

BUILDINGENERGY NYC

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

Dan Arons (Perkins Eastman Architects)

Ryan Dirks (Perkins Eastman Architects)

Alejandra Menchaca (Airlit Studio)

Christine Vohringer (Perkins Eastman Architects)

Curated by Sara Bayer and Sanjana Nagaraj

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

An architectural rendering of a modern, multi-story building with a glass facade and a landscaped courtyard. The building features a mix of dark and light panels, with large glass windows reflecting the sky. In the foreground, there is a paved walkway, a bench, and some greenery. A few people are visible walking in the courtyard. The sky is blue with light clouds.

Technology: Friend or Foe in the Carbon Challenge?

NESEA NYC 2024

**PERKINS —
EASTMAN**

Human by Design

Your Guides



Dan Arons
Principal
Perkins Eastman



Alejandra Menchaca
Principal
AIRLIT studio



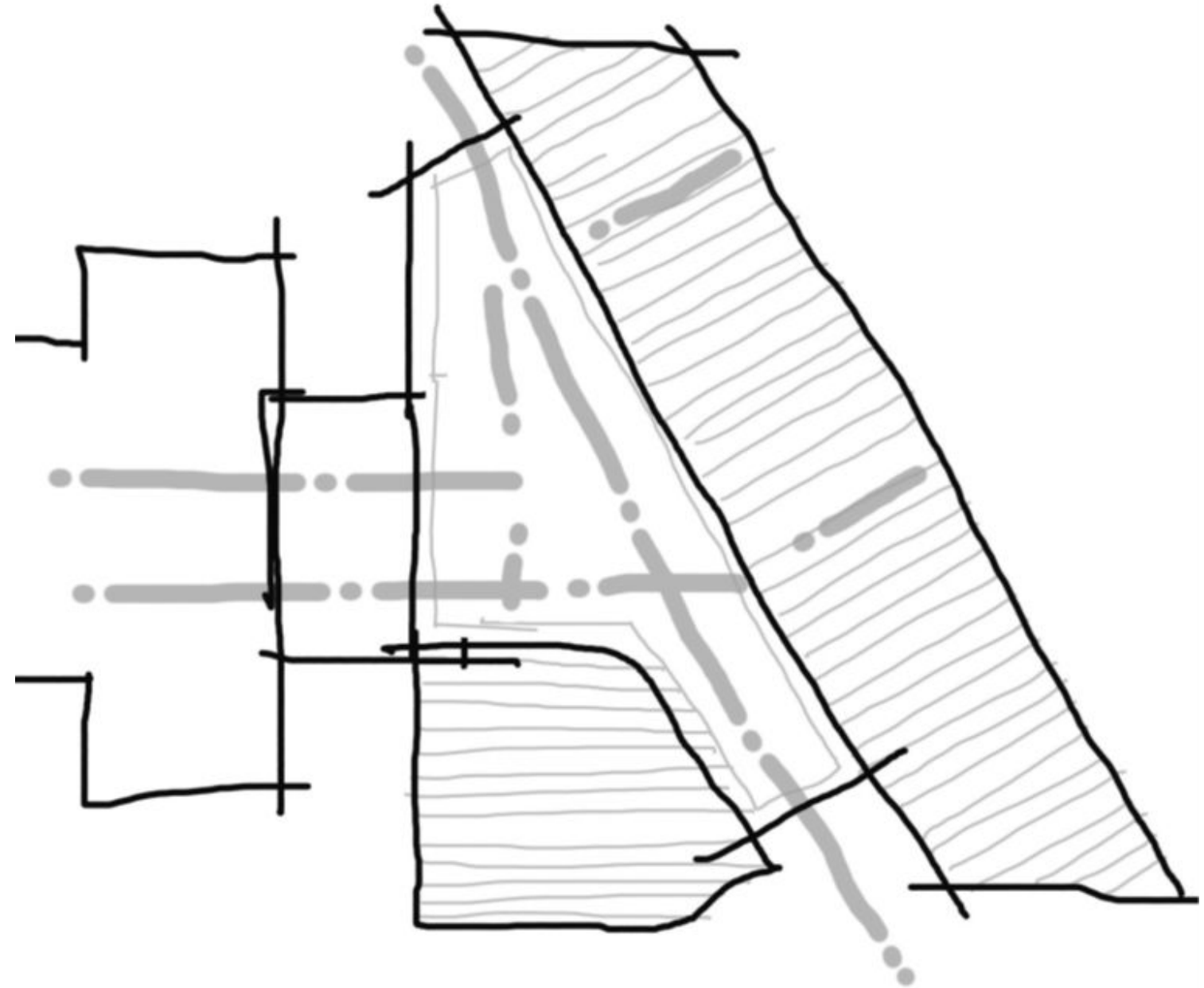
Christine M. Vohringer
Sustainability Specialist
Perkins Eastman



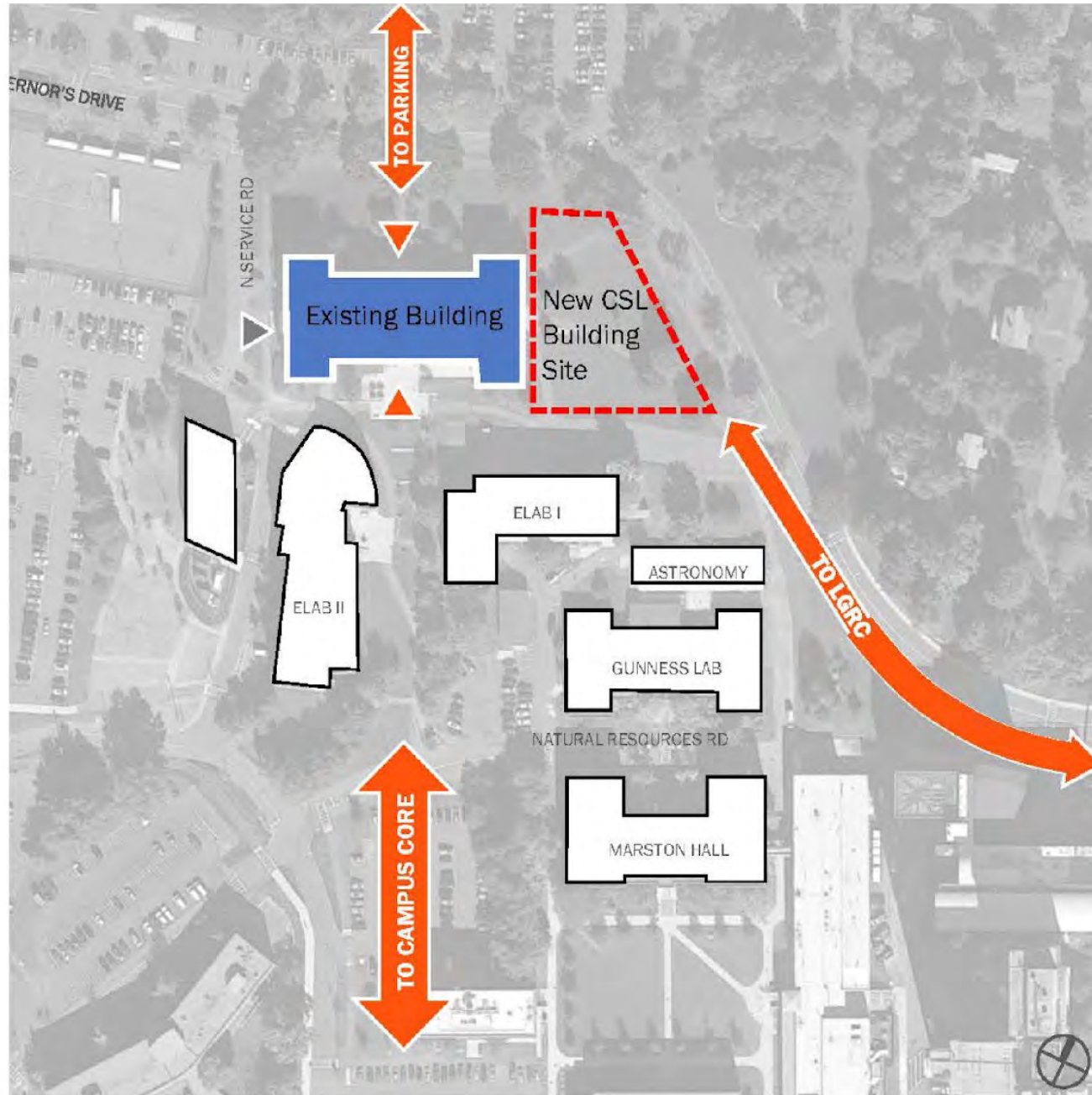
Ryan Dirks
Sustainability Specialist
Perkins Eastman

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



South Approach



COMMONS

LEVEL 2 – LOOKING NORTH

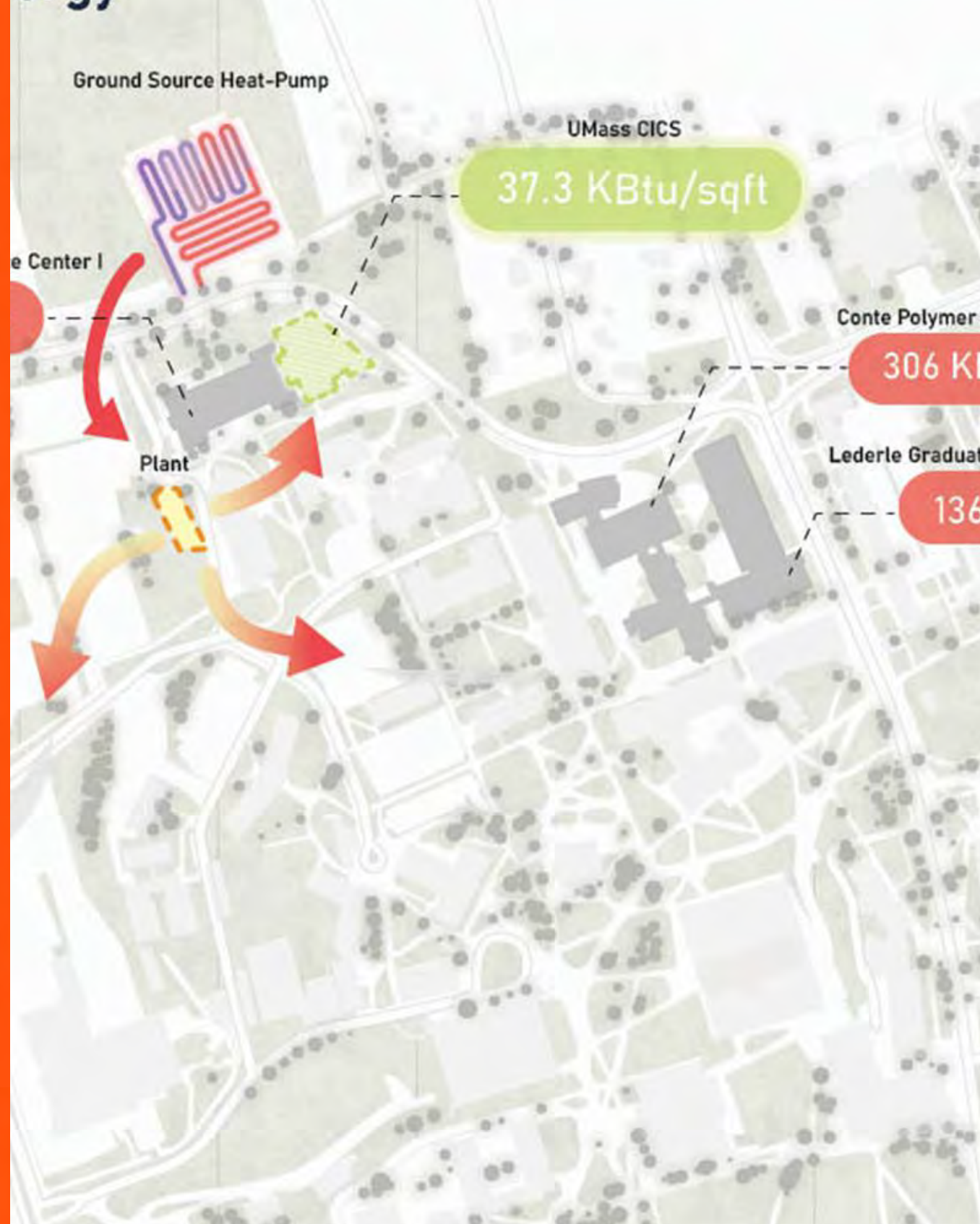


RESEARCH & COLLABORATION

LEVEL 3



A high performance building

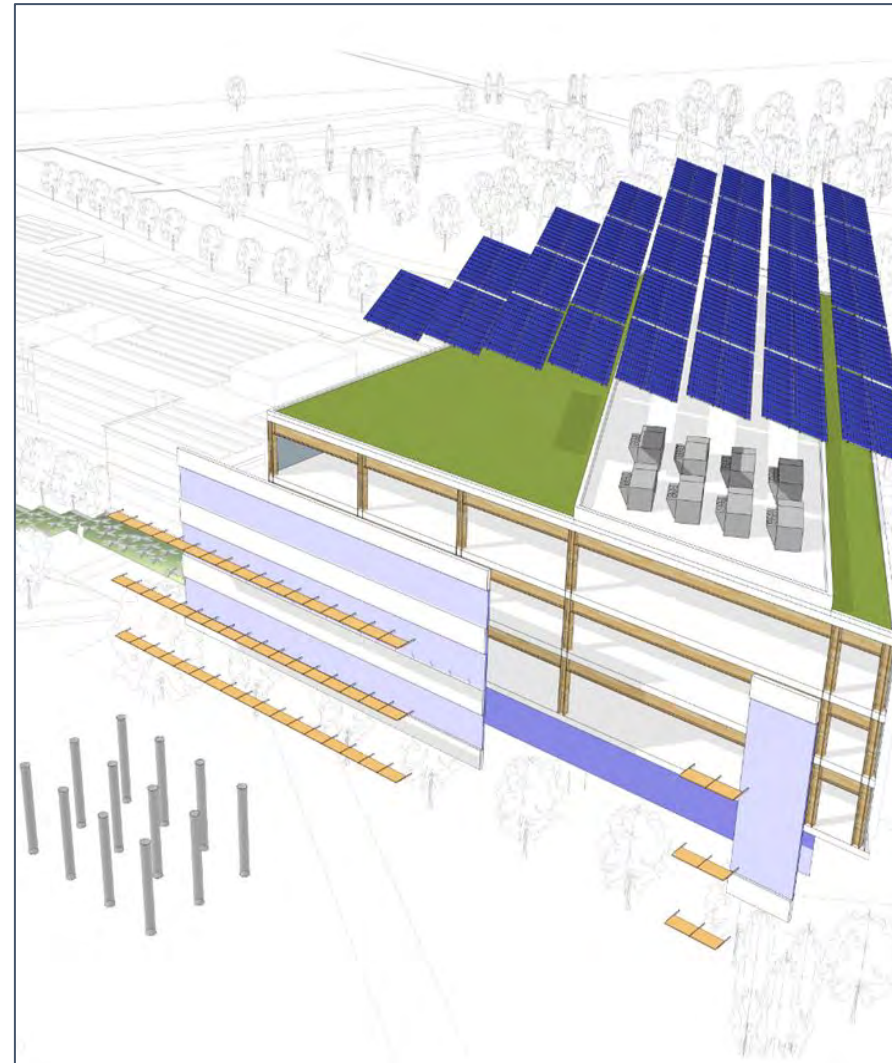


High Performance Building | Goals

Enhance Occupant Experience



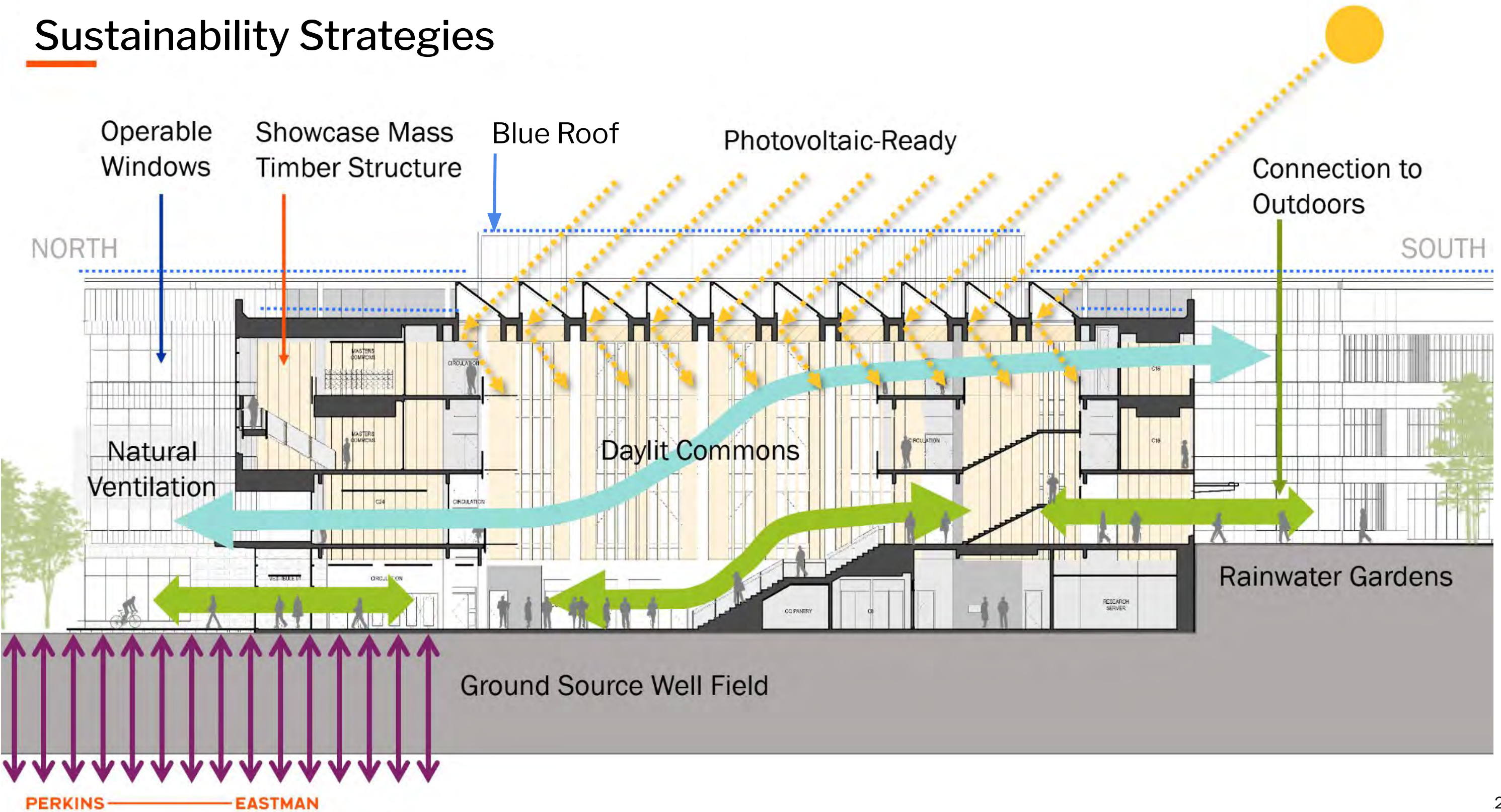
Minimize Operational Carbon



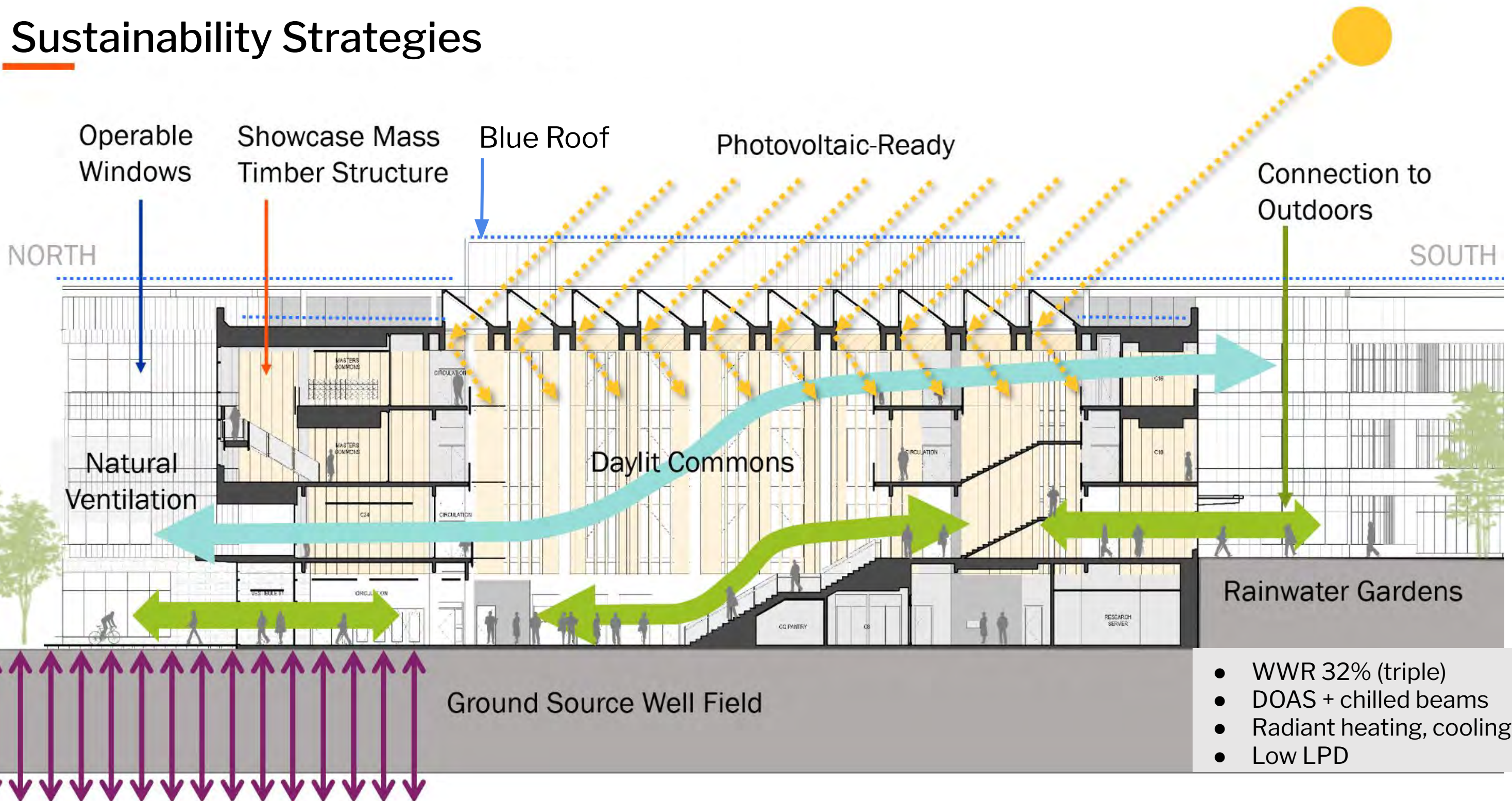
Minimize Embodied Carbon



Sustainability Strategies

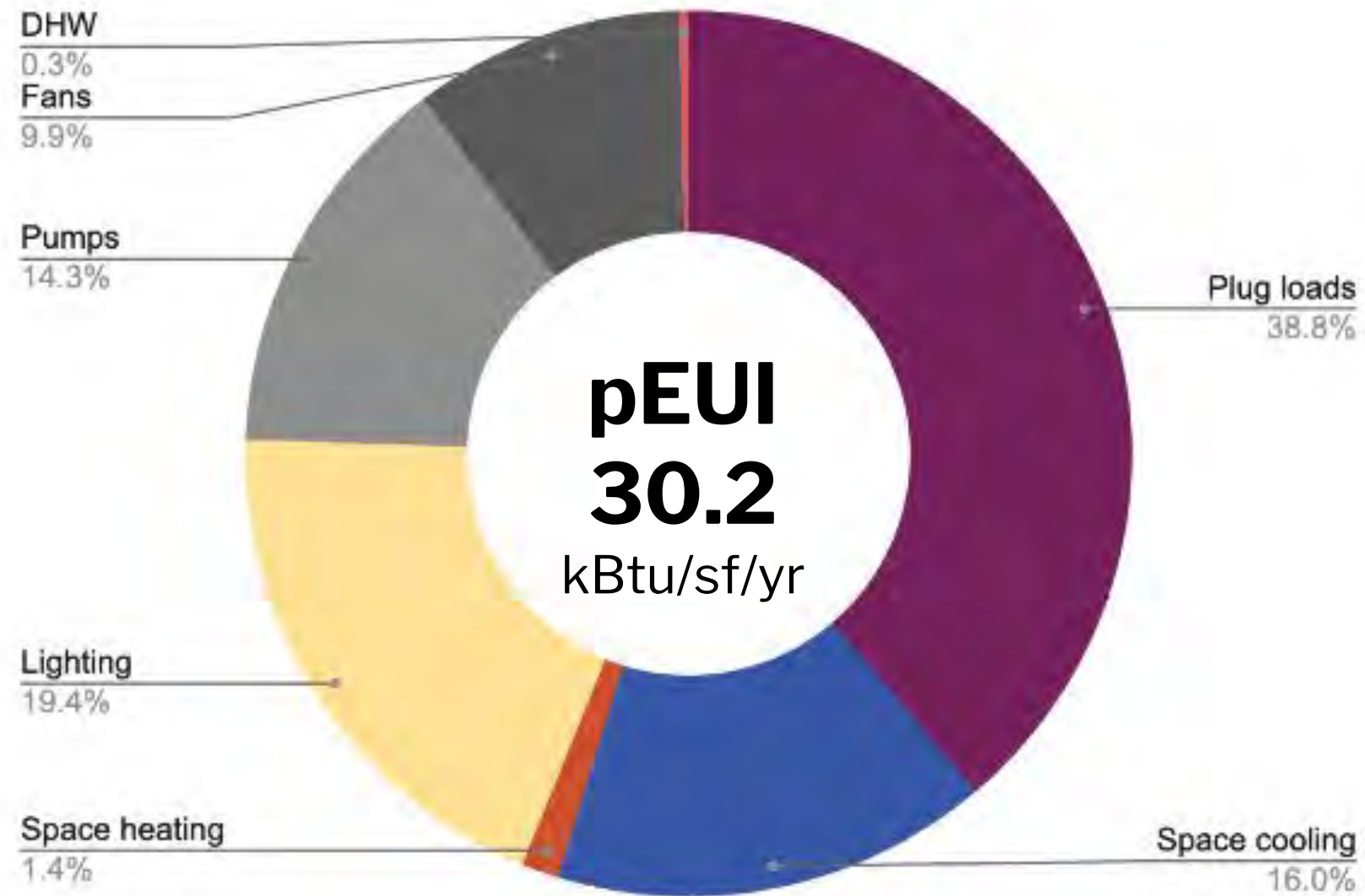


Sustainability Strategies

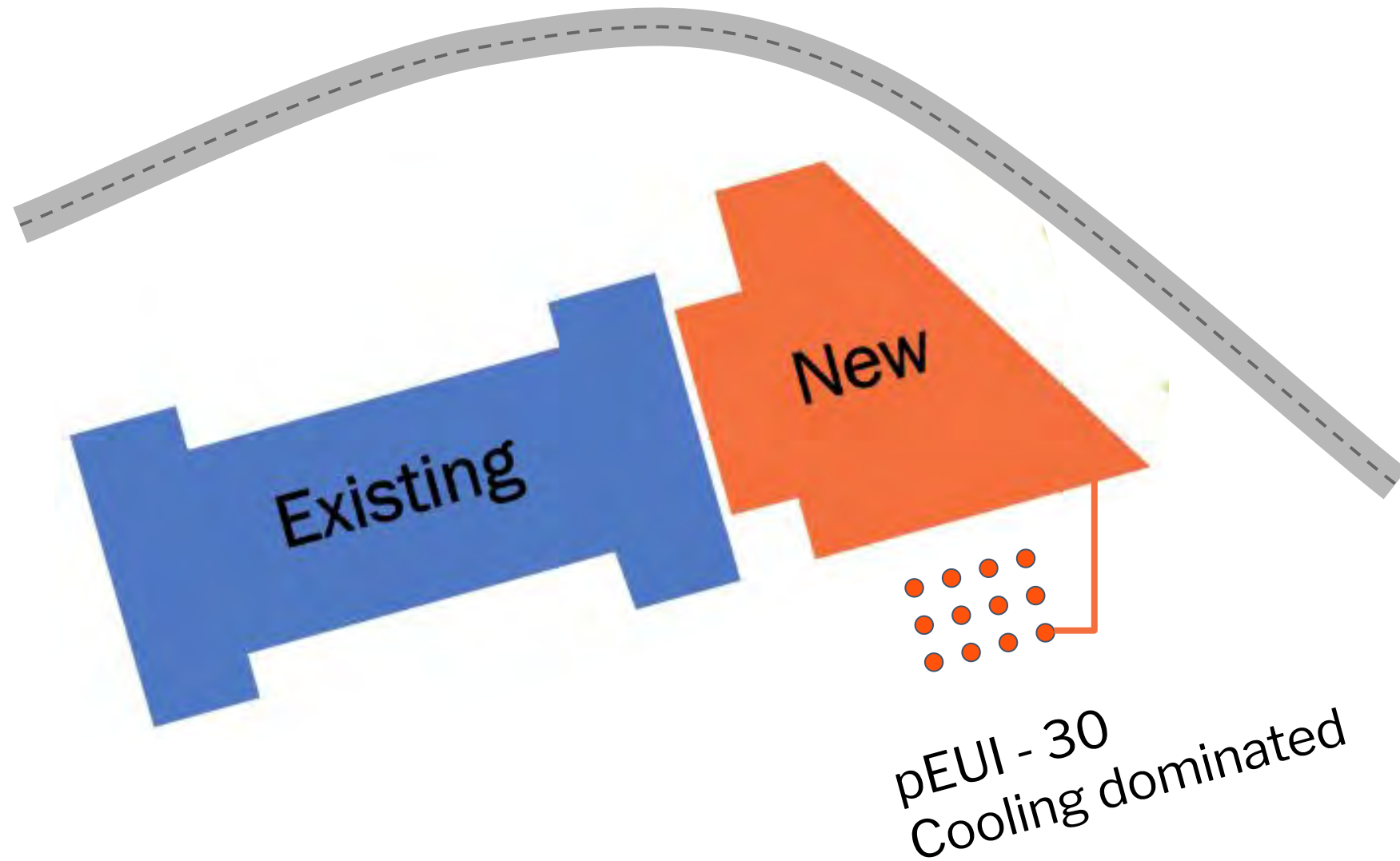


- WWR 32% (triple)
- DOAS + chilled beams
- Radiant heating, cooling
- Low LPD

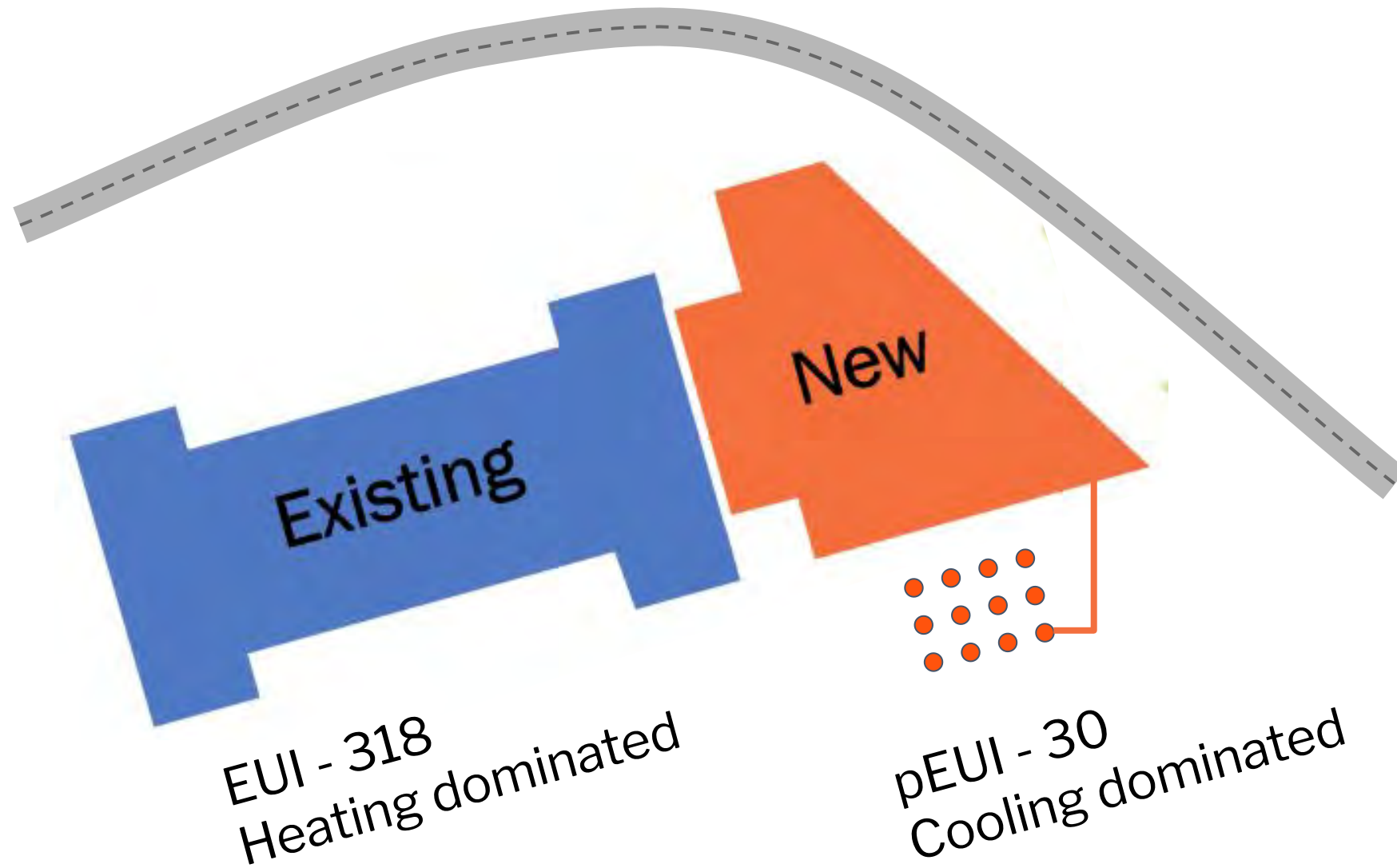
Operational Carbon | pEUI



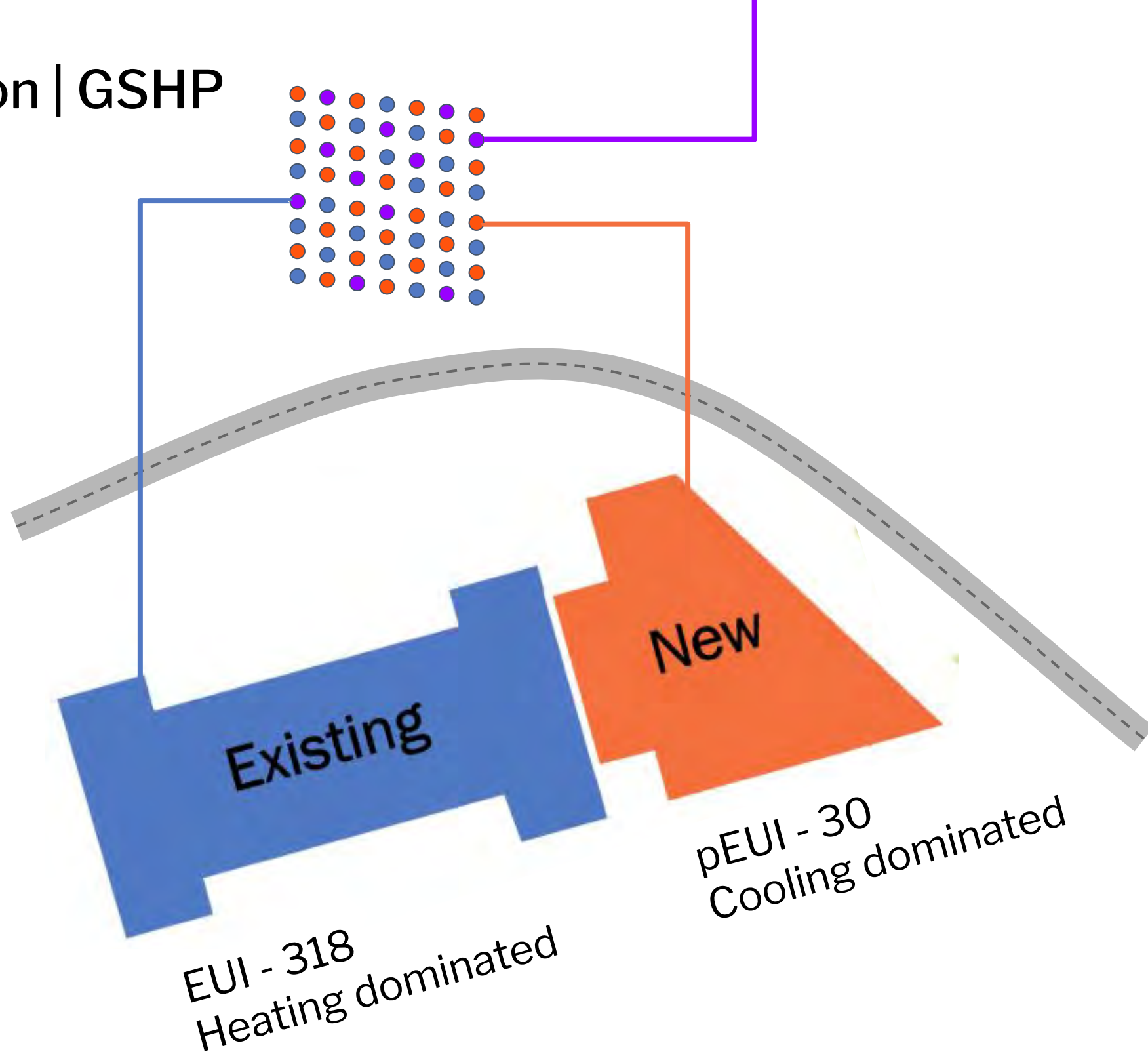
Operational Carbon | GSHP



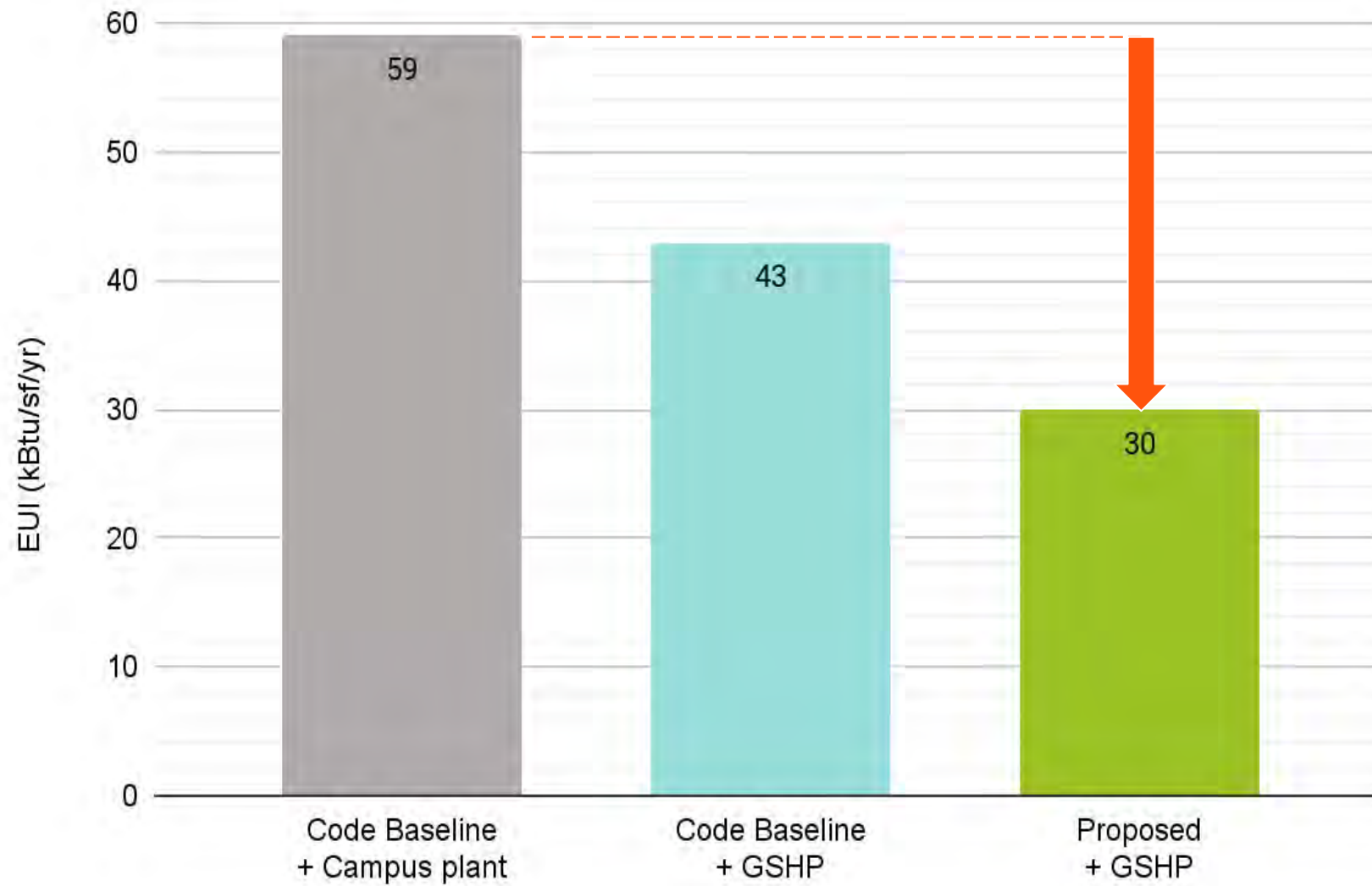
Operational Carbon | GSHP



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

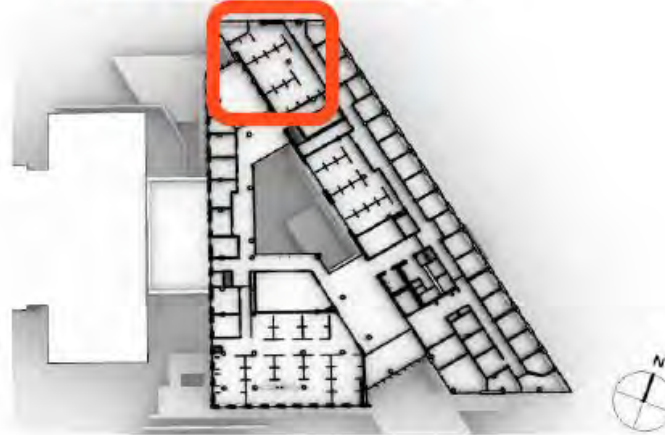
Excess glare
=

Shade deployment

Dean's Office E470C



Lab E440+Huddle 440A



Conference Room E208



Master Commons E439



Office E437



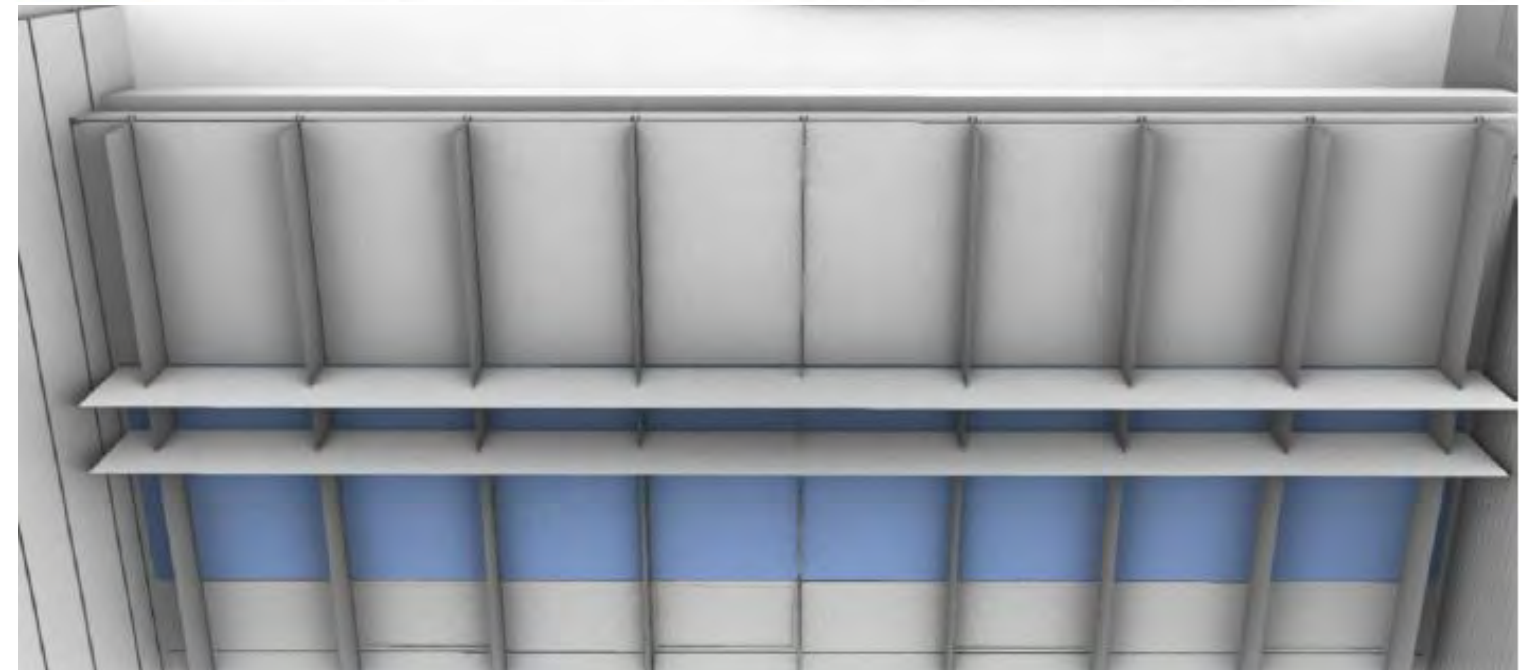
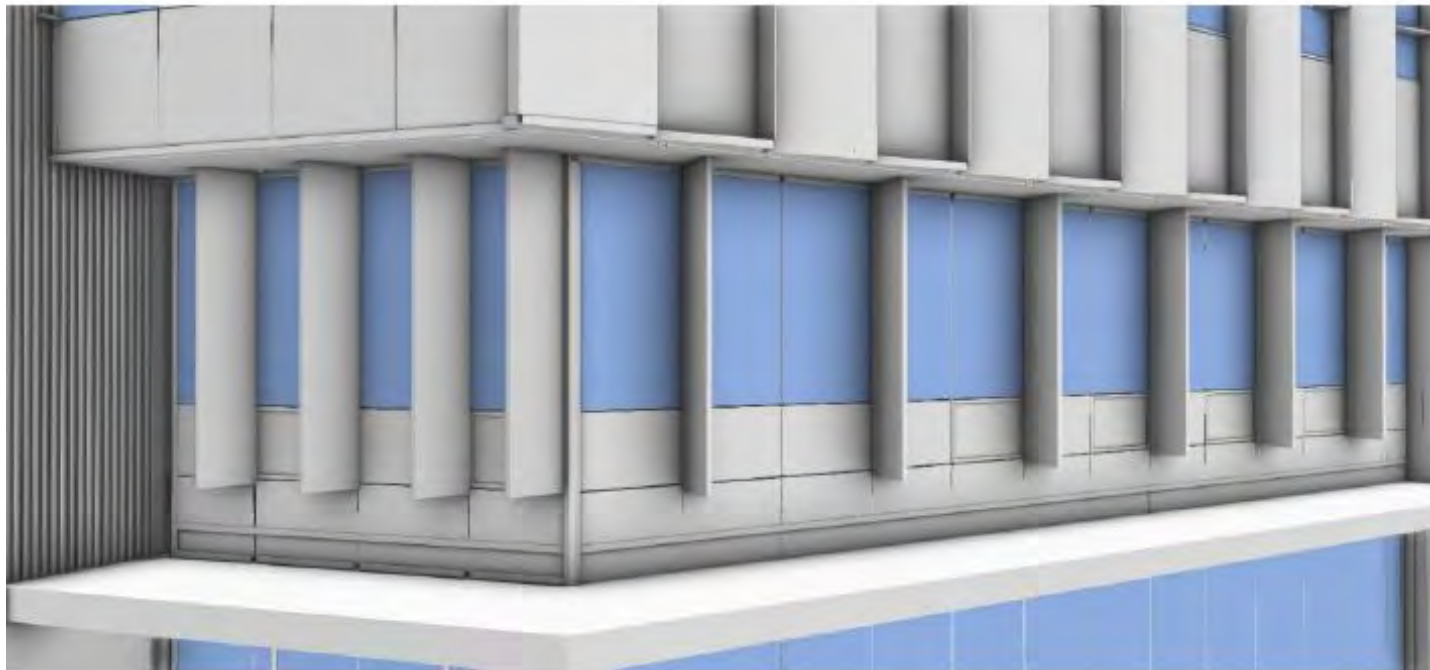
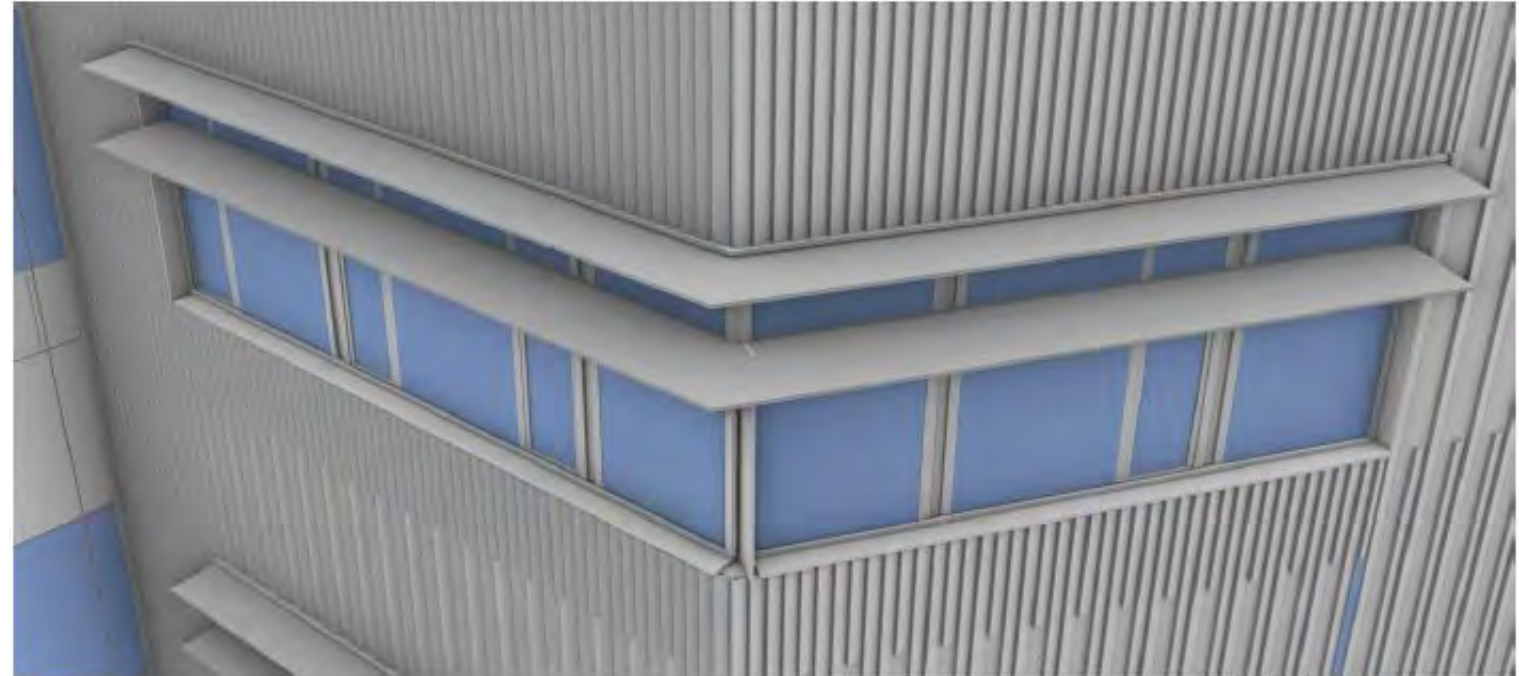
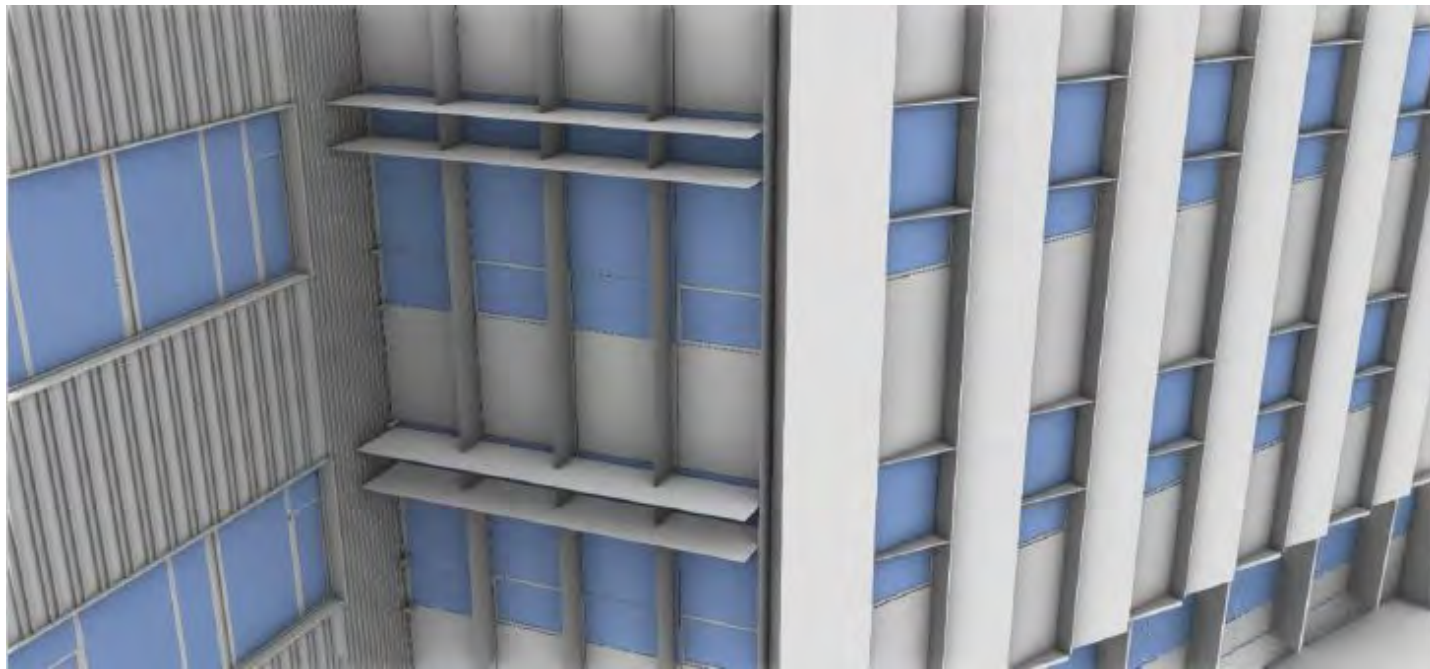
Conference Room E400



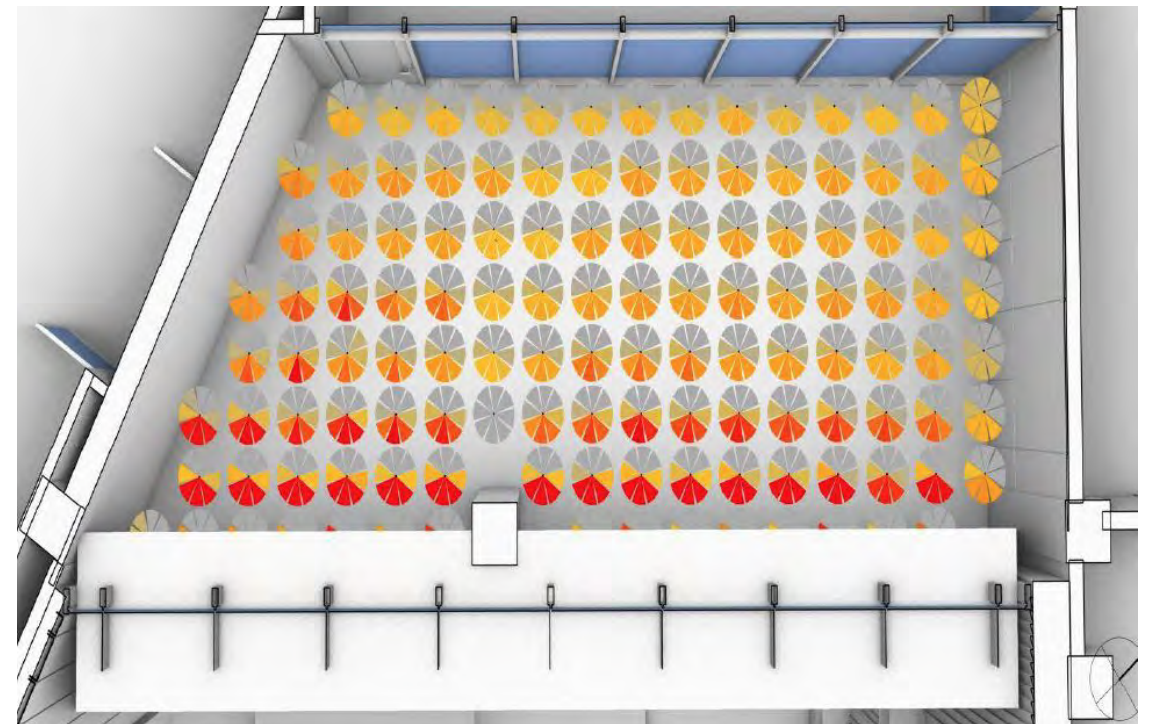
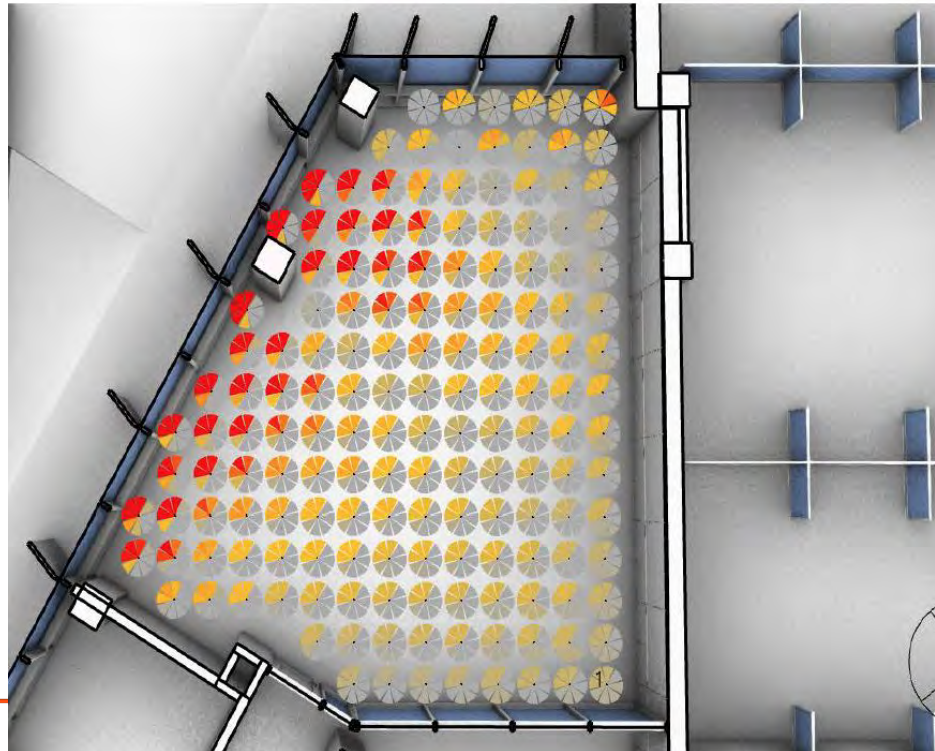
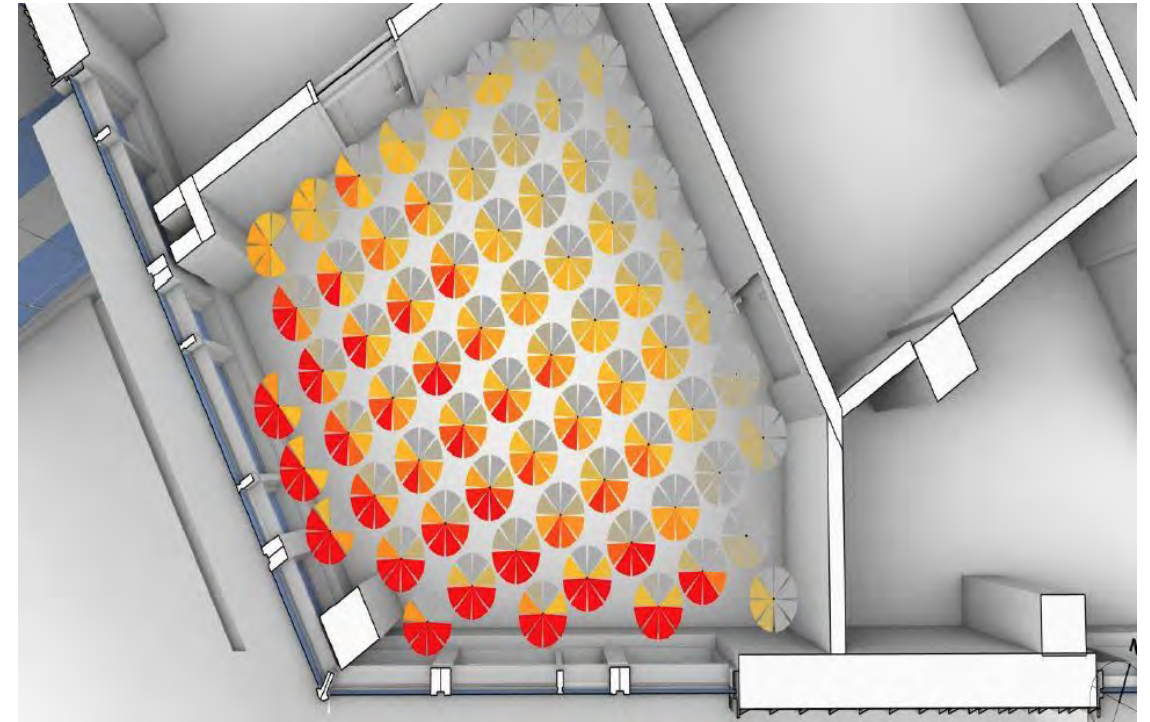
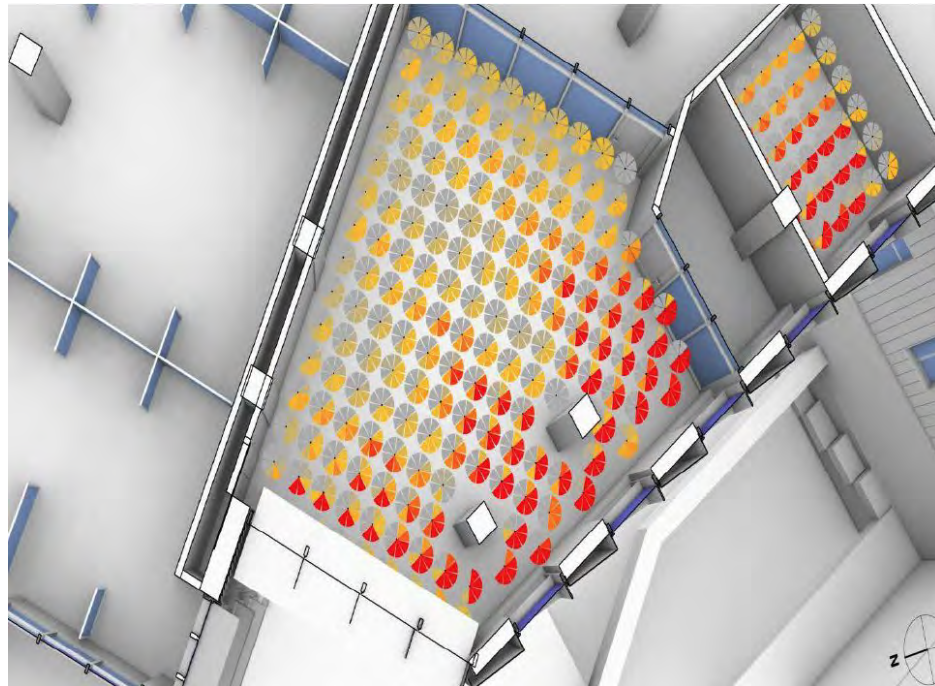
Conference Room E239



Façade Performance | Exterior Shading



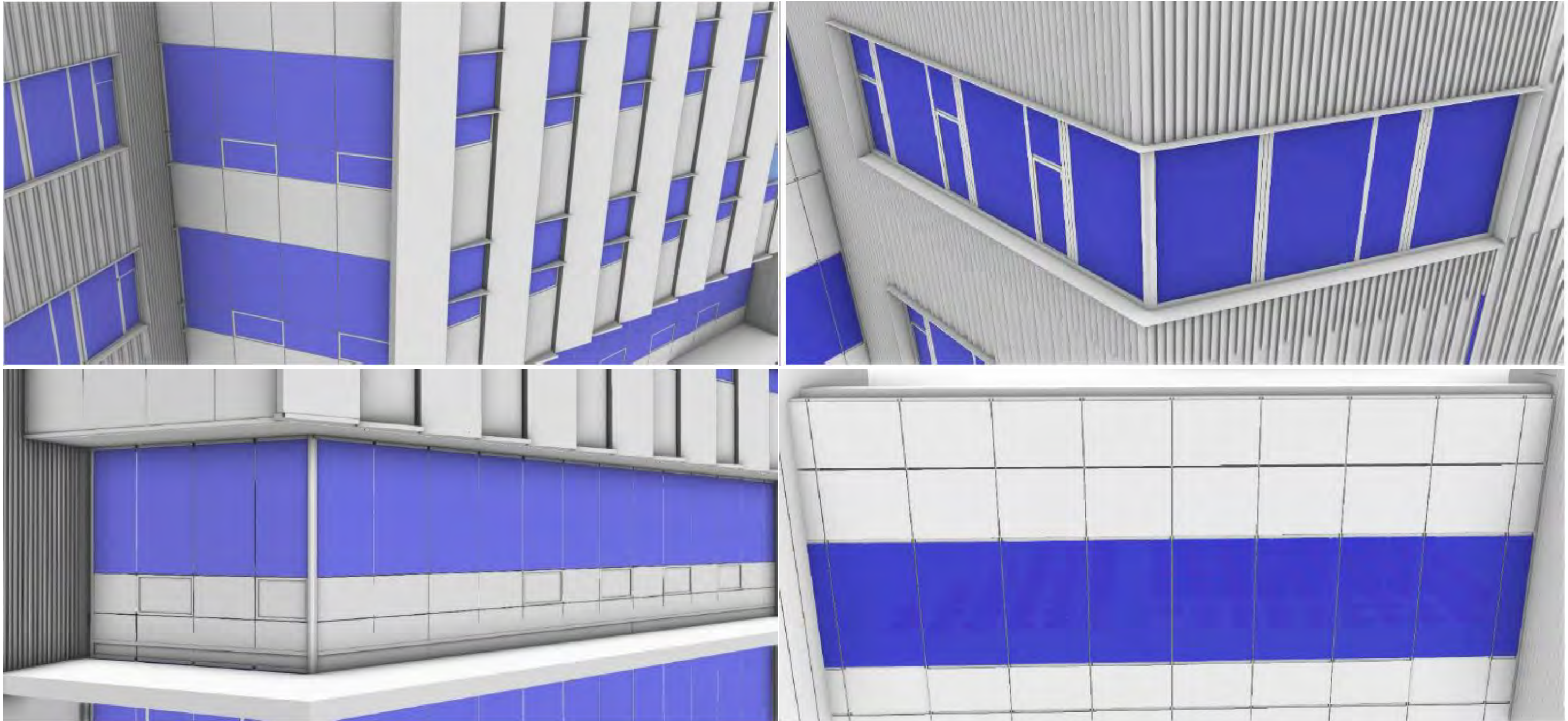
Façade Performance | Exterior Shading Glare Assessment



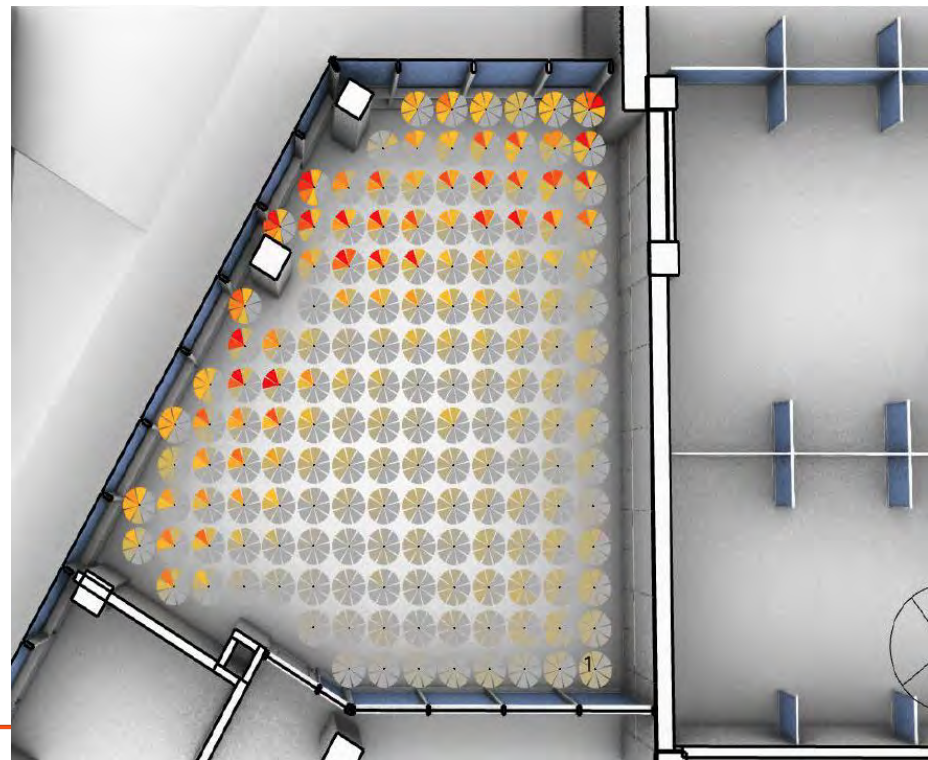
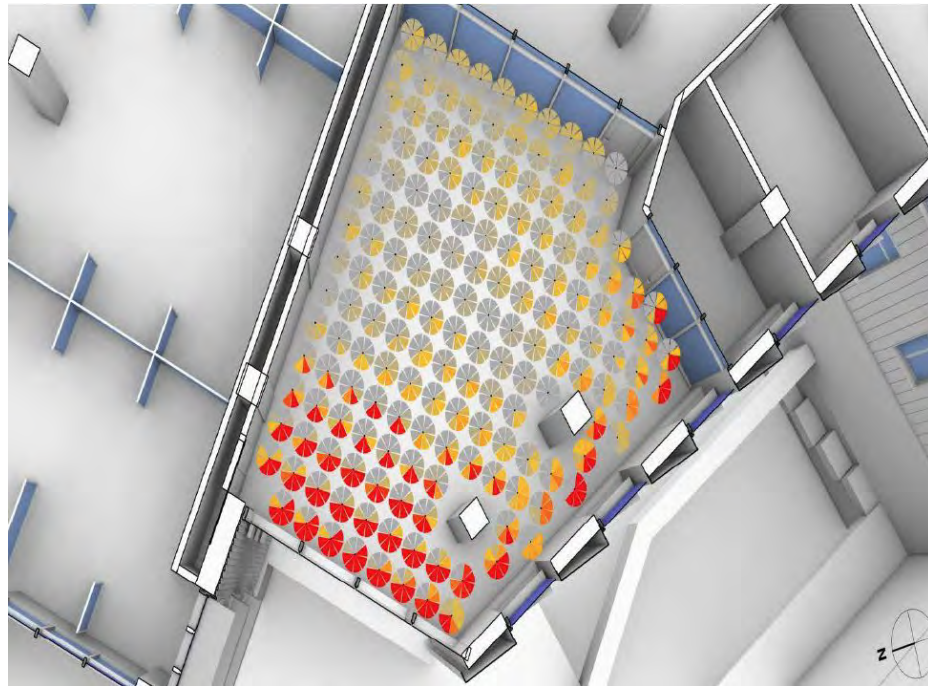
Façade Performance | Solar Gain Reduction

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

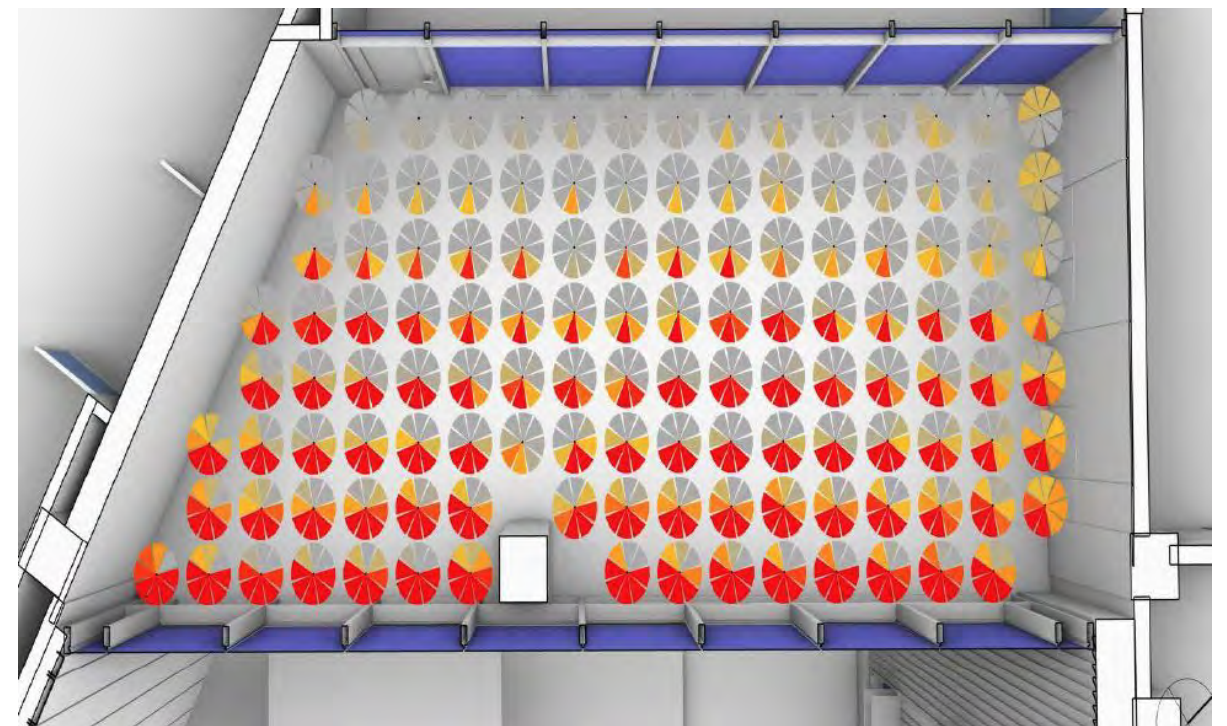
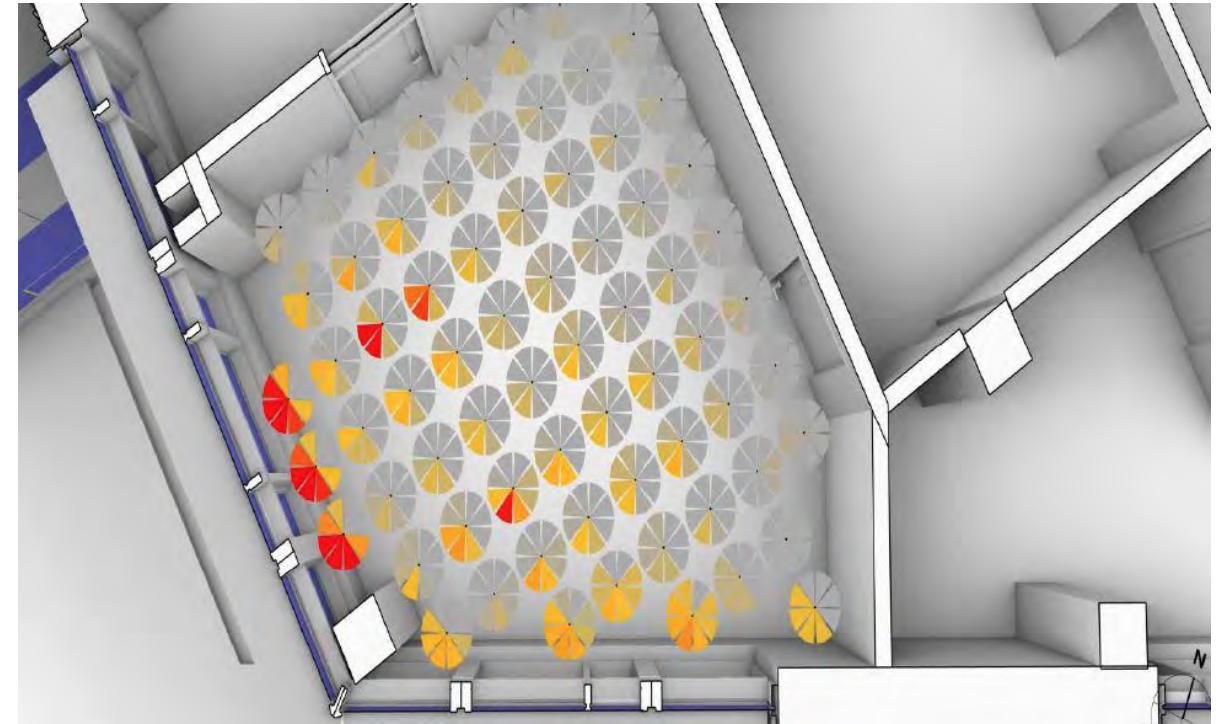
Façade Performance | Electrochromic Glass



Façade Performance | Electrochromic Glass Glare Assessment



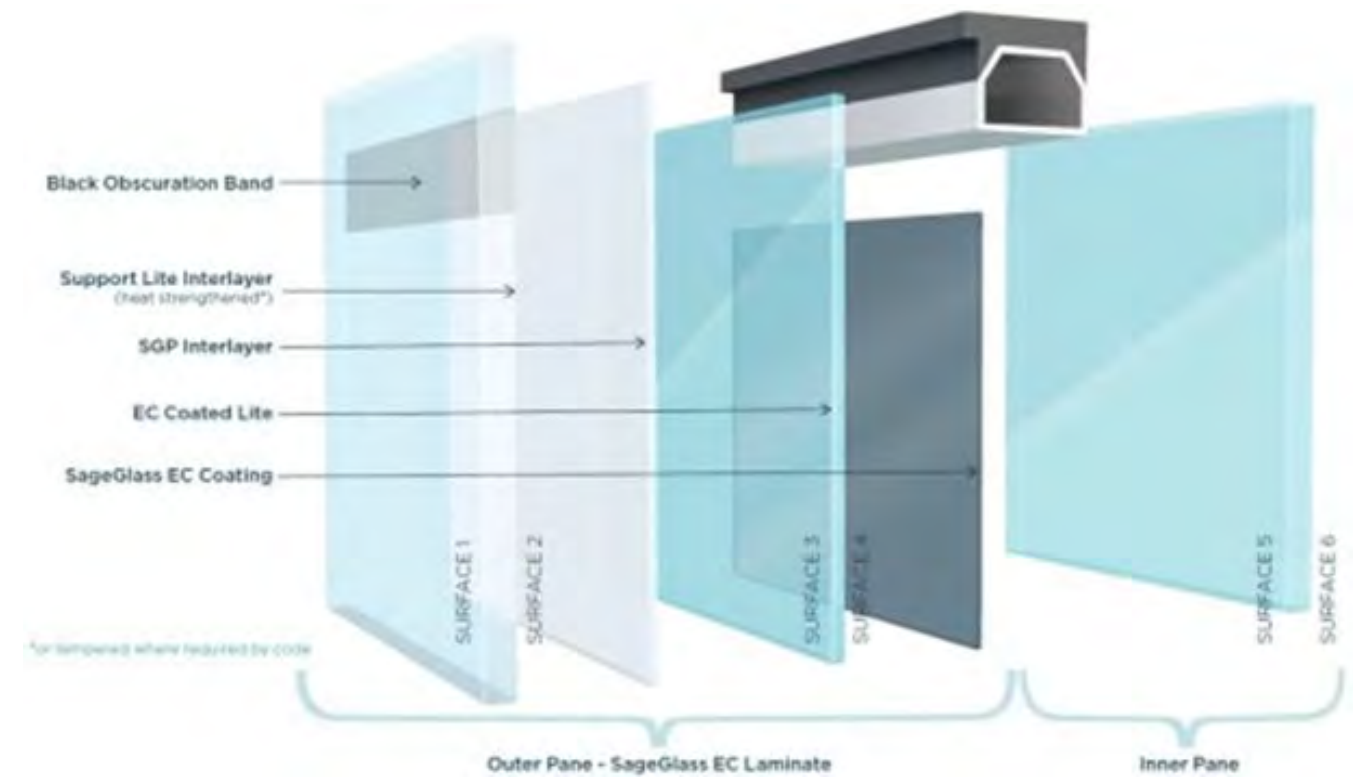
**5% avg
high glare
reduction**



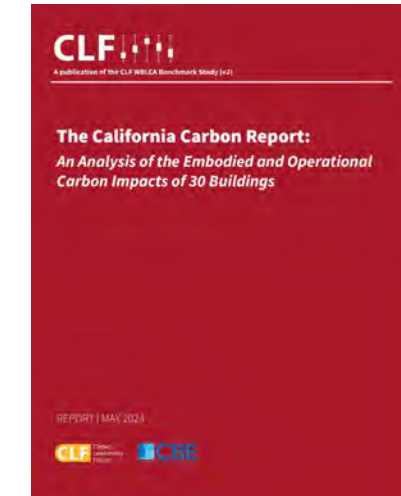
Façade Performance | Solar Gain Reduction

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?



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?

**First Full Publication Public Review
Draft**

BSR/ASHRAE/ICC Standard 240P

Quantification of Life Cycle Greenhouse Gas Emissions

First Full Public Review (February 2024)

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research-technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by ASHRAE, ICC, and ANSI. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

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ASHRAE, 180 Technology Pkwy NW, Peachtree Corners, GA 30092



Impact of Scope

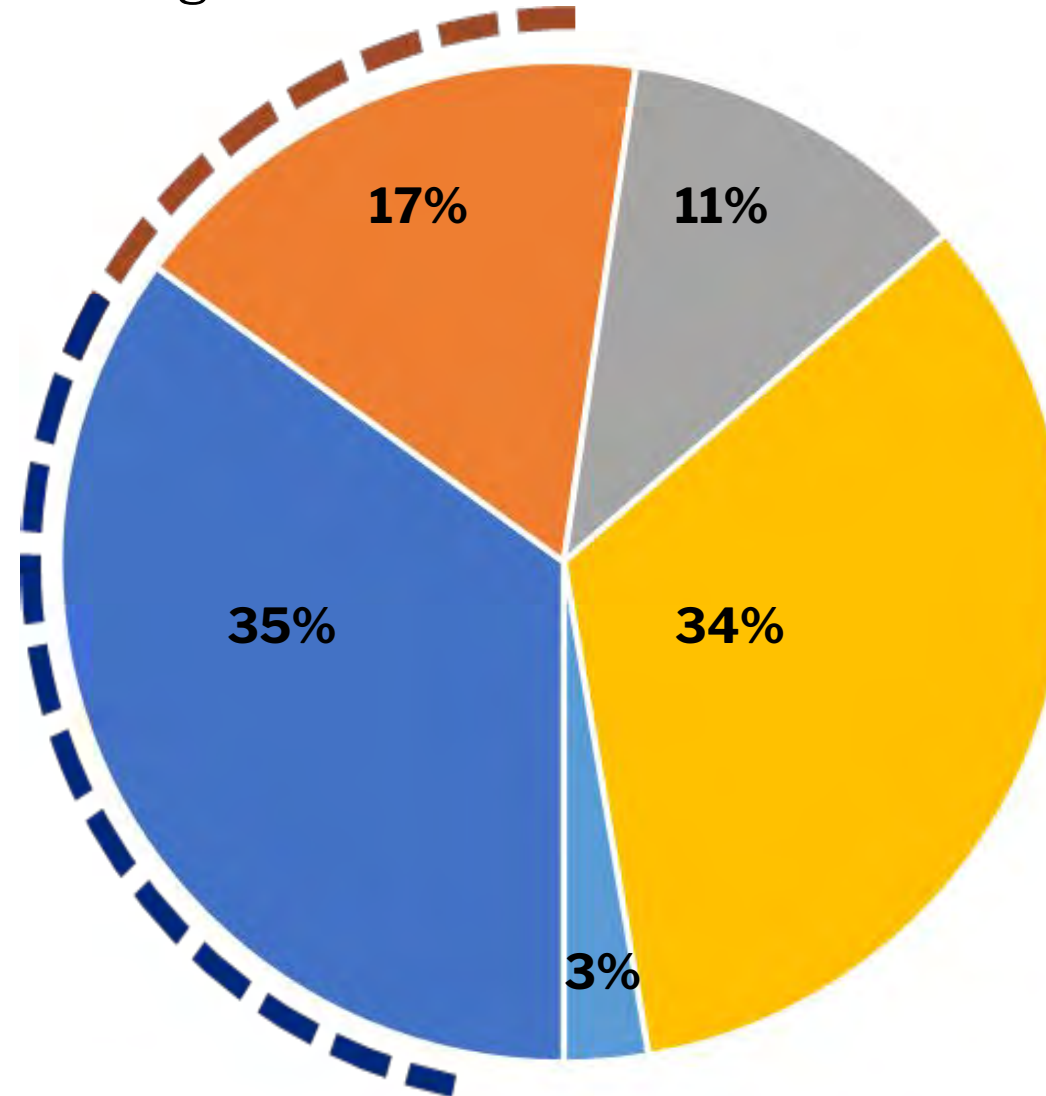
LEED / ISO 14044

CLF CA Report: Median EC: 390 kg/M3

ASHRAE 240P

Median EC: Double results of CA Report?

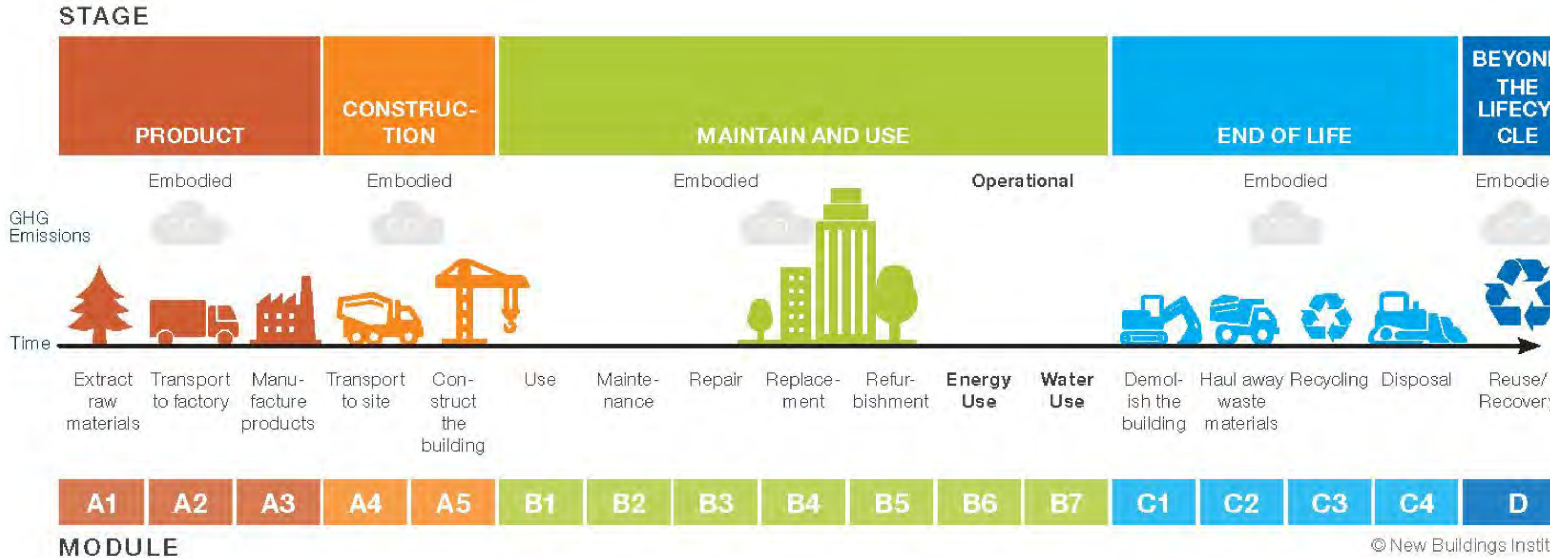
52% of total EC



Defining Life Cycle Modules

Tally (for LEED)

ASHRAE 240P



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



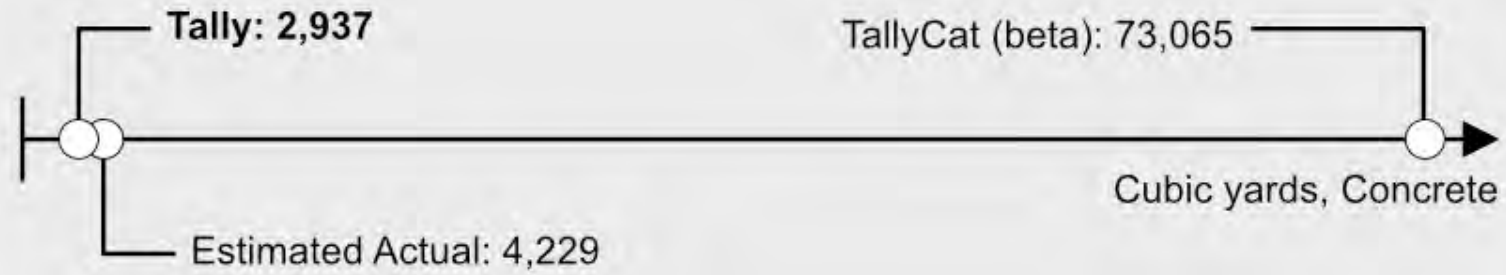
Generate Material
Takeoffs and initial
embodied carbon
analysis



Compare individual
manufacturers and
refine embodied carbon
analysis

Challenges in Quality of Data

Material Quantity



Material Quality



Challenges in Quality of Data

Material Quantity

Tally: 2,937

ISO
14044

Cat (beta): 73,065

4,229

INTERNATIONAL
STANDARD

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.

EPS MFR A: 2.61

Tally EPS: 2.82

Tally Mineral Wool: 7.94

Mineral Wool MFR A: 1.31

Mineral Wool MFR B: 0.88

kgCO₂e/m²-RSI



Concrete Values

4X Variation

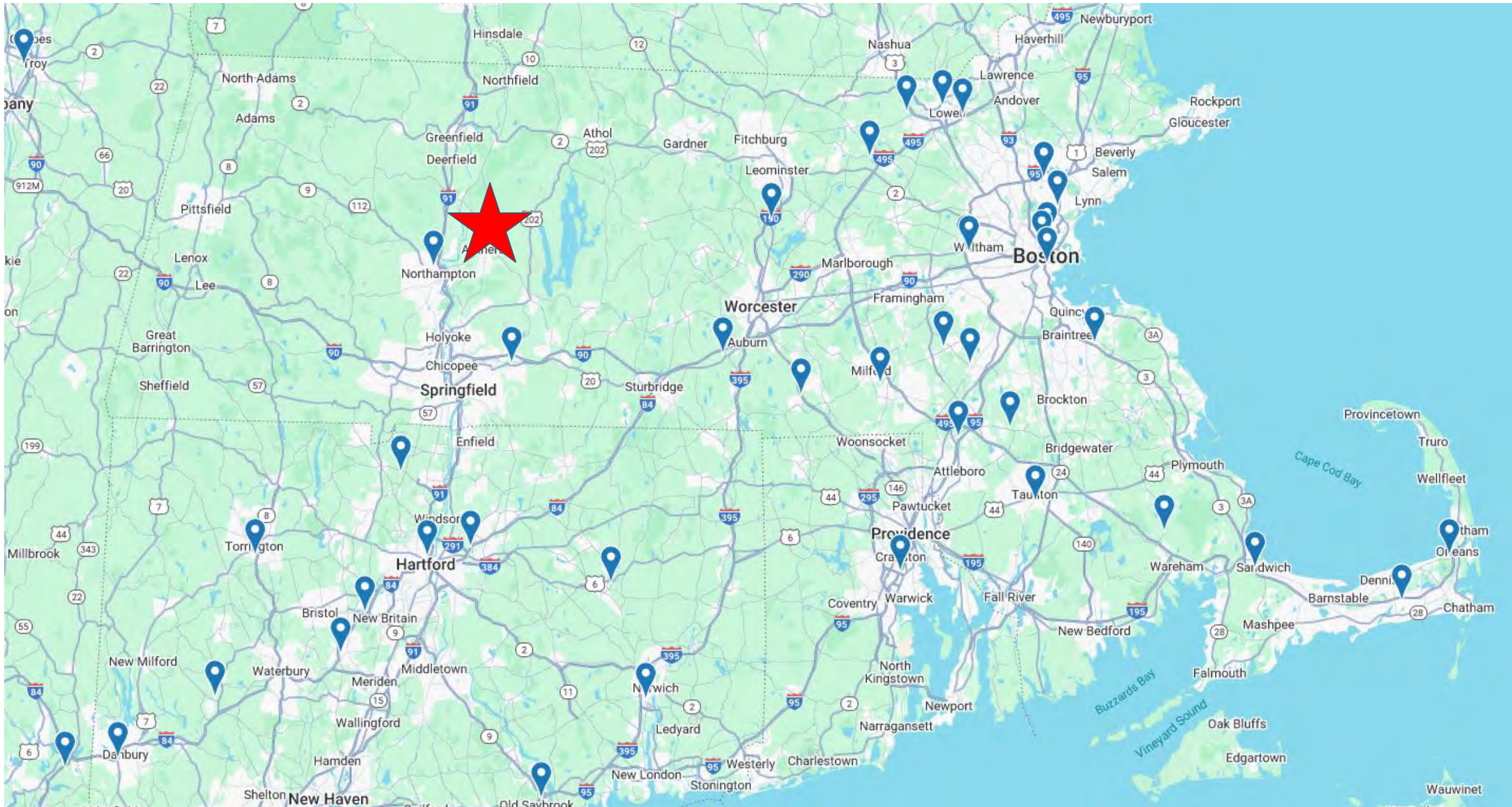
Actual Mix



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

EPD Availability

By Region



Resilient flooring: 128 EPDs

Face Brick: 3 EPDs

Sustainable Minds® Transparency Catalog

Search to find brands and products

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Filter and/or search to find brands, products and transparency documentation

Click a brand name to find ALL their products, contact info and more.

CSI MasterFormat® 37 brands | 128 products

09 Finishes

- 09 65 13 Resilient Base and Accessories
- 09 65 16 Resilient Sheet Flooring
- 09 65 19 Resilient Tile Flooring
- 09 65 33 Conductive Resilient Flooring
- 09 65 36 Static-Control Resilient Flooring
- 09 65 43 Linoleum Flooring
- 09 65 66 Resilient Athletic Flooring
- 09 66 Terrazzo Flooring
 - 09 66 16 Terrazzo Floor Tile
 - 09 66 23 Resinous Matrix Terrazzo Flooring
- 09 67 Fluid-Applied Flooring
 - 09 67 23 Resinous Flooring
 - 09 67 26 Quartz Flooring
- 09 68 Carpeting
 - 09 68 13 Tile Carpeting
 - 09 68 16 Sheet Carpeting
- 09 69 Access Flooring

Featured Brand Showrooms

Manufacturers: Learn how to become a Featured Brand in this division. Contact us

Export products Log in or create an account to select and export products to add to your spec and BoD libraries.

ENVIRONMENTAL PERFORMANCE MATERIAL INGREDIENTS

BRAND PRODUCT	PROGRAM	SCOPE, REGION, CO2E, IND AVG	EXPIRES	PROGRAM	SCOPE / RESULTS	EXPIRES
Armstrong Flooring						
09 65 16 RESILIENT SHEET FLOORING (4)						
MedinPure™ PVC-Free Homogeneous Sheet	EPD ASTM	C2Grave, N. America	08/31/25	HPD v2.2 ✓	1000 ppm;C, S, I / BM1	09/30/24
	CO2e EC3	80th+ percentile				
Medintone™ Homogeneous Sheet	EPD ASTM	C2Grave, N. America	08/31/25	HPD v2.3	100 ppm;C, S, I / BM1	07/09/27
	CO2e EC3	60th percentile				
Nidra™ - Heterogeneous Sheet	EPD ASTM	C2Grave, N. America	08/31/25			
	CO2e EC3	60th percentile				
Zenscape™ - Heterogeneous Sheet	EPD ASTM	C2Grave, N. America	08/31/25			
	CO2e EC3	60th percentile				
09 65 19 RESILIENT TILE FLOORING (9)						

Keyword: Brand, product type, name

Sustainable Minds® Transparency Catalog

Search to find brands and products

SEE ALL BRANDS | ABOUT PRODUCT TRANSPARENCY | PCR CATALOG | WEBINARS | BLOG

Filter and/or search to find brands, products and transparency documentation

Click a brand name to find ALL their products, contact info and more.

CSI MasterFormat® 3 brands | 3 products

04 Masonry

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Export products Log in or create an account to select and export products to add to your spec and BoD libraries.

ENVIRONMENTAL PERFORMANCE MATERIAL INGREDIENTS

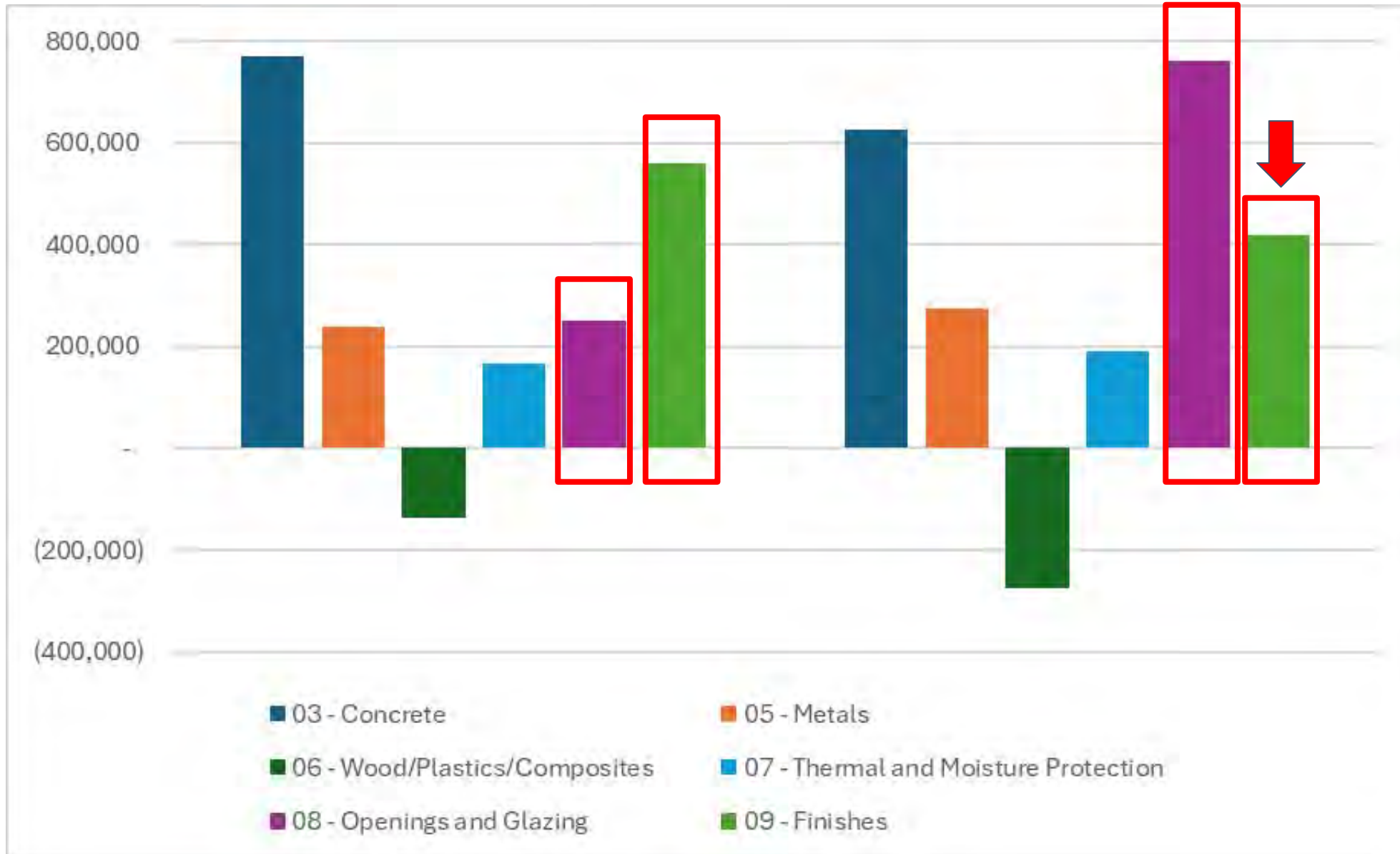
BRAND PRODUCT	PROGRAM	SCOPE, REGION, CO2E, IND AVG	EXPIRES	PROGRAM	SCOPE / RESULTS	EXPIRES
Boehmers						
04 22 00 CONCRETE UNIT MASONRY (1)						
Normal-Weight And Light-Weight Concrete Masonry Units	EPD ASTM	C2Gate, N. America	01/07/24			
	CO2e EC3	40th percentile				
Interstate Brick						
04 21 00 CLAY UNIT MASONRY (1)						
Clay Bricks and Clay Brick Pavers	EPD ASTM	C2Gate, N. America	03/12/25			
	CO2e EC3	60th+ percentile				
Shaw Brick & Stone						
04 21 00 CLAY UNIT MASONRY (1)						
Clay Brick	EPD ASTM	C2Gate, N. America	09/20/27			
	CO2e EC3	80th+ percentile				

Keyword: Brand, product type, name

Tally Versus EPD Data

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

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

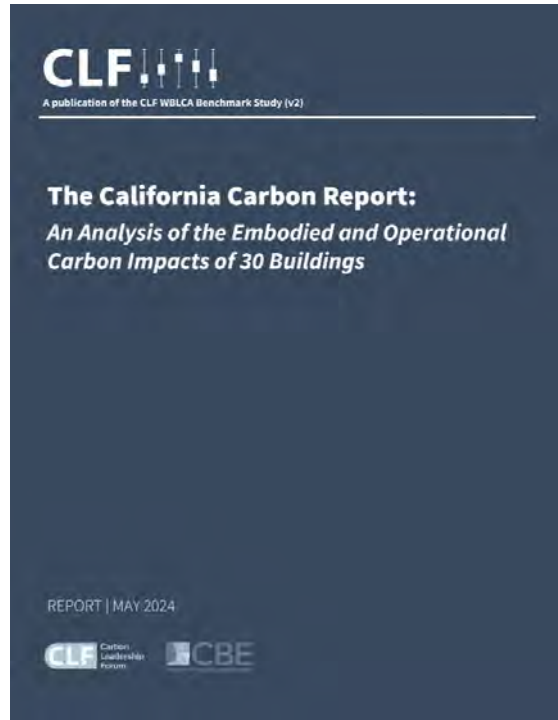


UMass Amherst CSL

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



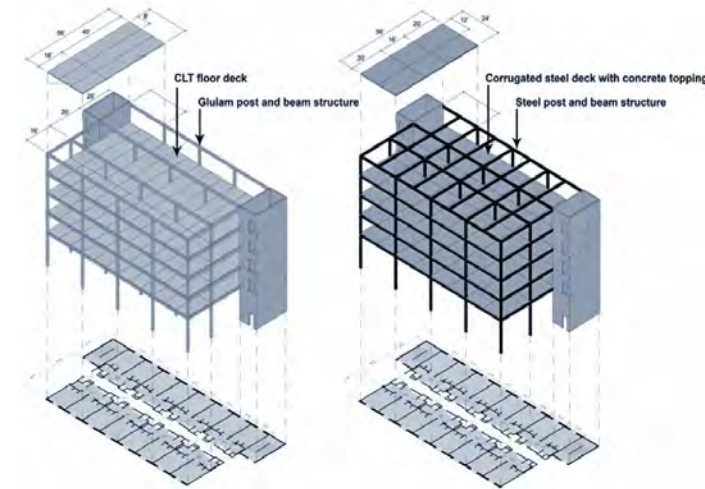
Compare to similar project

Time: Low (assuming having reference)

Accepted by LEED? Maybe??

Accepted by CalGreen? No

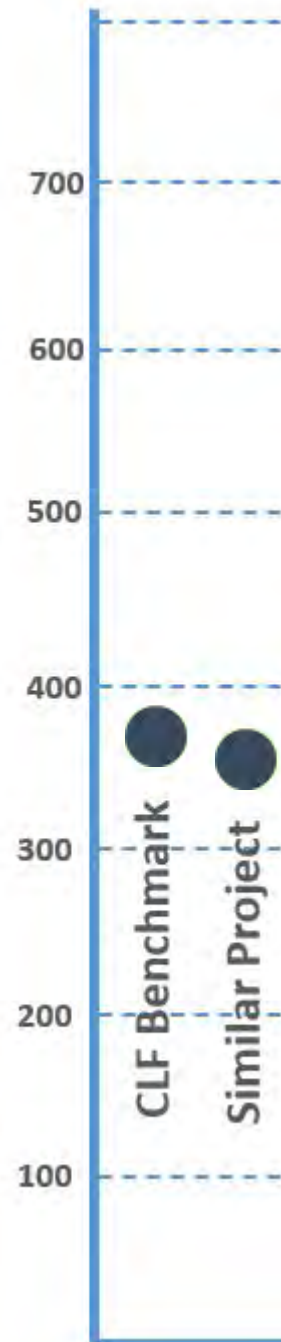
Predicted EC for Baseline: 378 kg/M2



Create Reference Building



kg CO2/M2
 floor area



Apples to Apples?

interiors



envelope



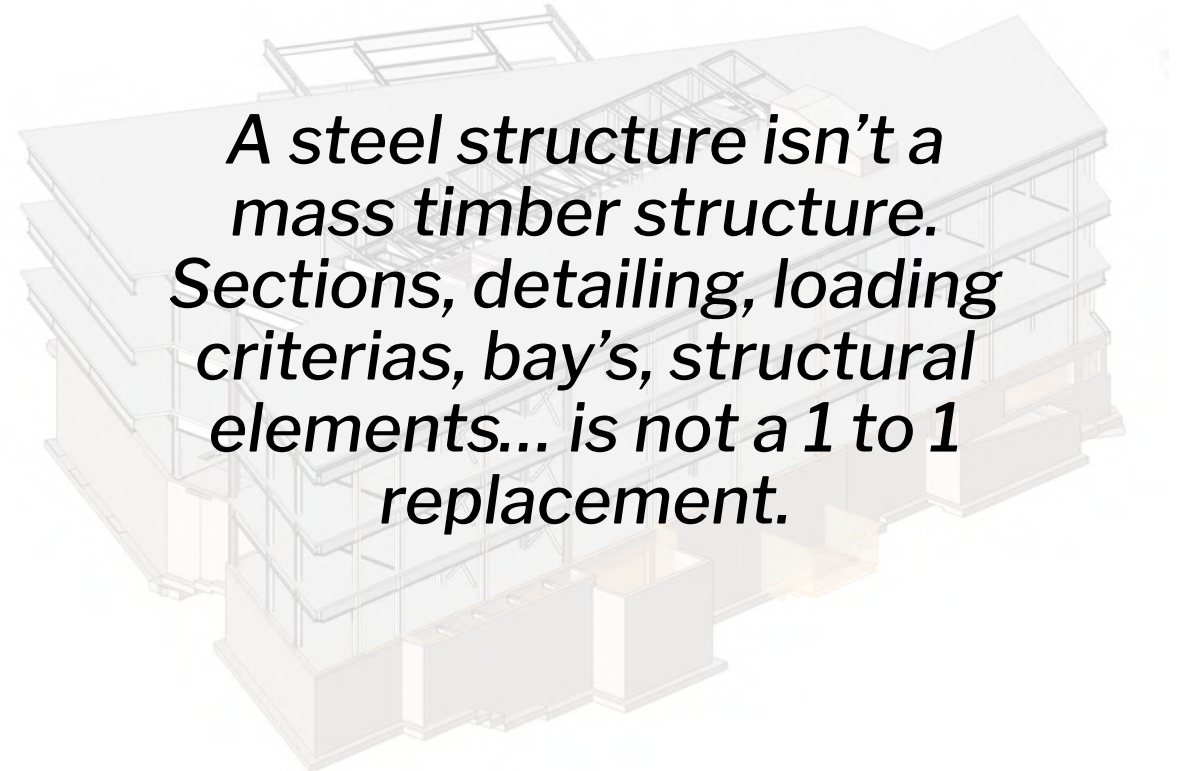
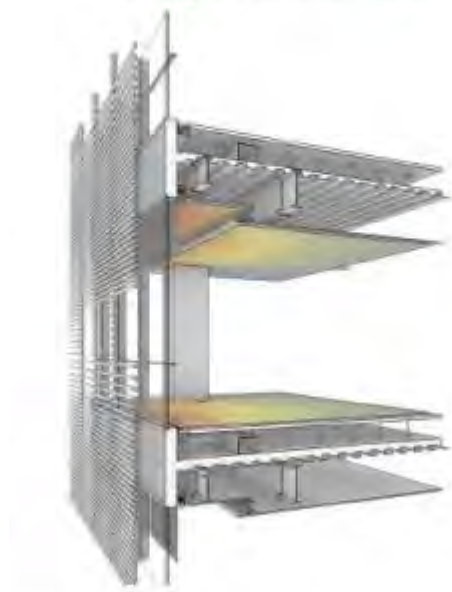
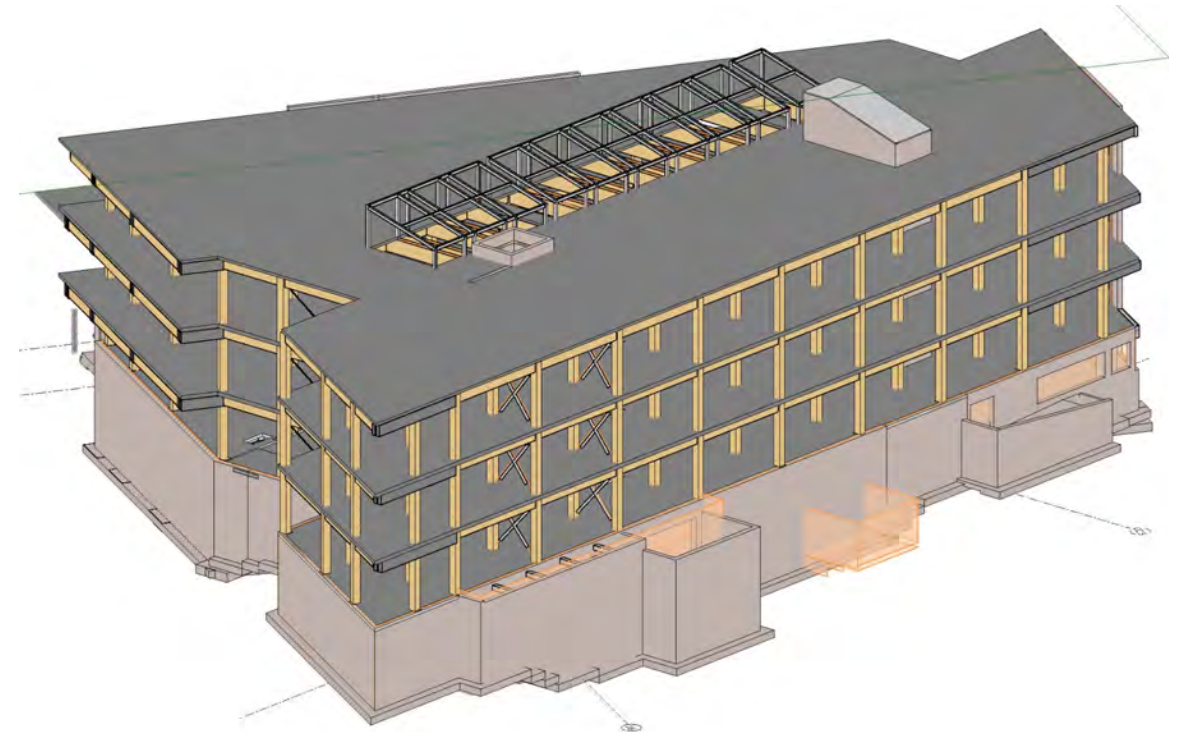
foundations



structure

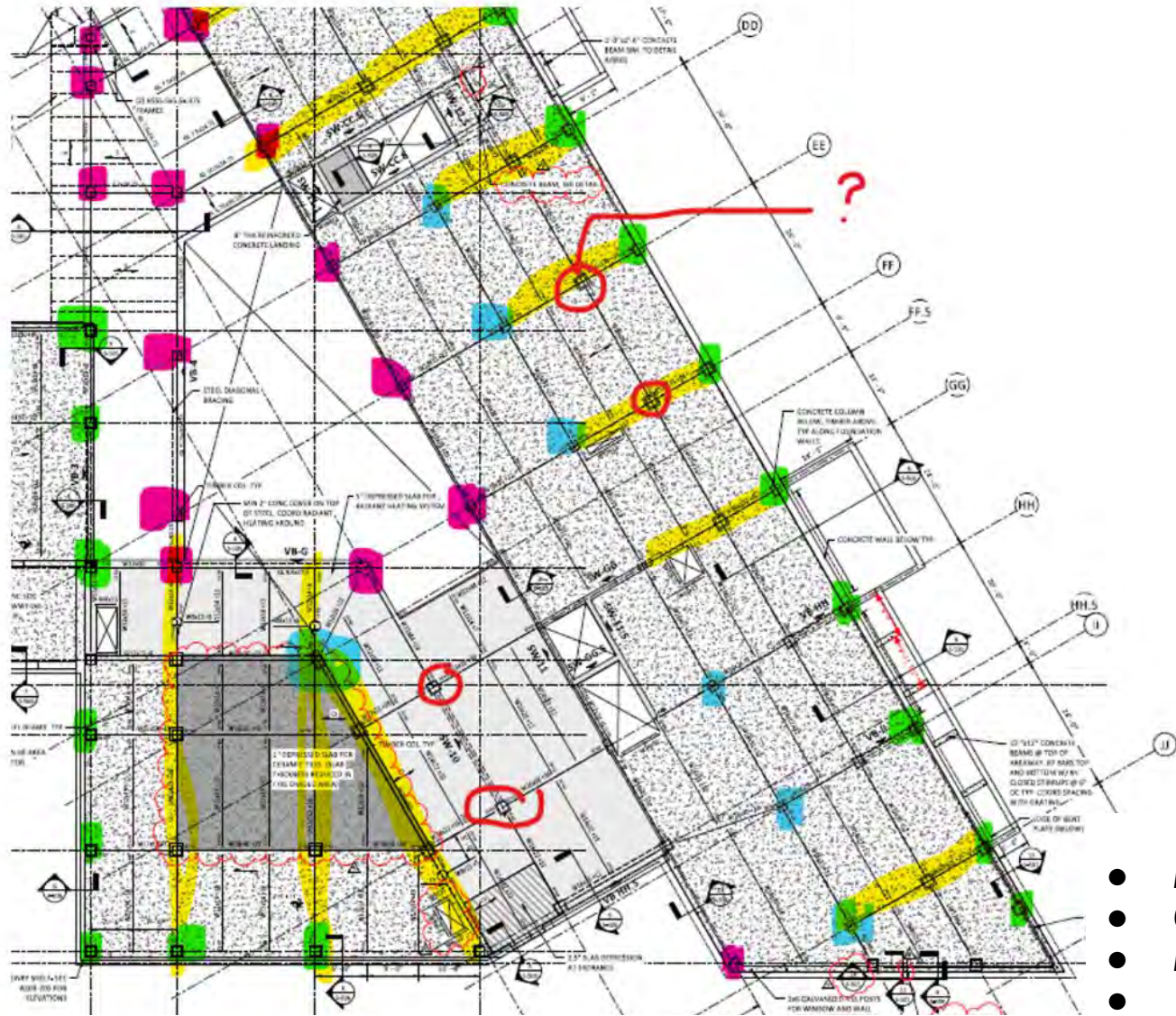


mech

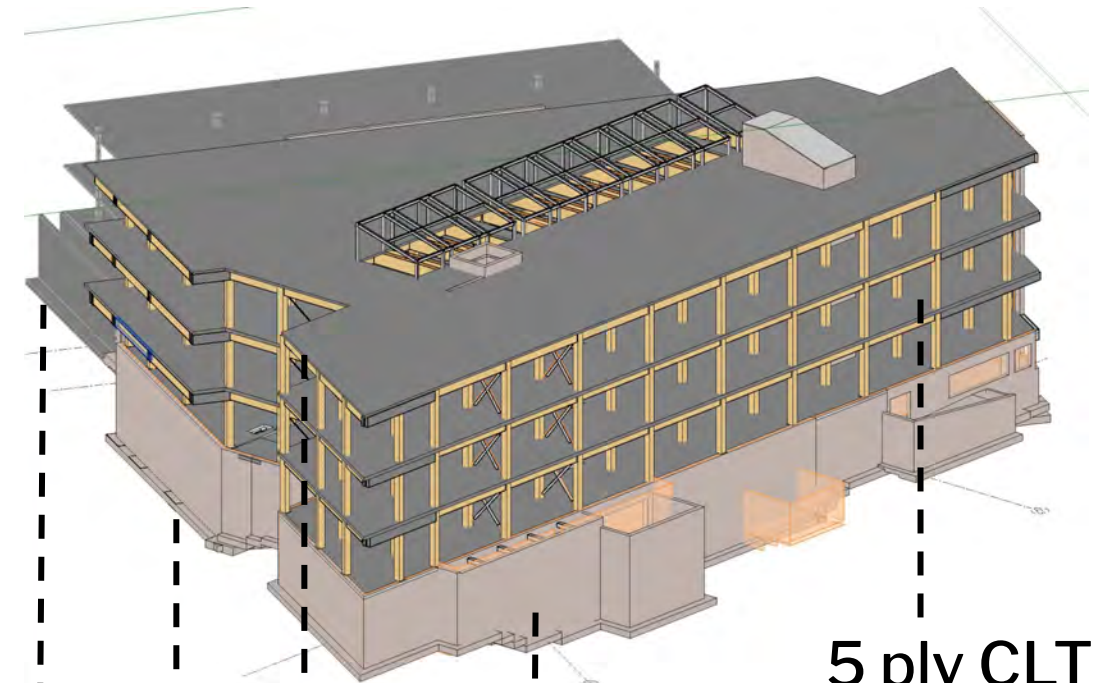


A steel structure isn't a mass timber structure. Sections, detailing, loading criterias, bay's, structural elements... is not a 1 to 1 replacement.

What if.....



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



Glulam columns and beams

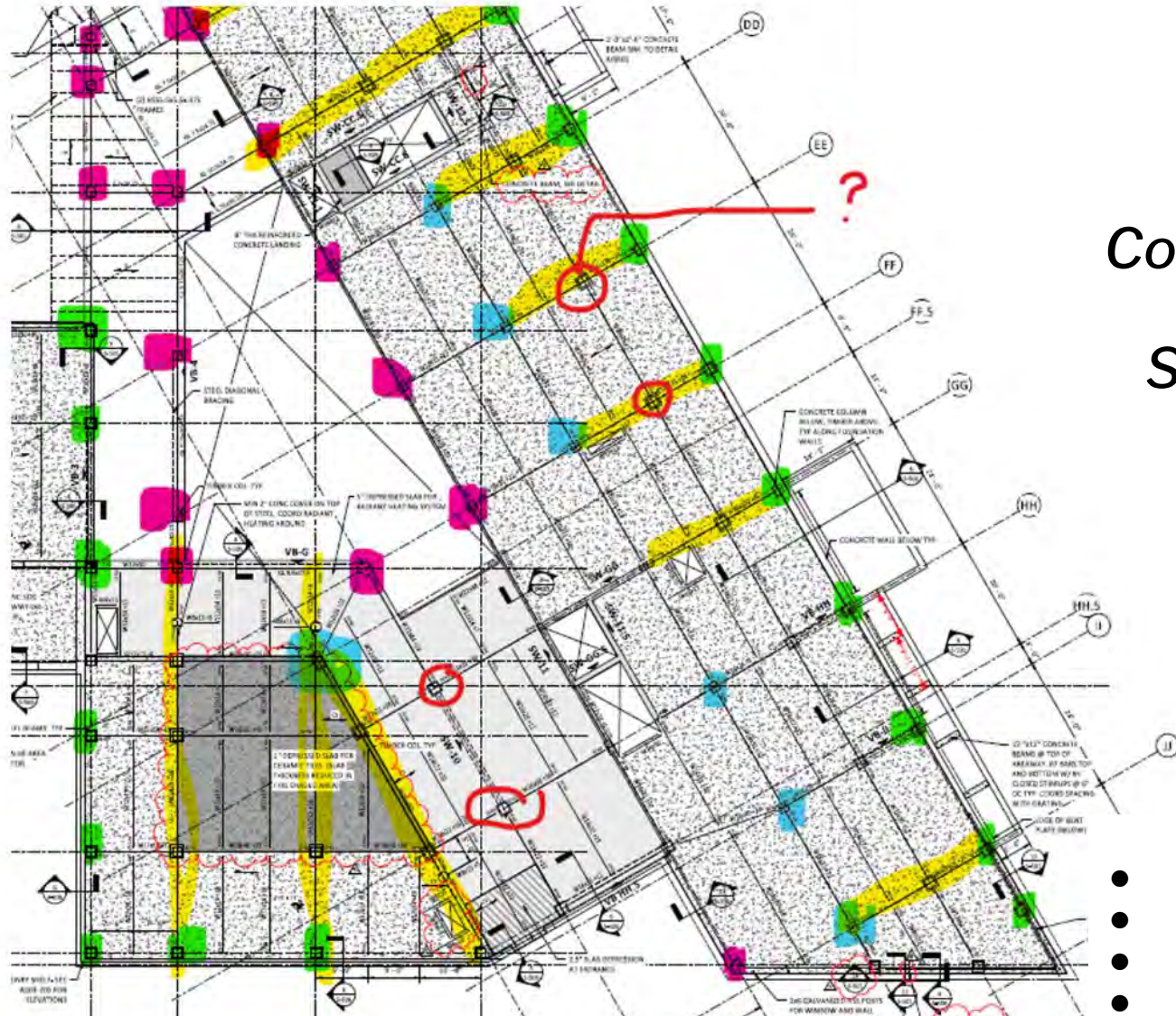
CLT walls

Steel beams and columns

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

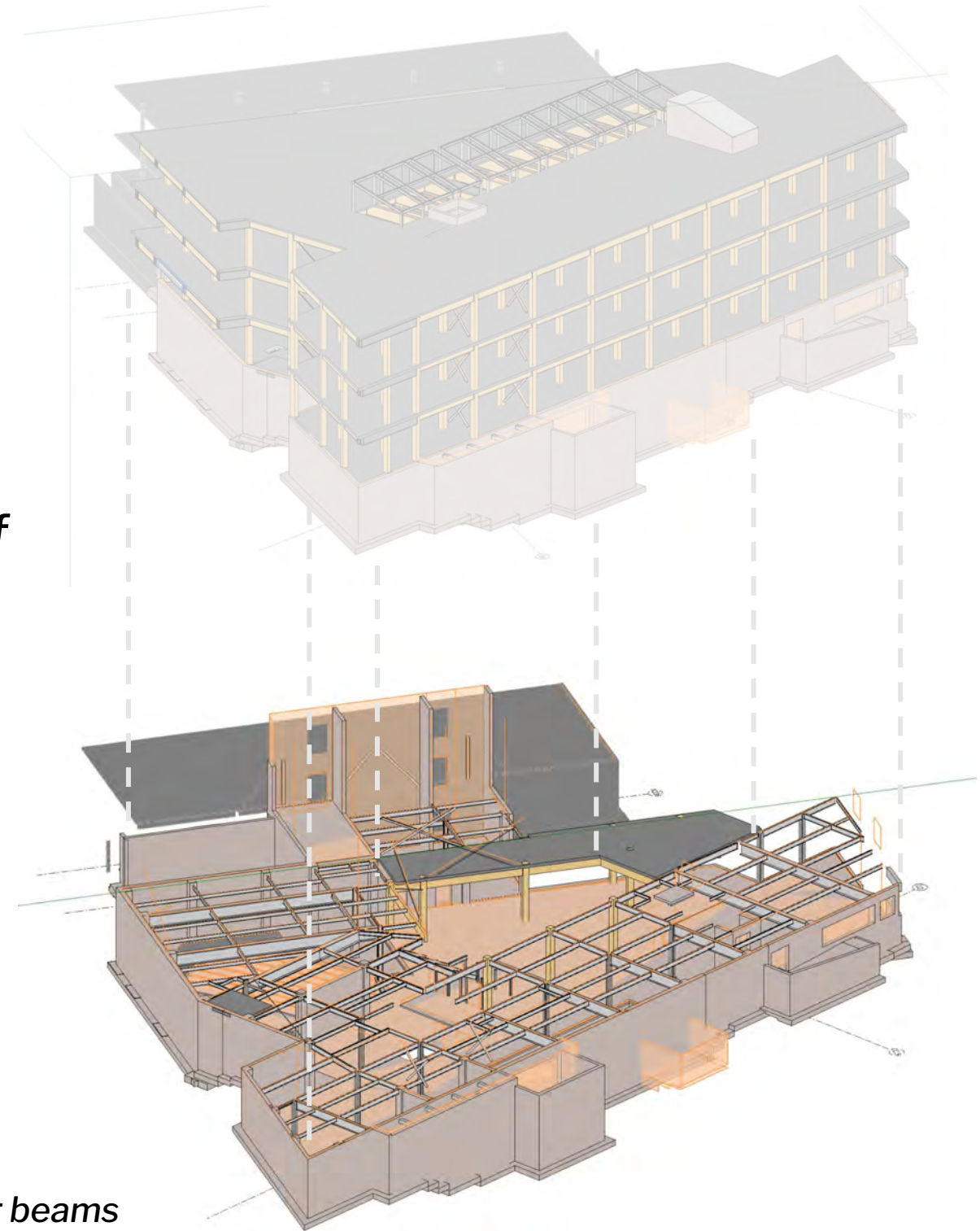
5 ply CLT floor with 2" concrete topping and insulation

What if.....

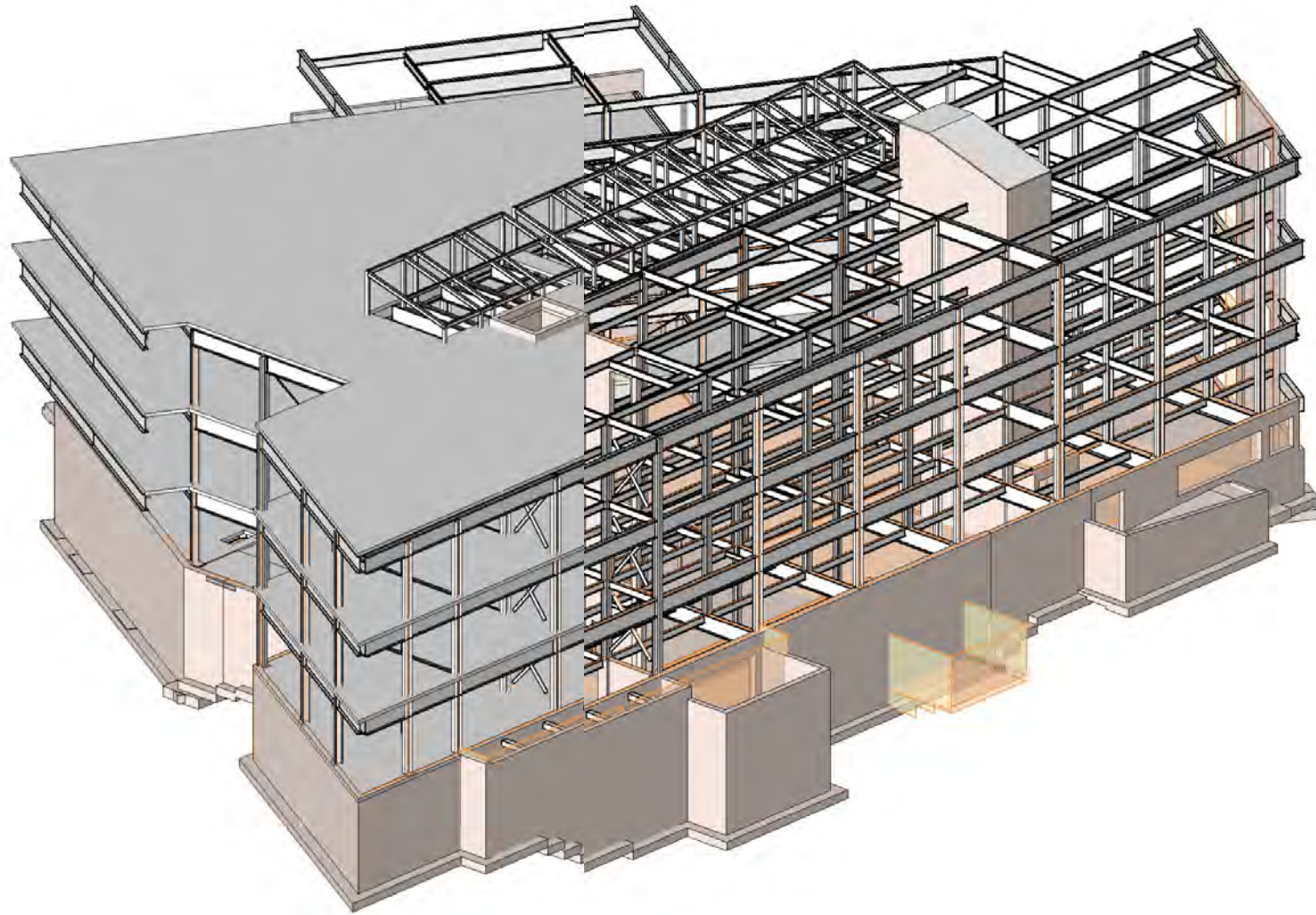


How will the
Beams and
Columns change if
this was a
Steel-Concrete
Composite?

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



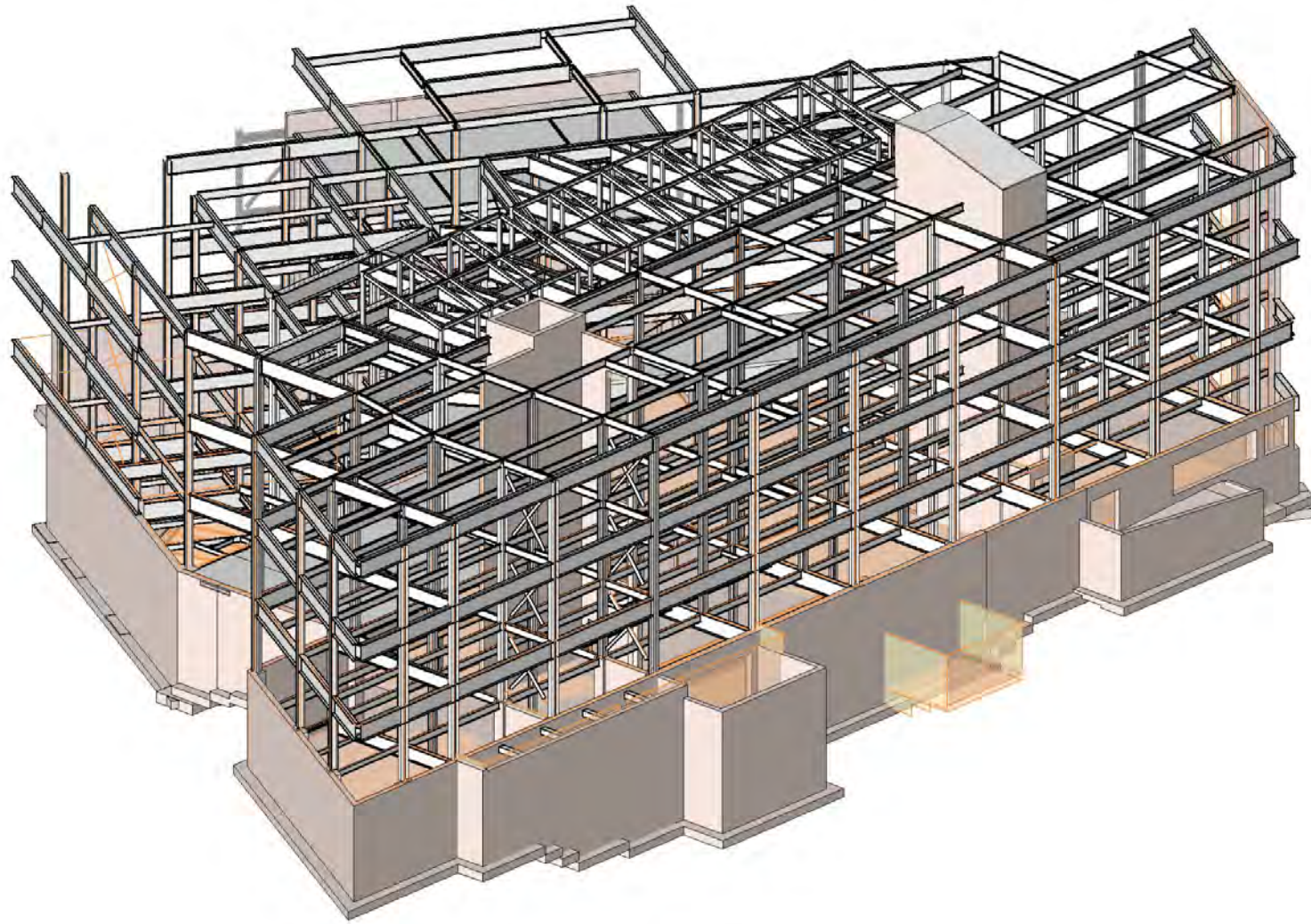
A hybrid structure = A resource for a baseline



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



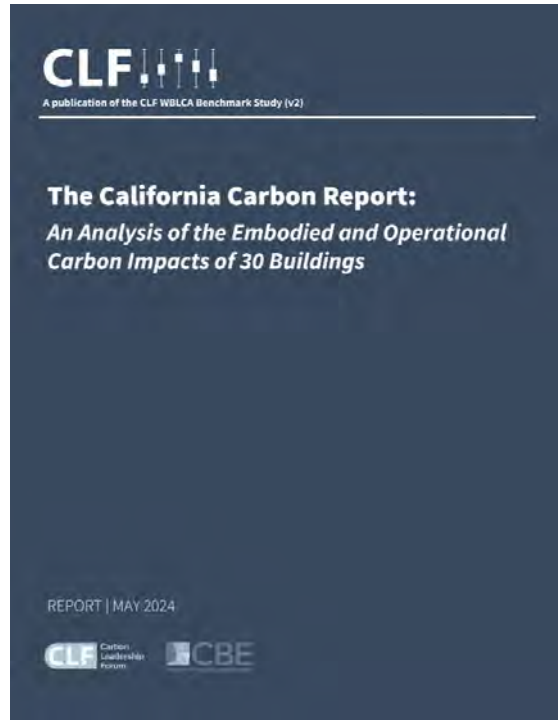
A steel baseline



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

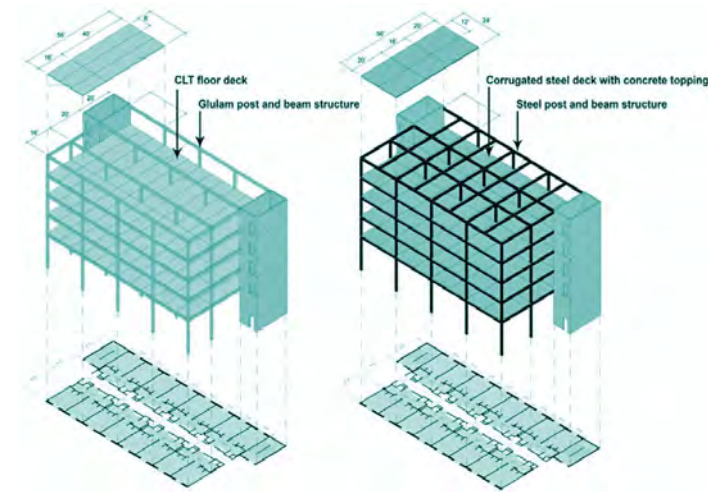
Time: Negligible
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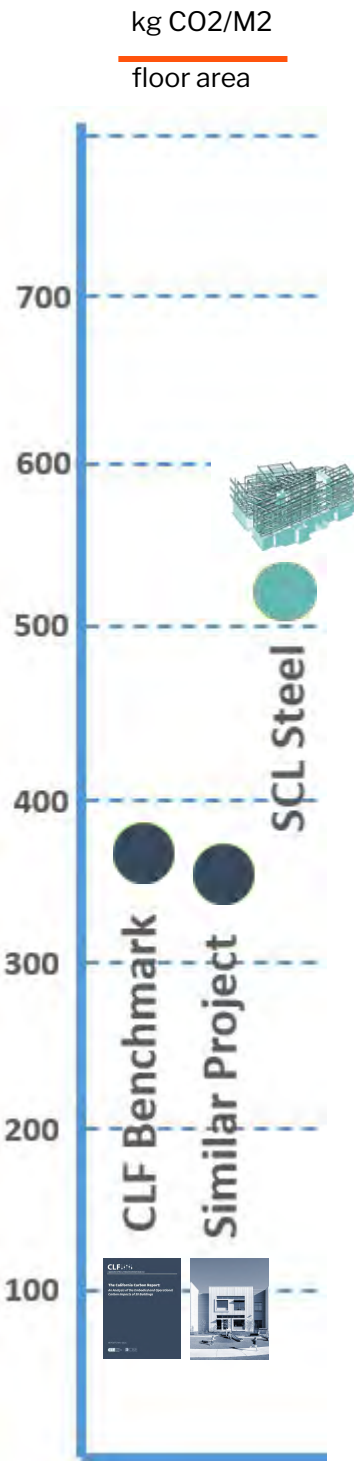
Compare to similar project

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?

kg CO2/M2

floor area

CLT AND GLULAM WITHOUT BIOGENIC

42%
↓



312
kg CO2/M2

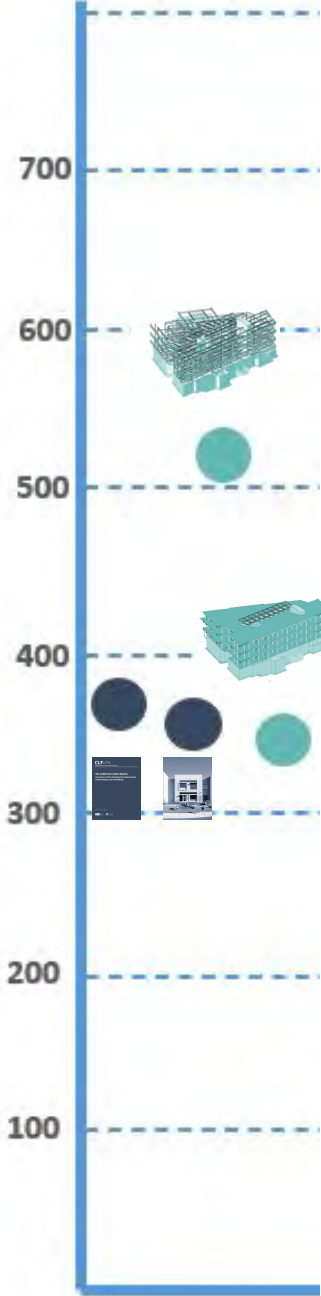
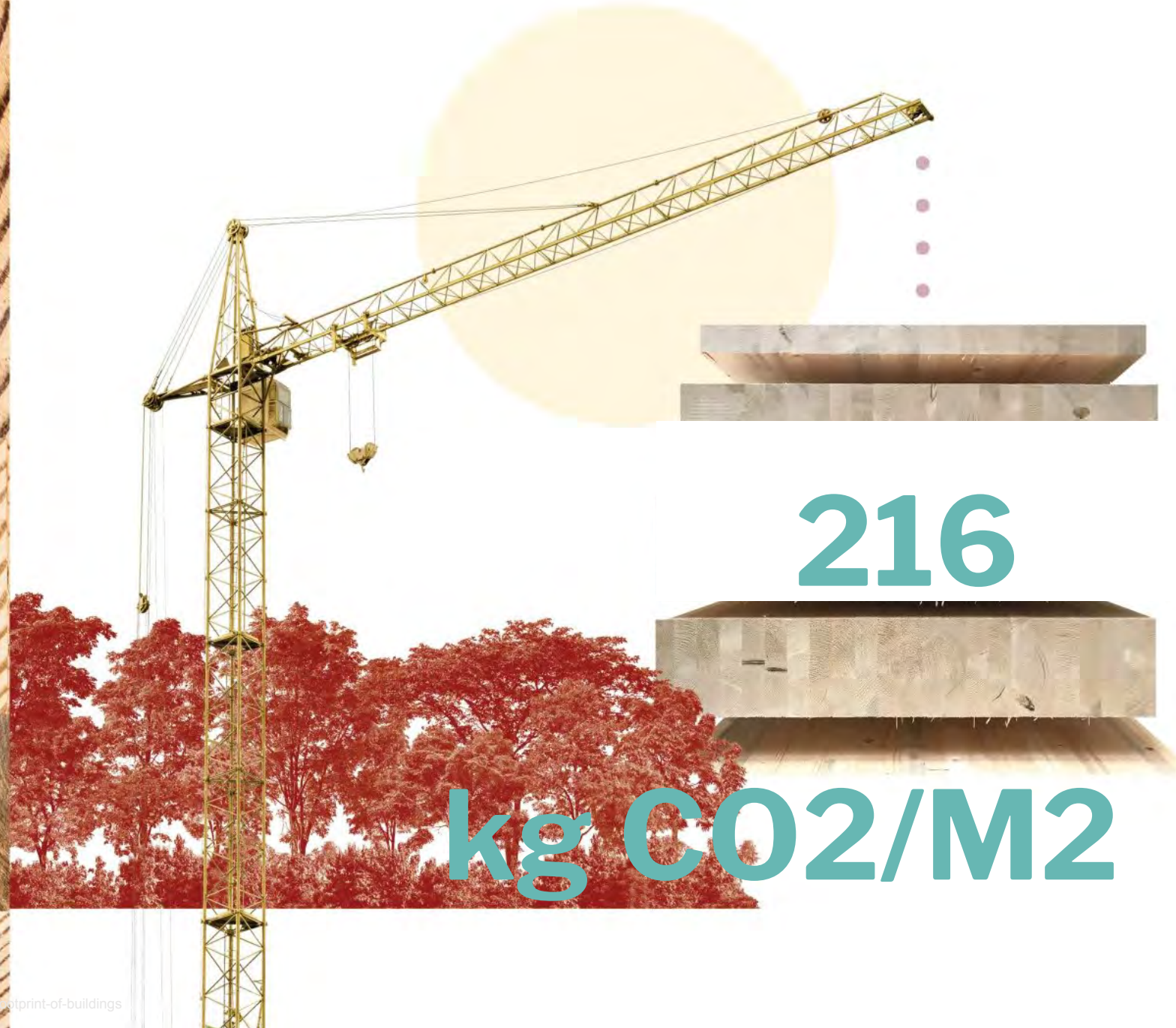


Image source: www.cannondesign.com/perspectives/is-mass-timber-the-solution-to-the-massive-carbon-footprint-of-buildings

Wood including biogenic

CLT AND GLULAM WITH BIOGENIC

59%
↓



216

kg CO2/M2

kg CO2/M2

floor area

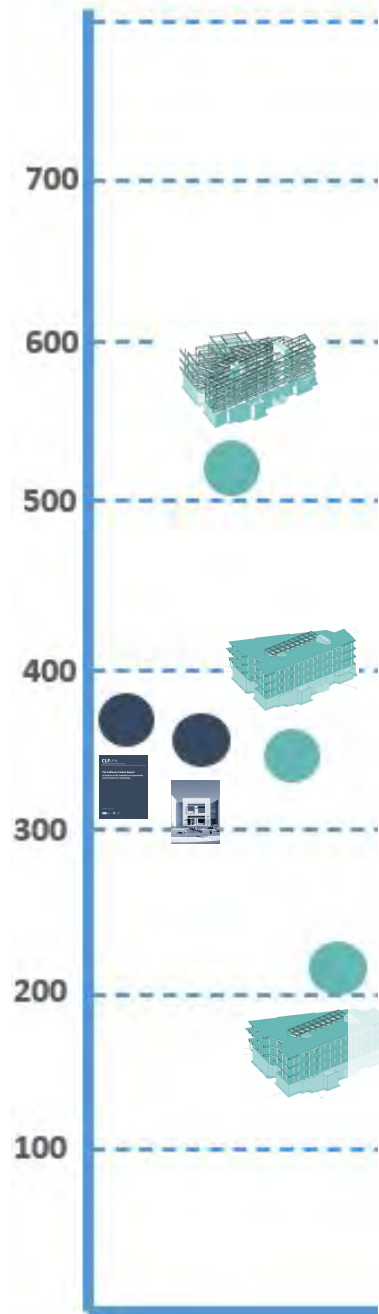
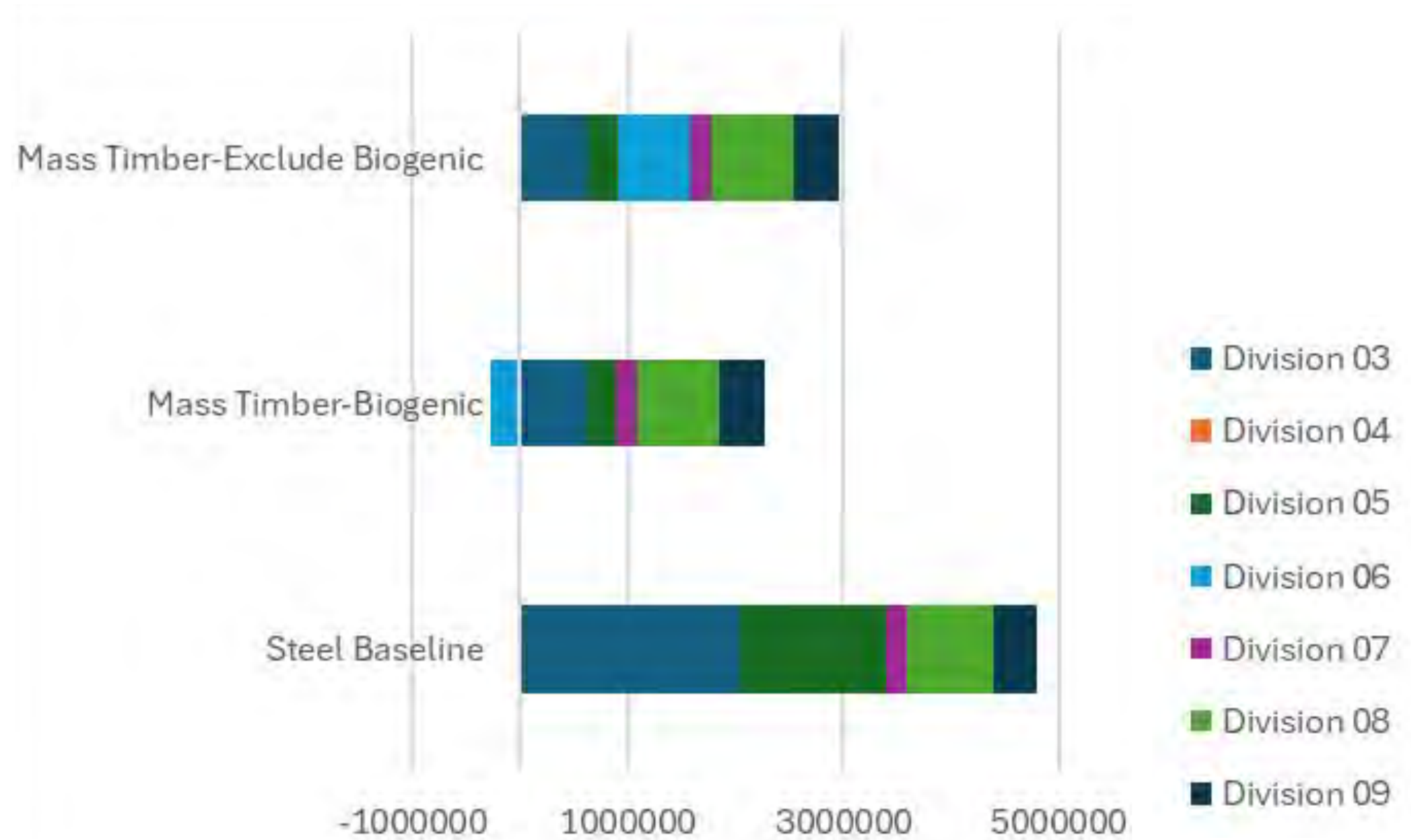
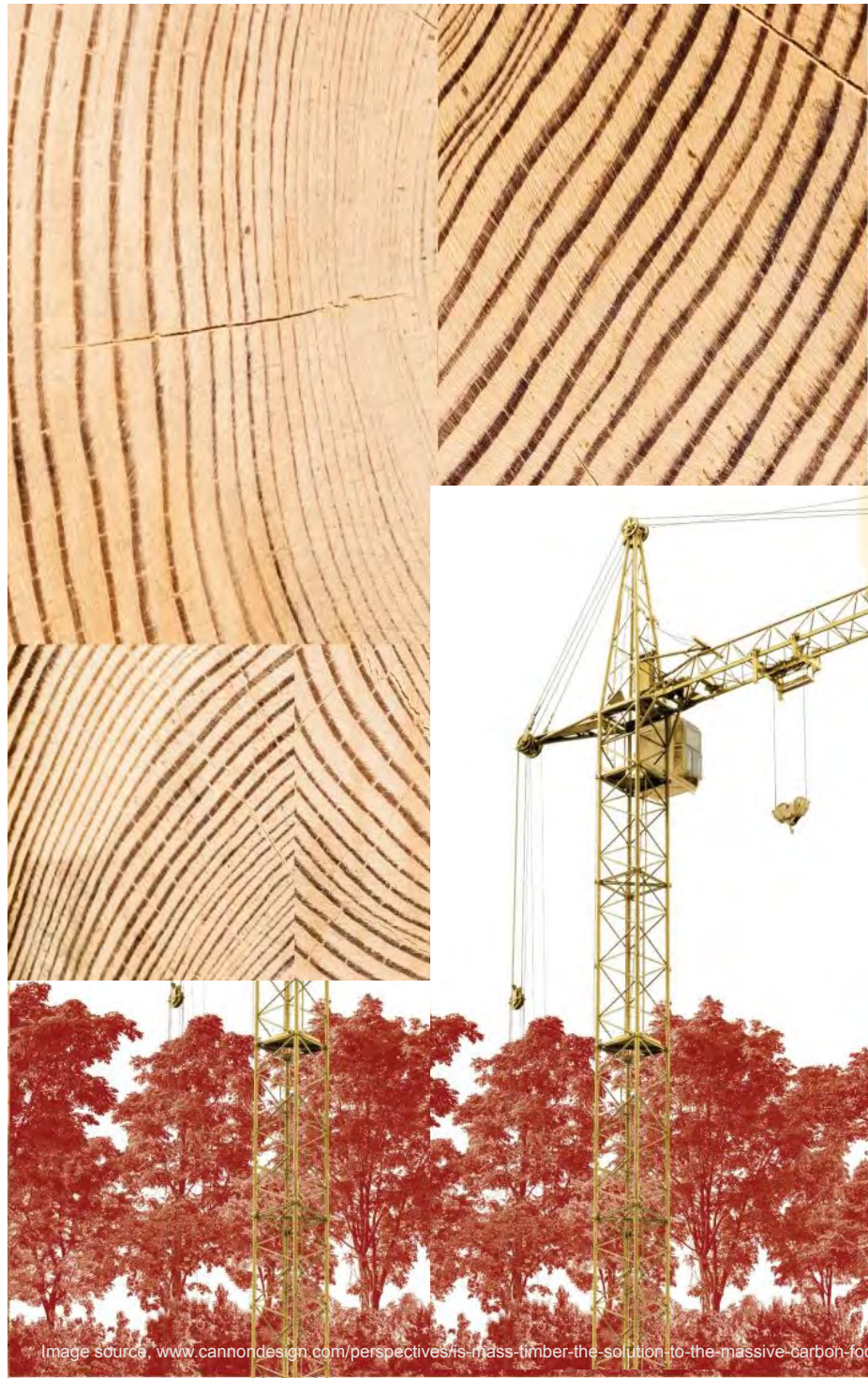


Image source: www.cammondesign.com/perspectives/is-mass-timber-the-solution-to-the-massive-carbon-footprint-of-buildings

Which are the main contributors?

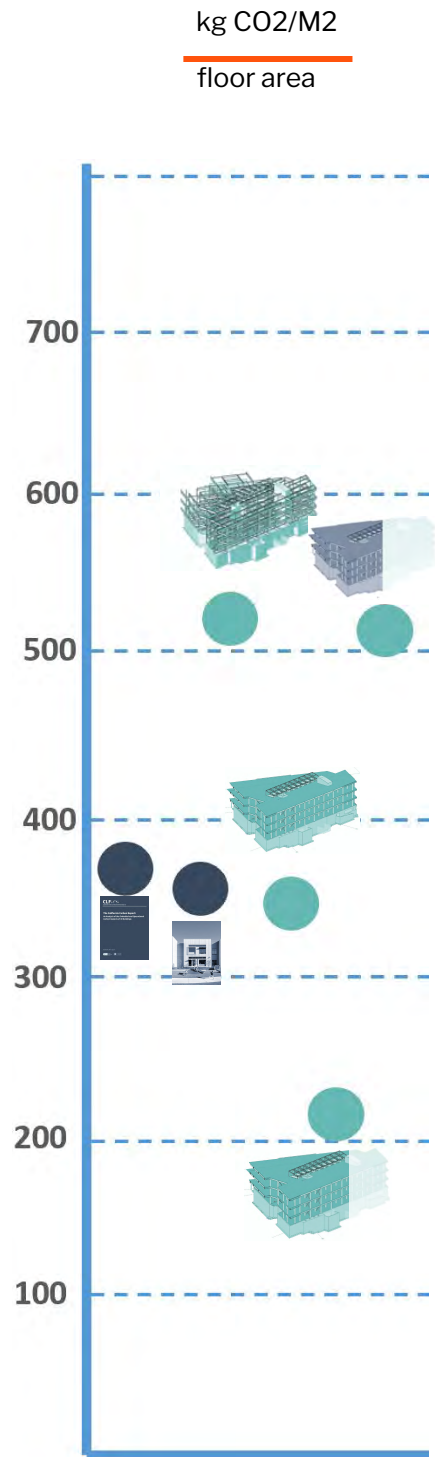


...and ECG, what role does it play?

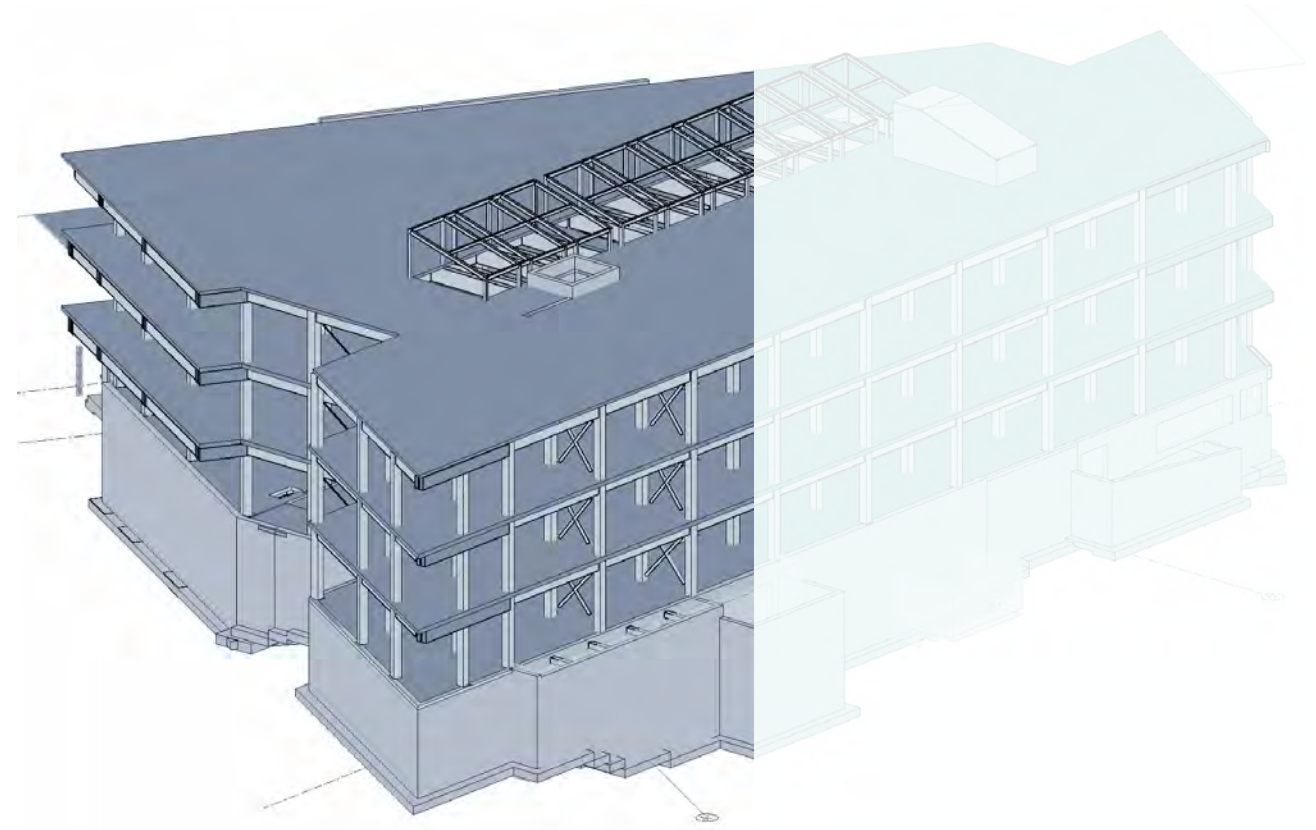
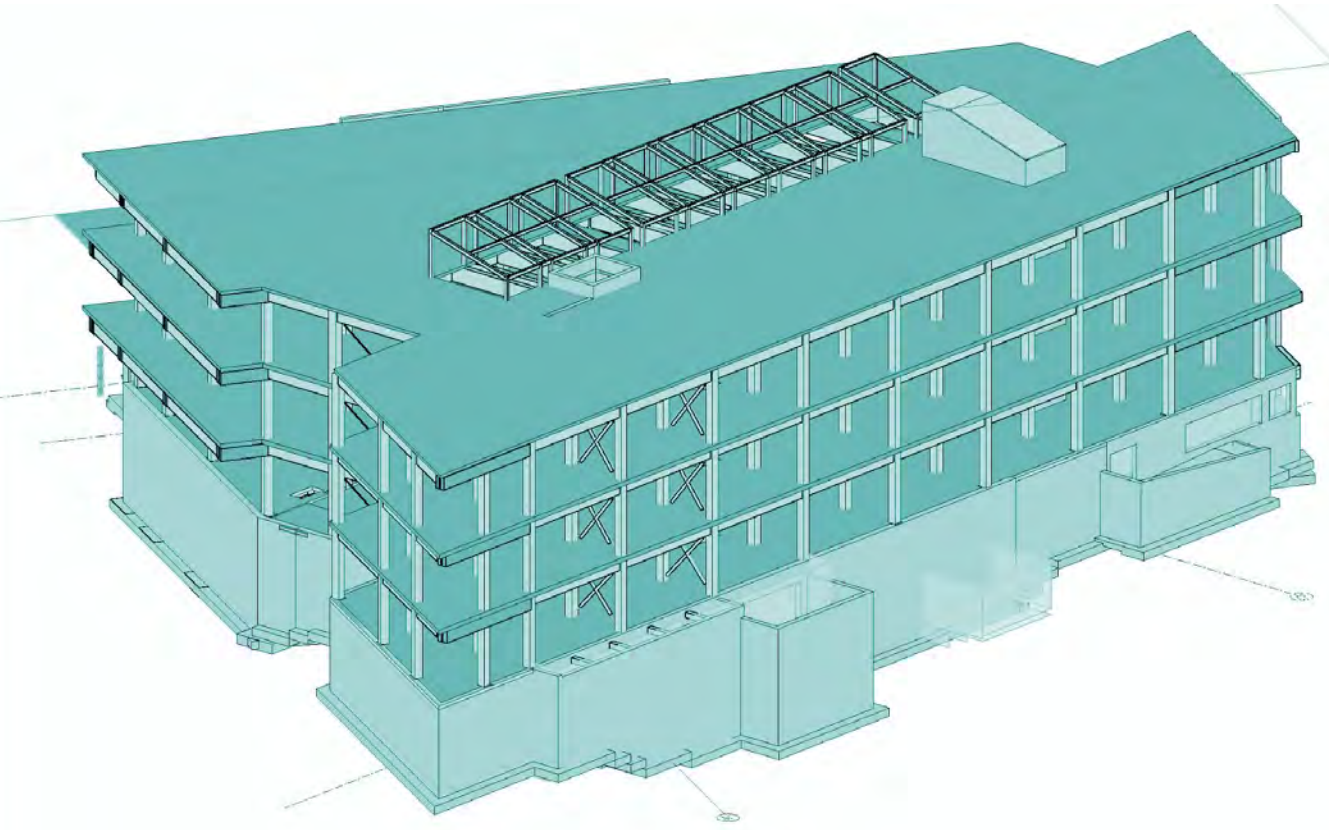


>

216
kgCO2e/M2
CLT AND GLULAM WITH TRIPLE PANE GLASS



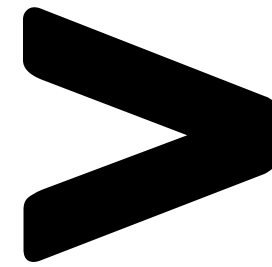
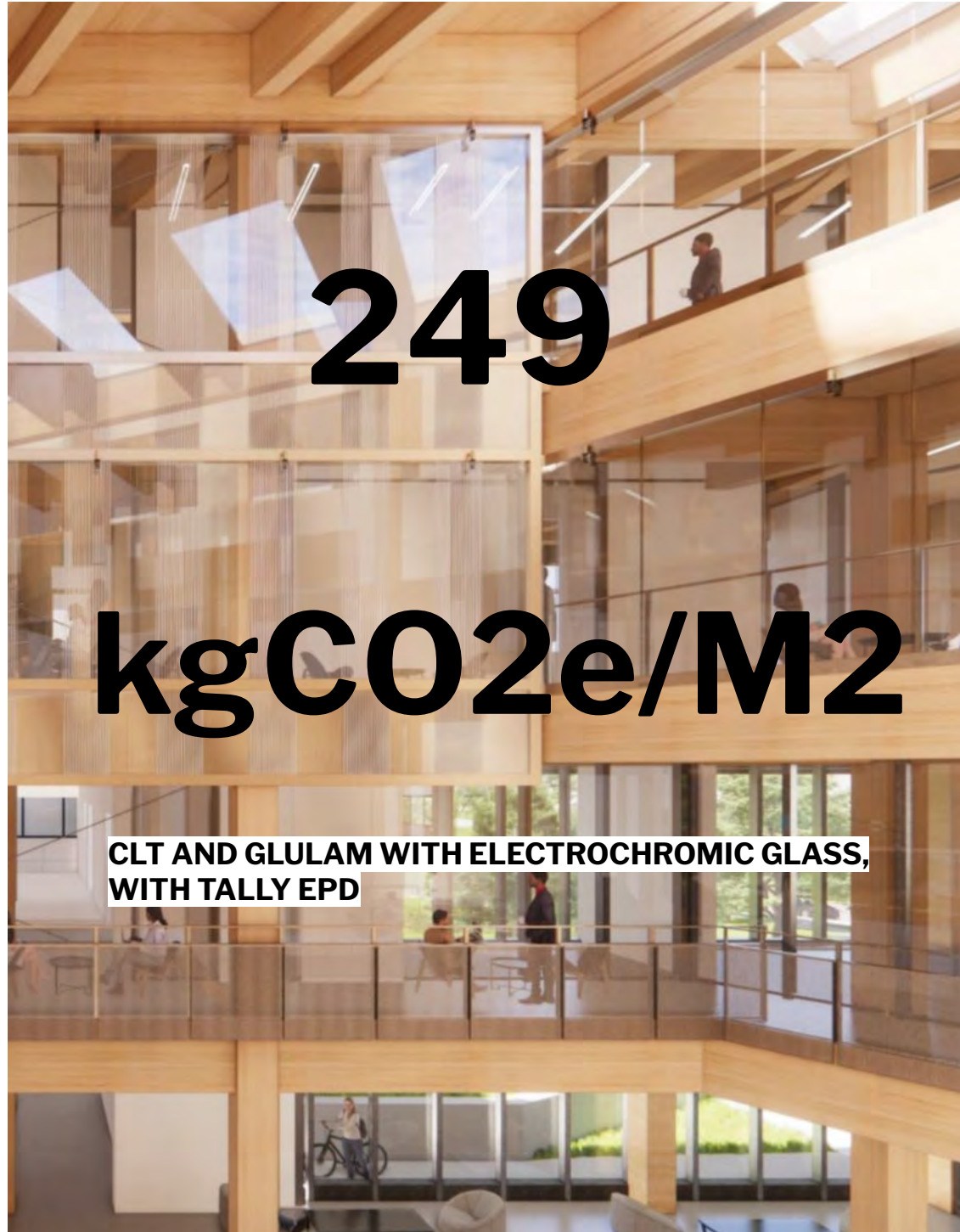
...magnitude?



100%
kg CO2e/M2

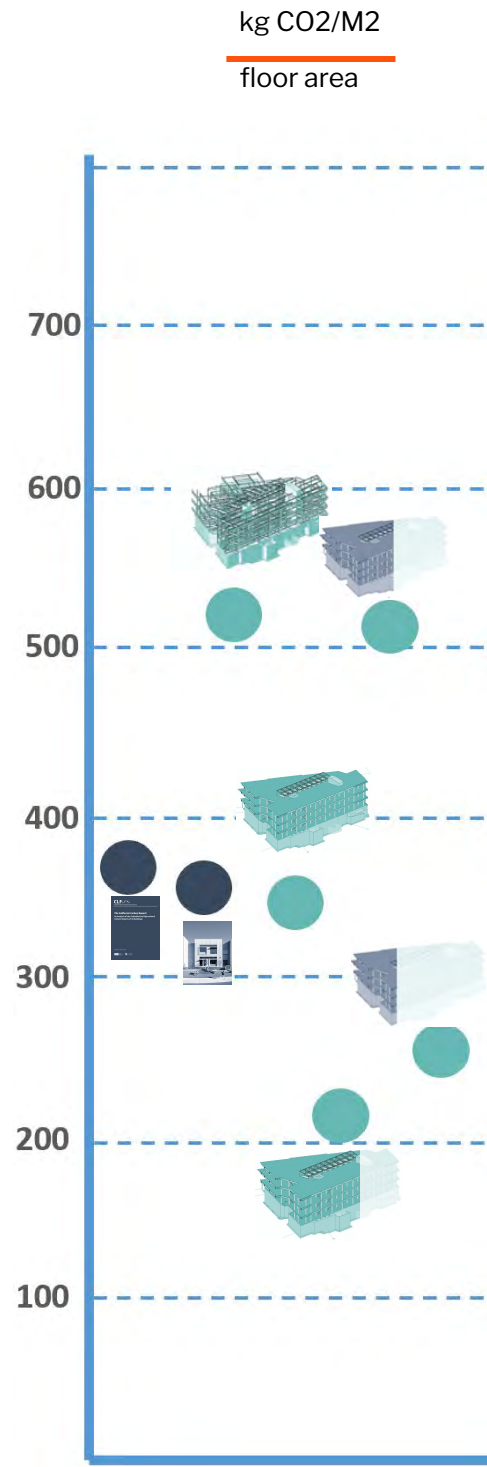
50%
kg CO2e/M2

Product specific EPD



216
kgCO₂e/M²

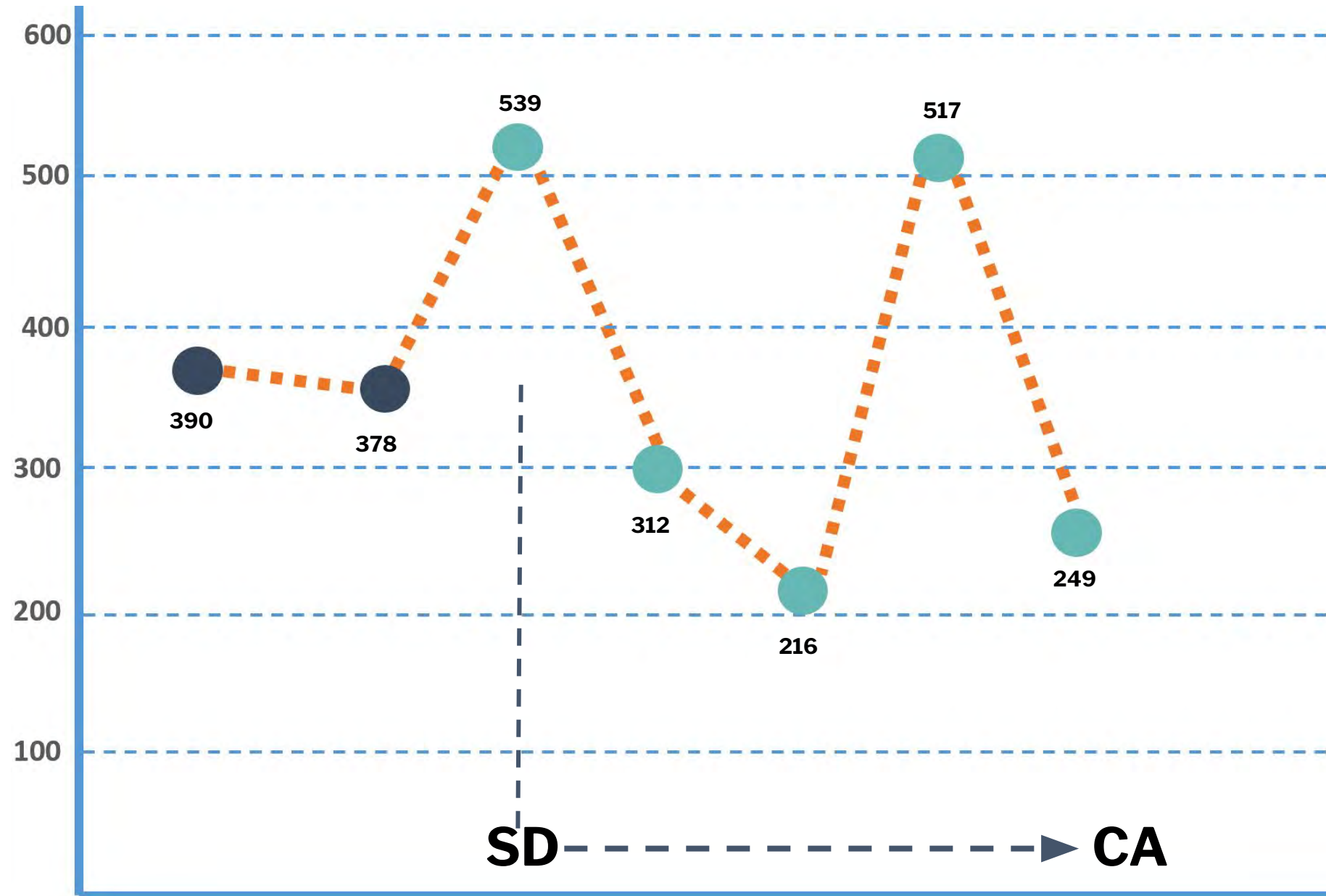
CLT AND GLULAM WITH ELECTROCHROMIC GLASS,
WITH PRODUCT SPECIFIC EPD



Friend or Foe?



Final results recap



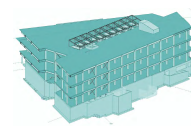
CLF baseline



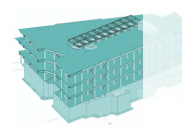
Similar model



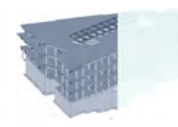
Steel Baseline



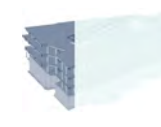
Mass Timber



Mass Timber Biogenic

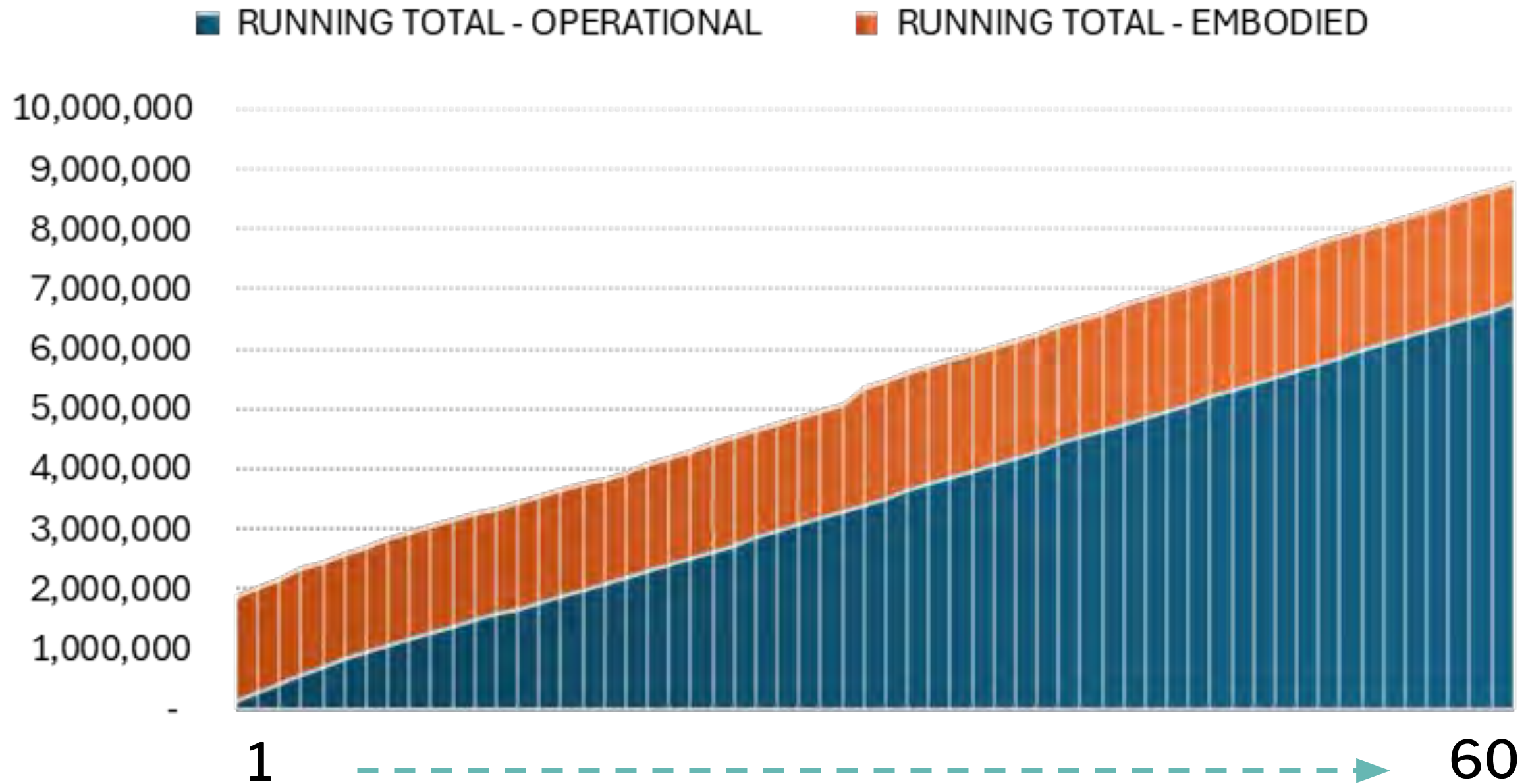


ECG



ECG Specific EPD

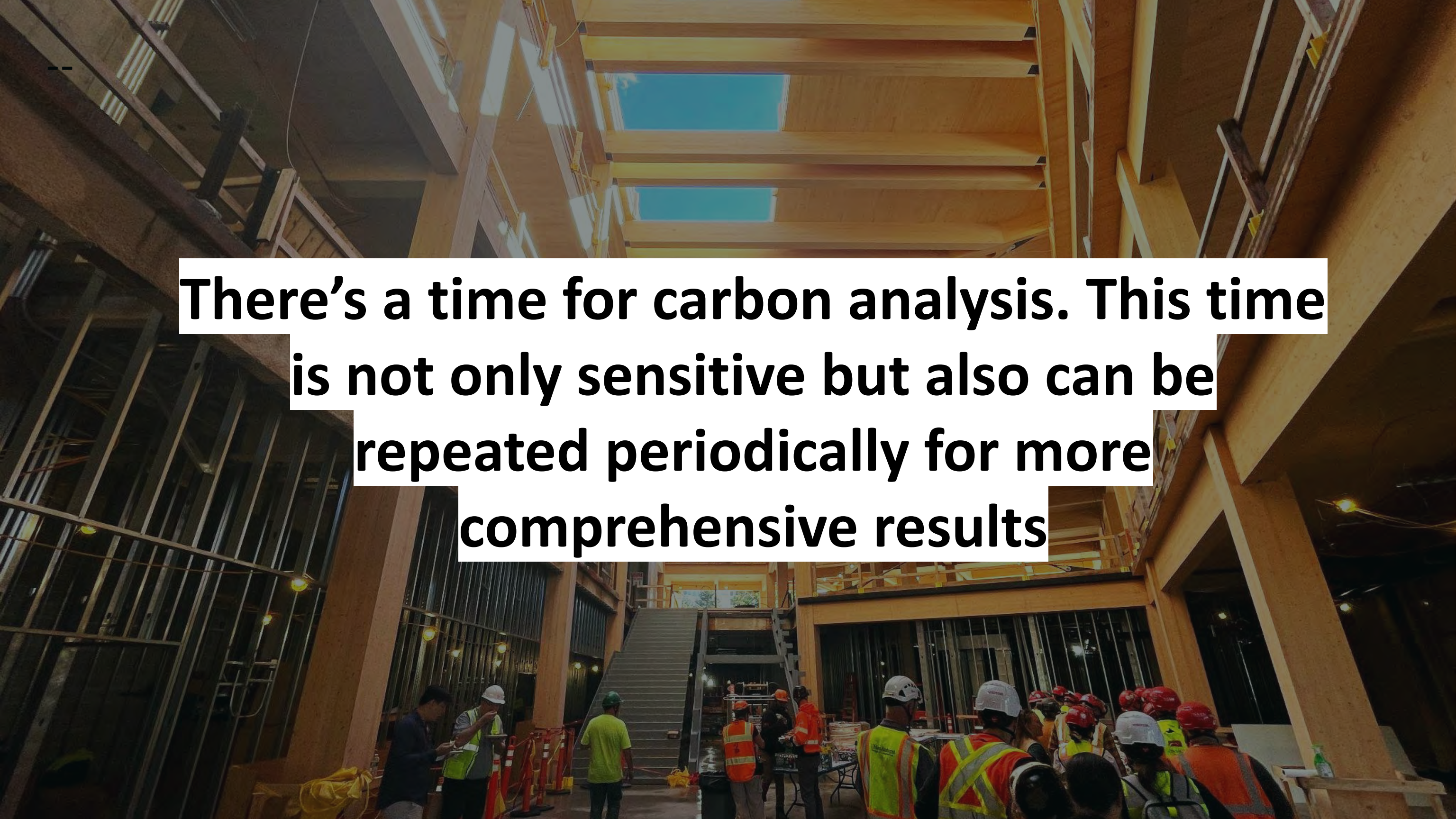
Whole Life Carbon Emissions



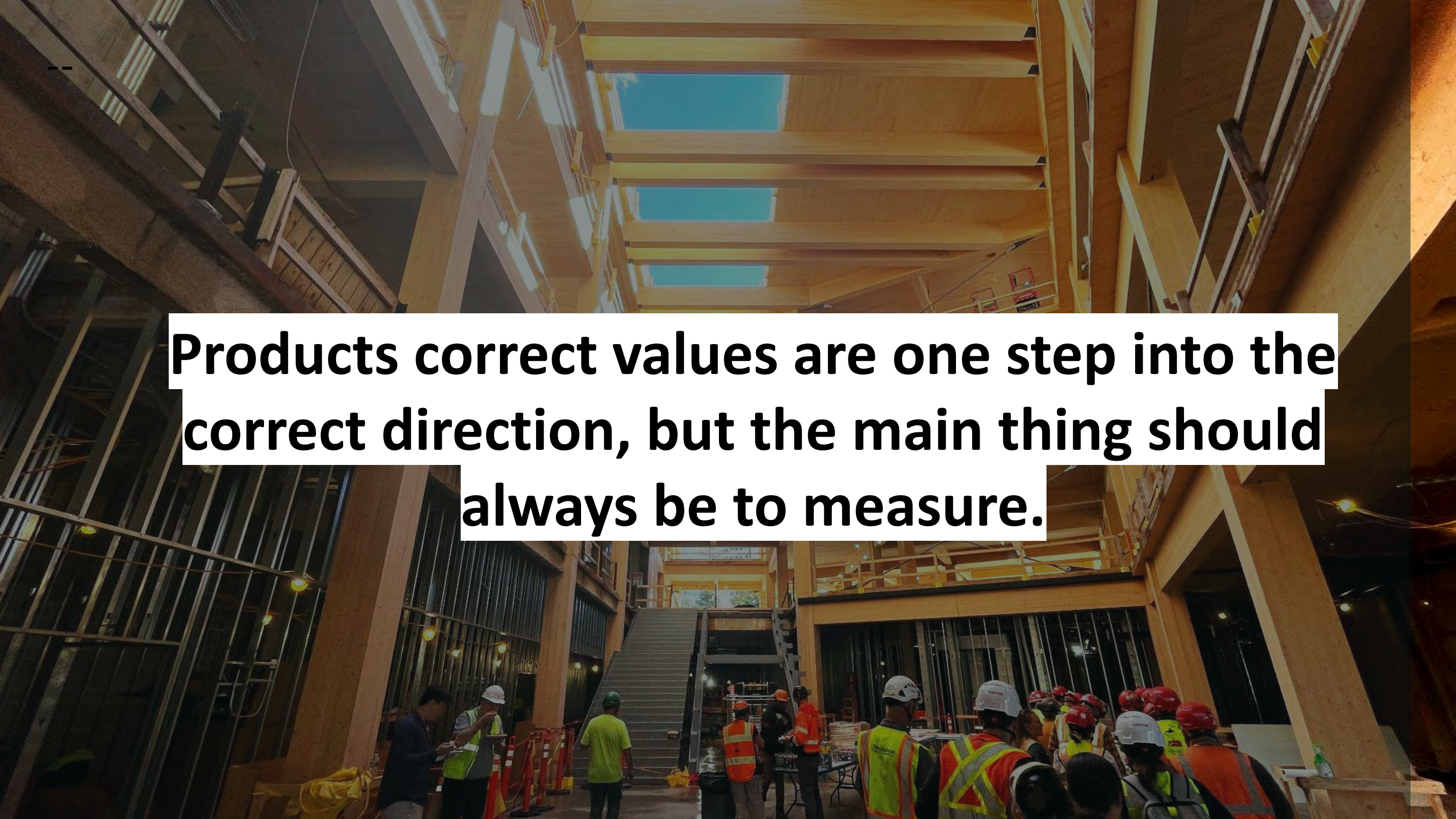


There's no Friend nor Foe in this challenge.

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.

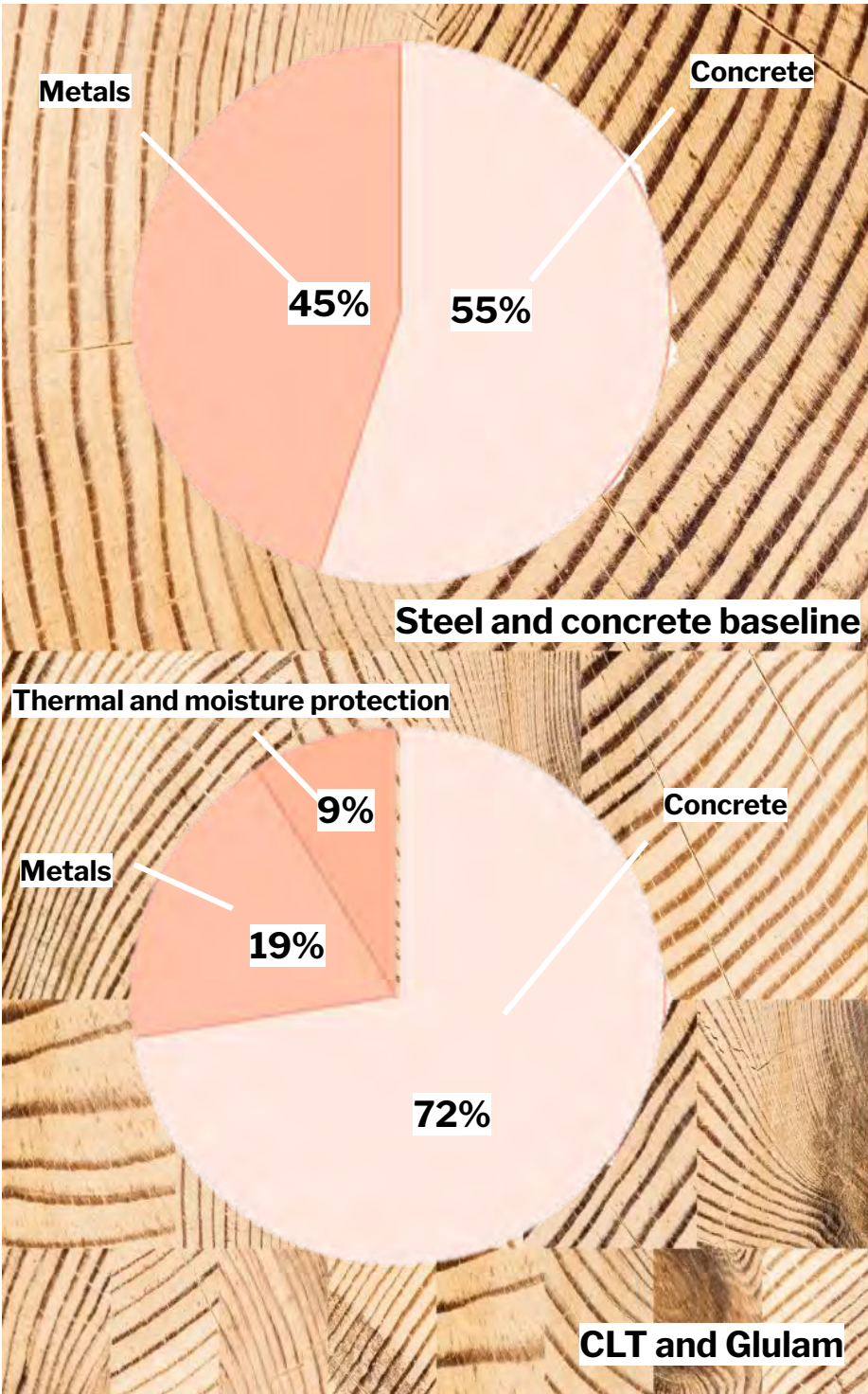


Thank you

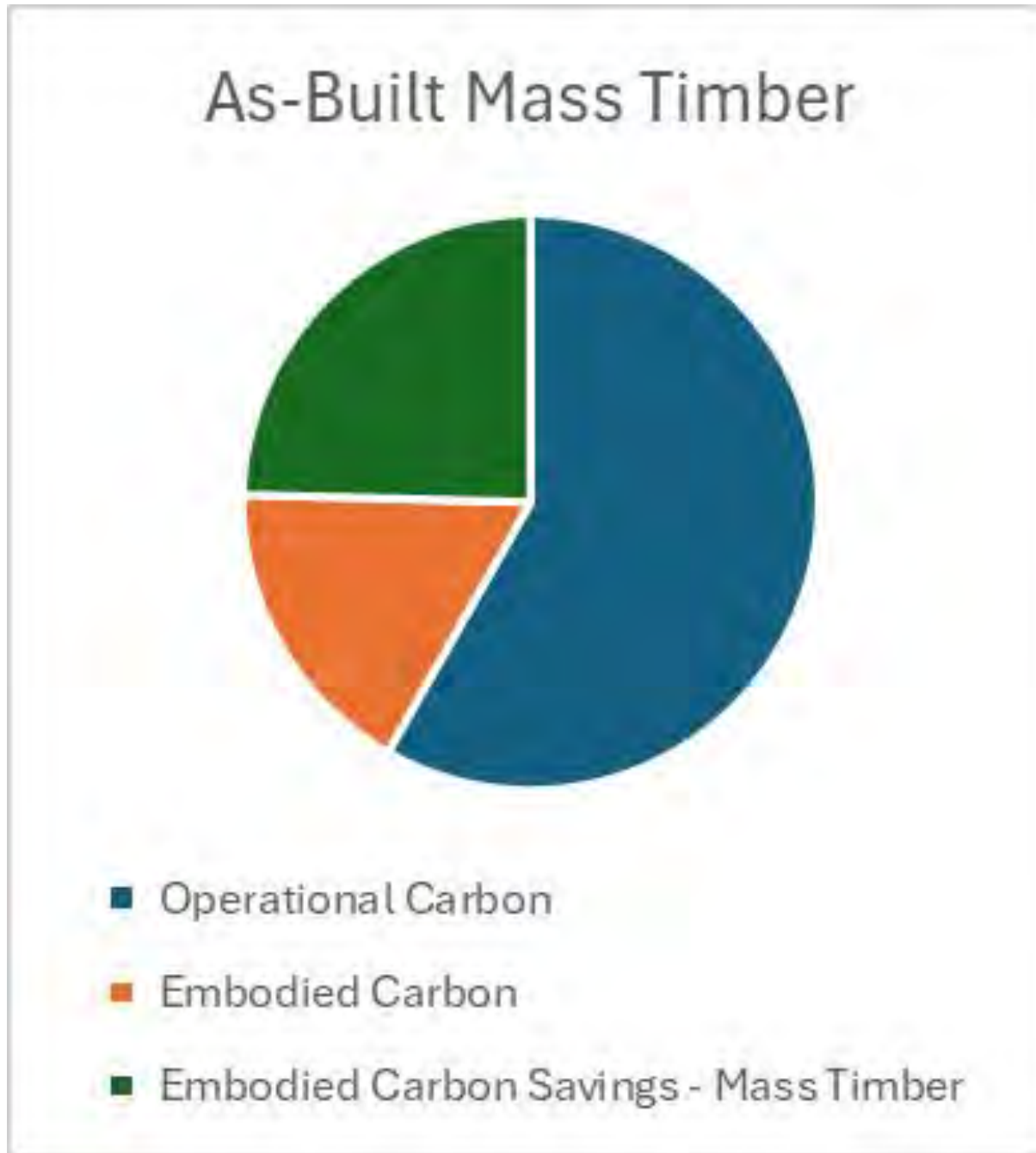
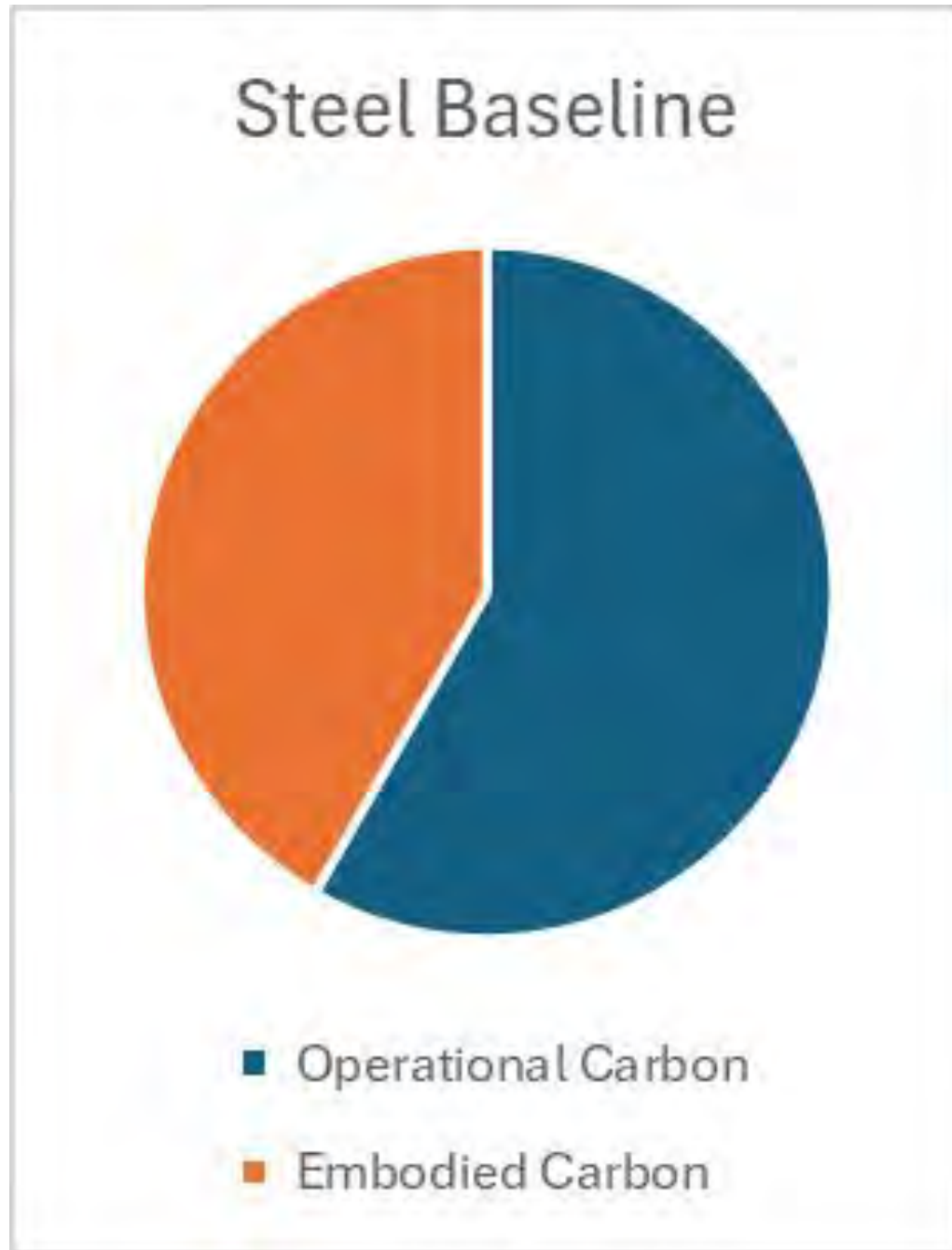
Which are the main contributors?

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



NOT SURE WHERE TO PUT THIS - LET'S DISCUSS

christi

