Director	Municipal Manager/Deputy Municipal Manager

COUNCIL AGENDA

Date: December 16, 2024 Item: 6.

DISTRICT OF WEST VANCOUVER

750 17TH STREET, WEST VANCOUVER BC V7V 3T3

COUNCIL REPORT

Date:	November 28, 2024
From:	Heather Keith, Senior Manager, Climate Action & Environment
Subject:	Climate Action Strategy
File:	0332-03

RECOMMENDATION

THAT the Climate Action Strategy, attached as Appendix A to the report dated November 28, 2024 titled Climate Action Strategy, be approved.

RECOMMENDATION

THAT staff be directed to continue to enhance and accelerate programs and initiatives to reduce GHG emissions through the implementation schedule in the Climate Action Strategy and request supportive funding through the annual budget process.

1.0 Purpose

To provide the final Climate Action Strategy (the "CAS") for Council consideration and receive direction to begin the implementation of the CAS to reduce greenhouse gas (GHG) emissions to meet the District's emission reduction targets.

2.0 Legislation/Bylaw/Policy

Legislation

The Province of British Columbia, in support of their CleanBC Roadmap to 2030, requires that local governments have targets, policies, and actions to reduce GHG emissions.

Bylaws and Policies

The District has completed several plans, programs, and bylaws that include specific guidance and resources to take the necessary steps to reduce GHG emissions, including but not limited to:

- Corporate Energy and Emissions Plan (2016)
- Community Energy and Emissions Plan (2016)
- Sustainable Building Policy (2018)
- District Fleet Strategy (2021)

- Building Bylaw No. 4400, 2004 (2023 amendment) – Step Code 4 and Zero Carbon Step Code adoption for new homes.
- Zoning Bylaw No. 4662, 2011 – EV station requirements.
- Environmental Reserve Fund Bylaw 5188, 2022

3.0 Official Community Plan/Council Strategic Objectives

Official Community Plan

The Official Community Plan (Bylaw No. 4985, 2018) provides high-level policies under an overarching objective to manage the urban environment as well as respond to climate change and build climate resiliency across the community. There are several policies related to climate change mitigation within Sections 2.5 and 2.6. Specifically, the OCP includes GHG emission reduction targets for the community, including:

- Policy 2.5.19 - Implement corporate energy and emissions reduction initiatives (e.g., energy and GHGs derived from municipal operations) to advance towards the District's corporate GHG reduction target of 33% below 2007 levels by 2020 and 80% by 2050 and seek to achieve goals earlier if possible.
- Policy 2.6.19 - Implement community energy and emissions initiatives to advance towards meeting the District's greenhouse gas emissions reduction targets of 45% below 2010 levels by 2030 and 100% by 2050 or sooner, notably through the land use, housing, transportation, low carbon energy and infrastructure policies contained in this plan.

Council Strategic Objectives

Council's 2024-2025 Strategic Plan includes a goal to "Protect our natural environment, reduce our impact on it, and adapt to climate change" and includes various objectives to meet this goal specifically in relation to this report:

- Objective 1.1: Create and implement a Climate Action Plan with a reporting framework to track progress towards GHG emission reduction targets and net zero goal for both community and corporate sectors in alignment with the Clean BC Roadmap.
  - Deliverable 1.1.1: Climate Action Plan completed.
  - Deliverable 1.1.3: Reporting and carbon accounting framework and key actions established to achieve 2030 and 2050 GHG emission reduction targets.
  - Deliverable 1.2.2: [Environment Committee] Participation in deliverable 1.1.1.

4.0 Financial Implications

The CAS is a framework of required measures to reduce GHG emissions both in the community and corporately to meet the District's GHG emissions reduction targets by 2030 and 2050. The CAS will support the provision and allocation of funds, particularly from the Environmental Reserve Fund, for future projects and initiatives to implement the required measures. If the CAS is approved by Council, budget allocation from the Environment Reserve Fund for each of the measures will require Council approval at that time.

5.0 Background

5.1 Previous Decisions

Council, at its September 19, 2022, regular meeting, passed the following resolutions:

THAT

- *Council receive the report titled "Climate Action Strategy Overview: Scoping Report" from the Senior Manager, Climate Action & Environment, dated September 2, 2022, for information.*
- *staff be directed to use $100,000 from the Environmental Reserve Fund to complete the Climate Action Strategy.*

Council, at its December 11, 2023, regular meeting, passed the following resolution:

THAT the report from the Senior Manager, Climate Action & Environment, dated December 1, 2023, and titled "Progress Update on Greenhouse Gas Emissions Inventory and Modelling Project and Next Steps to Develop a District Climate Action Strategy", be received for information.

The Environment Committee, at its October 8, 2024 meeting, passed the following resolutions:

THAT

- *the Climate Action Strategy presentation be received for information;*
- *the Environment Committee endorse the draft Climate Action Strategy to support greenhouse gas emissions reduction priority actions for the community; and*
- *this endorsement be forwarded to Council by forming part of a report to be brought forward for consideration at an upcoming open Council meeting.*

5.2 History

The Intergovernmental Panel on Climate Change (IPCC) updated their emissions reduction targets in 2018 based on the understanding that climate change is happening more rapidly than previously calculated. The new targets include an emissions reduction of 45% from 2010 levels by 2030 and 100% reduction (or net zero) by 2050 to limit global warming to no more than 1.5 deg Celsius, a threshold considered critical to limit the effects of climate change. Through the CleanBC Roadmap to 2030, the

Province has also updated their strategy and action plan to move toward net zero emissions by 2050. The District's OCP was adopted in 2018 to officially include the latest IPCC reduction targets as Council policy and embed emissions reduction measures into planning and land use management. West Vancouver's emission target seeks to reduce GHG emissions by 45% under 2010 levels by the year 2030 (to a total of 148 $ktCO_2e$), and to achieve net zero emissions by the year 2050.

Since Council recognized that climate change constitutes an emergency for West Vancouver in 2019, the District has made steady progress to implement policies and regulations to reduce GHG emissions both corporately and in the community, including but not limited to the adoption of BC Energy Step Code and Zero Carbon Step Code standards, residential/facility energy retrofit programs, solid waste diversion, fleet electrification, EV station network expansion and electric infrastructure planning and upgrades, municipal building energy efficiencies, local area plans (LAPs), parking reductions, and other corporate "green" policies.

To determine whether these initiatives result in emission reductions, regular tracking and measuring is required. The District established a baseline emissions inventory in 2010. The intent of this project was to complete an updated emissions inventory for the year 2021 (last census year), model the potential emissions reductions through various measures that have already been planned (as identified above) as well as additional measures needed to meet the District's emission reduction targets by 2050, and develop an implementation and cost schedule for these measures.

The following section provides an overview of the CAS, which is provided in **Appendix A**.

6.0 Analysis

6.1 Discussion

Context

The District's Official Community Plan has policies and objectives to: (1) protect the natural environment; (2) reduce community and corporate GHGs; and (3) adapt to climate change. Recognizing that these three pillars are inter-connected, a strategy requires the integration of climate change adaptation and emission mitigation measures to minimize risk and generate community co-benefits. For example, reducing GHG emissions will provide a cleaner, healthier community and natural environment; the enhancement and maintenance of the natural environment will in turn help to reduce GHG emissions; and early adaptation to the changing climate will help to build resilience in the community to reduce significant impacts on our well-being and daily life.

As the District works towards incorporating a climate lens into decisions and operations, the CAS aligns with other plans already being implemented to ultimately address all three pillars of climate action including mitigation (reduction of GHG emissions), adaptation to climate change impacts, and the protection of the natural environment, to ensure a resilient community (Figure 1).

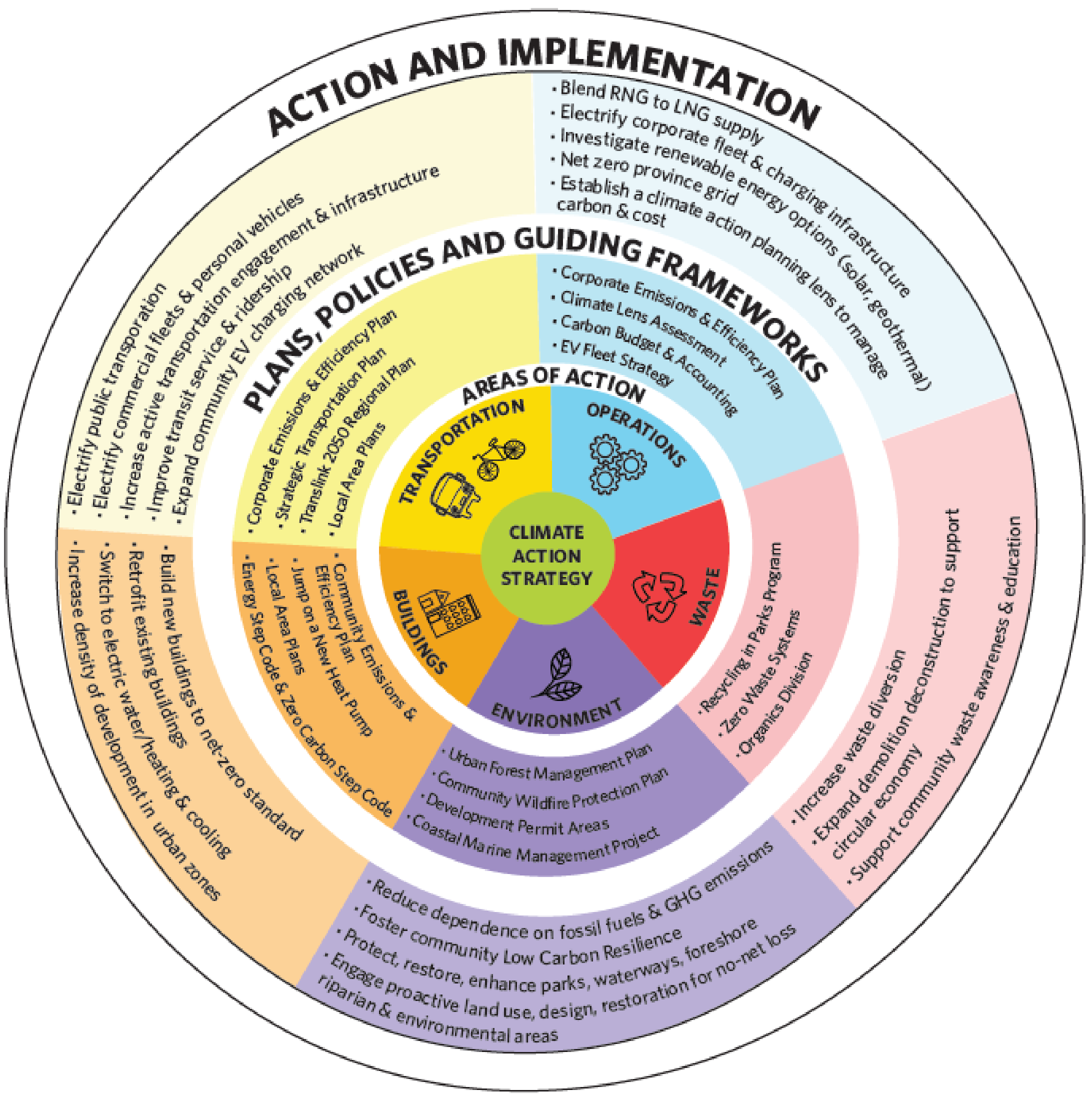

Figure 1 Alignment of the CAS with other District plans and guiding frameworks for climate resiliency.

In 2016, West Vancouver coordinated climate action through the completion of the Community Energy & Emissions Plan and Corporate Energy & Emissions Plan. The CAS builds on these plans by identifying the quantity of emissions reductions from previously planned, approved, or implemented measures and then identifying additional measures necessary to achieve the District's emission reduction targets by 2030 and

2050. As the urgency for climate action grows stronger year after year as communities face climate change impacts, the key message is that while the District is making progress on reducing GHG emissions, the CAS demonstrates that it will be necessary to expedite these measures as well as expand the suite of measures in order to meet the OCP targets.

Overview

The CAS details measures and investment recommendations to meet the District's emissions reduction targets of 45% from 2010 levels by 2030, and net zero emissions by 2050. This strategy is accompanied by a carbon budget and GHG calculator that have been developed as tools for staff and Council by providing a determination of annual GHG emissions volume maximums and acting as a climate lens through which to assess municipal project decisions.

The CAS includes the following:

- A summary of climate action efforts and initiatives at the global, federal, provincial, and municipal levels.
- Community and corporate GHG emissions inventory for the year 2021 (updated from 2010).
- Modelling of GHG emissions from 2021 to 2050 under the following scenarios:
    - Business-as-Usual - forecasts the community's expected energy use and GHG emissions profile year-over-year until 2050, assuming no emission reduction interventions beyond those currently expected.
    - Business-as-Planned - accounts for measures implemented through the Clean BC climate action plan plus planned land use planning and transportation measures in West Vancouver.
    - Low Carbon scenario - models deeper potential emission reduction measures that can be taken in each sector of the community to reach the District's 2050 emissions reduction target. Each action is defined by a set of assumptions and is modelled year-over-year until 2050.
- Financial modelling of GHG emissions reduction measures to achieve the Low Carbon scenario.
- Co-benefits to the community from the reduction of GHG emissions to improve tangible and intangible community services, including cleaner air, improved energy efficiency and security and ultimately cost savings, sustainable active transportation, healthier walkable, inclusive, and livable communities, and improved economic impacts from job creation and job conditions. Planning climate actions that also deliver community co-benefits enable municipalities to strengthen key stakeholder support, mobilize capacity across municipal departments,

and maximize opportunities to address multiple social, economic, and ecological challenges.

- Climate equity lens on programs and initiatives to reduce GHG emissions in the community that deliver more equitable and inclusive benefits of emissions reductions for vulnerable groups. This could be by directing climate investments towards lower-income neighbourhoods and/or and by ensuring programs that reduce household cost savings and improve health outcomes accrue to groups with lower socio-economic status.
- Implementation framework including both corporate and community measures and metrics to quantify progress towards the District's GHG emissions reduction targets.

2021 GHG Emissions Inventory

Table 2 and 3 provide a summary of the GHG emissions for the entire community and municipal operations, respectively. For details on the methodology, the "Data, Assumptions and Methodology Manual", prepared by the consultant, Sustainable Solutions Group ("SSG"), is provided in **Appendix B**.

In comparison to the 2010 baseline year, overall emissions have slightly decreased, primarily in the waste sector due to increased waste diversion from landfills. GHG emissions from the transportation and buildings sectors have increased, likely due to population growth. The initiatives to reduce emissions that the District has put into place in recent years have not yet resulted in meaningful GHG emissions reductions.

Sector	Total GHG Emissions (tCO_2e)				2010 Baseline Emissions (tCO_2e)
	Scope 1	Scope 2	Scope 3	2021	
Stationery Energy (Buildings)	151,950	3,221	107	155,278	133,132
Transportation	73,848	85	35,093	109,207	101,862
Waste	0	0	4,170	4,170	34,605
Total	**225,798**	**3,306**	**39,371**	**268,475**	**269,600**

Table 2 Summary of community GHG emissions as of 2021, compared to baseline emissions in 2010.

Within the total community GHG emissions, a small percentage (~3%) comes from municipal operations (Table 3). Emissions from municipal operations have decreased primarily due to the ongoing electrification of the District fleet despite an increase in emissions coming from the operation of municipal buildings (due to an increase in the number/size of facilities owned by the District). Similar to community emissions, it is expected that more recent efforts to improve building efficiency will take time to provide a noticeable decrease in emissions.

Sector	**Total GHG Emissions (tCO_2e)**				**Baseline Emissions (tCO_2e)**	
	Scope 1	**Scope 2**	**Scope 3**	**2021**	**2013**	**2007**
Stationery Energy (Buildings)	2,659	420	14	3,093	1,825	2,231
Transportation	970	0	0	970	1,512	1,397
Total	3,629	420	14	**3,163**	**3,336**	**3,611**

Table 3 Summary of corporate GHG emissions as of 2021, compared to baseline emissions in 2007 and 2013.
Note: Waste is reported as a “community” emission source.

Emissions Modelling and Reduction Measures

The District as well as the Province have some emission-reducing measures underway, which are categorized in the CAS as Business-As-Planned actions. Community-wide energy and emissions modelling demonstrates that the potential of these provincial and local measures is substantial, reducing emissions by 59% by 2050 from 2021 levels, if all are implemented (Figure 2). Most reductions are in the transportation sector, as trips shift to active transportation and transit, and as electric vehicles (EVs) replace gas models.

Although effective, currently planned provincial and local measures fall short of achieving the District’s 2030 and 2050 emission reduction targets. Additional local measures can be taken across all sectors to further reduce emissions to meet the targets. A variety of additional measures were assessed through modelling (Low Carbon scenario, LC in Figure 2) to determine the effort required to bridge the gap between the Business-as-Planned measures and the District’s targets. These measures are categorized as those that reduce energy consumption, improve energy efficiency, and/or fuel switch to low or zero carbon renewable energy sources. The modelling demonstrates that West Vancouver’s emission reduction targets can be met by implementing these measures starting now, with coordinated, equitable, and dedicated efforts. The greatest emission reductions from these measures will be in the building sector through building retrofits with improved insulation, windows, doors, and zero-emission energy systems for space and water heating. The District can lead by example by retrofitting municipal buildings and facilities and transitioning its vehicle fleet to zero-emission models.

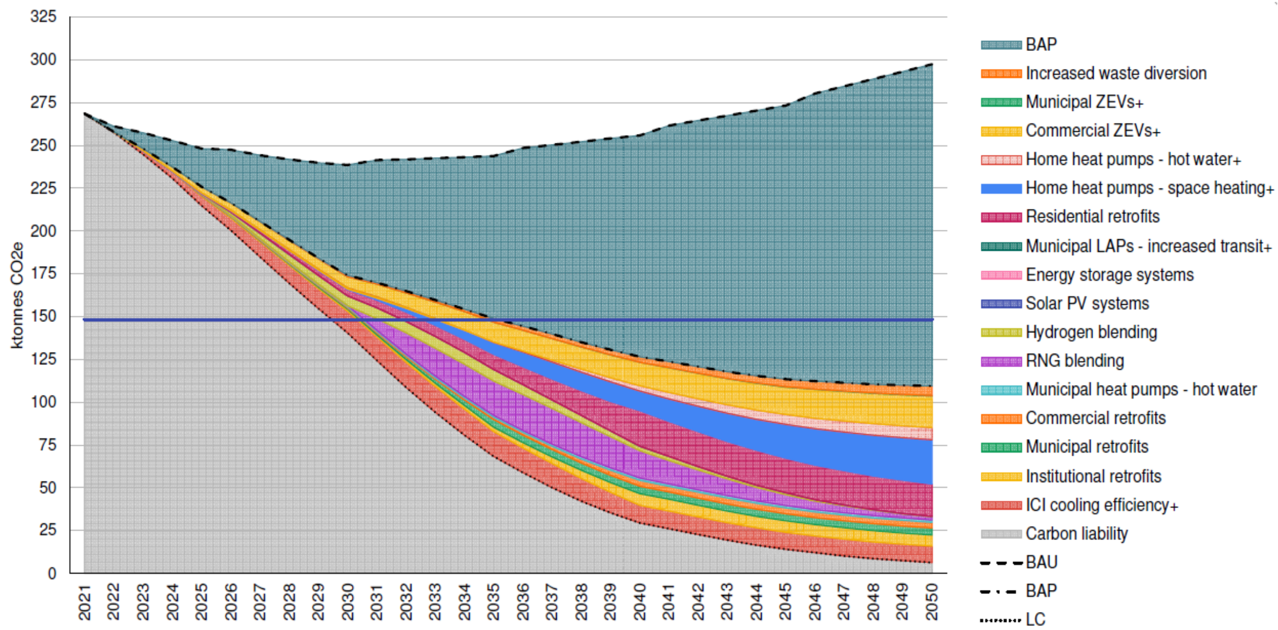

Figure 2 Cumulative emissions reductions by measure for the Low-Carbon scenario beyond the emissions reductions through the Business-as-Planned measures.

District's Role and Responsibility

As much of the emissions in West Vancouver come from community sources rather than municipal operations, the District's role in reducing emissions is primarily in support and facilitation. The goal of the District will be to unlock emission reduction opportunities, incentives, and mechanisms, and to provide education and information to support residents in their transition to low carbon heating systems in their homes and in exploring and using active and micro-mobility options for transportation.

In addition, it is important for the District to continue to lead by example to demonstrate how low carbon options can be implemented either through facility upgrades, procurement practices, infrastructure, etc. to support market transformation, utility advancements and capacity, and contractor expertise in low carbon system installations. The District also has an important role in providing information to residents in terms of available low carbon options but also to ensure that residents are receiving the correct information and understand the co-benefits in GHG emissions reductions that will improve their community.

Examples of actions that can be taken to support residents to transition to low carbon energy sources both for their homes and transportation as well as in municipal operations include:

- Progressing on Energy Step Code and Zero Carbon Step Code implementation (moving to the next step by 2027).

- Retrofitting support for existing buildings:
  - Jump on a New Heat Pump Program service.
  - Incentives and rebates for all housing types.
  - Education and outreach of programs through other organizations and levels of government.
- Continuing to implement and update the District's fleet strategy.
- Developing a public charging station strategy to determine expansion requirements and partnerships opportunities for a public charging network that meets the needs of residents and visitors to West Vancouver.
- Transitioning to low carbon small non-road engine equipment.
- Installing appropriate infrastructure for active transportation and micro-mobility transportation modes (bikes, e-bikes, e-scooters, bike lanes, sidewalks, etc.).
- Implementing Local Area Plans to support new low-carbon housing and walkable neighbourhoods.
- Increasing waste diversion efforts and circular economy principles focusing on demolition waste, reuse, and recycling of materials.
- Continuing to collaborate with senior levels of government, utility companies, and other partners in implementing actions to reduce GHG emissions.

These measures will strive to address the barriers and challenges to reduce GHG emissions in the community. Additional measures will be incorporated into the CAS as new approaches, technology, or advancements are made available in BC or as new guidance emerges from senior levels of government and other organizations and partners.

Financial Implications

Financial modelling shows the expenditures required to implement the measures to reduce GHG emissions, as well as the returns realized over the next 26 years across the community (i.e., not just those borne by the District). Savings and avoided costs are primarily realized by those making the expenditures, including vehicle owners, home and building owners, the municipality, etc. Although capital costs to implement the CAS measures are significant, the implementation of mitigation measures is expected to generate a net savings of $286.1M over the next 26 years (to the year 2050) through more energy efficient buildings and utility costs, lower fuel and maintenance costs for EVs, lower trip costs from active or public transportation, and avoided carbon taxes. This is in addition to avoidance costs that may have been borne to the District and community from climate change impacts (i.e., wildfires, floods, etc.).

Next Steps

Dashboard Development – In order to provide information about the District's progress towards achieving the targets, goals, and actions established in the CAS, a Climate Action Dashboard will be developed, which will help the District to communicate and transparently report on CAS implementation progress, promoting accountability. Although the CAS is a static document, the dashboard will be a dynamic tool and will be continuously updated as progress is made to reduce GHG emissions.

GHG Calculator Tool – A calculator tool has been developed to determine the potential GHG emissions or savings for new District projects or operational activities to incorporate climate considerations into municipal operations. Staff have received training on the tool but will continue to work internally to incorporate this tool and output as a supporting component to the annual budget cycles.

6.2 Climate Change & Sustainability

The District has made steady progress in implementing plans and policies to reduce GHG emissions although an accelerated pace is required to meet the District’s net zero target by 2050. The measuring and tracking of emissions over time through the CAS will continue to advance the District’s climate action initiatives in a coordinated approach across the organization and on a schedule to meet the District’s GHG emissions reduction targets to mitigate climate change impacts while creating a more resilient and sustainable community.

6.3 Public Engagement and Outreach

Staff engaged with the District’s Environment Committee on the development of the CAS. The Environment Committee received presentations from staff and the authoring consultant on the CAS and were provided an opportunity to review the draft CAS and provide input and comment. Comments received by the Environment Committee were incorporated into the CAS.

If approved, staff will continue to work with the Environment Committee to develop new programs and initiatives to reduce GHG emissions through the implementation of the CAS. Members of the public or stakeholder groups can continue to provide feedback through the implementation phase, either through staff or during Environment Committee meetings as work under the CAS continues.

6.4 Other Communication, Consultation, and Research

The consultant, SSG, worked with staff from the Climate & Environment, Finance and Corporate Services, Planning, Engineering, and Parks departments to gather and verify data that were used for the GHG emissions inventory. Staff engagement included individual meetings as well as two team meetings with SSG.

In addition, SSG has completed strategies for many municipalities and regional districts in the lower mainland and has a good understanding of the measures established by all levels of government to meet GHG emissions reductions targets to then develop a methodology to establish a science and knowledge-based inventory and emissions reduction pathway to meet the District's 2030 and 2050 targets.

Squamish Nation has just completed their Climate Legacy Strategy and staff will seek the opportunity to engage with the Squamish Nation to ensure the CAS measures and path forward are in alignment and areas of collaboration are identified.

7.0 Options

7.1 Recommended Option

THAT:

1. the Climate Action Strategy be approved.
2. staff be directed to continue to enhance and accelerate programs and initiatives to reduce GHG emissions through the implementation schedule in the Climate Action Strategy and request supportive funding through the annual budget process.

7.2 Considered Options

Council may request further information or provide alternative direction (to be specified).

8.0 Conclusion

The emissions inventory and pathway modelling identified the highest-emitting sectors and actions needed to reduce GHG emissions to meet the District's GHG emission reduction targets, including the transition to renewable energy sources, electrifying vehicles, diverting waste, and supporting homeowners in transiting to low carbon equipment for space and water heating in their homes. The co-benefits of these actions will help to mitigate climate change, improve our natural environment, and create a more resilient, healthy, and sustainable community.

Author: Heather Keith

Heather Keith, Senior Manager, Climate Action & Environment

Concurrence:

Jenn Moller, Director, Engineering and Transportation Services

Concurrence:

Isabel Gordon, Director, Finance and Corporate Services

Appendices:

Appendix A – Climate Action Strategy
Appendix B – District of West Vancouver Greenhouse Gas Emissions Inventory Data, Methods, and Assumptions Manual

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APPENDIX A

2024

District of West Vancouver

CLIMATE ACTION STRATEGY

west vancouver

OUTLINE

CONTRIBUTORS

DISTRICT OF WEST VANCOUVER LEAD STAFF

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Jenn Moller, *Director of Engineering & Transportation Services*
Emily Willobee, *Senior Manager of Engineering Services*
David Hawkins, *Senior Manager of Community Planning & Sustainability*

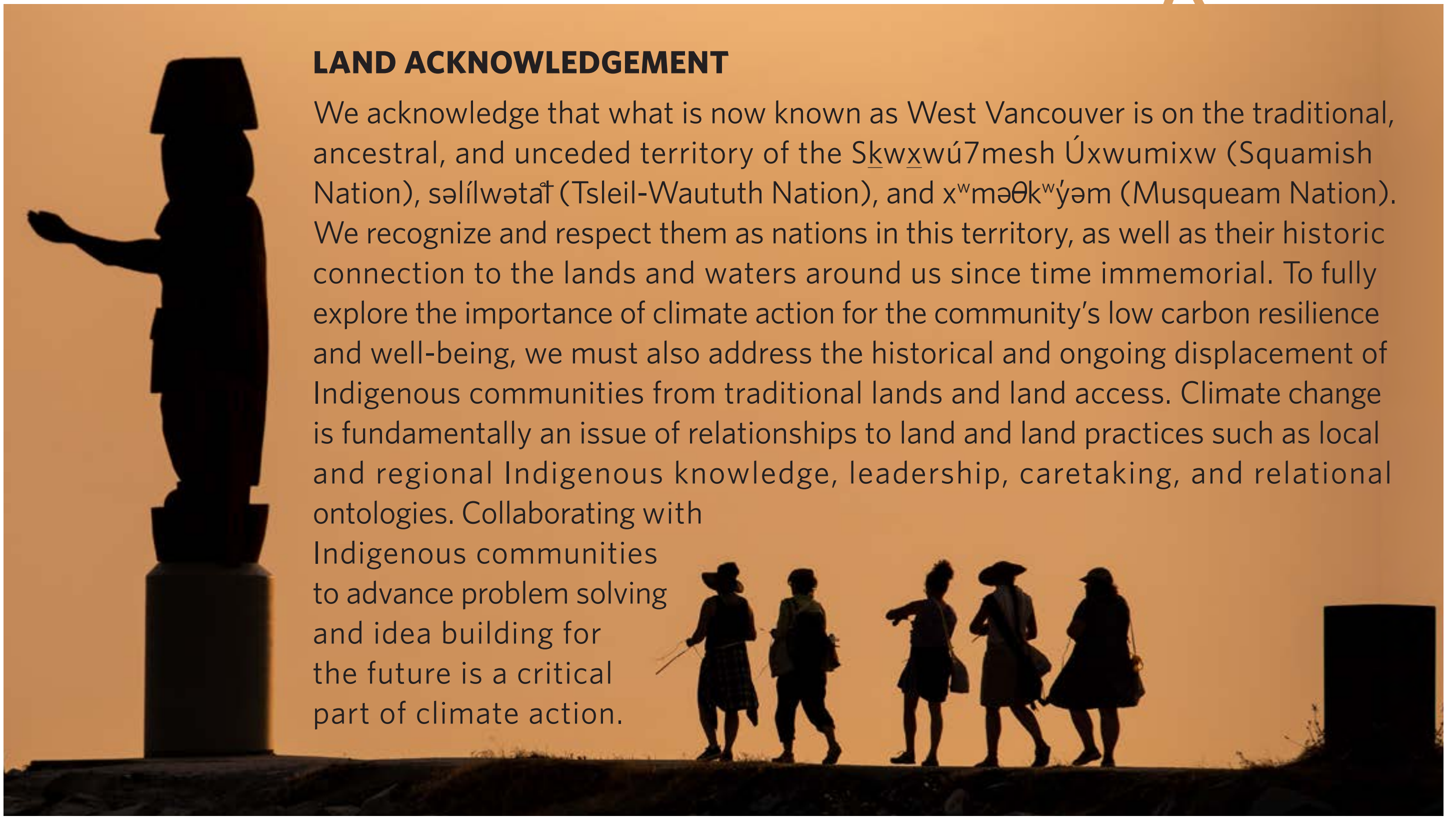
COMMITTEE

District Environment Committee

PREPARATION

Energy and emissions modelling, financial analysis, and report preparation was led by an external consulting team, Sustainability Solutions Group (SSG). This report was designed by the District of West Vancouver.

Line drawings throughout this document are from freepik.com.



LAND ACKNOWLEDGEMENT

We acknowledge that what is now known as West Vancouver is on the traditional, ancestral, and unceded territory of the Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), səlílwətaɬ (Tsleil-Waututh Nation), and xʷməθkʷy̓əm (Musqueam Nation). We recognize and respect them as nations in this territory, as well as their historic connection to the lands and waters around us since time immemorial. To fully explore the importance of climate action for the community's low carbon resilience and well-being, we must also address the historical and ongoing displacement of Indigenous communities from traditional lands and land access. Climate change is fundamentally an issue of relationships to land and land practices such as local and regional Indigenous knowledge, leadership, caretaking, and relational ontologies. Collaborating with Indigenous communities to advance problem solving and idea building for the future is a critical part of climate action.

PURPOSE OF DOCUMENT

THE DISTRICT OF WEST VANCOUVER'S *CLIMATE ACTION STRATEGY* ENDEAVORS TO:

1. Update the municipal corporate and community greenhouse gas (GHG) emissions inventory for the current year;
2. Perform GHG emissions modelling to determine projected business-as-usual emissions to 2030 and 2050 as well as GHG emission reduction trajectories of various climate investment scenarios over these time periods; and
3. Develop a carbon budget and accounting framework that will inform District operating and budget decisions.

The *Climate Action Strategy* details action and investment recommendations to meet the District's emissions reduction targets of -45% of 2010 levels by 2030, and net zero emissions by 2050.

This strategy is accompanied by a carbon budget and GHG calculator that have been developed as information and decision-making tools. In addition to providing a determination of annual GHG emissions volume maximums, it will act as a climate lens through which to assess municipal project decisions.

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 authors. The information provided by others is believed to be accurate but has not necessarily been verified.

This analysis includes strategic-level estimates that should not be relied upon for design or other purposes without verification. The authors do not accept responsibility for the use of this analysis for any purpose other than that stated above or for any third-party use, in whole or in part, of the contents of this document. The findings of this study cannot be applied to other jurisdictions without analysis. Any use or any reliance on or decisions based on this document, are the responsibility of the user or third party.

ABBREVIATIONS

BAP	Business-as-Planned scenario
BAU	Business-as-Usual scenario
CAS	Climate Action Strategy
CDD	cooling degree days
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent(s)
CNG	compressed natural gas
CRNG	compressed renewable natural gas
CEEP	Community Energy & Emissions Plan
DE	District energy
DWV	District of West Vancouver
EV	electric vehicle
GHG	greenhouse gas
GPC	Global Protocol for Community-scale Greenhouse Gas Emissions Inventories
GWP	global warming potential
HDD	heating degree days
HDV	heavy-duty vehicle(s)
HWH	hot water heater
ICE	internal combustion engine
ICI	industrial, commercial, and institutional buildings
IPCC	Intergovernmental Panel on Climate Change
LAP	Local Area Plan
LC	low-carbon
LCS	low-carbon scenario
LDV	light-duty vehicle(s)
LNG	liquid natural gas
OCP	Official Community Plan
PV	photovoltaic(s) (solar photovoltaic energy generation)
RCP	representative concentration pathway
RNG	renewable natural gas
VKT	vehicle kilometres travelled
ZEV	zero emissions vehicle

UNITS

m^3	cubic metre	
tCO_2e	metric tonnes of carbon dioxide equivalent	
$ktCO_2e$	kilotonnes of carbon dioxide equivalent	1 $ktCO_2e$ = 1,000 tCO_2e
$MtCO_2e$	megatonnes of carbon dioxide equivalent	1 $MtCO_2e$ = 1,000,000 tCO_2e
GJ	gigajoules	
TJ	terajoules	1 TJ = 1,000GJ
PJ	petajoules	1 PJ = 1,000,000GJ
kWh	kilowatt hour	1 kWh = 0.0036 GJ
kW	kilowatt	
MW	megawatt	1 MW = 1,000,000 kW

To compare fuels on an equivalent basis, all energy is reported as units of energy content primarily as petajoules (PJ) or sometimes as gigajoules (GJ). Emissions are characterized as kilotonnes of carbon dioxide equivalent ($ktCO_2e$). These measures can be characterized as follows*:

- An average house uses about 100 GJ of energy in a year.
- 100 liters of gasoline provides about 3.5 GJ of energy.
- Burning 50,000 tonnes of wood produces 1 PJ energy.
- A typical passenger vehicle emits about 4.7 metric tons of carbon dioxide per year.

SCOPE 1, 2, 3 EMISSIONS:

Scope 1: Covers emissions from sources that a community owns or controls directly.

Scope 2: Covers emissions that a community causes indirectly from the energy it uses that is imported from outside the community boundary.

Scope 3: Encompasses emissions that are not produced in the community itself and that are not the result of activities from assets owned or controlled in the community, but those that it is indirectly responsible for across its supply chain.

** Data provided by the United States Environmental Protection Agency.*

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

CONTEXT

The District of West Vancouver's *Climate Action Strategy* (CAS) details a pathway to near-net-zero emissions by 2050 and achieving 45% emission reductions under 2010 levels by 2030. These targets follow from the District's 2016 Community Energy & Emissions Plan, Official Community Plan policy, and its 2019 climate emergency declaration, and are aligned with what the global scientific community has determined necessary to avoid catastrophic climate change impacts.

GHG EMISSIONS INVENTORY AND EMISSIONS LEVELS BY 2050

In 2021 (the most recent census year), West Vancouver's community-wide GHG emissions totalled 268 ktCO_2e with 57% from buildings, 41% from transportation, and 2% from solid waste and wastewater. Without any further mitigation effort, the community's emissions are expected to grow 11% by 2050 (business-as-usual scenario, BAU).

PLANNED EMISSION REDUCTION MEASURES

The provincial government's CleanBC Plan and CleanBC Roadmap to 2030 commit to reducing emissions across the province through various measures in the building, transportation, and waste sectors. In addition, *BC's Clean Energy Strategy** outlines the actions to accelerate the shift to clean energy and the best use of each type of energy across sectors (e.g. using electricity for buildings and transportation in urban and temperate-climate regions while directing fossil fuel use toward sectors that are more difficult to decarbonize such as shipping, some industrial practices, long-haul transport, home heating in rural or northern community heating).

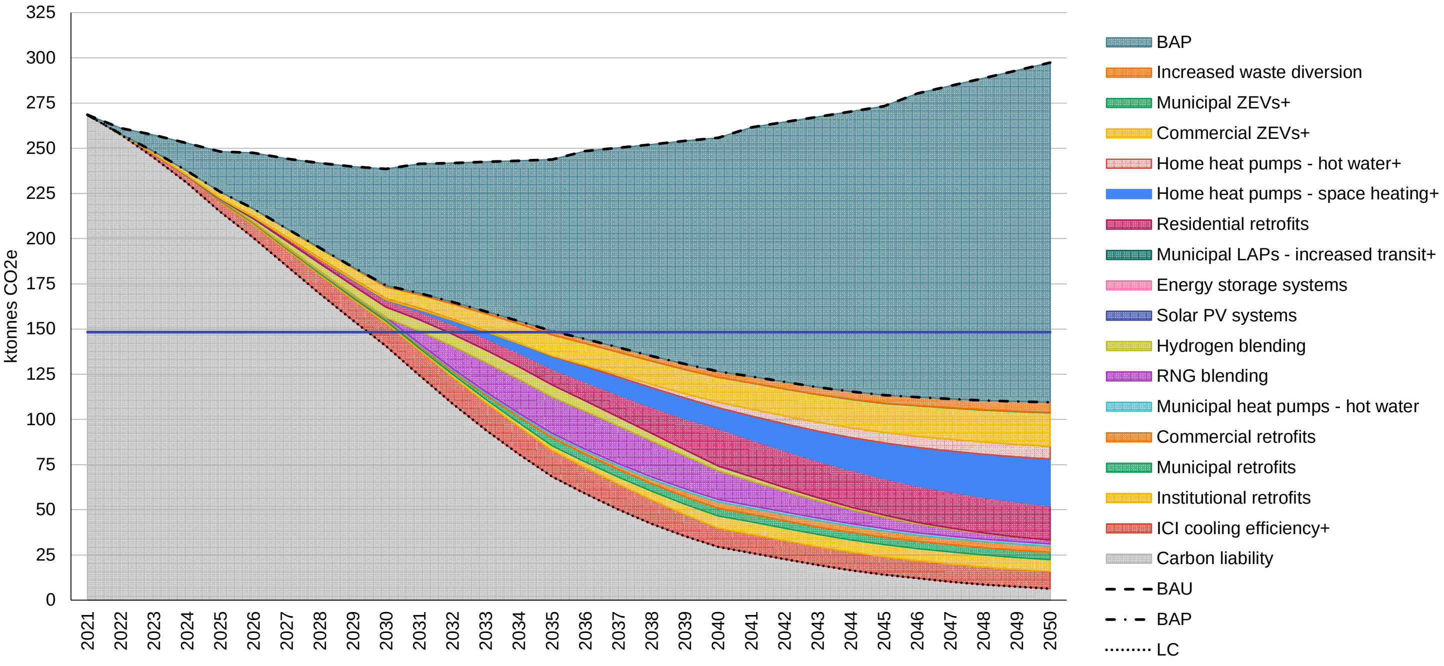
West Vancouver also has some emission-reducing measures underway, such as sustainable building and transportation requirements for new developments and local area plan (LAP) implementation, which will create more compact, complete neighbourhoods. Implementing the LAPs under the LCS and BAP scenarios will result in a greater decrease in building and transportation emissions compared to the BAU scenario. Community-wide energy and emissions modelling performed for the CAS demonstrates that the potential of these provincial and local measures (business-as-planned scenario, BAP) are substantial, reducing emissions by 59% by 2050 from 2021 levels. Most reductions are in the transportation sector, as trips shift to active transportation and transit, and as electric vehicles (EVs) replace gas models.

* *Powering Our Future: BC's Clean Energy Strategy. June 27, 2024.*
www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/2023_climate_change_accountability_report_supporting_materials.pdf

REQUIRED ADDITIONAL EMISSION REDUCTION MEASURES

Although effective, currently planned provincial and local measures fall short of achieving the District's 2030 and 2050 emission reduction targets. Additional local measures can be taken across all sectors to further reduce emissions to meet the targets. A variety of additional measures were assessed through modelling (low-carbon scenario, LCS, Figure 1) to determine the effort required to bridge the gap. These actions are categorized as those that reduce energy consumption (Reduce), improve energy efficiency (Improve), and/or fuel switch to low or zero carbon renewable energy sources (Switch). The modelling demonstrates that West Vancouver's emission reduction targets can be met by implementing these actions starting presently, with coordinated, equitable, and dedicated efforts. The greatest emission reductions from these measures will be in the buildings sector through building retrofits with improved insulation, windows, doors, and zero-emission energy systems for space and water heating. The District can lead by example by retrofitting municipal buildings and facilities and transitioning its vehicle fleet to zero-emission models.

FIGURE 1: Cumulative emission reductions by action for the LCS (low-carbon scenario) beyond the emissions reductions through the Business-as-Planned actions



LOW-CARBON FUTURE FINANCES

Financial modelling performed for the CAS shows the expenditures required to implement the measures, as well as the returns realized over the next 26 years across the community (i.e. not just those of the District, Figure 2). Savings and avoided costs are primarily realized by those making the expenditures: vehicle owners, home and building owners, the municipality, etc. The implementation of mitigation measures is expected to generate a net savings of $286.1M over the next 26 years (Table 1). Modelling also indicates that the expenditures made will provide 11,500 person-years of employment during this time within West Vancouver.

CARBON MITIGATION WILL PROVIDE:

- a net savings of $286.1M over the next 26 years
- 11,500 person-years of employment

TABLE 1: Summary of expenditure & savings for modelled emission reduction measures

	BAP MEASURES net present value	LCS MEASURES net present value	BAP+LCS MEASURES net present value
capital expenditures	$112.8M	$1,127.0M	$1,239.9M
operations & maintenance savings	-$48.9M	-$16.4M	-$65.3M
energy cost savings	-$416.2M	-$584.8M	-$1,001.0M
avoided carbon taxes	-$277.8M	-$181.9M	-$459.7M
TOTAL	**-$630.1M**	**-$343.9M**	**-286.1M**

FIGURE 2: Year-over-year incremental expenditures and savings for the implementation of community-wide LCS measures

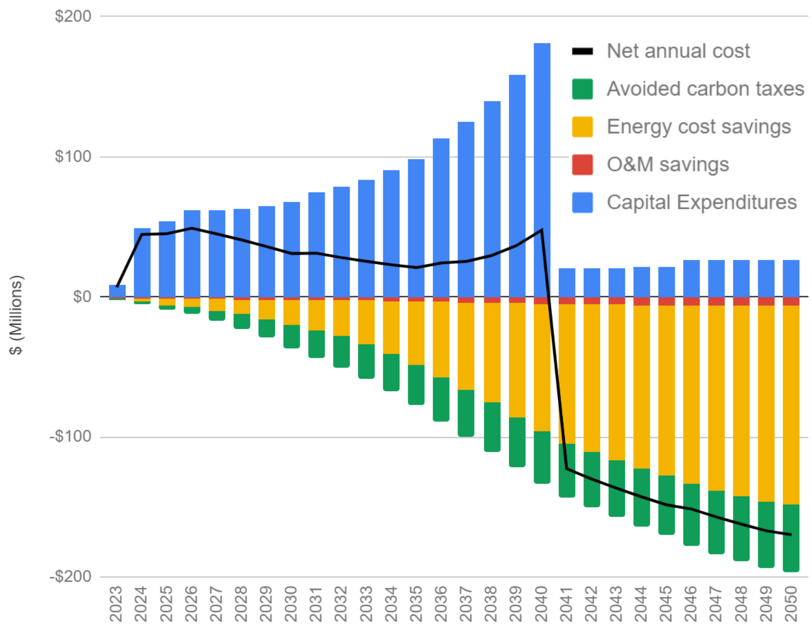


Table 2 provides a summary of the current and future states for West Vancouver based on planned and additional required emission reduction measures to chart West Vancouver's low-carbon pathway.

TABLE 2: West Vancouver by the numbers

	VALUE	CHANGE FROM 2021
2030 emissions target	148 $ktCO_2e$	-45% (of 2010 levels)
2050 emissions target	Net zero	
2021 to 2050 population	45,262 to 62,988	+39%
new dwellings by 2050	12,186	+41%
new non-residential floor space by 2050	1,170,000 m^2	+19%
2021 GHG emissions	268,475 $ktCO_2e$	
Business-as-Usual (BAU) 2050 GHG emissions	297 $ktCO_2e$	+11%
Business-as-Planned (BAP) 2050 GHG emissions	109 $ktCO_2e$	-59%
low-carbon scenario (LCS) 2050 GHG emissions	6 $ktCO_2e$	-98%
2021 per capita GHG emissions	5.93 tCO_2e	
BAU 2050 per capita GHG emissions	4.71 tCO_2e	-21%
BAP 2050 per capita GHG emissions	1.83 tCO_2e	-69%
LCS 2050 per capita GHG emissions	0.10 tCO_2e	-98%
2021 total energy consumption	5,864 TJ	
BAU future total energy consumption	6,852 TJ	+17%
BAP future total energy consumption	4,606 TJ	-21%
LCS future total energy consumption	2,806 TJ	-52%
net financial impact of implementing *Climate Action Strategy* measures (discounted @ 3%)	$286M savings over 26 years	

COMMUNITY CO-BENEFITS OF TAKING ACTION

Climate action measures improve tangible and intangible community services by providing cleaner air, improved energy efficiency and security, sustainable active transportation, and healthier walkable, inclusive, and livable communities, which are referred to as co-benefits. Climate co-benefits are additional, desirable health and social well-being, economic, and environmental outcomes from a given action that improve quality of life and community resiliency (Table 3).

A variety of community co-benefits accompany the implementation of CAS measures. Planning climate actions that also deliver community co-benefits enable municipalities to strengthen key stakeholder support, mobilize capacity across municipal departments, and maximize opportunities to address multiple social, economic, and ecological challenges.

These co-benefits—combined with energy consumption and emissions reduction outcomes—make a very compelling case for implementing the measures outlined in the CAS.

TABLE 3: Examples of co-benefits associated with climate action strategies that reduce GHG emissions

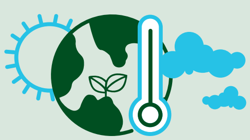
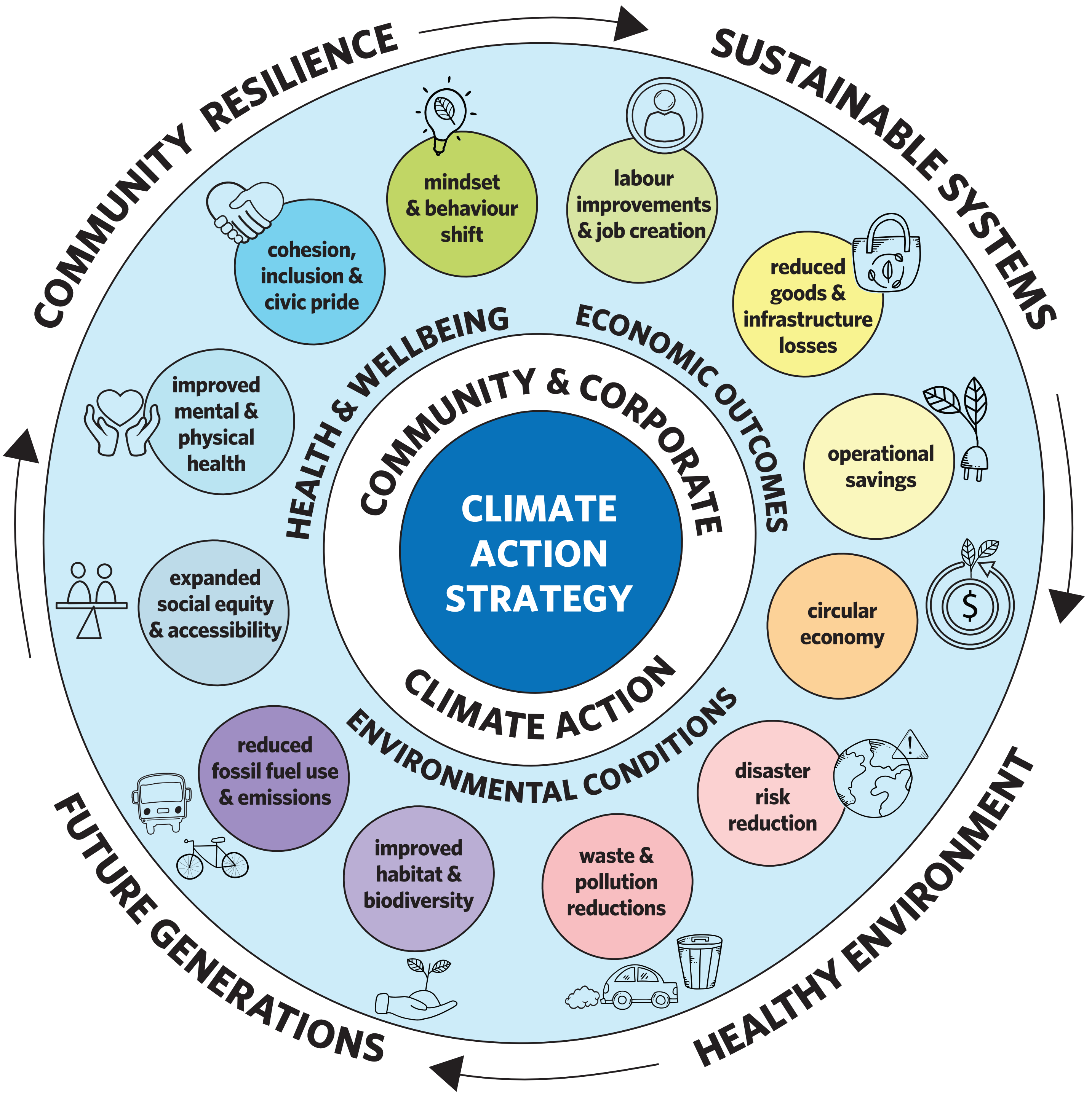
HEALTH & SOCIAL WELL-BEING	ECONOMIC OUTCOMES	ENVIRONMENTAL CONDITIONS
• improved mental/physical health • expanded social equity • community cohesion & civic pride • reduced air pollution • reduced extreme heat exposure • shift to sustainable behaviours • social inclusion	• higher employment & job creation • reduced goods & infrastructure losses • operational savings • reduced climate impacts on businesses & local economy • labour & work improvements • shift to circular economy	• reduced fossil fuel dependence & emissions • improved habitat & biodiversity • green space access • waste stream reduction • improved air, water, soil quality • disaster risk reduction • reduced traffic congestion
		

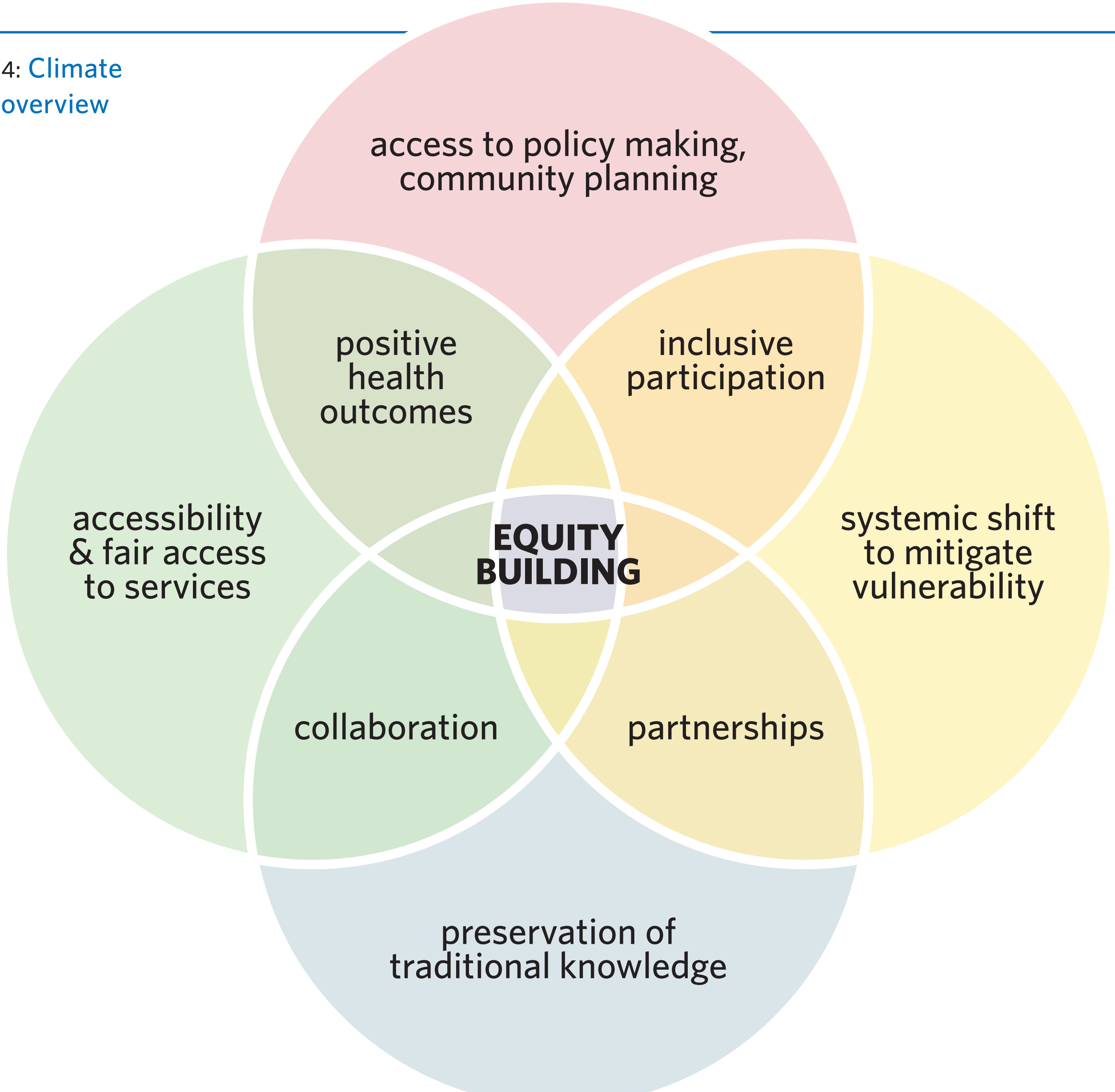
FIGURE 3: Climate action co-benefits overview



COMMUNITY CLIMATE EQUITY

The District is developing a DEI (Diversity, Equity, and Inclusion) strategy and action plan for the organization. It will help ensure that all staff know and feel they belong, they are valued, and their thoughts, ideas, and talents are not only welcomed but are needed to make a difference now and into the future. This strategy will provide the District's foundation on which to support and provide services to the community, including climate action initiatives. The initiatives identified in this CAS will be implemented through a DEI lens. Implementation will account for diverse identities and needs and prioritize the well-being of populations especially vulnerable to climate change impacts.

FIGURE 4: Climate equity overview



PART 1: INTRODUCTION

PART 1: INTRODUCTION

Human-caused global warming[1] is changing global climate functions with large-scale changes to weather patterns, including increases in the severity and frequency of storms, flooding, droughts, wildfire, air pollution, and other extreme weather events.[2] These changes are impacting our, health, infrastructure, buildings, natural ecosystems, and can magnify existing community inequities. The Intergovernmental Panel on Climate Change (IPCC) estimates that human activities have caused approximately 1.0°C of global warming above pre-industrial levels. Warming is likely to reach 1.5°C in the next several years. According to the IPCC, limiting warming to 1.5°C requires achieving net zero GHG emissions globally by 2050.[3] According to many scientists contributing to the IPCC reports, achieving net-zero global emissions much sooner—by 2030—is critical to limiting warming to 1.5°C.

Environment Canada's automatic weather station in West Vancouver has historically experienced an annual average temperature of 10.5°C and average annual precipitation of 1,593 mm.[4] Under current emission trajectories, annual average temperatures are projected to be 12.3°C for the 2021–2050 period, 13.7°C for the 2051–2080 period, and 15.2°C for the last 30 years of this century. Average annual precipitation is projected to be 7% higher for the 2051–2080 period and 10% higher for the last 30 years of this century. Average annual precipitation is projected to be 7% higher for the 2051–2080 period and 10% higher for the last 30 years of this century.[5]

EMISSIONS REDUCTIONS PLAN

To play its part in equitably addressing the challenges of climate change, and to lessen anticipated local climate change impacts, West Vancouver's CAS details a pathway to near net-zero emissions by 2050 and achieving 45% emission reductions under 2010 levels by 2030.

1 Global warming is the long-term warming of the planet's overall temperature. It occurs when excess heat-trapping particles collect in the atmosphere and absorb greater amounts of sunlight and solar radiation than is natural. Human activity has dangerously increased the presence of these atmospheric particles (known as anthropogenic global warming).

2 ibid.

3 Intergovernmental Panel for Climate Change. Special Report: Global Warming of 1.5°C. ***ipcc.ch/sr15***

4 The historical period used for the West Vancouver automatic weather station was the 30-year period from 1994–2023 and the climate indicator projections were based on the period from 1971–2000.

5 McKenney, D. W., M. F. Hutchinson, P. Papadopol, K. Lawrence, J. Pedlar, K. Campbell, E. Milewska, R. F. Hopkinson, D. Price, and T. Owen, 2011: Customized Spatial Climate Models for North America. Bull. Amer. Meteor. Soc., 92 12, 1611-1622. Accessed January 2024. ***climatedata.ca***

A GLOBAL & LOCAL IMPERATIVE

CANADA'S NATIONAL & INTERNATIONAL COMMITMENTS

Canada is a signatory to the Paris Agreement (2015), under which it has committed to achieving a 30% reduction in emissions below 2005 levels by 2030, and 80% below 2005 levels by 2050. The Paris Agreement aims to strengthen the global climate change response by keeping the global temperature rise this century well below 2.0°C relative to pre-industrial levels, and to pursue efforts to limit temperature increase even further to 1.5°C, to avoid the severe climate change impacts projected to occur if 1.5°C of warming is surpassed.

CARBON PRICING

Following direction in the Pan Canadian Framework, the *Greenhouse Gas Pollution Pricing Act* (2018) established a Canadian benchmark carbon price that began at \$20/tCO_2e in 2019 and increased to \$65/tCO_2e in 2023. The tax will increase by \$15/tCO_2e every year until it reaches \$170/tCO_2e in 2030. The federal carbon pollution pricing system has two parts:

- a trading system for large industry, known as the output-based pricing system; and
- a regulatory charge on fuel (fuel charge).

Provinces and territories can implement their own carbon pricing that meets or exceeds this national benchmark.

ZERO EMISSIONS VEHICLES

2019's Zero Emission Vehicle Infrastructure Program is supporting the transition to zero-emissions vehicles by helping to address the required investments and upgrades to the EV charging network.[8] The program targets public, on-street, workplace, multi-unit residential buildings, and commercial and public fleet charging infrastructure improvements. As of June 2021, the federal government has established a mandatory target for all new light-duty cars and passenger truck sales to be zero-emission by 2035.[9]

BUILDING ENERGY EFFICIENCY

The federal government's Canada Greener Homes Loan Program was launched mid-2021, providing homeowners with federal loan funding for energy efficiency upgrades and EnerGuide evaluations.[10] There are several related federal government efforts supporting green building programs including Local Energy Efficiency Partnerships[11] for new construction and Integrated Community Energy Solutions[12] for built community environments.

6 Natural Resources Canada. Zero Emission Vehicle Infrastructure Program. 16 Apr. 2019.
natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/20996

7 Transport Canada. "Building a Green Economy: Government of Canada to Require 100% of Car and Passenger Truck Sales Be Zero-Emission by 2035 in Canada."
tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/canada-s-zero-emission-vehicle-sales-targets

8 Natural Resources Canada. Canada Greener Homes Grant. 17 Mar. 2021.
natural-resources.canada.ca/energy-efficiency/homes/canada-greener-homes-initiative/canada-greener-homes-loan/24286

9 Natural Resources Canada. Local Energy Efficiency Partnerships (LEEP). 22 Apr. 2015.
natural-resources.canada.ca/energy-efficiency/homes/local-energy-efficiency-partnerships-leep/17338

10 Natural Resources Canada. Integrated Community Energy Solutions. 9 Oct. 2009.
natural-resources.canada.ca/homes/about-integrated-community-energy-solutions/4369

PROVINCIAL DIRECTION

In 2007 BC legislated the *Climate Change Accountability Act* to reduce province-wide emissions. GHG reduction targets are set to 40%, 60%, and 80% below 2007 levels by 2030, 2040, and 2050 respectively. In 2021, the Province released its *CleanBC Roadmap* to 2030, a plan to put BC on the path to net-zero emissions by 2050, with a focus on near-term actions to 2030. The plan details directions and targets from the Province, including:

- a zero-emission vehicle law achieving 26% of new light-duty vehicle sales by 2026, 90% by 2030, and 100% by 2035
- a target of 10,000 public EV charging stations by 2030
- actions supporting mode-shift toward active transportation and public transit
- nearly eliminating all industrial methane emissions by 2035
- enhancing the CleanBC Program for industrial emissions reductions
- a cap on emissions for natural gas utilities
- new requirements for all new buildings to be zero carbon and new space and water heating equipment to be highest efficiency by 2030
- implementing a 100% Clean Electricity Delivery Standard for the BC Hydro grid
- a new program to support local government climate and resiliency goals with predictable funding

Under the *Climate Change Accountability Act*, the Province is required to submit a report to the legislature each year outlining progress on climate action. The *2023 Climate Change Accountability Report** is the most recent report and focuses on BC's progress on climate actions across a range of policies, programs, and legislation implemented during the 2022–23 year (April 1, 2022, to March 31, 2023).

BC ENERGY STEP CODE

The BC Energy Step Code is a compliance path in the BC Building Code that local governments may use to incentivize or require increasing levels of energy efficiency in new construction that goes above and beyond the requirements of the BC Building Code. By 2032, the target is net-zero ready where the BC Building Code will move toward the Step Code's highest steps, as a minimum requirement. Many municipal governments are increasingly adopting more stringent Step Code levels as well as the currently optional Zero Carbon Step Code, in advance of their provincially planned implementation dates to achieve improved energy efficiency in new buildings sooner.

* *2023 Climate Change Accountability Report: Supporting Material.*
www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/2023_climate_change_accountability_report_supporting_materials.pdf

MUNICIPAL EFFORTS

Approximately 70% of global emissions are under the direct or indirect control or influence of municipal governments (Figure 5)*. Municipalities are taking action and enacting policies to reduce greenhouse gas emissions within their borders. Dozens of municipalities across Canada have adopted 100% renewable energy by 2050 (or sooner) targets. Dozens more have declared climate emergencies, identifying climate change impact mitigation as a critical, top priority issue alongside adaptation measures.

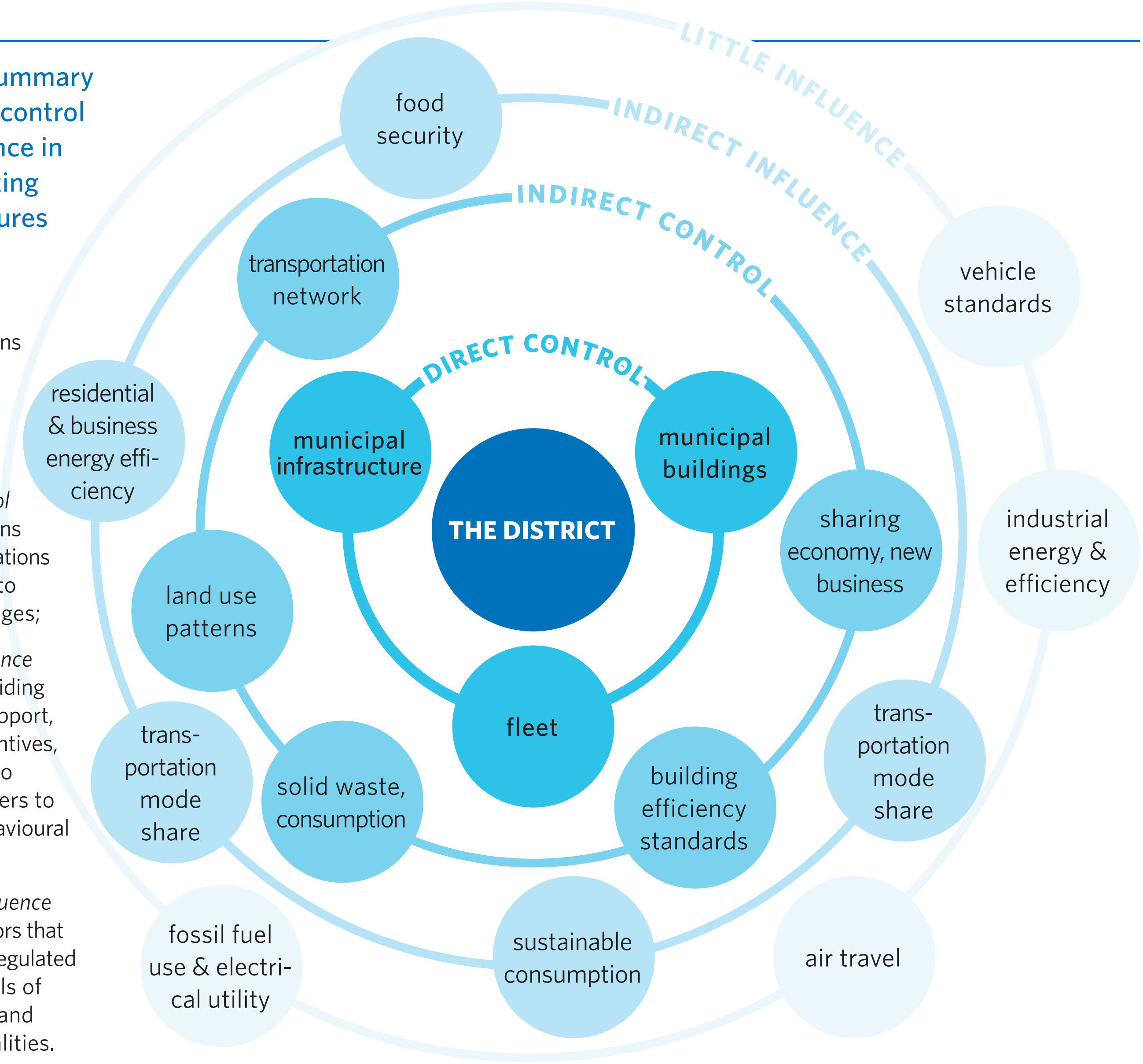
FIGURE 5: **Summary of District control and influence in implementing CAS measures**

Direct control refers to actions related to changes in municipal operations;

Indirect control refers to actions such as regulations and policies to achieve changes;

Indirect influence refers to providing resources, support, financial incentives, and actions to remove barriers to promote behavioural changes;

and *Little influence* refers to sectors that are typically regulated by other levels of government and not municipalities.

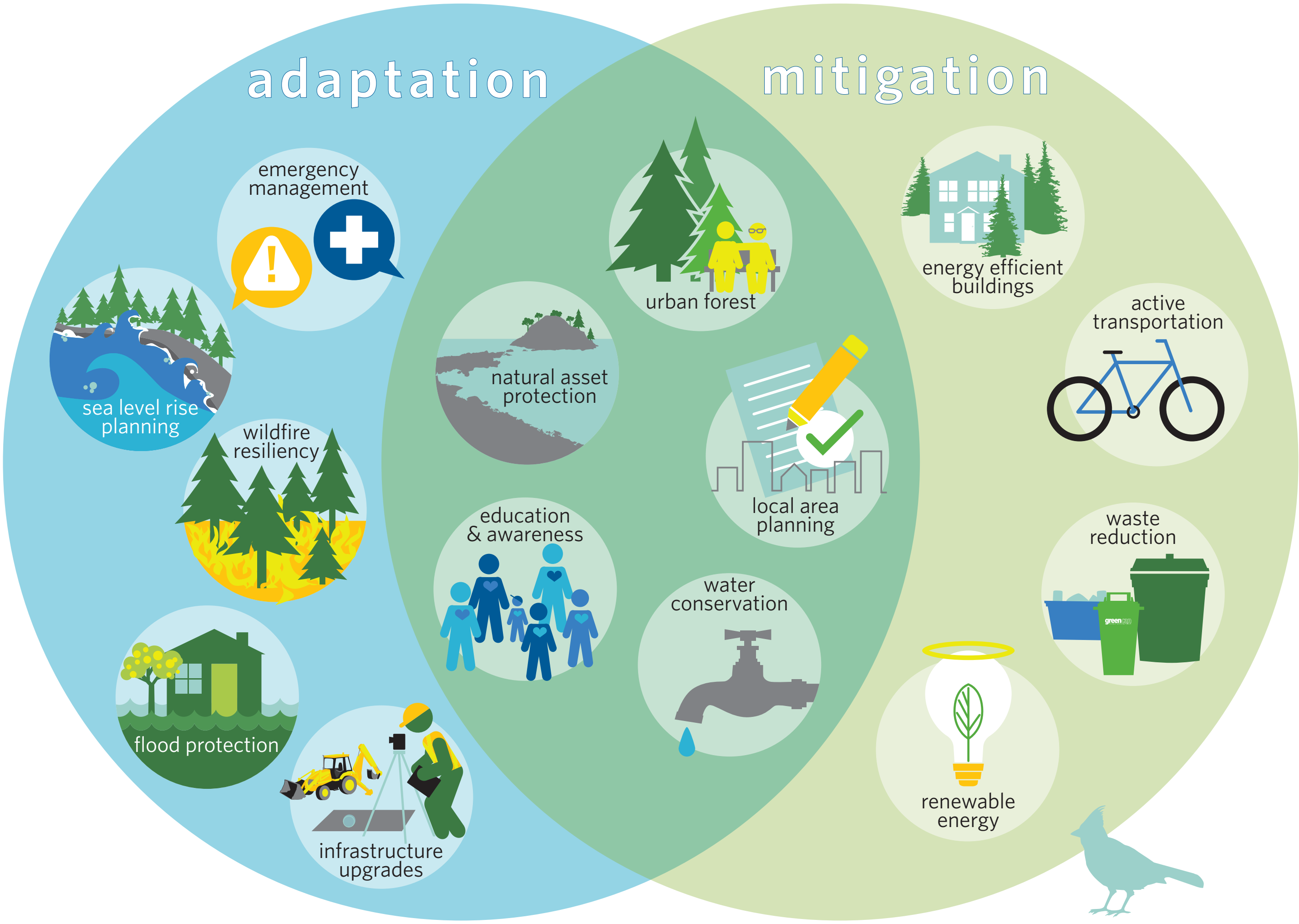


* *C40 Cities, and Arup. Deadline 2020: How Cities Get the Job Done. Analysis and Research, p. 59. c40.org/wp-content/uploads/2021/07/Deadline_2020.pdf*

WEST VANCOUVER'S *CLIMATE ACTION STRATEGY*

The District' Official Community Plan has policies and objectives to: (1) protect the natural environment; (2) reduce community and corporate GHGs; and (3) adapt to climate change. Recognizing that these three pillars are inter-connected, the strategy requires the integration of climate change adaptation and emission mitigation measures to minimize risk and generate community co-benefits (Figure 6). For example, reducing GHG emissions will provide a cleaner, healthier community and natural environment; the enhancement and maintenance of the natural environment will in turn help to reduce GHG emissions; early adaptation to the changing climate will help to build resilience in the community to reduce significant impacts on our well-being and daily life.

FIGURE 6: The connection between adaptation & mitigation efforts to achieve the District's goal of a low carbon resilient community



The CAS accounts for current and planned initiatives by the District to address the objective to reduce GHGs and a pathway to achieve its emission reduction targets. It acknowledges the global scientific consensus that identifies present and increasing ecosystems and climate impacts caused by increased greenhouse gas emissions from fossil fuel burning activities currently required to live our day-to-day lives*. West Vancouver's emission target seeks to reduce GHG emissions by 45% under 2010 levels by the year 2030 (a total of 148 $ktCO_2e$), and to achieve net zero emissions by the year 2050.

In 2016, West Vancouver coordinated climate action through the completion of a community and corporate emissions inventories known as the Community Energy & Emissions Plan (CEEP) and the Corporate Energy & Emissions Plan, respectively. Three years later, on July 8, 2019, the District of West Vancouver would join other Canadian and global municipalities in their declarations of a climate emergency. The CAS was built from these plans to prioritize actions to reduce GHGs and aligns with other District plans and policies to adapt to climate change and protect the natural environment (Figure 7).

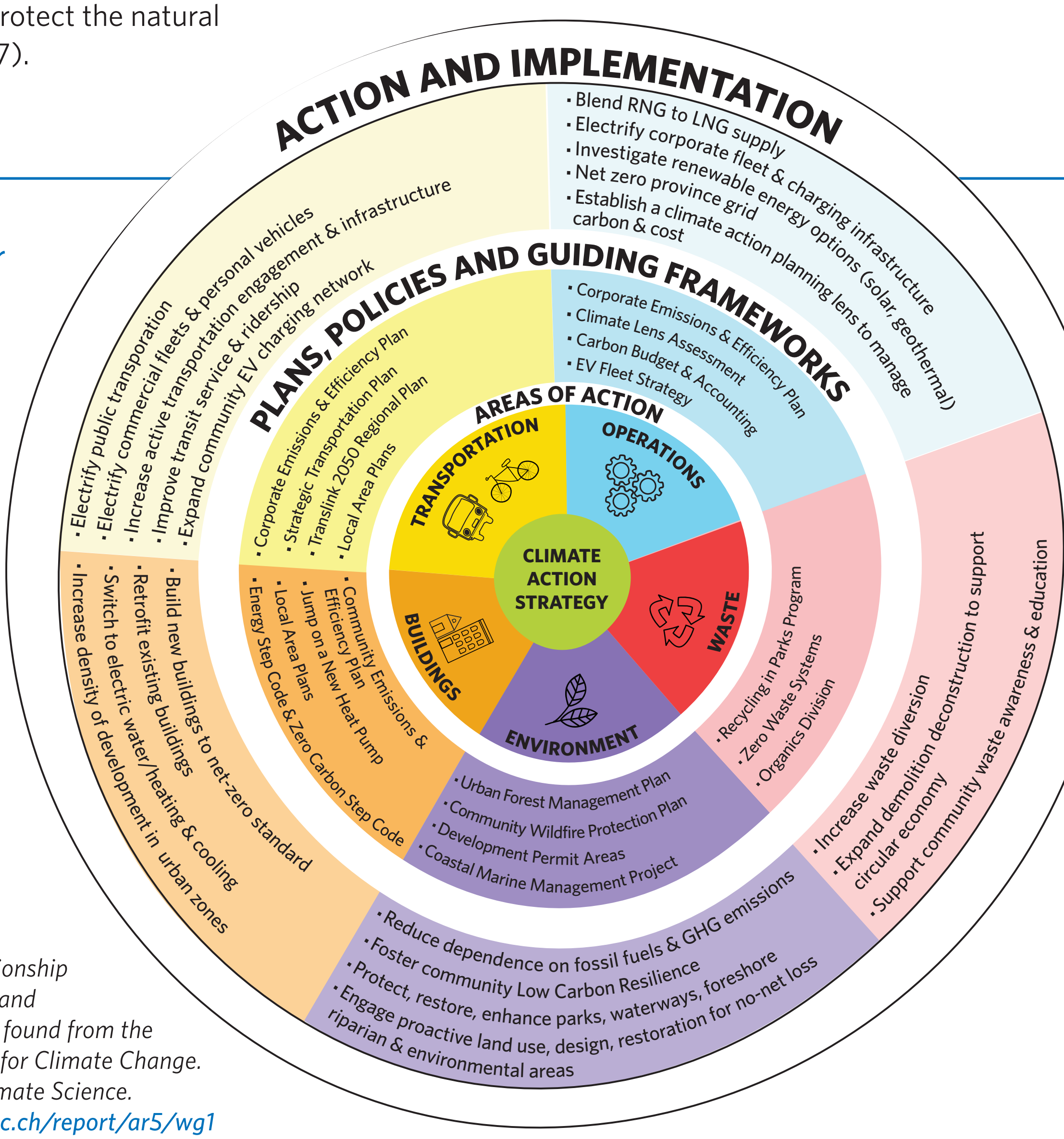


FIGURE 7: Alignments of the CAS with other District plans and guiding frameworks

* *More details on the relationship between climate change and greenhouse gases can be found from the Intergovernmental Panel for Climate Change. 1.2.2 Key Concepts in Climate Science. Assessment Report 5. ipcc.ch/report/ar5/wg1*

THE REDUCE-IMPROVE-SWITCH PARADIGM

Low-carbon community planning considers a wide variety of actions in transportation, buildings, energy use and generation, waste, and land-use. The actions can be classified under one or more categories of Reduce, Improve, and Switch: reducing energy consumption, improving the efficiency of the energy system (supply and demand), and fuel switching to low or zero carbon renewable sources (Figure 8).

The least wasteful and most cost-effective approach in transitioning to a low-carbon future is to first reduce the amount of energy needed as much as possible through energy efficiency and conservation, and then to switch to renewable energy sources to supply the remaining demand. The sequence of the approach is important: by avoiding energy consumption (Reduce), retrofit requirements (Improve), and the need to generate renewable energy (Switch) are both reduced. Table 4 explores some examples of measures in each of the paradigm's categories.

FIGURE 8: The Reduce/Improve/Switch model

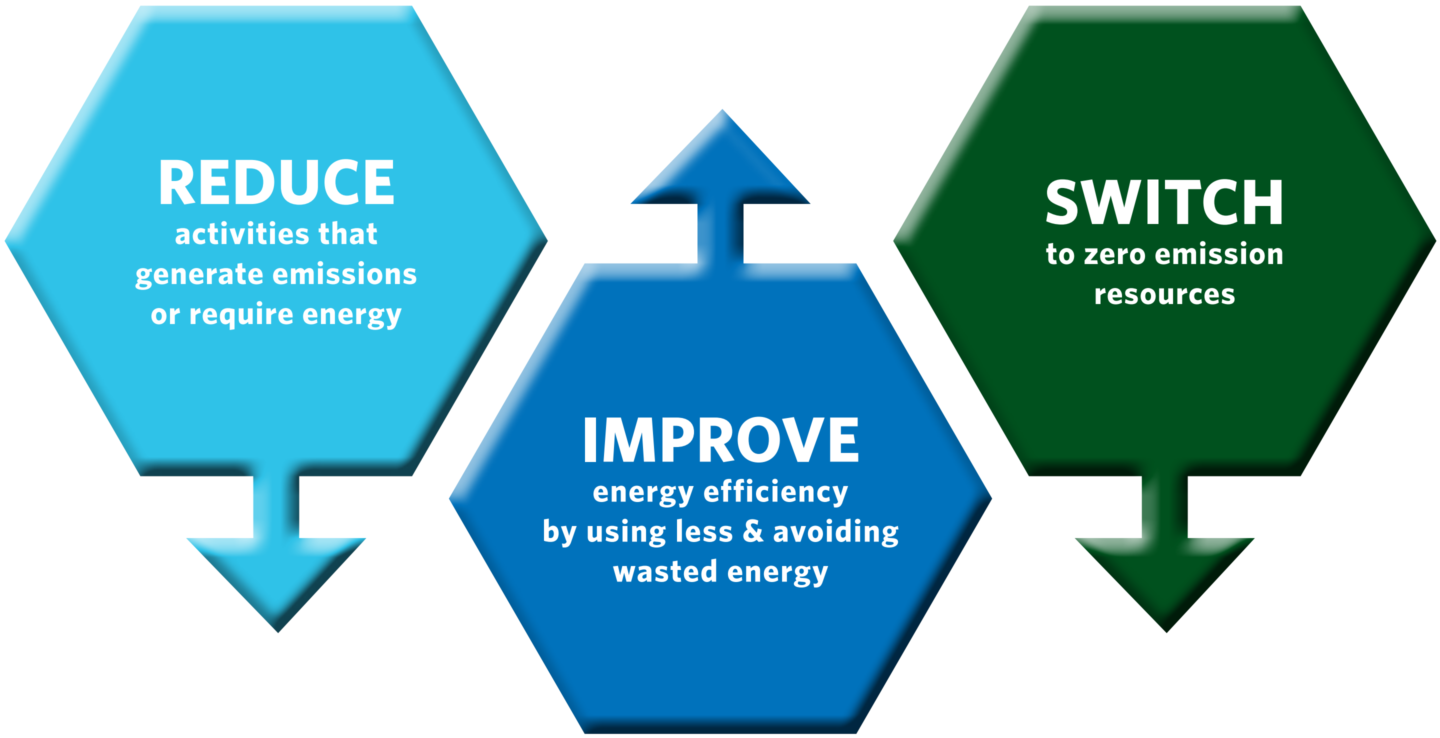


TABLE 4: Areas to explore using Reduce/Improve/Switch actions

SECTOR	ACTION NAME	APPROACH
URBAN FORM	increase urban density	reduce
BUILDINGS	raise standards to require reduced energy use & improved energy efficiency in new buildings	improve
ENERGY USE	decarbonize electricity	reduce, switch
	replace all natural gas for water heating and space heating with zero emissions fuels and/or waste heat	switch
TRANSPORTATION	vehicle energy efficiency	improve
	decarbonize vehicles	reduce, switch
	promote transit and active transportation	reduce, switch
WASTE & WASTEWATER	reduce generation of waste	reduce
WATER USE	decrease use of treated fresh water	reduce

PART 2:
COMMUNITY & CORPORATE GHG EMISSIONS INVENTORY

PART 2: COMMUNITY AND CORPORATE GHG EMISSIONS INVENTORY

WHICH ACTIVITIES ARE INCLUDED?

Emissions inventories use the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC), a standard ensuring consistency, transparency, and replicability. Emissions sectors and emissions-producing activities are well-defined. The BASIC+ level of GPC used in this report includes all emissions sources inside the municipal boundary, as well as some from activities occurring outside the boundary for which West Vancouver residents, visitors, and commuters are responsible.

Thus, West Vancouver's emissions inventory includes scope 1 emissions from stationary energy use (primarily buildings), transportation, waste, local industrial processes and product use, local agriculture, local forestry, and other land use. It includes scope 2 emissions from grid-supplied electricity use. It also includes scope 3 emissions from transboundary transportation, waste, and energy transmission and distribution. Figure 9 provides an overview of emissions sources for each scope.

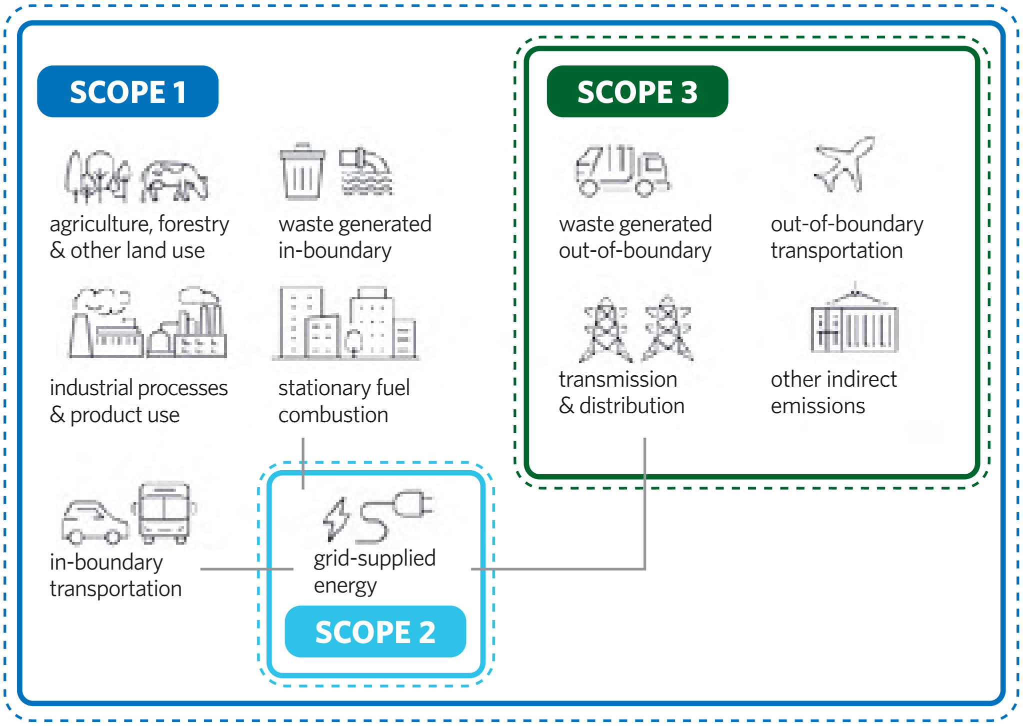


FIGURE 9: Illustration of GHG emission scopes

Note that this inventory does not include emissions associated with elements like embedded carbon for products created outside of the municipal boundary but consumed inside the boundary (e.g. construction materials, consumer products). In theory, these emissions are inventoried in the jurisdictions where the products are made.

WHICH GREENHOUSE GASES ARE INCLUDED?

GHG inventories typically focus on carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions—the greenhouse gases of highest presence.

Gases are measured in tonnes and converted into tonnes of carbon dioxide equivalents (tCO_2e). The conversion allows comparison of each gas' greenhouse gas effect—or global warming potential (GWP)—relative to the GWP of one unit of carbon dioxide (Table 5). For example, the global heating effect of one tonne of methane is 86 times that of one tonne of CO_2 over 20 years.

Acknowledging the different heating effects of the main GHGs allows appropriate action in mitigating their sources. For example, it is historically widely acknowledged that vehicle tailpipe emissions need to be eliminated, but only more recently has it been acknowledged that natural gas use needs to be eliminated, as its methane release poses direct public health risks[1] and severe global heating consequences.

TABLE 5: Greenhouse Gas Global Warming Potential Value[2]

GREENHOUSE GAS	OVER 20 YEARS	OVER 100 YEARS
carbon dioxide (CO_2)	1	1
methane (CH_4)	86	34
nitrous oxide (N_2O)	268	298

1 Examples: pubs.acs.org/doi/10.1021/acs.est.1c04707; cbc.ca/news/science/gas-stoves-air-pollution-1.6394514; ncbi.nlm.nih.gov/pmc/articles/PMC10901287/

2 Intergovernmental Panel on Climate Change IPCC Global Warming Potentials - 100-Year Time Horizon, Assessment Report 6, Synthesis Report, Table 7.SM.6 Tables of Greenhouse Gas Lifetimes, Radiative Efficiencies and Metrics. ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_07_Supplementary_Material

BASE YEAR INVENTORY

The base year inventory provides a recent catalogue of energy-using activities and their resulting emissions across the community. It describes where energy is currently sourced and how it is used, as well as the GHG emissions associated with its use. West Vancouver's total GHG emissions for the 2021 base year is 268 ktCO_2e compared to 269 ktCO_2e in 2010 (baseline year) (Table 6). The modelling in this report uses the 2021 base year as a reference point (as there is current and accurate data available across all sectors in this year) while the 2030 and 2050 emission reduction targets are compared to 2010 emission levels.

TABLE 6: Summary of West Vancouver's base year (2021) emissions inventory

SECTOR		TOTAL BY SCOPE (tCO_2e)			TOTAL (2021)	2010 BASELINE EMISSIONS (tCO_2e)
		SCOPE 1	SCOPE 2	SCOPE 3		
stationary energy	energy use	151,950	3,221	107	155,278	133,132
	energy generation supplied to the grid	0			0	
transportation	all internal trips + fractions of outbound trips + fractions of inbound trips	73,848	85	35,093	109,027	101,862
waste	generated in the District	0		4,170	4,170	34,605
	generated outside the District			0	0	
	TOTAL	**225,798**	**3,306**	**39,371**	**268,475**	**269,600**

57% of West Vancouver emissions are generated by stationary energy consumption (155 ktCO_2e). With no major manufacturing and industry present, this value comprises residential (112 ktCO_2e) and commercial (41 ktCO_2e) emissions from energy consumption. 41% of emissions are from the transportation sector (109 ktCO_2e), all from on-road transportation. Personal use vehicles (primarily gasoline) travelling short distances (under 4 kms) represent the largest portion of trips. The remaining 2% of emissions are generated from waste, composed of two major sources: solid waste landfill and wastewater treatment. This snapshot shows opportunities for emission reductions and priority areas to chart West Vancouver's low-carbon future.

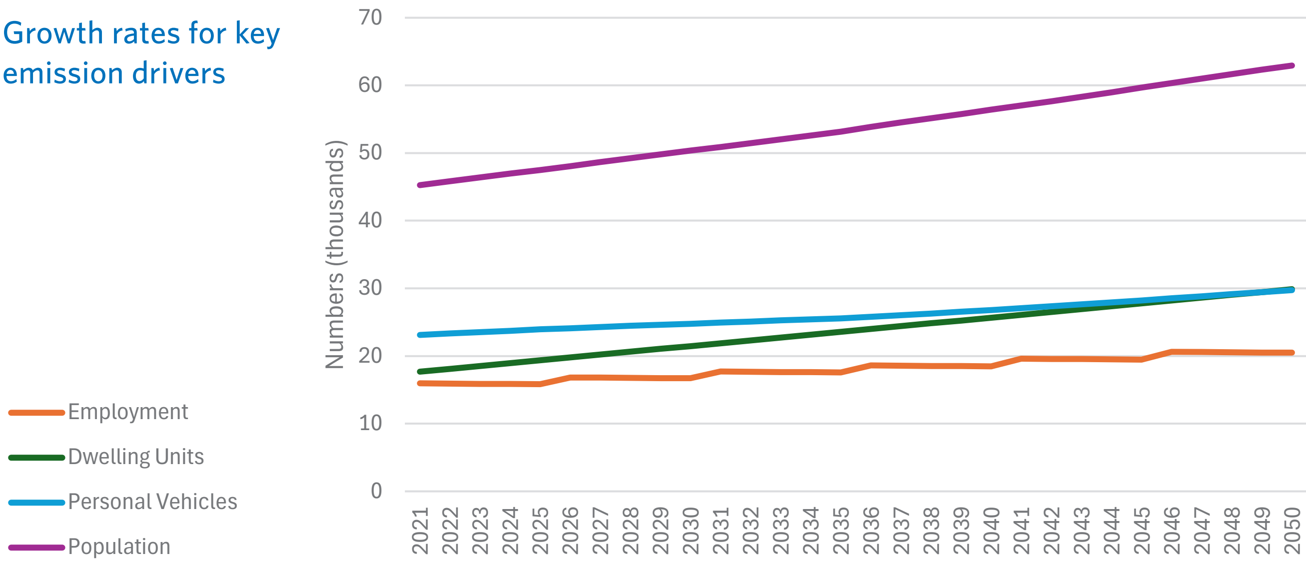
PART 3: EXPLORING WEST VANCOUVER'S ENERGY & EMISSIONS FUTURES

PART 3: EXPLORING WEST VANCOUVER'S ENERGY & EMISSIONS FUTURES

EMISSION DRIVERS*

Population and employment growth drive buildings and vehicles growth, which are the primary drivers of energy use and thus emissions production (Figure 10). West Vancouver was home to 45,262 residents in 2021 (adjusted for census undercount and student populations). The population is expected to grow by 39% by 2050 (62,988 people). Housing stocks are expected to grow almost proportionately by 41% by 2050 (29,876 total dwelling units). Vehicle stocks are expected to grow 29% over the same time period (29,739 total vehicles). Employment is expected to grow by 29% (20,360 total jobs), while commercial floorspace is expected to increase from 0.98 to 1.17 million m^2. Without major technology improvements (e.g. improved efficiency, fuel switching) and behavioural shifts, population growth is traditionally accompanied by additional GHG emissions. More buildings and vehicles using energy, more trips made, more waste and wastewater produced, and other growth-related emissions.

FIGURE 10: Growth rates for key emission drivers



* *Population and employment projection numbers are from Translink modelling data (April 2023). Modelling necessarily requires making reasonable assumptions about the future. Figures provided here are projections that reflect trends, macro conditions, local, provincial, and federal government sources. These projections are subject to change and may be updated from time to time to reflect latest policies, demographic trends, household composition, as well as external factors. Actual growth will be influenced by market conditions and Council decisions. Irrespective of the exact amount of future population and household growth, the actions provided in the CAS provide a pathway to meet the District's emissions reduction targets of 45% from 2010 levels by 2030, and net zero emissions by 2050.*

SCENARIO MODELLING

West Vancouver seeks to reduce GHG emissions by 45% from 2010 levels by the year 2030 (a total reduction of 148 $ktCO_2e$ in that year) and achieve net zero annual GHG emissions by 2050. Energy and emissions scenario modelling was used to determine what measures the District, residents, businesses, and the community can take to achieve these targets. Scenario modelling assumptions are summarized in Table 7.

TABLE 7: Summary of modelled emission reduction scenarios

SCENARIO	DESCRIPTION	KEY ASSUMPTIONS
Business-as-Usual (BAU) 2021–2050	The BAU scenario forecasts the community's expected energy use and GHG emissions profile year-over-year until 2050. It assumes no emissions reduction interventions beyond those currently expected. The BAU represents current land use patterns and plans (e.g. Marine Drive LAP), and projects historical trends across all sectors.	• population growth • employment growth • new building growth • heating & cooling degree days • transportation fuel standards • electricity emissions factor
Business-as-Planned (BAP) (Clean BC + District Plans) 2021–2050	The BAP scenario accounts for measures implemented through Clean BC, the province's climate change action plan, plus planned District of West Vancouver land use planning and transportation measures.	BAU information and: • residential & commercial building heat pumps & hot water heaters • new personal ZEVs (prov/fed targets) • new commercial ZEVs • vehicle emissions intensity reduction • Provincial Step Code 4 in 2023 • improved electricity emissions factor • 95% waste diversion • District land use (OCP) policies and LAPs for Cypress Village, Horseshoe Bay & Ambleside • municipal fleet electrification • improved transit service • ZEV transit buses
Low-Carbon Scenario (LCS) 2021–2050	The LCS models deeper potential emission reduction measures that can be taken in each sector of the community to reach West Vancouver's 2050 emissions reduction target. Each action is defined by a set of assumptions and is modelled year-over-year until 2050.	BAU and BAP information and: • Taylor Way Future LAP • Provincial Step Code 5 by 2027 • ambitious building energy retrofits • home solar PV and heat pumps • RNG and hydrogen to replace natural gas • 100% waste diversion & methane capture • active transportation infrastructure

TOTAL ENERGY USE OUTLOOK

BAU

Energy use increases by 17% by 2050 from 2021 levels. The transportation sector energy use declines by 25% over this period as EVs replace gas models—although there are more vehicles, EVs are far more energy efficient than gas models. New homes push residential sector energy demand up 47% from 2021 levels, despite reduced heating demand expected as heating degree days decrease (due to climate change effects). This trend also results in a 1% energy use reduction in commercial sector buildings.

BAP

Energy use decreases by 21% from 2021 levels by 2050. More stringent vehicle efficiency regulations and federal and provincial EV uptake targets decrease transportation emissions by 58%. Heat pump installations, the BC Energy Step Code for new buildings, and an improved electricity emissions factor decrease building sector emissions by 4%, despite the increase in new homes. The same trends achieve 15% reductions in the commercial building sector.

LCS

Energy use decreases by 52% from 2021 levels by 2050. Improved transit and active transportation support decrease transportation emissions further, down 69%. The suite of residential measures decreases emissions by 35% including fuel switching, heat pumps, highest Step Code tiers, and performing energy efficiency retrofits in existing buildings. The same measures decrease commercial buildings' emissions by 73%.

FIGURE 11: BAU energy use outlook by sector

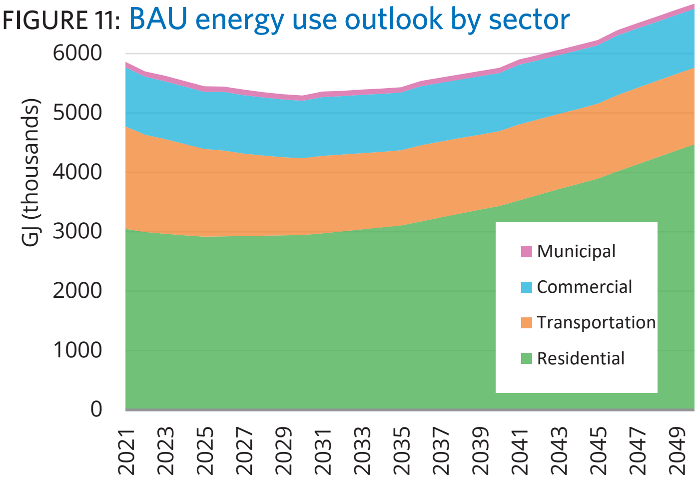


FIGURE 12: Modelled BAP energy use by sector

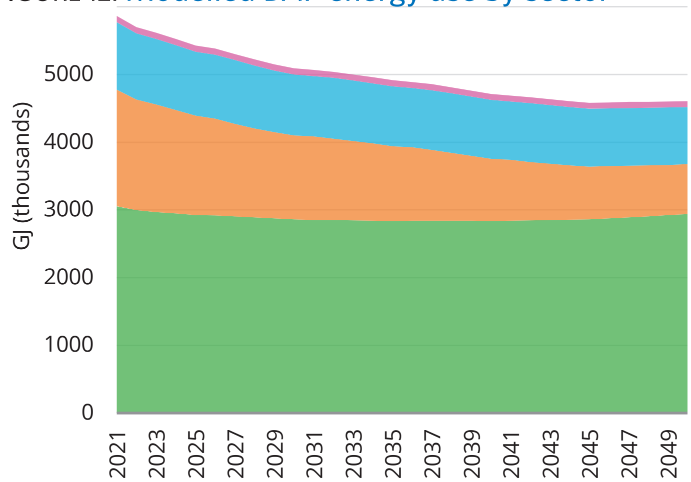
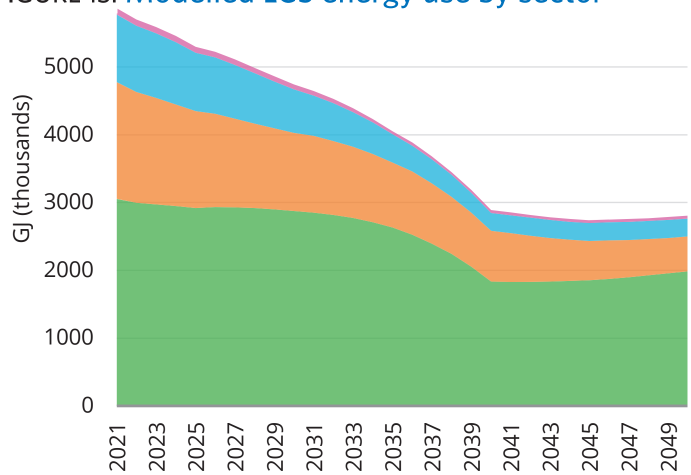


FIGURE 13: Modelled LCS energy use by sector



ENERGY SOURCES OUTLOOK

BAU

Mostly due to new homes, net electricity consumption increases 35% by 2050, while natural gas use increases 34%. As EVs replace internal combustion engine vehicles, diesel and gasoline use decreases by 3% and 30%, respectively.

BAP

More electricity is used in the BAP scenario as electricity-using technologies like EVs and heat pumps become more prevalent. Net electricity consumption increases 41% by 2050. Conversely, natural gas use decreases by 49%. Transportation measures implemented in the BAP scenario decrease diesel and gasoline use by 47% and 90%, respectively.

LCS

Despite more homes and EVs, net electricity use decreases by 15% from 2021 levels by 2050 in the LCS, primarily due to replacing baseboard heaters with heat pumps (increasing electric heating efficiency by at least 300%). Natural gas is eliminated as energy systems electrify, and the remainder of natural gas is switched to hydrogen and RNG. Diesel and gasoline are all but eliminated from the transportation sector.

FIGURE 14: BAU energy use by fuel type and sector

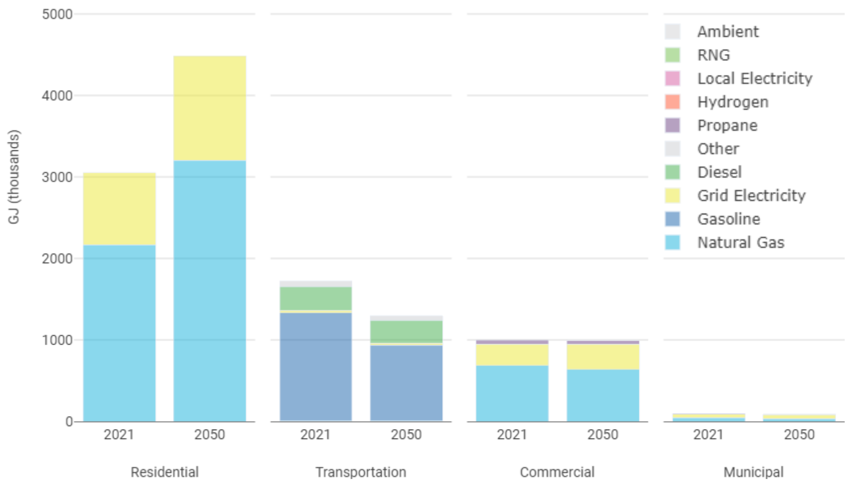


FIGURE 15: BAP energy use by fuel type and sector

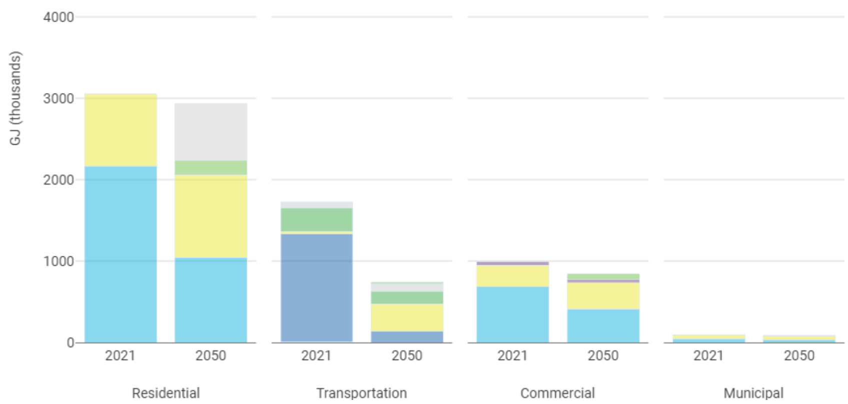
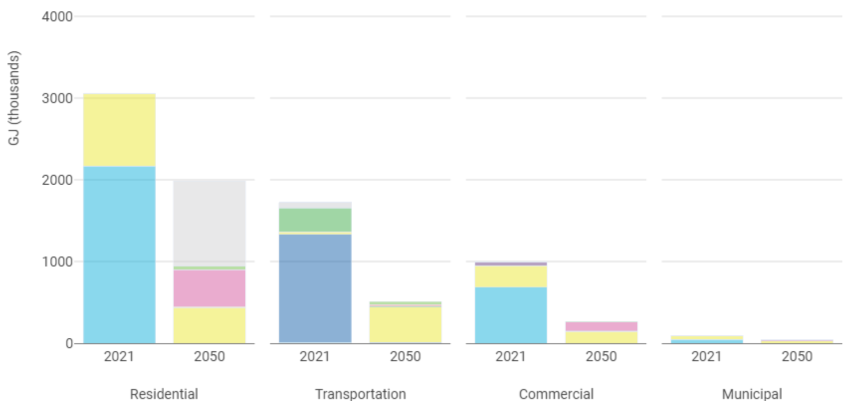


FIGURE 16: LCS energy use by fuel type and sector



TOTAL EMISSIONS OUTLOOK

BAU

Following from the energy outlook, BAU emissions decrease 11% from 2021 levels in 2030. Transportation emissions continue to decline by 24% by 2050. In other sectors, effects of emissions drivers' outpace reductions past 2030. Residential emissions dominate the future, increasing by 48%. Commercial buildings' emissions decrease 6% as less heating is required. The net emissions increase by 2050 is 11% from 2021 levels. Neither of West Vancouver's 2030 nor 2050 emission reduction targets are met under BAU.

BAP

In the BAP scenario, emissions decline 59% from 2021 levels by 2050. The fuel and technology switching measures taken under CleanBC and the compact complete communities developed under certain LAPs are effective at mitigating emissions. This is especially true in the transportation sector where emissions are down 81% by 2050. Residential, commercial, and municipal building emissions decrease by 53%, 40%, and 33%, respectively.

LCS

Additional measures taken in the LCS prove highly effective at reducing emissions, which are all but eliminated across all sectors by 2050. Remaining emissions in 2050 include those from residual fossil fuel use in the commercial and transportation sectors, and those from legacy waste in landfills.

FIGURE 17: BAU emissions by sector

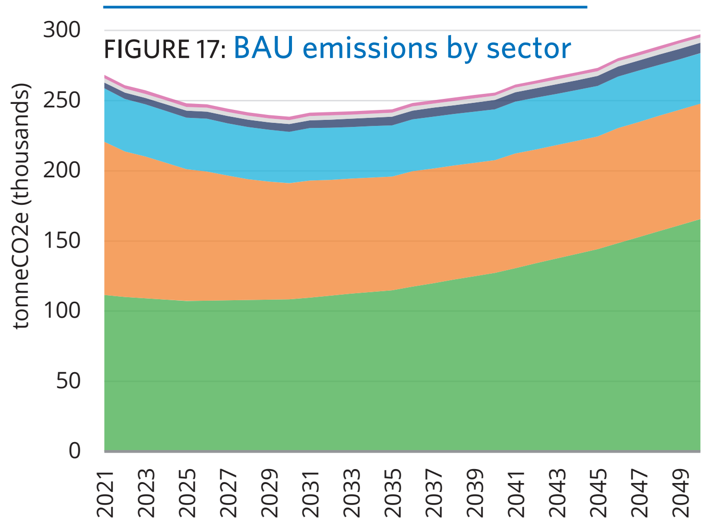


FIGURE 18: BAP emissions by sector

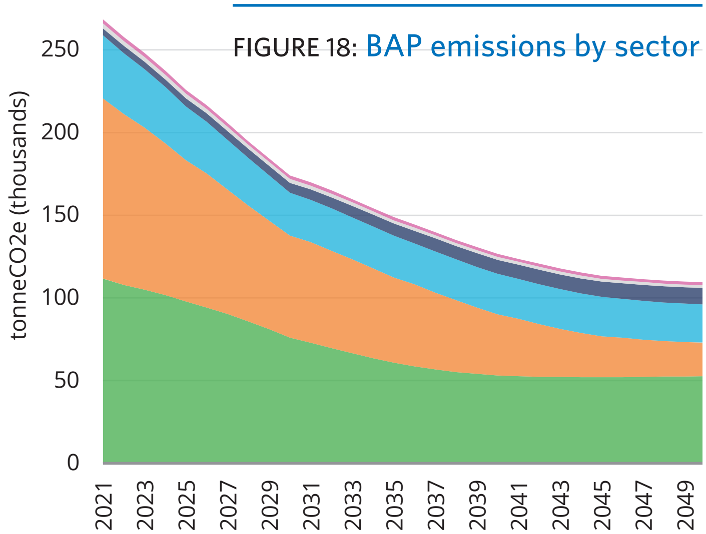
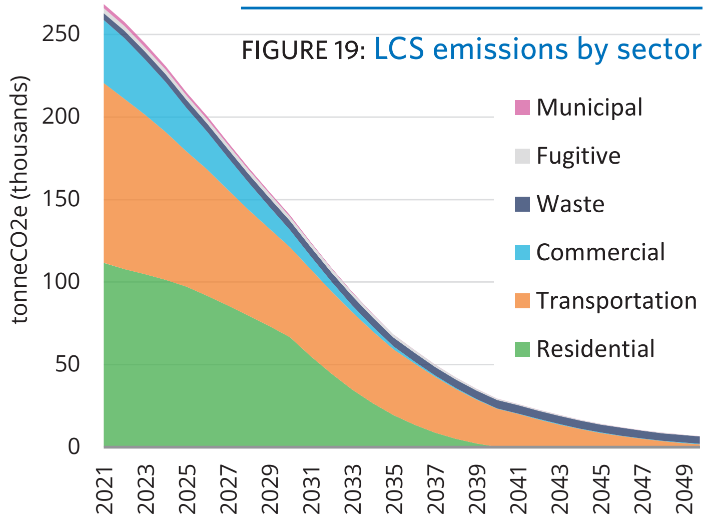


FIGURE 19: LCS emissions by sector



EMISSIONS SOURCES OUTLOOK

BAU

With no additional fuel switching and efficiency measures, natural gas use grows by 34% as buildings are developed to 2050, maintaining its place as the top emitter amongst all energy sources. Fugitive emissions from natural gas transmission increase in kind. Emissions from gasoline and diesel use decrease by 3% and 30%, respectively, in step with their decreased demand as mandated EV sales replace fossil fuel vehicles. Waste emissions increase 80%, as the growing population generates more waste.

BAP

As BAP measures decrease natural gas demand, emissions from its transmission and use decline by 39% and 49%, respectively. More ambitious ZEV targets and compact complete communities that encourage walking and biking trips decrease diesel and gasoline emissions by 46% and 90%, respectively. Although the total mass of solid waste produced is the same across scenarios, organic waste diversion in the BAP reduces landfill waste emissions by 12% from 2021 levels.

LCS

As almost all fossil fuel use is eliminated in the LCS, their emissions are nearly zero. Legacy landfilled waste continues to emit GHGs, making up the majority of remaining emissions by 2050 in this scenario.

FIGURE 20: BAU emissions by energy source

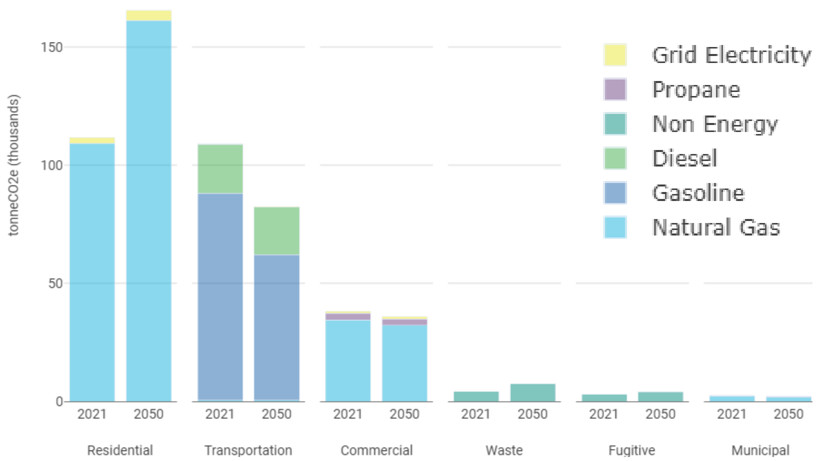


FIGURE 21: BAP emissions by energy source

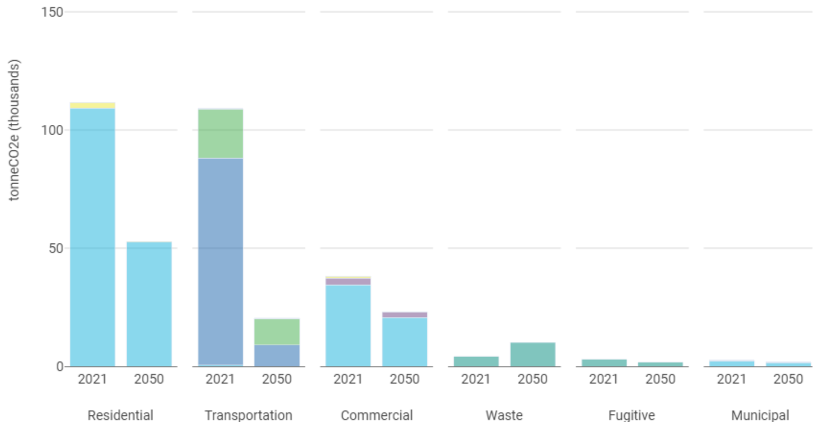
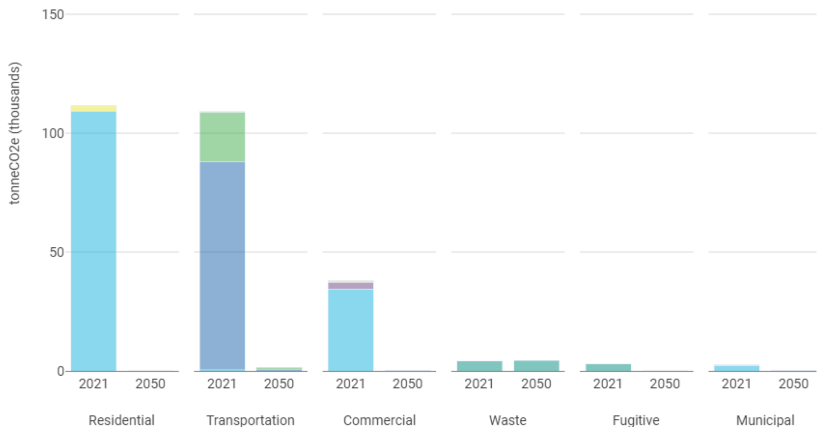


FIGURE 22: LCS emissions by energy source



OVERVIEW BY SECTOR

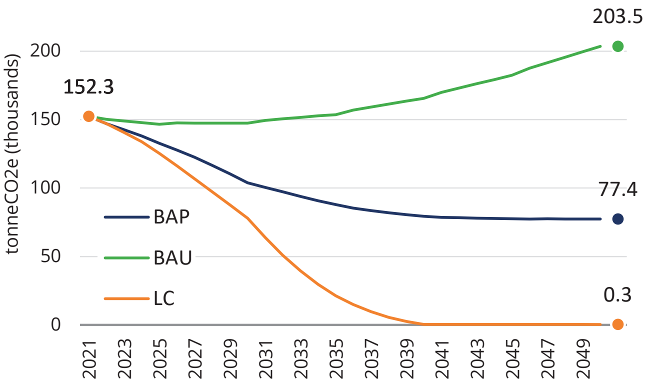
BUILDINGS EMISSIONS

The scenario modelling shows the significant emission reductions achievable by accelerating higher Energy Step Code level and Zero Carbon Step Code adoption, performing building energy efficiency retrofits, and switching natural gas heating and hot water systems for heat pumps (Table 8). By doing so, emissions from buildings are just 0.3 ktCO_2e by 2050 in the LCS, a 99% reduction from 2021 levels (Figure 23). By 2050, building measures will reduce over 200 ktCO_2e in the LCS compared to what they would be in that year without taking any actions (i.e. BAU scenario).

TABLE 8: Summary of key targets supporting building sector emission reductions

<table>
<tr><th>KEY TARGETS</th><th>BAU</th><th>BAP</th><th>LCS</th></tr>
<tr><td>new residential and non-residential building energy efficiency targets</td><td>no increase</td><td>by 2023, 40–80% more efficient</td><td>by 2027, net-zero emissions*</td></tr>
<tr><td>homes, commercial, and institutional buildings** retrofits</td><td>none included</td><td>none included</td><td>by 2040, achieve 50% thermal savings and 20% electrical savings in 95% of all existing buildings</td></tr>
<tr><td>municipal buildings retrofits</td><td>none included</td><td>none included</td><td>by 2035, 100% of municipal buildings are net zero</td></tr>
<tr><td>space heat pump installations</td><td>current uptake rate</td><td rowspan="2">by 2030, 1,412 residential buildings and 0.47 million m² of commercial floorspace served by electric heat pumps</td><td rowspan="2">by 2040 95% of residential and commercial buildings use electric heat pumps</td></tr>
<tr><td>hot water heat pump water installations</td><td>current uptake rate</td></tr>
</table>

FIGURE 23: Total building sector emissions in each scenario



* *Step Code 5 for residential buildings and Step Code 4 for non-residential buildings.*

** *Institutional buildings include schools and churches.*

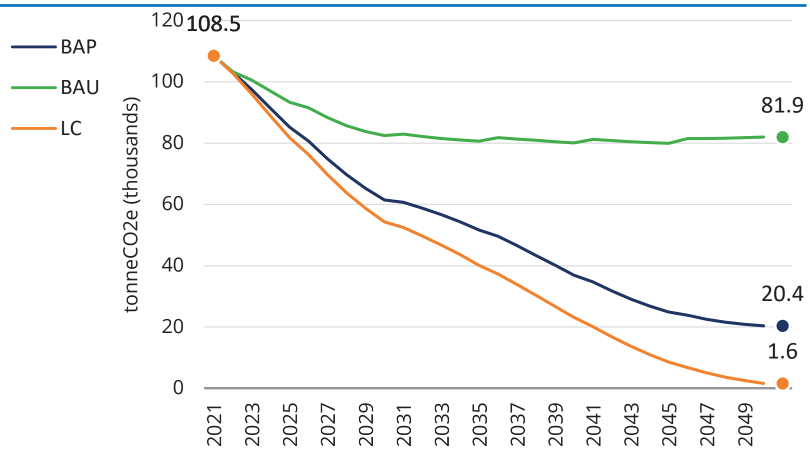
TRANSPORTATION EMISSIONS

Table 9 summarizes the transportation sector modelled targets. Vehicle electrification makes large contributions to emission reductions by 2050 in both the BAP scenario and LCS. Improved transit service and efforts to increase opportunities for active transportation across the District, especially in the LAP neighbourhoods, achieve substantial emission reductions as well*. Emissions from transportation are 2 ktCO_2e by 2050 in the LCS, a 99% reduction from 2021 levels (Figure 24). By 2050, transportation measures will achieve over 80 ktCO_2e of annual emissions reductions in the LCS compared to what they would be without taking any actions (i.e. BAU scenario)**.

TABLE 9: **Summary of key targets supporting transportation sector emission reductions**

	BAU	BAP	LCS
expand transit	service correlates with population and employment growth	Translink plans: expand transit through higher occupancy rates and added service	transit services increase in-line with LAP population and density growth
electrify transit	none	Follows Translink's Low-carbon Fleet Transition Plan	
municipal ZEVs	none	West Vancouver fleet strategy: 33–50% electric by 2030	West Vancouver fleet strategy: 100% ZEV by 2040
walking & rolling infrastructure	no additional efforts	Direction in LAPs provide new infrastructure for active transportation trips	
personal EVs	no change	2026: 26% of new vehicle sales (CleanBC Roadmap) 2030: 90% of new vehicle sales (CleanBC Roadmap) 2035: 100% of new vehicle sales (Federal)	
commercial EVs	no change	10% of new vehicles are EVs; 16% of new vehicles use CNG by 2030	100% of all new vehicles are zero-emissions by 2050
vehicle efficiencies	federal standard.	emissions intensity for new light duty vehicles declines 10% to 105g/km by 2030; for new HDV declines 20% by 2025 and 24% by 2030 (relative to 2015)	

FIGURE 24: **Total transportation sector emissions in each scenario**



* *These transportation mode switch actions are generally preferred over zero emission vehicle solutions as they have far greater socio-economic co-benefits.*

** *It is anticipated that by the 2030s, ZEV and renewable fuel solutions will be more widely available for medium and heavy duty vehicles.*

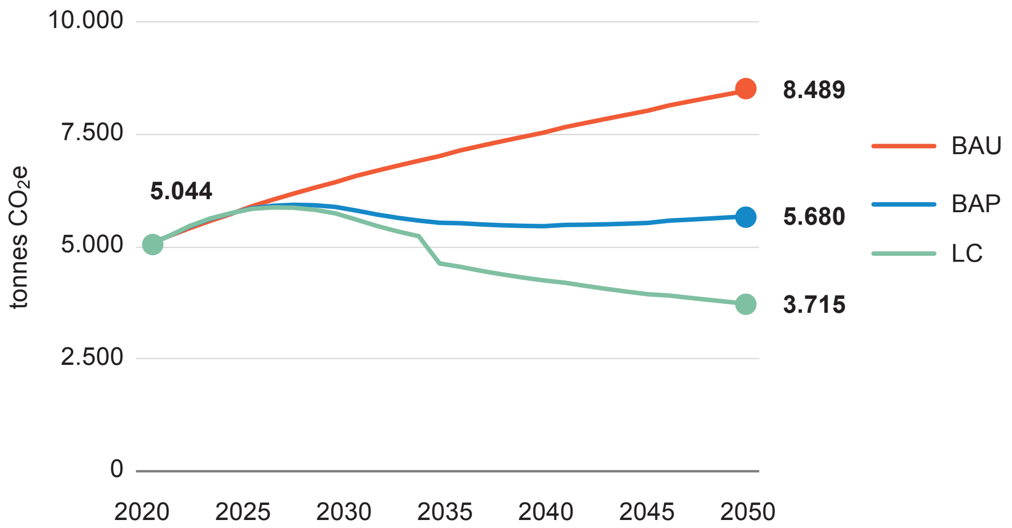
WASTE EMISSIONS

Waste relates to a number of environmental challenges, including emissions from upstream materials extraction, manufacturing and processing, and downstream pollution and environmental degradation. Emissions from waste (mostly from methane from landfills) represented less than 2% of total emissions in West Vancouver in 2021. Although this is a small portion of the emissions profile, one tonne of methane creates 86 times the global heating impact compared to one tonne of CO_2. As the population grows, emissions from waste are anticipated to increase by 68% by 2050, making waste reduction important for emissions reduction. Diversion of residential organic and wood waste, deeper reductions and diversion of construction and commercial waste, and increased landfill methane capture can greatly limit emissions from waste (Table 10). Emissions from waste are 3.7 $ktCO_2e$ by 2050 in the LCS, a 26% reduction from 2021 levels (Figure 25). By 2050, waste reduction and diversion measures will achieve almost 5 $ktCO_2e$ of annual emissions reductions in the LCS compared to what they would be without taking any actions (i.e. BAU scenario).

TABLE 10: Summary of key targets supporting solid waste sector emission reductions

	BAU	BAP	LCS
solid waste measures	waste generation scales with population growth no additional diversion efforts	waste generation scales with population growth 95% organics diversion (CleanBC)	• waste generation scales with population growth • 100% residential organics diversion • 100% methane capture from landfills • 50% of commercial & construction waste will be diverted by 2050 compared to 2016 levels • 100% wood waste diversion target by 2050

FIGURE 25: Total waste sector emissions in each scenario



ENERGY & EMISSIONS OUTLOOK SUMMARY

Despite a declining trend in energy use and GHG emissions by 2030, without substantial efforts to reduce energy demand, mode switch travel, and fuel switch, energy use (Figure 26), and GHG emissions (Figure 27) will increase substantially by 2050, as demonstrated in the BAU scenario. The BAP scenario shows the effectiveness of CleanBC measures implemented in West Vancouver, as well as the District's own land use planning measures. Total energy use and emissions decrease across the community, although the District's 2030 and 2050 emission reduction targets are not met. Additional measures and increased ambition in some measures achieve the 2030 and 2050 targets, as demonstrated by the LCS. Measures taken in the LCS result in 60% less energy consumption than in the BAU scenario in 2050.

FIGURE 26: Scenario modelling total energy use comparison

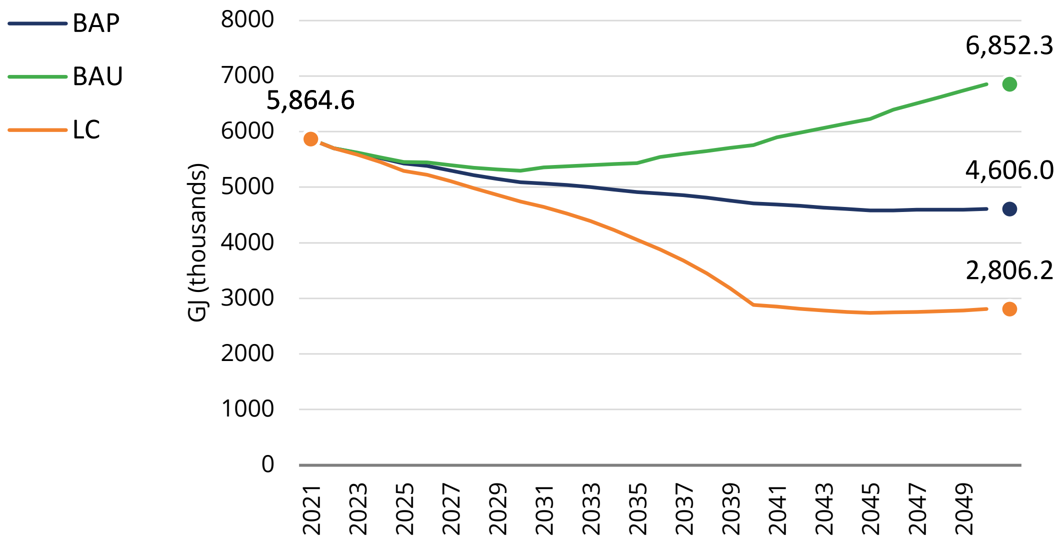
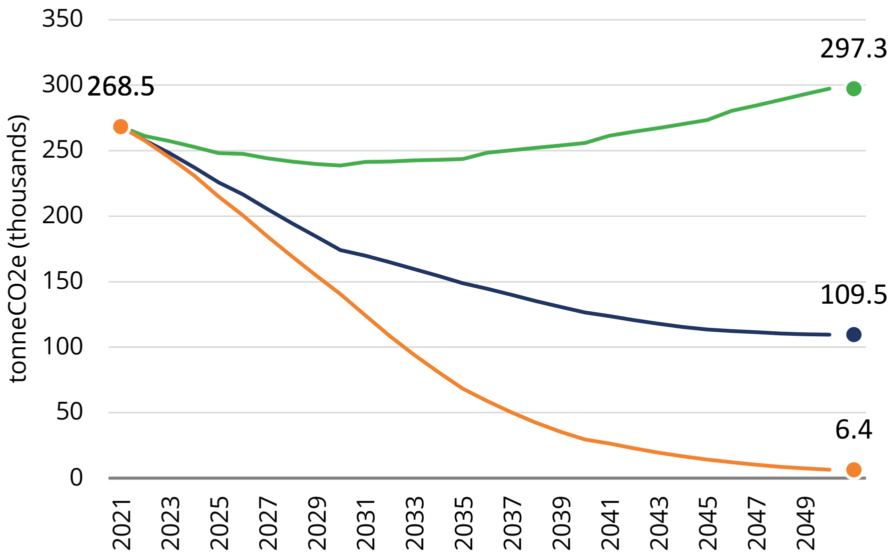


FIGURE 27: Scenario modelling total emissions comparison



The emission wedge diagrams (Figures 28 and 29) visualize how the modelled climate measures each reduce emissions over time in the BAP scenario versus the LCS. The grey area represents remaining carbon liability. As climate change impacts incur various social, economic, and environmental costs, the greater the remaining emissions, the greater the community's liability. The LCS wedge diagram demonstrates that although current local and provincial measures and commitments are effective at reducing emissions, additional measures are needed to meet the emission reduction targets required to avoid catastrophic climate change impacts.

FIGURE 28:

Cumulative emission reductions by action for the BAP

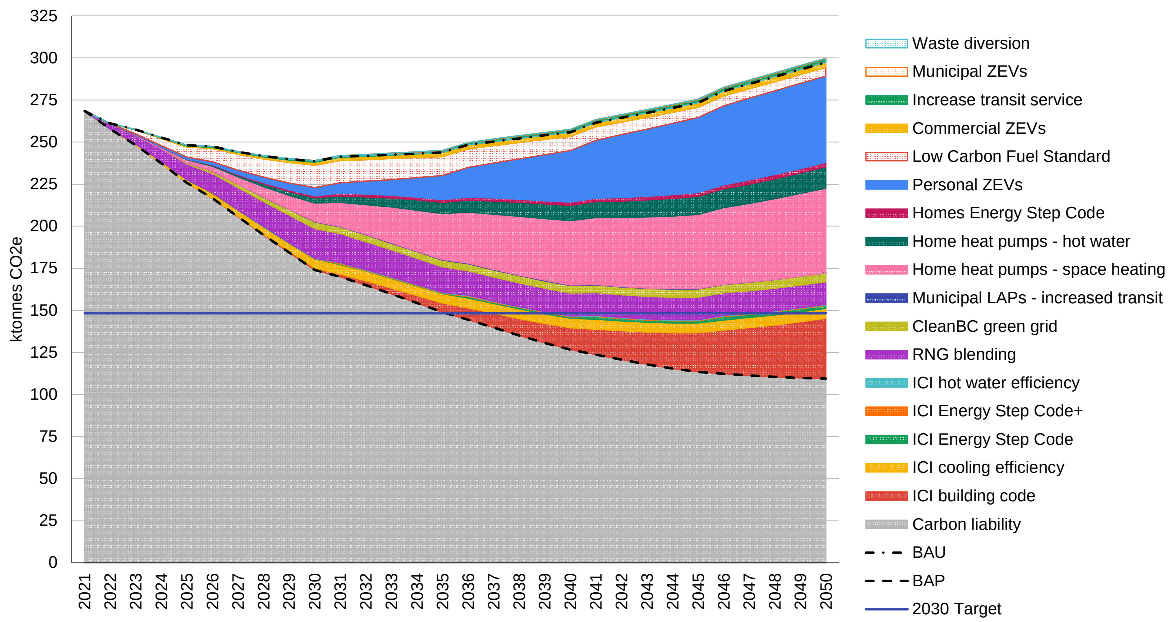
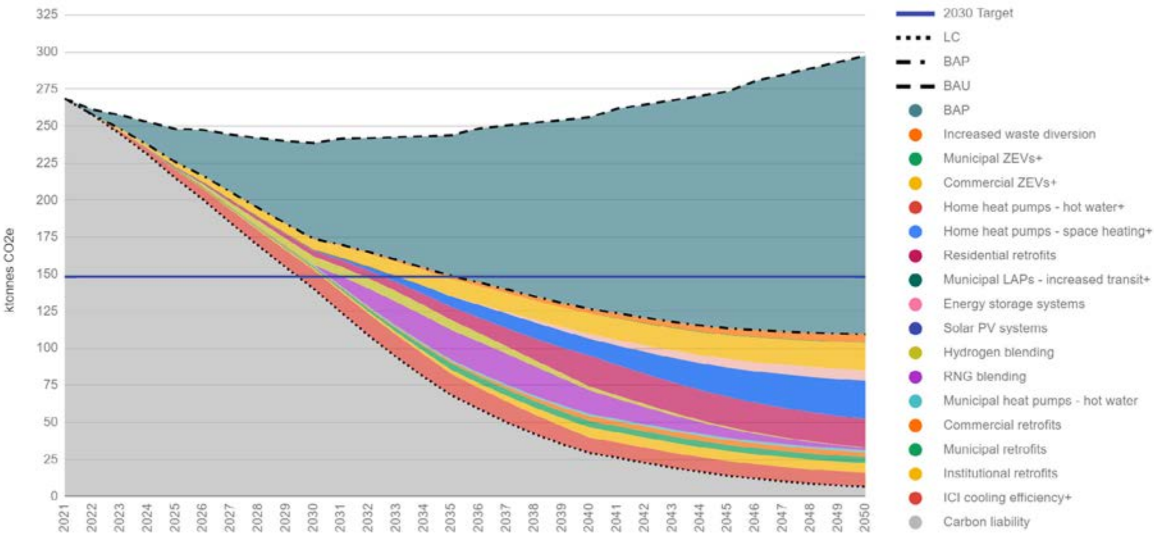


FIGURE 29:

Cumulative emission reductions by action for the LCS *(low-carbon scenario)* beyond the emissions reductions through the Business-as-Planned actions



PART 4: FINANCING THE LOW-CARBON TRANSITION

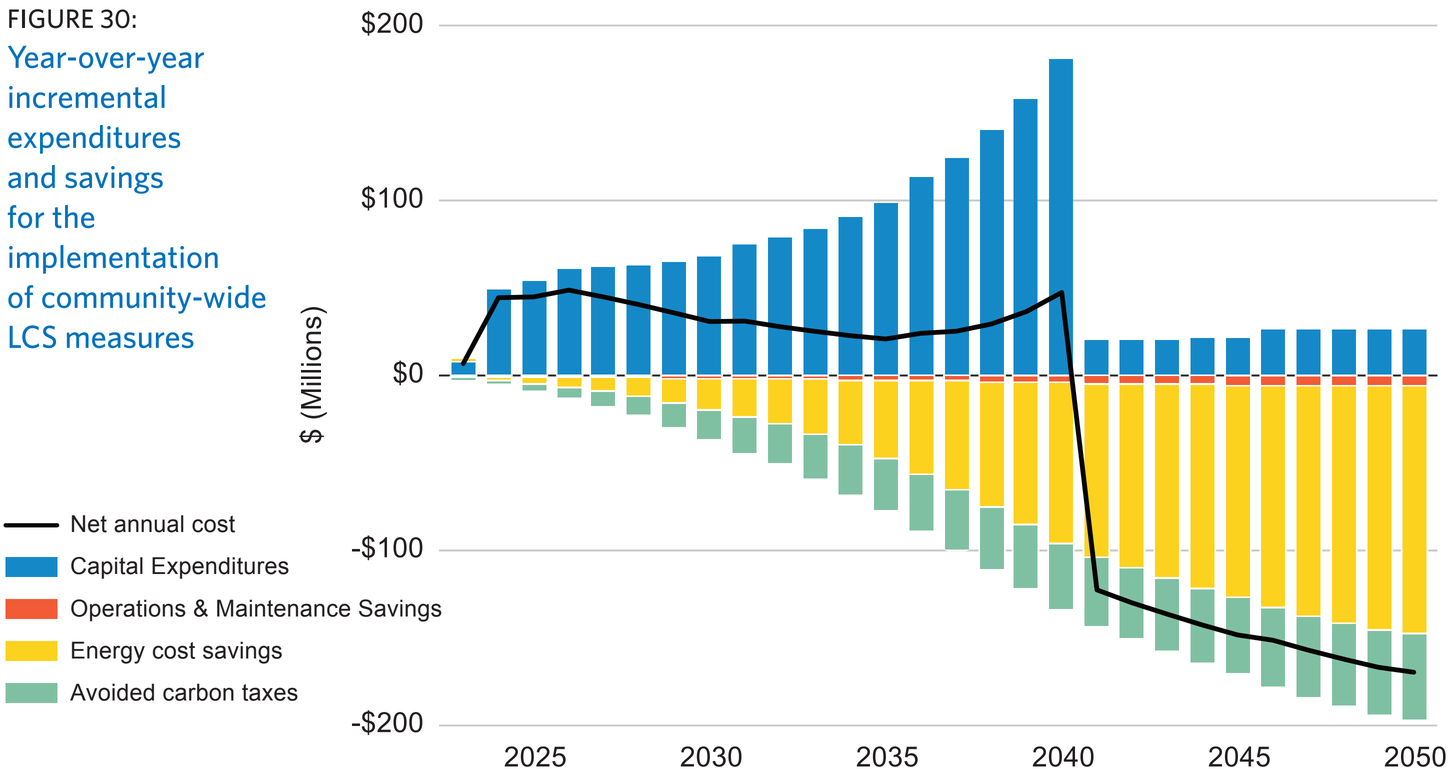
PART 4: FINANCING THE LOW-CARBON TRANSITION

What will the low-carbon transition of West Vancouver cost? High-level modelling reveals the financial implications of LCS measure implementation. Expenditures, savings, net present value, and employment were determined for LCS measures implementation as compared to the BAU scenario (i.e. expenditures, savings, and employment from BAP scenario and LCS measures are additional to those incurred in the BAU scenario). The expenditures and savings modelled represent those incurred across the municipal, private, and public sectors and not borne by the District alone. Savings consider capital expenditures, operating and maintenance costs (including fuel and electricity), and carbon pricing.

TOTAL EXPENDITURES & SAVINGS

Figure 30 summarizes modelled annual LCS measures costs and savings over those in the BAU scenario. Costs vary year-over-year as investments in transit vehicles, active transportation infrastructure, District fleet, building retrofits, and other elements are made. Expenditures fall dramatically after 2040 as most measures are completed by then.

FIGURE 30:
Year-over-year incremental expenditures and savings for the implementation of community-wide LCS measures



As building's energy systems electrify and vehicles become more efficient and powered by electricity, operations and maintenance savings grow (electric systems and vehicles require less maintenance). More efficient buildings and vehicles save on energy costs. Increased transit use and active transportation (more affordable trips than those made by car) also decrease transportation costs. Some energy generation sales are realized by solar PV installations.

Carbon pricing escalates from its current value of $65/tonne to $170/tonne in 2030. It is assumed this value stays constant to 2050. As the pricing escalates, decreasing natural gas use in homes and vehicles saves more and more.

The black trend line in Figure 30 shows the sum of expenditures and savings/avoided costs—the net annual cost. It indicates that the modelled break-even point across all actions investments is 2040, once most measures conclude. Some expenditures continue past 2040, but the overall savings and avoided costs of the measures significantly outweigh previous and continued investments. Savings and avoided costs are primarily realized by those making the expenditures: vehicle owners, home and building owners, the municipality, etc.

Total modelled expenditures and savings are summarized in Table 11. Modelled savings from reduced operations and maintenance costs, energy cost savings, and avoided carbon taxes demonstrate potential to achieve a net savings of $286.1 million over the next 26 years. BAP scenario measures save the majority in O&M costs and carbon taxes. This is mostly due to ZEV measures in that scenario —ZEVs are low-maintenance and greatly reduce fuel use (thus avoiding carbon taxes on fuel purchases). LCS measures achieve greater energy cost savings. This is primarily due to the increased ambition in energy efficiency measures in new and existing buildings.

TABLE 11: Summary of modelled emission reduction measures' expenditures & savings

	BAP MEASURES net present value	**LCS MEASURES** net present value	**BAP+LCS MEASURES** net present value
capital expenditures	$112.8M	$1,127.0M	$1,239.9M
O&M savings	-$48.9M	-$16.4M	-$65.3M
energy cost savings	-$416.2M	-$584.8M	-$1,001.0M
avoided carbon taxes	-$277.8M	-$181.9M	-$459.7M
TOTAL	**-$630.1M**	**-$343.9M**	**-286.1M**

CARBON BUDGET & ACCOUNTING FRAMEWORK

A carbon budget is an accounting system that municipalities can use to help ensure it is making progress toward its emission reduction targets while making decisions that are informed through a climate lens. The carbon budget embeds emission reduction targets, measures, and considerations into decision-making as part of a municipality's ordinary budgeting process.

Setting up a carbon budget involves establishing the limit of carbon emissions that can ever be produced by a community if we are to stay within +1.5°C of global heating (the scientifically-determined limit beyond which the climate emergency transitions into catastrophic climate impacts). This community emissions limit is the total carbon budget. It is assigned a timeline, for example to 2050, and the total carbon budget over this period is divided into annual limits. This is the carbon accounting framework: the year-over-year carbon limits the municipality must not exceed to meet its climate action commitments.

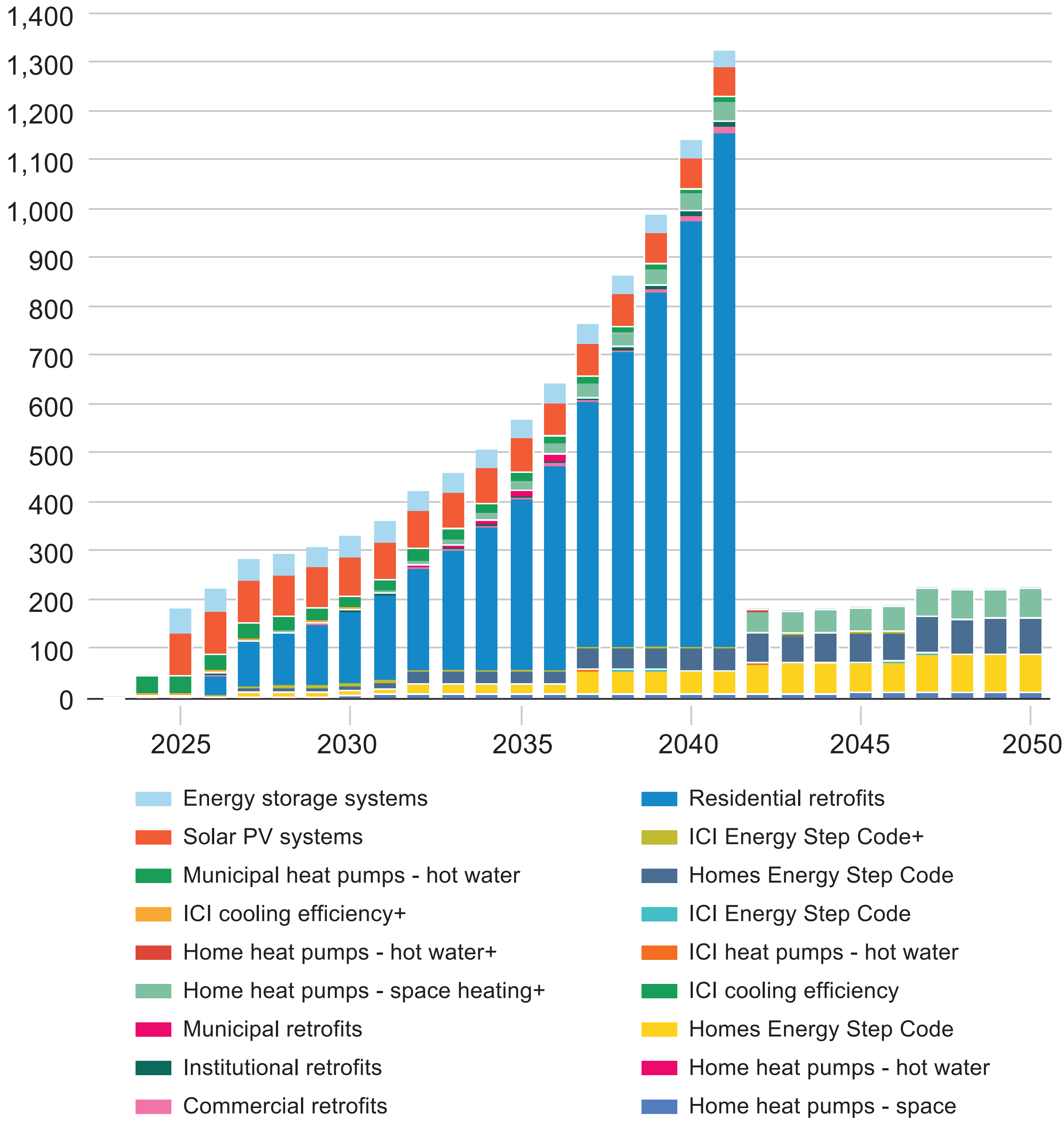
As part of staying within the annual and total carbon budget, proposed projects for buildings, transportation, infrastructure, waste, energy, etc. are assessed for their potential emissions production. The assessment determines the project parameters required to ensure its implementation does not exceed annual and total carbon budgets.

Such a framework is a critical tool to tracking municipal progress toward its emission reduction targets while ensuring new projects do not add to the emissions burden. Creating a carbon budget and accounting framework is an important next step in West Vancouver's climate action planning trajectory.

EMPLOYMENT

Many of the expenditures required to implement the measures are accompanied by employment gains. High-level employment modelling of LCS building sector measures indicates that 11,500 person-years employment will be generated in addition to any employment gains in the BAU reference scenario (Figure 31). New jobs are required to meet the demands of energy efficiency home construction, heat pump and solar PV system installations, and building retrofitting measures. The demand for most of these jobs declines as building measures are completed by 2040. Without these additional jobs, implementing the measures to the level of ambition sought will be very challenging. There is an amazing opportunity in West Vancouver to provide new jobs over the next few decades in the energy efficient building sector.

FIGURE 31: Person years of employment based on expenditures of LCS building sector measures



PART 5:
CO-BENEFITS TO ACTION

PART 5: CO-BENEFITS TO ACTION

This strategy focuses on measures that mitigate GHG emissions across the District of West Vancouver in an effort to do our part to meet scientifically determined GHG emission reduction targets that, if achieved, will help avoid the most dangerous impacts of human-caused climate change.

Evidence shows that carefully planned climate action can result in a snowball effect of positive outcomes, including reduced air pollution, expanded job creation, reduced inequality and improved public health and quality of life*. The District, Metro Vancouver, and the provincial government are working to enable the implementation of many emission reduction measures, with homeowners, commuters, residents, and businesses absorbing the benefits, including enhanced social health and well-being, economic outcomes, and environmental conditions.

SOCIAL HEALTH & WELL-BEING

The actions outlined in this strategy help to reduce GHG emissions through electrification of fleet vehicles, improvements to active public transportation and infrastructure, supporting high-efficiency building retrofits, electrification of heating and cooling systems, and climate-forward land use planning. These actions provide mental health, physical health, community cohesion, and sense of place and pride co-benefits. These can include, but are not limited to, reduction of harmful indoor and outdoor air pollution, improved community extreme heat preparedness, reduction in traffic congestion and noise pollution, expansion of equitable greenspace, as well as healthy, more social and accessible commuting options.

ECONOMIC OUTCOMES

Undertaking investments to reduce GHG emissions can help communities avoid and mitigate expensive physical damage and losses from climate impacts (e.g. extreme weather events, wildfire, flooding, sea level rise, heat strain on infrastructure). The benefits of transitioning to a low-carbon economy and high efficiency systems can foster economic generation through job creation, operational cost savings, as well as fostering leadership and influence toward circular economy practices that reduce resource demand and GHG emissions.

ENVIRONMENTAL CONDITIONS

Implementing the CAS will work to preserve, protect, and enhance our natural assets and air quality. Through urban forest management, foreshore planning, wildfire management, watercourse protection, switching to clean energy, and nature-based solutions, community exposure and vulnerability to extreme weather, urban heat island effects, and stormwater impacts are reduced.

Table 12 summarizes a variety of co-benefits associated with the measures identified in this strategy.

* *Climate action has valuable health benefits. Journal of the International Society for Environmental Epidemiology. February 2024.* *journals.lww.com/environepidem/fulltext/2024/02000/climate_action_has_valuable_health_benefits.9.aspx*

These are just some of the key co-benefits to be realized through the implementation of measures in this strategy. The measures reduce climate change impacts, increase public health, equity and quality of life, save money, and avoid the high costs of inaction, making them highly compelling

TABLE 12: Some co-benefits of *Climate Action Strategy* measures

MEASURES	CO-BENEFITS
BUILDINGS & LAND USE	
• build new buildings to net-zero standards • retrofit existing buildings • switch to electric heating and cooling systems • switch to electric water heating systems	• improved housing quality and indoor and outdoor comfort • improved indoor air quality • reduced noise pollution due to improved building insulation and high-performance windows • reduced energy bills and vulnerability to energy price fluctuations • new investment opportunities in retrofits and new builds • job creation • improved comfort during heat waves, especially for vulnerable segments of the populations such as the elderly and young children
Local Area Plans	• improved extreme weather event resilience through equitable design for reduced urban heat island effects, stormwater infiltration (e.g. bioswales), and tree plantings • affordable housing options through a conscious mixture of housing types and tenancy options • increased amenities and shopping choices • increased social interaction opportunities • increased choice of transportation options *(walk, bike, roll, transit, vehicle, etc.)* • opportunity to create more greenspace through more condensed neighbourhoods

MEASURES	CO-BENEFITS
TRANSPORTATION	
• electrify public transit • electrify municipal fleet • electrify personal and commercial vehicles	• reduced nitrogen oxide and particulate matter pollution in the air • improved local air quality results in better respiratory health outcomes, especially for young children and elderly • reduced traffic-related noise pollution results in better mental health outcomes like lower stress levels • as fossil fuel prices increase, electricity use saves household and business costs • urban tree growth and health improves as air pollution is reduced
• increase active transportation infrastructure	• biking and walking paths that are well-lit and protected make it safer to move around in the community • increased physical activity and positive health outcomes • increased opportunities for social interaction • improved productivity and mental health outcomes with less time spent in traffic • reduced wear and tear on road infrastructure • increased choice for how to get around • reduced vehicle-related injury and fatality rates
• improve transit services • increase transit ridership	• commuting requires some physical activity to reach the closest transit stop, resulting in improved health outcomes • increased opportunities for social interaction • household transportation cost savings as transit use is cheaper than vehicle ownership/use • reduced time spent in traffic • reduced wear and tear on road infrastructure • potential to reclaim street space for green space
WASTE	
• increase waste diversion through recycling and composting	• improved outdoor air quality from less organic decay in landfills • innovation and new businesses from circular economy opportunities • reduced reliance on new, raw materials • job creation • encourages social responsibility • potential for households to reduce spending • improved habitat and biodiversity conservation

PART 6: CLIMATE EQUITY

PART 6: CLIMATE EQUITY

Community systems, planning, and policy can play an integral role in shaping community wide social determinants of health and community equity. As climate change impacts magnify across a community, existing inequities, vulnerabilities, and barriers that affect individuals' or community capacity to navigate climate challenges can intensify. Engaging a diversity, equity, and inclusion (DEI) lens in community climate planning can meaningfully mitigate and address root causes of community vulnerabilities amid climate change.

Implementing the CAS through this lens may look like expanding safe, affordable, energy efficient housing, providing support for heat pump installations, conserving and ensuring equitable access to public green space, building safe pedestrian and cycling infrastructure, increasing public transit access, growing community food gardens, creating accessible and purpose-built community spaces to foster community cohesion, and addressing governance and community systems that perpetuate inequity and oppression. With cultural, traditional and enduring linkages to land, air, water and living landscapes, Indigenous communities face historical, additional, and unique impacts from a changing climate that must be considered when taking action. The District will implement CAS measures that support vulnerable and disproportionately impacted communities to ensure equitable distribution of the measures' costs and benefits.

IDENTIFYING & BUILDING CLIMATE EQUITY

Disproportionately impacted and equity seeking communities can include but are not limited to the identified groups below, with an understanding that each community is unique and experiences marginalization differently, as do individuals within these communities*.

- Indigenous, Black, and other racialized peoples
- migrants and refugees
- people with limited English-speaking ability
- people with disabilities
- 2SLGBTQIA+ people
- children and youth
- women and girls
- and more

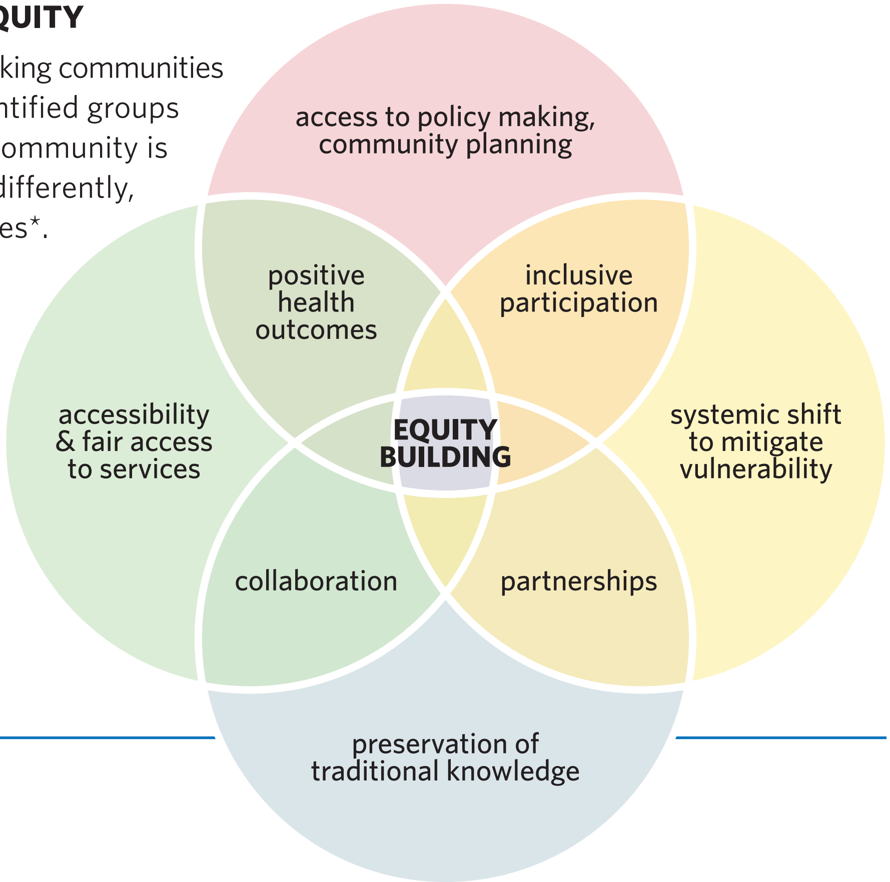


FIGURE 32: Climate equity overview

* *Vancouver Climate Justice Charter.* *vancouver.ca/files/cov/climate-justice-charter-vancouver.PDF*

UNDERSTANDING INEQUITY AND CLIMATE CHANGE

EXTREME HEAT

Extreme heat is a growing local issue, as shown with events like the 2021 heat dome resulting in 619 heat-related deaths within BC. Extreme heat events are predicted to magnify during summer months. High indoor temperatures, especially in homes without air conditioning, and on higher floors, are a major cause of negative health impacts during extreme heat events. Older adults, infants and young children, people who are pregnant, people with chronic conditions, people with disabilities, people on certain medications, people experiencing homelessness and/or poverty, people living alone, and people who work or exercise outdoor are especially sensitive and vulnerable to the health effects of heat.

WILDFIRE & AIR QUALITY

Over recent years, West Vancouver has endured wildfire threat and smoky air. A warmer, drier climate increases the frequency and severity of wildfire, as well as the length of fire season. Exposure to wildfire smoke is found to have increasing negative effects on population health. Additionally, air pollution from fossil fuel emissions has been identified as causing over 7 million premature deaths globally each year. Fossil fuel emissions like ground level ozone are found to have a wide array of public health impacts including asthma, lung disease, heart disease, stroke, cancer, dementia and more. Older adults, infants, young children, pregnant people, people with existing respiratory conditions, outdoor workers and the unhoused are especially susceptible to the health effects of poor air quality.

PART 7: IMPLEMENTATION

PART 7: IMPLEMENTATION

A detailed implementation framework is provided in Appendix 1, which includes priority measures, implementation timelines, associated costs, and possible external funding support to reduce corporate and community GHG emissions. The framework includes measures under the Business-As-Planned scenario and additional measures under the Low Carbon Scenario that will achieve the District's emission reduction targets. The following sections provide a summary of the priority measures, the District's influence of these measures, and the associated co-benefits.

DISTRICT POLICIES & REGULATIONS

The CAS provides direction on policy or regulatory updates that can support achieving the District's emission reduction targets. Municipal policies require review of, revision of, and updates to existing policies, which can take time, depending on the complexity of the policies. The Local Area Plans included in the measures assessment in this strategy are approved or underway. Other policy updates—including accelerated Energy Step Code and Zero Carbon Step adoption, retrofitting of existing buildings, and waste diversion policies—need to be expedited if they are to be implemented in time to achieve targets. Appropriate District departments will be coordinated in these efforts. Climate action commitments in regional government strategies like Metro Vancouver's Climate 2050 and provincial strategies like Clean BC have bearing on the District's climate action efforts. These directions can benefit West Vancouver if the contributions of these governments are specified. The District can work more closely with higher levels of government to establish how the District's climate action efforts can best be supported and expedited.

TYING IT ALL TOGETHER: social health & well-being: ♥ economic outcomes: $ environmental conditions: 🌍

MEASURE	MEASURE TYPE	SCOPE OF INFLUENCE	CO-BENEFITS	♥ $ 🌍
Energy Step Code and Zero Carbon Step Code	reduce improve	direct control	improved housing quality	♥
			improved air quality	♥ 🌍
			reduced energy costs & vulnerability to energy price fluctuations	$
			job creation	$
			reduced fossil fuel use	♥ 🌍
Existing building retrofits and heat pump installations	reduce improve switch	indirect control	improved indoor comfort and air quality	♥
			improved extreme heat preparedness	♥
			increased energy efficiency	$ 🌍
			reduced fossil fuel use	♥ 🌍
			job creation	$
expand intergovernmental partnerships to expedite climate action	improve	direct control	increased capacity for climate change action mobilization	$

DISTRICT MEASURES

The District can lead by example in its climate action efforts. Energy efficiency upgrades and electrification of District buildings and facilities can get underway immediately with energy assessments and retrofit planning, led by the Facilities & Assets Department. The West Vancouver Fleet Strategy can be updated with direction from the CAS and fleet transition to zero-emissions vehicles can be expedited, while understanding that market availability for larger fleet vehicles will influence the timing of full transition. A strategy or framework should also be developed to look at public EV charging needs to support residents with the transition to EVs, particularly those residents in multi-family buildings where charging capabilities may be limited. Similarly, the District's field equipment (e.g. lawn mowers, landscaping equipment) can transition to zero-emissions models. Fleet and equipment transitions can occur in concert with neighbouring and regional governments (Metro Vancouver), with procurement departments coordinating bulk purchases to reduce capital costs. The District's annual budget will need to be updated with these elements.

In some areas, West Vancouver's terrain provides a challenge to active transportation infrastructure. Luckily, increasingly efficient, compact, and inexpensive battery technologies are enabling micro mobility options like e-bikes, e-skateboards, e-scooters, and other vehicles. Electrified transportation options enable the community to diversify how people can get around, giving residents more choices, especially for the short trips that make up the majority of outings. The District can support these and other modes of active transportation by providing appropriate infrastructure. Separated bike lanes and sidewalks are invariably the top choice. The safety they provide is the key to increasing active transportation adoption.

TYING IT ALL TOGETHER: social health & well-being: ♥ economic outcomes: $ environmental conditions: ♻

MEASURE	MEASURE TYPE	SCOPE OF INFLUENCE	CO-BENEFITS	♥ $ ♻
energy efficiency upgrades on District buildings & facilities	reduce improve switch	direct control	decreased fossil fuel dependency	$ ♻
			operational savings due to lower energy use	$
			enhanced resiliency to disruption due to climate impacts	♥ $
			exhibits leadership for sustainability	$ ♻
fleet & equipment transition	improve switch	direct control	improved air quality	♥
			reduced noise pollution	♥
			reduced fossil fuel use	$ ♻
			labour improvements	♥
infrastructure upgrades for active and electrified transportation	improve	direct control	increased capacity for community mobilization	♥ $
			improved physical and mental health	♥
			improved air quality	♥ ♻
			savings associated with reduced vehicle use	$
			reduced fossil fuel dependency	$ ♻

HOME MEASURES

Market forces and federal and provincial programs are driving some energy efficiency upgrades in the housing sector, but District efforts can greatly accelerate the transition. Perhaps the most effective implementation measure would be to establish staff positions to coordinate District, provincial, and federal grant and incentive programs, as well as utility programs, for residents. These positions would provide navigation and coordination services to residents to maximize their support for home retrofits, removing barriers and inertia to access these programs. The staff could promote this service through a communications and education program (e.g. continuation and expansion of the Jump on a Heat Pump program). The program could include home envelope upgrades, HVAC system transitions, heat pump installation, energy generation systems (e.g. solar PV), and EV charging systems.

Improved recyclable materials and organics diversion requires expanding current waste collection practices and services. The District can coordinate with Metro Vancouver on delivering its Solid Waste Management Plan to improve curbside waste separation, engagement with Industrial, Commercial, and Institutional (ICI) entities, and engagement with multi-unit buildings in improving diversion rates. Strategizing with waste haulers and the regional landfill will also be required. In addition, demolition waste diversion and reuse practices could be improved to minimize waste going to landfills.

TYING IT ALL TOGETHER: social health & well-being: ♥ economic outcomes: $ environmental conditions: ♻

MEASURE	MEASURE TYPE	SCOPE OF INFLUENCE	CO-BENEFITS	♥ $ ♻
expand support and services to maximize existing home retrofits and heat pump uptake	improve	direct control	job creation	$
			exhibits leadership toward sustainability	$
			expands community climate equity and inclusion	♥
			builds awareness of energy efficiency strategies to reduce energy use	$ ♻
community and demolition waste diversion	reduce improve	indirect influence	reduced strain on landfills	♻
			increased circular economy	$
			increased resources efficiency	$ ♻
			reduced local waste pollution	♥ ♻

INDUSTRIAL, COMMERCIAL & INSTITUTIONAL SECTOR MEASURES

As housing makes up the majority of the District's land use footprint, attention to the institutional, commercial, and industrial sector is often low priority. Although West Vancouver has little in the way of industrial entities, it is one of the largest operators of ICI facilities (e.g. school district facilities) and many commercial and retail outfits serve the community. The District can coordinate with the West Vancouver Chamber of Commerce as well as business improvement associations and engage directly with businesses to support them with upgrading buildings, transitioning to ZEV fleets, and improving waste diversion. Evolving these relationships to encourage implementing actions through a climate lens will align the whole community in working toward a better, more secure, and sustainable future.

TYING IT ALL TOGETHER: social health & well-being: ♥ economic outcomes: $ environmental conditions: ✣

MEASURE	MEASURE TYPE	SCOPE OF INFLUENCE	CO-BENEFITS	♥ $ ✣
coordinate with businesses to support energy upgrades and building retrofits	improve	indirect influence	decreased fossil fuel dependency	$ ✣
			long term operational savings due to lower energy use	$
			enhanced resilience to climate impacts	♥ $
			exhibits leadership for sustainability	$ ✣
support transition of commercial fleets and equipment	improve switch	little influence	improved air quality	♥
			reduced noise pollution	♥
			reduced fossil fuel use	$ ✣
			labour improvements	♥

PART 8: IN CLOSING

PART 8: IN CLOSING

West Vancouver's CAS maps a pathway to reduce emissions to respond to the District's 2019 climate emergency declaration. The analysis presented here demonstrates that local climate measures are required in addition to those of higher-level governments to achieve the emission reductions targets necessary to avoid catastrophic climate change impacts.

In addition to their emissions reduction benefits, CAS measures reduce community-wide energy use while improving quality of life for all residents. Although ambitious, the measures offer few detriments. There are up-front costs to building owners and vehicle owners, but these are typically offset by grants and incentive programs as well as reduced operating and maintenance costs. Improved comfort, local economic development, and better health and well-being outcomes also accompany the measures.

In coordination with other levels of government, the District will lead and enable local action. District infrastructure upgrades, policy updates, and programs will usher in the low-carbon transition. Inter-departmental coordination and evaluating decisions through an equitable climate lens will ensure consistent, effective measure implementation. Tracking progress and updating approaches, when necessary, will keep the District on track to achieving its emission reduction targets. Through these efforts and those of residents and businesses, West Vancouver stands to foster a climate-safe, sustainable, and resilient future.

GLOSSARY

BC Step Code: The BC Energy Step Code sets building energy efficiency performance requirements for new construction and groups them into "steps." Each step requires increased energy efficiency over the last. Local governments can choose to require or incentivize builders to meet one or more steps of the BC Energy Step Code.

CAFE: Corporate Average Fuel Efficiency standards are US vehicle fuel efficiency requirements that become more stringent over time. Canada's Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations align with these standards.
See US CAFE standards: nhtsa.gov/laws-regulations/corporate-average-fuel-economy.
See Canada's Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations under the Environmental Protection Act: lois-laws.justice.gc.ca/eng/regulations/SOR-2010-201/FullText.html

Carbon dioxide (CO_2): A common gas that is a potent heat trapping agent in the atmosphere if present in high concentrations. CO_2 is emitted from combustion, fermentation, and respiration activities.

Carbon dioxide equivalents (CO_2e): The heat trapping ability of a given gas expressed in terms of how much CO_2 is essential to produce a similar warming effect over the chosen time. It is calculated by multiplying the amount of gas by its accompanying global warming potential. Expressed in tons as tCO_2e and kilotons ($ktCO_2e$). In the US, it is also expressed as metric tons ($MtCO_2e$).

Carbon neutral: Making no net release of greenhouse gasses into the atmosphere, either by reducing emissions to zero or by offsetting emissions.

Climate: The long-term weather patterns of a given location averaged over a period of time, typically 30 years.

Climate action planning: The act of identifying actions to take across socio-economic and community sectors (e.g. buildings, transportation, waste, industry, etc.) to mitigate greenhouse gas emissions, remove harmful emissions from the atmosphere, and adapt to current and anticipated climate change impacts.

Climate adaptation: The process by which built, natural, social, and human systems adjust to actual or expected climate change. Adaptation seeks to manage unavoidable harm.

Climate change: Changes in long-term weather patterns caused by natural phenomena and exacerbated by human activities that alter the chemical composition of the atmosphere by the buildup of greenhouse gasses, which trap heat and reflect it back to Earth's surface.

Climate equity: Ensuring the just distribution of the benefits of climate protection efforts and alleviating unequal burdens created by climate change.

Climate change mitigation: Any activities (e.g. policy, program, regulation, infrastructure, activity, or other project-based measures) that contribute to the reduction of greenhouse gas concentrations in the atmosphere.

Equity seeking communities: Communities and groups that experience significant collective barriers in participating in society. This could include but is not limited to attitudinal, historic, social and environmental barriers based on age, ethnicity, disability, economic status, Indigeneity, gender identity and gender expression, nationality, race, sexual orientation.

Fossil Fuels: Non-renewable, carbon-based fuels from hydrocarbon deposits, including coal, oil and natural gas which are burned as a source of energy.

Global warming potential (GWP): The measure of each greenhouse gas' ability to trap heat in the atmosphere compared to carbon dioxide (CO_2), measured over a specified time.

Greenhouse gas (GHG): A variety of gases whose presence in the atmosphere keeps the Earth's temperature stable. The increased presence of these gases over the past 200 years is causing more heat to be trapped inside the atmosphere, which is generating changes to Earth's climate.

Greenhouse gas intensity: The amount of emissions associated with a certain metric. For example, per the energy use of a square meter of a building; per liter of gasoline burned; per kilowatt-hour of electricity used.

Joules: A joule is a basic unit of energy, equal to the kinetic energy of a kilogram mass moving at one meter per second or the work done on an object by a force of one newton. It is expressed as one thousand joules (kJ), megajoules (one million joules, MJ), gigajoules (one billion joules, GJ), and terajoules (one trillion joules, TJ), and petajoules (one quadrillion joules, PJ).

Kilowatt hour (kWh): The energy delivered by one kilowatt of power for one hour, equal to 3.6 megajoules. Also expressed in megawatt hour (MWh) and gigawatt hour (GWh).

Low-carbon energy system: Energy systems that provide heating, cooling, and sometimes hot water, with limited GHG emissions, typically regulated through a maximum annual emissions per square meter basis.

Methane (CH_4): A colourless, odourless gas that occurs abundantly in nature and as a product of certain human activities. It is among the most potent of the greenhouse gases—28 times more potent than carbon dioxide over the long term (100 years) and 83 times more potent over the short term (20 years).

Net-zero emissions: As defined in the *Canadian Net-zero Emissions Accountability Act*: human caused or influenced (anthropogenic) emissions of greenhouse gasses into the atmosphere are balanced by anthropogenic removals of greenhouse gasses from the atmosphere over a specified period.

Nitrous oxide (N_2O): A colourless gas that is produced from fossil fuel combustion and many fertilizers. It is among the most potent greenhouse gases—265 times more potent than carbon dioxide over 100 years.

Representative concentration pathway: A measure of atmospheric greenhouse gas concentration ranging from stringent (RCP 2.6), intermediate (RCP 4.5), peaking in 2080 (RCP 6), and continuing to increase past 2080 (RCP 8.5).

Renewable natural gas (RNG): Biogas (the gaseous product of the decomposition of organic matter) that has been processed to purity standards and is interchangeable with conventional natural gas.

Social determinants of health: The broad range of personal, social, economic, and environmental factors that determine individual and population health.

Zero Carbon Step Code: A complement to the BC Energy Step Code, the Zero Carbon Step Code requires new buildings to achieve decreasing total GHG emissions production in their operation and heating systems, reaching zero emissions from all new buildings by 2030.

APPENDIX 1: IMPLEMENTATION FRAMEWORK

A. BUSINESS AS PLANNED EMISSION REDUCTION MEASURES: COMMUNITY AND CORPORATE MEASURES IMPLEMENTATION

ACTION	SPECIFICATION	PRIORITY	KEY MEASURES to monitor & report	CUMULATIVE EMISSIONS REDUCTIONS ($ktCO_2e$)	CUMULATIVE ENERGY REDUCTIONS (million GJ)	START DATE	END DATE	RESPONSIBLE/ROLE
BUILDINGS								
New Residential Building Code Standards	Follow BC Step Code: By 2030, 20% more efficient By 2027, 40% more efficient By 2032, 80% more efficient	high	12,000 buildings	366	16	2024	2030	REGULATORY ROLE: DWV *(Planning, Development & Environmental Services)* IMPLEMENTATION ROLE: home and MURB owners, stratas
New Non-Residential Building Code Standards		moderate	1,010 buildings	31	1	2024	2030	REGULATORY ROLE: DWV *(Planning, Development & Environmental Services)* IMPLEMENTATION ROLE: business owners, business associations, Park Royal
Transition to heat pumps for residential space conditioning and water heating	160,000 new residential heat pumps installed province-wide (1,400 for West Vancouver).	high	12,000 heat pumps	950	4	2024	2030	FACILITATOR/SUPPORT ROLE: DWV *(Planning, Development & Environmental Services, Environment Committee)* IMPLEMENTATION ROLE: home and MURB owners, stratas
Transition to heat pumps for non-residential space conditioning and water heating	53 million m^2 commercial floorspace heated by heat pumps province wide (0.47 million m^2 heated by heat pumps in West Vancouver).	moderate	1,010 buildings	148	2	2024	2030	FACILITATOR/SUPPORT ROLE: DWV *(Planning, Development & Environmental Services, Environment Committee)* IMPLEMENTATION ROLE: business owners, business associations, Park Royal
TRANSPORTATION								
Increase transit ridership	Translink plans: expand transit through higher occupancy rates and extra service.	moderate	200,000 km	27	0.05	2024	2040	IMPLEMENTATION ROLE: DWV (*Engineering Services, West Vancouver Transit*), Translink
Electrify personal use vehicles	By 2026, 26% of total sales By 2030, 90% of total sales By 2035, 100% of total sales	high	29,000 vehicles	635	6	2024	2035	ADVOCACY/FACILITATOR ROLE: DWV *(Planning, Development & Environmental Services, Environment Committee)* IMPLEMENTATION ROLE: Province, residents, local point of sale dealerships
Zero emission commercial use vehicles	By 2030, of total car sales: 10% are electric 16% are natural gas	low	N/A	65	0.5	2024	2035	ADVOCACY/FACILITATOR ROLE: DWV (*Planning, Development & Environmental Services, Engineering Services, Purchasing Department)* IMPLEMENTATION ROLE: Province, commercial companies, local point of sale dealerships
Electrify municipal vehicles	WestVan fleet strategy, 33-50% of fleet electric by 2030.	moderate	99 vehicles	7	0.05	2024	2030	IMPLEMENTATION ROLE: DWV (*Planning, Development & Environmental Services, Engineering Services -fleet, Facilities Department, Financial Services)*
Low Carbon Fuel Standard	Emissions intensity of new Light Duty Vehicle declines over 10% to 105g/km in 2030, relative to 2015. Emissions intensity of new Heavy Duty Vehicle declines 20% by 2025 and 24% by 2030, relative to 2015.	moderate	N/A	239	0	2024	2035	FACILITATOR ROLE: DWV *(Engineering Services)* IMPLEMENTATION ROLE: Province
ENERGY								
Net Zero Provincial Grid	Net-zero electricity generation by 2030.	low	N/A	104	0	2024	2030	ADVOCACY/FACILITATOR ROLE: DWV (*Planning, Development & Environmental Services, Purchasing Department, Facilities Department, Financial Services)* IMPLEMENTATION ROLE: BC Hydro
Blend RNG into NG	RNG in natural gas supply increases to 15% by 2030.	moderate	10,900 m^3	382	-0	2024	2030	ADVOCACY/FACILITATOR ROLE: DWV IMPLEMENTATION ROLE: utility companies
WASTE								
Waste Diversion Targets	CleanBC - 95% organics diversion.	low	6,400 tonnes composted	41	0	2024	2030	IMPLEMENTATION ROLE: DWV, MetroVancouver

B. BUSINESS AS PLANNED FINANCIAL IMPLICATIONS: COMMUNITY & CORPORATE MEASURES IMPLEMENTATION

ACTION	SPECIFICATION	TOTAL INVESTMENT in millions (discounted @3%)	TOTAL RETURN	NET PRESENT VALUE in millions (*cost is positive; savings are negative*)	LOCAL JOB YEARS CREATED	MARGINAL ABATEMENT COST ($/$tCO_2e$)	POTENTIAL FUNDING SOURCES
BUILDINGS							
New Residential Building Code Standards	Follow BC Step Code: By 2030, 20% more efficient By 2027, 40% more efficient By 2032, 80% more efficient	$69	-$344	-$275	935	-$857	
New Non-Residential Building Code Standards		$6	-$18	-$12	85	-$534	
Transition to heat pumps for residential space conditioning and water heating	160,000 new residential heat pumps installed province-wide (1,400 for West Vancouver).	$20	-$271	-$251	196	-$264	Canada Greener Homes Loan
Transition to heat pumps for non-residential space conditioning and water heating	53 million m^2 commercial floorspace heated by heat pumps province wide (0.47 million m^2 heated by heat pumps in West Vancouver).	$4	-$23	-$19	25	-$125	Business energy-saving incentives (bchydro.com)
TRANSPORTATION							
Increase transit ridership	Translink plans: expand transit through higher occupancy rates and extra service.	N/A	N/A	N/A	N/A	N/A	
Electrify personal use vehicles	By 2026, 26% of total sales By 2030, 90% of total sales By 2035, 100% of total sales	$39	-$470	-$431	0	-$679	BC Go Electric
Zero emission commercial use vehicles	By 2030, of total car sales: 10% are electric 16% are natural gas	$2	-$58	-$56	0	-$858	BC Go Electric
Electrify municipal vehicles	WestVan fleet strategy, 33-50% of fleet electric by 2030.	$0	-$8	-$8	0	-$1,155	Go Electric Fleet Charging Program - CleanBC
Low Carbon Fuel Standard	Emissions intensity of new Light Duty Vehicles declines over 10% to 105g/km in 2030, relative to 2015. Emissions intensity of new Heavy Duty Vehicles declines 20% by 2025 and 24% by 2030, relative to 2015.	N/A	-$25	-$25	0	-$105	
ENERGY							
Net Zero Provincial Grid	Net-zero electricity generation by 2030.	N/A	N/A	N/A	N/A	N/A	
Blend RNG into NG	RNG in natural gas supply increases to 15% by 2030.	$71	-$38	$33	0	$86	
WASTE							
Waste Diversion Targets	CleanBC - 95% organics diversion.	N/A	N/A	N/A	N/A	N/A	

C. LOW CARBON SCENARIO EMISSION REDUCTION MEASURES: COMMUNITY MEASURES IMPLEMENTATION

ACTION	SPECIFICATION	PRIORITY	KEY MEASURES to monitor & report	CUMULATIVE EMISSIONS REDUCTIONS ($ktCO_2e$)	CUMULATIVE ENERGY REDUCTIONS (million GJ)	START DATE	END DATE	RESPONSIBLE/ROLE
BUILDINGS								
Increase density of development in urban zones	Implementation of Taylor Way LAP by 2040, 600 new high density units.	high	N/A	0.2	0.006	2024	2040	IMPLEMENTATION ROLE: DWV *(Planning, Development & Environmental Services)*
Deep retrofits in the residential building stock	Retrofit 95% of existing buildings by 2040 to achieve a 50% reduction in space heating/cooling and a 20% reduction other non water heating energy use.	high	16,000 dwelling units	319	16	2025	2040	FACILITATOR/SUPPORT ROLE: DWV *(Planning, Development & Environmental Services, Environment Committee)* IMPLEMENTATION ROLE: home and MURB owners, stratas
Deep retrofits in the commercial and institutional building stock	Retrofit 95% of existing buildings by 2040 to achieve a 50% reduction in space heating/cooling and a 20% reduction other non water heating energy use.	moderate	670 buildings	156	2	2025	2040	FACILITATOR/SUPPORT ROLE: DWV *(Planning, Development & Environmental Services, Environment Committee)* IMPLEMENTATION ROLE: business owners, business associations, Park Royal
Deep retrofits in the municipal building stock	100% of municipal buildings use zero emissions energy by 2035.	moderate	48 buildings	77	2	2025	2035	IMPLEMENTATION ROLE: DWV *(Planning, Development & Environmental Services, Purchasing Department, Facilities Department, Financial Services)*
Transition to heat pumps for residential space conditioning and water heating	95% of existing buildings are equipped with electric heat pumps for space and water heating by 2040. Heat pumps are installed when existing equipment needs to be replaced.	high	16,000 heat pumps	341	6	2024	2040	FACILITATOR/SUPPORT ROLE: DWV *(Planning, Development & Environmental Services, Environment Committee)* IMPLEMENTATION ROLE: home and MURB owners, stratas
Transition to heat pumps for commercial space conditioning and water heating	95% of existing commercial buildings are equipped with electric heat pumps for space and water heating by 2040. Heat pumps are installed when existing equipment needs to be replaced.	moderate	718 buildings	326	6	2024	2040	FACILITATOR/SUPPORT ROLE: DWV *(Planning, Development & Environmental Services, Environment Committee)* IMPLEMENTATION ROLE: business owners, business associations, Park Royal
TRANSPORTATION								
Zero emission municipal vehicles	100% ZEV by 2040 includes light duty electric, renewable diesel, Compressed Renewable Natural Gas and hydrogen.	moderate	177 vehicles	3	0.02	2024	2040	IMPLEMENTATION ROLE: DWV *(Planning, Development & Environmental Services, Engineering Services -fleet, Facilities Department, Financial Services)*
Zero emission commercial use vehicles	100% of vehicle stock is zero emission by 2050, includes a mix of electricity, hydrogen and RNG.	low	N/A	315	4	2024	2050	FACILITATOR/SUPPORT ROLE: DWV *(Purchasing Department, Engineering Services)*, Province IMPLEMENTATION ROLE: commercial companies
ENERGY								
Enable distributed energy resources with Enhanced Energy Storage	Add 142 MW of rooftop solar capacity to residential and commercial buildings by 2040. Add 19 MW of energy storage to non apartment residential buildings equipped with rooftop solar by 2040. Assume each energy storage unit is 14 kWh.	low	161 MW	1	0	2024	2040	FACILITATOR/SUPPORT ROLE: DWV *(Planning, Development & Environmental Services, Environment Committee)* IMPLEMENTATION ROLE: home and MURB owners, stratas
Blend green hydrogen into the natural gas supply	Blend up to 15% hydrogen into the natural gas supply by 2035.	low	1,400,000 kg	86	0	2024	2033	ADVOCACY ROLE: DWV IMPLEMENTATION ROLE: utility companies
Blend RNG into the natural gas supply	Replace remaining natural gas with 100% RNG by 2040	low	19,000,000 m^3	235	0	2024	2033	ADVOCACY ROLE: DWV IMPLEMENTATION ROLE: utility companies
WASTE								
Waste Diversion Targets	100% residential organics diversion. 100% methane capture from landfills. 50% of commercial/construction waste by 2050 compared to 2016 levels.	moderate	10,200 tonnes composted 5,907 tonnes recycled	68	0	2024	2050	IMPLEMENTATION ROLE: DWV, Metro Vancouver

C. LOW CARBON SCENARIO EMISSION REDUCTION MEASURES: MUNICIPAL MEASURES IMPLEMENTATION

ACTION	SPECIFICATION	PRIORITY	KEY MEASURES to monitor & report	CUMULATIVE EMISSIONS REDUCTIONS ($ktCO_2e$)	CUMULATIVE ENERGY REDUCTIONS (million GJ)	START DATE	END DATE	RESPONSIBLE/ROLE
BUILDINGS								
Deep retrofits in the municipal building stock	100% of municipal buildings use zero emissions energy by 2035.	moderate	48 buildings	77	2	2025	2035	IMPLEMENTATION ROLE: DWV *(Planning, Development & Environmental Services, Purchasing Department, Facilities Department, Financial Services)*
Transition to heat pumps for space conditioning and water heating	95% of existing buildings are equipped with electric heat pumps for space and water heating by 2040. Heat pumps are installed when existing equipment needs to be replaced.	moderate	48 buildings	72	1	2024	2040	IMPLEMENTATION ROLE: DWV *(Planning, Development & Environmental Services, Purchasing Department, Facilities Department, Financial Services)*
TRANSPORTATION								
Zero emission municipal vehicles	100% ZEV by 2040 includes light duty electric, renewable diesel, Compressed Renewable Natural Gas and hydrogen.	moderate	177 vehicles	3	0.02	2024	2040	IMPLEMENTATION ROLE: DWV *(Planning, Development & Environmental Services, Engineering Services-fleet, Facilities Department, Financial Services)*
ENERGY								
Enable distributed energy resources	Add 5.6 MW of rooftop solar capacity to municipal buildings by 2040.	low	5.6 MW	0	0	2024	2040	IMLEMENTATION ROLE: DWV *(Planning, Development & Environmental Services, Purchasing Department, Facilities Department, Financial Services)*
Blend green hydrogen into the natural gas supply	Blend up to 15% hydrogen into the natural gas supply by 2035 and enacted a new round of standards for appliances and equipment beyond those codified in 2021 to support.	low	43,000 kg	19	0	2024	2031	IMLEMENTATION ROLE: DWV *(Planning, Development & Environmental Services, Purchasing Department, Facilities Department, Financial Services)*
Blend RNG into the natural gas supply	Replace remaining natural gas with 100% RNG by 2040.	low	510,000 m^3	3	0	2024	2032	IMLEMENTATION ROLE: DWV *(Planning, Development & Environmental Services, Purchasing Department, Facilities Department, Financial Services)*

D. LOW CARBON SCENARIO FINANCIAL IMPLICATIONS: COMMUNITY MEASURES IMPLEMENTATION

ACTION	SPECIFICATION	TOTAL INVESTMENT in millions *(discounted @3%)*	TOTAL RETURN	NET PRESENT VALUE in millions *(cost is positive; savings are negative)*	LOCAL JOB YEARS CREATED	MARGINAL ABATEMENT COST ($/$tCO_2e$)	POTENTIAL FUNDING SOURCES
BUILDINGS							
Increase density of development in urban zones	Implementation of Taylor Way LAP by 2040, 600 new high density units	N/A	N/A	N/A	N/A	N/A	FEDERAL: GST/HST New Residential Rental Property Incentive - Better Buildings (betterbuildingsbc.ca) PROVINCIAL: New Construction Market Transformation
Deep retrofits in the residential building stock	Retrofit 95% of existing buildings by 2040 to achieve a 50% reduction in space heating/cooling and a 20% reduction other non water heating energy use	$485	-$275	$210	5,936	$658	FEDERAL: CGAH: Canada Greener Affordable Housing Program [Umbrella Program] PROVINCIAL: Community Buildings Retrofit (CBR)
Deep retrofits in the commercial and institutional building stock	Retrofit 95% of existing buildings by 2040 to achieve a 50% reduction in space heating/cooling and a 20% reduction other non water heating energy use	$13	-$107	-$94	154	-$601	FEDERAL: News & Updates - Community Climate Funding (gov.bc.ca) Deep Retrofit Accelerator Initiative (DRAI) PROVINCIAL: CleanBC Commercial Express Program - Better Buildings
Deep retrofits in the municipal building stock	100% of municipal buildings use zero emissions energy by 2035	$6	-$45	-$39	63	-$508	FEDERAL:Capital project: GHG reduction pathway retrofit | Green Municipal Fund Capital project: GHG impact retrofit | Green Municipal Fund PROVINCIAL: Community Climate Funding (gov.bc.ca)
Transition to heat pumps for residential space conditioning and water heating	95% of existing buildings are equipped with electric heat pumps for space and water heating by 2040. Heat pumps are installed when existing equipment needs to be replaced.	$94	-$103	-$8	700	-$25	PROVINCIAL: Energy-efficiency Programs for Community Buildings Heat pump rebates Heat pump rebate > FortisBC
Transition to heat pumps for commercial space conditioning and water heating	95% of existing commercial buildings are equipped with electric heat pumps for space and water heating by 2040. Heat pumps are installed when existing equipment needs to be replaced.	$74	-$104	-$30	444	-$92	FEDERAL: Low Carbon Economy Challenge PROVINCIAL: Business Energy Savings Incentive Program
TRANSPORTATION							
Zero emission municipal vehicles	100% ZEV by 2040 includes light duty electric, renewable diesel, Compressed Renewable Natural Gas and hydrogen	$2	-$3	-$1	0	-$470	PROVINCIAL: CleanBC Go Electric Public Charger Program - Plug In BC
Zero emission commercial use vehicles	100% of vehicle stock is zero emission by 2050, includes a mix of electricity, hydrogen and RNG	$8	-$324	-$316	0	-$1,004	PROVINCIAL: CleanBC Go Electric Commercial Vehicle Pilots (CVP) Program
ENERGY							
Enable distributed energy resources with Enhanced Energy Storage	Add 142 MW of rooftop solar capacity to residential and commercial buildings by 2040. Add 19 MW of energy storage to non apartment residential buildings equipped with rooftop solar by 2040. Assume each energy storage unit is 14 kWh.	$421	-$226	$195	1,920	$186,583	FEDERAL: Community Climate Funding (gov.bc.ca) PROVINCIAL: Community Works Fund
Blend green hydrogen into the natural gas supply	Blend up to 15% hydrogen into the natural gas supply by 2035 and enacted a new round of standards for appliances and equipment beyond those codified in 2021 to support.	$18	-$10	$8	0	$90	
Blend RNG into the natural gas supply	Replace remaining natural gas with 100% RNG by 2040.	$82	-$25	$58	0	$246	
WASTE							
Waste Diversion Targets	100% residential organics diversion. 100% methane capture from landfills. 50% of commercial/construction waste by 2050 compared to 2016 levels.	N/A	N/A	N/A	N/A	N/A	FEDERAL: Study: Waste stream management | Green Municipal Fund

D. LOW CARBON SCENARIO FINANCIAL IMPLICATIONS: MUNICIPAL MEASURES IMPLEMENTATION

ACTION	SPECIFICATION	TOTAL INVESTMENT in millions *(discounted @3%)*	TOTAL RETURN	NET PRESENT VALUE in millions *(cost is positive; savings are negative)*	LOCAL JOB YEARS CREATED	MARGINAL ABATEMENT COST ($/t$CO_2$e)	POTENTIAL FUNDING SOURCES
BUILDINGS							
Deep retrofits in the municipal building stock	100% of municipal buildings use zero emissions energy by 2035	$6	-$45	-$39	63	-$508	FEDERAL: Smart Renewables and Electrification Pathways (SREPs) Program Capacity Building Stream Capital project: Retrofit of municipal facilities PROVINCIAL: Capital project: Retrofit of municipal facilities Community Buildings Retrofit (CBR) Net-Zero Transformation
Transition to heat pumps for space conditioning and water heating	95% of existing buildings are equipped with electric heat pumps for space and water heating by 2040. Heat pumps are installed when existing equipment needs to be replaced.	9	8	16	50	$224	FEDERAL: Pilot project: Retrofit of municipal facilities PROVINCIAL: Pilot project: Retrofit of municipal facilities
TRANSPORTATION							
Zero emission municipal vehicles	100% ZEV by 2040 includes light duty electric, renewable diesel, Compressed Renewable Natural Gas and hydrogen	$2	-$3	-$1	0	-$470	CAPITAL PROJECT: Reduce fossil fuel use in fleets | Green Municipal Fund PROVINCIAL: Community Climate Funding (gov.bc.ca)
ENERGY							
Enable distributed energy resources	Add 5.6 MW of rooftop solar capacity to municipal buildings by 2040.	1	-0.5	0.5	32	$26,486	PROVINCIAL: Community Climate Funding (gov.bc.ca) Energy-efficiency Programs for Community Buildings
Blend green hydrogen into the natural gas supply	Blend up to 15% hydrogen into the natural gas supply by 2035 and enacted a new round of standards for appliances and equipment beyond those codified in 2021 to support.	$0.5	-$0.2	$0.3	0	$13	
Blend RNG into the natural gas supply	Replace remaining natural gas with 100% RNG by 2040.	$2	-$0.4	$1	0	$451	

DEFINITIONS

high: high emissions reductions and have control over it and access to support/capacity to influence

moderate: high emissions reductions but lower ability to regulate and influence change

low: lower emissions reductions and limited control and capacity to influence

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District of West Vancouver Greenhouse Gas Emissions Inventory

Data, Methods, and Assumptions Manual

November 2nd 2023

Prepared for the District of West Vancouver by:

Sustainability Solutions Group

Table of Contents

Purpose of this Document

This Data, Methods, and Assumptions (DMA) manual details the modelling approach used to provide community energy and emissions benchmarks and projections while providing a summary of the data and assumptions used in scenario modelling. The DMA makes the modelling elements fully transparent and illustrates the scope of data required for future modelling efforts.

1. Introduction

The District of West Vancouver will investigate options to a low carbon pathway by completing a Greenhouse Gas (GhG) Inventory with the aim to:

1. Decrease GhG emissions by 45 percent from 2010 levels by 2030 and
2. Achieve net-zero[1] GhG emissions by 2050

The recommended low carbon path will set the course for a 27-year time horizon (2021 to 2050). A key output is a model representing the current and potential future scenarios of community emissions in the District.

1.1 Geographic Boundary

The geographic scope of the modelling assessment is the municipal boundary for the district boundary District of West Vancouver (figure 1). The model will assign energy use and greenhouse gas emissions spatially by traffic zone.

[1] "Net-zero" refers to balancing the amount of emissions put into the atmosphere with the amount taken out

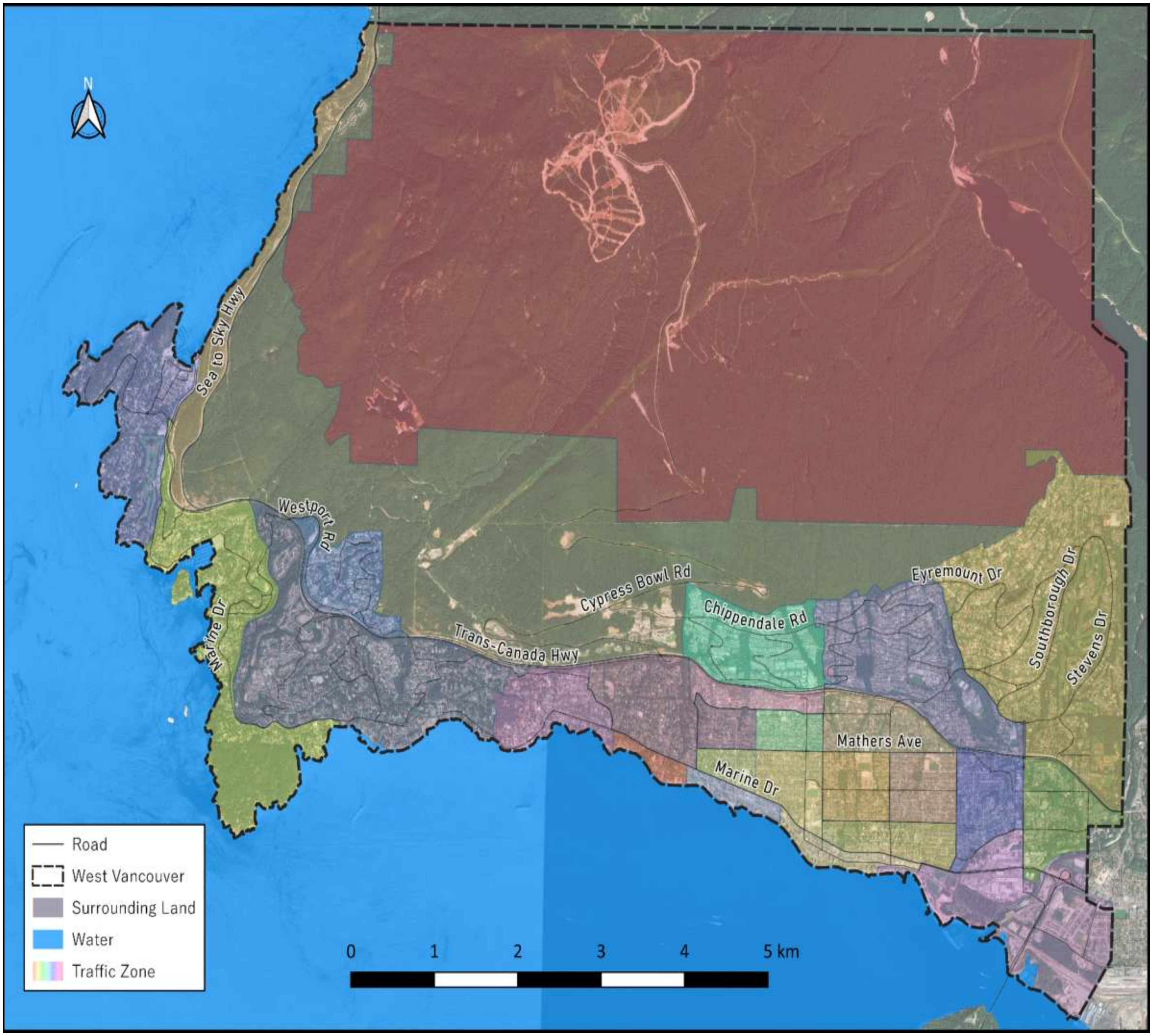

Figure 1. Basemap for District of West Vancouver featuring the shoreline, municipal boundary, adjacent lands and major roads which are labelled.

1.2 Time period of the assessment

- The assessment will cover the years from 2021 to 2050.
- The baseline year within the models is 2021 with the rationale that:
    - The model requires the calibration of a base year system state (initial conditions) using as much observed data as possible in order to develop an internally consistent snapshot of the municipality.
    - A key data source for the model is census data. At the time of modelling, the last census year for which there is data available is 2021.
- 1-year increments are modelled from the 2021 baseline year. 2021 is the first simulation period/year.

2. Accounting Framework

2.1 Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)

The inventory will include the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)[2]. The GPC is the result of an effort to standardize municipal-scale inventories by the World Resources Institute[3], C40 Cities Climate Leadership Group Inc.[4], and ICLEI – Local Governments for Sustainability (ICLEI)[5].

The GPC provides a robust framework for accounting and reporting municipal-wide greenhouse gas emissions. It seeks to:

- Help cities develop a comprehensive and robust greenhouse gas inventory in order to support climate action planning;
- Help cities establish a base year emissions inventory, set reduction targets, and track their performance;
- Ensure consistent and transparent measurement and reporting of greenhouse gas emissions between cities, following internationally recognized greenhouse gas accounting and reporting principles;
- Enable municipal inventories to be aggregated at subnational and national levels;
- Demonstrate the important role that cities play in tackling climate change, and facilitate insight through benchmarking – and aggregation – of comparable data.

To date, more than 100 cities across the globe have used the GPC (current and previous versions) to measure their greenhouse gas emissions.

The GPC has been adopted by the following programs and initiatives:

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[2] http://www.ghgprotocol.org/city-accounting
[3] https://www.wri.org/about
[4] https://www.c40.org/about-c40/
[5] ICLEI was formerly the "International Council for Local Environmental Initiatives"' https://iclei.org/about_iclei_2/

- The Global Covenant of Mayors for Climate & Energy[6] (GCoM) is an agreement led by city networks to undertake a transparent and supportive approach to reduce municipal emissions and enhance resilience to climate change. GCoM cities are required to measure and report greenhouse gas emissions using the GPC. The District of West Vancouver is currently not committed as a GCoM municipality.
- Carbon Climate Registry is the common, publicly available repository for the Compact of Mayors. It provides standard reporting templates to help cities report their GHG emissions using the GPC. Currently about 300 cities have reported their emissions using the carbonn Climate Registry.
- CDP[7] runs the world's largest environmental reporting platform. More than 5,000 companies, 200 cities, and 12 states and regions use CDP's platform every year to report on their environment-related data, including GHG emissions, climate risks, water risks, and economic opportunities. CDP serves as the official reporting platform for C40 cities, and the GCoM. CDP has also partnered with ICLEI, the Under2 Coalition[8] and RegionsAdapt[9] to track the progress of states and regions as part of the Race to Zero[10] and Race to Resilience[11] campaigns.[12] CDP supports cities in reporting their emissions using the GPC.

The GPC is based on the following principles in order to represent a fair and true account of emissions:

- **Relevance:** The reported GHG emissions shall appropriately reflect emissions occurring as a result of activities and consumption within the municipal boundary. The inventory will also serve the decision-making needs of the municipality, taking into consideration relevant local, subnational, and national regulations. Relevance applies when selecting data sources, and determining and prioritizing data collection improvements.
- **Completeness:** All emissions sources within the inventory boundary shall be accounted for. Any exclusions of sources shall be justified and explained.
- **Consistency:** Emissions calculations shall be consistent in approach, boundary, and methodology.
- **Transparency:** Activity data, emissions sources, emissions factors and accounting methodologies require adequate documentation and disclosure to enable verification.
- **Accuracy:** The calculation of GHG emissions should not systematically overstate or understate actual GHG emissions. Accuracy should be sufficient enough to give decision makers and the public reasonable assurance of the integrity of the reported information. Uncertainties in the quantification process should be reduced to the extent possible and practical.

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[6] Global Covenant of Mayors for Climate & Energy was formerly the "Compact of Mayors" and the "European Union's Covenant of Mayors" https://www.globalcovenantofmayors.org/
[7] CDP was formerly the "Carbon Disclosure Project" https://www.cdp.net/en/info/about-us
[8] coalition of subnational governments that aims to achieve GhG mitigation https://www.theclimategroup.org/under2-ambition-tracker
[9] The first global initiative for regional governments to plan and take concrete action, cooperate and report efforts on climate adaptation. https://regions4.org/project/regions-adapt/
[10] Supported by the United Nations, a global campaign to reduce GhGs https://racetozero.unfccc.int/system/race-to-zero/
[11] Supported by the United Nations, a sister campaign to Race to Zero whereby the goal is to increase the resilience of four billion people living in vulnerable communities, in collaboration with global partners https://racetozero.unfccc.int/system/racetoresilience/
[12] https://www.cdp.net/fr/articles/media/states-and-regions-to-report-progress-on-un-backed-climate-campaigns-through-cdp-platform

2.2 Role of the CityinSight model: Future emissions projections

A GHG reporting protocol, such as the GPC described above, defines a standard set of categories, breakdowns, scopes, boundary treatment methods, and estimation methods. These protocols are typically geared towards reporting historical periods of observed data, designed for governments or companies to disclose the emissions impacts or progress of recent years activities. However, such protocols offer limited guidance for the development of GHG emissions projections for future years, which requires additional layers of data, inputs, and assumptions to establish a trajectory of emissions estimates. Figure 2 shows reported versus projected GHG emissions on a conceptual timeline.[13]

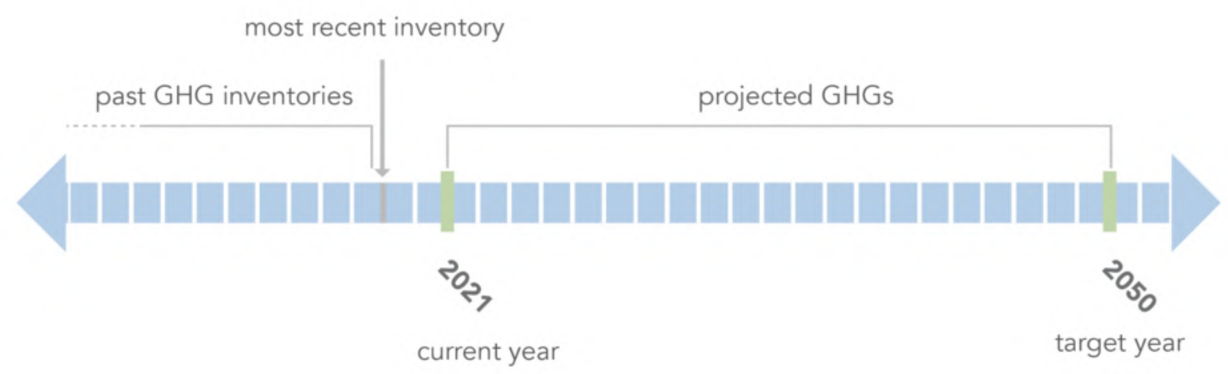

Figure 2. Conceptual timeline showing inventory reporting period and projection period.

Projecting GHG emission scenarios in support of low-carbon action planning requires:

1. the consideration of various alternative municipal plans, policies and contextual assumptions, and
2. the definition of the quantitative relationships between a municipality's activities, infrastructure, energy consumption, finances, and GHG emissions.

The *CityInSight* model facilitates this process by capturing these relationships in a computable form, allowing them to be altered, examined, and understood.

CityInSight, initially developed in 2015, is designed so that its representation of a municipality's GHG emissions can be exported to the GPC reporting standard. The model is calibrated for a specific model base year (in this instance, for 2021) and can effectively produce a GPC inventory report for that year, as well as for all subsequent years in its projection horizon. Figure 3 shows the major components of CityInSight and the relationship to the GPC reporting standard.

[13] When a model is introduced things can become more complicated, with overlapping reported and modelled time ranges. A more detailed version of this diagram is presented in the Appendix.

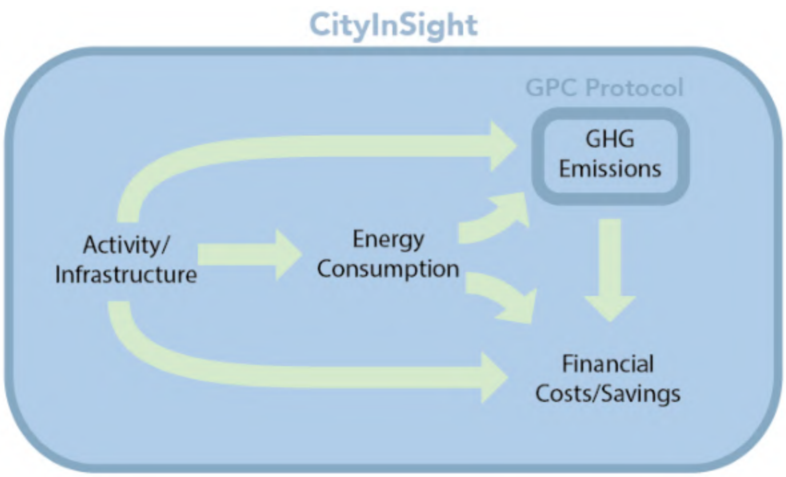

Figure 3. High-level components of CityInSight and relationship to the GPC reporting standard

The GPC is billed as an accounting framework for municipal-level GHG emissions. CityInSight, as an integrated systems model, offers an extended accounting framework for community infrastructure, activity, energy, and financial flows, which is aligned with the GPC accounting framework. A description of energy accounting structure in CityInSight is provided in Section 5.2.

3. Assessment Boundary

3.3 GHG emissions scope

A list of GHG emission sources by sector and sub-sector that are included or excluded in the inventory will be provided in an Appendix. The inventory will include Scopes 1 and 2, and some aspects of Scope 3 emissions. A list of GHG emission sources by Scope that will be included in the Appendices.

Table 1. GHG emissions scopes.

Scope	Definition
1	All GHG emissions from sources located within the municipal boundary.
2	All GHG emissions as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the municipal boundary.
3	All other GHG emissions that occur outside the municipal boundary as a result of activities taking place within the municipal boundary.

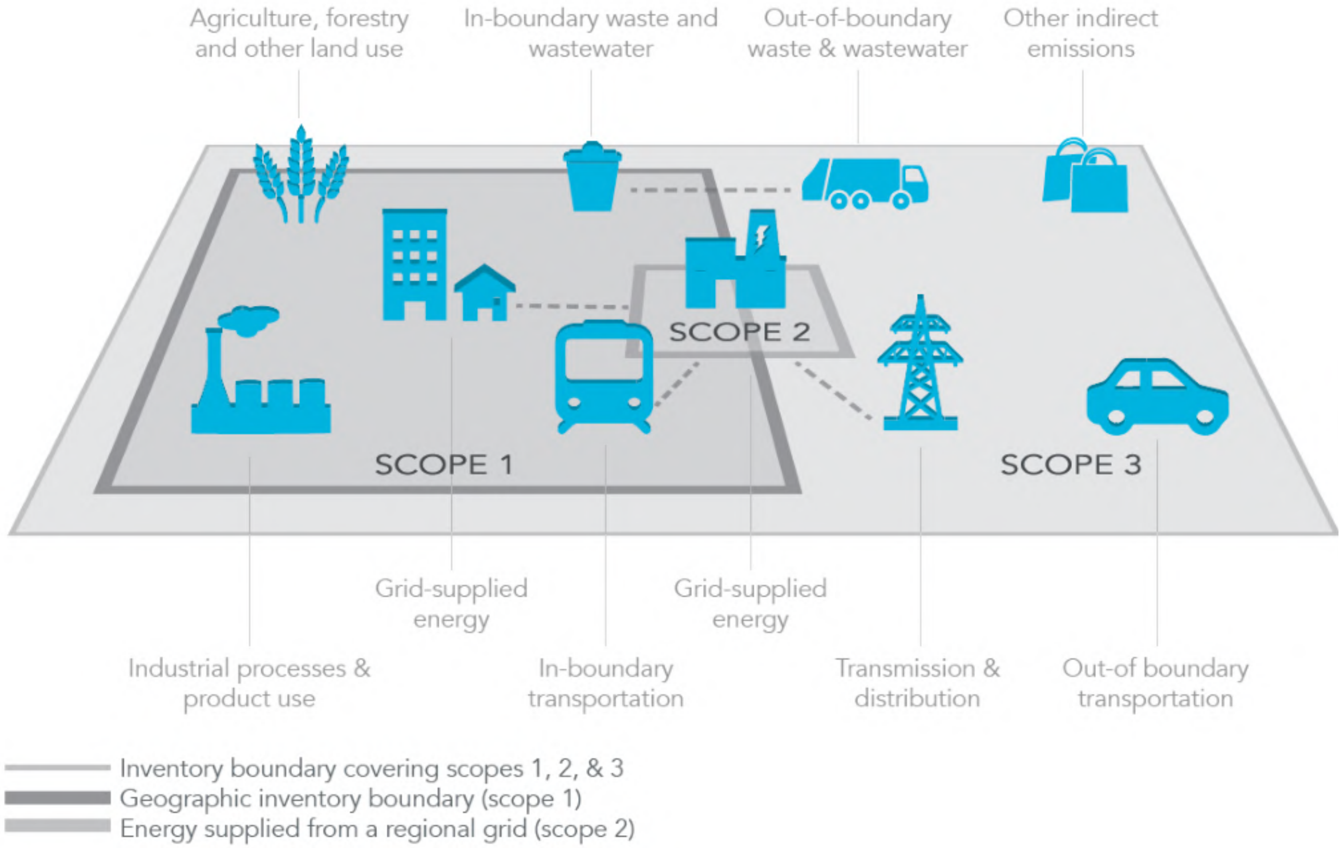

Figure 4: Generic representation of all possible GHG emissions by scope.

3.5 Greenhouse Gases

The inventory addresses carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_20). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen triflouride (NF_3) are not included. Emissions are expressed in CO_2 equivalents per the assumptions in Table 2.

Table 2. Global Warming Potentials for selected greenhouse gases. [14]

Greenhouse Gas	CO_2 equivalents	Notes
CO_2	1	
CH_4	27.9	*These have been updated from the IPCC 5th Assessment Report onward to include climate-carbon feedback.*
N_20	273	*These have been updated from the IPCC 5th Assessment Report onward to include climate-carbon feedback.*

[14] Intergovernmental Panel on Climate Change IPCC Global Warming Potentials - 100-Year Time Horizon, Assessment Report 6, Synthesis Report, Table 7.SM.6 Tables of Greenhouse Gas Lifetimes, Radiative Efficiencies and Metrics, https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter_07_Supplementary_Material.pdf

4. Modelling

4.1 About CityInSight

CityInSight is an integrated spatially-disaggregated energy, emissions and finance model developed by Sustainability Solutions Group and whatIf? Technologies. The model enables bottom-up accounting for energy supply and demand, including renewable resources, conventional fuels, energy consuming technology stocks (e.g. vehicles, heating systems, dwellings, buildings) and all intermediate energy flows (e.g. electricity and heat).

CityInSight incorporates and adapts concepts from the system dynamics approach to complex systems analysis. Energy and GHG emissions are derived from a series of connected stock and flow models. The model accounts for physical flows (i.e. energy use, new vehicles by technology, vehicle kilometres travelled) as determined by stocks (buildings, vehicles, heating equipment, etc). For any given year within its time horizon, CityInSight traces the flows and transformations of energy from sources through energy currencies (e.g. gasoline, electricity) to end uses (e.g. personal vehicle use, space heating) to energy costs and to GHG emissions. The flows evolve on the basis of current and future geographic and technology decisions/assumptions (e.g. EV penetration rates). An energy balance is achieved by accounting for efficiencies, conservation rates, and trade and losses at each stage in the journey from source to end use.

Table 3. Characteristics of CityInSight.

Characteristic	Rationale
Integrated	CityInSight is designed to model and account for all sectors that relate to energy and emissions at a municipal scale while capturing the relationships between sectors. The demand for energy services is modelled independently of the fuels and technologies that provide the energy services. This decoupling enables exploration of fuel switching scenarios. Physically feasible scenarios are established when energy demand and supply are balanced.
Scenario - based	Once calibrated with historical data, CityInSight enables the creation of dozens of scenarios to explore different possible futures. Each scenario can consist of either one or a combination of policies, actions and strategies. Historical calibration ensures that scenario projections are rooted in observed data.
Spatial	The configuration of the built environment determines the ability of people to walk and cycle, accessibility to transit, feasibility of district energy and other aspects. CityInSight therefore includes a full spatial dimension that can include as many zones - the smallest areas of geographic analysis - as are deemed appropriate. The spatial component to the model can be integrated with Municipal GIS systems, land-use projections and transportation modelling.

GHG reporting framework	CityInSight is designed to report emissions according to the GhG Protocol for Cities (GPC) framework and principles.
Economic impacts	CityInSight incorporates a full financial analysis of costs related to energy (expenditures on energy) and emissions (carbon pricing, social cost of carbon), as well as operating and capital costs for policies, strategies and actions. It allows for the generation of marginal abatement curves to illustrate the cost and/or savings of policies, strategies and actions.

4.2 Model Structure

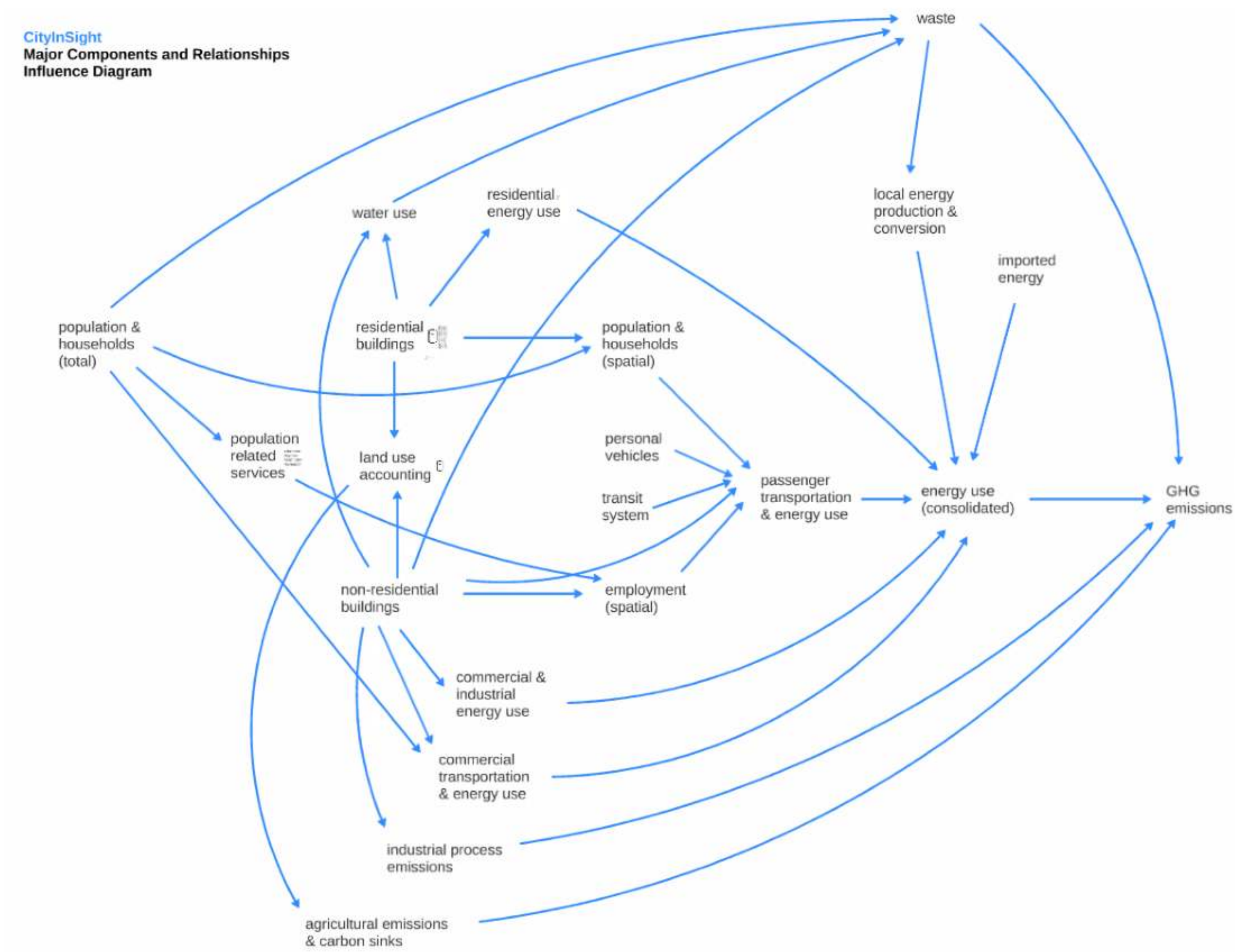

Figure 5. Representation of CityInSight's structure.

The major components of the model, and the first level of modelled relationships (influences), are represented in Figure 5. These sub-models are all interconnected through various energy and financial flows.

Additional relationships may be modelled in CityInSight by modifying inputs and assumptions - specified directly by users, or in an automated fashion by code or scripts running "on top of" the base model structure. Feedback relationships are also possible, such as increasing the adoption rate of non-emitting vehicles in order to meet a particular GHG emissions constraint.

The model is spatially explicit. All buildings, transportation and land use data is tracked within the model through a GIS platform, and by varying degrees of spatial resolution. Where applicable, a zone type system can be applied to break up the municipality into smaller configurations. This enables consideration of the impact of land-use patterns and urban form on energy use and emissions production from a baseline year to future dates using GIS-based platforms. CityInSight's GIS outputs can be integrated with municipal mapping systems.

4.3 Stocks and Flows

Within each sub-model is a number of stocks and flows that represent a municipality. For any given year various factors shape the picture of energy and emissions flows in a municipality, including: the population and the energy services it requires; commercial floorspace; energy production and trade; the deployed technologies which deliver energy services (service technologies); and the deployed technologies which transform energy sources to currencies (harvesting technologies). The model makes an explicit mathematical relationship between these factors - some contextual and some part of the energy consuming or producing infrastructure - making up the energy flow picture.

Some factors are modelled as stocks - counts of similar things, classified by various properties. For example, population is modelled as a stock of people classified by age and gender. Population change over time is projected by accounting for: the natural aging process, inflows (births, immigration) and outflows (deaths, emigration). The fleet of personal use vehicles, an example of a service technology, is modelled as a stock of vehicles classified by size, engine type and model year - with a similarly-classified fuel consumption intensity. As with population, projecting change in the vehicle stock involves aging vehicles and accounting for major inflows (new vehicle sales) and major outflows (vehicle discards). This stock-turnover approach is applied to other service technologies (e.g. furnaces, water heaters) and also harvesting technologies (e.g. electricity generating capacity).

4.4 Sub-models

The stocks and flows that make up each sub-model are described below.

<u>Population, Households and Demographics</u>

- Municipal-wide population is modelled using the 'standard population cohort-survival method', which tracks population by age and gender on a year-by-year basis.

- It accounts for various components of change: births, deaths, immigration and emigration.

- The age structured population is used for analysis of demographic trends, generational differences and implications for shifting energy use patterns, listed below.

- Population is allocated to households, and these are placed spatially in zones, via physical dwellings.

- The population sub-model influences energy consumption in various sub-models
    - School enrollment totals (transportation)
    - Workforce totals (transportation)
    - Personal vehicle use (transportation)
    - waste generation

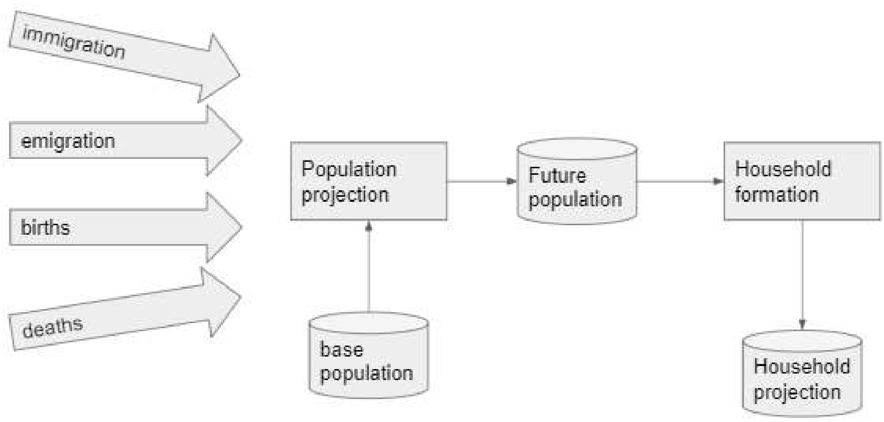

Figure 6. Population and employment submodel design flow. Arrows with model components represent flows, rectangles represent model calculations, cylinders represent stocks.

Building Land Use Accounting

Land use accounting identifies buildings in space and over time, through construction, retrofits and demolitions. In the baseline, this is often directly informed by municipal GIS files.

- Quantitative spatial projections of buildings / dwelling units, by:
    - Type of residential structure (single detached, semi detached, row house, apartment, etc)
    - Type of non-residential structure (retail, commercial, institutional)
    - Development type (greenfield, intensification)
    - For non-residential buildings in particular, buildings are further classified into archetypes (such as school, hospital, industrial etc).[15] This allows for the model to account for differing intensities that would occur in relation to various non residential buildings.
    - Jobs are allocated to zones via non-residential floor area, using a floor area per worker intensity.

- Residential land-use accounting takes "components of change" into account:
    - New development

[15] Where possible, this data comes directly from the municipality.

- Removals / demolitions
- Year of construction

- Land use accounting influences other aspects of the model, notably:
  - Passenger transportation: the location of residential buildings influences where home-to-work and home-to-school trips originate, which in turn also influences their trip length and the subsequent mode selected. Similarly, the location and identification of non-residential building influences the destination for many trips. For example, buildings identified as schools would be identified in home-to-school trips.

  - Access to energy sources by buildings: building location influences access to energy sources, for example, a rural dwelling may not have access to natural gas or a dwelling may not be in proximity to an existing district energy system. It can also be used to identify suitable projects: for example, the location and density of dwellings is a consideration for district energy development.

  - Non-residential building energy: the identification of non-residential building archetypes influences their energy consumption based on their use type. For example, a building identified as a hospital would have a higher energy use intensity than a building identified as a school.

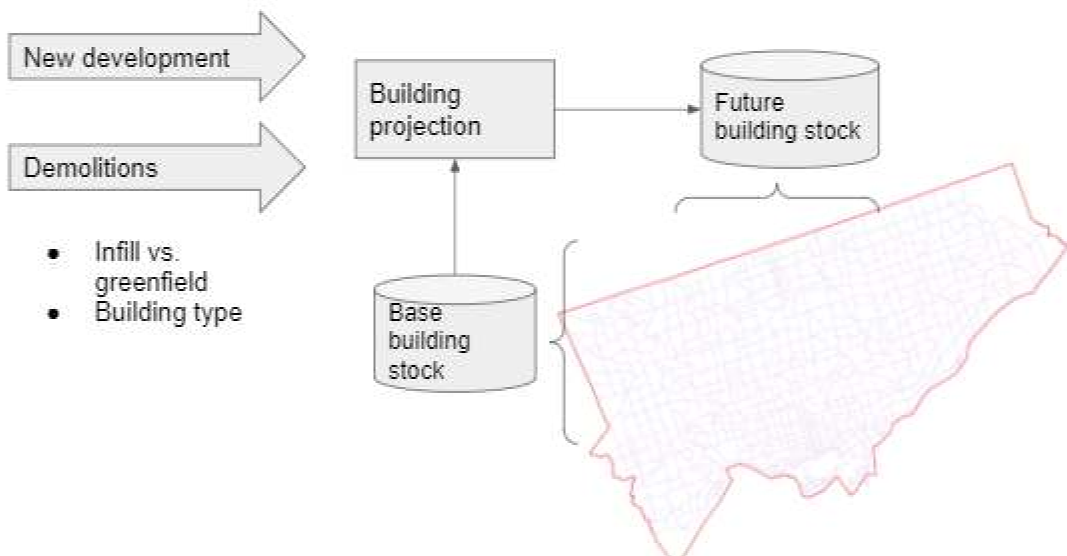

Figure 7. Building Land Use Accounting submodel design flow. Arrows with model components represent flows, rectangles represent model calculations, cylinders represent stocks.

<u>Residential Buildings Energy</u>

Building energy consumption is closely related to the land use accounting designation it receives, based on where the building is located, its archetype, and when it was constructed. Building energy consumption calculated by:

- Total energy use intensity of the building type, including the proportion from thermal demand, is built up from energy end uses in the building. This is related to the building archetype and its age.

- Then, energy use by fuel is determined based on the space heating or cooling technology used in each building. From here, heating system types are assigned to building equipment stocks (heating systems, air conditioners, water heaters).

- Building energy consumption in the model also considers:
  - solar gains and internal gains from sharing walls;
  - local climate (heating and cooling degree days); and
  - energy losses in the building.

- Building equipment stocks are modelled with a stock-turnover approach that captures equipment age, retirements, and additions. In future projections, the natural replacement of stocks is often used as an opportunity to introduce new (and more efficient) technologies.

- Residential building energy sub-model is one of the core components of the model. It influences and produces important model outputs:
  - Model outputs: total residential energy consumption and emissions and residential energy and emissions by building type, by end use, by fuel
  - Local/imported energy balance: how much energy will need to be imported after considering local capacity and production.

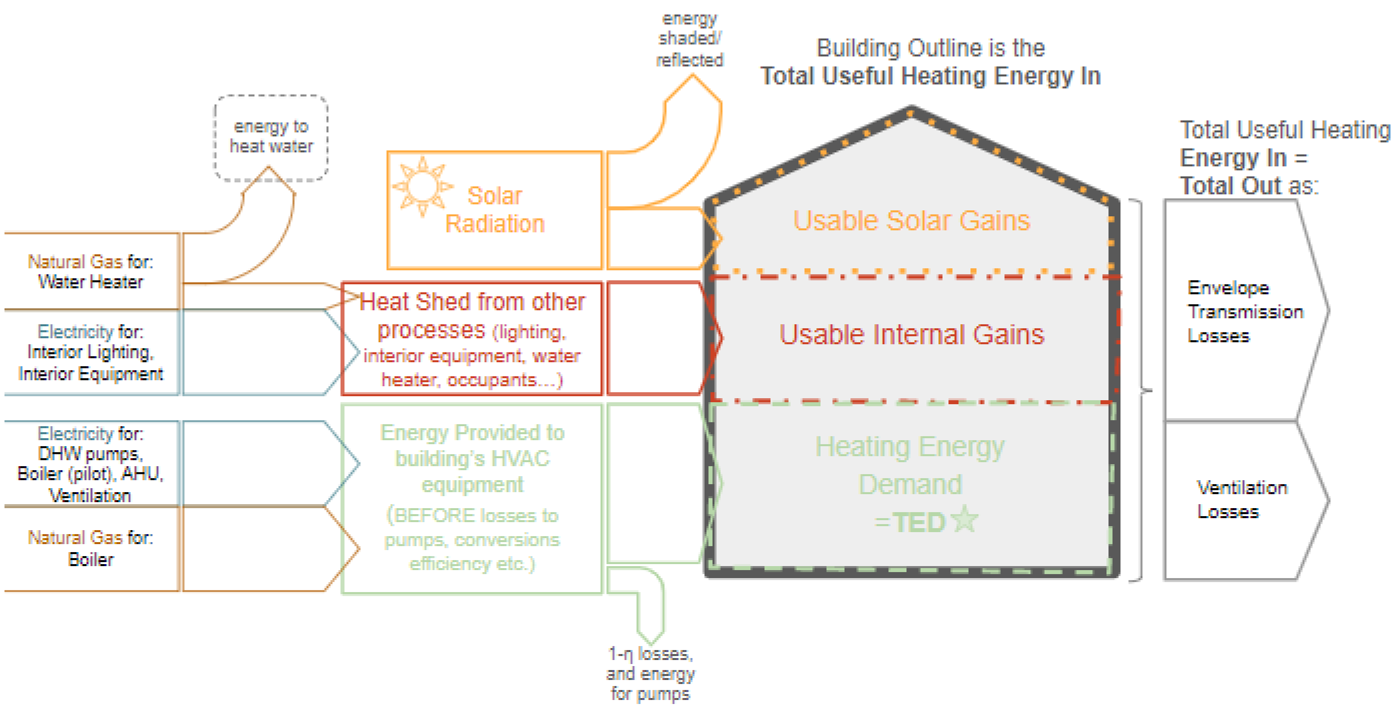

Figure 8. Building energy sub-model schematic.

Non-residential buildings

This sub-model shares similar characteristics to residential building energy, as energy consumption is based on the land use accounting designated to buildings.These are spatially located and classified by a detailed use/ purpose-based set of 50+ archetypes, and the floorspace of these non-residential building archetypes can vary by location. Non-residential floorspace produces waste and demand for energy and water and provides an anchor point for locating employment of various types.

Personal mobility

CityInSight includes a spatially explicit passenger transportation sub-model that responds to changes in land use, transit infrastructure, vehicle technology, travel behavior changes and other factors. It has the following features

- CityInSight uses the induced method for accounting for transportation related emissions: accounts for in-boundary tips and 50% of transboundary trips that originate or terminate within the municipal boundary. This shares energy and GHGs between municipalities.
- The model accounts for "trips", as follows:Trips are generated in the following steps
    1. Trip generation. Trips are divided into four types (home-work, home-school, home-other, and non-home-based), each produced and attracted by different combinations of spatial influences (population, employment, classrooms, non-residential floorspace).
    2. Trip distribution. Trips are distributed with trip volumes specified for each zone of origin and zone of destination pair. O-D matrix data is based on local travel surveys and transportation models
    3. Mode share. For each origin-destination pair, trips are shared over walk/bike, public transit and automobile.
        a. Walk / bike trips are identified based on a distance threshold: ~2km for walking, ~5-10km for biking.
        b. Transit trips are allocated to trips with an origin or destination within a certain distance to a transit station.
    4. Vehicle distance. Vehicle kilometres travelled (VKT) are calculated based on the number of trips by mode and the distance of each trip based on a network distance matrix for the origin-destination pairs.

- For personal vehicles, energy by fuel type is calculated based on VKT.
- VKT is also assigned to a stock of personal vehicles, based on vehicle type, fuel type, and fuel efficiency. The number of vehicles is influenced by the total number of households identified in the population sub-model. Vehicles also use a stock-turnover approach to model vehicle replacements, new sales and retirements.
- The energy use and emissions associated with personal vehicles is calculated by VKT of the stock of personal vehicles and their type, fuel and efficiency characteristics.
- The personal mobility sub-model is one of the core components of the model. It influences and produces important model outputs:
    - Total transportation energy consumption (by fuel)
    - Including electricity consumption

- Active trips and transit trips, by zone

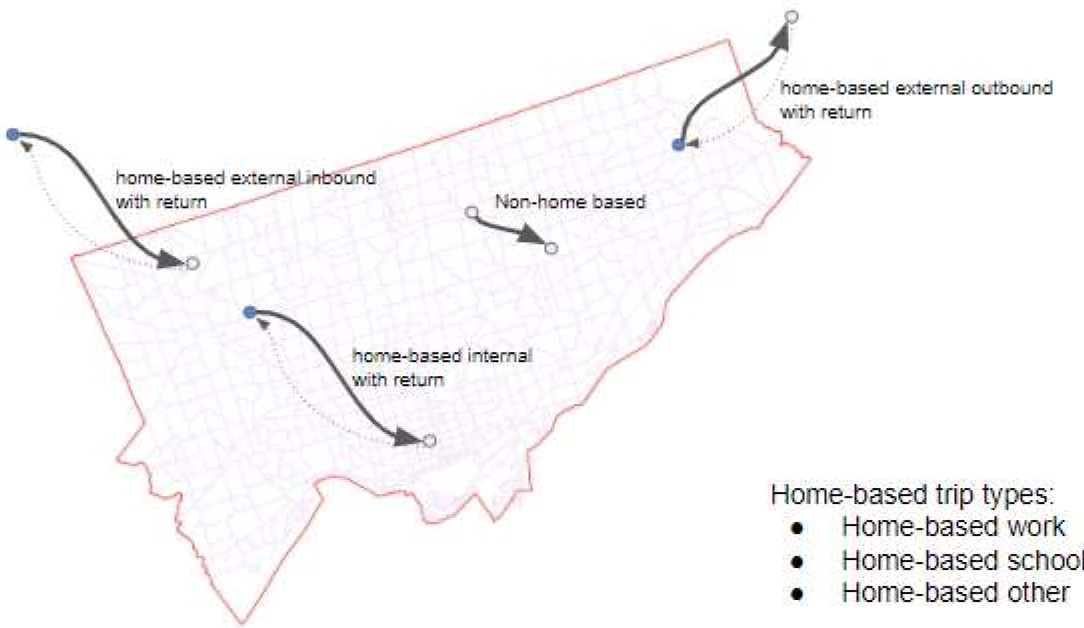

Figure 9. Trips assessed in the personal mobility sub-model

Waste

Households and non-residential buildings generate solid waste and wastewater, and the model traces various pathways to disposal, compost and sludge. If present in the Municipality, the model can also capture energy recovery from incineration and biogas. Waste generation is translated to emissions based on decay models.

Local energy production

Energy produced from primary sources (e.g. solar, wind) is modelled alongside energy converted from imported fuels (e.g. electricity generation, district energy, CHP). The model accounts for conversion efficiency. As with the transportation sub-model, the district energy supply model has an explicit spatial dimension and represents areas served by district energy networks.

Financial and Employment Impacts

Energy related financial flows and employment impacts are captured through an additional layer of model logic. Costs are calculated as new stock is incorporated into the model, through energy flows (annual fuel costs), as well as other operating and maintenance costs. Costs are based on a suite of assumptions that are input into the model. See Section 5.x for financial variables tracked within the model.

Employment is calculated using standard employment multipliers, often expressed as person-years of employment per million dollars of investment. Employment is calculated from the financial flows of new stocks entering the model, like new buildings and energy infrastructure.

4.5 Energy and GHG Emissions Accounting

CityInSight accounts for the energy flows through the model, as shown in Figure 10. Source fuels crossing the geographic boundary of the municipality are shown on the left. The four “final demand” sectors - residential, commercial, industrial, and transportation - are shown towards the right. Some source fuels are consumed directly in the final demand sectors (e.g. natural gas used by furnaces for residential heating, gasoline used by personal vehicles for transportation). Other source fuels are converted to another energy carrier before consumption in the final demand sectors (e.g. solar energy converted to electricity via photovoltaic cells, natural gas combusted in heating plants and the resulting hot water distributed to end use buildings via district energy networks). Finally, efficiencies of the various conversion points (end uses, local energy production) are estimated to split flows into either “useful” energy or conversion losses at the far right side of the diagram.

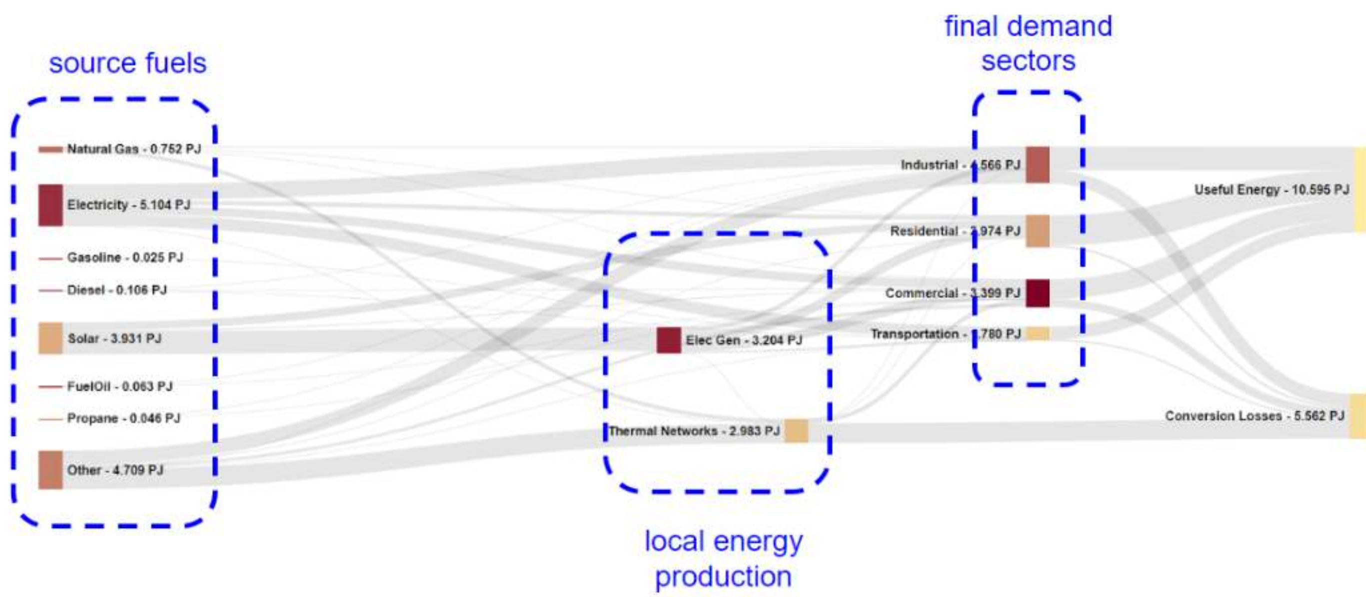

Figure 10. Energy flow Sankey diagram showing main node groups

Figure 10 shows the potential for ambiguity when energy is reported: which of energy flows circled are included and how do you prevent double counting? To address these ambiguities, CityInSight defines two main energy reports:

- **Energy Demand,** shown in Figure 11. Energy Demand includes the energy flows just before the final demand sectors (left of the dotted red line). Where the demand sectors are supplied by local energy production nodes, the cut occurs after the local energy production and before demand. A sample of the Energy Demand report is shown in Figure 12.
- **Energy Supply,** shown in Figure 13. Energy Supply includes the energy flows just after the source fuel nodes (left of the dotted red line). Where the source fuels supply local energy production nodes, the cut occurs between the source fuels and local energy production.

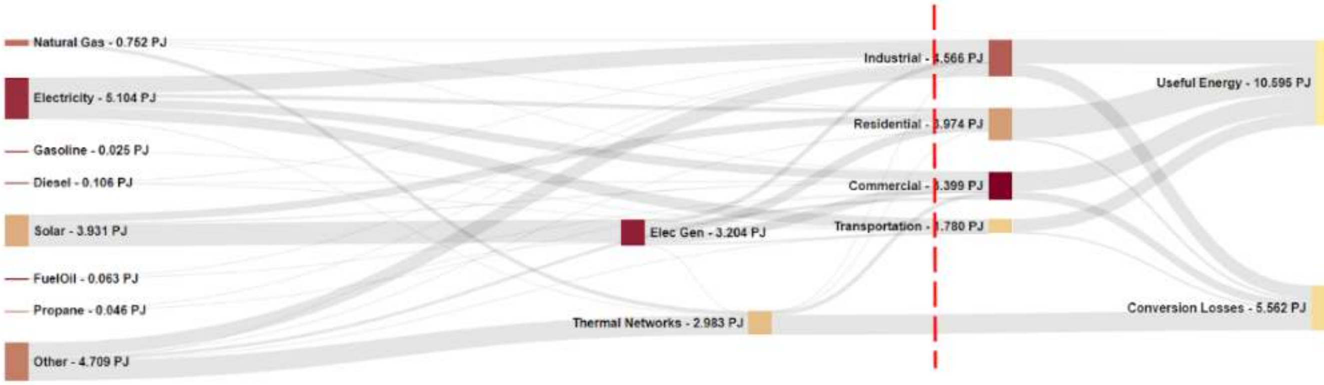

Figure 11. Energy Demand report definition

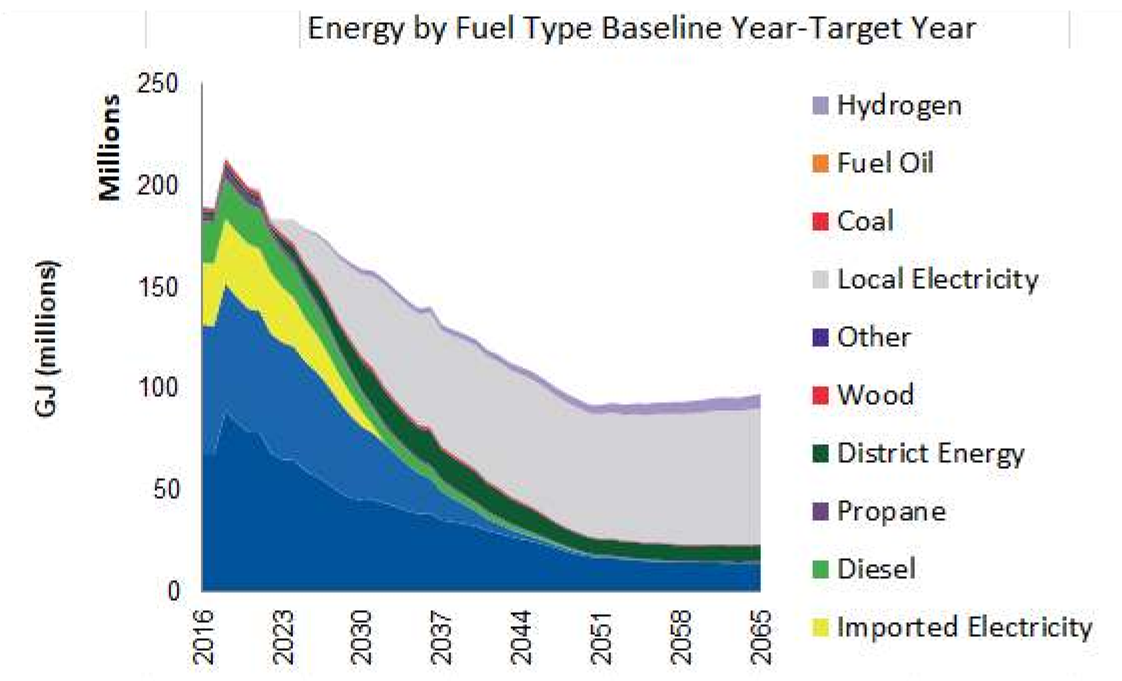

Figure 12: Energy Demand report sample (over time).

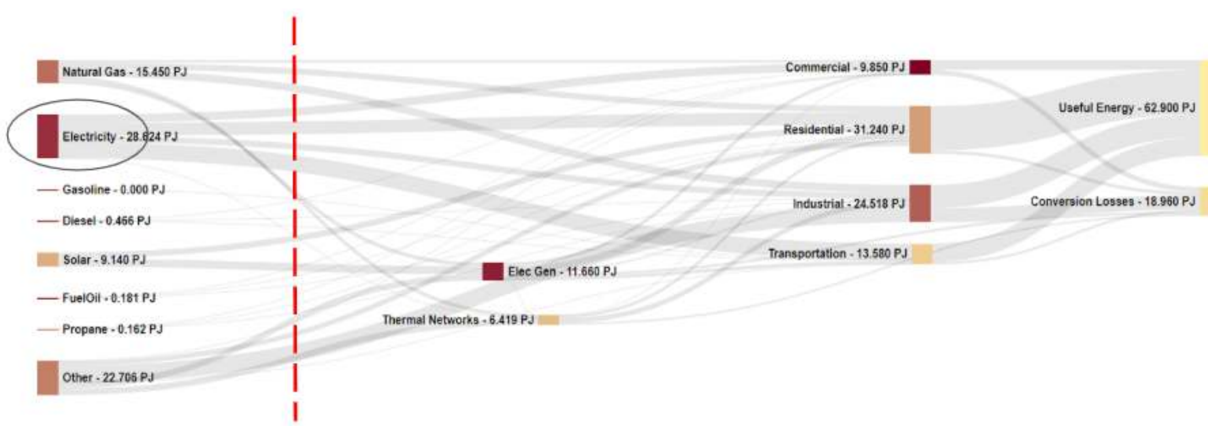

Figure 13: Energy Supply report definition.

In the integrated CityInSight energy and emissions accounting framework, GHG emissions are calculated after energy consumption is known. Figure 14 below shows the energy Sankey diagram outline "laid flat" on a surface. The closest row of nodes are the fuel sources; the nodes in the middle are local energy production; and the nodes towards the back are final demand sectors. Three-dimensional bars, representing GHG emissions, protrude from the nodes of associated energy conversion. The solid blue and red bars represent the reported emissions. Red bars represent actual emissions released at the energy conversion node (e.g. natural gas combusted at a commercial building, diesel combusted in a vehicle). Solid blue bars represent emissions released elsewhere - to supply energy to that node - such as imported electricity whose generation created GHG emissions outside the study area. The transparent blue bar represents "virtual" emissions associated with the generation of imported electricity, and the fine blue arrows show allocation of those virtual emissions to electricity consumption nodes. This is conceptually aligned with the energy-based GHG emissions reporting of GPC.

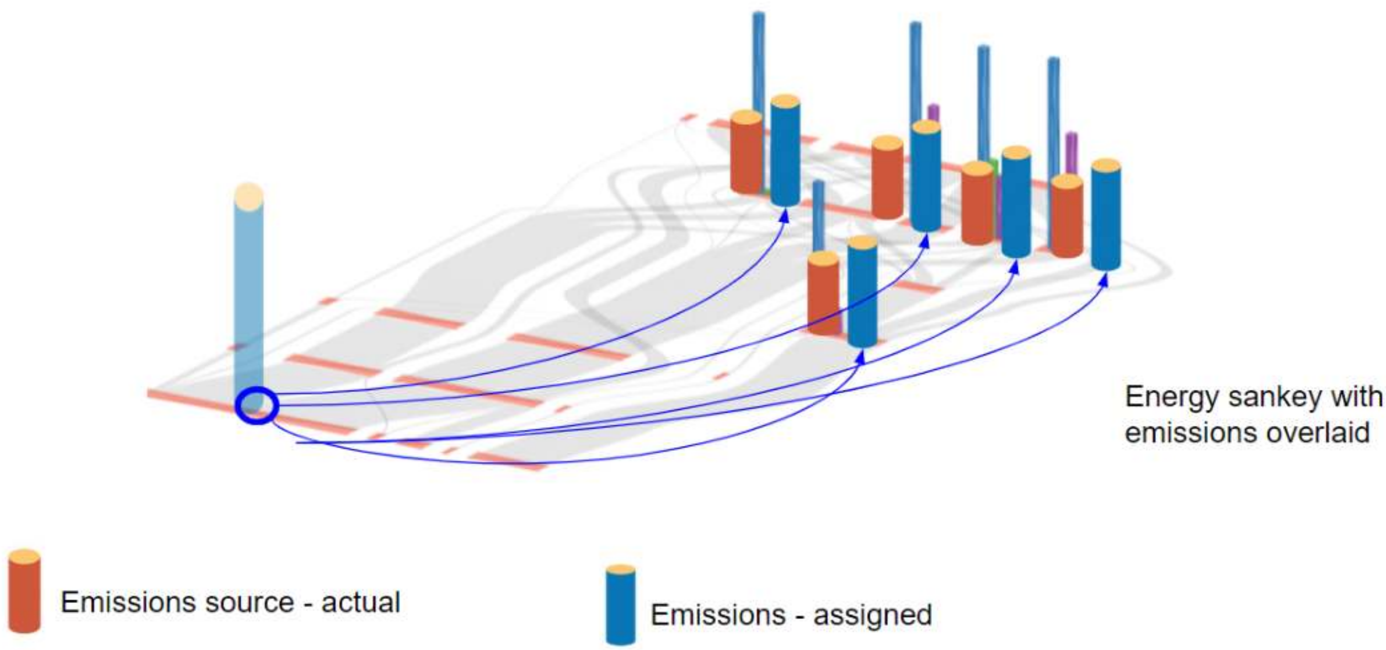

Figure 14: GHG emissions report conceptual definition

4.6 Financial Accounting

Costs and savings modelling considers upfront capital expenditures, operating and maintenance costs (including fuel and electricity), and carbon pricing. Table 4 summarizes expenditure types as evaluated.

Table 4. Categories of expenditures evaluated.

Category	Description
Residential buildings	Cost of dwelling construction and retrofitting; operating and maintenance costs (non-fuel).
Residential equipment	Cost of appliances and lighting, heating and cooling equipment.
Residential fuel	Energy costs for dwellings and residential transportation.
Residential emissions	Costs resulting from a carbon price on GHG emissions from dwellings and transportation.
Commercial buildings	Cost of building construction and retrofitting; operating and maintenance costs (non-fuel).
Commercial equipment	Cost of lighting, heating and cooling equipment.
Commercial vehicles	Cost of vehicle purchase; operating and maintenance costs (non-fuel).
Non-residential fuel	Energy costs for commercial buildings, industry and transport.
Non-residential emissions	Costs resulting from a carbon price on GHG emissions from commercial buildings, production and transportation.
Energy production emissions	Costs resulting from a carbon price on GHG emissions for fuel used in the generation of electricity and heating.
Energy production fuel	Cost of purchasing fuel for generating local electricity, heating or cooling.
Energy production equipment	Cost of the equipment for generating local electricity, heating or cooling.
Municipal capital	Cost of the transit system additions (no other forms of municipal capital assessed).
Municipal fuel	Cost of fuel associated with the transit system.
Municipal emissions	Costs resulting from a carbon price on GHG emissions from the transit system.
Energy production revenue	Revenue derived from the sale of locally generated electricity or heat.
Personal use vehicles	Cost of vehicle purchase; operating and maintenance costs (non-fuel).

Transit fleet	Costs of transit vehicle purchase.
Active transportation infrastructure.	Costs of bike lane and sidewalk construction.

A financial cost catalogue will be prepared that summarizes all the financial assumptions used in the model.

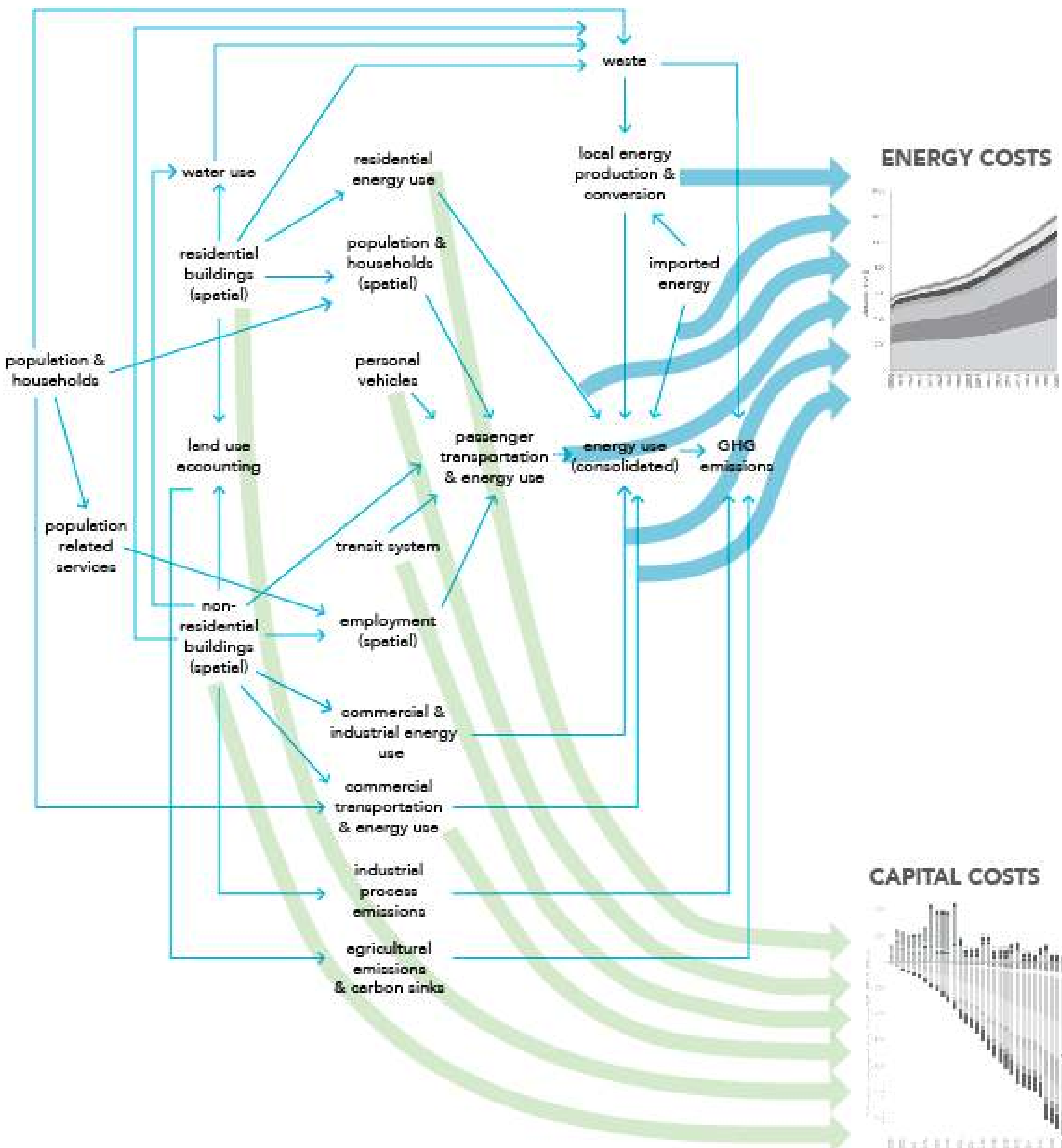

Figure 15: Conceptual diagram showing the relationship between CityInSight's biophysical model structure on the left and the derivative energy and capital cost reports on the right.

Financial Reporting Principles

The financial analysis is guided by the following reporting principles:

1. Sign convention: Costs are negative, revenue and savings are positive.
2. The financial viability of investments will be measured by their net present value.
3. All cash flows are assumed to occur on the last day of the year and for purposes of estimating their present value in Year 1 will be discounted back to time zero (the beginning of Year 1). This means that even the initial capital outlay in Year 1 will be discounted by a full year for purposes of present value calculations.
4. We will use a discount rate of 3% in evaluating the present value of future government costs and revenues.
5. Each category of stocks will have a different investment horizon
6. Any price increases included in our analysis for fuel, electricity, carbon, or capital costs will be real price increases, net of inflation.
7. Where a case can be made that a measure will continue to deliver savings after its economic life (e.g. after 25 years in the case of the longest lived measures), we will capitalize the revenue forecast for the post-horizon years and add that amount to the final year of the investment horizon cash flow.
8. In presenting results of the financial analysis, results will be rounded to the nearest thousand dollars, unless additional precision is meaningful.
9. Only actual cash flows will be included in the financial analysis.

4.7 Inputs and Outputs

The model relies on a suite of assumptions that define the various stocks and flows within the model for every time-step (year) in the model. Assumptions are detailed in Appendix i.

Baseline

For the baseline year, many model inputs come from calibrating the model with real energy datasets. This includes real building and transportation fuel data, municipal data on population, housing stock and vehicle stock etc. Other assumptions come from underlying relationships between energy stocks and flows identified through research, like the fuel efficiency of personal vehicles, the efficiency of solar PV.

Future Projections

CityInSight is designed to project how the energy flow picture and emissions profile will change in the long term by modelling potential change in:

- the context (e.g. population, development patterns),
- emissions reduction actions (that influence energy demand and the composition of stocks).

Potential changes in the system are also based on a suite of input assumptions, which are frequently referred to as “actions”. Actions are an intervention point in the model that changes the relationship between a certain stock and flow at a certain time. Action assumptions can be based on existing projections and on proposed policy design, and can be as wide ranging as the stocks and flows present in the model.

Stock-turnover models enable users to directly address questions about the penetration rates of new technologies over time constrained by assumptions such as new stock, market shares and stock retirements. Examples of outputs of the projections include energy mix, mode split, vehicle kilometres of travel (VKT), total energy costs, household energy costs, GHG emissions and others. Energy, emissions, capital and operating costs are outputs for each scenario. The emission and financial impacts of alternative climate mitigation scenarios are usually presented relative to a reference or "business as planned" scenario.

For example, an action may assume: "Starting in 2030, all new personal vehicles are electric." This assumption would be input into the model, where, starting in 2030, every time a vehicle is at the end of its life, rather than be replaced with an internal combustion engine vehicle, it is replaced with an electric vehicle. As a result, the increase in the electric vehicle stock means greater VKT allocated to electricity and less to gasoline, thereby resulting in lower emissions.

4.8 Spatial Disaggregation

As noted above, a key feature of CityInSight is the geocoded stocks and flows that underlie the energy and emissions in the community. All buildings and transportation activities are tracked within a discrete number of geographic zones, specific to the municipality. This enables consideration of the impact of land-use patterns and urban form on energy use and emissions production from a baseline year to future points in the study horizon. CityInSight outputs can be integrated with municipal mapping and GIS systems. This is the feature that allows CityInSight to support the assessment of a variety of urban climate mitigation strategies that are out of reach of more aggregate representations of the energy system. Some examples include district energy, microgrids, combined heat and power, distributed energy, personal mobility (the number, length and mode choice of trips), local supply chains, and EV infrastructure.

For stationary energy use, the foundation for the spatial representation consists of land use, zoning and property assessment databases routinely maintained by municipal governments. These databases have been geocoded in recent years and contain detailed information about the built environment that is useful for energy analysis.

For transportation energy use and emissions, urban transportation survey data characterizes personal mobility by origin, destination, trip time, and trip purpose. This in turn supports the spatial mapping of personal transportation energy use and greenhouse gas emissions by origin or destination.

4.9 Modelling Process

CityInSight is designed to support the process of developing a municipal strategy for greenhouse gas mitigation. Usually the model is engaged to identify a pathway for a community to meet a greenhouse gas emissions target by a certain year, or to stay within a cumulative carbon budget over a specified period. The generalized process is shown in Figure 16.

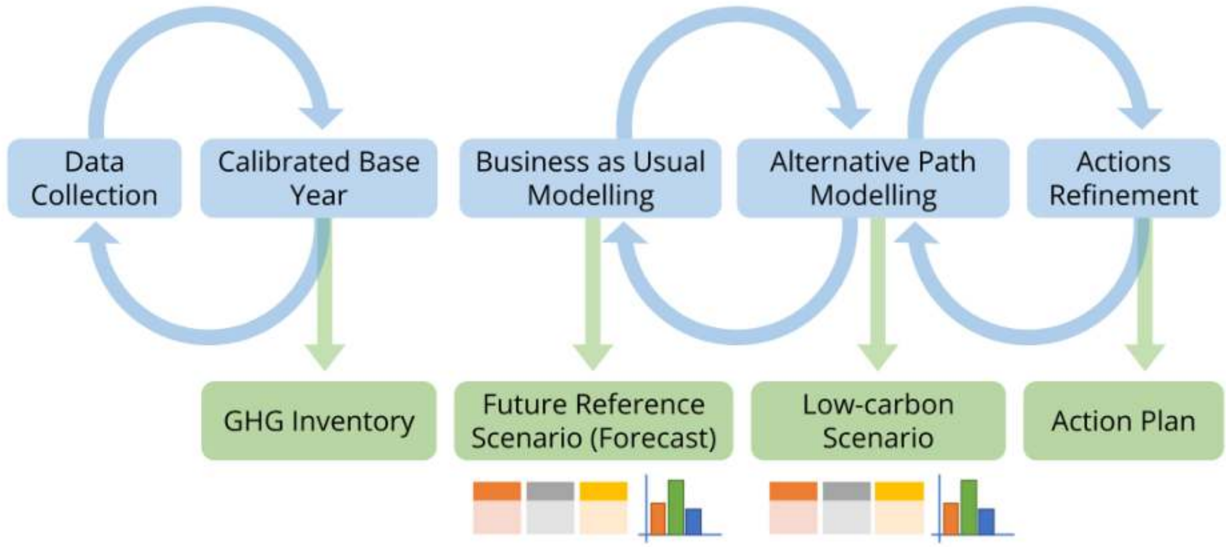

Figure 16. Schematic representation of municipal climate mitigation action plan.

<u>Data Collection and Calibration.</u>

A typical CityInSight engagement begins with an intensive data collection and calibration exercise in which the model is systematically populated with data on a wide range of stocks and flows in the community that affect greenhouse gas emissions. A picture literally emerges from this data that begins to identify where opportunities for climate change mitigation are likely to be found in the community being modeled. The calibration and inventory exercise helps establish a common understanding among community stakeholders about how the greenhouse gas emissions in their community are connected to the way they live, work and play. Relevant data are collected for variables that drive energy and emissions -- such as characteristics of buildings and transportation technologies -- and those data are reconciled with observed data from utilities and other databases. The surface area of buildings is modeled in order to most accurately estimate energy performance by end-use. Each building is tracked by vintage, structure and location, and a similar process is used for transportation stocks. Additional analysis at this stage includes local energy generation, district energy and the provincial electricity grid. The primary outcome of this process is an energy and GHG inventory for the baseline year, with corresponding visualizations.

<u>The Reference Projection.</u>

Once the baseline is completed, a "business-as-usual" (status quo, where we are at) or "business-as-planned" (planned actions in progress) projection to the target year or the horizon year of the scenario exercise is developed. This process involves identifying future population and employment and allocating the population and employment to building types and space. In the process the model is calibrated against historical data, providing a technology stock as well as an historical trend for the model variables. This process ensures that the demographics are consistent, that the stocks of buildings and their energy consumption are consistent with observed data from natural gas and electricity utilities, and that the spatial/zonal system is consistent with the municipality's GIS and transportation modelling. The projection typically includes approved developments and official plans in combination with simulation of committed energy infrastructure to be built, existing regulations and standards (for example renewable energy and fuel efficiency) and communicated policies. The projection incorporates conventional assumptions about the future development of the electrical grid, uptake of electric vehicles, building code revisions, changes in climatic conditions and other factors. The resulting projection serves as a reference line against which the impact and costs of GHG mitigation measures can be measured. Sensitivity analysis and data visualizations are used to identify the key factors and points of leverage within the reference projection.

Low carbon scenario and action plan.

CityInSight draws on an in-house database that specifies the performance and cost of technologies and measures for greenhouse gas abatement. These are used to develop a list of candidate measures for climate mitigation in the community being modelled, supplemented by additional measures and strategies that are identified in the calibration and reference projection analyses and through stakeholder engagement exercises. CityInSight inputs are developed for characterizing these measures relative to the reference projection for the community being modeled. Integrated scenarios are then generated in which packages of measures are analyzed together to ensure that there is no double counting and that interactive effects of the proposed measures are captured in the analysis.

5. Scenario Development

Scenarios are generated by identifying population projections into the future, identifying how many additional households are required and then applying those additional households according to existing land-use plans and/or alternative scenarios. A simplified transportation model evaluates the impact of the new development on transportation behaviour, building types, agricultural and forest land and other variables.

The model seeks to address five aspects of scenarios (Xiang & Clarke, 2003);

1. Alternatives: variations of housing types, locations, technologies can be expressed using scenarios in the model.
2. Consequences: the immediate and cumulative effects (physical, ecological and economical) are expressed through the outputs of the analysis and in the course of a mapping exercise.
3. Causations: causal bonds between alternatives and consequences are illustrated using transparent equations between assumptions and inputs.
4. Time frames: periods of time between implementation of the alternatives and the unfolding of their consequences are indicated in the inputs spreadsheet.
5. Geographical footprints: the place-oriented blueprints or alternatives are developed using a GIS methodology.

Throughout the CityInSight accounting framework there are input variables - for user assumptions and projections - which collectively comprise an interface to controlling the physical trajectory of the urban energy system and resultant emissions. Different settings for these inputs can be interpreted as alternative behaviours of various actors or institutions in the energy system (e.g. households, various levels of government, industry, etc). This interface can be directly set or controlled by the model user, to create "what if" type scenarios. The modelling platform upon which CityInSight is built allows for a "higher layer" of logic to operate at this physical-behavioural interface, in effect enabling a flexible mix-and-match approach to behavioral models which connect to the same constraining physical model. CityInSight is able to explore a wide variety of policies, actions and strategies. The resolution of CityInSight enables the user to apply scenarios to specific neighbourhoods, technologies, building or vehicle types or eras, and configurations of the built environment.

A table will be developed that describes the scenarios. Each row will represent a sector or subsector. Columns will describe scenarios. Each column will describe the assumptions for the scenario relevant to a sector.

Business-As-Usual Scenario

The Business-As-Usual (BAU) scenario estimates energy use and emissions volumes from the base year (2021) to the target year (2050). Because it assumes the absence of policy measures that would differ substantially from those currently in place, it can be considered a projection of what would happen if nothing changes, except for the anticipated population and economic growth. This scenario provides a reference against which to assess the impacts of currently planned rules, bills and legislation. Detailed assumptions for the BAU scenario can be found in Table 5.

Methodology

1. Calibrate model and develop a 2021 base year data for the district using observed data and filling in gaps with assumptions where necessary.
2. Input existing projected quantitative data to 2050 where available, such as:
    - Population, employment, and housing projections by transport zone
    - Build out (buildings) projections by traffic zone
    - Transportation modeling from Translink
    - Economic growth projections
    - Heating and cooling degree days projections
3. Where quantitative projections are not carried through to 2050, extrapolate what the projected trend would be to 2050.
4. Where specific quantitative projections are not available, develop projections through:
    - Analyzing current, on-the-ground action (reviewing action plans, engagement with staff, etc.), and where possible, quantifying the action.
    - Analyzing existing policy that has potential impact and, where possible, quantifying the potential impact.

Table 5. Business as Usual assumptions

Action	Details	Sources
Population Growth	45,260 people in 2021 50.35 thousand by 2030 62.93 thousand people by 2050 Average rate of growth - 609 people per year	Translink Metro Vancouver transportation modelling
Employment Growth	15,950 jobs in 2021 16,710 jobs by 2030 20,500 jobs by 2050 Average rate of growth - 157 jobs per year	
Heating and Cooling Degree Days	Projections of Heating and Cooling degree days	Climate Change in Canada | Climate Atlas of Canada
Energy Use by Buildings	Baseline building equipment types/stocks held from 2021-2050.	BC Community Energy and Emissions Inventory Natural Resources Canada Comprehensive Energy Use Database
New Building Growth	Residential buildings: Buildings are added alongside population growth; building types added based on the building mix of zones where population growth is happening. Non-residential buildings: Growth based on projected growth in employment; building types added based on building mix of zones where job growth is happening.	

Business-As-Planned Scenario

The Business-As-Planned (BAP) scenario estimates energy use and emissions volumes from the base year (2021) to the target year (2050), incorporating assumptions about the likely effects of planned policies and programs.

Methodology

- Create BAU (see steps above)
- Add additional assumptions to the BAU to capture known policies and plans that are or will be implemented in the coming years. Key programs and pieces of legislation reflected in the BAP:
    - Clean BC strategies
    - BC Energy Step Code which requires new buildings to meet specified energy efficiency standards
    - Translink Transport 2050 plan

Detailed assumptions for the BAP scenario can be found in Table 6.

Table 6. Business as Planned assumptions

Action	Specification
Buildings	
New Residential Building Code Standards	Follow BC Step Code: 20 percent more energy efficient by 2023, 40 percent more energy efficient by 2027, and up to 80 percent more energy efficient by 2032
New Non-Residential Building Code Standards	
Transition to heat pumps for residential space conditioning and water heating	Clean BC - 160,000 new residential heat pumps installed province wide - scaled by population West Vancouver gets 1,412
Transition to heat pumps for non-residential space conditioning and water heating	Clean BC - 53 million m2 commercial floorspace heated by heat pumps province wide - scaled by floorspace West Vancouver gets 0.47 million m2
Transportation	
Increase transit ridership	Translink plans - expand transit through higher occupancy rates and extra service
Electrify personal use vehicles	Percentage of new vehicles (sales) that are electric by: 2026 - 26% (Clean BC) 2030 - 90% (Clean BC) 2035 - 100% (Federal)
Zero emission commercial use vehicles	Clean BC - Percentage of new vehicles (sales) that are zero emission by 2030: Electric - 10% Natural Gas - 16%
Low Carbon Fuel Standard	Emissions intensity of new light-duty vehicles declines by over 10% to 105g/km in 2030. Emissions intensity of new heavy-duty vehicles declines by 20% by 2025 and 24% by 2030, relative to 2015
Energy	
Net Zero Provincial Grid	Clean BC - Net-zero electricity generation by 2030
Blend RNG into NG	Clean BC - Begin with 2% RNG in natural gas supply in 2020, and increase to reach 15% by 2030 RNG content for all buildings.
Waste	
Waste Diversion Targets	CleanBC - 95% organics diversion

Business-As-Planned + Scenario

The Business-As-Planned + (BAP+) scenario estimates energy use and emissions volumes from the base year (2021) to the target year (2050), incorporating assumptions about the likely effects of planned policies and programs specific to the District of West Vancouver that go beyond Clean BC. Detailed assumptions for the BAU scenario can be found in Table 7.

Methodology

- Create BAP (see steps above)
- Add additional assumptions to the BAP to capture known policies and plans that are or will be implemented in the coming years. Key programs and pieces of legislation reflected in the BAP+:
    - Cypress Village, Eagle Ridge, Horseshoe Bay, Ambleside and Marine Drive Local Area Plans
    - BC Energy Step Code which requires new buildings to meet specified energy efficiency standards
    - West Vancouver Fleet Strategy

Table 7. Business as Planned + assumptions

Action	Specification
Buildings	
Increase density of development in urban zones	Fraction of single new builds to be reduced in Horseshoe Bay, Ambleside Marine Drive and Cypress Village according to LAPs by 2040, decrease in personal use vehicle kilometers traveled
New Residential Building Code Standards	Implement BC Step Code faster: 40 per cent more energy efficient by 2023, 80 per cent more energy efficient by 2027
New Non-Residential Building Code Standards	
Transportation	
Electrify municipal vehicles	WestVan fleet strategy, 33-50% of fleet electric by 2030

Low Carbon Scenario

The Low Carbon (LC) scenario estimates energy use and emissions volumes from the base year (2021) to the target year (2050), incorporating assumptions about future planned policies and programs that are implemented by a range of actors including local government, provincial government, federal government, citizens and industry.

Methodology

- Create BAP+ (see steps above)
- Add additional assumptions (outlined in the table below) to the BAP+ with the goal of reaching emission reductions targets

Table 8. Low Carbon assumptions

Action	Specification
Buildings	
Increase density of development in urban zones	Implementation of Taylor Way LAP by 2040, 600 new high density units
Deep retrofits in the residential building stock	Retrofit 95% of existing buildings by 2040 to achieve a 50% reduction in space heating/cooling and a 20% reduction other non water heating energy use
Deep retrofits in the commercial and institutional building stock	Retrofit 95% of existing buildings by 2040 to achieve a 50% reduction in space heating/cooling and a 20% reduction other non water heating energy use
Deep retrofits in the municipal building stock	100% of municipal buildings use zero emissions energy by 2035
Transition to heat pumps for residential space conditioning and water heating	95% of existing buildings are equipped with electric heat pumps for space and water heating by 2040. Heat pumps are installed when existing equipment needs to be replaced.
Transition to heat pumps for commercial space conditioning and water heating	95% of existing commercial buildings are equipped with electric heat pumps for space and water heating by 2040. Heat pumps are installed when existing equipment needs to be replaced.
Transportation	
Zero emission municipal vehicles	100% ZEV by 2040 includes light duty electric, renewable diesel, CRNG and hydrogen
Zero emission commercial use vehicles	100% of vehicle stock is zero emission by 2050, includes a mix of electricity, H2 and RNG
Energy	
Enable distributed energy resources with Enhanced Energy Storage	Add 142 MW of rooftop solar capacity to residential and commercial buildings by 2040. Add 19 MW of energy storage to non apartment residential buildings equipped with rooftop solar by 2040. Assume each energy storage unit is 14 kWh.
Blend green hydrogen into the natural gas supply	Blend up to 15% hydrogen into the natural gas supply by 2035 and enacted a new round of standards for appliances and equipment beyond those codified in 2021 to support.

Blend RNG into the natural gas supply	Replace remaining natural gas with 100% RNG 2040.
Waste	
Waste Diversion Targets	100% organics diversion -residential 100% methane capture from landfills. 50% of commercial/construction waste by 2050 compared to 2016 levels

6. Addressing Uncertainty

There is extensive discussion of the uncertainty in models and modelling results. The assumptions underlying a model can be from other locations or large data sets and do not reflect local conditions or behaviours, and even if they did accurately reflect local conditions, it is exceptionally difficult to predict how those conditions and behaviours will respond to broader societal changes and what those broader societal changes will be (the “unknown unknowns”).

An analysis of land-use models used to assess climate change impacts for Sydney, Australia, emphasised that the models should be used only for scenario testing and not forecasting because of limits to the possible precision. The importance of this point is demonstrated by the fact that the models considered in this analysis can generate a range of outcomes from the same starting point (Oydell et al., 2007, pg. 10).

The modelling approach identifies four strategies for managing uncertainty applicable to community energy and emissions modelling:

1. Sensitivity analysis: From a methodological perspective, one of the most basic ways of studying complex models is sensitivity analysis, quantifying uncertainty in a model’s output. To perform this assessment, each of the model’s input parameters is described as being drawn from a statistical distribution in order to capture the uncertainty in the parameter’s true value (Keirstead, Jennings, & Sivakumar, 2012).

> Approach: Each of the variables will be increased by 10-20% to illustrate the impact that an error of that magnitude has on the overall total.

2. Calibration: One way to challenge the untested assumptions is the use of ‘back-casting’ to ensure the model can ‘forecast’ the past accurately. The model can then be calibrated to generate historical outcomes, which usually refers to "parameter adjustments" that "force" the model to better replicate observed data.

> Approach: Variables for which there are two independent sources of data are calibrated in the model. For example, the model calibrates building energy use (derived from buildings data) against actual electricity data from the electricity distributor.

3. Scenario analysis: Scenarios are used to demonstrate that a range of future outcomes are possible given the current conditions that no one scenario is more likely than another.

> Approach: The model will develop a reference scenario.

4. Transparency: The provision of detailed sources for all assumptions is critical to enabling policy-makers to understand the uncertainty intrinsic in a model.

> Approach: The assumptions and inputs are presented in this document.

Appendix 1: GPC Emissions Scope Table

Blue rows = Sources required for GPC BASIC inventory

Green rows = Sources required GPC BASIC+ inventory

Red rows = Sources required for territorial total but not for BASIC/BASIC+ reporting

Reason for Exclusion Rationale Legend

N/A	Not Applicable, or not included in scope
ID	Insufficient Data
NR	No Relevance, or limited activities identified
Other	Reason provided in other comments

Table 1-1 GPC Community Emissions Summary

Sector		Total by Scope (tCO2e)			Total
		Scope 1	Scope 2	Scope 3	
Stationery Energy	Energy use (all I emissions except I.4.4)	151,950	3,221	107	155,278
	*Energy generation supplied to the grid (I.4.4) **	0			
Transportation (all II emissions)		73,848	85	35,093	109,027
Waste	Generated in the municipality (all III.X.1 and III.X.2)	0		4,170	4,170
	Generated outside municipality (all III.X.3)				
Total		225,798	3,306	39,371	**268,475**

Table 1-2 GPC Detailed Community Emissions

GPC ref No.	Scope	GHG Emissions Source	Inclusion	Exclusion	CO2 (in tonnes)	CH4	N2O	Total CO2e
I		**STATIONARY ENERGY SOURCES**						
I.1		**Residential buildings**						
I.1.1	1	*Emissions from fuel combustion within the municipal boundary*	**Yes**		108,588	58	539	109,184
I.1.2	2	*Emissions from grid-supplied energy consumed within the municipal boundary*	**Yes**		2,386	0	0	2,386
I.1.3	3	*Emissions from transmission and distribution losses from grid-supplied energy consumption*	**Yes**		79	0	0	79
I.2		**Commercial and institutional buildings/facilities**						
I.2.1	1	*Emissions from fuel combustion within the municipal boundary*	**Yes**		39,569	21	240	39,830
I.2.2	2	*Emissions from grid-supplied energy consumed within the municipal boundary*	**Yes**		835	0	0	835
I.2.3	3	*Emissions from transmission and distribution losses from grid-supplied energy consumption*	**Yes**		28	0	0	28
I.3		**Manufacturing industry and construction**						
I.3.1	1	*Emissions from fuel combustion within the municipal boundary*	**Yes**		0	0	0	0
I.3.2	2	*Emissions from grid-supplied energy consumed within the municipal boundary*	**Yes**		0	0	0	0
I.3.3	3	*Emissions from transmission and distribution losses from grid-supplied energy consumption*	**Yes**		0	0	0	0
I.4		**Energy industries**						
I.4.1	1	*Emissions from energy used in power plant auxiliary operations within the municipal boundary*	**No**	NR	0	0	0	0
I.4.2	2	*Emissions from grid-supplied energy consumed in power plant auxiliary operations within the municipal boundary*	**No**	NR	0	0	0	0
I.4.3	3	*Emissions from transmission and distribution losses from grid-supplied energy consumption in power plant auxiliary operations*	**No**	NR	0	0	0	0
I.4.4	1	*Emissions from energy generation supplied to the grid*	**No**	NR	0	0	0	0
I.5		**Agriculture, forestry and fishing activities**						
I.5.1	1	*Emissions from fuel combustion within the municipal boundary*	**Yes**		0	0	0	0

I.5.2	*2*	*Emissions from grid-supplied energy consumed within the municipal boundary*	***No***	*NR*	*0*	*0*	*0*	*0*
I.5.3	*3*	*Emissions from transmission and distribution losses from grid-supplied energy consumption*	***No***	*NR*	*0*	*0*	*0*	*0*
I.6		***Non-specified sources***						
I.6.1	*1*	*Emissions from fuel combustion within the municipal boundary*	***No***	*NR*	*0*	*0*	*0*	*0*
I.6.2	*2*	*Emissions from grid-supplied energy consumed within the municipal boundary*	***No***	*NR*	*0*	*0*	*0*	*0*
I.6.3	*3*	*Emissions from transmission and distribution losses from grid-supplied energy consumption*	***No***	*NR*	*0*	*0*	*0*	*0*
I.7		***Fugitive emissions from mining, processing, storage, and transportation of coal***						
I.7.1	*1*	*Emissions from fugitive emissions within the municipal boundary*	***No***	*NR*	*0*	*0*	*0*	*0*
I.8		***Fugitive emissions from oil and natural gas systems***						
I.8.1	*1*	*Emissions from fugitive emissions within the municipal boundary*	***Yes***		*4*	*2,932*	*0*	*2,936*
II		***TRANSPORTATION***						
II.1		***On-road transportation***						
II.1.1	*1*	*Emissions from fuel combustion for on-road transportation occurring within the municipal boundary*	***Yes***		73,016	158	532	73,706
II.1.2	*2*	*Emissions from grid-supplied energy consumed within the municipal boundary for on-road transportation*	***Yes***		85	0	0	85
II.1.3	*3*	*Emissions from portion of transboundary journeys occurring outside the municipal boundary, and transmission and distribution losses from grid-supplied energy consumption*	***Yes***		*34,926*	*65*	*102*	*35,093*
II.2		***Railways***						
II.2.1	*1*	*Emissions from fuel combustion for railway transportation occurring within the municipal boundary*	***No***	*NR*	*0*	*0*	*0*	*0*
II.2.2	*2*	*Emissions from grid-supplied energy consumed within the municipal boundary for railways*	***No***	*NR*	*0*	*0*	*0*	*0*
II.2.3	*3*	*Emissions from portion of transboundary journeys occurring outside the municipal boundary, and transmission and distribution losses from grid-supplied energy consumption*	***No***	*NR*	*0*	*0*	*0*	*0*
II.3		***Water-borne navigation***						
II.3.1	*1*	*Emissions from fuel combustion for waterborne navigation occurring within the municipal boundary*	***No***	*N/A*	*0*	*0*	*0*	*0*

II.3.2	2	Emissions from grid-supplied energy consumed within the municipal boundary for waterborne navigation	**No**	N/A	0	0	0	0
II.3.3	3	Emissions from portion of transboundary journeys occurring outside the municipal boundary, and transmission and distribution losses from grid-supplied energy consumption	**No**	N/A	0	0	0	0
II.4		**Aviation**						
II.4.1	1	Emissions from fuel combustion for aviation occurring within the municipal boundary	**No**	N/A	0	0	0	0
II.4.2	2	Emissions from grid-supplied energy consumed within the municipal boundary for aviation	**No**	N/A	0	0	0	0
II.4.3	3	Emissions from portion of transboundary journeys occurring outside the municipal boundary, and transmission and distribution losses from grid-supplied energy consumption	**No**	N/A	0	0	0	0
II.5		**Off-road**						
II.5.1	1	Emissions from fuel combustion for off-road transportation occurring within the municipal boundary	**Yes**	NR	139	0	3	143
II.5.2	2	Emissions from grid-supplied energy consumed within the municipal boundary for off-road transportation	**No**	NR	0	0	0	0
III		**WASTE**						
III.1		**Solid waste disposal**						
III.1.1	1	Emissions from solid waste generated within the municipal boundary and disposed in landfills or open dumps within the municipal boundary	**Yes**		0	0	0	0
III.1.2	3	Emissions from solid waste generated within the municipal boundary but disposed in landfills or open dumps outside the municipal boundary	**Yes**		0	2,890	0	2,890
III.1.3	1	Emissions from waste generated outside the municipal boundary and disposed in landfills or open dumps within the municipal boundary	**No**	N/A	0	0	0	0
III.2		**Biological treatment of waste**						
III.2.1	1	Emissions from solid waste generated within the municipal boundary that is treated biologically within the municipal boundary	**No**	N/A	0	0	0	0
III.2.2	3	Emissions from solid waste generated within the municipal boundary but treated biologically outside of the municipal boundary	**Yes**	N/A	0	665	488	1,153
III.2.3	1	Emissions from waste generated outside the municipal boundary but treated biologically within the municipal boundary	**No**	N/A	0	0	0	0
III.3		**Incineration and open burning**						

III.3.1	*1*	*Emissions from solid waste generated and treated within the municipal boundary*	**No**	*N/A*	*0*	*0*	*0*	*0*
III.3.2	*3*	*Emissions from solid waste generated within the municipal boundary but treated outside of the municipal boundary*	**No**	*N/A*	*0*	*0*	*0*	*0*
III.3.3	*1*	*Emissions from waste generated outside the municipal boundary but treated within the municipal boundary*	**No**	*N/A*	*0*	*0*	*0*	*0*
III.4		***Wastewater treatment and discharge***						
III.4.1	*1*	*Emissions from wastewater generated and treated within the municipal boundary*	**No**	*N/A*	*0*	*0*	*0*	*0*
III.4.2	*3*	*Emissions from wastewater generated within the municipal boundary but treated outside of the municipal boundary*	**Yes**		*0*	*0*	*127*	*127*
III.4.3	*1*	*Emissions from wastewater generated outside the municipal boundary*	**No**	*N/A*	*0*	*0*	*0*	*0*
IV		***INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)***						
IV.1	*1*	*Emissions from industrial processes occurring within the municipal boundary*	**No**	*NR*	*0*	*0*	*0*	*0*
IV.2	*1*	*Emissions from product use occurring within the municipal boundary*	**No**	*NR*	*0*	*0*	*0*	*0*
V		***AGRICULTURE, FORESTRY AND LAND USE (AFOLU)***						
V.1	*1*	*Emissions from livestock within the municipal boundary*	**No**	*NR*	*0*	*0*	*0*	*0*
V.2	*1*	*Emissions from land within the municipal boundary*	**No**	*NR*	*0*	*0*	*0*	*0*
V.3	*1*	*Emissions from aggregate sources and non-CO2 emission sources on land within the municipal boundary*	**No**	*NR*	*0*	*0*	*0*	*0*
VI		***OTHER SCOPE 3***						
VI.1	*3*	*Other Scope 3*	**No**	*N/A*	*0*	*0*	*0*	*0*

TOTAL	***268,475***

Table 1-3 GPC District Emissions Summary

Sector		Total by Scope (tCO2e)			Total
		Scope 1	Scope 2	Scope 3	
Stationery Energy	Energy use (all I emissions except I.4.4)	2,659	420	14	3,093
	*Energy generation supplied to the grid (I.4.4) **				

Transportation (all II emissions)		970	0	0	970
Waste	Generated in the municipal (all III.X.1 and III.X.2)	0		4,170	4,170
	Generated outside municipal (all III.X.3)				
Total		3,629	420	4,184	**8,234**

Table 1-4 GPC Detailed District Emissions

					in tonnes			
GPC ref No.	***Scope***	***GHG Emissions Source***	***Inclusion***	***Exclusion***	***CO2***	***CH4***	***N2O***	***Total CO2e***
I		***STATIONARY ENERGY SOURCES***						
I.1		***Residential buildings***						
I.1.1	*1*	*Emissions from fuel combustion within the municipal boundary*	***Yes***					
I.1.2	*2*	*Emissions from grid-supplied energy consumed within the municipal boundary*	***Yes***					
I.1.3	*3*	*Emissions from transmission and distribution losses from grid-supplied energy consumption*	***Yes***					
I.2		***Commercial and institutional buildings/facilities***						
I.2.1	*1*	*Emissions from fuel combustion within the municipal boundary*	***Yes***		*2,421*	*2*	*16*	*2,439*
I.2.2	*2*	*Emissions from grid-supplied energy consumed within the municipal boundary*	***Yes***		*416*	*1*	*3*	*420*
I.2.3	*3*	*Emissions from transmission and distribution losses from grid-supplied energy consumption*	***Yes***		*14*	*0*	*0*	*14*
I.3		***Manufacturing industry and construction***						
I.3.1	*1*	*Emissions from fuel combustion within the municipal boundary*	***Yes***					
I.3.2	*2*	*Emissions from grid-supplied energy consumed within the municipal boundary*	***Yes***					
I.3.3	*3*	*Emissions from transmission and distribution losses from grid-supplied energy consumption*	***Yes***					
I.4		***Energy industries***						
I.4.1	*1*	*Emissions from energy used in power plant auxiliary operations within the municipal boundary*	***No***	*NR*				
I.4.2	*2*	*Emissions from grid-supplied energy consumed in power plant auxiliary operations within the municipal boundary*	***No***	*NR*				

I.4.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption in power plant auxiliary operations	**No**	NR				
I.4.4	1	Emissions from energy generation supplied to the grid	**No**	NR				
I.5		***Agriculture, forestry and fishing activities***						
I.5.1	1	Emissions from fuel combustion within the municipal boundary	**Yes**					
I.5.2	2	Emissions from grid-supplied energy consumed within the municipal boundary	**No**	NR				
I.5.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption	**No**	NR				
I.6		***Non-specified sources***						
I.6.1	1	Emissions from fuel combustion within the municipal boundary	**No**	NR				
I.6.2	2	Emissions from grid-supplied energy consumed within the municipal boundary	**No**	NR				
I.6.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption	**No**	NR				
I.7		***Fugitive emissions from mining, processing, storage, and transportation of coal***						
I.7.1	1	Emissions from fugitive emissions within the municipal boundary	**No**	NR				
I.8		***Fugitive emissions from oil and natural gas systems***						
I.8.1	1	Emissions from fugitive emissions within the municipal boundary	**Yes**		0	220	0	220
II		TRANSPORTATION						
II.1		***On-road transportation***						
II.1.1	1	Emissions from fuel combustion for on-road transportation occurring within the municipal boundary	**Yes**		817	1	9	828
II.1.2	2	Emissions from grid-supplied energy consumed within the municipal boundary for on-road transportation	**Yes**		0	0	0	
II.1.3	3	Emissions from portion of transboundary journeys occurring outside the municipal boundary, and transmission and distribution losses from grid-supplied energy consumption	**Yes**		0	0	0	
II.2		***Railways***						
II.2.1	1	Emissions from fuel combustion for railway transportation occurring within the municipal boundary	**No**	NR				
II.2.2	2	Emissions from grid-supplied energy consumed within the municipal boundary for railways	**No**	NR				
II.2.3	3	Emissions from portion of transboundary journeys occurring outside the municipal boundary, and transmission and distribution losses from grid-supplied energy consumption	**No**	NR				
II.3		***Water-borne navigation***						

II.3.1	1	Emissions from fuel combustion for waterborne navigation occurring within the municipal boundary	**No**	N/A				
II.3.2	2	Emissions from grid-supplied energy consumed within the municipal boundary for waterborne navigation	**No**	N/A				
II.3.3	3	Emissions from portion of transboundary journeys occurring outside the municipal boundary, and transmission and distribution losses from grid-supplied energy consumption	**No**	N/A				
II.4		**Aviation**						
II.4.1	1	Emissions from fuel combustion for aviation occurring within the municipal boundary	**No**	N/A				
II.4.2	2	Emissions from grid-supplied energy consumed within the municipal boundary for aviation	**No**	N/A				
II.4.3	3	Emissions from portion of transboundary journeys occurring outside the municipal boundary, and transmission and distribution losses from grid-supplied energy consumption	**No**	N/A				
II.5		**Off-road**						
II.5.1	1	Emissions from fuel combustion for off-road transportation occurring within the municipal boundary	**No**	NR	139	0	3	142
II.5.2	2	Emissions from grid-supplied energy consumed within the municipal boundary for off-road transportation	**No**	NR				
III		**WASTE**						
III.1		**Solid waste disposal**						
III.1.1	1	Emissions from solid waste generated within the municipal boundary and disposed in landfills or open dumps within the municipal boundary	**Yes**		0	0	0	0
III.1.2	3	Emissions from solid waste generated within the municipal boundary but disposed in landfills or open dumps outside the municipal boundary	**Yes**		0	2,890	0	2,890
III.1.3	1	Emissions from waste generated outside the municipal boundary and disposed in landfills or open dumps within the municipal boundary	**No**	N/A	0	0	0	0
III.2		**Biological treatment of waste**						
III.2.1	1	Emissions from solid waste generated within the municipal boundary that is treated biologically within the municipal boundary	**Yes**		0	0	0	0
III.2.2	3	Emissions from solid waste generated within the municipal boundary but treated biologically outside of the municipal boundary	**No**	N/A	0	665	488	1,153
III.2.3	1	Emissions from waste generated outside the municipal boundary but treated biologically within the municipal boundary	**No**	N/A	0	0	0	0
III.3		**Incineration and open burning**						
III.3.1	1	Emissions from solid waste generated and treated within the municipal boundary	**No**	N/A	0	0	0	0
III.3.2	3	Emissions from solid waste generated within the municipal	**No**	N/A	0	0	0	0

		boundary but treated outside of the municipal boundary						
III.3.3	*1*	*Emissions from waste generated outside the municipal boundary but treated within the municipal boundary*	**No**	*N/A*	*0*	*0*	*0*	*0*
III.4		***Wastewater treatment and discharge***						
III.4.1	*1*	*Emissions from wastewater generated and treated within the municipal boundary*	**Yes**		*0*	*0*	*0*	*0*
III.4.2	*3*	*Emissions from wastewater generated within the municipal boundary but treated outside of the municipal boundary*	**No**	*NR*	*0*	*0*	*127*	*127*
III.4.3	*1*	*Emissions from wastewater generated outside the municipal boundary*	**No**	*N/A*	*0*	*0*	*0*	*0*
IV		***INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)***						
IV.1	*1*	*Emissions from industrial processes occurring within the municipal boundary*	**No**	*ID*				
IV.2	*1*	*Emissions from product use occurring within the municipal boundary*	**No**	*ID*				
V		***AGRICULTURE, FORESTRY AND LAND USE (AFOLU)***						
V.1	*1*	*Emissions from livestock within the municipal boundary*	**No**	*NR*				
V.2	*1*	*Emissions from land within the municipal boundary*	**No**	*NR*				
V.3	*1*	*Emissions from aggregate sources and non-CO2 emission sources on land within the municipal boundary*	**No**	*NR*				
VI		***OTHER SCOPE 3***						
VI.1	*3*	*Other Scope 3*	**No**	*N/A*				

TOTAL	***8,234***

Appendix 2: Data Sources & Uses

Table 2-1. Input assumptions and calibration targets.

Data	Source	Use
Population by age, sex	Stats Canada - 2021 census profile	Calibration target
Population by zone	Translink - Metro Vancouver transportation model	Calibration target
Residential buildings by parcel, type, and year built	BC Assessment - Building Information Report, 2019	Input assumption
Employment by zone	Translink - Metro Vancouver transportation model	Calibration target
Non-residential buildings by parcel, type and year built	BC Assessment - Building Information Report, 2019	Input assumption
Natural gas consumption by sector	BC Community Energy and Emissions Inventory	Calibration target
Electricity consumption by sector	BC Community Energy and Emissions Inventory	Calibration target
Gasoline and diesel fuel use	Kalibrate Canada, Inc. - fuel sales report	Calibration target
End use equipment fuel shares	NRCAN Comprehensive Energy Use Database ● Residential Sector - Table 21 ● Commercial Sector - Table 3	Input assumption
Personal use vehicles	ICBC vehicle registration data	Calibration target
Personal use vehicles kilometers and fuel use	Translink - Metro Vancouver transportation model	Calibration target
Transit kilometers and fuel use	Translink	Input assumption
Heating and cooling degree days by county	Climate Atlas of Canada	Input assumption
Waste consumption	District of West Vancouver	Input assumption
Wastewater treatment properties	District of West Vancouver	Input assumption

Appendix 3: Emission Factors

Table 3-1. Fuel emission factors

Category	Value	Comment
Natural gas	49 kg CO2e/GJ	Environment and Climate Change Canada. National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada. Part 2. Tables A6-1 and A6-2, Emission Factors for Natural Gas.
Electricity	g/kWh CO2: 40.1 CH4: 0.000952 N2O: 0.000243	2017 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions
Gasoline	g/L CO2: 2316 CH4: 0.32 N2O: 0.66	Environment and Climate Change Canada. National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada. Part 2. Table A6–12 Emission Factors for Energy Mobile Combustion Sources
Diesel	g/L CO2: 2690 CH4: 0.07 N2O: 0.21	Environment and Climate Change Canada. National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada. Part 2. Table A6–12 Emission Factors for Energy Mobile Combustion Sources
Fuel oil	Residential g/L CO2: 2560 CH4: 0.026 N2O: 0.006 Commercial g/L CO2: 2753 CH4: 0.026 N2O: 0.031 Industrial g/L CO2: 2753 CH4: 0.006 N2O: 0.031	Environment and Climate Change Canada. National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada. Part 2. Table A6–4 Emission Factors for Refined Petroleum Products
Wood	Residential kg/GJ CO2: 299.8 CH4: 0.72 N2O: 0.007 Commercial kg/GJ CO2: 299.8 CH4: 0.72 N2O: 0.007	Environment and Climate Change Canada. National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada. Part 2. Table A6–56 Emission Factors for Biomass

	Industrial kg/GJ CO_2: 466.8 CH_4: 0.0052 N_2O: 0.0036	
Propane	Transport g/L CO_2: 1515 CH_4: 0.64 N_2O: 0.03 Residential g/L CO_2: 1515 CH_4 : 0.027 N_2O: 0.108 All other sectors g/L CO_2: 1515 CH_4: 0.024 N_2O: 0.108	Environment and Climate Change Canada. National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada. Part 2. Table A6–3 Emission Factors for Natural Gas Liquids Table A6–12 Emission Factors for Energy Mobile Combustion Sources
Waste	Landfill emissions are calculated from first order decay of degradable organic carbon deposited in landfill. Derived emission factor in 2016 = 0.015 kg CH_4/tonne solid waste (assuming 70% recovery of landfill methane); 0.050 kg CH_4/tonne solid waste not accounting for recovery.	Landfill emissions: IPCC Guidelines Vol 5. Ch 3, Equation 3.1
Wastewater	CH_4: 0.48 kg CH_4/kg BOD N_2O: 3.2 g / (person * year) from advanced treatment 0.005 g /g N from wastewater discharge	CH_4 wastewater: IPCC Guidelines Vol 5. Ch 6, Tables 6.2 and 6.3; MCF value for anaerobic digester N_2O from advanced treatment: IPCC Guidelines Vol 5. Ch 6, Box 6.1 N_2O from wastewater discharge: IPCC Guidelines Vol 5. Ch 6, Section 6.3.1.2

Table 2-2. Global Warming Potentials for selected greenhouse gases

Greenhouse gases	Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N20) are included. Global Warming Potential CO_2 = 1 CH_4 = 34 N_2O = 298	Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3) are not included.

Appendix 4: Financial Data Dictionary