



Pacific Institute
for Climate Solutions
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The Path to “*Net-Zero Energy*” Buildings in BC

The case for action and the role of public policy

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1. INTRODUCTION

Along with its Pacific Coast Collaborative partners—the states of California, Oregon, and Washington—British Columbia (BC) has committed to “lead the way to ‘net-zero’ buildings.”ⁱ While this is an admirable commitment, BC has yet to define its net-zero target and articulate a plan to get there. Operational definitions vary, but net-zero buildings are generally understood as highly efficient buildings that produce as much energy as they use, averaged over the course of a year, onsite or nearby.ⁱⁱ 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

Meanwhile, buildings continue to be major energy users and contributors to climate change. Globally, they account for about one-third of final energy demand and 30% of greenhouse gas emissions (GHG).ⁱⁱⁱ In BC the numbers are approximately 29% and 12% respectively.^v The building sector also offers large energy cost saving opportunities and is amenable to some of the most cost-effective GHG-mitigation strategies.^{vi} With these energy savings come significant economic and job creation opportunities: up to a \$19 billion to \$48 billion increase in net annual gross domestic product (GDP) and 121,000 to 304,000 net new jobs per year in Canada can be achieved with a move toward high efficiency buildings and processes.^{vii}

This paper looks specifically at the necessary components of a roadmap to make new complex (Part 3) buildings net-zero ready. It describes the environmental and economic case for a deep efficiency pathway, reviews some of the targets and policies adopted in leading jurisdictions, and then articulates ten key policies to get to “net-zero ready”. Focusing on the uptake of energy efficiency technologies in new buildings, this paper does not explicitly address the role of on-site renewable energy, the unique challenges related to the low-rise residential sector, nor the goal of reducing energy in the existing building stock—though some of the policies discussed in this paper can also support these other aspects of a broader building sector energy and emissions strategy.

2. A DEEP ENERGY EFFICIENCY PATHWAY IS NECESSARY: Emissions from the building sector and BC’s climate targets

In its Fifth Assessment Report (AR5), the International Panel on Climate Change (IPCC) shows that total GHGs in the atmosphere must not exceed 1 trillion tonnes of carbon for a 50% chance to limit a global average temperature increase to 2°C. More than half of this “carbon budget” has already been expended.^{viii} To avoid exceeding the remaining carbon budget, annual global GHGs must peak by 2020, decline globally by ~50% by 2050 (as much as 80%^{ix} to 95%^x in developed countries), and approach near zero for the power and oil and gas sector between 2070 and 2080.^{xi}

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. 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. newbuildings.org/sites/default/files/2014_Getting_to_Zero_Update.pdf). As the average EUI in BC for a building designed to 90.1-2004 is about 210 kWh/m²/yr (Curt Hepting, Summary Review Assessment of Energy Performance Codes ASHRAE 90.1-2004, 90.1-2010 and NECB for British Columbia (2011), A3. http://housing.gov.bc.ca/building/green/energy/ASHRAE_vs_NECB_Summary-FINAL.PDF) this level of performance is equivalent to roughly 70% below 90.1-2004.

Numerous studies have identified the building sector as the sector with some of the largest and most cost-effective emission abatement opportunities, indicating that this sector must cut emissions by at least as much as the overall economy.^{xii, xiii} For example, Architecture 2030—a non-profit think tank that seeks to address climate change through design of the built environment—states that building sector emissions must peak this decade and fall to zero by 2050.^{xiv} Similarly, the International Energy Agency (IEA) calculates that, to stabilize global temperatures at safe levels, emissions from the building sector must decrease 77% to 80% below business as usual (BAU) projections by 2050.^{xv} These decreases in emissions are made more challenging by the fact that total floor area is expected to increase globally by 127% between now and 2050.^{xvi} Decreasing emissions as the total floor area more than doubles will require significant improvements in building energy efficiency as well as a shift to low-carbon energy sources.

In BC detailed abatement cost curves are not available. In the absence of this information we assume that the building sector must decrease emissions by the same amount as the overall economy. BC has committed to reducing GHGs by 80% below 2007 levels by 2050.

To identify how much energy-related GHG reductions could be achieved through energy efficiency in the building sector, the Central European University (CEU) undertook a modelling analysis considering three scenarios:

- **Deep efficiency:** All new buildings and major renovations transition to highly efficient buildings (equal to today's state of the art) in a decade, and energy renovations occur at an accelerated rate of 3% per year
- **Moderate efficiency:** Energy efficiency continues its current trend for new buildings (the BAU scenario) and major renovations, matching performance of new buildings at a rate of between 1.5% to 2.1% depending on location
- **Frozen efficiency:** No further efficiency improvements are made for new buildings and retrofits improve efficiency by 10% at a renovation rate of 1.4% per year^{xvii}

This modelling exercise shows that by 2050, in the deep efficiency scenario, energy use in buildings could be reduced globally by 33% from energy efficiency measures alone, despite a doubling of total floor area (Table 1). Under the moderate efficiency scenario, the increase in energy use would be limited to 48%, while total energy use from buildings would increase by 111% under the frozen efficiency scenario.^{xviii}

Achieving the deep efficiency scenario would require today's best-practice buildings to become the norm in less than 10 years. This is a significant effort, but not unachievable. As discussed below, Europe and the states of California and Washington, among others, have set targets for new buildings to reach net-zero or near net-zero energy in the next five to 15 years.

Table 1: Global energy demand from building sector under different efficiency scenarios

Scenario	2050 floor area (2005 = 100)	2050 energy use (2005 = 100)	2050 EUI (2005 = 100%)
Deep	227	67	29%
Moderate	227	148	65%
Frozen	227	211	93%

Floor area and energy use numbers are from CEU. EUI is "energy use intensity", calculated here as the ratio of total energy use per floor area.

While the CEU study focuses on the United States (US), China, India and Europe (together accounting for 60% of current building energy use), its results can inform back-of-the-envelope calculations for the potential of energy efficiency in BC. Using population growth as a proxy for growth in floor area, we estimate the total floor area of residential and commercial buildings in BC will increase 58% between 2007 and 2050.^{xix} Using the relative improvement in energy use intensity (EUI) under each of the three CEU scenarios (Table 1), we can estimate the resulting total energy use from the building sector in BC under these three efficiency paths (Table 2). These are crude assumptions, but they allow us to get a sense of energy reductions that could be achieved under different policy trajectories. These results show that, when considering both growth in demand and efficiency gains, final energy use from buildings could be reduced to about half of 2007 levels by 2050 under a deep efficiency scenario (Table 2).^{xx} The remaining reduction to meet an 80% target would need to come from fuel decarbonization of the energy supply. Under a moderate efficiency scenario, on the other hand, the gains in performance would roughly match the increase in demands, leading us back to an energy demand comparable to 2007 levels. In that case, most of the GHG reductions would need to come from fuel switching, requiring greater investment in low-carbon energy systems.

Better analysis of deep energy efficiency pathways are needed, but this initial analysis does illustrate the difficulty of achieving significant reductions under a growing demand. Electrification of the building sector, powered by low-carbon renewables, will likely have a significant role to play in meeting an 80% target.^{xxi} Biofuels might also contribute to some low-carbon heating fuels in certain areas, particularly for district energy systems. Ultimately, what fraction of emissions reductions should come from fuel switching and what fraction should come from efficiency and conservation remains to be determined. The ‘right’ balance between efficiency and low carbon supply depends on factors such as the availability, economic costs and environmental impacts of each. While BC has an ample potential supply of renewable energy, access to this resource is uncertain, the environmental impacts of developing it are non-negligible and development costs can increase significantly after the best sites are developed. Given these considerations, we would argue that planning for a deep efficiency pathway is not only prudent, but likely necessary to meet an 80% target.

Table 2: Projected emissions from BC building sector under three scenarios

Scenario	2050 floor area (2007 = 100)	2050 energy use (2007 = 100)	2050 GHG emissions*	Change in 2050 GHG emissions
Deep	158	46	3.5 Mt	- 54%
Moderate	158	103	7.8 Mt	+ 3%
Frozen	158	147	11.1 Mt	+ 47%

* From energy efficiency alone, i.e. assuming the carbon intensity of energy supply remains constant

3. A DEEP ENERGY EFFICIENCY PATHWAY IS ECONOMICALLY BENEFICIAL: Energy savings, job creation, and economic activity from energy efficiency investments in buildings

Following a deep efficiency scenario will require significant investment to improve the energy performance of new and existing buildings in BC. Part 3 refers to all buildings over three storeys or more than 600m² in area. Generally, these buildings are commercial and industrial buildings,

as well as multi-unit residential buildings. Part 9 includes all buildings with three storeys or less, up to 600m² in area, and are generally housing and small buildings.

A study by the World Business Council for Sustainable Development (WBCSD) quantified the investments needed to attain different levels of energy savings including the IEA's 77% reduction target needed to stabilize GHG concentrations at safe levels.^{xxiii} Assuming energy prices of \$60 per barrel equivalent, the study shows that \$150 billion in annual investments in US, EU, China, India, Brazil and Japan collectively could decrease energy use and corresponding GHG emissions in buildings by 40% by 2050, at a discounted payback of zero to five years. An additional \$150 billion in investment could yield an additional 12% of energy savings, at a discounted payback of five to 10 years. Additional annual investments of \$650 billion would be required to achieve the remaining 25% needed to reach the IEA's 77% reduction target.^{xxiii} This last slice would not return savings sufficient to be justifiable solely on economic return. The study estimated the total marginal cost to meet the 77% reduction target to be about 7% of annual construction costs. WBCSD concludes that "the scale of this net cost demonstrates the need for both public subsidies and for businesses to develop products that achieve energy efficiency at lower cost to meet decision-makers' return criteria."^{xxiv} Economic benefits of energy efficiency, however, go much beyond the direct energy cost savings and include job creation, economic growth from energy cost savings reinvestment, and mitigation of climate risks and resulting costs.

Investments in the building sector create more jobs per dollar invested than investments in resource extraction or the energy sector. Research by the University of Massachusetts estimates that the total number of jobs (direct, indirect and induced) from efficiency capital upgrades in multifamily buildings to be 13.41 per million dollar invested—more than double the number of jobs created for a similar investment in energy generating infrastructure (5.32 per million dollars invested). Similarly, the EU's Energy Efficiency Industrial Forum found that investing in energy efficiency in the building stock would create 19 direct jobs in the construction and energy efficiency sector per million Euros invested (or 18 in \$USD).^{xxvi}

Even more than the direct investment, it is the savings from lower utility bills that have the greatest impacts on local economic development. A macro economic modelling study undertaken for Natural Resources Canada (NRCan) has estimated that savings realized by consumers and industry drive the majority (75-85%) of overall macroeconomic impact from energy efficiency investments.^{xxvii} Savings from lower energy bills cause consumer re-spending in other forms, stimulating the local economy.² Furthermore, lower energy bills also decrease the cost of doing business, increasing business competitiveness and promoting additional demand throughout the supply chain—further stimulating employment.

The NRCan study found that high energy efficiency standards in the residential, commercial/ institutional and industrial sectors (transportation not included), would return \$3 to \$5 for every \$1 invested, increase Canada's annual GDP by \$19 to \$48 billion and create 121,000 to 304,000 net new jobs per year. This in turn would increase federal and provincial income tax revenue by \$2.7 billion and \$2.0 billion respectively.^{xxviii}

² Admittedly, some of these savings might get invested in products and services that in turn increase energy demand, a phenomena known as the rebound effect. According to the IPCC's literature review included in the 2014 Fifth Assessment Report, "for household-efficiency measures, the majority of studies show rebounds in developed countries in the region of 20–45%... meaning that efficiency measures achieve 65–80% of their original purposes," IPCC Working Group III, "Drivers, Trends and Mitigation," in *Mitigation of Climate Change* (2014), 391.

4. A DEEP ENERGY EFFICIENCY PATHWAY IS POLITICALLY FEASIBLE: Jurisdictions leading the way on building policies

Much has been written about countries around the globe advancing energy efficiency strategies for buildings.^{xxix, xxx} In addition to these reports from the field, various professional organizations have outlined key desirable characteristics of energy codes and other public policies needed to accelerate the transition to net-zero or near net-zero buildings.^{xxxii, xxxiii, xxxiv} To provide a context for the adoption of energy efficiency targets in BC, we review the targets set and the approach taken by three leading jurisdictions: the European Union and the states of California and Washington. The EU example offers guidance on what is possible, while the California and Washington examples help to situate BC in the context of its PCC partners—close economic neighbours moving in the same direction will smooth the road for BC.

The European Union

The EU considers a transition to energy efficient buildings to be a core part of its climate change strategy. The EU targets emission reductions of 80–95% below 1990 levels by 2050; 36% of its GHGs come from buildings.^{xxxv} The transition to energy efficient buildings is formalized through the European Commission’s Energy Performance of Buildings Directive (EPBD), which was first introduced in 2002, and recast in 2010 to reflect advances in construction practices.

The EPBD Recast has three key strategies to improve the energy performance of buildings:

- Setting mid-range national targets for “nearly zero energy buildings” by 2020, with public institutions leading the way by 2018
- Ensuring immediate and ongoing improvement in minimum energy performance standards by making all cost optimal measures required by code for new construction and major renovation
- Accelerating market transformation for energy efficiency and ensuring ongoing data collection to track progress through the issuance of energy performance certificates (energy labelling).^{xxxvi}

Each member state is left free to set its own operational definition of nearly zero energy buildings. Table 3 presents a select group of leading EU nations.

Table 3 Targets set for the performance of new buildings in select European countries

Country	Target	Target year
General EPBD directive	“A building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.” ^{xxxvii}	2018 for new public buildings; 2020 for other new buildings
France	Energy positive building	2020
U.K.	Zero carbon emissions buildings	2016
Brussels	Passive House equivalent (45 kWh/m ² /yr)	2015
Luxembourg	Passive House equivalent	2020
Denmark	20 kWh/m ² limit for heating, cooling, ventilation and hot water	2020

California

California is one of the leading jurisdictions worldwide in addressing climate change.^{xxxviii} Along with its cap-and-trade regulation, renewable portfolio standard for electricity generation and zero-emission vehicle regulation, increasing efficiency in buildings is a key state policy toward decreasing GHGs 80% below 1990 levels by 2050.^{xxxix}

In contrast to other North American jurisdictions that rely on external energy standards, California writes its own building energy code. This gives the state more control in achieving its targets and gives consideration to the state's unique climate and predominant building types.

Title 24, Section 6 of the California Code of Regulations (commonly referred to as Title 24) regulates energy efficiency of new buildings. Title 24 aims to make new residential and commercial buildings zero-net energy (ZNE) by 2020 and 2030 respectively. In addition, half of the existing commercial building stock must be renovated to ZNE performance levels by 2030.^{xl}

California's Energy Commission enacts standards into building codes. The commission's first goal is to meet increased energy demand from new buildings with cost-effective energy efficiency initiatives, defined over a 30-year life cycle period. The 2013 California Building Code (effective July 1, 2014) focuses on these cost-effective energy efficiency measures, and is expected to increase efficiency by 30% compared to the state's previous code and 12% compared to ASHRAE 90.1-2010.^{xli}

The commission's second goal is to increase renewable energy generation in new buildings. The current building code already demands solar ready requirements for new buildings, bringing the state closer to its ambitious ZNE goals. The 2016 code is currently being developed and is expected to further increase the required energy efficiency and renewable energy generation capabilities of new buildings.^{xlii}

Since 2010, California also has a stretch code, defined under Section 11 of Title 24. It is called the California Green Building Standard, commonly referred to as CALGreen. CALGreen is a voluntary standard that local jurisdictions are encouraged to adopt. The second iteration, CALGreen 2013, came into effect January 1, 2014. It applies to both residential and commercial buildings. CALGreen has two tiers. Tier 1 improves upon the basic energy standards in Title 24 (defined by Section 6) by 15%. Tier 2 improves upon the energy performance by 30%.^{xliv}

Washington

Washington is a leader in energy efficiency because of its energy code roadmap to higher performance buildings. The 2009 released Senate Bill 5458 directs the Washington State Building Code Council (SBCC) to develop energy standards that achieve a 70% reduction in building energy use by 2030 compared to the 2006 Washington State Energy Code.^{xlvi} The 2014 Energy Efficiency Building Strategy Update established a roadmap towards achieving this target. Two explicit pathways are proposed that progressively update the energy codes on a three-year cycle: 1) each code cycle improves upon the original 2006 level by 8.75%, or 2) each code cycle improves 14% over the previous code cycle. The former pushes the compliance burden to the future as energy gains will be harder to achieve towards the end of the regulatory period, while the latter pushes the compliance towards the present. Figure 1 summarizes Washington's incremental code improvement roadmap.

Currently Washington adopts the International Energy Conservation Code (IECC) 2012 energy code (which refers to ASHRAE 90.1-2010 for commercial buildings), though the state amends

and strengthens the energy section to fit its requirements. Through this approach, Washington can benefit from the research and structure offered by the IECC process while increasing the bar as needed to meet its own energy roadmap.

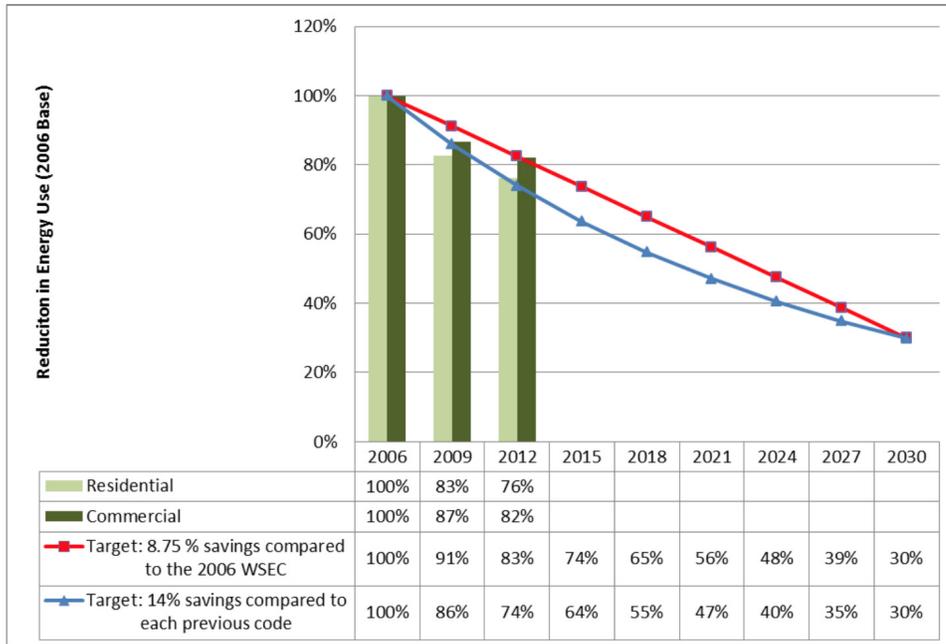


Figure 1: Washington’s energy code roadmap Source: Washington Department of Commerce ^{xlviii}

The City of Seattle, like Vancouver, has the jurisdiction to set its own building code. This allows the City of Seattle to pilot higher efficiency codes, which can then inform state codes. Seattle introduced an outcome-based compliance path in their 2012 energy code - a first in North America.^{xlix} Applicants for the Target Performance Path must provide a financial security to ensure their post-occupancy compliance.³ The building is allowed three years in which to complete a 12-month period for which the energy use is below the agreed-upon maximum, at which time the pledge letter would be returned. In the event that a fine was to be assessed, up to half of that money could be returned as reimbursement for further energy-conservation improvements.¹

5. KEY ELEMENTS OF THE PATHWAY TO NET-ZERO READY BUILDINGS

From the experience of these three jurisdictions and discussions in the literature, some key policy initiatives emerge as promising practices to enable a timely transition to net-zero ready buildings. These policies aim to provide both sticks and carrots: setting regulatory requirements for better energy efficiency and increasing market demand for energy efficient buildings.

³ This security can take the form of a performance bond or a bank letter of credit, but the more appealing option is known as “pledge and fine,” wherein the owner agrees to be fined according to a specific schedule if the building does not comply. (The maximum fine is US\$4.00 per square foot for gross non-compliance).

1. Set vision and targets

This includes a clear definition of the desired goal (e.g. net-zero energy, near net-zero energy, passive house, carbon neutral, percent better than baseline), associated metrics (e.g. site energy, source energy, carbon intensity) and target years. Target years can differ based on sector, as is the case in California (commercial vs. residential) and Europe (public vs. private). The vision could also include plans for the renovation of the existing building stock. Defining a metric with a fixed baseline is helpful in measuring progress and setting interim targets.

2. Develop an energy code roadmap

Setting a transparent and predictable roadmap outlining how energy codes will evolve to meet these targets allows industry and institutional actors to adequately prepare and plan for code changes, minimize surprises and increase cost effectiveness. It also allows manufacturers of building components to foresee demand for energy efficient products and prepare to meet market demand.

3. Develop opt-in stretch codes

Stretch codes offer one or several tiers of performance requirements beyond the current base code. They are generally used as criteria for incentives or rezoning policies. Stretch codes, such as California's CALGreen, the two-tiered Toronto Green Standards or the City of Vancouver's Green Rezoning Policy and Higher Building Policy provide consistent guidelines for "beyond code" incentives. A set of provincial "opt-in" stretch codes would allow local governments to have a shared basis to set rezoning policies, and possibly to adopt as base codes. This consistency would decrease development and construction costs and facilitate administration and permitting processes.^{lviii} By incenting leading developers and builders to set a path for the rest of the market, stretch codes can increase the pace of base code energy efficiency improvements. Basing future base-code performance level on levels set and tested under stretch codes increases the predictability and transparency of code changes.^{liv}

4. Improve energy code compliance

Because building code compliance has historically focused on health and safety issues, many jurisdictions acknowledge that compliance with commercial energy codes is seldom achieved and only enforced sporadically. Recent audits in New York City found that over 90% of building plans examined failed to meet the energy code.^{lv} Minimum training and ongoing education for building officials is a central aspect of code enforcement, which is being addressed in BC by the recently introduced Building Act.^{lvi} As performance-based compliance using energy models becomes more common, adopting standards for energy modelling and ensuring third-party verification of energy models can also contribute to improving compliance and streamlining permitting processes.^{lvii, lviii}

5. Provide incentives and innovative financing solutions

Well-designed incentives can offset some of the incremental costs and risks associated with higher energy efficiency and motivate developers to go beyond code and adopt stretch targets. Incentives may include cash incentives from utilities, reductions in development cost charges, accelerated permit processing, rezoning and density bonuses. Alongside incentives, innovative financing models can help offset some of the incremental costs of higher performance. This is particularly needed when the developer is not the long-term owner of the buildings, "splitting" the financial incentive to invest for long-term energy savings. The split incentive barrier could be addressed through on-bill (or on-property tax) financing through transfer of some of the

incremental cost to the strata council. Both of these financing mechanisms would allow developers to transfer some of the initial costs to the party who will benefit from the savings.^{lix}

6. Benchmark, report and disclose building energy performance

Energy benchmarking provides building owners with a platform to track the energy performance of their buildings over time, and compare them to buildings with similar function, size and climate. This provides building owners a unique tool to identify underperforming buildings; the simple act of tracking energy performance on a regular basis has been shown to reduce energy use on average 2.4% per year.⁴ Reporting of that data to government agencies provides intelligence on the performance of new and existing buildings, which is necessary to assess the impact of energy codes and to target incentive programs.⁵

In addition, public disclosure of benchmarked data, by making energy performance visible to consumers and real estate actors, can be a key factor in accelerating market transformation for high performance buildings. A study by the Market Transformation Institute estimated that implementing a US-wide reporting and disclosure requirement could reduce energy use in the US by over 50,000 GWh per year, reduce energy costs by \$3.8 billion per year and create 59,000 jobs by 2020.^{lx}

Two states, one county and 13 cities in the United States have adopted mandatory benchmarking policies for larger commercial (and sometimes residential) buildings.^{lxi} Seven of these require the benchmarking results to be disclosed on a public website.^{lxii}

7. Require building commissioning

Building codes assume that each system and piece of equipment works as intended. Research has shown that this is seldom the case.^{lxiii} Building commissioning is a quality assurance process that spans the entire design and construction process, helping ensure that the new building's performance meets design expectations. Review by the Lawrence Berkeley National Laboratory of 649 commissioning projects covering 100 million square feet of floor space reveals that commissioning identified over 10,000 energy-related problems, resulting in 16% energy savings in existing buildings and 13% in new construction with a payback time of 1.1 years and 4.2 years, respectively.^{lxiv} In addition to the operating cost savings, the study shows that significant first-cost savings (e.g. through right-sizing of heating and cooling equipment) routinely offset a portion or all of the commissioning costs.^{lxv}

⁴ The United States Environmental Protection Agency's (EPA) ENERGY STAR Portfolio Manager is used to track and manage energy use in buildings. Over 35,000 buildings entered complete energy data in Portfolio Manager and received ENERGY STAR scores for 2008 through 2011. These buildings realized savings every year, as measured by average weather-normalized EUI and the ENERGY STAR score, which accounts for business activity. Their average annual savings is 2.4%, with a total savings of 7.0% over the entire period. United States Environmental Protection Agency, Energy Star Portfolio Manager Data Trends: Benchmarking and Energy Savings (2012). <http://www.energystar.gov/buildings/tools-and-resources/datatrends-benchmarking-and-energy-savings>

⁵ For example, data collected by the City of New York, which has a mandatory reporting and disclosure policy for buildings above 50,000 square feet since 2010, shows that multi-unit residential buildings in the top 95th percentile of energy use 3.3 times the energy per square meter than the bottom 5th percentile. Such large differences illustrate that certain buildings constitute low-hanging fruit where incentives could lead to increased energy savings. The ratio between high and low performance increases seven-fold for office buildings. New York City Mayor's Office of Long-Term Planning and Sustainability, New York City Local Law 84 Benchmarking Report (2013). http://www.nyc.gov/html/planyc/downloads/pdf/publications/2014_nyc_ll84_benchmarking_report.pdf

Beyond energy savings, commissioning is used as a risk management strategy, ensuring that building owners get what they pay for when constructing or retrofitting buildings. By offering a third-party certification of the state of the building at the time of property transfer, commissioning can also reduce liability risks for builders and developers.

The City of Seattle 2012 Energy Code requires commissioning of the HVAC system, water heating, lighting controls and metering system above certain size thresholds for residential buildings taller than three stories and for all non-residential buildings.^{lxvi} Basic commissioning is also a pre-requisite for LEED certification and up to five points can be earned for enhanced commissioning.^{lxvii}

8. Reduce plug loads

Plug and process loads represent the fastest growing source of energy use in the residential and commercial sector; they are projected to account for 28% of residential and 49% of commercial building energy consumption in 2035.^{lxviii} Improvements in efficiency of major appliances have been offset by increased demand for large appliances, growing product saturation and the proliferation of new plug load devices. Getting to net-zero ready will require improved energy performance of the various devices driving plug load increases as well as consideration of plug load controls and occupant engagement in building design. Because most plug loads are installed by occupants, it is challenging to regulate their energy use through building codes that are enforced before occupancy. Today, equipment efficiency regulations under the provincial and federal Energy Efficiency Acts are the primary tools used to reduce energy demand from plug loads. However, there is much discussion about how energy codes could be extended to include more plug load consideration, including through controls and occupant engagement devices providing dynamic feedback on energy use.^{lxix} Increasing gains from plug load will be facilitated by designing energy codes which change the emphasis from improving specific regulated end uses (and prescriptive component performance) to improvements in whole-building energy use.

9. Address performance gap through outcome-based codes or other policies

In outcome-based codes, building performance (and code compliance) is demonstrated by analysis of energy use data after occupancy, rather than assumed based on review of prescriptive requirements or modelling of buildings “as designed”. The central purpose of outcome-based codes is to minimize the performance gap between expected and actual energy performance, and to incentivize strategies for energy savings through system-level design, occupant engagement, continuous optimization of building operations and quality installation. As discussed above, the Seattle’s energy code and the 2015 IgCC include optional outcome-based compliance paths.

Outcome-based codes are one of several policies to increase accountability for building operations and reduce the performance gap. Other examples include contractual agreement under public-private partnership projects, conditional incentives based on verified performance after occupancy, and retrofit requirements at time of renovation. Commissioning and benchmarking policies, as discussed above, also play a key enabling role in ensuring expected performance is delivered and maintained over time. Specific elements of energy codes can also help owner, operator and occupants run their buildings at maximum efficiency after construction, such as control strategies (e.g. automatic shut off when there are no occupants, light dimming based on natural lighting, etc.), graphic energy use displays for troubleshooting by building managers, in-house energy use displays to engage tenants, etc.

10. Lead with public buildings

Public institutions are well suited to lead the transition towards net-zero ready buildings. Public institutions generally have a mandate for social good and tend to be long-term occupants of buildings they commission (or spaces they lease), both factors that make the case for higher initial spending to reduce energy costs and avoid negative externalities such as carbon pollution. Leadership by the public sector will be a key factor in proving the viability of net-zero ready buildings, increasing demand for higher performance buildings and preparing the ground for more risk-averse sectors. In BC, the BC government is required to be carbon neutral in operation as of 2010, and all new public buildings must be certified LEED Gold.^{lxx} In Europe, public buildings are expected to meet the nearly zero-energy buildings target by the end of 2018, two years ahead of private buildings.

11. Increase the price on carbon

In BC and elsewhere, the cost of energy does not reflect the true costs to society. Including the full extent of externalities, such as by increasing the price on carbon to reflect the real costs of climate pollution, will increase the price of energy accordingly. This will give an economic signal for greater investments in energy efficiency.

These eleven policy strategies provide a framework to support a transition to net-zero energy and low-carbon buildings. The second strategy, the development of an energy code roadmap, is discussed further in the next section.

6. OPTIONS FOR BC'S ENERGY CODE

BC historically has relied on the national code process to define its building code, making minimal amendments to suit its unique geography, climate and policy objectives. The inclusion in 2008 of a new code objective for the reduction of energy and water, and the adoption of ASHRAE 90.1-2004 as energy code for Part 3, was a significant departure from this history, and set the ground for future energy code adoptions. Currently, BC's energy code is based on ASHRAE's 90.1 standard and the NRC's NECB. Both of these standards are expected to continue to improve energy efficiency in future editions, but will these gains be sufficient for BC to meet its net-zero commitment in a reasonable timeframe?

This question cannot be answered with certainty as both standards are developed through a consensus process, which depends on the stakeholders involved and the state of the industry. However, some long-term vision documents can be used as guides, offering some clarity as to where these standards might go. ASHRAE's Board of Directors has adopted long-term targets for the performance evolution of 90.1, published in their Vision 2020 document (Figure 2).^{lxxi} This pathway sees 90.1 get to 50% below 90.1-2010 by 2030. Similarly, the Standing Committee on Energy Efficiency in Buildings recommended a pathway leading NECB to produce "net zero ready" buildings by 2030, but set this target at 50% below NECB 2011, a lower level of performance than that achieved by the average net-zero building without on-site renewables.⁶ It should be noted that this target has been proposed by the standing committee, but has not yet been adopted by the Canadian Commission on Building and Fire Codes. While these targets represent significant performance gains, they are not quite hitting the "net-zero ready" mark (roughly equivalent to a 70% decrease from 90.1-2004, as discussed previously).

In addition to the 90.1 standard, ASHRAE also produces a "green building" standard: ASHRAE 189.1 for the Design of High Performance Green Buildings except Low-rise Residential Buildings. ASHRAE 189.1 is the first "green building" standard that is designed to be incorporated into the

building code. It includes more stringent energy performance requirements (along with requirements for other environmental objectives), including it requires the incorporation of on-site renewable, and tighter controls on plug and process loads. Given this broader scope, the ASHRAE Board of Directors has set the target for 189.1 to achieve net-zero energy by 2030.^{lxxiii} The projected energy performance of ASHRAE 90.1, 189.1 and the NECB are summarized in Figure 2 below. Figure 2 makes evident that continuing to reference ASHRAE 90.1 and NECB alone might not allow BC to get to “net-zero ready” until after 2030.⁷

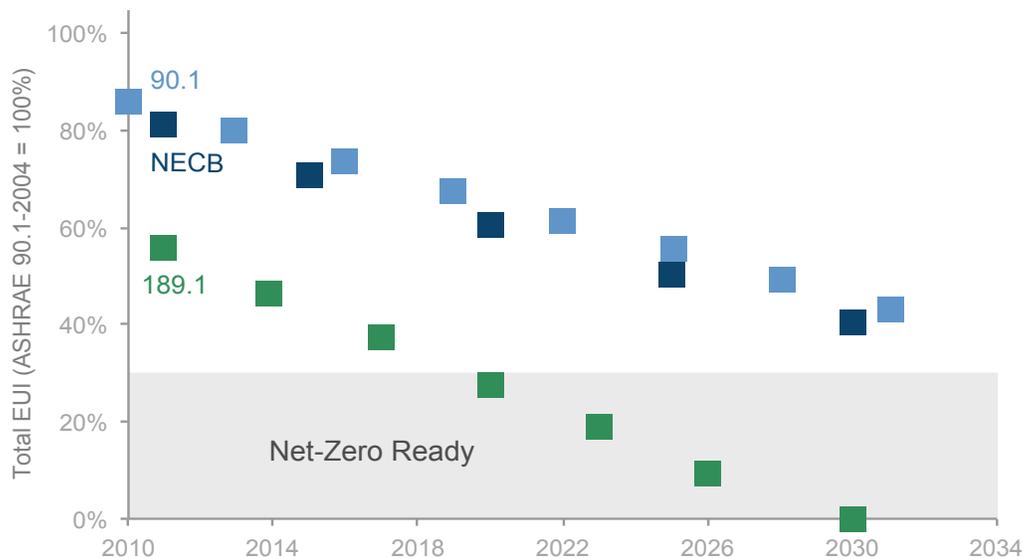


Figure 2: Proposed trajectories for 90.1, 189.1 and NECB, expressed relative to ASHRAE 90.1-2004. Of the three standards, only ASHRAE 189.1 reaches a level of performance sufficient to be “net-zero ready” (roughly 70% below 90.1-2004, or lower) before 2030.⁷

This is in part an issue of scope: these standards mostly address regulated loads (heating, cooling, ventilation, lighting, hot water) and therefore miss opportunities for energy savings in plug and

6 National Research Council, Performance Improvement Goals for NECB, Standing Committee on Energy Efficiency in Buildings (2013). This memo also proposes that new buildings should be “net-zero ready” by 2030, but sets this goal post at a higher EUI target than this paper proposes. The 50% target aims for a EUI equivalent to “the lowest possible Energy Use Intensity (EUI) of a building without renewable energy” which at the time they estimated at about 100 kWh/m². As discussed in previous footnote, the average EUI for current net-zero verified buildings is about 65 kWh/m². It should also be noted that the memo does not explicitly state if the proposed target should be for total energy use, or only regulated load — but given the framing around “net-zero” and their statement that “the remainder of the energy use would be offset by on and off-site renewable generation to reach net zero energy performance in new buildings”, we assume they refer to total energy reductions target. Given that NECB does not currently regulate plug loads, this would require the reductions in regulated energy to exceed the 50% below NECB-2011 target.

7 It is worth noting that both California and Washington State are faced with a similar challenge in meeting their energy code objectives. California writes its own energy code, designing it to suit its performance targets, climate and energy supply context. Washington State, with a smaller tax base, bases its code on the International Energy Conservation Code (based on ASHRAE 90.1), but amends it heavily to meet higher energy performance targets. Mike D. Kennedy, Comparison of the 2012 Seattle Energy Code with ASHRAE 90.1-2010, prepared for the City of Seattle Office of Sustainability & Environment, 2014, 4. http://www.seattle.gov/Documents/Departments/OSE/SEC2012toASHRAE90-1-2010_20June2014.pdf.

process loads (appliances, etc.). As we discussed above, some plug load strategies could be integrated in energy codes; others will rely on equipment efficiency regulations or occupant engagement programs. Either way, plug loads will likely remain a significant source of energy consumption, and getting to “net-zero ready” will require greater reductions from regulated loads.

It is uncertain whether 90.1 and NECB will be able to deliver regulated load reductions of the order needed to get to net-zero ready (70% or more from 90.1-2004) by 2030. To meet this goal in a more timely fashion, we see four options available to BC:

1. Encourage the NECB development process to adopt bolder performance targets.
2. Amend 90.1 to increase energy performance, similarly to the approach taken by Washington State.
3. Coordinate with neighboring Pacific Coast Collaborative partners, particularly Washington, on the development of a “Cascadia” energy code.^{lxxiii}
4. Shift to a performance-based code, and use on-design guide documents (such as ASHRAE’s Advanced Design Guides series) to support building designers to meet these targets.

The first three options would allow BC to continue to offer a prescriptive compliance path for the energy code. The fourth option would entail a shift away from prescriptive codes (though some prescriptive elements could remain) and a heavier reliance on whole-building energy modelling to assess compliance.

A performance-based code, similarly to the performance-base compliance path currently available under ASHRAE 90.1 and NECB, uses energy models to predict the overall performance of a proposed building. Whereas prescriptive codes set requirement for the energy efficiency of each component, performance-based codes require the overall building to be considered as a single system.^{lxxiv} If the modelling shows that the building meets certain performance targets (either expressed as “percent better than” a reference building or as absolute energy or carbon intensity targets), the building is deemed to comply.

One benefit of a performance approach is that, once the methodology is set, it is relatively simple to adjust the level of required performance over time: simply adjust the minimum metrics that must be met for compliance. This approach also offers more flexibility for designers and developers, allowing optimization of design based on building type, use, and location.^{lxxv} Setting targets based on energy or carbon intensity use would also increase the predictability of energy code outcomes, as the actual energy performance resulting from prescriptive energy codes varies greatly depending on which prescriptive options are chosen.^{lxxvi} A ‘whole building’ approach is also more likely to consider innovative options to decrease plug loads.

An alternative to a purely prescriptive code could be the “prescriptive packages” approach suggested by PNNL, a hybrid performance/prescriptive approach where compliance is achieved by either meeting the performance target, as demonstrated by whole building energy modelling, or by choosing one of a series of prescriptive packages. Instead of prescriptive requirements for individual components, these packages offer linked requirements that have been shown through modelling to lead to an equivalent performance level for a certain building type.^{lxxvii}

Yet another possible approach for a performance-based code would be to skip intermediate steps and jump directly to requiring performance equivalent (or comparable) to that of the Passive House standard: space heat demand no greater than 15 kWh/m²/yr, air leakage of less than 0.6 air changes per hour, and an overall maximal total primary energy of 120 kWh/m²/yr.^{lxxviii} Obvi-

ously, preparing the construction industry for this transition would require lead time to build capacity and to ensure the availability of a range of high performance components. This would require concerted effort from government and industry, but preparing for a one-time jump to high performance could be easier for the industry to adapt to than new requirements every five years. This was the approach taken by the City of Brussels, which announced in 2008 that by January 1, 2015, all new construction would need to meet the Passive House standards.^{lxxix}

It should be noted that options 2 to 4 above, while potentially allowing BC to move faster on the path to net zero ready, will challenge BC's commitment to harmonize with the national system. Option 1, banking on the NECB to set bolder targets, might be a challenging route as the national process aims to meet the objectives and limitations of various provinces and stakeholders. One option might be to work with the Canadian Commission on Building and Fire Codes to create a series of performance-based stretch target for provinces to use. Similarly to the dynamic between local jurisdictions and the Province of BC, this could allow leading provinces to accelerate energy efficiency uptake while maintaining some level of national harmonization.

This is, however, predicated on the willingness and capacity of the national process to develop these policies in a timely manner. If this does not seem likely, BC could continue to rely on the National Building Code for the bulk of the BCBC, but decide to align more closely with regional partners within the PCC to develop its energy code. Or it could opt for a performance approach using NECB as baseline (i.e. setting targets expressed as “percent better than” the NECB); while not necessarily the simplest route from a code design perspective,^{lxxx} this could allow BC to move faster on energy while continuing to harmonize to some extent with the national system.

7. CONCLUSION

Achieving BC's climate change targets will require deep emission reductions from the province's building sector. This is a considerable challenge, especially considering BC's growing population and projected increase in total building floor area. Modelling commissioned by the Global Building Performance Network showed that a deep efficiency path, featuring both retrofit targets and a broad adoption of state of the art technology for new buildings within 10 years, would allow building sector energy use and emissions to decrease even as floor space increases.

BC's commitment under the Pacific Coast Action Plan on Climate and Energy to lead the way toward net-zero buildings is a key aspect of this deep efficiency path. Achieving this target within the next 10 to 15 years would ensure new buildings do not lock us into a high-energy high-emission future, and would return significant economic benefits, including increased job creation and tax revenues.

Energy codes will play a central role in achieving this target. Because the current energy standards referenced in BC's building code—ASHRAE 90.1 and the NRC's NECB—might not achieve net-zero ready in the desired timeframe, BC needs to consider other options, such as amending 90.1 to increase component performance requirements, leveraging resources of Pacific Coast Collaborative partners to develop a regional energy code, and/or shifting to a performance-based code. These options, however, are at odds with another objective of the BC Building Code, which is to maintain some level of national harmonization. Encouraging the Canadian Commission on Building and Fire Codes to accelerate performance gains in the next iterations of the NECB, or to create a series of performance-based stretch target for provinces to use, could accelerate energy efficiency uptake while maintaining a higher level of national harmonization.

Whether developed nationally or provincially, stretch codes can help reduce risks and costs associated with the adoption of a new energy code. Using a multi-tiered provincial stretch code to set utility incentives, rezonings, and public procurement policies will provide a common framework for developers willing to go beyond minimal codes. By setting the stretch code levels such that they match the performance expected in future energy codes, learnings from leading developers can be leveraged to facilitate transition to the next code cycle.

Other policies are needed to help ensure buildings perform to their expected level over the years. Energy efficiency regulations and utility programs will be crucial in slowing, or reversing, the growth of plug loads. Commissioning ensures new buildings meet expected performance when delivered to clients. Benchmarking and reporting policies provide invaluable data on the state of the building, which building managers and local governments can use to address under-performing buildings. Energy performance disclosure policies provide information needed by market to value energy efficiency, and incentives to maintain high performance.

These policies help reduce the performance gap, but also provide the ongoing feedback needed for energy codes to evolve dynamically and respond to changes in the industry and reach the net-zero target at a reasonable cost.

8. RECOMMENDATIONS

Based on the findings of this report, we recommend that the provincial government:

- Develop a roadmap to move towards net-zero or net-zero ready new Part 3 buildings in BC. This roadmap should set targets for new buildings to achieve net-zero ready performance (about a 70% decrease in total energy use compared to the 2008 code) within 10 to 15 years, and propose a schedule of energy code changes to get to this target — either based on a series of incremental changes, or preparing for a one-time transition to a high efficiency standard such as Passive House. This roadmap should also address the 11 supporting policies outlined above.
- Work with the Provincial/Territorial Policy Advisory Committee on Codes, the Standing Committee on Energy Efficiency in Buildings, and other working groups to advocate for the adoption of long-term energy efficiency targets for the National Energy Code for Buildings aligned with a deep efficiency path.
- Consider alternative options for the energy code should the level of performance or the structure of ASHRAE 90.1 or the NECB not be adequate to meet the roadmap targets. This paper proposes three options to do so:
 1. Amend 90.1 to increase energy performance, similar to the approach taken by Washington State.
 2. Coordinate with neighboring Pacific Coast Collaborative partners, particularly Washington, on the development of a “Cascadia” energy code.
 3. Shift to a performance-based code — either expressed as “percent better than NECB”, based on prescriptive packages, based on EUI targets, or following the Passive House standard.
- Appoint a permanent multi-stakeholder Energy Efficiency Advisory Council to advise on matters related to the province’s and utilities’ efforts to advance energy efficiency in buildings. The council should include representatives from all branches of government with responsibilities connected to building energy consumption and GHGs. The Energy Efficiency

Working Group to be convened soon by the Buildings and Safety Standards Branch could act as a catalyst for the formation of this ongoing advisory body.

- Develop a comprehensive deep efficiency strategy for the building sector as a whole, integrating the recommendations made here for new Part 3 buildings, but also considering new Part 9 buildings and the existing building stock.

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