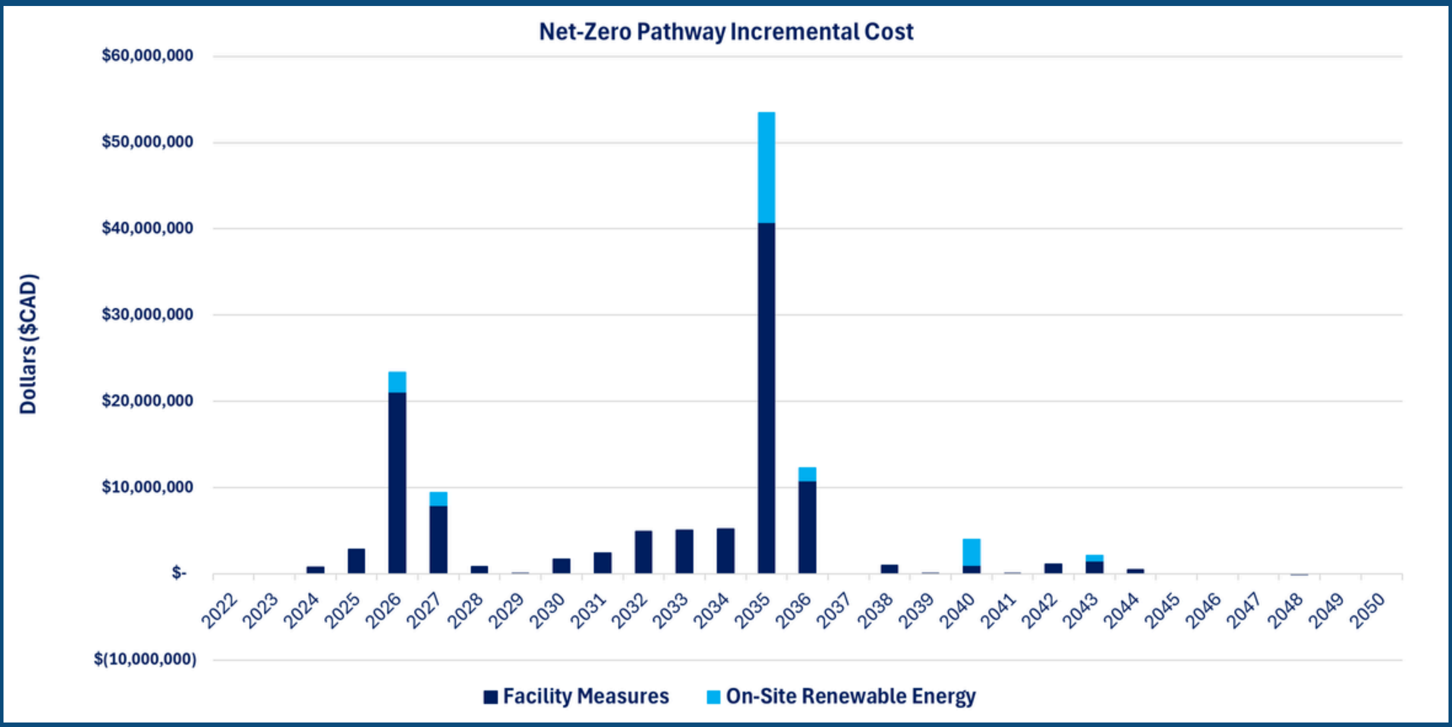


Incremental Capital Cost

There are incremental capital costs associated with the NZ0 Pathway comparative to the BAU Pathway for the City's Corporate Buildings. The below graph shows the incremental capital costs associated with implemented the optimization, fuel switching, and equipment upgrades across the City's facilities. These measures, focusing on improvements within the facilities, are grouped together, while the incremental capital costs for installing and/or retrofitting on-site solar PV are presented separately in another group. The cumulative incremental cost of implementing the NZ0 Strategy for Corporate Buildings is projected to total $131 million by 2050, taking into account the projected cost of inflation.

MAJOR INCREMENTAL CAPITAL COSTS

- Near-term facility measures driving initial capital investment for Corporate Buildings are primarily focused on the capital required for energy efficiency improvements, fuel switching, and equipment upgrades. Facility measures in the longer term, marked by a significant spike in 2035, are driven by scheduled facility renewals and planned new construction.
- Installation of solar PV systems is expected to require an initial investment of $3.5 million, while the replacement of existing solar PV systems at City facilities—currently under contract with Alectra Utilities—is projected to incur a replacement cost of $12 million upon the City assuming operation of these systems in 2035.



Water Operations

The City of Barrie has two raw water supply sources, surface water from Kempenfelt Bay and groundwater from a deep aquifer that lays underneath the City. The water supply system is currently serviced by groundwater wells and the Surface Water Treatment Plant (SWTP). Water is treated and supplied to the system and distributed through approximately 600 km of watermains, booster stations, elevated towers and reservoirs.

For the City's Water Operations Branch, energy is required for heating and cooling of administrative areas as well as to process, treat, and distribute water throughout the city. Unlike other facilities, these additional energy requirements will increase over time as the community continues to grow, creating unique challenges to how energy is managed in the future.

BASELINE GHG EMISSIONS

In 2022, the operational energy cost to the City to power the SWTP and water distribution facilities was roughly $1.56 million and resulted in 1,160 tonnes CO_2e or 3 percent of the City's operational energy emissions. Of this, 72 percent of the total emissions resulted from powering the SWTP.

1,160

Tonnes CO_2e emissions in 2022

The SWTP currently utilizes roughly 70 percent of the energy consumed to process and treat water and 30 percent to power and heat the building. The SWTP relies equally on natural gas and electricity while other Water Operation facilities and assets primarily utilize electricity. Currently, natural gas accounts for 60 percent of the GHG emissions from Water Operations, despite representing only 28 percent of the fuel requirements. The reliance on natural gas presents a significant opportunity at the SWTP to reduce GHG emissions through fuel switching.

BAU Pathway - GHG Emissions

The BAU Pathway for Water Operations projects a significant increase in energy use and GHG emissions by 2050, driven primarily by Barrie's expected population growth. The population is projected to grow from about 150,000 today to 300,000 by 2050, in line with provincial targets. This population growth will lead to a proportional rise in water demand. According to the City's 2019 Water Supply Master Plan, water supply needs are expected to more than double, from 38 megalitres per day (MLD) to 78 MLD by 2050. This increase in demand will drive up energy requirements to meet it.

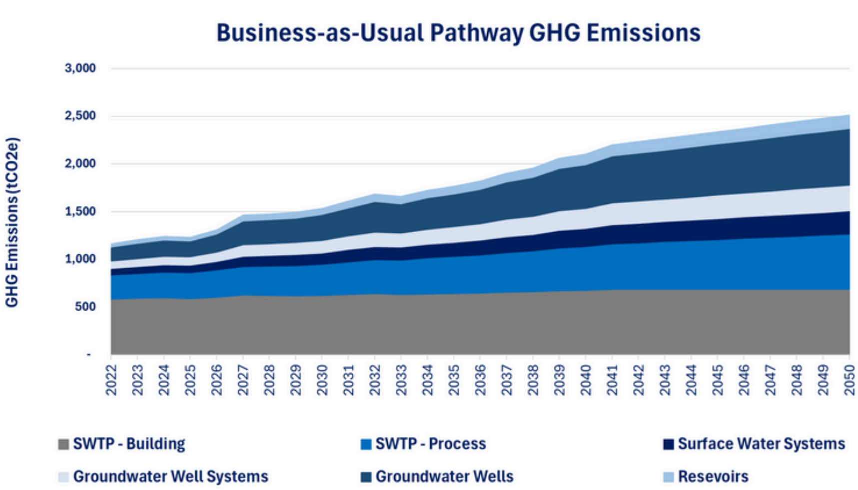
116%

Increase in GHG emissions by 2050

The BAU Pathway assumes that energy use will strongly correlate with rising water supply demand. As the population grows and water demand rises, energy consumption for Water Operations will increase similarly. This highlights the need for energy considerations in Barrie's water planning and future master plans. As water demand grows, energy consumption for water treatment, distribution, and related processes will also rise significantly.

BUSINESS-AS-USUAL TRENDS

- GHG emissions are projected to rise from 1,165 tonnes to 2,514 tonnes of CO_2e by 2050, raising their share of the City's total emissions from 3% to 6%.
- Energy demand for Water Operations is expected to increase by 98% under the BAU Pathway, driving energy costs up from $1.67 million to over $4.7 million—an increase of 201% by 2050 compared to the baseline.
- GHG emissions from the SWTP are expected to rise modestly for building operations, while process energy-related emissions will see a more significant increase. Both operations use natural gas and electricity. While the GHG intensity of natural gas is projected to remain stable, the emissions from electricity are expected to increase as the GHG intensity of the provincial power grid rise.
- Energy demand for other Water Operations facilities is projected to increase in response to growing water demand driven by the community's population growth.



% Increase C02e	
Year	**2050**
SWTP Building	17%
SWTP Process	134%
Surface Water Systems	240%
Groundwater Systems	248%
Groundwater Wells	306%
Reservoirs	306%
Water Operations BAU	**116%**

NZ0 Pathway - GHG Emissions

The NZ0 Pathway for Water Operations projects a significantly lower GHG emission trajectory compared to the BAU Pathway. While an increase in emissions is still expected, the increase is 51 percent rather than 116 percent with no action taken.

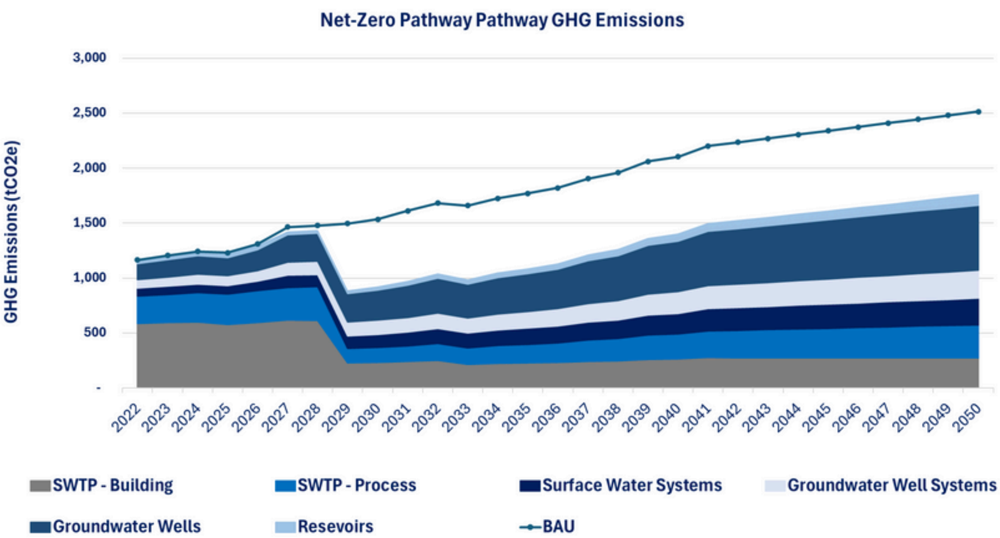
51%

Increase in GHG emissions by 2050 ↑

The NZ0 Strategy for Water Operations uses an initial capital investment and asset management approach, replacing equipment only at the end of its useful life to maximize infrastructure lifespan. A key focus is the SWTP, which contributes 72% of the City's Water Operations emissions. Emissions reductions will primarily be achieved by cutting natural gas usage at the SWTP through energy-efficient systems and alternative energy sources. By reducing reliance on natural gas and optimizing energy use, the SWTP will significantly lower its emissions, supporting the NZ0 Pathway's goals.

NET-ZERO TRENDS

- → The major driver of GHG emission reduction for Water Operations under the NZ0 Pathway is the installation of a multi-pipe heat pump recovery system at the SWTP in 2028. Installing this system will replace natural gas with electricity, resulting in a reduction of 560 tonnes of CO_2e, representing a 60 percent decrease in emissions at the SWTP, starting in 2029.
- → While energy demands will continue to rise due to increased water demand, GHG emissions from SWTP processes will grow at a slower rate, resulting in a 20 percent increase in emissions compared to a 134 percent increase under the BAU Pathway.
- → Under the NZ0 Pathway, solar PV installation at the Anne Street Booster Station, SWTP, and reservoirs has the potential to generate nearly 400 MWh and offset 30 tonnes of GHG emissions.



% Change C02e	
Year	**2050**
BAU	**116%**
SWTP Building	-53%
SWTP Process	20%
Surface Water Systems	240%
Groundwater Systems	227%
Groundwater Wells	306%
Reservoirs	179%
Water Operations NZ0	51%

Water Operations - Key Strategies

OPTIMIZATION

EQUIPMENT UPGRADES

FUEL SWITCHING

ON-SITE RENEWABLE ENERGY

OPTIMIZATION

To achieve optimal energy performance, energy systems should be subjected to regular recommissioning, ongoing maintenance, and precise calibration. In the context of Water Operations, energy optimization strategies should prioritize enhancing the energy efficiency of water pumping systems, ensuring they operate at peak performance. Additionally, improving the management and control of heating and cooling systems within the SWTP building will reduce operational energy requirements. This includes fine-tuning temperature regulation and ventilation systems to reduce energy consumption while maintaining a comfortable and effective working environment.

FUEL SWITCHING

The facility currently uses natural gas boilers for heating and water-cooled chiller modules for cooling, with heat rejected into the raw water loop. The proposed upgrade involves replacing these systems with a multi-pipe heat pump recovery system, utilizing the raw water both for heat rejection during cooling and as a heat source during heating. This shift will reduce both energy consumption and GHG emissions, as the multi-pipe heat pump system is more energy efficiency and utilizes electricity rather than natural gas and so switches the system to a lower-carbon intensity energy source.

EQUIPMENT UPGRADES

Undertaking an asset management approach, replacing equipment at its end of useful life with newer, more efficient models. This includes upgrading to higher efficiency motors, compressors, fans, or pumps

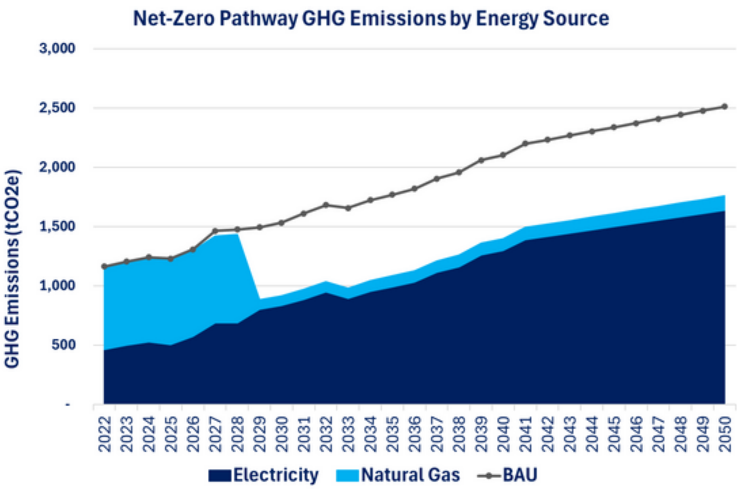
ON-SITE RENEWABLE ENERGY

Rooftop solar PV panels will be installed at the SWTP site to complement the ground-mounted solar PV system planned for installation in 2026. The rooftop system has the potential to generate 500 kW, which will add to the 375 kW ground-mounted system and could be installed in 2030. Additionally, a 150 kW ground-mounted solar PV system could be installed at the Anne Street Booster Station in 2030, and a 352 kW system will be installed at the Harvie Road Reservoir in 2027.

GHG Emission Reduction

FUEL SOURCE COMPOSITION

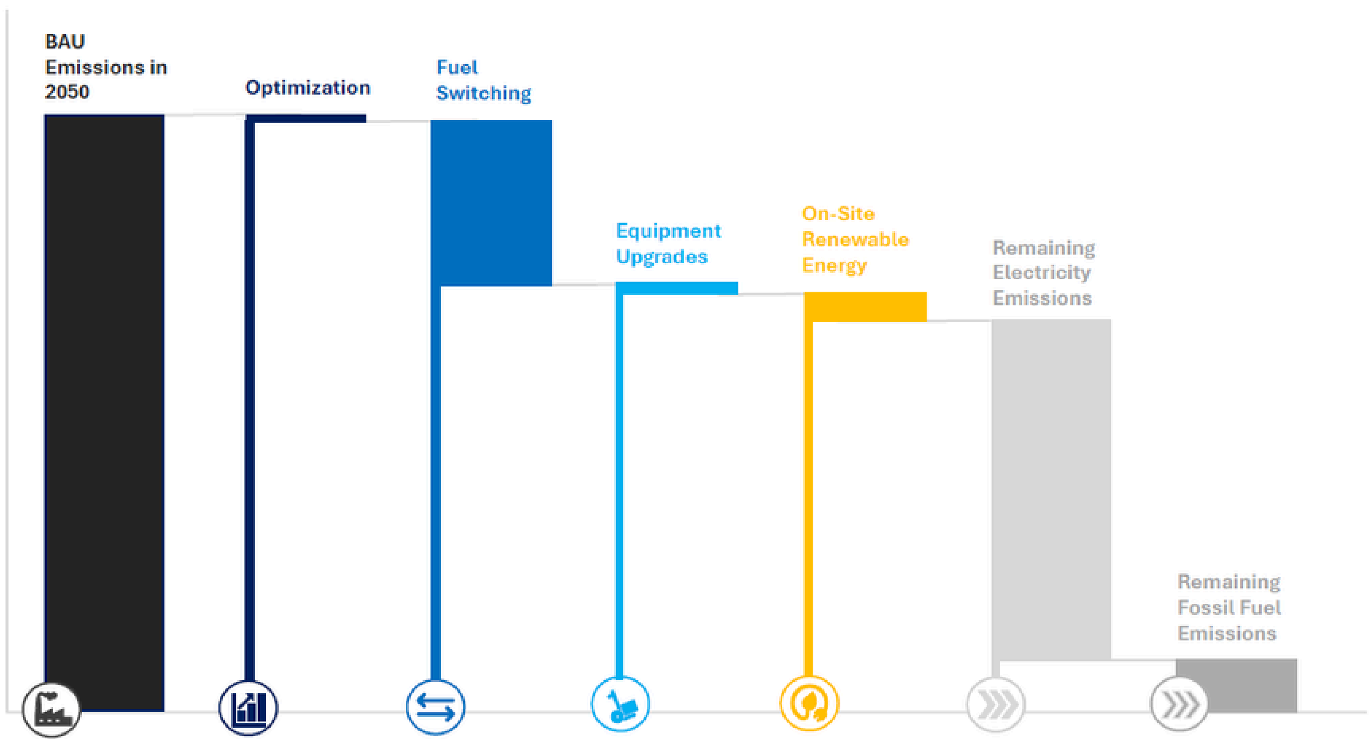
A significant reduction in GHG emissions is projected for 2029 under the NZ0 Pathway, driven by the fuel switch from natural gas to electricity with the installation of a multi-pipe heat pump recovery system at the SWTP. This transition will cut natural gas usage at the SWTP by 96 percent in 2029, resulting in a reduction of 560 tonnes CO_2e in GHG emissions.



STRATEGY GHG REDUCTION

The net-zero actions for the City's Water Operations were developed through consultations with staff and an external engineering consultant. These actions were evaluated for operational and economic feasibility and grouped into broader net-zero strategies. Four priority actions were analyzed and incorporated into the net-zero model for the Water Operations Branch.

The chart below shows the projected GHG reductions for 2050, assuming all actions are implemented. While significant reductions are expected, full net-zero emissions are not achieved for Water Operations. Remaining emissions stem from electricity and natural gas use at the SWTP and other sites, which cannot be fully mitigated through on-site renewable energy or fuel switching.



Operational Energy Cost Savings

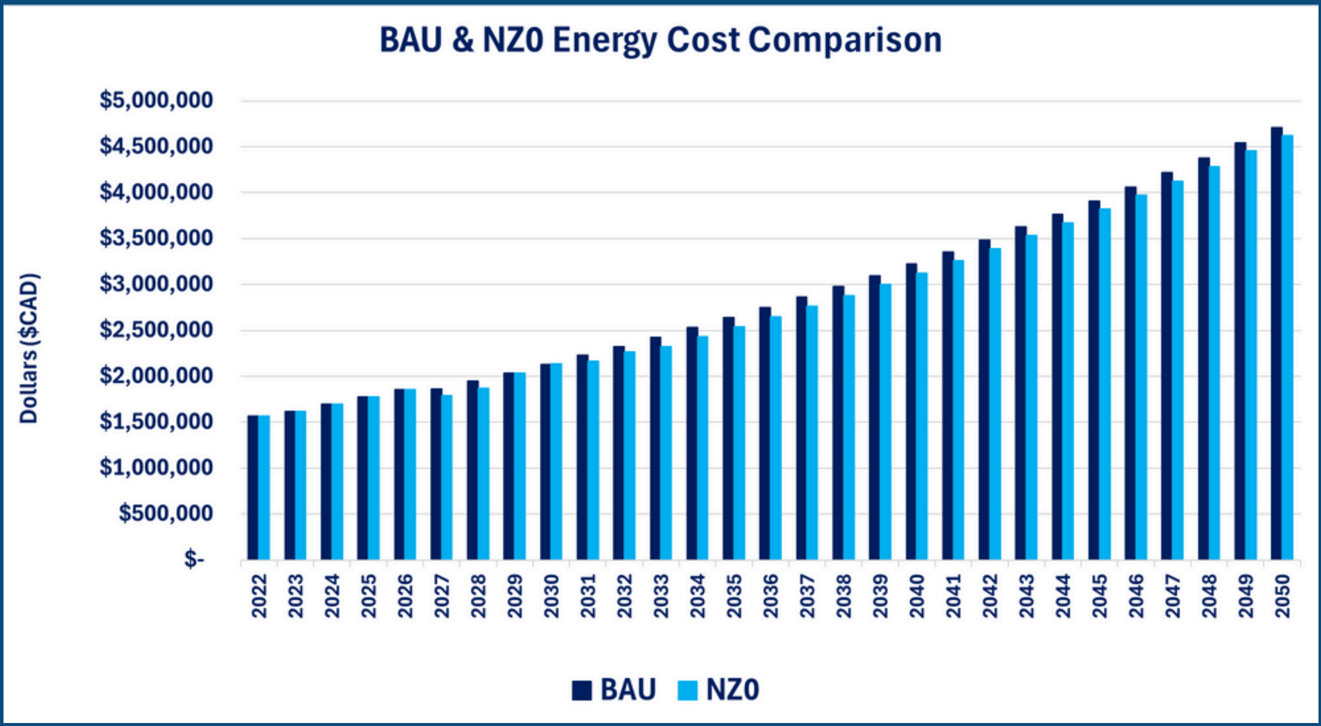
The operational cost of energy for Water Operations is projected to increase from approximately $1.56 million annually in 2022 to $4.7 million by 2050 under the BAU Pathway. This rise is primarily driven by higher water demand from population growth and an expected increase in utility prices, largely due to inflation. Under the NZ0 Pathway, the projected annual energy cost follows a similar trend but is slightly lower, reflecting energy conservation measures at the SWTP recommended under this scenario.

196%

Increase in energy cost by 2050

NET-ZERO COST SAVING TRENDS

- The total cumulative operational energy cost savings projected under the NZ0 Pathway amount to $1.98 million, compared with the BAU Pathway.
- Energy efficiency improvements and fuel switching at the SWTP are expected to reduce energy costs. By 2033, savings will reach $120,000 annually, growing to $270,000 by 2050.
- The installation of solar PV at Water Operations could save $112,000 annually by 2031 and rise to savings of $174,000 annually by 2050.

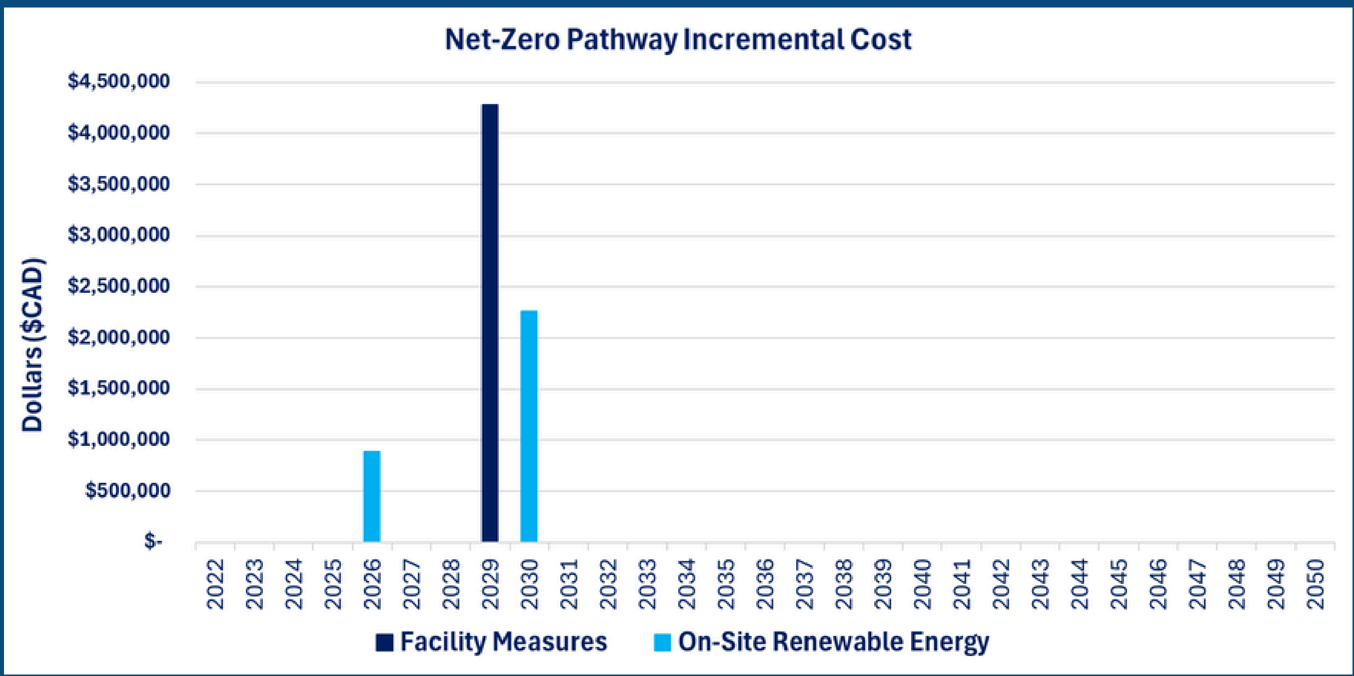


Incremental Capital Cost

The Net-Zero Pathway for Water Operations will require higher upfront capital costs compared to the BAU Pathway. These incremental costs, outlined in the graph below, are expected to be realized in the near to mid-term. The primary investments target major infrastructure upgrades aimed at minimizing the environmental footprint of Water Operations. Key expenditures include the installation of a multi-pipe heat pump recovery system at the SWTP, which is projected to cut GHG emissions from natural gas by 96 percent. The pathway also includes the installation of on-site ground-mounted and rooftop solar PV systems at various Water Operations sites. These strategic investments will not only enhance energy efficiency and reduce reliance on fossil fuels but will also support the successful implementation of the NZ0 Pathway for Water Operations.

NET-ZERO CAPITAL COST TRENDS

- The total cumulative incremental capital costs projected under the NZ0 Pathway amount to $7.4 million. These costs are primarily front-loaded and are expected to be realized in the near to medium term, with the majority of expenditures occurring by 2030. Key investments include solar PV installations and major facility upgrades planned for 2029.
- The major costs outlined in the graph below are as follows:
  - Multi-pipe heat pump recovery system System at SWTP: $4.8 million in 2029
  - Solar PV installations: $3.2 million by 2030



Wastewater Operations

The City of Barrie's Wastewater Treatment Facility (WwTF), located on the shores of Kempenfelt Bay, processes all wastewater generated in the city, which is brought to the facility through sanitary sewers and pumping stations. To comply with provincial regulations, the WwTF treats wastewater to meet effluent standards before discharging it into Lake Simcoe. The treatment process produces by-products, including biogas, which is reused and flared on-site, and sludge, which is transported to the biosolids facility.

Like Water Operations, energy is used to power the WwTF building and the processes required to treat wastewater. Accounting for GHG emissions is more complex, as not all sources are required for reporting in a corporate inventory. A summary of the GHG emission requirements, inclusions, and exclusions is provided on the following page. While not all emission sources were reported in the 2022 inventory, evaluating and managing all emissions remains a key part of the City's Net-Zero Strategy.

BASELINE GHG EMISSIONS

In 2022, the City's Wastewater Operations were responsible for producing a total of 920 tonnes of CO_2e GHG emissions, accounting for 2 percent of the City's overall emissions. However, it's important to note that this figure does not include all the GHG emissions generated during the processing and treatment of wastewater, as certain sources of emissions were not included in the 2022 inventory.

920

Tonnes CO_2e emissions in 2022

In terms of energy consumption, Wastewater Operations utilized a total of 11,000 MWh, representing 11 percent of the City's total operational energy usage. The total energy costs for these operations in 2022 amounted to $1 million, which makes up 9 percent of the City's overall energy expenditures. Of this, 83 percent was allocated to powering the WwTF, with the remaining costs covering the operation of additional wastewater infrastructure.

Accounting for Wastewater Emissions

The following table outlines the scopes of GHG emissions that apply to wastewater treatment. Scope 1 and Scope 2 emissions have been included in the City's 2022 GHG emission inventory. While Scope 3 emissions from Wastewater Operations were investigated, they were excluded from the 2022 inventory due to significant uncertainty in the data and current methodological processes. The major contributors to Scope 3 emissions are fugitive and process emissions, which are released directly into the atmosphere during wastewater collection, treatment, and discharge. With enhanced on-site monitoring at the WwTF, it may become possible to report on process emissions in the future, providing a more comprehensive understanding of the overall emissions associated with Wastewater Operations.

SCOPE 1 & 2 EMISSION SOURCES (INCLUDED)

1

ON-SITE FUEL COMBUSTION

Wastewater Operations utilizes natural gas and biogas at the WwTF for building and process energy needs, while propane is utilized at its biosolids facility.

1

ON-SITE ENERGY GENERATION

On-site energy generation is considered a scope 1 emission and required reporting. The City's WwTF has a co-generation system that utilizes biogas from wastewater to create electricity and thermal energy. Excess biogas not utilized by this system is flared. The inventory captures emissions and emission reductions resulting from biogas combustion and flaring.

2

GRID SUPPLIED ELECTRICITY

The majority of Wastewater Operations energy, nearly 80 percent is derived from grid supplied electricity. Grid supplied electricity is considered a Scope 2 emission source and is required reporting.

SCOPE 3 EMISSION SOURCES (EXCLUDED)

3

FUGITIVE EMISSIONS

Fugitive CH_4 emissions are released into the atmosphere from wastewater flow in the sewer influent and collection system, while fugitive N_2O emissions occur when wastewater enters aquatic environments. Both of these sources of GHG emissions are difficult to monitor and estimate.

3

BIOLOGICAL PROCESS EMISSION

Biological process N_2O emissions occur as a result of a by-product of microbial activity during the treatment of wastewater, primarily generated in the aeration treatment process. Biological process CO_2e emissions also occur as a by-product of microbial activity during the treatment of wastewater, and occurs both in the aerobic and anaerobic phases of treatment.

3

CONTRACTOR TRAVEL

Emissions resulting from vehicles utilized by the waterwater branch have been allocated under the Fleet Vehicles section of the inventory. The City outsources biosolid removal from the WwTF to the Biosolids facility in Oro Medonte. Due to operational improvements at WwTF, the number of contractor trips were reduced saving both emissions and cost. Contractor travel is a Scope 3 emission and not included within the 2022 inventory.

BAU Pathway - GHG Emissions

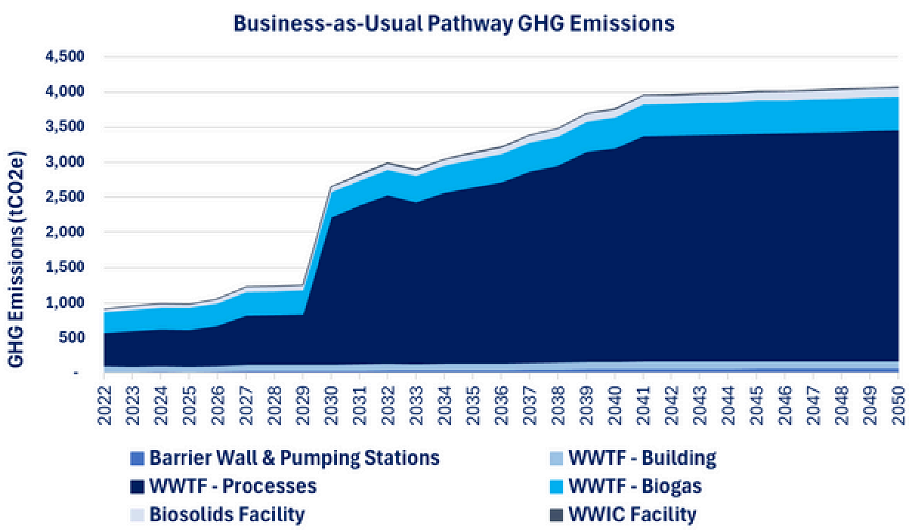
344%

Increase in GHG emissions by 2050

The Lake Simcoe Phosphorus Reduction Strategy is a key initiative to address phosphorus pollution, a significant water quality concern for Lake Simcoe. The provincial government, in collaboration with local stakeholders, municipalities, and the Lake Simcoe Region Conservation Authority (LSRCA), developed this strategy to achieve aggressive phosphorus reductions and restore the lake's ecological health. The strategy aims to reduce phosphorus discharge into the lake, significantly impacting operational processes for Wastewater Operations. The planned infrastructure upgrades at for the WwTF, particularly the membrane bioreactor project, will substantially increase energy requirements, leading to a 246 percent increase in process energy requirements by 2050. Additionally, energy demands at pumping stations are expected to increase by 62 percent to meet the needs of Barrie's growing population. As a result, GHG emissions from Wastewater Operations are projected to rise from 920 to 4,100 tonnes CO_2e by 2050, primarily driven by the increased energy needs for wastewater treatment and infrastructure upgrades required to meet stricter effluent regulations.

BUSINESS-AS-USUAL TRENDS

- As mentioned above, the primary driver for the projected increase in GHG emissions is the necessary infrastructure upgrades to meet stricter phosphorus discharge regulations. These upgrades will lead to a significant rise in electricity consumption at the WwTF.
- GHG emissions from the combustion of biogas on-site are expected to increase, reflecting the higher volume of wastewater generated by a growing population. Biogas-related emissions will rise from 300 to 475 tonnes CO_2e.
- GHG emissions from the WwTF building operations are not expected to increase significantly, as energy demand will remain relatively stable. However, the overall emissions will be impacted by the increasing intensity of the electricity grid.
- The new Wastewater Innovation Centre (WWIC) will be constructed to net-zero standards, resulting in a minimal increase of 4 tonnes CO_2e in 2030.



% Increase CO_2e	
Year	**2050**
Pumping Stations	216%
WwTF - Building	23%
WwTF - Processes	599%
WwTF - Biogas	62%
Biosolids Facility	180%
Wastewater Operations BAU	**344%**

NZ0 Pathway - GHG Emissions

The NZ0 Pathway for Wastewater Operations projects a reduction in GHG emissions compared to the BAU Pathway, as both pathways show similar growth across all operational sectors aside from the WwTF building energy. There is a decrease in emissions relative to the BAU Pathway, 18 percent comparatively, primarily due to equipment upgrades at the WwTF, including improvements to the co-generation system and the installation of on-site solar PV.

264%

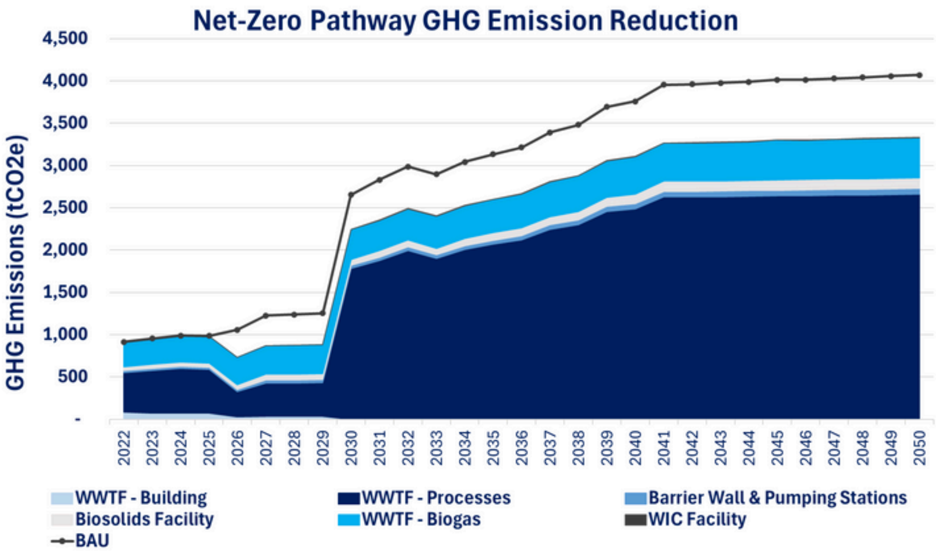
Increase in GHG emissions by 2050

The major challenge for Wastewater Operations under the NZ0 Pathway arises from the substantial increase in electricity demand for process energy at the WwTF, expected to occur in 2030. This increase, coupled with the limited potential for expanding on-site solar PV at the WwTF or other wastewater facilities, highlights the need for off-site renewable energy to help offset emissions.

Although Scope 3 emissions were not included in the 2022 inventory, they remain a significant concern and could substantially contribute to overall emissions for the Corporation. A key part of the Wastewater Operations strategy going forward will be to investigate fugitive and process emissions where possible and gather plant-specific data, with the goal of reporting on Scope 3 emissions in future inventories.

NET-ZERO TRENDS

- The NZ0 Pathway projects an 18 percent reduction in GHG emissions for Wastewater Operations by 2050 compared to the BAU Pathway, with a cumulative reduction of nearly 14,500 tonnes CO_2e.
- Under the NZ0 Pathway, installation of rooftop solar PV at the WwTF, with a capacity of 680 MWh, could reduce GHG emissions by approximately 5 tonnes CO_2e annually and enable the operational energy to reach net-zero.
- Equipment upgrades to the co-generation system at the WwTF could enable both engines to operate simultaneously, generating additional on-site electricity and thermal energy, which would offset emissions from grid supplied electricity and natural gas consumption.



% Change CO_2e	
Year	**2050**
BAU	344%
Pumping Stations	216%
WwTF - Building	-100%
WwTF - Processes	466%
WwTF - Biogas	62%
Biosolids Facility	180%
Wastewater Operations NZ0	**264%**

Key Strategies

EQUIPMENT UPGRADES

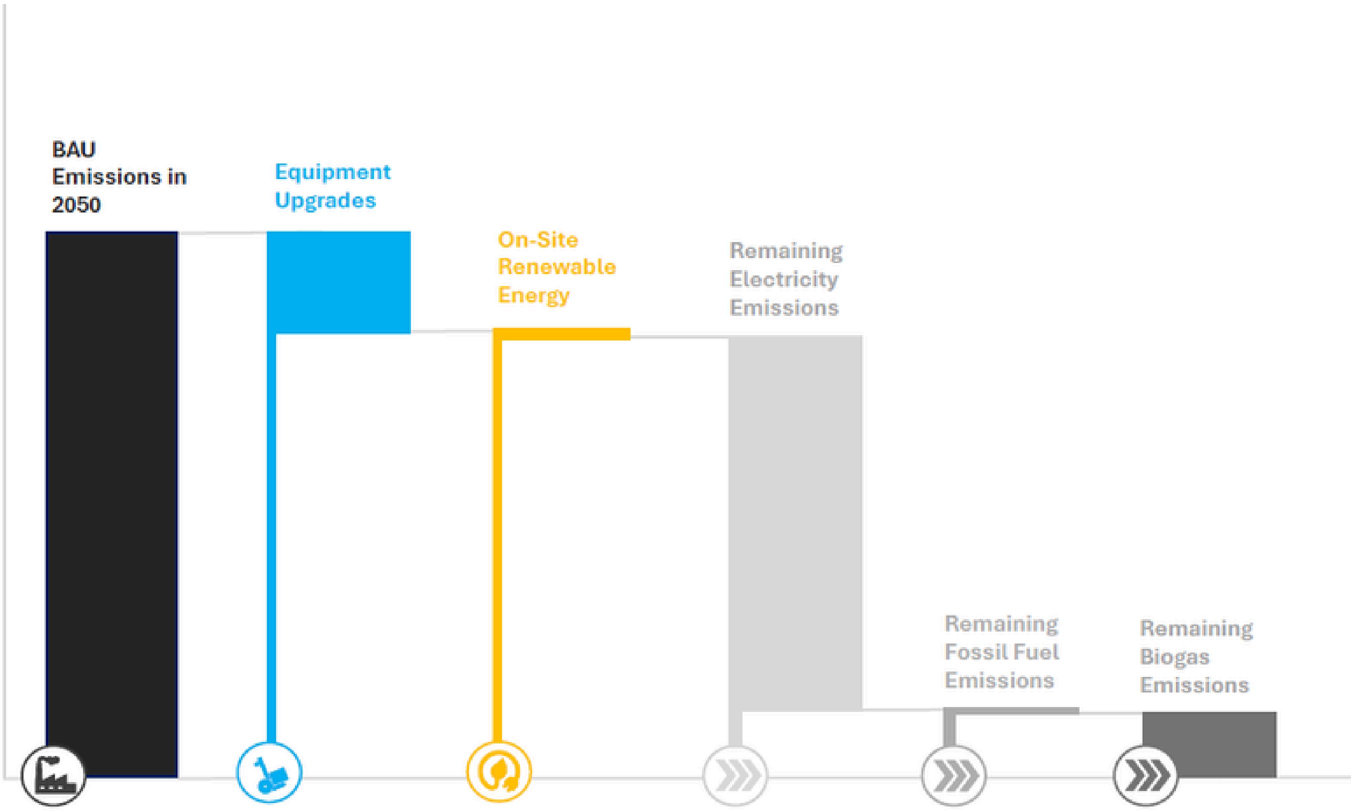
ON-SITE RENEWABLE ENERGY

EQUIPMENT UPGRADES

The Barrie Wastewater Treatment Facility operates two co-generation engines, each capable of generating 250 kW at 600V, 3-phase power. Currently, only one engine is used at a time, but running both simultaneously could double the power output, reducing the facility's dependence on the utility grid. Both engines can utilize natural gas or biogas; natural gas serves as the start-up and stand-by fuel, while biogas is used for continuous operation. With biogas being the primary fuel for ongoing operations, this upgrade could aim to optimize the use of biogas, thereby further reducing reliance on external power sources.

ON-SITE RENEWABLE ENERGY

Under the NZ0 Pathway rooftop solar PV panels will be installed at the WwTF. The size of the system would be a 558 kW with the potential to generate 680 MWh of electricity annually for the plant.



Operational Energy Cost

The operational energy costs for Wastewater Operations are expected to rise significantly, from $1 million in 2022 to $7 million by 2050 under the BAU Pathway and to $6 million under the NZ0 Pathway. This translates to a significant rise of 567 percent under the BAU Pathway and 493 percent under the NZ0 Pathway, indicating a sharp upward trend in energy expenses over the coming decades.

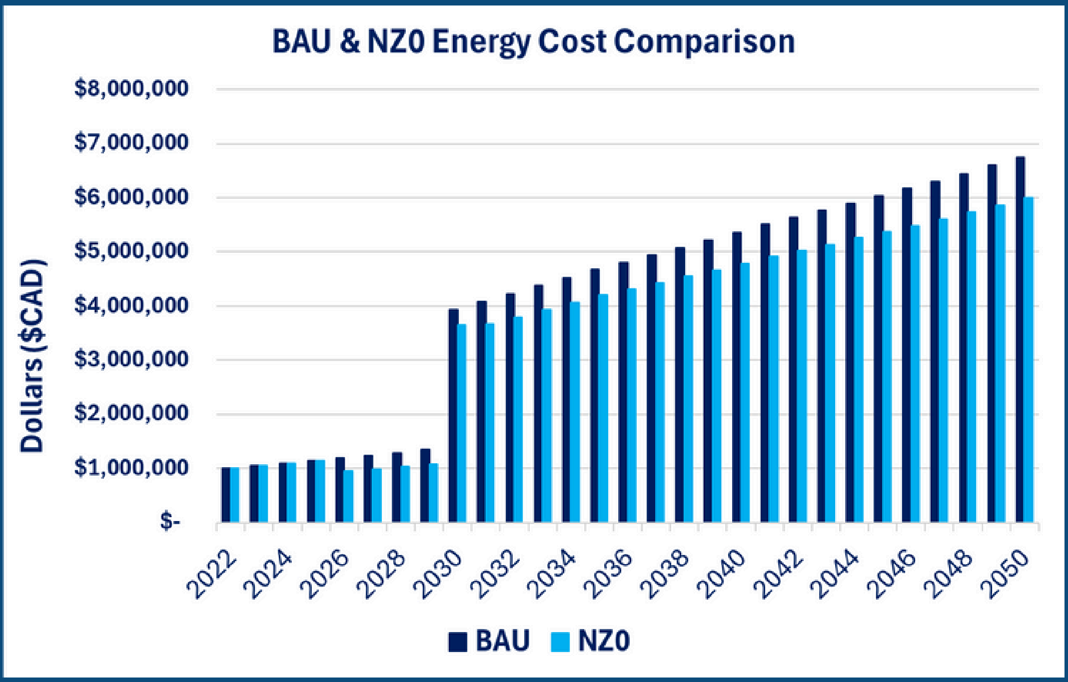
493%

Increase in energy cost by 2050

The primary factor contributing to this substantial increase in energy costs is the expected surge in process energy demand around 2030, which will be driven by major upgrades at the WwTF to comply with more stringent effluent quality regulations. These necessary facility upgrades are set to result in a near threefold increase in the plant's electricity consumption, as the treatment processes become more energy-intensive to meet the higher quality standards required. Once these upgrades are completed, energy costs at the facility are projected to escalate sharply, with a significant jump from $800,000 in 2029 to $3 million in 2030. Beyond the upgrades themselves, other factors contributing to the overall increase in process energy costs include the rising service demands associated with a growing population, which will require additional wastewater treatment capacity, and the ongoing escalation in utility prices.

NET-ZERO ENERGY COST TRENDS

- The operational energy costs under both the BAU and NZ0 Pathways are projected to be substantial. However, the NZ0 Pathway offers a cumulative energy cost reduction of approximately $13 million by 2050, highlighting the potential savings associated with measures outlined under the NZ0 Pathway.
- Installation of rooftop Solar PV at the WwTF will offer energy cost reduction at the WwTF. Beginning in 2030, the system will save approximately $85,000 annually, with savings growing to $110,000 per year by 2050, providing a long-term reduction in overall energy expenditures.



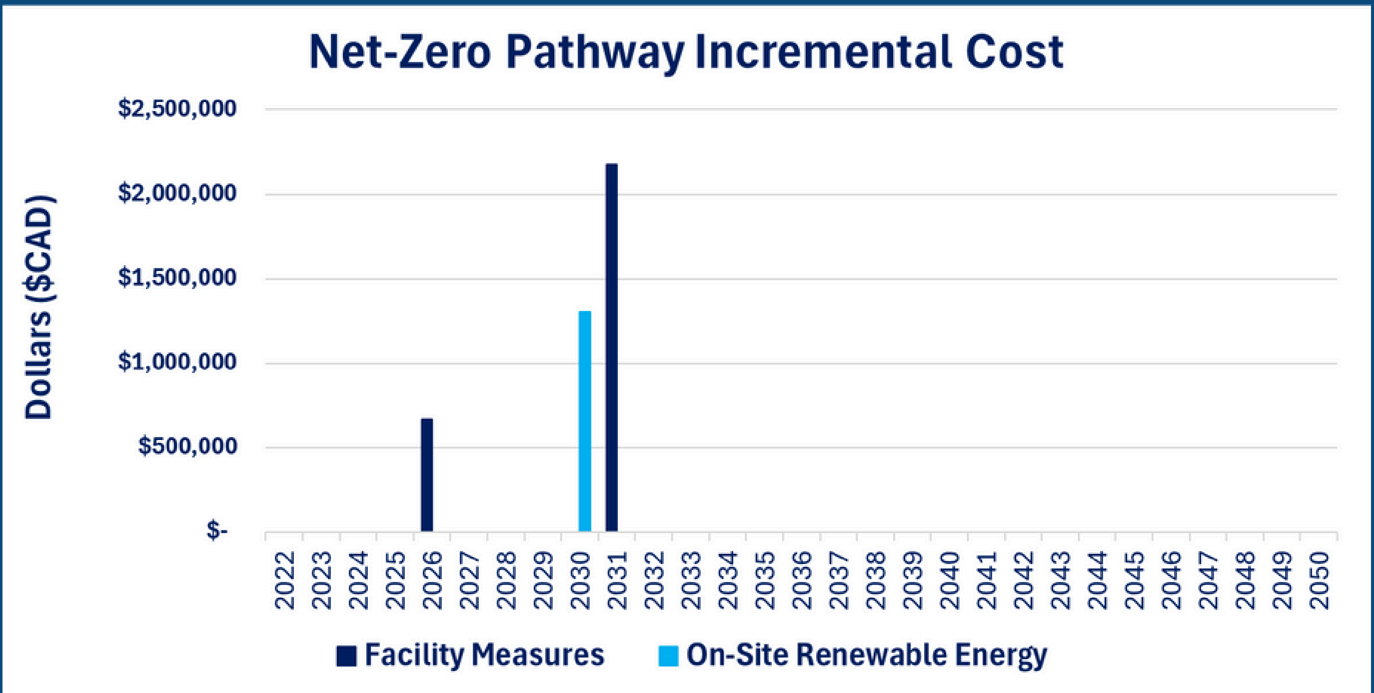
Incremental Capital Cost

The NZ0 Pathway for Wastewater Operations will require higher initial capital expenditures compared to the BAU Pathway. These initial investments are essential for implementing NZ0 strategies where feasible. Although the relative impact of these measures is modest, optimizing on-site energy generation and implementing energy efficiency initiatives will help reduce energy costs and GHG emissions, thereby reducing the need for managing these emissions under the Corporate-Wide Strategies discussed later in this report.

The incremental costs associated with the Net-Zero Pathway are outlined in the graph below, which illustrates the additional capital required to implement the proposed measures. The majority of these costs occur in the near term, prior to 2032, and are primarily linked to upgrades and optimization efforts at the WwTF. Key actions include enhancing the co-generation system, which involves system upgrades and synchronizing the two units to optimize energy efficiency. This will enable greater biogas utilization, thereby reducing reliance on external energy sources. Additionally, the installation of rooftop solar PV systems, where feasible, at the WwTF is a key component of the initial investment. The solar PV system will generate renewable energy on-site, reducing long-term energy costs and further decreasing dependence on grid electricity.

NET-ZERO CAPITAL COST TRENDS

- Under the NZ0 Pathway, the total cumulative incremental capital costs are projected to reach $4 million by 2031. No further incremental costs are projected beyond this date.
- The identified measures aimed at enhancing energy efficiency and improving on-site energy generation are expected to require an initial investment of approximately $3 million.
- The installation of on-site solar PV is projected to involve an initial investment of $1 million.



Fleet Vehicles

The City of Barrie operates a large vehicle fleet that supports multiple departments and provides essential services to the community. This fleet includes both light-duty and heavy-duty vehicles, from SUVs and pickup trucks to specialized equipment like fire response vehicles, snowplows, and road maintenance machinery. Each type of vehicle plays a key role in maintaining the City's infrastructure and public safety. The fleet is primarily composed of internal combustion engine (ICE) or fossil fuel powered vehicles, with roughly 60 percent of the fleet powered by gasoline and the rest powered by diesel. The City's light-duty vehicles (SUVs, pickup trucks) are expected to be fully replaced with EVs over the next 10 years. Heavy-duty vehicles and large equipment will be replaced with EV models, depending on the availability of suitable technology.

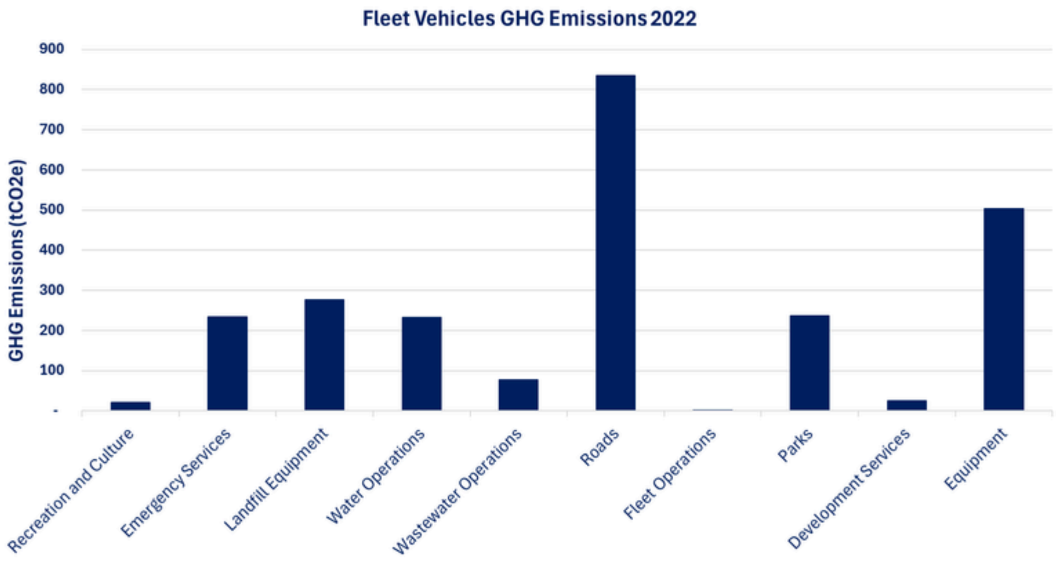
In 2022, the City advanced its electrification efforts by replacing two ice resurfacers with electric models. Following the success of these initial units, the City plans to transition to a fully electric ice resurfacing fleet by 2025. Additionally, seven Ford Lightning electric pickup trucks were added to the fleet 2024 with three more scheduled for delivery in 2025. These trucks have been designated for Wastewater Operations, Water Operations, Roads Operations, and Parks Operations. These first EVs will be tested across these City departments to assess their functionality and guide future fleet electrification.

BASELINE GHG EMISSIONS

In 2022, the fuel required to power the City's owned fleet vehicles and equipment was roughly 990,000 litres. The GHG emissions resulting from fuel consumption across all of the fleet vehicles in 2022 was 2,470 tonnes CO_2e or 7 percent of the City's emissions. The vehicle fleet fuel costs amounted to $1.6 million, representing approximately 14 percent of the City's total energy costs.

2,470

Tonnes CO_2e emissions in 2022



BAU Pathway - GHG Emissions

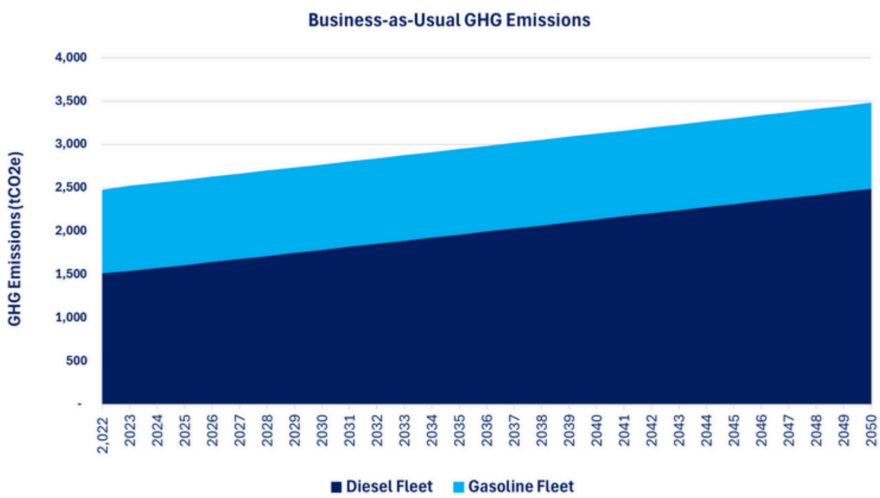
The BAU pathway for the City's fleet projects a significant increase in GHG emissions, rising from 2,470 tonnes CO_2e in 2022 to 3,480 tonnes CO_2e by 2050. The rise in emissions is driven by the growth of the fleet across all departments, to meet the service needs of the City's growing population. Higher service needs will see an increase in assets such as roads, parks, and other infrastructure supported by the fleet.

41%

Increase in GHG emissions by 2050

BUSINESS-AS-USUAL TRENDS

- The City's vehicle fleet and equipment are projected to expand over time to meet the service needs of a growing population. This increase in service wiill require more fuel to power the fleet and result in more overall emissions.
- In 2022, the fleet consumed around 990,000 liters of fuel, with this amount projected to increase to 1.4 million liters by 2050.



- The BAU Pathway projects an increase in the number of vehicles required per department, along with the corresponding fuel needs, through 2050. These estimates are based on historical trends and growth rates of fleet vehicles, with GHG emissions projected to increase linearly in accordance with the anticipated growth.

NZ0 Pathway - GHG Emissions

The NZ0 Pathway for fleet vehicles projects a significant reduction in emissions, from 2,470 tonnes CO_2e in 2022 to 1,360 tonnes CO_2e by 2050, representing a 45 percent decrease compared to the baseline in 2022. Compared to the BAU Pathway, this marks a 61 percent reduction in GHG emissions at 2050. The net-zero strategy for fleet vehicles follows an asset management approach, replacing fleet vehicles with electric models as they reach the end of their useful life. While electric alternatives are available for light-duty vehicles and some equipment, the replacement of heavy-duty vehicles is contingent on the availability of suitable EV models on the market. The pathway accounts for this limitation, with emission reductions occurring as existing assets are replaced by electric vehicles only where currently feasible.

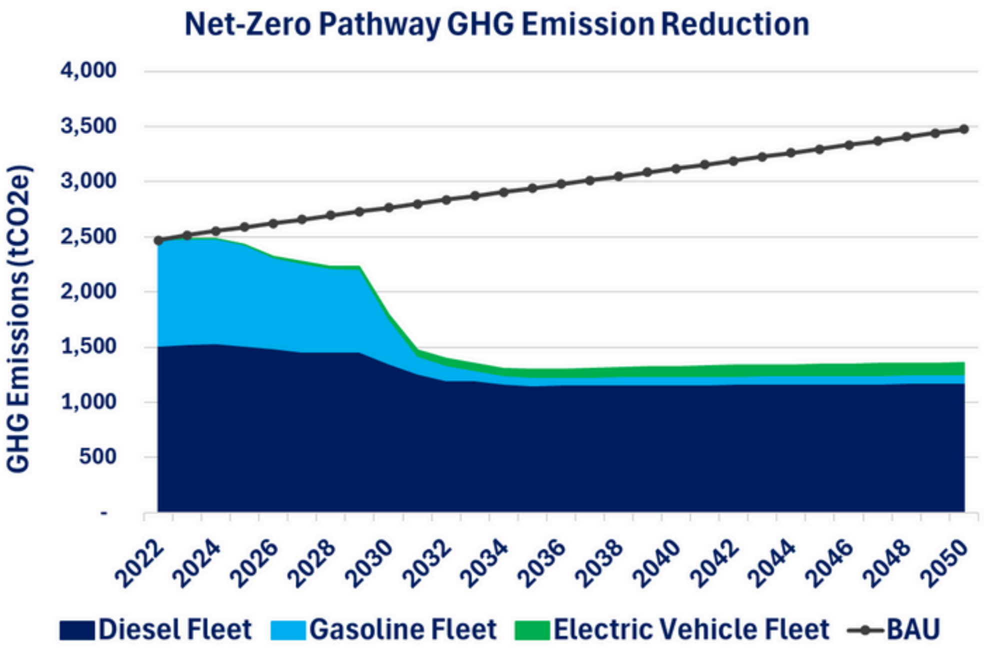
-45%

Decrease in GHG emissions by 2050

NET-ZERO TRENDS

- The NZ0 Pathway for the City's fleet outlines an electrification strategy based on asset management and technology availability. Most light-duty vehicles, trucks, and equipment will be converted to EV models at the end of their useful life. Due to an aging fleet, the majority of these conversions are projected to occur around 2030 and be finalized by 2036.

- Heavy-duty vehicles and off-road equipment will be converted to electric models as technology allows. However, as many of these models currently lack EV alternatives, most will remain gasoline or diesel-powered when replaced.



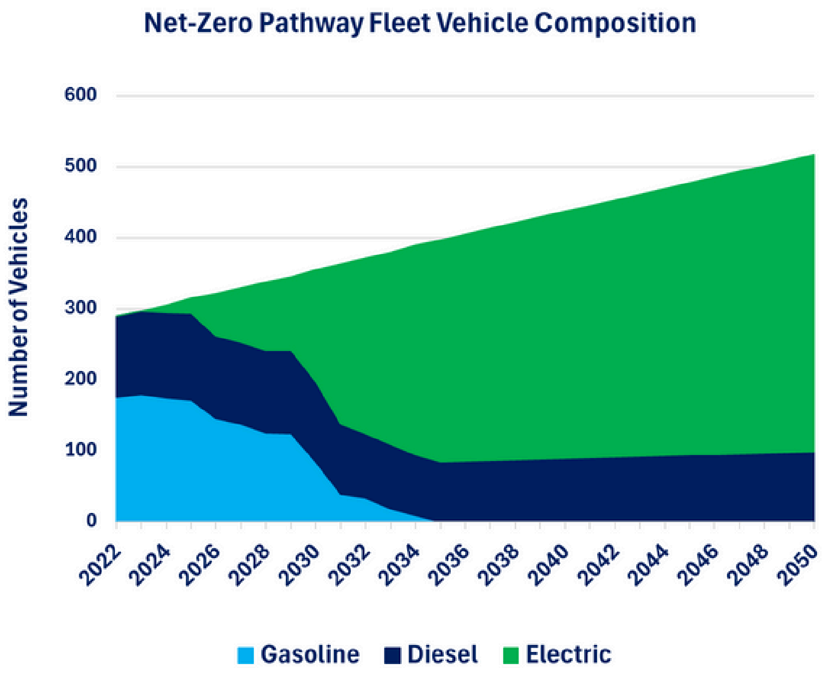
- EVSE infrastructure is another limitation. While some City sites can accommodate it, most EVSE will be installed at the Operations Centre. Since this facility is being retrofitted, the completion date will determine when fleet vehicles can be converted to electric.

Fleet Vehicles - Key Strategies

FUEL SWITCHING

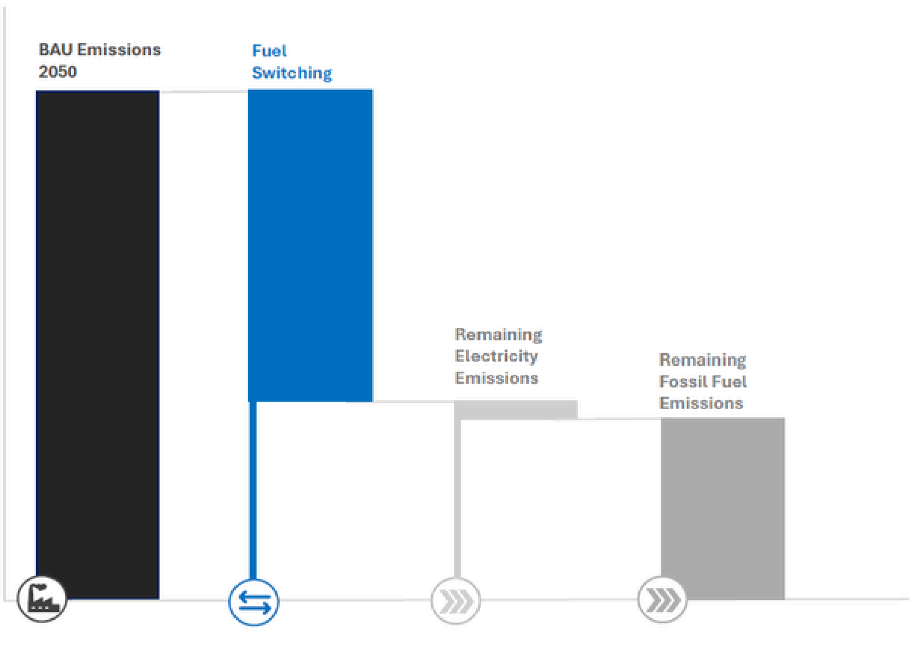
FLEET COMPOSITION

The primary NZ0 strategy for the City's vehicle fleet is to transition existing vehicles to electric models when they reach the end of their useful life, and to purchase electric vehicles (EVs) for all new acquisitions. The strategy accounts for the current limitations of EVSE availability on City properties and follows an electrification pathway that aligns with where EVSE can feasibly be installed. In the short term, EVSE will be installed at the STWP and Fire HQ, with additional installation planned at the Operations Centre as part of or following the current revitalization project. The adjacent graph illustrates the NZ0 pathway for fleet vehicle composition, showing the shift by fuel type from 2022 to 2050.



STRATEGY GHG REDUCTION

This strategy is part of the broader fuel-switching measures outlined in the plan. Additional measures, such as fleet right-sizing and anti-idling policies, are relevant but not included in the GHG reduction modelling of this report. While GHG emissions remain with electric models, significant efficiency improvements are expected during the transition. Fossil fuel emissions will persist from heavy-duty vehicles and equipment that currently lack EV alternatives. The conversion of these assets will be reassessed as alternative EV models become available.



Operational Energy Cost Savings

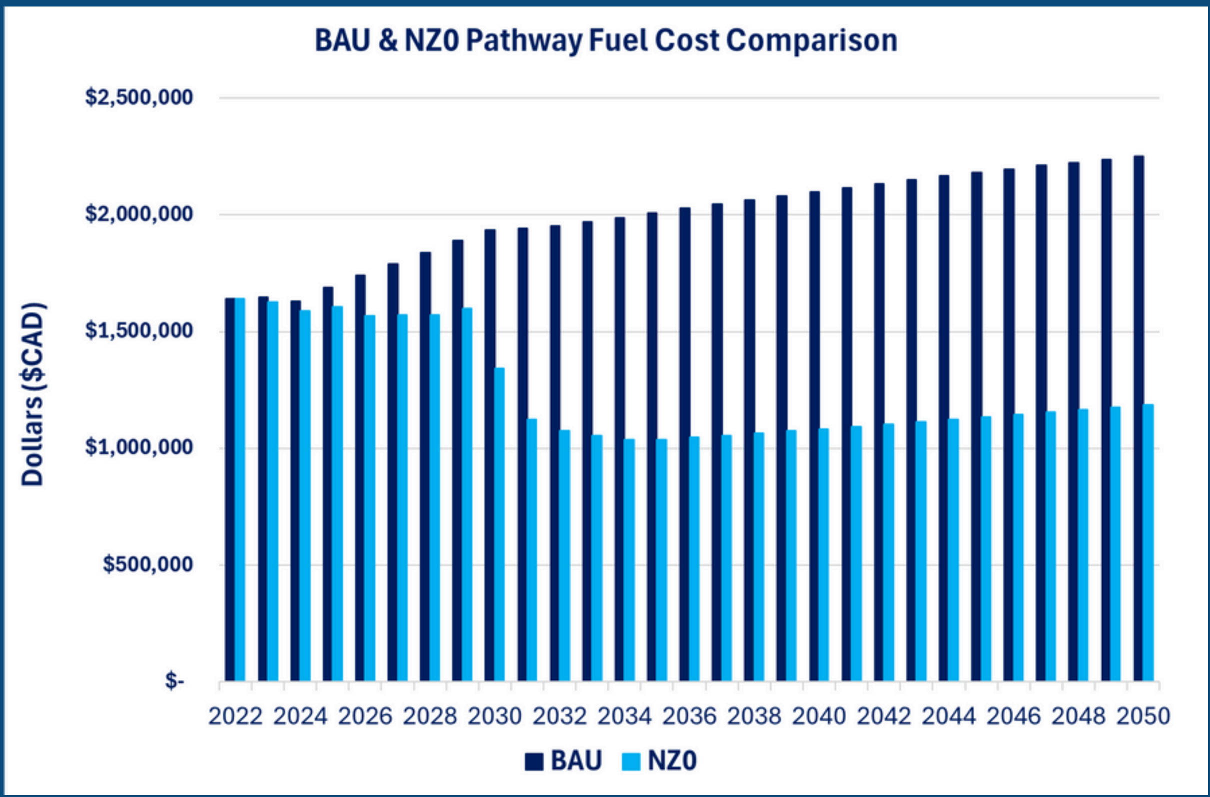
-47%

Decrease in energy cost at 2050

The NZ0 pathway for fleet vehicles and equipment projects a 47 percent decrease in operational energy costs to power the City's fleet by 2050 compared to the BAU projection. This reduction is mainly driven by the superior fuel efficiency of EV models over their ICE counterparts and the lower cost of electricity versus gasoline and diesel. Additionally, the operational cost of maintaining an EV fleet is expected to be lower due to reduced maintenance costs. Though these savings are not included in this analysis they will still provide a financial benefit to the City. The annual energy cost savings will fluctuate over the next 25 years. However, by 2050, the projected annual savings for powering the City's fleet is estimated to reach $1 million.

NET-ZERO COST SAVING TRENDS

- The NZ0 Pathway demonstrates a significant reduction in the operational cost of energy, as illustrated in the graph below, particularly around 2030, when the majority of vehicles are transitioned to electric models.
- The cumulative fuel cost savings achieved under the NZ0 Pathway are projected to be $22 million lower than those under the BAU Pathway.
- Heavy-duty models and some equipment, for which electric models are not currently available, are replaced at the end of their life with traditional gasoline and diesel models.



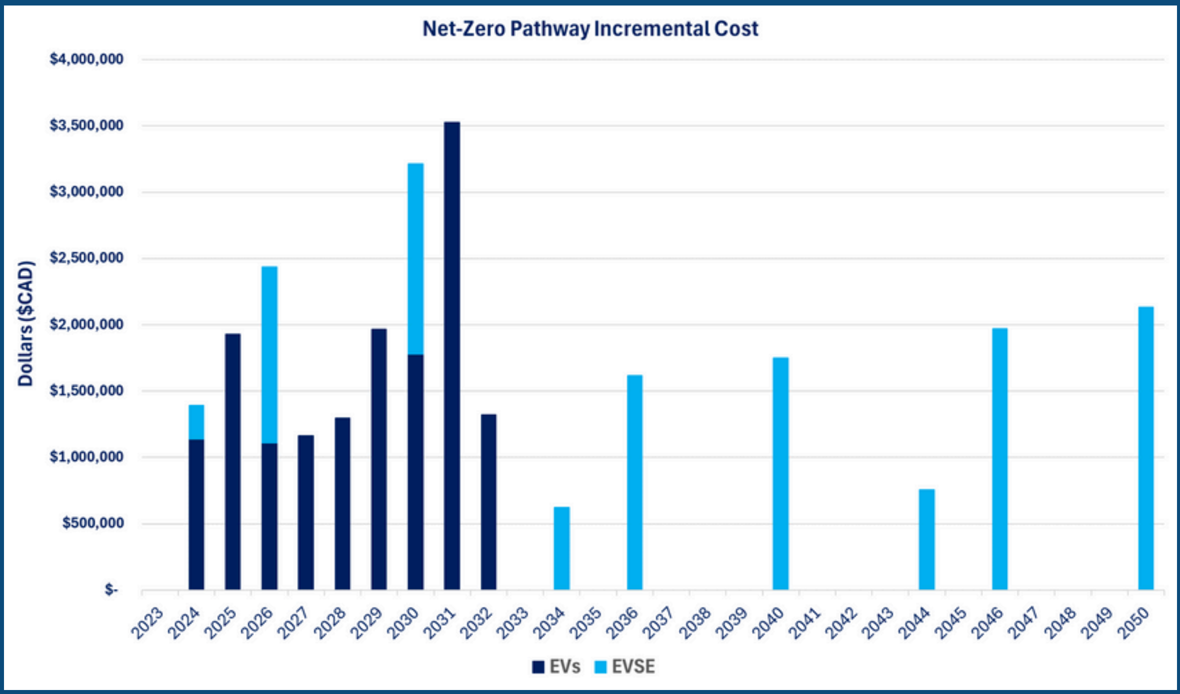
Incremental Capital Cost

The NZ0 Pathway for fleet vehicles follows an asset management approach, aligning with current anticipated replacement schedules. However, due to higher initial investment costs, there will be incremental capital expenditures above the BAU pathway in the near to medium term as vehicles transition to electric models. Over time, as the fleet is replaced, these costs are expected to decrease as the price of EV models reaches parity with traditional vehicles. For models where EV alternatives are available, price parity is anticipated by 2030, at which point the incremental cost of EVs will align with the current BAU projections.

The City has already started its transition by acquiring two electric ice resurfacers and seven electric Ford Lightnings. These initial transitions will offer valuable insights into the full life-cycle costs of these vehicles, helping inform strategic decisions as the fleet continues to shift to electric models in the future. While initial investments may be higher, energy and maintenance savings are expected to offset these costs over time, providing a payback on the initial investment.

NET-ZERO CAPITAL COST TRENDS

- The cumulative incremental capital cost associated with vehicle electrification under the NZ0 Pathway is projected to reach $15 million by 2050, with the capital cost of EVSE amounting to $12 million by the same year. Comparatively, the cumulative operational fuel savings by 2050 are expected to total $22 million.
- After 2030, price parity is expected to be achieved for light-duty vehicles, trucks, and equipment. As a result, incremental capital costs beyond this point will primarily be related to the replacement of EVSE infrastructure.
- EVSE infrastructure will require additional capital investment in the near term, with installations planned at the SWTP and Fire HQ. Further installations will also be made at the Operations Centre once the current revitalization is completed.



Transit Buses

The City of Barrie provides a range of mobility services, including conventional transit, Transit ON Demand, and specialized services for individuals with mobility restrictions. The 2019 Transportation Master Plan (TMP) established a goal to increase daily transit ridership from approximately 9,600 boardings to 76,900 by 2041, in line with projected population and employment growth. As ridership is anticipated to grow, the expansion of transit services and the fleet will lead to a corresponding increase in the energy demand of the transit system.

In the City's Community Energy and GHG Emission Reduction Plan, single-occupancy vehicles were identified as being responsible for 99 percent of transportation GHG emissions and nearly 55 percent of the community's GHG emissions or over 500,000 tonnes CO_2e each year. While fuel consumption and emissions are expected to rise, increasing transit ridership will have a significant benefit to overall community emissions.

In 2021, the City Council approved a pilot project to transition the Barrie Transit fleet to BEBs, starting with two battery electric buses. This initiative was supported through funding from the Government of Canada's Zero Emission Transit Fund (ZEVIP), which provides funding for BEBs and EVSE infrastructure. Set to launch in 2025, the pilot BEB program will see these electric buses operate alongside the City's conventional diesel fleet. The pilot will enable the City to gather data on the buses' performance, electrical demand, and infrastructure needs to optimize future operations. As ridership and network coverage grow, BEBs will reduce tailpipe emissions, improve air quality, and enhance public health. The electric fleet has the potential to significantly reduce both maintenance and operational costs over time.

BASELINE GHG EMISSIONS

In 2022, the fuel required to power the City's transit buses was nearly 2 million litres or 19,500 MWh equivalent of energy. The operational energy cost to the City was roughly $3 million. The fuel consumption required by the City's transit buses resulted in 5,200 tonnes of CO_2e or 14 percent of the City's emissions.

5,200

Tonnes CO_2e emissions in 2022

BAU Pathway - GHG Emissions

The BAU Pathway for Barrie's transit bus fleet projects an increase in fuel consumption over time, driven by the expansion of the fleet to meet the growing demands of the community. In alignment with the goals outlined in the Transportation Master Plan (TMP 2019) and the Community Energy and GHG Reduction Plan (Community Plan 2022), increasing transit ridership is identified as a critical objective for the City.

248%

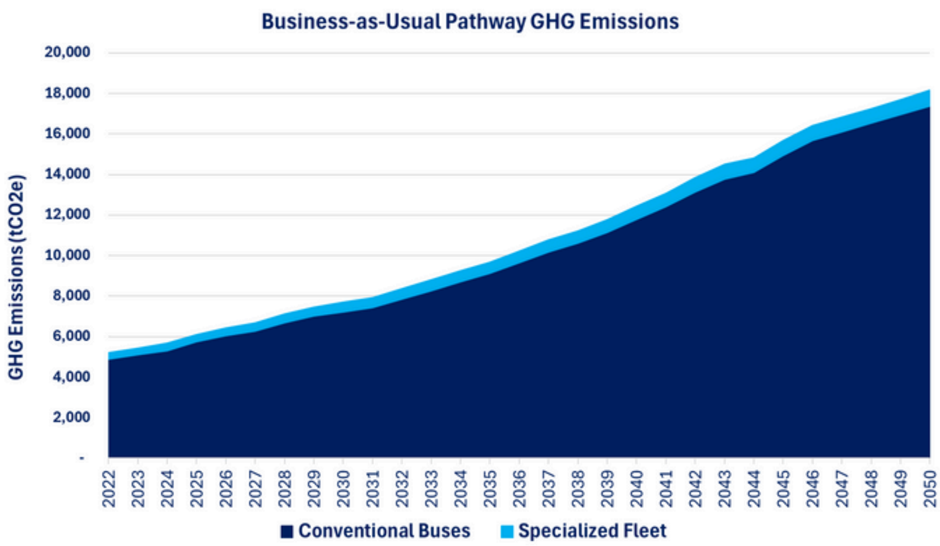
Increase in GHG emissions by 2050

In 2022, Barrie operated approximately 65 City-owned transit buses, a number which is projected to grow to approximately 200 by 2050. This expansion will result in a significant increase in GHG emissions, with emissions from the transit fleet expected to rise from 5,200 to 18,200 tonnes CO_2e by 2050. This represents a nearly 250 percent increase, which will substantially contribute to the City's overall projected GHG emissions.

It is important to recognize that while transit-related emissions are expected to rise over the next 25 years, transit plays a critical role in reducing overall GHG emissions within the community. According to the Community Plan, private vehicles account for 55 percent of the GHG emissions in Barrie. Therefore, increasing transit ridership and reducing private vehicle use are necessary strategies for achieving the community's broader emissions reduction goals.

BUSINESS-AS-USUAL TRENDS

- Under the BAU Pathway, GHG emissions will rise in proportion to the increased transit demand over time as the City works to meet the service needs of the community.
- The City's transit bus fleet currently consists of 65 buses. To meet future demand, the fleet is projected to expand to 200 buses by 2050.
- Transit services are also expected to expand in the future to align with the goals outlined in the TMP, which include extending service coverage to growing communities and increasing the frequency of transit bus routes, and ultimately increasing modal share from 12,000 to 76,000 trips per day.



NZ0 Pathway - GHG Emissions

-30%

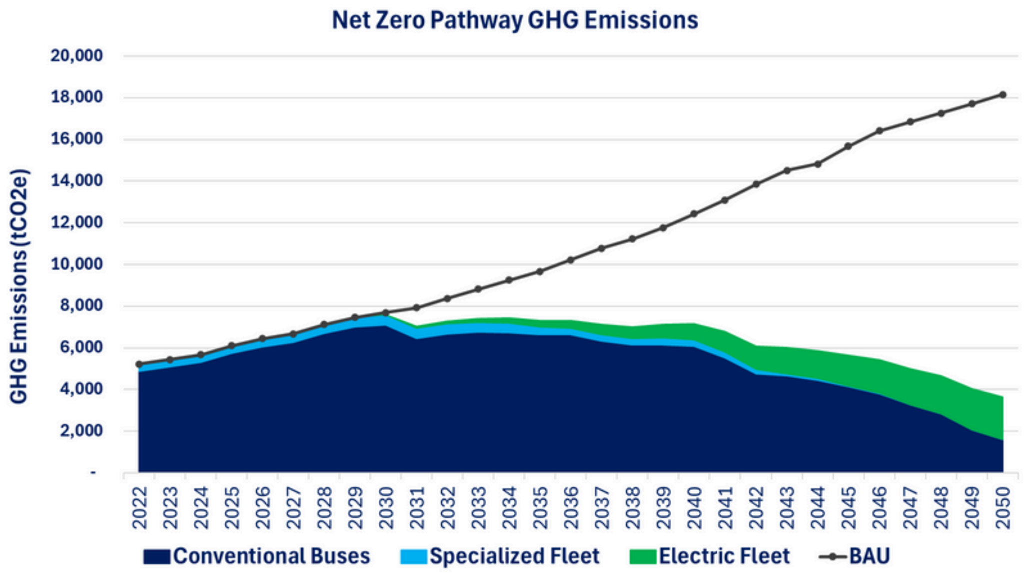
Decrease in GHG emissions by 2050

The Net-Zero (NZ0) Pathway for transit buses is projected to result in a 30 percent decrease in GHG emissions compared to the baseline year of 2022, and an 80 percent reduction by 2050, compared to the BAU pathway. This pathway follows an asset management approach but accounts for the significant capital investment needed to transition to electric buses. Due to these investment requirements, the NZ0 pathway adopts a conservative approach, transitioning 50 percent of the bus fleet to electric models at the end of their life, with a full replacement starting in 2040. The transition to electric buses is projected to begin in 2030.

To support this transition, the City has invested in two electric buses for a pilot study, set to begin in 2025. This study will collect critical data on the performance of the buses and their charging infrastructure under real-world conditions, providing valuable insights to shape a financially viable and effective electrification strategy. The findings from this pilot program will guide the broader transition from diesel to electric buses and inform necessary infrastructure upgrades

NET-ZERO TRENDS

- Under the NZ0 Pathway, greenhouse gas (GHG) emissions from the City's transit buses are projected to decrease from 5,200 tonnes CO_2e in 2022 to 3,600 tonnes by 2050.
- Under the NZ0 Pathway, the City's transit bus fleet is projected to transition to electric models starting in 2030. By this time, 50 percent of bus replacements will involve a shift from traditional models to electric alternatives. By 2040, 100 percent of bus replacements will be converted to electric alternatives.
- As technology continues to evolve, the City's specialized fleet will progressively transition to electric models, with conversions occurring as suitable electric alternatives become available.

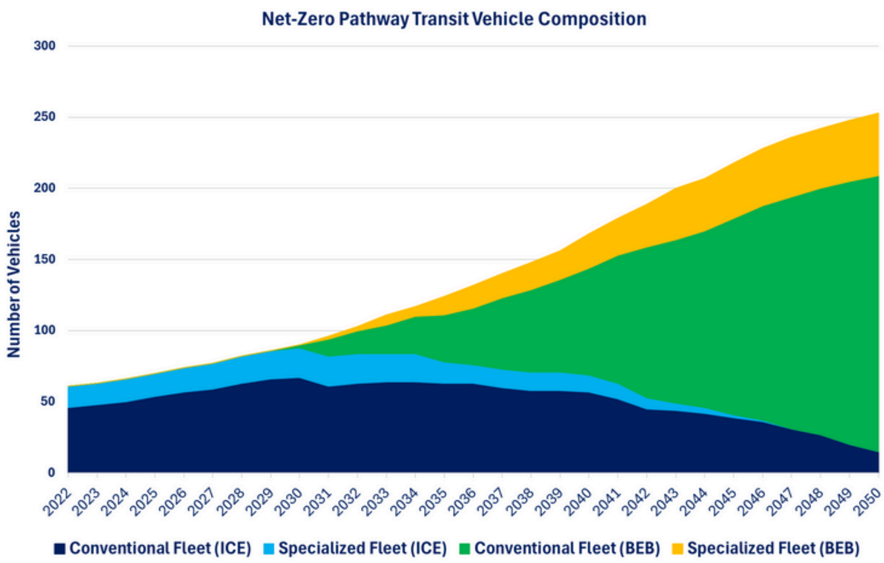


Transit Buses - Key Strategies

FUEL SWITCHING

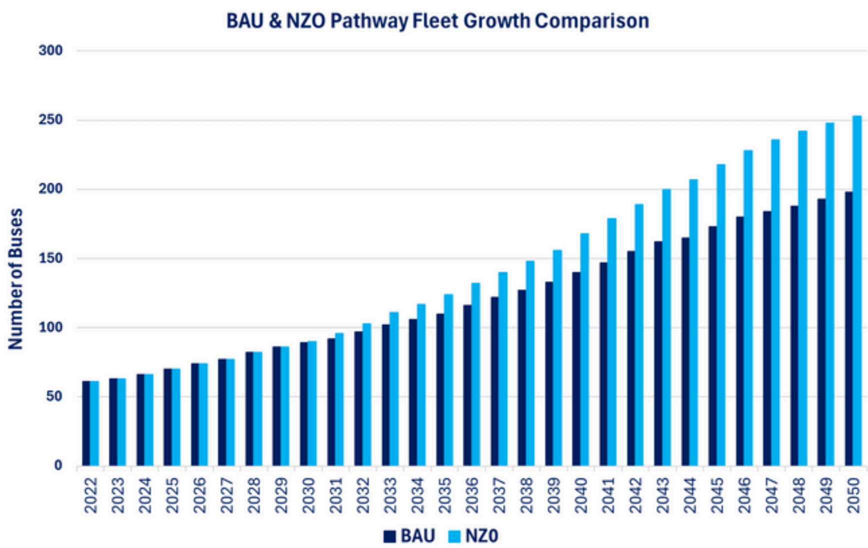
FLEET COMPOSITION

The primary strategy for achieving net-zero emissions in the City's transit bus fleet is to replace traditional ICE models with EVs at the end of their useful life. Over time, the City's transit bus fleet is expected to grow, as shown in the accompanying graph. The graph highlights the projected increase in the transit bus fleet and the transition to electric models for both conventional and specialized vehicles. This transition will take place gradually, with 50 percent of the current fleet converted to electric by 2030 and the full conversion to 100 percent electric vehicles by 2040, as older models reach their end of life. The fleet composition over time, as depicted in the adjacent graph, illustrates this approach for the City's transit bus fleet through to 2050.



FLEET GROWTH

For every conventional bus replaced with an electric bus, approximately 1.3 electric buses will be required to meet the same service demands due to the projected differences in operational characteristics between ICE buses and BEBs. Electric buses typically have shorter ranges and require more frequent charging, which means additional buses are needed to maintain the same level of service without compromising frequency or coverage. As a result, the projected fleet size under the NZ0 Pathway is expected to be 30 percent higher than the BAU Pathway, as shown in the adjacent graph.

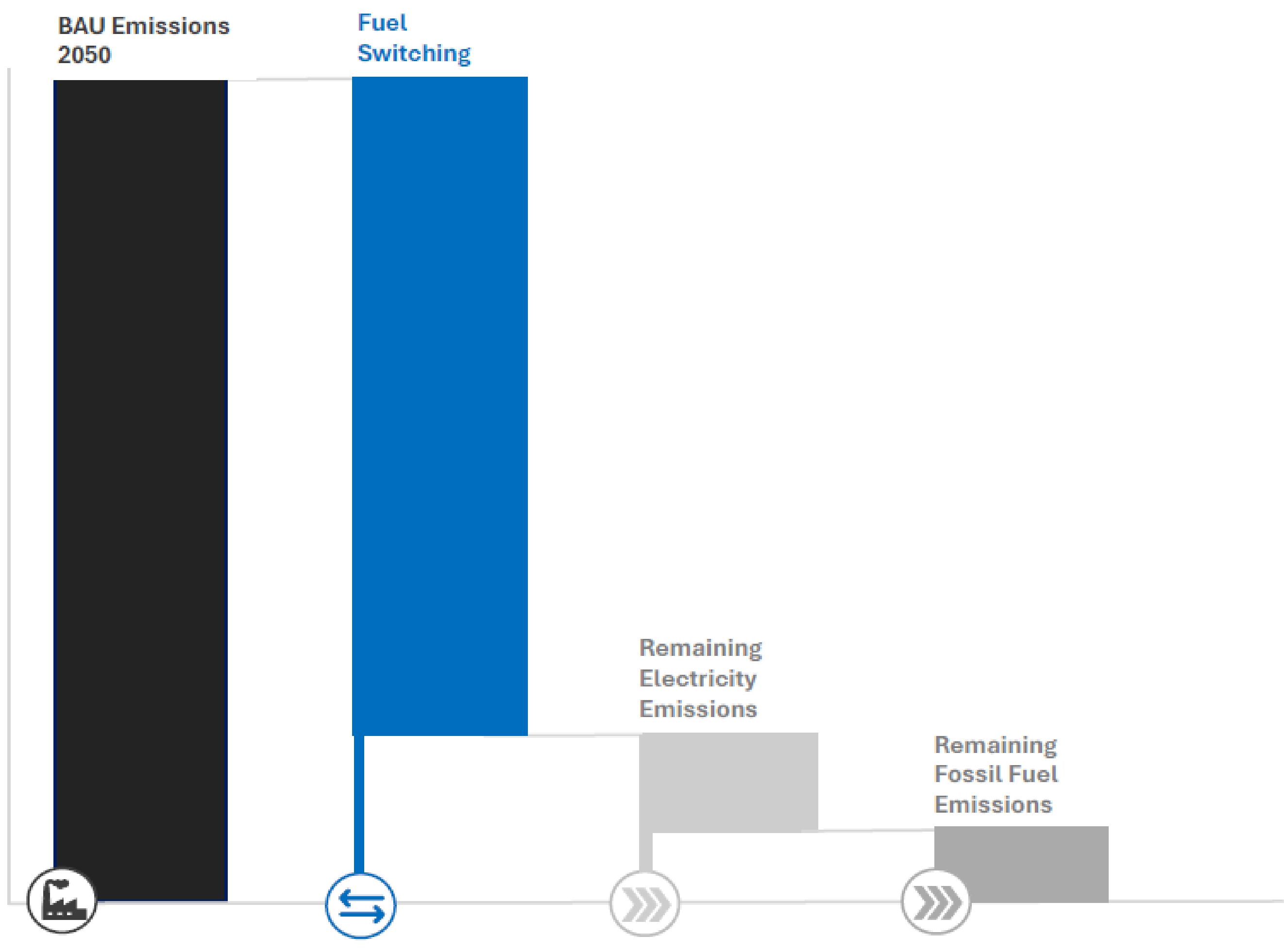


GHG Emission Reduction

The net-zero strategy for the City's transit fleet focuses on transitioning from gasoline and diesel-powered buses to electric models. This transition follows an asset management strategy, replacing buses gradually as they reach the end of their useful life. Financial factors are considered to ensure the transition is fiscally responsible. To manage costs, the strategy plans to replace 50 percent of the fleet with electric buses beginning in 2030 at their useful end of life. This allows the City to spread investment over time while ensuring the necessary charging infrastructure is in place. The transition will be paced to develop infrastructure—such as charging stations and grid capacity—before further electrification, minimizing disruptions and optimizing efficiency. This approach balances environmental goals with financial and logistical considerations, carefully managing operational, economic, and infrastructure needs.

The strategy reduces GHG emissions by replacing fossil fuel-powered buses with electric vehicles, but by 2050, some emissions will remain from the electricity needed to power electric buses and from gasoline and diesel for buses not yet converted. The graph below shows the significant reduction in emissions under the net-zero strategy compared to the BAU Pathway.

RELATIVE GHG EMISSION REDUCTION FROM STRATEGIES



Operational Energy Cost Savings

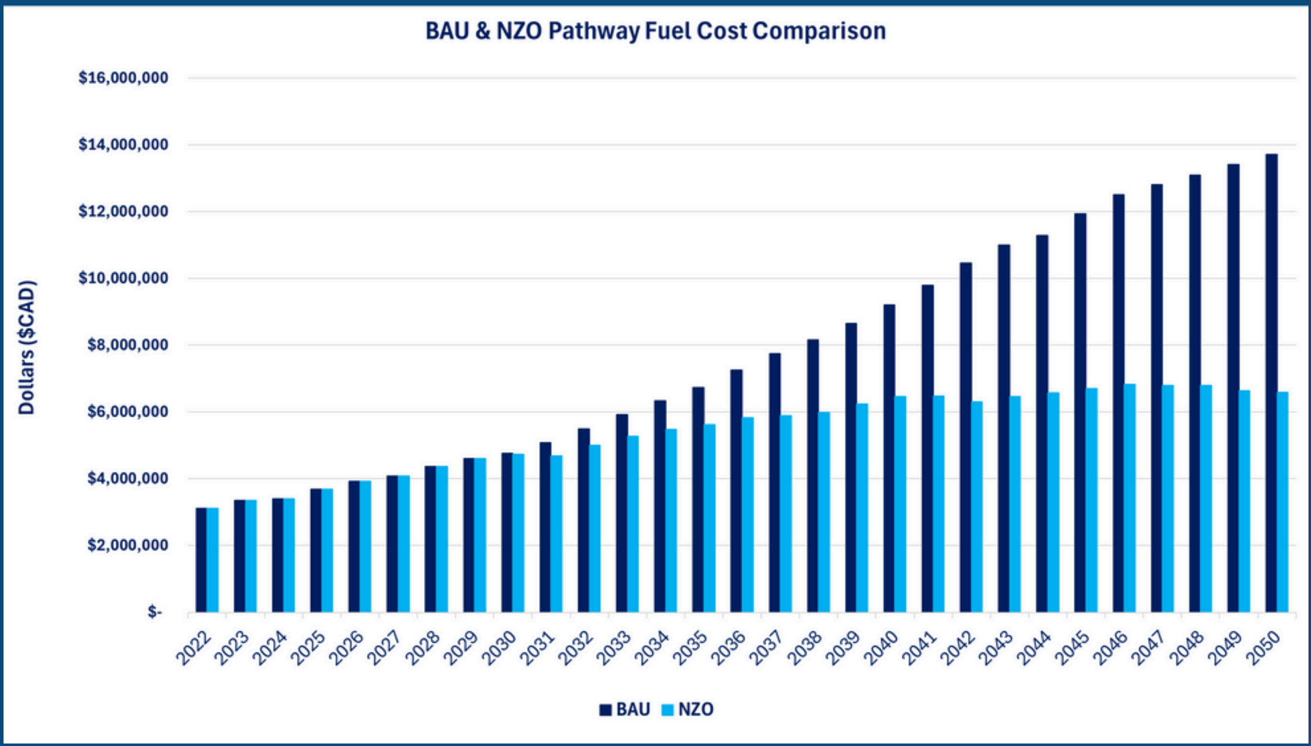
The annual operational energy cost to power the City's transit buses is projected to rise from $3 million in 2022 to $14 million annually by 2050 under the BAU Pathway, while the NZ0 Pathway projects a cost of $7 million. Although energy costs increase under both pathways, the NZ0 Pathway offers a 53 percent reduction in operational costs by 2050 compared to the BAU Pathway. Transitioning the City's transit bus fleet to electric models is expected to significantly reduce operational costs. This reduction is likely to be even greater when factoring in the potential for lower maintenance costs of a BEB fleet compared to traditional ICE fleet.

111%

Increase in energy cost by 2050

NET-ZERO COST SAVING TRENDS

- Under the BAU Pathway, the cost to power the City's transit bus fleet steadily increases to 2050, rising from $3 million to $14 million by 2050.
- Under the NZ0 Pathway, the cost to power the City's transit bus fleet increases to 2030 and holds relatively steady beyond 2030, increasing from $3 million in 2022 to $6.6 million by 2050.
- The total cumulative energy cost savings from the baseline year to 2050 under the NZ0 Pathway is $68 million.

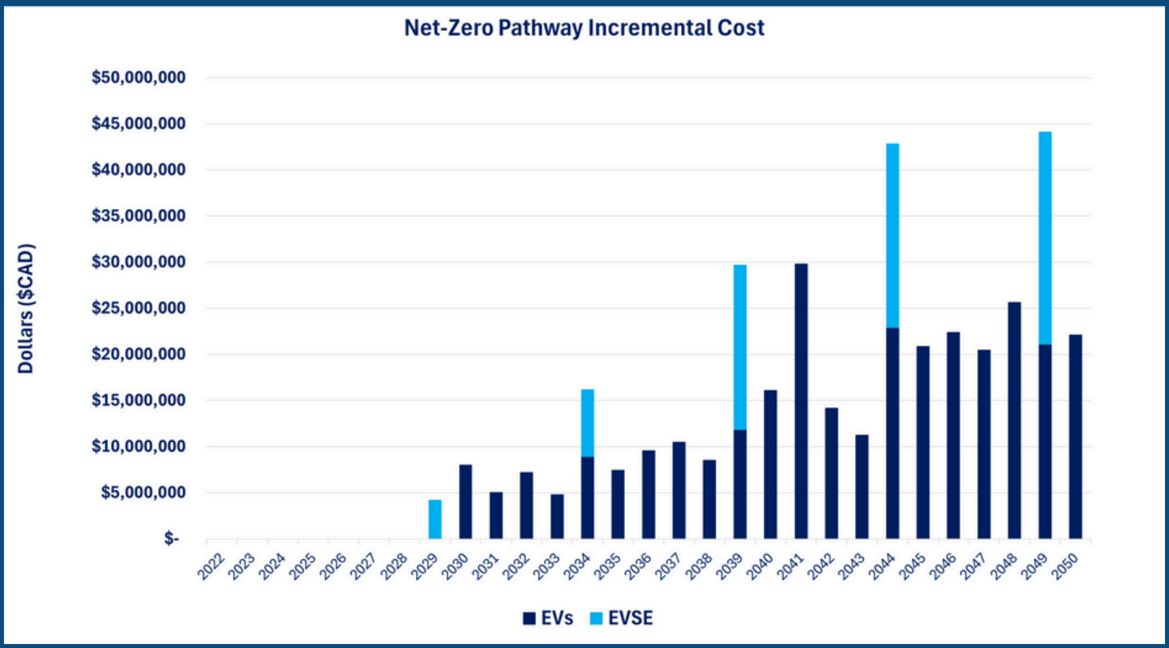


Incremental Capital Cost

The NZ0 Pathway for transit buses involves incremental capital costs associated with the current and projected costs of Battery Electric Buses (BEBs) compared to traditional diesel and gasoline buses. Additionally, the pathway accounts for the projected increase in the number of BEBs needed to meet the service requirements of the traditional buses, with an estimated need of 1.3 BEBs for every internal combustion engine (ICE) bus replaced. This shift to BEBs reflects both the higher initial investment and the growing fleet size necessary to transition to a more sustainable, zero-emission transportation system.

NET-ZERO CAPITAL COST

- → The incremental capital cost of BEBs is expected to begin in 2029, coinciding with the installation of Electric Vehicle Supply Equipment (EVSE) necessary to support a BEB fleet which will be phased in as the fleet expands.
- → Over the next 25 years, the total cumulative incremental capital cost is anticipated to reach approximately $300 million and is shown in the graph below in dark blue. The incremental capital costs within the NZ0 Pathway account for both the higher cost of BEBs, as price parity has not been factored into the projection below, as well as the necessary expansion of the fleet relative to a fossil fuel-powered fleet.
- → The total cumulative capital cost for EVSE infrastructure is projected to amount to approximately $72 million over a 25-year period and is shown below in light blue. Note, as the lifespan of EVSE is generally 10 years, replacement costs for EVSE have been factored into the NZ0 Pathway.
- → Upgrades to the Transit Garage's transformer will be necessary to accommodate the increased electricity demand the charge BEBs. The capital costs for these upgrades are projected to be approximately $1.3 million in 2030 and $1.02 million in 2040. These costs have not been included in the model below, as they are accounted for in the Corporate Buildings section of this report.



Solid Waste

The City owns and operates the Sandy Hollow Landfill Site, as known as the Barrie Landfill, and has been in operation since 1964. The facility is currently licensed to accept solid non-hazardous domestic, commercial, and industrial waste within municipal boundaries. Facilities located at the Sandy Hollow Landfill site include a scale house, vehicle garage, and administrative building. The emissions resulting from the operation of these facilities have been included within the corporate buildings section of this report and the 2022 GHG emission baseline. Emissions included within this section are from the decomposition of solid waste which results in release of biogas, of which, methane (CH_4) represents roughly 50 percent. Biogas at the site is both released directly to the atmosphere as well as captured and flared.

As the landfill is owned and operated by the City, the GHG emissions associated with landfill are required to be included within the City's corporate inventory, although the waste deposited predominantly comes from the community. The principle of operational control is significant, as the City has the ability to implement measures and management practices at the landfill site that could result in a reduction of GHG emissions.

BASELINE GHG EMISSIONS

In 2022, the emissions released to the atmosphere at Barrie's landfill site were 23,600 tonnes CO_2e or 61 percent of the City's total emissions. Emissions from solid waste result from the decomposition of degradable organic carbon (DOC) found in materials deposited to landfill which decompose and are released to the atmosphere as methane. The methane released in a given year is not directly proportional to the waste deposited in that year as waste decomposes overtime, and emissions generated are the result of the entire lifetime of a landfill. Additionally, a portion of the biogas produced at the landfill is captured and flared resulting in an overall reduction of emissions should the methane be released directly to the atmosphere. Since the flare was introduced, GHG emissions have decreased by roughly 34 percent annually. See Appendix for more information on emission calculation methodology.

23,600

Tonnes CO_2e emissions in 2022

History of Sandy Hollow

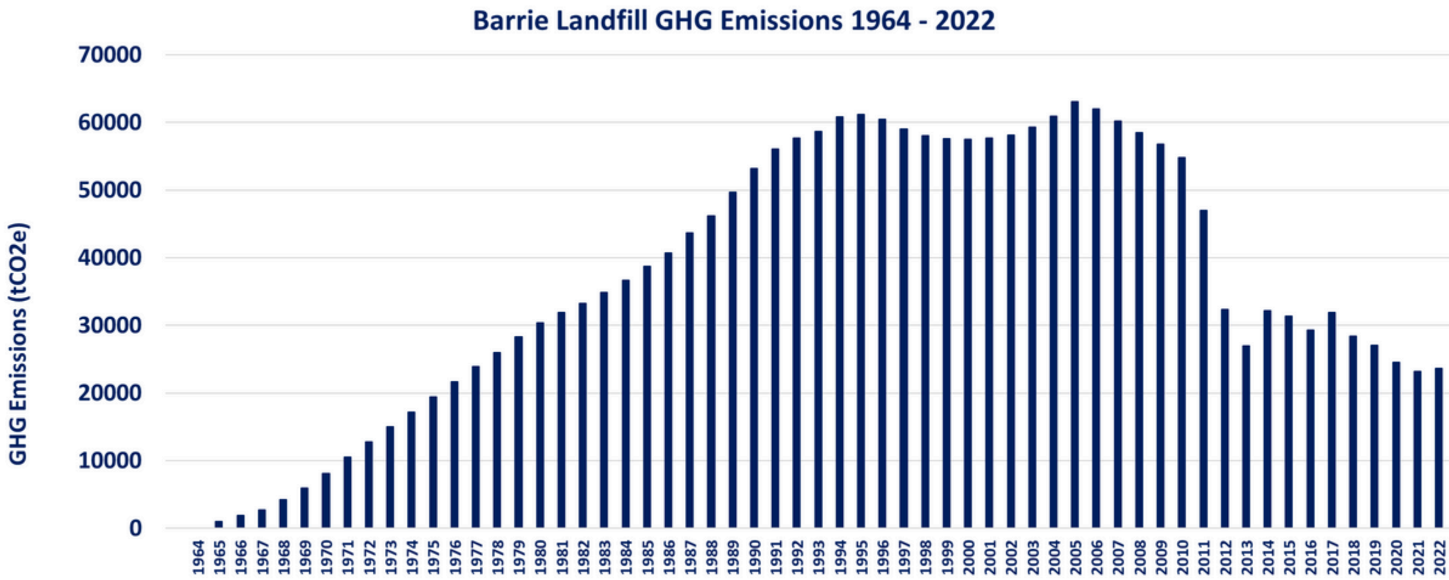
Waste reduction efforts at the landfill began in 1984 with the introduction of the Blue Box program, marking the start of the City's diversion initiatives. Since then, the City has continuously expanded its waste diversion programs, with a current focus on diverting organic waste. All of these efforts have and continue to have a important impact on reducing both overall GHG emissions.

The landfill's projected closure is anticipated by 2035, after which waste will be transported outside the city, though waste reduction initiatives will remain a priority, the City will no longer have operational control of landfilled solid waste. According to accounting protocols for solid waste GHG emissions, the responsibility for accounting for the community's solid waste emissions will shift to another jurisdiction, rather than being reduced as it appears in the City's projected BAU pathway. However, implementing initiatives to prevent solid waste from entering any landfill will continue as these programs have a significant positive benefit to waste management, supporting a circular economy, and reducing GHG emissions.

The following table highlights key initiatives undertaken at the Sandy Hollow landfill both currently and historically.

Year	Initiative	Year	Initiative
1964	**FOUNDING OF LANDFILL** Landfilling begins at the Sandy Hollow site beginning in 1964 in the northwest end of Barrie.	2007	**NEW LINING** Landfill reclamation and re-engineering project begins, excavating waste material and removing materials, such as large amount of tires.
1984	**BLUE BOX PROGRAM** The first year of the Barrie blue box program which began as a basic recycling program diverting paper, bottles, and cans from the landfill.	2011	**GAS FLARE** Installation of landfill biogas collection system and flaring stack, significantly reducing methane emissions from site.
1993	**DIVERSION PROGRAMS** Tipping fees on industrial, commercial, and institutional waste, a ban on cardboard, and backyard composting program introduced.	2022	**CIRCULAR ECONOMY STRATEGY** The Circular Economy Strategy is completed and approved
2006	**FURTHER DIVERSION** Landfill reclamation and re-engineering project begins, excavating waste material and removing materials, such as large amount of tires.	2024	**CURRENT INTIATIVES** Continued waste diversion programs, including circular economy initiatives and increased effort capture organics.

Historical GHG Emissions



HISTORICAL GHG EMISSION TRENDS

- Since the landfill's opening in 1964, GHG emissions have steadily risen in line with the increasing volume of solid waste deposited each year. Emissions reached a peak in 1995, again then again in 2005, before declining in subsequent years. The pattern of GHG emissions from the landfill is directly tied to the volume and composition of waste over time.
- The Blue Box program, introduced in 1984, reduced waste, but its impact on GHG emissions was limited as much of the material was inert and did not contribute to biogas generation aside from paper and cardboard.
- In 1993, tipping fees for non-residential waste, a cardboard ban, and a backyard composting program were implemented, along with further diversion efforts in the early 2000s. These measures reduced waste volume and high-DOC materials, likely contributing to the decline in GHG emissions after the peaks.
- In 2008, Ontario passed legislation mandating the collection of landfill gas. Supported by provincial funding, and the installation of a biogas capture system was completed in 2010. The collection and flaring of biogas at the site led to a significant reduction in GHG emissions, as reflected in the trend, with a marked decrease in 2011.

-36%

Decrease in GHG emissions from flare

In terms of overall GHG emission reduction, the installation of the landfill biogas capture systems and flare has been one of the most successful initiatives to reduce GHGs at the City. While the system does not currently capture all of the biogas, the average annual reduction in GHGs emitted at the site has been reduced by an average of 36 percent since its installation. Since the establishment of the flare, the City has reduced biogas emissions from the landfill by over 180,000 tonnes CO_2e. Optimizing the capture system at the site has been identified as a priority, as even small improvements will result in significant GHG reductions.

BAU Pathway - GHG Emissions

The business-as-usual projection for solid waste at the Sandy Hollow landfill estimates the amount of methane that will be released into the atmosphere through the decomposition of waste and flared methane gas up to 2050. Several factors were considered in developing this projection of future emissions at the site. The total tonnes of historically deposited waste and the annual waste deposition have the most significant impact on emissions.

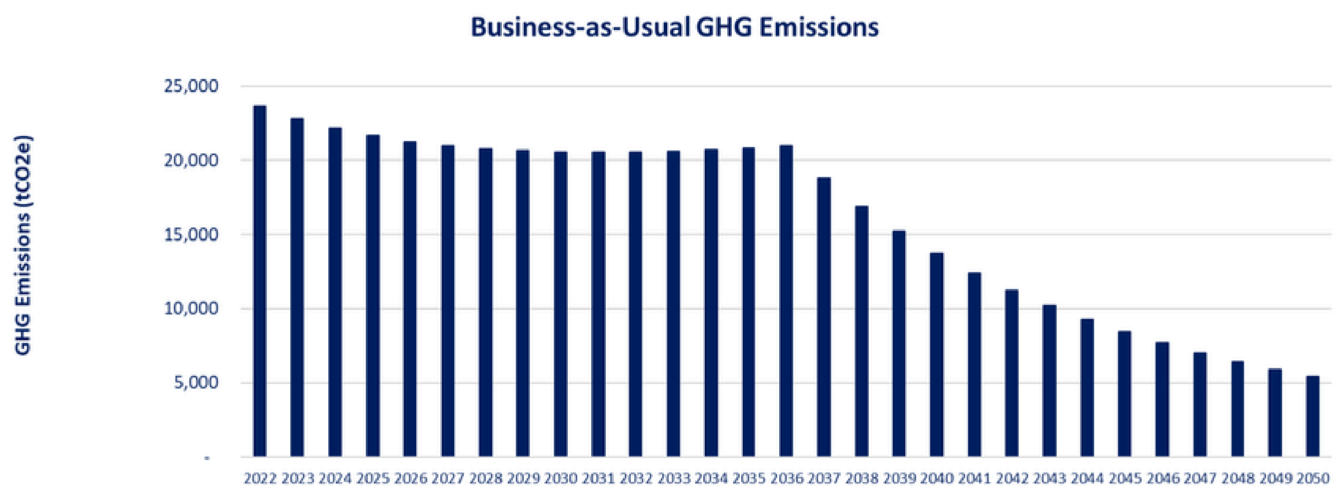
-77%

Decrease in GHG emissions by 2050

If the business-as-usual projection includes the historical waste as well as an estimate for the amount of waste that will be deposited annual form 2022 to 2035, the estimated year for the end of life of the landfill. The model assumes an annual growth rate in overall waste deposition to be 2 percent annually, following a similar trend in projection population growth. Importantly, the end of life of the landfill is estimated to be 2035 and following this year the BAU scenario assumes that there is no further waste deposited in the Sandy Hollow Landfill and waste from the community is transported a site outside of the City's boundary.

BUSINESS-AS-USUAL TRENDS

- In 2022, the total GHG emissions resulting from the landfill were 23,600 tonnes CO_2e. These emissions resulted from the deposition of solid waste at the landfill site historically as well as in the baseline year of the inventory.
- As diversion programs implemented by the City have resulted in a reduction in both the amount of waste deposited as well as the type of waste (i.e. higher DOC content) the GHG emissions from the site are expected to decrease from 2022 to 2035.
- The current estimated closure year for the Sandy Hollow landfill is 2035. Following this assumption for the closure of the landfill, GHG emissions resulting from solid waste may be outside of Barrie and therefore would be accounted for within another jurisdiction. The remaining GHG emissions at the site will be entirely from historical deposited and will steadily decrease overtime, as depicted in the graph.



Solid Waste - Key Strategies

OPTIMIZATION

ON-SITE RENEWABLE ENERGY

GHG emissions from landfill sites are unique for several reasons. Emissions from energy used to power on-site buildings and equipment are accounted for separately under Corporate Buildings and Fleet Vehicles. As a result, emissions in this section are solely attributed to the biogas produced by the decomposition of solid waste. Estimating these emissions is highly uncertain without advanced technology, as calculations depend on the landfill's characteristics and the volume and type of waste deposited over time. The concentration of DOC is estimated based on current and past waste audits, as well as assumptions about waste composition influenced by City programs and policies.

While estimates derived from established protocols, along with intermittent on-site monitoring and audits of solid waste streams, provide valuable insights into emissions, the ability to assess the impact of strategies to reduce these emissions lacks the level of detail seen in other operational areas. As a result, the strategies outlined in this section follow the same tiered approach, however the quantification of these strategies has been excluded from this report. This does not diminish the value of these strategies but highlights the need for future on-site monitoring to enhance the accuracy of estimates and fully capture the impact of emission reduction measures at the site.

OPTIMIZATION

The successful flaring of biogas at the site has significantly reduced overall GHG emissions. To maintain this success, it is essential to continue this effort to ensure the landfill’s biogas collection system operates at full capacity. Ongoing monitoring, maintenance, and system improvements are strongly recommended to ensure continuous improvement of the biogas collection system at the site.

Additionally, preventing recyclable or reusable solid waste from entering the landfill not only supports valuable circular economy initiatives but could also extend the landfill’s lifespan and further reduce GHG emissions at the source. Therefore, optimizing diversion programs and policies, as well as enhancing the landfill gas system, have been identified as key strategies for improving solid waste management

ON-SITE RENEWABLE ENERGY

The Sandy Hollow site offers significant potential for on-site, ground-mounted solar PV installation. To move forward with this, further investigation is needed to identify sections of the landfill that have been closed and are suitable for solar panels. Additionally, areas of the property not located above the landfill may also be viable for ground-mounted solar PV. A thorough analysis of site characteristics, regulatory requirements, closure plans, and net-metering regulations should be conducted before planning the installation. Nevertheless, the potential to generate electricity at the site is substantial, with an estimated system capacity of approximately 20,000 MWh annually, leading to potential energy savings of $2.8 million annual per year for the City.

Currently, biogas that is flared at the site is not being utilized. This biogas could be utilized within a co-generation system to provide on-site electricity and thermal energy. A co-generation system at the landfill has the potential to produce 3,800 MWh of electricity and reduce roughly 250 tonnes CO_2e from grid supplied electricity.

Operational Groups: Combined Net-Zero Pathway

This section outlines the NZ0 Pathway for the six Operational Groups within the plan. Providing a tiered, structured approach that could be followed across the organization while allowing for flexibility and customization for each operational group. The NZ0 Pathway for each group integrates four key strategies: Optimization, Fuel Switching, Equipment Upgrades, and On-Site Renewable Energy. The strategy follows an asset management approach, aligning with the City's established framework to ensure that asset replacements occur only when they reach the end of their useful life, thereby maximizing the lifespan of existing infrastructure. These strategies have been thoroughly evaluated for each Operational Group and are detailed in the preceding sections of the report. This section combines the NZ0 Pathway for each group, offering a comprehensive analysis of the overall impact on the City's GHG emissions, energy consumption, operational energy costs, and projected incremental capital costs.

Net-Zero Pathway

The NZ0 Pathway presented below illustrates the projected percent increase in energy consumption, energy costs, and GHG emissions relative to the baseline inventory of 2022.

ENERGY USE

In 2022, the Corporation utilized 100,300 MWh of energy to power facilities and vehicles. Under the NZ0 Pathway, energy demand is expected to increase to 130,000 MWh by 2050, an increase of 29%. This is a significant reduction compared with the BAU Pathway, which projects an increase of 98% by 2050.

2030	2040	2050
21%	27%	28%

ENERGY COST

In 2022, roughly $12 million was spent by the City on energy. Under the NZ0 Pathway, energy cost is projected to increase to $25 million annually by 2050, an increase of 117%. This is a substantial decrease compared with the BAU Pathway, which projects energy costs to increase 215% by 2050.

2030	2040	2050
41%	81%	117%

GHG EMISSIONS

In 2022, emissions from all sources totaled 38,500 tCO_2e. Under the NZ0 Pathway, emissions from all sources are projected to decrease by 53% from the baseline. By 2050, the NZ0 Pathway will result in 22,300 fewer tonnes of CO_2e compared to the BAU Pathway.

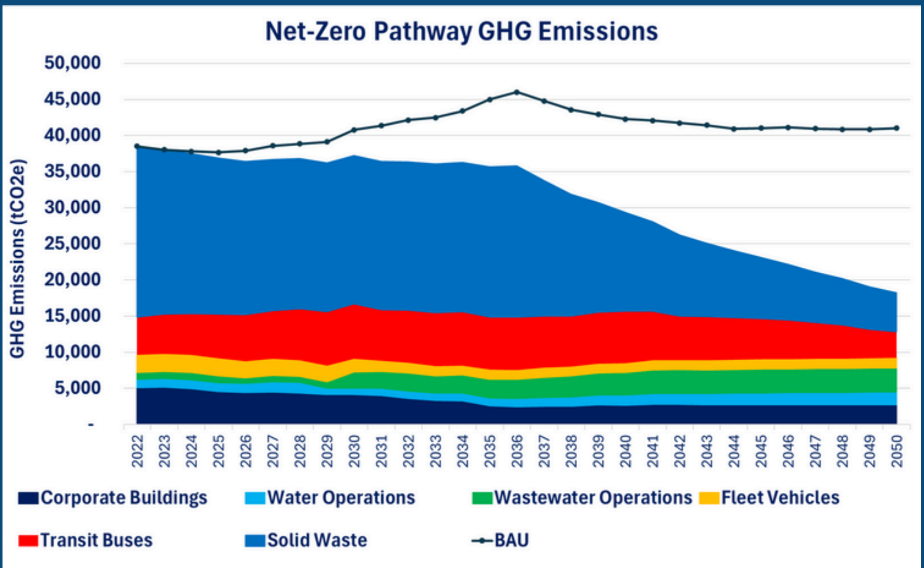
2030	2040	2050
-3%	-24%	-53%

NZO Pathway - GHG Emissions

In 2022, the City's total GHG emissions from all reported sources amounted to 38,500 tonnes CO_2e. Under the NZ0 Pathway, emissions from all sources are projected to decrease by 53 percent below the baseline by 2050. This reduction in GHG emissions under the NZ0 Pathway will result in 22,300 fewer tonnes of CO_2e compared to the BAU Pathway. The graph below illustrates the projected GHG emissions for each operational group within the NZ0 strategies, highlighting the overall emissions reduction trajectory in comparison to the BAU Pathway.

-53%

Decrease in GHG emissions by 2050



% Change tCO_2e	
Year	**2050**
Solid Waste	-77%
Transit Buses	-30%
Fleet Vehicles	-45%
Wastewater Operations	264%
Water Operations	51%
Corporate Buildings	-47%
Total	**-53%**

NET-ZERO GHG EMISSION TRENDS

- Under the BAU Pathway, GHG emissions from Transit Buses are a significant contributor to overall GHG emissions, increasing from 5,200 tonnes CO_2e in 2022 to 18,200 tonnes CO_2e by 2050. However, due to electrification, emissions from transit buses are expected to decrease substantially by 2050, saving approximately 14,500 tonnes CO_2e annually compared to the BAU Pathway.

- Due to the NZ0 Pathway measures at Corporate Buildings and the construction of new buildings to NZ0 standards, there is a 46% reduction in emissions compared with the baseline. A significant improvement compared with the BAU Pathway, which projected an increase of 45%.

- Under the BAU Pathway, GHG emissions from Fleet Vehicles are projected to increase by 41%. As a result of fleet electrification, emissions are projected to decrease by 45% by 2050 compared with the baseline.

- While GHG emissions from Water Operations are expected to rise under the NZ0 Pathway due to increased energy demand, the increase will be notably lower than the BAU Pathway. The BAU Pathway projects a 116% rise in emissions by 2050, while the NZ0 Pathway anticipates a more modest 61% increase.

- Although slightly lower than under the BAU Pathway, GHG emissions from Wastewater Operations are still projected to increase significantly, primarily due to the planned upgrades to processing infrastructure.

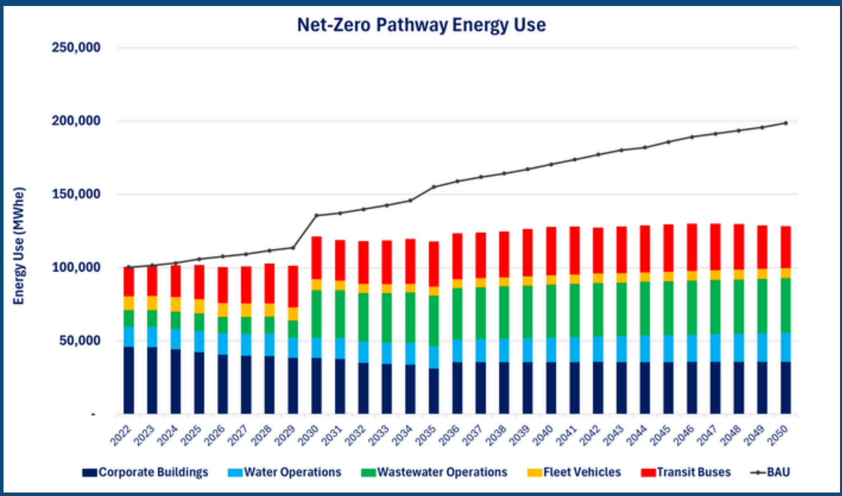
NZO Pathway - Energy Demand

In 2022, the Corporation consumed a total of 100,300 MWh of energy to power its various facilities and vehicles. Under the NZ0 Pathway, energy demand is projected to rise to 128,000 MWh by 2050, representing a 28% increase. This forecasted growth is notably lower than the BAU Pathway, which predicts a 98% increase in energy demand by 2050. The projected changes in energy demand reflect a shift in consumption patterns across different sectors, with increases anticipated for Transit Buses, Wastewater Operations, and Water Operations, while energy use for the City's Fleet Vehicles and Corporate Buildings is projected to decrease. These trends are illustrated in the graph and table below.

28%

Increase in energy use by 2050

Energy consumption from facilities at the landfill is included in the Corporate Buildings category, as there is currently no dedicated energy infrastructure for biogas generation at the site. As such, the Solid Waste group is not included within this section.



% Change Energy Use	
Year	**2050**
BAU	98%
Transit Buses	45%
Fleet Vehicles	-30%
Wastewater Operations	231%
Water Operations	46%
Corporate Buildings	-22%
Total	**28%**

NET-ZERO ENERGY TRENDS

- A key factor driving the reduction in overall energy consumption under the NZ0 Pathway is the electrification of the City's transit buses, which is expected to begin in 2030. Since EVs are more energy-efficient than ICE models, this transition will significantly reduce energy use in the transit sector. While energy demand for transit buses is still projected to increase by 45 percent above the baseline by 2050, this is a substantial reduction compared to the BAU Pathway, which anticipates a 248 percent increase in energy use for transit buses by 2050.

- Corporate Buildings under the BAU energy use is projected to increase by 19 percent, while under the NZ0 Pathway, energy use is projected to decrease by 22 percent. This is primarily due to energy efficiency and energy conservation measures included within the strategies for Corporate Buildings, additionally, as new buildings are constructure net-zero standards there will be significant energy saving compared with current practices.

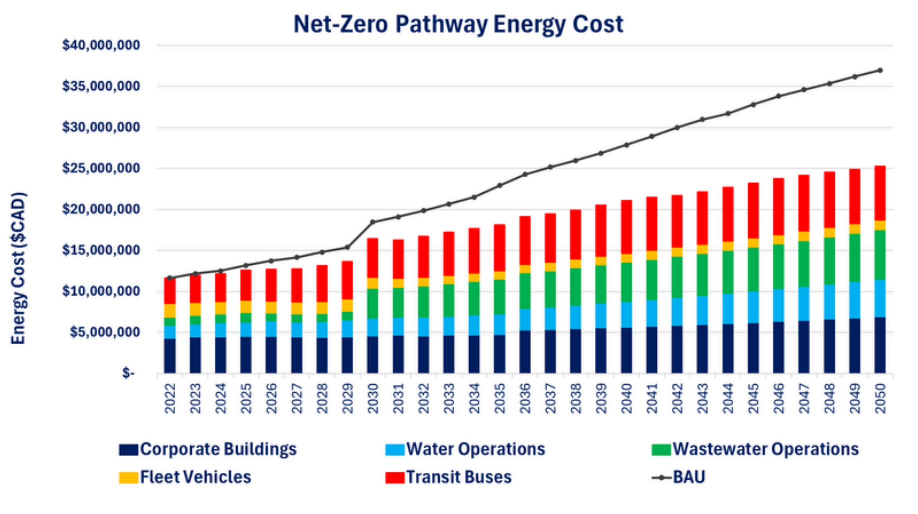
- Under the BAU Pathway the City's vehicle fleet is projected to increase energy use by 43 percent above the baseline by 2050, whereas under the NZ0 Pathway the projected change is energy use is expected to decrease by 30 percent. Similar to transit buses, this is due to the increased efficiency of EVs compared with ICE counterparts.

NZO Pathway - Operational Cost

117%

Increase in energy cost 2050

In 2022, the total cost to power the City's facilities and vehicles was $12 million. Under the BAU Pathway, this cost is projected to rise to $37 million by 2050, while the NZ0 Pathway projects a more moderate increase, rising to $25 million. Several factors influence these operational energy costs, including the total energy consumed, the type of energy used, and future commodity prices. While all these factors play a role, the most significant driver for the lower energy costs under the NZ0 Pathway is the substantial reduction in energy consumption outlined previously. The graph and table below illustrate the changes in energy costs for each Operational Group and the corresponding reductions compared to the BAU Pathway.



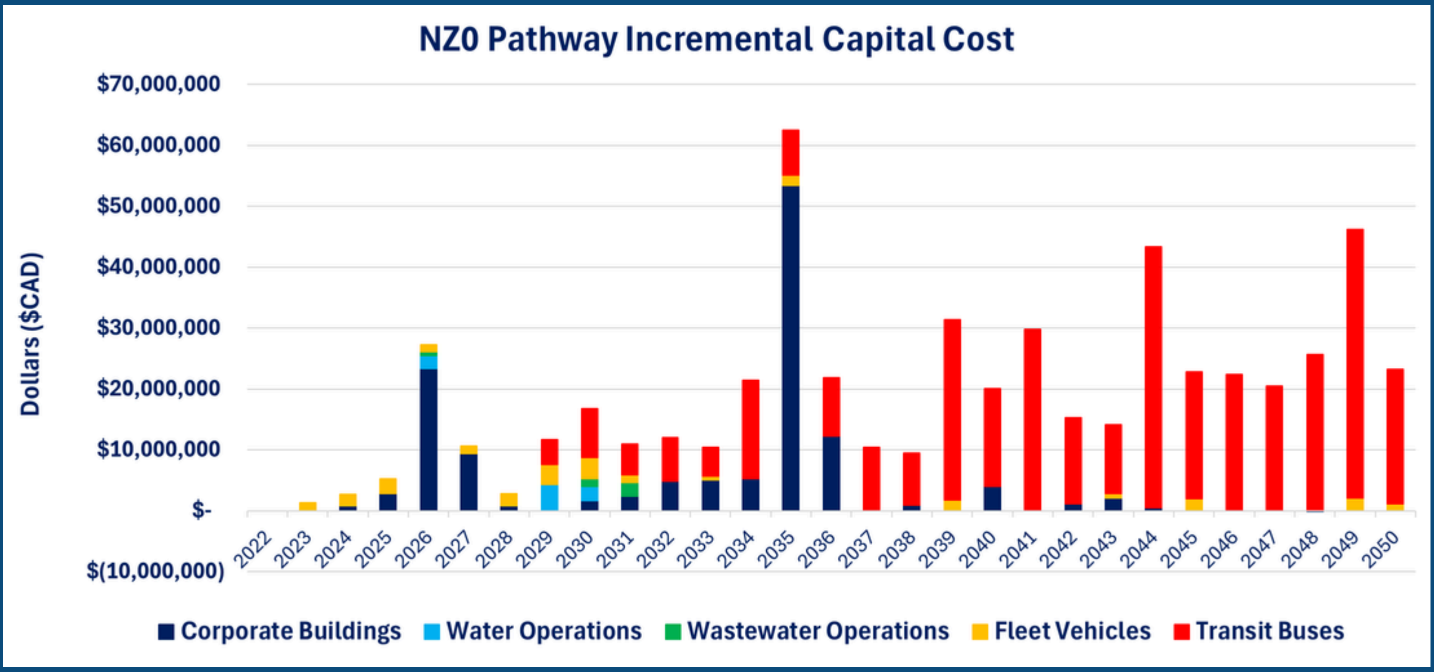
% Change Energy Cost	
Year	**2050**
BAU	217%
Transit Buses	111%
Fleet Vehicles	-28%
Wastewater Operations	493%
Water Operations	196%
Corporate Buildings	59%
Total	**117%**

NET-ZERO ENERGY COST TRENDS

- A major driving factor in lower energy costs under the NZ0 Pathway is the electrification of the City's transit buses. As transit buses represent a large portion of the City's energy use, the significant reduction of fuel consumption from the City's transit fleet under the NZ0 Pathway substantially influences the overall energy cost trajectory.
- Under the BAU Pathway, energy costs for corporate buildings are projected to increase by 123 percent, while under the NZ0 Pathway, the increase is projected to be 60 percent. This difference is mainly due to reduced energy use at the City's facilities, despite projected increases in utility and fuel prices driven by inflation.
- Under the BAU Pathway, the City's vehicle fleet is projected to increase energy costs by 37 percent above the baseline by 2050. In contrast, under the NZ0 Pathway, energy costs are expected to decrease by 28 percent. This is due to the higher efficiency of EVs compared to internal combustion engine vehicles, along with a reduction in overall energy use.
- For Wastewater, there is substantial increase in the cost of energy due to the increase in energy demand and the rising commodity cost of energy due to inflation.

NZ0 Pathway - Incremental Capital Cost

The Net-Zero Pathway will incur higher initial capital costs compared to the BAU Pathway. These additional expenditures are essential for transitioning the Corporation to net-zero over time. The capital cost estimates account for projected inflation and offer a glimpse of potential future expenses needed to implement the NZ0 Pathway. They are intended to provide insight into future costs, rather than serve as a detailed capital plan. The below graph illustrates the incremental capital costs projected annually for each of the Operational Groups.



NET-ZERO INCREMENTAL CAPITAL COSTS

- Incremental capital cost of transit buses & transit EVSE is shown above in red. The cumulative incremental capital costs for BEB's is projected to be $309 million and the total cost for transit EVSE is $72 million.
- The cumulative incremental capital cost for new facilities is $32 million, including within Corporate Buildings.
- Energy efficiency improvements and equipment upgrades at facilities are projected to require an initial investment of $30 million.
- Fuel switching measures are projected to require an initial investment of $43 million.
- The installation of on-site renewable energy is projected to require an initial investment of $4 million, with an additional $13 million anticipated for the replacement of existing solar PV infrastructure at the end of its lifecycle (currently contracted to Alectra Utilities).

Corporate-Wide Strategies

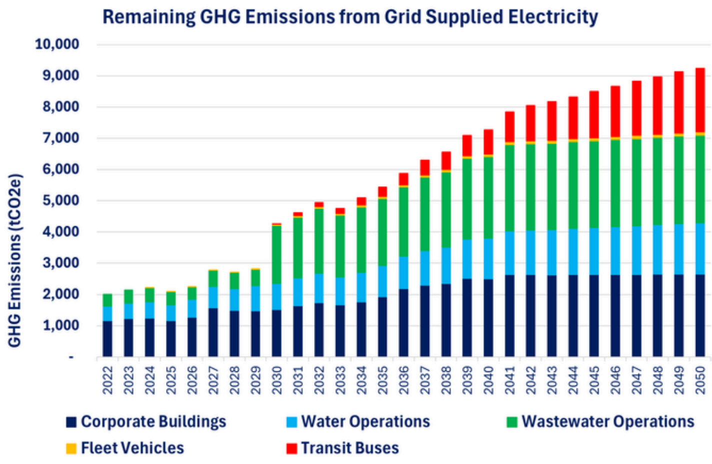
The strategies for each operational group prioritize key measures to move the Corporation toward net-zero. However, not all GHG emissions can be addressed by these measures alone. This section outlines how remaining emissions will be managed, including installing off-site renewable energy to offset electricity use to mitigate emissions from grid supplied electricity. This will involve ground-mounted solar PV at a City-owned brownfield site. Additionally, the City will promote nature-based solutions by enhancing carbon sequestration in its parks and natural areas. Any remaining emissions will be mitigated through carbon offsets, supported by a City policy to govern these purchases.

CORPORATE-WIDE STRATEGIES

Remaining GHG Emissions

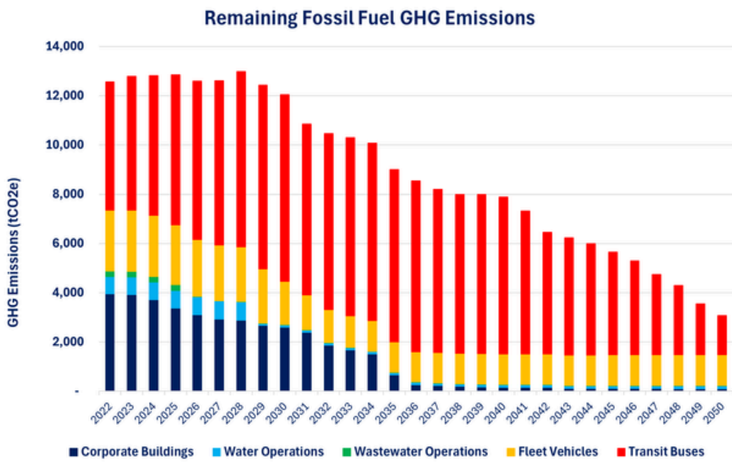
GRID-SUPPLIED ELECTRICITY

There is considerable GHG emission reduction associated with switching from high GHG intensity fuels to electricity. However, due to the projected growth in the GHG intensity of the electrical grid, the remaining emissions from grid-supplied electricity is 9,200 tonnes CO_2e by 2050. This largely driven by the increased demand for electricity from Wastewater and Water Operations.



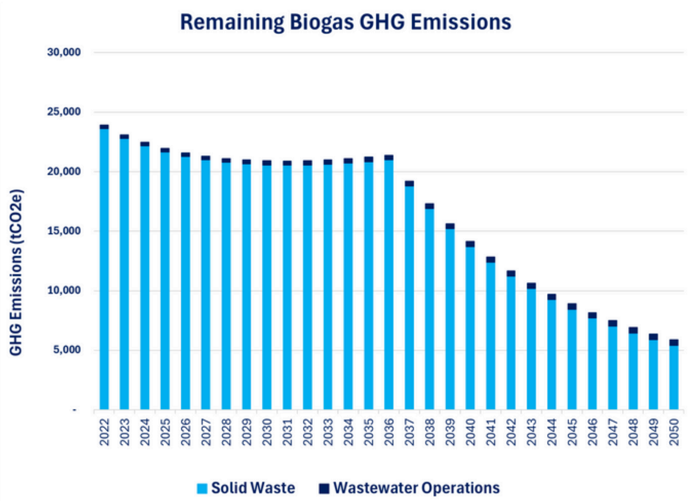
FOSSIL FUELS

The initial strategies focus on optimization, fuel switching, equipment upgrades, and on-site renewable energy, bringing the Corporation closer to net-zero emissions by 2050. However, some fossil fuel use will persist due to technological constraints. Remaining emissions will need to be mitigated through nature-based solutions and carbon offsets. The adjacent graph illustrates the remaining fossil fuel emissions by operational group with a total of 3,100 tonnes CO_2e remaining in 2050. These remaining emissions will need to be mitigated through nature-based solutions and carbon offsets.



BIOGAS

Biogas is produced at the landfill as a byproduct of solid waste decomposition and at the WwTF as a by-product of wastewater treatment. At the landfill, approximately 35 percent of emissions are mitigated through on-site biogas flaring. At the WwTF, a portion of the biogas is used to fuel the co-generation system at the WwTF, while the remaining biogas is flared. The remaining emissions at 2050 from both sites is projected to be 5,900 tonnes CO_2e.

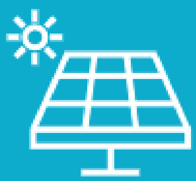


Off-Site Renewable Energy

The amount of remaining electricity projected for 2050 is 100,100 MWh annually. The City will explore generating renewable energy through the installation of a large, solar PV field on a city-owned property, where feasible, to offset the grid-supplied electricity remaining after the first of set of actions have been implemented. With the Ontario electricity grid expected to become more carbon-intensive due to increased reliance on natural gas, it is crucial to assess the feasibility of renewable energy sources. This will ensure that the City's electrification efforts lead to meaningful emission reductions, despite the anticipated rise in grid emissions.

100,100 MWH

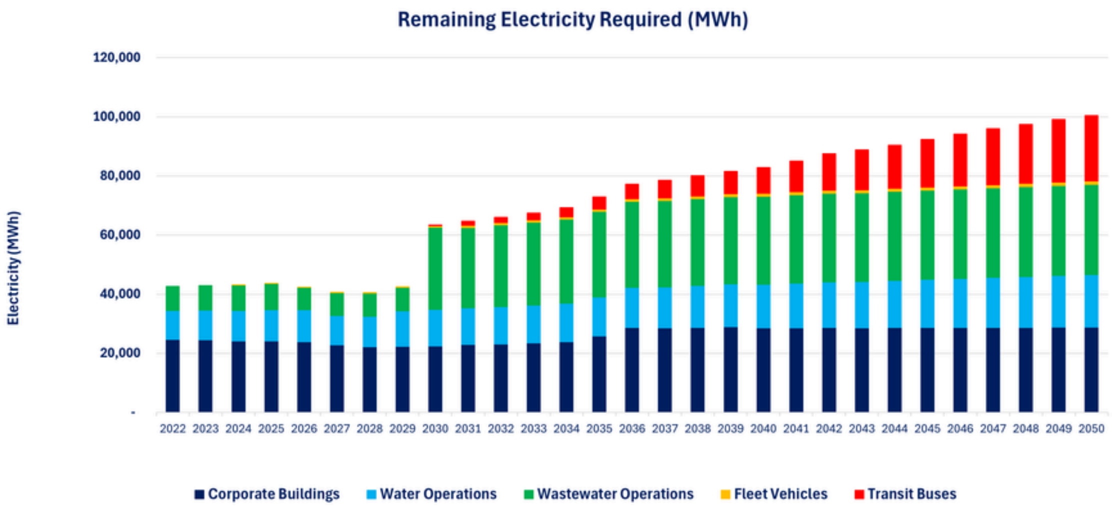
Electricity need by by 2050



Explore the opportunity for larger renewable energy and energy storage infrastructure projects through a pre-feasibility study and business case.

ELECTRICITY DEMAND

In 2022, the City's electricity consumption from grid-supplied energy was 42,700 MWh. As part of the City's operational strategy, transitioning from high-GHG intensity fossil fuels to electric alternatives is a key focus. However, under the NZ0 Pathway, electricity demand is projected to rise to 100,100 MWh, a 134 percent increase. To offset the emissions from this increased demand, the corporate strategy includes the development of a solar PV field, which will need to generate approximately 100,100 MWh to achieve net-zero emissions for electricity. This is projected to decrease the remaining GHG emissions from electricity consumption by 9,200 tonnes CO_2e by 2050.



Nature-Based Solutions

The City features a broad array of parks, outdoor recreation facilities, and natural landscapes that offer significant advantages to the community. These spaces not only offer ample opportunities for leisure and social interaction but also play a crucial role in environmental protection. They contribute to mitigating the urban heat island effect, improving water quality, and supporting diverse ecosystems. Reaching net-zero emissions by 2050 will require reducing emissions to the greatest extent possible and advancing additional solutions to remove carbon emissions from the atmosphere. Enhancing natural assets and planting trees on City-owned properties can significantly increase carbon sequestration through photosynthesis.

The Net-Zero Strategy highlights the critical importance of protecting, expanding, and enhancing natural assets that serve as carbon sinks. This includes optimizing the carbon sequestration potential of City-owned parks, trails, and natural areas. By incorporating nature-based solutions into the NZ0 approach, the City aims to strengthen efforts to reduce carbon emissions and promote sustainable environmental practices. The key objectives for this strategy are to preserve and amplify the carbon sequestration capacity of these essential green spaces, ensuring that they not only support our climate goals but also provide valuable recreational and ecological benefits to the community.

As a first step, the City must actively seek to understand, quantify, and normalize the measurement of its carbon sequestration capabilities to guide future planning.

The City must begin by understanding, quantifying, and standardizing the measurement of its carbon sequestration capabilities to inform future planning. A key step in this process is conducting a comprehensive study of a City-owned park or naturalized area to assess the carbon sequestration potential of parkland. This study should include a carbon sequestration analysis before park redesigns, such as those planned for Heritage Park. The results will guide efforts to enhance sequestration at other City-owned parks and establish design standards that align with climate mitigation and adaptation goals. By integrating these requirements into park planning, the City can ensure its green spaces play a more active role in achieving climate objectives while providing greater environmental and community benefits.

Carbon Offsets

Purchasing emission offset credits from other governments or entities is a key strategy for the City to manage its remaining emissions after implementing reductions through internal measures. This approach involves investing in activities that create carbon sinks in other locations, such as reforestation projects or methane capture from landfills, to offset the City's unavoidable emissions. The underlying principle behind this strategy is grounded in scientific consensus, which stresses that to effectively address climate change, every remaining tonne of GHG emissions must be balanced by the removal of an equivalent amount of carbon dioxide from the atmosphere. This ensures that for each tonne of GHG emitted, an equal amount is removed and securely stored, either in natural processes like forestry or through technological means such as carbon capture.

A carbon credit, which is purchased from carbon offset programs, allows one organization to emit a certain amount of CO_2e, provided that an equivalent amount is removed from the atmosphere elsewhere. These carbon credits are generated by projects that capture or store carbon, such as forest conservation or soil carbon sequestration. Globally, carbon markets exist to facilitate the exchange of these credits, and the standards for defining what constitutes a valid credit can vary between regions and market structures. Some of these markets are regulatory, with set rules and compliance requirements, while others are voluntary, allowing entities to invest in carbon offset programs on a voluntary basis.

To guide the City's efforts effective, the City will develop a carbon offsets policy that defines the types of offsets permissible, ensuring transparency, accountability, and measurable impact.

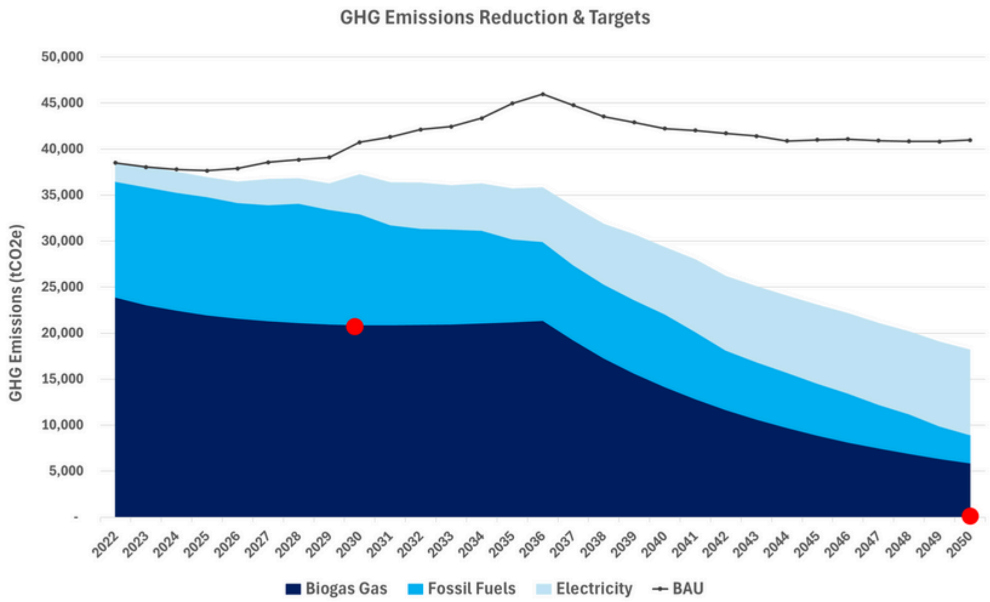
Two emerging carbon markets are particularly relevant to the City's efforts to offset emissions. The first is Canada's Clean Fuel Regulation (CFR), a federal initiative designed to reduce GHG emissions in the transportation sector. This program promotes the use of cleaner fuels and low-carbon technologies while generating carbon credits as part of its emissions reduction efforts. The second is the Independent Electricity System Operator (IESO) Clean Energy Credit (CEC) registry, which supports Ontario's transition to cleaner electricity by generating credits through renewable energy projects. Both of these markets could offer the City potential opportunities to offset emissions by purchasing credits from programs that reduce GHG levels.

In addition to these carbon markets, the City could explore the feasibility of entering into a carbon offset agreement with organizations like the Lake Simcoe Conservation Authority or other similar entities, which focus on nature-based solutions. This would allow the City to work directly with third parties to support initiatives that sequester carbon emissions from the atmosphere.

To ensure that carbon offsetting goals are met, the City should evaluate all available options and assess their suitability. As part of this process, the City should develop a comprehensive carbon offsets policy. This policy would establish a standardized approach, evaluate available offset opportunities, and define transparent, accountable criteria for selecting carbon offset projects.

Corporate GHG Targets

The NZ0 Strategy, developed through a bottom-up approach, outlines the annual GHG emissions limits for each Operational Group to align with the goals of the plan. At the global and national levels, a carbon budget has been established to limit emissions and keep average global temperature rise to below 1.5°C, and the City's plan strives to meet these same objectives. However, due to operational and financial constraints, the 2025 plan will not fully meet these targets. The current plan outlines what is achievable given present limitations, while continuously striving for improvement. Future iterations of the plan will build upon this foundation, with the aim of accelerating GHG reductions to meet scientific GHG emission reduction targets. The graph below shows the remaining GHG emission by energy type for the Corporation.



The reduction targets in the table below illustrate potential emissions reductions if the City fully implements the strategies outlined for the Operational Groups. A second set of targets shows the reductions achievable with 100% clean energy for all electricity demand. The red points on the graph represent targets set by the scientific community, serving as aspirational goals for the City.

NZ0 PATHWAY (OPERATIONAL GROUPS)

Percent reduction of GHG emisions below the baseline year 2022 from implementation of Operational Group strategies.

2030	2040	2050
-3%	-24%	-53%

NZ0 PATHWAY WITH 100% RENEWABLE ELECTRICITY

Percent reduction of GHG emisions below the baseline year 2022 from implmentation of Operational Group strategies and off-site renewable energy.

2030	2040	2050
-14%	-43%	-77%

NZ0 Implementation - Key Actions

The successful implementation of the NZ0 Strategy across City departments will require a range of activities and strategies. This section outlines the key strategies needed to achieve the plan's objectives, including proposed changes to the City's capital planning and renewal processes with an emphasis on prioritizing low-carbon alternatives. Additionally, net-zero objectives will be incorporated into existing planning documents during updates to ensure alignment with the plan's long-term goals. The section also highlights essential enabling factors that will support the successful achievement of these goals.

1 Capital Planning & Renewal

- Net-zero objectives will be integrated into the City's capital planning and renewal framework, with a focus on an inclusion and evaluation of low-carbon alternatives. Low-carbon options that demonstrate a life cycle payback will be incorporated as standard business-as-usual solutions. Conversely, where substantial initial capital investment is required without a projected return on investment, such items will be explicitly highlighted for Council's consideration.

2 Plan Governance & Integration

- The NZ0 Strategy will be executed through a collaborative effort between the EMB and the Operational Groups, ensuring alignment with the City's net-zero goals. Each group will be guided by an annual carbon budget, informed by the NZ0 Pathway, to help track progress. Successful implementation will be supported by integrating net-zero strategies into existing policies, ensuring consistent and effective execution across all departments.

3 Data Monitoring & Plan Reporting

- Data monitoring and plan reporting will support the asset-based approach by emphasizing evidence-driven decision-making, using accurate data to guide planning and actions. Regular progress updates will maintain momentum, recognize successes, and identify areas for improvement, ensuring continuous progress toward long-term goals.

Capital Planning & Renewal

The NZ0 Strategy was developed using a bottom-up approach, analyzing data at the asset level for each operational group. Assets with energy consumption were assessed, and low-carbon alternatives were identified for upgrades and fuel transitions. These options were mapped to the asset management schedule to assess their GHG reduction potential. This approach also projected operational cost savings and incremental capital costs, showing that many low-carbon options offer significant savings over the asset's lifetime.

A low-carbon asset management approach will be integrated into the City's capital planning and renewal processes, ensuring that low-carbon options are selected whenever they offer life-cycle cost savings compared to traditional alternatives.

Through assessing this pathway, staff identified that low-carbon options often present potential cost savings over the lifetime of an asset. As an initial step, the City should evaluate the low-carbon alternatives within its capital and renewal processes. Furthermore, when life-cycle cost savings are evident, the City should prioritize selecting the low-carbon option. Even when low-carbon alternatives do not offer immediate cost savings, they should still be considered for their broader benefits, including supporting the City's net-zero goals and contributing to the well-being of the community.

The following points provide further details on specific assets, potential low-carbon options to be assessed, and suggested policy approaches for each group of assets.

- **Asset Renewal Projects:** For all corporate assets that consume energy, low-carbon solutions will be considered when an asset reaches the end of its life or needs replacement. If the life-cycle costs of low-carbon alternatives are lower than existing options, they will be prioritized and selected where technically feasible. Additionally, the City should assess infrastructure for net-zero readiness, such as upgrading transformers to accommodate future electrical needs and support low-carbon options, to future proof assets and enable cost savings.

- **New Assets: Buildings** – All new buildings and infrastructure will be designed to meet a net-zero energy standard where feasible, striving to generate as much renewable energy as they consume, using electricity from low-carbon sources. When on-site energy generation cannot fully meet a building's energy needs, renewable energy will still be utilized to cover as much of the energy demand as possible.

- **New Assets: Vehicles** – The City will strive to replace all ICE vehicles with functional EV equivalents whenever feasible. This transition will be guided by logistical considerations such as the availability of suitable EV models, operational requirements, the infrastructure needed to support electric vehicles, and maintaining and improving services levels to the community.

- **Emergency Replacement**: In situations where equipment failure necessitates immediate replacement under the City's emergency purchase provisions, staff will prioritize selecting low-carbon options, whenever feasible.

Plan Governance & Integration

The NZ0 Strategy will guide the Corporation toward achieving net-zero emissions over time. The EMB will collaborate with the existing NZ0 Strategy Operational Groups to ensure effective implementation of the plan. This joint effort will define how each group contributes to advancing the strategy, aligning with the City's overall net-zero goals. Successful implementation will also depend on integrating net-zero priorities into the City's existing policy framework, including Wastewater and Water Master Plans, Asset Management Plans, Waste Management Strategies, Fleet and Transit Plans, and Strategic Plans.

The EMB will collaborate with the existing NZ0 Strategy Operational Groups to ensure effective implementation of the plan. This joint effort will define how each group contributes to advancing the strategy, aligning with the City's overall net-zero goals.

At the global and national levels, a carbon budget has been set to limit emissions and keep average global temperature rise to below 1.5°C, and the City's plan strives to meet these same objectives. The City aims to achieve net-zero emissions by 2050, in alignment with global climate goals. Undertaking a robust bottom-up approach the 2025 plan will not fully align with these objectives, due to existing technological limitations, as well as current operational and financial constraints.

By developing the NZ0 Strategy through a data-driven, evidence-based methodology, the City is able to fully understand and assess current constraints while taking practical and achievable steps toward its net-zero aspirations now. The NZ0 Strategy establishes a solid foundation for integrating net-zero practices across the organization, while fostering the development of the knowledge, structures, and capacities necessary to accelerate the transition in the future.

- **Carbon Budgeting:** Establish a system with each operational group to create a budget tied to their emissions or related metrics, fostering accountability and ownership of targets. As groups report their progress, this approach will increase the value of reporting, drive greater commitment to the targets, and enhance overall responsibility towards achieving the City's net-zero objectives.
- **Net-Zero Planning Integration:** Integrate net-zero pathway actions into all relevant corporate strategies and master plans to ensure alignment with the City's long-term sustainability and climate goals. This includes embedding specific actions for reducing emissions, promoting low-carbon technologies, and enhancing energy efficiency across all sectors.
- **Carbon Credits:** Develop a comprehensive carbon credit management framework or policy that outlines the methodology for acquiring, tracking, and utilizing carbon credits. This framework will ensure transparency, accountability, and alignment with the organization's net-zero goals. It will establish clear criteria for selecting carbon offset projects, provide guidelines for verifying and reporting carbon credit usage, and create a process to ensure that credits effectively contribute to emission reductions.

Data Monitoring & Plan Reporting

The NZ0 Strategy was developed through comprehensive data analysis and evidence-based insights, ensuring a solid foundation for moving the City forward on a net-zero pathway. The EMB and the Operational Groups have a strong history of continuous improvement in tracking assets related to energy use and biogas production. While gaps remain, these have been identified and are recognized as operational priorities for future iterations of GHG emissions inventorying and NZ0 Pathway enhancements. This approach provides valuable insights driven by data and evidenced based practices and enables future improvements to the accuracy and breadth of reporting.

The asset-based approach prioritizes evidence-driven decision-making, relying on accurate data to guide actions. Regular progress reporting maintains momentum, highlights successes, and identifies areas for improvement, ensuring continuous progress toward long-term goals.

→ **Annual Reporting:** EMB will provide an annual report to Council on corporate GHG emissions and progress toward achieving the NZ0 pathway. This report will include detailed data on emissions across relevant sectors, updates on the implementation of the NZ0 Strategy, and any adjustments made to improve performance in reducing the City's carbon footprint.

→ **NZ0 Plan Updates**: The NZ0 Strategy will be updated every five years and will align with required CDM reporting updates. This report will include detailed data on emissions across relevant sectors, updates on the implementation of the NZ0 Strategy, and any adjustments made to improve performance in reducing GHG emissions.

→ **Fleet Monitoring:** Implement an asset-based energy and GHG monitoring system for fleet and transit vehicles. This system will track energy costs associated with fuel and electricity usage, assigning these costs to each department to be incorporated into their annual budgets.

→ **Biogas Monitoring:** Improve the monitoring of biogas at the landfill, as well as fugitive and process-related wastewater emissions, including:

- Investigate the feasibility of utilizing remote sensing technology to detect and measure fugitive biogas emissions from landfill sites and wastewater treatment plants, ensuring accurate data collection and timely identification of emission sources.
- Installing continuous monitoring systems to measure biogas generation, flaring, and capture at landfill sites to better track methane emissions and optimize mitigation efforts.
- Investigate feasibility of installing on-site measuring equipment for tracking emissions from the wastewater treatment process, including methane and nitrous oxide, and conducting regular audits to assess emission levels.

→ **Scope 3 Emissions:** Develop a comprehensive system for tracking and managing Scope 3 emissions, which encompass indirect emissions from activities such as the supply chain, contractor travel, and embodied carbon emissions.

Appendix

Intensity Targets - Corporate Buildings

TOTAL ENERGY USE INTENSITY (TEUI)

BAU Pathway: In 2022, the TEUI for all the City's buildings was 28.56 kwh/sq. Under the BAU Pathway this is project to increase by 3% by 2050.

NZO Pathway: Under the NZO Pathway, the TEUI is projected to decrease by 37% by 2050.

	2030	2040	2050
BAU	28.67	29.05	29.39
NZO	23.39	18.05	18.00

NATURAL GAS INTENSITY (NGI)

BAU Pathway: In 2022, the natural gas use intensity (NGI) for all the City's buildings was 14.80 ekWh/sq and is projected to increase under the BAU Pathway by 0.5%.

NZO Pathway: Under the NZO Pathway, the NGI is projected to decrease by 98% by 2050.

	2030	2040	2050
BAU	14.65	14.53	14.87
NZO	9.76	0.50	0.29

GREENHOUSE GAS INTENSITY (GHGI)

BAU Pathway: In 2022, the GHG intensity (GHGI) for all the City's buildings was 3.5 kg/sq and is projected to increase under the BAU Pathway by 23% by 2050.

NZO Pathway: Under the NZO Pathway, the GHGI is projected to decrease by 54% by 2050.

	2030	2040	2050
BAU	3.9	4.2	4.4
NZO	2.9	1.6	1.6

Intensity Targets - Water Operations

TOTAL ENERGY USE INTENSITY (TEUI)

BAU Pathway: In 2022, the TEUI for Water Operations was 1.00 MWh/ML. Under the BAU Pathway this is project to decrease by 20% by 2050.

NZ0 Pathway: Under the NZ0 Pathway, the TEUI is projected to decrease by 30% by 2050.

	2030	2040	2050
BAU	0.91	0.84	0.80
NZ0	0.79	0.73	0.70

NATURAL GAS INTENSITY (NGI)

BAU Pathway: In 2022, the natural gas use intensity (NGI) for Water Operations was 0.28 eMWh/ML and is projected to decrease under the BAU Pathway by 33% by 2050.

NZ0 Pathway: Under the NZ0 Pathway, the NGI is projected to decrease by 92% by 2050.

	2030	2040	2050
BAU	0.24	0.21	0.19
NZ0	0.03	0.02	0.02

GREENHOUSE GAS INTENSITY (GHGI)

BAU Pathway: In 2022, the GHGI was 0.08 tCO_2e/ML and is projected to increase under the BAU Pathway by 4% by 2050.

NZ0 Pathway: Under the NZ0 Pathway, the GHGI is projected to decrease by 27% by 2050.

	2030	2040	2050
BAU	0.09	0.09	0.09
NZ0	0.05	0.06	0.06

Intensity Targets - Wastewater Operations

TOTAL ENERGY USE INTENSITY (TEUI)

BAU Pathway: In 2022, the TEUI for Wastewater Operations was 0.50 ekWh/ML. Under the BAU Pathway this is project to increase by 112% by 2050.

NZ0 Pathway: Under the NZ0 Pathway, the TEUI is projected to increase by 102% by 2050.

	2030	2040	2050
BAU	1.23	1.11	1.06
NZ0	1.18	1.06	1.01

NATURAL GAS INTENSITY (NGI)

BAU Pathway: In 2022, the natural gas use intensity (NGI) for Wastewater Operations was 0.05 ekWh/ML and is projected to decrease under the BAU Pathway by 13% by 2050.

NZ0 Pathway: Under the NZ0 Pathway, the natural gas use for building operations is projected to be discontinued.

	2030	2040	2050
BAU	0.05	0.05	0.05
NZ0	0.00	0.00	0.00

GREENHOUSE GAS INTENSITY (GHGI)

BAU Pathway: In 2022, the GHGI was 0.04 $kgCO_2e/ML$ and is projected to increase under the BAU Pathway by 172% by 2050.

NZ0 Pathway: Under the NZ0 Pathway, the GHGI is projected to increase by 120% by 2050.

	2030	2040	2050
BAU	0.10	0.11	0.11
NZ0	0.08	0.09	0.09

Conservation and Energy Demand Management (CDM) Update

Ontario Regulation 25/23 (formerly On. Reg 507/18) mandates public sector entities in Ontario to report annually on energy consumption and GHG emissions from buildings, as well as update their Conservation and Energy Demand Management Plans (CDM) every five years. The City of Barrie's original CDM plan, completed in 2012, laid the foundation for the establishment of the City's Energy Management Branch. During the first implementation period (2014–2018), the branch achieved a notable reduction in energy consumption across City facilities, resulting in operational cost savings of $6.6 million.

Building on this success, the CDM update in 2019 with an implementation period from 2020 to 2024, set more ambitious energy efficiency targets for the City's corporate building portfolio, including energy intensity targets for water and wasteWater Operations. An update on energy use targets for corporate facilities is provided in the first section of the Appendix and the table below outlines the progress achieved on the energy management actions outlined in the 2019 plan.

The NZ0 Strategy builds on the CDM planning, summarizing the City's energy management approach and outlining priorities for the next five years and beyond. As the NZ0 Strategy meets the requirements of the 2024 CDM update and provides a long-term roadmap to 2050, it should be regarded as the primary document for future CDM Plan updates.

Conservation and Energy Demand Management Plan 2020 – 2024

#	Identified Actions	Action Implementation Update
1	Develop a formal Energy Policy and Strategy	*Discontinued*
2	Collaboratively work with all relevant departments to establish a policy and process to quantify and embed the net operating cost of utilities within the capital planning process.	*Complete*
3	Conduct annual review of client operational plans and collaboratively identify energy opportunities and / or future planning or study initiatives. This exercise will include the following operational branches – Wastewater / Water / Recreational Facilities / Corporate Facilities / Parks / Traffic & Parking / Transit.	*Ongoing*

Conservation and Energy Demand Management Plan 2020 – 2024

#	Identified Actions	Action Implementation Update
4	Conduct scan of internal municipal policy development and planning efforts to identify opportunities to enhance Energy Management participation and involvement throughout the corporation. These efforts include: • Compiling and reviewing all significant policy and strategic plans for all City departments. • Identifying and ranking policies / plans that impact energy conservation. • Delineating renewal timelines of the prioritized items and including review efforts in staff workplans. • Reaching out and establishing relationships with key staff that are leading prioritized items.	*Ongoing*
5	Develop a three-year capital project plan that identifies larger scale energy conservation initiatives. Utilizing the best practices outlined in Element 4 – Projects, provide a framework for the identification and selection of these projects.	*Ongoing*
6	Establishment of a corporate-wide Green Team that is focused on continuous engagement and conservation awareness of staff.	*Discontinued*
7	Establishment of a Recreation Optimization Team to focus conservation opportunities specific to Recreational Facilities.	*Complete*
8	Revise job descriptions to include energy management responsibilities with an objective is to normalise energy management within day-to-day functions. Target facility management, supervisors, coordinators, and technician positions.	*Ongoing*
9	Energy Management staff will complete a benchmarking analysis bi-annually to support project selection and implementation efforts.	*Ongoing*
10	Energy Management staff will conduct facility base load studies of the top ten energy consuming facilities. Study results will be utilized to identify and prioritize potential conservation projects for implementation.	*Ongoing*
11	Establish an internal commissioning and recommissioning team by providing essential tools, resourcing, and training. Lead the development of an internal recommissioning standard and adopt a schedule of facility system audits to perform.	*Complete*
12	Utilizing the findings of the benchmarking, base load analysis, recommissioning studies, and renewables assessment, develop a three-year capital project plan that identifies larger-scale energy conservation initiatives.	*Ongoing*

Conservation and Energy Demand Management Plan 2020 – 2024

#	Identified Actions	Action Implementation Update
13	Include ‘solar ready’ design considerations when constructing all new facilities and infrastructure. This includes all new facilities and major retrofits, and other infrastructure projects such as water and wastewater pumping stations.	*Ongoing*
14	Complete a portfolio analysis of potential roof and ground-mounted solar PV deployments for all City-owned infrastructure. Identify ideal locations and complete preliminary feasibility analyses for implementation opportunities.	*Complete*
15	Annually review findings of the Environmental Centre landfill gas study to determine if any of the identified opportunities become feasible due to potential changes in regulation, utility prices or site operations.	*Ongoing*
16	Communicate the benefit of large-scale energy efficiency investment, particularly for new building design and construction, to senior management, capital planning staff and Council.	*Ongoing*
17	As part of the capital planning process, work with FPD and Engineering staff to identify funding streams to support feasibility studies, design work and energy efficient initiatives. At a minimum, successfully apply and receive funding to support a progressive, innovative and energy efficient capital project.	*Ongoing*
18	Investigate the potential value and benefit of developing an energy efficiency reserve to support capital and operational expenditures of the EMB.	*Complete*
19	Develop an encompassing plan for the deployment of submetering within City operations.	*Complete*
20	Update current KPIs with targets set forth in this CDM plan. Establish secondary KPIs to be tracked internally for Energy Management purposes	*Complete*
21	Target improved building efficiency by establishing new minimum construction building efficiency standards	*Ongoing*
22	Establish a measurement and verification protocol for projects led by the EMB	*Complete*
23	Improve communications throughout the corporation, by establishing regular reporting meetings with the following entities: - Executive Management Team (EMT) - Senior Leadership Team (SLT) - Department Management Teams (DMT)	*Ongoing*

Conservation and Energy Demand Management Plan 2020 – 2024

#	Identified Actions	Action Implementation Update
24	Standardize reporting to client groups by developing a newsletter-type format that is circulated on a regular basis (i.e. quarterly or monthly)	*Discontinued*
25	Establish a new engagement campaign to target occupant behaviour	*Ongoing*
26	Establish a Facilities Award program to celebrate the success of outstanding facility conservation performance	*Complete*
27	Coordinate with Human Resources to conduct a training needs assessment that targets key personnel that have significant impact on energy consumption.	*Discontinued*
28	Enhance Energy Management capacities. - Obtain Certified Building Commissioning Professional (CBCP) designation within EMB - Develop an internal 'Energy Management 101' training program to be delivered to staff	*Ongoing*
29	Provide specialized awareness training targeting building operators, coordinators, and supervisors, to augment 'Energy Management 101' training. Provide this training on a semi-regular basis to key departments including Corporate Facilities, Recreational Facilities, Water and Wastewater Operations.	*Discontinued*
30	Establish a building automation system training program that provides vendor-specific training package for operational staff that utilize that software and controls system.	*Ongoing*

Methodology Notes

GHG EMISSIONS INVENTORY - DATA SOURCES & PROTOCOLS

The Corporate Greenhouse Gas (GHG) Inventory builds upon the City's established experience in energy and GHG tracking. In 2015, the City implemented EnergyCap, an energy management software that forms the foundation for all energy analysis, reporting, and conservation efforts. Data is sourced from utility bills and offers a high level of certainty regarding energy consumption across the corporation. The software automates data from various utilities, including Enbridge Gas, Alectric Utilities, and propane suppliers, ensuring accurate tracking of natural gas, electricity, and propane consumption for each facility.

The GHG emissions inventory is based on utility bill data, with emission factors sourced from Environment and Climate Change Canada's National Inventory Report. For natural gas, the 2021 emission factor was used, as well as the 2021 emission factor for electricity and propane. Fugitive emissions, such as methane released during the distribution of natural gas, were calculated using IPCC's default emission factors and aggregated with natural gas consumption data.

Vehicle fleet emissions are tracked by the City through manual reporting by vehicle operators, with data categorized by vehicle type, fuel type, and model year. Transit buses, primarily using diesel, have their fuel consumption monitored by City Transit Services. Emission factors were applied based on vehicle characteristics and fuel type, with default emission factors used where vehicle data was not available.

Alternative fuels, such as ethanol and biodiesel, are accounted for based on Ontario's Cleaner Transportation Fuel Regulation. Future improvements in data accuracy are expected as the City installs fleet tracking software in vehicles, which will provide more detailed information for the energy and GHG inventory in future years. This initiative will allow for enhanced monitoring and more precise emissions reporting, helping to ensure better alignment with the City's sustainability goals.

The 2022 GHG emission inventory for the City's solid waste was developed using IPCC guidelines and GPC/PCP protocols. These emissions result from the decomposition of organic carbon in landfill materials, which releases methane. The amount of methane depends on factors like the waste's organic content, landfill management, and environmental conditions. The City's solid waste inventory was developed utilizing the Waste-in-Place Model (WPM), which accounts for both historical and future waste decomposition. Landfill gas flaring was accounted within the historical emission profile beginning in 2011 when the system was installed.

GHG emissions coefficients and global warming potentials have been outlined in the following section of the Appendix.

Key Assumptions to Inform Future Projections	
Corporate Buildings	• New buildings are built to current standards (where designs are not already higher), current energy consumptions trends for existing buildings remain constant
Water Operations	• Population growth and future MLD aligns with that specified in the Water Master Plan
Wastewater Operations	• Population growth and future MLD aligns with that specified in the Wastewater Master Plans, electricity increase is estimated through IPD project
Transit & Fleet	• Population and ridership projection
Solid Waste	• Assumption for closure date of landfill and export of solid waste outside of community boundaries
Commodity & Capital Cost	• An average 2 percent annual inflation rate was applied to energy and capital costs; the federal carbon tax was applied to energy sources where appropriate.

Inventory Coefficients

Greenhouse Gas Emission Factors

The City of Barrie Corporate GHG Inventory sourced emissions factors from Environment and Climate Change Canada's National Inventory Report: 1990-2023. The scope of the inventory included activities resulting in emission of carbon dioxide (CO_2e), methane (CH), and nitrous oxide (N_2O). For natural gas, the marketable emission factor gas consumed in Ontario was utilized in this inventory.

GHG Emission Factor for Common Fuels		
	Unit	tCO_2e/unit
Natural Gas (Institutional)	tonnes/m3	0.00193235
Propane (Institutional)	tonnes/L	0.00154774
Gasoline Boats	tonnes/L	0.00233124

For electricity, the emission factor is an average GHG intensity and is not reported by time of use. The electricity consumption intensity factor was utilized, which includes electricity losses during transmissions and distribution.

Projected GHG Emission Factors for the Ontario Electricity Grid (g/CO_2e)	
2022	47.0
2023	50
2024	51.3
2025	48
2026	53.1
2027	68.6
2028	67.1
2029	66.3
2030	67.2
2031	71.5
2032	75
2033	70.5
2034	73.5
2035	74.7
2036	76.2
2037	80.3

Inventory Coefficients

Projected GHG Emission Factors for the Ontario Electricity Grid (g/CO_2e)	
2038	81.9
2039	87
2040	87.7
2041	92.2
2042	92
2043	92
2044	92
2045	92
2046	92
2047	92
2048	92
2049	92
2050	92

Global Warming Potentials

The City of Barrie Corporate GHG Inventory sourced emissions factors from Environment and Climate Change Canada's National Inventory Report: 1990-2023. The scope of the inventory included activities resulting in emission of carbon dioxide (CO_2e), methane (CH_4, and nitrous oxide (N_2O). For natural gas, the marketable emission factor gas consumed in Ontario was utilized in this inventory.

GHG Emission Factor for Common Fuels	
	Fourth Assessment Report, 100-Year Report Time Period
Carbon Dioxide (CO_2e)	1
Methane (CH_4)	25
Nitrous Oxide (N_2O)	298

Energy Conversion Factors

To compare different sources of energy utilized across the City of Barrie's corporate operations, the total volume of fuel and electricity were converted to gigajoules according to the values in the following table.

Conversion Factors, Energy		
	Unit	**ekWh/unit**
Electricity	**kWh**	1.0
Natural Gas	**m3**	10.55
Propane	**L**	7.08
Biogas	**m3**	1.7
Diesel	**L**	10.68
Gasoline	**L**	8.5

Glossary & Acronyms

Glossary	
Adaptation	Includes any initiatives or actions in response to actual or projected climate change. impacts and which reduce the effects of climate change on built, natural and social systems.
Baseline	Estimation of the 2022 energy use, energy costs, and greenhouse gas emissions.
Business-as-Usual	The Business-as-Usual (BAU) scenario is developed to understand future energy consumption, energy costs, and emissions.
Carbon budget	The cumulative amount of carbon dioxide (CO_2e) emissions permitted over time to keep within a certain temperature threshold.
Carbon Capture Storage	Carbon capture and storage (CCS) captures CO_2 emissions from sources, transports it, and stores it underground to reduce greenhouse gas emissions and combat climate change.
Carbon sequestration	The long-term removal of carbon dioxide (CO_2e) from the atmosphere through storage in solid or liquid form.
Climate Change	Climate change refers to changes in long-term weather patterns.
Co-benefits	The added benefits from climate action, above and beyond the direct benefits of a more stable climate
Embodied carbon	The total carbon dioxide emitted by the creation of a product or development of a building. It also includes emissions generated from end-of-life disposal or recycling.
Emission intensity	The emission rate of a given pollutant relative to the intensity of a specific activity or industrial production process.
Emission lock-in	The dynamic where previous decisions relating to GHG emitting technologies, infrastructure, and systems delay or prevent future transition to low-carbon alternatives.

Glossary

Energy use intensity (EUI)	A metric that expresses a building's energy use as a function of its size, typically expressed by energy/meter squared.
Greenhouse gas emissions	Emissions of gasses known to cause warming by trapping heat in the lower. The main greenhouse gases are carbon dioxide (CO_2e), methane (CH_4), and nitrous oxide (N_2O).
Mitigation	Reducing or avoiding the emission of greenhouse gases into the atmosphere to limit the severity of climate change.
Net-zero emissions	A system that generates no greenhouse gas emissions or offsets all its emissions through actions and technologies that remove the amount generated from the atmosphere.
Net-positive emissions	A system that generations no greenhouse gas emissions as well as captures carbon from the atmosphere.
Resilience	The capacity of a system, community or society exposed to hazards to adapt, by resisting or changing to reach and maintain an acceptable level of functioning and structure.
Stationary Energy	Stationary energy sources are those used in buildings – including homes, stores, offices, and schools. Stationary energy is one of the largest sources of GHG emissions in many communities.
Thermal energy demand intensity (TEDI)	A measure of the amount of annual heating energy delivered to a building for maintaining its internal temperature.

Acronyms	
BAU	Business-as-usual
BEB	Battery electric bus
CDM	Conservation Demand Management
CEC	Clean Energy Credit
CH_4	Methane
CO_2e	Carbon dioxide equivalent
DOC	Degradable Organic Carbon
ekWh	Equivalent kilowatt hour
EMB	Energy Management Branch
EUI	Energy Use Intensity
EV	Electric vehicle
EVSE	Electric vehicle supply equipment
FCM	Federation of Canadian Municipalities
GHG	Greenhouse gas
GHGI	Greenhouse gas intensity
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GWP	Global Warming Potential
ICE	Internal Combustion Engine
ICLEI	International Council on Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
MCM	Methane Commitment Model
MLD	Megaliters Per Day
MMC	Mayors' Megawatt Challenge
MWh	Megawatt hour
N_2O	Nitrous Oxide
PCP	Partners for Climate Protection
PTTW	Permit to take Water
PV	Photovoltaic (solar)
SWTP	Surface Water Treatment Plant
tCO_2e	Tonnes of carbon dioxide equivalent
TEDI	Thermal energy demand intensity
UNFCCC	United Nations Framework Convention on Climate Change
WWIC	Wastewater Innovation Centre
WPM	Waste-in-Place Model
WwTF	Wastewater Treatment Facility