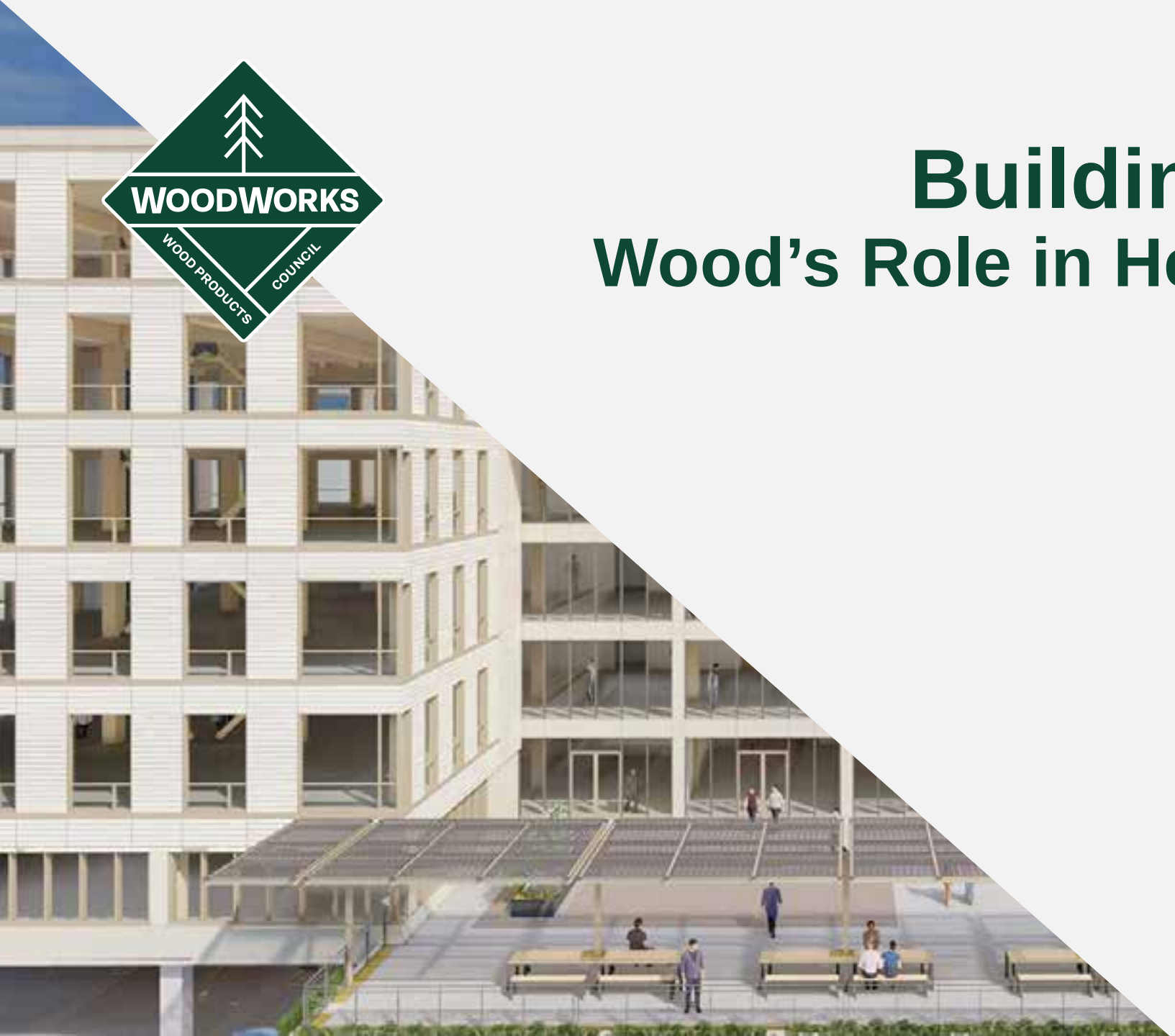


Building Sustainably:
Wood's Role in Healthy Forests and Healthy Buildings

February 28, 2023
&
March 2, 2023

Presented by
John O'Donald II, PE, WoodWorks

Apex Plaza / Courtesy William McDonough + Partner

Land Acknowledgement

Recognizing the Nacotchtank and Piscataway People, the First Residents of the land that would become the District of Columbia.

Every community owes its existence and vitality to generations from around the world who contributed their hopes, dreams, and energy to making the history that led to this moment. Some were brought here against their will, some were drawn to leave their distant homes in hope of a better life, and some have lived on this land for more generations than can be counted. Truth and acknowledgment are critical to building mutual respect and connection across all barriers of heritage and difference. We begin this effort to acknowledge what has been buried by honoring the truth. We stand on the ancestral lands of the Nacotchtank and the Piscataway People. We pay respects to their elders past and present. Please take a moment to consider the many legacies of violence, displacement, migration, and settlement that bring us together here today. And please join us in uncovering such truths at any and all public events and to use such truths to guide the legacy of this Arts Commission.

The land acknowledgement was created by CAH Commmissioner Quanice Floyd with resources provided by the U.S. Department of Arts and Culture, and was adopted by the Board of Commissioners on May 21, 2020. It is read at the beggining of all public meetings of the Commission.

AIA CES Course

“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.

Course Description

Explore the benefits of using wood products in construction, from our forests to wood buildings. In addition to their renewability, wood products require less embodied energy to manufacture than other structural building materials. This presentation will discuss three topics: forestry and the impact of wood use on forest health, the relevance of wood to green building rating systems, and biophilic design strategies for healthy buildings. It will answer questions such as: Where do our trees and forests grow? How have forests changed over time? What is the relationship between people and forests—now and in the past? How does wood contribute to biophilic design principles? What is the purpose of green building rating systems and how do they vary? How can wood products be used in construction to gain points and credits within a number of green building rating systems?

Learning Objectives

1. Highlight North America’s ecological capacity to support a diverse range of forests.
2. Discuss how using a variety of forest products can economically support healthy and sustainable forests.
3. Describe how wood’s use can be leveraged in a number of green building rating systems to help achieve certification.
4. Demonstrate how wood can contribute to sustainable development trends such as biophilic design and healthy buildings.

The Business Case for Healthy Buildings

ULI Report

Global Wellness Real Estate Industry:

- $134 billion industry in 2017
- 6.4% annual increase since 2015
- $180 billion industry by 2022

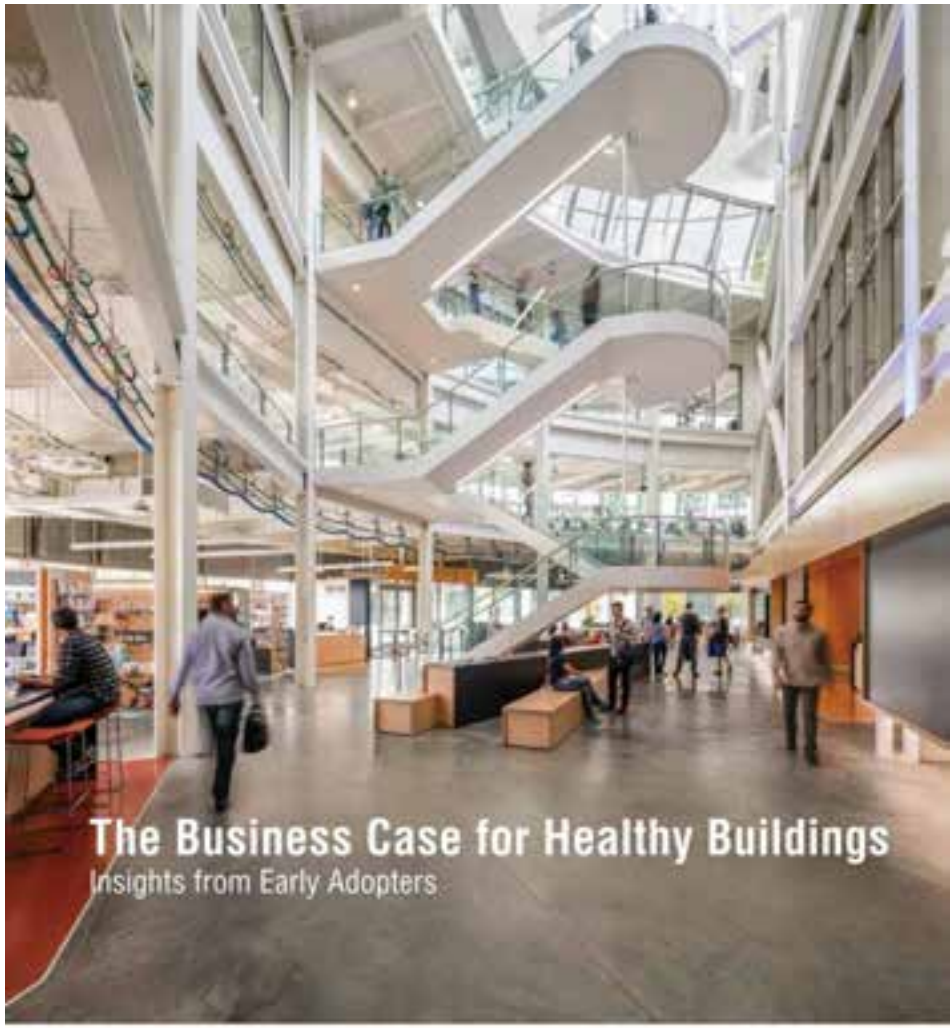
Healthy Bldgs ROI (Survey of 200 Canadian Bldg Owners):

- 46% easier to lease
- 28% command premium rents
- 38% of those who reported value in healthy bldgs said they are worth 7% more than conventional ones

Millennials:

- 78% say workplace quality is important
- 69% would trade other benefits for good workplace

"**Health and wellness-focused environments**…can help **reduce company operating costs** and **increase revenues and profits**."



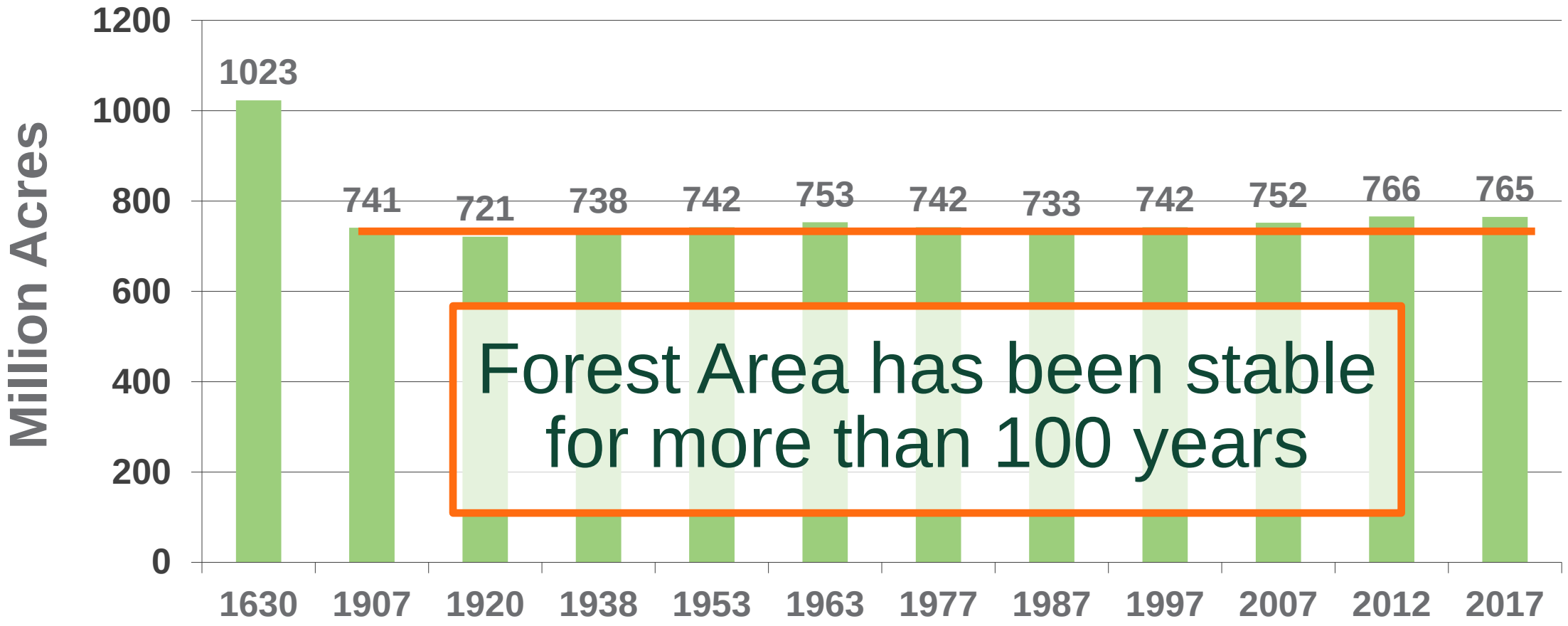
2018 Report

State of Our Forests

Common Environmental Concerns About Specifying Wood

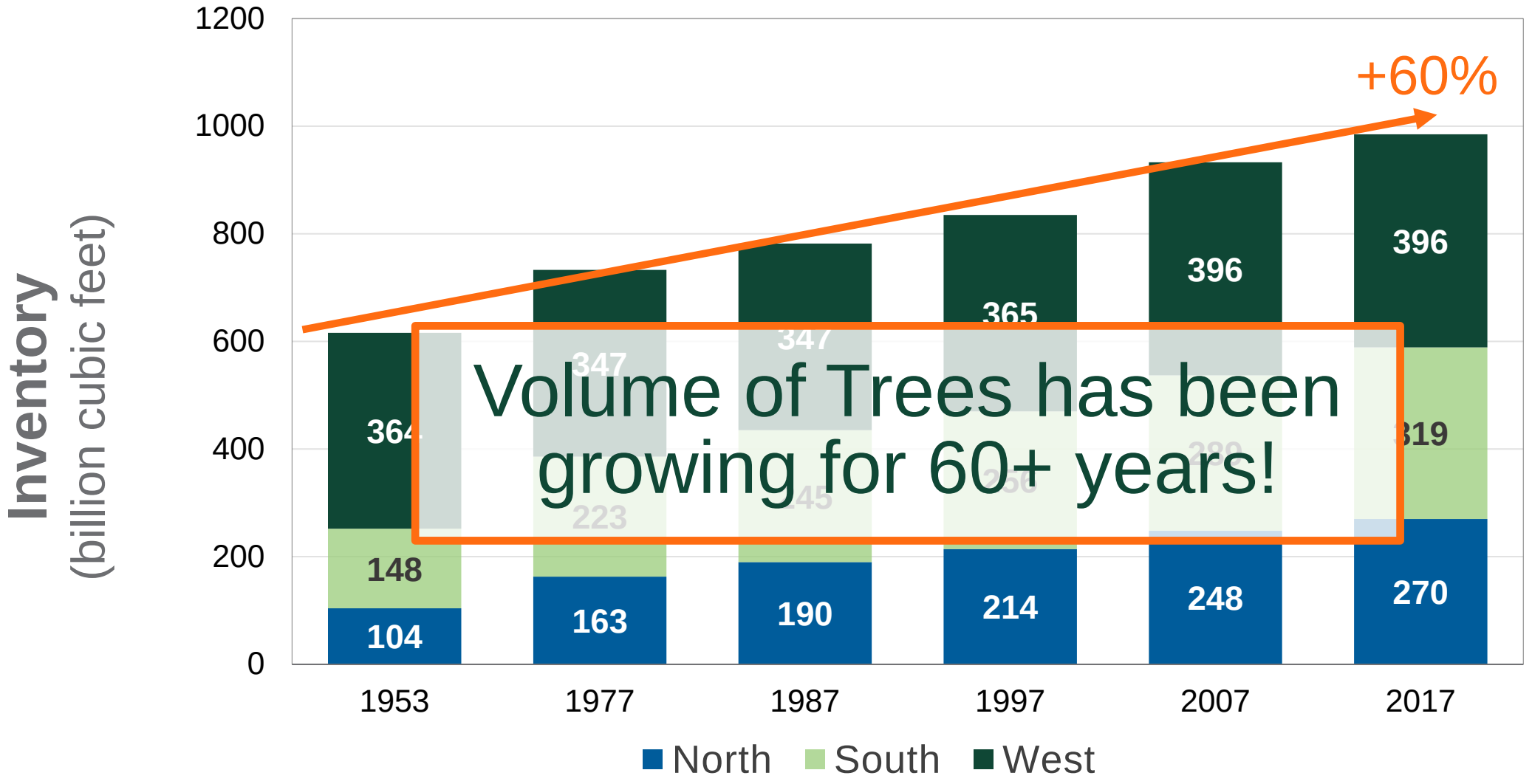
1. Is North America **running out of forests?**
2. Does specifying wood products contribute to **deforestation?**
3. Is wood a **renewable resource?**

U.S. Forest Land:
Forest **Area** in the United States 1630 – 2017



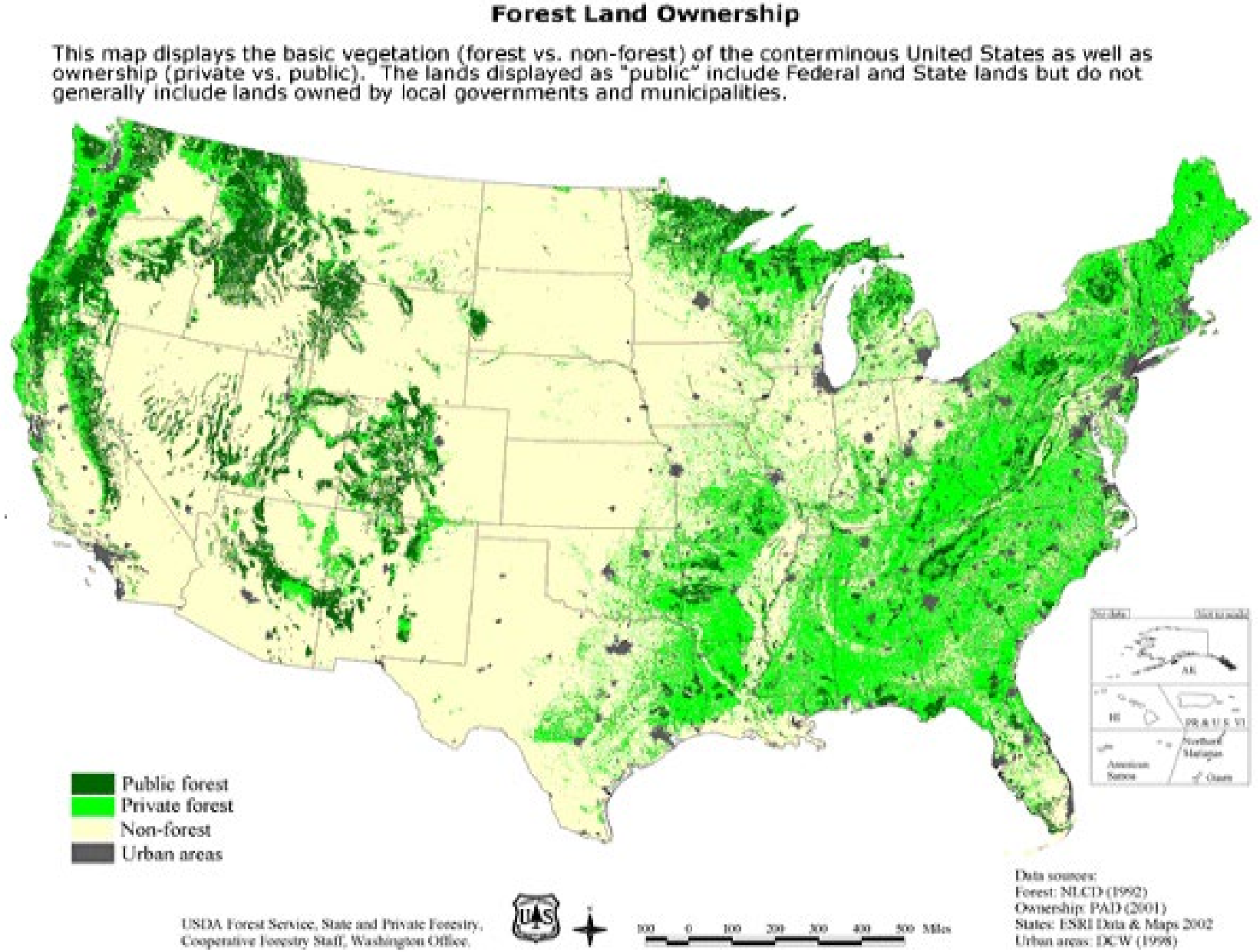
Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

State of our Forests: US Timber Volume on Timberland

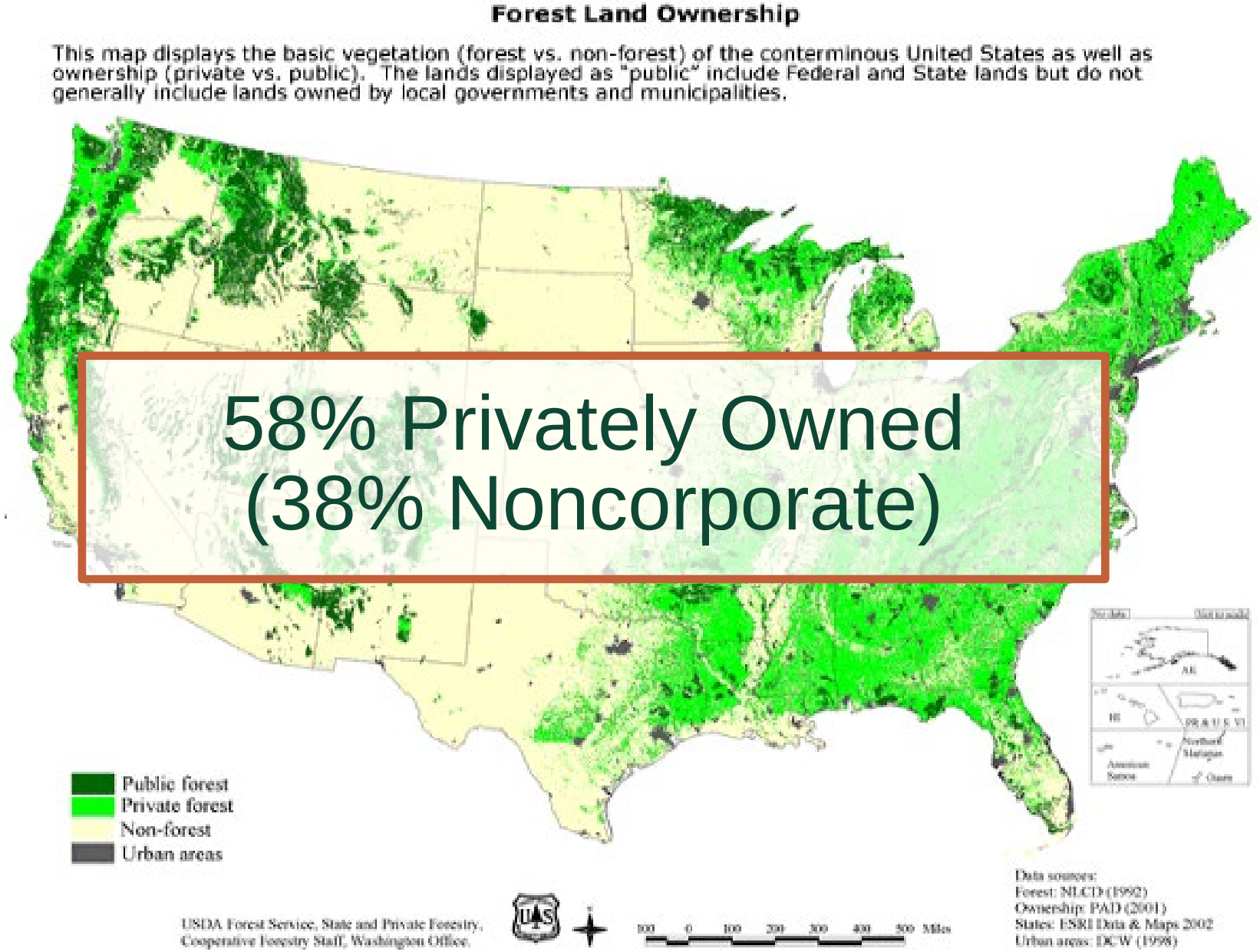


Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

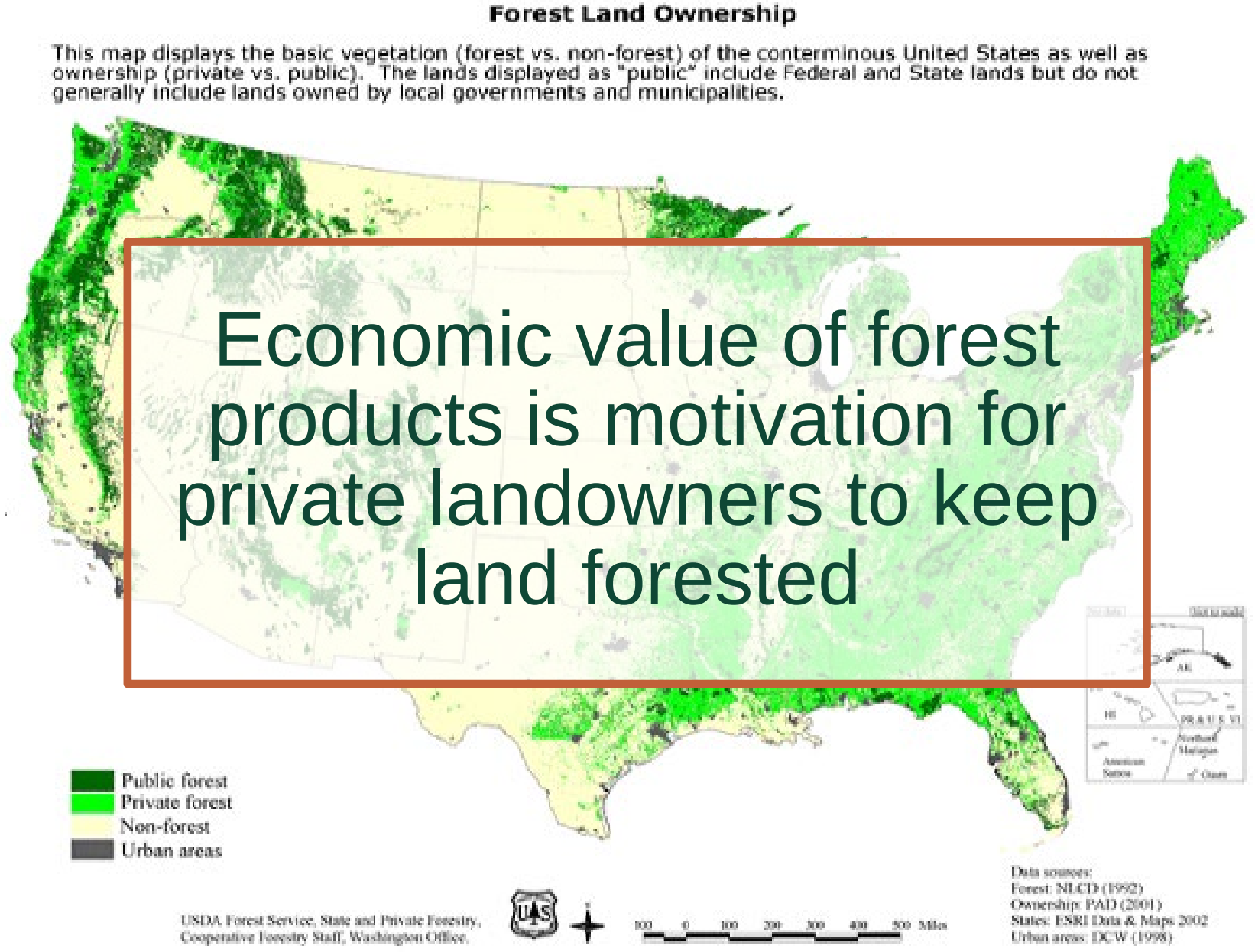
US Forest Lands



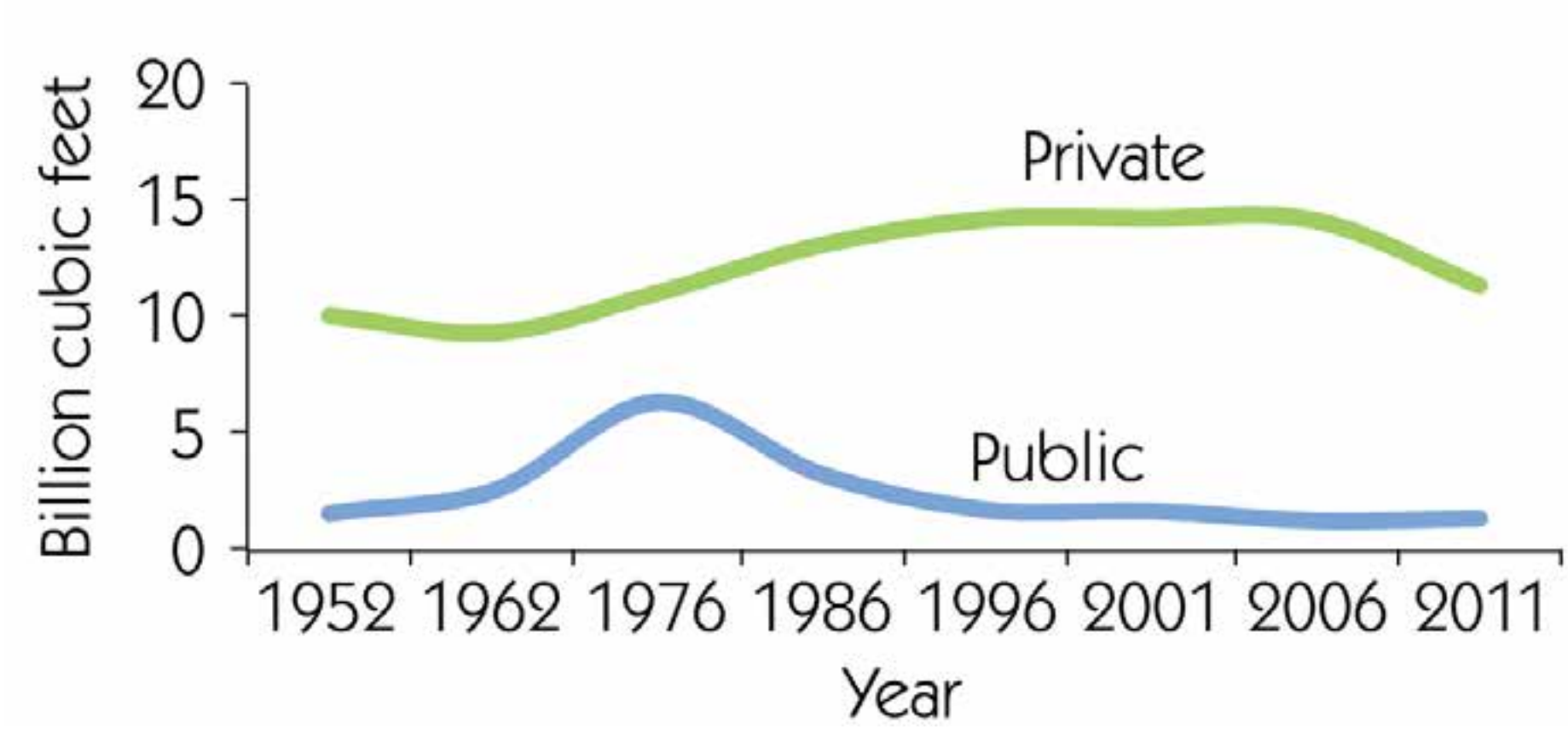
US Forest Lands



US Forest Lands



US Forest Harvest by Owner



Source: USDA-Forest Service, US Forest Resource Facts and Historical Trends FS-1035. (2014).

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)

Forests are more than Lumber Factories

Photo: Green Diamond Resource Company

- We can balance the long-term and short-term desires and the multiple uses through responsible forest management.
- Best Management Practices (BMPs)
- State, Federal and Provincial monitoring and forest inventory programs
- Forestry Practices and Laws
- Professional Logger Training and Certification
- Sustainable Forest Management Systems

Sustainable Forestry Management Systems

- Wood from well-managed forests is sustainable over the long term.
- Forest certification shows that the wood comes from well-managed forests
- The major North American programs are:

FSC

SFI

CSA

ATFS

Sustainable Forestry Management Systems

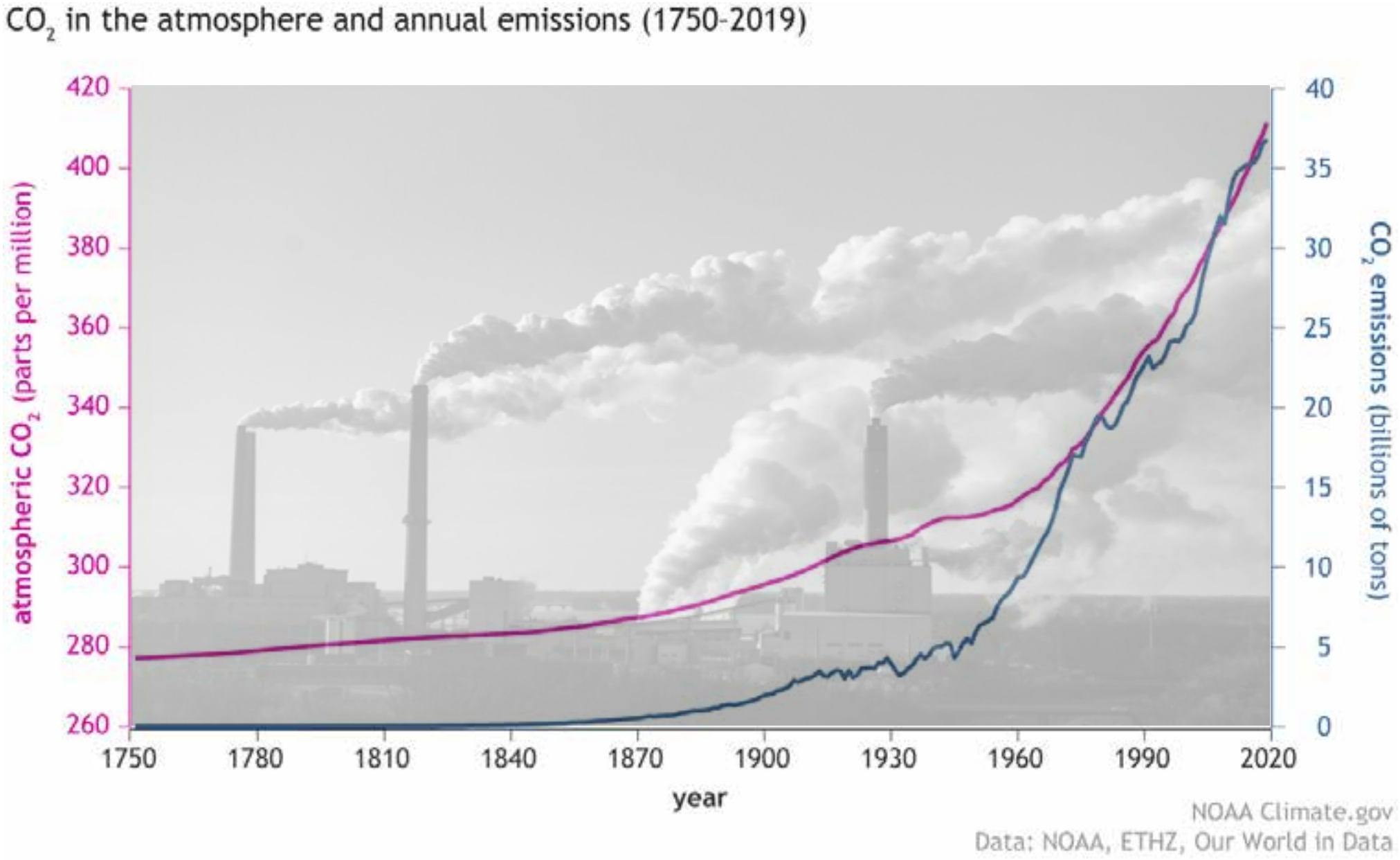
Similarities:

- Biological diversity
- Wildlife habitats / species diversity
- Special sites/values
- Soil & water resources
- Sustainable harvests
- Prevent illegal or unauthorized sources
- Protect from deforestation and conversion
- Aboriginal rights and/or involvement
- Independent audit required
- Audit of forest planning and practices
- Public disclosure required
- Chain of custody and label option

Background on Climate Change

Rising Temperatures and Melting Glaciers

Carbon & Greenhouse Gas Emissions



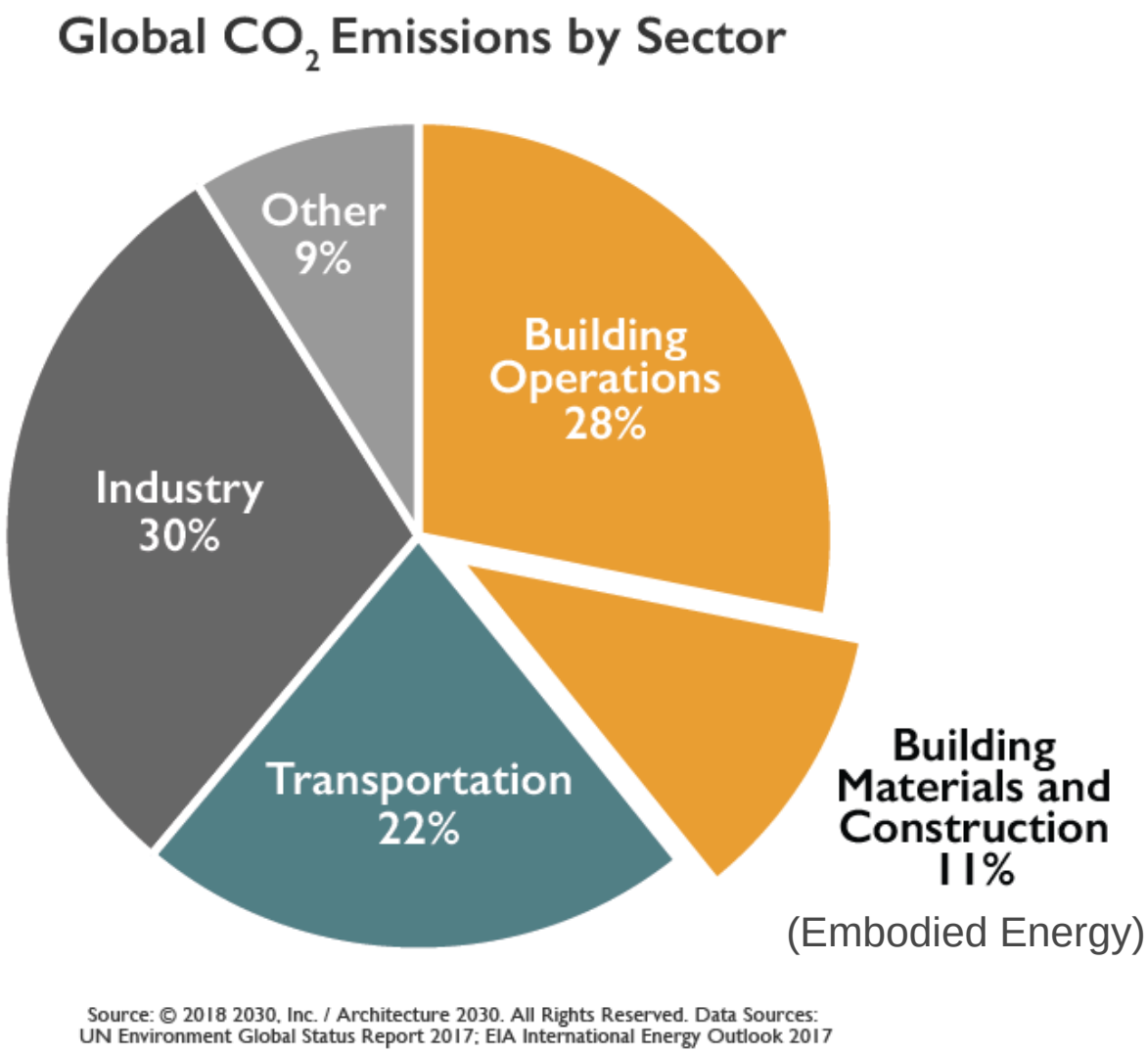
Global Population Increase

2020 = 7.8 billion people

2050 = 9.9 billion people

Source: www.prb.org

New Buildings & Greenhouse Gases



Buildings generate nearly **40%** of annual global greenhouse gas emissions (*building operations + embodied energy*)

Embodied energy: **11%**

Concrete, iron, steel **~9%**

Image: Architecture 2030

Carbon Terms

- **Embodied Carbon**: Carbon emissions associated with the entire life cycle of the building including harvesting, mining, manufacturing, transporting, installing, maintaining, decommissioning, and disposing/reuse of a material or product
- **Operational Carbon**: Carbon emissions associated with operating a building including power, heat, and cooling

Image: Boston Society for Architecture

Embodied Carbon

- Primarily related to **manufacturing of materials**
- More significant than many people realize, has been **historically overlooked**
- Big upfront GHG “cost” - which makes it a **good near-term target** for climate change mitigation

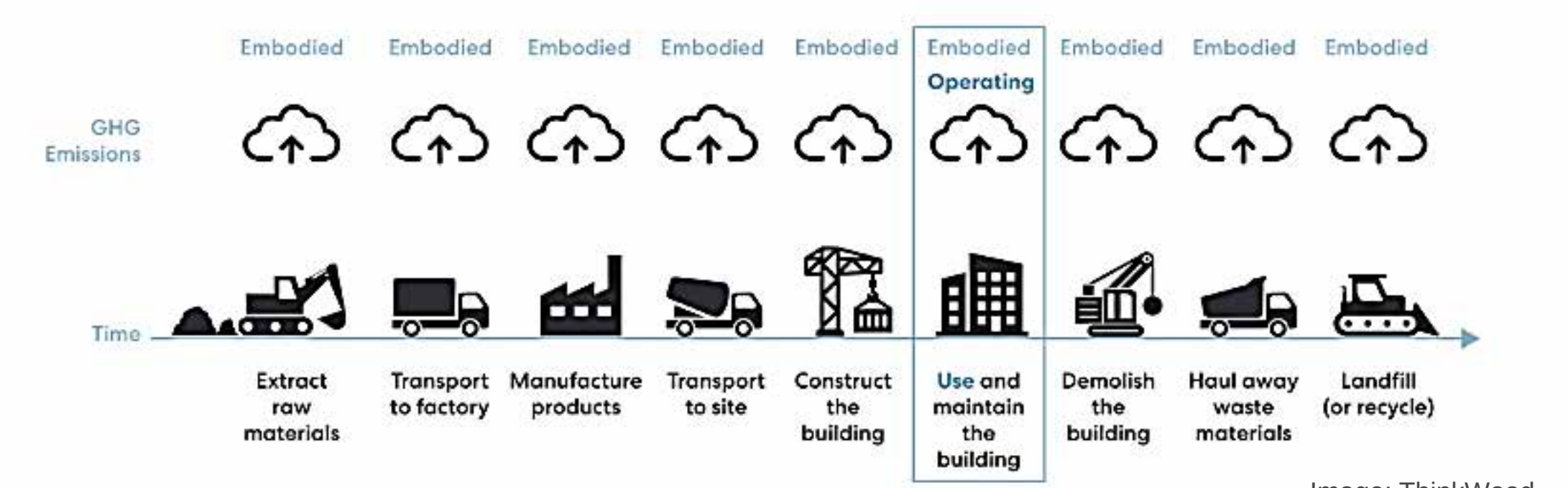


Image: ThinkWood

Embodied Energy vs Embodied Carbon

Embodied Energy:

Amount of energy used to:

- Extract, harvest, mine resources
- Process and assemble materials
- Transport products
- Construct building
- Maintain and repair building
- Deconstruct building and dispose or recycle materials

Embodied Carbon:

Carbon emissions resulting from:

- Combustion of fuels to generate embodied energy
- Chemical reactions

Carbon emissions may be offset by:

- Carbon sequestration during growth or manufacturing

Embodied vs. Operational Energy

Traditional Non-Wood Building

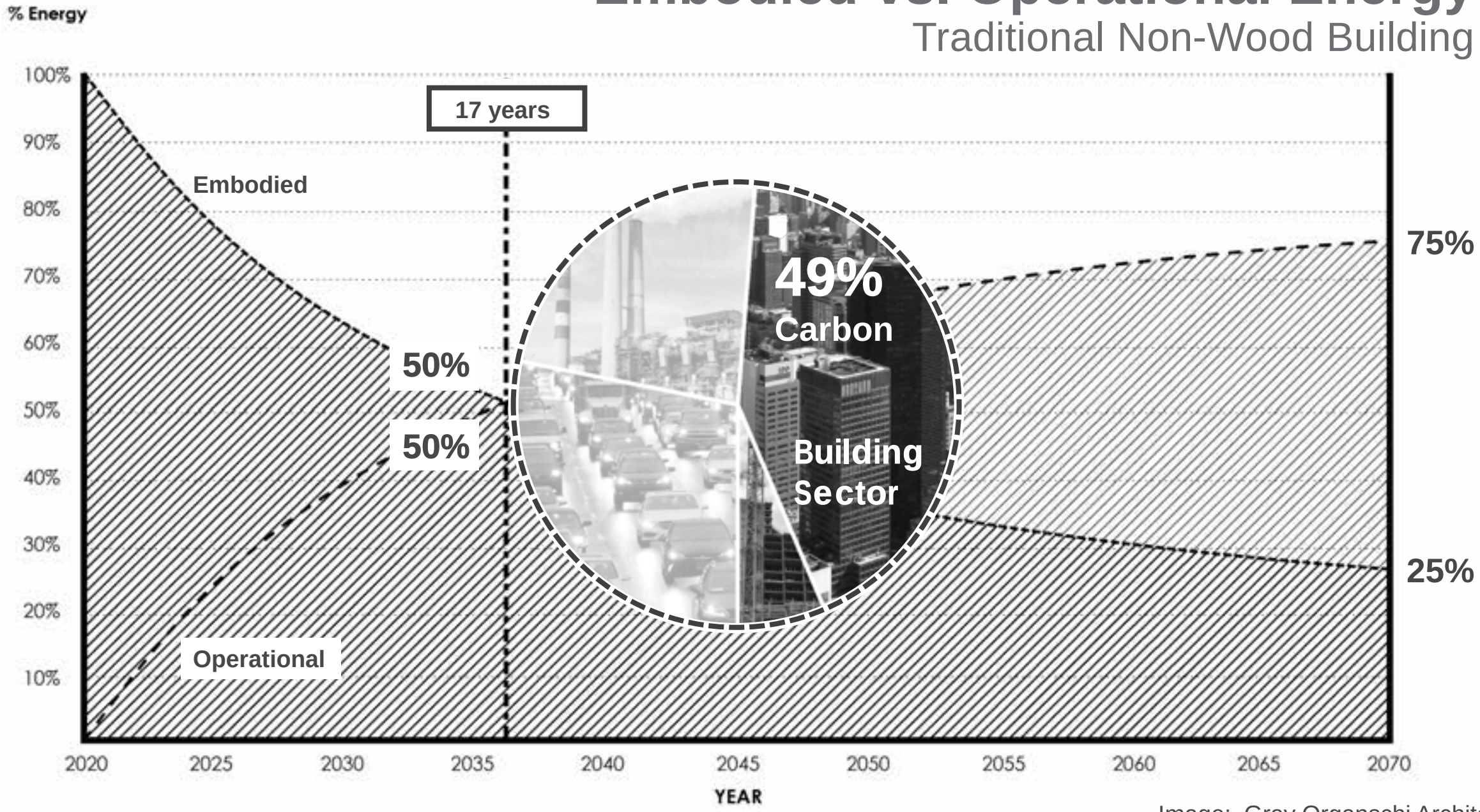
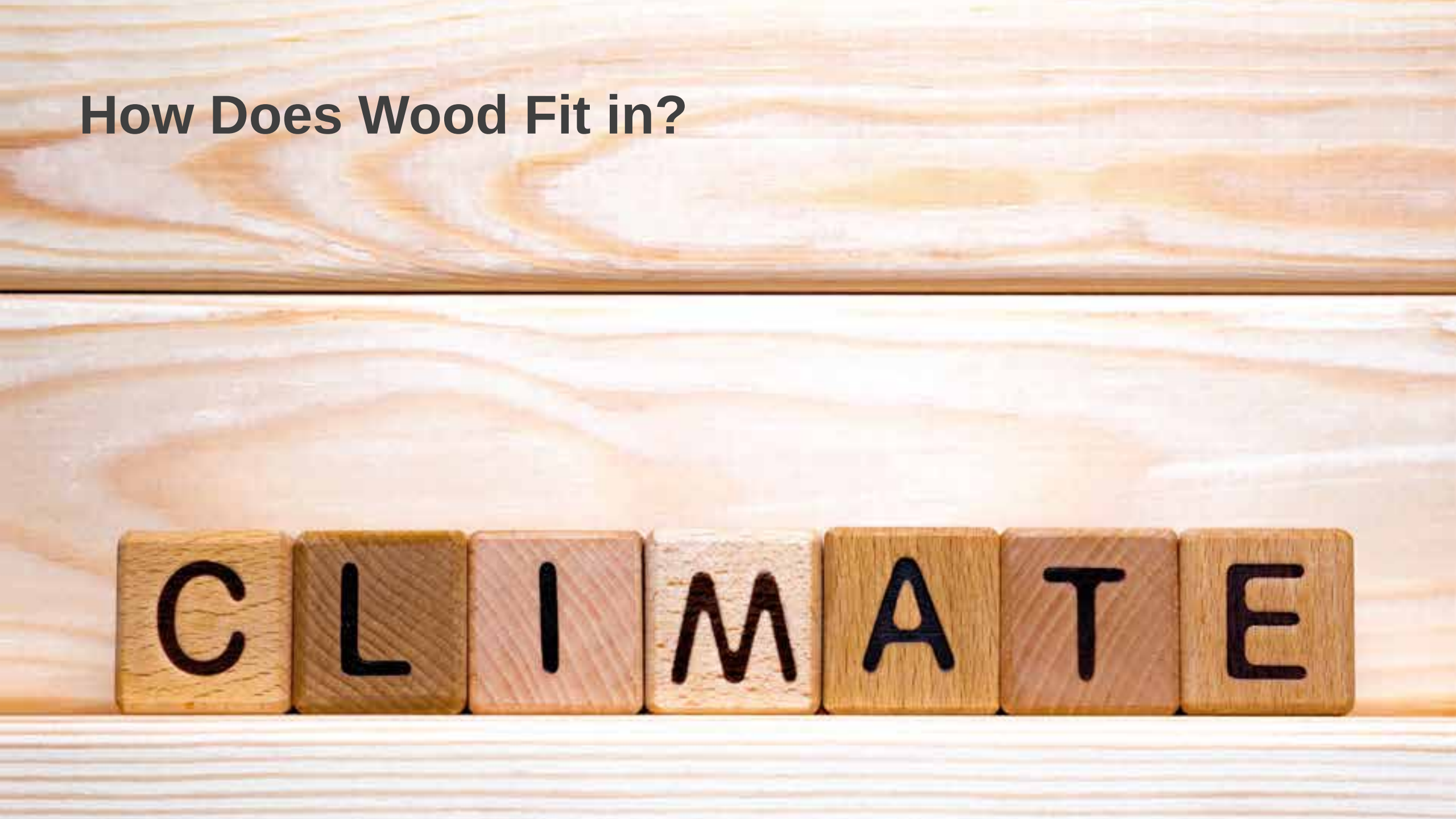


Image: Gray Organschi Architecture

How Does Wood Fit in?



Carbon Benefits of Wood

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

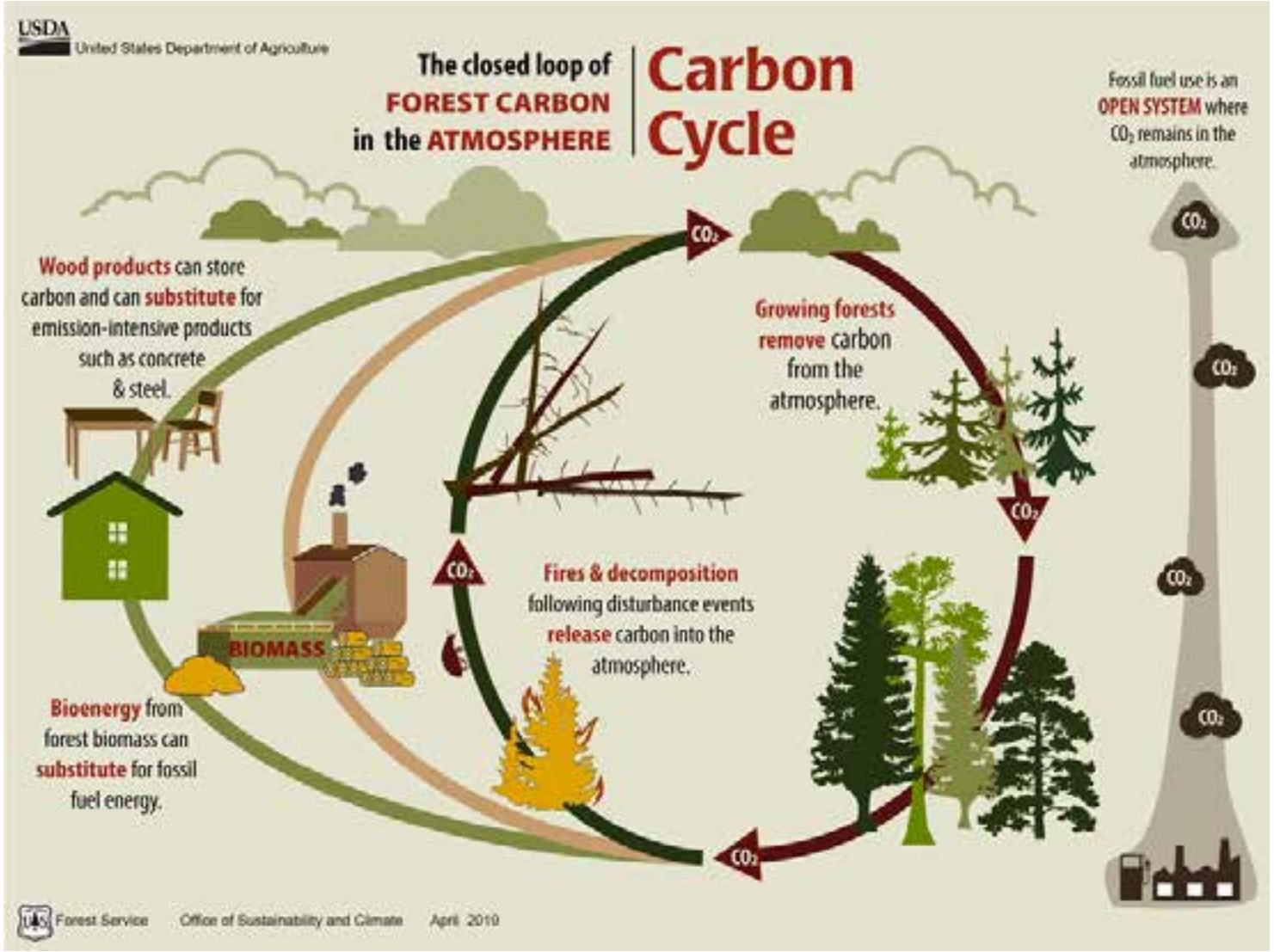


Image: USDA US Forest Service

More Carbon Terms

Carbon Sequestration: The process by which CO_2 is **removed** from the atmosphere and deposited in solid or liquid form in oceans, living organisms, or land.

Carbon Storage: Carbon is **stored as a solid** in the form of plant material: roots, trunks, branches, stems, and leaves. It can continue to be stored in **wood building materials**.

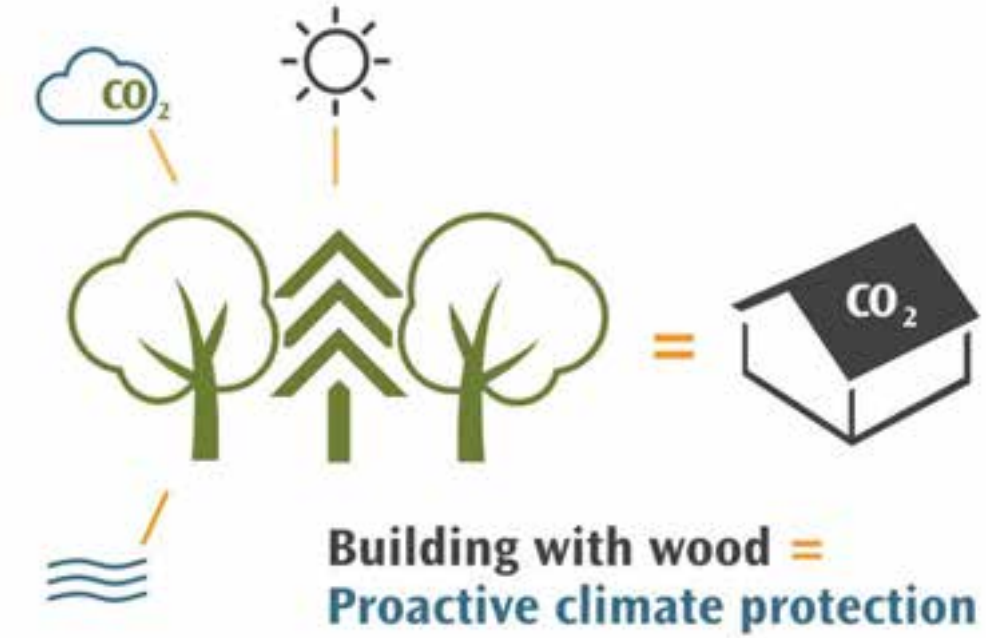


Image: Dovetail Partners, Inc.

Carbon Storage

Wood ≈ 50% Carbon (dry weight)

Image: Kaiser + Path

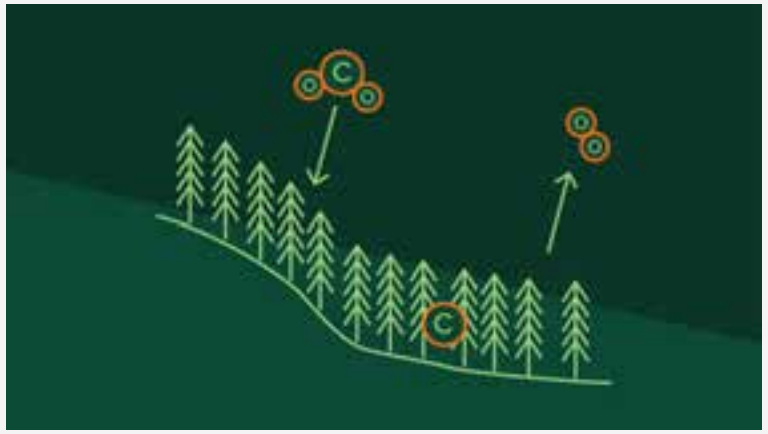
Image: Lever Architecture

Biogenic Carbon

"**<u>Carbon derived from… material of biological origin</u>**
excluding material embedded in geological formations or transformed to fossilized material and excluding peat."

Photosynthesis:

$$6\ CO_2 + 6\ H_20 \rightarrow C_6H_{12}O_6\ (\text{stored}) + 6\ O_2\ (\text{released})$$

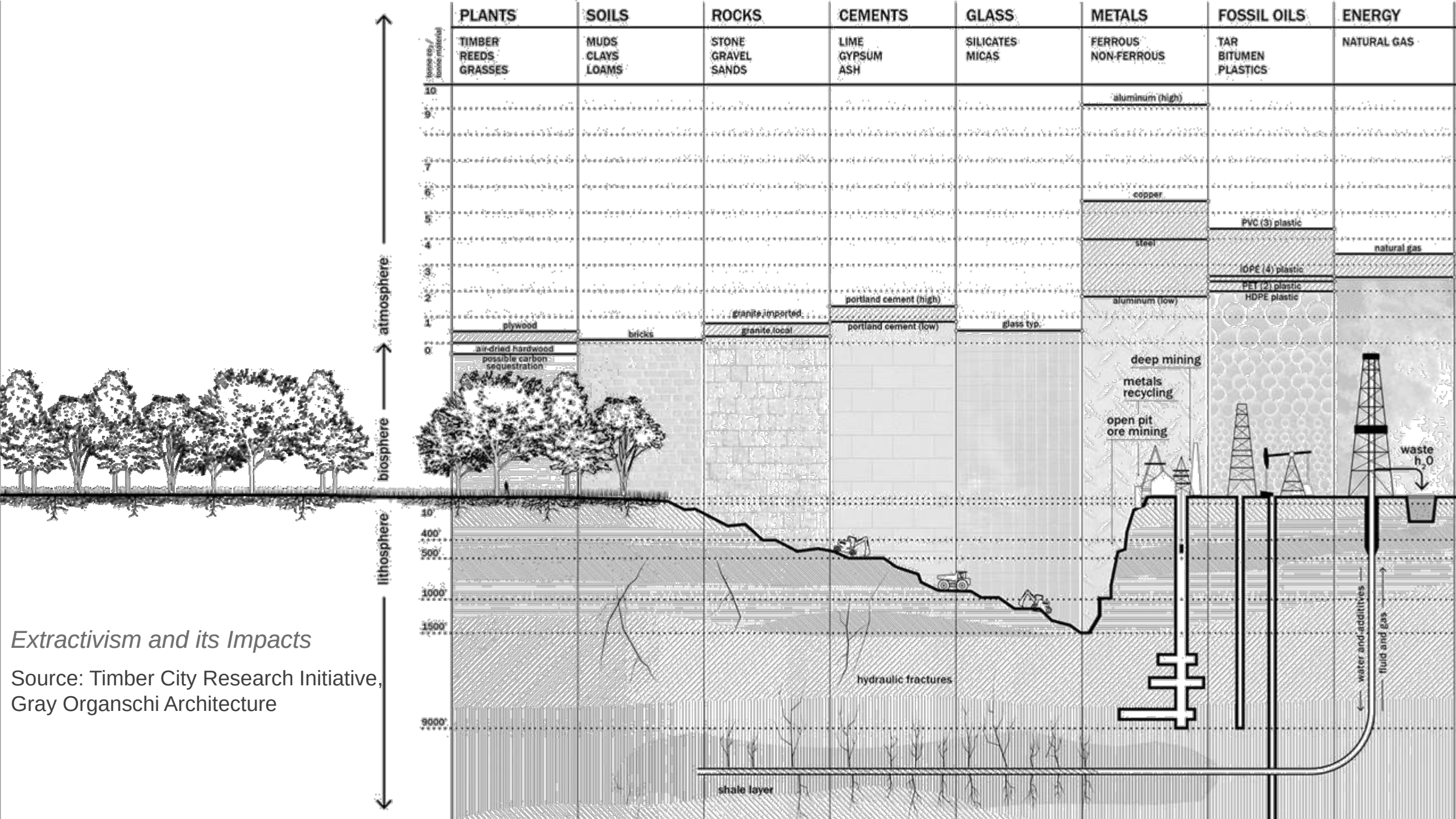


Source: ISO 21930:2017(E), 3.7

Long-Term Positive Effects

		Energy effect	Carbon effect	Value-added effect
	**Forest**	Stores solar energy	Removes C from Atmosphere	**Increases forest value**; supplies wood
	**Timber**	Often local, short transit	C in raw material	**Strengthens rural economies**
	**Lumber**	**Low embodied energy**	**Stores C**; replaces materials w/ greater C impact	Supports energy independence; strengthens US Forestry
	**Wood structure**	**Low thermal conductivity** & bridging	**Stores C**; reduces insulation / GHG emissions	**Cost effective** & provides **biophilic environment**
	**Modernization, refurbishment, urban densification**	**Lightweight** & easy to transport	**More C storage**	Increasing use of prefab; saves resources & retains value
	**Demo, recycling, energy recovery**	Low energy recycling or emissions neutral energy recovery	Extended C fixation due to recycling	**Innovative solutions for circular economy**

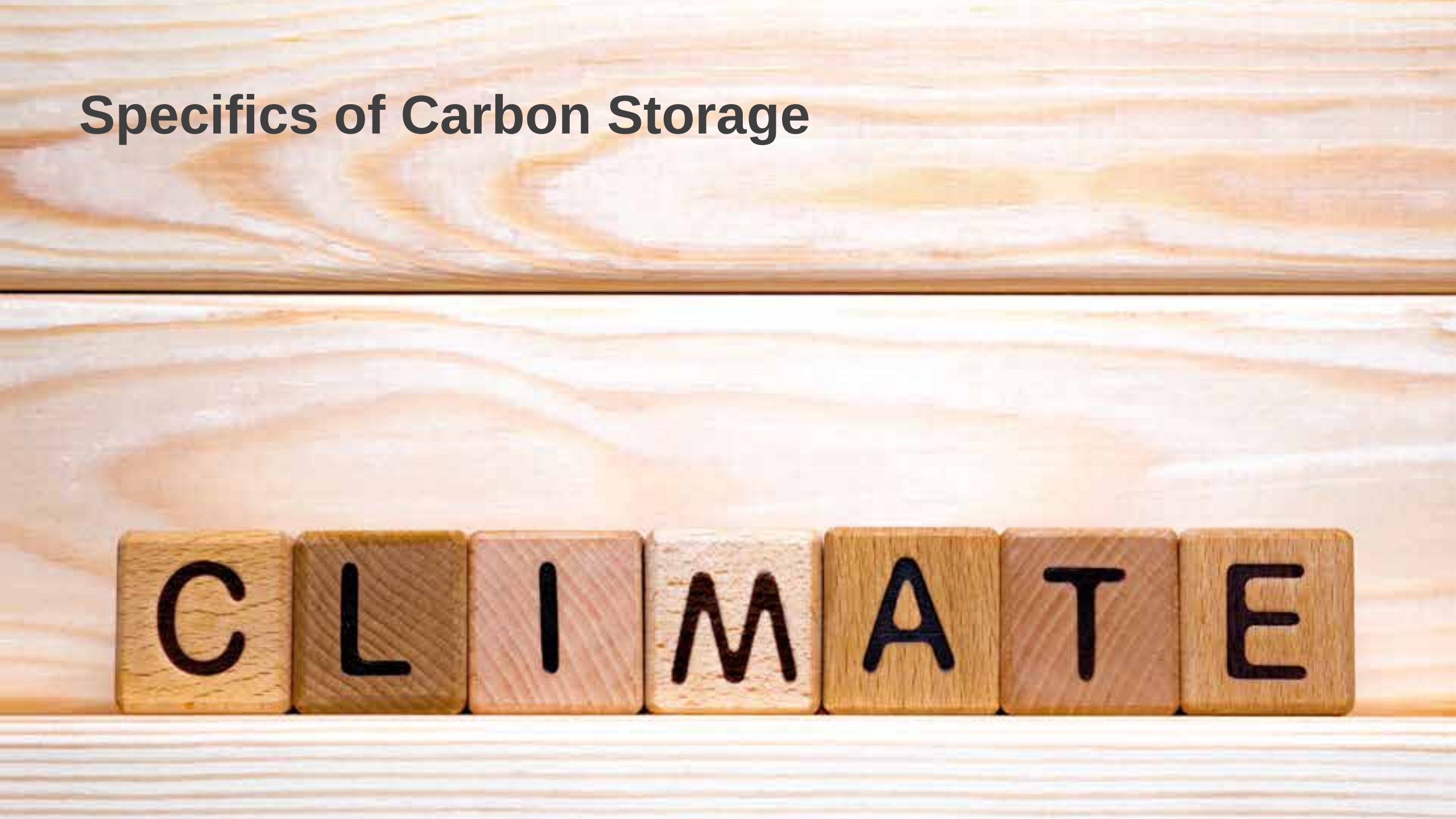
Source: Building with Wood – Proactive Climate Protection, Dovetail Partners, Inc.



Extractivism and its Impacts

Source: Timber City Research Initiative, Gray Organschi Architecture

Specifics of Carbon Storage



Where is Carbon Stored?

Harvested Wood Pools

- Harvested Wood Products
- Solid Waste Disposal Sites

Forest Pools

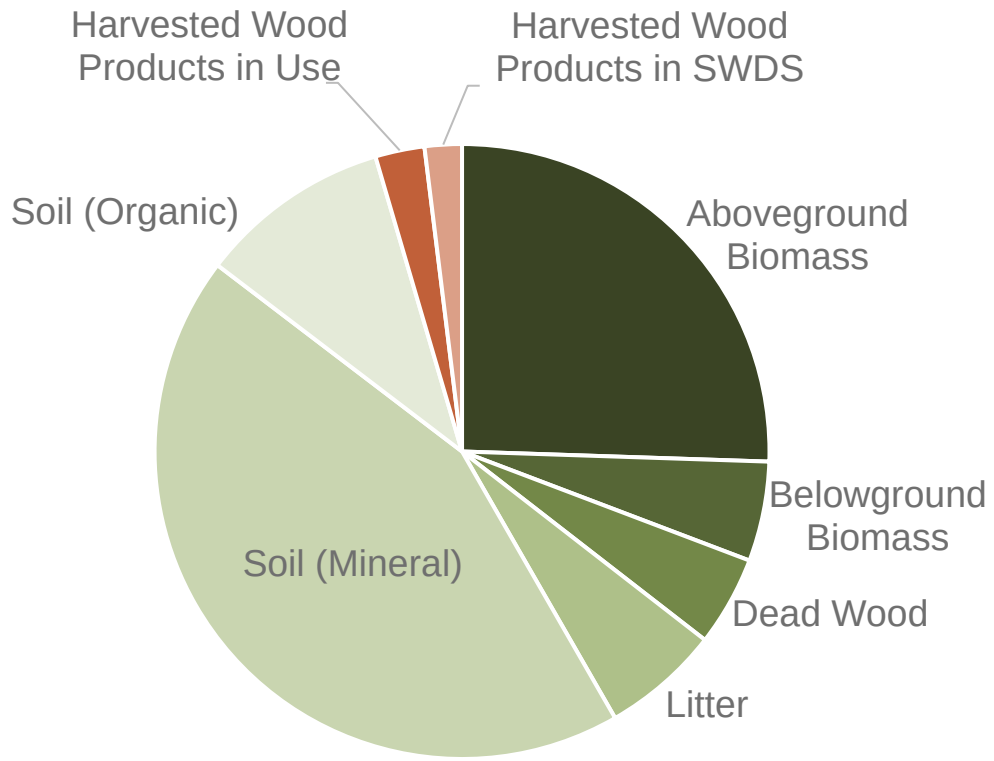
- Aboveground Biomass
- Belowground Biomass
- Dead Wood
- Litter or Forest Floor
- Soil Organic Carbon


Image: naturallywood.com

Source: https://usaforests.org/

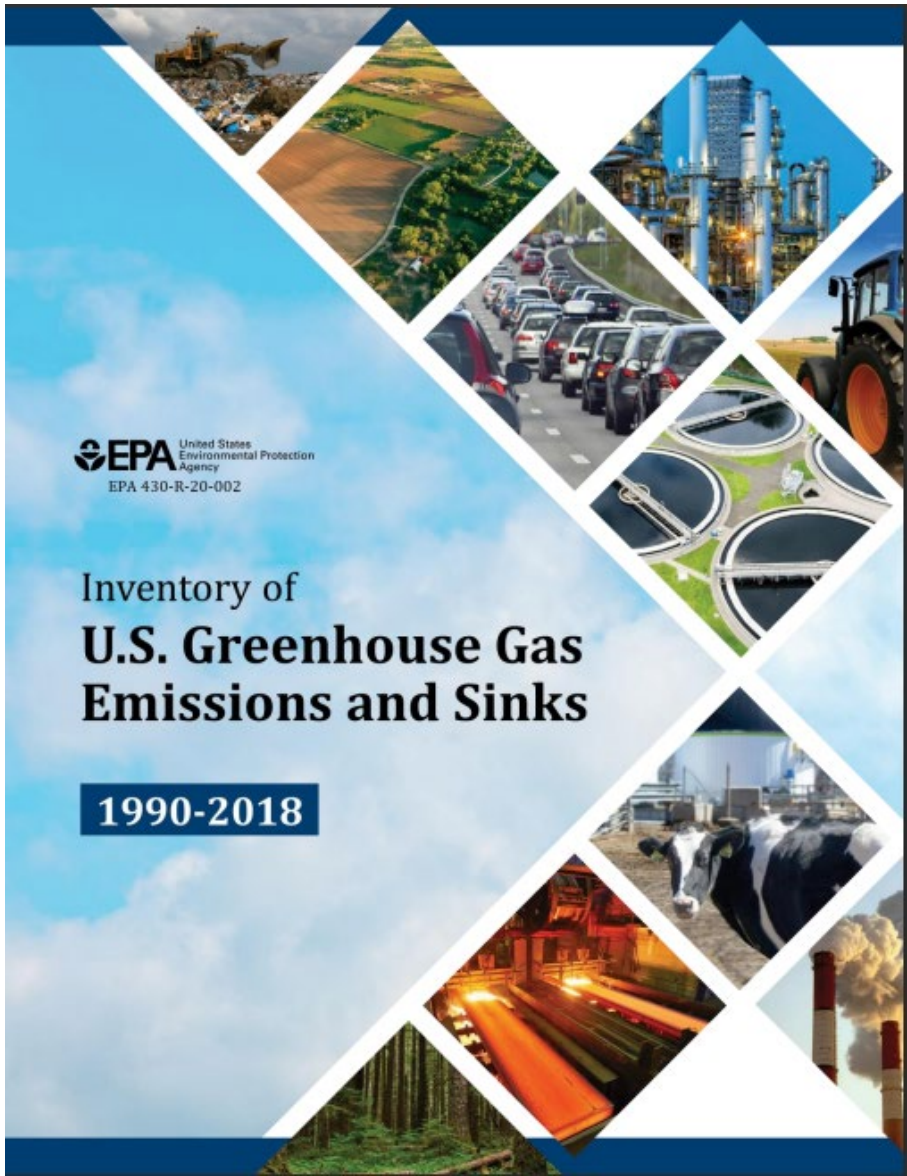
Carbon Storage in Harvested Wood Products

As of 2019, the carbon stock for Harvested **Wood Products in Use** in the conterminous 48 states is estimated at **1,521 Million Metric Tons**.



Carbon Stocks in Forest Land and Harvested Wood Pools, 2019

https://www.epa.gov/sites/production/files/2020-04/documents/us-ghg-inventory-2020-main-text.pdf



Harvested Wood Products

- **Solid sawn** wood products have the lowest level of embodied energy.

- Wood products requiring more processing steps (for example, plywood, engineered wood products, flake-based products) require more energy to produce but still require **significantly less energy** than their non-wood counterparts.

Image: Weyerhaeuser

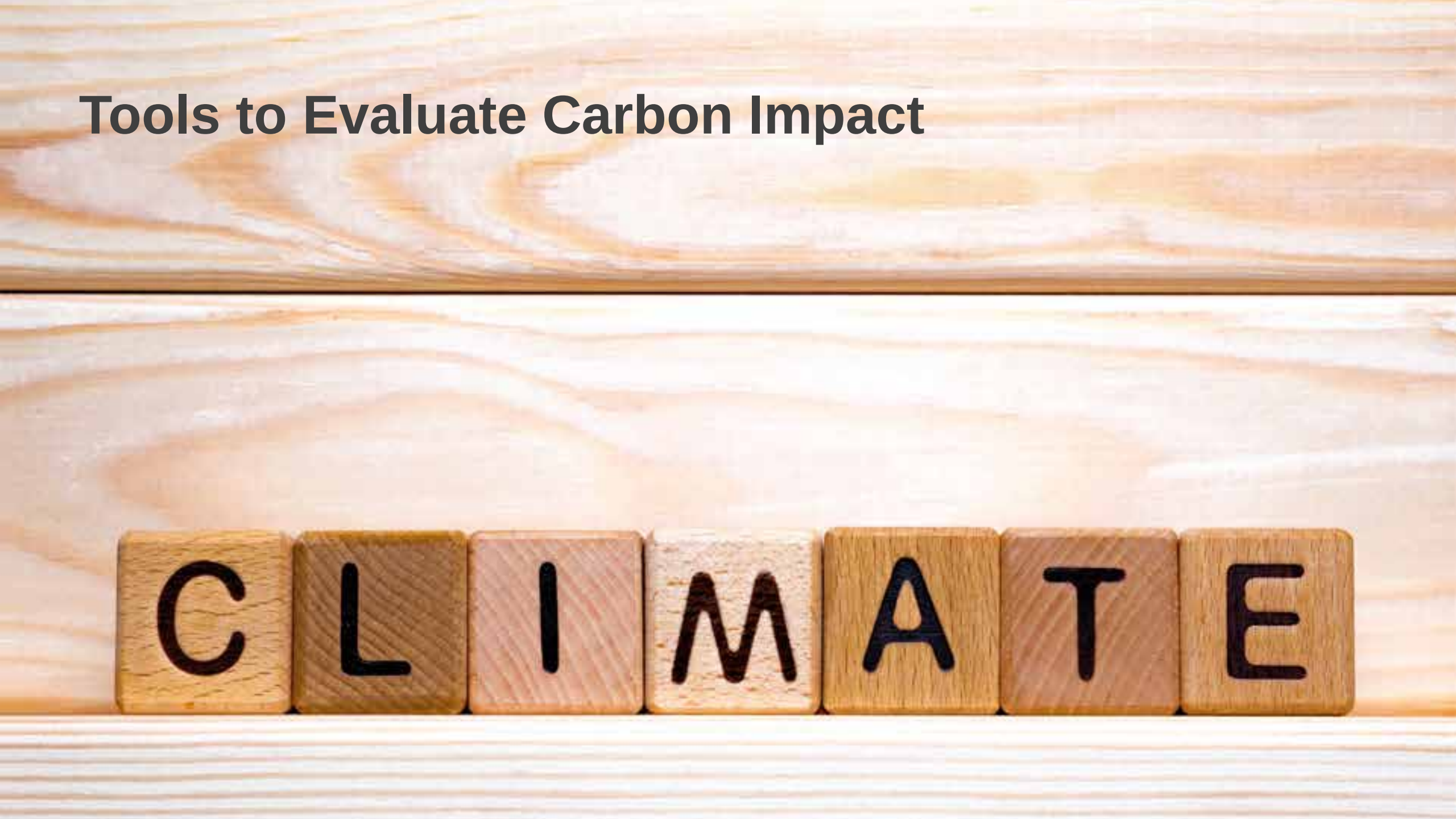
Image: LP Building Solutions

Image: Structurecraft

Image: Georgia-Pacific

Source: USFPL Wood Handbook; Wood as a Sustainable Building Material

Tools to Evaluate Carbon Impact



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/

Whole Building Life Cycle Assessment (WBLCA)

"Evaluation of the inputs, outputs, and potential environmental impacts… throughout its life cycle"

- WBLCA covers all stages in the life cycle of a building and its components
- Several tools available; various methodologies
- https://www.thinkwood.com/education/calculate-wood-carbon-footprint
- https://www.thinkwood.com/blog/understanding-the-role-of-embodied-carbon-in-climate-smart-buildings

Resources from WoodWorks

Whole Building Life Cycle Assessment (WBLCA)

- Introduction to Whole Building Life Cycle Assessment: The Basics

Biogenic Carbon and Carbon Storage

- When to Include Biogenic Carbon in an LCA
- How to Include Biogenic Carbon in an LCA
- Biogenic Carbon Accounting in WBLCA Tools
- Long-Term Biogenic Carbon Storage
- Calculating the Carbon Stored in Wood Products

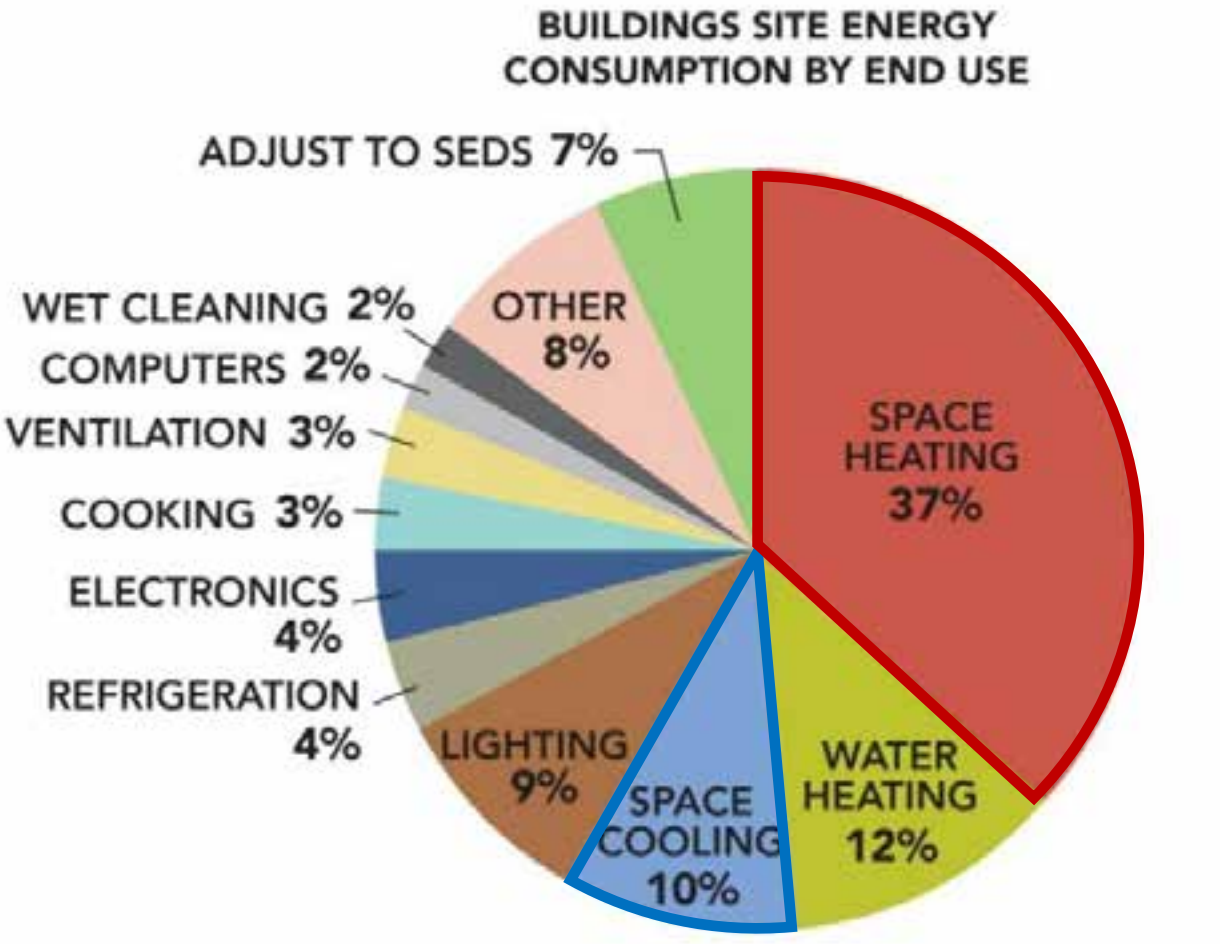
Environmental Product Declarations (EPDs)

- Current EPDs for Wood Products
- How to Use Environmental Product Declarations

Scan to view

Photo: DPR Office, SmithGroup, photo Chad Davies

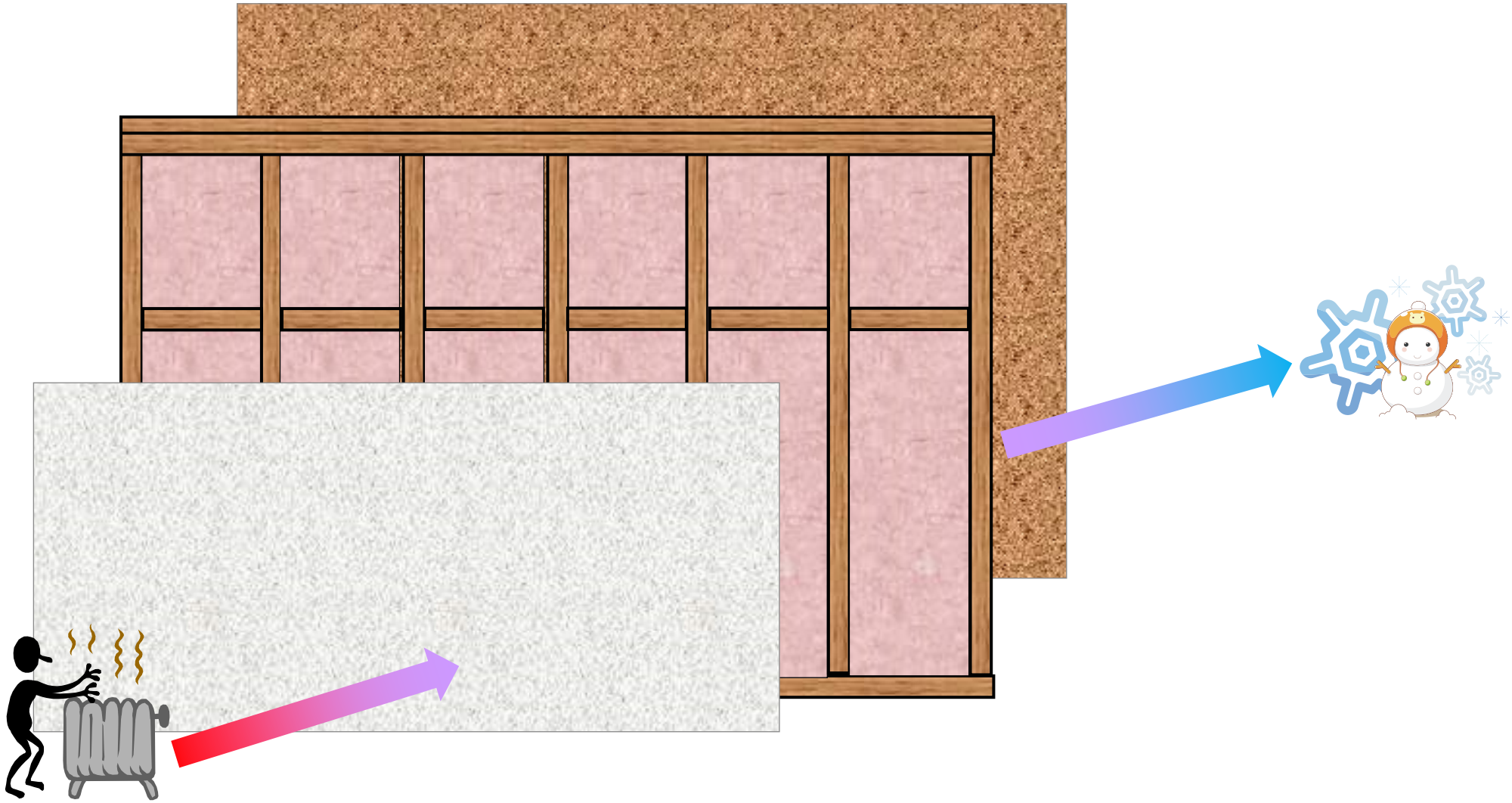
Energy Use of US Buildings



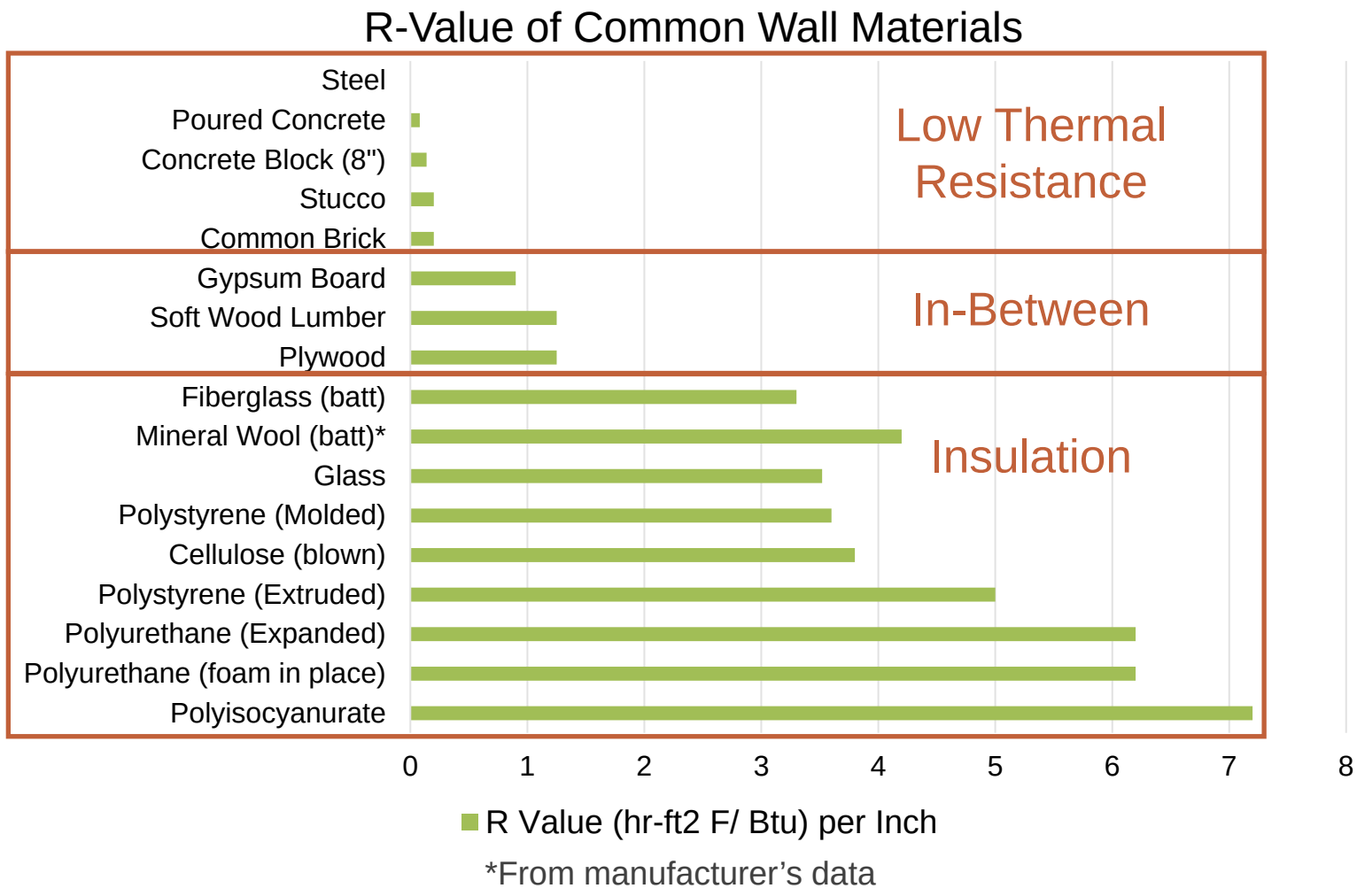
47% of energy goes to HVAC Systems

Source: US DOE Buildings Energy Data Book (2011 Data)

Thermal Performance of Walls

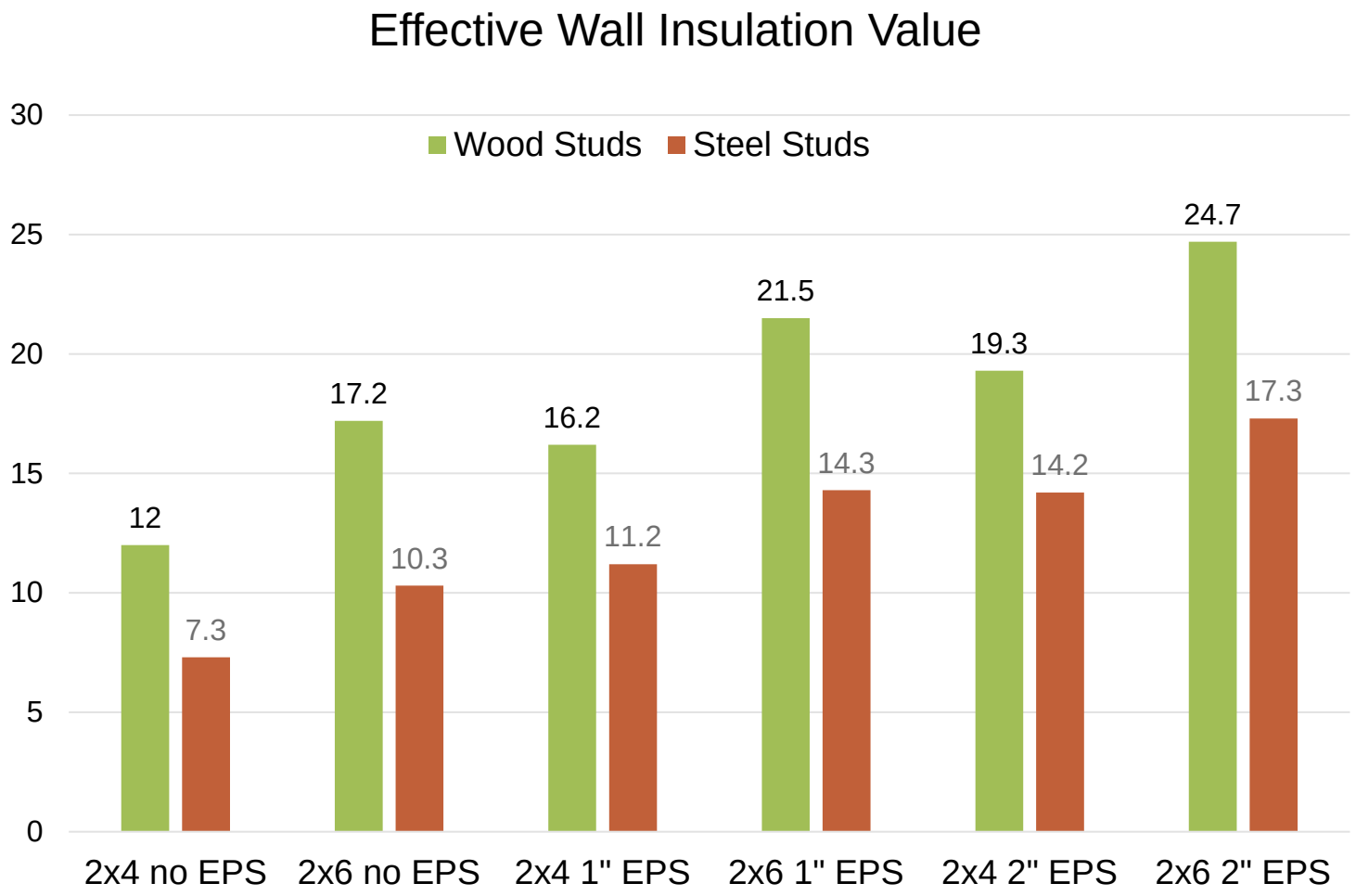


Thermal Conductivity of Materials



Data Source: "Building Construction Illustrated" 3rd Edition (2001). Ching & Adams

Wood vs Steel Framing



Given same amount of insulation, the wood framing walls perform better.

OR

It takes more insulation to get equivalent performance out of a steel stud wall.

Thermal Performance of Light Frame Structures-CWC, Wood Handbook – FPL USDA

The Passive House Path

Objective: Radically reduce energy consumption by **insulating beyond code** minimums, use of **high-efficiency ventilation** system, and **air-tight** construction

- Perform 60-85% better on energy consumption basis over code-compliant building
- Use 40-60% less energy for space conditioning than conventional building

Source: PHIUS.org, February 2021

Passive Building Works Well for All Climate Zones

- Works in all climates; tailored to each climate zone
- Already integrated into North American codes and standards
- Passive retrofitting is like regular retrofitting: messy and worth it
- Test the airtightness as construction progresses

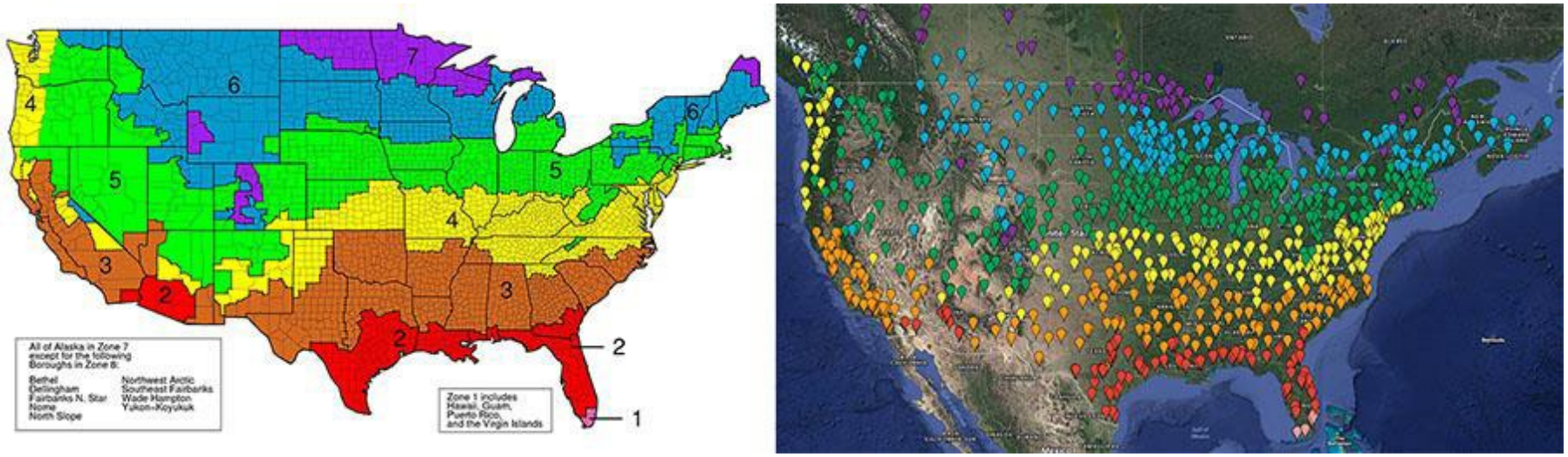


Image: PHIUS

The Many Benefits of Passive Buildings

- Superinsulation and tight construction make buildings comfortable to be in
- Better buildings are more predictable and affordable to operate – at little extra cost
- Passive buildings have:
  1. Continuous insulation: eliminate thermal bridging
  2. Airtight construction: stop heat and moisture
  3. Optimized windows and doors: keep heat in or out
  4. Balanced ventilation: ensure fresh air and control moisture
  5. Minimal space conditioning

Energy Efficiency

Techniques such as **Passive House** can be paired with wood's inherent thermal benefits to gain greater savings

- Minimize thermal bridging
- Can act as a continuous air barrier (i.e. plywood-sheathed wall with taped joints)

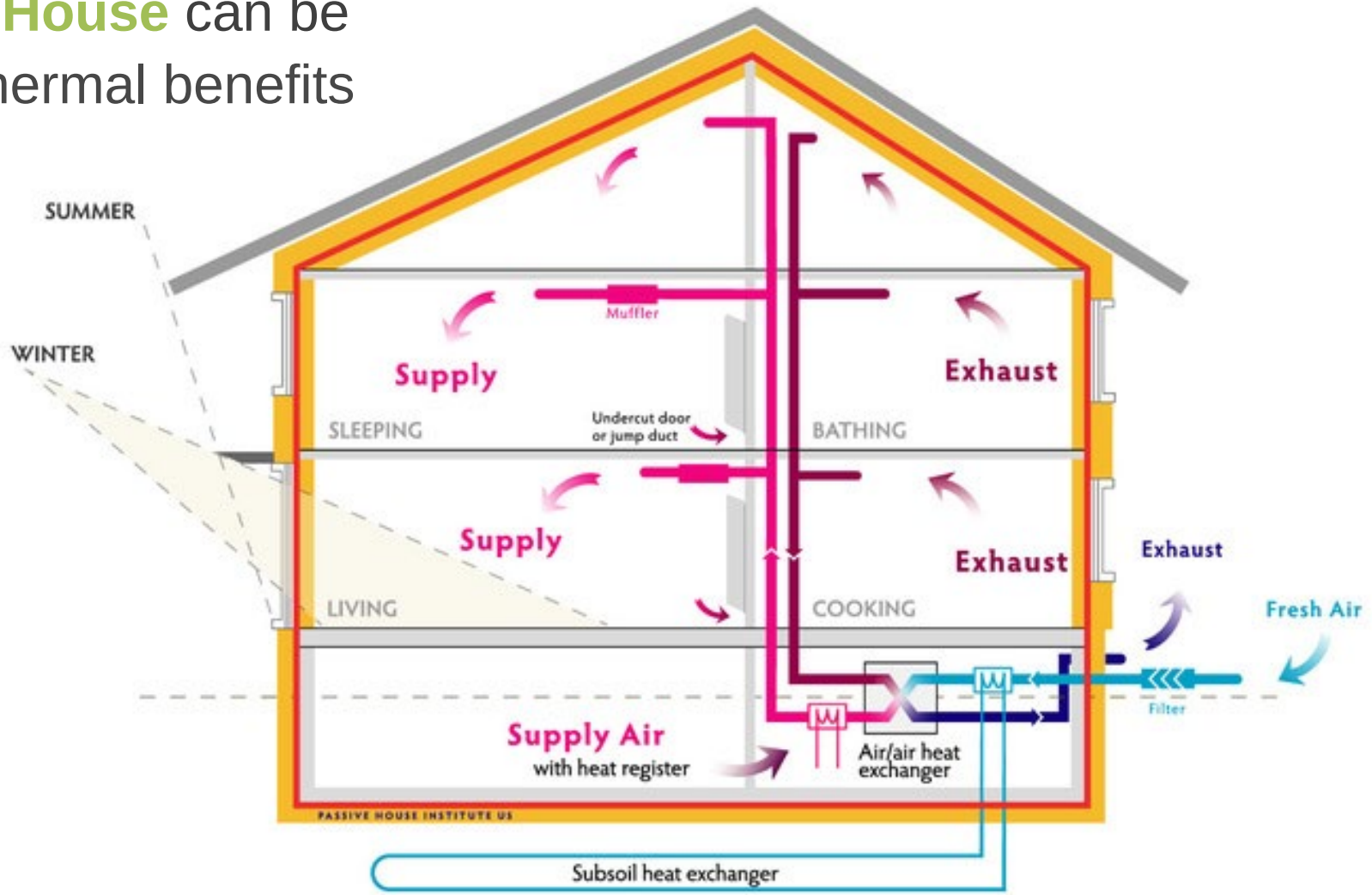


Image: PHIUS

ICON Architecture | Photo: Trent Bell Photography

V-A

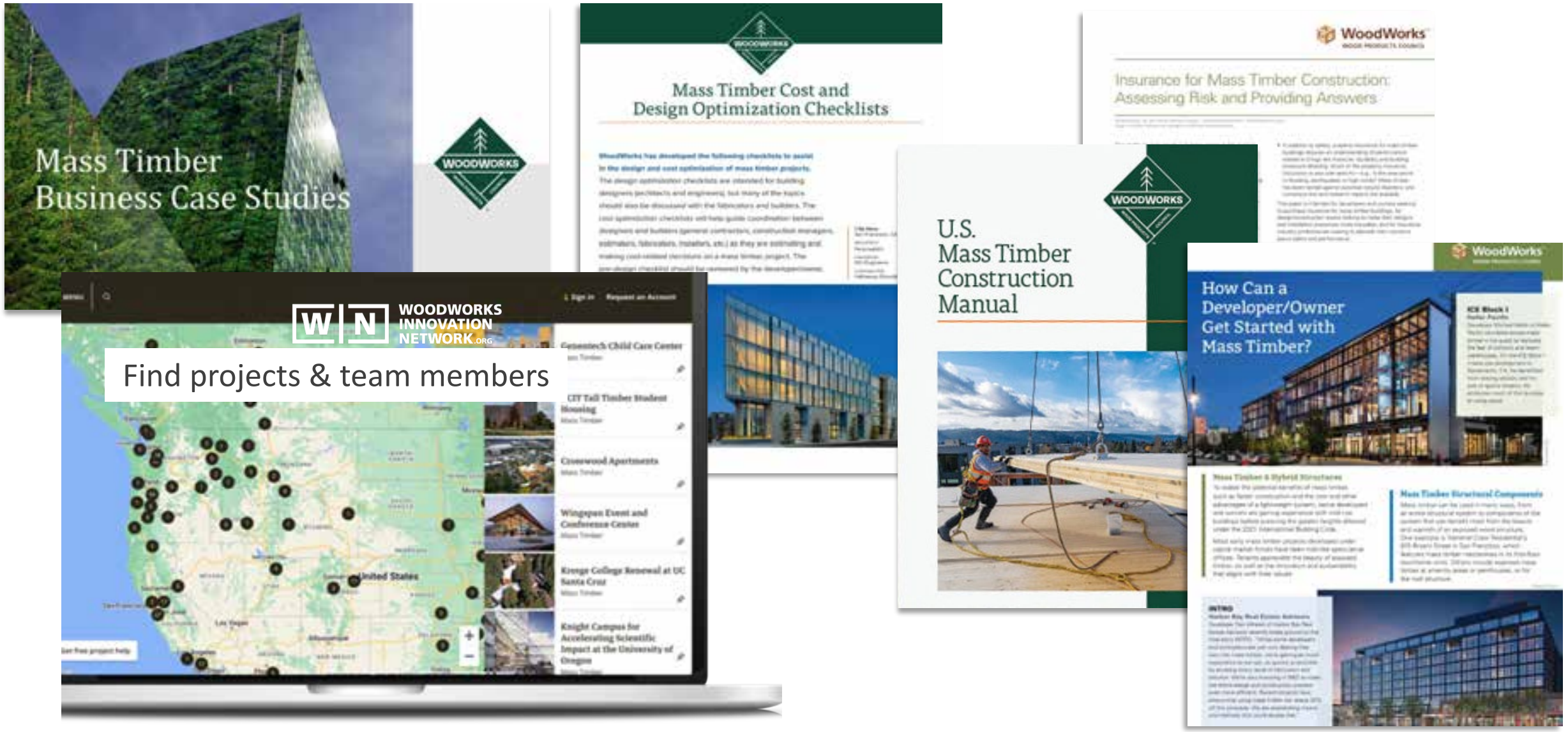
The Distillery

Boston, MA

- 4 stories wood over 2 story podium
- 60,000 sf total
- 28 residential units over parking & retail
- First multi-family Passive House building in New England

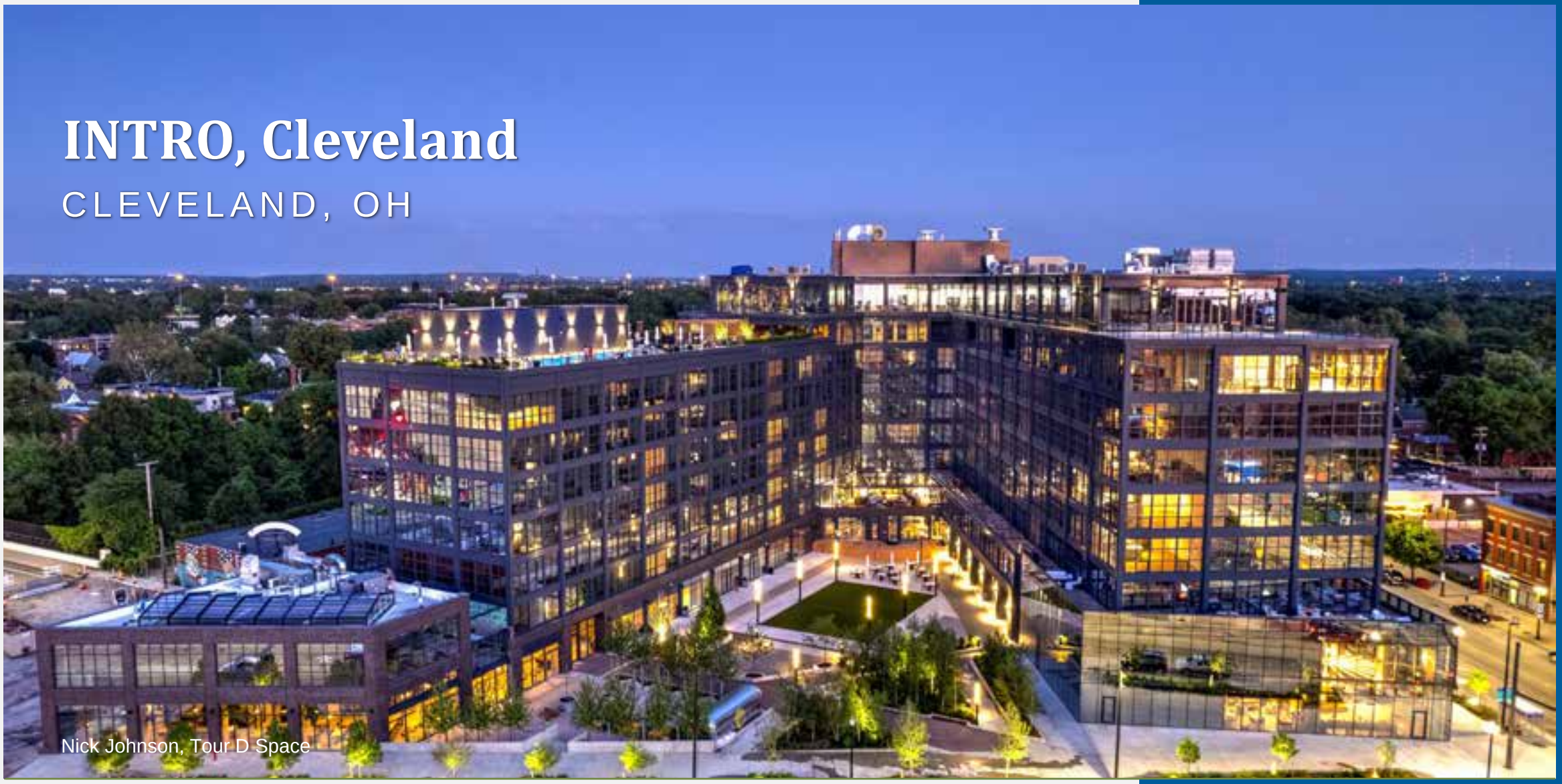
Resources for Developers/Owners

www.woodworks.org/learn/mass-timber-clt/mass-timber-business-case/



INTRO, Cleveland

CLEVELAND, OH



Nick Johnson, Tour D Space

WOODWORKS
WOOD PRODUCTS COUNCIL

Mass Timber Business Case Study

INTRO, Cleveland: Project Team

Developer
Harbor Bay Ventures

Investor Profile
Private Family Office

Lender Profile
First National Bank of Omaha
Busey Bank
First National Bank of Pennsylvania

Architect
Hartshorne Plunkard Architecture

Structural Engineer
Forefront Structural Engineers
Fast + Epp

Contractor
Panzica Construction


Nick Johnson, Tour D Space

Development Overview

- 9-story, 115’ tall building
- 8 stories of CLT & glulam construction over a podium
- Strategy:
  - Create Cleveland's best, most distinctive urban living experience; a new level and bespoke brand
  - Combine best-in-city amenity package and contemporary interiors to appeal to health/ wellness & entertainment-focused young professionals

Property Information	
Property timing	Completed Feb 2022
Submarket	Cleveland’s Ohio City neighborhood
Construction Type	4-B over 1-A retail & parking
Site size	2.1 acres (FAR 5.5)
Gross building area	512,000 SF
Net rentable area (total)	279,000 SF


Nick Johnson, Tour D Space

Quantitative Overview

Costs				
Total project cost		$147,000,000 $494,950/ unit		
Land Cost		$10,450,000	@ appraised value	
		Market Standard*	**Pro Forma**	**Realized****
Construction costs		$212 / GSF	$200 / GSF	$215 / GSF

NOI				
Apartment		**Market**	**Realized**	
Rental rates				
	Studio	$1,279	$1,500 -$1,750 (P.H. $2,000)	~26% higher
	1-BR	$1,631	$1,675 -$2,500 (P.H. $5,700)	~28% higher
	2-BR	$2,301	$2,500 -$5,200 (P.H. $7,800)	~67% higher
	3-BR	$3,334	$8,800 -$19,500 P.H.	~324% higher
Occupancy at stabilization		91%	98%	~7% higher
Parking Revenue		**Market**	**Pro Forma**	**Realized****
Included or in addition to lease?		Additional	Additional	Additional
Rate		$175 / lot / month	$185 -$200 / lot / month	$225 -$375 / lot / month
Retail		**Market**	**Pro Forma**	**Realized****
Retail rental rates		$30 -$40 / RSF/YR	$45 / RSF/YR	$45 / RSF/YR
Rent type (e.g., NNN)		NNN & Gross	NNN	NNN
Expenses		$7 -$10 / RSF/YR	$8 / RSF/YR	$8 / RSF/YR
Tenant improvement allowance		$40 -$50 / RSF	$150 / RSF	$150 / RSF
Occupancy after 12 months		60% -70%	90%	75%

**Market standard costs refer to normal cost to build for subject's use, irrespective of structural approach.*
***Realized metrics at stabilization*
****Conversations with local building officials were held concurrent to land use entitlement approvals processes such that the overall building code review process was only slightly longer. This concurrent approach was essential given that Ohio was not adopting the 2021 IBC, so the Type 4 code path was performance-based, albeit a mirror of what other states have adopted.*

Return Performance				
	Market	**Pro Forma**	**Realized****	
Yield on cost – untrended	6.25%	7.00%	7.35%	Higher
Cap rate	4.75%	4.50%	TBD	
Value/rentable SF	$550 / RSF	$717 / RSF	TBD ($800+ / RSF)	Higher
Leverage	65%	65%	N/A	

Timeline		
	Date	**Context/Comment**
Date of conception (first dollar spent)	Mid 2018	Mid-cycle
Date underwriting finalized (go/no-go decision)	Mid 2019	Mid-cycle
Date equity capital secured	N/A	Developer is equity
Permitting duration***	3 + 6 mo.	Demolition permit first, then building permit
GMP in place	Feb/March 2020	COVID
Construction start	April 2020	
Duration of construction	24 months	Faster by about 2 months
Construction completed	April 2022	Early-cycle
Date stabilized (80% occupancy, NOI, or at pro forma or refinanced)	June 2022	Faster

Project Context

Unparalleled leasing velocities at significant premiums

- The project was 90% leased 4 months after completion
- The premium product drives both velocity and rates with rents significantly higher than market counterparts
- Leasing velocity allowed refinancing activities to start 3 months after completion

Unparalleled leasing velocities at significant premiums

Exceptional Leasing Velocity and Premiums

Lessons Learned

- **Schedule Savings:** Anticipated schedule savings not fully achieved - subcontractors had not shifted approaches
- **Critical paths:** Exterior cladding system required multiple subcontractors & erection did not keep up w/ speed of timber structure; faster (unitized) skin would be better

Challenges

- **International shipping**: Issues during COVID delayed delivery; assurances compromised by lowest cost bid
- **Moisture Protection:** Laborious repairs required due to insufficient water management

Successes

- **Fast lease-up**: 60% pre-leased & stabilized after 4 months
- **Premiums**: Achieved rent premiums in market

Nick Johnson, Tour D Space

Architectural Connection to Forests

George Fox University – Canyon Commons
Hacker | Photo: Jeremy Bittermann

Biophilic Design Patterns
Nature in the Space

	Pattern	Stress Reduction	Cognitive Performance	Emotion, Mood & Preference
Nature in the Space	Visual Connection w/ Nature	✓	✓	✓
	Non-Visual Connection w/ Nature (smell, touch)	✓	✓	✓
	Non-Rhythmic Sensory Stimuli	✓	✓	
	Thermal & Airflow Variability	✓	✓	✓
	Presence of Water	✓	✓	✓
	Dynamic & Diffuse Light	✓		
	Connection w/ Natural Systems			✓

Source: Terrapin Bright Green: *14 Patterns of Biophilic Design*, 2014

How Might Wood Buildings Contribute to Biophilic Design?
Nature in the Space

	Pattern	
Nature in the Space	Visual Connection w/ Nature	Design opportunity (glazing/ courtyards)
	Non-Visual Connection w/ Nature (smell, touch)	Smell & touch – might the soft wood feel & wood scent contribute?
	Non-Rhythmic Sensory Stimuli	Design opportunity (biomimicry)
	Thermal & Airflow Variability	Wood is a living material & can help control temperature & humidity
	Presence of Water	Design opportunity (water features)
	Dynamic & Diffuse Light	Design opportunity (timber slats)
	Connection w/ Natural Systems	Wood buildings support healthy forests

Source: Conversations and emails between Bill Browning (Terrapin Bright Green) and Melissa Kroskey (WoodWorks)

Material Connection to Nature (visual)

Biophilic Pattern

- Wood is a natural material – timber is sourced from trees in our forests.
- Exposing natural materials provides a connection to nature in this biophilic pattern

First Tech Credit Union
Hacker

Material Connection to Nature (non-visual)

Biophilic Pattern

Other sensory connections to nature:

- Soft feel of wood – might this contribute to this biophilic pattern?
- Smell of wood in offices- might this contribute to this biophilic pattern?
- Smell of wood has surprised some designers who didn’t consider it in design

Albina Yard
LEVER Architecture | Photo: LEVER Architecture

Feature Stairs

Encouraging Exercise

Albina Yard
LEVER Architecture | Photo: LEVER Architecture

The Bullitt Center
Miller Hull Partnership | Photo: John Stamets

SAC Federal Credit Union HQ
Leo A Daily | Photo: Brad Anderson

People Pay More $$$ for a Connection to Nature

- People pay more for good views of nature (obvious w/ real estate prices)
- Potential for leasing velocity and/ or higher leasing rates for offices w/ natural wood materials*

The Bullitt Center
Miller Hull Partnership | Photo: John Stamets

Venture Capital Office HQ
Paul Murdoch Architects | Photo: Eric Staudenmaier

*Source: WoodWorks: Mass Timber Cost and Design Optimization Checklists
https://www.woodworks.org/wp-content/uploads/wood_solution_paper-Mass-Timber-Design-Cost-Optimization-Checklists.pdf

Office Buildings
Biophilic Design

Wellness + Wood = Productivity

Workplaces

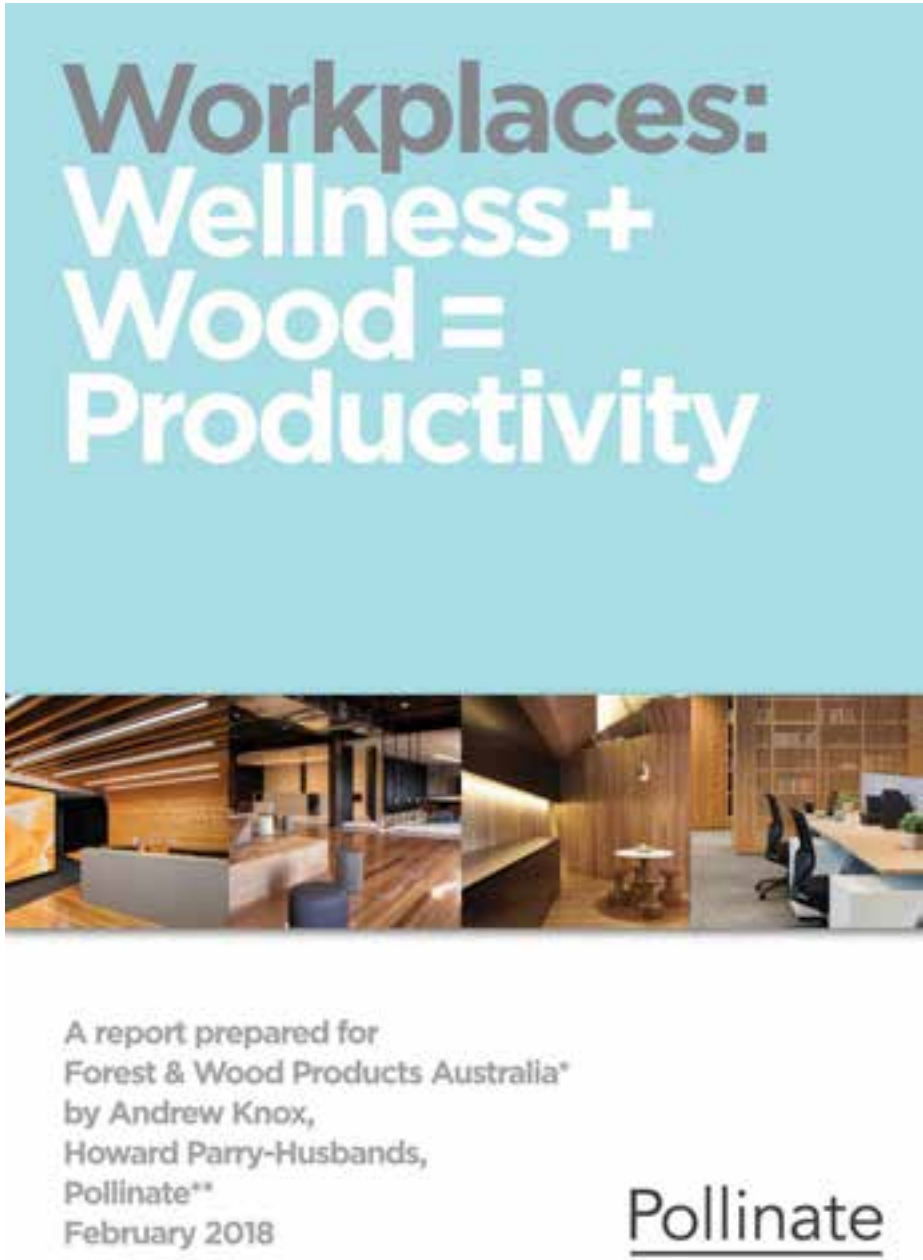
"Those in workplaces with a higher proportion of **visible wood** **feel more connected to nature** and rate their working environment far more positively."

These people report:

- lower stress levels
- higher concentration
- improved overall mood

"Wood in the workplace is associated with **higher productivity** and **reduced sick leave**."

Report based on survey of 1,000 typical Australians working indoors



First Tech Credit Union | Image: Hacker

Employee Retention

Healthy Building/ Biophilia

Cost of losing an employee (assume: $33/ hr):

- $ 1,000 termination
- $ 9,000 replacement
- $15,875 lost productivity
- **$25,875 total**

The Hudson
Mackenzie | Photo: Christian Columbres

Sources by Terrapin Bright Green:

- *Economics of Biophilia*, 2012
- *14 Patterns of Biophilic Design*, 2014
  (includes list of testing citations)

Investing in Employees Pays off for Bank

Case Study

ING Bank, Amsterdam HQ

Design focused on connections to nature to enhance productivity of workers.

Results:

- Absenteeism decreased 15%
- Employees voluntarily tended to natural features
- Employees looked forward to coming to the office & productivity increased

Graphic: ing.com

* Source: *Economics of Biophilia*, Terrapin Bright Green, 2012

Natural Materials for Warm Gathering Spaces

Amenity Spaces

- Modern amenities battle: Spaces for informal collaboration are in demand
- Amenities provide a place to recharge & interact
- Connection to nature proven most impactful through outdoor access*
- Connection to nature indoors through materials & views is beneficial*

Clay Creative
Mackenzie | Photo: Christian Columbres

T3 Minneapolis
Michael Green Architecture | Photo: Ema Peter

* Source: *14 Patterns of Biophilic Design*, Terrapin Bright Green, 2014
(includes list of testing citations)

Heavy Timber Revolution: California's Hip New Commercial Block

ICE Block I

Location: Sacramento, CA
Architect: RMW Architecture & Interiors
Engineer: Buehler Engineering

III-B

- 3 Story heavy timber over podium
- 87,460 sf
- Traditional heavy timber

"The **building sold itself** because of its unique character. There was no competition. **A lot of the credit goes to the fact that it is a timber building**."

– Mike Heller, Heller Pacific

Tech Companies Invest in Healthy Corporate Campuses

Microsoft Silicon Valley Campus

Microsoft Campus | Image: WRNS Studio

Biophilic Design Schools

Study of Wood vs. Non-wood Finishes

Wood and Human Health

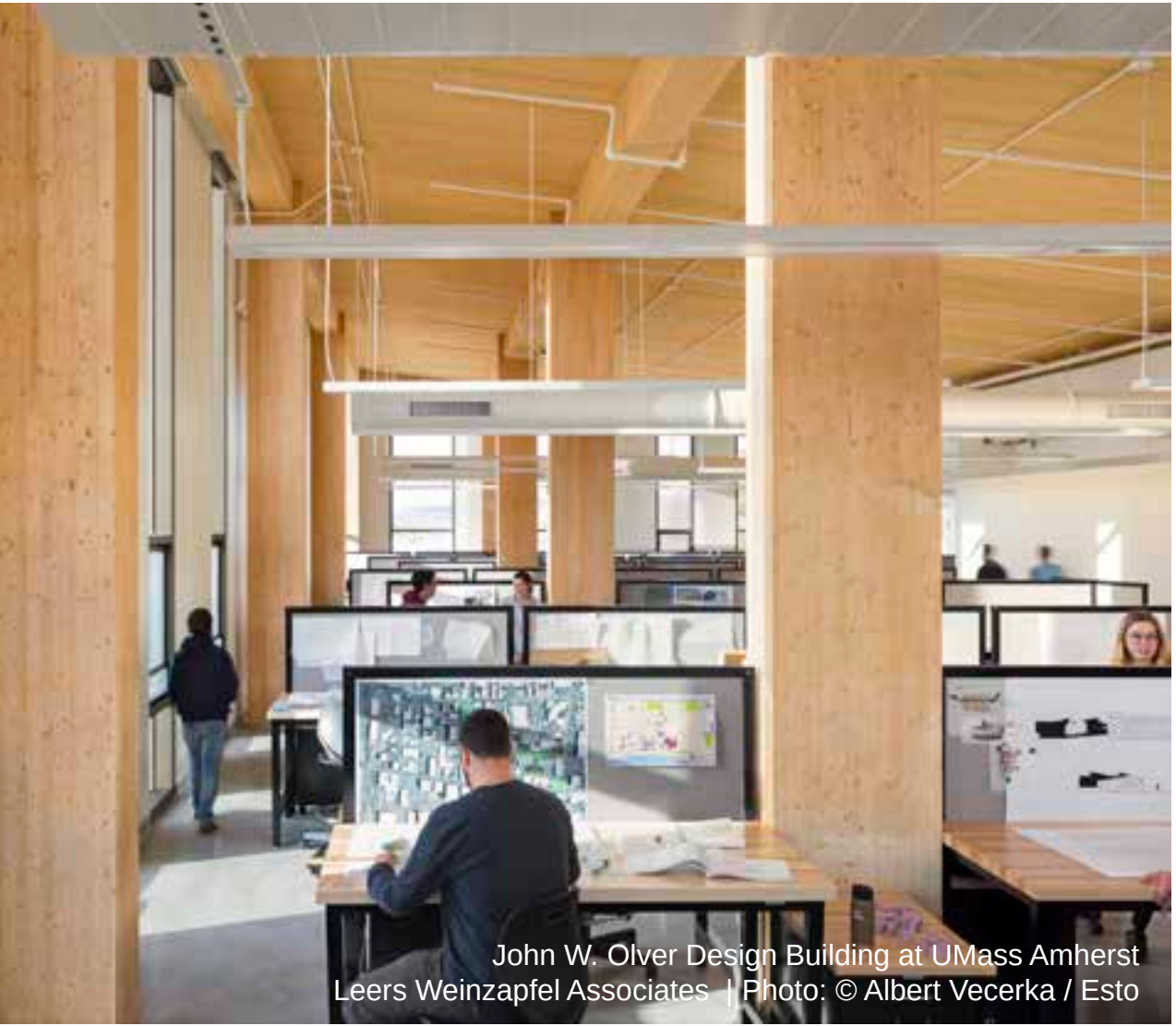
- Univ. of British Colombia & FP Innovations study
- 4 rooms: white furnishings vs. wood furnishings; plants vs. no plants

"Stress, as measured by sympathetic nervous system activation, was lower in the wood room in all periods of the study."

Source: *Wood and Human Health*
https://www.woodworks.org/wp-content/uploads/2014-SE-WSF-Fell-Healthy-Buildings.pdf

Wood Grain Pattern – Can it Stimulate our Senses?

Might Wood Help Increase Ability to Think and Learn?



John W. Olver Design Building at UMass Amherst
Leers Weinzapfel Associates | Photo: © Albert Vecerka / Esto

George Fox University – Canyon Commons
Hacker | Photo: Jeremy Bittermann

A Living/ Learning Destination for Students

Adohi Hall, University of Arkansas

Location: Fayetteville, AR
Architect: Leers Weinzapfel Associates; Mackey Mitchell Architects; Modus Studio (AOR)
Structural Engineer: Equilibrium Consulting; Engineering Consultants, Inc.

III-B

- 202,000 sf
- 708 bed student housing
- CLT and glulam framing

"…the wood-based construction system we developed forges a bond between setting, human comfort, and sustainability."

– Andrea Leers, Leers Weinzapfel

Healthier Learning Environment for the 2nd Generation

Cottonwood Valley Charter School E-Pod

Photos: Patrick Coulie Photography

V-B

- 6,400 sf
- Wood trusses and framing w/ SIPs
- Operable wall extends multipurpose space outdoors
- Design echoes the simple shed structures of industrial and agricultural buildings in the area

Location: Socorro, NM
Architect: Environmental Dynamics, Inc.
Structural Engineer: Walla Engineering, Ltd.

Biophilic Design
Multifamily Residential

Innovative, Sustainable, Tall Timber Multifamily
Carbon 12

- 42,000 sf
- 8-story tower
- 14 condos + 2 retail units
- CLT and glulam framing
- Each unit has light & ventilation from 3 sides

Location: Portland, OR
Architect: Path Architecture
Structural Engineer: Munzing Structural Engineering

Green Building Rating Systems
What are They?

Building certification system that rates or rewards relative levels of compliance or performance with specific environmental goals and requirements.

Analyze project as a whole, going beyond (but factoring in) performance of individual products used in the project.

Amtrak Cascades Station at Freighthouse Square,
Architect: VIA Architecture, Photo: Chris Eden/Eden Photography

Source: WBDG

Green Building Rating Systems

What is their main goal?

To clearly define, implement, and measure green strategies and their outcomes and impacts.

Amtrak Cascades Station at Freighthouse Square,
Architect: VIA Architecture, Photo: Chris Eden/Eden Photography

Source: USGBC

Green Building Rating Systems
Why target certification?

The reasons for pursuing a green building certification for a project are varied:

- Verification of the green nature of the project
- Valuable educational and marketing tool for owners and design and construction teams
- Provide an incentive for clients, owners, designers, and users to develop and promote highly sustainable construction practices
- It is important to note that a building does not have to be certified to be sustainable and well-built.

Source: WBDG

Source: USGBC & ILFI

Green Building Rating Systems

What are the benefits?

There are a wide range of economic and environmental benefits to sustainable design, often achieved through the use of standards, rating, and certification systems. Examples include:

- Reduced embodied carbon
- Reduced building energy and water use
- Reduced construction waste
- Increased occupant comfort/satisfaction
- Increased building value, lease rates, ROI

RISD North Hall, Architect: NADAAA Architects, Photo: John Horner

Source: WBDG

Green Building Rating Systems

Single vs. multi-attribute

A few of these programs are single-attribute, focusing solely on water or energy, while others are multi-attribute addressing emissions, toxicity, and overall environmental performance in addition to water and energy. While the philosophy, approach, and certification method vary across these systems, a common objective is that projects awarded or certified within these programs are designed to reduce the overall impact of the built environment on human health and the natural environment.

Source: WBDG

COMPARISON OF ENVIRONMENTAL IMPACTS OF STEEL VS. WOOD DESIGN (Values indicate magnitude of impact associated with steel design as multiple of wood design impact)							
Fossil Fuel Consumption	Weighted Resource Use	Global Warming Potential	Acidification Potential	Human Health Respiratory Effects Potential	Eutrophication Potential	Ozone Depletion Potential	Smog Potential
1.4x	1.02x	1.6x	1.4x	1.3x	3.0x	1.5x	1.2x
COMPARISON OF ENVIRONMENTAL IMPACTS OF CONCRETE VS. WOOD DESIGN (Values indicate magnitude of impact associated with concrete design as multiple of wood design impact)							
Fossil Fuel Consumption	Weighted Resource Use	Global Warming Potential	Acidification Potential	Human Health Respiratory Effects Potential	Eutrophication Potential	Ozone Depletion Potential	Smog Potential
1.9x	2.3x	3.0x	2.4x	2.1x	4.7x	5.8x	2.4x

Source: Athena EcoCalculator

Source: USGBC

Green Building Rating Systems
Which one should I use?

Ultimately, the type of certification system pursued for a project depends upon that singular project; none of these certification systems are one-size-fits all. Project variables that can influence rating system choice include:

- Location
- Size
- Budget
- Overall project goals
- Rating system cost & ease of use

Rating systems are regularly updated & changed

Oregon Conservation Center, Photo: Jeremy Bittermann; Lara Swimmer; Shawn Records; LEVER Architecture

Green Building Rating Systems
Credits for wood use

Generally, every prescriptive-based rating system offers a certain percentage of credits that can be achieved with the use of wood or wood products. In most cases, wood is recognized in the following areas:

- Certified wood
- Life Cycle Impacts
- Recycled/reused/salvaged materials
- Local sourcing of materials
- Materials efficiency
- Waste minimization
- Indoor air quality

ICE Block I, RMW Architecture & Interiors, Buehler Engineering, Bernard André Photography

Source: *Green Building and Wood Products*

Green Building Rating Systems
Certified wood

Credits are awarded for wood that has been 3rd-party certified as coming from a sustainably managed forest. Different rating systems allow for different certification programs, with some more inclusive than others.

While rating systems commonly reward projects that use certified wood, they do not require any demonstration that other materials such as concrete, steel, or plastic have come from a sustainable resource.

Photo: Frank Rosenstein, Courtesy of Plum Creek

Source: *Green Building and Wood Products*

Green Building Rating Systems

Life cycle impacts

Many rating systems give credits for the use of products with lower embodied energy and lifecycle carbon impacts. Wood products regularly perform well in embodied carbon comparisons of building materials.

John W Olver Design Building, Architect: Leers Weinzapfel Associates, Photo: ©Albert Vecerka/Esto

Green Building Rating Systems
Local material sourcing

Some systems place special emphasis on the use of local materials as an approach to reducing the environmental impacts of projects, rewarding materials sourced from within a certain radius—commonly 500 miles.

However, simply tracking transportation distances ignores such critically important factors as mode of transportation and the type, efficiency, and impacts of manufacturing processes.

Richard Woodcock Education Center, Western Oregon University. Mahlum Architecture. Photo: DR Johnson

Source: *Green Building and Wood Products*

Green Building Rating Systems

Material efficiency & waste minimization

Many rating systems reward use of lower quantities of building materials.

Credit is often awarded for avoiding or diverting construction waste—e.g., through jobsite protocols that include pre-cut packages or off-site production of building modules.

Platte 15, OZ Architecture. Photos: JC Buck

Source: *Green Building and Wood Products*

Green Building Rating Systems

Indoor air quality

Most rating systems have strict limits on the use of products that contain volatile organic compounds (VOCs). Many wood products are available that verifiably meet or exceed these guidelines.

Adohi Hall, University of Arkansas, Leers Weinzapfel Associates, Photo: Timothy Hursley; Kiara Luers

Source: *Green Building and Wood Products*

Green Building Rating Systems
Ancillary benefits of wood

Other key areas where wood may have further advantages that are currently not being considered in most of the ratings systems:

- **Acoustics** –Wood panel products can be useful in sound abatement and control strategies
- **New products in traditional applications** – i.e. wood fiber insulation
- **Thermal mass** – Use of wood framing in wall and roof assemblies can result in less thermal bridging

ICE Block I, RMW Architecture & Interiors, Buehler Engineering, Bernard André Photography

Source: *Green Building and Wood Products*

Green Building Rating Systems

System choices

BREEAM®

GREEN GLOBES® BUILDING CERTIFICATION

fitwel

earthcraft
A Program of Southface

U.S. GREEN BUILDING COUNCIL LEED USGBC

INTERNATIONAL WELL BUILDING INSTITUTE™

BUILT GREEN®

NATIONAL GREEN BUILDING STANDARD™

LIVING BUILDING CHALLENGE™

CASBEE®
Comprehensive Assessment System for Built Environment Efficiency

earth advantage institute
Sustainable Building and Climate Solutions

…and many more

Wood in Green Globes

GREEN GLOBES
BUILDING CERTIFICATION

GREEN GLOBES RATINGS:

Once an assessment is verified by a third party, properties achieving a score of 35% or more receive a Green Globes rating based on the percentage of total points (up to 1,000) achieved.

85-100% FOUR GREEN GLOBES

Demonstrates national leadership and excellence in the practice of water, energy and environmental efficiency to reduce environmental impacts.

70-84% THREE GREEN GLOBES

Demonstrates leadership in applying the best practices regarding energy, water, and environmental efficiency.

55-69% TWO GREEN GLOBES

Demonstrates excellent progress in achieving reduction of environmental impacts and use of environmental efficiency practices.

35-54% ONE GREEN GLOBES

Demonstrates a commitment to environmental efficiency practices

4 tiers, up to 1,000 points possible

Multiple certification types available

Source: *Green Building Initiative*

Wood in Green Globes

Potential points applicable to wood

3.5.1.1 Path A: Performance Path for Building Core and Shell

Athena Impact Estimator for Buildings or other LCA tool used during design to evaluate a minimum of two different core and shell designs, based on life cycle assessment (LCA) in compliance with the assessment guidance and resulting in selection of the building core and shell with the least anticipated environmental impact? IF YES – 33 POINTS

The Athena Impact Estimator for Buildings is an LCA-based software package that helps designers easily incorporate environmental information while in the early stages of a project.

Source: *Green Building Initiative*

Wood in Green Globes

Potential points applicable to wood

3.5.1.2 Path B - % products have third-party sustainable forestry certifications – 20 points max

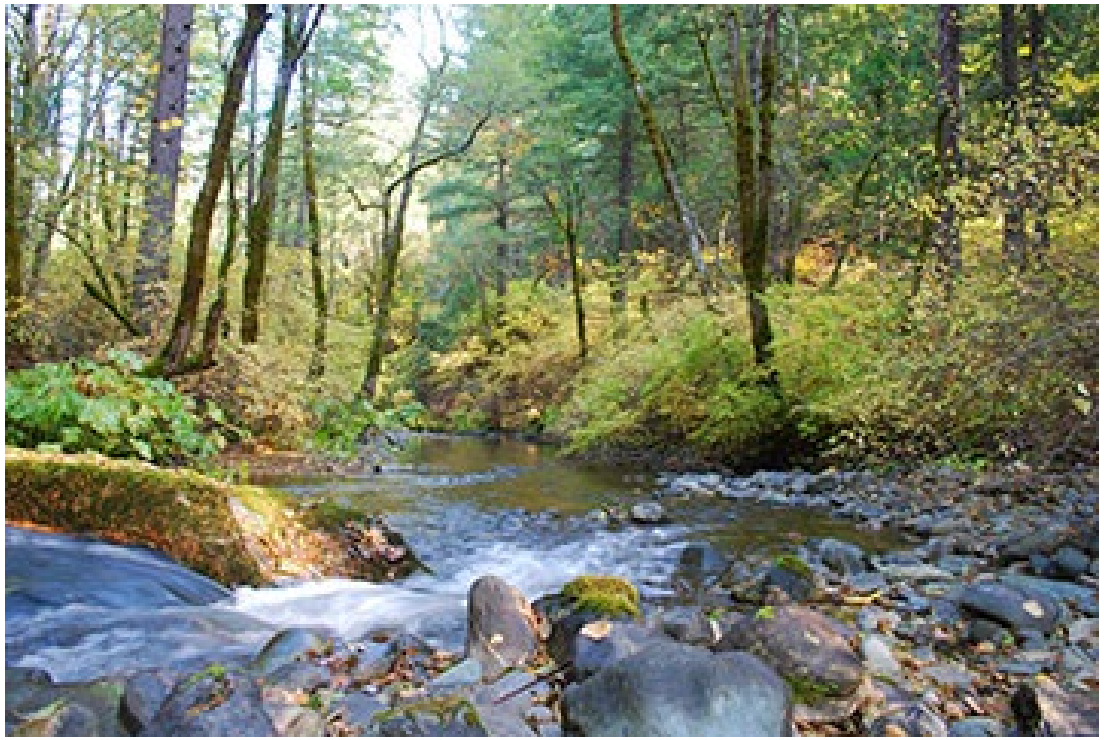
- Canadian Standards Association (CSA)
- Sustainable Forestry Initiative (SFI)
- Forest Stewardship Council (FSC)
- American Tree Farm System (ATFS)

≥ 40% (20 points)

25 - 39% (15 points)

10 - 24% (10 point)

0 - 9% (0 points)



Source: *Green Building Initiative*

Photo: Sustainable Forestry Initiative

Wood in LEED

Source: *USGBC*

Wood in LEED

Point Distribution in LEED v4 & v4.1 New Construction (NC)

Credit Category	Max Points
Integrative Process	1
Location and Transportation	16
Sustainable Sites	10
Water Efficiency	11
Energy and Atmosphere	33
Materials and Resources	13
Indoor Environmental Quality	16
Innovation	6
Regional Priority	4
Total	110

Primary areas of points related to use of wood

Source: *USGBC*

Wood in LEED
V4 & v4.1

The use of wood products can contribute up to 12 points, accounting for more than 10 percent of LEED v4's total credits.

According to USGBC's *Industry Materials Brief on Forest Products*, the "use of wood as a building material is among the most highly incentivized strategies in LEED."

Oregon Zoo Education Center, Opsis Architecture, Photo: Christian Columbres

Source: Barbara Horwitz-Bennett & *USGBC*

Wood in LEED
V4 & v4.1

Specifically, wood products qualify for credits in these categories:

1. Materials & Resources: **Building Life-Cycle Impact Reduction** (up to 5 points). Materials and products with comparatively low environmental impacts fare well in this whole building life-cycle credit.

2. Materials & Resources: **Environmental Product Declarations** (up to 2 points). Many wood EPDs are available.

3. Materials & Resources: **Sourcing of Raw Materials** (up to 2 points). Projects can either specify wood from suppliers and manufacturers with a Corporate Sustainability Report or choose new wood products certified by a Forestry Certification Program (*using the ACP) to contribute toward this credit.

Source: Barbara Horwitz-Bennett & *USGBC*

Wood in LEED
V4 & v4.1

Point Distribution in LEED v4 & v4.1 NC – Materials and Resources – ACP for Certified Wood

WHAT IS AN ACP?

An Alternative Compliance Path allows LEED projects to achieve an existing green building credit, using an alternative approach to what is specified in the existing rating tool.

An ACP pilot is used to test and work out any kinks with the new pathway. If the ACP pilot credit is adopted, it will become part of the LEED rating system.

In order to count towards a LEED point, the user must first know that:

- 100% of the forest products are from legal (non-controversial) sources, and
- 70% from responsible sources, and
- The remainder must be certified sources as evidenced by a chain of custody certification (CoC).

Generates opportunity to use wood products certified to SFI, FSC, ATFS, CSA and PEFC

Source: Sustainable Forestry Initiative

Wood in Living Building Challenge

The Living Building Challenge (LBC) is widely considered the most stringent green building standard in the world. It attempts to emulate a flower by encouraging net-zero or net-positive impact on virtually everything the built environment touches. Its requirements are categorized under seven petals:

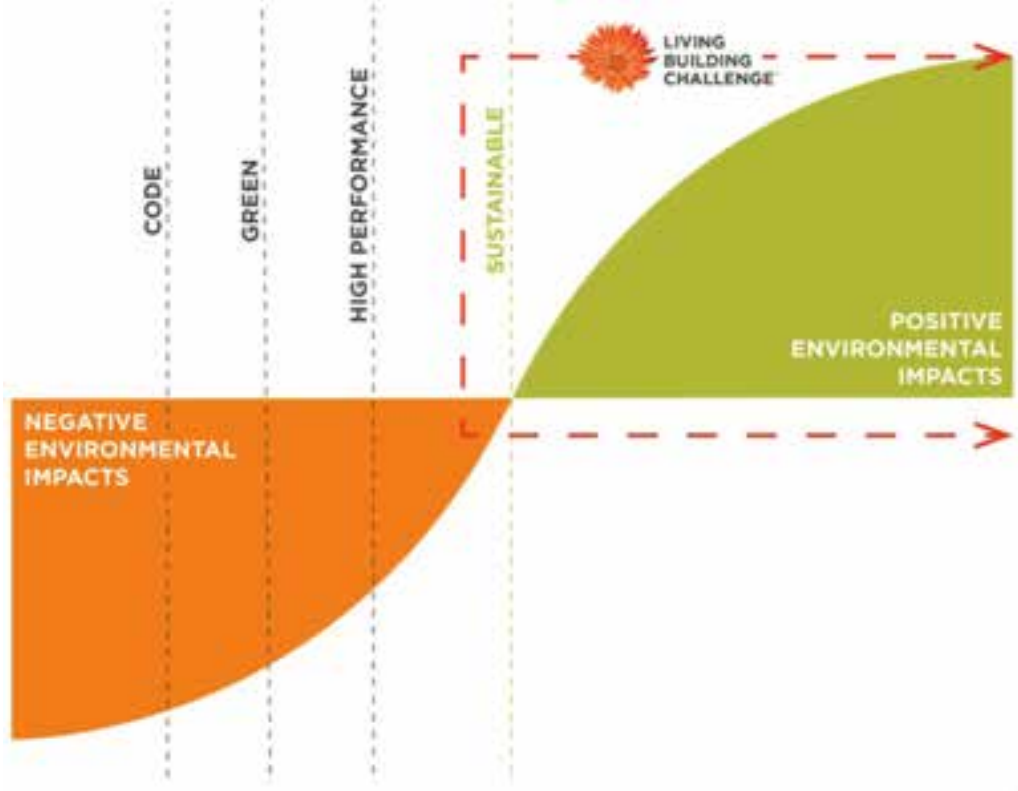
1. Place
2. Water
3. Energy
4. Health
5. Materials
6. Equity
7. Beauty

Source: *ILFI*

Wood in Living Building Challenge

LIVING BUILDING CHALLENGE

Through detailed “imperatives” within each petal, LBC leaves little wiggle room. Everything is a prerequisite, unlike in LEED, where project teams can choose among credits.



Source: *ILFI*

Wood in Living Building Challenge

Projects can be ‘Petal Certified’ but can also extend to:

- Net Zero Energy Building
- Zero Carbon
- Living Community
- Petal Community

Many of the LBC petal-certified projects completed to date have implemented the use of wood and timber framing to meet the Materials Petal Imperatives

Source: *ILFI*

Wood in Living Building Challenge

R.W. Kern Center, Amherst, MA

- 17,000 SF
- Glulam frame with T&G decking
- The building is self-sustaining—generating its own energy, capturing its own water, and processing its own waste

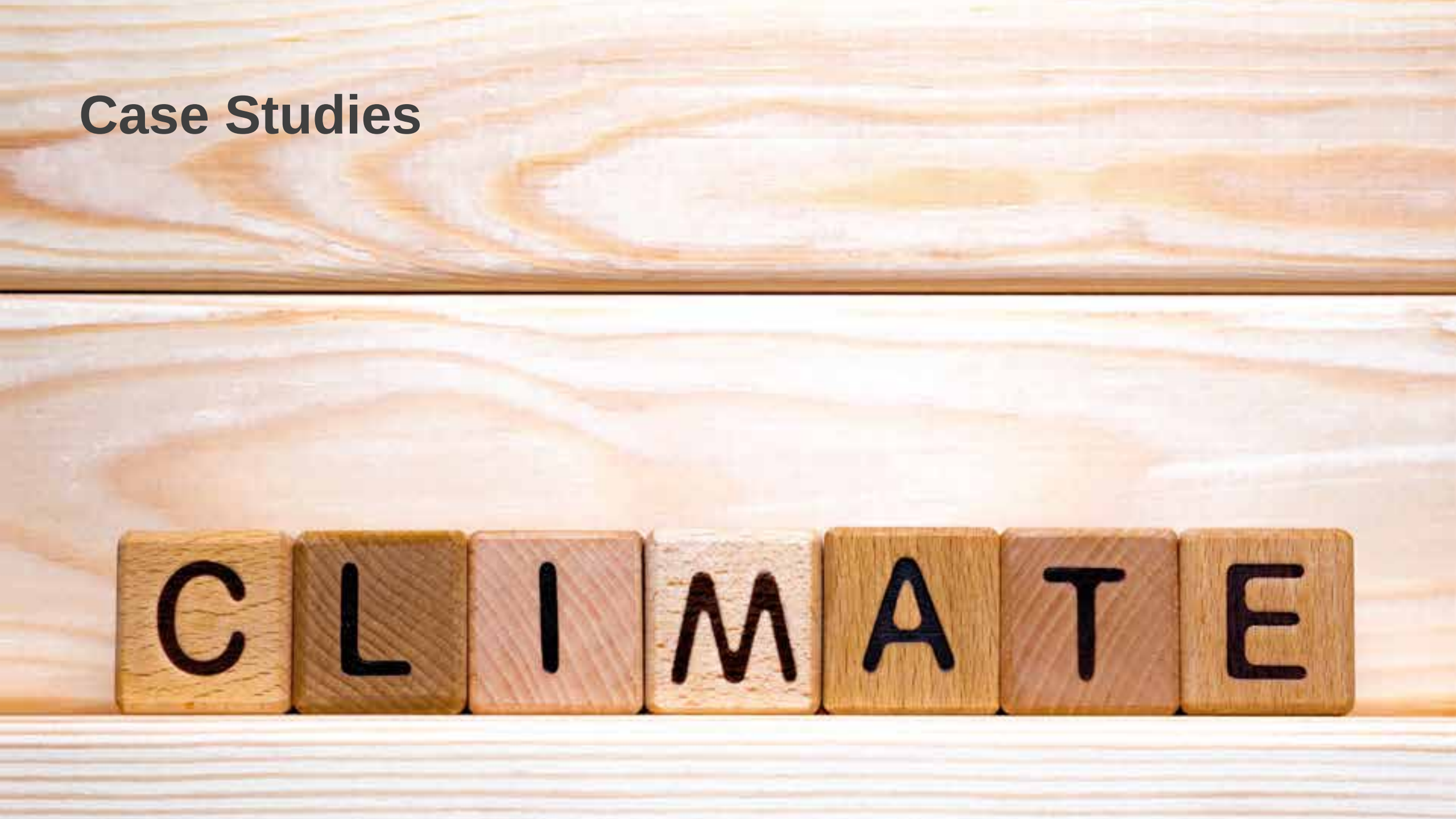
Architect: Bruner/Cott & Associates
Photos: Robert Benson Photography

Whole Building LCA Tools
Detailed LCA Analysis

		Acceptability for Green Building Credits/ Certificates			
WBLCA Tool	**Analysis**	**LEED v4 credits**	**LEED v4.1 credits**	**ILFI Zero Carbon Certificate**	**Green Globes**
Athena Impact Estimator for Buildings	Detailed robust WBLCA	Yes	Yes	Yes	Yes
Tally	Detailed robust WBLCA	Yes	Yes	Yes	Yes
One-Click LCA	WBLCA w/ regionalized generic data & global EPD library	Yes	Yes	Yes	Yes

WoodWorks LCA Expert Tip: https://www.woodworks.org/resources/calculating-the-embodied-carbon-of-different-structural-systems/

Case Studies



Bullitt Center
Seattle, WA

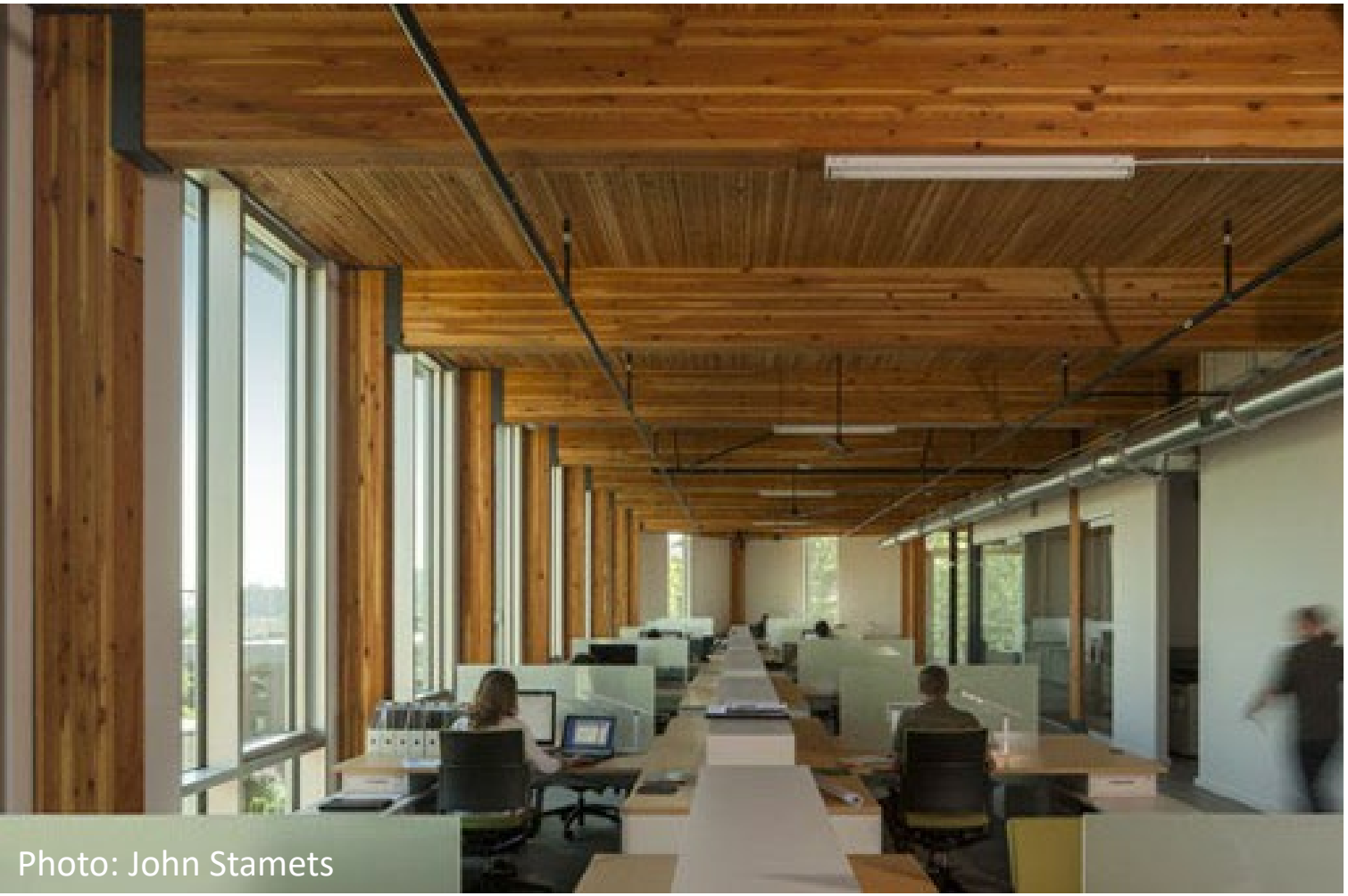


Photo: John Stamets

Architect: The Miller Hull Partnership
Structural Engineer: DCI Engineers

IV (HT)

- Designed for a **250-year** life span
- Met criteria for **Living Building Challenge 2.0**
- Rooftop photovoltaic cells generate electricity for the building; building recycles its own water
- 6 over 2 design; 52,000 sf
- Heavy timber frame: glulam and NLT panels

Bullitt Center
Seattle, WA

Volume of wood used:
24,526 cubic feet

U.S. and Canadian forests grow this much wood in:
2 minutes

Carbon stored in the wood:
545 metric tons of CO_2

Avoided greenhouse gas emissions:
1,158 metric tons of CO_2

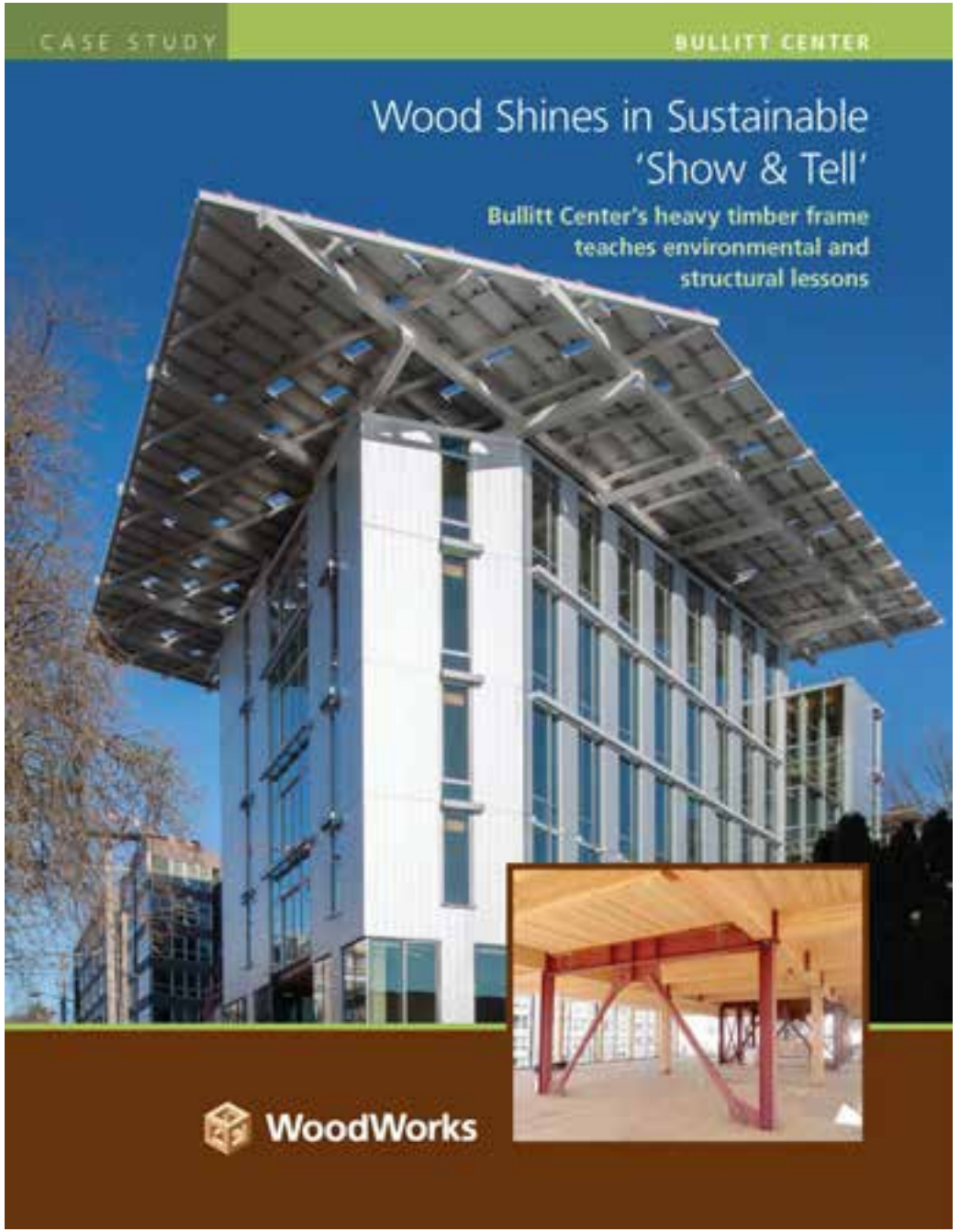
TOTAL POTENTIAL CARBON BENEFIT:
1,703 metric tons of CO_2

EQUIVALENT TO:

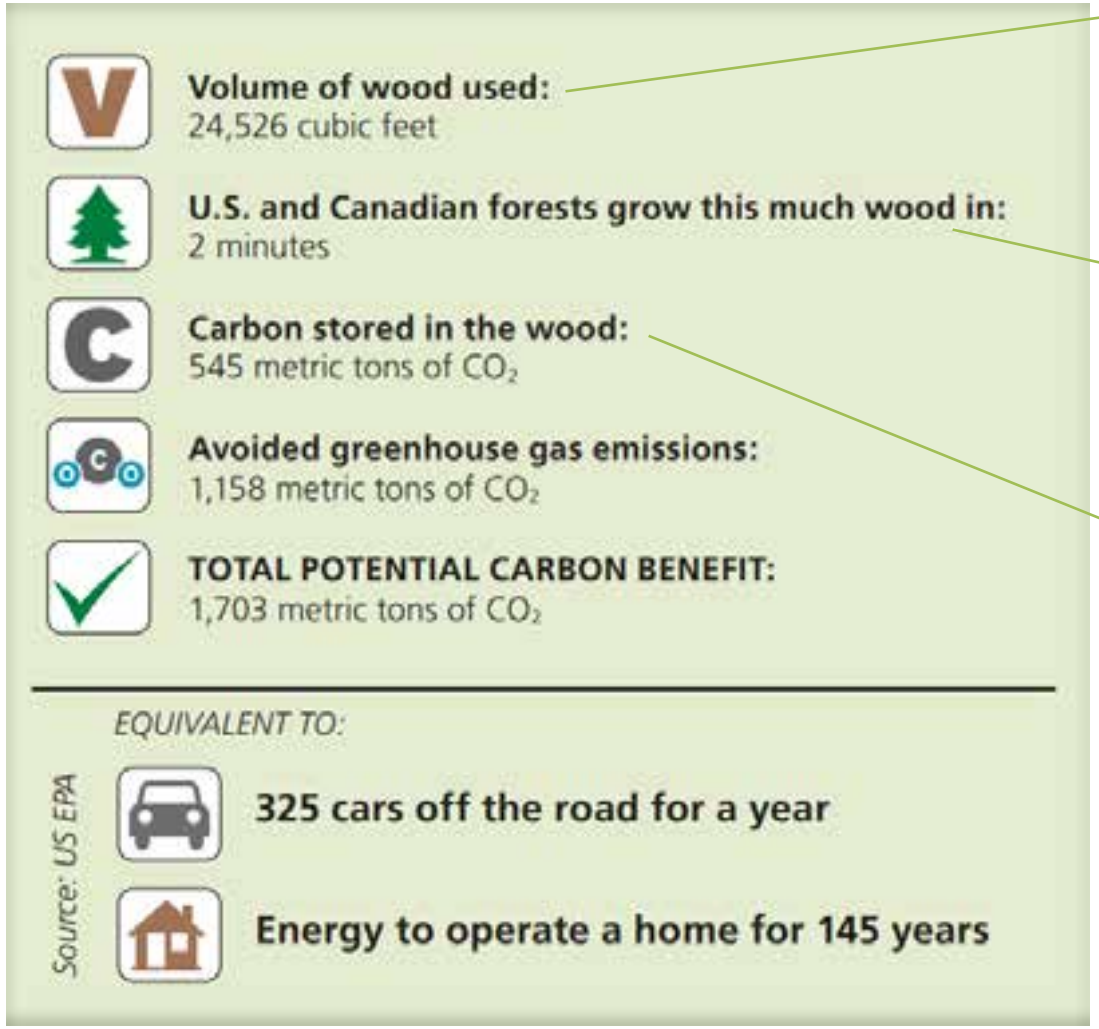
325 cars off the road for a year

Energy to operate a home for 145 years

Source: US EPA



Bullitt Center
Seattle, WA



Volume of wood:
Based on user inputs

Volume of Wood → Volume of Logs → Volume of Trees → **Tree Growth Rate**

Volume of Wood → Mass of Wood → Mass of Carbon (50% of wood) → **Mass of CO_2** (3.67 x mass of Carbon)

1430 Q
Sacramento, CA

IIIA

- **6 stories of wood + mezzanine** over 2-story concrete podium (IIIA over IA)
- 63,000 square feet
- **First** of its kind in USA
- Needed 6 floors of residential units to make the project viable
- Concrete and steel were too expensive

Architect: HRGA, The HR Group Architects
Structural Engineer: Buehler

1430 Q
Sacramento, CA

Photo: Gary Folkins

1430 Q

Volume of wood products used:
1,708 cubic meters (60,334 cubic feet)

U.S. and Canadian forests grow this much wood in:
5 minutes

Carbon stored in the wood:
1,426 metric tons of CO_2

Avoided greenhouse gas emissions:
3,031 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
4,457 *metric tons of* CO_2

EQUIVALENT TO:

942 cars off the road for a year

Energy to operate 471 homes for a year

Source: US EPA

Estimated by the Wood Carbon Calculator for Buildings, based on research by Sarthre, R. and J. O'Connor, 2010, A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, FPInnovations. Note: CO_2 on this chart refers to CO_2 equivalent.

Crescent Terminus
Atlanta, GA

Project Architect: Lord Aeck Sargent
Structural Engineer: SCA Consulting Engineers

IIIA

- 5 stories wood over 3 stories of concrete parking (Type IA podium)
- Savings by using wood could be spent on **luxury amenities**
- Dedication to **sustainable investments**
- Flexibility in design
- **Rooftop gardens** supported by wood trusses

Crescent Terminus
Atlanta, GA


Photo: Crescent Communities

Volume of wood products used:
3.1 million board feet (equivalent)

U.S. and Canadian forests grow this much wood in:
16 minutes

Carbon stored in the wood:
4,327 metric tons of CO_2

Avoided greenhouse gas emissions:
9,196 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
13,523 metric tons of CO_2

EQUIVALENT TO:

2,583 cars off the road for a year

Energy to operate a home for 1,149 years

Source: US EPA

Estimated by the Wood Carbon Calculator for Buildings, based on research by Sarthre, R. and J. O'Connor, 2010, A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, FPInnovations. Note: CO_2 on this chart refers to CO_2 equivalent.

Project Architect: Lord Aeck Sargent
Structural Engineer: SCA Consulting Engineers

Arena Stage at the Mead Center for American Theater
Washington, DC

Photo: Nic Lehoux

- 200,000 square feet
- First modern structure to use heavy timber in DC
- **Hybrid wood & glass enclosure** around 2 existing historic structures
- Wood columns did **double-duty** to support roof gravity loads *and* façade wind loads
- Exposed wood **saved money** on finishes

Architect: Bing Thom Architects
Base Building Structural Engineer:
Fast+Epp Structural Engineers
Specialty Timber Façade Design-Builder:
StructureCraft Builders, Inc.

Arena Stage at the Mead Center for American Theater

Washington, DC

Bing Thom Architects | Fast + Epp | Photo: Nic Lehoux

Volume of wood used:
8,800 cubic feet of panel and engineered wood products

U.S. and Canadian forests grow this much wood in:
1 minute

Carbon stored in the wood:
215 metric tons of CO_2

Avoided greenhouse gas emissions:
460 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
675 metric tons of CO_2

EQUIVALENT TO:

129 cars off the road for a year

Energy to operate a home for 58 years

Source: US EPA

Estimated by the Wood Carbon Calculator for Buildings, based on research by Sarthre, R. and J. O'Connor, 2010, A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, FPInnovations. Note: CO_2 on this chart refers to CO_2 equivalent.

APEX PLAZA
CHARLOTTESVILLE, VA

187,000 SF

Photo: WoodWorks | Architect: William McDonough + Partners

APEX PLAZA
CHARLOTTESVILLE, VA

8 STORIES
6 TIMBER OVER 2 PODIUM, 100 FT

PRIMARILY OFFICE SPACE

Photo: William McDonough + Partners | Architect: William McDonough + Partners

Forest to Cities

A Systemic Solution in Action

www.ForesttoCities.org

Questions? Ask us anything.

John O'Donald II, PE
Regional Director | VA, DC, DE, MD, WV
(814) 880-5636
john.odonald@woodworks.org

901 East Sixth, Thoughtbarn-Delineate Studio, Leap!Structures, photo Casey Dunn