ZERO CARBON BUILDING STANDARD

Canada Green Building Council®

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EXECUTIVE SUMMARY

Over the past several decades, Canada has often been at the forefront of advocacy and action in response to environmental concerns. A prominent example is the Montreal Protocol, which was drafted during an international summit in the city in September 1987 and marked a significant step forward in dealing with the effects of ozone depletion. Indeed, former United Nations Secretary-General Kofi Annan regarded the agreement as "a model for international cooperation."[1]

A year later, Canada served a key role as host of the world's first major conference to examine the broader subject of climate change. Several hundred leading scientists gathered in Toronto in June 1988. The conference, "Our Changing Atmosphere: Implications for Global Security," was regarded as a landmark event.[2]

Fast-forward through the years and it becomes even clearer that Canadians have embraced our role as a galvanizing force for action. Today, Canada is recognized for being the first country to successfully negotiate carbon-trading mechanisms as part of the 2015 COP21 Climate Conference agreements in Paris, ensuring that broad market participation across nations can be achieved.[3] Within our own borders, the 2016 Pan-Canadian Framework on Clean Growth and Climate Change represents more than just our country's commitments to reducing its greenhouse gas emissions: it formalizes a path forward to secure our climate future.

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[1] "International Day for the Preservation of the Ozone Layer," United Nations, http://www.un.org/en/events/ozoneday/background.shtml.

[2] Elizabeth May, "When Canada Led the Way: A Short History of Climate Change," *Policy Options*, October 1, 2006, http://policyoptions.irpp.org/magazines/climate-change/when-canada-led-the-way-a-short-history-of-climate-change/.

[3] Bruce Cheadle, "Canadian Negotiators Pushing Emissions Trading Mechanisms at Climate Conference," *National Observer*, November 14, 2016, http://www.nationalobserver.com/2016/11/14/news/canadian-negotiators-pushing-emissions-trading-mechanisms-climate-conference.

The Canadian green building sector has been active – for decades in finding ways to limit harmful impacts from the built environment. While many of these efforts have been voluntary, an increasing number of governments across the country have recognized the potential of the building sector to fight climate change and have set more specific targets. To meet the COP21 goal of keeping global average temperature increases well below 2ºC, green building organizations around the world are supporting the objective of eliminating greenhouse gas (GHG) emissions associated with the operation of new buildings by 2030, and eliminating the GHG emissions from *all* buildings by 2050.

To meet those targets, bold new approaches are required to drive innovation. For its part, the Canada Green Building Council (CaGBC) has created a new zero carbon standard for assessing the carbon performance of commercial, institutional, and multi-family buildings in Canada. The CaGBC Zero Carbon Building Standard is a unique, made-in-Canada solution to achieving our climate change commitments, providing a path for both new and existing buildings to reach zero carbon.

A zero carbon building is defined as one that is **highly energy-efficient** and **produces onsite, or procures, carbon-free renewable energy** in an amount **sufficient to offset the annual carbon emissions** associated with operations.

ZERO CARBON REPRESENTS THE NEXT FRONTIER FOR THE BUILDING SECTOR

Canada has one of the most advanced green building sectors in the world and is well positioned to meet the challenge of reducing and eventually eliminating GHG emissions from building operations. Over the last decade green building certification programs have raised the bar for energy-efficiency, renewable energy and sustainability practices and, as a result, have changed the way buildings are designed, constructed, maintained, and operated.

Leadership in Energy and Environmental Design™ (LEED®) certification has demonstrated the market's interest in, and capability to adopt, leading sustainability practices, and has established the business case for such approaches. LEED projects certified in Canada before 2015 are projected to support 700,000 jobs and economic benefits exceeding $62 billion over their life spans.[4] Not only are these buildings better for the environment, but owners also benefit from higher lease rates, report greater tenant satisfaction scores, and spend approximately 28 percent less on energy compared with their non-certified counterparts.[5]

Building on these advancements, the next evolution is underway to meet the needs of a low-carbon economy. Green buildings can and should provide a gateway to innovation, representing an opportunity to apply new approaches, technologies and products that will lead to low carbon performance.

The CaGBC's Zero Carbon Building Standard provides a means to that end by making carbon reductions the key indicator for building performance and encouraging owners to drive down real emissions from buildings. Taking a carbon-centric approach is crucial because the most important factor in the emissions footprint of a building is often not energy performance, but rather the carbon intensity of the local electrical grid and the fossil fuels used. Recognizing the differences in electrical grids and fuels sources is critical to accurately assessing impacts and guiding investments.

The Zero Carbon Building Standard re-enforces the importance of energy efficiency while also driving careful choices about the types of energy used and encouraging more renewable energy generation both on the building site and offsite.

New construction projects present the best opportunities to achieve zero carbon performance and create a low carbon building stock for future generations. New buildings can be designed for optimal efficiency and resiliency. They can readily integrate renewable energy generation and select technologies that avoid the onsite combustion of fossil fuels.

At the same time, over 80 percent of existing buildings will still be in operation in 2030 and 50 percent in 2050, and therefore existing buildings need to be addressed in order to meet GHG reduction targets for the building sector. To help these buildings overcome the considerable physical and financial limitations in implementing deep retrofits, as much flexibility as possible should be provided in meeting a zero carbon objective.

To acknowledge these differences, the CaGBC's Zero Carbon Building (ZCB) Standard is designed to allow owners of both new construction projects and existing buildings to apply for certification, with unique requirements for each.

New construction projects earn **Zero Carbon Building – Design** certification by modeling a zero carbon balance, highly efficient envelope and ventilation systems, and onsite renewable energy systems. Project teams are required to evaluate energy use holistically, including impacts on peak electricity, and determine the GHG emissions associated with structural and envelope materials. Once occupied, buildings must demonstrate a zero carbon balance over the course of twelve months of operation before they earn **Zero Carbon Building – Design + Performance** designation. Existing buildings can only pursue **Zero Carbon Building – Performance** certification, which does not require a minimum of onsite renewable energy or a minimum level of thermal energy demand performance.

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[4] *Market Impacts Report*, Canada Green Building Council, 2016.

[5] Avis Devine and Nils Kok, "Green Certification and Building Performance: Implications for Tangibles and Intangibles," *Journal of Portfolio Management* – Special Real Estate Issue, 2015, http://www.iinews.com/site/pdfs/JPM_RE_2015_Kok.pdf.

Requirements of the Standard

	ZCB-Design (new construction)	ZCB-Performance (existing buildings)
Demonstrate Zero Carbon Balance	✓	✓
Provide Zero Carbon Transition Plan*	✓	Every 5 years
Install Minimum 5% Onsite Renewable Energy	✓	No requirement
Achieve Thermal Energy Demand Intensity Target	✓	No requirement
Report Energy Use Intensity	✓	✓
Report Peak Demand	✓	✓
Report Embodied Carbon	✓	✓

*Where fuels other than zero emissions biofuels are used onsite

ZERO CARBON BALANCE

Central to the standard's requirements is the achievement of a zero carbon balance, measured annually, in all building operations. To achieve that balance, GHG emissions associated with building operations must be offset using low-carbon renewable energy, either produced onsite or procured from offsite through a contractual arrangement.

The standard applies the GHG inventory methodology used by ENERGY STAR® Portfolio Manager®, the most commonly used energy-performance tracking and benchmarking platform in Canada. Portfolio Manager is used by over 13,000 buildings across the country and serves as the basis for evaluating energy efficiency under the LEED for Existing Buildings: Operations & Maintenance (EB:O&M) rating system. It is also increasingly being adopted for tracking and reporting energy use under benchmarking and disclosure regulations.

The Portfolio Manager methodology is based on the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard developed by the World Resources Institute and World Business Council for Sustainable Development. Portfolio Manager uses average regional emissions intensities for both natural gas and grid electricity to most accurately reflect the actual emissions intensity of a building's operational energy use.

ZERO CARBON TRANSITION PLAN

Significant financial and technological barriers to all-electric buildings may exist in some climate zones and building markets. For this reason, the Zero Carbon Building Standard allows the onsite combustion of fossil fuels and biologically derived fuels. All applicants who rely on onsite combustion of fuels other than zero emissions biofuels must provide a transition plan to demonstrate how the building will decarbonize in the future, showing that they have considered appropriate building design or retrofit measures. Buildings pursuing ZCB-Performance certification are required to update their transition plans every five years.

ONSITE RENEWABLE ENERGY

While the zero carbon balance can be achieved using either onsite or offsite sources of renewable energy, ZCB-Design certification requires that at least five percent of the building's total energy consumption be met using renewable energy that is generated onsite. Generating onsite renewable energy helps to improve building resilience in the face of power outages, reduces overall demand from the electrical grid, minimizes environmental impacts from power generation facilities, and helps prepare for a distributed energy future. To recognize the challenges and limitations faced by existing buildings, this requirement does not apply to ZCB-Performance certification.

THERMAL ENERGY DEMAND INTENSITY

Thermal energy demand intensity (TEDI) refers to the annual heat loss from a building's envelope and ventilation, after accounting for all passive heat gains and losses. Specific TEDI targets for ZCB-Design certification have been set, as per the table on the next page.

The inclusion of a specific TEDI target results in greater occupant comfort and ensures that building designers focus on minimizing a building's demand for energy prior to producing or procuring renewable energy. The target also helps to ensure long-term energy performance, as building

envelopes have long life spans and yield very reliable efficiency gains. Furthermore, they are typically challenging to retrofit.

Finally, improved thermal performance is correlated with improved resilience in the face of power outages, as building interiors are better able to maintain comfortable temperatures when the power supply is disrupted.

TEDI targets for ZCB-Design certification

Climate Zone	TEDI target (kWh/m2/year)
4	30
5	32
6	34
7	36
8	40

Given the challenges and cost implications of major envelope retrofits, applicants for ZCB-Performance certification are not required to meet specific TEDI targets. However, they are encouraged to consider measures to reduce thermal energy demand intensity as opportunities arise.

ENERGY USE INTENSITY

Energy use intensity (EUI) refers to a building's total operational energy use, including all heating, cooling, ventilation, lighting, plug, and process loads. The Zero Carbon Building Standard requires applicants to report their EUI to provide transparency and enable the industry to learn from each zero carbon building. Reporting EUI also enables the building operators to gauge the effectiveness of energy conservation measures and demonstrate progress over time. To provide flexibility to design teams, and in recognition of the further reductions in EUI that codes and incentive/recognition programs can be expected to drive over time, no EUI targets for new construction have been established. Similarly, EUI targets have not been set for operational performance to recognize the wide range in performance of existing buildings and encourage the greatest number of buildings to achieve zero carbon.

PEAK DEMAND

Several Canadian grids are experiencing significant stresses as populations grow and extreme weather events challenge the reliability of utility service delivery. Increased demand can also push up the marginal emissions intensity of electricity use in lower-carbon grids, as sources of backup power often rely on natural gas. To address these concerns, applicants for zero carbon certification will be required to report their annual peak demand. As with EUI, the rationale for this component of the standard is to encourage projects to track and reduce their peak demand over time, helping to reduce stress on the grid and the need for additional generation capacity.

EMBODIED CARBON

Although operational carbon emissions represent the key focus of the Zero Carbon Building Standard, there is a growing awareness of the importance of addressing the embodied carbon and other GHG emissions associated with building materials. Emissions associated with the manufacturing, transport, and installation of building components currently represent a relatively low proportion of an average building's total carbon footprint, but these emissions grow in importance as operational emissions are reduced. Applicants will be required to report the embodied emissions of the building's structural and envelope materials using life-cycle assessment (LCA) software. The embodied carbon requirement has been limited to reporting, to encourage the building industry to grow capacity for conducting LCA - a practice that is still relatively new in Canada.

LOOKING AHEAD

The standard is the product of a broad stakeholder consultation process, driven by a desire to craft a program that is both attractive to the building industry and rigorous in the outcomes it produces. In order to help inform the standard's evolution, the CaGBC launched the **Zero Carbon Building Pilot Program** in January 2017.[6] It offers a two-year immersion opportunity for developers and designers attempting to achieve zero carbon in new or existing buildings. The program is designed to support participants,

[6] Zero-Carbon Buildings Pilot Program, Canada Green Building Council, http://bit.ly/2qsaJsd.

recognize excellence and leadership, and inform the development of tools, resources and education to accelerate market transformation. The pilots themselves will assist CaGBC in refining the standard to ensure it can be adopted widely by the marketplace.

While there is no doubt that Canada's building sector has been dramatically transformed over the last two decades, the time has come to be more ambitious. The CaGBC's Zero Carbon Building Standard will drive meaningful change by defining new levels of performance and bringing focus to carbon emissions reduction. By recognizing the enormous potential that built environments offer, the Standard will help the building industry do its part in shaping Canada's climate future.

***Box 1** Working Group members*

ZCB Working Group members	CaGBC Energy and Engineering Technical Advisory Group members
Natural Resources Canada	Jason Manikel (chair) – Energy Profiles
National Research Council	Lindsay Austrom – Stantec Consulting Ltd.
Public Service and Procurement Canada – Real Property Branch	Eric Van Benscoten – Van-Fort Inc.
Royal Architectural Institute of Canada	Christian Cianfrone – Morrison Hershfield
Real Property Association of Canada	Kevin Henry – HDR Architecture Associates Inc.
Toronto and Region Conservation Authority	Curt Hepting – Enersys Analytics Ltd.
Toronto Atmospheric Fund	Steve Kemp – RDH Building Science Inc.
Pembina Institute	Wendy MacDonald – Advicas Group Consultants Inc.
Province of BC Building Safety Policy Branch	Craig McIntyre – Provident Energy Management Inc.
ON Ministry of Municipal Affairs & Housing	Andrew Morrison – Caneta Research Inc.
City of Toronto	Jean-Francois Pelletier – Vellum
City of Vancouver	Martin Roy – Martin Roy et Associés Groupe Conseil Inc.
University of British Columbia	Gordon Shymko – G.F. Shymko & Associates Inc.
	Anrej Simjanov – Mission Green Buildings
LEED Canada Steering Committee members	**Renewable Energy Working Group members**
Jennifer Sanguinetti (chair) – University of British Columbia	Chris Caners – Solar Share
Cindy Choy - Ministry of Infrastructure and	Ron Seftel – Bullfrog Power
Transportation, Government of Manitoba	Victoria Gagnon – IESO
Marsha Gentile – Ledcor	Patrick Bateman – CanSIA
Arsheel Hirji - City of Calgary Engineering & Energy Services	Nancy Rondeaux – Nova Scotia Department of Energy
Edwin Lim – ECOlibrium	Donovan Woollard – RADIUS Ventures
Josée Lupien – Vertima	Gerard MacDonald – Reshape Strategies
Jamie MacKay – Morrison Hershfield	Kevin Wallace, BC Hydro
Jason Manikel – Energy Profiles	Joan Haysom – Leidos Canada
Grant Peters – Fluent Group	Maryse Lambert, Hydro Quebec
Keith Robertson – Solterre Design	Jeff Toye & Michael Shaw – Manitoba Hydro
Lyle Scott – Footprint	
Doug Webber – WSP Canada Inc.	

THE KEY COMPONENTS OF THE ZERO CARBON BUILDING STANDARD

The Canada Green Building Council's **Zero Carbon Building Standard** represents a unique, made-in-Canada solution that can help us achieve our climate change commitments.

1 ZERO CARBON BALANCE

No net greenhouse gas (GHG) emissions are associated with building operations. GHG emissions are offset by generating clean, renewable energy onsite or offsite.

2 EFFICIENCY

New construction projects consider peak energy while maximizing energy efficiency with a focus on the building envelope and ventilation strategies that drive down thermal energy demand.

3 RENEWABLE ENERGY

Onsite renewable energy is incorporated into new construction projects to provide added resiliency, minimize offsite environmental impacts, and prepare buildings for a distributed energy future.

4 LOW-CARBON MATERIALS

An assessment of the carbon associated with structural and envelope materials—from manufacturing to end of life—informs design decisions.

TO LEARN MORE, VISIT WWW.CAGBC.ORG.

Canada Green Building Council
Every Building Greener

INTRODUCTION

Over the past several decades, Canada has often been at the forefront of advocacy and action in response to environmental concerns. A prominent example is the Montreal Protocol, which was drafted during an international summit in the city in September 1987 and marked a significant step forward in dealing with the effects of ozone depletion. Indeed, former United Nations Secretary-General Kofi Annan regarded the agreement as "a model for international cooperation."[7]

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[7] "International Day for the Preservation of the Ozone Layer," United Nations, http://www.un.org/en/events/ozoneday/background.shtml.

[8] Elizabeth May, "When Canada Led the Way: A Short History of Climate Change," *Policy Options*, October 1, 2006, http://policyoptions.irpp.org/magazines/climate-change/when-canada-led-the-way-a-short-history-of-climate-change/.

[9] Bruce Cheadle, "Canadian Negotiators Pushing Emissions Trading Mechanisms at Climate Conference," *National Observer*, November 14, 2016, http://www.nationalobserver.com/2016/11/14/news/canadian-negotiators-pushing-emissions-trading-mechanisms-climate-conference.

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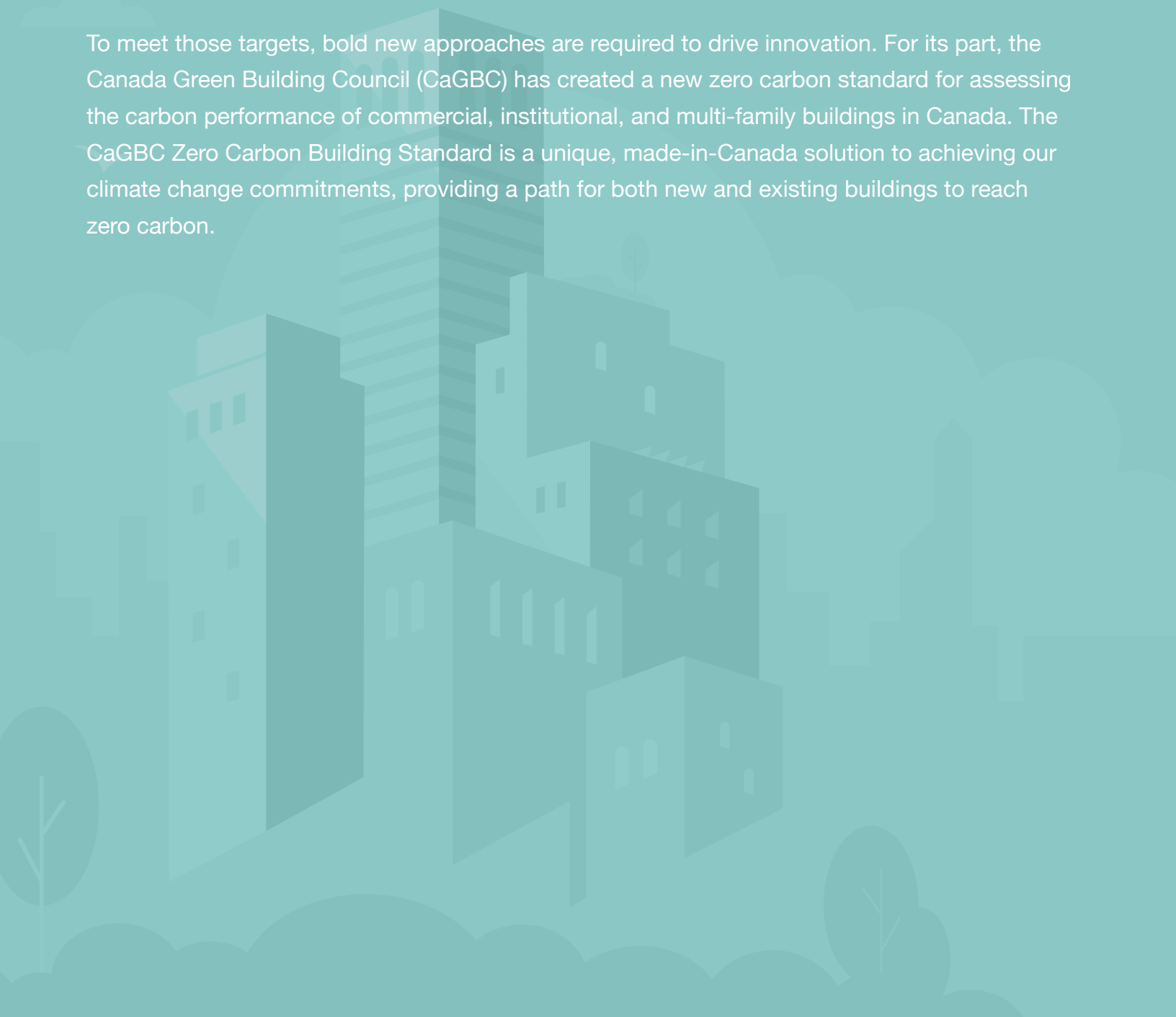

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Building on these advancements, the next evolution is underway to meet the needs of a low-carbon economy. Green buildings can and should provide a gateway to innovation, representing an opportunity to apply new approaches, technologies and products that will lead to low carbon performance.

The CaGBC's Zero Carbon Building Standard provides a means to that end by making carbon reductions the key indicator for building performance and encouraging owners to drive down real emissions from buildings. Taking a carbon-centric approach is crucial because the most important factor in the emissions footprint of a building is often not energy performance, but rather the carbon intensity of the local electrical grid and the fossil fuels used. Recognizing the differences in electrical grids and fuel sources is critical to accurately assessing impacts and guiding investments. The Zero Carbon Building Standard re-enforces the importance of energy efficiency while also driving careful choices about the types of energy used and encouraging more renewable energy generation both on the building site and offsite.

New construction projects present the best opportunities to achieve zero carbon performance and create a low carbon building stock for future generations. New buildings can be designed for optimal efficiency and resiliency. They can readily integrate renewable energy generation and select technologies that avoid the onsite combustion of fossil fuels.

At the same time, over 80 percent of existing buildings will still be in operation in 2030 and 50 percent in 2050, and therefore existing buildings need to be addressed in order to meet GHG reduction targets for the building sector. To help these buildings overcome the considerable physical and financial limitations in implementing deep retrofits, as much flexibility as possible should be provided in meeting a zero carbon objective.

To acknowledge these differences, the CaGBC's Zero Carbon Building (ZCB) Standard is designed to allow owners of both new construction projects and existing buildings to apply for certification, with unique requirements for each.

NEW CONSTRUCTION AND EXISTING BUILDINGS

A zero carbon building is defined as one that is highly energy-efficient and produces onsite, or procures, carbon-free renewable energy in an amount sufficient to offset the annual carbon emissions associated with operations.

Projects that achieve the requirements for new construction earn **ZCB-Design** certification. Certification is based on final building design and requires a modelled zero carbon balance; highly efficient envelope and ventilation systems to meet a defined threshold for thermal energy demand intensity; and onsite renewable energy systems capable of providing a minimum of 5% of building energy consumption.

[10] *Market Impacts Report*, Canada Green Building Council, 2016.

[11] Avis Devine and Nils Kok, "Green Certification and Building Performance: Implications for Tangibles and Intangibles," *Journal of Portfolio Management* – Special Real Estate Issue, 2015, http://www.iinews.com/site/pdfs/JPM_RE_2015_Kok.pdf.

At its heart, the program is about demonstrating a zero carbon balance in building operations year after year. Buildings that achieve a zero carbon balance and meet the other requirements for existing buildings earn **ZCB-Performance** certification. ZCB-Performance certification is awarded based on a twelve month period of operations, and performance must be verified annually. Recognizing the inherent challenges to retrofitting existing buildings, ZCB-Performance does not require a minimum of onsite renewable energy or a minimum level of thermal energy demand performance.

Buildings that receive ZCB-Design certification are expected to pursue ZCB-Performance certification annually following occupancy. A building that has achieved ZCB-Design certification can apply for ZCB-Performance certification any time after one year of building performance data has been collected. Achieving dual-certification earns buildings the unique designation of **ZCB–Design + Performance**.

Under both ZCB-Performance and ZCB-Design, applicants must evaluate energy use holistically, including impacts on peak electricity, and determine the GHG emissions associated with structural and envelope materials (i.e. embodied carbon). The program's alignment with ENERGY STAR® Portfolio Manager® ensures streamlined documentation of energy performance and GHG emissions.

The requirements of the Zero Carbon Building Standard are summarized below and detailed in subsequent sections.

***Table 1** Requirements of the Standard*

	ZCB-Design (new construction)	ZCB-Performance (existing buildings)
Demonstrate Zero Carbon Balance	✓	✓
Provide Zero Carbon Transition Plan*	✓	Every 5 years
Install Minimum 5% Onsite Renewable Energy	✓	No requirement
Achieve Thermal Energy Demand Intensity Target	✓	No requirement
Report Energy Use Intensity	✓	✓
Report Peak Demand	✓	✓
Report Embodied Carbon	✓	✓

*Where fuels other than zero emissions biofuels are used onsite

ELIGIBILITY AND CERTIFICATION

The ZCB-Design program applies to new commercial, institutional, and multi-family residential buildings other than those covered by Part 9 of the National Building Code, and major renovations to existing buildings. Major renovations to existing buildings include any HVAC, envelope, and/or interior renovations that require a new certificate of occupancy and/or prevent normal building operations from occurring while they are in progress. Proposed changes of use to the building in question are also considered major renovations.

The ZCB-Performance program applies to commercial, institutional, and multi-family residential buildings other than those covered by Part 9 of the National Building Code, provided they have been in operation for three or more years at the time of submittal or were previously certified under ZCB-Design.

Applicants will be awarded certification once all requisite documentation has been received and a review by the CaGBC has confirmed the requirements of the Zero Carbon Building program have been met.

SCOPE

The Zero Carbon Building Standard applies to the entirety of a building site and includes all energy use and generation. A site may include one or more buildings, either as independent or interconnected structures. Consistent with ENERGY STAR® Portfolio Manager®, parking areas may be excluded if all associated energy use and generation is sub-metered.

LOOKING AHEAD

The standard is the product of a broad stakeholder consultation process, driven by a desire to craft a program that is both attractive to the building industry and rigorous in the outcomes it produces. In order to help inform the standard's evolution, the CaGBC launched the Zero Carbon Building Pilot Program in January 2017.[12] It offers a two-year immersion opportunity for developers and designers attempting to achieve zero carbon in new or existing buildings. The program is designed to support participants, recognize excellence and leadership, and inform the development of tools, resources and education to accelerate market transformation. The pilots themselves will assist CaGBC in refining the standard to ensure it can be adopted widely by the marketplace.

While there is no doubt that Canada's building sector has been dramatically transformed over the last two decades, the time has come to be more ambitious. The CaGBC's Zero Carbon Building Standard will drive meaningful change by defining new levels of performance and bringing focus to carbon emissions reduction. By recognizing the enormous potential that built environments offer, the Standard will help the building industry do its part in shaping Canada's climate future.

[12] Zero-Carbon Buildings Pilot Program, Canada Green Building Council, http://bit.ly/2qsaJsd.

PROGRAM REQUIREMENTS

1. ZERO CARBON BALANCE
2. ZERO CARBON TRANSITION PLAN
3. ONSITE RENEWABLE ENERGY GENERATION
4. THERMAL ENERGY DEMAND INTENSITY
5. ENERGY USE INTENSITY
6. PEAK DEMAND
7. EMBODIED CARBON
8. COMPLIANCE AND DOCUMENTATION SUMMARY

1. ZERO CARBON BALANCE

Applicants to the Zero Carbon Building (ZCB) program must demonstrate a zero carbon balance in building operations – that is, projects must annually generate or procure enough zero-emissions, *renewable energy* to offset 100% of the GHG emissions associated with the building's total annual site energy consumption. Existing buildings are evaluated using actual performance, while new construction and major renovation projects are evaluated based on final design.

1.1. ENERGY STAR® PORTFOLIO MANAGER®

The ZCB program leverages ENERGY STAR Portfolio Manager's methodology for calculating GHG emissions in order to support consistency across the building sector and facilitate the calculation of ZCB program requirements. All GHG emission calculations for compliance to the ZCB program follow the Portfolio Manager methodology unless otherwise stated below. For clarification on any component of the Portfolio Manager approach to GHG emissions calculations, please refer to the Technical References on *GHG Emissions*[13] and *Green Power*[14].

Applicants to the ZCB program are required to use Portfolio Manager to track their GHG emissions. However, separate calculations may be required where:

1. *Renewable Energy Certificates (RECs)* are purchased to achieve the zero carbon balance (see Section 1.6);
2. Any energy generated using onsite zero emission *renewable energy* systems is exported to the grid (see Section 1.7); and
3. An applicant chooses to apply custom emissions factors for any district energy, electricity from an *islanded grid*, or onsite biogas or biomass systems used in building operations (see sections 1.4 and 1.5).

As noted in the Technical Reference on GHG Emissions[15], Portfolio Manager does not account for energy consumed for onsite vehicle use, industrial or manufacturing processes, or fugitive refrigerant emissions that result from a building's use of refrigeration or air conditioning equipment.

1.2. CALCULATING THE ZERO CARBON BALANCE

A zero carbon balance is demonstrated by achieving a net emissions balance of zero or less, where net emissions are defined as follows:

Net Emissions =

(*Direct Emissions* + *Indirect Emissions* + Biomass Emissions) – (Avoided Emissions from Offsite Green Power + Avoided Emissions from Exported Green Power)

This calculation has been adapted from Portfolio Manager's standard method of calculating the emissions balance, which does not recognize avoided emissions from exported *green power* (electricity generated from renewable resources, such as solar or wind resources). *Renewable energy* generated and used onsite (typically *green power*) does not contribute to avoided emissions in the calculation of Net Emissions under Portfolio Manager or the ZCB program, as these avoided emissions are already captured through the reduced reliance on energy sources that have associated emissions, such as grid electricity.

The individual components of the equation and their relevance to the zero carbon balance are outlined in the sections below, with a summary provided in Section 1.9.

1.3. DIRECT EMISSIONS

'*Direct Emissions*' refers to emissions associated with onsite combustion, with the exception of biomass combustion (see Section 1.5). Portfolio Manager applies transparent emissions factors to calculate annual building emissions associated with onsite combustion. Provincial GHG factors are used for natural gas, while national factors are used for other fossil fuels (e.g. propane, fuel oil, and diesel). Specific emissions factors are summarized in Figures 1 and 2 of Portfolio

[13] ENERGY STAR® Portfolio Manager Technical Reference: Greenhouse Gas Emissions. August 2016. https://portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf.

[14] ENERGY STAR® Portfolio Manager, Technical Reference: Green Power, 2013, https://portfoliomanager.energystar.gov/pdf/reference/Green%20Power.pdf.

[15] ENERGY STAR® Portfolio Manager Technical Reference: Greenhouse Gas Emissions. August 2016. https://portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf.

Manager's 2016 Technical Reference on GHG Emissions[16]. Portfolio Manager sources all Canadian GHG emissions factors from Canada's annual National Inventory Report.

1.3.1. BIOGAS

The ZCB program recognizes the emissions benefits of certain forms of renewable natural gas (biogas). Eligible biogas resources (i.e. those that are considered 'zero emissions' biofuels) that can be used onsite include gaseous products produced by the anaerobic decomposition of organic wastes from one of the following sources:

a) Sewage treatment plants;

b) Manure and other farm and food/feed-based anaerobic digestion processing facilities; and

c) Landfill gas.

Portfolio Manager currently uses provincial GHG factors for all natural gas combustion and does not recognize the carbon emissions benefits of biogas. Applicants must therefore perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with biogas.

1.4. INDIRECT EMISSIONS

'*Indirect Emissions*' refers to those emissions associated with purchased energy, such as electricity or thermal energy.

1.4.1. GRID OR DISTRICT ELECTRICITY

Provincial emissions factors are used to represent the average emissions of all grid-connected electricity generators in a given province (whether baseload, intermediate, or peaking). Provincial emissions factors for 2016 are summarized in Figure 6 of Portfolio Manager's 2016 Technical Reference on GHG Emissions[17].

The ZCB program recognizes that in some instances electricity may be sourced from a district energy system or an *islanded grid* (a small grid not connected to the provincial grid). The emission factors for these specific sources may be used where they are available and can be verified by a registered professional. As Portfolio Manager does not permit changes to default emissions factors, applicants must perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with the district energy system or *islanded grid*.

1.4.2. DISTRICT HEATING AND COOLING

Portfolio Manager provides national GHG emissions factors for district steam, district hot water, and three types of district chilled water systems (Figure 3 of Portfolio Manager's 2016 Technical Reference on GHG Emissions). Applicants are required to identify and enter the fuel being used and, if using district chilled water, the system used to power the building.

The ZCB program recognizes that the emissions factors in Portfolio Manager may not accurately reflect those of the district heating or cooling source for a given building. The emission factors for these specific sources may be used where they are available and can be verified by a registered professional. As Portfolio Manager does not permit changes to default emissions factors, applicants must perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with the district heating or cooling system.

1.5. BIOMASS EMISSIONS

Portfolio Manager applies a single emissions factor for wood to all biomass (see Figure 7 of Portfolio Manager's 2016 Technical Reference on GHG Emissions[18]).

However, the ZCB program recognizes the emissions benefits of certain forms of renewable biomass. As such, applicants who use an onsite form of biomass may submit more specific emissions factors where they can be verified by a registered professional. As Portfolio Manager does not permit changes to default emissions factors, applicants must perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with biomass.

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[16] ENERGY STAR® Portfolio Manager Technical Reference: Greenhouse Gas Emissions. August 2016. https://portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf.

[17] ***Ibid.***

[18] ***Ibid.***

1.5.1. ELIGIBILITY OF BIOMASS RESOURCES AS ZERO EMISSIONS BIOFUELS

Biomass resources used onsite that are *eligible* to be treated as *zero emissions biofuels*[19] include:

a) Solid biomass removed from fields and forests which are managed by following sound environmental management practices. Solid biomass can either be whole plants, parts of plants, or harvesting and industrial by-product residues arising from the harvesting and processing of agricultural crops or forestry products that would otherwise be land filled or incinerated;
b) Dedicated energy crops with a rotation of less than 10 years; and
c) Liquid fuels derived from biomass as defined in items (a) and (b) above, including among other things ethanol, biodiesel, and methanol.

Biomass resources that are *ineligible* to be treated as *zero emissions biofuels* include:

a) Municipal solid waste;
b) Forest biomass waste other than mill residue; and
c) To prevent toxic emissions, those manufacturing process by-products that have been treated in the manners listed below:
    i. Wood coated with paint, plastics or formica;
    ii. Wood treated with preservatives containing halogens, chlorine or halide compounds like chromated copper arsenate or arsenic;
    iii. Wood that has been treated with adhesives; and
    iv. Railroad ties.

If the treated biomass types (per 'c' above) comprise 1% or less by weight of the total biomass used and the remainder is from eligible sources of biomass, all biomass may be considered eligible to be treated as a *zero emissions biofuel*.

1.6. AVOIDED EMISSIONS FROM OFFSITE GREEN POWER

'Avoided Emissions from Offsite Green Power' refers to the emissions that are avoided as a result of generating *green power* offsite. Avoided emissions from offsite *green power* can be used to offset any emissions associated with Direct, Indirect or Biomass Emissions.

1.6.1. ELIGIBILITY OF OFFSITE GREEN POWER

To qualify under the ZCB program, offsite *green power* must be generated from:

- Solar energy;
- Wind;
- Water (including low-impact hydro, wave, tidal, and in-stream sources);
- Qualifying biogas (see Section 1.3.1);
- Qualifying biomass (see Section 1.5), or;
- Geothermal energy

Electricity products that drive additional offsite green power generation include both *Renewable Energy Certificates* (*RECs*) and *bundled green power products* (*green power* purchased together with associated *RECs*). The EcoLogo CCD-003 Renewable Low-Impact Electricity Products standard establishes requirements for both. Note that the term "renewable low-impact electricity", as used in the EcoLogo standard, may be considered to be the equivalent of "*green power*", as used here and within Portfolio Manager.

Per the EcoLogo requirements, the electricity associated with all *green power* products (both *bundled green power products* and *RECs*) must be generated within the calendar year in which they are sold, the first three months of the following calendar year, or the last six months of the prior year.

Under the ZCB program, all *RECs* must be certified by EcoLogo and generated from *green power* facilities located in Canada.

Bundled green power products must either be certified under the EcoLogo standard, or meet a set of specific requirements (see Section 1.6.2). If the energy generator providing *green power* does not also provide the associated *RECs*, applicants must purchase *RECs* for 100% of the *green power* that is procured. Under the ZCB program, all *bundled green power products* must be generated in Canada, and per the EcoLogo standard, from a generation facility located

[19] 'Zero emissions' is meant to characterize certain biofuels from a net-carbon emissions perspective; it is understood that other combustion products are released during combustion.

in the *provincial power pool* in which the building is located or a neighbouring *provincial power pool*. Applicants are encouraged to purchase *green power* generated as locally as possible, i.e. within the local municipality, region, or province.

1.6.2. REQUIREMENTS FOR NON-ECOLOGO CERTIFIED BUNDLED GREEN POWER PRODUCTS

Where EcoLogo certification cannot be obtained, applicants to the ZCB program must demonstrate that the *bundled green power products* that have been procured meet the following criteria:

- Demonstrate that all bundled electricity is generated within the *provincial power pool* in which the building is located (note that EcoLogo certified products may also come from neighbouring *provincial power pools*). All bundled electricity must be generated in Canada;
- Conform to all local land use polices and building codes. The project must achieve planning permission and all applicable local permits as defined by the Authority Having Jurisdiction;
- Meet the requirements of the acceptable sources of offsite *green power* as defined in Section 1.6.1;
- For combustion-based systems, meet all of the requirements surrounding biofuels as outlined in Section 1.3.1 (biogas) and 1.5 (biomass);
- For combustion-based systems, meet all local and regional air quality by-laws and requirements and receive all necessary air quality permits from the Authority Having Jurisdiction;
- For all water-powered systems, demonstrate that the facility's installation and operations have achieved all regulatory licenses, requirements, and all other authorizations pertaining to fisheries, without regard to waivers or variances or authorized. These include authorizations issued by the relevant provincial authorities, and under Section 35(2) of the Fisheries Act, by the Minister of Fisheries and Oceans or regulations made by the Governor in Council under the Fisheries Act;
- For all water-powered systems, demonstrate that the facility's installation and operations do not achieve authorization with terms that allow for the harmful operation and or disruption or destruction of fish habitat, as verified by a registered professional Biologist;
- For wind-powered systems, demonstrate that the impacts from the facility are not located in known migratory routes for avian or bat species, and that the impacts on avian and bat species from the facility have been minimized as verified by a registered professional Biologist.

1.6.3. CALCULATING AVOIDED EMISSIONS FROM OFFSITE GREEN POWER

Avoided emissions from the procurement of offsite *green power* are calculated using the marginal or "non-baseload" emissions factor for the province in which the power is generated, regardless of the location of the applicant's building. Marginal grid emission factors (not average emission factors) are used in calculating avoided emissions to reflect the fact that when building loads decrease, non-baseload, or "peak load", power output is typically reduced first.[20] Portfolio Manager obtains marginal emissions factors for each province from Natural Resources Canada. These factors are summarized in Figure 9 of Portfolio Manager's 2016 Technical Reference on GHG Emissions[21].

An electricity meter in Portfolio Manager must be used to record all purchases of *bundled green power products*. Portfolio Manager does not allow the entry of *RECs* in an amount greater than the amount of grid electricity purchased, however; as a result *RECs* cannot be used to offset emissions associated with onsite combustion. To address this, ZCB program participants must track *RECs* and the associated avoided emissions outside of Portfolio Manager.

[20] ENERGY STAR® Portfolio Manager Technical Reference: Greenhouse Gas Emissions. August 2016. https://portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf.

[21] *Ibid.*

1.6.4. ATTRIBUTING RECS TO MULTIPLE PROGRAMS

RECs may be used, or "retired", to meet any applicable regulatory programs in addition to the ZCB program. For example, where a building is located in a municipality or province that requires buildings to offset their operational energy consumption with the purchase of either *bundled green power products* or *RECs*, these purchases can also be used to meet the requirements of the ZCB program.

1.7. AVOIDED EMISSIONS FROM EXPORTED GREEN POWER

The ZCB program recognizes avoided emissions from onsite solar PV or wind energy exported to the grid in the calculation of the zero carbon balance, provided that the associated *RECs* are retained. The avoided emissions are to be calculated using marginal provincial CO_2e factors. As Portfolio Manager does not recognize these avoided emissions, applicants must perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with exported *green power*.

1.8 REQUIRED DOCUMENTATION

Applicants must provide the following documentation to demonstrate achievement of a zero carbon balance.

1.8.1. ENERGY STAR® PORTFOLIO MANAGER®

Applicants must use Portfolio Manager to track the project's energy consumption and associated GHG emissions. Modeled data should be used in Portfolio Manager for the purposes of ZCB-Design certification. The following must be provided to demonstrate the zero carbon balance has been achieved:

- A download of the annual data for each meter (grid purchased electricity, natural gas, *green power* generated onsite (used onsite and/or exported), *bundled green power products*, *RECs*, etc.), and;
- Emissions data: Total GHG Emissions (the sum of *Direct Emissions* and *Indirect Emissions*), Biomass Emissions, Net Emissions, and Avoided Emissions from Offsite *Green Power*.

Applicants must also share access to the property in Portfolio Manager, by providing Read Only Access to the Canada Green Building Council (account is called "CaGBC ZCB Program").

1.8.2. ALTERNATIVE GHG EMISSIONS FACTORS

While Portfolio Manager assigns a national emissions factor for district energy systems, the ZCB program recognizes that more accurate emissions factors may be obtainable. Where an applicant wishes to use a more specific emissions factor for district energy used in the building, the specific emissions factor calculated by the district energy provider will be accepted. This also applies to any electricity that is procured from an *islanded grid*.

Similarly, applicants using biogas or biomass as an onsite source of energy may submit separate GHG emission calculations that utilize a more accurate emissions factor, where one can be issued by a third party (i.e. not the building owner/manager).

In all cases, a registered professional must sign-off on any custom GHG emissions factor. Applicants must submit all calculations to the CaGBC for review.

1.8.3 ONSITE RENEWABLE ENERGY

Applicants to the ZCB–Design program must report on the quantity of usable energy predicted to be produced by *renewable energy* systems annually (calculated as the output energy from the system less any transmission and conversion losses, such as standby heat loss or losses when converting electricity from DC to AC), and the quantities predicted to be used onsite and exported.

Applicants to the ZCB–Performance program must report on the quantity of *renewable energy* that was generated onsite, and the amounts that were used onsite and exported, during the year for which certification is being sought.

These values may be provided in the form of a downloaded report from Portfolio Manager.

The Portfolio Manager meter used to record any energy generated by *onsite renewable energy* systems other than solar PV or wind (such as solar thermal), which have their own meters, should be classified as electric onsite solar to ensure that all *onsite renewable energy* is reported.

Applicants must provide calculations for the avoided emissions from *onsite renewable energy* that is exported, using the marginal provincial CO_2e factors.

1.8.4. OFFSITE GREEN POWER

The emissions that must be offset with *green power products* (*bundled green power products* and/or *RECs*) to achieve a zero carbon balance can be calculated as follows:

Required avoided emissions from purchases of *green power products* =

***Direct Emissions* + *Indirect Emissions* + Biomass Emissions – Avoided Emissions from Exported Green Power**

Applicants to the ZCB-Design program must provide the following information:

- A narrative indicating the commitment to fulfil the zero carbon balance requirement using purchases of offsite *green power products*, including the intended supplier;
- Estimates of the total quantity of offsite *green power products* that will be required to achieve the zero carbon balance;
- Estimates of the anticipated annual costs associated with the purchase of any required offsite *green power products*, and;
- Sources for all costs used in the calculation of annual cost estimates

Applicants to the ZCB-Performance program must submit proof of purchase (executed contracts) for all offsite *green power products*, as well as the following details for each source of offsite *green power*:

- Type of facility
- Project owner
- Ownership structure
- Year of generation
- Location of generation
- Fuel mix (if from more than one source)
- Estimates of total annual energy generation
- Proof of EcoLogo certification, if applicable (mandatory for *RECs*)
- The quantity of *bundled green power products* and *RECs* purchased
- The type of purchase agreement
- The length of the purchase agreement (in years)
- A copy of the purchase agreement.

1.8.5. NON-ECOLOGO CERTIFIED BUNDLED GREEN POWER PRODUCTS

Where EcoLogo certification cannot be obtained, applicants to the ZCB program must demonstrate that the *bundled green power products* that have been procured meet the criteria established in Section 1.6.2. In addition to the documentation requirements under 1.8.4, applicants must also provide the following documentation:

- A report from the generation facility that notes the methodology and calculations that were used to ensure that the design and operation of the facility will be sufficient to meet the contractual commitment made to the applicant. It will also note and detail the resources used to generate the energy and outline any limiting factors that may impact the ability of the facility to deliver energy. In such cases where resources are prone to fluctuations, a range will be provided to represent the best and worst-case scenarios, noting the methodology used to develop these scenarios (e.g. if the wind blows as anticipated; if the wind blows at the lowest annual recorded levels, etc.)
- Proof of the generation facility's commitment to retire the *environmental attributes* (i.e. *RECs*) that have been procured by the applicant (e.g. proof that *RECs* have been registered with a third party tracking system).

1.8.6. ANNUAL ADJUSTMENTS OF OFFSITE GREEN POWER PROCUREMENT

Applicants to the ZCB-Performance program must submit a copy of all purchase agreements for offsite *green power* products on an annual basis. Applicants wishing to demonstrate that a surplus of *renewable energy* was purchased in the preceding year must submit documentation to indicate the nature and extent of the surplus and how this affects the current year's emissions balance.

1.9. SUMMARY - ACHIEVING THE ZERO CARBON BALANCE

***Table 2** Summary – Achieving the Zero Carbon Balance*

Energy Source	Portfolio Manager Meter	GHG Calculation Method	Emissions Balance
***Direct Emissions** (onsite combustion)*			
Fuel Oil, Propane, Diesel, Kerosene	Fuel Oil, Propane, Diesel, or Kerosene Meter	Total site energy is multiplied by national CO_2e factor	Added to Direct Emissions
Natural Gas / Biogas	Natural Gas Meter	Total site energy is multiplied by provincial CO_2e factors[1]	Added to Direct Emissions
Indirect Emissions			
Grid or District Electricity	Electric Meter	Total site energy is multiplied by average provincial CO_2e factors[1]	Added to Indirect Emissions
District Heating/ Cooling	District Steam, Hot Water, or Chilled Water Meter	Total site energy is multiplied by national CO_2e factors[1]	Added to Indirect Emissions
***Biomass Emissions** (onsite combustion)*			
Biomass	Wood Meter	Total site energy is multiplied by national CO_2e factor for wood[1]	Added to Biomass Emissions
Avoided Emissions			
Offsite Green Power – Bundled Electricity	Electric Meter, specified as Green Power	Calculated using marginal provincial CO_2e factors, based on the location of power generation	Added to Avoided Emissions - Offsite Green Power
Offsite Green Power - RECs	Tracked outside Portfolio Manager[2]	Calculated using marginal provincial CO_2e factors, based on the location of power generation	Added to Avoided Emissions - Offsite Green Power
Onsite Green Power – Solar PV or Wind (used onsite, ownership of RECs retained)	Electric Onsite Solar or Wind Meter	Calculated using average provincial CO_2e factors	Indirect emissions reduction as a result of decreased consumption of grid electricity[3]
Onsite Green Power – Solar PV or Wind (exported, ownership of RECs retained	Electric Onsite Solar or Wind Meter	Calculated using marginal provincial CO_2e factors[4]	Added to Avoided Emissions - Exported Green Power[4]
Onsite Renewable Energy – Other than onsite green power (such as solar thermal)	Electric Onsite Solar Meter[5]	Calculated using average provincial CO_2e factors	Indirect emissions reduction as a result of decreased consumption of grid electricity[3]

[1] The ZCB program allows participants to submit individually-sourced emissions factors for biogas, biomass, district heating/cooling systems, and islanded or district electricity systems, where the emissions factors are available and can be verified by a registered professional. Biogas and biomass may qualify as zero emissions. As Portfolio Manager does not permit changes to default emissions factors, applicants must submit separate calculations.

[2] Portfolio Manager enables tracking of RECs however they must be tied to an electricity meter. For the purposes of the ZCB program RECs must be tracked outside Portfolio Manager so as to enable participants to use RECs to offset emissions from onsite combustion.

[3] Portfolio Manager reports the benefit from reduced reliance on grid electricity in the Onsite Avoided Emissions metric; this metric does not contribute to lowering Net Emissions under Portfolio Manager or the ZCB program, as it is only a quantification of the benefit gained from consuming less grid electricity.

[4] The ZCB program recognizes avoided emissions from exported electricity generated from solar PV or wind. As Portfolio Manager does not recognize these avoided emissions, applicants must submit separate calculations.

[5] The ZCB program recognizes avoided emissions from other zero-emissions onsite renewable energy systems. As Portfolio Manager cannot assess emissions if any meter is classified as "Other", the meter for a renewable energy system other than solar PV or wind should be classified as electric onsite solar.

2. ZERO CARBON TRANSITION PLAN

Applicants to the ZCB program who rely on onsite combustion of fuels other than *zero emissions biofuels* must prepare a Zero Carbon Transition Plan. The transition plan must indicate how the impact of onsite combustion will be mitigated over the lifetime of the building, including the way emissions derived from onsite combustion will be reduced or eliminated using specific design or energy efficiency measures.

2.1 REQUIRED DOCUMENTATION

The Zero Carbon Transition Plan must include the following information:

- A narrative describing why combustion of fuels, other than *zero emissions biofuels*, is necessary (e.g. cite financial and/or technical limitations to design/retrofit);
- A narrative of how building loads have been reduced using heat recovery strategies and/or passive design strategies;
- A narrative describing the mechanical HVAC strategy and how components of the system may be adapted to accommodate non-combustion based technologies, including:
    - Operating temperatures of the distribution system and its ability to accommodate renewable or electrical sourced heating;
    - Space allocation for renewable or electrical-sourced heating technologies;
    - Any barriers to be overcome or preconditions that must be in place for a conversion to a non-combustion based heating source to occur;
- Drawings that show provisions for future upgrades (e.g. space for electricity-based systems, roof space, etc.); and
- A financial comparison of the designed or current system and a non-combustion based alternative, including a 20-year net present value calculation, which includes current and projected fuel cost escalation and a 3% discount rate.

Applicants to the ZCB–Performance program that rely on onsite combustion of fuels other than *zero emissions biofuels* are required to submit a Zero Carbon Transition Plan as part of their initial certification (unless ZCB-Design certification was achieved within the last 5 years). Transition Plans must be updated every five years.

3. ONSITE RENEWABLE ENERGY GENERATION

Applicants to the ZCB-Design program must install *onsite renewable energy* systems to generate a minimum of 5% of the building's total annual energy consumption. Generating *onsite renewable energy* helps to improve building resilience in the face of power outages, reduces overall demand from the electrical grid, minimizes environmental impacts from power generation facilities, and helps prepare for a distributed energy future.

A separate meter in Portfolio Manager must be created to track each *onsite renewable energy* generation system. Note that a Portfolio Manager onsite solar meter should be used to track energy from a solar thermal system[22]. Applicants should refer to the Portfolio Manager Technical Reference on Green Power[23] for details on entering information about onsite *green power* such as solar PV or wind. All *environmental attributes* (in the form of *RECs*) associated with the onsite generation and/or export of *onsite renewable energy* must be retained by the applicant (cannot be sold) to be counted toward the fulfillment of the 5% minimum requirement and the achievement of the zero carbon balance.

Applicants to the ZCB-Performance program are not required to meet the minimum 5% *onsite renewable energy* generation requirement, but are encouraged to consider retro-fitting *onsite renewable energy* generation.

3.1. REQUIRED DOCUMENTATION

Applicants to the ZCB-Design program are required to submit calculations for the predicted amount of usable energy produced onsite annually, demonstrating that at least 5% of the predicted total annual energy consumption will be met through *onsite renewable energy* generation. Include the type of *renewable energy* system(s) and output files from the whole building energy simulation used to calculate the predicted total annual energy consumption. Note that the usable energy produced by the *renewable energy* system is the output energy from the system less any transmission and conversion losses, such as standby heat loss or losses when converting electricity from DC to AC).

[22] As Portfolio Manager cannot assess emissions if any meter is classified as "Other", the meter for a renewable energy system other than solar PV or wind should be classified as electric onsite solar.

[23] ENERGY STAR Portfolio Manager, Technical Reference: Green Power, 2013, https://portfoliomanager.energystar.gov/pdf/reference/Green%20Power.pdf.

4. THERMAL ENERGY DEMAND INTENSITY

Thermal Energy Demand Intensity, or *TEDI*, refers to the annual heat loss from a building's envelope and ventilation, after accounting for all passive heat gains and losses. When measured with modelling software, this is the amount of heating energy delivered to the project that is outputted from any and all types of space heating equipment, per unit of *gross floor area*.

The inclusion of a specific *TEDI* target results in greater occupant comfort and ensures that building designers focus on minimizing a building's demand for energy prior to producing or procuring *renewable energy*. The target also helps to ensure long-term energy performance, as building envelopes have long life spans and yield very reliable efficiency gains. Furthermore, they are typically challenging to retrofit. Finally, improved thermal performance is correlated with improved resilience in the face of power outages, as building interiors are better able to maintain comfortable temperatures when the power supply is disrupted.

Applicants seeking ZCB-Design certification are required to achieve a minimum level of performance in *thermal energy demand intensity* according to the climate zones in which their building is located. *TEDI* targets for each climate zone are outlined in Table 3. *TEDI* is to be calculated according to the Zero Carbon Building Energy Modeling Guidelines[24] and must be reported in kWh/m^2/year.

Table 3 *TEDI targets for ZCB-Design*

Climate Zone	TEDI target (kWh/m2/year)
4	30
5	32
6	34
7	36
8	40

The 30/kWh/m^2/year target for Climate Zone 4 aligns with some of the more stringent tiers of forthcoming zero emissions building frameworks in leading Canadian jurisdictions.[25]

4.1 REQUIRED DOCUMENTATION

ZCB-Design applicants must provide the modelled *TEDI* performance of the building, as well as a narrative of how *TEDI* has been reduced through the use of passive design measures.

Applicants seeking ZCB-Performance certification are not required to calculate or report *TEDI* performance.

[24] Available at http://www.cagbc.org/zerocarbon.

[25] For example, a TEDI target of 30 kWh/m^2/year approximately reflects a Tier 3 level of building performance under the City of Toronto's Zero Emissions Building Framework, as well as the proposed BC Step Code's Step 3.

5. ENERGY USE INTENSITY

Energy Use Intensity (EUI) refers to the sum of all site (not source) energy consumed on site (e.g., electricity, natural gas, district heat), including all process energy, divided by the building *gross floor area*. Applicants must report the total site EUI of the building in kWh/m^2/year. This will enable industry to learn from each zero carbon building. Reporting EUI also enables the building operators to gauge the effectiveness of energy conservation measures and demonstrate progress over time. To provide flexibility to design teams, and in recognition of the further reductions in EUI that codes and incentive/recognition programs can be expected to drive over time, no EUI targets for new construction have been established. Similarly, EUI targets have not been set for operational performance to recognize the wide range in performance of existing buildings and encourage the greatest number of buildings to achieve zero carbon.

5.1. REQUIRED DOCUMENTATION

ZCB-Design applicants must provide the modelled site EUI of the building, calculated based on the total predicted annual energy consumption from the whole building energy simulation divided by the *gross floor area*.

ZCB-Performance applicants must provide the metered site EUI reported in Portfolio Manager.

6. PEAK DEMAND

Several Canadian electrical grids are experiencing significant stresses as populations grow and extreme weather events challenge the reliability of utility service delivery. Increased demand can also push up the marginal emissions intensity of electricity use in lower-carbon grids, as sources of backup power often rely on natural gas. To address these concerns, applicants for certification under the Zero Carbon Building Standard are required to report their annual *peak demand* (or peak power) – the highest electrical load requirement in a year. Reporting will encourage projects to track and reduce their *peak demand* over time, helping to reduce stress on the grid and the need for additional generation capacity.

Peak demand must represent the highest electrical load requirement on the grid in a year, reflecting any peak-shaving impacts from demand management strategies including onsite power generation or energy storage. *Peak demand* must be measured and reported in kilowatts (kW).

6.1. REQUIRED DOCUMENTATION

ZCB-Design applicants must provide the modelled *peak demand* of the building, as well as the date and time of day when peak is modelled to occur.

ZCB-Performance applicants must provide the metered *peak demand* and, if available, the date and time of day when *peak demand* occurred.

7. EMBODIED CARBON

Although operational carbon emissions represent the key focus of the Zero Carbon Building Standard, there is a growing awareness of the importance of addressing the embodied carbon and other GHG emissions associated with building materials. Emissions associated with the manufacturing, transport, and installation of building components currently represent a relatively low proportion of an average building's total carbon footprint, but these emissions grow in importance as operational emissions are reduced.

Applicants must conduct a cradle-to-grave life cycle assessment (LCA) of the project. The embodied carbon requirement has been limited to reporting, to encourage the building industry to grow capacity for conducting LCA - a practice that is still relatively new in Canada.

The LCA must include all envelope and structural elements (including parking structure), including footings and foundations, and complete structural wall assemblies (from cladding to interior finishes, including basement), structural floors and ceilings (not including finishes), roof assemblies, and stairs construction, but exclude excavation and other site development, partitions, building services (electrical, mechanical, fire detection, alarm systems, elevators, etc.), and parking lots.

The LCA must assume a building service life of 60 years. If the service life of a product used in initial construction is greater than the building's assumed service life, the impacts associated with the product may not be discounted to reflect its remaining service life.

The LCA must include the following life cycle phases: resource extraction, product manufacturing and transportation, building construction, product maintenance and replacement, and building demolition/deconstruction/ disposal. Do not include the operating energy used by the building.

Embodied carbon must be reported as the LCA impact measure "global warming potential" (GWP), in kilograms of carbon dioxide equivalent (CO_2e), following the US EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI).

The LCA can be conducted in any manner that is consistent with international best practices, using regionally-appropriate data and impact assessment methods. The LCA is easiest to accomplish using a software tool specifically intended for building design teams, with the necessary background data and complex LCA methods already integrated within the tool. Building-specific simplified tools that do not require advanced LCA knowledge and that are regionally-appropriate include:

- The Athena Impact Estimator for Buildings. This is a free desktop software tool suitable for any stage of design, and can operate on an imported bill of materials or will estimate material quantities based on user inputs about the building.
- Tally. This a Revit® plugin – it operates on the bill of materials in a BIM model. There is an annual subscription fee to access the software.

7.1. REQUIRED DOCUMENTATION

ZCB-Design applicants must provide an embodied carbon report.

ZCB-Performance applicants must provide an embodied carbon report for initial certification (if ZCB-Design certification was not previously awarded) and whenever there are significant changes to the structural or envelope materials.

Embodied carbon reports must identify:

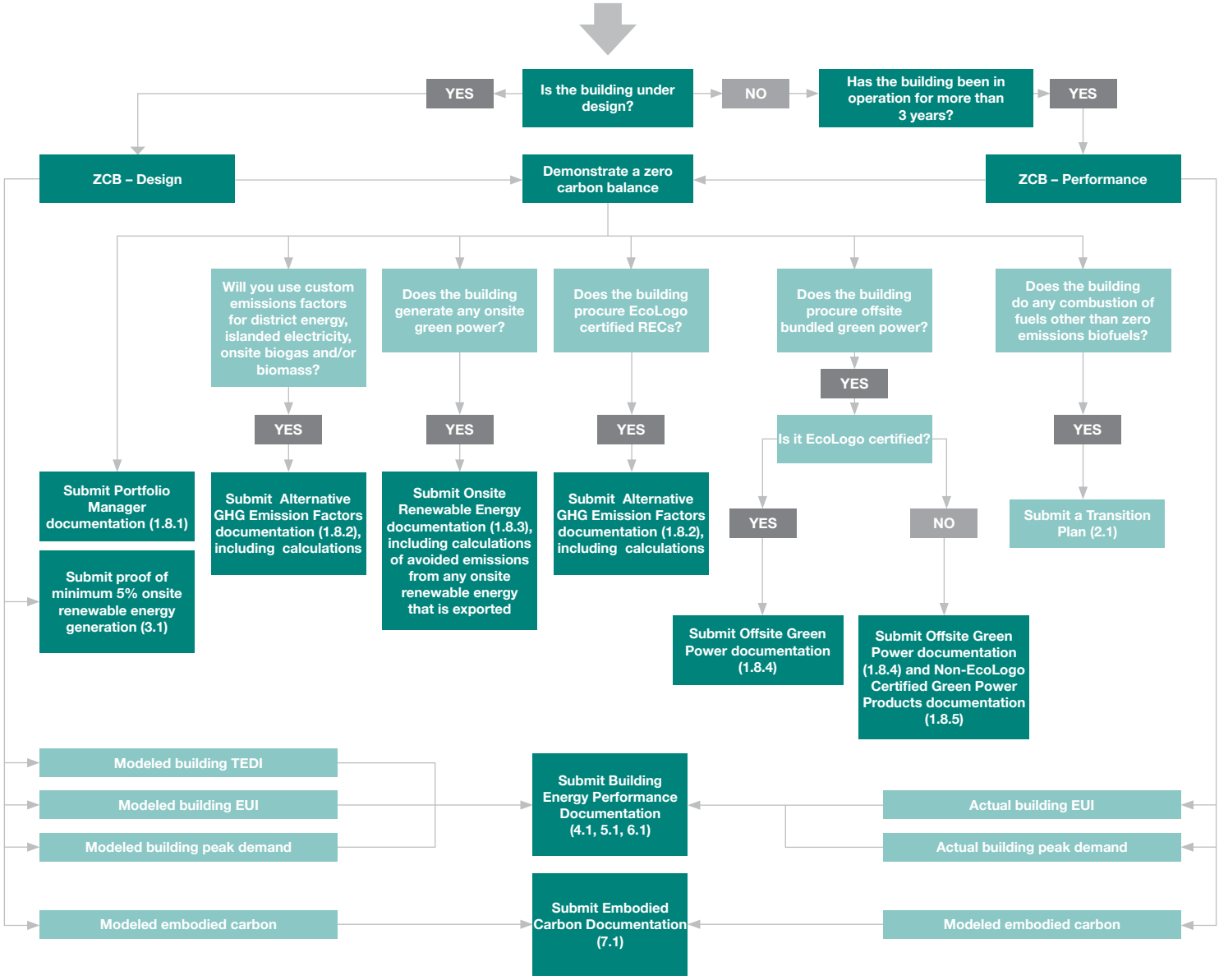
- The LCA software selected
- The elements of the building that are included in the calculation
- Total GWP (in kg CO_2e) of the building

Applicants may also submit a brief commentary on any challenges in meeting this requirement and any measures taken to reduce embodied carbon (*optional*).

If applicants are seeking the LCA credit in the LEED v4 BD+C: Building Life-Cycle Impact Reduction credit, *Option 4. Whole-Building Life-Cycle Assessment*, they may submit the relevant LEED documentation in lieu of the above requirements.

8. COMPLIANCE AND DOCUMENTATION SUMMARY

Figure 1 *Compliance and Documentation Summary Flow Chart*



DEFINITIONS

Building site: The building(s) and all associated area where energy is used or generated. A site may include one or more buildings, either as independent structures or interconnected.

Bundled green power product: See *bundled renewable low-impact electricity product.*

Bundled renewable low-impact electricity product: As defined in the EcoLogo standard, a product that includes both renewable low-impact electricity and the associated *RECs*.

Direct Emissions: Emissions from fuel that is directly burned at the building site, for example natural gas that may be combusted to heat the building.

Embodied carbon: The emissions associated with the production, transportation, assembly, use and eventual decommissioning of materials used in a building's construction. Embodied carbon is measured in kilograms of carbon equivalent.

Energy Use Intensity (EUI): The sum of all *site energy* (not *source energy*) consumed on site (e.g., electricity, natural gas, district heat), including all process loads, divided by the building *gross floor area*. EUI must be reported in kWh/m^2/year.

Environmental attributes: The representation of the environmental costs and benefits associated with a fixed amount of energy generation.

Generation facility: A power station designed and built to generate electricity.

Green power: Electricity generated from renewable resources, such as solar, wind, geothermal, low-impact biomass, and low-impact hydro resources. Green power is a subset of *renewable energy* that does not include *renewable energy* systems that do not produce electricity, such as solar thermal systems. "Green power" is synonymous with "renewable low-impact electricity", a term used within the CCD-003 Renewable Low-Impact Electricity Products standard from EcoLogo.

Green power product: A *bundled green power product* or *REC*.

Greenhouse Gas Intensity (GHGI): The total greenhouse gas emissions associated with energy use on the *building site*. GHGI is reported in gCO_2 e/m^2year.

Gross Floor Area (GFA): The total property floor area, measured between the outside surface of the exterior walls of the building(s). This includes all areas inside the building(s) including supporting areas. GFA is reported in square meters.

Indirect Emissions: Emissions associated with energy purchased from a utility, for example emissions associated with the generation of electricity or district steam.

Islanded grid: A small grid not connected to the provincial grid.

Peak demand: The building's highest electricity load requirement in a year. *Peak demand* is measured and reported in kW.

Provincial power pool: Any power pool of which a province is part including the power pool defined by the local North American Electric Reliability Corporation (NERC) region or, for provinces and territories that are not part of a NERC region (i.e. Newfoundland and Labrador, Yukon, Nunavut, and the Northwest Territories), the provincial/ territorial electricity system. The NERC regions define the following groupings of Canadian provinces:

1. British Columbia and Alberta
2. Saskatchewan and Manitoba
3. Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island

Onsite Renewable Energy: Energy generated on site from renewable sources, such as solar or wind. Where a site is not able to export energy off the site (i.e. where the building is not connected to the electricity grid), only that energy that can be consumed (or stored and then consumed) onsite is considered *onsite renewable energy*.

Renewable energy: A source of energy that is replenished through natural process or using sustainable management policies such that it is not depleted at current levels of consumption. Air-source and ground-source (geothermal) heat pump systems do not constitute *renewable energy*.

Renewable Energy Certificate (REC): An authorized electronic or paper representation of the environmental attributes associated with the generation of 1 MWh of *renewable energy*.

Site Energy: The amount of energy used on the *building site*.

Source Energy: The amount of raw fuel that is required to operate the building, incorporating all transmission, delivery, and production losses (such as in the generation and transmission of electricity).

Thermal Energy Demand Intensity (TEDI): The annual heat loss from the building envelope and ventilation. When calculated with modelling software, this is the amount of heating energy delivered to the project that is outputted from any and all types of space heating equipment, per unit of *gross floor area*. *TEDI* must be reported in kWh/m^2/year.

Zero Carbon Building: A highly energy efficient building that produces onsite, or procures, carbon-free *renewable energy* in an amount sufficient to offset the annual carbon emissions associated with building operations.

Zero Emissions Biofuel: Biogas or biomass fuels considered to be net-carbon neutral as the amount of carbon released by combustion approximately equates to the carbon that would have been released by natural decomposition processes.

Canada Green Building Council
Every Building Greener

Conseil du bâtiment durable du Canada
Verdir tous les bâtiments

Canada Green Building Council
202-47 Clarence Street
Ottawa, ON K1N 9K1
Telephone: +1 (613) 241-1184
Fax: +1 (613) 241-4782
Toll-free: +1 (866) 941-1184
cagbc.org/zerocarbon
zerocarbon@cagbc.org