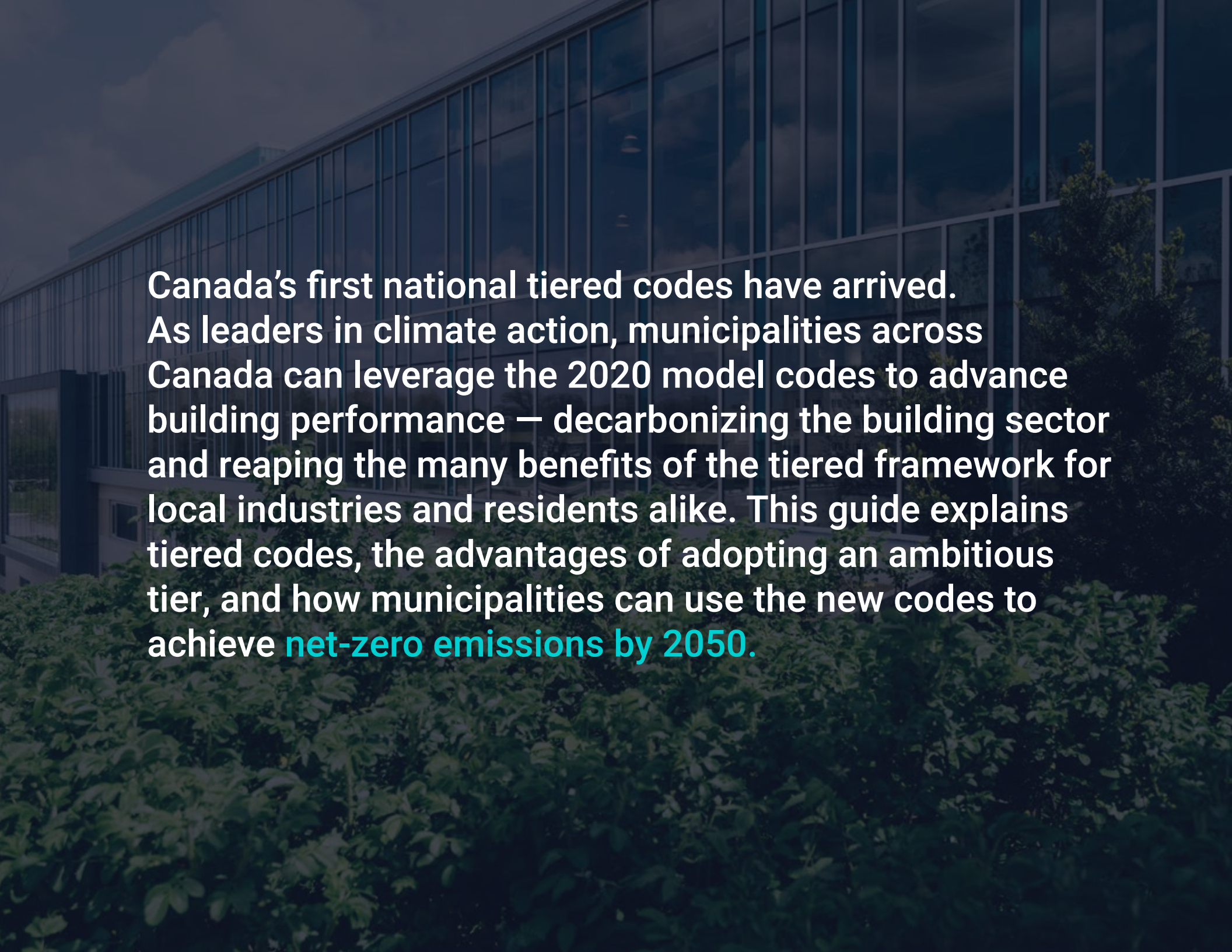
The Municipal Guide to Net-Zero Energy Ready Building Codes

Efficiency Canada

Carleton University

low carbon cities canada LC3



Canada's first national tiered codes have arrived. As leaders in climate action, municipalities across Canada can leverage the 2020 model codes to advance building performance — decarbonizing the building sector and reaping the many benefits of the tiered framework for local industries and residents alike. This guide explains tiered codes, the advantages of adopting an ambitious tier, and how municipalities can use the new codes to achieve net-zero emissions by 2050.

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Glossary

Air changes per hour (ACH): The number of times the full volume of air in the building exchanges in an hour when a building is at a specified pressure. This metric of how much air leaks through the building envelope is measured by a 'blower door test.'

Authority having jurisdiction (AHJ): The municipality, province or territory responsible for the oversight of construction activities and for enforcing compliance with the building code.

Building code: A law or regulation that establishes specifications for the design and construction of residential or commercial buildings. They ensure new construction meets minimum health, safety and performance standards.

Building energy code: A regulatory standard that sets minimum efficiency requirements for new and renovated buildings to reduce energy use and greenhouse gas emissions over the life of the building. Energy codes are a subset of building codes, which establish baseline requirements and govern building construction.

Building envelope: A building's physical separation between the indoor and outdoor environment. It includes walls, floors, ceilings, windows, and doors.

Code adoption: Model codes have no force in law until they are adopted by an authority having jurisdiction. In Canada, that responsibility lies with the provinces, territories, and in some cases, municipalities.

Embodied carbon: The total amount of emissions — carbon dioxide emissions and other gases linked to global warming — created to extract, refine, fabricate, and transport a building material.

Model code: A model set of requirements which provide for the health and safety of the public in buildings. In Canada, model codes are produced nationally and published for adoption by authorities having jurisdiction — municipalities, provinces, and territories.

Net-zero energy ready (NZER): A building standard designated to make a building so energy efficient that it can easily produce as much energy as it consumes annually once a renewable energy source (solar, wind, and/or micro-hydro) is added. NZER buildings are typically 80 per cent more energy efficient than a typical new building, according to Natural Resources Canada.

Operational carbon: The total emissions — carbon dioxide and other gases linked to global warming— created to keep buildings warm, cool, ventilated, lit, and powered.

National Framework for Clean Growth and Climate Change: The structure developed by the 2017 Pan-Canadian Framework with provinces and territories, and in consultation with Indigenous Peoples to help meet Canada's emissions reduction targets, grow the economy, and build resilience to a changing climate.

Performance path: A code compliance path that uses absolute energy values — such as Energy Use Intensity — to demonstrate compliance. The performance path offers the designer or builder the most flexibility in meeting the building energy code requirements.

Prescriptive path: Requirements a building must meet to demonstrate code compliance. Each element of a building is prescribed a minimum acceptable standard — no energy modelling or calculations required! For example, a specific minimum insulation value for different types of wall assemblies across different climate zones.

Reference building: A hypothetical building modelled to the base prescriptive requirements of the building code.

Tiered code: A progressive approach to achieve more energy efficient buildings. This series of performance-based steps starts with a familiar base building code and each subsequent step becomes increasingly energy efficient. Sometimes referred to as a step code or stretch code.

Thanks

This report was supported by Low Carbon Cities Canada (LC3). We'd like to thank the many buildings practitioners and policymakers who provided insights and perspectives on how municipalities can leverage the national model codes during interviews conducted in the spring of 2022, as well as those who provided a peer review of individual drafts.

About Low Carbon Cities Canada (LC3)

LC3 is a partnership among seven LC3 Centres, working in collaboration with the Federation of Canadian Municipalities (FCM), and is funded by the Government of Canada. The LC3 Network serves as a catalyst for the identification, incubation and widespread adoption of low carbon solutions in seven city regions across Canada.

By working as a Network, LC3 supports peer-to-peer learning to improve outcomes for all, helps accelerate the adoption of low- carbon solutions in multiple cities, and creates synergies and economies of scale regarding services and national-level programming.

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. Efficiency Canada is housed at Carleton University's Sustainable Energy Research Centre, which is located on the traditional unceded territories of the Algonquin nation.

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

About the author

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Introduction

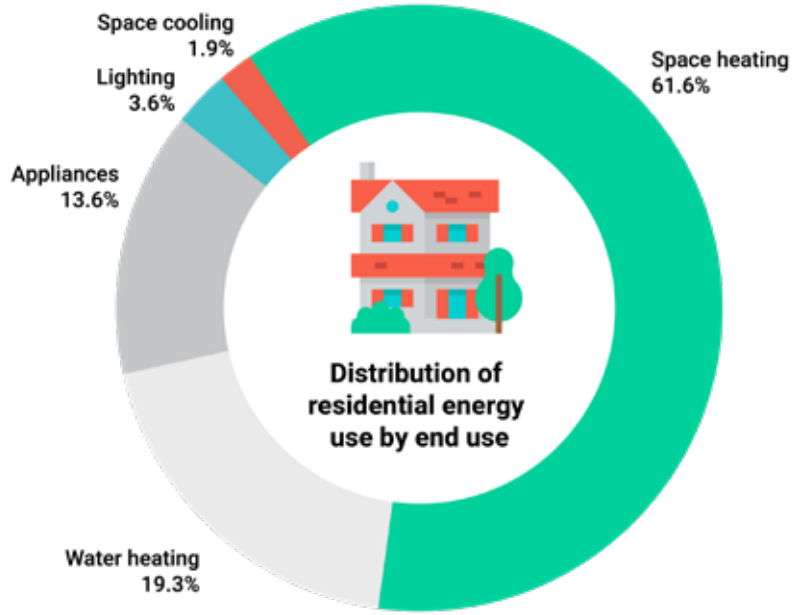
Municipalities across Canada have set ambitious climate targets. The path to meeting these climate commitments must include finding ways to optimize building energy efficiency.

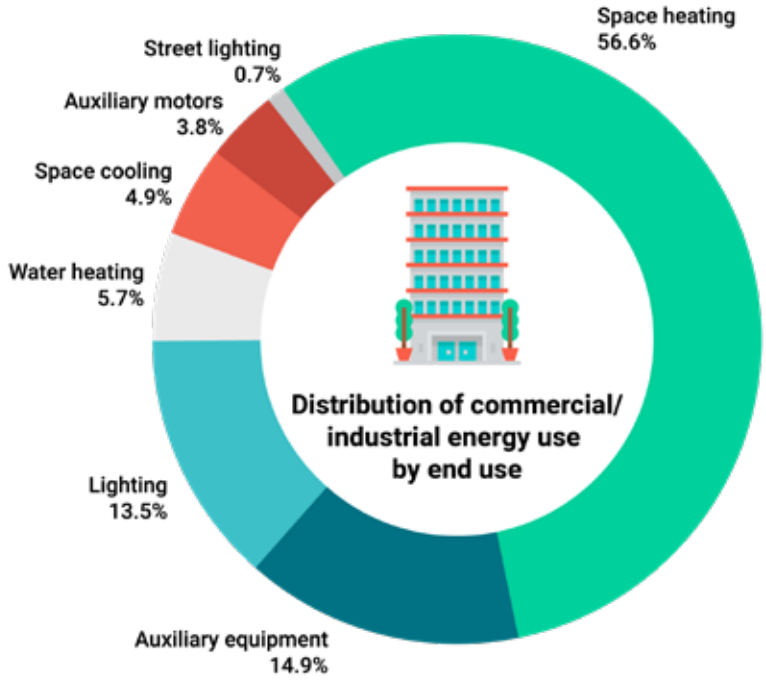
Stringent building energy codes, like the 2020 model codes, are a near-term transformational action local governments can use to achieve their climate change targets. The result: low-carbon buildings that improve the health, resilience, and livability of the community.

Canada's recently released national model building codes are tiered. They provide a path that sees building performance improved with each tier. The top tier is the net-zero energy ready (NZER) standard, which indicates a building so energy efficient that it can produce as much energy as it consumes annually once a renewable energy source (solar, wind and/or micro-hydro) is added. NZER buildings are typically 80 per cent more energy efficient than a typical new building, according to Natural Resources Canada.

The tiered code framework offers the flexibility local governments need to accelerate the energy performance of buildings. However, municipalities face significant limitations and constraints in achieving deep energy and emission reductions. By working with, and supporting, senior levels of government and the building sector, municipalities can leverage building codes as a tool to support their climate action plans.

In this guide, you'll learn how your municipality can use model code adoption to reach your net-zero goals, capture a range of energy and non-energy benefits, and lay the foundation to reach net-zero emissions.





Source: NRCan, Energy Efficiency Trends in Canada, 2017

The road to climate action runs through Canada's municipalities

Climate change is a global problem, but Canadian municipalities are on the front lines of extreme weather events. They are tasked with mitigation and response — using limited resources to harden existing infrastructure and respond to heat domes, flooding and drought — while continuing to provide basic services and social infrastructure.

They also lead the execution and implementation of several international, national and provincial commitments. This signals an increasingly prominent role for municipalities as leaders in climate action.

Climate commitments signal future building policies

2017

Pan-Canadian Framework

The Pan-Canadian Framework (PCF) signalled a change in building codes from those that are designed to create a minimum acceptable standard towards a 'stretch' goal — new building design and construction practices to meet climate change goals.

Provinces and territories committed to develop and adopt increasingly stringent model building codes starting in 2020, with an ultimate goal of adopting net-zero energy ready model building codes by 2030.[1]

2019

Regulatory Reconciliation and Cooperation Table

Established under the Canadian Free Trade Agreement (CFTA), the Regulatory Reconciliation and Cooperation Table (RCT) endorsed the Construction Codes Reconciliation Agreement. It aims to reduce or eliminate variations in provincial building codes and to establish a standardized period of adoption of new model codes as they are published.

All provinces and territories ratified this agreement in 2020, effectively binding them to implement the 2020 national codes within 24 months of their publication, and subsequent codes within 18 months of their publication.

2021

2021 Mandate Letters

In late 2021, the Ministers of Natural Resources and the Minister of Innovation, Science and Industry were given a mandate regarding the "development of model building codes … that align with national climate objectives and provide a standard for climate-resilient buildings."

These mandates signalled an impactful shift in building code development and implementation. They demonstrate recognition that accelerating building code adoption, enforcement, and compliance will require federal action to spur market readiness activities in provinces and municipalities.

[1]Pan-Canadian Framework on Clean Growth and Climate Change. Retrieved from: https://www.canada.ca/en/services/environment/weather/

[2]December 2021, Federal government mandate letters

2022

Net Zero by 2050

In early 2022, the International Energy Agency released it's Net Zero by 2050: A Roadmap for the Global Energy Sector report. In this, it urges governments to "act before 2025 to ensure zero carbon-ready compliant buildings codes are implemented".[3]

2022

Intergovernmental Panel on Climate Change (IPCC)

The UN Intergovernmental Panel on Climate Change (IPCC) determined that we have roughly a decade to dramatically reduce emissions enough to avoid catastrophic climate change. The IPCC's report underlines the urgency for new policies that recognize the buildings sector, and building codes, as an ideal component to achieve deep emissions reductions.[4]

2022

The Canada Green Buildings Strategy

Announced in the Emissions Reduction Plan, the Strategy places renewed focus on building standards and policies that are needed to reach net zero. This includes forging coalitions of provinces, municipalities, utilities, and businesses. A significantly accelerated adoption and enforcement of net-zero building codes by 2025 appears to be built into the plan's assumptions.

2022

The Net Zero Building Code Acceleration Fund

Expected to support training and market development activities, this fund is anticipated to be established in the fall of 2022. It will help provinces, territories, and municipalities accelerate code adoption and increase code compliance levels.

[3] International Energy Agency, "Net Zero by 2050: A Roadmap for the Global Energy Sector", Pg. 148.

[4] IPCC, Summary Report for Policy Makers. Retrieved from:
https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_FinalDraft_FullReport.pdf
climatechange/pan-canadian-framework/climate-change-plan.html
from: https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html

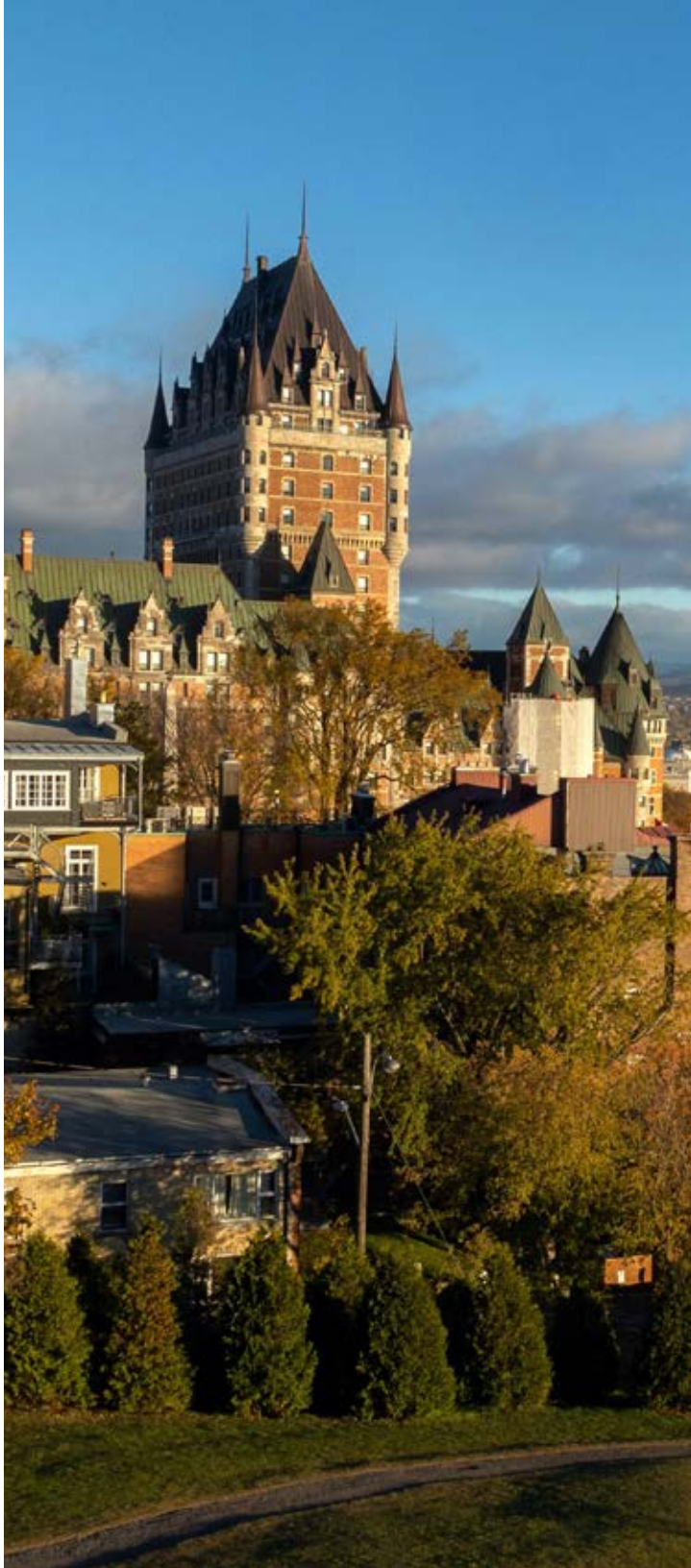
Senior levels of government have signalled the role the buildings sector is expected to play in achieving a net-zero future. Municipalities need to act on these signals by a committing to leverage Canada's buildings sector as a primary tool to decarbonize local economies and reach their net-zero goals.

Leading Canadian municipalities can act as catalysts in the new economy, create good local jobs, and save residents money otherwise spent on energy costs. The money saved and created can return to the local economy for more productive uses.

Along the way, municipalities can accelerate global climate action by supporting senior levels of government in normalizing a standard of excellence in Canada's buildings sector.

LC3 Centre	Total Energy Use by Buildings	Total Emissions from Buildings
Metro Vancouver	27%	15%
Calgary	43%	40%
Edmonton	43%	42%
Toronto	51%	37%
Ottawa	59%	42%
Montreal	40%	31%
Halifax	44%	49.8%

Municipal Energy + Emissions Database. Retrieved from: https://meed.info/en/ca/
Note: The methodology used by MEED differs from that used by some municipalities to develop their emissions inventories thus discrepancies in emissions reported may occur.



Municipalities can lead advancements in building performance

The jurisdictional boundaries of Canada's provinces, territories, and municipalities are outlined in Section 92 of the *Constitution Act*. It gives provincial and territorial governments responsibility for regulating building and construction. In turn, provinces hold power over "municipal institutions in the province," and municipalities, as "creatures of the province," act as extensions of the province in which they reside. This places municipalities in the role of managing local matters, but only to the extent that the provinces have granted them the power to do so.

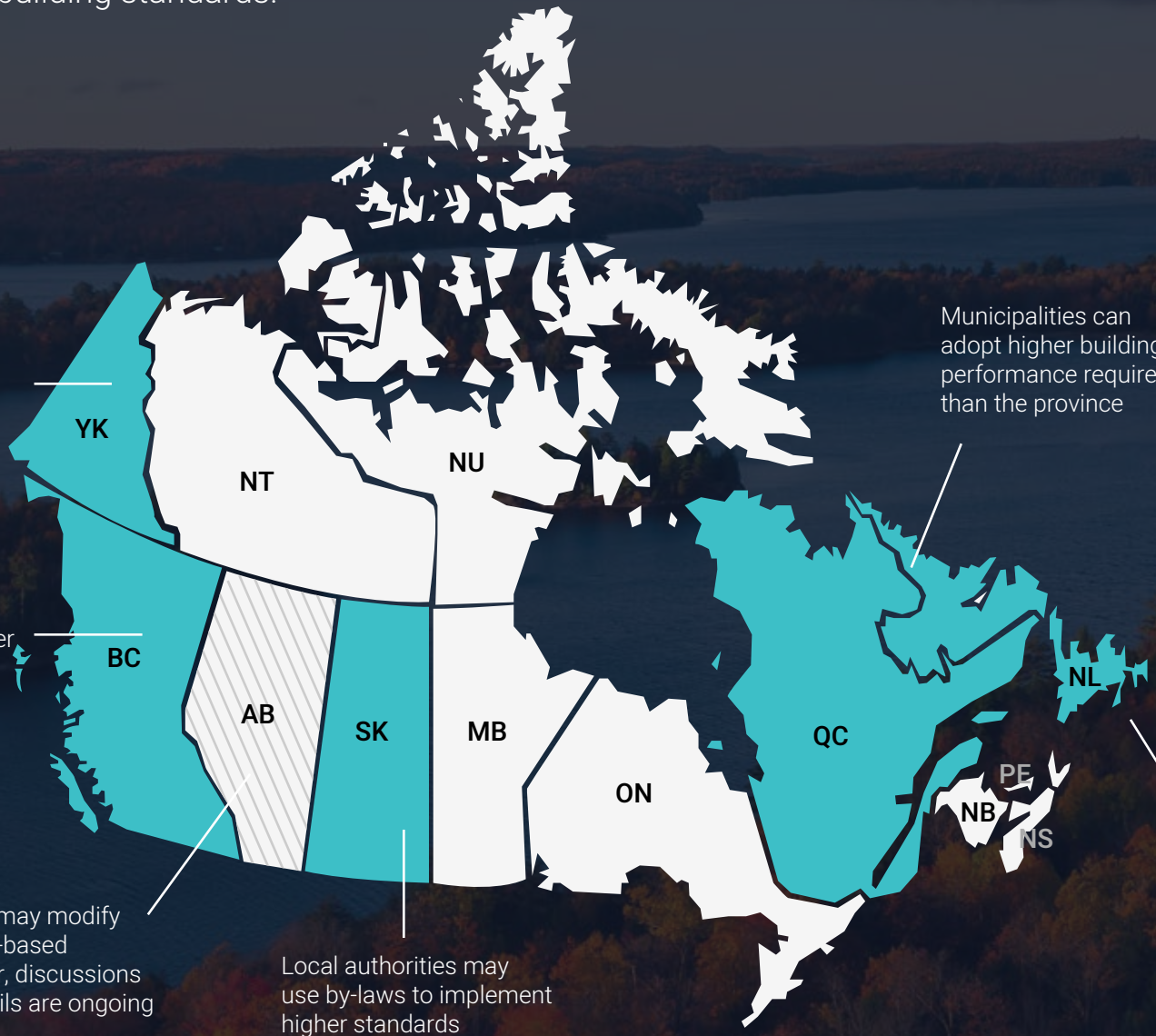
When the Constitution was written, urban areas represented only 20 per cent of the population. Today, 80 per cent of Canada's population is based in urban areas.[5]

Over the past several decades, municipalities have gained greater flexibility, latitude, and legal powers through municipal empowerment. Nonetheless, their ability to implement building codes that support their climate agendas remains constrained. In Efficiency Canada's Provincial Scorecard, only British Columbia, Quebec, and Saskatchewan stated that they allow municipalities to implement local building codes or adopt different tiers of the 2020 model codes (or BC Energy Step Code). Also of note, the City of Calgary and the City of Edmonton have been enabled through regulation to modify provincial codes for place-based circumstances. However, discussions on implementation details are ongoing. This means most municipalities in Canada could face jurisdictional complications if they seek to move ahead on requiring accelerated building performance.

Smaller geographic jurisdiction, land use and building code enforcement activities, and advanced capacity make municipalities uniquely positioned to lead as catalysts for energy efficiency, emissions reductions, and climate change resilience innovation. To play this role and advance Canada's path to NZER buildings at a manageable scale, upper levels of government need to enable them to lead.[5]

[5]Statistics Canada, Population growth in Canada's rural areas, 2016 to 2021. Accessed September 28, 2022.

Provinces and territories that allow municipalities to adopt supplemental building standards.



The City of Whitehorse has adopted more stringent requirements via by-laws

Municipalities can adopt higher building performance requirements than the province

Local governments have limited authority to administer and enforce the BC Building Code, including the adoption BC Energy Step Code tiers

Calgary and Edmonton may modify provicial codes or place-based circumstances; however, discussions on implementation details are ongoing

Local authorities may use by-laws to implement higher standards

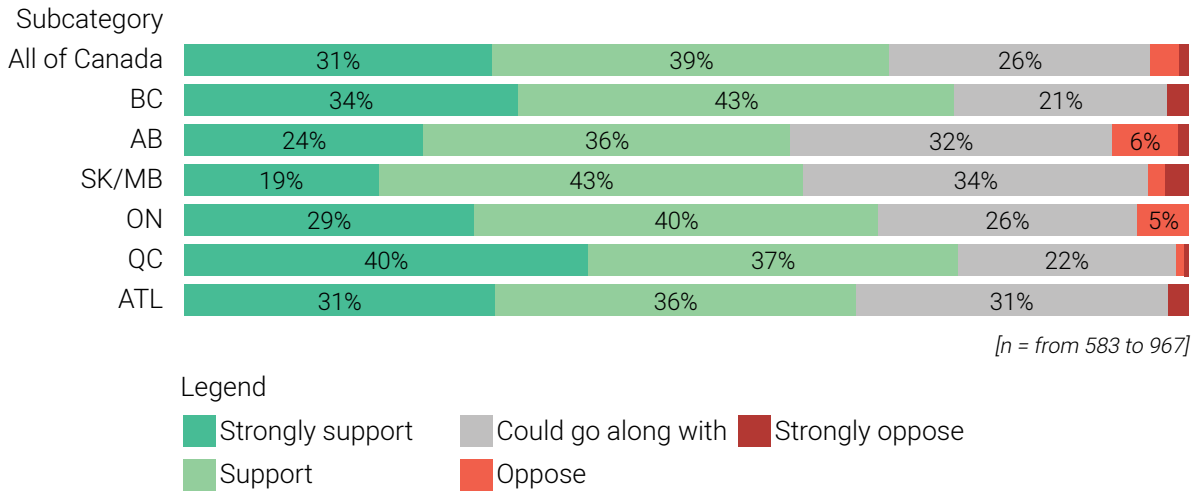
Local governments may require buildings standards that differ from the provincial building Code

Source: Efficiency Canada, Provincial Energy Efficiency Scorecard, 2022 information request.

Canada's climate plan aims for all new buildings to be NZER by 2030. Polling by Abacus Data for Efficiency Canada shows that NZER building codes are supported or strongly supported by 60-77 per cent of Canadians in all regions. All provinces have public support in adopting the latest model codes.

Polling shows widespread support for net-zero buildings

Support for changing building codes so that every new building can be so energy efficient that it can supply its own needs using renewable forms of energy.



[n = from 583 to 967]

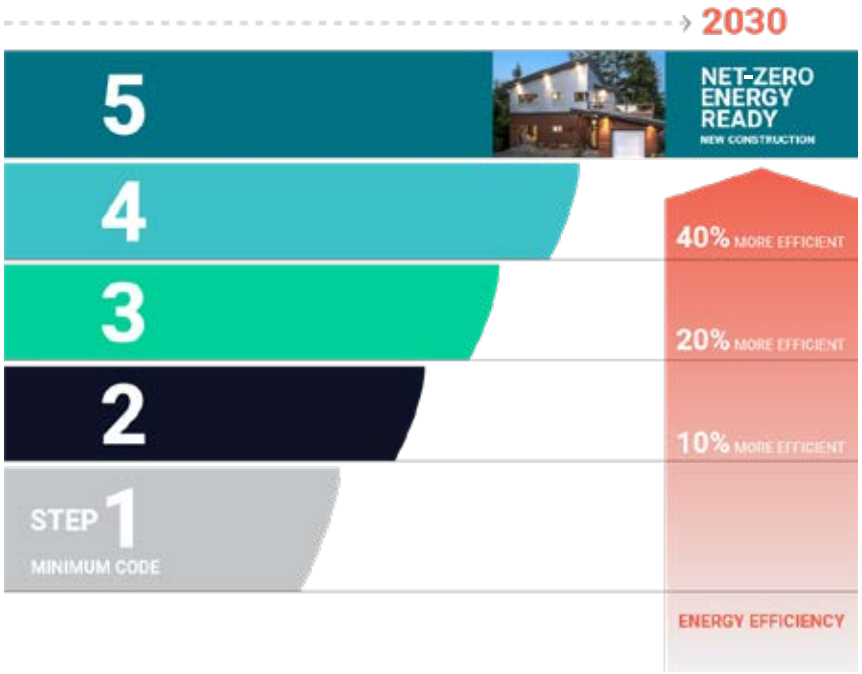
Widespread support for net-zero buildings

Past building codes have established a minimum standard – the lowest standard for constructing a building in a given jurisdiction. First introduced in British Columbia in 2017, tiered codes offer a different approach to achieving increased energy efficiency in buildings.

Tiered codes, including Canada's 2020 national model codes, offer a progressive series of performance-based steps. Starting with a familiar base building code, the energy used to operate the building is incrementally reduced at each tier. Consequently, the minimum energy performance standard of the building increases at each tier. While ensuring that additional construction costs encourage affordability in fact, high performance buildings — even those comparable to the 2020 model codes highest tiers — can now be built at costs comparable to and even less than conventional buildings.

Tiered codes make sure that everyone in the buildings industry moves toward increased energy performance along a shared path, and that they compete on the same terms. By raising the minimum standard of construction incrementally, tiered codes raise the energy performance of the entire sector.

They also clearly set out building code requirements years in advance so that all involved — from construction trades to municipal councillors — can prepare for future changes in the building energy code.



Tiered codes deliver direct and immediate benefits to municipalities

With a tiered code, provinces, territories, and municipalities 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 a number of reasons.

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 — no need to develop unique building codes, or additional construction standards!

Tiered codes set a clear and predictable path towards an end date (accelerated from 2030 to 2025 as per the federal *Emissions Reduction Plan*), at which point each new building is expected to meet NZER standards. By signalling the desired end state, the 2020 codes provide both the time and direction required to build capacity in the market over the coming years.

They foster confidence in the market by offering regulatory certainty and an anchor by which to develop a long-term strategy. From technical leadership and coordination to education, incentives, and enforcement programs, certainty is key. It helps builders, developers, and manufacturers prepare to meet the market's needs, invest in their business, and introduce innovative ways to deliver safe, affordable, high-performance buildings.

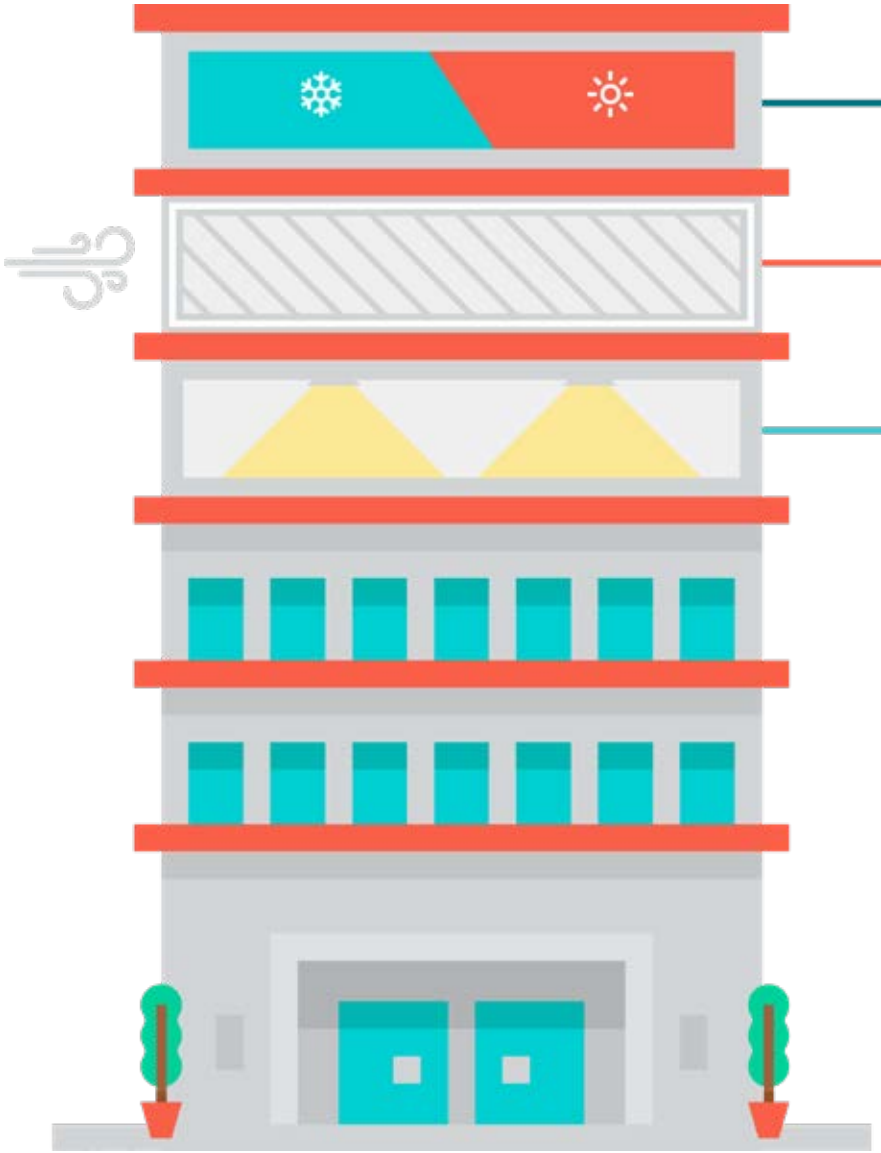
They deliver direction and focus to better help the workforce — carpenters, energy advisors, architects, and more — invest in themselves to build the knowledge and skills that pay off in the form of good local jobs.

It makes it easier for utilities and other program providers to align incentives with municipal, provincial, territorial, and federal climate commitments.

It offers municipalities a standardized path by which to align supplemental standards, such as green development standards. The flexibility to adopt more stringent standards than their municipal peers has been a key factor in accelerating uptake of the BC Energy Step Code.

Cracking the codes: What's in the 2020 national model codes

NECB 2020 explained



Mechanical Systems

Building Envelope

Interior and Exterior Lighting

The National Energy Code for Buildings (NECB) and the National Building Code (NBC) are the foundation for Canada's first national tiered energy codes, released in March 2022.

Building on NECB 2017, NECB 2020 introduces 15 changes that add or refine procedures, update equipment performance tables, and insulation on equipment. The table below highlights each change, alongside a brief explanation of what the change entails.

NECB 2020 explained

The NECB was Canada's first national standard for building energy performance. It was introduced in 1997 as the Model National Energy Code for Buildings and later renamed the National Energy Code (NECB) for Buildings in 2011. The NECB applies to what are commonly referred to as Part 3 buildings, large residential and commercial buildings exceeding 600 m2 in building area or exceeding three storeys in building height.

Established in 1941, the NBC first introduced energy compliance requirements, known as Section 9.36, in 2012. Section 9.36 is specifically intended for Part 9 buildings. These are considered small buildings with a floor area under 300m^2 and residential buildings with footprint less than 600m^2 and whose height is three storeys or fewer storeys.

Building on NECB 2017, NECB 2020 introduces 15 changes that add or refine procedures, update equipment performance tables, and insulation on equipment.

Part of Code and Title	Description	Intended Outcome
Part 3: Whole building airtightness testing	This updates testing procedure for voluntary air leakage testing of the building envelope. Updated references to additional standards such as ASTM E1358 which help to reduce air infiltration rates through the building envelope, resulting in reduced energy consumption.	Whole building air tightness reduces energy loss through the building's walls, windows and doors — along with the infiltration of moist air into the building cavity, which can impact durability. Other benefits include comfort and health for occupants, as well as building resilience during power outages.
Part 3: Thermal characteristics of opaque building assemblies	This reduces the maximum U-values (increase the R-Value) for above-ground building assemblies, excluding doors and windows.	Measures that decrease energy losses through the building envelope are the most effective and long-lasting energy conservation measures and result in the highest local economic spin-off.
Part 3: Thermal characteristics for fenestration and doors	This reduces the allowable U-values of doors and windows (skylights are excluded) and includes a prescriptive maximum U-factor requirement for a 10-12 per cent reduction.	Increasing the thermal resistance of windows and doors helps to reduce heat losses in the building and enables the use of right-sized heating and cooling equipment.
Part 4: Interior lighting power	Updates the lighting power density (LPD) values to better align them with the efficacy of lighting products available in the marketplace (now aligned with recent changes to IESNA/ASHRAE).	Lower LPD values reduce energy costs and lead to lower lighting system maintenance requirements and associated costs.

NECB 2020 explained

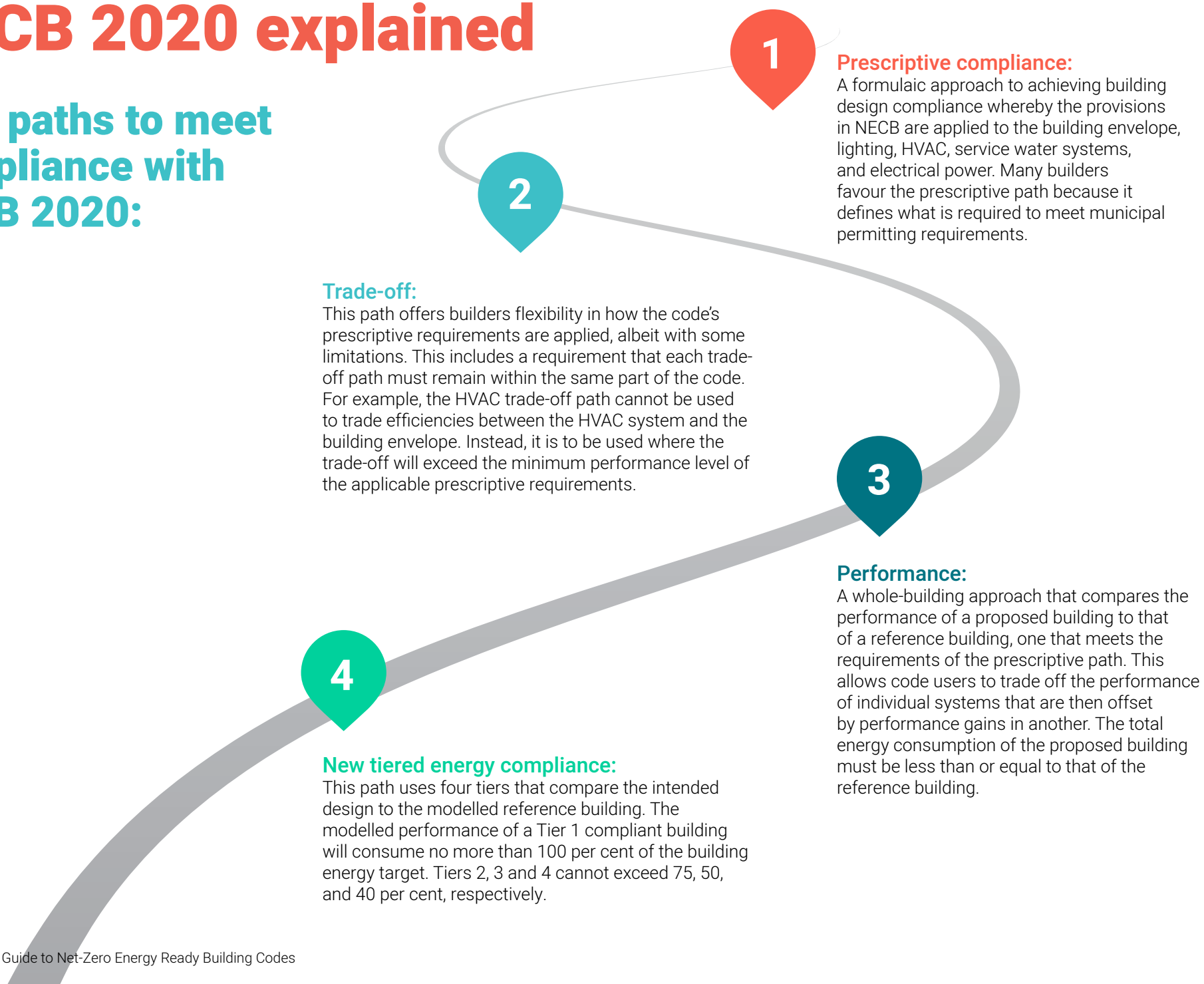
Part of Code and Title	Description	Intended Outcome
Part 4: Exterior lighting power	This introduces lighting power allowances to be used for building exterior applications that are not covered by existing provisions.	Updated lighting power allowances that increase the efficiency of lighting can be expected to reduce system maintenance costs and lead to lower initial capital costs.
Part 5: Piping insulation – service water systems and HVAC systems	This eliminates options to alter the manufactured insulation thicknesses for piping in HVAC systems and for service water systems.	These changes are intended to prevent the combination of different insulation materials to achieve a given R-value. Code users will benefit from reduced costs and longer life of the materials.
Part 5: Duct and plenum insulation	This adds a requirement for supply ducts to be insulated.	Heating and cooling losses can occur in poorly sealed ducts and plenums. Insulating these components contributes to greater efficiency of HVAC systems.
Part 5: HVAC trade-off path	This deletes the trade-off paths for heating, ventilating and air-conditioning systems (Part 5) and service water heating systems (Part 6).	The HVAC trade-off path was not used in practice and, as such, is no longer relevant.
Part 5: Supply air systems	This harmonizes the requirements on HVAC system controls in Parts 5 and 8.	Reductions in the minimum airflow rate means that less energy is required for re-heating and re-cooling supply air.
Part 5: HVAC equipment performance requirements	Updates the minimum performance requirements stated in tables 5.2.12.1. and 5.2.12.2. and introduces requirements for new types of equipment.	Changes in industry and market practice are reflected and align with ASHRAE 90.1-2019 requirements and Canada's Energy Efficiency Regulations.

NECB 2020 explained

Part of Code and Title	Description	Intended Outcome
Part 5: Service water heating equipment performance requirements	HVAC equipment and efficiency tables are to be updated.	It could increase minimum standards for the efficiency of service water heating equipment reduce equipment energy use.
Part 9: Tiered performance requirements	These introduce provisions on energy performance tiers and associated compliance calculations.	See 'Tiered codes deliver direct benefits to municipalities'
Part 8: Climatic loads	This updates wind loads in climatic tables	Tables updated based on the latest observed climate data. Wind loads can affect the air pressure distribution on building surfaces, which controls the heat loss and gain.
Division A: Update of NECB application to include interior improvement/ tenant fit-up	Updates the NECB application statements in Article 1.1.1.1. to cover subsequent alterations to and within buildings.	This change closes a loophole in the NECB to ensure that interior improvements made for specific tenants after occupancy comply with the NECB.

NECB 2020 explained

Four paths to meet compliance with NECB 2020:



Prescriptive compliance:
A formulaic approach to achieving building design compliance whereby the provisions in NECB are applied to the building envelope, lighting, HVAC, service water systems, and electrical power. Many builders favour the prescriptive path because it defines what is required to meet municipal permitting requirements.

Trade-off:
This path offers builders flexibility in how the code's prescriptive requirements are applied, albeit with some limitations. This includes a requirement that each trade-off path must remain within the same part of the code. For example, the HVAC trade-off path cannot be used to trade efficiencies between the HVAC system and the building envelope. Instead, it is to be used where the trade-off will exceed the minimum performance level of the applicable prescriptive requirements.

Performance:
A whole-building approach that compares the performance of a proposed building to that of a reference building, one that meets the requirements of the prescriptive path. This allows code users to trade off the performance of individual systems that are then offset by performance gains in another. The total energy consumption of the proposed building must be less than or equal to that of the reference building.

New tiered energy compliance:
This path uses four tiers that compare the intended design to the modelled reference building. The modelled performance of a Tier 1 compliant building will consume no more than 100 per cent of the building energy target. Tiers 2, 3 and 4 cannot exceed 75, 50, and 40 per cent, respectively.

NECB 2020 explained

As in past iterations, NECB 2020 continues to use the reference approach to demonstrate code compliance. The reference approach uses two different modelled buildings.

A model building created according to the minimum code compliance requirements of the prescriptive path. It is used to reference a hypothetical building energy use target.

A proposed building designed and modelled as it is intended to be built, complete with all intended energy conservation measures required to meet a specific performance target.

Tier 4 ≤ 40%

Tier 3 ≤ 50%

Tier 2 ≤ 75%

Tier 1 100% Building Energy Target

NBC 2020 explained

NBC 2020 does not include requirements for the regulation of energy associated with appliances such as refrigerators, ovens and dryers. It also excludes lighting, or electrical power systems such as transformers and motors connected to the building's electrical service. Instead, NBC 2020 includes requirements for regulated energy uses including space heating, space cooling, ventilation, lighting, service water heating, motors, and a few other end-uses.

NBC 2020 introduces six changes in several areas that introduce or refine procedures for HVAC and service water heating, and that makes changes to modelling parameters. To reduce confusion and duplication for code users, NBC 2020 now references the EnerGuide Rating System (ERS).

Title	Description	Intended Outcome
HVAC equipment performance requirements	These update the HVAC equipment and service water heating equipment performance requirements.	By aligning subsection 9.36.3 with current and anticipated standards for the performance of HVAC and service water heating equipment, this change will help reduce confusion and inconsistency in the marketplace.
References the EnerGuide Rating System	This would introduce the EnerGuide Rating System as an alternative compliance path to Subsection 9.36.5.	By referencing ERS directly in subsection 9.36.5., confusion and duplication over the voluntary use of ERS will be minimized. This change is expected to encourage more builders to use ERS for code compliance.
Alignment of subsection 9.36.5. with EnerGuide Rating System	This would revise certain provisions in Subsection 9.36.5. to align them with the EnerGuide Rating System.	Code compliance with subsection 9.36.5 can now be demonstrated using the same modelling tools and techniques as those used for voluntary programs. This change helps to reduce confusion and duplication in the market.

NBC 2020 explained

Title	Description	Intended Outcome
Airtightness measurement	This introduces requirements on the voluntary measurement of airtightness in buildings for the purpose of applying the provisions of subsection 9.36.5., new Subsection 9.36.6, and new Article 9.36.6.8.	Airtightness testing reduces energy loss through the building's walls, windows, and doors. As a result, energy losses and the infiltration of moist air into the building cavity that can harm the durability and health of the building are minimized. CAN/CGSB-149.10-2019 is referenced and a translation between different metrics used to determine the airtightness of the building envelope is provided. Ensuring airtightness in attached buildings can be a challenge because of air leakage through the shared 'party wall.' This change increases the default air leakage rate for attached dwelling units from 2.5ACH to 3.0 ACH, when tested.
Prescriptive solutions for energy tier compliance	These introduce prescriptive requirements for compliance with the new energy prescriptive performance improvement tiers.	Prescriptive requirements for the upper tiers were not developed in the 2015-2020 code cycle. Values for Tiers 3, 4, and 5 are 'reserved' and are expected to be developed in the next code cycle. These values will be associated with specific energy conservation measures required to achieve compliance with upper tiers.
Tiered performance requirements	This/these introduces/s energy performance tiers for Part 9 residential buildings and provides associated compliance calculations.	Tier 1 requirements are similar to section 9.36. of the NBC 2015 while Tiers 2 through 5 approximate the energy savings targets of ENERGY STAR, R2000, the Candaian Homebuilders Association's (CHBA) Net Zero Energy Ready standard, and the Passive House program.

NBC 2020 includes a proposed peak cooling load that cannot exceed reference home peak cooling load. This will help manage solar gains in the heating season, but also control overheating during the warmer season.

It also recognizes the benefits of smaller homes, and the challenge smaller homes have in meeting the energy performance requirements of the upper tiers. It provides additional credits for smaller homes (less than 300 m^3) including a 10 per cent energy credit as well as lower envelope requirements.

NBC 2020 explained

Under NBC 2020, there are five ways a building can demonstrate compliance: prescriptive, prescriptive trade-off, performance, and the newly added tiered performance and tiered prescriptive compliance paths.

NBC 2020 introduces tiered energy requirements that provide energy efficiency targets at each of the five tiers. They are approximate to the performance level of voluntary energy programs: ENERGY STAR (Tier 3), R-2000 (Tier 4) and the CHBA's Net-zero Energy Ready program (Tier 5). New construction built to passive house standards also meets or exceeds Tier 5 requirements.

To better ensure an envelope-first approach, NBC 2020 includes a second set of requirements for envelope performance and minimum airtightness. The performance requirement calls for envelope improvements of 0, 5, 10, 20, and 40 percent, for Tiers 1 through 5 respectively, of the equivalent prescriptively built house.

Envelope performance requires a model of the proposed house with the same space heating, cooling, ventilation and service water heating as the reference house. This allows the energy model to eliminate all non-envelope efficiency measures resulting in relatively simple envelope energy savings calculation.

What's not in the model codes

The 2020 model codes are an important first step towards the market transformation of the building sector. They represent 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.

Nonetheless, a number of leading measures and practices that are highly effective in raising building energy performance measures are absent from the 2020 model codes. Provinces, territories, and municipalities may choose to make amendments to introduce these measures into their jurisdiction's building codes

Below, we outline four areas for those jurisdictions to consider.

Mandatory airtightness testing

Reducing heating and cooling loads are key to the design and construction of net-zero energy ready buildings. The building envelope must be as airtight as possible, while taking in fresh air and expelling stale air through controlled ventilation. The only way to quantitatively ensure this is an airtightness test. It measures where, and how much, air is leaking into or out of a building.

It is often called a 'blower door test' because it uses a large fan or 'blower' to extract air from, or supply air into, the building.

Airtightness testing is an important step towards creating safe and healthy high-performance buildings such as those in the upper tiers of Canada's net-zero energy ready standard model codes. This is why airtightness testing was specified as a mandatory measure in most compliance paths when the 2020 model codes were sent for public review.

However, the Canadian Commission on Building and Fire Codes' (CCBFC) executive committee, at the behest of some provinces and territories, directed its technical committee of industry experts to make this a voluntary measure within NBC 2020. This directive came after the proposed changes had been released for public comments in which the public widely supported the proposed change that included mandatory airtightness testing.

Airtightness testing is a pillar of government programs such as NRCan's EnerGuide Rating System (ERS) and R-2000, as well as voluntary programs like Passive House. Moreover, leading codes and certifications including the BC Energy Step Code, the Toronto Green Standard, and the EnergyStar standard all include mandatory airtightness testing.

While NBC 2020 provides guidance for voluntary airtightness testing, including improved testing procedures, provinces, territories and municipalities can go a step further and make amendments to re-introduce this crucial energy conservation measure.

Absolute performance approach

Canada's 2020 model codes currently use the "reference building approach" to assess the energy performance of buildings and demonstrate code compliance. The reference building approach, often expressed as a "percent better than," uses a proposed building and theoretical reference building to demonstrate that building designs achieve a set percentage improvement in energy performance over the baseline reference building's performance. Because this approach uses a modelled energy use metric and does not predict a proposed building's actual energy use it is often criticized as contributing to the building performance gap — the difference between anticipated and actual performance of a building. This building performance gap produces buildings that consume far more energy than a building designed to a performance-based target or approach.

Alternatives to the reference approach are the performance-based approach or the use of absolute energy metrics. This approach sets a consistent target on absolute energy use and/or emissions for different types of buildings. This approach is based on the energy consumed in a building per unit of floor area expressed over time, frequently expressed in terms of the building's thermal energy demand intensity (TEDI) and/or energy use intensity (EUI).

TEDI calculates the annual heat loss from a building's envelope and ventilation, after accounting for all passive heat gains and losses. TEDI is formulated as the summation of space and ventilation heating output divided by modeled floor area. TEDI is reported in kWh/m2/year. Targeting a lower TEDI encourages passive solutions like good insulation, air tightness, and building orientation to reduce energy use directly.

EUI looks at total energy use, including factors such as plug loads. EUI is expressed as the energy per square area per year and reported in kWh/m²/year. Unlike the BC Energy Step Code and the Toronto Green Standard, the NECB will not be using absolute energy use intensity, nor does it require a specific envelope performance.

TEDI and EUI drive an outcomes-based approach that is more likely to encourage builders and designers to put a greater emphasis on whole building efficiency. This approach incentivizes passive energy measures such as window type and placement for daylighting, thermal mass, and solar gains, and more simple

shapes and forms. In this way, TEDI and EUI encourage the construction of new buildings better suited for adaptation to climate fluctuations and more likely to mitigate emissions

While the 2020 model codes establish a reference building approach as a compliance path for houses and small buildings (Part 9) and large buildings (Part 3), the CCBFC is exploring the use of absolute energy metrics for use as a code compliance tool in future iterations of the model codes.

Greenhouse gas emissions requirements

Municipalities across Canada are striving to cut emissions in the buildings sector, and the building code is a well-suited tool by which to do so. However, emissions are not an explicit objective of the 2020 model codes. In the early 2000s, Canada adopted an 'objective-based' code system. This system ties the requirements of the model code to five objectives: safety, health, accessibility for persons with disabilities, fire and structural protection of buildings, and the environment. The model code's requirements can be considered the minimum acceptable measures required to adequately achieve these five objectives.

Environment is the key objective Meant to limit the impact of new construction on the environment, including excessive energy and resource use, this objective does not consider emissions related to building operations or materials used in a building's construction.

This means that even at the most stringent tiers emissions from building operations, those typically generated by space conditioning and hot water heating, or the carbon embodied in construction materials, cannot be tackled directly through the 2020 model codes. This gap is noted by advocates and sub-national governments alike.

A shift is underway. This past spring, the CCBFC cleared the path for the model codes to directly address emissions, and thus better support Canada's Net Zero by 2050 goals, through the addition of a "climate change mitigation" policy task force for the 2020-2025 code cycle. Building on this measure, efforts to introduce a new objective to address excessive emission of GHGs (operational and embodied emissions) resulting from the design or construction of buildings are underway.

These changes are necessary to develop code requirements that incentivize the installation and use of zero-emissions heating and hot water equipment in future iterations of the model codes. In the meantime, however, several Canadian jurisdictions, including Vancouver and the province of Quebec, now require all new and replacement heating and hot water building systems to be zero emission.

As most embodied emissions occur in the construction phase, incentivizing improved practices around embodied emissions management can be achieved through measures such as lifecycle carbon reporting for new buildings, low-carbon design requirements. A number of municipalities are exploring ways to encourage low-carbon construction through expedited permitting or density bonusing for low-carbon projects.

An early example is the City of Vancouver's Green Building Policy, one of the first embodied emissions policies in North America, which will require new construction projects to report embodied emissions associated with construction via a life cycle assessment (LCA).

Electric vehicle and renewable energy requirements

Electric vehicle (EV) ready and renewable energy ready requirements in building codes are one of the most effective and low-cost strategies governments can use to encourage the transition to EVs and local, low-carbon on-site energy generation.

At their most basic, EV and renewable energy ready requirements in building codes can include provisions that ensure the electrical capacity and pre-wiring for future installation is in place at the time of construction. Minor changes at the time of construction can dramatically reduce the cost for future building owners to install EV charging equipment and renewable energy sources.

Renewable energy readiness should be seen as core elements of a NZER code, given that the addition of on-site renewables is the last step to achieving net zero.

In 2021, the International Code Council issued a new framework to support local governments with building code guidelines to help them reach their carbon emissions goals. However, there is not a similar requirement to prepare newly constructed buildings to be EV or renewable energy ready in the 2020 model codes. Similar to requirements governing emissions from buildings, this is because there is no applicable objective that can be tied to requirements for either of these technologies.

Effective compliance enforcement

The federal government is tasked with creating the model codes. This set of standards become a jurisdiction's building code once established by law in a given province, territory, or municipality. Compliance with the building code is enforced by the city or municipality, known as the AHJ. AHJs are responsible for enforcing the safety, accessibility, and other objectives of code for new buildings.[6]

As agents of the AHJ, building officials are responsible for ensuring compliance with the relevant building and energy codes and that the as-built building is constructed in accordance with the issued permit.

Each year, Efficiency Canada reviews how provinces and territories are contributing to AHJ compliance activities, including:

- Code training and technical assistance for building officials and/or the design and building community;
- Involvement of utilities in promoting compliance;
- Creation of tools such as energy models to promote compliance, and/or;
- The presence of a stakeholder group or collaborative prioritizing code compliance.

Compliance varies widely by AHJs, and is a challenge across all municipalities. A 2015 informal survey of building officials and professionals conducted by BC Hydro and the province found that energy code compliance reached an estimated 60 per cent.[7]

[6] Andrew Pride, Tiered Code Energy Compliance

[7] Ibid – see 10
climatechange/pan-canadian-framework/climate-change-plan.html
from: https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html

Efficiency Canada: 2021 Provincial Energy Efficiency Scorecard Compliance Rating

Province	Compliance study in last 5 years (1 point)	Dedicated resources (1 point)	Other activities (1 point total, 0.25 points each)				Score (3 points)
			Code training & technical assistance	Utility involvement	Compliance tools	Stakeholder group or compliance collaborative	
BC	✓	-	✓	✓	✓	✓	2
MB	-	-	-	✓	✓	-	0.5
NB	-	-	✓	✓	-	-	0.5
NL	-	-	-	-	✓	✓	0.5
ON	-	-	-	-	✓	✓	0.5
QC	-	-	✓	-	✓	-	0.5
SK	-	-	✓	-	✓	-	0.5
NS	-	-	-	-	-	✓	0.25
PE	-	-	✓	-	-	-	0.25
AB	-	-	-	-	-	-	0

Building energy codes only work if builders comply with them, and building officials enforce them. The energy efficiency provisions of building codes can be neglected, as compliance with fire and plumbing regulations tend to present more immediate concerns. But, without higher levels of compliance, it will be challenging for municipalities to achieve their energy savings and GHG reduction goals. Building owners would also face significant long-term costs and lower-performing buildings, thereby de-valuing the effect of stringent building codes in the eyes of builders and policymakers.

Engage early and often

The most effective way to increase support for greater compliance among all stakeholders in the buildings sector is early outreach and education. An early awareness of compliance requirements can bridge the gap between policy priorities and energy code compliance. It also builds needed human resource capacity for building officials and energy practitioners alike. An added benefit of early stakeholder engagement is increased consistency in the permit submission processes, code interpretations, and compliance reporting. Lack of clarity and consistency is an oft-cited source of frustrations on the part of many stakeholders.

Reduce barriers related to energy modelling

Municipalities can up-skill their building officials and ensure that those entering the field understand the required energy modelling techniques and conduct adequate quality assurance on energy modelling files submitted (see sidebar).

For their part, utilities can be leveraged to build capacity among building officials and developers to provide energy modelling coaching. This approach has been used by BC Hydro to support Building Energy Managers (BEM) for AHJs, and in Ontario through the Independent Electricity System Operator's SaveOnEnergy™ Roving Energy Managers program. Each of these programs deliver a higher degree of confidence and consistency in the permit review process while encouraging higher performance and compliance.

Reducing the burden on building officials

The City of Toronto leverages existing staff resources to conduct energy modelling reviews.

To confirm compliance with energy requirements of the Toronto Green Standard, the City's environment and evergy divison reviews energy models during the planning approvals and pre-building permit stages. It also conducts mechanical equipment inspections, verification of third-party commissioning, and airtightness test (for large buildings).

Leverage voluntary programs

Resources dedicated to building code compliance enforcement can be reduced by ensuring that NZER codes align with existing certification programs in the market. Given the reliance on NRCan's EnerGuide Rating System (ERS), which includes mandatory review of energy models by NRCan, can help reduce the burden of energy code compliance on building officials and take advantage of expertise in energy efficiency programs already in the market. If existing voluntary programs are referenced or aligned with the technical requirements in NZER codes, the certification process can be leveraged to support enforcement capacity.

Conduct a compliance study

Even in the absence of upper-tier adoption by the provinces, effective compliance enforcement can immediately raise the level of energy performance in new buildings, leading to swift reductions in energy waste and emissions.

Municipalities can use a code compliance study to set a baseline in both residential and commercial buildings. They can also identify opportunities for increasing compliance and reveal gaps in code knowledge and implementation that can be addressed through training and education. Code compliance studies help identify trends in code enforcement and highlight common areas of noncompliance. Municipalities can use these studies to target workforce training to improve energy code compliance across the sector in both the short and long term. Past efforts in the US set a target to achieve a 90% compliance rate, as a policy objective.

How municipalities can support adoption of the 2020 model codes

Bold action is required to achieve the energy and emissions reductions laid out in Canada's climate plan. Municipalities are ideally suited to drive these reductions by successfully implementing and enforcing the 2020 model codes.

Municipalities can leverage local knowledge and expertise in building code implementation to deliver and enforce the upper tiers of the 2020 model codes. They are well positioned to serve as living laboratories for energy efficiency, emissions reductions, and climate change resilience innovation. By taking advantage of their smaller scale, municipalities can build on lessons learned from the implementation of higher building performance standards and inform implementation of the upper tiers in larger jurisdictions, while increasing capacity of the wider market more quickly and effectively.

Given the vast range of size and capacity within Canada's municipalities, the tiered codes represent an opportunity to let our municipal leaders drive the success of the 2020 model codes.

To do so, municipal leaders can:

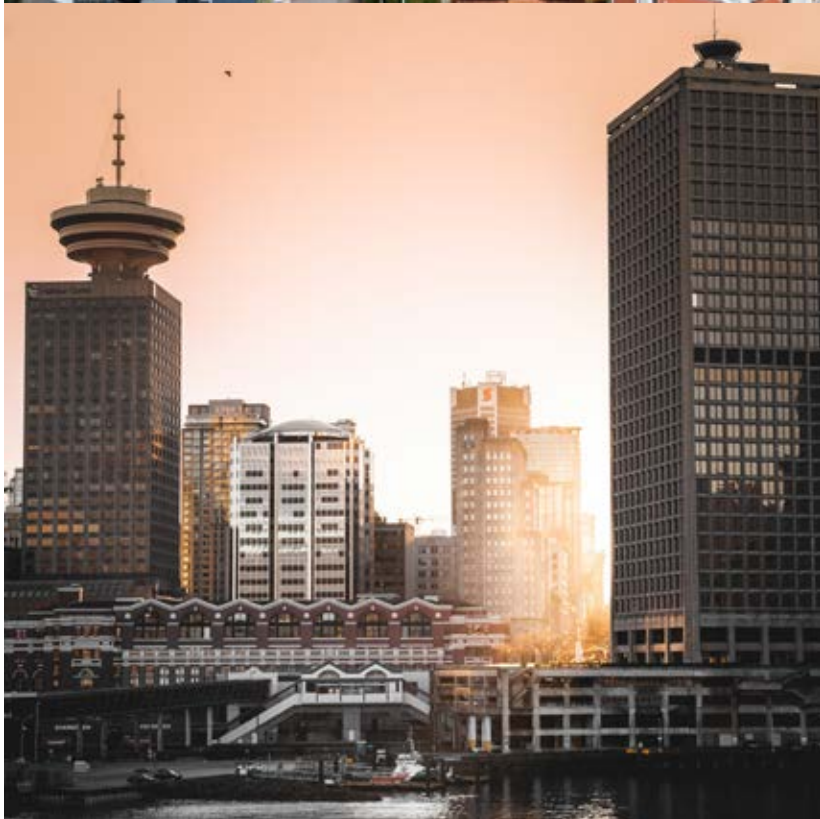
Support provincial or territorial adoption of higher tiers of the code

In some provinces and territories, adoption of the lower tiers may be a continuation of the status quo, or may weaken the stringency of existing provincial or territorial building codes. However, Canada's plan to meet its emissions reduction targets, grow the economy, and build resilience to a changing climate includes the adoption of NZER building codes by 2030, or sooner. This means provinces and territories must adopt an ambitious tier that sets a path for adoption of the upper tiers over the coming eight years. Ambition today means that provinces and territories will better prepare their markets and help businesses and consumers avoid a rushed and costly implementation of NZER in 2030.

Municipalities can support an ambitious adoption plan and demonstrate their commitment to excellence by highlighting the strength of existing municipal building standards and, through market readiness and building code compliance studies, demonstrate the capacity of their local markets to deliver high-performance buildings required in the upper tiers of the 2020 model codes.

Seek municipal autonomy to adopt a building code tier above the provincial floor

Only select provinces and territories permit their municipalities to implement local building codes, or different tiers of the 2020 model codes. Municipalities have a distinct advantage in building code adoption and implementation as their smaller geographic jurisdiction, and responsibility for land use and code enforcement activities, make it possible for them to pilot implementation of the upper tiers of the NZER code that may not be viable across an entire province or territory.



Where appropriate, seek amendments in the adoption process

Provinces and territories can use the adoption process to make amendments to the 2020 model codes that reintroduce mandatory air tightness testing or introduce zero-carbon heating and hot water requirements, such as those implemented in Vancouver. Potential amendments also include 'electric-ready' initiatives that will require new homes to install outlets for electric heating and appliances, even if gas equipment is being installed, as well as electric vehicle charging or electric vehicle readiness requirements.

Leverage federal support

Direct access to federal supports such as the *Net Zero Building Code Acceleration Fund* will enable municipalities to play an important role accelerating adoption of the upper tiers of the 2020 model codes and adequately enforcing building code compliance. Leading jurisdictions have demonstrated that long-term and consistent supports serve to de-risk adoption of the upper tiers of the model codes, verify that each building is achieving the energy and emissions reductions desired, and smooth the building sector's transition to its net-zero future.

Potential activities considered under this fund may include access to funding, support, and tools that support market readiness and training. For example, workshops and training help address industry concerns around costing and technical feasibility directly and proactively, while building capacity in the buildings sector. Activities that engage stakeholders early in the delivery of the tiered code adoption and implementation process will foster informed networks of builders, analysts, contractors, and officials and, as a consequence, accelerate adoption of the upper tiers.

Municipalities may also be able to access resources that help manage the increased complexity of tiered energy code compliance, such as building field guides, compliance checklists. In addition to furthering local government efforts to streamline the permit and inspection processes, these resources can help develop internal capacity for regulating NZER construction, particularly for municipal building officials and staff.

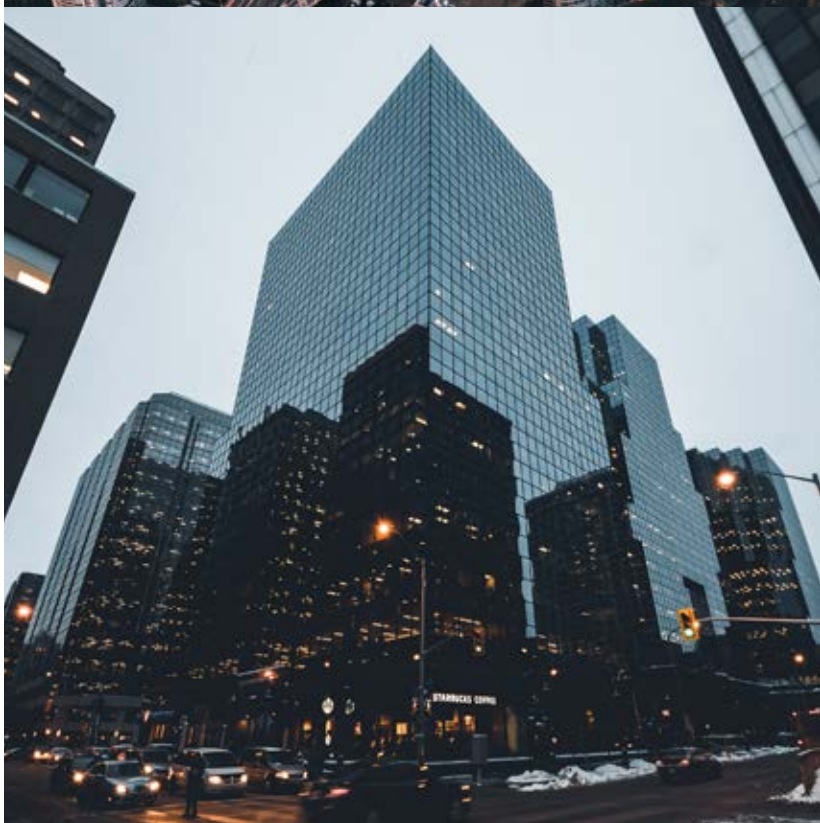
Remove barriers, no matter how minor

Local government land use policies may also require adjustments to support the implementation of the 2020 model codes, particularly at the upper tiers. Potential barriers in zoning and land-use policies, such as setback requirements for example, may limit the construction of highly insulated buildings with thicker wall cavities.

Barriers that limit innovation in building form or construction processes, such as restrictive design guidelines or heritage restrictions, may discourage the community from demonstrating their ability to construct buildings of all NZER archetypes.

Build awareness of the standard

Drawing on the success of the BC Energy Step Code, municipal governments can develop plain-language descriptions of the 2020 model code requirements, and provide stakeholders with clear, consistent, and accurate information. These can include explanations, presentation templates, and diagrams that champions can use to explain the code to time-pressed industry and government decision makers. A good example is the technical 'explainer' materials used in the BC Energy Step Code to drive uptake by builders and local governments.



Align Green Development Standards with the model codes

Green development standards can be implemented as mandatory requirements (where allowed), optional standards, or a combination of both. Through the use of GDS, municipalities can support the market's acceleration towards the upper tiers of the 2020 model codes.

Aligning GDS requirements or incentives with the upper tiers encourages projects that demonstrate the feasibility of high-performance buildings while capturing community benefits such as good local jobs and healthy, comfortable, and resilient buildings for all.

Through their GDS, municipalities can also act as catalysts in their province or territory, and demonstrate the feasibility of measures not yet considered in the 2020 model codes such as requirements for the use of low-carbon building materials or electric vehicle charging/readiness requirements for new construction.

Build capacity

In 2016, the CCBFC identified the need to provide clear and coordinated communication about NZER code requirements. This means a coordinated strategy that links codes, education, incentives, and enforcement.

In the development of the BC Energy Step Code, stakeholders involved in the process identified a need for the building code to provide long-term certainty to the market. Mapping out the transition from current codes to NZER provides specific direction to all aspects of the industry, highlighting areas of capacity building and innovation that may be necessary.

Capacity concerns are different for each segment of the sector.

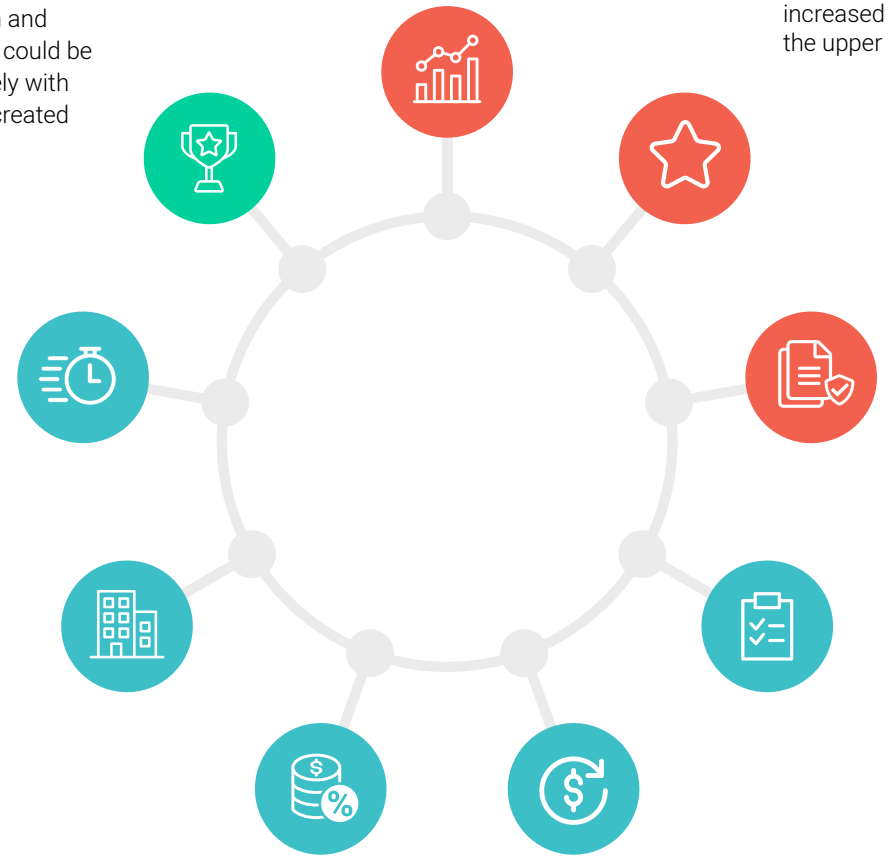
Stakeholder group	Constrains	Solutions
Industry	Limited capacity for the design, construction, and enforcement of NZER buildings There is a need for better understanding of NZER standards by building envelope, HVAC trades.	Industry requires a systems understanding of how their work impacts the energy efficiency of a building. Consult with local builder communities and develop programming and educational materials that help industry understand incoming requirements. In return, survey industry stakeholders to identify barriers and solutions to the implementation of NZER standards.
Building officials	Additional knowledge and skills needed to implement and inspect NZER/energy specific code requirements.	NZER-specific coursework based on industry needs — such as the Energy Foundations program offered by the Building Officials Association of British Columbia — can help raise the energy code literacy in local governments. Align code requirements with existing certification programs in the market. Offer third party oversight to support building officials rather than adding to workload.
Energy Advisors/ Building Energy Managers	Considering the limited capacity in some municipalities, there is a need for energy code training and testing.	Consider targeted stakeholder training on tiered energy codes. Build capacity via programs, such as BC Hydro's Building Energy Manager Program which provides roving energy managers between building portfolios and jurisdictions.
Utilities	Market transformation changes like building codes can be neglected in demand-side management strategies focused on measurable energy savings through incentives.	Make code adoption activities and code compliance a specific objective in utility demand side management plans. Building code adoption can be part of integrated resource plans, and utilities can help develop baselines, assess energy savings, and align energy efficiency programs with the tiers of the codes. For instance, in BC utilities must spend at least 1 per cent of budget on codes and standards.
Architects and engineers	Continuous education to overcome system-level issues related to constructability, impact of design decisions, and the coordination of trades may be required.	There may be need for ongoing and targeted training as part of accreditation systems.

Leverage existing powers to encourage upper-tier activity

Use Site Plan Control Policies
to set performance targets. Align incentives with tiers of the 2020 model codes.

Establish a recognition and awards program
to promote NZER construction and provide a platform for community recognition and appreciation. This type of recognition could be done at the local level or collaboratively with nearby municipalities that have also created green building standards.

Use non-financial incentives
to speed the processing of permits or allow increased floor area for projects that meet the upper tiers of the 2020 model codes.



Offer expedited development applications
to incentivise NZER standards. To ensure the system can process applications and that applications meet all requirements ensure additional staff resources are available to process development applications.

Use zoning and development by-laws and related planning policies
to encourage construction at the upper tiers to offer relaxations of frontage requirements or site coverage, and/or increases in floor area/density.

Offer a density bonus
in exchange for building to the upper tiers of the 2020 model codes. Municipalities can authorize increases to the height and density of developments in return for the provision of facilities or services that create community benefits.

Offer free and/or convenient building energy performance services
— such as energy modelling verification or compliance checklists — that boost the technical feasibility of building to the upper tiers.

Offer tax breaks or cash rebate
to help offset the increased costs of upper-tier construction. Encourage innovative construction processes by offering grants or loans within community improvement plan project areas.

Offer a development charge refund
to encourage voluntary uptake of the upper tiers.