SUSTAINABILITY BULLETIN

Canadian Precast Concrete Institute
Institut Canadien du Béton Préfabriqué

cpci.ca

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Figure 1:
The real-life project which was used as the building structure typology for this wbLCA.

A Summary of Whole-Building Life Cycle Assessment (wbLCA) for Total Precast Concrete Structures

Introduction

Mantle Climate has conducted a Whole-Building Life Cycle Assessment (wbLCA) for CPCI to quantify the whole-life carbon emission (operational and embodied carbon) for a total precast concrete building structure. This CPCI sustainability bulletin summarizes the results and highlights key findings.

The wbLCA examined carbon emissions in five Canadian cities: Vancouver, Edmonton, Toronto, Montreal, and Halifax. The assessment methodology follows the National Whole-Building LCA Practitioner's Guide. Both embodied carbon emissions (due to manufacture, transport, and construction/assembly of the structure and envelope) and operational carbon emissions (due to annual heating, cooling, ventilation, etc.) are considered. Life cycle stages assessed include A1- A5 (product manufacture, transport, and construction), B1-B5 (use stage), and C1-C4 (end-of-life).

Figure 2-3: Photos of the building used for this wbLCA Study.

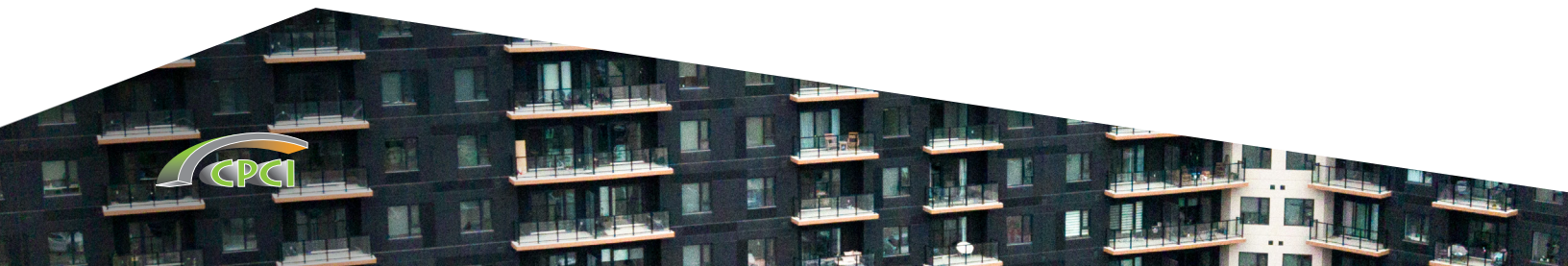
Building Typology Details:

The building structure typology modelled is based on a real project, which consisted of precast concrete structure, flooring, and envelope.

- **Building height:** 8 storeys, with no parking levels
- **Gross floor area (excludes parking):** 18,000 m²
- **Total dwelling units:** 178
- **Structural system:** Load-bearing precast concrete shear walls
- **Envelope:** Single-wythe precast concrete panels with interior steel stud framing and spray foam insulation
- **Floor system:** 250 mm (10 inch) thick hollowcore precast slabs

Results

All carbon intensity values are calculated based on gross floor area (does not include parking area). This will provide a more conservative intensity value than using the built floor area, which includes the parking area. This is the approach preferred by most jurisdictions in Canada.



Embodied Carbon

In all cities included in this study, the embodied carbon emissions for the total precast concrete structure were below current industry limits, demonstrating precast concrete's ability to achieve low-carbon construction. The results are shown in **Figure 4**.

The Canada Green Building Council (CAGBC)'s Zero Carbon Building – Design (ZCB-Design) Standard™ v4 sets an embodied carbon intensity limit of 425 kg CO_2e/m^2 of built floor area. The whole-life carbon emissions of the building across all five cities are below this limit.

A comprehensive embodied carbon benchmarking report released by the **Carbon Leadership Forum (CLF)** produced the following percentile results for multifamily residential buildings of the same LCA scope (structure and envelope) and life cycle stages (A-C):

- 75th percentile "high" = 520 kg CO_2e/m^2
- 50th percentile "typical" = 390 kg CO_2e/m^2
- 25th percentile "low" = 320 kg CO_2e/m^2

The building's emissions across all five cities fall below the CLF 25th percentile ("low") benchmark of 320 kg CO_2e/m^2

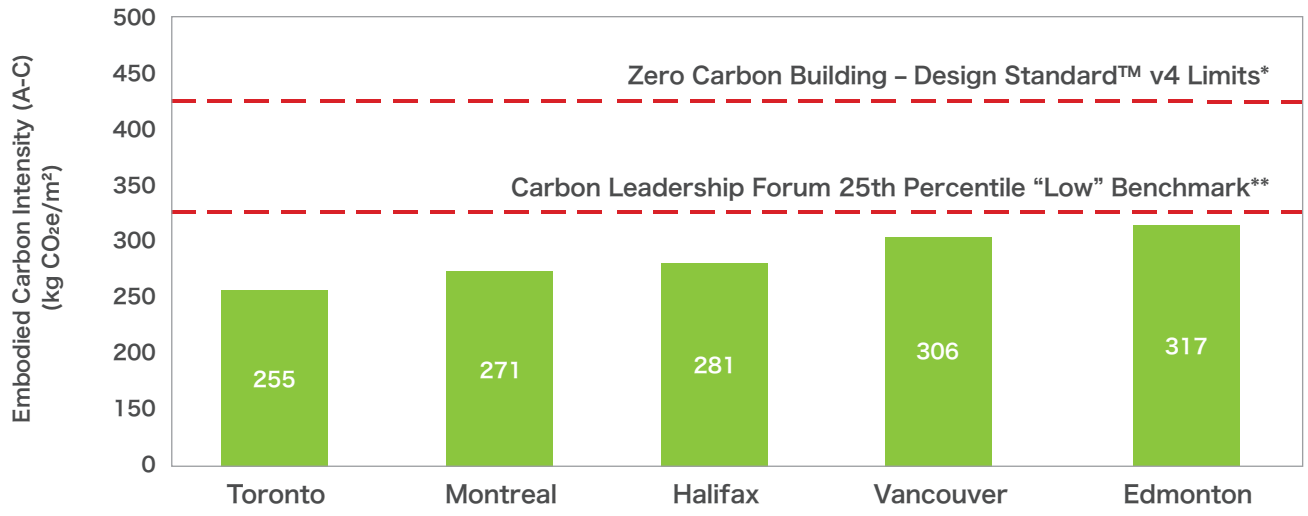


Figure 4: *Cradle-to-Grave (A-C) Embodied Carbon for the building across five Canadian cities.*
**The Canada Green Building Council (CAGBC)'s Zero Carbon Building – Design (ZCB-Design) Standard™ v4 sets an embodied carbon intensity limit of 425 kgCO_2e/m^2 of built floor area.*
*** Carbon Leadership Forum (CLF) Benchmarking Study V2 sets a 25th percentile "low" value of 320 kgCO_2e/m^2 of built floor area*

Operational Carbon

Operational carbon was examined over 60 years, with the assumption that the building typology will be constructed as a new build in each city, following the latest local energy requirements. Operational carbon emissions vary across regions due to differences in climate (energy demand), energy efficiency requirements, and the emission intensity of local energy systems (including the electricity grid). Some locations, such as Halifax, has a very carbon-intensive electricity grid. While other locations, like Montreal, have a low-carbon electricity grid and a newly enacted ban on combustion for heating. The results for operational carbon are shown in **Figure 5**. The figure provides relative scales of operational vs embodied carbon for different cities. In regions like Edmonton and Halifax, operational carbon is the most dominant contributor to whole-life carbon emissions.

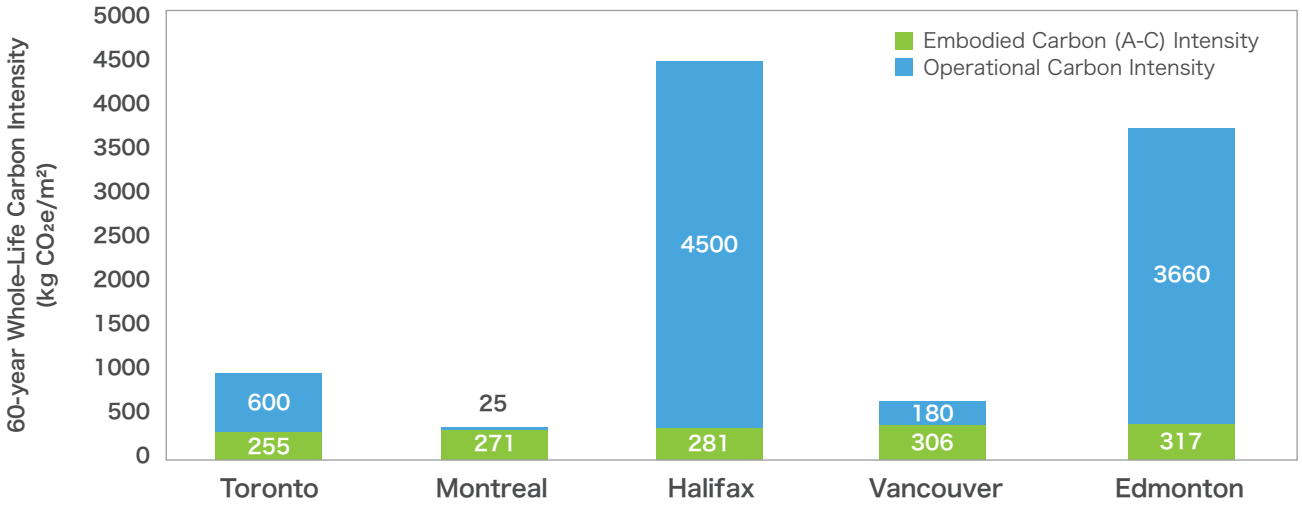


Figure 5: *Whole-life carbon intensity (A-C), with breakdowns of embodied and operational carbon intensity, over 60 years. Green represents embodied carbon intensity, and blue represents operation carbon intensity. Operational carbon emissions vary across regions due to differences in climate (energy demand), energy efficiency requirements, and the emission intensity of local energy systems (including the electricity grid).*

For the full report, scan the QR code

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