Whitby Climate Emergency Response Plan

Phase 2: Mitigation

Financial Analysis

Whitby SSG

Purpose

This document was finalized in December 2023 to provide a summary of the projected costs, revenues, and savings associated with the implementation of the low-carbon scenario modelled for the Town of Whitby (Town) Climate Emergency Response Plan (CERP) Phase 2: Mitigation Plan, on the whole, and on an action-by-action basis. It also provides an overview of the low-carbon transition's broader economic impacts, such as on jobs and household energy costs.

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, the information and basis on which it relies, and the associated factors are subject to changes that are beyond the control of the author. The information provided by others is believed to be accurate but has not been verified.

This analysis includes strategic-level estimates of capital investments and related revenues, energy savings, and avoided costs of carbon represented by the proposed CERP Phase 2: Mitigation Plan in relation to the modelled business-as-planned scenario. It should not be relied upon for other purposes without verification. The authors do not accept responsibility for the use of this analysis for any purpose other than that stated above and do not accept responsibility to any third party for the use, in whole or in part, of the contents of this document.

This analysis applies to the Town and cannot be applied to other jurisdictions without further analysis. Any use by the Town, 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.

Overview

Transitioning to the low-carbon scenario requires immediate investments across all community sectors, including the Town, residents, businesses, institutions, and other levels of government. While the Town does not have direct control over external investments, it plans to lead by example, by taking immediate action following the Council's endorsement of the Plan and sustaining these efforts through 2045 and beyond.

The financial analysis was developed to understand the costs associated with implementing the low-carbon scenario. The analysis examined the total cost across the community and did not allocate costs and savings specifically to the Town or other sectors.

This analysis describes the projected costs (capital investment), returns (revenue generation and savings in operations, maintenance, energy costs, and carbon taxes), and job creation opportunities associated with implementing the recommended low-carbon scenario outlined in the CERP Phase 2: Mitigation Plan. The analysis also calculates marginal abatement costs, which identifies net cost per tonne of greenhouse gas (GHG) emissions reduced.

The financial modelling and analysis was completed in April 2023 under the assumption that implementation would begin in Q4 2023. As a result the financial analysis projected investments starting from 2023, under the assumption that the Mitigation Plan would be endorsed by Council and initiated in 2023. Although certain Governance and Leadership activities identified in the Implementation Plan will be carried out in 2023, the implementation of the actions and sub-actions related to the low-carbon scenario's Big Moves will not commence until Q1 of 2024.

Five categories of costs and returns are included in this financial analysis:

1. Capital costs;
2. Maintenance costs and savings;
3. Revenues;
4. Energy costs and savings; and
5. Carbon tax avoidance.

The analysis does not include administration, education, and marketing costs associated with actions. Nor are any of the costs or avoided costs associated with adding central energy infrastructure projected to be required with population growth and business-as-planned energy use. Similarly, the analysis excludes any land purchases for renewable energy infrastructure.

In addition, where defensible cost and returns cannot be identified for particular actions, they are excluded from the financial analysis. As a result, the analysis does not include the following action from the Plan's low-carbon scenario:

- Waste and water investment, maintenance, and revenue costs (referred to as Action 5.1 Increase residential, institutional, commercial, and industrial (ICI) diversion rates, and decrease waste per capita in the Mitigation Plan and Implementation Plan); and
- Personal-use vehicle electrification (referred to as Action 4.3 Electrify personal use vehicles in the Mitigation Plan and Implementation Plan).

Key Financial Concepts

The following are key concepts that are used to analyze the economic and financial impacts of the Plan.

COSTS ARE RELATIVE TO THE BUSINESS-AS-PLANNED SCENARIO

This financial analysis tracks projected costs and savings associated with low-carbon measures that are above and beyond the assumed business-as-planned (BAP) costs. The financial assumptions used to develop the analysis were shared with the Mitigation Plan's Project Team[1] for input and revision.

DISCOUNT RATE

The discount rate is the baseline growth value an investor places on their investment dollar. An investor considers a project to be financially beneficial if it generates a real rate of return equal to or greater than their discount rate.

An investor's discount rate varies with the type of project, investment duration, risk, and scarcity of capital.

Some argue that evaluating climate change mitigation investments should be based on the application of a low or even zero discount rate to reflect the value to society, known as "a social discount rate." As a social discount rate is the discounted rate applied for comparing the value to society of investments made for the common good, it is inherently uncertain and difficult to determine. In this project, we evaluate investments in a low-carbon future with a 3 percent (%) discount rate.[2]

NET PRESENT VALUE

The net present value of an investment is the difference between the present value of the capital investment and the present value of the future stream of savings and revenue generated by the investment.

NPV = (PV savings + PV revenue) - PV capital investment

This analysis uses five aggregate categories to track the financial performance of the low-carbon actions: capital expenditures, energy savings (or additional costs), carbon tax avoidance, operation and maintenance savings, and revenue generation associated with renewable energy production facilities and some transit actions. Carbon tax avoidance assumes that the carbon price will increase in line with current federal plans, reaching $170 per tonne of carbon dioxide equivalent (tCO_2e) in 2030 and held constant thereafter.

[1] The Mitigation Plan's Project Team consisted of representatives for the Town of Whitby, Region of Durham, and Elexicon Energy.

[2] 3% is the social discount rate recommended by the Treasury Board of Canada (Treasury Board of Canada Secretariat, Canadian Cost-Benefit Analysis Guide Regulatory Proposals, 2007, at 38). A social discount rate is recommended for instances where a regulatory proposal primarily affects private consumption of goods and services, and a regulatory proposal's impacts occur over the long term (50 years or more)

Treasury Board of Canada, 'Policy on Cost-Benefit Analysis', policy effective as of September 2018, online: www.canada.ca/en/government/system/laws/developing-improving-federal-regulations/requirements-developing-managing-reviewing-regulations/guidelines-tools/policy-cost-benefit-analysis.html

The analysis does not include administrative costs associated with implementing programs, as well as any energy system infrastructure upgrades that may be required, including associated land purchases. It also does not include the broader social costs that are avoided from mitigating climate change.

MARGINAL ABATEMENT COST

The marginal abatement cost of an action is the estimated cost for that action to reduce one tonne of GHG emissions. It is calculated by dividing the action's net present value (NPV) by the total GHG emissions it reduces (tCO_2e) over its lifetime. For example, if a project has an NPV of $1,000 and generates 10 tCO_2e of savings, its abatement cost is $100 per tCO_2e reduced. The abatement cost is marginal because it captures the incremental cost above the BAP activity and cost.

AMORTIZATION

The costs of major capital investments are typically spread out over a period of time. For example, a mortgage on a house commonly has a 25-year mortgage period. Amortization refers to the process of paying off capital expenditures (debt) through regular principal and interest payments over time. In this analysis, we have applied a 25-year amortization rate to all investments where noted. This period has been selected as it is the average amortization period for home mortgages in Canada, and the majority of the investments included in the plan are similar infrastructure investments.

A NOTE ON THE PLAN'S MOTIVATION AND CO-BENEFITS

The direct financial impacts of the Plan provide important context for local decision-makers. However, it is important to note that the direct financial impacts are a secondary motivation for undertaking actions that reduce GHG emissions. First and foremost, GHG emissions reductions are a critical response to the global climate crisis.

Note that most measures included in the Plan provide additional benefits to the community, such as cleaner air and positive health outcomes. These benefits are not captured in this analysis.

Financial Analysis Results

To implement the actions of the community wide low-carbon scenario modelled and generate a financial return, capital investments of $3.9 billion across various sectors in the community must be made between 2023 and 2045. In addition, the operations and maintenance costs required across the community are $504 million. These investments and operational and maintenance costs are offset by the cost savings related to avoided energy, carbon pricing, and increased generation revenues. This means that implementing the low-carbon scenario will result in a net return (financial return) of $1.7 billion across the community.

The overall returns translate to a weighted average return of $171 per tCO_2e reduced.[3] Table 1 summarizes the NPV and marginal abatement cost by action for the overall low-carbon scenario recommended in the Plan. For this reason, what is most important when looking at the following table is the abatement cost for the entire plan, as well as identifying which actions are considered to have a positive versus negative abatement cost. Measures with a positive net present value (i.e. where the investment has a positive return of at least 3%) will therefore have a negative abatement cost (i.e. they would be worth doing even without consideration of the carbon benefits), whereas measures with a negative net present value will have a positive abatement cost (i.e. these are measures with returns less than 3%). Actions with a positive abatement cost (or net financial loss) are highlighted in purple, and measures with a negative abatement cost (or net financial return) are highlighted in green.

The most expensive action in comparison to the amount of GHG emissions reduced is expanding the active transportation networks at a cost of $2,485 per tCO_2e avoided which would be borne by the Town and Region.[4] The second-most expensive action is constructing new commercial buildings to higher performance requirements outlined in the Whitby Green Standard and the Ontario Building Code (OBC) at $279 per tCO_2e avoided. The third-most expensive action is electrifying transit at $235 per tCO_2e avoided.

Installing solar photovoltaics (PV) in parking lots has the largest impact on GHG emissions per dollar spent, with a savings of $1,858 per tCO_2e avoided. Reducing community-wide commuting between work and home has the second-largest impact on GHG emissions in comparison to the financial investment, this action amounts to a savings of $1,149 per tCO_2e avoided. Installing rooftop PV on all buildings has the third-largest impact on GHG emissions in comparison to the financial investment, this action amounts to a savings of $1,149 per tCO_2e.

[3] This average is weighted in terms of actions that reduce more tonnes of GHGs influence the average more than actions that reduce less tonnes of GHGs. The net present value of the measures includes credit for the avoided costs of carbon ($170/tonne CO_2e by 2045); if that credit were excluded, the net savings per tonne of GHG mitigated would be correspondingly lower.

[4] Note that this cost is a simplification - active transportation capital costs were estimated from the construction costs identified in the 2021 Active Transportation Plan's Capital Works Table for Active Transportation Plan's Capital Works. In addition, the financial analysis does not provide a complete picture of the impact of this action. There are several co-benefits of increasing active transportation, such as enhancing health, improving air quality, and fostering social connection.

Table 1. Net present value and marginal abatement costs by action. Actions with a positive abatement cost (or net financial loss) are highlighted in purple, and measures with a negative abatement cost (or net financial return) are highlighted in green.

LOW-CARBON ACTION	CUMULATIVE EMISSIONS REDUCTION (KT CO2EQ)	NET PRESENT VALUE	MARGINAL ABATEMENT COST ($ / T CO2 EQ)
Install parking lot solar PV (Action 3.1)	208.57	-$387,519,552	-$1,858
Decrease home-to-work trips (Action 4.7)	38.09	-$61,587,506	-$1,617
Install roof top solar PV (Action 3.1)	596.13	-$685,099,475	-$1,149
Net-zero new construction residential buildings (Action 2.4)	463.01	-$403,928,151	-$872
Electrify Offroad Vehicles (Action 6.1)	202.43	-$78,463,650	-$388
Electrify municipal fleets (Action 4.2)	24.89	-$8,520,102	-$342
Retrofit program for ICI buildings (Action 2.1)	466.42	-$154,724,013	-$332
Electrify Agriculture Motive (Action 6.1)	25.15	-$8,162,346	-$325
Electrify ICI fleets (Action 4.4)	338.72	-$100,849,704	-$298
Industrial Actions (Action 6.1)	1,136.18	-$290,328,729	-$256
Decarbonizing the Grid[5]	1,303.66	-$249,551,928	-$191
Water conservation[6]	21.31	-$4,065,809	-$191
Reduce livestock emissions (Action 6.1)	5.79	-$602,603	-$104
Heat pumps new construction ICI buildings (Action 2.4)	332.85	-$33,713,883	-$101
Retrofit electric water heaters ICI buildings (Action 2.3)	46.79	-$2,464,972	-$53
Electric water heaters new construction ICI buildings (Action 2.4)	80.26	$1,353,751	$17
Retrofit electric heat pumps ICI buildings (Action 2.3)	243.66	$7,827,785	$32
Shift Auxiliary Equipment to Electricity (Action 6.1)	17.17	$1,249,174	$73

[5] Decarbonizing the grid is a provincial wide action, as a result sub-actions were not identified in the Implementation Plan.

[6] A standard 1% improvement per year over 20 years was modelled as water conservation and water treatment. Additional sub-actions for water conservation were not developed as part of the Implementation Plan, these can be further explored during the five year update to the CERP Phase 1 and Phase 2.

LOW-CARBON ACTION	CUMULATIVE EMISSIONS REDUCTION (KT CO2EQ)	NET PRESENT VALUE	MARGINAL ABATEMENT COST ($ / T CO2 EQ)
Retrofit electric heat pumps residential buildings (Action 2.3)	1,539.35	$116,052,133	$75
Retrofit electric water heaters residential buildings (Action 2.3)	340.28	$29,211,456	$86
Heat pumps new construction residential buildings (Action 2.4)	496.09	$105,528,035	$213
Expand transit (Action 4.5)	91.53	$19,570,599	$214
Retrofit program for residential buildings (Action 2.1)	1,142.79	$247,664,367	$217
Electrify transit (Action 4.1)	412.69	$96,813,724	$235
Net-zero new construction ICI buildings (Action 2.4)	271.52	$75,631,185	$279
Expand active transportation (Action 4.6)	31.37	$77,951,856	$2,485
TOTAL	**9,876.71**	**-$1,690,728,357**	**-$171**

Marginal Abatement Cost

The marginal abatement cost curve (Appendix B) illustrates the individual marginal abatement cost of each of the actions included in the Plan. Note that although the presentation of the cost curve implies that each action has a unique marginal abatement cost, individual actions cannot be neglected without impacting the overall financial and GHG reduction outcomes of the broader set of actions. For example, if building retrofits are not completed, the amount of renewable energy required to meet the targets laid out in the Plan will increase drastically, which will change the financial cost of this action. In addition, in order to achieve the Town's community GHG emissions reduction targets all, the actions need to be undertaken, as soon as possible as delaying actions will impact savings that households and businesses can achieve through those actions.

The marginal abatement cost curve provided useful insights when developing the Plan, particularly for implementation considerations. For example, it makes apparent which actions will be necessary but costly and may not be financially appealing for the private sector to undertake on its own. This highlights where action can be spurred using powerful tools such as subsidies, incentives, or in some cases, regulations from the municipal government or other funders or regulators. This cost curve will remain useful as the Plan is implemented, including as programs, policies, and initiatives are planned and launched, and reviewed and adjusted over time based on changing conditions and lessons learned.

During the implementation of the Plan, the marginal abatement cost curve will help answer critical questions, such as:

- Can high-cost and high-savings actions be bundled to achieve greater GHG emissions reductions?
- How can the Town help reduce the costs of the high-cost actions by supporting innovation

or providing subsidies, such as the Durham Greener Homes Program?[7]

- Which actions save money and reduce the most GHG emissions?
- Which actions are likely to be of interest to the private sector, assuming barriers can be removed or supporting policies introduced?

Present and Net Present Value

Most of the actions recommended in the Plan have net present values (NPVs) that are net financial returns, as does the entire program of actions (or overall low-carbon scenario). Table 2 shows the NPV of the major components of the Plan including capital investments, operations and maintenance savings, energy cost savings, avoided costs of carbon, and revenue compared to the undiscounted.

Table 2. Summary of financial results. Financial considerations with a positive number are net financial loss, and financial considerations with a negative number are net financial return.

FINANCIAL CONSIDERATION	NET PRESENT VALUE (DISCOUNT RATE 3%), 2023-2045	CUMULATIVE, INCREMENTAL EXPENDITURES AND SAVINGS, 2023-2045
Net financial loss of the low-carbon scenario		
CAPITAL INVESTMENTS	$3.9 billion	$5.3 billion
OPERATIONS & MAINTENANCE COSTS	$205 million	$365 million
Net financial savings of the low-carbon scenario		
ENERGY COST SAVINGS	-$3.9 billion	-$7.7 billion
CARBON TAX AVOIDANCE (I.E., SAVINGS)	-$1.4 billion	-$2.5 billion
REVENUE FROM LOCAL RENEWABLE ENERGY GENERATION AND SERVICES	-$544 million	-$1 billion
The total return[8] of the low-carbon scenario		
NET RETURN OF ACTIONS	-$1.7 billion	-$5.5 billion

[7] To learn more about the Durham Greener Homes Program, visit: https://durhamgreenerhomes.ca/.

[8] The net return of actions = (energy cost saving [-$1.4 billion] + carbon tax avoidance [-$3.9 billion] + revenue from local renewable energy generation and services [-$205 million]) - (capital investments [$3.9 billion] + operations and maintenance costs [$504 million]). In the formula financial considerations with a positive number are net financial loss, and financial considerations with a positive number are net financial return.

Cash Flow Analysis

Figure 1 shows in detail the annual costs, savings, and revenue associated with fully implementing the actions in the Implementation Plan. Capital expenditures are shown in full in the years in which they are incurred. As is characteristic of net-zero transitions, the capital expenditures in the early years of the transition are significantly greater than the savings and revenues generated, but, by 2035, the annual benefits exceed the annual investments and the cumulative benefits are greater than the cumulative costs.

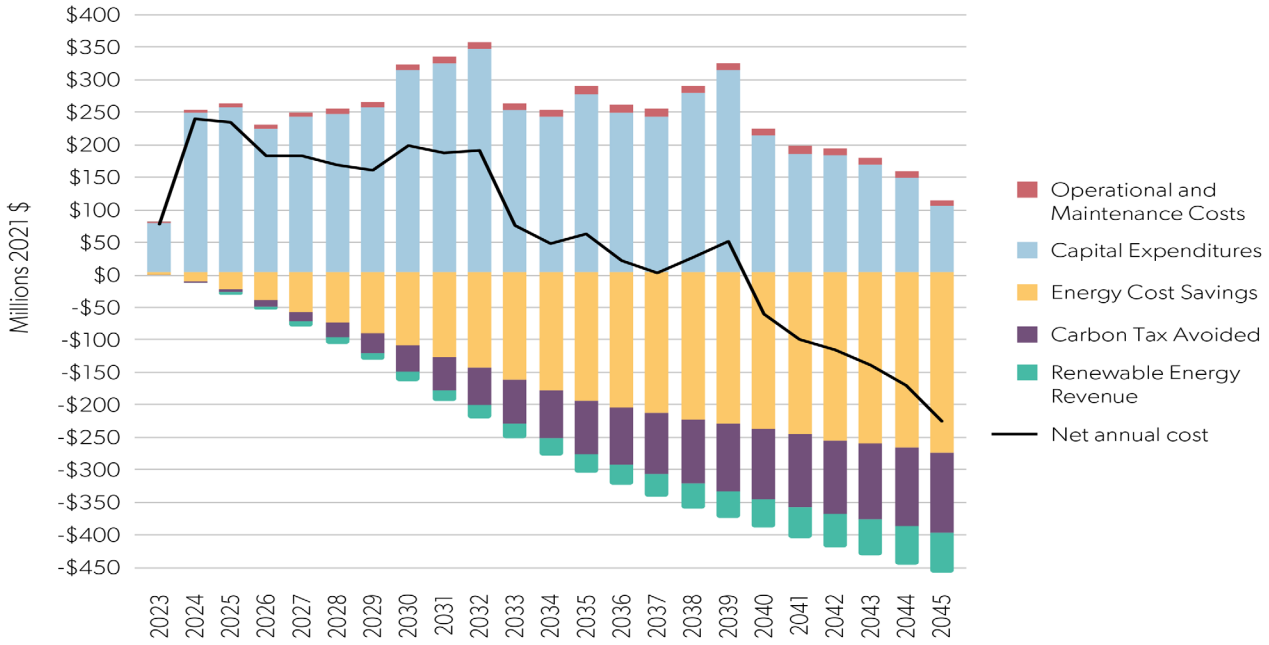

Figure 1. Year-over-year low-carbon scenario investments and returns/avoided costs. Numbers displayed as positives have a net financial loss (capital expenditures, and operational and maintenance), and numbers displayed as negative have a net financial return (revenue generation, carbon tax avoidance, and energy cost savings).

Figure 2 presents the same costs and benefits, but with the capital expenditures amortized over 25 years at 3%. With this approach, which presumably better reflects actual approaches for financing the transition, the savings and revenue generation throughout the scenario are greater than the annualized capital payments. After 2045 (not shown in Figure 2), the benefits and revenues continue, resulting in continuous growth in the net annual benefit.

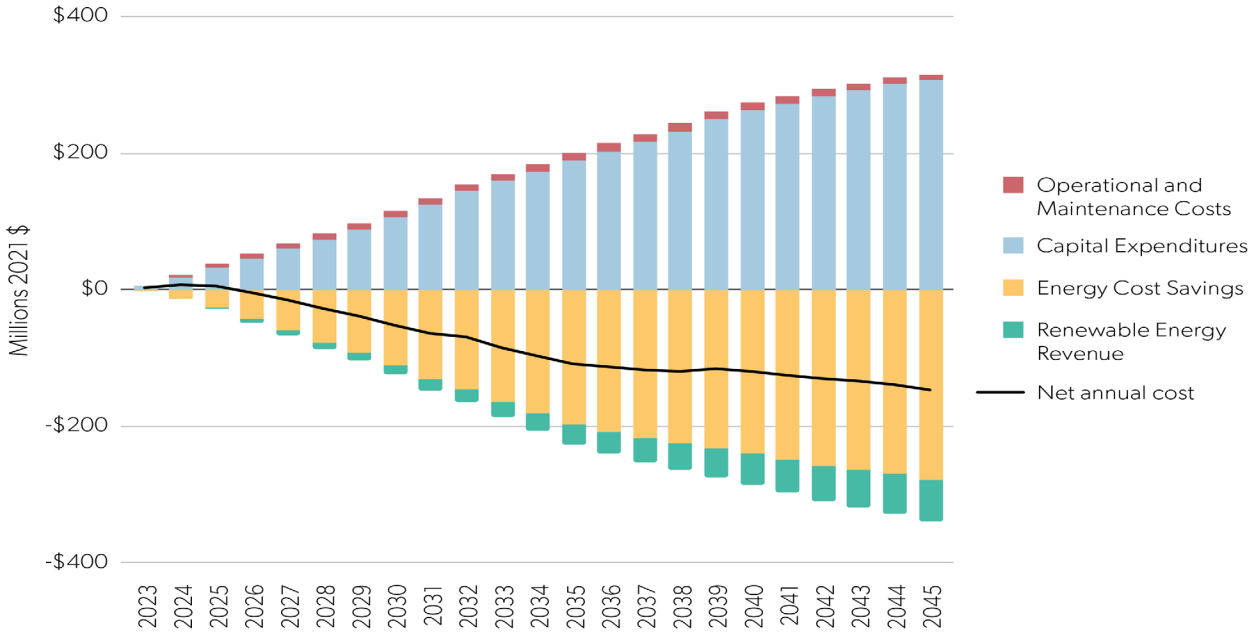

Figure 2. Year-over-year low-carbon scenario investments and returns/avoided costs, with capital investments, annualized. Numbers displayed as positives have a net financial loss (capital expenditures, and operational and maintenance), and numbers displayed as negative have a net financial return (revenue generation, carbon tax avoidance, and energy cost savings).

Cost Savings for Households

Household expenditures on energy are projected to decline in both the business-as-planned (BAP) and low-carbon scenarios. The baseline financial modelling and assumptions record an average household energy cost of over $6,113 in 2020 (the Mitigation Plan's baseline year). In the BAP scenario, household energy costs are projected to decrease to $3,034 by 2045. The low-carbon scenario involves shifting away from natural gas, diesel, and gasoline to electricity and renewable energy, which are currently more expensive than natural gas in Whitby. The increased cost of these sources, however, is offset by the increased efficiency of homes and electric vehicles, as well as the avoided carbon tax.

In the low-carbon scenario, an average household in Whitby is expected to spend $1,717 on household energy costs by 2045. This is $1,317 less per household than the projected 2045 cost in the BAP scenario, and 72% lower than the 2020 energy costs (Figure 3).

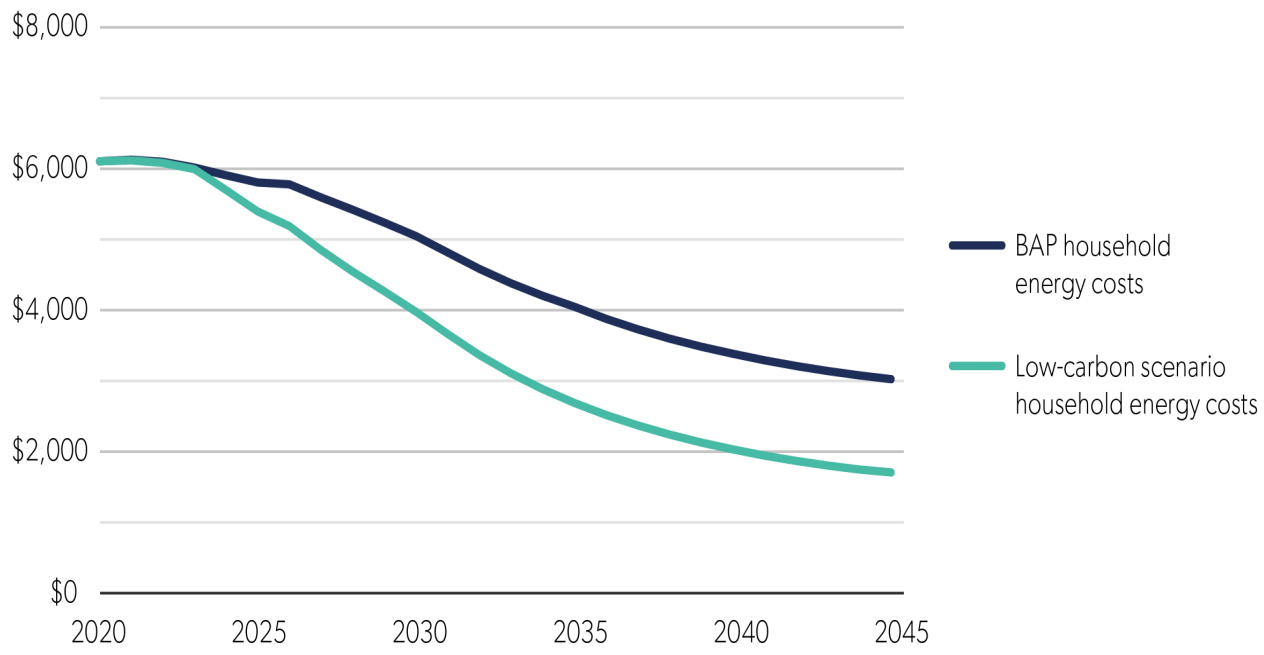

Figure 3. Projected household energy costs in Whitby in the business-as-planned and low-carbon scenarios, 2020-2045.

New Job Opportunities

Transitioning to a low- or zero-carbon economy is expected to impact labour markets in four main ways: additional jobs will be created in emerging sectors, some employment will be shifted (e.g., from fossil fuels to renewables), certain jobs will be reduced or eliminated, and many existing jobs will be transformed and redefined.

This is especially important as Whitby's population continues to grow substantially, as these new residents will need to find work in new and existing roles. According to the direct job multipliers from Census Canada, implementing the low-carbon scenario will result in approximately 45,355 person years of employment generated between 2023 and 2045—this equates to an average of 2,062 full-time equivalent (FTE) jobs annually across all sectors. The top five sectors for job growth between 2023 and 2045 are residential building retrofits, expanding transit, commercial building retrofits, electrifying transit, and installing rooftop solar PV.

A larger increase in jobs per year above the BAP scenario is projected between 2023 and 2032, than in the later years of the low-carbon scenario. This is due to Whitby's ambitious GHG emissions target and the resulting low-carbon scenario that requires many actions to be completed by 2035. The actions happening early on in the scenario require infrastructure and renovations that will create jobs (Figure 4).

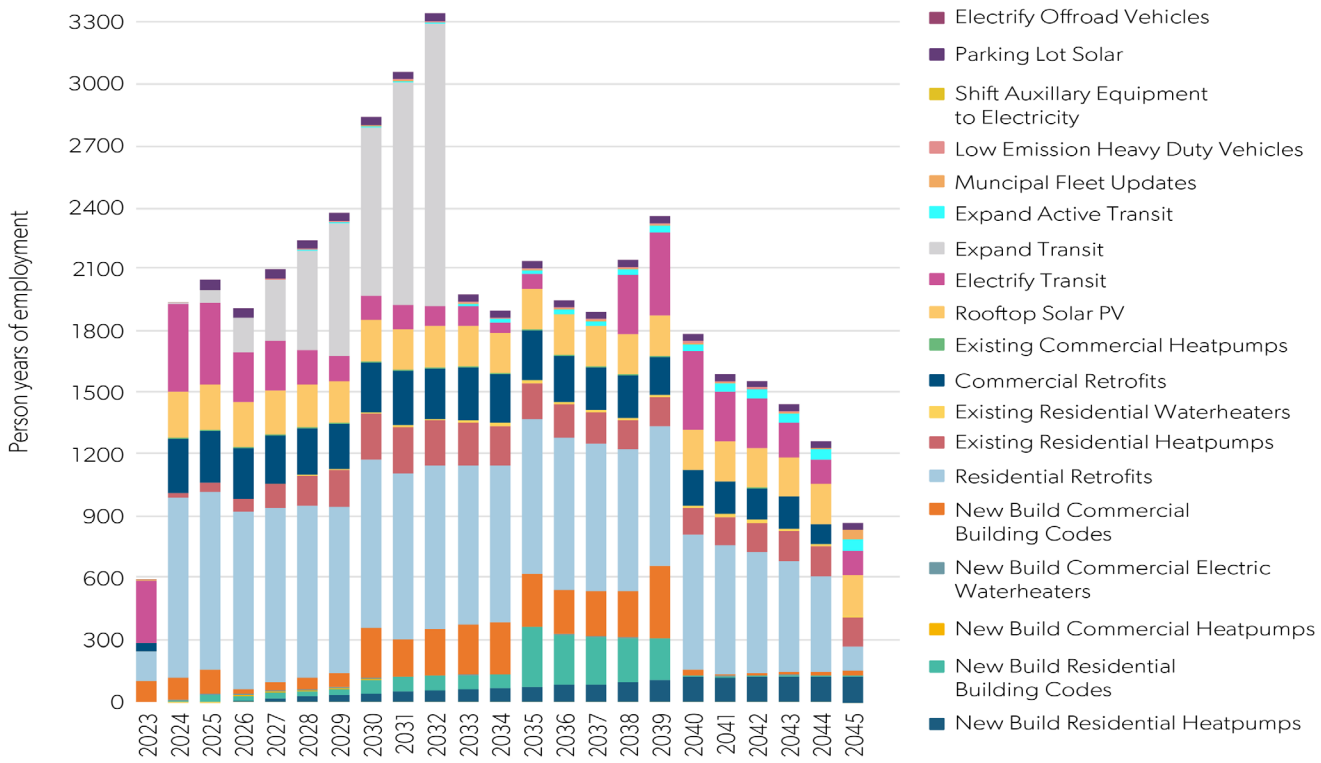

Figure 4. Projected increases in person years of employment in the low-carbon scenario compared to the business-as-planned scenario.

Appendix A: Key Financial Assumptions

Table 1A. Key financial assumptions used in Whitby's financial modelling and analysis.

BIG MOVE	CAPITAL INVESTMENT ASSUMPTION
NEW BUILDINGS	

New residential buildings with heat pumps
New industrial building efficiency
New commercial building efficiency with heat pumps
	• The cost for new construction of buildings on a $/m² is estimated to be:
	  • Single-detached: $1,702/m²
	  • Double/row: $1,565/m²
	  • Apartment 1-6 storey: $2,415/m²
	  • Apartment 7-12 storey: $2,662/m²
	  • Apartment > 12 storey: $2,745/m²
	  • Commercial: $2,800/m²
	  • Industry: $3,157/m²
	• A residential air-source heat pump has a capital cost of approximately $5,295 (non-residential is ~$17,680) and annual operating cost of approximately $160 annually (~$400 annually for non-residential).

RENEWABLE ENERGY	
Rooftop Solar and Ground Mount Solar	• Ground mount solar PV has a capital cost of approximately $1,760 per kW, which is expected to decrease to $1,463 by 2030. • Residential rooftop solar PV has a capital cost of approximately $3,437 per kW, which is expected to decrease to $1,087 by 2030.
WASTE AND WASTEWATER	
Wastewater process efficiency	• Improving wastewater process efficiency will cost an estimated $497 per tonne of GHG reduced.
Landfill gas capture increase	• The landfill gas capture increase is expected to cost $700,000/year from 2022 to 2050.
TRANSPORT	
Establish local electric bus service Electrify municipal fleets Electrify personal vehicles Net-zero commercial transport activity Expand active transportation	• Today electric buses cost approximately $630,000, and are expected to cost less than a diesel bus by 2031. A fast charger costs about $140,000 and is assumed to be needed on a 1:20 ratio with electric buses. Electric bus maintenance costs are approximately 30% lower than for diesel buses. • Electric vehicle infrastructure is assumed based on the ChargePoint quoted (supply only) the Level 2 and Level 3 charger at $8,240.22 and $57,698.91 respectively. • Heavy duty combustion engine vehicles are not expected to reach cost parity with their electric counterparts by 2050. • Active transit network expansions were estimated from the construction costs identified in the 2021 Active Transportation Plan's Capital Works Table for Active Transportation Plan's Capital Works.

BIG MOVE	CAPITAL INVESTMENT ASSUMPTION
EXISTING BUILDINGS	

Retrofits of homes and heat pumps
 	
Industrial improvements (process motors/ efficiency)
 	
Retrofits of commercial and industrial buildings
	• The average cost of a 50% energy efficiency retrofit is assumed to be:
	  • Residential (per unit): $45,000
	  • Non-Residential ($/m2) : $275
	• Industrial upgrades average the following in 2022 and 2045 per GJ/year
	  • Lighting system: $134⇢ $59
	  • Space heating: $25 ⇢ $34
	  • Water Heating: $32 ⇢ $49
	  • Motive: $66 ⇢ $176
	  • Process heat: $27 ⇢ $43
	• Cost of retrofits
	  • Cost estimates for fuel-switching and envelope measures are assumed constant over the economic modelling period, not included in these estimates are:
	  • Base cost of repairs (i.e. assuming these upgrades happen at or near component
	  • End-of-life, we include only the incremental cost above the base cost of business-as usual replacement)
	  • Lighting, appliances upgrades, and demand-response technologies
	  • Upgrade of electrical panel or electrical hookup to accommodate additional load
	  • Climate adaptation measures (e.g. protection against floods or forest fires)

Appendix B: Marginal Abatement Cost Curve

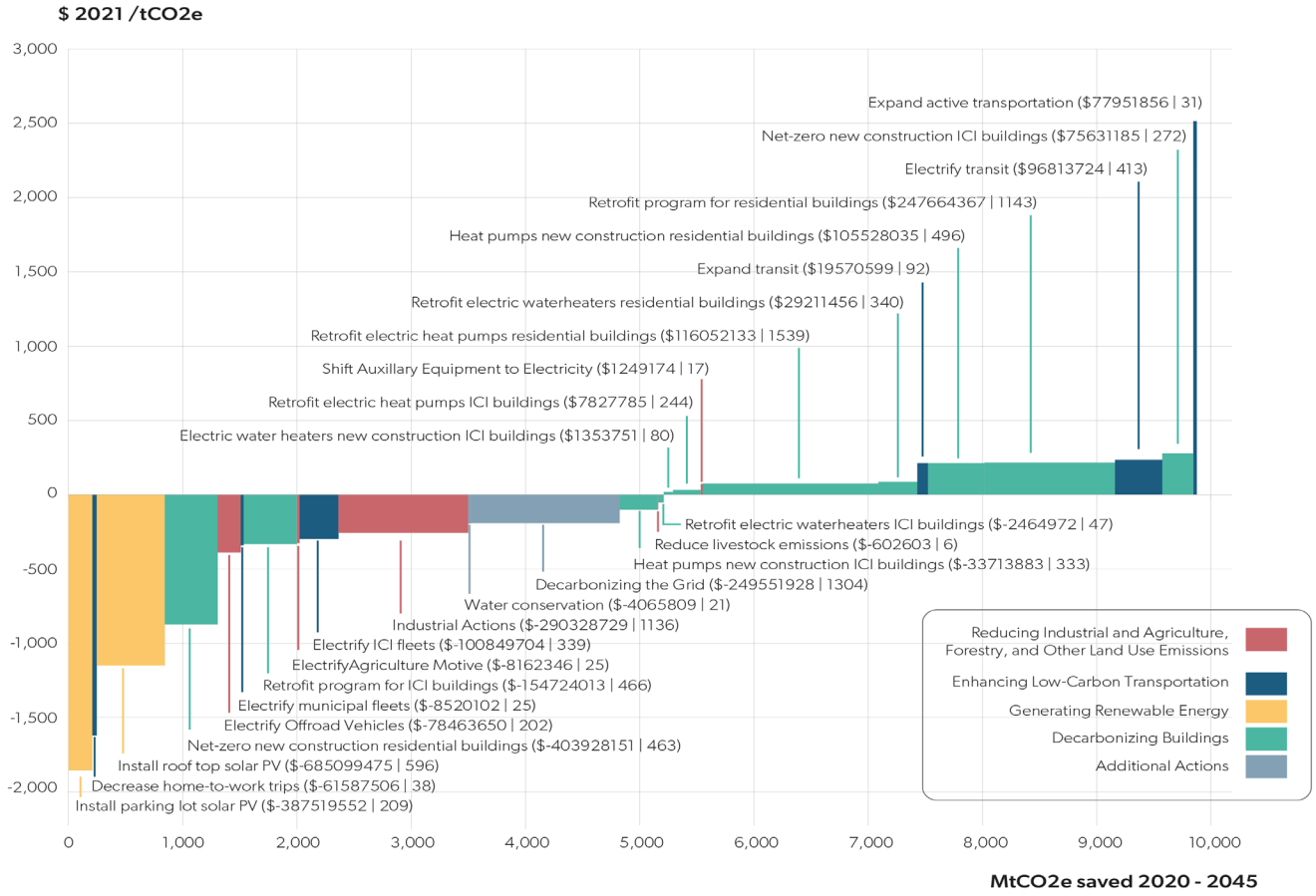

Figure 1B. Marginal abatement cost curve for actions included in the Mitigation Plan.