New energy efficiency requirements for Part 3 buildings in British Columbia

Part 2: Key differences between ASHRAE 90.1-2010 and NECB 2011

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Commissioned by the Climate Action Secretariat[1]

Summary

As of December 20, 2013 (January 24, 2014 for Vancouver), new mid- and high-rise buildings (i.e. Part 3 buildings) in British Columbia have to meet a new energy code with two compliance options: the ASHRAE 90.1-2010 standard and the 2011 National Energy Code for Buildings (NECB 2011). The key similarities and differences between these two standards are outlined here:

- Both standards are similar in their organization, with sections for envelope, lighting, HVAC (heating, ventilating, and air-conditioning), service water heating, miscellaneous equipment. NECB references several CAN/CSA standards which must be purchased separately. ASHRAE 90.1 generally includes direct references to required performance levels, simplifying usage.
- Both standards offer prescriptive, trade off, and performance-based compliance paths. NECB offers more trade-off options than ASHRAE, which only trades off the envelope. For trade-off and performance-based paths, ASHRAE uses a **cost** budget method, comparing the total energy cost between the proposed design and a base case, while NECB uses an **energy** budget method, comparing the total energy use between the two models. Given the higher cost of electricity in B.C., ASHRAE's method favors measures that save electricity over measures that save gas, which tends to reduce the total energy savings and greenhouse gas (GHG) reductions. The NECB method is fuel agnostic.
- Which of the two standard is the most stringent varies across building archetypes and climate zones. Generally, NECB 2011 requires higher insulation levels, boiler and furnace efficiency, and lower infiltration from fenestration.
- The two standards have different thresholds and methods for determining whether heat recovery ventilation (HRV) is required, based on climate zone, size of ventilation system, and percentage of outside air. Prescription for HRV units is an important factor when it comes to comparing the overall energy performance of the two standards. NECB can be more stringent for multi-unit residential buildings (MURBs), even requiring in-suite HRV units in certain cases (though the Lower Mainland and southern Vancouver Island (zone 4) are exempt). For most other cases, the NECB tends to be less stringent with regard to HRVs, allowing larger sized systems to be installed without heat recovery.
- Although both standards offer an energy model performance method for evaluating energy savings of a proposed building over a baseline, the requirements for some types of models differ. For example, a MURB with electric baseboard heating, under ASHRAE 90.1 must use a baseline model with heat pumps with a COP of 3. However, under

[1] The author would like to thank Antony Ho (FortisBC) and Susan Hayes (Focal Engineering) for performing a technical review of this briefing note.

NECB, the baseline model may also use electric baseboard heaters, which can produce drastically different results.

- Since ASHRAE is a North American standard, it includes many provisions for energy savings from cooling that are not covered in the NECB, due to its jurisdiction over Canada's cooler climate zone. For example, ASHRAE includes maximum allowable Solar Heat Gain Coefficients (SHGCs) for glazing.

Introduction

As of January 1, 2015, in Vancouver — and December 20, 2013, in the rest of B.C. — new Part 3 buildings[2] have to comply with either ASHRAE 90.1-2010 or the 2011 National Energy Code for Buildings (NECB 2011), with minor adjustments specific to B.C.[3] This briefing note summarizes the key differences between these two standards.[4]

General differences between ASHRAE 90.1-2010 and NECB 2011

Table 1 summarizes some of the key differences between ASHRAE 90.1-2010 and NECB 2011. Both standards are organized similarly, with sections for envelope, lighting, HVAC, service water heating, miscellaneous equipment, etc. Some commenters have noted that ASHRAE 90.1 is more user-friendly, including in the document direct references to performance levels derived from other efforts and standards, while NECB provides references to many CAN/CSA standards, which must be separately purchased to confirm the required performance levels.

Both standards offer alternative energy performance compliance comparing the overall modelled performance of the proposed building to that of a 'base case' building built to the standard requirements. If the proposed building is modelled to perform as well as or better than the base case model, the building design is deemed compliant. However, the method used to evaluate this performance differs between the two standards: ASHRAE compares the total cost of energy between the proposed and base models, while NECB compares the actual energy use.[5]

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[2] Part 3, 'complex buildings': buildings that are taller than 3 storeys, that are used as post-disaster buildings, for assembly, for care, for correction, or for high-risk industrial use. All other buildings are considered 'simple' buildings, and follow requirement outlined in Part 9 of the Building code. See Table 5 for more details, and the companion briefing note New energy efficiency requirements for Part 9 buildings in B.C.

[3] Building and Safety Standards Branch, *New Energy Requirements - Information Bulletin* (2013). http://www.housing.gov.bc.ca/pub/bulletins/B13-05 New Energy Requirements.pdf; and City of Vancouver, *By-law no. 9419: A By-law to regulate the construction of buildings and related matters and to adopt the British Columbia Building Code.* http://app.vancouver.ca/bylaw_net/Report.aspx?bylawid=9419.

[4] Strictly speaking, ASHRAE 90.1 is a standard while NECB is a model energy code. For simplicity, we refer to both as 'standards' in this document.

[5] In addition to the cost budget method, ASHRAE 90.1 also offers a different performance path method called Performance Rating Method (PRM), commonly referred to as Appendix G for its location in the Standard. The PRM is used for rating beyond-code energy performance and is the method used in LEED certification. The PRM tends to require a more independent baseline with parameters following more closely the prescriptive standard, thus allowing the proposed case to differentiate itself further from the base case. For example, it might allow the base case to use a standard HVAC system (e.g. rooftop unit) while the proposed design uses a more innovative approach (e.g. passive ventilation). In the standard cost budget method, both the base case and proposed case should have the same general HVAC system design, the difference between the two being limited to the performance of the equipment used. It should be noted that compliance with Appendix G does not establish compliance with the standard; an additional modelling exercise, based on the cost budget method, is required to show code compliance. Therefore, at the moment, LEED certification, which requires above-code energy performance (according to Appendix G methodology), does not constitute proof of compliance with code.

Given the fact that electricity is three to four times the cost of natural gas in B.C., ASHRAE's cost budget method tends to favor measures that save electricity over measures that save gas. For example, the proposed building could balance the cost of using a below-standard boiler that uses 4% more energy (mostly natural gas) by using above-standard lighting systems that decrease energy use by 1% (mostly electricity). Since natural gas is about eighteen times as carbon intensive as electricity in B.C. (~ 180 $gCO_2e/kWhe$ vs. 10 $gCO_2e/kWhe$[6]), this tendency to favour electricity saving over natural gas savings makes ASHRAE's energy cost budget method a less effective tool for climate protection (but a more effective tool for minimizing energy cost).

The two standards also allow a 'trade-off' compliance route, offering designers the possibility to bypass certain prescriptive requirements if they can show that equivalent performance can be met by going beyond prescribed requirements in other elements of the system. Many of these trade-offs also require energy modelling. ASHRAE allows trade-offs for envelope components only (e.g. trading off an increase in fenestration ratio with an increase in insulation levels), while NECB allows trade-offs within mechanical systems and other energy components — though the methodology is complex.

Table 1: Areas of difference between ASHRAE 90.1-2010 and NECB 2011

<table>
<tr><th>Topic</th><th>NECB 2011</th><th>ASHRAE 90.1-2010</th></tr>
<tr><td rowspan="2">Performance path</td><td>Energy based
Trade-offs throughout (more flexible)</td><td>Energy-cost based
Trade-offs for envelope only (more prescriptive)</td></tr>
<tr><td colspan="2">Requirements for modeling assumptions differ. For example, a MURB with electric baseboard heating, under AHRAE 90.1 must use a baseline model with heat pumps with a COP of 3. However, under NECB, the baseline model may also use electric baseboard heaters, thus making compliance easier.
The profiles used to define baselines also differ in each standard (i.e. Plug loads, lighting schedules, occupancy schedules, Mechanical setpoints, etc.), which can impact the relative savings from different energy efficiency measures, and therefore the overall modeling results.</td></tr>
<tr><td>Prescriptive path</td><td>Many references to Canadian standards (more complex compliance)</td><td>Mostly refers to performance requirement (simpler compliance)</td></tr>
<tr><td>Insulation</td><td>More stringent insulation, yet simpler requirements[7]
Required full slab insulation (unheated)
Limits exclusions of small-area assemblies (ex. Balconies) to 2%</td><td>Generally less stringent insulation requirements
Slab insulation required on in some areas (north)
Limits exclusions of small-area assemblies (ex. Balconies) to 5%</td></tr>
<tr><td>Fenestration to wall ratio (FWR)</td><td>40 % FWR – few trade-offs
FWR indexed to heating degree days</td><td>40% FWR across all regions
Trade-offs allow for up to 70% glazing</td></tr>
</table>

[6] B.C. Ministry of Environment, *Methodology for Reporting 2014 B.C. Public Sector Greenhouse Gas Emissions, 2014* Table 1 and 3; (natural gas: 49.75 kg CO_2e/GJ * 0.0036 GJ/kWh * 1000g/kg = 179.1 g $CO_2e/kWhe$). http://www2.gov.bc.ca/gov/DownloadAsset?assetId=6DF9D0E1E46D4DC28F96E190AF4D7783&filename=2014_bc_best_practices_methodology_for_quantifying_greenhouse_gas_emissions.pdf

[7] NECB requirements for roof and wall R-value are ~13% higher for Vancouver, and 37% (for roof) and 64% (for wall) higher for Prince George (averaged over a range of roof and wall types representative of current market)

maximum		Beyond 70%: need to use performance compliance through energy cost budget modelling
Windows	Provides a single overall fenestration thermal performance for each climate zone More stringent air leakage rates and U values[8] No restrictions on solar heat gain coefficient (controls cooling load)	Performance requirements set for four distinct glazing types Less stringent air leakage rates and U values Provides max. solar heat gain coefficient allowance
Boiler efficiency	83-85% minimum efficiency levels Prescribes modulating boilers	77-82% minimum efficiency levels Allows single stage boilers[9]
Furnace efficiency[10]	Slightly higher for all categories — e.g. 92.4% AFUE requirement for smaller gas-fired furnaces	Slightly lower for all categories — e.g. 78% AFUE requirement for smaller gas-fired furnaces
Heat recovery[11,12]	Heat recovery with 50% effectiveness, whenever the sensible heat content of the exhaust air is greater than 150 kW	Heat recovery with 50% effectiveness, based on the region and percentage outdoor air supplied
Ventilation	Rates based on ASHRAE 62.1-2001	Rates based on ASHRAE 62.1-2001 (B.C. modification; 90.1-2010 normally refers to 62.1-2007) Mandatory requirements for controlling ventilation based on occupancy Heat recovery applied to lab and kitchen exhaust systems
Service water heating (SWH) equipment	Does not list natural gas boilers for SWH; if using same as in HVAC section, performance would be higher than for ASHRAE Minimum efficiency requirements for shower and faucet flows	No shower and faucet flows requirement Pool covers required Automatic control of the pump operation to enable shut off when there is no demand
Power, motors and	Only minor differences: ASHRAE sets lighting and ventilation power restrictions on elevator; NECB requires electricity sub-metering for tenants[13]	

[8] NECB requires fixed windows and skylights to have 80% less leakage than ASHRAE 90.1-2010. Based on an estimated market mix of fenestration types, the NECB overall glazing performance ranges from 31% higher in Vancouver to 64% higher in Prince George

[9] Hepting notes that modulating boilers are already the usual practice in B.C.; therefore, the fact that they are not required by ASHRAE does not make a significant difference between the two standards.

[10] Note that the B.C. Energy Efficiency Act also sets requirements for furnace and boiler efficiency which might exceed the minimum requirements set by these standards.

[11] Note that NECB dictates 50% *sensible heat* recovery effectiveness, whereas ASHRAE dictates 50% *total* effectiveness. Since most HRV units are rated for at least this effectiveness, this difference should not make a material difference on resulting building either way.

[12] The two standards have different thresholds and methods for determining whether heat recovery is required, varying according to climate zone, size of ventilation system, and percentage of outside air. NECB can be more stringent for MURBs, even requiring in-suite HRV units in certain cases (though Lower Mainland and Vancouver Island are exempt). For most other cases, the NECB tend to be less stringent, i.e. it allows larger-sized system to be installed without heat recovery.

other equipment	
Lighting	Only minor differences: ASHRAE is a bit more stringent on parkade lighting controls; NECB has fewer allowances on interior lighting power levels

Sources: Hepting[14] and B.C. Office of Housing and Construction Standards[15]

Comparing overall energy savings expected from ASHRAE 90.1-2010 and NECB 2011

Three modelling studies can be used to compare the overall effectiveness of the two new standards, ASHRAE 90.1-2010 and NECB 2011, over the previous energy standard in B.C., ASHRAE 90.1-2004:

- Stantec (2012)[16] models the energy, emissions, and financial performance associated with the prescriptive requirements of ASHRAE 90.1-2010 and NECB 2011, comparing the new standards to the previous provincial standard, ASHRAE 90.1-2004. Stantec's study considers three building archetypes in three climate regions of B.C.
- Hepting (2011) analyzes energy savings expected from ASHRAE 90.1-2010 and NECB 2011 compared to ASHRAE 90.1-2004. Eight building archetypes are considered across three B.C. climate regions. Three of these archetypes are similar to Statec's: multi-unit residential, commercial and big box store; though the detailed building parameters (e.g. number of floors, square footage, occupancy) differ (see Appendix 2).
- Caneta (2012)[17] compares the performance of NECB 2011 directly to that of ASHRAE 90.1-2010 for eight building archetypes in 13 Canadian cities. It does not compare these results to performance of ASHRAE 90.1-2004, so no conclusions can be drawn on energy savings compared to current building practices. The results are nevertheless useful in understanding the difference between the two standards. Vancouver was the only B.C. location considered in that study; we use here the results for Calgary as a proxy for performance in the interior and northern B.C. climate regions.

Below are the results of these three studies in the comparison of ASHRAE 90.1-2010 and NECB 2011. See Appendix 2 of Part 1 for a summary of key differences between the archetypes considered in the three studies.

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[13] This is already common building practice in B.C.

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

[15] B.C. Office of Housing and Construction Standards, "New Energy Efficiency Requirements in B.C.," presentation to BCBEC, September 2013. http://www.bcbec.com/docs/2013Sept_BCBEC_EnergyEfficiency.pdf

[16] Stantec Consulting, *B.C. Energy Code Comparison (Final Report)*, prepared for B.C. Ministry of Energy and Mines (2012). http://housing.gov.bc.ca/building/green/energy/Stantec - Part 3 Energy - FINAL-rpt01_bc_energy_code_comparison__update_201201022.pdf

[17] Caneta Research, *ASHRAE 90.1 2010 and NECB 2011 Cross Canada Comparison* (2012). http://housing.gov.bc.ca/building/green/energy/Caneta_ASHRAE90 1-2010 - NECB 2011 Report_FINAL_20120216 pdf.pdf

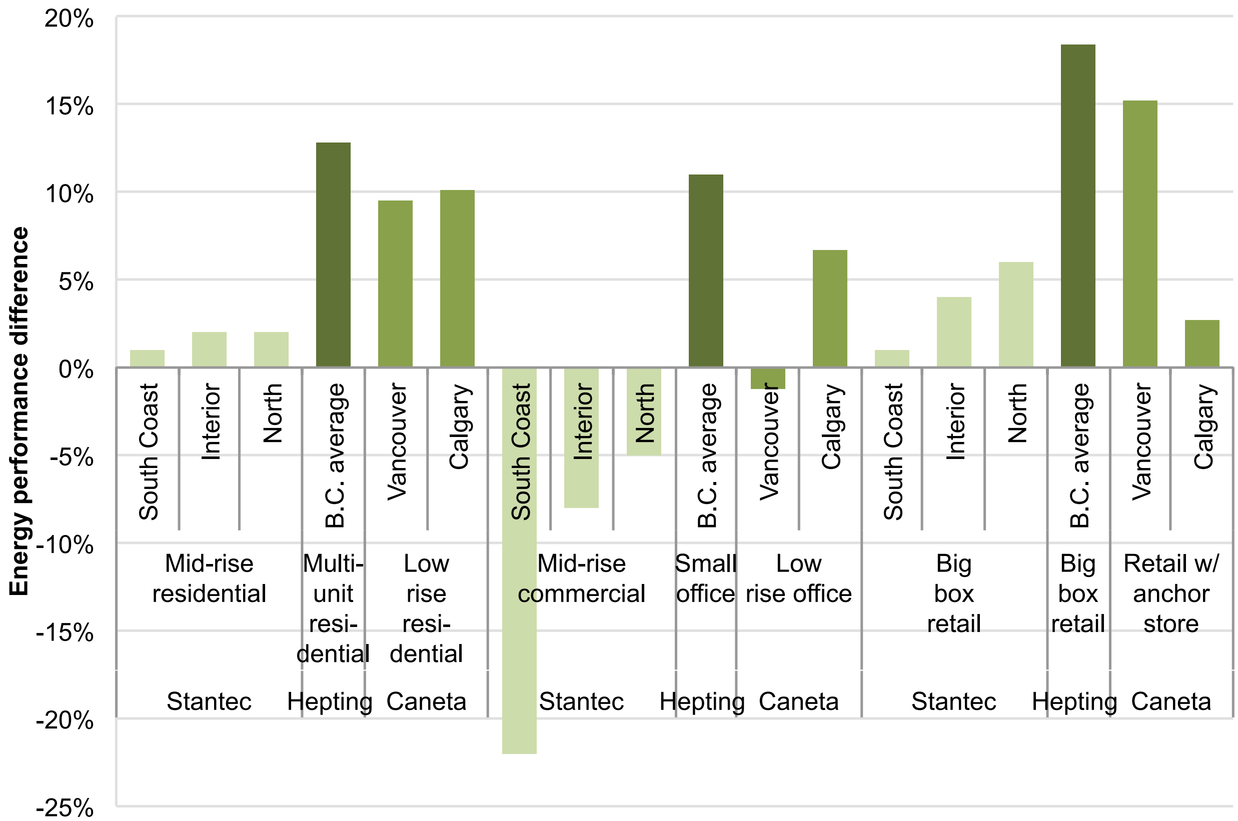

Figure 1: Difference in energy performance of NECB 2011 over ASHRAE 90.1-2010 for three building archetypes based on Stantec, Hepting, and Caneta

For most of the archetypes developed by Stantec, the performance difference between NECB 2011 and ASHRAE 90.1-2010 is small (i.e. within 5% of total energy use; see Figure 1) and in favor of NECB 2011. The only exception is the mid-rise commercial archetype, where ASHRAE 90.1-2010 outperforms NECB 2011 by a significant margin (up to 22%).

Hepting shows a much larger difference between ASHRAE 90.1-2010 and NECB 2011 (Figure 1). Of the eight archetypes considered by Hepting, NECB 2011 outperforms 90.1-2010 by more than 10% for all but the hotel and extended care facility (for which the two standards are comparable).[18] This difference stands in all three regions: in the Lower Mainland/Southern Interior the energy savings averaged over the eight archetypes are estimated at more than 20% for NECB 2011, against 10% for ASHRAE 90.1-2010. The north shows a similar difference (~30% for NECB vs ~20% for 90.1). Generally, Hepting shows NECB as offering another 10% additional savings above ASHRAE 90.1-2010 .

Caneta's conclusions are similar to that of Hepting: in both the Vancouver and Calgary climates (Calgary being used here as a proxy for northern B.C.), NECB 2011 shows on average 10-15% better energy performance than ASHRAE 90.1-2010 (see Table 2 for results for all archetypes).

[18] For detailed results from Hepting, see Table 4 in the companion briefing note *New energy efficiency requirements for Part 3 buildings in B.C. Part 1: Overall impacts on energy savings, GHG reductions, and incremental costs.*

However, it is worth noting the difference between the two standards is small (5% or less) for low-rise office, high-rise office and high-rise MURB in Vancouver.[19]

Table 2: Caneta results: Energy performance gains of NECB 2011 over ASHRAE 90.1-2010 for eight building archetypes in Vancouver and Calgary (used as a proxy for B.C. interior and north)

Archetype	NECB 2011 savings relative to ASHRAE 90.1-2010	
	Vancouver	Calgary
High-rise office	3%	10%
High-rise MURB	5%	9%
Retail with anchor store	15%	3%
Low-rise office	-1%	6%
Low-rise MURB	10%	10%
Education	11%	15%
Read without anchor store	15%	18%
Warehouse	12%	18%

Note: cell shading indicates a standard that outperforms the ASHRAE 90.1-2004 baseline by more than 10% (dark green) or between 5% and 10% (medium green). Percentages have been rounded.

It should be noted that each study uses different parameters for the three archetypes compared here; see Appendix 2 for details.

Table 3 outlines the key design differences between the two standards, as well as their implications on energy performance as outlined in the Stantec and Hepting studies. Looking at the results from those two studies in more details, a few key differences stand out. These are examined in subsequent sections, which compare the studies' results for ASHRAE and NECB independently.

Table 3: Energy savings and conservation advantages from Stantec and Hepting studies

Archetype / study	Region	Energy savings over ASHRAE 90.1-2004		Differ-ence	Key energy conservation advantages	
		NECB 2011	ASHRAE 90.1-2010		NECB 2011	ASHRAE 90.1-2010
Mid-rise residential (Stantec)	South Coast	11%	10%	1%	Higher insulation requirements Furnace AFUE ≥ 92.4% (vs 80%) **NO heat recovery**	Heat pump for retail area with higher COP (3.2 vs 2.8) **NO heat recovery**
	Interior	10%	8%	2%	Same as above + Heat pump for retail area with higher COP (2.8 vs 2)	
	North	10%	8%	2%	Same as above	
Multi-unit	B.C.	20%	7%	13%	Higher insulation	Contrary to Stantec, no plug load difference were

[19] Comparison with Hepting is not possible as Hepting did not provide detailed results broken down by archetype and region, only archetype averages and regional averages.

residential (Hepting)	average				requirements 84% AFUE furnace (vs 82%) **Heat recovery** (all climate zones)[20]	assumed between the two models (for all archetypes) Heat recovery only for North
Mid-rise commercial (Stantec)	South Coast	11%	33%	-22%	Higher insulation requirements Modulating boiler, 83% efficiency (vs non-modulating, 80%) Make up air unit AFUE ≥ 92.4% (vs 80%)	Heat recovery Plug load control in office spaces
	Interior	12%	20%	-8%	Same as above	Same as above, BUT heat recovery NOT required in this case
	North	30%	35%	-5%	Same as above except MUA 81% efficient (vs 80%) + Heat recovery	Same as above except + Heat recovery
Small office (Hepting)	B.C. average	23%	12%	11%	Higher insulation requirements 92.5% AFUE furnace (vs 80%)	
Big box retail (Stantec)	South Coast	11%	10%	1%	Higher insulation requirements Heat recovery for retail core only	Plug load control in office spaces Heat recovery for retail core only
	Interior	13%	9%	4%	Same as above + heat recovery for all zones	Plug load control in office spaces NO heat recovery
	North	18%	12%	6%	Same as above	Plug load control in office spaces Heat recovery for all zones
Big box retail (Hepting)	B.C. average	30%	12%	18%	Higher insulation requirements Heat recovery	

Savings expected from ASHRAE 90.1-2010 for mid-rise commercial buildings

As shown in Figure 2, the expected savings from ASHRAE 90.1-2010 are roughly comparable between the two studies, except for the mid-rise commercial archetypes, where they differ by nearly 20%. This is most likely due to different assumptions on the requirement for, and impact of, plug load controls and heat recovery ventilation. For the Stantec mid-rise commercial archetype, controls were assumed to reduce plug load demand by 30%; for the Hepting low-rise office, no significant savings from plug load control were estimated. Stantec's mid-rise commercial also require heat recovery ventilation for south coast, while Hepting's low-rise office did not require heat recovery. These different outcomes might be due to differences in the

[20] Heat recovery is required by NECB assuming the air system is centralized (with over 150 kW exhaust heat content), which is common in MURBs. If MURBs go with in-suite units that are not served by a central make-up air unit (which might have been Stantec's assumption), heat recovery is not required.

archetypes each study started with,[21] or could be due to different assumptions made by the modellers during the modelling process. Either way, this example serves as a useful illustration of the sensitivity of modelling results to modelling assumptions — even when the results are presented as 'fraction better than' a baseline.

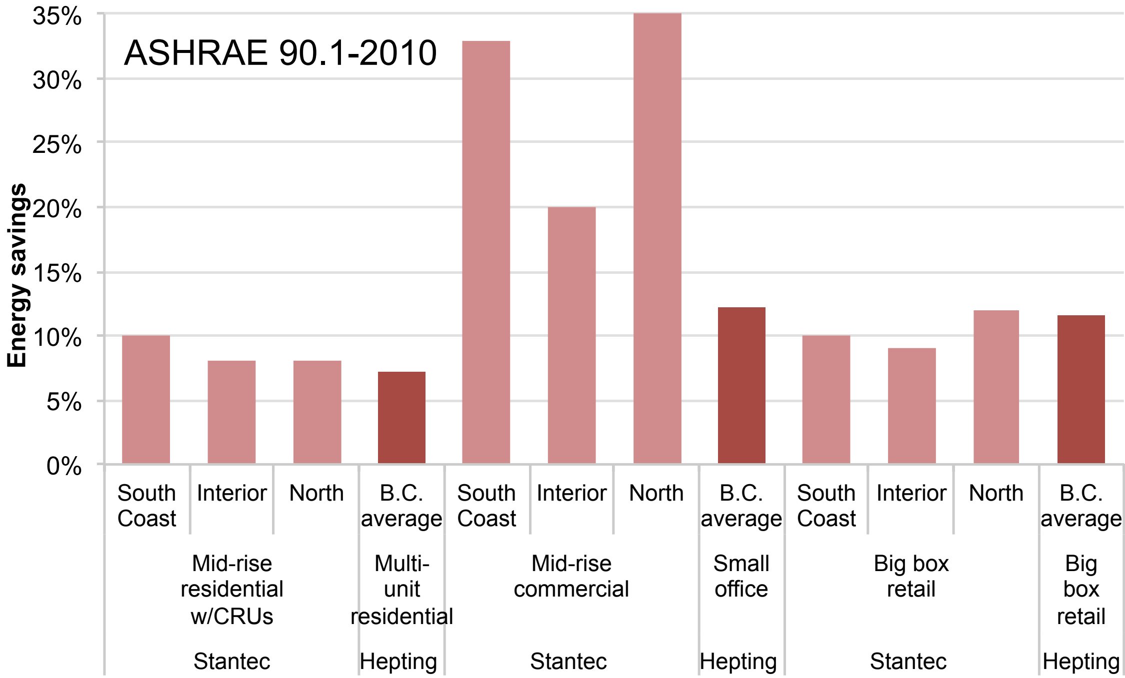

Figure 2: Percentage energy savings from ASHRAE 90.1-2010 over ASHRAE 90.1-2004 from Stantec and Hepting studies

Savings expected from NECB 2011

The two studies differ significantly in their estimates of how much energy savings are expected from NECB 2011 (Figure 3).

The reason for this discrepancy is unclear. Insulation requirements are similar in both studies. Details of building shape and fenestration ratios differ between their archetypes, but not greatly (Table 5). Both studies use a consistent occupancy schedule across the three standards (90.1-2004, 90.1-2011, and NECB). The main 'material' difference we can find that might explain some of the discrepancies between results is the presence or absence of heat recovery. Each standard has different criteria for requiring heat recovery, which depend on climate, volume of air exchange, and fraction of outdoor air in the ventilation system.[22] It is not straightforward to say when heat recovery will be required or not by either standard, and there is no clear leader between the two. In this case, under NECB 2011, Hepting assumes heat recovery is required for only MURB and big box stores, while Stantec assumes heat recovery is required for the mid-rise commercial archetype in the north, and for the big box store archetype in all climate zones (see Table 5).

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[21] Though these differences are small: e.g. one is 5-storey high and 50,000 sqft; the other 3-storey and 43,000 sqft (see Appendix 2), different assumptions regarding ventilation rates, percentage of new air, etc. can triggered different thresholds for requirement and therefore lead to significant changes in performance.

[22] For a good discussion of the difference between the two requirements, see Hepting, D-5.

Another possible source of difference for the MURB results is between assumptions made for in-suite heating approaches. While Stantec assumed electric baseboard heating, Hepting considered three in-suite heating options (base board, heat pump, and gas hydronic), and assigned to each a market allocation.[23] Since the energy savings between different heating approaches varies significantly, this difference in assumptions might explain some of the discrepancy between the savings expected from MURBs in the two studies.

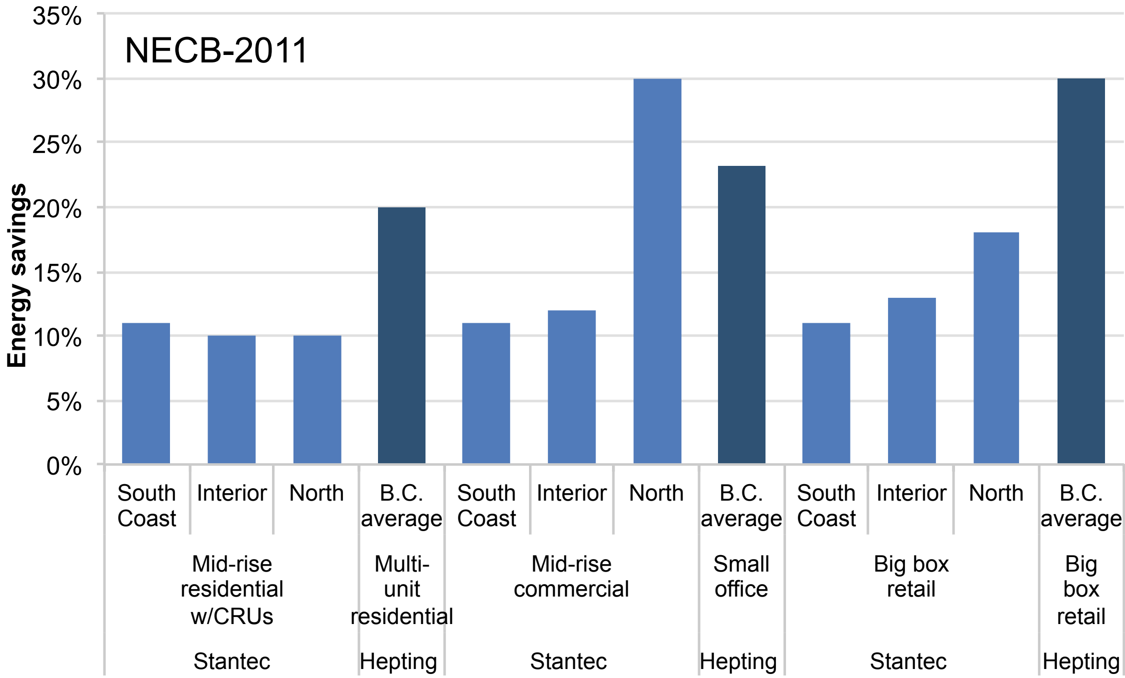

Figure 3: Percentage energy savings from NECB 2011 over ASHRAE 90.1-2004 from Stantec and Hepting studies

Conclusion

Despite some variations in study results, certain general conclusions can be drawn on the difference between ASHRAE 90.1-2010 and NECB 2011:

- Envelope and heating equipment performance requirement generally are stricter under NECB 2011, yielding more energy savings.
- Requirements for plug load control are tighter in ASHRAE 90.1-2010, which is mostly relevant for archetypes with typically high plug loads (such as commercial offices), but, , this difference is still small overall.
- Heat recovery requirements vary between the two standards and can differ for a given archetype and region, creating a significant difference in energy demand.
- The energy cost budget method used in ASHRAE's performance compliance path will value electricity savings three to four time more than natural gas savings, thus potentially minimizing energy cost at the expense of GHG reductions; the total energy cost method used in NECB, on the other hand, is fuel agnostic.

[23] Hepting, personal communication, April 2015.

- Overall, performance gains are expected to be greater with NECB 2011 than ASHRAE 90.1-2010.

For any given project, there may be significant differences depending on which energy code is followed, and the ultimate building energy performance will vary accordingly.

Since both the B.C. Building Code and the Vancouver Building Bylaw offer developers the option to follow either of the two standards, overall energy savings province-wide will depend on which is used for each project.

In addition, significant variations exist between different model results. In the case of the three studies considered, it is unclear how much of that variation is due to choices made by modellers along the modelling process, and how much is attributable to small difference between starting archetypes. Some of the difference in results obtained may be more methodological than material as modelling approaches and selection of input parameters can make a significant difference in modelling outcomes.

Appendix 1: Definition of Part 3 and Part 9 buildings

Table 4: B.C. Building Code scopes: definition of Part 3 (complex) and Part 9 (simple) buildings[24]

Part 3: Complex Buildings	Part 9: Simple Buildings
1. Post disaster buildings (i.e. buildings that are essential to the provision of services in the event of a disaster: hospitals, power stations, water treatment plants, emergency response center, etc.) 2. Buildings that are used for: • assembly • care, or detention • high-hazard industrial 3. Buildings that are: • greater than 3 stories or larger than $600m^2$	Buildings that are • ≤ 3 stories • ≤ 600 m^2 in building area with these occupancy types: • residential • business and personal services • mercantile • medium- and low-hazard industrial
These buildings must comply with requirements outlined in Part 3 (Fire Protection), 4 (Structural Design), 5 (Envelope), and 6 (HVAC) of the building code.* Registered professional architect and/or engineer required to ensure compliance with code.	These buildings must comply with requirements outlined in Part 9 (Housing and Small Buildings) of the building code.* General contractor can sign off on compliance. P.Eng required in specific cases.

* Along with Part 7 (Plumbing), 8 (Safety), and 10 (Energy and Water Efficiency), which apply to all buildings.

[24] B.C. Building code, 2012, Division A, Section 1.3, article 1.3.3.2 and 1.3.3.3

Appendix 2: Comparison of assumptions between the three modelling studies

Table 5: Comparison of archetype definitions and energy performance analysis studies by Stantec, Hepting, and Caneta

	Stantec (2012)[25]	Hepting (2011)[26]	Caneta (2012)[27]
Mid-size residential			
Closest equivalent archetype in study	Mid-rise residential with commercial retail units (CRUs)	MURB	Low-rise residential
Size	5-storey, 50,000 ft²	5-storey, 56,000 ft²	3-storey, 42,000 ft²
wall to roof area ratio	unknown	2	1.1
Number of units	40 apartments, with retail on first floor	64 apartments	45 apartments
Glazing ratio	32%	40%	max 29% per area
Cooling	Interior B.C. only: package terminal air conditioners (PTACs)	Interior B.C. only: PTACs and DX cooling unit for make up air and common areas.	PTACs and direct expansion (DX) cooling unit for make up air and common areas.
Heating	Electrical baseboard in units Indirect gas-fired outdoor air unit for make up air and common areas Split system heat pump with electrical reheat for retail area	Three suite heating cases: (1) electric baseboard, (2) heat pump, (3) gas hydronic (each assigned a market allocation derived from previous LEED equivalency studies)[28] Gas furnace for make up air and common areas	Hydronic baseboards in units Gas boiler for hydronics and hot water coil for make-up air and common areas
Small office			
Closest equivalent archetype in study	Mid-rise commercial (offices)	Small office	Low-rise office
Size	5-storey, 50,000 sq.ft	3-storey, 43,000 ft²	2-storey, 32,000 ft²
wall to roof area ratio	unknown	1.2	1.85

[25] Stantec, 34–59.

[26] Hepting, B1–B55.

[27] Caneta, 4.

[28] The fact that Hepting accounted for a range of in-suite heating approaches while Stantec considered only a baseboard heating case could explain some of the discrepancy between the two studies, as electric resistance, heat pumps and gas heating would provide for different relative savings. Hepting, personal communication, April 2015.

Glazing ratio	32%	40%	maximum 33% glazing (per area, variable)
Heating and cooling	Distributed heat pumps for offices with centrifugal closed circuit fluid cooler and gas-fired boiler for central plant	Three cases: (1) VAV reheat, all gas heat; (2) distributed heat pump with gas boiler; (3) VAV with parallel fan power boxes and electric terminal heating. All air cooled (DX).	Packaged variable air volume (PVAV), with natural gas furnace and DX cooling coils
Big box retail			
Closest equivalent archetype in study	Big box retail	Big box retail	Retail with anchor store
Size	1 storey, 100,000 ft^2	1 storey, 45,000 ft^2	1 storey, 190,123 ft^2
Wall to roof area ratio	unknown	1.0	0.42
Glazing ratio	23% vertical, +5% skylights	10%	18.2%
Heating and cooling	Packaged constant volume roof top units (natural gas furnace and DX cooling)	Packaged constant volume roof top units with DX cooling, with two heating cases: (1) gas fired, (2) electrical heat pump.	Packaged constant volume roof top units (natural gas furnace and DX cooling)
Climate zones	"South coast": Vancouver weather data (ASHRAE climate zone 5c, NECB climate zone 4 "Interior" Kamloops weather data, ASHRAE climate zone 5, NECB climate zone 5 "North" Prince George weather data, ASHRAE climate zone 7, NECB climate zone 7	"Lower Mainland": Vancouver weather data, ASHRAE climate zone 5c, NECB climate zone 4. "Southern Interior" Summerland weather data, ASHRAE climate zones 5a and 5b, NECB climate zone 5 "Northern Interior" Prince George weather data, ASHRAE climate zone 7, NECB climate zones 7A and 7B	Vancouver weather data (ASHRAE climate zone 5c, NECB climate zone 4).