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Evolution of *Energy Efficiency Requirements* in the BC Building Code

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1. INTRODUCTION

Achieving market transformation towards net-zero buildings in British Columbia (BC) will require a multitude of policy tools, including incentives, funding, training, improvements in compliance and enforcement, benchmarking, a strong carbon tax, and building regulations. Net-zero buildings are generally defined as highly efficient buildings that produce as much energy as they use averaged over the course of a year on site (or nearby). High energy efficiency buildings where energy use has been reduced to a level such that it could be generated on site are often labelled as 'ultra-low energy' or 'net-zero ready'.[1]

Along with its Pacific Coast Collaborative partners (California, Oregon, and Washington), BC has committed to "lead the way to 'net-zero' buildings"[1] but it has yet to define its target nor a plan of how to get there. The technology and know-how already exists for designing, building, and operating net-zero and ultra-low energy buildings, and their numbers are increasing rapidly (Figure 1). However, since these buildings represent only a small fraction of the market; much needs to be done before net-zero buildings become the norm rather than the exception.

This paper focuses specifically on the role and history of building regulations in accelerating energy efficiency. Other policies are discussed further in the second paper in this series.[iii] And while energy performance requirements in the BC Building Code (BCBC) are improving, they are still far from being on track to be 'net-zero ready'. The last targets for the building sector set in BC date back to the 2008 Energy Efficient Building Strategy,[iv] but the strategy did not explicitly lay out how the BCBC would be subsequently amended to achieve these targets, and there has been no official reporting on progress to meet them. 2013-14 updates to the BCBC introduced new energy efficiency requirements for large and complex buildings over 600 sq. m (Part 3 buildings) and small buildings and houses, 3 storys or less (Part 9 buildings),[2] which are a step in the right direction, but still lack the level of ambition indicated by the commitment to "lead the way to 'net-zero.'"

To understand the context for the 'net-zero' objective, this white paper reviews the recent history of energy efficiency in the BCBC, focusing on Part 3 buildings. It then compares this history to that of Ontario, which has used stretch codes[3] and target setting effectively to prepare for upcoming code changes and increase their predictability. Synthesizing the performance gains from recent energy code revisions, we characterize their pace and then project how fast 'status quo' would get us near to net-zero.

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[1] While there is no unique definition for "net-zero ready" or "nearly zero-energy building" (the label used in the European Union), surveys of buildings that have been certified after at least a year of operation as net-zero buildings show that their energy use is approximately 25% of average building energy use (about 80% better than MNECB). The average EUI is 21 kBTU/sf/yr (66 kWh/m2/yr), and most of them have an actual total building energy use intensity of less than 30 kBTU/sf/yr (95 kWh/m2/yr) (New Buildings Institute, 2014 Getting to Zero Status Update, 41).

[2] Part 3 buildings include public assembly, care, detention, high hazard industrial, and post-disaster buildings, along with any construction of more than three storys or 600 m2 in area. Part 9 buildings include commercial, residential, and low-to-medium risk industrial buildings of three storys or less. B.C. Building Code, 2012, Division A, Section 1.3, article 1.3.3.2 and 1.3.3.3.

[3] Stretch codes are energy codes that go beyond the base code and that are either adopted by local governments as an opt-in code or used to set requirements for rezoning or incentives.

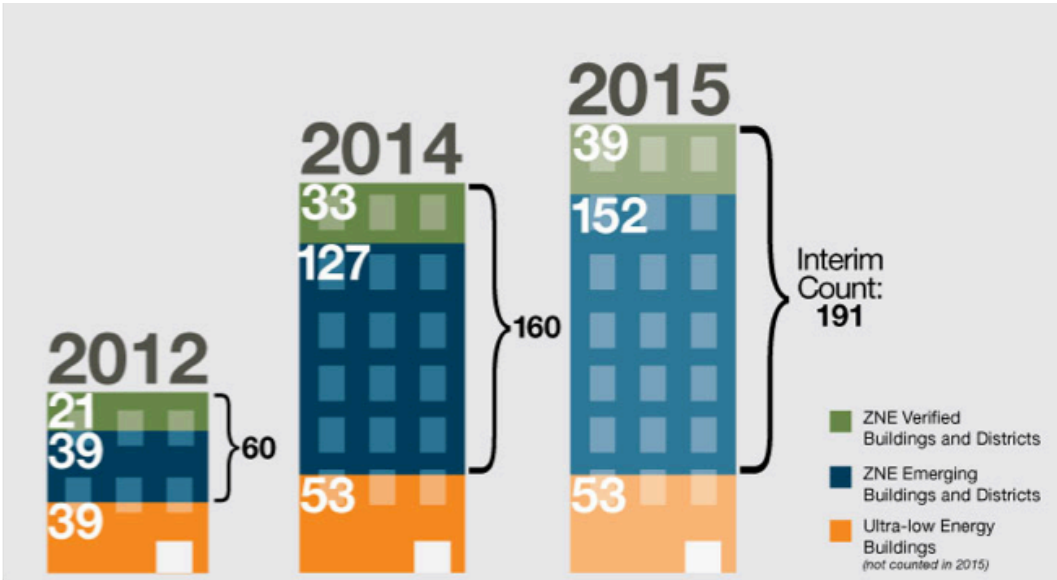

Figure 1. Growth of zero net energy buildings in North America Source: New Buildings Institute

2. THE ROLE OF ENERGY REQUIREMENTS IN BUILDING CODES

Historically, the primary purpose of building codes has been to set minimum standards to ensure structural integrity, fire protection, thermal comfort, air quality, and other factors affecting safety, health and accessibility. Energy codes (and energy standards[v]), on the other hand, focus explicitly on aspects of building design that affect energy use, such as building envelope, electrical lighting, mechanical heating, cooling & ventilation systems, and hot water systems. Energy standards are generally developed independently from building codes and are updated on a regular basis. Code-setting jurisdictions can choose which version they adopt (if any) and make amendments before incorporating these requirements into their building code. There are two such jurisdictions in BC: the City of Vancouver via the Vancouver Building Bylaw and the province via the BC Building Code.

The ASHRAE 90.1 standard is the basis of most energy codes in North America. It is developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASRHAE), in collaboration with the Illuminating Engineering Society (IES) and the American National Standards Institute (ANSI). It was first introduced in 1989 and is revised every three years. The 90.1 standard is adopted, by reference, by the International Energy Conservation Code (IECC), developed by the International Code Council in the US The IECC applies both to commercial and residential buildings, but is mostly used in the US to set a standard for energy use in residential buildings, while ASHRAE 90.1 is used for commercial and multi-family high rise buildings.[vi]

Canada's first energy code, the Model National Energy Code for Buildings (MNECB), was developed in 1997 by a consortium of industry stakeholders, provinces, utilities, the National Research Council of Canada, and Natural Resources Canada's Office of Energy Efficiency. It was revised in 2011 and renamed the National Energy Code for Buildings (NECB 2011). The next revision has been mostly completed and is anticipated to be released in 2015.

Following common usage in the Canadian literature, we use in this paper the MNECB 1997 as a baseline against which to rank and evaluate the energy performance of other energy codes (i.e. as % better than MNECB).

3. EVOLUTION OF ENERGY EFFICIENCY REQUIREMENTS IN BC BUILDING CODES

Building regulations have a short history in BC In September 1973, BC adopted its first provincial building code (reg # 140/73), an adaptation of the 1970 National Building Code (NBC). Prior to that date, local governments each adopted their own building codes under local bylaws. A 1973 amendment to the Municipal Act gave the provincial government the power to make regulations establishing a provincial building code that would apply consistently across the province. It had no provisions for the inclusion of energy efficiency considerations.

From this point on, the BC Building Code has been based on the National Building Code five-year cycle. BC generally adopts the latest NBC and brings it into force a year or two after its release.[vii] Aspects of the building's energy systems, like sizing of heating equipment, insulation levels and window thermal breaks, were gradually integrated, but mostly for the purpose of ensuring building durability and the health and comfort of the occupants.

In 2005, the province released its first Energy Efficient Buildings Strategy (EEBS), setting targets for new Part 3 buildings to perform 25% better than MNECB and for new residential houses to be rated at EnerGuide 80 by 2010.[viii] This strategy, however, did not call explicitly for changes in building code; instead, savings were to be driven through equipment regulations under the provincial and federal Energy Efficiency Acts, as well as other market transformation measures such as training, incentives, and home energy labelling.

Meanwhile, the City of Vancouver, granted by its charter the right to set its own building code, had been setting minimum energy efficiency requirements though its building bylaws. In 1991, the City adopted the first ASHRAE 90.1 standard (90.1-1989) through its Energy Utilization By-law.[ix] In 2004, the bylaw was updated to refer to the stricter ASHRAE 90.1-2001 (equivalent to about 13% better than MNECB).[x] By 2007, Vancouver had moved to ASHRAE 90.1-2007 with an estimated performance gain of 26% over MNECB.[xi] Thus, the City of Vancouver has led the way in piloting energy efficiency requirements in a building code.

The province's EEBS was revised in 2008, updating the targets to an overall 9% reduction in energy use per square metre of commercial/institutional floor space and a 20% reduction in energy use per household, by 2020 for both existing and new buildings.[xii,xiii] Shortly after, the 2006 BCBC was amended to include energy efficiency and water conservation as explicit objectives:

> *An objective of this Code is to limit the probability that, as a result of design, construction or renovation of a building, the use of energy or water will be unacceptably inefficient or the production of greenhouse gases will be unacceptably excessive.*

To achieve this objective, a new part was added to the code (Part 10), which set energy and water efficiency requirements for Part 9 and Part 3 buildings. Part 9 buildings had to meet minimum insulation levels, or show that they could perform to a level equivalent to an EnerGuide rating of 77 or more,[4] while Part 3 buildings where required to comply with ASHRAE 90.1-2004.[xiv] A modelling study conducted in 2011 estimated that compliance with ASHRAE 90.1-2004 should

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[4] It is worth noting that very few builders actually used this performance compliance path, likely because the resulting performance required (EnerGuide 77) was much higher than that achieved by following the prescriptive route (which generally lead to ratings of EnerGuide 69 to 72). Frank Murray, personal communication, August 15, 2014.

result in energy savings of 23% beyond MNECB, on average.[xv] Thus, barring significant performance gaps between modelled and actual energy, adoption of the 90.1-2004 standard in 2008 contributed a significant step toward meeting the target set for new buildings in the 2005 Energy Efficient Buildings Strategy (25% below MNECB by 2010). Since the new code only applies to new construction (and, at the discretion of the local authority, to some major renovations), its contribution to the 2020 target set by the 2008 EEBS was to be limited.[xvi] The rest of the savings were to come from other policies, such as provincial and federal energy efficiency regulations for equipment, LiveSmart BC incentives, utility demand-side management plans, and actions taken under the BC Climate Action Plan, such as the instigation of the carbon tax.[xvii]

In September 2012, BC launched a new edition of the provincial building code (BCBC-2012); at its release, energy requirements remained unchanged from 2008, despite previous announcements that new energy efficiency revisions would rise to an equivalent of EnerGuide 80 by 2010 or 2011.[xviii] New energy efficiency provisions were delayed by a few more years, being adopted as a code revision in April 2013, and coming into force in December 2013 for Part 3 buildings and December 2014 for Part 9 buildings. The City of Vancouver adopted the same energy requirements for Part 3 soon after (January 2014) and developed its own requirements for Part 9. In June, it also revised its Green Rezoning policy to require LEED Gold including six energy points (equivalent to a 22% energy cost saving above 90.1-2010).[xix] It also revised its Higher Building policy, which applies to buildings seeking approval for significant additional height above current zoning and policy, and which should aim to achieve a 45% energy savings beyond 90.1-2010.[xx]

Table 1 below outlines the various increases in energy efficiency in both the BCBC and VBBL from 1973 until present, showing how the City of Vancouver has acted as a leader in the enactment of energy codes. The impact of the new energy code for Part 3 buildings is discussed in the next section.

Table 1: Chronology of energy efficiency improvements in B.C

Jurisdiction	Regulation	Enacted	First compliance deadline	Standard referenced	Estimated performance gain over MNECB
B.C.	BC Building Code (reg #140/73)	1973	Sept. 1, 1973	No comprehensive requirements for EE	N/A
Vancouver	VBBL Energy Utilization Code	Aug. 15, 1991	Fall 1991	ASHRAE 90.1-1989	-4.6% to -3%[i]
B.C.	BC Building Code (reg #383/93)	1993	21 Feb 1994	Insulation requirements (Part 9 only)	N/A
Vancouver	VBBL Energy Utilization Code	June 8, 2004	~ August 2005	ASHRAE 90.1-2001	13%[ii]
B.C.	BCBC-2006 (#216/2006)	July 17, 2006	Dec. 15, 2006	No comprehensive requirements for EE	N/A
Vancouver	VBBL 2007 (#9419)[iii,iv]	Jan. 30, 2007	May 1, 2007	ASHRAE 90.1-2007	26%[v]
B.C.	BCBC-2006 r2[vi]	April 15, 2008	Sept. 5, 2008	ASHRAE 90.1-2004	23%[vii]

B.C.	BCBC-2012[xxviii] (#264/2012)	Sept. 7, 2012	Dec. 20, 2012	ASHRAE 90.1-2004	23%
B.C.	BCBC-2012 r2[xxix] (#167/2013)	April 5, 2013	Dec. 20, 2013	ASHRAE 90.1-2010[xxx] or	33%[xxxi]
				NECB 2011	37%[xxxii]
Vancouver	Amendment to 2007 VBBL (#10852)[xxxiii,xxxiv]	Jan. 21, 2014	Jan. 21, 2014	ASHRAE 90.1-2010 OR NECB 2011	As above
Vancouver	Green Building Rezoning policy[xxxv]	June 25, 2014	June 25, 2014	LEED gold + 22% energy cost savings above 90.1-2010	48%[xxxvi]
Vancouver	Higher Building policy [xxxvii]	June 25, 2014	June 25, 2014	45% energy savings above 90.1-2010	63%

A national counterpoint: energy efficiency in the Ontario Building Code and the Toronto Green Standard

Ontario has a longer history of integrating energy efficiency considerations in its building codes, as discussed below. It offers a useful example of how the predictability of code changes can be increased through the use of 'stretch' codes — energy codes that go beyond the base code and that are either required or incentivized by leading jurisdictions within the province.

Ontario was the first Canadian province to adopt a comprehensive energy code into its building code. The province first established energy efficiency requirements for houses in 1991 with the release of the 1990 Ontario Building Code (OBC).[xxxviii] Two years later, OBC-1990 was amended to require Part 3 and non-residential Part 9 buildings to comply to ASHRAE 90.1-1989, with a few Ontario-specific modifications. The energy code was further amended in OBC-1997, allowing builders to comply either with ASHRAE 90.1-1989 or MNECB.[xxxix]

The 2006 Ontario Building Code introduced for the first time an explicit objective on resource conservation. It continued the dual compliance option, allowing builders to comply either with ASHRAE 90.1-2004 or with a modified MNECB (modifications outlined in Supplementary Standard SB-10). These new requirements offered energy savings of about 17% over the original MNECB.[xl] Most significantly, the next step in energy performance improvement was announced when the new code was launched: the next performance increment would come five years later and target savings of 25% above MNECB 1997.[xli] This advance notice of the next code increment can be very useful in preparing for the higher level of performance required, particularly for manufacturers, who can get a head start in preparing the next line of energy efficient products.[xlii]

As the province advanced energy codes, so did the City of Toronto. Unlike Vancouver, the City of Toronto does not have its own building code. The City of Toronto instead uses the City of Toronto Act to require higher energy performance requirements for new construction, above the Ontario Building Code. The City recognizes that high performance buildings are essential in a rapidly growing urban region, and targets greenhouse gas emission reductions of 80% by 2050.[xliii] The first Toronto Green Standard (TGS) took effect in January 2010 and energy efficiency targets were set at 25% below MNECB which then became the code requirements in 2012. The TGS covers a range of environmental performance measures grounded in the local planning context, including water conservation, transportation infrastructure, solid waste, ecology and energy.[xliv]

The TGS is a two-tier system, where Tier 1 is mandatory and implemented through development approvals and Tier 2 is a voluntary package of stretch targets incentivized through significant reductions in development charges paid at building permit stage. For Part 3 and non-residential Part 9, the energy targets for TGS-2010 were set at 25% better than MNECB (10% better than OBC-2006) for Tier 1; and 35% better than MNECB (22% better than OBC-2006) for Tier 2.[xlv] Between February 1, 2010 and April 30, 2015, 75 projects (about 15% of total eligible projects) pursued Tier 2 level and incentives.[xlvi]

Updating the energy codes: a predictable affair

In January 2012, as announced five years earlier, the Province of Ontario adopted its next step in energy efficiency. This new step was set to the level of performance equivalent to that of the first level of stretch code. The OBC-2012 provided prescriptive energy requirements based on ASHRAE 90.1-2010, equivalent to the target previously adopted in the TGS-2010 Tier 1: 25% better than MNECB.[xlvii] At the same time, the province announced the schedule for the next update in energy efficiency, giving developers an early notice that by January 1, 2017, a new energy code would require 13% better than OBC-2012 (35% better than MNECB) — a level of performance equivalent to the second level of stretch code (TGS Tier 2).[xlviii]

About a year after the Province of Ontario adopted OBC-2012, Toronto City Council revised the thresholds for its own standard, which came into force at the same time as the new OBC requirements, in January 2014. The TGS-2013 targets for Part 3 and non-residential Part 9 were set at 15% better than OBC-2012 for Tier 1 (equivalent to the TGS-2010 Tier 2 performance); and 25% better than OBC-2012 for Tier 2 (or 44% better than MNECB).[xlix]

Table 2: Evolution of base and stretch energy codes in Ontario Source: Oh and Manikel [l]

	Energy performance required (relative to MNECB)		
	OBC-2006	OBC-2012	OBC-2017
Base code (OBC, required province-wide)	17%	25%	35% (announced)
Stretch level 1 (TGS Tier 1, required in Toronto)	25%	36%	tbd
Stretch level 2 (TGS Tier 2, incentivized in Toronto)	35%	44%	tbd

One of the most striking contrasts with the evolution of energy efficiency in BC is the regularity and predictability of performance increases in the OBC and TGS. Since 2006, energy efficiency increments have been announced one cycle ahead, letting the development community know both the timing and the level of the next increment. These increments have matched those of the stretch code implemented by Toronto, where developers have established the feasibility of these targets. As leading developers aim for the Tier 2 incentives, they not only prepare the way for the next Toronto base code, but also establish the feasibility of the level of performance that could be required by the OBC two code cycles down the line — as illustrated by the announcement that OBC-2010 would require performance equivalent to the TGS-2010 Tier 2. Once feasibility of higher performance requirements has been established in Toronto's competitive market, these are more easily adopted province-wide.

Figure 2 illustrates the integration of stretch codes and base code in Ontario. While energy codes in BC and City of Vancouver are targeting higher energy savings (relative to the MNECB baseline, which varies regionally), the approach is more ad hoc and does not, as of yet, leverage the two Vancouver 'stretch' steps (the Green Rezoning and Higher Building polices) to define targets for province-wide base codes.

This is despite the fact that over 60% of large residential and commercial buildings in Vancouver are subject to rezoning (and estimated 30% of all new development),[li] making the Green Rezoning policy a very effective policy for higher energy efficiency, and a useful baseline for feasibility of adopting similar performance requirements in the base code (at least for the south coast region).[5]

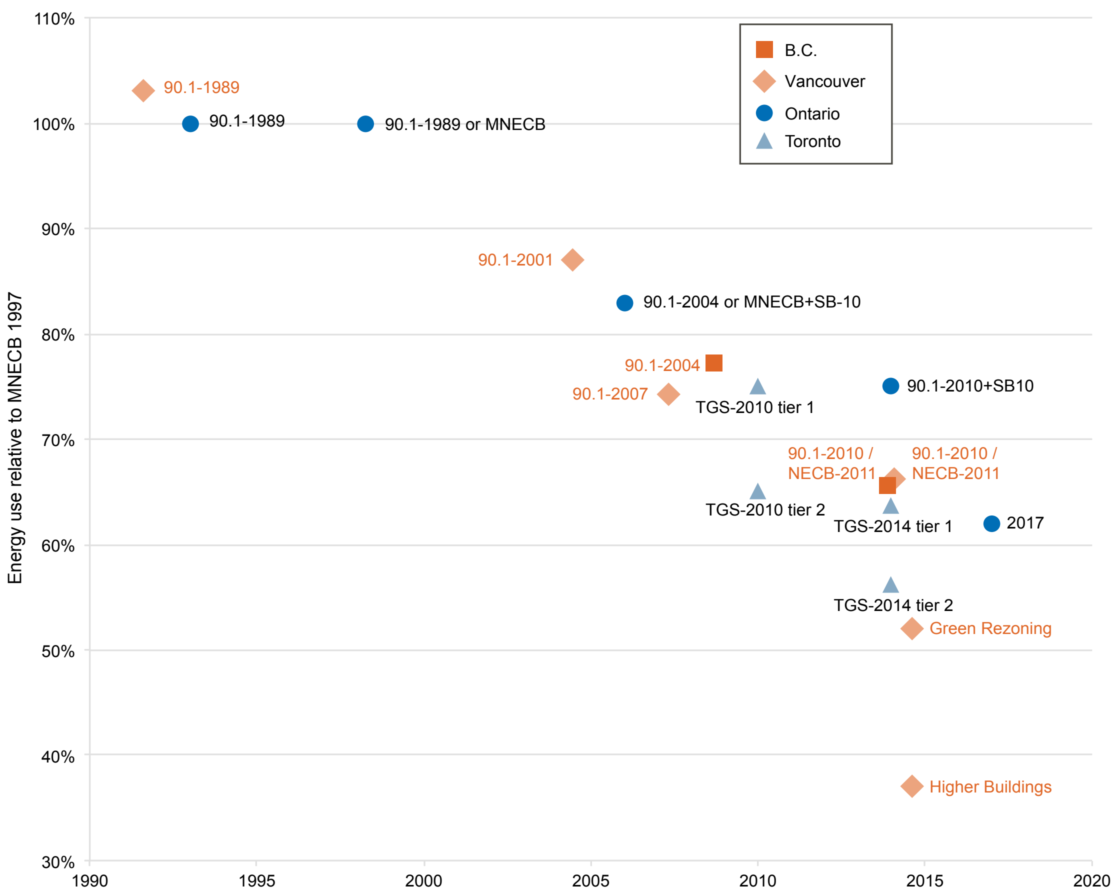

Figure 2. Evolution of energy performance requirements in B.C. and Ontario

[5] The City of Vancouver is not the only municipality to have used rezoning policies or density bonusing to require higher energy efficiency standards; see for example the City of North Vancouver (http://www.fraserbasin.bc.ca/_Library/CCAQ/caee_manual_2009.pdf), Surrey (http://www.surrey.ca/files/2013-09-density_bonusing_v3.pdf), Kamloops (http://www.kamloops.ca/communityplanning/pdfs/northshore/08-DevelopmentCheckList.pdf) and Ladysmith (http://www.ladysmith.ca/docs/bylaws/1860-zoning-bylaw.pdf).

4. IMPACTS OF LATEST ENERGY CODE FOR PART 3 BUILDINGS

Section 3 discussed the evolution of codes in BC, including the most recent 2013 change. This section takes a deeper look at that change to examine the specific reductions in energy use we can expect to see going forward.

A code revision adopted in April 2013 (BCBC-2012 r2) introduced new energy efficiency measures to the BC Building Code, requiring Part 3 buildings to comply either with ASHRAE-90.1-2010 or NECB 2011 by December 2013.[lii] Vancouver also adopted these two standards, replacing ASHRAE 90.1-2007 as of January 2014.[liii] Which of the two standards is used for compliance is left up to the developer since the two standards have different requirements for different regions and uses. This can have an important impact on final performance.

Based on two modelling studies, expected energy savings over the previous BCBC energy code (ASHRAE 90.1-2004) range from 10% to 30% under NECB 2011 and 9% to 33% under ASHRAE 90.1-2010, depending on building type and climate zone.[liv, lv, lvi] Generally, commercial archetypes (e.g. mid-rise commercial, big box retail) are expected to show greater savings under the new code than multi-unit residential buildings, as the high lighting loads in commercial buildings offer significant saving opportunities. As can be expected, increased insulation requirements lead to larger performance gains in northern and interior regions of the province than in the south coast climatic region. Which of the two standards is the most stringent changes from building to building based on design assumptions. Generally, NECB 2011 requires higher insulation levels, boiler and furnace efficiency, and lower infiltration from fenestration. Averaging savings over all the archetypes and climate zones, NECB yields an average savings of 18% above previous code, 5% more than the average for ASHRAE 90.1-2010 (13%, Table 3). If for each archetype the most lenient of the two standards (and therefore likely the lowest cost option) is selected, the averaged energy savings across all archetypes would be reduced to 11%. If, on the other hand, the most energy efficient standard was selected each time, the average savings would increase to 30% (Table 3).

Table 3: Energy savings from ASHRAE 90.1-2010 and NECB 2011 compared to ASHRAE 90.1-2004

		ASHRAE 90.1-2010	NECB 2011
Average energy savings*	South coast	13%	16%
	Southern interior	11%	18%
	Northern interior	18%	24%
	B.C. average	**13%**	**18%**
	Systematically selecting lowest cost standard	11%	
	Systematically selecting higher efficiency standard	30%	
Average GHG savings		15%	16%
Average cost increment		0.7%	1.2%

* Relative to 90.1-2004, averaged over the multi-unit residential, mid-rise office, and big box store archetypes in Stantec and Hepting (except for GHGs and cost increment figures, which are from Stantec only)

Averaging energy savings for all archetypes and regions in the two studies gives an overall estimated savings of 15%. It should be noted that both modelling studies used the prescriptive paths to construct their archetypes. Proponents also have the option to use the trade-off or performance path, which can be more lenient.[lvii] Given the complexity added by allowing six different compliance paths (three for each standard), uncertain compliance rates, and the already existing performance gap between 'as designed' and actual energy use, it is difficult to predict what the effective energy performance gains from the new code will be. An overall improvement in the range of 10% to 15% seems likely, particularly for areas with the largest amount of Part 3 development in the province (south coast).

The GHG emissions reductions resulting from the new code were estimated by the Stantec study only, and average 16% over all regions and archetypes (ranging from 6% for mid-rise residential to up to 30% for mid-rise commercial, mostly due to increase use of heat recovery in this archetype).[lviii]

The average incremental cost of the improved energy efficiency measures is below 1% of total construction cost, with average simple payback ranging from less than a year to six years for mid-rise residential and mid-rise commercial, and from three to 26 years for big box retail.[lix]

Overall, updating the BC energy code from ASHRAE 90.1-2004 to ASHRAE 90.1-2010 and NECB 2011 will provide modest energy savings (~10-15%) and GHG reductions (~16%) for a small construction cost increment (~1%). These are relatively small gains when we consider that the previous changes to the energy code were made six years prior, in 2008.

If we assume future energy code iterations will follow a similar pace, 10–15% improvement over

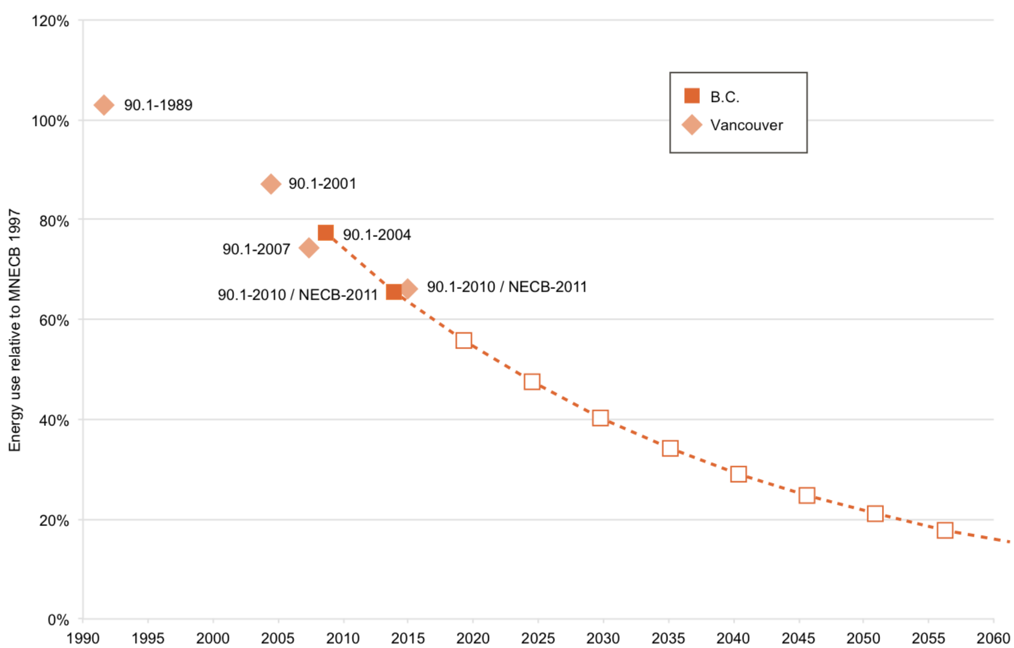

Figure 3. Projection of energy improvements in B.C. based on current pace

the previous code every six years, it would take forty years or so before the base code would bring energy use down to the net-zero ready range (~ 80% better than MNECB).

5. CONCLUSION

Despite significant advances since 2008, BC does not yet have energy efficiency policies in place to "lead the way to net-zero buildings"[lx] as per its Pacific Coast Collaborative commitment.

The province took significant steps in 2008 by revising its Energy Efficient Buildings Strategy, adding energy and water conservation as explicit objectives of the code, and adopting ASHRAE 90.1-2004 as the first province-wide energy code. However, the approach to energy efficiency improvements going forward was not clearly laid out. There were expectations of further changes to come by 2010 or 2011, but when the new energy provisions finally came into force, in December 2013 and 2014, the changes were more modest than expected. There is no plan to date for the next energy efficiency steps.

B.C's approach stands in contrast to the approach in Ontario and Toronto, where code changes are announced well in advance and coordinated with stretch code targets. Since 2006, energy efficiency increments have been announced one cycle ahead, letting the development community know both the timing and the level of the next increment. As leading developers aim for the TGS-Tier 2 incentives, they not only prepare the way for the next Toronto base code, but also establish the feasibility of the level of performance that could be required by the OBC two code cycles down the line.

The City of Vancouver and other leading local governments have used rezoning and density bonusing policies to require higher efficiency from new constructions. Vancouver has been leading energy code adoption since the early 1990's. Its Green Rezoning policy applies to about half of all new construction in the city, and, less then ten years after the adoption of 90.1-2004 by the provincial code (equivalent to ~20% below MNECB), is now requiring performance equivalent to ~50% below MNECB. Using such rezoning policies more broadly to drive market transformation and explicitly connecting stretch targets with future base code requirements to increase clarity and ease code transitions would help accelerate energy efficiency in new buildings to make BC net-zero ready.

6. RECOMMENDATIONS FOR THE BC GOVERNMENT

1. Define either a net-zero or net-zero ready target date for new buildings in BC. This target should be in line with the level of ambition needed to achieve BC's GHG reduction targets, and aligned with targets set by other PCC partners. This paper has focused on new Part 3 buildings, but consideration should equally be given to new Part 9 structures as well as the existing building stock.

2. Create a roadmap to achieve the net-zero or net-zero ready target including sustaining policies (incentives, financing, tax regime, etc.) and mechanisms to assess the performance of new construction and provide ongoing feedback for code development (e.g. benchmarking, measurement and verification). The roadmap should include a series of interim targets for energy code performance to increase predictability for builders, developers, and permitting offices.

3. Review and learn from the Ontario and Toronto experience and consider the role of stretch code in preparing the ground for code changes and clarifying the expected future level of performance expected. Work with the City of Vancouver and other leading municipalities to align stretch code tiers with projected targets for the next base code iterations, and consider how opt-in energy codes could be used to accelerate efficiency improvements in areas of the province where market conditions allow.

ENDNOTES & REFERENCES

[i] For a more thorough discussion on the possible definitions of 'net-zero' buildings, see http://www.regulations.gov/#!documentDetail;D=EERE-2014-BT-BLDG-0050-0002 and comments from PCC jurisdiction at http://www.regulations.gov/#!documentDetail;D=EERE-2014-BT-BLD+G-0050-0051

[ii] Pacific Coast Collaborative, Pacific Coast Action Plan on Climate and Energy (2013). http://www.pacificcoastcollaborative.org/Documents/Pacific%20Coast%20Climate%20Action%20Plan.pdf

[iii] Pembina Institute, The Path to 'Net-Zero Ready' Buildings in BC: The case for action and the role of public policy (2015).

[iv] The strategy, aimed at achieving 33% reduction in GHG emissions in the building sector by 2020, proposed new targets aiming for a 9% reduction in energy use per square metre of commercial/institutional floor space and a 20% reduction in energy use per household, by 2020 for both existing and new buildings.

[v] A distinction is generally made between energy 'standards' such as ASHRAE 90.1, and 'energy codes' such as IECC or NECB, though there is no uniformly recognized definition of the difference between codes and standards. Generally speaking, a code is broader in context and is intended to be given the force of law, while a standard is narrower in scope, often developed by industry associations, and can only be given force of law by inclusion, or reference, in a national, regional, or local code. See http://www.nrc-cnrc.gc.ca/eng/solutions/advisory/codes_centre/codes_brochure.html. For simplicity, we will refer to both 90.1 and NECB as 'energy standards'.

[vi] US Department of Energy, Building Energy Codes 101, 2010.

[vii] The 1975 NBC was adopted in 1975, 1980 NBC in 1981, 1985 NBC in 1987, 1990 NBC in 1992, 1995 NBC in 1998, 2000 NBC in 2003, 2005 NBC in 2006, and 2010 NBC in 2012; see Building and Safety Standards Branch, History of British Columbia Building Regulations (2007). http://www.housing.gov.bc.ca/pub/regHistory.pdf

[viii] The strategy also set targets for existing buildings, aiming for energy savings of 17% (on average) for 12% of residential homes, energy savings of 9% for 16% of multi-unit residential buildings, and energy savings of 14% for 20% of industrial, commercial, and institutional buildings. BC Ministry of Energy and Mines, Energy Efficient Buildings Strategy (2008), 8-9. http://www.empr.gov.bc.ca/EEC/Strategy/EEBS/Pages/default.aspx

[ix] Note that MNECB was in fact based on ASHRAE 90.1-1989, with minor adjustments to be more specific to Canadian locations and climates. See Doug Cane and B.E. Sibbitt, Case Study Analysis of the New National Energy Code for Buildings (1995); and City of Vancouver, "Updating the Energy Utilization By-law," administrative report, May 11, 2004, 9. http://former.vancouver.ca/ctyclerk/cclerk/20040608/a5.pdf

x "Updating the Energy Utilization By-law."

[xi] Tim Ryce, "City of Vancouver Green Building Strategy," presentation, 13. http://www.boabc.org/assets/Education/Vancouver%20Powerpoint.pdf

[xii] Compared to 2007. Energy Efficient Buildings Strategy.

[xiii] These targets were based on the "upper achievable" energy savings estimated by the 2007 BC Hydro Electricity conservation potential review (BC Hydro, BC Hydro's Electricity Conservation Report (2009). https://www.bchydro.com/content/dam/hydro/medialib/internet/documents/planning_regulatory/meeting_demand/DSM_Report_2009.pdf) and the Canadian Gas Association's natural gas conservation potential review (Marbek Resource Consultants and M.K. Jaccard and Associates, Demand Side Management Potential in Canada: Energy Efficiency Study (2006). http://www.electricity.ca/media/pdfs/policy_statements/EE-DSM_Final_Report.pdf). "Achievable" is meant to denote energy savings that have a net economic benefit and are deemed implementable in the timeframe considered. "Upper achievable" represents savings that are possible with utility incentives along with broader policy initiatives, aggressive codes and standards, and land use measures. (Andrew Pape-Salmon, Katherine Muncaster and Erik Kaye, "British Columbia's Energy Efficient Buildings Strategy," ASHRAE Transactions 117 (2011), 5 http://www.ashrae.bc.ca/vi/images/stories/BCs_Energy_Efficient_Buildings_Strategy_ASHRAE_final_revised.pdf

[xiv] BC Ministry of Housing, Proposed Revisions to BCBC-2012 Part 10. http://www.housing.gov.bc.ca/building/green/energy/Part 10 code change.pdf

[xv] Curt Hepting, Summary Review Assessment of Energy Performance Codes ASHRAE 90.1-2004, 90.1-2010 and NECB for British Columbia (2011), 3. http://housing.gov.bc.ca/building/green/energy/ASHRAE vs NECB Summary-FINAL.PDF

[xvi] According to unpublished analysis by the Pembina Institute and Ministry of Energy and Mines, the new code requirements (2008) were expected to yield annual average savings of 1.49 GJ per home and 0.04 GJ per square metre of commercial buildings by 2020. This represents respectively reductions of 1% and 2% over the 2007 averages of 137 GJ/home and 1.95 GJ/m2.

Katie Laufenberg and Matt Horne, BC's Energy Efficient Building Strategy: Overview of Gap Analysis (Pembina Institute, 2010), accompanying spreadsheet.

[xvii] "British Columbia's Energy Efficient Buildings Strategy," 6.

[xviii] See Energy Efficient Buildings Strategy, 15 and "British Columbia's Energy Efficient Buildings Strategy," 5.

[xix] City of Vancouver, Green Buildings Policy for Rezonings (2014). http://former.vancouver.ca/commsvcs/guidelines/G015.pdf

[xx] City of Vancouver, General Policy for Higher Buildings (2014). http://former.vancouver.ca/commsvcs/guidelines/H005.pdf.

[xxi] Based on 1995 study comparing upcoming MNECB to typical building practices in Vancouver: Case Study Analysis of the New National Energy Code for Buildings. Note that MNECB was in fact based on ASHRAE 90.1-1989, with minor adjustments to be more specific to Canadian locations and climates ("Updating the Energy Utilization By-law," 9).

[xxii] The City of Vancouver claims that ASHRAE 90.1-2001 is 10–15% better than ASRHAE 90.1-1989, depending on building types, or 13% better on average, and that ASHRAE 90.1-1989 was roughly equivalent to MNECB. ("Updating the Energy Utilization By-law," 3.) Compared to the 1989 standard, the 2001 standard is equivalent in building envelope performance requirements, but has increased stringency for mechanical system performance and lighting systems.

[xxiii] City of Vancouver, By-law 9419: A by-law to regulate the construction of buildings and related matters and to adopt the British Columbia Building Code (2007) http://app.vancouver.ca/bylaw_net/Report.aspx?bylawid=9419

[xxiv] City of Vancouver, Proposed 2007 Building By-law, October 31, 2006. http://former.vancouver.ca/ctyclerk/cclerk/20061114/documents/p2.pdf

[xxv] VBBL was designed to "attain or exceed the ASHRAE 90.1-2007 energy standard," (City of North Vancouver, Consultation on Higher Energy Standards for New Construction, report to council, November 20, 2012, 2. http://www.cnv.org/attach/2012 11 26 item 34.pdf); ASHRAE 90.1-2007 is 4% better than ASHRAE 90.1-2004 for buildings in Vancouver ("City of Vancouver Green Building Strategy," 13); and ASHRAE 90.1-2004 is 23% better than MNECB for BC (Summary Review Assessment of Energy Performance Codes, 12), so we calculate 1–(1–0.23)*(1–.04) = 0.26 or 26% better than MNECB.

[xxvi] Murray Frank, Greening the BC Building Code, 2008. http://www.bcbec.com/Murray_Frank_GreeningtheBCBuildingCode.pdf

[xxvii] Summary Review Assessment of Energy Performance Codes, 3.

[xxviii] Government of British Columbia, Local Government Act: British Columbia Building Code Regulation, Reg. 264/2012. http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/264_2012

[xxix] BC Building and Safety Standards Branch, New Energy Requirements, Information Bulletin No. B13-05, May 22, 2013. http://www.housing.gov.bc.ca/pub/bulletins/B13-05 New Energy Requirements.pdf

[xxx] With the modification that ventilation rates should follow ASHRAE 62.1-2001, which was the standard referenced in BCBC-2012 Part 6, instead of ASHRAE 62.1-2007 (as referenced in ASHRAE 90.1-2010).

[xxxi] Averaging results over all archetypes and climate zones in Hepting (2011) and Stantec (2012) ASHRAE 90.1-2010 performs on average 13% better than 90.1-2004 (Table 3); since ASHRAE 90.1-2004 is 23% better than MNECB 1997 in BC (Summary Review Assessment of Energy Performance Codes, 12), this is equivalent to 1–(1–0.13)*(1–0.23) = 0.29 = 33% better than MNECB.

[xxxii] Similarly, using NECB 2011 average results in Hepting and Stantec study of 18% below 90.1-20 (Table 3)

[xxxiii] City of Vancouver, By-law 9419.

[xxxiv] City of Vancouver, By-law 10852: A by-law to amend Buildings By-law No. 9419 regarding a new energy standard for Part 3 and Part 9 buildings, excluding one and two-family dwellings and residential buildings three storeys or less in height. http://former.vancouver.ca/blStorage/10852.PDF

[xxxv] Green Buildings Policy for Rezonings.

[xxxvi] Note that the LEED target is based on energy cost reductions, and therefore does not translate directly to total energy savings, since it depends on which fuel is being saved (small savings in electricity decrease significantly the energy cost, given electricity is more expensive than gas in BC). Here, we assume energy savings equivalent to the energy cost savings (i.e., that the savings in each fuel is proportional to their total respective use).

[xxxvii] General Policy for Higher Buildings.

[xxxviii] Sustainable Buildings Canada, Development of Energy Efficiency Requirements for the Toronto Green Standard (2012), 7. http://www.towerwise.ca/wp-content/uploads/2013/07/TGS-Phase-I-Energy-Efficiency-Requirements.pdf

[xxxix] Ibid.

[xl] Juhee Oh and Jason Manikel, City of Toronto TGS Energy Efficiency Workshop Report (2014), 10. http://www.toatmosphericfund.ca/wp-content/uploads/2014/03/TGS-Workshop-Report.pdf

[xli] OBC-2006 Subsection 12.2.1.2, cited in Development of Energy Efficiency Requirements for the Toronto Green Standard, 22.

[xlii] Anton Van Dyk, business development manager at Centra Construction Group, personal communication, March 12, 2015.

[xliii] Lisa King, senior planner, City of Toronto, personal communication, May 19, 2015.

[xliv] Toronto City Planning, Toronto Green Standard: 2014 Update (2014). http://www1.toronto.ca/City Of Toronto/City Planning/Developing Toronto/Files/pdf/TGS/TGS_2014_Update_HIGHLIGHTS.pdf

[xlv] City of Toronto TGS Energy Efficiency Workshop Report, 23.

[xlvi] Lisa King, senior planner, City of Toronto, personal communication, May 19, 2015.

[xlvii] The energy component of OBC-2012 is based on ASHRAE 90.1-2010 with Ontario-specific addenda: SB-10/Division 3. The addenda, amongst other changes, replaces the requirements for thermal performance of envelope elements by referring to the tables included in the more stringent standard ASHRAE 198.1-2009, instead of the tables of 90.1-2010. The new requirement came into force province-wide in January 2014. Development of Energy Efficiency Requirements for the Toronto Green Standard, 18.

[xlviii] Development of Energy Efficiency Requirements for the Toronto Green Standard, 3.

[xlix] For homes, the TGS-Tier 1 requires an EnerGuide rating of at least 83, while houses with an EnerGuide rating of 85 or more are eligible for Tier 2 incentives.

l City of Toronto TGS Energy Efficiency Workshop Report.

[li] Sean Pander, personal communication, 25 May 2015

[lii] New Energy Requirements and City of Vancouver, By-law 9419. Note that some BC-specific revisions have been made to harmonize ventilation requirements between ASHRAE 90.1-2010 and NECB 2011.

[liii] City of Vancouver, "Energy requirements, forms, and checklists for large and retail / commercial buildings." http://vancouver.ca/home-property-development/large-building-energy-requirements-forms-checklists.aspx ; for a full history of revisions, see City of Vancouver, By-law 9419.

[liv] BC Energy Code Comparison.

[lv] Summary Review Assessment of Energy Performance Codes.

[lvi] These ranges are comparing the new energy code to the previous provincial code, based on ASHRAE 90.1-2004. The net gains will be smaller in Vancouver, since its building bylaw was already referring to the (stricter) 2007 version of ASHRAE 90.1. Only minor changes are expected in Vancouver as ASHRAE 90.1-2007 is replaced by 90.1-2010: the envelope requirements will generally be the same, while HVAC and service water heating systems only see minor changes.

[lvii] Particularly for NECB 2011. Later work from Hepting has shown that, particularly for buildings with relatively low glazing areas and small HVAC systems, the relative savings expected from the performance or trade-off path could be 5–10 percentage points lower than the savings under the prescriptive path. Summary Review Assessment of Energy Performance Codes, 1 (annotation).

[lviii] BC Energy Code Comparison, E2.

[lix] BC Energy Code Comparison, E3.

[lx] Pacific Coast Action Plan on Climate and Energy.

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