Community Energy Association | **Build to Zero**





Modelling High-Impact Local Government Measures to Reduce Energy Use and GHG Emissions For New and Existing Buildings in BC's Lower Mainland

July, 2010

FINAL REPORT

Prepared by the Community Energy Association

Community Energy Association

Acknowledgements

Build to Zero, a project of the Community Energy Association, aims to accelerate local government adoption of policy, planning and regulatory measures to reduce greenhouse gas emissions from new and existing buildings, community-wide. The current initiative is being piloted in the Lower Mainland of British Columbia.

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Executive Summary

This study supports ongoing research by Natural Resources Canada's CanmetENERGY group as well as the Community Energy Association's (CEA) ***Build to Zero*** program. CanmetENERGY is Canada's research centre for scientific expertise on clean energy technologies.

This study is an essential element in the 15-month ***Build to Zero*** initiative that is designed to help local governments in BC's Lower Mainland prepare selected policies and strategies to a near-state-of-readiness for implementation. ***Build to Zero*** supports local governments in British Columbia's Lower Mainland, through a regional and sub-regional approach, to mitigate climate change by implementing high-impact bylaws and policies that encourage the creation of low-energy buildings. This initiative encompasses both new and existing buildings. While this initiative is envisioned as potentially being replicated in other regions of BC, its initial phase focuses on 34 local governments within the Lower Mainland.

Build to Zero has the following objectives:

- Increase local government capacity to develop and implement municipal bylaws, policies and practices that promote energy efficiency and renewable energy in new and existing buildings.
- Set the framework for a collaborative approach to encourage low-emission buildings throughout the Lower Mainland of British Columbia (31 municipalities and three regional districts).
- Support local governments in overcoming existing barriers to action on high-performance buildings.

This study deals primarily with the potential impact of key **policy measures** available to BC local governments. However, **technical** approaches, such as emissions inventories and modelling, are required to provide important feedback to the local government workings groups as they seek to understand the potential impact of various ***Build to Zero*** actions. As such, Section 4 of this report provides detail on proposed GHG emission reduction modelling approaches for four high-potential measures. These measures are deemed suitable for modelling GHG emission reductions based upon strong local government interest as well as the potential to make a difference over a short period of time. For each of these measures, a methodology for estimating the magnitude of GHG emission reductions has been proposed.

Existing Buildings - Financial Incentives and Program Funding

1. Explore use of energy retrofit financing mechanisms such as local improvement charges and service area bylaws to foster retrofits in single family dwellings and to foster district energy at the neighbourhood scale.
2. Identify and promote retrofit financing mechanisms for Multi-Unit Residential Buildings (MURBs).

New Buildings – Improved Regulatory Approaches

3. Improve enforcement of the BC Building Code by ensuring that existing energy related standards within the building code are achieved.
4. Working with the Province of BC, develop model bylaws requiring solar ready and district energy ready homes.

A methodology for estimating the magnitude of GHG emission reductions possible from each of these measures has been proposed, and a thorough review of existing modelling tools in BC is provided. Models reviewed in this report include:

Name of Modelling Tool (if any)	Proponent
No formal name	HB Lanarc (HBL)
CIMS and GEEM	MK Jaccard and Associates (MKJA)
SCEC[3] (Spatial Community, Energy, Carbon and Cost Characterization Model)	Natural Resources Canada
SHIFT Accelerator	SHIFT was developed through a collaborative effort [1]
CE2 (Community Energy and Emissions model)	Stantec (formerly the Sheltair Group)
No formal name	Sustainability Solutions Group (SSG)
No formal name	University of British Columbia (UBC)

[1] This included representatives from a variety of BC organizations and independent professionals with an interest in energy sustainability and climate action.

1. Introduction

The purpose of this report is to provide background investigation that supports local government working groups in BC's Lower Mainland as they assess, prioritize, collaborate on, and implement selected building energy efficiency and GHG emission reduction strategies attributable to buildings. This research is an essential element in the 15-month ***Build to Zero*** initiative that is designed to help local governments in BC's Lower Mainland prepare selected policies and strategies to a near-state-of-readiness for local government implementation.

This report incorporates findings from the **Local Government Survey** and **White Paper** (drafts completed during the first phase of research for ***Build to Zero***), workshop discussion provided by participants at the December 9, 2009 ***Build to Zero*** **Workshop** in Vancouver, as well as additional input provided by local governments in early 2010. Priority measures have already been identified, and beginning in April 2010, they will be reviewed by the local government working groups.

This study deals primarily with the potential offered by **policy tools** used by local governments. However, **technical** approaches, such as emissions inventories and modelling may be required to provide important feedback to the local government workings groups as they seek to understand the potential impact of various ***Build to Zero*** actions.

The following high priority measures were selected based upon strong local government interest as well as their potential to make a difference over a short period of time. For each of these measures, a methodology for estimating the magnitude of GHG emission reductions has been proposed.

Existing Buildings - Financial Incentives and Program Funding

1. Explore the use of energy retrofit financing mechanisms such as local improvement charges and service area bylaws to foster retrofits in single family dwellings and to foster district energy at the neighbourhood scale
2. Identify and promote retrofit financing mechanisms for Multi-Unit Residential Buildings (MURBs)

New Buildings – Improved Regulatory Approaches

3. Improve enforcement of BC Building Code by ensuring that existing energy-related standards within the Code are achieved

4. Working with the Province of BC, develop 'model' (sample) bylaws requiring solar-ready and district energy-ready homes

Build to Zero Program

Build to Zero supports local governments in British Columbia's Lower Mainland, through a regional and sub-regional approach, to mitigate climate change by implementing high-impact bylaws and policies that encourage the creation of low-energy buildings. This initiative encompasses both new and existing buildings. While ***Build to Zero*** is envisioned as potentially being replicated in other regions of BC, its initial phase focuses on 34 local governments, including municipalities and Regional Districts, within the Lower Mainland (shown in the table below). The University of British Columbia, which forms part of Metro Vancouver's Electoral Area "A", is included in this list. Metro Vancouver is the civic planning authority for those parts of Electoral Area 'A' not administered by the provincial government. UBC's Official Community Plan, developed by Metro Vancouver in partnership with UBC, sets objectives for land use and transportation, particularly in relation to non-institutional development. University development, in accordance with the provisions of the *Universities Act,* is the purview of UBC.

Metro Vancouver RD	City of Surrey
Village of Anmore	City of Vancouver
Village of Belcarra	District of West Vancouver
Bowen Island Municipality	City of White Rock
City of Burnaby	University of British Columbia
City of Coquitlam	
Corporation of Delta	**Fraser Valley RD**
City of Langley	City of Abbotsford
Township of Langley	City of Chilliwack
Village of Lions Bay	Village of Harrison Hot Springs
District of Maple Ridge	District of Hope
City of New Westminster	District of Kent
City of North Vancouver	District of Mission
District of North Vancouver	
District of Pitt Meadows	**Squamish-Lillooet RD**
City of Port Coquitlam	Village of Pemberton
City of Port Moody	District of Squamish
City of Richmond	Resort Municipality of Whistler

For purposes of this report, the term “local government” includes both municipalities and regional districts in BC. “Municipalities” can be cities, towns, villages or municipal districts whereas regional districts, particularly in urbanized areas, typically include more than one municipality. Often regional districts provide services that are more efficiently shared between adjacent municipalities, such as water treatment and delivery services as well as management of liquid and solid waste.

Build to Zero has the following objectives:

- Build local government capacity to develop and implement bylaws, policies and practices that promote energy efficiency and renewable energy in new and existing buildings.
- Set the framework for a collaborative approach to encourage low-emission buildings throughout the Lower Mainland of British Columbia (in terms of geographic scope, the Lower Mainland includes 31 municipalities and three regional districts).
- Support local governments in overcoming existing barriers to action on high-performance buildings.

While some local governments in this region have made significant progress in encouraging high-performance buildings through green building bylaws and policies at the local level, widespread adoption has not been achieved. As such, there is a need to share innovative approaches and collaborate regionally to provide a supportive environment for accelerated deployment of energy-efficient, low-emission buildings. Some local governments find it difficult to move alone, fearful that development will move to the next municipality. Others do not have adequate staff resources to undertake a project of this scale by themselves. By approaching this challenge by cooperation at a regional or sub-regional level, this barrier can be reduced or eliminated.

Developers and homebuilders have indicated frustration at time lost due to varying development and permitting rules between municipalities. Both the development and regulatory community will benefit from a regionally consistent and supportive approach to emissions reductions in new construction and building retrofits. Policies do not have to be consistent region-wide, but it would be advantageous to have harmonious approaches within sub-regions of similar municipalities (i.e. to make the development ‘playing-field’ more consistent within various parts of the Lower Mainland).

Municipal governments have indicated that barriers to action include insufficient time to research best practices and policy mechanisms that would encourage or require enhanced energy efficiency and renewable energy in buildings. ***Build to Zero*** intends to provide local councils and staff with information necessary to make informed decisions to begin the acceleration toward energy efficient, low-emission buildings.

Background Research

According to BC's *Community Energy & Greenhouse Gas Emissions Inventory* (CEEI), the proportion of GHG emissions from buildings in the Lower Mainland varies quite widely, depending primarily upon the proportion of urban and rural land within the municipality. Buildings tend to account for a higher proportion of emissions in urbanized areas. Within the Lower Mainland, buildings typically account for between 30 and 50 percent of GHG emissions, and thus present a significant emissions reduction opportunity.

Cascadia Region Green Building Council presented preliminary results of a 'White Paper' focusing on key enabling strategies to reduce GHG emissions from new and existing buildings within the Lower Mainland. The draft White Paper provided:

- An overview and summary evaluation of relevant municipal policy, regulatory and financial tools to reduce carbon emissions from buildings in place elsewhere in Canada and the United States.
- Based upon existing research, an identification of high-potential measures.
- Conceptual policy/regulatory/incentive approaches to reduce GHG emissions from buildings in the Lower Mainland.

The final White Paper report is expected to be complete at the end of June 2010. It will be posted on CEA's website at: http://www.communityenergy.bc.ca/community-energy-association-connecting-community-sustainability-and-energy/build-to-zero

To support the development of the White Paper and the ***Build to Zero*** workshop and program, CEA surveyed each of the 34 local governments within the Squamish-Lillooet, Fraser Valley, and Metro Vancouver regional districts. The purpose of this survey was to identify the various approaches being taken by local governments to reduce greenhouse gas emissions from new and existing private buildings within their communities. Note: This survey did not include initiatives related to the local government-owned building stock. A presentation summarizing key results from this survey was delivered at the December 9th workshop, along with a draft copy of the survey. A final version of the local government survey report is expected to be complete in May, 2010. It will be posted on CEA's website at: http://www.communityenergy.bc.ca/community-energy-association-connecting-community-sustainability-and-energy/build-to-zero

With the exception of the City of Vancouver, which has its own charter, all local governments operate primarily within the limitations of two statutes: the *Local Government Act* and the *Community Charter*. In 2008, these two statutes were amended by the *Local Government (Green Communities) Statutes Amendment Act* (also known as Bill 27). Bill 27 requires local governments to include greenhouse gas emission reduction targets in their Official Community Plans (OCPs) by May 31, 2010, and within Regional Growth Strategies (RGSs) by May 31, 2011, along with policies and actions proposed for achieving those targets. This legislation enables local governments to encourage development that will reduce greenhouse gas emissions.

The powers of local government with respect to buildings (with the exception of the City of Vancouver) are restricted by Section 9 of the *Community Charter*, which defines a number of spheres of 'concurrent authority,' including 'buildings and other structures.' In areas of concurrent authority, local governments cannot make requirements that differ from provincial regulations covering the same topic, without specific provincial approval to do so. This means that local governments (with the exception of the City of Vancouver) cannot require either new or existing buildings to differ from the BC Building Code and cannot regulate in areas where the BC Building Code could potentially regulate.

Preliminary survey results indicate that some policies are being used much more than others. Most local government in the Lower Mainland have a policy framework in place to support energy efficiency in buildings. Many have also created policies that are supportive of district energy and renewable energy. Other measures, like the use of Development Permit Area (DPA) guidelines, expedited approvals, density bonusing, tax exemptions, and innovative financing are being used less frequently. According to the survey, three other measures – development cost charges (DCC) reductions, local improvement charges, and building labelling – are not being used at all in the Lower Mainland for purposes of improving building energy efficiency or lowering emissions. Most local governments are using less than five of the possible tools and half are using less than two.

A number of the underused policy measures have financial implications (DCC reductions, tax exemption bylaws, fee rebates) which suggest that there is an opportunity for additional research that identifies financial implications of these tools for local governments.

Preliminary conclusions:

- Many of the available tools are underused. Further research is needed to understand why and what could be done about it.
- If the available tools are not truly highly effective at emissions reductions measures, would they work better if all local governments (or at least a significant group of local governments) were to use them in the same way?

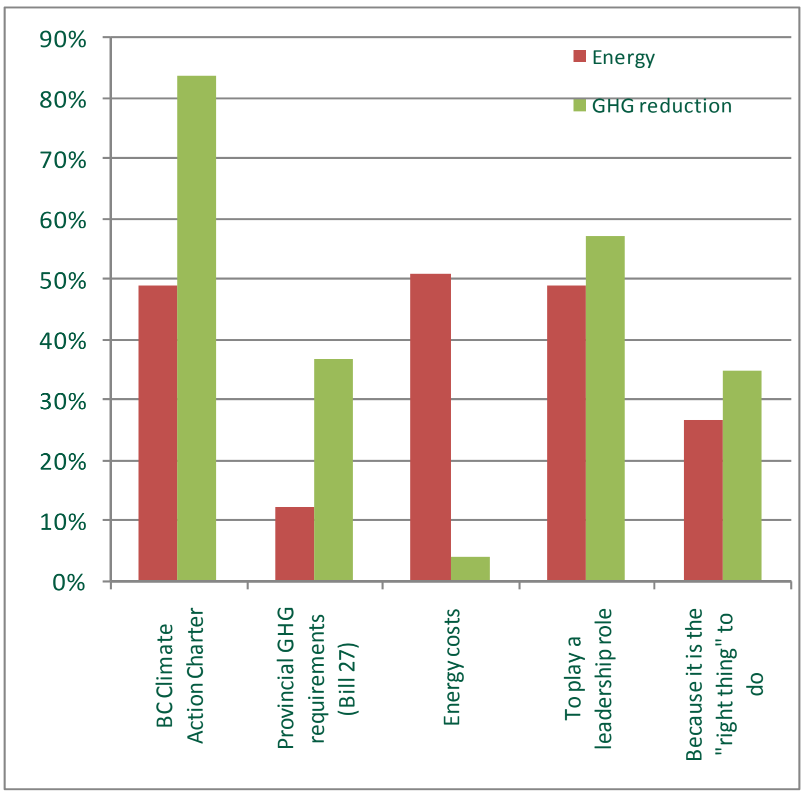
2. Context – BC Legislation and Local Government Action

BC Local Governments – Role and Motivation

Local governments have a critical role in reducing community-wide greenhouse gas (GHG) emissions. Residential, commercial and institutional buildings account for about 10% of Canada's GHG emissions.[2] Local governments design their communities, and through various policy mechanisms, shape emissions profiles of buildings throughout their communities and in their own facilities. In 2008, the Community Energy Association surveyed BC local governments to identify, among other things, their motivations for taking action on energy innovation and greenhouse gas reductions.

As the adjacent graph, from the *BC Local Government Energy Survey* (2008) illustrates, top drivers for action on **building energy efficiency** are:

- Rising energy costs over the long term;
- the BC Climate Action Charter; and,
- a desire to play a leadership role.



Top drivers for GHG action on **GHG emission reductions** are:

- the BC Climate Action Charter;
- a desire to play a leadership role; and,
- new provincial legislative requirements.

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[2] According to Canada's 2008 Greenhouse Gas Inventory: Summary of Trends http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=F1CA74A6-1

Results of the survey can be found at: http://www.communityenergy.bc.ca/resources-introduction/2008-energy-survey-report

In 2007, the Province of British Columbia set targets for provincial GHG emissions cuts of 33% by 2020 and 80% by 2050, relative to 2007 levels, and set interim targets for 2012 and 2015. The 2008 BC Climate Action Plan set out a strategy to achieve provincial targets, and an array of policy mechanisms for BC local governments to encourage energy efficiency, GHG reductions, and alternative energy - within their corporate operations and in the broader community.

The Province committed to becoming carbon neutral in its own operations by 2010 and encouraged local governments to share a similar commitment by signing and implementing the voluntary Climate Action Charter. Signatory local governments agree to develop strategies and take action to achieve the following goals:

- Becoming carbon neutral in respect of their operations by 2012 (solid waste facilities regulated under the Environmental Management Act are not included in 'operations' for the purposes of the Charter);
- Measuring and reporting on their community's greenhouse gas emissions profile; and
- Creating complete, compact, more energy-efficient rural and urban communities. For example, fostering a built environment that supports a reduction in car dependency and energy use, establishing policies and processes that support fast tracking of green development projects, or adopting zoning practices that encourage land use patterns that increase density and reduce sprawl.

As of January 20, 2010, 177 local governments in BC (plus the Islands Trust) have signed the Charter. Implementation of the Charter is being supported by a "Green Communities Committee" established by the Province and Union of British Columbia Municipalities (UBCM).

In British Columbia, buildings are regulated under the BC Building Code, which is administered by the Ministry of Housing and Social Development. In 2008, the Province "greened" the building code by incorporating energy and water conservation requirements. These new code provisions require small residential buildings to meet a standard of EnerGuide 77 or equivalent, while large commercial, institutional and high-rise residential buildings must meet the ASHRAE 90.1 (2004) standard.

The *BC Energy Efficient Buildings Strategy: More Action, Less Energy*, released in May 2008, encourages energy efficiency improvements to communities, homes and businesses and establishes the following energy efficiency targets:

- Reduce average energy demand per home by 20 percent by 2020;
- Complete energy conservation plans for all BC communities;
- Reduce the energy demand of commercial and institutional buildings by 9 percent per square metre by 2020;
- Make public sector buildings carbon neutral by 2010.

This strategy included funding to support the **Live*Smart* BC** building energy efficiency incentive program, which provides grants to homes and businesses. Funding for this program was reinstated in the most recent Provincial budget announcement on March 2, 2010. More information on this strategy can be found at: www.energyplan.gov.bc.ca/efficiency/

Energy Management and Local Government Policy

In British Columbia, local governments are considered creatures of the Province, meaning all planning and administrative actions are enabled by provincial legislation. With the exception of the City of Vancouver[3], all local governments operate primarily within the limitations of two statutes: the Local Government Act and the Community Charter. The Local Government Act provides local governments with the powers they require to fulfill their purposes and respond to the different needs and changing circumstances of their communities. The Community Charter, a companion statute to the Local Government Act, establishes a core of enabling provisions to local governments. In 2008, the Province passed legislation that amended these two statutes through the Local Government (Green Communities) Statutes Amendment Act or Bill 27. This legislation requires local governments to include greenhouse gas (GHG) emission reduction targets in their Official Community Plans by May 31, 2010 and Regional Growth Strategies (RGSs) by May 31, 2011, along with policies and actions proposed for achieving those targets. The table below compares various aspects of Provincial policy with regard to climate action (Bill 10, Bill 27 and voluntary Local Government Climate Action Charter).

[3] The City of Vancouver operates under its own unique enabling legislation known as the Vancouver Charter.

	Greenhouse Gas Reduction Targets Act	Targets, Policies and Actions (Bill 27)	Climate Action Charter
Purpose	Legal requirement for provincial ministries, schools, hospitals, universities, colleges and crown corporations to be carbon neutral by 2010	Legal requirement for communities to establish targets and develop policies and actions to reduce GHG emissions	Identify the shared commitment that local governments have in addressing climate change
Legislation	Yes	Yes	No
Voluntary	No	No	Yes
GHG reductions targeted	Requires **Province-wide** greenhouse gas reduction from 2007 levels: 6% by 2012, 18% by 2016, 33% by 2020, 80% by 2050	Reduce **community-wide emissions** through smart planning and by creating compact communities	Reduce emissions from **corporate operations** and commit to carbon neutral operations
Activities	None for local governments Province of BC: develop carbon neutral plan, implement energy efficiency, pay Pacific Carbon Trust $25 per Tonne to offset remaining emissions	Local governments set targets in Official Community Plans (OCP) or Regional Growth Strategies (RGS); and define actions to meet those emission targets	Local governments measure and report corporate emissions, and become carbon neutral in operations
Dates to meet	None for local governments Province of BC: must report GHG emissions regularly	OCP's May 31, 2010 RGSs May 31, 2011	2012
Funding Attached	No	No	Signatories receive Carbon Tax rebate (CARIP grants).

As noted earlier, provincial legislation defines the powers of local government with respect to buildings. These powers are in part restricted by Section 9 of the Community Charter, which defines a number of spheres of 'concurrent authority,' including 'buildings and other structures.' In areas of concurrent authority, local governments cannot make requirements that differ from provincial regulations covering the same topic, without specific provincial approval to do so. That means local governments cannot directly require buildings to differ from the BC Building Code.

The next section describes planning frameworks and policy mechanisms through which it is possible to encourage energy efficiency, greenhouse gas emission reductions and the use of alternative energy in buildings and developments.

Policy and Planning Frameworks

This section describes both planning policy and organizing frameworks that are helpful to local governments seeking to reduce energy end-use and associated GHG emissions.

Canadian Institute of Planners (CIP) policy on Climate Change

As the professional body representing planners across Canada, CIP has recognized that the role of planners is vital in helping Canada meet the challenges of climate change. In launching this policy, CIP is breaking new ground. In the past, CIP has focused its policy activity on reacting to government initiatives rather than creating new policy. However, given that climate change affects every dimension of the planning profession and adds considerable uncertainty to the planning process, CIP maintains that all sectors of society must work together and that planners can play a significant role. CIP's climate change policy draws from the fifth core principle established in the institute's Strategic Plan. This principle commits CIP to "reduce the rate of climate change, mitigate its effects, and plan for adaptation."

To achieve the expressed goal of acknowledging their "...share of responsibility to future generations for custodianship of this planet and its habitats," the Canadian Institute of Planners' Policy on Climate Change aims to empower its members to tackle the effects of climate change. To achieve this goal, CIP has set the following objectives:

- To increase planners' capacity to mitigate and adapt to climate change locally, nationally, and internationally,
- To increase planners' knowledge about climate change, mitigation techniques, and adaptation strategies,

- To raise awareness of the links between planning and climate change among its members, the general public, other professionals, and our international colleagues, and
- To build networks of professionals to support collaborative solutions for meeting the challenges of climate change.

Detailed policy directives to achieve these objectives are located in Appendix B.

Quality Urban Energy Systems of Tomorrow (QUEST)

QUEST is a national collaborative network of representatives from industry, environmental groups, governments, academia and consulting communities working together to make Canada a world leader in urban integrated energy systems. This network has developed the following principles to guide future development:

- Encouraging **mixed-use higher density** urban development
- Reducing the **energy input** required for a given level of service
- **Matching** the type of energy with its use
- Managing **surplus heat** across applications and sectors
- Converting **waste to energy**
- Integrating **on-site renewable** sources of energy
- Optimizing use of grid energy and as a resource to **optimize the overall system** and ensure reliability.

These principles provide a national framework for evaluation of policies and development projects.

The Four R's of Sustainable Community Energy Planning

Another useful planning framework to guide local government planning and priorities, is the pyramid of planning priorities developed by **BC Hydro**. This pyramid suggests that the first step for action is to reduce energy demand through community design, green / high-performance buildings and improved energy efficiency in

Suggested steps in energy planning.
Concept source: Robyn Wark and Jorge Marques, BC Hydro

buildings. Next, waste heat can be recovered, and renewable heat sources developed. And, as a final priority, renewable electricity sources can be developed. This framework, together with the QUEST principles above, suggests steps for consideration, and criteria for evaluation, of potential policy measures for action which follow.

Policy & Financing Mechanisms

A fairly broad suite of measures are available to help BC local governments encourage or require energy efficiency in **new buildings**. Fewer policy measures (instruments) are available to support retrofit of **existing buildings**. Several of the measures described below are also helpful for requiring or supporting district energy or renewable energy systems. The use of these measures by local governments can be supported and encouraged by modelling techniques that will allow the potential impact of the measure to be evaluated.

1. The following six policy measures are especially applicable to the initiatives proposed in Section 4 of this report: Estimating GHG emission reductions from Build to Zero actions by local governments:

a. Supportive policies within the Official Community Plan (OCP)

Bill 27, passed by the Province in 2008, requires local governments to include greenhouse gas (GHG) emission reduction targets in their Official Community Plans by May 31, 2010 and Regional Growth Strategies (RGSs) by May 31, 2011, along with policies and actions proposed for achieving those targets. Supportive objectives and policies within OCPs provide important foundational elements to encourage the development of energy and heating systems or utilities in the community. They also raise awareness about the role for local government staff and developers in promoting these policies. Inclusion of such supportive policies in an OCP puts them on the agenda, and provides staff with an explicit mandate to explore energy opportunities in the community.

Since an Official Community Plan provides policy guidance for a community over a five to ten year period, it is appropriate to include comprehensive language on energy management, thus providing a context for both immediate and future decisions. In addition, policies and actions taken on the City's own operations can demonstrate leadership, further justifying community-wide initiatives.

Supportive policies within an OCP are a necessary basis for all further community action on reducing energy use and GHG emissions. Policies can be prepared to support energy efficiency and district or renewable energy for both new and existing buildings.

Excerpts from two Lower Mainland Local Government OCPs:

i. District of West Vancouver Official Community Plan (2004)

Policy BF-A 1 Promote superior environmental design in new development.

- *Encourage high performance building design for major new construction to minimize the use of energy, water and materials in construction and operation of buildings.*
- *Promote the use of passive energy, environmentally friendly materials, storm water management and construction practices that minimize impacts on the natural environment.*
- *Consider incentives for superior environmental designs such as density bonuses to offset increased construction costs.*

ii. Whistler Built Environment and Energy Strategies

In 2020, Whistler's built environment is vibrant, reflects the community's character, contributes to individual health and wellbeing, and is moving toward its identified sustainability objectives. By this time:

- *Building design, construction and operation is characterized by efficiency, durability and flexibility for changing and long-term uses*
- *The new and renovated built environment has transitioned towards sustainable management of energy and materials*
- *Building ownership is structured to continually encourage transition toward a flexible and improved built environment over time....*

In 2020, Whistler's energy system is reliable, flexible and moving toward our sustainability objectives. By this time:

- *Whistler's energy system is supplied by a mix of sources that are local and regional wherever possible*
- *The energy system is continuously moving towards a state whereby a build up of emissions and waste into air, land and water is eliminated*
- *Whistler's energy system is transitioning to renewable energy sources*
- *Residents, businesses and visitors understand energy issues....*

b. Bylaws requiring new buildings to be ready for future energy upgrades

In recent years, federal and provincial governments, including interested local governments, have explored the possibility of creating bylaws that require buildings to be constructed so that they may readily be adapted to future renewable energy systems. Alternatives are:

- **Solar Ready Bylaws** – requiring buildings to include infrastructure to support solar hot water heating equipment

- **District Energy Ready Bylaws** – requiring buildings to include infrastructure to support connections to future district energy systems
- **Net Zero Ready Bylaws** – requiring buildings to achieve high levels of thermal efficiency and include infrastructure to support either stand alone or district renewable energy systems such that the building may produce its own energy and achieve a 'net zero' effect.

Significant progress has been made towards the development of solar ready bylaws. As noted previously, with the exception of the City of Vancouver, BC local governments may not create regulations pertaining to building construction – this power remains with the Province through the BC Building Code. However, the Province of BC Energy Mines and Resources, Building Standards Branch, is developing an alternative stream for local governments who wish to require solar water heating. (A local government may choose to require traditional water heating requirements in their implementation of the building code or may opt to require solar water heating as well.) The Province expects to have completed this work by early in 2011. Examples of language for a solar water heating bylaw are contained in Appendix C.

The City of Vancouver, under powers provided by their unique Charter, is exploring the development of a district energy ready bylaw. This work is in its early stages.

c. Local Service Area bylaws

The *Community Charter* authorizes local governments to create a local area service, enabling them to provide and charge for any service that Council considers necessary or desirable, either directly or through another public authority, person or organization. Consequently, local governments are able to provide local energy services, such as heating via a district energy system or through solar hot water systems for individual buildings, and charge for their use. A service area bylaw can be used to establish service areas for particular types of energy services (e.g. a hydronic district energy system) and to require buildings within the service area to connect to the energy source. A service area could encompass part or all of each of the City's areas.

This approach was used by the Lonsdale Energy Corporation (LEC) in the City of North Vancouver. The City established a Hydronic Heat Energy Service Bylaw to create a district heating service area for Lower Lonsdale, with a requirement that all new or retrofitted buildings greater than 10,000 square feet be connected to and use the system. This bylaw requires developers in the district to provide infrastructure to connect to the system, avoiding the construction of baseboard heating in the district. The Lonsdale Corporation requires that developers post a performance bond to ensure compliance with the bylaw. This bond is normally around $50,000, but can increase to $100,000 if LEC anticipates that the project will require a high level of involvement from LEC staff and contractors.

The Lonsdale Energy Corporation focused their educational efforts on developers and engineers active in the Lonsdale Quarter.[4] Most of LEC's efforts were focused on facilitating project design and engineering to accommodate the systems necessary to connect to the district heating system. The required level of developer and engineer education needed varies greatly. For the City, the process of undertaking an energy plan led to identifying sites within the municipality that would have a high demand for heating, as well as a mix of building types. The process contributed to the City acknowledging a need for contractual obligations with builders purchasing City-owned land to connect to district energy. As part of the rezoning process for development on City-owned lands, connection to the LEC is required and is treated like other municipal infrastructure requests, such as provisions for sidewalks, roads, sewer connections, and stormwater management. Before any development proceeds, every builder must sign a heat service contract. Because of this agreement, every customer pays the same rate for heating.[5]

A local service area bylaw can be used to support a district-energy-ready initiative after the construction of a district energy system is complete.

d. Local Improvement Charges

Municipalities have traditionally used local improvement charges (LICs) to help cover the costs of infrastructure investments that benefit a specific neighbourhood - for example the construction of residential sidewalks or grants to support business improvement areas.

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[4] Geographically, the area serviced by LEC encompasses both Lower Lonsdale and Upper Lonsdale neighbourhoods on either side of Lonsdale Avenue.

[5] Seattle New Building Energy Efficiency Policy Analysis (EDAW, Inc.) - Vancouver District Heating Program Case Study Latest revision: 11/4/08

Landowners who benefit from improvements are assessed a charge that is added to their property taxes each year until their share of the improvements has been paid for. The possibility of using LICs to fund energy efficiency and renewable energy improvements within privately owned buildings is a potential new application of this policy measure that is supported by widespread interest in reducing greenhouse gas emissions.

In BC, the *Community Charter* outlines these powers under Part 7 – Municipal Revenue - Division Five, entitled *Local Service Taxes*:

> *Authority for local area services*
>
> *210 (1) A local area service is a municipal service that is to be paid for in whole or in part by a local service tax under section 216 [local service taxes].*
>
> *(2) The only services that may be provided as local area services are*
>
> *(a) services that the council considers provide particular benefit to part of the municipality, and*
>
> *(b) business improvement area services under section 215 [business improvement areas].*
>
> *(3) Nothing in this Division restricts a municipality from recovering part of the costs of a local area service by means of any other source of municipal revenue.*

There are two key differences between the traditional use of local area service taxes and their potential application to encourage renewable energy or energy efficiency upgrades in privately owned residences:

- This kind of upgrade is entirely contained on the resident's private property and does not directly benefit other residents; and,
- Once paid for, upgrades are fully owned by the resident – they are not municipal property.

However, if LIC financing could be used, permanent comprehensive improvements with long paybacks (e.g. high-efficiency windows; wall upgrades; heating, ventilation and air-conditioning [HVAC] systems; and control systems) would be more attractive to home and building owners because both their costs and benefits are passed on to new owners if the property is sold before the investments are paid off.

Several studies completed by the Pembina Institute have found that the mechanism for establishing and collecting local service area taxes can be adapted to finance improvements in residential and/or commercial building energy efficiency. A study prepared by the Pembina Institute in 2004 for BC Hydro and Climate Change Central[6] reviewed how the concept could be implemented in BC and proposed a "model" program for municipalities to design and implement an energy efficiency or renewable energy LIC program. This work was followed by a comprehensive study, funded by The Office of Energy Efficiency of Natural Resources Canada, to explore applicability of the concept across Canada.[7] More recently, Pembina has worked with the City of Dawson Creek to further develop the concept.

Most interested parties agree that the *Community Charter* neither supports nor prohibits the use of local service taxes for upgrades located on private property. However, some BC local governments are interested in finding ways to use this tool for this purpose for two reasons:

- Privately owned single family dwellings account for a large portion of the existing building stock, and opportunities to directly influence energy efficiency and renewable energy upgrades in this residential sub-sector are limited; and,
- This tool has the potential to significantly reduce greenhouse gas emissions within communities, helping to meet community-wide GHG emission reduction targets and, consequently, providing a benefit to the entire community.

The Vancouver Charter regulates LICs in a less restrictive manner. There is no specific requirement for the City of Vancouver to pay maintenance costs for LIC improvements. Based on the Charter, Vancouver appears to have sufficient powers to expand its use of LICs to include energy efficiency improvements; however, similar to other jurisdictions interested in an application of LICs, Vancouver is actively exploring financial considerations associated with loan risks and guarantees, as well as other key financial matters.

The development of a modelling technique to estimate the potential impact of such a tool will support further work in this area.

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[6] *Using Local Improvement Charges to Finance Building Energy Efficiency Improvements: A Concept Report*, located at http://re.pembina.org/pub/170
[7] http://www.pembina.org/pub/197

e. Public Endowed Funds

A public endowed fund is a fixed amount set aside by a local government to provide loans for development that combats global climate change and improves air quality.[8] The Toronto Atmospheric Fund is an example of this approach. Under this program, loans are advanced to developers interested in building local solar generation capacity or improving energy efficiency in high-rise buildings. Another program, called *TowerWise*, is focussed on improving the energy efficiency of Toronto's high-rise condominium and rental buildings through 'green condo' loans for new buildings and retrofit loans for existing buildings. Developers secure the loan during construction and unit owners pay the loan back through utility savings. Neither the developer nor the owner incurs extra costs. The City of Toronto is now working on a loan guarantee model.

RETScreen and other whole-building energy models would be appropriate to help calculate the impact of this measure.

f. Public loan guarantee concept

A public loan guarantee option operates in conjunction with bank lending. It is also called 'First Loss' fund. A pool of capital is created and held by a public body but it is not used to provide loans. Instead, the fund is used as a guarantee for a private lending institution, and is only accessed if there is a default on the loan, in which case the lender is reimbursed by the fund. This approach helps offset the risk of a conventional lender and encourages them to consider this type of loan, or to offer a better rate. Typically, only part of the loan is guaranteed. In the past, this approach has been used to support lending associated with social community goals (such as community economic development.)

Non-governmental policy measures include innovative approaches to private sector financing and "on-bill" financing programs initiated by energy utilities. *The Verdant*, a building located at UniverCity (Simon Fraser University) in Burnaby, provides a good example of private sector financing. Vancity provided an unsecured loan, based on future cash flow revenue from the

[8] Heather Tremain, *Innovative Financing Strategies for New Buildings*, Presentation at Build to Zero December 2009 Workshop http://www.communityenergy.bc.ca/december-9-2009-workshop-proceedings-and-presentations

building's strata corporation, to the developer to cover the cost of premium green elements. In the case of the Pomeria building in Vancouver, the developer delivered a highly energy efficient building financed by Terasen Utility Service. Terasen owns the system and leases it back to the strata council. Fees can be collected via an extra charge on the utility bill.

More information on these approaches can be found in Heather Tremain's presentation titled *Innovative Financing Strategies for New Buildings* on the ***Build to Zero*** webpage at: http://www.communityenergy.bc.ca/december-9-2009-workshop-proceedings-and-presentations

RETScreen and other whole-building energy models could be appropriate to help calculate the impact of this measure, depending on the technology being considered.

2. The following measures can also be used by local governments to encourage energy efficient buildings and the development of district and/or renewable energy systems, but are less applicable to the four initiatives proposed for modelling in this report. These tools can be used in conjunction with the six tools described above or on their own.

a. Zoning for high density and mixed use development

Promoting mixed-use, higher density development through zoning can establish the necessary conditions for alternative energy/heating supply utilities. Although developments with higher residential density and mixed commercial-residential uses do not on their own guarantee the financial and operational feasibility of district energy systems, they can provide a sufficient level of demand for shared heating and cooling.

b. Development Permit Area (DPA) guidelines

Bill 27 expanded local government authority to establish DPA requirements with respect to energy conservation and GHG reductions. Local governments may now establish DPAs for the purpose of promoting energy conservation and reducing GHG emissions. Within DPA areas, as a development permit condition specified in development permit guidelines, local governments can now require specific features within the development, including machinery, equipment and systems external to buildings and other structures. This makes it easier for local governments to require building systems that are supportive or compatible with renewable energy systems (e.g. solar hot water heating) or district energy systems (e.g. hydronic building heating).

Local governments may be able to use these expanded powers to mandate particular types of renewable energy systems that can be located onsite, although this approach has not yet been explored by any local governments in BC. Although Bill 27 expanded the scope of DPA's as a tool for energy conservation, previously existing DPA powers for landscaping, siting and form have been used to promote passive solar heating in the City of Richmond and District of Saanich, and these types of requirements remain valid for energy planning today.

c. Negotiated requirements at the development application stage

Consideration of the feasibility of a district energy system can become part of an agreement with a private developer if a zoning or OCP amendment, development permit, or the development of a comprehensive development zone is necessary to allow the proposed development. The City of Coquitlam applied this approach to a major rezoning application for a new neighbourhood called Fraser Mills. In exchange for granting a rezoning from industrial to mixed use residential, the City required the developer to ensure that the new neighbourhood was designed according to sustainability principles, including undertaking a district energy feasibility study.

d. Development Cost Charges

Local governments may now waive or reduce development cost charges (DCCs) for new development with a low environmental impact. As with previously allowed DCC exemptions, the requirements that must be met to receive a DCC reduction must be clearly stated in the DCC bylaw or regulation. The ability to provide a waiver or exemption is similar to the process used now to exempt affordable housing developments from DCCs.

DCCs may be waived or reduced even if infrastructure cost reductions are not quantifiable. However, exemptions or reductions cannot be funded by charging higher DCCs on other projects. Benefits of developments with low environmental impact can include reduced automobile dependency (increasing the longevity of local roads, avoiding maintenance costs or preventing the need to widen the road) or reducing the need for energy infrastructure and increasing local energy security by including renewable or district energy in the development.

e. Tax Exemption Bylaw

The powers of tax exemption were strengthened in 2007, allowing local governments to use tax exemptions to encourage particular forms of revitalization, including environmental revitalization, primarily because long-term lower energy costs can help achieve local government revitalization objectives. In particular, the restriction of tax exemptions to areas designated as 'revitalization areas' has been removed. Tax exemptions can represent a significant financial benefit, and are an attractive incentive to the developer of a district energy system, particularly to help offset capital costs during the early stages of the project.

The Ministry of Community Development has prepared a guide on the use of revitalization tax exemptions. Local governments could also use the tax exemption power to promote green buildings or energy efficiency retrofits on existing buildings (e.g. properties that install solar panels or solar hot water heaters), or multi-building or neighbourhood-scale initiatives (e.g. heat pump or heat recovery system). Dockside Green, a sustainable development located in Victoria, BC, was facilitated by a tax exemption bylaw, particularly with respect to development of a biomass plant to provide district energy.[9]

f. Density Bonusing

The *Local Government Act* allows local governments to exchange density for amenities. This means that a developer may be allowed to build more units than what is normally permitted in the zone (via increased floor space ratio, site coverage or number of buildings per parcel) in exchange for the provision of amenities such as recreation centres, public squares, or pedestrian or bicycle paths. Typically these amenities have included parks, public areas, improvements to roads and sidewalks, public art, space for recreational or community services, and affordable housing, but this tool may be able to be used to promote a district energy system that serves as a community amenity. Density bonusing is only an incentive if both developer and local government agree that the site can reasonably accommodate more density, if both developer

[9] http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/buildings_communities/communities/publications/dockside_green.html

and local government agree upon type and value of the preferred amenity, and if the developer can anticipate a reasonable profit while providing the amenity.

Density bonusing was used by the City of Burnaby to encourage green buildings at the UniverCity site. UniverCity and the City of Burnaby implemented a set of zoning bylaws that included requirements for sustainable features and practices in all new developments. This is one of the first bylaws in North America that mandates green building practices as part of the development process resulting in significantly more environmentally friendly and energy efficient projects. The bylaw includes a green building bonus, which provides density bonusing for projects demonstrating further enhancements in the areas of stormwater management, energy efficiency, and utilization of alternative energy systems. Innovative financing was also used to support construction of a key building on the site, the Verdant.[10]

g. Expedited approvals and/or reduced permit fees

Expedited approvals and reduced permit fees save developers time and money, and can provide an added incentive to consider district energy or renewable energy systems during development. The attractiveness of an expedited approval process for innovative projects should not be underestimated.

Further information on policy tools, as well as examples from other communities, can be found in *Energy Efficiency and Buildings: A Resource for BC's Local Governments* http://www.communityenergy.bc.ca/resources-introduction/energy-efficiency-buildings-a-resource-for-bcs-local-governments and in the *Renewable Energy Guide for Local Governments in BC* – Policy *and Governance* module: www.communityenergy.bc.ca/resources/cea-publications-0

[10] Lowry, Sam: *Taking Green Higher*, American Planning Association, 2008 http://www.univercity.ca/upload/documents/APA-magazine_TakingGreenHigher.pdf

Summary of policy and financial measures and their suitability for emission modelling

Policy or Financial Measure	New Buildings	Existing Buildings	Effect could be Modelled *
Supportive policies within the Official Community Plan	■	■	Yes
Bylaws requiring new buildings to be ready for future energy upgrades	■		Yes
Local Service Area bylaws	■	■	Yes
Local Improvement Charges (or similar)		■	Yes
Public endowed funds	■	■	More difficult
Public loan guarantee concept	■	■	More difficult
Zoning for high density and mixed use	■		Yes
Development Permit Area (DPA) guidelines	■		Yes
Negotiated requirements at development application stage	■		More difficult
Development Cost Charges	■		Yes
Tax exemption bylaw	■		More difficult
Density bonusing	■		Yes
Expedited approvals and/or reduced permit fees	■		More difficult

* Although the impacts of any of these measures can be modelled, the purpose of this column is to attempt to distinguish between policies and measures that can be defensibly modelled at the neighbourhood or community level versus those where the number and degree of assumptions would make a modelling exercise more difficult.

Community Energy and Emissions Inventory (CEEI)

The 2007 CEEI Reports developed by the Province of BC represent high level modeled community energy consumption and greenhouse gas emissions from on-road transportation, buildings, solid waste and land-use change (deforestation at regional district scale only). The first of their kind in North America, these reports are intended to help local governments meet their Climate Action Charter commitments to measure and report on their community's greenhouse gas (GHG) emissions profile.

These inventories also help local governments meet the Green Communities legislative requirement (Bill 27) to establish greenhouse gas targets, policies and actions in official community plans or regional growth strategies. Subsequent releases of CEEI reports will include secondary indicators to expand the emission inventory range and to support the government's emerging Green Communities Performance Reporting Program.

Like all inventory systems, the BC government's CEEI reports are live documents that will continue to improve.[11] They are designed to create a solid foundation upon which local governments can build. [12]

Community energy use and GHG emission inventories for Lower Mainland municipalities

Municipality	Population	Dwellings	Residential Buildings		Commercial Buildings	
	(2007)	(2007)	Energy (GJ)	CO2e t	Energy (GJ)	CO2e t
Metro Vancouver	2,237,559	870,992	78,687,089	2,826,151	68,925,052	1,913,615
Anmore	2,032	571	118,423	4,499	2,882	20
Belcarra	679	296	46,767	1,486	2,605	46
Bowen Island	3,615	1,640	130,487	797	20,096	123
Burnaby	214,993	82,950	6,733,730	246,031	8,309,722	223,273
Coquitlam	120,286	43,241	4,460,108	167,541	2,859,369	80,954
Delta	99,588	35,125	4,367,951	167,122	3,654,821	91,877
Langley City	25,155	11,110	738,233	23,816	1,155,992	36,118
District of Langley	99,132	35,098	4,795,616	172,263	3,251,292	90,861
Lions Bay	1,404	552	62,060	637	4,439	30
Maple Ridge	72,577	26,488	2,971,450	102,725	1,255,564	34,281

[11] The figures in the table represent the May 2010 version of the 2007 CEEI reports.
[12] Appendix C contains additional information on CEEI.

Municipality	Population	Dwellings	Residential Buildings		Commercial Buildings	
	(2007)	(2007)	Energy (GJ)	CO2e t	Energy (GJ)	CO2e t
New Westminster	61,671	28,670	1,481,663	46,583	2,218,254	71,815
City of North Vancouver	47,296	22,643	1,264,516	40,155	2,010,705	64,413
District of North Vancouver	85,993	30,957	3,806,948	144,947	1,390,274	38,917
Pitt Meadows	16,600	6,149	685,540	22,899	519,861	13,196
Port Coquitlam	55,024	19,689	2,050,054	77,250	1,394,397	40,806
Port Moody	29,936	10,680	1,086,995	39,410	477,377	13,227
Richmond	186,554	64,367	6,011,535	215,948	7,238,750	198,155
Surrey	422,786	139,193	15,327,448	565,254	8,290,955	226,745
Vancouver	610,156	273,804	17,580,485	615,988	22,111,763	629,095
West Vancouver	42,945	18,057	2,938,076	112,449	899,017	28,217
White Rock	18,620	10,192	695,262	23,646	470,420	17,300
Fraser Valley RD	271,633	100,157	11,120,738	371,042	7,445,161	222,273
Abbotsford	131,310	45,286	4,626,018	150,288	4,051,553	126,538
Chilliwack	73,409	27,929	3,034,106	99,819	2,122,900	66,226
Harrison Hot Springs	1,585	934	111,859	4,533	65,781	1,613
Hope	6,159	2,855	323,946	12,480	178,052	4,942
Kent	5,308	2,071	285,541	9,626	157,373	4,283
Mission	36,287	12,598	1,582,201	54,899	594,362	16,015
Squamish-Lillooet RD	37,189	20,436	2,257,498	37,640	1,885,341	51,336
Lillooet	2,320	1,124	135,224	1,404	38,527	264
Pemberton	2,361	1,115	95,117	809	41,772	286
Squamish	15,960	6,011	584,738	12,661	454,027	12,149
Whistler	9,753	8,751	855,475	16,681	1,271,703	38,093

While all local governments within the Lower Mainland are working towards establishing GHG emission targets, the following communities had already determined specific targets as of April 2010:

Municipality	Community Target
Metro Vancouver RD	A 15% reduction by 2015 and a 33% reduction by 2020 below 2007 levels.
Bowen Island	Stabilize greenhouse gas emissions at 2000 levels by the year 2010.
Delta	Provincial Target: Reduce overall emissions by 33% of 2007 levels by 2020
North Vancouver City	6% below projected levels by 2010.
Port Coquitlam	Target is 1,075 tonnes CO2e, an amount that will reduce emissions by 37% below 2002 levels by 2012. A target will be determined later this year
Vancouver	6% by 2012, 33% by 2020, 80 % by 2050. All new construction to be carbon neutral by 2030.
Squamish-Lillooet RD	30% below 1990 levels by 2020 and 90% below 1990 levels by 2050.
Squamish	GHG emissions per capita for regional energy systems are less than one tonne by 2030.

A list of CEEI secondary indicators was developed by the Sheltair Group for the Ministry of Environment CEEI Working Group.[13] This list consists of energy and GHG outcome indicators, as well as influence indicators. For the purpose of a CEEI community indicator report, Sheltair proposes that both types of indicators be included. Using sectors as an organizing framework, a refined list of **indicators** was developed using the criteria that an ideal indicator would be:

- Within the influence of local government
- Meaningful and measurable data are available (or could be developed if indicator is important)
- Easily and affordably measured
- Easily understood by a broad range of readers and audiences
- Comparable to indicators

Secondary indicators are particularly helpful because there is a range of activities and influences that local governments cannot control. Secondary indicators can be used to help measure progress towards achieving outputs that will hopefully result in an improvement in the outcome indicator.

Recommended secondary indicators for buildings are as follows:

- Number of new, energy efficient residential units
- Number of new, energy efficient (LEED Certified or better) commercial/institutional buildings
- Number of existing homes evaluated for EnerGuide rating through the ecoENERGY initiative
- Number of dwellings on a renewable energy district heating system

[13] The Sheltair Group, *Community Energy & Emissions Inventory (CEEI) Secondary Indicators for Community Inventory Interpretation*, June 2008 http://www.env.gov.bc.ca/epd/climate/pdfs/ceei-second-indicators.pdf

3. Modeling Tools to Discern Impacts of Specific Local Government Actions

Model Overview

As 187 [14] local governments in British Columbia respond to the legal requirement to have a GHG reduction target and action strategy in the document that guides development in the community (official community plan or regional growth strategy), there is increasing use of modeling tools to support the establishment of achievable goals and to discern the impacts of specific local government actions.

Models to measure GHG emission reduction can be segregated into two broad groups. The first group includes a "comprehensive" approach that addresses multiple aspects of development at a community scale, typically addressing emissions from several categories of buildings and transportation options. These models are applied at a community level rather than a provincial or national level. The second category of models are "topic-specific", which typically address a particular topic area at a building or unit scale such as RETScreen (http://www.retscreen.net) or detailed transportation modeling tools.

To support modeling efforts related to ***Build to Zero***, the Community Energy Association (CEA) has conducted a review of community-scale GHG models with a view to identifying best practice approaches to model the impact of local government actions that influence building-related GHG emissions. Only models in use within BC in March 2010, or those that would shortly be available for which we could gather information, were reviewed.

There are several comprehensive models that are currently being used in BC to analyze and predict the potential impact of policies and decisions on community greenhouse gas emissions related to buildings. The models are referred to by the organizations that have developed them, or in the case of SHIFT, it is referred to by its name as it was developed by a collaboration of volunteers. With the proponents in alphabetical order, the models are listed in the following table:

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[14] According to the BC Ministry of Community & Rural Development, see http://www.cd.gov.bc.ca/lgd/pathfinder-rd.htm

Name of Modelling Tool (if any)	Proponent
CEEP-Lite	BC Hydro (with Community Energy Association (CEA))
No formal name	HB Lanarc (HBL)
CIMS and GEEM (known by their acronyms)	MK Jaccard and Associates (MKJA)
SCEC[3] (Spatial Community, Energy, Carbon and Cost Characterization Model)	Natural Resources Canada
SHIFT Accelerator	SHIFT was developed through a collaborative effort and is currently managed by CEA
CE2 (Community Energy and Emissions model)	Stantec
No formal name	Sustainability Solutions Group (SSG)
No formal name	University of British Columbia (UBC)

Other organizations such as MetroQuest were also contacted, but they considered that their model did not sufficiently deal with emissions from buildings to warrant inclusion.

CEA has a full version of CEEP-Lite, and was able to obtain full versions of both SHIFT and SSG models. The other models are considered on the basis of background material that is available for them, such as reports that have been conducted for clients, as well as communication with the proponents. The UBC model is that described in the paper “City of North Vancouver 100 Year Sustainability Mapping Vision: GHG Measurement and Mapping / Technical Paper”, by Nicole Miller and Duncan Cavens on behalf of the UBC Design Centre for Sustainability.

It is important to note that the effectiveness of GHG emissions models is highly correlated to the assumptions and data upon which they are based. In addition, all models reviewed by this report are continually evolving and improving functionally. The review that follows is based upon current functionality as of March 2010.

Key characteristics of GHG emissions modelling programs used in British Columbia

The characteristics by which each model is considered are described in the following table.

Characteristic	Description
Open source?	Whether access to the model is open and free or not.
Includes economic analysis?	Whether the model accounts for economics or not; such as whether it includes technology costs, fuel prices, and uses this information to great extent to achieve its results. A model that partially achieves this usually can provide energy cost forecasts, while a model that fully achieves this may for example use increasing fuel prices to increase demand for sustainable energy technologies.
Interim targets	Whether there is one final result that the model provides based on the inputs, or whether it is also capable of providing interim results from the base case to the final result.
Estimated complexity level	An estimate of the level of complexity the model has, i.e. the extent to which it tries to represent the real world.
Effort to implement	An estimate of the amount of effort that is involved in implementing the model.
Software basis	The name(s) of the software packages that the model uses.
Spatial at the community level?	Whether the model has a spatial component at the level of individual communities or not, e.g. through GIS.
Number of building archetypes	The number of building archetypes that the model uses.
Attempt to simulate human behavioural choices?	Whether the model makes any effort to simulate the effects of human behavioural choice or not (e.g. the likelihood of choosing to walk instead of drive, or not select a building technology due to unfamiliarity). Some models may only incorporate one behavioural aspect, while others are more comprehensive.

The table below compares each model by the key characteristics.

	BC Hydro / CEA	HBL	MKJA	NRCan	SHIFT	Stantec	SSG	UBC
Open source?	√	×	×	√	√	×	√	×
Includes economic analysis?	(partial)	(partial)	√	(partial)	(partial)	×	(partial)	×
Interim targets	Annual	3	Every 5 years or user choice of milestones	Every 5 years or user choice of milestones	Annual	Annual, up to 2050	None	1
Estimated complexity level	Medium	High	High	High	Medium	Medium	Medium	Medium
Effort to implement	Medium	High	High	High	Medium	Medium	Medium	High
Software basis	Excel	Excel and GIS	CIMS and GEEM	HOT2000, GIS, Excel, Access	Excel	Excel	Excel	Unknown and GIS
Spatial at the community level?	×	√	Partial	√	×	×	×	√
Number of building archetypes	None	Unknown (likely 7+)	15	16	None	None	4	8
Attempt to simulate human behavioural choices?	√ (limited)	Unknown	√	√ (limited)	×	√ (limited)	√ (limited)	√

Best practices for GHG emissions modelling in BC

There are several practices in these models that appear valuable for ***Build to Zero***:

Inputs	▪ Leverage existing data (CEEI, BC Stats, Census, BC Assessment) ▪ Characterize built environment (residential and commercial building archetypes, spatial characteristics such as density and proximity) ▪ Model / estimate current emissions based on characterization and compare to CEEI to calibrate model ▪ Measure reductions from a Business as Usual Scenario
Modeling Content	▪ Model the impact local government policies and actions can have on factors driving energy and emissions ▪ Identify all assumptions and key variables including rationale for values ▪ Include ability to vary timing of each local government action ▪ Identify saving opportunities for all fuels (including electricity) ▪ Include economic development potential for local government actions ▪ Recognize level of confidence for each measure and include sensitivity ▪ Calculate actions within a sector (existing buildings) sequentially: measure reduction from first measure from business as usual but measure reduction from second measure against the remaining emissions after the first measure is applied (to avoid double-counting)
Outputs	▪ Include multiple interim dates – not just results for the end target date ▪ Display results graphically in formats such as maps, wedge diagrams or histograms ▪ Recognize the inherent uncertainty in models and use them to test multiple scenarios or possible futures to inform decisions and plans ▪ Include increases and decreases across fuels including electricity
General	▪ Open source where possible to assist community GHG modeling evolution overall ▪ Use Microsoft Excel as a base ▪ Match modeling approach and effort to need

The following pages contain a table that summarizes the key assumptions used in some specific applications of each model. The CEA and SHIFT models are not part of this table because they do not contain sufficient assumptions. The NRCan model is not part of the table because there is insufficient information available on it.

Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
Notes	Information sourced from District of North Vancouver report and personal communication	Information sourced from Metro Vancouver report and personal communication	Information sourced from NRCan personal communication, based on Prince George study	Information sourced from Stantec personal communication	Information sourced from model implemented for District of Kent and personal communication	Information sourced from City of North Vancouver report
	Emissions – baseline and business as usual projection					
Current emissions profiles utilised, and business as usual projection	CEEI calibrated with information including: • Population • Number of residences and type • Number of jobs • Average energy intensity of building stock (NRCan) • Existing transportation infrastructure • Solid waste diversion rates Data from census data & information from municipality	Lower Fraser Valley Emissions Inventory and BC's greenhouse gas inventory. The models forecast greenhouse gas emissions to an end-year (e.g. 2020, 2030 or 2050), and are calibrated using the following information: • Population, households, and economic growth • Type of dwelling (i.e. single family detached, apartments, etc) • Forecasts of energy prices and industrial output • BC's input-output accounts (which show the material, labour, energy and capital inputs for each sector of the economy)	Energy simulation for 16 different residential, commercial and industrial building types defined by BC Assessment year built dates, manual class and actual use values and calculated using HOT2000 software. Energy and emissions for industrial buildings that include process energy adjusted based on CEEI results All results compared with CEEI values Household occupation rates gathered from census data and BC Hydro studies Two different future projections were created based on a growth study by	CEEI data as basis for baseline Projection based on: • Population growth & statistics • Housing statistics from census data • Impact of announced policy measures of BC to reduce energy use in residential and commercial buildings • Changes of building type splits in the future • Forecast calibrated with BC Hydro and Terasen data for different housing types in different regions	CEEI calibrated with information including: • Number of households • Population • People per household • Number of buildings & of which type • Factors for transportation, waste, forestry & agriculture Data from census data & information from municipality	City of North Vancouver and CEEI inventories calibrated with information including: • Population • Number of residences and type • Commercial, industrial, and institutional floor space • Number of jobs • Population density • Residential density • Annual growth rate • Transportation • Waste Population, employment, household, dwelling number and type information using National Census data sourced from Statistics Canada Building footprints provided by the City of North Vancouver, with some adjustment

		Other information provided by data from NRCan, National Energy Board, BC Climate Action Plan, Environment Canada	Urban Strategies Simulations and growth projections linked with City of Prince George GIS			for Comprehensive Development Zones using information from BC Assessment No Business As Usual baseline projection was made

	Economics					
Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
Energy price information – current & forecasted	Unspecified third party sources used for future energy prices	Flexible format, but options include the National Energy Board energy outlook, NRCan's 2006 Energy Outlook, BC Hydro for electricity	Used current pricing for future as well: • Electricity rates from BC Hydro • Natural gas rates from Terasen	Uses current approximate price information (e.g. for CEEI data year). Does not currently include future price forecasting	Current only: • Fuel – BC Gas Prices • Electricity – BC Hydro rates • Natural gas – NRCan • Heating oil – NRCan • Wood – woodheat.org	N/A
Current and projected capital and operating costs	N/A	Technical and market literature	Capital costs for retrofit improvements gathered from a detailed study	N/A	N/A	N/A

	Buildings					
Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
Energy intensity of current building stock	NRCan data for all buildings. Calibrated with CEEI data for commercial & industrial	Residential – historic data from Metro Vancouver on energy consumption Commercial – historic energy data used Industrial – derived using data from Lower Fraser Valley GHG inventory, labour statistics, and BC Stats 2003 information on energy costs and value added Sources include NRCan, Environment Canada, CIEEDAC and contact with industry representatives	Energy simulation for 16 different residential, commercial and industrial building types defined by BC Assessment year built dates, manual class and actual use values and calculated using HOT2000 software. Energy and emissions for industrial buildings that include process energy were adjusted based on CEEI results	CEEI data, crosschecked against BC Hydro (e.g. Conservation Potential Review) and Terasen actual energy use statistics for building types and climate zones	All buildings except apartments >5 stories – NRCan Comprehensive Energy Use Database Apartments > 5 stories – a CMHC research paper	Residential – BC Hydro Conservation Potential Review (CPR) Commercial & Industrial – for the City of North Vancouver project, the CPR did not correlate well with energy & emission inventory data, and so that data was preferred over the CPR

	Buildings (continued)					
Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
Residential units turnover rate (i.e. reselling)	N/A	Flexible format, but for Metro Vancouver study, Multiple Listing Service data from the Real Estate Board of Greater Vancouver – 5% per year	N/A	N/A	N/A	N/A
Replacement rates for buildings	2% per year – figure derived in consultation with local government staff	A figure is used, but neither the figure nor the source are specified	Percentage smaller than 1% based on Prince George demolition records. Therefore, replacement was not considered separately from retrofit schemes	N/A	N/A	Replacement and retrofit rates are assumed. E.g. by 2107 all residential units built before 2050 would be replaced or retrofitted (replacements and retrofits are not provided separated out from each other). No source for this figure is provided

	Buildings (continued)					
Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
Retrofit rates	1-2% per year depending on scenario – figure derived in consultation with local government staff	Determined by the model using forecasts of economic conditions and energy/climate policy. Some assumptions (e.g. high energy prices) produce more favourable conditions for retrofits In Metro Vancouver study, if policy is enacted so that retrofits are prescribed when properties are resold then 4% per year. Based on MLS data from Real Estate Board of Greater Vancouver that states 5% of all properties resold each year	For all future scenarios the percentage of retrofits occurring are in 2018 - apartment 5%, mobile home 5%, row house 10% and single family 15%; in 2028 - apartment 10%, mobile home 10%, row house 20% and single family 30%, in 2038 - apartment 15%, mobile home 15%, row house 30% and single family 45% A conservative number of retrofits were modeled for each building type at future milestones based on the initial distribution of ecoENERGY audits among various building types	N/A as input data. Subsequent scenario building allows assumption of the rate of retrofit – either natural or through action	N/A	

	Buildings (continued)					
Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
Current building stock age, and number / floor space	2006 Census data for ages of residential housing types, GIS data for floor space areas of building types	Residential and commercial - Most information is from NRCan, but MKJA also uses supplemental information from Statistics Canada census data Industrial – emissions modelled by industrial output. Various means used to estimate industrial output	BC Assessment Clarifications obtained through additional enquiries to BC Assessment or in the case of apartments, to the City of Prince George Where gaps in information on floor space and number of units existed, values were derived from the building footprints layer of the Prince George GIS database	Census data for dwelling type and age distribution	Dwelling number and type information using National Census data sourced from Statistics Canada Residential – Average floor area for each building type from NRCan Comprehensive Energy Use Database	Dwelling number and type information using National Census data sourced from Statistics Canada Building footprints provided by the City of North Vancouver, with some adjustment for Comprehensive Development Zones using information from BC Assessment

	Buildings (continued)					
Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
Rate of increase of residential / commercial / industrial buildings	Residential – units increase based on population growth of 0.75% per year (based on Statistics Canada census data of 30 year trend of 1% per year, and discussions with District staff), distributed into housing types based on the scenario Commercial and industrial assumed to grow at a flat annual rate for District of North Vancouver at 1% per year to corroborate with projected regional economic/job growth rates and figures used for OCP planning	Residential – growth rates estimated from population and forecasts for BC housing stocks. Information source not provided Commercial – assumption that floor space is proportional to employment in service industries and going forward, to population. Information used from "CBRE Market Views" reports provided by Metro Vancouver Industrial – estimate for floor space of each industrial type matched with sub-sector increases in GHG emissions from Lower Fraser Valley Emissions Inventory forecasts, and corroborated with a previous model conducted by MKJA for BC as a whole	Based on growth strategy conducted by Urban Strategies Two future growth trends were modeled: one that showed little increase in multifamily units and another that showed almost all new construction as multifamily Growth in commercial and industrial buildings is not currently included	Indirectly included. Rate of growth of energy and emissions is defined by population growth. Model is not specific about number or floor space of buildings. (NB model can use forecasted dwelling or floor space projections if available to forecast energy and emissions)	Residential - growth rates estimated from BCStats growth projections Commercial / Industrial – no categories for commercial or industrial buildings	Not clear how rate of increase is assumed

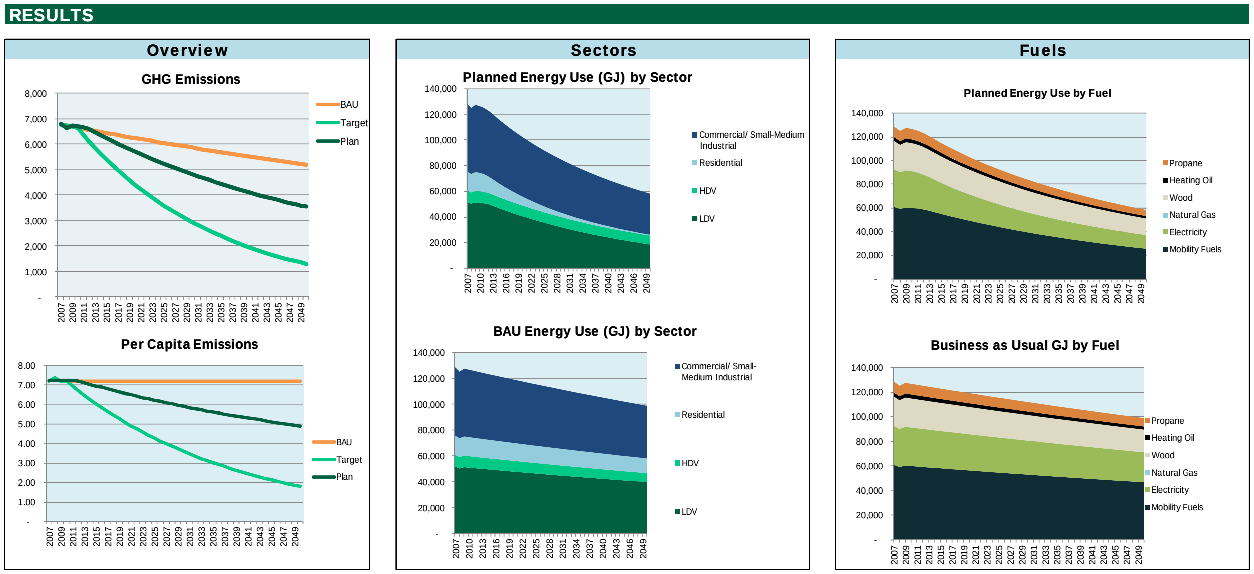
	Buildings (continued)					
Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
Estimated efficiency improvement from retrofits	30% improvement for single family, based on ecoENERGY data for BC. 20% improvement in energy efficiency for all other building types – no assumption source, but based on assumption that it is less than single family homes	Residential sector – assumed retrofit to R2000 archetype, bringing 20-35% improvement in heat load energy intensity Commercial sector – building shells retrofitted to basic LEED archetype, bringing 16-20% improvement in HVAC energy intensity Information sources not provided	Estimated efficiencies based on retrofits for the residential building stock were modeled for individual retrofit options and for a suite of retrofit options. Efficiency improvements ranged from 3% to over 50% depending on the dwelling type and retrofit options selected For the commercial and industrial building stock, retrofits were assigned as potential improvements of either 10%, 20% or 30% based on guidance from the BC Greenhouse Gas Emission Assessment Guide	Retrofits to non-electrically heated homes typically reduce energy and GHG emissions by the same amount (30% per retrofit, based on BC EnerGuide dataset). Retrofits to electrically heated homes have similar energy conservation but smaller GHG reductions Reductions in commercial buildings based on staff experiences – currently approximated as a 30% reduction in energy use and GHG emissions	N/A	2107 scenario assumes that all residential retrofits will be conducted to today's best practice standards, based on literature review, including the David Suzuki Foundation's report "Kyoto and Beyond"
Energy intensity of new buildings for business as usual (BAU) case	Anticipated changes to the BC Building Code (Province) are combined with existing building energy intensities (NRCan) Scenarios also impact energy intensity through changes in land use	Not clear if a progression in energy efficiency standards for new buildings is assumed for BAU case	2008 BC Building Code Energy intensity also changed according to the percentage of new multifamily units vs. single-family dwellings	Estimates include declared policy in BC for the improvement of the energy use of residential and commercial buildings. This improvement in efficiency is set as a variable and can be adjusted or turned off	N/A	N/A, as there is no business as usual scenario

	Buildings (continued)					
Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
New buildings going beyond the code	Estimated 10% additional improvement relative to existing 2006 data. In one scenario also assumes a further strengthening of the code	Residential – equivalent of R2000 homes in 2015, and LEED in 2020. Equivalent to 10-30%, and 40-60% reduction in heat load energy intensity compared to standard Commercial – Use of the model's archetype of LEED Silver for new buildings in 2015, Gold in 2020, and Platinum in 2025. Equivalent to 19%, 32%, & 45% improvement in HVAC energy intensity compared to existing buildings	In the current version of the model there is a low energy future that quantifies new buildings as 25% more efficient than the 2008 code standards	BAU scenario is the building code. Scenarios allow users to define a level of penetration for higher efficiencies (e.g. EnerGuide for Houses 80 or 85)	N/A	2107 scenario assumes that all new residential buildings will be built to today's best practice standards, based on literature review, including the David Suzuki Foundation's report "Kyoto and Beyond" Scenarios also impacted energy intensity through changes in land use Average building energy consumption assumed to be reduced by 50% by 2050, 70-90% by 2107 depending on building type

	Buildings (continued)					
Proponent	**HBL**	**MKJA**	**NRCan**	**Stantec**	**SSG**	**UBC**
Change to the energy mix used by buildings	Energy mix can be varied in forecasts. Options include district energy and other low carbon / renewable energy sources In North Vancouver report district energy assumed to be 25% of the emissions intensity of conventional all-gas heating, and for MURBs and commercial only	Can assume increasing use of heat pumps (air or ground source) and solar hot water systems for buildings For industrial buildings in Metro Vancouver report, assumption of no wood waste fuelled boilers	Air source heat pumps included as residential retrofit measure in high-efficiency scenario	In scenarios, users can define a change of energy source such as conversion to electric heat pumps or connection to a district energy system (renewable or not). Input parameters would be the penetration of the change, and the amount of savings achieved for adopters	Energy mix to buildings can be varied by the user, using (clean) electricity, natural gas, heating oil, “other” (e.g. propane), wood or district energy systems. Emissions factors for these energy sources can also be varied except for district energy which assumes a default reduction in energy intensity from the other energy sources	This can be varied, through both low carbon district energy implementation for high density and other low carbon energy sources for low density

BC Hydro (with CEA) – CEEP Lite

Background



On behalf of BC Hydro, CEA is developing a non-spatial Excel-based tool for assessing community greenhouse gas emissions. The tool was still undergoing development in March 2010. It is intended for use in communities with a population under 20,000, to assist with a rapid, action-oriented approach to Community Energy and Emissions Planning, and to help communities meet community GHG targets such as those required under Bill 27. Unlike other models, CEEP-Lite starts with what policy, regulatory, fiscal, and organizational actions a local government can take.

Overview

The model is based in large part on the Community Energy and Emissions Inventories (CEEI). In summary, a user inputs the CEEI data from a particular community, confirms a population growth projection and selects a GHG reduction target. The user answers several key questions which are used to narrow the scope of specific actions. The user then identifies when specific actions will start to take place. At this point, one can accept the 'default' values and go directly to graphical results or fine tune the impact of actions. The model has been set up to facilitate a user in varying the actions selected, in order to understand what policies are necessary to meet or exceed their community GHG target.

A representative sample of the key questions and possible actions are shown in the table below.

	Sample of Key Questions	Sample of Possible Actions
General	• Is there strong interest in clean energy in the community?	• Establish an Energy Task Force • Establish a regional energy co-op
Buildings	• Can enforcement of the energy components of the building code in all renovations and new building be improved?	• Improve building code enforcement
	• Is there a source of waste heat (e.g. rink, WWTP) near to heat demand (e.g. pool, hospital) OR Are several public-sector buildings located close to each other? • Are new public-sector (local government, PSO's…) buildings planned?	• District Energy/Renewable Energy Systems or Studies
Transportation	• Are there major trip destinations less than 3km from a significant number of residences? (commercial services, schools, hospitals, employers, etc.) • Are there trip destinations within 5km-8km of a significant number of residences? • Are there major trip destinations beyond 8km that are not sufficiently served by transit?	• Information/Education/Outreach (topic: transportation, audience: commercial) • Ride-Sharing and Guaranteed Ride Home Programs • Intercommunity Transit Services
Waste	• Is a significant amount of organics going to landfill that could be diverted?	• Organics Diversion

Results from the model are given in the form of total GHG emissions and per capita GHG emissions, allowing simple comparison between the business as usual, the target, and the planned scenarios. Results from the model are also given in energy use in GJ, by sector and by fuel, for both the business as usual scenarios and the planned scenarios. The results minimize double-counting by applying actions in a particular sector sequentially.

Benefits and Potential for Future Development

The benefits of this model include:

1. It is easy to use, with just a few worksheets to control the variables. Measures can be easily selected or deselected, or brought forward or delayed in time
2. Important assumptions are exposed

3. Actions can start at different times, creating a true action plan
4. There are many measures that can be varied, including ones where the GHG reductions will be less tangible and therefore harder to model. E.g. formation of an energy task force
5. Measures are directly related to specific policy and regulations

This model may benefit from future development to:

1. Improve the business as usual scenario emissions which are only based on per capita GHG emissions from the CEEI reports. Other factors, such as economics, are not considered
2. Include an ability to overlay a number of different scenarios (i.e. overlaying the results of different action plans)
3. Although the model is not aimed at larger communities, the land use component is too simplified to be of great use to them compared to other models

HB Lanarc

Background

HB Lanarc has developed a detailed spatial and temporal tool to look at the emissions from a community, and to forecast estimated impacts that various policies will make. As of March 2010, HB Lanarc had utilized the model in six communities inside and outside BC, with three more underway. The District of North Vancouver modeling (used for the table of assumptions above and also referenced below) was the first of the communities to utilize this modeling framework.

The baseline and business-as-usual scenario is made using CEEI, GIS data sets, assumptions, and meta-analysis from peer-reviewed papers, government commissioned studies, and local government reports.

Overview

The model is detailed and requires many inputs and assumptions.
Inputs include:

- Population
- Number of and the spatial distribution of the following housing types:
  - Single detached homes
  - Townhouses
  - Low rise apartments

  - High rise apartments
  - Secondary suites
- Number and distribution of existing jobs
- Average energy intensity of the existing building stock using data from Natural Resources Canada
- Information on existing transportation network including bus routes and cycle routes
- Existing rates for diversion of solid waste

The expected emissions from these parameters are compared to the baseline established with CEEI.

When forecasting into the future, changes in the variables are made at future milestone dates, e.g. 2020, 2030, and 2050. With respect to buildings, the following changes to variables are made:

- Growth and distribution of new development
  - Population growth and growth of commercial/industrial floor space (projections from recent analysis or studies are used)
  - Population growth rate is converted to an estimate of unit types, the mix of these are determined by the scenario
  - Over time, some existing buildings are assumed to be replaced with new buildings constructed to the latest building code standards, while remaining buildings are assumed to be retrofitted for greater energy efficiency
- Buildings
  - Total floor space for each building type is multiplied by an energy intensity factor, kWh/m^2/year
  - In the District of North Vancouver report energy intensity was based on NRCan data for existing buildings in BC. Forecasting into the future, the factors were varied according to anticipated future changes to the BC Building Code. For commercial and industrial buildings, the energy intensities were calibrated to reflect data from the CEEI report for that community. For some scenarios, an additional 10% improvement in energy efficiency for new buildings (relative to existing 2006 buildings) was expected, meaning that the District would strive to go beyond the code
  - Regarding retrofits and replacements to existing buildings, in the District of North Vancouver report existing single-family dwellings were assumed to achieve a 30% improvement in energy efficiency retrofits (figure based on ecoENERGY data for BC). All

other buildings were assumed to achieve a 20% energy efficiency improvement. Retrofit rates for all building types were assumed to vary 1-2% per year depending upon the scenario, and replacement rates for existing buildings were assumed to be at 2% per year

- Emissions factors for buildings are also based on the energy supply mix (electricity and gas). The energy mix for forecasts can be varied through the introduction of renewable / low carbon energy sources, including district energy. The model can also vary the carbon intensity of electricity
- Floor space is estimated from GIS data, and then replaced or retrofitted according to the assumptions above

In addition to buildings, many variables are altered with respect to solid waste and transportation. (The tool contains a large transportation component, which is based on the CMHC transportation tool.)

Buildings assumptions for each scenario conducted for District of North Vancouver are shown in the table below. This does not imply that the same assumptions are used each time the model is utilized. The model assumptions are configured on a project- and scenario- specific basis in consultation with local government staff.

	Variable	Do a Little	Do More	Do a Lot	Do the Most
Residential Buildings	*Residential new building energy efficiency standard*	As per existing green building code[15] and anticipated code changes to 2020	Reduce energy consumption (relative to existing buildings[16]) by a further 5% beyond code requirements by 2020.	Reduce energy consumption (relative to existing buildings) by a further 10% beyond code requirements by 2020.	Reduce energy consumption (relative to existing buildings) by a further 10% beyond code requirements by 2020
	Residential retrofit take up rate (per annum)	1%	1.5%	2%	2%
	Residential retrofit efficiency improvements.	30% better than current average existing building for single family, 20% for multi-family.	30% better than current average existing building for single family, 20% for multi-family.	30% better than current average existing building for single family, 20% for multi-family	30% better than current average existing building for single family, 20% for multi-family

[15] The "Green Building Code" refers to the energy efficiency measures introduced into the BC Building Code in 2008.

[16] Building energy efficiency is measured relative to the average energy efficiency of the existing building stock.

	Variable	Do a Little	Do More	Do a Lot	Do the Most
Building Energy Supply	*District Energy*	No district energy. Rely primarily on natural gas and grid electricity.	District energy (with renewables) for about 20% of all new apartment homes and commercial building stock by 2050	District energy (with renewables) for about 40% of all new apartment homes and commercial building stock by 2050	District Energy (with renewables) for about 60% of all new apartment homes and commercial building stock by 2050
Industrial/ Commercial/ Institutional (ICI) Buildings	*ICI new building efficiency standard*	As per existing BC green building code and anticipated code changes to 2020	Reducing energy consumption (relative to existing buildings[17]) by a further 5% beyond code requirements to 2020	Reducing energy consumption relative to existing buildings by a further 10% beyond code requirements to 2020	Reducing energy consumption relative to existing buildings by a further 10% beyond code requirements to 2020 and further improvements to commercial/ industrial buildings to 2030.
	Commercial/ institutional retrofit take up per annum	1%	1.5%	2%	2%
	Industrial retrofit take up	1%	1.5%	2%	2%
	Residential retrofit efficiency improvements.	20% better than current average existing building	20% better than current average existing building	20% better than current average existing building	20% better than current average existing building

Outputs the model can produce include:

- Estimates for changes in per capita CO_2 emissions for different areas of a community (down to the neighbourhood or block level), for certain dates (e.g. 2030, 2050)
- Future forecasts of GHG emissions for a community, put into per capita emissions, compared against other targets such as Provincial, and also split into the following categories:
  - solid waste
  - public transit
  - private transportation
  - industrial buildings
  - commercial buildings

[17] Ibid

  - residential buildings
- Energy cost forecasts
- Wedge analyses, which can be split in various different ways, and where each wedge corresponds to a single policy or a set of policies. In the report for District of North Vancouver the emissions reduction wedge analysis showed what components are reducing emissions compared to the BAU case and by how much. Components making up the wedges included:
  - Improved vehicle fuel efficiency
  - Improvements in the BC Building Code and greening of the grid
  - Increased diversion of solid waste, based on a plan by the Regional District
  - Increased diversion of solid waste, going beyond a Regional District plan
  - Smart growth (compact, complete community land use planning)
  - Greener buildings (higher efficiency new buildings, increased uptake of retrofits, district energy, and onsite renewable energy technologies)
  - Any remaining emissions

Benefits and Potential for Future Development

The benefits of this model include:

1. It is a very comprehensive model that also includes a spatial component at the community level
2. The assumptions regarding building code changes may be incorporated as the business as usual scenario and/or as part of other scenarios

This model may benefit from future development to:

1. Maintain robustness of the model while reducing the effort required to implement the model

MK Jaccard & Associates – CIMS and GEEM

Background

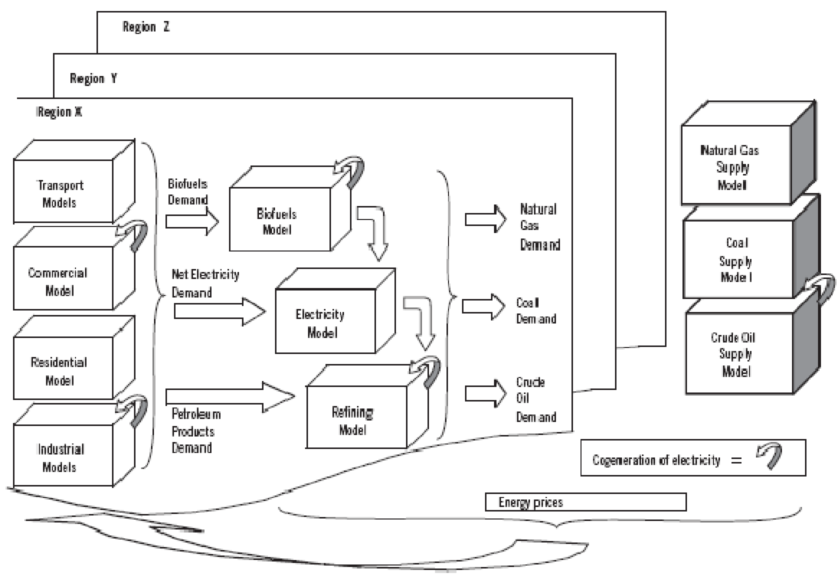
MK Jaccard and Associates (MKJA) employs two energy economy models – CIMS and GEEM, which are known by their acronyms. The CIMS model is a technologically detailed model primarily used to forecast the effect of energy/climate policy or changing economic conditions on energy consumption, greenhouse gas emissions, and economic costs. The GEEM model is an economic model primarily used to estimate impacts of policies or economic conditions on economic performance (e.g. gross domestic product) and employment among other indicators.

The CIMS tool is frequently used for provincial and national analysis, but can also be calibrated for sub-regions within BC (it has for example been calibrated for Metro Vancouver). Although not strictly spatial, the model includes some spatial components that are pertinent to municipal analyses. Specifically, CIMS can simulate an explicit urban planning policy package that affects the emissions and energy consumption of the residential, commercial and transportation sectors. Furthermore, CIMS can be used to explore the criteria that support district energy systems while determining how the development of the systems will affect energy consumption and emissions.

To date, GEEM has only been used for provincial and national level analyses, but it could be adapted to a municipal level project. The current version of GEEM represents British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Atlantic Canada and the United States as separate regions.

CIMS

Overview



The CIMS model is a technologically detailed model that represents individual technologies that can be used to meet the demand for energy services. CIMS tracks existing technology stocks, while simulating how households and firms select technologies, processes or behaviour under different economic conditions and policy levers, and how these choices affect energy consumption and greenhouse gas emissions. For example, in the residential model CIMS represents various building shells and space heating technologies that can satisfy the demand for heated residential floor space. Each specific technology archetype for a building shell has different costs, energy requirements, and emissions. The same is true for space heating technology archetypes. Energy prices, policies and consumer behaviour determine the range of building shells and heating technologies in use as well as their resulting energy consumptions and emissions. These are also affected by rates of building turnover, retirements, retrofits, and new purchases. Similar competitions take place for other energy uses in the residential sectors and for all other sectors.

The model simulates the interaction of energy supply and demand. For example, reductions in energy use, apart from reducing emissions, can also lead to reductions in the price of that energy source if they are large enough.

Both the costs and energy efficiency of new technologies are estimated through technical and market literature. Consumer preferences are estimated, based upon a literature review, judgement, analysis, and consumer surveys. The use of surveys to model behaviour is unique compared to the other models. Considerable detail on technologies is contained in the model, in order to ensure that policies are modelled in a realistic technological and economic context.

Projecting forwards, the baseline is based upon assumptions about how the economy may evolve in the future, given historic trends as well as research about the evolution of technology and economics.

The baseline includes assumptions on:

- Population forecast (e.g. trend from BC stats)
- Local GHG emission inventories, supplemented by data sources such as projections from the BC Climate Action Plan
- Technology development, as described above
- Consumer behaviour, as described above
- Energy prices – derived from reported figures from the National Energy Board, Natural Resources Canada, BC Hydro, as well as professional judgement
- Economic activity in various sectors of the economy
- Federal policies for buildings (e.g. continuation of a federal renewable power production incentive, and introduction of planned federal minimum energy performance standards for household appliances)
- Provincial policies – CIMS can also include Provincial climate action policies, such as those from the BC Climate Action Plan

CIMS has the capacity to simulate a wide variety of policy options, such as carbon or energy pricing policies, regulatory policies, market oriented regulations, and subsidy programs. With respect to policy options open to local governments that are specific to buildings, MKJA modelled four policy options in a report written for Metro Vancouver:

1. Retrofit standards for buildings
   - Requiring that, when sold, existing residential and commercial buildings would need to meet minimum energy efficiency standards. The report states that the annual retrofit rate is estimated at 4% of the building stock per year, based on MLS data that states that there is turnover of 5% of the residential building stock each year. Residential buildings would be retrofitted to the R2000 standard (bringing a 20-35% decrease in heat load energy intensity), and commercial building shells would be retrofitted to the basic LEED standard (bringing a 16-20% decrease in HVAC energy intensity). The retrofit regulation also assumes that new buildings will be built to these standards
   - By 2020, this measure is estimated to reduce GHGs by 0.4 MTs below the baseline for Metro Vancouver
   - Of the policy measures considered in the report (including policy measures that both relate to and are unrelated to buildings), this measure scores the lowest. MKJA also highlight potential difficulties in implementing this policy measure, they conclude that considerable analysis would be required before proceeding with it, and they highlight a preference to other approaches to building energy retrofits, such as direct incentives, and local improvement charges
2. Energy efficiency standards for new buildings
   - Requiring that new buildings meet increasingly stringent energy efficiency targets. For commercial sector LEED Silver by 2015 (reducing HVAC energy intensity by 19%), LEED Gold by 2020 (32%), and Platinum by 2025 (45%). For residential sector, R2000 standards for homes by 2015 (reducing heat load intensity by 10-30%), and LEED standard by 2020 (40-60%)
   - By 2020, this measure is estimated to have reduced GHGs by 0.9 MTs below the baseline
3. Electrification of building heating systems (low energy)

- Requiring all new heating systems to use electricity, or to reduce demand using on-site renewable energy systems, e.g. solar water heating. This was modelled by limiting the selection of space heating and water heating technologies after 2010. Because this is a "low energy" option (see other option below) electric baseboard heaters are not considered, so options are limited to heat pumps (ground- or air-source) or solar water heating (by itself or supplemented with electricity)
- By 2020, this measure is estimated to have reduced GHGs in Metro Vancouver by 2.4 MTs below the baseline and to have increased electricity consumption by 21% above the baseline (the report states that this is approximately equivalent to the output from a 1,800 MW wind farm)

4. Electrification of building heating systems (low capital cost)
   - As with the policy measure above except that electric baseboard heaters are considered. It is assumed that existing subsidies on air source heat pumps continue and therefore remain popular, and that the fraction of heating that is baseboard heating remains similar to the current proportion. Adoption rates of solar water heating under this scenario were very similar to the "low energy" scenario, and adoption rates for ground source heat pumps were almost as high
   - By 2020, this measure is estimated to have reduced GHGs in Metro Vancouver by 2.4 MTs below the baseline and to have increased electricity consumption by 23% above the baseline

Benefits and Potential for Future Development

The benefits of this model include:

1. CIMS is perhaps the most detailed of all of the models reviewed in this report, and therefore it should provide the most accurate estimate regarding the forecasted impact of future policies
2. In deriving its forecast, the CIMS model forecasts the actual response of households and firms, rather than producing scenario based analysis that shows the energy consumption and greenhouse gas emissions that would result if certain people adopted certain technologies. The CIMS model considers the following details:
   - An assessment of how financial costs affect uptake of new technology
   - Modelling of non-financial behaviour impacting the adoption of new technologies in buildings (e.g. uncertainty around an unfamiliar technology)

- Energy cost forecasting within the model, linked to expected uptake rates of new technology
- Learning-by-doing, which simulates how the costs of new technologies decline over time as households and firms accumulate experience with the technology (e.g. the cost of plug-in hybrid vehicles declines if they attain significant market penetration)
- Neighbour effect, which simulates how consumer preferences toward specific technologies may improve if they are widely adopted

CIMS may benefit from future development in the following areas:

1. Maintain robustness of the model while reducing the effort required to implement the model
2. Incorporation of a spatial component
3. Consideration of a variety of renewable energy technologies including industrial conversions to wood waste fuelled boilers

GEEM

<u>Overview</u>

MKJA employs a computable general equilibrium (CGE) model called GEEM, essentially a sophisticated input-output economic model that balances supply and demand for commodities and services in all markets though prices. Capital is assumed to be mobile between provinces/states within each country, while labour is assumed to be mobile within regions (inter-region migration is not assumed to be influenced by the policy). In the model, a representative household in each region is the owner of primary factors (labour, capital and natural resources) which they rent to producers who combine them with intermediate inputs to create commodities. Commodities can be sold to other producers (as intermediate inputs), to final consumers, or to other regions and the rest of the world as exports. Commodities can also be imported from other regions or the rest of the world.

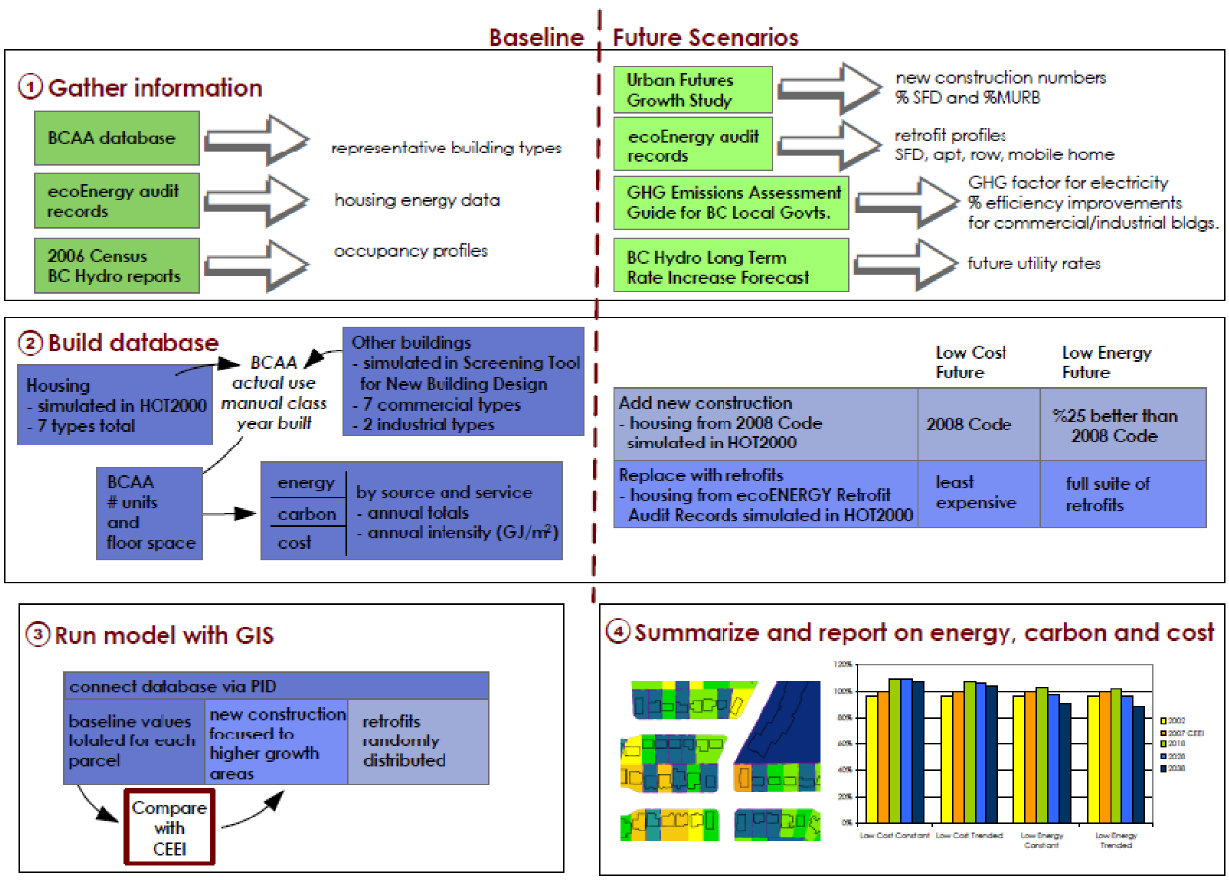
GEEM could be utilised by a local government for a detailed forecast of the anticipated economic effects of implementing certain policies, i.e. the impact on the bottom line for households and businesses. GEEM could also help a local government understand if people and businesses would relocate to other communities if they implemented certain policies.

Natural Resources Canada – SCEC^3

Background

The CanmetENERGY division of Natural Resources Canada, developed the Spatial Community Energy, Carbon and Cost Characterization Model (SCEC^3) for the City of Prince George, British Columbia. Created in 2008 -2009 as part of the Prince George *Smart Growth on the Ground* process, SCEC^3 was originally limited to energy performance of the existing residential housing stock. In 2010, the model was expanded to include commercial and industrial buildings, as well as GHGs and cost. Designed to support the City's ICSP/OCP process and for research purposes, the SCEC^3 model, in part, uses building energy information that is that is either not presently readily available for use by local governments or must be generated through simulation.

A summary schematic of SCEC^3 is shown below.



Overview

The functionality of the $SCEC^3$ model enables the calculation of present day energy aspects for the building sector, including residential, commercial and industrial buildings. It strives for an accurate accounting of the current building stock using modeled housing and building energy information, as well as the ability to link Parcel ID (PID) numbers to BC Assessment building attribute information.

The model consists of data tables containing the results of housing and building energy simulation connected to ArcInfo GIS software (ArcView version), custom queries developed within Access and scenarios developed within ArcInfo GIS custom scripts.

The $SCEC^3$ model also facilitates the exploration of energy, carbon and cost futures through the addition of new buildings in specific locations and the retrofit of the current building stock in random locations; retrofits can also be targeted to select neighbourhoods.

Energy modelling for homes was completed by HOT2000, using ecoENERGY Retrofit Audit records from Prince George, obtained from NRCan's Office of Energy Efficiency. Seven housing types were selected for modelling for being representative of both the ecoENERGY Retrofit audit records and the overall housing stock as described by BC Assessment data. In addition to baseline energy, GHGs and operating energy costs, low cost and low energy retrofit scenarios were developed for individual housing types based on information contained in the audit records. Five housing types were derived for existing houses, and two were derived for new housing: one type was derived for new single family dwellings, and another type for new townhouses built to the 2008 BC building code.

The model's objective was to match the values for the residential, commercial and industrial buildings contained in the 2007 CEEI data. To calibrate the model to the 2007 CEEI, 2007 weather year data was used and 2006 census occupancy in housing simulations. Residential simulations also referred to BC Hydro data for internal temperatures and lighting and appliance needs.

Commercial and industrial building categories were developed based on a relationship between BC Assessment Manual Class and Actual Use codes as well as the archetypes contained in the *Screening Tool for New Building Design.* These archetypes included commercial extended care facilities, hospital, small office, retail – big box, retail – strip mall, retail – suburban, and schools. Industrial buildings were divided into two classes of warehouse, one with minimal process energy and the second to which additional process energy could be assigned. Actual buildings reflective of these categories were identified in the BC Assessment data and their attributes were used for simulation. Due to the limited functionality of the *Screening Tool*, it was not possible to calibrate commercial and industrial building simulations using the 2007 weather year. Additionally, no retrofit information corresponding to representative buildings was available; therefore assumptions of 10, 20 and 30 % efficiency improvements had to be assigned.

The baseline data incorporates:

- BC Assessment Jurisdiction and roll numbers and associated building attribute information. The building stock as a whole was tailored to reflect what was in existence in 2007
- ecoENERGY Retrofit Audit records
- 2007 weather year data from Environment Canada
- 2006 census residential occupancy by building type from Statistics Canada
- Cost information including 2007 electricity and natural gas rates; capital costs of residential retrofits were also included for identified residential retrofits
- Construction of new buildings to 2008 BC Building Code

Current measures in the model that can impact emissions from buildings are:

- Low cost and low energy retrofit scenarios for residential houses based on the retrofit types found in the ecoENERGY post-retrofit audit records
- Build-out scenarios as guided by the Official Community Plan, in consistent time steps

Benefits and Potential for Future Development

The benefits of this model include:

1. Accurate representation of housing stock including energy, emissions and cost relevant attributes; close calibration of residential sector with 2007 CEEI inventory
2. Calibration of the model using weather data
3. Advanced development of retrofit scenarios based on actual housing retrofit data
4. Advanced exploration of use of BC Assessment Jurisdiction and Roll data, use of this information to inform modelling and linking of building energy information to PIDs

The model could benefit from future development in the following areas:

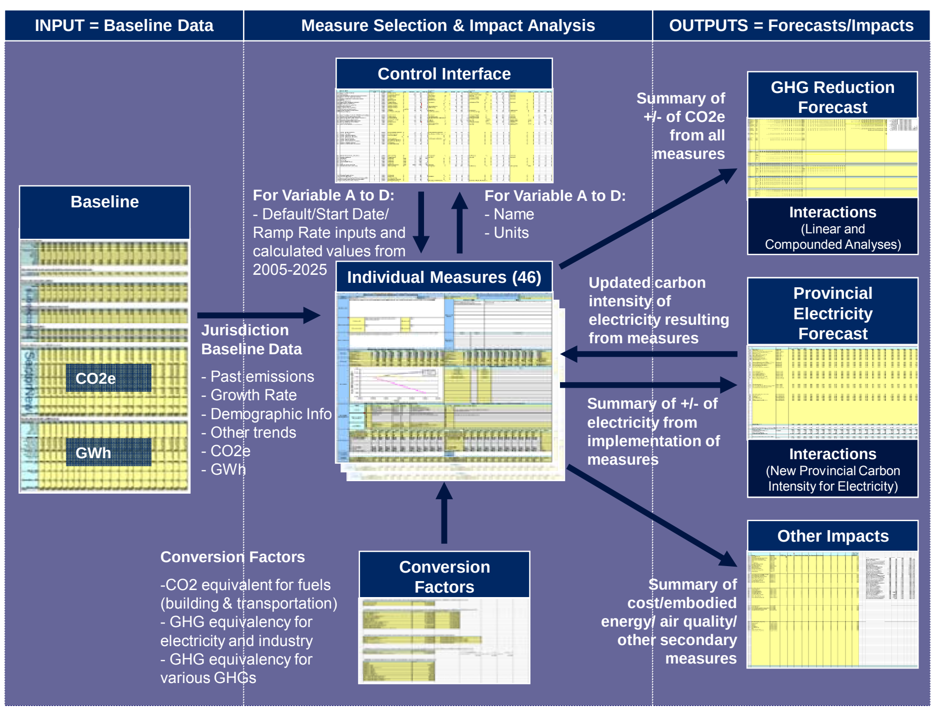
1. Currently available data for commercial and industrial buildings limit the accuracy of this aspect of the model. The Screening Tool for New Building design is limited in the range of building archetypes it can model and simulations cannot be calibrated using weather year from a specific year. Lack of retrofit and capital cost information for commercial and industrial buildings mean that more generalized assumptions are relied upon
2. High level of complexity would currently preclude this model from being readily usable by either consultants or municipalities; more work is required to simplify inputs, automate query processes and standardize outputs for optimal use in municipal decision making

SHIFT Accelerator

Background

SHIFT is a volunteer-led modelling approach. The formation of the model took about 4,000 hours of volunteer time from dedicated professionals. It is a non-spatial, Excel-based model that can be readily used by a community.

Overview



The GHG baseline for a community is taken from its emission inventory, and as with the majority of the other models reviewed, a business-as-usual baseline is projected forward based upon trends and professional judgement, and reductions from that baseline are based upon policy decisions. SHIFT does not address urban form changes in depth.

SHIFT provides a single control sheet for all variables to facilitate "what if" analysis. There are a series of sheets to show results, a sheet for the baseline, and separate sheets for the approximately 50 different policy measures. The model includes emissions from waste, and Metro Vancouver point emissions. Agriculture was intended to be included, but the current version of the model does not accommodate this. Concurrent with IPCC methodology, the model does not include the following: international marine or aircraft travel, emissions from forest fires or landfills, or CO_2 emissions from either combustion or degradation of biomass.

The baseline data is based on:

- Past emissions (1990-2005 or present) in $MtCO_2e$, by Sector/Sub-Sector
- Baseline Electricity Use in GWh by Sector/Sub-Sector
- Building floor area by type (millions ft^2)
- Transportation baselines
- Baseline growth ratios
- Interesting trends (selected)
- Demographic Info
- Industry emissions information

Current measures within the model that can impact emissions from buildings are:

- Improved building standards for new homes to R2000
- Envelope, HVAC improvements for retrofits
- Smart growth – phasing out of single-detached homes and moving to higher density residential
- Electrical efficiency improvements
- District heating/cooling and hot water
- Net zero buildings (new buildings)
- Solar photovoltaic installations
- Phasing out gas appliances and equipment

For the replacement of buildings there is a rate that the user can adjust by varying the assumed average age of buildings. Conservation programs (e.g. building energy efficiency retrofit incentives) are also modelled by applying a percentage reduction to the emissions for a sector or sub-sector.

Benefits and Potential for Future Development

The benefits of this model include:

1. It is easy to use, with just a single worksheet to control the variables. Unlike other models, it does not require a database of the community; so t is considerably simpler and quicker to use it to compare the relative impacts of different policy measures. The set-up time for the model is shorter
2. Important assumptions are exposed
3. Perhaps more measures that can be varied than any of the other models, and new measures can be added

The model could benefit from further development in the following areas:

1. While accessible, some of the measures that can be varied require specialist knowledge that some local governments will not have. Although users can simply select not to incorporate those measures
2. Enhanced land-use considerations
3. Inclusion of buildings archetypes

Stantec (formerly the Sheltair Group) – CE2

Background

The Community Energy and Emissions model (CE2) was developed by staff from The Sheltair Group (a Vancouver based sustainability consulting firm – now part of Stantec Consulting).

This model was developed in 2009, and has been piloted in several communities. It continues to evolve, and can be easily used by a community. The model does not have a spatial component, and uses simplified assumptions to derive possible scenarios.

The model has evolved from an internal analysis tool to a workshop facilitation tool, used to facilitate a "what-if" analysis.

Overview

The inputs to the model include:

- CEEI data
- Number of dwellings by type and age (census data)
- Population

The model includes a library of about 30 strategies pre-configured for the reductions that would occur from implementation. Users then review and discuss their desire for action and establish potential uptake estimates.

As well, the user can define and describe up to 20 additional strategies/actions that are not in the library. These are quantified in terms of the savings and the uptake expected. Work on the additional strategies involves estimating:

- The emissions reduction potential of a given strategy as a percentage reduction from business-as-usual (BAU) for each action or strategy that is applied to (e.g. residential retrofits save 30%)
- Uptake as a percentage of total units / or population / or energy use
- Starting year of the action / strategy and the phase in period for achievement of the action

Benefits and Potential for Future Development

The benefits of this model include:

1. Ability to rapidly deploy the model, and its ease of use and graphical representation
2. Minimal data requirements. The model can be swiftly pre-loaded with CEEI, housing, and population data (all available without charge on government websites). Users can begin analysis with only one assumption – a population growth forecast value. Subsequent refinements can be made with a small number of optional parameters if desired

The model could benefit from future development in the following areas:

1. Extending the model to address spatial components for larger communities
2. Increased linkage to specific policy

Sustainability Solutions Group (SSG)

Background

Sustainability Solutions Group (SSG) has developed an open source tool for assessing community greenhouse gas emissions and costs resulting from existing and potential land use patterns. The model uses basic GIS analysis to prepare data for the excel-based tool. The excel-based tool was initially released in March 2010, and was developed with the assistance of a research grant provided by CMHC. The model and its user guidebook can be freely accessed, edited and shared for non-profit purposes at: http://www.sustainabilitysolutions.ca/landuse/

Because this tool is open source, it was easier to directly assess the merits of this model compared with some of the other tools reviewed by this report.

Overview

The projection of emissions for future scenarios is calculated using the following information:

	Factor	Baseline	BAU	Scenario 1	Scenario 2	Units
General	1. Total Households	1,920	2,920	3,018	2,940	#
	2. Total Population	5,376	8,176	8,176	8,176	#
	3. People per household	2.8	2.8	2.7	2.8	#
	4. Year	2006	2036	2036	2036	
Transportation	5. Trip length (B. Trip length calculation)	13.9	17.3	18.9	16.7	km
	6. CBD, 400m	680	850	755	925	# of dwelling units
	7. Public transit, 400m	897	1,237	1,165	1,302	# of dwelling units
	8. Road length, asphalt	158	158	158	158	km
	9. Road length, gravel	10	10	10	10	km
Buildings	10. Detached	1,525	1,905	2,258	1,835	# of dwelling units
	11. Attached	180	500	315	520	# of dwelling units
	12. Apartments ≤ 5 stories	215	515	445	585	# of dwelling units
	13. Apartments > 5 stories	0	0	0	0	# of dwelling units
	14. Community energy- detached	0	0	0	0	# of dwelling units
	15. Community energy- attached	0	0	0	0	# of dwelling units
	16. Community energy- apt ≤ 5	0	0	0	0	# of dwelling units
	17. Community energy- apt > 5	0	0	0	0	# of dwelling units
Waste	18. Solid waste, no gas collection	2,688	4,088	4,088	4,088	tonnes/year
	19. Solid waste, gas collection	0	0	0	0	tonnes/year
	20. Liquid waste, tertiary treatment	839	1,163	1,002	1,235	# of households
	21. Liquid waste, septic	1,081	1,757	2,016	1,705	# of households
Forest and agriculture	22. Agriculture, total area in crops	4,957	4,957	4,957	4,957	ha
	23. Agriculture, local consumption	48%	48%	48%	48%	percent
	24. Agricultural land- perennial cover	298	298	298	298	ha
	25. Agricultural land- till	1,759	1,759	1,759	1,759	ha
	26. Agriculture no-till	72	72	72	72	ha
	27. Beef and heifer cows	4,874	4,874	4,874	4,874	# of cows
	28. Dairy cows	4,733	4,733	4,733	4,733	# of cows
	29. Forest, absorption	0	0	0	0	ha
	30. Forest- wood removals	0	0	0	0	m3
	31. Forest- fuel removals	0	0	0	0	m3
		12059 total forest cover				
		1897 locally controlled forest cover				

- General
  - Population
  - Number of households
  - People per household
- Transportation
  - Trip length
  - Dwelling units within 400m of the Central Business District
  - Dwelling units within 400m of public transit
  - Asphalt and gravel road lengths in the community
- Buildings
  - Number of detached buildings
  - Number of attached buildings
  - Apartments under five stories
  - Apartments over five stories
  - If any of the buildings are on a district energy system
- Waste

  - Solid waste produced in tonnes per year, and whether or not landfill gas is collected
  - Number of households connected to the sewer mains
  - Number of households on septic systems
- Forest and agriculture
  - Total area in crops
  - Percentage of agricultural land where food is locally consumed
  - Agricultural land with perennial cover
  - Agricultural land where the soil is tilled or not tilled
  - Number of beef and heifer cows, and number of dairy cows
  - Area of forest that can absorb CO_2
  - m^3 of wood removed from local forest
  - m^3 of wood for fuel removed from local forest

The tool makes 65 total assumptions for each scenario based on local trip diary data and research studies from government, non-government and academic sources. All the assumptions and their source information are visible in the excel spreadsheet and can be adjusted if more localized information exists. Assumptions include number of trips per household per day, percentage of trips taken by car, cost of fuel and other items, the emissions factors from imported and local food, and other agricultural emissions. With a scenario test for the SSG model conducted for the District of Kent, the sources of all assumptions are laid out.

In order to generate the BAU scenario, the community emissions generated by the model should be corroborated against CEEI. This can lead to tweaking the CEEI or the assumptions, 'ground-truthing', and explanation of any discrepancies. The BAU for this model can also include more than CEEI (e.g. agriculture).

In addition, SSG has been able to use this tool to estimate the community-wide emissions impact of specific policies (e.g. 160 people switching to public transit, or providing district heating to 3,000 households).

Benefits and Potential for Future Development

The benefits of this model include:

1. It is open source and free to download with support from a community of users. The open source approach allows local governments who have been taken through the model to update their baselines and monitor their greenhouse gas reduction targets over time
2. Policy-relevant – measures the impact of individual policies on greenhouse gases
3. Easy to use – quick and straightforward to use
4. Includes both agriculture and forestry
5. Takes into account the lifecycle of asphalt and gravel roads, and how many kilometres of roads there are in the community, and the resulting emissions from replacing that infrastructure
6. Goes beyond generally accepted carbon accounting to incorporate the transportation (supply-chain) emissions from food. E.g. locally grown food has lower embodied carbon

The model could benefit from further development in the following areas:

1. Inclusion of commercial or industrial buildings and related actions and projections in the model
2. Increased temporality including multiple interim targets and ability to vary start-dates for initiatives

UBC Design Centre for Sustainability

Background

Assessment of the UBC modelling approach is based on the City of North Vancouver's *100 Year Sustainability Vision: GHG Measurement and Mapping / Technical Paper*. The work was conducted by Nicole Miller and Duncan Cavens.

The UBC model contains both spatial components (to forecast GHG implications of land-

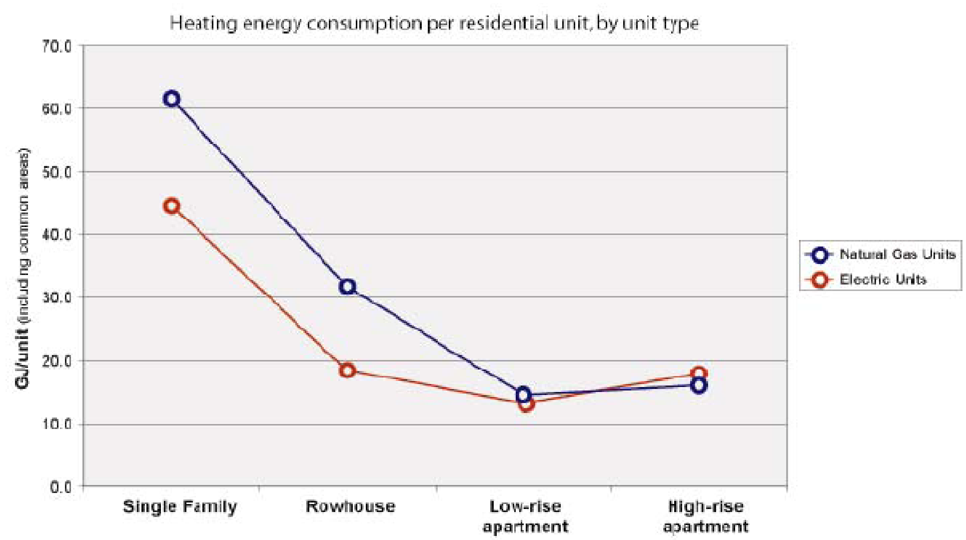


Figure 1: Heating energy consumption per residential unit by unit type, adapted from the BC Hydro Conservation Potential Review, 2007.

use and transportation decisions), as well as non-spatial components (to forecast building related GHG emissions). To calibrate the model, the City's present conditions were forecast, and the resulting GHG emissions were compared with currently available energy and emissions inventories.

The technical paper asserts that based upon a literature review, including BC Hydro's *Conservation Potential Review*, urban form characteristics such as density, location of jobs and services, and availability of transportation alternatives may have the greatest impact on energy use and GHG emissions.

Overview

Energy profiles for various categories of buildings were created. These profiles are quantitative descriptions of energy sources and end use. The categories are:

- Single-detached homes
- Duplex housing
- Row housing
- Units in apartment buildings < 5 stories
- Units in apartment buildings > 5 stories
- Commercial
- Institutional
- Industrial

The data for the residential unit types listed above was obtained from the BC Hydro Conservation Potential Review, which provides energy data for building types in the Lower Mainland region. However for commercial buildings, data from the BC Hydro report did not correlate well with reported commercial energy demands for City of North Vancouver. Therefore, data was taken from community energy and emissions inventories done for the City, and divided by the total areas attributed to each building type.

For 2107, no reports or estimates were available, so the authors used professional judgement (e.g. by 2107 the authors estimated that all residential retrofits or replacement buildings would be done to the best currently available construction practice and energy performance standard). The final energy figures are given on a per-unit basis for residential buildings, and a per- square metre basis for all other buildings.

As with other models reviewed in this report, forecasted community-wide emissions are calibrated against the emissions inventories that have been conducted for the community for the base year. However, the unique feature of the UBC model is that there is no BAU projection for the future that show what the community's emissions would be if no further action was taken by the community. The model only allows scenario forecasting, showing what the emissions reductions would be like compared to the base year.

To achieve the required carbon emission reductions of 80% by 2050 and 100% by 2107 for the City of North Vancouver, the following was necessary:

- Land use and density choices could lead to substantial reductions in energy demand
- Intensive building energy efficiency retrofits were required
- Substantially greater levels of energy efficiency in new construction (reducing building energy consumption by approximately 50% by 2050, and 70-90% by 2107, depending on building type)
- Adoption of zero carbon energy sources (primarily for heating by 2050, and for all energy needs by 2107)

Benefits and Potential for Future Development

The benefits of this model include:

1. There appears to be an excellent spatial component to the model

The model could benefit from future development in the areas of:

1. While maintaining robustness of the model, reducing the effort required to implement the model
2. Inclusion of economic aspects in the model
3. Inclusion of a business-as-usual baseline projection, to show what emissions would be like if no further action was taken by the community. This can be useful to compare the results of different policy measures and actions

4. Estimating GHG Emission Reductions from Build to Zero Actions by Local Governments

This section of the report includes a measurement methodology that can be used to model / forecast anticipated GHG emission reductions that would result from the suite of actions, policies, and initiatives chosen by participating Lower Mainland municipalities. Articulation of this measurement methodology, and the data required, will be invaluable to the overall 15-month ***Build to Zero*** initiative in terms of measuring progress and informing the iterative work being done by the local government working groups as they select and prioritize the suite of actions appropriate for their municipalities. This information will also be of great interest to participating staff from various Provincial ministries with an interest in improving building energy performance and province-wide emission reduction targets.

Note: In the tables that follow, MEMPR refers to the BC Ministry of Energy, Mines and Petroleum Resources, MCRC refers to the Ministry of Community and Rural Development, and NRCan refers to Natural Resources Canada. Information from BC Stats can be found at http://www.bcstats.gov.bc.ca/ and information from Statistics Canada can be found at http://www.statcan.gc.ca/start-debut-eng.html .

Existing Buildings: Financial Incentives and Funding Programs for Building Energy Retrofits for Single Family Homes and Multi-Unit Residential Buildings

1. Single Family Homes

Explore use of local improvement charges and service area bylaws to foster retrofits in **single family dwellings** and to foster district energy at the neighbourhood scale

<table>
<tr><th colspan="2">Challenge</th><th>Data Requirements / Metrics</th><th>Likely Data Sources</th></tr>
<tr><td>1</td><td>What are the GHG emission reductions if __% of single family homes in Lower Mainland received an energy retrofit (i.e. thermal improvements in insulation and windows, changes in heating source, or solar H/W heating)?

Note that results will vary according depending upon combinations of retrofits in different house types. The approach that was taken in Prince George was to model low-cost and low-energy retrofits. Articulating a typical energy retrofit ‘package’ per building type would be useful for purposes of modelling results.</td><td>▪ Existing building stock profile for Lower Mainland (i.e. dwelling units by type and age)
▪ Average energy and emissions by type (class) of building
▪ Create a Business as Usual (BAU) forecast of emissions from low-rise homes (now and into the future)
▪ Estimated energy efficiency improvements from ‘average’ LiveSmart retrofit
▪ Estimate the proportion of likely single-detached retrofits in Lower Mainland over time (i.e. annual uptake)
▪ Estimate the number of years that each retrofit program would be in place</td><td>▪ BC Assessment
▪ BC Stats
▪ NRCan – Existing housing archetypes based on ecoENERGY retrofit audit records. from NRCan’s Office of Energy Efficiency, and CanmetENERGY
▪ Research from Prince George suggests that housing archetypes can be used to model the impact of energy retrofits for existing low-density residential
▪ LiveSmart BC program
▪ BC Hydro Conservation Potential Review
▪ Data from local governments
▪ Multiple Listing Service data from the Real Estate Board of Greater Vancouver – for data on resale rates if assuming retrofits will occur when properties resold
▪ MK Jaccard and Associates Metro Vancouver paper for estimated improvement in energy efficiency</td></tr>
<tr><td></td><td colspan="3">Policy and financial tools: Local improvement charges, supported by Official Community Plan policies and targets related to reducing energy use and GHG emissions from existing single family homes.</td></tr>
<tr><td></td><td colspan="3">CEEI secondary indicator(s): Number of existing homes evaluated for EnerGuide rating through the federal ecoENERGY initiative and LiveSmart BC programs.
Suggested indicator(s): Number of existing homes who have completed retrofits as part of the LIC program.</td></tr>
</table>

	Generalized algorithm for GHG emissions reduction: **BAU** = CEEI 2007 emissions from SF homes in lower mainland * annual % projected population increase **AI** = Annual Improvement = Average % improvement from retrofits (how much does one dwelling improve) * annual % uptake in lower mainland (what proportion of dwellings implement) **Y** = program duration in number of years **OC** = Outcome (GHG % reductions from BAU due to retrofits to single-detached homes)
	ΣBAU * ΣAI * Y = OC

Notes:

- Completing the data requirement points listed above will also benefit the 'New Buildings' modelling section.
- Research conducted by CanmetENERGY on characterization and mapping for the City of Prince George explored the usefulness of BC Assessment data and the potential role of existing housing archetypes derived from ecoENERGY audit records. Results suggest that by combining aspects of these two datasets, that robust characterization of existing single family dwellings, duplexes and row houses can be achieved. Further work needs to be done however to make these datasets available more broadly for community energy and greenhouse gas characterization and mapping purposes.

2. Multi-Unit Residential Buildings

Identify and promote retrofit financing mechanisms for **Multi-Unit Residential Buildings (MURBs)**

<table>
<tr><th colspan="2">Challenge</th><th>Data Requirements / Metrics</th><th>Likely Data Sources</th></tr>
<tr><td>2</td><td>What are the GHG reductions if __ % of multi-unit buildings in Lower Mainland received an energy retrofit (i.e. thermal improvements to building envelope / windows, changes in heating source, solar H/W heating, etc.)?</td><td>▪ Existing building stock profile for Lower Mainland (i.e. dwelling units by type and age)
▪ Average emissions by type (class) of building
▪ Create a Business as Usual (BAU) forecast of emissions from MURBs (now and into the future)
▪ Estimated energy efficiency improvements through ‘average’ retrofit of an existing MURB (Note: may need to look at programs from other jurisdictions to establish an estimate)
▪ Estimate proportion of likely MURB retrofits in Lower Mainland over time (i.e. annual uptake)
▪ Estimate the number of years each retrofit program would be in place</td><td>▪ BC Stats
▪ Statistics Canada Census Data
▪ NRCan – stats from Office of Energy Efficiency or CanmetENERGY group
▪ Need to identify other relevant energy efficiency programs for MURBs to establish proxies (archetypes). If none exist locally, look at data from Ontario or Portland / Seattle
▪ BC Hydro Conservation Potential Review
▪ CMHC research paper ‘Analysis of the Annual Energy and Water Consumption of Apartment Buildings in the CMHC HiSTAR Database’
▪ MK Jaccard and Associates Metro Vancouver paper for estimated improvement in energy efficiency</td></tr>
<tr><td></td><td colspan="3">Policy and financial tools: The use of public endowed funds and public loan guarantees, and OCP policies and targets supporting existing building retrofit and administrative/financial policies.</td></tr>
<tr><td></td><td colspan="3">CEEI Secondary indicator(s): Number of MURB dwellings on a renewable energy district heating system.
Suggested indicator(s): Number of approved applications for funding or loan guarantees.</td></tr>
<tr><td></td><td colspan="3">Generalized algorithm for GHG emissions reduction:
OC = (GHG emissions from MURBs in LM) * (average % improvement from retrofits * annual estimated uptake % in LM) * (program duration in number of years)
OC = Outcome (GHG % reductions from BAU due to MURB retrofits)
NOTE: Completing the data requirement points listed above will also benefit the ‘New Buildings’ modelling section.</td></tr>
</table>

New Buildings: Better Enforcement of BC Building Code & Model Solar and District Energy Ready Bylaws

3. <u>Better Enforcement of the BC Building Code</u>

Improve enforcement of the **BC Building Code** by ensuring that existing energy related standards within the building code are achieved.

	Challenge	Data Requirements / Metrics	Likely Data Sources
3	BC Building Code EnerGuide standard is not being implemented due to lack of expertise. What if all new residential buildings actually met EnerGuide 70? What if the BC Building Code required EnerGuide 80? *What would be the GHG impact on new buildings through a __% improvement in both training and capacity of local government building permit officers, builders and developers?*	▪ Create a Business as Usual (BAU) forecast of emissions from new buildings (by type) based upon current construction code requirements. Denote the mix of natural gas versus electric heating for single-detached homes, MURBs and commercial buildings. ▪ Estimate percentage (%) of potential training 'reach' into various building regulatory professions in Lower Mainland ▪ Estimate the number of years each training program would be in place ▪ Estimate the required increase in number of trained building code / permitting officials in Lower Mainland (i.e. capacity improvements)	▪ Statistics Canada Census Data, to estimate projected population growth, which is proportional to the number of new residential units, for business-as-usual (BAU) ▪ Future changes to BC Building Code, to define Business as Usual (BAU) ▪ NRCan – Check if OEE has stats on effectiveness of training programs for various professions (permit officials, building inspectors, planners, architects, builders /developers). Do figures exist on the effectiveness of MNECB and R2000 training programs? ▪ BC Hydro – See if Hydro has stats on effectiveness of PowerSmart training for regulatory officials, as well as effectiveness of Energy Manager program ▪ CaGBC / LightHouse – May have stats on LEED training effectiveness in BC (note: LightHouse and CaGBC have a number of ongoing training programs for a variety of audiences) ▪ The Building Officials Association of BC provides training for building officials and is a possible future source of energy efficiency training programs.

	Policy and financial tools: Public endowed funds to either: (a) self finance local government building inspections to ensure that Building Code targets are achieved; or (b) to provide grants to non-profit organizations to provide third party inspections, supported by OCP and administrative policies recognizing the importance of providing appropriate resources.
	CEEI Secondary indicator(s): Number of confirmed new energy efficient residential units.
	Generalized algorithm for GHG emissions reduction: **OC** = (Number of new buildings * average GHG emissions per building) * (annual % improvement in training * annual % capacity increase) * (program duration in years) **OC** = Outcome (GHG reductions for new buildings because of better enforcement of the Code)

4. Model Solar and District Energy Ready Bylaws

Working with the Province of BC, develop model bylaws requiring **solar ready** and **district energy ready homes.**

	Challenge	Data Requirements / Metrics	Likely Data Sources
4	*What 'model bylaws' and accompanying regulatory language would encourage solar-ready and district energy-ready new buildings? What is the appropriate wording for development agreements (i.e. compatible with the authority implied through the Local Government Act and Community Charter)?*	▪ Create a Business as Usual (BAU) forecast of emissions from new buildings (by type) based upon current BC Building Code requirements. Denote the mix of natural gas versus electric heating for single-detached homes, MURBs and commercial buildings. ▪ Estimate % of new single-detached homes, MURBs and commercial buildings that would comply with new bylaws and development agreements (i.e. the proportion of new development that would be affected). ▪ Create a BAU estimate of the % of new development that is already DES-ready in Lower Mainland. ▪ Estimate percentage of GHG emission reductions based on the above assumptions.	▪ Statistics Canada Census Data, to estimate projected population growth, which is proportional to number of new residential units, for business-as-usual (BAU) ▪ Future changes to BC Building Code, to define BAU ▪ MCRD – Obtain supporting amendment to be made to the Local Government Act and/or Community Charter allowing local governments to create a 'solar-ready bylaw'. ▪ MEMPR – Check status and timing of Province of BC's *Super Efficient New Construction Program* ▪ SolarBC– Derive baseline figure on current take-up of SolarBC residential retrofit program in BC ▪ BC Hydro / Terasen – See if utility companies have estimates of District Energy-ready new development in Lower Mainland (i.e. buildings of suitable density near existing or planned district energy locations that would connect)
	Policy and financial tools: Development of solar-ready and district energy-ready bylaws (assuming Provincial framework allowing local governments to require these) and local service area (or hydronic heat energy services) bylaws requiring connection, and OCP policies supporting the use and development of renewable energy and district energy.		
	CEEI Secondary indicator(s): Number of dwellings on a renewable energy district heating system. **Suggested indicator(s):** Number of local governments who have opted to require either solar or district energy readiness by creating bylaws.		

	Generalized algorithm for GHG emissions reduction – Solar Ready Bylaw: **OC** = (Average GHG emissions per building) * (annual N^o. of new buildings already affected by SolarBC programs – annual N^o. of non-participating that would become solar ready because of bylaw) * (program duration in years) **Generalized algorithm for GHG emissions reduction – District Energy Ready Bylaw:** **OC** = (Total GHG emissions from heating and cooling of new buildings in LM) * (1 - % of new buildings in LM already DES-ready) * (% of DES-ready connecting - % of non-ready that would connect)

5. Coordination of Build to Zero actions with BC Utility Providers

Both BC Hydro and Terasen are actively engaged with local governments in BC through various energy efficiency programs and knowledge transfer in areas of integrated energy planning / district energy. Both of these utility providers are already involved in the overall ***Build to Zero*** initiative, and will provide advice and knowledge support to the local government working groups.

BC Hydro is a regulated Crown corporation engaged in climate action through a wide variety of demand side management programs. **Terasen** is a regulated private utility company engaged in innovative energy solutions both through demand side management requirements and investments in alternative energy. By 2050 Terasen predicts that a significant portion of its business will be comprised of district energy, biogas, natural gas vehicles, geoexchange and solar hot water heating systems.

	BC Hydro	**Terasen**
Energy Efficiency in Buildings	<u>Power Smart Program – Residential</u> A wide variety of assistance for the residential sector, including: • Rebates, savings and other incentives for retrofits • Advice and information on building retrofits • Working with builders and developers for new homes <u>Power Smart – Commercial & Institutional</u> A wide variety of assistance for the commercial and institutional sector, including: • Financial incentives, e.g. for Energy Managers, energy surveys, or through the Product Incentive Program for retrofits (lighting, controls, HVAC, refrigeration, kitchens) • Advice on technologies, energy efficient design, employee awareness, new buildings • Advice and information specific for energy managers	<u>Renewable Energy/Energy Efficiency</u> Terasen builds, owns and operates alternative energy systems for new buildings and building retrofits. Technologies actively being deployed include geoexchange and solar hot water. <u>Energy Efficiency and Conservation</u> Terasen provides incentives to developers, builders, building owners and owners' designated representatives, such as property managers, to encourage the use of high efficiency, natural gas space and water heating systems, as well as commercial cooking appliances. <u>Information and Advice</u> Free information and advice to residential and commercial sectors is provided on the website, and customers spending more than $20,000 a year on natural gas qualify for a free energy assessment.

	BC Hydro	Terasen
Energy Efficiency in Buildings (cont'd)	Power Smart – Industrial A wide variety of assistance for the industrial sector, tailored for small, medium, and large industry, including: • Financial incentives, e.g. for Energy Managers (for medium to large electricity users), projects, energy surveys • Energy Management Initiatives, e.g. workshops, employee energy awareness • Free site assessments for small & medium electricity users • Free assistance for new plant design, and financial incentives for implementation	
Energy and Emissions Planning, (including District Energy and Renewable Energy)	Power Smart – Sustainable Communities Program A wide variety of assistance to local governments and other organisations to assist the development of sustainable communities, including: • Funding for Community Energy Managers for local governments • Funding for Community Energy & Emissions Plans for local governments • Funding for energy design charrettes • Capital incentives for district energy implementation • Funding for district energy studies for local governments, developers, and other organisations	District Energy and Renewable Energy Systems Terasen collaborates with developers and communities to identify opportunities for district energy systems utilizing renewable energy sources such as biomass, waste heat recovery and geoexchange. Terasen offers municipalities various collaboration options to help meet renewable energy targets, deliver value, and provide affordable energy to end users.
Vehicles	BC Hydro is preparing for the impacts of electric vehicles to the grid. It is conducting a distribution grid impact study, has developed charging infrastructure guidelines, and is also engaged in marketing the region to electric vehicle suppliers as a location for development and early deployment.	Terasen promotes fleet use of natural gas vehicles (NGVs) and provides incentives to offset up to 100% of the incremental cost of purchasing NGVs. Terasen is also working with industry partners to provide compressed natural gas or liquefied natural gas fueling infrastructure for natural gas fleets. The focus is on fleets that return to base for fueling. Eligible fleet vehicles include light, medium, or heavy duty vehicles including tractor trailers. Total grant funds available per year are limited.

	BC Hydro	Terasen
Other	BC Hydro also supports programs and organisations that help promote energy efficient communities such as Community Action on Energy and Emissions, Smart Planning for Communities, QUEST BC (Quality Urban Energy Systems for Tomorrow), and the Community Energy Association.	Terasen also supports programs and organisations that help promote energy efficient communities such as QUEST BC (Quality Urban Energy Systems for Tomorrow), and the Community Energy Association.

Sources

Bell, Patricia, Dale Littlejohn, and Laura Porcher: *BC Initiatives: Meeting Community GHG Reduction Targets in Buildings*, Municipal World, August 2009

Fraser Basin Council and Community Energy Association: *Energy Efficiency & Buildings: A Resource for BC's Local Governments, Fraser Basin Council, 2009*

Appendix A: Canadian Institute of Planners Climate Change Policies

CIP ENDORSES THE FOLLOWING ACTIONS TO ENSURE PLANNERS CONTRIBUTE TO MITIGATING AND ADAPTING TO CLIMATE CHANGE:

1. CIP will champion action on climate change policy nationally and internationally.
2. CIP will facilitate the exchange of information between the scientific community and professional planners to make sure our members have access to the best available information on climate change, in language that is easily understood.
3. CIP will empower its members to consider climate change in their actions and recommendations within the broad ambit of planning activities (including for example, long-range plan preparation, development approval, planning for energy, infrastructure and transportation, resource management) in order to:
    a. minimize risks associated with extreme events and with the cumulative effects of climate change;
    b. protect natural resources and habitats;
    c. ensure no adverse public health effects;
    d. build resilience into communities; and
    e. take advantage of mitigation and adaptation techniques, whenever possible.

4. Given that mitigation efforts alone cannot avoid further impacts of climate change, CIP will increase the knowledge and skills amongst its members to develop suitable adaptation strategies to enable communities to manage the effects of climate change and minimize adverse impacts.
5. In keeping with policies 3 and 4 above, CIP will support its members by:
    a. commissioning applied research that addresses climate change challenges from a planning perspective;
    b. supporting demonstration projects in climate change mitigation and adaptation strategies and methods;
    c. developing and disseminating best-practice recommendations for climate change mitigation and adaptation planning; and
    d. designing climate change educational resources for use in continuous professional learning (CPL) and academic programs.

6. CIP will work collaboratively with universities and other post-secondary institutions to ensure climate change is integrated into the curriculum for planners.
7. CIP will continue to work with Natural Resources Canada and Environment Canada for the development and consolidation of reliable data, adaptation tools and mitigation techniques that are usable at the regional and local level.
8. CIP will issue a Report Card to monitor how well this policy is being implemented

Appendix B: Language for Solar Ready Bylaw

1. Province of BC's Proposed Solar Hot Water Ready Requirement Options for Single Family Homes

In response to interest from a number of local governments in BC, the Province is proposing an optional requirement that would enable local governments to mandate that all new single family dwellings within their communities be solar hot water ready. The proposed requirement would only apply in local government jurisdictions that voluntarily adopt it. The proposed Solar Hot Water Ready requirement for single family homes would apply in jurisdictions where required by local government bylaw. Creating a Solar Hot Water Ready requirement that local governments can choose to adopt will provide consistent provisions across BC. The proposed Solar Hot Water Ready requirement for single family homes would apply in the following areas:

- Required roof space for solar collector
- Mandatory roof loading requirement
- Conduit specifications

Possible Language - Areas Designated for Future Installation of Solar Collectors

1) An area designated for installation of solar collectors for a Solar Domestic Hot Water System shall allow for the installation of a solar collector that

a. has unobstructed access to sunlight when construction of the building is commenced, and
b. has an area of not less than 2.7m by 2.7m

2) Structural members of areas designated for installation of solar collectors for a Solar Domestic Hot Water System shall be designed to accommodate the anticipated load or a minimum additional load of 0.2 kpa in addition to design loads required by the British Columbia Building Code.

Possible Language - Conduit Requirements

1) One or more straight, continuous, conduits shall be provided that extend from the area directly adjacent to each dwelling unit's primary service water heater to

a. an accessible attic space adjacent to the roof area designated for installation of solar collectors for a Solar Domestic Hot Water System,
b. the roof space designated for installation of solar collectors for a Solar Domestic Hot Water System, or

c. the exterior wall surface directly adjacent to the area designated for installation of solar collectors for a Solar Domestic Hot Water System.

2) The conduit(s) described in Sentence 5.2.(1) shall

a. be accessible at both ends,
b. be capped or sealed at both ends to prevent water ingress and air leakage,
c. be identified by markings that are permanent, distinct and easily recognized,
d. have a minimum inside diameter of 50mm if two conduit runs are provided, or 100mm if only one conduit run is provided, and
e. be able to accommodate the installation of insulated plumbing services for a Solar Domestic Hot Water System in conformance with CAN/CSA-F383-87.

For more information visit BC's Housing and Construction Standards website at:

http://www.housing.gov.bc.ca/building/consultation/shwr/index.htm

2. **Vancouver's Green Homes Program – Requirement for Pre-piping for Roof-mounted Solar Energy Generation**

Vancouver's Green Homes Program requires that every new house be equipped with two 50 mm (2 inch) pipes that run from the home's service room (where the water tank is) to the attic. This will allow for the future installation of roof-mounted solar energy generating equipment without needing to tear open walls and ceilings. In addition, these pipes are suitable for use with either solar hot water or solar photovoltaic energy systems, giving the future homeowner the greatest amount of flexibility.

By-law No. 9691 – Green Building for one family homes, one family homes with secondary suites and two family homes
Pre-piping for roof mounted solar energy generation

12.2.2.9. Vertical Service Shaft

1) A solar ready pipe run, consisting of at least two 50 mm pipes, capped at both ends and having at least a 20° angle measured above the horizontal level, shall extend from a location in close proximity to the service water heater to the attic space.

http://vancouver.ca/commsvcs/CBOFFICIAL/greenbuildings/greenhomes/

Other Sources of Information:

The Canadian Solar Industries Association

CanSIA has prepared guidelines for homeowners, renovators, architects, designers and builders that outlines how homes can be made solar-ready either during construction or major renovations. The Solar Ready Technical Guidelines, found at the link below, outline requirements for roof orientation, utility room size and other parameters, and piping.

http://www.cansia.ca/government-regulatory-issues/provincial/solar-ready

Natural Resources Canada's Solar Ready Homes Guidance

This guideline defines the term "solar ready" and discusses various factors associated with installation, including costs. Oriented towards consumers, the guideline is applicable to both solar domestic hot water systems and photovoltaic systems for new homes.

http://oee.nrcan.gc.ca/residential/personal/new-homes/solar-homeowner.cfm?attr=4

Appendix C: CEEI Secondary Indicators Related to Buildings

Indicator	Measurement Units	Data Source	Update Frequency	Comments
B-1: New Energy Efficient Residential Units	Number of new units built annually Note: Energy efficiency to be defined against relevant energy standards (e.g. -BuiltGreen, R-2000, EnerGuide 80, LEED certified).	BC Home Builders Association Canadian Green Building Council Local Governments	Annual	Shows uptake rate of green building practices in the residential market. Provides a measure of action. Suggest not calculating as a % of total new dwellings as total new dwellings is not tracked in all municipalities and would be challenging to calculate annually for all communities.
B-2: New Energy Efficient Commercial/Institutional Buildings	a) number of new buildings built annually b) total new floor space built annually Note: "Energy efficient" means either LEED Certified or higher	Canada Green Building Council; Occupancy Permits from the Municipality, if available, if not available, use Building Permits, B.C. Assessment Authority data	Annual	Shows uptake rate of green building practices in the commercial market. Provides a measure of action.
B-3: Existing Home Energy Evaluations	Number of existing homes evaluated for EnerGuide rating through Federal EcoEnergy Initiative	EnerGuide data base at NRCan	Annual	Existing homes are a key area for reducing energy consumption and this indicator helps capture this. Note that while a home may be evaluated, this does not indicate that the homeowner has conducted energy retrofits (but this is more difficult to track)
B-4: Dwellings on Renewable Energy District Heating Systems	Number of dwellings on a district energy system with a renewable energy source (e.g. biomass) or geo-exchange.	Requires contacting providers of individual systems (e.g. district energy system providers), as there is no central reporting capability. The B.C. utilities commission will have data on regulated district energy systems, but there are a number that are self regulated (e.g. Lonsdale), or not regulated at all (e.g. Halcyon). Geoexchange B.C. might have some information for geo-exchange systems.	Annual	Related intent to LES-1. If data is available, would provide an indication of the uptake of a relatively new to B.C. technology. Solar Domestic hot water systems (single dwelling) may be tracked as the Provincial Climate Change Plan (June 2008) includes a 100,000 solar roofs initiative.

Source: The Sheltair Group, *Community Energy & Emissions Inventory (CEEI) Secondary Indicators for Community Inventory Interpretation*, June 2008 http://www.env.gov.bc.ca/epd/climate/pdfs/ceei-second-indicators.pdf