MASS TIMBER+℠

OFFSITE CONSTRUCTION CONFERENCE

PRODUCED BY WOODWORKS | FEA Forest Economic Advisors

Wood's Role in Low-Embodied Carbon Buildings

Credits: 1.0 AIA/CES HSW LUs, 1.0 PHD credit, 0.10 ICC credit

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

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Course Description

Opportunities for the built environment to help address carbon-related issues are at the forefront of discussions within the building design and construction community. The spotlight once held by operational energy efficiency has shifted to material choice and embodied carbon—in particular, which building products should be specified to achieve a more sustainable structure. This course examines some of the environmental benefits of using wood construction. Carbon-related terminology will be reviewed along with information on biogenic carbon storage. Life cycle assessment (LCA) will also be discussed as a scientific way to measure, report, and compare the carbon impacts of building systems. The focus will be on biogenic carbon accounting throughout the life cycle of a wood building, specifically when and how it should be

Learning Objectives

1. Review carbon basics and how material choice is related to sustainability.
2. Define biogenic carbon and understand how to calculate the amount of carbon stored in wood products.
3. Learn when it is appropriate to include biogenic carbon in life cycle carbon accounting according to ISO standards.
4. Explain biogenic carbon removals, emissions, and exports at each stage of a wood product's life cycle, in alignment with ISO standards.

WoodWorks Resources

Whole Building Life Cycle Assessment (WBLCA)

- Introduction to Whole Building Life Cycle Assessment: The Basics
- Worksheet for Structural WBLCA of Mass Timber Buildings
- WBLCAs of Built Projects

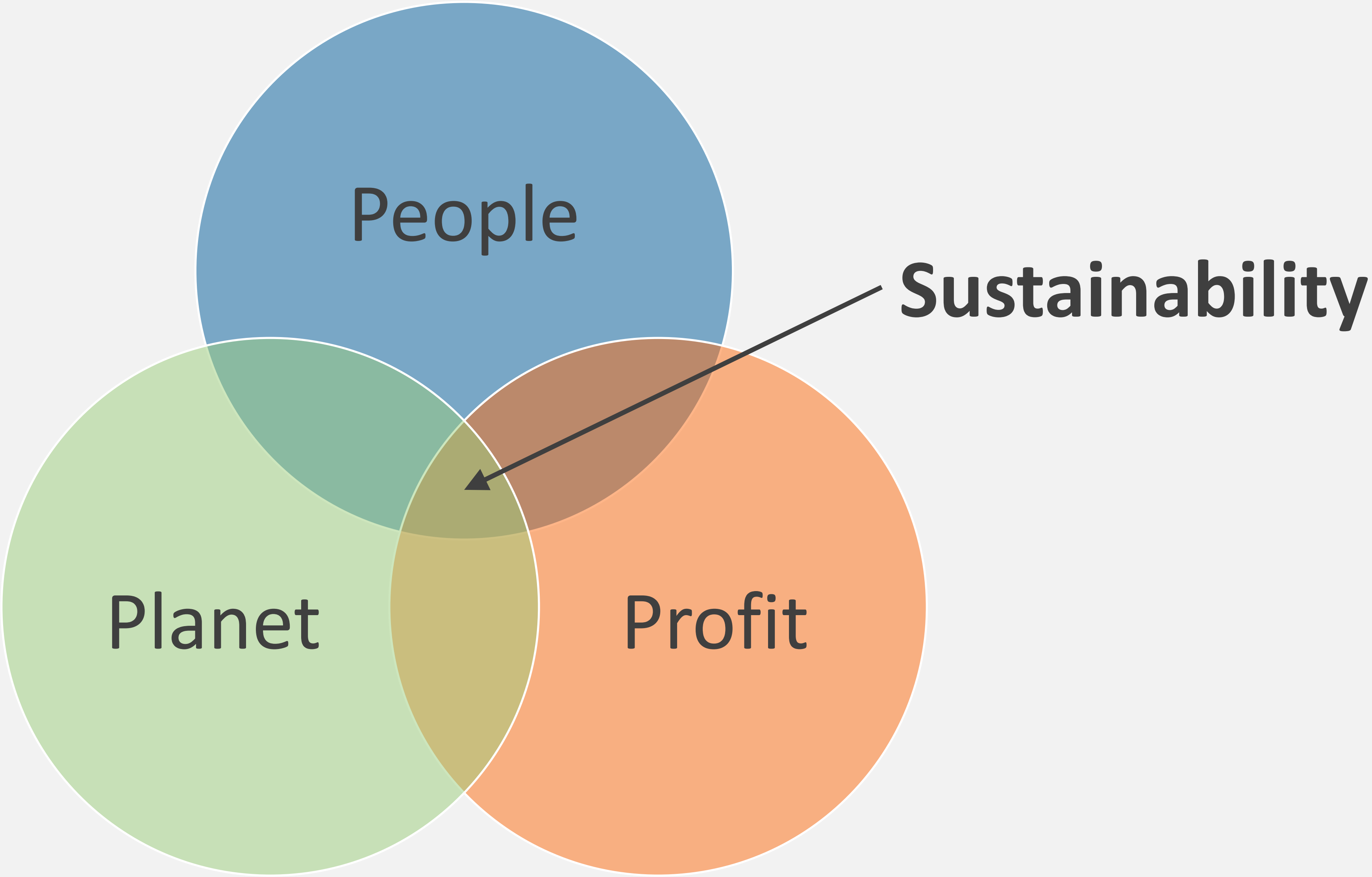
Expert articles on topics such as:

- Biogenic Carbon in LCA Tools
- Long-Term Biogenic Carbon Storage
- What Net Zero Means in Building Construction
- Environmental Product Declarations (EPDs)

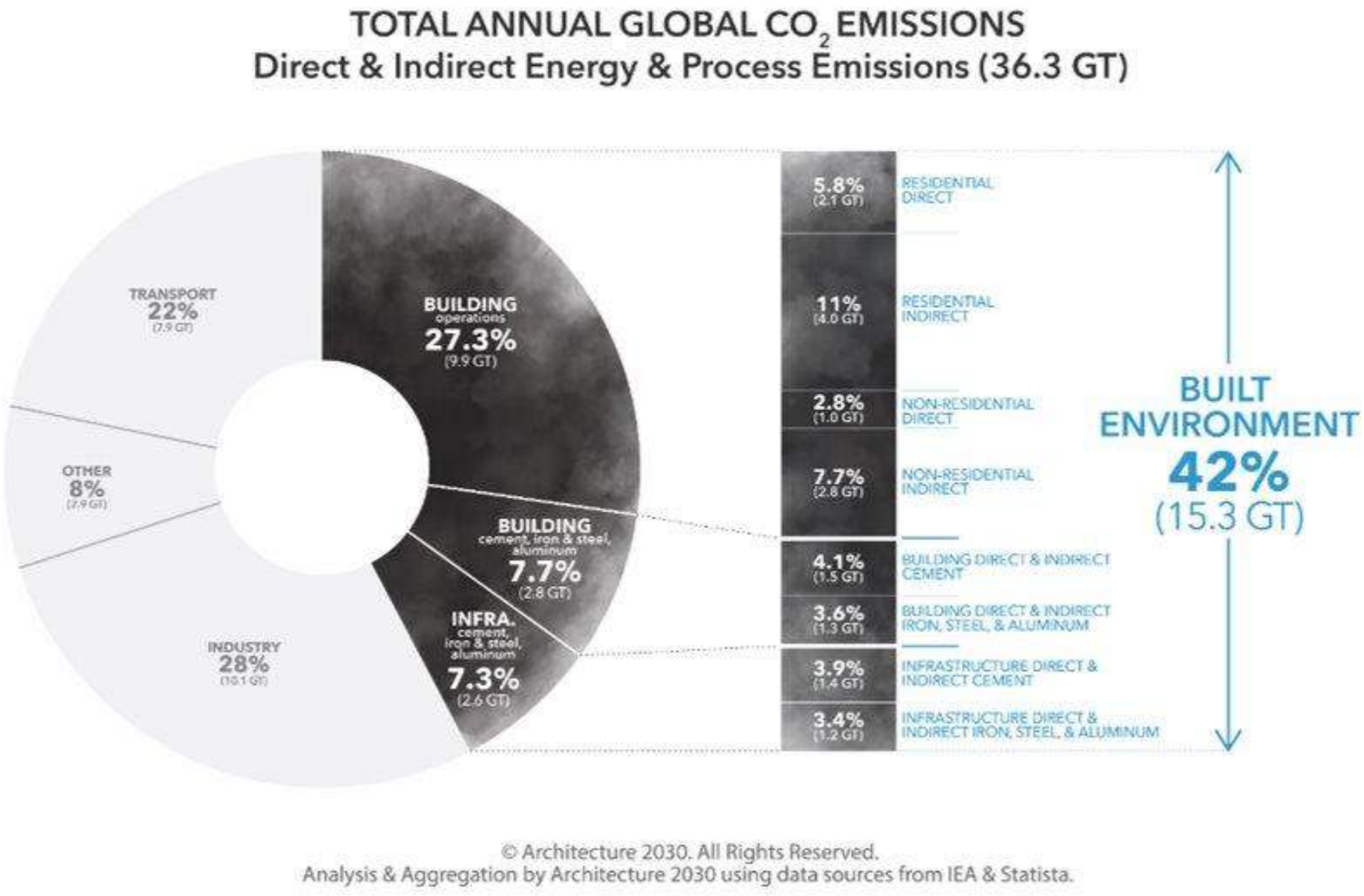
Scan for a complete list of sustainability resources at woodworks.org

Photo: DPR Office, SmithGroup, photo Chad Davies

The Triple Bottom Line



The Built Environment & Carbon Dioxide Emissions



Built environment generate about **42%** of annual carbon dioxide emissions

- *Building Operations*
- *Embodied Carbon*

Embodied carbon: **15%**

- Cement
- Iron
- Steel
- Aluminum

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

Measuring Greenhouse Gases (GHG)

Global Warming Potential (GWP)

- Allows comparisons of global warming impacts of different gases
- Measures energy emissions 1 ton of gas absorbs over a given period of time relative to emissions of 1 ton of carbon dioxide (CO_2)
- Time period usually **100 years** (EPA)

	GWP
Carbon Dioxide (CO_2)	1
Methane (CH_4)	28-36
Nitrous Oxide (N_2O)	265-298
Fluorinated Gases	Thousands to Tens of Thousands

Carbon Dioxide Equivalents (CO_{2eq})

- International standard to express greenhouse gases in terms of CO_2 equivalents

Embodied Carbon

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

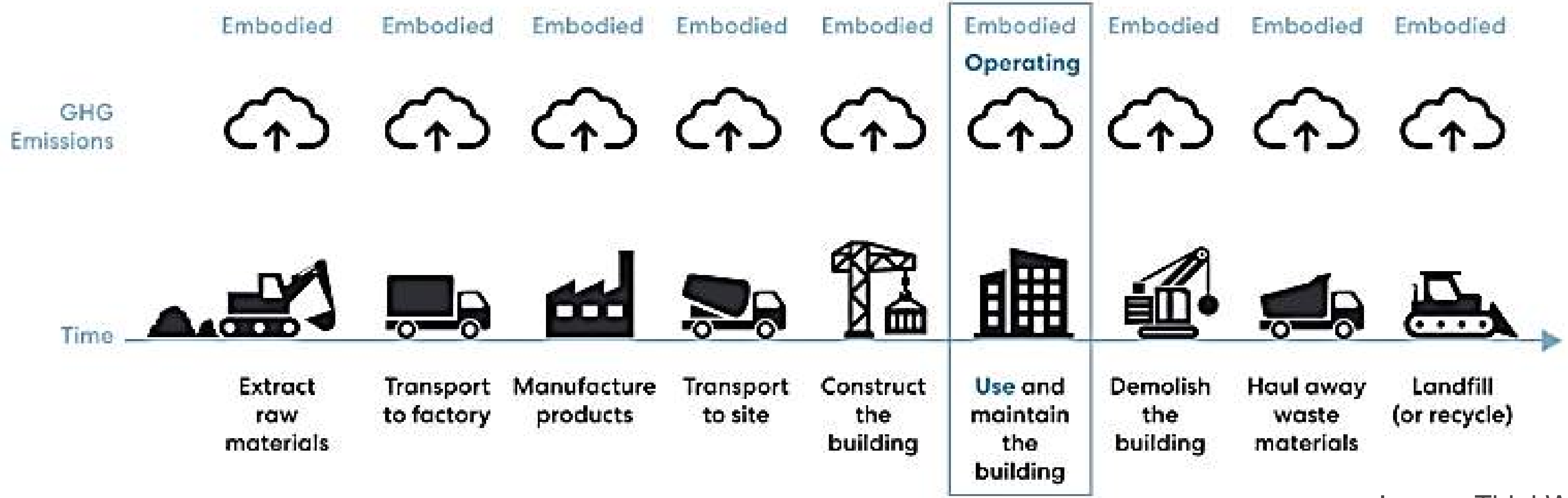


Image: ThinkWood

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 storage in wood products:

- Sometimes included in embodied carbon as a reduction
- Sometimes reported separately

Embodied vs. Operational Energy

Traditional Non-Wood Building

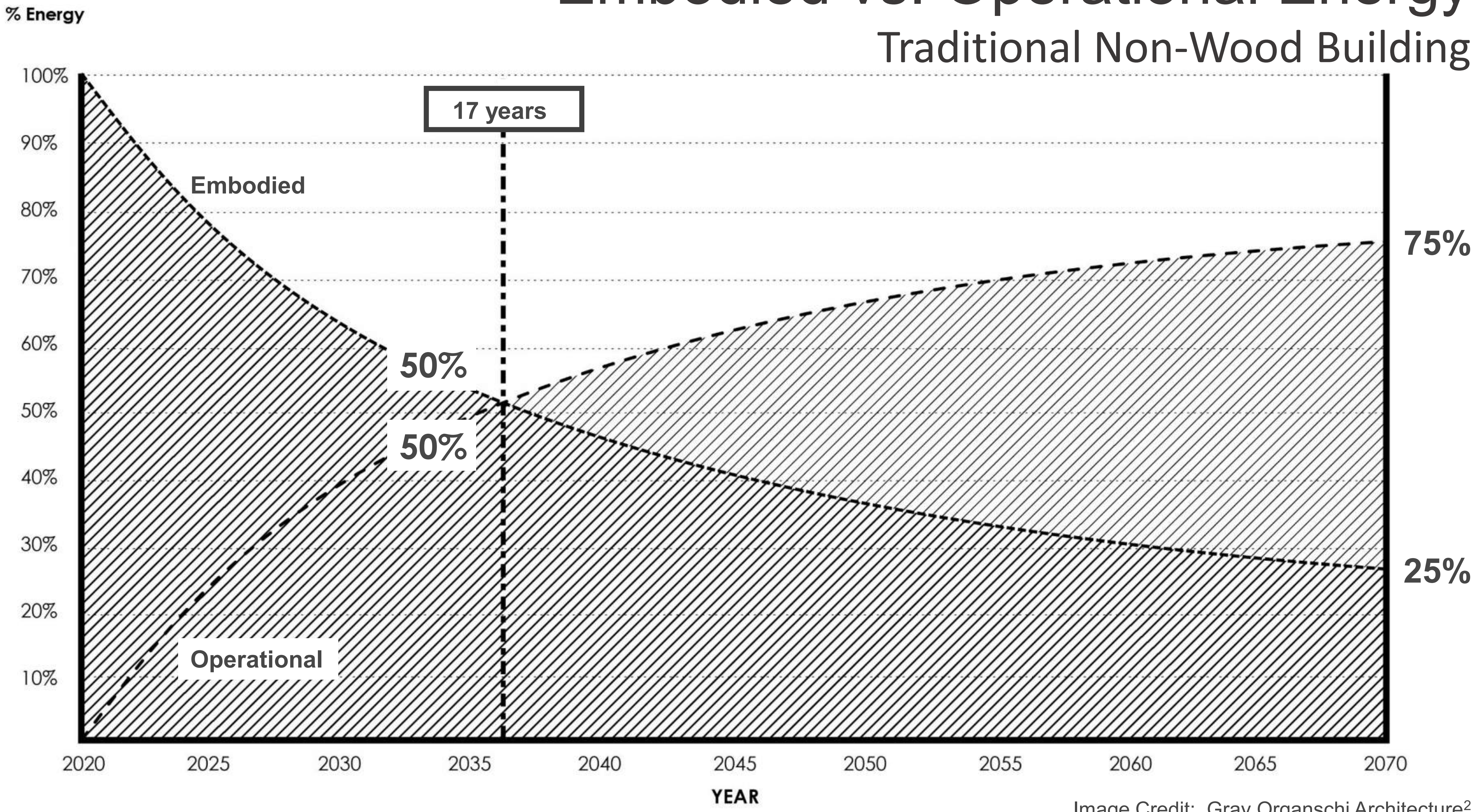


Image Credit: Gray Organschi Architecture[2]

How Does Wood Fit In?

Common Environmental Concerns About Specifying Wood

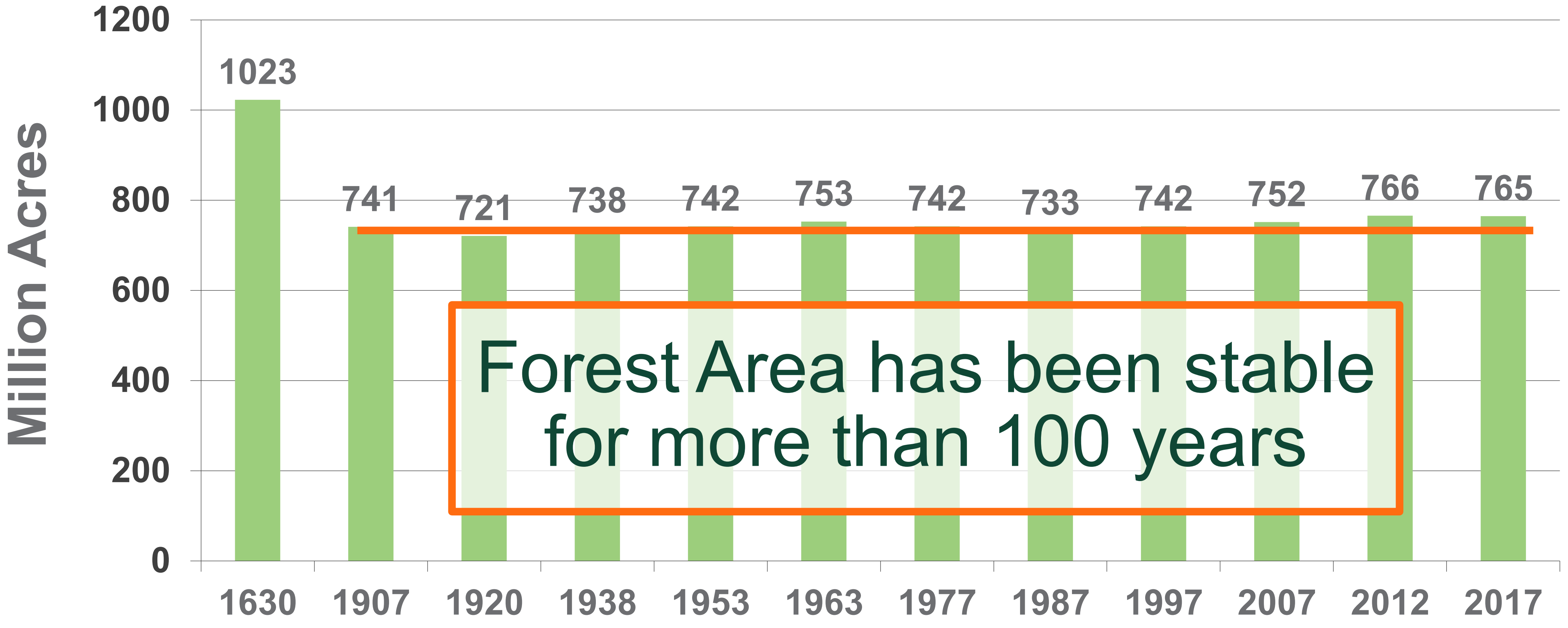
1. Is North America **running out of forests?**

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

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

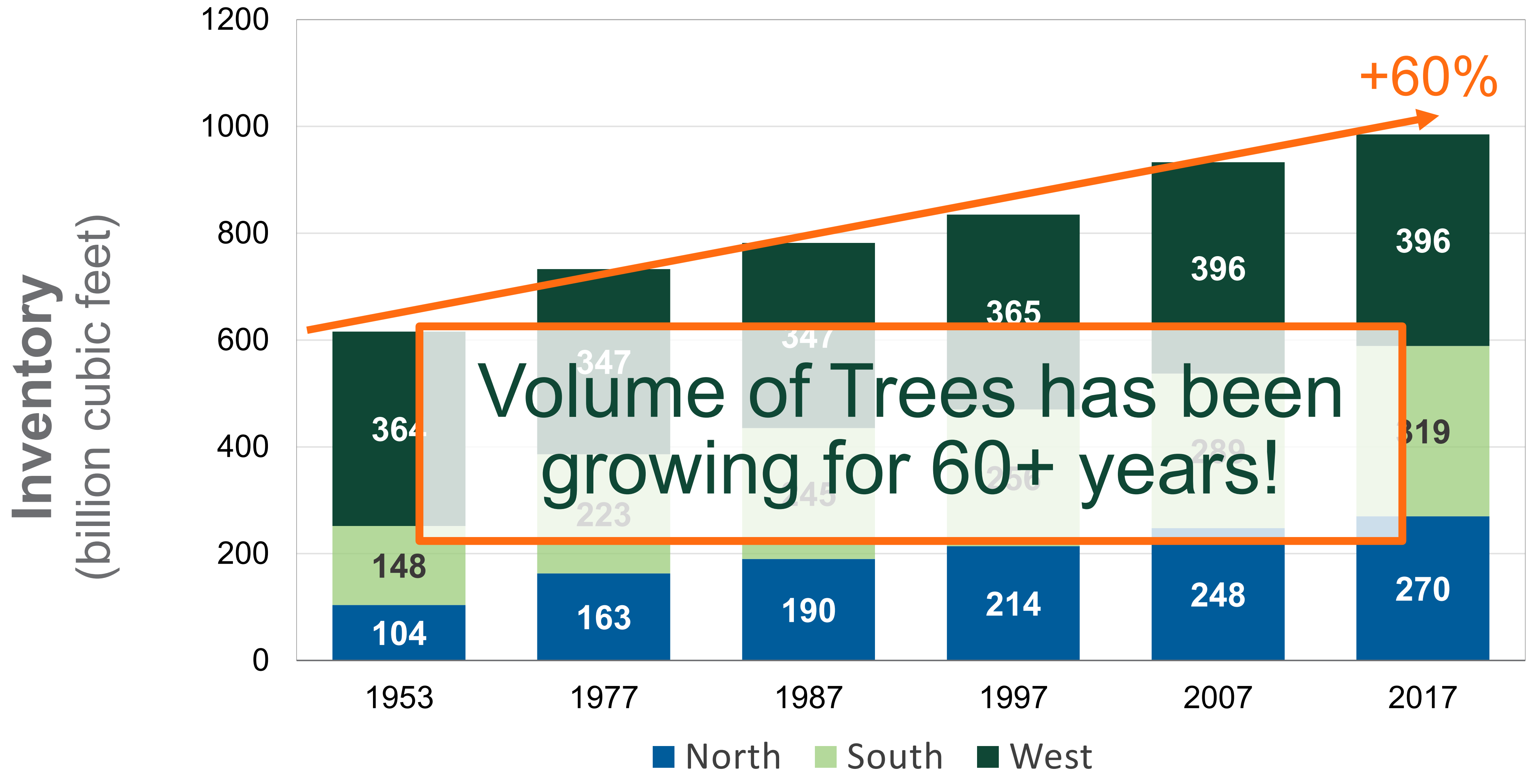
U.S. Forest Land:

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



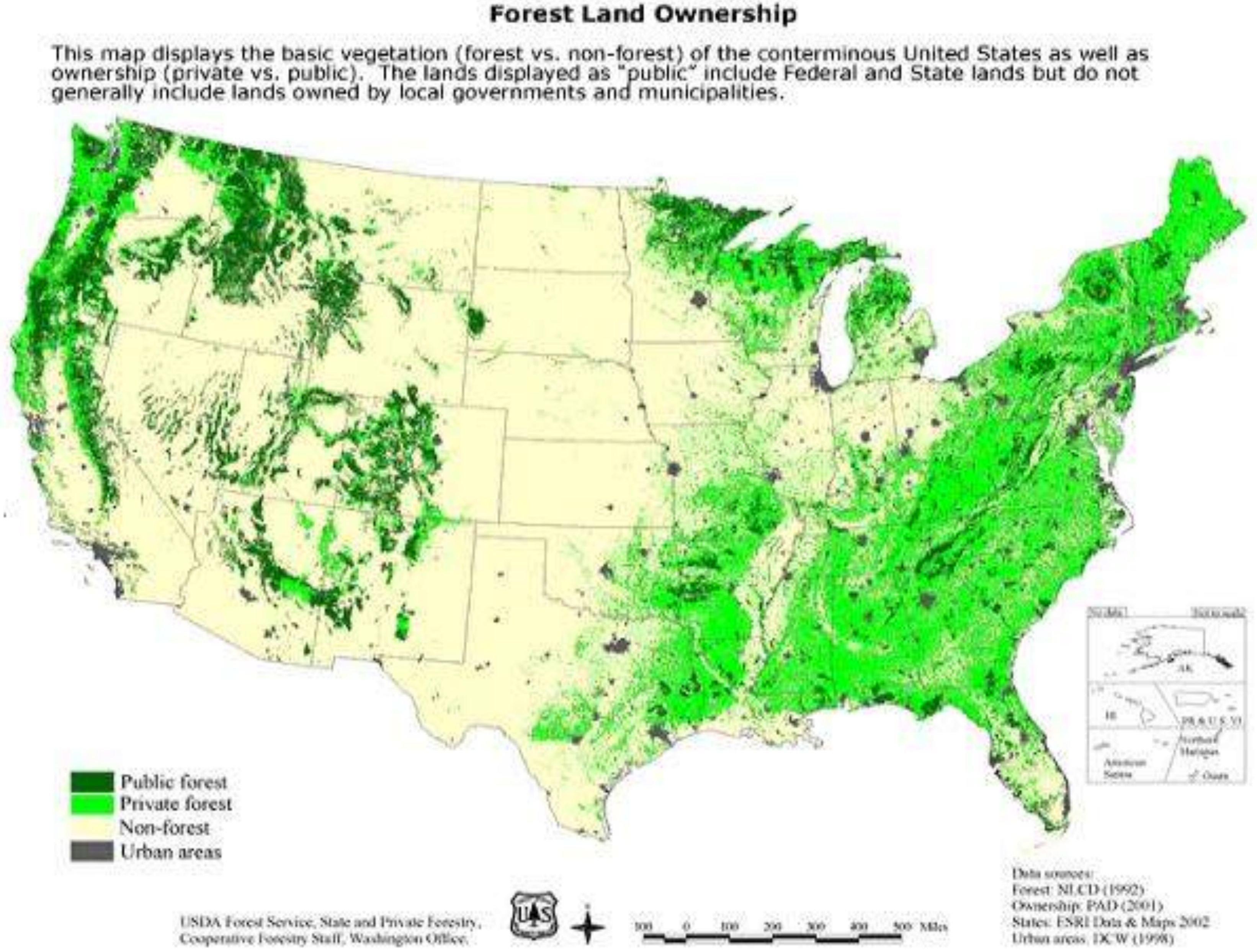
Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

State of our Forests: US Timber Volume on Timberland

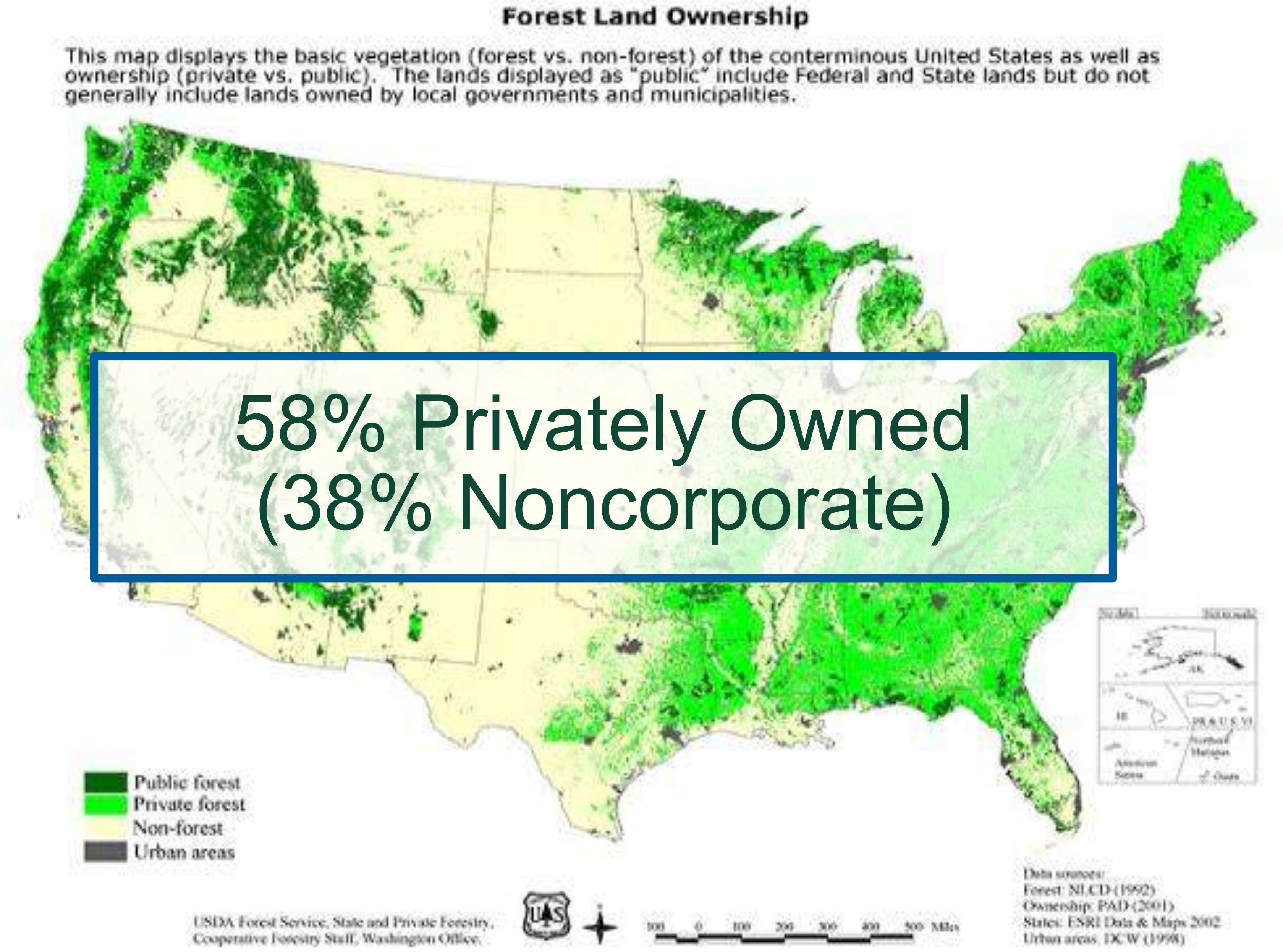


Source: USDA-Forest Service, Forest Resources of the United States, 2017 (2018)

US Forest Lands

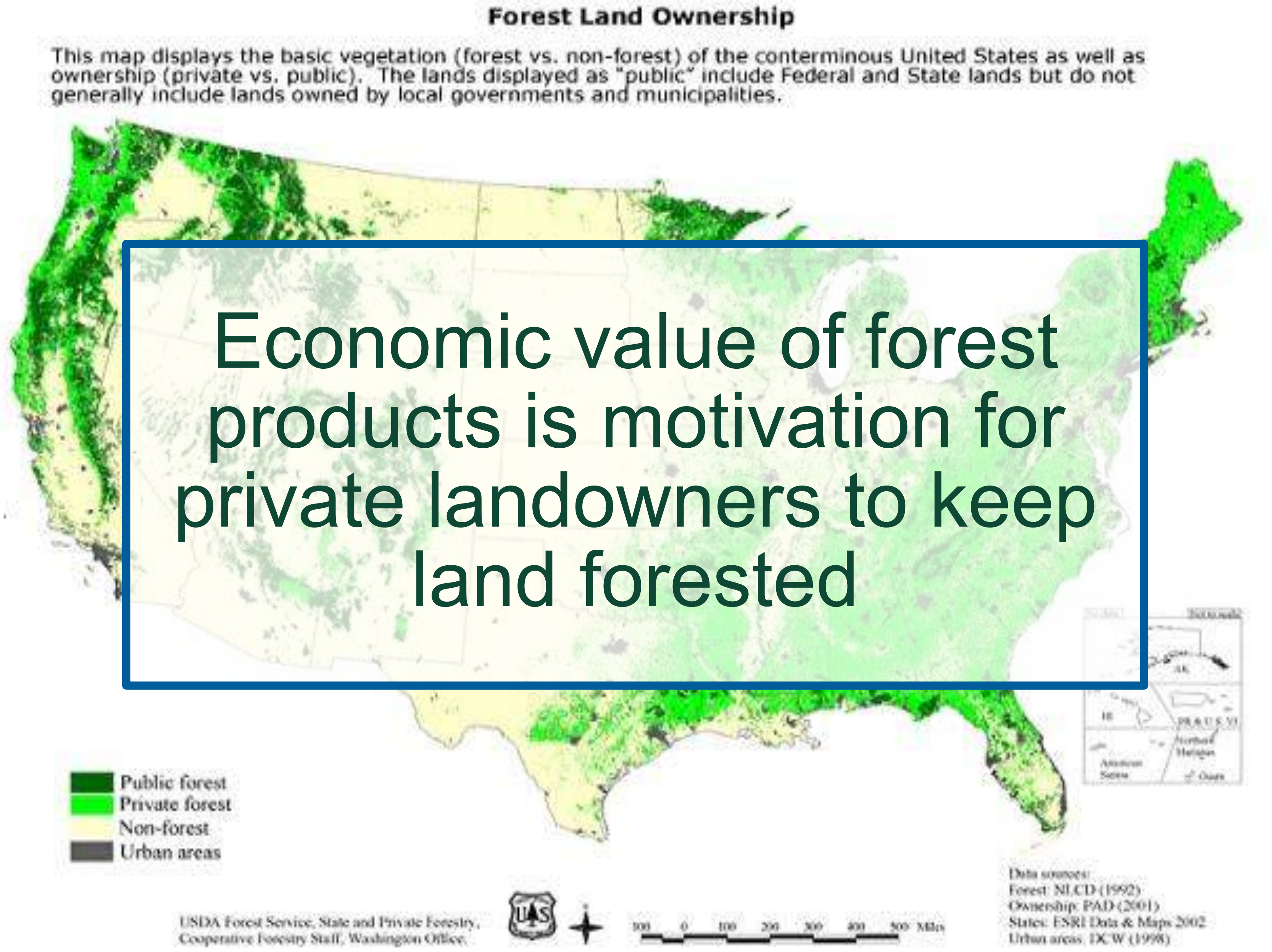


US Forest Lands



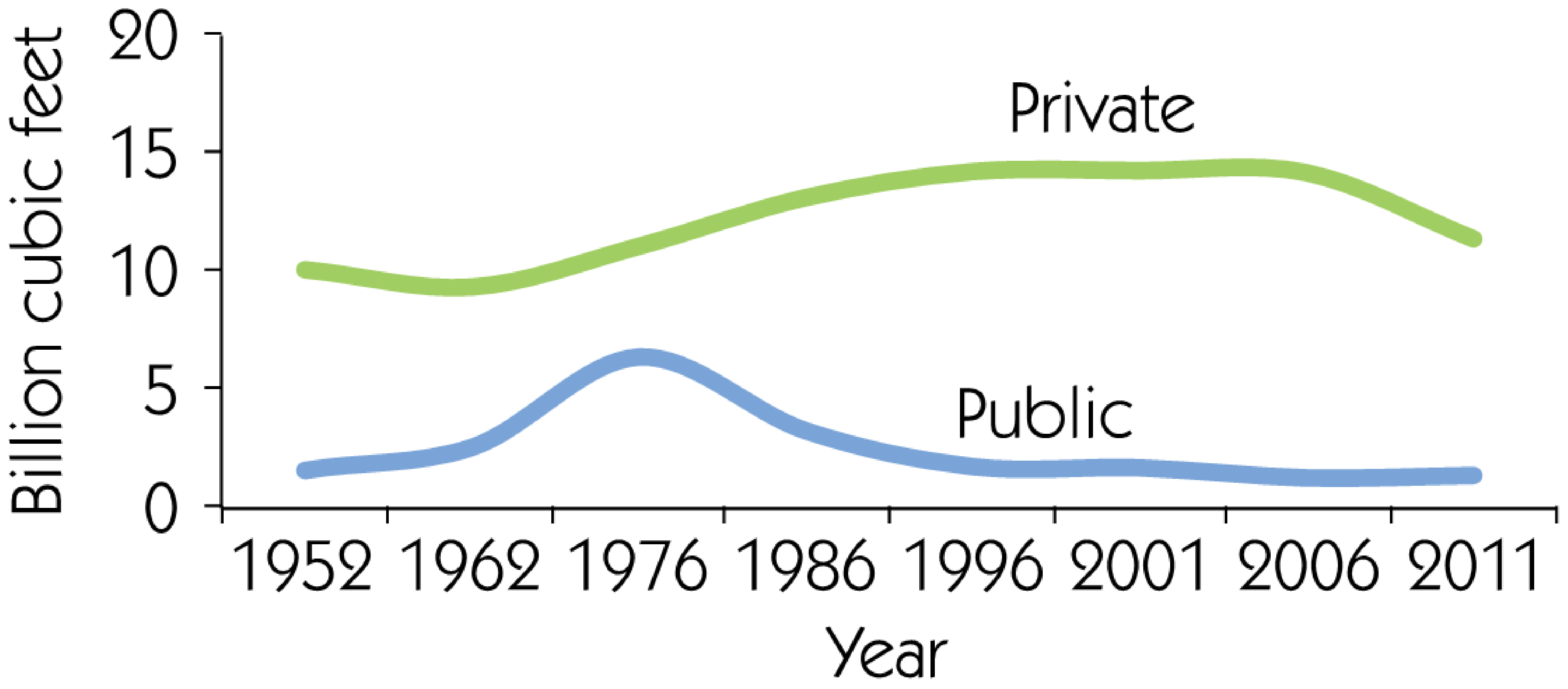
58% Privately Owned
(38% Noncorporate)

US Forest Lands

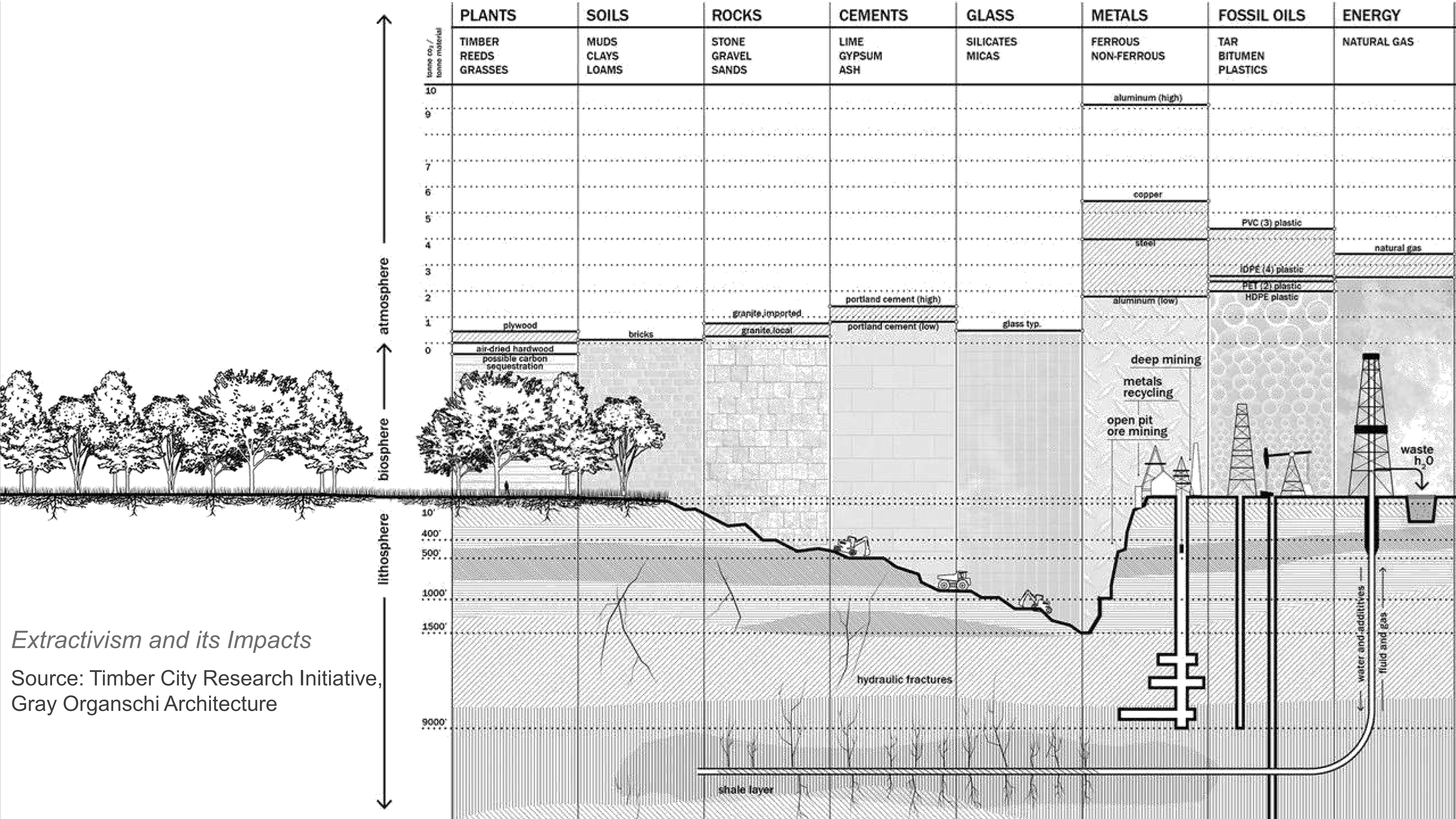


Economic value of forest products is motivation for private landowners to keep land forested

US Forest Harvest by Owner



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



Extractivism and its Impacts

Source: Timber City Research Initiative, Gray Organschi Architecture

Carbon Benefits of Wood

- **Lower embodied carbon** compared to other common building materials
- **Less fossil fuel consumed** during manufacture
- **Avoid process emissions**
- Extended carbon **storage in products**
- **Carbon sequestration** in forests
- Promotes **forest health**

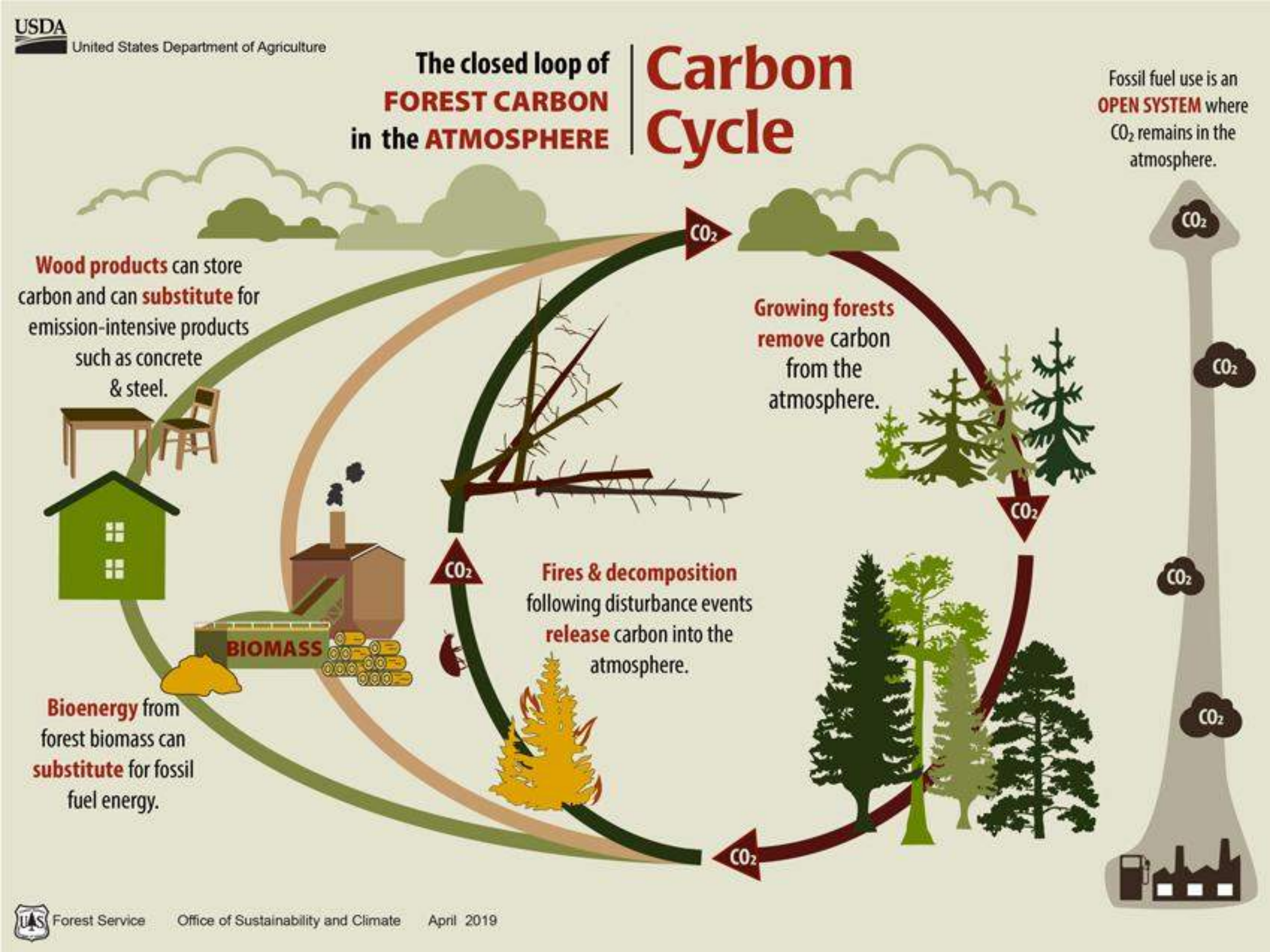


Image: USDA US Forest Service

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**.

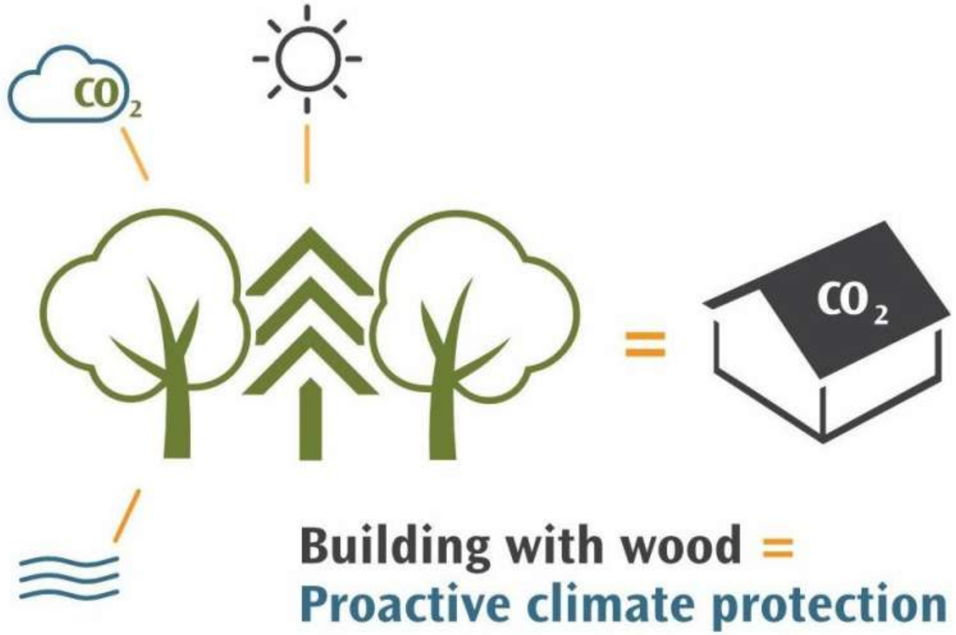


Image: Dovetail Partners, Inc.

Carbon Storage

Wood ≈ 50% Carbon (dry weight)


Image: Kaiser + Path


Image: Lever Architecture

Carbon vs CO_2

+ 2 *

= 44 CO_2

1 ton Carbon ≠ 1 ton CO_2

1 ton Carbon = (44/12=) **3.67 tons CO_2**

Carbon Storage Calculation

Douglas-Fir-Larch:

1 ft^3 = 34.5 lb (15% MC)

= 30.0 lb (dry)

50% Carbon by (dry) weight:

1 ft^3 = 15 lb Carbon stored

1 lb Carbon converts to 3.67 lb CO_2:

1 ft^3 = 55 lb CO_2

https://www.woodworks.org/resources/calculating-the-carbon-stored-in-wood-products/

Where is Carbon Stored?

Harvested Wood Pools

- Harvested Wood Products
- Solid Waste Disposal Sites

Forest Pools

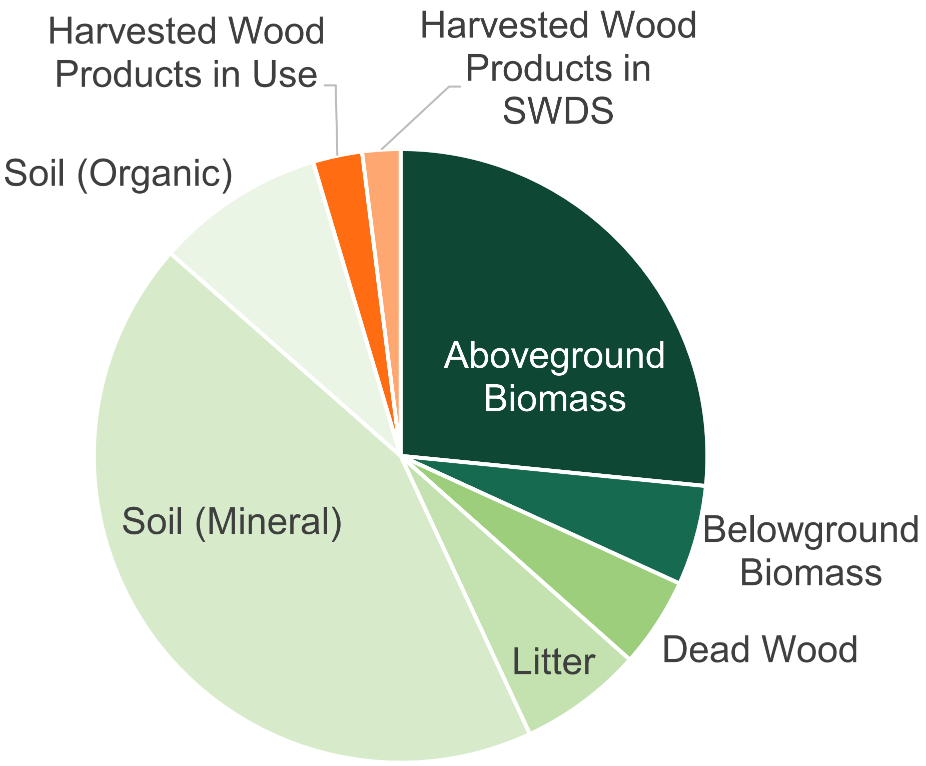
- Aboveground Biomass
- Belowground Biomass
- Dead Wood
- Litter or Forest Floor
- Soil Organic Carbon

Image: naturallywood.com

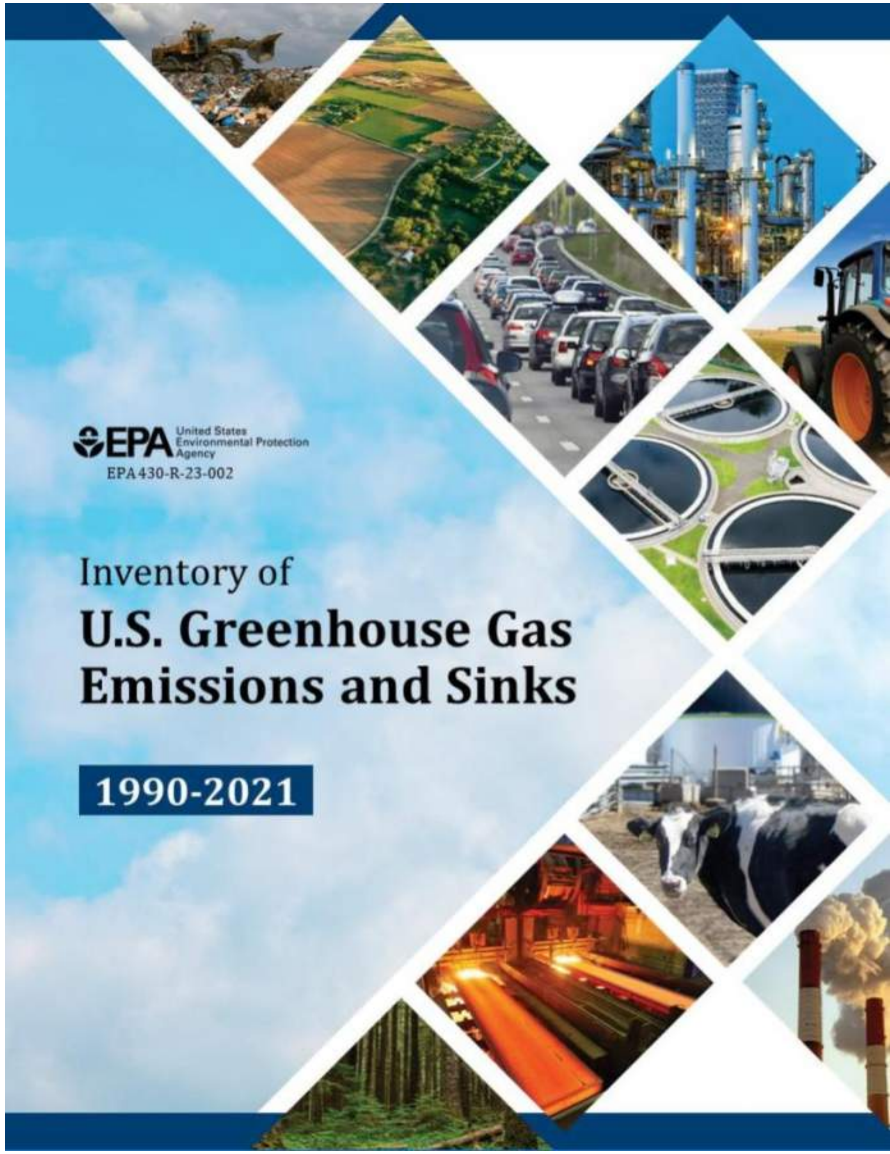
Source: https://usaforests.org/

Carbon Storage in Harvested Wood Products

As of 2022, the carbon stock for **Harvested Wood Products in Use** in the conterminous 48 states and Alaska is estimated at **1,549 Million Metric Tons**.



Carbon Stocks in Forest Land and Harvest Wood Pools, 2022



https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-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		2018	2019	2020	2021	2022
Forest Area (1,000 ha)	*282,150*		*281,096*		*280,467*	*280,299*	*280,120*	*279,962*	*279,800*
Carbon Pools (MMT C)									
Forest Ecosystem	**51,354**		**54,098**		**56,303**	**56,470**	**56,623**	**56,790**	**56,951**
Aboveground Biomass	11,899		13,849		15,406	15,523	15,635	15,749	15,861
Belowground Biomass	2,344		2,740		3,052	3,076	3,098	3,121	3,143
Dead Wood	1,948		2,359		2,717	2,745	2,771	2,799	2,827
Litter	3,929		3,922		3,896	3,896	3,888	3,888	3,888
Soil (Mineral)	25,920		25,911		25,914	25,914	25,914	25,915	25,916
Soil (Organic)	5,315		5,318		5,318	5,317	5,317	5,317	5,317
Harvested Wood	**1,895**		**2,353**		**2,645**	**2,671**	**2,695**	**2,721**	**2,749**
Products in Use	1,249		1,447		1,516	1,523	1,530	1,539	1,549
SWDS	646		906		1,129	1,147	1,165	1,182	1,200
Total C Stock	**53,249**		**56,451**		**58,948**	**59,141**	**59,318**	**59,511**	**59,701**

https://www.epa.gov/system/files/documents/2023-04/US-GHG-Inventory-2023-Main-Text.pdf

Harvested Wood Products

- **Solid sawn** wood product:
  - **Lowest embodied** carbon
- **Engineered** wood products:
  - More processing steps (more embodied carbon)
  - **Significantly less embodied** carbon than non-wood

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

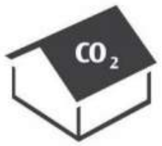
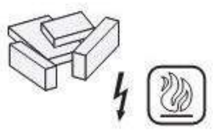
Image: Weyerhaeuser

Image: LP Building Solutions

Image: Structurecraft

Image: Georgia-Pacific

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 carbon**	**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.

WoodWorks Carbon Calculator

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

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

ULI Report: The Materials Movement

Office Occupier Demand for Healthy Materials:

- » Powerful expression of tenant’s brand
- » Helps recruit top talent
- » Healthy air quality supports worker productivity, cognitive performance, mental & physical health

Enhanced Building Value:

- » Office green premium on rents: from 2% to >15%
- » Certified healthy buildings transact 4.4% to 7.7% higher rent per SF than noncertified buildings

“Building with mass timber provides a host of benefits to stakeholders across the real estate value chain.”

https://knowledge.uli.org/reports/research-reports/2023/the-materials-movement-creating-value-with-better-building-materials

Lakeridge Middle School / Mahlum Architects / KPFF / Photo Arthur Ross

Credits for Sustainable/ Well Certifications

LEED v4.1 BD+C

Indoor Environmental Air Quality

- Low-Emitting Materials Thermal Comfort

Materials & Resources

- Environmental Product Declarations
- Responsible Sourcing of Raw Materials
- Building Life-Cycle Impact Reduction
- Construction & Demolition Waste Management

Passive House 3rd Edition

Core Principles

- Thermal Insulation
- Thermal Bridge Reduced Design
- Airtightness

WELL v2

Materials

- Materials Transparency

Mind

- Nature & Place
- Restorative Spaces

Thermal Comfort

- Thermal Performance
- Verified Thermal Comfort

Living Building Challenge 4.0

Energy Petal

- Energy + Carbon Reduction
- Net Positive Carbon

Materials Petal

- Responsible Materials
- Responsible Sourcing
- Living Economy Sourcing
- Red List
- Net Positive Waste

Beauty Petal

- Beauty + Biophilia

Source: Mercer Mass Timber and The Environment

Quantifying the Benefits

Life Cycle Assessment (LCA)

"Evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle"

» Systematic, scientific **quantification**

Used for:

» Single products or processes: e.g., a wood product

» Complex, integrated systems: e.g., an entire building (**WBLCA**)

https://www.woodworks.org/resources/introduction-to-whole-building-life-cycle-assessment-the-basics/

Source: ISO 21930:2017(E), 3.3.2

Life Cycle Assessment (LCA)

"Evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle"

Environmental Impacts:

- Global Warming Potential (GWP)
- Ozone depletion
- Smog formation
- Acidification
- Eutrophication
- Depletion of nonrenewable resources
- Etc.

Source: ISO 21930:2017(E), 3.3.2

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- Global Warming Potential (GWP)
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- Eutrophication
- Depletion of nonrenewable resources
- Etc.

Life Cycle Stages:

- Harvesting or mining
- Manufacture
- Transportation and installation
- Maintenance, repair and replacement
- Decommissioning and disposal/reuse

Source: ISO 21930:2017(E), 3.3.2

Life Cycle of a Building

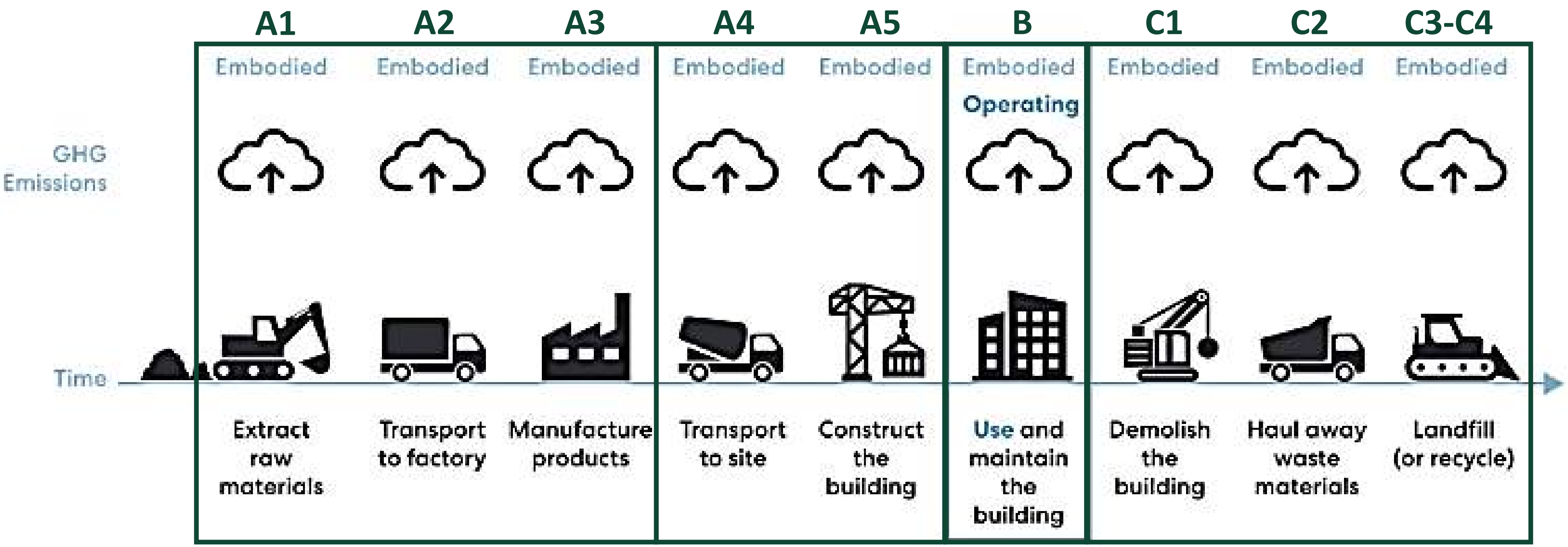
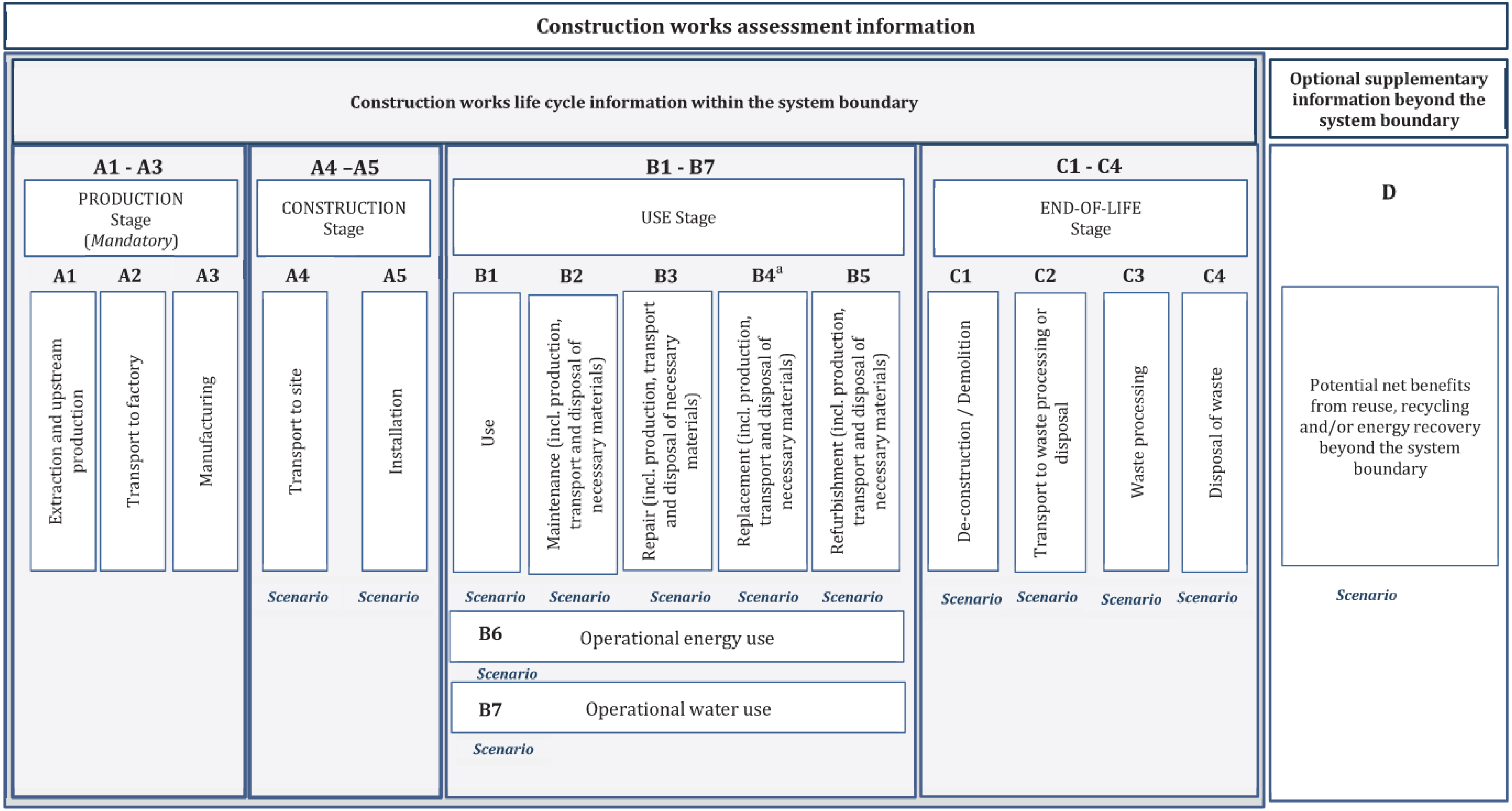


Image: Think Wood



[a] Replacement information module (B4) not applicable at the product level.

Source: ISO 21930:2017(E), Figure 2

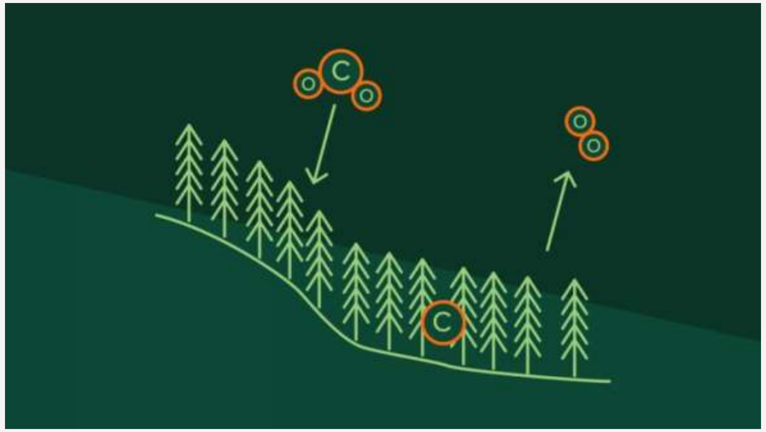
What makes wood different?
Biogenic Carbon

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:

$$6\ CO_2 + 6\ H_2 0 \rightarrow \mathbf{C_6} H_{12} O_6\ (\textbf{stored}) + 6\ O_2\ (\text{released})$$



Source: ISO 21930:2017(E), 3.7

Biogenic Carbon

"Bio-based materials originating from renewable resources (such as wood…) contain biogenic carbon."

» Biogenic carbon removals and emissions **shall be reported** as CO_2 in the LCI
» When entering the product system (**removal**), characterized with a factor of **-1**
» When converted to emissions (**emission**), characterized with a factor of **+1**
» When leaving the product system (**export**), characterized with a factor of **+1**

https://www.woodworks.org/resources/when-to-include-biogenic-carbon-in-an-lca/

Source: ISO 21930:2017(E), 7.2.7

Biogenic Carbon Accounting

-1 in

Removal of carbon from the atmosphere

+1 out

Emission or export of carbon from product system

Biogenic Carbon Accounting

-1 in

Removal of carbon from the atmosphere

+1 out

Note that "exports" are <u>not</u> direct emissions to the atmosphere.

Emission or export of carbon from product system

Biogenic Carbon

“For wood, biogenic carbon may be characterized with a -1… when entering the product system **only when the wood originates from sustainably managed forests.”**

So…

What is a sustainably managed forest?

Source: ISO 21930:2017(E), 7.2.7

Sustainably Managed Forests

“… zero emissions associated with land use change”

Option 1:

Includes wood products *responsibly sourced and certified* to:

» **Standards** globally endorsed by PEFC and FSC

» FSC, SFI, CSA, ATFS, etc.

Option 2: (NOTE 2)

» “The concept of sustainably managed forests is linked but not limited to respective certification schemes”

» Evidence such as national reporting under UNFCCC to identify forests with stable or increasing forest carbon stocks

Source: ISO 21930:2017(E), 7.2.11

Sustainably Managed Forests

"... zero emissions associated with land use change"

Option 1:

Includes wood products *responsibly sourced and certified* to:

- » **Standards** globally endorsed by PEFC and FSC
- » FSC, SFI, CSA, ATFS, etc.

This includes "responsible sourcing" standards and does not require that all wood come from certified forests.

Option 2: (NOTE 2)

- » "The concept of sustainably managed forests is linked but not limited to respective certification schemes"
- » Evidence such as national reporting under UNFCCC to identify forests with stable or increasing forest carbon stocks

Source: ISO 21930:2017(E), 7.2.11

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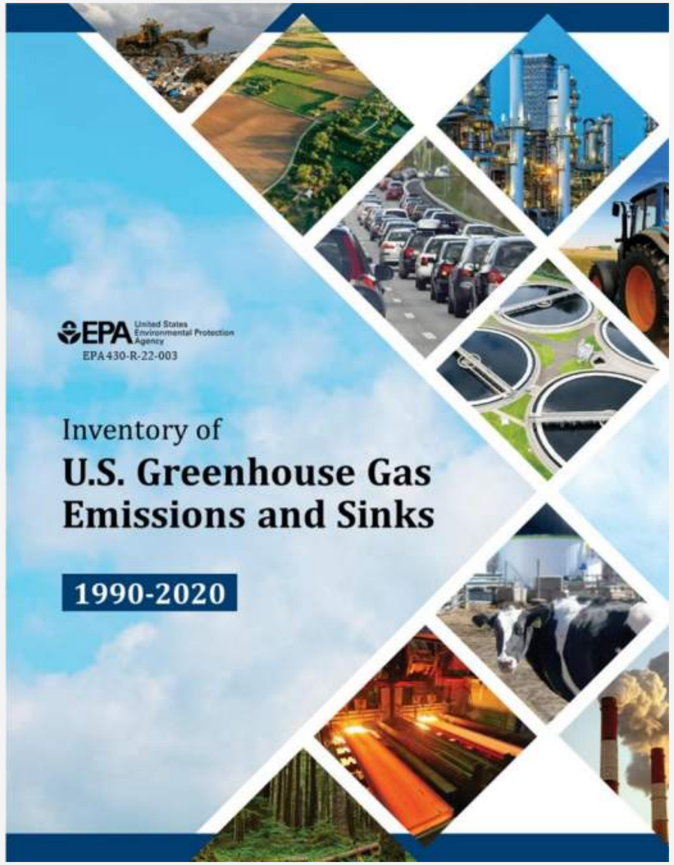
https://www.woodworks.org/resources/when-to-include-biogenic-carbon-in-an-lca/

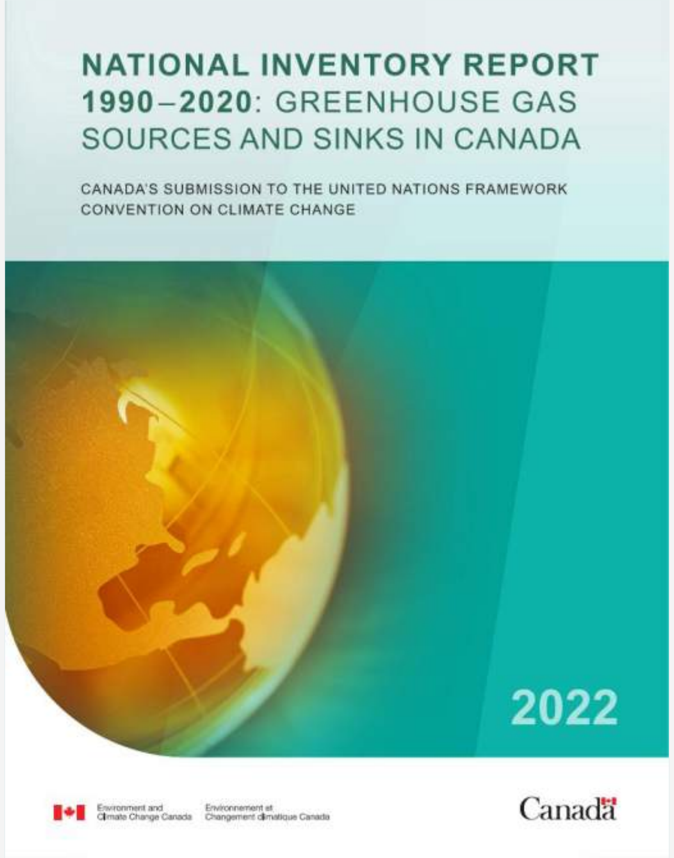
Source: ISO 21930:2017(E), 7.2.11

UNFCCC National Reporting

"… stable or increasing forest carbon stocks"



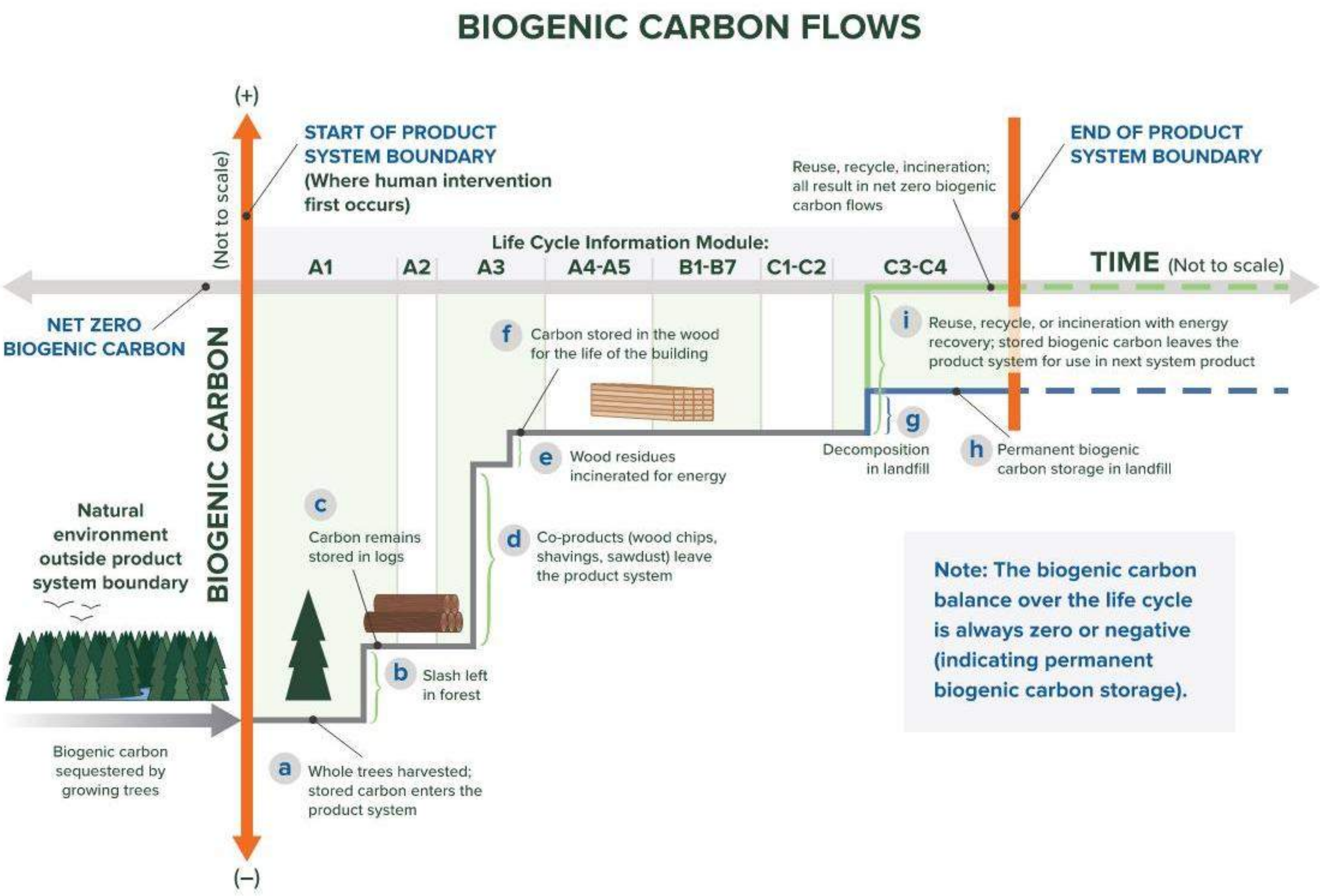
See Table 6-10



See Table 6-1

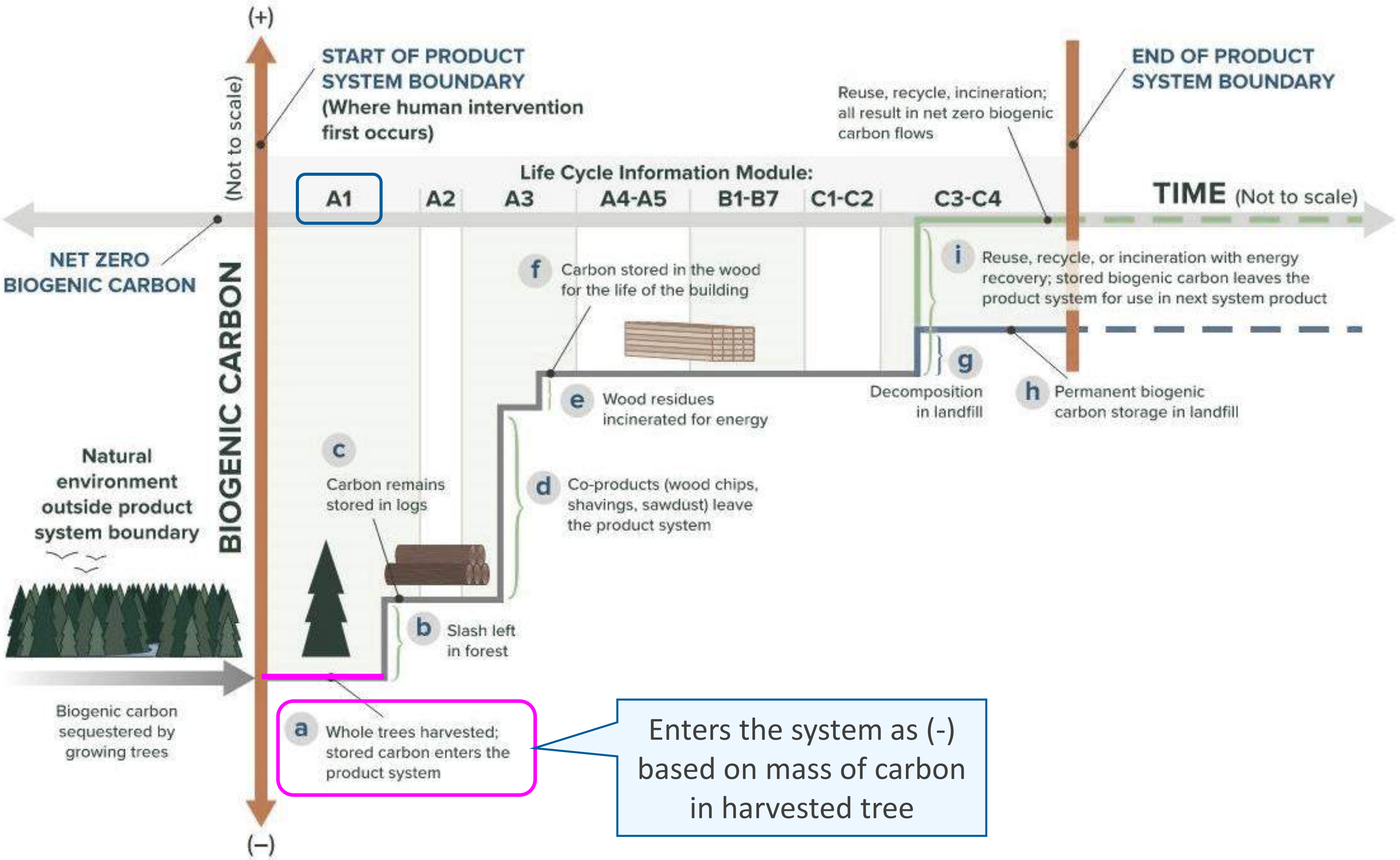
Should I include biogenic carbon?

Yes! But how?



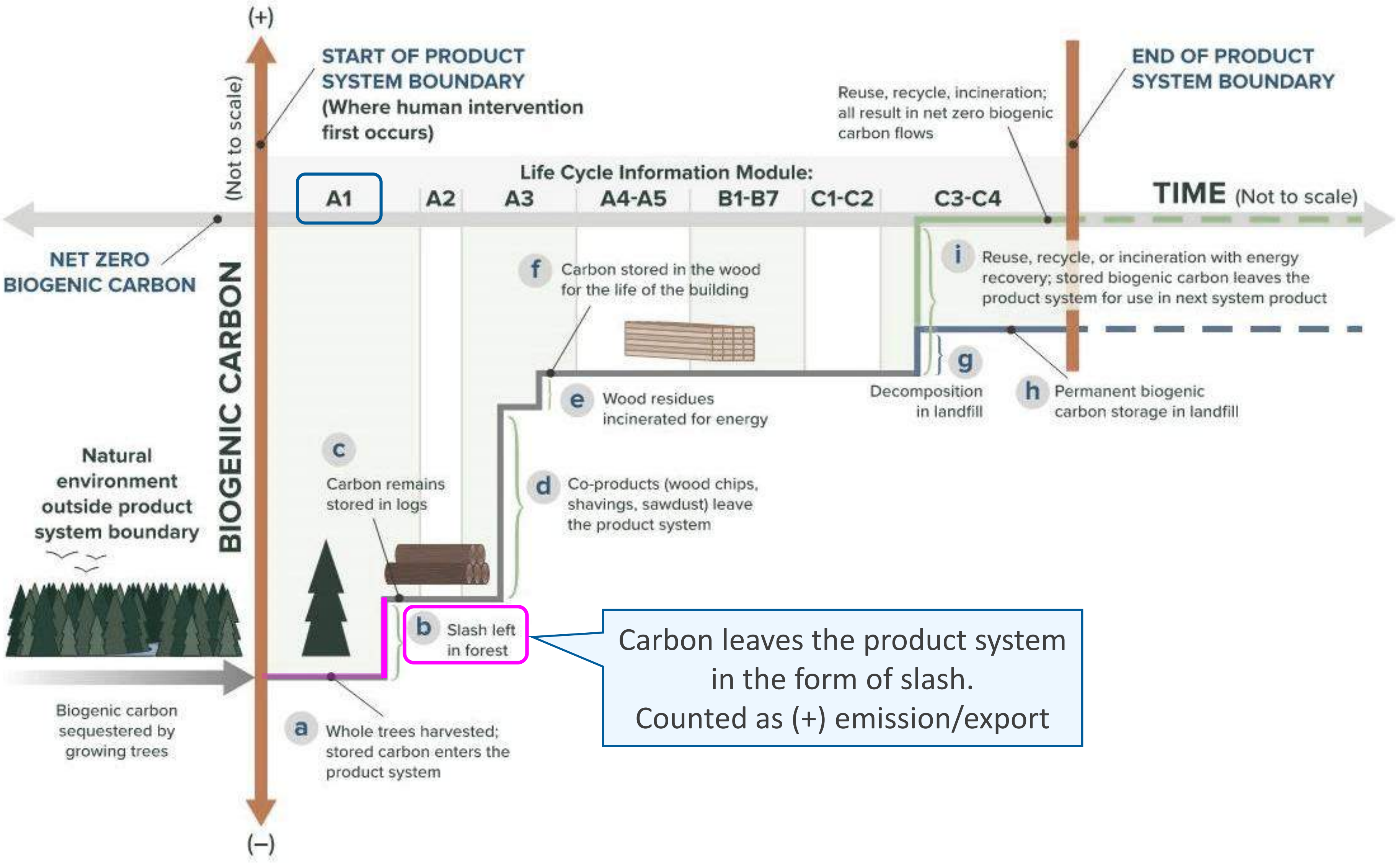
https://www.woodworks.org/resources/how-to-include-biogenic-carbon-in-an-lca/

BIOGENIC CARBON FLOWS



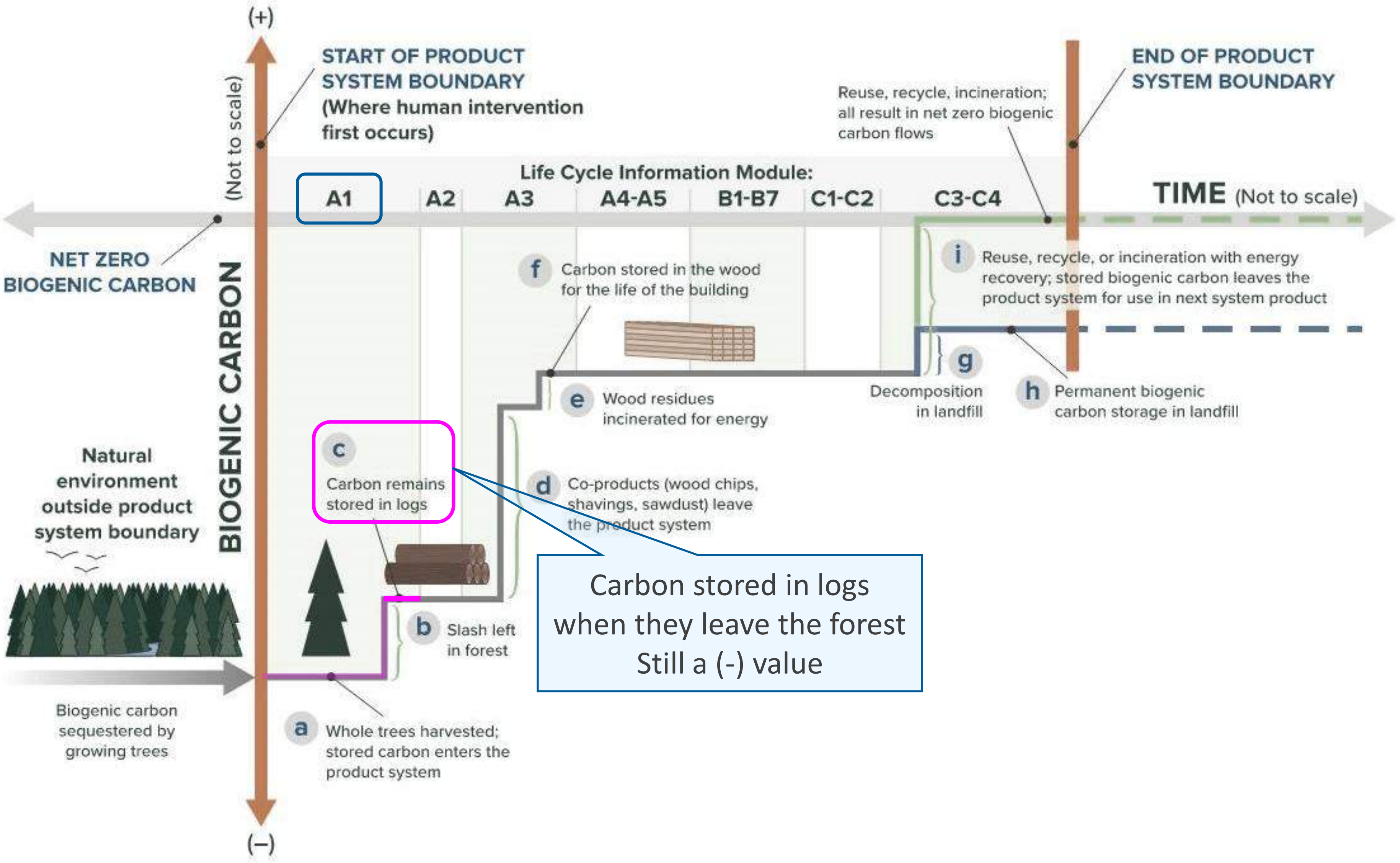
Enters the system as (-) based on mass of carbon in harvested tree

BIOGENIC CARBON FLOWS

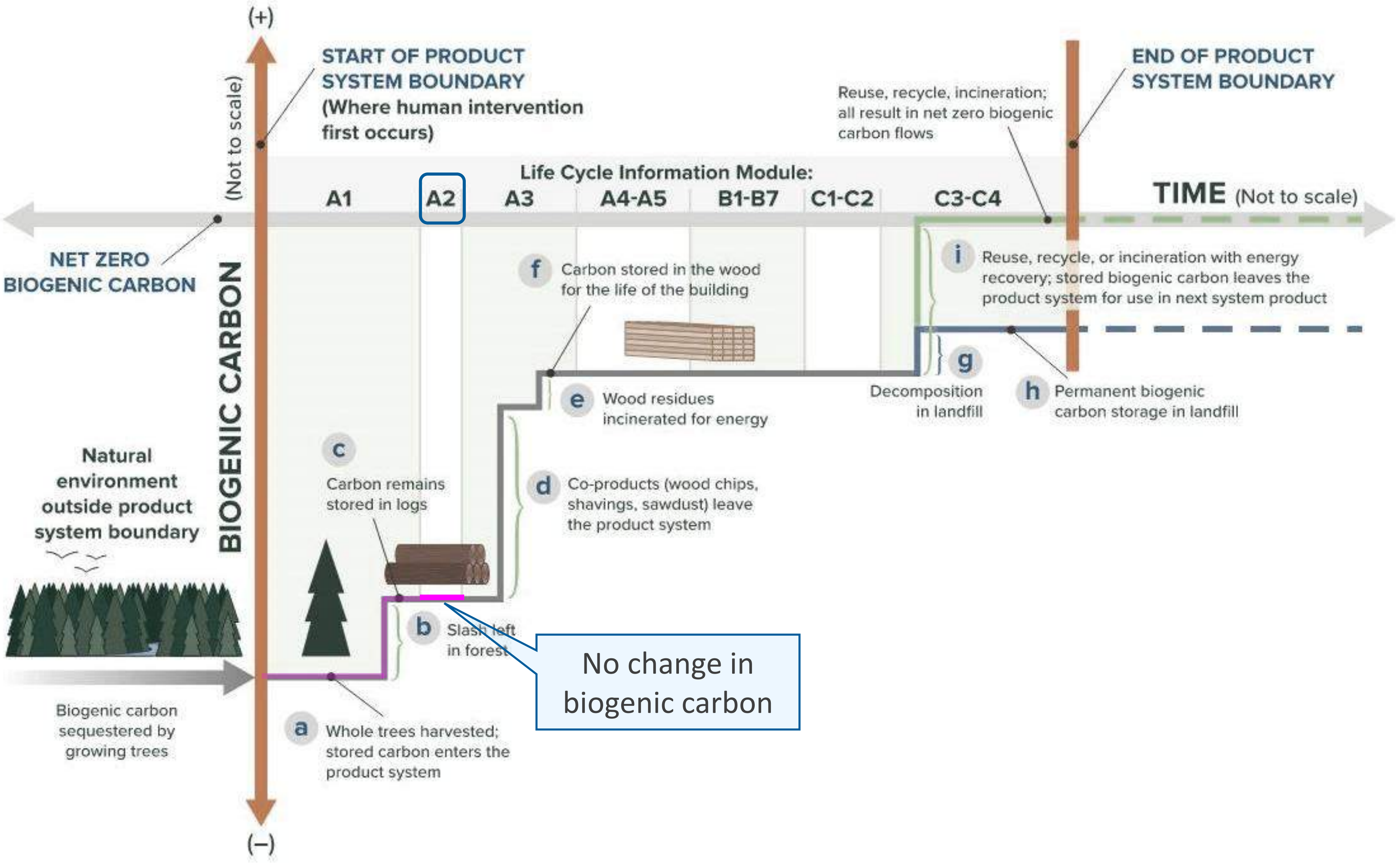


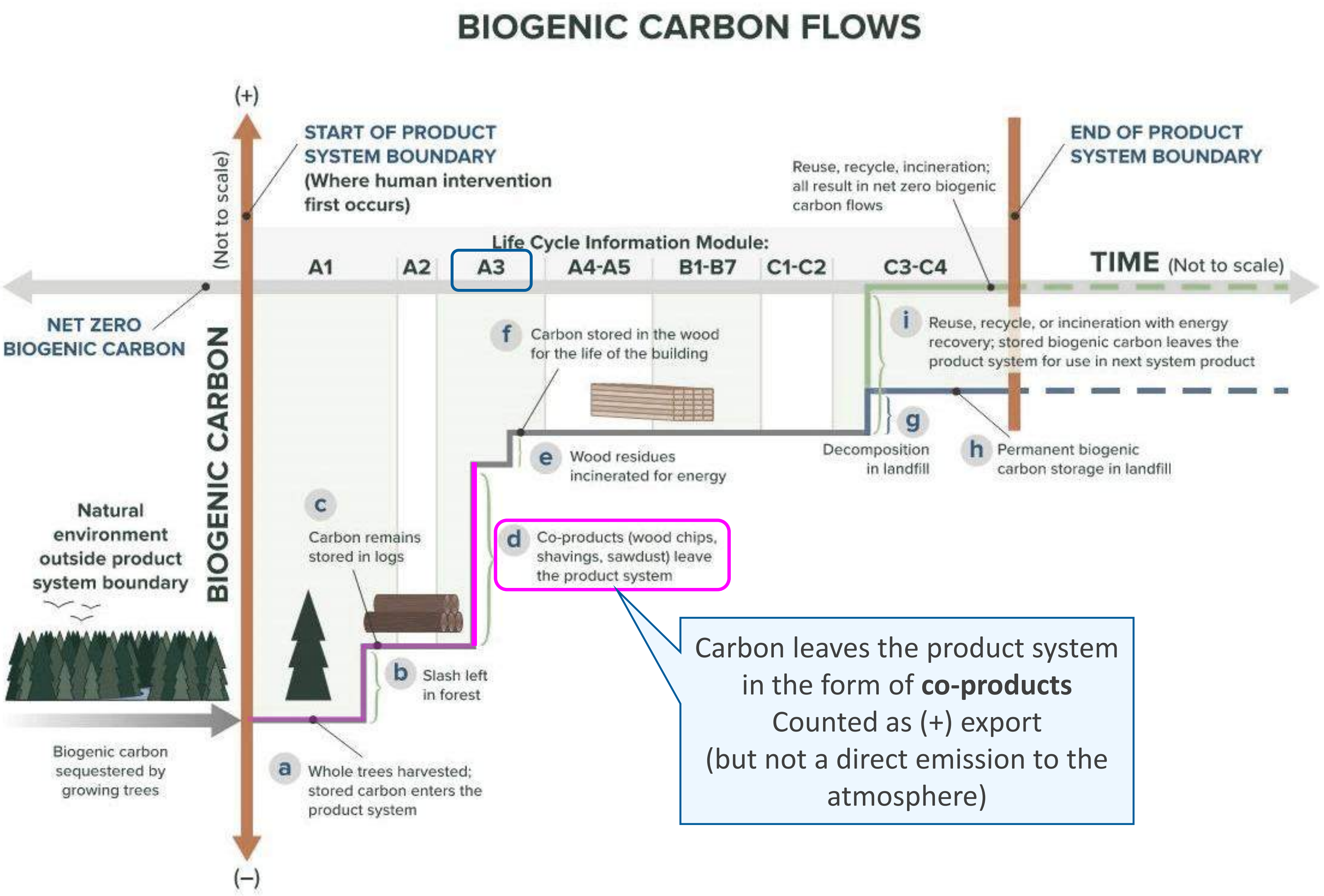
Carbon leaves the product system
in the form of slash.
Counted as (+) emission/export

BIOGENIC CARBON FLOWS

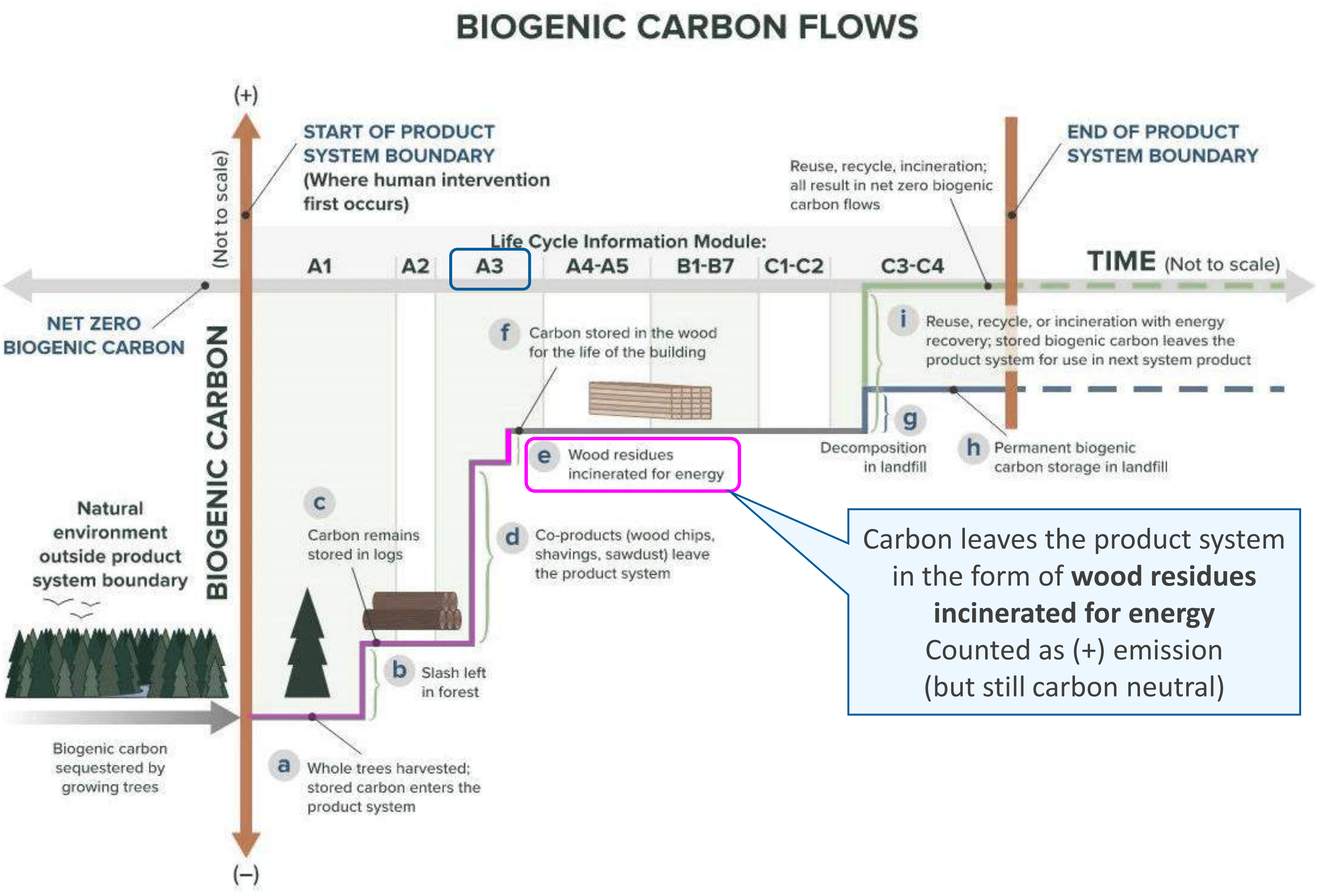


BIOGENIC CARBON FLOWS



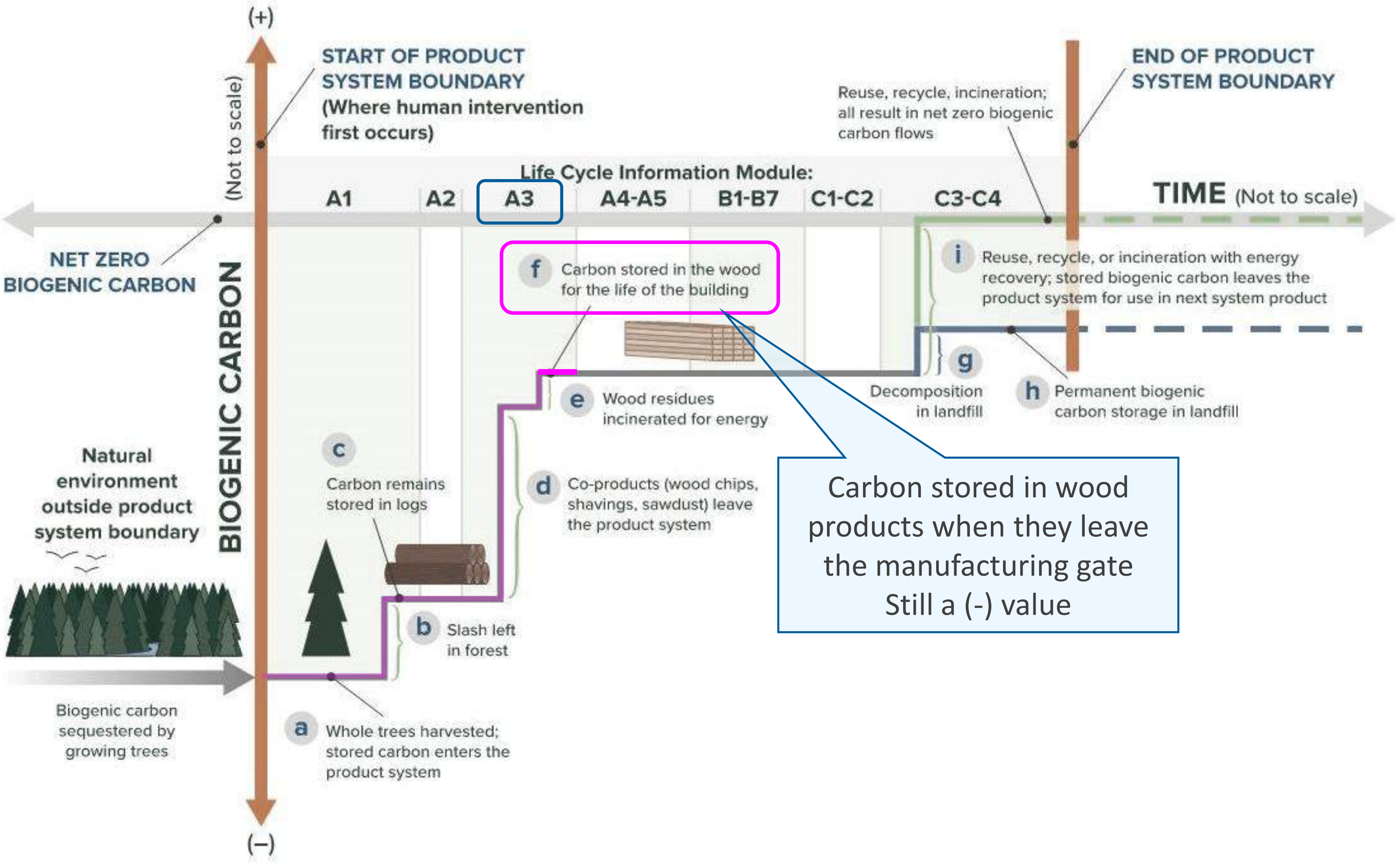


Carbon leaves the product system in the form of **co-products**
Counted as (+) export
(but not a direct emission to the atmosphere)

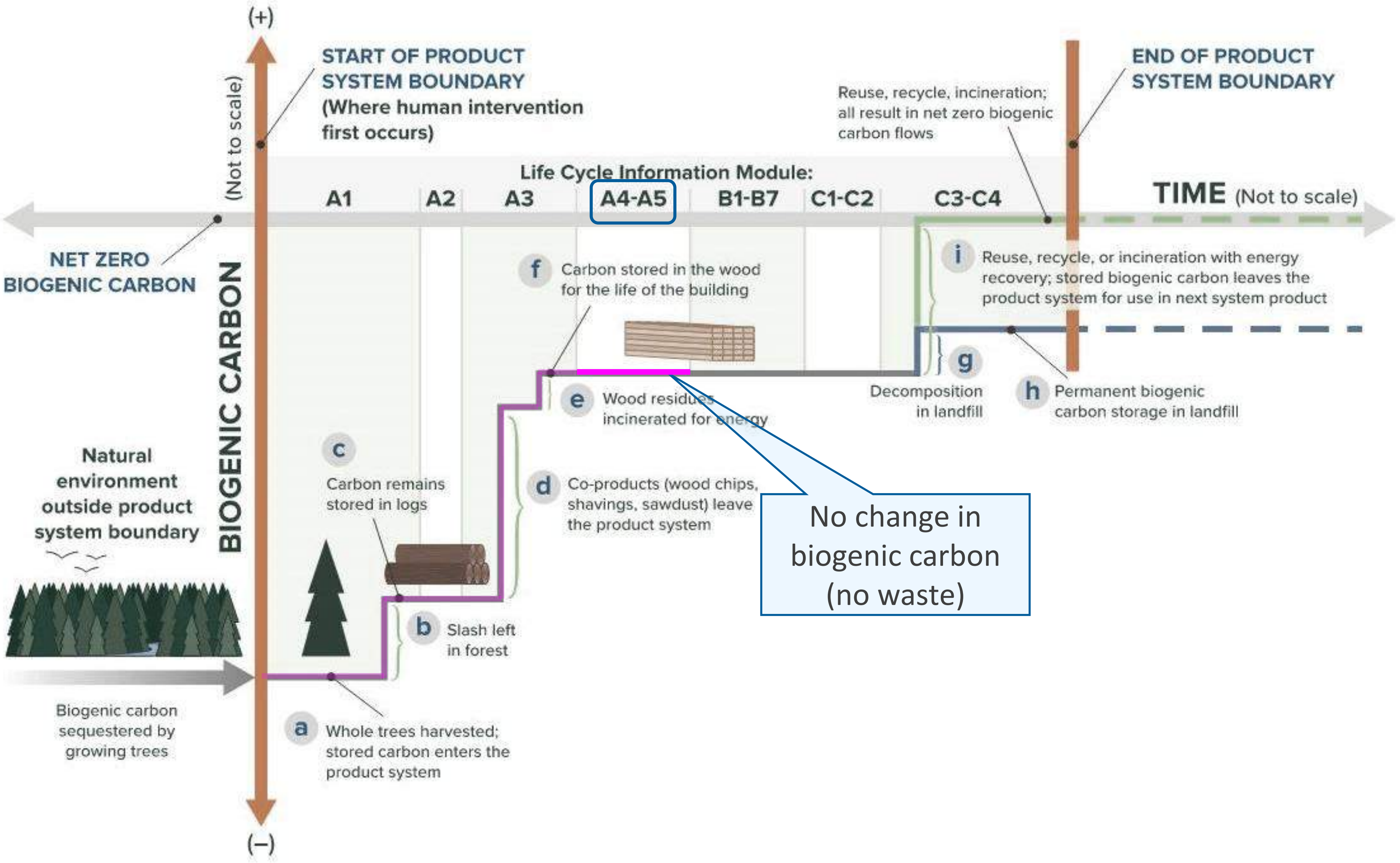


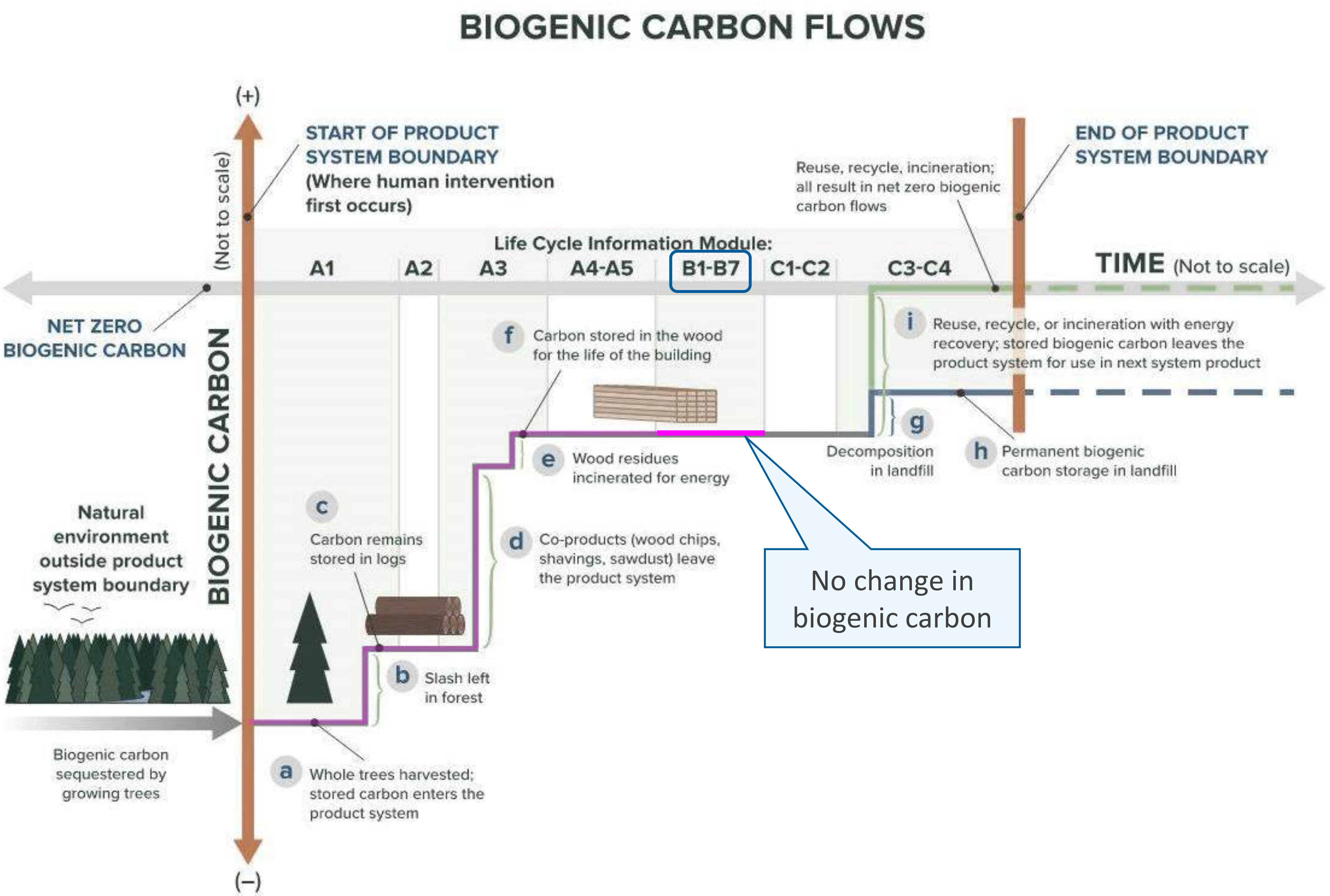
Carbon leaves the product system in the form of **wood residues incinerated for energy**
Counted as (+) emission
(but still carbon neutral)

BIOGENIC CARBON FLOWS

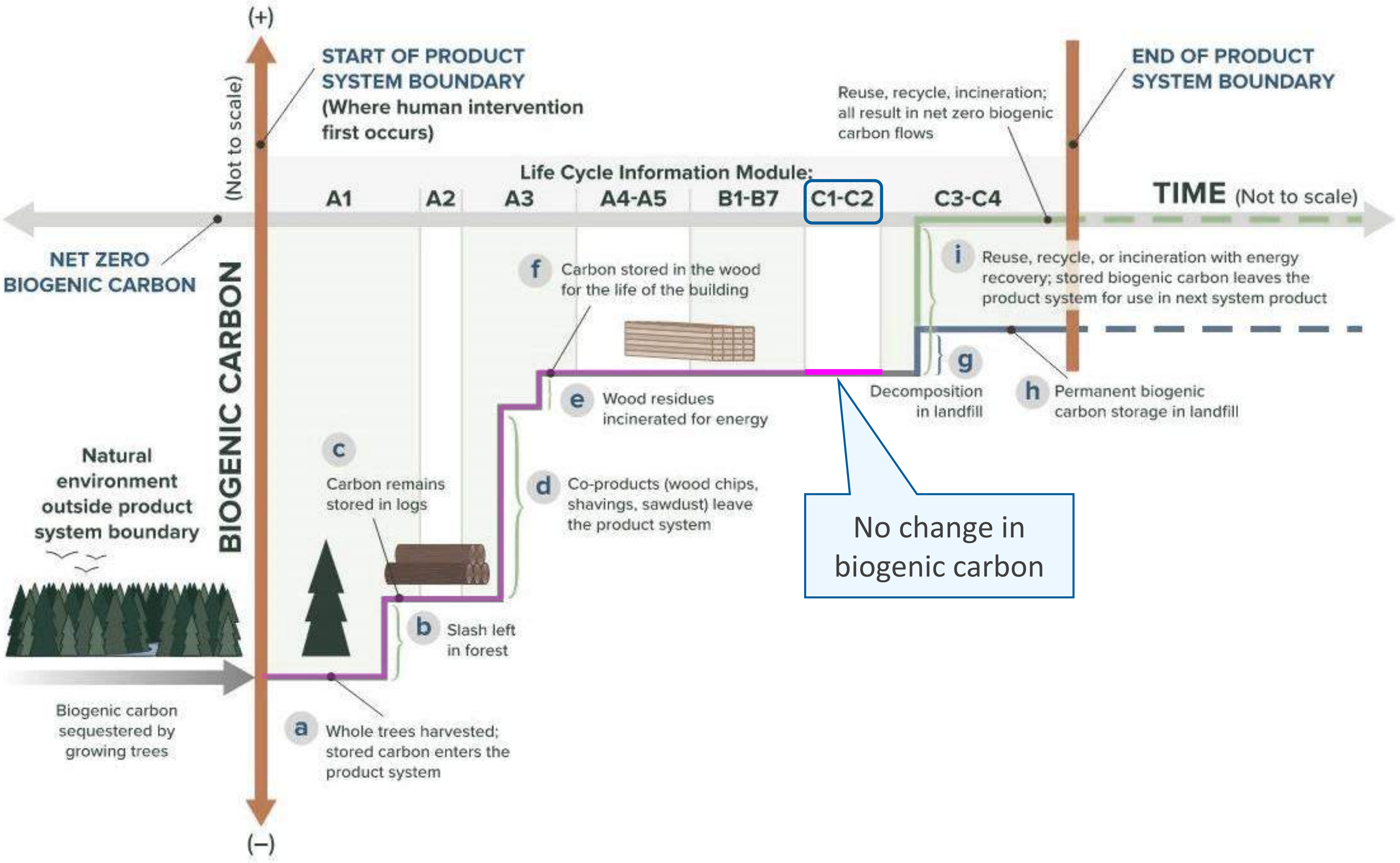


BIOGENIC CARBON FLOWS




BIOGENIC CARBON FLOWS
(+)
START OF PRODUCT SYSTEM BOUNDARY (Where human intervention first occurs)
(Not to scale)
END OF PRODUCT SYSTEM BOUNDARY
Reuse, recycle, incineration; all result in net zero biogenic carbon flows
Life Cycle Information Module:
A1
A2
A3
A4-A5
B1-B7
C1-C2
C3-C4
TIME (Not to scale)
NET ZERO BIOGENIC CARBON
BIOGENIC CARBON
i Reuse, recycle, or incineration with energy recovery; stored biogenic carbon leaves the product system for use in next system product
f Carbon stored in the wood for the life of the building
g Decomposition in landfill
h Permanent biogenic carbon storage in landfill
e Wood residues incinerated for energy
c Carbon remains stored in logs
d Co-products (wood chips, shavings, sawdust) leave the product system
No change in biogenic carbon
Natural environment outside product system boundary
b Slash left in forest
Biogenic carbon sequestered by growing trees
a Whole trees harvested; stored carbon enters the product system
(–)

BIOGENIC CARBON FLOWS



End-of-Life Fates for Wood Products

1. **Landfill**
2. **Incineration (for energy recovery)**
3. **Recycle**
4. **Direct Reuse**

End-of-Life Fates for Wood Products

1. Landfill
2. Incineration (for energy recovery)
3. **Recycle**
4. **Direct Reuse**

Processing required to turn existing product into new product for input into next system (i.e., chipping)

Minimal processing required

All biogenic carbon **leaves** the product system as an ***export*** (+1).

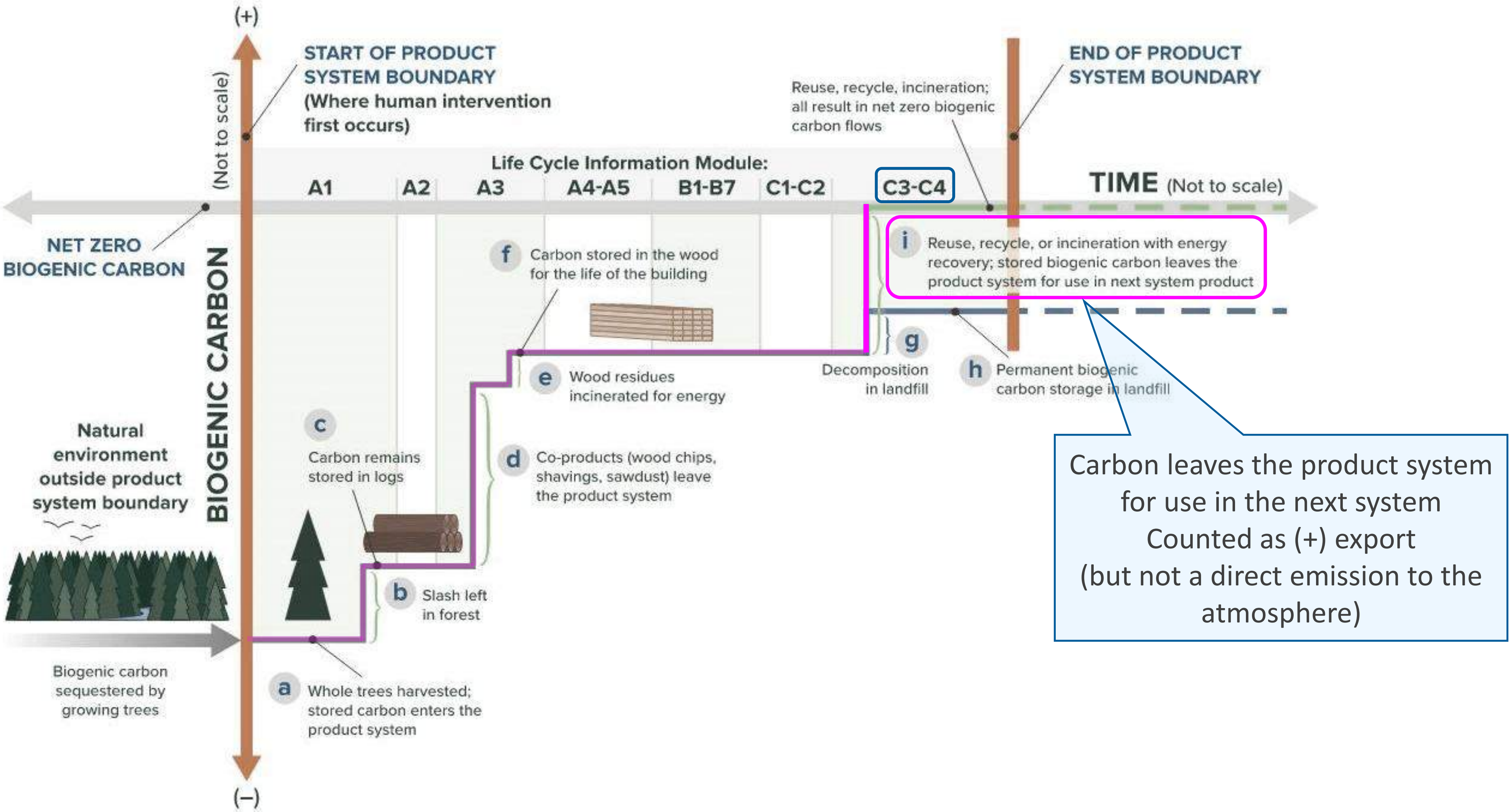
End-of-Life Fates for Wood Products

1. Landfill
2. **Incineration (for energy recovery)**
3. Recycle
4. Direct Reuse

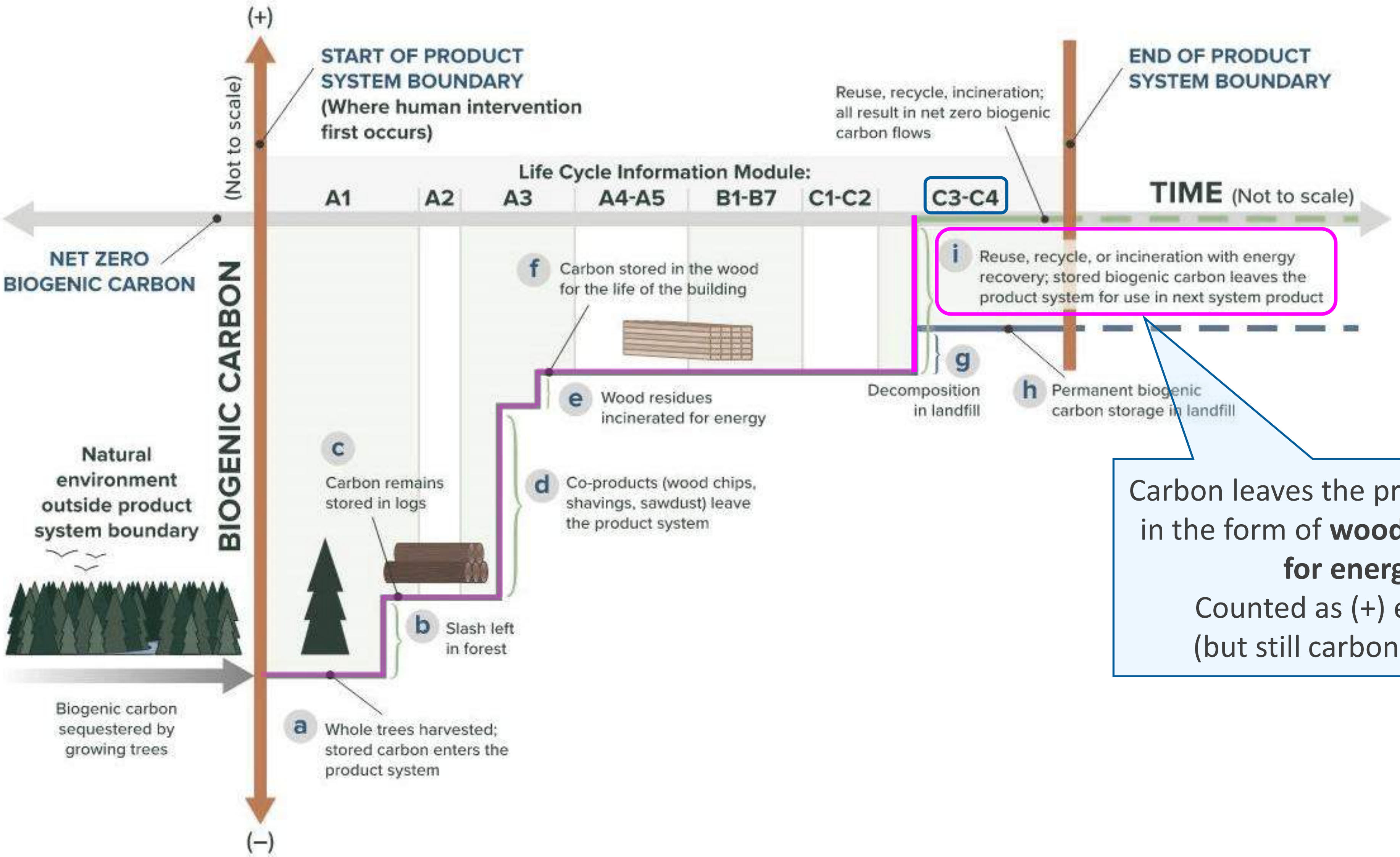
Does not include benefits of using recovered energy

All biogenic carbon **leaves** the product system as an ***emission*** (+1).

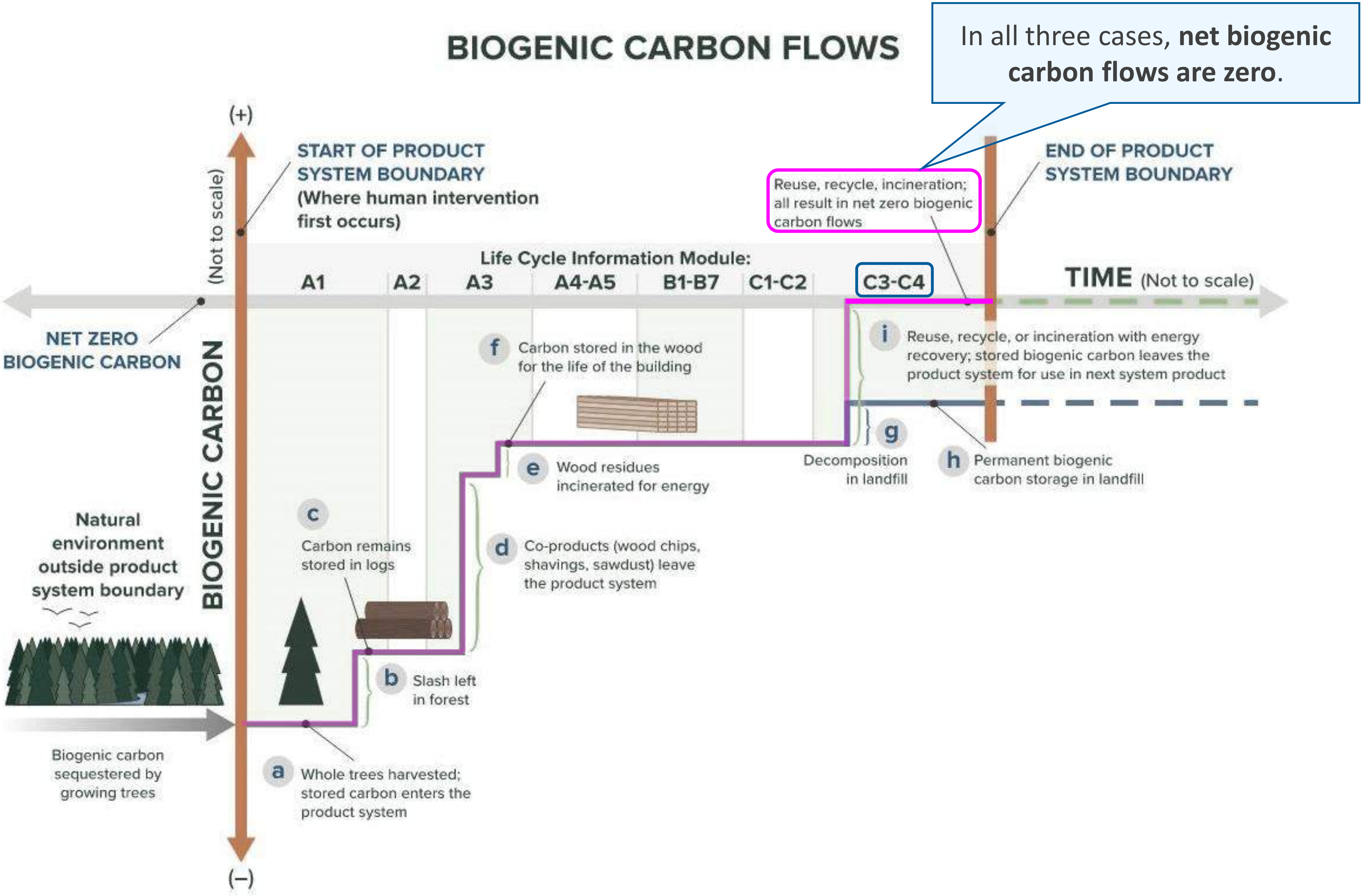
BIOGENIC CARBON FLOWS



BIOGENIC CARBON FLOWS



Carbon leaves the product system in the form of **wood incinerated for energy**
Counted as (+) emission
(but still carbon neutral)


BIOGENIC CARBON FLOWS
In all three cases, **net biogenic carbon flows are zero**.
(+)
START OF PRODUCT SYSTEM BOUNDARY
(Where human intervention first occurs)
Reuse, recycle, incineration; all result in net zero biogenic carbon flows
END OF PRODUCT SYSTEM BOUNDARY
(Not to scale)
Life Cycle Information Module:
A1
A2
A3
A4-A5
B1-B7
C1-C2
C3-C4
TIME (Not to scale)
NET ZERO BIOGENIC CARBON
BIOGENIC CARBON
f Carbon stored in the wood for the life of the building
i Reuse, recycle, or incineration with energy recovery; stored biogenic carbon leaves the product system for use in next system product
g Decomposition in landfill
h Permanent biogenic carbon storage in landfill
e Wood residues incinerated for energy
c Carbon remains stored in logs
d Co-products (wood chips, shavings, sawdust) leave the product system
Natural environment outside product system boundary
b Slash left in forest
Biogenic carbon sequestered by growing trees
a Whole trees harvested; stored carbon enters the product system
(–)

End-of-Life Fates for Wood Products

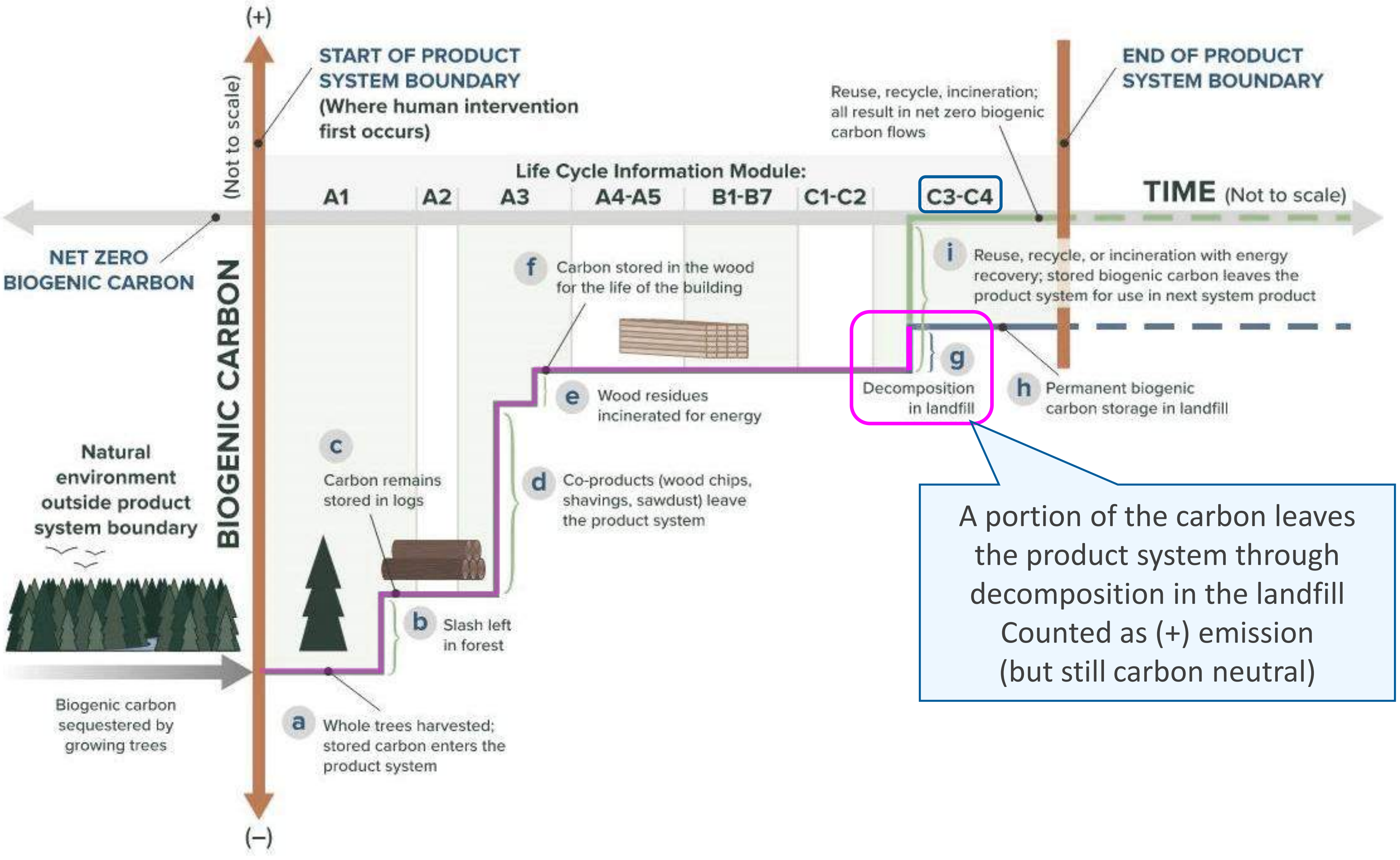
1. **Landfill**
2. Incineration (for energy recovery)
3. Recycle
4. Direct Reuse

Landfill operations
- Most does not decay
- Decay releases landfill gases
  - Emitted directly to atmosphere, or
  - Landfill gas capture for energy recovery

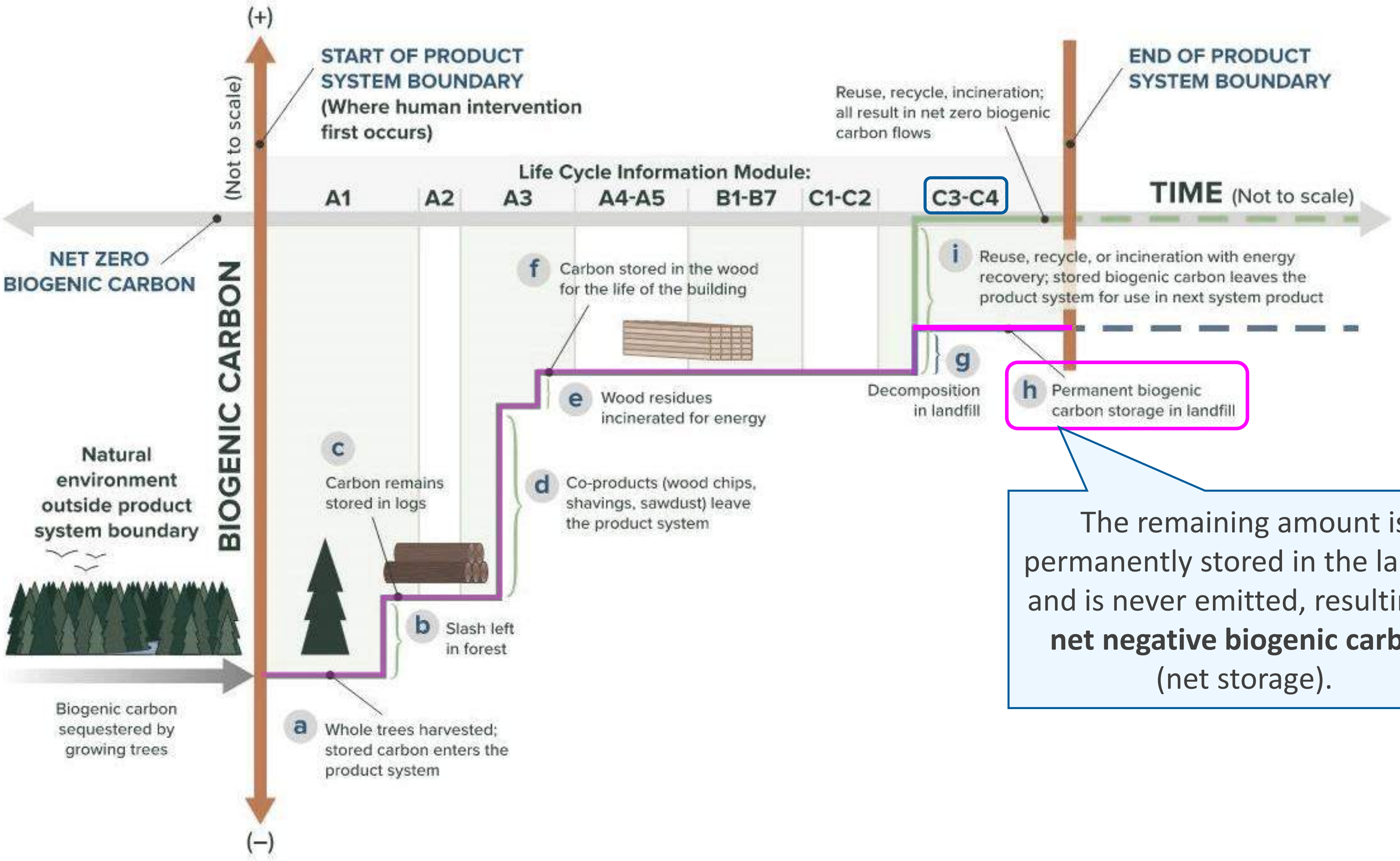
Does not include benefits of using recovered energy

Most biogenic carbon is **permanently stored** in the landfill. The rest is released through decay as an ***emission*** (+1).

BIOGENIC CARBON FLOWS

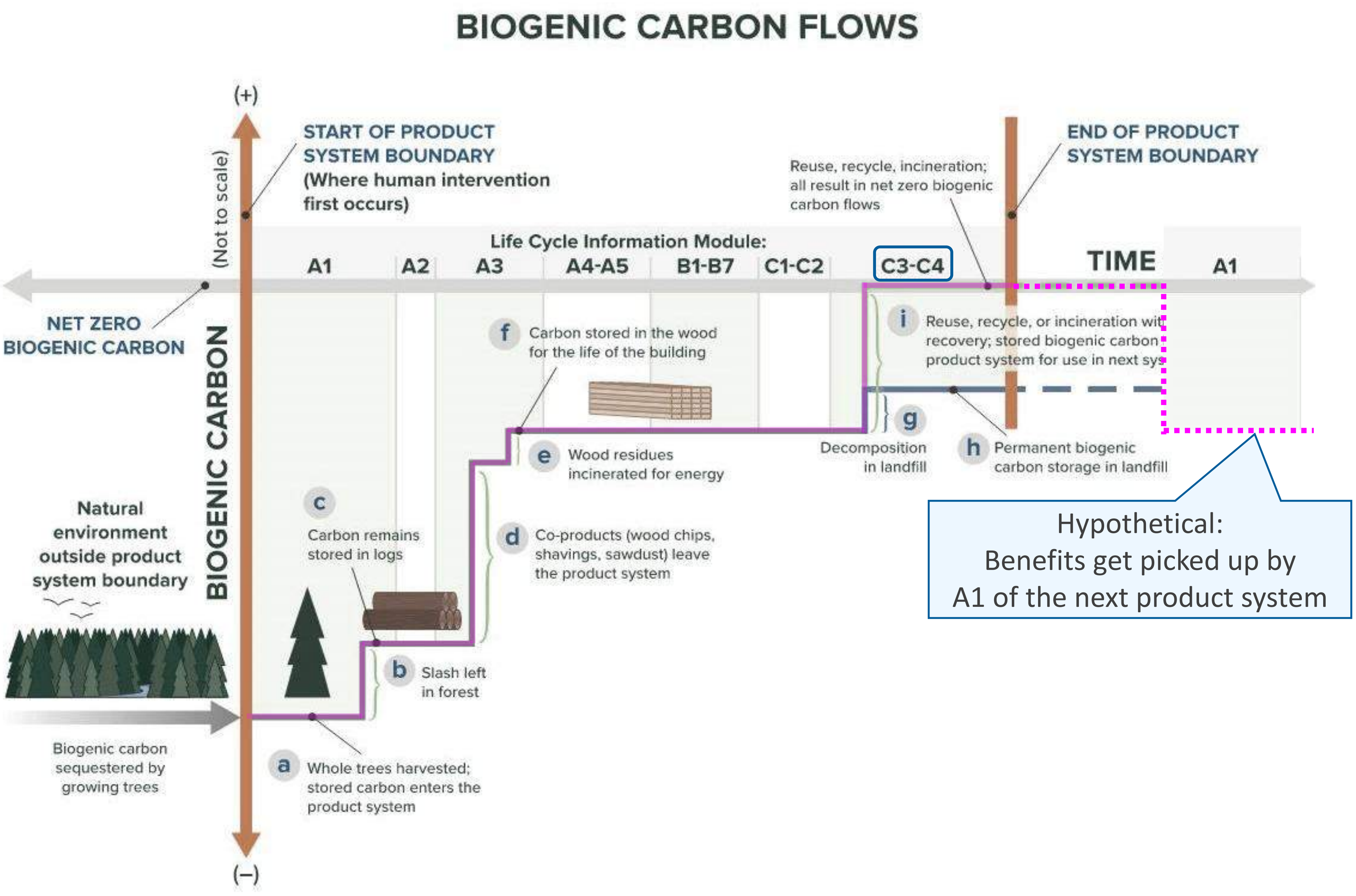


BIOGENIC CARBON FLOWS



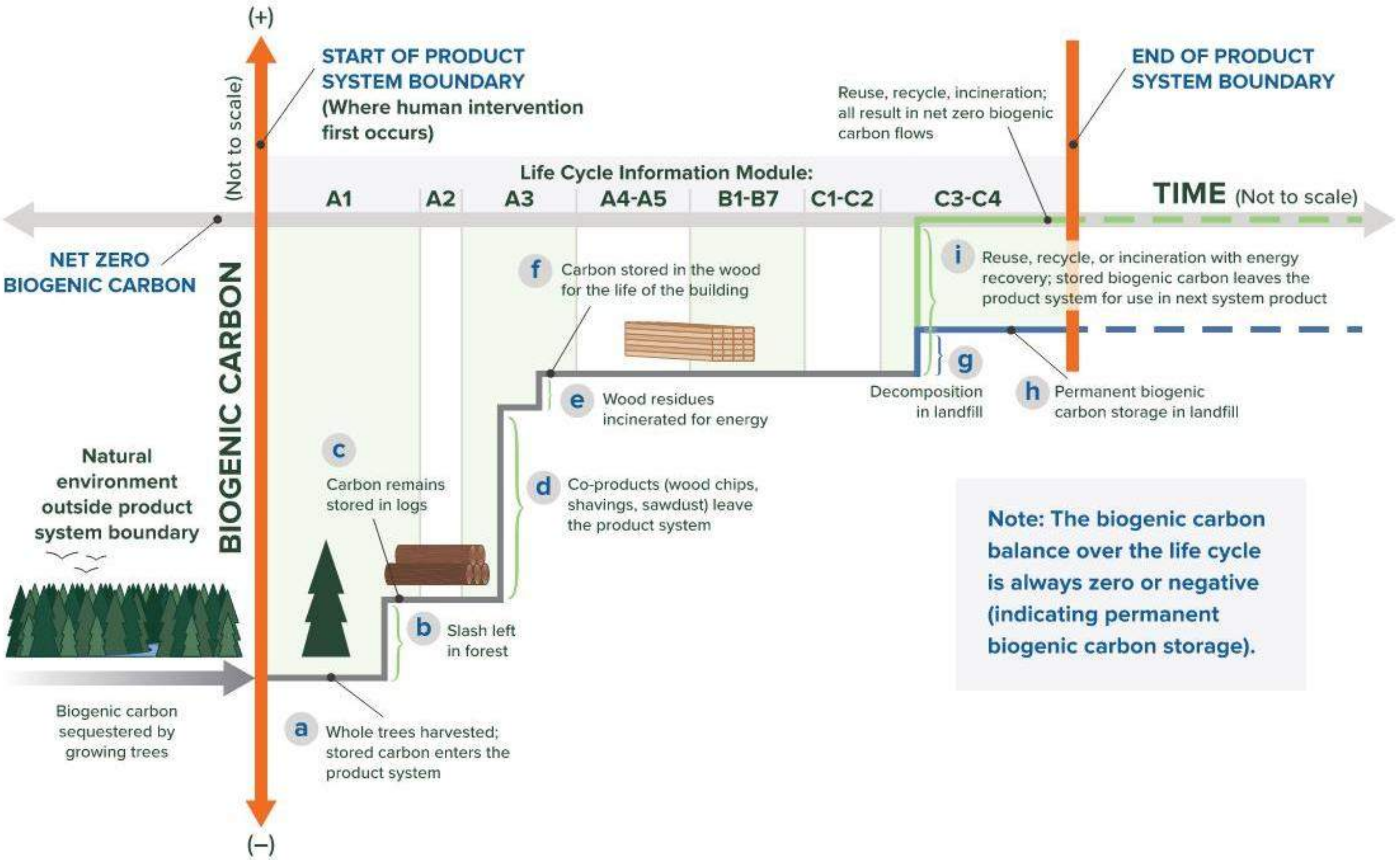
The remaining amount is permanently stored in the landfill and is never emitted, resulting in **net negative biogenic carbon** (net storage).

But, isn’t reuse better?



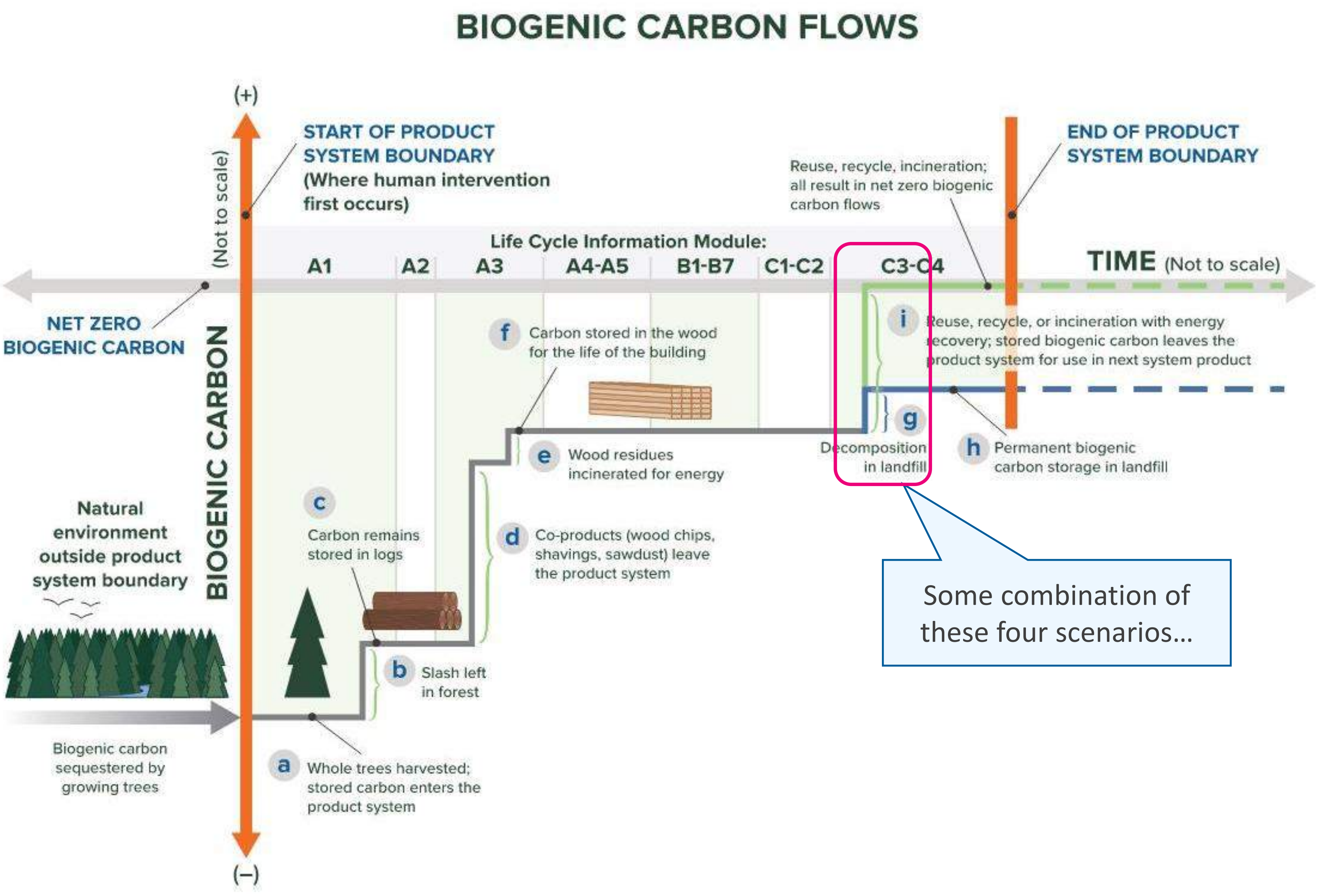
BIOGENIC CARBON FLOWS
(+)
(−)
(Not to scale)
BIOGENIC CARBON
START OF PRODUCT SYSTEM BOUNDARY (Where human intervention first occurs)
END OF PRODUCT SYSTEM BOUNDARY
Reuse, recycle, incineration; all result in net zero biogenic carbon flows
Life Cycle Information Module:
A1
A2
A3
A4-A5
B1-B7
C1-C2
C3-C4
TIME
A1
NET ZERO BIOGENIC CARBON
f Carbon stored in the wood for the life of the building
i Reuse, recycle, or incineration wit
recovery; stored biogenic carbon
product system for use in next sys
g Decomposition in landfill
h Permanent biogenic carbon storage in landfill
e Wood residues incinerated for energy
d Co-products (wood chips, shavings, sawdust) leave the product system
c Carbon remains stored in logs
Natural environment outside product system boundary
b Slash left in forest
a Whole trees harvested; stored carbon enters the product system
Biogenic carbon sequestered by growing trees
Hypothetical:
Benefits get picked up by
A1 of the next product system

BIOGENIC CARBON FLOWS



https://www.woodworks.org/resources/how-to-include-biogenic-carbon-in-an-lca/

What end-of-life option should I use?


BIOGENIC CARBON FLOWS
(+)
(−)
(Not to scale)
BIOGENIC CARBON
START OF PRODUCT SYSTEM BOUNDARY (Where human intervention first occurs)
END OF PRODUCT SYSTEM BOUNDARY
Life Cycle Information Module:
A1
A2
A3
A4-A5
B1-B7
C1-C2
C3-C4
TIME (Not to scale)
NET ZERO BIOGENIC CARBON
Reuse, recycle, incineration; all result in net zero biogenic carbon flows
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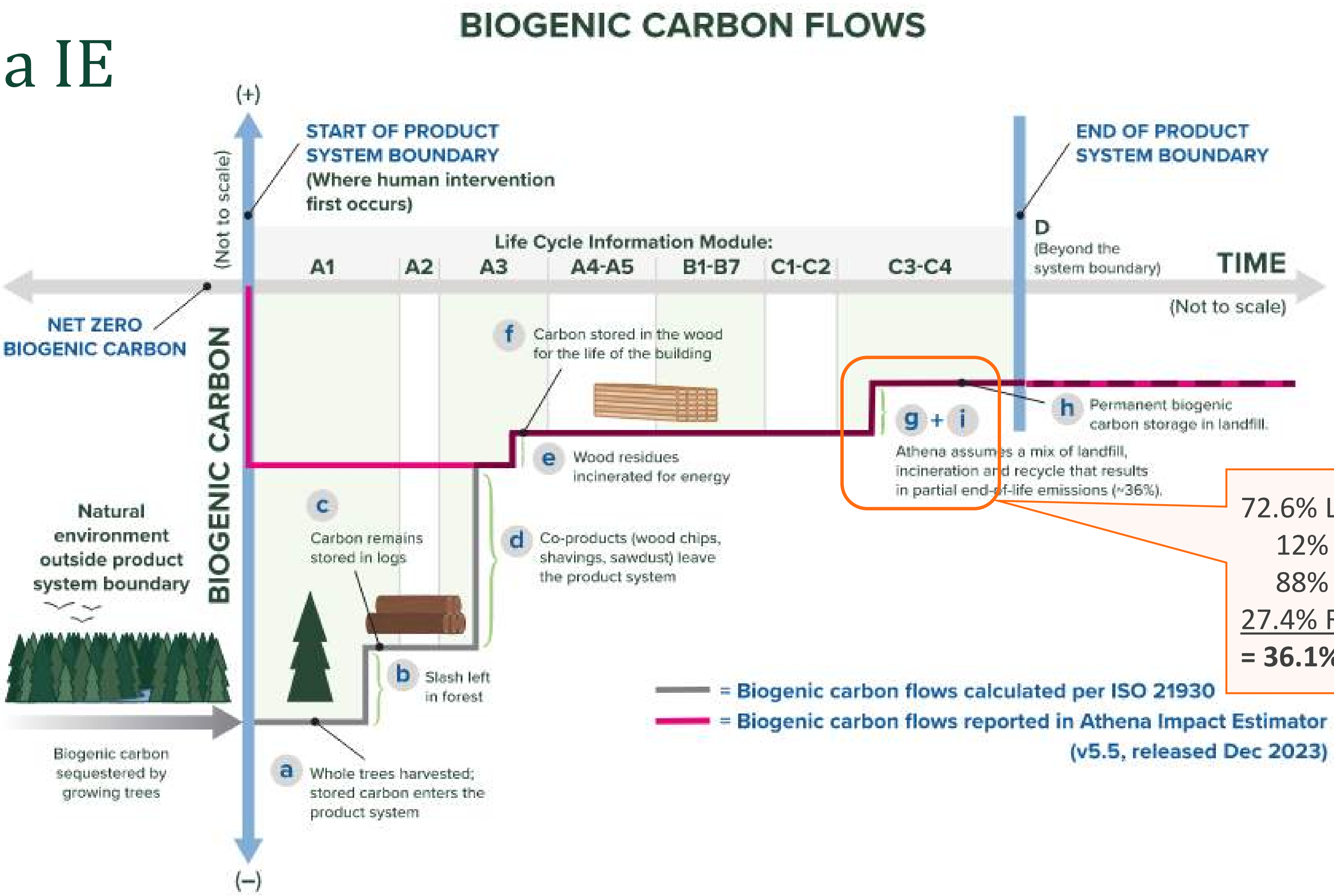
g Decomposition in landfill
h Permanent biogenic carbon storage in landfill
i Reuse, recycle, or incineration with energy recovery; stored biogenic carbon leaves the product system for use in next system product
Some combination of these four scenarios…

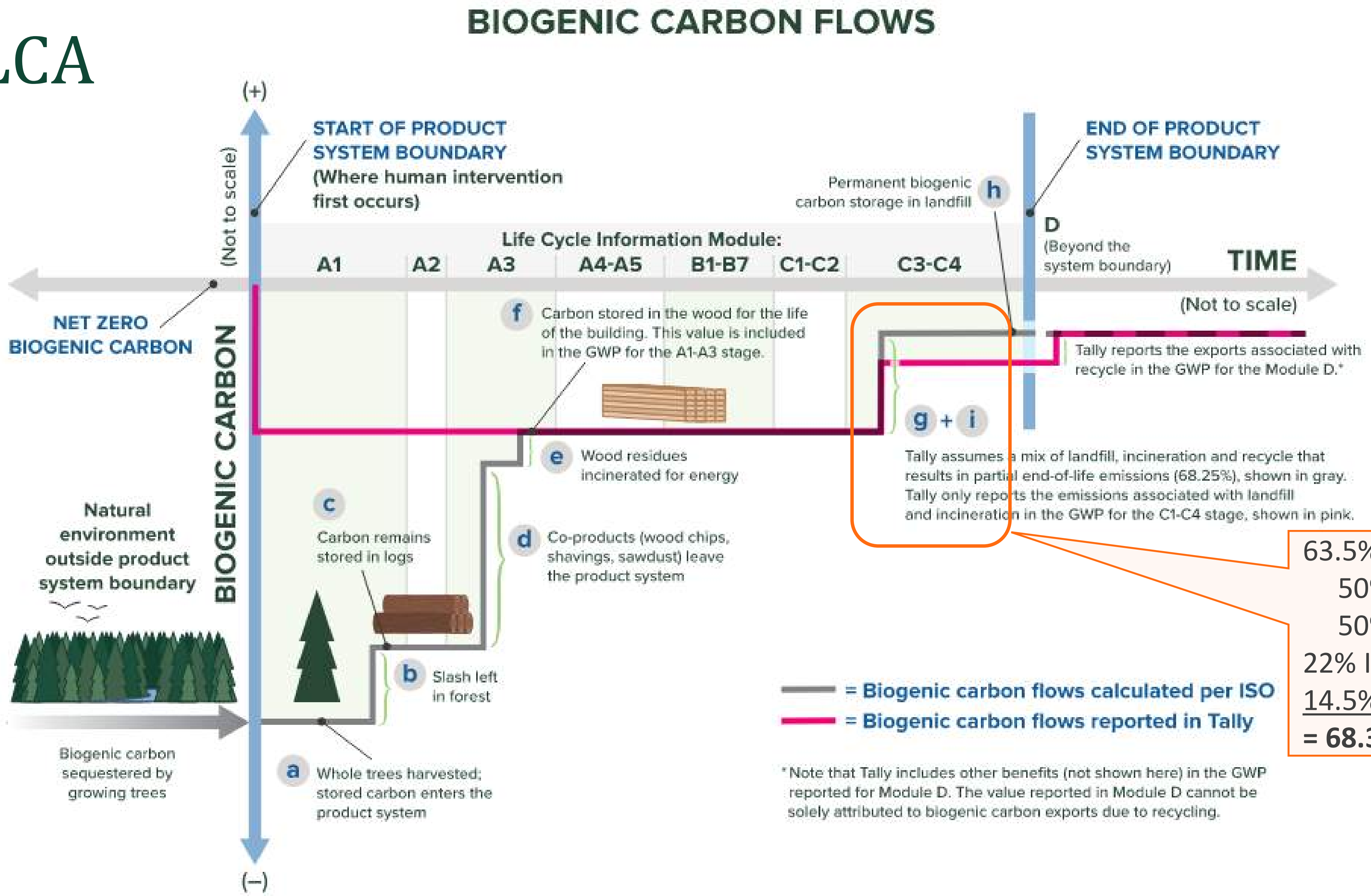
Athena IE



72.6% Landfill
12% decompose
88% stored
<u>27.4% Recycle/other use</u>
= 36.1% emit/export

https://www.woodworks.org/resources/biogenic-carbon-accounting-in-wblca-tools/

TallyLCA

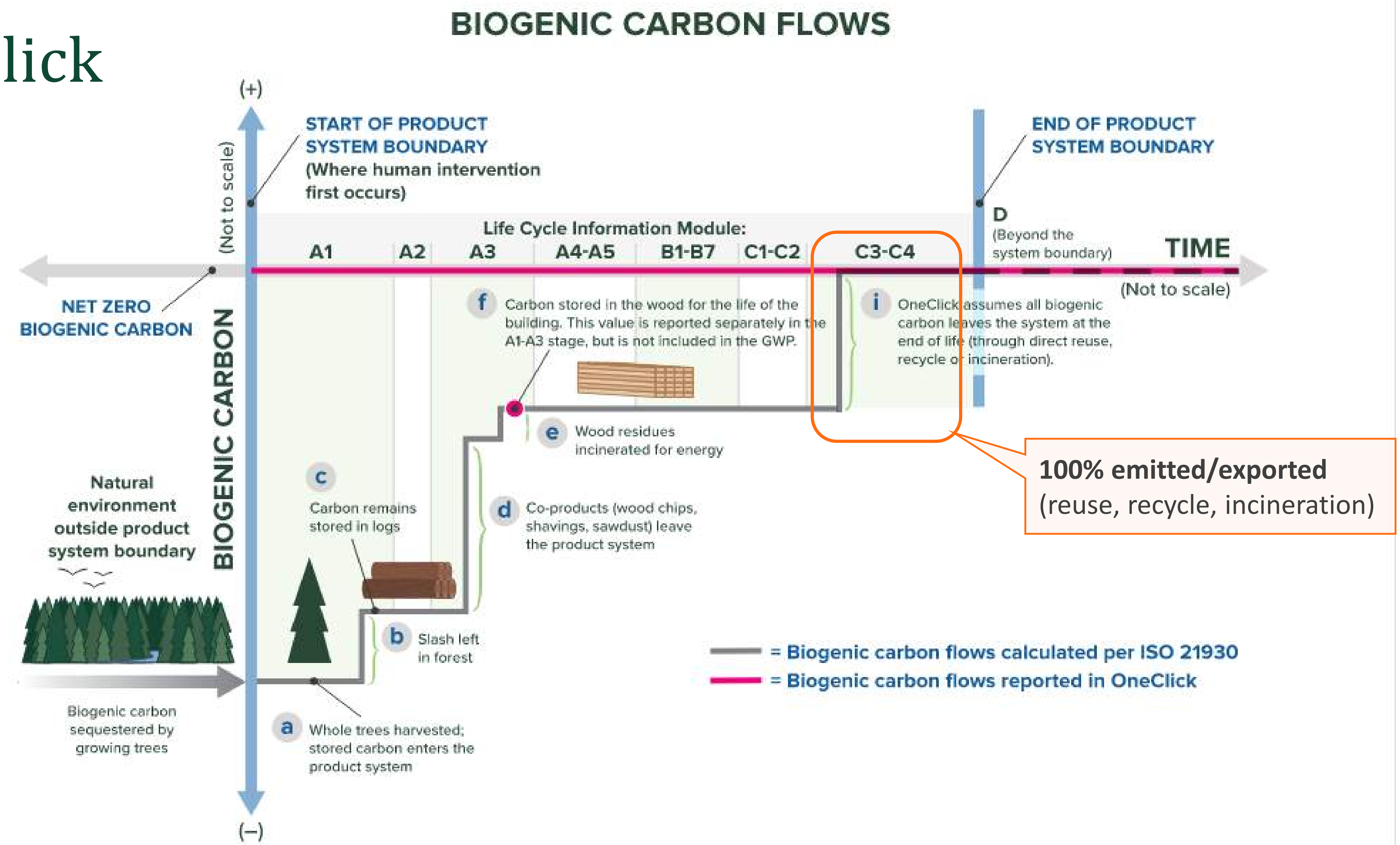


63.5% Landfill
- 50% decompose
- 50% stored

22% Incineration
14.5% Recycle
= 68.3% emit/export

https://www.woodworks.org/resources/biogenic-carbon-accounting-in-wblca-tools/

OneClick



https://www.woodworks.org/resources/biogenic-carbon-accounting-in-wblca-tools/

A Note About Tools:

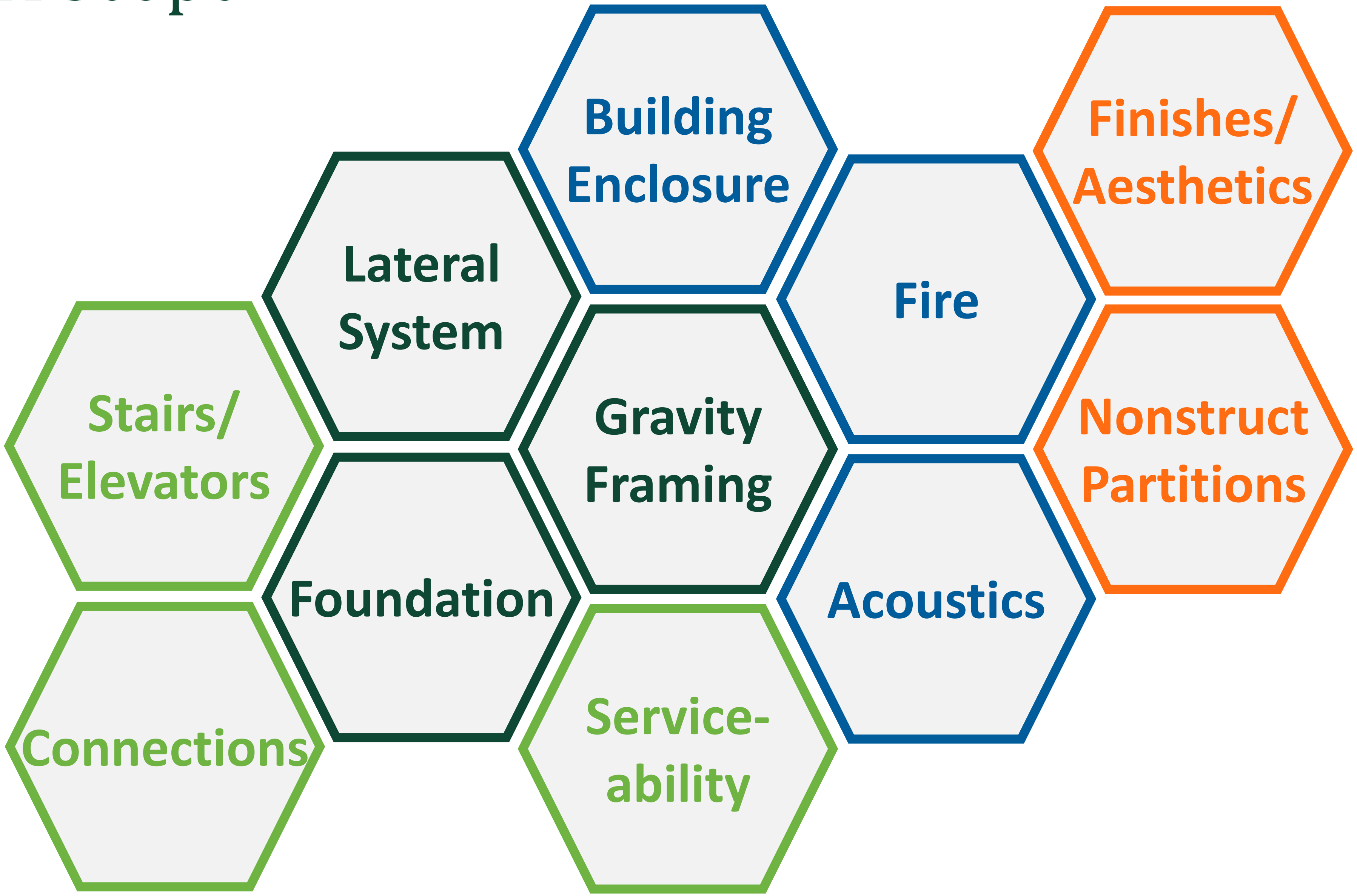
In addition to differences in end-of-life scenarios:

- Where end-of-life effects are reported (C3-C4 vs Module D)
- Methodology (ISO compliance)
- LCI Databases (background data)
- User interface, workflow

https://www.woodworks.org/resources/biogenic-carbon-accounting-in-wblca-tools/
https://www.woodworks.org/resources/calculating-the-embodied-carbon-of-different-structural-systems/

How to Compare Structures

WBLCA Scope


Building Enclosure
Finishes/ Aesthetics
Lateral System
Fire
Stairs/ Elevators
Gravity Framing
Nonstruct Partitions
Foundation
Acoustics
Connections
Service-ability

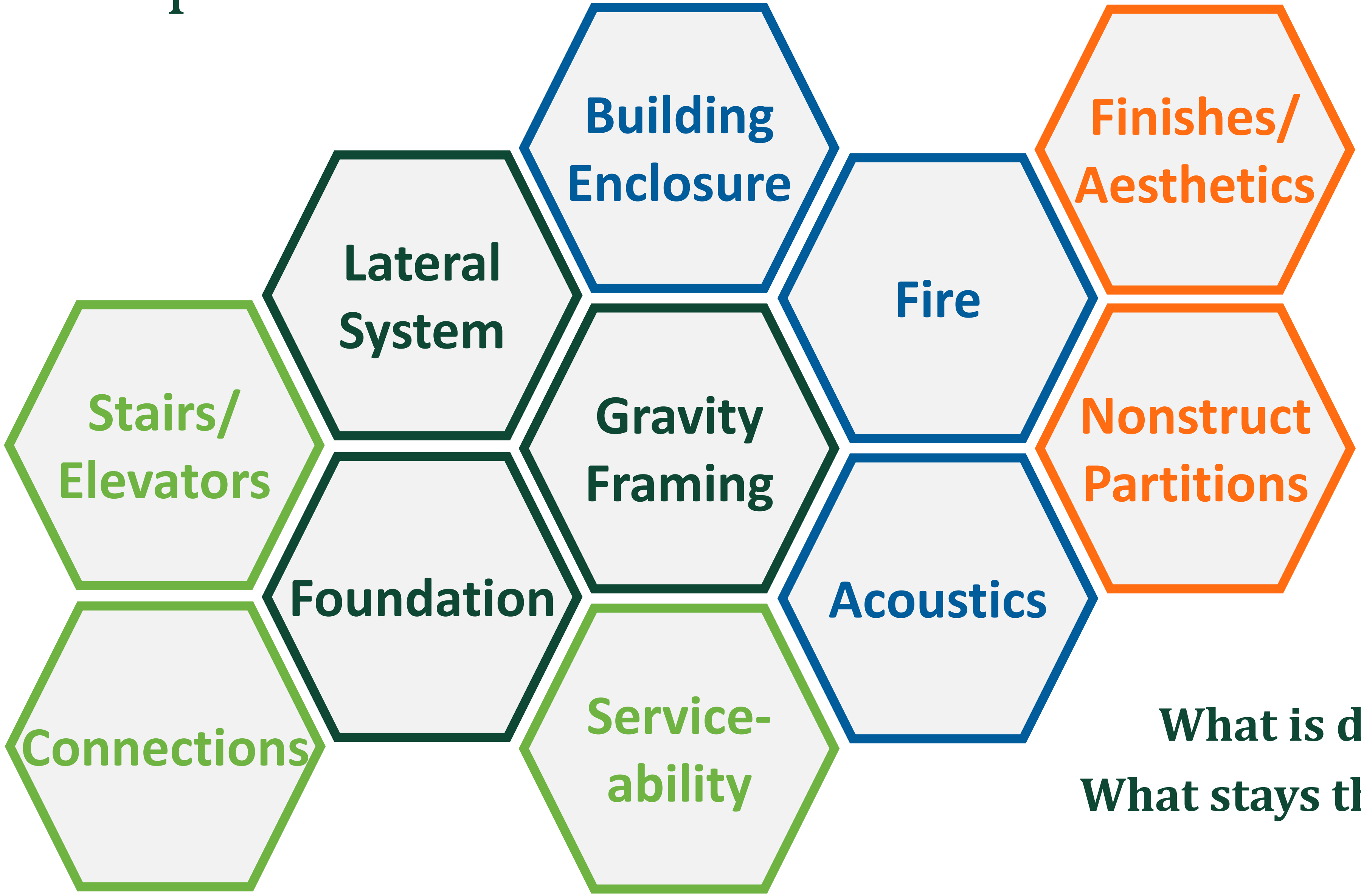
Comparative WBLCA

Mass Timber Building vs **Steel or Concrete Building**

requires

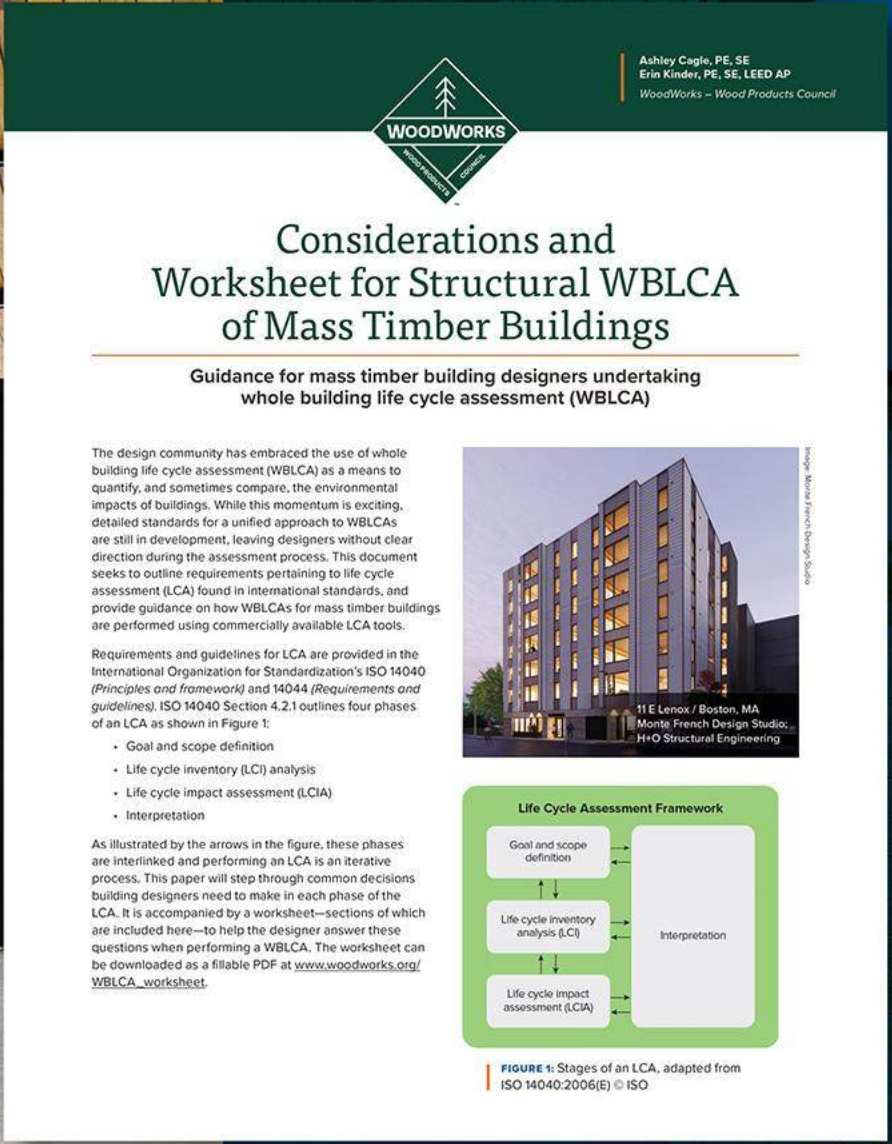
Functional Equivalency

WBLCA Scope



What is different?

What stays the same?



Ashley Cagle, PE, SE
Erin Kinder, PE, SE, LEED AP
WoodWorks – Wood Products Council

Considerations and Worksheet for Structural WBLCA of Mass Timber Buildings

Guidance for mass timber building designers undertaking whole building life cycle assessment (WBLCA)

The design community has embraced the use of whole building life cycle assessment (WBLCA) as a means to quantify, and sometimes compare, the environmental impacts of buildings. While this momentum is exciting, detailed standards for a unified approach to WBLCAs are still in development, leaving designers without clear direction during the assessment process. This document seeks to outline requirements pertaining to life cycle assessment (LCA) found in international standards, and provide guidance on how WBLCAs for mass timber buildings are performed using commercially available LCA tools.

Requirements and guidelines for LCA are provided in the International Organization for Standardization's ISO 14040 *(Principles and framework)* and 14044 *(Requirements and guidelines)*. ISO 14040 Section 4.2.1 outlines four phases of an LCA as shown in Figure 1:

- Goal and scope definition
- Life cycle inventory (LCI) analysis
- Life cycle impact assessment (LCIA)
- Interpretation

As illustrated by the arrows in the figure, these phases are interlinked and performing an LCA is an iterative process. This paper will step through common decisions building designers need to make in each phase of the LCA. It is accompanied by a worksheet—sections of which are included here—to help the designer answer these questions when performing a WBLCA. The worksheet can be downloaded as a fillable PDF at www.woodworks.org/WBLCA_worksheet.

Image: Monte French Design Studio

11 E Lenox / Boston, MA
Monte French Design Studio;
H+O Structural Engineering

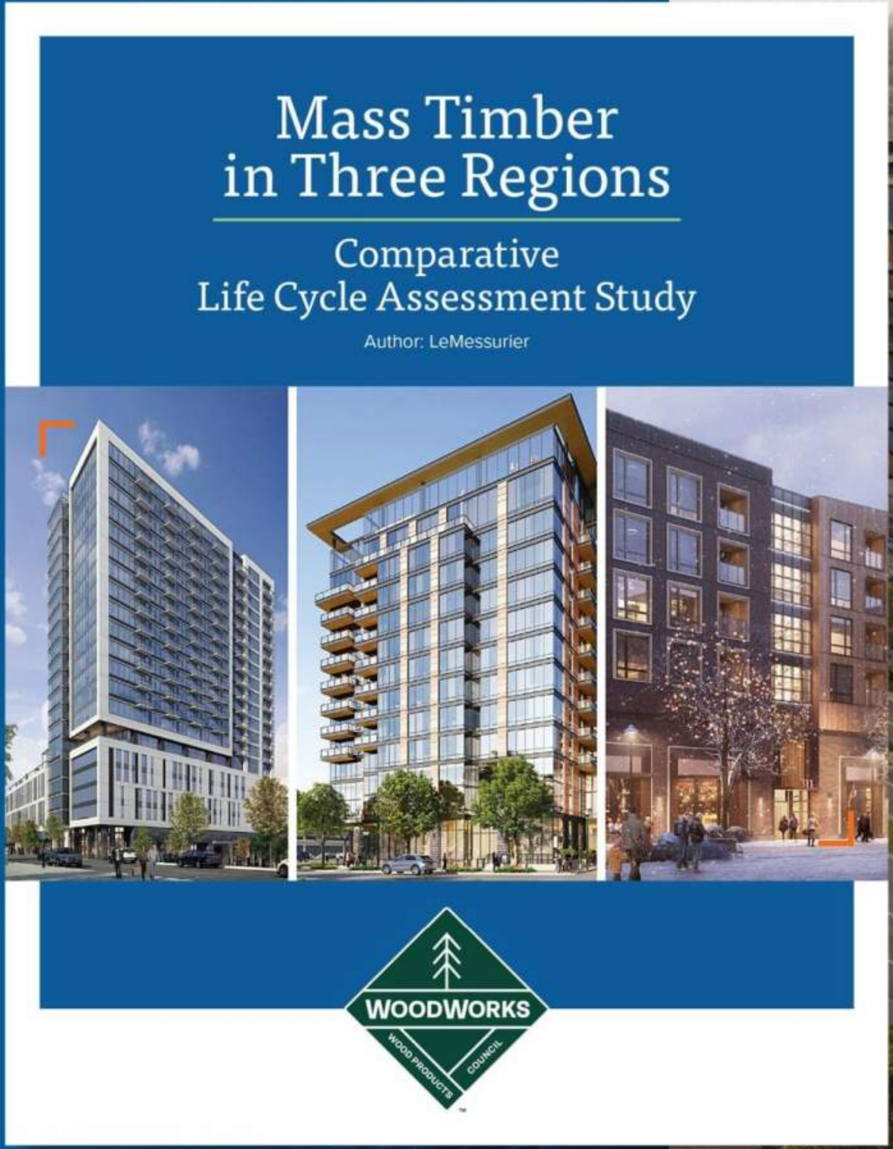
Life Cycle Assessment Framework

Goal and scope definition
Life cycle inventory analysis (LCI)
Life cycle impact assessment (LCIA)
Interpretation

FIGURE 1: Stages of an LCA, adapted from ISO 14040:2006(E) © ISO

Nez Perce-Clearwater National Forests Supervisor's Office / Kamiah, IDMosiac Architecture; Morrison-Maierle
https://www.woodworks.org/resources/considerations-and-worksheet-for-structural-wblca-of-mass-timber-buildings/

https://www.woodworks.org/resources/mass-timber-in-three-regions-comparative-lca/



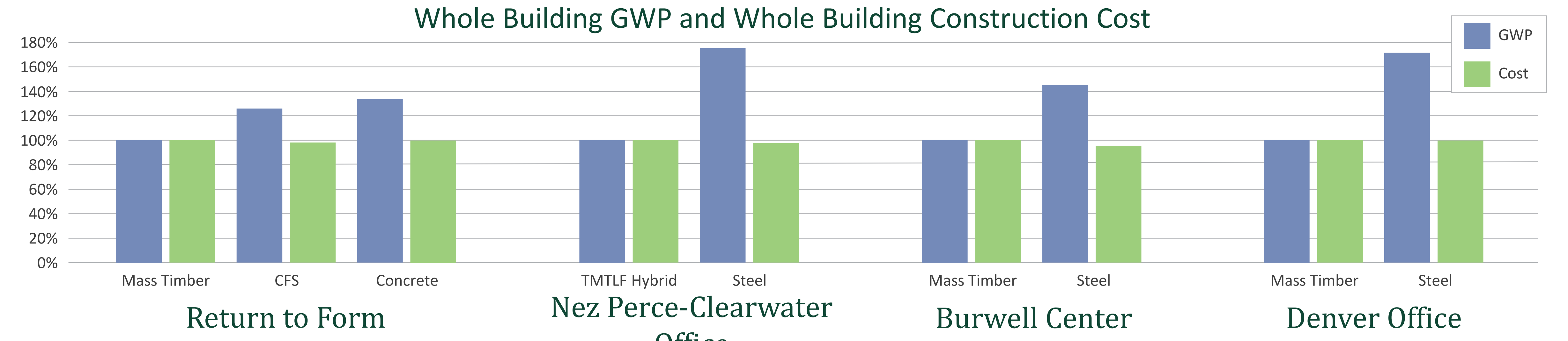
Mass Timber Comparative Life Cycle Assessment Series

Rendering tres birds

Mosaic Architecture / Morrison-Maierle / Photo Heidi Long, Longview Studios

University of Denver Burwell Center for Career Achievement / Lake|Flato Architects / Shears Adkins Rockmore / KL&A Engineers and Builders / Photo © Frank Ooms

Rendering Shears Adkins Rockmore



Source: https://www.woodworks.org/resources/mass-timber-comparative-lca-series/

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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Funding provided in part by the Softwood Lumber Board