SUSTAINABILITY SOLUTIONS GROUP

APPENDIX D: Financial Analysis

July 2021

Purpose of this Document

This document provides a summary of the projected costs, revenues, and savings represented by the Town of Halton Hills Low-Carbon Transition Strategy (LCTS). The pathway's financial impacts are assessed as a whole and on an action-by-action basis.

A detailed analysis of the net-zero scenario modelled as the basis of the LCTS is provided in Appendix C.

Contents

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 Low-Carbon Transition Strategy (LCTS). The intent of this analysis is to help inform project stakeholders about the potential costs and savings represented by the LCTS in relation to the modelled reference 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 of Halton Hills and cannot be applied to other jurisdictions without further analysis. Any use by the Town of Halton Hills, its sub-consultants or any third party, or any reliance on or decisions based on this document, is the responsibility of the user or third party.

Acronyms

AV	autonomous vehicle
BAP	business-as-planned
GHG	greenhouse gas
LCTS	Low-Carbon Transition Strategy
NPV	net present value
MAC	marginal abatement cost
MACC	marginal abatement cost curve
PV	photovoltaic
RNG	renewable natural gas

Overview

The following table highlights the key findings from the financial analysis of the net-zero scenario modelled for the Town of Halton Hill's Low-Carbon Transition Strategy (LCTS). Further details about what is captured in each financial estimate are provided in the body of the report, as indicated in the right-hand column.

Table 1. Summary of high-level financial analysis of Halton Hills' LCTS.

Financial estimate	Key results	Where to find further details
The net benefit of the LCTS investments, 2021-2069	*≈ $854 million, NPV.*	NPV, Figure 4
Total incremental capital investment, 2021-2030	*≈ $1,966 million NPV.*	NPV and MAC Values
Total savings (avoided energy maintenance and carbon costs), 2021-2069[1]	*≈ $1,397 million, NPV.*	Cash Flow Analysis
Total revenue, 2021-2069	*≈ $1,423 million, NPV.*	Cash Flow Analysis
Average cost to reduce each tonne of GHG	*≈ $448 in savings, NPV.*	Table 3
Most cost-effective GHG-reduction action ($/ tonne CO2e)	*1. Ground mount solar: ≈ $4,000 in savings* *2. Municipal fleet electrification: ≈ $2,000 in savings* *3. Residential and commercial rooftop solar PV: ≈ $1,300-2,100 in savings* *4. Personal use vehicle electrification: ≈ $900 in savings*	Table 3
Household savings on energy, 2021-2030 (annual)	*≈ $1,800 on average in 2030*	Pt. 2, Cost Savings for Households

[1] While the capital investments in the LCTS all occur by 2030, the savings and revenue from many of those investments continue well beyond 2030 and are tracked in this analysis to the year 2069.

What Is and Is Not Included

The following five categories of costs and savings are included in this financial analysis:

1. capital costs,
2. maintenance costs,
3. revenues,
4. energy costs/savings, and
5. carbon cost savings.

Operating costs associated with actions (e.g., administration, education, or marketing costs) are not included in this analysis.

Where defensible cost and savings are not identified for particular actions, they are excluded from the financial analysis. As a result, the following LCTS actions are not included in this financial analysis:

- district energy,
- electricity distribution system costs,
- active transportation (a detailed study would be required to provide an estimate of the capital costs required),
- sustainable soil management (a detailed study required to determine what programs are needed and what they would cost), and
- off-road vehicle electrification (missing data on current fleet vehicle share type).

An exception was made in the case of long-distance transit, which was included despite lack of data for capital costs, as these costs are likely to be spent by higher levels of government, and the benefits are likely to be experienced locally.

Part 1. Key Financial Analysis Concepts

The direct financial impacts of Halton Hills' Low-Carbon Transition Strategy (LCTS) 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 greenhouse gas (GHG) emissions. First and foremost, GHG reductions are a critical response to the global climate emergency. In addition, most measures included in the LCTS provide social goods to the community, such as net job creation and positive health outcomes. These benefits are only marginally captured in this financial analysis via the cost of carbon.

Key concepts that are used to analyze the financial impacts of the LCTS are summarized below.

Costs Are Relative to the BAP

This financial analysis tracks projected costs and savings associated with net-zero measures that are above and beyond the assumed "reference" costs under a business-as-planned (BAP) scenario, which is a projection of current plans and policies.

Discount Rate

The discount rate is the baseline growth value an investor places on their investment dollar. A project is considered financially beneficial by an investor 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, the duration of investment, risk, and the scarcity of capital.

The social discount rate is the discount rate applied for comparing the value to society of investments made for the common good. As such, it is inherently uncertain and difficult to determine. Some argue that in the evaluation of climate change mitigation investments a very low or even zero discount rate should be applied. In this project, we evaluate investments in a net-zero future with a 3% discount rate.[2]

Net Present Value

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

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

Five aggregate categories are used to track the financial performance of the net-zero actions in this analysis: capital expenditures, energy savings (or additional costs), carbon

[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
- 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).

cost savings (assuming the carbon price reaches $170/tonne CO2e in 2030 and is held constant thereafter), operation and maintenance savings, and revenue generation (associated with renewable energy production facilities and some transit actions).

What is NOT included are administrative costs associated with implementing programs, as well as any energy system infrastructure upgrades that may be required. Similarly, the broader social costs that are avoided from mitigating climate change are not included in the financial analysis.

Abatement Cost

The abatement cost of an action is the estimated cost for that action to reduce one tonne of greenhouse gas emissions (GHG) and is calculated by dividing the action's net present value (NPV) by the total GHG emissions it reduces (tCO2e) over its lifetime. For example, if a project has a NPV of $1,000 and generates 10 tCO2e of savings, its abatement cost is $100 per tCO2e reduced.

Amortization

The costs of major capital investments are typically spread over a period of time (e.g., 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. 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.

Energy and Carbon Cost Projections

The energy cost projections (not including the federal cost of carbon or the fixed cost of delivery for natural gas and electricity) displayed in Figure 1 underlie the financial analysis. These projections were derived from:

- Halton Hills Hydro, the Ontario Energy Board, and the Canada Energy Regulator (electricity);
- Enbridge (natural gas);
- the US Energy Information Administration (propane); and
- the Canadian Energy Regulator (formerly National Energy Board) for all other fuels.

The financial analysis is sensitive to electricity and natural gas costs. Electricity costs are projected to increase more rapidly than natural gas; if natural gas costs increase more rapidly, then the financial benefit of many of the actions increases. The impact of increasing or decreasing energy costs are outlined in the sensitivity analysis at the end of this report.

An escalating cost of carbon, based on federal regulation, was applied out to 2030.

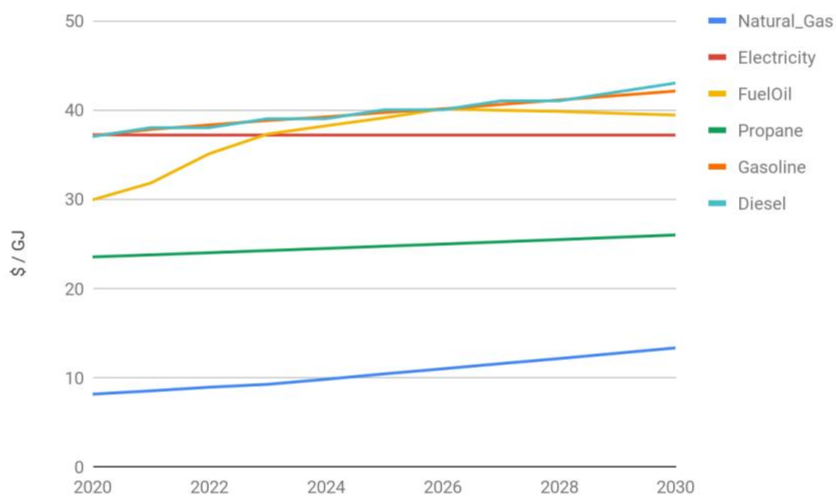

Figure 1. Projected energy costs (not including the federal cost of carbon).

Part 2. Town of Halton Hills LCTS Financial Analysis Results

Abatement Costs

As outlined in Table 2 (below), the investments included in the LCTS presented here actually yield a negative cost of carbon; that is, the net savings and revenues they generate yield a positive financial return that translates to a weighted average *benefit* of $448/tonne of CO2e reduced.[3] The values for the individual measures are included in Table 2; all measures that have a positive abatement cost (i.e., greater costs than benefits) are highlighted in red, all measures with a negative abatement cost (i.e., greater benefits than costs) are highlighted in green.

The most expensive actions are municipal retrofits, at $2,432 per tonne of CO2e avoided. The municipality, in its leadership role, has set an ambitious target of retrofitting all of its buildings to net zero by 2030. This retrofit action is followed closely by residential retrofits for older homes, at $1,896 per tonne of CO2e avoided, and for newer homes, at $1,483 per tonne of CO2e avoided. Though not quite as ambitious as the municipality's retrofit program, the LCTS has set ambitious energy efficiency targets for the rest of the Town's buildings. However, the marginal abatement cost for these retrofit actions does not capture the savings from avoided increased energy generation infrastructure (i.e., new nuclear or other large-scale electricity generation facilities), which can be significant.

The autonomous vehicle car share (shift to AV) and local solar power generation have the lowest cost per tonne of GHG reduction. An autonomous electric vehicle car share program is expected to provide a net benefit of $6,343 per tonne of C02e avoided, primarily because it is expected to reduce the need for personal-use vehicles. Ground mount solar is estimated to provide $4,263 of fuel savings and revenue per tonne of avoided GHG emissions; followed by rooftop residential and commercial rooftop solar, at $2,126 and $1,338, respectively. Rooftop solar provides fewer benefits as there is no revenue associated with it; however, it does result in fuel savings.

As mentioned at the outset of this report, no capital costs were modelled for long-distance transit, which explains why it is shown so positively in this analysis at $1,973 of benefits per tonne of GHG reduced. We decided to keep this action within this analysis, despite the missing data, as the costs are likely to be covered by higher-levels of government while the

[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 CO2e by 2030); if that credit were excluded, the net savings per tonne of GHG mitigated would be correspondingly lower.

benefits are likely to be experienced locally.

Reviewing the following table action-by-action requires understanding the action's sequencing in the model (i.e., what the action is offsetting), which is not provided here as it would require a complex and lengthy model description. 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%).

Table 2. Net present value and marginal abatement costs by action.

Action *(see Appendix A for additional details on the actions listed below)*	Cumulative emissions reduction (kt CO2eq)	Net present value	Marginal abatement cost ($ / t CO2 eq)
New residential buildings	133	$60,842,457	$458
Residential retrofits, pre-1980	217	$411,565,409	$1,896
Residential retrofits, post-1980	136	$202,395,768	$1,483
Residential heat pumps - non-retrofits	62	$8,646,493	$140
New non-residential buildings	71	-$50,341,935	-$711
Municipal buildings	4	$8,872,602	$2,432
Non-residential retrofits	92	$10,013,414	$109
Commercial heat pumps - non-retrofits	56	-$14,458,954	-$257
Industrial efficiency	98	$20,440,398	$210
Industrial switch to RNG	38	-$2,413,037	-$63
Residential rooftop solar PV	11	-$22,916,494	-$2,126
Commercial rooftop solar PV	9	-$12,074,066	-$1,338
Long-distance transit	15	-$29,485,258	-$1,973
Medium-distance transit	10	-$4,387,294	-$448
Work from home	71	-$105,136,142	-$1,477
Municipal fleet electrification	2	-$3,368,164	-$2,008

Commercial vehicle electrification	78	-$57,926,389	-$739
Tree planting	37	$917,394	$25
Electrify PUV	219	-$198,569,230	-$906
Shift to AV	24	-$153,069,082	-$6,343
Ground mount solar	206	-$878,128,964	-$4,263
RNG procurement	192	$10,790,711	$56
TOTAL	1,780.87	-$797,790,362	-$448

Marginal Abatement Cost Curve

Figure 3 shows the marginal abatement cost curve (MACC) for measures included in the Town of Halton Hills' LCTS.

While a MACC illustrates the financial profile of the suite of actions, it is an imperfect indicator. The presentation of the MACC implies that the actions are a menu from which individual actions can be selected. In fact, many of the actions are dependent on each other. For example, the energy use costs increase without retrofits. In addition, in order to achieve the Town's target all the actions need to be undertaken, as soon as possible. Delaying action for any reason, including waiting for technological improvements, will reduce the savings that can be achieved for households and businesses, and the new employment opportunities created.

The MACC provides useful insights that guide implementation planning. It helps 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 by providing subsidies?
- Which actions both save money and reduce the most GHG emissions? These can be considered "big" moves.
- Which actions are likely to be of interest to the private sector, assuming barriers can be removed or supporting policies introduced?

Such insights are illustrated in Figure 2.

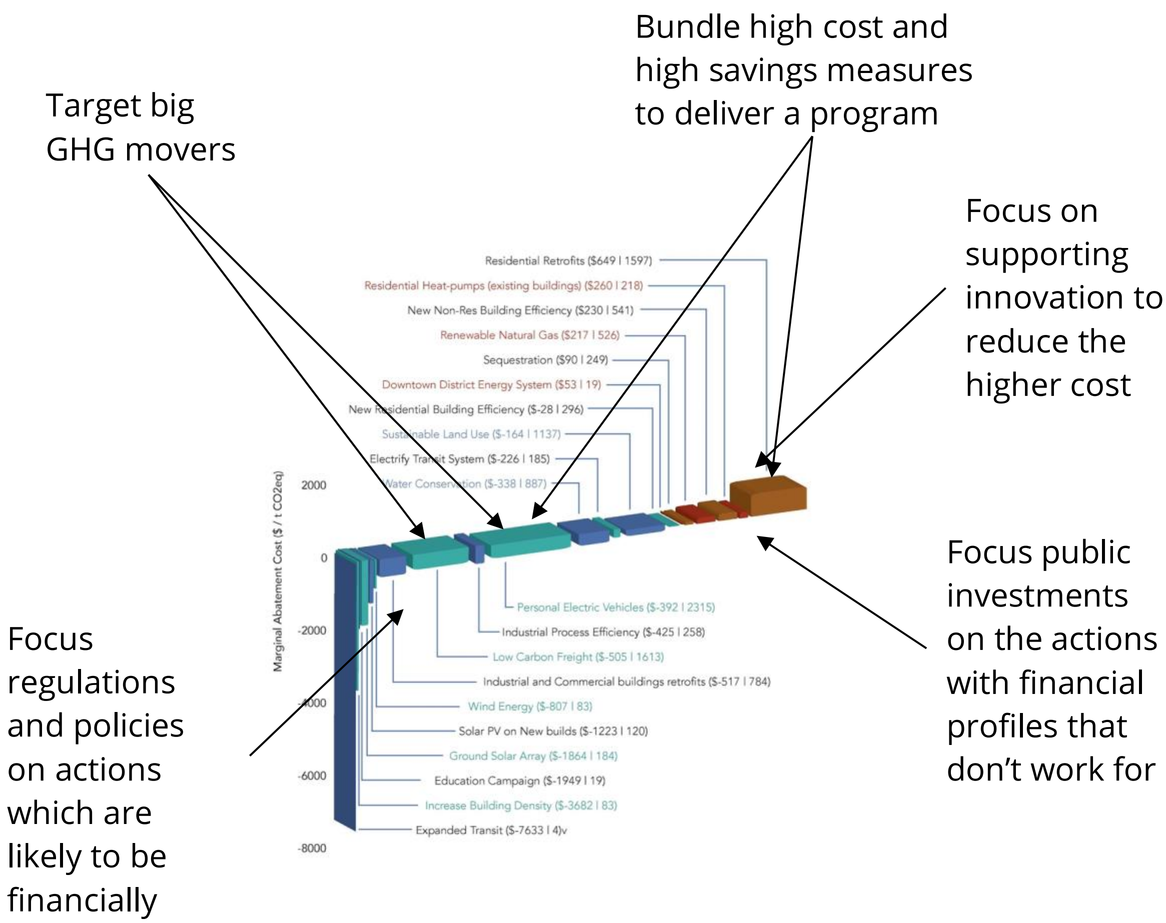

Figure 2. Examples of the strategic uses of a marginal abatement cost curve analysis.

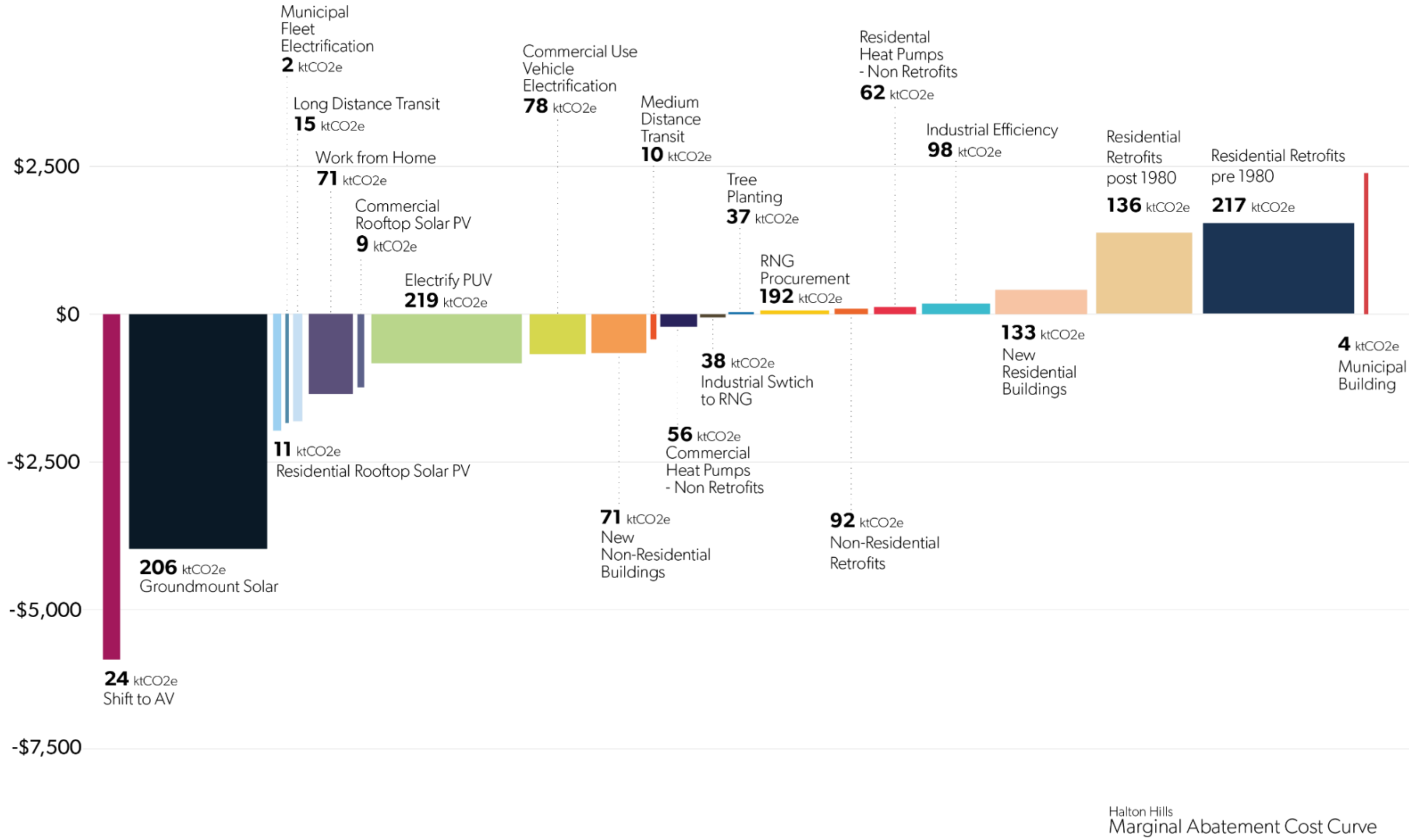

Figure 3. The Marginal Abatement Cost Curve (MACC) for the actions included in the LCTS.

Present and Net Present Values

As noted in the previous section, most of the actions in the net-zero scenario have positive net present values, as does the program of investments as a whole. Figure 4 shows the present value of the major components of the LCTS: investments, operations and maintenance savings, fuel and electricity savings, avoided costs of carbon, and revenue from transit and local energy generation. After discounting at 3%, the investments in the program have a present value of almost $2 billion and the savings and revenue have a present value of $1.4 billion. The NPV of the whole scenario is $854 million.

Even though capital investment for the plan ends in 2030, the NPV includes the energy, maintenance, carbon costs savings and projected revenue over the full life of the measures, which, in some cases, extends as far as 2069.

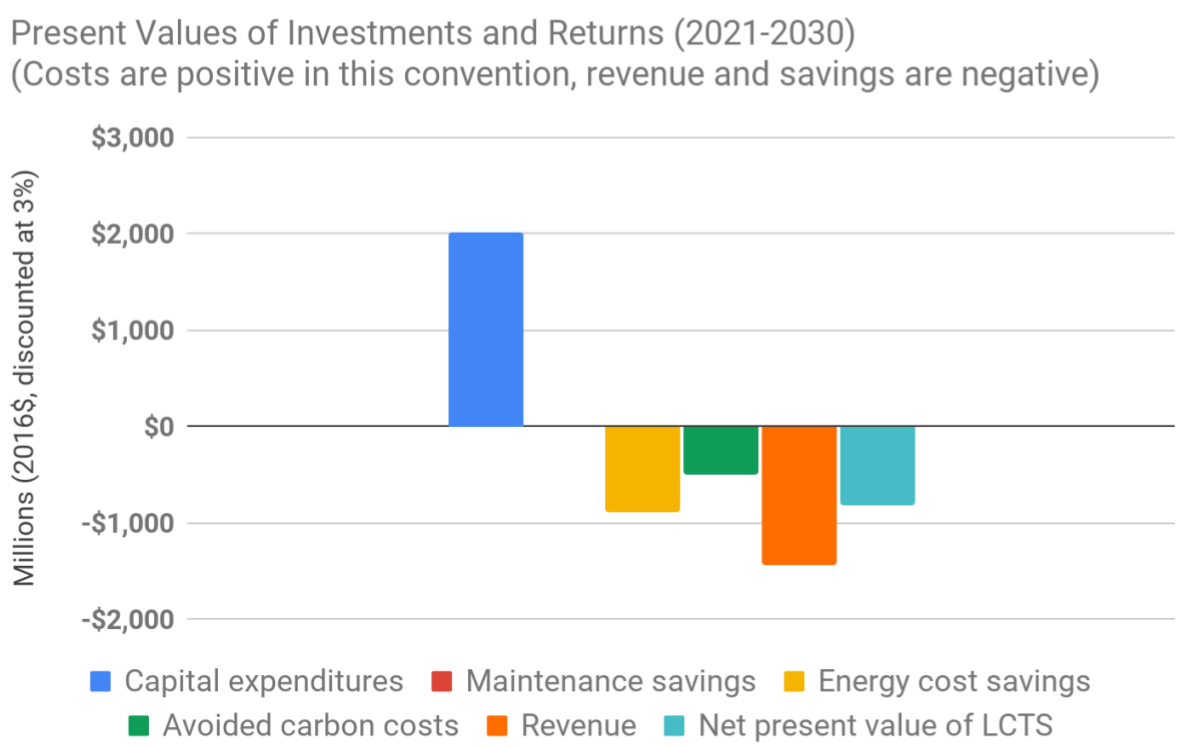

Figure 4. Present values of net-zero scenario costs, and savings, and net present value of the scenario.

Cash Flow Analysis

The annual costs, savings, and revenue associated with fully implementing the actions in the LCTS are shown in detail in Figure 5, with capital expenditures shown in full in the years in which they are incurred. (Please review the section ‘What Is and Is Not Included’, above.)

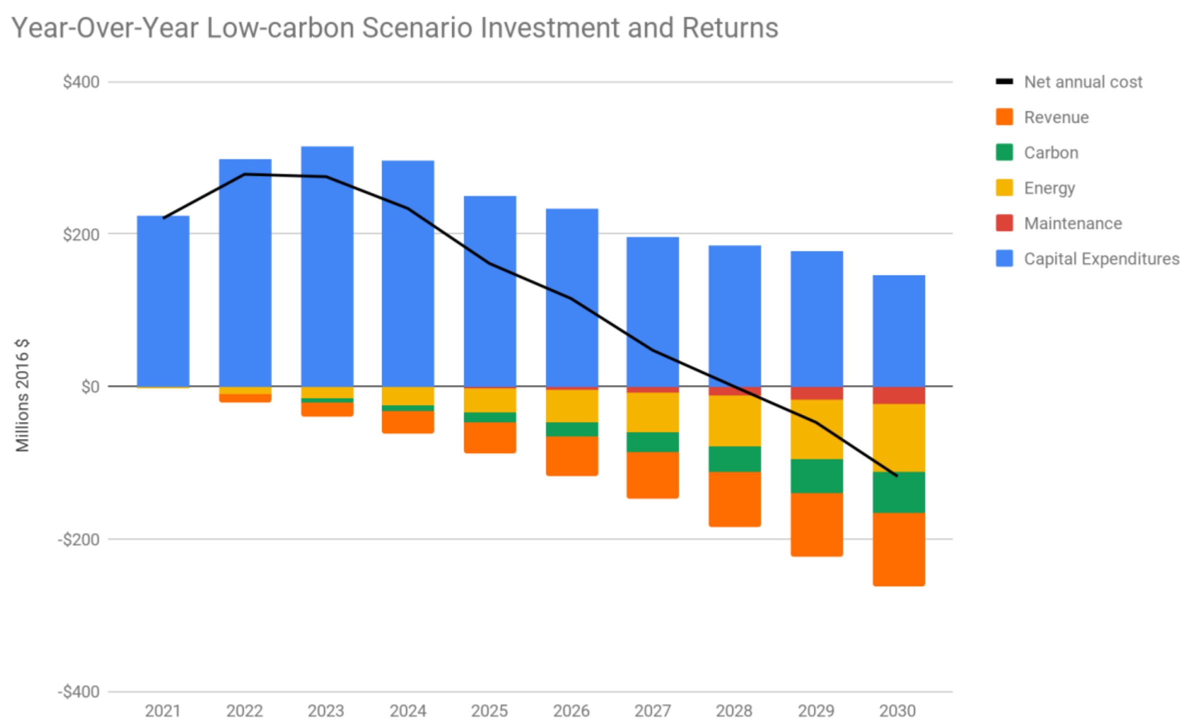

Figure 5. Capital expenditures vs. savings and revenues from the net-zero scenario, 2021-2030.

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 2028, the annual benefits exceed the annual investments and the cumulative benefits are greater than the cumulative costs.

Figure 6 presents the same costs and benefits, but with the capital expenditures amortized over 25 years at 3%. With this approach, which presumably would reflect actual approaches for financing the transition, the annualized capital payments are about equal to the savings and revenue generation from 2024. On an annual basis, the program never has a significant annual deficit; there is a net annual benefit that grows steadily throughout the 2020s. By 2030, the annual net benefit is over $100 million. After 2030 (not shown in Figure 6), the benefits and revenues continue, resulting in continuing growth in the net annual benefit in the post-2030 period.

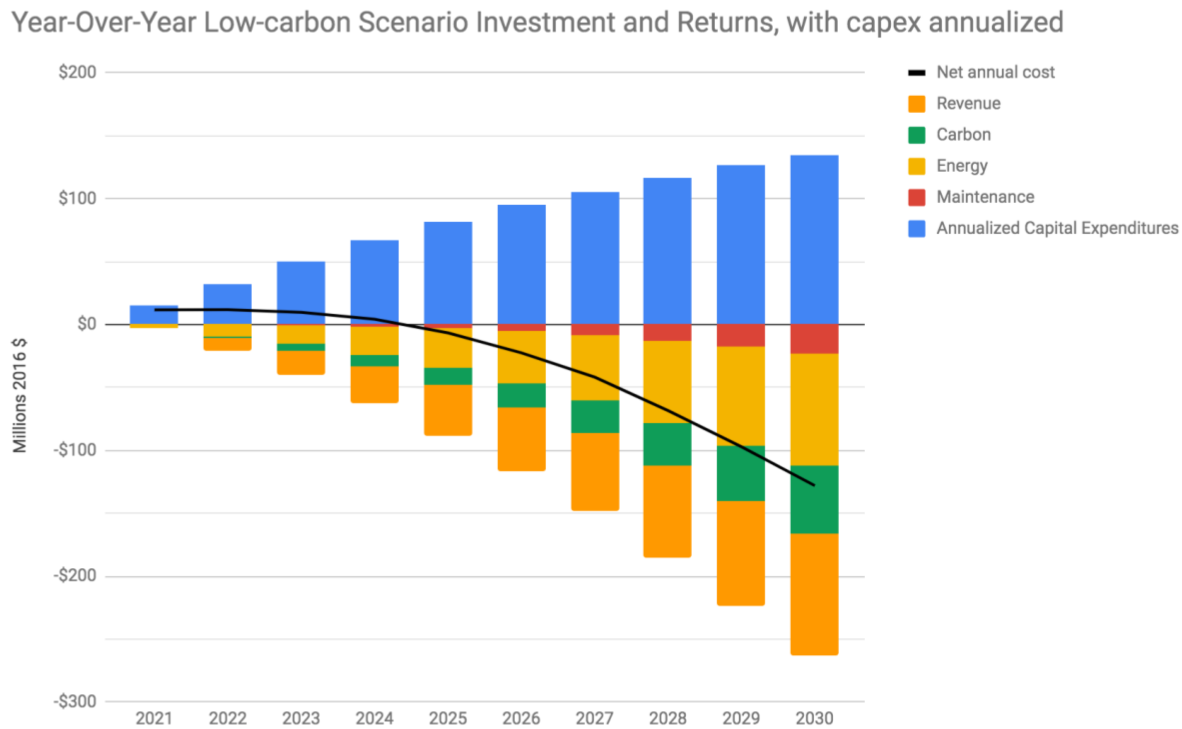

Figure 6. Annualized capital expenditures vs. savings and revenue from the net-zero scenario, 2021-2030.

Cost Savings for Households

Household expenditures on energy—natural gas, electricity, gasoline, and diesel—are projected to increase in the BAP and decline in the net-zero scenario. In the BAP, household energy expenditures are relatively flat because vehicles become more efficient due to national fuel efficiency standards and because of decreased heating requirements as the climate becomes milder due to climate change.

The net-zero scenario involves shifting away from natural gas and gasoline to electricity, a more costly energy source. The increased cost of electricity, however, is offset by the increased efficiency of homes and electric vehicles. The carbon price also adds to the cost of using fossil fuels for heating and transport.

In the net-zero scenario, an average Halton Hills household spends $2,500 on fuel and electricity (household energy and transportation expenditures) in 2030—almost 50% less than they would have in a BAP scenario ($4,600).[4]

[4] This does not include fixed energy bill charges (e.g. delivery charges), nor does it include the cost of carbon.

Between 2022 and 2030, the LC scenario saves the average Halton Hills household about $12,000 in fuel and electricity expenditures. Depending on the business, policy and financing strategies used in the implementation of the actions, these savings will be partly offset by the incremental capital expenditures required.

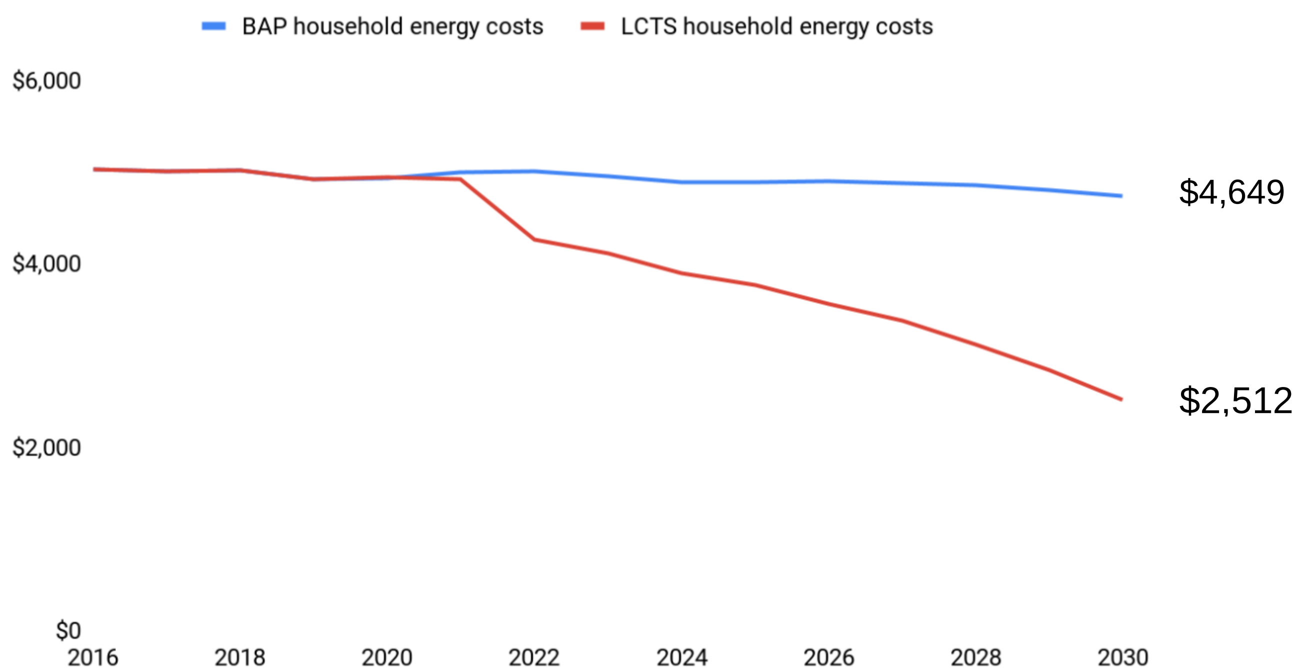

Figure 7. Average annual household energy costs in the net-zero and BAP scenarios, 2021-2030 (not including fixed delivery costs).

New Job Opportunities

Transitioning to a low- or zero-carbon economy is expected to have four categories of impacts on labour markets: 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 (e.g., combustion engine vehicle mechanics), and many existing jobs will be transformed and redefined.

According to average job multipliers from Census Canada, the LCTS will result in a net job increase of about 1,400 jobs in Halton Hills (or 14,000-person years of employment over 10 years), primarily due to the investment in retrofits, followed by large scale solar (see Figure 8). The clean tech and renewable energy sectors have been identified by the Town's Economic Development Department as a target sector in its Economic Development and Tourism Strategy, and its Foreign Direct Investment Attraction Strategy.

The LCTS is likely to cause some minor job losses due to the proposed introduction of shared autonomous vehicle car-share service, which would replace the need for multiple personal use vehicles; however, these are minor relative to the jobs created.

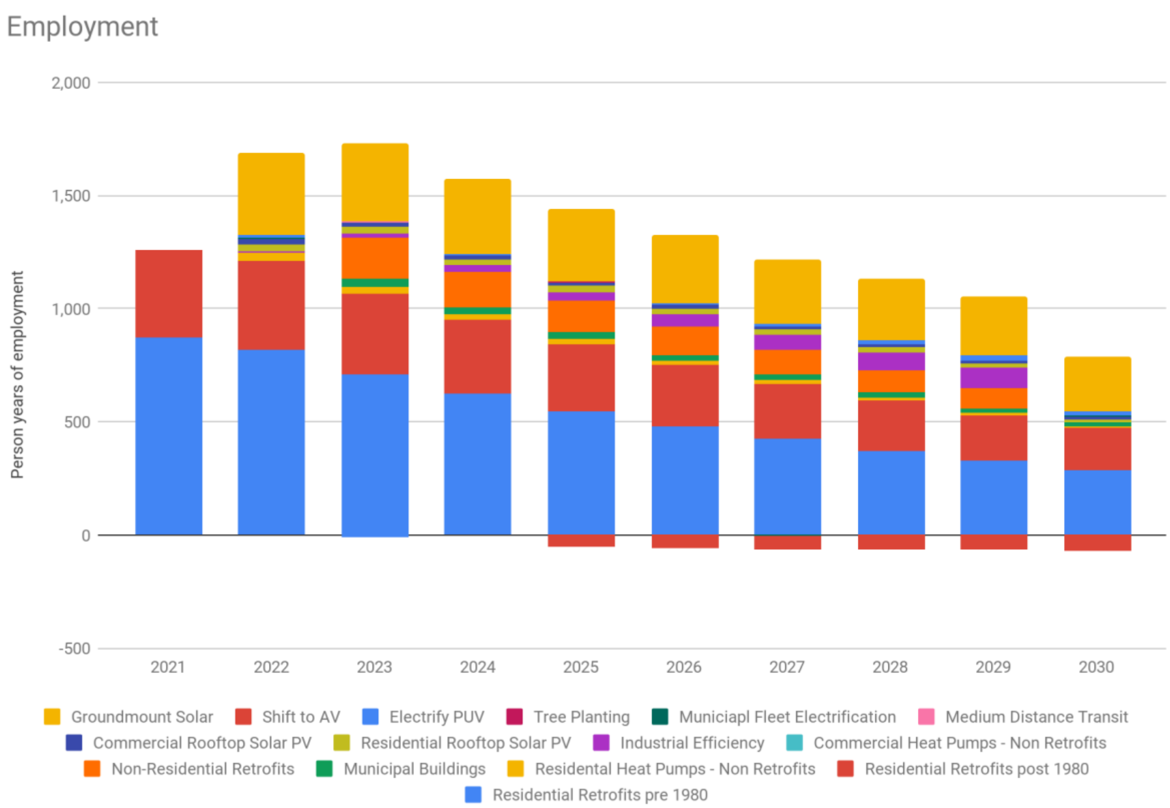

Figure 8. Additional person-years of employment associated with LCTS actions.

Sensitivity Analysis

The financial analysis involves several assumptions on building, infrastructure, equipment, and energy costs. A sensitivity analysis was conducted to assess how uncertainties in future costs could affect the overall results. The following chart shows how changing key parameters (i.e., energy costs) in the model will affect the net-zero costs pathway for the Town of Halton Hills.

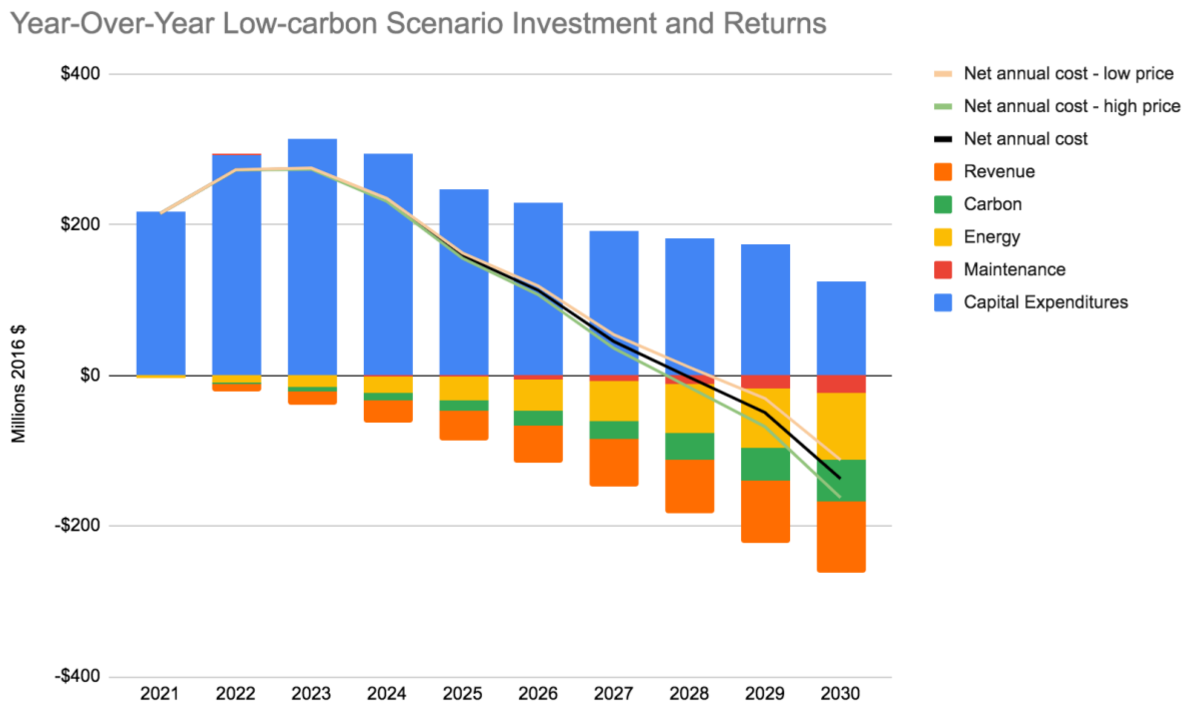

Figure 9. Sensitivity analysis of the energy costs for the LCTS investment and returns.

The sensitivity analysis, which is displayed in Figure 9, shows that, when you increase or decrease the overall energy costs by 20%, the net cost of the scenario in 2050 is affected by 18% in either direction. A major conclusion that can be drawn by this sensitivity analysis is the important co-benefit of energy efficiency and local energy generation measures in terms of hedging against future energy price increases.

APPENDIX A - Key Financial Assumptions

Land Use	Capital Investment Assumption
Land use intensification	- Capital costs associated with land-use intensification encompass standard investment in the community, such as new housing developments. - Generally speaking, with more infill development, new infrastructure spending decreases.
New Buildings	

New residential buildings with heat pumps	- The cost for new construction of buildings on a $/m^2 is estimated to be:
	    - Single-detached: $1,776 / m^2
	    - Double: $1,426 / m^2
	    - Apt 1-6 storey: $2,314 / m^2
	    - Apt 7-12 storey: $2,422 / m^2
	    - Apt > 15 storey: $2,395 / m^2
	    - Commercial: $2,494/ m^2
	    - Industry: $3,229 / m^2
	- A residential heat pump has a capital cost of approximately $6,000 (non-residential is ~$10,000) and annual operating cost of approximately $160 annually (~$400 annually for non-residential).

New industrial building efficiency	
New commercial building efficiency with heat pumps	
Existing Buildings	

Retrofits of homes and heat pumps	- The average cost of retrofits is assumed to be (per GJ/yr of energy saved):
	    - Residential: $210-$2,100
	    - Non-Res: $1,600-$2,900
	- Industrial upgrades average the following in 2022 and 2050 per GJ/year
	    - Lighting system: $134→ $59
	    - Space heating: $25 → $34
	    - Water Heating: $32 → $49
	    - Motive: $66 → $176
	    - Process heat: $27 → 43

Retrofits of commercial and industrial buildings	
Industrial improvements (process motors/efficiency)	
Renewable Energy	

Rooftop Solar PV 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.
Transport	
Establish local electric bus service Electrify municipal fleets Electrify personal vehicles Net-zero commercial transport activity	- 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. - The cost of a personal electric vehicle is approximately $34,000 in 2021 and is expected to decrease to $32,000 by 2030, dropping below the cost of an average combustion engine vehicle by 2025. As of today, maintenance costs for an EV are assumed to be half of those for combustion engine vehicles. - Heavy duty combustion engine vehicles are not expected to reach cost parity with their electric counterparts by 2050. - Fuel cost of gasoline is expected to increase by 11% by 2030 due to the carbon tax and market factors.
Waste and Wastewater	
10% less water use (technology and behaviour change) Wastewater process efficiency	- The cost of behaviour change programs will be based on the cost of Town staff and communications. - Improving wastewater process efficiency will cost an estimated $210 per tonne of GHG reduced.
Natural Environment and Sequestration	
Tree planting	- Tree planting will cost over $900,000.