Health Sciences Education Building University of Washington

Carbon Analysis

August 04, 2022

AGENDA

Introductions

Sustainability Goals
Why is Tracking Carbon Important

Project Overview
Small Studies
Full Building Analysis
Lessons Learned

Questions/Discussion

INTRODUCTIONS

Chris Hellstern, Associate

Living Building Challenge Services Director

Elizabeth Moggio, Principal

HSEB Project Manager

Brie McCarthy
Research & design staff

LCA modeler

Katherine Martin
Research & design staff

LCA modeler

Alex Ianchenko
Research & design staff

Data analyst

UW GREEN BUILDING STANDARDS

LEED Gold,
minimum

15% More efficient than
local code

50% Reduction of potable
water from current code
baseline

WHY CARBON TRACKING IS IMPORTANT

“EMBODIED CARBON”
REPRESENTS GREENHOUSE GAS EMISSIONS THAT ARE RELEASED DURING PROCESSES ASSOCIATED WITH BUILDING MATERIALS.

Material extraction

Manufacturing

Installation

Disposal

WHERE DOES EMBODIED CARBON FIT WITHIN UW'S SUSTAINABILITY ACTION PLAN?

X. 45% REDUCTION OF GREENHOUSE GAS EMISSIONS BY 2030

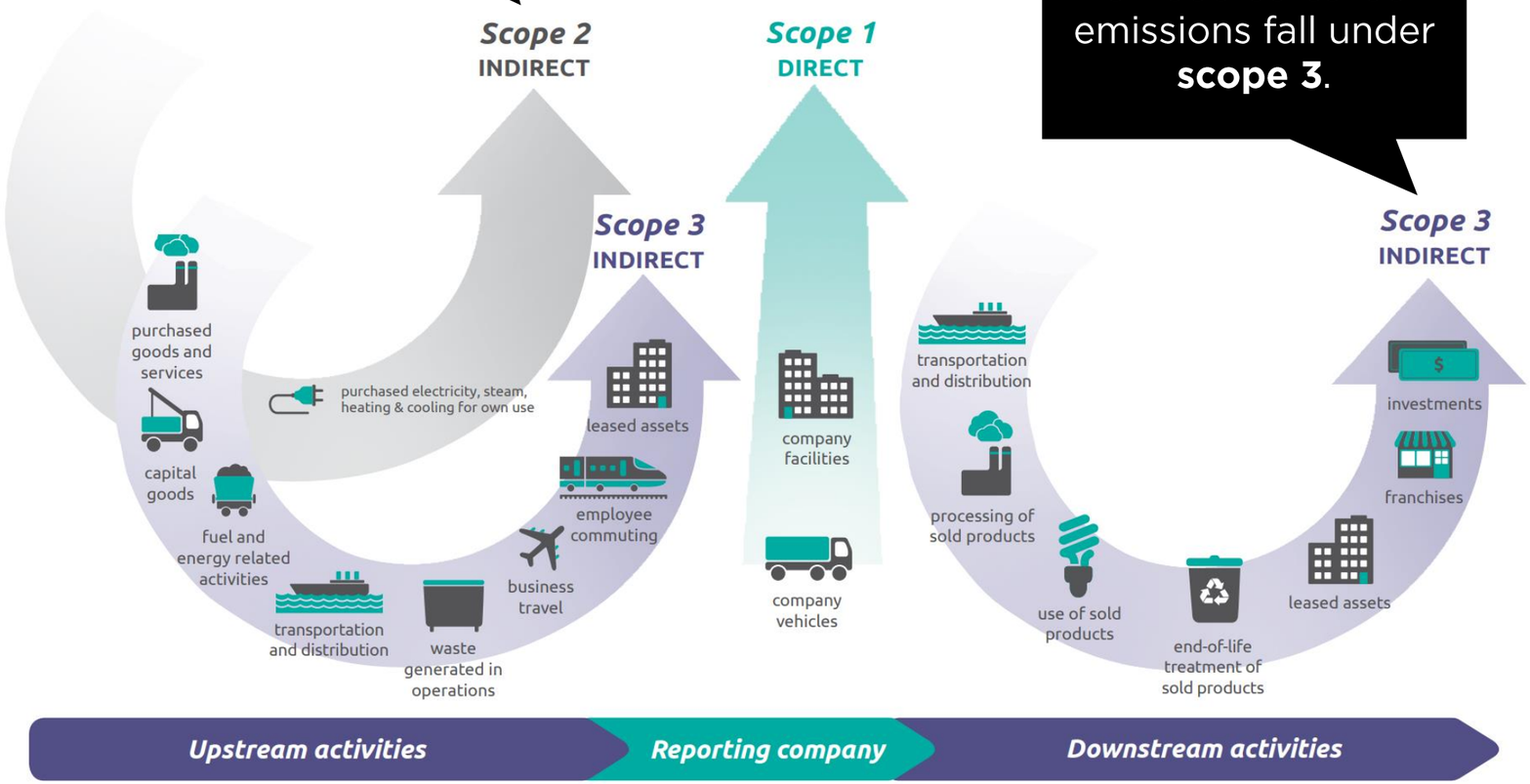
Target Actions

- Electrify UW Transportation Services
- Plan to repower the Seattle campus
- Implement Campus Solar Plan

sustainability-action-plan-fy2022-final.pdf (uw.edu)

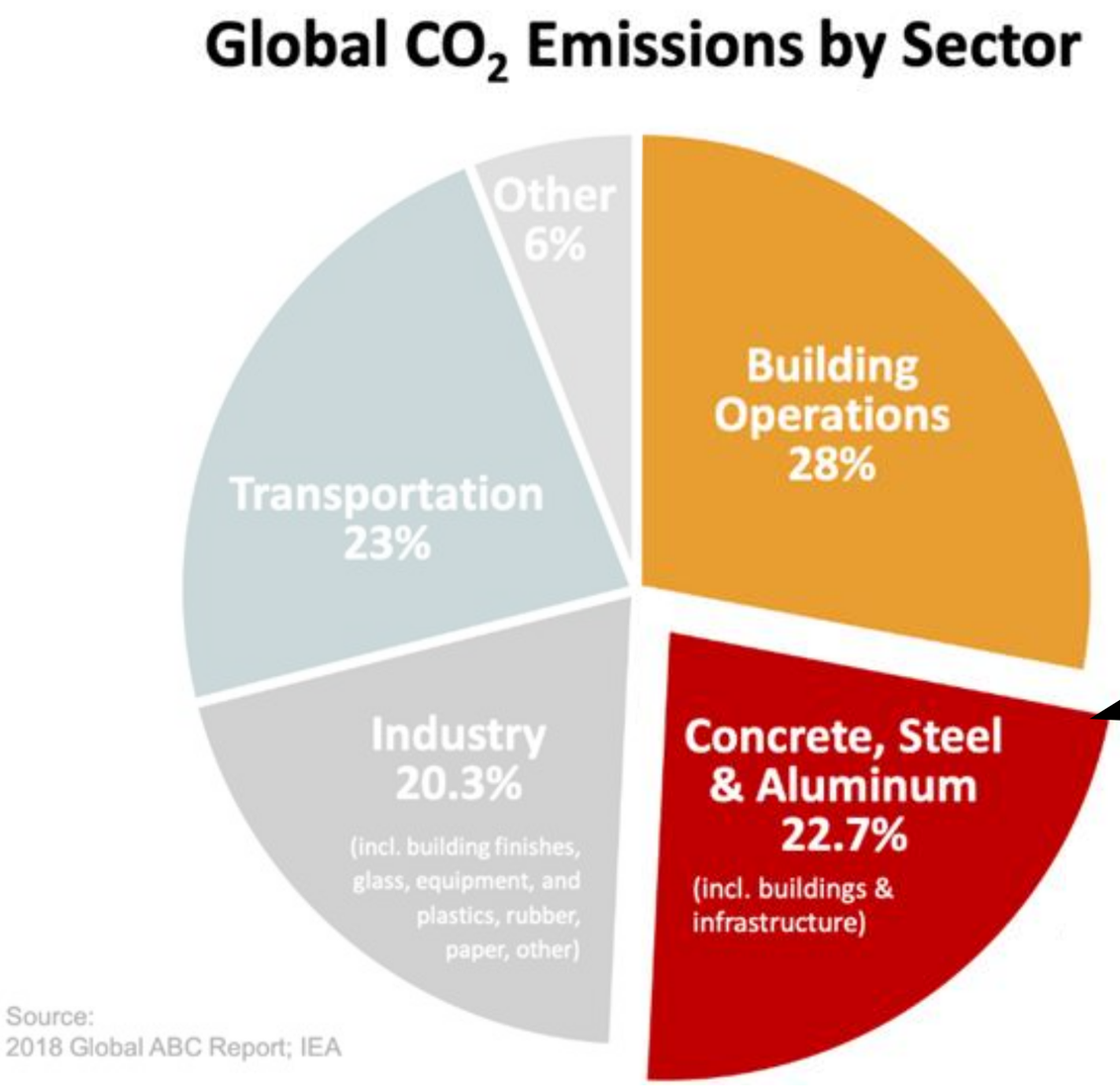
UW's target actions reduce **scope 1 & scope 2** emissions...

...embodied carbon emissions fall under **scope 3**.



Greenhouse Gas Protocol: Corporate Value Chain (Scope 3) Accounting and Reporting Standard : Supplement to the GHG Protocol Corporate Accounting and Reporting Standard. 2011. Washington, DC]; [Geneva, Switzerland: World Resources Institute ; World Business Council for Sustainable Development.

WHERE DOES EMBODIED CARBON FIT WITHIN GLOBAL EMISSIONS?



Source:
2018 Global ABC Report; IEA

This is the embodied carbon associated with **making our built environments.**

If we do not address embodied emissions, we will never meet climate targets.

Read more:

United Nations Environment Programme. "**2020 Global Status Report for Buildings and Construction: Towards a Zero-Emissions, Efficient and Resilient Buildings and Construction Sector**." Nairobi, 2020. https://globalabc.org/resources/publications/2020-global-status-report-buildings-and-construction.

The global building stock is projected to double in area between now and 2060.

Read more:
Edward Mazria. *It's Time to Quit: A Call to Action on Climate, Carbon, and the Built Environment.* Architect Magazine, 15 Jan. 2020

THE MORTALITY COST OF CARBON

A new study finds that the lifetime emissions from 3 Americans will result in the death of 1 person.

Under this scenario, **climate change would cause 83 million excess deaths by 2100** (conservatively).

Read more:

Bressler, R. Daniel. "The Mortality Cost of Carbon." *Nature Communications* 12, no. 1 (July 29, 2021): 4467. https://doi.org/10.1038/s41467-021-24487-w.

EMISSION ZERO IS AN INITIATIVE TARGETING THE ELIMINATION OF GREENHOUSE GAS EMISSIONS INCURRED BY THE PROJECTS WE DESIGN.

DESIGN

EDUCATE

ADVOCATE

OFFSET

Kendeda Building for Innovative Sustainable Design
Georgia Tech, Atlanta, GA

We champion the use of new integrative design processes that **address embodied carbon**, in addition to our **ongoing commitment to design every building for carbon-neutral operation by 2030**.

Kendeda Building for Innovative Sustainable Design
Georgia Tech, Atlanta, GA

We use our own resources to provide a **sustainable analysis for every project** to show our clients how their project can do less environmental harm.

Bullitt Center, Seattle, WA

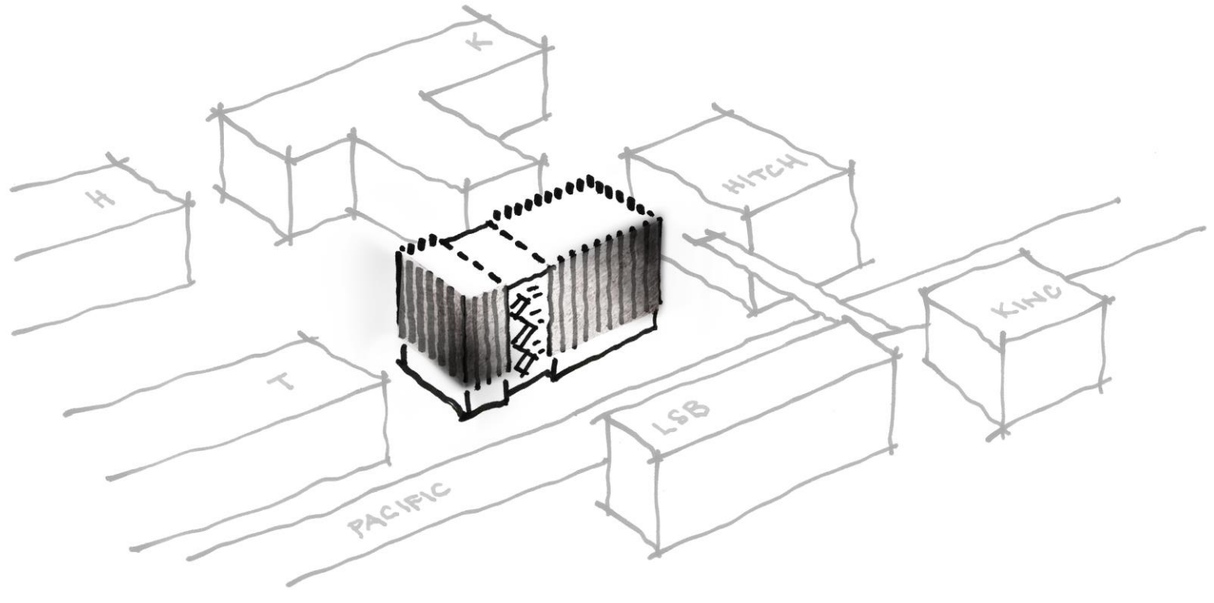
At every possible opportunity, we campaign for systemic and structural changes at all levels that **decarbonize the electric grid** and **restrict the continued use of fossil fuels**.

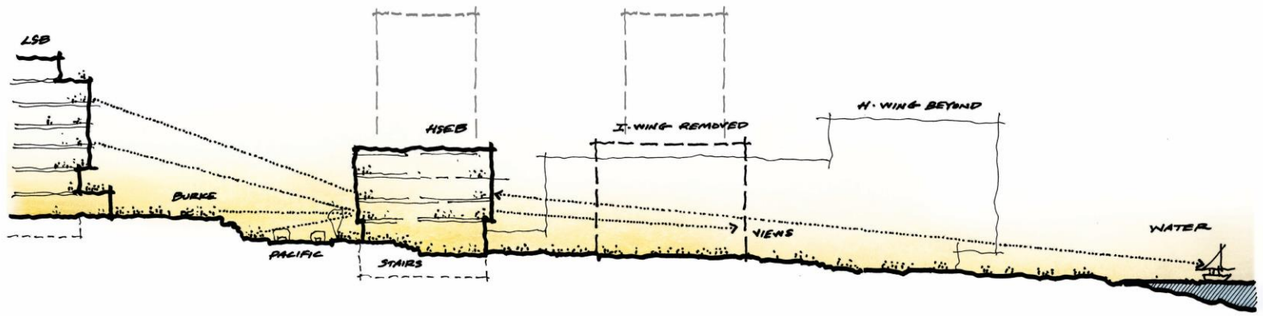
Miller Hull is committed to quantifying the upfront embodied carbon of every project we finish through construction and purchasing third-party certified carbon offsets equivalent to **1/3 of every project's impact** upon project completion.

HEALTH SCIENCES EDUCATION BUILDING - OVERVIEW

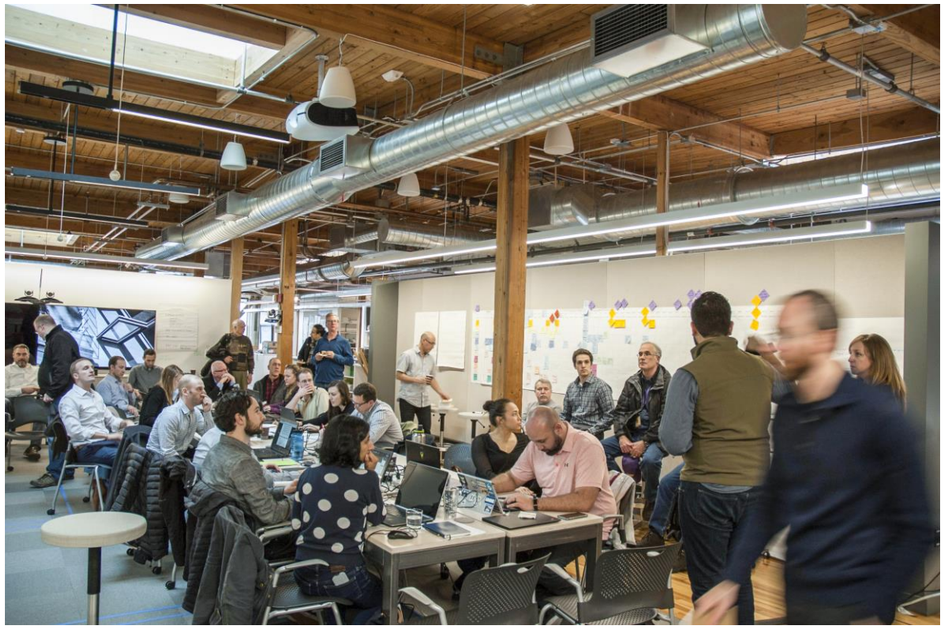
PROJECT INTRODUCTION

UW SEATTLE
SOUTH CAMPUS



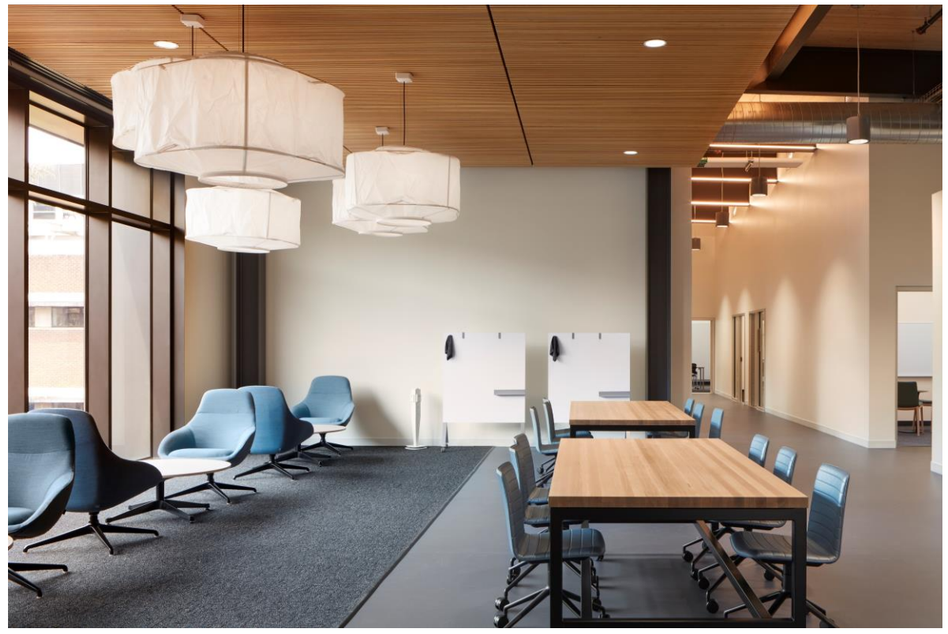


PROJECT INTRODUCTION



2018

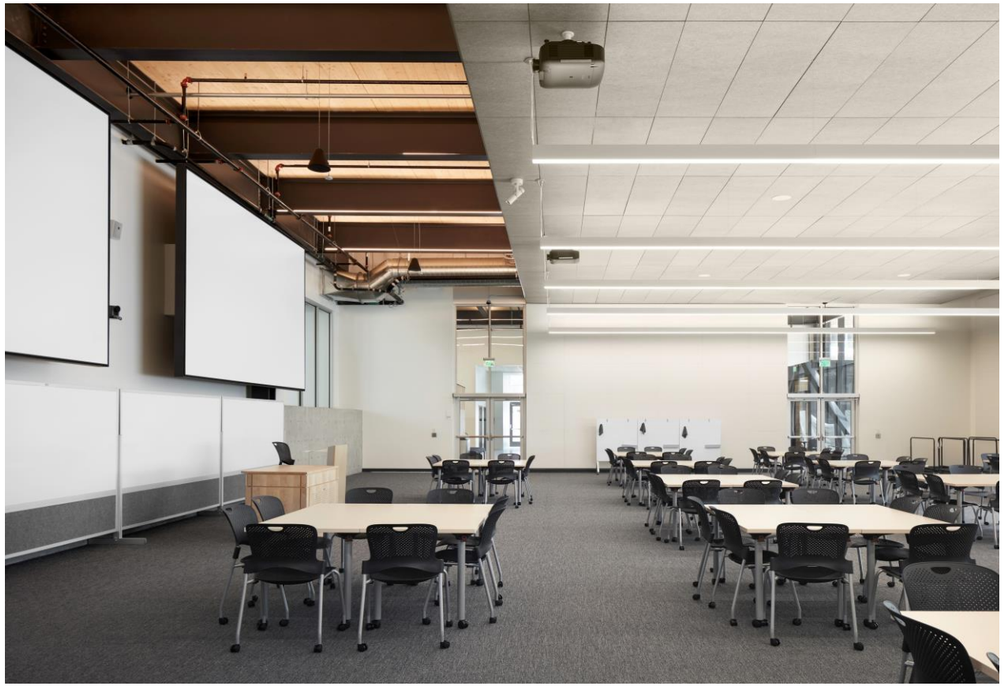
Project Kickoff

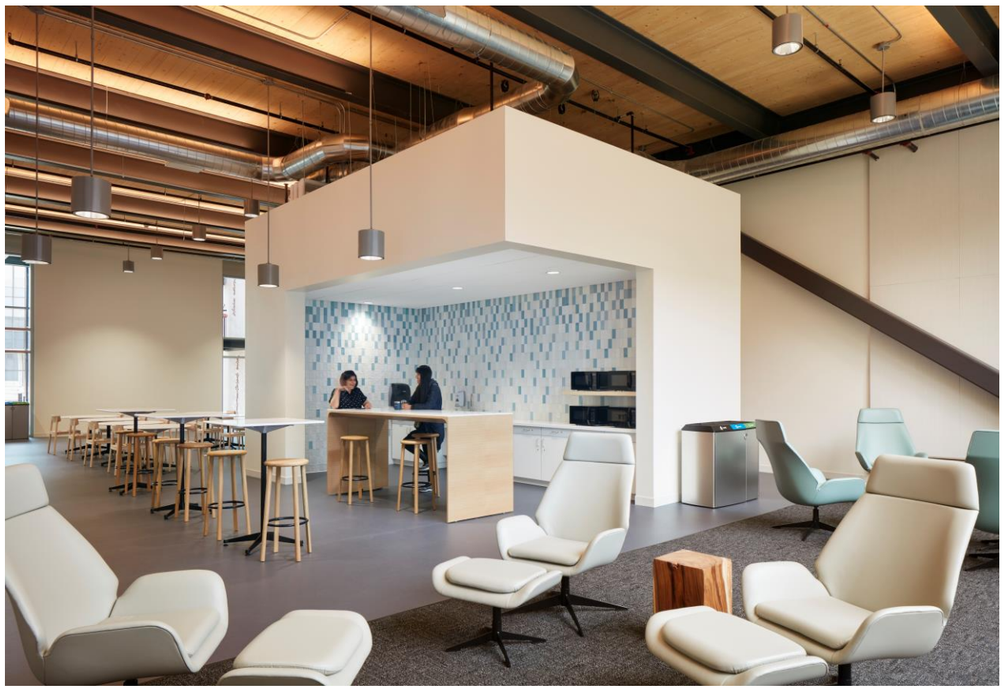


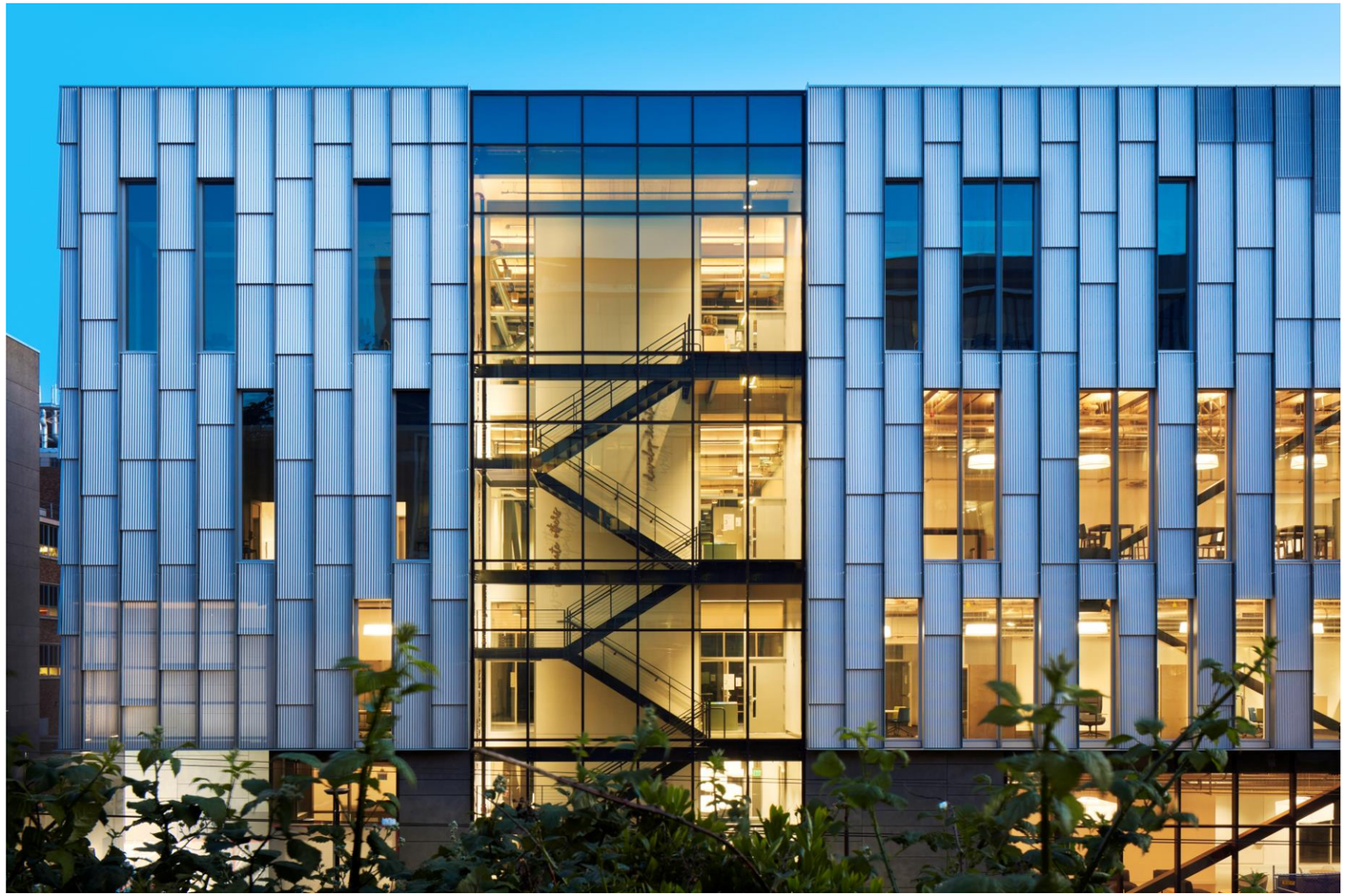
2022

Occupancy

PROJECT INTRODUCTION







- Active Learning, Interdisciplinary Classrooms
- New Anatomy and Skills Labs
- Student Success Spaces
- New Face to South Campus

PROJECT INTRODUCTION

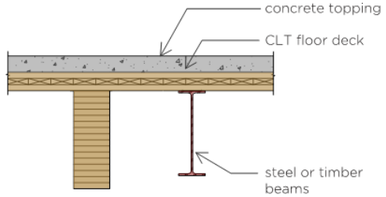
CLT OPPORTUNITIES
UW HEALTH SCIENCES EDUCATION BUILDING

The UW Health Sciences Education Building will be a physical space that sparks innovation and creativity with a diversity of environments that encourage collaboration where Health Science School students learn from each other how to be part of high performing health delivery teams. This physical space can enhance the student experience through the inclusion of CLT in floor and roof assemblies bringing the warmth of wood to the learning environment while supporting regional economic growth.

LEARNING OUTCOMES
Interior spaces that include wood as a material can help to reduce stress levels and advance learning outcomes. A recent study at the University of British Columbia and FPInnovations has established a link between wood and human health. In the study the presence of visual wood surfaces in a room lowered sympathetic nervous system (SNS) activation. The SNS is responsible for physiological stress responses in humans. This result opens the door to a myriad of stress-related health benefits that the presence of wood may afford in the built environment. The application of wood to promote health indoors is a new tool for practitioners of evidence-based design.

Source: Wood and Human Health by FPInnovations

QUANTITY
Health Sciences Education Building is targeting CLT assemblies for above grade floors and roofs. This has potential to be a signature architectural and structural element in the building.



Typical Floor Section

ECONOMICAL BENEFITS TO WA
The inclusion of CLT offeres the project a chance to directly support local and regional economy.

"It's an amazing opportunity for the Spokane area to be in the center of this evolving technology. It will put a lot of the spindly logs and trees we have in Eastern Washington to good use, utilizing a resource right in our backyard."

Better Spokane's Michael Cathcart

CLT Manufacturers
2 coming online in Washington

CLT OPPORTUNITIES
UW HEALTH SCIENCES EDUCATION BUILDING

1 CATALYST FOR UW SOUTH CAMPUS DEVELOPMENT
Health Sciences Education Building will be the first new education building on UW South Campus and can be a catalyst for future projects that employ CLT and mass timber.

TANGIBLE REMINDER
Health Sciences Education Building proposes a hybrid system of CLT, concrete and steel brace frames.

Bullitt Center by Miller Hull Partnership

ATTRACT STUDENTS AND FACULTY FROM AROUND THE WORLD
The project will attract students and faculty from around the world with an environment where evidence-based teaching enables UW faculty to lead the way in advancing IPE at a national level and health science students learn together.

City Academy by Sheppard Robson

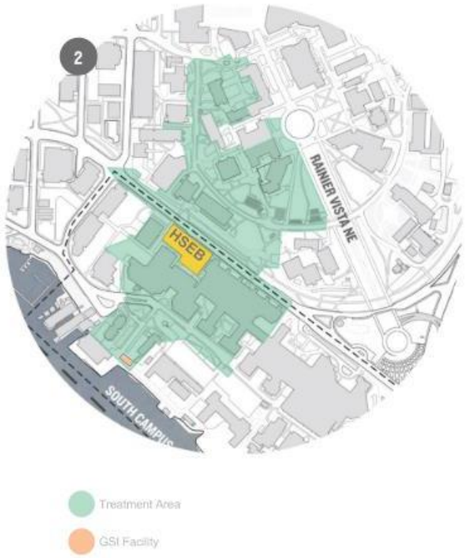
HEALTHY SPACES
"Both our physical wellbeing, as measured by criteria such as blood pressure, and our psychological welfare, as assessed by stress levels, are enhanced when wood is employed."

Source: Sally Augustine and David Fell, Wood as a Restorative Material in Healthcare Environments

ECOLOGICAL BENEFITS TO WA
The inclusion of CLT in the project supports the ecology of the region and the state by:
- Helping responsibly manage and protect WA State's renewable, natural resources
- Supporting efforts to mitigate wildfire risks
- Reducing embodied carbon impact of building materials

SUSTAINABILITY

The Health Services Education Building on University of Washington's (UW) Seattle Campus supports several sustainability goals as defined the University's 2019 masterplan. Reducing reliance on the campus steam plant, optimizing stormwater treatment, carbon sequestration, implementing higher passive strategies, and providing healthier and adaptable spaces for students, researchers, and clinicians were among the priorities of this project. Project is targeting LEED Gold certification.



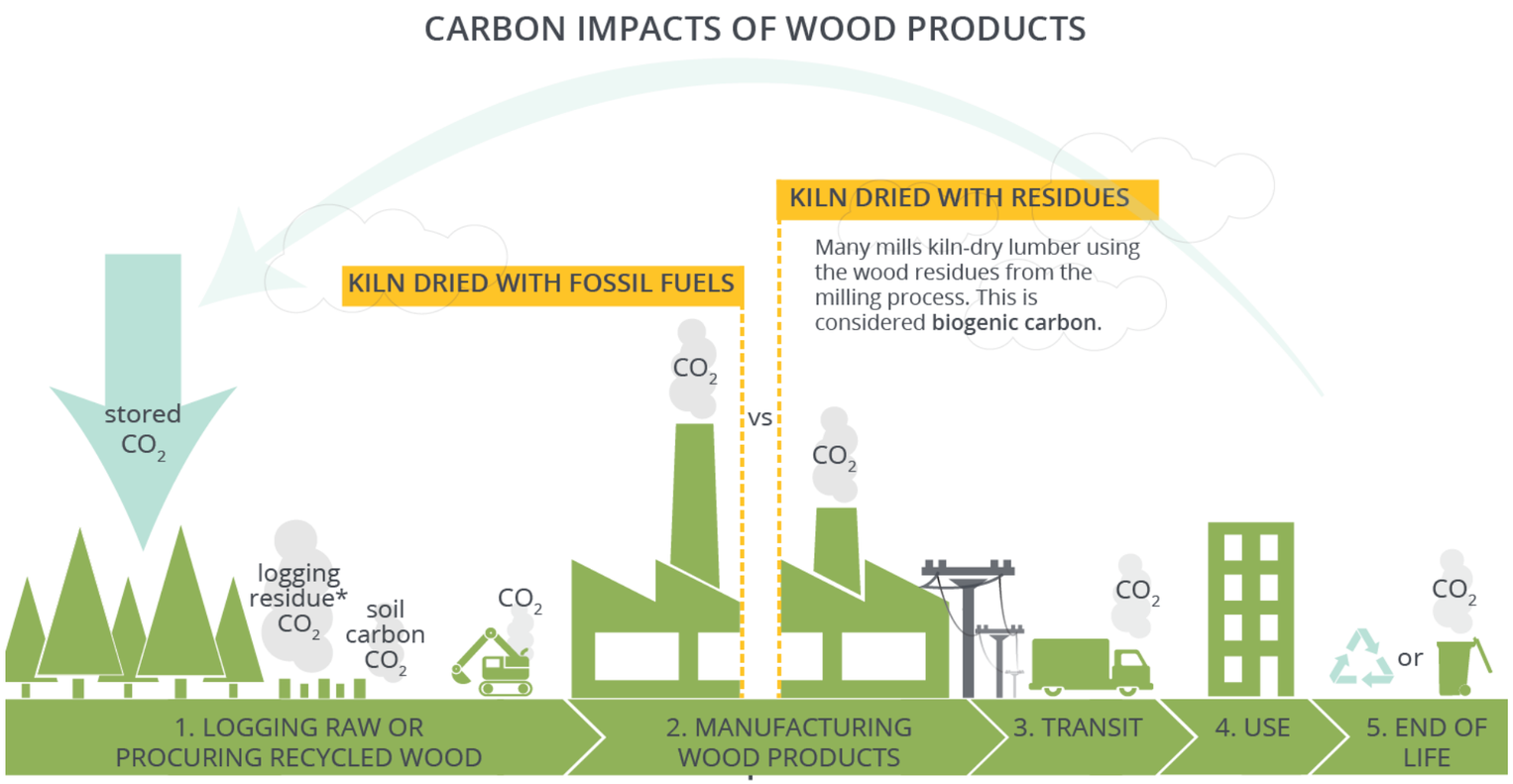
OUR PROCESS: SMALL STUDIES

EMBODIED CARBON BENEFITS OF CLT

1. **Locking up sequestered carbon** in the wood mass for the building's full lifetime.

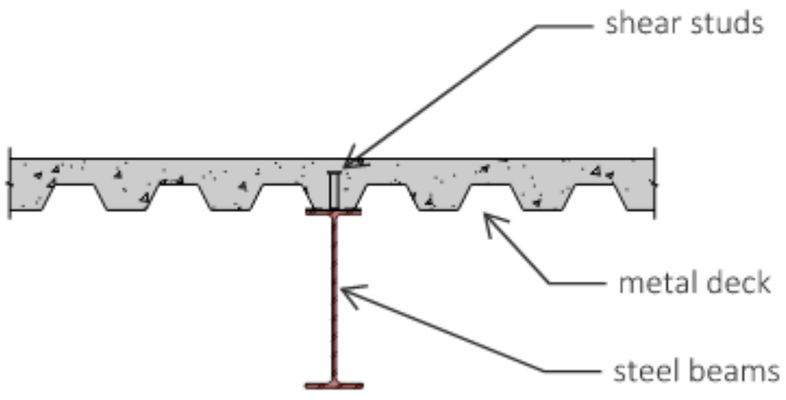
2. **Reduced weight** of CLT assembly can reduce overall building weight and allow for smaller foundations and structural members.

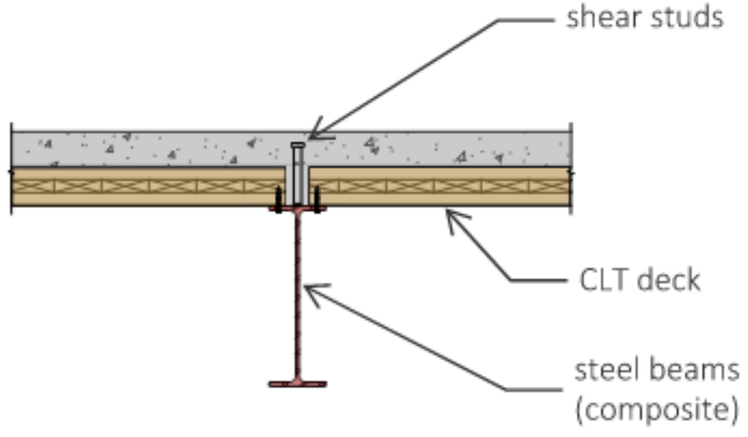
3. **Avoiding emissions associated with alternative assemblies** - 150% reduction in upfront embodied carbon (per ft^2), or 50% reduction in full lifecycle embodied carbon (per ft^2), compared to steel deck assembly, which is often produced in a Basic Oxygen Furnace mill using little recycled steel content.



Source: Architecture 2030

EARLY EMBODIED CARBON STUDIES: FLOOR ASSEMBLY

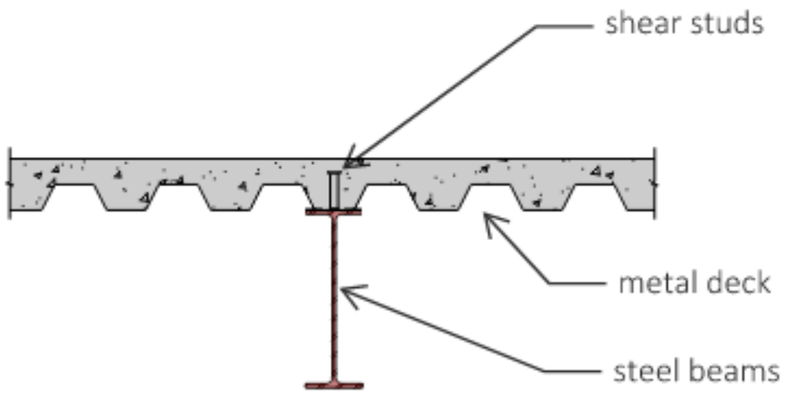


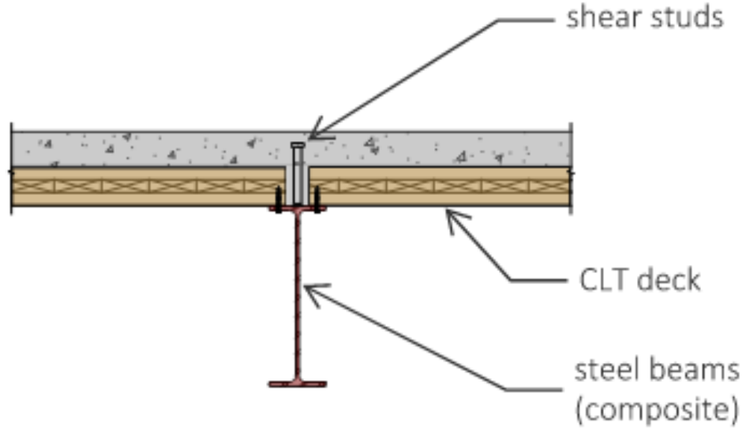


	METAL DECK $kgCO_2/ft^2$	CLT HYBRID $kgCO_2/ft^2$
UPFRONT CARBON (stages A1-A3)	+6.35	-3.21
FULL LIFECYCLE CARBON (stages A1-A4, B2-B5, C2-C4, D)	+6.76	+3.30

CLT floor manufacturing is a net carbon sequestering process

EARLY EMBODIED CARBON STUDIES: FLOOR ASSEMBLY





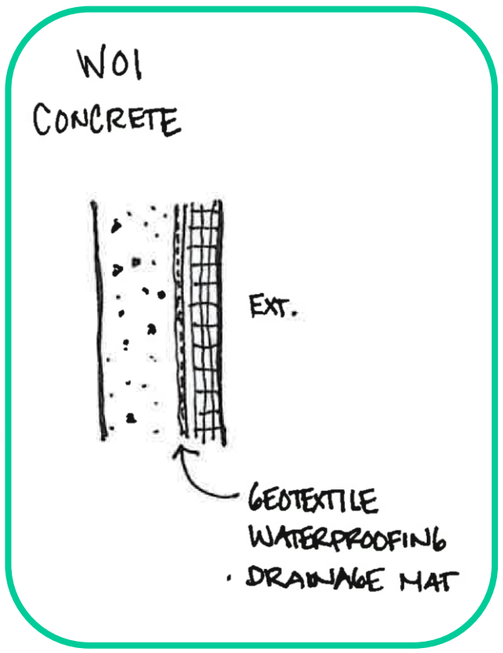
	METAL DECK $kgCO_2/ft^2$	CLT HYBRID $kgCO_2/ft^2$
UPFRONT CARBON (stages A1-A3)	+6.35	-3.21
FULL LIFECYCLE CARBON (stages A1-A4, B2-B5, C2-C4, D)	+6.76	+3.30

CLT floor through use stages and end of life still outperform metal deck

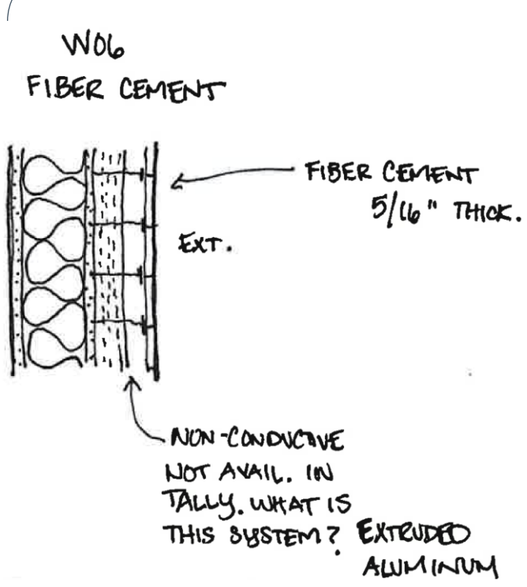
EARLY EMBODIED CARBON STUDIES: WALL ASSEMBLY STUDY EXTENTS

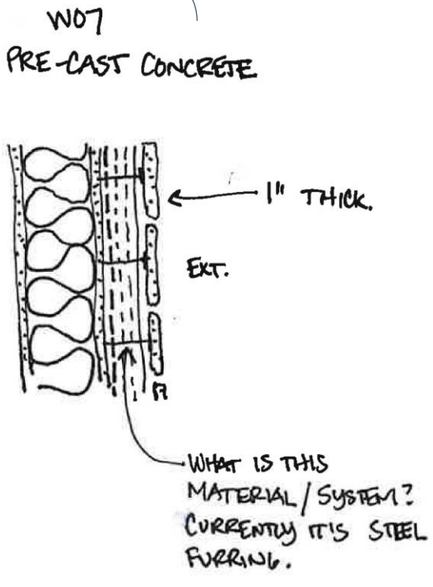
EARLY EMBODIED CARBON STUDIES: WALL ASSEMBLY

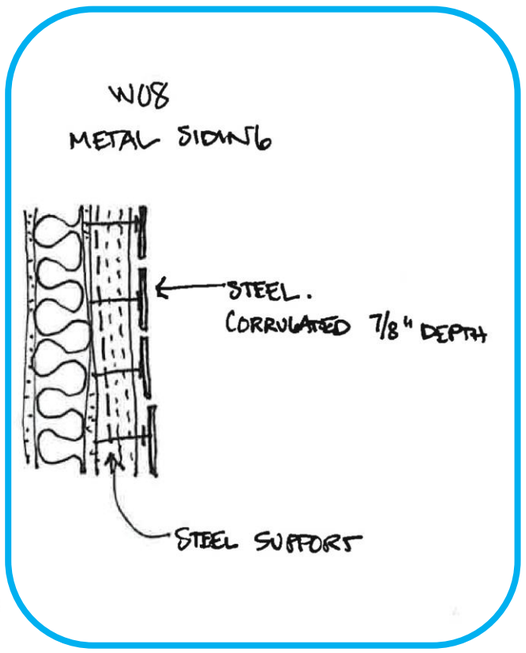
Which option makes most sense for the exterior wall between ground and Level 2?



We know this application will be below ground...

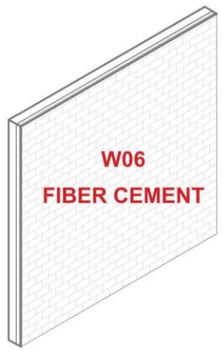






...and this will be the wall above Level 2.

EARLY EMBODIED CARBON STUDIES: WALL ASSEMBLY



MODEL INPUTS:

W01	W06	W07-A	W08
18” 4,000 PSI CONCRETE W/ MODERATE REINFORCEMENT	5/8” GYPSUM WALL BOARD	5/8” GYPSUM WALL BOARD	5/8” GYPSUM WALL BOARD
DRAINAGE MAT*	8” METAL FRAMING W/ KNAUF ECOBATT	8” METAL FRAMING W/ KNAUF ECOBATT	6” METAL FRAMING W/ KNAUF ECOBATT
GEOTEXTILE WATERPROOFING*	5/8” GYPSUM WALL BOARD W/ FLUID APPLIED AIR BARRIER	5/8” GYPSUM WALL BOARD W/ FLUID APPLIED AIR BARRIER	5/8” GYPSUM WALL BOARD W/ FLUID APPLIED AIR BARRIER
3” XPS RIGID INSULATION	3” MINERAL WOOL INSULATION	2” AIRSPACE	3” MINERAL WOOL INSULATION
	METAL CLADDING SUPPORT SYSTEM	3” MINERAL WOOL INSULATION	METAL CLADDING SUPPORT SYSTEM
	5/16” FIBER CEMENT PANELS	METAL CLADDING SUPPORT SYSTEM	7/8” CORRUGATED METAL SIDING
		1” PRECAST CONCRETE PANEL	
		W07-B	
		2” PRECAST CONCRETE PANEL	
			*MATERIAL NOT AVAILABLE IN TALLY

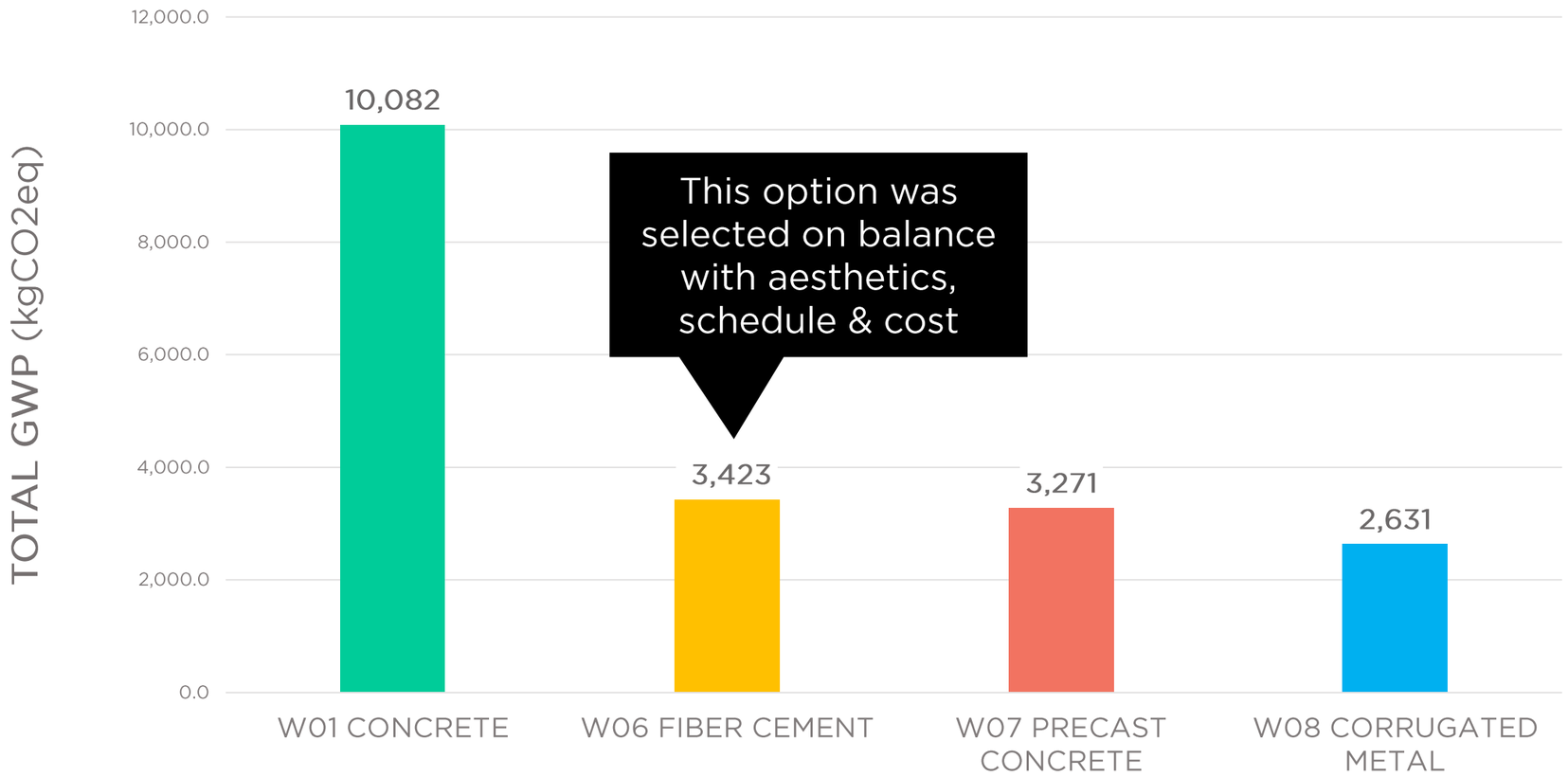
TOTAL GWP:

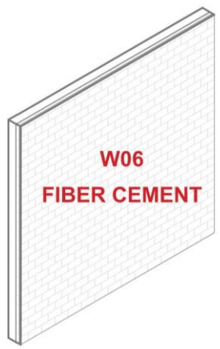
10,082 kgCO_2eq.	**3,423 kgCO_2eq.**	(A) 2,786 kgCO_2eq. **(B) 3,271 kgCO_2eq.**	**2,631 kgCO_2eq.**

ANALYSIS PARAMETERS:

LCA BOUNDARY:
CRADLE TO GRAVE
STUDIED WALL UNIT SIZE:
20’L x 20’H
EXPECTED BUILDING LIFE:
60 YEARS
CONSTRUCTION IMPACTS:
NOT INCLUDED
OPERATIONAL ENERGY:
NOT INCLUDED
BIOGENIC CARBON:
INCLUDED
TRANSPORTATION DISTANCES:
TALLY DEFAULT

EARLY EMBODIED CARBON STUDIES: WALL ASSEMBLY





OUR PROCESS: WHOLE BUILDING CARBON

WHOLE BUILDING ANALYSIS

100,000 sf

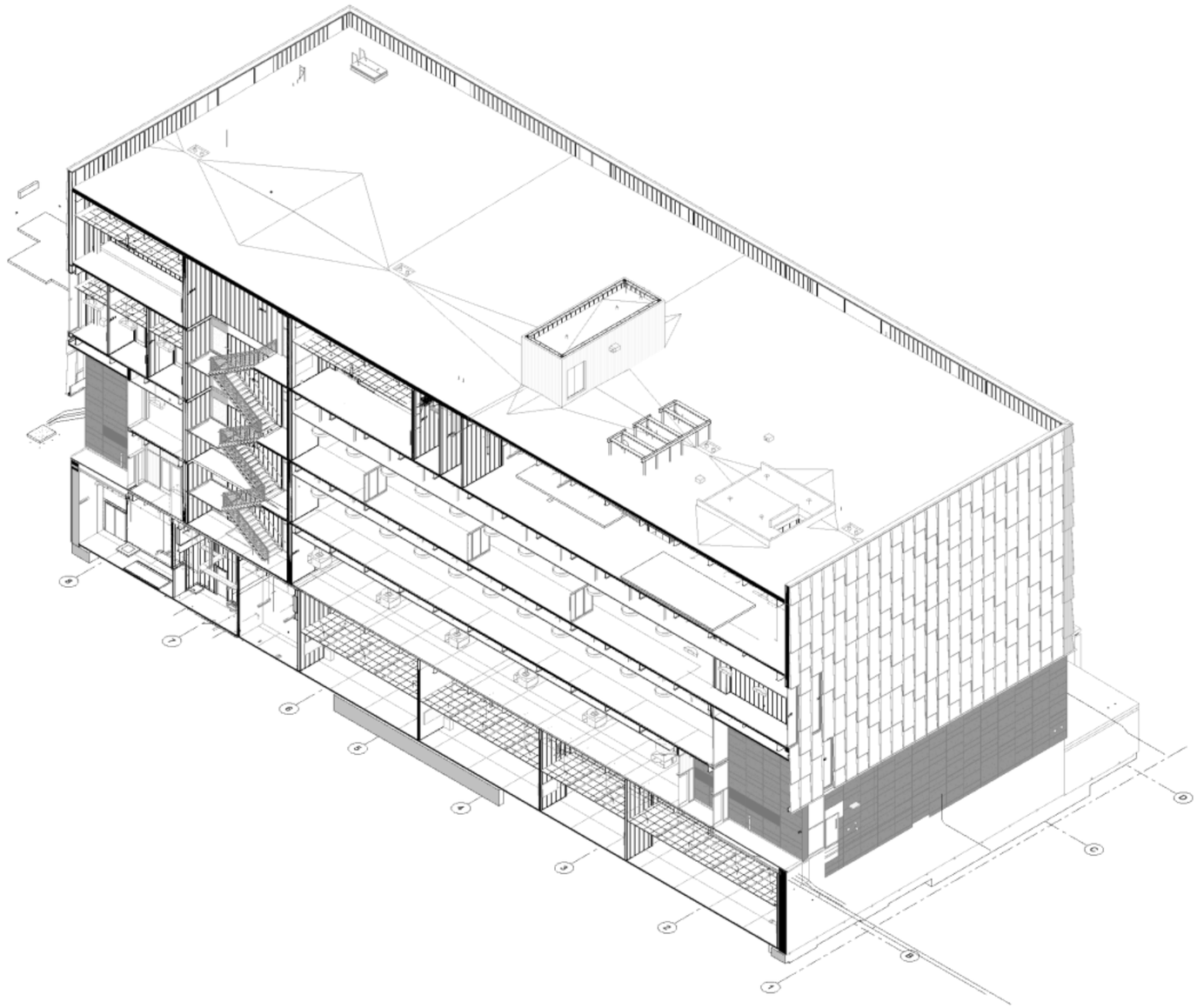
Analyzed ceilings, curtainwalls, doors, floors, stairs and railings, roofs, walls, structural framing and windows

Over **50** wall assembly types in design

Over **20** floor + roof assembly types in design

57 individual material types assigned

4 days to complete



WHOLE BUILDING ANALYSIS

TOTAL GWP: **2,865 tCO2e** *(618.7 passenger vehicles driving for a year*)*
GWP / AREA: **318 kgCO2e/m2**

Study date:	May 20, 2022
Tally modeler:	Katherine Martin
Tally version:	Null
Project area:	100,000 sf
Reference lifespan:	60 years
Notes:	Envelope and Structure

Top impact associated with structural steel frame...

TOP MATERIALS BY GWP *(57 materials defined, total)*

			GWP (kgCO2eq)	Mass Total (kg)
1	Steel, W section (wide flange shape)	59	588,166	517,281 *8.4% of total*
2	Cast-in-place concrete, structural concrete, 5000 p..	60	484,508	2,355,158 *38.1% of total*
3	Extruded polystyrene (XPS), board	60	416,084	5,578 *0.1% of total*
4	Cast-in-place concrete, structural concrete, 3000 p..	60	293,318	1,350,786 *21.8% of total*
5	Cast-in-place concrete, structural concrete, 4000 p..	60	154,025	869,023 *14.0% of total*
6	Polyethelene sheet vapor barrier (HDPE)	60	89,467	34,145 *0.6% of total*
7	Steel, HSS section	60	86,564	48,942 *0.8% of total*
8	Aluminum, sheet	60	85,836	21,243 *0.3% of total*
9	Steel, deck	60	75,352	36,306 *0.6% of total*
10	Mineral wool, board, generic	60	70,684	39,858 *0.6% of total*

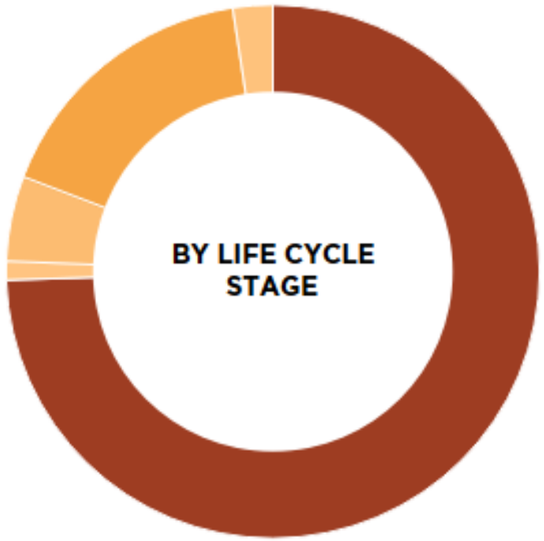
-200K 0K 200K 400K 600K 800K 0K 1000K 2000K 3000K

GWP (kgCO2eq) Mass Total (kg)

...even though there's more concrete in the project by mass.

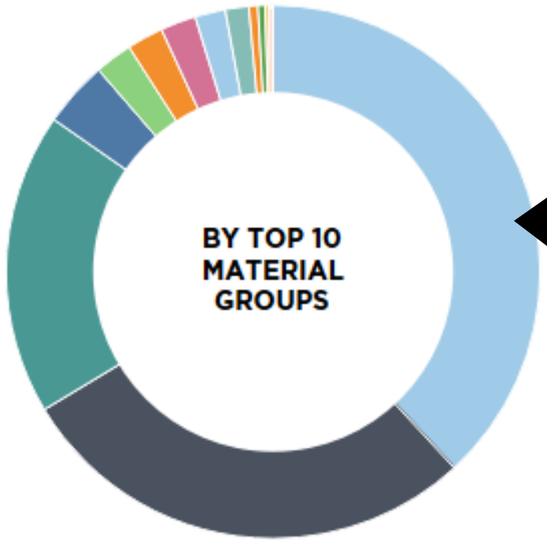
Note that this is #3 by carbon, despite low quantity!

WHOLE BUILDING ANALYSIS



[A1-A3] Product	75%
[A4] Transportation	1%
[B2-B5] Maintenance and Replacement	5%
[C2-C4] End of Life	17%
[D] Module D	2%

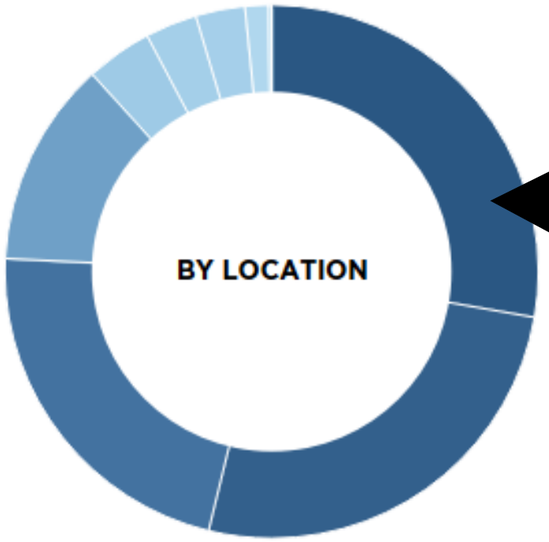
Note that most impacts are expected to occur during the production of materials – transport to site is ~1% of the total impact.



Together, metal, concrete, and insulation on the project account for 87% of the impact

Metal	39%
Concrete	29%
Insulation	19%
Vapor barrier	4%
Glazing	2%
Plaster	2%
Metal Coating	2%
Ceiling tile	2%
Roofing membrane	1%
Window frame	1%
Coating	0%
Adhesive / Sealant	0%
Composite	0%
Door	0%
Door frame	0%
Opening hardware	0%

WHOLE BUILDING ANALYSIS



While structure, walls and floors appear to be the places with the most impact...

Structure	●	28%
Walls	●	26%
Floors	●	22%
Roofs	●	12%
Curtainwall Panels	●	4%
Ceilings	●	3%
Curtainwall Mullions	●	3%
Stairs and Railings	●	1%
Doors	●	0%
Windows	●	0%

...keep in mind there are 'blind spots' in the study, like sitework & MEP equipment:

WHOLE BUILDING ANALYSIS

TOTAL GWP: **2,865 tCO2e** *(618.7 passenger vehicles driving for a year*)*
GWP / AREA: **318 kgCO2e/m2**

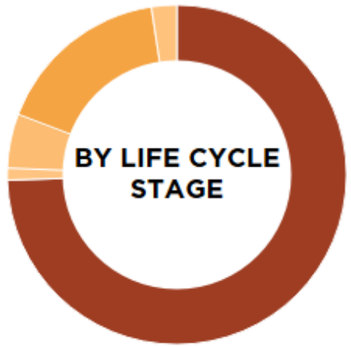
Study date:	May 20, 2022
Tally modeler:	Katherine Martin
Tally version:	Null
Project area:	100,000 sf
Reference lifespan:	60 years
Notes:	Envelope and Structure

TOP MATERIALS BY GWP *(57 materials defined, total)*

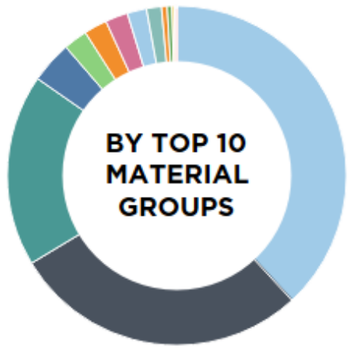
			GWP (kgCO2eq)	Mass Total (kg)
1	Steel, W section (wide flange shape)	59	588,166	517,281 *8.4% of total*
2	Cast-in-place concrete, structural concrete, 5000 p..	60	484,508	2,355,158 *38.1% of total*
3	Extruded polystyrene (XPS), board	60	416,084	5,578 *0.1% of total*
4	Cast-in-place concrete, structural concrete, 3000 p..	60	293,318	1,350,786 *21.8% of total*
5	Cast-in-place concrete, structural concrete, 4000 p..	60	154,025	869,023 *14.0% of total*
6	Polyethelene sheet vapor barrier (HDPE)	60	89,467	34,145 *0.6% of total*
7	Steel, HSS section	60	86,564	48,942 *0.8% of total*
8	Aluminum, sheet	60	85,836	21,243 *0.3% of total*
9	Steel, deck	60	75,352	36,306 *0.6% of total*
10	Mineral wool, board, generic	60	70,684	39,858 *0.6% of total*

-200K 0K 200K 400K 600K 800K 0K 1000K 2000K 3000K

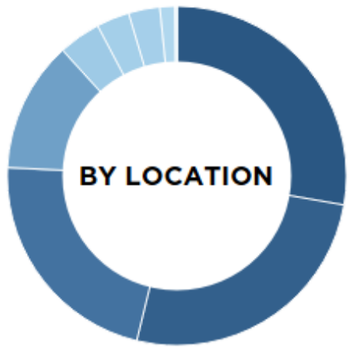
GWP (kgCO2eq) Mass Total (kg)



[A1-A3] Product	75%
[A4] Transportation	1%
[B2-B5] Maintenan..	5%
[C2-C4] End of Life	17%
[D] Module D	2%



Metal	39%
Concrete	29%
Insulation	19%
Vapor barrier	4%
Glazing	2%
Plaster	2%
Metal Coating	2%
Ceiling tile	2%
Roofing membra..	1%
Window frame	1%
Coating	0%
Adhesive / Seala..	0%
Composite	0%
Door	0%
Door frame	0%
Opening hardwar..	0%



Structure	28%
Walls	26%
Floors	22%
Roofs	12%
Curtainwall Panels	4%
Ceilings	3%
Curtainwall Mulli..	3%
Stairs and Railings	1%
Doors	0%
Windows	0%

LESSONS LEARNED

HOW DID OUR DESIGN DECISIONS TO REDUCE CARBON STACK UP?

LEED NCv4.1 MR Building Life-Cycle Impact Reduction Credit Option 2. Whole-Building Life-Cycle Assessment (1-4 points)

For new construction… **earn up to 4 points**:

- Path 1: **Conduct a life cycle assessment** of the project's structure and enclosure (1 point).
- Path 2: Conduct a life cycle assessment of the project's structure and enclosure that **demonstrates a minimum of 5% reduction, compared with a baseline building in at least three of the six impact categories** listed below, one of which must be global warming potential (2 points)….

For Paths 2, 3 and 4 listed above, **no impact category assessed as part of the life-cycle assessment may increase by more than 5%** compared with the baseline building.

Select at least three of the following **impact categories** for reduction:

- **global warming potential** (greenhouse gases), in kg CO2e;
- depletion of the stratospheric ozone layer, in kg CFC-11e;
- acidification of land and water sources, in moles H+ or kg SO2e;
- eutrophication, in kg nitrogen eq or kg phosphate eq;
- formation of tropospheric ozone, in kg NOx, kg O3 eq, or kg ethene; and
- depletion of nonrenewable energy resources, in MJ using CML / depletion of fossil fuels in TRACI.

MILLER HULL

KEEP IN MIND LEED ASKS US TO TRACK:

MATERIAL SCOPES

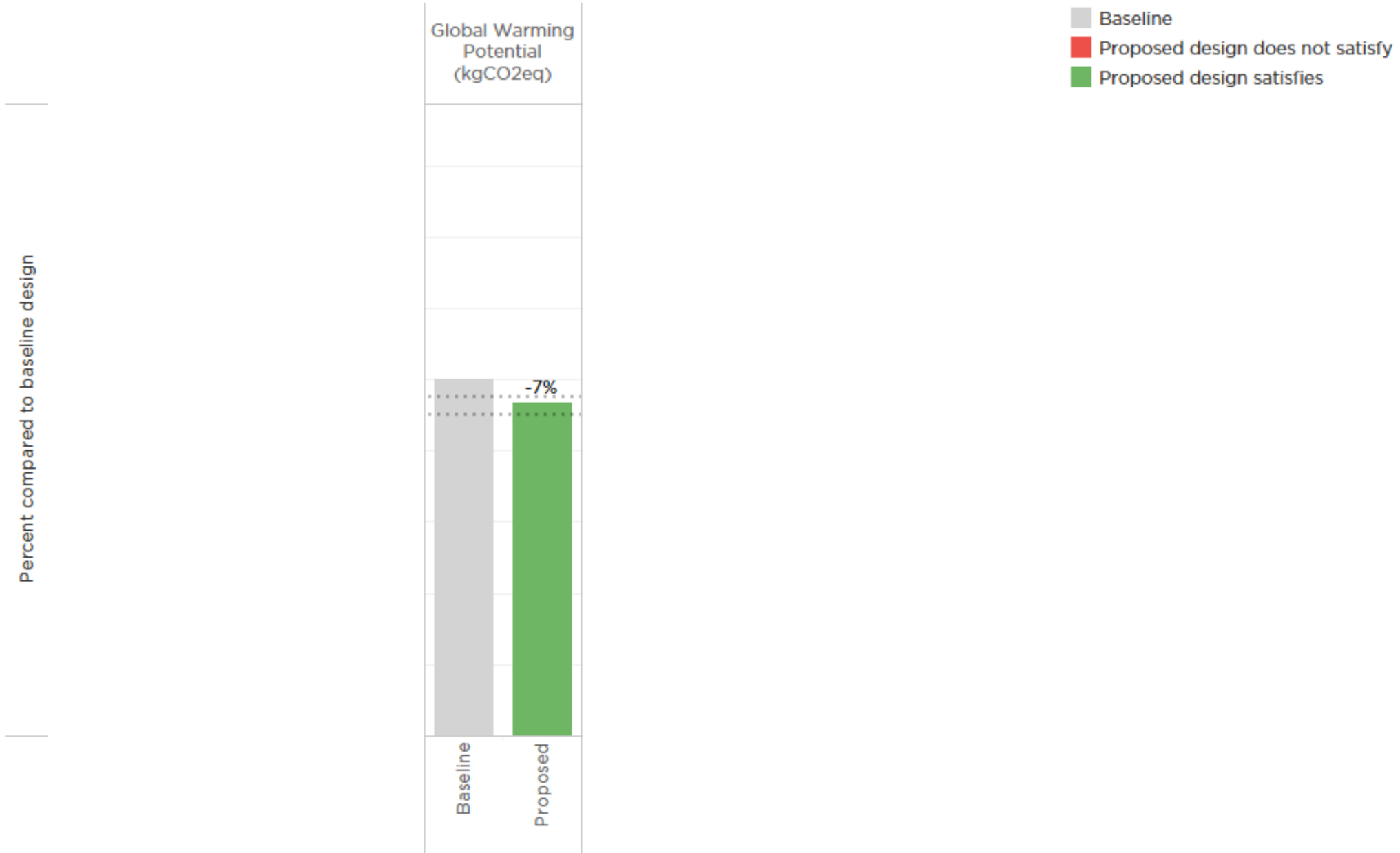
		STRUCTURE	FOUNDATIONS	ENCLOSURE	INTERIORS FIXED	SITEWORK	FFE	MEP
A1	Raw material supply	•	•	•	•			
A2	Transport	•	•	•	•			
A3	Manufacturing	•	•	•	•			
A4	Transport	•	•	•	•			
A5	Construction/installation							
B1	Use	•	•	•	•			
B2	Maintenance	•	•	•	•			
B3	Repair	•	•	•	•			
B4	Refurbishment	•	•	•	•			
B5	Replacement	•	•	•	•			
B6	Operational energy use							
B7	Operational water use							
C1	Deconstruction/demolition	•	•	•	•			
C2	Transport	•	•	•	•			
C3	Waste processing	•	•	•	•			
C4	Disposal	•	•	•	•			
D	Beyond the lifecycle							

LIFE CYCLE STAGES

Most of the benefit of using wood occurs in these stages as wood grows and pulls carbon from the atmosphere...

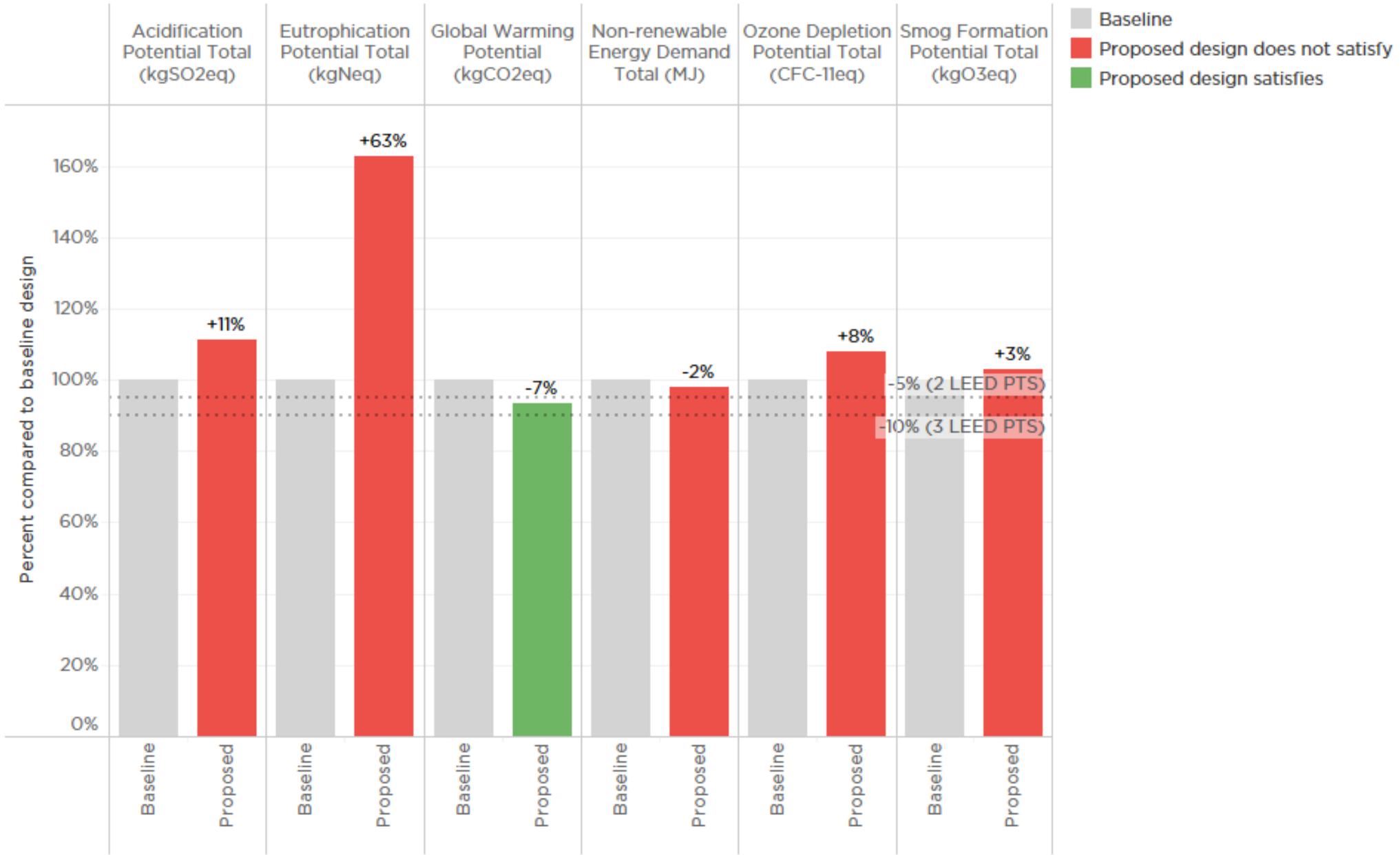
...and is negated when wood rots at the end of its lifespan.

HOW DID OUR DESIGN DECISIONS TO REDUCE CARBON STACK UP?



MILLER HULL

HOW DID OUR DESIGN DECISIONS TO REDUCE CARBON STACK UP?



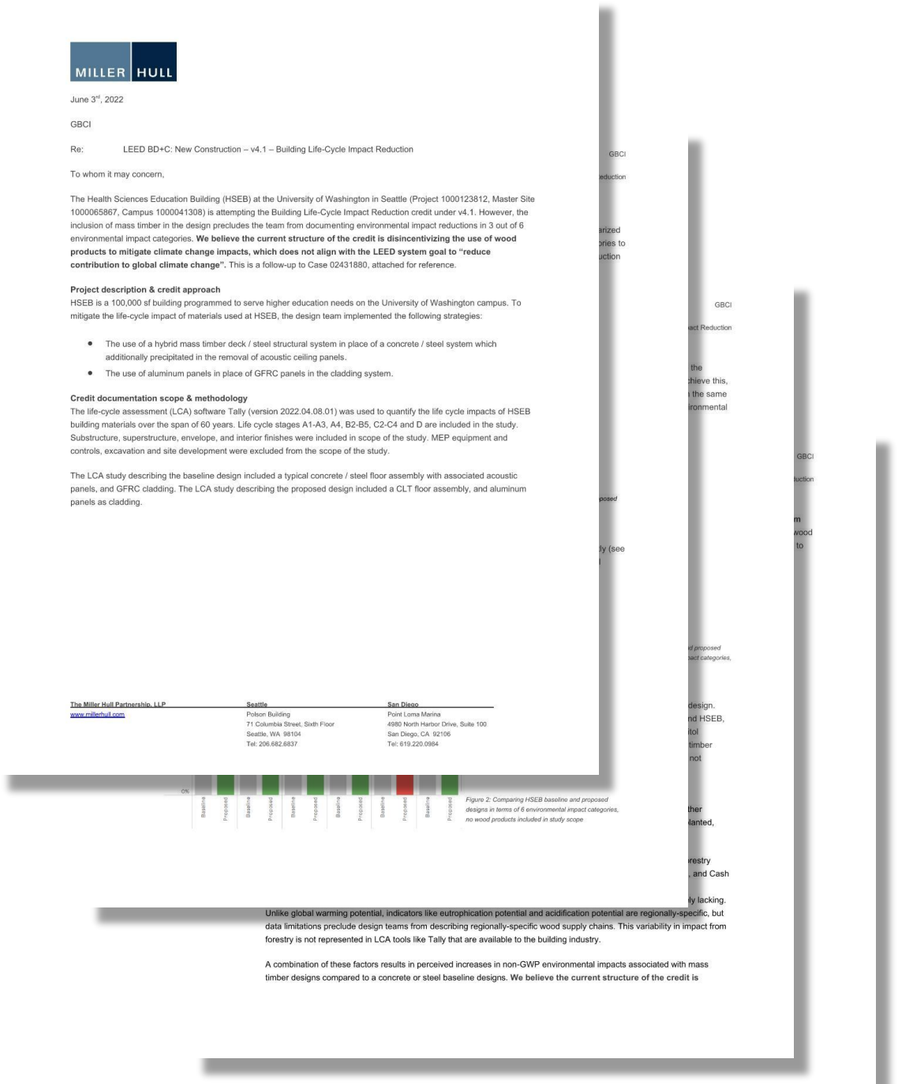
MILLER HULL

WHY IS THIS?

Kendeda Building for Innovative Sustainable Design
Georgia Tech, Atlanta, GA

MILLER | HULL

NEXT STEPS: MOVING THE INDUSTRY



MILLER HULL

June 3rd, 2022

GBCI

Re: LEED BD+C: New Construction – v4.1 – Building Life-Cycle Impact Reduction

To whom it may concern,

The Health Sciences Education Building (HSEB) at the University of Washington in Seattle (Project 1000123812, Master Site 1000065867, Campus 1000041308) is attempting the Building Life-Cycle Impact Reduction credit under v4.1. However, the inclusion of mass timber in the design precludes the team from documenting environmental impact reductions in 3 out of 6 environmental impact categories. **We believe the current structure of the credit is disincentivizing the use of wood products to mitigate climate change impacts, which does not align with the LEED system goal to "reduce contribution to global climate change".** This is a follow-up to Case 02431880, attached for reference.

Project description & credit approach
HSEB is a 100,000 sf building programmed to serve higher education needs on the University of Washington campus. To mitigate the life-cycle impact of materials used at HSEB, the design team implemented the following strategies:

- The use of a hybrid mass timber deck / steel structural system in place of a concrete / steel system which additionally precipitated in the removal of acoustic ceiling panels.
- The use of aluminum panels in place of GFRC panels in the cladding system.

Credit documentation scope & methodology
The life-cycle assessment (LCA) software Tally (version 2022.04.08.01) was used to quantify the life cycle impacts of HSEB building materials over the span of 60 years. Life cycle stages A1-A3, A4, B2-B5, C2-C4 and D are included in the study. Substructure, superstructure, envelope, and interior finishes were included in scope of the study. MEP equipment and controls, excavation and site development were excluded from the scope of the study.

The LCA study describing the baseline design included a typical concrete / steel floor assembly with associated acoustic panels, and GFRC cladding. The LCA study describing the proposed design included a CLT floor assembly, and aluminum panels as cladding.

The Miller Hull Partnership, LLP
www.millerhull.com

Seattle
Polson Building
71 Columbia Street, Sixth Floor
Seattle, WA 98104
Tel: 206.682.6837

San Diego
Point Loma Marina
4980 North Harbor Drive, Suite 100
San Diego, CA 92106
Tel: 619.220.0984

Figure 2: Comparing HSEB baseline and proposed designs in terms of 6 environmental impact categories, no wood products included in study scope

Unlike global warming potential, indicators like eutrophication potential and acidification potential are regionally-specific, but data limitations preclude design teams from describing regionally-specific wood supply chains. This variability in impact from forestry is not represented in LCA tools like Tally that are available to the building industry.

A combination of these factors results in perceived increases in non-GWP environmental impacts associated with mass timber designs compared to a concrete or steel baseline designs. **We believe the current structure of the credit is**

Memo to GBCI
(via O'Brien)

Same issue has already affected LEED documentation for Founders' Hall & will continue to affect CLT projects on campus.

QUESTIONS / DISCUSSION