BUILDINGENERGY NYC

Is Technology a Hero or a Villain in the Quest to Reduce Whole-Life Carbon?

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Curated by Sara Bayer and Sanjana Nagaraj

Northeast Sustainable Energy Association (NESEA) | October 24, 2024

Technology: Friend or Foe in the Carbon Challenge?

NESEA NYC 2024

PERKINS EASTMAN

Human by Design

Your Guides

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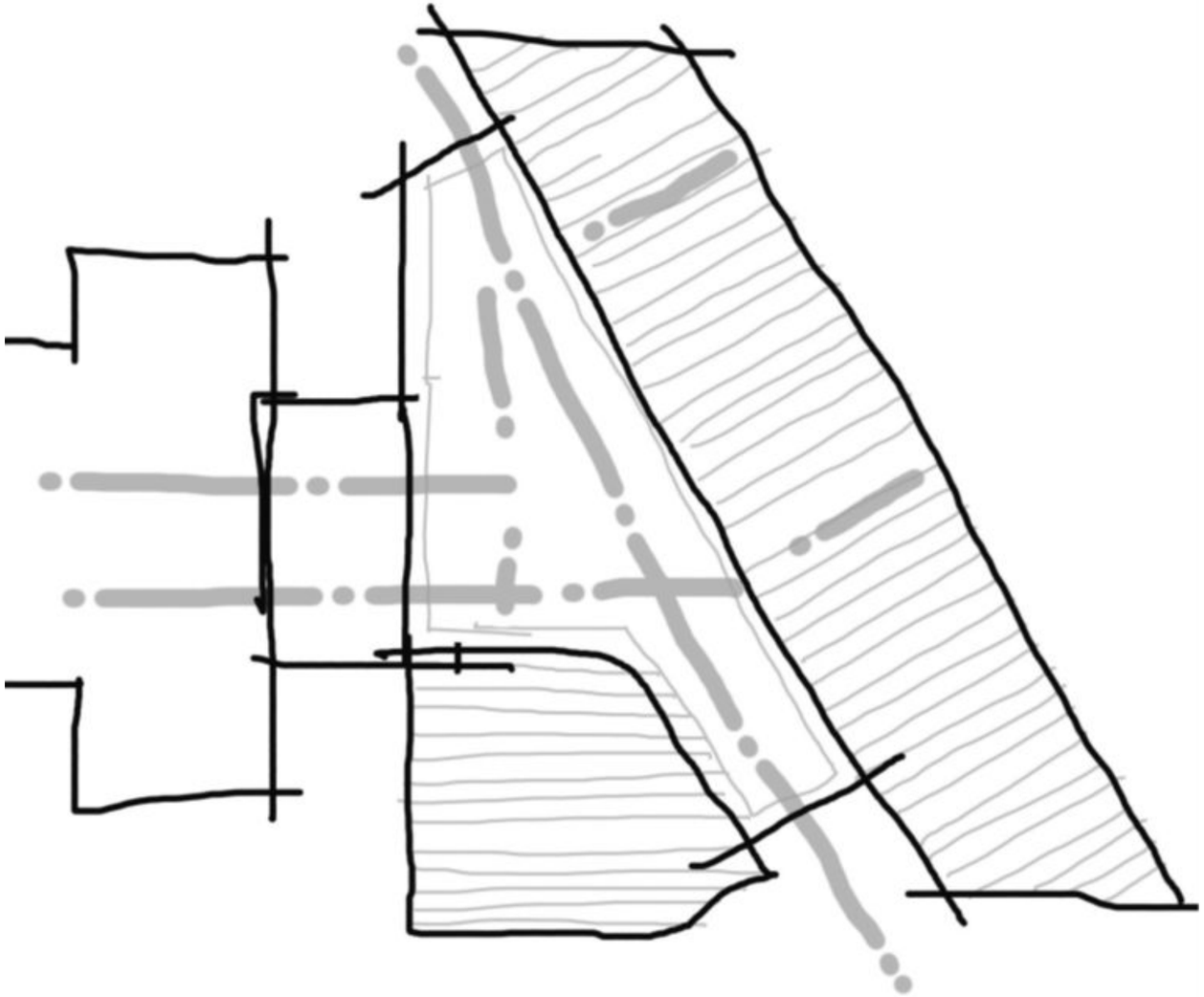
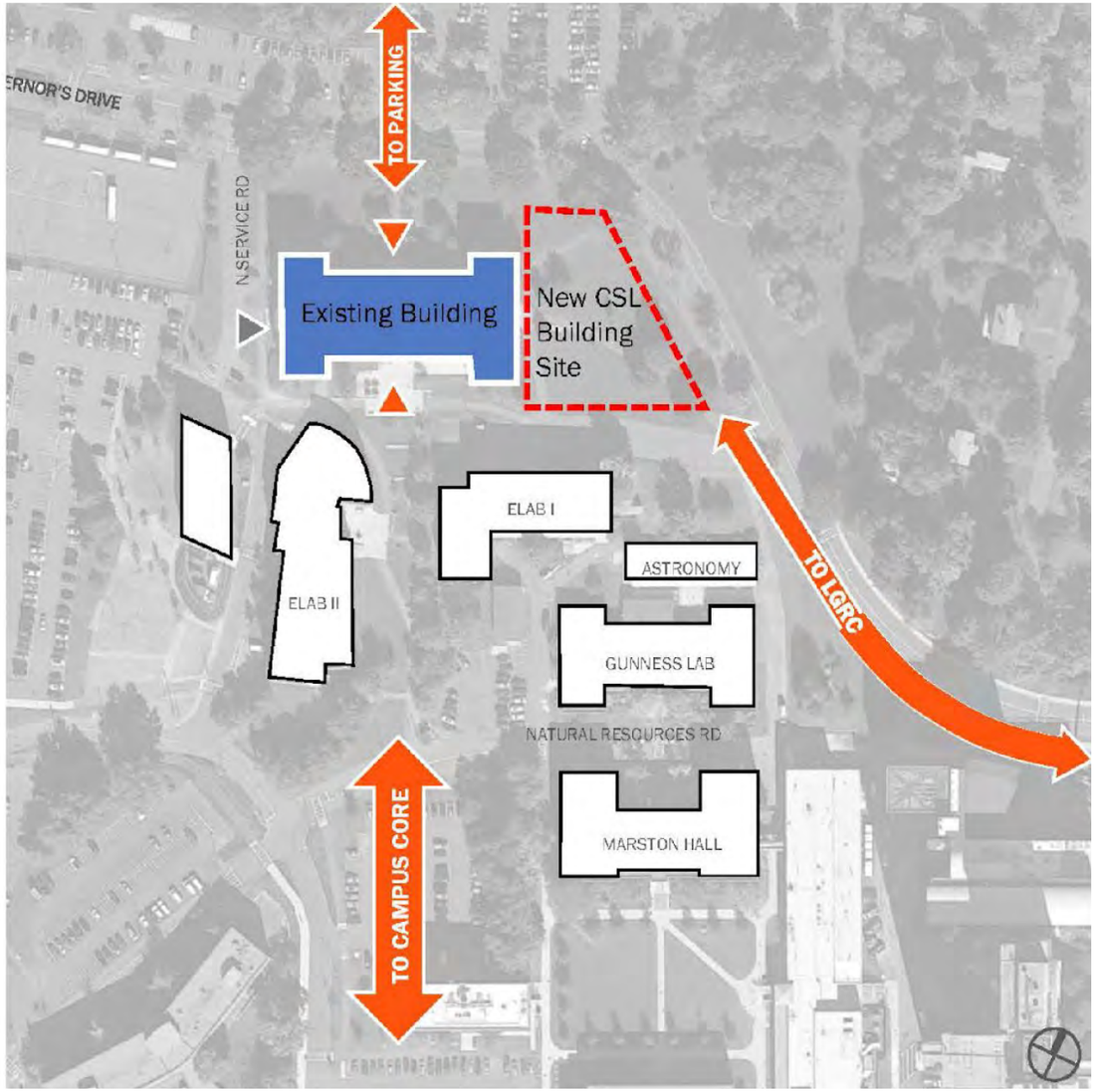
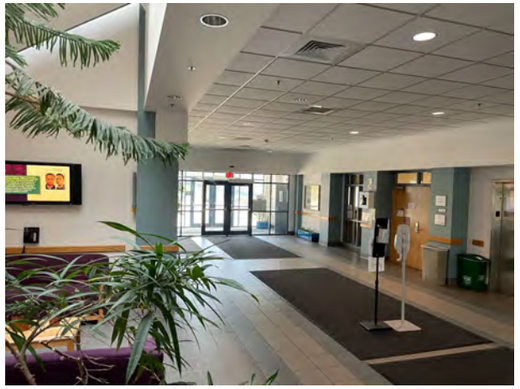
Today

1. Case Study Introduction
2. A high performance building approach
3. How should we count carbon?
4. Unpacking Whole-Life Carbon Analysis



Project Context





Holistic Sustainability

LOW ENERGY LED LIGHTING

NATURAL VENTILATION

MAXIMIZE ON-SITE RENEWABLE

LOW-CARBON EMBODIED MATERIALS

LOW-FLOW PLUMBING FIXTURES & HEAT PUMPS

ZERO ON-SITE GREENHOUSE GAS EMISSIONS

ON-SITE STORMWATER MANAGEMENT

ENERGY RECOVERY SYSTEMS

ALL ELECTRIC

MASS TIMBER STRUCTURE

HIGH-PERFORMANCE BUILDING ENVELOPE

SOLAR SHADING

A BUILT ENVIRONMENT THAT EDUCATES

LEED GOLD or PLATINUM

Typical Floor Plan

Image source, detail/description

South Approach

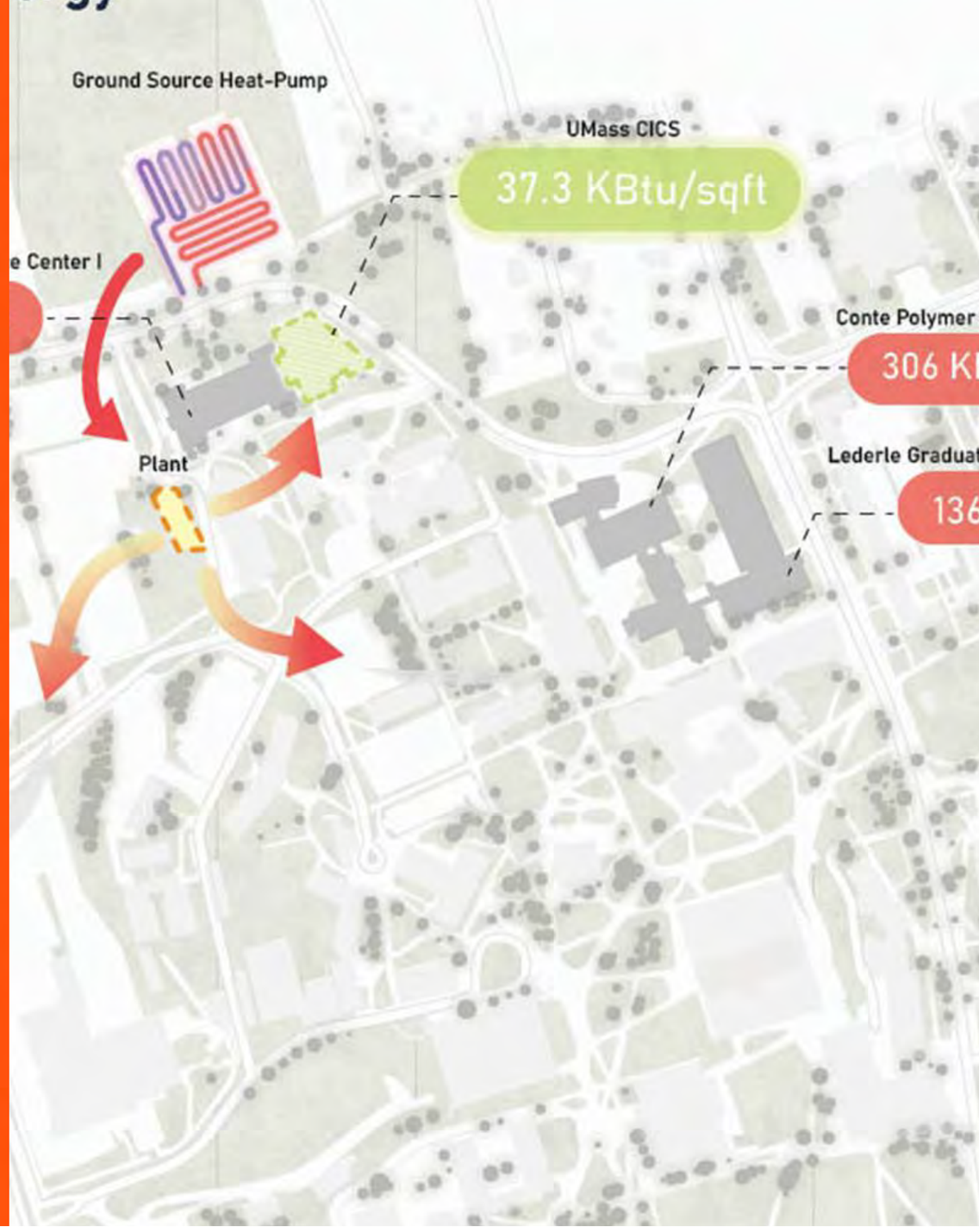
COMMONS

LEVEL 2 – LOOKING NORTH

RESEARCH & COLLABORATION

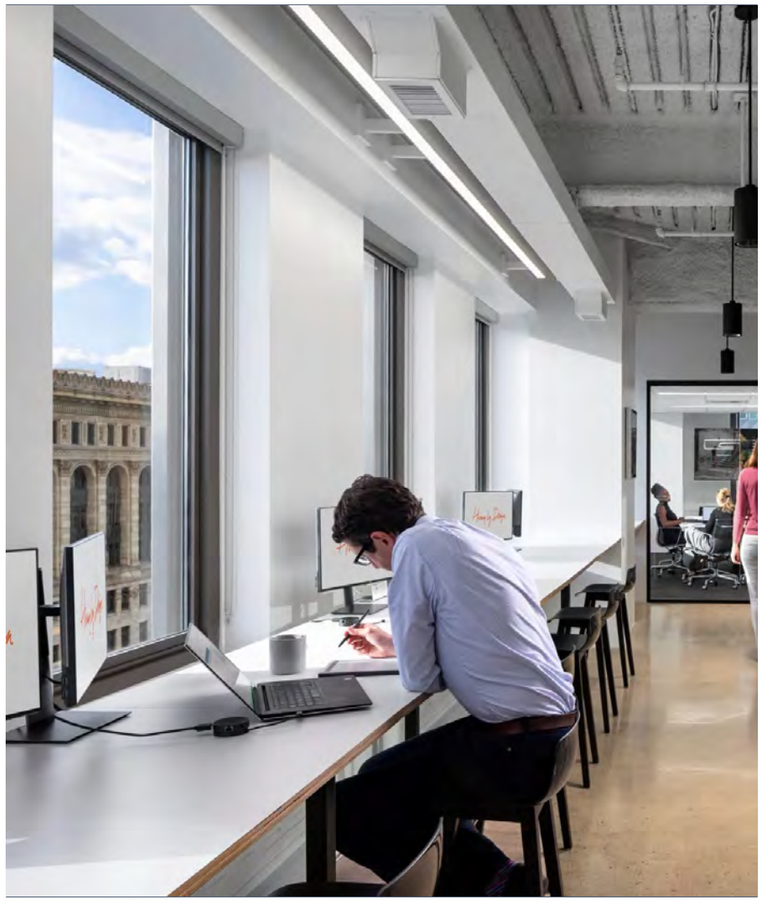
LEVEL 3

A high performance building

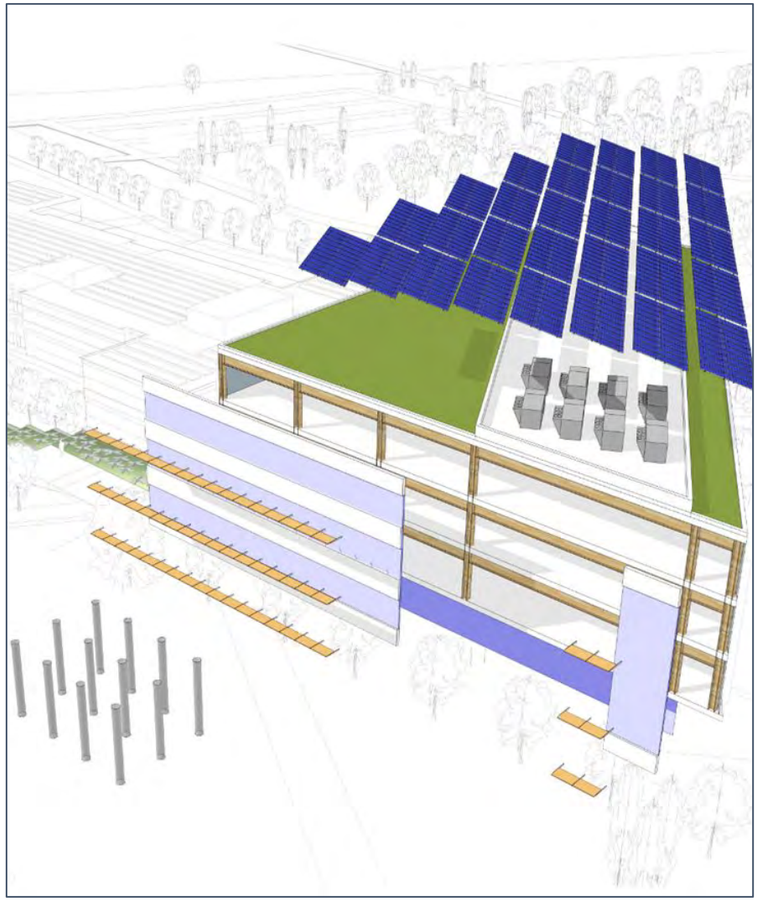


High Performance Building | Goals

Enhance Occupant Experience

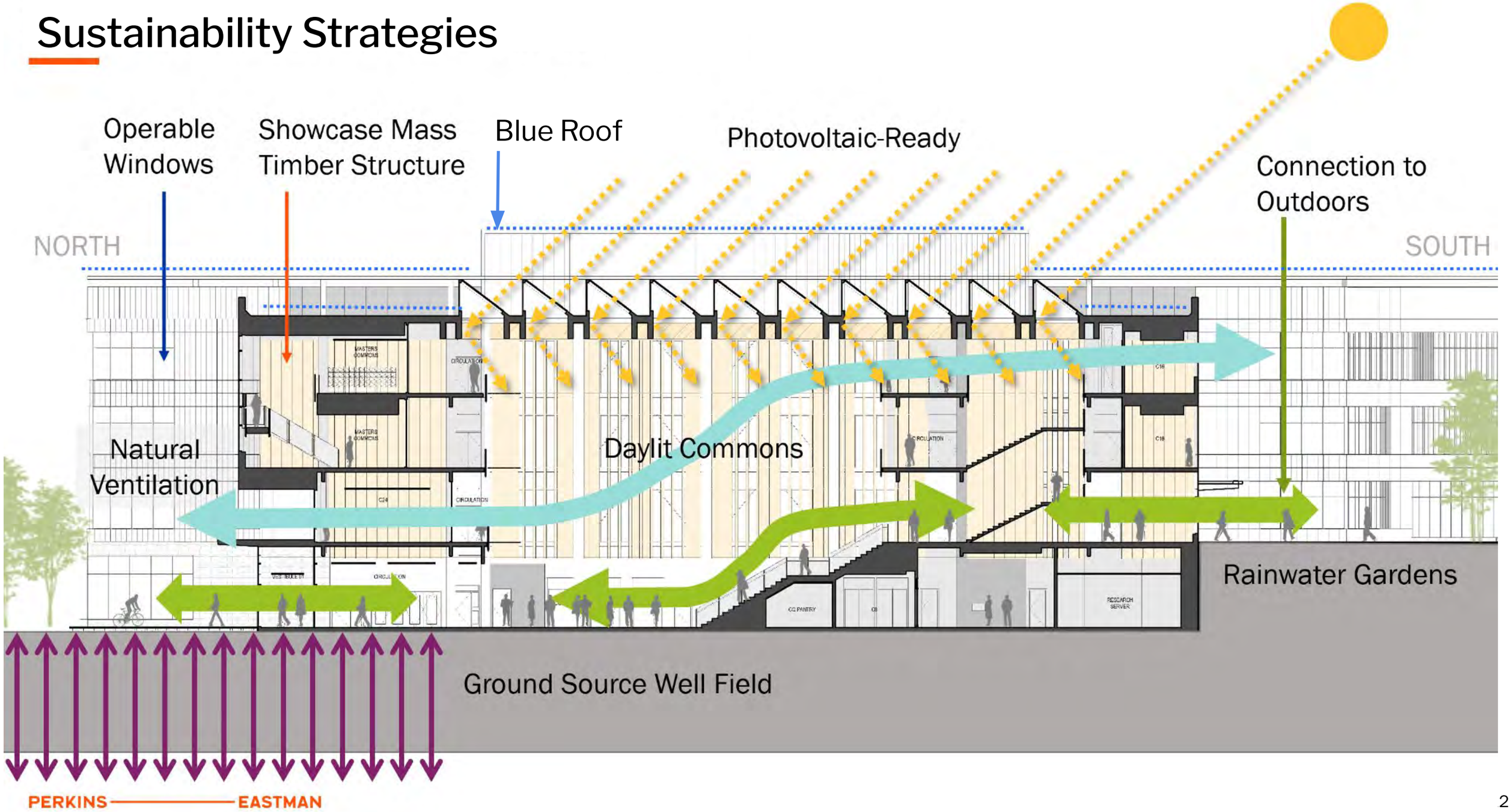


Minimize Operational Carbon



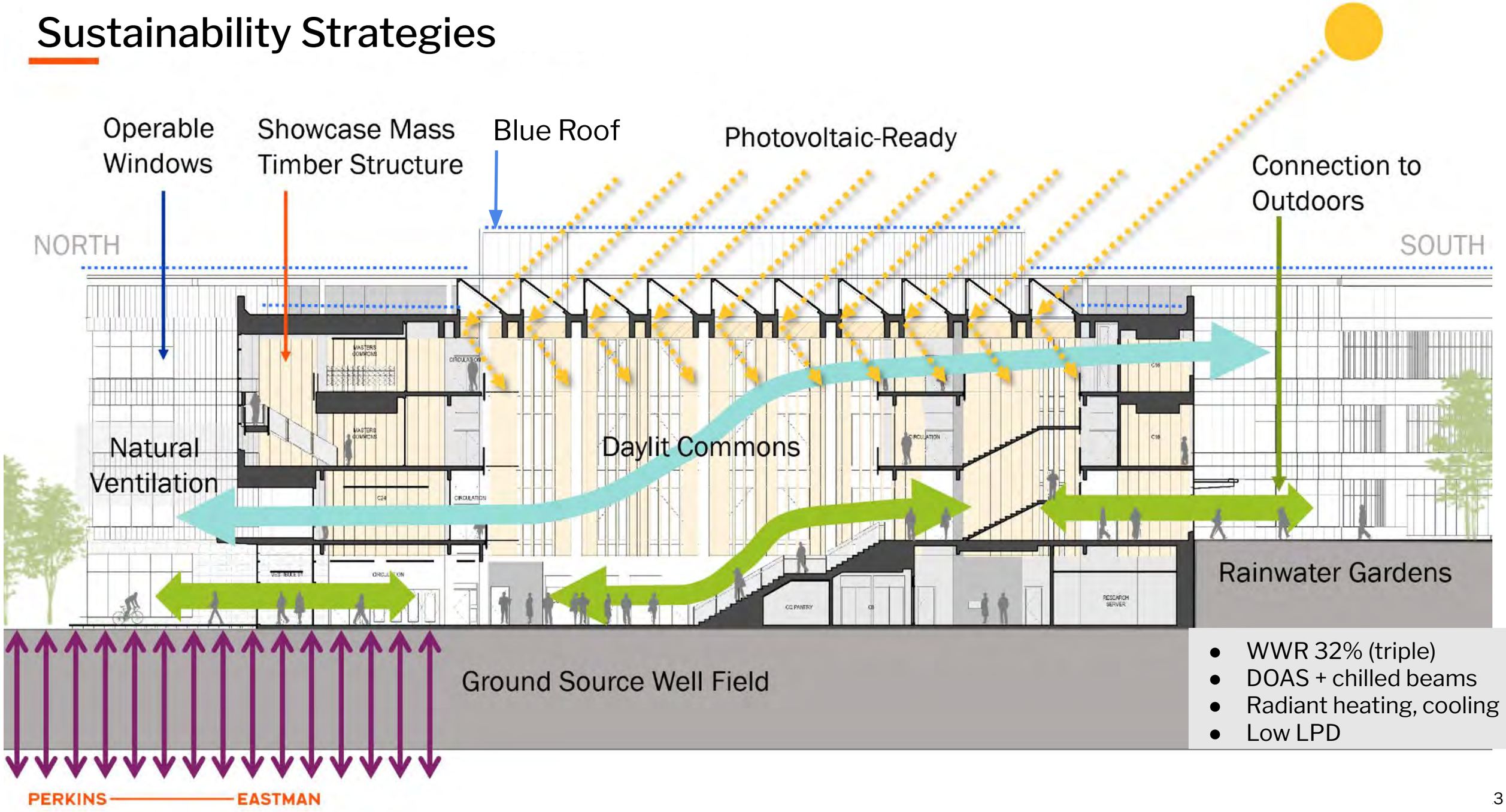
Minimize Embodied Carbon

Sustainability Strategies



PERKINS EASTMAN

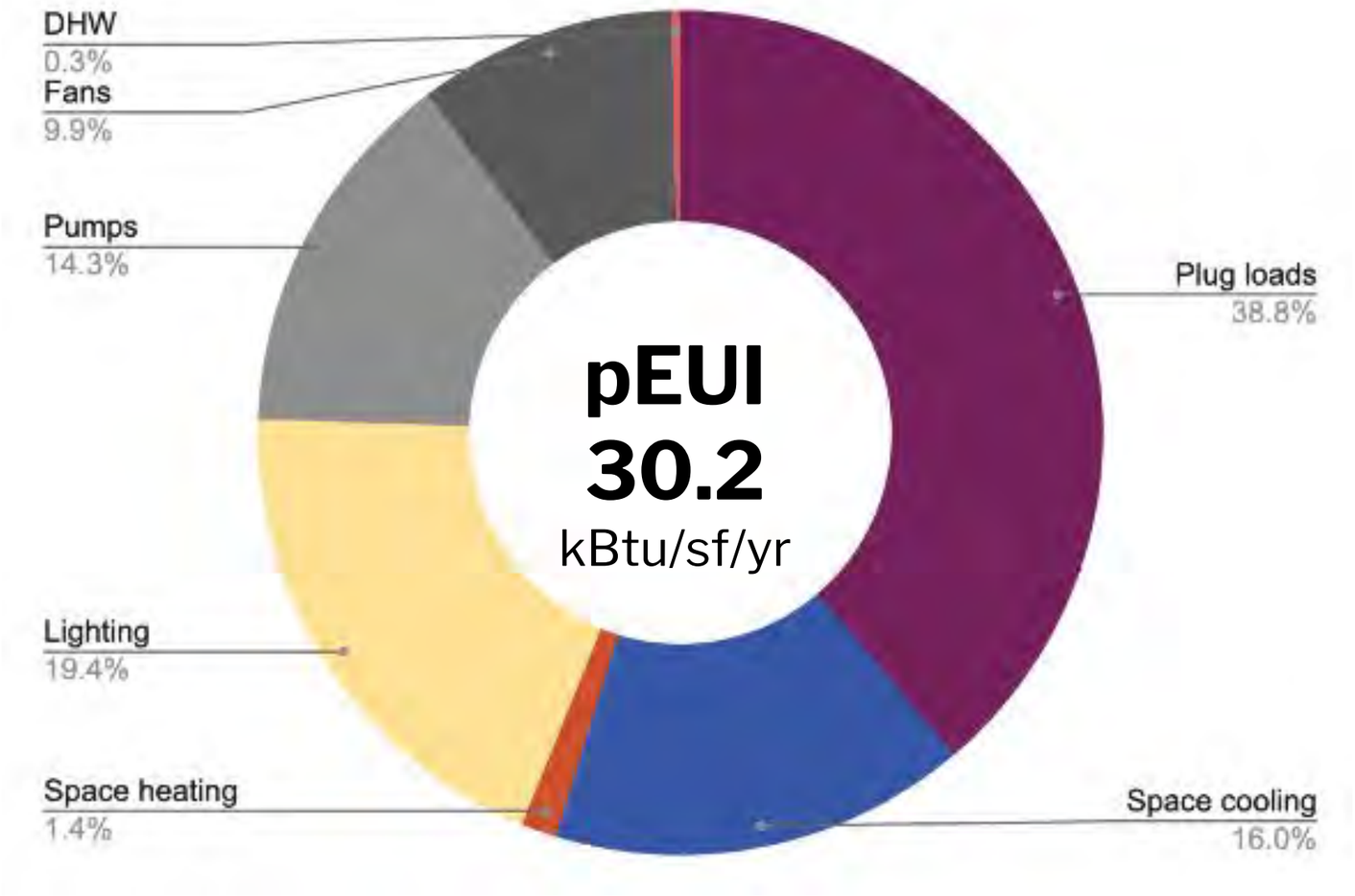
Sustainability Strategies



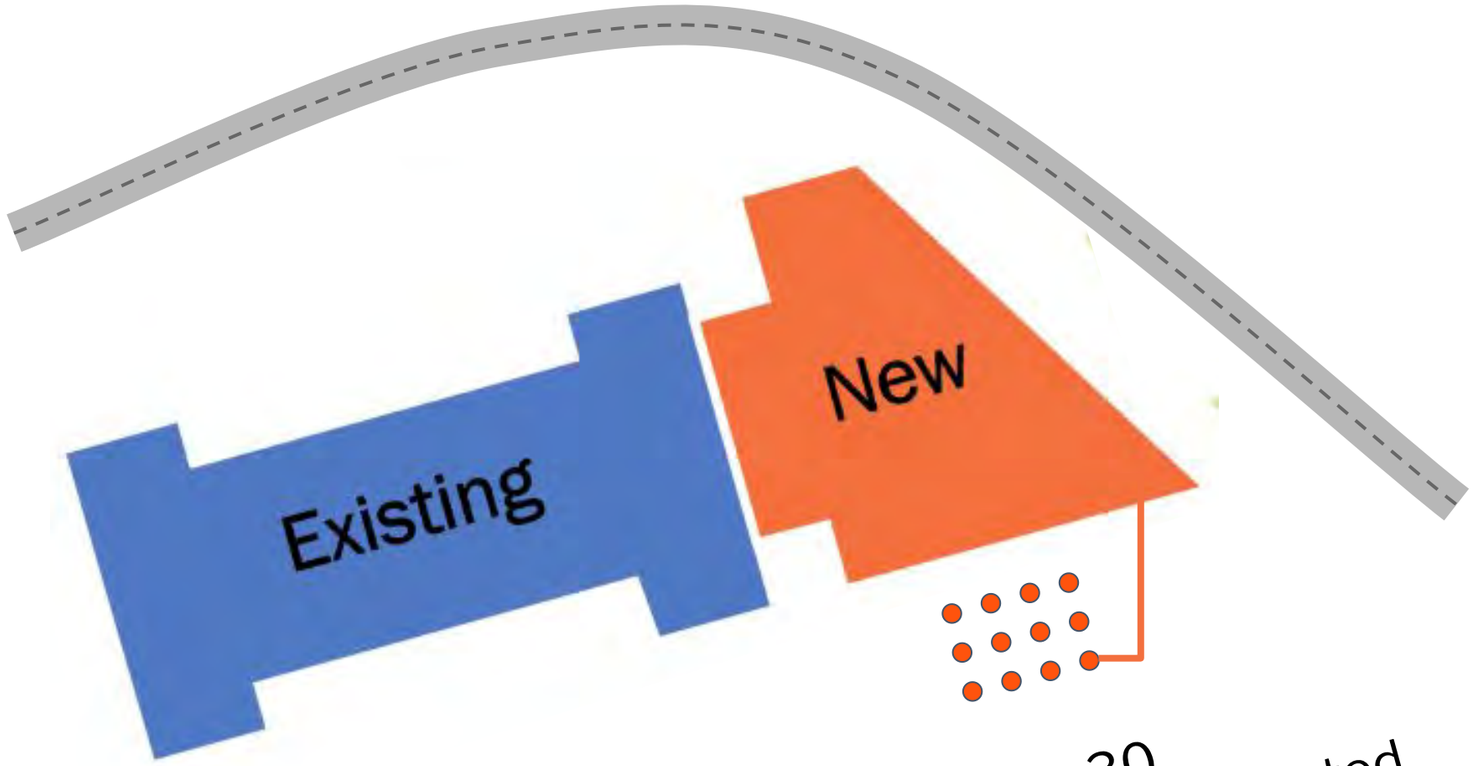
- WWR 32% (triple)
- DOAS + chilled beams
- Radiant heating, cooling
- Low LPD

PERKINS EASTMAN

Operational Carbon | pEUI

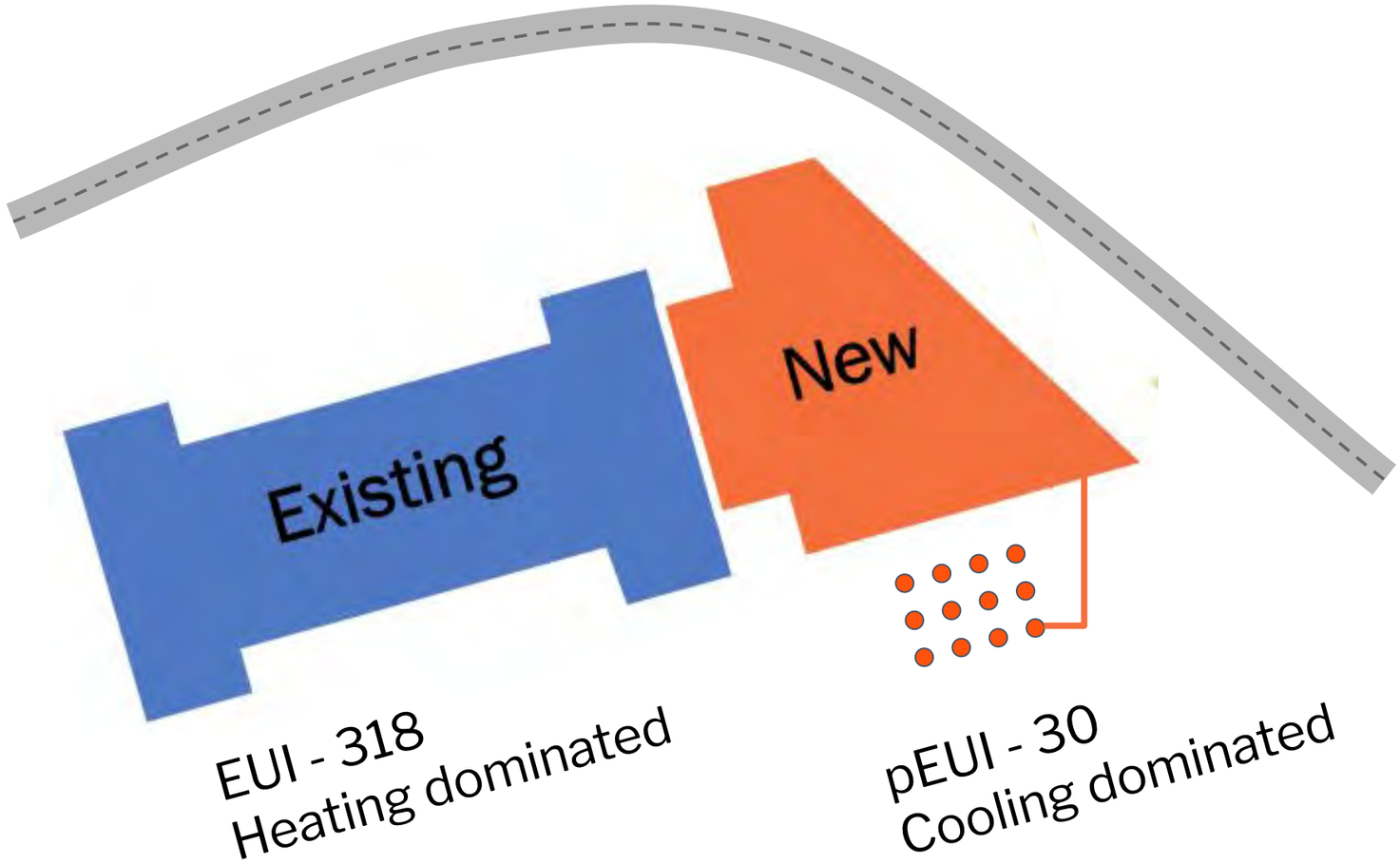


Operational Carbon | GSHP

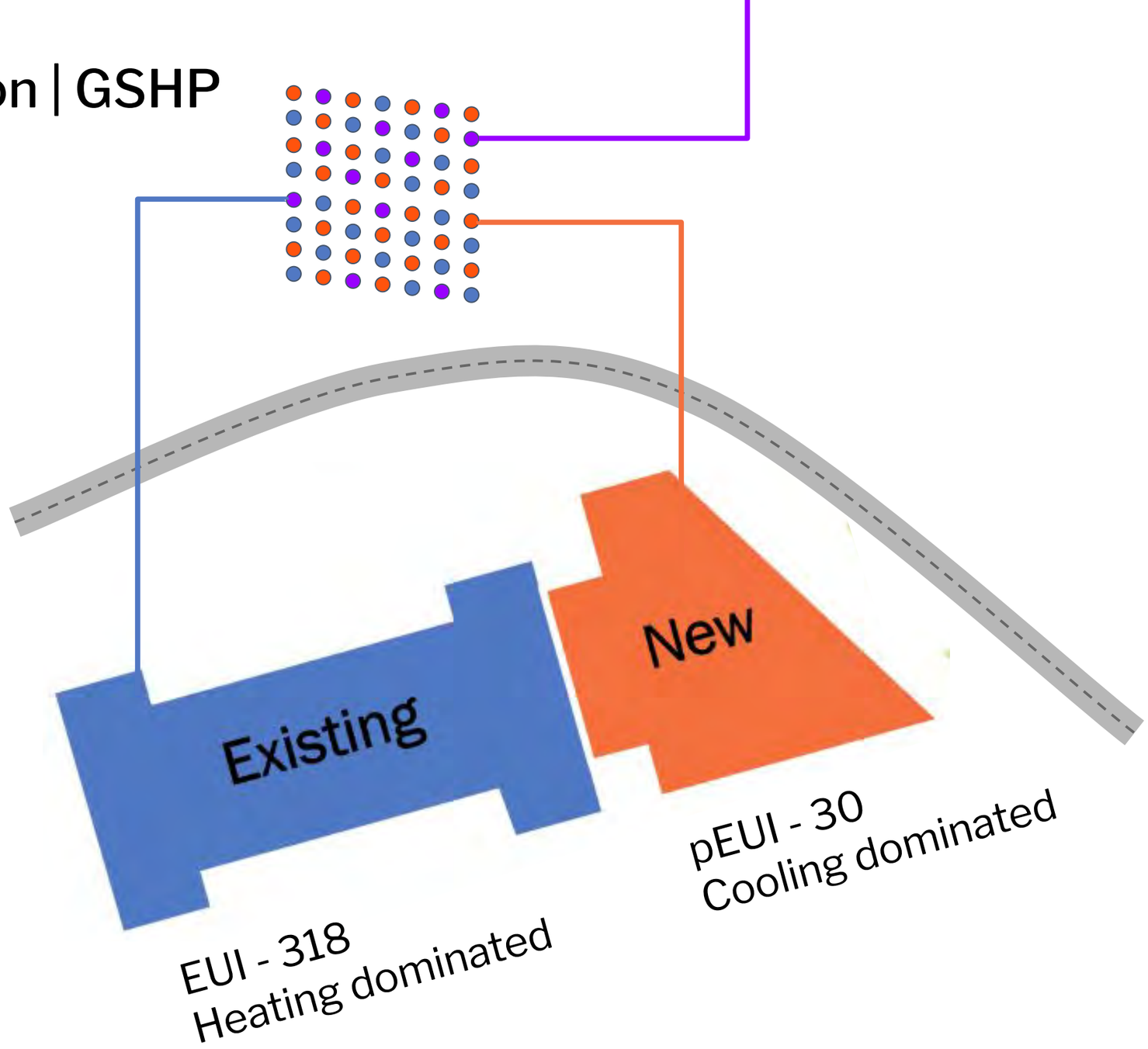


pEUI - 30
Cooling dominated

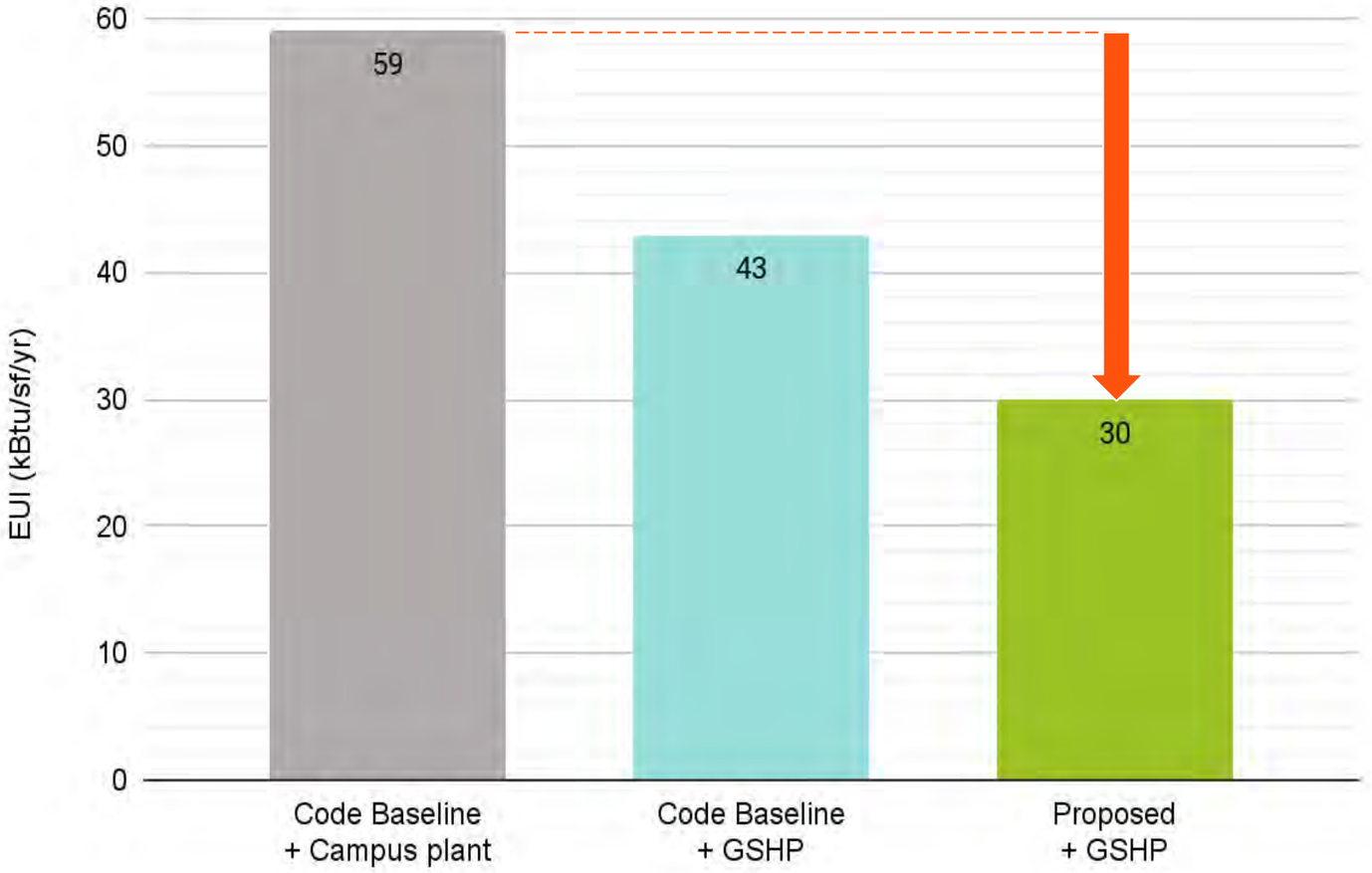
Operational Carbon | GSHP



Operational Carbon | GSHP



Operational Carbon | pEUI



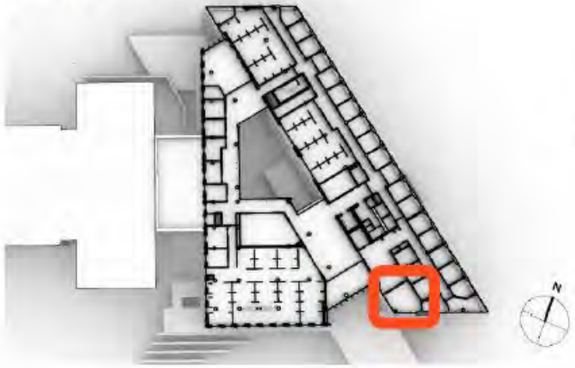
49% reduction
from campus-powered baseline

Façade Performance | Occupant Wellness + MEP Embodied Carbon

Excess solar load
=
Chilled beams cannot be used

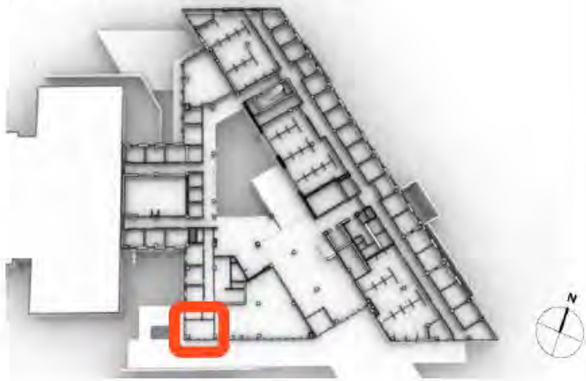
Excess glare
=
Shade deployment

Dean's Office E470C

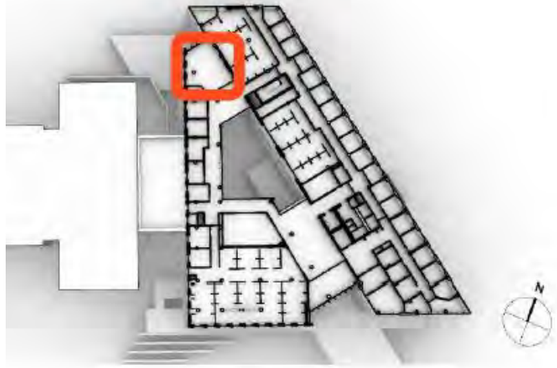


Lab E440+Huddle 440A

Conference Room E208

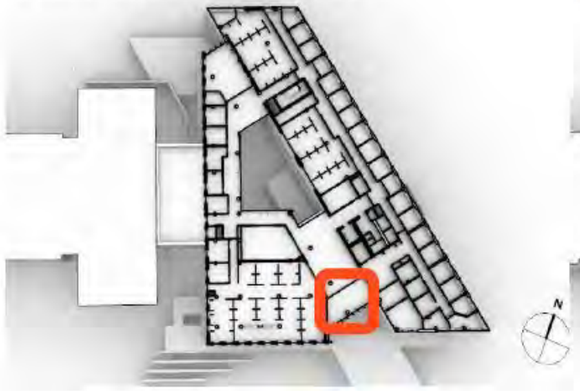


Master Commons E439



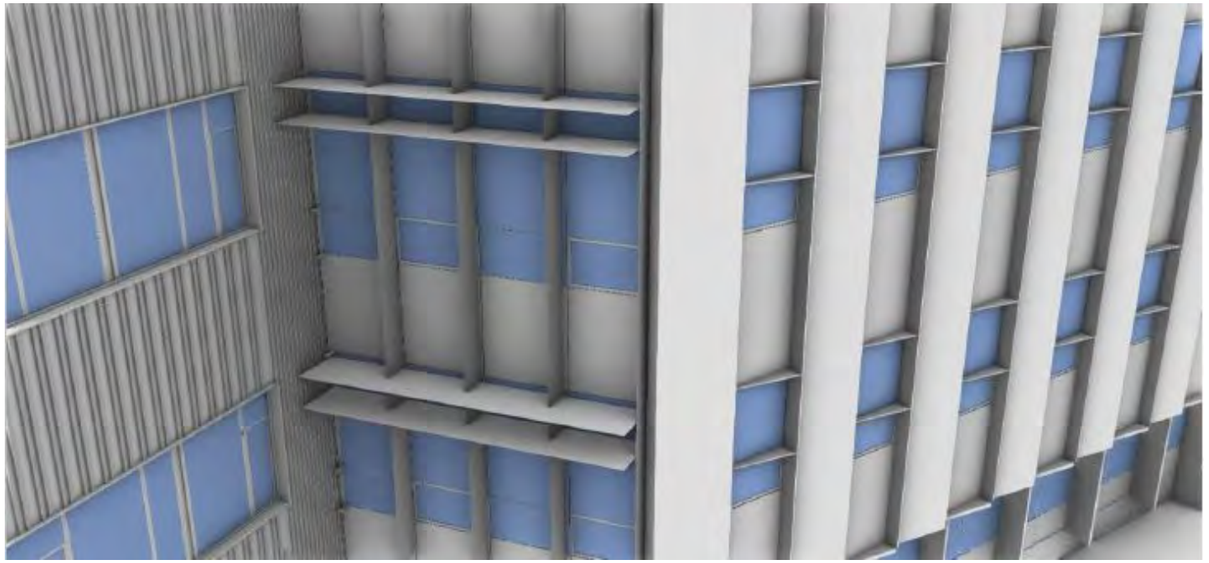
Office E437

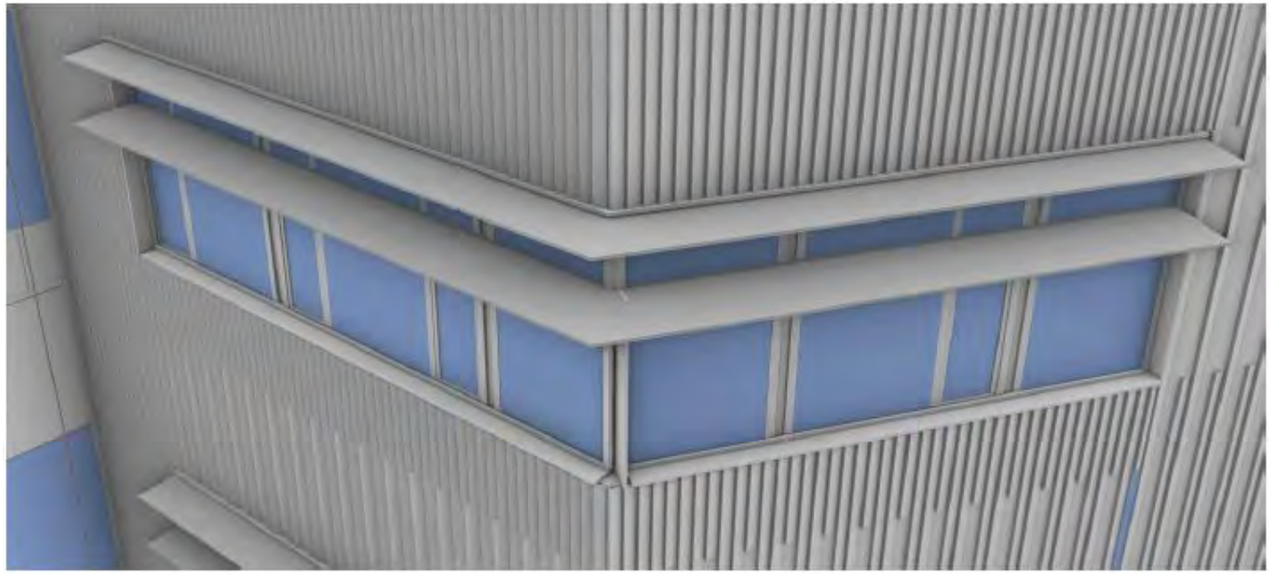
Conference Room E400

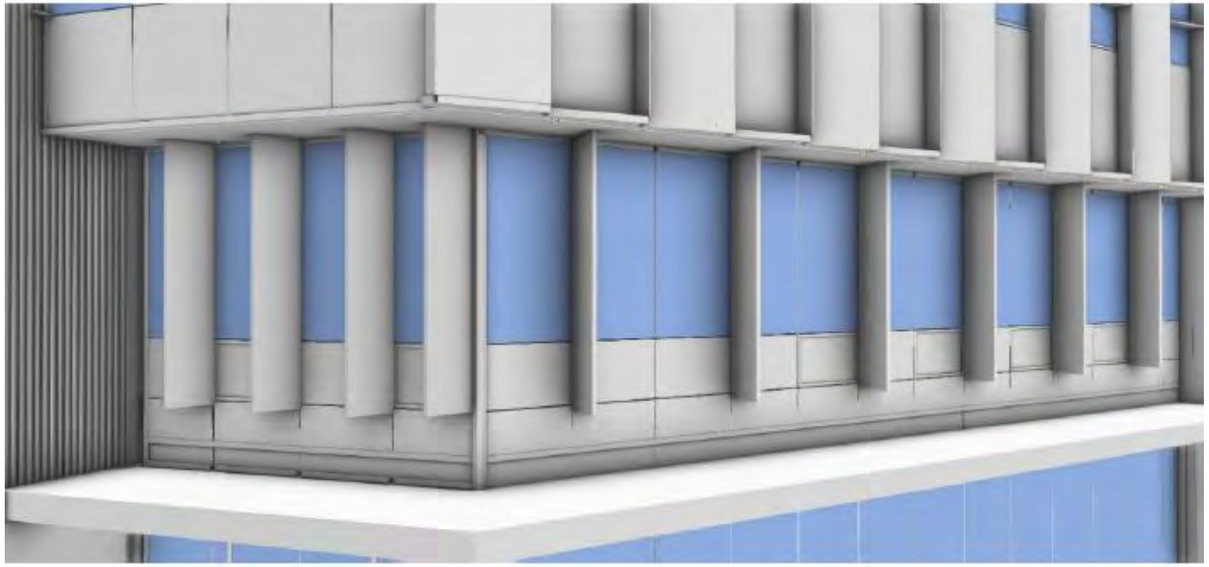


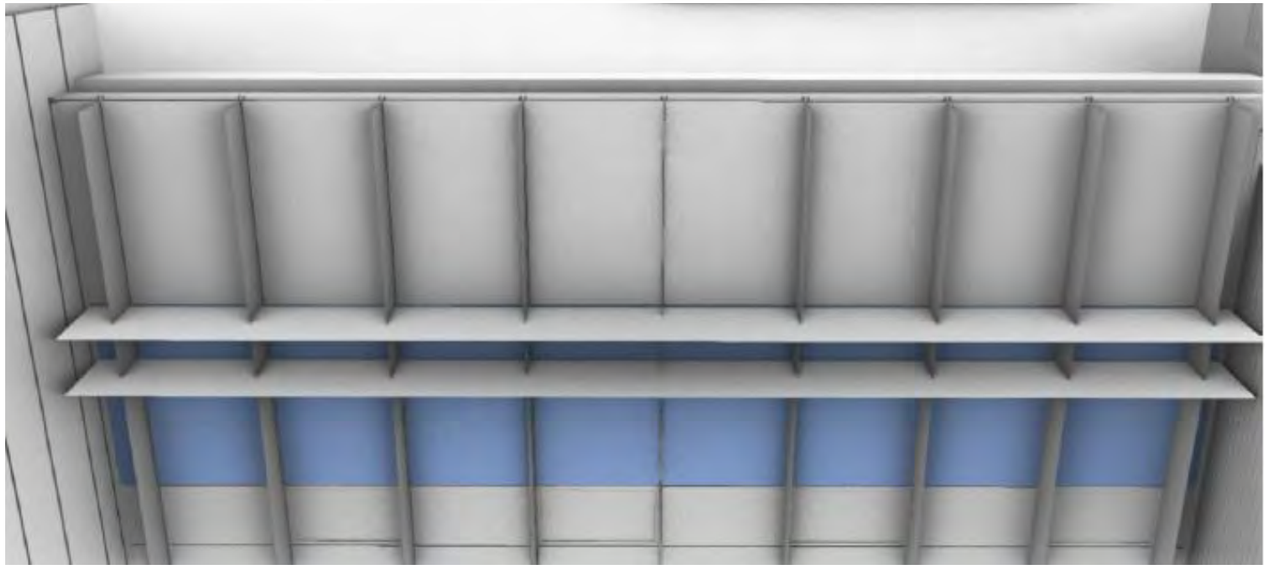
Conference Room E239

Façade Performance | Exterior Shading

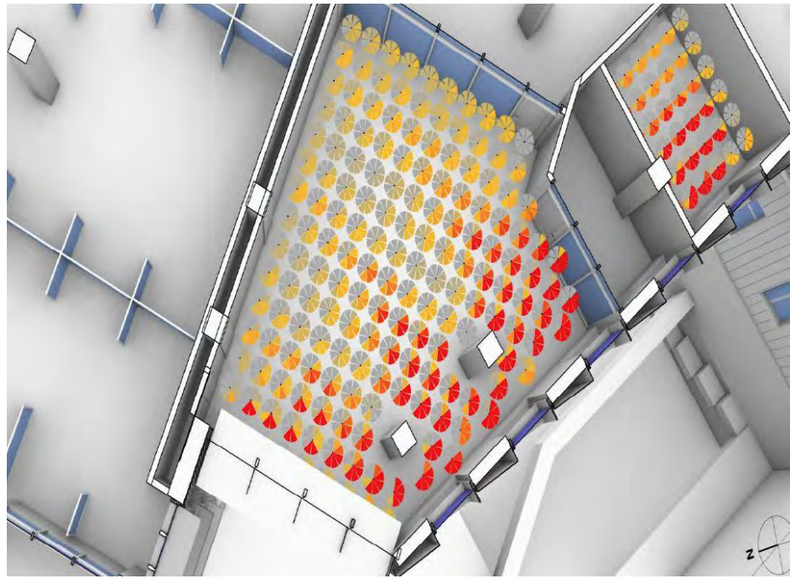


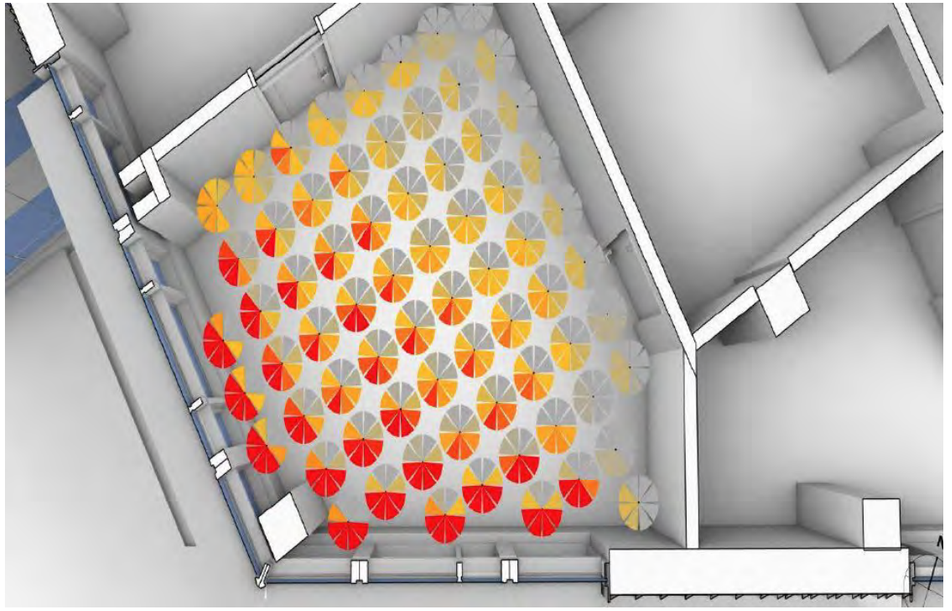


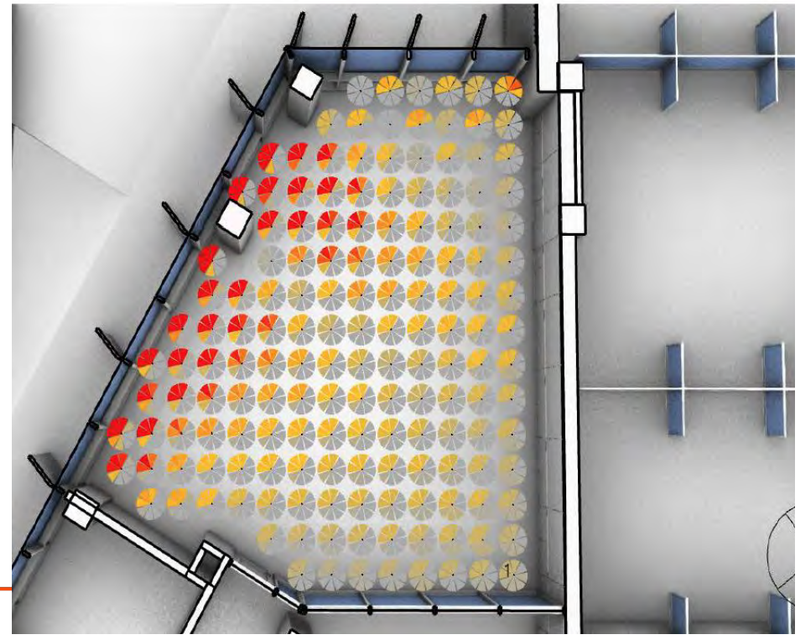


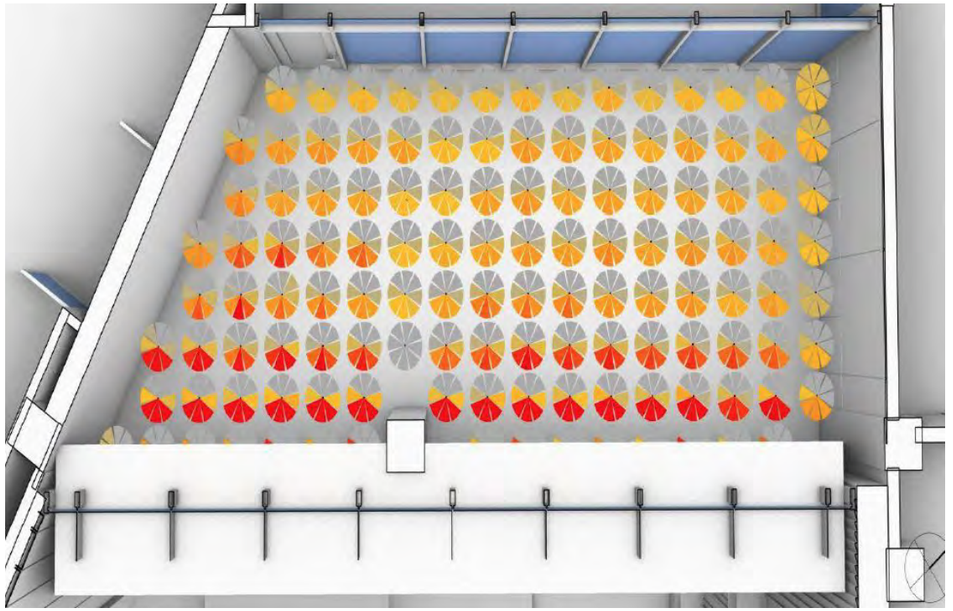


Façade Performance | Exterior Shading Glare Assessment





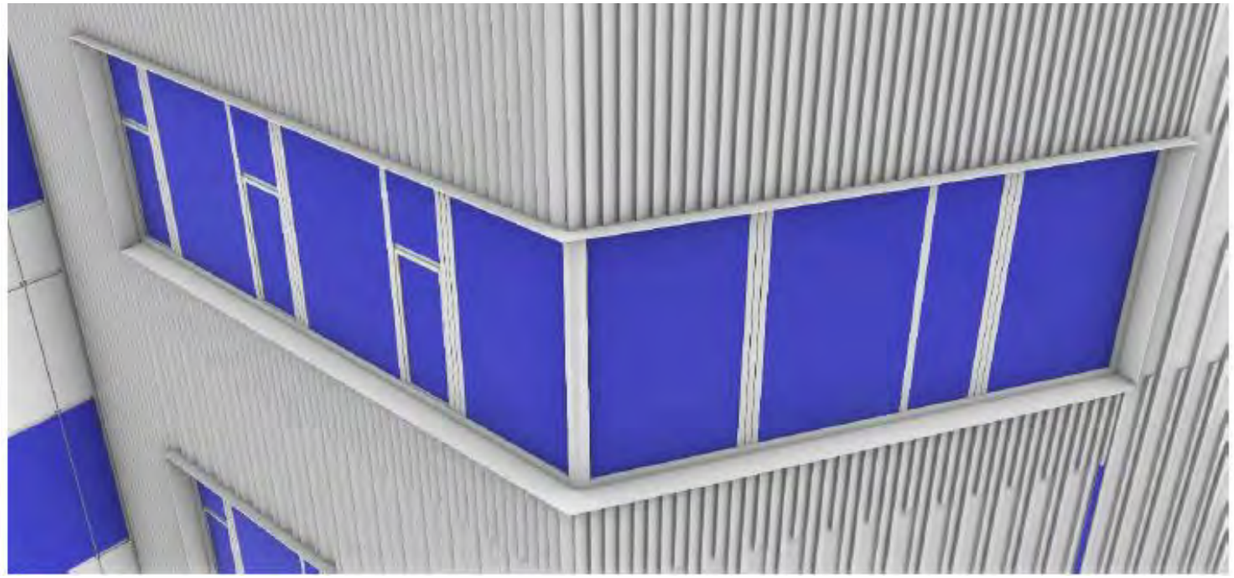


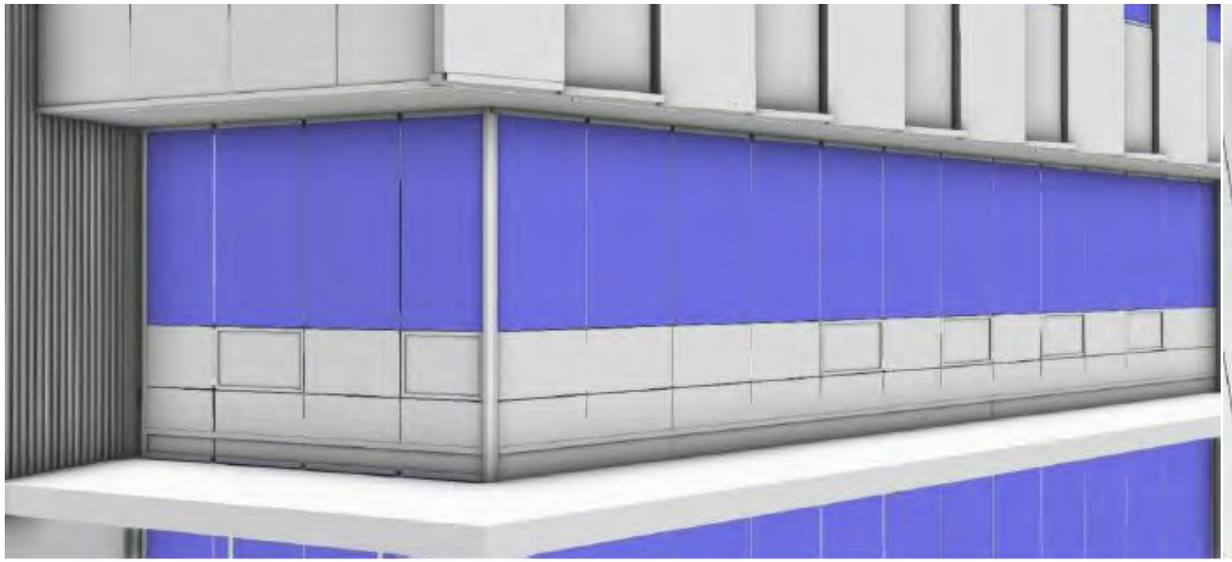


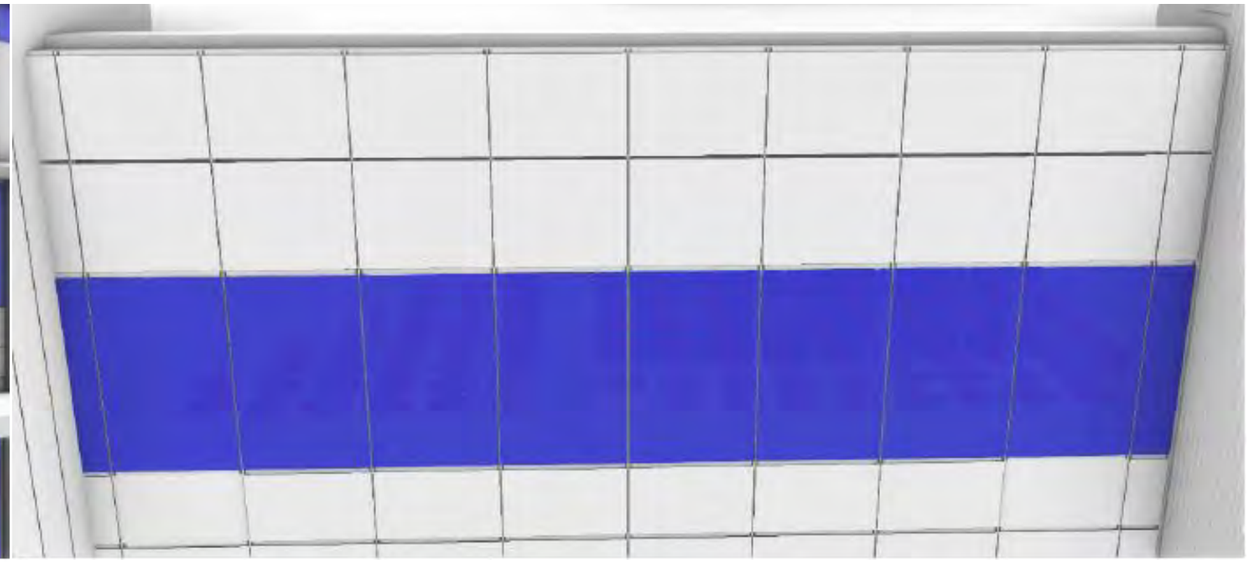
Façade Performance | Solar Gain Reduction

Room	Target Solar Reduction from DD's	Option #1: Exterior Shading	Option #2: Added Spandrel
C24 Conf E239	47%	18% Reduction	28% Reduction
C8 Conf E201	74%	0% Reduction	52% Reduction
C16 Conf E300	67%	14% Reduction	46% Reduction
C16 Conf E400	73%	14% Reduction	46% Reduction

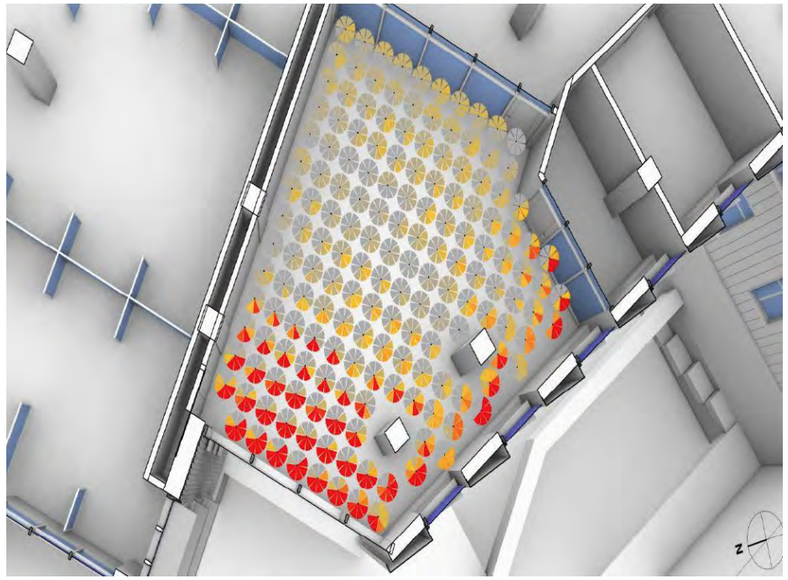
Façade Performance | Electrochromic Glass

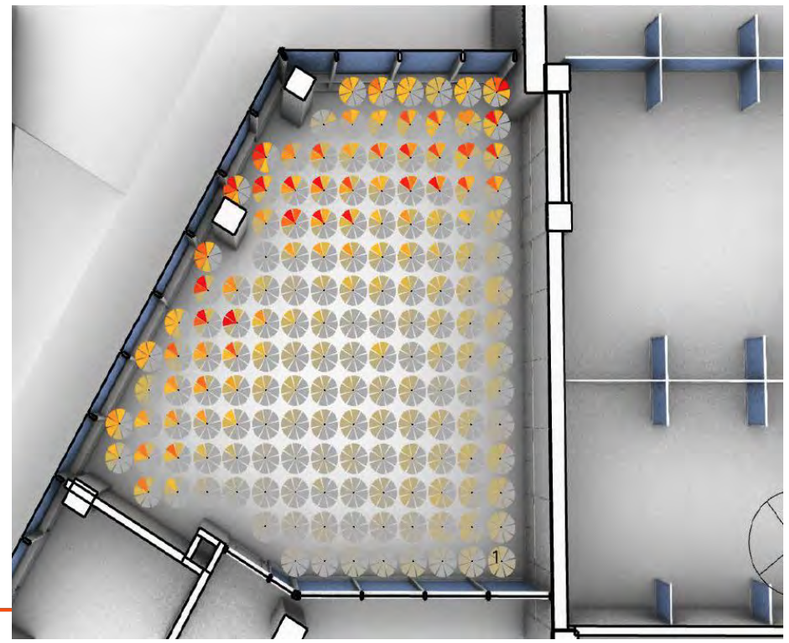




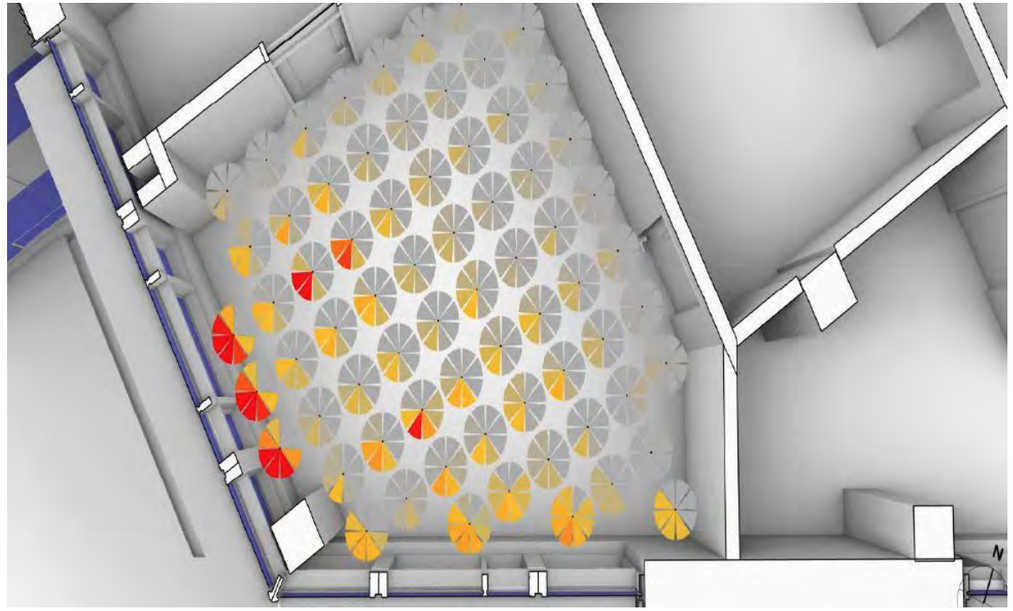


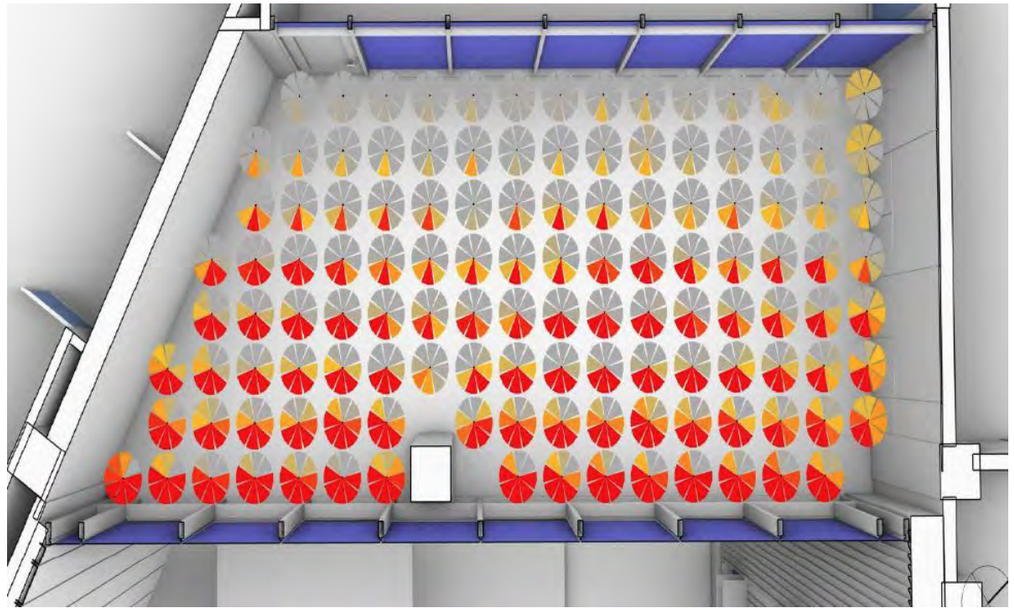
Façade Performance | Electrochromic Glass Glare Assessment





5% avg high glare reduction

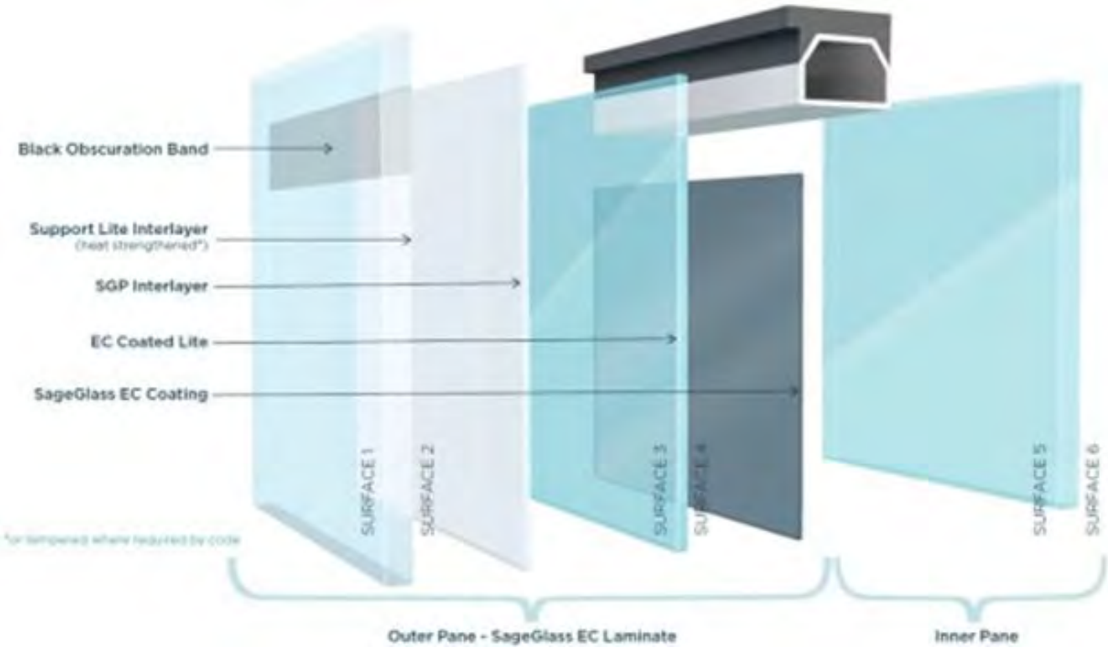




Façade Performance | Solar Gain Reduction

Room	Target Solar Reduction from DD's	Exterior Shading + Adjusted Spandrel	Electrochromic + Adjusted Spandrel
C24 Conf E239	47%	40% Reduction	70% Reduction
C8 Conf E201	71%	52% Reduction	80% Reduction
C16 Conf E300	67%	64% Reduction	77% Reduction
C16 Conf E400	73%	64% Reduction	77% Reduction

Embodied Carbon | Quantifying Key Drivers



How should we count carbon?

epic.

tally®

One Click LCA

EC3

Counting Embodied Carbon

Embodied Carbon

Kgco2e

=

Material Quantity

M3

x

Material Quality

Kgco2e/M3

Standards for Embodied Carbon

LEED / ISO 14044

CLF CA Report: Median EC: 390 kg/M3

LEED BD+C: Schools • v4 - LEED v4

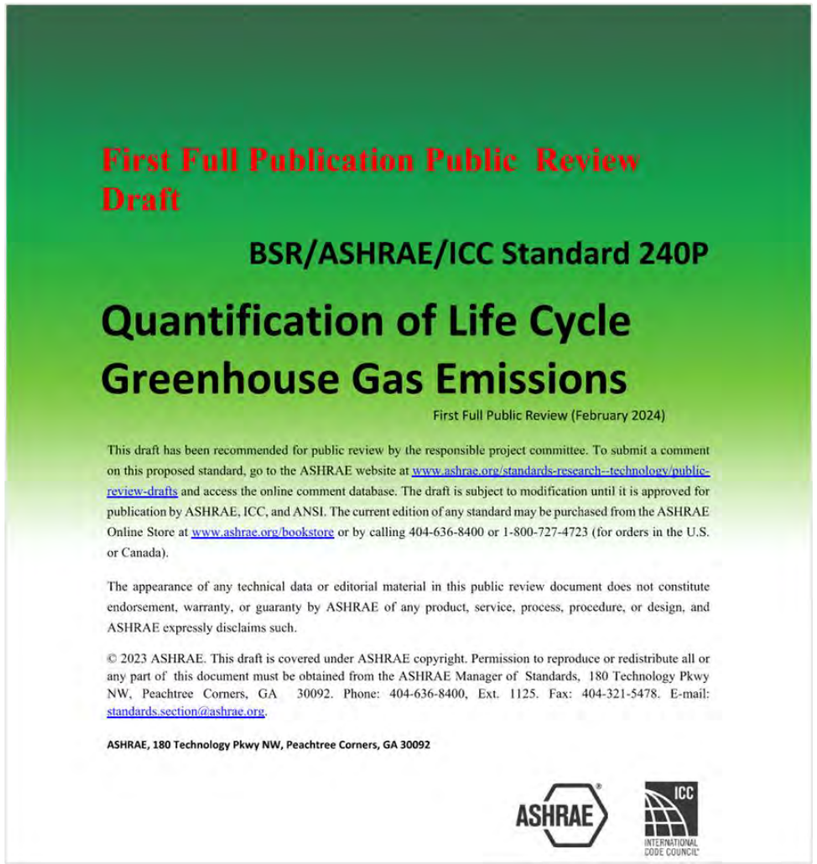
Building life-cycle impact reduction

Materials and Resources

Possible 5 Points

ASHRAE 240P

Median EC: Double results of CA Report?

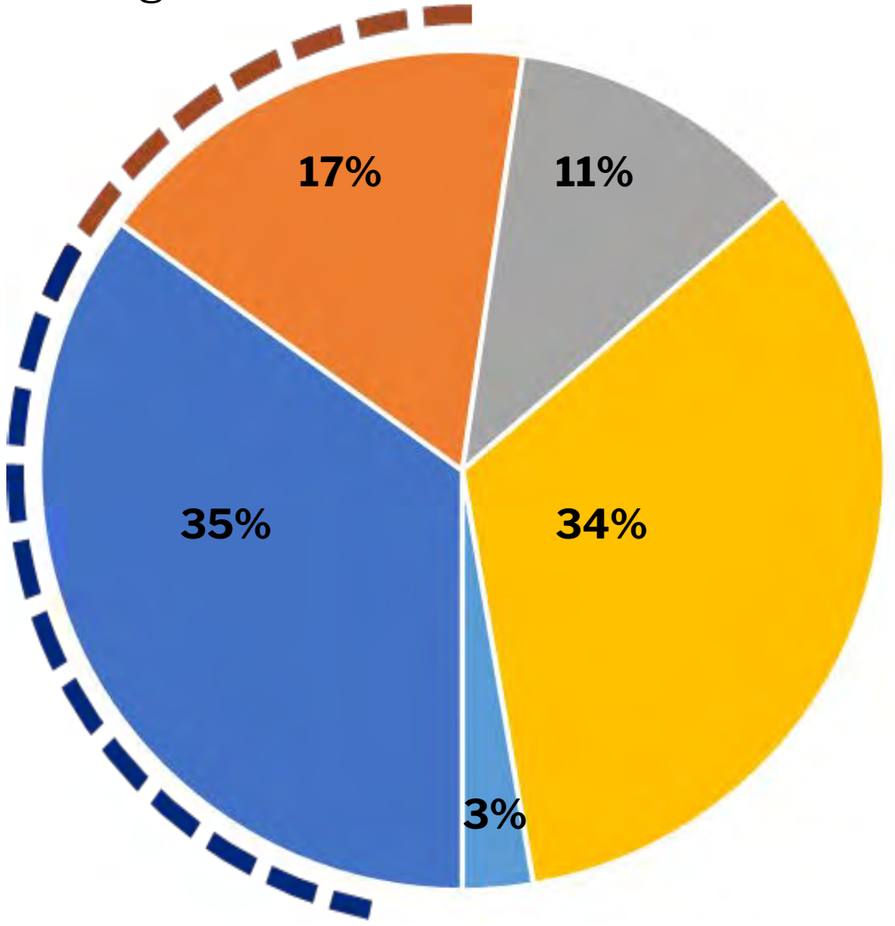


Impact of Scope

LEED / ISO 14044
CLF CA Report: Median EC: 390 kg/M3

ASHRAE 240P
Median EC: Double results of CA Report?

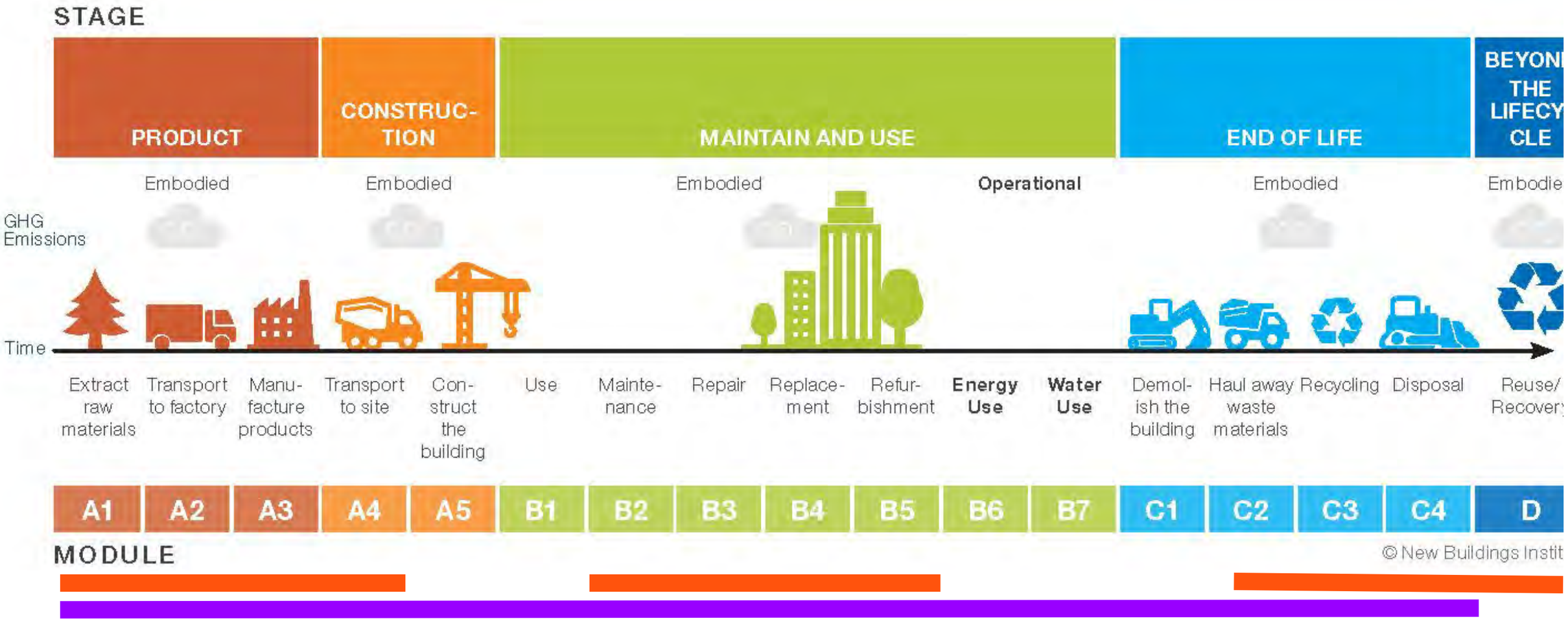
52% of total EC



Defining Life Cycle Modules

Tally (for LEED)

ASHRAE 240P



Source: New Buildings Institute

Defining Life Cycle Modules

Category	Product Creation			Const.		Use							End of Life				Reuse
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Demolition																	
Foundations																	
Structure																	
Enclosure																	
Interiors																	
Site																	
MEP Systems																	
Furniture																	
Transportation																	

= Not included = Tally Default = Product-Specific EPD

Tools Used

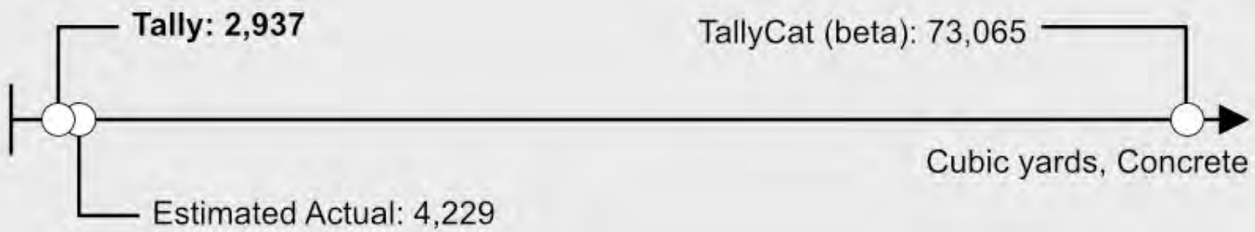
Rapid High Level Comparison of whole life carbon

Generate Material Takeoffs and initial embodied carbon analysis

Compare individual manufacturers and refine embodied carbon analysis

Challenges in Quality of Data

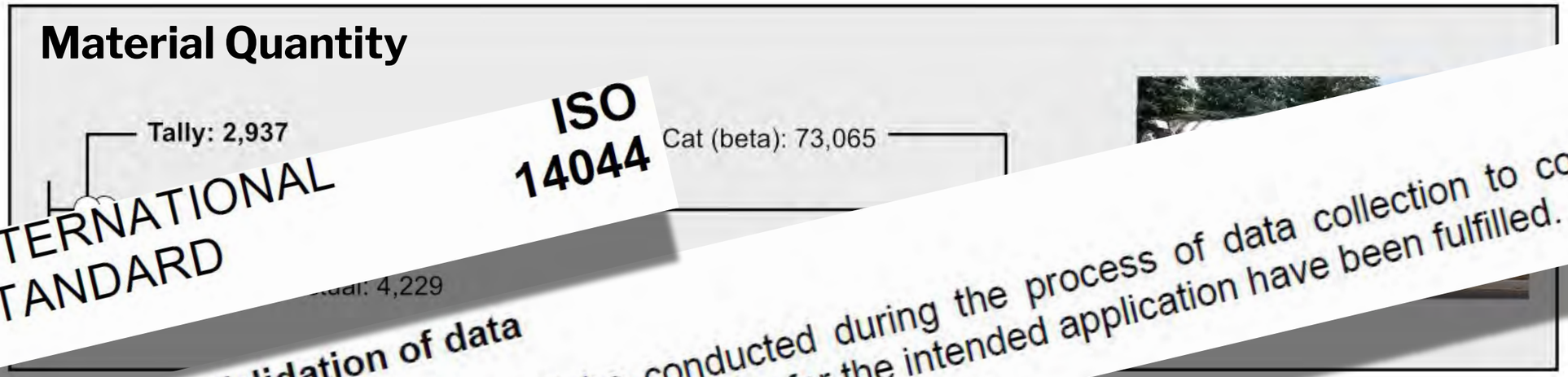
Material Quantity



Material Quality

Scope A1-A3 Emissions

Challenges in Quality of Data

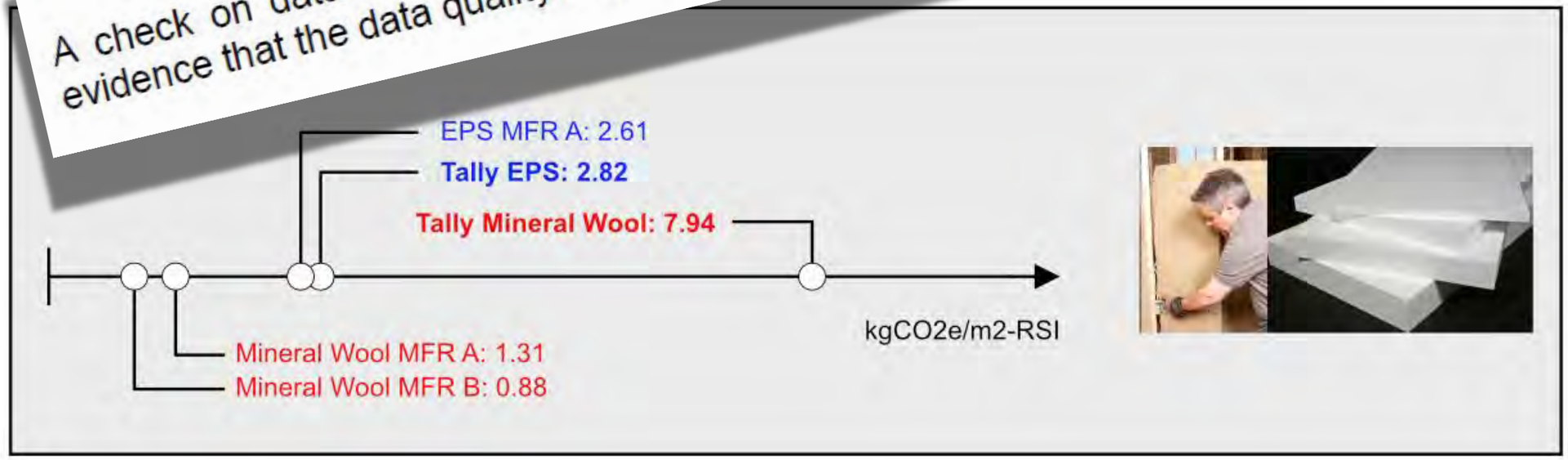


INTERNATIONAL STANDARD

ISO 14044

4.3.3.2 Validation of data

A check on data validity shall be conducted during the process of data collection to confirm and provide evidence that the data quality requirements for the intended application have been fulfilled.



Scope A1-A3 Emissions

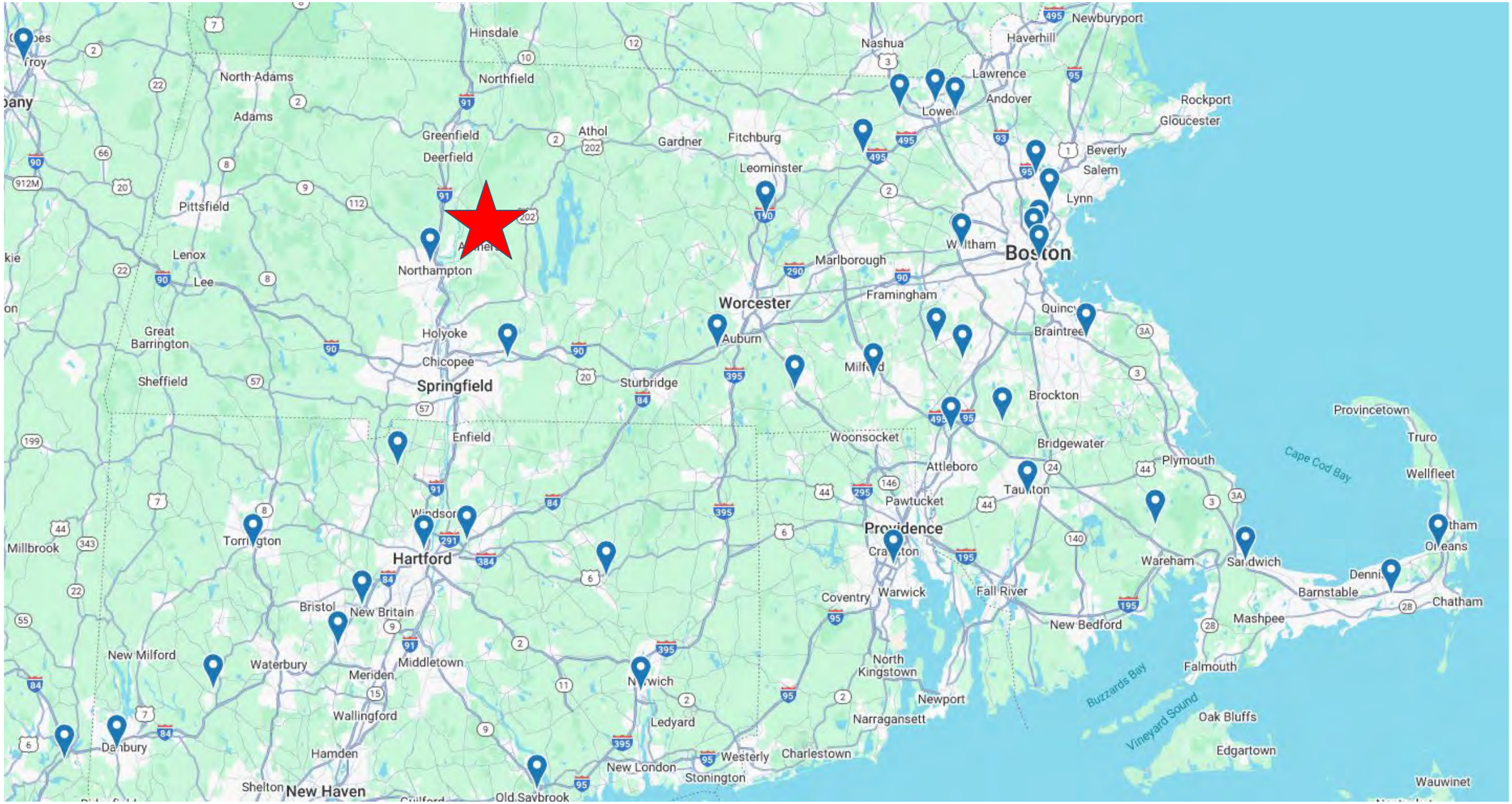
Concrete Values

4X Variation

(kgCO2e/cubic meter concrete, all mixes 4000 psi NW)

EPD Availability

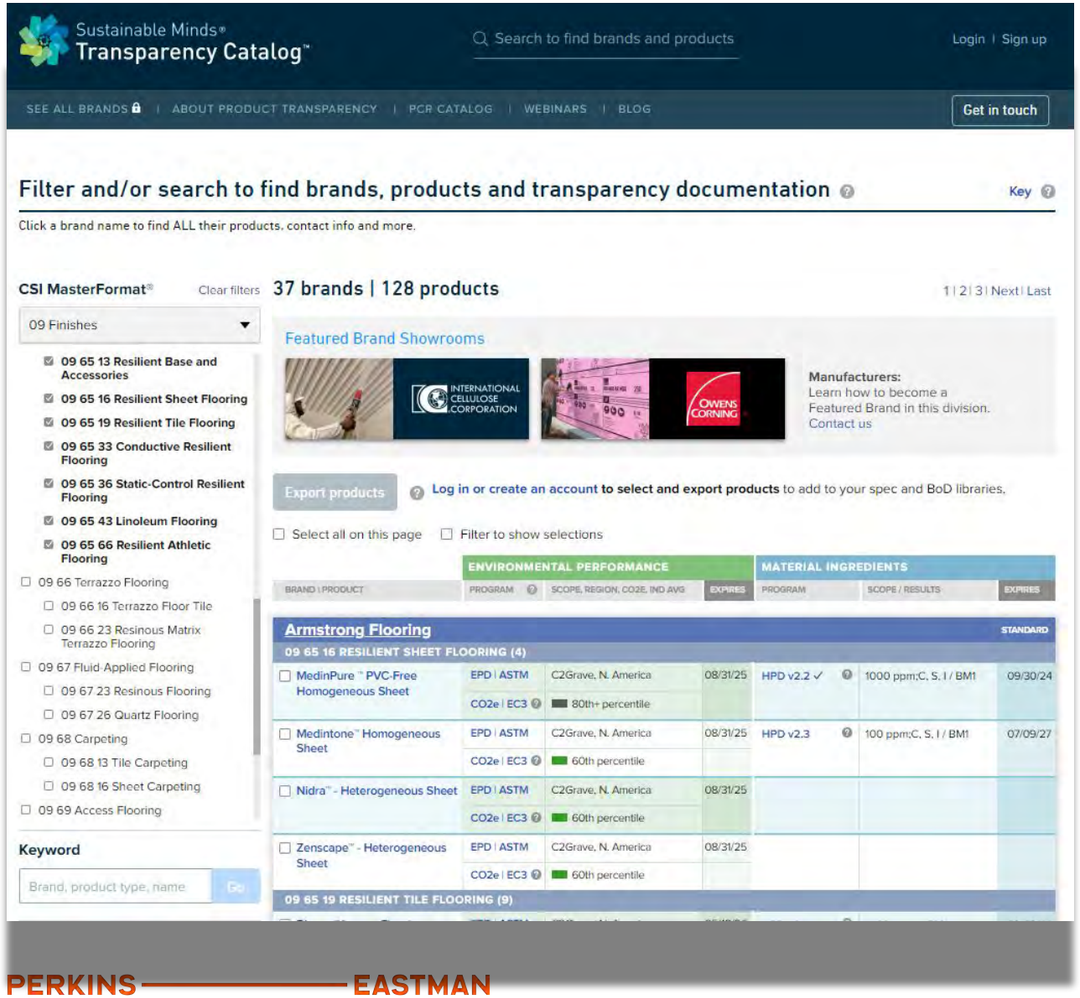
By Region



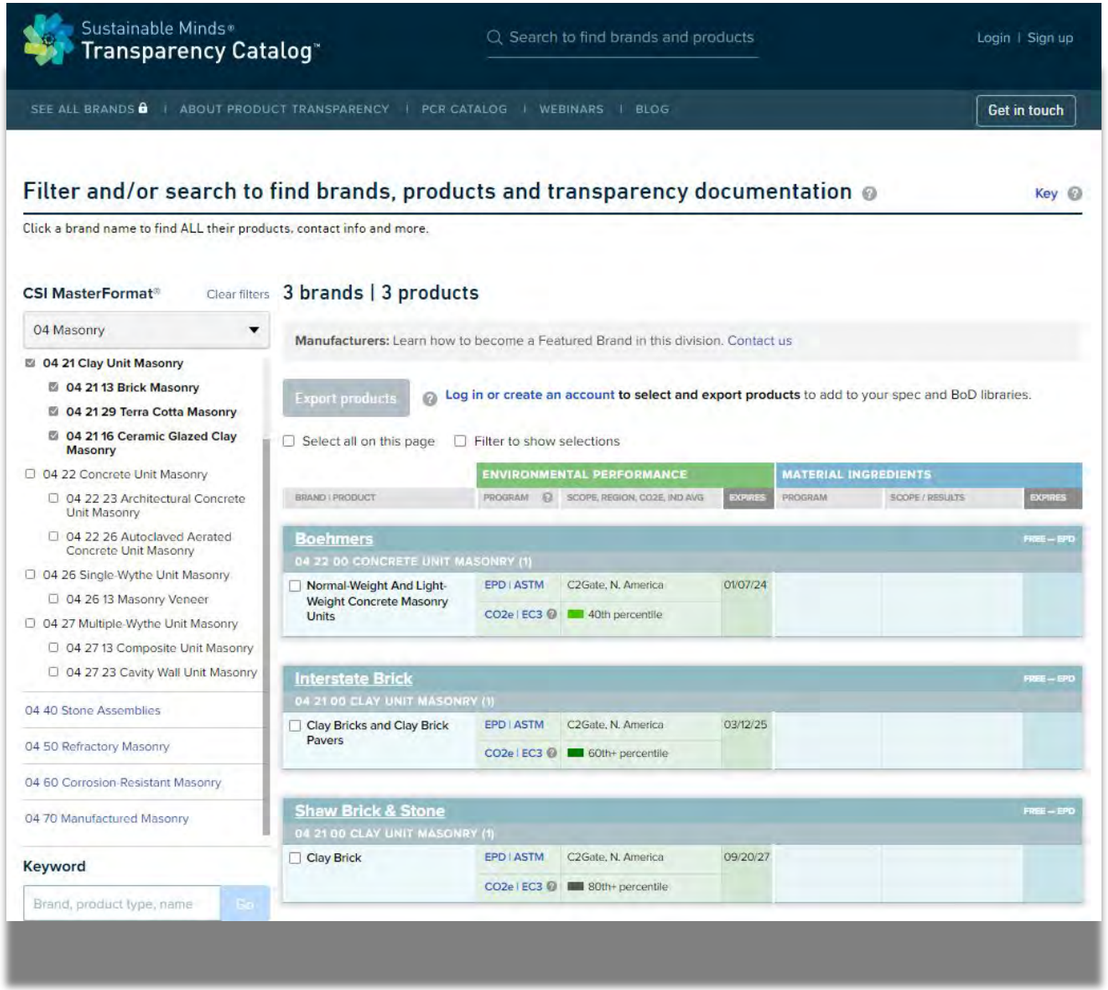
EPD Availability

By CSI

Resilient flooring: 128 EPDs



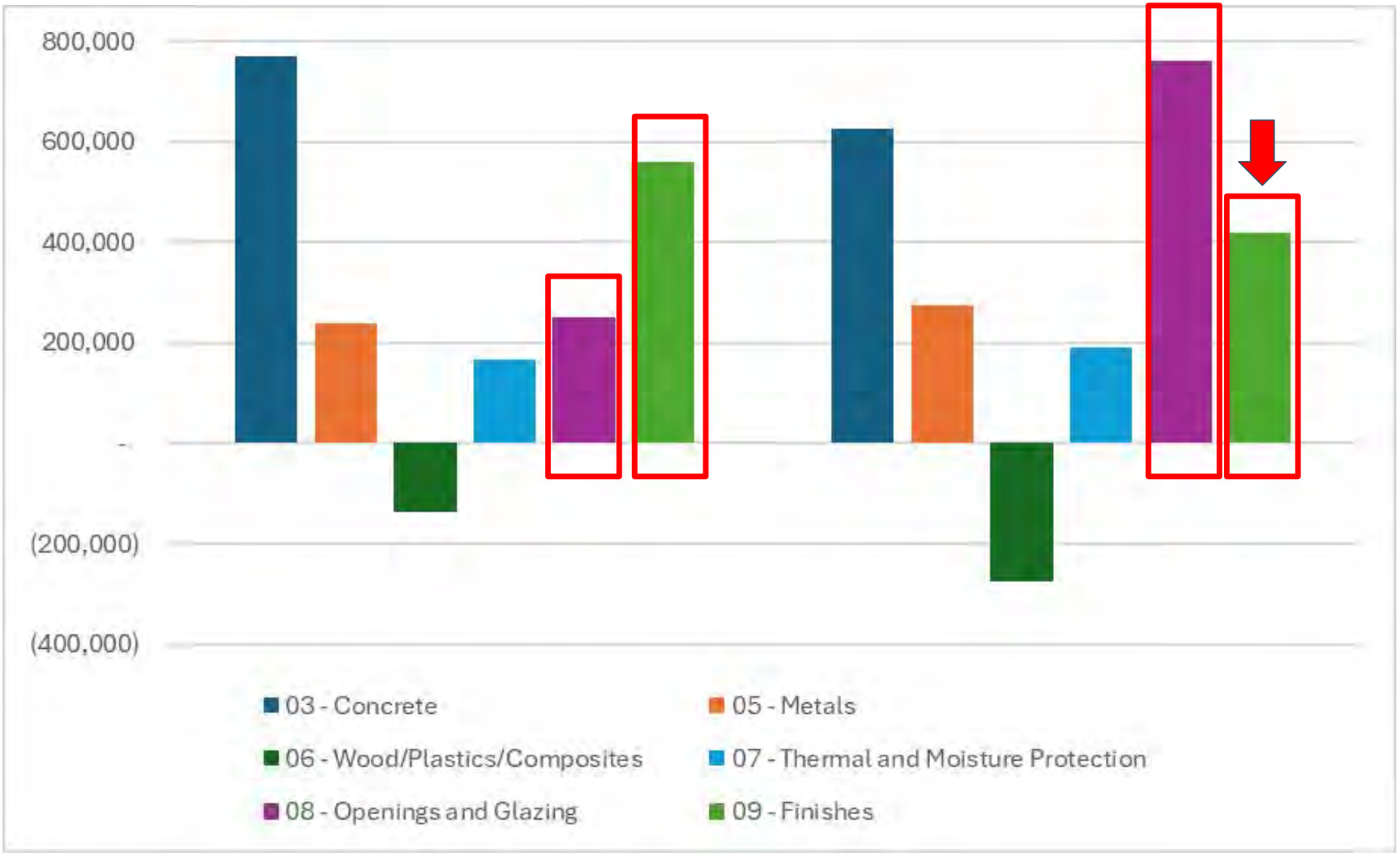
Face Brick: 3 EPDs



Tally Versus EPD Data

Tally Default:
216 kgCO2e/M2
(S,F,E,I)

Product-Specific EPDs:
234 kgCO2e/M2
(S,F,E,I)



UMass Amherst CSL

Unpacking Technology's Impact on Whole-life Carbon Reduction

Baseline: Mass Timber vs. Steel: Baselines

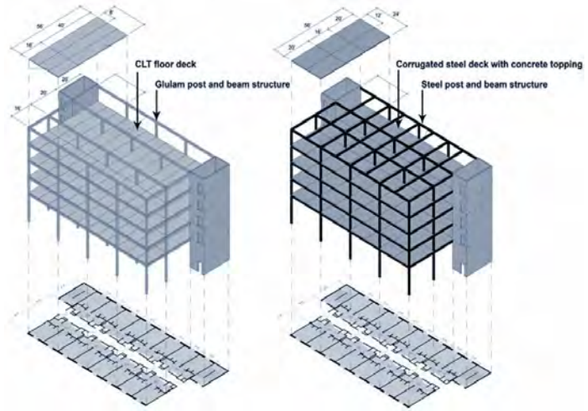
CLF Benchmarks

Time: Negligible
Accepted by LEED / CalGreen? No

Median EC: 390 kg/M2

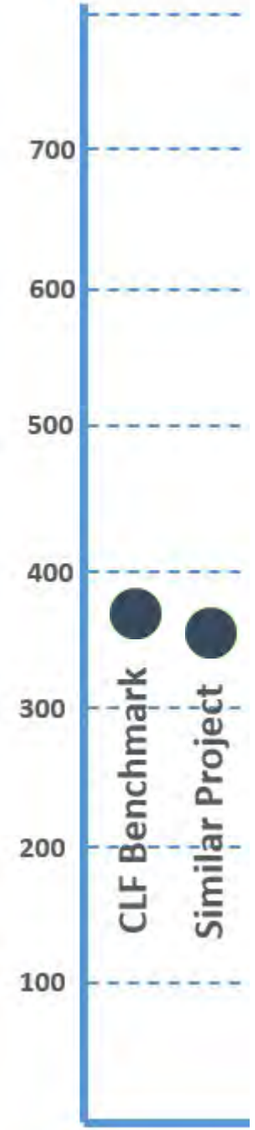
Compare to similar project

Time: Low (assuming having reference)
Accepted by LEED? Maybe??
Accepted by CalGreen? No
Predicted EC for Baseline: 378 kg/M2



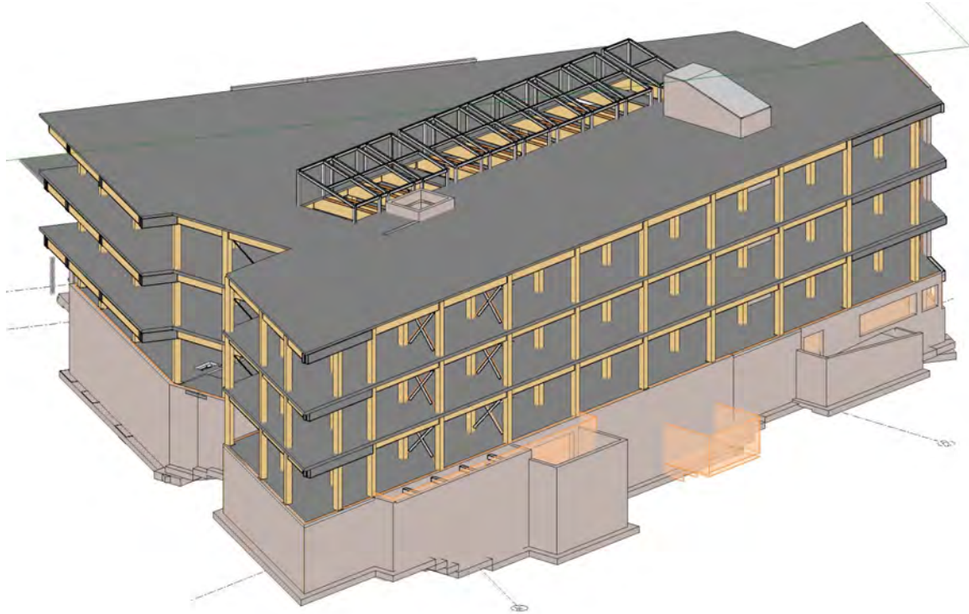
Create Reference Building

?



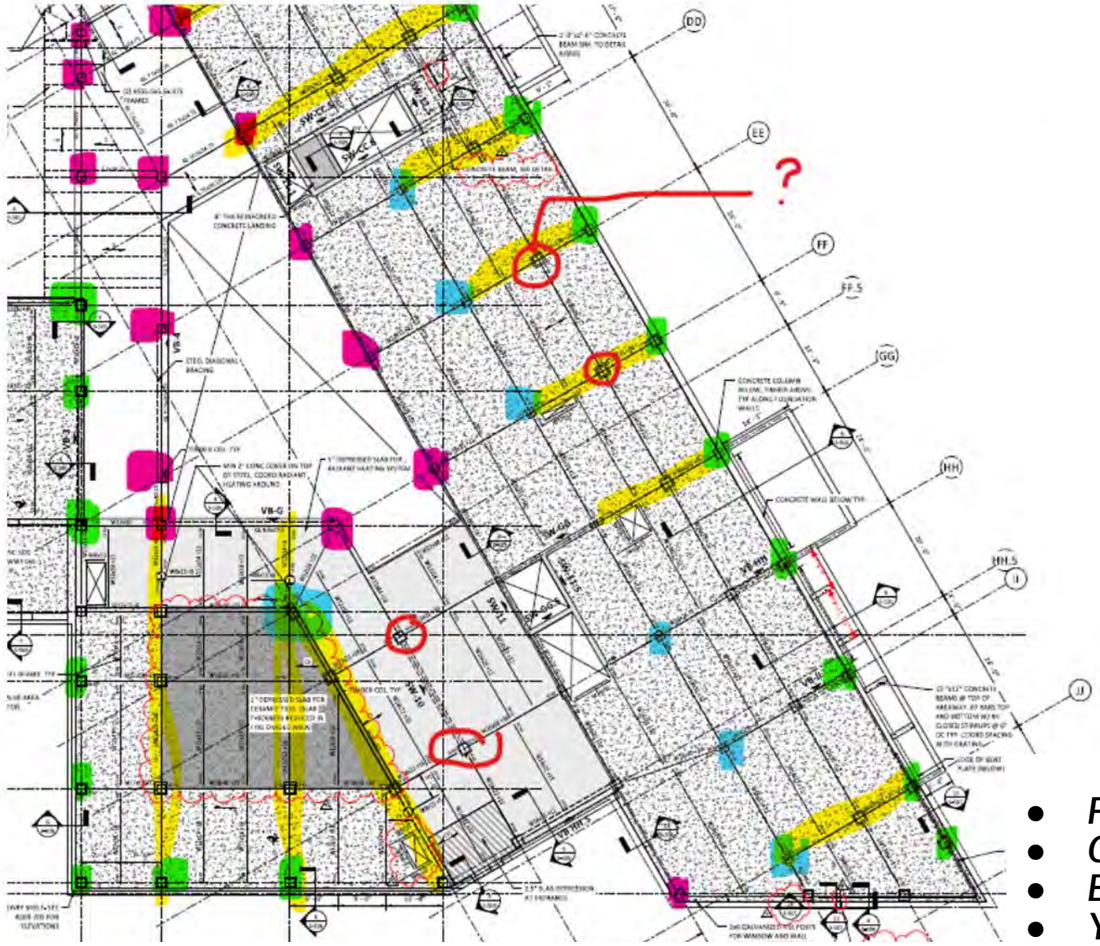
Apples to Apples?

- interiors ✓
- envelope ✓
- foundations ✓
- structure ✓
- mech ✗

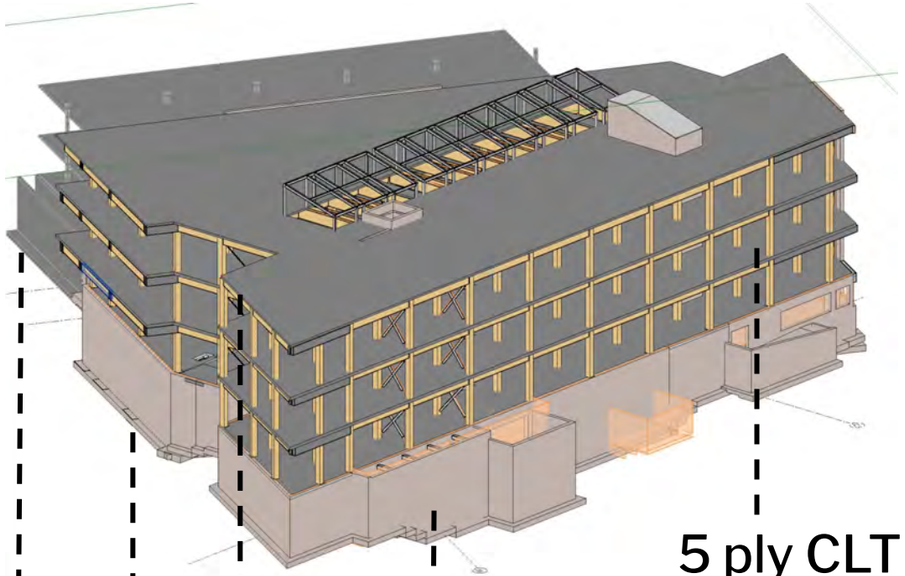


A steel structure isn't a mass timber structure. Sections, detailing, loading criterias, bay's, structural elements... is not a 1 to 1 replacement.

What if…..



- *Pink - Wood Columns*
- *Green - Concrete*
- *Blue - Steel*
- *Yellow - Steel Transfer beams*



Glulam columns and beams

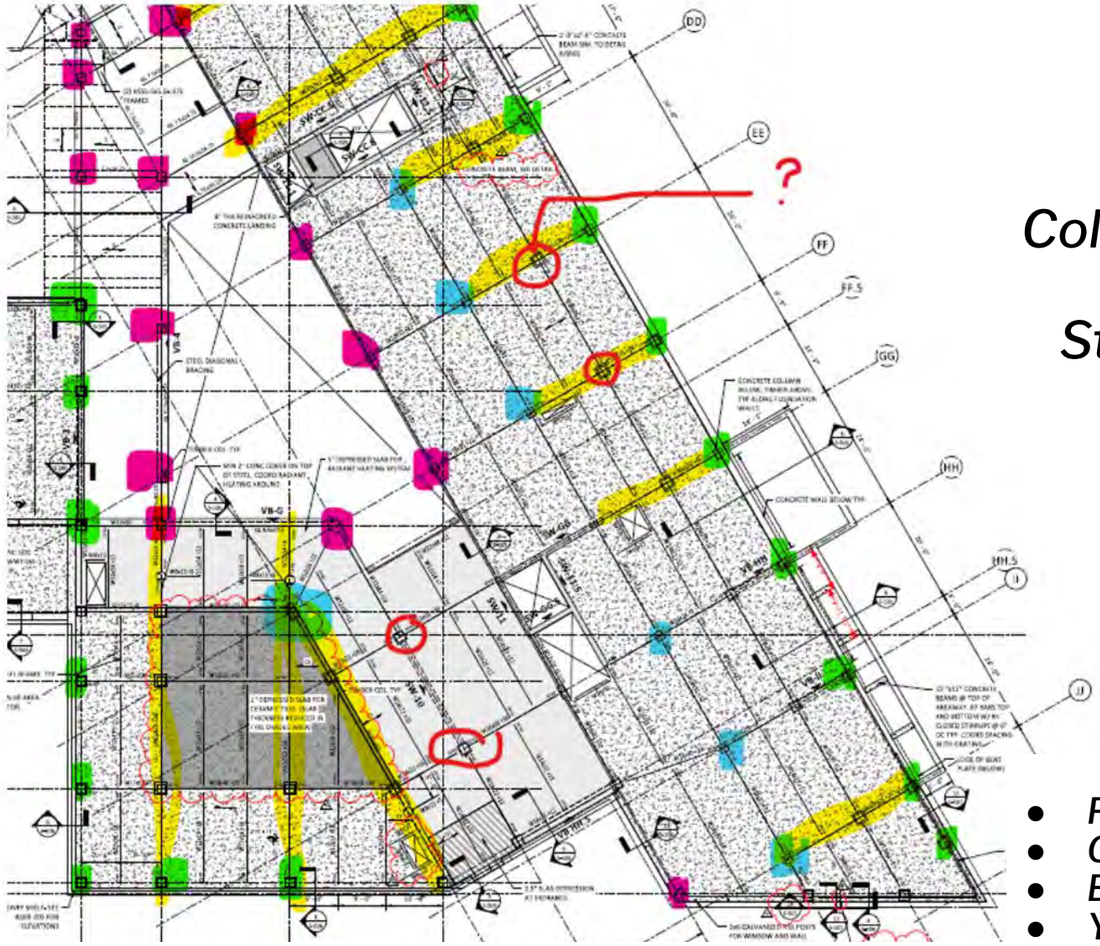
Steel beams and columns

CLT walls

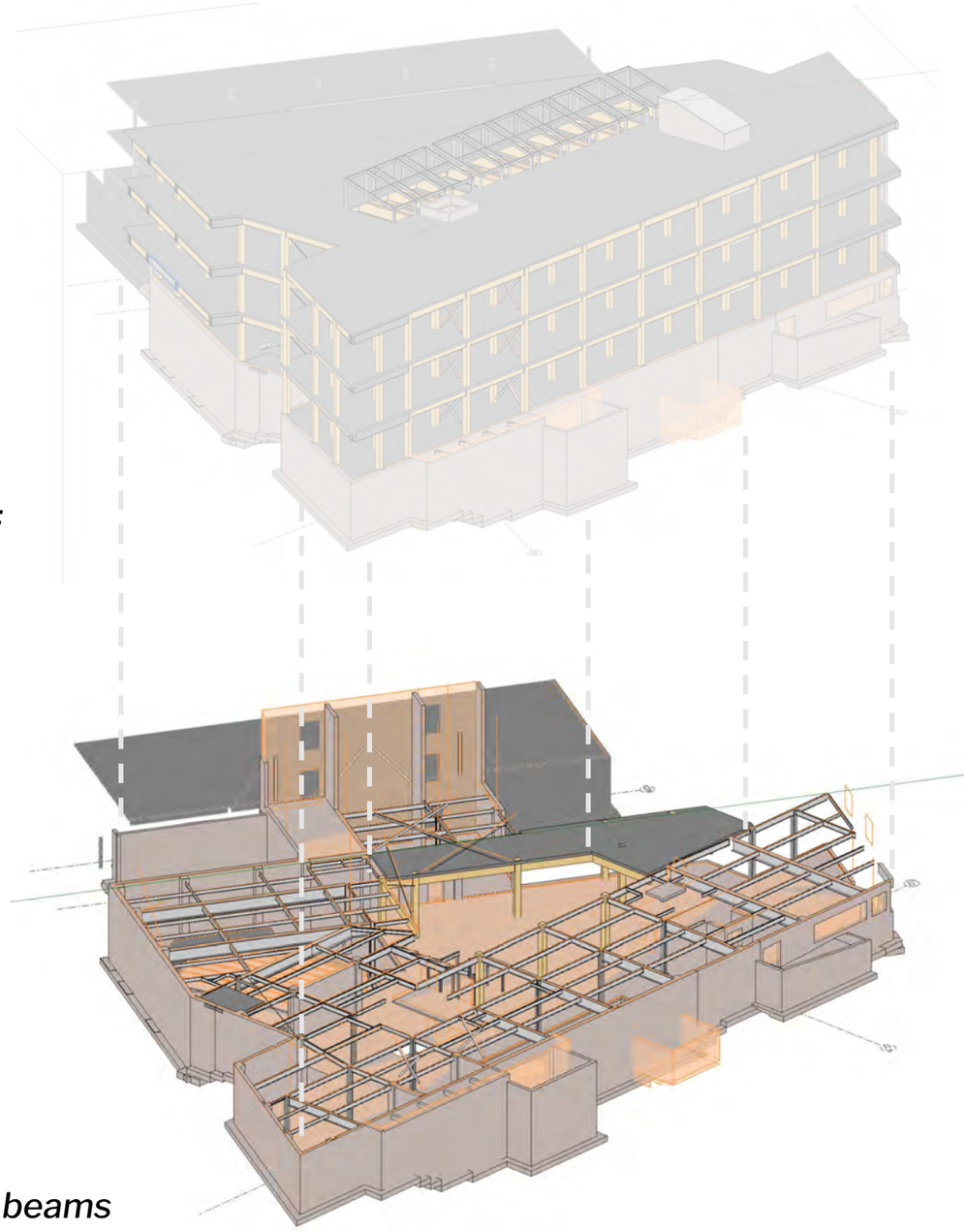
30% slag concrete foundations slab, footings and walls 1st floor

5 ply CLT floor with 2” concrete topping and insulation

What if…..

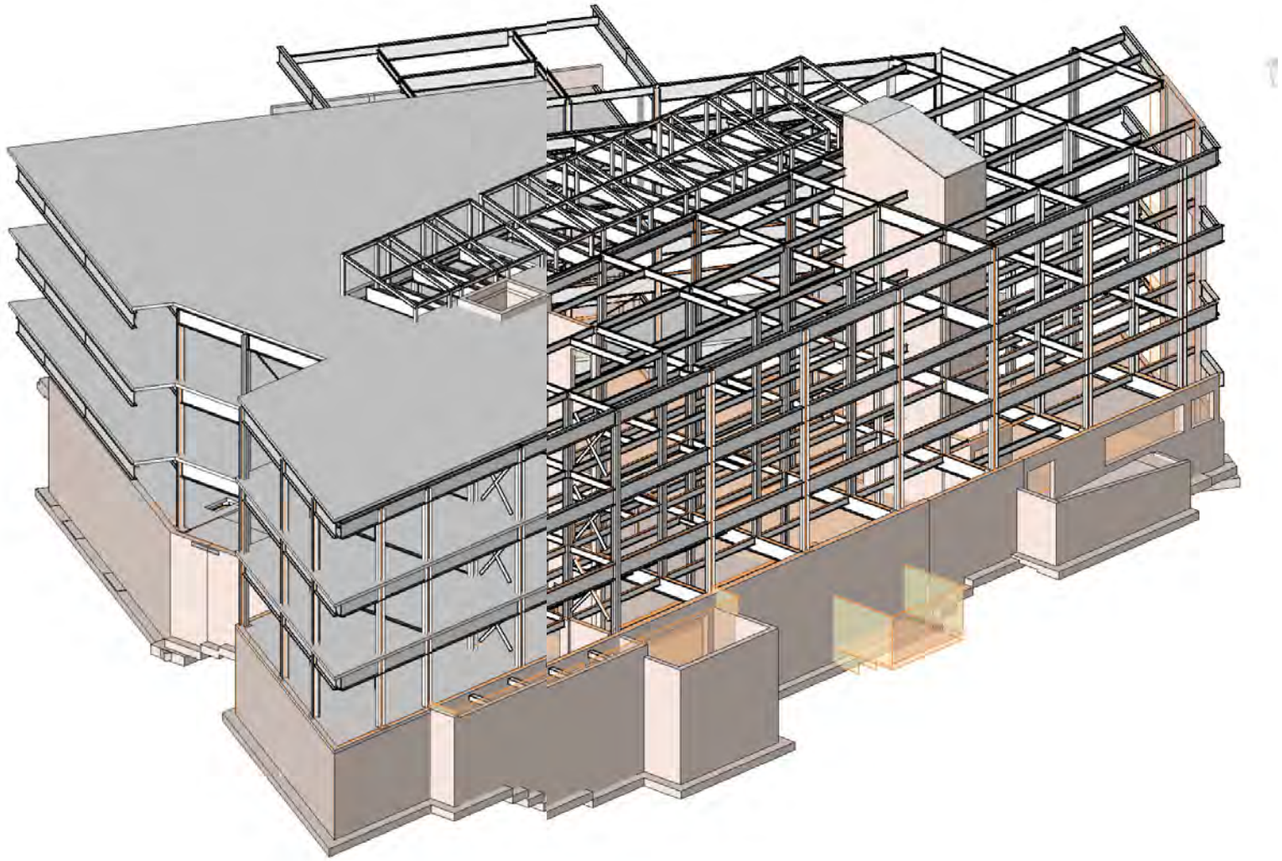


How will the Beams and Columns change if this was a Steel-Concrete Composite?



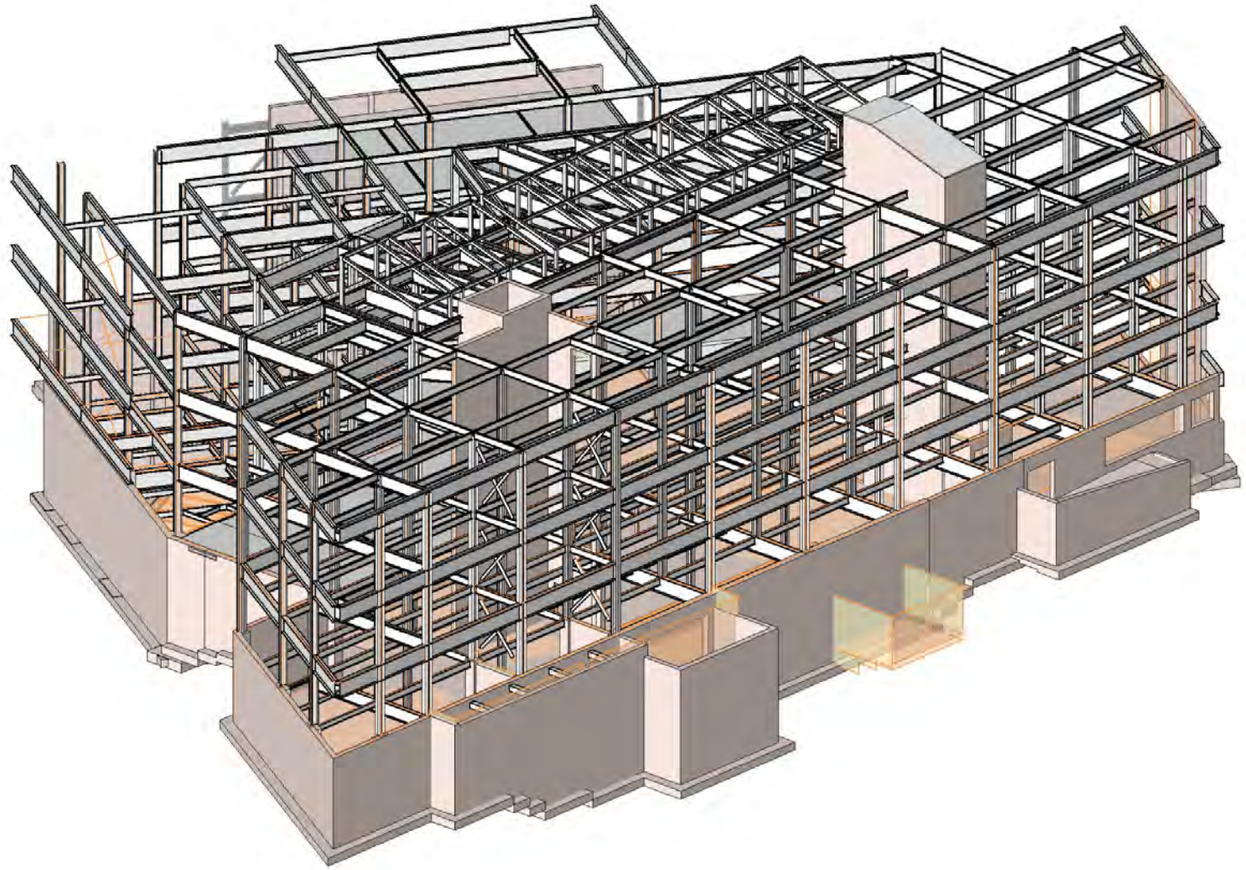
- *Pink - Wood Columns*
- *Green - Concrete*
- *Blue - Steel*
- *Yellow - Steel Transfer beams*

A hybrid structure = A resource for a baseline



Main loading elements would need to be replaced for smaller beams and columns.

A steel baseline



Foundations and concrete work was kept the same, but beams, columns and floors were changed to steel

Baseline: Mass Timber vs. Steel: Baselines

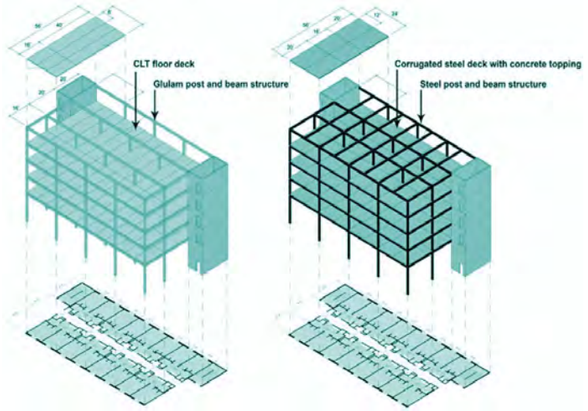
CLF Benchmarks

Time: Negligible
Accepted by LEED / CalGreen? No

Median EC: 390 kg/M2

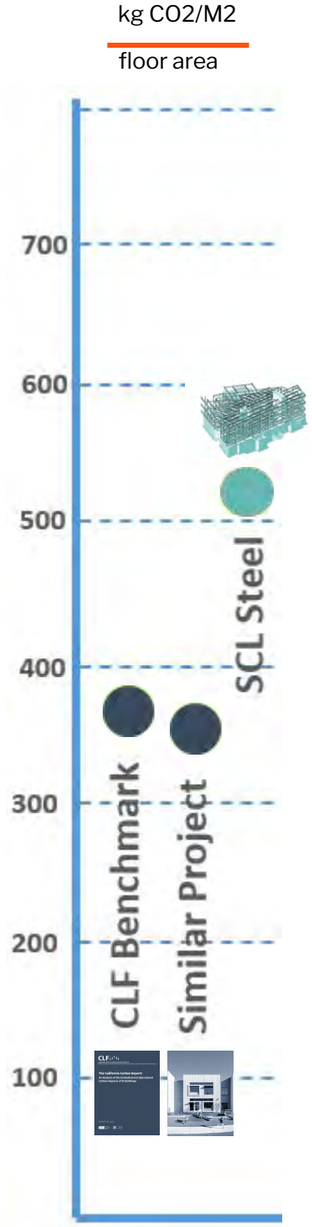
Compare to similar project

Time: Low (assuming having reference)
Accepted by LEED? Maybe??
Accepted by CalGreen? No
Predicted EC for Baseline: 378 kg/M2



Create Reference Building

539 kg/M2



What about Mass Timber?

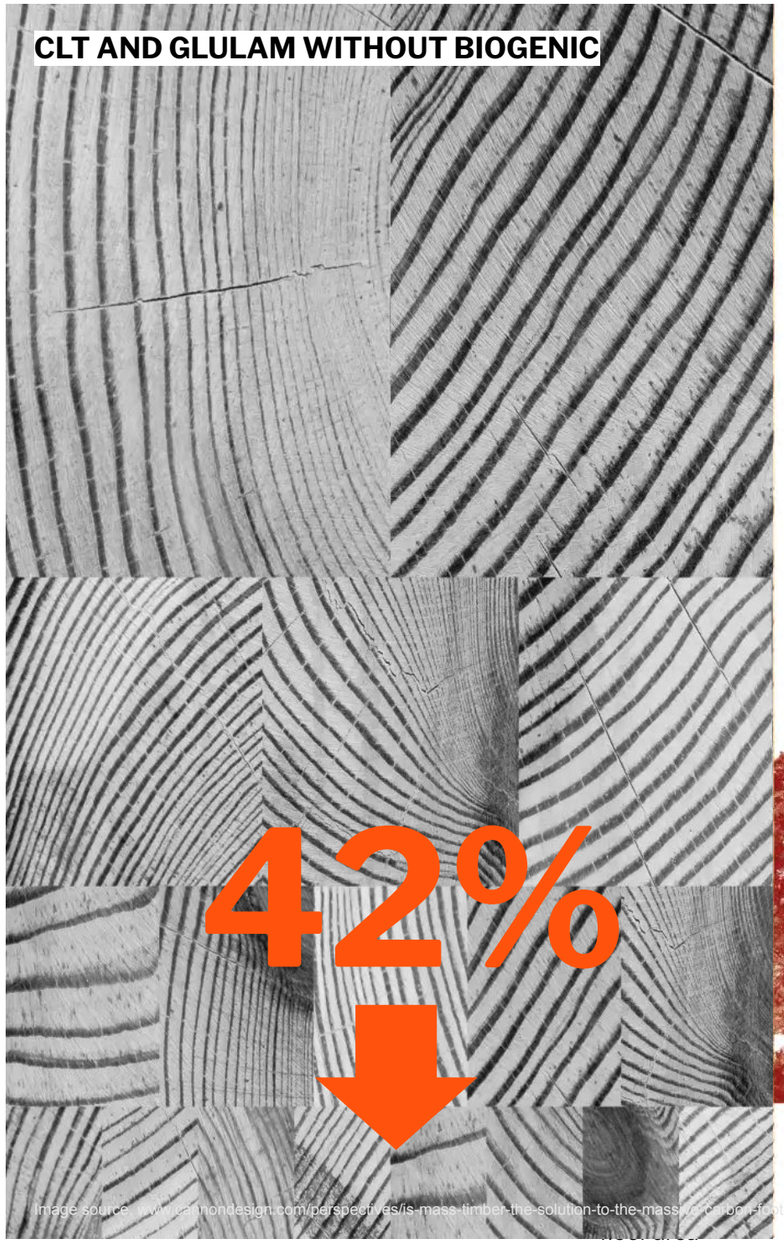
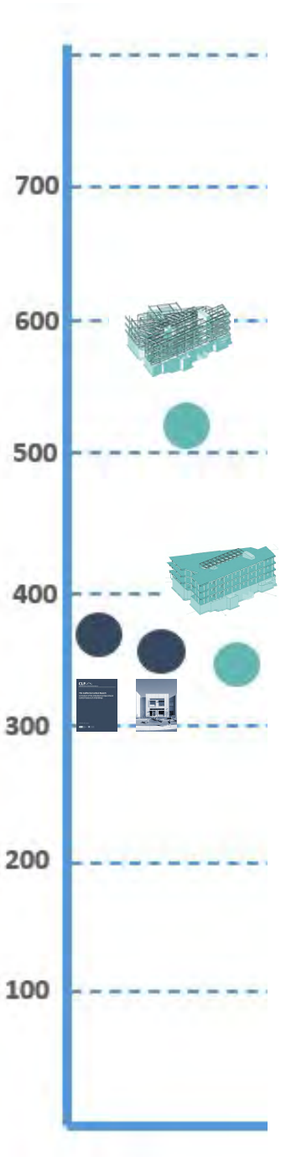


Image source: www.commondesign.com/perspectives/is-mass-timber-the-solution-to-the-massive-carbon-footprint-of-buildings



Wood including biogenic

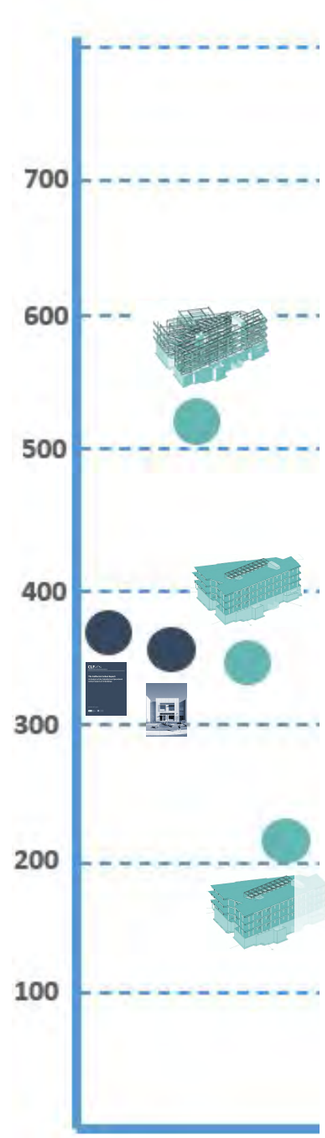


image source: https://timmondesign.com/perspectives/is-mass-timber-the-solution-to-the-massive-carbon-footprint-of-buildings

Which are the main contributors?

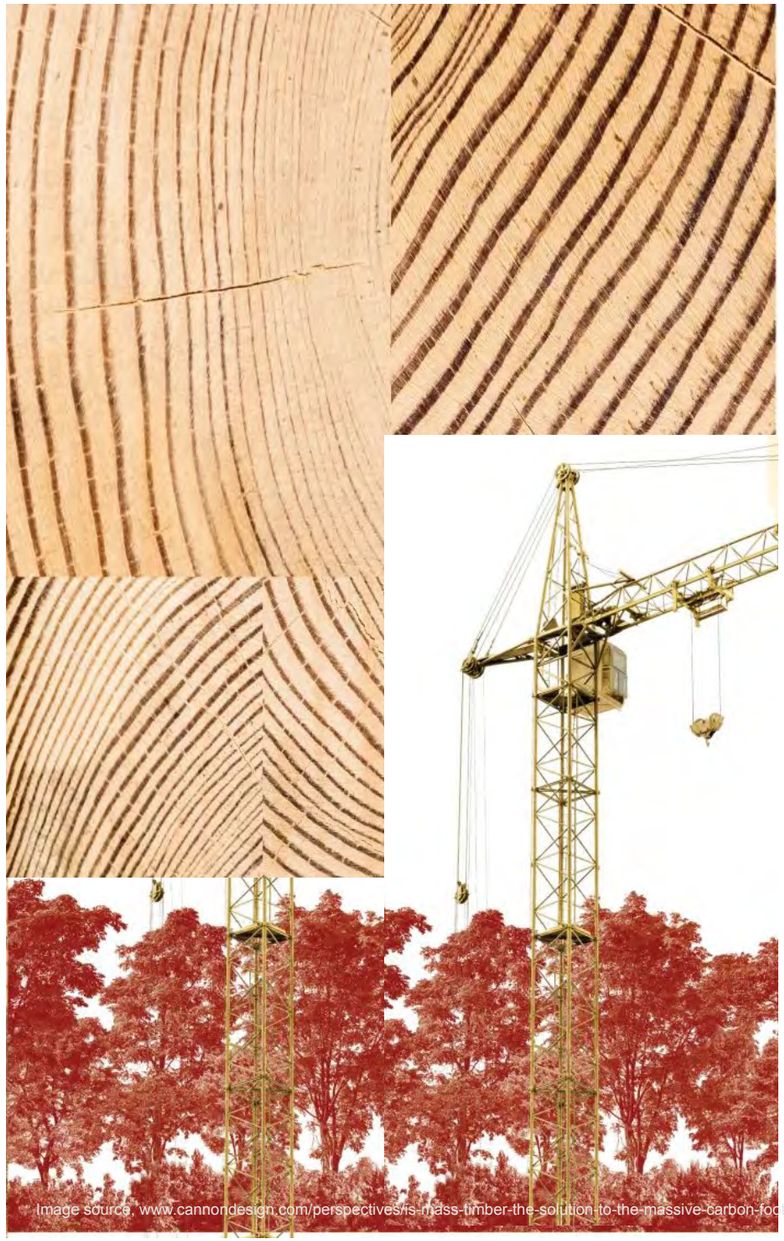
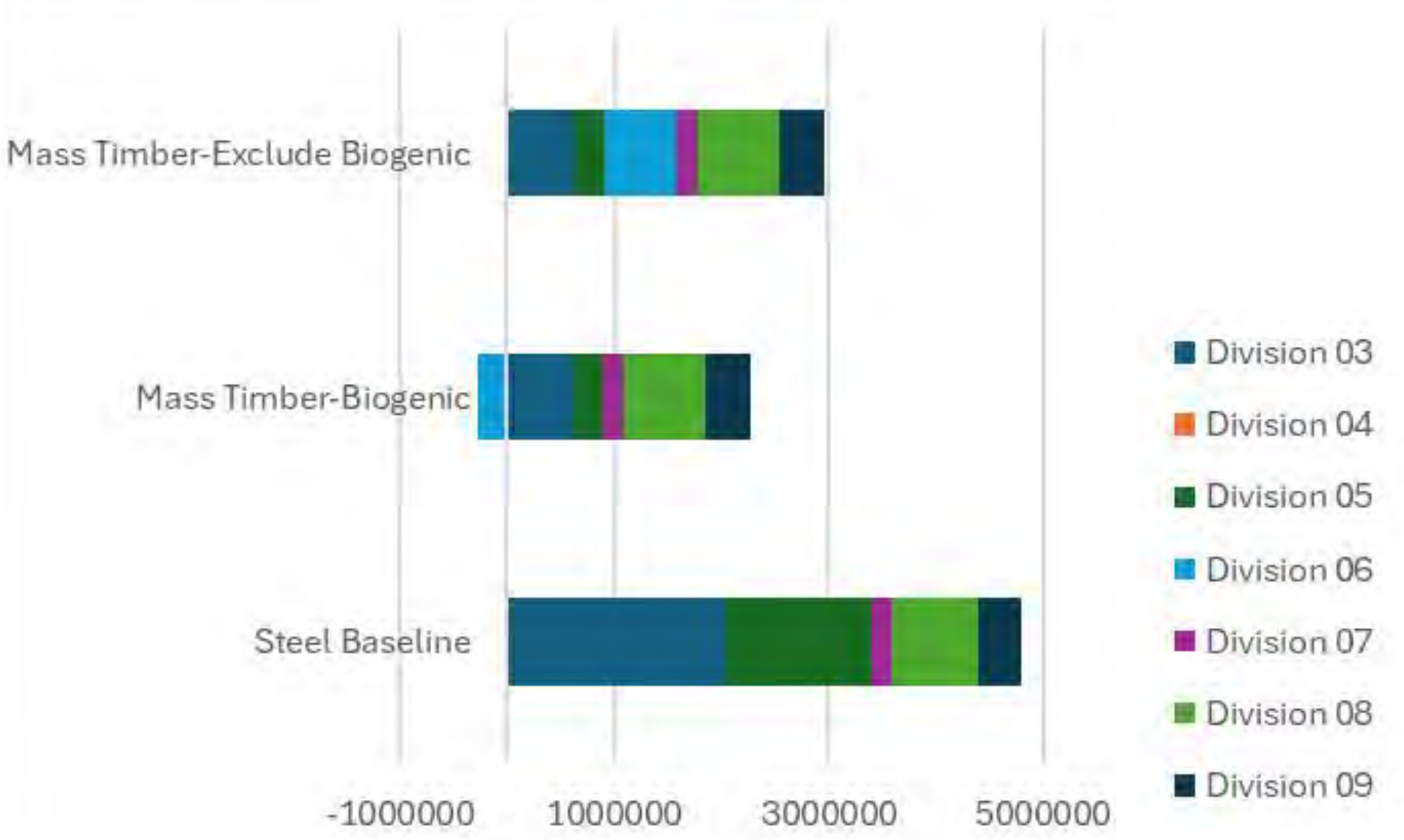
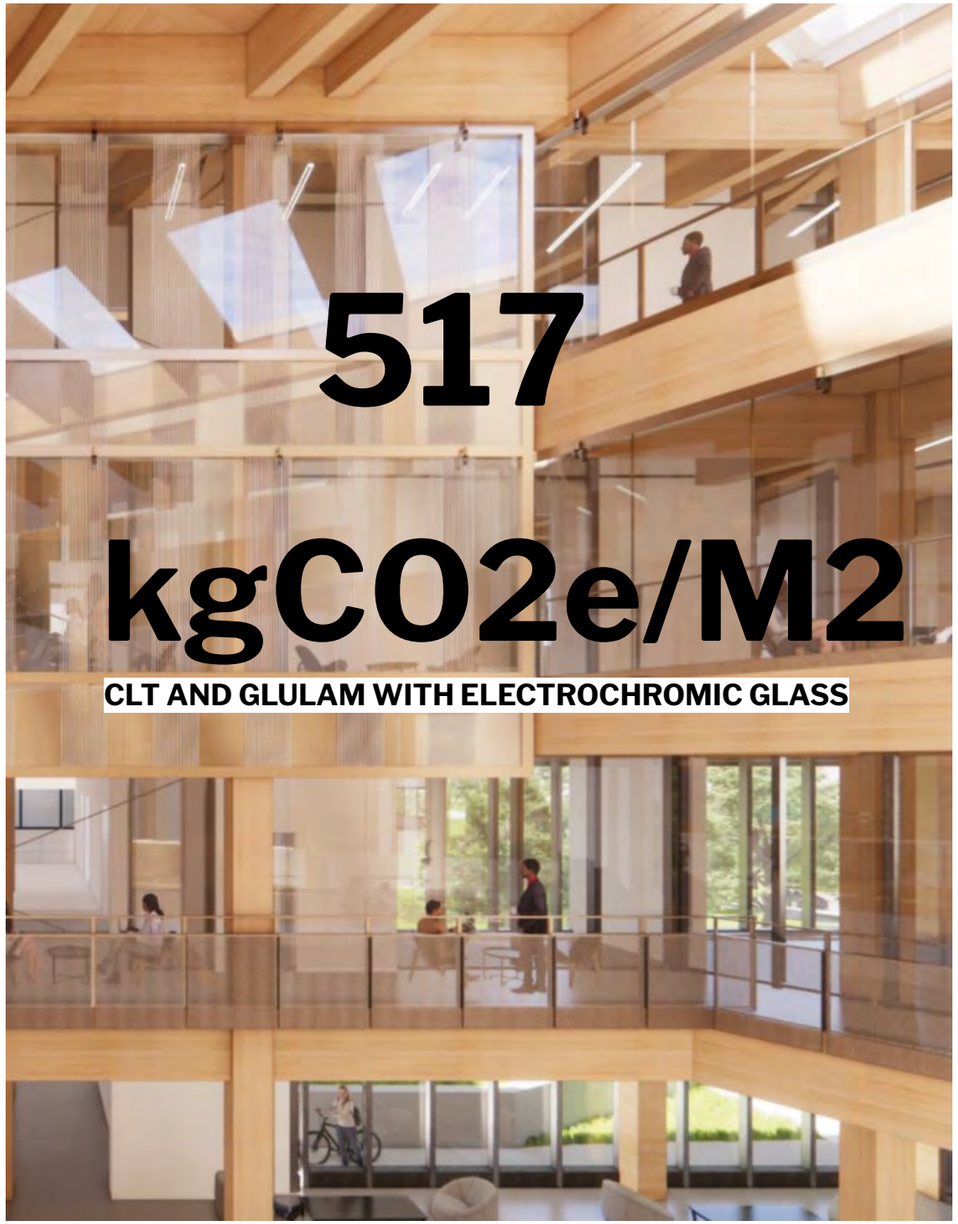


Image source: www.cannondesign.com/perspectives/is-mass-timber-the-solution-to-the-massive-carbon-footprint-of-buildings



...and ECG, what role does it play?



517

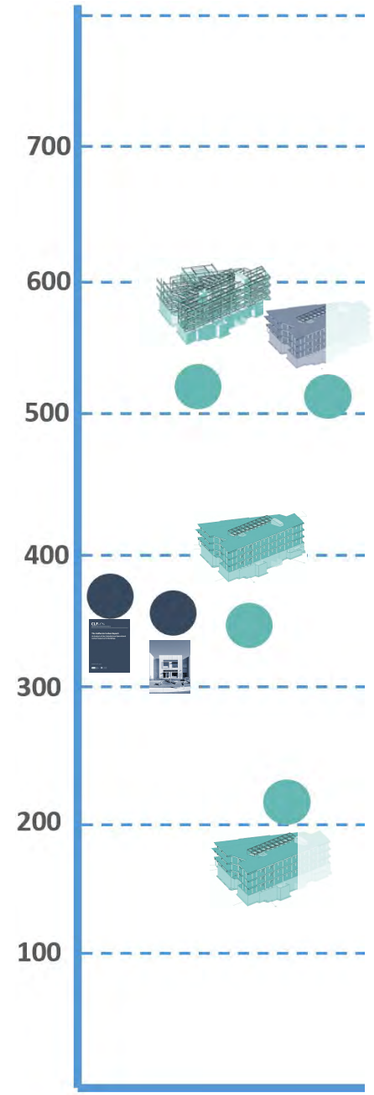
kgCO2e/M2

CLT AND GLULAM WITH ELECTROCHROMIC GLASS

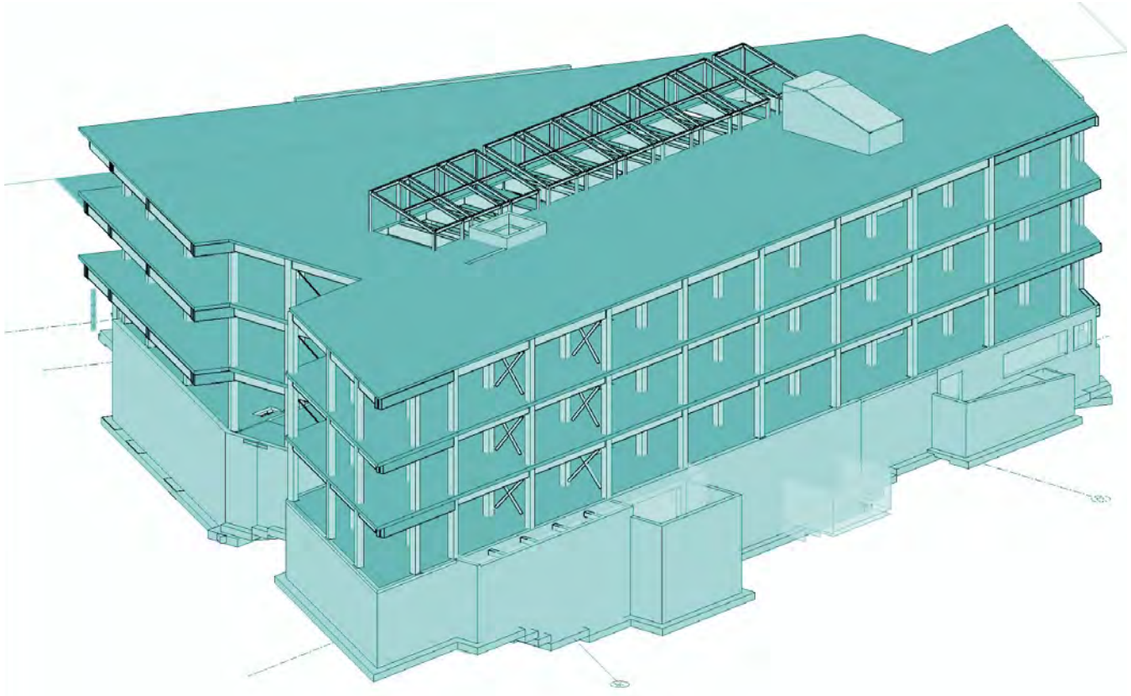
216

kgCO2e/M2

CLT AND GLULAM WITH TRIPLE PANE GLASS



...magnitude?



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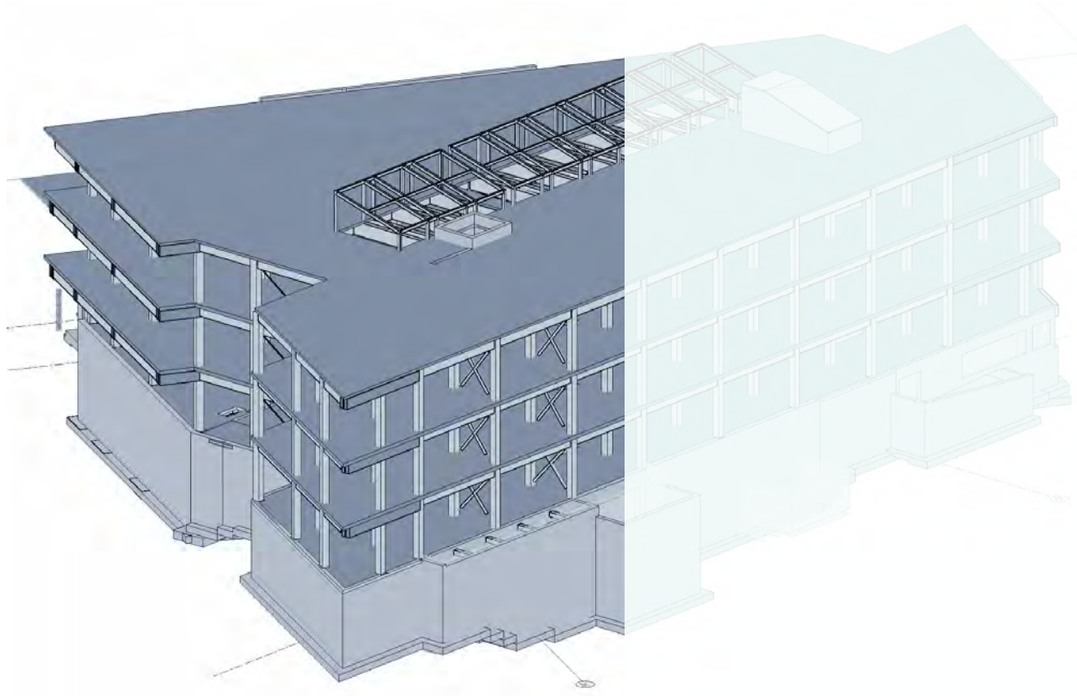


100%
kg CO2e/M2

50%
kg CO2e/M2

Product specific EPD

249

kgCO2e/M2

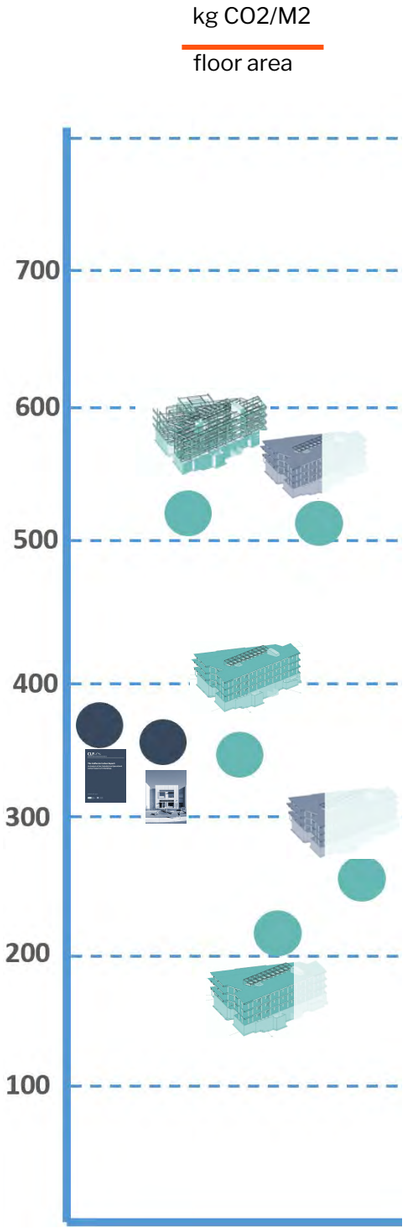
CLT AND GLULAM WITH ELECTROCHROMIC GLASS, WITH TALLY EPD

>

216

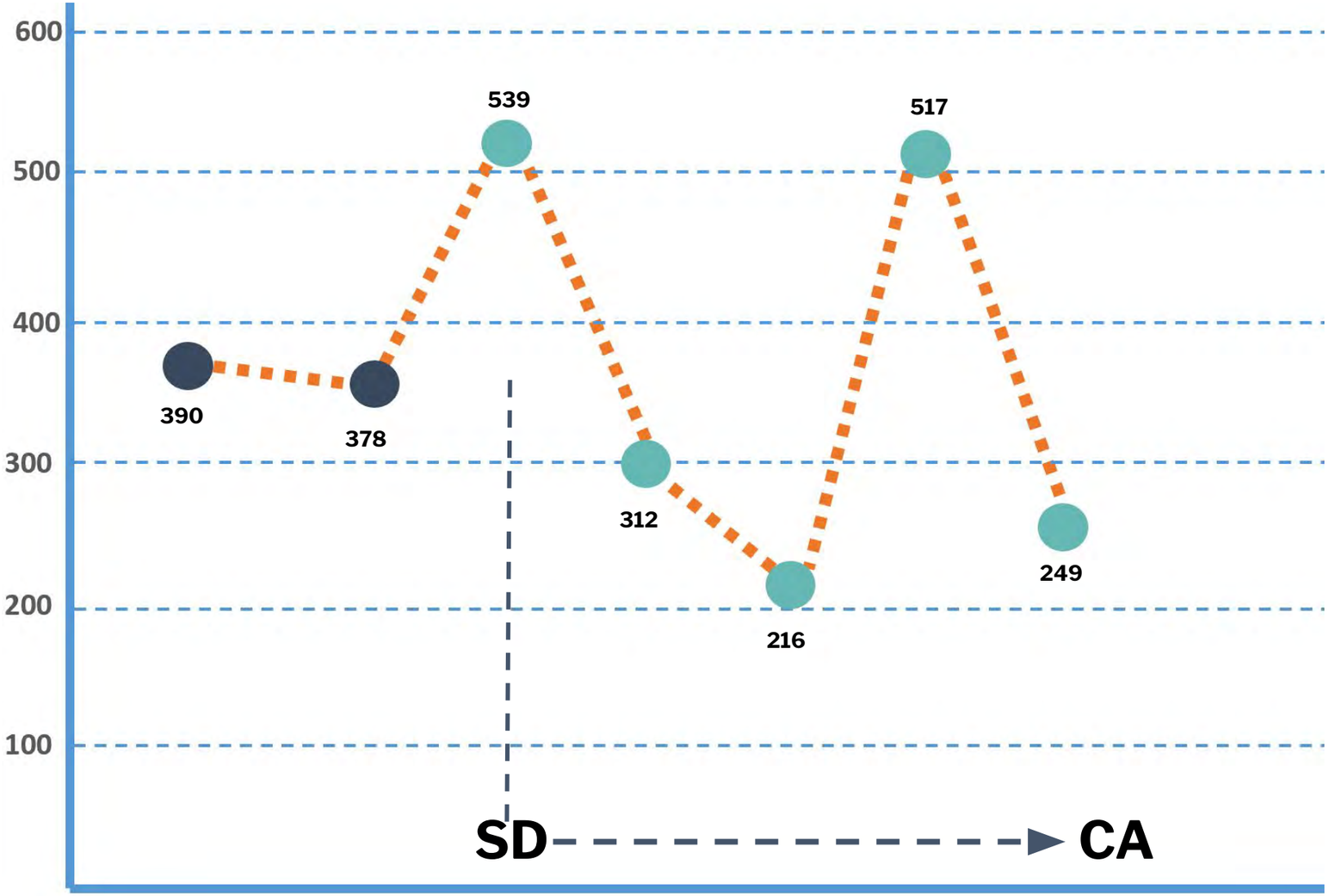
kgCO2e/M2

CLT AND GLULAM WITH ELECTROCHROMIC GLASS, WITH PRODUCT SPECIFIC EPD



Friend or Foe?

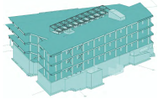
Final results recap



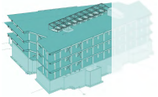
CLF baseline

Similar model

Steel Baseline



Mass TImber

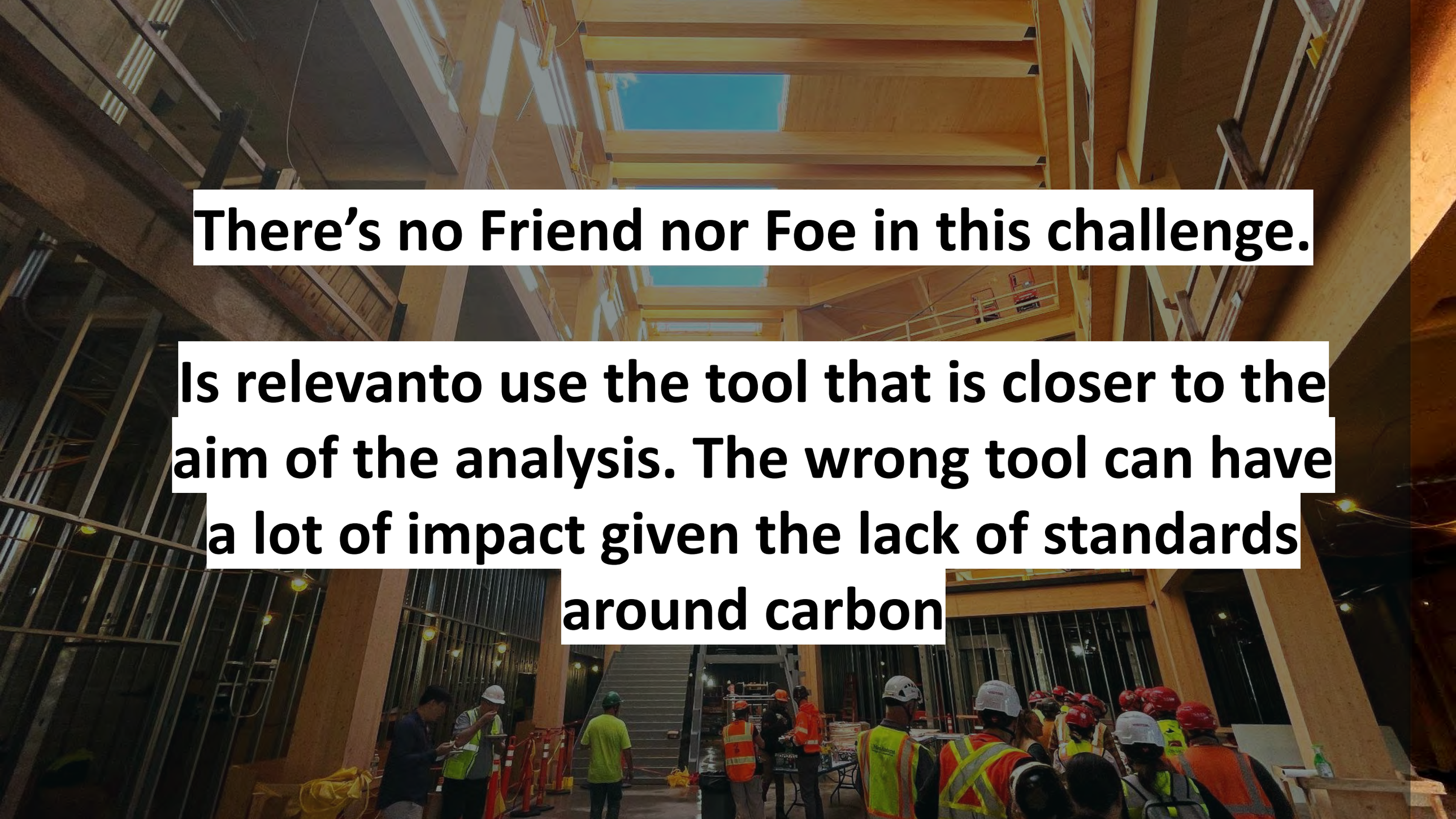


Mass Timber Biogenic

ECG

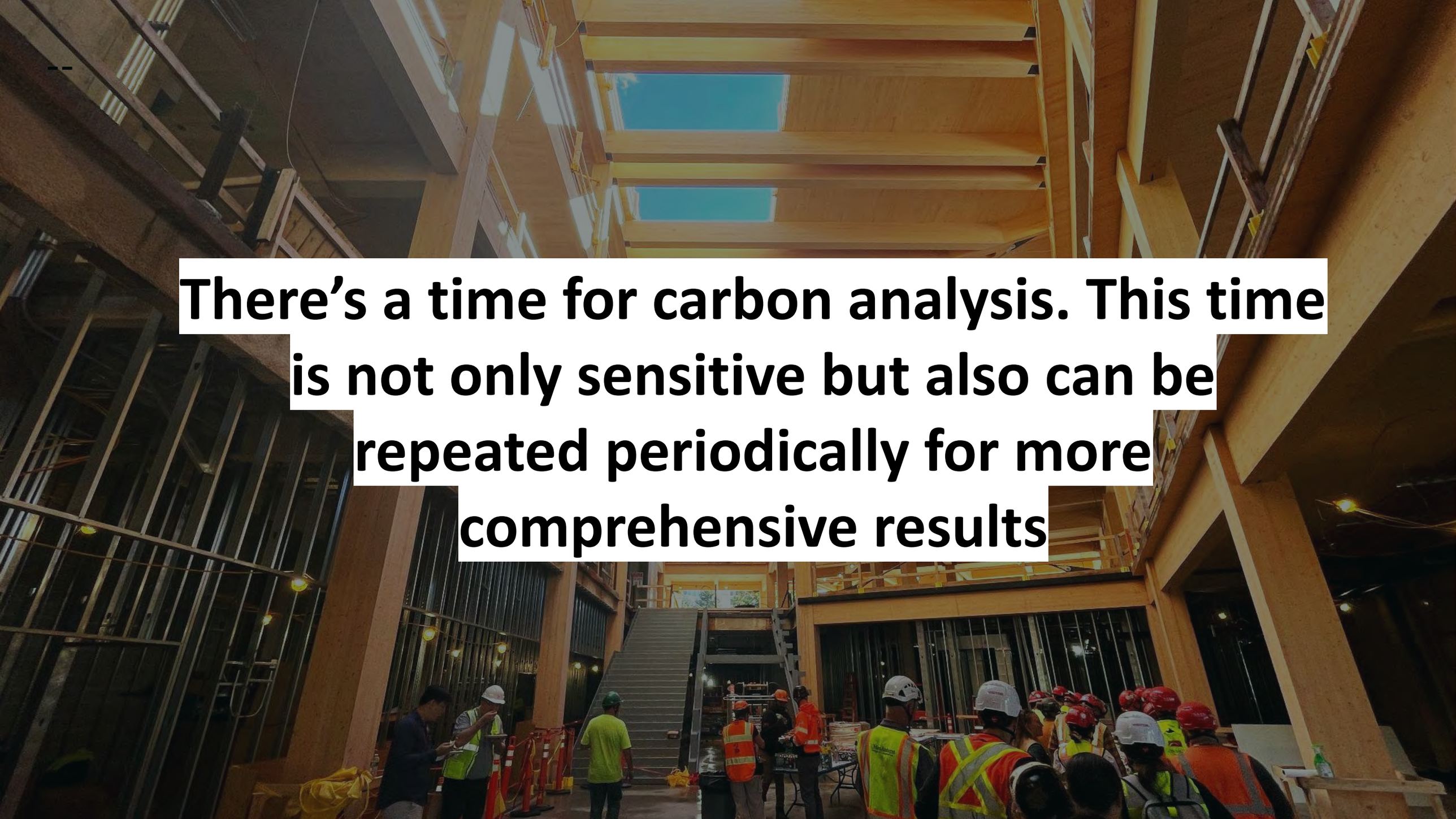
ECG Specific EPD

Whole Life Carbon Emissions

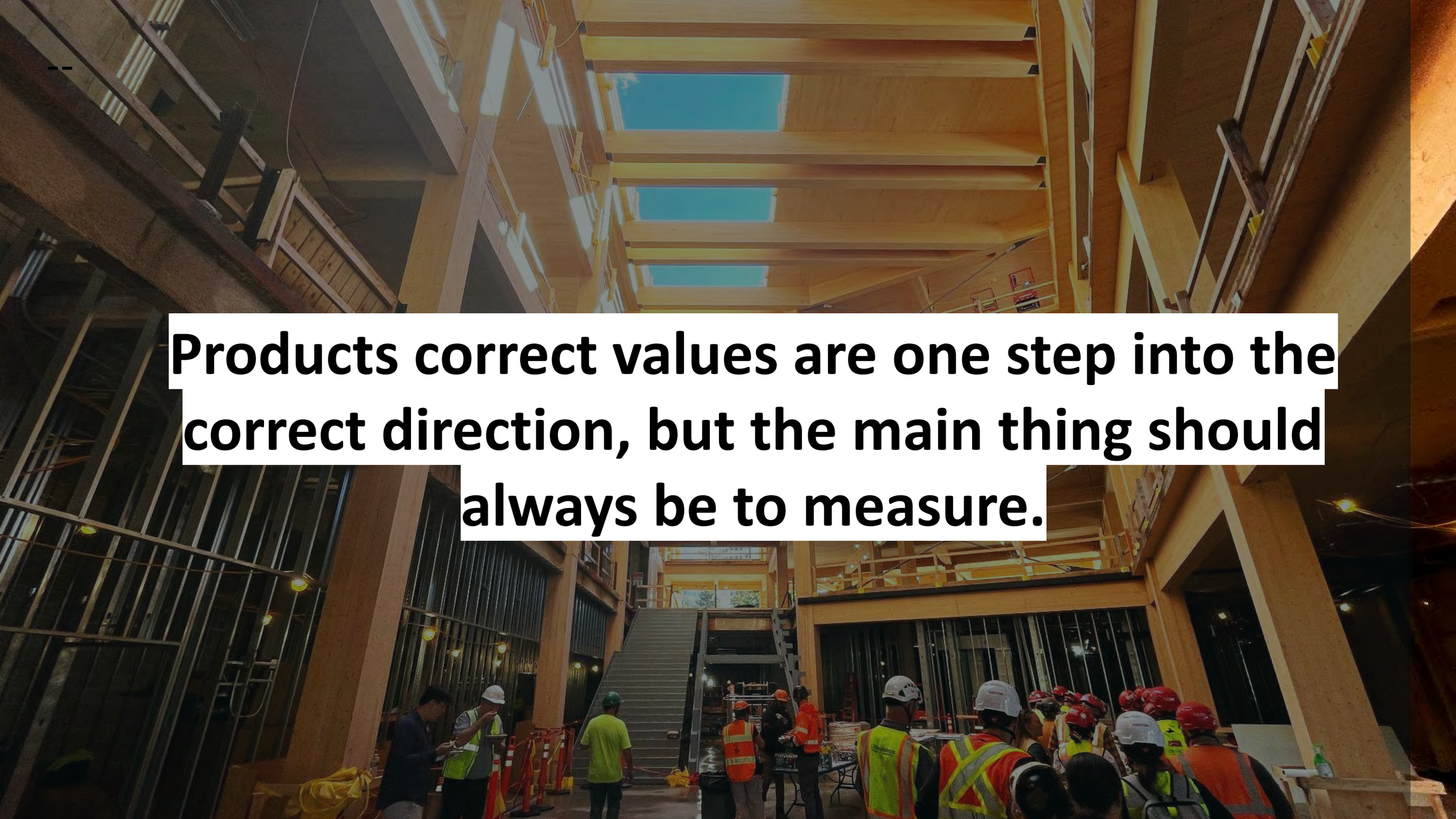


There’s no Friend nor Foe in this challenge.

Is relevanto use the tool that is closer to the aim of the analysis. The wrong tool can have a lot of impact given the lack of standards around carbon



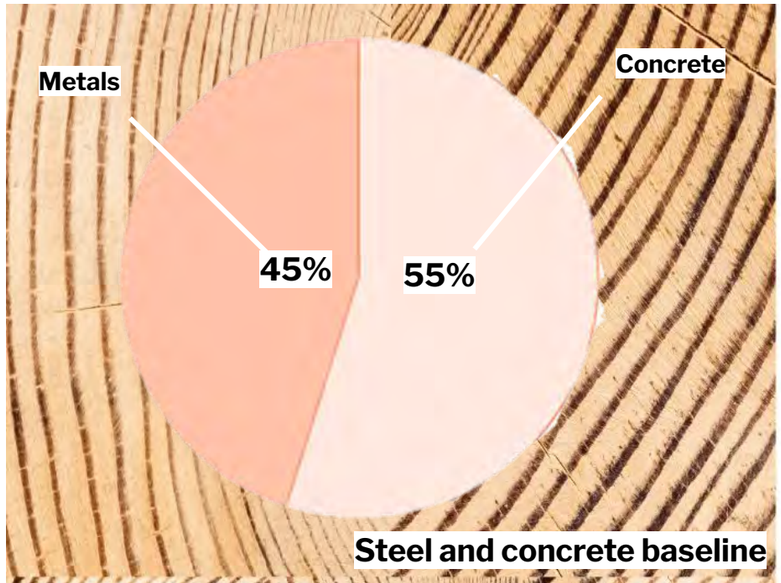
There’s a time for carbon analysis. This time is not only sensitive but also can be repeated periodically for more comprehensive results

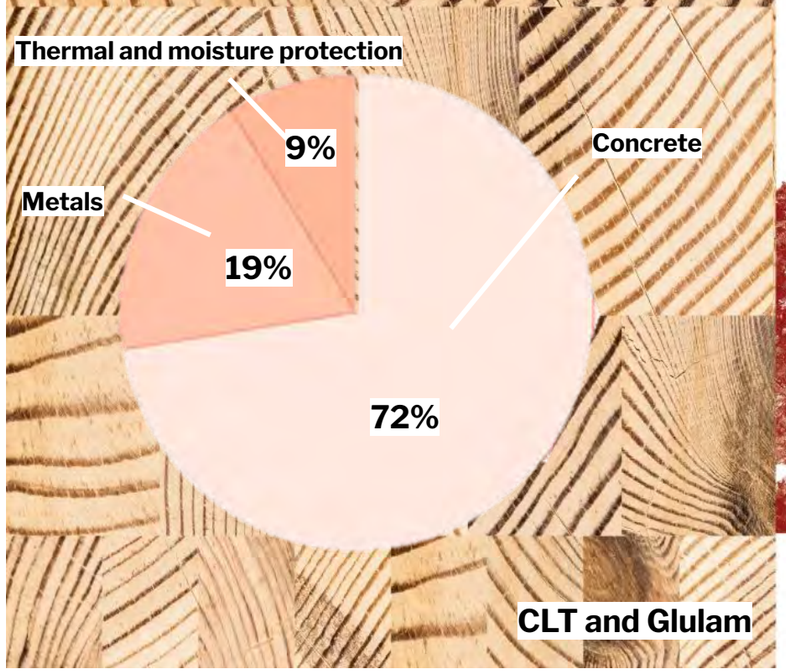

Products correct values are one step into the correct direction, but the main thing should always be to measure.


Thank you

Which are the main contributors?

christi

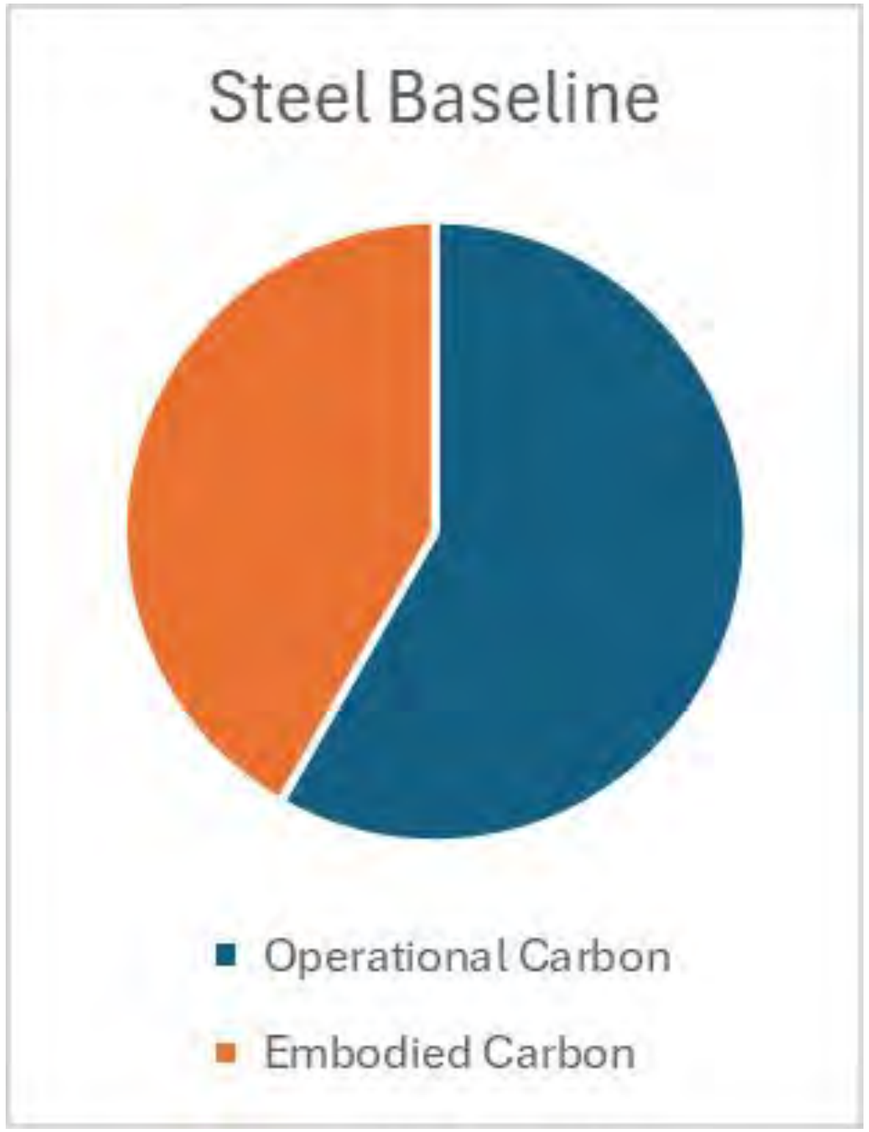


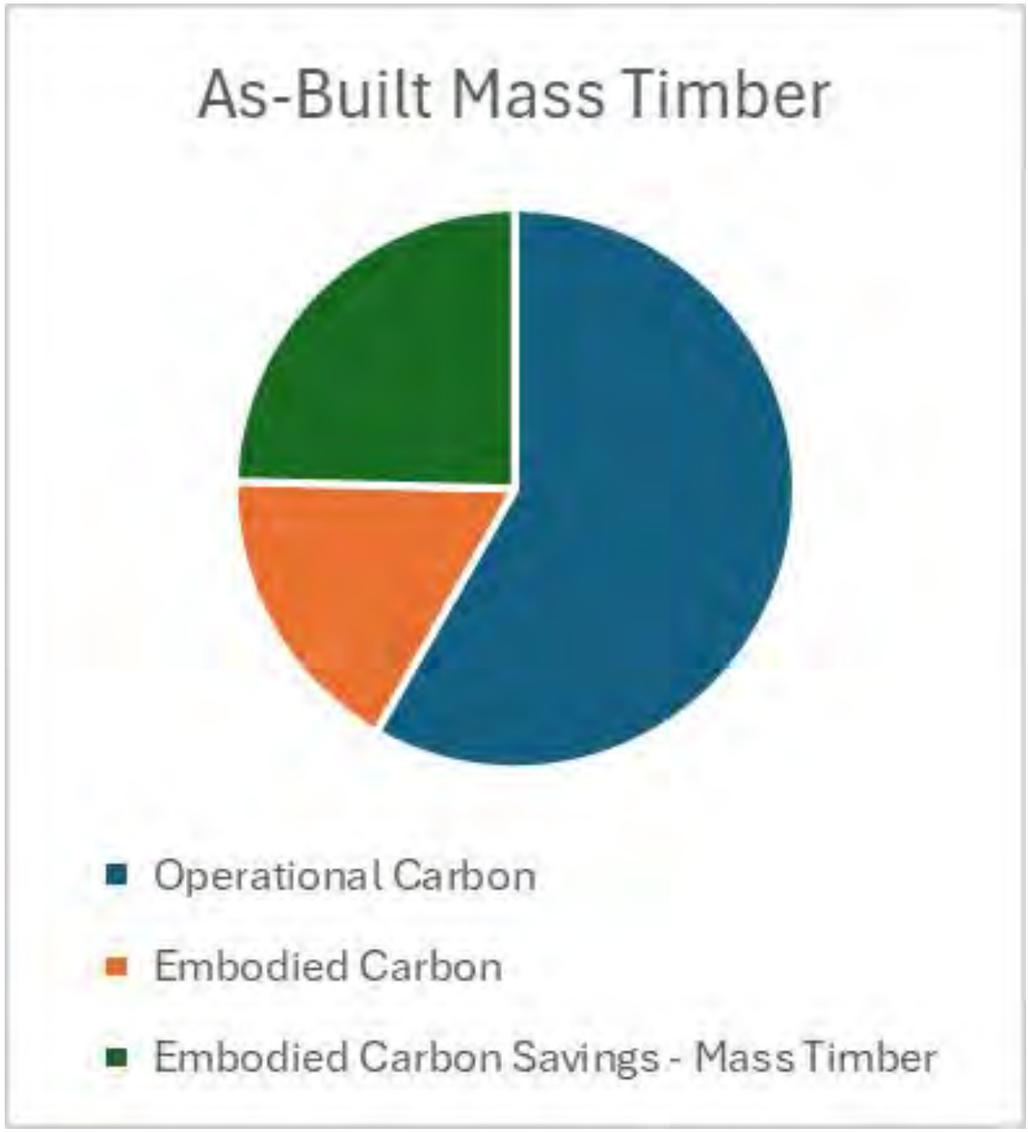


these are the original numbers - I think we should replace with the adjusted (product specific) numbers. Also, pie charts don't work well with biogenic carbon since the mass timber category is negative and everything else is positive.

Whole Life Carbon - Savings of Mass Timber

christi





NOT SURE WHERE TO PUT THIS - LET'S DISCUSS

christi