NOW

The Upfront Carbon Façade Materials Guide

April 22, 2025

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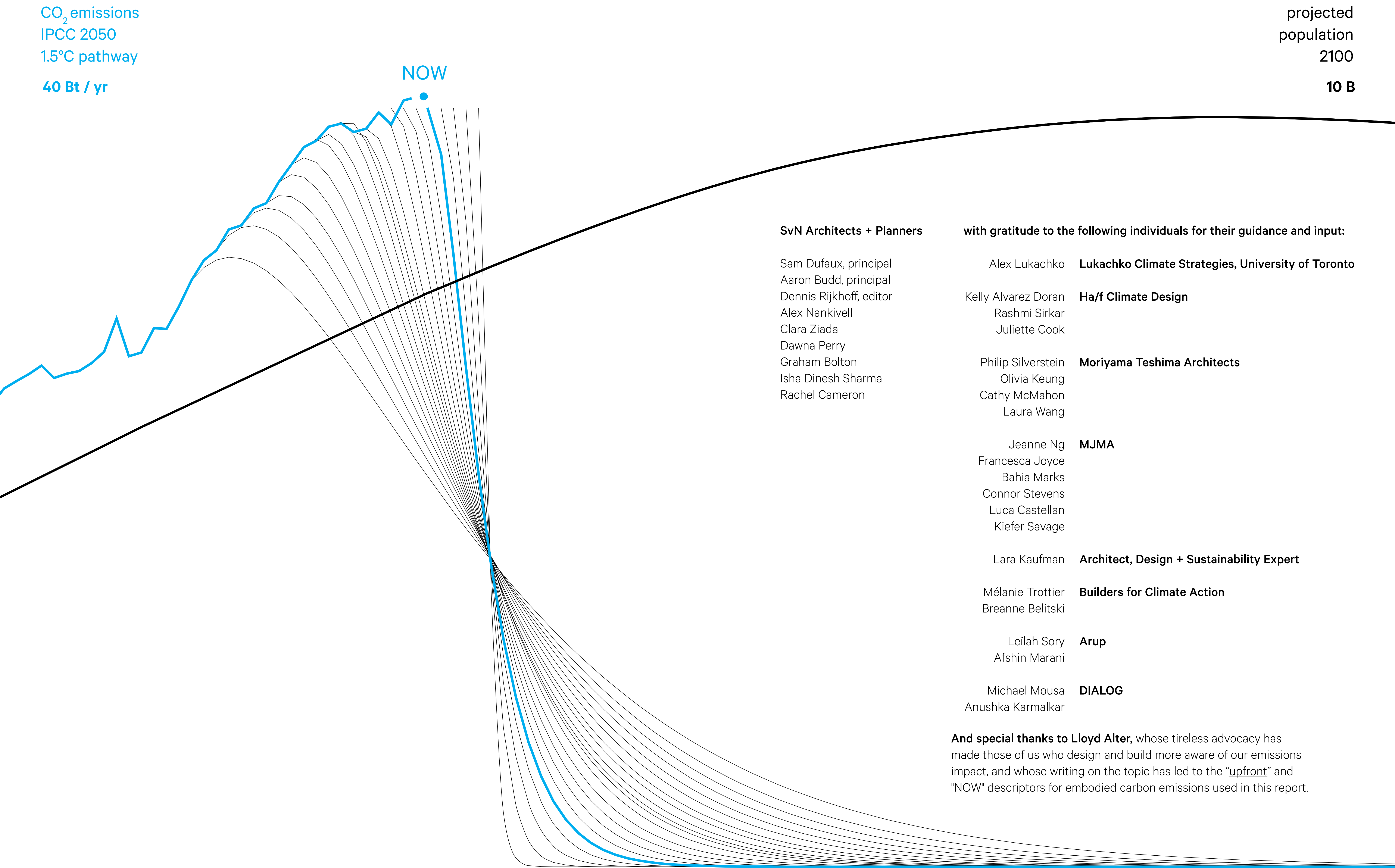

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And special thanks to Lloyd Alter, whose tireless advocacy has made those of us who design and build more aware of our emissions impact, and whose writing on the topic has led to the “upfront” and "NOW" descriptors for embodied carbon emissions used in this report.

table of contents

Note: all underlined text in this guide indicates cross-references or hyperlinks.

resources

Introductory materials and comprehensive overviews:

Carbon Leadership Forum, The Time Value of Carbon. 2017.
Ha/f Climate Design. Project Planning & Design Primer for Low-Carbon Construction. 2024.
International EPD System, A Short Introduction. Accessed online, March 2025.
Joseph Iano, Edward Allen, Fundamentals of Building Construction: Materials and Methods, 6th Ed. 2014.

Detailed references:

Arup, Saint-Gobain, Carbon Footprint of Façades: The Significance of Glass. 2022.
BDP Quadrangle, Embodied Carbon in High Performance Walls. 2022.
BDP Quadrangle, How Design Drives Embodied Carbon. 2024.
Builders for Climate Action, Emissions of Materials Benchmark Assessment for Residential Construction (EMBARC). 2022.
Ha/f Climate Design. A Whole Life Carbon Approach to Building Envelope Design. 2022.
Henning Larsen. Unboxing Carbon - Exterior Materials Catalog. 2024.
KPMB. Embodied Carbon Values in Common Insulation Materials. 2021.
RDH Building Science. New Design Resources for Embodied Carbon Targets. 2024.
WZMH. Re-make it Better; the WZMH Recladding Guide. 2024.

definitions

Embodied Carbon: emissions associated in the production and construction of a building including emissions from raw material supply, manufacturing, transportation, and construction or installation.

Embodied Carbon Intensity (ECI): embodied carbon measured per square metre of façade area, measured in this report as $kgCO_2e/m^2$. This is also referred to as "**emissions intensity**" and "**global warming potential (GWP)**", as defined below.

End-of-life Embodied Carbon: the carbon emissions associated with deconstruction or demolition, transportation from site, waste processing and disposal phases of a building or infrastructure's lifecycle which occur after its use.

Environment Product Declaration (EPD): material label that describes its environmental performance or impact over its lifetime. The calculations are based on LCA. In this document, EPDs are current as of January 2025.

Global Warming Potential (GWP): metric examining each greenhouse gas's ability to trap heat in the atmosphere compared to carbon dioxide. It is given units in its equivalent weight of carbon dioxide emissions: $kgCO_2e$.

Life Cycle Analysis (LCA): process of evaluating the effects that a product has on the environment over the entire period of its life.

Upfront Carbon: also known as "embodied" or "cradle-to-construction" emissions. These emissions are released into the atmosphere as we extract our materials, produce our products, and build our buildings. In LCA analysis, these typically include: raw material supply (A1), transportation (A2), and manufacturing (A3). To achieve net zero by 2050, we need to "buy time" by limiting / delaying emissions release until technology and consumption patterns can align with this goal. This is the reason for our current focus on "upfront" or "now" emissions. Refer to CLF's The Time Value of Carbon for a more detailed explanation.

Vertical Surface Area to Floor Area Ratio (VFAR): ratio of building façade area to floor area.

Window-to-Wall Ratio (WWR): ratio of glazed façade area to opaque façade area.

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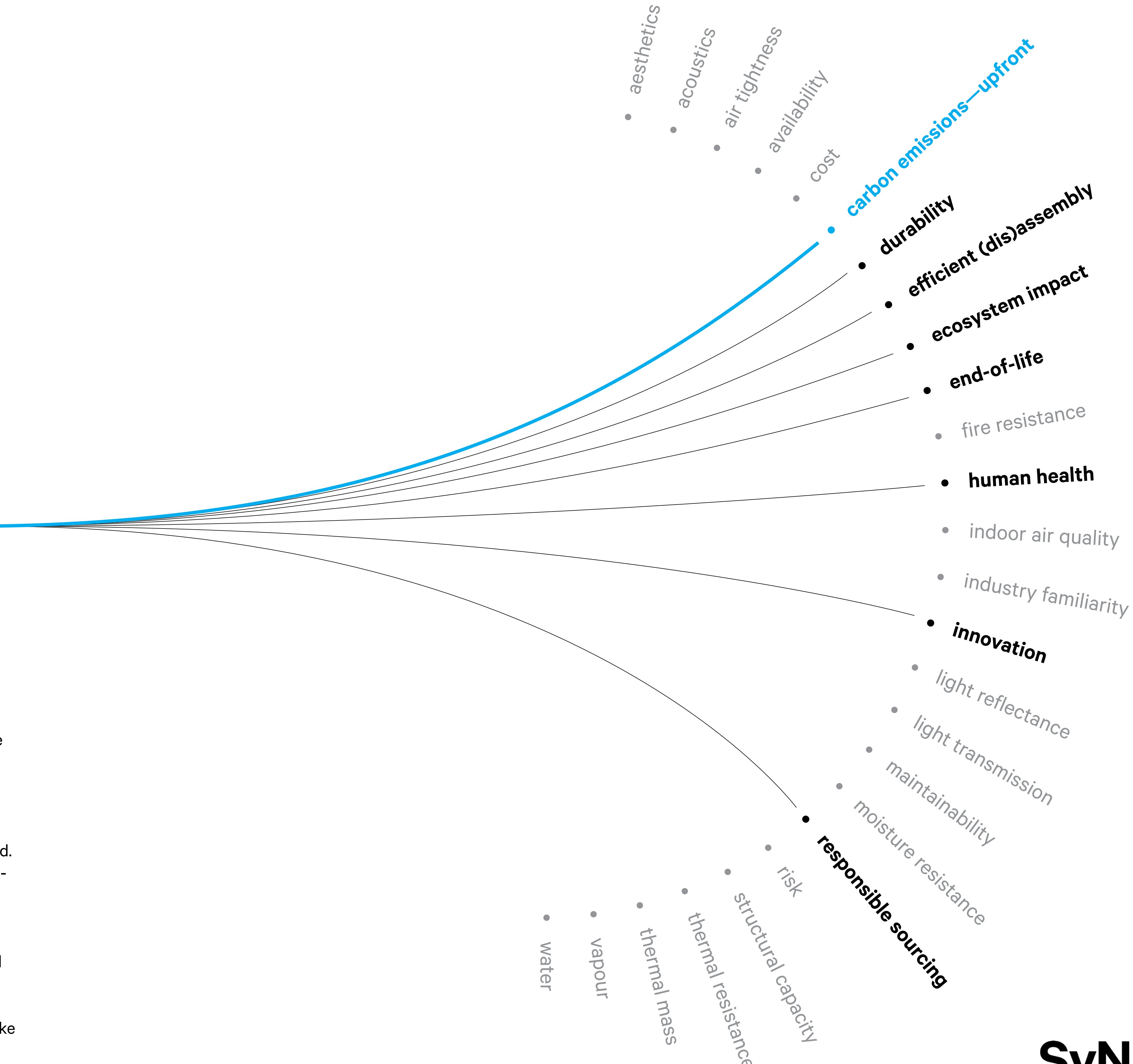
we need to make better choices:



this document provides a path.

Climate change is an urgent problem; it must be addressed NOW. Architecture can play a pivotal role in addressing this crisis because the materials we choose make a large impact. Through side-by-side comparisons and strategic insights, this guide gives context to the products that are commonly used in building façades, empowering designers to make more responsible choices when it matters most.

While carbon emissions are emphasized in this guide, we acknowledge that this is only one facet of the many overlapping concerns involved in "responsible" material selection. The health and well-being of Earth's ecosystems and our fellow humans must also be considered. To this end, materials in this guide are assessed through a lens that discourages petroleum-based, harmful products and encourages low-carbon, bio- and geo-based alternatives.

This guide is not a comprehensive solution, but a starting point: it intentionally simplifies complex decisions to spark deeper, project-specific conversations about the trade-offs and priorities that characterize materials selection. Shifting industry norms is no small task—it takes an immense amount of collaboration, as evidenced by the collective effort of the experts who generously contributed to this document. The results—the chance to help make the Earth a better place—are worth this effort. In the words of Kate Raworth: “let's make it irresistible, and get to work!”

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scope

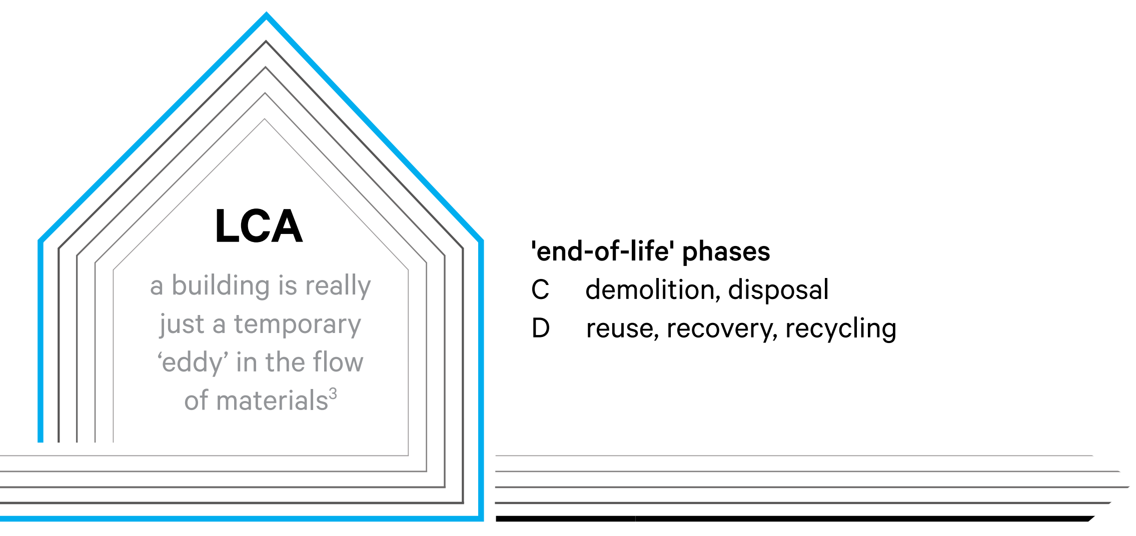
This guide is written for the design of large(r)-scale buildings in Ontario.
By focusing on OBC Part 3 buildings—including multi-unit residential, institutional, and commercial typologies—this guide supports projects that contribute to urban density, vibrancy, and climate-conscious development. By rooting itself in Ontario's regulatory, material, and climatic context, the catalogue prioritizes regionally-available products to reduce transportation emissions, support circular markets, and improve transparency around sourcing and labour.

This guide focuses on a building's façade—its exterior envelope or "skin".
Façade systems are incredibly impactful for both upfront and operational carbon emissions. In upfront emissions alone, a building's envelope accounts for approximately 13% of its initial "day-one" total, increasing to 37% over a building's life due to repairs and replacements.[1] Architects also have a high degree of interest for—and agency over—the outcome of building façades.

This guide focuses on "product stage" emissions.[1]
Environmental Product Declarations (EPDs) for North American building products are relatively rare.[2] Where available, the most accurate data covers the A1-A3 "cradle-to-gate" LCA phases: the extraction, initial transportation and manufacturing of a material into a product. While there is no doubt that the view presented by this data is limited—especially for important factors like durability—these initial phases are crucial for several reasons:

- **Immediate impact:** early stage emissions are released into the atmosphere immediately (NOW) making their reduction an urgent priority to mitigate climate change;
- **Large impact:** emissions from these stages are the largest contributor to a building's upfront carbon, often accounting for 60-80% of the total;
- **Design influence:** Architects and engineers have the most control over emissions from these stages through our design choices and role in material selection.

product phases
material extraction / harvesting A1
transportation to plant A2
product manufacturing A3



'end-of-life' phases
C demolition, disposal
D reuse, recovery, recycling

'on-site' phases
A4 transportation to site
A5 construction and installation
B use, maintenance, operation

	lifespan, material proportion
structure	30-300 years, 50-75%
skin	30-75 years, 15-20%
services	5-30 years
space plan	5-20 years, 25-30%
stuff	1-7 years

This guide has limitations.
The data presented in this guide is a simplified lens that primarily considers upfront carbon. Each team that is serious about making responsible materials choices should do so from a first-principles basis. This means considering the inherent "trade-offs" in every design decision with respect to the many other social and environmental factors, as well as an analysis of whole-life emissions impacts that includes both operational and embodied emissions.

Overall, a significant limitation in this guide is the lack of transparent data from product manufacturers.

[1] LCA descriptions + impacts adapted from Ha/f Climate Design, Project Planning & Design Primer, 2024.
[2] Use of Databases such as EC3, OneClick, and Materials 2050 are enabling designers to access this information more readily, potentially leading to systemic change.
[3] LCA diagram adapted from Stewart Brand "Building Shearing Layers" 1994; Material "flow" concept based on Kiel Moe, "Empire, State & Building" 2017.

concrete steel brick aluminum

The construction industry's use of materials—especially concrete, steel, brick, and aluminum—are creating a serious carbon debt. If we continue on our current "business-as-usual" (BU) path, the annual rate of this debt is set to increase 30% by 2060, as illustrated by the graph below. Note: while reading this graph, consider that 1 gigatonne = 1 trillion (1,000,000,000,000) kilograms, or approximately twice the mass of all humans on earth.

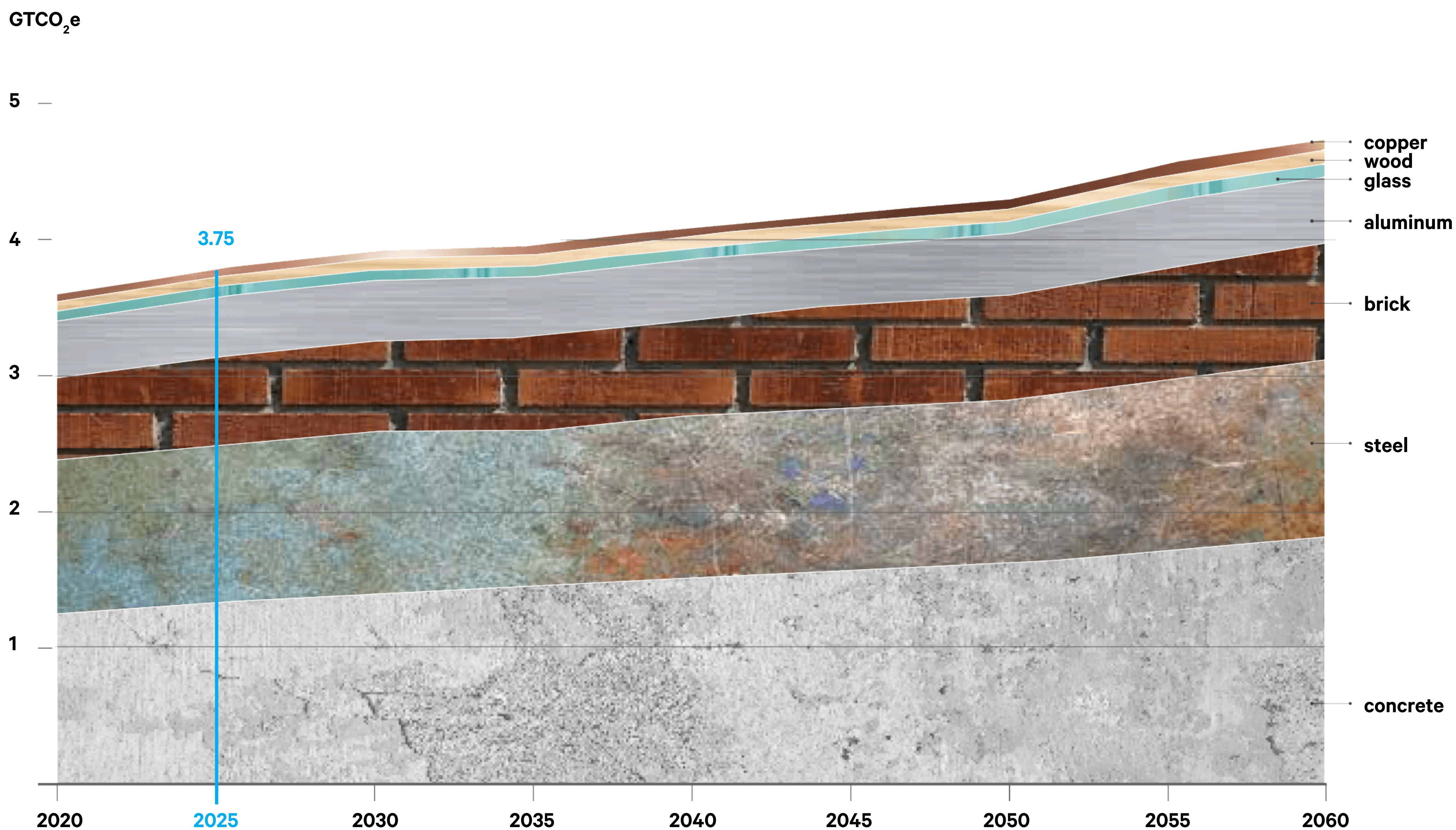


Diagram from Sustainable Materials Hub - UN Environment Programme 2023, Nairobi, with data based on Zhong et al 2021. Minor modifications and annotations by SvN.

concrete

- Second only to water, concrete production comprises our largest use of natural resources in the world, consuming over 4.4Bt of cement (WRI 2022), over 10Bt of sand and rock, and over 1 Bt of water annually (Iano, p.523).
- Cement generates 80-90% of concrete's upfront carbon, totalling nearly 8% of global annual CO_2 emissions (WRI 2022). 1 tonne of cement produces approximately 1 tonne CO_2 emissions (RM 2022).
- Concrete's raw materials are sourced from open-pit quarries. These activities often disrupt ecosystems, displace agriculture, and pollute water sources.
- Concrete construction also uses large quantities of other materials—wood, steel, aluminum and plastics—for formwork and reinforcing.
- Concrete is the largest contributor of construction waste in Canada accounting for approximately 40% of the total (NZWC). Re-use or recycling possibilities for concrete are limited. Downcycling—for landscape elements and gabion walls for example—is an option, but these applications have limited impact in terms of quantity.
- Emission reduction strategies include those that reduce the need for cement and new aggregates. Both of these strategies are outlined in the "precast cladding" section of this guide on page 11.

steel

- Globally, the steel industry accounts for about 7% of our greenhouse gas emissions (Kazmi et al, 2023).
- Canada's steel supply has one of the lowest emissions intensities in the world (GEI 2019, p.3). One kilogram of typical Canadian steel supply produces approximately 1.5 kg CO_2 emissions. However, steel that includes high amounts of recycled content can reduce emissions to roughly 0.4 kgCO_2 per kg of product. Recycled steel is also processed using Electric Arc Furnaces (EAFs), creating the potential to use renewable energy.
- Canada produces over 13 million tonnes of steel each year, approximately half of which is produced in Ontario (CSPA). Most of Ontario's structural steel is produced using 92% recycled content (AISC).
- The use of recycled content and renewable energy in EAFs (aka "Green Steel") has the potential to reduce emissions intensity by up to 75% (Kazmi et al, 2023).
- Steel is primarily composed of iron; Canada's main sources for iron ore are in Quebec and Labrador. Steel production also requires coal (coke) and limestone, which are sourced from mining and quarrying. These activities often disrupt ecosystems, displace agriculture and pollute air and water sources (Iano, p.316).
- While steel is highly carbon intensive, it is fully recyclable at its end-of-life.

brick

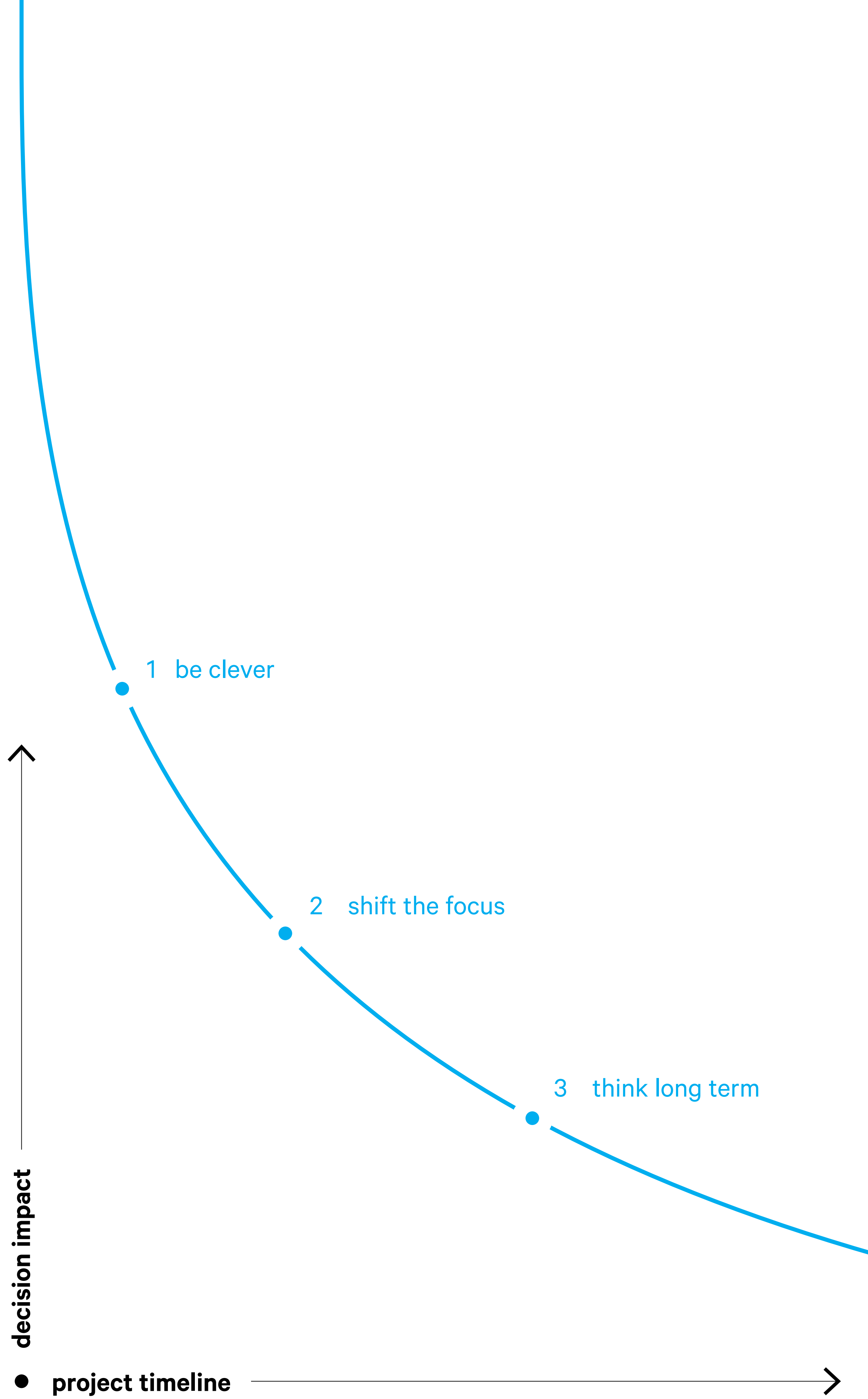
- Brick is one of the most common building materials in the world, but production statistics are rare. It is estimated 1.5 trillion bricks are produced globally each year (UN Environment Program 2022 p. 43), and over 4 billion bricks are produced annually in the US alone (EPA 2014).
- Current Canadian production statistics are unavailable. However, Brampton Brick, the second largest brick manufacturer in Canada, claims to produce 400 million bricks annually (Brampton Brick). This is nearly enough to build a 6 foot high brick wall around Ontario each year.
- On average, every conventional brick that is made emits 1.1 kg of upfront CO_2 emissions (Architect Magazine 2023).
- Clay and shale—the primary raw materials for brick— are generally obtained from open-pit quarries, which can disrupt ecosystems, displace agriculture and pollute water sources. These quarries are often located close to brick production facilities.
- Bricks are exceptionally durable, often being demolished well before reaching the end of its technical lifespan. Re-use is relatively rare; demolished brick is typically either crushed for aggregate or sent to landfills. This is due primarily to the labour associated with separating bricks from mortar without damage. Ontario-based company Brick Recyc has developed technology to facilitate brick cleaning, reducing labour for re-use.

aluminum

- The production of aluminum is very energy-intensive, consuming about 10x more electricity than steel production and accounting for 4% of global electricity demand (WEF 2023).
- Despite having no domestic sources of ore, Canada is the world's fourth-largest aluminum producer (NRC 2023), and the world's top exporter (OEC 2023).
- Each kilogram of aluminum produced releases between 2 and 13 kg of upfront carbon emissions, depending on the method of production (Hydro Circal). Aluminum production processes are also a major source of perfluorocarbons (PFCs), which are thousands of times more potent than carbon dioxide at trapping heat in the atmosphere (Mdlovu et al, 2024).
- In addition to its emissions, aluminum production has significant health and environmental impacts at each step in its process. Aluminum ore (bauxite) is generally found in tropical areas, commonly resulting in rainforest clearcutting, displacement of traditional communities, human right impacts on workers and heavy metal contamination in local water sources. Bauxite processing requires large volumes of water, leading to waste water laced with cyanide, antimony, nickel, fluorides, and other pollutants (Iano p.852, Environmental Integrity Project, 2023).
- The use of recycled aluminum and renewable or hydro power in aluminum production can limit these negative impacts, and should be urgently prioritized within our industry.

General Note:

While the negative impacts associated with the extraction of each of these materials are significant, it should be noted that each of these industries are making efforts to improve. As with any systemic intervention, materials innovations take years to implement.



strategy: designing a low-carbon façade

While using this guide, it is important to consider the entire spectrum of systemic leverage available to reduce upfront emissions in façade design. Decisions made early in the process have a massive influence on outcomes. The information on this page contextualizes the scope of this guide within these decisions, providing a tool to maximize emissions reduction in collaboration with clients and other project team members:

1 be clever

make better design choices:

- Sufficiency: consider how much space is needed—can you work with less?
- High-road + low-road design strategies: beautiful, functional (loose-fit, long-life) and well-crafted designs can reduce lifecycle emissions by enabling longevity.
- Set targets and iteratively analyze performance:
    - "Boxy-but-Beautiful" massing: use simple + strategic building massing and consider façade orientation to address heat gain, daylighting, and passive ventilation. Compare vertical area to floor area ratio (VFAR) and façade assembly embodied carbon intensity (ECI) with typological benchmarks;
    - Window-wall ratio (WWR) and insulation levels based on whole lifecycle emissions analysis, considering both operational and upfront emissions.

Note: the industry should address the current lack of typological benchmarks to guide this decision making.

2 shift the focus

make better materials choices:

- Determine whether existing façade materials—on or off your project site—can be re-used, retrofitted, or re-assembled to minimize the use of new materials and components.
- Consider whether façade assemblies can be simplified or streamlined.
- Choose low upfront carbon materials, paired with the following considerations:
    - Durability and circularity: limiting the debt of future emissions and economic and environmental costs due to replacement cycles and end-of-life pathways.
    - Human and ecological health: prioritizing geo- and bio-based materials and including HPD and Cradle-to-Cradle data in your decision making
    - Regional sourcing: limiting transportation emissions, stimulating local economies, and encouraging fair labour practices.

3 think long term

enable the high-quality construction and durability of your choices:

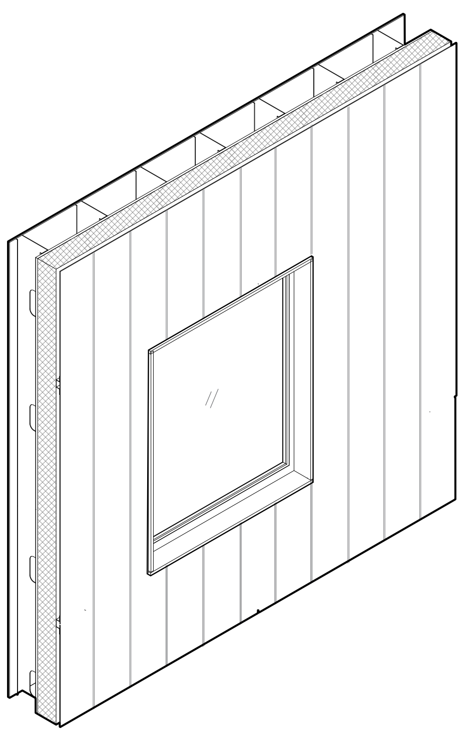
- Establish a design service life for the building, hone material choices based on full LCA
- Detail to prioritize durability, maintenance, replacement, and end-of-life systems disassembly. Use an in-situ performance mock-up to verify assumptions and expectations.
- Opt for prefabrication and unitization to reduce material waste and improve construction quality and safety.
- Optimize sequencing for labour and resources appropriate to the project's location.

strategy: the impact of better façade materials

This guide aims to empower designers to achieve outcomes similar to the example below, illustrating product substitutions that have:

- similar aesthetics;
- similar performance characteristics;
- similar installation processes + construction trades;
- *significantly reduced* upfront carbon emissions.

Note: This example is based on a 40:60 WWR and excludes factors such as comprehensive energy analysis, relative product cost, availability and other decision-making criteria.



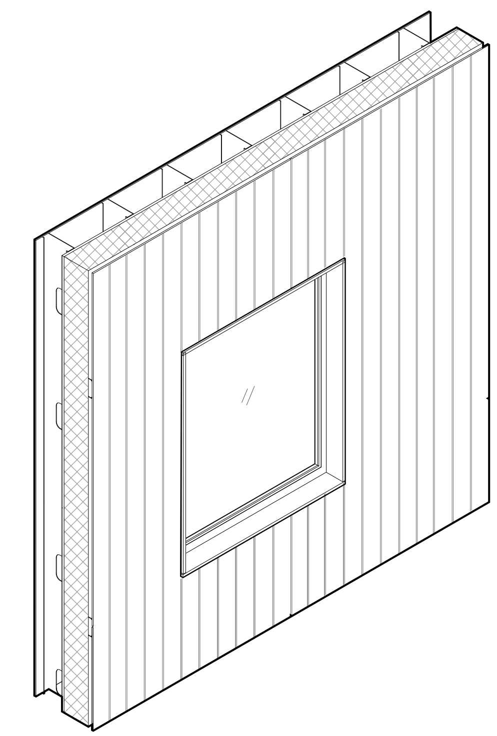
207

$kgCO_2e/m^2$

-44%

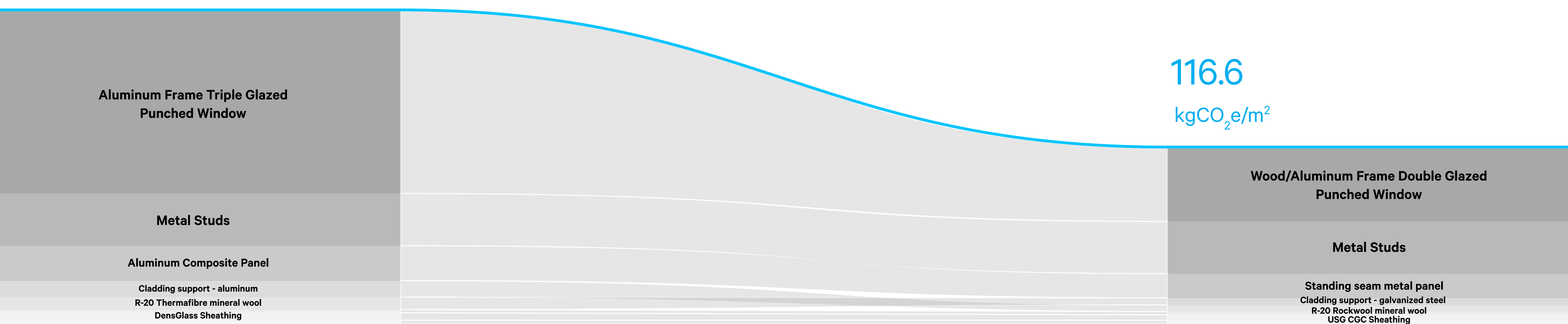
$kgCO_2e/m^2$

initial selections		→	substitutions
Triple glazed aluminum frame window	121	49	Double glazed wood/aluminum frame window
Aluminum composite panel	23	16	Standing seam metal panel
Cladding support - aluminum	10.9	4.4	Cladding support - galvanized steel
R-20 Thermafibre mineral wool	8.1	4.6	R-20 Rockwool mineral wool
AVB Membrane	2.2	2.2	AVB Membrane
DensGlass Sheathing	4.9	3.5	USG CGC Sheathing
Metal studs	34.4	34.4	Metal studs
Drywall	2.5	2.5	Drywall



116.6

$kgCO_2e/m^2$



guide: choosing better façade materials

The rest of this document compares emissions intensity ranges of 136 different façade products on a per square metre basis, helping designers make informed materials choices. The primary tool for comparison is the graph on this page.

This graph is a useful way to identify the fact that emissions can vary significantly within each material group, meaning that generalizations about which materials are "better" cannot be made. Best-in-class versions of typically high-emission materials can sometimes outperform poor versions of typically low-emission materials.

Therefore, to effectively address upfront emissions, designers should prioritize investigating products with **large emissions ranges** on this graph, as well as those that will be used in **large quantities** in their project.

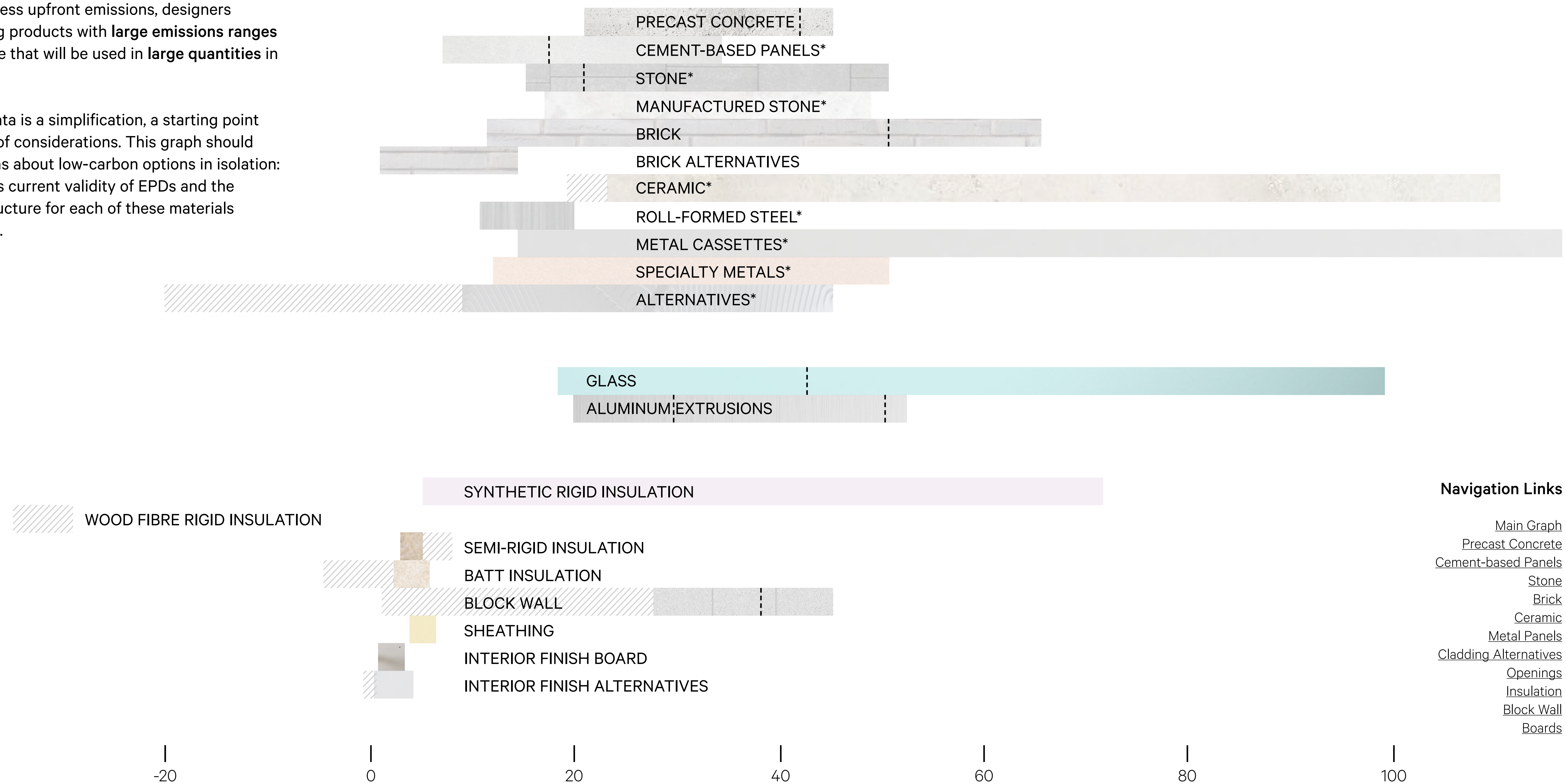
It is important to note that data is a simplification, a starting point that excludes a wide variety of considerations. This graph should not be used to make decisions about low-carbon options in isolation: at a minimum, factors such as current validity of EPDs and the requirements for support structure for each of these materials should be taken into account.

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account. *



Navigation Links

Main Graph
Precast Concrete
Cement-based Panels
Stone
Brick
Ceramic
Metal Panels
Cladding Alternatives
Openings
Insulation
Block Wall
Boards

guide: choosing better precast concrete

In general, concrete is one of the most emissions-intensive materials in the construction industry (see "context: the impact of materials extraction" on page 7). When considering single-wythe precast cladding panels, emissions are moderate on average when compared with other options. However, as with any material, there are many factors to consider when making this judgement. As a system, precast cladding offers a high degree of flexibility: finish options, installation speed, and cost-effectiveness among them.

In context of this guide, a major opportunity to consider is that concrete is a recipe, not a defined product—we can choose to make it low(er) carbon.

Upfront emissions reduction strategies:

- Use lower strength mixes if practical. Review this option with your project engineers / manufacturerw to determine its impact on durability and concrete quantity.
- Use supplementary cementitious materials (SCMs) to reduce cement content in concrete mixes. This strategy can significantly reduce upfront carbon emissions and lead to a variety of other performance benefits. Based on conversations with CPCI, LaFarge, and several local precast panel manufacturers, we have found that the use of SCMs with little or no impact on curing time and setup are common: GUL / PLC at 15% replacement, and slag up to 25% replacement can be included in most mixes. SCM replacement beyond this are possible, but may require the input of specialized technicians, admixes, or additional costs.

It is important to qualify these strategies with a brief discission of limitations.

Precast cladding panels have specific typological considerations that sometimes make their ingredients more restrictive than ready-mix. In particular, precast has a very high quality and efficiency threshold: consistency and speed are important. This means that the ability to choose project-specific mixes can be limited by their impact on factors like curing time and unique set-up requirements. This in turn has led to a wide variety of results within the industry: in some projects, it's possible to work closely with manufacturers to specify desired mixes. In others, manufacturers sometimes deliver precast panels using mixes that differ from project specifications (ie. greater strength) in order to simplify processes and maintain project schedules.

In summary, this section of the guide aims to illustrate potential solutions, and to encourage designers to **have conversations with contractors and manufacturers early and often** during every project to minimize upfront carbon emissions.

For a full summary of concrete emissions reduction strategies, see:
CRMCA Guidelines for low-carbon concrete

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account. *

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Insulation
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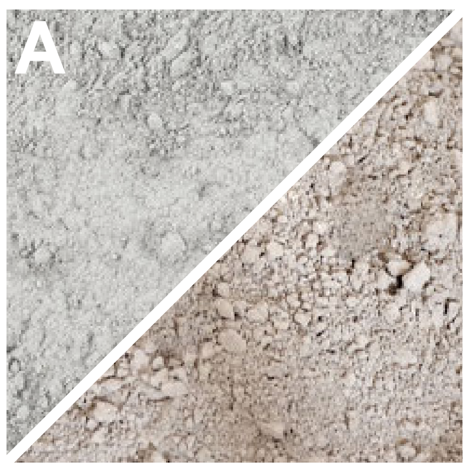
$kgCO_2e/m^2$ -40 -20 0 20 40 60 80 100

precast concrete

- The following chart displays the impact of various "ingredients" on emissions intensity for a standard precast concrete mix. As noted on the previous page, SCMs provide the greatest opportunity for upfront carbon emissions reduction. To simplify the comparison, only slag and GUL/PLC are used in this chart. Other options for SCMs can be found on the following page. It should be noted that while the focus of this catalogue section is precast concrete panels, any concrete element in a building can make use of the information provided here, including a building's foundations or superstructure.
- GWP metrics used are calculated using EPD 10092 and a density of 2,400 kg/m^3.
- Precast panels are heavy: using them as cladding requires additional structure, which will in turn increase upfront emissions. These emissions, as well as those for reinforcing and connections, are not included in this summary.
- Examples on this page use a notional 100mm panel thickness as a reasonable average to obtain a per-square-meter metric. Actual thickness is dependent on a variety of factors, and should be determined by a structural engineer.

22 kgCO$_2$e/m^2

Blended Cement Concrete



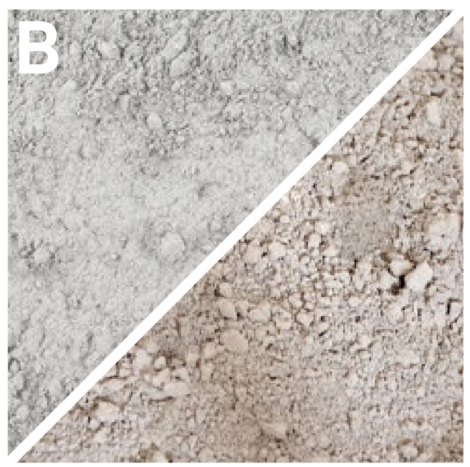
35% Slag, 25MPa GUL AE
CRMCA Mix #17

25MPa
GUL - Portland Limestone Cement
35-50% Slag
Air-Entrained

Reducing concrete strength reduces emissions intensity by reducing cement content. Whether this is possible or whether this results in increased panel thickness must be carefully considered, but the potential for impact can be significant.

30 kgCO$_2$e/m^2

Blended Cement Concrete



35% Slag, 35MPa GUL AE
CRMCA Mix #55

35MPa
GUL - Portland Limestone Cement
35-50% Slag
Air-Entrained

Using portland limestone cement (GUL, or PLC) reduces emissions intensity by adding ground limestone to reduce cement content. This strategy typically maintains concrete mix properties like strength and curing time, and is little or no cost. For these reasons, the use of this strategy should be investigated in every concrete mix.

33 kgCO$_2$e/m^2

Blended Cement Concrete

35% Slag, 35MPa GU AE
CRMCA Mix #54

35MPa
GU - General Use Cement
35% Slag
Air-Entrained

Increasing SCM content reduces emissions intensity; this potential should be fully explored in every project.

36 kgCO$_2$e/m^2

Blended Cement Concrete

25% Slag, 35MPa GU AE
CRMCA Mix #50

35MPa
GU - General Use Cement
25% Slag
Air-Entrained

42 kgCO$_2$e/m^2

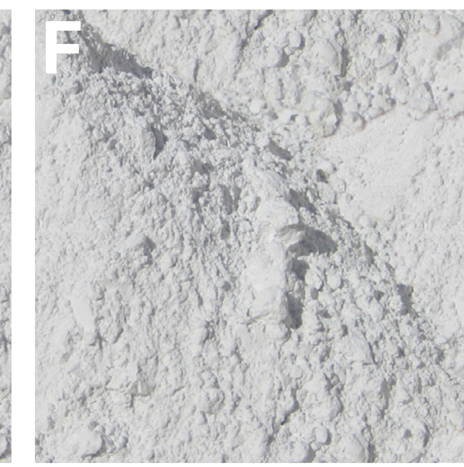
Typical Concrete

35MPa GU
CRMCA Mix #41

35MPa
GU - General Use Cement

45 kgCO$_2$e/m^2

Air-Entrained Concrete



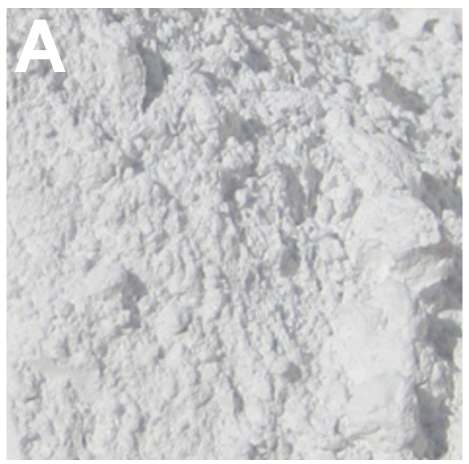
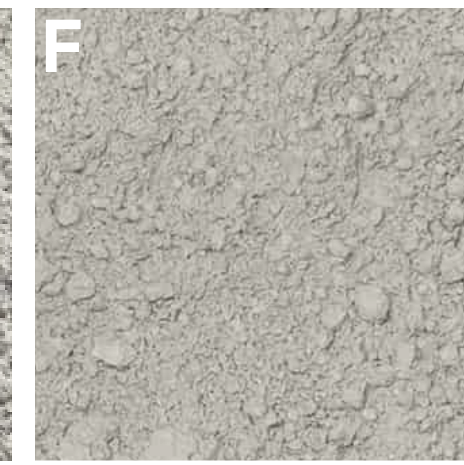
35MPa GU AE
CRMCA Mix #39

35MPa
GU - General Use Cement
Air-Entrained

Air entrainment is included as a baseline due to typical frost exposure conditions in Ontario. Although air entrainment increases emissions intensity, it can also reduce water content requirements of concrete mixes.

supplementary cementitious material (SCM) options

- Each SCM option in this chart is compared to a baseline of Portland cement, and can be used to produce low-GWP concrete mixes. This list focuses on the most common SCMs in the industry, but a variety of other options may be available.
- The market for SCMs is rapidly changing in response to increased awareness of the high emissions intensity of concrete. For instance:
    - Due to abundant sources of kaolin clay in some parts of Canada, LC3 is a high-potential future source of SCMs. Current manufacturers claim that ica can replace 25 to 40% of the Portland cement in a concrete formulation, achieves similar performance, can be up to 25% cheaper to produce and can slash CO_2 emissions by up to 40% (Clayson).
    - The use of recycled concrete powder (RCP) as an SCM and carbonated coarse recycled concrete aggregates (RCA) are being explored, with promising results for both concrete characteristics and emissions performance. One research group found that concrete with a 50% replacement rate of carbonated RCA can be produced without a significant compressive strength reduction (Bergmans et al, 2024), and a rate of 30% is currently approved by Canadian standards (RenewCanada).

Baseline **Portland Cement**	**GUL / PLC: Portland-Limestone Cement**	**Granulated Ground Blast Furnace Slag**	**Ground Glass Powder Pozzolan**	**Silica Fume**	**LC3: Limestone Calcined Clay Cement**
					
Source	Same	Industrial Waste	Recycling / Waste	Industrial Waste	Industrial Processing
Process	Same	Steel Manufacturing	Glass Recycling Facilities	Silicon Metal Production, EAF furnaces	Thermal modification of kaolin clay
Location	Same	Ontario	USA, British Columbia	Ontario	India, South America; Canadian sources of kaolin clay exist
Curing Time	Equal	Longer at SCM volumes >25%	Similar	Similar	Similar
Typ. Replacement	15%	25% typical, greater is possible.	20% ref	10-15% ref	25-40% ref: RMI
Additional Benefits	Enhances hydration efficiency, improves workability; low or zero cost. Use of GUL/PLC should be investigated in every concrete mix to reduce emissions.	Enhances long-term strength and durability, reduces permeability, and enhances resistance to sulfate attack.	Improves workability, reduces water demand, and enhances strength and durability of concrete.	Increases strength and durability, reduce permeability, and improve resistance to chemical attack.	Good strength development; improved durability characteristics, resistance to chloride and sulfate attack

guide: choosing better cement-based panels

Cement-based panels typically have a long lifespan, low maintenance requirements, and are lightweight. All of these factors can make them a competitive cladding choice from an upfront carbon and overall lifecycle perspective. This report section compares two cement-based panel types: fibre-cement, and glass-fibre reinforced cement (GFRC). It is important to note that these products have similarities, but are not direct replacements for one-another: durability, size, and other important factors are excluded for simplicity. Ultra-high-performance concrete (UHPC) panels are not included in this comparison due to lack of comparative data.

In general, GFRC panels are typically much larger and come with secondary steel backup structures, while fibre cement panels are thin, light, and often supported by aluminum framing.

In terms of material composition, fiber cement boards consist of portland cement, silica sand, and wood pulp. GFRC typically uses alkali-resistant glass fibres instead of wood pulp, and often includes polymers and other additives. These ingredients mean that GFRC has a higher embodied energy than fiber cement per unit of weight. GFRC panels are quite versatile and are readily made into expressive forms, making them a suitable replacement for precast panels in some instances.

The ingredients of cement-based panels have significant environmental impacts. Portland cement is discussed in "context: the impact of materials extraction" on page 7. Silica sand is mined, disturbing natural ecosystems, and its manufacturing process requires substantial water usage. Furthermore, there are limited end-of-life recycling options due to the composite nature of cement-based panels.

Upfront emissions reduction strategies:

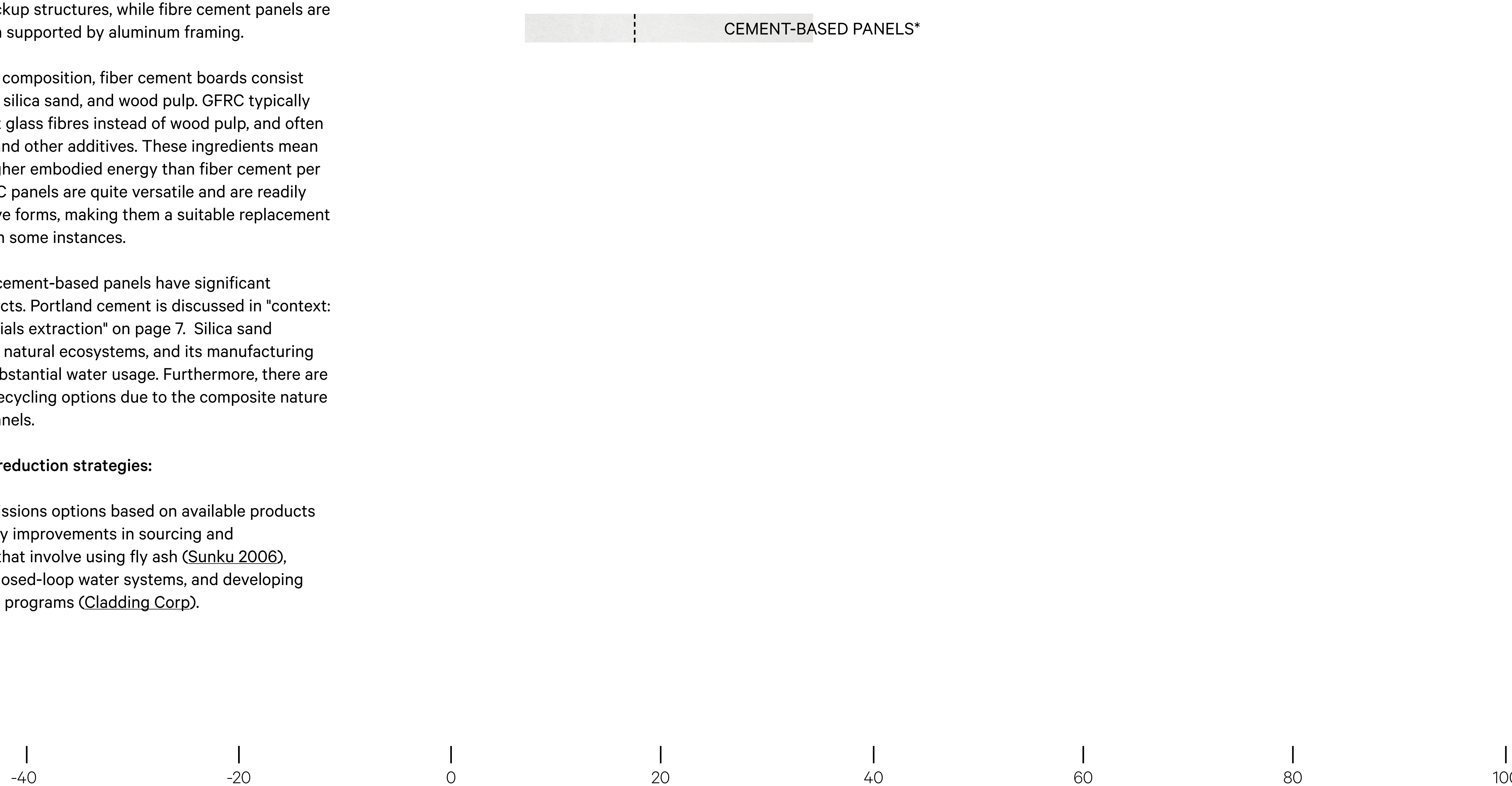
- Choose low-emissions options based on available products
- Support industry improvements in sourcing and manufacturing that involve using fly ash (Sunku 2006), implementing closed-loop water systems, and developing better recycling programs (Cladding Corp).

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account.



Navigation Links

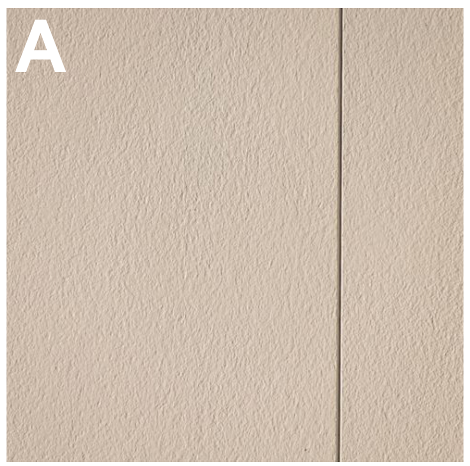
Main Graph
Precast Concrete
Cement-based Panels
Stone
Brick
Ceramic
Metal Panels
Cladding Alternatives
Openings
Insulation
Block Wall
Boards

cement-based panels

- Support structure required for these cladding products has not been included in the data presented here. Support systems are often created from aluminum or steel, significantly impacting emissions intensity.
- Biogenic carbon sequestration data is unreliable due to the wide range of assumptions necessary for estimation, but data has been included here for consideration.
- As discussed on the previous page, due to the complexity of factors in materials selections, the products shown here are not necessarily direct substitutions for each other.

6.8 $kgCO_2e/m^2$

Fibre Cement Panel



Architectural Panel HZ10

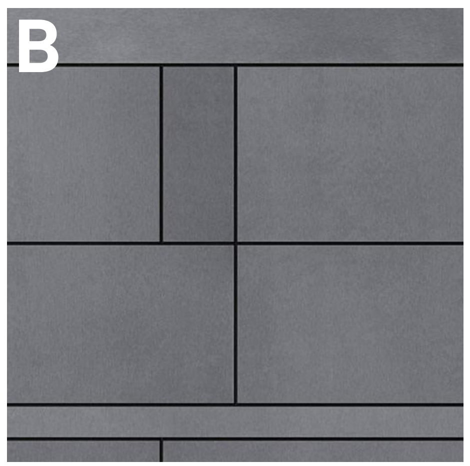
James Hardie
USA

EPD S-P-05037
Thickness: 8mm

6.6 w/ biogenic

7.0 $kgCO_2e/m^2$

Fibre Cement Panel



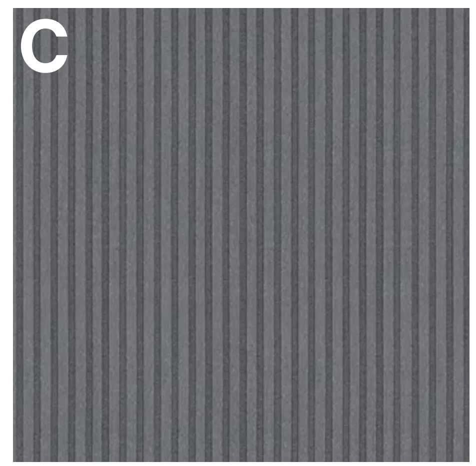
Tectiva

Equitone
Belgium

EPD 21-0135-04-00-00-EN
Thickness: 8mm

10 $kgCO_2e/m^2$

Fibre Cement Panel



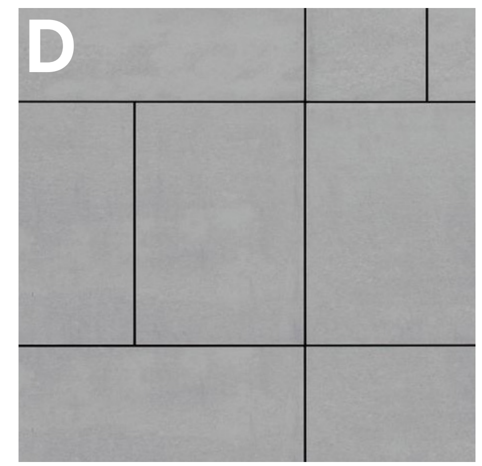
Patina Inline

Swiss Pearl
Hungary

EPD MD-20045-EN_rev4
Thickness: 8mm

17 $kgCO_2e/m^2$

Industry Average, Fiber Cement



Fibre Cement Panel

PBC, BfCA, TAF
Canada

EMBARC report,
Builders for Climate Action

20 $kgCO_2e/m^2$

Glass Fibre Reinforced Cement (GFRC) Panel

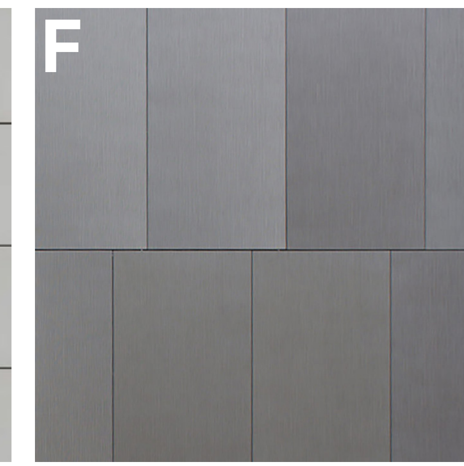
Façade Elements

BB Fiberbeton
Denmark

EPD MD-21008-EN
Thickness: 12mm

34 $kgCO_2e/m^2$

Glass Fibre Reinforced Cement (GFRC) Panel



Ultra High Performance

TAKTL
PA, USA

EPD 248
Thickness: 16mm

SvN

guide: choosing better stone

Stone is a beneficial material choice from both an upfront carbon and overall lifecycle perspective. It is very durable, reducing the need for repair or replacement and making it ideal for reuse. Its emissions intensity is moderate according to available data.

Ontario has significant potential for building stone, including granite, limestone, and sandstone, due to its abundant quarries. However, extraction activities can be resource-intensive and can sometimes lead to habitat destruction, biodiversity loss, and pollution.

Fabrication processes vary significantly, but are potentially energy-intensive and use large quantities of water that can become contaminated with residue, lubricants, and abrasives. Due to current quality expectations and aesthetics targets, as much as half of quarried stone can become waste during fabrication (Iano p.362).

Stone is also heavy: it is energy-intensive to transport (Alquadi et al, 2023). Stone that is transported over long distances before arriving at the building site may have an embodied energy 10 or even 20 times greater than local stone (Iano p.362). It should be noted that these emissions have been excluded in the data in this guide.

The weight of stone also means that these façades require robust structural support, adding additional upfront carbon. This impact is not included in this catalogue due to variability and lack of data.

Upfront emissions reduction strategies:

- use local stone
- minimize stone thickness / weight

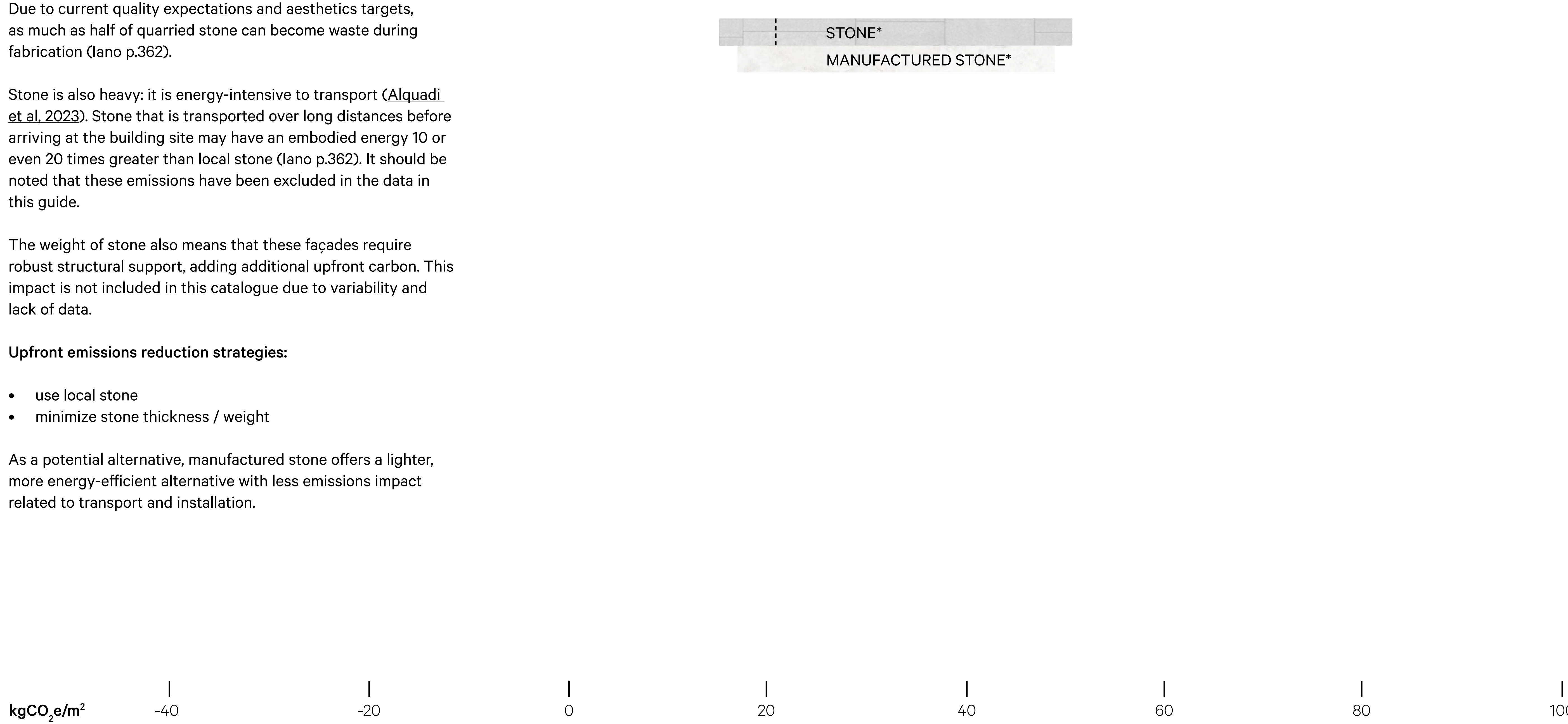
As a potential alternative, manufactured stone offers a lighter, more energy-efficient alternative with less emissions impact related to transport and installation.

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account.



Navigation Links

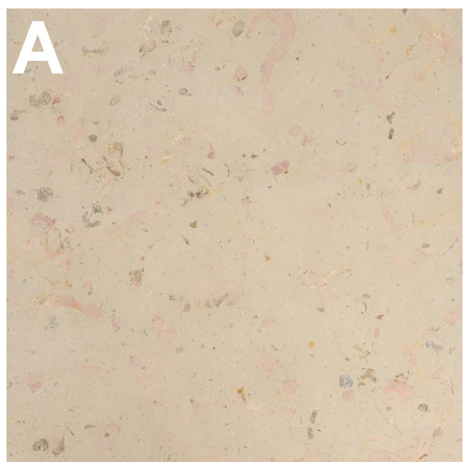
Main Graph
Precast Concrete
Cement-based Panels
Stone
Brick
Ceramic
Metal Panels
Cladding Alternatives
Openings
Insulation
Block Wall
Boards

natural stone

- Support structure required for these cladding products has not been included in the data presented here. Support systems are often created from aluminum or steel, significantly impacting emissions intensity.
- A much greater variety of local stone products is available than what is shown here. However, EPD data on domestic stone products is rare.

14 $kgCO_2e/m^2$

Limestone

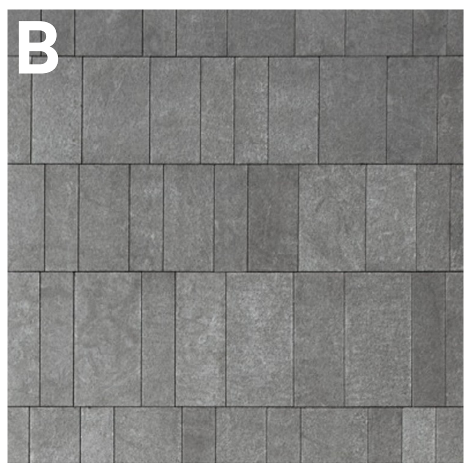


Polycor Inc.
QC, Canada

EPD POL–20230131–007
Thickness: 57mm
Density: 2307 kg/m^3
Weight: 81 kg/m^2

21 $kgCO_2e/m^2$

Industry Average

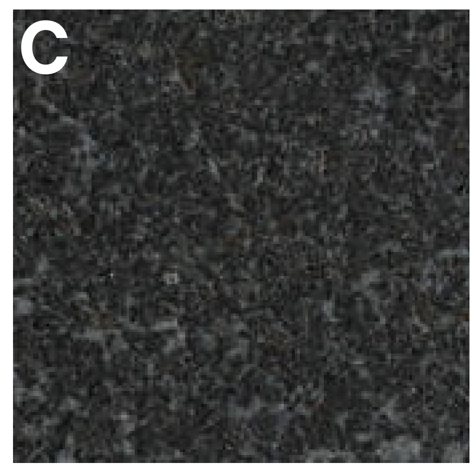


Natural Stone Institute
Canada

EPD NSI–20221101–003
Thickness: 50mm
Density: 2507 kg/m^3
Weight: 83 kg/m^2

29 $kgCO_2e/m^2$

Granite

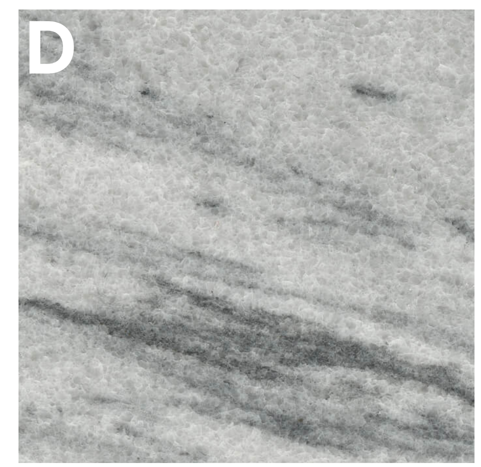


Polycor Inc.
QC, Canada

EPD POL–20230131–006
Thickness: 42mm
Density: 2654 kg/m^3
Weight: 90 kg/m^2

51 $kgCO_2e/m^2$

Marble Veneer



Polycor Inc.
QC, Canada

EPD POL–20230131–008
Thickness: 48mm
Density: 2699 kg/m^3
Weight: 130 kg/m^2

emissions data unavailable

Slate

L'Ardoisière
NS, Canada

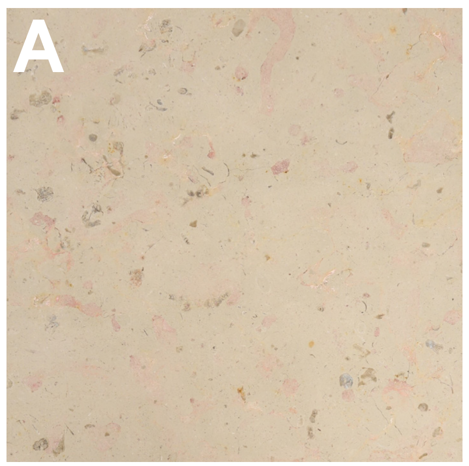
EPD unavailable
Thickness: 13mm

manufactured stone

- Support structure required for these cladding products has not been included in the data presented here. Support systems are often created from aluminum or steel, significantly impacting emissions intensity.
- Local availability and transportation-related emissions should be considered for internationally-produced products. Despite these challenges, international products have been included to highlight what is possible, potentially encouraging the creation of similar products in Ontario in the future.

17 $kgCO_2e/m^2$

Composite Crushed Stone

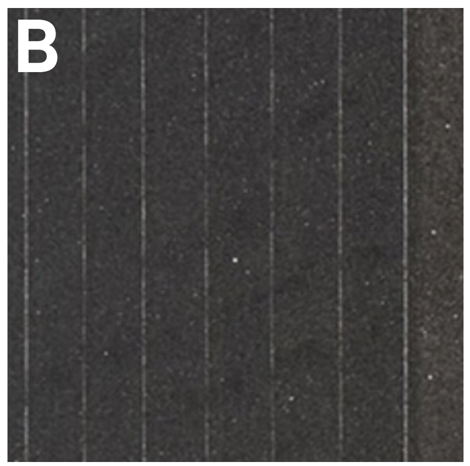


Steni AS
Norway

EPD 2580-1307-EN1
Thickness: 17mm
Density: 1875 kg/m^3
Weight: 15 kg/m^2

21 $kgCO_2e/m^2$

Composite Stone Panel



Cosentino
Spain

EPD S-P-00916–vers2
Thickness: 21mm
Density: 2555 kg/m^3
Weight: 31 kg/m^2

29 $kgCO_2e/m^2$

Artificial Stone Panel

Ulma Architectural Solutions
Spain

EPD S-P-07728
Thickness: 12mm
Density: 2300 kg/m^3
Weight: 28 kg/m^2

49 $kgCO_2e/m^2$

Sintered Stone

Elemex - TheSize Surfaces
Spain

EPD S-P-04941
Thickness: 12mm
Density: 2400 kg/m^3
Weight: 29 kg/m^2

guide: choosing better brick

Brick is the predominant "standard" material for many façades. On a per square metre basis, brick has a wide range of emissions intensities depending on the type of brick chosen. A detailed discussion of its impacts can be found in "context: the impact of materials extraction" on page 7.

Upfront emissions reduction strategies:
(based on Iano et al., p.316)

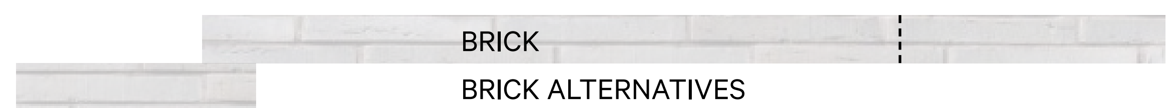
1. Reducing brick quantities by choosing other less carbon-intensive production / sourcing options, such as calcium silicate bricks, face bricks, or reclaimed bricks.
2. Prioritizing brick sources that utilize the following strategies:
   - firing techniques powered by renewable energy
   - energy-efficient firing techniques such as kiln heat recovery systems or tunnel kilns
   - production techniques that incorporate recycled brick or post-industrial waste such as fly-ash.
3. Choosing low-carbon finishes:
   - Glazed finishes can increase emissions, but can also enhance brick durability, enabling future re-use. Emissions impact of this factor was not available at time of writing.
   - Dark colored bricks are often a result of increased firing temperatures and therefore more energy / emissions intensive. Emissions impacts of this factor are not available at time of writing, but choosing light-coloured brick appears to be a valid consideration.
4. Limiting or choosing low-carbon mortar:
   - mortar is made of energy-intensive portland cement and lime. Emissions impacts of this factor are not available at time of writing. However, using dry-stacked brick systems should be considered as a way to avoid the use of mortar and also reduce maintenance requirements over brick's lifecycle.

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account. *



kgCO$_2$e/m^2 -40 -20 0 20 40 60 80 100

Navigation Links

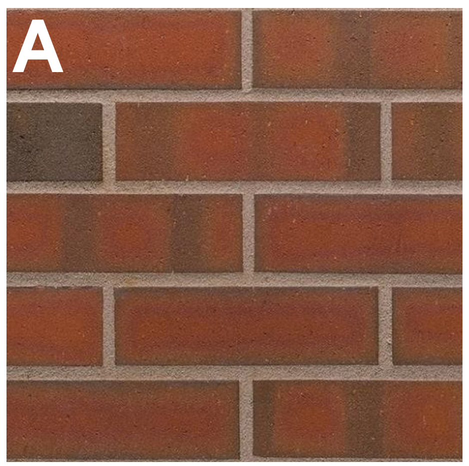
Main Graph
Precast Concrete
Cement-based Panels
Stone
Brick
Ceramic
Metal Panels
Cladding Alternatives
Openings
Insulation
Block Wall
Boards

brick

- The emissions intensity of mortar, brick ties, and shelf angles are not included in the data shown here.
- Estimates for these materials can be obtained using tools such as Kaleidoscope, but are dependent on a variety of factors that may be unique to actual project conditions or products used.

16 $kgCO_2e/m^2$

Perforated Clay Brick



Weinerberger
Finland

EPD RTS_46_20 Group

Perforated bricks use less material than typical bricks, leading to lower emissions intensities.

30 $kgCO_2e/m^2$

Sand-Lime Brick

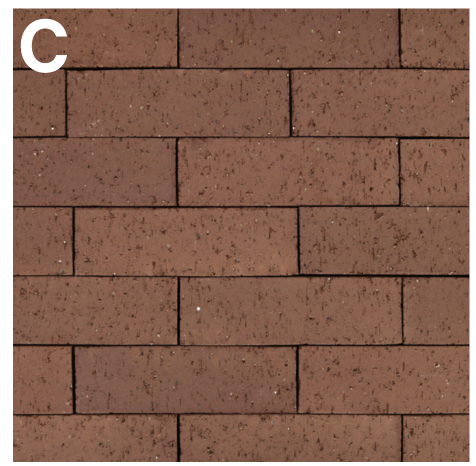
Arriscraft
ON, Canada

EPD-055

Sand-lime (calcium silicate) brick is cured using steam and pressure, which is more energy efficient than firing clay bricks in a kiln.

31 $kgCO_2e/m^2$

Thin Brick - 16mm



Interstate Brick
UT, USA

EPD 131 Group

As their name suggests, thin bricks are narrower than typical bricks, using less material which equates to lower emissions intensity. Note that facing bricks require mounting on a backer material, whose emissions are not accounted for in this comparison. Common backers include cement board and precast panels.

51 $kgCO_2e/m^2$

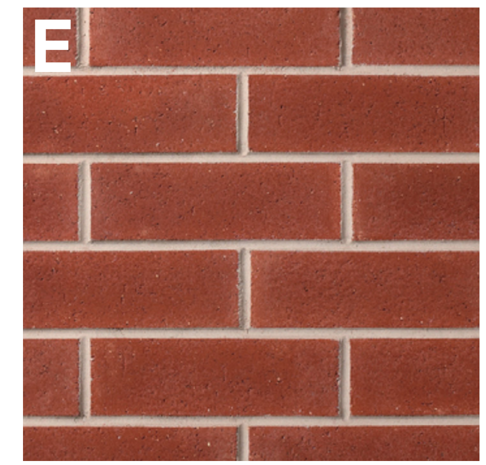
Industry Average Clay Brick

The Brick Industry Association
North America

EPD 10447

51 $kgCO_2e/m^2$

Clay Brick



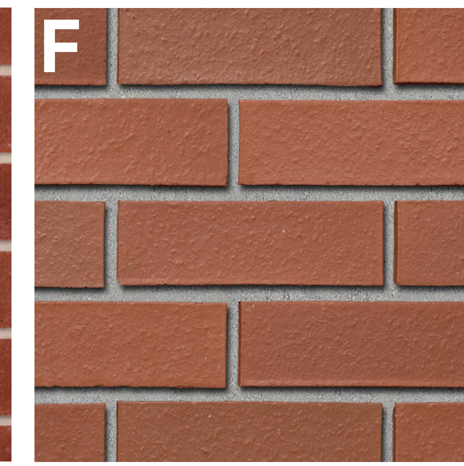
Brampton Brick
ON, Canada

EPD-733

Despite this guide's preference for local materials, this manufacturer's emissions performance is average; lower-emissions alternatives should be investigated if possible.

66 $kgCO_2e/m^2$

Clay Brick



Shaw Brick
NS, Canada

EPD 359 Group

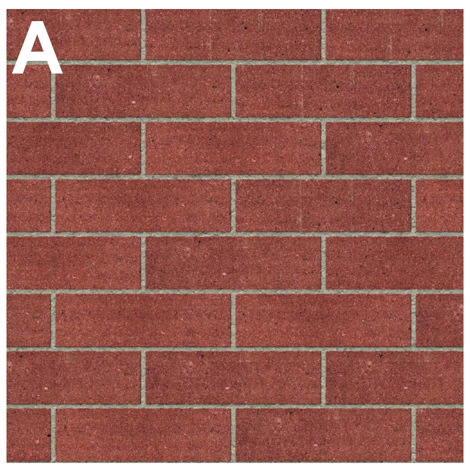
SvN

brick alternatives + innovations

- The emissions intensity of mortar, brick ties, and shelf angles are not included in the data shown here.
- The options on this page have the potential to be direct replacements for typical clay brick, subject to availability and matching of performance-related characteristics.
- Since most brick is produced locally, transportation-related emissions should be considered for internationally-produced products. Despite these challenges, international products have been included to highlight what is possible, potentially encouraging the creation of similar products in Ontario in the future.

1.0 $kgCO_2e/m^2$

Waste-Based Brick



K Briq
UK

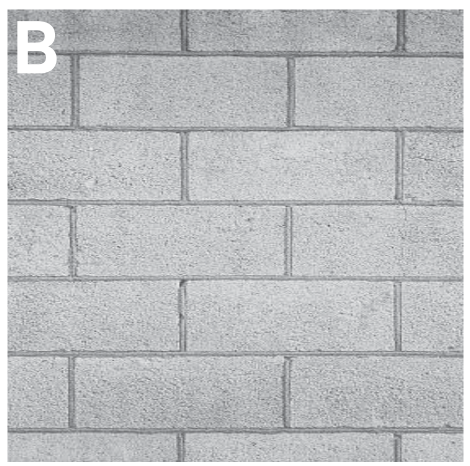
EPD not available

Made from construction and demolition waste. This brick is not fired and uses a proprietary cement-free binder.

Emissions intensity is based on company claims, but verified EPD was not available at the time of writing. Review of further documentation is recommended.

5.2 $kgCO_2e/m^2$

Fly Ash Brick



Calstar
WI, USA

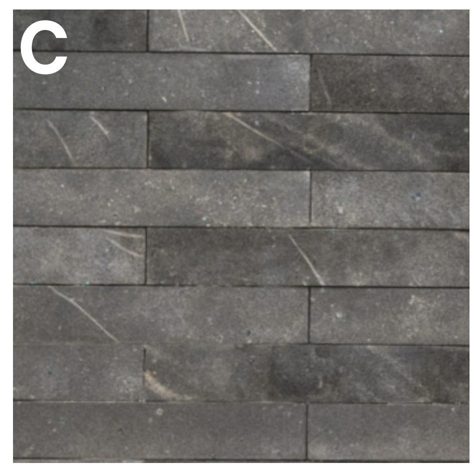
EPD; expired, not numbered

Fly ash bricks require less energy to produce than conventional bricks and provide opportunity to recycle otherwise landfilled post-industrial waste.

Calstar no longer produces fly ash brick; however, the opportunity for this low-carbon option still remains.

14 $kgCO_2e/m^2$

Biocement



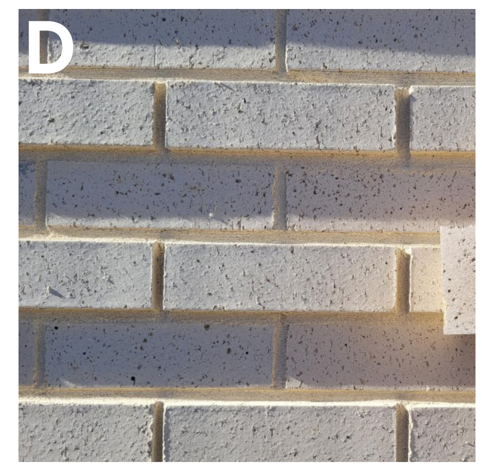
Biomason, Biolith Tile
NC, USA

EPD 4789442185.101.1

Manufactured using “biocement” technology, where bacteria and nutrients create a calcium carbonate aggregate.

emissions data unavailable

Waste-Based Brick



Grown Stone
ON, Canada

EPD not available

Made from agriculture, lumber, mining, stone, and demolition waste. These materials are combined with a proprietary "bio gel" and cured to form the final product.

Reclaimed Brick

Canyon Stone
ON, Canada

EPD not available

Although emissions intensity data is not available for reclaimed bricks, it is less than new brick. One of the largest barriers to brick reuse is the labour involved in demolition and cleaning. A good resource is Brick Recyc, an Ontario-based company that has developed technology to facilitate brick cleaning, facilitating re-use.

Dry-stacked Brick

Weinerberger Click Brick
Netherlands

EPD not available

Dry-stacked bricks eliminate the need for mortar. While emissions intensity metrics for mortar are beyond the scope of this catalogue, its composition of portland cement and lime make it a factor for consideration.

guide: choosing better ceramics

Given that ceramics are composed of fire-clay products, the material shares many of the same processes and characteristics of brick manufacturing (refer to "guide: choosing better brick" on page 19). However, many nuances exist depending on the specific type of ceramic and its source, making the emissions intensity range for this product very broad.

Very few ceramic panel products are manufactured in Ontario or even North America, and even fewer have EPDs. Therefore, most of the examples presented here are primarily from European sources. Local sources with EPDs record higher A1-A3 emissions intensity than those produced abroad. However, A4 (transportation) emissions should be taken into account for non-local products.

Ceramics are very durable, despite being fragile to impact. End-of-life reuse / recycling of ceramic tiles has high potential, but does not appear to be a dominant practice in the industry.

Upfront emissions reduction strategies:

- Choosing larger-format panels to reduce support structure and its emissions.
- Choose suppliers that utilize renewable energy in production processes and innovations such as ceramic printing technologies can be used to reduce the GWP associated with the glazing process.

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account.

*

CERAMIC*

Navigation Links

Main Graph
Precast Concrete
Cement-based Panels
Stone
Brick
Ceramic
Metal Panels
Cladding Alternatives
Openings
Insulation
Block Wall
Boards

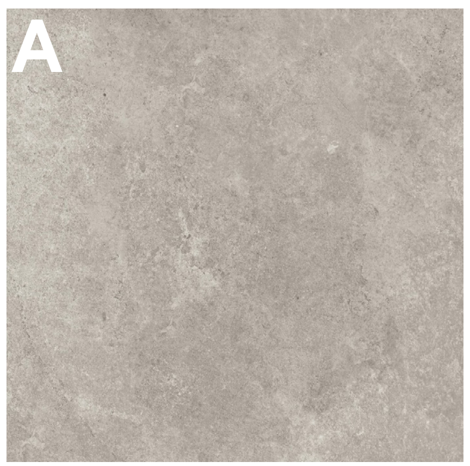
$kgCO_2e/m^2$ -40 -20 0 20 40 60 80 100

ceramic

- Support structure required for these cladding products has been included only where noted.
- Biogenic carbon sequestration data is unreliable due to the wide range of assumptions necessary for estimation, but data has been included here for consideration.
- EPD data for North American ceramics is rare, so most of the products shown on this page are internationally-produced. Local availability and transportation-related emissions should be considered for these products.

23 $kgCO_2e/m^2$

Porcelain



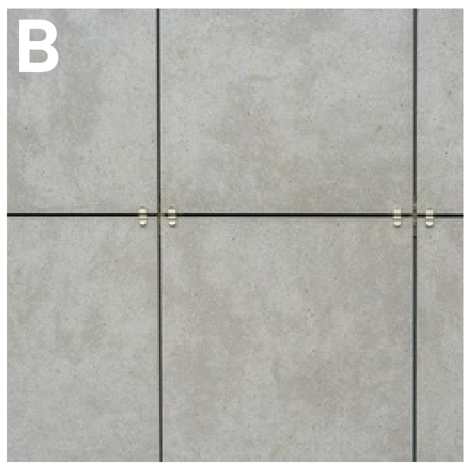
Extruded Tile

Faveker
Spain

EPD S-P-06511
Thickness: 19mm

26 $kgCO_2e/m^2$

Ceramic w/ substructure



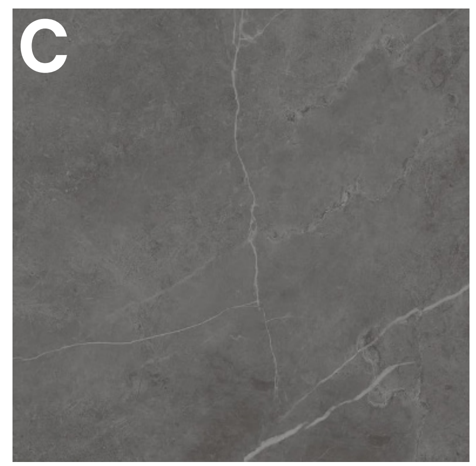
Façade Panel

Tonality GmbH
Germany

EPD 6708-6035-EN
Thickness: 22mm

36 $kgCO_2e/m^2$

Terracotta



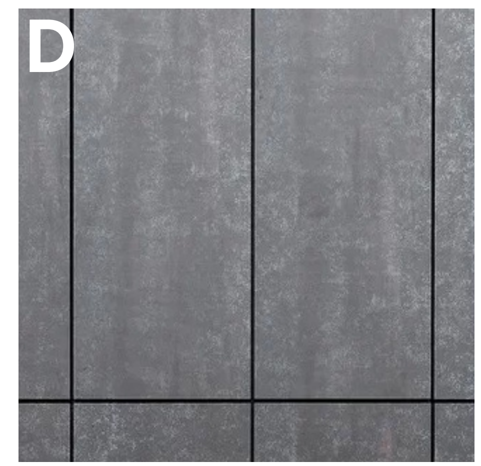
Laminam 5

Elemex
Italy

EPD 148
Thickness: 30mm

39 $kgCO_2e/m^2$

Ceramic w/ substructure



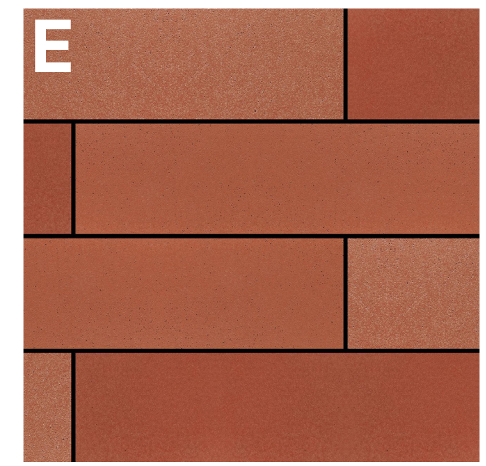
Longoton Façade Panel

Moeding
Germany

EPD MFA-GB-48.0
Thickness: 40mm

40 $kgCO_2e/m^2$

Terracotta



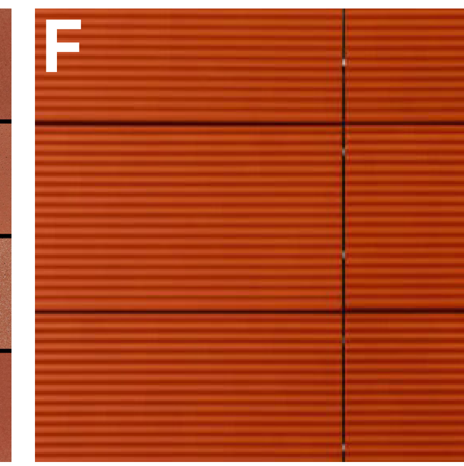
Terrart Panel

NBK
Germany

EPD NBK-20240022-CBA1-DE
Thickness: 28mm

111 $kgCO_2e/m^2$

Terracotta



Terraclad

Boston Valley Terracotta
NY, USA

EPD UL Provided
Thickness: 40mm

Despite the fact that terracotta is typically produced at lower temperatures than other ceramics, these panels have a relatively high emissions intensity. This is particularly true for the US product. Details describing the reason for this result are not available, but are likely due to energy source emissions for the production processes.

guide: choosing better metal panels

Metal panels are one of the most impactful categories of material selection due to their wide emissions range.

Overall, aluminum has a major emissions impact, both as a façade panel material or as a substructure for other panel types (refer to page 7 for more information).

Upfront emissions reduction strategies:

- Avoid aluminum panels which have a high embodied energy compared to other metal panel types.
- Choose metal panel types that are thinner gauge if durability and mounting criteria allow.
- Choose metal panel types that incorporate high degrees of recycled content, reducing production energy intensity. For instance, data suggest that improved sourcing and manufacturing strategies and the use of offcuts can produce twice the steel with 75% fewer greenhouse gas emissions.

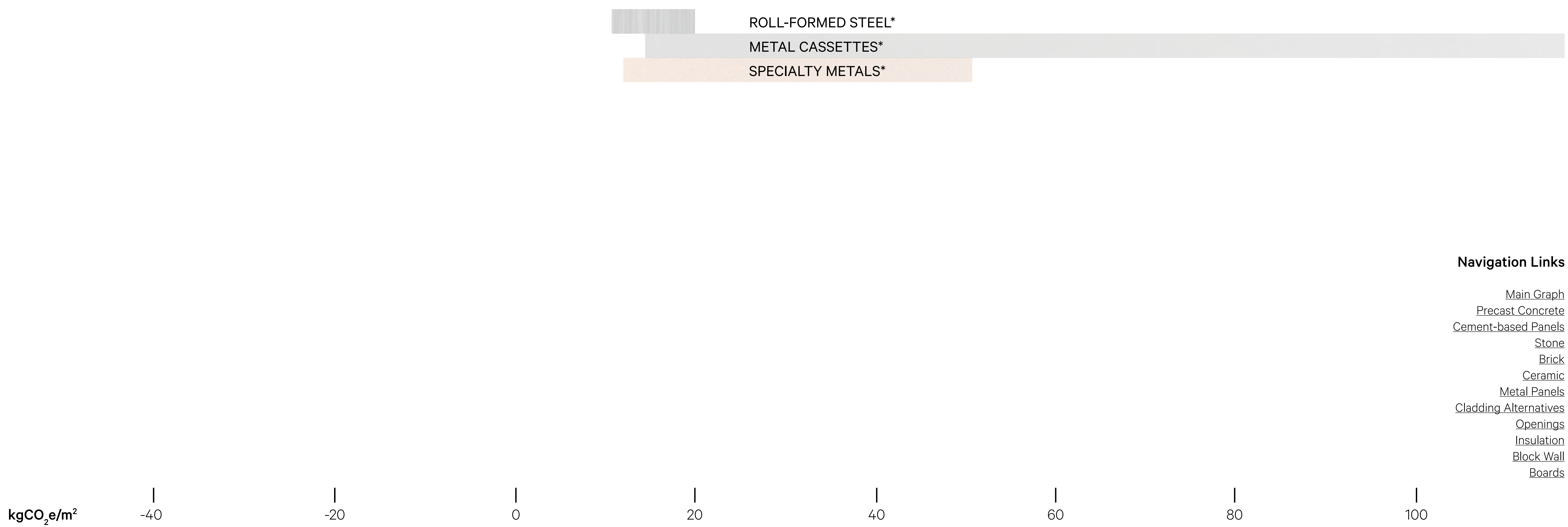
Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account.

*



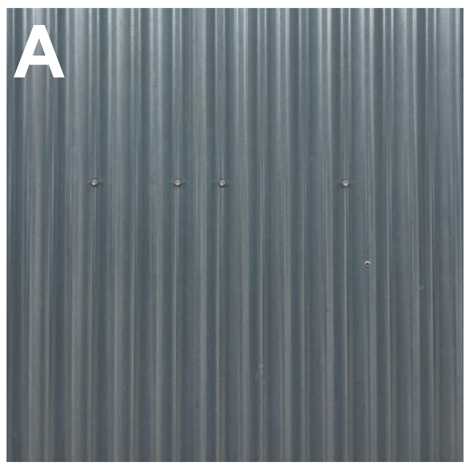
Navigation Links

roll-formed steel

- Support structure required for these cladding products has not been included in the data presented here. These systems are often created from aluminum or steel, significantly impacting emissions intensity.

11 $kgCO_2e/m^2$

Corrugated Steel



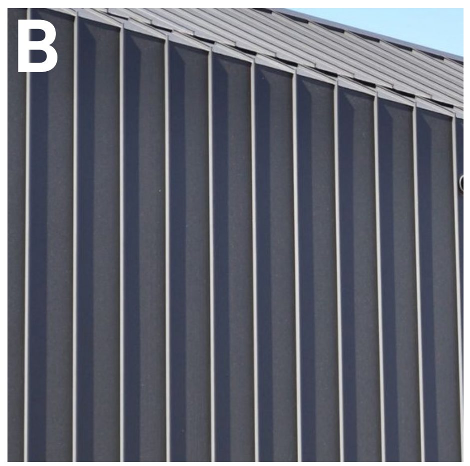
Painted Galvanized

Taylor Metal Products
OR, USA

EPD F73eab7a
Thickness: 0.7mm

16 $kgCO_2e/m^2$

Steel Standing Seam



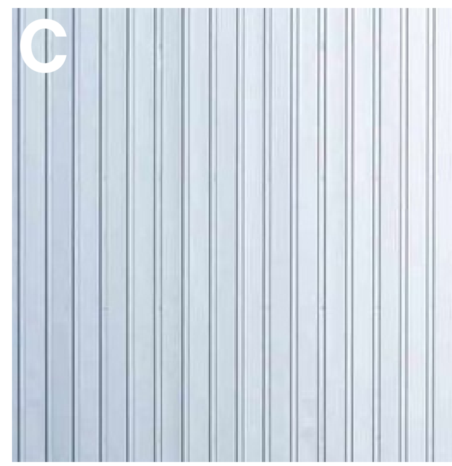
Tite-Loc

PAC Clad
IL, USA

EPD 4789365778.101.1
Thickness: 0.7mm

20 $kgCO_2e/m^2$

Corrugated Steel



Galvalume Coated

Arcelor Mittal
Brazil

EPD ARC-20190174-CBC2-EN
Thickness: 1mm

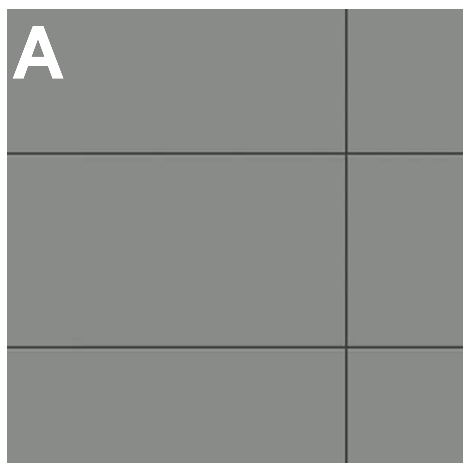
SvN

metal cassettes

- Support structure required for these cladding products has not been included in the data presented here. Support systems are often created from aluminum or steel, significantly impacting emissions intensity.
- Due to the complexity of factors in materials selections, products shown here are not necessarily direct substitutions for each other.
- Due to the use of petrochemical plastic components and high emissions intensity, none of the products on this page are recommended when compared with other options in this materials category.

17 $kgCO_2e/m^2$

Composite Aluminum Panel



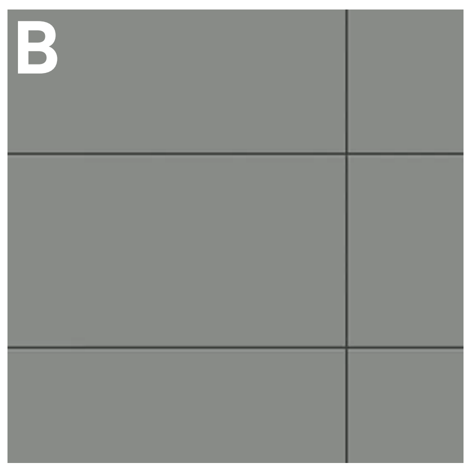
Alpolic MCM

Mitsubishi Polyester Film GmbH
Germany

EPD 307-EN (Rev.1_19.07.2023)
Thickness: 4mm

23 $kgCO_2e/m^2$

Composite Aluminum Panel



Alucobond Plus MCM

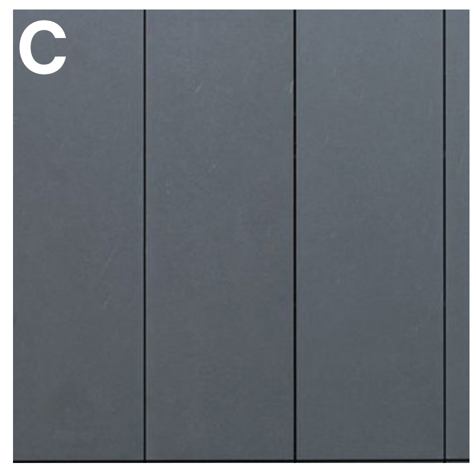
3A Composites
Germany

EPD HUB-2026
Thickness: 4mm

Composite panels are primarily petrochemical plastic with a thin aluminum covering. These panels cannot be easily recycled, presenting end-of-life disposal issues.

36 $kgCO_2e/m^2$

Insulated Metal Panel



Quadcore

Kingspan
BC, Canada

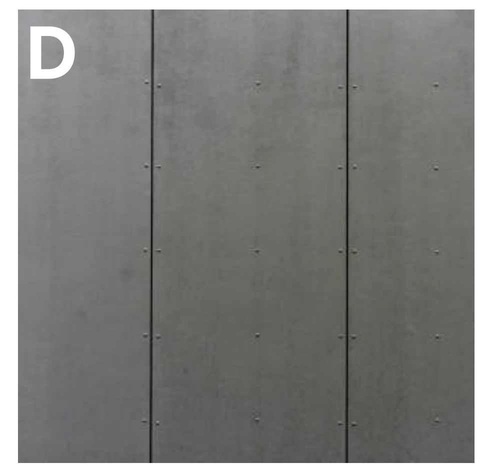
EPD SCS-EPD-08096
Thickness: 63.5mm

This product is the only insulated metal panel product in this guide.

The manufacturer claims to use a low-GWP version of spray foam insulation as its core. While entire panels can be detached from the system and potentially re-used, the use of spray foam insulation presents end-of-life disposal issues.

91 $kgCO_2e/m^2$

Anodized Aluminum Cassette



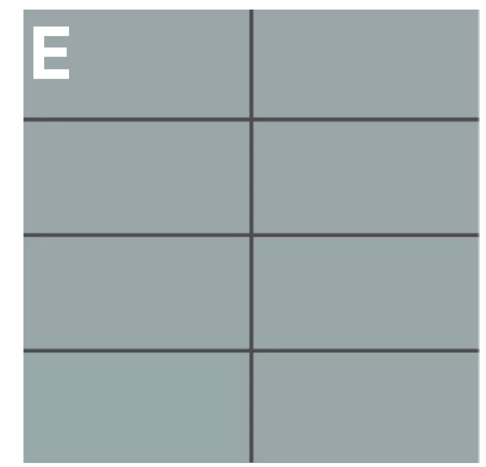
Liberta

Ruukki Construction
Finland & Estonia

EPD RTS_190_22
Thickness: 2mm

114 $kgCO_2e/m^2$

Anodized Aluminum Cassette



Anodized Aluminum

Dri-Design
MI, USA

EPD SCS-EPD-10200
Thickness: 2mm

Despite the stated thickness, these two panels contain the greatest quantity of aluminum of products on this page, significantly impacting emissions intensity. Refer to "context: the impact of materials extraction" on page 7 for more information.

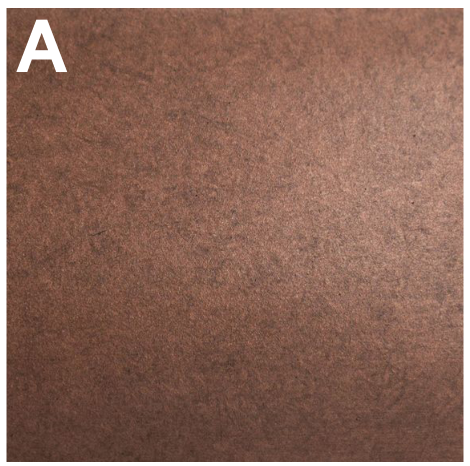
SvN

specialty metal cladding

- Support structure required for these cladding products has not been included in the data presented here. Support systems are often created from aluminum or steel, significantly impacting emissions intensity.
- “Pre-weathering” or "pre-patina" of metals sometimes involve chemical baths with harmful environmental impacts; further research is required for the examples shown on this page.
- Local availability and transportation-related emissions should be considered for internationally-produced products.

6.7 $kgCO_2e/m^2$

Copper



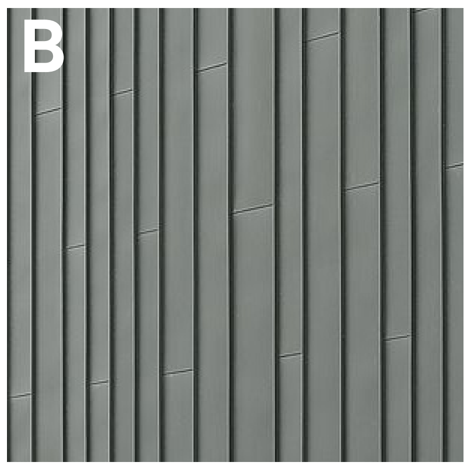
Lamella

Ruukki Construction
Finland & Estonia

EPD RTS_190_22
Thickness: 1mm

23 $kgCO_2e/m^2$

Zinc Standing Seam



prePATINA

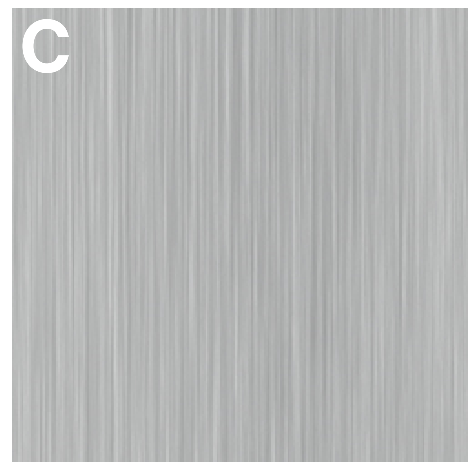
Rheinzink
Germany

EPD RHE-20230366-IBA1-EN
Thickness: 1mm

While beneficial from an upfront emissions perspective, it's important to note that zinc is a heavy metal, and its dissolved form can negatively impact water quality and is potentially toxic to aquatic organisms.

33 $kgCO_2e/m^2$

Stainless Steel Cassette



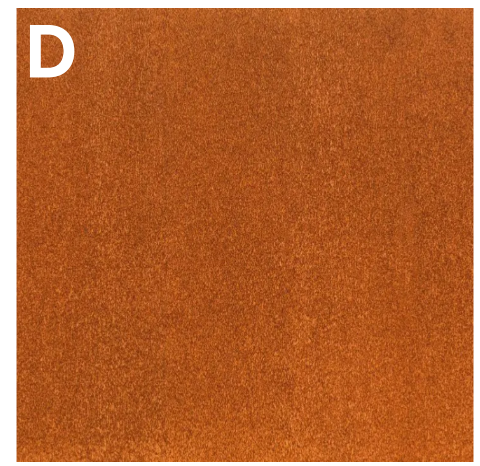
Liberta

Ruukki Construction
Finland & Estonia

EPD RTS_190_22
Thickness: 1mm

35 $kgCO_2e/m^2$

Corten Steel Cassette



Lamella

Ruukki Construction
Finland & Estonia

EPD RTS_190_22
Thickness: 1mm

51 $kgCO_2e/m^2$

Corten Steel Panel

Weathering Steel

Dri-Design
MI, USA

EPD SCS-EPD-10206
Thickness: 0.8mm

Corten steel is often much thicker than these examples, potentially leading to higher emissions values for the material itself and associated support structure. Designers should take care to ensure that thicknesses match durability and exposure requirements.

guide: cladding alternatives + innovations

The products in this section are suitable replacements for a wide variety of cladding options presented on the preceding pages. The primary goal is to highlight products that innovate by incorporating waste or other untapped material sources.

It is important to note that while the upfront carbon emissions for these products is lower than many others, the fact that they are produced outside of North America makes it worth considering their transportation (A4) emissions and availability.

The use of some of the products in this section is currently not possible or practical in Ontario. However, these examples are included to highlight what is possible, potentially encouraging the development of similar products in our market in the future.

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account. *

Navigation Links

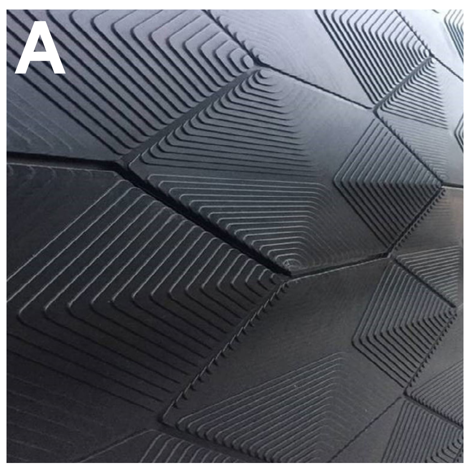
Main Graph
Precast Concrete
Cement-based Panels
Stone
Brick
Ceramic
Metal Panels
Cladding Alternatives
Openings
Insulation
Block Wall
Boards

guide: synthetic and bio-composite cladding alternatives

- Support structure required for these cladding products has not been included in the data presented here. Support systems are often created from aluminum or steel, significantly impacting emissions intensity.
- The bio-based options featured on this page can have beneficial life cycle characteristics, which should be considered in addition to emissions intensity. Biogenic carbon sequestration data is unreliable due to the wide range of assumptions necessary for estimation, but data has been included here for consideration.
- These products claim adequate fire resistance based on their local regulations, but care should be taken to ensure compliance with OBC and regulations applicable to intended use cases.
- Local availability and transportation-related emissions should be considered for internationally-produced products. Despite these challenges, international products have been included to highlight what is possible, potentially encouraging the creation of similar products in Ontario in the future.

-22 w/ biogenic
non-biogenic
emissions data unavailable

Biocarbon-based



Hexchar Panel

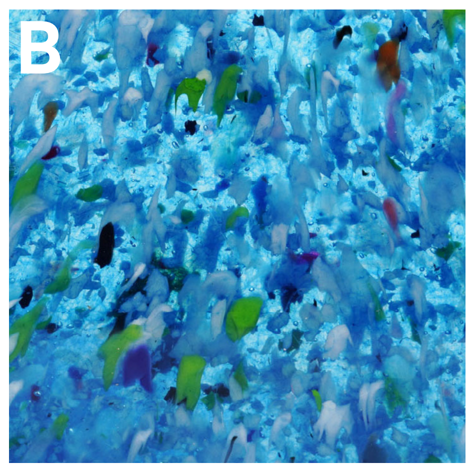
Made of Air
Germany

EPD not available.

Manufactured from biochar—produced from biomass such as plant waste and forestry offcuts—and 10% plant-based binders. Biogenic content theoretically provides the ability for this material to sequester carbon, leading to a negative GWP value.

9.1 $kgCO_2e/m^2$

Recycled Plastic



Polygood Surface

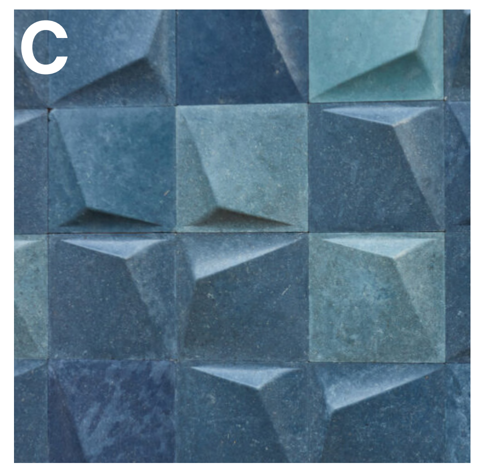
Good Plastic Company
Netherlands

EPD S-P-09636

Made entirely from recycled post-consumer and post-industrial polystyrene (rPS) waste. This includes materials such as refrigerators, single-use cutlery, electronic equipment, and industrial components. Manufacturers have a take-back program for end-of-life panels.

8.7 w/ biogenic
13 $kgCO_2e/m^2$

Bio-Based Composite



Nabasco 8012 Panel

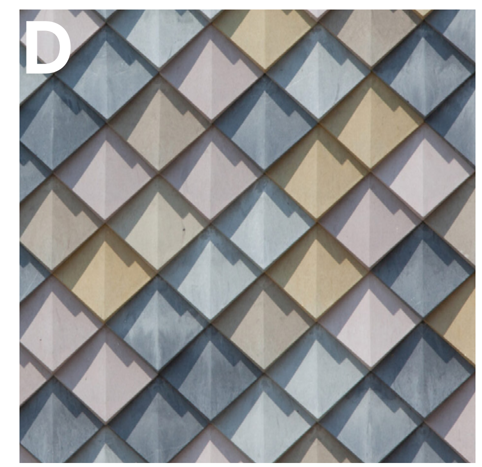
NPSP BV
Netherlands

EPD

These tiles are a bio-composite pressed from reed fibers, recycled toilet paper cellulose, softening lime, and a 50% bio-resin made from biodiesel production residue. NPSP is developing end-of-life recycling methods for these tiles.

29 $kgCO_2e/m^2$

Recycled Plastic



Pretty Plastic Panel

FRONT
Netherlands

EPD NIBE-20221112-31571

Made from recycled PVC waste. The "shingle" style installation process can potentially reduce the aluminum substructure requirements inherent in most façade systems. Panels are detachable and can be recycled up to 8 times. Manufacturers have a take-back program.

45 $kgCO_2e/m^2$

Bio-Based Composite

Duplicor Façade Elements

Duplicor
Netherlands

EPD not available.

Manufactured from agricultural waste. Its foam core is made from recycled PET bottles, old plastic packaging, bio-based cork or recycled cardboard. The composite has a Euro fire class B rating.

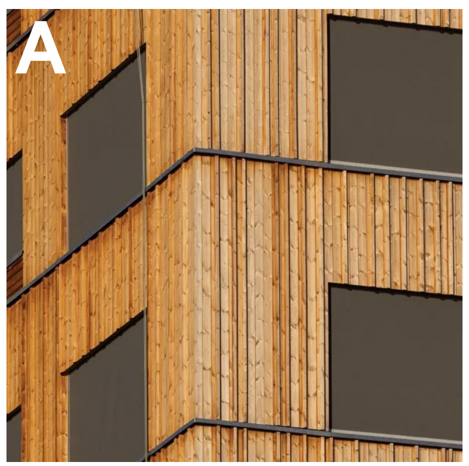
guide: geo- and bio-based cladding alternatives

- Some of the products noted below include combustible materials. Confirm compliance with OBC and local regulations applicable to intended use cases. Regulations are particularly restrictive for combustible cladding in Part 3 buildings.
- The bio- and geo-based options featured on this page can have beneficial life cycle characteristics which should be considered in addition to emissions intensity.

-7.3 w/ biogenic

non-biogenic emissions data unavailable

Wood Planks



Woodify

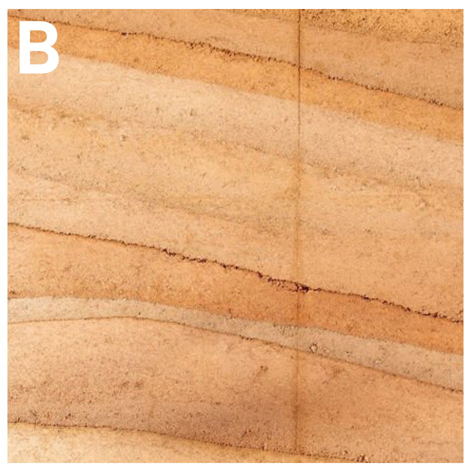
Bimbear
Norway

NEPD-1865-805-NO

Thermally modified wood cladding offers several benefits including enhanced durability, improved dimensional stability, and an attractive, consistent aesthetic. It requires less maintenance and lasts longer than untreated wood. Note that many comparable versions of this product are available from other suppliers.

emissions data unavailable

Stabilised Rammed Earth



Structural + Wall Elements

Aerecura
ON, Canada

Rammed Earth incorporates natural, local and abundant subsoils to create highly durable walls. The natural thermal mass allows humidity regulation and temperature control with lower operational energy. Generally used as a structural material but can function as a finish if panelized or if the structure is outboard of other façade assembly components.

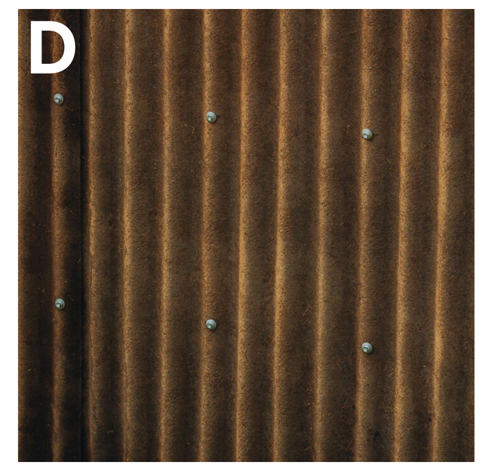
Thatch

Thatch Panel

SJE Master Thatchers
ON, Canada

Due to the flammable nature of thatch, its potential use in OBC Part 3 buildings is quite limited. However, certain use cases may exist, and Ontario has a high degree of access to straw as an agricultural by-product.

Corrugated Hemp Panels



Corrugated Hemp Panel

Margent Form
UK

Produced from agricultural byproducts: hemp fibre bound by a sugar-based resin.

guide: choosing better openings materials

Openings—curtain walls, windows, and doors—are commonly made from aluminum framing and float glass components, both of which have significant emissions intensities. However, as their name suggests, openings serve a unique purpose as part of a façade, meaning the trade-offs associated with operational and embodied carbon impacts must be balanced with the impact of light, views, and air on the functional, experiential, and aesthetic quality of a building.

Openings are very complex assemblies, meaning that the upfront emissions discussion and data included in this guide are an oversimplification. A more detailed overview of relevant factors can be found in Arup et al. 2022, which states several important factors for consideration:

- The upfront carbon of openings can vary significantly depending on system type and design
- Holistic assessment of design options against the specific needs of a project is required in order to make informed decisions. Despite the prevalence of WWR targets, there is no shortcut: operational energy performance cannot be generalized.

In the context of holistic emissions assessments, if upfront carbon is determined to be a driving factor, designers can consider the following strategies:

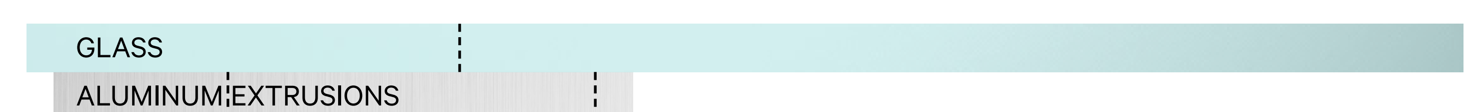
1. Reduce the use of both glass and aluminum by optimizing opening sizes and quantity. Utilize performance-based design metrics, prioritizing passive energy design by considering façade orientation, purposeful opening placement, and optimized window-wall-ratio (WWR).
1. The majority of the embodied carbon in typical openings assemblies are a result of aluminium framing. Therefore, minimize the use of aluminum by choosing using alternatives as outlined on the following pages. For both curtain wall and windows, combustible glazing support systems are allowable per OBC 3.1.5.4. In these cases, wood framing is preferable over PVC and fibreglass based on full lifecycle considerations.
2. Where aluminum extrusions are necessary, choose better sources: utilize recycled aluminum—ideally post-consumer—which typically utilizes 95% less energy in production processes. Source framing members from billets smelted with renewable electricity.
3. Choose float glass with recycled glass content if available
4. When practical, code, and performance limitations allow, consider the following strategies:
    - Minimize glazing layers and thicknesses (optimize whole-life carbon)
    - Reduce energy-intensive post production modifications such as tempering, lamination, coatings and ceramic frit
5. Maximize durability and other factors that increase the service life of openings to minimize the need for replacement.

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account. *



kgCO$_2$e/m^2 -40 -20 0 20 40 60 80 100

Navigation Links

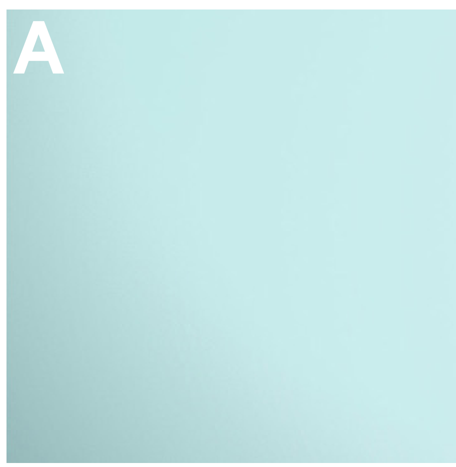
Main Graph
Precast Concrete
Cement-based Panels
Stone
Brick
Ceramic
Metal Panels
Cladding Alternatives
Openings
Insulation
Block Wall
Boards

glass

- Emissions intensity for each product is calculated based on theoretical 6mm panes of glass installed as double glazing for material comparison purposes.
- No float glass is currently produced in Canada; most available sources originate in the USA. This means that transportation-related emissions should be considered in addition to the data shown here.
- Distinction is not made between low-iron or clear glass in EPD documentation, so the impact of these choices is unknown. Similarly, the impact of potential heat-strengthening, ceramic frit application, and low-e coatings are not available, but are likely to increase the upfront carbon emissions of glazing products.

18 $kgCO_2e/m^2$

Recycled Glass



Saint-Gobain
France

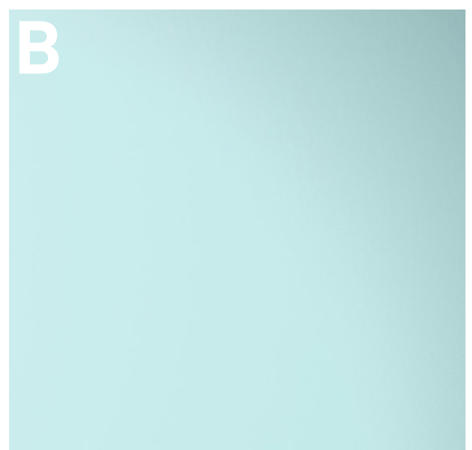
EPD S-P-08970

Virtually no float glass is recycled in the North American market. This is due to the presence of coatings and interlayers that complicate the process, as well as a lack of economic incentives.

This product illustrates the potential emissions reduction associated with glass recycling; it is recommended that this strategy be investigated in the Canadian market.

33 $kgCO_2e/m^2$

Low-Iron Glass

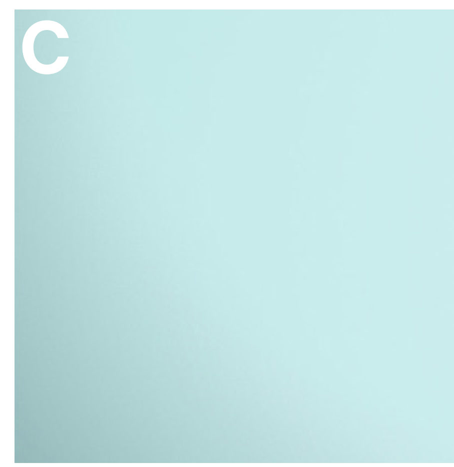


Guardian Glass
USA & Mexico

EPD 4791213166.101.1

33 $kgCO_2e/m^2$

Clear or Low-Iron Glass

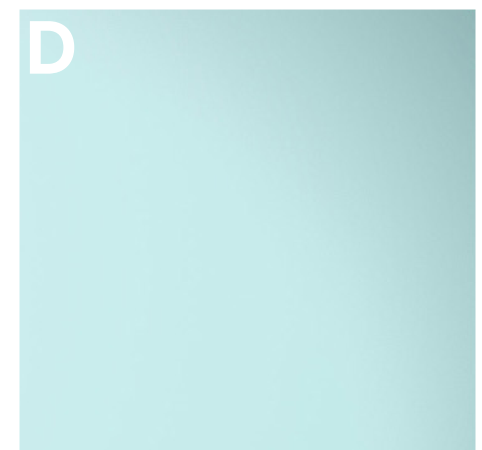


Saint-Gobain
France

EPD S-P-00882

37 $kgCO_2e/m^2$

Clear Glass

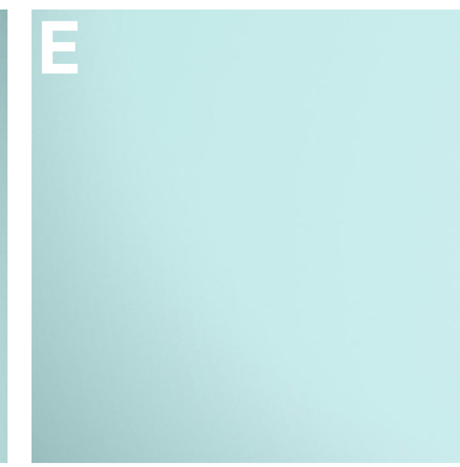


Vitro Architectural Glass
PA, USA

EPD 08776

43 $kgCO_2e/m^2$

Industry Average



National Glass Association (NGA)
USA

EPD ASTM-EPD121

99 $kgCO_2e/m^2$

Clear Glass

Prelco
QC, Canada

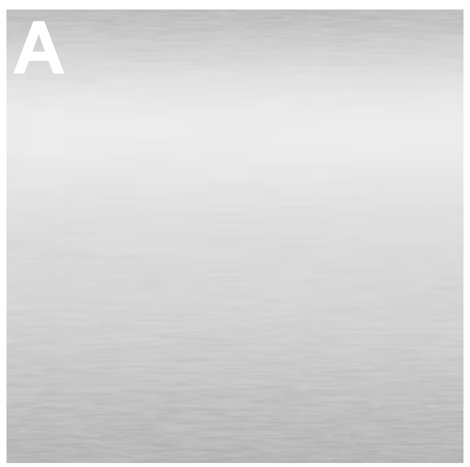
EPD 4761-4853

aluminum extrusion framing

- Emissions intensity data isolates aluminum framing only. This is calculated based on theoretical framing for a 1m^2 fixed curtain wall unit / window, with extrusions sized at 40x100x1.5mm, totaling 0.001644m^3 of aluminum at 2700kg/m^3 density. As noted in this section's introduction, this is a greatly simplified model that omits a range of factors that will exist in a typical project, but this framework allows for a direct comparison of suppliers. Project-specific calculations for aluminum framing and other aluminum openings components are recommended.

14 $kgCO_2e/m^2$

Aluminum Extrusions



Aluminum Extrusions

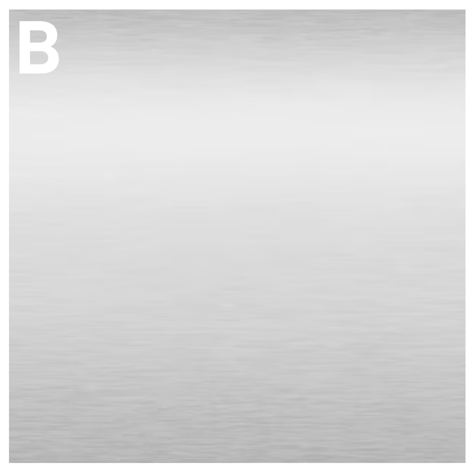
Hydro Circal
Stockholm Sweden

EPD S-P-07358

Contains 75% post-consumer recycled content, and produced using hydro power.

20 $kgCO_2e/m^2$

Aluminum Extrusions



UCB Gateway WT-2

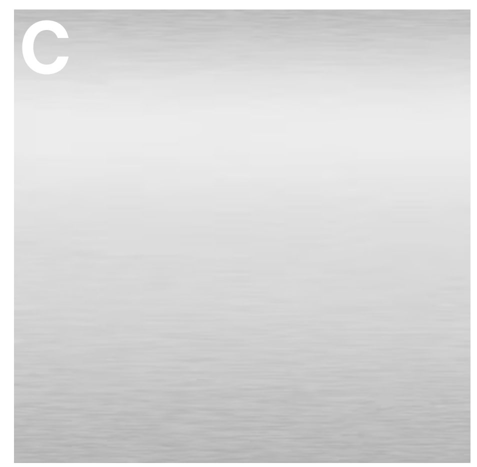
Permasteelisa North America Corp.
CT, USA

EPD HUB-1295

Project-specific EPD; other extrusions products from this manufacturer may vary in terms of emissions intensity.

29 $kgCO_2e/m^2$

Industry Average (AA)



Aluminum Extrusions

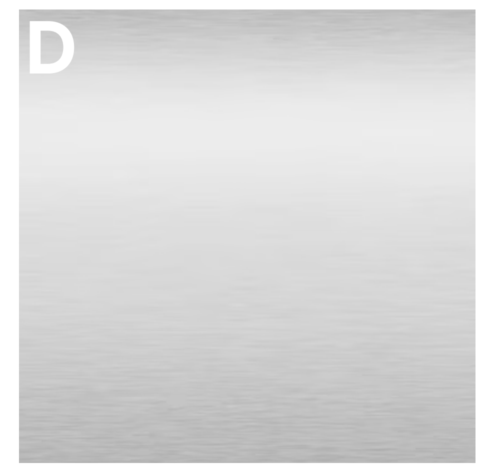
The Aluminium Association
VA, USA

EPD 4790545973.104.1

The Aluminum Association represents the broader aluminum industry across all market segments and a wide variety of extrusion products throughout North America.

37 $kgCO_2e/m^2$

Aluminum Extrusions



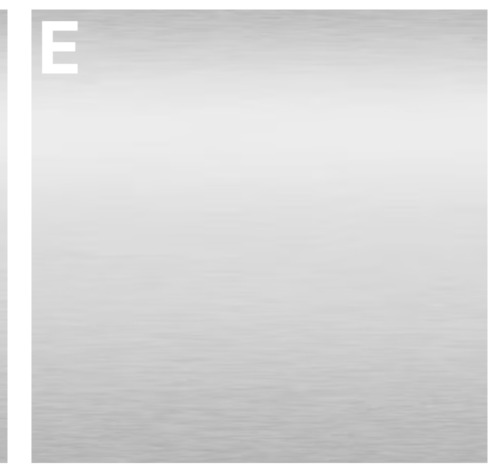
Anodized or Painted Finish

Hydro
QC, Canada

EPD 4790427057.122.1

51 $kgCO_2e/m^2$

Industry Average (AEC)



Anodized or Painted Finish

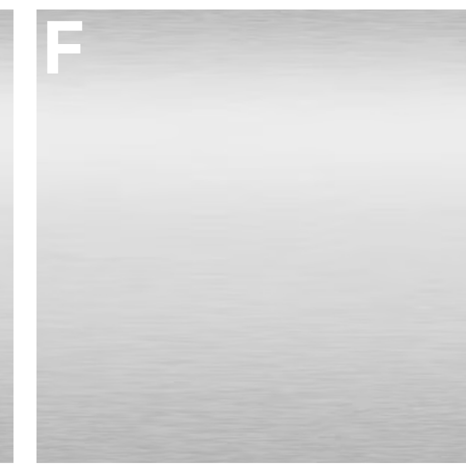
Aluminum Extruders Council (AEC)
IL, USA

EPD 4790414446.101.1

The AEC specializes in serving the specific needs of the aluminum extrusion sector in North America. It does not include all extrusion suppliers, and appears to focus primarily on US manufacturers.

53 $kgCO_2e/m^2$

Aluminum Extrusions



Aluminum Extrusions

Longboard Architectural Products
BC, Canada

EPD 4790062561.101.1

framing alternatives

- Combustible glazing support systems are allowable in Part 3 buildings subject to OBC 3.1.5.4, “Combustible Windows, Glazing, and Skylights”.
- Emissions data for complete assemblies is available for several of these products, but those related to the framing alone are generally unavailable.

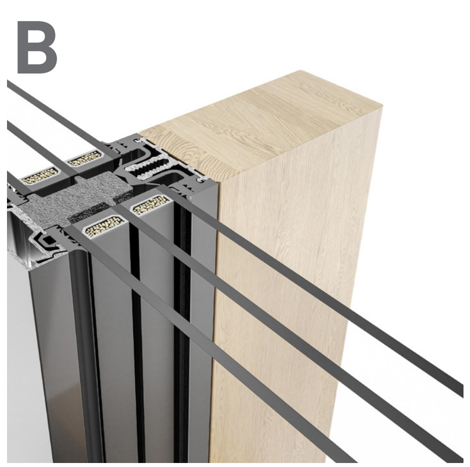
emissions data unavailable

Wood curtainwall mullions

Timber Curtainwall

H Window
WI, USA

Wood curtainwall mullions

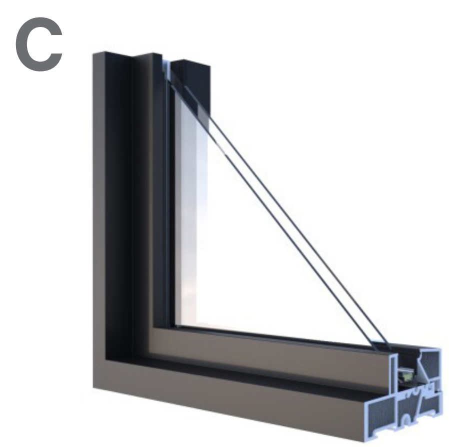


Therm+ H-I

Raico
Germany

10 $kgCO_2e/m^2$

Fibreglass window frames



Universal Series

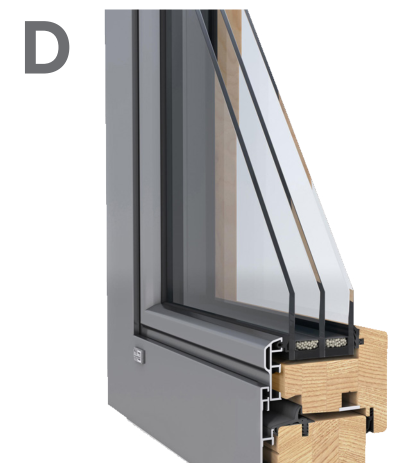
Cascadia
Canada

EPD CAS – 090524 – 001

From an upfront emissions perspective, fiberglass window frames are a viable alternative to aluminum. When considering full lifecycle characteristics, fibreglass frames exhibit exceptional durability, but they cannot be easily recycled.

emissions data unavailable

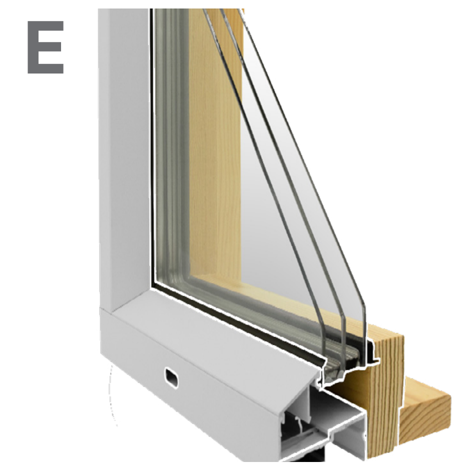
Wood window frames



Energate 963

Energate
Germany

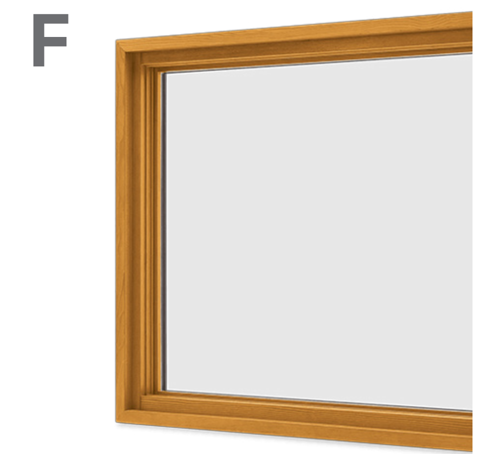
Wood window frames



Direct Set Windows

H Window
WI, USA

Wood window frames



Fixed Window

Accoya
NS, Canada

guide: choosing better insulation

Due to their quantity and impact, insulation materials are a significant choice in any project. They are also one of the most critical materials to consider when analyzing a building envelope in terms of "trade-offs": insulation plays a crucial role in energy efficiency, but its production is often carbon-intensive and associated with negative environmental impacts such as toxic pollution from formaldehyde and flame retardants. Plastic-based insulation is responsible for 18% of plastics produced for the construction industry worldwide (Zhao et al., 2022) The catalogue entries shown on the following pages attempt to circumvent this problem by including non-plastic alternatives.

Upfront emissions reduction strategies:

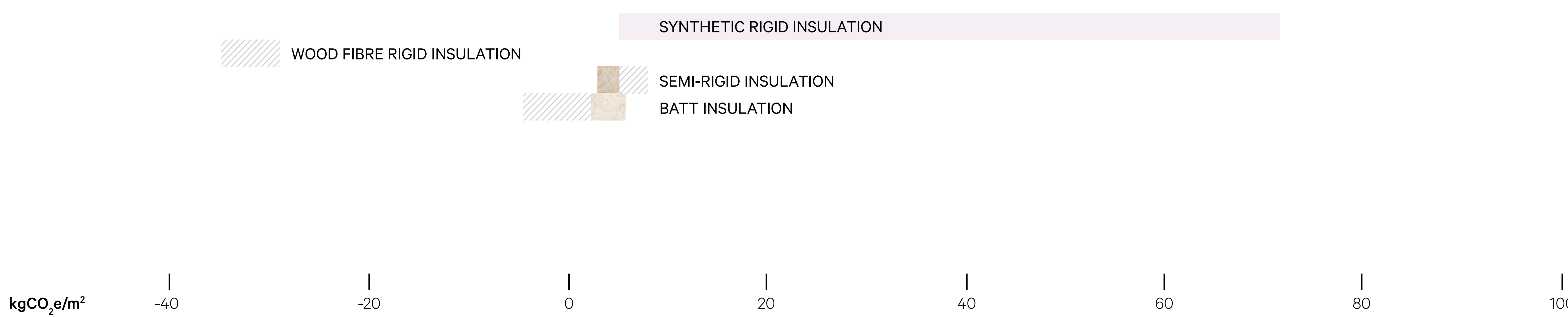
- **Use only what you need:** detail continuous insulation outboard of building structure and continuous air barrier systems to maximize thermal performance. Reduce insulation quantity through an optimization analysis (KPMB 2021), balancing emissions impacts for both operational and embodied CO_2.
- **Choose best-in-class alternatives** composed of inert materials with high recycled content.
- **Consider natural fibre insulation:** combustible insulation is allowable in Part 3 non-combustible buildings per OBC 3.1.5.14. Under the right conditions, this creates the potential to use natural fibre insulations such as wood fiber. At time of writing, testing for these products is pending in Ontario, but their use in other jurisdictions suggests that broad compliance is attainable. Currently, approval is possible by AHJs on a case-by-case basis.

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account. *



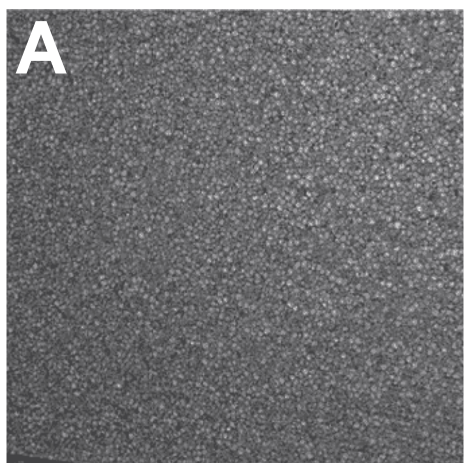
Navigation Links

synthetic rigid insulation

- Insulation thicknesses have been calculated to achieve thermal performance of approximately R-20.
- Synthetic insulations have one of the largest emissions ranges documented in this guide. They are typically made of petrochemicals (foamed plastic), making their end-of-life disposal problematic. Examples are included in this guide as a benchmark, but non-plastic alternatives are encouraged when practical.

5.3 $kgCO_2e/m^2$

Rigid Insulation



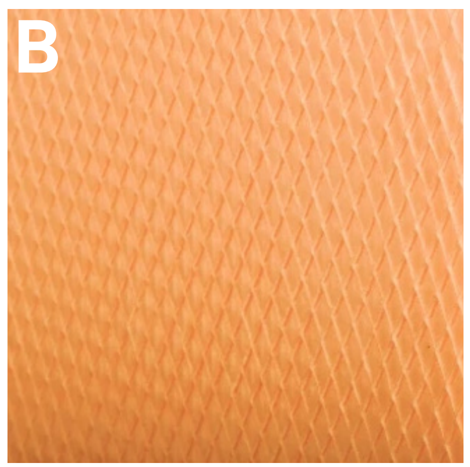
Graphite Polystyrene

BASF, Neopor F5300 Plus
NJ, USA

EPD 10841
R-20 Thickness: 110mm

6.2 $kgCO_2e/m^2$

Rigid Insulation



Extruded Polystyrene (XPS)

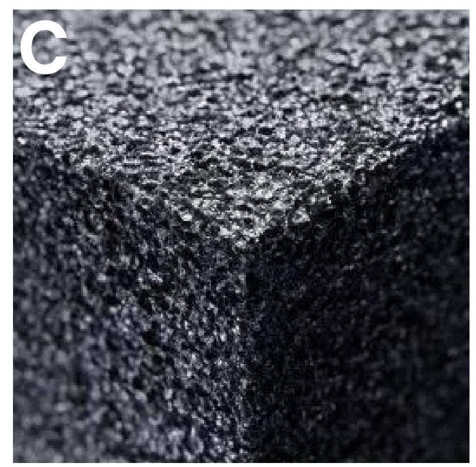
Soprema, SOPRA-XPS
QC, Canada

EPD 283
R-20 Thickness: 100mm

Manufacturer claims 70% recycled / recovered content.

24 $kgCO_2e/m^2$

Rigid Insulation



Cellular Glass

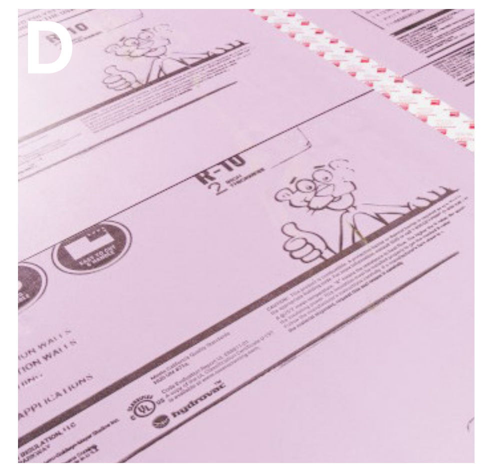
Owens Corning, Foamglas T4+
Belgium

EPD PCE-20200299-IBB1-EN
R-20 Thickness: 145mm

Cellular glass insulation can replace closed-cell plastic XPS insulation in below-grade applications, which has traditionally been one of the most challenging applications to find replacements for. Cellular glass is generally inert, so end-of-life disposal or potential recycling is straightforward.

26 $kgCO_2e/m^2$

Rigid Insulation



Extruded Polystyrene (XPS)

Owens Corning, Foamular NGX XPS
Belgium

EPD SCS-OPT-09753
R-20 Thickness: 152mm

From a long term perspective, plastic foam insulation is harmful to the environment. This example is included as a benchmark for best-in-class plastic foam, from an emissions intensity perspective.

72 $kgCO_2e/m^2$

Rigid Insulation

Extruded Polystyrene (XPS)

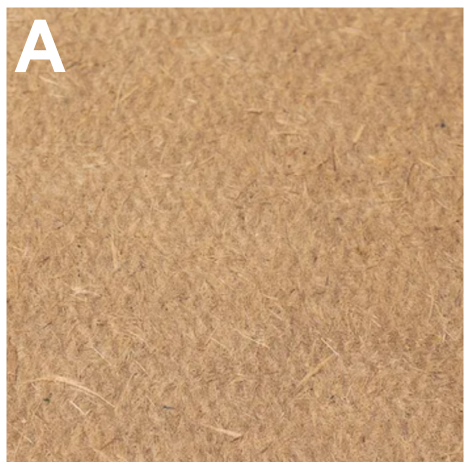
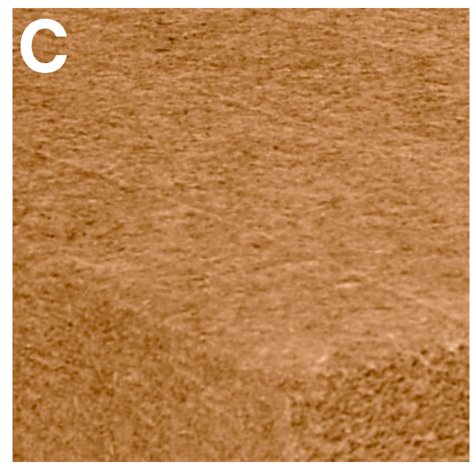
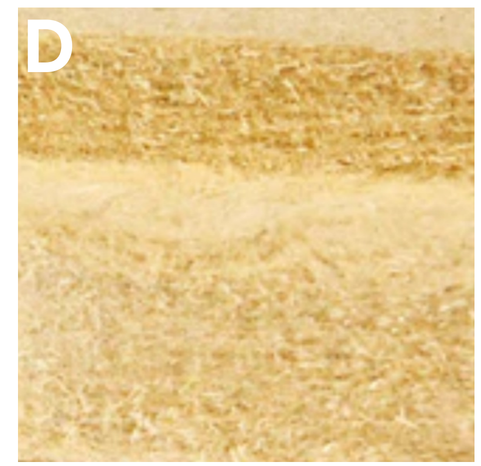
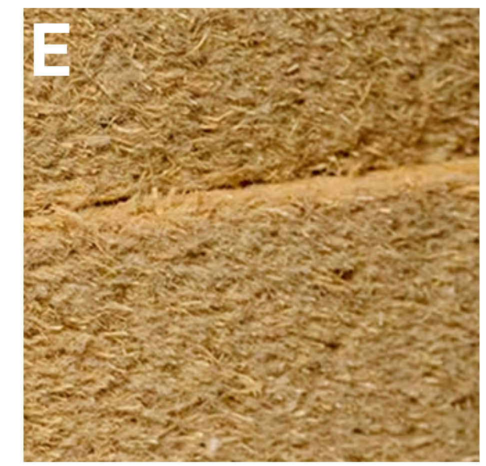
Dupont, Styrofoam Brand XPS
USA

EPD 4789559274.102.1
R-20 Thickness: 102mm

This product is not recommended, but it is included as a benchmark for poor emissions performance.

wood fibre rigid insulation

- Insulation thicknesses have been calculated to achieve thermal performance of approximately R-20.
- Wood fibre insulation is typically made from waste that is collected from sawmill factories, making it an efficient use of natural resources. It is often combined with starch and paraffin to achieve performance characteristics. Descriptions suggest that these components make up approximately 1-2% of the final product (TimberHP).
- Wood fibre insulation is allowable in Part 3 non-combustible buildings under limitations specified by OBC 3.1.5.14. At time of writing, testing for these products is pending in Ontario, but their use in other jurisdictions suggests that broad compliance is attainable. Currently, approval is possible by AHJs on a case-by-case basis.
- Biogenic carbon sequestration data is unreliable due to the wide range of assumptions necessary for estimation, but data has been included here for consideration. Note that on this page, the negative GWP numbers indicate that wood fibre insulation has the potential to store (sequester) carbon emissions.
- Local availability and transportation-related emissions should be considered for internationally-produced products.

A	B	C	D	E
emissions data unavailable		**-28** w/ biogenic non-biogenic emissions data unavailable	**-32** w/ biogenic	**-35** w/ biogenic
Rigid Insulation	**Rigid Insulation**	**Rigid Insulation**	**Rigid Insulation**	**Rigid Insulation**
				
Wood Fibre	**Wood Fibre**	**Wood Fibre**	**Wood Fibre**	**Wood Fibre**
MSL, SONOclimat ECO4 QC, Canada	TimberHP, TimberBoard ME, USA	Steico France	Gutex, Thermafiber Germany	Pavatex, Pavatherm Germany
		EPD STE-20150327-IBD1-EN	EPD GTX-20200178-IBC1-EN	EPD PAV-20190182-IBA1-DE
R-20 Thickness: 165mm	R-20 Thickness: 140mm	R-20 Thickness: 160mm	R-20 Thickness: 160mm	R-20 Thickness: 140mm

TimberHP is currently pursuing testing for compliance with Ontario regulations; targeting completion in mid to late 2025.

Biogenic content theoretically provides the ability for these materials to sequester carbon, leading to negative GWP values.

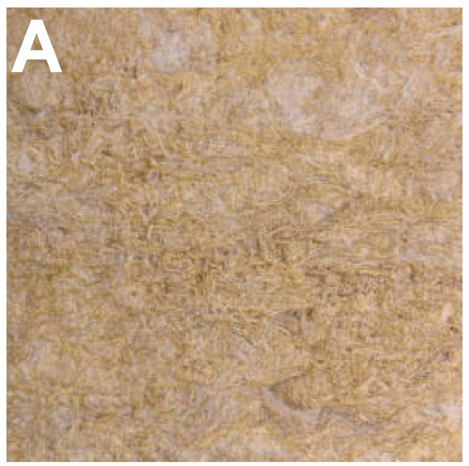
SvN

semi-rigid insulation

- Insulation thicknesses have been calculated to achieve thermal performance of approximately R-20.
- Biogenic carbon sequestration data is unreliable due to the wide range of assumptions necessary for estimation, but data has been included here for consideration.

4.6 $kgCO_2e/m^2$

Semi-Rigid Insulation



Mineral Fibre - Stone Wool

Rockwool
ON, Canada

EPD RWI-20190075-CCD1-EN
R-20 Thickness: 130mm

Stone wool is made from basalt rock, recycled slag from the steel industry, and other minerals such as limestone or dolomite.

5.3 $kgCO_2e/m^2$

Semi-Rigid Insulation

Mineral Fibre - Slag Wool

Owens Corning, Thermafiber
OH, USA

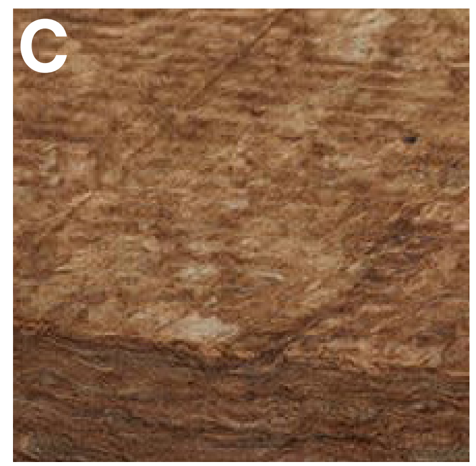
EPD 4790011847.101.1
R-20 Thickness: 140mm

Slag wool is made from blast furnace slag, a byproduct of steel production. Thermafiber claims 70% recycled material content.

-28 w/ biogenic

non-biogenic emissions data unavailable

Semi-Rigid Insulation



Mineral Fibre - Formaldehyde Free

Owens Corning, Thermafiber
OH, USA

EPD 4790011847.102.1
R-20 Thickness: 123mm

Certified bio-based, but no definition of actual content is presented in product literature.

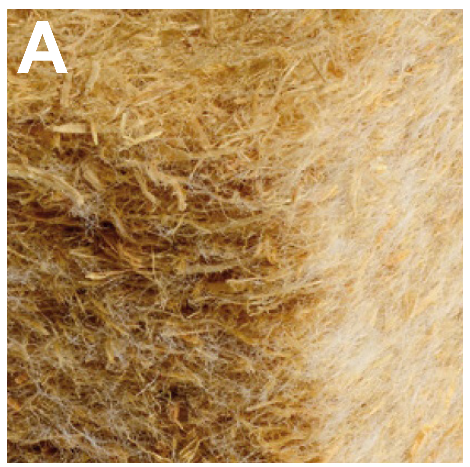
batt insulation

- Insulation thicknesses have been calculated to achieve thermal performance of approximately R-20.
- Some of the insulation products noted below include combustible materials. Confirm compliance with OBC 3.1.5.14 and local regulations applicable to intended use cases.
- The bio-based options featured on this page can have beneficial life cycle characteristics which should be considered in addition to emissions intensity. Biogenic carbon sequestration data is unreliable due to the wide range of assumptions necessary for estimation, but data has been included here for consideration. Note that on this page, the negative GWP numbers indicate that wood fibre insulation has the potential to store (sequester) carbon emissions.

-4.0 w/ biogenic

non-biogenic emissions data unavailable

Batt Insulation



Wood Fibre

Pavatex, Pavaflex
Belgium

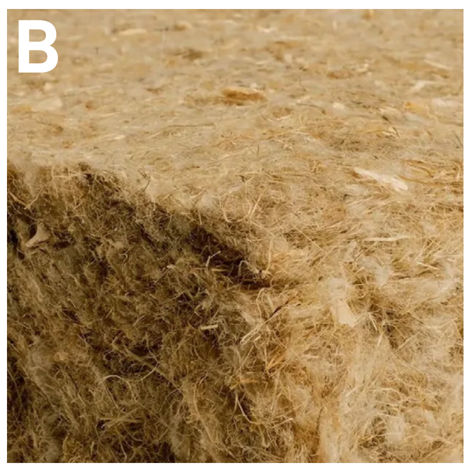
EPD
R-20 Thickness: 140mm

Made from 100% wood fibre, combined using a "wet" process that activates lignin for bonding. Biogenic content theoretically provides the ability for this material to sequester carbon, leading to a negative GWP value.

-0.9 w/ biogenic

non-biogenic emissions data unavailable

Batt Insulation



Hemp Fibre

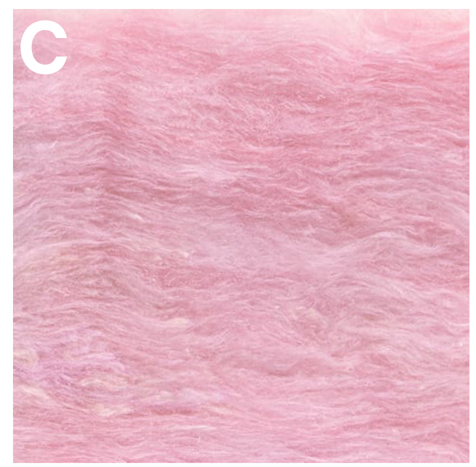
Hempitecture, Hemp Wool
ID, USA

EPD not available
R-20 Thickness: 140mm

Made from 90% natural industrial hemp fiber, combined with sheep's wool and polyester binders. Biogenic content theoretically provides the ability for this material to sequester carbon, leading to a negative GWP value.

2.3 $kgCO_2e/m^2$

Batt Insulation



Fibreglass

Owens Corning
ON, Canada

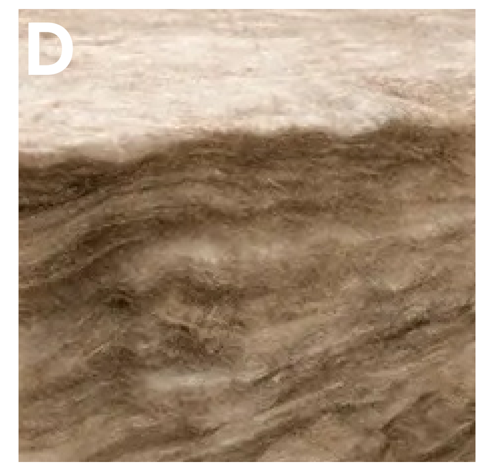
EPD SCS-EPD-09348
R-20 Thickness: 150mm

"Typical" batt insulation.

2.8 w/ biogenic

3.5 $kgCO_2e/m^2$

Batt Insulation



Fibreglass

Knauf Insulation, EcoBatt
MI, USA

EPD KNA–12122023–001
R-20 Thickness: 140mm

Made from recycled glass, sand and a bio-based binder that replaces phenol formaldehyde.

-2.9 w/ biogenic

6.2 $kgCO_2e/m^2$

Batt Insulation

Hemp Fibre

Nature Fibres, Profib Mat
QC, Canada

EPD 197
R-20 Thickness: 140mm

Made from industrial non-woven hemp fibres combined with a synthetic binder. Biogenic content theoretically provides the ability for this material to sequester carbon, leading to a negative GWP value.

guide: choosing better blocks

Concrete masonry units (CMUs) are highly standardized: they are generally unseen and unconsidered, often used in utilitarian buildings, in back-of-house spaces, or as a substrate.

Most of the upfront carbon in CMUs is associated with their cement content. Unlike precast, the concrete mix used to manufacture CMU blocks is typically non-customizable, so emissions reduction strategies related to cement content in blocks are less accessible, but still exist in some cases. This opportunity does exist for the concrete used to fill voids in reinforced or "solid" block walls.

Upfront emissions reduction strategies:

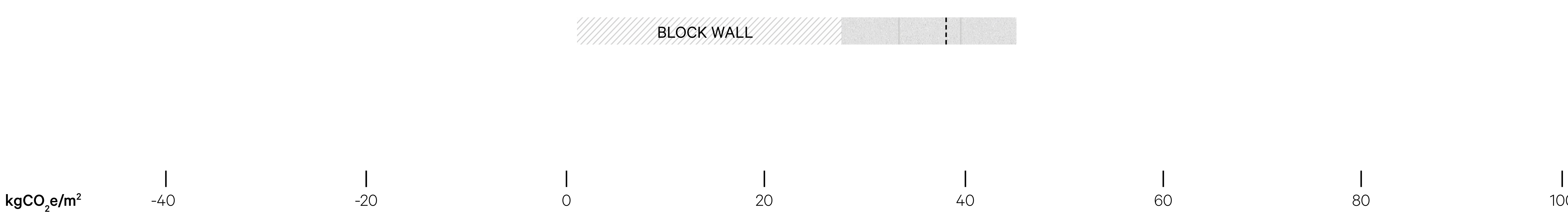
- Avoiding heat-cured CMU blocks, which consume additional energy. Innovative techniques such as dry-cast processes can reduce these emissions.
- When possible choose CMUs whose cement is manufactured with SCMs, including carbon sequestering materials and post-industrial waste.
- For cement fill in voids, use emissions reduction strategies for concrete as outlined in "guide: choosing better precast concrete" on page 11.
- Choose non-concrete alternatives when practical.

Legend

Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account. *

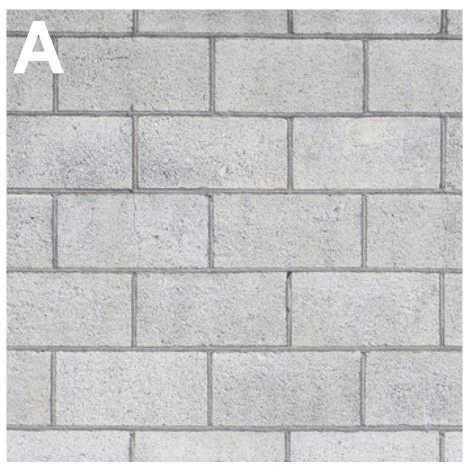


Navigation Links

Main Graph
Precast Concrete
Cement-based Panels
Stone
Brick
Ceramic
Metal Panels
Cladding Alternatives
Openings
Insulation
Block Wall
Boards

2.2 biogenic

Normal Weight CMU



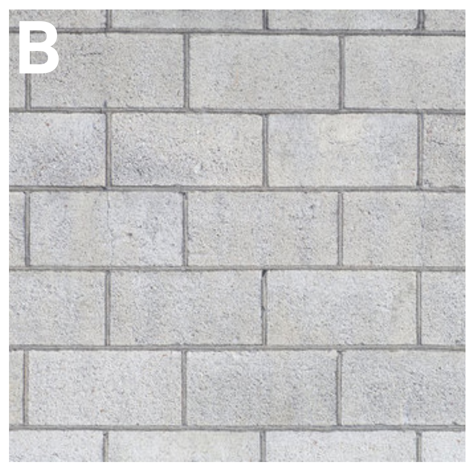
Carbicrete
QC, Canada

EPD 668

Carbicrete is made from decarbonized concrete. Blast furnace slag eliminates the cement binder and “carbon mineralization” technology converts atmospheric CO_2 into calcium carbonate to add to the strength and density of the units.

27 $kgCO_2e/m^2$

Normal Weight CMU



Angelus Block, Carbon Kind
CA, USA

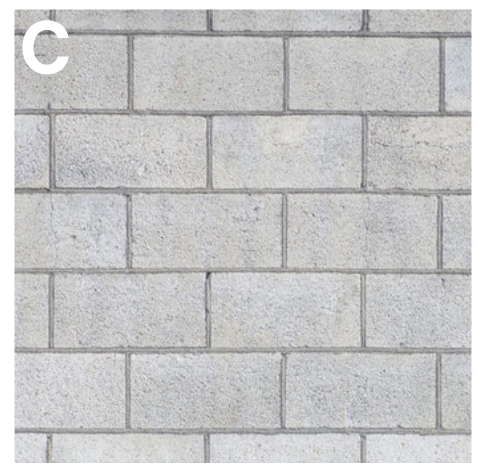
EPD available, but not numbered

Use of SCMs and PLC reduces the emissions intensity of this product. Refer to "guide: choosing better precast concrete" on page 11 of this catalogue for more information.

Given that this product is not produced locally, this catalogue entry is offered to highlight the opportunity for innovation in Ontario.

37 $kgCO_2e/m^2$

Normal Weight CMU



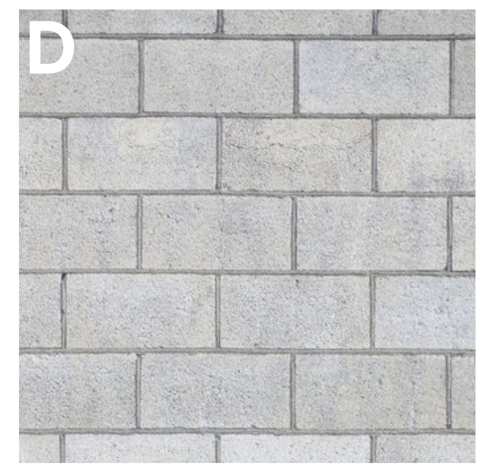
Boehmers/ Carboclave
ON, Canada

EPD 088

Carboclave uses CO_2 as a curing agent and energy source. The manufacturer claims that CO_2 absorption also increases the density and strength of these CMU blocks.

38 $kgCO_2e/m^2$

Industry Average

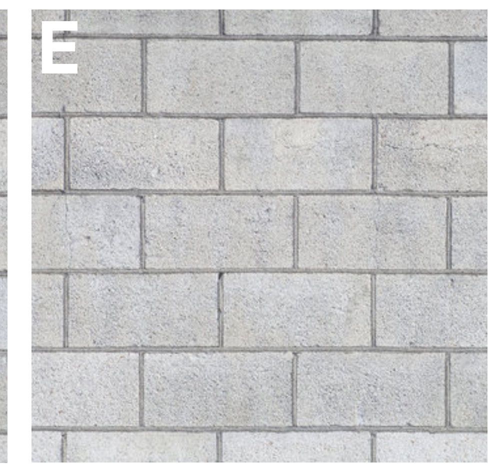


Canadian Concrete Masonry Producers Asociation (CCMPA)

EPD 338

39 $kgCO_2e/m^2$

Normal Weight CMU



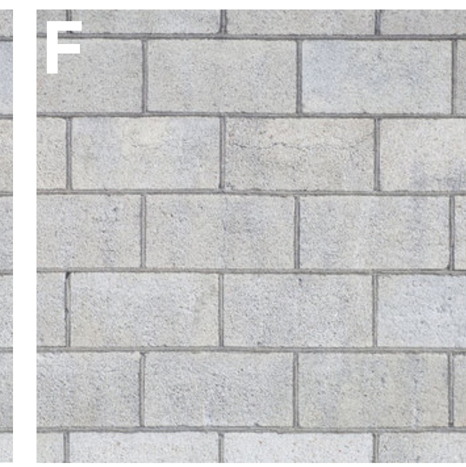
Oldcastle APG Canada West
AB, Canada

EPD HUB-0468

Alberta data is presented here as similar data from Ontario is not currently available.

45 $kgCO_2e/m^2$

Light Weight CMU



Oldcastle APG Canada West
AB, Canada

EPD HUB-0467

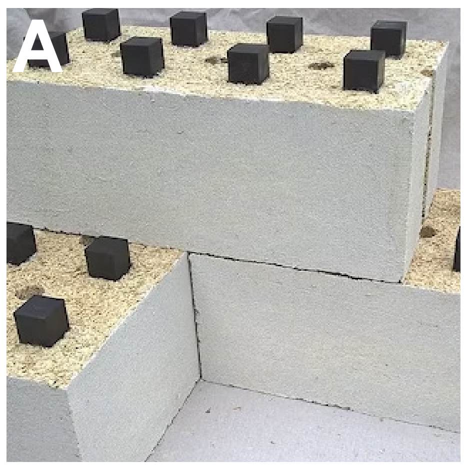
Light weight CMUs are higher in emissions since they use expanded aggregates which require additional processing. They are also more porous than normal aggregates so more cement is used to maintain strength and to coat and bind the aggregates. The upfront carbon impacts should be considered holistically with the improved thermal efficiency and reduced structural loads of these units.

block wall alternatives

- CMU is typically sourced locally to each project. Since none of the options on this page are local, they have been included to highlight what is possible, potentially encouraging the creation of similar products in Ontario in the future.
- While emissions data for these products is unavailable, their use of bio- and geo-based materials and emissions-limiting technology provide opportunities for beneficial lifecycle and emissions characteristics.

emissions data unavailable

Hemp-lime



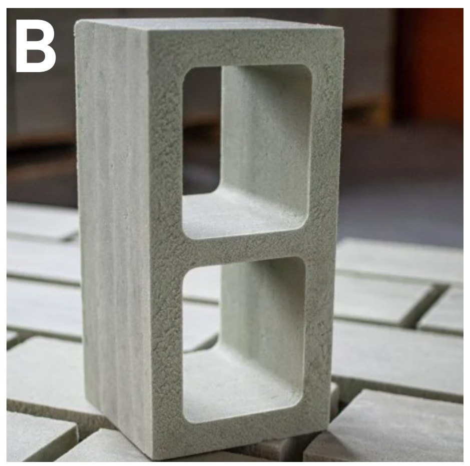
Hempcrete Block

Just BioFiber
AB, Canada

Manufactured using industrial hemp and lime without portland cement. The blocks have an interlocking design that can be built rapidly and reduce mortar requirements as well as construction time and cost.

Product is easily disassembled.

Algae-Based Cement

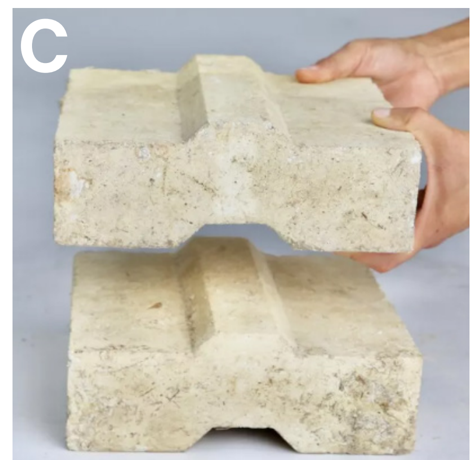


Bio-Block

Prometheus Materials
CO, USA

Manufactured from a low-carbon cementitious material grown from micro-algae.

Sugarcane Bio-waste



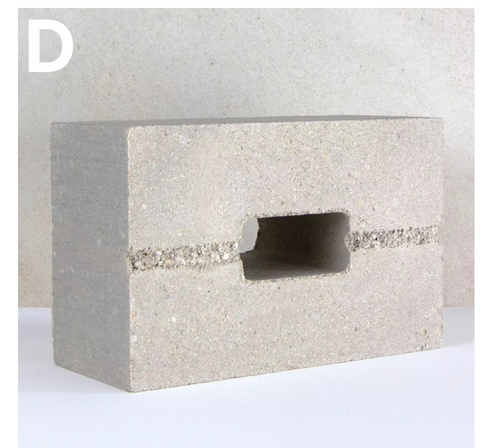
Sugarcrete

University of East London
UK

Manufactured from sugarcane fibres byproducts with sand-mineral binders. Product is demountable and circular at its end-of-life.

A similar product is "Agrocrete" by GreenJams, which uses crop residues and a slag-based mineral binder from steel production.

Compressed Earth

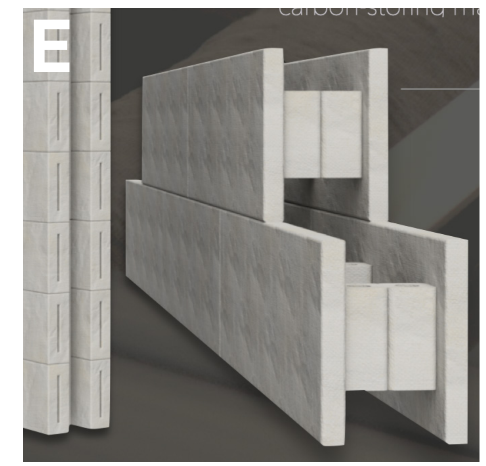


Compressed Earth Block

BC Materials
Belgium

Manufactured from a mixture of clay, loam, sand, and a small percentage of stabilizers such as portland cement or lime (~4%).

Mycelium

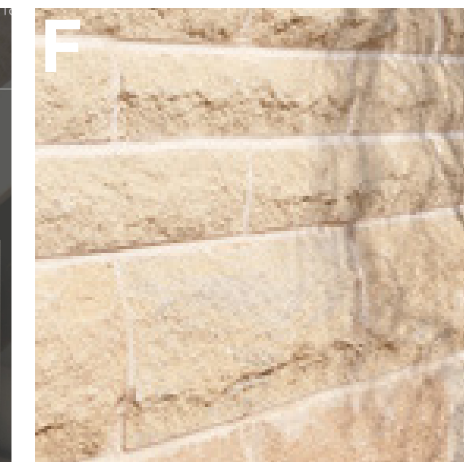


"Zero Frm" Structural Block

Okom Wrks Labs
IL, USA

This block is grown from plant- and fungus-based materials. The manufacturer claims that these units are significantly stronger than other mycelium composites currently available in the market.

Dry-Cast CMU



Dry-Block System

GCP Applied Technologies
MA, USA

This product incorporates admixtures which claim to reduce production-related energy in CMU blocks and mortar.

SvN

guide: choosing better boards

Sheet goods such as sheathing and interior finish boards have the smallest emissions intensity range within this guide.

Although some boards incorporate high-GWP components such as fibreglass and cement, the primary material for standard sheet products is gypsum. While the emission intensity is small, these materials are used in large quantities for interiors, so their impact can be significant.

Naturally occurring gypsum is non-renewable, but abundant in many geographies. It is inert, and readily recyclable into new products. It can even be downcycled into soil amendment and plant nutrients. One of the largest drawbacks to this material is that it is obtained from surface mining, which causes loss of wildlife habitat, loss of agricultural land, surface erosion, water pollution, and mining by-product disposal. Because these products are relatively cheap, they are often discarded as construction waste, often at a rate of more than 10% on typical project sites (Iano p.898).

Upfront emissions reduction strategy:

- Synthetic gypsum can be made from recovered waste material from power plants. Along with recycled paper facing, this strategy can result in a very high degree of recycled content within new gypsum wallboard products (MACOPA).

A number of potential alternatives and future product innovations have been included in this catalogue, primarily for interior finish boards. Many use waste by-products or materials that improve sourcing and lifecycle characteristics.

Legend

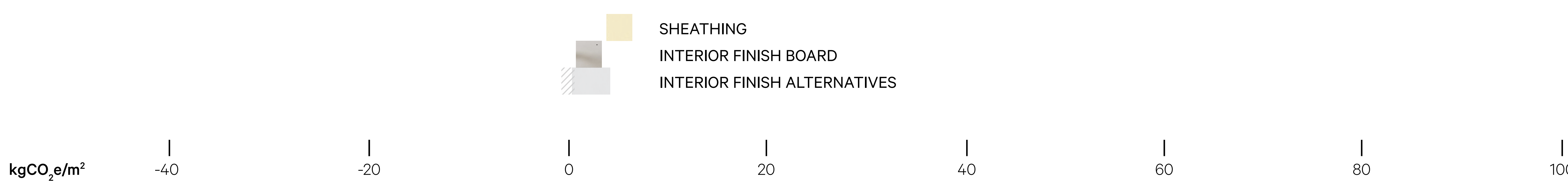
Dashed line indicates industry averages, when data is available.

Hatch indicates emissions range with biogenic carbon sequestration credit. This data is generally unreliable due to the high degree of assumptions, but biogenic content is considered beneficial in terms of overall lifecycle.

Asterisk denotes cladding that requires support structure; emissions intensity impact of this structure is not included in these graphs. Estimates can be obtained from Kaleidoscope, but project-specific considerations should be taken into account. *

Navigation Links

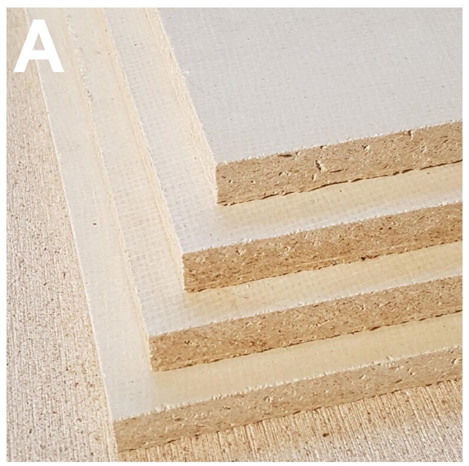
Main Graph
Precast Concrete
Cement-based Panels
Stone
Brick
Ceramic
Metal Panels
Cladding Alternatives
Openings
Insulation
Block Wall
Boards



- Sheathing product selection is often driven by performance characteristics, particularly structural capacity, durability, moisture resistance, and code limitations for combustibility. However, non-gypsum options can have beneficial life cycle characteristics and are generally lower in upfront emissions, so they should be considered where use cases and regulations allow.

emissions data unavailable

Mineral-based board



Magnum Board

Magnum Board Products
FL, USA

Thickness: 12mm

Fiberglass reinforced with Magnesium Oxide (MgO), which has the potential to sequester carbon dioxide. Unlike gypsum, MgO can be processed at room temperature, reducing upfront emissions. This product has the potential to be recycled at the end of its life.

Plywood

PureBond

Columbia ForestProducts
ON, Canada

Thickness: 12.7mm

This product uses soy-based adhesive instead of urea formaldehyde (UF). Durability is limited in exterior use cases without protective barriers. Product is combustible.

3.5 kgCO_2e/m^2

Fiberglass-Faced Gypsum

UltraLight Glass-Mat Sheathing Firecode Panel

USG CGC
USA

EPD 492
Thickness: 15.9mm
Fire-rated

4.2 kgCO_2e/m^2

Fiberglass-Faced Gypsum

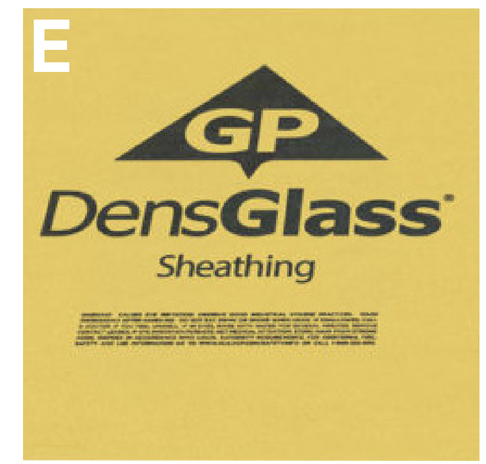
GlasRoc Sheathing Gypsum Board

CertainTeed Gypsum
QC, Canada

EPD 4790745506.107.1
Thickness: 15.9mm
Fire-resistant

4.9 kgCO_2e/m^2

Fiberglass-Faced Gypsum



DensGlass Fireguard Sheathing Panel

Georgia-Pacific Gypsum LLC
GA, USA

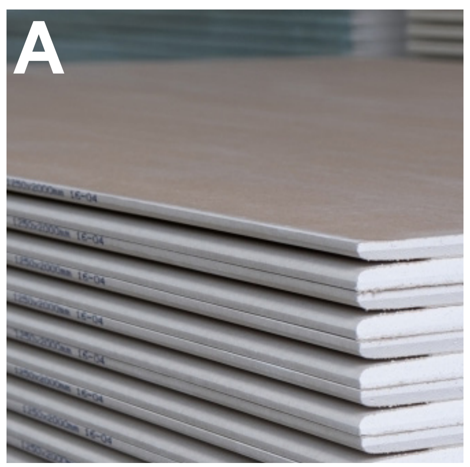
EPD 10268
Thickness: 15.9mm
Fire-rated

interior finish board

- Upfront emissions appear to be higher in fire rated gypsum wallboard than in standard board, likely due to the addition of glass fibres in the board composition.
- Due to EPD limitations, some thicknesses have been corrected to 1/2” using material density to ensure consistency of comparison. These are indicated by an asterisk ‘ * ‘.

1.5 $kgCO_2e/m^2$

Lightweight Gypsum Board



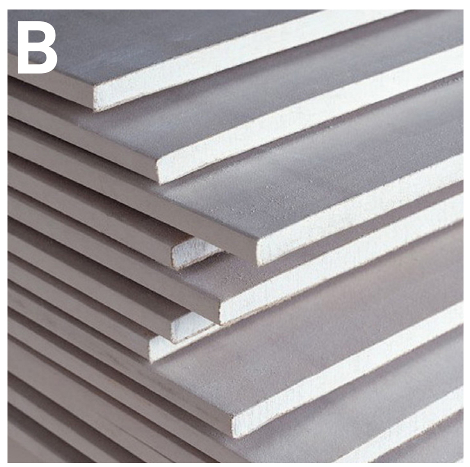
Easi-Lite Lightweight Gypsum Board

CertainTeed Gypsum
QC, Canada

EPD 4786663719.111.1
Thickness: 12.7mm

1.5 $kgCO_2e/m^2$

Lightweight Gypsum Board



Sheetrock Brand Ultralight Panel

USG CGC
North America

EPD 516
Thickness: 12.7mm

1.9 $kgCO_2e/m^2$

Lightweight Gypsum Board

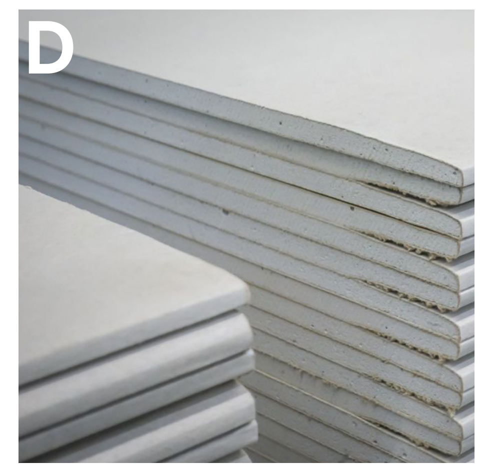
Sheetrock Brand Ultralight Panels

USG CGC
Canada

EPD 527
Thickness: 12.7mm*

2.2 $kgCO_2e/m^2$

Lightweight Gypsum Board



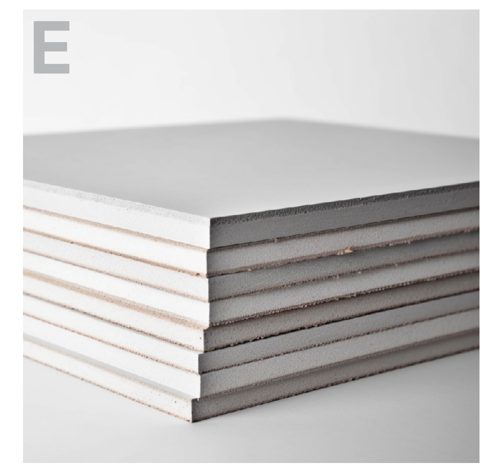
ToughRock Lite-Weight Panel

Georgia-Pacific Gypsum LLC
GA, USA

EPD 10311
Thickness: 12.7mm

2.5 $kgCO_2e/m^2$

Lightweight Gypsum Board



ToughRock Lite-Weight Fire-Rated Panel

Georgia-Pacific Gypsum LLC
GA, USA

EPD 10316
Thickness: 12.7mm*

2.5 $kgCO_2e/m^2$

Type X Gypsum Board

CertainTeed Type X

CertainTeed Gypsum
QC, Canada

EPD 4789532059.132.1
Thickness: 12.7mm*

Typical fire rated gypsum board for comparison.

interior finish board alternatives + innovations

- The bio- and geo-based options featured on this page can have beneficial lifecycle characteristics which should be considered in addition to emissions intensity. Biogenic carbon sequestration data is unreliable due to the wide range of assumptions necessary for estimation, but data has been included here for consideration.
- Many of these products include combustible materials. Confirm compliance with OBC and local regulations applicable to intended use cases.
- Local availability and transportation-related emissions should be considered for internationally-produced products. Despite these challenges, international products have been included to highlight what is possible, potentially encouraging the creation of similar products in Ontario in the future.

1.1 $kgCO_2e/m^2$

Cellulose fibre board

Honext Board

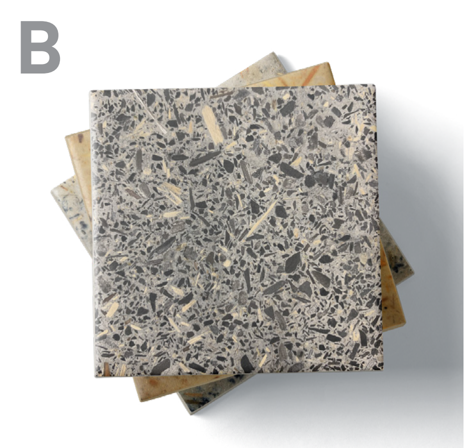
Honext
Barcelona

EPD EN15804-036
Thickness: 12mm

Manufactured from upcycled fibres sourced from industrial byproducts.

2.5 $kgCO_2e/m^2$

Straw board



Durra Panel

Ortech Industries Pty Ltd
Australia

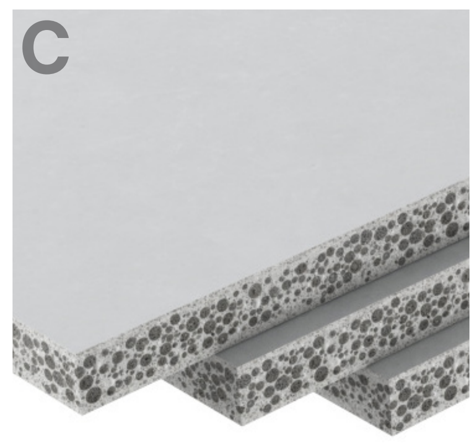
EPD S-P-10940
Thickness: 50mm

Made from straw compressed between two layers of Kraft Paper Liner; it has no glues or binding agents and is fire resistant.

-0.5 w/ biogenic

3.1 $kgCO_2e/m^2$

Waste-based boards



Fermacell Board

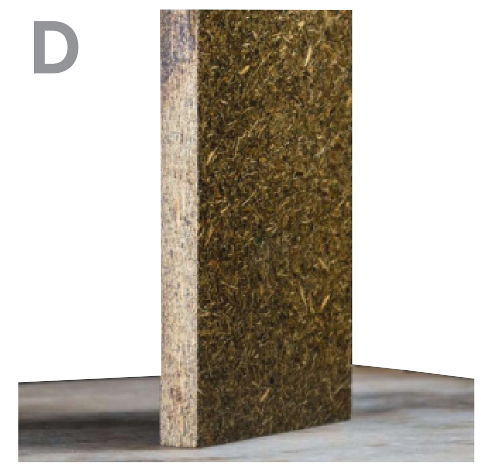
James Hardie
UK

EPD JAM-20220071-CBD1-EN
Thickness: 12.5mm

100% recycled product made from post-consumer gypsum and cellulose fibers. Can be used as a direct substitute for typical gypsum wallboard products.

3.9 $kgCO_2e/m^2$

Straw board



AgriBio Panel

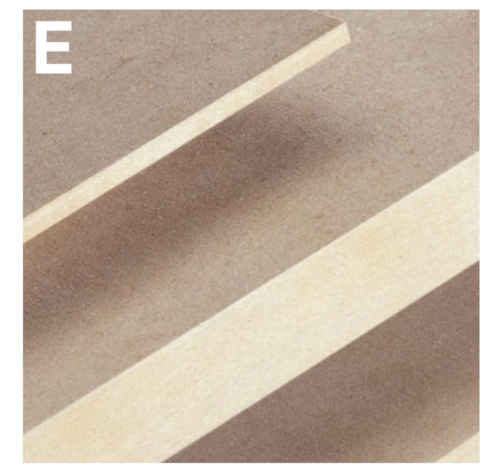
Strawcture Eco
India

Unverified EPD
Thickness: 12mm

Made out of highly compressed straw and no other ingredients; fire resistant.

emissions data unavailable

Wood Fiber board



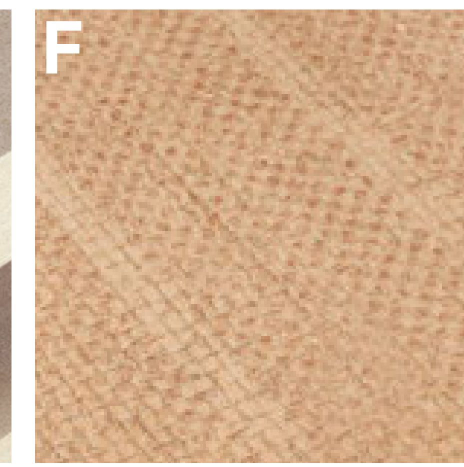
NU Green MR50

Uniboard
QC, Canada

Thickness: 12.7mm

Made from 100% recycled and wood fiber recovered from industrial processes.

Clay board

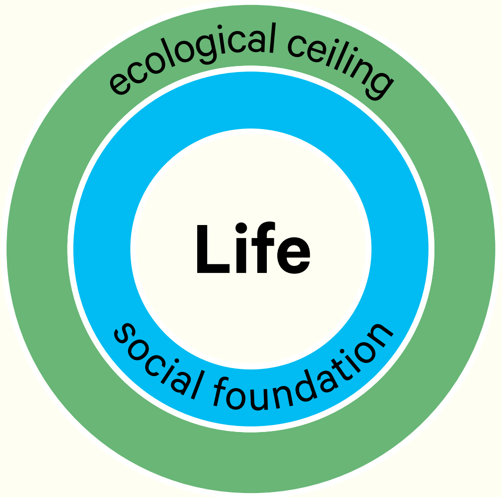


Clay Panel

Lemix
Germany

Thickness: 16mm

Made of clay, earth, wood fibre, starch, and jute fabric. Clay boards can absorb air pollutants and have the capacity to regulate humidity and temperature.



SvN