

# Rapid Decarbonization Throughout the Building Lifecycle

Center for the Built Environment, SmithGroup, the Carbon Leadership Forum and PG&E

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KIERANTIMBERLAKE

# **1. Defining Embodied Carbon**

**A building project causes**  
**environmental impacts far**  
**beyond its building site.**







**Buildings and infrastructure**  
**account for nearly 40 percent of**  
**all global CO<sub>2</sub> emissions.**



**Embodied carbon will be responsible**  
**for almost half of total new**  
**construction emissions between now**  
**and 2050.**

# Embodied carbon ?

**Embodied carbon is the CO<sub>2</sub> emissions associated with materials and construction processes throughout the whole life cycle of a building and infrastructure which includes...**

**Embodied carbon is the CO<sub>2</sub> emissions associated with materials and construction processes throughout the whole life cycle of a building and infrastructure which includes...materials extraction, transport to manufacturer, manufacturing, transport to site, construction, use, maintenance, repair, replacement, refurbishment, deconstruction, transport to end of life facilities, processing, disposal, along with benefits from reuse, recovery and recycle.**





- Image by NASA





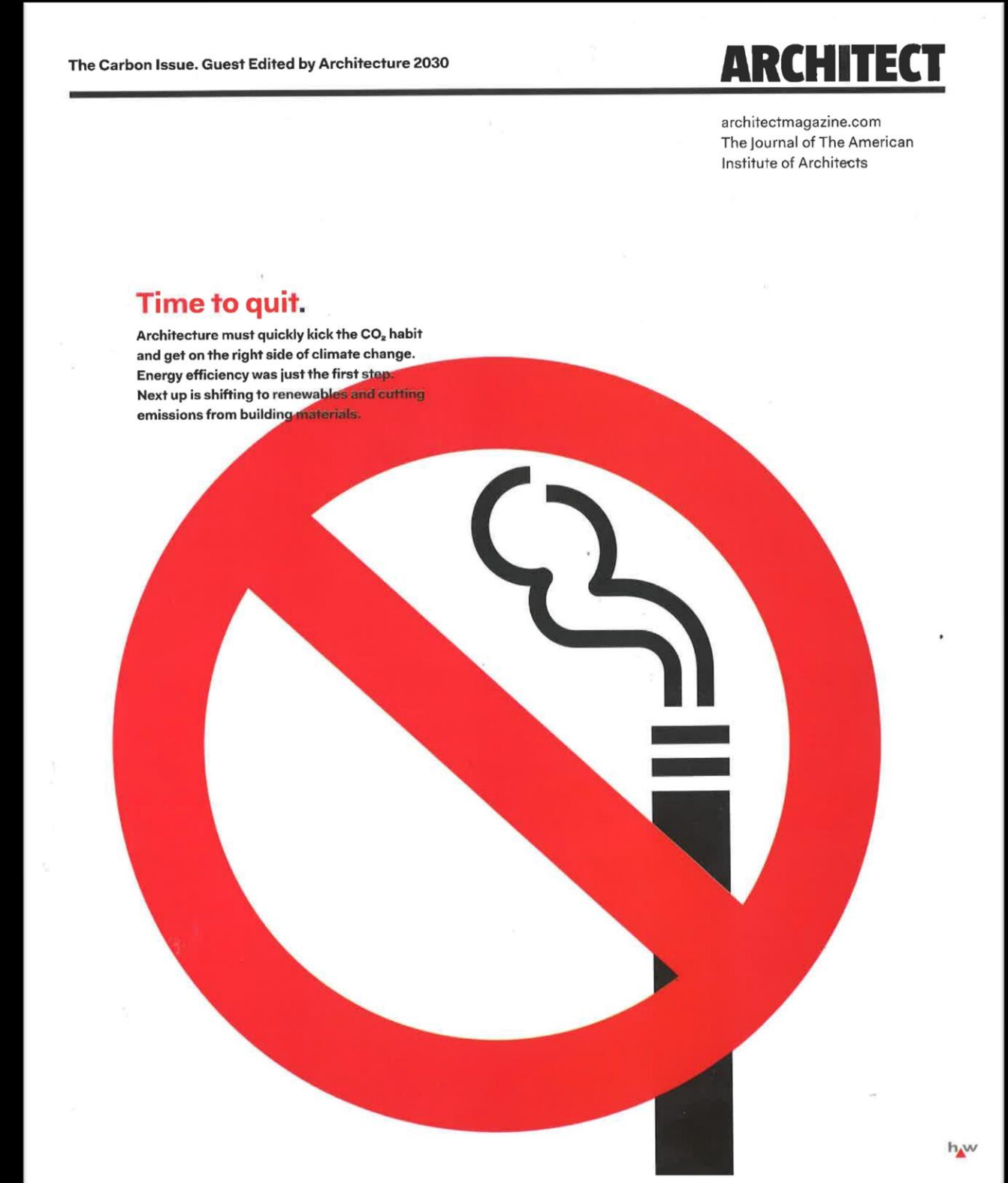


- The US Embassy in London, 2018



**Operational carbon is the CO<sub>2</sub> emissions associated with energy used to operate the building or in the operation of infrastructure.**

**We have an ethical  
responsibility to address  
carbon and climate change  
on every single project.**





# The Code

## AIA CODE OF ETHICS and PROFESSIONAL CONDUCT

2018 CODE OF ETHICS AND PROFESSIONAL CONDUCT

**CANON VI**  
**Obligations to the Environment**  
Members should recognize and acknowledge the professional responsibilities they have to promote sustainable design and development in the natural and built environments and to implement energy and resource conscious design.

**E.S. 6.1** Energy conservation:  
Members should set ambitious performance goals for greenhouse gas emission reduction with their clients for each project.

**E.S. 6.2** Water Use:  
Members should optimize water conservation in each project to reduce water use and protect

<https://www.aia.org/pages/3296-code-of-ethics-and-professional-conduct>

# The Resolution

## 19-11: RESOLUTION for URGENT and SUSTAINED CLIMATE ACTION

**AIA prioritize and support urgent climate action** to exponentially **accelerate the “decarbonization” of buildings**, the building sector, and the built environment. In addition to calling for revisions to AIA Public Policies and Position Statements, the resolution advocated that the Institute **engage its full membership, clients, lawmakers, and communities** in a multi-year education, practice, and advocacy strategy.

(YES: 4860, NO: 312, Abstain: 28)

<https://www.aia.org/articles/6160007-aia-162nd-annual-meeting-illuminates-ambi>

# The Framework

## AIA DESIGN EXCELLENCE FRAMEWORK

Designing for Ecology

Center for Sustainable Landscapes by The Design Alliance Architects is a 2018 COTE® Top Ten recipient.

**Focus topics**

- landscaping/habitat/biodiversity
- dark skies
- bird-friendly design
- site acoustics

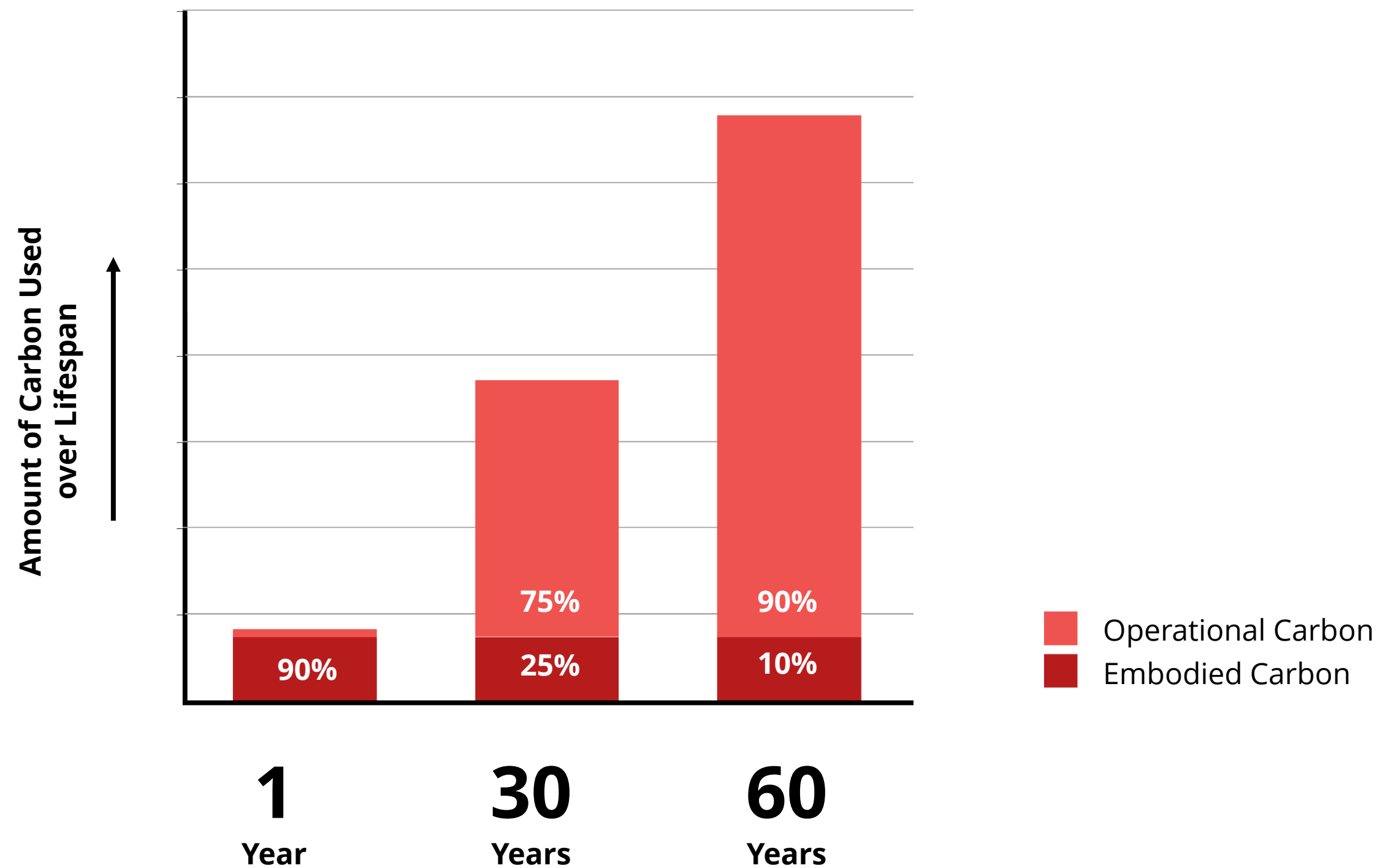
**The Framework for Design Excellence**  
[Return to the Framework >](#)

**Related resources**  
[AIA COTE® Top Ten Awards >](#)  
[Download the COTE® Super Spreadsheet >](#)

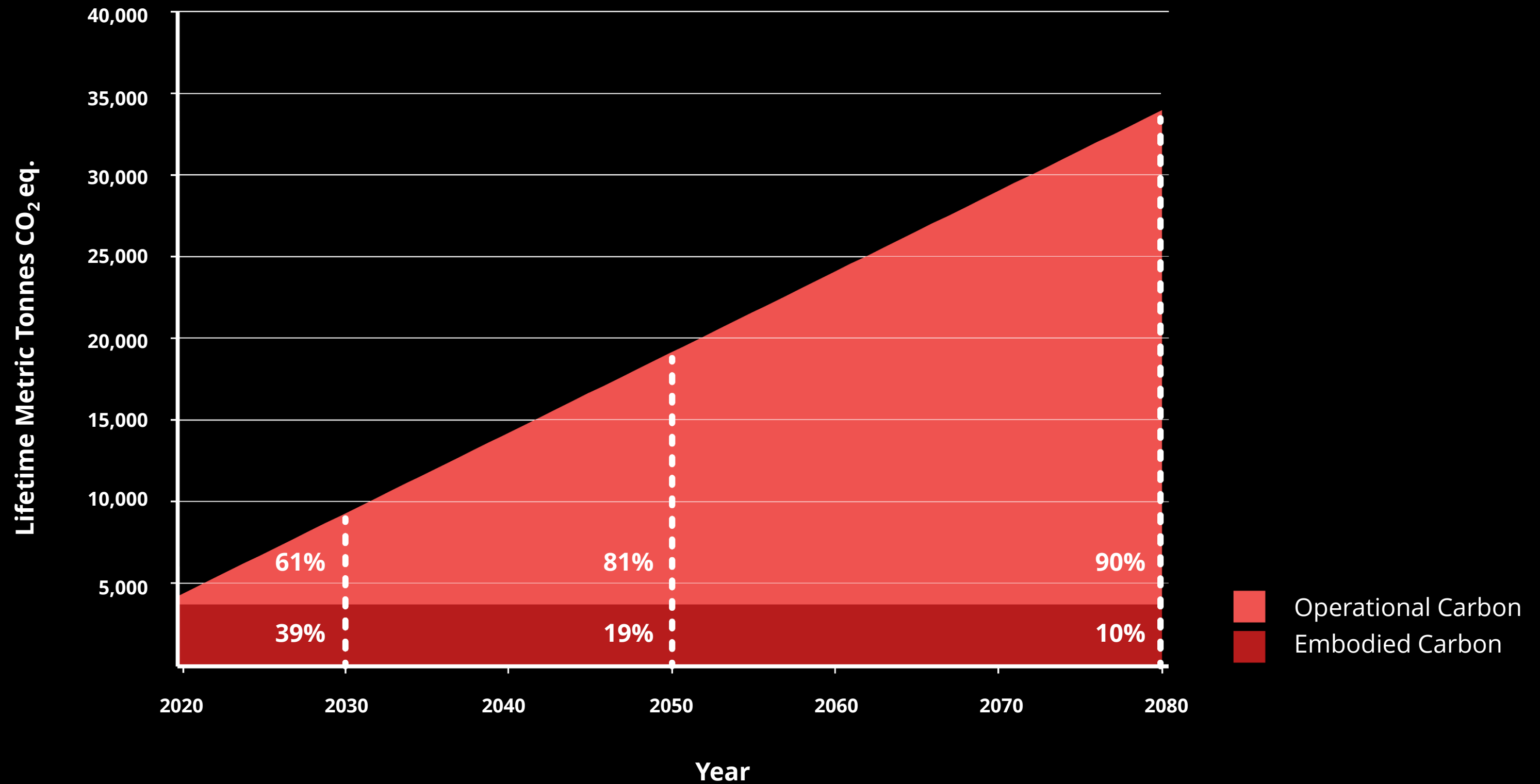
**Measure 3: Design for Ecology** is unique among AIA COTE® Top Ten measures in that it focuses solely on nature. Although the strategies presented, such as keeping the night sky dark and minimizing undesirable noises, will improve the environment for humans, this measure asks design teams to think beyond the anthropocentric world of traditional architecture and to design specifically for the rest of biodiversity.

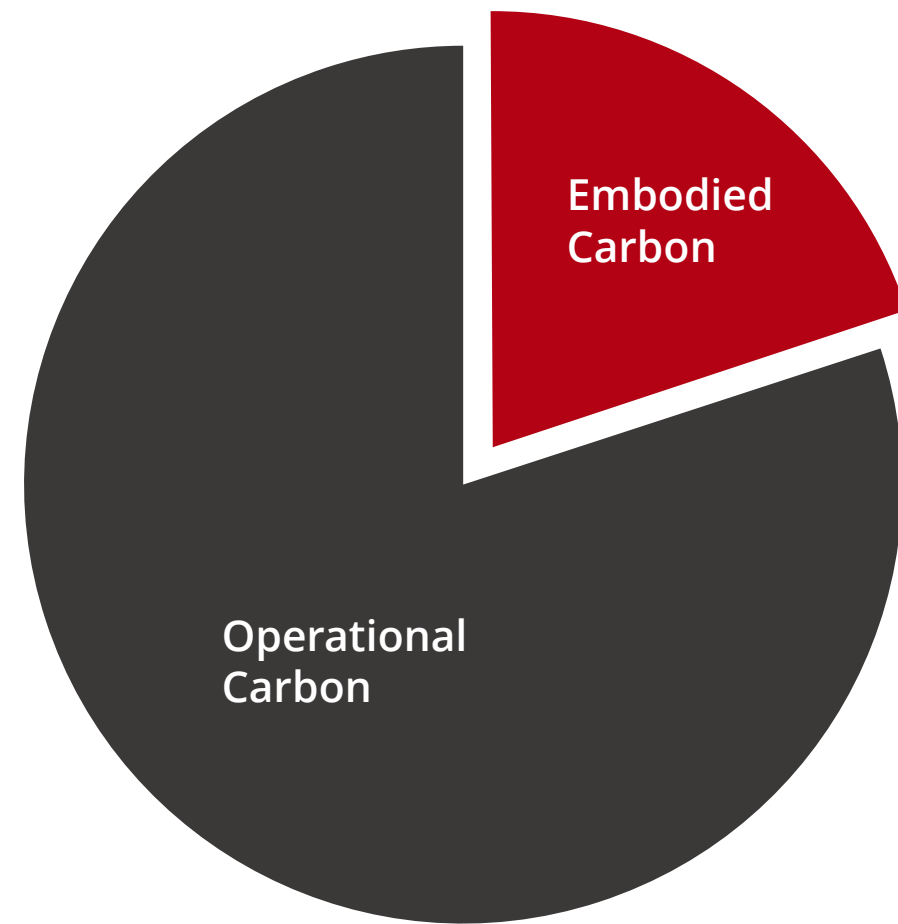
<https://www.aia.org/resources/6077668-framework-for-design-excellence>

# Cumulative Total Carbon Emissions Business as Usual

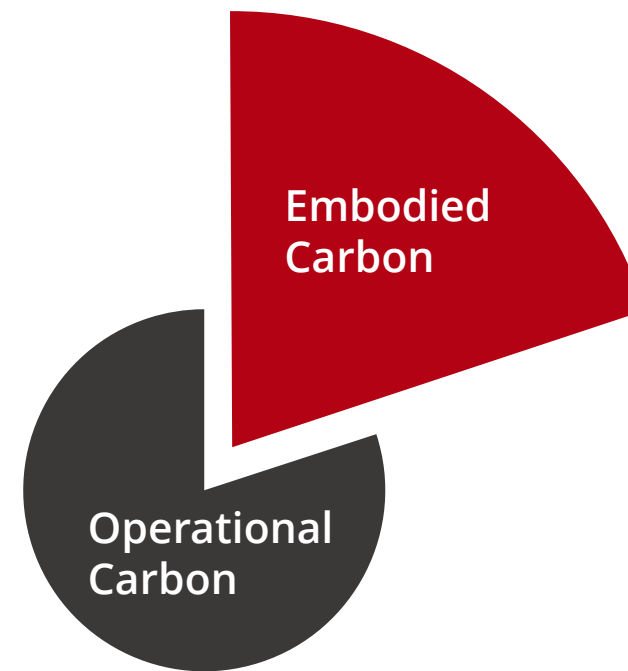


# Cumulative Total Carbon Emissions Business as Usual

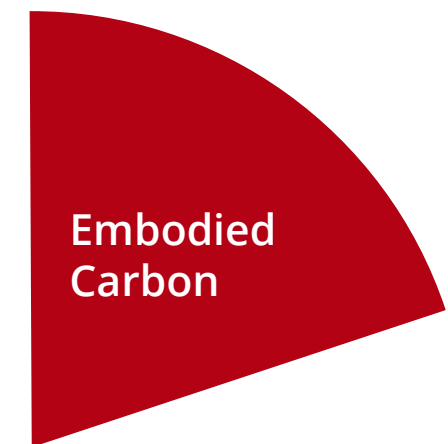




**Typical Building**



**High Performance Building**

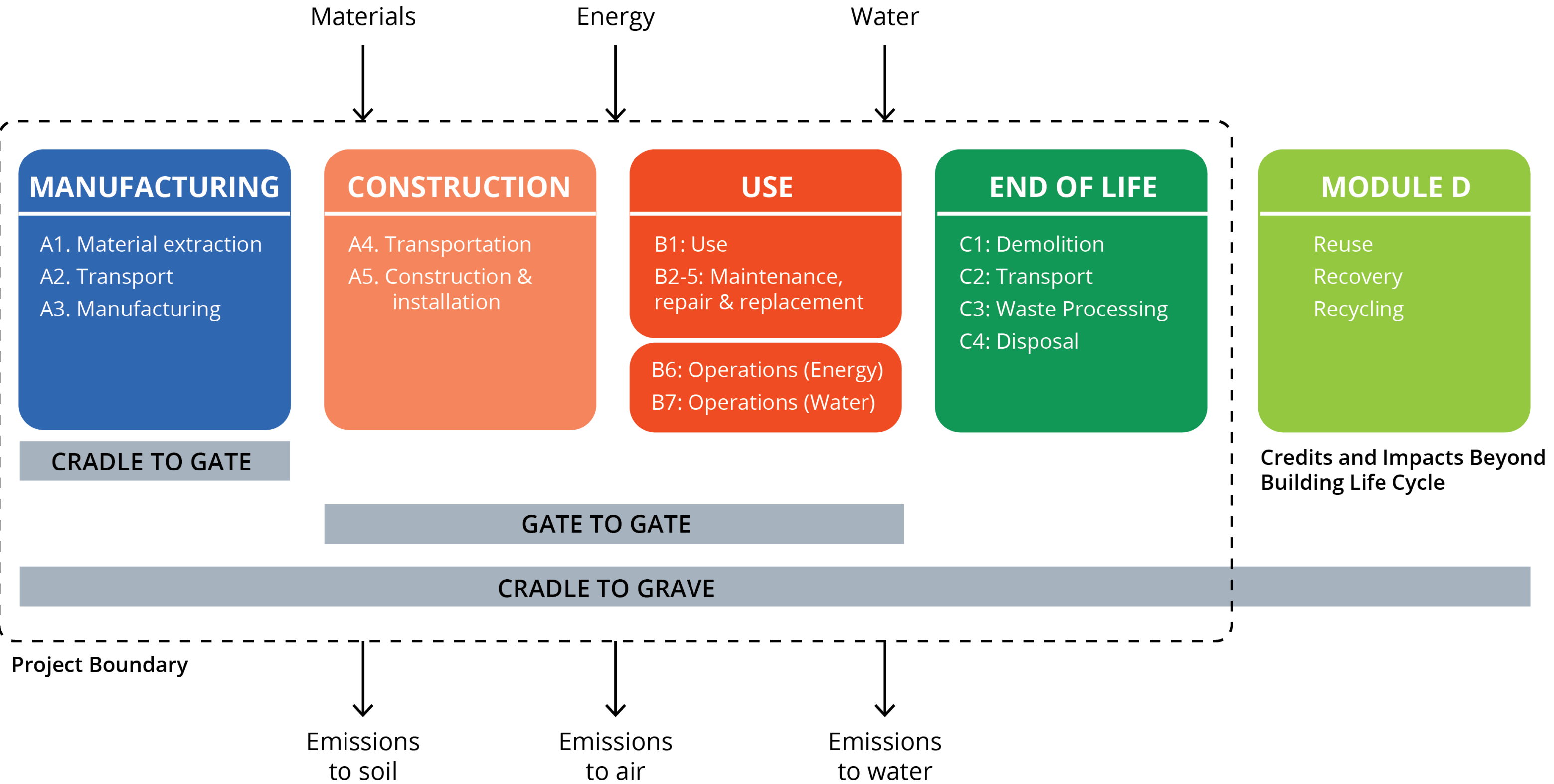


**Net Zero Energy Building**

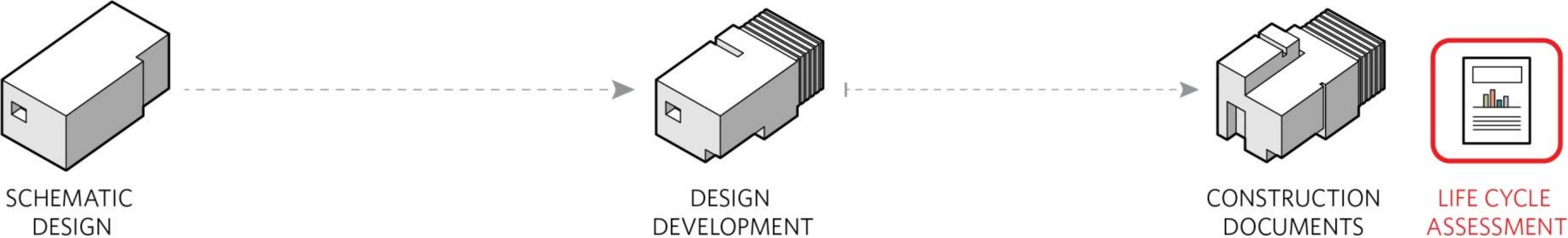


## **2. Measuring Embodied Carbon**

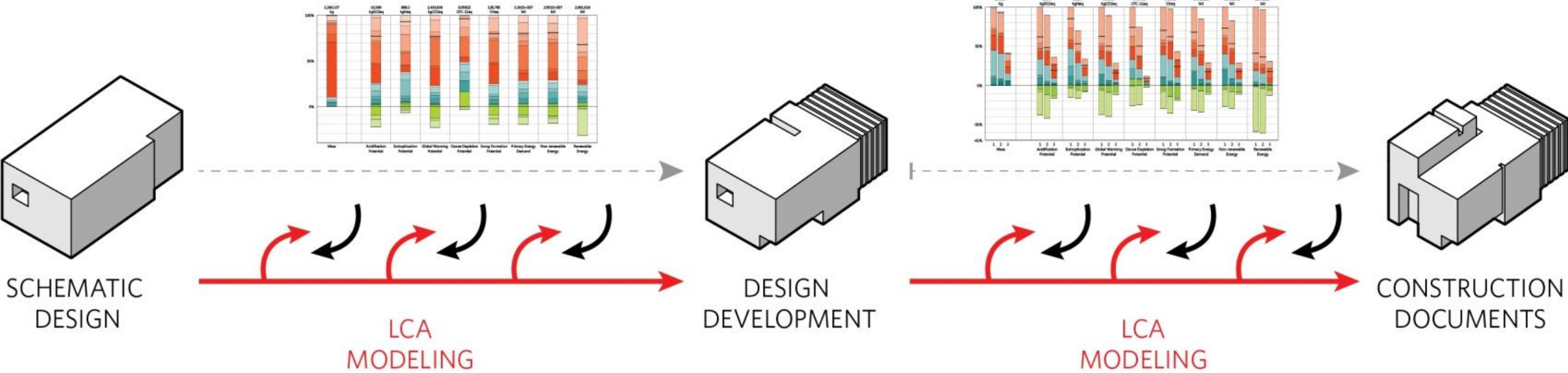
**Lifecycle Assessment (LCA) is a modeling method that evaluates the inputs, outputs, and the potential environmental impacts of a product system through its life cycle.**



TRADITIONAL WORKFLOW

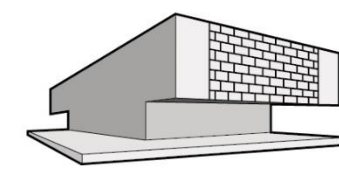
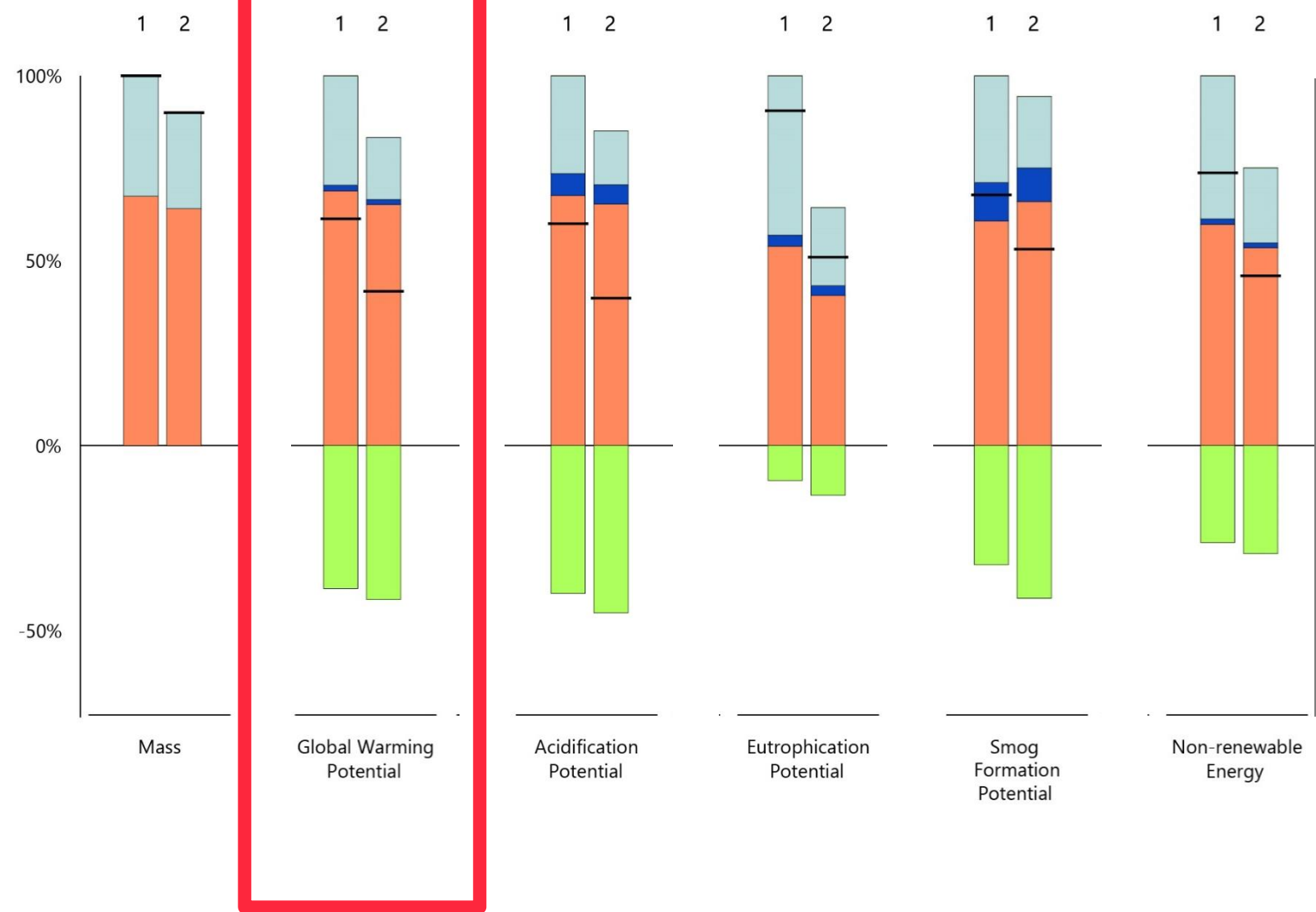


OPTIMAL WORKFLOW

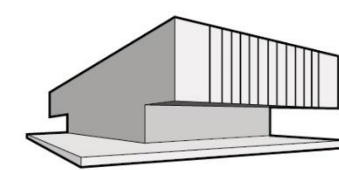




# You can use *tally* to measure embodied carbon.



Option 1



Option 2

- Life Cycle Stages
- Manufacturing
  - Transportation
  - Maintenance and Replacement
  - End of Life
  - Net Value (impacts and credits)

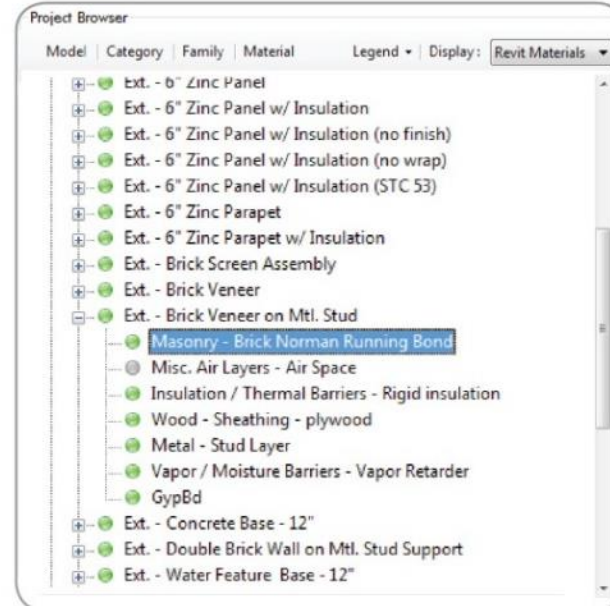
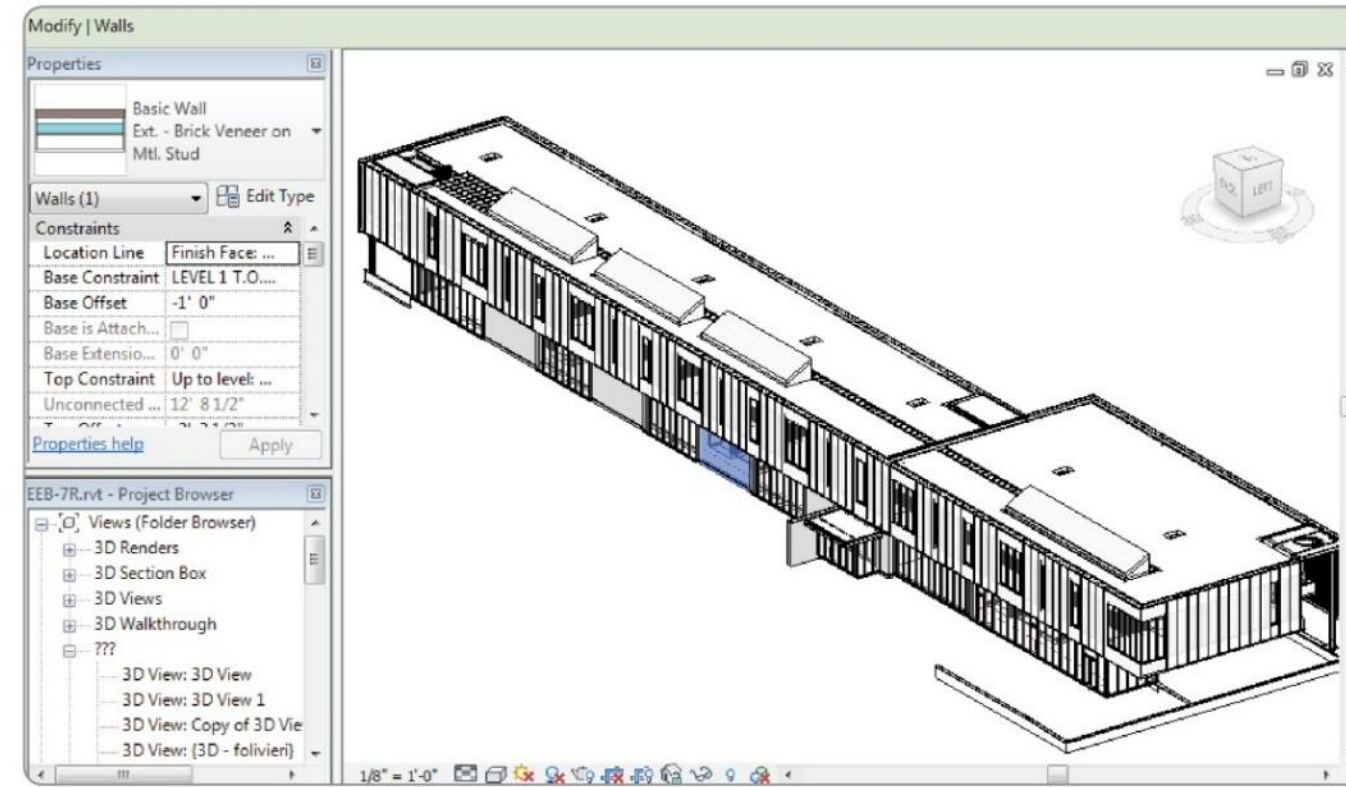
© KT INNOVATIONS



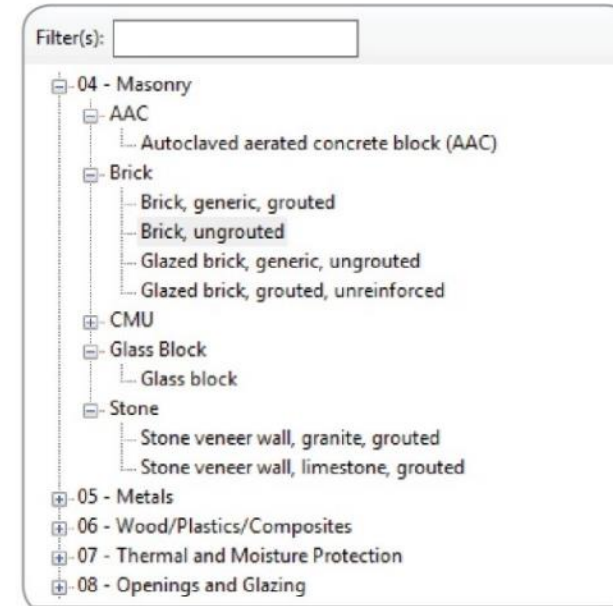
**KT INNOVATIONS**  
An affiliate of KieranTimberlake



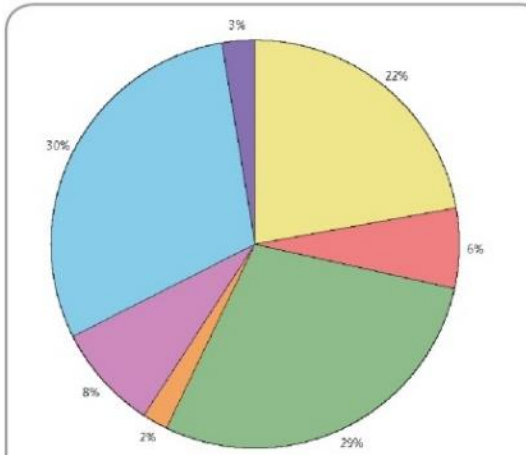
## REVIT MODEL



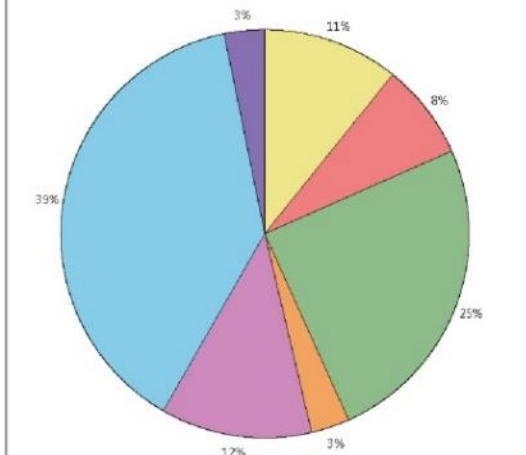
**TALLY™** Material quantities are pulled from the Revit model



**DATABASE** Impacts are captured in an LCA database



Global Warming Potential

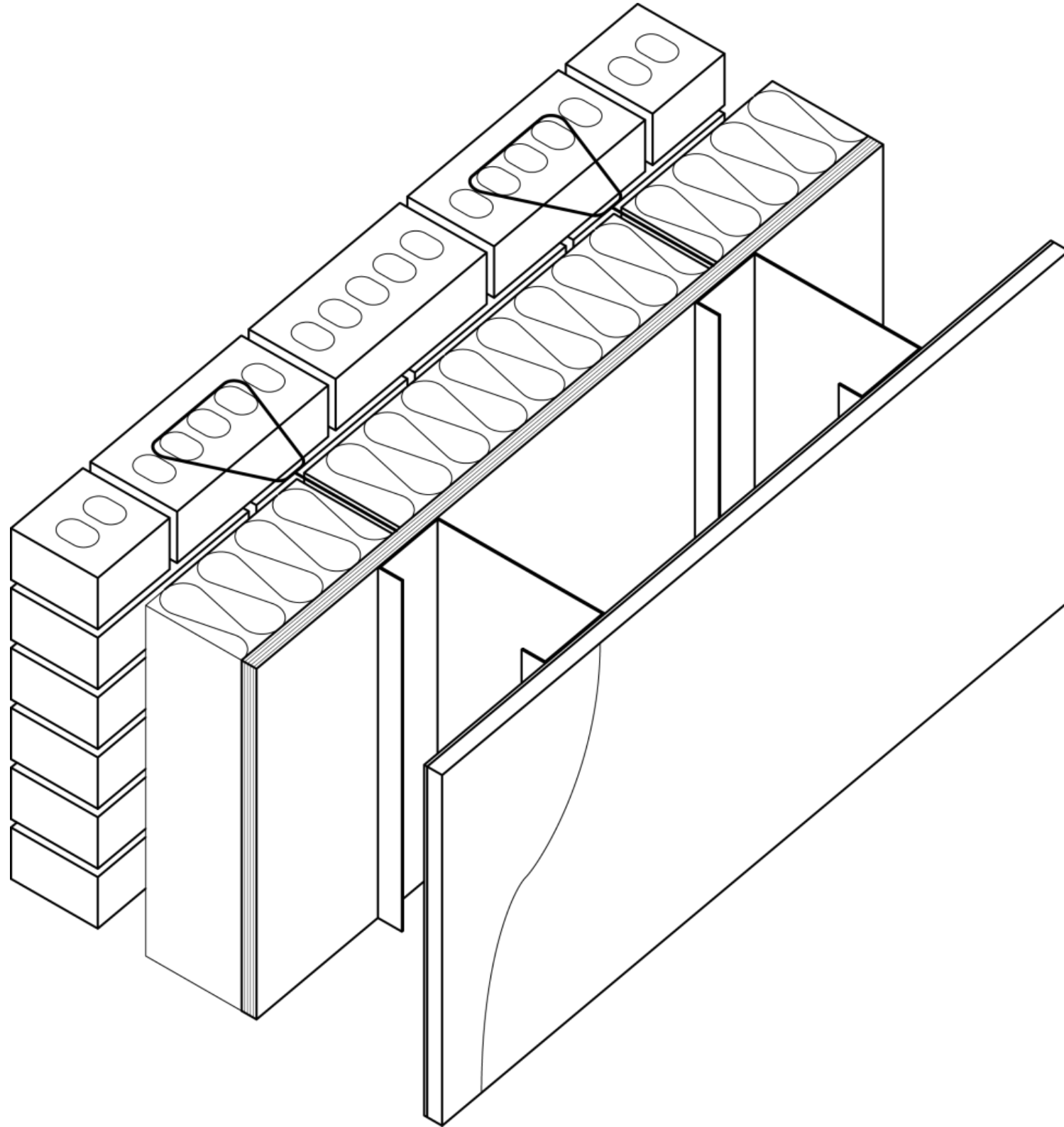
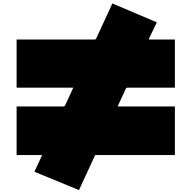
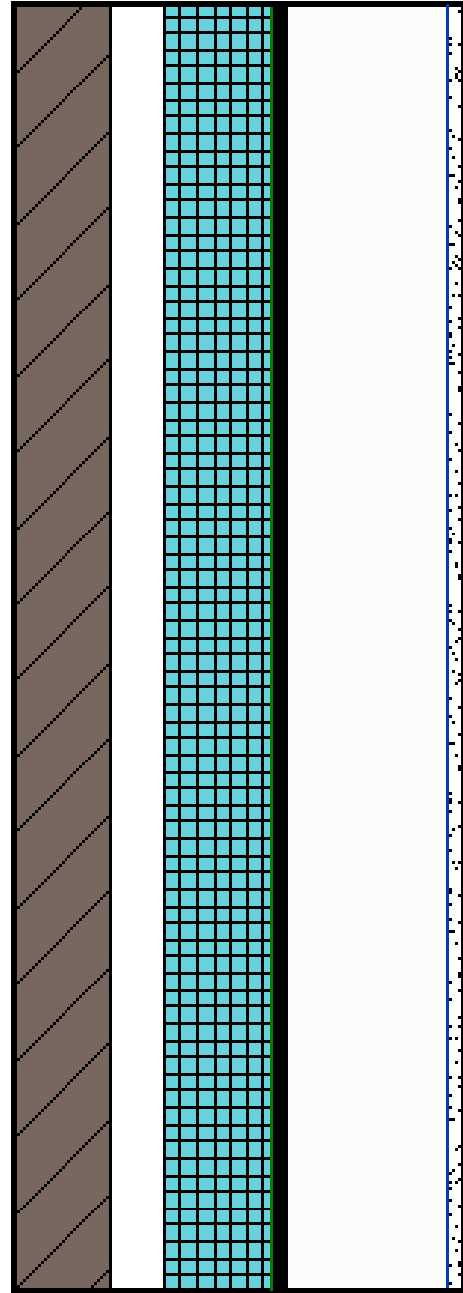


Primary Energy Demand

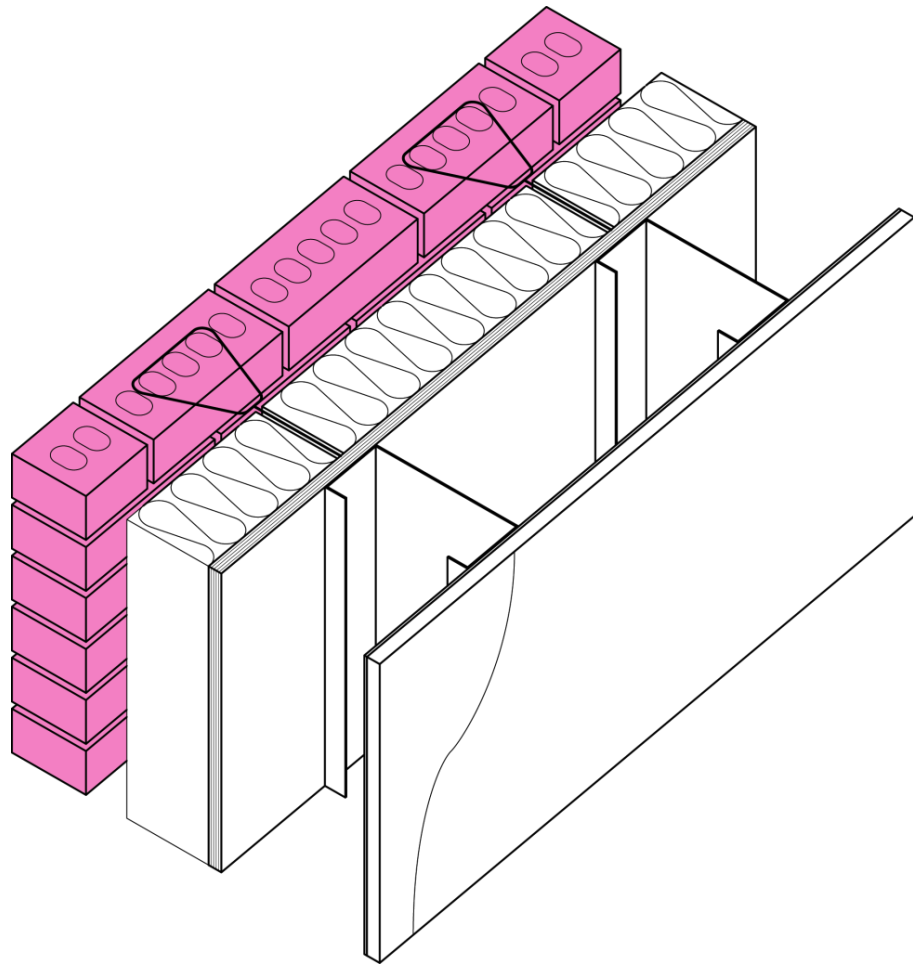
### LEGEND

- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing
- 09 - Finishes

**TALLY™ REPORT** Design and material selection questions are rapidly answered







Tally® Environmental Impact Tool - EEB Hub 7R Tally\_2019.rvt

Define Components and Quantity Takeoffs
SaveCancel

### Brick

Brick, size as specified by user. Entry includes user-specified mortar, reinforcement (none/low/high), grout (if any) and finish (if any).

Brick type

Brick, generic

Common extruded brick, excludes mortar.

Service Life

Set to building life

☐ Existing or salvaged material

Takeoff Method

by Volume

Brick volume

3/8" joint

81.87

% by vol

Mortar type

Mortar type N

Grout fill

None

Reinforcement

Steel, reinforcing rod

Common unfinished tempered steel rod suitable for structural reinforcement (rebar)

Service Life

Default to building life

☐ Existing or salvaged material

Takeoff Method

by Area

Masonry reinforcement

Low Reinforcing (#4 @ 48" on center)

0.815365415

kg/m<sup>2</sup>

Finish

None

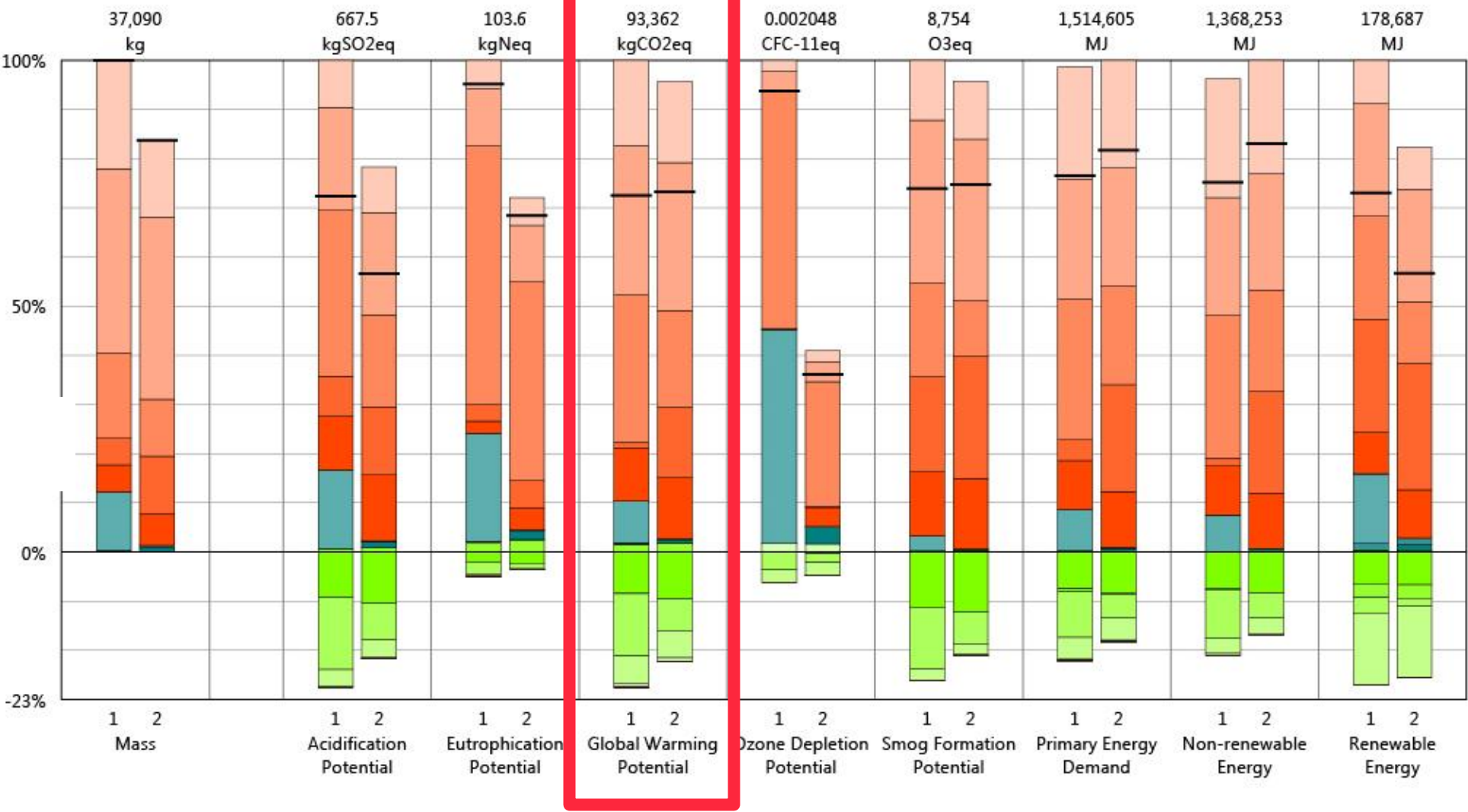


# You can use *tally* to measure embodied carbon.

Option 1 – Corrugated Shingle Cladding



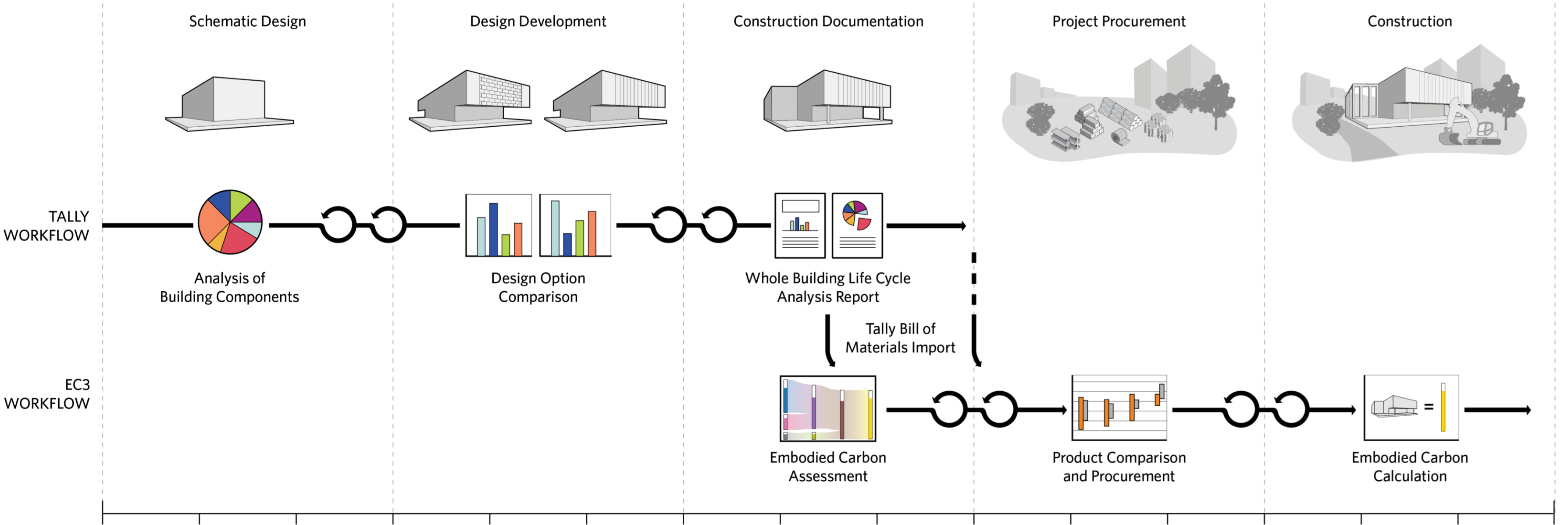
Option 2 – Translucent Panel Cladding



- Manufacturing**
- 05 - Metals
  - 06 - Wood/Plastics/Composites
  - 07 - Thermal and Moisture Protection
  - 08 - Openings and Glazing
  - 09 - Finishes
- Maintenance and Replacement**
- 05 - Metals
  - 06 - Wood/Plastics/Composites
  - 07 - Thermal and Moisture Protection
  - 08 - Openings and Glazing
  - 09 - Finishes
- End of Life**
- 05 - Metals
  - 06 - Wood/Plastics/Composites
  - 07 - Thermal and Moisture Protection
  - 08 - Openings and Glazing
  - 09 - Finishes

# tally for design phase life cycle assessment (LCA) tool.

## EC3 for specification, procurement and construction phase tool



### **3. Making Decisions Using Embodied Carbon Models**



# Types of Embodied Carbon Studies

## A. Early-phase LCA

Part to whole, focus on assemblies and materials

## B. Comparing Options

Targeted design questions, detailed comparisons

## C. End-of-project Benchmarking

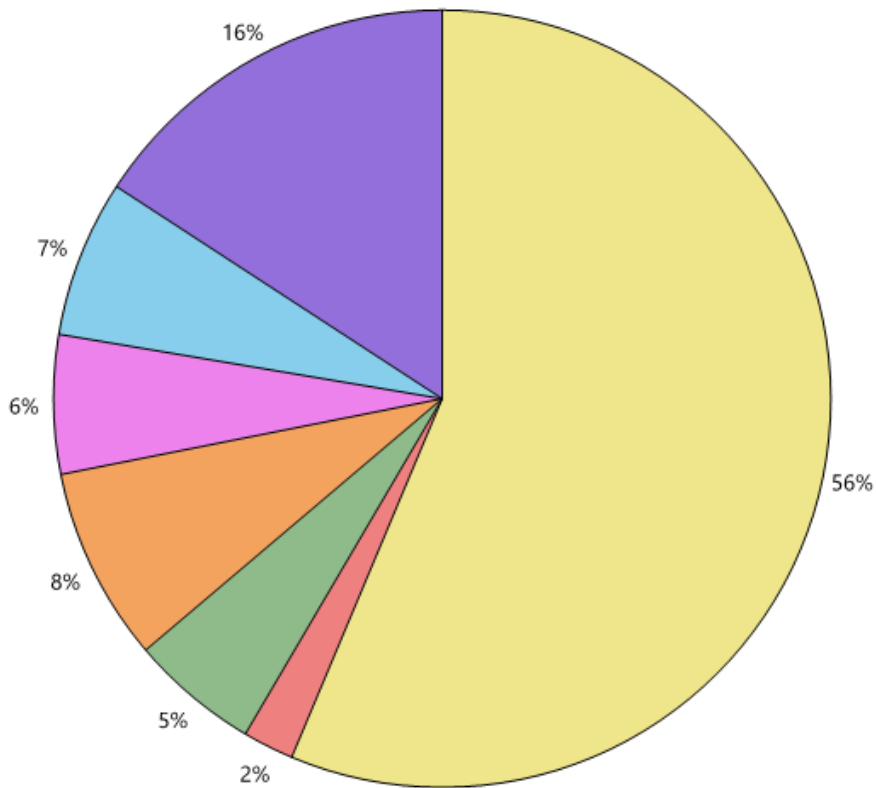
Construction documentation, products, and overall performance



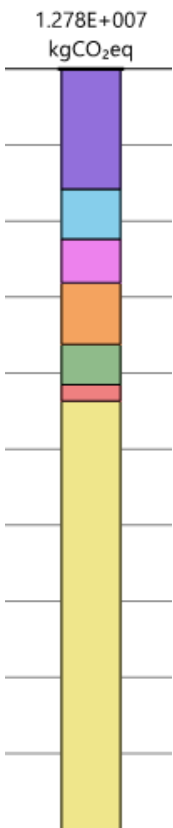
# A. Early-phase LCA

Results per CSI Division

- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing
- 09 - Finishes



Global Warming Potential

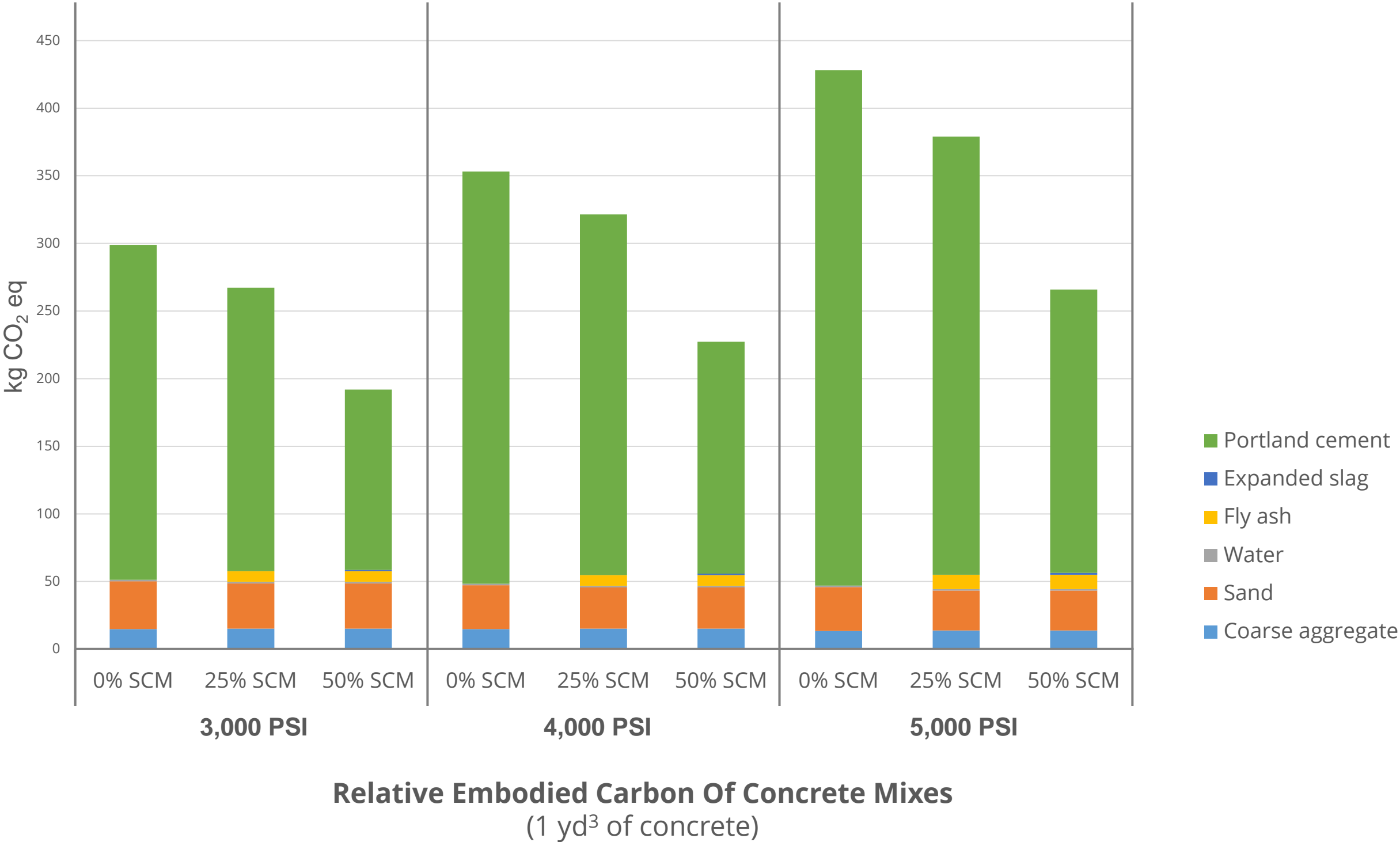


GWP





# B. Comparing Options





# B. Comparing Options

## Life Cycle Stages

- Manufacturing
- Maintenance and Replacement
- End of Life
- Net value (impacts + credits)

## Design Options

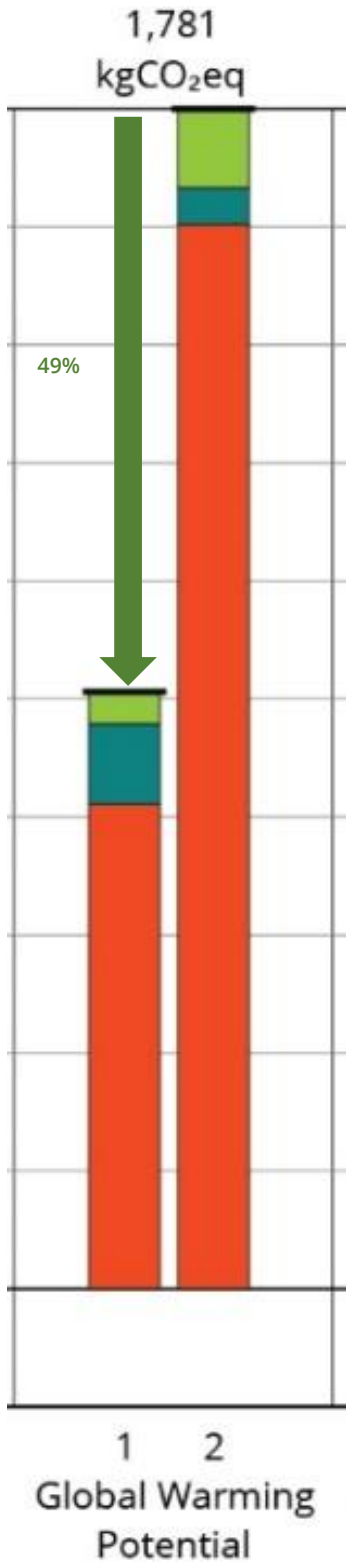
- Option 1 - Brick (primary)
- Option 2 - Conc.



Option 1

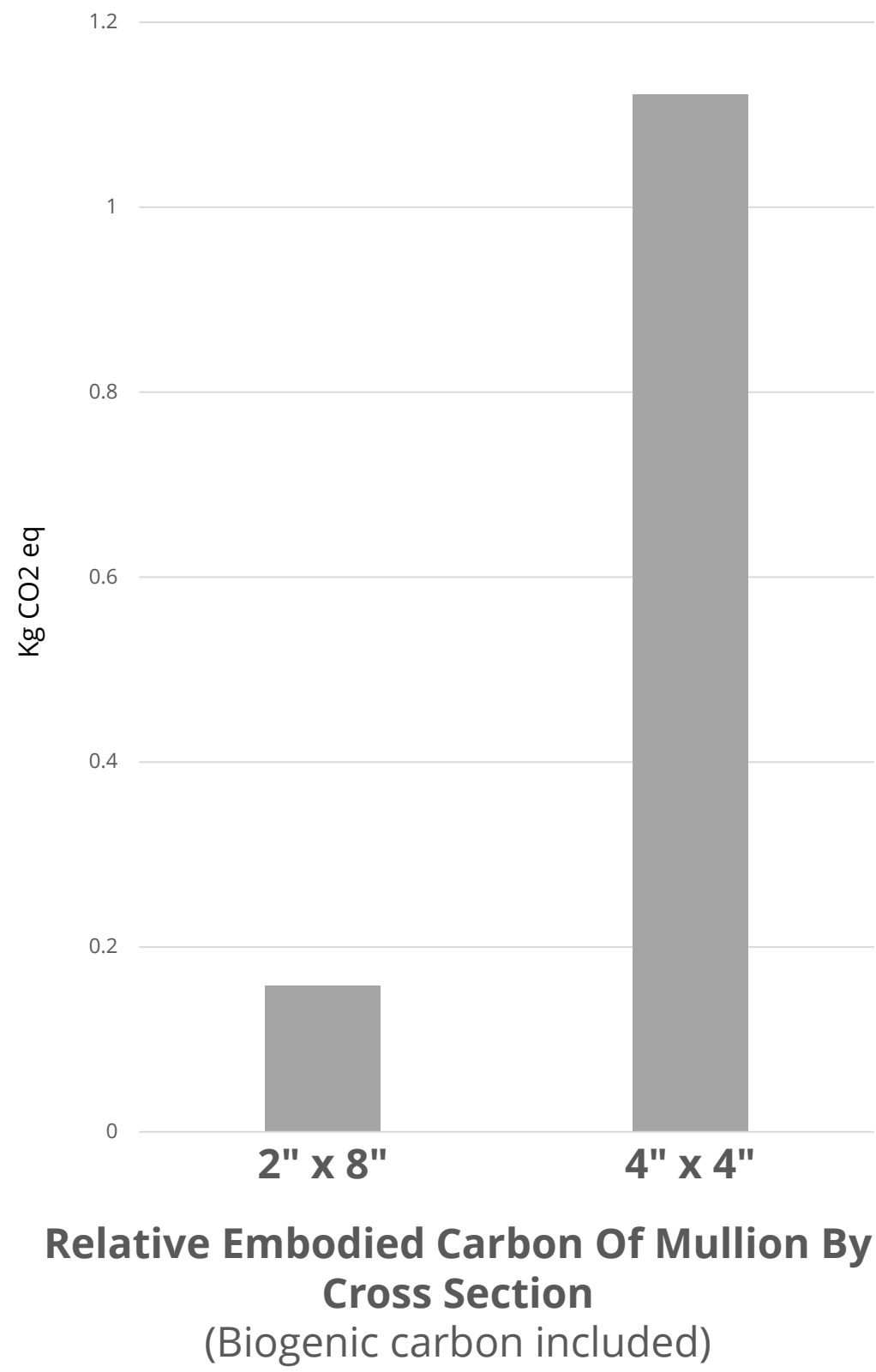


Option 2



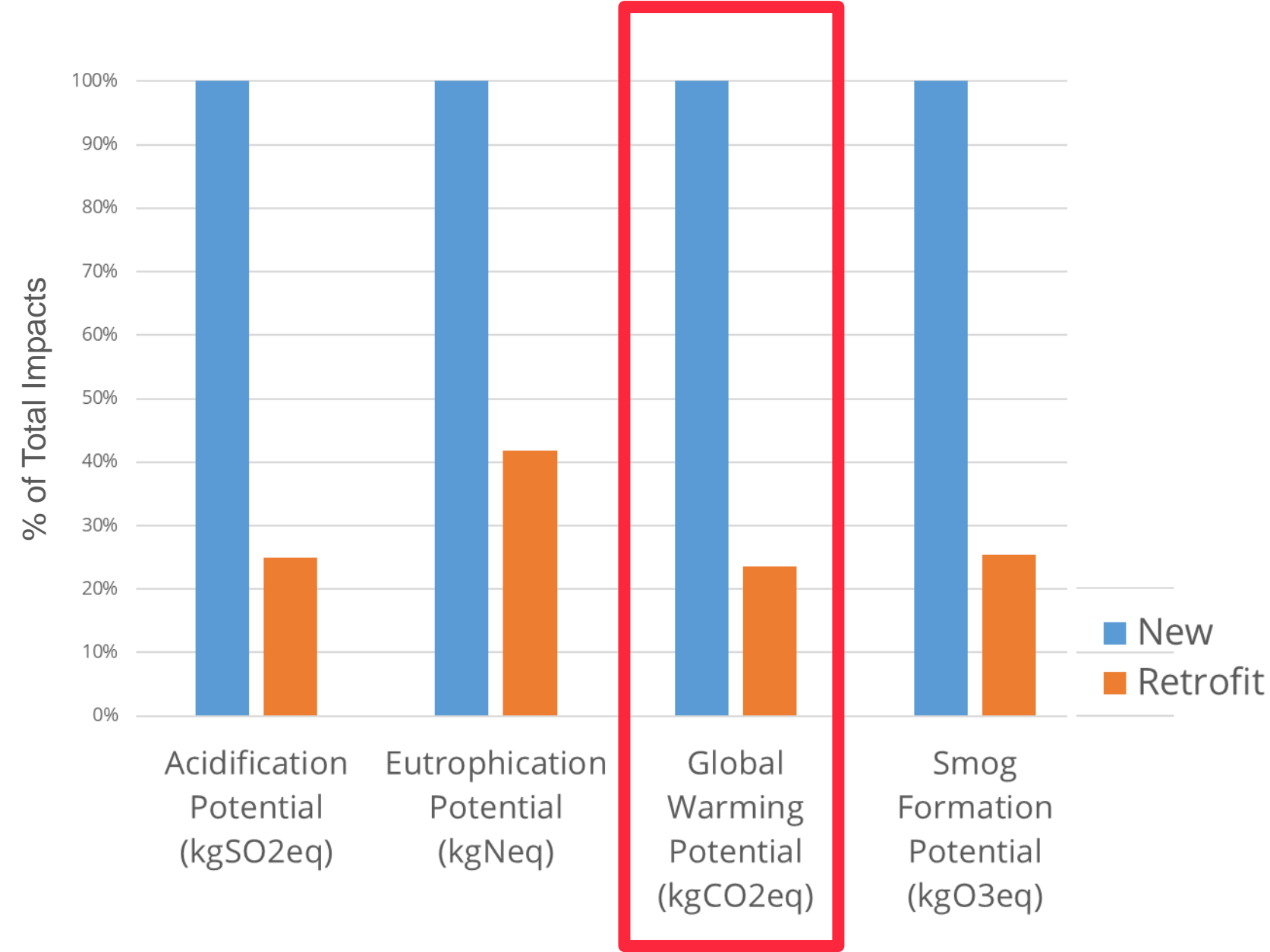


# B. Comparing Options





# C. End of Project Benchmarking



Environmental Benefit of Adaptive Reuse  
(Removing Module A)





# C. End of Project Benchmarking

## CASE STUDY OUTLINE

Introduction

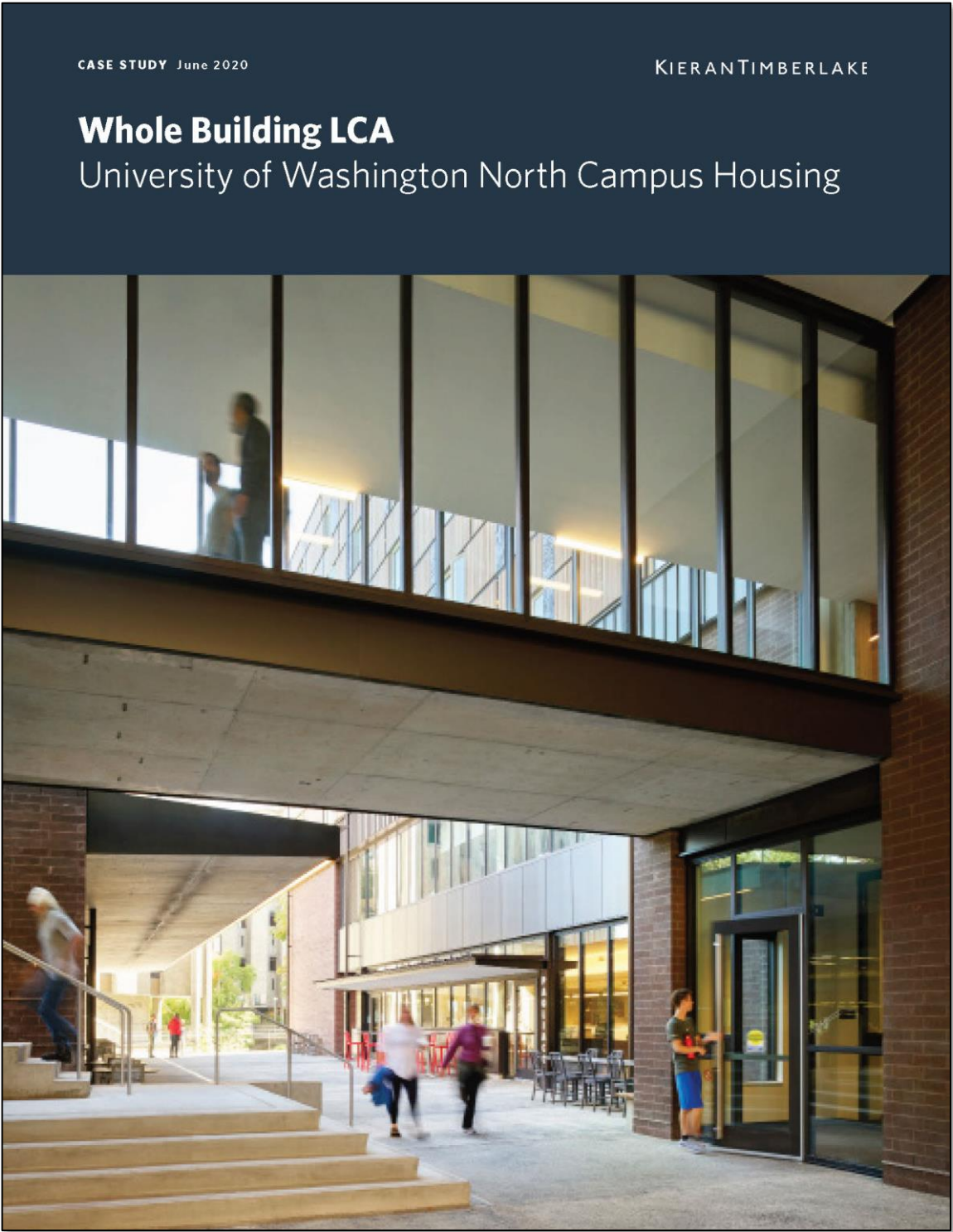
Project Overview

WBLCA Methodology

Project Findings

Opportunities for Improvement

Lessons Learned



**REFERENCES**  
<sup>1</sup> Simonen, K., Rodriguez, B., Barrera, S., Huang, M., (2017) CLF Embodied Carbon Benchmark Database, database. Available at <http://hdl.handle.net/1773/38017>.

<sup>2</sup> ISO 14040-14044:2006, Environmental Management - Life Cycle Assessment. EN15804 - Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.

**COVER PHOTO**  
Matthew Millman

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**CASE STUDY** Whole Building LCA

### OPPORTUNITIES FOR IMPROVEMENT

In this first-ever use of iterative WBLCA on a project, KieranTimberlake followed the best practices as recommended in 2015, which did not account for biogenic carbon. As WBLCA practices evolved to include biogenic carbon, a study done now would show that advanced framing techniques to reduce the amount of wood likewise reduces a wood structural system’s capacity to sequester carbon.

The project team was able to significantly reduce the embodied carbon of the cast-in-place concrete system by decreasing the percentage of the cement in the concrete mix design. Project teams who pursue embodied carbon reductions through concrete mix design should begin this process in the earliest possible design phase. Equally important at this time is to engage the structural engineering team in embodied carbon reductions. In the five years following this work, KieranTimberlake has created even deeper reductions of concrete structural components’ embodied carbon impacts through this type of early, strategic structural interventions.

The reduction of the metals in the rainscreen had an appreciable impact on reducing the embodied carbon of the building. Most importantly, it was the associated reduction of the metal coatings that had the most significance, even more than the underlying metals.

### LESSONS LEARNED

- Working towards environmental impact reductions in the earliest possible design phases is the most important intervention in a building’s embodied carbon output.
- Any project containing concrete should reduce the cement content in each concrete mix, even when concrete is not the majority of the building structure by volume.
- This study shows the importance in the updated LCA standards to include biogenic carbon sequestration when working with wood and other bio-based materials, as biogenic carbon should be considered as an essential source for potential carbon sequestration to offset embodied carbon in other materials.
- Dematerialization is an effective strategy when applied to materials that contribute to an outsized proportion of the environmental impacts when compared to their percentage of the building’s mass.

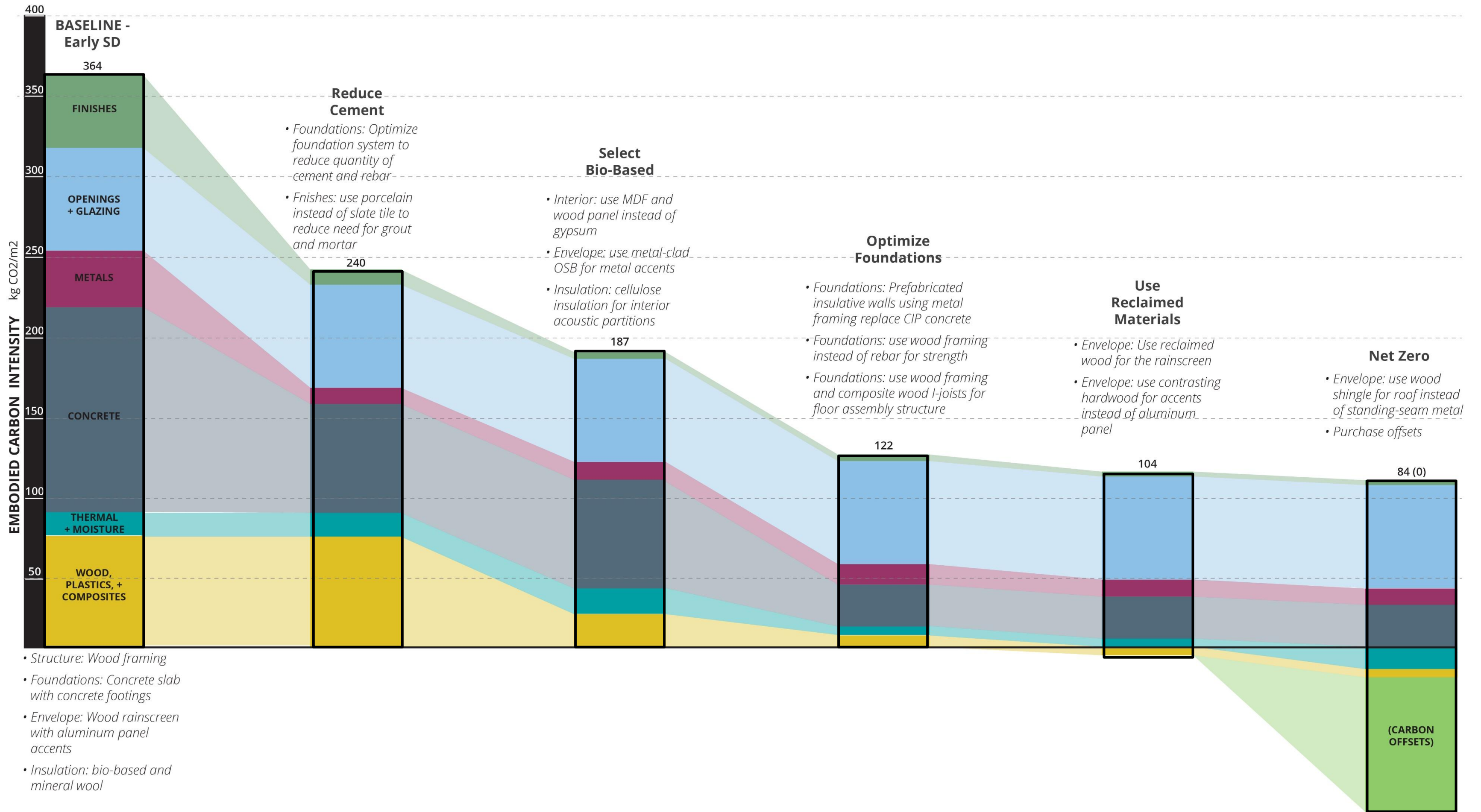
# What makes a good question for LCA?

1. It sets up a comparison.
2. It relates to a design decision.
3. It implies information about a functional unit.
4. The answer will be dependent upon a material choice.









KT OPEN HOME: PATH TO NET ZERO EMBODIED CARBON

# Carbon Initiative: Model Database

## GOALS

- 1. Evaluate the whole carbon pie.**
- 2. Compare carbon figures.**
- 3. Create benchmarks for embodied carbon.**
- 4. Design low carbon buildings.**

# Carbon Initiative: EC Working Group

## GOALS

- 1. Coordinate low carbon strategies with clients, consultants and contractors.**
- 2. Set embodied carbon goals on every project.**
- 3. Develop tacit knowledge of embodied carbon.**
- 4. Design with carbon in mind throughout all design phases.**





# KNOW YOUR IMPACT

Questions? Free educational license?  
Webinar recordings? LEED guide?

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