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

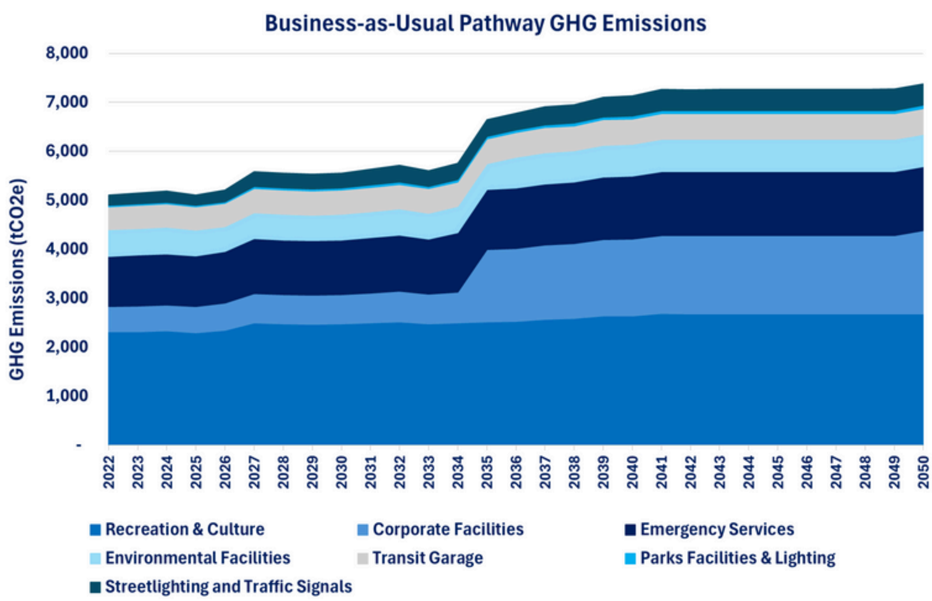
The BAU Pathway for Corporate Buildings projects a 19 percent increase in energy consumption by 2050, which would result in a corresponding 122 percent rise in operational energy costs. Starting from the baseline year of 2022, the total GHG emissions from the City's corporate buildings were 5,100 tonnes 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

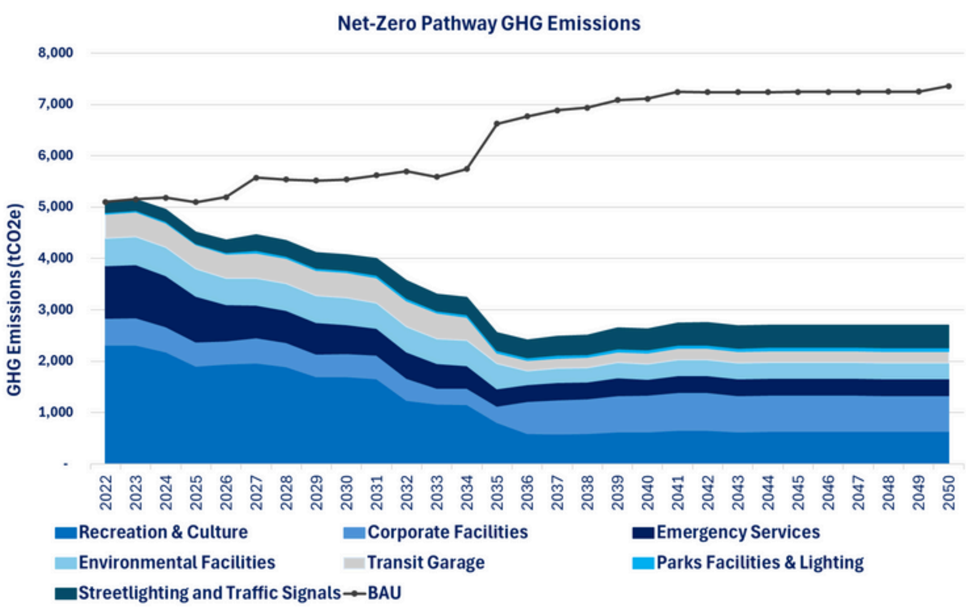
The NZ0 Pathway for Corporate Buildings projects a 22 percent reduction in energy consumption by 2050 compared to the baseline year. This decline in energy use will be driven by the implementation of energy-efficient technologies and strategies across the City's buildings. However, with utility and fuel 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

1%

Corporate Buildings GHG emissions

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.

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.

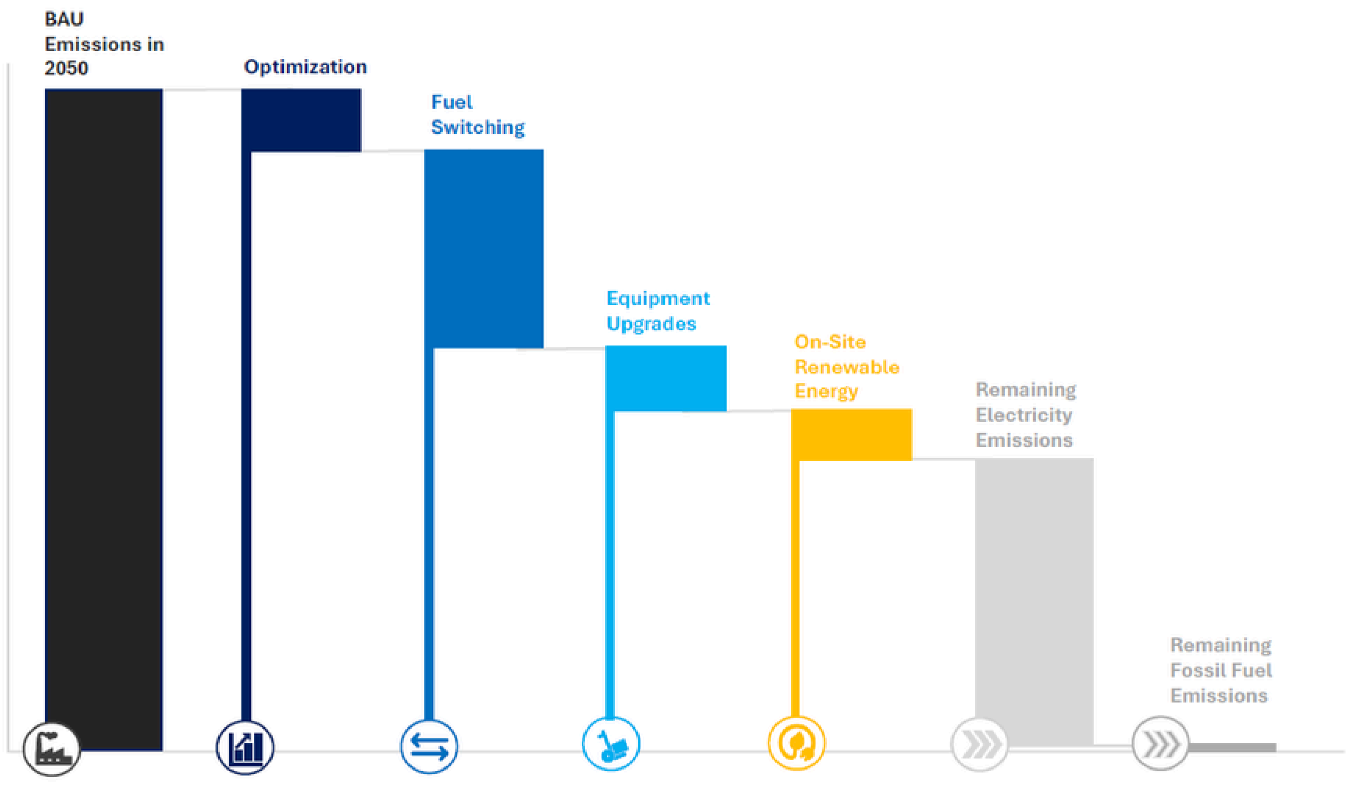
GHG Emission Reduction

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.

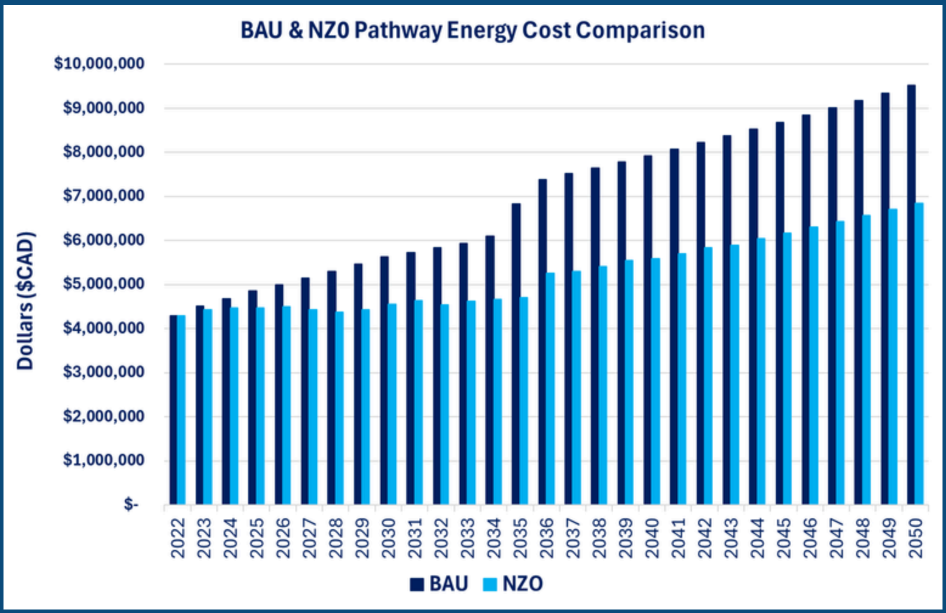
60%

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.

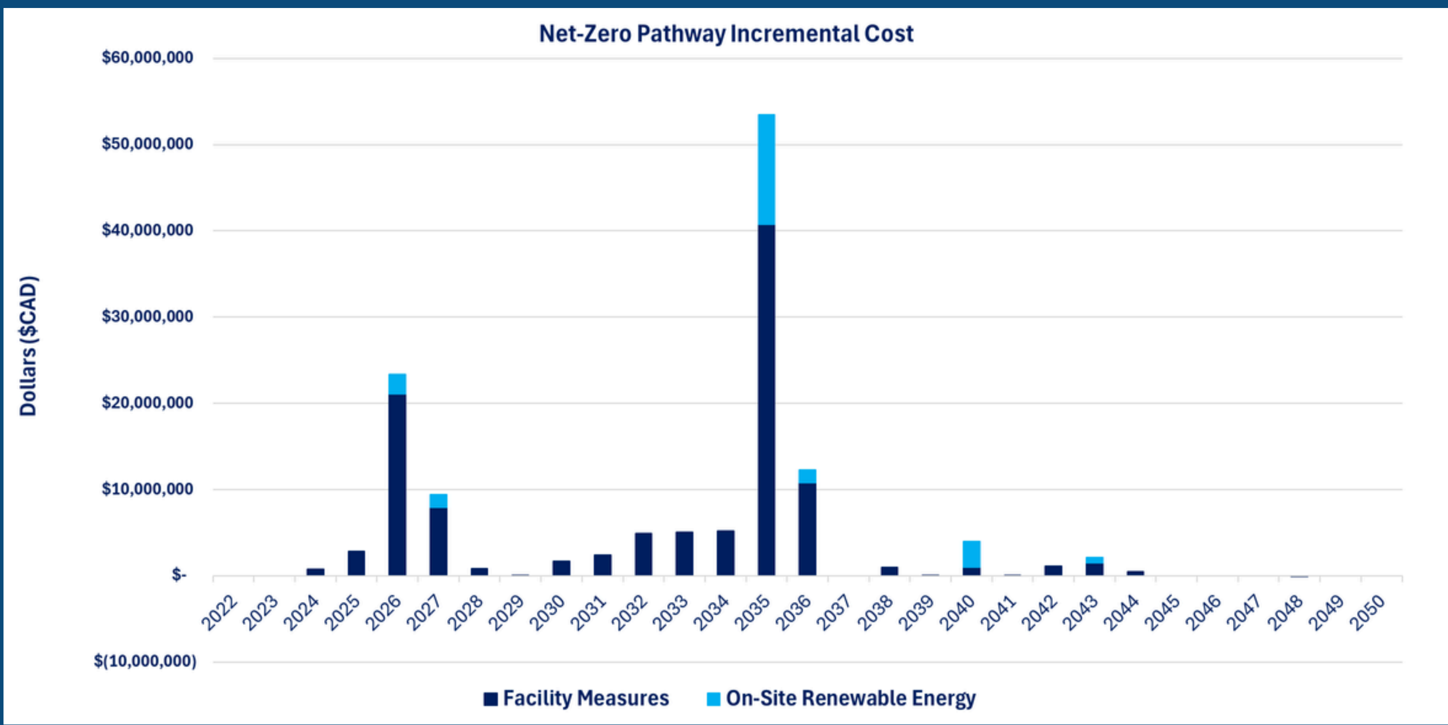


Incremental Capital Cost

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

116%

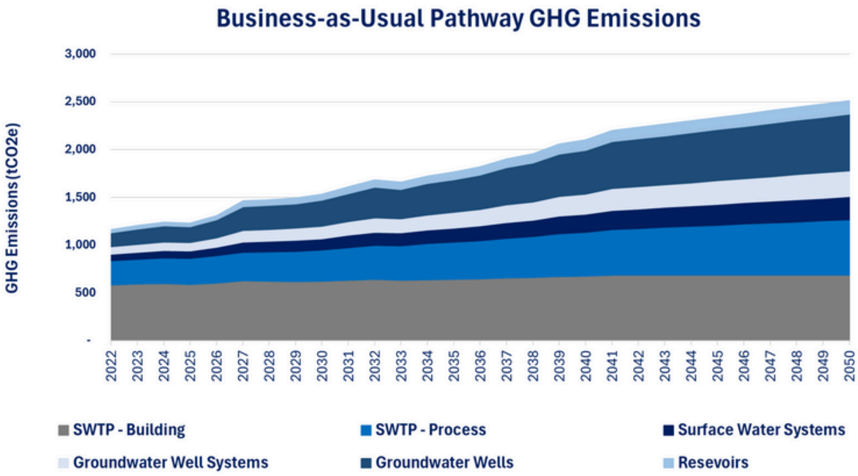
Increase in GHG emissions by 2050

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.

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.

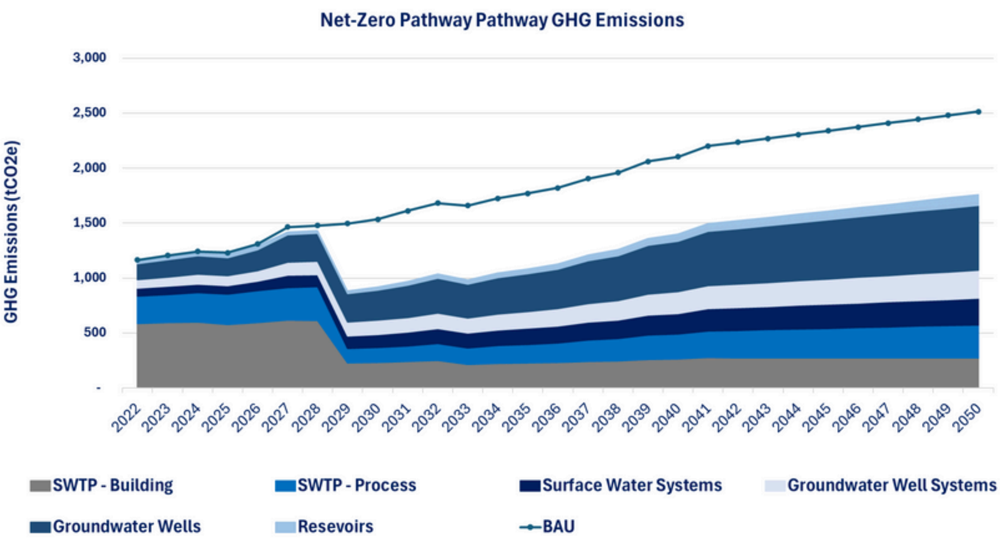
51%

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

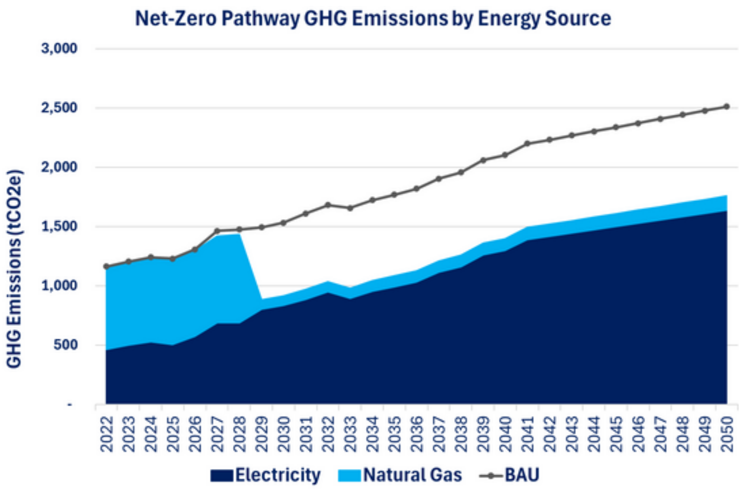
ON-SITE RENEWABLE ENERGY

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

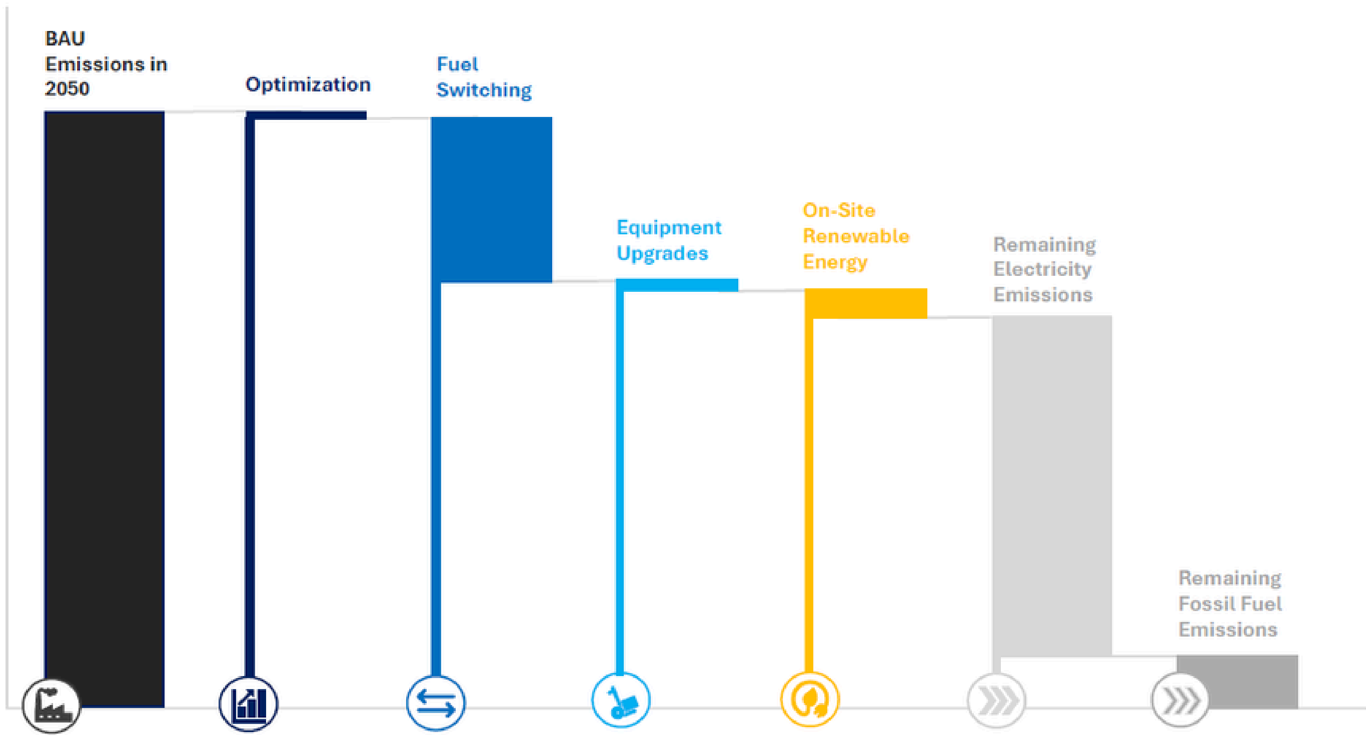
A significant reduction in GHG emissions is projected for 2029 under the NZ0 Pathway, driven by the fuel switch from natural gas to electricity with the installation of a multi-pipe heat pump recovery system at the SWTP. This transition will cut natural gas usage at the SWTP by 96 percent in 2029, resulting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

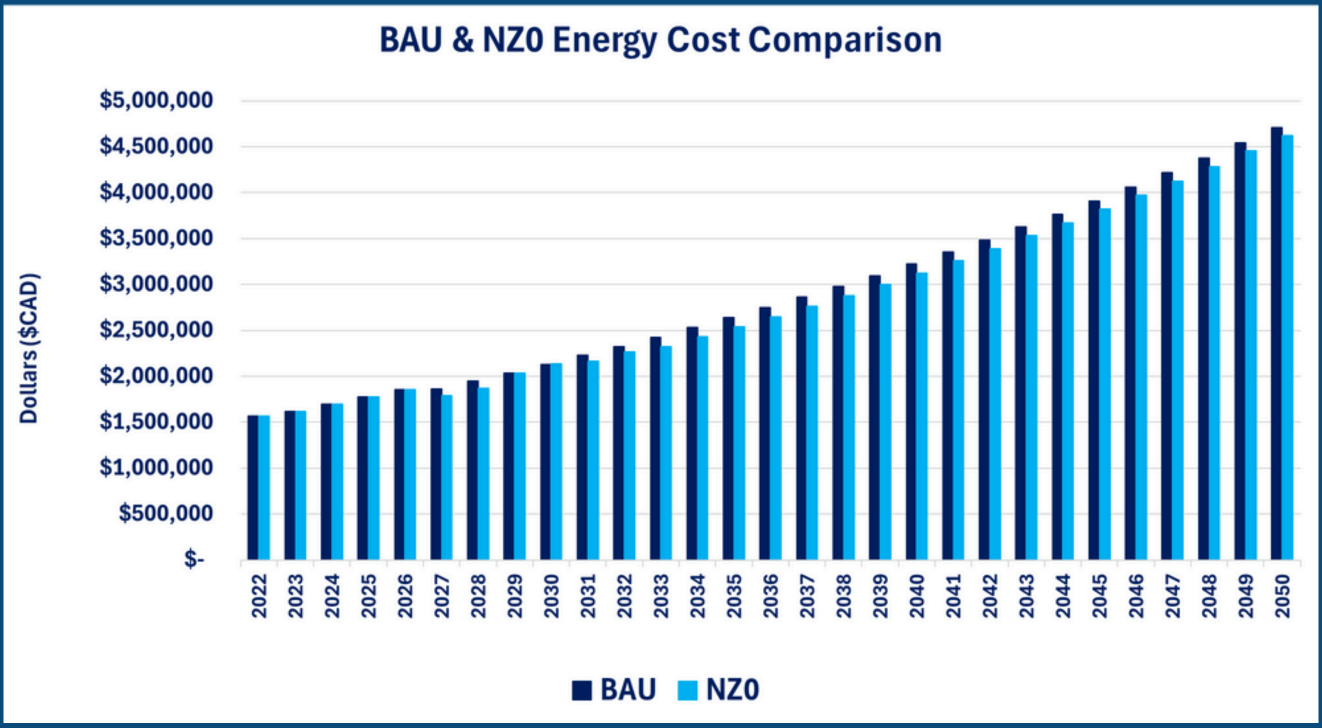
The operational cost of energy for Water Operations is projected to increase from approximately $1.56 million annually in 2022 to $4.7 million by 2050 under the BAU Pathway. This rise is primarily driven by higher water demand from population growth and an expected increase in utility prices, largely 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.

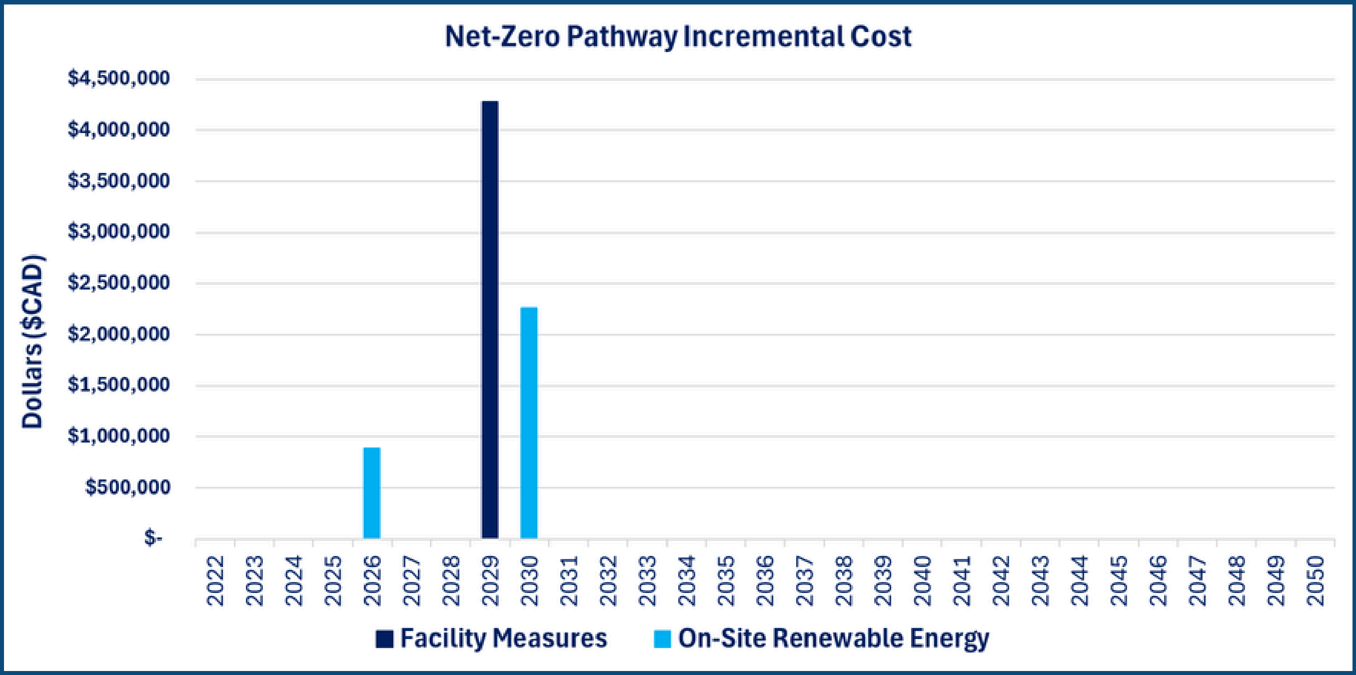


Incremental Capital Cost

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

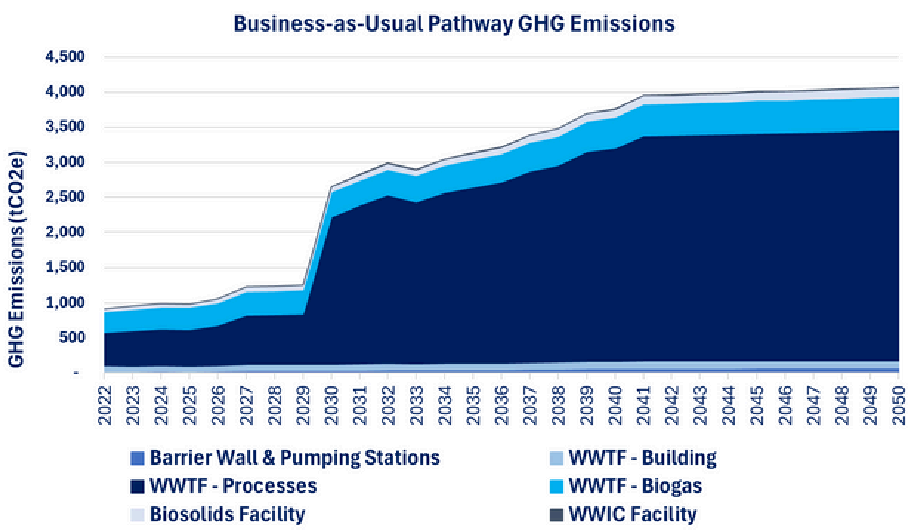
The Lake Simcoe Phosphorus Reduction Strategy is a key initiative to address phosphorus pollution, a significant water quality concern for Lake Simcoe. The provincial government, in collaboration with local stakeholders, municipalities, and the Lake Simcoe Region Conservation Authority (LSRCA), developed 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.

344%

Increase in GHG emissions by 2050

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%

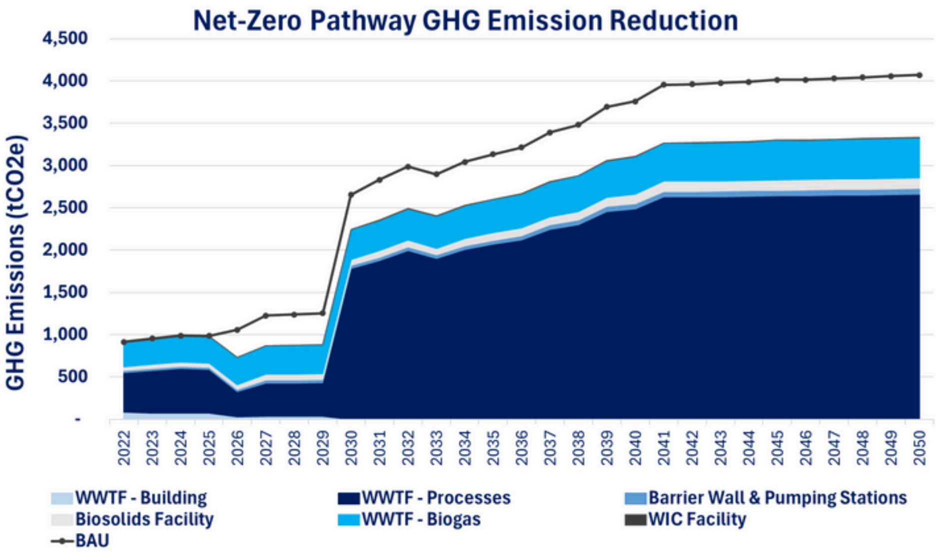
Increase in GHG emissions by 2050

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

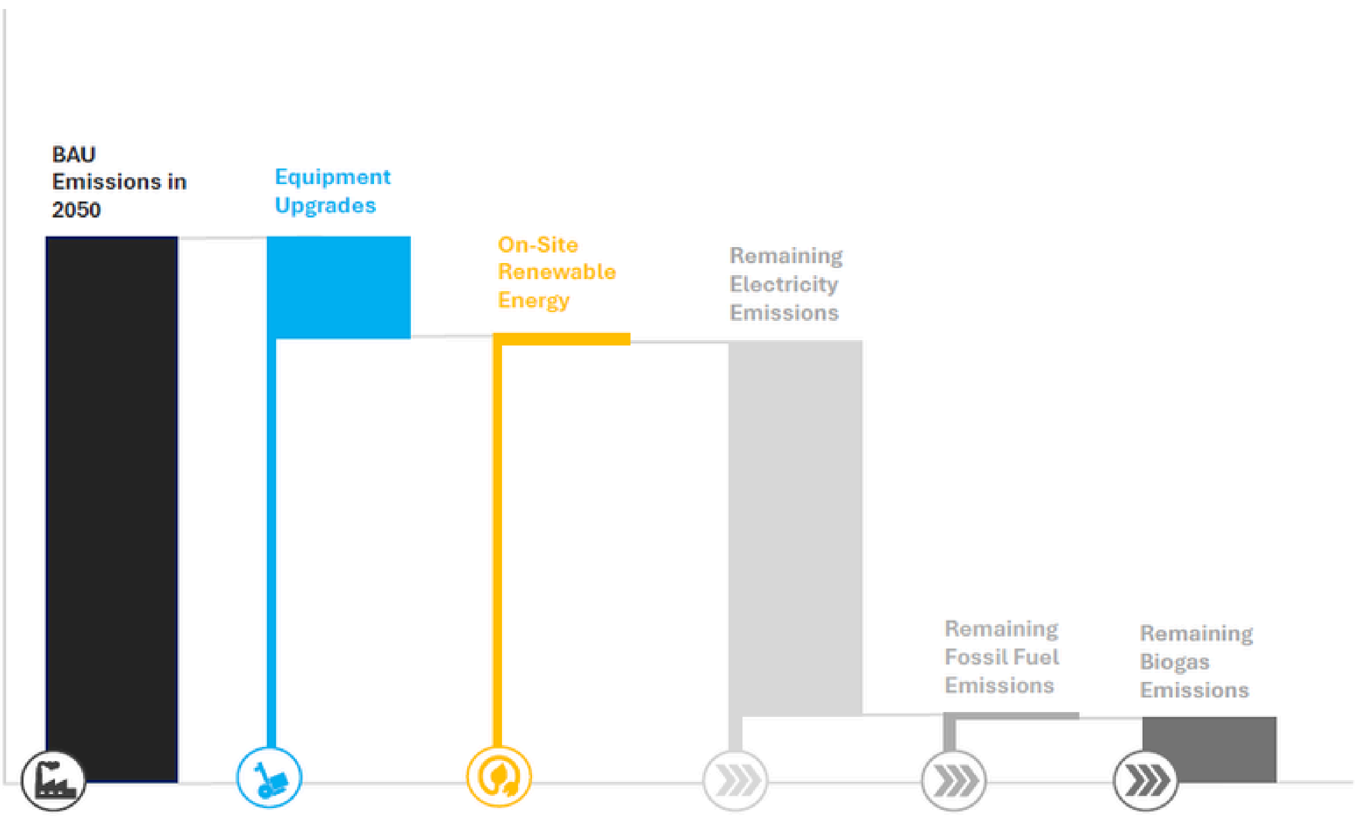
EQUIPMENT UPGRADES ON-SITE RENEWABLE ENERGY

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%

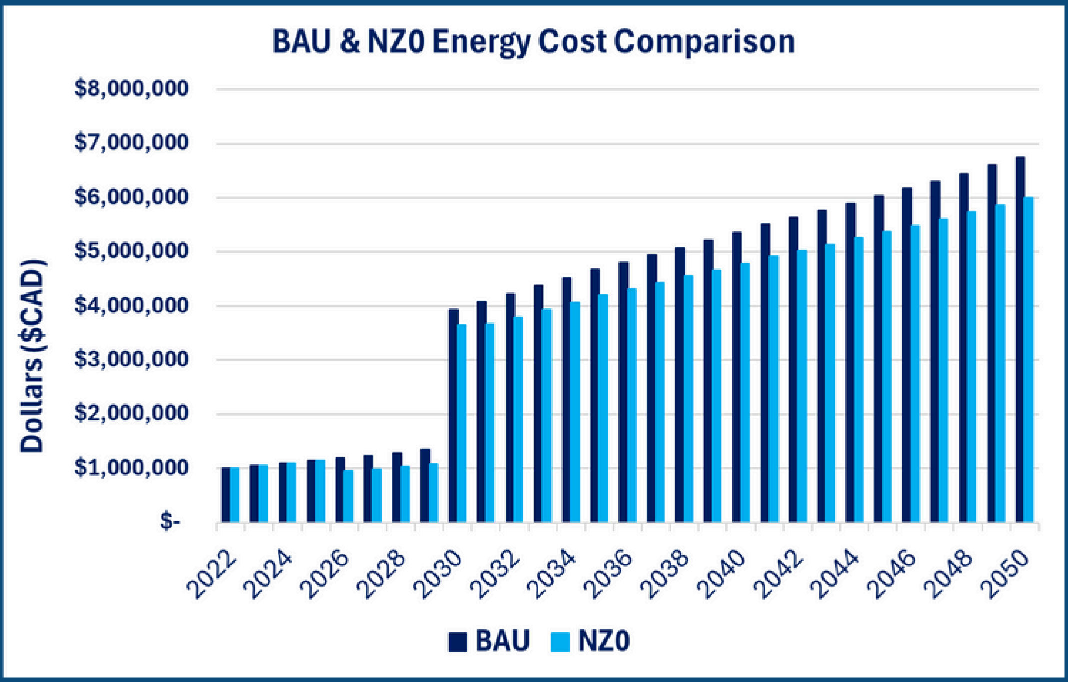
Increase in energy cost by 2050

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.



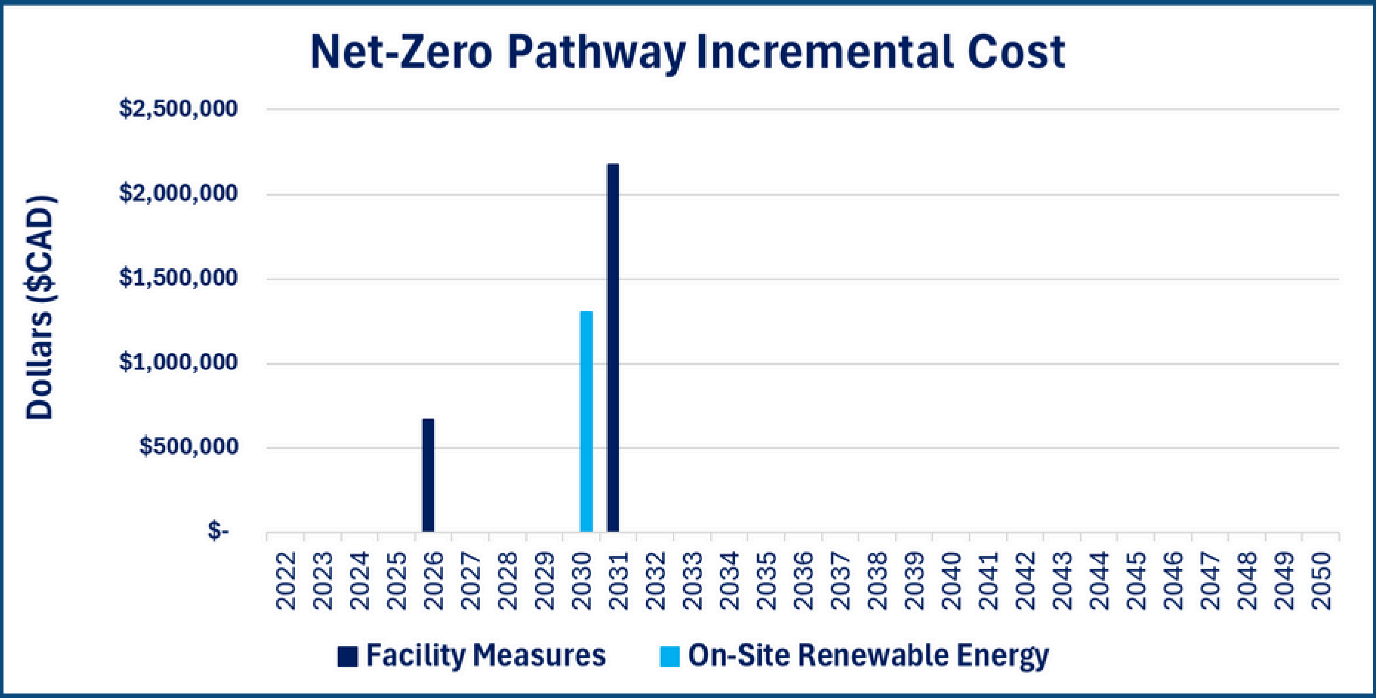
Incremental Capital Cost

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.

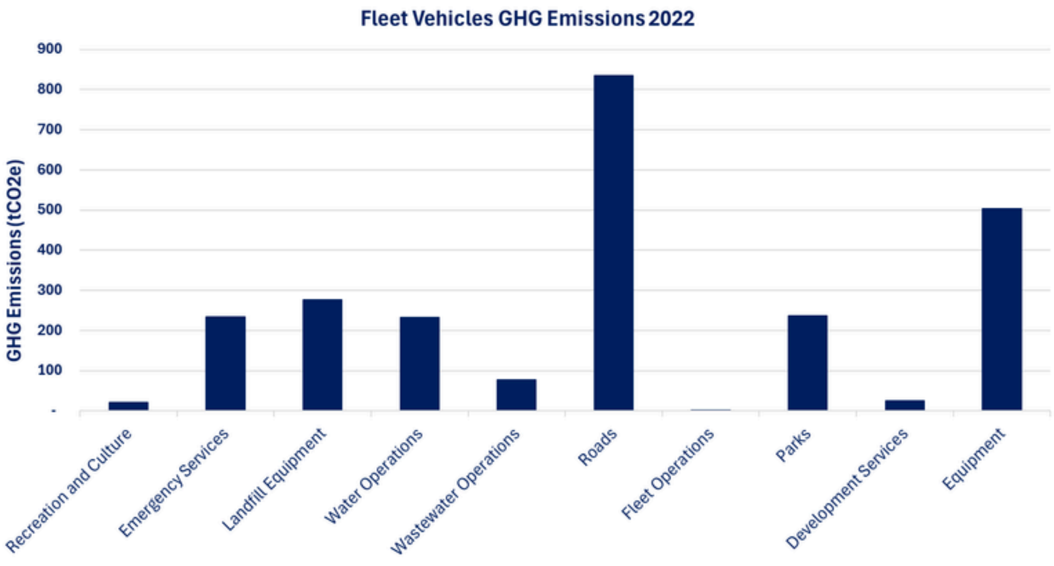
In 2022, the City advanced its electrification efforts by replacing two ice resurfacers with electric models. Following the success of these initial units, the City plans to transition to a fully electric ice resurfacing fleet by 2025. Additionally, seven Ford Lightning electric pickup trucks were added 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

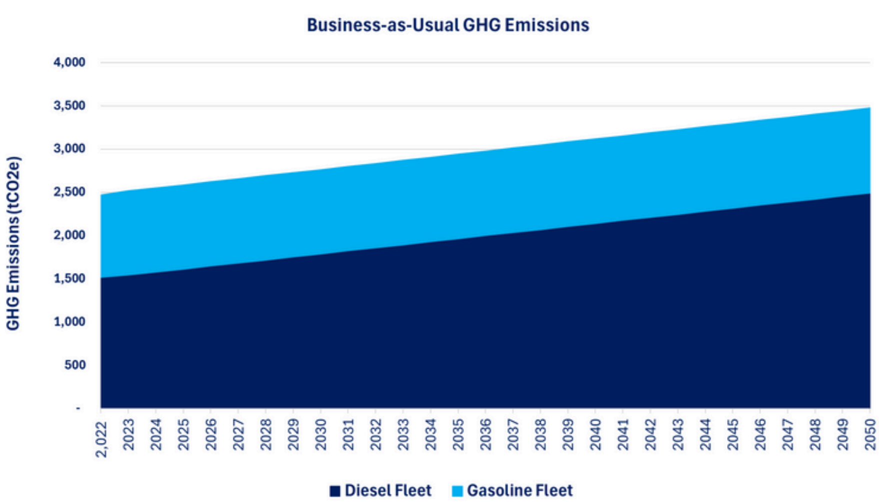
The BAU pathway for the City’s fleet projects a significant increase in GHG emissions, rising from 2,470 tonnes CO_2e in 2022 to 3,480 tonnes CO_2e by 2050. The rise in emissions is driven by the growth of the fleet across all departments, to meet the service needs of the City's growing population. Higher 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.

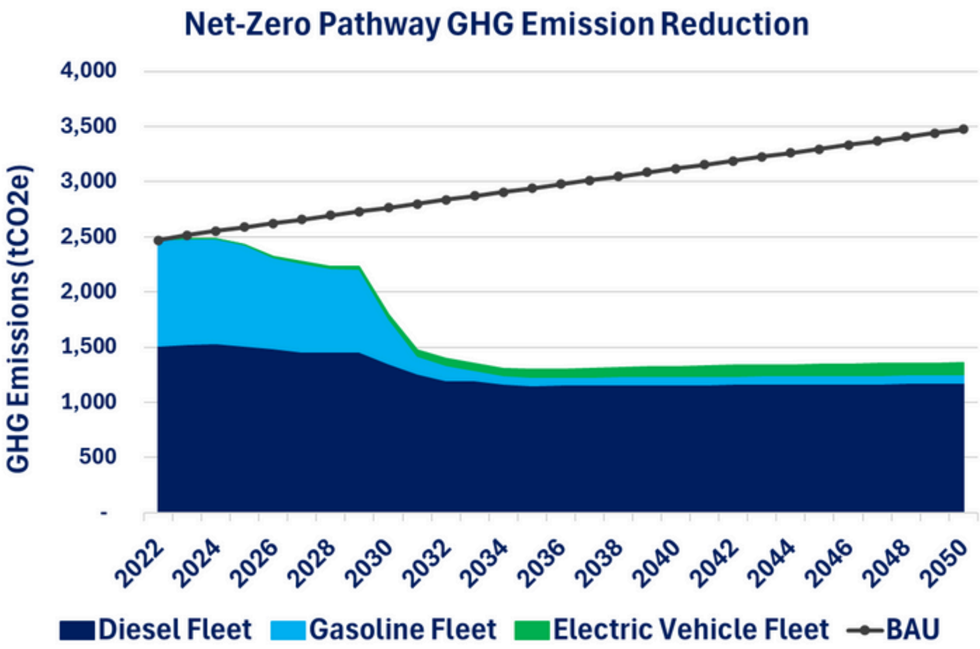
-45%

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.



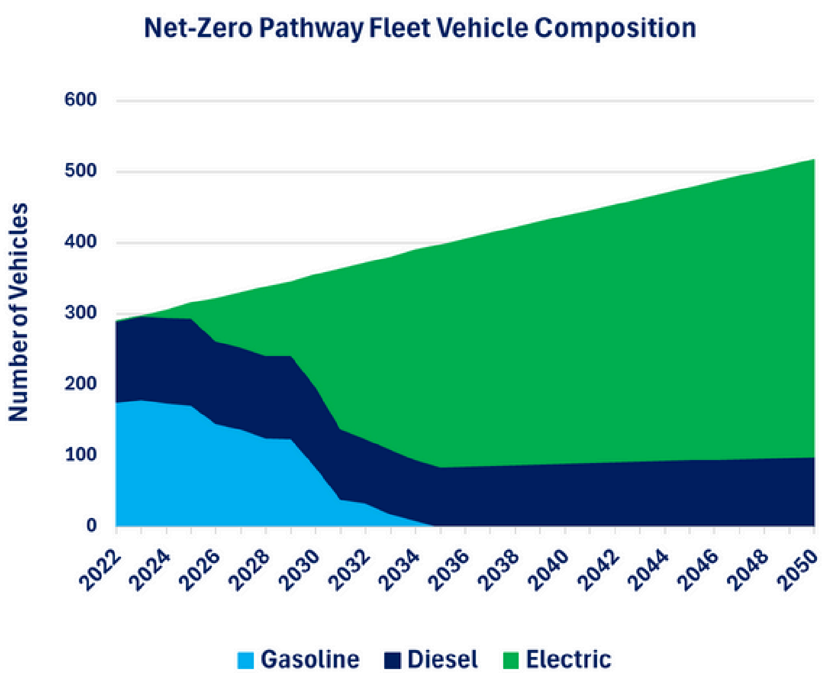
- EVSE infrastructure is another limitation. While some City sites can accommodate it, most EVSE will be installed at the Operations Centre. Since this facility is being retrofitted, the completion date will determine when fleet vehicles can be converted to electric.

Fleet Vehicles - Key Strategies

FUEL SWITCHING

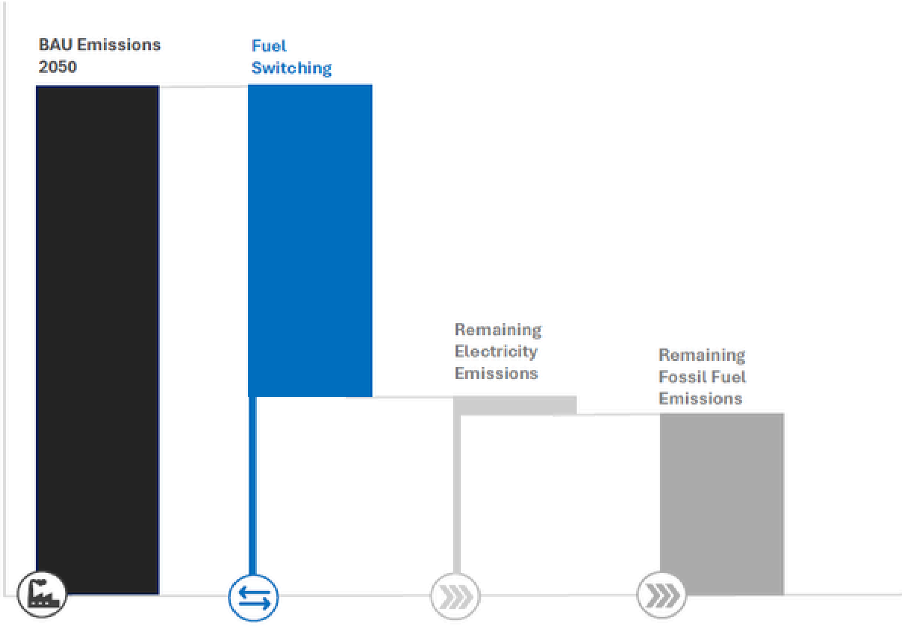
FLEET COMPOSITION

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

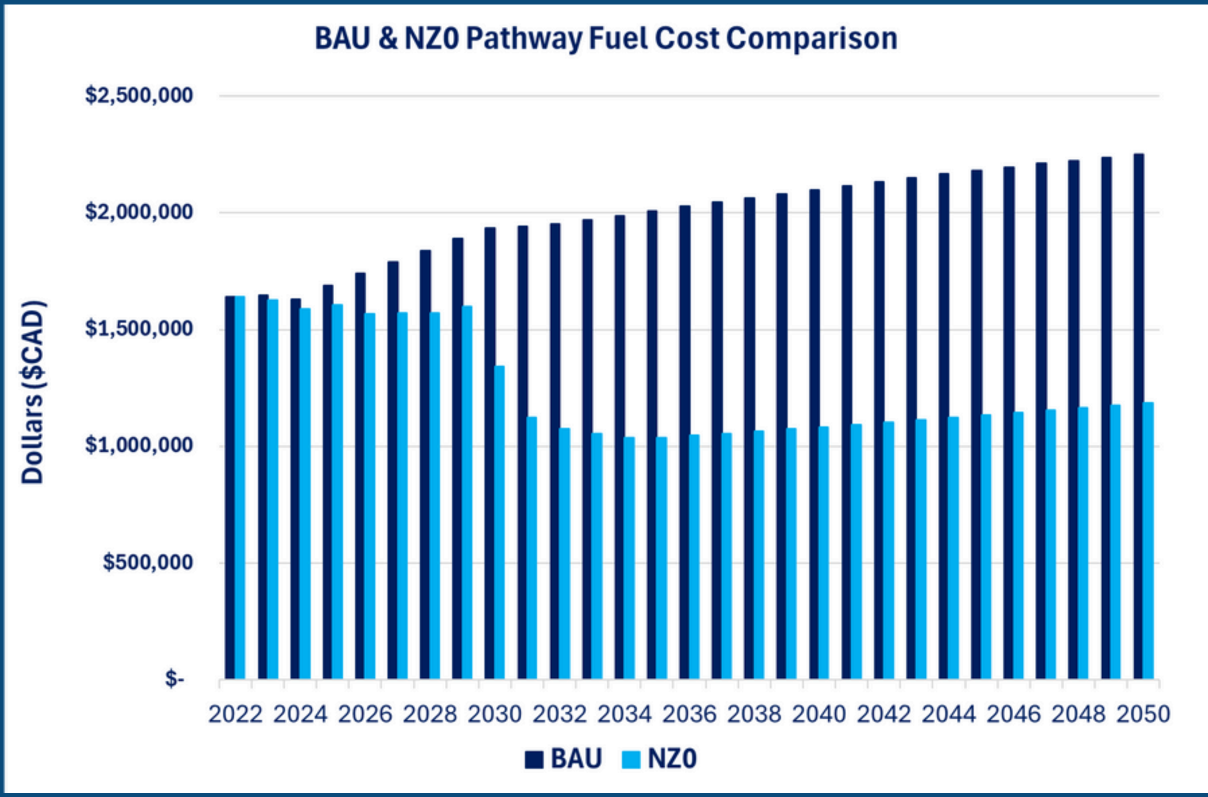
The NZ0 pathway for fleet vehicles and equipment projects a 47 percent decrease in operational energy costs to power the City's fleet by 2050 compared to the BAU projection. This reduction is mainly driven by the superior fuel efficiency of EV models over their ICE counterparts and the lower cost of 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.

-47%

Decrease in energy cost at 2050

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.



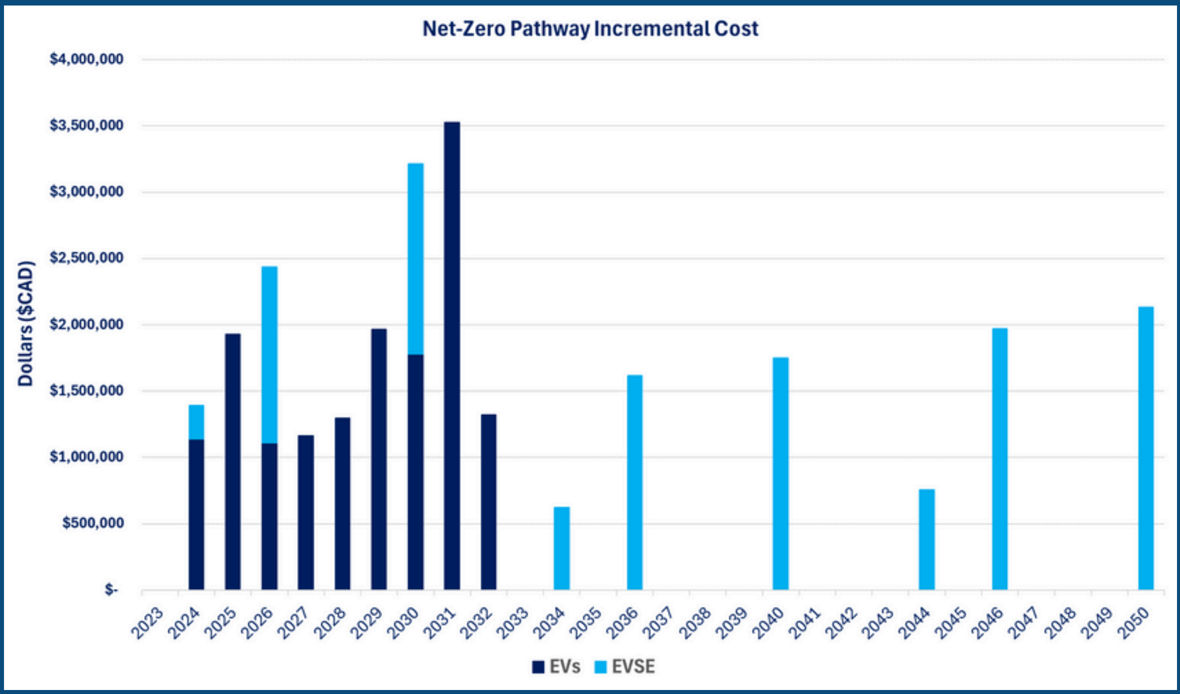
Incremental Capital Cost

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%

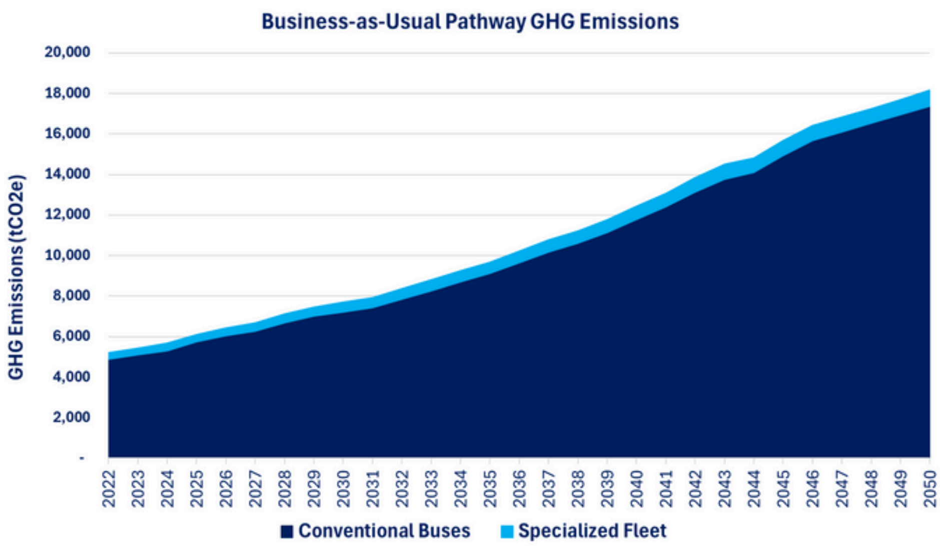
Increase in GHG emissions by 2050

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%

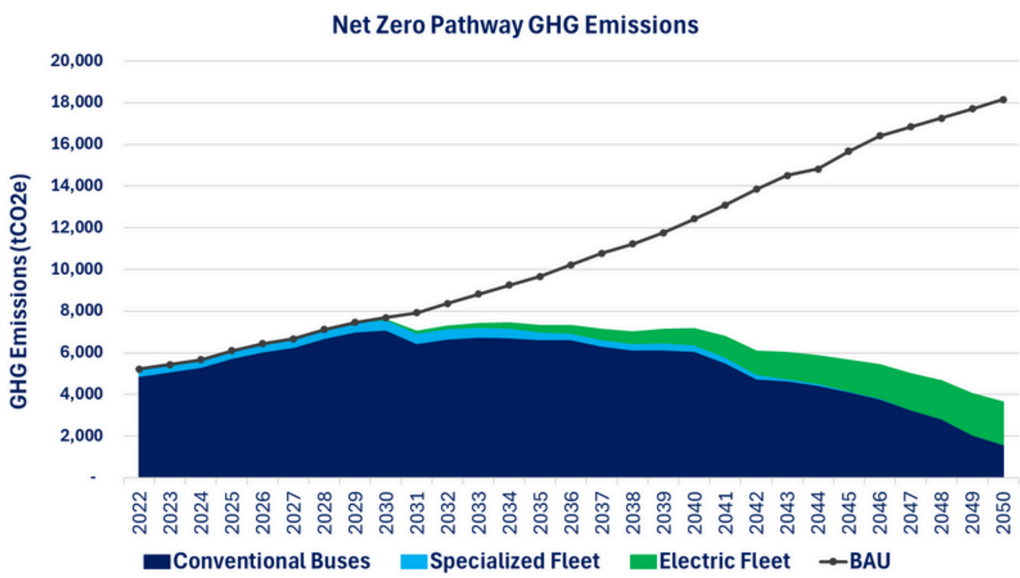
Decrease in GHG emissions by 2050

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.

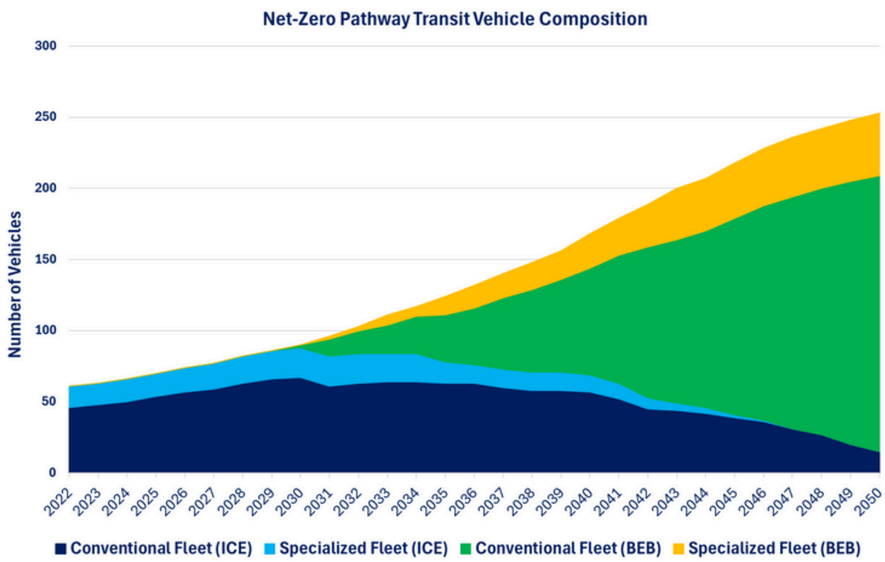


Transit Buses - Key Strategies

FUEL SWITCHING

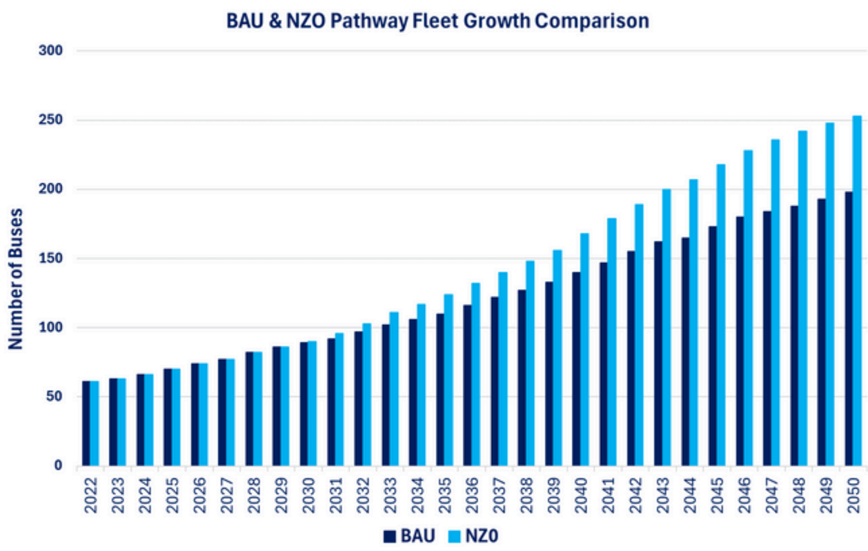
FLEET COMPOSITION

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.

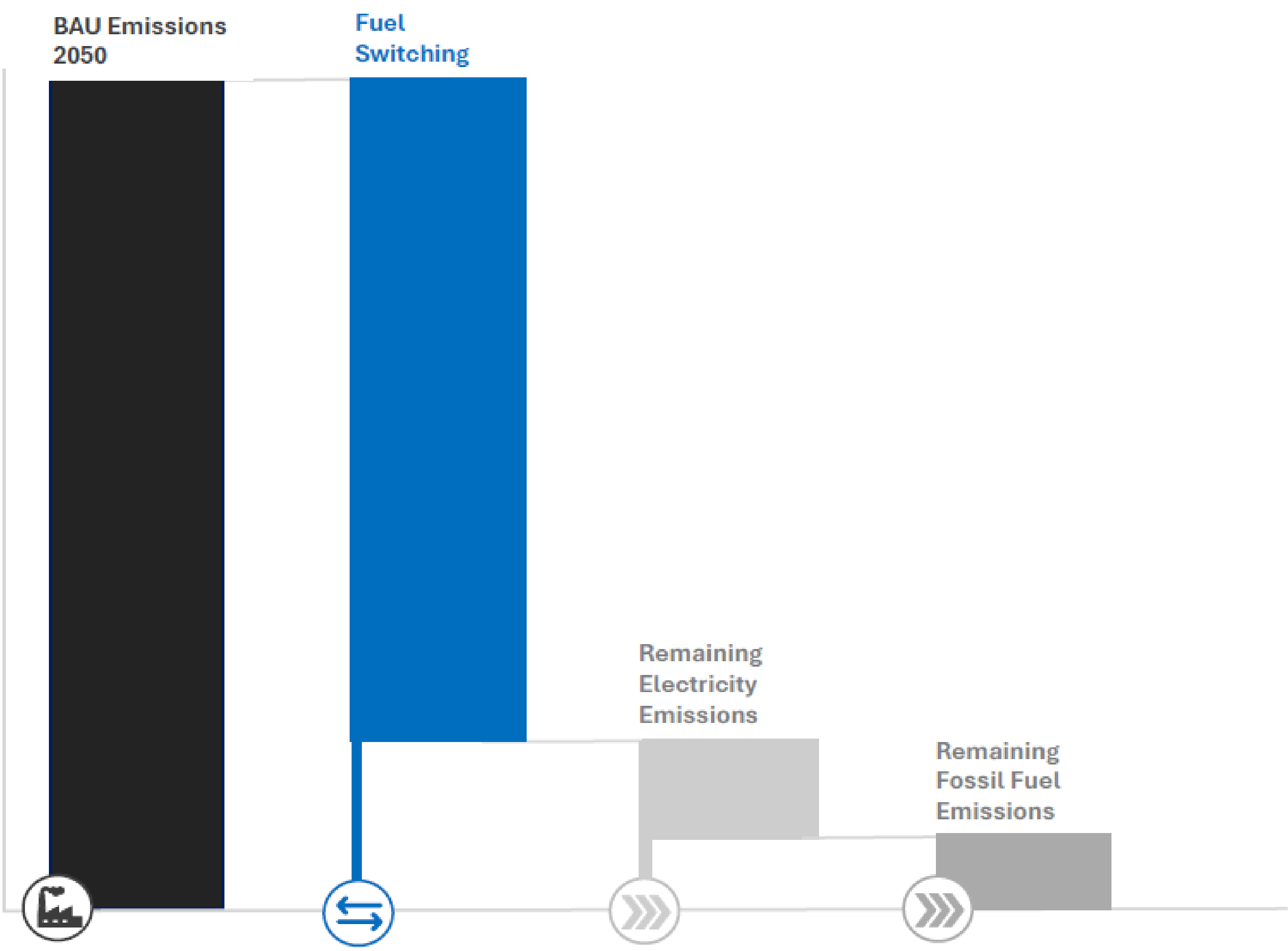


GHG Emission Reduction

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

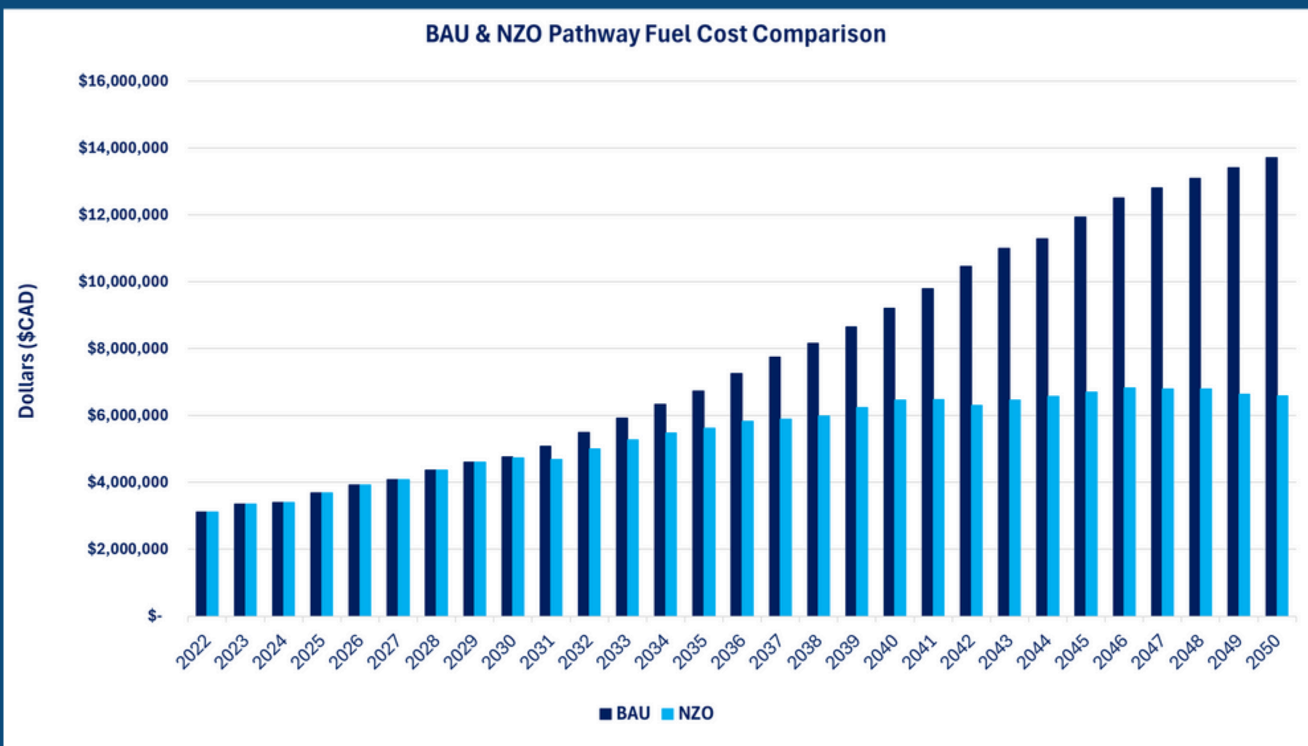
The annual operational energy cost to power the City's transit buses is projected to rise from $3 million in 2022 to $14 million annually by 2050 under the BAU Pathway, while the NZ0 Pathway projects a cost of $7 million. Although energy costs increase under both pathways, the NZ0 Pathway offers a 53 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.

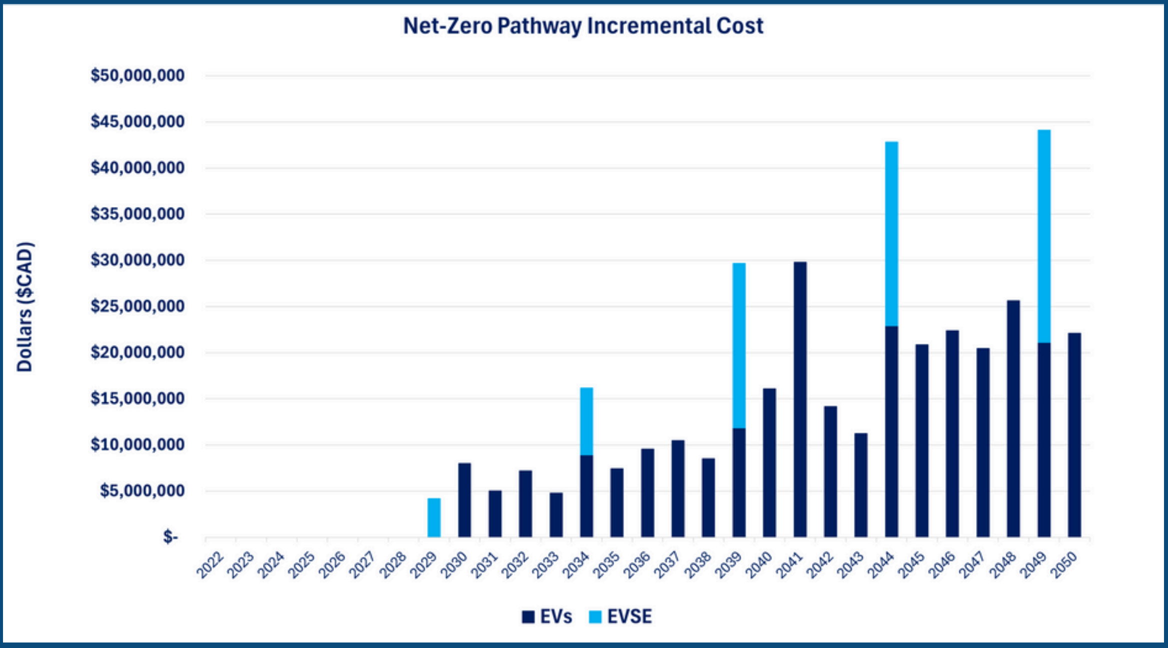


Incremental Capital Cost

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.

1964
FOUNDING OF LANDFILL
Landfilling begins at the Sandy Hollow site beginning in 1964 in the northwest end of Barrie.

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.

1993
DIVERSION PROGRAMS
Tipping fees on industrial, commercial, and institutional waste, a ban on cardboard, and backyard composting program introduced.

2006
FURTHER DIVERSION
Landfill reclamation and re-engineering project begins, excavating waste material and removing materials, such as large amount of tires.

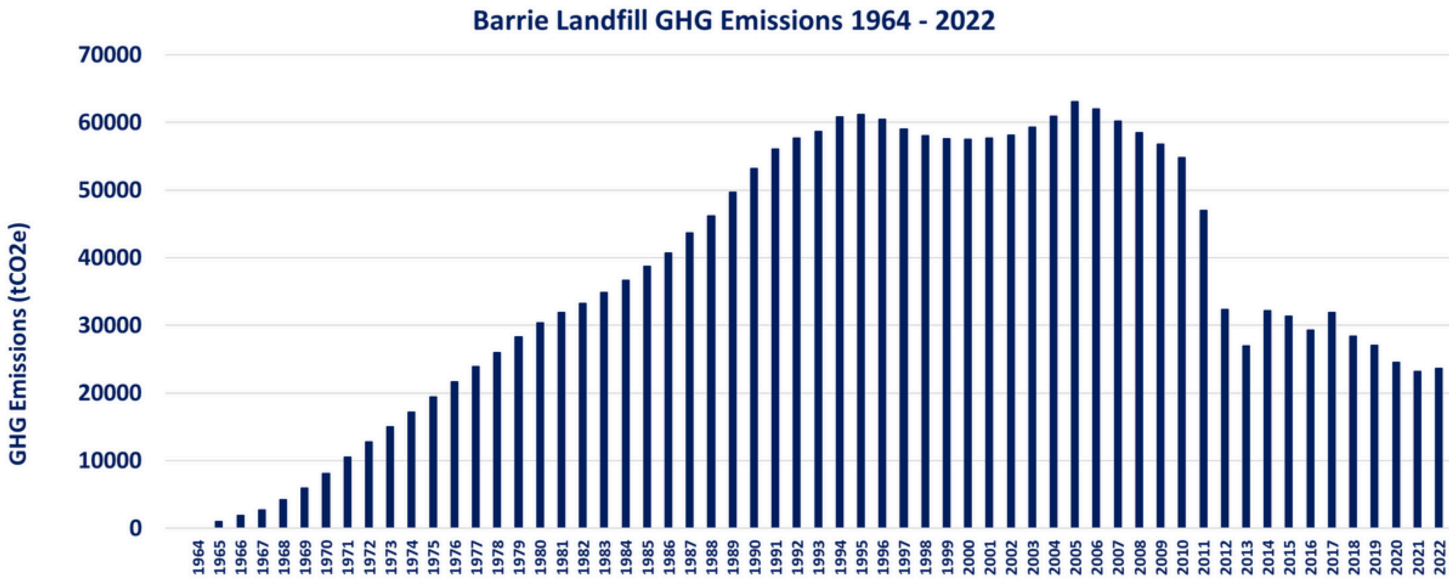
2007
NEW LINING
Landfill reclamation and re-engineering project begins, excavating waste material and removing materials, such as large amount of tires.

2011
GAS FLARE
Installation of landfill biogas collection system and flaring stack, significantly reducing methane emissions from site.

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

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.

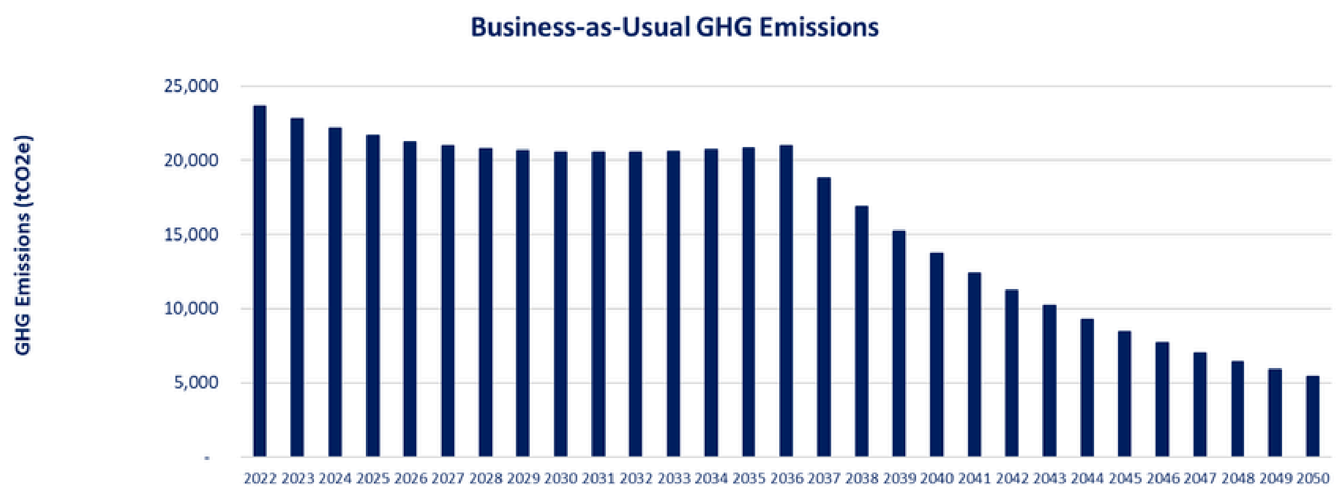
-77%

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.

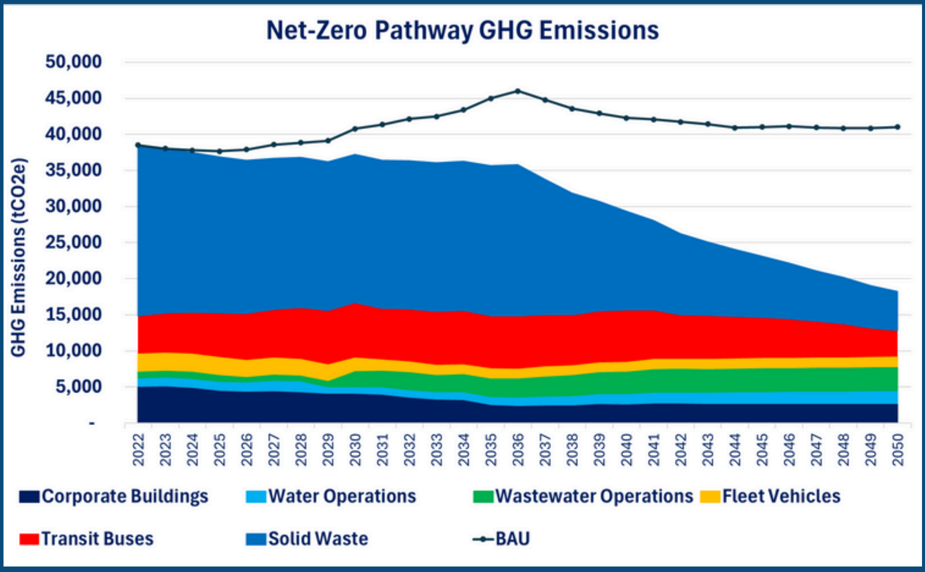
2030	2040	2050
-3%	-24%	-53%

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.

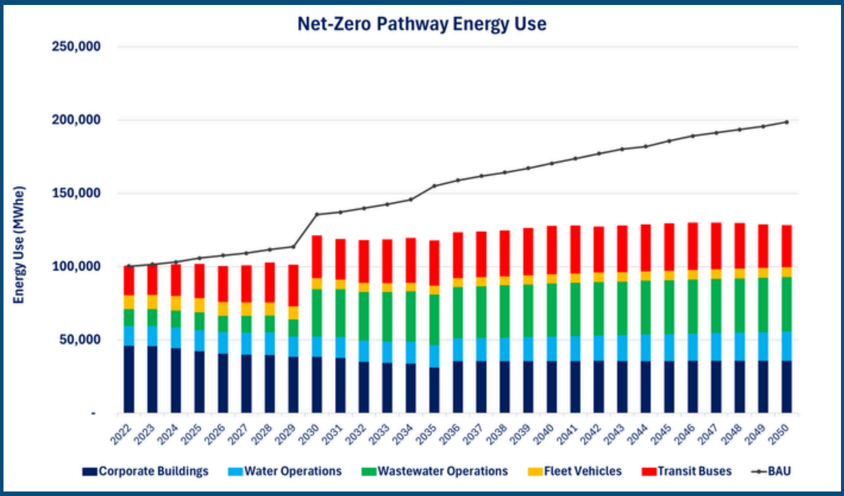
NZO Pathway - Energy Demand

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.

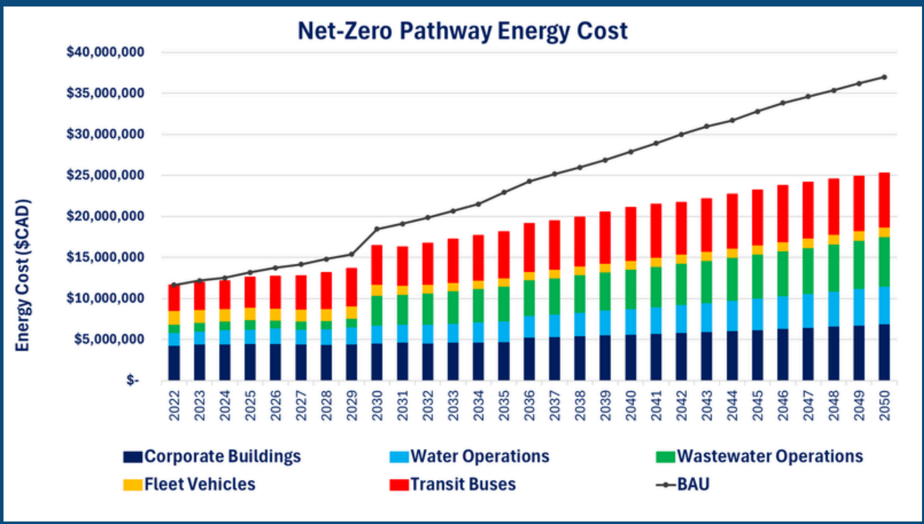
- Under the BAU Pathway the City's vehicle fleet is projected to increase energy use by 43 percent above the baseline by 2050, whereas under the NZ0 Pathway the projected change is energy use is expected to decrease by 30 percent. Similar to transit buses, this is due to the increased efficiency of EVs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



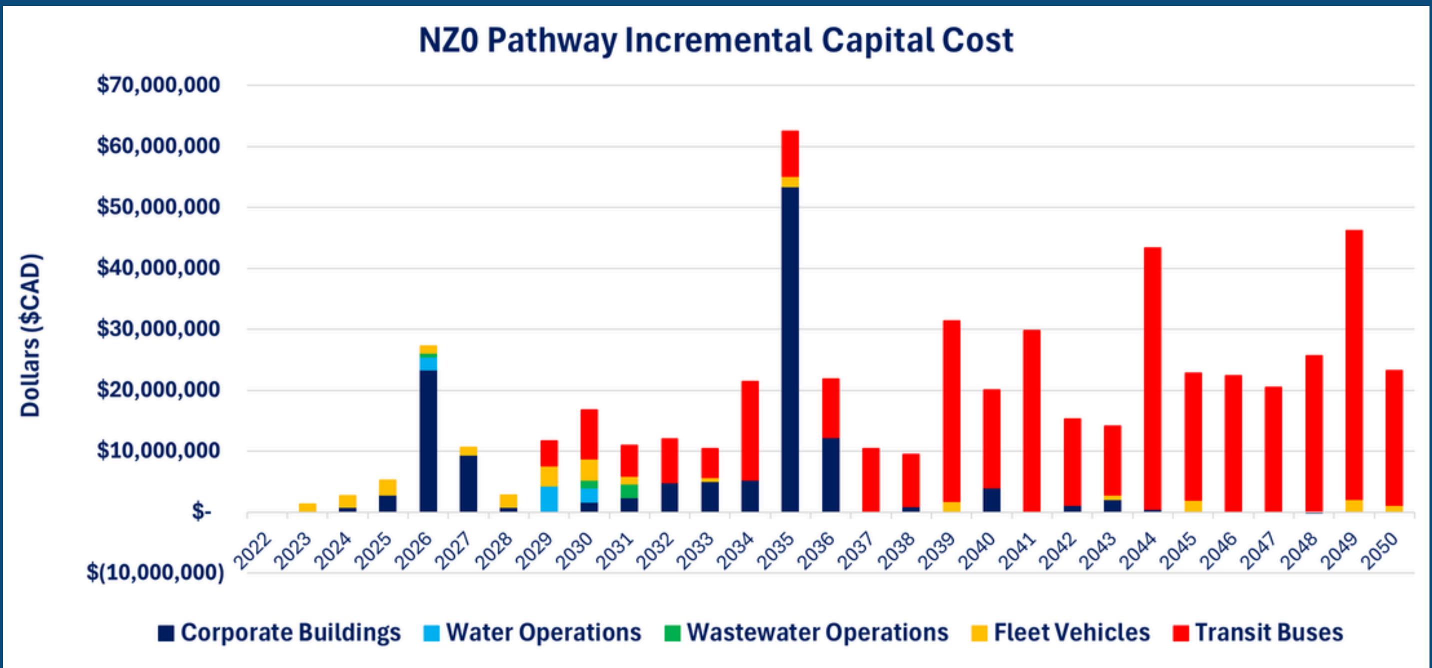
% Change Energy Cost	
Year	**2050**
BAU	217%
Transit Buses	111%
Fleet Vehicles	-28%
Wastewater Operations	493%
Water Operations	196%
Corporate Buildings	59%
Total	**117%**

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.

NZO 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).