# MAKING THE CASE FOR BUILDING TO ZERO CARBON

Canada Green Building Council®

## Executive Summary

STUDY SUPPORTERS:

Government of Canada / Gouvernement du Canada

real estate foundation British Columbia

REALPAC

NOVA SCOTIA / NOUVELLE-ÉCOSSE

# ACKNOWLEDGEMENTS

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**About CaGBC**

The CaGBC (www.cagbc.org) is a not-for-profit, national organization that has been working since 2002 to advance green building and sustainable community development practices in Canada. Through its leading programs that include the Leadership in Energy and Environmental Design (LEED®) and Zero Carbon Building Standard and in collaboration for its membership of over 1,200 industry organizations involved in designing, building, and operating buildings, homes, and communities, CaGBC has made excellent inroads toward achieving its mission of reducing the environmental impact of the built environment in Canada.

**About the Researchers (WSP)**

A leading engineering professional services consulting firm, WSP is a network of technical experts and strategic advisors that includes engineers, technicians, scientists, planners, surveyors, environmental specialists, and other design, program and construction management professionals. WSP experts are problem solvers who evolve, improve, modernize and excel, constantly working toward shaping the communities of tomorrow and helping societies thrive sustainably.

**About the Real Estate Foundation of British Columbia (REFBC)**

The Real Estate Foundation of British Columbia is a philanthropic organization based in British Columbia, Canada. REFBC supports land use and real estate practices that contribute to resilient, healthy communities and natural environments. The Foundation works to transform land use attitudes and practices in two ways: through grants to support research, education and law/policy reform; and through initiatives and special projects that bridge gaps in research and collaboration.

**About REALPAC**

Founded in 1970, REALPAC is a not-for-profit institutional real estate association, dedicated to advancing the long-term vitality of Canada's investment real estate sector. The Association advocates for global accounting, tax, market, sustainability and governance best practices. Membership is comprised of large public and private companies, pension funds, banks, life insurers and fund managers. Visit us at realpac.ca.



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# 1.0 EXECUTIVE SUMMARY

The Pan-Canadian Framework on Clean Growth and Climate Change committed to by Canada's First Ministers in December 2016 established Canada's vision for meeting its international commitment of a 30% reduction of greenhouse gas (GHG) emissions below 2005 levels by 2030 — a critical objective in Canada's transition to a low-carbon future.

Canada's built environment is a significant contributor to GHG emissions, with 17% of GHGs coming from residential, commercial and institutional buildings.[1]

The standard approach for decreasing GHG emissions associated with Canada's building stock remains the reduction of energy use required to heat, cool and power buildings through energy efficiency. By investing in energy efficiency measures, and as a result of cleaner electrical grids, Canada's GHG emissions associated with buildings have trended downward.[2]

However, current projections reveal that GHG emissions associated with buildings will grow modestly by 2030 unless further action is taken.[3] To effectively reduce GHG emissions at the building level, and to help ensure Canada meets its GHG reduction commitments, both energy use and carbon emissions need to be reduced simultaneously, which can be accomplished cost effectively by taking a Zero Carbon Building (ZCB) approach.

By turning existing and new buildings into ZCBs, Canada can significantly reduce its GHG emissions, decrease the demand for carbon intensive energy, and support Canadian real estate owners in optimizing the returns and resiliency of their portfolios. ZCBs can do this because they are designed to minimize carbon emissions and then offset any remaining emissions by generating clean, renewable energy onsite or offsite, which can reduce life-cycle costs and mitigate exposure to carbon pollution pricing.

1 Pan-Canadian Framework on Clean Growth and Climate Change. Canada's Plan to Address Climate Change and Grow the Economy. 2016. Available at: https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html

2 Environment Canada. Canada's Emissions Trends. 2014. Available at: http://publications.gc.ca/collections/collection_2014/ec/En81-18-2014-eng.pdf

3 Pan-Canadian Framework on Clean Growth and Climate Change. Canada's Plan to Address Climate Change and Grow the Economy. 2016. Available at: https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/climate-change-plan.html

A ZCB is characterized by four key components:

1. The building demonstrates a zero-carbon balance in its operations. Over the course of a year, its operations contribute zero carbon emissions.
2. Design prioritizes reducing energy demand and meeting energy needs efficiently.
3. Onsite renewable energy is used.
4. The embodied carbon of the structural and envelope materials (primarily carbon associated with manufacturing) is evaluated as part of the design.

ZCBs are essential to supporting Canada in meeting its Pan-Canadian Framework commitments, supporting building owners and operators in future proofing their building portfolios, and contributing to achieving carbon neutrality by 2050 as recommended by the United Nations' Intergovernmental Panel on Climate Change (IPCC).

## ZERO CARBON COSTING STUDY PROCESS

ZCB is a new approach in Canada that is not yet well understood by the development and construction industry, governments, and the real-estate sector with regards to the business case and necessary considerations for their implementation.

To address this knowledge gap, the Canada Green Building Council (CaGBC) commissioned WSP, supported by A.W. Hooker and Associates, to evaluate the financial viability and impact of constructing new buildings as ZCBs. The study examined seven building archetypes across six communities (see right).

**BUILDING ARCHETYPES:**

Low-rise office
Mid-rise office
Low-rise multi-unit residential
Mid-rise multi-unit residential
Primary school
Big box retail
Warehouse

**COMMUNITIES:**

Vancouver
Calgary
Ottawa
Toronto
Montreal
Halifax

The study applied a tailored package of carbon reduction measures across all building archetypes, including: wall and roof enhancements, window upgrades, enhanced user controls (i.e., smart controls), efficient ventilation systems, better heating and cooling delivery systems, fuel switching, and the use of onsite renewable power, such as photovoltaics (PV). The financial, energy and carbon reduction outcomes of the ZCBs were examined and compared to a baseline design that reflected the 2011 National Energy Code for Buildings.

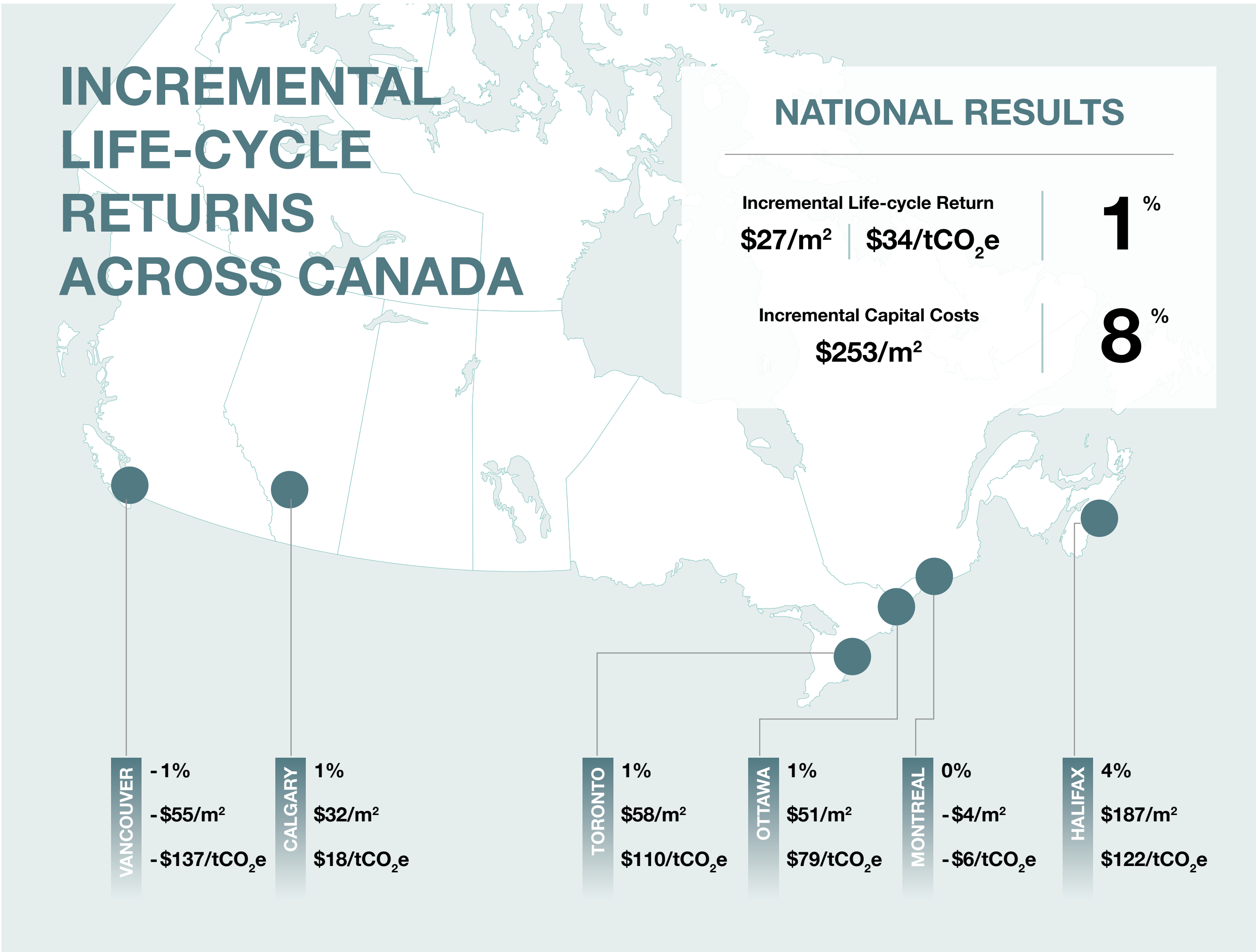


*Figure 1 – Incremental life-cycle returns across Canada*

## ZERO CARBON BUILDINGS OFFER MEANINGFUL CARBON REDUCTIONS AND POSITIVE FINANCIAL RETURNS

The study found that by 2030, over 4 million tonnes (Mt) of carbon dioxide equivalent emissions per year ($CO_2e$/yr) could be avoided cost-effectively if the building types studied are built to be ZCBs. This represents over 22% of the 20 Mt of GHG reductions that the Pan-Canadian Framework recognizes as potential savings from the buildings sector.[4] By 2050, over 12 Mt $CO_2e$/yr could be avoided.[5] The emissions reductions could be delivered at a total incremental capital cost of $3.3 billion per year, which would fund the construction of approximately 47,500 new residential units and 4,800 new commercial/institutional ZCBs annually.

This level of carbon reduction can be achieved with existing market-ready technologies and approaches for the building types evaluated. The study also confirmed that ZCBs are

[4] Canada's Buildings Strategy Update (2018), Energy and Mines Ministers' Conference. Available from https://www.nrcan.gc.ca/publications/11102

[5] This was determined by examining the floor area forecasted to be built for each archetype, in each province, assuming floor area grows at the same rate as the population (~26% between 2019 and 2050 ). These floor areas were then multiplied by the corresponding carbon savings per square meter per year, assuming NECB-2011 as the baseline.

financially viable: on average, ZCBs can be achieved with a positive financial return of 1% over a 25-year life-cycle, inclusive of carbon pollution pricing, and require a modest 8% capital cost premium.[6] As the cost of carbon rises over time, the financial return from ZCBs will only grow.

Nationally, the different archetypes yielded the following financial outcomes:

- Mid-rise and low-rise offices offer the highest life-cycle returns at close to 3%.
- Warehouses and big box retail facilities can yield returns of 1-2%.
- Multi-unit residential buildings (MURBs) and primary schools are cost neutral or nearly cost neutral.

Regionally, the outcomes for ZCBs are strongest in Halifax due to the high carbon intensity of the Nova Scotia electricity grid (which results in higher carbon cost savings potential) and the relatively low cost of electricity relative to natural gas (2:1 compared to almost 5:1 in Ontario). These factors make switching from natural gas to electricity for heating and hot water more financially advantageous.

In Montreal, Ottawa, Toronto and Calgary, the outcomes for ZCBs are economically strong with any upfront capital cost premium mitigated over the life-cycle by higher operating and emissions savings.

The financial outcome of ZCBs is less strong in Vancouver because of the low-carbon intensity of the electricity grid (which results in lower carbon cost savings potential), the low cost of natural gas, and the milder climate, which reduces the demand for energy. While the current economic case in Vancouver is less favourable than in the other communities profiled in this study, the financial returns will improve over time as the cost of carbon rises, which will lead to a higher price on all types of fossil fuels, including natural gas. The closer that electricity and natural gas come in price, the stronger the economic case for ZCBs. Vancouver's milder climate also enables alternate approaches to ZCB design, such as the use of air-source heat pumps and lower levels of building envelope performance, that would yield superior financial results.

The results of the study confirmed that ZCB can be achieved using only onsite carbon reduction measures in over 70% of the scenarios evaluated. In other cases, it is necessary to offset emissions by purchasing green power generated offsite. In this study, offsite green power is assumed to take the form of renewable energy credits (RECs). Where required, the financial impact of purchasing RECs is modest.

## AVOIDED COSTS OF BUILDING TO ZERO CARBON

The economic case for ZCBs presented above is further strengthened by the costs that are avoided by building to zero carbon, including:

| Avoided Cost | Explanation |
|---|---|
| Costly future retrofits | Buildings that are not designed at the outset to be ZCBs can expect to undergo more costly retrofits. These retrofits are likely to be disruptive, resulting in adverse economic impacts such as lost rent, or in the case of owner-operator buildings, displacement of staff. Life-cycle economic analyses need to account for these future retrofits. |
| Reduced service life of buildings | Although some of the carbon reduction measures evaluated for this study were not always cost-effective, such as window frames and additional wall insulation, their service lives exceed the 25-year time frame used for this study, extending their energy cost savings. |
| Reduced resilience and value impairment | ZCBs can help insulate owner-operators from future energy and carbon cost risks. There is the potential that the cost of carbon emissions in the period 2030-2050 will be higher than assumed in this study. It is also possible that the price for electricity and natural gas will rise faster than presumed. Additionally, ZCBs that incorporate low-powered systems and onsite green power generation will further support buildings to withstand, respond and recover from prolonged power outages and other impacts of extreme weather events. |

[6] Over 25 years, the averaged cost of carbon pollution used for this study was $150/tonne. The starting cost was $50/tonne and an annual increase of $8/year was applied over 25 years.

## UNLOCKING THE POTENTIAL OF ZERO CARBON BUILDINGS

There are immediate opportunities for owner-operators, design teams and policy decision-makers to benefit from undertaking ZCB development, and to support the development of a ZCB marketplace.

### OWNER-OPERATORS AND DESIGN TEAMS

The business case for building owner-operators is strong, as they often pay both capital and operating costs over the entire life-cycle and are likely to have broader carbon reduction targets and commitments for their organizations. Furthermore, the incremental capital cost for developing ZCBs is expected to come down over time as building codes are strengthened and the price of carbon pollution increases. To unlock the value of ZCBs, building owner-operators and their design teams are encouraged to:

1. **Evaluate ZCB options to maximize carbon reductions and associated carbon costs today:** It is important to consider the risk of escalating carbon pollution pricing in the years ahead. Owner-operators should use life-cycle costing that factors in tightening building codes and increasing carbon pollution pricing as a tool to make future-proofing decisions early in the building development cycle.

2. **Use existing financial incentives to achieve a ZCB design:** There is a wide range of incentives and capital improvement grant opportunities to draw on to advance the development of ZCBs. Owner-operators can inform governments and utilities that they are willing to go beyond code - even going carbon neutral now – with the support of incentives targeted at the uptake of effective carbon reduction measures.

3. **Accept the challenge to be innovative:** Following an integrated design, construction and commissioning process can optimize carbon savings relative to capital costs and deliver a building that achieves its targets (including savings) during operation. The carbon reduction approaches and bundles evaluated for each archetype in this study could be further optimized through a properly leveraged integrated design process that includes early interaction with cost and construction experts.

Owner-operators can seek to maximize opportunities for carbon reduction measures and the benefits of an integrated design, especially at the bid development and contracting stages. Owner-operators can also recognize and promote the non-financial benefits of ZCBs to tenants/occupants and market peers, such as improved occupant comfort and increased resiliency.

### POLICY DECISION-MAKERS

The establishment of a robust ZCB marketplace can be accelerated by a range of pricing mechanisms, procurement and partnership models, and regulations that address the known impediments. To unlock the value of ZCBs, government policy-makers are encouraged to:

1. **Continue to incrementally raise the price for carbon pollution to achieve alignment with the IPCC target of carbon neutrality by 2050:** All users should see and pay the full real costs of carbon pollution from energy use. An incrementally rising cost on carbon causes conventional fossil fuel sources used for electricity and heating to gradually rise in cost based on their direct environmental impact. This helps re-enforce the business case for ZCBs and spurs innovation. An increasing price on carbon pollution is a critical measure for advancing GHG emissions reductions from Canada's buildings.

2. **Support time of use pricing for electricity, the use of renewable energy generation and storage, and net-metering:** Electricity pricing regimes can exert a strong influence on energy conservation and carbon reduction efforts. For example, if the commercial and mid-rise residential archetypes evaluated in this study were subject to time-of-use pricing (as are low-rise residential buildings in Ontario), building owner-operators could use demand reduction and demand response actions to achieve significant reductions in the cost of electricity, which would greatly support the uptake and viability of ZCBs. The use of distributed renewable energy generation, such as PV, and energy storage at the building site level can be instrumental to ZCB. The use of net metering, including virtual net metering, offers building owner-operators opportunities to benefit from the use of renewable energy generation and energy storage technologies, and avoid the potential need to use RECs.

3. **Incentivize capital based on carbon reduction potential:** Due to capital costs accruing to the owners/developers and energy cost savings to the tenant, referred to as the split incentive, there is a market barrier to considering the long-term benefit of carbon reductions. To address this, private investment can be incented by making ZCBs a new capital cost allowance class with an accelerated depreciation rate. This would allow owners to mitigate the capital cost premiums associated with ZCBs and support government efforts to reduce carbon emissions. Creating this new capital cost allowance class is an opportunity to direct the investment of capital to building projects that achieve carbon reductions.

4. **Demonstrate leadership through public building portfolios:** Governments are encouraged to demonstrate leadership by making it policy that any new buildings be constructed and operated as a ZCB. Federal, provincial, and municipal governments and their agencies own significant portfolios that can be levered to demonstrate the business case for ZCBs. This should also extend to buildings leased by government. In addition, federal-provincial infrastructure agreements should make ZCBs a key criterion for social infrastructure projects (e.g., affordable and social housing, education and training institutions, and healthcare facilities) funded under these bi-lateral agreements, including agreeing to fully fund any capital cost premium associated with ZCBs.

5. **Move the market to zero carbon and provide training to accomplish it:** Governments across Canada are introducing updated performance-based building codes that are placing increased emphasis on energy efficiency and the opportunity for renewable energy. As more stringent building codes are introduced, the most cost-effective measures for energy efficiency and carbon reduction will become business as usual. This will decrease the incremental capital costs required to achieve ZCBs, but it will also decrease the energy savings available and therefore make it harder to justify the investments needed. To address this, more progressive and targeted incentives and financing mechanisms that adapt to evolving building codes will be needed to support both public and private sector owner-operators in achieving ZCBs. In addition, a wide range of new skills and capabilities are needed for trades and other members of the construction workforce. Governments will need to invest in green building training, education and apprenticeship programs that target low carbon skills for tradespeople.

## ACCELERATING TO ZERO

The need for climate action is growing. In its recent report on limiting global temperature rise to 1.5°C, the United Nations' Intergovernmental Panel on Climate Change (IPCC) updated their recommended targets to 50% GHG emissions reduction by 2030 and 100% reduction by 2050.[7] The latest recommendations require accelerated reductions between now and 2030.

This study demonstrates that Canada can significantly and economically advance its current targets and those advised by the IPCC by taking a ZCB approach in the real estate sector, achieving up to 22% of the building sector's 20 Mt GHG reduction potential recognized in the Pan-Canadian Framework.[8]

The cost of not adopting a ZCB approach increases with each passing day. Every building built today that is not designed to achieve near-zero carbon emissions is contributing to a continued increase in carbon emissions. Buildings not built to be ZCBs will require major investments in retrofits of mechanical equipment, ventilation systems and building envelopes (walls, roofs, and windows) by 2050 to meet Canada's targets. These retrofits will be costly and disruptive to building owner-operators and tenants, and will likely need to occur before the normal 25 to 40-year cycle of re-investment in major equipment and building upgrades.

CaGBC has worked with its members and industry stakeholders to develop a ZCB Standard for new and existing buildings. Supported by the insights of this study, the ZCB Standard is a made-in-Canada solution to achieving our climate change commitments, providing a path for buildings to reach zero carbon and contributing to the clean growth economy.[10]

Working together, Canada's building owner-operators, their design teams, and governments at every level can demonstrate leadership in proving the economic case for ZCBs and normalizing the processes and technologies that will make ZCBs the Canadian industry standard for value and resilience.

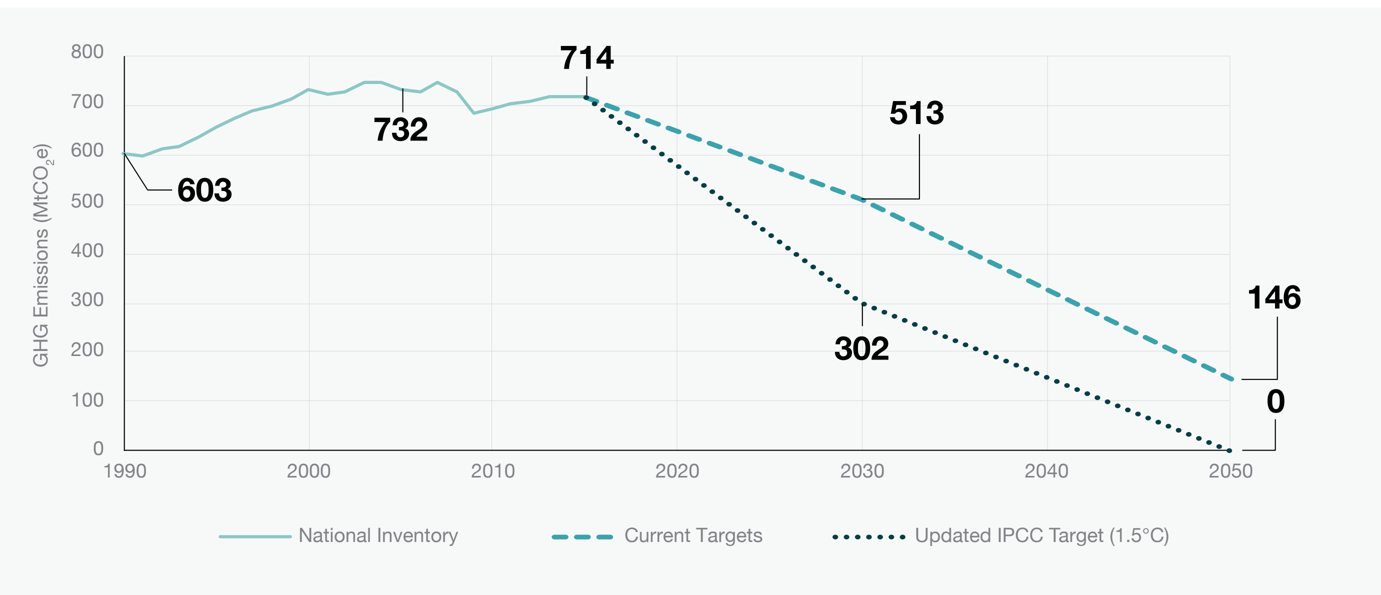


*Figure 2 – Historical and targeted GHG emissions for Canada*[9]

[7] Intergovernmental Panel on Climate Change (2018). Global Warming of 1.5°C. Available from http://www.ipcc.ch/report/sr15/

[8] Canada's Buildings Strategy Update (2018), Energy and Mines Ministers' Conference. Available from https://www.nrcan.gc.ca/publications/11102

[9] Data from Canada's National GHG Inventory Report (2017), available at https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/inventory.html

[10] CaGBC's Zero Carbon Building Standard is available at https://www.cagbc.org/zerocarbon

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