Carbon Footprint of Wood Products & Buildings

Ashley Cagle, P.E., S.E.
Technical Director

June 23, 2022

How Does Wood Fit in?

Carbon Benefits of Wood

- **Less energy intensive** to manufacture than steel or concrete
- **Less fossil fuel consumed** during manufacture
- Reduce process emissions
- Carbon **storage in forests** and **promote forest health**
- Extended carbon **storage in products**

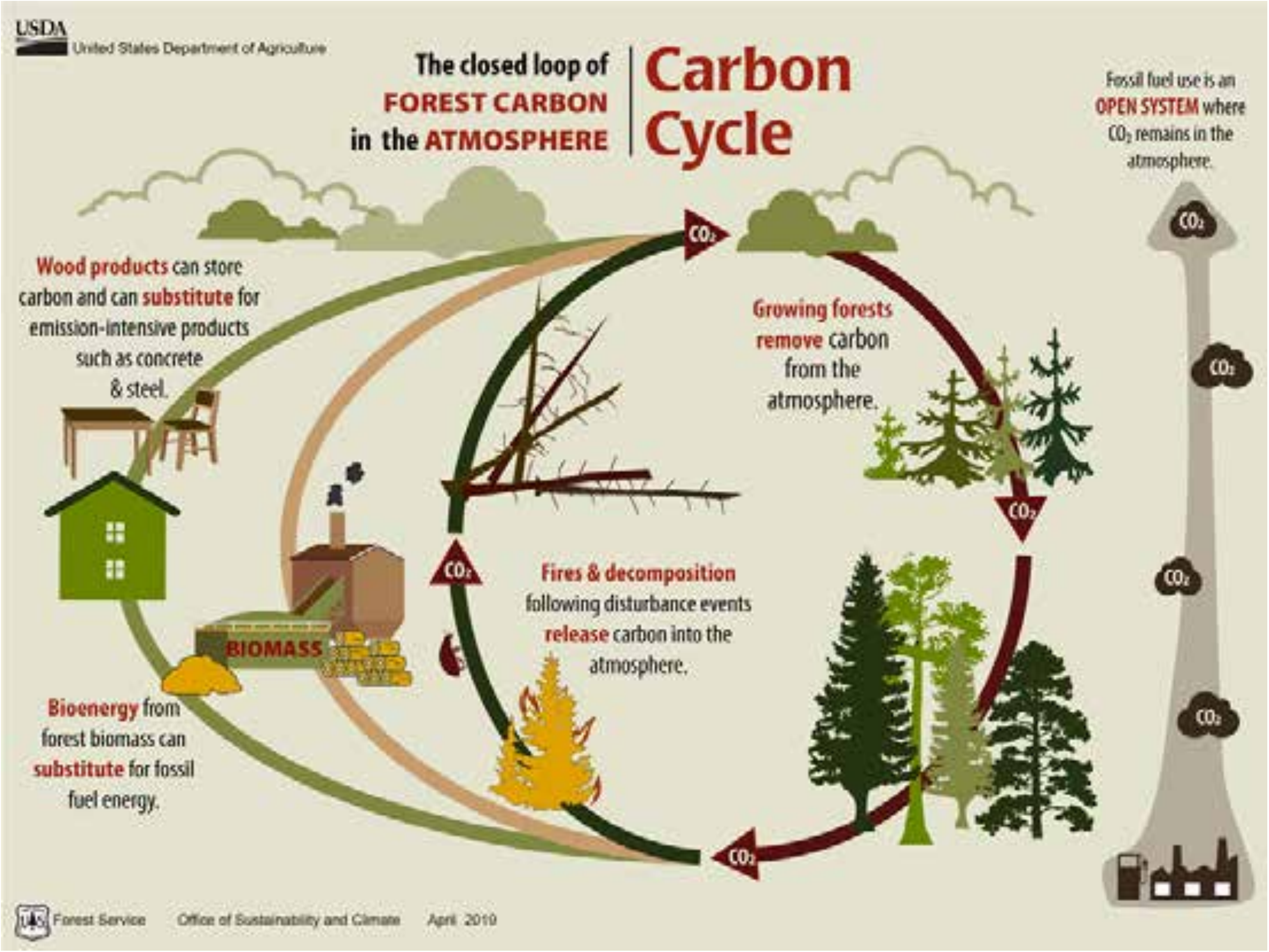


Image: USDA US Forest Service

State of our Forests

Common Environmental Concerns About Specifying Wood

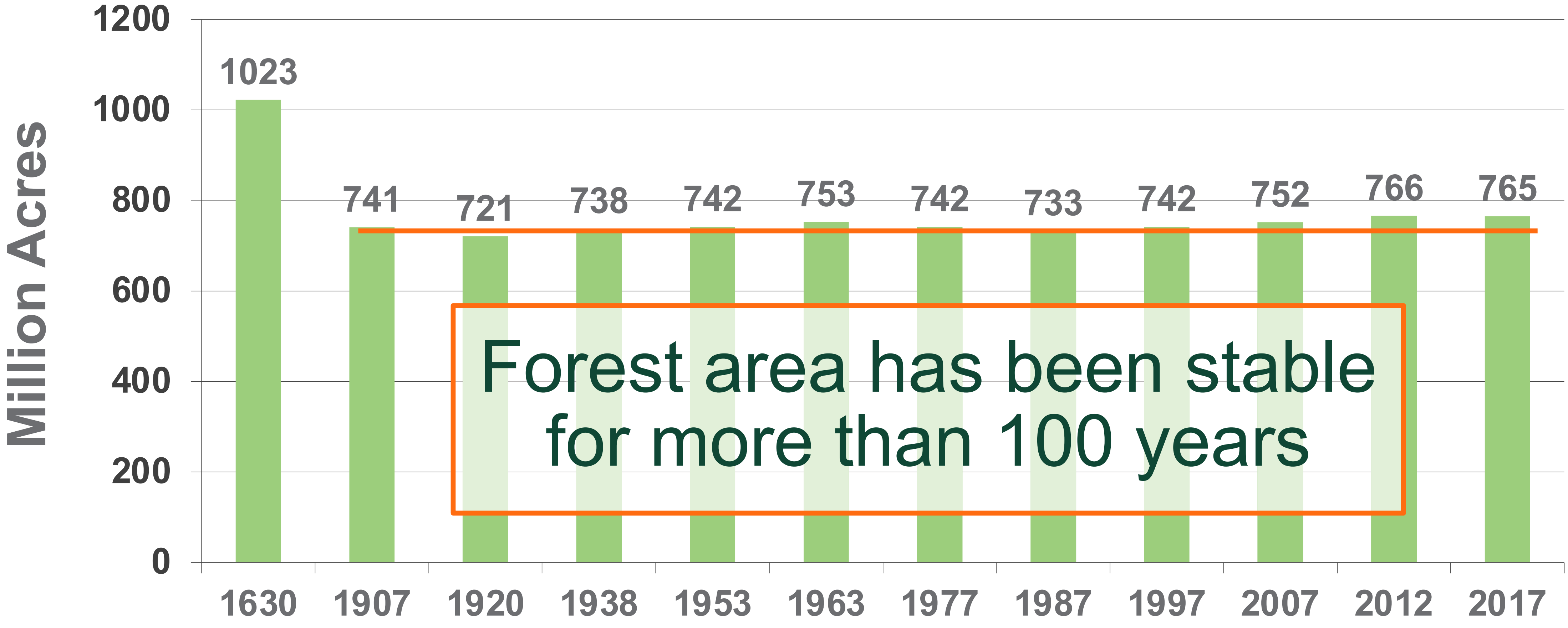
1. Is North America **running out of forests?**

2. Does specifying wood products contribute to **deforestation?**

3. Is wood is a **renewable resource?**

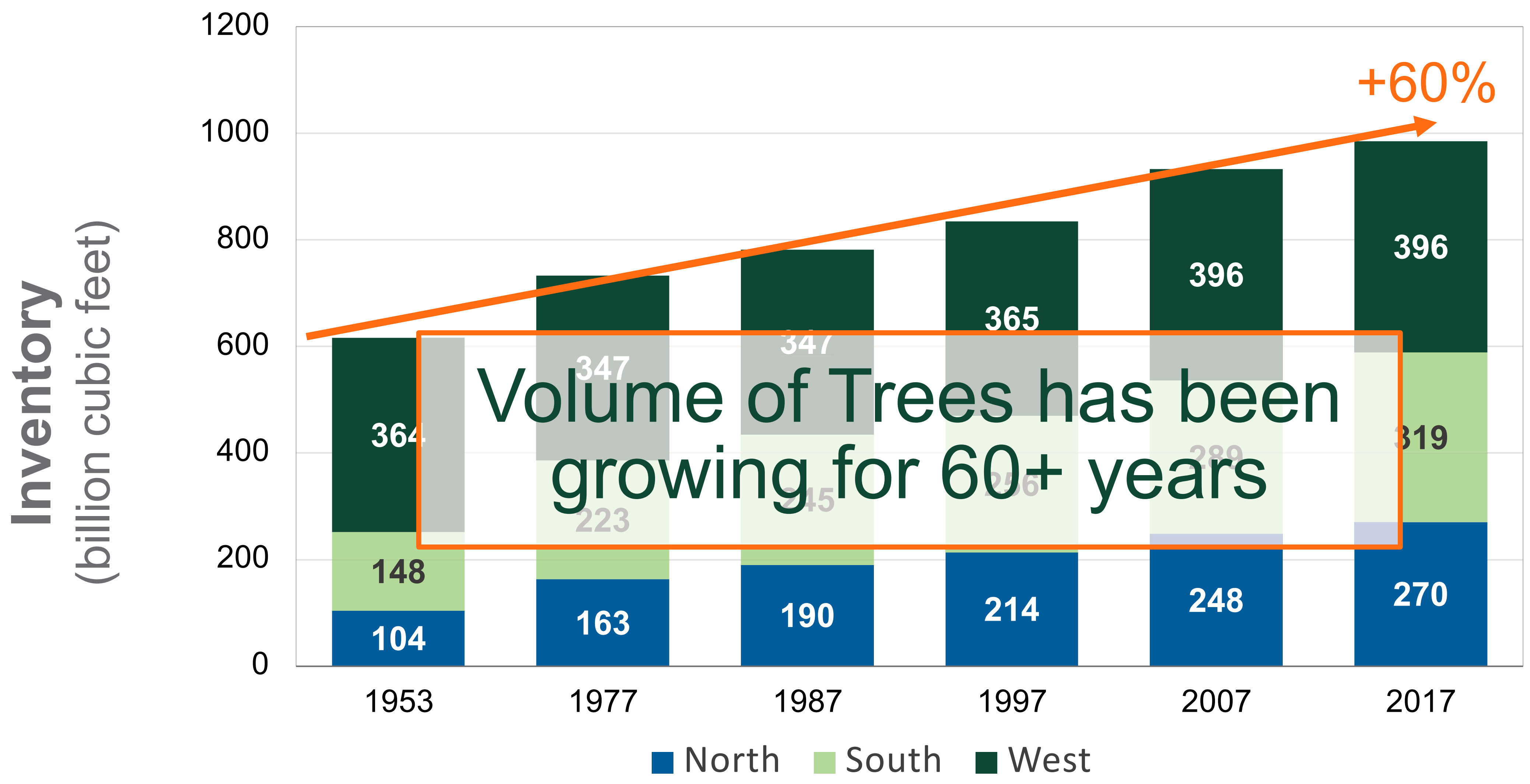
U.S. Forest Land:

Forest **Area** in the United States 1630 – 2017



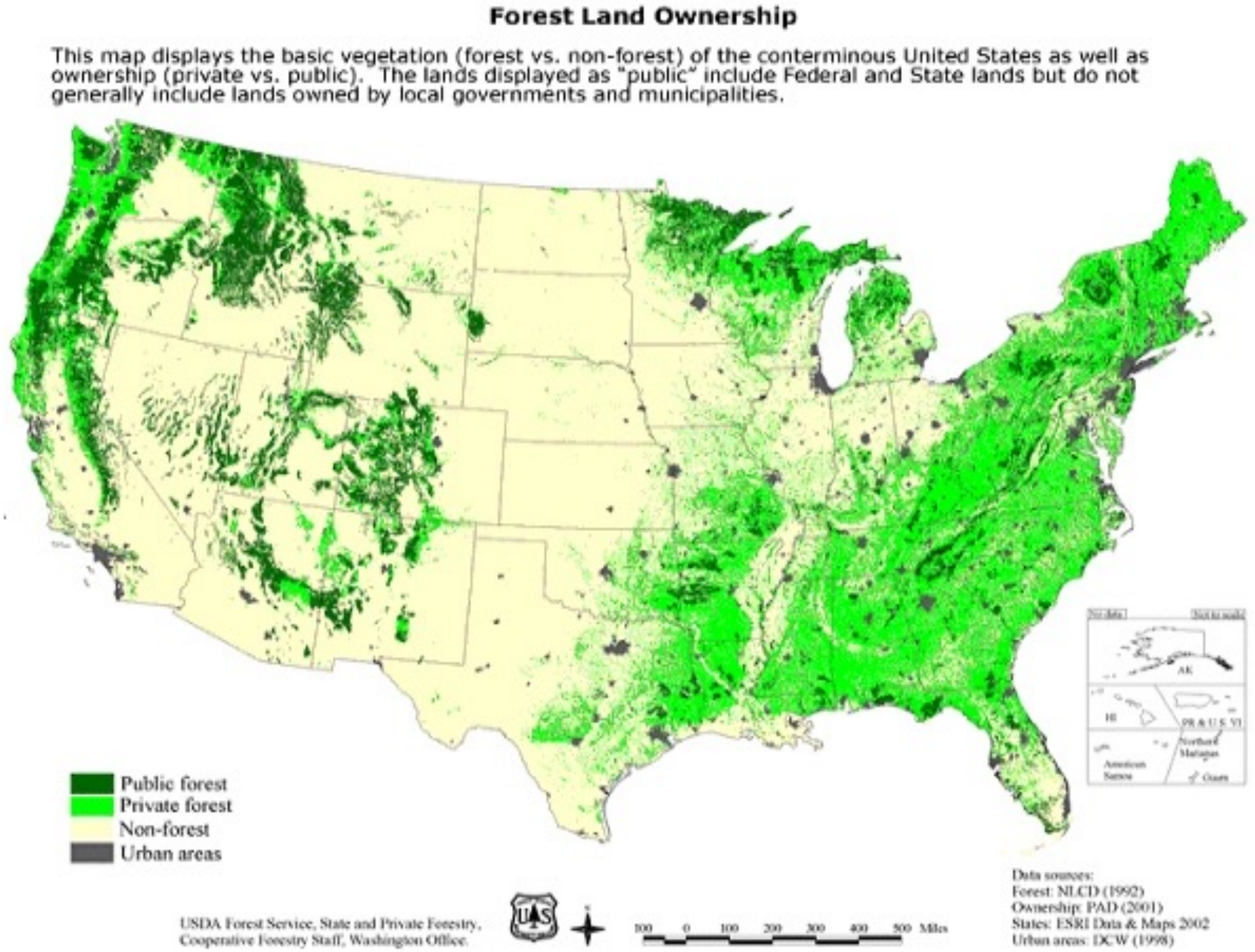
Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

State of our Forests: US Timber Volume on Timberland

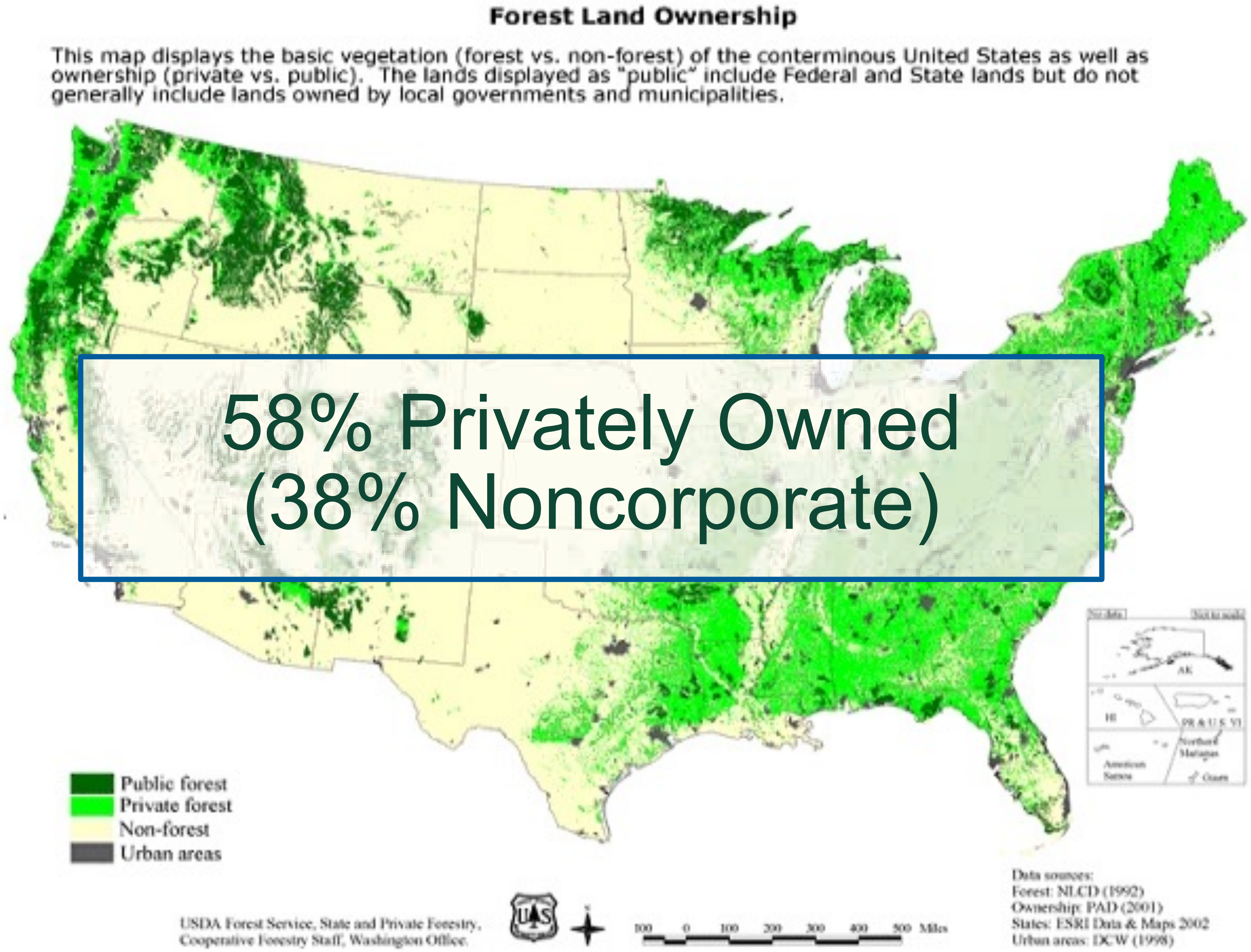


Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

US Forest Lands

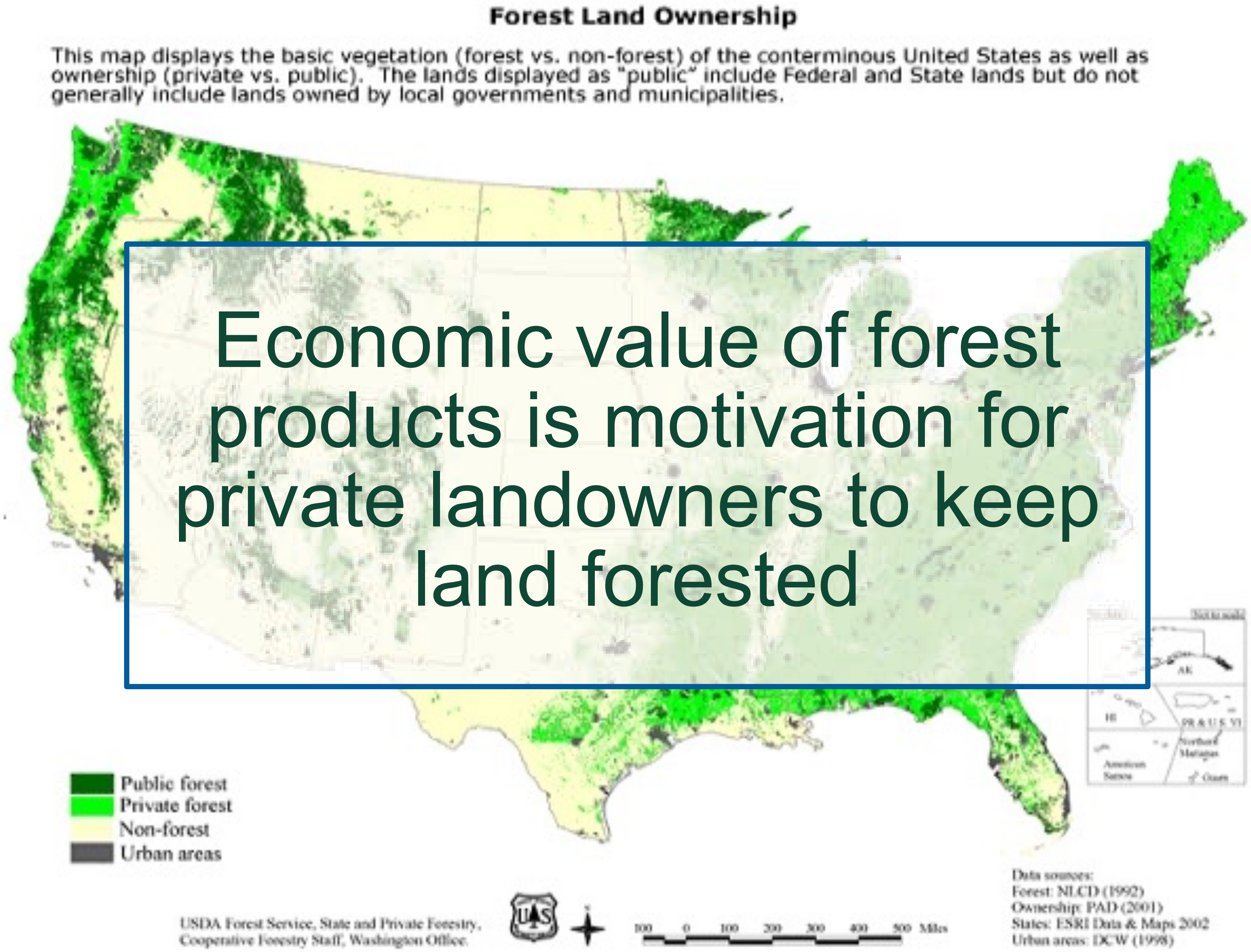


US Forest Lands



58% Privately Owned
(38% Noncorporate)

US Forest Lands



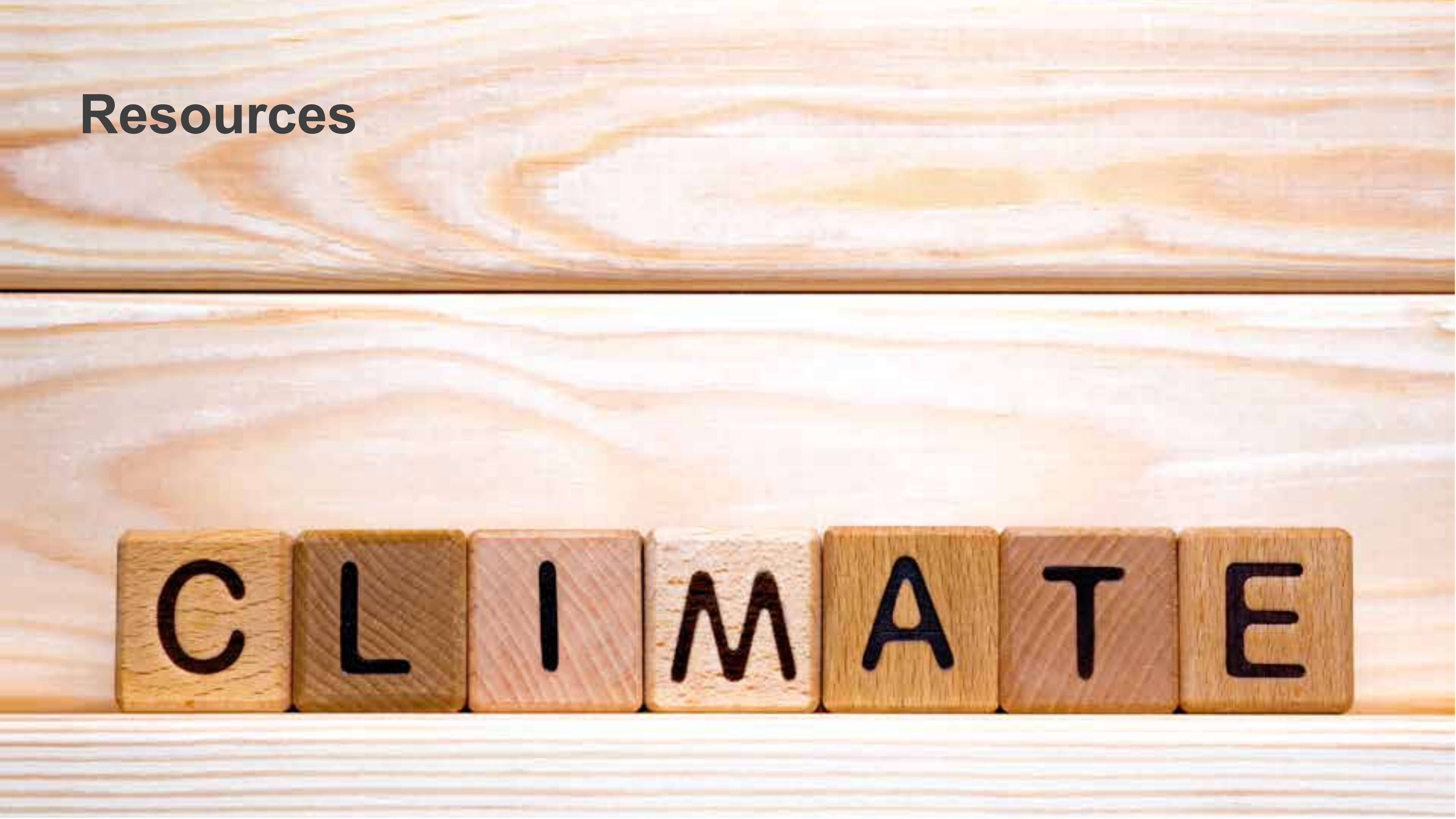
Economic value of forest products is motivation for private landowners to keep land forested

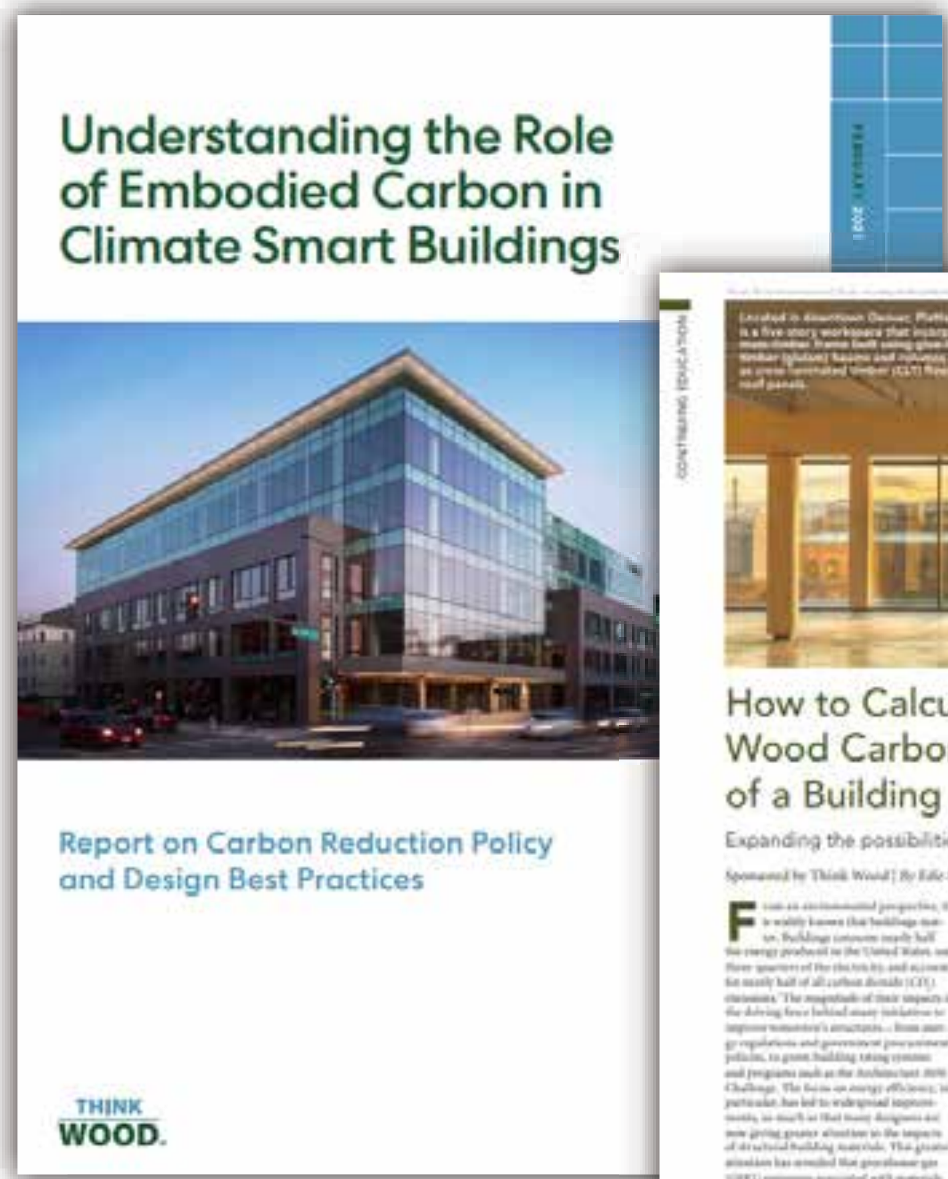
Regeneration vs. Deforestation

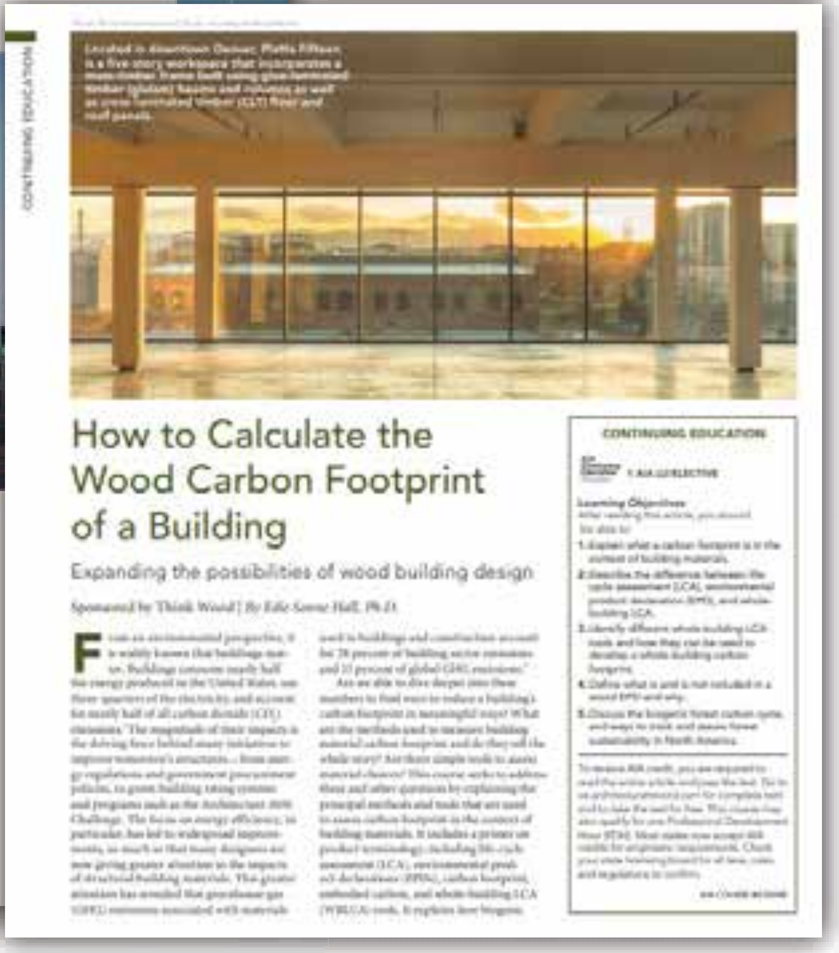
Deforestation is the permanent conversion of forest land to non-forest land uses. Worldwide, agricultural expansion is the main driver of deforestation, but in the U.S., the rate of deforestation has been virtually zero for decades.

Source: State of the World's Forests—2020– FAO and UNEP, USDA Forest Service, US Forest Resource Facts and Historical Trends FS-1034 (2014)

Resources







[The Impact of Wood Use on North American Forests]

[Understanding the Role of Embodied Carbon in Climate Smart Buildings]

[How to Calculate the Wood Carbon Footprint of a Building]

WoodWorks Carbon Calculator

- Available at **woodworks.org**
- Estimates total wood mass in a building
- Provides **estimated** carbon impacts:
    - Amount of **carbon stored** in wood
    - Amount of **greenhouse gas emissions avoided** by choosing wood over a non-wood material

WOODWORKS WPC WOOD PRODUCTS COUNCIL

http://www.woodworks.org/carbon-calculator-download-form/

Questions?

Ashley Cagle
ashley.cagle@woodworks.org

This concludes The American Institute of Architects Continuing Education Systems Course

Photo: Structurlam | Seagate Structures

Copyright Materials

Funding provided in part by the Softwood Lumber Board

Carbon and Cost: Evaluating the Impact of Different Structural Systems

Presented by Greg Kingsley, PE, PhD

KL&A Engineers & Builders

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.

"The Wood Products Council" is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES), Provider #G516.

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Acknowledgements/Credits

We are grateful for the support and participation of multiple entities in this work.

Course Description

The spotlight for green construction once held by operational energy efficiency has shifted to material choice and embodied carbon—and which building products should be specified to achieve a more sustainable structure. However, to meet a client's sustainability goals and budget, we cannot look at embodied carbon impacts of structural systems in a vacuum. Costs and carbon impacts can be looked at concurrently.

This presentation will highlight a recent project where these topics were studied in depth. *KL&A Engineers and Builders* will present the results of an LCA study comparing the embodied carbon, construction costs and speed of construction of three functionally equivalent buildings in mass timber, steel and concrete. They'll review the methodology, assumptions, analysis and results to better understand the impact of each system on embodied carbon and economy for a given project.

Learning Objectives

1. Review carbon basics and how material choice is related to sustainability.

2. Examine characteristics of wood products that can have positive environmental impacts.

3. Understand carbon storage in wood products.

4. Evaluate case studies illustrating the benefits of wood construction from a sustainability perspective.

Outline

1. Introduction to Platte Fifteen
2. Basics of embodied carbon
3. Measurement of embodied carbon: Life Cycle Assessment (LCA)
4. Comparative LCAs: Platte Fifteen in Timber, Steel, and Concrete
5. Comparative costs
6. Conclusions

Photo by Joel Vodell on Unsplash

PLATTE FIFTEEN

Office / Retail
Type III-B over IA Construction
2 floors concrete below grade
1 floor concrete above grade
3 floors + roof in mass timber
Concrete cores

30’ x 30’ grid

PLATTE 15 UNDER CONSTRUCTION

Office / Retail
Type III-B Construction
30’ x 30’ grid

PLATTE 15 UNDER CONSTRUCTION

Office / Retail
Type III-B Construction
30’ x 30’ grid

PLATTE 15 UNDER CONSTRUCTION

50+ ft panels
span five 10 ft bays

PLATTE 15 UNDER CONSTRUCTION

PLATTE 15 UNDER CONSTRUCTION

PLATTE 15 UNDER CONSTRUCTION

PLATTE 15 UNDER CONSTRUCTION

2,000 sf / day
with 6-8 laborers

PLATTE 15

Photo Credit: JC Buck

PLATTE 15

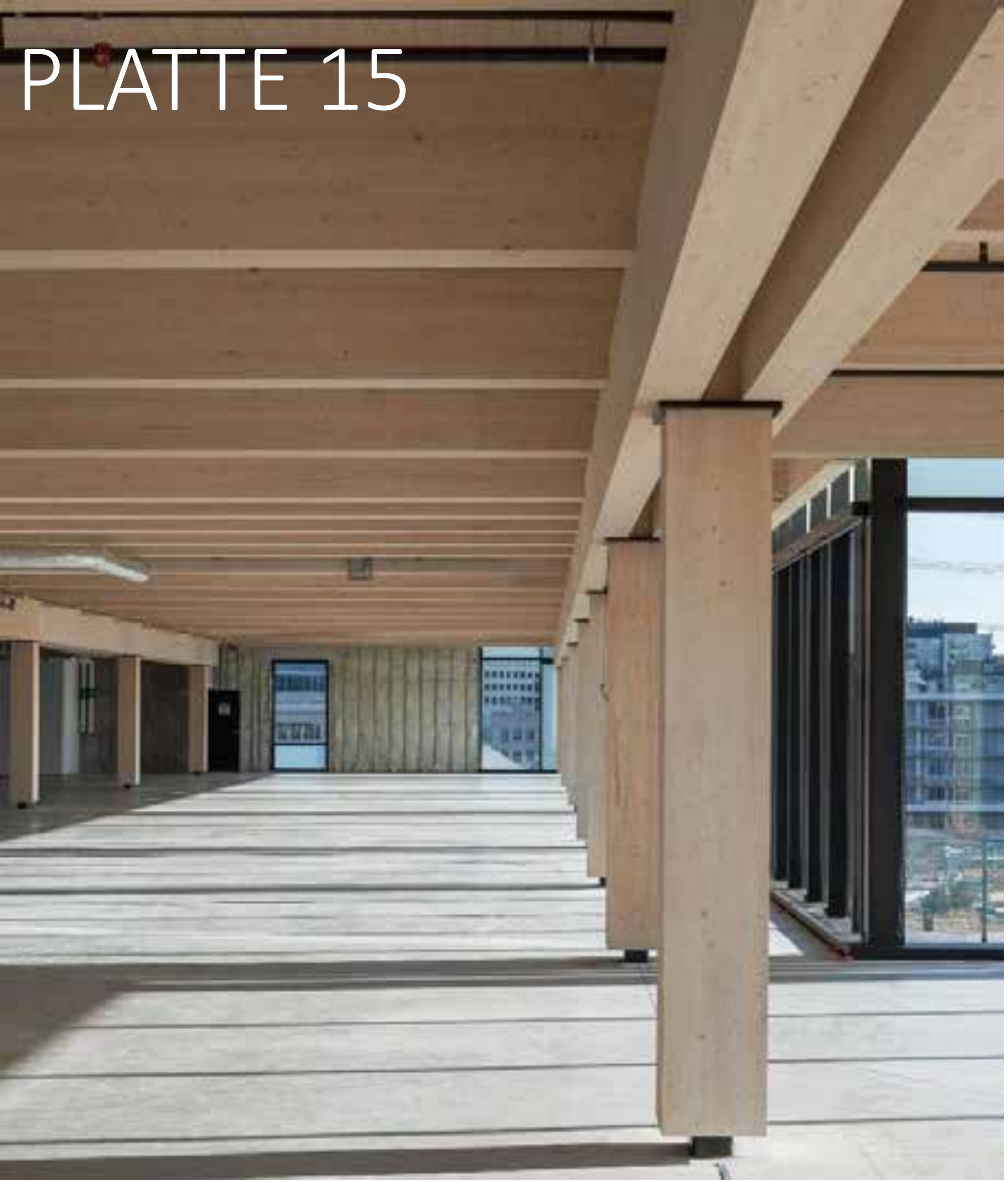


Photo Credit: JC Buck

PLATTE 15

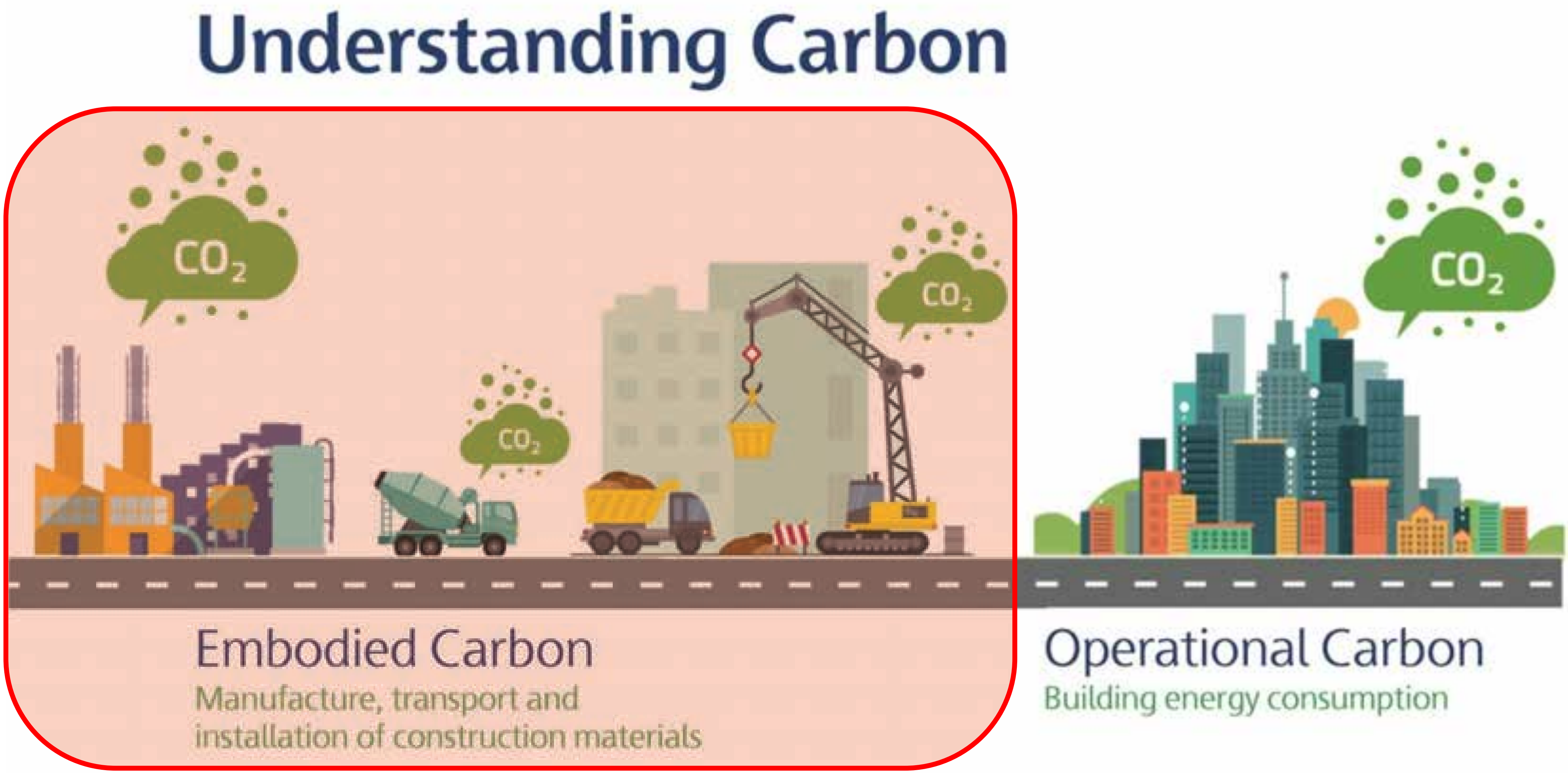
Photo Credit: JC Buck

Photo Credit: JC Buck

PLATTE 15

Photo Credit: JC Buck

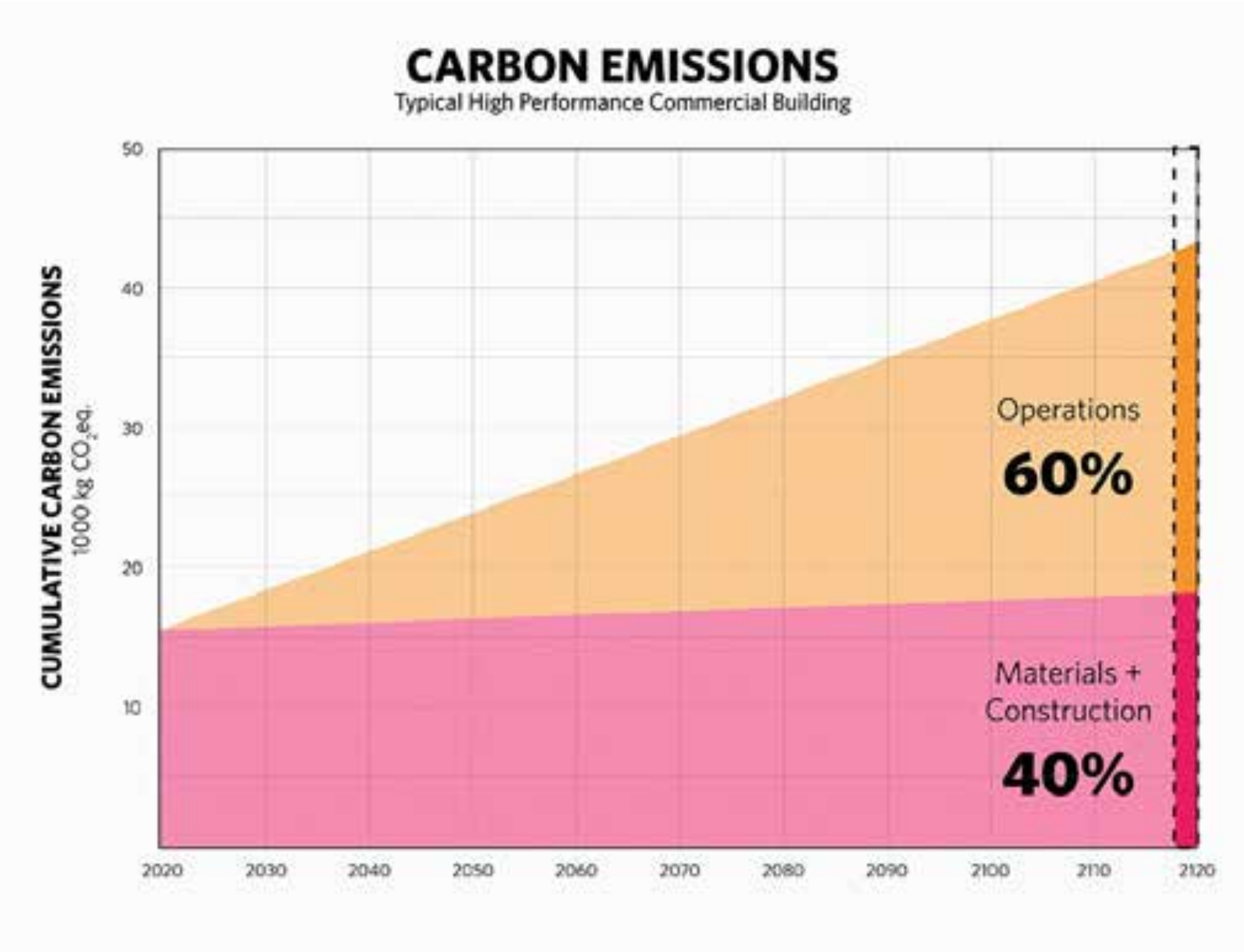
Meanwhile, embodied carbon starts getting attention…



Source image: Carbon Leadership Forum

Image by Skanska

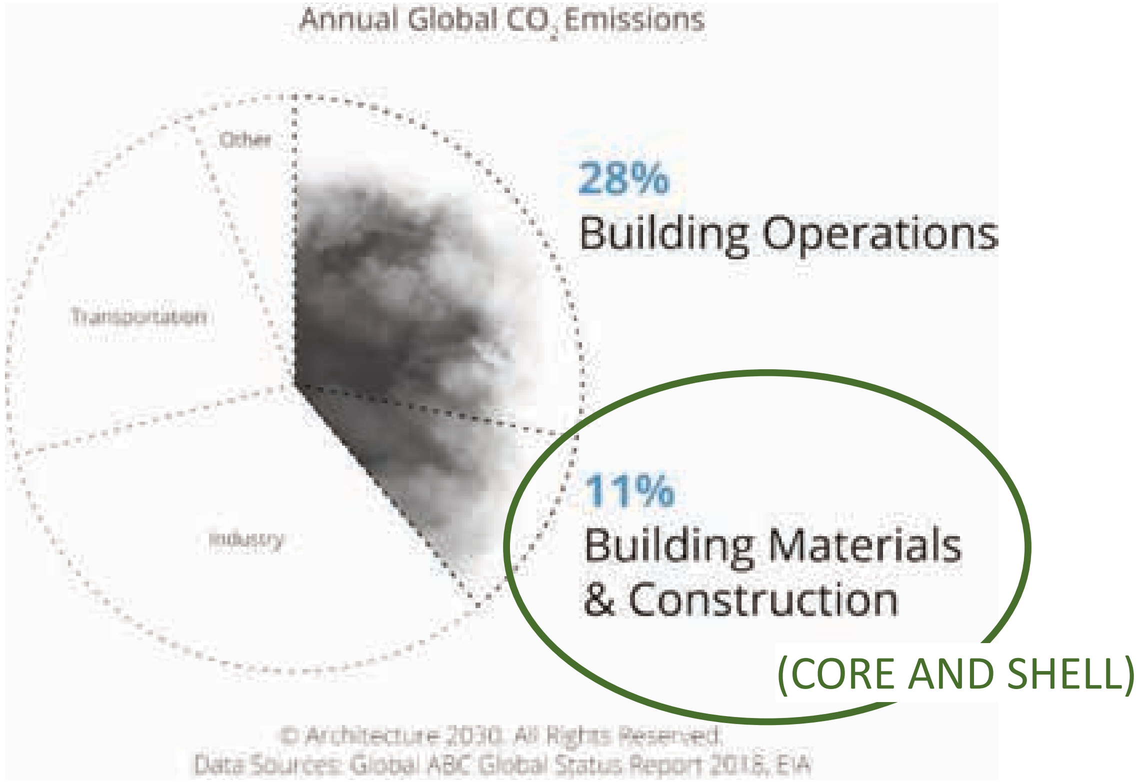
OPERATIONAL VS EMBODIED CARBON

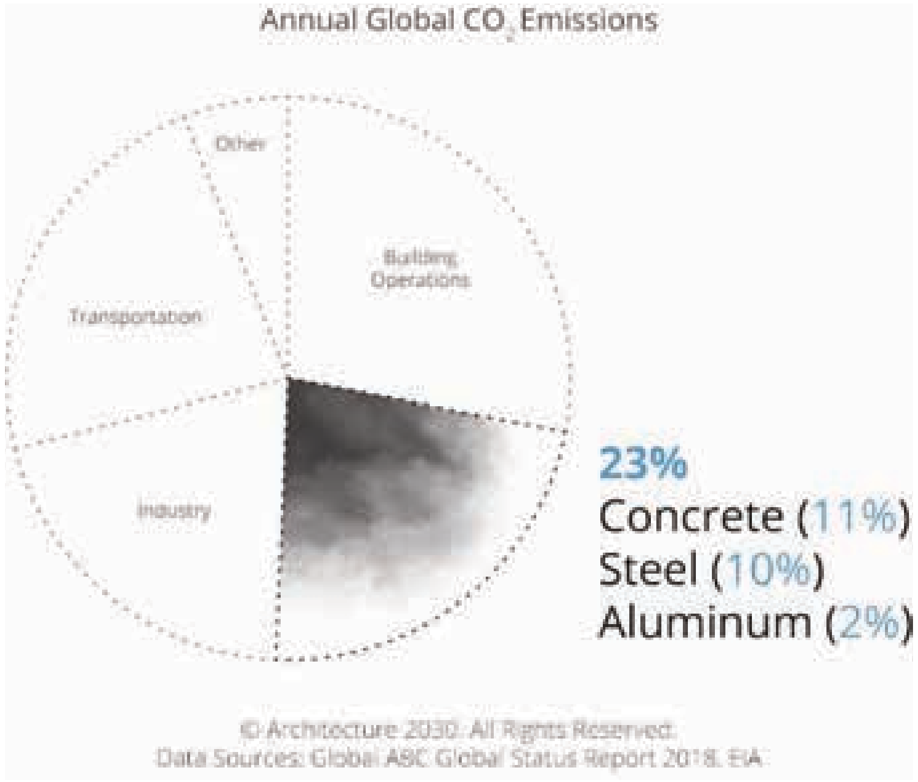


Initial embodied carbon of buildings with respect to operational energy over 50 years varies with building type:

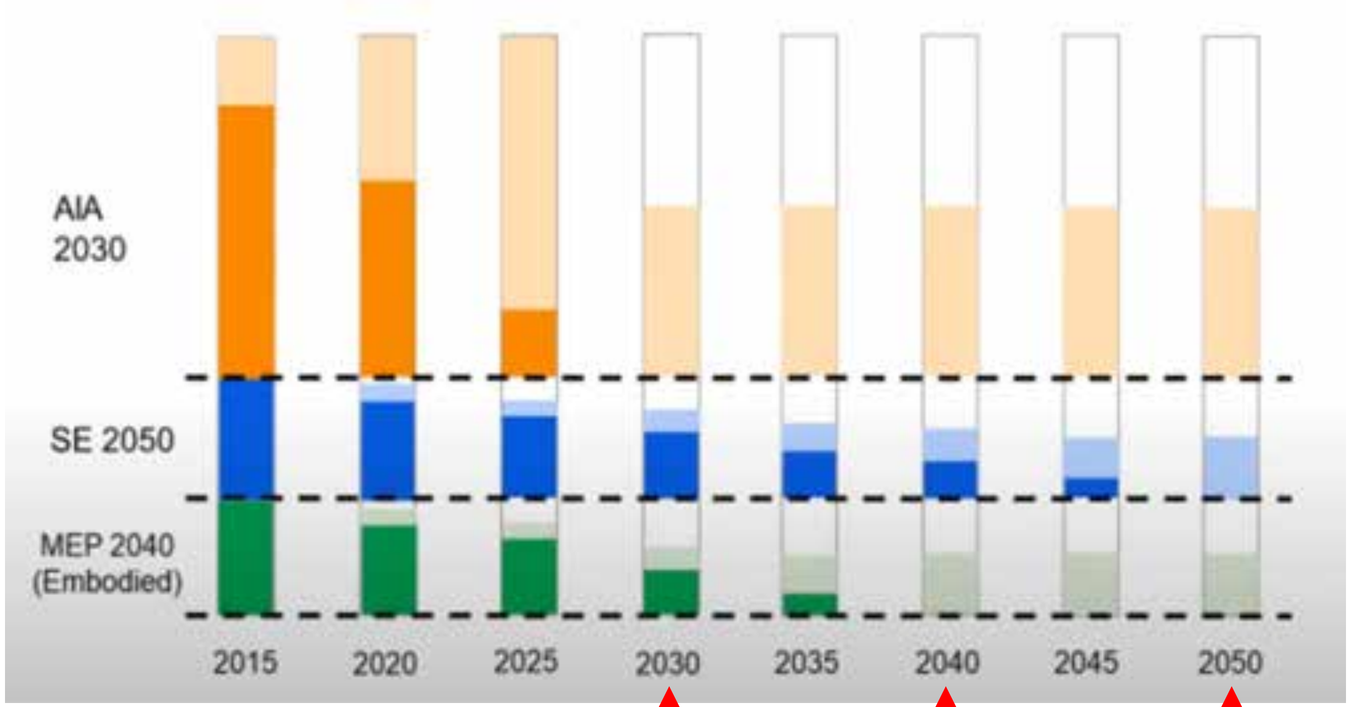
- Office 50%
- Residential 62%
- Warehouse 66%

CONSTRUCTION INDUSTRY = 39% +





WHAT IS THE INDUSTRY DOING ABOUT IT?



DARK COLORS =
OPERATIONAL & EMBODIED

LIGHT COLORS =
RENEWABLE OPERATIONAL & EMBODIED

KL&A 2020 SIGNATORY

ZERO OPERATIONAL

ZERO EMBODIED BY 2040

ZERO OPERATIONAL & EMBODIED

ZERO EMBODIED

WHAT IS NET ZERO?

- CURRENT DAY = NET ZERO OPERATIONAL
- FUTURE = NET ZERO OPERATIONAL & EMBODIED
- HOW TO ACHIEVE NET ZERO?

Photo by Phoenix Han on Unsplash

MEASURING EMBODIED CARBON - TERMINOLOGY

- GWP = GLOBAL WARMING POTENTIAL (kgCO_2eq)
- EPD = ENVIRONMENTAL PRODUCT DECLARATION
- LCA = LIFE CYCLE ASSESSMENT
- SMQ = STRUCTURAL MATERIAL QUANTITIES

MEASURING EMBODIED CARBON – WHY?

- UNDERSTAND & IDENTIFY HOT SPOTS
- UNDERSTAND THE IMPACT OF MODIFICATIONS & INNOVATIONS
- VALIDATE DECISIONS & INVESTMENTS

Photo by Verstappen Photography on Unsplash

MEASURING EMBODIED CARBON – LIFE CYCLE ASSESSMENT

CRADLE TO GATE

CRADLE TO GRAVE

Life Cycle Stages & Study Scope

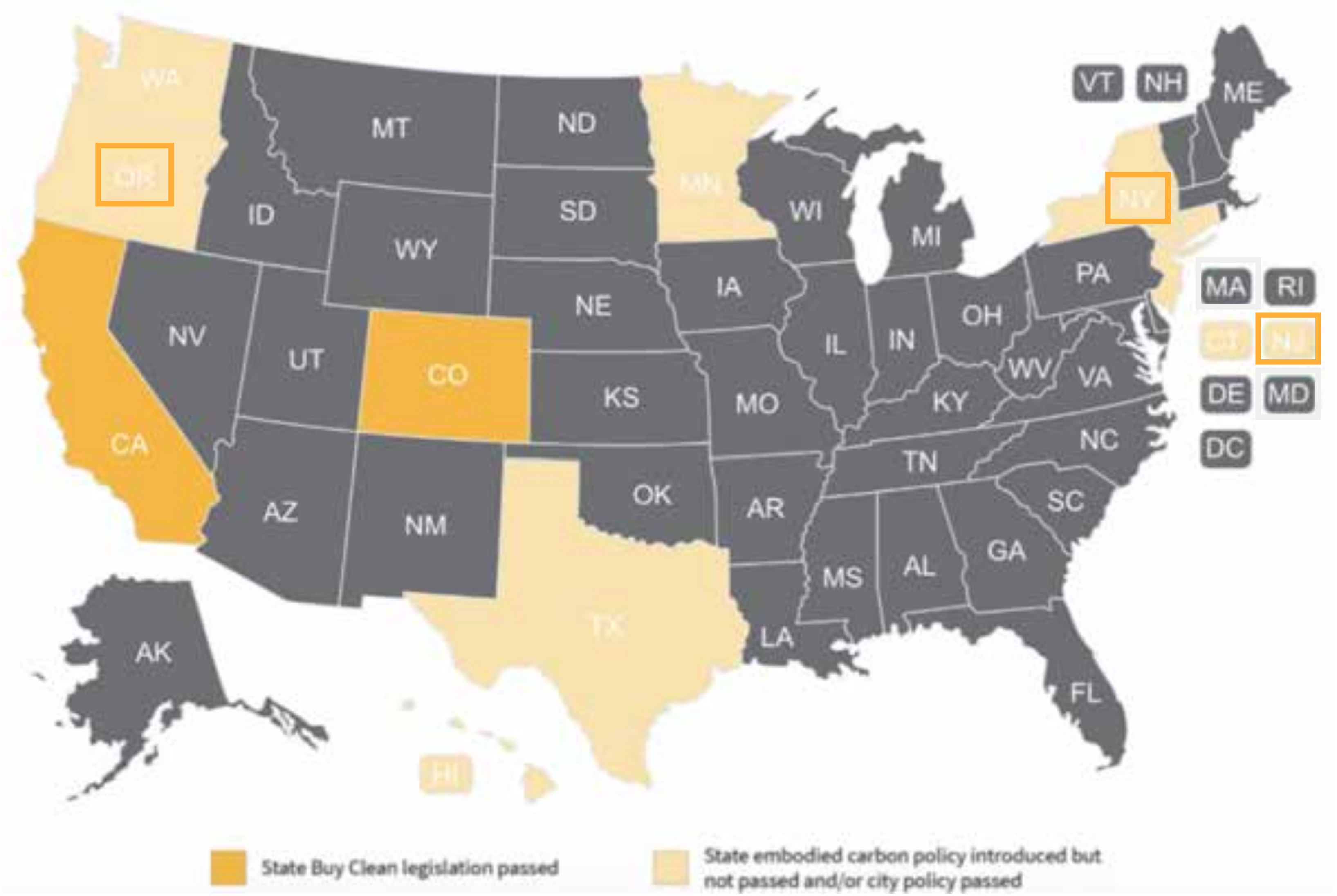
Product			Constr-uction		Use							End-of-Life				Module D		
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D1	D2	D3
Raw material supply	**Transport**	**Manufacturing**	**Transport**	***Construction\Installation***	Use	**Maintenance**	**Repair**	**Replacement**	**Refurbishment**	***Operational Energy Use***	*Operational Water Use*	Deconstruction	**Transport**	**Waste Processing**	**Disposal**	**Reuse**	**Recycling**	**Energy Recovery**
✓	✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓

Figure 3. Life Cycle Stages[3] as defined by EN 15978. Processes included in Tally modeling scope are shown in bold. Italics indicate optional processes.

BUY CLEAN LEGISLATION – STATE & LOCAL

BUY CLEAN CALIFORNIA

- 2017
  First case of Buy Clean legislation in the US
- January 1, 2022
  establish acceptable **GWP limits**
- **July 1, 2022**
  Takes effect



Source: https://carbonleadershipforum.org/clf-policy-toolkit/

BUY CLEAN LEGISLATION – STATE & LOCAL

- Los Angeles, CA
- Oakland, CA
- San Francisco, CA
- Marin County, CA

- Portland, OR
- Eugene, OR

- Seattle, WA
- King County, WA

- Phoenix, AZ

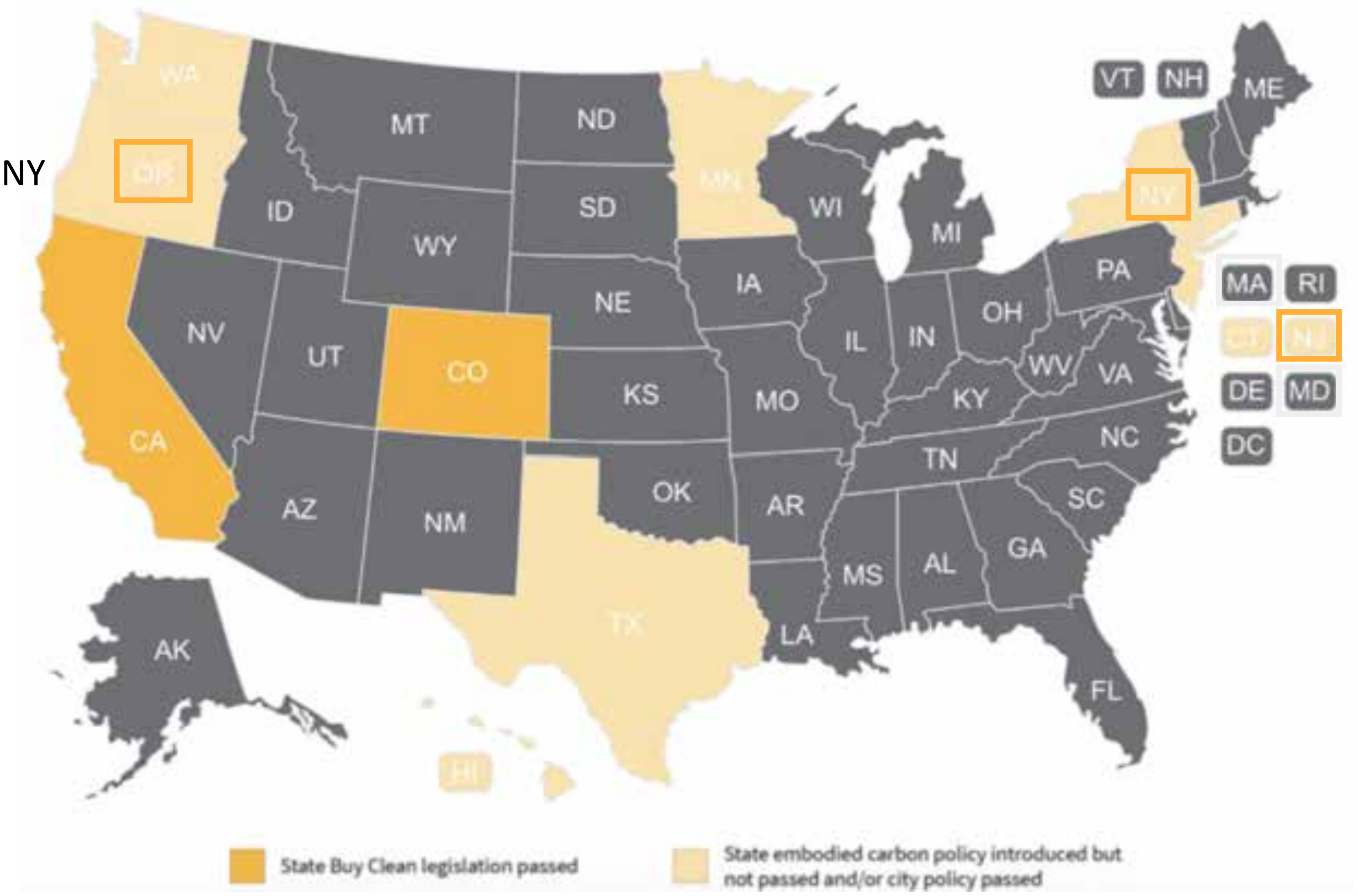
- Austin, TX
- Houston, TX

- Boston, MA
- Newton, MA
- Somerville, MA

- Port Authority, NY NJ
- Hudson, NY

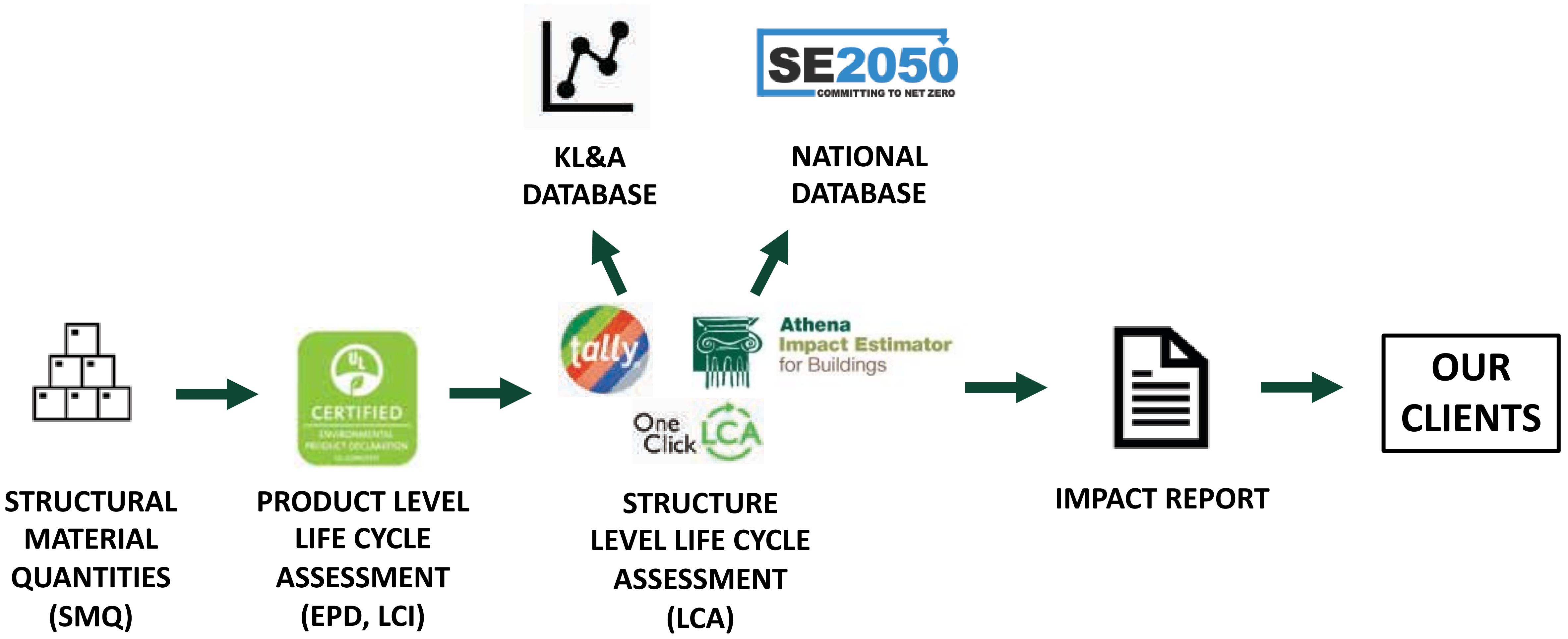
- Honolulu, HI

- Albany, CA
- Dublin, CA
- Toronto, ON
- Vancouver, BC



Source: https://carbonleadershipforum.org/clf-policy-toolkit/ c

MEASURING EMBODIED CARBON – IN PRACTICE



https://info.thinkwood.com/platte-fifteen-life-cycle-assessment

Platte Fifteen Life Cycle Assessment

JULY 2021

Authors

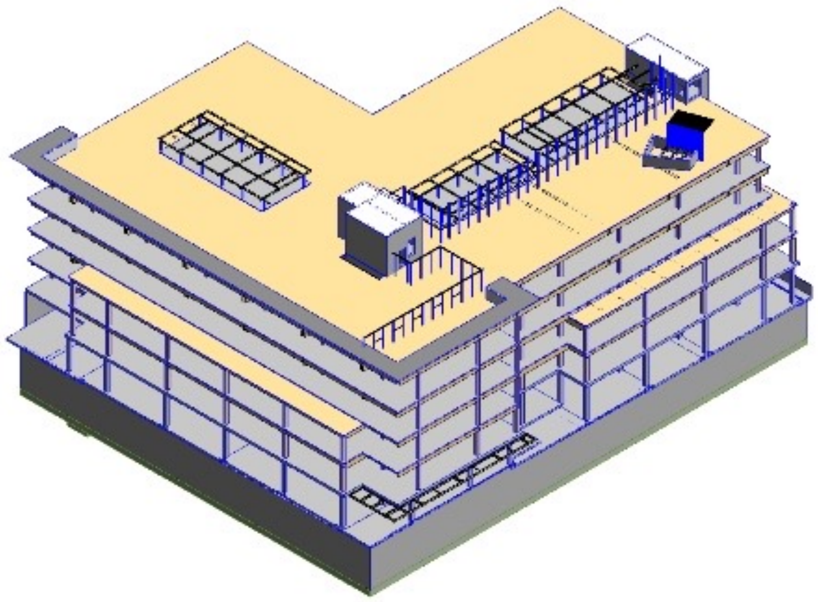
KL&A Engineers and Builders

Adolfson & Peterson

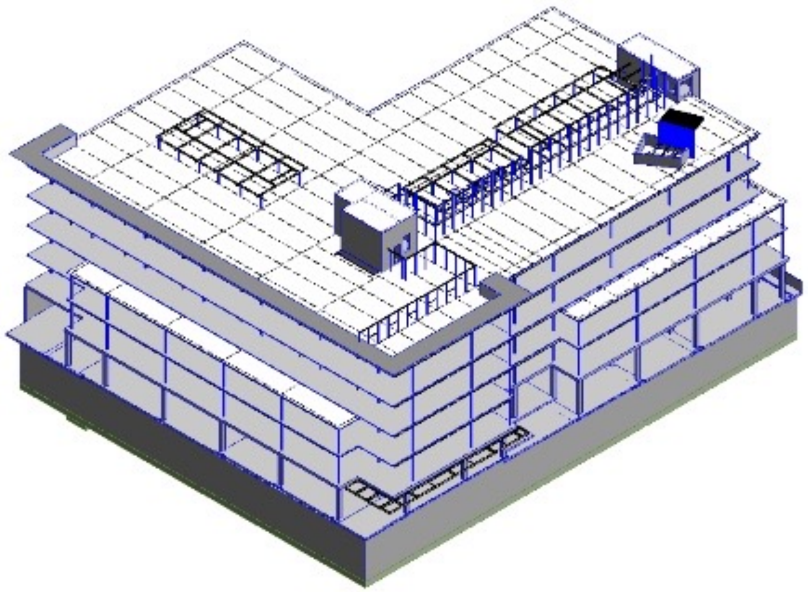
THINK WOOD.

WOODWORKS

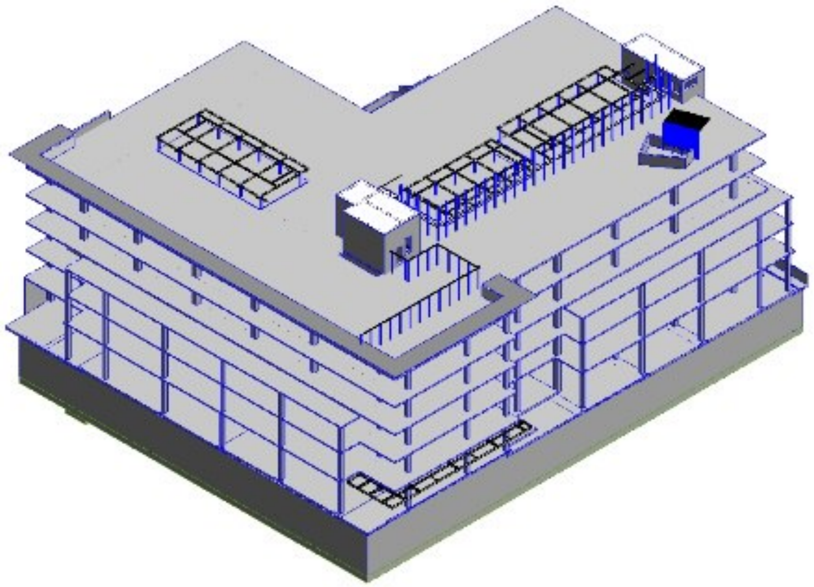
PLATTE FIFTEEN LCA



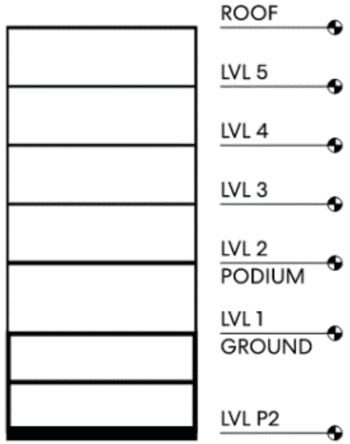
MASS TIMBER
(AS CONSTRUCTED)



STEEL



PT CONCRETE



LIFE CYCLE ASSESSMENT SCOPE

CRADLE TO GATE

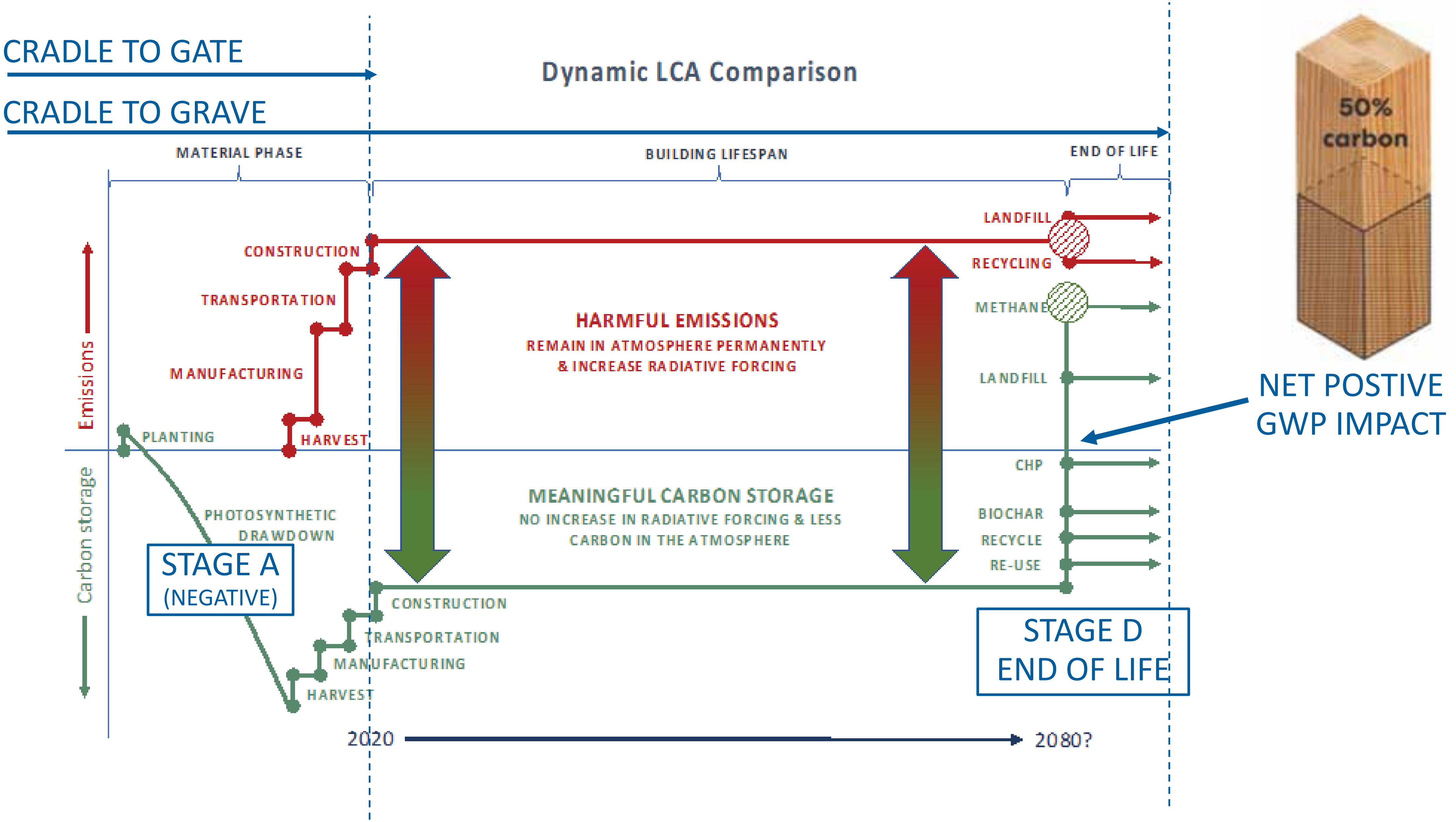
CRADLE TO GRAVE

Life Cycle Stages & Study Scope

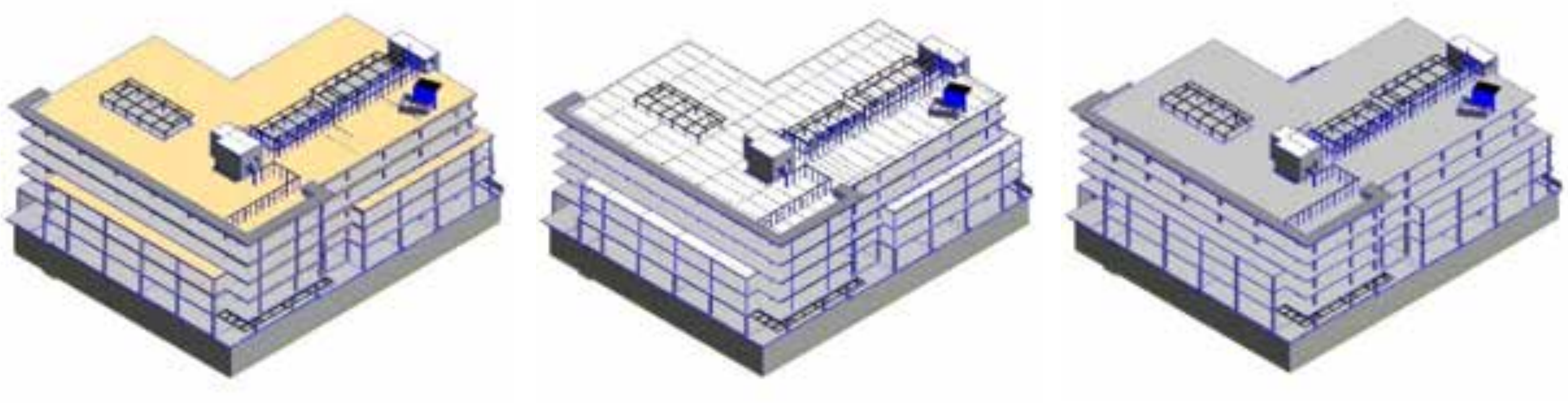
Product			Constr-uction		Use							End-of-Life				Module D		
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D1	D2	D3
Raw material supply	Transport	Manufacturing	Transport	Construction\Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction	Transport	Waste Processing	Disposal	Reuse	Recycling	Energy Recovery
✓	✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓

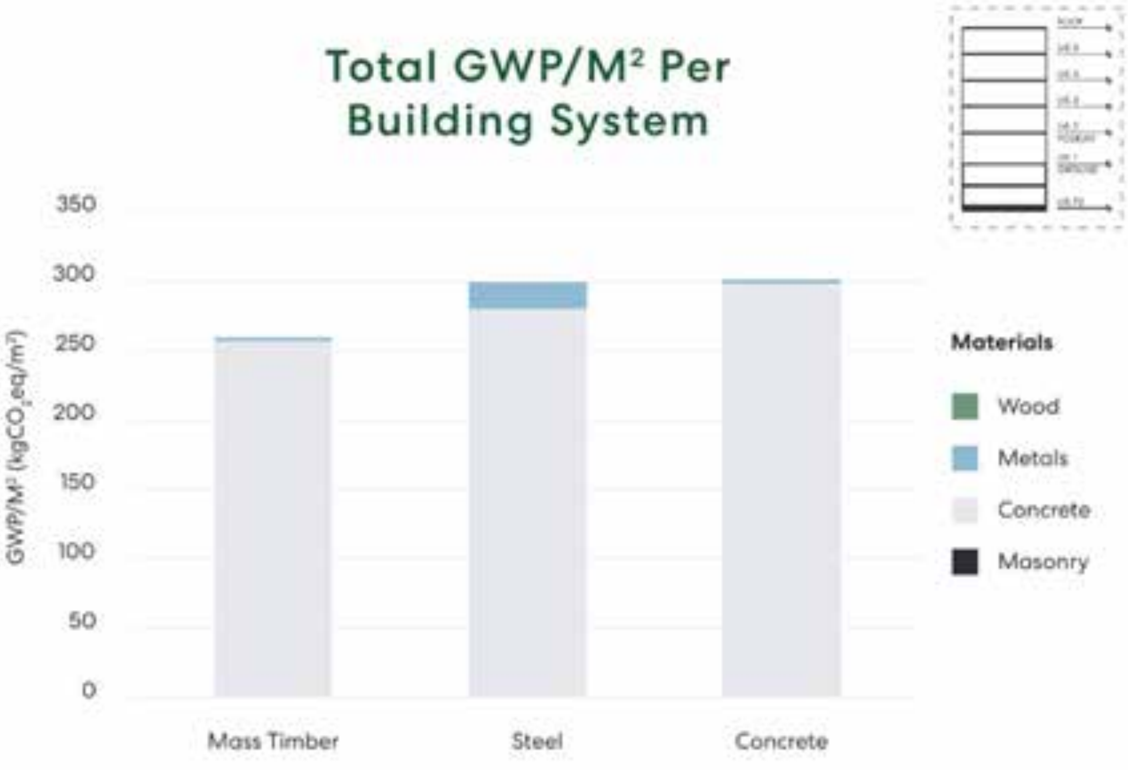
Figure 3. Life Cycle Stages[3] as defined by EN 15978. Processes included in Tally modeling scope are shown in bold. Italics indicate optional processes.

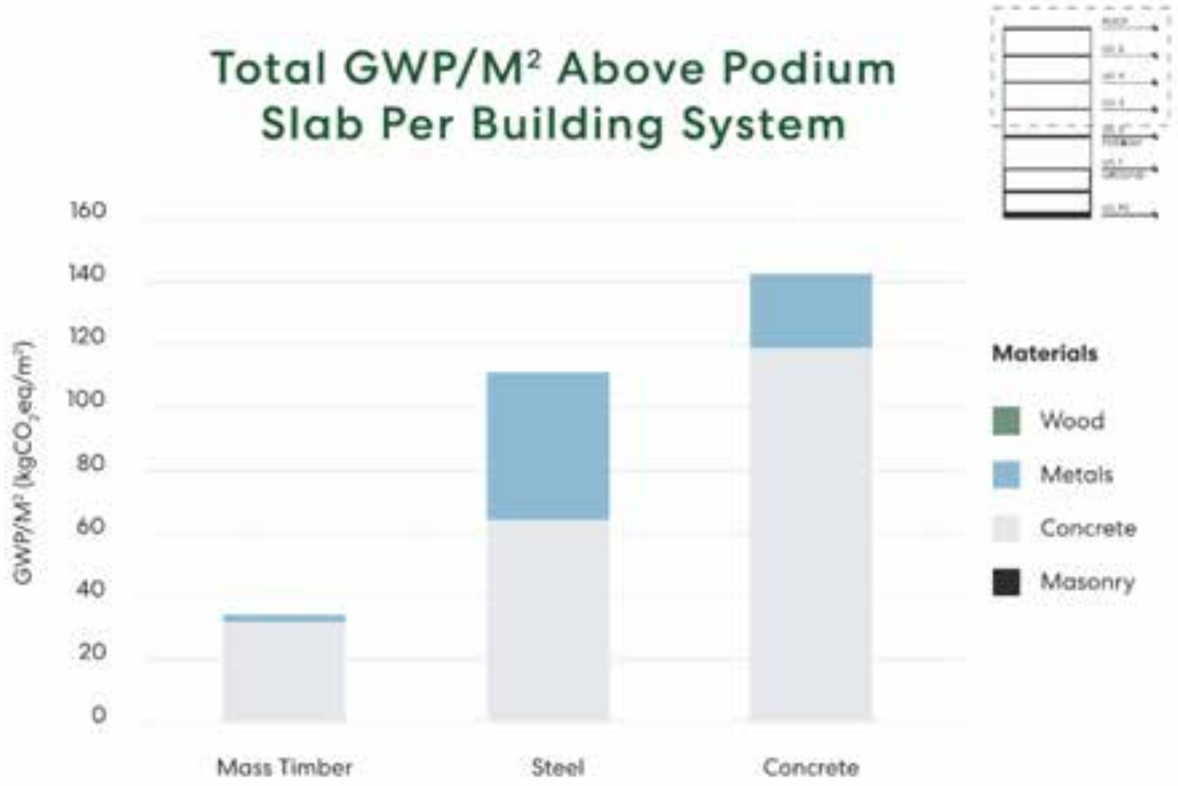
BIOGENIC CARBON



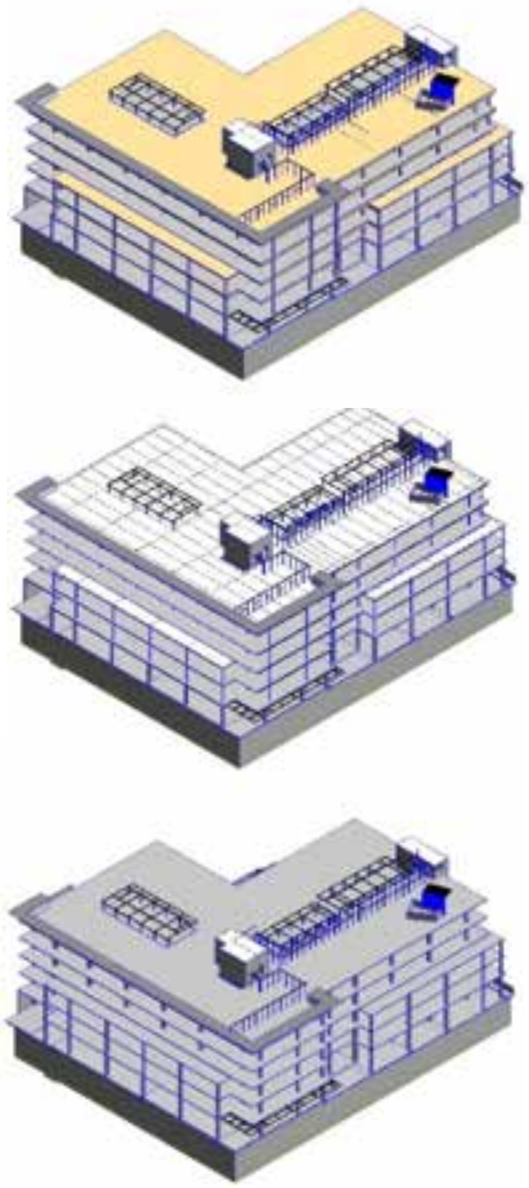
PLATTE FIFTEEN LCA STUDY

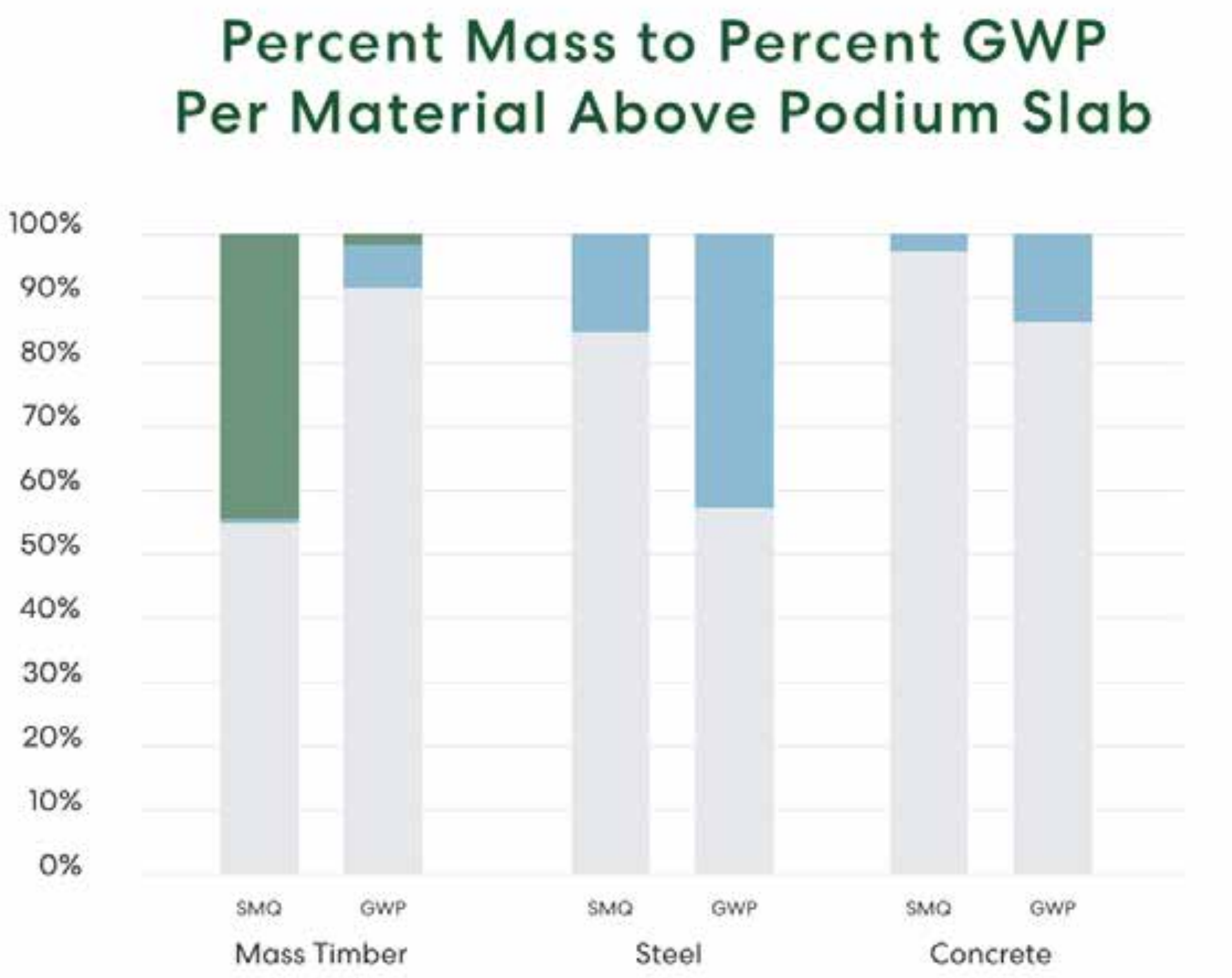


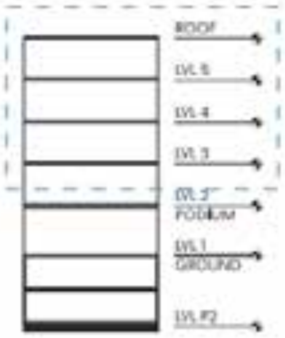




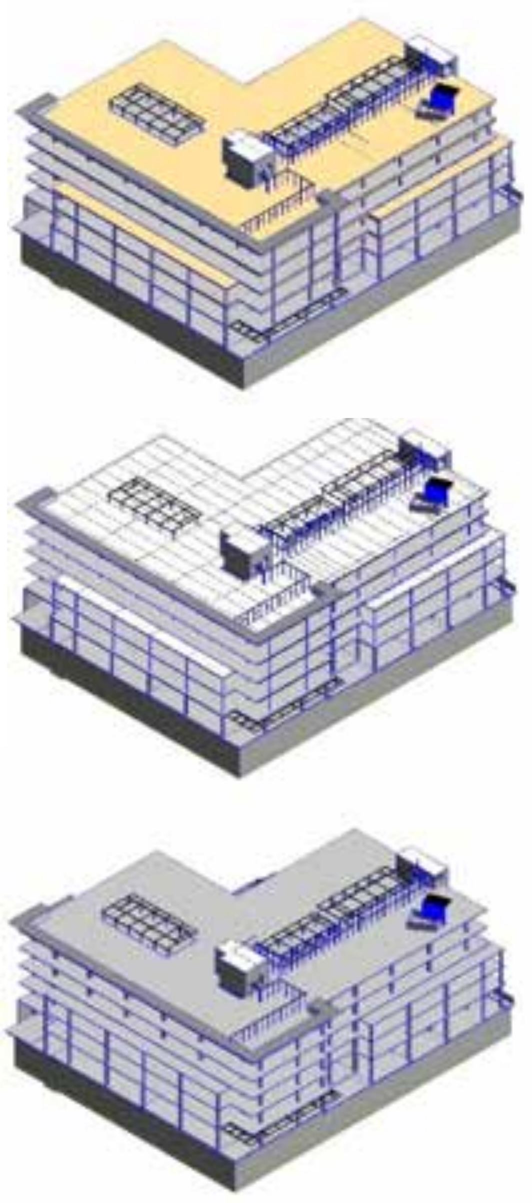
PLATTE FIFTEEN LCA STUDY

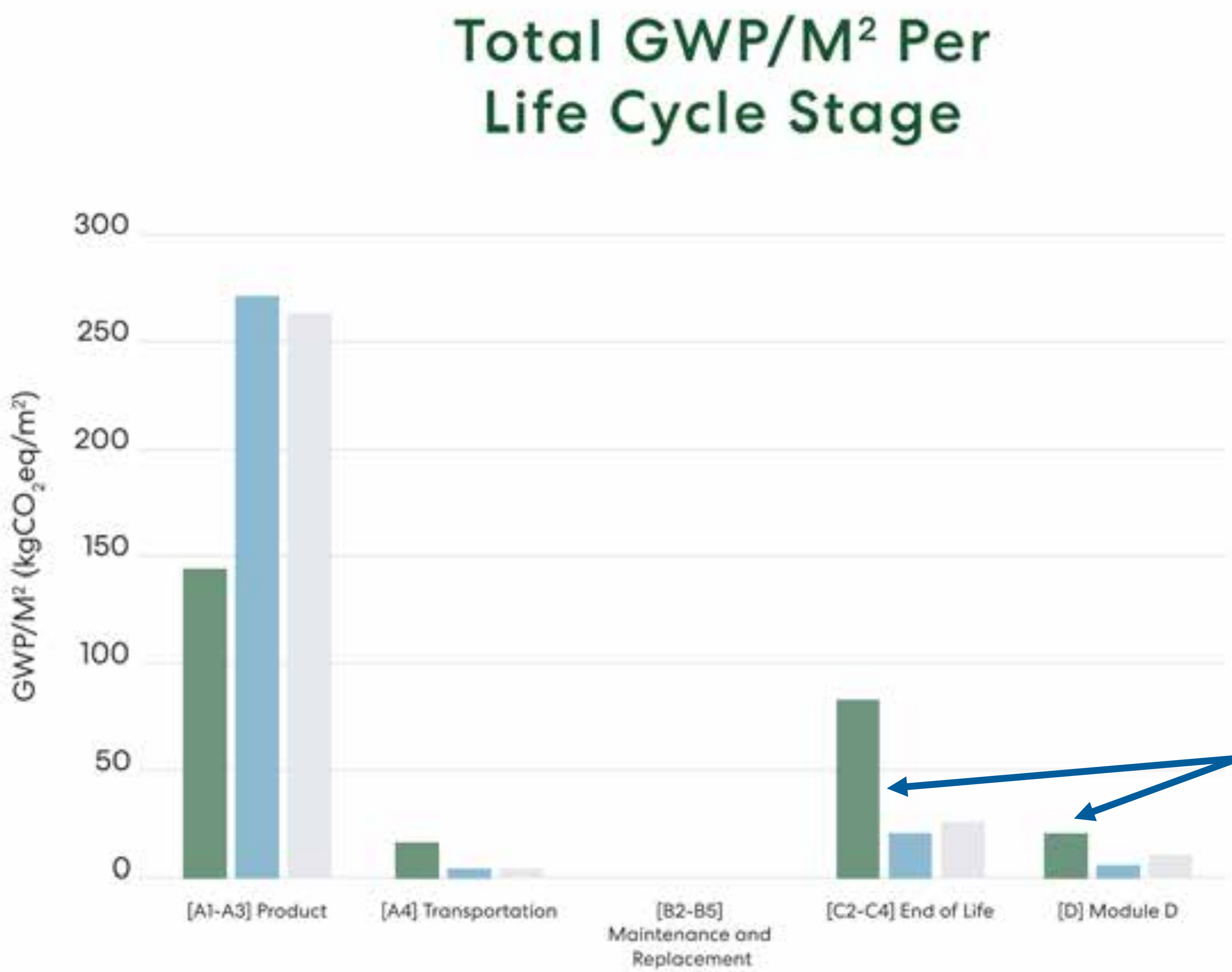






PLATTE FIFTEEN LCA STUDY





Building Systems

- Mass Timber
- Steel
- Concrete

Tally Mix Assumptions for Wood:

- 65.5% landfill
- 17.5% incineration
- 17.5% recycle

BIOGENIC CARBON AT END OF LIFE

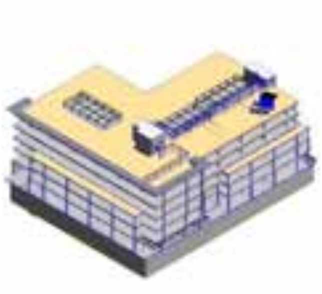
LONG LIFE, LOOSE FIT

WHAT ABOUT COST?

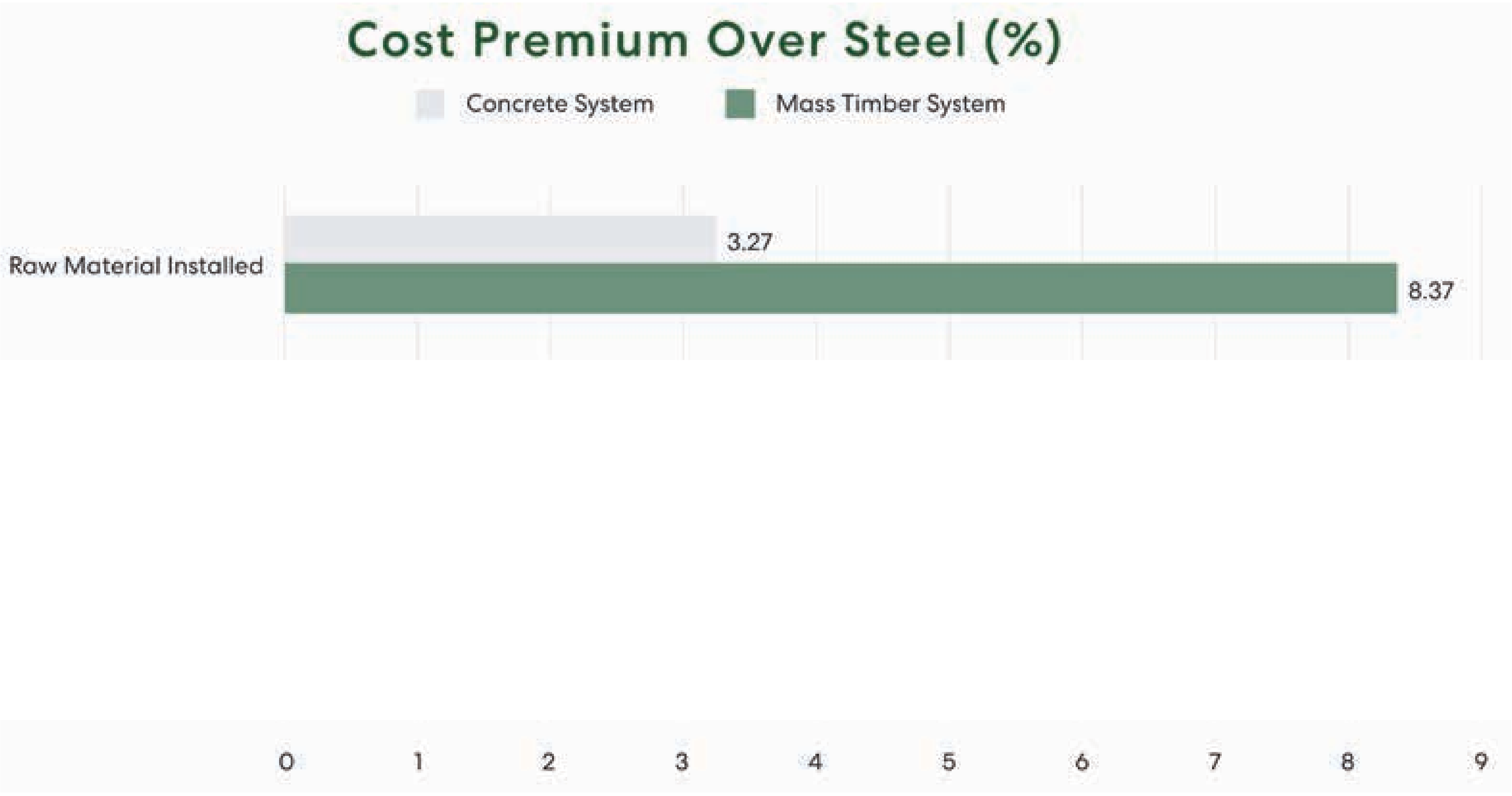
MATERIAL COST (STRUCTURE AND VERTICAL ENCLOSURE)

Steel: Lowest = Baseline

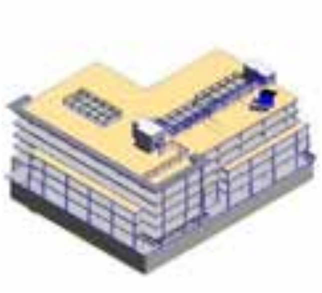
Concrete: Middle



Mass Timber: Highest



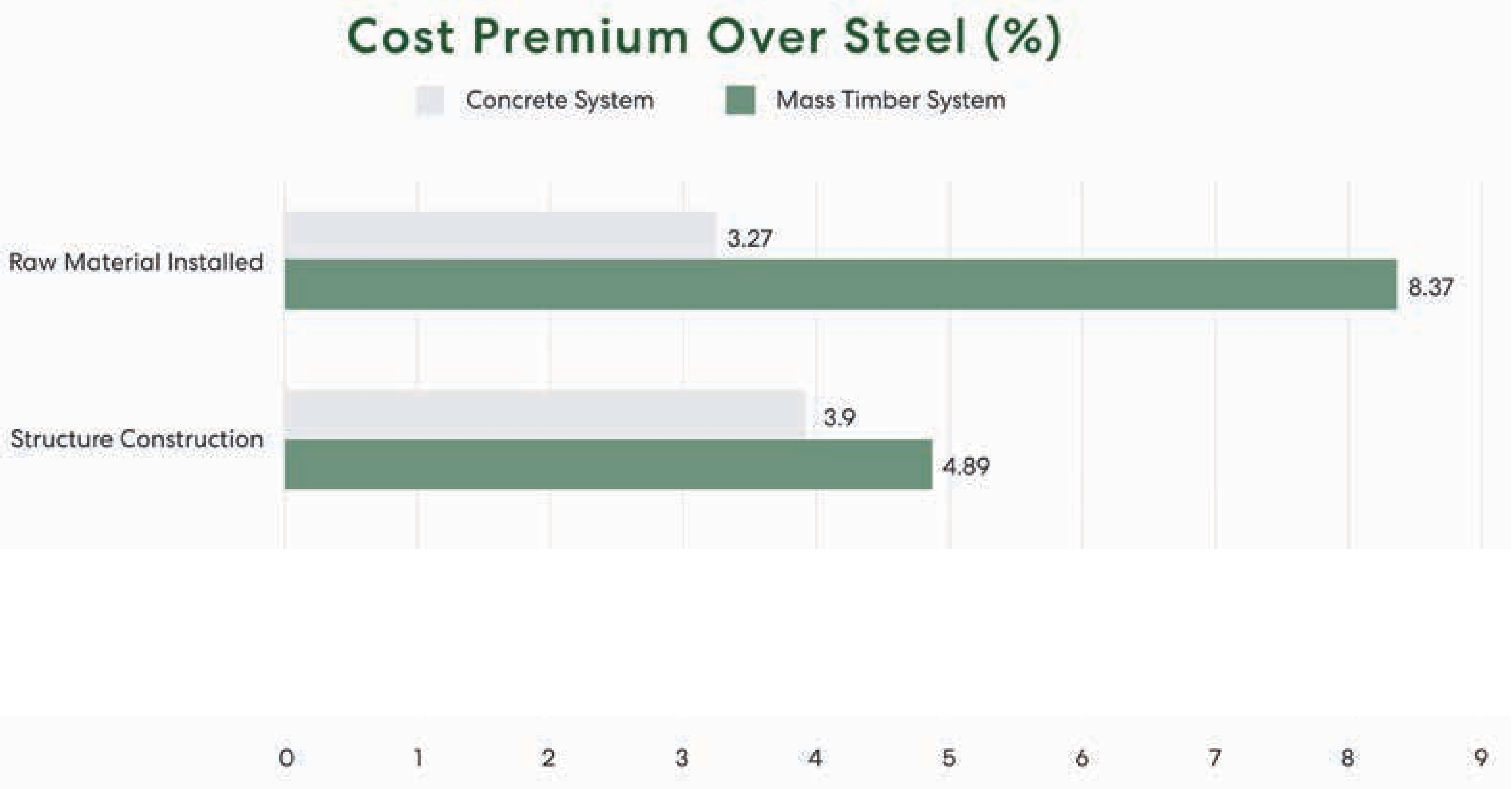
SUPERSTRUCTURE



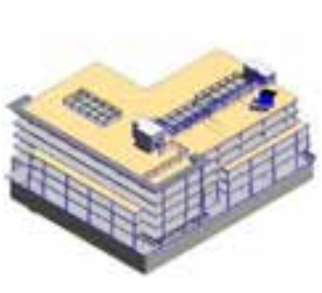
Mass Timber:
Baseline time

Steel:
+ 2 months

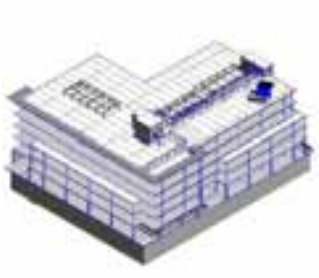
Concrete:
+ 3.5 months



TOTAL BUILDING COST

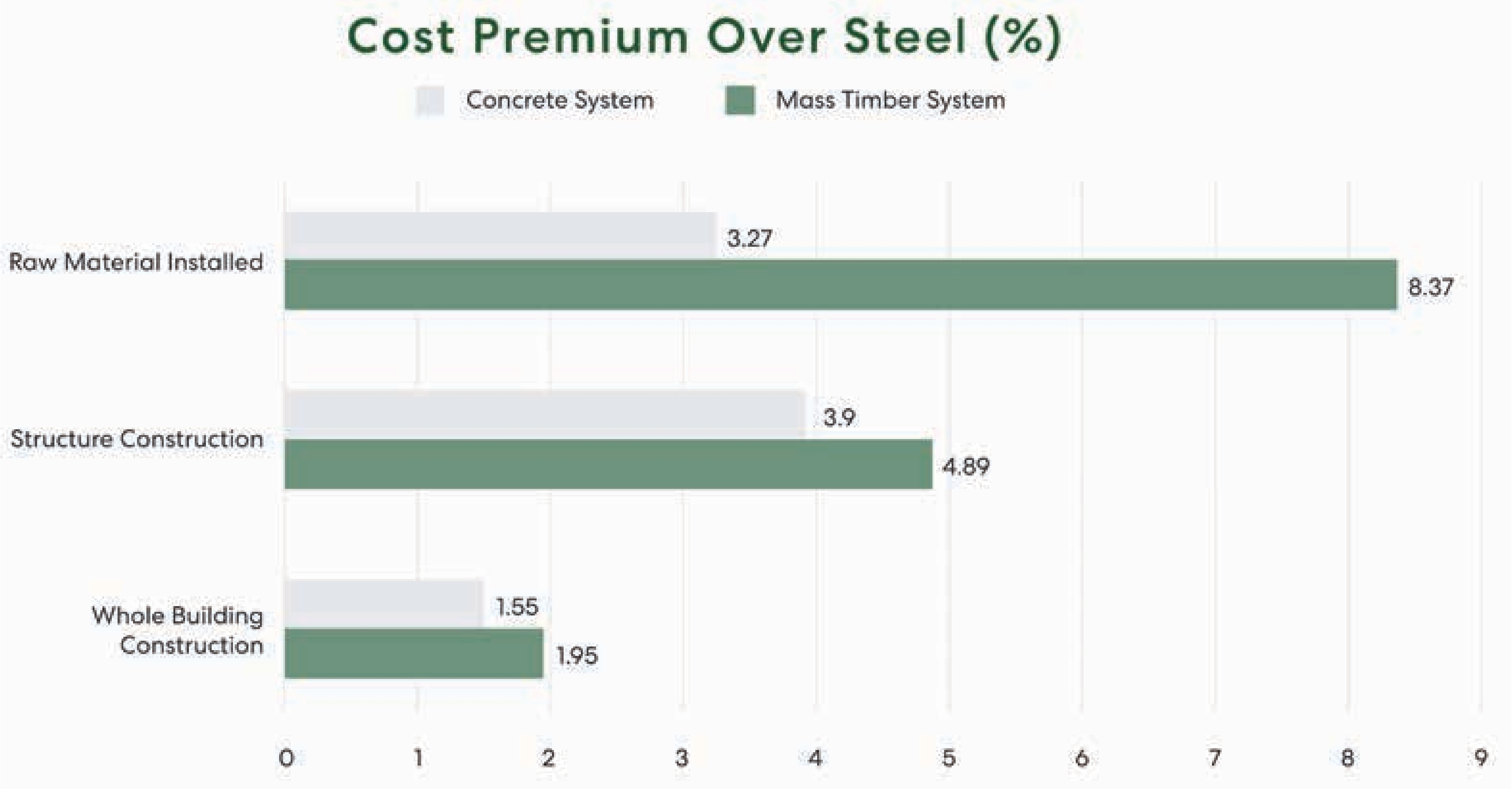


Mass Timber:
Baseline time

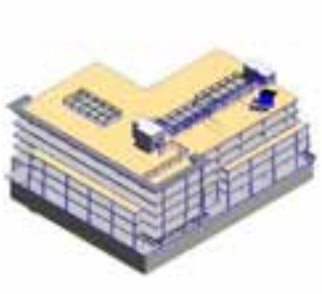


Steel:
+ 2 mos

Concrete:
+ 3.5 mos



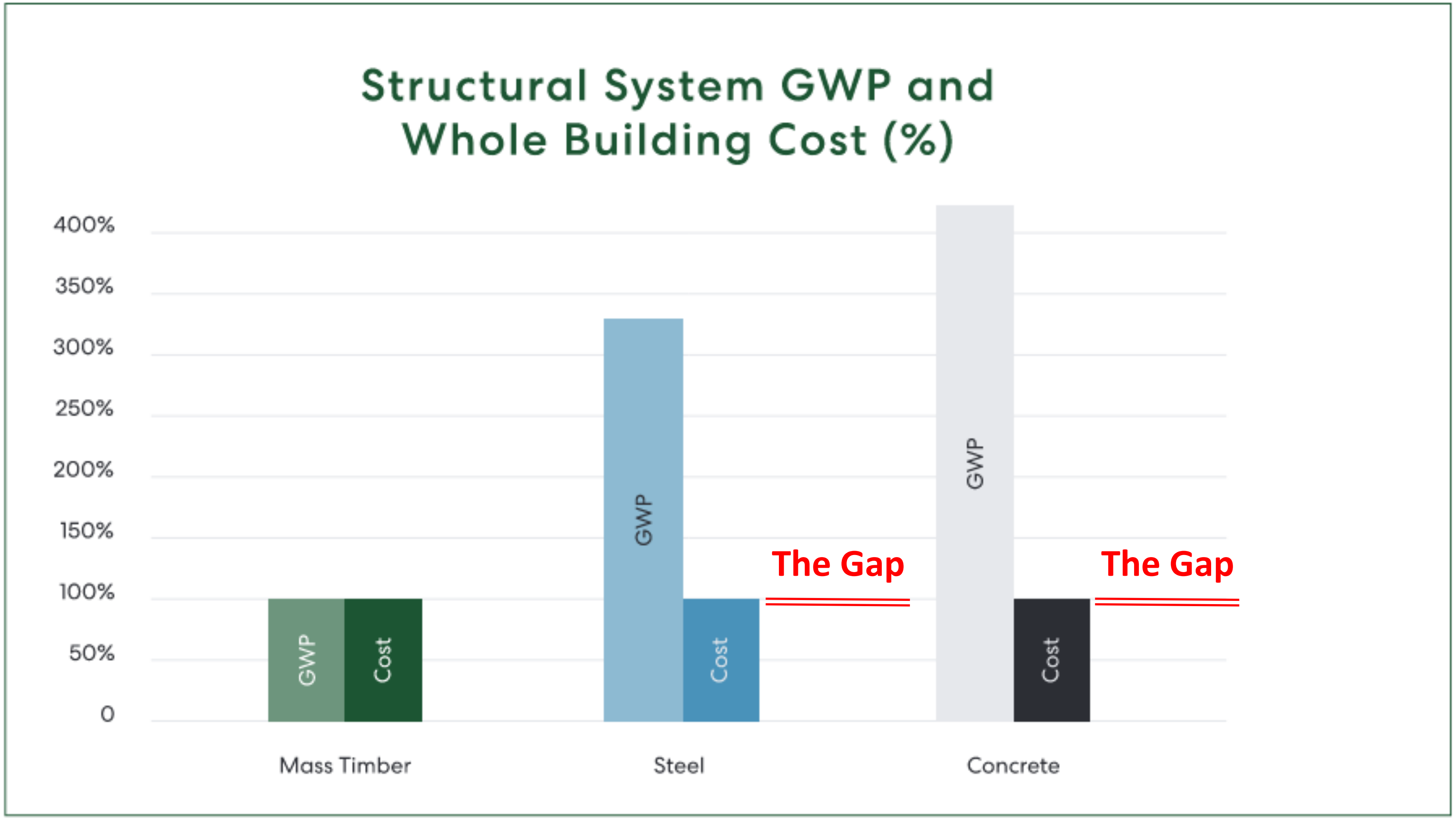
EMBODIED CARBON COST vs. DOLLAR COST



Mass Timber:
Baseline

Steel

Concrete



"**The Gap**" in this study is less than 2% of building cost

WHY MASS TIMBER?

IN THE FINISHED BUILDING, MASS TIMBER…

- LOOKS GREAT!
- HEALTHY ENVIRONMENT (BIOPHILIA)
- HIGH LEASE RATES
- HIGH LEASING VELOCITY

WHY MASS TIMBER?

UNDER CONSTRUCTION, MASS TIMBER…

- IS FAST
- REQUIRES LIMITED LABOR
- IS QUIET
- HAS LITTLE WASTE
- REDUCES CONSTRUCTION TRAFFIC

WHY MASS TIMBER?

MASS TIMBER IS SUSTAINABLE

- RENEWABLE
- REUSABLE, EASE OF DECONSTRUCTION
- SUPPORTS FOREST HEALTH
- SUPPORTS RURAL ECONOMIES
- SEQUESTERS CARBON / LOW EMBODIED CARBON (50% CARBON BY DRY WEIGHT)

Photo Credit: JC Buck

❯ QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

Greg Kingsley

KL&A Engineers and Builders

gkingsley@klaa.com