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Canada's Building Code in the Context of Climate Change, Adaptation, and Sustainability

White paper on the urgency of building code modernization and implementation

June 2019

Office of the Honourable Rosa Galvez

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EXECUTIVE SUMMARY

The buildings sector lies at the heart of climate change challenges. Our built environment produces a significant fraction of Canada's national greenhouse gas emissions and represents a fundamental vulnerability in a world where risks associated with climate change are increasing in frequency and severity. In Canada, research into construction, operation, energy efficiency, and resilience of our buildings is overseen at the national level by the National Research Council (NRC) which produces the National Building Code (NBC), a compendium of standards which is recommended to provinces for adaptation and adoption.

Along with highlighting the importance of the buildings sector in the low-carbon and climate-resilient landscape, the objective of this discussion paper is to analyze current practices in the development and implementation of Canada's building codes and to present some recommendations and topics for further discussion and action. These topics are described at the end of each chapter and broadly fall into the following three themes:

Incentives framework – Jurisdictions that have achieved success in this field all have strong renewable energy and climate change resiliency incentive programs.

Stringency of technical requirements – Energy efficiency standards must be ambitious and consider Canada's national and international greenhouse gas (GHG) reduction obligations. Standards for both energy efficiency and climate resiliency must be holistic, lifecycle-based, and encourage long-term perspectives on effectiveness and related cost savings without disproportionately affecting vulnerable populations.

Implementation and administration – Provinces and territories are currently working towards harmonization and timely adoption of building codes. This huge step forward must be accompanied by a careful consideration of the relevance of and extent to which international codes should be relied upon in Canada's buildings sector and considerable acceleration of the pace of code development and adoption.

The NRC is working towards developing a new iteration of its Codes Canada publications for 2020 but the codes must be accompanied by a cohesive, harmonic, and informed framework of policy instruments and incentives. We must learn from the countries and international organizations which have found successes in developing and implementing modernized codes while maintaining a cornerstone of accountability, transparency, and responsible use of public funds. Specifically, the EU's Eurocodes provide a robust groundwork for directing climate change adaptations and there are outstanding examples of *smart cities* in the US that have spearheaded energy efficiency and renewable energy – both of which are discussed herein.

INTRODUCTION

This document is a foundation for the analysis and study of Canada's National Building Code system in the context of global climate change. It provides an overview of the historical and current state of standards and regulations, a brief comparison to other predominant standards systems, and finally some insight into the administrative dynamics at play which are ultimately responsible for code adoption and implementation.

BACKGROUND

Building codes comprise regulations for the construction, occupation, and modification of structures. Modern building codes emerged in the mid-19th century with the adoption of rudimentary municipal codes in London, Baltimore, and Paris. At their most basic, building codes from around the world address the safety of humans as they interact with structures. However, codes are evolving to take a more holistic approach to building management by including provisions for energy efficiency, construction materials, and accessibility.

The Canadian constitution describes power over "local works and undertakings" along with "generally all matters of a merely local or private nature in the Province" as provincial responsibilities. This has been interpreted to include the regulation of buildings and construction. Before 1941 construction was largely unregulated or under municipal oversight. In 1941 Canada's first National Building Code (NBC) was published as a model code recommended for provincial implementation and enforcement. Later that decade, in 1947, an arm of the National Research Council that would become today's Institute for Research in Construction (NRC-IRC) was established to, among other tasks, lead the development of the NBC. Today, all NBC publications are collectively referred to as Codes Canada and are developed and maintained by the Canadian Commission on Building and Fire Codes (CCBFC) while the NRC provides administrative and technical support.[1]

The NBC refers to 192 standards which have been produced and maintained by standards-writing bodies such as the Canadian Gas Association and the Canadian Standards Association. All such bodies are privately funded except for the Canadian General Standards Board, a branch of the Department of Supply and Services.[2] Codes Canada is updated approximately every 5 years by about 40 staff at a cost of $40 million per cycle, principally funded by code sales.[3]

[1] About Codes Canada (NRC, 2017)
[2] Building Codes and Regulations (The Canadian Encyclopedia, 2013)
[3] Canada's National Model Construction Codes Development System, NRC publication

Codes Canada comprises the following 5 model codes:

> **The National Building Code of Canada (NBC)** addresses the design and construction of new buildings and the substantial renovation of existing buildings.
>
> **The National Fire Code of Canada (NFC)** provides minimum safety requirements for buildings, structures, and areas where hazardous materials are used, and addresses fire protection and prevention in the ongoing operation of buildings and facilities.
>
> **The National Plumbing Code of Canada (NPC)** covers the design and installation of plumbing systems in buildings and facilities.
>
> **The National Energy Code of Canada (NECB)** provides minimum energy efficiency requirements for the design and construction of new buildings and additions.
>
> **The National Farm Building Code of Canada (NFBC)** addresses the particular needs of farm buildings.

From within these codes, infrastructure resiliency and energy efficiency provisions are primarily contained within the NBC and NECB respectively. The NECB makes recommendations across five key categories: building envelope; lighting; heating, ventilation, and air conditioning (HVAC); water heating; and electrical systems. Three paths to energy efficiency compliance are offered[4]:

> **Prescriptive path** – Design must follow the prescribed requirements of each section of the code. This is the simplest path and doesn't take into account interactions between different building components.
>
> **Performance path** – Designer must show that the building will not consume more energy than an equivalent building built using the prescriptive path requirements.
>
> **Trade-off path** – This path allows for the compensation of energy efficiency shortcomings in one design aspect with a more robust energy efficiency design in another aspect.

The next iteration of Codes Canada publications is anticipated for 2020 and is expected to emphasize reducing the energy demand of houses and buildings through improved energy efficiency. Additionally, the federal government has committed to funding for considerations towards national climate adaptation and planning.

[4] Canada's National Energy Code (NRC, 2018)

ISSUES

CLIMATE RISK AND RESILIENCE

Extreme weather events, climate change, and water crises consistently rank among the most pressing global risks in the World Economic Forum's Global Risk report.[5] Building code revisions represent a key opportunity to implement climate change adaptations which serve to attenuate or avoid harm to persons as well as damage to buildings and infrastructure.

One glaring example of the need for increased resilience in infrastructure is the thawing of permafrost, an aspect of climate change that uniquely affects countries with colder climates. The Northwest Territories Association of Communities in collaboration with Tetra Tech engineering consultants and consultancy firm Enviroeconomics has found that this issue is causing approximately $51M worth of damage to NWT public infrastructure each year.[6] Canada's northern communities are particularly vulnerable because they tend to rely heavily on permafrost for the foundations of their buildings and roadways.

> "Adaptation requires justification. Through both sound scientific evidence and democratic mandates, adaptation can move forward when its case is made. Further, economic arguments about the costs of not adapting will be a driving component of effective adaptation governance."
>
> **The Governance of Climate Change Adaptation in Canada, Institute for Catastrophic Loss Reduction 2018**

On another front, Prince Edward Island is experiencing rapid shoreline retreat due to sea-level rise. Parts of the Atlantic coast of Nova Scotia, the Arctic coast in the Beaufort Sea, and the Pacific coast at Haida Gwaii, BC have experienced shoreline retreat of 10-15 m per year.[7] These encroachments are leaving our infrastructure in peril as we scramble to mitigate the risks to human safety and environmental stability. The recent government-commissioned report *Canada's Changing Climate* predicts that Vancouver, Canada's thirds largest city, will experience a 50 to 100 cm rise in sea-level by 2100.[8] According to John Clague, a professor at Simon Fraser University, this will endanger about 250,000 people who currently live within a metre of mean sea-level.

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[5] Global Risks Report (World Economic Forum, 2017)
[6] Thawing permafrost causes $51M in damages every year to N.W.T. public infrastructure: study (CBC, 2017)
[7] Canada's Marine Coasts in a Changing Climate (NRCan, 2016)
[8] Canada's Changing Climate Report (Environment and Climate Change Canada, 2019)

ENERGY CONSUMPTION

Due to our climate and standard of living, Canada experiences a relatively high electricity use per capita of 14.8 MWh/person (2016), 63% greater than the OECD average (primary energy intensity (MJ/GDP) is discussed further, in figure 2 (page 10), as an energy efficiency metric).[9] In 2017, buildings accounted for 12% of Canada's GHG emissions (an additional 5% if emissions created from generating the electricity used in buildings is included)[10] and in 2015, 62% of residential energy use was a result of space heating.[11] Canada's current energy consumption policy framework does not account for this increased intensity, which is largely attributed to a north American propensity for larger homes (average home size in Canada was more than twice that of the UK in 2015)[12]. Along with current industrial and transportation regulatory frameworks, provisions in the NBC and NEBC are insufficient to curb this elevated and increasing demand, thus, we find ourselves behind the curve in a sector where we can and should be world leaders.

OBJECTIVES

Our approach to energy waste reduction and climate change adaptation must be technical first, then political. There is an urgent need for a shift towards science-based decision-making. Additionally, the government should continue to facilitate grass roots movements and encourage safe and responsible development and innovation. Each challenge provides a unique opportunity to enhance public safety, modernize infrastructure, stimulate economic growth, and improve quality of life for Canadians.

The objectives of this report are to:

1. Stimulate discussion regarding a shift towards a more holistic and effective national building code system;
2. Highlight the importance of our buildings sector in the current low-carbon and climate-resilient landscape and provide a useful comparison to other national and international building code models; and
3. Explore ways to accelerate the pace of development, adoption, and implementation of Canada's Building Codes.

[9] ACEEE: A Comparison of Building Codes in 15 Countries (2014); International Energy Agency: Atlas of Energy (IEA, 2016)
[10] Greenhouse Gas Emissions (Environment and Climate Change Canada, 2019)
[11] Energy Fact Book 2018-2019 (NRCan, 2019)
[12] Average Home Size by Country (The Globe and Mail, 2015)

CODES CANADA IN THE CONTEXT OF CLIMATE CHANGE

CLIMATE RISK AND RESILIENCE

Extreme events linked to climate change are increasing in frequency and severity. Importantly, risks are not only associated with an increase in the yearly average of adverse events but also, and perhaps more so, with the outliers or extreme scenarios. A recent estimate from *The Economist* found inaction on climate change will cause a staggering loss of manageable assets, up to 10% of the global total.[13] Insurance payouts and subsequently insurance costs are rising as well, contributing to ongoing affordability concerns within the Canadian housing market. Adaptations must be accessible and affordable to Canadians and their implementation must be supported by a robust enforcement and inspection framework.

"Budget 2017 did provide $182 million over eight years for new action for energy-efficient buildings:

$99 million was earmarked to develop net-zero energy-ready codes for new buildings, and research, development and demonstration to lower costs of high-performance homes and buildings.

$82 million was earmarked to retrofit existing buildings."

Sarah Stinson, Natural Resources Canada before ENEV 19 Sept 2017.

The NRC has already taken the lead in building and infrastructure considerations for climate resiliency by establishing the Climate-Resilient Buildings and Core Public Infrastructure (CRBCPI) Project in 2016. A five-year initiative including a $40 million investment to integrate climate resiliency into the design and guideline profiles across five domains: buildings, bridges, roads, wastewater, and rail transit.[14] This is part of a larger initiative by the federal government which sees the investment of $21.9 billion in green infrastructure over 11 years including support for climate change adaptation, building resilient communities, and emissions reduction.[15]

[13] The Cost of Inaction (The Economist, 2015)
[14] The National Research Council Canada and Infrastructure Canada take the lead in preparing Canada's buildings and infrastructure for climate resiliency (NRC, 2018)
[15] Pan-Canadian Framework on Clean Growth and Climate Change (Environment and Climate Change Canada, 2016)

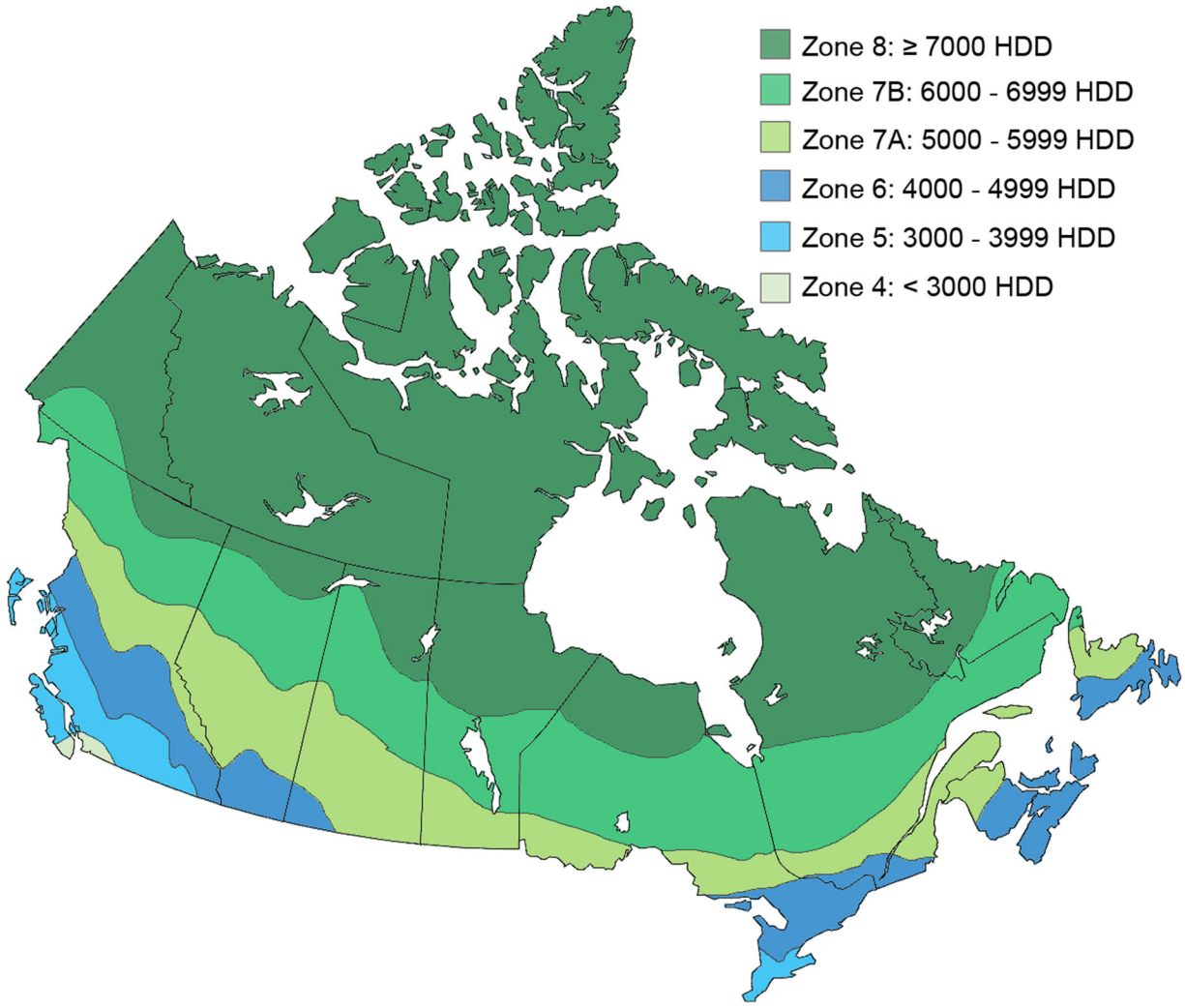


Figure 1: ASHRAE climate zones as adopted by NECB in their 2011 publication[16]

Most building codes, including Canada's NBC, organize their guidelines by climate zone with increasingly stringent recommendations in regions that experience more HDD (heating degree days, a measure of the heating requirements of a given building in a specified location). In 2011, the NECB adopted the ASHRAE (section 3.1 further describes the importance and significance of ASHRAE) climate zones (Figure 1). Unfortunately, northern communities tend to lack the resources to accommodate this increased stringency. The NRC, in collaboration with Environment and Climate Change Canada, is working to update weather data used in the NBC through the Climate-Resilient Buildings and Core Public Infrastructure (CRBCPI) project.

[16] ASHRAE 90.1 (ASHRAE, 2010)

TOPICS WHICH NEED TO BE ADDRESSED FOR FUTURE CODE EVALUATIONS

Resiliency criteria – Future iterations of the NBC should contain realistic and comprehensive criteria which serve to adapt communities to emerging climate risks. The criteria should include considerations for human safety and mitigate climate-related risks to buildings and infrastructure.

Shift from life-safety focus to holistic approach – The incorporation of resiliency in Canada's codes will require a shift towards more holistic consideration of factors such as vulnerability and cumulative weather impacts. This shift will give infrastructure standards the flexibility to adapt to the degree of unpredictability in climate change impacts.

Validity of climate zones –Climate zones must be revised periodically to account for changes in average daily temperatures and frequency and severity of adverse weather conditions.

Community impact definitions and criteria – In order to assess the impact of guidelines or regulations on a population it is important to work with municipalities, towns, neighbourhoods, and indigenous communities to carefully define the assessment criteria and the target population. This notion applies to clarification for gender-based analysis and consideration of indigenous rights, knowledge, and principles.

Green infrastructure standards – Encourage the use of vegetation, soils, and natural processes to manage water and mitigate the impacts of urban flooding, drought, and coastal damage. Examples of green infrastructure include semi-permeable pavement, green roofs, and land conservation programs.

Missing from the Code – Water use and reuse standards, waste management, sustainability, and life cycle analysis are points that must be addressed in the next iteration of Codes Canada publications.

ENERGY EFFICIENCY

Canadians saved $38.5 billion as a result of energy efficiency improvements between 1990-2014. However, our per capita energy consumption and energy intensity (energy use per unit GDP) are consistently among the highest in the developed world (7th highest energy intensity in 2017[17], 8th highest per capita consumption in 2014[18]). When compared to countries with similar populations, climate, and economic indices, e.g. Scandinavia, Canada does poorly in energy consumption metrics (Figure 2, below). Our population density presents a challenge for the implementation of energy efficient centralized technologies, and our propensity for larger indoor living spaces means that more energy is used for

[17] Global Energy Statistical Yearbook 2018 (Enerdata, 2018)
[18] World Fact Book (Central Intelligence Agency, 2017)

heating (which is already the largest contributor of building sector energy consumption) and transportation.

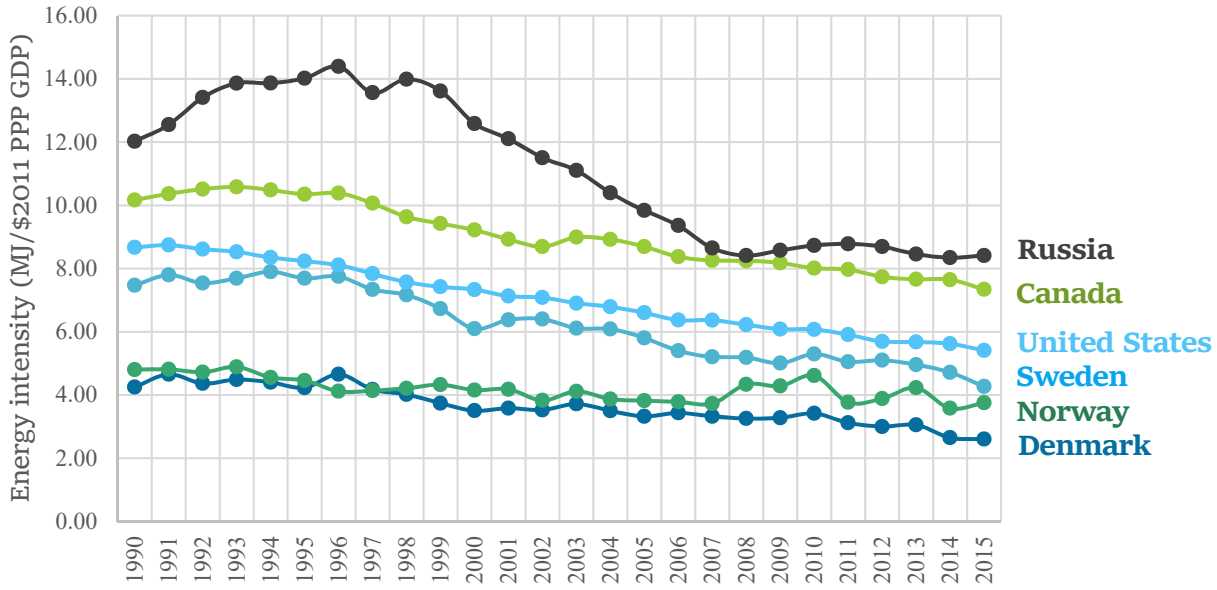


Figure 2: Energy intensity level of primary energy (MJ/$2011 PPP GDP)[19]

The Energy Efficiency Act (1992) sets out minimum efficiency provisions for appliances which are imported to Canada for sale and transportation of appliances into Canada or between provinces.[20] This federal legislation promotes regional interconnection, one of the four priority areas laid out by the World Energy Issues Monitor.[21]

> "Energy efficiency can deliver almost half of the emission reductions needed by 2030 to limit the increase in global temperatures to 2 degrees."
>
> **International Energy Agency**

Using policy-based regulation and incentives to drive down energy consumption is not unfamiliar territory, there are examples all over the world of successful government intervention. Massachusetts (US), for example, has been consistently ranked most energy efficient state due to energy efficiency planning efforts, fuel-neutral targets, state-level financial incentives, $220 million over three years in utility investment and grid modernization, and ambitious GHG reduction targets.[22] Some Canadian jurisdictions have taken steps towards emissions reductions such as Ontario's recent

[19] Energy intensity level of primary energy (World Bank, 2015)
[20] Guide to Canada's Energy Efficiency Regulations (NRCan, 2018)
[21] World Energy Issues Monitor 2018 (World Energy Council, 2018)
[22] The 2018 State Energy Efficiency Scorecard (ACEEE, 2018)

building code amendments which include provisions to facilitate future installation of charging stations in new homes as well as additional compliance pathways.[23]

POTENTIAL ACTIONS AND AREAS OF CONCERN

Existing buildings – 75% of the buildings that will be in existence in 2030 have already been built. This underscores the importance of a policy program for the development of codes for existing buildings as they change uses or undergo renovation.

Minimum energy performance standards (MEPs) and renewable energy standards (RES) – Different levels of government should declare explicit, long-term energy efficiency (including lifecycle costs) and renewable energy use standards. This can be and has been done through legislation or regulation[24] e.g. by 2020 on Vancouver, new homes must be carbon-neutral and use 50% less energy than homes used in 2007.[25] Also, Ontario aims to reduce emissions by 30% below 2005 levels by 2030. MEPs and RESs have been implemented in Arizona, Arkansas, Massachusetts, Michigan, Minnesota, and many others.

NZER code Urgency – The NRC has stated they will have net-zero energy ready (NZER) codes prepared by 2022 but that they will not be adopted before 2030.[26] However, in light of recent findings and conclusions draw by the UN through the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2030 will be too late. This falls on the deadline of 12 years from 2018 which the IPCC has suggested for making substantial and unprecedented changes to global energy infrastructure. Encouraging the adoption of the NZER codes before 2025 will stimulate the renewable energy sector, reduce load on existing energy infrastructure, and bring Canada's energy intensity further in line with other industrialized nations.

> "We're working with the National Research Council Canada to publish a net zero energy-ready code by 2022…We're also working to publish a retrofit code by 2022 that would also be adopted by the provinces and territories."
>
> **Sarah Stinson, Natural Resources Canada before ENEV 19 Sept 2017**

[23] Electrical Vehicle Charging Systems (Electrical Safety Authority, 2018)
[24] Energy Efficiency Resource Standard (ACEEE, 2016)
[25] Energy-efficiency requirements and resources for new homes up to 6 storeys (City of Vancouver, 2019)
[26] Construction Innovation (NRCan, 2018)

Standard for lifecycle analysis – Life-cycle analysis has emerged as the industry standard for considering energy efficiency of materials and practices. Must be integrated into building code assessments.

Tiered Efficiency Guidelines – Rather than solely providing minimum requirements, the code should outline targets and paths to progressively higher degrees of efficiency. The more knowledge is available, the more consumers will be motivated and resourced to act. Codes Canada recognizes Canada's current difficult-to-navigate "better than code" system could be improved using a tiered approach.

> "Tiers of progressively advanced energy performance requirements for houses and buildings would represent science-backed and evidence-based voluntary standards that could be supported with incentives offered by governments."
>
> **Long-Term Strategy for Developing and Implementing More Ambitious Energy Codes, NRC 2016**

Assessment of previous programs – The federal government introduced the ecoENERGY retrofit program which granted homeowners up to $5000 to make their homes more energy efficient. The program ran from 2007 to 2012 with 640,000 registered participants.[27] Development of future incentives programs must be done in consideration of the success or shortcomings of similar programs.

Government procurement – Federal, provincial, and municipal governments are responsible for most building-related contracts awarded in Canada. Federal funding for these projects should be contingent upon meeting energy efficiency benchmarks.

ADMINISTRATION, ADOPTION, AND JURISDICTIONAL CO-OPERATION

Currently, codes are developed in co-operation with a committee made up of government-appointed senior representatives called the Provincial/Territorial Policy Advisory Committee on Codes (PTPACC). This system helps to facilitate adoption and foster a sense of ownership over the codes. Provinces and municipalities best understand their own environmental challenges. Their participation helps to eliminate differences in provincial codes, moving towards a more uniform code model.[28]

To address a historic lack of timely code uptake and implementation, the recent Canadian Free Trade Agreement (CFTA) stipulates that provinces and territories engage with the NRC and NRCan in the development of a uniform adoption system. This was reiterated in the

[27] ARCHIVED - ecoENERGY Retrofit – Homes Program (NRCan, 2014)
[28] About Codes Canada (NRC, 2017)

Fall Economic Statement 2018 where the Government of Canada also announced $67.5 million over 5 years to making access to the National Building Codes free.[29]

Free access to building codes will further facilitate municipal adherence. Municipalities are best equipped to manage infrastructure resiliency projects as they are the ones who operate and maintain the infrastructure. Municipal planning committees such as that of the Communauté métropolitaine de Montréal (CMM) have launched several pilot projects which aim to mitigate risks associated with flooding. Coordination and collaboration between municipalities could reduce the estimated $4 billion required to address resiliency in Québec over the next five years.[30]

"Five provinces and territories and two cities have adopted codes covering about 70% of new commercial space or floor space in Canada. Those are for the commercial building code 2015, Ontario and Nova Scotia. For the commercial building code 2011, British Columbia, Alberta, Manitoba, Yukon and then the cities of Whitehorse and Vancouver.

For the residential code, 9 out of 13 provinces and territories have adopted that."

Sarah Stinson, Natural Resources Canada before ENEV 19 Sept 2017

POTENTIAL ACTIONS

"We're also looking to work with provinces and territories to implement [by 2019] mandatory labelling of home energy ratings and building energy use to help demonstrate the improved performance of new buildings, so consumers and building owners can see the impact it would have."

Martin Gaudet, Natural Resources Canada before ENEV Committee, 19 Sept 2017

Data strategy – Canada's energy efficiency landscape is incomplete and fragmented across jurisdictions. Of interest are: NRCan's National Energy Use Database, ENERGY Canada Portfolio Manager, EnerGuide Rating System, and StatsCan. Compare with EU Building Stock Observatory and the U.S. DOE Better Buildings Financing Navigator.[31] NRCan is expecting to release an online registry for labelling and data sharing by 2019.[32]

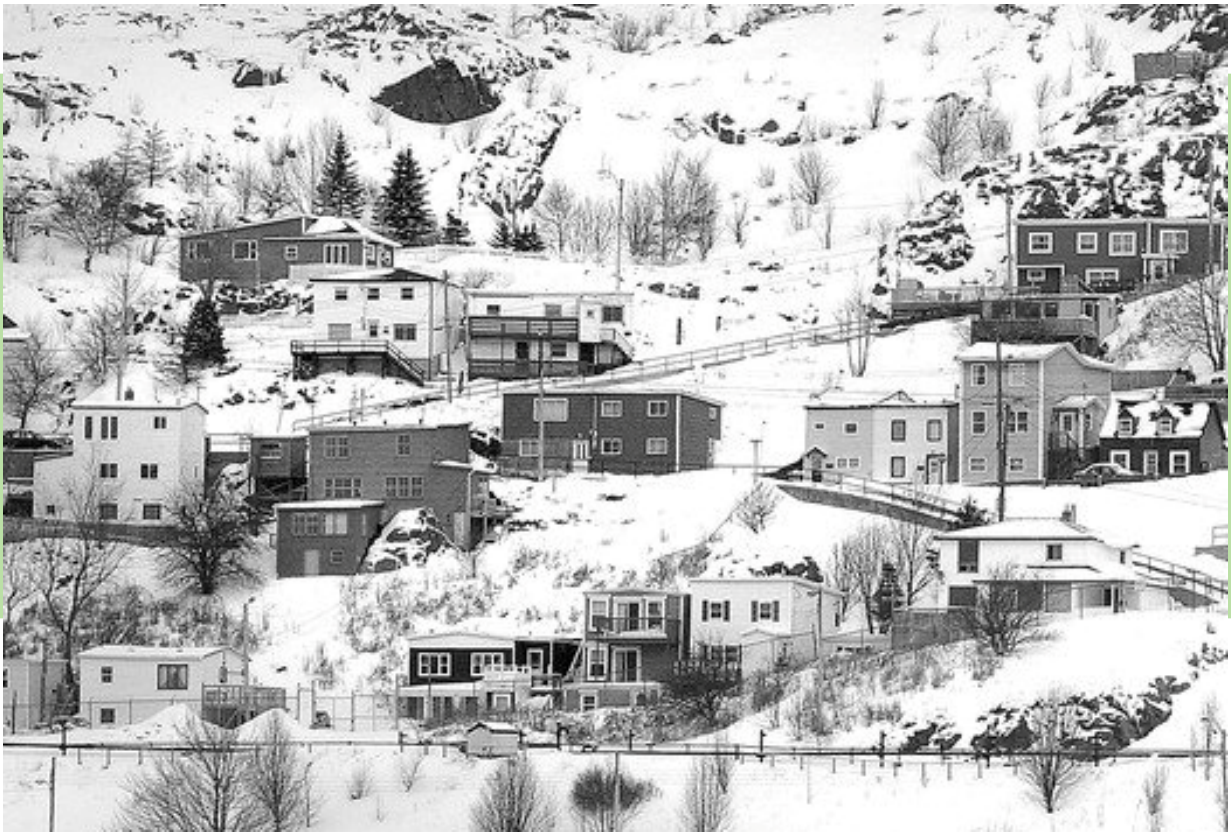
Flexibility – Codes Canada's guidelines must strike a balance between flexibility and stringency such that they are effective, yet there is not undo or unjust burden on provinces

[29] 2018 Fall Economic Statement (Department of Finance Canada, 2018)
[30] Évaluation comparative de paiements Pour les services écosystémiques et Autres incitatifs économiques pour Encourager l'adaptation aux Changements climatiques (Agéco, 2015)
[31] Federal Policies for Low-Carbon Buildings (Pembina Institute, 2018)
[32] Natural Resources Canada Presentation to the Senate of Canada

and territories. Coordination and consultation are key factors in maintaining this flexibility. For example, careful consideration of the dynamic between climate zone-dependent stringency and capacity of northern jurisdictions to adhere to more stringent codes.

Cycle pace – Consultations took place to get feedback on moving to a 3-year cycle, but provinces and industry said that this is too fast, that it did not provide enough time to train staff, and technology couldn't be developed and put on the market fast enough.[33] Relationships with unions should be formed to support and develop worker training. This could improve worker competencies, create jobs, and facilitate the shift towards a 3 year code modernization cycle.

Transparency –Oversight is required for the $40 million over 5 years initiative to integrate climate resiliency and for the $21.9 billion allocated to green infrastructure. The public must be assured that their money is used effectively and with the original intent.



[33] Personal correspondence with the NRC

HARMONIZATION AND CODE STRUCTURES ACROSS OTHER JURISDICTIONS

Developed nations employ either mandatory, voluntary, or a mixed building code system. Canada uses a mixed code model; our codes are issued as voluntary at the federal level but becomes mandatory once adopted provincially. Resiliency and energy efficiency criteria occasionally fall under different code systems within a single jurisdiction. In Europe, for example, resiliency is directed by the Eurocodes while energy efficiency falls under the Energy Efficiency Directive.

THE U.S. AND ASHRAE

In the US, like Canada, the national government does not have the authority to issue *mandatory* building codes. The U.S. Department of Energy (DOE), however, supports the code development process which is administered by The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and the International Code Council (ICC). Together, these organizations publish the International Energy Conservation Code (IECC) which applies to both residential and commercial buildings.[34]

ASHRAE maintains a set of standards relating to HVAC including the use of refrigerants, ventilation and thermal comfort standards, and most pertinently energy-use standards. Standard 90.1, commonly known as ASHRAE 90.1 is the energy standard for buildings excluding low-rise buildings and has been in publication since 1975. Another commonly referenced ASHRAE standard in Canada is 62.1, ventilation standards.

The DOE provides technical support to states and local governments and tracks the adoption of the IECC. As of 2014, thirty-two states had adopted or exceeded the 2009 IECC standards for residential buildings and thirty-eight states had adopted or exceeded the ASHRAE Standard 90.1-2007 for commercial buildings. Ten states have no statewide energy code, or the code predates the 2006 IECC.[35] Currently in the US, there are 10 states whose code meets or exceeds the 2015 IECC or equivalent and 10 states who meet or exceed the 2012 IECC with the remaining states and territories either meeting the 2009 IECC, predating the 2009 IECC, or not having a statewide code at all.

Several provinces, including Ontario and British Columbia, have chosen to offer energy efficiency compliance pathways through either NECB or ASHRAE 90.1. To reiterate for emphasis, every day in **several provinces across Canada ASHRAE standards are being adhered to and enforced instead of NECB**. In 2015, NECB took steps towards harmonization with ASHRAE 90.1 including adoption of their (simpler) climate zones,

[34] Building Energy Codes Program (US Department of Energy, 2017)
[35] Residential Energy Code Adoption (Building Codes Association Project, 2018)

lighting power allowances, and some aspects of water pumping.[36] Note, building management must choose one or the other to follow but they cannot, for example, choose to adhere to the NECB lighting efficiency standards and the building envelope standards of ASHRAE 90.1.[37]

ASHRAE 90.1 is generally less stringent than the NECB but this varies with climate zone, building size, and building construction. Because it is developed in the US, ASHRAE 90.1 contains standards which are less applicable to the Canadian climate such as maximum allowable solar heat gains. Notably, the ASHRAE system uses a cost budget method which considers the source of energy. In other words, this method will favour measures which reduce costly electricity over those that conserve inexpensive gas. Another key difference in administration is that ASHRAE standards as a whole undergo a continuous updating process, while the NECB publishes an entirely new edition with several years' worth of changes. ASHRAE uses a subscription-based model to monetize this.[38]

AREAS REQUIRING REFLECTION – SOLUTIONS APPROACH

Code applicability – Gain a greater understanding for the dynamic between ASHRAE, IECC, and any other US or internationally-based alternatives that are being referenced in US State building codes. Consideration of resiliency, energy efficiency, funding model, and transparency.

ASHRAE's Role in Codes Canada – ASHRAE is generally a less stringent and therefore less costly alternative to meeting the NECB standards. Adoption of alternative codes should be done as a complement to - and not as a replacement of - our nationally developed standards.

EUROPEAN UNION AND OTHERS

As of 2018, buildings are responsible for 40% of energy consumption, and 36% of CO_2 emissions in the EU.[39] The 2010 Energy Performance of Buildings Directive (EPBD) and the 2012 Energy Efficiency Directive (EED) are the EU's primary legislative framework for improving building performance. [40] In 2018, the EPBD was amended to include provisions aimed at accelerating renovation of existing buildings with the goal of decarbonization by 2050.

[36] Important changes in NECB 2015 (NRC, 2015)
[37] New Energy Requirements (Government of British Columbia, 2013)
[38] Which to choose – ASHRAE 90.1-2010 or NECB 2011? (Canadian Consulting Engineer, 2014); New energy efficiency requirements for Part 3 buildings in BC (Pembina Institute, 2015)
[39] The Energy Performance of Buildings Directive Factsheet (European Commission, 2018)
[40] Energy performance of buildings (European Commission)

The European Commission is also dedicated to incorporating provisions for climate change resiliency in future editions of its Eurocode. These are a cohesive collection of mandatory design codes with the intent of providing uniform levels of safety throughout the European Union (EU). Harmonization between member states is the basis of exchange of services and building contracts.[41] Though discouraged, there is some room for local interpretation due to differences in geography, climate, or traditional building practices in the form of a database of Nationally Determined Parameters (NDPs).[42] As the name suggests, this is a catalogue of what are essentially "negotiable" design criteria. The list of NDPs includes design coefficients, analytical methods, and minimum design standards.

The adoption of the Eurocodes has been mandated in the EU and the codes have been adopted voluntarily by non-member states including countries in South-East Asia and in Africa.[43]

NEED FOR ACTION AND FURTHER STUDY

In depth analysis – It will be beneficial to produce a concise review of existing literature on differences in specific criteria, stringency, adherence, and outcomes in the Eurocode/EPBD and in Codes Canada.

Cost-optimization reports – The European Commission produced and updated reports on cost-optimization for meeting energy requirements in each member state. There may be an opportunity to apply this analysis to Canadian Provinces.[44]

Certification schemes – The EU has been running it's BUILD UP Skills program which designs and implements training programs for the building and construction industry so that they may be better prepared to meet energy efficiency and renewable energy goals. Canadian policy should consider the implementation regime, cost, impact, and lessons learned from this program.

[41] Adoption of the Eurocodes Outside the EU (European Commission)
[42] Eurocodes Database for Nationally Determined Parameters (European Commission)
[43] Use of EN Eurocodes outside EU-EFTA (European Commission)
[44] Energy performance of buildings (European Commission)

CONCLUSIONS AND RECOMMENDATIONS

Increasing risks due to climate change reinforce the urgency of emissions reduction and climate change adaptation and resilience policies and standards. The buildings sector represents both a significant opportunity for mitigating climate-related risks and a vulnerability to those same risks. A set of comprehensive, cohesive, and ambitious energy efficiency and climate resiliency policies is overdue and will be vital to Canada's continued economic growth and stability, will help us meet our national and international climate obligations, and enhance the safety and wellbeing of Canadians.

The building code needs to be meaningfully updated with quicker revision cycles and adoption must be timely and uniform throughout the country. These weaknesses carry high financial, economic, environmental, and social burdens that Canadians cannot continue to afford.

SUMMARY OF RECOMMENDATIONS

Climate Change Resilience

- Inclusion of climate resiliency criteria
- Shift from life-safety focus to holistic approach
- Validity of climate zones
- Community impact definitions and criteria
- Green infrastructure standards
- Water use and reuse standards, waste management, sustainability, and life cycle analysis should be included

Energy Efficiency

- Target existing buildings
- Minimum energy performance standards and renewable energy standards
- Urgency of net-zero energy ready code development and implementation
- Standard for lifecycle analysis
- Tiered Efficiency Guidelines
- Assessment of previous programs
- Green government procurement programs

Administration, Adoption, Jurisdiction

- Development of a national data strategy
- Balance between flexibility and stringency
- Quicker cycle pace
- Revise ASHRAE's Role in Codes Canada
- Examination of cost-optimization reports
- Consideration of international certification schemes
- Transparency, accountability, and oversight for public funds

"It is clear now that for Canada to adapt and thrive in the face of climate change, there is an onus, a shared responsibility, of all Canadians to do their part."

The Governance of Climate Change Adaptation in Canada, Institute for Catastrophic Loss Reduction 2018