Envisioning a Carbon-Neutral City
Modeling a 100 Year Sustainability Vision for the City of North Vancouver

The global community faces significant challenges as it deals with the impact of urban development on greenhouse gas emissions. The City of North Vancouver recognizes the need to build sustainable and resilient communities. It is imperative to think strategically, beyond the next decade, and beyond the next 50 years. The 100 Year Sustainability Vision provides a starting point for discussion and action, allowing the City to develop proactive planning that will help us become a carbon-neutral community.

Mayor Darrell Mussatto
City of North Vancouver
Summary

Building on a century-old tradition of leadership in livable urbanism, the City of North Vancouver initiated one of the first efforts in British Columbia to meet the challenging new Provincial targets for the reduction of greenhouse gas (GHG) emissions at the municipal scale. The result was the 100 Year Sustainability Vision, a plan to achieve community-wide net zero GHG emissions by the City’s bicentennial in 2107. This concept plan has been developed through a participatory charrette process led by the University of British Columbia Design Centre for Sustainability (DCS) and in cooperation with the District of North Vancouver. Researchers utilized a highly integrated design, modeling and multi-stakeholder decision-making process to integrate building, transportation, infrastructure and technology options that, in combination, demonstrate the feasibility of achieving a vibrant, diverse, highly liveable and carbon neutral community.

Background

The City of North Vancouver is a small, urban municipality located across the Burrard Inlet from the City of Vancouver. With a land area of approximately 12 square kilometers and a population of 48,000 residents, we have one of the highest municipal densities in Canada. The City also supports more than 23,000 jobs and is identified by Metro Vancouver as the regional town centre serving the North Shore communities. Our City has been recognized for its commitment to sustainability and was selected as the featured community in Canada’s award-winning entry at the 2003 World Gas Conference in Tokyo, Japan, and was awarded the Province’s inaugural Green City Award in 2007.

The City’s 2007 Centennial presented an opportunity for us to both reflect on the early decisions that shaped the City to date and to consider how actions taken today can serve the City to the end of the 21st century. Recognizing the far-reaching consequences of climate change—a concern unanticipated a century ago—the City crafted a 100 Year Sustainability Vision. During the following year, we articulated this concept plan in order to reach our primary goal, which is:
THE CITY OF NORTH VANCOUVER

…to be a vibrant, diverse and highly liveable community that provides for the social and economic needs of our community within a carbon neutral environment by the City’s 200th birthday in 2107.

Developing the 100 Year Sustainability Vision required confronting the existing gap between land use planning decisions and their GHG implications. We also needed to build an implementation bridge between the City’s current 20 to 30-year planning work and the longer century-long perspective. At workshops and a multiday charrette involving a range of local and regional community members, stakeholders and researchers defined a community planning approach, developed specific implementation strategies through an iterative design process, and quantified the GHG impact of selected urban form choices.

Our broad targets for the 100 Year Sustainability Vision are to reduce GHG emissions by 80% below 2007 levels by 2050 and achieve net zero carbon emissions by 2107. The project developed a highly integrated, collaborative design and modeling tool that incorporates:

1) strategic framing to link project outcomes transparently to existing legislation and policy;
2) multi-stakeholder decision-making events to develop low-carbon community design strategies;
3) a case-based, development pattern modeling methodology that links urban form design strategies to measurable data;
3) GIS based analysis for quantifying the GHG emissions related to those urban form design strategies.

Figure 2: The 100 Year Sustainability Vision is a planning and design project that informs sustainable decision making over a long term (100 Year Vision)

Figure 3: Strategies to realize net-zero GHG emissions articulated during a multiday charrette process (100 Year Vision)
Policy Framework

Within British Columbia, GHG emission reductions are the focus of Provincial legislation and policy such as the Climate Action Plan (2008), Carbon Tax Act (2008), Greenhouse Gas Reduction Targets Act (2007) and Energy Plan (2007, 2010). Achieving the targets set forth in these documents requires increased levels of cooperation between the Province, its regions and its municipalities and will demand both broad planning agendas and negotiated, locally appropriate strategies across a geographically, climatically, economically, demographically and politically varied landscape.

The City’s existing 2002 Official Community Plan (OCP) provides a basis for community planning centred on sustainability as an integrating tool. This policy document served as a solid framework for the design of the 100 Year Sustainability Vision, contributing energy management goals and objectives to the process. Recent legislation was another key factor as the Provincial GHG reduction target for 2050 was used as a key milestone along the path to achieving the overall target of zero carbon emissions by 2107.

![Figure 4: The Provincial 2050 reduction target was utilized as a key milestone for the Vision](image-url)

The Vision provides one possible future for our City. By stimulating imaginations with a tangible process rooted in urban design and systems thinking, the 100 Year Sustainability Vision supports both the City’s implementation of our existing OCP as well as the consideration of energy and climate adaptation factors in our future planning processes. Our vision for the future provided the context for the subsequent modeling approach completed by HB Lanarc for the City’s Community Energy and Emissions Plan (CEEP) process of 2009-2010 and described in Taking Action on Climate Change: Community Energy and Emissions Planning in the City of North Vancouver on the BC Climate Action Toolkit website.
Approach

The 100 Year Sustainability Vision is an illustration of how to achieve the challenging GHG emissions reduction targets set forth by the Province. Our vision demonstrates the ability of a collaborative, multi-stakeholder design process to integrate a modeling methodology and link design outputs to measurable data. The results describe which design strategies are most effective in supporting municipalities to reach GHG emissions reduction targets.

The Vision relies on development patterns, a methodology that facilitates the measurement of scenarios within a participatory planning process. Areas of the City are assigned an urban development pattern that can be revised to reflect current or proposed conditions for each scenario. The ability to replicate the patterns is central to their utility; derived from specific, parcel-level archetypes they provide a means to measure indicators citywide without requiring detailed data for each parcel.

The Vision considers four scenarios: a 2007 baseline; preliminary 2050; preliminary 2107; and charrette result scenario. The 2007 baseline scenario helped us to calibrate a development pattern methodology that aligned with the City’s previously completed 2005 inventory of community GHG emissions.

We employed a series of workshops leading up to the multi-day 100 Year Sustainability Vision charrette. The final product was a publication printed and made openly available on the City and DCS websites. Background information and data required for modeling was gathered and synthesized prior to the charrette, to facilitate additional analysis done.
concurrently with the design decision making process. This integrated process allowed the evaluation and selection of different urban forms based on their expected net impact to GHG emissions. We were thus able to confirm as a group the feasibility of meeting our established broad goal of carbon neutrality by our 200th birthday. The charrette environment supported the identification of preferred design approaches and the Vision was revised as consensus on issues was reached.
Preparation of materials to inform the charrette occurred over 4-6 months. Following the charrette, our focus shifted to compiling and describing the principal outcomes of the project. Documentation and editing of the final publication required an additional 6 months.

The Tool

The methodology supporting the 100 Year Sustainability Vision can be used to assess a range of decisions, generate varied scenarios and develop strategies for implementation. The multi-stakeholder decision-making process effectively identifies the sustainability intentions of a community, links these to specific indicators for measuring success and, through the use of a collaborative design process, generates specific design strategies for implementation. This process integrates a modeling methodology with actual physical design strategies and supporting data, allowing stakeholders to measure and evaluate the relative success of alternative design strategies. The case-based development pattern methodology allows for different sets of data to be attached at the case level, thus enabling the modeling of a wide range of physical design scenarios. These scenarios can be tested against various targets and policies and are largely limited only by the availability and accessibility of data. This tool is highly scalable, and can potentially be applied to an area as small as a block or to a neighbourhood, city, region, or even greater area.

The modeling tool can incorporate a range of attributes that impact community-wide emissions, and depends largely on the availability and accessibility of data. Two sources of GHG emissions were modeled: building energy use and transportation related to residential units. Building types included single family detached, duplexes, rowhouses, low-rise apartments, high-rise apartments, commercial buildings, institutional buildings and industrial buildings. The transportation demand model included only private vehicle trips with a start or end point at a residential unit within the City.
A full description of the methodology, sources and calculations is available in the technical paper that is linked at the conclusion of this document. Entitled *City of North Vancouver 100 Year Sustainability Vision: GHG Measurement and Mapping*, the paper was prepared for the Ministry of the Environment CEEI Working Group.

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<th>Residential Dwellings</th>
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<th>Preliminary 2071 Scenario</th>
<th>Charrette 2107 Scenario</th>
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<td>% change</td>
<td># units</td>
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Figure 9: Development patterns enable the testing of future spatial arrangements—such as the transition of dwellings away from detached single-family (above)—that, combined with the adoption of renewables and better construction methods, may deliver substantial emissions reductions (below) (Technical Paper)

**Model Inputs**

Inputs for the 100 Year Sustainability Vision included:

1) Alternative design scenarios: including land use and transportation strategies (generated internally and through collaborative design events with stakeholders);
2) Physical data on City buildings and parcels: average parcel area, average FAR, building form, gross and net floor area by use, residential unit count, assumed residential unit size, population, assumed household size by unit type, job count, assumed employment density, and average density (UBC elementsLAB elements database);
3) Potential energy performance for land uses: residential electrical energy use (BC Hydro Conservation Potential Review), residential natural gas energy use (BC Hydro net space heating and cooling load data), commercial, institutional and industrial space energy use (City of North Vancouver GHG inventory report);

Figure 10: Both building and transportation changes impact modeled results (100 Year Vision)
4) Residential transportation trips: private vehicle trips with a start or end point at a residential unit within the City (City of North Vancouver GHG inventory report, BC Ministry of Environment Community Energy and Emissions Inventory, TransLink Trip Diary Survey), generic trip generation data (Institute of Transportation Engineers Trip Generation, 6th Edition, Suzuki Foundation Kyoto and Beyond, Statistics Canada Census data);

5) Energy and emission inventories for general methodology calibration: (City of North Vancouver GHG inventory report, BC Ministry of Environment Community Energy and Emissions Inventory).

Assumptions

The building energy model used assumptions about the long-term potential for GHG emission reductions through technological advancements based on available sources (e.g. David Suzuki Foundation Kyoto and Beyond) and educated judgment (e.g. assuming universal residential building retrofit to a minimum of current best energy-efficiency design practices). The transportation model used significant trip length and mode split assumptions (e.g. percent trips by alternative transportation modes within 400m of significant transit), as the available data was aggregated at a broader scale than the project scenarios.
Calculations built into the model include: population (number and density), employment population, residential units (total, density, by dwelling type), and energy and emissions (building and transportation).

**Model Process**

The model is highly adaptable to the specific context and questions being addressed in a given project. Generally, a process similar to that used with the City of North Vancouver 100 Year Sustainability Vision is appropriate:

1) Create a sustainable planning framework that strategically aligns legislation and policy into a set of guidelines (principles, goals, objectives);
2) Define a set of indicators, metrics and targets for measuring success against the planning framework. For this project, the meta-target was to reduce GHG emissions by 80% below 2007 levels by 2050 and achieve net zero carbon emissions by 2107;
3) Collect data related to metrics;
4) Physicalize data into cases;
5) Generate existing development patterns;
6) Generate 2007 baseline scenario;
7) Calibrate model against available GHG emission inventories;
8) Generate preliminary low-GHG diagrams (for preliminary verification of targets and identification of “big moves”, and to inform generation of future development patterns);
9) Generate future development patterns;
10) Generate 100 Year Sustainability Vision scenario (in charrette process), iteratively testing alternative design strategies through GIS analysis;
11) Translate final 100 Year Sustainability Vision scenario into digital development pattern map;
12) Import map into GIS to measure performance.

*Figure 13: 2007 land use mapping by parcel (left) and analysis of applied development patterns in baseline scenario (right) (100 Year Vision)*
Strategies

Through the 100 Year Sustainability Vision, we approached sustainable urban design through the lens of climate change and were fundamentally guided by the reduction targets as outlined in Provincial legislation as well as our City’s own aspiration for carbon neutrality. Two broad targets informed the Vision: 80% GHG emissions reduction by 2050; and net-zero carbon emissions by 2107. These targets provided the standard by which we measured the concept plan. The strategies to reach these broad targets were structured by seven sustainability design principles:

1) access to linked public places, parks and natural areas;
2) green, durable, timeless infrastructure;
3) climate change adaptation;
4) mixed-use corridors accessible to all;
5) five minute walking distance;
6) appropriate housing for all;
7) good and plentiful jobs close to home.

Two stakeholder workshops explored the methodologies and underlying assumptions which would be used to evaluate the community-wide GHG emissions and estimate future reductions. The research team provided stakeholders with background data and assumptions, including population, employment and GHG estimates, which would be used for the modeling and charrettes and to quantify the extent to which the Vision achieved the broad targets. The development pattern-based methodology then integrated building, transportation, infrastructure and technology options to quickly assemble and evaluate scenarios representing baseline 2007 conditions and the Vision for carbon neutrality developed by stakeholders. GIS analysis generated the emissions estimates and spatial maps reflecting the various urban form decisions.
The strategies developed by the charrette team include the creation of an interconnected green street network and development of mid-block connectors to improve connections across the City’s linear core. Our concept plan gradually reconfigures blocks and parcels to improve pedestrian movement and accessibility given the City’s steep topography. The plan ensures amenities and green space are within walking distance of all dwellings and businesses, and fosters pedestrian, bicycle and transit connections to reduce automobile dependency. Our plan also proposes the construction of mixed-use and higher density development along existing corridors and within nodes. The Vision reinforces the City’s current design strategies to develop a mix of housing types, tenures and densities tailored to the unique character of the City’s neighbourhoods. Strategic placement of development supports transit infrastructure as well as the expansion of our City’s municipally-owned district energy system (Lonsdale Energy Corporation).

Green infrastructure including green roofs, gardens and active mobility pathways will connect our community, contribute to water quality and flood resiliency, conserve habitat and improve local food production. With substantial regional utility infrastructure located on the North Shore, our concept plan considers recovering biogas from an anticipated new wastewater treatment plant, hydroelectricity from existing drinking water reservoirs and wind, tidal and biomass potential.
Higher density, mixed land uses mean greater energy efficiency, access to goods and services, better transit, and less need for automobiles, reducing per capita energy by 60-70%.

Almost half of energy is supplied by “green” low-carbon, renewable sources, with emission factors close to 0. Much of this energy is generated within the City.

Reduced energy loads and clean energy sources for many uses reduces GHG emissions by the Provincial target of 80%.

Figure 17: In this exercise to define the problem, the reduction in energy consumption and conversion of energy sources required to meet the Provincial GHG emissions targets is determined at the scale of a local government. Shifts include both policy measures and urban form, such as higher density and mixed use patterns that reduce energy consumption in the left column, and new technologies that reduce the emissions factors of energy consumed as shown in the middle column. The product of these two factors yields community GHG emissions. The 2050 figure (above) demonstrating 80% reduction of the 2007 baseline (below). The 2107 figure (next page) demonstrates the achievement of net-zero GHG emissions (Technical Paper).
Results

The key results of our 100 Year Sustainability Vision are a set of implementable, low-carbon community design strategies that illustrate how the City can achieve the targets of reducing GHG emissions by 80% below 2007 levels by 2050 and achieving net zero carbon emissions by 2107. The Vision includes hand-generated sketches, diagrams and scenario plans that illustrate our chosen design strategies. In order to support further analysis, the final scenario was translated into digital maps illustrating the component development patterns, projecting energy demand per unit (both buildings and transportation) and describing potential GHG emission implications.

The innovative methodology of development pattern modeling and the integrated collaborative design process we used for the 100 Year Sustainability Vision provided participants with quick and accessible calculations of the energy and GHG impacts of various planning and design choices. This approach creates capacity by quickly measuring design choices against specific sustainability and GHG emissions reduction targets during an iterative and fast-paced design process—as opposed to only evaluating final project outcomes—providing invaluable, grounded knowledge to stakeholders and designers involved in decision making. This widely-accessible method to measure the urban form-GHG relationship makes the role of neighbourhoods in the reduction of GHG emissions more apparent to stakeholders and decision makers, enables analysis on the number of auto trips and transportation emissions directly generated by alternative design scenarios, and meaningfully informs policy making.

The modeling used to create our Vision demonstrates that the challenge of achieving an 80% reduction in GHG emissions by 2050 and a shift to net-zero GHG emissions by 2107 is achievable. Our GHG estimates indicate that the urban form decisions alone
have the potential to reduce total GHG emissions by as much as 30%. Furthermore, with the inclusion of appropriate technology—often made possible by changes in urban form—such as the expansion of the district energy system fueled by renewable energy sources, high efficiency new construction, and retrofits and low-carbon modes of transportation, our City has the potential to achieve net-zero GHG performance by 2107. The 100 Year Sustainability Vision informed and supported the direction of policies and actions identified in the subsequent Community Energy and Emissions Plan (CEEP), which will guide the City’s tangible activities to achieve carbon neutrality.

The decisions required to mitigate climate change at the regional and municipal level will necessarily involve land use and urban form. By addressing growth, infrastructure, transportation and building form, decisions at the local government level have significant impacts on GHG emissions. Addressing the existing gap between understanding urban form changes and the corresponding energy implications, the development pattern methodology provides participants with quick and accessible means to calculate the energy and emissions impacts of land use and design decisions.

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<tr>
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*Figure 19: Reductions realized through urban form alone versus with new building technologies (100 Year Vision)*
Implementation

In May 2009, Council endorsed the wide distribution of the 100 Year Sustainability Vision. Recognizing that climate action is required from all communities, sharing the ideas generated during this innovative process is important to us. Making the Vision publicly available supports the Province’s interest in highlighting sustainability measures that other local governments can apply as well as showcasing B.C.’s communities to the world. A City staff article presenting the City and District’s concept plans was featured in the March 2009 volume of Planning West. Further, the technical paper City of North Vancouver 100 Year Sustainability Vision: GHG Measurement and Mapping was prepared by UBC researchers for the Ministry of the Environment CEEI Working Group.

Sharing the results of the process demonstrates the substantial completion of the initiative. However, as a Vision for the next century, the concept plan will continue to shape the City for future generations. The principles articulated and strategies tested through the Vision informed the creation of the City’s Community Energy and Emissions Plan and the work underway to update the City’s Official Community Plan (OCP). By integrating social, environmental economic considerations directly into the previous 2002 OCP, the City was one of the first communities to embed sustainability principles in its OCP. The upcoming revision (OCP 2021 + Beyond) is focused on addressing energy and emissions even more comprehensively.

The OCP 2021 + Beyond will be a distinct and separate effort from the 100 Year Sustainability Vision. However, the City’s recent Vision for the future a century from now will necessarily influence—and improve—the OCP revision. Since most OCPs have a time horizon of two decades and are utilized for five to ten years before revision, this concept plan will help ensure that important, long-term strategies are reflected in the City’s official plan. The length of the 100 Year Sustainability Vision outlook is particularly appropriate given that the adopted 2050 Provincial GHG reduction target is outside of the range of most community plans.

Through its influence on the drafting of the OCP, the Vision will inform future City policies and plans for many years. This will have far reaching impacts, since the OCP serves not only as a land use planning guide, but as a comprehensive set of policies to enable a “vibrant, diverse and highly liveable community.” Recent GHG emissions inventories
indicate that community emissions continue to rise. The Vision demonstrates that, although our efforts must be substantial, a serious and durable commitment to emissions reduction can achieve net zero carbon emissions.

**Barriers & Breakthroughs**

Community interest in a long-term Vision and commitment by staff and Council were central to the project’s development. Accessing funds for a project that was not anticipated in the prior budgetary process was a significant challenge. However, the project was deemed to be a key opportunity and a priority during the City’s Centennial; the creation of a long-range Vision would have a lasting influence for the community. The project’s $160,000 cost was covered in part with funds received as a financial award accompanying the Province’s inaugural 2007 Green City Award, and in part from additional funding approved by Council.

![Figure 21: This adaptation of the BC Hydro energy hierarchy illustrates that most strategies are appropriate at the local government or regional scale, rather than building, scale (100 Year Vision)](image)

Local governments face many limitations in planning for GHG emissions reductions; the project had to account for the fact that GHG emissions within the City are often influenced by decisions made outside the City. Geographic limitations were partially overcome by working in cooperation with neighbouring jurisdictions and including regional stakeholders. The project also explored regional transit options to address the issue of commuter-related GHG emissions.

Time constraints are always a factor. Additional public consultation on the final draft document would have provided additional perspectives by extending input opportunities beyond those included in the initial stakeholder and charrette process.

Key breakthroughs of the 100 Year Sustainability Vision was increased awareness to issues of climate change within our municipal organization and our ability to demonstrate that a tripling of the population in the City is possible through a variety of forms of housing not limited to high-rise construction. A further breakthrough was the utilization of
the century-long horizon for the process. Planning for 2107, instead of the typical five, ten or twenty year horizon common to most planning initiatives, provided the opportunity to consider ideas with benefits that may only be realized over decades and have a potential to create meaningful change. The 100 Year Sustainability Vision has provided the long-term goal of carbon neutrality for the City’s recently completed CEEP and related OCP amendment targets. The Vision is also an important background document that will shape the OCP 2021 + Beyond update process currently underway. The Vision describes our desired future for the City based on a net zero carbon community.

**Engagement and Governance**

The project was led by the UBC Design Centre for Sustainability (DCS) with the support of City staff. The DCS is an applied collaborative-research organization featuring project teams that include faculty, students and research staff. With the sources of and solutions to reducing GHG emissions not confined by jurisdictional boundaries, the City sought a cooperative approach with its neighbours. As a result, the District of North Vancouver embarked on a complementary process focused on two areas proximate to City boundaries, and representatives from the Squamish First Nation also contributed to the Vision. This collective process created many more opportunities than would have otherwise been available to each government alone.

Key community stakeholders and government agencies were engaged throughout the process and during the charrette. These included BC Hydro, TransLink, Terasen, local business and community groups, advisory body members and school district representatives. A series of Workshops were held with key staff and stakeholders to develop the goals and objectives of the project, as well as key guiding principles. A broader stakeholder group was tasked with developing specific design strategies for achieving GHG emission reductions and completing an analysis of the 2107 scenario.
Conclusion

The widespread recognition of sustainability as a core planning principle, and an increasing sophistication in its application at the local government level, has had dramatic effects in B.C.’s communities. The Province’s leading efforts to reduce GHG emissions through legislation and policy has supported this shift from business as usual. With all local governments now required to address GHG emissions, the City’s decision to undertake our sustainability-centred, extensive and long-range sustainability vision may benefit other communities’ efforts to address climate change as well.

The modeling used to create our 100 Year Sustainability Vision enabled us to provide meaningful, flexible and efficient feedback during an iterative design process. This methodology also created a foundation upon which we could build a long-term Vision that has already informed—and will continue to inform—planning efforts in the City.

Our City’s Centennial highlighted that many of our contemporary successes are due to prudent and ambitious decision made during the City’s inaugural years. Over a century ago, civic leaders envisioned an urban centre that far exceeded the realities of that era. The City’s growth since its birth has created many opportunities, and our community now looks towards accommodating a tripling of the population while becoming carbon neutral by our 200th birthday.

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Online Resources:

City of North Vancouver webpage:
http://www.cnv.org/100yearvision

100 Year Sustainability Vision document:
http://www.cnv.org/c/data/3/541/100%20year%20sustainability%20vision.pdf

GHG Measurement and Mapping technical paper:
http://www.env.gov.bc.ca/cas/pdfs/ceei-nvan.pdf

elementsLAB case study database
http://elementsdb.sala.ubc.ca