Strengthening Canada’s Building Code Process to Achieve Net-Zero Emissions

Kevin Lockhart and Brendan Haley

Efficiency Canada

Carleton University

Strengthening Canada’s Building Code Process to Achieve Net-Zero Emissions

Kevin Lockhart and Brendan Haley

October 2020

c/o Carleton University
1125 Colonel By Drive
Ottawa, ON K1S 5B6
www.efficiencycanada.org

Facebook: facebook.com/EfficiencyCanada
Twitter: twitter.com/EfficiencyCAN
LinkedIn: linkedin.com/company/efficiency-canada
Instagram: https://instagram.com/efficiencycanada

Contents

About the authors

Kevin Lockhart is Efficiency Canada's Efficient Buildings Lead. He has a Master of Sustainable Energy Policy and a Bachelor of Arts in Political Science from Carleton University. Kevin also completed and instructed in the Advanced Housing: Construction Carpentry program at Algonquin College.

Brendan Haley is Efficiency Canada's Policy Director. He has a PhD in Public Policy from Carleton University, a Master of Environmental Studies from York University, and a Bachelor of Science in Economics from Dalhousie University. Before joining Efficiency Canada on a full-time basis in September 2018, Brendan was a Banting Postdoctoral Fellow at Dalhousie University.

Acknowledgements

This report was supported by The Atmospheric Fund (TAF).

The authors would like to thank the more than 20 building code practitioners and policymakers who provided insights and perspectives on the national model codes during interviews conducted in the spring of 2020, as well as those who provided a peer review of individual drafts.

The views expressed, as well as any errors or omissions, are the sole responsibility of the authors.

About Efficiency Canada

Efficiency Canada is the national voice for an energy efficient economy. Our mission is to create a sustainable environment and better life for all Canadians by making our country a global leader in energy efficiency policy, technology, and jobs. We conduct rigorous policy analysis, communicate compelling narratives, and convene and mobilize Canada's dynamic energy efficiency sector. Efficiency Canada is housed at Carleton University's Sustainable Energy Research Centre.

Executive summary

Building codes are traditionally designed to create a minimum acceptable standard, including for acceptable levels of energy efficiency. The Pan-Canadian Framework on Clean Growth and Climate Change (PCF) signalled a change to this traditional approach, as provinces and territories committed to develop and adopt increasingly stringent model building codes starting in 2020, with an ultimate goal of adopting a “net-zero energy ready” model building code by 2030. This goal changes the nature of building energy codes from minimum standards, towards a “stretch” goal: one that encourages the transition towards new building design and construction practices to meet climate change goals.

This report examines how the development of the 2020 model national energy codes navigated this tension between a minimum standard building energy code and an implicit goal within the PCF to promote market transformation towards highly efficient and low-carbon buildings. While the 2020 model building codes will introduce significant changes and a path towards a net-zero energy ready standard, there is also evidence that the institutional inertia associated with the traditional ways building codes are developed held back the development of the model building code required for a net-zero emissions future.

This report outlines challenges encountered in the 2020 code development process through interviews with experts involved. We provide examples where the building code development process rejected more energy efficient standards and practices, and explore why these decisions were made. The challenges encountered relate to an uncertain and limited scope for the net-zero energy ready objective, and a lack of connection between building code development and complementary policies (such as strategies to encourage provincial adoption, and capacity building in the building and construction trades).

With the energy components of the 2020 national model codes largely finalized (however, not expected to be publicly released until December 2021), policymakers must turn towards the development of the 2025 version of the model code for new buildings and strategies to promote adoption and compliance with the 2020 model codes. By learning lessons from the previous code development cycle, we suggest the following priorities to truly make our national model codes a tool for achieving net-zero energy ready standards and reduced emissions associated with buildings energy systems:

1. **Clear ministerial direction.** The federal government must clearly mandate the codes community to develop a highly energy efficient and zero-carbon, outcomes-based standard to transform the buildings sector.

2. **Connect codes to a broader policy mix.** A building policy "champion" within the federal government can help ensure the building code acts as a tool for the market transformations required, while also developing complementary policies that integrate building code policy with sector capacity building, manufacturing, and tools for provincial/municipal adoption and compliance.

The buildings sector has the potential to play a key role in achieving Canada's climate objectives. However, to effectively do so requires a transition to a model codes system capable of delivering the ambitious vision presented in the PCF. This transition, led by a champion in government that can connect codes to the larger policy systems and alleviate tensions in the development process, can help ensure that our national model codes actively encourage the market transformation towards highly efficient and low-carbon buildings.

The changes recommended in this report— if implemented during the next model code development — offer a path to overcome these challenges, as well as to prepare the national model codes development system for challenges beyond the next building code development cycle.

Introduction

The buildings sector accounts for about a quarter of Canada's total final energy consumption[1] and approximately 15% of greenhouse gas (GHG) emissions when emissions associated with electricity used in buildings are included.[2] Energy use in buildings is expected to continue to rise over the next decade,[3] and stringent building energy codes play a critical role in reducing energy waste and emissions associated with the energy buildings consume. Given that a quarter of the homes and buildings in which we will live and work by 2030 have yet to be constructed, stringent standards for new buildings are urgently needed to avoid locked-in inefficiencies and emissions from the our built environment.[4] Improved energy efficiency in the building sector also frees up clean energy resources to be used for decarbonization, such as the electrification of transportation, and use of zero carbon fuels in industry.

In December of 2016, the federal, provincial, and territorial governments, in consultation with Indigenous stakeholders, outlined their plan to grow Canada's economy while reducing emissions, and build the resilience necessary to adapt to a changing climate. The result was the Pan-Canadian Framework on Clean Growth and Climate Change (PCF) which included a multi-level government commitment to develop and adopt increasingly stringent model building codes. Provinces and territories — except Saskatchewan — committed to adopting a "net-zero energy ready" (NZEr) model building code by 2030. This would require buildings to be designed, modelled and constructed to be so efficient that the building can acquire all the energy it needs to operate through on- or off-site renewable energy. A core aspect of net-zero energy "readiness" is the use of improved air sealing, increased insulation levels, and high-performance windows and doors to reduce thermal demand and facilitate appropriately sized space and water heating equipment.

---

[1] International Energy Agency, May 2019. Heating and Cooling Strategies in the Clean Energy Transition Outlooks and lessons from Canada's provinces and territories. Accessed September 2020. https://www.iea.org/reports/heating-and-cooling-strategies-in-the-clean-energy-transition

[2] 2017 figures calculated from Environment and Climate Change Canada (2019) National Inventory Report 1990-2017: Greenhouse Gas Sources and Sinks in Canada & Comprehensive Energy Use Database, Residential Sector (Table 1), Commercial Institutional Sector (Table 1).

[3] NRCan, 2019. Advancing Energy Efficiency in the Built Environment. Accessed June 2020. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/2019/Advancing-Energy-Efficiency-in-the-Built-Environment-EN-access.pdf

[4] Government of Canada, 2017. Build Smart: Canada's Buildings Strategy. Accessed May 2020. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/Building_Smart_en.pdf

This report views Canada's proposed 2020 national model codes from a market transformation perspective, exploring the tensions that arose between the traditional building code development process, and the challenges introduced to this process by those commitments made in the PCF.

This report is divided into four parts:

1. A brief history of building codes in Canada and the path to NZEr model codes.
2. A discussion of the PCF's NZEr objectives through the lens of market transformation.
3. How the 2020 national model codes development process absorbed a potentially disruptive NZEr objective.
4. Recommendations for policymakers, based on the lessons learned from the 2015-2020 model code development cycle, to ensure the next iteration of Canada's model codes are a robust tool for achieving net-zero GHG emissions.

Methodology

Confidential informational interviews

To develop this report, interviews were conducted to obtain the insights of building code experts and practitioners, including representatives from utilities, government, private practice, academic institutions, and non-governmental organizations (NGOs). Altogether more than 20 subject matter experts participated in one-on-one interviews.

Those interviewed were selected based on their experience working in the national model codes community. Interviewees were asked to speak in confidence and generally about challenges encountered with the framework for development of the national model codes, and how various environmental and societal concerns (e.g. energy efficiency and climate concerns) are incorporated within the process. The objective of the interviews was to reflect on the national model code development process, explore how effectively codes help meet energy efficiency and climate objectives, and provide recommendations that may inform the future model codes development. All interviews were confidential and not intended for direct attribution.

Part 1: A brief history of codes development in Canada

The need to regulate the buildings in which we live and work has a long history. Codes, laws and regulations that oversee our built environment can be traced back to around 1700 B.C., beginning with a code of laws from the sixth Babylonian king of Mesopotamia, Hammurabi. At the time, the consequences for poor building practices were quite severe. As dictated by the laws, the builder of a house would be put to death if a building-related failure caused injury to the occupants.[5] Since then, building codes around the world have evolved in response to challenges such as natural disasters, seismic activity, tragic fires and structural collapses. Code requirements are designed to protect occupants from building failures.

More recently, energy — and how it is consumed in our buildings — has become an increasing concern of the building code and its practitioners. Over time, aspects of the building's energy systems have been gradually integrated into building codes around the world, largely to ensure the building's durability and the health and comfort of the occupants. The result is building energy codes that focus solely on building components, assemblies, and equipment directly impacting energy use, such as the building envelope, electrical lighting, mechanical heating, cooling and ventilation systems, and hot water systems.[6]

Building codes have come to be recognized as an effective means to increase energy efficiency in buildings, and over 40 national and sub-national governments around the world now have building energy codes in place.[7]

As recently noted by the International Panel on Climate Change (IPCC), limiting global temperature increases to 1.5 °C requires transformational changes that will allow for rapid decarbonization.[8] This points to a new role for building energy codes as a critical tool to encourage swift and needed changes to the buildings sector, and to consider how buildings interact with both energy systems and the natural environment.

---

[5] Smith Currie & Hancock, Construction law - the history is ancient! Accessed July 2020. https://www.lexology.com/library/detail.aspx?g=5181e80b-f307-42e6-a357-c2d081b678ff

[6] Frappé-Sénéclauze, Tom-Pierre and MacNab, Josha. The Evolution of Energy Efficiency Requirements in the BC Building Code. Pembina Institute, 2015.

[7] Sadie Cox, 2016. Clean Energy Solutions Center, Building Energy Codes: Policy overview and good practices. National Renewable Energy Laboratory.

[8] IPCC, 2018: Summary for Policymakers.

Building codes in the Canadian context

In Canada, responsibility for building regulation began with the 1867 *British North America Act.* At the time, building codes were considered a municipal matter: each municipality was responsible for developing a building code unique to its jurisdiction. To harmonize the ensuing melange of local regulations, the National Research Council (NRC) was tasked with developing a national model building regulation in 1937, first released in 1941 as the National Building Code. Since 1960, Canada's national model building code has been revised about every five years.

Through the federal government, the Canadian Commission of Building and Fire Codes (CCBFC) — a volunteer-based decision-making body made up of over 400 members who participate in standing committees (SC), task groups and working groups — is responsible for development of the national model codes (see Figure 1). The CCBFC was established by the National Research Council's (NRC) Institute for Research in Construction (NRC-CNRC) to oversee the development of Codes Canada publications, and ensure standardized building regulations throughout Canada. With technical support from the Canadian Codes Centre (CCC), the CCBFC is tasked with preparing the National Model Construction Codes (the "model codes"). These include:

- The National Building Code of Canada (NBC)
- The National Fire Code of Canada (NFC)
- The National Plumbing Code of Canada (NPC)
- The National Energy Code of Canada for Buildings (NECB)
- The National Farm Building Code of Canada (NFBC)

This report focusses on both the NBC and the NECB. The NBC regulates the design and construction (or substantial renovation) of new houses and small buildings. The NECB was first developed in 1997 as the Model National Energy Code for Buildings (MNECB), and in 2011 was renamed the National Energy Code for Buildings or NECB. The NECB provides minimum energy efficiency requirements for the design and construction of all new buildings and additions, except for farm buildings.

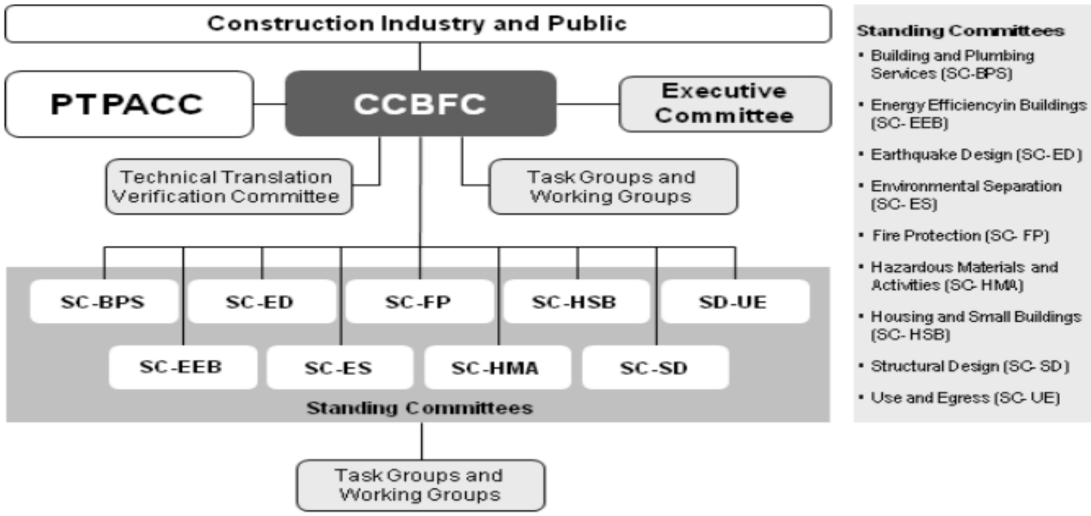

Figure 1: NRC-CNRC, Canada's National Model Construction Codes Development System. Accessed June 2020.

Canadian provinces and territories, through adoption and implementation of the model codes, are responsible for the regulation of the design and construction of buildings. Provinces, territories, or municipalities, in the role of authority having jurisdiction (known as AHJs), are responsible for enforcing compliance with all aspects of the model codes, where adopted.

Since the 1990s, harmonization of the building code has been coordinated through the provincial/territorial/national code development system. Provinces and territories provide input through the Provincial and Territorial Policy Advisory Committee on Codes (PTPACC), a committee made up of senior representatives appointed by provincial and territorial deputy ministers to provide policy advice to the CCBFC.[9]

In 2020, provinces and territories agreed to begin harmonizing construction codes under the Regulatory Reconciliation and Cooperation Table (RCT). Under the RCT, suppliers and builders will benefit from greater consistency as provinces and territories harmonize their construction codes by 2025.[10]

Over the past several decades, efforts have been made to address a wider array of impacts to the built environment within the model codes. This includes enhanced accessibility, more attention to indoor air quality and occupant health, and greater energy efficiency. The introduction of a broader array of concerns has forced Canada's national model codes to evolve beyond a sole life-

---

[9] NRC-CNRC, Canada's National Model Construction Codes Development System. Accessed June 2020.

[10] Canadian Free Trade Agreement's Regulatory Reconciliation and Cooperation Table, 2019 Annual Report. June 2020.

safety focus, and place greater emphasis on society's evolving priorities vis-à-vis energy and environmental performance.

Model codes development process

Canada's model codes are regulatory instruments that specify minimum energy efficiency standards for residential, commercial, industrial and farm buildings. They mandate certain energy efficiency characteristics for building technologies. Over a multi-year period, the model codes are developed at the national level with guidance and support provided by technical institutions, such as Natural Resources Canada (NRCan) and stakeholders from government, industry, and the public. The Standing Committee on Energy Efficiency (SC-EE) provides recommendations to the CCBFC on technical content and provides advice, receives advice and coordinates with other committees.

Broad stakeholder participation is an important aspect of national model code development. A consensus-based framework encourages the deep and broad expertise of participants, generally those considered to be code users, including: designers, developers, builders, manufacturers, regulatory officials, policymakers, owners, and managers. Figure 2 illustrates the codes development process, and the interaction between the many stakeholders that collectively make up the "codes community."

The model code development process is intended to be open, transparent, continuous, and consensus-based. Members of the public, the provinces and territories, or the CCBFC Executive Committee itself can request code changes. However, only changes agreed upon by the provinces and territories and acceptable to AHJs, are considered. Through the PTPACC, provinces and territories are involved in each stage of the process. The aim is to reduce the number of amendments that are required before provincial or territorial adoption, thus allowing for faster adoption.

The process used to develop the model codes is geared towards creating a minimum legal performance standard. It is based on consensus. The stringency of the model codes can be reduced if practices are unacceptable to the provinces and territories, and/or stakeholders in the buildings sector. As we will explore, this process was ill-suited to adopting a code aimed at pulling the country towards leading-edge construction practices.

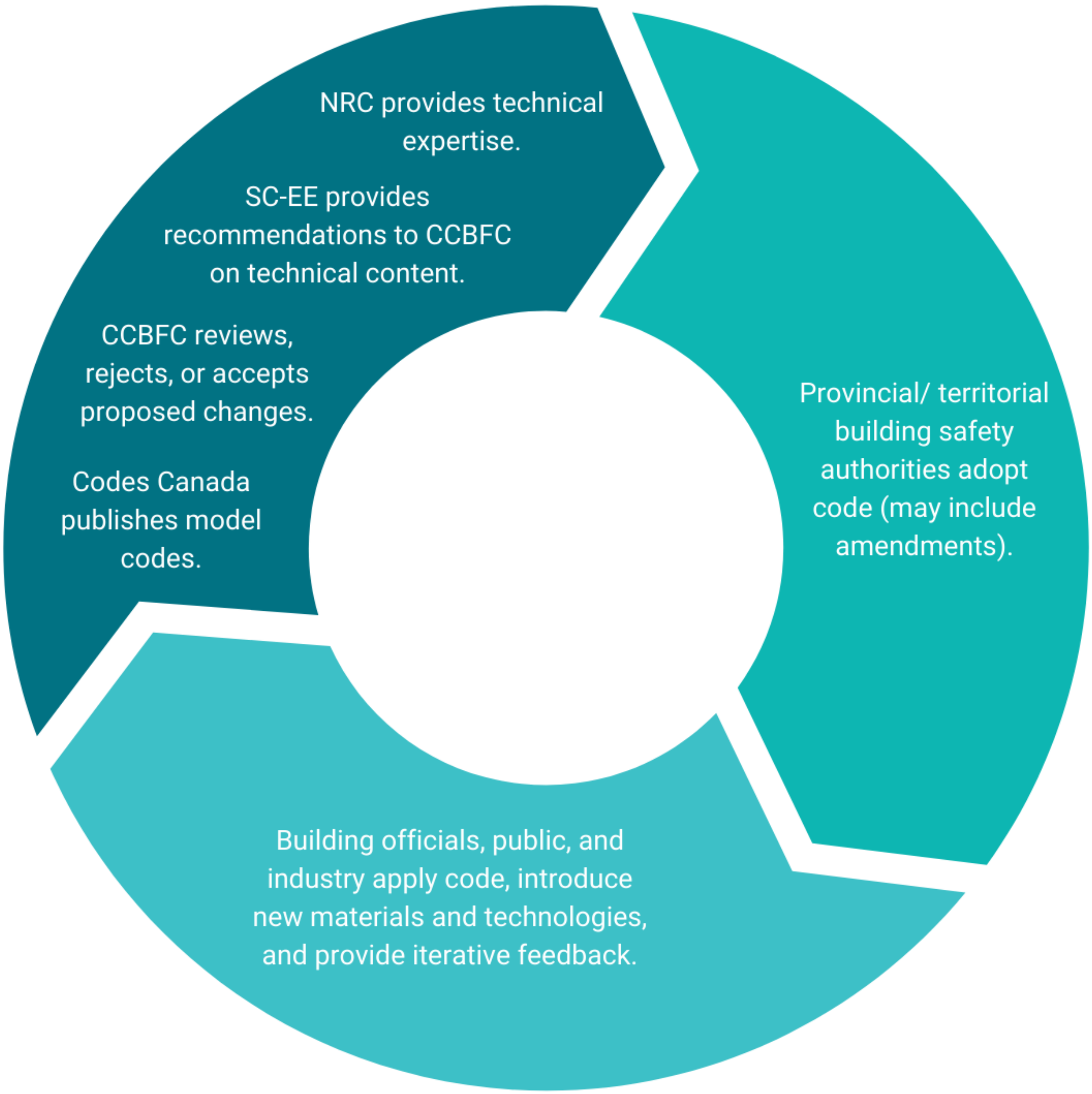

Figure 2: The model codes development community's stakeholders.

Tiered codes

The integration of energy into Canada's building codes laid the groundwork for the introduction of tiered codes within the NECB and NBC. Tiered codes are not new to Canada. In fact, British Columbia introduced its Energy Step Code (Figure 3) in 2017. A tiered code is simply an incremental approach to achieving more energy efficient buildings. It is a progressive series of performance-based steps that start with a familiar base building code.

A tiered code has the benefit of raising the floor of building standards and practices, thereby ensuring that all industry is competing on the same terms. While this component of the tiered code pushes those interested in only building to the minimum standard incrementally upward, it also has the effect of pulling builders and designers towards higher performance building practices and offers an opportunity to plan for future code requirements years in advance.

Figure 3: BC Energy Step Code for Part 9 (Homes).

With a tiered code, AHJs — the provinces, territories, and cities with jurisdiction over building construction — have greater flexibility in how they implement the building code. This aspect of the tiered codes is particularly valuable for two reasons. Firstly, the tiered code eliminates the need for AHJs to develop their own unique building codes to pursue their energy efficiency objectives. Secondly, municipalities looking to implement aggressive energy efficiency and carbon reduction strategies can easily choose a tier that meets the knowledge and capacity of their community from the well-defined upper levels of the model code.

Tiered codes present policymakers with an opportunity to formulate policies and incentives that move both those at the leading edge of the market and those in the middle of the market transformation curve forward. Other actors also benefit from a building energy code roadmap: industry benefits from clear direction that high-performance buildings are to be the norm in the future, and can adjust business processes accordingly; supply chains can be adapted to make high-performance products and technologies accessible and widely-available; and, both the trades and building professionals can develop the knowledge and skills required to effectively construct NZEr buildings.

NZEr buildings represent only a small fraction of the market for houses and buildings at present. Tiered codes are a tool to initiate a market transformation approach (described in Part 2) that positions NZEr buildings as the norm rather than the exception.

Part 2: Code development through the lens of market transformation

Market transformation was first applied to encourage competition within newly unregulated gas and electricity industries in the 1980s as counter to traditional, short-term utility demand-side management (DSM) programs that focused on individual customer changes, not entire markets. The goal is to accelerate the uptake of energy efficiency products or technologies at market-scale (for example energy efficient lighting, appliances, and heating, ventilation, and air conditioning equipment) through long-term strategic interventions in targeted markets.[11]

Market transformation is not just about raising the floor, but also about moving markets forward more quickly to the next generation of advanced technologies.[12] A technology is introduced and, aided by supports such as research and development and knowledge sharing, gains market share as awareness of the technology becomes widespread and the merits of the technology become increasingly recognized for the benefits that arise from its adoption. A new technology such as NZEr buildings is influenced by interactions between the technology, market conditions, public policy and, of course, the decisions of a wide range of stakeholders. Ideally, the technology scales up and leads to lasting change.

As a vehicle for market transformation, the proposed tiered codes can increase the market penetration of NZEr buildings and associated high-performance products and technologies. In Canada, as in the U.S., less than 1% of buildings currently constructed are considered NZEr.[13] However, each iteration of the model codes development cycle has the potential to spur the advancement of innovative products, technologies, processes, and practices.

Market transformation

First articulated by Geller & Nadel for the American Council for an Energy-Efficient Economy (ACEEE) in the 1990s, market transformation is, "a process whereby energy-efficiency innovations are introduced into the marketplace and over time penetrate a large portion of the eligible market."[1] Achieving market transformation requires a sustained program approach "to make a deliberate and rigorous effort to intervene in [a targeted], clearly defined market."[1]

[11] York et al, 2017.

[12] Nevius et al, 2013.

[13] Renilde Becque et al, 2019. Accelerating Building Decarbonization: Eight Attainable Policy Pathways to Net Zero Carbon Buildings for All. World Resources Institute.

This requires a "push" through programs such as NRCan's "ecoEII" Net Zero Energy Housing Community Demonstration Project, which provided technical assistance and incentives for net-zero energy performance housing demonstration projects using off-the-shelf technologies and methods.[14]

It also requires a "pull" that helps to increase market demand for NZEr buildings by helping home and building owners understand the benefits of high-performance buildings. Ideally, the model codes development process stretches towards higher standards, and the sector responds with innovative solutions and programs needed to overcome those challenges. In this way, the model codes are a policy objective by which to realize technological, social, and economic change in the direction of high-performance buildings.

The following sections seek to capture the key themes and issues raised by interview participants that arose during the development of the 2020 model national energy codes, and highlight the tension between a minimum standard building energy code and an implicit goal to promote market transformation towards highly efficient and low-carbon buildings.

[14] NRCan, Net Zero: Future Building Standards. Retrieved from: https://www.nrcan.gc.ca/energy-efficiency/energy-efficiency-homes/buying-energy-efficient-new-home/netzero-future-building-standards/20581

Part 3: How the national model codes process fails to address market transformation

Commitment to a NZEr model building code by 2030 is an important first step towards the market transformation of the building sector. It also represents a marked transition from traditional codes that set the minimum acceptable performance, to codes that set a clear path for future performance and increased energy efficiency (see Figure 4). This market transformation approach sends a strong signal to the buildings sector. It indicates the long-term path of increased building energy standards and has the effect of both increasing capacity and reducing costs over the course of the transition to NZEr buildings.

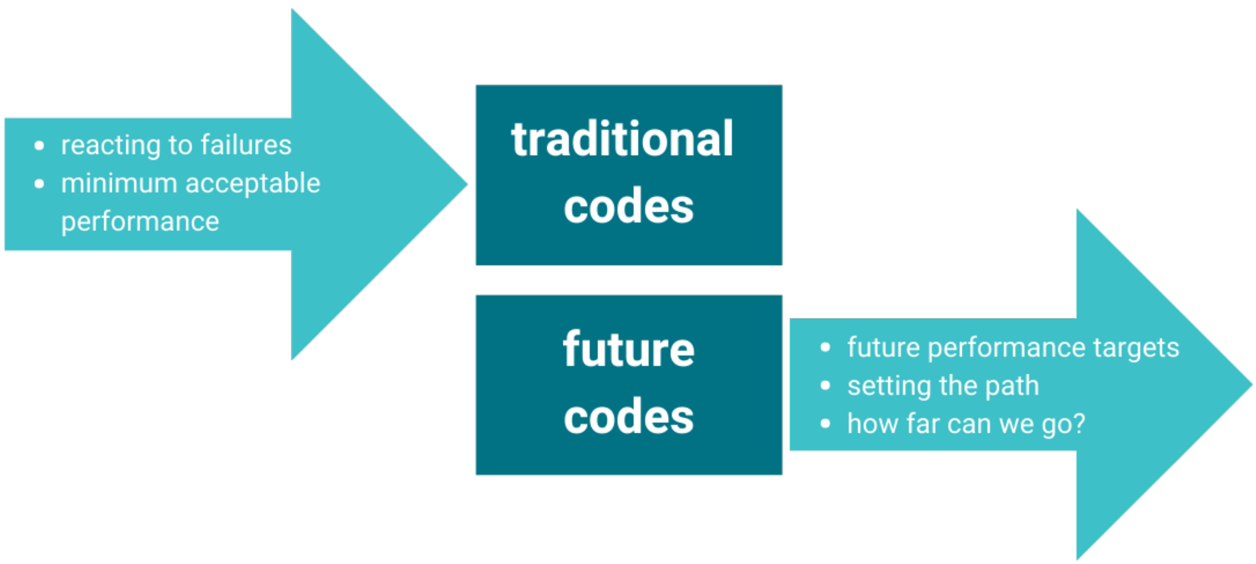

Figure 4: Adapted from NRC, Net Zero Energy Codes in Canada: Goals, status and research. June 2018 ACEEE Washington DC

As outlined previously, the development of the 2020 model codes highlighted the tension between a minimum standard and an implicit goal to promote market transformation towards highly efficient buildings. Below, we provide three examples — capacity concerns related to airtightness testing, the reference building approach, and the weakening of NZEr performance requirements in NECB 2020 — that highlight the tension between the “minimum standard” mentality and that of a “stretch goal” approach. These examples demonstrate the institutional inertia associated with the traditional ways building codes are developed that held back the development of the model building code required for a net-zero emissions future.

Air tightness testing

Air tightness testing was first introduced into building energy codes as a measure to reduce the infiltration of moisture laden air into insulated wall cavities and minimize condensation-related damage. And, as air leakage is the largest source of heat loss in buildings, air tightness testing is also the primary measure to reduce building energy losses. Minimizing heat loss due to air leakage through the building envelope can significantly reduce the energy needed for heating or cooling a building.

Initially, the proposed NECB 2020 introduced a mandatory requirement for airtightness testing in the tiered performance compliance path, without any required threshold or target, for large commercial, institutional, and multi-residential buildings. In this way, capacity for energy modelling could meet the gradual increased demand for performance testing as the tiered codes were introduced. However, shortly before the SC-EE's public review meetings in the spring of 2020, the SC-EE was directed by the CCBFC's Executive Committee to, "revise the proposed changes such that airtightness testing is not mandatory in any compliance path for buildings and houses (NECB and NBC, Section 9.36.) at this time."[15] The reason cited for this decision was the lack of capacity, particularly in rural and remote areas as well as concerns regarding the availability air barrier testing expertise, cost implications, unintended consequences and reservations on the part of PTPACC.[16]

This decision stands in contrast to the notion of a NZEr objective as a tool for market transformation. However, reduced stringency of energy efficiency measures is the model codes development process' only option in situations where additional supports may be required, whereas a market transformation approach would seek ways to fill gaps in areas such as training and capacity-building to ensure new approaches can be met. While capacity is included as a policy objective in the CCBFC Position Paper on Energy Codes, the reach of the codes development system only extends to the task of establishing technical standards.

The incremental cost of NZER

According the US based Rocky Mountain Institute's report, The Economics of Zero-energy Homes, the incremental construction costs of NZEr residential homes in the US experience is between 0.9% and 2.5% more than conventional construction costs in most climates, and slightly more in colder climates. Moreover, costs are falling as markets matures and construction practices such as integrated design become the norm.

[15] Carss, Barbara. Canada wavers on airtightness testing, Proposed change to National Energy Code has been withdrawn. Canadian Property Management, June 2020.

[16] Participant observation, 2020 Model Code public review.

Eliminating mandatory air tightness testing (without the requirement to verify or report such testing) was a missed opportunity to move the market towards NZEr performance. Ironically, failure to include mandatory air tightness testing made the capacity issue worse – the number of tests performed and capacity in the sector would be increased if the market knew the direction the codes were going. This is exactly what happened with the B.C. Energy Step Code, which also included air tightness testing when first introduced and saw the scale of testing increase.

Reliance on the reference building approach

The reference building approach is often expressed as a "percent better than" approach in that building designs are required to achieve a set percentage improvement in energy performance over the baseline reference building's performance (see Table 1). The 2020 model codes are expected to permit a reference building approach as a compliance path for houses and small buildings (Part 9) and large buildings (Part 3).

Approaches to measuring building energy performance	
Reference building approach	Outcomes-based approach
• Expressed as a "percent better than" approach, in that building designs are often required to achieve a set percentage improvement over the baseline reference building's performance. • Requires design teams to develop a modelled reference building (often defined using prescriptive elements). • Inconsistent correlation between modelled energy consumption and actual energy consumption.[17] • Shifting baseline can lead to confusion regarding which standards to follow.	• Sets one or more absolute energy use and/or emissions targets for different types of buildings. • Often based on the energy per unit of floor area expressed over time in terms of the building's Energy Use Intensity (EUI). • Clear metrics make for straightforward comparison between buildings. • Encourages passive design measures such as optimal building orientation, increased insulation, and better performing windows. • Common in European building energy codes, and high-performance building standards such as Passive House and Minergie. • Emission based targets can also be used alongside, or in place of, EUI targets.

[17] Ibid. The City of Toronto has found that the reference building methodology resulted in modeled Energy Use Intensity (EUI) that varied by more than 230% for multi-residential buildings and 450% for commercial buildings.

Table 1: Approaches to measuring building performance.

In contrast to an outcomes-based approach to measure building energy performance based on actual energy use per unit of floor area, a reference approach does not create accountability for actual energy performance.[18]

A perverse outcome arising from reliance on a reference approach is that it could actually lead to less efficient designs. In addition to not incentivizing passive energy measures such as window type and placement for daylighting, thermal mass, and solar gains, the reference approach can also encourage the design of buildings with more complex forms. Because it is based on the envelope area relative to the enclosed space, the reference approach can favour complex (and more expensive) buildings with multiple articulations along vertical and horizontal planes that increase the area to volume ratio, as illustrated in Figure 5.[19] Put simply, a reference building that has a simple, inherently energy efficient, form is difficult to make more energy efficient during the modelling process.

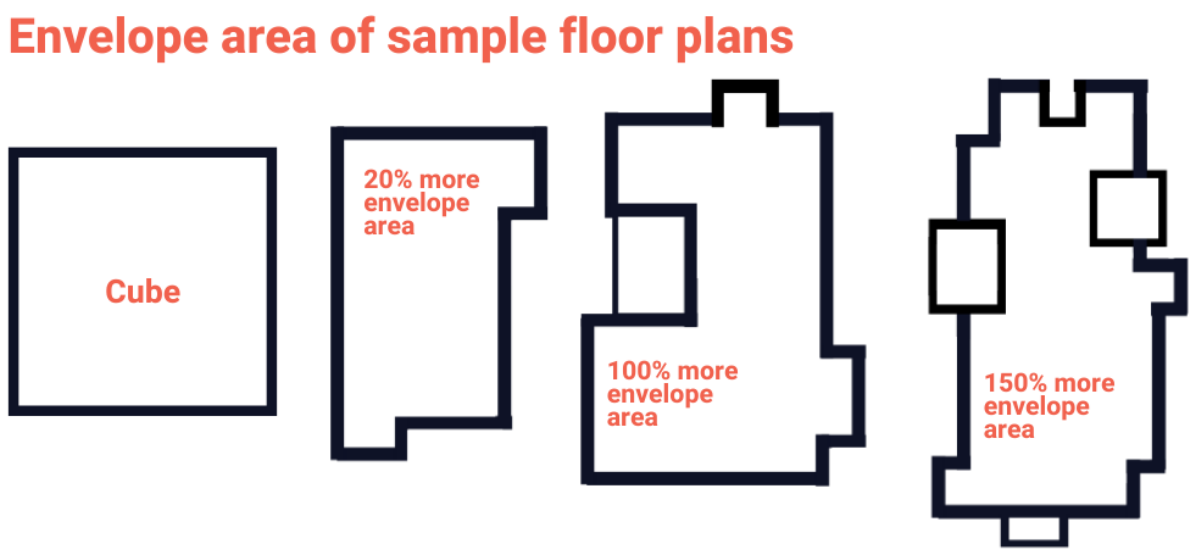

Figure 5: Envelope area increases as form becomes more complex

The reference approach is also open to manipulation, either through misrepresentation, such as submitting an energy model for a similar but different building, or through loopholes that increase

[18] IPEEC Building Energy Efficiency Taskgroup, Building Energy Performance Gap Issue: An International Review, 2019.

[19] Passive House Canada. Policy Series #5: The Reference Building Approach. October 2020.

the modelled energy performance versus the actual energy performance. For example, adding articulations, a crawlspace over four feet high, or increased ceiling heights to the modelled design. Any of these measures will increase the volume of conditioned floor space, which increases the energy loads in the reference building from which energy savings are calculated, and thereby lowers the requirements for increased air tightness.[20]

An outcomes-based approach to measuring building energy performance would set a consistent target on absolute energy use and/or emissions for different types of buildings. These approaches are based on the energy consumed in a building per unit of floor area expressed over time, frequently expressed in terms of the building's Energy Use Intensity (EUI) or Thermal Energy Demand Intensity (TEDI). TEDI calculates the annual heat loss from a building's envelope and ventilation, after accounting for all passive heat gains and losses, while EUI looks at total energy use, including factors such as plug loads.

An outcomes-based approach is also more likely to encourage builders and designers to put a greater emphasis on whole building efficiency, particularly measures that boost the performance values of the building envelope and windows. It will also encourage the construction of new buildings that are better suited for adaptation to climate fluctuations and more likely to mitigate emissions.

Weakening the NZEr objective

Within the NECB's tiered codes the modeled performance is as follows: A tier 1 compliant building will be expected to consume 100% or less than a modelled buildings energy target, while tiers 2 and 3 must consume 75%, 50% of the modelled buildings energy use, respectively. Prior to the public review tier 4, the most stringent tier, was changed from 25%, a target that more closely reflected an accepted NZEr building standard, to 40%. This change was made largely because achieving 25% through the existing energy modelling software could not be achieved at the time. This reduces the energy efficiency performance of the NECB's highest tier, thus moving farther away from the climate policy mission that informed the inclusion of a NZER code within the PCF. A true approach to market transformation, as intended by the PCF, would place these outcomes as items to be resolved on the agenda, rather than allowing technical issues to limit the integrity of the intended NZEr objective.

[20] City of Toronto, Zero Emissions Buildings Framework Report, 2017.

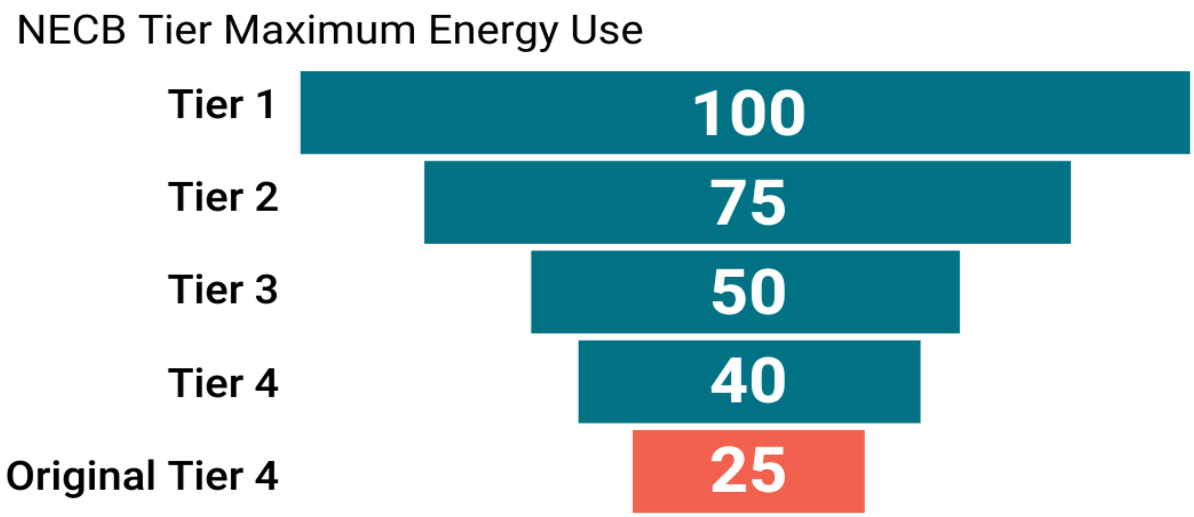

Figure 6: Maximum Energy Use, NECB 2020

Already, voluntary programs such as Passive House, as well as the B.C. Energy Step Code, offer ample evidence that the Canadian buildings sector is capable of constructing buildings that are highly energy efficient. Moreover, the tiered codes' end-point — NZEr in 2030 — provides ample time to allow building modelling software to catch up to the voluntary programs that have proven that low energy buildings can be safely constructed and that continue to push the performance envelope, and evolve in response to lessons learned. Taking into consideration the building code community's efforts to develop a market-moving upper tier, there is justification to demand the resources needed to develop more sophisticated modeling.

Conclusion

The three examples outlined above serve to illustrate the tension between a minimum standard and an implicit goal to promote market transformation towards highly efficient buildings. Buildings are one of the key areas the IPCC has identified that will require rapid and transformational change in order to limit global temperature increases to 1.5 °C and,[21] as such, there is an urgent need to address the institutional inertia that led to these distorted outcomes.

[21] IPCC, 2018

Part 4: Overcoming the disconnect between Canada's code objectives and climate commitments

This report has shown the growing disconnect between Canada's climate objectives, as laid out in the Paris Agreement, under which Canada committed to reducing its GHG emissions by 30% below 2005 levels by 2030, and the outcomes the national model codes are intended to achieve.[22] Simply put, the urgent task of reducing emissions needs to be a priority. Given that the federal government and more than 450 Canadian municipalities have declared a climate emergency, it is clear, a regulatory framework that addresses embodied and operational GHG emissions arising from buildings is needed.

The struggle to align the national model codes with Canada's national climate objectives points to the absence of a clear accountability for oversight by the government itself. This is due, in part, to the various federal ministries with an interest in the outcomes of the national model codes. These include:

- Innovation, Science, and Industry with direct oversight of the NRC and, indirectly, the CCBFC and Codes Canada;
- Natural Resources Canada which, in addition to being tasked with charting an energy vision for Canada, is a critical partner in model codes development; and,
- Environment and Climate Change Canada which leads on complex, high-profile files such as climate change and therefore has a direct interest in the outcomes of the model codes.

The cross-ministerial nature of codes development and limited representation by federal ministries with mandates related to environmental and climate issues — as well as economic development and workforce capacity — places Canada's building energy codes without a clear political champion to oversee the process and ensure their integration within the government's larger agenda. Instead of actively aligning ministerial objectives with model code outcomes, the federal government risks becoming a stakeholder on par with others.

The tension between the objectives of the PCF — particularly those PCF objectives related to reducing emissions associated with building energy systems— and the traditional model code development process are likely to be exacerbated in future code cycles without increased

[22] Government of Canada, Progress Towards Canada Greenhouse Gas Emissions Reduction Target. Retrieved from: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/progress-towards-canada-greenhouse-gas-emissions-reduction-target.html

opportunity for participation by a broader cross-section of society. Traditionally, the codes development process has been driven by expert knowledge provided by building codes practitioners, engineers, industry associations, architects, and other technocrats. Participation from the health community, environmental organizations, and others could encourage new ways of thinking, bring new priorities to the table and counter a perceived resistance by some members of the PTPACC to include items such as embodied and operational carbon metrics in the model codes. It would also provide an opportunity for the CCBFC Executive Committee to respond to the public input gathered and lead the call for the inclusion of key civil society priorities in future iterations of the model codes.

As the codes community turns its attention towards the development of the next version of the model codes for new buildings (the 2025 model codes), it is valuable to reflect on the lessons from the previous development cycle. This report has demonstrated a clear disconnect between the traditional way building codes are developed, and the market transformation objectives set out in the government's climate policy. Given this analysis, we suggest a path forward that can ensure Canada's building energy codes are a tool for achieving a true NZEr objective and reducing GHG emissions in the buildings sector.

The path forward has two complementary components: articulate clear direction and connect codes to a broader policy mix.

Clear ministerial direction

Market transformation of the buildings sector demands government take the leading role in the development and oversight of the national model codes, with support from market actors such as utilities, manufacturers, builders, contractors, and others. Clear direction is a critical function needed to bridge the disconnect between Canada's climate ambitions, as well as those related to health, industrial strategy, urban issues, and the codes development process. These measures are critical to ensure that there is a broader framing for building energy codes development that puts into perspective the relationship that the model codes have with other regulatory policies, for example, policies related to workforce training, research and development, and climate change. Clear direction will clarify the role building codes play in reducing energy consumption, emissions and natural resource consumption and have the effect of creating broad support for building codes and energy efficiency within the public, industry, non-governmental organizations, and government.[23]

As described previously, the codes development process is marked by uncertain lines of accountability and the unclear role of multiple ministries, including: Natural Resources;

---

[23] Ibid.

Environment and Climate Change; and, Innovation, Science and Economic Development. The codes development process is also influenced by federal-provincial relationships and stakeholder negotiations. This process can successfully produce consensus, but it is ill-suited for development of a “stretch” code seeking to encourage market transformation. For the latter, a clearer ministerial direction from the government, as the entity capable of integrating building codes into national climate change and energy objectives, is required.

The blurred lines of accountability also mean that building code policies lack a clear “champion” within government with the authority to clearly direct the codes community towards market transformation objectives. This champions’ mandate could also include building up a larger policy mix that can give the codes community confidence in Canada’s ability to move the market towards advanced, energy efficient, and low-carbon, buildings. This could be a Minister, or perhaps a parliamentary secretary with a specific mandate.[24]

For the 2025 code cycle, we urge the Ministers of Natural Resources, Environment and Climate Change, and Innovation, Science and Economic Development issue a joint directive, clarifying the role of building codes as a tool for market transformation, and requiring the following results from the advanced tiers:

- outcomes-based building codes that encourage the construction of new buildings more likely to mitigate emissions, as well as contribute to the resiliency of our built environment;
- airtightness testing for all buildings, addressing the largest source of heat loss in buildings; and,
- incorporation of embodied and operational carbon to help Canada meet its climate objectives while also increasing resilience.

A directive of the building code’s renewed purpose will provide a clearer mandate to those developing the code, and avoid the pressures that exist to define the code as a solely a minimum standard. It would clearly connect the building code objectives with Canada’s climate change commitments.

The codes community should be encouraged to provide recommendations to a governmental building codes champion concerning what complementary actions must be taken for the advanced model codes they develop to come into fruition.

[24] For instance, in 2019 the Parliamentary Secretary for Families, Children and Social Development was given a specific mandate for housing.

Another mandate of a governmental building codes champion could be making the model codes a tool for economic development. In particular, this would entail integrating the building code with a strategy to promote Canadian manufacturing of the anticipated market demands from high-performance building codes. Building energy codes are an effective means to provide Canadian manufacturers and suppliers with a clear, coherent, and credible long-term roadmap towards high-performance building products and technologies.

Finally, a building codes champion can lead a public policy comment period that encourages non-technical participation in the early stages of each five-year code cycle to bring new considerations to the CCBFC Executive Committee such as embodied and operational carbon, energy storage, and electric vehicle integration. Similar to environmental assessments and public utility board hearings, civil society representatives can be provided funding access to expert consultants to ensure their input is both technically sound and relevant.

Connecting codes to the broader policy mix

Reaching the market transformation objective of all new buildings constructed to NZEr standards by 2030 requires a multitude of policy tools that support the national model codes development system. Robust building energy codes, together with training, guidance surrounding adoption, and improvements in compliance and enforcement will accelerate the widespread adoption of energy efficient technologies in the building sector.

Increase capacity by connecting codes to training

As the Canadian Green Building Council (CaGBC) recently noted in its assessment of training needs for the trades in the province of Ontario, the construction landscape is rapidly evolving. As the level of performance in buildings increases, the margin of error decreases and trades, designers, architects, engineers, buildings officials and buildings managers each need a deeper understanding of their role in the construction of high-performance buildings projects.[25] The CaGBC calls for allocating $500 million per year to provide the buildings sector workforce with access to training, and a further investment to attract and train new people to create energy efficiency and green building careers.[26] The CaGBC also emphasizes that people looking to build careers in energy efficient and green buildings need to see a direct connection with their training and market demand.

[25] Trading Up: Equipping Ontario Trades with the Skills of the Future. Canadian Green Building Council, 2017

[26] Efficiency Canada, Written Submission for the Pre-Budget Consultations in Advance of the Upcoming Federal Budget. August 2020.

Addressing skills training in the near-term will ensure that builders, tradespeople, and professionals are prepared to deliver NZEr buildings that meaningfully reduce energy waste and associated emissions. Training and educational programs demonstrating the important role building energy codes play in the building sector can bend the learning curve for design and engineering professionals, tradespeople, contractors, building officials and others to accelerate broad market transformation.[27] As noted by the Task Force for a Resilient Recovery, investing in workforce development will create a large number of jobs over the coming decade that are expected to be in skilled trade positions.[28] Connecting codes to training for high-performance buildings represents a unique opportunity for the federal government to increase capacity in the buildings sector while advancing NZEr buildings.

Guidance for adoption

While the PCF calls for *adoption* of NZEr model codes by all provinces/territories by 2030, Canada's jurisdictional bifurcation prevents the federal government from mandating when the provinces and territories should adopt the tiered code and move towards the upper tiers, or when the lowest tiers will be dropped. However, it must be acknowledged that without guidance regarding a timeline for progression through the tiers, industry does not have a clear signal regarding how and when they will be required to act on upper tiers of the proposed model codes.

A timeline, similar to that suggested in Figure 7, has the benefit of articulating the federal government's expectations for adoption and preparing provincial and regional markets for the 2030 NZEr model codes.

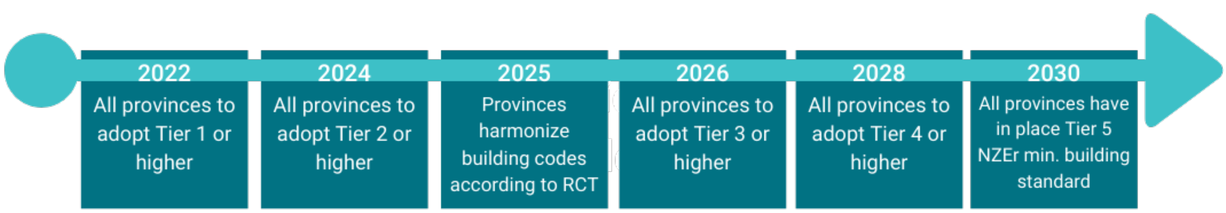

Figure 7: Suggested progression towards Tier 5 of NBC

---

[27] CaGBC, 2017.

[28] The Task for a Resilient Recovery, Preliminary Report. July 2020. Retrieved from: https://www.recoverytaskforce.ca/wp-content/uploads/2020/07/TFRR-Preliminary-Report-Jul-2020.pdf

A suggested timeline may also act as a potential guide for federal funding to provinces and territories to aid in adoption and implementation. Finally, without a clear expectation of when specific tiers will be adopted, developers and manufacturers will be reluctant to invest in high-performance technologies and capacity-building.

Increased support for adoption of the model codes is increasingly important given that the model codes have been delayed until December of 2021.[29] This delay in the codes release creates a risk that provinces/territories may further delay adoption, a concerning prospect because it does not recognize the urgency required to immediately begin supporting the 2030 adoption of the highest tiers of the model codes. Thus far, B.C. is the only province to commit, and it is notable that — despite extensive preparatory work — the province expects to reach a new construction standard of NZEr by 2032: two years after the goal set in the PCF.

Government can pave the way for provincial and territorial adoption through a mix of capacity-building, knowledge-sharing and incentives that accelerates long-term market transformation. Notably, this includes attaching significant fiscal incentives to provincial and territorial code adoption of a NZEr model code. Not only will this provide much needed support for code adoption, it also has the benefit of sending a strong signal to the provinces, industry, and consumers that high-performance buildings are the future of the buildings sector.

Prioritize compliance

To effectively reduce energy waste and drawdown energy associated carbon emissions, the model codes must be enforced once adopted. As reported in Efficiency Canada's 2019 *Canadian Provincial Energy Efficiency Scorecard,* few resources are currently dedicated to promoting compliance with building energy codes and, if compliance rates are low, national model building energy codes will not result in the expected energy savings, even if widely adopted by the provinces and territories.[30]

The jurisdictional responsibilities of building code enforcement, which lies with AHJs, forces unique challenges in building energy code compliance. While stringent energy code compliance contributes to federal and provincial government's efficiency and emissions reductions objectives, AHJs alone — often municipalities — are required to take on the burden of enforcing the federally-developed and provincially- or territorially-adopted model codes. The benefits of higher compliance rates go well beyond consumer savings. In addition to the benefits accrued by the consumer — improved occupant comfort and health, better indoor air quality, and a more resilient building — building energy code compliance is a low-cost, ready-made way for federal,

[29] Lockhart, Kevin, Canada's National Model Building Codes Delayed Until December 2021. Accessed September 2020.

[30] Haley, Brendan, Gaede, James, Correa, Cassia, Canadian Provincial Energy Efficiency Scorecard, 2019.

provincial and territorial, and municipal governments to achieve both their energy efficiency and emissions reduction objectives.

As noted in Efficiency Canada's *Tiered Energy Code Compliance Best Practices for Code Compliance* report, national compliance guidelines, increased stakeholder compliance training and awareness, and access to compliance subject matter experts will increase stakeholder confidence in the benefits of tiered energy codes and provide verification that buildings perform as designed.[31] As Figure 8 illustrates, compliance training can take place at all stages of construction, particularly when the code is first adopted to ensure building market actors are updated on new technologies, design elements, and revisions to the code. Code compliance is also an opportunity for local governments and industry to elevate construction standards and provide the local building sector with technical assistance and support.

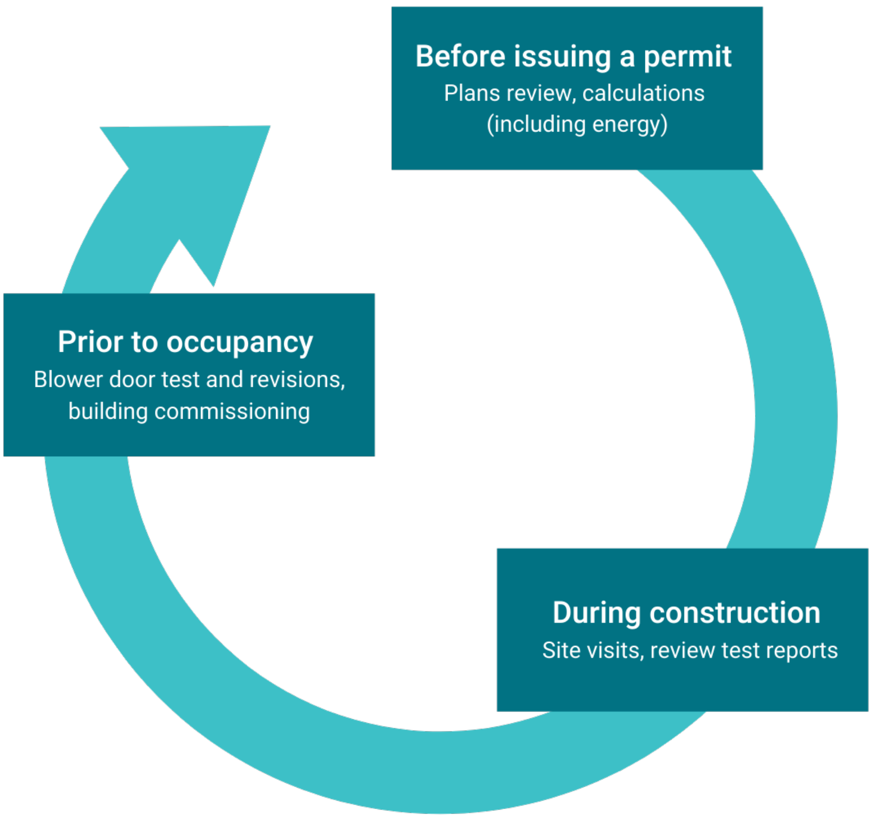

Figure 8: Building energy code compliance at all stages of construction.

Finally, compliance could be increased through a national database of compliance tools that provides an accessible way to track results from compliance assessments and final reports. An electronic database of building performance levels, compliance concerns and compliance tips would be of value to the buildings sector and has been identified in interviews as a much-needed resource for provinces to deliver lessons learned, exception handling, and best practices.[32]

[31] Pride, Andrew. Tiered Energy Codes Compliance Best Practices. 2020, Efficiency Canada.

[32] Ibid.

A vision for future building energy codes development

The way Canada develops complex building energy codes needs to change. We must incorporate a market transformation lens to the process and begin positioning NZEr buildings as the norm in the Canadian buildings sector. Achieving this will depend on dynamic interactions between construction technology, human behaviour, market conditions, and public policy over the next decade. And, while achieving full market potential requires decisions made by an array of manufacturers, builders, architects, contractors, and consumers, the federal government's clear direction is critical to overcome the barriers and perceived risks associated with high-performance buildings.

As envisioned in the PCF, the buildings sector has the potential to play a key role in achieving Canada's climate objectives. However, as currently developed, today's model codes are not expansive enough to effect the level of change required to mitigate climate change. This report has pointed to several reasons for this, including a model code development framework that is challenged by the ambitious vision presented in the PCF, and a lack of connection between codes and complementary policies. The changes recommended — if implemented during the next model code development — offer a path to overcome these challenges, as well as to prepare the national model codes development system for challenges beyond the next building code development cycle.

References

Corvidae J, Gartman M, Petersen A. 2019. The economics of zero-energy homes. Rep., Rocky Mount. Inst., Basalt, CO. https://rmi.org/insight/economics-of-zero-energy-homes/

City of Toronto. 2020. Zero Emissions Buildings Framework Report. Accessed April. https://www.toronto.ca/wp-content/uploads/2017/11/9875-Zero-Emissions-Buildings-Framework-Report.pdf

DOE (U.S. Department of Energy). 2015. Achieving Energy Savings and Emission Reductions from Building Energy Codes: A Primer for State Planning Washington, D.C.: U.S. Department of Energy. https://www.energycodes.gov/sites/default/files/documents/Codes_Energy_Savings_State_Prime r.pdf.

DOE (U.S. Department of Energy). 2015. Achieving Energy Savings and Emission Reductions from Building Energy Codes: A Primer for State Planning Washington, D.C.: U.S. Department of Energy. https://www.energycodes.gov/sites/default/files/documents/Codes_Energy_Savings_State_Prime r.pdf.

EERE (U.S. Department of Energy Office of Energy Efficiency and Renewable Energy). 2013. Building Energy Codes Program: Toolkit Definitions. Last modified January 31. https://www.energycodes.gov/resource-center/ace/definitions. EPA (Environmental Protection Agency). 2015. Energy and Environment

Energy Star Portfolio Manager. 2012. Benchmarking and Energy Savings. DataTrends. Accessed May 2020. www.energystar.gov/sites/default/files/buildings/tools/DataTrends_Savings_20121002.pdf

Frappé-Sénéclauze, Tom-Pierre et. al. Accelerating Market Transformation for High-Performance Building Enclosures: State of market, policy developments, and lessons learned from the Passive House movement. The Pembina Institute, 2016.

Frappé-Sénéclauze, Tom-Pierre and MacNab, Josha. The Evolution of Energy Efficiency Requirements in the BC Building Code. Pembina Institute, 2015.

Geller, Howard and Nadel, Steve, 1994. Market Transformation Strategies to Promote End-Use Efficiency. ACEEE.

GBPN (Global Buildings Performance Network). 2015. Building Energy Codes Portal. Accessed April 2020. http://www.gbpn.org/beet-3/.

Government of Canada, Progress Towards Canada Greenhouse Gas Emissions Reduction Target. Retrieved from: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/progress-towards-canada-greenhouse-gas-emissions-reduction-target.html

Government of Canada, 2017. Build Smart: Canada's Buildings Strategy. Accessed May 2020. https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/Building_Smart_en.pdf

Hayes, Sara, Ungar, Lowell, and Herndon Garret. The Role of Building Energy Codes in the Clean Power Plan. January, 2015.

Haley, Brendan, Gaede, James, Correa, Cassia. Canadian Provincial Energy Efficiency Scorecard. Efficiency Canada, 2019.

IBE (Institute for Building Efficiency). 2011. Driving Transformation to Energy Efficient Buildings: Policies and Actions – Building Efficiency Codes and Standards. Milwaukee: Johnson Controls.

IPEEC, Building Energy Efficiency Taskgroup, Building Energy Performance Gap Issue: An International Review, 2019.

IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp

Levine M, Ürge-Vorsatz D, Blok K, Geng L, Harvey D, et al. 2007. Residential and commercial buildings. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. B Metz, OR Davidson, PR Bosch, R Dave, LA Meyer, Cambridge, UK/New York: Cambridge Univ. Press.

Lowell Ungar, Take a ride on the energy slide with building codes. ACEEE, Feb. 12, 2016. Accessed June 2020. https://www.aceee.org/blog/2016/02/take-ride-energy-slide-building-codes.

National Resource Defense Council & Institute for Market Transformation. 2016. Establishing a Plan to Achieve Energy Code Compliance in Cities. City Energy

Project. http://www.cityenergyproject.org/wp-content/uploads/2016/11/CEP-Establishing-a-Plan-to-Achieve-Energy-Code-Compliance-in-Cities_2016Final.pdf.

Nevius, M., L. Hoefgen, L. Wilson-Wright, and C. Browne. 2013. A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts. Somerville, MA: NMR Group. www.calmac.org/publications/FINAL_NMR_MT_Practices_Report_20131125.pdf.

Pride, Andrew. Tiered Energy Codes Compliance Best Practices. September 2020, Efficiency Canada.

Renilde Becque, Weyl, Debbie, Stewart, Emma, Makres, Eric, Luting, Jin, and Shen, Xufei, 2019. Accelerating Building Decarbonization: Eight Attainable Policy Pathways to Net Zero Carbon Buildings for All. World Resources Institute, 2019.

York, Dan, Bastian, Hannah, Relf, Grace and Amann, Jennifer. Transforming Energy Efficiency Markets: Lessons Learned and Next Steps. December, 2017.

Acronyms

ACEEE - American Council for an Energy-Efficient Economy

ARRA - American Recovery and Reinvestment Act of 2009

AHJ - Authority Having Jurisdiction

BC - Province of British Columbia

CCBFC - Canadian Commission on Building and Fire Codes

EUI - energy use intensity

NRCan – Natural Resources Canada

NRC – National Research Council

NZEr - Net Zero Energy Ready

NBC - National Building Code

NECB - National Energy Code for Buildings

PCF - Pan Canadian Framework on Clean Growth Climate Change

RCT - Regulatory Reconciliation and Cooperation Table

SME - subject matter experts

TEDI - thermal energy demand intensity

TEUI - total energy use intensities