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How to Make Informed Embodied Carbon Decisions

in Glass and Glazing

Helen Sanders, PhD
Technoform North America

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May 20, 2021, 1:00 pm ET

Thirsty Thursday – Designing for School Security
June 17, 2021, 1:00 pm ET

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July 15, 2021, 1:00 pm ET

NGA Glass Conference: Chicago
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How to Make Informed Embodied Carbon Decisions

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Overview

This presentation will address strategies for minimizing embodied carbon in buildings, and then dive deeper into the impact of façades on embodied carbon, with the aim of providing a framework for making sound carbon-based decisions when designing and constructing with glass.

Learning Objectives

- Describe an embodied carbon decision making framework and prioritization strategy for buildings.
- Identify the source(s) of the largest embodied emissions in insulating glass and understand how that compares to the impacts from other parts of the building.
- Explain the relative roles of insulating glass durability, flat glass manufacturing, IGU manufacturing, IGU sealant materials and manufacturing plant location in determining the embodied carbon of insulating glass.
- Explain how to make an informed decision in designing and specifying glass and glazing with embodied carbon in mind.

Outline

- Operational vs embodied carbon & why we should care
- The big picture of embodied carbon in buildings – where are the big impacts and a decision-making framework for reducing embodied carbon
- Introduction to EPDs and precision of their data
- Dive into insulating and flat glass embodied carbon
- Takeaways from the data
- 5 ways to impact embodied carbon in façades

What is operational carbon?

A single focus for reduction for many years

Photo by Sebastien Gabriel on Unsplash

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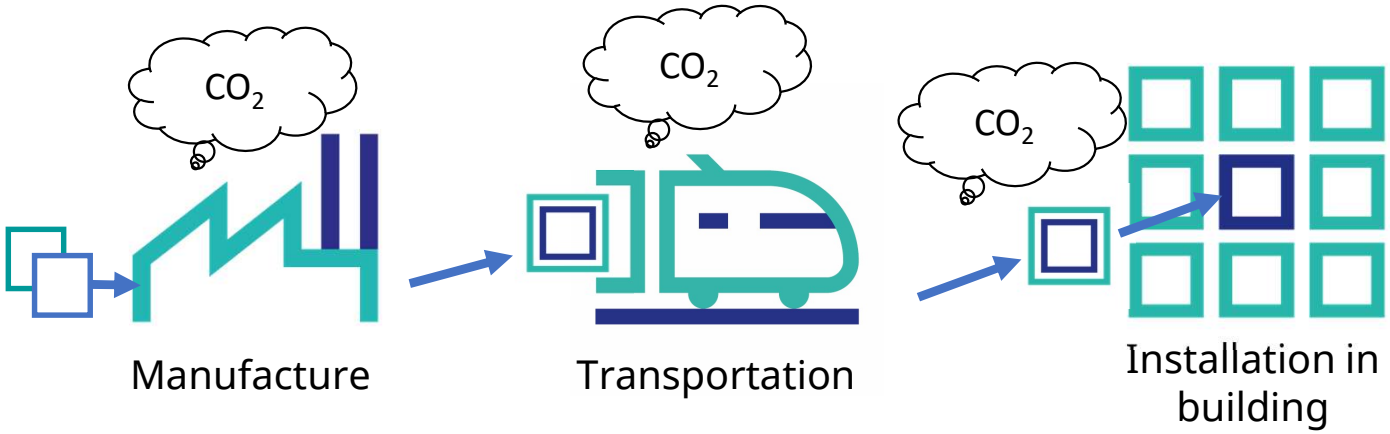
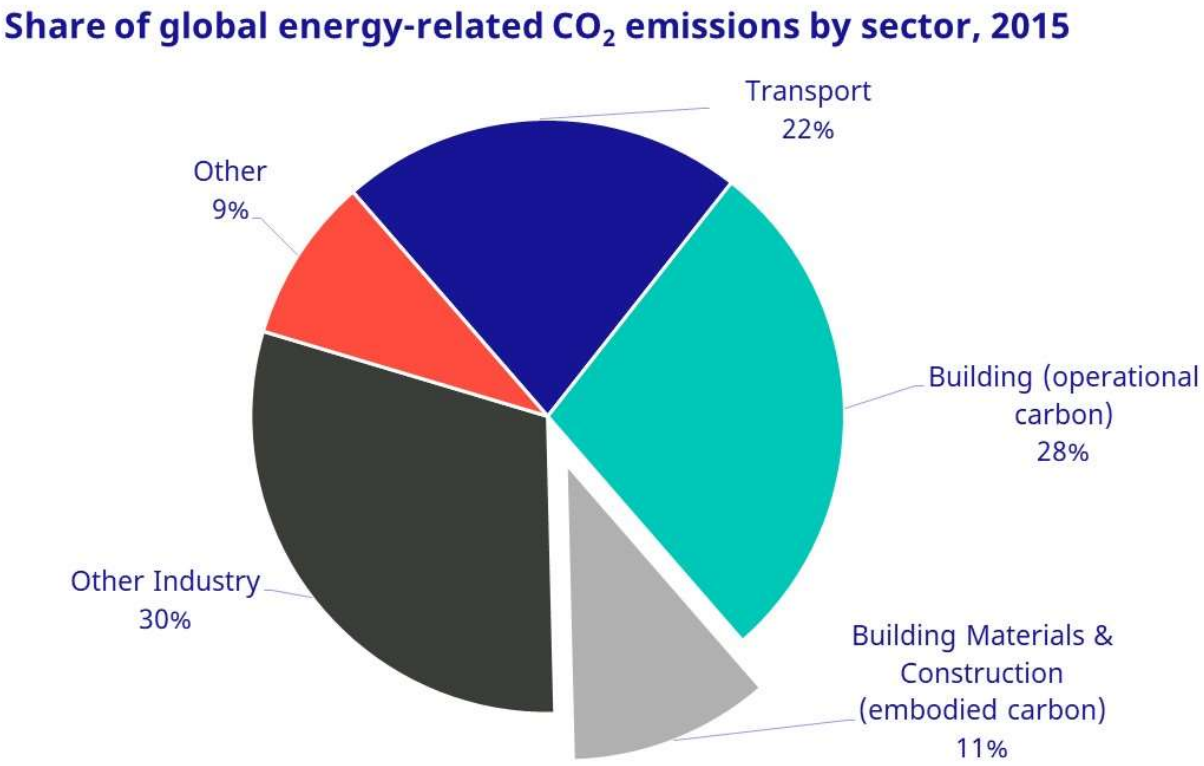
What is embodied carbon?



- “Embodied” not the best word
- “Upfront” emissions better reflects the immediacy of the impact

Why consider embodied carbon?



Source: UN Environment Global Status Report 2017

Annually, embodied carbon is responsible 11% of global GHG emissions and 28% of global building sector emissions

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*The equivalent of 1 New York City will be added to the planet **every 34 days** for the **next 40 years** - Architecture 2030*

Construction is accelerating

By 2060*:

- 230 billion m^2 of buildings will be added worldwide
- an area equal to the entire current global building stock.

In construction from 2020 to 2050:

- Embodied emissions = operational emissions^

**UN Environment, Global Status Report 2017*

^Architecture 2030

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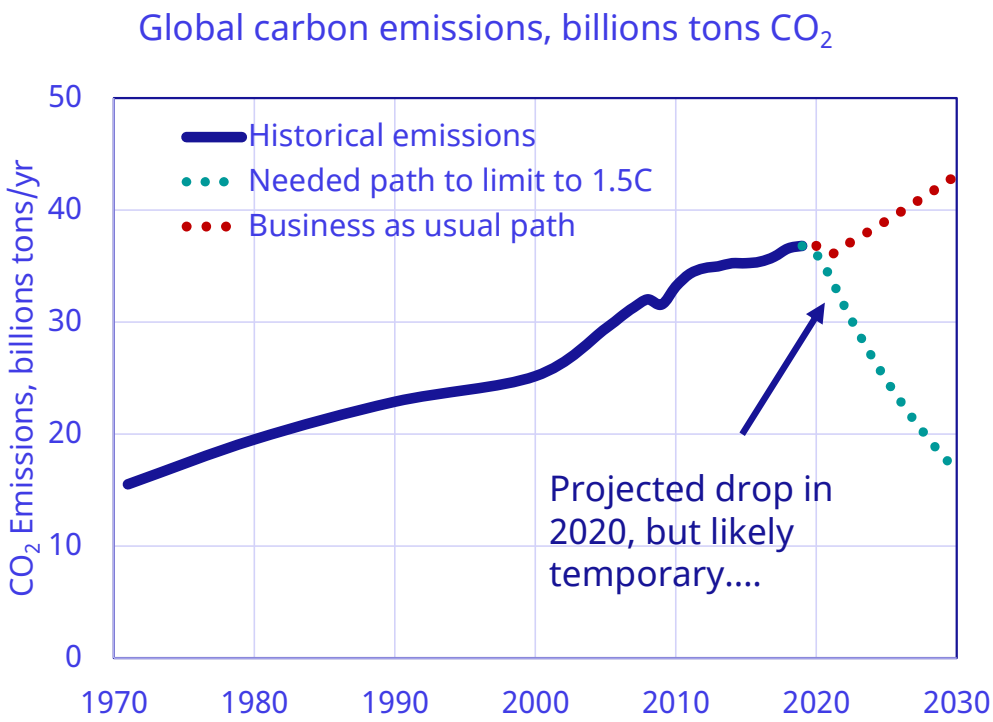
Flattening the curve: Time value of carbon



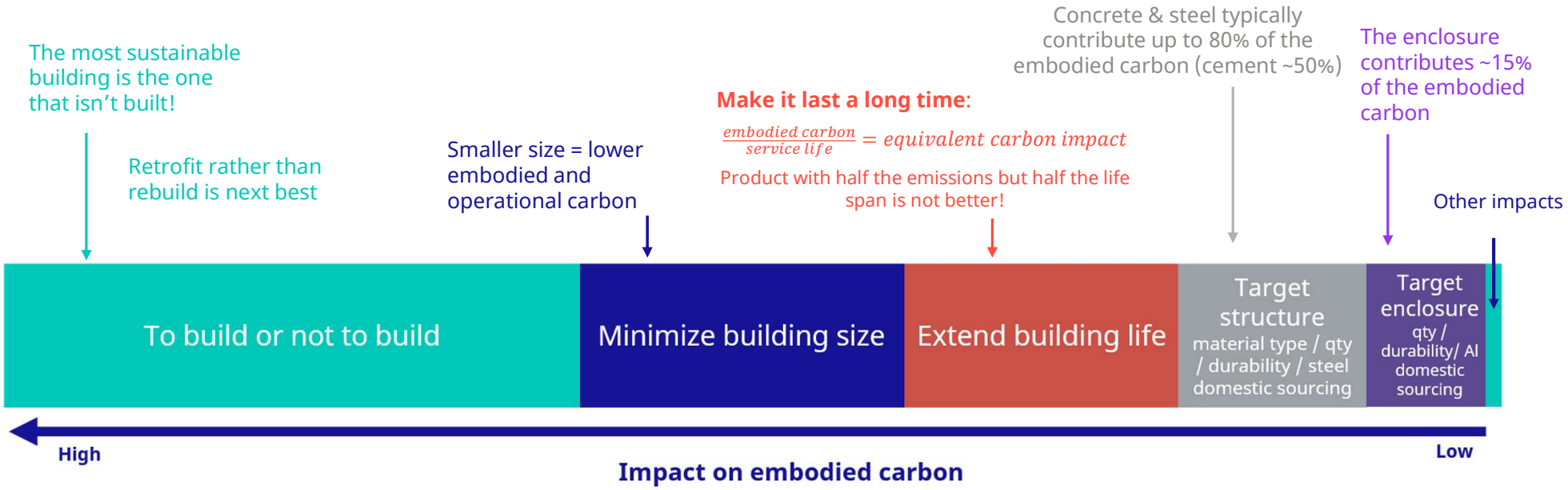
<u>Timing of emissions is critical</u>:

- UN Environment:
  - Reduce by 7.6%/yr starting 2020
  - The longer we delay, the larger the annual reductions need to be
- Embodied emissions are front loaded
- More time to reduce operational carbon

We must address embodied carbon now!

The big picture of embodied carbon in buildings

Decision making framework for embodied carbon

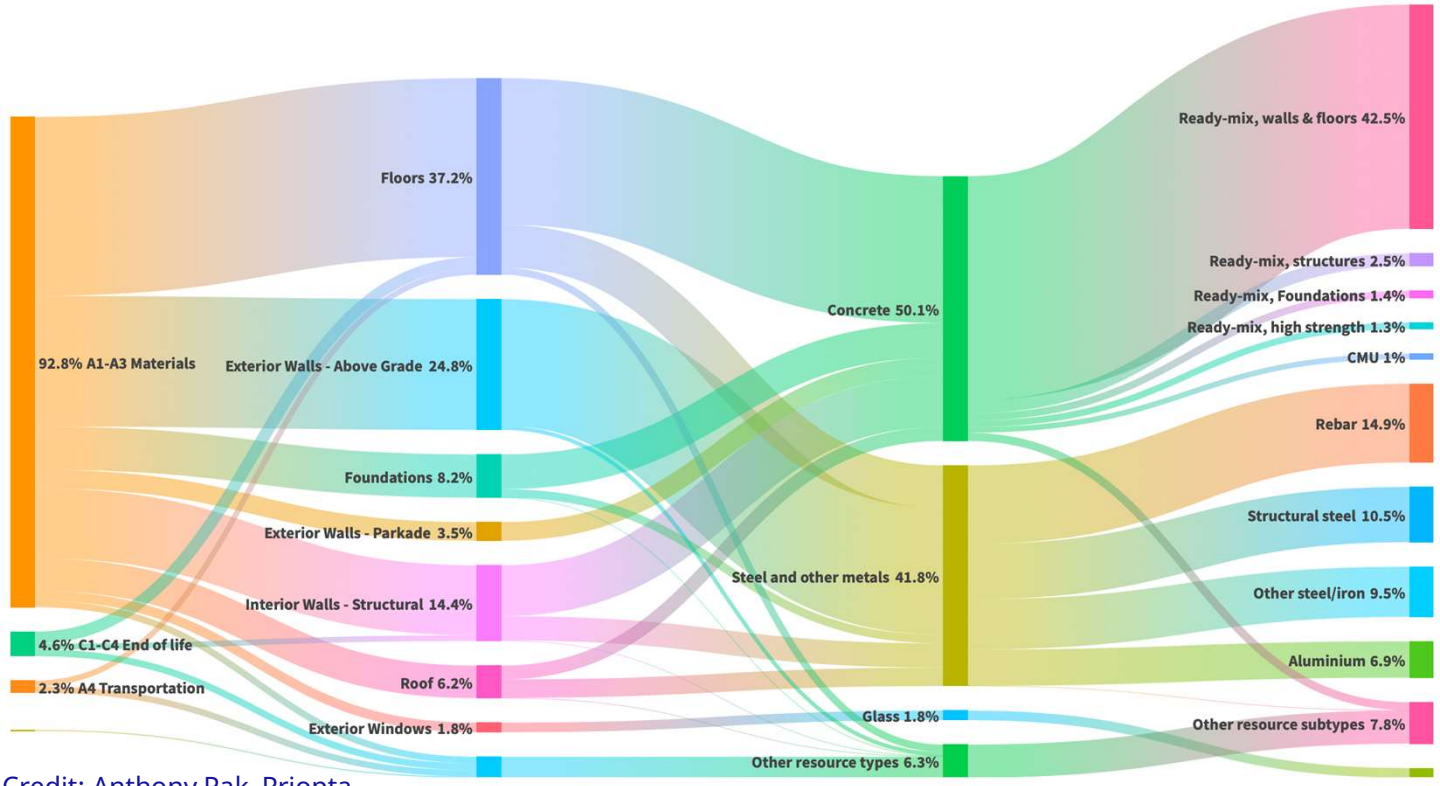


What would a 100, 200, 300+ year building lifetime would mean for the facade:

- Upgradeability?
- Maintenance for curtainwall?
- IGU service life optimization/extension?

If you must build, extending service life is the most important consideration

Relative impacts of building materials



Credit: Anthony Pak, Priopta

- Concrete: 50%
- Steel: 30%
- Aluminum: 7%
- Glass: 2% (assuming counted 2 panes)

Note: This is specific to one prototype office building, details will change between buildings

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Like a nutrition label for a building

Trounce, Public domain, via Wikimedia Commons

Example EPD results

Parameter	Unit	Flat glass – raw materials	Flat glass – production	Flat glass – total
TRACI 2.1				
Global warming potential – 100 years	kg CO_2 eq.	5.07E+02	9.48E+02	**1.45E+03**
Acidification potential	kg SO_2 eq.	1.24E+00	4.60E+00	**5.84E+00**
Eutrophication potential	kg N eq.	6.35E-02	2.29E-01	**2.92E-01**
Stratospheric ozone layer depletion potential	kg CFC-11 eq.	6.72E-08	3.77E-08	**1.05E-07**
Photochemical ozone creation potential	kg O_3 eq.	1.93E+01	1.16E+02	**1.35E+02**

What is an Environmental Product Declaration (EPD)?

- Results of a **lifecycle assessment** of a product calculating
  - Global warming potential (CO_2 equivalent emissions)
  - Other environmental impacts: potentials for acidification, eutrophication, ozone layer depletion, ozone creation etc.
- Carried out according to rules governed by a product category rule: PCR
- Scope:
  - Cradle to Gate (supply chain and manufacturing only)
  - Cradle to Grave (including life and disposal)

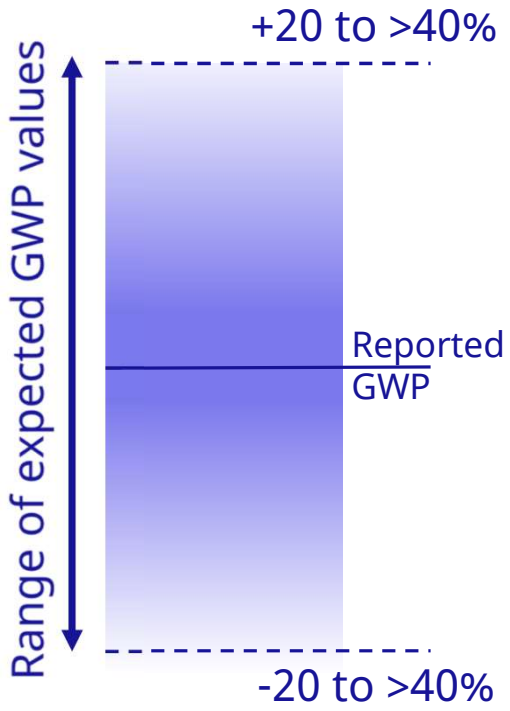
Diversion into the precision of EPD data

Variations derive from

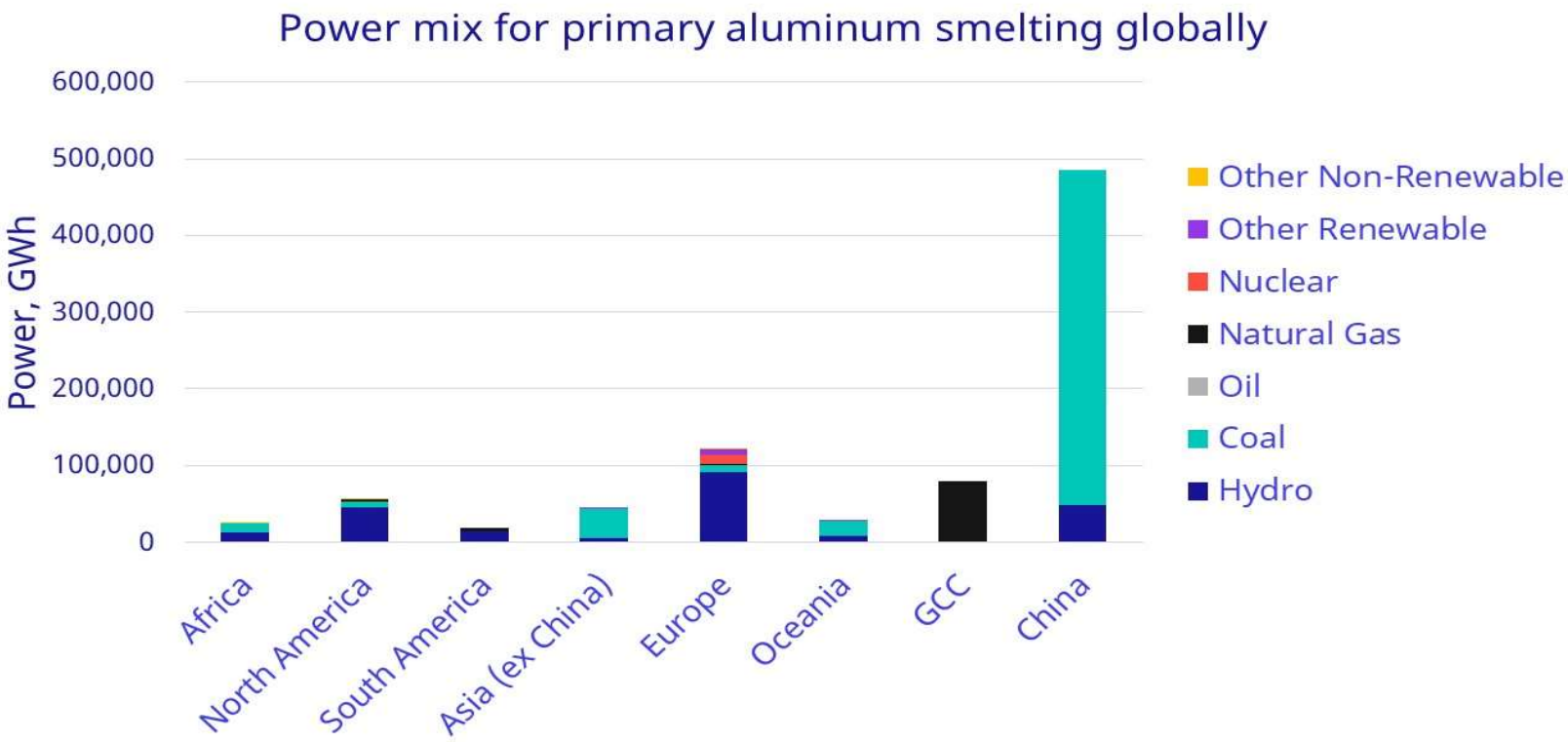
- Averaging industry-wide data
- Averaging over multiple plants
- Averaging over large product mix
- Averaging over multiple supply chains
- Differences in data sources & software tools used
- Data quality and allocations within a facility

Typical margin of errors: 20% (best case) to >40%

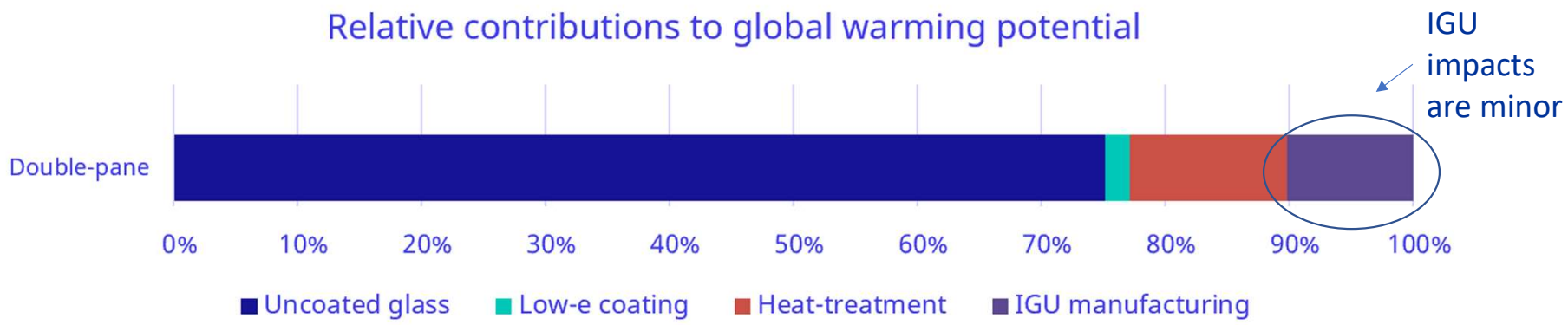
- When interpreting GWP, assume a large range of variation for expected values



Interesting implications for aluminum sourcing



Insulating Glass: Dissecting the embodied carbon



- 75% of the impacts come from float glass production
- 13% of the impacts come from heat treatment
- 10% of the impacts come from the IGU process itself
  - 50% (5% overall) from electricity to run the IG line
  - 50% (5% overall) from the IGU materials

Data from Vitro processed glass EPD

What does this data mean?

Comparing EPDs for **IGUs** from different IGU fabricators in order to make **supply chain decisions** is **not meaningful** for project-level carbon reduction decision making

Design level decisions are the driver

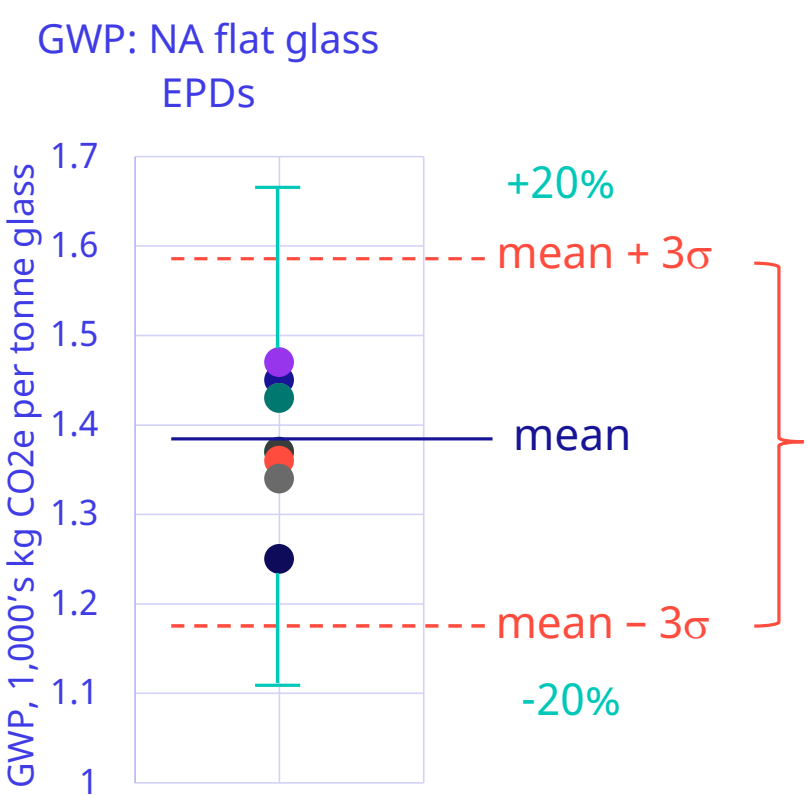
Because…

- **IGU manufacturing impacts are relatively minor compared to the rest of the structure**
  - Represents only 0.2% of the overall buildings GWP (2% x 10%)
  - Float glass impacts dominate
  - 10% of GWP of IGU is within the margin of error of the float glass impacts

- **IG fabricator location drives the electricity-based emissions (5%) b/c grid mix:**
  - Consider impacts of transportation to site, and the small size of the electricity source impacts

- **Impacts from IGU materials (5%) are mostly fixed across fabricators**
  - Materials defined by the design and specification
  - Similar materials (PIB, silicone, desiccant) by all fabricators
  - All need to be used in sufficient quantities to deliver service life (shouldn't skimp).

So, should we focus on the flat glass supply chain?



Based on NA data, 99.7% chance GWP lies in this range

The min. margin of error expected.

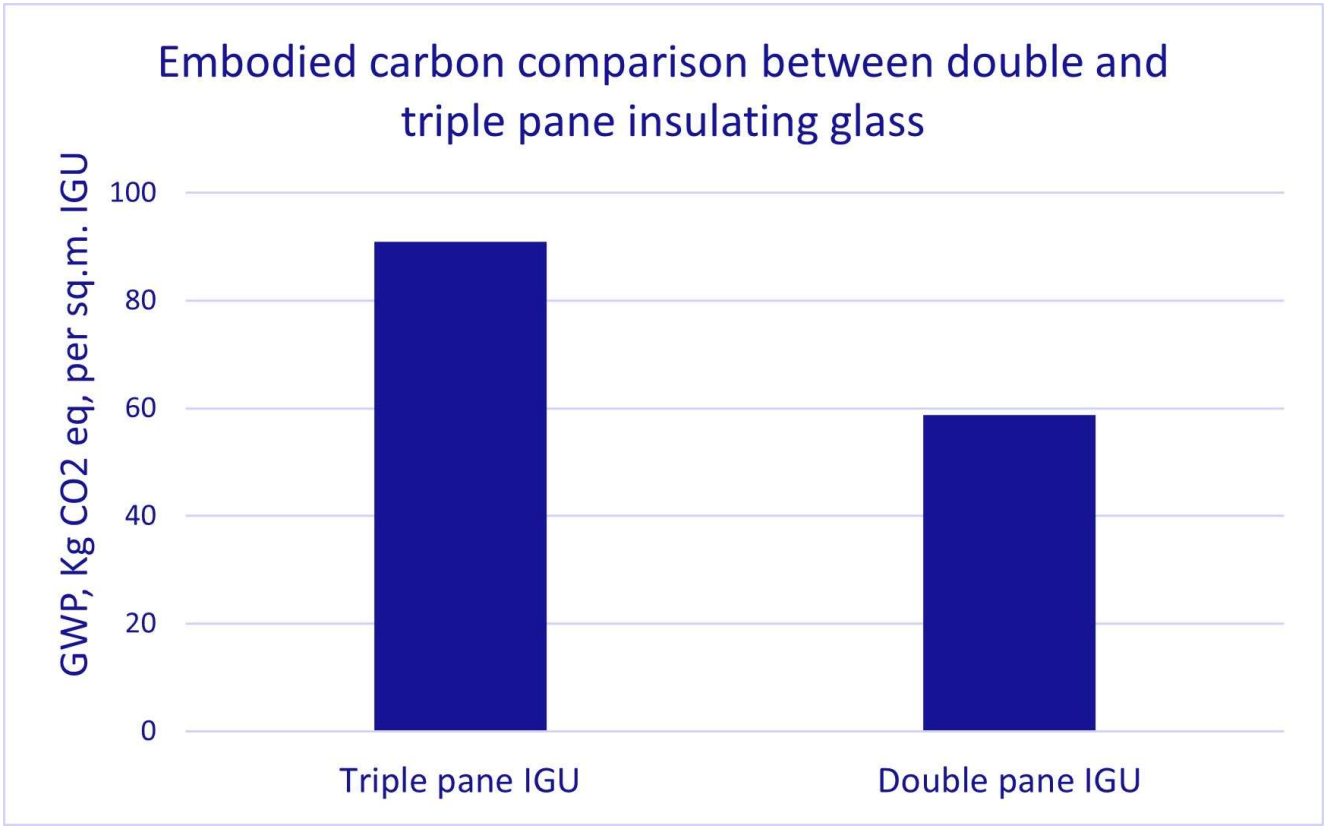
Conclusion:

All flat glass in NA appears to have the same embodied carbon within the margin of error

Conclusion:

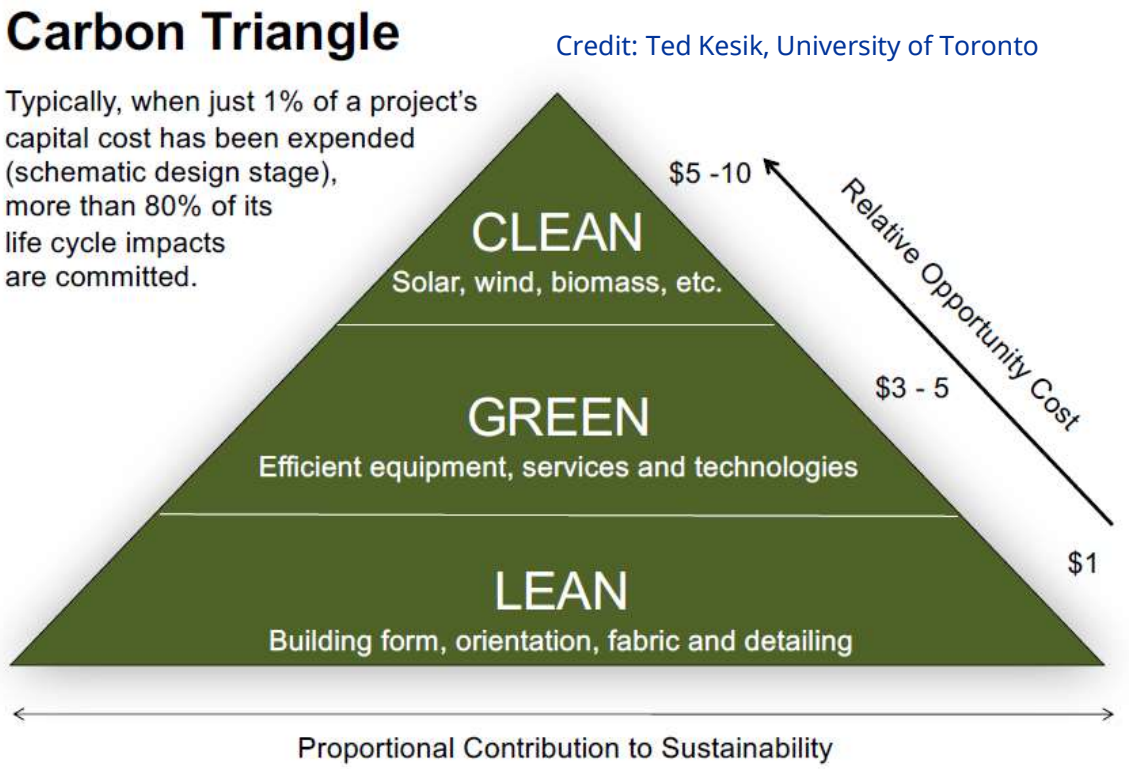
Don't use flat glass supply chain as a carbon reduction strategy either

Design driver: Double vs triple pane



Driven by the addition of the 3rd pane

What does this mean?



Credit: Ted Kesik, University of Toronto

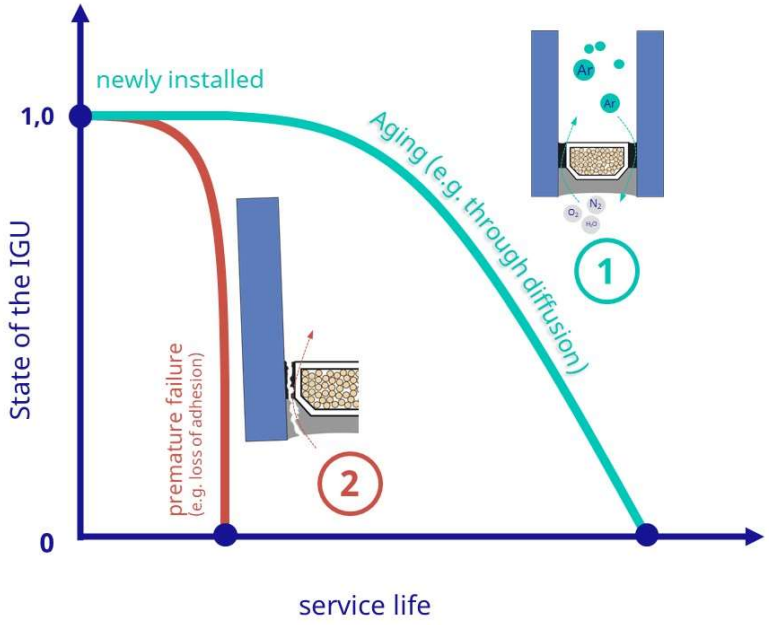
By the time the fabricator produces an IGU, the major impacts have already been determined by the **architectural design**:

- number of lites
- thickness of the lites
- heat treatment
- the glass area
- the number of different unique sizes/shapes (determines fabrication efficiencies), etc.

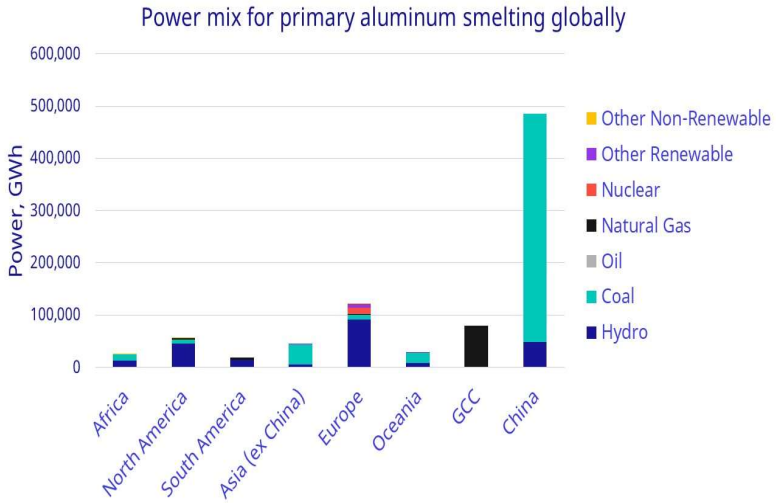
What can we do to impact embodied carbon in façades?

1. Focus on optimizing IGU durability and service life

- Edge seal carefully designed
- Well manufactured
- Installed well



2. Locally source aluminum made from renewable electricity sources with high recycled content



3. Assess the lifecycle value of triple pane versus double pane, carefully

4. Design with efficiency in mind

5. **Find alternative, lower cost ways, to allow your IGU fabricator partners to demonstrate their commitment to reducing the environmental impact of their operations**

Conclusion

- EPDs for glass and aluminum can be useful in determining the relative GWP impacts on a project scale

- **EPDs** for processed glass or float glass **should not** be used as a way of selecting your supply chain
  - Glass represents a single digit percentage contribution to a building's embodied carbon
  - North American float glass impacts are the same within the margin of error
  - The impacts from the IGU processing are only 10% of the overall embodied carbon of the IGU

- The **design bakes** in most of the impacts before the supply chain is selected and should be a focus

- Focus on **service life first** to drive down carbon emissions in façades

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QUESTIONS?

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