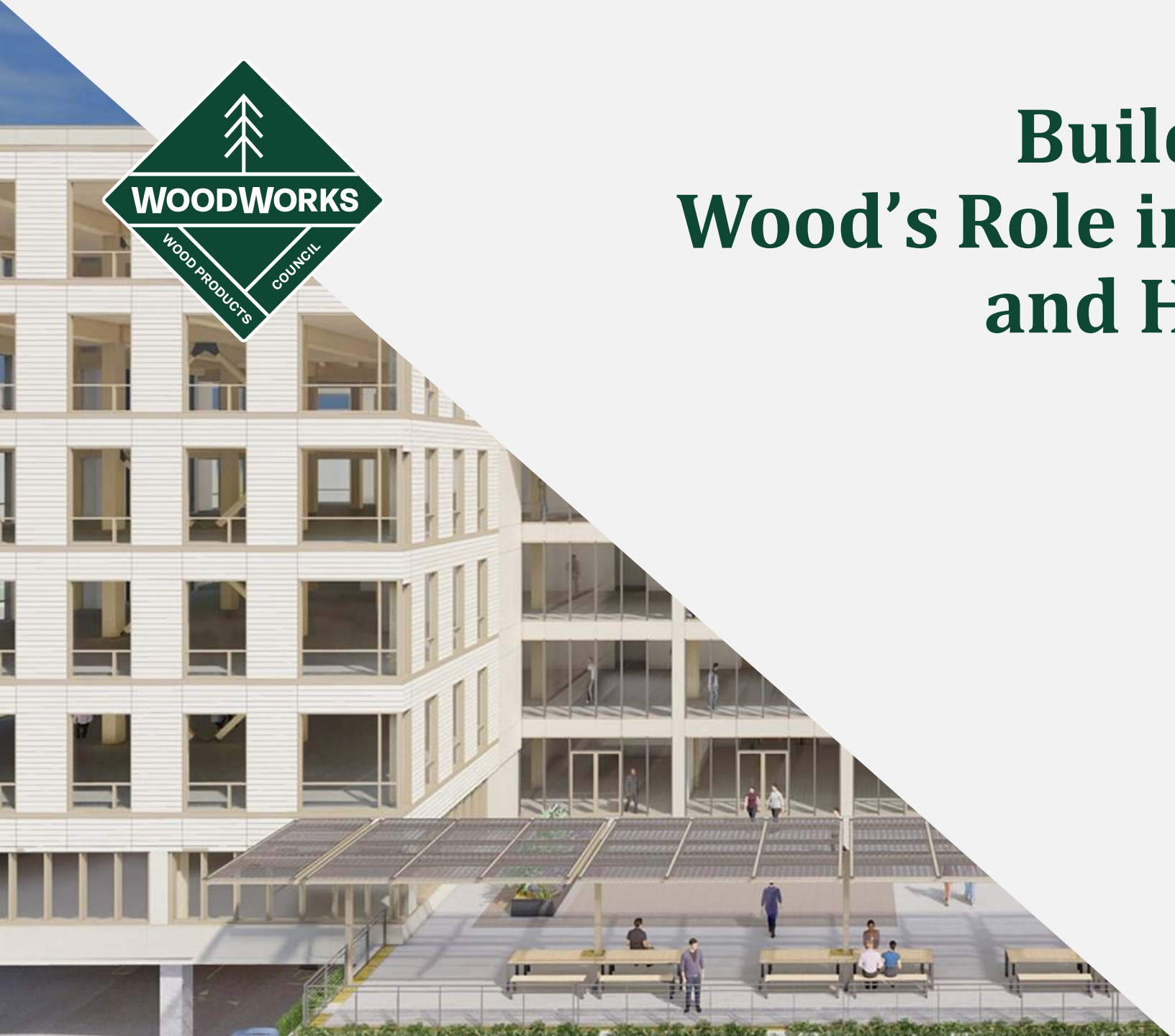

Building Sustainably: Wood's Role in Healthy Forests and Healthy Buildings

August 17, 2023

Presented by
Laura Cullen, PE
WoodWorks

Apex Plaza / Courtesy William McDonough + Partner

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

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

AIA Approved Continuing Education

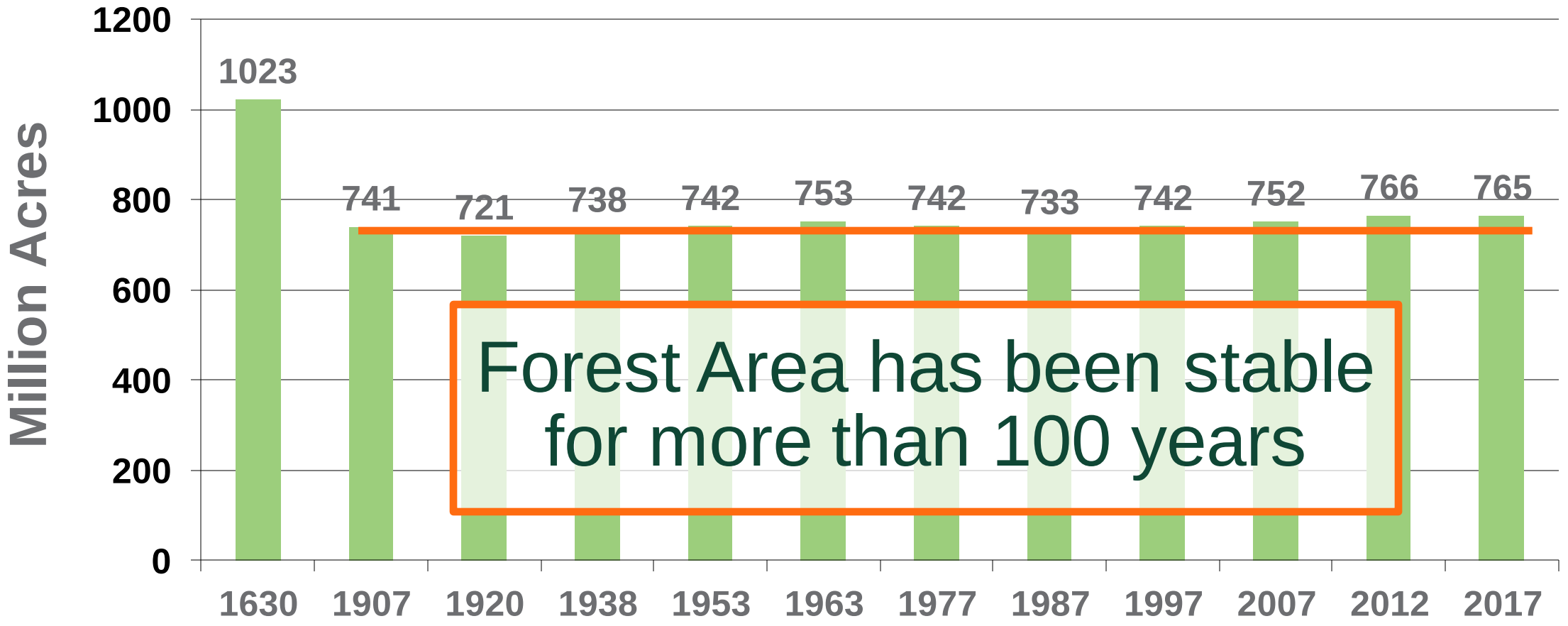

State of Our Forests

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?**

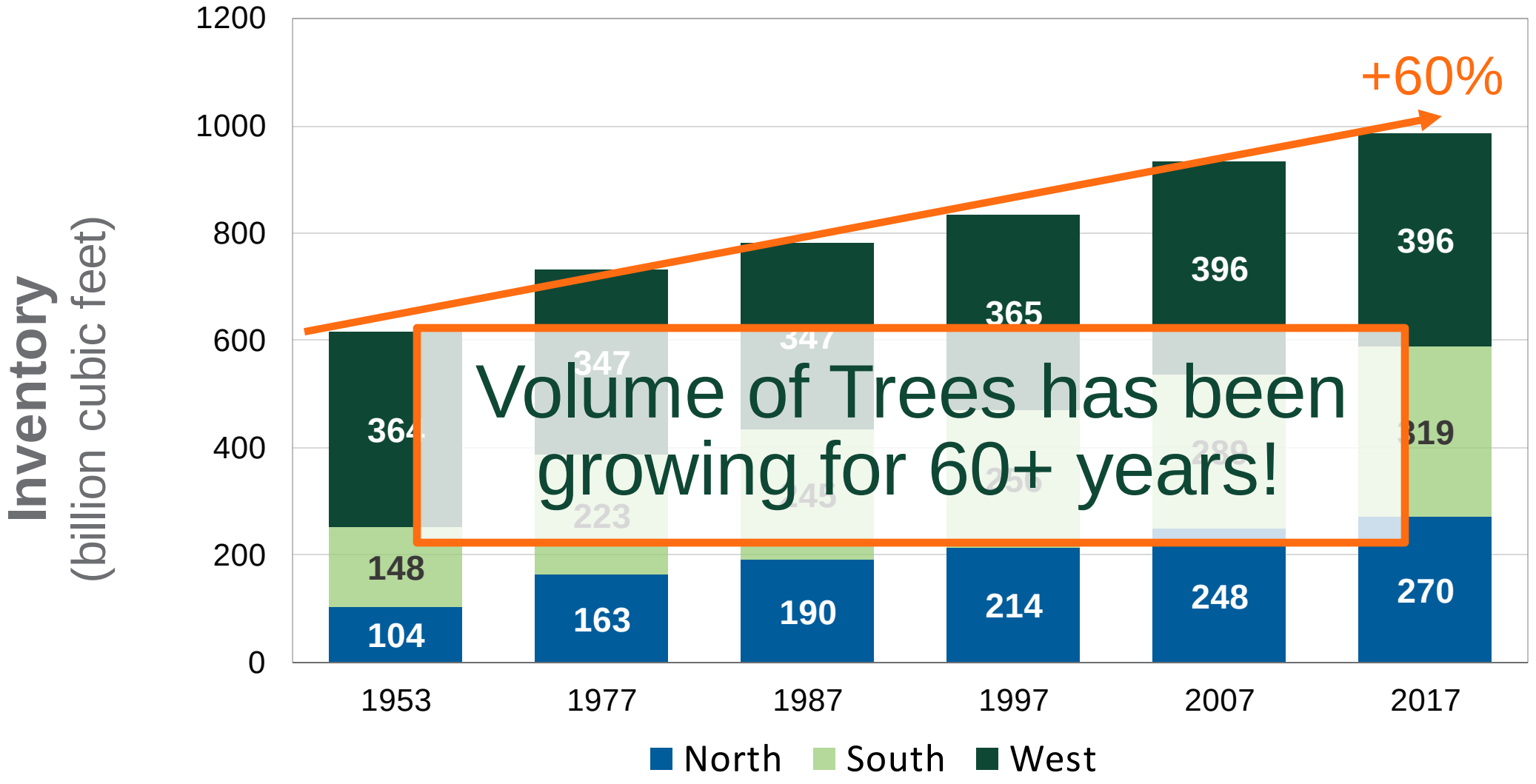
U.S. Forest Land:

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



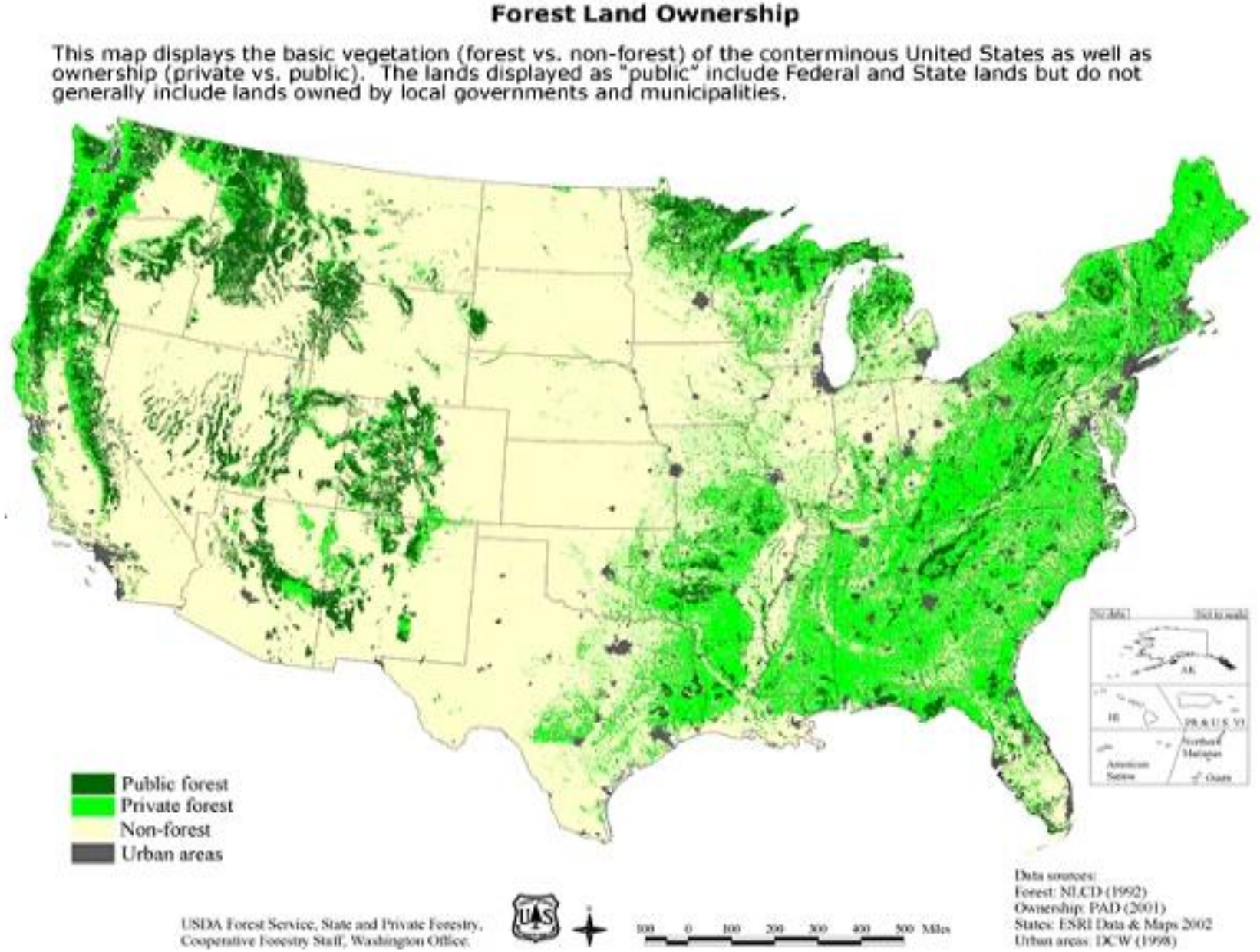
Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

State of our Forests: US Timber Volume on Timberland

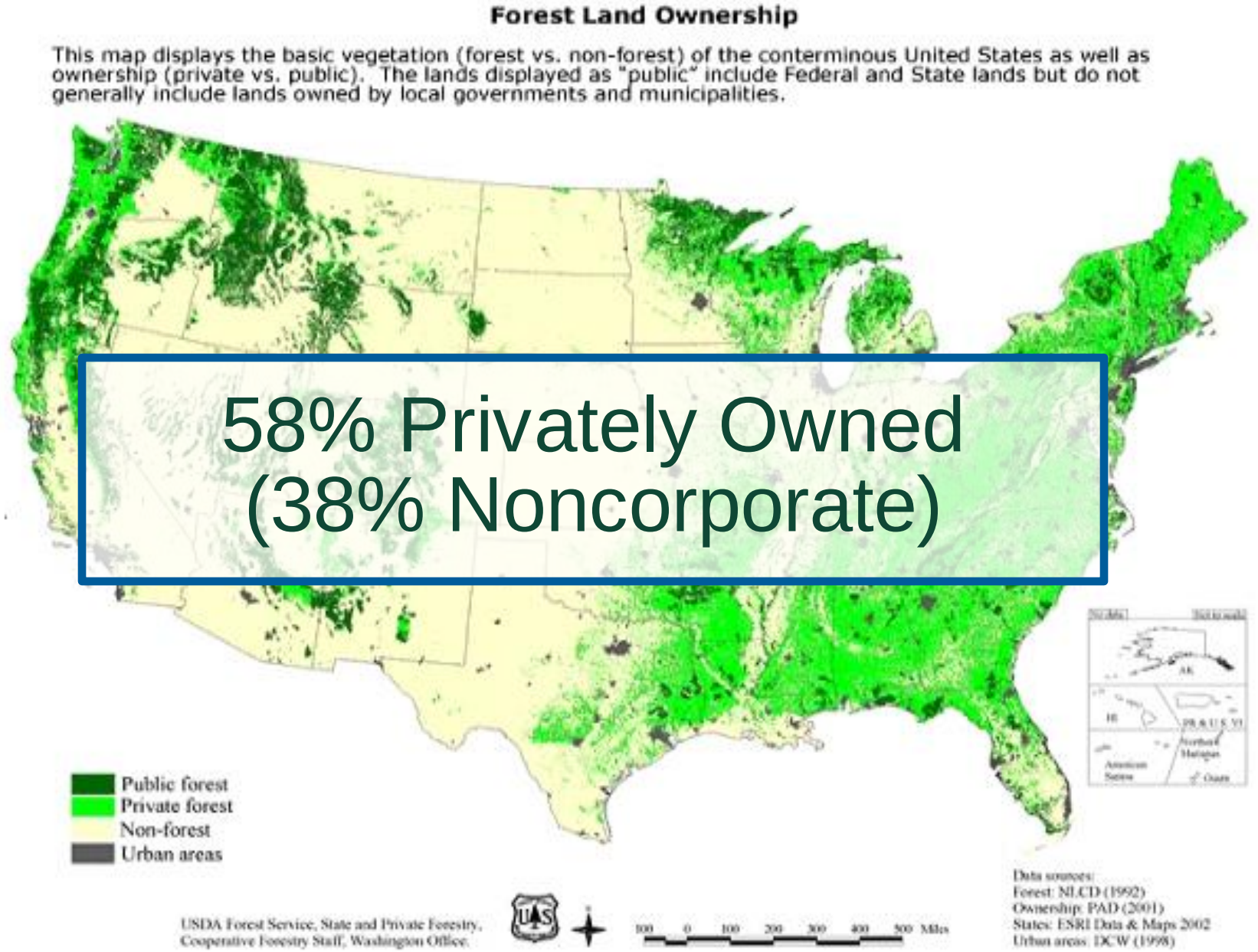


Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

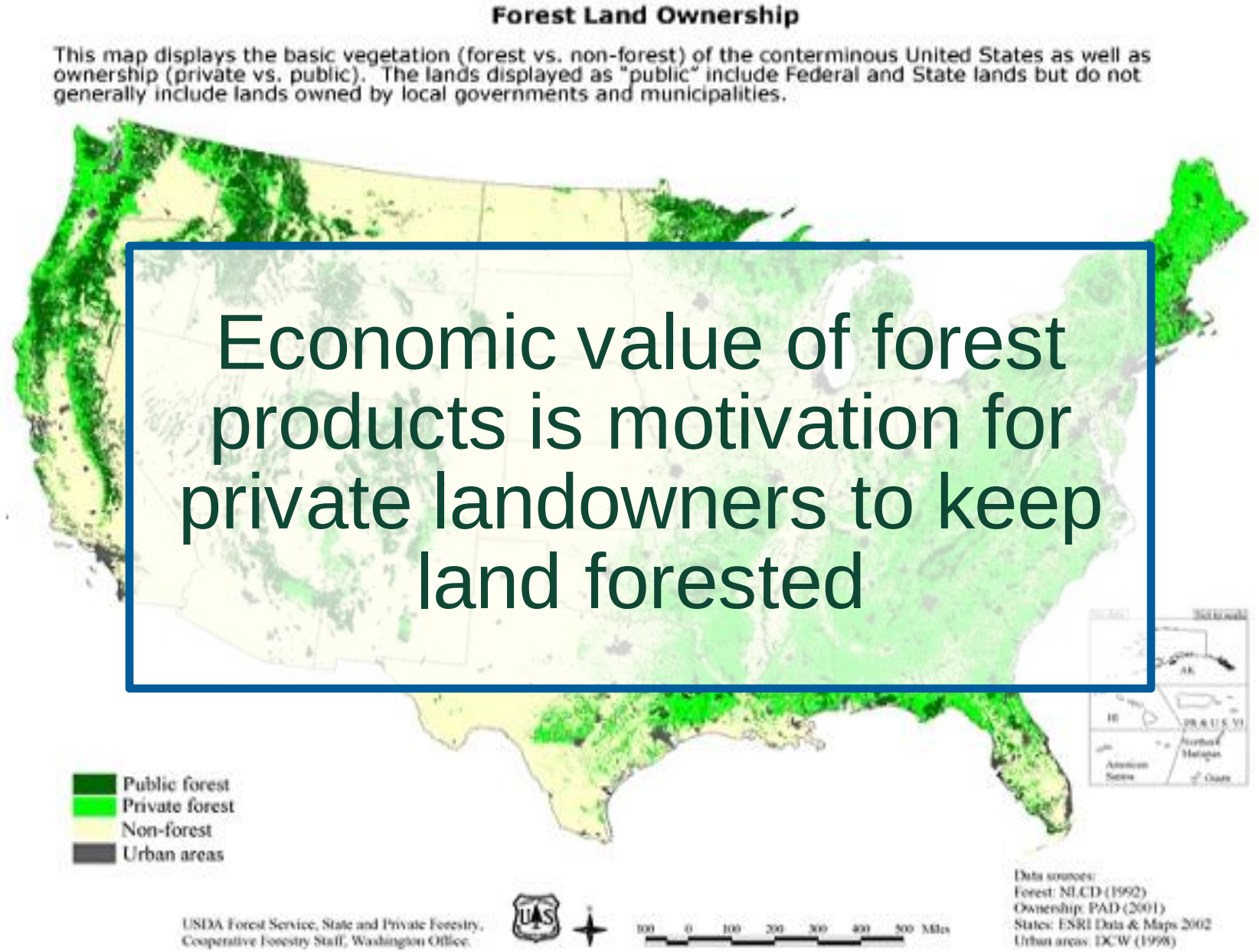
US Forest Lands



US Forest Lands

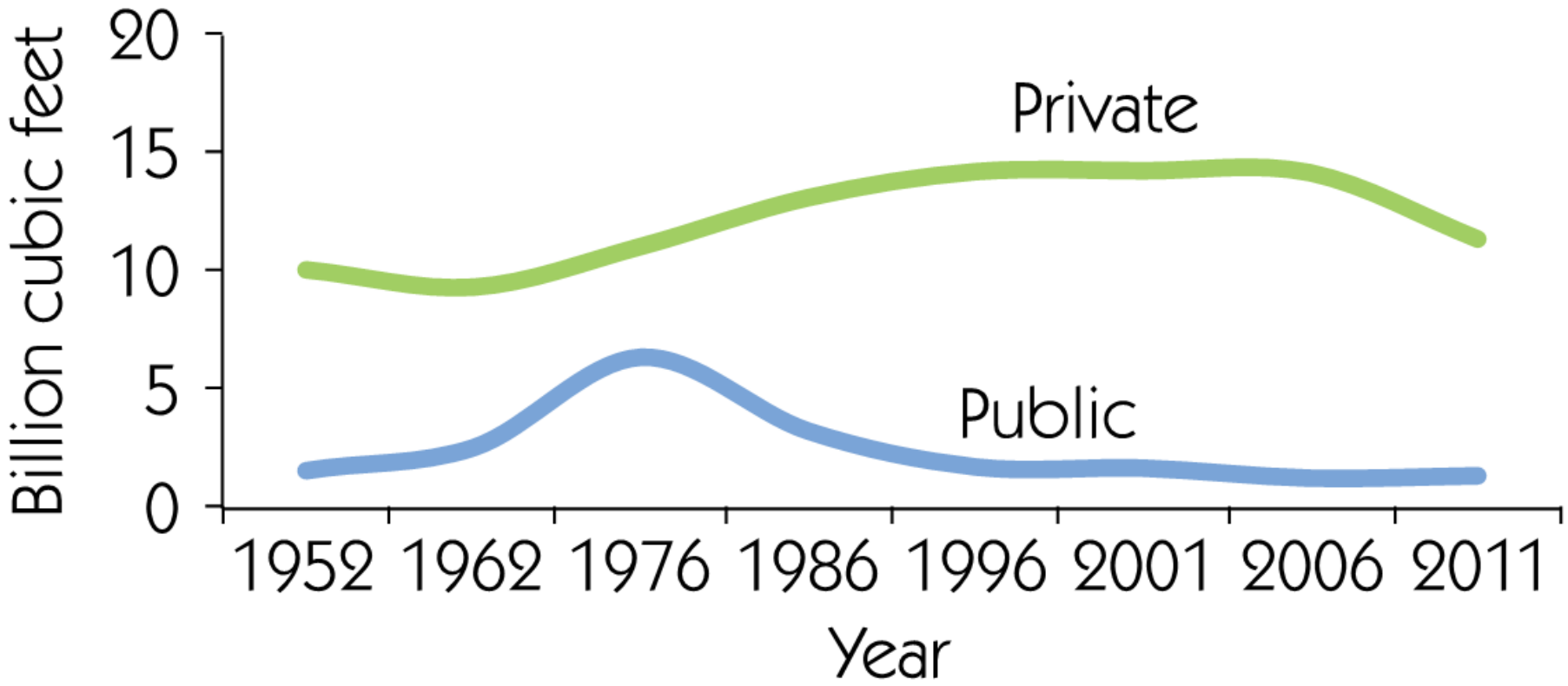


US Forest Lands



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

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

FSC | SUSTAINABLE FORESTRY INITIATIVE SFI-01569 | PEFC PEFC/01-4-16 | WOOD WATER RECREATION WILDLIFE CERTIFIED FAMILY FOREST

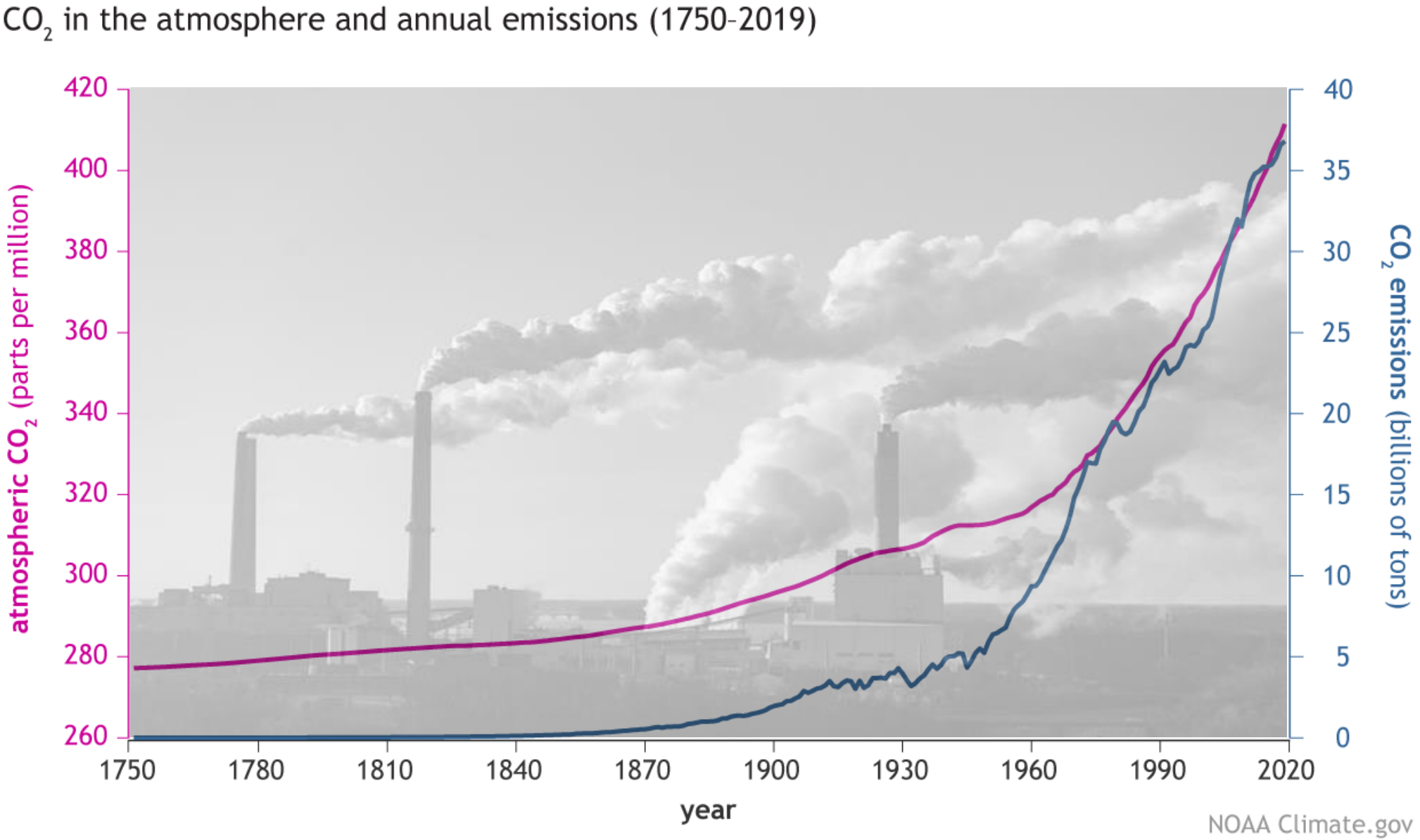
Similarities:

- 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

Climate Change Background

Rising Temperatures and Melting Glaciers

Carbon & Greenhouse Gas Emissions



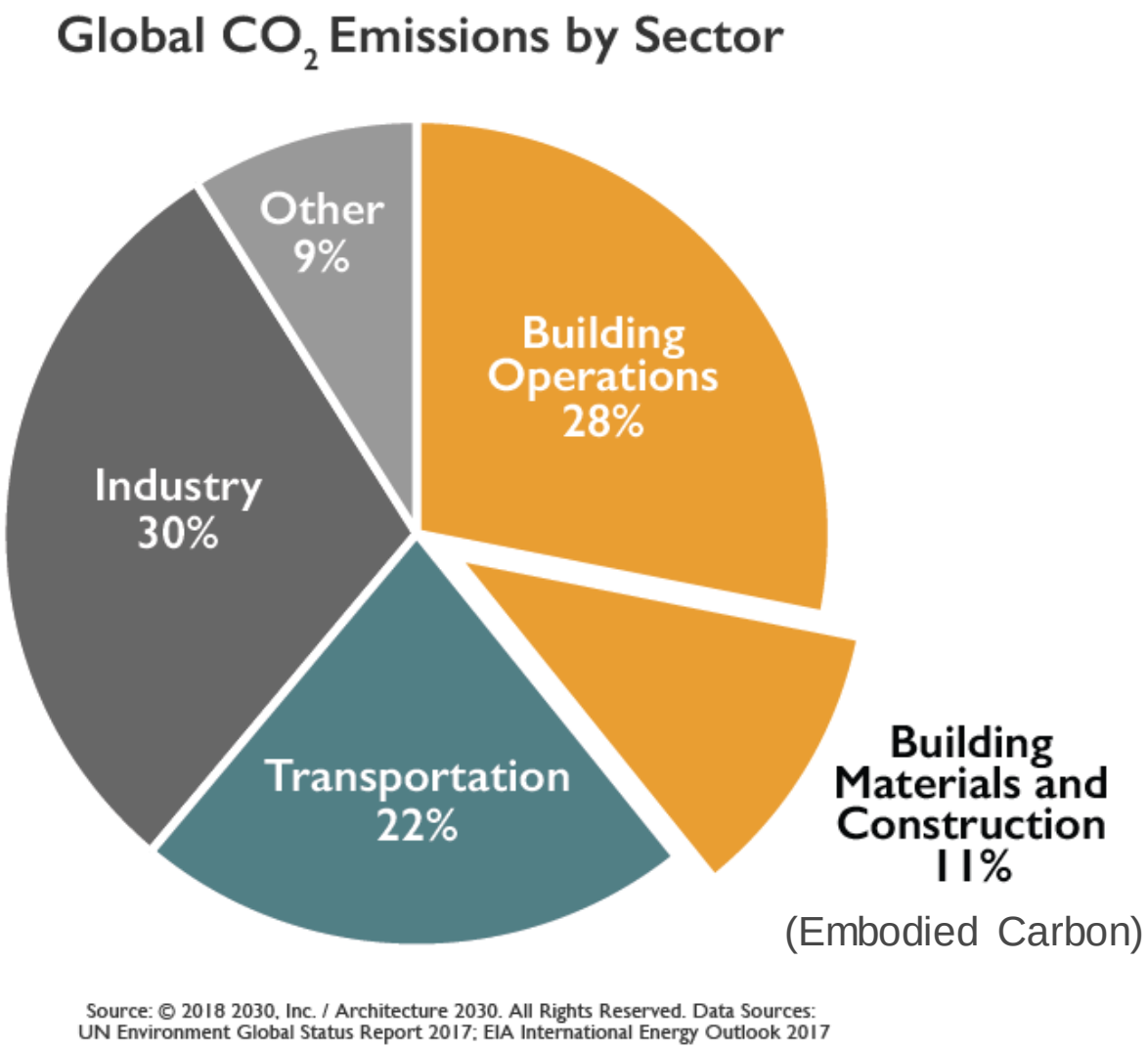
Global Population Increase

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 carbon: **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

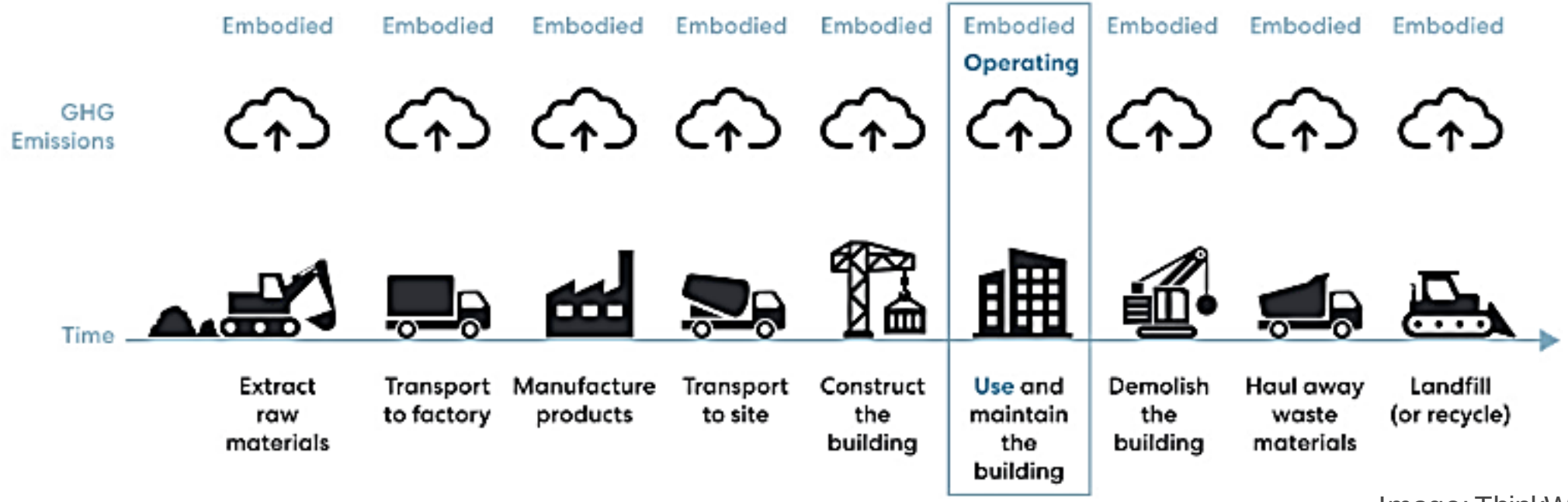


Image: ThinkWood

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*

* Sequestered carbon may be included in embodied carbon calculation or considered separately.

Embodied vs. Operational Energy

Traditional Non-Wood Building

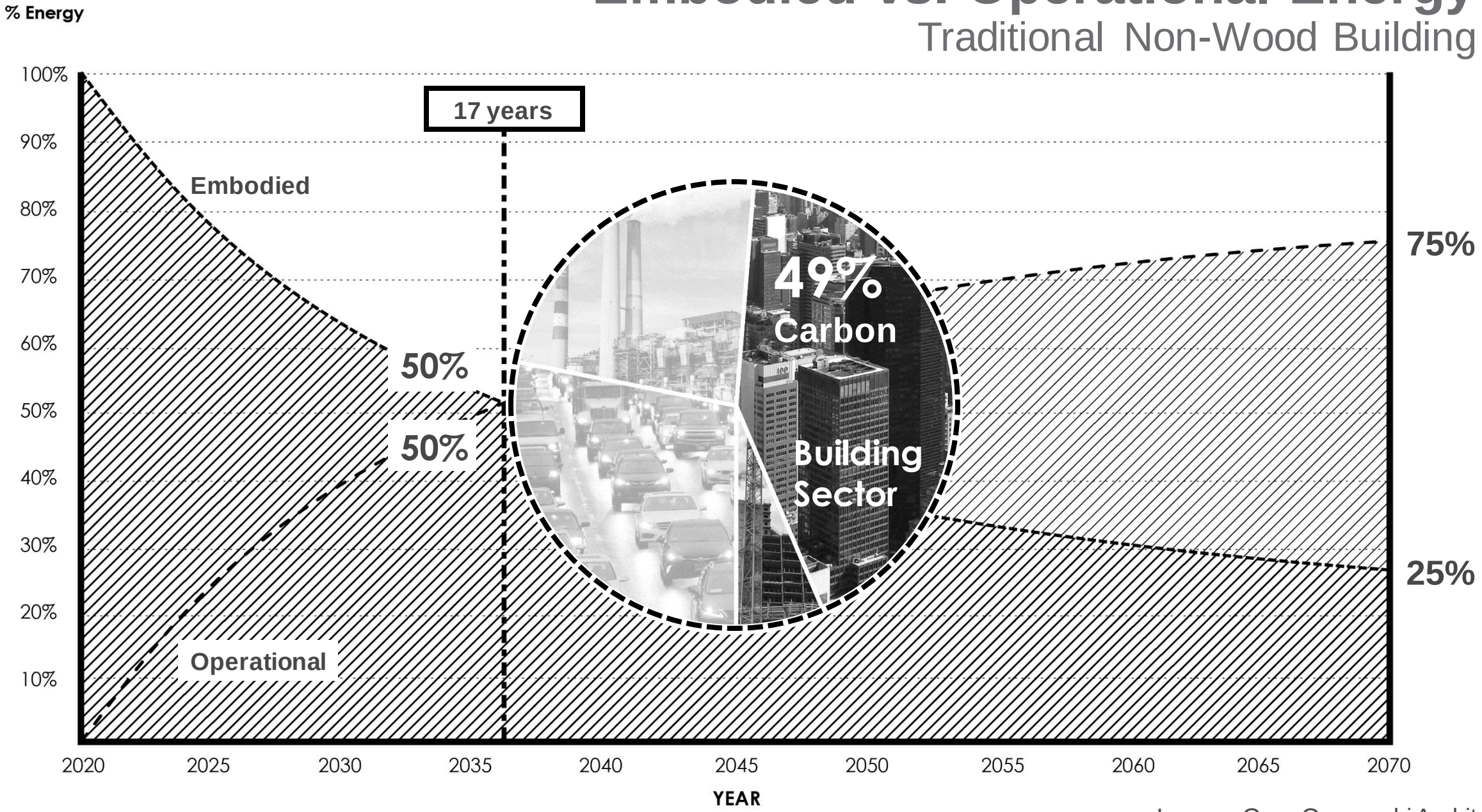
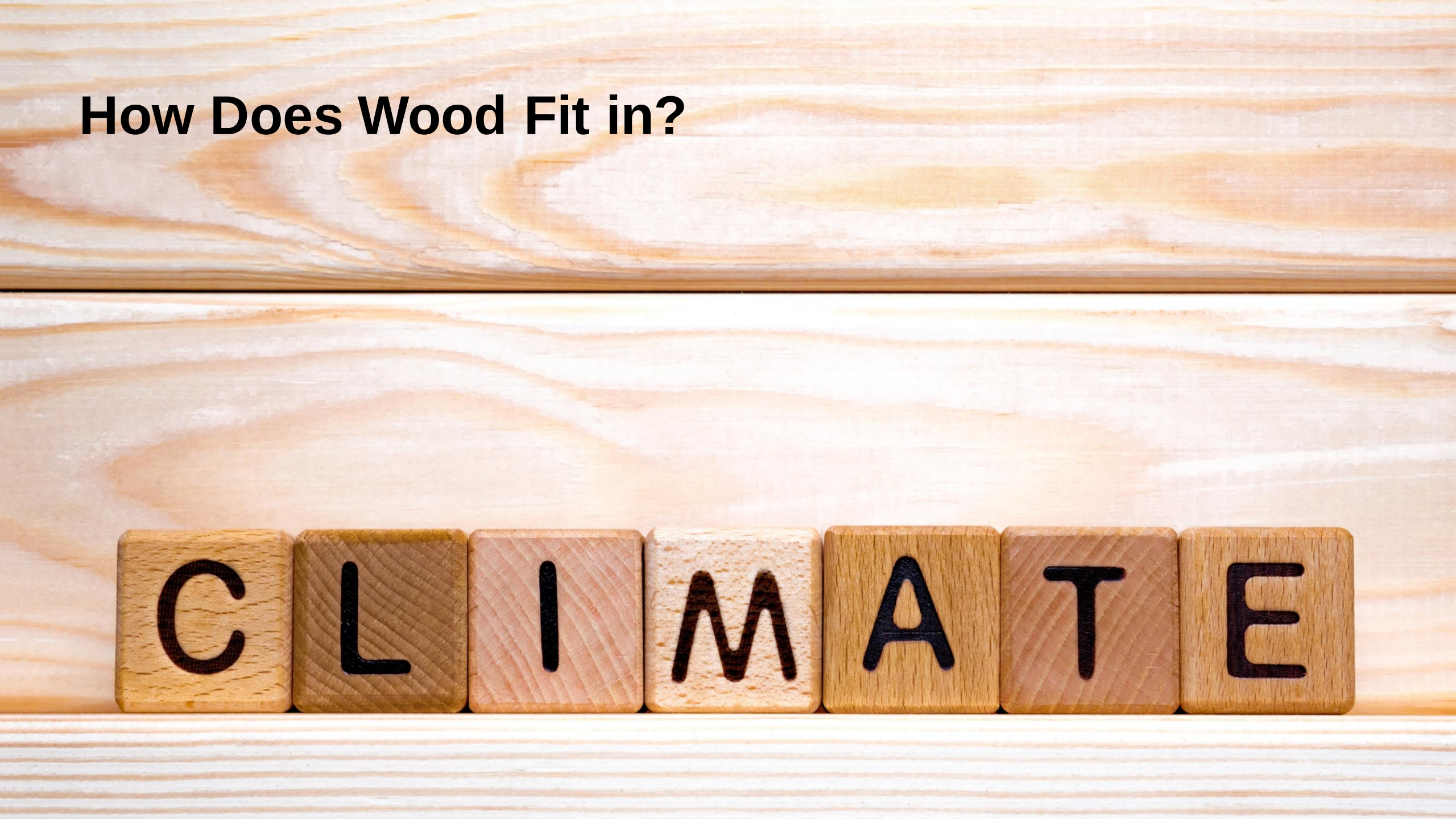


Image: Gray Organschi Architecture

How Does Wood Fit in?



Carbon Benefits of Wood

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

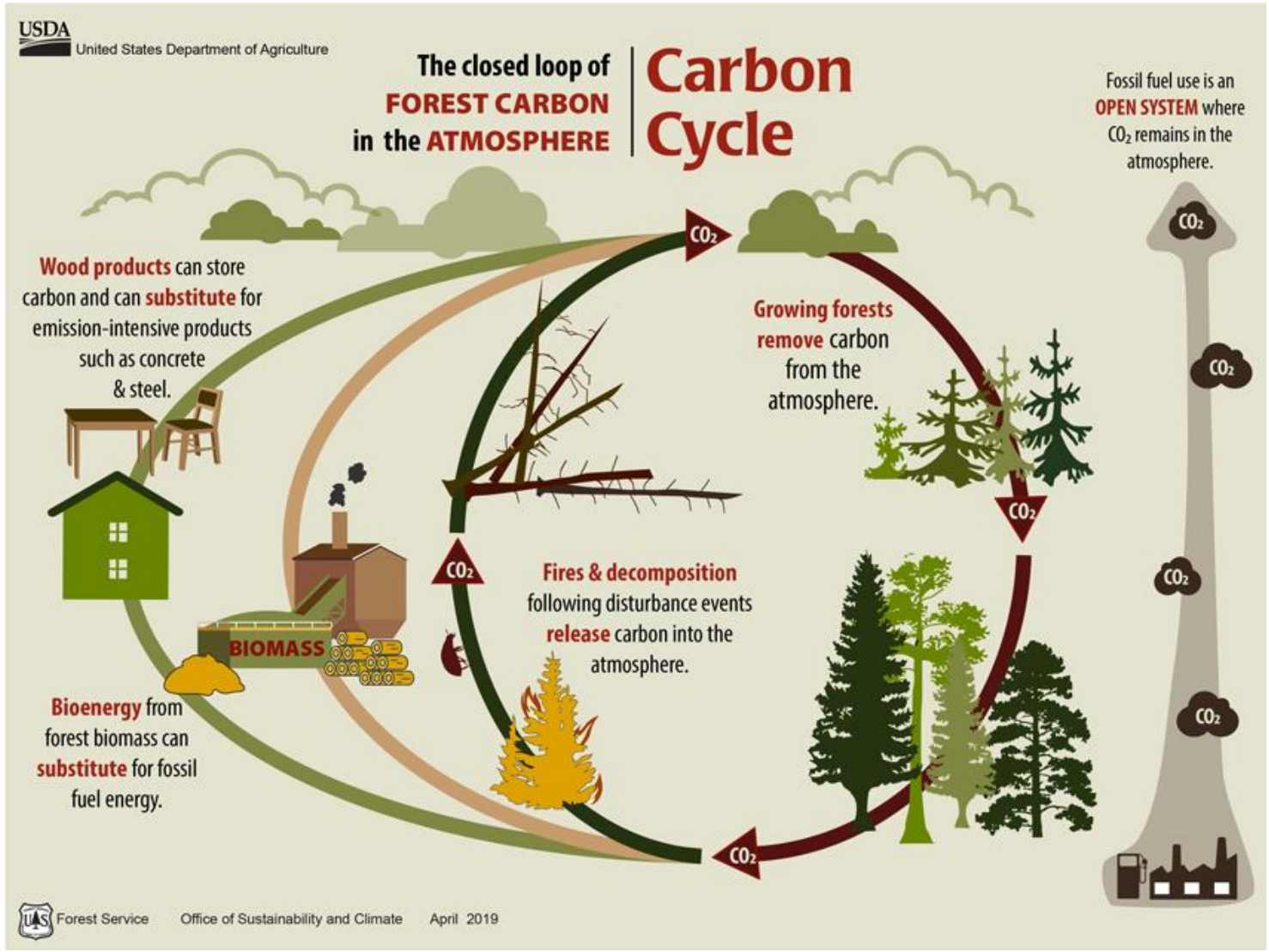


Image: USDA US Forest Service

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**.

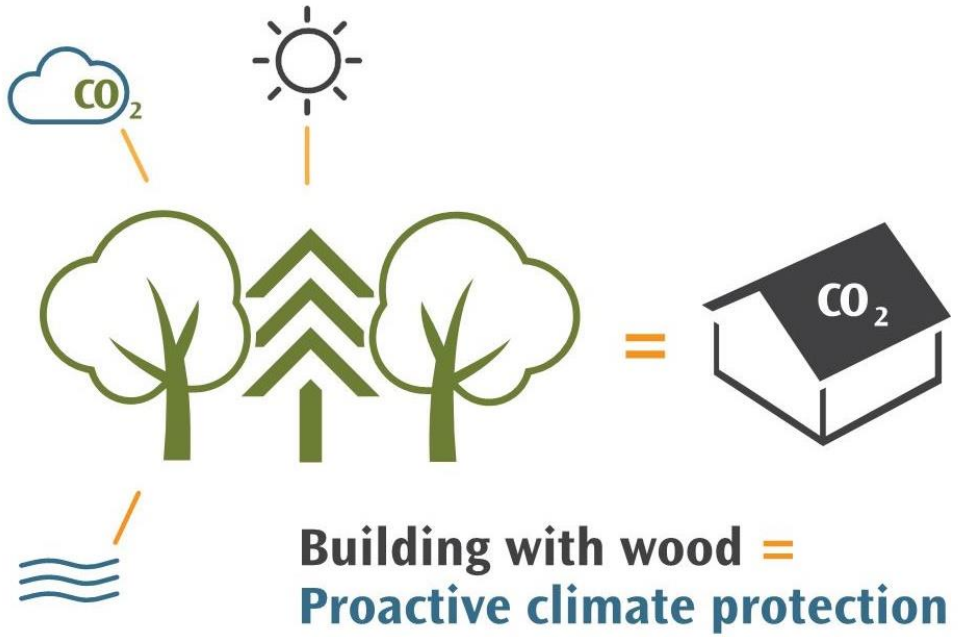


Image: Dovetail Partners, Inc.

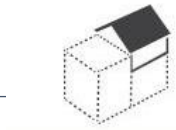
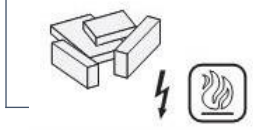
Carbon Storage

Wood ≈ 50% Carbon (dry weight)

Image: Kaiser + Path

Image: Lever Architecture

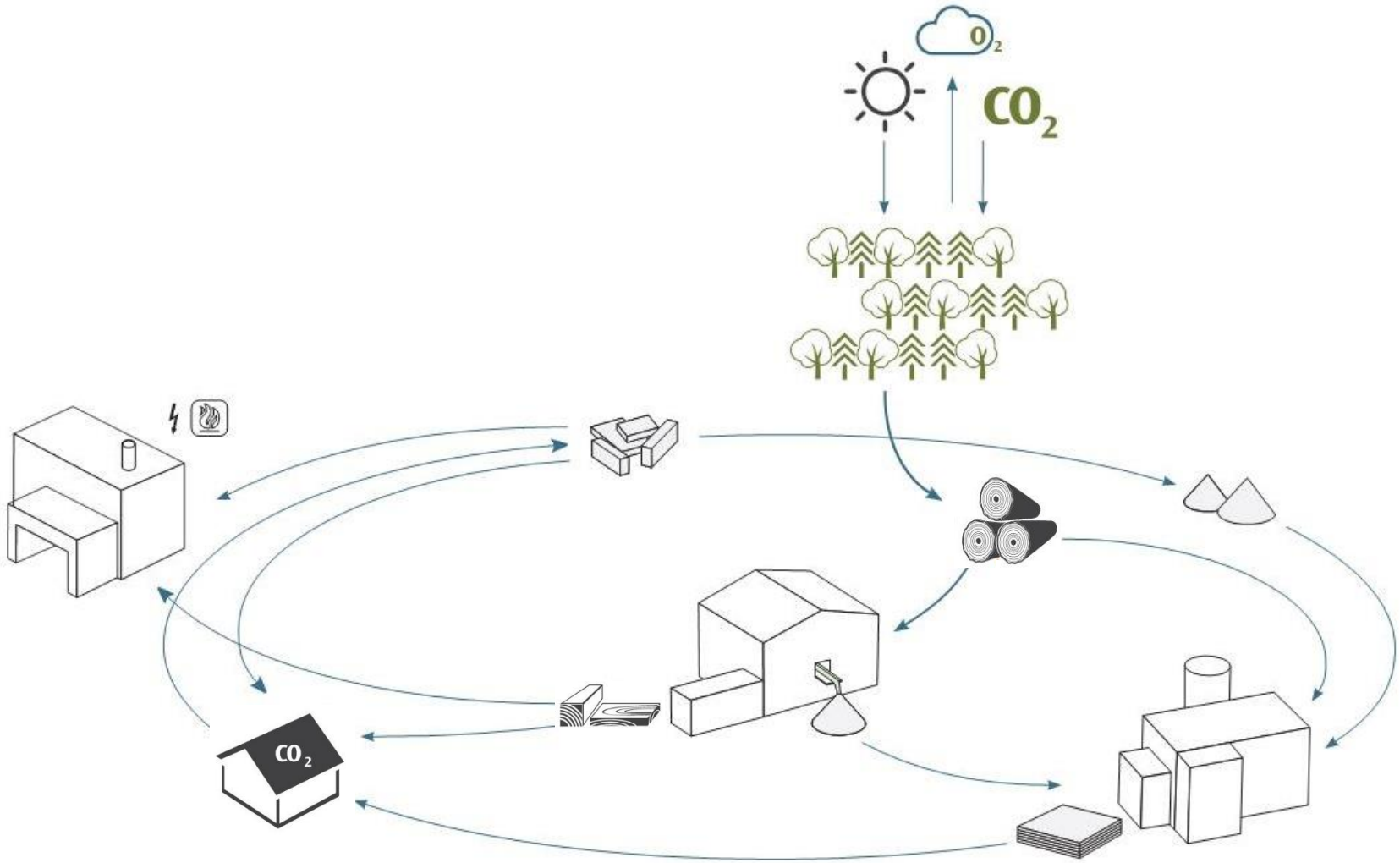
Long-Term Positive Effects

		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**

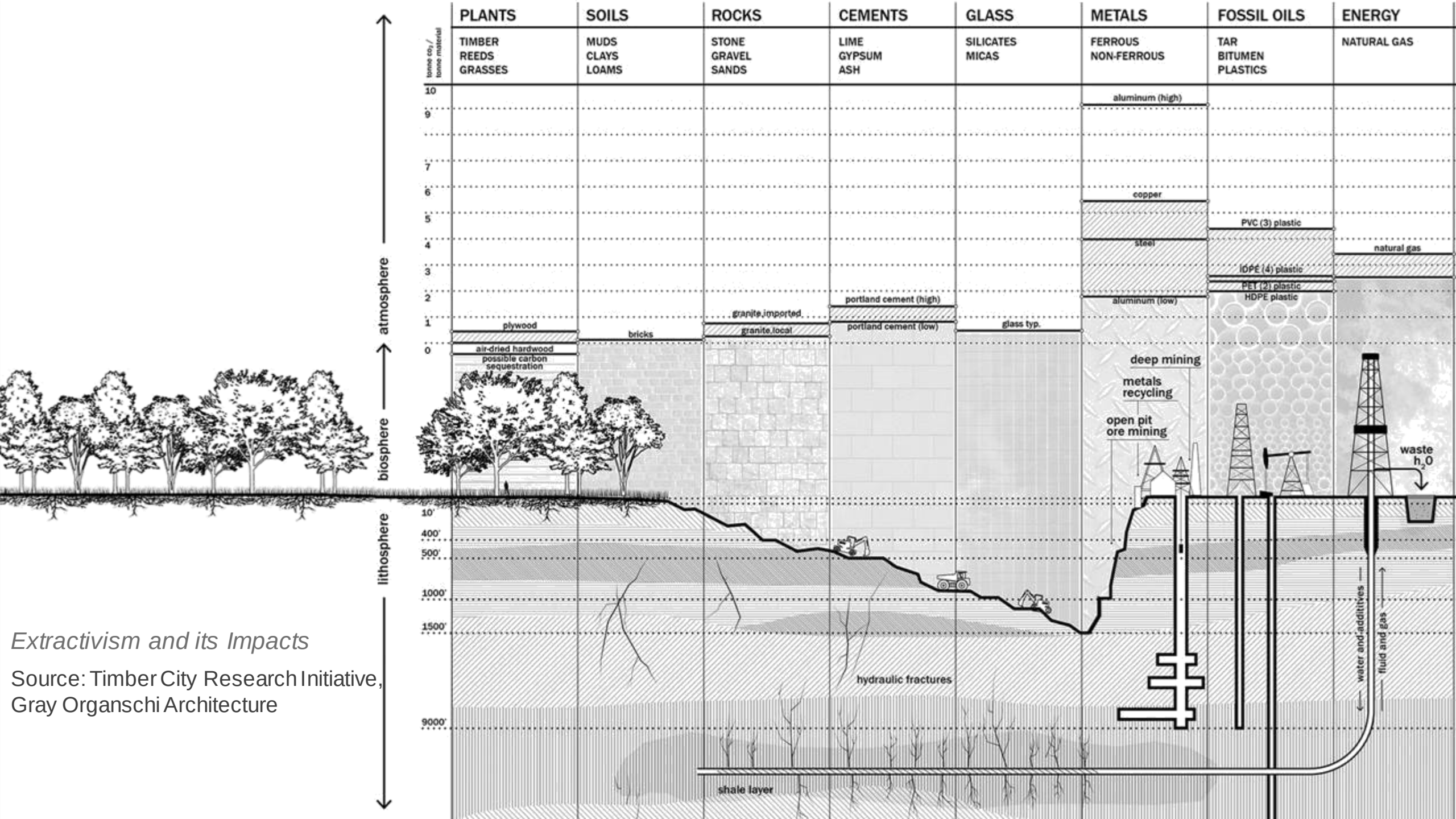
Source: Building with Wood – Proactive Climate Protection, Dovetail Partners, Inc.

Carbon Cycle

Renewable Resource | Carbon Sequestration



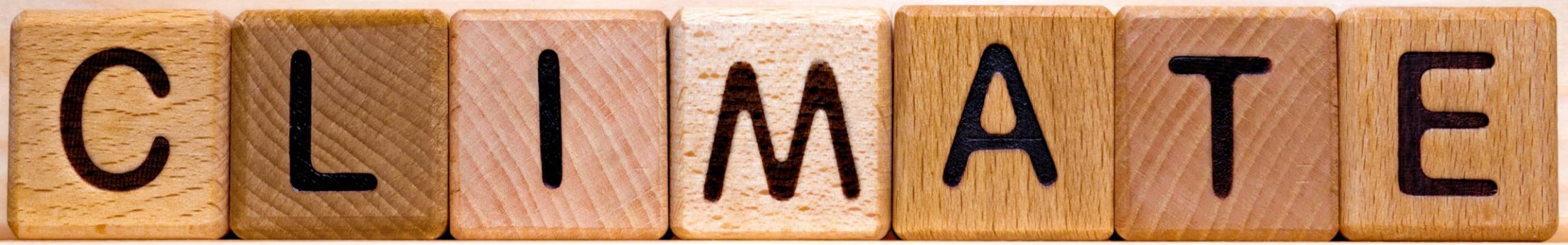
Source: Building with Wood – Proactive Climate Protection, Dovetail Partners, Inc.



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

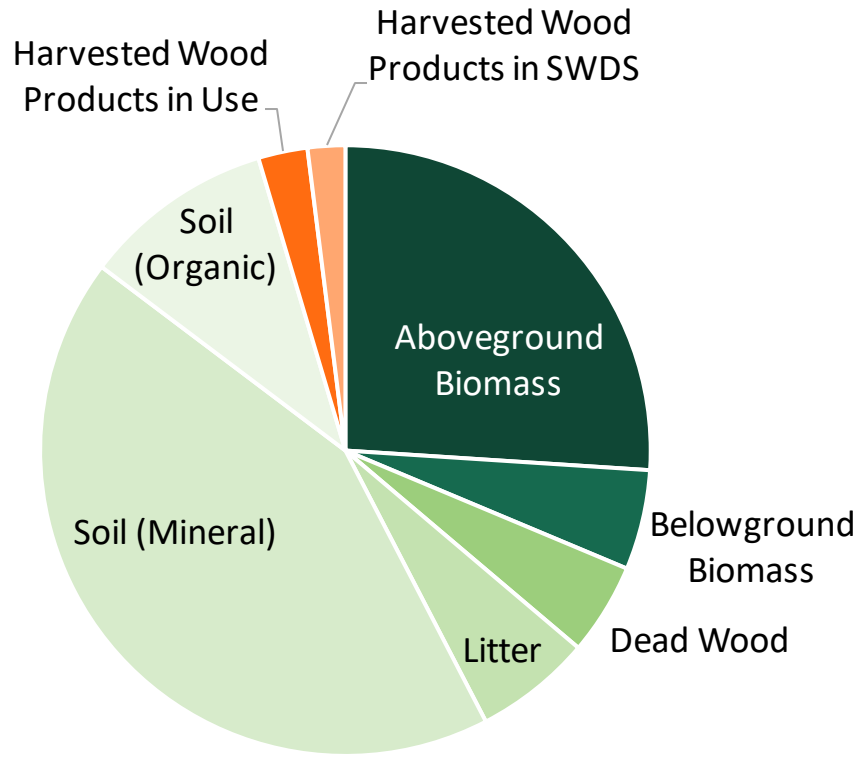
- Aboveground Biomass
- Belowground Biomass
- Dead Wood
- Litter or Forest Floor
- Soil Organic Carbon

Image: naturallywood.com

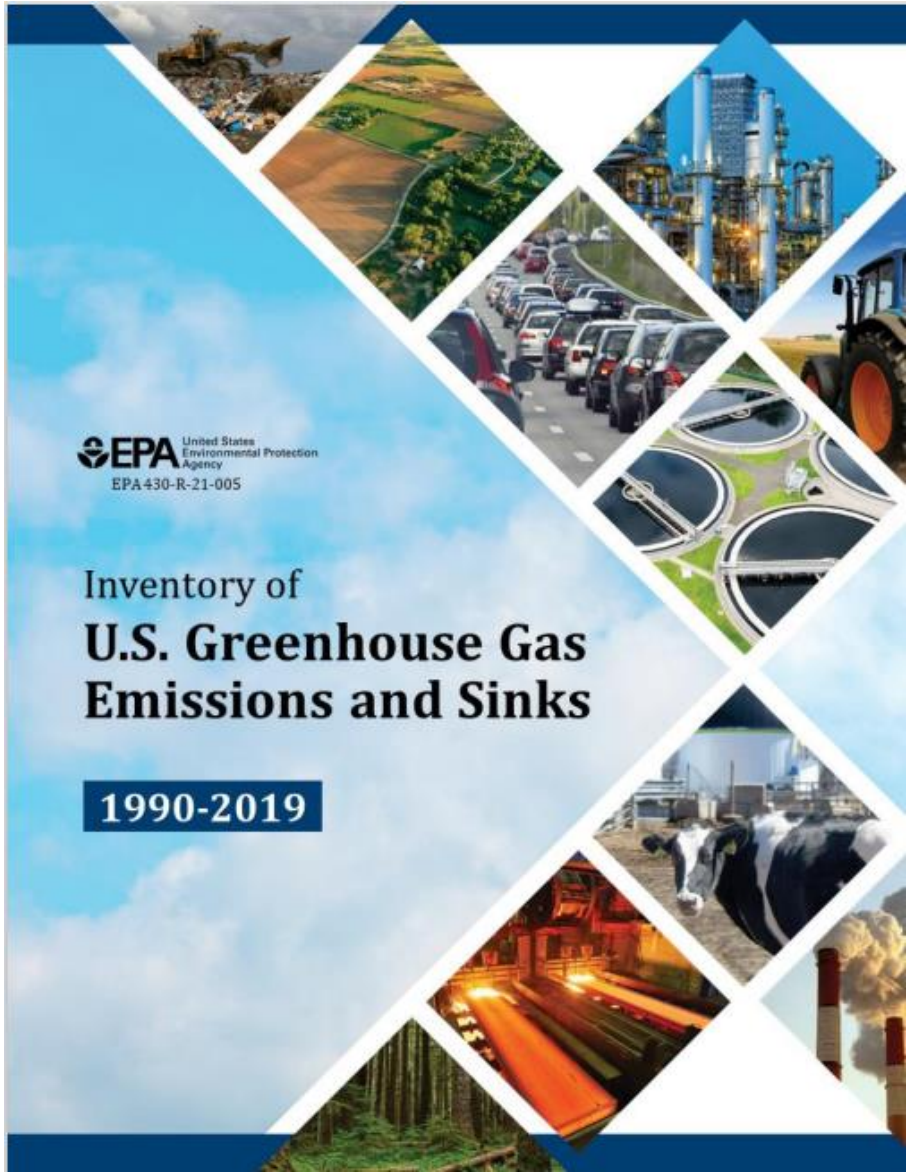
Source: https://usaforests.org/

Carbon Storage in Harvested Wood Products

As of 2020, the carbon stock for **Harvested Wood Products in Use** in the conterminous 48 states and Alaska is estimated at **1,532 Million Metric Tons**.



Carbon Stocks in Forest Land and Harvest Wood Pools, 2020



https://www.epa.gov/sites/production/files/2021-04/documents/us-ghg-inventory-2021-main-text.pdf

Table 6-10: Forest Area (1,000 ha) and C Stocks in *Forest Land Remaining Forest Land* and Harvested Wood Pools (MMT C)

	1990	2005	2016	2017	2018	2019	2020
Forest Area (1,000 ha)	***279,661***	***279,491***	***279,533***	***279,511***	***279,483***	***279,386***	***279,289***
Carbon Pools (MMT C)							
Forest Ecosystem	**50,913**	**53,489**	**55,284**	**55,456**	**55,610**	**55,774**	**55,933**
Aboveground Biomass	11,810	13,584	14,820	14,935	15,043	15,152	15,260
Belowground Biomass	2,319	2,723	3,004	3,030	3,054	3,079	3,103
Dead Wood	2,049	2,446	2,743	2,771	2,798	2,825	2,852
Litter	3,656	3,655	3,636	3,637	3,637	3,638	3,638
Soil (Mineral)	25,145	25,145	25,147	25,149	25,145	25,146	25,147
Soil (Organic)	5,934	5,936	5,935	5,934	5,934	5,933	5,933
Harvested Wood	**1,895**	**2,353**	**2,591**	**2,616**	**2,642**	**2,669**	**2,699**
Products in Use	1,249	1,447	1,497	1,505	1,513	1,521	1,532
SWDS	646	906	1,094	1,112	1,129	1,148	1,167
Total C Stock	**52,808**	**55,842**	**57,875**	**58,072**	**58,252**	**58,443**	**58,632**

https://www.epa.gov/sites/production/files/2021-04/documents/us-ghg-inventory-2021-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.

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

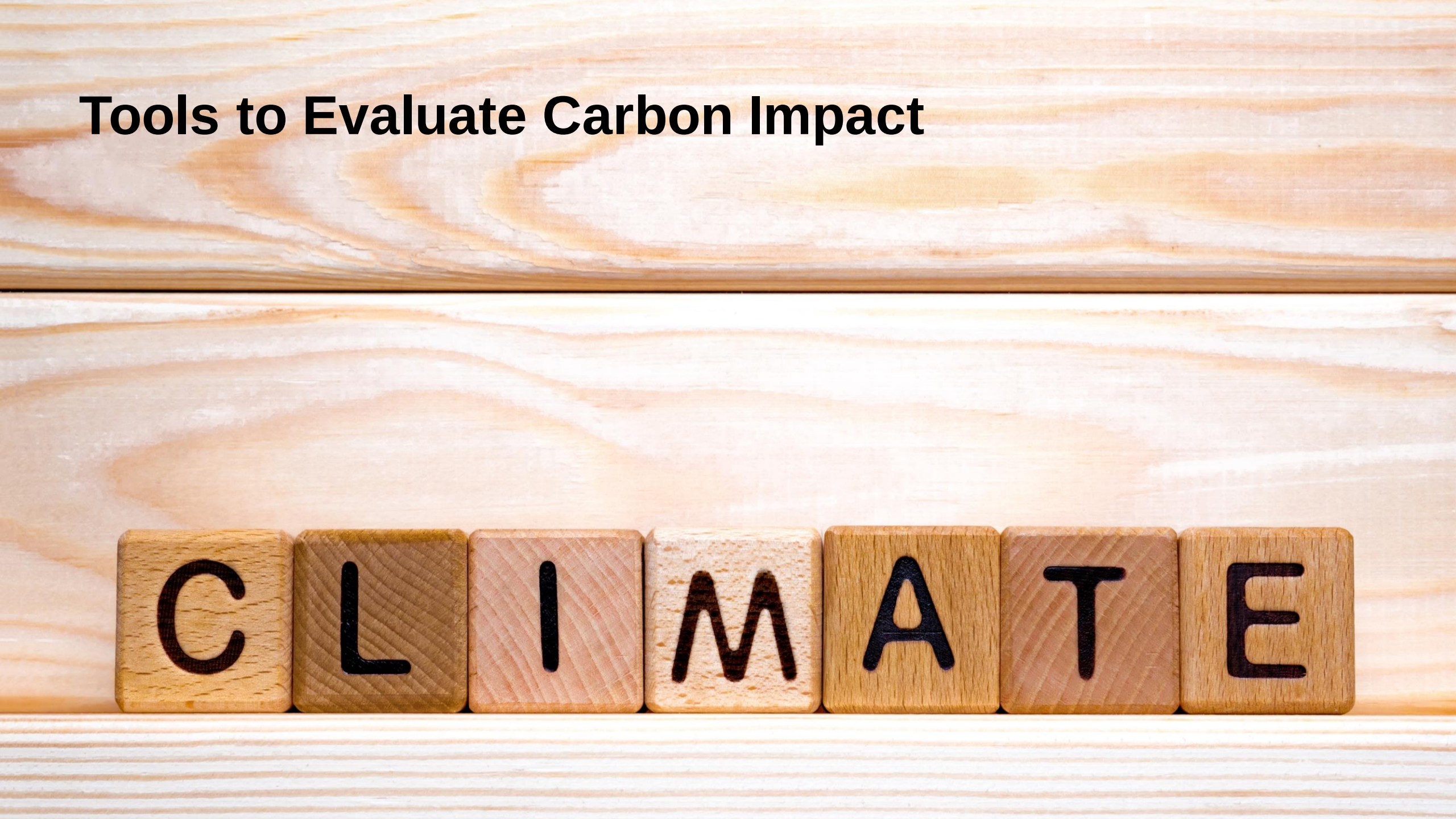
Image: Weyerhaeuser

Image: LP Building Solutions

Image: Structurecraft

Image: Georgia-Pacific

Tools to Evaluate Carbon Impact



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)

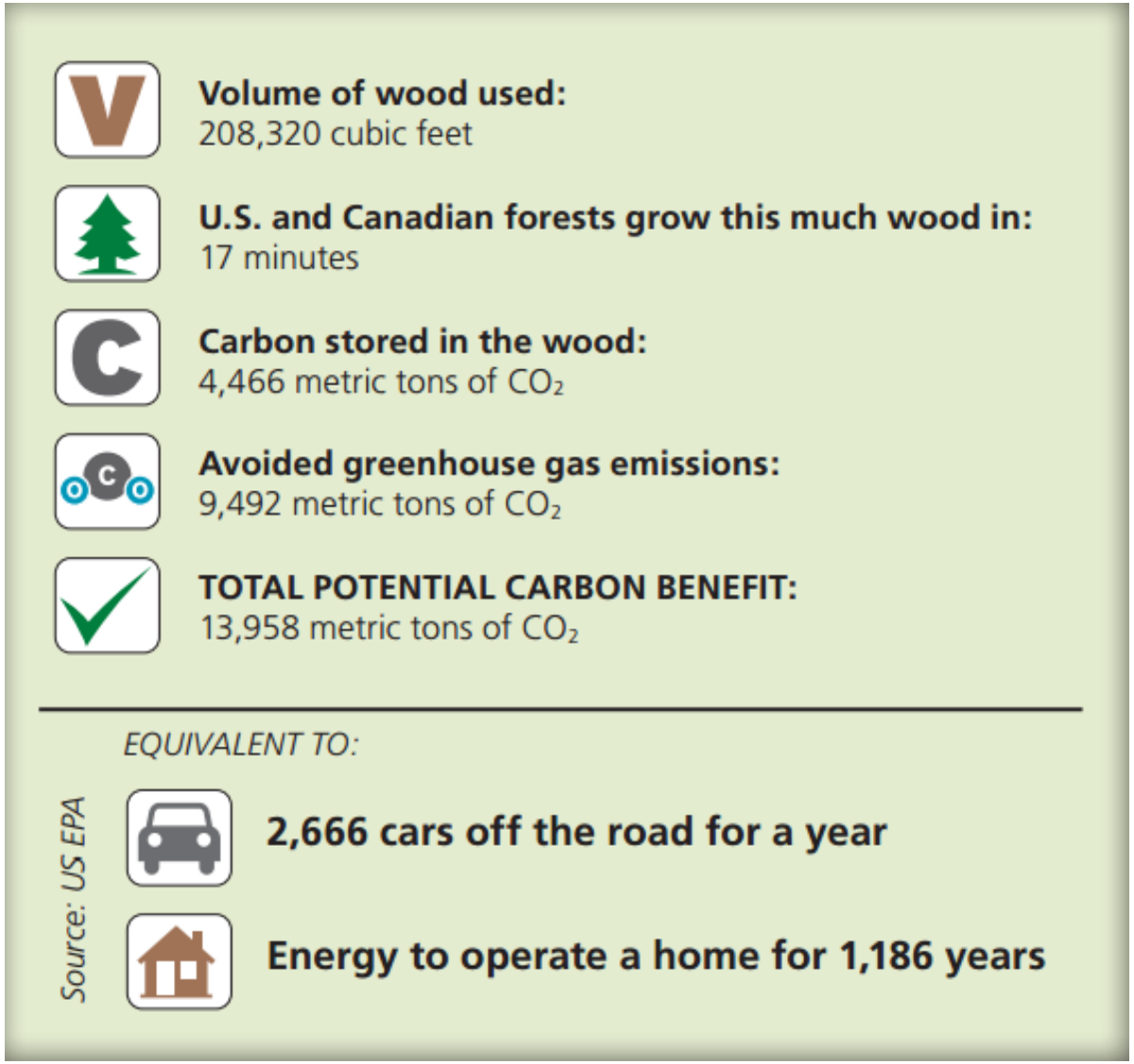
- Current EPDs for Wood Products
- How to Use Environmental Product Declarations

Scan to view

Photo: DPR Office, SmithGroup, photo Chad Davies

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/

Natural Wood Supports Healthy Buildings

August 11, 2023 | Laura Cullen, PE | Regional Director, WoodWorks

Architectural Connection to Forests

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

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

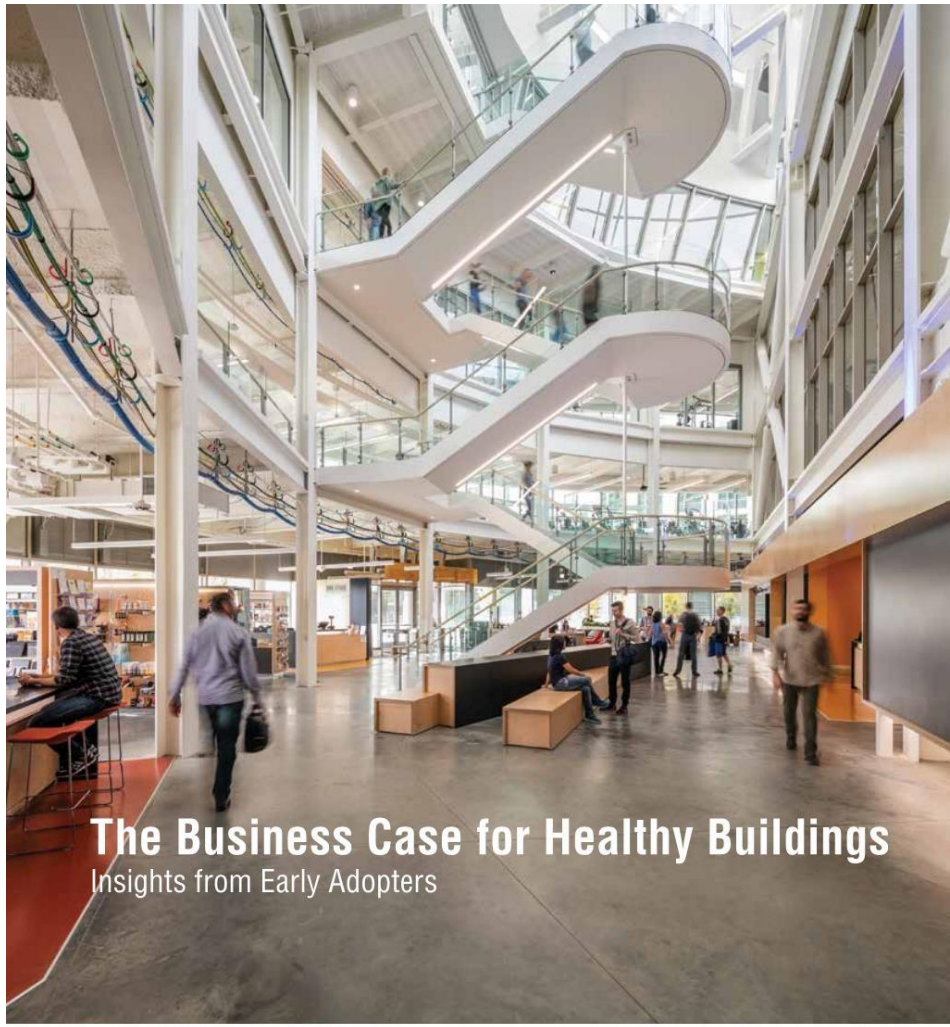
Healthy Bldgs ROI (Survey of 200 Canadian Bldg Owners):

- 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**."



Urban Land Institute Center for Sustainability and Economic Performance

2018 Report

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

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

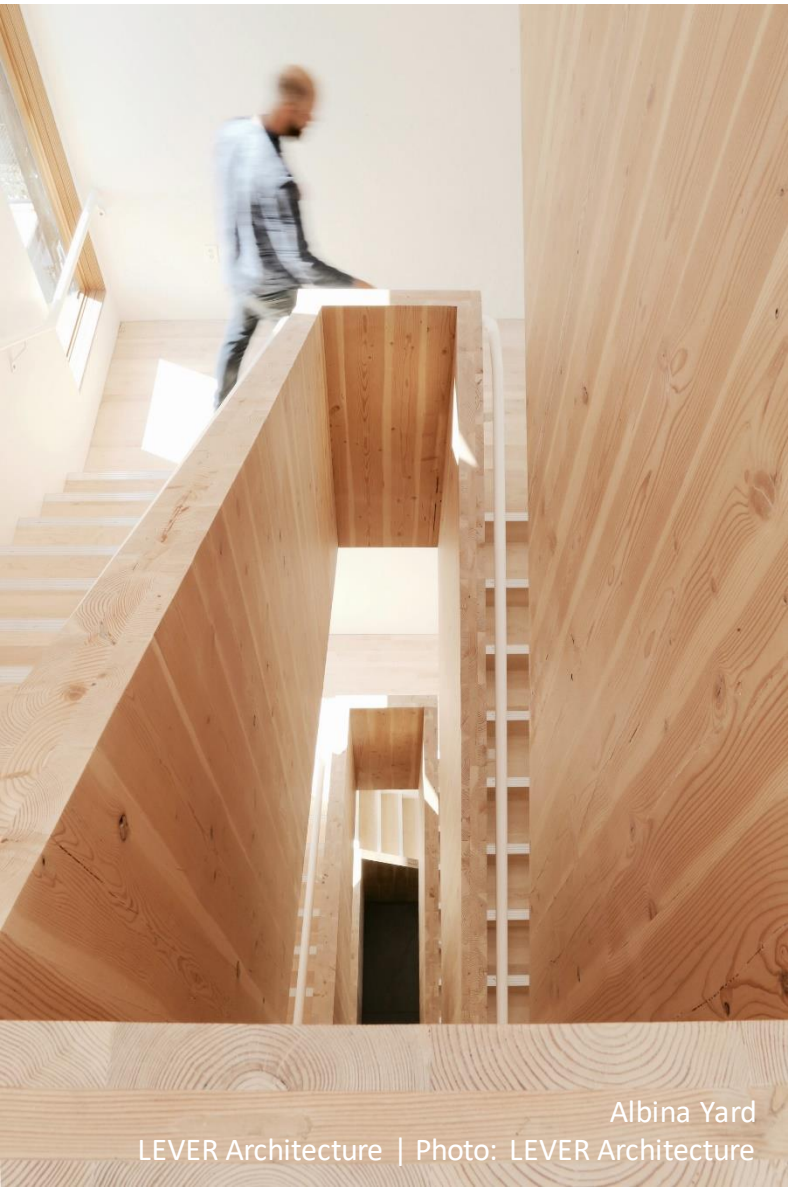
Material Connection to Nature (non-visual)
Biophilic Pattern

Other sensory connections to nature:

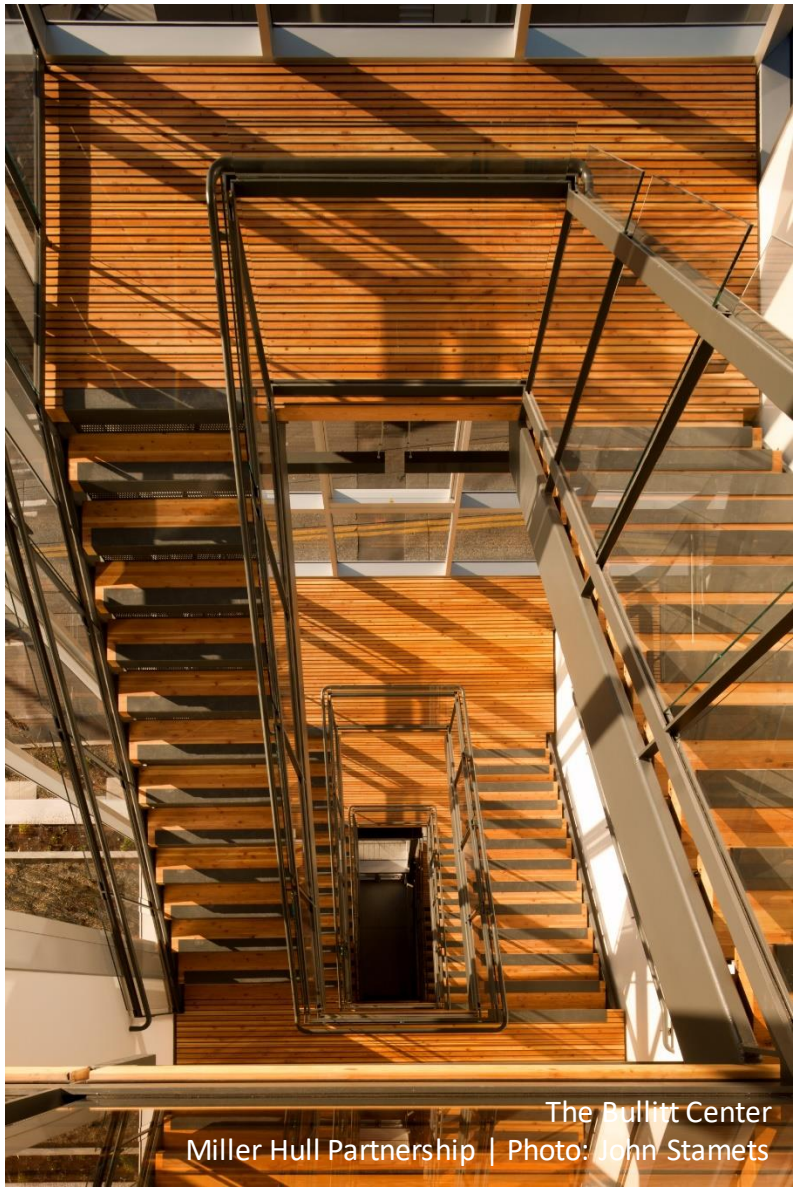
- Soft feel of wood – might this contribute to this biophilic pattern?
- Smell of wood in offices- might this contribute to this biophilic pattern?
- Smell of wood has surprised some designers who didn't consider it in design

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

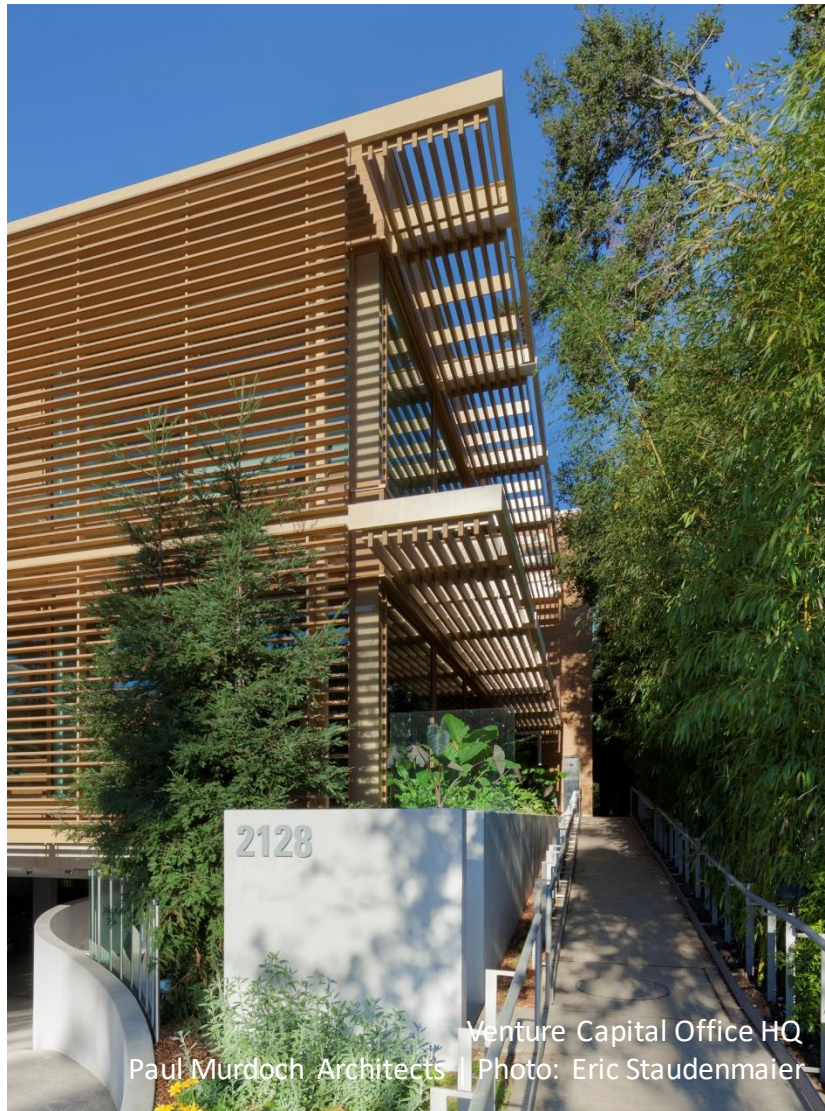
SAC Federal Credit Union HQ
Leo A Daily | Photo: Brad Anderson

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*

*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

The Bullitt Center
Miller Hull Partnership | Photo: John Stamets



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

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)

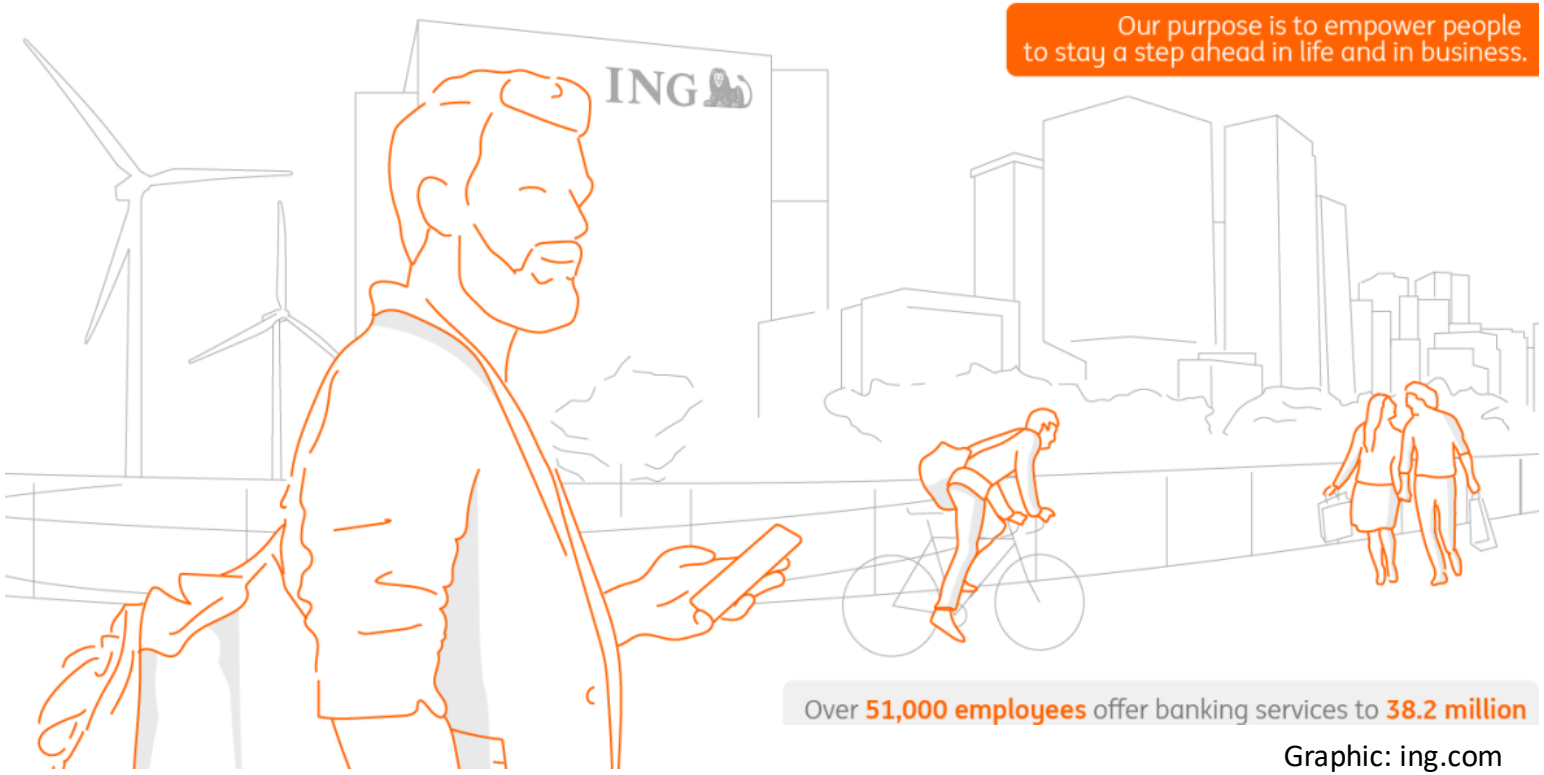
Investing in Employees Pays off for Bank
Case Study

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



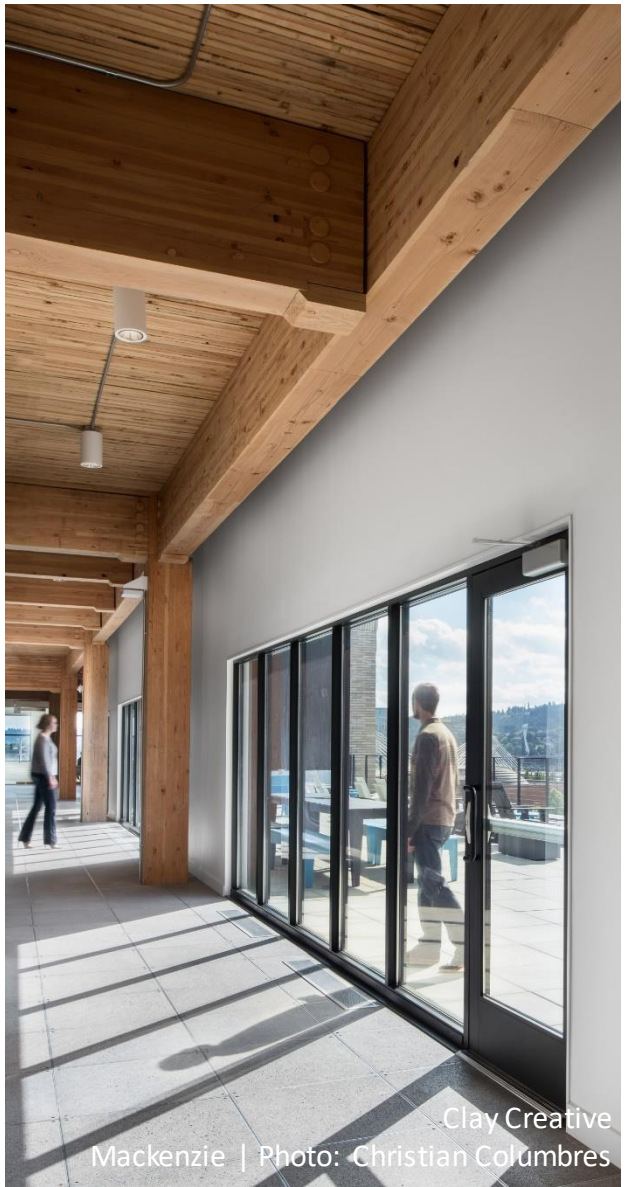
Graphic: ing.com

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

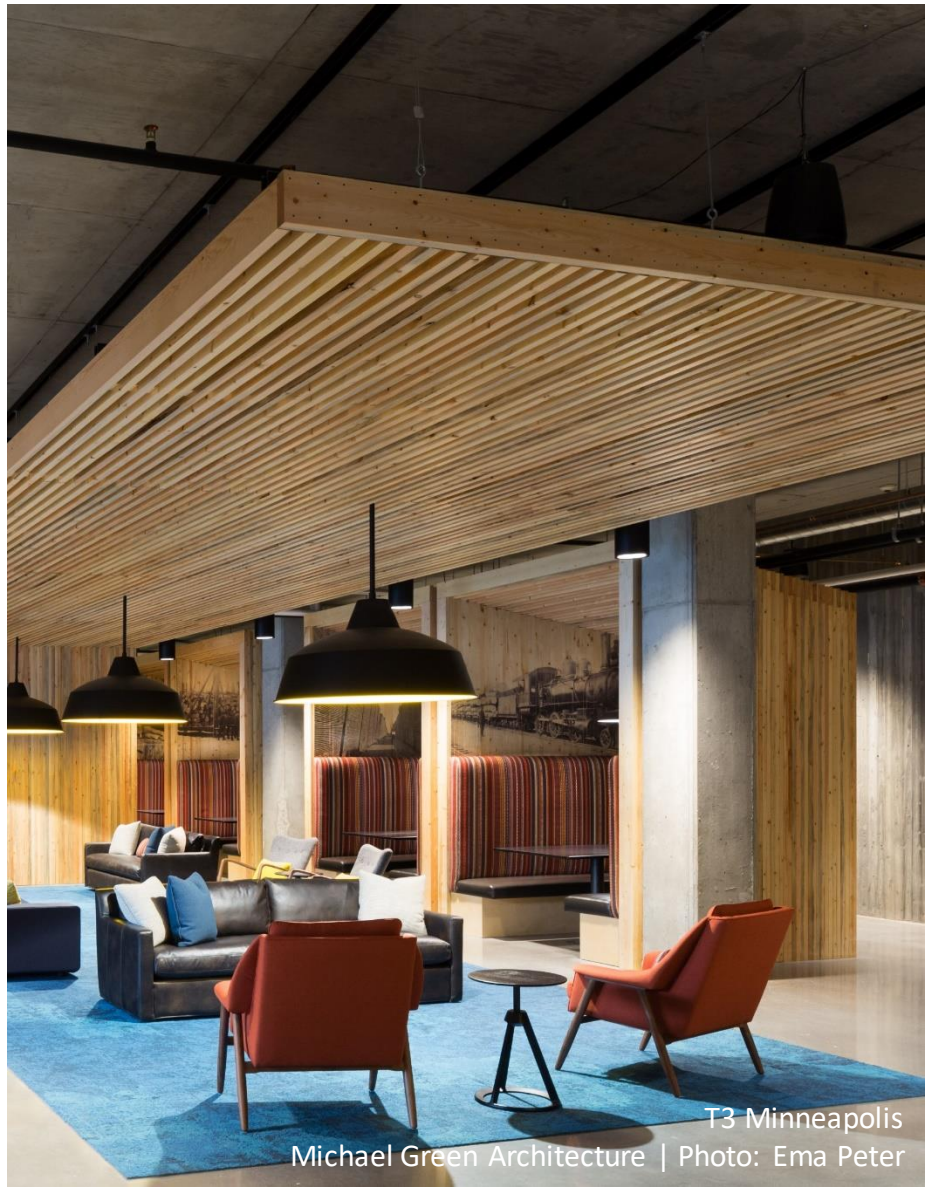
Natural Materials for Warm Gathering Spaces

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

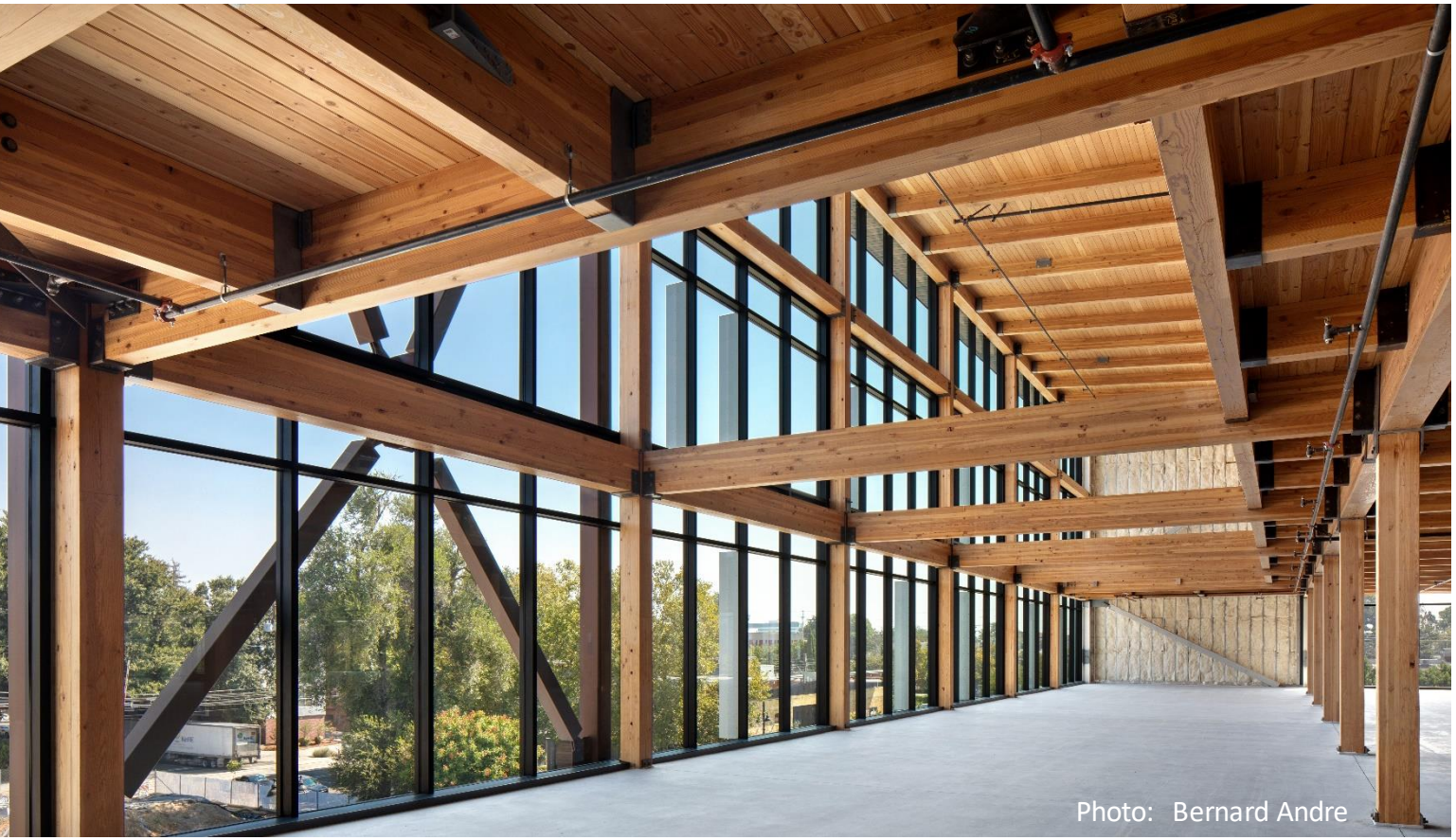


T3 Minneapolis
Michael Green Architecture | Photo: Ema Peter

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

Mass 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 mass timber over podium
- 87,460 sf

"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

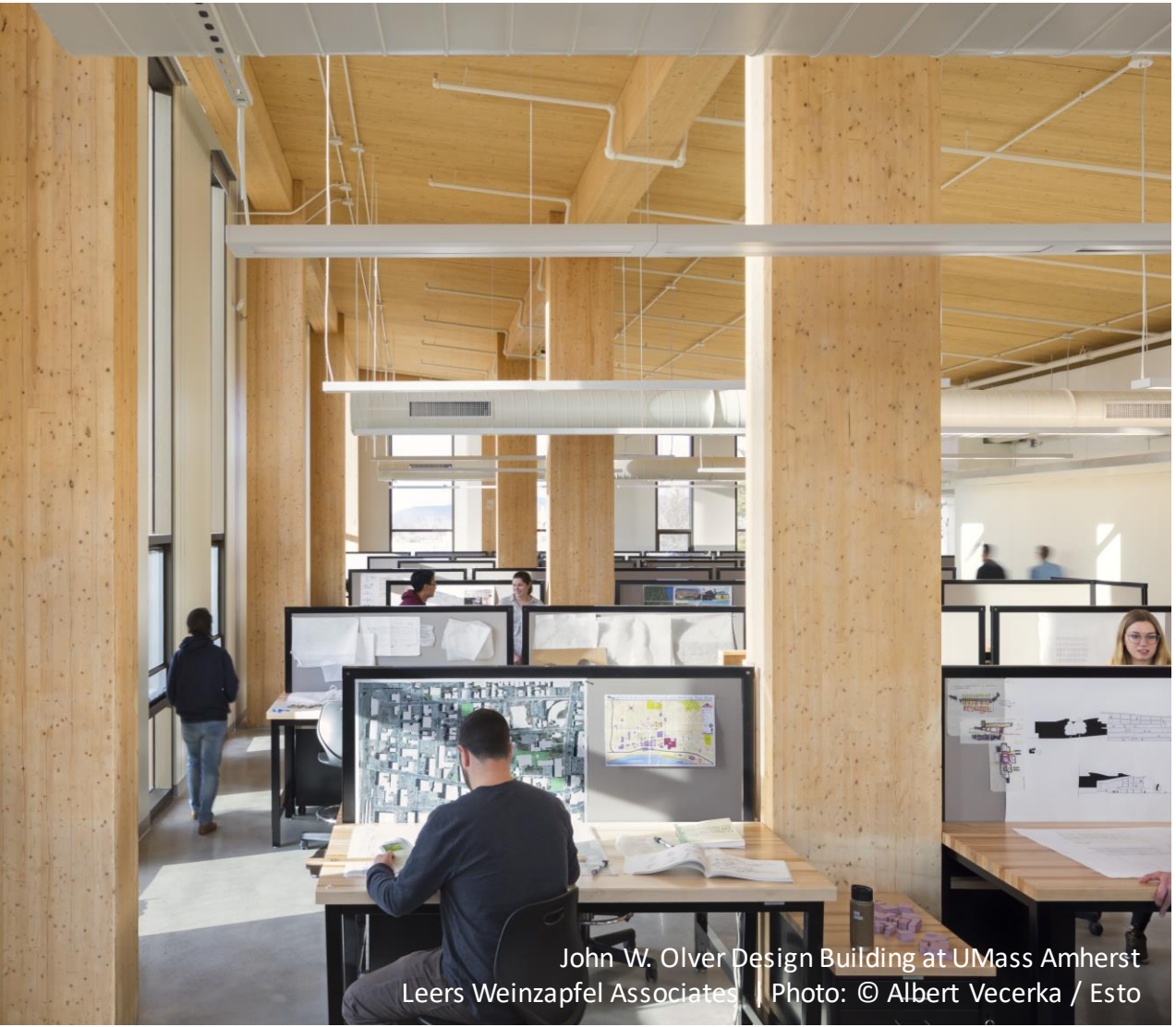
Microsoft Silicon Valley Campus

Microsoft Campus | Image: WRNS Studio

Biophilic Design Schools

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

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

Multifamily – Structural Warmth is a Value-Add

TMBR (unbuilt) Minneapolis, MN | Images: D/O Architects

Green Building Rating Systems: Wood's Role in Building Certifications

August 11, 2023 | Laura Cullen, PE | Regional Director, WoodWorks

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
- <u>It is important to note that a building does not have to be certified to be sustainable and well-built.</u>

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

Rating systems exist for single-family homes to entire neighborhoods

New and existing construction

One DeHaro, Pfau Long Architecture, Photo: Paul Chinn | The Chronicle

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 third-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.

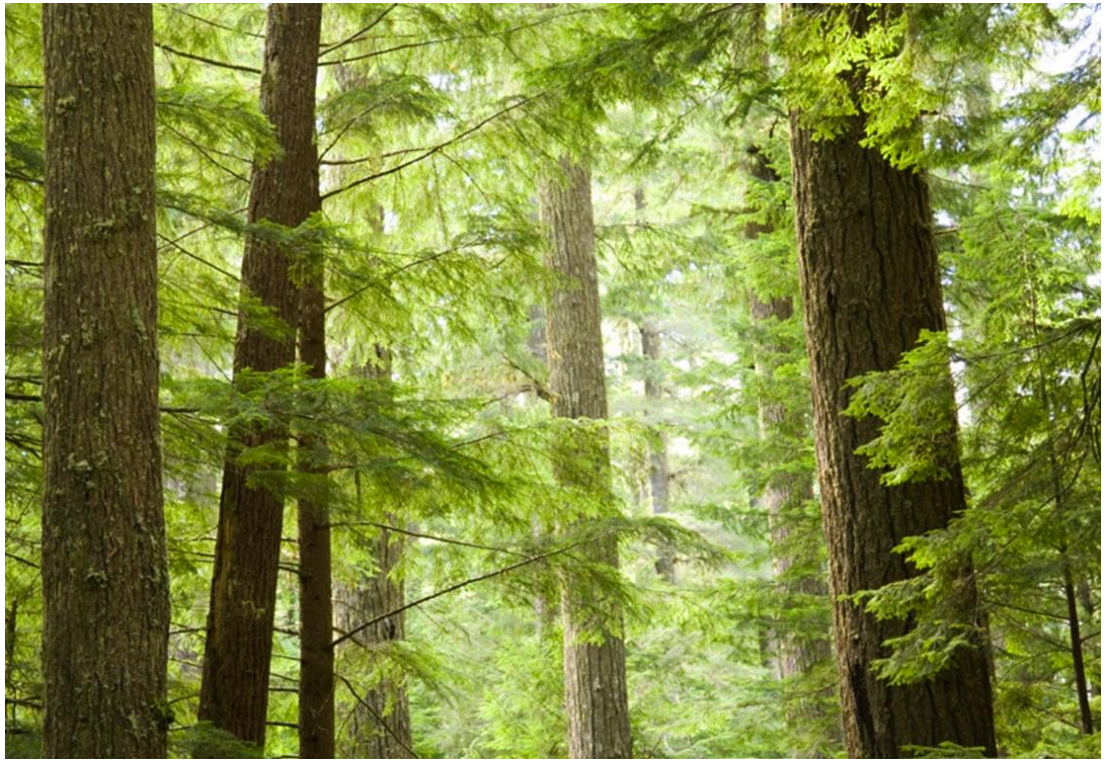


Photo: Frank Rosenstein, Courtesy of Plum Creek

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

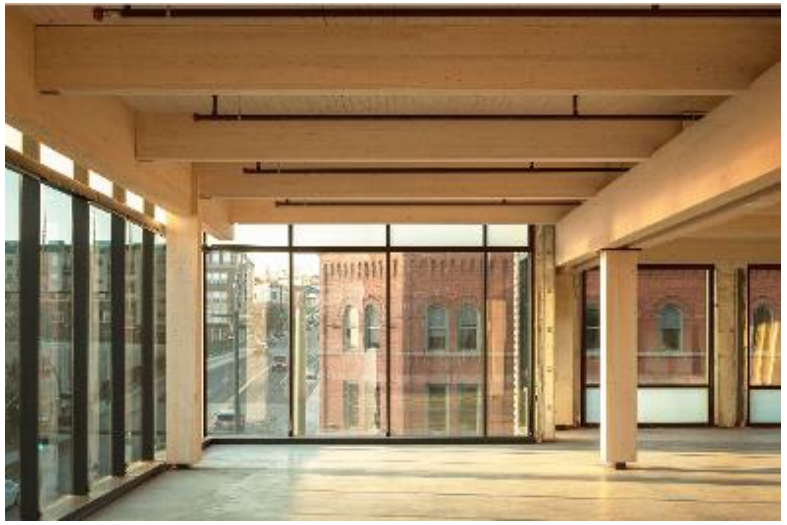
Source: *Green Building and Wood Products*

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.



Source: *Green Building and Wood Products*

Platte 15, OZ Architecture. Photos: JC Buck

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

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

Green Building Rating Systems
LEED

LEED® (Leadership in Energy & Environmental design) was developed by the U.S. Green Building Council (USGBC) and provides third-party verification that a building or community was designed and built-in accordance with specified practices and performance measures within eight categories.

- Established in 2000
- Adherence to required elements and numerical scores across all categories is used in determining an overall project rating.,
- Has certified more than 2.8 billion ft^2 of building space globally.
- The newest version (V4.1) was released in 2019

Source: *Green Building and Wood Products*

Green Building Rating Systems
Green Globes

Green Globes began in Canada as an offshoot of BREEAM. The Green Building Initiative (GBI) acquired the rights to distribute Green Globes in the United States in 2004, and in 2005 became the first green building organization accredited as a standards developer by the American National Standards Institute (ANSI).

- Includes new construction and continuous improvement in office buildings, multifamily, hospitals, and institutional.
- Web-based tool allows self- assessment of building projects, with third-party on-site inspection required for certification.
- One of two rating systems approved by the U.S. government for accreditation of federal building projects.

Source: *Green Building and Wood Products*

Green Building Rating Systems

Living Building Challenge

Living Building Challenge, a program of the Cascadia Green Building Council (a chapter of both the USGBC and Canadian Green Building Council) was developed in 2006.

- Now administered by the International Living Future Institute, it is meant to be the next step after LEED Platinum and a step before regenerative buildings.
- Intended "to define the highest measure of sustainability attainable in the built environment based on the best current thinking—recognizing that 'true sustainability' is not yet possible."

Source: *Green Building and Wood Products*

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

Green Certification Types

Choose your project type to learn more about how Green Globes works

- NEW CONSTRUCTION (NC)
- MULTIFAMILY (NC)
- CORE & SHELL (NC)
- EXISTING BUILDINGS (EB)
- MULTIFAMILY (EB)
- MULTIFAMILY PERFORMANCE PLUS
- SUSTAINABLE INTERIORS(SI)

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)

Photo: Sustainable Forestry Initiative

Source: *Green Building 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.

MATERIALS PETAL

PETAL INTENT

10. RED LIST

11. EMBODIED CARBON FOOTPRINT

12. RESPONSIBLE INDUSTRY

13. LIVING ECONOMY SOURCING

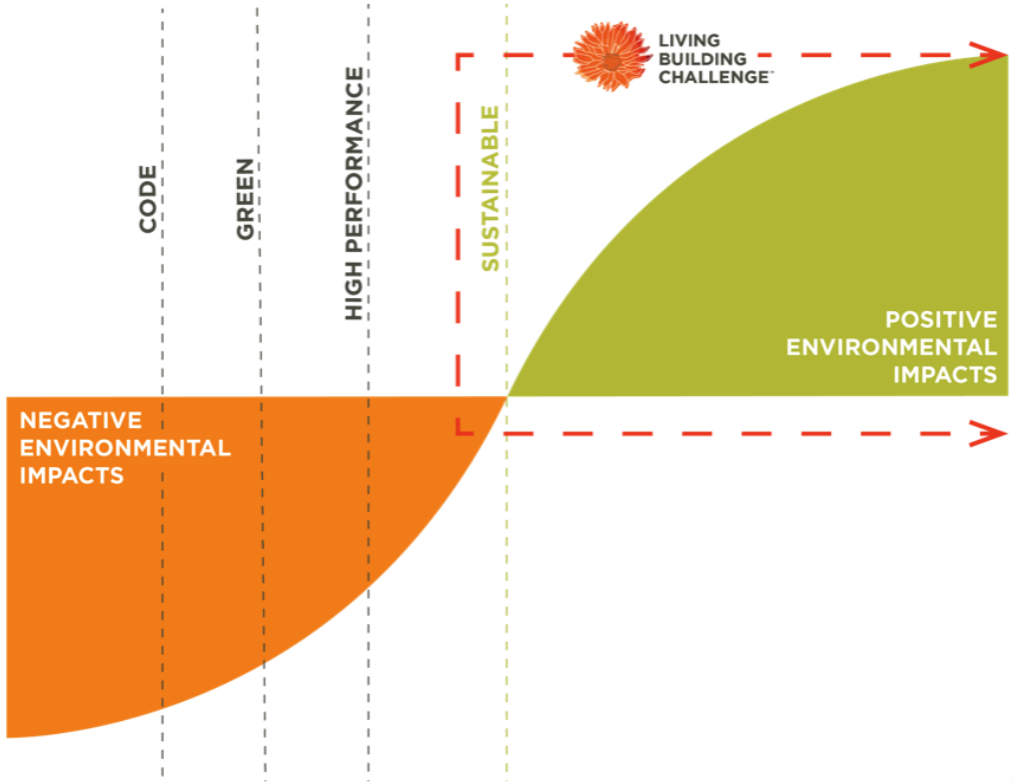
14. NET POSITIVE WASTE

10. RED LIST IMPERATIVE

There are temporary exceptions for numerous Red List items due to current limitations in the mat
Materials Petal Handbook for complete and up-to-date listings. The project cannot contain any of

RED LIST MATERIALS OR CHEMICALS

- Alkylphenols
- Asbestos
- Bisphenol A (BPA)
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethylene



Source: *ILFI*

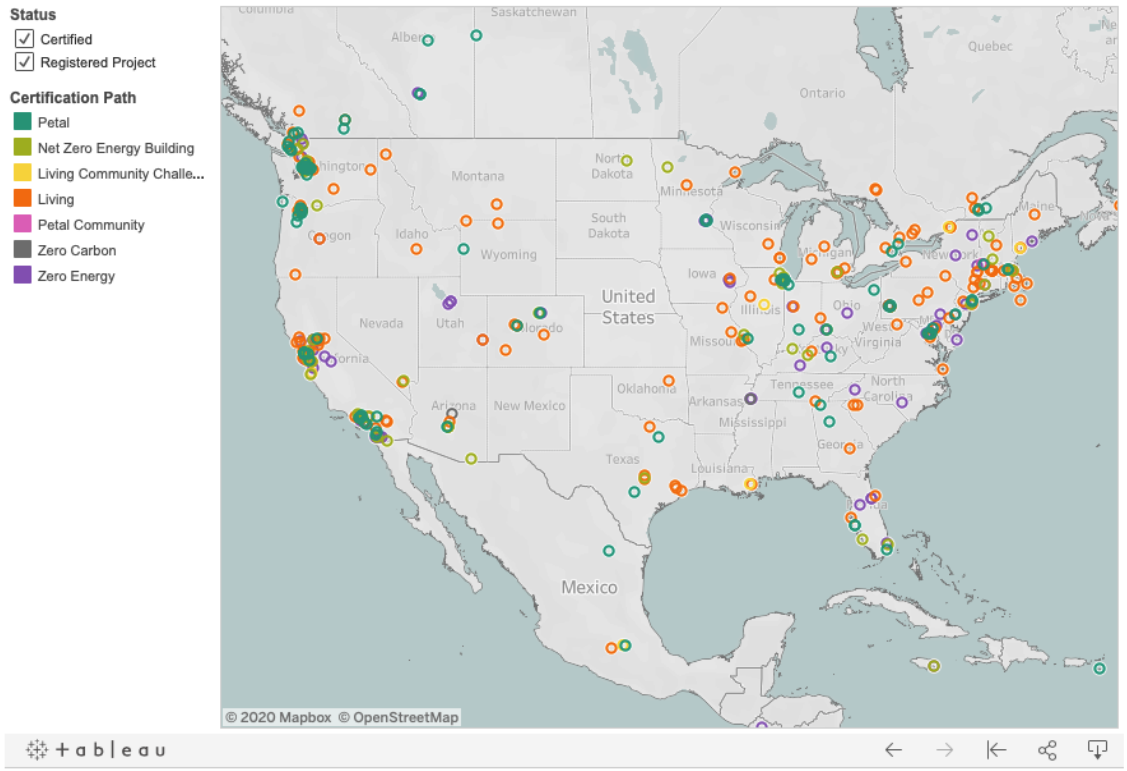
Wood in Living Building Challenge

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

REGISTERED & CERTIFIED PROJECT MAP



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

LCA tools for Green Building Certifications

WoodWorks Expert Tip

What **tools** are available to help designers and owners **compare** the **embodied carbon**, or **upfront greenhouse gas emissions** (GHG), of commercial or multi-family buildings designed with different structural systems in the US?

View WoodWorks Expert Tip online at:

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

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/

LCA Tools for use in Pre-Design & Conceptual Design

Simplified Early 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 EcoCalculator for Commercial Assemblies	Early estimate simplified LCA (note: no longer updated, some data out of date)	Yes	Yes	No	Yes
Carbon Designer (One-click LCA add-on tool)	Early estimate simplified LCA w/ regionalized generic data	Yes	Yes	No	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
- Mass 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

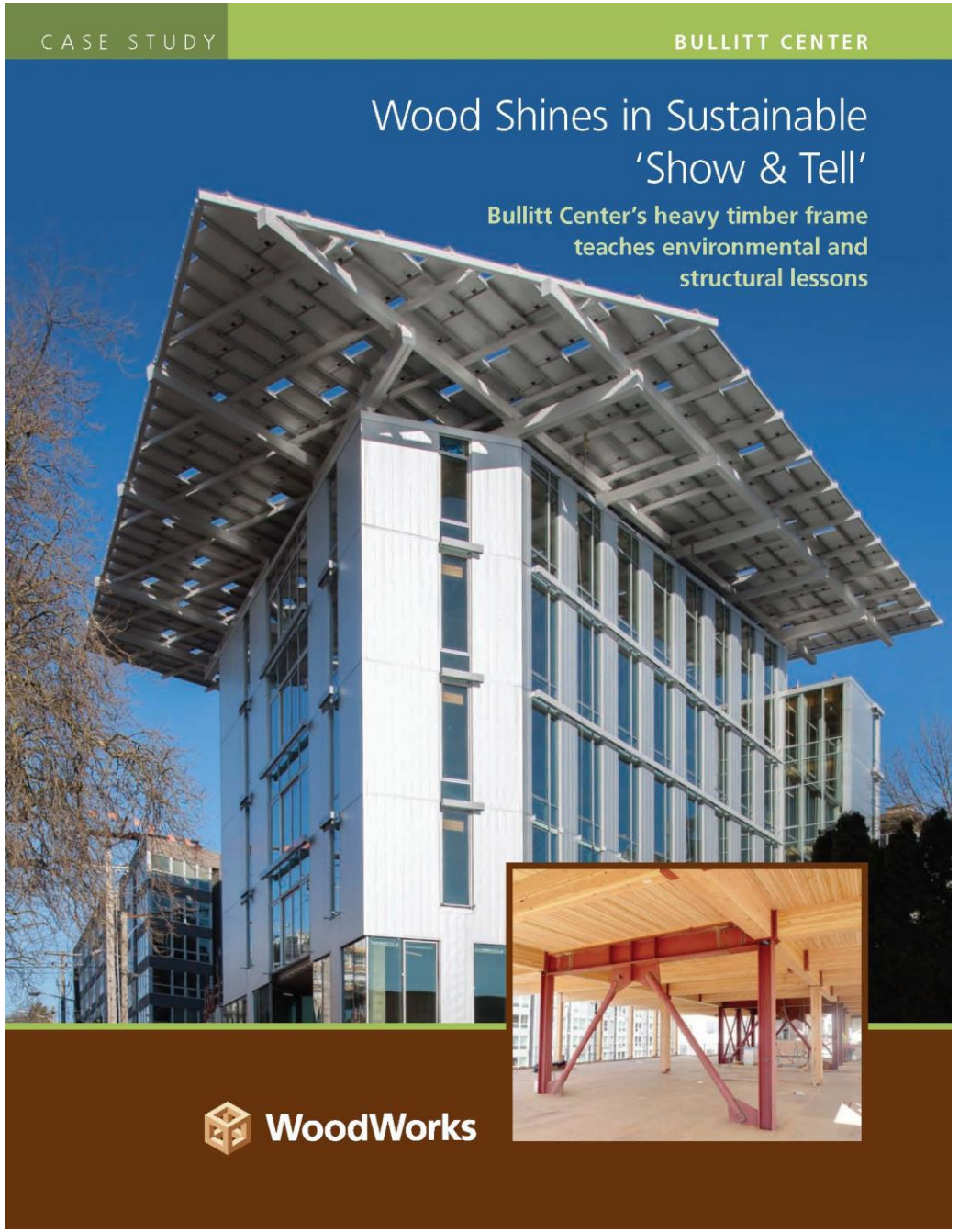
TOTAL POTENTIAL CARBON BENEFIT:
1,703 metric tons of CO_2

EQUIVALENT TO:

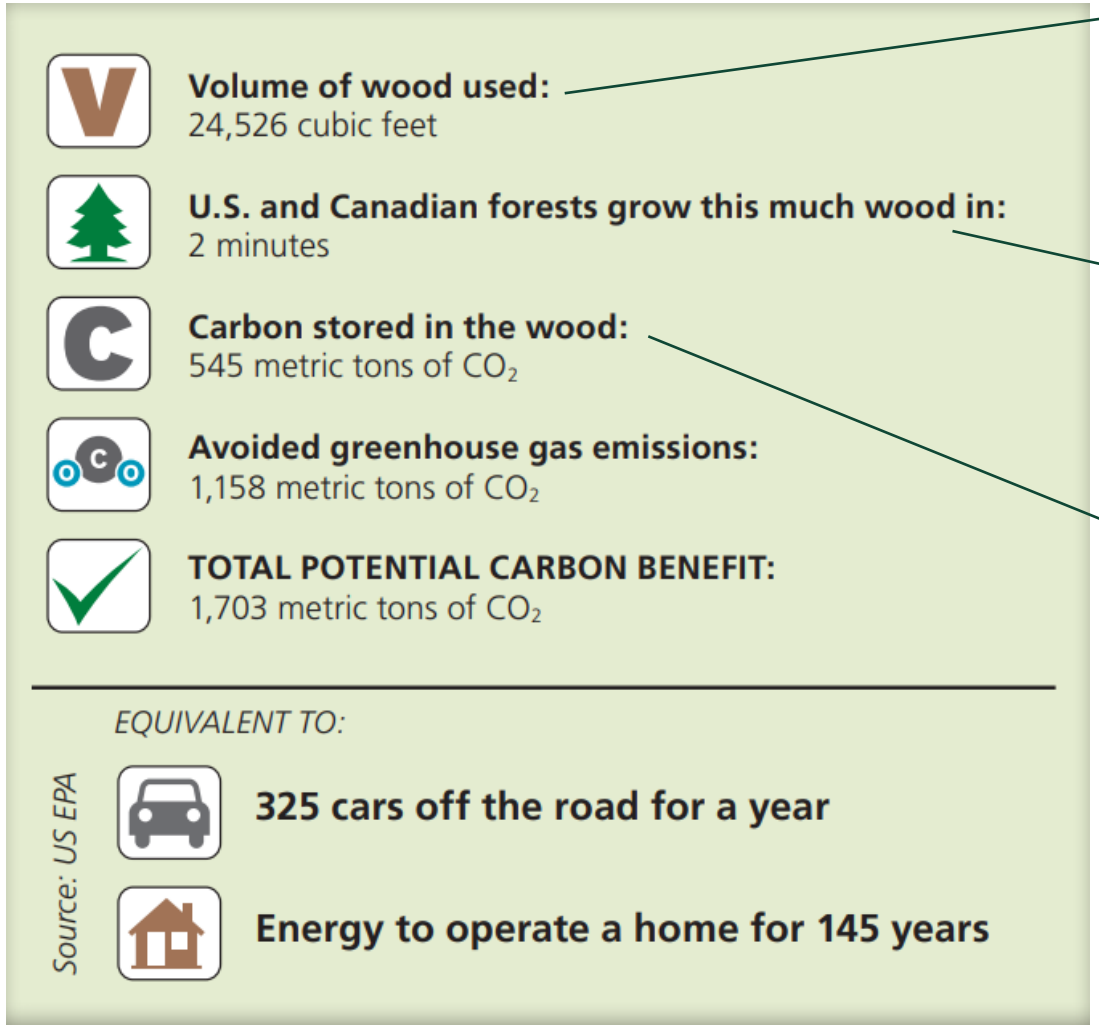
325 cars off the road for a year

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)

Candlewood Suites
Redstone Arsenal, AL


Photo: IHG Army Hotels, Lendlease

III-B

- 4 stories; 62,688 sf
- **First CLT hotel** in USA
- **37% faster** overall construction
- 40% fewer construction workers
- Trained unemployed veterans

Architect: Lendlease
Project Engineer: Schaefer Structural Engineers

Candlewood Suites

Redstone Arsenal, AL

Photo: IHG Army Hotels, Lendlease

Carbon Benefits

Wood lowers a building's carbon footprint in two ways. It continues to store carbon absorbed by the tree while growing, keeping it out of the atmosphere for the lifetime of the building—longer if the wood is reclaimed and reused or manufactured into other products. When used in place of fossil fuel-intensive materials such as steel and concrete, it also results in 'avoided' greenhouse gas emissions.

Volume of wood products used:
935,696 board feet (equivalent)

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

Carbon stored in the wood:
1,276 metric tons of CO_2

Avoided greenhouse gas emissions:
494 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
1,770 metric tons of CO_2

EQUIVALENT TO:

374 cars off the road for a year

Energy to operate 187 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.

Candlewood Suites

Redstone Arsenal, AL

Carbon Stored in Wood
(from previous calculation)

Emissions avoided by choosing wood over alternative building material based on building type

Total Potential Carbon Benefit =
Carbon Stored + Emissions Avoided

Convert Total Potential Carbon Benefit to emissions from operating a car or a home

Carbon Benefits

Wood lowers a building's carbon footprint in two ways. It continues to store carbon absorbed by the tree while growing, keeping it out of the atmosphere for the lifetime of the building—longer if the wood is reclaimed and reused or manufactured into other products. When used in place of fossil fuel-intensive materials such as steel and concrete, it also results in 'avoided' greenhouse gas emissions.

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Questions? Ask us anything.

Laura Cullen, PE

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laura.cullen@woodworks.org

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