Community Energy and Emissions Plan

City of North Vancouver

Prepared for:

Prepared by:

HB LANARC
PLANNING DESIGN SUSTAINABILITY

April 6, 2010

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Executive Summary

Climate change will be a defining challenge for the 21st Century. The balance of scientific evidence shows that the climate is changing, and that this change is attributable to the surge in greenhouse gas emissions generated predominantly by the combustion of fossil fuels, such as oil, coal and gas. Communities are immensely vulnerable to climate change and at the same time have significant influence over emissions. Strategically taking action to reduce greenhouse gas emissions can advance an integrated sustainability agenda that simultaneously reinforces other community priorities, such as reduced energy spending, improved long term fiscal performance, better mobility and a more liveable community.

Given the City of North Vancouver's relatively low per capita emissions and current actions, this Plan is fundamentally about deepening the course of current land use, development, transportation, infrastructure and waste management activities and priorities. Achieving the deep emission reductions outlined in this Plan involves a significant commitment by the City. Moreover, it assumes, and will require, collaboration and commitment from the Province, the Federal Government, utilities, as well as businesses, non-governmental organizations and residents.

This Community Energy and Emission Plan provides analysis to support the Official Community Plan Amendment necessary for the City to comply with the new Local Government Act requirements to include greenhouse gas reduction targets, policies and actions by May 31, 2010.

The Plan's objectives are to:

- Develop a climate and energy vision that supports core City priorities;
- Develop a high level framework that builds on and guides existing City activity, with new sector-specific policies and actions;
- Estimate the near term costs of climate and energy-related policies and actions;
- Develop defensible and meaningful greenhouse gas reduction target(s).

In 2007, residents, businesses and the City generated 225,763 tonnes CO_2e, or 5 tonnes CO_2e per capita.

A Low Carbon Energy and Emissions Path was developed, encompassing the emissions reduction strategies presented in this Plan. It melds rigorous quantitative analysis and realistic local and senior government policy considerations with meaningful engagement, while being informed by existing City of North Vancouver plans, programs and policies.

The overarching strategies for reducing emissions in each sector are the following:

Land use planning: Increasing density and integrating residential and commercial uses in key zones. The *Low Carbon Path* has been built around one possible way in which future growth could be accommodated. Most of the proposed increase in density is concentrated in Lower and Central Lonsdale according to Smart Growth principles. The forthcoming OCP Update process will ultimately determine how these land uses would be amended. These changes are a major driving factor in future energy use and emission reductions and are integral to many sector-specific strategies.

Buildings: Constructing and retrofitting buildings to be more energy efficient, and maximizing opportunities for renewable energy sources and usage.

Transportation: Making walking, bicycling and transit easier; reducing distance driven by cars; improving transit service; and making private vehicles and transit less GHG intensive.

Energy Supply: Decreasing carbon intensity of the energy supply through efficient systems, the expansion and de-carbonisation of Lonsdale Energy Corp's district energy systems and onsite renewable energy opportunities.

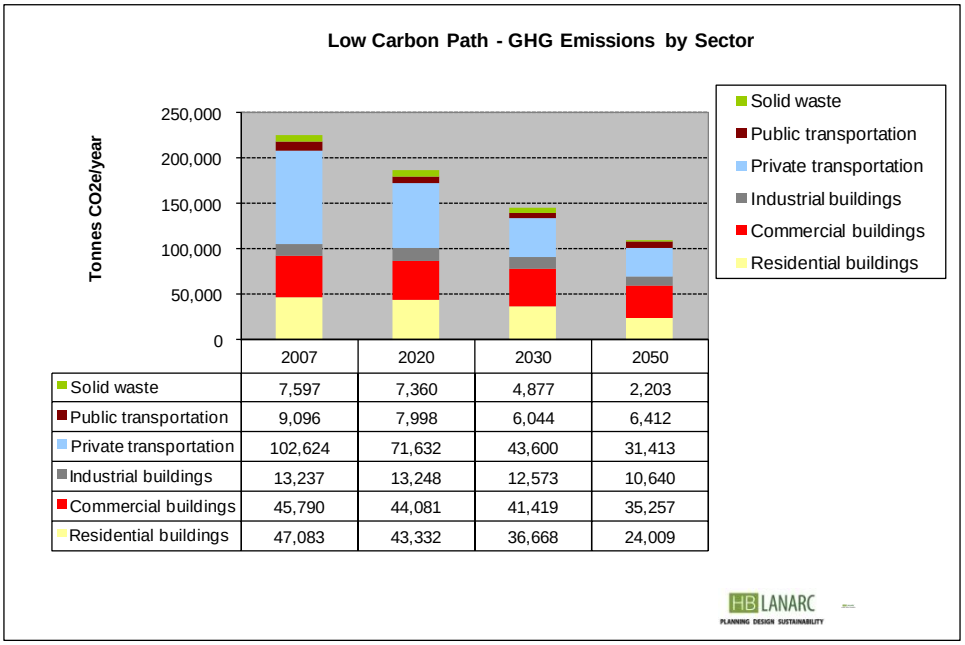
Solid Waste: Reducing the volume of waste *and* recyclables; and diverting waste from disposal through composting and recycling.

Urban Agriculture & Landscape: Focus on community gardening and urban agriculture to reduce emissions associated with today's food supply; and expanding urban trees and forests to improve carbon sinks.

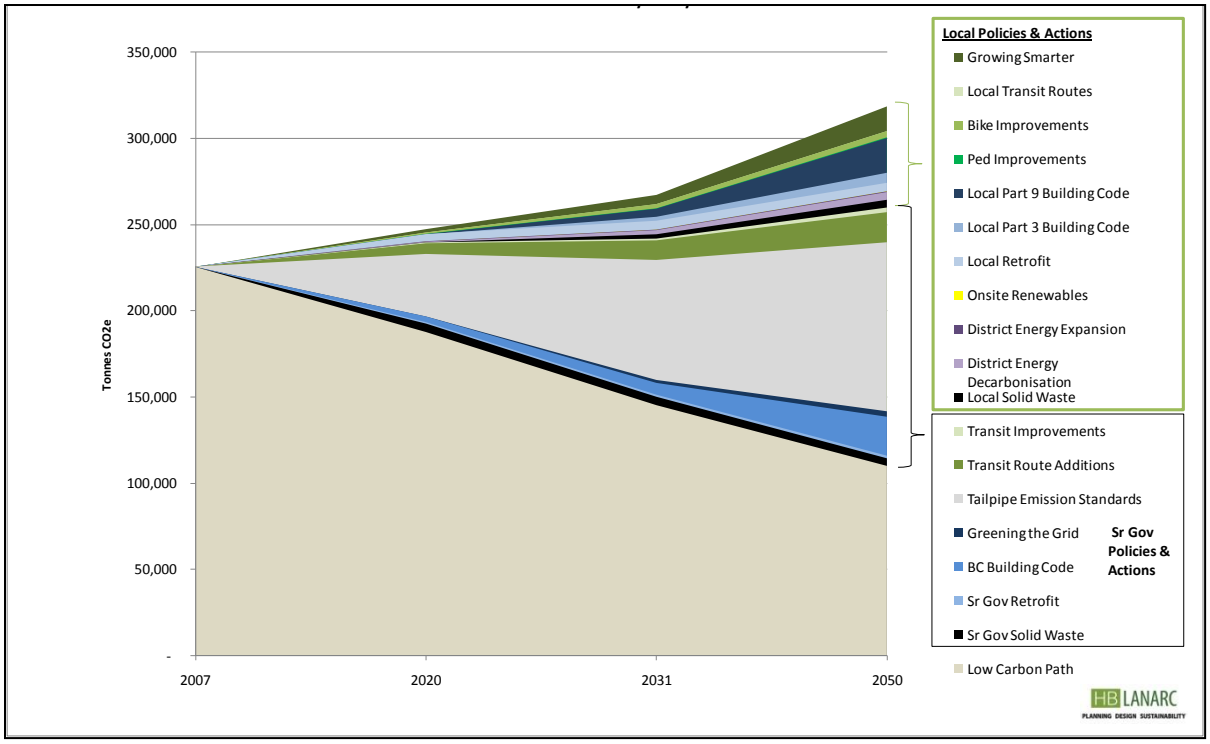
The specific strategies in the above sectors could achieve the following community-wide reductions.

- Total GHG Emissions: 16.8% below 2007 by 2020; 35.7% by 2030; 51.3% by 2050
- Per capita GHG reductions: 26.9% below 2007 by 2020; and 68.3% by 2050

These reductions assume a 1% per annum cumulative population growth rate. Even with the expected population growth being sustained, total emissions can be reduced by half in the next forty years.

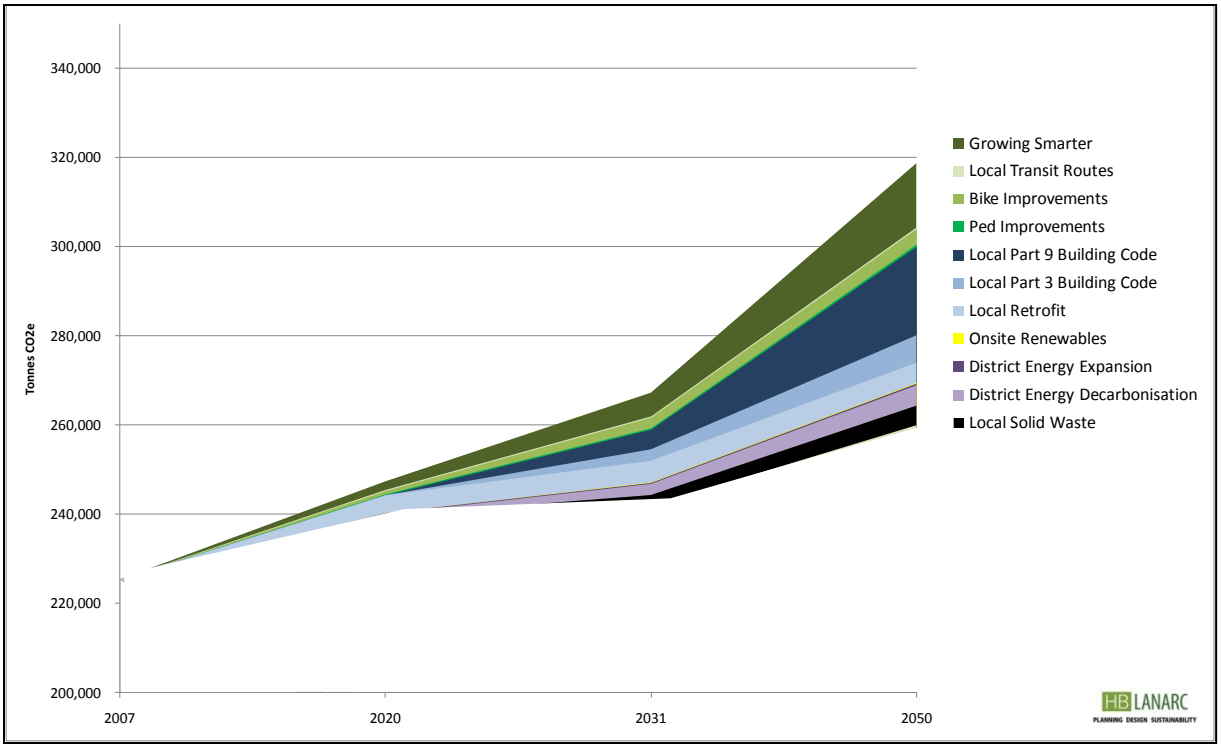


	2007	2020	2030	2050
Solid waste	7,597	7,360	4,877	2,203
Public transportation	9,096	7,998	6,044	6,412
Private transportation	102,624	71,632	43,600	31,413
Industrial buildings	13,237	13,248	12,573	10,640
Commercial buildings	45,790	44,081	41,419	35,257
Residential buildings	47,083	43,332	36,668	24,009



The above figure illustrates emission reductions by policy wedge, below the Business as Usual path (top line) for the City of North Vancouver. Wedges are organized by Level of Government.

The figure above isolates the modeled emission reductions by City of North Vancouver Policy Bundles. Again, the top of the wedge represents Business as Usual, and the bottom of the wedge, the emission path if all policies are implemented



Taking into consideration the analysis and stakeholder engagement that took place in the development of the Low Carbon Path and in recognition that there is much uncertainty regarding the future of technology, energy prices, the implementation of senior government policies and actions and other important factors that will drive emission trends, it is recommended that the City of North Vancouver adopt a target to reduce emissions over the course of the next decade that is both ambitious and achievable. This recommended target is to reduce community greenhouse gas emissions from buildings, transportation and waste 15% below 2007 levels by 2020; and in the longer term to aim toward zero emissions by 2107, the City's 200th birthday – as envisioned in the 100 Year Sustainability Vision.

These targets are the result of the City's first efforts to rigorously quantify emission reductions from changing land use, transportation networks and systems, building performance, energy supply and waste management practices. This low carbon path reflects a realistic, ambitious effort that pushes the political and financial boundaries of current planning processes. Deeper emission reductions will require even greater collaboration and deeper government investment in active and public transit, and renewable energy supply.

On top of the strategies that are described as a part of the Low Carbon Path, there are additional policies and actions identified that could be explored in greater detail through other planning processes such as an Official Community Plan Update that could yield further emission reductions. Suggestions for these additional actions are given for each sector in the Plan and could be further explored in the context of the 2010-2011 OCP update process.

Low Carbon Path **City of North Vancouver Local Climate and Energy Policies and Actions**	
Land Use	1. 10 minute complete neighbourhood planning, with an emphasis on increased access to services such as grocery stores
	2. Mixed use, high density, multi-unit residential buildings that integrate office and retail commercial developments such as neighbourhood grocery stores
	3. Development occurs around transit oriented hubs, nodes and corridors
	4. Increase the quantity, diversity and quality of local jobs by encouraging the appropriate types of commercial building development
	5. Create street and road designs that are attractive to active transportation modes and public transit use
Transportation	1. Strengthen infrastructure (sidewalks)
	2. Strengthen infrastructure (connectivity across highways/creeks/rail)
	3. Strengthen infrastructure (crosswalks, bulges, signage, street lighting, traffic calming)
	4. Progressively extend network of bicycle routes, lanes and paths, including greenways such as the Green Necklace and Spirit Trail
	5. Establish bike lockers at Lonsdale Quay
	6. Transportation demand management, including education and outreach to reduce single occupant vehicle trips
	7. TravelSmart plan development for neighbourhoods, schools, major/minor employers
	8. Pay parking implemented to fund alternative transportation initiatives with clear climate protection and liveability values

	9. Support improved transit services with infrastructure improvements (signal pre-emption, bus bulges, queue jumpers)
	10. Enhance transit stop comfort, accessibility, convenience, safety
	11. School oriented programs to increase safety and participation of walking and cycli
	12. Low and Zero Emission Vehicle Promotion
Buildings	1. Promote energy efficient building design and practices for all development projects and City-owned buildings
	2. Pursue increasingly aggressive energy standards for new and existing buildings over time; establish enforcement mechanism for building energy standards
	3. Require the use of hydronic or high efficiency energy systems in new and existing buildings, as appropriate, to enable transition to renewable energy sources such as ground-source heat pumps
	4. Require new buildings to be solar hot water ready and develop policies and programs that make it easier for developers and building owners to incorporate solar hot water into new and existing buildings
	5. Develop policies that promote the use of passive energy efficient design to minimise the lighting, heating and cooling demands of new buildings
	6. Promote uptake of single family and semi-detached retrofit programs
	7. Promote retrofits in multifamily, commercial, and industrial sector
	8. Energy efficient process upgrades in commercial and industrial sector
	9. Communications, social marketing and schools programs to reduce energy use
Energy Supply	1. Work with LEC to expand into new buildings or service areas
	2. Work with LEC to decarbonise and strategically phase in renewables
	3. Work with LEC to utilize waste heat from various sources possibly including large existing buildings
Solid Waste	1. Implement the Zero Waste Challenge; develop community programs on Zero Waste, the 3 Rs (reduce, reuse, recycle) and moving towards a broader conservation ethic regarding consumption and materials
	2. Expand food waste diversion opportunities in the single-family, multi-family and commercial sectors
	3. Work with Metro Vancouver and the private sector to increase the diversion of construction and demolition materials from disposal
	4. Work with Metro Vancouver and other municipalities to ensure an adequate supply of land is available for recycling collection and processing
	5. Encourage and support Metro Vancouver and the Province in establishing extended producer responsibility for waste and instituting packaging standards

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1. Introduction

It has been said that communities are where the rubber meets the road on climate change. In the City of North Vancouver, climate change is where the shoes meet the sidewalk. Fundamental to the City's approach to reducing greenhouse gas emissions is deepening the City's commitment to liveability, sustainability and walkability.

Given the City's relatively low per capita emissions and current activity, this Plan is fundamentally about deepening current land use, development, transportation, infrastructure and waste management plans and priorities.

Achieving the deep emission reductions outlined in this Plan involves a significant commitment by the City. Moreover, it assumes and will require collaboration and commitment from the Province, the Federal Government, utilities, as well as businesses, non-governmental organizations and residents.

This Community Energy and Emissions Plan provides analysis to support the Official Community Plan Amendment necessary for the City to comply with the new Local Government Act requirements to include greenhouse gas reduction targets, policies and actions by May 31, 2010.

The Plan's objectives are several-fold:

- Develop a climate and energy vision that supports core City priorities;
- Develop a high level framework that builds on, and provides guidance to existing City activity with new sector-specific policies and actions;
- Estimate the near term costs of climate and energy-related policies and actions;
- Develop defensible, meaningful greenhouse gas reduction targets.

1.1. REPORT STRUCTURE AND APPROACH

The Plan is organized in five sections:

Section 1: Introduction shares the City's vision and historical sustainability activity from which the Plan is based, and outlines the approach taken for its development.

Section 2: Situational Analysis examines the global and regional climate and energy context for the Plan, and provides a profile of the City's energy and emissions.

Section 3: Low Carbon Path presents the overarching targets, goals, and policies and actions of the Plan by sector.

Section 4: Low Carbon Zone Design Guidelines provides strategic guidance for operationalizing the policies and actions according to the unique zones of the City.

Section 5: Near-Term Direct Costs estimates at a high level the costs associated with the next strategic steps to advance this Plan.

Appendix A: Energy and GHG Emission Trends

Appendix B: Detailed Modeling Results

Appendix C: Technical Model description

1.2. CITY SUSTAINABILITY HISTORY AND LOW CARBON VISION

Shaped by input from Council, staff, stakeholders and the public, the Plan's vision essentially puts a climate change lens on the current Official Community Plan vision:

> *The City will establish a low carbon path that leads to a net zero carbon community while being vibrant, diverse, highly liveable and striving to balance the social, economic and environmental needs of our community. The City will work with senior governments, local governments, non-governmental organizations, businesses, and residents to achieve these deep emission reductions.*

This vision is rooted in a proud tradition of balancing the social, economic and environmental priorities of the community. At its inception a century ago, the City was planned around a quadrangle of parks supported by a traditional streetcar system with a budding town centre in Lower Lonsdale. The rapid pace of development and growth that emerged in the community earned it the Ambitious City moniker.

Adopted in 1980, the City's first Official Community Plan placed an emphasis on quality of life and sought to create a diverse, healthy and livable community. In 1996, Metro Vancouver's Livable Region Strategic Plan recognized Lower Lonsdale's economic vitality and role as a North Shore transportation hub by designating it a Regional Town Centre. In 2002, the City updated its OCP around the theme of sustainability, creating a far more comprehensive and integrated plan than a traditional land use document.

With one of North America's first community Greenhouse Gas Local Action Plans and an enterprising district energy system, the Lonsdale Energy Corp, the City's climate protection leadership was recognized in 2005 by the UBCM Energy Aware Award. In 2007, the City's success in developing a complete, compact community and in the integration of sustainability principles as outlined in its OCP earned it the BC Government's inaugural Green City Award.

Building on these achievements, the City's 2008 Long Term Transportation Plan focuses on the efficient movement of people and freight, maximizing travel choice within a people- oriented accessible community with a strong sense of place.

To commemorate its centennial in 2007, the City developed a 100 Year Sustainability Vision. This vision aspires to create a community with net zero greenhouse gas emissions by 2107. This new plan provides a path out to 2050 with an emphasis on policies and actions out to 2020.

1.3. OVERVIEW AND GENERAL APPROACH

Developing the Low Carbon Energy and Emissions Path was an exercise that melded rigorous quantitative analysis and realistic local and senior government policy considerations with meaningful engagement, while being informed by existing City of North Vancouver plans. The plans that most directly informed the formation of the Low Carbon Path were the City's Official Community Plan (OCP), the Long Term Transportation Plan (LTTP), the 100 Year Sustainability Vision for a low carbon future, the 2005 City of North Vancouver Greenhouse Gas Local Action Plan, Metro Vancouver's Draft Solid Waste Management Plan, and the British Columbia Climate Action Plan and Energy Plan. Documents such as the OCP and LTTP provide practical guidance that has been carefully planned and well vetted, while documents such as the

100 Year Sustainability Vision shows what the community should be striving for and what it could look like in the distant future. In sum, the Low Carbon Path was shaped by overarching goals that contain dynamic tensions:

- Consistent intensification of realistic policies and actions undertaken by the City in major energy and emission sectors within its sphere of influence.
- Consistent intensification/engagement by senior governments of realistic policies and measures.
- Pursuit of the City's 100 Year Sustainability Vision of reducing carbon emissions to zero by 2107.

The result is a ground-up, quantitatively modeled path informed by policies and actions across all sectors that if implemented, will lead to the low carbon future the Community is striving for over the long term. Policies and actions were defined and quantified over three milestones:

A. 2020 (Provincial and International climate marker)
B. 2030 (the OCP horizon)
C. 2050 (another dominant climate marker)

The process for developing the path was the following:

1. Map future land use changes adhering to direction set by the City's current OCP over the first two milestones and continuing that trend.
2. Map future transportation infrastructure and service improvements as laid out by the LTTP.
3. Translate proposed senior government policies and actions into impacts on the emission and energy profile of the City of North Vancouver.
4. Through consultation with Council, staff, stakeholders and the public, identify opportunities for building on current local and senior governments plans to achieve deeper emission reductions across all sectors:
    a. Land use
    b. Transportation
    c. Buildings
    d. Energy Supply
    e. Solid Waste
5. Model the Low Carbon Path, as defined by the identified policies and actions, and fine-tune strategies to achieve an optimal balance of deep emission reductions and level of effort within each sector.

Short Term Priorities & Long Term Plan

Because climate protection is a long term goal and requires long term commitments, the horizon for the Low Carbon Path extends to 2050. Moreover, it is useful to understand where the community wants to be in order to plot out the near term actions to get the City on the right path. Some of the policies and actions described in the Low Carbon Path show small reductions in 2020, but early implementation is needed to realise meaningful long term, deeper reductions. The Lonsdale Energy Corp's district energy system is an example of an early City commitment that could have growing importance through the Plan's life.

Evaluation Criteria

The creation of a Community Energy and Emissions Plan (CEEP) is a process that must employ open lines of communication to negotiate competing, complementary, and sometimes contradictory priorities. No blueprint exists to guide the process of deciding which strategies to include. The list of selection criteria that could be used to choose strategies to include in the CEEP is long. It is challenging to pare it down because with every strategy comes trade-offs. To accurately identify trade-offs, it is necessary to evaluate each strategy from multiple perspectives. It is also important to recognize that trade-offs can exist between selection criteria that are quite similar, such as implementation cost, operation and maintenance cost, and annual cost savings. To encompass the range of criteria, capture potential trade-offs, and to avoid becoming bogged down by analysing each strategy for a long list of criteria, the project team used the following high-level categories to select and shape the recommended actions:

- **Climate Protection** – The GHG reduction potential and contribution to energy sustainability;
- **Cost Effectiveness** – The multiple dimensions of cost accounting, including simple payback, first costs and operation maintenance costs incurred by the City, and the distribution of cost burden among stakeholders;
- **Ease of Implementation** – The relative effort to implement each strategy;
- **Community Co-Benefits** – The extent to which each strategy addresses other City priorities like liveability, transportation efficiency and local job creation.

The Municipal Role in the Global and Provincial Climate Challenge

The BC Government's emission reductions targets are roughly in line with the scientific consensus of the reductions necessary to avoid dangerous, run-away climate change. The City of North Vancouver is committed to contributing to this provincial and global challenge, and aspiring to achieve a zero carbon city in 100 years.

It is important for the Province, nevertheless, to evaluate the relative efficiency of emission reductions by sector. While local governments have influence, they do not have control over most emissions within their boundaries. The City of North Vancouver's 225,000 tonnes of GHGs emitted annually are widely distributed across thousands of businesses and 48,000 residents using cars and transit, and powering and heating their homes.

Almost 40% of the Province's emissions are from industry. The vast majority of these emissions are from large point sources, many of which emit more annually than the combined commercial and residential emissions of the City of North Vancouver. At least one large emitter generates more GHGs annually than all North Shore communities combined.

Although not universal, it is generally more cost effective and efficient to reduce emissions from large point sources. While the City acknowledges its dependence and prosperity on many of these industrial outputs –e.g. cement, aluminum, and oil and gas – it is committed to forging a low carbon path, and notably reducing dependence on oil and gas. It aims to do this by establishing a more liveable, safe community. It is important for the Province to establish an efficient and equitable approach to sharing the burden of emission reductions across our entire provincial economy and society in a manner that strengthens the long term economic, social and environmental sustainability of the province.

Setting Targets

There are a wide variety of target setting methods that can be generalized into the categories *top down* or *bottom up*.

Top Down: Conventionally, most national, local and institutional targets have been symbolic in nature and directly informed by scientific (e.g. Intergovernmental Panel on Climate Change) or political (e.g. Kyoto or BC Government) developments. This is a top down approach and is an important first step in demonstrating political support and understanding ultimately where one should be aiming for.

Bottom Up: More methodical approaches quantify the GHG reduction of specific policies and measures against an empirically derived baseline. There is a diversity of approaches with varying degrees of rigour in bottom up approaches, too, e.g. they can be roughly informed by precedent or modeled. Once again, depending on the energy knowledge and stage in planning, expectations can change.

The urgency of our energy security and climate stabilization challenges will ultimately demand more defensible and strategic quantitative evaluation of policies and actions of all levels of government. For this purpose, target setting should provide meaningful guidance for policy and program development, and support ongoing measurement and monitoring for staff, council, and the community. This is the approach the City of North Vancouver has selected. These targets and benchmarks are more definitively laid out in Appendix B.

2. Situational Analysis

This section examines the broader context for the City's Energy and Emission Reduction Plan. It has two main subsections:

- **Climate and Energy Context**, examining big picture climate science and energy security, the policy implications, and how the City can strategically take advantage of this situation to strengthen its integrated sustainability agenda.
- **City of North Vancouver Energy and Emission Profile,** presenting a current snapshot of emissions, and a business as usual forecast.

2.1. CLIMATE AND ENERGY CONTEXT

2.1.1. CLIMATE SCIENCE AND POLICY

The balance of scientific evidence shows the climate is changing, and that this change is attributed in large part to the surge in greenhouse gas emissions generated by the combustion of fossil fuels, e.g. oil, coal and gas. The Intergovernmental Panel on Climate Change (IPCC) is the world's preeminent climate science authority. The IPCC's 2007 Fourth Assessment Report, based on extensive review of the latest peer reviewed science, concluded global emissions need to peak around 2015, with 50-85% reductions below 2000 levels by 2050, if we are to avoid tipping points with dangerous disruptions such as severe agricultural collapses and sea level rise.[1]

Communities are vulnerable to climate change. Property damage from extreme weather events is doubling in Canada every 5-10 years. A climate change fingerprint is clearly visible in this damage. From droughts to drinking water shortages, and floods to forest fires, local governments are generally on the front line when disasters strike.

The economics is also increasingly clear. Commissioned by the British Government and authored by former World Bank Chief Economist Nicholas Stern, the Economics of Climate Change estimated the costs of reducing greenhouse gas emissions to a safe level were one percent of global gross domestic product; compared to a loss of up to 20% of global GDP if we do nothing. Stern concluded, 'the benefits of strong, early action on climate change outweigh the costs.'[2]

2.1.2. ENERGY SECURITY AND POLICY

Beyond reducing emissions to avoid dangerous climate change, sustainable energy strengthens economic security in the face of steadily rising prices. City of North Vancouver residents and businesses currently spend over $100 million per year on energy – more than $2000 per capita.[3] The vast majority of this spending leaves town, flowing predominantly to utilities and petroleum companies. It is not unreasonable to expect that without superior building performance, more efficient transportation, and a land use regime that reduces distances travelled, spending would at least double by 2020.

Constrained supply and increasing demand is expected to drive price increases:

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[1] IPCC. Climate Change 2007: Synthesis Report. http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

[2] HM Treasury. Stern Review on the Economics of Climate Change. http://www.hm-treasury.gov.uk/sternreview_index.htm

[3] See Table 1 below. Energy expenditures were estimated using 2007 average energy costs for electricity, natural gas, gasoline and diesel in Metro Vancouver.

- The International Energy Agency's indicates global energy demand will increase 45% between now and 2030[4], largely due to Asian and Middle Eastern growth.
- Supplies of many conventional energy forms, notably oil, are declining, and new sources have higher production costs because of their inaccessibility, e.g. tar sands. US Energy Information Administration estimates oil prices in 2020 to be $115-185 per barrel,5 a conservative 40-130% increase.
- BC Hydro forecasts a doubling of electricity prices by 2020. Current electricity rates are 7.04 and 7.77 cents per kilowatt hour for residential and commercial/institutional customers, respectively. They would rise to 13.08 and 14.43 cents/kWh.6
- Natural gas prices are expected to rise but not as significantly, 13-85%, by 2020.7
- Carbon prices are expected to increase fossil fuel costs, and in turn the cost of other energy. Conservative carbon price estimates vary dramatically from $30-60 per tonne, equating to 7-14 cents per litre of gasoline.[8]

The volatility in oil and natural gas prices expected by most industry and government sources is potentially worse than rising energy costs. These fluctuations create uncertainty about the future, compromising budget forecasting and long term planning and increasing risk.

The economic benefits of sustainable energy are both direct and indirect. Investing in renewable energy creates twice as many jobs as equivalent investments in new conventional supply. [9] Investing in conservation and efficiency creates four times as many jobs.[10] Much of this job creation is from the re-spending effect of avoided energy costs. Most activities generate more jobs than conventional energy sector. Overall, a significantly higher percentage of the energy spending and re-spending effect is at the community level.

Transportation Electrification

BC Hydro's Long-Term Acquisition Plan's demand forecast did not include the increased demand for electricity that significant uptake of electrical vehicles would take. This transition is being driven both by rising oil prices and policy, i.e. fuel economy standards, notably to reduce carbon emissions. Meeting this demand would likely force BCH to increase rates beyond those forecast.

Gilbert and Perl estimate a switch to 33% of vehicle kilometres traveled (VKT) to electric transport by 2025 would require a 6% increase in electricity production (based on a US estimate). [11] This magnitude of penetration would require significant support from all levels of government to ensure the necessary infrastructure, specifically plug in requirements in garages, and chargers in key public areas, e.g. strategic parking lots.

[4] International Energy Association. World Energy Outlook 2008 Fact Sheet: Global Energy Trends.
[5] Energy Information Administration 2009. Annual Energy Outlook, p. 161.
[6] BC Hydro Directive 17, 2006 IEP/LTAP Long Term Rate Increase Forecast filed with BC Utilities Commission. The average residential customer spends about $720 per year on electricity.
[7] Energy Information Administration 2009. Annual Energy Outlook.
[8] BC's Carbon Tax will be $30/tonne by 2012, i.e. 7 cents per litre.
[9] Hornung, Robert. 1997. *Comparative Analysis of Employment from Air Emission Reduction Measures.* Pembina Institute
[10] Ibid
[11] Gilbert, Richard & Anthony Perl. 2008. *Transport Revolutions: Moving people and freight without oil.* Earthscan.

2.1.3.BC CLIMATE AND ENERGY POLICY DRIVERS

In light of the consensus on the dangers of climate change, the BC Government announced in 2007 a commitment to reduce Province-wide GHG emissions 33% below current levels by 2020 and 80% by 2050. While many factors influenced development of these targets, the most important from a risk management perspective is their consistency with scientific evidence on the scale of reductions necessary to avoid dangerous climate change.

Since this time, the BC Government has begun to develop plans and policies that will require and support all sectors of the province to contribute to this commitment. Some of the more important policy drivers for local government change include:

- **Green Communities Act:** Bill 27 amended the Local Government Act and related Acts to address energy conservation and GHG reduction. Most importantly, new content requirements for Official Community Plans (by 2010) and Regional Growth Strategies (by 2011) include:
    - "…targets for the reduction of GHGs… and policies and actions of the local government proposed with respect to achieving those targets"
- **Climate Action Charter:** The BC Government and local governments unveiled the Charter in fall, 2007. It acknowledges the critical role of communities and the shared provincial-local responsibility in tackling climate change. The City is a signatory along with most other local governments. The Charter involves voluntary commitments to:
    - Measure and report community GHG emissions
    - Create complete, compact, energy efficient rural and urban communities
    - Become carbon neutral in local government operations by 2012
- **GHG Reduction Targets Act:** Bill 44 added legislative rigour to the province-wide targets and GHG reduction objectives inside government operations:
    - Province-wide GHG emissions reduction will be 33% below 2007 levels by 2020 and 80% by 2050
    - Public sector organizations, including school districts, health authorities and post secondary institutions, will be carbon neutral in 2010. This requirement presents partnership opportunities for the City.
- **BC Energy Plan:** Launched in 2007, the Plan features 55 policy actions to address climate change and energy security. Key policies include:
    - Clean generation and conservation goals (see BC Hydro below)
    - Building energy efficiency goals (see BC Building Code below)
- **BC Building Code:** The recently revised code contains some of North America's highest building standards. The BC Energy Plan contains 2020 targets for 20% reductions in energy use per home, and a 7% reduction in energy consumption per m^2 of commercial floor space. Due to the long turnover of building stock, reaching these targets will require stringent energy efficiency requirements for new buildings in the Building Code, and retrofit project encouragement.
    - Provincial officials have indicated that by 2020, within the first planning horizon of this Plan, net zero energy homes may be required and standards for larger (part 3) buildings may be 43% more efficient than current regulations[12].
- **BC Hydro's Long Term Acquisition Plan:** This 2008 Plan aligns with Provincial commitments in the BC Energy Plan. The Plan specifies:

[12] Based on HB Lanarc's communications with Provincial code authorities

- A plan to meet 50% of new power by 2020 through conservation
- All new power be carbon neutral; BC be electricity self-sufficient by 2016
- Development of new clean power sources
- BC Hydro has also established a Sustainable Communities Group that is supporting local governments in advancing conservation and renewable energy.

- **Western Climate Initiative Cap and Trade:** Large emitters in five sectors across 11 jurisdictions, including BC and California, will meet legislated emission reduction targets. They will also be able to purchase a limited number of offsets that reduce emissions elsewhere but are applied to their target.

2.1.4. CLIMATE, ENERGY AND SUSTAINABLE COMMUNITIES

Getting traction on big new policy agendas involves establishing a compelling imperative for action, and underscoring the risks of inaction.

Climate programs fail when they focus exclusively on greenhouse gases and climate change. Climate change impacts are slow moving and distributed around the globe. The benefits from deep emission reductions will be enjoyed by future generations and at a global level only if jurisdictions worldwide take collective action.

Local governments with successful climate change programs have shown how emission reduction measures compliment other core priorities that deeply resonate with Council, staff and the community, e.g. Sudbury's interest in community economic development or Portland's commitment to liveability and integrated land use and transportation planning.

The most successful emission reduction measures have, in fact, never been driven by a concern about climate change, e.g. London's investment in public transit and tolls was to reduce the burgeoning costs of congestion, or Copenhagen's deep emission reductions were won through a fight for energy security. The deep emission reductions in these cases have consolidated support for existing programs and inspired broader action.

In attributing success and failure to municipal programs across in the US, Professor Michele Betsill from Colorado State, explains the best programs are inspired by strategic twist on an old philosophy: "Think Local. Act Local."[13]

Fortunately, reducing greenhouse gas emissions *can* support the broader more integrated sustainability agenda envisioned by the City. Some of the priorities Council, staff and the community have identified that can be reinforced the Climate Plan include:

- Reducing congestion with a land form and transportation system that supports more efficient mobility.
- Improving affordability by increasing housing choice, improving energy performance, and reducing transportation costs.
- Strengthening the City's asset management regime by building lighter, more strategic infrastructure.
- Developing a walking and bicycling infrastructure to support residents' active lifestyles.
- Developing a complete, compact community that is safe, liveable and enables residents to work where they live.

[13] Betsill, Michelle. 2001. "Mitigating Climate Change in US Cities: opportunities and obstacles." Local Environment. 6(40): 393–406

2.2. CURRENT BASELINE

In 2007, residents, businesses and the City generated 225,763 tonnes CO_2e, or 5 tonnes CO_2e per capita.[14] This is among the lowest in Metro Vancouver and BC. Because of its dense development pattern and the concentration of jobs in a central business district with good transit connections, the percentage of transportation emissions and energy use is lower than is typical for municipalities in British Columbia.

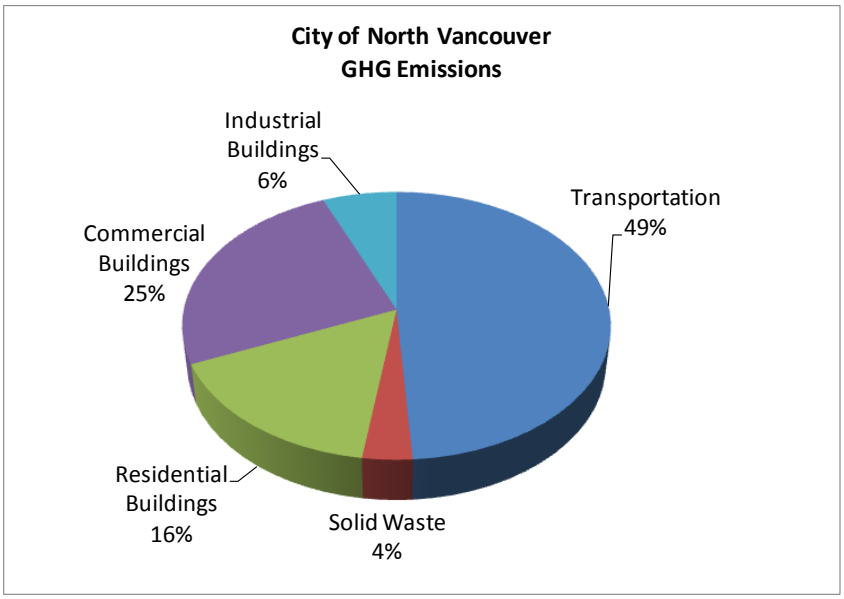


Figure 1 – 2007 GHG Emissions, from CEEI Report

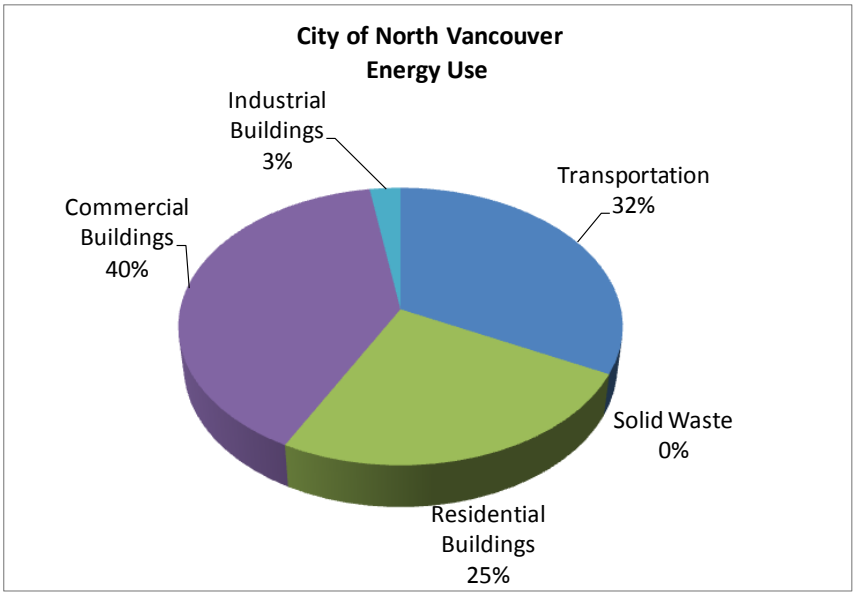


Figure 2 – 2007 Energy Use, from CEEI Report

[14] City of North Vancouver 2009. CEEI Report Review and Comparison to Metro Municipalities.

2.3. City of North Vancouver Energy & Emissions Profile

Table 1 – Energy Use and GHG Inventory for the City of North Vancouver.[15] [16]

Buildings - 2007 CEEI						%	%	**Estimated Energy Expenditures ($2007)**	
	Electricity (kWh)	Natural Gas (GJ)	Fuel Oil (GJ)	Energy Total (GJ)	GHG Total (Tonnes CO2e)	Energy	Emissions	Estimated Expenditures - Electricity	Estimated Expenditures - Natural Gas
Residential Buildings	151,826,924	655,213		1,201,790		24.0%		$ 9,826,239	$ 9,385,926
GHG Emissions (Tonnes CO2e)	3,340	33,514			36,854		16.3%		
Commercial Buildings	243,761,270	1,010,968		1,888,509		37.7%		$ 18,501,932	$ 15,670,004
GHG Emissions (Tonnes CO2e)	5,363	51,710			57,073		25.2%		
Industrial Buildings	33,251,477	262,872		382,577		7.6%		$ 2,523,849	
GHG Emissions (Tonnes CO2e)	732	13,446			14,178		6.3%		
Subtotal				3,472,876	108,105	69%	48%	$ 30,852,019	$ 25,055,930

Transportation - 2007 CEEI						%	%	**Estimated Energy Expenditures ($2007)**	
	Gasoline (liters)	Diesel (liters)	Mobile Propane (liters)	Total Energy (GJ)	Total GHG Emissions (Tonnes CO2e)	Energy	Emissions	Estimated Expenditures - Gasoline	Estimated Expenditures - Diesel
Small Passenger Cars	11,909,066	126,390		417,657		8.3%		$ 12,897,518	$ 128,741
GHG Emissions (Tonnes CO2e)	29,741	351			30,092		13.3%		
Large Passenger Cars	5,737,062	45,642		200,612		4.0%		$ 6,213,238	$ 46,491
GHG Emissions (Tonnes CO2e)	14,328	127			14,455		6.4%		
Light Trucks, Vans, SUVs	20,458,725	171,710	73,131	717,592		14.3%		$ 22,156,799	$ 174,904
GHG Emissions (Tonnes CO2e)	51,093	477	111		51,681		22.8%		
Commercial Vehicles	1,876,294	1,893,335	37,116	139,206		2.8%		$ 2,032,026	$ 1,928,551
GHG Emissions (Tonnes CO2e)	4,686	5,262	56		10,004		4.4%		
Tractor Trailer Trucks		437,754		16,932		0.3%		$ -	$ 445,896
GHG Emissions (Tonnes CO2e)		1,217			1,217		0.5%		
Motorhomes	439,606	23,840		16,159		0.3%		$ 476,093	$ 24,283
GHG Emissions (Tonnes CO2e)	1,098	66			1,164		0.5%		
Motorcycles and Mopeds	307,644			10,663		0.2%		$ 333,178	
GHG Emissions (Tonnes CO2e)	768				768		0.3%		
Buses	175,560	378,000		20,706		0.4%		$ 190,131	$ 385,031
GHG Emissions (Tonnes CO2e)	438	1,051			1,489		0.7%		
Subtotal				1,539,527	110,870	30.7%	48.9%	$ 44,298,985	$ 3,133,897

Solid Waste - 2007 CEEI								%	%
	Tonnes Landfilled	Tonnes CO2e - Landfill	Tonnes Incinerated	Tonnes CO2e - Incineration	Tonnes Recycled / Composted (est.)	Energy Equivalent (GJ)	Total CO2e	Energy	Emissions
Landfilled Waste	16,438	2,166	13,180	5,431	29,618	0	7,597	0.0%	3.4%

Grand total	**5,012,403**	**226,572**	**100.0%**	**100.0%**

[15] BC Ministry of the Environment and Hyla Environmental Services, 2009. *City of North Vancouver Community Energy & Greenhouse Gas Emissions Inventory: 2007*. April 14, 2009

[16] Energy Expenditures were estimated based on average 2007 costs for each energy type in Metro Vancouver.

Table 2 – Energy Use and GHG Emissions by Energy Type[17] [18]

Energy Type - 2007 CEEI	Energy (GJ)	GHG Emission (CO2e)	Estimated Expenditures
Electricity	1,543,823	9,434	$ 30,852,019
Natural Gas	1,929,053	98,670	$ 25,055,930
Gasoline	1,417,731	102,152	$ 44,298,985
Diesel	119,006	8,551	$ 3,133,897
Fuel Oil	unknown	unknown	unknown
Propane	unknown	unknown	unknown
Mobile Propane	2,790	168	unknown
Wood	unknown	unknown	unknown
Solid Waste	0	7,597	unknown
Total	**5,012,403**	**226,572**	**$ 103,340,832**

Table 3 – Comparison of Emissions and Related Indicators in the City of North Vancouver and municipal averages across Metro Vancouver[19]

Emission Indicator		CNV	Metro Van
Emissions Per Capita Per Yr		5 tonnes CO_2e	5 tonnes CO_2e
Emissions Per Resident and Employee Per Yr		3 tonnes CO_2e	4 tonnes CO_2e
Residential Building Emissions Per Capita Per Yr		1 tonnes CO_2e	1 tonnes CO_2e
Transportation Emissions Per Capita (Residential) Per Yr		2 tonnes CO_2e	2 tonnes CO_2e
Commute Mode Split	Auto Driver	62%	67%
	Auto Passenger	6%	7%
	Transit	20%	17%
	Walk	9%	6%
	Bike	2%	2%
	Other	3%	1%

Table 3 above compares the City of North Vancouver's GHG emissions with average municipal emissions across Metro Vancouver. Looking at emissions per combined residents and employees, it is clear that there is a higher efficiency associated with the land use pattern and buildings in the City (3 tonnes CO_2e) than Metro Vancouver (4 tonnes CO_2e) as a whole. Although, the City of North Vancouver has a higher transit and walking mode share than the Metro Vancouver average and the shortest median commute distance (2006 Census), per capita transportation emissions are the same (2 tonnes), preliminarily suggesting that the data used to calibrate the transportation sector emissions is overestimating the reliance on private vehicles.[20]

[17] BC Ministry of the Environment and Hyla Environmental Services, 2009. *City of North Vancouver Community Energy & Greenhouse Gas Emissions Inventory: 2007*. April 14, 2009

[18] Energy Expenditures were estimated based on average 2007 costs for each energy type in Metro Vancouver.

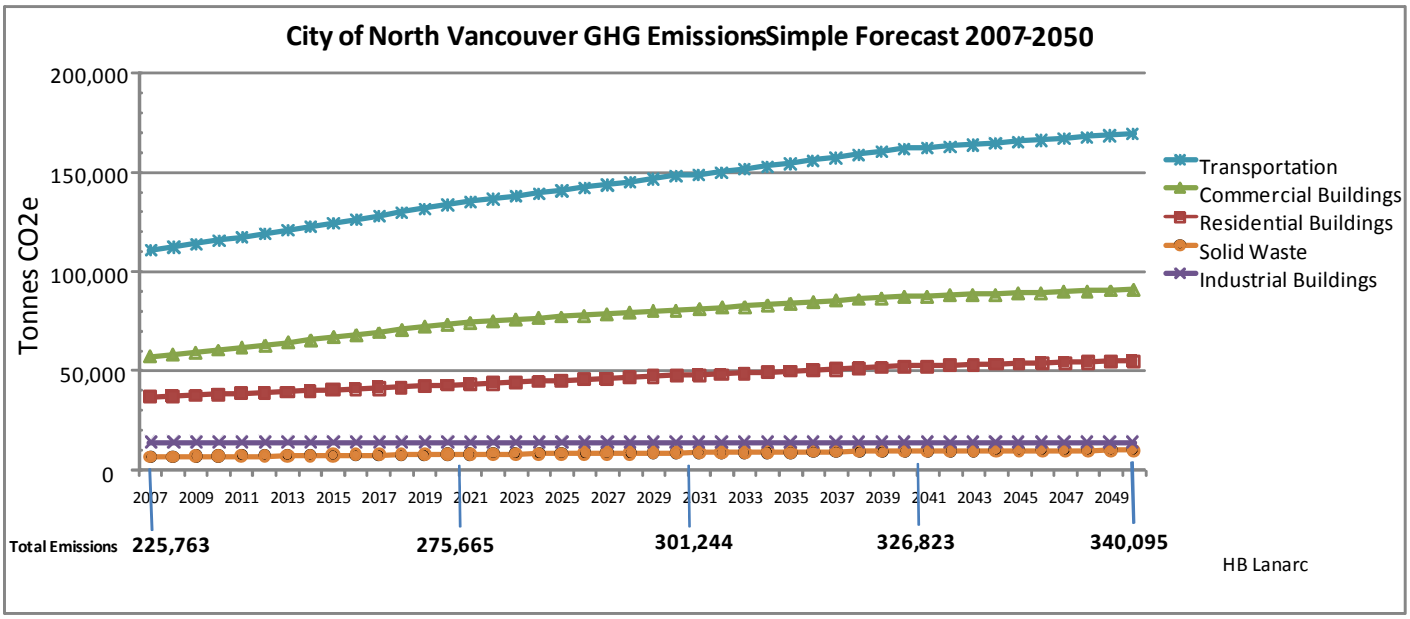
[19] Data Source: 2006 Census; 2007 CEEI inventory (for Metro Vancouver GHG Emissions); HB Lanarc analysis of 2007 CEEI report for City of North Vancouver GHG Emissions. Methodologies for CNV and Metro Van Municipal are ostensibly the same. CNV emissions figures used subsequently in the Plan have subtly different results due to further HBL inventory enhancements and modeling.

[20] CNV 2009. CEEI Report Review and Comparison to Metro Municipalities. June 2009.

2.3.1. PRELIMINARY SIMPLE GROWTH FORECAST

Figure 2 forecasts emissions going forward to 2050 using a "simple growth" scenario from the 2007 CEEI inventory. It assumes emissions will increase with population and job growth going forward. This is a hypothetical scenario that essentially reflects would happen if there was no intervention to address climate and sustainability by the City, senior governments and utilities. Under this scenario emissions would increase approximately 50% by 2050.

Figure 2 - Simple GHG Growth Forecast for City of North Vancouver by sector, 2007 – 2050[21]



[21] Annual sector emissions were calculated by multiplying per-capita and per-employment emissions average from 2007 by the forecasted population and number of jobs for each future year. Projections are from Metro Vancouver's Draft Regional Growth Strategy: http://www.metrovancouver.org/planning/development/LRSPreviewithLRSPDocs/DraftRGSNovember2009.PDF. Population growth for 2041 through 2050 follows the same trend as the previous ten year period. For the transportation and waste sectors a composite population-employment emission factor was multiplied by future population and jobs. For the residential sector, per-capita emissions were held constant. For the commercial sector, per-job emissions were held constant over the forecast period.

3. Low Carbon Path

The Low Carbon Path is comprised of a vision and overarching goals, in addition to sector-specific goals, policies and actions. The Low Carbon Path describes a compilation of policies and actions that will result in significant GHG emission reductions. To ensure that the policies and actions result in an emissions path that is both achievable and ambitious, HB Lanarc utilised GHG emission modeling techniques that forecast future GHG emissions levels based on hundreds of input variables developed through consultations with staff, Council and the community (see Appendix C and D for more details). The tables, maps and graphs are outputs from these modeling exercises.

The description of the goals, policies and actions that comprise the Low Carbon Path is organized in the following sub-sections:

- **Community Overview:** This section provides a summary of the impact of the strategies across all sectors.
- **Land use planning:** Land use planning and design profoundly shape emissions in the transportation and buildings sectors as it determines travel patterns and building types.
- **Buildings**: One of the major emission sectors, it focuses on constructing and retrofitting buildings to be more efficient, and maximizing opportunities for onsite and building-scale renewable energy.
- **Transportation:** The other large emission sector, it focuses on making walking, bicycling and transit easier; reducing distance driven by cars; and improving emission performance of cars and transit.
- **Energy Supply:** This sector provides energy for building heating and cooling and equipment use. It focuses on decreasing carbon intensity of the energy supply through efficient systems and larger and onsite renewable energy opportunities.
- **Waste:** This sector involves reducing the volume of waste generated in the first place and diverting waste from disposal through composting and recycling. Note that significant energy and emissions from upstream product manufacture are not included in the community inventory but must be considered in terms of their global impact.
- **Urban Agriculture and Landscape:** This sector focuses on community gardening and urban agriculture to reduce emissions associated with today's food supply; and expanding urban trees and forests to improve carbon sinks. Detailed analysis of these potential elements is not included in the analysis but has been flagged for future opportunities and analysis to be completed by the City.
- **Education & Outreach:** This sector focuses on deepening and sustaining lifestyle and behavioural choices amongst key constituencies through education and outreach to support broader emission reduction policies, and increasing general awareness climate change and sustainable energy.

3.1. CITY OF NORTH VANCOUVER TARGETS

The City envisions being a net zero carbon community by its 200th birthday in 2107. The low carbon path delineated in this Plan will build on the community's success in *slowing* emission growth. This new journey is focussed on deep emission *reductions*. Two community wide targets will be included as an amendment to the Official Community Plan:

- 15% emission reductions below 2007 by 2020
- 50% emission reductions below 2007 by 2050

With per capita emissions already lower than the vast majority of communities in Metro Vancouver, BC, Canada, and, in fact North America, this low carbon path will continue to drive per capita emissions down – almost 70% by 2050 – and build on the community's success in advancing a highly liveable, safe and sustainable community.

These targets reflect the City's first efforts to rigorously quantify emission reductions from changing land use, transportation networks and systems, building performance, energy supply and waste management practices. These changes are described here under *Community Overview* as well as in each of the sectors, below. They are the result of extensive modeling explained in Appendix C.

This low carbon path reflects a realistic, ambitious effort that pushes the political and financial boundaries of current planning processes. The City intends to explore policies and plans that could achieve deeper emission reductions that more decisively move the community towards its long-term net zero carbon aspiration, contribute more significantly to the provincial government's commitments, and make the reductions collectively required by all jurisdictions and parts of the economy to avoid dangerous, run-away climate change.

These targets, policies and actions will be reviewed and refined through the forthcoming Official Community Plan Update, the evolving green building program, more detailed transportation planning, and Lonsdale Energy Corporation's business planning process. Some *additional opportunities* that were not quantified are identified at the end of each sector, below.

In contrast to a small number of industrial companies with *direct* control over immense single point sources that comprise about 40% of the Province's emissions, local governments have limited direct control, but significant influence over tens of thousands small, distributed emission sources. Successfully implementing the low carbon path depends, therefore, on close collaboration with local residents, businesses, public sector organizations and non profits, as well as neighbouring local governments, and senior levels of government, utilities and transportation authorities. Deeper emission reductions will require even greater collaboration and deeper government investment in active and public transit, and renewable energy supply.

3.2. COMMUNITY OVERVIEW

3.2.1. GOALS

In contrast to most North American communities, the City of North Vancouver has already put in place policies and actions that establish a solid foundation for moving towards a low carbon future. While emissions are still increasing, the pace is slowing.

Overarching community goals are:

- Develop a beautiful, liveable community that enables residents to live, work and recreate locally in a highly satisfying low carbon manner, and support these opportunities through education and outreach.
- Work with utilities and senior governments to enable residents and businesses to meet most new energy requirements by reducing demand in transportation and building sectors.

3.2.2. PATH, COMMUNITY-WIDE TARGETS, POLICIES & ACTIONS

Implementing the Low Carbon Scenario would steadily decrease greenhouse gas emissions, on a sector-by-sector basis, through the three milestone years for all major sectors and sub-sectors (see Figure 3 and Table 10), with the exception of commercial and industrial buildings. The efficiency gains of commercial and industrial buildings are not anticipated to be as great as the residential sector. The efficiency gains will also be counteracted by the rapid growth in jobs and floor space, with emissions staying approximately constant over time. Significant additional local effort to advance commercial and industrial building performance well beyond that which is anticipated to be regulated at a Provincial level would be needed to reduce emissions further. Emissions from public transportation decrease due to switching from diesel to lower carbon alternatives, despite large increases in passenger-kilometres-traveled (PKT) from increased ridership.

3.2.3. TARGETS

The low carbon path, described in the following sub-sections could achieve the following community-wide targets:

Net community GHG reductions: 16.8% by 2020; 35.7% by 2030; 51.3% by 2050

Per capita GHG reductions: 26.9% by 2020; 68.3% by 2050

The per capita reduction assumes a 1% per annum cumulative population growth rate. In other words, even with the expected population growth being sustained in this highly liveable City, total community emissions can be reduced by half in the next forty years.

3.2.4. CROSS CUTTING MEASURES

As well as strong policies developed by sector in buildings, energy supply, waste, land use and transportation, successful plans depend on policies that are cross-cutting in nature. These measures help ensure the local governments' typical operations and decisions do not undermine a low carbon agenda typified by some strong individual projects.

- The annual budget process will gradually integrate life cycle costing and carbon quantification, and a staff person with knowledge of energy and emissions and finance will be actively involved in the budget review process and tasked with considering these priorities.
- The capital planning process will integrate life cycle costing and carbon quantification with the intention of constraining both.

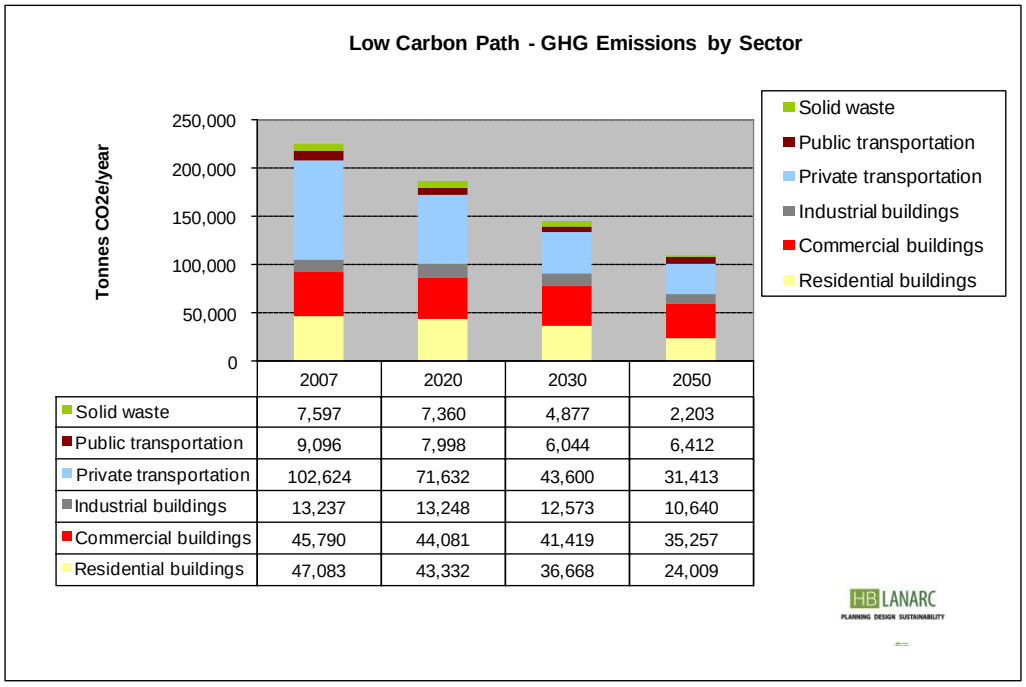
- The procurement processes will be updated to require in RFPs and tendering for all capital projects greater than a prescribed threshold a statement on the greenhouse gas and energy implications and the life cycle costs of the expenditure.

Energy & Emissions and Finance

Different capital investments options have different long term cost implications for operation, maintenance and replacement. They can also drive or constrain greenhouse gas emission growth. When life cycle costing is integrated into financial decisions, it generally supports less carbon intensive investment by the municipality and the private sector. Consistently incorporating life cycle costing and carbon quantification in an analysis of options allows richer decision-making. Key processes for such analysis include:

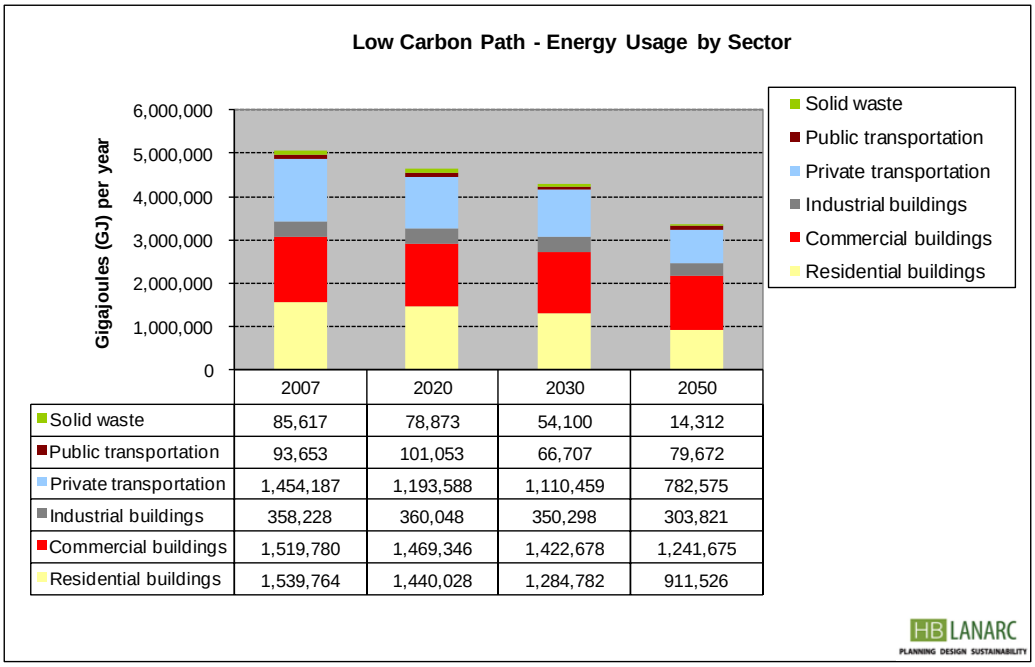
- Annual budget
- Capital planning
- Procurement

This analysis can help the City and the community manage and reduce its carbon liability and energy costs. On a long term basis this will likely become more and more important as municipalities will be under pressure to reduce emissions.



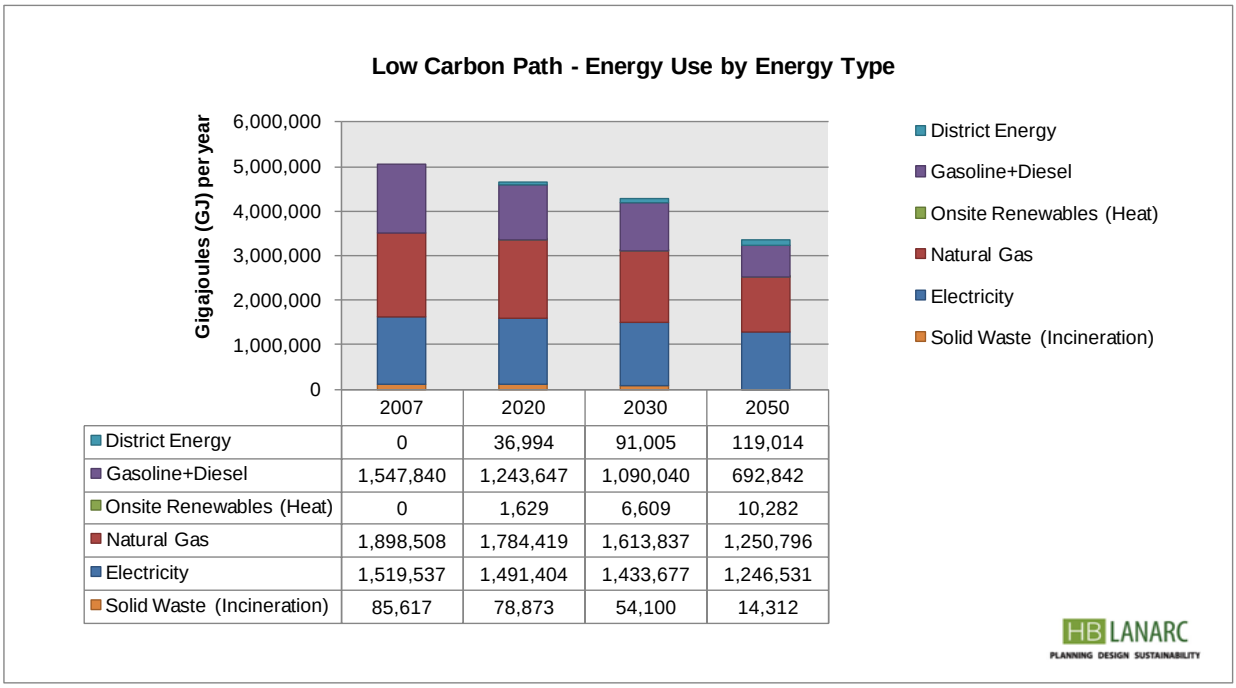
	2007	2020	2030	2050
Solid waste	7,597	7,360	4,877	2,203
Public transportation	9,096	7,998	6,044	6,412
Private transportation	102,624	71,632	43,600	31,413
Industrial buildings	13,237	13,248	12,573	10,640
Commercial buildings	45,790	44,081	41,419	35,257
Residential buildings	47,083	43,332	36,668	24,009

Figure 3- City of North Vancouver Low Carbon Path – Modeled Emissions by Sector



	2007	2020	2030	2050
Solid waste	85,617	78,873	54,100	14,312
Public transportation	93,653	101,053	66,707	79,672
Private transportation	1,454,187	1,193,588	1,110,459	782,575
Industrial buildings	358,228	360,048	350,298	303,821
Commercial buildings	1,519,780	1,469,346	1,422,678	1,241,675
Residential buildings	1,539,764	1,440,028	1,284,782	911,526

Figure 4 - City of North Vancouver Low Carbon Path – Modeled Energy Usage by Sector



	2007	2020	2030	2050
District Energy	0	36,994	91,005	119,014
Gasoline+Diesel	1,547,840	1,243,647	1,090,040	692,842
Onsite Renewables (Heat)	0	1,629	6,609	10,282
Natural Gas	1,898,508	1,784,419	1,613,837	1,250,796
Electricity	1,519,537	1,491,404	1,433,677	1,246,531
Solid Waste (Incineration)	85,617	78,873	54,100	14,312

Figure 5 – Modeled Energy Use by Energy Type, Low Carbon Path

Figure 5 illustrates the reduction in energy use by energy type. The largest modeled reduction in energy use of the energy types analysed between 2007 and 2050 is gasoline and diesel in the transportation sector as a result of local land use changes, implementation of transportation planning initiatives and the increased fuel efficiency of

vehicles. Onsite renewable heat and district energy comprise a relatively small portion of the total energy use over the timeframe. Energy use in the solid waste sector is from the combustion of waste that was generated within the City and sent to the Greater Vancouver Regional District Waste-to-Energy Facility in Burnaby. The number includes the estimated energy value of the steam that was produced at the facility, which was subtracted from energy contained in the incinerated waste.

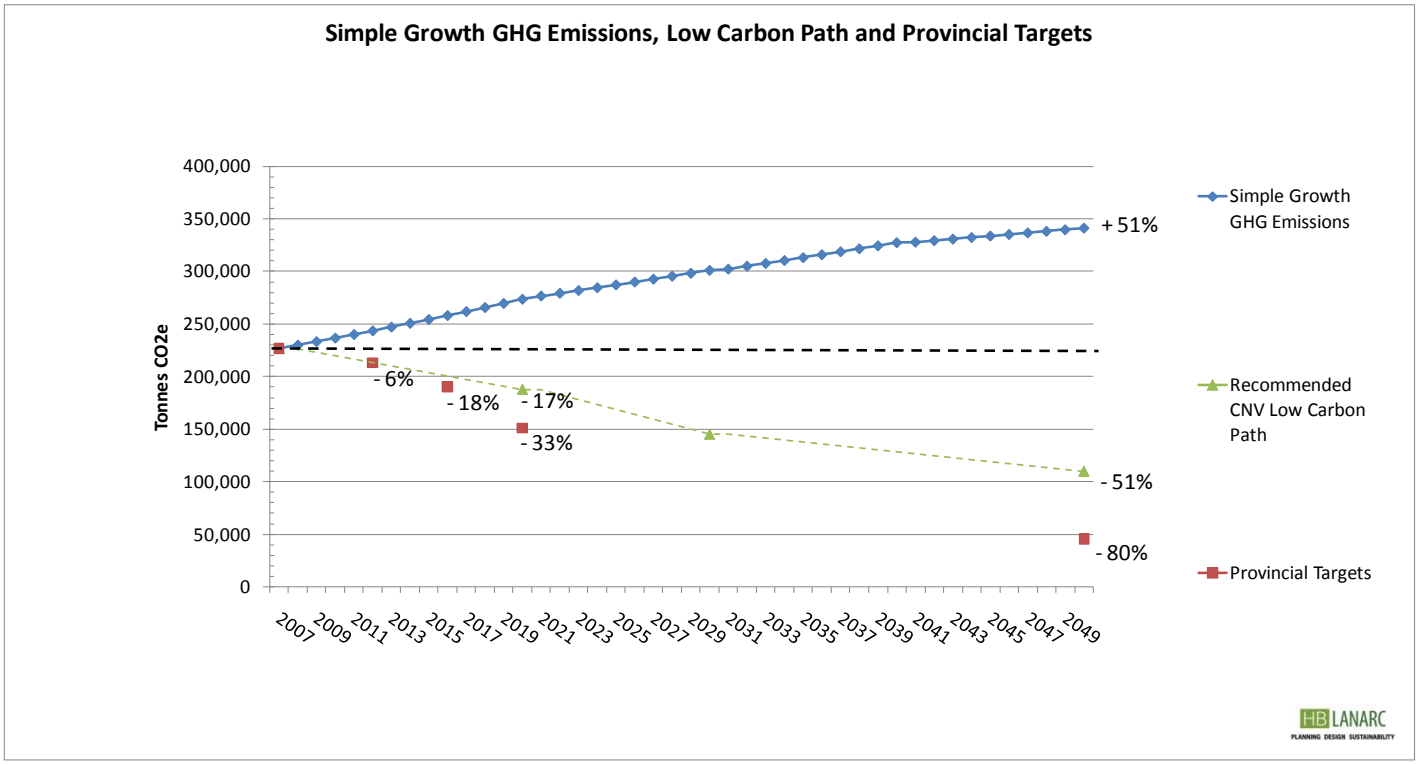


Figure 6 – Comparison of a forecasted Simple Growth Emission Scenario for the City of North Vancouver, the Recommended Low Carbon Path and the Province's emission reduction targets.

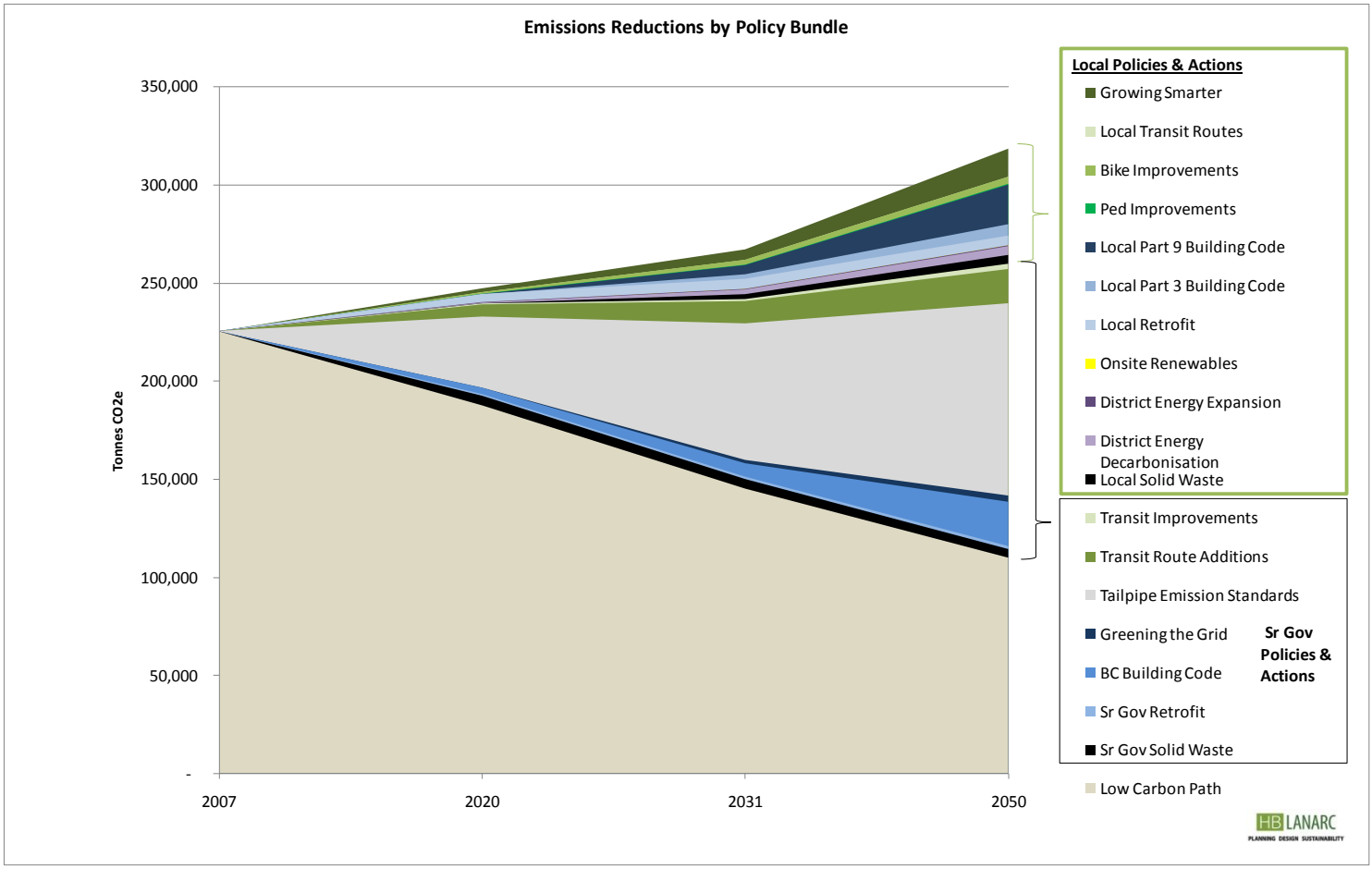


Figure 7 - illustrates emission reductions by policy wedge below the Business as Usual (BAU) path for the City of North Vancouver. Wedges are organized by Level of Government.

Fifteen percent of the modeled emission reductions in 2020 and 29% in 2050 occur as a result of policies and actions enacted in the City of North Vancouver. The remainder are most directly connected to policies and actions that need to be instituted at the region, provincial or federal level, including measures by BC Hydro and TransLink. The various emission reduction policies, including attribution by level of government, are best illustrated by the wedge chart above, Figure 7.

3.3. LAND USE

3.3.1. GOAL

- Strengthen per capita and per unit energy and emission performance, while maintaining the liveability of our community through continued smart growth based strategic land use planning principles.

Complementary Goals

- Buffer residents and businesses from energy price volatility and overall expenditures.
- Establish an efficient built form that minimizes per capita ecosystem impacts, strengthens liveability and healthy lifestyles, and supports travel and housing choice.
- Support long term City fiscal performance by lowering demand for additional infrastructure.

3.3.2. PATH, POLICIES AND ACTIONS

Metro Vancouver projects population and job growth to occur at a rate of approximately 1% per annum[22] within an already developed land area. This will require some land use changes in many parts of the City, as the future population will not be accommodated in current neighbourhood zoning. The *Low Carbon Path* has been built around one possible way in which future growth could be accommodated.

Figure 9 illustrates the increase in density over the milestone years. Most of the increase in density is concentrated in a few neighbourhoods. The forthcoming OCP Update process will ultimately determine how these land uses would be amended. These changes are a major driving factor in future energy use and emission reductions and are integral to many sector-specific strategies. The strategies below are based on input from Council, staff, stakeholder and public engagement, and subsequently modeled.

New Development

- Future development is primarily mixed use high density, multi-unit residential buildings that integrate office and retail commercial developments such as neighbourhood grocery stores.
- Development occurs around transit oriented hubs, nodes and corridors.
- "10 minute complete neighbourhood planning".
- From 2010 to 2030, the majority of new residential units are allocated to Lower and Central Lonsdale.
- From 2030 to 2050, Marine-Hamilton and Grand Boulevard gain significant numbers of residential units in conjunction with improved transit corridors, in addition to continued development in Lower and Central Lonsdale.
- Commercial growth from 2010 to 2050 is concentrated in Marine-Hamilton, Lower and Central Lonsdale.
- Increase the quantity, diversity and quality of local jobs by encouraging the appropriate types of commercial building development.

[22] Metro Vancouver 2009. Draft Regional Growth Strategy.

Infill

- Create street and road designs and parking standards that are attractive to active transportation modes and public transit use.
- Emphasis on mixed use, higher density development in the form of multi-unit residential buildings and coach houses.
- Transit oriented hubs, nodes & corridors.
- 10 minute complete neighbourhood planning, with an emphasis on increased access to services such as grocery stores.

Ten Minute Neighbourhood Planning

The "10 minute neighbourhood" is a planning concept providing guidance to integrated land use, transportation and development planning. The City's 100 Year Sustainability Vision, discusses "the mix and balance of land uses allowing all residents to live within 400 metres – corresponding to the average 5 minute walking distance – of their daily needs." (This is a 10 minute return.) Such neighbourhoods are recognized as highly liveable and safe. They are characterised by three features:

- Infrastructure and design that makes walking safe and enjoyable
- Access to key destinations such as shops, jobs, and parks
- Compact residential form to ensure the success of commercial key destinations

As part of Portland's continuing commitment to reduce GHGs, the City is planning to ensure all residents live in "20 minute neighbhourhoods." Existing ones are being mapped. New ones are being planned. Context is critical in planning and designing such complete neighbourhoods. The scale and type of key destinations will be different in predominantly residential areas versus higher density, mixed use areas. The Low Zone Design Guidelines, Section 5, begin to address these unique opportunities.

Portland Plan: Status Report: Twenty-Minute Neighborhoods
http://www.portlandonline.com/portlandplan/index.cfm?a=246917&c=46822

Neighbourhood Grocery Stores

Neighbourhood grocery stores are on the front line of defence against climate change. One in five trips is for shopping. One of the top contributors to the steady increase in distances people travel is the shift to large, car-oriented retail outlets in low density areas. A large body of literature shows people who live near small stores walk more for errands and, when they do drive, their trips are shorter. Moreover, the presence of small retailers influences the likelihood that people take public transit because they are able to chain errands on their commute home. Living close to grocery stores and even fast food outlets also lowers the likelihood of obesity. A small, but growing number of jurisdictions are establishing policies to promote neighbourhood grocery stores for the wide variety of social economic and environmental gains.

Obesity linked to fewer neighbourhood food options http://www.unews.utah.edu/p/?r=102609-2

Neighbourhood Grocery Stores and the Fight Against Global Warming
http://www.newrules.org/retail/article/neighborhood-stores-overlooked-strategy-fighting-global-warming

Roads, Streets and Paths

- Increase in street density, improved connectivity for walking and cycling

Green Streets & Lanes

Repurpose over time select streets and lanes for pedestrian and bike paths, community gardens, as well enhanced storm water infiltration and ecosystem protection. Access to safe and enjoyable infrastructure is a key determinant to walking and cycling likelihood. The City's small area requires creative and multipurpose application of existing land and streets to meet multi-facetted climate and sustainability objectives of the City and its residents. These strategies are discussed in the City's 100 Year Sustainability Vision, and build on the City's current efforts to promote urban agriculture and promote multi-modal opportunities in some laneways and streets.

Table 4 – Modeled Community Growth and Land Use Change Rates

	Year	Rate
*Residential Population Growth Rate (% per annum)	2010-2050	1%
*Number of New Jobs per New Resident	2020 2030 2050	0.97 1.13 1.16
* Commercial Floor Space Growth Rate (% per annum)	2010-2050	1.25%
*Industrial Floor Space Growth Rate (% per annum)	2010-2050	1.25%

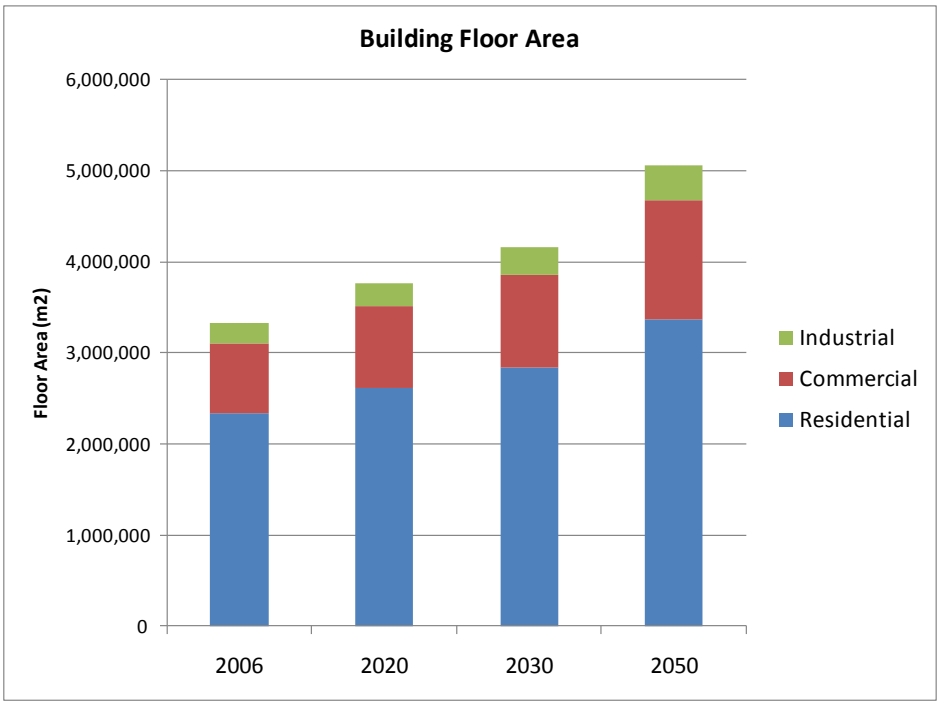


Figure 8 – Floor Area for Industrial, Commercial and Residential Buildings

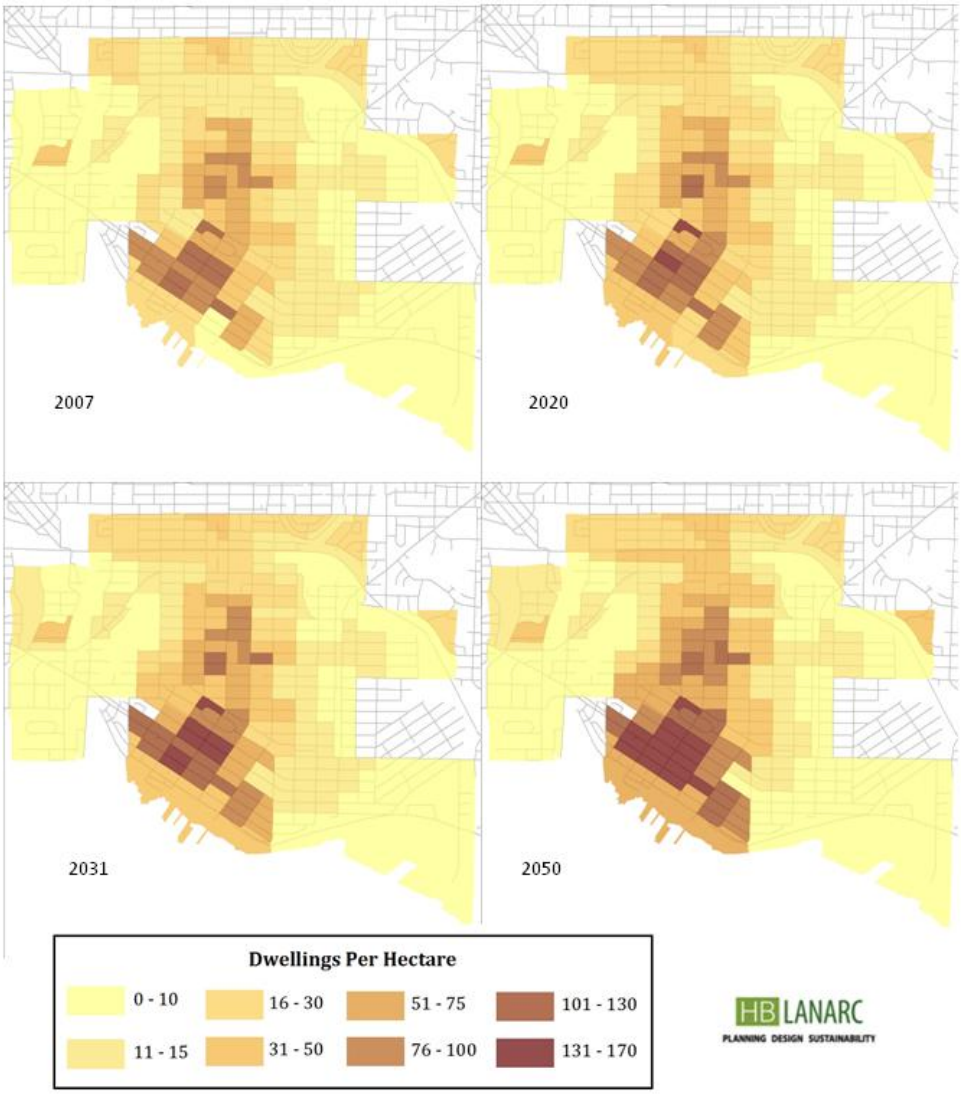


Figure 9 – Low Carbon Path: dwellings per hectare for the City of North Vancouver

Potential Additional Opportunities

Other items that were not quantified but could contribute to further emission reductions and be considered in future energy and emission planning work or in future initiative such as further transportation plan development or the OCP Update, include:

- Establish select commercial and institutional key destinations and allocate greater residential growth around small nodes in single use, lower density areas while respecting the character of these areas. These micro, mixed use centres, including an intensification of neighbourhood grocery stores and cafes, can substantially increase walking and biking, and strengthen transit use.
- Encourage a wide diversity of small format residential developments across the city respecting neighbourhood character. Encourage work-live opportunities throughout the City and support amenities to support local enterprise such as larger meeting rooms, and more work-live offices in Lonsdale corridor. Support building flexibility that permits residential, commercial or residential/commercial for demographic and economic transitions.

- A more comprehensive integration of urban agriculture and urban forestry (see section 2.8) into the City would advance complimentary City goals and help further drive down greenhouse gas emissions through increasing carbon sink opportunities. This could also include general purpose green space and smaller informal pockets of community gardening.
- Seek opportunities for the development of *Sustainability Precinct* where an area with substantial development (brownfield, greenfield or infill) could be used for making significant advances in energy efficient buildings, low carbon/renewable energy heat and power, smart grid development, sustainable transportation, community gardening, ecosystem restoration/protection (carbon sequestration). One of the project's objectives would be to build internal staff knowledge, capacity and policy, as well external (community, builder, developer, utility, financer) knowledge and capacity to enable broader deployment of these technologies and practices. Such a project would require allocation of staff time, as well as collaboration with a willing developer, and active involvement from key players like utilities, and potentially anchor tenants, the Province, a financial institution, and of course broader community engagement.

3.4. TRANSPORTATION

3.4.1. GOALS

- Work towards a mode split with a higher concentration of transit use, carpooling, walking and cycling.
- Public transit will be convenient, comfortable and safe to ride in all neighbourhoods.
- Improve sidewalks, signs and signals, lighting and pathways so that walking is convenient and safe in all neighbourhoods.
- Reduce annual per capita vehicle kilometres traveled.

Complementary Goals

- Promote transportation choice.
- Support liveability and healthy lifestyles by creating environments that are enjoyable for residents and visitors to walk a cycle.
- Support long term City fiscal performance by using less infrastructure.
- Reduce price volatility and overall expenditures on energy.

3.4.2.PATH

To decrease emissions in the transportation sector it is necessary to do the following:

- Reduce the number of trips that people take in private vehicles.
- Reduce the length of trips.
- Reduce the amount of greenhouse gases that are emitted by private and public vehicles per kilometre traveled.

Coordinated efforts are needed between local, regional and senior levels of government in order to successfully achieve transportation emission reductions. One key area of coordination will be land use and transportation planning to minimize the need for private vehicle use and maximize pedestrian, bicycle and transit travel. Another area will be the integration of freight transportation planning with other community transportation priorities to more fully realise the mobility potential of rail and minimize the use of commercial vehicles while maximizing efficient goods movement.

Table 5 – Modeled Transportation Sector Emissions

	Annual GHG Emissions - Tonnes CO_2e/yr			
	2007	**2020**	**2030**	**2050**
Private transportation	102,624	71,632	43,600	31,413
Public transportation	9,096	7,998	6,044	6,412
Total transportation	**111,720**	**79,630**	**49,644**	**37,825**
Total transportation per capita	2.47	1.55	0.87	0.55

3.4.3.TRANSPORTATION POLICIES AND ACTIONS

The following strategies emerged from the stakeholder engagement and analysis process to help the City achieve emission reductions while also meeting complementary community goals and priorities. These strategies should be basis for developing more detailed policies and actions.

Senior Government

- **California Tailpipe Standards** – The BC Provincial government is close to implementing Bill 39, the vehicle tailpipe emission standards legislation modeled California's. This will require manufacturers to produce and sell progressively cleaner vehicles, significantly reducing emissions from private vehicle use.
- **Transit Strategy** – At the regional or sub-regional scale, transit agencies and local government would need to collaborate to progressively improve access to transit through increasing the frequency and coverage of service, increasing the number of high-speed and inter-city routes, phasing in natural gas and electric drive vehicles. Other strategies that could increase the desirability of **transit** would be sub-regional or regional level transit passes, and road pricing for private vehicles.
    - **Major Transit Backbones** – New high speed transit service, specifically the B-Line or Bus Rapid Transit on Highway 1 and between Bridgeheads on 3rd Street/Marine Drive by 2020 or 2030.
    - **Sea Bus** – Put a 3rd Sea Bus in service; phase in natural gas; enhance the multi-modal capacity of terminals.
    - **Improved Local Transit Service** – To support new frequent transit lines, including the 3rd Sea Bus, make improvements to local bus service.
- Decreased headway (increased frequency of service), increased capacity and average speed.

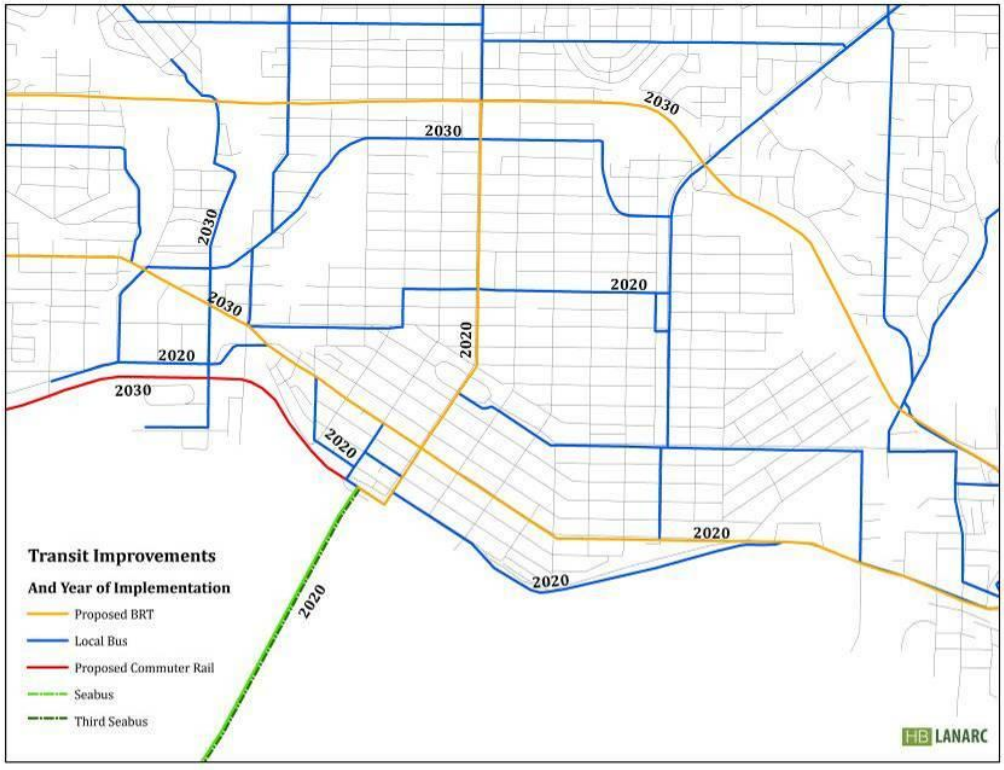


Figure 10 – City of North Vancouver Low Carbon Path Transit Improvements

City of North Vancouver Strategies

- **Implement the Pedestrian Plan**[23]
  - Progressively strengthen infrastructure:
    - Sidewalks;
    - Enhanced connectivity across highways, creeks, rail;
    - Cross-walks and signs;
    - Street lighting.
  - Dedicated areas (greenways, Spirit Trail),
  - Education and outreach.
- **Implement the Bicycle Plan**[24]
  - Progressively extend network of bicycle routes, lanes and paths.
  - Strengthen infrastructure,
  - Strengthen multi-modal opportunities,
  - Education and outreach,
  - Add bike lockers at Lonsdale Quay and additional bicycle parking along Lonsdale Ave and other commercial centres.
- **Additional Bicycle Strategies**
  - Encourage the use of electric bicycles community-wide.
- **Implement the Transit Strategy**[25]
  - Supplementary City of North Vancouver infrastructure/routes.
  - Expanded U-Pass program to Capilano College.
  - Create City-wide or neighbourhood specific Transit Pass program modeled after U-Pass.
  - Education and outreach,
- **Additional Transit Strategies**
  - Enhance transit stop comfort, convenience and safety.
  - More shelters and better lighting at bus stops.
  - Real-time "Next Bus" information at bus stops.
  - Shuttle to service the industrial areas (City-business partnership, includes Harbourside).
  - Water connection from Harbourside to Vancouver.
  - Frequent service on Lonsdale Avenue with significant bike capacity.
  - ~~o~~ New major multi-modal hub at upper or central Lonsdale (see box below)
- **Commuter Rail Corridor** – Examine the feasibility of utilizing the rail line for commuter transport.

[23] See: *The City of North Vancouver Long Term Transportation Plan*
[24] See: *The North Vancouver Bicycle Master Plan* and *The City of North Vancouver Long Term Transportation Plan*
[25] See: *The City of North Vancouver Long Term Transportation Plan*

- Potential commuter shuttle to/from Harbourside

- **Low and Zero Emission Vehicle Promotion** – Local measures to facilitate use of low emission vehicles/zero emission vehicles, e.g., premium parking stalls, right size parking stalls, chargers for plug in electric cars/hybrids, electric bikes.
- **Implement the Travel Demand Management (TDM) Strategy** [26]
  - Parking Management Strategies:
    - Reduced parking requirements in Transit Oriented Developments
    - Broader on-street/off-street parking strategy
  - Education and outreach on reducing Single Occupancy Vehicle trips.
  - Practice integrated and use and transportation planning in accordance with the City's Official Community Plan (OCP):
  - Mixed use re-development and densification strategies.
  - TravelSmart - community-based social marketing initiatives to reduce barriers for using transit.
- **Additional Transportation Demand Management (TDM) Measures** – This could include:
  - Pay parking implemented to fund alternative transportation initiatives that have clear climate protection and community liveability value.
  - School oriented programs:
    - Safe-Routes-to-School. These programs use a variety of education, engineering and enforcement strategies that help make routes safer for children to walk and bicycle to school and encouragement strategies to get more children to walk and bike. They have grown popular in recent years in response to problems created by an expanding built environment and a growing reliance on motor vehicles for student transportation.
    - "Walking school bus." A walking school bus is a group of children walking to school with one or more adults. It can be as informal as two families taking turns walking their children to school to as structured as a route with meeting points, a timetable and a regularly rotated schedule of trained volunteers.
    - Bicycle parking
      - Bicycle parking standards for new development (Buildings strategies).

Multi-Modal Transportation Hubs & Nodes

Multi-modal transportation hubs are the nexus of efficient urban transportation systems. They support a diversity of seamless intermodal travel options – emphasizing transit, walking and cycling but also taxis, car sharing and private automobile – serving a wide range of scales from neighbourhood, city and metropolitan area to region. The most celebrated feature atriums or plazas within a complete, compact zone that ensures their success supporting mobility, serving as social gathering places as well as commercial centres where locals and visitors can conveniently shop or integrate errands into their commute. Lonsdale Quay and the sea bus terminal are close to this high mark. The City's plans to strengthen the public realm and bike security will further contribute to its importance. Upper Lonsdale could be another appropriate site for such a hub. Smaller scale multi-modal nodes with fewer transit routes can serve smaller commercial sites with sufficient density. There are a number of areas outside the Lonsdale corridor that could benefit from such nodes, reducing emissions, enhancing liveability and building community.

[26] See: *The City of North Vancouver Long Term Transportation Plan*

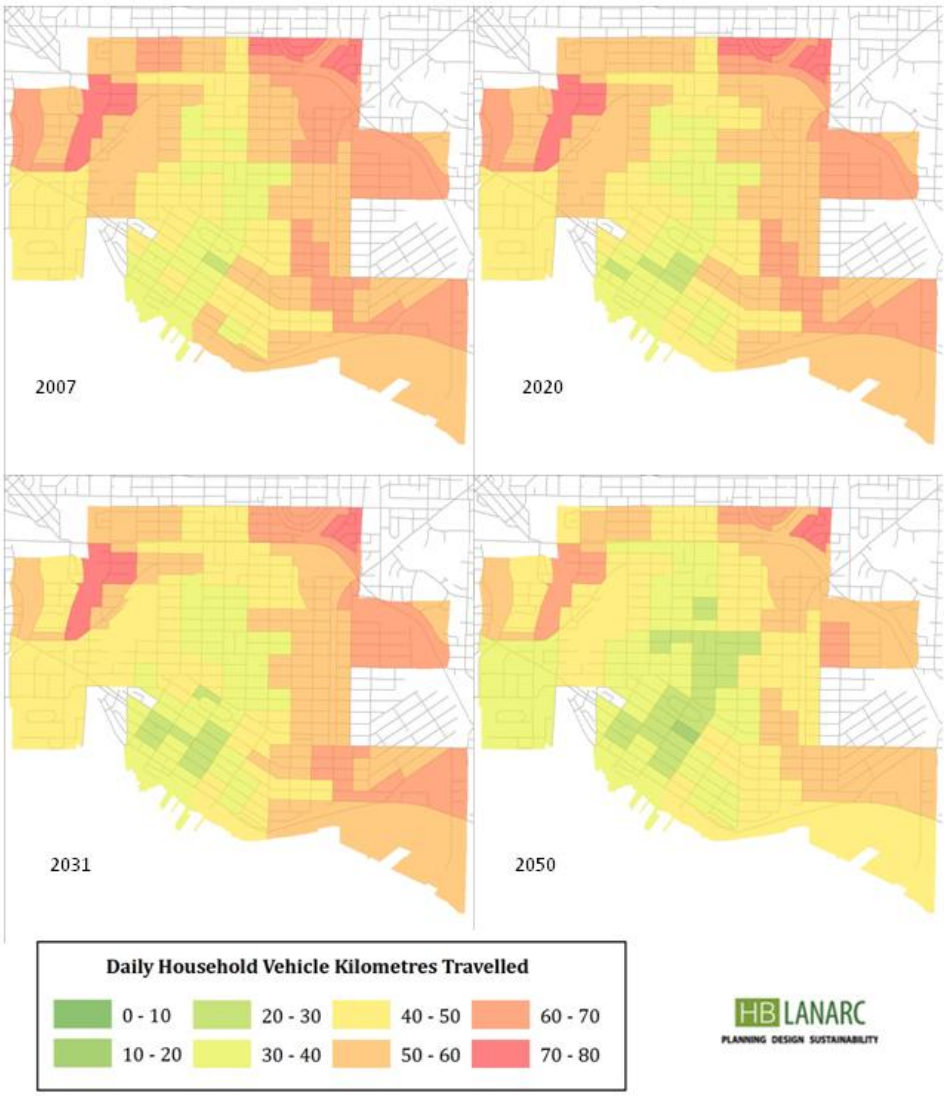


Figure 11 – Low Carbon Path results for daily household vehicle kilometres traveled, City of North Vancouver

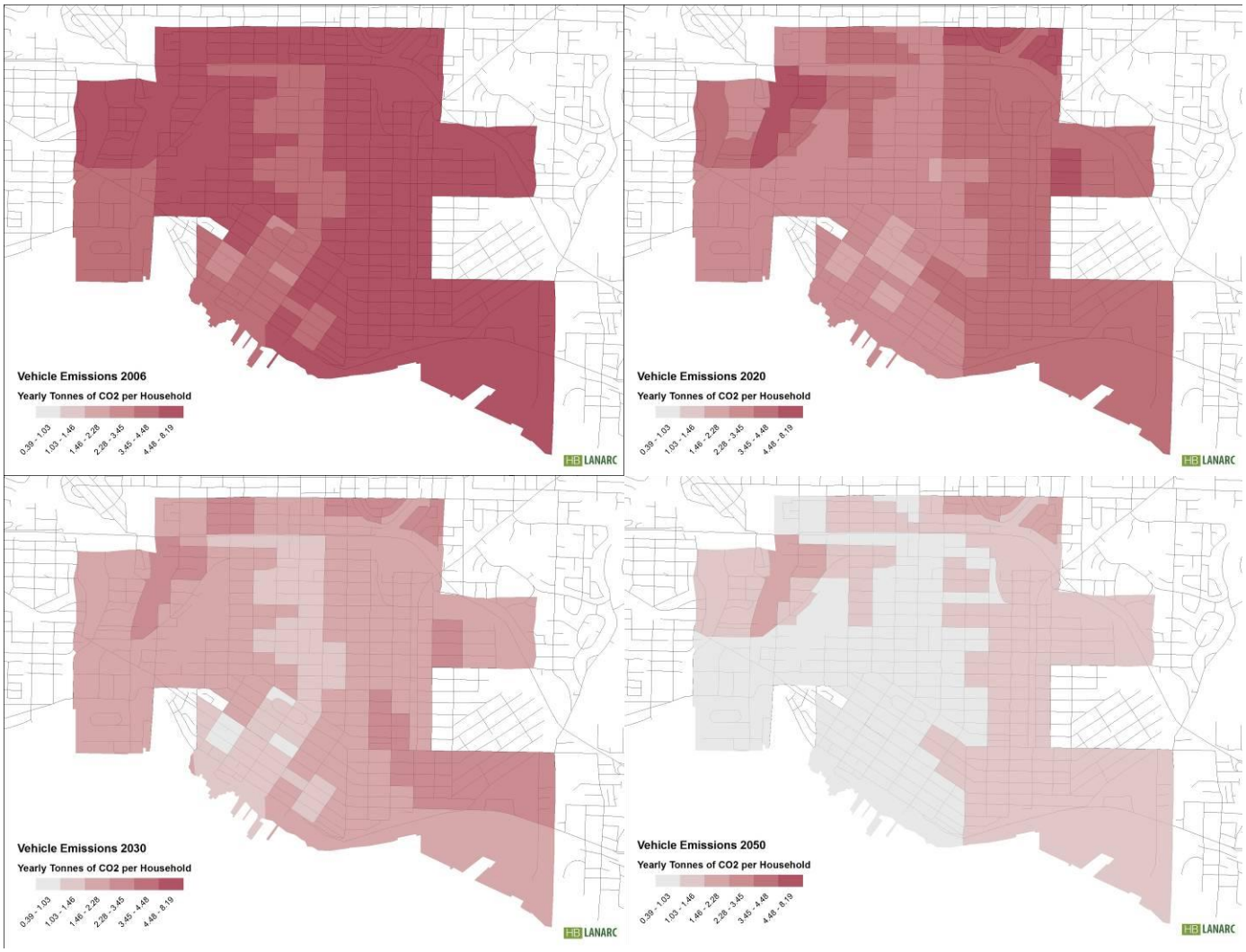


Figure 12 - Annual Vehicle Emissions per Household in the Low Carbon Path, City of North Vancouver

Potential Additional Opportunities

Other items that were not quantified but could contribute to further emission reductions and be considered in future energy and emission planning work or in future initiative such as further transportation plan development or the OCP Update, include:

- Replace lanes for private automobiles along major commercial streets with more transit, biking and walking infrastructure, commercial terraces and urban plazas and parks, along with planned increase in residential density as described in the 100 Year Sustainability Vision. Shift freight off of these commercial streets onto other major arteries.
- Establish a multi modal transportation hub near Highway #1 and Lonsdale and a series of smaller multi-modal nodes at secondary mixed-use centres for seamless inter-modal transitions, notably between walking, biking, electric-biking, transit and car sharing with appropriate facilities such as shelters and secure bike storage, as well a strong public realm. The Upper Lonsdale Hub would have strong inter-city mass or medium transit connections up Highway 99 and East along Highway 1.

- As residential and commercial density increases along 3rd Street/Marine Drive corridor in the City and District of North Vancouver, and along Marine out to District of West Vancouver, increase transit speed along 3rd Street/Marine Drive with light rail.
- Make the City a major centre for bikes for all ages with separated lanes along key arteries, active transportation exclusive paths and/or alleys, and significant safe and secure all-weather parking.

Increasing the Intensity of Modeled Transportation Sector Strategies

The Low Carbon Path contains aggressive and wide-sweeping policies/actions in the transportation sector by senior governments and the City of North Vancouver. Sensitivity analysis showed that the emission reductions that can be achieved through increasing the intensity of policies already modeled in the Low Carbon Path are small. The action that would have the greatest effect is extending the Canada Line across the inlet from Waterfront Station to Lonsdale Quay in 2020 with supporting local transit service occurring at the same time. This would result in VKTs reducing 8% below the Low Carbon Path in 2031 and 4% below in 2050. While the VKT reduction is significant, due to improved vehicle fuel efficiency standards the decrease in emissions is not as great: 1,000 tonnes CO_2e in 2031 and 2050. The second most effective action modeled in sensitivity analysis was adding a 3rd SeaBus and increased local transit service in 2020. This would result in a VKT reduction of 1% (650 tonnes CO_2e) below the Test Run scenario in 2031 and 2050.

There are additional policies and actions aimed at facilitating an increase in walking, cycling and transit use that are likely to reduce transportation sector emissions further (mentioned at the end of this section), but too little is known about the impacts to include them in the list of modeled strategies.

A Need for New Financial Incentives to Facilitate Mode Shift?

The transportation sector strategies outline in this section, in combination with those described for land use, lay the foundation for deep emission reductions over the long term. Because the relationships between the factors that determine how many kilometres each household drives in a year are calibrated on present day behaviour, it is difficult to accurately predict how people will respond to future incentives and disincentives to drive. $3 per litre gasoline would undoubtedly reduce how much people drive, but because we have not seen prices that high, it is difficult to predict by exactly how much. While creating land use patterns and putting in place public transit, walking and bicycle infrastructure and services that make it possible for people to use private automobiles significantly less are recognised as a cornerstone for reducing transportation sector emissions, it is also important to acknowledge that North America cities, including North Vancouver, were built around the automobile. Significant changes to the public financing structure, where local and senior governments subsidise the cost of owning and driving private vehicles through road construction and tax incentives to oil companies, will be needed to facilitate the transition from fossil fuels. A recent study by Morrow et al (2010) modeled the impact of five future national government level policy scenarios on GHG emission in the United States transportation sector. The study found that the most effective mechanism for increasing the fuel efficiency of vehicles and decreasing the annual distance traveled was increasing the cost of driving using fuel taxes, such that the cost of gasoline exceeded $8 per gallon ($2.11 per litre).

Morrow, W. Ross, Gallagher, Kelly Sims, Collantes, Gustavo, and Henry Lee (2010). "Analysis of Policies to Reduce Oil Consumption and Greenhouse-Gas Emissions from the U.S. Transportation Sector." Energy Policy, Vol. 38, No. 3, March: 1305-1320.

3.5. BUILDINGS

3.5.1. GOALS

- Improve the energy efficiency of *new* and *existing* residential, and commercial, industrial and institutional buildings.
- Reduce GHG emissions of new and existing residential, commercial, industrial and institutional buildings through increased use of renewable energy sources.
- Encourage the displacement of low efficiency systems through high efficiency system upgrades and renewable heating systems.

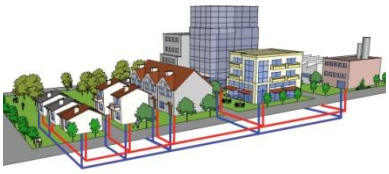
Complementary

- Build on the City's commitment to housing diversity to address issues such as accessibility, aging in place, affordability, and accommodating changing demographics.
- Reduce resident and business risk to energy price volatility and increases.

3.5.2.PATH

By 2050, the buildings sector in CNV will need to be transformed into a dramatically more efficient, low carbon building stock. The elements of this transformation will need to include the following:

- Over time, nearly all buildings that exist today will need to be retrofitted for improved efficiency, with many of these being retrofitted to utilize renewable energy sources such as solar energy.
- All new buildings will need to be built to progressively increasing energy efficiency standards, achieving "passive house" or near-net zero levels for most buildings by 2030. New buildings will also need to incorporate increasing contributions from renewable energy sources; these would include connection to a "de-carbonized" district energy system.



- Building GHG emissions need to be reduced by more efficient use of space, for example through compact, space efficient building forms. This will also contribute to the reduction of embodied energy and carbon in the construction of new buildings.

By 2020, substantial progress will need to be achieved in both constructing and retrofitting buildings for high energy efficiency, in order to stay on track with long term reduction targets. Displacement of low efficiency heating sources will need to be encouraged through on-site renewable heat, likely focused in single detached homes and areas beyond Lonsdale Energy Corp service area.

CNV has already begun to develop energy efficient new building policies that augment the BC Code; key challenges include overcoming some of the limitations of local government regulatory authority with respect to building standards, and the capacity of the development and building industry to successfully respond to new standards. Early adoption of higher standards will lead to greater overall reductions: there is a need to accelerate adoption of increased efficiency standards. Moreover, rigorous enforcement of minimum building code energy standards will be required.

Additional focus will need to be applied to ensure progress can be made across all key building sectors and industries, and to facilitate the adoption of on-site renewable energy sources and higher efficiencies though the use of passive design.

CNV land use policies will also require changes to lay the foundation for more space efficient building forms, as discussed.

In this future low-carbon scenario, the quality and liveability of community buildings is expected to be maintained or increase. Energy efficiency and renewable energy can be part of broader green building strategies and systems such as LEED® that can increase indoor environmental quality; in efficient buildings, increased attention to overall design and integrated design is typically required, resulting in improved overall building quality.

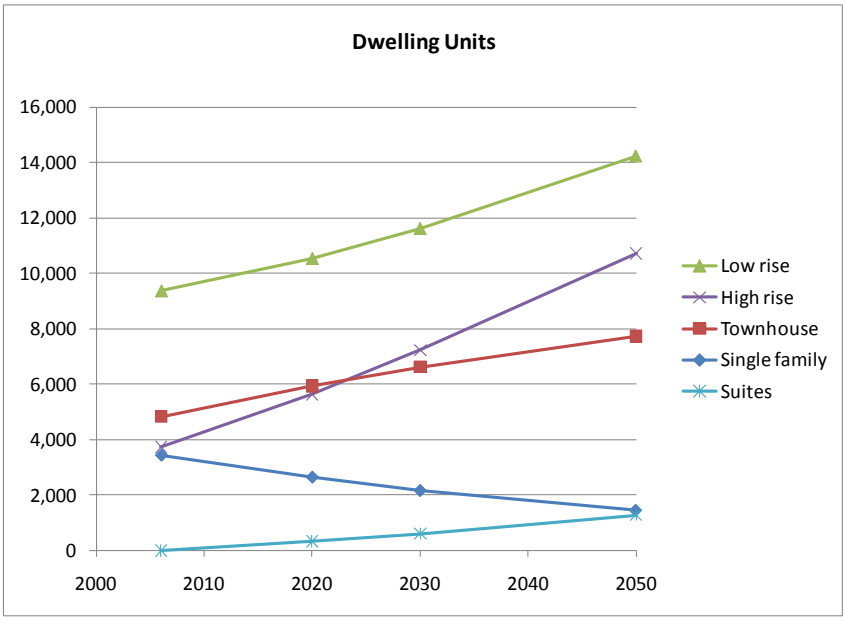


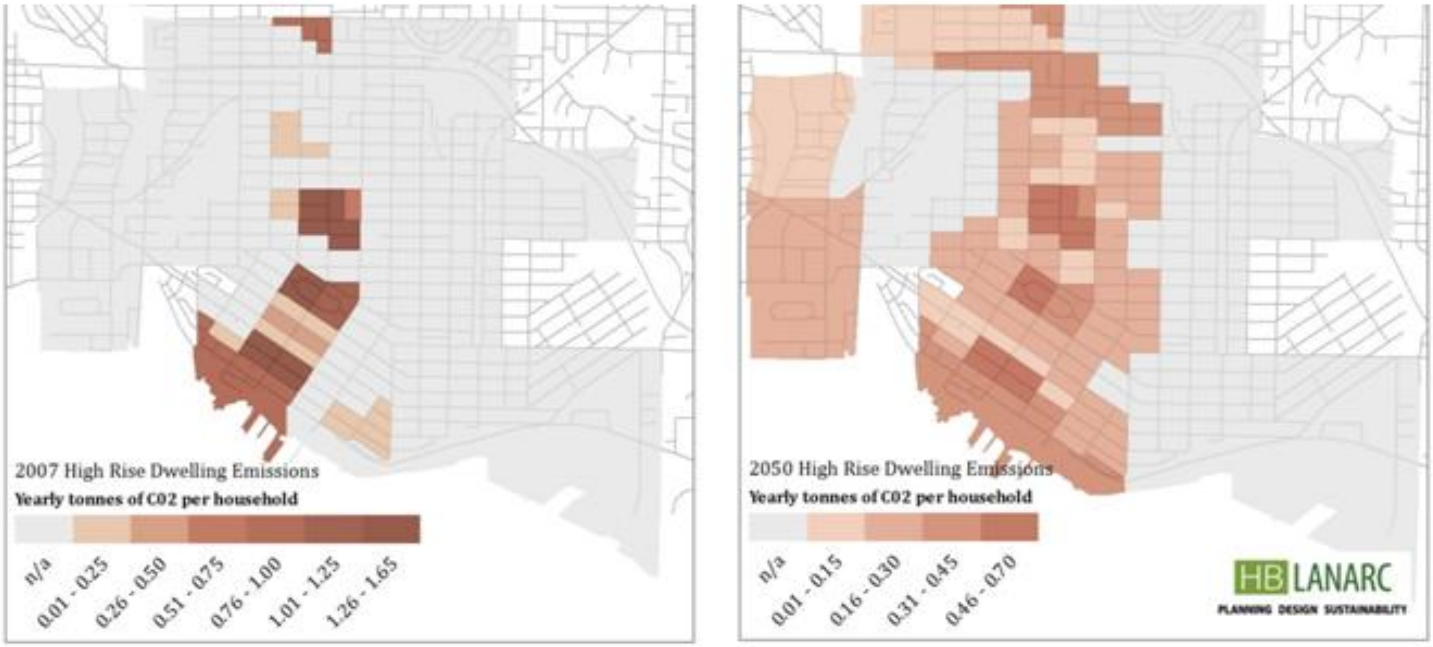
Figure 13 – Projected Increase in Dwelling Units, by type, modeled for the Low Carbon Path

The modeled results show that GHG emissions from the buildings sector could potentially decrease as shown in Table 6, should the key assumptions outlined below Table 4 and Figure 13 proceed as envisioned.

Table 6 – Low Carbon Path Modeled Buildings Sector Emissions

	Annual GHG Emissions - Tonnes CO_2e/yr			
	2007	**2020**	**2030**	**2050**
Residential buildings	47,083	43,332	36,668	24,009
Commercial buildings	45,790	44,081	41,419	35,257
Industrial buildings	13,237	13,248	12,573	10,640
Total buildings	**106,110**	**100,661**	**90,414**	**69,742**
Total buildings per capita	2.35	1.96	1.59	1.01

Figure 14 – Emissions reductions for High Rise Dwellings, 2007 to 2050



Key assumptions in the low carbon path for buildings:

- For new buildings, an aggressive path of new building energy efficiency is assumed, based on a rapidly progressing BC Building Code augmented by strong enforcement of code standards and additional CNV building policies intended to push building energy performance beyond minimum code requirements.
- Uptake of building efficiency and renewable energy retrofits that is facilitated by CNV policies and programs.
- Nominal replacement of older buildings with new ones of similar size and type.
- Redevelopment of older, low density building forms with higher densities where appropriate, with mixed, energy sharing uses.
- Substantial improvements in industrial energy efficiency, recognizing that the bulk of energy use is associated with processes rather than building performance. Reusing waste heat and other energy wherever appropriate.

3.5.3.SENIOR GOVERNMENT POLICIES AND ACTIONS

The BC Building Code contains some of North America's highest building standards, and the energy performance requirements are expected to progress steadily. This will result in a level of increasing energy and emissions performance in community buildings, essentially independent of CNV policies and actions.

The anticipated building performance required by the BC Code is illustrated in

Figure 15 and Figure 16 for selected building types.

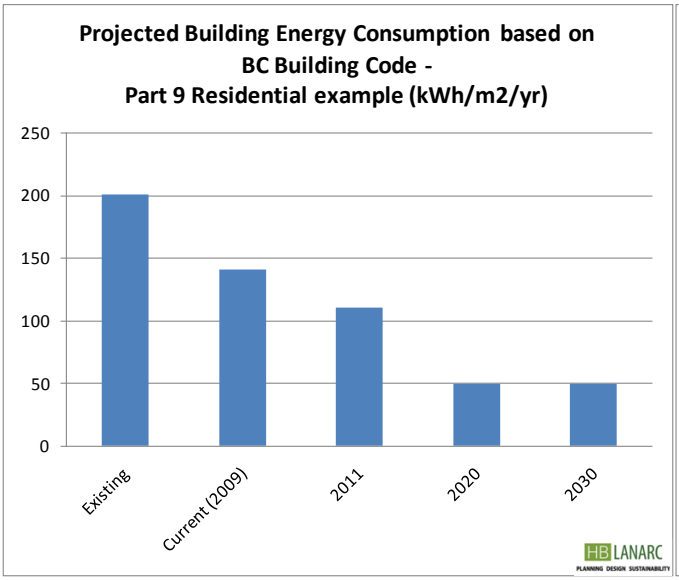


Figure 15 – Projected Part 9 Building Performance

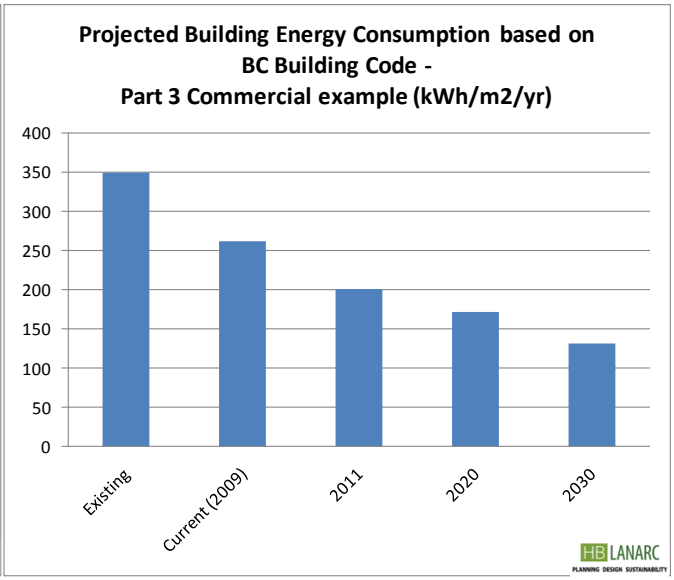


Figure 16 – Projected Part 3 Building Performance

Given that the implementation of the future Code is not yet known, clearly it is possible that the Code may progress differently than shown. A very progressive Code is assumed in the forecasts in order to illustrate the potential GHG reductions of a low carbon path, directions on the future Code as stated by several sources in the BC government, and to clearly show the level of follow-through necessary from senior governments in order to move toward provincial GHG emissions reduction targets. In addition to the Code, senior government and third party (such as BC Hydro and Terasen) energy incentive programs support building energy efficiency retrofits.

Building Codes – The Importance of Local Enforcement

The CNV's Community Development Department is responsible for ensuring that buildings meet minimal BC Building Code requirements, including energy standards, as part of permitting and inspections. However, anecdotal/unpublished evidence from major Lower Mainland jurisdictions indicates that many buildings are failing to meet Code energy standards. While CNV data is not available, it is possible that some new buildings are in violation of the Code.

As Code energy requirements and CNV energy policies are made more stringent, enforcing adherence to standards will become increasingly important. Moreover, future iterations of the BC Building Code may contain new mandatory performance measures, such as air leakage tests. It is important that the CNV's Permits and Inspections Division possess the resources and capacity to enforce the Code.

3.5.4. LOCAL POLICIES AND ACTIONS

Given the unique opportunities that exist in the community, the City of North Vancouver will work to advance building design and performance beyond what would be accomplished through senior government action alone. This will include:

- Cross Cutting Measures

- Strengthened capacity building through education and outreach to build capacity in both the CNV and industry for successful implementation of energy efficient, low carbon and green buildings.

Promoting Solar Hot Water (SHW)

To promote SHW, the CNV can streamline its approvals processes. Consider reducing permit fees, and hold joint industry/inspector workshops on installation techniques (Solar BC organizes such events). Promote SHW incentives in conjunction with distributing the CNV's Solar Panel Guidelines (in development by CNV staff).

- An award program to recognize high performance building projects.

- Rigorous enforcement of BC Building Code energy standards and any future City standards.

- Work with the Province to emphasize the importance of energy performance as well as embodied energy in future building codes.

Capacity Building

Many builders lack the skills and understanding of advanced construction techniques to ensure air-tight construction, and properly install new energy efficient technologies. Many designers are unfamiliar with passive design techniques, and lack experience managing projects for energy efficiency. A range of capacity building programs are available, to help develop these skills. The CNV can encourage participation in such programs, by hosting and incenting participation.

Likewise, capacity development can benefit CNV staff. For example, the City of Red Deer initiated a training program for inspectors. According to Paul Meyette, Inspections and Licensing Manager: "Our building inspectors state they are more open to code equivalencies for green buildings. An additional benefit has been the ability to explain energy efficiency techniques to builders... some significant reductions in heat loss can be achieved for very little extra cost."

Opportunities to combine industry and staff capacity building can create greater common understanding of energy efficient building techniques.

- Promote energy efficient, low carbon building design and practices for all new development projects and City-owned buildings.

    - Pursue increasingly aggressive energy standards for new buildings over time.

- In December 2009 the City resolved to update its Sustainable Development Guidelines to include more rigorous standards for energy efficiency. Buildings are expected to meet the new energy efficiency Guidelines when applying for rezoning.

- In 2010 the City will consider seeking permission from the Province to obtain concurrent authority for building performance standards and verification requirements, secured by City bylaw.

- In the short term, performance standards for new and retrofitted residential and commercial buildings will exceed those of the Province and will become increasingly more efficient over time.

    - Require the use of hydronic or high efficiency energy systems in new and existing buildings, as appropriate, to enable transition to renewable energy sources such as ground-source heat pumps.

- Require new buildings to be solar hot water ready and develop policies and programs that make it easier for developers and building owners to incorporate solar hot water into new and existing buildings.

- Develop policies that promote the use of passive energy efficient design to minimise the lighting, heating and cooling demands of new buildings.

- Develop a program aimed at improved compliance to energy standards - both BC Code and potential City standards.

Passive Design Guidelines

Building orientation, form, exterior design elements (like shading features), materials, and landscaping can significantly impact energy consumption – 'Passive Design' optimizes these features.

Passive Design can be hardwired into neighbourhood developments through Development Permit Area Guidelines – municipalities including the District of Saanich and City of Dawson Creek have developed such guidelines to reduce energy use.

Recent Bill 27 powers, may present opportunities to incorporate low-carbon building strategies like renewable energy in DPA Guidelines, in addition to passive design. As these powers have not been tested, the CNV should seek formal legal advice before initiating development of DPA Guidelines prescribing such features.

- Work with agency partners to promote retrofits to existing buildings in the City, such as creation of a Building Retrofit Program, to reduce energy consumption and GHG emissions through voluntary, incentive and possibly regulatory measures.

  - Strengthen the City's existing programs promoting existing senior government and third party energy efficiency incentive programs. This could include targeting specific neighbourhoods, for example those with older, larger houses that are typically much higher energy users.

  - Explore the development of new policies that could further increase retrofits, and put into place minimum energy requirements for retrofits.

Encouraging Retrofits

CNV staff already conduct public outreach promoting participation in the Provincial LiveSmart BC home energy retrofit program, recognized as a best practice in BC. Future improvements on the program could include:

- Home energy labelling at time of sale, to facilitate greater awareness of energy use. In the longer term, this may facilitate mandatory improvements.
- Property Assessed Clean Energy (PACE) Financing, whereby the CNV or a partner finances retrofits. Loans should be tied to the property, paid back through property taxes, local improvement charges, or some other mechanism. Leading municipalities such as Berkeley, California are implementing such systems.

  - Strengthen promotion of low-carbon energy sources such as geo-exchange for space heating and solar thermal hot water where appropriate in existing buildings beyond the LEC network, for both new and existing buildings.

- Progressively increase space- and energy-efficient, highly liveable building forms and neighbourhoods, for example efficient multi-family housing and diverse commercial buildings, through land use planning and potentially other mechanisms.
- Pursue the construction of low-carbon buildings within a sustainability precinct that could be created in neighbourhoods such as Marine Hamilton, Central or Lower Lonsdale; this could include facilities such as the Harry Jerome Recreation Complex, and could include elements such as smart electrical grids, active transportation, low carbon buildings, and more.
- Advance the reduction in transportation and waste related greenhouse gas emissions through complementary building policies.
    - Create policies that require outlets and space for electric bicycles, scooters and cars in new residential and commercial buildings.
    - Increase the availability and accessibility of quality bicycle parking and storage facilities in residential and commercial vehicles.
    - Consider requirements for provision of space for food gardens in multi-family housing.
    - Strengthen policies to encourage or require sufficient space for optimal recycling and composting facilities in new commercial, industrial and multi-family residential buildings.

Potential Additional Opportunities

The Low Carbon Path strategies in the Buildings Sector were developed to be both aggressive and implementable. Several barriers exist that would prevent the City from reducing emissions beyond what was modeled. This includes the current lack of legal authority to independently move beyond the building code, and the low capacity of developers and contractors to construct and retrofit buildings to higher performance standards, and integrate onsite renewable energy sources.

The following items were not quantified but could contribute to further emission reductions and be considered in future energy and emission planning work or in future initiative such as work by the City's green building work or the OCP Update:

- Accelerate the rate at which its local construction standards bylaw (pending Provincial approval of concurrent authority) requires zero carbon buildings for the residential sector and increase the rate of energy performance improvements for the commercial and industrial sectors. (See Appendix C for specific timelines and building performance modeled).
- Increase the rate at which new and existing buildings incorporate onsite renewable heat systems, such as solar hot water heaters and geo-exchange systems.
- Build capacity among the skilled construction and building technology trades in practices that result in higher energy performance buildings and the incorporation of onsite renewable into buildings. The City of North Vancouver could explore partnering with the Province, energy utilities, the private and/or non-profit sectors to train and build local capacity for green building practices and techniques.

3.6. ENERGY SUPPLY

3.6.1. GOALS

- Plan and build out the City's district energy system so that it uses low or zero carbon energy supply
- Increase onsite renewable heat and electricity generation while pursuing options for larger scale renewable energy sources.

Complementary Goals

- Reduce local resident and business vulnerability to energy price volatility and increases, and potential commodity supply shortfalls by establishing stronger local, independent supply opportunities that are efficient, diverse and have strong renewable content.

3.6.2. PATH

By 2050, the City will need to rely substantially on renewable and low carbon energy sources, with a much lower reliance on electric and fossil-fuel based heating for buildings. As electric heating decreases, electricity will need to be utilized for a significant portion of transportation energy, displacing fossil fuels and reducing the GHG emissions intensity of transportation, including both private vehicles and public transportation systems.

To support this overall transition, the City will need to work with the district energy (DE) system operated by Lonsdale Energy Corporation (LEC) to help transition to relying primarily on renewable and low carbon energy sources, such as geo-exchange, solar, biomass or others. This will require a substantial shift from the current energy mix, where the district energy system relies primarily on natural gas for heat. Factors influencing this transition include linking and expansion of existing grid networks, achieving sufficient base loads to support alternative energy sources, and financing the development of these new energy sources.

At the same time, buildings not connected to DE systems, which would likely include many of the low density buildings in the City, will need to incorporate on-site renewable and low-emissions energy sources such as solar and geo-exchange. Depending on the long term electricity supply and price changes, these on-site sources could also include solar or wind electricity generation, which is currently not cost competitive.

Achievement of the transition to low carbon energy sources discussed above would result in a number of significant potential benefits, including increased energy security and a strengthened economic base in the City, through channelling a higher proportion of energy spending through local businesses.

Table 7 – Modeled Emission Reductions due to District Energy and Energy Supply Policies

Emissions Reductions by Energy Policy Bundle (Tonnes CO_2e)				
	District Energy Decarbonisation	District Energy Expansion	Onsite Renewables	Greening the Grid
2020	493	134	7	0
2030	2,528	184	177	1,716
2050	4,628	295	262	3,188

The impact of district energy takes time to develop – this is because of the time required to expand service areas, build new infrastructure, and develop alternative energy sources. It is also dependent on the amount of floor space in CNV that is connected – it is anticipated that this would generally not include low density buildings, and most existing buildings. Table 7 illustrates that of the modeled energy related policies, reducing the GHG emission factor of the DE system (decarbonising DE) will have the biggest impact. Expansion of DE without decarbonisation will result in only marginal emission reductions.

Modeling of the low carbon path has incorporated assumptions that include:

- A DE service area that increases toward 2050, connecting with a high proportion of new, higher density buildings.
- Connection of a portion of existing buildings within the above service areas, where possible, to the DE system via retrofits.
- A steady decarbonisation of the DE system, that parallels the Provincial emission reduction targets.
- For new buildings not anticipated to be connected with the DE system, primarily lower density buildings, an increasing role of on-site renewable/low-carbon energy sources, displacing gas usage; for existing lower density buildings, slow but steady retrofits of these buildings to incorporate on-site renewable/low-carbon energy sources such as solar thermal panels.

3.6.3. SENIOR GOVERNMENT POLICIES AND ACTIONS

Electricity supply through BC Hydro embodies a low GHG emissions intensity relative to fossil fuels and electricity supply in many other jurisdictions outside of BC. BC Hydro has committed to further reducing the upstream carbon emissions associated with the production of electricity by increasing the amount of renewable power generation in Province.

3.6.4.LOCAL POLICIES AND ACTIONS

There are a number of opportunities the City is able to advance either independently or in association with Lonsdale Energy Corporation, the local district energy utility:

- Strategically phase in renewable and low-carbon energy sources such as geo-exchange, ocean source, biomass, solar thermal, or liquid waste heat, and examine the potential for tapping into "renewable gas" from solid and liquid waste for combustion in the system. Despite the high efficiency of the current gas combustion heat plants, this "decarbonisation" of the system is essential to meet GHG emissions goals, especially where the system service areas will continue to expand.
- Expand service to neighbourhoods such as Marine Hamilton and further up Central Lonsdale (e.g. as part of a potential sustainability precinct). Explore opportunities to expand in neighbouring communities, potentially with variations to the existing design.
- Extend service into existing buildings, such as the Hospital Precinct, Harry Jerome Recreation Centre redevelopment building retrofits, central Lonsdale and beyond. Some of these new opportunities could include variations to the existing design. Consider the potential for renewable/low-carbon energy sources in prioritizing new service areas.
- Strategically phase in Combined Heat and Power (CHP) when market conditions are appropriate.
- Pursue development of waste heat project opportunities through application of Integrated Resource Recovery principles, which could include energy sharing between industrial facilities and other building types, and potentially the DE system.

- Examine the feasibility of integrating micro hydro renewable systems in the City`s pressure reducing valves during capital replacement cycles of sewage infrastructure.
- Work with BC Hydro to explore sustainable energy opportunities as part of future North Vancouver Substation upgrades. The site at 4th and Saint David streets shared with Terasen and a TransLink bus depot may have potential in short or long term for electric transit bus charging, district energy or smart grid development.

Strategic Investments in District Energy to Avoid Zero-Sum Actions

A multi-pronged approach to emission reductions will be necessary if communities are to achieve meaningful reduction targets. At the same time, actions across different levels of government need to be coordinated and considered jointly in order to avoid implementing strategies that have small or zero emission benefits because of reductions from another strategy. If the BC Building Code improves building performance to the extent that is anticipated, the emissions benefits of Lonsdale Energy Corp expanding its district energy system will rapidly diminish on a per-floor area basis. Using fuel sources that are less carbon intensive than natural gas (the system's current fuel source) will further reduce emissions beyond what is possible with expansion alone. Finding a locally available low carbon fuel source will also have the co-benefit of increasing energy security and reducing vulnerability to energy price volatility.

3.7. SOLID WASTE

3.7.1. GOAL

- Make progress towards achieving zero waste and foster a broad zero waste ethic regarding consumption and management of materials over their full life cycles in order to reduce the amount of waste and, in turn, emissions associated from waste.

Complementary Goal

- Contribute to a broader agenda of reducing consumption.

3.7.2.PATH

If current regional and local plans are implemented, we will witness a significant increase in the amount of solid waste that is diverted from disposal through composting and recycling along with waste generation avoidance in the first place. A number of new actions are needed to approach zero waste by 2050, including efforts at the local, provincial and national level to reduce packaging and eliminate the production of products and materials that cannot be reused and recycled. The Low Carbon Path does not include all of the policies and actions that are needed to get to zero carbon, but it is an important step in the right direction. Actions to reduce the generation of solid waste are currently hampered by the practice of only accounting for downstream emissions from the disposal of waste in emission inventories, while ignoring the energy, resources and emissions emitted from the manufacture and transport of those materials. By decreasing the amount of waste generated through fostering a broad zero waste ethic the City can contribute to a worldwide reduction in energy use and greenhouse gas emissions.

In the Low Carbon Path, the downstream emissions will be reduced 4,400 tonnes CO_2e from both senior government and local policies and actions in the year 2050. Additional efforts will be needed beyond those modeled and described in the Low Carbon Path to reduce the upstream emissions from product manufacture, which were 11 times as great as the downstream emissions in 2007.

3.7.3.SOLID WASTE POLICIES AND ACTIONS

Senior Government Policies and Actions

- Through its draft Solid Waste Management Plan, Metro Vancouver has put in place the first steps towards reducing waste generation and increasing waste diversion. These regional level plans entail significant involvement by municipalities, residents, and waste haulers along with the commercial, institutional and industrial sectors. The City of North Vancouver has endorsed the principles of Metro Vancouver's Zero Waste Challenge. This includes:
    - A net reduction in the amount of waste generated.
    - Intensification of diversion such that the overall diversion rate is 70% by 2015.
- The BC Ministry of the Environment has taken the lead at the provincial level for creating a closed product life-cycle loop for a growing number of products, which currently includes beverage containers, pharmaceuticals, solvents, flammable liquids, pesticides, paints, tires, and electronics, with new programs for additional electronics, lead acid batteries and anti-freeze in the works. Additional efforts will be needed, including expanding extended producer responsibility to all household goods, if the long term goal of zero waste is to be achieved.

City of North Vancouver Policies and Actions

- Conduct outreach and education to the community on Zero Waste, the 3 Rs (reduce, reuse, recycle) and moving towards a broader conservation ethic regarding consumption and materials.
- Expand food waste diversion opportunities in the single-family, multi-family and commercial sectors.
- Work with Metro Vancouver and the private sector to increase the diversion of construction and demolition materials from disposal.
- Work with Metro Vancouver and other municipalities to ensure an adequate supply of land is available for recycling collection and processing.
- Encourage and support Metro Vancouver and the Province in establishing extended producer responsibility for waste, including packaging.

Greenhouse Gas Emissions from Landfills and Incineration

Landfill Methane

When organic waste such as food, yard clippings, wood, paper and some textiles decompose in a landfill under anaerobic conditions (very little oxygen), large amounts of methane are produced, a gas with a global warming potential 21 times greater than carbon dioxide. This methane generation is the reason that landfills are significant contributors to global warming. Landfill methane emissions can be reduced by keeping organic waste out of landfills through backyard and centralised composting programs. Gas capture systems can also be installed at landfills to destroy methane through flaring or the production of electricity or heat by using the methane to power a gas turbine.

Incineration

When solid waste is burned at incineration (waste to energy) facilities to generate electricity and/or heat, a significant amount of carbon dioxide is released to the atmosphere. The carbon dioxide that is produced from the combustion of inorganic material is included in greenhouse gas inventories because it was not a part of the active carbon cycle prior to incineration.

Lifecycle GHG Emissions of Materials, Food and Waste

As consumers, the residents and businesses of the City of North Vancouver are responsible for energy use and GHG emissions from the manufacture of materials, products and food, in addition to emissions from their disposal. The "upstream" manufacturing emissions typically dwarf the "downstream" waste disposal emissions. Using waste composition numbers from Metro Vancouver and upstream emission factors from the U.S. EPA's Waste Reduction Model (WARM), upstream emissions associated with the solid waste from the City in 2007 amounted to 85,723 tonnes CO_2e. If included in CNV's emission inventory, upstream consumption emissions would comprise 27% of the total and increase the per-capita rate to 6.9 tonnes CO_2e (from 4.7). This is comparable with estimates by the US EPA and the Institute for Self Reliance, which calculate that upstream emissions account for 33% and 37%, respectively, of total emissions in the United States. Acknowledging the shared responsibility for emissions among producers and consumers is a precursor for putting in place policies to reduce these emissions and can help address the regional and historical inequity of emissions.

3.8. URBAN AGRICULTURE AND LANDSCAPE

3.8.1. GOALS

- To expand community gardening and urban agriculture as a way of reducing the greenhouse gas emissions associated with the production, processing and transportation of today's food system.
- To expand urban trees and forests to enhance their potential as carbon sinks.

Complementary Goal

- Support the community's interest in local food production as a form of leisure, strengthening community resiliency, and a commitment to broader sustainability.
- Strengthen the City's tree networks and forests as a way of enhance the beauty of parks and streets, and building the community's resiliency to heat waves and extreme precipitation events.

3.8.2. PATH, POLICIES & ACTIONS

The emission reductions and carbon sequestration from these policies and actions have not been quantified as part of this modeling process. However, the City acknowledges that an effective community food production, and forest and tree program can make an important contribution to climate change mitigation and adaptation.

City of North Vancouver Policies and Actions

- Continue to expand community gardening and urban agriculture as a way of increasing food security and reducing the greenhouse gas emissions associated with the production, processing and transportation of today's food system.
- Pursue opportunities to expand urban trees and forests to enhance their potential as carbon sinks while meeting wildlife habitat, biodiversity, and environmental protection objectives outlined in the City's Official Community Plan and associated plans such as the Urban Forest Master Plan.
- Consider the development of a Food Security Strategy to explore and encourage opportunities for community gardening and urban agriculture in the City.
- Implement the Urban Forest Master Plan.
- Implement the Street Tree Master Plan.
- Quantify GHG annual flux from tree and forest management in the City

Energy Savings and GHG Reductions from Street Trees

Street trees create microclimate that are cooler than the surrounding, conserving building energy use through shading, the reduction of wind speed and absorbing sunlight and heat. Street trees also capture carbon dioxide as they grow (and subsequently release it when they die). In the City's 2004 *Street Tree Master Plan* annual energy savings are estimated to be 34.1 MWh of electricity and 426.2 Mbtu of natural gas, reducing emissions by 2 tonnes CO_2. The 5,415 trees also sequestered 569 tonnes of CO_2.

3.9. EDUCATION AND OUTREACH

3.9.1 GOALS

- To encourage people living and working in the City to make lifestyle and behavioural choices through education and outreach to key constituencies to deepen the impact of other policies and actions, and build community resiliency.
- To create greater public awareness of local, regional and global climate change trends, including the causes of, anticipated impacts of, and recommended local responses to climate change.

Complementary Goal

- Support activities that promote healthy lifestyles, enhance safety, build community, foster resiliency, and reduce resident and business energy expenditures.

Path

While some deep emission reductions will involve changes that will be invisible to most citizens (e.g. automobile efficiency standards), many must involve changing lifestyles (e.g. taking transit over taking the car) or overcoming knowledge barriers to "new" technologies (e.g. solar hot water). Effective education and outreach will greatly facilitate these behavioural changes in each of the key sectors, as discussed above in transportation, buildings, waste as well community food and agriculture.

A strong education and outreach program can *deepen*, *sustain* and in some cases *elicit* behavioural change. Effective programs are integrated into a suite of mutually reinforcing policies and actions. Moreover, the process of designing an effective educational program complements the design of good policies and measures, and collectively they should inform one another. For instance, identifying target audiences, their motivations and barriers to desired behaviours, and analyzing their situational context will not only shape effective education and outreach, it should also shape broader policy design, such as the type of bike safety and security infrastructure critical to increase cycling propensity in a specific constituency. Building the right infrastructure will automatically get a certain response. Effective education and outreach can significantly deepen and sustain the behavioural change. The City has undertaken some preliminary research in identifying barriers and benefits to sustainable transportation and energy conservation. The City also works in partnership with the Districts of North Vancouver and West Vancouver in delivering award-winning waste reduction community programs through the North Shore Recycling Program. Partnerships are critical, whether with other municipalities and public institutions, non-profits or the private sector.

This work would build on the City's existing education and outreach programs for schools and residents in energy conservation, waste reduction, and water conservation and an emerging program with small businesses aspiring to reduce their emissions.

City of North Vancouver Policies and Actions

- Work with partners to build on the City's existing education and outreach activity to key community constituencies to reinforce and refine goals, policies and actions across all sectors.

4. Low Zone Design Guidelines

Low carbon opportunities are not uniform across a City. Unique urban zones create unique opportunities for managing energy and emissions. These design guidelines are a guide to maximizing low carbon opportunities by urban zone, *right sizing* the sector-specific strategies discussed above by zone. They would be complemented by more cross cutting strategies.

4.1. URBAN CENTRE ZONES

These are the medium to high density residential/commercial areas (Town Centre and Urban Corridor). Transportation and building emissions are relatively low on a per resident basis, moderate on a per employee basis, and high in waste given lower recycling penetration.

Sector	Design Guidelines
Land Use	**Residential:** Locate sufficient residential in high/mid/low rise or nearby in high/mid/low rise or townhouse to strengthen retail success, and load balancing for district energy; work-live homes. **Commercial:** Continue to concentrate most office and retail employment in this zone to increase transportation efficiency/transit viability, and commercial networking. **Public realm:** street and park furniture; plazas; playgrounds/pocket parks; street retail terraces.
Transportation	**Pedestrian:** street and park furniture; covered/shaded sidewalks in many areas; many, marked crosswalks; intersection buttons; wide curbed sidewalks with ramps and bulges; enhance connectivity with green lanes. **Bike:** End of trip infrastructure in commercial and residential buildings and key destinations; paths are dedicated and ideally separated, high density/connectivity; intersection buttons; strong intermodality. **Transit:** high frequency; long hours; med-high speeds; 200 metre transit stop access; shelters; strong inter-modality. **Multi-Modal Transportation hubs:** Strengthen public realm of Lower Lonsdale hub, end of trip bike/E bike infrastructure; upper Lonsdale hub that includes car share and bus for intercity transportation. **Automobiles:** Maximize alternatives; minimize on-street parking; encourage/incent car sharing in residential and commercial; promote electric bikes; increase plug in availability.
Buildings	**Typologies:** high rise, mid-rise, low rise, significant mixed use buildings. **Performance:** high/mid rise building operator training; high/mid-rise retrofit program with DE connection; advanced ASHRAE standards.
Energy Supply	**District Energy:** Establish or extend nodes; decarbonize. **Renewables:** Large roofs near heat demand for solar thermal.
Waste	**Reduction:** Program to reduce retail packaging. **Recycling:** require space in new buildings; mandatory recycling. **Composting:** Food-related commercial/institutional for priority composting; require space in new buildings; phase in curbside.
Greenspace	**Trees:** Select tree-lined streets; plazas; playgrounds/pocket parks. **Parks:** 400 m pocket park access; green laneways; green roofs. **Food:** 800 m community garden access; promote regional food in retail.

Urban Centre: Big Opportunities

- strengthening pedestrian, bike, and transit infrastructure
- extending low carbon district energy
- high/mid rise building operator training
- high/mid rise recycling
- food-related commercial and institutional composting

4.2. MEDIUM DENSITY, MIXED-USE ORIENTED ZONES

This zone characterizes areas with retail and medium density residential buildings in close proximity. Transportation emissions are relatively moderate and building emissions are low on a per resident basis, moderate on a per employee basis, and moderate in waste given lower recycling penetration in mid/low rises and townhouses.

Sector	Design Guidelines
Land Use	**Residential:** sufficient residential population to support retail success; work-live homes. **Commercial:** sufficient key retail destinations to support walkability and strong transit; some office. **Public realm:** street and park furniture; plazas; playgrounds/pocket parks; medium sized parks; street retail terraces; school gardens; boulevards.
Transportation	**Pedestrian:** street and park furniture; covered/shaded sidewalks in some areas; some marked crosswalks; key intersection buttons; medium/wide width curbed sidewalks with ramps; enhance connectivity with green lanes; strong multi-modal transportation hub connectivity. **Bike:** end of trip infrastructure in commercial and residential buildings and key destinations; paths on traffic calmed streets and bike boulevards, moderate density/high connectivity, notably to multi-modal transportation hub; key intersection buttons; strong bike-bus connectivity compatibility. **Transit:** moderate frequency; moderate hours; med speeds; 400 metre transit stop access; key shelters; strong bus-bike compatibility; strong pedestrian/bike connectivity and compatibility. **Automobiles:** maximize alternatives; some on-street parking; encourage/incent car sharing in residential and commercial; promote ultra low emission automobiles and E-bikes; increase plug in availability.
Buildings	**Typologies:** mid-rise; low rise; townhouse; multi-unit ground oriented; significant mixed use buildings; significant mixed use buildings. **Performance:** mid rise building operator training; mid-rise retrofit program with DE connection; advanced ASHRAE and EnerGuide standards.
Energy Supply	**District Energy:** Extend where sufficient density, mixed use. **Renewables:** Solar thermal and geo-exchange near demand; potentially DE integrated.
Waste	**Reduction:** program to reduce retail packaging; smart product and packaging *education.* **Recycling:** require space in new multi unit buildings; mandatory recycling. **Composting:** require space in new buildings; curbside collection.
Greenspace	**Trees:** Tree-lined streets and boulevards; parks; playgrounds; schools. **Parks:** Encourage greenroofs; medium-sized parks; 400 m pocket park access; school greenspace. **Food:** encourage backyard food gardens; school food gardens; 500 m community garden access; promotion of local/regional food in retail.

Med Density, Mixed: Big Opportunities

- sufficient key destinations (e.g. park, library, retail) to support walkability
- sufficient residential to support retail success and strong transit
- strengthening pedestrian, bike, and transit infrastructure
- extending district energy
- building/site scale renewables
- mid/low rise building operator training
- mid/low rise recycling

4.3. RESIDENTIAL ORIENTED ZONES

This is the City's lower density, residentially-oriented areas. Transportation and building emissions are relatively high on a per resident basis. Waste emissions are relatively low.

Sector	Design Guidelines
Land Use	**Residential:** Supplement single family with laneway housing, secondary suites. **Commercial:** Encourage live-work; support development of key destinations (e.g. small grocery, café) within 500 m (potentially adjacent zone). **Public realm:** park furniture; nature; pocket parks/playgrounds.
Transportation	**Pedestrian:** park furniture; some marked crosswalks; key intersection buttons; medium width sidewalks; ramps if curbed; good connectivity; good intermodality, notably to access multi modal hub. **Bike:** wide paths are signed/painted on shared street, moderate density/moderate connectivity to boulevards and trails; end of trip infrastructure at key destinations; strong bike-bus connectivity compatibility **Transit:** moderate frequency; moderate hours; med speeds; 600 metre transit stop access; strong pedestrian/bike connectivity and compatibility. **Automobile:** promote ultra low emission automobiles and E-bikes; encourage car sharing access.
Buildings	**Typologies:** ground-oriented, townhouse, low rise, focussed/small format mixed use buildings in <600 m. **Performance:** residential retrofits with an emphasis on *furnaces*, hot water systems, windows, insulation; advanced EnerGuide standards.
Energy Supply	**Renewables:** Solar thermal and geo-exchange.
Waste	**Reduction:** smart product and packaging *education.* **Recycling:** mandatory recycling. **Composting:** backyard or neighbourhood composting; prohibit food and yard waste.
Greenspace	**Trees:** Tree-lined streets and boulevards; parks; playgrounds; school greenspace; residential tree program. **Parks**: Nature parks, Large parks, pocket parks, school greenspace. **Food:** Encourage backyard food gardens; school food gardens; site community gardens for residents in mixed use and urban zones; urban farms.

Residential Oriented: Big Opportunities

- increasing automobile efficiency
- promoting building/site scale renewables
- encouraging secondary suites, laneway housing and live-work homes
- residential retrofits with an emphasis on furnaces
- backyard/neighbourhood composting

5. Near-Term, Estimated Direct Costs

The direct costs to the City of North Vancouver have been estimated for the period 2010 – 2020, for the next strategic steps for advancing and/or implementing the policies and actions described for each sector. Because many climate and energy actions are about enhancing existing activity, an effort has been made to estimate marginal cost, i.e. costs listed for policies and actions in addition to those that have already been described in existing City of North Vancouver Plans. The costs are rough estimates given significant uncertainty about the final policy and action design. At the time of writing, cost estimates for some large service and infrastructure actions including LEC expansion and decarbonisation were not yet available. It should also be noted that costs not borne by the City of North Vancouver were not included in this analysis, including costs to residents, businesses, utilities, industry, and senior governments. Because of the preliminary and incomplete nature of these estimates, it is not advisable to use them for financial planning purposes or to compare the costs effectiveness among the proposed policies and actions. A subsequent Implementation Strategy will further address the full cost implications and prioritization of actions over the life of the plan.

Total known estimated near term (2010-2020) costs for each sector

Summary	Ten Year Cost		Annual Cost	
	Budgeted	**Incremental**	**Budgeted**	**Incremental**
Transportation*	$ 12,168,833.00	$ 11,681,667.00	$ 1,216,883.30	$ 1,168,166.70
Buildings	$ -	$ 1,300,000.00	$ -	$ 130,000.00
Solid Waste		$ 2,737,500.00	$ -	$ 273,750.00
Energy Supply**	$ -	$ 150,000.00	$ -	$ 15,000.00
Total	$ 12,168,833.00	$ 15,869,167.00	$ 1,216,883.30	$ 1,586,916.70
Notes: Costs do not account for inflation				
Transportation and energy supply costs estimated over 10 yrs; solid waste and buildings costs estimated annually				
*Budgeted transportation costs do not include additional grant funding secured ($670K annually); incremental transportation costs could be offset by 10-30% through possible granting opportunities				
**Energy Supply costs cover feasibility studies with implementation cost to be determined; annual cost for near term is greater than estimate as feasibility studies would be completed sooner				

Energy & Emissions and Finance

Different capital investments options have different long term cost implications for operation, maintenance and replacement. They can also drive or constrain greenhouse gas emission growth. When life cycle costing is integrated into financial decisions, it generally supports less carbon intensive investment by the municipality and the private sector. Consistently incorporating life cycle costing and carbon quantification in an analysis of options allows richer decision-making. Key processes for such analysis include:

- Annual budget
- Capital planning
- Procurement

This analysis can help the City and the community manage and reduce its carbon liability and energy costs. On a long term basis this will likely become more and more important as municipalities will be under pressure to reduce emissions.

5.1. TRANSPORTATION

Action	Next Steps	Total Capital Cost (staff estimate; 2010-2020); includes grant funding	Amt covered in existing 10-year plan (2010-2020); City funding	Amt covered in existing 10-year plan (2010-2020); external funding	Incremental cost not covered (2010-2020); could be offset by grants	Potential External Financing	Key Considerations (financial, logistical, etc)
Local Government Initiatives							
Pedestrian improvements	Strengthen infrastructure (sidewalks)	$ 2,300,000.00	$ 700,000.00	$ -	$ 1,600,000.00		$2.3 million over 10 years for 30 priority sidewalk locations (Council rpt). 70% of annual Local Area Service $100,000 (street light, sidewalks, lane paving) provides $700,000.
	Strengthen infrastructure (connectivity across highways/creeks/rail). Lynn Valley highway, MacKay and Mosquito Creeks.	$ 2,000,000.00	$ -	$ -	$ 2,200,000.00	MOT, DNV cost share, fed grants	$1.7 million for Lynn valley overpass. Other creek crossings estimated at $150,000 each. Harbourside overpass included in Spirit Trail costs.
	Strengthen infrastructure (crosswalks, bulges, signage, street lighting, traffic calming).	$ 3,300,000.00	$ 2,695,000.00	$ 110,000.00	$ 495,000.00	Translink, ICBC	$175K APC; $235K TCP; $1.065 safety/pedestrian; $370k Grand blvd; $660K street lighting + 300K from LAS; new pedestrian signals/special crosswalks
	Complete Green Necklace Greenway*	$ 5,950,000.00	$ 1,983,333.00	$ -	$ 3,966,667.00	Province, fed grants	
	Complete Spirit Trail Multi-Use Path*	$ 15,800,000.00	$ 5,900,000.00	$ 4,600,000.00	$ 5,280,000.00	Regional, province, fed grants	
Bike improvements	Progressively extend network of bicycle routes, lanes and paths	$ 2,000,000.00	$ 551,000.00	$ 750,000.00	$ 699,000.00	Translink, ICBC, fed grants	Bicycle Master Plan est. $1.5 million for implementation; costs account for inflation and cost sharing. $1.051M for bike program, $260K for last section of Esplanade.
	Establish bike lockers at Lonsdale Quay	$ 130,000.00	$ 10,000.00	$ -	$ 120,000.00	Translink	
	Add bicycle parking along Lonsdale and in other key commercial centres.	$ -	$ -	$ -	$ -	C-Media	City has a bicycle rack contract with advertiser C-Media; provides funding for community initiatives. Could add additional racks, or be required during redevelopment.

Action	Next Steps	Total Capital Cost (staff estimate; 2010-2020); includes grant funding	Amt covered in existing 10-year plan (2010-2020); City funding	Amt covered in existing 10-year plan (2010-2020); external funding	Incremental cost not covered (2010-2020); could be offset by grants	Potential External Financing	Key Considerations (financial, logistical, etc)
Transportation demand management	Transportation Demand Management Coordinator (dedicated function through contract or staff)	$ 900,000.00	$ 140,000.00	$ 140,000.00	$ 620,000.00	ecoMobility, other fed grants	Coordination of Travelsmart, Safe-Routes-to-School/"Walking School Bus", telework programs to reduce trips; promotion of no/low emission vehicles.
	TravelSmart plan development for neighbourhoods, schools, major/minor employers	$ 920,000.00	$ 50,000.00	$ 50,000.00	$ 820,000.00	ecoMobility, Translink	Prepare 1-2 plans per year with higher priority for schools and high density neighbourhoods. $100K/neighbourhood (8), $30K/employer (2 major/minor), $30K/school (2)
	Potential pay parking implemented to fund alternative transportation initiatives with clear climate protection and livability values	$ (5,000,000.00)	$ -	$ -	$ (5,000,000.00)		After initial capital and annual administrative costs accounted for, estimate annual City revenue of 1.5M/year (500K/yr for sustainable tranportation initiatives)
City Support of Transit Initiatives	Support improved transit services with infrastructure improvements (signal preemption, bus bulges, queue jumpers)	$ 300,000.00	$ -		$ 300,000.00	Translink	Assume some signal work, two queue jumpers, bus bulges on Lonsdale
	Enhance transit stop comfort, accessibility, convenience, safety	$ 860,000.00	$ 139,500.00	$ 139,500.00	$ 581,000.00	Translink, Pattison	Improvements include lighting, passenger landing pad/wheelchair pad, seating/shelters; prioritization required. $10,000 per bus stop. 56 of 165 bus stops are not accessible ($560K); seating and lighting ($300K).
Total City Cost (2010-2020)		$ 29,460,000.00	$ 12,168,833.00	$ 5,789,500.00	$11,681,667		

* includes pedestrian improvements

Senior Government or Private Sector Initiatives							
Increase transit ridership and decrease passenger	Real-time "Next Bus" info at bus stops					Translink	

Action	Next Steps	Total Capital Cost (staff estimate; 2010-2020); includes grant funding	Amt covered in existing 10-year plan (2010-2020); City funding	Amt covered in existing 10-year plan (2010-2020); external funding	Incremental cost not covered (2010-2020); could be offset by grants	Potential External Financing	Key Considerations (financial, logistical, etc)
vehicle trips	U-Pass Program (for neighbourhoods, new developments, businesses, educational institutions such as Capilano College)					Private, Translink	Translink / developers. City can work with private and senior government partners in the development of U-Pass type programs.
	Improve accessibility to transit					Translink	
	Lonsdale frequent bus service with significant bike capacity					Translink	
Transit service additions	Add new local transit routes; add new rapid transit lines (by Translink)					Translink	City can support new route development by planning for density in key areas to provide ridership.
	Investigate feasibility of using rail line for commuter transport					Fed grant, CN Rail	
	Community bus system and/or water route					Private, Translink	Privately operated community bus system, shuttle service to industrial areas, and/or water taxi (Aquabus model)
Transit improvements (increased frequency, speed)	Add 3rd seabus and connecting bus services					Translink	
	Increase frequency of local transit connections; expand the frequent transit network					Translink	

Notes

Sustainable Transportation Reserve provides for $1,260,000 which could be used for funding above initiatives (approx $107K/yr)

Note that cost includes significant investment in greenways (approx 20 million over 10 years, of which 8 million is already budgeted in existing capital plan.

Many of the transportation improvements are implemented for reasons other than climate protection (for example, safety, health, livability, economic development and toursim)

Total estimated cost is offset by potential revenue of 5 million over 10 years from implementation of pay parking.

5.2. BUILDINGS

Action	Next Steps	Covered in Existing City Plan?	Annual Cost (staff estimate)	Amt covered in existing budget	Incremental cost not covered	Potential External Financing	Key Considerations (financial, logistical, etc)
Local Government Initiatives							
Promote energy efficient building design and practices for all development projects and City-owned buildings (Local Part 3 and Part 9 performance beyond code)	Pursue increasingly aggressive energy standards for new and existing buildings over time; establish enforcement mechanism for building energy standards	yes	$ 25,000.00	Included in existing staffing cost	$ 25,000.00	BC Hydro, NRCan	Need to establish legal authority to set standards different from BC Bldg Code. Enforcement integrated into building permit process (admin capacity); developer must provide test or modelling/commissioning results using authorized testers. (50K = CNV 0.25 FTE for bonding, enforcement)
	Require the use of hydronic or high efficiency energy systems in new and existing buildings, as appropriate, to enable transition to renewable energy sources such as ground-source heat pumps.		$ -	Included in existing staffing cost	$ -	BC Hydro, NRCan	Establish legal authority to set standards different from BC Building Code
	Require new buildings to be solar hot water ready and develop policies and programs that make it easier for developers and building owners to incorporate solar hot water into new and existing buildings.		$ -	Included in existing staffing cost	$ -	BC Hydro, NRCan, SolarBC	Establish legal authority for this requirement
	Develop policies that promote the use of passive energy efficient design to minimise the lighting, heating and cooling demands of new buildings.		$ -	Included in existing staffing cost	$ -	BC Hydro, NRCan	Incorporate in review of Sustainable Development Guidelines
Energy efficient retrofits to existing building stock	Promote uptake of single family and semi-detached retrofit programs	yes	$ -	Included in existing staffing cost	$ -	NRCan, BC Hydro, Terasen, Province	Continue to work in partnership with City of Vancouver in promoting ecoEnergy retrofits; look for new opportunities

Action	Next Steps	Covered in Existing City Plan?	Annual Cost (staff estimate)	Amt covered in existing budget	Incremental cost not covered	Potential External Financing	Key Considerations (financial, logistical, etc)
	Promote retrofits in multifamily, commercial, and industrial sector		$ 25,000.00	$ -	$ 25,000.00	BC Hydro	Funding provided for 50% cost share Community Energy Manager for 2010 capital project; additional ongoing funding may be req'd; position will have other duties but cost here
Energy efficient process upgrades in commercial and industrial sector	Work with commercial and industrial sector to implement process upgrades to save energy		$ 25,000.00	$ -	$ 25,000.00	BC Hydro	Funding provided for 50% cost share Community Energy Manager for 2010 capital project; additional ongoing funding may be req'd; position will have other duties but cost here
Utilize land use planning to improve the energy performance of buildings through multi-family housing and multi-use buildings	See land use sector; no direct buildings related costs (intention is to develop more attached dwellings, which are inherently more energy efficient)		$ -	Included in existing staffing cost	$ -		
Communications, social marketing and schools programs to reduce energy use			$ 70,000.00	Included in existing staffing cost	$ 55,000.00		Existing programs have had some impact, but overall branding is required for climate action campaign
Total City Cost (annual)			$ 145,000.00	$ -	$ 130,000.00		

Senior Government or Utility Initiatives							
Promote energy efficient retrofits of existing building stock	Utility and Senior government programs to promote retrofits of residential, commercial, and institutional building stock					BC Hydro, NRCan, Terasen	

Action	Next Steps	Covered in Existing City Plan?	Annual Cost (staff estimate)	Amt covered in existing budget	Incremental cost not covered	Potential External Financing	Key Considerations (financial, logistical, etc)
Energy efficient process upgrades in commercial and industrial sector	Utility and senior government incentive programs to improve processes to save energy					BC Hydro, NRCan, Terasen	

Notes

Many costs are included in existing budgets but not enumerated here so actual baseline cost is higher
Other than policy, admin, and some outreach, costs are largely borne by developers and industry in adjusting to higher standards over time
There can be some financial risk for the City in requiring higher energy standards in comparison to neighbouring municipalities
Community Energy Manager will be responsible for more than one area although costs included in buildings

This list includes a variety of actions, some of which are already underway, some planned and some new.
Implementation cost is minor; the majority of initiatives can be implemented within existing budgets.

5.3. ENERGY SUPPLY

Action	Next Steps	Total Capital Cost (staff estimate; 2010-2020)	Amt covered in existing 10-year plan (2010-2020)	Incremental cost not covered (2010-2020)	Potential External Financing	Key Considerations (financial, logistical, etc)
Local Government Initiatives						
Work with LEC to expand into new buildings or service areas	Continue to work with LEC to identify suitable buildings in existing service areas	$ -	Included in existing staffing cost	$ -		

Action	Next Steps	Total Capital Cost (staff estimate; 2010-2020)	Amt covered in existing 10-year plan (2010-2020)	Incremental cost not covered (2010-2020)	Potential External Financing	Key Considerations (financial, logistical, etc)
	Continue to work with LEC to expand into new buildings	$ -	Included in existing staffing cost	$ -		
	Work with LEC to identify suitable new areas and energy sources	$ -	Included in existing staffing cost	$ -	FCM, BC Hydro	
Work with LEC to decarbonize and strategically phase in renewables	Work with LEC to screen energy sources for technical/social/financial/environmental feasibility; create implementation plan; screen technologies for combined heat and power	$ 100,000.00	$ -	$ 100,000.00	FCM, BC Hydro	Possible linkages to Solid Waste Management Plan, Liquid Waste Management Plan, and Energy Mapping project Metro Vancouver is leading
	Work with LEC to phase in new renewable energy sources	to be identified	to be identified	to be identified	FCM, BC Hydro	Financing or capital funding. Implementation costs unknown.
	Work with LEC to adopt combined heat and power technologies	to be identified	to be identified	to be identified	FCM, BC Hydro	
Work with LEC to utilize waste heat from large existing buildings	Work with LEC to conduct opportunity assessment and establish implementation plan	$ 50,000.00	$ -	$ 50,000.00	BC Hydro, NRCan	
	Work with LEC to utilize waste heat from identified sources	to be identified	to be identified	to be identified	BC Hydro, NRCan	
Total LEC Cost (2010-2020)*		$ 150,000.00	$ -	$ 150,000.00		
* does not include implementation						

Notes

Many items relating to Lonsdale Energy Corporation will be addressed in a parallel business planning process.

Action	Next Steps	Total Capital Cost (staff estimate; 2010-2020)	Amt covered in existing 10-year plan (2010-2020)	Incremental cost not covered (2010-2020)	Potential External Financing	Key Considerations (financial, logistical, etc)

These elements will be integrated once complete into the CEEP Implementation Plan.

5.4. SOLID WASTE

Action	Next Steps	Covered in Existing City Plan?	Annual Cost (staff estimate)	Amt covered in existing budget	Incremental cost not covered	Potential External Financing	Key Considerations (financial, logistical, etc)
Local Government Initiatives							
Implement the Zero Waste Challenge; develop community programs on Zero Waste, the 3 Rs (reduce, reuse, recycle) and moving towards a broader conservation ethic regarding consumption and materials.	Implement Zero Waste (Goals 1 and 2 of draft regional solid waste management plan) in collaboration with NSRP	yes	$ 300,000.00	Included in existing staffing cost	$ 150,000.00		Current funding provides for social marketing and waste diversion program planning expertise to develop and implement Zero Waste Challenge initiatives. Future funding is for increased education and enforcement along with outreach to additional sectors such as business.
Expand food waste diversion opportunities in the single-family, multi-family and commercial sectors.	Develop and implement food waste collection for single family sector (purchase equipment, design educational materials) while also encouraging the increased use of backyard composters as a preferred method of food waste diversion.	yes	$ 75,000.00	Included in existing staffing cost	$ 48,750.00	FCM	North Shore Transfer Station cannot accept food waste in open yard, so modifications will be required. Costs assume upgrade to transfer station.

Action	Next Steps	Covered in Existing City Plan?	Annual Cost (staff estimate)	Amt covered in existing budget	Incremental cost not covered	Potential External Financing	Key Considerations (financial, logistical, etc)
	Facilitate food waste collection for multifamily (MF) and industrial, commercial, institutional (ICI) sector, work with Metro Vancouver to identify processing capacity for ICI and MF organics	yes	$ 25,000.00	$ -	$ 25,000.00	FCM	Fraser Richmond Soil & Fibre is not designed to accept straight food waste as would be generated by ICI/MF sectors. Composting capacity needs to be established first before programs initiated. See Seattle, San Francisco and Toronto experiences with MF food waste. Traditionally collection is managed by private sector. Muni cost = education.
	Adapt MV model bylaw for space requirements in MF developments for waste diversion; enforce waste diversion space requirement bylaw	no	$ -	Included in existing staffing cost	$ -	N/A	MV is developing a model bylaw that prescribes minimum space requirements for waste diversion both in-suite and the "garbage room" for new MF developments or significant renovations. Enforcement cost included in existing staffing.
Work with Metro Vancouver and the private sector to increase the diversion of construction and demolition materials from disposal.	Work with Metro Vancouver to identify land suitable for DLC diversion facilities; develop and enforce waste diversion bylaw for construction and demolition	yes	$ 50,000.00	$0	$ 50,000.00		Consider zoning, proximity to transportation and end uses. Adequate recycling capacity needs to be available before enforcing DLC diversion requirements. Note: CNV cost = enforcement and admin (1/4+ 1/4 FTE).
Work with Metro Vancouver and other municipalities to ensure an adequate supply of land is available for recycling collection and processing.	Conduct opportunity and constraints mapping exercise to identify land in CNV that is suitable for recycling depots and processing facilities; work with private sector to develop facilities to meet community's needs	no	$ -	Included in existing staffing cost	0	N/A	Consider zoning, proximity to transportation and end uses.
Encourage and support Metro Vancouver and the Province in establishing extended producer responsibility for waste and instituting packaging standards	Participate in regional advisory forums, such as the Regional Engineers Advisory Committee (REAC), REAC solid waste sub-committee. Participate in any special symposiums, work with product stewardship associations to ensure sufficient access in CNV.	yes	$ -	Included in existing staffing cost		Product stewards	Product stewards should pay the cost of recycling for extended producer responsibility items. However, CNV will work with Metro Vancouver to investigate establishing "one stop drop" facilities to combine blue box recyclables with product stewardship items.

Action	Next Steps	Covered in Existing City Plan?	Annual Cost (staff estimate)	Amt covered in existing budget	Incremental cost not covered	Potential External Financing	Key Considerations (financial, logistical, etc)
Total City Cost (Annual)			$ 450,000.00	$ -	$ 273,750.00		

Senior Government or Private Sector Initiatives							
SW-2 Expand food waste diversion opportunities in the single-family, multi-family and commercial sectors.	Upgrade NS Transfer Station to accept food waste; investigate possibility of new organics facility on the North Shore	no					Determine where food waste will be processed and how it will be transported there. North Shore Transfer Station cannot accept food waste in open yard, so modifications will be required.
	Identify processing capacity for ICI and MF organics. Establish facility to accept food waste (without yard waste) from MF and ICI sectors	no					Focus on ability of facility to accept food waste (as an isolated stream) to increase capacity for MF and ICI food waste. Coordinate with opportunity and constraints mapping exercises for DLC diversion facilities and recycling processing facilities. Likely implemented by private sector.
	Develop method of achieving ICI food waste diversion	no					Traditional role of municipalities and regional districts in dealing with commercial waste is to set standards and leave servicing to the private sector. A franchising approach would require careful design and consideration of cost and legal implications.
SW-4 Work with Metro Vancouver and the private sector to increase the diversion of construction and demolition materials from disposal	Identify land for collection, processing, diversion of DLC material.						Consider zoning, proximity to transportation and end uses.

Action	Next Steps	Covered in Existing City Plan?	Annual Cost (staff estimate)	Amt covered in existing budget	Incremental cost not covered	Potential External Financing	Key Considerations (financial, logistical, etc)
SW-5 Work with Metro Vancouver and other municipalities to ensure an adequate supply of land is available for recycling collection and processing.	Conduct opportunity and constraints mapping exercise to identify land in CNV that is suitable for recycling depots and processing facilities; work with private sector to develop facilities to meet community's needs	no				No	Consider zoning, proximity to transportation and end uses.

Notes

Costs are consistent with costs presented to Council in 2009 in association with implementation of the regional Zero Waste Challenge

Some costs will be borne by senior levels of government and by industry (e.g product stewardship programs)

Appendix A: Energy and GHG Emission Trends

The City of North Vancouver has conducted energy and greenhouse gas emissions inventories for the years 1995, 2005, 2006 and 2007. Because of scope and methodological differences among the inventory years, it is difficult to discern trends in energy use and emissions over the past 15 years. The most consistent records are in the residential sector, though it is unclear to what extent these records are affected by differences in rate category definitions. A casual examination of the City's development patterns over this time horizon shows the City growing more dense, with the construction of numerous low and high-rise apartments in the town centre and expansion of transit networks that link the town centre to other communities on the North Shore and to Vancouver across the Burrard inlet. Table 8 and Table 9 show that in the residential sector, total and per capita emissions have grown over this period which means not only are emissions rising with population and job growth but that people are using more energy per capita.

Table 8 – City of North Vancouver Residential Energy Sector Use (GJ/Capita)

Year	1995	2005	2006	2007
Electricity	9.9	11.4	11.4	11.6
Natural Gas	(unknown)	11.6	11.9	13.9

Table 9 - City of North Vancouver Residential Energy Sector Use (Total GJ)

Year	1995	2005	2006	2007
Electricity	411,626	527,572	536,261	546,577
Natural Gas	(unknown)	534,975	557,227	655,213

5.5. PRELIMINARY SIMPLE GROWTH FORECAST

Figure 17 – Comparison of a forecasted Simple Growth Emission Scenario for the City of North Vancouver, the Recommended Low Carbon Path and the Province's emission reduction targets. Figure 17 forecasts emissions going forward to 2050 using a "simple growth" scenario from the 2007 CEEI inventory. It assumes emissions will increase with population and job growth going forward. Under a Business as Usual this scenario emissions would grow increase approximately 50% by 2050.

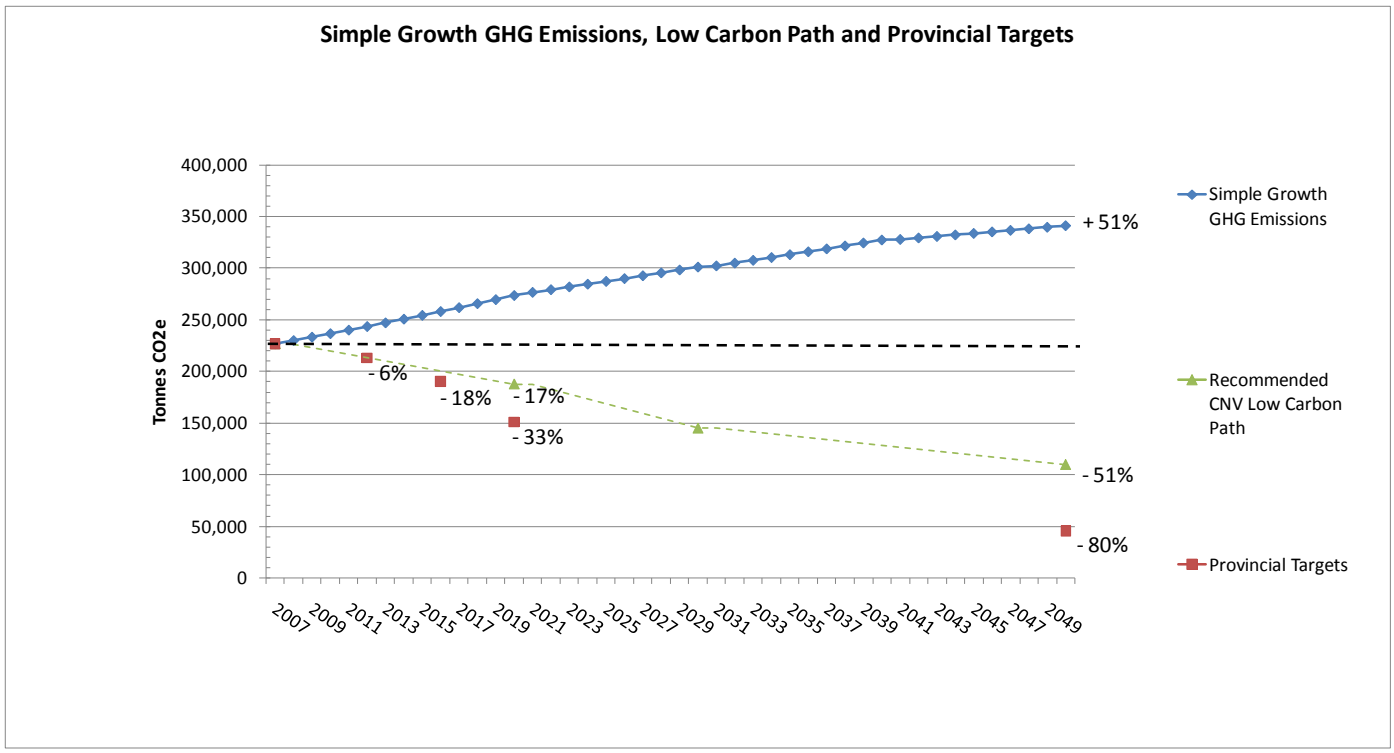


Figure 17 – Comparison of a forecasted Simple Growth Emission Scenario for the City of North Vancouver, the Recommended Low Carbon Path and the Province's emission reduction targets.

Appendix B: Detailed Modeling Results

Table 10 – Modeled Annual Emissions by Milestone, Sector and Community Wide

Low Carbon Path	Annual Emissions – Tonnes CO_2e/yr			
	2007	**2020**	**2030**	**2050**
Residential buildings	47,083	43,332	36,668	24,009
Commercial buildings	45,790	44,081	41,419	35,257
Industrial buildings	13,237	13,248	12,573	10,640
Total buildings	**106,110**	**100,661**	**90,414**	**69,742**
Total buildings per capita	2.35	1.96	1.59	1.01
Private transportation	102,624	71,632	43,600	31,413
Public transportation	9,096	7,998	6,044	6,412
Total transportation	**111,720**	**79,630**	**49,644**	**37,825**
Total transportation per capita	2.47	1.55	0.87	0.55
Solid waste	**7,597**	**7,360**	**4,877**	**2,203**
Solid waste per capita	0.17	0.14	0.09	0.03
Community Total	**225,426**	**187,651**	**144,935**	**109,770**
Total change over baseline (tonnes)		-37,775	-80,492	-115,656
Total change over baseline (%)	**0.0%**	**-16.8%**	**-35.7%**	**-51.3%**
Total per capita	4.99	3.65	2.55	1.58
Per capita change over baseline (tonnes)		-1.34	-2.44	-3.41
Per capita change over baseline		-26.9%	-48.9%	-68.3%

Table 11 – Modeled Annual Energy Use by Milestone, Sector and Community Wide

Low Carbon Path	Annual Energy Usage – Gigajoules (GJ)			
	2007	**2020**	**2030**	**2050**
Residential buildings	1,539,764	1,440,028	1,284,782	911,526
Commercial buildings	1,519,780	1,469,346	1,422,678	1,241,675
Industrial buildings	358,228	360,048	350,298	303,821
Total buildings	**3,417,771**	**3,269,423**	**3,057,758**	**2,457,022**
Total buildings per capita	75.67	63.60	53.85	35.46
Private transportation	1,454,187	1,193,588	1,110,459	782,575
Public transportation	93,653	101,053	66,707	79,672
Total transportation	**1,547,840**	**1,294,641**	**1,177,166**	**862,246**
Total transportation per capita	34.27	25.19	20.73	12.45
Solid waste	85,617	78,873	54,100	14,312
Solid waste per capita	1.90	1.53	0.95	0.21
Community Total	**5,051,229**	**4,642,937**	**4,289,023**	**3,333,581**
Total change over baseline (tonnes)		-408,292	-762,205	-1,717,648
Total change over baseline (%)		**-8.1%**	**-15.1%**	**-34.0%**
Total per capita	111.84	90.33	75.54	48.12
Per capita change over baseline (tonnes)		-22	-36	-64
Per capita change over baseline		-19%	-32%	-57%

Table 12 – Low Carbon Path Modeled Energy Use, by Energy Type

Low Carbon Path	Annual Energy Use - Gigajoules (GJ)/yr			
	2007	2020	2030	2050
Residential buildings				
Electricity	700,648	650,947	584,622	414,777
Natural Gas	839,238	761,482	647,813	424,050
Onsite Renewables (Heat)	0	1,629	6,609	10,282
District Energy		19,853	45,840	62,490
Commercial buildings				
Electricity	706,754	683,301	661,598	577,425
Natural Gas	813,147	772,963	726,478	620,885
District Energy		13,201	34,715	43,465
Industrial buildings				
Electricity	112,134	112,704	109,652	95,104
Natural Gas	246,122	243,433	230,224	195,683
District Energy		3,940	10,450	13,059
Total buildings				
Electricity	1,519,537	1,446,952	1,355,873	1,087,306
Natural Gas	1,898,508	1,777,877	1,604,515	1,240,617
Onsite Renewables (Heat)	0	1,629	6,609	10,282
District Energy	0	36,994	91,005	119,014
Private transportation				
Gasoline+Diesel	1,454,187	1,149,135	1,045,149	643,818
Electricity	0	44,453	65,310	138,757
Public transportation				
Diesel	93,653	94,512	44,891	49,024
Natural Gas	0	6,541	9,321	10,179
Electricity	0	0	12,495	20,468
Total transportation				
Gasoline+Diesel	1,547,840	1,243,647	1,090,040	692,842
Natural Gas	0	6,541	9,321	10,179
Electricity	0	44,453	77,805	159,225
Solid waste				
Municipal Solid Waste (combusted)	147,616	135,987	93,275	24,676
Steam and Electricity *produced*	*61,999*	*57,115*	*39,176*	*10,364*
TOTAL				
Electricity	1,519,537	1,491,404	1,433,677	1,246,531
Natural Gas	1,898,508	1,784,419	1,613,837	1,250,796
Onsite Renewables (Heat)	0	1,629	6,609	10,282
Gasoline + Diesel	1,547,840	1,243,647	1,090,040	692,842
District Energy	0	36,994	91,005	119,014
Municipal Solid Waste (Incineration)	85,617	78,873	54,100	14,312

Table 13 – Modeled Energy and Use and GHG Emissions – Private Vehicles and Public Transit

Private Vehicles	Annual VKT	Annual VKT per Capita	Litres Gas + Diesel		Electric VKT	kWh Electricity	Gas + Diesel Tonnes CO_2e	Electricity Tonnes CO_2e	Total Private CO_2e	Total GJ
2007	422,319,690	9,351	43,625,624		0	0	101,357	0	101,357	1,454,187
2020	444,970,167	8,657	34,474,064		111,242,542	12,347,922	71,434	198	71,632	1,193,588
2030	466,966,471	8,224	31,354,464		163,438,265	18,141,647	43,401	200	43,600	1,110,459
2050	534,214,769	7,711	19,314,535		347,239,600	38,543,596	30,989	424	31,413	782,575
Public Transit	**Annual PKT**	**Annual PKT per Capita**	**Litres Diesel**	**Natural Gas (GJ)**	**Electric PKT**	**kWh Electricity**	**Diesel + NG Tonnes CO_2e**	**Electricity Tonnes CO_2e**	**Total Transit CO_2e**	**Total GJ**
2007	90,060,051	1,994	2,715,924	0	0	0	4,863	0	4,863	90,531
2020	121,181,532	2,358	2,740,837	6,541	0	0	4,847	0	4,847	97,903
2030	143,897,075	2,534	1,301,843	9,321	57,558,830	3,470,797	3,022	38	3,060	65,211
2050	188,574,602	2,722	1,421,702	10,179	94,287,301	5,685,524	2,829	63	2,891	78,037

Analysis of energy use and emission from private vehicles and public transit in the City of North Vancouver is summarised in Table 13 above. For private vehicles, population growth is the primary factor for the increase in vehicle kilometres traveled (VKT) between 2007 and 2050. Local land use changes and improved transit services result in the annual VKT per capita to decrease 17.5%. Because electricity has a significantly lower emission factor per unit of energy than gasoline and diesel, the switch to partial and fully electric-drive vehicles significantly reduces transportation section emissions. The increased efficiency of both private and public vehicles leads to a steady decline in total energy use.

Modeled Energy Use Reductions, by City of North Vancouver Policy Wedge, per Year (GJ/year)

City of North Vancouver Policies

	Business-as-Usual	Low Carbon Path	Local Solid Waste	DE Decarbonisation	DE Expansion	Local Retrofits	Onsite Renewables	Local Part 3 performance beyond Code	Local Part 9 performance beyond Code	Ped Improvements	Bike Improvements	Local Routes	Growing Smarter
2007 Baseline													
Total	5,051,502												
2020													
Electricity	1,647,956	1,491,404				63,690							
Natural gas	2,065,844	1,823,042		9,865	2,690	76,287	133						
Gasoline + Diesel	2,233,034	1,243,647								3,415	11,684	2,484	28,691
MSW Energy Content	144,159	78,873											
Total	6,090,994	4,636,966	-	9,865	2,690	139,977	133	-	-	3,415	11,684	2,484	28,691
Percent Reduction (from 2007 Baseline)				0.2%	0.05%	2.8%	0.003%	-	-	0.07%	0.2%	0.05%	0.6%
2030													
Electricity	2,116,704	1,433,677				76,860		40,432	71,140				
Natural gas	2,335,145	1,711,451		50,558	3,680	92,062	3,531	48,429	85,212				
Gasoline + Diesel	2,890,130	1,090,040								4,103	36,304	2,989	78,823
MSW Energy Content	172,901	54,100	29,095										
Total	7,514,880	4,289,268	29,095	50,558	3,680	168,922	3,531	88,860	156,352	4,103	36,304	2,989	78,823
Percent Reduction (from 2007 Baseline)			0.6%	1.0%	0.07%	3.3%	0.07%	1.8%	3.1%	0.08%	0.7%	0.06%	1.6%
2050													
Electricity	2,909,870	1,246,531				71,966		97,020	316,573				
Natural gas	3,042,700	1,380,092		92,566	5,895	86,201	5,244	116,210	379,191				
Gasoline + Diesel	3,583,592	692,842								7,256	52,807	4,179	212,679

MSW Energy Content	142,864	14,312	28,624									
Total	9,679,026	3,333,777	28,624	92,566	5,895	158,168	5,244	213,230	695,764	7,256	52,807	4,179	212,679
Percent Reduction (from 2007 Baseline)			0.6%	1.8%	0.1%	3.1%	0.1%	4.2%	13.8%	0.1%	1.0%	0.08%	4.2%

Modeled Energy Use Reductions, by Senior Government Policy Wedge, per Year (GJ/year

Senior Government Policies

	Business-as-Usual	Low Carbon Path	Sr Gov Solid Waste	Sr Gov Retrofit programs	BC Building Code	BC Hydro Green Electricity	Low Carbon - Tailpipe	Transit Route Additions	Transit Improvements
2007 Baseline									
Total	5,051,502								
2020									
Electricity	1,647,956	1,491,404		13,392	52,029	(691)			
Natural gas	2,065,844	1,823,042		16,041	62,320				
Gasoline + Diesel	2,233,034	1,243,647					536,466	95,708	6,745
MSW Energy Content	144,159	78,873	58,542						
Total	6,090,994	4,636,966	58,542	29,434	114,349	(691)	536,466	95,708	6,745
Percent Reduction (from 2007 Baseline)			1.2%	0.6%	2.3%	0.01%	10.6%	1.9%	0.1%
2030									
Electricity	2,116,704	1,433,677		19,064	108,808	280,864			
Natural gas	2,335,145	1,711,451		22,835	130,330				
Gasoline + Diesel	2,890,130	1,090,040					1,032,658	172,878	14,535
MSW Energy Content	172,901	54,100	58,189						

Total	7,514,880	4,289,268	58,189	41,899	239,137	280,864	1,032,658	172,878	14,535
Percent Reduction (from 2007 Baseline)			1.2%	0.8%	4.7%	5.6%	20.4%	3.4%	0.3%
2050									
Electricity	2,909,870	1,246,531		24,322	358,784	521,668			
Natural gas	3,042,700	1,380,092		29,133	429,751				
Gasoline + Diesel	3,583,592	692,842					1,455,917	263,863	39,051
MSW Energy Content	142,864	14,312	28,624						
Total	9,679,026	3,333,777	28,624	53,456	788,535	521,668	1,455,917	263,863	39,051
Percent Reduction (from 2007 Baseline)			0.6%	1.1%	15.6%	10.3%	28.8%	5.2%	0.8%

Modeled Emissions Reduction, by City of North Vancouver Policy Wedge, per Year (Tonnes CO_2e/year)

City of North Vancouver Policies

	Business-as-Usual	Low Carbon Path	Local Solid Waste	DE Decarbonisation	DE Expansion	Local Retrofits	Onsite Renewables	Local Part 3 performance beyond Code	Local Part 9 performance beyond Code	Ped Improvements	Bike Improvements	Local Routes	Growing Smarter
2007 Baseline													
Total	225, 426												
2020	247,374	187,651											
Reductions			-	493	134	4,009	7	0	0	230	785	167	1,929
Percent Reduction (from 2007 Baseline)			-	0.2%	0.06%	1.8%	0.003%	-	-	0.1%	0.3%	0.07%	0.9%
2030	267,240	145,182											
Reductions			2,439	2,528	184	4,838	177	2,545	4,478	276	2,440	201	5,298
Percent Reduction (from 2007 Baseline)			1.1%	1.1%	0.1%	2.1%	0.1%	1.1%	2.0%	0.1%	1.1%	0.1%	2.4%
2050	318,641	109,934											
Reductions			4,406	4,628	295	4,530	262	6,107	19,927	488	3,550	281	14,296
Percent Reduction (from 2007 Baseline)			2.0%	2.1%	0.1%	2.0%	0.1%	2.7%	8.8%	0.2%	1.6%	0.1%	6.3%

Modeled Emissions Reduction, by Senior Government Policy Wedge, per Year (Tonnes CO_2e/year)

Senior Government Policies

	Business-as-Usual	Low Carbon Path	Sr Gov Solid Waste	Sr Gov Retrofit programs	BC Building Code	BC Hydro Green Electricity	Low Carbon - Tailpipe	Transit Route Additions	Transit Improvements
2007 Baseline									
Total	225, 426								
2020	247,374	187,651							
Reductions			4,907	843	3,275	0	36,061	6,434	453
Percent Reduction (from 2007 Baseline)			2.2%	0.4%	1.5%	0.0%	16.0%	2.9%	0.2%
2030	267,240	145,182							
Reductions			4,877	1,200	6,849	1,716	69,415	11,621	977
Percent Reduction (from 2007 Baseline)			2.2%	0.5%	3.0%	0.8%	30.8%	5.2%	0.4%
2050	318,641	109,934							
Reductions			4,406	1,531	22,584	3,188	97,867	17,737	2,625
Percent Reduction (from 2007 Baseline)			2.0%	0.7%	10.0%	1.4%	43.4%	7.9%	1.2%

5.5.1. MODELED BUILDINGS INDICATORS & VALUES

						Comments	Indicator notes
Sr Gov Policy & Action		**2007**	**2020**	**2031**	**2050**		
Provincial Building Code energy performance (kWh/m2/yr)	Single Family	141* -30%	111, -45%	90, -55%	63, -69%		Forecasts are based on discussions with BC Gov out to 2020 and extending trajectory, potentially more aggressively in a scenario. *2007 values are for the 2008 Building Code. Current overall building performance is approx 40% less efficient than 2008 code. For the industrial sector, energy consumption is not as dependent on building code. However it is assumed that energy efficiency will progress at the same rate as for commercial buildings based on building efficiency initiatives as well as process efficiency improvements.
	Town Home	128* -30%	100, -45%	82, -55%	57, -69%		
	Low Rise	121* -30%	95, -45%	43, -75%	43, -75%		
	High Rise	130* -25%	99, -43%	85, -51%	65, -62%		
	Commercial	413* -25%	316, -43%	270, -51%	206, -63%		
	Industrial	338* -25%	258, -43%	221, -51%	167, -63%		
Residential **existing** buildings energy efficiency retrofit takeup rate (% per annum)	Single family	2% (no gov action=1%)					This is the energy retrofit rate attributed to senior government programs such as EcoEnergy alone. Retrofit take-up rates vary significantly across communities. Reported annual take-up rates for single family homes were 0.5% to over 10%, with an average of 3%. Deep reductions will require added incentive.
Residential **existing** buildings energy efficiency retrofit takeup rate (% per annum)	Multi-family	1% (no gov action=0.5%)					Ideally these are refined with additional data sources.
ICI **existing** buildings energy efficiency retrofit takeup rate (% per annum)	Commercial/ Institutional	1.5% (no gov action=1.0%)					

ICI **existing** buildings energy efficiency retrofit takeup rate (% per annum)	Industrial	1.5% (no gov action=1.0%)				
Local Gov Policy & Action		**2007**	**2020**	**2031**	**2050**	
Building energy performance (kWh/m2/yr) as a result of local policy and action beyond building code	Single Family	141* -30%	-75%	-87%	-100%	
	Town Home	128* -30%	-75%	-87%	-100%	
	Low Rise	121* -30%	-75%	-87%	-100%	
	High Rise	130* -25%	-75%	-90%	-90%	
	Commercial	413* -25%	-75%	-90%	-90%	
	Industrial	338* -25%	-75%	-90%	-90%	
* Average residential energy efficiency **retrofit** take-up rate (per annum)	Single family	5%				Local governments can potentially increase uptake of building retrofits through incentive programs. This is the retrofit rate combining senior and local government action. Assumed to be double the Sr Govt rate due to LG programs, and assuming the greatest influence in the residential sector.

* Average residential energy efficiency **retrofit** take-up rate (per annum)	Multi-family	5%	No data is currently available for multi family housing, however retrofit rates are expected to be lower than for single family housing. Assumed to be double the Sr Govt rate due to LG programs, and assuming the greatest influence in the residential sector.
Residential building retrofit efficiency improvement (%)	All residential types	25%	Average % reduction of annual energy consumption due to a building energy retrofit
Residential building redevelopment rate (% per annum)	Single Family Town House Low Rise	2% 1.5% 1%	% of existing buildings that are replaced with higher density buildings each year on average. This will likely be adjusted during the modeling.
* Average commercial/ institutional building retrofit take up rate (% per annum)		5%	Assumed to be 50% greater than Sr Govt rate, assuming LG has some influence.
Commercial/ institutional building retrofit efficiency improvement (%)		25%	Average % reduction of annual energy consumption due to a building energy retrofit
* Average industrial building retrofit takeup rate (% per annum)		3%	Assumed to be the same as the Sr Govt rate, as LG has limited influence.
Industrial building retrofit efficiency improvement (%)		25%	Average % reduction of annual energy consumption due to a building energy retrofit This number is fairly arbitrary, as it varies so much between specific industries and sites. The same value is assumed as for commercial buildings.

ICI building replacement rate (% per annum)	All ICI types	0.5%	% of buildings that are replaced with new buildings each year on average. Assumes these are replaced with buildings of the same type and size.

5.5.2. MODELED ENERGY SUPPLY INDICATORS & VALUES

		Low Carbon Scenario	Comments	Indicator notes
Sr Gov Policy & Action				
Electrical grid emissions factor (kg CO2e/MWh)	2007 2020 2031 2050	22 11 11 11		The applicable GHG emissions factor for grid-supplied electricity (i.e. BC Hydro) is expected to decrease going forward.
Community-wide on-site renewable energy participation rate (%)	Low density residential – single family, row houses 2020 2031 2050	 3% 10% 21%		Average % of all units in each year that utilize significant on-site renewable energy systems, primarily solar or geo-exchange

		Low Carbon Scenario	Comments	Indicator notes
Local Gov Policy & Action				
* District energy emissions factor Kg CO2e / MWh (Baseline emission factor is 180 kg CO2e/MWh)	2020 2031 2050	80 40 10	In order for LEC to decrease its reliance on natural gas fuels, and support the provincial objectives of 33%,55% and 80% GHG reductions, the following would need to occur: 1) Linkage of and the expansion of the existing grid network in order to increase the system base load in order to support alternative energy source. 2) Significant capital investment to support the "green" technologies so that the alt. energy fuel source does not impose a rate burden on LEC customers or CNV revenues. 3) Service area expansion to include all high density residential pockets of development. 4) Expansion of existing pipe infrastructure will make the connection of existing and new developments more feasible.	This is the emissions factor for supplying heat, expressed as a percent of the natural gas emissions factor. E.g., 50% means the heat is supplied to buildings with a major renewable component resulting in a 50% reduction in heating emissions intensity relative to gas.
District energy demand reduction (%)	All buildings	15%	Connected properties operate approx 15% more efficient then compatible stand alone gas based systems. This efficiency will increase as additional heat reclaim are added to the LEC system.	This is the average overall efficiency (energy demand reduction) improvement over conventional heating and systems realized from interconnection of different buildings in the district system.

		Low Carbon Scenario	Comments	Indicator notes
*District energy new building participation rate (%)	Residential Apartments 2020 2031 2050	 40%* 65%* 80%	With service area expansions nearly all new high density residential developments should be captured	Average % of new building floor space in the CNV (not just in service areas) that is DES-connected **Cumulative rates**: 2020 - 22% 2031 – 38% LR, 37% HR 2050 - 67%
	Commercial & Industrial 2020 2031 2050	 20% 32% 40%	There is min. Commercial development in CNV.	This includes mixed use buildings as these are classified as commercial in the buildings database. **Cumulative rates**: 2020 – 11% 2031 – 21% 2050 - 28%
* Retrofit rate for DES connection (% per annum)	Residential Apartments	1.5%	There needs to be a retrofit strategy put into place to support the conversion of existing apartments with hydronic bases systems. Permit for the replacement of existing boilers should require the adoption DE design changes and the installation of pre-connections for future hook up to the DE network.	Average annual % of existing buildings (all, not just in service areas) retrofitted with a DES connection Equivalent annual rates have been estimated based on cumulative projections provided by CNV.

		Low Carbon Scenario	Comments	Indicator notes
	Commercial & Industrial	0%	n/a	
* Average **residential renewable energy** retrofit takeup rate (% per annum)	Single family	2% (SF and suites), 1% townhomes		% of buildings retrofitted with renewable/alternative energy sources such as solar or geo-exchange that result in a net decrease in emissions
	Multi-family (townhouse)	0		
Residential retrofit emissions reduction (%)	All residential types	20%		Average reduction in emissions intensity for a renewable energy retrofit installation
Community-wide on-site renewable energy participation rate (%)	Low density residential – single family, row houses 2020 2031 2050	 6% 21% 42%		Average % of all units in each year that utilize significant on-site renewable energy systems, primarily solar or geo-exchange
New residential renewable energy emissions reduction (%)	Low density residential – single family, row houses	30%		Average reduction in emissions intensity for a renewable energy installation in a new building

5.5.3. MODELED TRANSPORTATION INDICATORS & VALUES

	Year	Low Carbon Scenario	Comments	Notes
Sr Gov Policy & Action				
Light vehicle fuel efficiency		Assume vehicle fuel efficiency improvements over time based on implementation of California Fuel Efficiency Standards through 2020. Extend the fuel efficiency increase trend through 2030. Hold constant from 2030 to 2050.		
Vehicle fuel source (assumption - not directly modeled)	2020 2031 2050	25% VKT by electric drive 35% VKT by electric drive 65% VKT by electric drive		
Mass Transit		+(See table below)		
Transit fuel efficiency and fuel source	2030	Electrification of mass transit and most buses		
Local Gov Policy & Action				
Transit Route Growth (KM)	2020 2031 2050	++(See table below)		
Average headway between buses		1% annual decrease		
Average Service Day (hrs)		0.25% annual increase		
Average speed of fleet		0.25% annual increase		
*Cycle path growth		1% annual increase	+++(Also see table below)	
TDM Measures (parking, curb bulges, calming etc.)		Not modeled		

+Senior Gov Transit Route additions

Name	Service Day (hours)	Max Speed	Peak Headways	Implementation Date
Third Seabus	19	50	30	2020
Commuter Rail	6	60	20	2031
BRT Lonsdale	18	50	8	2020
BRT Highway #1	18	50	8	2031
BRT 3rd Street West	19	50	8	2020
BRT 3rd Street East	18	50	8	2031

++Community Supported Transit Route Additions

Name	Service Day (hours)	Max Speed	Peak Headways	Implementation Date
Harbourside Water Shuttle to Downtown	8	35	30	2020
Industrial Shuttle	8	30	30	2020
Lonsdale Shuttle	8	30	30	2020

+++Bike Network additions (as per Transpo Plan)

Year	Increase from Pervious Milestone Point LCP	Increase from Pervious Milestone Point BAU
2020	16km	0
2031	21km	0
2050	8km	0

5.5.4. MODELED WASTE INDICATORS & VALUES

		Test Run Scenario	Comments
Sr Gov Policy & Action			
Metro SW overall diversion rate (%)	2020 2031 2050	70% 70% 70%	Metro Vancouver's targeted overall waste diversion rate is 70% by 2015.
DLC wood waste diversion	2020 2031 2050	Not modeled separately	This will be looked at for the refined scenario, was not be included in the test run scenario.
ICI food waste diversion	2020 2031 2050	Not modeled separately	This will be looked at for the refined scenario, was not be included in the test run scenario.
Local Gov Policy & Action			
*Overall diversion rate plus additional local government recycling	2020 2031 2050	70% 80% 90%	The current overall waste diversion rate on the north shore is approximately 50%.
*Organics diversion rate	2020 2031 2050	Not modeled separately	This will be looked at for the refined scenario, was not be included in the test run scenario.

Appendix C: Technical Description of Modeling

This document outlines the essential assumptions and methodologies used to quantify the City's emissions by sector, by neighbourhood and by household. It is organized in three sections:

1. Transportation
2. Buildings
3. Solid Waste

5.6. TRANSPORTATION EMISSIONS MODELING

5.6.1. HOW DOES IT WORK?

There have been numerous studies completed documenting the connections between land-use and transportation. Land-use patterns, which can increase travel distances because of the separation of homes, jobs, and other destinations, have been found to have a direct impact on travel distances. Land use is not simply limited to buildings and destinations, but includes infrastructure as well. Transportation networks, be it transit, automobile or active transportation, all have measured effects on transportation behaviours.

Time and geography are also important factors in determining transportation emissions. When developing land use and transportation policy, it is useful to know not just the total emissions for the transportation sector but how these emissions vary geographically across a community. Emissions from transportation are notoriously hard to localize let alone temporalize[27]. Little research has been conducted on how emissions or their drivers change over time. That is to say it is difficult to model future behaviours let alone current ones. Thus to forecast future emissions HB Lanarc used a customized regression model calibrated for the present day but run with inputs reflective of future theoretical scenarios.

In order to tease out the influence of various factors within an urban context, the Canadian Municipal Housing Corporation (CMHC) commissioned IBI Group[28] to use trip diaries from the Greater Toronto Area to isolate factors such as density, grid network, location and socio-economic factors and develop a model that can be applied to four neighbourhood types within a metropolitan region.

HB Lanarc has adapted the CMHC-IBI model to be fully spatialized and run within ArcGIS, a geographic information system (GIS). Inputs to the model and formulas were spatialized and the outputs mapped using GIS. Using this approach, current and future emissions for personal vehicles and transit can be modelled for each census dissemination area (CDA) based on a wide range of factors.

Nine of the most common factors from the literature are listed in Table 14 below. We have matched the factors to their equivalents in the CMHC-IBI transportation model and qualitatively evaluated the impact of each on vehicle kilometres traveled (VKT) and passenger kilometres traveled (PKT).

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[27] Pacific Analytics Inc. (2008) *Assessing Vehicular GHG Emissions. A Comparison of Theoretical Measures and Technical Approaches*. Prepared for the CEEI Working Group.

[28] IBI Group 2000. CMHC Tool for Evaluating Neighborhood Sustainability

Table 14 – Land Use – Transportation Factors in the CMHC-IBI Model

Factor	Researched Effects of Factors on Vehicle and Transit Kilometres Traveled (VKT,PKT)		Predicted Effects of Factors using CMHC-IBI Regression Model	
	VKT	**PKT**	**VKT**	**PKT**
Density	Moderate	Moderate	Moderate	Low
Land Use Mix	Moderate	Low	Moderate	None
Regional accessibility	High	High	High	Moderate
Centeredness	Moderate	High	Moderate	Moderate
Network Connectivity	Low-Moderate	Low	None	Low
Roadway design and management	Low	Low-Moderate	Not Modeled	Not Modeled
Walking and cycling conditions	Moderate	Low	None	Low
Transit quality and accessibility	Moderate	High	Low	High
Parking supply and management	High	None	Not Modeled	Not Modeled
Site design	Low	Low	Not Modeled	Not Modeled

Model set-up and greenhouse gas emissions were calculated using the following steps:

1. Data that was used to calculate the CMHC-IBI regression analysis is collected and assembled at the dissemination area level. The general categories are:
   a. Census data for each dissemination area:
      i. Average age of residents
      ii. Average size of dwellings
      iii. Average number of persons per household
      iv. Average family income
      v. Number and type of dwellings
   b. Transportation infrastructure information for each dissemination area
      i. Length of roads
      ii. Length of wide arterial roads
      iii. Length of bike paths
      iv. Number of street intersections
      v. Road configuration type
      vi. Mass transit routes, headways, speeds, service hours and stations
      vii. Local transit routes, headways, speeds and service hours

   c. Employment data for each dissemination area
      i. Number of employees within 1km
      ii. Number of employees within 5km
      iii. Number of grocery stores
   d. Other location information
      i. Distance to the central business district
      ii. Buildable area
      iii. Density (households per hectare)

2. All data is prepared for processing.
    a. Census data is usually sourced from spreadsheets and massaged into formats ready for GIS
    b. Road network information is gathered in GIS format and massaged for automated processing
    c. Transit network information is gathered in GIS format and updated with timing information from transit authorities
    d. Employment locations are typically figured from assessment information, employment surveys or regional data sources
    e. The central business district was specified as downtown Vancouver.
    f. Buildable area is usually measured as total area minus parks, conservation areas, rivers and hazard areas (steep slopes, ravines etc.)

3. Census data, as it is already stored in the dissemination area, is massaged to meet the criteria of the CMHC-IBI model.

4. The road configuration is manually evaluated based on guidelines provided in the CMHC-IBI model documentation.

5. Each spatial attribute is automatically allocated by intersecting or measuring against geometry of the dissemination area and summing/averaging where appropriate. In this fashion the data requirements of the CMHC-IBI model are achieved spatially.
    a. For intersection-based calculations against point geometries, such as grocery stores, intersections and employment locations all intersecting locations are summed either by count or by employee
    b. For distance-based calculations against point geometries, such as distance to mass transit and central business district, a shortest path distance network calculation from the dissemination centroid to that of the target is evaluated.
    c. For intersection-based calculations against line geometries such as bike routes, arterial roads, transit routes, and all roads all intersecting centreline segments are summed by length and, in the case of transit, by headway, service day and speed.

6. Derived attributes such as land use mix, housing mix and density are calculated according to the CMHC-IBI documentation.

7. An adaptation of the regression model is run for each dissemination area producing three main output variables:
    a. Vehicles per household
    b. Vehicle kilometres traveled
    c. Transit kilometres traveled

8. Yearly Household Emissions are calculated using:
    a. day-to-year expansion factors (390 for VKT, 300 for PKT)
    b. tailpipe CO_2 emission factors created from NRCan, ICBC and BC Provincial government data (see below for an explanation of the calculation of future tailpipe emission rates)

9. Yearly Total Transportation Emissions are calculated by multiplying the number of households by their average yearly emissions. Because the CMHC-IBI model

is based on trip diary data collected in the GTA, it is likely less accurate for modelling absolute emission levels in BC. It is more reliable for modelling relative changes. Therefore, current emissions (used to establish the baseline) were corrected to the BC Community Energy and Emissions Inventory (CEEI). In the case of the City of North Vancouver, very little calibration was required as the metropolitan area approximately resembles the transportation travel patterns and dynamics of the GTA.

5.6.2. VEHICLE TAILPIPE EMISSION FORECAST

Modelling the change in on-road vehicle emissions involved combining empirical data on trends of vehicle sales, the age of vehicles on the road and the distribution of kilometres traveled among vehicle types and the vehicle emission standards that the BC provincial government has proposed for the years 2011 to 2020, which are based on the proposed standards in California (and align with the newly proposed Canadian federal standards from 2016 onwards). The following assumptions were used:

- The average age of scrapped cars in future years will be the average age of all cars on the road. In recent years the average age of cars when they are scrapped has been increasing, as the quality of cars has been increasing. At the same time, scrapping rates for older vehicles is likely to increase in the future as more aggressive incentive-based programs are rolled out in order to take older, polluting vehicles off of the road.

- In 2006, diesel fuel accounted for approximately 5% of energy expended for passenger transportation in Canada. Because of a lack of data on the stock and sales of diesel vehicles, the effect of the change in fuel efficiency of diesel vehicles on the fleet average fuel efficiency has been excluded. The proposed vehicle emission standards affect all new vehicles sold, including gasoline, diesel, grid-charged battery electric vehicles and all other alternative fuelled vehicles.

- Vehicle sales and the stock of vehicles on the road will follow the same trend line as 2004 to 2006 until 2020, except for light trucks, which will grow at 1% per year. At that point, stock and annual vehicle sales will remain constant.

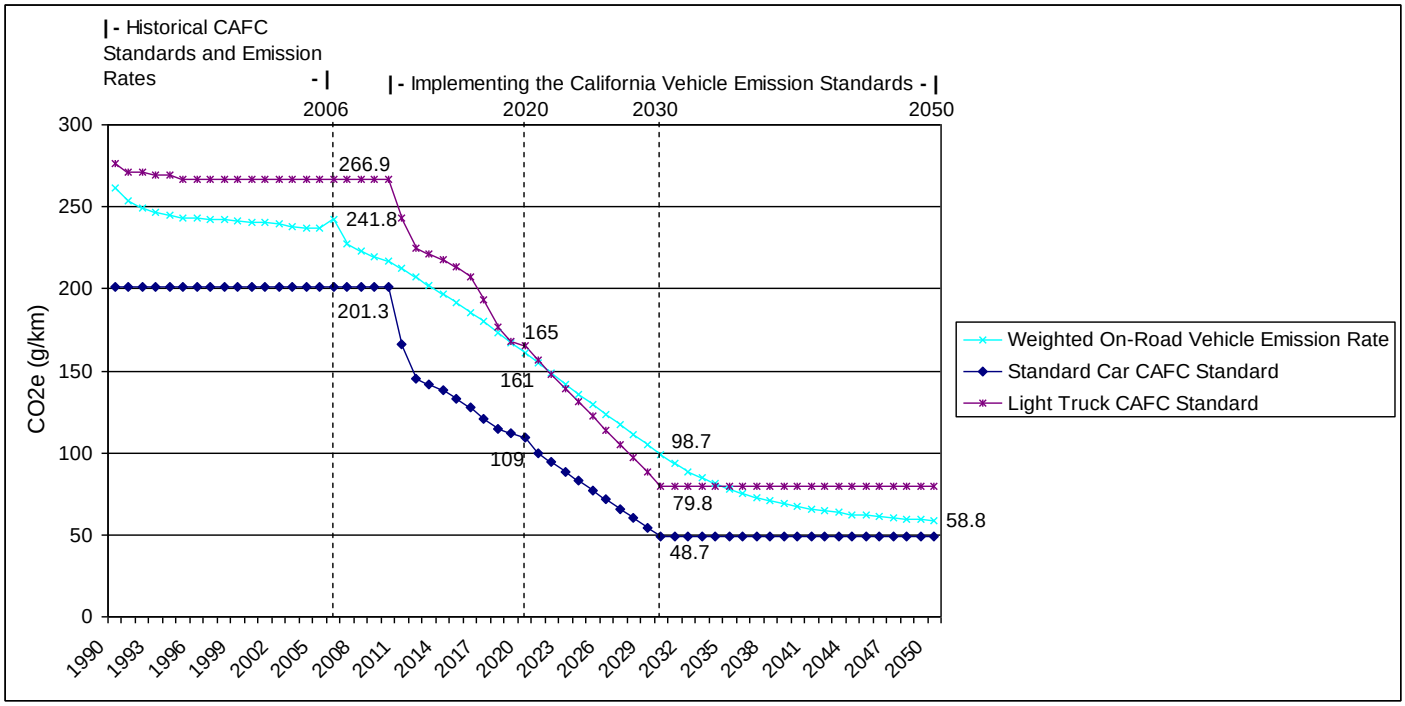
- From 2007 onwards, it will be assumed that the proportion of kilometres traveled among the vehicle classes will be the same as the proportion in 2006.

- From 2021 to 2030, vehicle fuel efficiency standards will increase at the same average annual rate as 2011 to 2020. As the policy future beyond 2020 is anything but certain, the increased fuel efficiency that occurs in this time frame could be attributed to other factors including rising oil prices, the implementation of a higher carbon tax or cap-and-trade regulation regime. Under any of these scenarios, the emission reductions shown in the model from 2021 to 2030 should be considered at the most ambitious end of the spectrum of the range of action that the provincial or federal government could take. We have chosen to model this scenario in order to illustrate the likely maximum reductions that could be achieved by provincial/federal action on vehicle emission rates.

- From 2031 to 2050, we have assumed that the vehicle fuel efficiency standards will be the same as 2030.

- From 2011 to 2050 the proposed emission standards will be met. This will require that the vehicle manufactures produce vehicles that have a lab-measured emission rate at the standard and new car buyers purchase the lower emission vehicles.

Figure 18 - *Vehicle Emission Rates from Historical Corporate Average Fuel Consumption (CAFC)[29] [30] Standards and Proposed Vehicle Emission Rate Standards [31]*



- The "Weighted On-Road Vehicle Emission Rate" is the same number that was used as an input to the adapted CMHC model. For 2007, 241.8 g CO_2e/km was used. In 2020 the weighted average is predicted to drop to 161 g CO_2e/km. In 2030 it will be 98.7 g CO_2e/km. And in 2050 it will drop to 58.8 g CO_2e/km.

  Data for 1990 - 2006 were from the following sources:

  - Vehicle sales: 1 and 3
  - Vehicle stock: 1, 2 and 5
  - On-road average fuel consumption: 1, 6 and 4
  - Lab-tested new vehicle fuel consumption: 6

[29] The Corporate Average Fuel Consumption (CAFC) Standard is a federally mandated fleet average that every vehicle manufacturer that sells passenger cars and trucks in Canada must meet. The CAFC is calculated by taking the average lab-measured fuel consumption of all vehicles sold. The vehicle emission rates that the BC provincial government has proposed would be measured and regulated analogously to the CAFC.

[30] CAFC standards have been converted into the equivalent emission rates (grams of CO2e per km) for the purpose of comparison to the proposed BC emission rate standards.

[31] From 2011 to 2050, the Standard Car CAFC Standard and the Light Truck CAFC Standard are the modeled BC emission rate standards.

1. Natural Resources Canada, Transportation End-Use Model, Ottawa, September 2008.
2. Statistics Canada, Road Motor Vehicle Registrations, Ottawa, November 1999 (Cat. No. 53-219-XIB); and Statistics Canada, Motor Vehicle Registrations 2000–2006, Table 405-0004, Ottawa, 2008 (CANSIM).
3. Statistics Canada, New Motor Vehicle Sales 1990–2006, Table 079-0001, Ottawa, December 2006 (CANSIM).
4. U.S. Department of Transportation, National Transportation Statistics, Table 4-1, 2006.
5. DesRosiers Automotive Consultants, Canadian Vehicle in Operation Census 1990–2006, Richmond Hill (Toronto), December 2007.
6. Transport Canada, Vehicle Fuel Economy Information System 1979–2006, Ottawa, 2007.

Table 15: Proposed BC Vehicle Emission Rate Standards *(Source: Province of BC, Climate Change Plan).*

Year	Passenger Cars & Small Trucks (g CO_2e / km)	L / 100 km eq	Trucks (g CO_2e / km)	L / 100 km eq
2011	166	7.09	243	10.38
2012	145	6.19	225	9.61
2013	142	6.07	221	9.44
2014	138	5.89	218	9.31
2015	133	5.68	213	9.10
2016	128	5.47	207	8.84
2017	121	5.17	193	8.24
2018	115	4.91	177	7.56
2019	112	4.78	168	7.18
2020	109	4.66	165	7.05

5.6.3.KEY ASSUMPTIONS

Applicability of CMHC-IBI model to non GTA contexts

The relationships between population, land use and transportation are relatively well documented and have been thoroughly explored in the context of urban travel by the CMHC. Using the CEEI and trip diary studies, HBL has tested the CMHC-IBI model in several contexts and has found it to be most applicable/accurate in urbanised areas such as the City of North Vancouver.

Expansion and Emission Factors

HBL uses the same day-to-year expansion factors as the CMHC-IBI, but uses vehicle tailpipe emissions factors that have been developed using BC specific data.

Correctness of Source Data

As the data requirements of the spatial model are varied and from numerous different data sources, it is often difficult to assess the quality or currency of information. It is assumed that data received from the City and the CRD are correct. Census data is known to be 95% accurate

5.7. BUILDINGS ENERGY AND EMISSIONS MODELING

5.7.1. HOW DOES IT WORK?

HB Lanarc models buildings energy and emissions in the following way:

1. The total floor space values of different building 'archetypes' (various residential housing types, commercial and industrial) are estimated
2. Floor space values are multiplied by energy intensity factors (measured in kWh/m^2/year) for each archetype, to produce total energy use
3. Energy use by archetype is multiplied by average energy source split values for each archetype, providing total energy use by source. Sources include:
    a. Grid electricity
    b. Natural gas
    c. Heating oil
    d. District energy supplied heat
    e. Onsite renewable heat and power
4. Emissions factors (tonnes CO_2equivalent/MWh) are applied to total energy use by source, providing emissions by building archetype.

5.7.2. KEY ASSUMPTIONS

Floor Space

Average dwelling sizes for different archetypes are determined using real estate assessment data. The number of units is determined from census data.

Building Archetype Energy Intensity

All buildings of a given archetype are assumed to have the same energy intensity, energy supply mix and emissions factors; therefore the assumptions used for each of these are intended to be averages. In actuality, building energy intensity varies widely according to a number of factors which are outside the scope of analysis.

Low rise residential energy intensity is based on NRCan data for existing buildings in areas of BC with similar climate zones to City of North Vancouver (Lower Mainland). Census housing age data is used to determine appropriate intensity values. Residential energy use is verified and calibrated to inventoried values (CEEI and other community inventory sources).

For commercial and industrial buildings, energy intensities are calibrated so that emissions are equivalent to inventoried values.

Energy Source Mix

Energy source split values are derived from inventoried values.

Emissions Factors

Utility emissions factors are derived from reported values.

5.8. SOLID WASTE MODELING

5.8.1. METHODS AND ASSUMPTIONS USED TO CALCULATE GHG EMISSIONS FROM SOLID WASTE

Greenhouse gas emissions from the solid waste sector were calculated using a "methane commitment" approach, where Scope 3, indirect emissions, that occur outside the geographic boundaries of the City are included in the City's inventory. The methane commitment method attributes all future emissions to the year in which the waste was produced. The main advantage of using the methane commitment method is that it provides results that are comparable to the estimated emissions avoided by reduce, reuse, and recycle programs. For example, reducing the amount of waste produced avoids all emissions that would have been released over the lifetime of the waste's decomposition. Therefore, it is easier to account for all of the emissions that will be released and all of the emissions that will be avoided in one year.

The inputs required for this method are tonnage of waste generated by waste type, the disposal technology, the diversion rate and emission factors for each waste type and disposal technology. For the City of North Vancouver, the following steps were followed:

- Calculated the tonnage of waste by waste type that was generated from the community.
  - Metro Vancouver calculates the tonnage of waste that comes from each jurisdiction at transfer stations. Based on this data, an estimate of the total tonnage for the City of North Vancouver was made.
  - Metro Vancouver conducted a waste composition study in 2006. We used this information to divide the total tonnage of waste into waste types according to the results of the waste composition study (this assumes that the City of North Vancouver's waste stream composition is the same as Metro Vancouver overall).
- Divided the waste stream into diverted waste (recycled, composted, etc), landfilled waste and incinerated waste based on estimates from North Shore Recycling and Metro Vancouver.
- Calculated the total methane that will be emitted over the lifetime of each material type in the landfill using emission factors in Table 17.
- Assumed a methane capture rate of 80% for Cache Creek Landfill based on the 2008 Cache Creek Annual Report[32] and guidance provided by the IPCC.[33]
- Multiplied the total tonnage of methane emissions by 21 to obtain tonnage of CO_2e.
  - For the modeled years of 2020, 2030 and 2050, waste composition was adjusted according to Metro Vancouver projections.

[32] Golder and Associates 2009. 2008 Annual Report, Cache Creek Landfill, Cache Creek BC. Report Number: 09-1411-0028/9210. April 29, 2009.

[33] Bogner, J., et al, Waste Management, In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, et al (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

- Total waste generated in future years was calculated by adjusting downward the per capita was generation rate, based on the anticipated effect of the recommended policies and actions. Likewise, the diversion rate was adjusted downward to account for zero waste related programs. (See
- Table 18)

Table 16 – Composition of Solid Waste in Metro Vancouver, 2006 and forecasted

Waste Type	2006 (%) Composition	2020-2050 (%) Composition
Yard and garden	6.1%	3.4%
Food waste	21.2%	21.2%
Organic Composites	4.0%	6.3%
Paper and Paperboard	20.2%	19.3%
Plastics	9.8%	13.1%
Wood and Wood Products	9.5%	4.7%
Inorganic - composites	4.4%	3.5%
Textiles	2.7%	4.2%
Metal	4.1%	3.3%
Glass	1.8%	1.4%
Hazardous Waste	1.7%	1.3%
Household Hygiene	7.9%	12.4%
Non-Ferrous Metal	0%	0%
Rubber	0.4%	0.6%
Small Appliances	4.0%	2.4%
Other	2.20%	2.4%
Total	100.0%	100%

Table 17 – Emission Factors Used for Calculating Solid Waste Sector GHG Emissions [34]

	Emission Factor (Methane Commitment) tonnes CO2e/tonne waste	Emission Factor CO2 (incineration) CO2e/tonne waste	Emission Factor N2O (incineration) CO2e/tonne waste	Emission Factor Upstream [35](process energy) CO2e/tonne
Yard and garden	0.529		0.04409	
Food waste	0.904		0.04409	
Organic Composites	0.5		0.04409	15
Paper and Paperboard	1.65		0.04409	1.87
Plastics		2.76		2.205
Wood and Wood Products	0.7165		0.04409	0.28
Inorganic - composites				
Textiles	0.5	1.9		
Metal				3.505
Glass				8.09
Hazardous Waste				
Household Hygiene			0.04409	
Non-Ferrous Metal				9.072
Rubber		8.3		15.43
Small Appliances		0.4189		33.07
Other		0.4079	0.04409	

[34] US EPA 2006. Solid Waste Management and Greenhouse Gases – A Lifecycle Assessment of Emissions and Sinks. Exhibit B-7

[35] Upstream emissions were not included in the total community emissions.

Table 18 – Baseline and Modeled Solid Waste Scenarios

2007		
Solid waste generated	59,236	t/y
Waste Generation per Capita	1.24	t/y
Landfill Rate	27%	
Incineration Rate	23%	
Diversion rate	50%	
Emissions	**7,597**	tCO_2e/y
2020		
Solid waste generated	61,014	t/y
Waste Generation per Capita	1.1	t/y
Landfill Rate	10%	
Incineration Rate	20%	
Diversion rate	70%	
Emissions	**7,360**	tCO_2e/y
2030		
Solid waste generated	55,800	t/y
Waste Generation per Capita	0.9	t/y
Landfill Rate	5%	
Incineration Rate	15%	
Diversion rate	80%	
Emissions	**4,877**	tCO_2e/y
2050		
Solid waste generated	53,469	t/y
Waste Generation per Capita	0.75	t/y
Landfill Rate	0%	
Incineration Rate	10%	
Diversion rate	90%	
Emissions	**2,203**	tCO_2e/y