U.S. DEPARTMENT OF AGRICULTURE

Harvested Wood Products (HWP) Biogenic Carbon and Life Cycle Assessment (LCA) - Managing Forest Systems Subchapter in USDA GHG Entity Guidelines Version 2 with Priorities for Version 3 and Beyond

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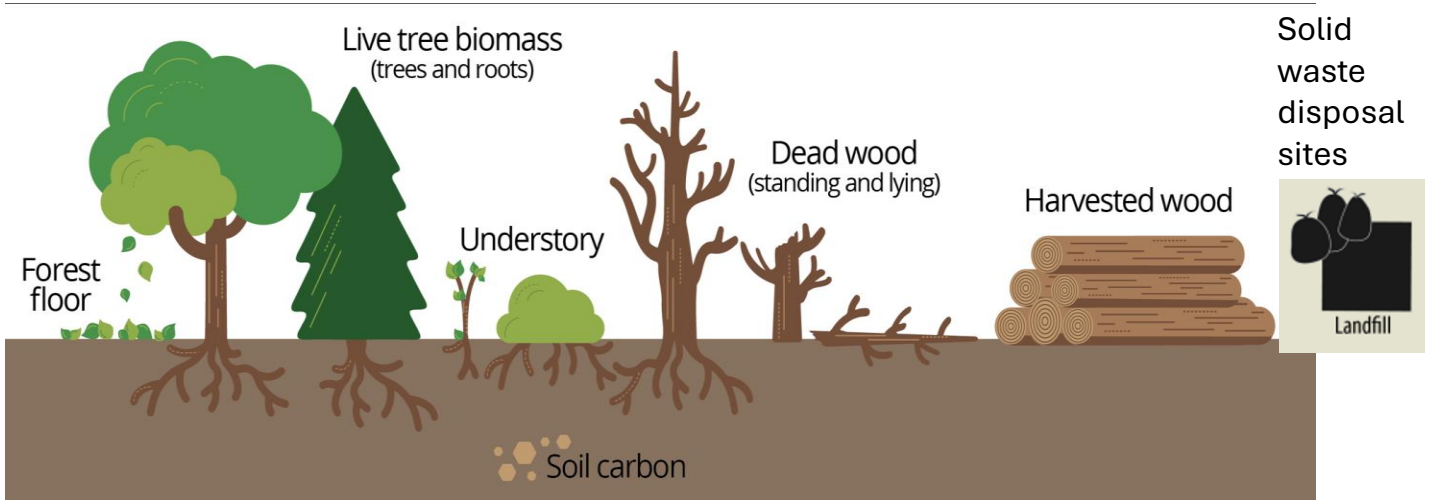


National Technology and Development Program &

Forest Products Laboratory

USDA GHG Results

Forest Products Laboratory

POST HARVEST CARBON IMPACTS

ChiSquare Decay Function	Year 0 post-harvest	By Year 100 Post-Harvest
I. CARBON STOCKS in HWP in Use (t CO_2eq)	10,084	848
J. CARBON STOCKS in HWP in SWDS (t CO_2eq)	0	4,977
K. AFOLU HWP emissions (t CO_2eq) (cumulative burned without energy capture, emissions shown as positive)	0	2,017
L. AFOLU HWP emissions (t CO_2eq) (cumulative burned with energy capture, emissions shown as positive)	10,053	12,295
TOTAL HWP Biogenic Carbon Stored from Harvest (t CO_2eq)	10,084	5,824
TOTAL AFOLU (Forest) BIOGENIC CARBON STOCK CHANGE (FLUX) from Management Action and Harvest (t CO_2eq).	-76,163	

This is the estimated stock change (flux) in AFOLU sector carbon and equals net ecosystem exchange (negative sequestration or zero sequestration) plus bark and logging residues emitted, plus harvested sawlogs, pulpwood and fuelwood minus annual stock change in harvested wood products in use and SWDS year zero. The difference between total harvest and change in HWP equals HWP emissions with and without energy capture combined.
A total carbon balance estimate at 100 years post-harvest was intentionally not provided because ecosystem side projections for up to 100 years post harvest are not provided in the calculator due to the high uncertainties associated with projecting post-harvest site carbon flux that far into the future.

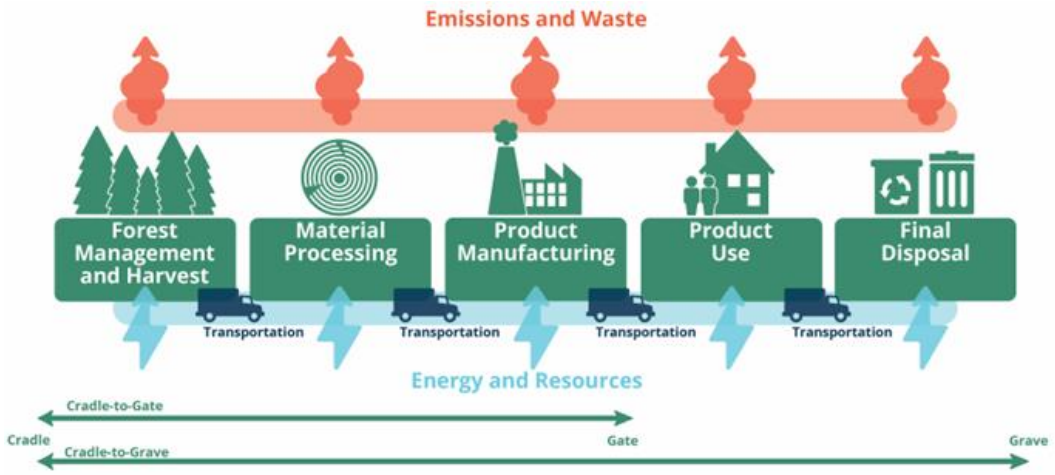
Quantified substitution benefits occur outside of the AFOLU sector and are intentionally presented separately and not combined with the AFOLU total above.

LCA Quantified Substitution Potential Associated with Harvest, Transport and Processing

Potential Substitution Benefits (CO_2 equivalent emissions avoided when wood substitutes non-wood fossil-based alternatives, a unitless factor estimated for cradle-to-gate life stages covering resource extraction, transportation and manufacturing).

	Cradle to Gate, Year 0
M. Products (t CO_2eq)	-11,384

These are estimated by comparing the LCA-quantified cradle-to-gate GHG emissions for wood products (and bark) against their functionally equivalent non-wood alternatives. GHG emissions per life stage of wood products are provided in the 'Potential Substitution' Tab of the workbook. We show electricity here, as it is the most conservative estimate compared to three thermal energy substitution options (coal, gas, or heating oil).



Level 1- LCA quantified the HWP value chain GHG Emissions

Life Cycle Assessment follows **ISO standards** to quantify the total environmental impacts from producing a wood product.

Table 5-9. Life Cycle GHG Emissions for Cradle-to-Gate Manufacturing of HWPs (Metric Tons CO_2-eq/Metric Ton of HWP Produced)

HWP	U.S. Average	Pacific Northwest	Southeast	Inland Northwest	Northeast–North Central	Study References
Softwood lumber	0.161	0.131	0.167	0.241	0.108	Puettmann, 2020a, 2020b, 2020c, 2020d
Hardwood lumber	0.273	ND	ND	ND	0.273	Hubbard et al., 2020
Plywood	0.476	0.395	0.558	ND	ND	Puettmann, 2020e, 2020f
Oriented strandboard	0.391	ND	ND	ND	0.391	Puettmann, 2020g
Non-structural panels[a]	0.742	ND	ND	ND	ND	Puettmann and Salazar, 2019; Puettmann and Salazar, 2018; Puettmann et al., 2016
Other industrial products[b]	0.272	ND	ND	ND	ND	Alanya-Rosenbaum and Bergman, 2020

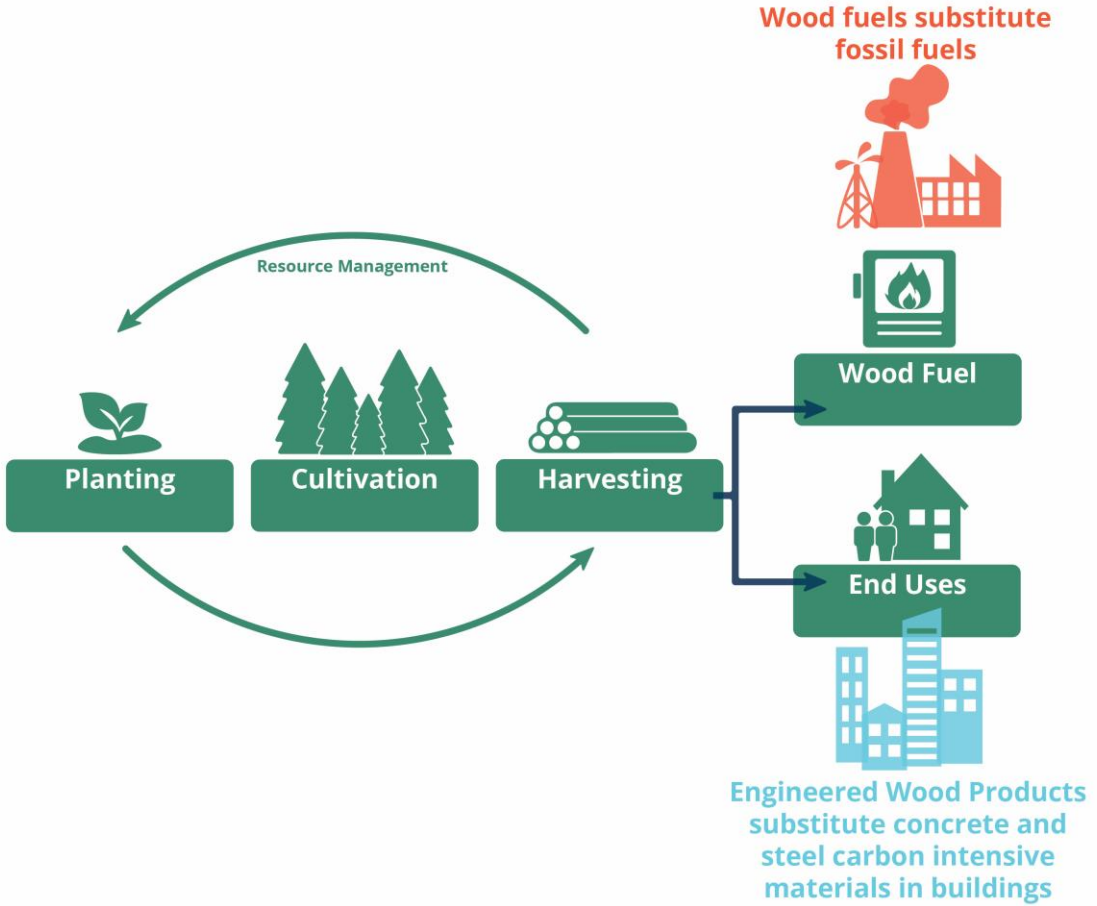
ND = No data.

[a] Non-structural panels include three HWPs (particleboard, medium-density fiberboard, and hardboard). The GHG emissions value is a weighted average of the three.

[b] GHG emissions for wood pallets were used as a reference for other industrial products.

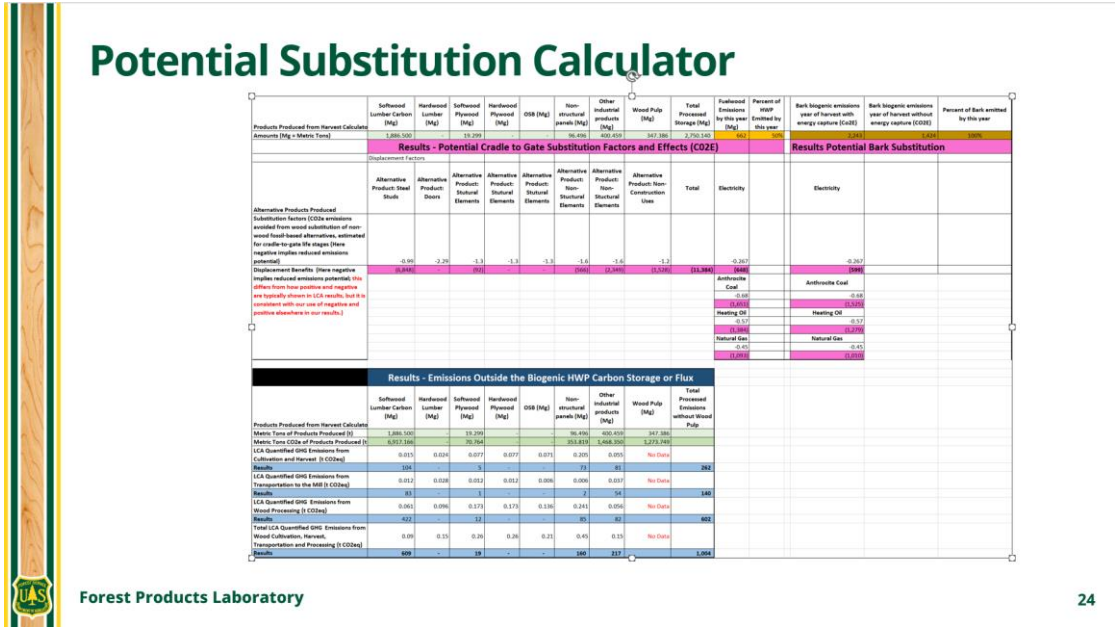
Harvested Wood Products Displacement Potentials

- The **LCA** quantified GHG emissions of wood products and their functionally equivalent non-wood products can be estimated to derive **displacement factors,** which we use to quantify total displacement potential benefits of HWPs through the substitutions.



Level 1- Displacement Factors and Potentials CALCULATION

Displacement Factor (DF) describes the amount of avoided GHG emissions when HWP substitute for a non-wood product with an equivalent function



Harvested wood product	Functionally equivalent alternative non-wood product	DF (tonne of CO2e avoided /tonne of CO2 in HWP used)	Reference
Softwood lumber	One Steel Stud	0.99	Adapted from Bergman et al. (2014)
Hardwood lumber	One Steel Door	2.29	Adapted from Bergman et al. (2014)
Plywood	Structural construction materials	1.3	Leskinen et al. (2018)
Oriented strand board	Structural construction materials	1.3	Leskinen et al. (2018)
Other industrial products	Non-structural construction materials	1.6	Leskinen et al. (2018)
Other industrial products	Non-construction use	1.2	Leskinen et al. (2018)

Harvested wood product	DF (*tonnes of CO_2e avoided per tonne of HWP*)
Electricity[a]	
Mill residues	0.270[c]
Logging residues	0.267[c]
Pulp, softwood	0.261[c]
Heat (wood fuel)[b]	
Coal	0.68[d]
Oil	0.57[d]
Natural gas	0.45[d]

Main Advantages

- Estimates produced in **all areas of the lower 48 states**
- Relies on **widely available Microsoft Excel** software
- **Flexibility**
  - Limited information needed, Region of the Country, forest area
  - Optional Information to improve estimates
    - Forest type, Age Class, Natural or Planted, Softwood or Hardwood, Timber Products (Sawlog, pulpwood or fuelwood), any or all if known
  - Percent of forest area treated
  - Volume or weight units accepted
  - New Chi Square (default) or classic exponential product lifespan functions both available
  - Options for various energy substitution fuels
  - Summarized and Detailed Results
- **LCA-quantified GHG emissions** from HWPs value chain production reflect the holistic carbon flux and global warming/climate impacts from HWPs.
- **Integrated approach,** combining Production Approach with LCA-informed GHG dynamics from forest to HWPs pool, including ecosystem carbon estimates from harvest activity

Remaining Gaps – Production Approach

LEGEND

Short Term

Long Term

- Production Approach
  - Update Existing
    - Conversion factors for more regional about volume/weight inputs
    - Update fuelwood ratios for growing stock calculator
    - Primary Product/Fuel and Other Emissions, End Use Ratios
    - Product lifespans (end use groupings and functions)
      - Address exports
    - Recycling modeling as part of EPA discards
    - Portions subject to landfill decay
    - Burned with Energy Capture ratios
- Integration with ecosystem component of forest carbon
  - Update Existing
    - Logging residues

Remaining Gaps – Context for the Production Approach

LEGEND

Short Term

Long Term

- New Functionality
  - Produce timber product outputs from additional growing stock management beyond clearcuts
  - Match reporting timeframes for forest ecosystem carbon with HWP (100 or more years)
  - Add uncertainty analysis
  - Better carbon market protocol and reporting alignment
  - Add methane reporting to complement IPCC production approach reporting

Gaps and Plans – LCA

LEGEND

Short Term

Long Term

- National average LCA or EPD data were used. More updated and regional LCA and EPDs are now available and can be applied.
  - Partners have updated US Wood Products LCA and EPDs (CORRIM, AWC, etc.)

  Continuing the updates is required and will be supported by the committed fundings from USFS and EPA on the wood products EPDs.

- Cradle-to-Gate LCA and EPDs of HWPs were used in Guideline v.2.
  - Extended LCA of **Cradle-to-Grave** will be incorporated in the future Guideline for estimating the holistic carbon impacts from HWPs by incorporating the **Forest Managements (upstream/Cradle) to End-of-Life (downstream/Grave)** processing of the products.

  Forest management activity data is available through the Silviculture/Ecosystem and fire team.

LEGEND

Short Term

Long Term

Gaps and Plans – Displacement

- The rough DFs offered in the Guideline v.2 focus only on traditional wood products and substitutions.
  - ➢ Emerging wood products, such as mass timber in buildings, biomass for bioenergy or higher-value products, are now developed and may reflect more substitution benefits.

Supporting research has developed:

- *DF tool is being developed on the Carbon Platform by Univ. of Washington team with more products and global data included.*
- *First ISO Standards (13391-1,2,3 on Wood and Wood-based Products Carbon dynamics) will be published in 2025 to standardize the Displacement Factor calculations of ALL wood products.*

Questions –

What are we missing?

What is the main audience you see for this work? Who will actually use the tool?

What are the best outputs for your needs?

Please feel free to contact us if you have any additional questions or input.

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