Town of Whitby
Staff Report

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Report Title: Zero Carbon Whitby Costing Study

Report to: Council

Date of meeting: September 26, 2022

Report Number: CAO 19-22

Department(s) Responsible:

Office of the Chief Administrative Officer
Financial Services Department
Community Services Department

Submitted by:
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Acknowledged by M. Gaskell, Chief Administrative Officer

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1. Recommendation:

1. **That Council receive the Zero Carbon Whitby Costing Study for information;**
2. **That Council direct staff to include the Zero Carbon Whitby Costing Study budget into the long-range capital forecast and asset management plan to include a zero-carbon pathway for buildings, fleet, lighting, and waste;**
3. **That staff be authorized to explore funding opportunities such as grants, bonds, and loans to support the seed funding of the Zero Carbon Revolving Reserve Fund; and,**
4. **That Council adopt a Zero Waste Target for corporate operations by 2040.**

2. Highlights:

- This report presents the Zero Carbon Whitby Costing Study for consideration.

- This study was completed as a result of a recommendation from the Zero Carbon Whitby Plan, which Council adopted in March 2021. This plan serves as the Town's corporate climate mitigation plan to eliminate emissions from municipal operations through a carbon budget process.

- Whitby's allotted portion of the global carbon budget was determined as 62.6 kilotonnes from 2021 to 2045. To remain within this budget, Zero Carbon Whitby embeds short, medium, and long-term greenhouse gas (GHG) reduction targets of:

    - 20 percent GHG emissions reduction by 2025, below 2019 levels
    - 40 percent GHG emissions reduction by 2030, below 2019 levels
    - 100 percent GHG emissions reduction by 2045, below 2019 levels

- The Zero Carbon Whitby Costing Study provides:
    1. Anticipated costs and savings for each of the projects to be undertaken to complete Zero Carbon Whitby;
    2. A schedule of the projects to be undertaken; and
    3. Guidance regarding funding options, and the establishment of the Zero Carbon Revolving Reserve Fund.

- Completing the Zero Carbon actions according to the schedule provided in this Study will permanently reduce the Town's corporate emissions by 74.6% by 2045. The remaining emissions are as a result of emissions associated with Ontario's consumption of natural gas to feed the provincial electrical grid, and high-level options are given for addressing these including the early retirement of combined heat and power at CRC, more rapid electrification of fleet vehicles as well as larger community renewable energy projects to help offset emissions.

- The estimated incremental cost of this work between 2022 and 2045 is $63.7 million. In return, over the same period it estimated there will be $75.3 million in total savings and avoided costs. Additional staffing resources to implement Zero Carbon Whitby have also been identified.

- The Study proposes that this incremental cost could be paid for entirely from a Zero Carbon Revolving Reserve Fund, seeded with an initial $34.8 million in funding and then utilizing cost savings from energy, carbon tax, and select capital projects to fund the balance of the program in later years. The approach for acquiring the seed funding is further detailed

under the Next Steps section of this report.

- The actions required to achieve the Zero Carbon Whitby Plan, include:
    - Deep retrofit of all Town facilities with low carbon technology as capital forecast and asset management is scheduled
    - Cancellation of the combined heat and power contract at the Civic Recreation Centre by 2030 and an equipment replacement of a ground source heat loop
    - Elimination of leased office space by 2025 through conversion to remote work and considerations for additional office space as part of the Operations office expansion
    - Electrification of all gasoline-powered fleet by 2035
    - Conversion of all lighting to LED
    - A zero corporate waste target by 2040 to be supported through a corporate waste strategy, annual waste audits, and an increased diversion program
    - New buildings built to zero carbon standards

- Several financial mechanisms have been identified to support the implementation of Zero Carbon Whitby, including community bonds, traditional loans, tax increases, grant funding, and a Revolving Zero Carbon Reserve Fund.

- The study includes recommendations for a revolving climate policy to allow energy cost savings from completed low carbon actions to be collected and transferred into a climate reserve to support the incremental costs of future low carbon actions.

3. Background:

Council adopted Zero Carbon Whitby in 2021. This plan serves as the Town's corporate climate mitigation plan to eliminate emissions from municipal operations.

Zero Carbon Whitby was developed using a carbon budget approach that aligns with global Greenhouse Gas (GHG) emission commitments as outlined in the 2016 International Paris Accord to keep global temperature increase below 1.5 degrees.

Developed through the Science-Based Target Network (SBTN) method, Whitby's allotted portion of the global carbon budget was determined as **62.6 kilotonnes from 2021 to 2045**.

To remain within this budget, Zero Carbon Whitby embeds short, medium, and long-term targets of:

- 20 percent GHG emissions reduction by 2025, below 2019 levels;
- 40 percent GHG emissions reduction by 2030, below 2019 levels; and,
- 100 percent GHG emissions reduction by 2045, below 2019 levels.

To assist with the implementation of actions to achieve emissions reduction, Zero Carbon Whitby outlines a **carbon budget framework** for implementing a low carbon decision mechanism across the organization. The carbon budget framework is a process that has been developed to be embedded within the municipal fiscal budget process and help with the ongoing implementation and monitoring of the Town's actions, in alignment with emission reduction targets.

Actions identified within Zero Carbon Whitby have a primary focus on the Town's highest emission sources, including the Facilities, Fleet, and Waste portfolios. To incorporate low-carbon actions into these services, a detailed cost analysis was undertaken to ensure maximized alignment of low-carbon actions with the existing capital budget forecast and asset management. The analysis also identifies the incremental capital costs and operating savings to enable the Town to integrate its first carbon budget as part of the 2023 budget process.

The purpose of this report is to highlight the findings of the Zero Carbon Whitby Costing Study, and to seek support for including low carbon actions in the 2023 budget process. Additionally, a climate change revolving fund is recommended to support the implementation of a sustainable financial mechanism to ensure resources are available to support the elimination of GHG emissions through the Town's corporate activities.

4. Discussion:

In Fall 2021, the Town retained Sustainable Solutions Group to complete a Zero Carbon Whitby Costing Study to develop a more detailed implementation plan for Whitby to achieve its carbon budget and reach zero emissions by 2045.This Costing Study provides a schedule and incremental budget for the Zero Carbon Whitby Plan that optimizes the Town's corporate carbon budget with its existing capital budget and asset management plans.

Completing the Zero Carbon actions according to the current capital forecast and asset management replacement schedule will permanently reduce the Town's corporate emissions by 74.6% by 2045. The remaining emissions to achieve net zero by 2045 will come from several additional options including increasing electrification of fleet, reducing waste, and removing gas fueled combined heat and power units ahead of schedule.

The estimated total incremental cost of this work between 2022 and 2045 will be $63.7 million. In return, over the same period it is estimated to provide $75.3 million in total savings and avoided costs.

Budgeted savings are a reduction of expenditures currently identified within the municipal budget (e.g. fuel budget, utility budget, maintenance budget). Whereas, avoided costs include the prevention of having to increase the budget for beyond current operating projections as a result of market inflation and future fees, avoided costs account for items like energy cost increases over time, increased

carbon pricing, as well as inflation associated with operating and maintenance costs.

The Study determined that the estimated incremental cost could be paid for entirely from a Zero Carbon Revolving Reserve Fund, seeded with an initial $34.8 million in funding and then utilizing cost savings from energy, carbon tax, and select capital projects to fund the balance of the program in later years. The following Table outlines how these costs and savings would be realized from 2022 to 2045.

Table 1 Incremental Investment, Savings and Avoided Costs by Period.

Cost	2022 - 2025	2026 - 2031	2032 - 2045	Total
Incremental Investment Required	$31,593,000	$13,832,000	$18,283,000	**$63,708,000**
Operational Budgetary Savings	$1,379,000	$13,668,000	0$	**$15,047,000**
Avoided Costs	$0	$0	$60,254,000	**$60,254,000**

Buildings

Between 2022 and 2045, Whitby will need to retrofit and replace energy systems in 63 buildings, build two new facilities (the Fire Station Training Tower and the Whitby Sports Complex), and complete the Operations Centre Phase 2 Expansion to a net-zero standard.

Actions to achieve net zero in buildings include:

- Building envelope upgrades (increased insulation, air tightness, window replacements)
- Removal of gas heating and cooling equipment and replacement with heat pump technology
- Enhanced building automation and monitoring
- Renewable energy systems
- Water conservation technologies

Table 2 Incremental Building Costs 2022-2045

Building Sector	Incremental Capital Cost
New Building Construction	$23.88 million
Building Retrofits	$27.89 million
Solar PV System Installations	$2.05 million
Total	$53.82 million

Between 2022 and 2025, estimated operational savings from buildings will total $1.2 million from savings in natural gas costs and associated carbon taxes and from 2026-2045 it is anticipated that incremental savings could total $44.7 million.

Civic Recreation Complex

The Civic Recreation Complex (CRC) is a single facility that is responsible for almost 20% of the Town's corporate GHG emissions. This is a result of a natural gas Combined Heat and Power system used to heat and power the facility. Whitby has a contract to operate the combined heat and power system for approximately 20 years.

If the Town maintains this system, this facility will emit almost 1,000 tonnes of GHGs annually or 14,200 additional tonnes of emissions by 2045. This raises Whitby's total forecast emissions between 2022 and 2045 to approximately 96,000 tonnes. This is 34,000 tonnes over the Town's 62,000 tonnes carbon budget.

Even if all the other actions in Zero Carbon Whitby are implemented, keeping the CRC on natural gas will make it difficult to stay within the carbon budget.

An alternative is to retrofit the building and switch the CRC to a ground source heat pump. This may result in a financial penalty for breaking the combined heat and power contract early and the capital costs of this work is estimated to be $3.6 million. It is estimated that if this was completed between 2030 and 2031, energy and carbon taxes would decrease by $136,000 in 2031, and the avoided costs would increase steadily to $402,000 in 2045, resulting in total savings and avoided cost combination of $4.2 million between 2030 and 2045. The difference between the capital investment required and the energy and carbon tax savings would be a net savings of $0.6 million and result in a reduction of 15,000 tCO2e GHG emissions compared to a business-as-usual scenario.

Fleet

Zero carbon modelling for fleet reflected a gradual conversion of all gasoline and diesel vehicle and equipment assets to fully electric models. (Note: hybrid vehicles were not included in the zero carbon scenario as they are not classified as electric vehicles).

The savings to be realized from converting internal combustion engines (ICEs) to electric vehicles (EVs) are significant, consisting of avoided gasoline, diesel, and carbon tax costs, lower and less frequent maintenance costs, and more energy-efficient engines. Engine efficiency for EVs is almost 100% whereas ICE vehicles are only about 40% energy efficient.

The incremental cost to convert fleet to electric from 2022-2025 is $110,000. Transitioning the remaining fleet and equipment between 2026 and 2045 results in total incremental avoided costs of $5.6 million.

Table 3 Incremental Costs of Fleet Retrofit 2022-2045

Item	Amount $
Incremental Cost of Zero Carbon Vehicles and Chargers	$9,796,073
Avoided Carbon Tax on Gas and Diesel	-$3,313,549
Avoided Fuel Costs	-$8,407,569
Avoided Operations and Maintenance Costs	-$3,710,818
Total	**-$5,635,864**

Costs include the purchase of 371 vehicles (61 vehicles in 2022-2025 and 310 vehicles in 2026-2045), the installation of 113 electric vehicle charging stations (one charger for every five vehicles), and avoided carbon tax in the amount of $3,313,549.

Additional Recommendations for Fleet 2026-2045

To remain within the carbon budget, it is recommended that gasoline vehicles be replaced at a more rapid pace than the current asset lifecycle.

Converting all the gasoline fleet vehicles to EV models five years prior to the zero-emission target date (2040) will eliminate 2,540 tonnes of emissions and converting them by 2035 will eliminate a further 4,010 tonnes over the same period.

Lighting

The Town has already made significant progress with lighting, having converted all its streetlights to LEDs, and it expects traffic lights to be fully converted by the end of 2022. Work has also begun to convert facility lighting to LED and work is underway on sport field lighting.

For the purposes of this Study, it was assumed that all lighting controlled by the Town will have been replaced with LED equivalents by 2024. This will reduce energy consumption and increase the bulb replacement period from every four years to every 16 years.

The capital costs provided by Whitby to replace the remaining non-LED lights with LEDs is effectively the same as the costs for non-LED lights. As a result, there is

no incremental investment required between 2022 and 2025 to complete the replacement of park and sports field lighting with LEDs.

The improved energy efficiency of the LED bulbs installed in this period, however, will provide incremental savings in electricity costs of $55,000 over the BAU scenario.

Waste

Corporate waste is currently tracked only at a very high level in Whitby. However, it is recommended that waste reduction targets be developed to align with the Region's waste strategy which includes a target of zero waste by 2040.

To support waste elimination, it is recommended that the Town of Whitby improve its corporate waste tracking with the following steps:

- Begin tracking corporate waste volumes by category (e.g., organic waste, recyclables, paper, landfill, etc.). Each category can be dealt with differently, so gathering basic data about the types and quantities of waste is fundamental to developing an effective waste reduction plan.
- Complete comprehensive waste audits at all major Town-operated facilities and selected smaller facilities to understand types and proportions of waste by facility and develop a Corporate Waste Strategy to reduce and manage corporate waste and related emissions.
- Educate staff on waste reduction broadly and support small-scale, continuous improvement initiatives throughout the organization.

Staff have identified a capital budget to initiate this work in 2023 to include the development of a waste strategy, completion of waste audits, and the standardization and replacement of waste containers.

Leased Spaces

Increasing remote working, in conjunction with the construction of the Operations Centre Phase 2 Expansion, could make it possible to discontinue leasing office space in the Garden Street building at the end of its current lease in 2025 and result in reducing emissions. The Town does not have control over the energy efficiency or heating and cooling systems in properties it leases, and as a result, it will be difficult to reduce its corporate emissions to zero if it continues to lease such spaces. Ending the lease on the Garden Street building will reduce the Town's emissions by 15 tonnes and reduce the Town's energy costs by approximately $30,000 annually.

Staff Resources

The Costing Study outlines the resources required to successfully implement Zero Carbon Whitby.

The study acknowledges that, to achieve the implementation, the Town will require additional administrative, project management, construction, and HVAC labour including:

1. Facilities:
   Three additional project managers will be required to complete all the building retrofits, new builds, and energy system replacements on schedule for Zero Carbon Whitby. The first two would be required almost immediately to support the immediate increase in building work. With the additional workload and complexity of projects and operations increasing, a Senior Manager of Facilities will be required to assist the Director of Facilities to manage the span and control of the facilities portfolio.
2. Procurement and Finance:
   While Zero Carbon Whitby reduces the number of overall capital projects for facilities, however, the size and scope are larger and additional resources are required to manage the carbon budget and provide carbon accounting/track budget savings to be allocated to the Zero Carbon Revolving Fund for all Town project increases. As a result, it is recommended that Finance converts a part-time position to a full-time position to support Zero Carbon Whitby.

Resourcing is also affected in terms of skills. Implementing Zero Carbon Whitby will cost tens of millions of dollars. To ensure these investments are protected and the new infrastructure will operate successfully for years, staff will need to be educated and experienced in zero-emissions infrastructure implementation and management. For example, Whitby will require:

- Project managers who understand and can navigate the complexities of building large, zero-emissions recreation facilities;
- Building operations staff who can operate and maintain large ground source heat exchange systems, air source heat exchange systems, and integrated solar Photo Voltaic systems, ensuring they all run as efficiently and effectively as possible; and,
- Fleet maintenance staff who are skilled in managing electric fleet operations to ensure that vehicles and equipment are always charged when they are needed, while minimizing the number of chargers required, and optimizing the use of off-peak electricity costs.

The Sustainability team is recommending an increase of $3,000 per year to its annual operating budget to support the ongoing corporate wide training and education for the implementation of Zero Carbon Whitby.

Funding Approaches

Zero Carbon Revolving Reserve Fund

The Zero Carbon Costing Study includes a framework for a Revolving Fund. Using the costs and savings described above, the Study projects that Zero Carbon Whitby could be completed with $34.8 million in seed funding of which $31.8 million would need to be received by the end of 2025. Cost savings from energy, carbon tax, and select capital projects would be directed into the Zero Carbon Revolving Reserve Fund to pay for the balance of the $63.7 million identified in the Study.

Town staff have developed the Zero Carbon Revolving Reserve Fund policy (Report FS 52-22) for Council consideration to support the implementation of Zero Carbon Whitby.

The funds from this Zero Carbon Revolving Reserve Fund would be used only for the incremental costs of completing the zero-carbon work. Following implementation, 100% of operating cost savings (e.g. energy and carbon tax) would be directed to repay the reserve. Once the incremental costs have been fully repaid, 75% of the operating cost savings resulting from the work would continue to be directed into the reserve and the remaining 25% would be removed from the Town's operating budget as budget reduction. After the Zero Carbon Whitby work is complete, excess savings could be directed to other climate initiatives in the Town such as climate resilience.

Revolving funds such as these have been successfully used by communities such as the City of Edmonton, Moncton, Peterborough, and Caledon, as well as by universities across the country.

Initial Funding

The Study identifies that opportunities to finance Climate Change Revolving Fund includes:

- Grant funding (currently $42.1 million in process of application as detailed in Table 4)
- Bonds
- Loans
- Increasing the Tax Levy – (Halifax recently approved a 3% property tax increase for a minimum of 10 years, which will appear as a separate line item on tax bills and will be directed into a fund to be used only for community climate action).

Keys to Success

Outlined in the study are several key areas that allow Whitby to be successful in achieving Net Zero Emissions by 2045. These include:

- The more work that is completed early, the greater the savings to fund later work, and the greater the opportunity to take advantage of current federal funding.
- Progress on all actions in Zero Carbon Whitby should be monitored and published annually. Further, every municipal budget should include both the financial and the carbon costs of the items within the budget. The carbon costs should be presented relative to Whitby's carbon budget, with clear indications of whether the budget aligns with or deviates from the carbon budget/goals established within the Zero Carbon Whitby Plan.
- Decarbonization requires an end to using natural gas, gasoline, and diesel. Without doing so on the timeline reflected in this Study's schedule, it will be extremely unlikely Whitby will be able to stay within its carbon budget, and increasingly expensive to use these fuels as carbon taxes increase.

Next Steps

To support the success of Zero Carbon Whitby, the costing study outlines the following recommendations:

- Bring the Zero Carbon Whitby Costing Study budget for 2022-2045 forward for inclusion in budget planning. Get approval for Capital and Operational funding until 2025 and obtain direction to carry out the Study's work schedule over this period.

- Finalize an approach for securing at least $34.8 million in Revolving Fund seed funding. As outlined in the Financial Considerations section of this report the Town is exploring $42.1 million in grants for the Zero Carbon Whitby work.

- Establish a steering committee to oversee the completion of Zero Carbon Whitby, ensuring all departments with responsibilities have representation. Assign the work to the appropriate Town departments and establish a reporting structure that ensures progress is monitored and encouraged.

- Decide on an approach for addressing the Town's residual emissions to ensure the net-zero-by-2045 goal can still be reached including the

expedited transition to an electric fleet, removal of Combined Heat and Power from the Civic Recreation Complex, and exploration of installing renewable energy systems to support the broader community and that offset grid-based emissions.

- Support an increase in operational budget to support capacity building for Town staff by providing workshops and training on the new energy systems, building energy monitoring, electric vehicles, etc. that will be part of completing Zero Carbon Whitby.

- Track emissions from staff using personal vehicles for work activities and promote staff commuting sustainably (with active transportation or transit), and eliminate policies that promote personal vehicle commuting.

- Incorporate hybrid work policies to reduce required office space and the resulting energy use and emissions as well as emissions from commuting.

- Begin providing construction and operational emissions projections for new assets when projects are presented to Council for approval, including:
    - An indication of how the emissions will impact the Town's carbon budget; and
    - Whether the Town will be able to remain within its carbon budget if the project is approved, as well as a description of how additional emissions will be reduced elsewhere if the Town is not able to remain within its carbon budget.

5. Financial Considerations:

Cost to Complete Zero Carbon Costing Study

The total cost of the development of the Zero Carbon Whitby Costing Study is $161,000 and was approved as part of the 2022 Capital Budget as capital project 55227607. This project is funded by the Long-Term Finance Reserve

Staff are in the process of seeking a grant from the Federation of Canadian Municipalities in the amount of $128,000 to offset the costs of the study. If successful, funding for this project will be revised to $33,000 from the Long-Term Finance Reserve and $128,000 from the Federation of Canadian Municipalities grant.

Incremental Capital Costs

Overall, implementing Zero Carbon Whitby requires an incremental Capital investment of $63.7 million between 2022 and 2045. In return, over the same

period it will provide $75.3 million in operational avoided costs and savings. These costs are based on current technology and cost estimates and will need to be refined annually as additional details, solutions and technologies emerge.

Incremental Operating Costs

To support the ongoing education and capacity building, staff have identified $3,000 to be included in the Sustainability Division's annual Operating Budget for Council consideration as part of the budget process. The funds would be used to support the delivery of training and workshops associated with Zero Carbon Whitby.

Grant Opportunities Being Sought

To support the incremental capital costs several grant opportunities are being explored including the following grants totaling $42.1 million:

Table 4 Grants Table

Funding Source	Agency/ Funder	Amount Requested	Work
Zero Emissions Infrastructure Vehicle Program	Natural Resources Canada	$0.6 million	Installation of Level 2 Charging Stations
Green and Inclusive Community Buildings	Infrastructure Canada	$25 million $3 million	Funding for WSC to achieve Zero Carbon and LEED Gold Certification. Deep Carbon Retrofit of McKinney Centre and a fulltime staff person to oversee the work.
Green Community Buildings Retrofit Program	Federation of Canadian Municipalities	$3 million	Deep Carbon Retrofit of McKinney Centre and a fulltime staff person to oversee the work.

Funding Source	Agency/ Funder	Amount Requested	Work
Low Carbon Economy Fund	Environment and Climate Change Canada	$10.5 million	Entire Deep Carbon Retrofit of IPSC, McKinney Centre & Operations and 2 full-time staff to oversee the work.

Staffing Costs

To support the implementation of Zero Carbon Whitby, three full-time permanent staff have been recommended to support the retrofit of buildings.

Funding to support 40% of the costs for two of the positions from 2023-2045 has been identified in a funding request through the Low Carbon Economy Fund and Green and Inclusive Community Buildings Fund.

In addition to Facilities staff, there is also a recommendation for the conversion of a part-time Finance position to a full-time Finance position to support the carbon accounting process.

These positions will be brought forward as part of the annual budget process.

Climate Revolving Fund

Town staff have developed a Zero Carbon Revolving Reserve Fund policy for Council consideration to support the implementation of Zero Carbon Whitby.

The reserve fund is meant to be revolving as investments (or draws from the fund) are to be repaid from operating budget savings (e.g. lower energy costs). Specifically, the policy notes that 100% of the annual operating budget savings will be directed into the reserve fund until the initial investment has been fully repaid. After the reserve fund has been fully repaid, 75% of the annual operating budget savings will continue to be allocated to grow the reserve fund, and the remaining 25% will be reduced from the Town's Operating Budget, as budget savings. After the Zero Carbon Whitby work is complete, excess savings may be directed to other climate initiatives in the Town.

6. Communication and Public Engagement:

Education and ongoing staff engagement will be required to continue to expand awareness of climate literacy across the organization, which will be led by the Sustainability Division. The Zero Carbon Whitby Plan will also be integrated into the annual budget communications planning to the general public to increase their understanding of the steps and investments the Town is taking to address climate change.

7. Input from Departments/Sources:

Project Team

A project team comprised of Strategic Initiatives, Financial Services, Community Services, Operational Services, and Fire Services have provided extensive input into the development of this Report.

Corporate Energy Team

In 2020, a Corporate Energy Team (CET) was formed which consists of staff from multiple departments that helped to identify and shape the Town's corporate energy and emissions performance. The CET has been engaged throughout the process of this study, including the completion of the Zero Carbon Whitby Plan, energy audits, the greenhouse gas inventory modelling process, and staff training.

8. Strategic Priorities:

The Zero Carbon Whitby Costing Study responds directly to Council's declaration of Climate Change as an emergency while aligning with several Council Goals including enhancing the transparency of the Town of Whitby's operations while ensuring responsible financial management and a sustainable, healthy, and balanced community.

Zero Carbon Whitby supports the implementation of the Town's Corporate Strategic Plan. The Carbon Budget enhances two core values - Accountability and Collaboration - meeting objectives that improve the organization by fostering innovation and focusing on making our processes better while also developing a mechanism to measure results in pursuit of ongoing improvements as it relates to climate change action.

The implementation of Zero Carbon Whitby aligns with the Town's Business Plan and responds directly to Environmental Sustainability.

Zero Carbon Whitby has been developed taking into account the ten principles of the One Planet Living Planet Framework for sustainability and addresses the Town of Whitby's role in addressing greenhouse gas emissions to secure a sustainable future. Methods used to develop the Plan consider fiscal responsibility as well as establishing targets in a fair and equitable manner helping to ensure environmental, economic, and social wellbeing.

9. Attachments:

Attachment 1 – Staff Report CAO 19-22 - Zero Carbon Whitby Costing Study

2022

Zero Carbon Whitby

The Costing Study to Eliminate Greenhouse Gas Emissions 2022-2045

whitby.ca/climatechange

Whitby

Disclaimer

Reasonable skill, care, and diligence have been exercised to assess the information acquired during the preparation of this analysis, but no guarantees or warranties are made regarding the accuracy or completeness of this information. This document, the information it contains and on which it relies, and other associated factors are subject to changes that are beyond the control of the author. Information provided by others is believed to be accurate but has not been verified. It includes strategic-level estimates of climate risk, impact, and cost that should not be relied upon for design or other purposes without verification. No part of this Study should be considered the equivalent of a detailed, engineering-level analysis of any specific facility within Whitby.

This analysis applies to the Town of Whitby and cannot be applied to other jurisdictions without further analysis. Any use by the Town of Whitby, its sub-consultants, or any third party, or any reliance on or decisions based on this document, are the responsibility of the user or third party. The authors do not accept responsibility for the use of this analysis for any purpose other than that stated below and do not accept responsibility for the use, in whole or in part, of the contents of this document by any third party.

Purpose of This Document

The Zero Carbon Whitby Costing Study ("the Study") is a schedule and costing analysis that details the work required for the Town of Whitby to become a 'net-zero emissions' corporation by 2045. It builds upon "Zero Carbon Whitby: The Corporate Plan to Reduce Greenhouse Gas Emissions" ("Zero Carbon Whitby") by providing a budgeted implementation plan for the work required over the next 22 years to reduce Whitby's corporate greenhouse gas inventory to net-zero emissions. This document provides Whitby with:

1. A work schedule that meets Whitby's emissions reduction targets, minimizes interruptions to building operations, optimizes the benefits of the 'high-impact emissions reduction' work by scheduling it early, and distributes the work over time to minimize the need for additional staff;
2. An analysis of the incremental costs and savings to implement Zero Carbon Whitby that is specific to the Town's buildings, fleet, and lighting and is presented in the context of the operational and capital budgets; and
3. An investment schedule and possible funding approaches that align with the work schedule, highlight key funding sources, and leverage the savings of early high-impact actions to fund subsequent investment.

This document includes detailed schedules, costs and savings for work required in the 2022 - 2025 period as well as high-level schedules, costs and savings for 2026 - 2045. Detailed schedules, costs and savings for the later period have been provided to the Whitby Project Team as work products from the Study.

TOWN OF WHITBY

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Executive Summary

This Costing Study provides a schedule and incremental budget for the Zero Carbon Whitby Plan that optimizes the Town's corporate carbon budget with its existing capital budget and asset management plans.

Completing the Zero Carbon actions according to the schedule provided in this Study will permanently reduce the Town's corporate emissions by 74.6% by 2045. The remaining emissions will come from the provincial grid, and high-level options are given for addressing these.

The Study includes a detailed schedule of the work to be completed in buildings, fleet, and lighting for the period of 2022 - 2025. It also includes a higher-level schedule of the work required between 2026 and 2045.

The total incremental cost of the work between 2022 and 2045 will be $63.7 million. In return, over the same period it will provide $75.3 million in net savings and avoided costs.

The Study determined that this incremental cost could be paid for entirely from a Zero Carbon Revolving Reserve Fund, seeded with an initial $34.8 million in funding and supplemented by the energy, carbon tax, and select capital savings from the Plan. Six potential approaches for securing the remaining funding are provided in this document.

Adherence to the following guiding principles will be key to the success of this work:

- The more work that is completed early, the greater the savings to fund later work and the greater the opportunity to take advantage of current federal funding.
- Progress on all actions in Zero Carbon Whitby should be monitored and published annually. Further, every municipal budget should include both the financial and the carbon costs of the items within the budget. The carbon costs should be presented relative to Whitby's carbon budget, with clear indications of whether the budget aligns with or deviates from the carbon budget.
- Decarbonization requires an end to using natural gas, gasoline, and diesel, and without doing so according to the timeline reflected in the Study's schedule, it will be a) extremely unlikely Whitby will be able to stay within its carbon budget and b) increasingly expensive to use these fuels as carbon taxes increase.

As one of the first municipalities to develop a Costing Study to decarbonize its corporate assets by 2045, the Town of Whitby is a leader in municipal climate action. This Study combines rigorous GHG modelling with the Town's capital budget and asset management schedule, resulting in an optimized decarbonization schedule and a detailed budget. This work has prepared Whitby to move quickly and take advantage of the significant federal funding currently available for this work. It has also provided Whitby with clear substantiation for long-term financial and operational benefits of decarbonization.

Costing Study Approach

The Zero Carbon Whitby Study is based on the actions and targets in Zero Carbon Whitby. The team leveraged building energy audits, the Fleet Strategic Master Plan, Whitby staff expertise, Canadian Green Building Council standards, and actions implemented in other cities to develop a detailed view of each action's pathway to zero. The Study's approach aligns with the four-year carbon budget cycle outlined in Zero Carbon Whitby. It details fiscal decisions to be made in the first carbon budget cycle (2022-2026), understanding that fiscal budget approval is annual.

A schedule was designed to align the timing of actions as much as possible with Whitby's Asset Management Plan, known funding constraints, and the carbon budget and targets from Zero Carbon Whitby. It also optimized opportunities to harvest energy savings from early large building retrofits to fund further retrofits.

Costs and forecast emission factors for the business-as-usual scenario came from Whitby staff, IESO, the Canada Energy Futures Report, and the federal carbon tax. Using these inputs, business-as-usual and zero-carbon-by-2045 scenarios for energy use, emissions, and costs were modelled. The resulting cost and savings forecasts were translated into an investment schedule, which informed guidance on a funding approach.

At each stage, Whitby staff participated in defining and reviewing the approach and assumptions. They evaluated the implications on staffing and operations and provided feedback to the risk analysis found in Appendix A of this document. Based on their input, adjustments were made throughout.

The final Study provides:

1. Anticipated costs and savings for each of the projects to be undertaken to complete Zero Carbon Whitby;
2. A schedule of the projects to be undertaken; and
3. Guidance regarding funding options, and the establishment of the Zero Carbon Revolving Reserve Fund.

These are supplemented by a high-level assessment of resourcing and operations impacts and a risk and mitigation analysis.

Scope

IN SCOPE

This Study focuses on Whitby's corporate assets responsible for producing the scope 1 and 2 emissions tracked in the Town's corporate greenhouse gas inventory. This includes emissions generated from:

- Heating and cooling buildings owned and operated by the Town;
- Electricity for internal and external building lights, equipment, appliances, and plug use;
- Work-related vehicle transportation and equipment use; and
- Electricity for street, traffic, park and sports field lighting.

OUT OF SCOPE

The following were out of the Study's scope:

- Transit and water and wastewater treatment are handled by the Region of Durham and are not within the Town's operational control.
- Emissions from employee commutes in personal vehicles.
- Engineering-level analyses of the actions required to make individual buildings net-zero were not completed as part of this study. Cost estimates will become more precise and accurate with subsequent analysis as the work progresses.
- Emissions from buildings leased by the Town from third parties. These buildings do not appear in Whitby's corporate GHG inventory, and the Town cannot control the systems within them. These buildings include:
  - The Municipal Branch Office at 3000 Garden Street;
  - Rossland Library Branch; and the
  - Industrial Drive Methane Monitoring Station.
- Buildings for which detailed energy use, asset management, and/or capital forecast data were not available or sufficient to develop zero-carbon pathways. These buildings include:
  - The Whitby Soccer Domes at 695 Rossland Road West;
  - James Rowe House;
  - The residential property at 220 Thomas Street; and
  - Splash pads.
- Detailed data about corporate waste composition and tonnage were not available for analysis of costs, savings, and earnings for specific waste-reduction actions. The Zero Carbon (ZC) scenario assumes waste reduction is aligned with the Region of Durham's target of zero waste by 2040. Recommendations for the Town of Whitby are included in the Next Steps section of this document.
- Impacts of Zero Carbon Whitby on the following:
  - General administrative costs, grants, purchased services, and supplies.
  - Requirements extending from decarbonization of the fleet, such as sufficiency of grid electricity distribution, IT requirements, and upskilling staff to maintain zero- emissions vehicles.
  - General staffing requirements. Where additional staff were required to do the work modelled, the number and type of staff are identified, but salary and benefit costs have not been included. In addition, any need to increase staffing levels for such activities as procurement and vehicle maintenance have not been analyzed, and the related costs are not included.

The Incremental Costs and Savings of Zero Carbon

The primary intent of this Study is to identify the incremental cost to the Town of Whitby to implement the Zero Carbon Whitby Plan, which involves transitioning all operations to net-zero emissions by 2045. For these purposes, the incremental cost is defined as the difference between the costs of the zero-emissions measures and those of the "Business-as-Usual" (BAU) scenario. This means that the incremental costs shown in this report are in addition to expected BAU costs, and savings are relative to the expected BAU costs.

In addition, the Study provides detailed incremental costs and savings for 2023 - 2025 to support immediate budget planning needs. Results for 2026 - 2045 are less detailed and provide the Town with flexibility to adjust the approach and technologies used during this period.

For details on the methodology used and the assumptions made, please see Appendix B.

Summary

Overall, implementing Zero Carbon Whitby requires a net incremental capital investment of $63.7 million between 2022 and 2045. Over the same period it will return $75.3 million in avoided costs, and from 2045 to 2050, a further $30.3 million of savings will be realized. As a result, the ultimate return on investment between 2022 and 2050 is $1.66 for every $1 invested.[1]

In the context of planning for the 2023 budget and immediate timeframe, the net investment and savings can be broken down as follows. Between 2022 and 2025:

- Incremental capital funding of $31.6 million is required and
- Operational budgetary savings will amount to $1.4 million.

In the context of existing long-term budget commitments, between 2026 and 2031:

- Incremental capital funding of $13.8 million is required and
- Operational budgetary savings will amount to $13.7 million.[2]

Between 2032 and 2045:

- Incremental capital funding of $18.3 million is required and
- Avoided costs will amount to $60.3 million.[3]
-
-

[1] All values are in 2022$.

[2] These are savings against planned operational costs that have been projected out to the end of 2031. For the period beyond 2031, because there is no operational budget projection, savings are represented as avoided future costs.

[3] The total net cost and savings between 2022 and 2045 will not be equal to the sum of costs and savings for shorter periods within this timeframe. This is because the shorter period will show costs and savings that are netted out in the total.

Table 1. Incremental investment, savings and avoided costs by period.

	2022 - 2025	2026 - 2031	2032 - 2045	TOTAL
Incremental Investment Required	$31,593,000	$13,832,000	$18,283,000	$63,708,000
Operational Budgetary Savings	$1,379,000	$13,668,000	0$	$15,047,000
Avoided Costs	$0	$0	$60,254,000	$60,254,000

Figure 1 shows the annual incremental costs and savings of implementing Zero Carbon Whitby over time and by category. Values shown above $0 on the y-axis represent net costs, and values below $0 are net savings.

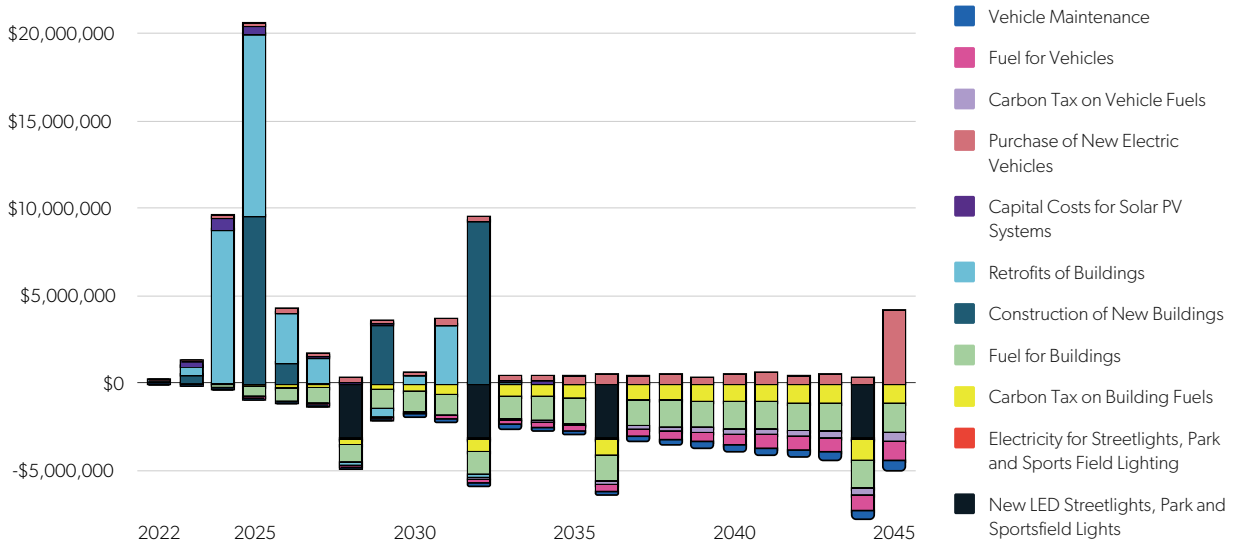

Figure 1. Incremental cost of Zero Carbon Whitby over time and by category.

SECTOR SUMMARIES

Investments

The largest single sector of incremental investment required for Zero Carbon Whitby is in capital costs for building retrofits. Renovating existing buildings' envelopes, roofs and replacing their heating systems[4] requires an additional $27.1 million (2022$) over the BAU scenario between 2022 and 2045.

The sector requiring the second-largest incremental investment is new building construction. Ensuring all new facilities are net-zero requires an additional $23.8 million (2022$) between 2022 and 2045 over the BAU scenario. Town staff have already submitted applications for over $30

[4] These are the most common renovations planned. Refer to Appendix B for a more detailed explanation of the retrofits modelled.

million in grants to cover these costs.[5]

In addition, replacing the fleet with zero-emissions vehicles will require an additional $9.8 million in capital investment, and the installation of solar PV (photovoltaic) systems on Town facilities will require $2.1 million in incremental investment.

Savings/ Avoided Costs

The sector providing the most savings between 2022 and 2045 is building fuel. Eliminating natural gas to heat buildings will save the Town of Whitby $28.4 million. The associated carbon tax will save an additional $17.0 million in the same period.

The third-largest savings will come from the significantly longer life expectancy of LED lights. Replacing LED bulbs ¼ as often as standard bulbs from 2024 on will avoid $13.0 million in costs between 2022 and 2045. This does not include the associated energy savings.

In the fleet, eliminating the use of gasoline and diesel will avoid $8.4 million in fuel costs and a further $3.3 million in carbon taxes. The reduced need for maintenance on zero-emissions vehicles will contribute $3.7 million to avoided costs.

CAPITAL BUDGET AND OPERATING BUDGET[6]

Between 2022 and 2045, Zero Carbon Whitby will require a 16% incremental investment over the BAU ($49.8 million in additional funding) for capital projects but will reduce operational costs (fuel, carbon tax, and building and vehicle operations and maintenance) by 29% ($59.3 million) relative to the BAU.

Figures 2 and 3 show the total capital and total operational costs, respectively, for the two scenarios over time.

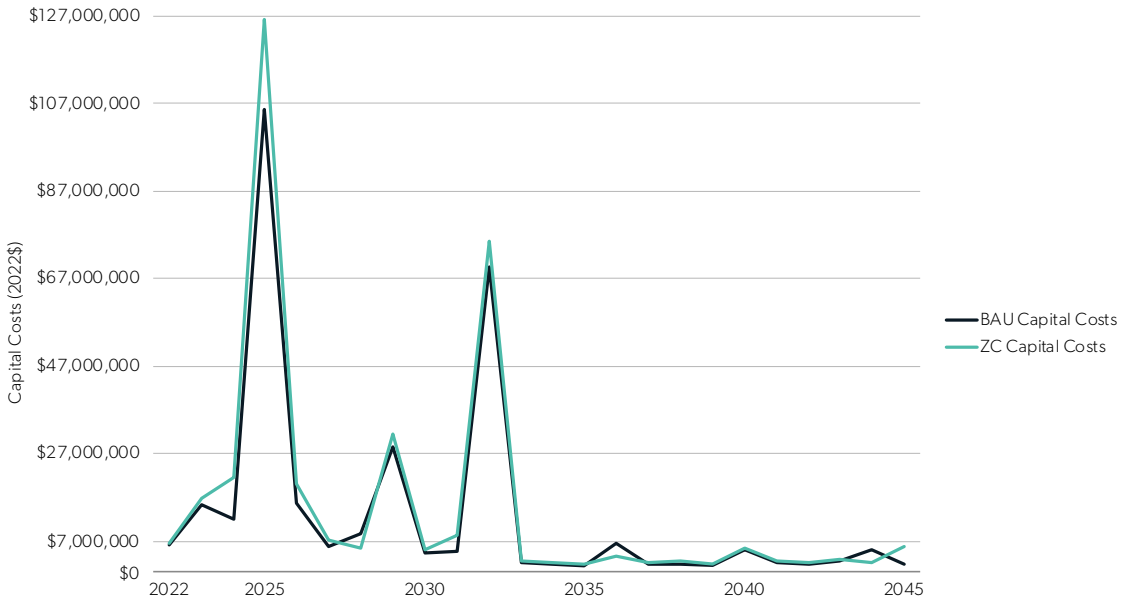

Figure 2. Total capital costs for BAU and ZC scenarios over time.

[5] Refer to Appendix C for Grants in Progress for Zero Carbon Whitby Work.

[6] Refer to Appendix B for the sources of costs used in the Study for both the BAU and ZC scenarios.

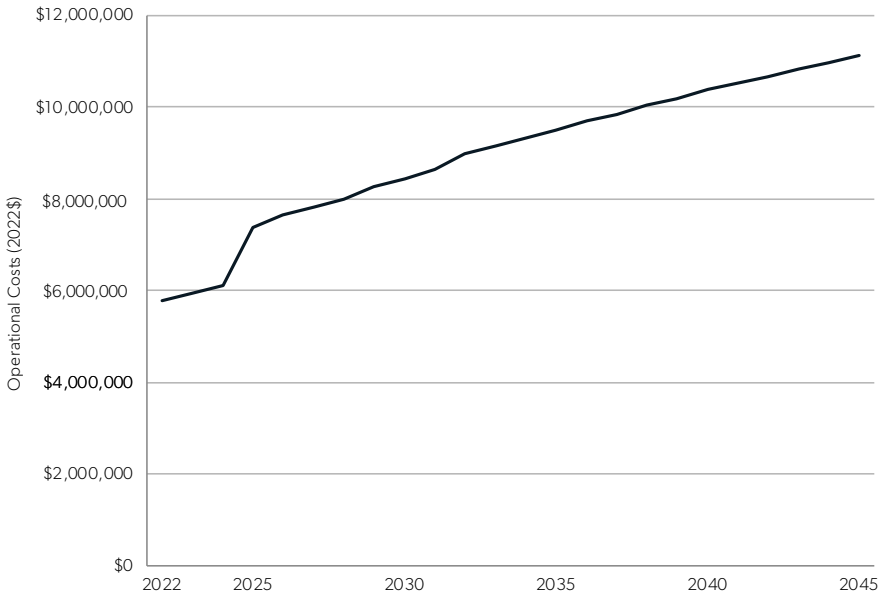

Figure 3. Total operational costs for BAU and ZC scenarios over time.

OVER TIME

The bulk of the work in Zero Carbon Whitby. Between 2022 and 2025, Zero Carbon Whitby requires $31.6 million (2022$) more in investment than the Business-as-Usual scenario. This puts financial pressure on the Town during this period and highlights the immediate need to hire staff who are skilled in deploying and managing zero-emissions infrastructure. Fortunately, the funds collected through the federal carbon tax are a significant source of financing to support the required capital investment and the hiring of additional resources.

Although Whitby has not relied heavily on external funding in the past, in this case, it will be beneficial to do so. Drawing significantly on external funding, especially for early capital projects, will immediately reduce energy use sufficiently to liberate millions of dollars from future operational budgets. These funds will be freed up for the Town to use on improving services and funding community climate mitigation and adaptation work. By the end of 2042, the Plan will have paid for itself and will have provided $600,000 in additional savings and avoided costs. In 2045, the Plan will have generated $11.6 million in net savings. These savings continue to grow steadily until 2050, at which point the Plan will have resulted in a cumulative net total of $23.2 million (2022$) in savings and avoided costs. The investment also reduces Whitby's exposure to fluctuating energy costs, which can be disruptive to operating expenditures and governance processes.

In the Funding Approaches section, this Study discusses the potential for further leveraging these funds through the creation of a revolving fund.

With appropriate seed funding and management, Zero Carbon Whitby can achieve the Town's goal of becoming net zero by 2045, and it can provide a steadily increasing source of funds that can be used to increase service levels and fund the Community Climate Mitigation and Adaptation Plans without increasing the tax levy.

RESIDUAL EMISSIONS

Zero Carbon Whitby identifies Whitby's carbon budget for the period of 2022 - 2045 as 62,562 tonnes of CO2e (or carbon dioxide equivalents). The schedule developed for this Study reduces the Town's corporate emissions to 81,136 tonnes of CO2e over this period. This amounts to 18,574 tonnes of "residual emissions", or emissions that exceed the Town's carbon budget. This is represented in Figure 4 as the space between the green line and the blue bars.

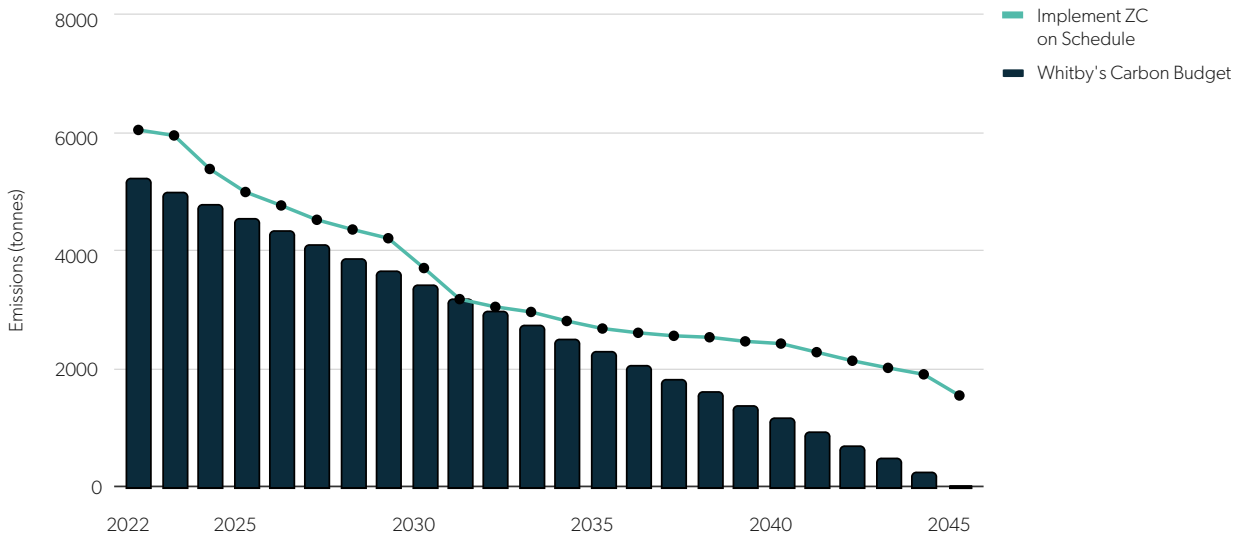

Figure 4. Whitby's carbon budget and the Zero Carbon Whitby costing study schedule.

To stay within its carbon budget and avoid additional, annual costs for offsets, Whitby must accelerate some actions or identify additional actions it will take to address these residual emissions. These actions may include the following:

- Completing the transition of gasoline vehicles to EVs by 2040 rather than 2045, eliminating 7,228 tonnes of emissions.
- Completing the transition of gasoline vehicles to EVs by 2035 to eliminate a further (i.e. in addition to those eliminated by accelerating the transition to 2040) 6,681 tonnes of emissions.
- Completing the transition of diesel vehicles to EVs by 2032 to eliminate 1,968 tonnes of emissions.
- Prior to buildings being retrofit, installing small-scale carbon capture units to sequester 5-8 tonnes of emissions annually per building.[7]

It should be noted that 1,317 tonnes of these emissions are forecast to come from the provincial grid. As such, they are outside the direct control of the Town of Whitby; however, these could still be offset by installing renewable energy within the municipality. This would allow the Town

[7] With the support of the Alberta Ecotrust Foundation, the City of Edmonton, ATCO Gas and others have installed CarbinX (carbinx.com) small-scale carbon capture units in corporate buildings, and reduced emissions until the buildings underwent renovations and energy system replacements..

to eliminate local emissions resulting from its operations, demonstrate leadership, and invest in local economic development rather than using offset purchases to fund development elsewhere.

TRACKING THE FINANCIAL BUDGET IMPLICATIONS AGAINST THE CARBON BUDGET

The 2023 financial budget should include the scheduled actions from this Study. It should also include a table similar to Figure 5, with values for both the carbon budget and the forecast emissions associated with the budget being requested filled out for each area for the 2023 - 2026 period.

	CARBON BUDGET MAXIMUM EMISSIONS[8]	2023 BUDGET FORECAST EMISSIONS	CARBON BUDGET MAXIMUM EMISSIONS	2023 BUDGET FORECAST EMISSIONS	CARBON BUDGET MAXIMUM EMISSIONS	2023 BUDGET FORECAST EMISSIONS	CARBON BUDGET MAXIMUM EMISSIONS	2023 BUDGET FORECAST EMISSIONS	CARBON BUDGET MAXIMUM EMISSIONS	2023 BUDGET FORECAST EMISSIONS
Year	**Buildings**		**Fleet**		**Streetlights**		**Waste**		**Total**	
2023	2,891		1,815		146		135		4,987	
2024	2,760		1,732		140		129		4,760	
2025	2,628		1,650		133		123		4,534	
2026	2,497		1,567		126		116		4,307	

Figure 5. Carbon budget and forecast emissions template for 2023 budget.

The values in the "Carbon budget Maximum Emissions" columns are taken from Table 4 of Zero Carbon Whitby.

The values in the "2023 Budget Forecast Emissions" will need to be filled out by Whitby staff to reflect the corporate emissions that will occur due to the items requested in the budget. For example, if the budget includes the purchase of electric vehicles, equipment and chargers as required in this Study's schedule for the 2023 budget period, the 2023 Budget Forecast Emissions for Fleet should be equal to or less than the values in the Carbon Budget Maximum Emissions column. If however, the budget includes some ICE vehicles instead of the required EVs, the Fleet 2023 Budget Forecast Emissions will be higher than the Carbon Budget Maximum Emissions column. This indicates that approving these purchases would cause the Town's carbon budget to be exceeded. The budget would need to be changed to reduce the emissions and remain aligned with the carbon budget.

Buildings

ZERO-CARBON COSTS AND SCHEDULE FOR 2022–2025

Capital Costs

Between 2022 and 2025, Whitby will need to retrofit and replace energy systems in 33 buildings, build two new facilities (the Fire Station Training Tower/ Fire Training Complex and the Whitby Sports Complex), and complete the Operations Centre Phase 2 Expansion to a net-zero standard. Table 2 lays out the incremental capital costs required by building and work type over

[8] All emissions values are in tonnes.

this period.[9]

Note that in a number of cases, the Zero Carbon Whitby work eliminates projects included in the BAU scenario. For example, installation of a ground source heat exchange system eliminates the need to replace a natural gas furnace. Table 2 shows the avoided BAU costs as negative numbers because they represent funds that were already included in the BAU Capital Forecast but can now be redirected to the Zero Carbon Whitby work. They effectively reduce the incremental cost of Zero Carbon Whitby.

Table 2. Incremental costs by building for retrofits and energy systems 2022–2025.[10]

BUILDING NAME	TYPE OF WORK	2022	2023	2024	2025	TOTAL INCREMENTAL CAPITAL COST 2022 - 2025
1855 INNOVATION HUB ACCELERATOR	BUILDING RETROFITS	$0	$16,058	$0	$0	$16,058
ASHBURN COMMUNITY CENTRE	BUILDING RETROFITS	$58	$4,370	$16,473	$3,271	$24,172
	SOLAR PV SYSTEM INSTALLATION	$0	$0	$0	$15,439	$15,439
BOAT STORAGE AND REPAIR	BUILDING RETROFITS	-$6,954	-$148,082	$270,200	-$64,502	$50,663
BROOKLIN COMMUNITY CENTRE (OLD)	BUILDING RETROFITS	$190	$978	$38,302	-$5,202	$34,268
BROOKLIN COMMUNITY CENTRE AND LIBRARY	BUILDING RETROFITS	$711	$6,845	$122,299	$1,350,273	$1,480,128
BROOKLIN COMMUNITY DAY CARE	BUILDING RETROFITS	$0	-$6,653	$0	-$23,952	-$30,606
CENTRAL LIBRARY	BUILDING RETROFITS	-$13,307	-$17,370	$718,917	$3,277,836	$3,966,076
	SOLAR PV SYSTEM INSTALLATION	$0	$0	$0	$192,988	$192,988
CIVIC RECREATION COMPLEX	BUILDING RETROFITS	$282,783	$123,227	$46,463	$947,516	$1,399,989
CAMP X	BUILDING RETROFITS	$0	$0	$9,472	-$12,516	-$3,044

[9] All costs are provided in 2022$ and include the costs for materials and labour for both construction and installing zero-emissions energy systems. Where required, feasibility studies and design are also included and are calculated as an additional 15% of capital costs. Details of the work to be done for each building are provided in the Zero-Carbon Measures document that has been provided with this Study.

[10] Negative numbers in this table represent savings in the form of building retrofits and maintenance that were budgeted for in the BAU scenario but are not required in the ZC scenario.

BUILDING NAME	TYPE OF WORK	2022	2023	2024	2025	TOTAL INCREMENTAL CAPITAL COST 2022 - 2025
FIRE DEPARTMENT HEADQUARTERS AND FIRE HALL #5	BUILDING RETROFITS	-$2,441	$453,616	$1,502,637	$0	$1,953,812
FIRE HALL #1	BUILDING RETROFITS	$0	$44,214	$147,133	$0	$191,347
FIRE HALL #2	BUILDING RETROFITS	$0	-$20,865	$71,231	$26,064	$76,430
FIRE HALL #3	BUILDING RETROFITS	$19,068	$198,878	-$85,783	$68,918	$201,081
FIRE HALL #4	BUILDING RETROFITS	-$11,838	-$13,013	$197,222	$91,690	$264,061
FIRE STATION TRAINING TOWER	NEW BUILDING CONSTRUCTION	$434,188	$0	$0	$0	$434,188
HEYDENSHORE PAVILION	BUILDING RETROFITS	$1,615	$187,588	$234,685	$140,344	$564,231
IROQUOIS PARK SPORTS CENTRE	BUILDING RETROFITS	-$260,334	-$412,836	$922,655	$1,525,636	$1,775,121
	SOLAR PV SYSTEM INSTALLATION	$0	$318,798	$0	$0	$318,798
LUTHER VIPOND MEMORIAL ARENA	BUILDING RETROFITS	$8,923	$0	$61,883	$193,408	$264,214
	SOLAR PV SYSTEM INSTALLATION	$0	$0	$0	$289,481	$289,481
LYNDE HOUSE ACTIVITY CENTRE	BUILDING RETROFITS	$0	$10,047	$46,274	$0	$56,321
MCKINNEY CENTRE	BUILDING RETROFITS	-$11,406	-$2,557	$164,676	$2,093,512	$2,244,225
	SOLAR PV SYSTEM INSTALLATION	$0	$0	$608,119	$0	$608,119
WHITBY SPORTS COMPLEX	NEW BUILDING CONSTRUCTION	$0	$9,233,291	$0	$0	$9,233,291
OLD MYRTLE FIRE STATION (STORAGE)	BUILDING RETROFITS	$0	$5,744	$25,713	$0	$31,456
OPERATIONS CENTRE	BUILDING RETROFITS	$2,051	$198,390	$3,537,164	$175,429	$3,913,034
	SOLAR PV SYSTEM INSTALLATION	$0	$0	$101,353	$0	$101,353
OPERATIONS CENTRE EXPANSION PHASE 2	NEW BUILDING CONSTRUCTION	$0	$315,772	$0	$0	$315,772

BUILDING NAME	TYPE OF WORK	2022	2023	2024	2025	TOTAL INCREMENTAL CAPITAL COST 2022 - 2025
OPERATIONS CENTRE MAINTENANCE BUILDING	BUILDING RETROFITS	$0	$0	$20,049	$100,245	$120,295
OPERATIONS CENTRE SAND AND SALT DOMES	BUILDING RETROFITS	-$125,887	$0	$0	$0	-$125,887
PORT WHITBY MARINA	BUILDING RETROFITS	$1,731	$80,814	$32,431	-$53,228	$61,748
PRINGLE PARK WASHROOMS	BUILDING RETROFITS	$90,421	$0	$0	$0	$90,421
RENTAL PROPERTY 117 KING STREET	BUILDING RETROFITS	$0	-$14,043	$30,413	$0	$16,370
RENTAL PROPERTY 316 COLBORNE STREET WEST	BUILDING RETROFITS	$0	$0	$0	$18,679	$18,679
SPENCER COMMUNITY CENTRE	BUILDING RETROFITS	$20	$10,211	$298	$20,003	$30,532
WHITBY ANIMAL SERVICES	BUILDING RETROFITS	$0	-$27,294	$41,325	$0	$14,031
WHITBY CENTENNIAL BUILDING	BUILDING RETROFITS	$577	$12,332	$344,672	-$149,551	$208,030
WHITBY MUNICIPAL BUILDING	BUILDING RETROFITS	$70,276	-$268,117	$151,872	$479,851	$433,883
WHITBY SENIORS ACTIVITY CENTRE	BUILDING RETROFITS	$151,262	$42,078	$114,429	$55,410	$363,179
WHITBY STATION GALLERY	BUILDING RETROFITS	-$30,460	$20,049	-$5,562	$200,706	$184,733

The total incremental investment required to complete this work is $31.4 million, as shown in Table 3.

Table 3. Incremental cost by category for new building construction, retrofits and energy systems 2022–2025.

SECTOR	COST/SAVINGS
New Building Constructions	Incremental Cost of $9.98 million
Building Retrofits	Incremental Cost of $19.89 million
Solar PV System Installations	Incremental Cost of $1.5 million

Operational Savings

Operational savings from building operations will remain relatively low until significant retrofits have been completed and renewable energy systems have been installed. Between 2022 and 2025, operational savings from buildings will total $1.2 million from savings in natural gas costs and associated carbon taxes.

ZERO-CARBON COSTS FOR 2026–2045

Capital Costs

Between 2026 and 2045, Whitby will need to retrofit and replace energy systems in 32 buildings, build three new facilities (two Satellite Public Works Facilities and Fire Hall 6), and complete expansions on the Whitby Municipal Building and the Operations Centre, all to a net-zero standard. The required $22.5 million in incremental capital investment is broken down in Table 4.

Table 4. Incremental cost by category for new building construction, retrofits and energy systems 2026–2045.

SECTOR	COST/SAVINGS
New Building Construction	Incremental Cost of $13.9 million
Building Retrofits	Incremental Cost of $8.0 million
Solar PV System Installations	Incremental Cost of $557,000

The individual retrofits required for all buildings modelled are provided in the Zero-Carbon Measures document developed as part of this Study.

Operational Savings

In the BAU scenario, operational costs for buildings grow steadily over time. By contrast, in the ZC scenario, operational costs level off as quickly as buildings are retrofit and then remain stable for the remainder of the period. As a result, operational savings from avoided energy and carbon tax costs grow significantly as more facilities are made energy efficient and switched to zero-emissions energy systems. Between 2026 and 2045, these incremental savings amount to $44.7 million.

Figure 6 shows the incremental savings from building operations over this period as the space between the blue and green lines.

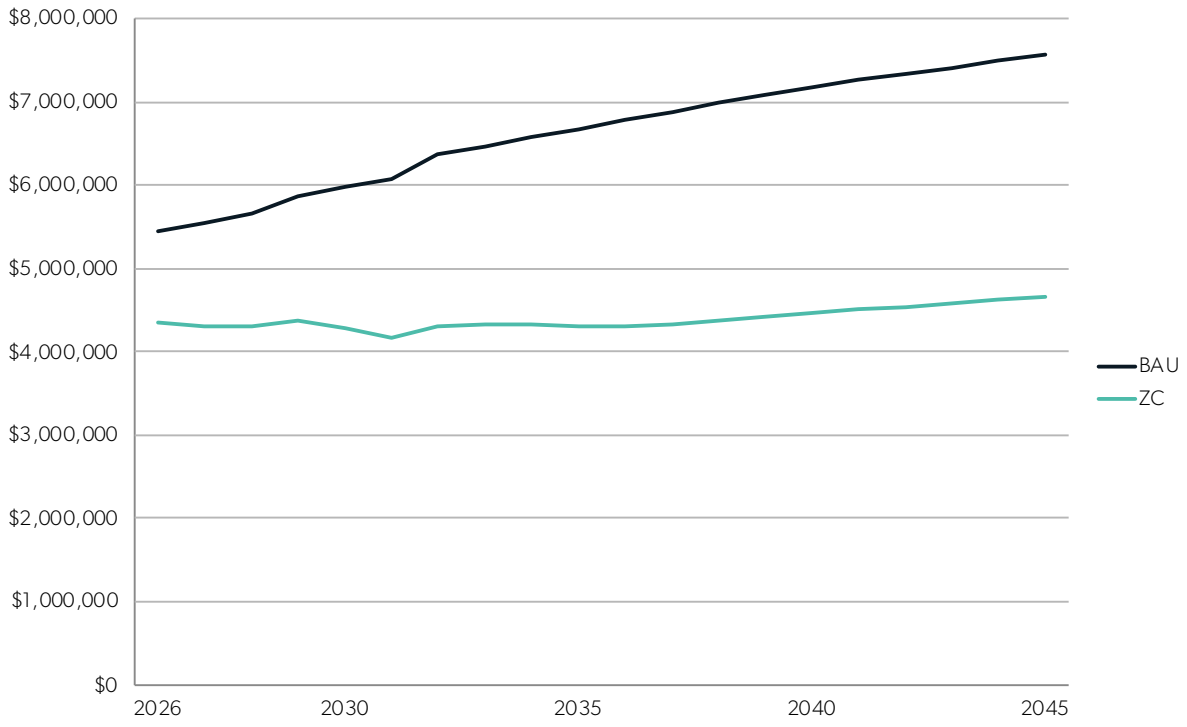

Figure 6. Savings from building operations in the ZC scenario between 2026 and 2045.

Specific Recommendations for Buildings in 2026–2045: Civic Recreation Complex

The Civic Recreation Complex (CRC) is a single facility that is responsible for almost 20% of the Town's corporate GHG emissions. Whitby has a contract to procure natural gas for this facility for approximately 11 more years.

If the Town continues to operate the CRC using natural gas, this facility will emit almost 1000 tonnes of GHGs annually, equalling 14,200 additional tonnes of emissions.[11] This increases Whitby's total forecast emissions between 2022 and 2045 to approximately 96,000 tonnes.[12] This is 34,000 tonnes over the Town's 62,000 tonne carbon budget.

Figure 7 below shows Whitby's carbon budget (blue bars), emissions in the BAU scenario (light blue line), emissions in the ZC scenario (pink line), and emissions in the ZC scenario without cancelling the CRC's natural gas contract and moving it to a zero-emissions heating system (green line).

[11] Between 2031 and 2045.

[12] Relative to the ZC scenario in which the building is converted to a zero emissions system in 2030/31.

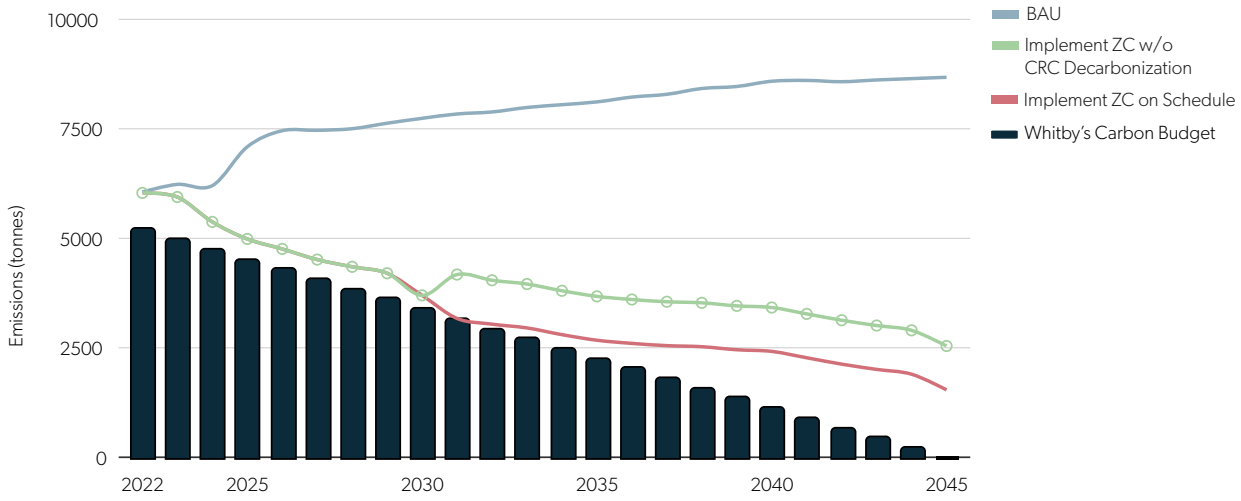

Figure 7. Whitby's carbon budget and emissions in BAU, Zero Carbon, and Zero Carbon without CRC Decarbonization scenarios.

Even if all the other actions in Zero Carbon Whitby are implemented, keeping the CRC on natural gas will make it profoundly difficult for the Town to stay within its carbon budget. Furthermore, purchasing offsets to reduce residual emissions may become a significant, additional cost.

The recommended alternative is to retrofit the building and switch the CRC to a ground source heat pump. The capital cost for this work has been estimated to be $3.6 million. In addition, this may result in a financial penalty for breaking the natural gas contract early. This Study modelled the impacts of carrying out this alternative approach between 2030 and 2031. The result was that energy and carbon taxes would decrease by $136,000 in 2031, and annual savings would increase steadily to $402,000 in 2045, resulting in a total savings of $4.2 million between 2030 and 2045. The total difference (excluding any penalty for breaking the natural gas contract) between the capital investment required and the energy and carbon tax savings would be a net savings of $0.6 million between 2030 and 2045.

It is highly recommended that Whitby realize the full benefit of the work it has initiated with Zero Carbon Whitby and remove all natural gas from the CRC no later than 2030. In this year, the federal carbon tax will reach $170 per tonne, making it costly to continue using this fossil fuel. From 2030 on, natural gas costs for this building are forecast to be $249,000 and the federal carbon tax will add a further $156,000, for an annual bill of $405,000.

Fleet

Whitby will avoid significant costs by converting its fleet from internal combustion engines (ICEs) to electric vehicles (EVs). The savings will include avoided gasoline, diesel, and carbon tax costs, and lower and less-frequent maintenance costs.

In addition, electric vehicle engine efficiency is almost 100%, whereas ICE vehicles are only about 40% energy efficient. This means an electric fleet will use significantly less energy than an ICE fleet. Figure 8 shows the total energy used by fleet vehicles over time in both the BAU and ZC scenarios.

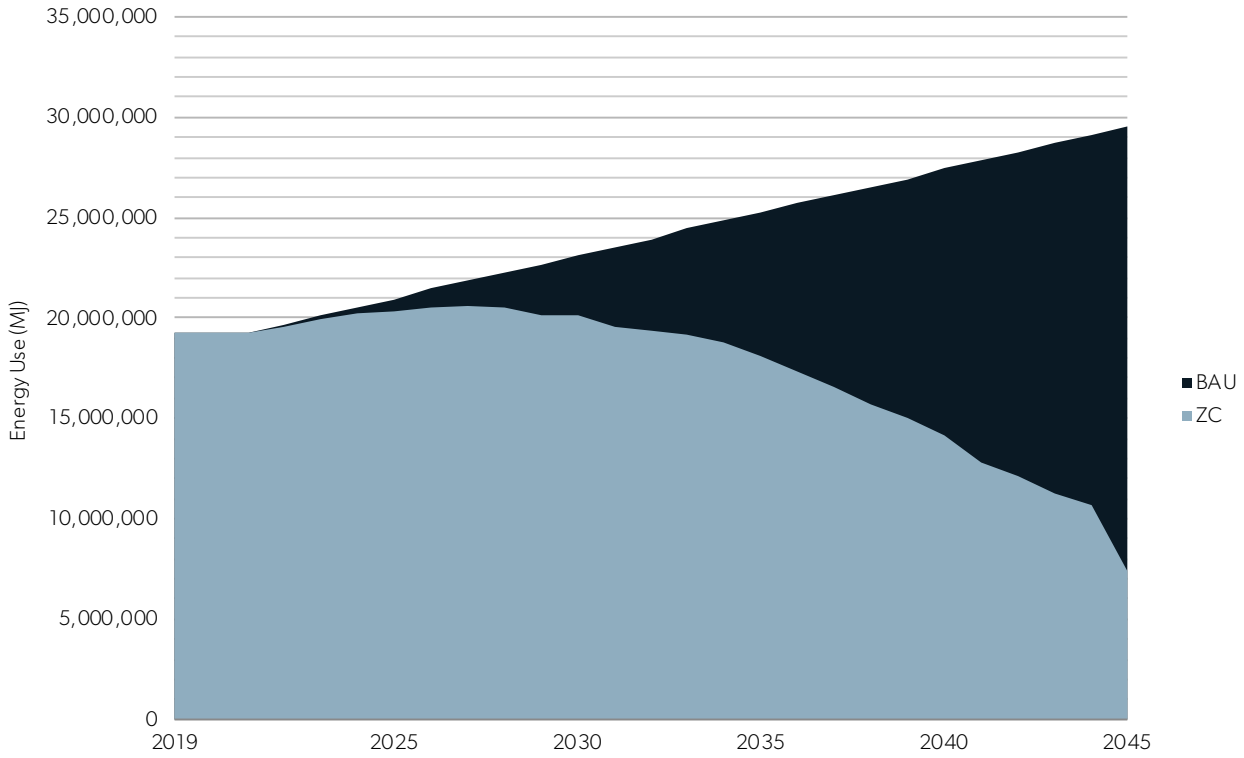

Figure 8. Total energy used by the fleet in the BAU and ZC scenarios.

Fleet zero-carbon modelling reflected a gradual conversion of all gasoline and diesel vehicle and equipment assets to fully electric models. (In alignment with federal and provincial classification, regular hybrids are not zero-emissions vehicles and were not included in Whitby's ZC scenario. Plug-in hybrids were included.) Transition timing was based on Whitby's 2021 Fleet Strategic Master Plan, updated to reflect the assumptions in Appendix B.

ZERO-CARBON COSTS AND SCHEDULE FOR 2022–2025

The EV and charger purchase schedule for the Zero Carbon Scenario is provided below.

Table 5. Electric vehicle and charger purchase schedule for 2022 – 2025.

	2022	2023	2024	2025
Cars	4	4	10	3
Class 2a Vehicles	0	2	1	2
Class 3 Vehicles	4	3	5	5
Class 4 Vehicles	1			
Class 5 Vehicles	1			
Class 7 Vehicles	0			
Class 8 Vehicles	7	3	3	3
EV Chargers	3	3	4	2

The total cost to transition the first portion of the fleet to EVs between 2022 and 2025 is $13 million, as shown in Table 6. This includes capital costs for 61 electric vehicles, 12 chargers (one for every five EVS), and the costs of charging and maintaining these and the ICE vehicles.

Table 6. Total cost by category of ZC fleet vehicles, fuel and equipment 2022 – 2025.

CATEGORY	COST
Cost of 61 Electric Vehicles and 11 Chargers	$4,989,107
Carbon Tax on Vehicle Fuel	$418,110
Cost of Vehicle Charging and Remaining ICE Vehicle Fuel	$3,636,397
Cost of O&M for All Vehicles (both ICEs and EVs)	$3,967,712
Total	$13,011,326

These costs are $110,000 more than the fleet costs in the BAU for the same period. Table 7 provides the incremental cost of the ZC fleet action from 2022 to 2025.

Table 7. Incremental cost by category of ZC fleet vehicles, fuel and maintenance 2022 - 2025.

CATEGORY	COST
Incremental Cost of ZC Vehicles and Chargers	$194,134
Avoided Carbon Tax on Gas and Diesel	-$8,229
Avoided Fuel Costs	-$48,066
Avoided Operations and Maintenance Costs	-$26,992
Total	$110,847

ZERO-CARBON COSTS FOR 2026–2045

Transitioning the remaining fleet and equipment between 2026 and 2045 results in total incremental avoided costs of $5.7 million during this period. Table 8 breaks down these costs.

Table 8. Incremental cost by category of ZC fleet vehicles, fuel and maintenance 2026–2045.

CATEGORY	COST
Cost of 310 Electric Vehicles and 62 Chargers	$9,601,939
Avoided Carbon Taxes on Vehicle Fuel and Electricity	-$3,305,320
Avoided Fuel and Electricity Costs	-$8,359,503
Avoided Operations and Maintenance Costs	-$3,683,826
Total	-$5,746,710

Whitby currently expects to maximize the life of fleet vehicles before switching them to electric models. This is partially due to an expected dearth of electric models of all required types of vehicles. As a result, the Town expects to wait one full lifecycle for light-duty vehicles and possibly two full lifecycles for medium- and heavy-duty vehicles before they are all converted.

One consequence of this is that a full 10% of the fleet will only be converted to electric models in the final year (2045) of the plan. This will require $5.8 million in 2045, up from $1.9 million in 2044. Although operational avoided costs will compensate for this, the cost of delaying complete fleet conversion until the last year of the Plan is significant. Instead, Whitby could advocate with other municipalities and regions for the expedited development of vehicles required by municipalities. Earlier purchasing would also allow the Town to take advantage of generous federal funding currently available for municipal fleet conversion.

This delay also does not align well with the Zero-Carbon scenario. The yellow and (to a lesser extent) black portions of Figure 9 show the impact of reducing the fleet's emissions later than those of other Town assets.

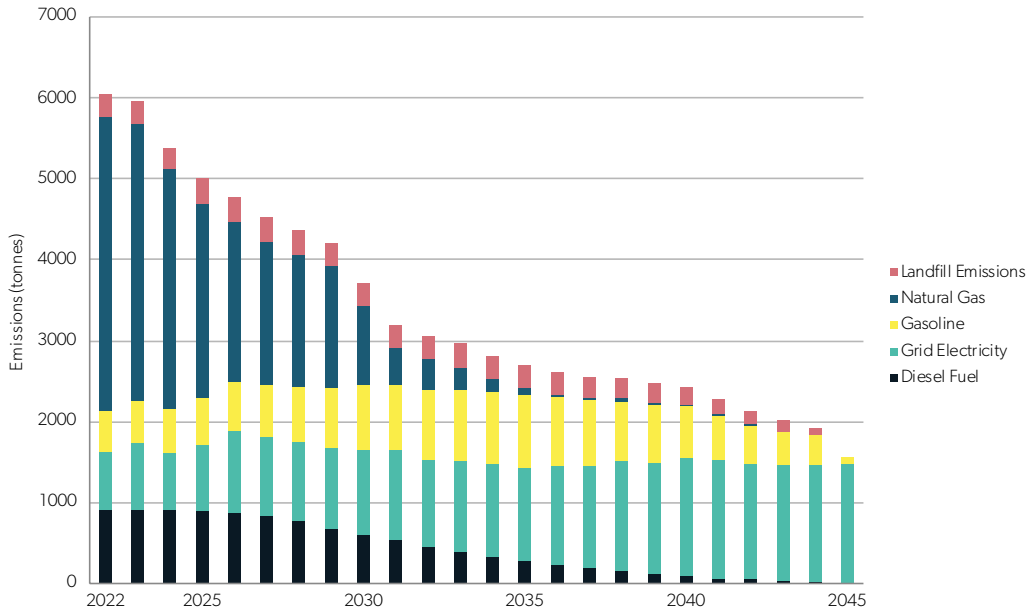

Figure 9. Corporate emissions by Fuel Type in the ZC scenario.

Until the fleet is fully converted, gasoline and diesel emissions will consume a disproportionate portion of the Town's carbon budget.

Alternatively, converting all gasoline fleet vehicles to electric models by 2040 will eliminate 2,540 tonnes of emissions, and converting them by 2035 will eliminate a further 4,010 tonnes over the period.

Lighting

The Town of Whitby is responsible for interior and exterior building lights at its own buildings and facilities, as well as all the town's streetlights, traffic lights, and park and sports field lighting. In the context of this Study, the effort, impact and cost of replacing interior and exterior building lights was included in the buildings analysis, and is not discussed further here. Of the remaining lighting, all the town's street lights have already been converted to LEDs, and traffic lights will be fully converted by the end of 2022. Only the conversion of park and sports field lights remains to be completed.

ZERO-CARBON COSTS AND SCHEDULE FOR 2022–2025

For the purposes of this Study, it was assumed that all lighting controlled by the Town that is not yet LED (i.e. park and sports field lighting) will have been replaced with LED equivalents by 2024. This will reduce energy consumption and increase the bulb replacement period from every four years to every 16 years.

The capital costs provided by Whitby to replace the remaining non-LED lights with LEDs is effectively the same as the costs for non-LED lights. As a result, there is no incremental investment required between 2022 and 2025 to complete the replacement of park and sports field lighting with LEDs.

However, the improved energy efficiency of the LED bulbs installed in this period will provide an incremental savings in electricity costs of $55,000 over the BAU scenario.

ZERO-CARBON COSTS FOR 2026–2045

LED lights only need to be replaced ¼ as often as non-LED lights, or once every 16 years rather than once every four years. Between 2026 and 2045, this amounts to four avoided cycles of bulb replacements (i.e. in 2028, 2032, 2036 and 2044), each of which would cost $3.2 million dollars. In total, this is a $13 million savings in capital costs over this period.

The electricity saved by continuing to use LED lights for parks and sports fields will save the Town $554,000 total in the period between 2026 and 2045.

Impacts on Operations and Resourcing

Resources Required

A shift to a zero-emissions future impacts the Town of Whitby's resources in two ways. The first is that additional staff resources will be required. The large amount of work to be done— retrofits, replacing heating and cooling systems, and new builds—particularly on the Town's buildings, will require additional administrative, project management, and construction and HVAC labour. During this Study, Whitby staff indicated that the following additional staff would be required to complete the work of Zero Carbon Whitby according to the schedule provided:

1. Facilities – Three additional project managers will be required to complete all of the building retrofits, new builds, and energy system replacements on schedule for Zero Carbon Whitby. The first two would be required almost immediately to support the immediate increase in building work.
2. Procurement and Finance – While Zero Carbon Whitby reduces the number of capital projects for facilities, the scope is larger. Additional staff will be required to manage the carbon budget and provide carbon accounting for all Town projects. As a result, it is recommended that Finance converts a part-time position to full-time for this work.

Resourcing is also affected in terms of skills. Implementing Zero Carbon Whitby will cost tens of millions of dollars. To ensure these investments are protected and the new infrastructure will operate successfully for years, staff will need to be educated and experienced in zero-emissions infrastructure implementation and management. For example, Whitby will require:

- Project managers who understand and can navigate the complexities of building large, zero-emissions recreation facilities;
- Building operations staff who can operate and maintain large ground source heat exchange systems, air source heat exchange systems, and integrated solar panel systems, ensuring they all run as efficiently and effectively as possible; and

- Fleet maintenance staff who are skilled in managing electric fleet operations to ensure that vehicles and equipment are always charged when needed, while minimizing the number of chargers required and optimizing the use of off-peak electricity costs.

The graph below shows key areas of investment in Zero Carbon Whitby that will require specialized knowledge to implement, maintain, and operate.

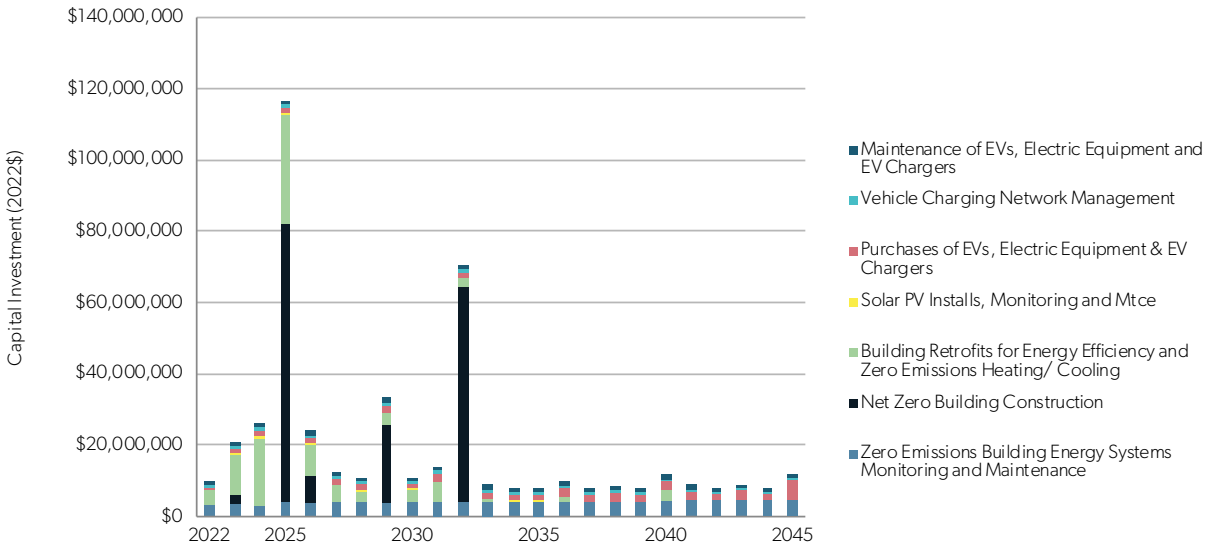

Figure 10. ZC investments requiring specialized knowledge.

Energy Use and Infrastructure

By 2045, the Town of Whitby's total corporate energy use will fall by 63% in the ZC scenario relative to the BAU.

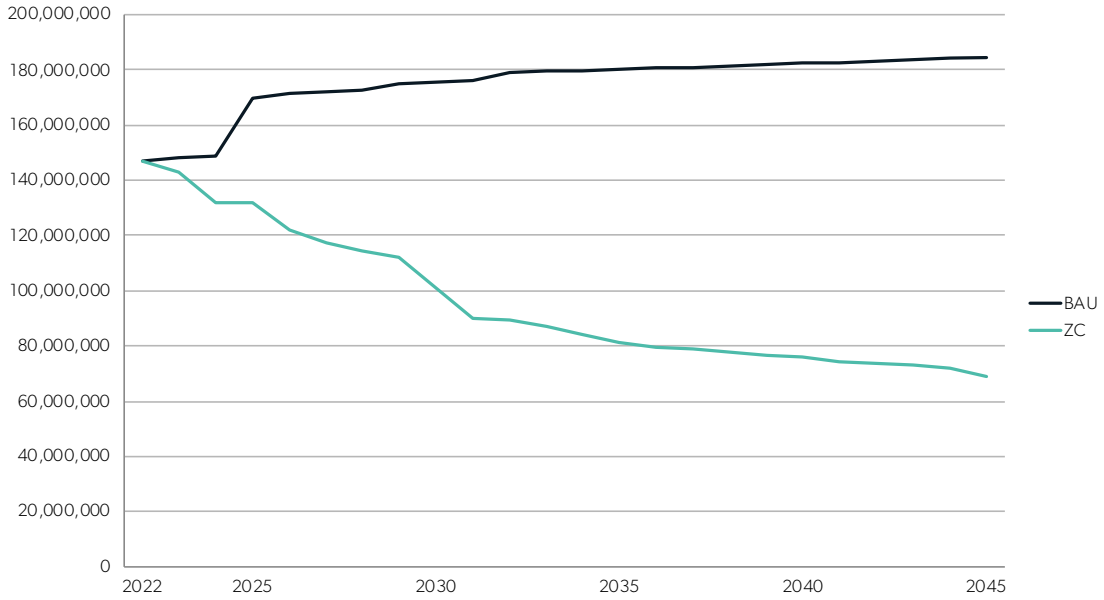

Figure 11. Total energy use in the ZC and BAU scenarios.

In 2045, 82% of all corporate energy used will be grid electricity. However, between 2022 and 2045, the ZC scenario will use a cumulative total of 191,000 TJ less electricity than the BAU scenario. This is due to many factors including:

- Energy efficiency improvements in buildings like recreation facilities;
- The replacement of current heating and cooling systems with efficient air and ground source heat exchange systems; and
- The efficiency of electric vehicle engines relative to ICE engines.

The result will help keep Whitby's electricity supply resilient because the overall corporate electricity draw will not exceed what existing distribution infrastructure is designed to support in the BAU scenario.[13] The graph below shows BAU and ZC electricity consumption. It also shows the impact of solar PV installations in the ZC scenario which will provide 4% of corporate electricity by 2045.

[13] This statement is true for the Town's total annual forecast electricity use. At specific times and locations, electricity use could still be higher than in the BAU scenario.

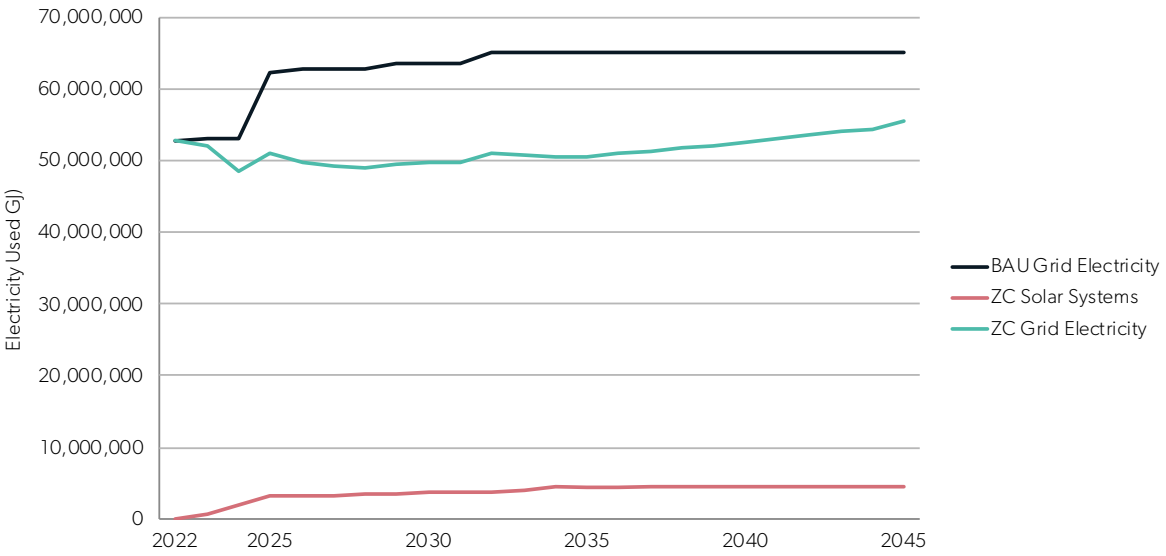

Figure 12. Total energy use in the ZC and BAU scenarios.

Remote Working and Leased Space

The Town of Whitby is shifting to a hybrid model of remote work. This may reduce the total office space required as well as the emissions from heating and cooling this space and providing water and processing wastewater.

Increasing remote working could also help reduce emissions by making it possible, in conjunction with the construction of the new Operations Centre, to stop leasing office space in the Garden Street building at the end of its current lease in 2025. The Town does not have control over the energy efficiency or heating and cooling systems in properties it leases, and as a result, it will be difficult to reduce its corporate emissions to zero if it continues to lease such spaces. Ending the lease on the Garden Street building will eliminate 15 tonnes of greenhouse gas emissions and save over $30,000 annually in energy costs and carbon taxes.

Funding Approaches

With careful financial management, Whitby is well positioned to acquire funding for the first major elements of Zero Carbon Whitby and leverage the resulting energy savings to fund the remainder of the plan.

Zero Carbon Revolving Reserve Fund

The analysis carried out for this Study included developing the financial structure for a reserve fund and identifying the seed funding required for the reserve to become self-perpetuating. This has been provided to the Town of Whitby in the form of a spreadsheet referenced in Appendix D of this report. It can be used in conjunction with the Zero Carbon Revolving Reserve Fund Policy to establish and manage the use of this fund.

The seed funding would be directed into a fund to be used only for the incremental costs of completing the zero-carbon work. Funds may come from a variety of sources. For the purposes of the framework provided, all energy, carbon tax savings, avoided costs, and avoided costs from the capital budget[14] resulting from the work were redirected into the fund. After the Zero Carbon Whitby work is complete, further savings could be directed to other initiatives in the Town, from service-level improvements to funding the community climate change adaptation and mitigation plans.

Using the costs and savings described above, it was determined that:

- The entire Plan could be completed with $34.8 million in seed funding, of which a minimum of $31.3 million should be received by the end of 2025[15] and
- By 2045, without any investment of the monies in the fund, it could cover $63.7 million of the Zero Carbon Whitby Plan work, plus an additional $9 million.

Revolving funds such as these have been successfully used by communities such as Edmonton, Moncton, Peterborough, and Caledon, as well as by universities across the country. The key to success for these communities has consistently been the careful, well-defined, strategic, and transparent management of the fund using strategies, such as the following, that are easy to incorporate into budgetary planning:

- Ensuring the definitions of costs that qualify for funding from the Zero Carbon Revolving Reserve Fund are clear and include incremental costs for projects in the Zero Carbon Whitby Plan.
- Determining whether and which project costs will be covered using a relatively quick and straightforward process.
- Investing accumulated monies in opportunities that will allow the fund to grow further, but also achieve the Town's objectives.
- Keeping the administration of the monies as simple as possible.[16]

[14] Avoided costs from the capital budget are retrofits and maintenance work that are already budgeted for in the capital budget but that will no longer be required in the ZC scenario.

[15] See Appendix D for the and the Zero Carbon Revolving Reserve Fund financials.

[16] See Appendix B: Governance Risks for details.

- Actively monitoring the health of the fund, making adjustments when necessary, and annually adjusting the amount of funds available to projects to ensure the fund is not depleted before the Zero Carbon Whitby Plan work is completed.

INITIAL FUNDING

As discussed earlier, carbon taxes gathered to-date are being offered as grant funding in a number of ways, to stimulate the transition to zero emissions. Whitby has taken advantage of this and has already initiated grant requests for over $30 million in funding.

Staff have applied for funding in the amount of $41,750,000.[17] However, if all the seed funding is not secured from grants, several alternatives are available:

1. Bonds

a. Green Community Bonds (Town) – The Town of Whitby could issue a total value (e.g. $20 million) of community bonds for relatively small amounts (e.g. $2,000), intended to be purchased by residents, local businesses, and the community in general. There would be a guaranteed return of a small percentage (e.g. 4%) after a certain number of years (determined by expected savings from avoided operational costs). The Town would deposit the funds from the bonds into the Zero Carbon Revolving Reserve Fund and withdraw them as needed to complete the Zero Carbon Plan work. The energy and carbon tax savings would also be directed into the Zero Carbon Revolving Reserve Fund where they would continue to fund additional work and from which the required returns would be drawn to pay bond holders. In this case, diverting the savings to paying bond holders would mean more funding would be required in total.

b. Green Community Bonds (Region) - A similar option to number 1 could be implemented by the Region of Durham on behalf of its municipalities. Just as the Region currently administers federal rebates for residential retrofits in communities throughout Durham, this could centralize administrative overhead associated with managing the bonds. Bonds could also be issued for larger amounts intended for regional businesses to purchase. Disbursement of the funds could be allocated to communities in a variety of ways: based on the location of the purchaser, on a per capita basis, or based on a community's success in reducing emissions.

c. Green Corporate Bonds –The Town could issue a total value of bonds, which would be for larger amounts and would be intended for corporations to purchase. Otherwise, they would operate in the same way as the community bonds. This could potentially generate greater total funding than the community bonds.

2. Loans

a. Traditional bank loans are a secure funding source that removes uncertainty and reduces the administrative effort associated with issuing bonds. Increasingly, banks and the insurance industry are actively seeking investment opportunities that support their targets and commitments to "green" their investment portfolios. In this context,

[17] See Appendix C for details.

investment options in reliable municipal government infrastructure projects are desirable and offer a secure source of funding for Whitby.

b. Some entities such as the Canada Infrastructure Bank (CIB), will only consider funding projects that require a large amount of funding. This prevents smaller communities like Whitby from accessing these funds. The Region of Durham could apply to the CIB on behalf of several communities within the Region, combining their financial needs into a single application with a high enough value that it would be considered for funding. Given the CIB's commitment to deploy $35 billion in infrastructure funding, this would open up a significant additional source of funding for Zero Carbon Whitby.

3. **Tax Levy** – Property taxes are increasingly being used to fully or supplementally fund climate action plans. Halifax recently approved a 3% property tax increase for a minimum of 10 years, which will appear as a separate line item on tax bills and will be directed into a fund to be used only for community climate action. Calgary is considering a similar approach - committing to spend $30 per citizen for a set number of years to ensure that its climate mitigation work is fully funded. This is then integrated into the existing budgeting processes.

In all of these cases, the Zero Carbon Revolving Reserve Fund should still be used to expedite the payback to bond holders or the loaning entity and to amplify the value of the savings to Whitby. In addition, the front-end-loaded nature of the project schedule should be retained as completing the large projects early will provide greater savings sooner, and Whitby can use these savings to fund community work.

PARTNERSHIPS

Whitby's community includes a number of significant energy consumers in both the public and private sectors. Regional facilities, hospitals, and manufacturing facilities are excellent potential partners to provide significant capital investment for large-scale energy system replacement, such as district energy systems, from which the Town can also benefit. In these cases, returns for the partner may come in the form of their own energy savings. Similarly, the "investment" required from the Town may include donating land and expediting development approvals, as well as other non-monetary means of support that result in greater financial benefit for the Town.

Conclusions/Next Steps

The Town of Whitby is well positioned organizationally and financially to complete Zero Carbon Whitby. The Town has completed sufficient study to initiate a comprehensive retrofit and energy system change for its entire building portfolio, transition its fleet, and complete the replacement of lighting within the town. Applications for over $30 million in funding have laid the groundwork to fund this work.

The next steps for the Town of Whitby are as follows:

1. Bring the Zero Carbon Whitby Carbon budget for 2022–2025 forward for inclusion in budget planning. Get approval for capital and operational funding in 2023 that aligns with the first four-year carbon budget, and obtain direction to carry out the Study's work schedule over this period.
2. Finalize an approach for securing at least the minimum required seed funding for the Zero Carbon Revolving Reserve Fund. Connect with bond, loan, etc. entities to establish a detailed approach. Apply for any additional grants available for the Zero Carbon Whitby work.
3. Establish a steering committee to oversee the completion of Zero Carbon Whitby, ensuring all departments with responsibilities have representation. Assign the work to the appropriate Town departments and establish a reporting structure that ensures progress is monitored and encouraged.
4. Decide on an approach for addressing the Town's residual emissions to ensure the net-zero-by-2045 goal can be reached.
5. Focus on capacity building for Town staff by providing workshops and training on the new energy systems, building energy monitoring, electric vehicles, etc. that will be part of completing Zero Carbon Whitby.
6. Incorporate remote work into operational practice to reduce required office space and resulting energy use and emissions.
7. Ontario's electricity grid is not currently forecast to decarbonize by 2045. With continued federal pressure for provincial grids to decarbonize by 2035, Ontario's course may change; however, Whitby should continue to monitor this to determine how and to what extent its residual emissions from the grid will need to be addressed.
8. Corporate waste is currently tracked only at a high level in Whitby. It is recommended that the Town of Whitby improve its corporate waste tracking with the following steps:

    * Begin source separation of organics and recyclables in Town facilities and buildings,[18] then track corporate waste volumes by category (e.g. organic waste, recyclables, paper, landfill, etc). Emissions from different types of waste require different reduction methods, so gathering basic data about the types and quantities of waste is key to developing an effective waste reduction plan.
    * Complete comprehensive waste audits at all major Town-operated facilities and selected

[18] Source separation has multiple benefits: it allows the volumes of waste to be measured by type; it avoids contamination of materials by mixing in the waste stream; it avoids having to estimate quantities of waste by type after collection; it demonstrates the Town taking a leadership role in addressing and managing its own waste stream.

smaller facilities to understand types and proportions of waste by facility, and develop a Corporate Waste Strategy to reduce and manage corporate waste and related emissions.[19]

* Broadly educate staff on waste reduction, including energy conservation, via training and incentives and support of small-scale, continuous improvement initiatives throughout the organization.

Next Steps for Leadership

1. Begin to incorporate embodied carbon into requirements for new Town buildings and infrastructure. For example, ensure that procurement standards for concrete vary based on the strength required for the structure rather than always requiring only the strongest concrete. Producing the strongest concrete generates significantly more emissions and is often much stronger than what is required. Adjusting these requirements can also have significant cost savings.
2. Track emissions from staff commuting and add these to the corporate GHG inventory. Incentivize and celebrate staff commuting sustainably (with active transportation or transit), and eliminate policies (e.g. providing parking for staff) that support personal vehicle commuting.
3. Incorporate remote work into operational practice to reduce required office space and the resulting energy use and emissions as well as emissions from commuting.
4. Begin providing construction and operational emissions projections for new assets when projects are presented to Council for approval. Include:

    * An indication of how the emissions will impact the Town's carbon budget;
    * Whether the Town will be able to remain within its carbon budget if the project is approved; and
    * A description of how additional emissions will be reduced elsewhere if the Town is not able to remain within its carbon budget.

[19] See the City of Edmonton's Corporate Waste Transformation project for an example of a corporate municipal waste management plan.

Appendix A: Risk Analysis

Risks are inherent in strategies, policies, and actions. A risk is defined as "the effect of uncertainty on objectives" and is the expression of the likelihood and impact of an event with the potential to affect the achievement of an organization's objectives.[20] This section identifies the potential risks to the implementation of Zero Carbon Whitby and outlines related mitigation and contingency strategies. Risks are classified according to the matrix below.

Table 9. Risk classification.

RISK CLASSIFICATION		OVERALL RISK
PROBABILITY	**IMPACT**	
High	Major	Very High
High	Moderate	High
High	Low	Low
Moderate	Major	High
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Major	Moderate
Low	Moderate	Low
Low	Low	Low

These risks should be used by the Zero Carbon Whitby implementation team as a starting reference list of factors that should be monitored regularly and addressed when and if necessary. Other risks should be added as they are identified, and mitigation and contingencies should be planned for each.

The Risks of Doing Nothing

If Zero Carbon Whitby is not implemented using the suggested schedule, a business-as-usual scenario will unfold. This scenario assumes no major energy- and fuel-related changes are made to Whitby's corporate buildings and fleet. The recommended mitigation for all of these risks is to implement Zero Carbon Whitby using the schedule provided in this Study.

[20] Treasury Board Secretariat. (2011). Guide to Corporate Risk Profiles. Retrieved from: https://www.canada.ca/en/treasury-board-secretariat/corporate/risk-management/corporate-risk-profiles.html

Table 10. The risks of doing nothing.

RISK	DESCRIPTION	PROBABILITY	IMPACT	OVERALL RISK
ENERGY COSTS ARE HIGHER THAN THEY WOULD BE	Energy in the BAU scenario is more costly than if Zero Carbon Whitby is implemented, even if fossil fuel prices do not experience significant fluctuations.	High	Major	
VULNERABILITY TO ENERGY PRICE SHOCKS	The Town is vulnerable to global fossil fuel prices, which will fluctuate in the future.	High	Major	
OPERATIONAL COSTS ARE HIGHER THAN THEY WOULD BE	Operational costs are higher in the BAU scenario than they would be if Zero Carbon Whitby is implemented.	High	Moderate	High
BUILDING/ ASSET FAILURE	Any buildings that are in poor or critical condition due to deferred maintenance are at risk of failure.	Moderate	Moderate	Moderate
STRANDED ASSETS	The Town invests in fossil-fuel-based infrastructure or energy contracts (e.g. the long-term natural gas contract for the Civic Recreation Complex) that must (in the case of infrastructure) be replaced before the end of their useful life or (in the case of the contract) be cancelled with penalties or offset financially in order to meet the Town's GHG reduction commitments.	High	Major	
GHG EMISSIONS INCREASE OR STABILIZE	GHG emissions continue to increase, imposing a burden on future generations to cope with increased infrastructure damage, food insecurity, crop failure, water shortages, threats to health, and shrinking biodiversity. The cost of future mitigation will also increase, requiring more extensive retrofits.	High	Major	
REGIONAL REPUTATION DAMAGED	The reputation of the Town is damaged because its operations do not align with its commitment to reduce GHG emissions.	Moderate	Low	Low
GHG INTENSIVE BUILDINGS ARE DISPOSED OF	The burden of GHG emissions reductions in buildings is transferred to entities without the resources to transform these buildings.	Low	Moderate	Low
ADDITIONAL OFFICE SPACE	Without ambitious policies to increase teleworking, additional floor space will need to be constructed or leased.	Moderate	Moderate	Moderate

Labour-Related Risks

Implementation of the retrofit schedule is dependent on the availability and skill of workers. (Table 11.)

Table 11. Labour-related risks.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
There are insufficient staff to complete the Zero Carbon Whitby projects on schedule and complete related administrative and operational work replacements, especially in years where there are many projects. Emissions reduction activities are delayed and project labour costs increase.	Moderate	Major	High	Funding is budgeted and allocated to acquiring sufficient resources to complete the work. Resource requirements are reviewed regularly and adjusted as needed. Grant applications include additional resources where required.	Staff are hired on contract to coordinate the work.
Available staff are not skilled in implementing, monitoring, and maintaining new building energy systems. Building retrofits and energy system replacements are delayed, and maintenance is of a lower quality.	High	Major	Very High	Position postings for staff who will work on Zero Carbon Whitby projects include mandatory requirements for skills related to the technologies being implemented. The Town works with nearby trade schools to ensure the appropriate training is available and incentivized if necessary to meet the Town's needs. The Town works with other municipalities such as Caledon to coordinate and address shortages of skilled staff.	Workers are imported from other jurisdictions to complete the work.
Fleet labour staff are not skilled in working with electric vehicles and chargers.	High	Moderate	High	Fleet maintenance staff are provided with sufficient training to ensure they are able to continue working successfully.	Workers are imported from other jurisdictions to complete the work.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
Traditional ways of doing things among Town staff continue to be used and are preferred to the changes required to implement Zero Carbon Whitby.	High	Major	Very High	Ongoing internal communication includes education on technologies, climate change, tracking of projects, and celebrations of successes (and the implications of those successes) throughout Zero Carbon Whitby, contributing to the required culture shift. Individual performance reviews incorporate the changes required for Zero Carbon Whitby.	

Electricity Risks

Changes to electricity generation sources and electricity demand will have associated risks for achieving GHG emissions reduction objectives (Table 12).

Table 12. Electricity-related risks.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
The emissions factor for the Ontario electricity grid increases.	Moderate	Major	High	The Town of Whitby, in conjunction with others, actively advocates for an accelerated decarbonization of the provincial grid. Solar PV systems are installed as outlined in this Study's detailed building retrofit plans. Town explores installing additional ground mount solar PV in locations such as Town-owned parking lots.	Purchase more renewable electricity from the local utilities.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
Electrification reduces energy system redundancy, making operations more vulnerable to disruption in the event of power outages.	Moderate	Major	High	The design of buildings and energy use incorporates the need for redundancy. For example, battery storage is added to the building retrofit schedule.[21] Whitby explores alternatives for energy storage for both its fleet and facilities. These could include using flywheels in vehicle maintenance garages to provide backup power[22] and generating green hydrogen from excess solar power.	Microgrids are installed in targeted nodes to create additional resiliency.
Electrification increases peak electricity demand, increasing expenditures on electricity.	Moderate	Moderate	Moderate	Fleet vehicles are charged overnight. Energy management systems in buildings are effectively used to manage peak demand. District energy is used to manage peak demand.	Additional energy storage is purchased to be used during peak periods.

[21] Analysis of this option was not included in this Study.

[22] Analysis of this option was not included in this Study; however, flywheels are being developed for energy storage and backup in Edmonton's electric bus garages.

Energy Market Risks

Energy supply and costs are dependent on market forces. Changes in the energy market have inherent risks that can impact the successful implementation of several components of Zero Carbon Whitby (Table 13).

Table 13. Energy market-related risks.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
Fossil fuel price decline challenges the business case for individual projects.	Moderate	Major	High	Incorporate the cost of emissions (e.g. carbon taxes) into Whitby project planning to ensure the cost of carbon supplements low fossil fuel prices to more accurately reflect the true cost of continuing to use fossil fuels. Ensure the requirement for net-zero-ready building standards and zero-emissions fleet vehicles are required irrespective of the cost.	Maximize funding possibilities and direct 100% of Zero Carbon Revolving Reserve Fund returns to future Zero Carbon Whitby investment.
Renewable energy price increase threatens the business case of renewable energy installations.	Low	Moderate	Low	Actively monitor and apply for renewable energy grants. Develop industry and governmental partnerships to leverage buying power, potential for shared district energy, and reuse of waste energy.	Leverage multiple renewable/ alternative energy sources to balance the risk.
Lack of technology/ component availability threatens the viability of installing new renewable energy infrastructure.	Low	Major	Moderate	Develop and encourage local technology/ component production where feasible.	Establish purchasing agreements with suppliers including longer term requirements.

Governance Risks

Competing Town priorities and timelines could affect implementation. Strong leadership and timely and consistent implementation by departmental staff are critical for success (Table 14).

Table 14. Governance-related risks.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
Lack of Climate Team leadership in financial decision-making results in funds not being approved for required projects, or being allocated to inappropriate projects.	Moderate	Major	High	Ensure funding decisions require Climate Team leadership agreement to projects submitted for funding in budgets or from the Zero Carbon Revolving Reserve Fund.	Track the impact on the carbon budget of fund allocations, and escalate at least annually. Extract the BAU scenario for impacted areas, and publish forecast repercussions on operating costs..
Pushback from departments causes delays or scope is reduced to address concerns.	High	Major	Very High	Executive leadership has direct access to information on the impact of delays or reductions in scope on Whitby's carbon budget and uses this to stay on course. Responsible departments are required to report on all delays or reductions in scope that impact the carbon budget.	Track the impact on the carbon budget of fund allocations, and escalate at least annually. Extract the BAU scenario for impacted areas, and publish forecast repercussions on operating costs.
Other government initiatives take funding priority and implementation is delayed or descoped.	High	Major	Very High	Require that any known upcoming delays in Zero Carbon Whitby funding are identified as part of the budgeting process and ensure the impact on the carbon budget is made clear at a public council meeting, with advance notice given to the public.	Extract the BAU scenario for impacted areas, and publish forecast repercussions on operating costs. Zero Carbon Revolving Reserve Fund provides additional funding.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
The Zero Carbon Revolving Reserve Fund Policy is overly complex and labour-intensive to administer, resulting in confusion, additional time and cost, errors, and ultimately the failure of the fund to fulfill its intended purpose.	High	Major	Very High	Simplify the Policy particularly with regard to where financial savings of ZC work are directed. Specifically, remove wording requiring that a) funding and savings be tracked on a per project basis, b) after a project has paid back its funding, savings be diverted partially into a fund to offset the tax levy. Continue directing the ZC savings back into the fund until Zero Carbon Whitby is complete. Communicate the benefits of the fund as having reduced the tax levy by X% each year or budget cycle.	Use a portion of the funds to add resources to ensure the complexities of the fund are managed correctly.

Service-Level Risks

Some changes may disrupt service levels for citizens using Whitby's facilities (Table 15).

Table 15. Service-level risks.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
Lowering the pool water temperature in Iroquois Park could exacerbate an existing complaint from the public that the water in the pool is already too cold.	Low	Moderate	Low	Implementation of the ground source heat loop will allow the pool temperature to be increased without increasing the natural gas used, meaning that lowering the pool water temperature will no longer be required.	Not required.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
Implementing a grey water ice flooding system in Iroquois Park could cause the quality of ice to deteriorate, impacting the service provided to skaters.	Low	Moderate	Low	Implement the grey water ice system in a limited area initially. Monitor and address any ice quality issues (e.g. additional filtering) before implementing throughout Iroquois Park.	Apply a layer of treated water of sufficient depth to ensure quality on the surface of the grey water.
Conversion to electric ice resurfacers in Iroquois could result in additional ice resurfacers being required to handle the amount of ice surfacing required.	Low	Major	Moderate	Use learnings from other municipalities (e.g. Mississauga, Kingston, Barrie) to adjust the schedule of ice resurfacers required for McKinney, IPSC, and the Whitby Sport Complex.	Leverage the Zero Carbon Revolving Reserve Fund for additional capital cost.
During retrofits, recreation facilities in particular, may experience a loss in revenue.	High	Low	Low	Where there are multiple facilities (e.g. pools), complete retrofits consecutively rather than simultaneously to ensure reduction in facility access is minimized. Schedule work to maximize accomplishments during periods of closure.	Forecast and track loss in revenue during retrofits, and provide comparisons of loss in revenue expected if retrofits were not completed.
Early versions of new technologies may fail more often, resulting in more frequent need for replacements.	High	Moderate	High	Advise Council early that this can be expected, that contingency has been built into budgeting, frame it as a cost of social leadership.	Provide contingency funding in planning; include as an appropriate use of Zero Carbon Revolving Reserve Fund monies.

Supply Risk

Supply issues have the potential to delay the completion of Zero Carbon Whitby (Table 16).

Table 16. Supply risk.

RISK	PROBABILITY	IMPACT	OVERALL RISK	MITIGATION	CONTINGENCY
Insufficient vehicle supply may delay Whitby's ability to purchase EVs at the rate required to achieve its emissions goals.	Moderate	Moderate	Moderate	Partner with other municipalities and regions to establish purchasing agreements with vehicle manufacturers. These can guarantee vehicle sales for the manufacturer and delivery dates for the municipalities. In-house or in partnership with trade schools, begin replacing ICE drive trains on existing vehicles with EV kits. This prolongs vehicle lives, reduces capital costs, contributes to a circular economy, and fosters EV maintenance skills.	Reduce the use of ICE fleet vehicles to partially offset emissions.

Appendix B: Methodology and Assumptions

The following methodology was used in combination with SSG's Corporate City InSight's modelling software to produce energy use, emissions, and costs estimates from 2022 to 2045 for business-as-usual (BAU) and zero carbon (ZC) scenarios. The sources used are identified by sector and scenario in the sections below. Zero Carbon measures were selected based on current service delivery requirements and matched with current technology. A sensitivity analysis was completed on the costing to ensure it accurately reflects 2022 prices.

As projects receive approval and proceed through engineering design into implementation, costing may change or be refined to address engineering constraints, service delivery requirements, and technological advancements. It is recommended that Zero Carbon Measures be reviewed as part of the annual fiscal budget process to ensure the most suitable technologies and accurate costs are reflected in the municipal budget while ensuring carbon emissions are sufficiently reduced to stay in alignment with the carbon budget.

BUILDINGS

The Study's buildings scope included 51 of the Town of Whitby's existing facilities, three building expansions, five new buildings, and one repurposed building. In general, buildings in the ZC scenario had improved energy efficiency and used zero-emissions sources. A key element of transitioning all buildings to generate zero emissions is to transition them off of natural gas by 2045. In the modelling, this meant replacing natural gas furnaces (including high-efficiency furnaces) with connections to zero-carbon district energy where possible or to ground or air source heat pumps.

Energy Use and Emissions for Existing Buildings

For existing buildings, a BAU energy use and emissions scenario out to 2050 was modelled using actual energy consumption data provided by Whitby. For the ZC scenario, a 'pathway to zero carbon' (PZC) was identified for each building. For the purposes of this Study, a PZC consisted of identifying the specific retrofits and lighting and energy source changes each existing Whitby building would require to bring its emissions to zero.

Energy audits completed for Whitby by a third party were the primary source used to define the PZCs for 22 of the Town's largest facilities. For the remaining existing buildings, those with unique energy-use patterns had PZCs developed by Whitby project staff. Those buildings with generic energy-use patterns (such as public washrooms in parks) had a general energy-use archetype developed and (e.g. "washroom"applied to their building area to define their PZC.

Energy Use and Emissions for New Buildings

New buildings fitting an existing Canadian Green Building Council (CaGBC) archetype were assumed to be built to the most recent building code standard for the BAU scenario and to a CaGBC zero-carbon standard for the ZC scenario.

The remaining new buildings and the building expansions were assigned energy use intensities (EUIs) of existing similar Whitby buildings with a 15% improvement over time for the BAU scenario. The ZC scenario assumed these buildings had EUIs of existing similar Whitby buildings after they had been retrofitted to be zero-emissions buildings.

Capital Costs for Existing and New Buildings

The cost to transform Whitby's building portfolio to net-zero emissions was calculated differently for existing buildings than for new buildings. For existing buildings, the process began by extracting the capital costs for a BAU scenario from Whitby's Capital Forecast. The costs for the PZC work was then compared, item by item, to the Capital Forecast items, and work that became unnecessary (e.g. replacing in the context of the PZC work) was removed.

For new buildings, the BAU costs were again extracted from the Capital Forecast. ZC scenario costs were generally developed by adding a percentage of the BAU costs (based on CaGBC guidance by archetype) and verifying the cost intensity against other similar existing Whitby buildings after their retrofits were completed. The Whitby Sports Complex was also adjusted to account for its connection to a district energy system.

Energy Consumption and Costs for Existing and New Buildings

Energy consumption for existing buildings in the BAU scenario was based on actual energy consumption reports, forecast into the future. For the ZC scenario, energy use for existing buildings was adjusted based on the PZC for each building. For example, if a building was scheduled to have its envelope improved in 2028 and its natural gas furnace replaced with an air source heat exchanger in 2030, the natural gas use was modelled to decrease in 2028 in proportion to the envelope improvements and then be eliminated altogether in 2030. The impact on electricity use would also appear at the appropriate times on the overall timeline.

Administration, Operations, and Maintenance Costs for Buildings

Carbon reduction measures generally have lower maintenance requirements than BAU technologies.[23] However, it was not practical to quantify the implications of Zero Carbon Whitby on building operations and maintenance costs within the constraints of this Study. As a result, it was assumed that the operating cost differences of all the measures would be negligible.

Additional staff required to complete the buildings portion of Zero Carbon Whitby were identified by Whitby Facilities based on a review of the Buildings Retrofit and New Build Schedule.

Assumptions

Table 17. Building Assumptions.

AREA	BUSINESS AS USUAL ASSUMPTION	ZERO CARBON ASSUMPTION
Building Portfolio Expansion and Disposal	Maintain existing portfolio expansion and disposal plans.	
Existing Building Retrofitting	Do not retrofit buildings and maintain as-is energy performance of buildings.	Retrofit energy performance according to net-zero standards according to retrofit schedule[24].

[23] Canadian Green Building Council. "Making the Case for Building to Zero Carbon." 2019. https://1b49982trudz12onla13ljpk-wpengine.netdna-ssl.com/wp-content/uploads/2022/01/Making_the_Case_for_Building_to_Zero_Carbon_2019_EN.pdf. Accessed May 20, 2022.

[24] The retrofit schedule for 2022 - 2025 is provided in Tables 2 and X. The remaining schedule has been provided as part of the detailed data results to the Whitby Project Team.

AREA	BUSINESS AS USUAL ASSUMPTION	ZERO CARBON ASSUMPTION
Fuel Switch	No electrification.	All fossil fuel heating is switched to air or ground source heating, or zero-emissions district energy according to the retrofit schedule.

FLEET

Assumptions

Table 18. Fleet Assumptions.

AREA	BUSINESS AS USUAL ASSUMPTION	ZERO CARBON ASSUMPTION
Expansion of Fleet	Fleet was assumed to expand in proportion to the forecast increase in total employees.	Fleet was assumed to expand in proportion to the forecast increase in total employees.
Light-Duty Vehicles	The current split of diesel and gasoline fuel types in light-duty vehicles will be maintained out to 2045.	Fully electric purchases begin in 2024 and ramp up so that by 2026 at least 20% of new LDVs purchased are EVs. By 2030 this rises to at least 60%, and by 2035 it's 100%. In 2045, all remaining ICE vehicles are converted to EVs.
Medium- and Heavy-Duty Vehicles	The current split of diesel and gasoline fuel types in medium- and heavy-duty vehicles will be maintained out to 2045.	Beginning immediately, assuming the required model is available, all new medium- and heavy-duty vehicles are gasoline and not diesel. Beginning in 2030, assuming the required model is available, 100% of new vehicles are either electric or hydrogen. In 2045, all remaining ICE vehicles are converted to EVs.
Installation of EV Chargers	No EV chargers are installed.	One EV charger is installed for every five electric vehicles in the fleet. The first charger is installed with the purchase of the first EV. EV chargers cost $40,000 each.
Hybrid Vehicles	Although hybrid vehicles are more efficient than gasoline vehicles, the 10 hybrids purchased in 2022 were not modelled differently than gasoline vehicles, as it would not have made a material difference to the final emissions, actions, or costs.	

STREET, TRAFFIC, PARK, AND SPORTS FIELD LIGHTING

Assumptions

Table 19. Street, Traffic, Park and Sports Field Lighting Assumptions.

AREA	BUSINESS AS USUAL ASSUMPTION	ZERO CARBON ASSUMPTION
Street Lights	All 13,000 street lights had been converted to LEDs by the end of 2021. No capital costs were included for replacements.	
Traffi c Lights	All traffic lights will be converted to LEDs by the end of 2022. No capital costs were included for replacements.	
Park and Sports Field Lighting	Energy use and costs for lights historically have been included in the Energy CAP values for buildings at the parks and sports fields. All of these lights were assumed to be and remain non-LEDs until 2045. Capital costs include replacing these every four years.	All bulbs at these locations were modelled to be replaced with LEDs in 2024, using capital costs provided by Whitby staff. They are subsequently replaced every 16 years.

Appendix C: Grants In Progress for Zero Carbon Whitby Work

The following is a summary of the grants applied for to cover the costs of Zero Carbon Whitby, and their status as of June 8, 2022.

Total Grant Funds Applied for: $41,750,000+.

Total Grant Funds Awarded: $590,000.

Total Grant Funds Not Awarded to Whitby: $25,000,000.

Total Grant Funds In Process: $16,160,000+.

Table 20. Grant Funding Applications.

FUNDING SOURCE	AGENCY/ FUNDER	AMOUNT REQUESTED	TOTAL PROJECT COST	NOTES	FACILITY	WORK	STATUS OF FUNDING	TO BE AWARDED BY	WORK TO BE DONE BY
Zero Emissions Infras. Vehicle Program	Natural Resources Canada	$50,000	$145,000	Amount provided can be up to 50% of total project cost.	Multiple	Installation of Level 2 Charging Stations	Awarded	2019	Dec 31 2021
Zero Emissions Infras. Vehicle Program	Natural Resources Canada	$50,000	$145,000	Amount provided can be up to 50% of total project cost.	Multiple	Installation of Level 2 Charging Stations	Awarded	2020	Dec 31 2021
Zero Emissions Infras. Vehicle Program	Natural Resources Canada	$150,000	$300,000	Amount provided can be up to 50% of total project cost.	Multiple	Installation of Level 2 & 3 Charging Stations	Awarded	2021	Dec 31 2023
Green & Inclusive Community Buildings	Infrastr. Canada	$25,000,000	$90,000,000	Amount provided can be up to 50% of total project cost.	Whitby Sports Complex	Funding to ensure facility achieves zero carbon emissions and LEED Gold Cert.	Not Awarded	2022	Dec 31 2025

FUNDING SOURCE	AGENCY/ FUNDER	AMOUNT REQUESTED	TOTAL PROJECT COST	NOTES	FACILITY	WORK	STATUS OF FUNDING	TO BE AWARDED BY	WORK TO BE DONE BY
Green & Inclusive Community Buildings	Infrastr. Canada	$3,000,000	$6,000,000	Amount provided can be up to 50% of total project cost.	McKinney Arena	Deep carbon retrofit of arena and one FT staff person.	In Progress	2022	Dec 31 2025
Green Community Buildings Retrofit Program	Federation of Canadian Muni's	$3,000,000	$6,000,000		McKinney Arena	Deep carbon retrofit of arena and one FT staff person.	In Progress	2022/ 2023	n/a
Low Carbon Fund	Infrastr. Canada	$10,500,000	$22,000,000	EOI Approved.	IPSC McKinney Ops, Cent, Marina	Deep carbon retrofit of IPSC, McKinney, and Operations, and two FT staff.	In Progress	2022	Dec 31 2025

Appendix D: Zero Carbon Revolving Reserve Fund

The following table provides the framework of the Zero Carbon Revolving Reserve Fund financials, including the balance of the fund at the start of each year of the Plan, the minimum required seed funding at the start of each year of the plan, annual payments required out of the Fund for ZC projects, annual monies coming into the Fund as savings and avoided costs due to ZC actions, and the fund balance at the end of each year of the Plan, assuming no investment.

	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fund Balance at Start of Year	$0	$9,118,868	$17,947,812	$20,757,838	$3,080,151	$557,656	$245,864	$4,734,196	$2,799,805
Seed Funding into Fund	$500,000	$8,800,000	$10,000,000	$12,000,000	$2,000,000	$500,000			
Payments out from Fund	-$185,873	-$1,274,446	-$9,553,851	-$20,578,444	-$4,183,159	-$1,642,786	-$222,974	-$3,574,106	-$608,506
ZC Savings into Fund	$4,741	$103,389	$363,878	$900,757	$1,160,663	$1,330,995	$4,711,306	$1,639,715	$1,891,567
Fund Balance at End of Year	$318,868	$7,947,812	$8,757,838	$1,080,151	$57,656	$245,864	$4,734,196	$2,799,805	$4,082,865

	2031	2032	2033	2034	2035	2036	2037	2038
Fund Balance at Start of Year	$4,082,865	$3,658,683	-$174,215	$2,007,051	$4,318,355	$6,882,786	$12,791,750	$15,703,429
Seed Funding into Fund		$1,000,000						
Payments out from Fund	-$3,600,483	-$9,450,127	-$340,431	-$373,959	-$324,630	-$437,466	-$372,592	-$466,351
ZC Savings into Fund	$2,176,301	$5,617,229	$2,521,696	$2,685,264	$2,889,061	$6,346,430	$3,284,271	$3,459,990
Fund Balance at End of Year	$2,658,683	-$174,215	$2,007,051	$4,318,355	$6,882,786	$12,791,750	$15,703,429	$18,697,068

	2039	2040	2041	2042	2043	2044	2045
Fund Balance at Start of Year	$18,697,068	$21,997,298	$25,349,034	$28,815,673	$32,613,137	$36,416,728	$43,815,987
Seed Funding into Fund							
Payments out from Fund	-$305,481	-$430,544	-$515,065	-$334,389	-$509,305	-$299,911	-$4,123,179
ZC Savings into Fund	$3,605,711	$3,782,280	$3,981,704	$4,131,853	$4,312,895	$7,699,170	$4,854,278
Fund Balance at End of Year	$21,997,298	$25,349,034	$28,815,673	$32,613,137	$36,416,728	$43,815,987	$44,547,085