# What Municipalities Need to Know about Canada's Net-Zero Emissions Building Codes

Efficiency Canada

Carleton University

low carbon cities canada

Canada has committed to develop a net-zero emissions building code by 2025. Introducing this code will require significant policy change. This guide is intended to help municipalities anticipate, prepare for, and use the development of a net-zero emissions building code as a lever to accelerate climate action in their communities.

In this guide, you'll learn about the stages, expected timeline, and key considerations for the development of a net-zero emissions code. We'll examine what net-zero emissions means for newly constructed buildings, including sources and reduction strategies of operational and embodied emissions.

While the net-zero emissions code is a welcome addition to Canada's suite of model codes, this guide highlights the need for municipalities to take immediate action related to building decarbonization. In the final section of this guide, we outline supports that will help municipalities make the transition to low carbon buildings, and immediate steps they can take to cut operational and embodied emissions in new construction.

Climate activists, building code practitioners, and municipal staff are encouraged to share sections of this guide with decision-makers, particularly municipal officials, to help inform buildings sector policy and practices and accelerate Canada's net-zero future.

[1] Government of Canada, Canada's 2030 Emissions Reduction Plan. Accessed Nov. 8, 2022. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030/plan/chapter-1.html

# How to Navigate This Guide

# Thanks

This report was funded by the LC3 network. We would like to thank the LC3 network's advisory group and other building practitioners and policymakers who provided insights and perspectives on what Canadian municipalities need to know to ensure it is best tailored to municipal needs and they are better prepared for the net-zero emissions building code—which is expected to be available by 2025.

## About Low Carbon Cities Canada (LC3)

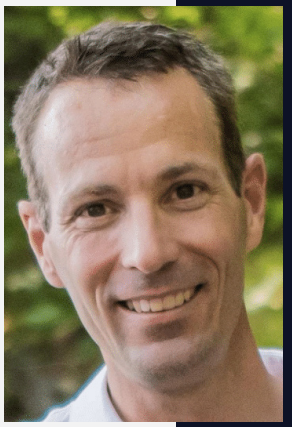
Low Carbon Cities Canada (LC3) supports cities in reaching their carbon emissions reduction potential. LC3 is a collaboration among seven local Centres in Canada's largest urban areas and the Federation of Canadian Municipalities (FCM).

LC3 helps demonstrate, de-risk and scale up local solutions to climate change, while embedding equity principles to ensure members of all communities receive access to resources and skills. LC3 was established thanks to an endowment from the Government of Canada.

## 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.





## About the author

Kevin Lockhart is Efficiency Canada's research manager. He has a master of sustainable energy policy and a bachelor of arts in political science from Carleton University. He also completed and instructed in the Advanced Housing: Construction Carpentry program at Algonquin College. Kevin has contributed several publications to the sector, including Strengthening Canada's Building Code Process to Achieve Net Zero Emissions and Codes4Climate, Canada's first online resource connecting building codes as a tool for climate action.

# Why We Need to Rapidly Cut Emissions from Canada's Buildings Sector

The places we live, work, play, and gather in account for 13 per cent[2] of Canada's GHG emissions. This rises to 18 per cent when considering electricity used for cooling, lighting, and appliance usage, and even higher when considering the upstream impact associated with the manufacturing of building materials or fossil fuel-intensive construction processes.

The buildings sector also accounts for a large proportion of local emissions, often reaching upwards of half of a municipality's overall emissions. This places the buildings sector at the centre of municipal climate action, and a core action area in response to **climate emergency declarations**.

New buildings constructed today will last for half a century or more. By directly addressing emissions in new buildings, municipalities can lock in immediate and long-term emission reductions, and accelerate further reductions in other areas such as the electrification of existing buildings and transportation. Along the way, municipalities can catalyze further reductions in upstream emissions, in particular those arising from electricity generation or those within building materials or construction processes.

In the past, the core strategy used to address emissions from new construction in the Canadian buildings sector has been via a narrow definition of energy efficiency that did not consider things like the fuel used to heat buildings or the implications of upstream material use choices. However, achieving our decarbonization goals requires a suite of tools, including building codes and complementary energy efficiency standards that serve to rapidly cut emissions from the buildings sector.

Canada's national model codes represent one of the most effective policy instruments to accelerate our transition to zero-carbon buildings. Few instruments in the federal government's current climate toolbox are as effective in transforming the market for buildings that are net-zero energy or net-zero emissions as the building codes can be.

[2] Natural Resources Canada (2019), Comprehensive Energy Use Database; Natural Resources Canada (2014) Survey of Commercial and Institutional Energy Use Database

# Municipalities Need Tools to Drive Emission Reductions

Municipalities need tools and supports that help them fulfill their role in the decarbonization of the buildings sector, starting with the construction of new buildings. The primary tool to regulate the construction of new buildings are building codes. When it comes to new construction, building codes offer a one-time opportunity in the buildings life cycle to lock in the high levels of energy and emissions performance in buildings in a cost-effective way, and in ways that would be cost-prohibitive in future retrofits. For example, a robust and highly insulated building envelope assembled with low-carbon materials that serves to reduce thermal energy losses, and enable the use of low-carbon heating and hot water systems. These same measures also enhance the climate-resilience of the building and reduce potential risks to occupants in the event of extreme weather.

Since their introduction to the Canadian market in the 1940s, building codes have helped raise the minimum performance of Canadian buildings in terms of safety, health, durability, accessibility and, more recently, energy efficiency. Applying this same approach to reducing GHG emissions from buildings is an important step in the market transformation of the buildings sector.

Building codes are highly effective in establishing clear market signals to industry, manufacturers, and consumers. By setting and defining long-term and durable net-zero emissions standards, building codes deliver the certainty market actors need to direct investments in low-carbon technologies, processes, and infrastructure to meet the demands of the buildings sector. They also set a market floor for standards of new construction that ensures each new building constructed in Canada will contribute to our net-zero goals and long-term resilience.

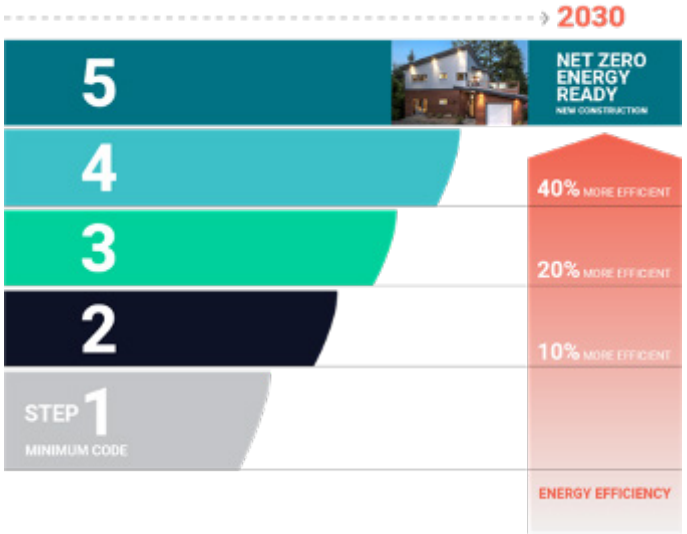
Recognizing this, the federal government's **mandate letters**, published in 2021, called for "a net-zero emissions building code … by the end of 2024 that align(s) with national climate objectives and provide(s) a standard for climate-resilient buildings."

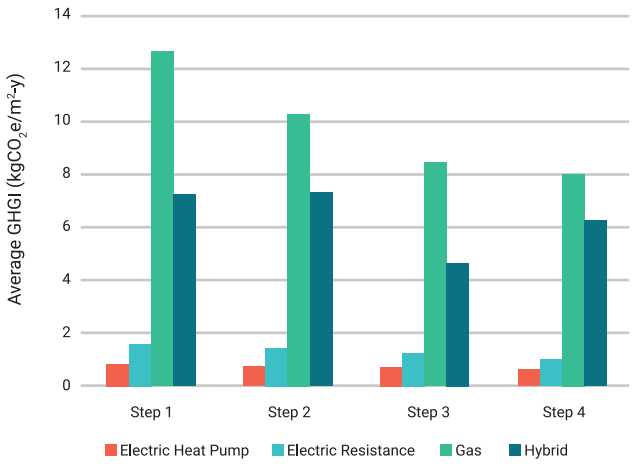
# Tiered Codes Alone Can't Drive Emission Reductions

The most recently published national model codes are the 2020 model codes. Through a tiered energy performance approach, the energy performance required is ratcheted up at each tier (see image to right). The top tier of the 2020 model codes is the net-zero energy ready (NZER) standard, a building so energy efficient that it can easily produce as much energy as it consumes annually once a renewable energy source (e.g., 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.

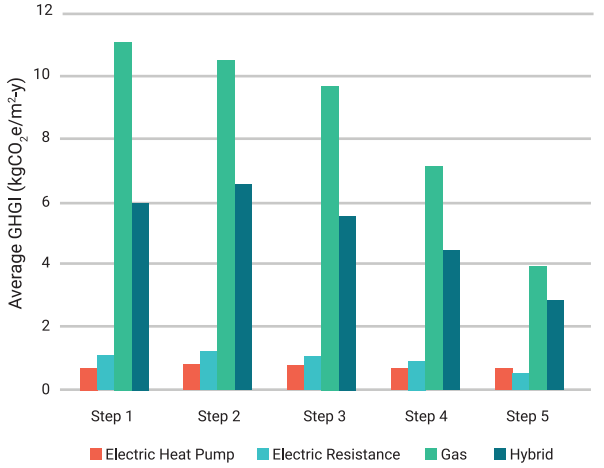
Each energy performance tier establishes an overall energy performance improvement target and, by proxy, reductions in the building's emissions. However, as the implementation of the BC Energy Step Code has shown, energy efficient tiered codes alone cannot guarantee reductions in a building's operational or embodied emissions. The figures below show that buildings using electricity instead of fossil fuel heating systems create significantly lower emissions in newly constructed buildings, regardless of the energy performance tier selected. Cutting emissions in building operations and materials begins with energy efficiency but demands a direct approach.

Canada's 2020 net-zero energy ready building code




Part 3: GHG Intensity by Mechanical System (average across all archetypes)




Part 9: GHG Intensity by Mechanical System (average across all archetypes)

Adapted from the 2022 Industry Survey: BC Energy Step Code, March, 2022

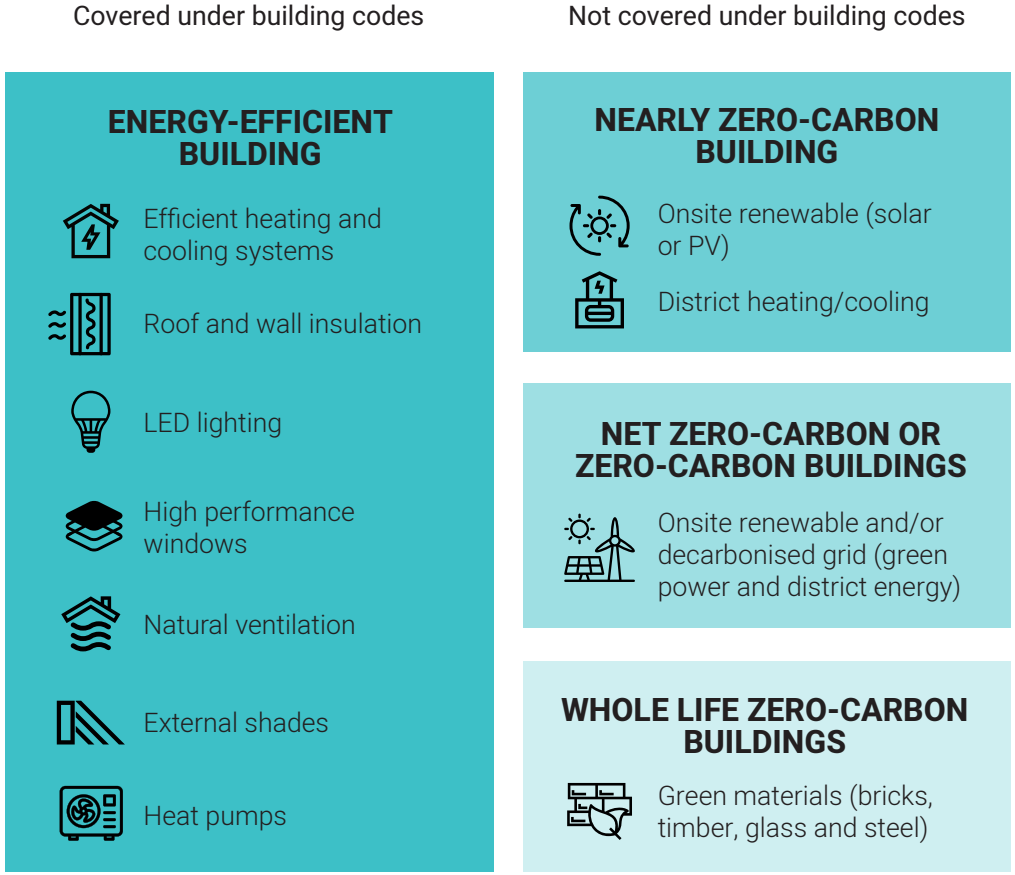
# Tiered Codes Alone Can't Drive Emission Reductions

**What is currently covered under building codes?**

Canada's 'objective-based' code 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 environmental impact. The model codes' requirements can be considered as the minimum acceptable measures required to adequately achieve these five objectives.

These requirements also define the limits of the building code. As the image on the right illustrates, many of the products, processes, and technologies with the potential to place Canadian buildings on a path to net-zero emissions (those to the right of the image) fall beyond the reach of Canada's national model building codes. This includes highly efficient appliances and equipment, renewable energy and/or district energy, and a full accounting of the entire life cycles of both operational and embodied emissions.

In addition to highlighting the need for an objective focused on emissions within the building code, these areas point to the need for stringent **efficiency standards for appliances and equipment**, and additional actions to accelerate **clean electricity generation**, and promote alternative systems for **clean heat**.




The building code is limited in fully tackling emissions

# Changes to Address Emissions Through Building Codes Are Underway

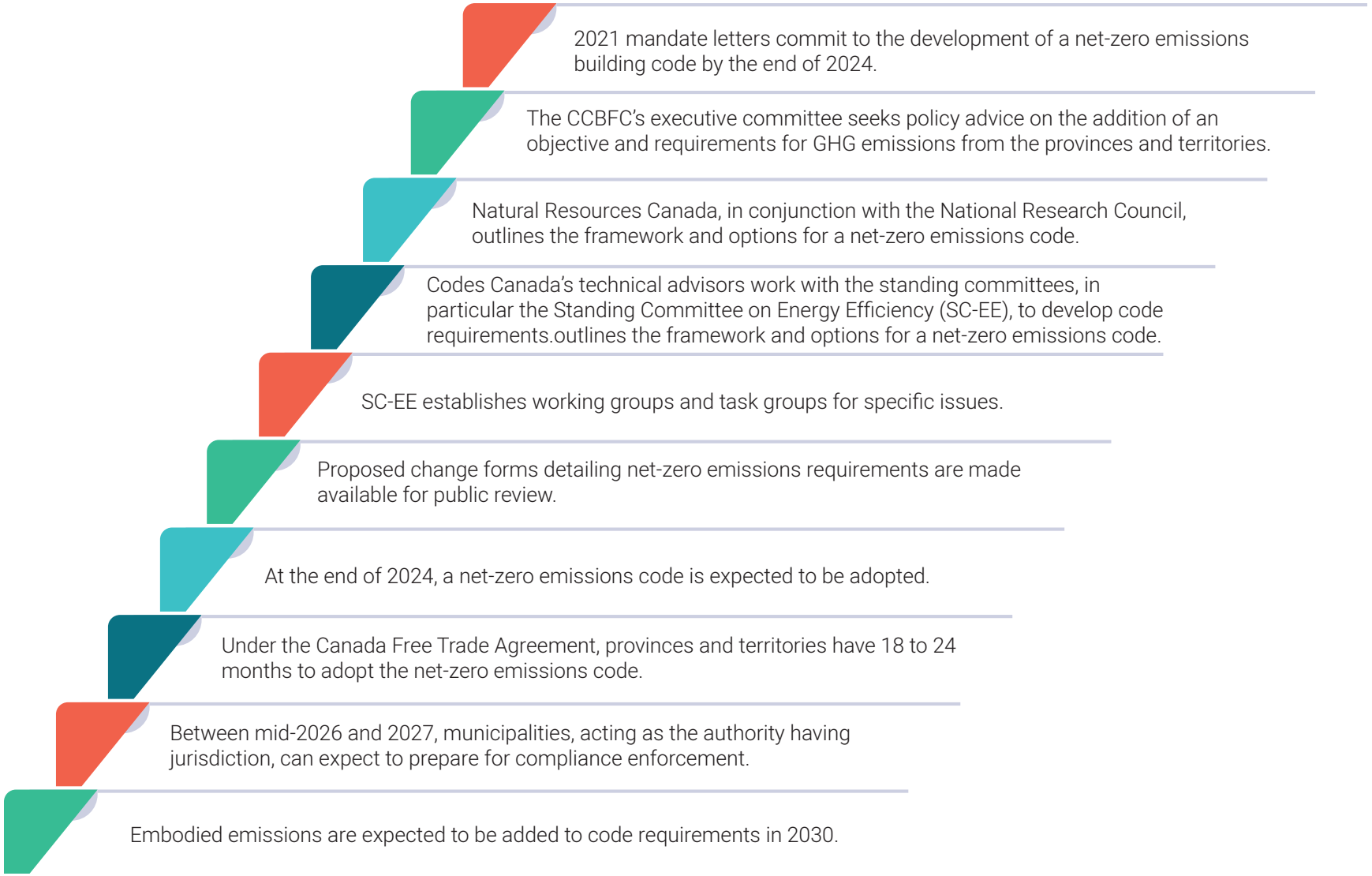
Guided by the 2021 federal mandate letters committing to develop a net-zero emissions building code by 2025, this past spring saw the Canada Commission on Building and Fire Codes (CCBFC), now the **Canadian Board for Harmonized Construction Codes (CBHCC)**, approve the policy and technical work needed to directly address emissions and thus better support Canada's **Net-Zero Emissions by 2050** objective. And building on this measure, Natural Resources Canada and National Research Council Canada recently moved forward a code change request (CCR) to add a new objective to the building code. The intent of the objective is to limit the probability of unacceptable risk related to GHG emissions resulting from the design or construction of buildings.

CCRs are submitted by individuals or organizations seeking a specific change in building code requirements, adding an objective to address emissions, for example. They are an important first step in adding new requirements to the national model codes. CCRs trigger a process in which each request is reviewed and evaluated by Codes Canada, which then advises code committees on the CCRs' potential impacts. Critically, CCRs can also trigger technical studies, committee papers, as well as discussion that helps inform policy and technical considerations.

The addition of this objective would be critical, as the code's objectives provide information for code-users to achieve compliance with each of the code's five objectives (safety, health, accessibility for persons with disabilities, fire and structural protection, and the environment). Each code requirement is linked to a code objective, and this change will facilitate the addition of provisions that require newly constructed buildings to incorporate low-emissions equipment and appliances, as well as low-embodied carbon construction materials in all new buildings across Canada.

With the federal government's commitment to a net zero emissions building code by 2025, work to fulfill this commitment is now underway. The point of this guide is to help municipalities anticipate and prepare for the significant policy change, and to use the upcoming of the net-zero emissions code as a lever to accelerate climate action.

# Steps in the Development Process for a Net-Zero Emissions Code

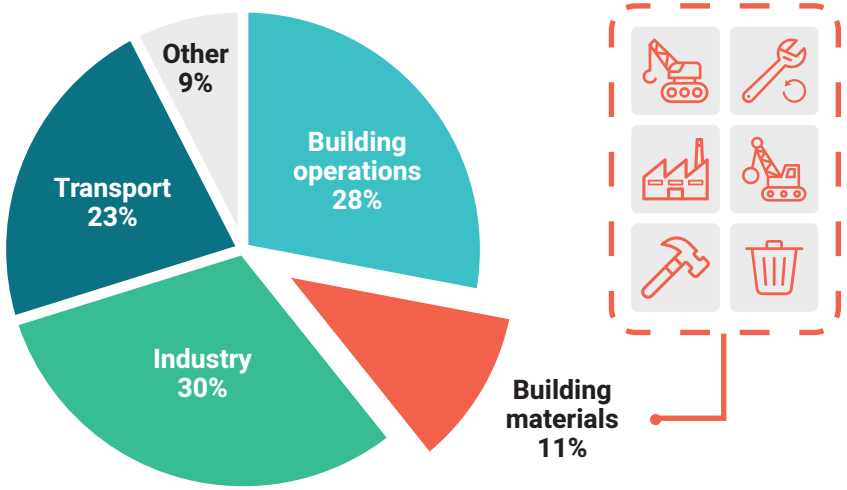


# Where Emissions From New Buildings Come From

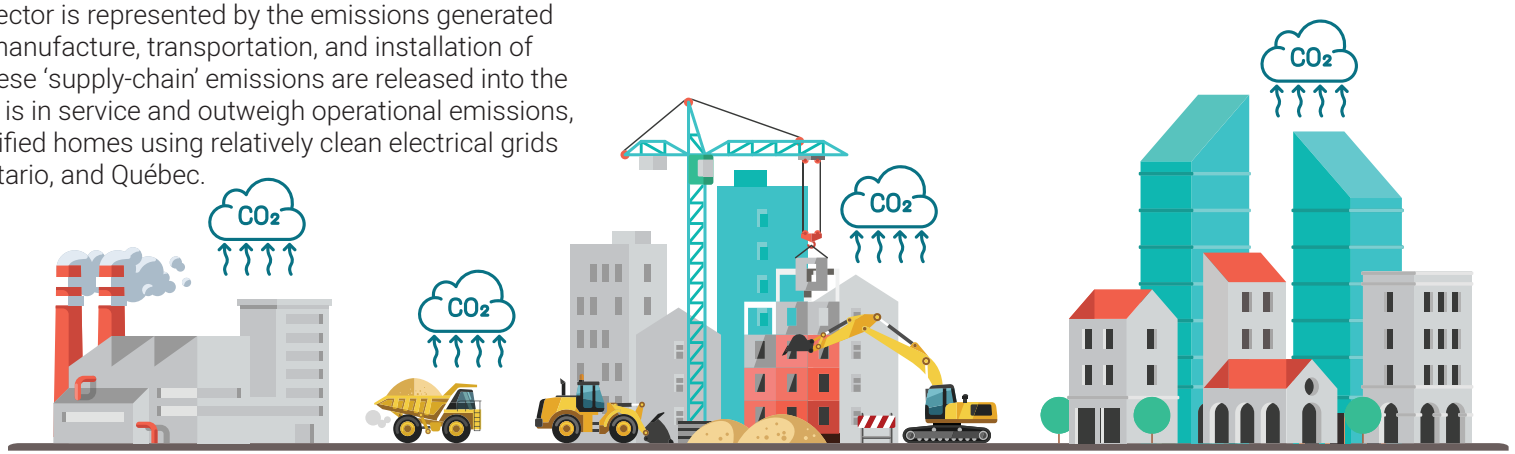
Building sector emissions can be split into operational emissions and embodied emissions. Operational emissions from the building sector accounts for 28 per cent of global emissions, while embodied emissions account for another 11 per cent.[4]

Operational emissions, those emitted during the building's operations or use, are largely the result of fossil fuels burnt to heat space and water. They make up the largest share of operational emissions in the building sector.[5] Operational emissions are heavily influenced by the $CO_2$ emission factor ($tCO_2$/MWh) associated with each unit of electricity in a given region, province, or territory. While efforts to decarbonize the electricity system are underway—namely through the federal government's proposed **2035 Clean Electricity Standard**—the high emissions factor of electricity grids in some provinces and territories can present a barrier to the widespread uptake of clean heating systems such as heat pumps. Nonetheless, the IEA has found that **installing heat pumps can significantly reduce emissions**, even with the current electricity generation mix. This means new buildings constructed to net zero emissions ready standards today can capture immediate benefits, and be net zero emissions in the coming years as efforts to decarbonize the electricity system are realized.

Embodied carbon in the building sector is represented by the emissions generated from the raw material extraction, manufacture, transportation, and installation of materials used in construction. These 'supply-chain' emissions are released into the atmosphere long before a building is in service and outweigh operational emissions, particularly for partially/fully electrified homes using relatively clean electrical grids such as those in BC, Manitoba, Ontario, and Québec.




Global energy-related $CO_2$ emissions.
Adapted from the UNEP 2019 Global Status Report




[4] UNEP, 2019 Global Status Report for Buildings and Construction Sector, December, 2019

[5] Natural Resources Canada Comprehensive Energy Use Database (2018): 55.9 Mt of total 65.6 Mt from residential sector Table 2 (Secondary Energy Use and GHG Emissions by End-Use), and 33.2Mt of total 49 Mt from commercial / institutional sector Table 4 (Secondary Energy Use and GHG Emissions by End Use – Including Electricity-related Emissions)

# Sources of Operational Emissions

On-site emissions are the result of fossil fuel combustion equipment, including space and water heating equipment, and to a lesser degree, equipment and appliances used for cooking.[6] Operational emissions are also associated with leakage of refrigerants throughout the equipment's life cycle.

Accompanying improvements to the building envelope that lower heating demands in new construction, switching out fossil fuel burning systems with zero-carbon heating and hot water equipment can all reduce or eliminate the building's operational emissions.

Highly efficient systems, such as heat pumps, typically have a high coefficient of performance (COP). The COP is the rate at which a heating system transfers thermal energy and the amount of electrical power needed to draw and distribute thermal energy to a building's conditioned space. The higher the COP, the more efficient the system. As an example, conventional equipment such as high-efficiency furnaces are approximately 96 per cent efficient (COP 0.96) and baseboards are approximately 100 per cent efficient (COP 1). Heat pumps, however, are often 300 per cent efficient (COP 3).[7]

Heat pumps work by extracting the heat from a source, such as air, the ground, or a source of water, and transforming it into a liquid which then passes through a compressor to create warm or cool air for space conditioning.

[6] Government of Canada, Green Buildings. Retrieved from: https://www.nrcan.gc.ca/energy-efficiency/green-buildings/24572
[7] BC Energy Step Code, 2022 Industry Survey Discussion Guide: BC Energy step Code. Retrieved from: https://www.crd.bc.ca/docs/default-source/climate-action-pdf/2022stepcodesurvey_infosheet.pdf

Graphic 5: **Strategies to reduce operational emissions in new construction**

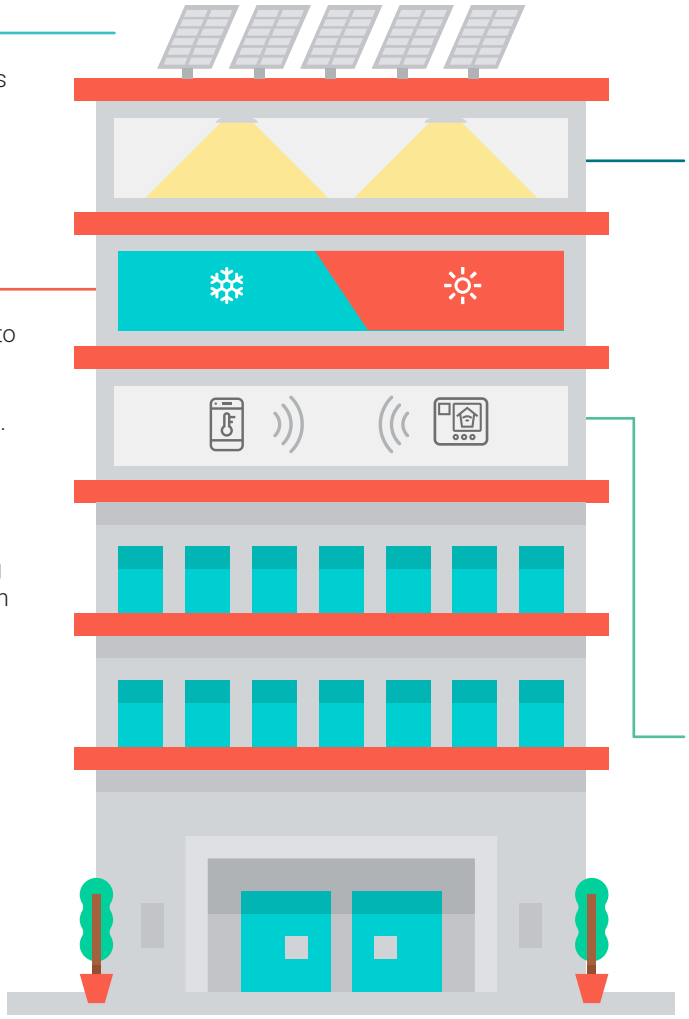
## Use low-carbon fuel sources

In addition to electrification, low-emissions fuels such as solar thermal, geothermal, and bioenergy can be used to provide alternative sources of thermal energy and to reduce a building's emissions.

## Leverage electrification

Use electricity for heating, cooling and hot water needs to immediately reduce a building's emissions. Heat pumps are currently the most efficient available technology for space heating in the commercial and residential sectors.

While not covered under Canada's national model codes, a core aspect of zero-emissions buildings is the use of locally available renewable energy to reduce the building's demands on the broader electricity grid. Going a step further, zero-emission buildings can integrate with the electricity grid to better balance energy demands while also providing local generation, supply, and storage opportunities.



## Reduce energy demand through energy efficiency

Scale up the tiers of NECB 2020/NBC 2020 and ensure that a robust building envelope that controls for air and moisture is a primary design consideration. This enables greater uptake of heat pumps or district heating where available.

Increase the use of high-performance LED lighting and, where feasible, intelligent building systems that ensure energy is used only where needed. These systems also can enable demand response during peak loads on the grid.

These measures serve to reduce the building's operational costs as well as the costs of further decarbonization measures.[8]

## Take advantage of intelligent building systems

Digitalization and smart controls can drive efficiency gains and reduce emissions. The growing market for smart thermostats, integrated renewables, and technologies that can direct space conditioning to where it's needed or to connected appliances and equipment can all enable further demand-side efficiencies.[9]

[8] IEA, Net Zero by 2050 – A Roadmap for the Global Energy Sector. November, 2022.

[9] Ibid

# The Role of Electrification

Driven by Canada's mostly decarbonized electricity system, as well as **ongoing efforts to further decarbonize Canada's electricity sector by 2035**, building electrification—coupled with the introduction of grid-enabled technologies like demand response and energy storage—can be expected to account for a significant share of **emission reductions related to buildings through to 2050**.

Building electrification shifts heating and cooling loads to electricity rather than fossil fuels. Energy efficiency remains a core aspect of electrification. A well-insulated building envelope, and equipment and appliances that use less energy, reduce the thermal and electrical energy demands of the building and enable a heat pump to meet the vast majority of the heating load. A properly sized heat pump that matches the building's heat load will work more efficiently and improve comfort by operating on a consistent basis.

Energy technologies that lay outside the purview of the national model codes also contribute to electrification. Solar energy production, electric vehicles, battery storage, and demand response programs can be expected to both reduce electricity demands and act as grid assets that help manage peak loads.

As municipalities seek to decarbonize their building sector through electrification, it is vital that they continue to emphasize energy efficiency, as reducing demand helps avoid potential grid constraints, and frees electricity resources that can be used for further building electrification, or the electrification of existing buildings and transportation.

Energy efficiency also helps utilities manage peak demand loads and avoid constraints related to the integration of more electrified buildings and vehicles. In particular, peak load management can shift or avoid the total amount of a buildings' peak power demands, and the time it spends at that demand level, which means a utility, in a relatively clean grid system, will not need to rely on emissions-intensive fossil fuel plants to accommodate peak demands.

Reducing operational emissions via electrification depends on a jurisdiction's electricity fuel mix, however. And, although some provinces have the advantage of an inherently low-emission grid via hydropower or nuclear energy resources, other provinces might place immediate focus on building envelope improvements and more limited electrification in preparation for a cleaner grid in the future.

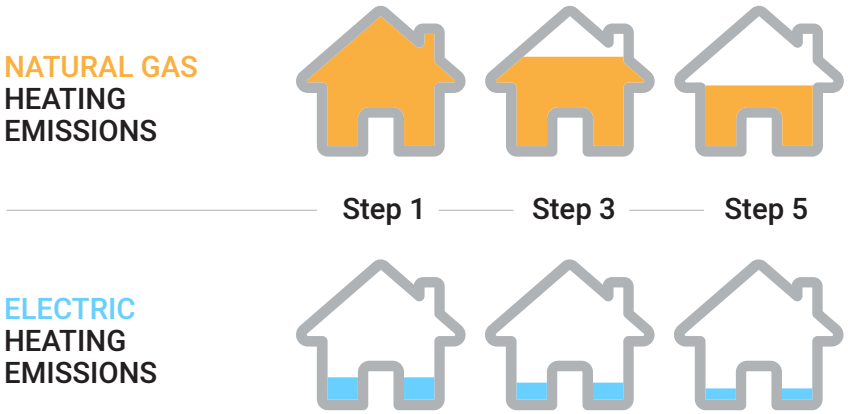



**Illustration of BC Energy Step Code Compliant Building Emissions by Fuel Type**

Even at net-zero energy ready standards, a newly constructed residential building can emit a significantly higher amount of GHG emissions compared to an electrified counterpart.

Adapted from the 2022 Industry Survey: BC Energy Step Code, March, 2022.

# Eliminating or Significantly Reducing Operational Emissions is Only a First Step

As building operations become more efficient, embodied carbon will become an increasingly significant issue. Embodied carbon will account for approximately **50 per cent of global building-sector emissions between now and 2050** and has the potential to draw down a significant amount of our remaining carbon budget for keeping global warming below 1.5°C. There is also a unique **time value component of embodied carbon**.

There is only one opportunity to reduce embodied emissions—at the beginning of the building's life. Where operational emissions could be reduced overtime through future energy efficiency measures, embodied emissions are locked in as soon as a building is built. This is why incorporating embodied emissions is so important for the design of a net-zero emissions building code.

# Sources of Embodied Emissions

The vast majority of embodied emissions from new construction typically come from the procurement of a handful of key materials. As an example, the typical breakdown of embodied emissions in new residential construction includes the following:

- **Concrete:** used for foundation walls, slabs, and footings, concrete accounts for approximately a third of material emissions.
- **Insulation:** used for foundations, walls, and roofs, insulation accounts for approximately a quarter of material emissions.
- **Exterior cladding/siding:** cladding and siding account for approximately a tenth of material emissions.[10]

The impact of materials can add up quickly. For example, the average as-built residential structure in Ontario has been found to have material emissions of approximately 40t $CO_2E$.[11]

As the image below illustrates, there are many opportunities to significantly reduce embodied emissions via material substitutions or replacement, with limited to no impact on cost and schedule. In large buildings, a **30 per cent reduction in embodied carbon is possible when low-carbon material is prioritized**, without impacting project cost or schedule. In residential buildings, material substitutions have demonstrated that it is now possible to **rapidly cut embodied emissions by half using the best materials available today**, for a conventional and cost competitive residential building.

[6] Government of Canada, Green Buildings. Retrieved from: https://www.nrcan.gc.ca/energy-efficiency/green-buildings/24572
[7] BC Energy Step Code, 2022 Industry Survey Discussion Guide: BC Energy step Code. Retrieved from: https://www.crd.bc.ca/docs/default-source/climate-action-pdf/2022stepcodesurvey_infosheet.pdf

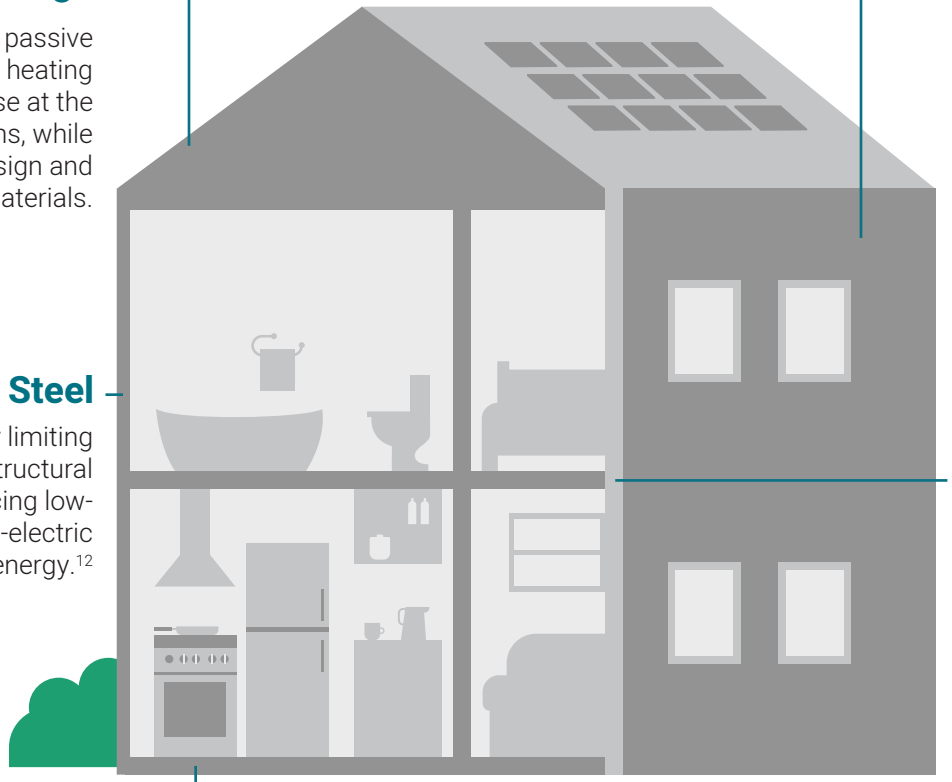
Graphic 6: **Strategies to reduce embodied emissions in new construction**

## Avoid high-carbon materials through whole-building design

From the design stage, consider passive measures that optimize demand-side heating and cooling loads. Considering these at the outset can lower operational emissions, while also leading to a simpler building design and form that requires fewer materials.

## Steel

Emissions in steel can be reduced by limiting its use, by switching to low-carbon structural components such as wood, or by sourcing low-emissions steel produced using hydro-electric or renewable energy.[12]



## Wood products

Typically a replacement for steel materials, wood products are less emissions intensive but cannot yet be considered a 'carbon sink' as it remains unclear how much is carbon stored or released during the harvesting, manufacturing, and use of those products.

## Insulation

Replacing carbon-intensive insulation materials with low-carbon alternatives, such as wood fiber board or cellulose, is a first step in reducing building emissions, as the **carbon emissions for specific products can vary significantly**.

## Concrete

The first step in reducing emissions from concrete materials is to minimize its use, typically through material switching or optimizing its use. Next, use **environmental product declarations (EPD) to identify concrete products with fewer emissions**. EPDs for concrete are verified in accordance with ISO 14025 and ISO 21930 and are now available in several provinces.

In the future, carbon-sequestering aggregate, biogenic cementitious materials, and carbon capture and storage offer the potential to reduce the carbon impact of concrete to zero.

[12] United Nations Environment Programme (2022). 2022 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector. https://wedocs.unep.org/20.500.11822/41133.

# What Does Net-Zero Emissions Mean?

The federal government has committed to the development and implementation of a net-zero emissions building code. However, there remains ambiguity and uncertainty about what the term 'net-zero emissions' means for newly constructed buildings (see image below).

Net-zero emissions refers to the balancing or cancelling out of any emissions associated with the building's operations and materials, including equipment used in its construction. Emissions considered included in this equation are all GHG emissions emitted into the atmosphere, such as methane ($CH_4$), nitrous oxide ($N_2O$), and other hydrofluorocarbons.

The 'net' component of net zero is typically achieved through offsets that provide an emission reduction elsewhere, for example, by using renewable energy sources or waste heat or heat recovery in place of fossil fuel-based energy sources.[13] However, given that recent studies have found that the Canadian buildings sector is already **well positioned to cut emissions from building operations and construction using materials available** today, net-zero offsets are particularly inappropriate for new buildings that can be designed to be near zero emissions from the outset.


[13] Burrows, Victoria Kate and Watson Edward. Advancing Net Zero Whole Life Carbon. World Green Building Council. 2022.

# Defining Net-Zero Emissions

**Zero operational emissions:**
A building that is highly energy efficient and uses only non-emitting energy for heat, hot water, and power. This should also account for potential refrigerant leaks.

**Net-zero ready operational emissions:**
This refers to a building that is highly energy efficient and can have net-zero operational emissions once the energy supply is fully decarbonized.

**Net-zero embodied emissions:**
a building that uses non-emitting materials (including offsets) throughout the manufacturing, construction, use, and disposal processes.

**Net-zero emissions:**
a building that is highly energy efficient, uses non-emitting energy for its operations, and that uses non-emitting materials (including offsets) throughout the manufacturing, construction, use, and disposal processes.

**Zero-carbon ready:**
the IEA defines a zero-carbon ready building as one that is highly energy efficient and uses either renewable energy directly or from an energy supply that will be fully decarbonized by 2050. It will become zero carbon without further changes to the building or its equipment.

**Zero-emissions building:**
defined by Natural Resources Canada as a building designed to be highly energy-efficient and use only non-emitting energy for heat and power.[14]

**Zero-carbon buildings**:
these are highly energy efficient buildings, ones in which $CO_2$ emissions from all operational energy consumed over the course of a year are balanced out to reach zero through renewable and/or other zero-emission energy sources. Actions that can reduce or offset emissions associated with building materials can be considered for the transition towards whole life cycle, net-zero carbon buildings.

[14]Natural Resource Canada, The Canada Green Buildings Strategy: Discussion Paper, July, 2022

# A Building Code for a Net-Zero Emissions Economy

The ambiguity surrounding the term, 'net-zero emissions,' points to a role for **Canada's Green Building Strategy**, under development in 2022-2024. By clearly defining the objectives and requirements expected for Canada's building codes in the net-zero emissions economy, the Green Building Strategy can ensure that net-zero offsets are not used to allow emissions-intensive buildings to claim net-zero emissions status and, more importantly, it positions buildings to be truly zero emissions or even sequester emissions.

This clarity also serves to bring purpose and coordination to policy initiatives led by municipalities or senior governments in the form of incentives, research and development, market development, and federal–provincial agreements, all of which can be oriented towards achieving these **standards**.

Guided by zero-emissions building standards that tackle both operational and embodied emissions, Canada's municipalities can rapidly cut emissions from new buildings thereby creating space to drive faster emission reductions in existing buildings, as well as create space for sectors in which emission reductions are less achievable.

### Building Emissions Extend Beyond Construction and Use

Life cycle analysis (LCA) can account for a variety of stages of the building's life cycle, beyond the building's operations. These include:

- **Cradle-to-gate (A1–A3)**: emissions generated in the extraction or manufacturing of construction materials, not including shipping.
- **Cradle-to-substantial completion (A1–A5)**: all emissions required for the project to be considered complete and ready for occupancy.
- **Cradle-to-grave (A1–C4, often excluding B6/B7 emissions)**: all building emissions generated over its entire life cycle, aside from those at the building's end of life (i.e., recycling).
- **Cradle-to-cradle (A1-D, often excluding B6/B7)**: emissions generated over a building's entire life cycle and extending to future re-purposing or recycling.
- **Whole-life carbon**: the total of a project's operational emissions and embodied emissions.


[15] Regulating Embodied Emissions of Buildings. Insights for Ontario's Municipal Governments. Policy Primer, August, 2022.

# Why Energy Efficiency Continues to Be the Cornerstone of a Net-Zero Emissions Building Code

Net-zero energy ready building codes, like Canada's 2020 tiered energy codes now available for provincial adoption, emphasize improvements to the building envelope and increased energy efficiency, particularly at the upper tiers. While net-zero energy ready building codes do not create a path to achieving net-zero emissions, they can act as a complement or starting point for net-zero emissions.

Energy efficiency is a **globally recognized pathway to building sector decarbonization.** Reducing both operational and embodied emissions in the building sector begins with cutting energy wasted throughout the building's life cycle.

At the design stage, energy efficient buildings typically reject needlessly complex roof or floor plans in favour of simpler building 'form factors' that reduce the building's envelope area. This means fewer materials are required—and wasted—throughout the extraction, transportation, and application of materials, leading to reductions in embodied carbon. These material efficiency strategies can cut cement and steel demand in the buildings sector by more than a third relative to today's conventional standards[16] without associated cost premiums.[17]

In operation, these same energy efficiency measures reduce a building's energy needs so that renewable energy or zero-carbon energy sources can meet all space conditioning requirements. As a result, energy resources are freed for higher value uses, like meeting growing demands for widespread electrification (of both buildings and vehicles) without the need for additional electricity system infrastructure.

These fundamental steps should be considered a critical component of any net-zero emissions standards. There is a risk that some actors might seek to avoid energy efficient design changes and construction practices assuming that simply switching existing materials for low-carbon building materials will lead to zero or net-zero emissions. That will create missed opportunities to achieve deeper emission reductions while capturing the many co-benefits of energy efficiency.

[16] International Energy Agency, Net Zero by 2050 – A Roadmap for the Global Energy Sector. October, 2021.
[17] Rocky Mountain Institute (RMI), Reducing Embodied Carbon in Buildings: Low-Cost, High-Value Opportunities. July, 2021. https://rmi.org/wp-content/uploads/dlm_uploads/2021/08/Embodied_Carbon_full_report.pdf

# How a Net-Zero Emissions Building Code Could Look

**Below, we map out several scenarios for a net-zero emissions code for new buildings. These scenarios are broken into two sections: measures to reach net-zero operational emissions, and measures to reach net-zero embodied emissions.**

## Building Code Measures to Reach Net-Zero Operational Emissions

**Scenario 1: Accelerate upper tier adoption, incentivize low-carbon heating systems**

In many new buildings, reaching the 2020 model code's upper tiers (the NZER standard) will be best achieved using highly efficient mechanical equipment. For example, heating and hot water equipment such as air source heat pumps.

Aided by strong incentives or requirements to encourage zero-carbon heating and hot water systems and appliances and equipment, this approach would immediately drive down operational emissions from new buildings. And, because this approach uses the existing tiered code framework, it has the benefit of being less complex for authorities having jurisdiction to enforce compliance.

**Scenario 2: Add GHGI/GHG cap to the tiered codes**

Similar to proposed changes to the BC Energy Step Code, adding a GHGI/GHG cap to the 2020 model codes offers three compliance paths for newly constructed buildings. These include:

1. An absolute GHG maximum cap for common building archetypes that is reduced at each tier.
2. GHGI limits (expressed as $kgCO_2/m^2/year$) established for common archetypes and reduced at each tier. This approach has the advantage of making GHGI reductions achievable for small buildings, while still requiring large buildings to meet similar stringency.
3. A prescriptive compliance path that requires zero-emissions heating systems, with upper tiers requiring additional measures such as low-emissions service water heating systems, and eventually low-emissions appliances and equipment.

Once again, because this approach leverages the tiers of the 2020 national model codes, it can be expected to be more easily understood by code users and enforced by authorities having jurisdiction.

**Scenario 3: Cut operational emissions by establishing GHGI and thermal energy limits**

In this scenario, GHGI limits (expressed as $kgCO_2/m^2/year$) are complemented by two additional metrics. These include a Thermal Energy Demand Intensity (TEDI) metric to limit the thermal energy losses through the building envelope and Energy Use Intensity (EUI) metric to lower the total amount of direct and indirect energy used for heating, ventilation, and hot water, as well as appliances and equipment.

Like the City of Vancouver's **Zero Emissions Building Plan**, introduced in 2016 under the Vancouver Charter, and the **Toronto Green Standard**, this approach focuses on highly efficient building envelopes (and ventilation systems) as simple and long-lasting measures. Incorporating these systems into the building design and construction phase avoids the need to undergo costly and disruptive time retrofits in the future.

**Scenario 4: Offer a prescriptive set of measures for reductions in operational emissions**

Prescriptive measures establish minimum acceptable standards for specific building elements. As such, this approach can be paired with the 2020 model code's tiers to tackle heating/cooling and hot water equipment to reduce operational emissions as follows:

Tier 1: Measure GHG emissions only.
Tier 2: Require space heating to be low carbon.
Tier 3: Require both heating and hot water to be low carbon.
Tier 4: Fully decarbonize the building (fireplaces and cooking equipment included).

# Building Code Measures to Reach Net-Zero Embodied Emissions

**Scenario 1: Prescriptive measures to reduce embodied emissions**

A prescriptive approach to limiting GHG emissions in construction materials could quickly achieve emission reductions from high-emitting materials such as concrete, steel, and insulation.

While the best approach to reducing embodied emissions is to employ a project-specific, whole-building, cradle-to-grave LCA study—a prescriptive approach can offer immediate reductions in emissions from common building materials such as concrete, steel, and insulation. To provide assurances of real emission reductions, this approach should be implemented alongside a robust LCA or use established product EPDs.

**Scenario 2: Offer a flexible hybrid set of emission reduction paths**

A hybrid approach can be used for embodied carbon by applying a metric such as Carbon Use Intensity (CUI) or a similar metric, with an alternative path that sets a relative (by floor area) or absolute cap on embodied emissions in construction materials for specific archetypes.

A CUI could be added to the building code or existing programs such as the EnerGuide rating program. Flexibility can be offered with an additional prescriptive compliance path that covers the most emissions-intensive materials.

**Scenario 3: Implement a measure only approach while the market for low-emissions material develops**

The challenge in regulating embodied emissions at scale is the relative immaturity in the LCA process and EPD markets. However, that is not a reason to delay action.

To address embodied emissions within the tiered code framework, a measure only requirement could be used to both signal that embodied emission reductions are a code objective and incoming requirement, and raise awareness that these requirements will be expected in future code editions.

An added benefit of this approach is that AHJs, and by extension the building codes development system, will capture real-world data on embodied emissions in new construction that can inform future code requirements.

# No Reason to Delay Action on Embodied Carbon

While a sophisticated accounting of embodied carbon might take many years to develop, we can take immediate action to cut material emissions today.

At minimum, a reporting/measurement only requirement for the embodied carbon of building materials in the national model codes by 2025 will put in place an immediate path to quickly reducing those emissions.

**By signalling that cutting material emissions from new buildings is both a building code and societal priority, Canada's national model codes can provide the long-term certainty needed to accelerate the widespread use of EPDs and the maturity of the LCA process.** This will have the effect of fostering greater transparency and accuracy in their use and accelerate action in this critical area by at least half a decade and provide municipalities with a much-needed tool to address building sector emissions.

# Tackling Operational Emissions Requires a Direct Approach

**As the BC Energy Step Code (ESC) has shown, stringent energy performance targets such as those provided by the 2020 model codes are not a driver for mechanical system selection**. While compliance with the ESC's requirements can be met with any type of heating system, there is a significant variation in GHGI at each step. For example, the **GHGI for a large single family dwelling at the highest tier using an electric heat pump is 93 per cent lower than the same building using an all-gas heating system**. This trend extends to part 3 buildings as well, with the GHGI at the highest step being 87 per cent lower on average for heat pump systems versus all-gas systems across all archetypes.[18]

These variations point to the need to reconsider the building codes' traditional fuel-agnostic approach that treats all fuels used for building operations equally. If the goal of the net-zero emissions code is indeed to decarbonize the buildings sector, there will be a substantial role for the use of low-emissions electricity heat pumps that produce fewer emissions than gas alternatives,[19] even when accounting for potential refrigerant leaks.[20]

[18] http://energystepcode.ca/app/uploads/sites/257/2019/11/BC-Step-Code-GHGI-Report_Nov-2019.pdf
[19] There are valid concerns related to the use of refrigerants in heat pumps which can have high global warming potential (GWP). These concerns can be offset with federal or provincial regulations on the allowable refrigerant types based in part on GWP.
[20] International Energy Agency. The Future of Heat Pumps. November, 2022.

# How Other Jurisdictions in North America Are Incorporating Net-Zero Emissions

| Jurisdiction | Zero-Carbon Provisions | Applies | Voluntary/Required | Metrics |
|---|---|---|---|---|
| Proposed changes to BC Step Code | BC ESC provisions offer three compliance paths:<br>1. Absolute GHG caps<br>2. GHGI limits (kgCO2/m2/year).<br>3. Prescriptive path to reduce emissions from building operations. | New Part 9 and Part 3 | Proposed but would be required | GHG emissions, GHGI, prescriptive measures (requires zero-emissions heating systems; upper tiers require low-emissions service water heating systems, and eventually low-emissions appliances and equipment) |
| Vancouver Zero Emissions Building Plan | Applies the Vancouver Building By-Law, Green Building Policy for Rezoning, Higher Buildings Policy, Passive House Standard and alternate solutions to reach near zero-emissions buildings | Step 3 of the Energy Step Code for large buildings, low-rise residential to exceed Step 3<br><br>Small buildings and residential (one to three storeys) fall under Part 9 of the BC Building Code and VBBL. | Required | Applies TEDI, TEUI, GHGI metrics to reduce operational emissions<br><br>Allows the use of Net Zero Homes Standard of Canadian Home Builders' Association, Zero Carbon Building Standard of the Canada Green Building Council, and Living Building, Core Green Building, Zero Energy, or Zero Carbon certifications of International Living Future Institute. |
| ASHRAE 90.1: Energy Standard for Buildings Except Low-Rise Residential | A model code to promote healthy buildings. Now merged with Standard 189.1-2017 | All new commercial building types | Intended to be required | Prescriptive and performance paths to reduce emissions from building operations and material and assemblies emissions. |

| Jurisdiction | Zero-Carbon Provisions | Applies | Voluntary/Required | Metrics |
|---|---|---|---|---|
| 2018 International Green Construction Code® Powered by Standard 189.1-2017 | Based on ASHRAE 90.1. It is a model code designed to be used and enforced with a jurisdiction's other building codes and ordinances. A full suite of sustainability measures are required. | All new commercial building types | Intended to be required | Prescriptive and performance paths to significantly increase energy efficiency, and reduce emissions from building operations and material and assemblies emissions. |
| Zero Energy Commercial Building Provisions to the 2021 IECC (Based on Architecture 2030 ZERO Code) | Zero energy is achieved via energy efficiency and renewables. Based on Energy Rating Index (ERI) and requires energy efficiency and renewables on- or off-site. | New commercial and mid- to high-rise residential | Voluntarily adopted by municipal governments | Operational emissions focus (EUI), optional embodied emissions, onsite prioritized but includes off-site options |
| CaGBC Zero Carbon Building (ZCB) Standard | The ZCB-Performance Standard prioritizes zero-carbon emissions (direct and indirect), energy efficient designs and requires refrigerants embodied carbon to be offset.<br><br>The ZCB-Design standard targets building operation emissions and reported refrigerant leaks and material emissions. | Any | Voluntary | The ZCB-Performance Standard seeks zero operational emissions, offset embodied carbon and refrigerant leaks. Renewable and carbon offsets must be provided.<br><br>The ZCB–Design Standard operations to be modelled to zero carbon, and refrigerants and embodied carbon to be reported. Renewable energy and carbon offsets can be used. Projects using combustion equipment for hot water or peak heating to provide a costed plan that outlines how equipment will be replaced in its life cycle to move toward decarbonization. Offsets must be quoted. |
| USGBC LEED Zero (zero-carbon) | Certification confirms net-zero emissions from operations by avoiding or offsetting carbon emissions within 12 months. | All new buildings | Voluntary | Prioritizes zero-carbon building operations. Requirements include operational $C0_2e$, on-site and off-site renewables, carbon offsets. |

| Jurisdiction | Zero-Carbon Provisions | Applies | Voluntary/Required | Metrics |
|---|---|---|---|---|
| New Buildings Institute Decarbonization Code | A model code overlay for the 2021 International Energy Conservation Code (IECC) and ASHRAE 90.1 | New commercial and residential | Voluntary | Operational emissions reduced via electrification or mixed fuel paths. Strong focus on demand response, building electrification and storage. |
| International Living Future Zero Carbon standard | A performance-based, as-operated, certification standard. Requires 100 per cent of operational energy to be offset by renewables (on- or off-site). | All new buildings | Voluntary | EUI, $CO_2e$, operational carbon, embodied carbon, on-site and off-site renewables, carbon offsets (Green-e Climate or equivalent)<br><br>Projects must show 12 months of actual net-zero carbon. |
| New York City Local Law 97 | Large buildings (25,000 ft2 or more) are to meet new energy efficiency/ emissions limits by 2024. Stricter limits coming into effect in 2030. The goal is to reduce emissions from large buildings 40 per cent by 2030 and 80 per cent by 2050. | New and existing buildings | Required | Operational emissions GHGI ($tCO_2e/sf$), prescriptive path, offsets for third-party certifications and, energy storage, renewables |
| Marin County | Embodied carbon (A1–A3) provision in its Marin County Building Code, California 2021 | All new buildings | Required | Chapter 19.07 of Title 19 sets embodied carbon limits (ranging from 260 to 675 kg $CO_2e/m3$) for concrete of various compressive strength levels. Exemptions allowed at a project level. |

# What's Happening to Support a Net-Zero Emissions Building Code

A net-zero emissions building code can be expected by 2025, with the provincial/territorial adoption process taking another 18 to 24 months. This means that local governments can expect to implement net-zero emissions requirements in mid-2026 to early 2027.

To prepare for the introduction and implementation of the net-zero emissions code, senior governments are taking the following actions:

## Continuing Development of Mature LCA/EPD Systems

Senior governments can develop a mature market for LCA/EPDs by encouraging a consistent methodology for calculating and reporting LCAs that are both high quality and transparent. Material life cycle data captured in the development of EPDs or in LCAs can help inform the development of effective limits on embodied emissions and inform future regulations.

Efforts underway include the National Research Council's low-carbon assets through **life cycle assessment (LCA²)** initiative. This project takes a product level approach that will offer builders and designers a way to identify low-carbon materials and address shortcomings in existing approaches to LCA/EPD. It aims to establish guidelines that account for variation in the construction, use, and end-of-life stages of a product, and it provides a framework for ongoing updates that reflect upstream changes to manufacturing processes and materials.

In addition to providing the market with confidence in the LCA process and EPD authenticity, these updates are critical in other ways as well. The end goal should be for the net-zero emissions code to re-shape building sector demand to such an extent that it induces upstream production changes.

# Enhanced Federal/Provincial/Territorial Energy Efficiency Standards

As local governments await the net-zero emissions code, the federal and provincial governments can increase the stringency of national and provincial equipment efficiency standards.

More demanding requirements for low-emissions space and water heating equipment can raise the floor for energy and carbon performance, and encourage low-carbon options such as heat pumps. Other options include the phasing out or red listing of certain pieces of equipment and appliances under federal or provincial/territorial energy efficiency acts.

In addition to accelerating building emissions performance in new buildings, energy efficiency standards implemented by senior governments will increase the uptake of low-emissions heating and hot water equipment in existing buildings.

# Standardized Tools for Reporting Building Emissions

As the level of government responsible for compliance enforcement, municipalities need support for the implementation of a net-zero emissions building code. This includes standardized tools and templates to allow for streamlined data collection and the benchmarking of building performance levels.

This will be an important first step in the setting of carbon emission limits for buildings. This approach has been used in the Vancouver Building By-law, which, through the building code and rezoning policy, already have GHG limits per unit of area for most building types, which and will be updated incrementally so that they will require zero emissions from all new construction by 2030.

Federal support for the development of standards, labels or similar tools will enhance the transparency and accountability of embodied carbon declarations. Such standards must be independent, verifiable, and auditable, and should be phased in over time, beginning with a voluntary approach and moving to mandatory requirements.

# Incorporate Embodied Emissions Requirements as Part of Circular Economy Efforts

The net-zero emissions code is a chance to transform our buildings and the materials used in their construction, from a source of emissions to instead store carbon and reduce emissions throughout their life cycles.

The net-zero emissions building code is a first step towards the **circular economy**. Tracking and monitoring material emissions in new construction, for example through a building logbook, can lead to new opportunities to use buildings and construction materials as an emissions sink, and find high-value applications for material reuse. Innovation in this area could allow builders to claim end-of-life savings off materials in pursuit of zero-carbon building standards.

# Government Procurement for Low-Carbon Materials

Reducing emissions in construction materials, such as steel, cement and concrete, forest products, and aluminum, requires support for the development of a low-carbon construction materials supply chain. As the largest buyer of goods and services in Canada, the federal government can leverage its $22 billion of goods and services purchased each year[21] to support the development of a low-carbon supply chain.

Combined with the federal government's LCA[2] initiative or MCE[2] tool that allows users to compare materials such as cladding, sheathing, or finish materials on a component-by-component or whole assembly scale. These initiatives will support the buildings sector in assessing and comparing material choices, as well as in establishing confidence in a net-zero emissions standard built on these processes.

[21] Public Services and Procurement Canada (Government of Canada). The Procurement Process. https://buyandsell.gc.ca/for-businesses/ selling-to-the-government-of-canada/the-procurement-process (2009)

# Here's What Municipalities Can Do Before the Code Arrives

**The net-zero emissions code must still be developed by 2025 and adopted and implemented in each province and territory by 2027. Nonetheless, local governments and their constituents are demanding action today.**

Municipalities can take immediate action to address emissions from buildings, however, and influence how our national net-zero emissions code will take shape in two ways. First, by implementing strong measures to reduce emissions from their buildings sectors, municipalities will send a strong signal to the federal government and building code development system that they will accept nothing less than an ambitious net-zero emissions code. Next, these municipalities will make clear that their advanced demands related to building sector decarbonization must be incorporated into the development of the net-zero emissions code.

# Include Emissions in Existing Education and Awareness Programs

Municipalities have played an important role in educating industry and constituents in areas such as climate change mitigation, and net-zero energy ready buildings. Continuing this work in relation to net-zero emissions or zero-carbon buildings will be critical as well. Municipalities can do so by developing case studies on low-carbon construction practices, implementation guides for choosing operational or embodied emissions boundaries, and on how to use common tools to measure emissions. Case studies on specific projects, such as those provided by the **Zero Energy Building Exchange (ZEBx)** can also serve to increase awareness and build the necessary knowledge infrastructure needed to reduce emissions in buildings.

# Increase Incentives for Low-emissions Buildings

Incentives alone cannot move the market toward buildings with low-emissions. However, all levels of government can offer financial and other incentives to encourage early adopters and catalyze their local markets. In addition to financial incentives, building approvals can be sped up for low-emissions projects, or planning and development tools such as density bonusing, parking relaxations, property tax abatements can help offset the capital costs associated with low-emissions technologies and materials.[22]

[22] Integral Group, Implications of the BC Energy Step Code on GHG Emissions. June, 2019

# Implement Standards for Operational Emissions

**Municipal governments can take immediate steps to cut both operational and embodied carbon in the near term by implementing incentive programs or local standards through site plan control, zoning, development bylaw tax breaks or rebates or, where available, climate change bylaws.**

### Step 1: Incent or require zero-carbon heating and hot water systems in new buildings

Municipalities can incent or require (where possible) zero-carbon heating and hot water systems such as heat pumps or building electrification. Existing incentives and/or 'top-up incentives' can help to reduce financial barriers to heat pumps or electrification in new construction.
Some municipalities may have existing authorities to require low-emissions or all-electric mechanical equipment. For example:

- The charter City of Vancouver has used existing powers to mandate specific targets and actions to achieve zero emissions in all new buildings by 2030 through its Zero Emissions Building Plan.
- Montreal will use its bylaw powers to mandate a zero-emission standard for all new construction beginning in 2025,
- The City of Victoria will require all new construction to produce no greenhouse gas emissions as of 2025. Using a phased approach,

Victoria is using building bylaw amendments to require smaller new residential buildings to meet a low-carbon standard by July, 2023, with all other residential and commercial types having to do so one year later. The zero-carbon standard will impact all new structures in July, 2025.

### Step 2: Incent or require operational emissions assessments

Voluntary or required 'reporting-only' measures for expected operational emissions in new buildings, as operated, has a twofold effect:

- Voluntary requirements highlight the expected emissions performance for building owners. When paired with education materials and when benchmarked against best practices, voluntary requirements can serve to reduce operational emissions.
- Reporting requirements signal that zero-carbon buildings are a priority for the local government and will be the norm in coming years.

Municipalities can use the collected data to transparently inform future regulations, and transition from voluntary requirements to mandatory ones as the standard becomes more widely accepted. Standard compliance software can be used to provide an estimate of emissions from building operations for residential buildings.

### Step 3: Leverage voluntary zero-carbon standards to catalyze the market

While voluntary certification programs are limited in how effectively they can transform entire markets, they do play a critical role in building innovation around new processes and technologies. Incorporating leading standards into municipal existing incentive programs, green development standards, or other planning and permitting requirements can catalyze the market in its early stages and better prepare it for the introduction of the net-zero emissions building code. Examples of zero-carbon programs include the CaGBC's Zero Carbon Building™ (ZCB) or LEED Zero.

# Implement Standards for Embodied Carbon

**Step 1: Incent or require embodied emissions assessments**

International standards such as ISO 14044 or the National Guidelines for Whole-Building Life Cycle Assessment can be used to help practitioners use a common approach allowing for consistency and comparability between whole-building LCA (WBLCA) results including embodied emissions.

**Step 2: Incent or require material switching**

Like other measures that leverage the planning and permitting process, offering financial or non-financial incentives for projects can demonstrate that municipalities have either:
- Incorporated embodied emissions assessments into the design phase of projects or,
- Taken steps to switch high-carbon materials—such as concrete, steel, or insulation—with low-carbon alternatives

By prioritizing low-carbon materials, a **typical project can cut embodied emissions by one third**, without associated cost increases.

**Step 3: Support supply chain development for low-carbon materials by enacting municipal procurement standards**

Municipalities can require low-embodied carbon materials such as concrete to be used in all projects owned or solicited by a city. In doing so, the municipality can shift the market from conventional products to low-carbon alternatives.

This approach has been implemented in **Langford, BC**, which requires both government and private projects to use post-industrial carbon dioxide mineralization technologies, or an equivalent which offers concrete with lower embodied $CO_2$.

# Initiatives to Support the Transition to Low-Carbon Buildings Across Canada

## Federal

**"A Healthy Environment and a Healthy Economy"** seeks to grow Canada's ability to develop a low-emissions building materials supply chain to ensure availability of Canadian low-carbon cement, and energy efficient windows and insulation.

Canada's Greening Government Strategy advances embodied carbon disclosure in government-owned or leased and aims for a 30 per cent reduction in structural material emissions in government projects by 2025. The Strategy will apply the National Research Council's **National Guidelines for Whole Building Life Cycle Assessment** in 2022.

The National Research Council's Low Carbon Assets through Life Cycle Assessment Initiative (LCA2) includes the development of whole-building life cycle assessment guidelines, life cycle inventory datasets for Canadian construction materials, and the integration of LCA into procurement processes.

Building electrification will play a big role in reaching net-zero emissions in the building sector. Achieving Net Zero Emissions Electricity Generation outlines the federal government's intention to move forward with regulations to achieve a net-zero electricity system by 2035, including a clean electricity standard (CES) under the Canadian Environmental Protection Act, 1999 (CEPA).

## Provinces and Territories


Guided by the **Clean BC Roadmap to 2030**, a new carbon pollution standard is to be added to the BC Building Code. Clean BC also supports municipal carbon pollution performance standards for new buildings via a provincial opt-in regulation. To support zero-carbon buildings, the province will **require all space and water heating equipment sold and installed** after 2030 to be at least 100 per cent efficient.



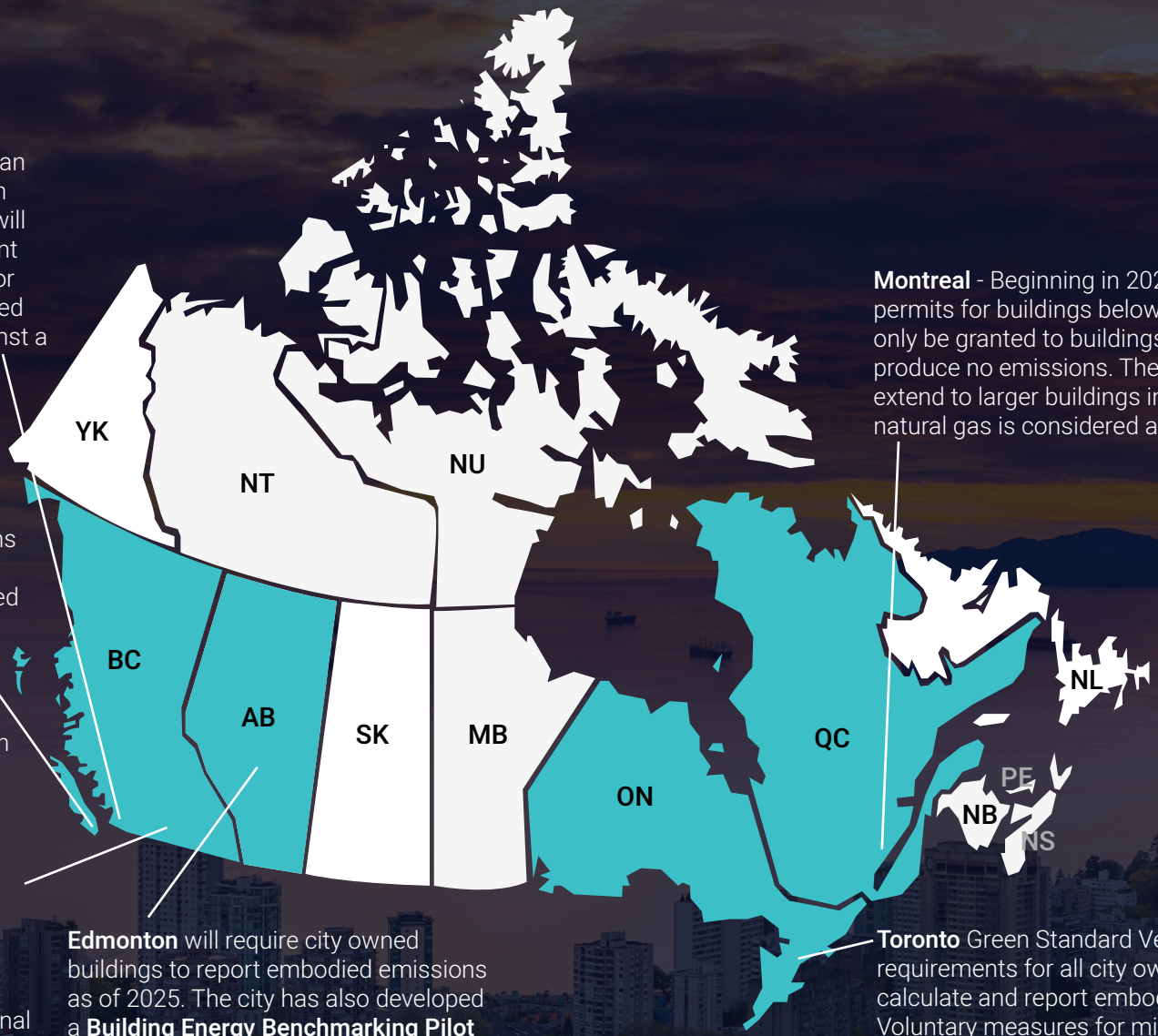
Source: Efficiency Canada, Provincial Energy Efficiency Scorecard, 2022 information request.

## Municipalities

**Vancouver** will require new construction to report embodied emissions which must be less than twice a baseline value by 2023. In 2025, building permit approvals will need to demonstrate a 10 per cent reduction (20 per cent for wood or mass timber projects) in embodied emissions, when compared against a baseline building.

**The City of Langford**, BC, announced a Low Carbon Concrete Policy in 2021, focused specifically on reducing emissions from concrete. As of June 2022, all concrete supplied to city owned or solicited projects and large private projects will be required to be produced using post-industrial carbon dioxide ($CO_2$) mineralization technologies, or an equivalent which offers concrete with lower embodied $CO_2$.

**Cities of Nelson and Castlegar**, BC - The Low Carbon Homes Pilot (2021) is meant to reduce the impact of buildings by taking embodied emissions into consideration alongside operational carbon emissions.




**Edmonton** will require city owned buildings to report embodied emissions as of 2025. The city has also developed a **Building Energy Benchmarking Pilot program** to help large buildings reduce their building energy use and reduce community emissions.

**Montreal** - Beginning in 2024, construction permits for buildings below 2,000 $m^2$ metres will only be granted to buildings whose operations produce no emissions. The requirement will extend to larger buildings in 2025. Renewable natural gas is considered a carbon-neutral fuel.

**Toronto** Green Standard Version 4 includes requirements for all city owned construction to calculate and report embodied emissions. Voluntary measures for mid- to high-rise residential and non-residential construction include Tier 2 levels of performance, or Tier 3 requiring a 20 per cent reduction against a baseline building. Multi-unit low-rise construction has a voluntary Tier 2 limit on material-based carbon intensity in buildings (life cycle stages A1–A3) of 250 kg $CO_2$e/m2.

The Municipal Guide to Net Zero Energy Ready Building Codes

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

# Net-Zero Emissions Terms and Definitions

**Authority having jurisdiction:** A municipality—or in some instances the province or territory—responsible for enforcing compliance with the building code.

**Beneficial electrification:** A term used to ensure electrification meets particular policy goals including lower net emissions, lower overall costs, reduced peak electricity demands, and reduced or improved load factors for utilities.

**Building code:** A law or regulation that establishes requirements for the design and construction of new buildings. Building codes ensure new construction meets minimum health, safety, and performance standards.

**Building energy code:** A regulatory standard that sets minimum efficiency requirements for buildings that serve to reduce energy use and emissions over the life of the building. Typically applied to new construction, energy codes are a subset of building codes.

**Building envelope:** The building's physical separation between the conditioned and unconditioned environment, including walls, floors, ceilings, windows, doors, etc.

**Coefficient of performance (COP):** A performance rating that demonstrates how effective a heat pump or air conditioner is at transferring heat, versus the amount of power it consumes. The higher the COP, the more efficient the equipment is.

**Electrification:** As a decarbonization strategy, electrification shifts heating and cooking loads to electricity. Energy efficiency is a core component of electrification, as a well-insulated building envelope and low-energy equipment and appliances reduce thermal and electrical energy demands. As a result, low-carbon heating and mechanical equipment can be used in place of fossil-fuel alternatives.

**Embodied carbon:** The greenhouse gas emissions arising from the manufacturing, transportation, installation, maintenance, and disposal of building materials.

**Environmental Product Declarations (EPDs):** The independently verified documents based on international standards. EPDs report the environmental impacts of a product, including global warming potential. These declarations can be used to track supply chain-specific product data and compare products with a similar function and scope.

**Greenhouse gas intensity (GHGI):** A measure of the greenhouse gas emissions associated with the use of all the energy required to operate a building. It is measured on an annual basis, and emissions are divided by the building's floor area. It is expressed as $kgCO^2e/m^2$.

**Heat pump:** A highly efficient heating and cooling system that transfers heat from the outdoor air in the colder months. A heat pump has the advantage of also extracting heat from indoor air to cool a building.

**Life-cycle assessment (LCA):** A standardized method used to quantify the environmental impacts of products and projects, including infrastructure and buildings. LCAs look at key stages in a product's life cycle, including material extraction, product manufacturing, product use, end of life, and beyond life (including reuse and recycling).

**Model code:** Canada's national model codes set out minimum requirements and form the basis of most building design in the country. It is a model set of requirements which provide for the health and safety of the public in buildings. These are produced nationally and published for adoption by authorities having jurisdiction (i.e., provinces and municipalities).

**Net-zero emissions building:** One that avoids or greatly reduces greenhouse gas emissions arising from the building's operations or construction materials. Residual emissions can be offset to achieve net zero.

**Operational emissions:** Those emitted during the building's operations or use.

**Site emissions:** All the energy used directly by the building. Site energy does not account for energy losses incurred during the production, transmission, and delivery of energy.

**Source emissions:** All energy used to power a building. It represents a combination of primary energy and secondary energy in a single common unit. It therefore includes the losses incurred during energy production, storage, transmission, and delivery.

**Zero-emissions building:** Defined by the City of Vancouver as a building that is highly energy efficient and uses only renewable energy.

**Zero-carbon building:** The Canadian Green Building Council (CaGBC) defines a zero-carbon building as one that is highly energy-efficient and minimizes greenhouse gas emissions from building materials and operations. Until all emissions can be eliminated, high-quality carbon offsets can be used as a counterbalance.

**Zero-carbon ready:** The International Energy Agency (IEA) defines a zero-carbon ready building as one that is highly energy efficient and uses either renewable energy directly or uses an energy supply that will be fully decarbonized by 2050, such as electricity or district heat. A zero-carbon ready building is expected to become a zero-carbon building by 2050, without any further changes to the building or its equipment.