



**WOOD
PRODUCTS
COUNCIL**



Carbon Footprint of Wood Products & Buildings

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

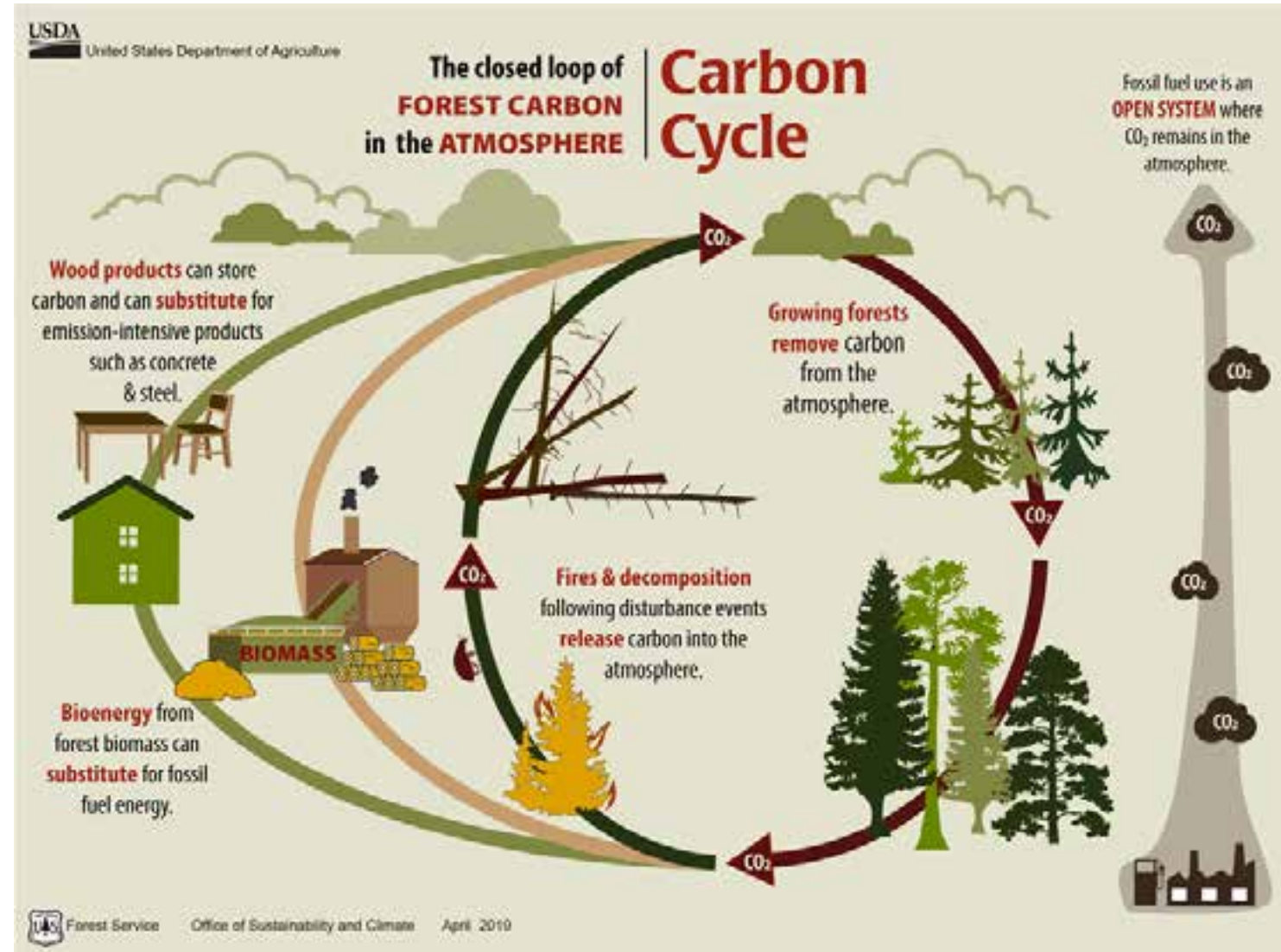
June 23, 2022

How Does Wood Fit in?

C L I M A T E

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**



State of our Forests

CLIMATE

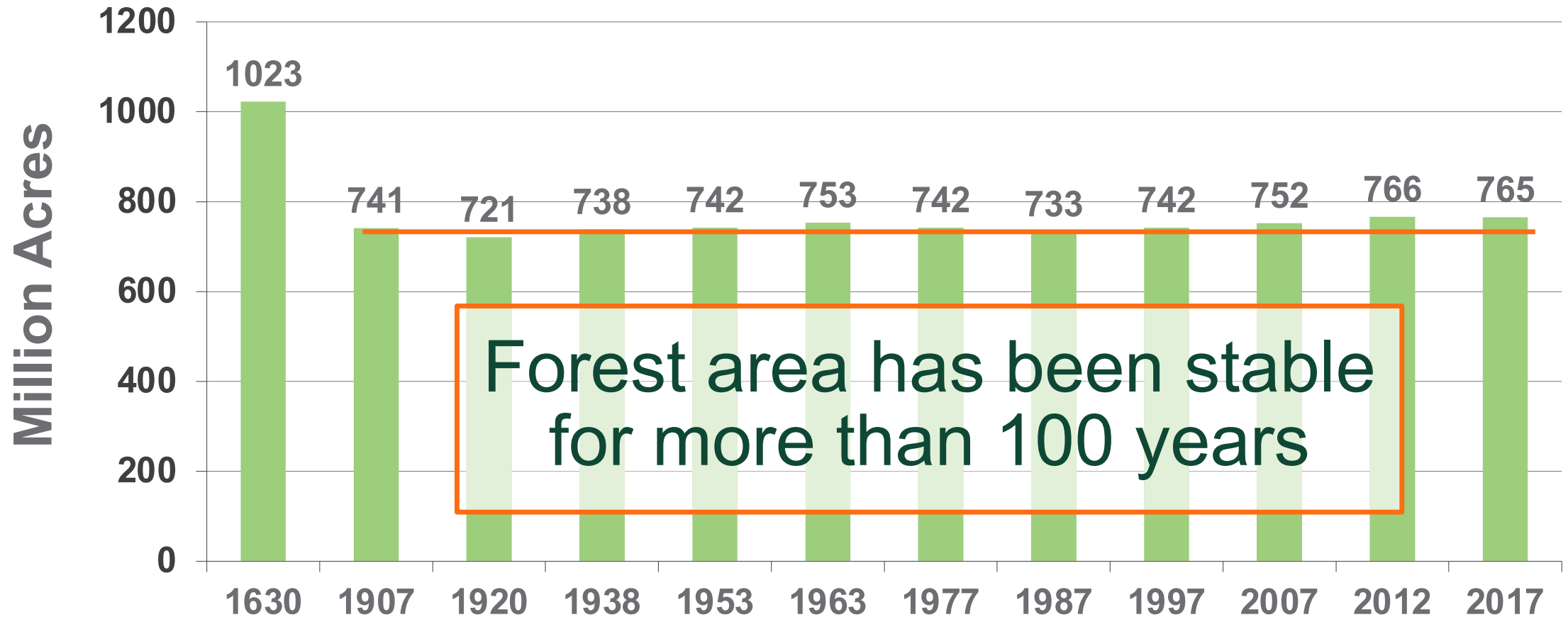


Common Environmental Concerns About Specifying Wood

1. Is North America **running out of forests?**
2. Does specifying wood products contribute to **deforestation?**
3. Is wood is a **renewable resource?**

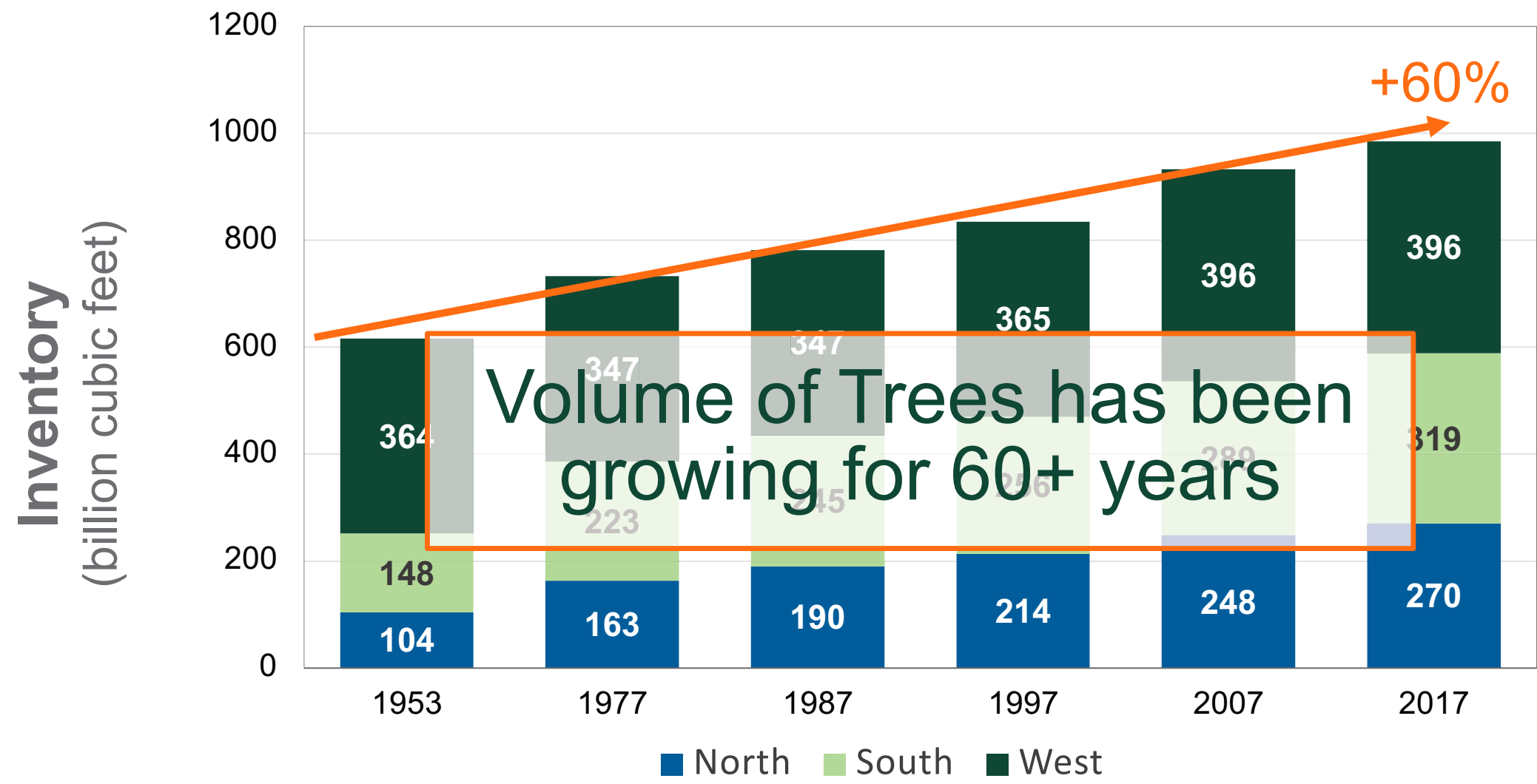
U.S. Forest Land:

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

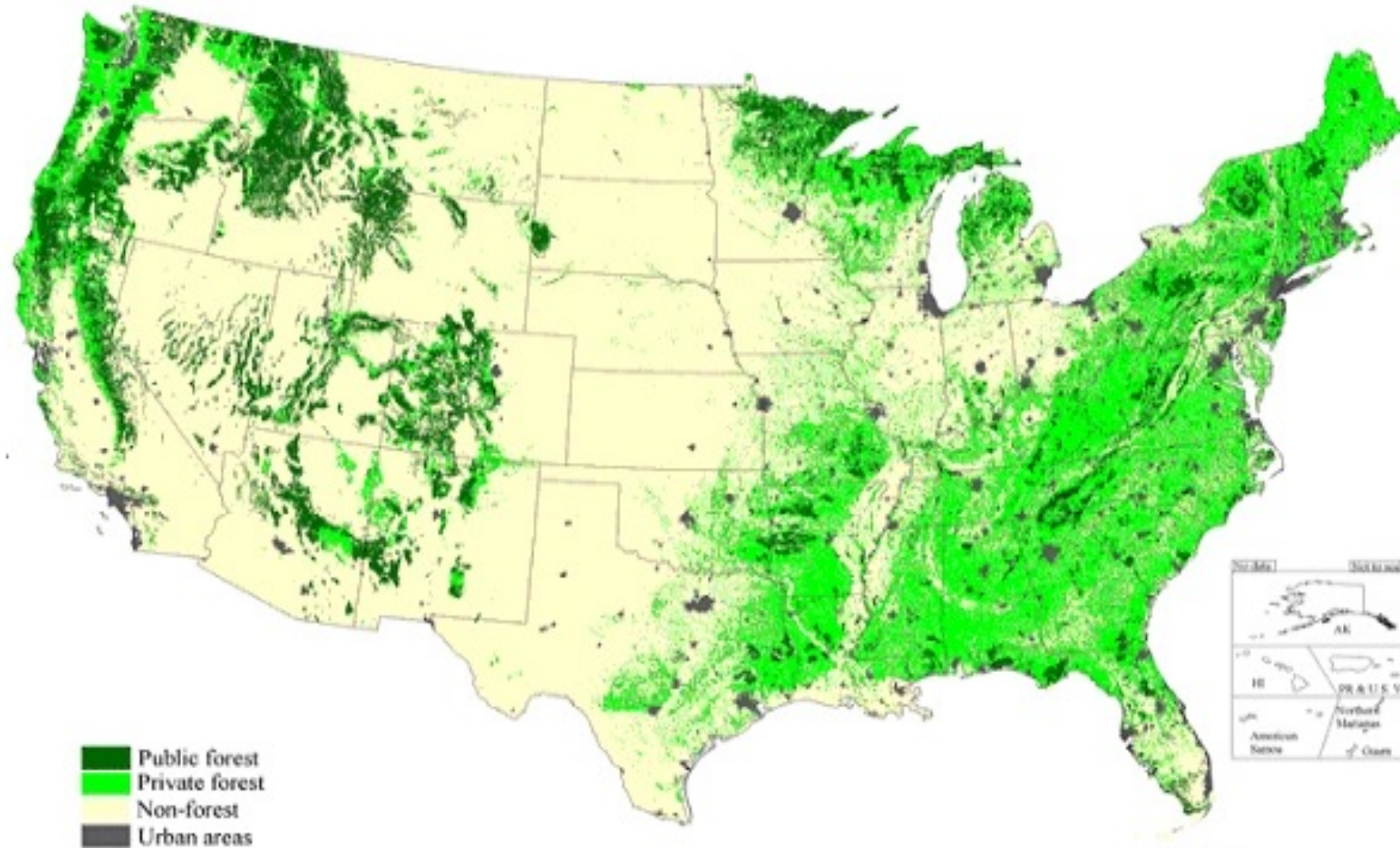


Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

US Forest Lands

Forest Land Ownership

This map displays the basic vegetation (forest vs. non-forest) of the conterminous United States as well as ownership (private vs. public). The lands displayed as "public" include Federal and State lands but do not generally include lands owned by local governments and municipalities.



USDA Forest Service, State and Private Forestry,
Cooperative Forestry Staff, Washington Office.



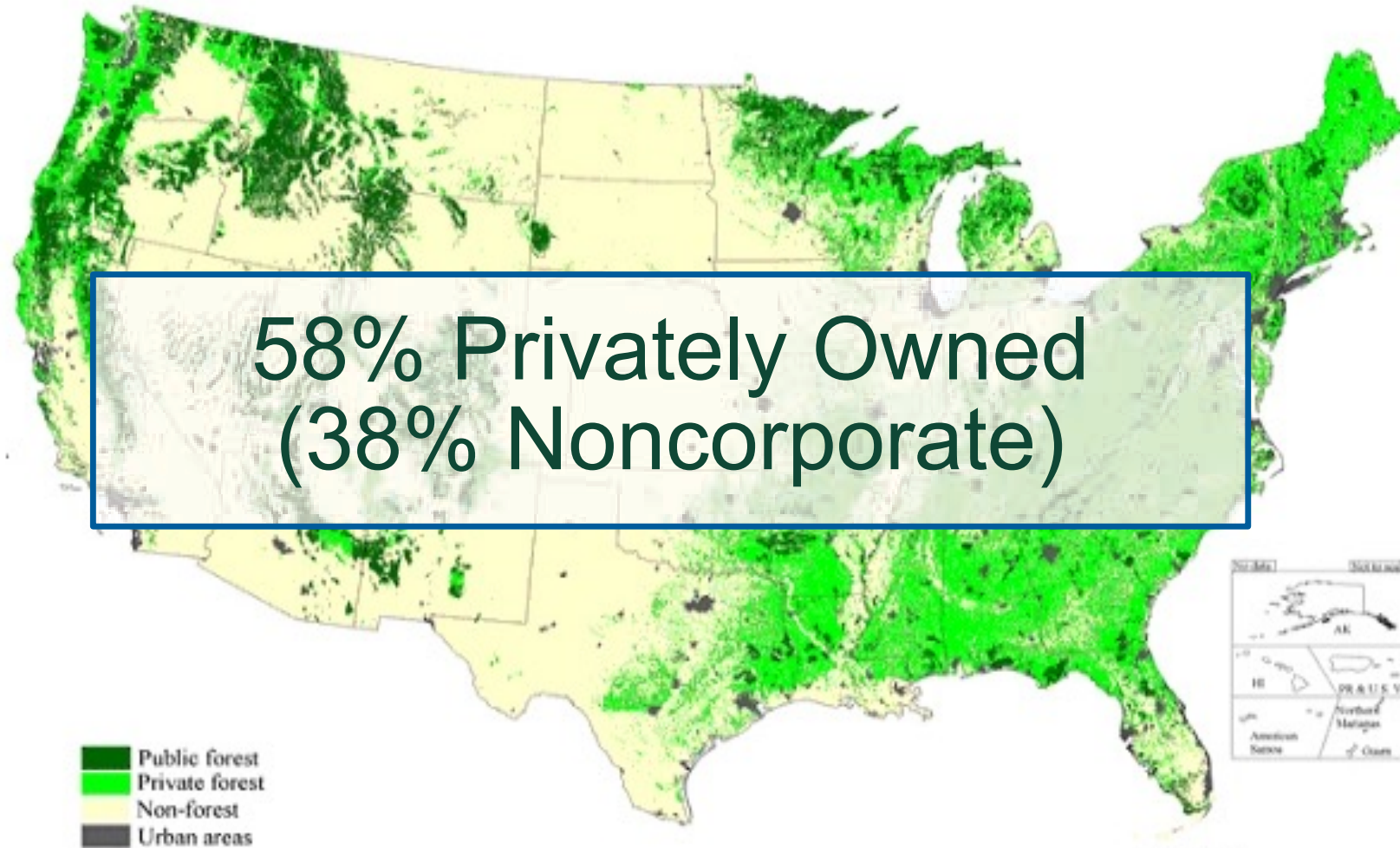
100 0 100 200 300 400 500 Miles

Data sources:
Forest: NLCD (1992)
Ownership: PAD (2001)
States: ESRI Data & Maps 2002
Urban areas: DCW (1998)

US Forest Lands

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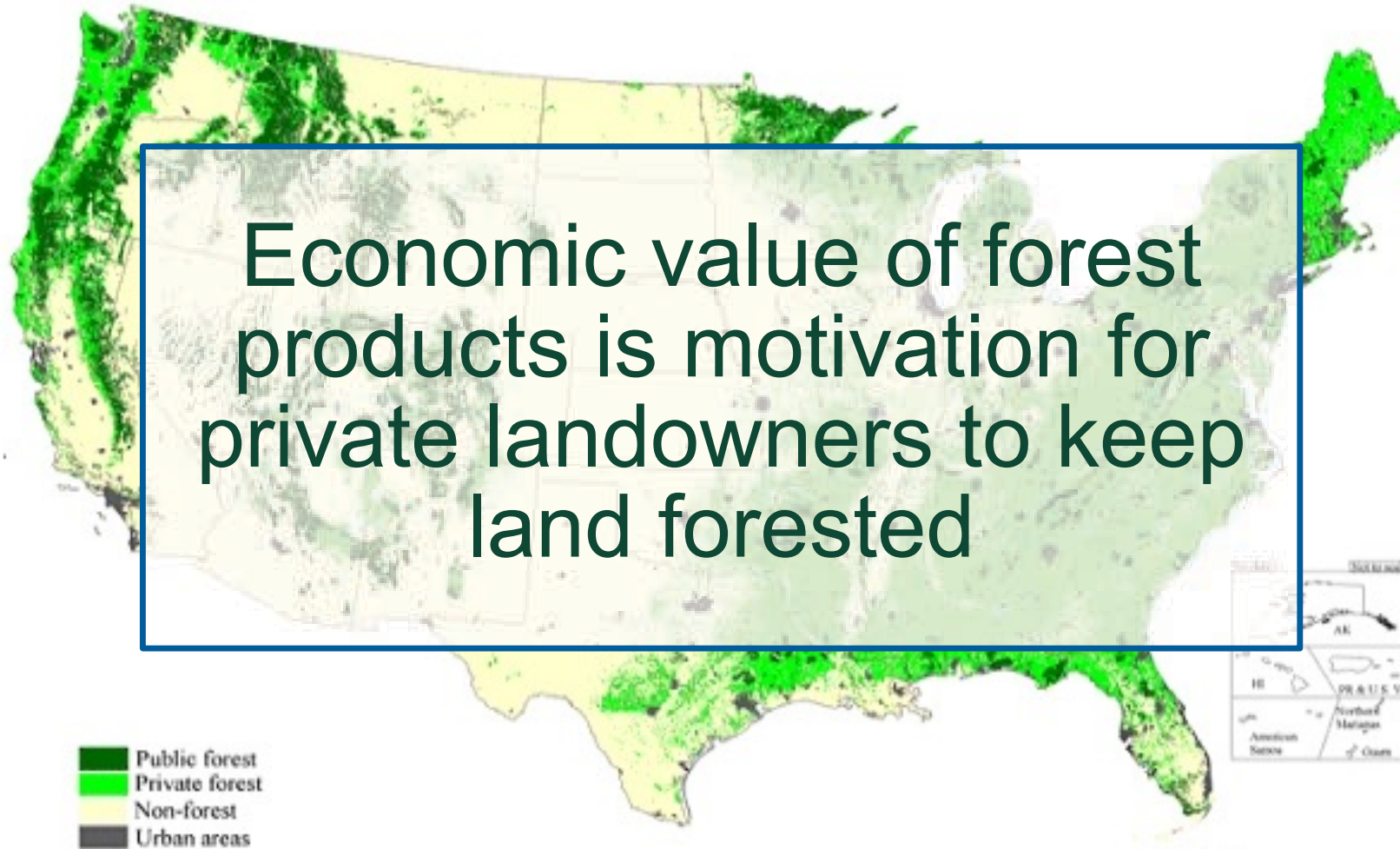
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USDA Forest Service, State and Private Forestry,
Cooperative Forestry Staff, Washington Office.



100 0 100 200 300 400 500 Miles

Data sources:
Forest: NLCD (1992)
Ownership: PAD (2001)
States: ESRI Data & Maps 2002
Urban areas: DCW (1998)

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.

Resources

CLIMATE



CONTINUING EDUCATION

The Impact of Wood Use on North American Forests

Can specifying wood for buildings contribute to forest sustainability?

Sponsored by Think Wood | By Emma Ward and Dave Peterson, RFP

A green building has evolved beyond its initial emphasis on energy efficiency; greater attention has been given to the choice of structural materials and the degree to which they influence a building's environmental footprint. Increasingly, wood from sustainably managed forests is viewed as a responsible choice—for a number of reasons. Wood grows naturally by harnessing energy from the sun, absorbing carbon dioxide and releasing oxygen. It is renewable and a carbon sink, and it outperforms other materials in terms of embodied energy, air and water pollution, and other impact indicators.

But what about the forest? The benefits shown notwithstanding, how can building designers be sure that specifying wood does not negatively impact the North American forest resource?

As this course will demonstrate, the answer to that question has several elements. On one hand, North American forest practices are among the world's best, and the amount of forested land, in both the United States and Canada, has been stable for decades. On the other, there are drivers—such as climate change, increased wildfires, insect infestation and disease, and deforestation due to urban development—which are broader than the forest industry and must be addressed at a societal level. Drawing from a wide range of recent public sources, the following paper will examine the current state of North American forests, modern forest practices, and criteria for sustainability, and consider some of the challenges that could potentially impact the future of the forest resource. In this context, the course will also discuss why strong markets for wood

CONTINUING EDUCATION

1 AIA LUSC1006

Learning Objectives

After reading this article, you should be able to:

1. Evaluate the use of wood as a construction material in the context of long-term forest sustainability as well as attributes such as low embodied energy and light carbon footprint.
2. Discuss forest sustainability measures such as biodiversity, soil and water quality, and harvest versus net growth.
3. Examine the concept that using wood in buildings provides an incentive to landowners to keep forested lands forested instead of converting them to uses such as urban development.
4. Compare the carbon benefits of an unmanaged forest versus a managed forest where timber is used for wood buildings.

To receive AIA credit, you are required to read the entire article and pass the test. Go to www.aiaa.org/education/courses for complete test and to take the test for free. This course may also qualify for your Professional Development Hours (PDH). Most states now accept AIA credits for engineering requirements. Check your state licensing board for all laws, rules, and regulations to confirm.

AIA COURSE NUMBER

Understanding the Role of Embodied Carbon in Climate Smart Buildings



Report on Carbon Reduction Policy and Design Best Practices

THINK WOOD.

1 AIA LUSC1006

CONTINUING EDUCATION

Located in downtown Denver, Pella Office is a five-story workplace that incorporates a mass-timber frame built using glulam and timber joists. Features and materials as well as green certified timber (SCL) floor and roof panels.



How to Calculate the Wood Carbon Footprint of a Building

Expanding the possibilities of wood building design

Sponsored by Think Wood | By Eric Somer Hall, PhD

From an environmental perspective, it is widely known that buildings matter. Buildings consume nearly half the energy produced in the United States, use three quarters of the electricity, and account for nearly half of all carbon dioxide (CO₂) emissions. The magnitude of their impacts is the driving force behind many initiatives to improve tomorrow's structures—from energy regulations and government performance policies, to green building rating systems and programs such as the Leadership in Energy and Environmental Design (LEED) Challenge. The focus on energy efficiency, in particular, has led to widespread improvements, so much so that many designers are now giving greater attention to the impacts of structural building materials. The greater attention has resulted that greenhouse gas (GHG) emissions associated with materials

used in buildings and construction projects be 26 percent of building sector emissions and 13 percent of global GHG emissions. As we dive to dive deeper into these numbers to find ways to reduce a building's carbon footprint in meaningful ways, what are the methods used to measure building material carbon footprint, and do they tell the whole story? Are there simple tools to derive material choices? This course works to address these and other questions by explaining the principal methods and tools that are used to assess carbon footprint in the context of building materials. It includes a primer on product terminology, including life cycle assessment (LCA), environmental product declaration (EPD), carbon footprint, embodied carbon, and whole building LCA (WBLC). credit, it explains how designers

CONTINUING EDUCATION

1 AIA LUSC1006

Learning Objectives

After reading this article, you should be able to:

1. Explain what a carbon footprint is in the context of building materials.
2. Describe the difference between life cycle assessment (LCA), environmental product declaration (EPD), and whole building LCA.
3. Identify where whole building LCA tools and how they can be used to develop a whole building carbon footprint.
4. Define what is and is not included in a whole EPD and why.
5. Discuss the benefits of forest carbon sinks and ways to track and measure forest sustainability in North America.

To receive AIA credit, you are required to read the entire article and pass the test. Go to www.aiaa.org/education/courses for complete test and to take the test for free. This course may also qualify for your Professional Development Hours (PDH). Most states now accept AIA credits for engineering requirements. Check your state licensing board for all laws, rules, and regulations to confirm.

AIA COURSE NUMBER

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



Questions?

This concludes The American
Institute of Architects Continuing
Education Systems Course

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Carbon and Cost: Evaluating the Impact of Different Structural Systems

Presented by Greg Kingsley, PE, PhD



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

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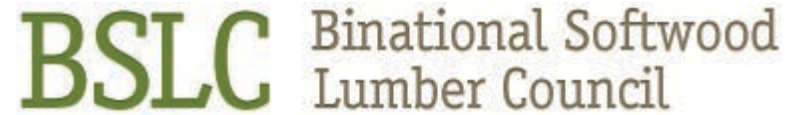
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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.



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

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 FIFTEEN

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



PLATTE 15



PLATTE 15



PLATTE 15



PLATTE 15



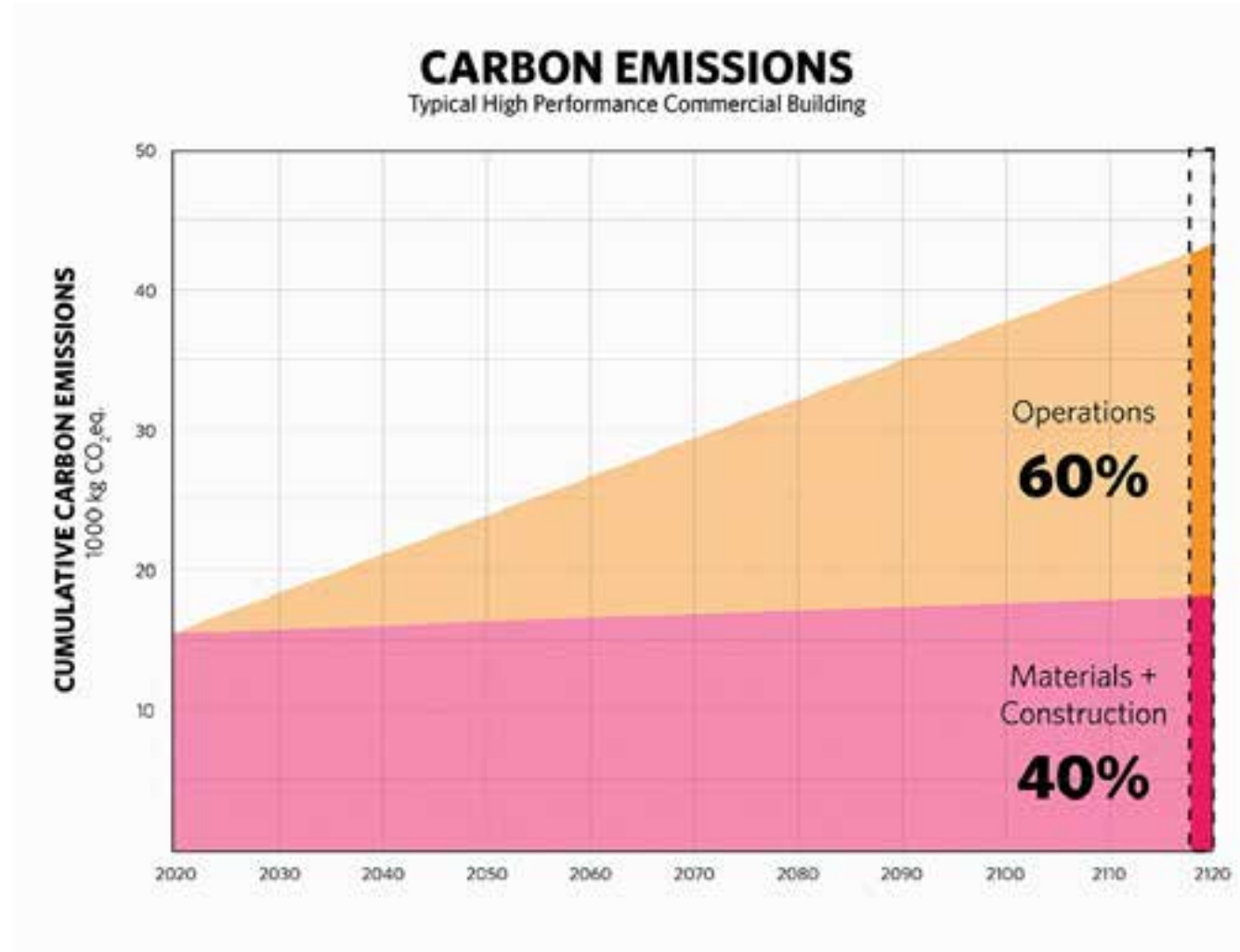
Meanwhile, embodied carbon starts getting attention...

Understanding Carbon



Operational Carbon
Building energy consumption

OPERATIONAL VS EMBODIED CARBON



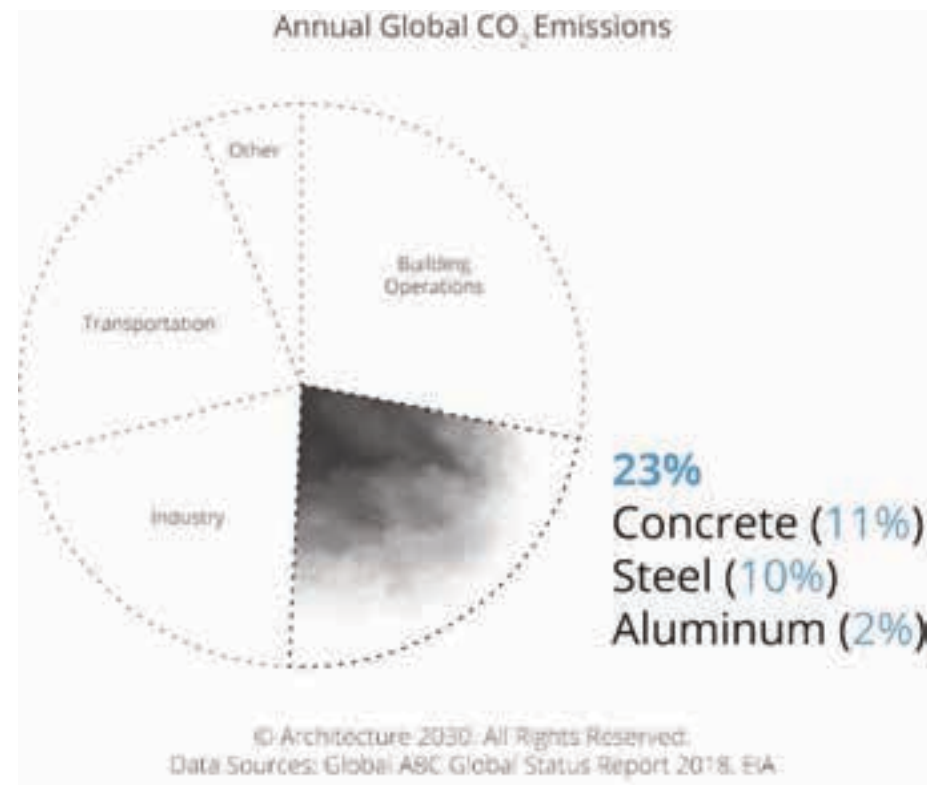
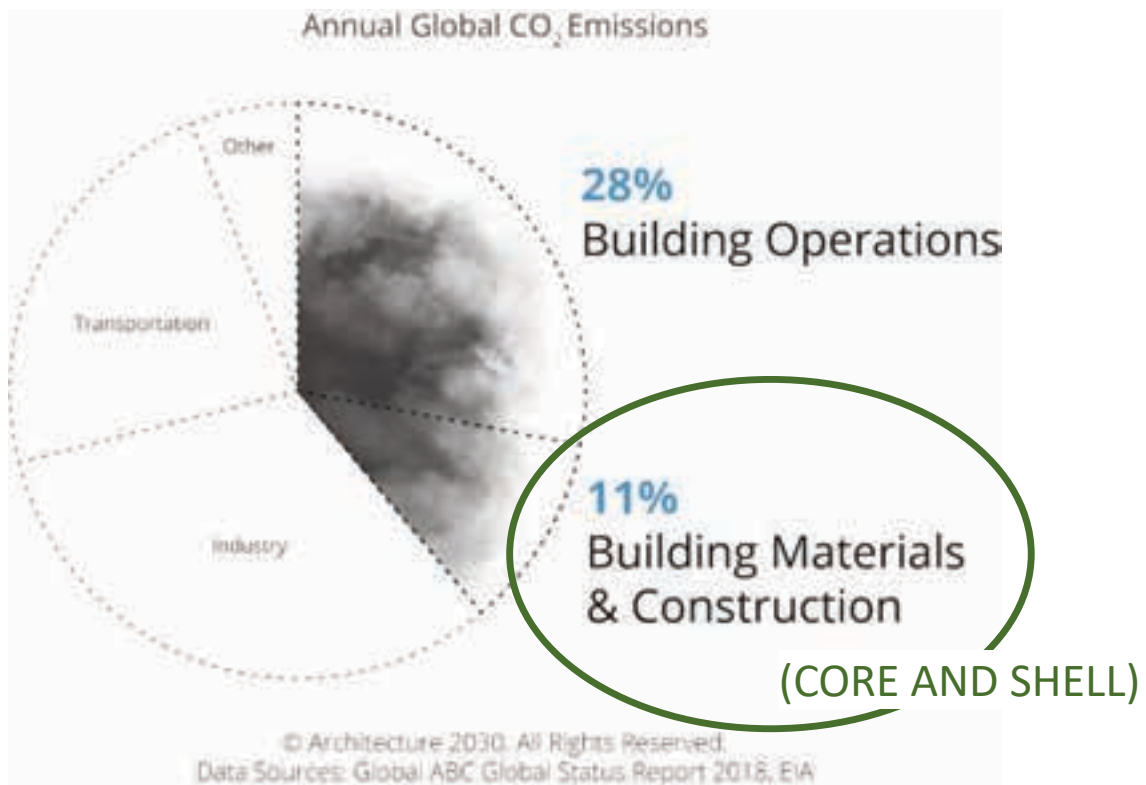
Initial embodied carbon of buildings with respect to operational energy over 50 years varies with building type:

Office 50%

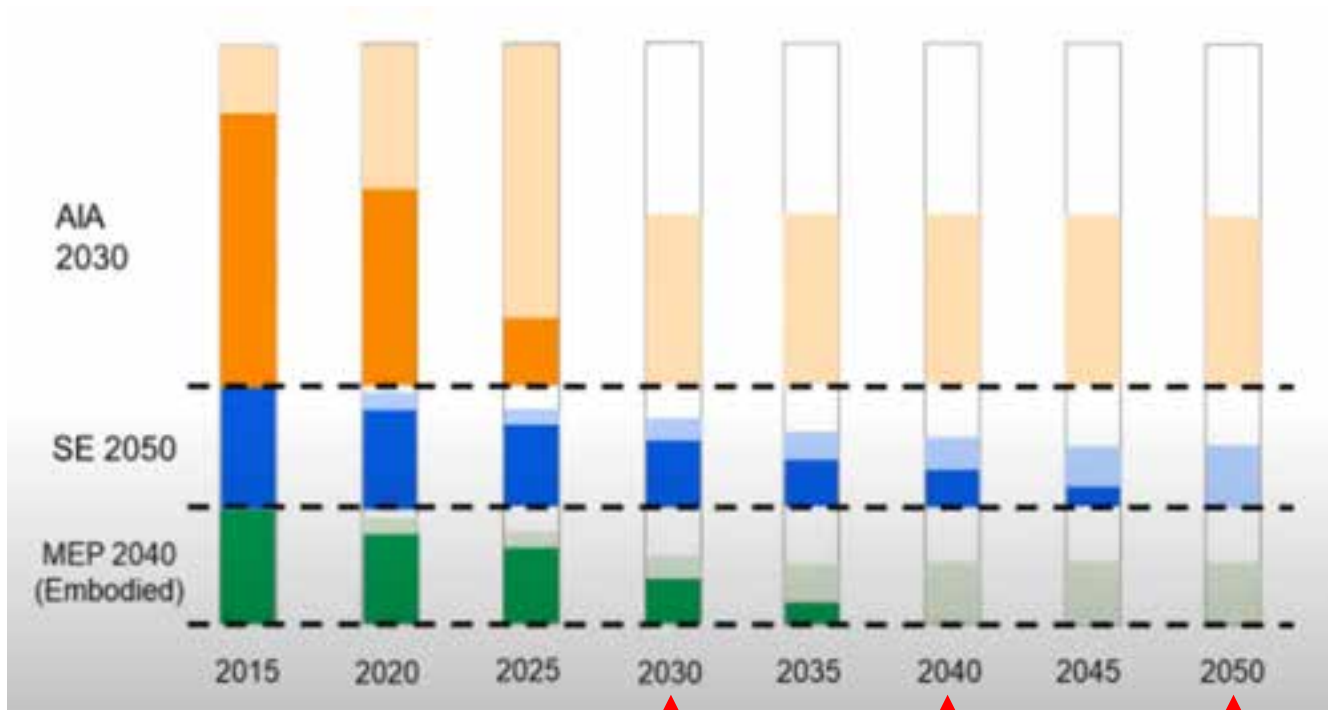
Residential 62%

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**

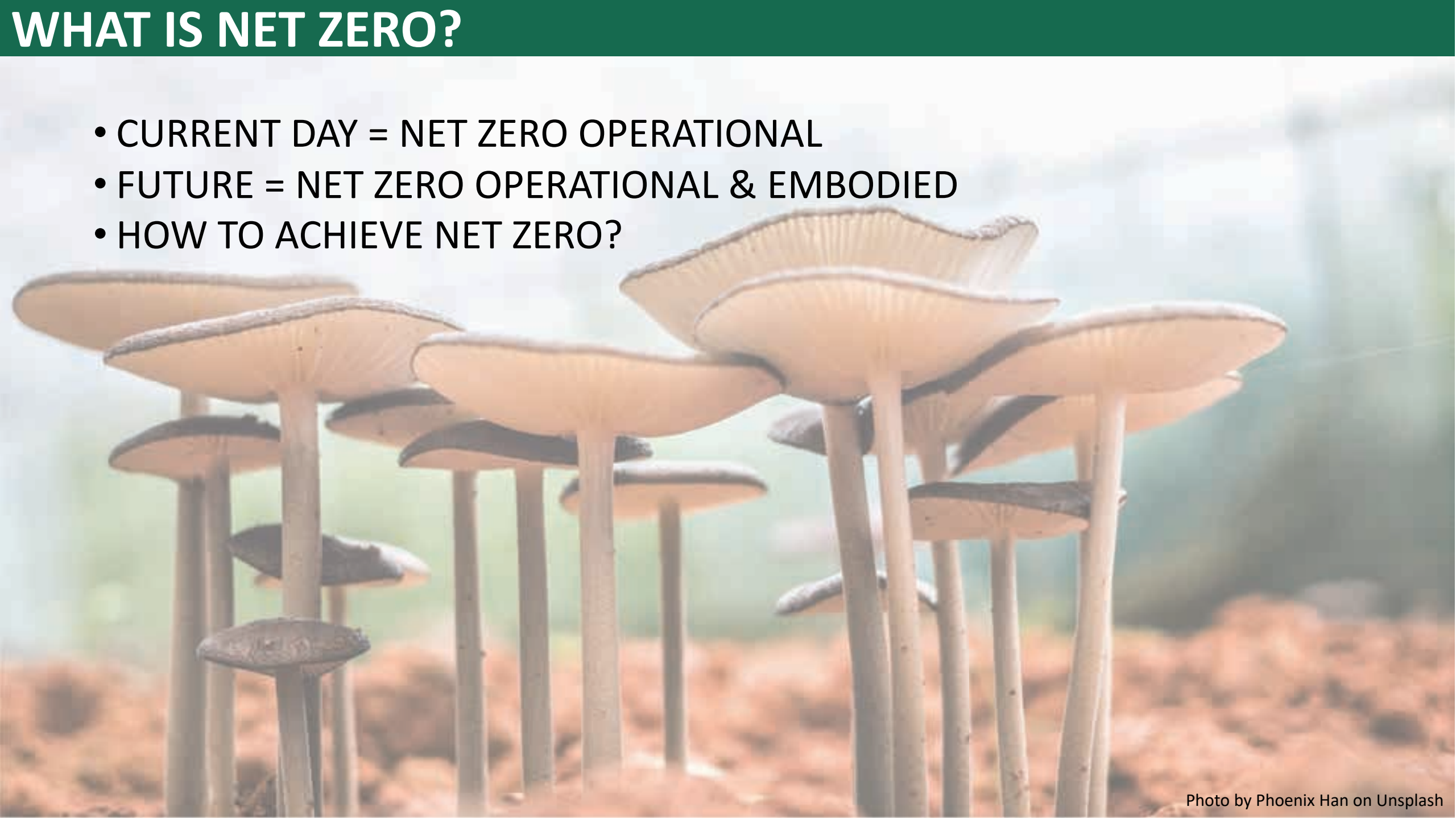


**ZERO
EMBODIED**



WHAT IS NET ZERO?

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



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



MEASURING EMBODIED CARBON – LIFE CYCLE ASSESSMENT

CRADLE TO GATE

CRADLE TO GRAVE

Life Cycle Stages & Study Scope

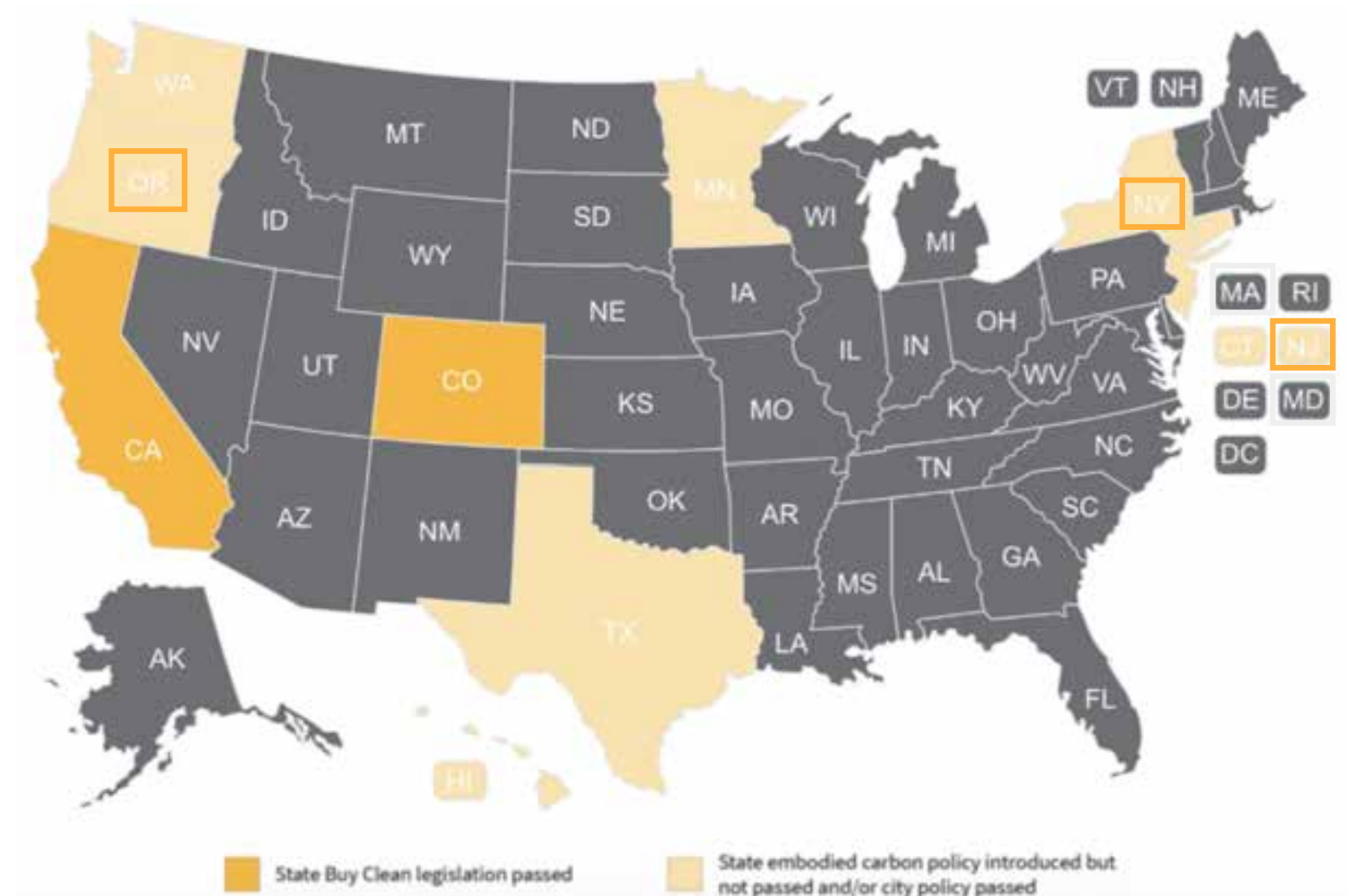
Product			Constr- uction	Use								End-of-Life				Module D		
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D1	D2	D3
Raw material supply	Transport	Manufacturing	Transport	Construction\Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction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

Figure 3. Life Cycle Stages³ as defined by EN 15978. Processes included in Tally modeling scope are shown in bold. Italics indicate optional processes.

BUY CLEAN LEGISLATION – STATE & LOCAL

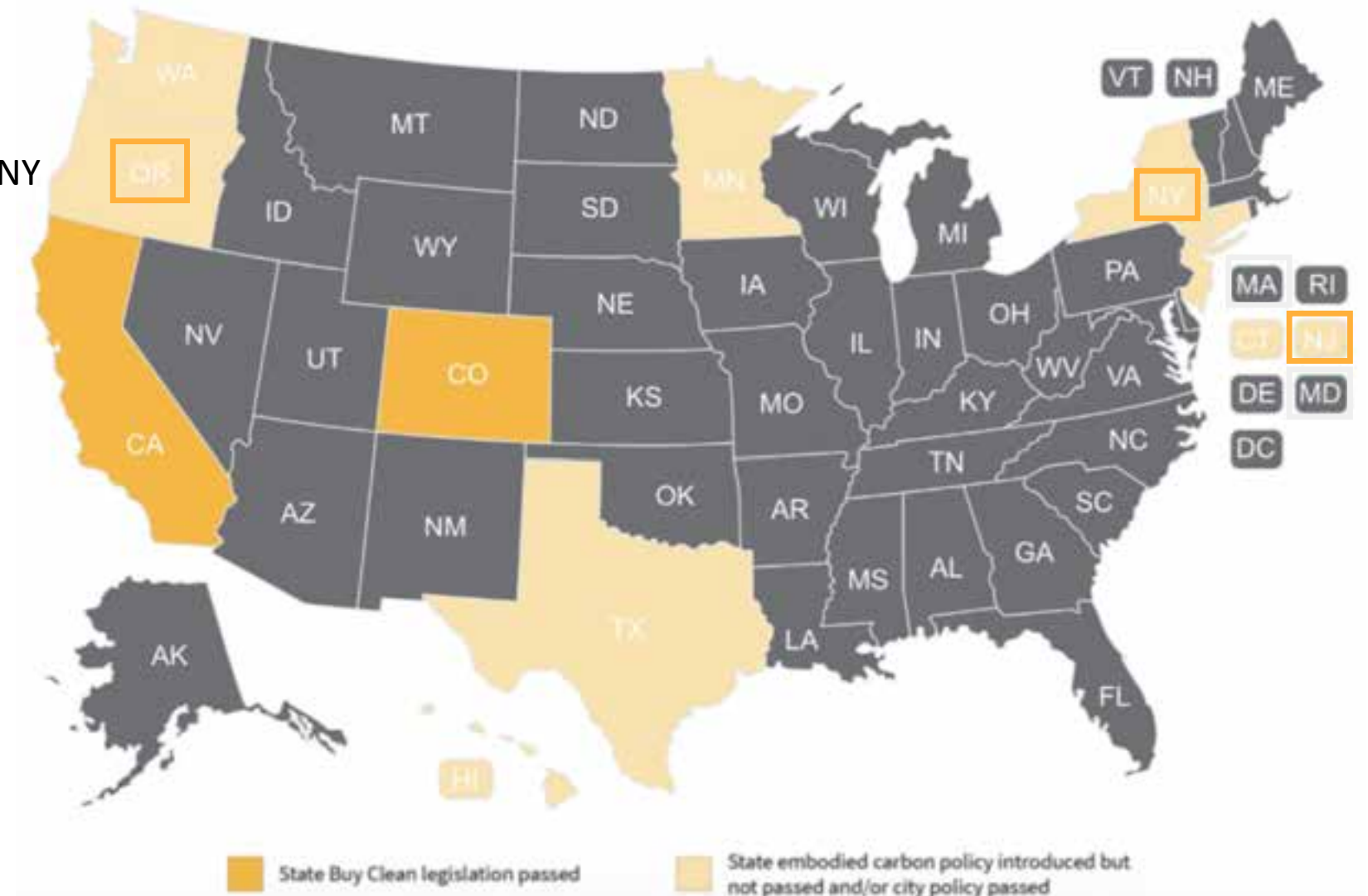
BUY CLEAN CALIFORNIA

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

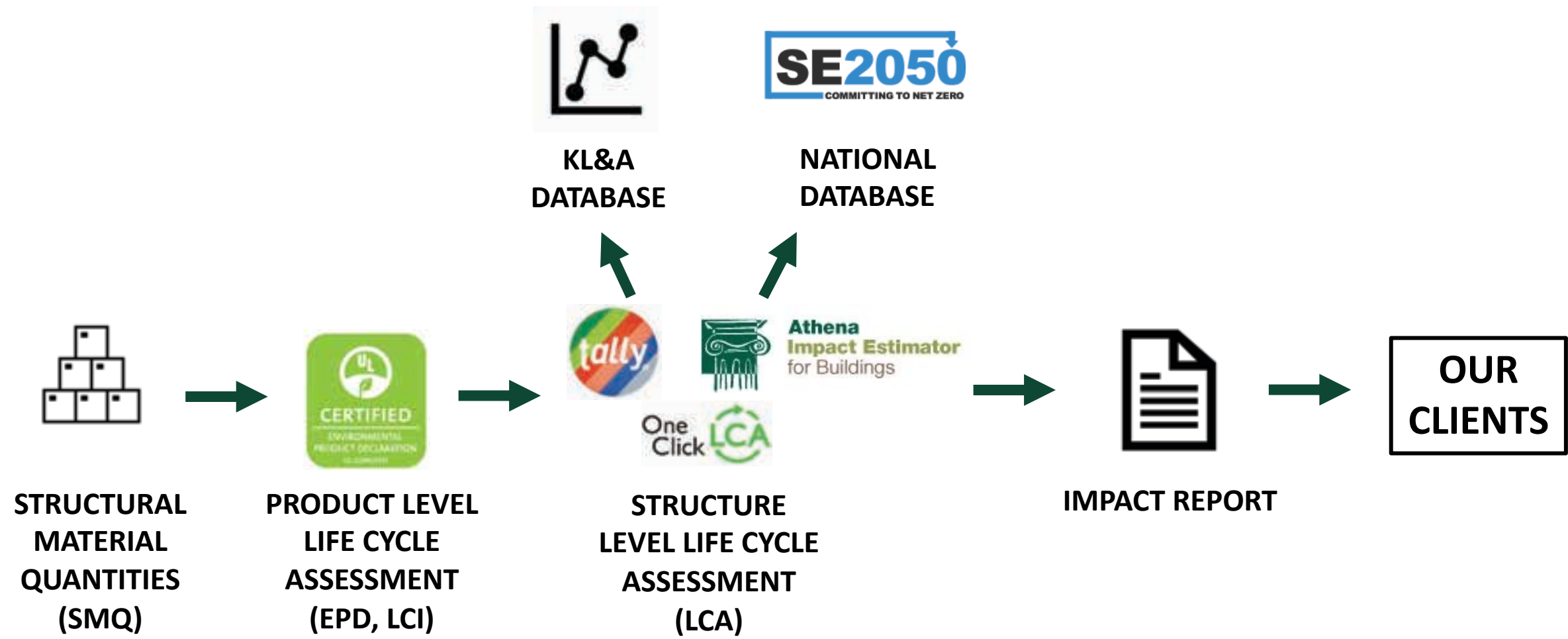


BUY CLEAN LEGISLATION – STATE & LOCAL

- 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



MEASURING EMBODIED CARBON – IN PRACTICE





Platte Fifteen Life Cycle Assessment



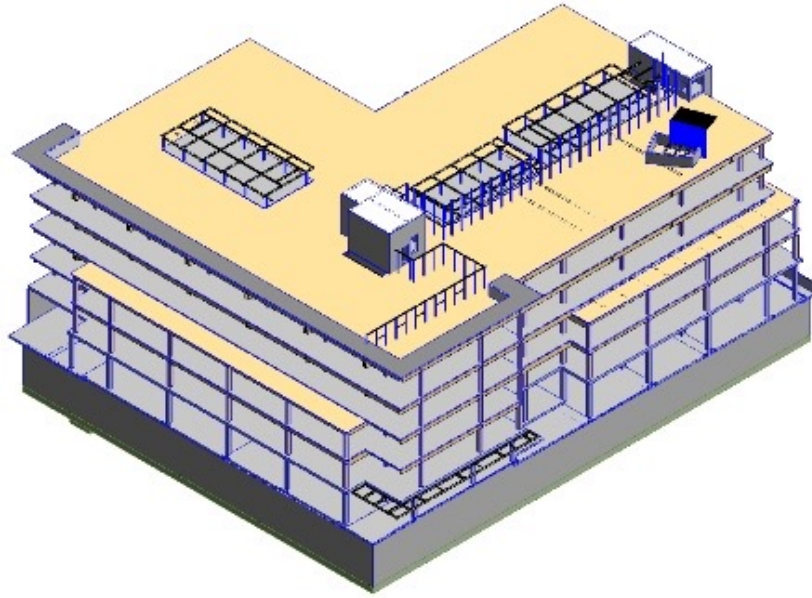
Authors

KL&A Engineers and Builders
Adolfson & Peterson

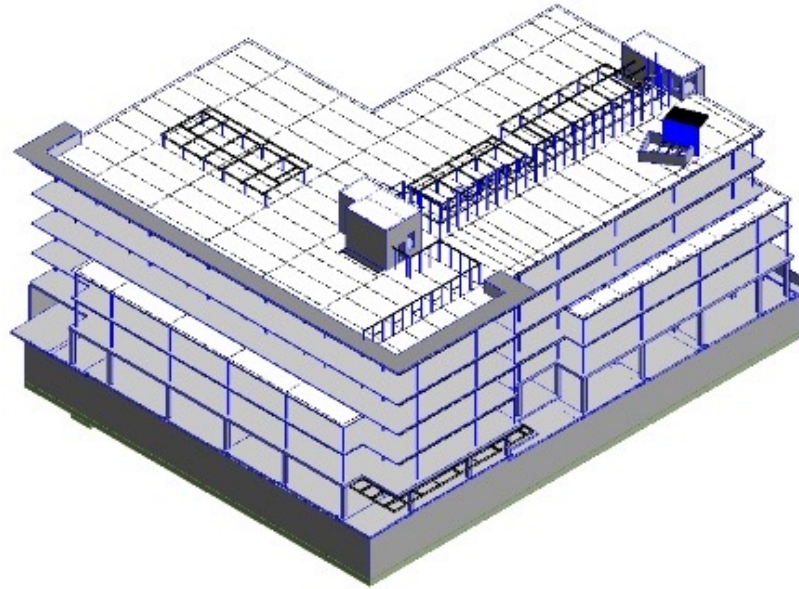
THINK
WOOD.



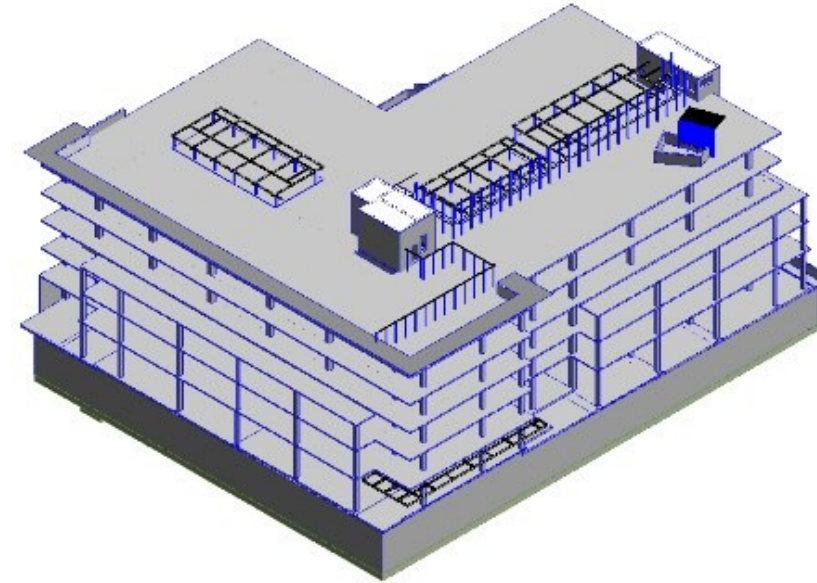
PLATTE FIFTEEN LCA



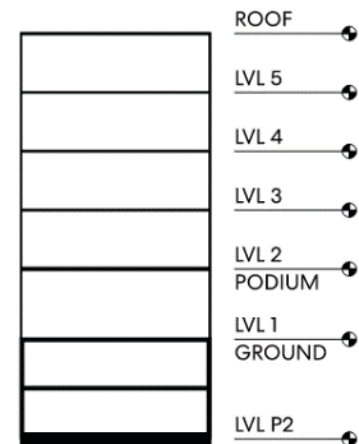
MASS TIMBER
(AS CONSTRUCTED)



STEEL



PT CONCRETE



LIFE CYCLE ASSESSMENT SCOPE

CRADLE TO GATE →

CRADLE TO GRAVE →

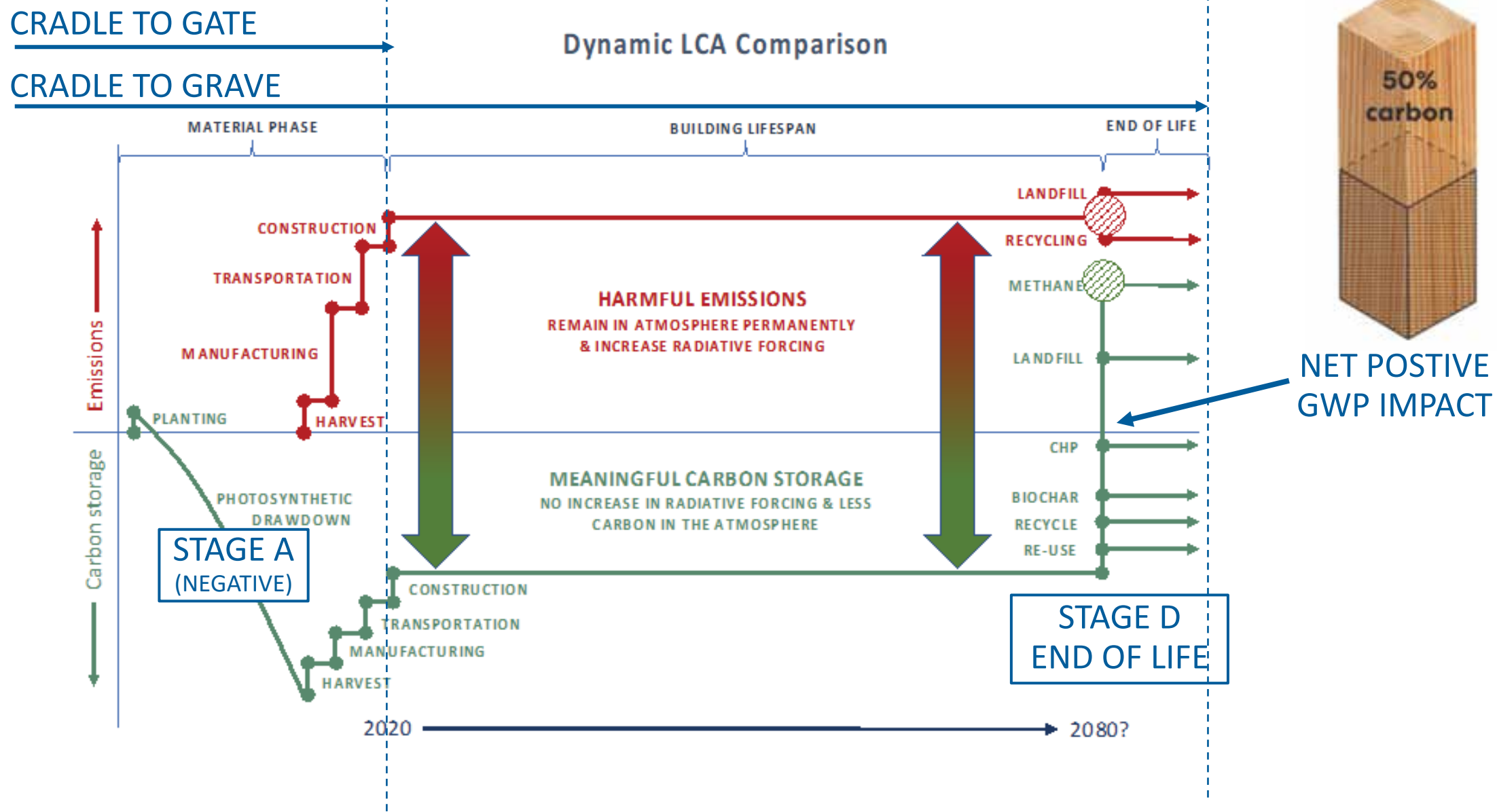
Life Cycle Stages & Study Scope

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
✓	✓	✓	✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓

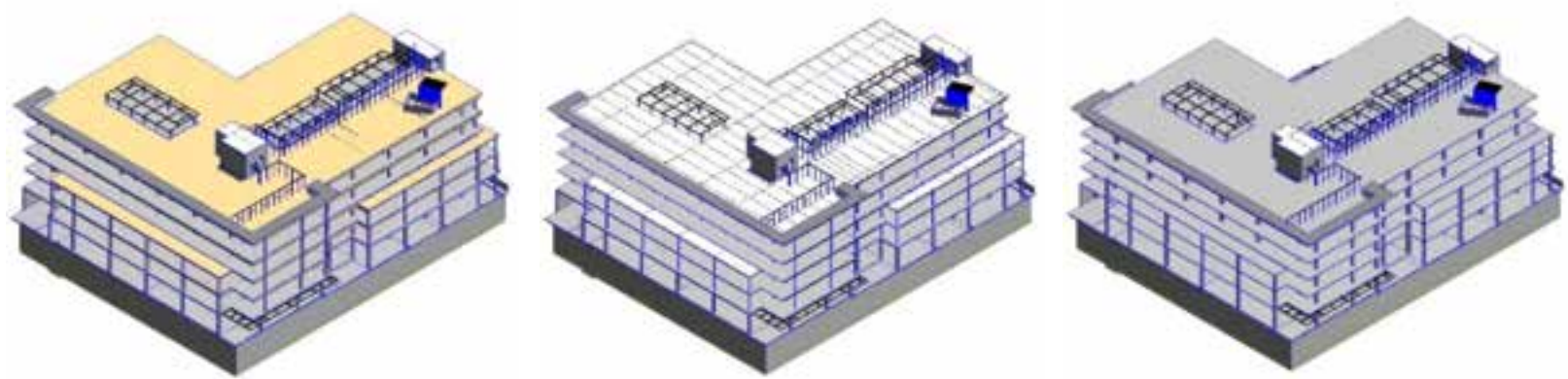
Figure 3. Life Cycle Stages³ as defined by EN 15978. Processes included in Tally modeling scope are shown in bold. Italics indicate optional processes.



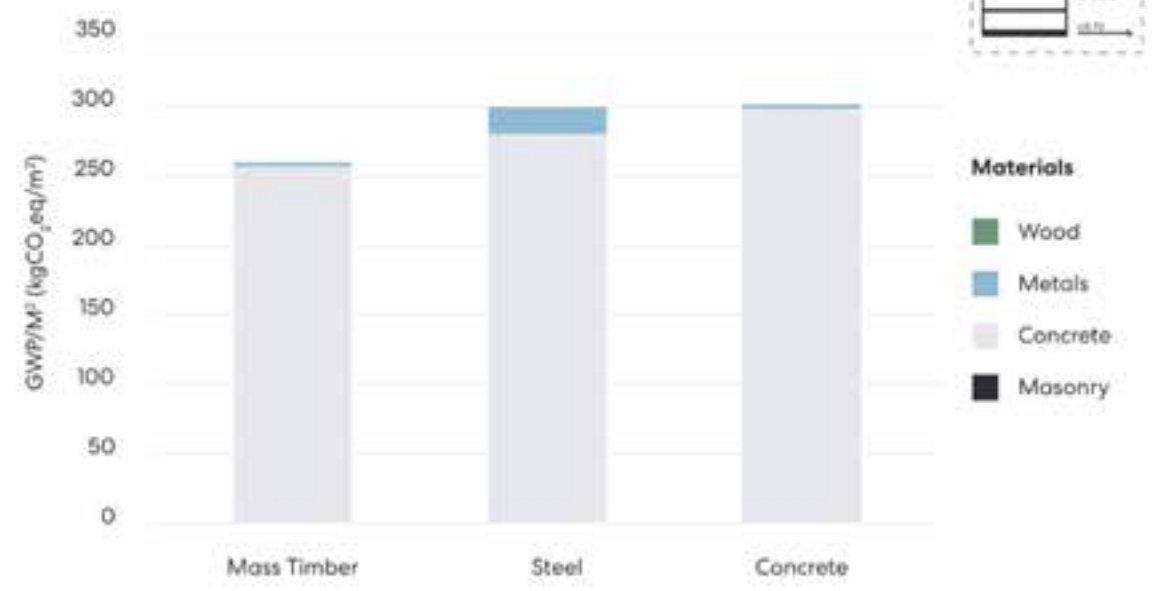
BIOGENIC CARBON



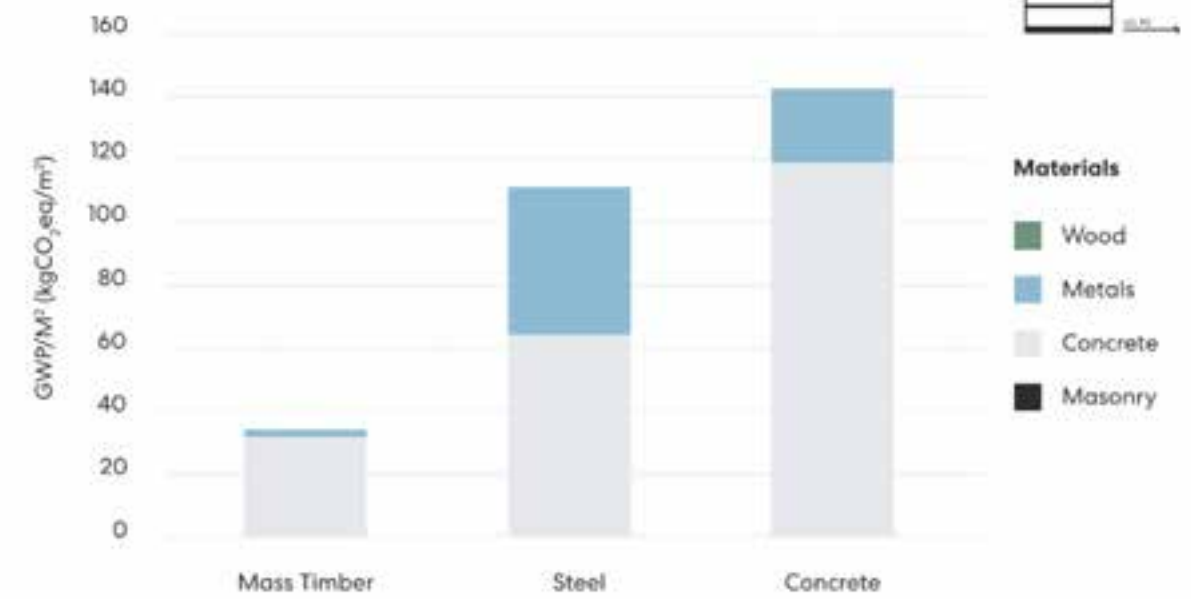
PLATTE FIFTEEN LCA STUDY



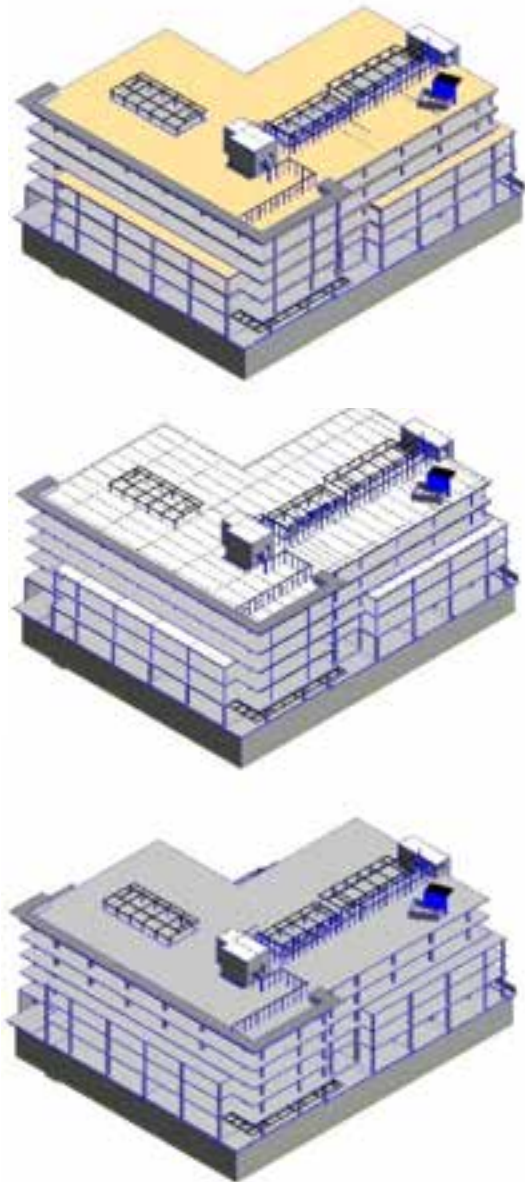
Total GWP/M² Per Building System



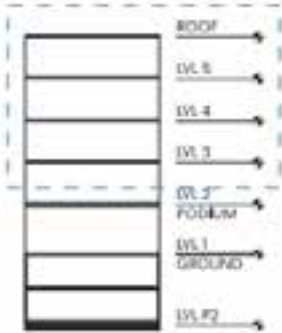
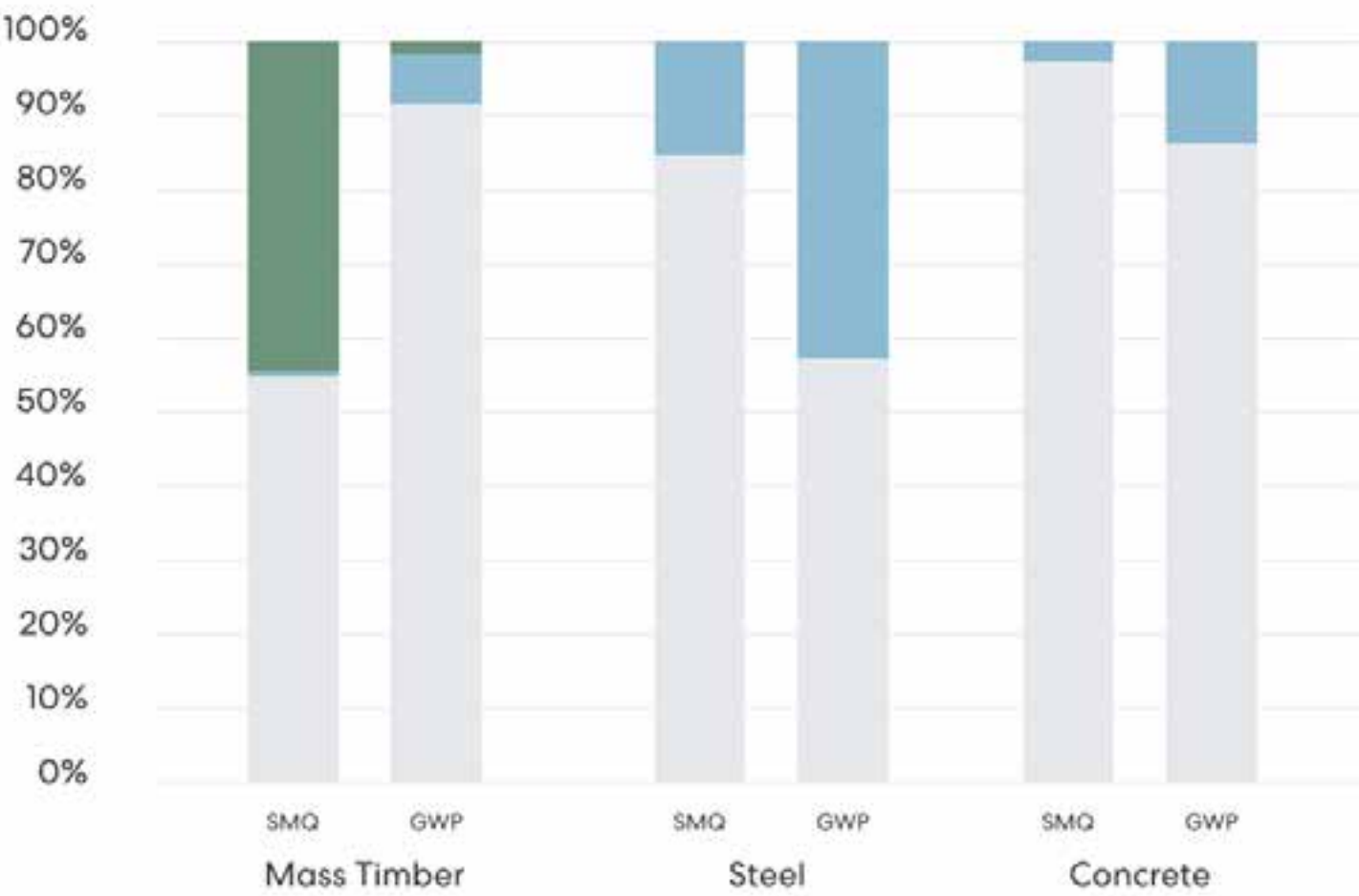
Total GWP/M² Above Podium Slab Per Building System



PLATTE FIFTEEN LCA STUDY

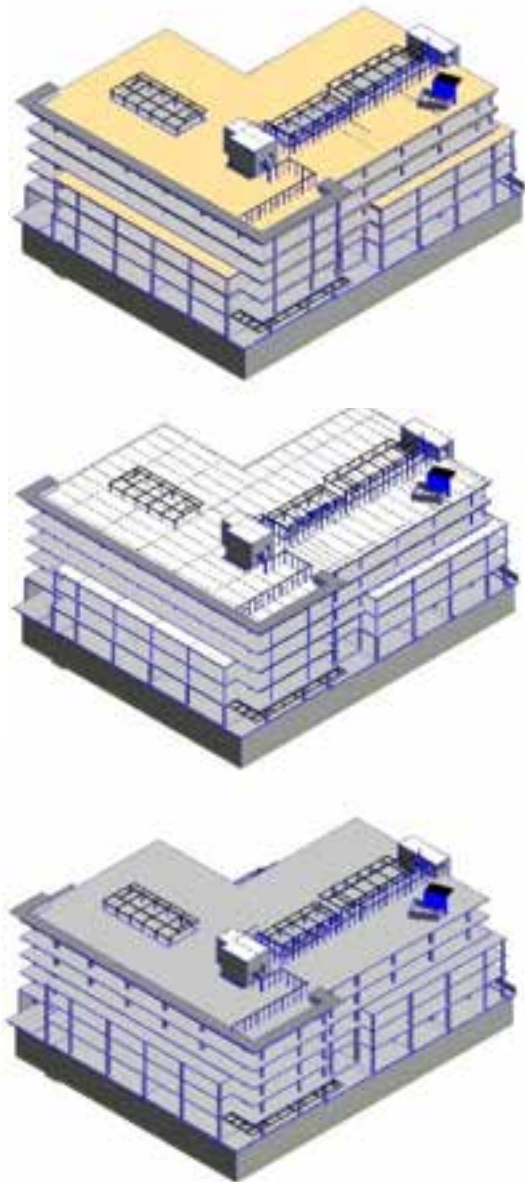


Percent Mass to Percent GWP Per Material Above Podium Slab

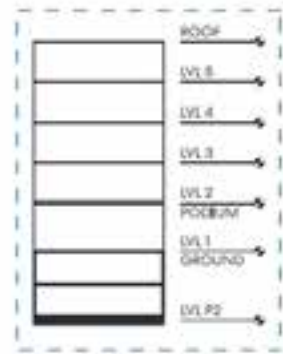
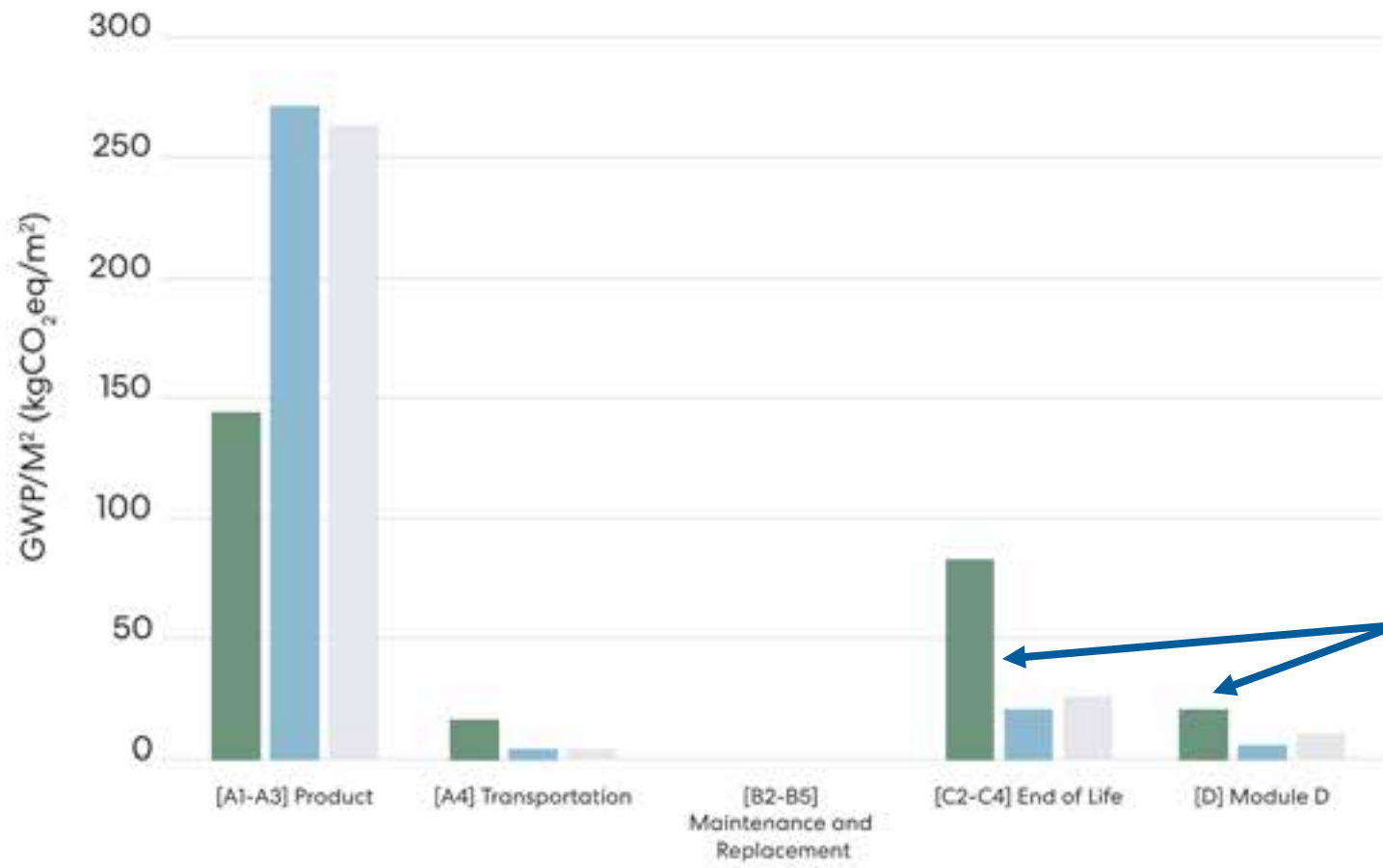


- Materials**
- Wood
 - Metals
 - Concrete

PLATTE FIFTEEN LCA STUDY



Total GWP/M² Per Life Cycle Stage



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



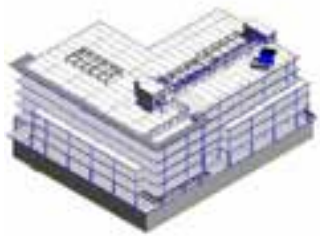
LONG LIFE, LOOSE FIT



A close-up photograph of a hand dropping a coin into a stack of coins. The hand is positioned at the top right, with fingers holding a single coin just above a tall stack. Below this, there are three more stacks of coins of increasing height, and several loose coins are scattered on the surface in the foreground. The background is a soft, out-of-focus green.

WHAT ABOUT COST?

MATERIAL COST (STRUCTURE AND VERTICAL ENCLOSURE)



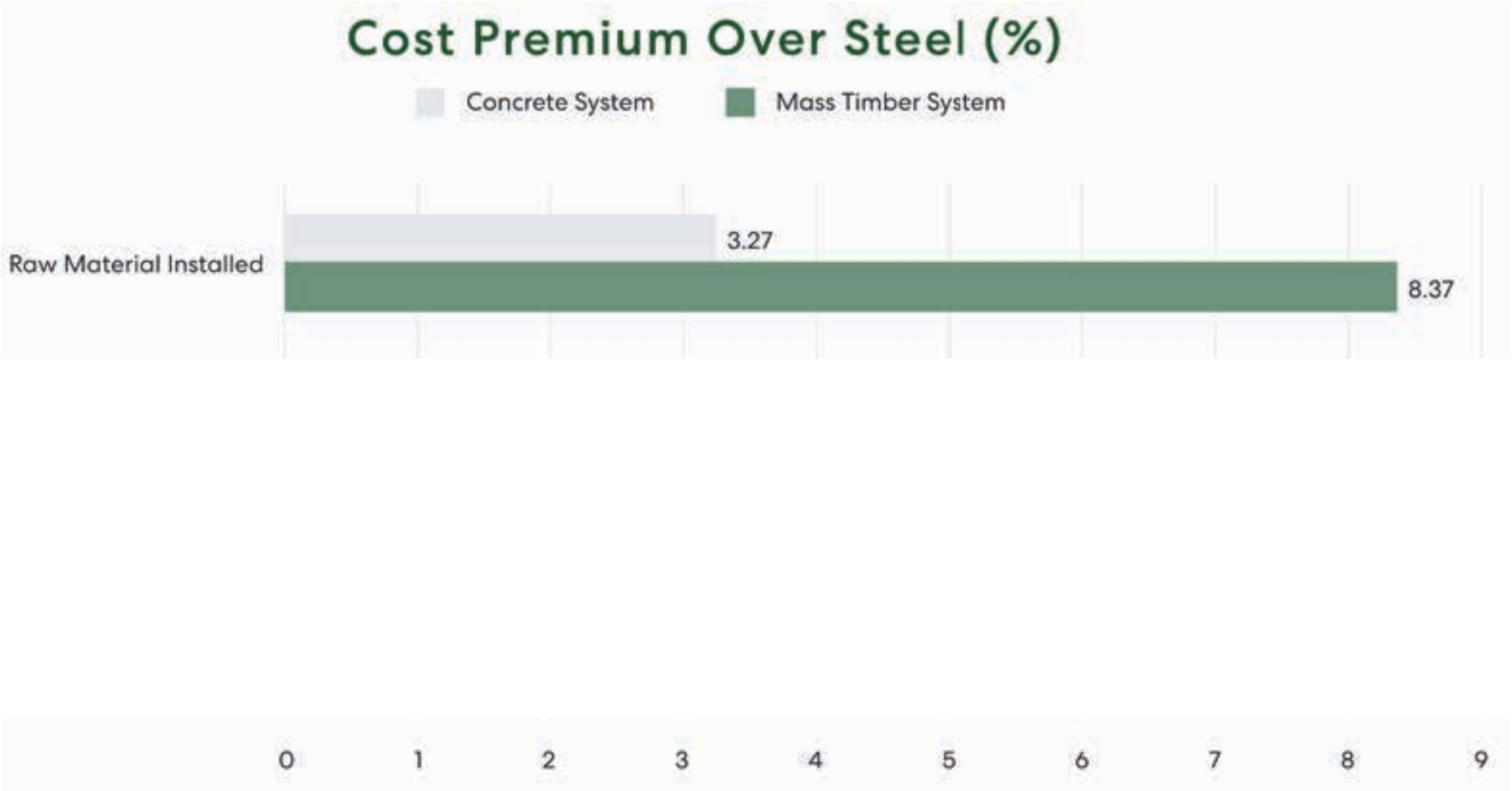
Steel: Lowest
= Baseline



Concrete: Middle



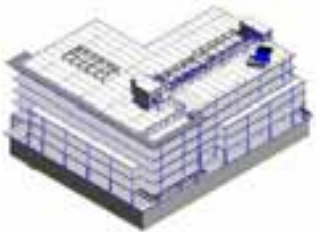
Mass Timber:
Highest



SUPERSTRUCTURE



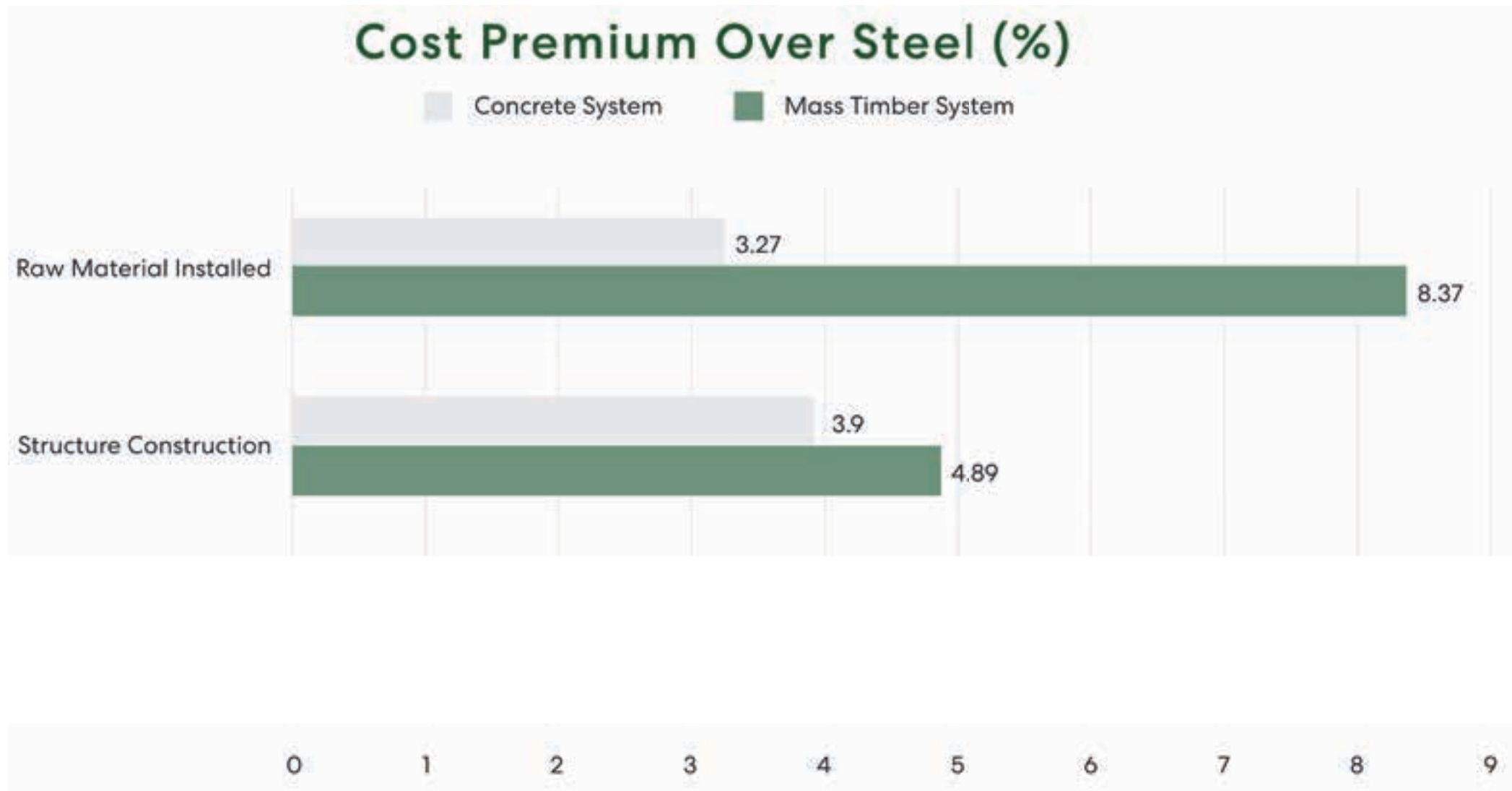
Mass Timber:
Baseline time



Steel:
+ 2 months



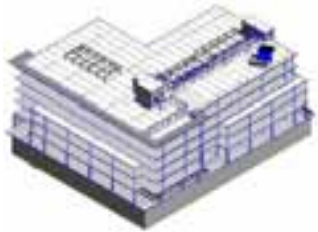
Concrete:
+ 3.5 months



TOTAL BUILDING COST



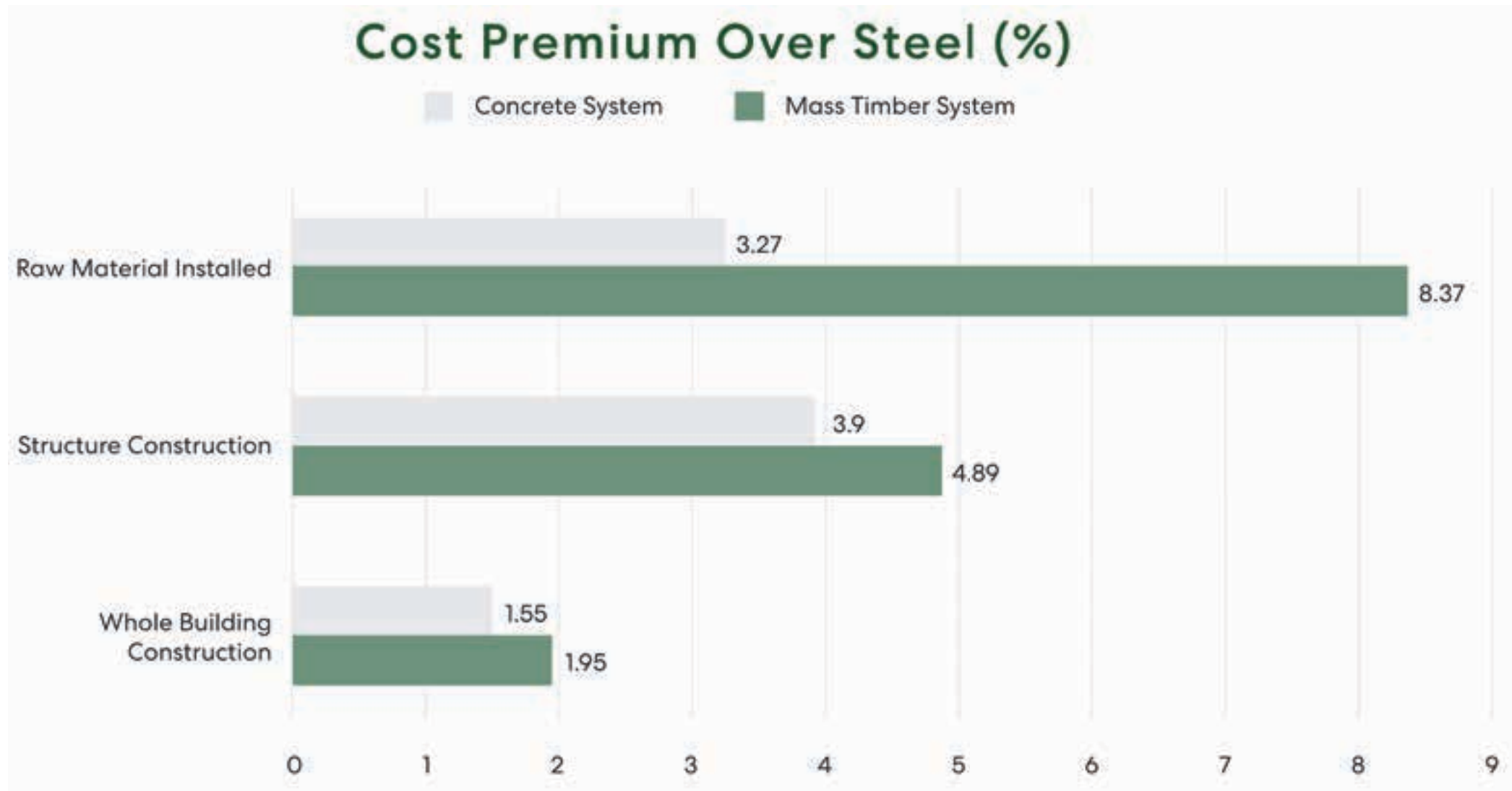
Mass Timber:
Baseline time



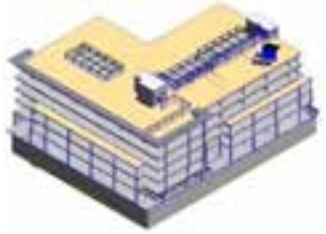
Steel:
+ 2 mos



Concrete:
+ 3.5 mos



EMBODIED CARBON COST vs. DOLLAR COST



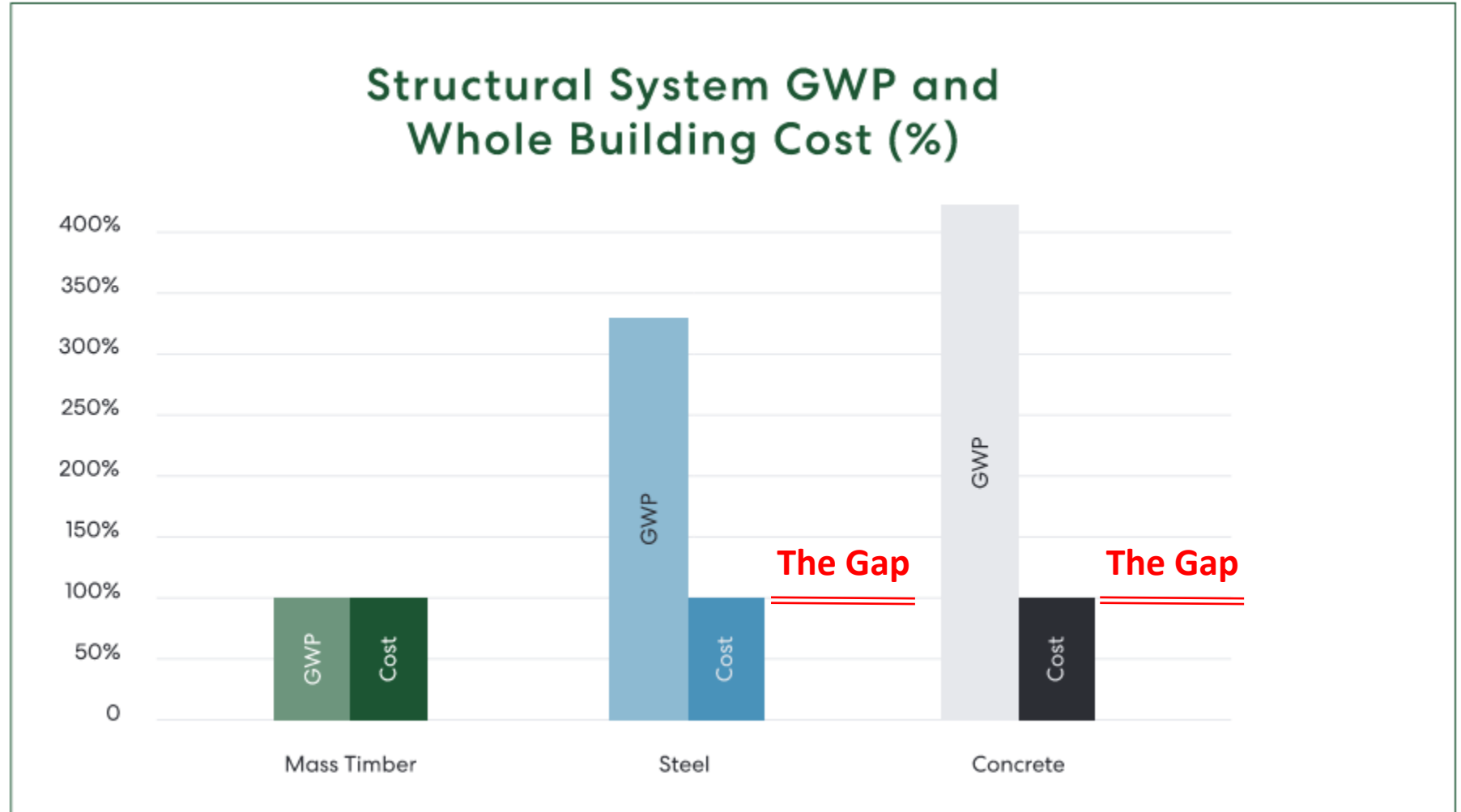
Mass Timber:
Baseline



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 by Aleksandar Radovanovic on Unsplash

A wide-angle photograph of a long, empty, modern interior space, likely a large hall or atrium. The ceiling is composed of light-colored wooden beams, and the floor is made of large, light-colored tiles. On the left side, there is a long wall of floor-to-ceiling windows with dark frames, offering a view of a cityscape and a body of water. The space is supported by several thick, light-colored concrete pillars. The lighting is bright and even, creating a clean and open atmosphere.

THANK YOU

➤ QUESTIONS?

This concludes The American Institute
of Architects Continuing Education
Systems Course



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