The Future of Forest and Biomass-derived Products: Challenges and Opportunities

Cindy Chen, PhD
Woody Biomass and Forest Products Advisor
April 2025

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About

Cindy Chen, PhD
Woody Biomass and Forest Products Advisor
UCCE Central Sierra (Tuolumne, Calaveras, Amador, El Dorado), Mariposa, and Alpine Counties
Website: http://cecentralsierra.ucanr.edu/

Email: cxchen@ucanr.edu
Phone: (209) 533-6989

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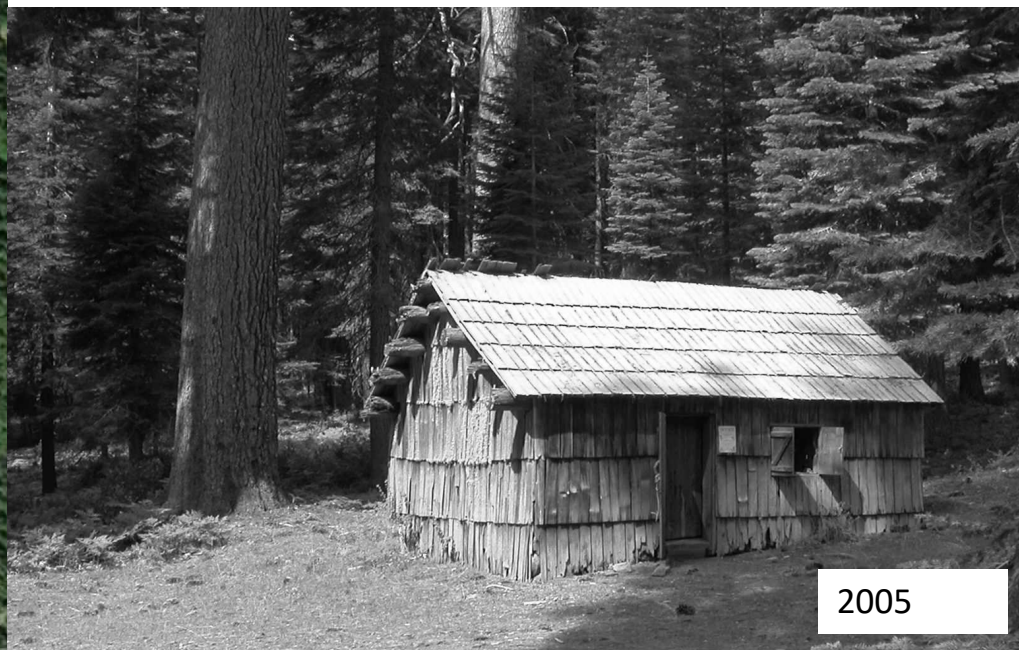
Bear Creek Fire Guard Station
Plumas National Forest



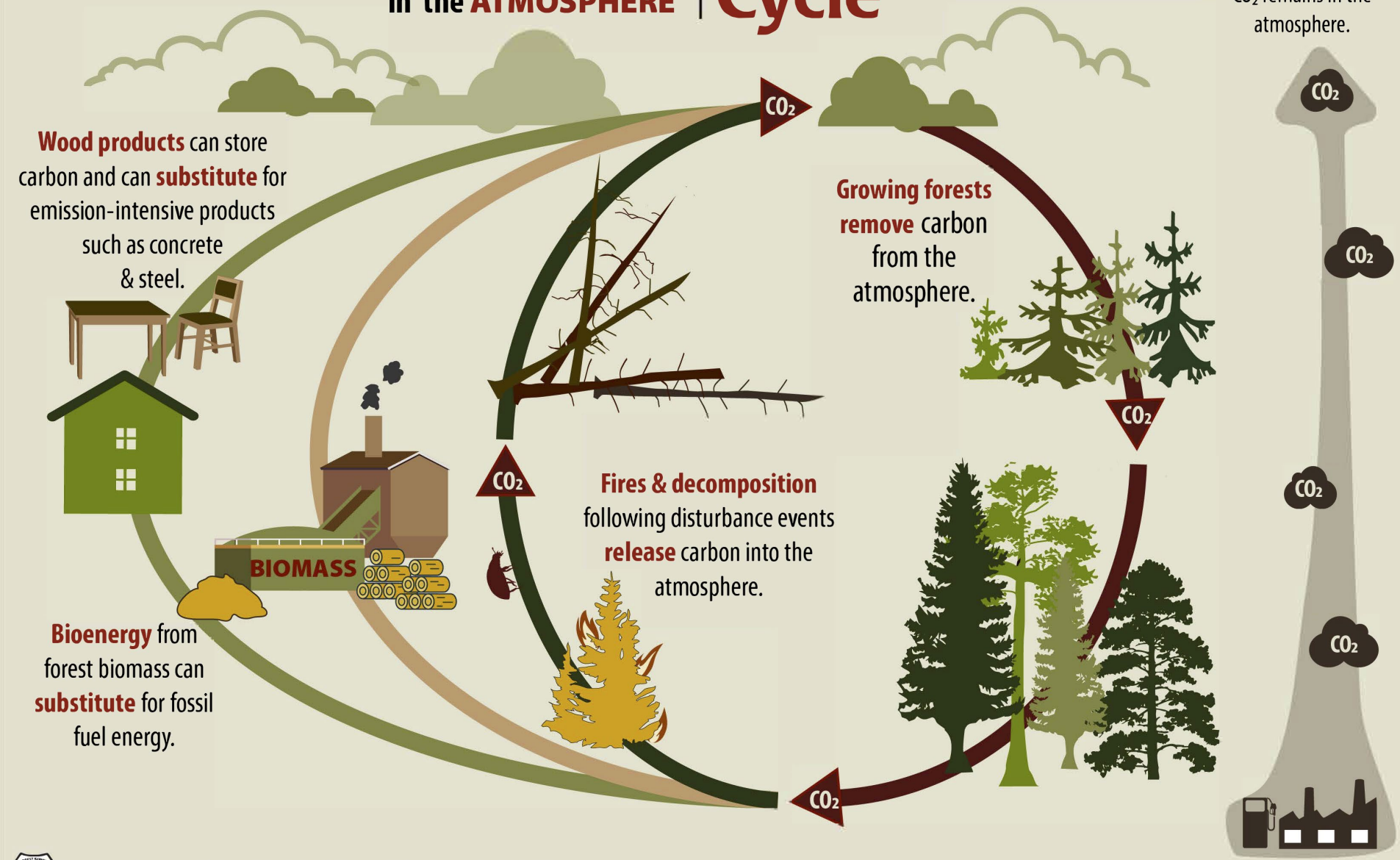

One of the biggest challenges for California:
Wildfires

What is Woody Biomass?

Material obtained from trees which **do not have a viable, *existing* market.** This includes non-timber trees (e.g., dead or small-diameter trees), forest management by-products (e.g., barks, limbs, tops, branches, leaves), manufacturing and processing residues, and urban consumer waste.

USDA United States Department of Agriculture

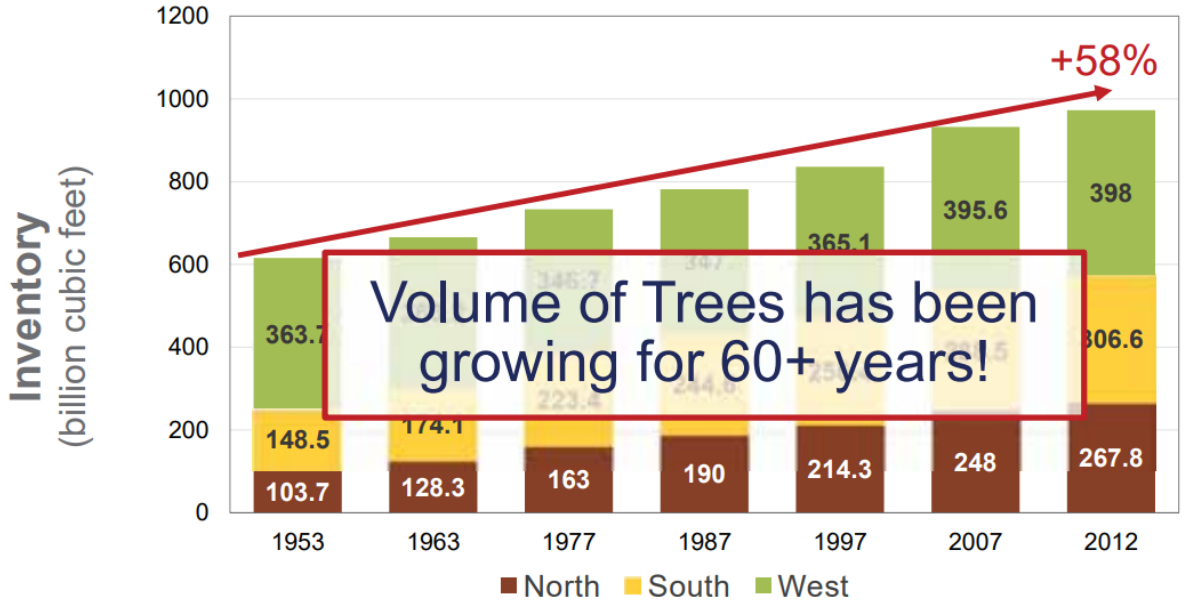
The closed loop of FOREST CARBON in the ATMOSPHERE | Carbon Cycle



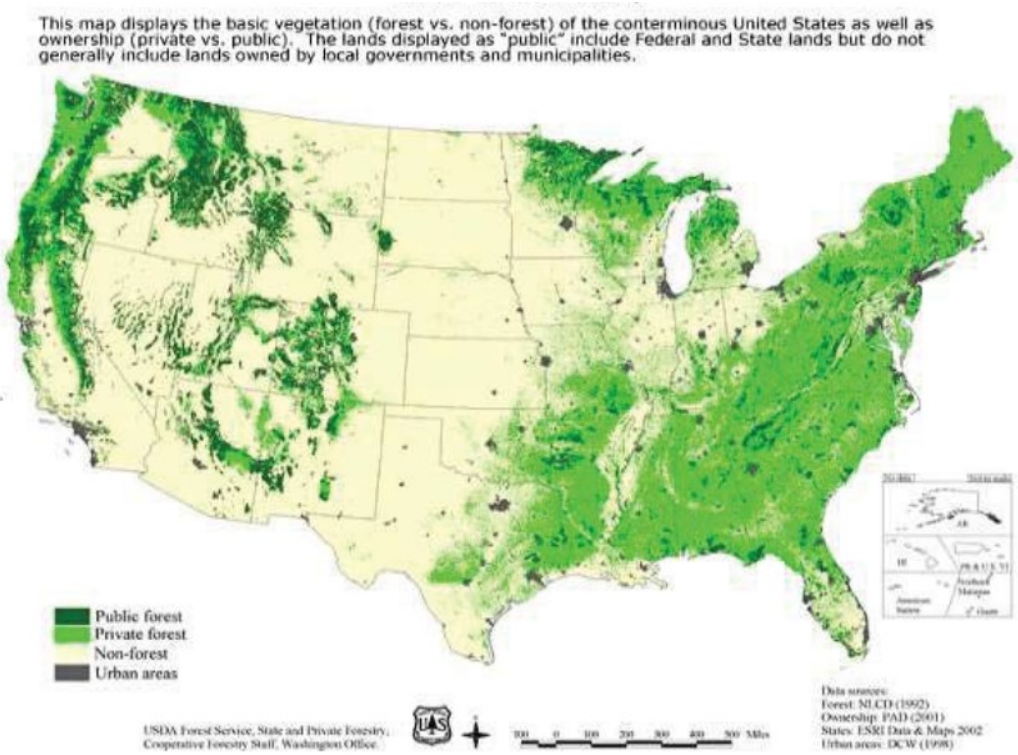
Fossil fuel use is an **OPEN SYSTEM** where CO_2 remains in the atmosphere.

Forest Service Office of Sustainability and Climate April 2019

- Forest land in the U.S. has been stable for over 100 years.
- We have more forests than lumber factories.
- Sustainable forest management is the key.



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



- In the U.S., 44% public owned and 56% privately owned.
- 40% of California's forestland is owned by families, Native American tribes, or companies. Industrial timber companies own 5 million acres (14%). Federal agencies owns 57% and 3% is owned by state agencies.
- Economic values of forest products is an important motivation for private landowners to keep their lands.

Common Products

Biomass Products

Advanced Wood Products

Woody Biomass Utilization

- Soil additives and amendments (mulch, compost, etc.)
- Firewood and fuelwood
- Fuel for biomass power plants
- Solid wood products (lumber and roundwood)
- Densified fuels such as wood pellets and fire logs
- Non-structural composite products including wood/plastic lumber and wood/cement products
- Composite products such as particleboard and medium density fiberboard (MDF)
- Engineered wood products such as laminated veneer lumber (LVL) and oriented-strand board (OSB)
- Pulp chips for paper products
- Organic chemicals including alcohol (ethanol, methanol), cellulose-based compounds, turpentine, tannins, pharmaceuticals, fragrances, and the basic building blocks for many plastics

Source: UCANR Woody Biomass Utilization Workgroup
https://ucanr.edu/sites/WoodyBiomass/

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Forest-derived products options for California

- Recent report identified several products that are most promising in California:
  - Mass timber and other engineered wood products
    - Cross-laminated timber, glue-laminated timber, Dowe-laminated timber, etc.
  - Liquid and gaseous transportation fuels
    - Ethanol, renewable hydrogen, etc.
  - Chemically and thermally treated wood
    - Thermally modified wood, chemical extractives

Source: Sanchez, D. et al. *Literature Review and Evaluation of Research Gaps to Support Wood Products Innovation*. Joint Institute for Wood Products Innovation. 2020.

Wood as a Construction Material

Carbon12 building in Portland, OR
Photo: Andrew Pogue

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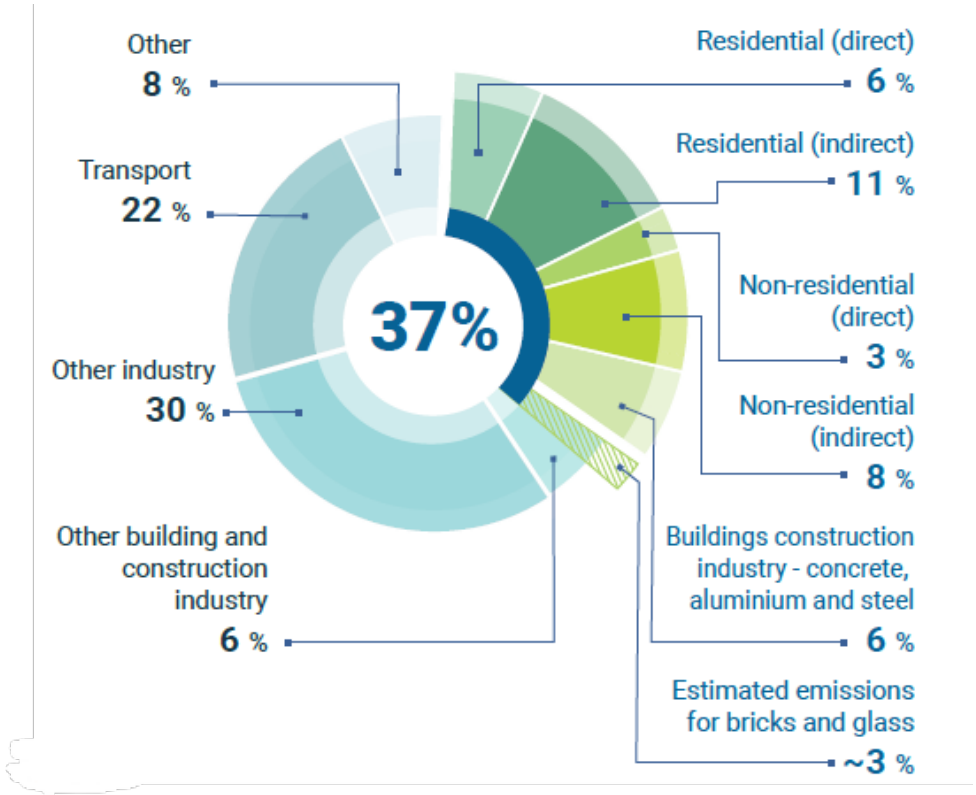
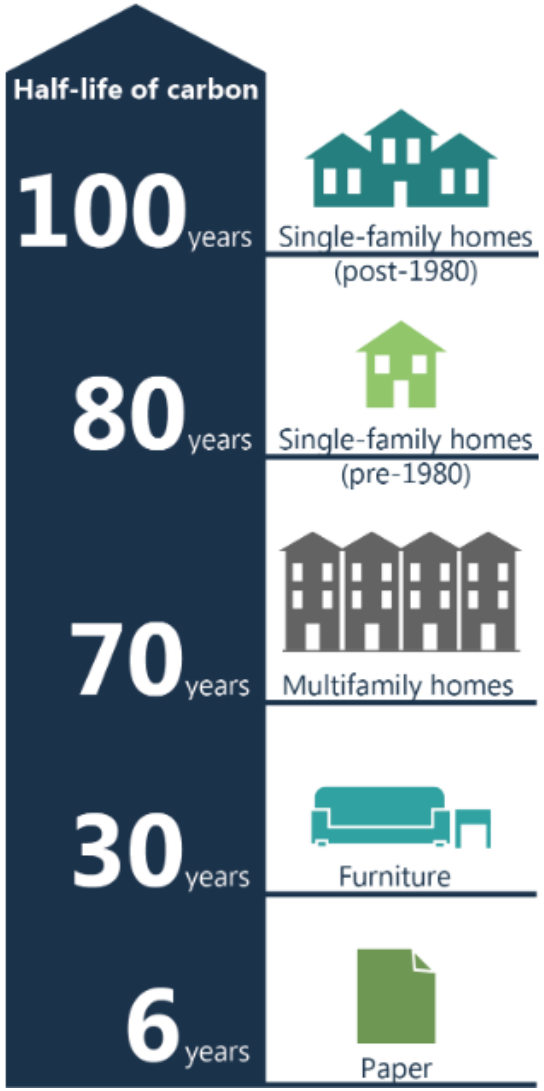
Wood in Construction



Notes: Buildings construction industry and other building construction industry refers to concrete, steel and aluminum for buildings and infrastructure construction respectively

Share of the building sector in global CO2 emissions in 2021



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Common Mass Timber Products

- CA is the largest consumer of engineered wood products west of Mississippi River.
- Viable alternative building material to concrete and steel.
- Fast construction time and less construction traffic compared to concrete buildings.
- Building code change, allowing mass timber tall buildings.
- Strong and high fire-resistance rating (i.e., charring)
- Multiple end-of-life options

Cross-laminated timber (CLT)

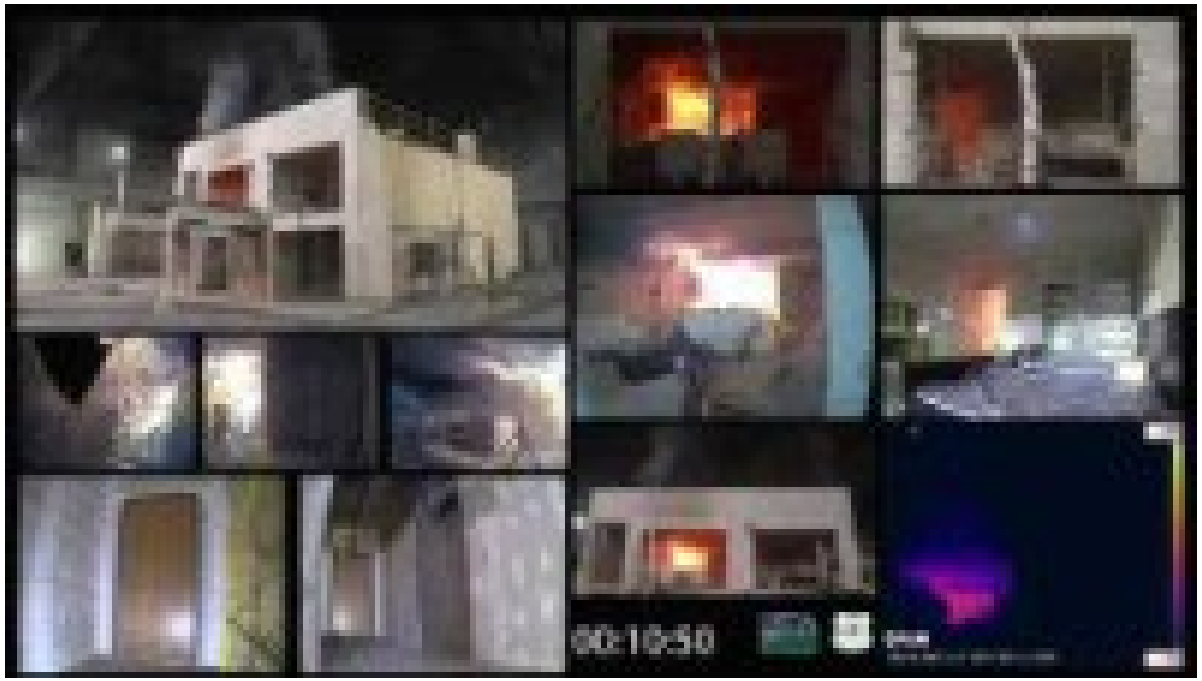
Glued-laminated timber (glulam)

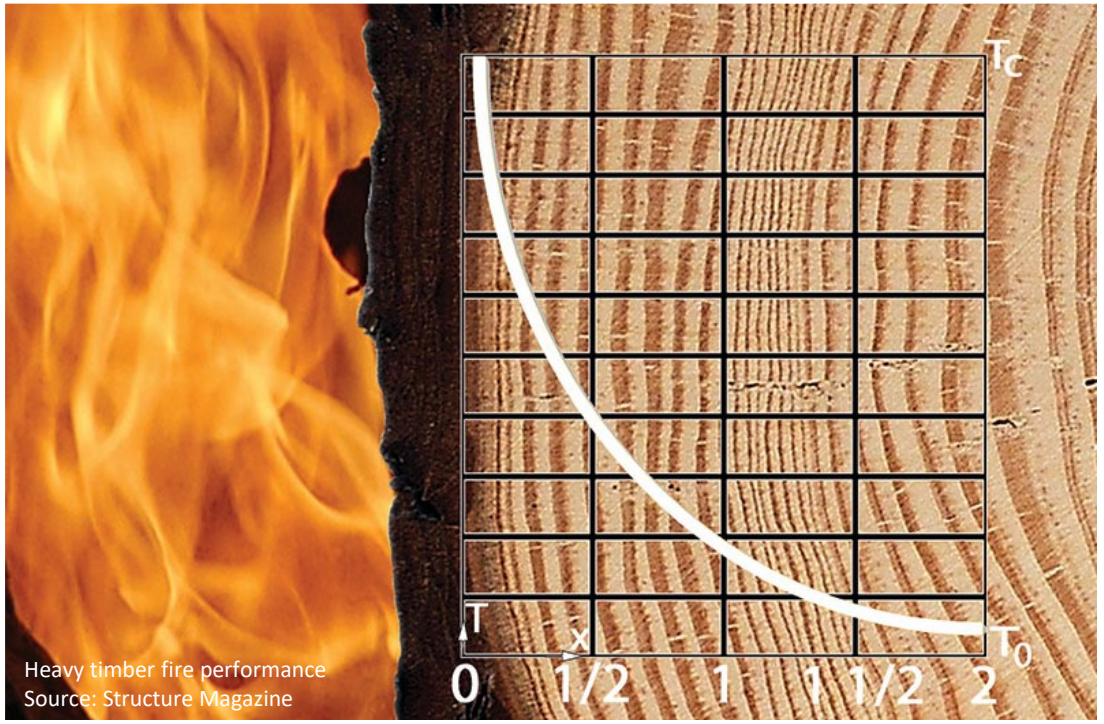
Nail-laminated timber (NLT)

Dowel-laminated timber (DLT)

Structural composite lumber (SCL)

Can wood be fire-resistant?

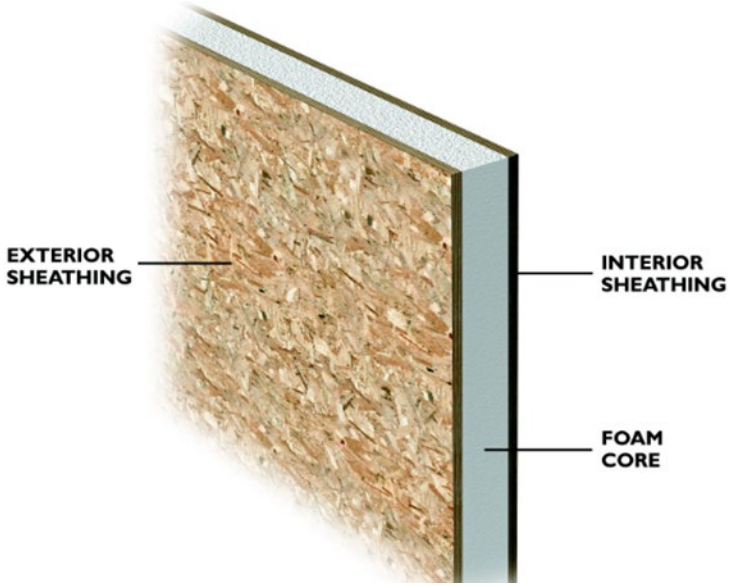




Heavy timber fire performance
Source: Structure Magazine

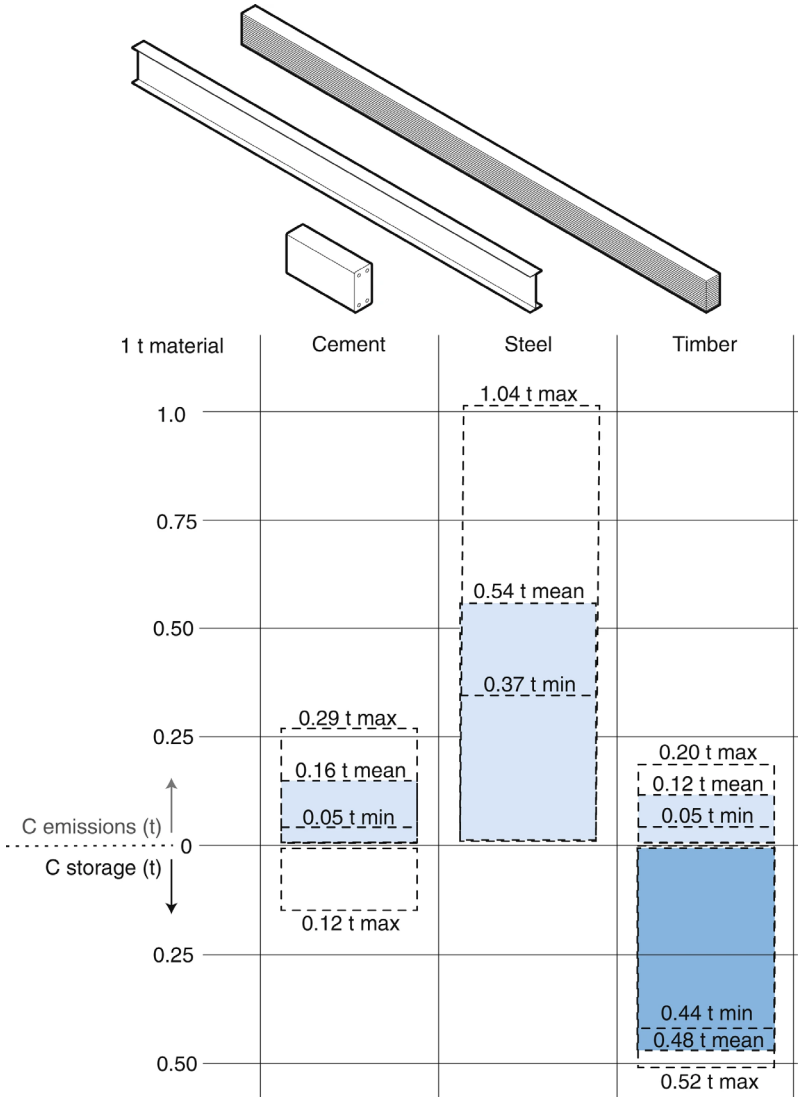

Source: www.naturallywood.com

Other engineered Wood Products



Engineered Wood Products

- California is the largest consumer of engineered wood products west of Mississippi River.
- Engineered wood products have long service life.
- A “turning point” of carbon emission will be reached with longer building service life.
- Case studies in the U.S. suggested at least 20% carbon reduction in mass timber hybrid buildings compared to concrete buildings.



Churkina, G., Organschi, A., Reyer, C.P.O. et al. Buildings as a global carbon sink. *Nat Sustain* 3, 269–276 (2020).

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Bio-based Homes

Source: Advanced Structures & Composites Center, University of Maine
https://composites.umaine.edu/biohome3d/

Post-fire Rebuild - Greenville, CA

Sierra Institute worked with atelierjones, LLC to develop CLT housing in Plumas County amid housing lost during the Dixie Fire. Sierra Institute is currently working with community members who want to rebuild with CLT construction.


2-bedroom prototype house. Greenville, CA.
Photo: atelierjones. LLC

Three housing prototypes (one-, two-, and three-bedrooms) were pre-approved by the county and built in Greenville, CA. These houses consisted of fire-prevention features such as defensible space and fire-resistant materials.

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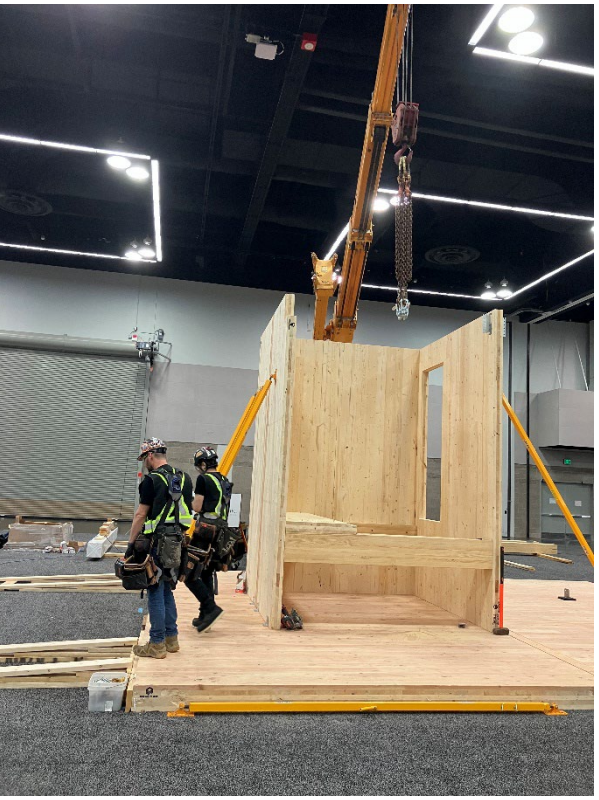
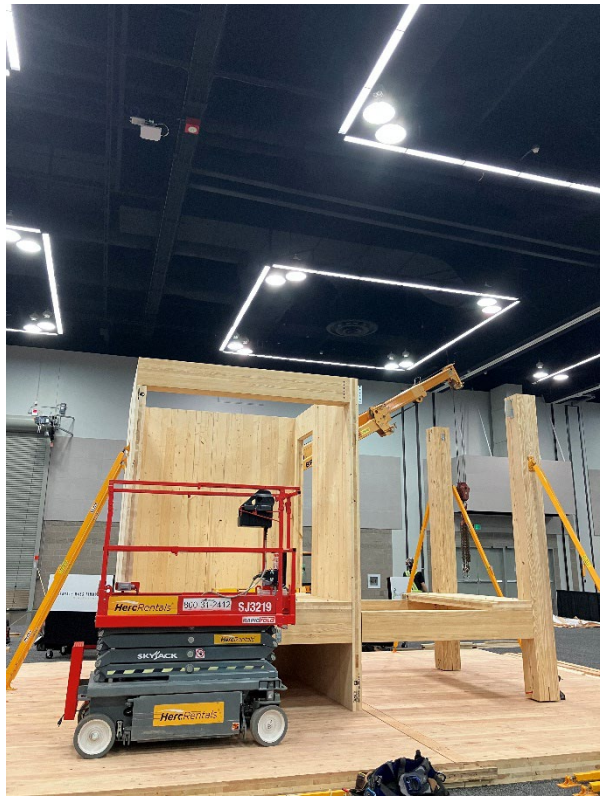
Mass timber construction in real time



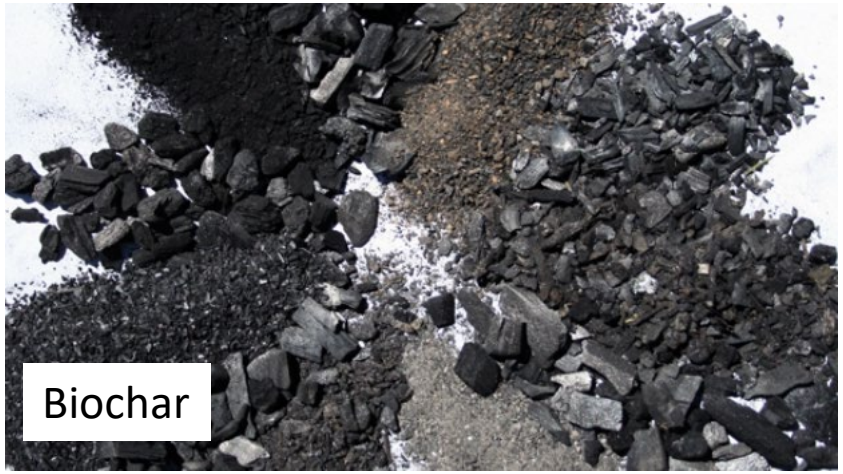


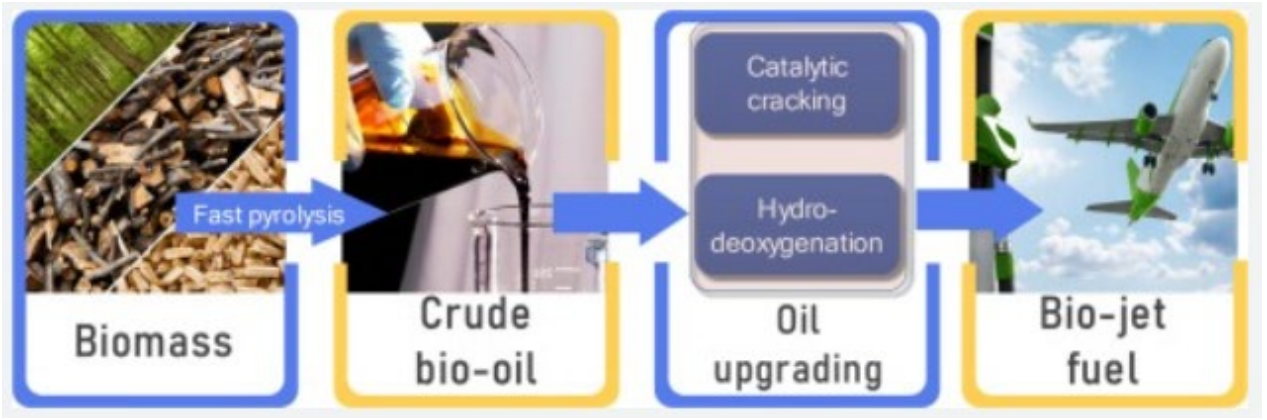
What can innovative wood products bring?

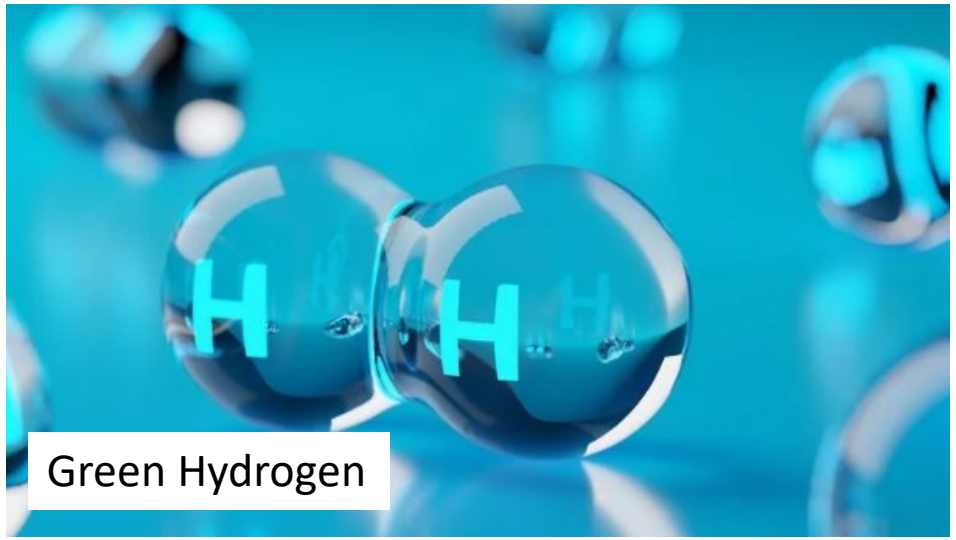
- Benefits:
  - Alternatives to concrete and steel
  - Regional economic development through manufacturing jobs and investments
  - Forest fuel reduction and value-added products
  - California-made sustainable materials
- Challenges:
  - Lack of facilities
  - Regulations hindering development of new infrastructure
  - Cost to build
  - Lack of skilled-labor

Energy, Biofuel, and More

Renewable energy share in California by source, 2021







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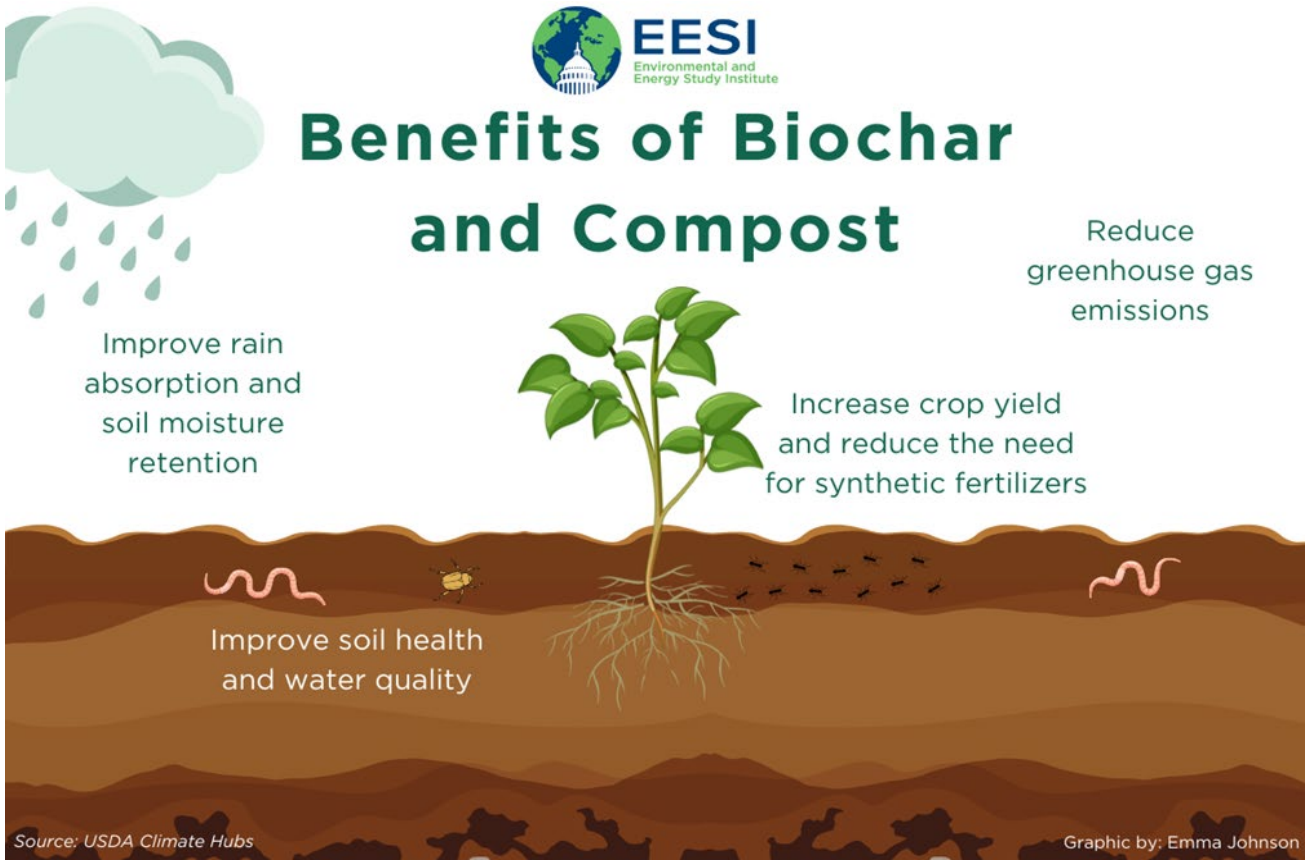
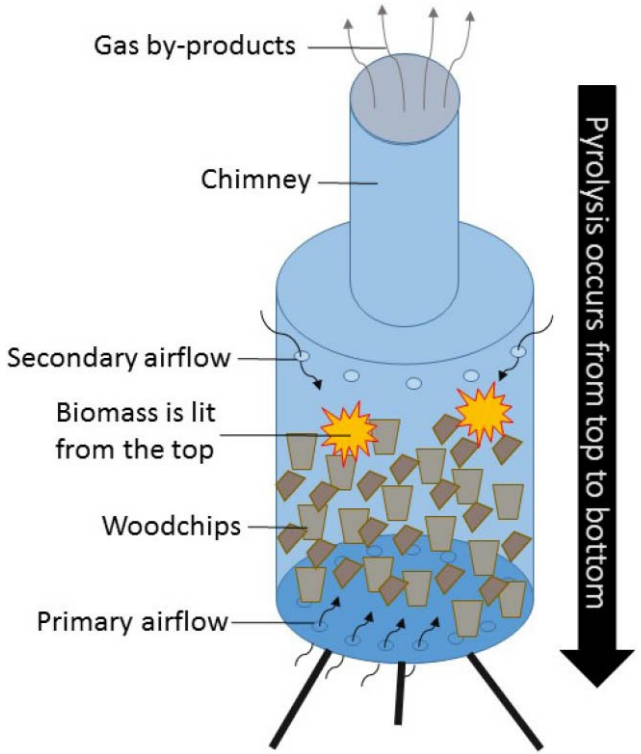
Bioenergy and Biofuel

- **Heat Energy** – Through the exothermic combustion process, wood or woody biomass, is converted into the primary products of carbon dioxide, water, inorganic ash, and various gaseous and particulate emissions while giving off about 8,000 BTU's of heat for every pound of dry wood burned.
- **Electrical Energy** – Coupling the combustion process with a steam boiler and using the produced steam to drive an electrical turbine is a well proven method of producing electricity from woody biomass.
- **Biofuels** – Common types:
  - **Solid or milled Wood** – wood in any size or shape can be directly combusted to produce heat and as such is a biofuel
  - **Densified wood** – wood particles are compressed into a smaller volume of a specific size and shape (pellets, logs, bricks, etc.) to increase the fuel density (Btu's per unit volume)
  - **Charcoal** – Produced by subjecting wood to a slow pyrolysis process (heating at 700 - 900°F in the absence of oxygen for many hours)
  - **Bio-diesel** – catalytic conditioning of syngas that was derived from the gasification of woody biomass can be directed towards the production of synthetic bio-diesel

Woody biomass for biochar

USDA Forest Service photo by Jessica Brewen





The design of the TLUD produces high quality char with efficient conversion rates
https://nfs.unl.edu/publications/small-scale-biochar

Potential Biofuel and hydrogen market for California:

- Transportation Fuels
- Cleaner fertilizer industry
- Benefits: Air pollution reduction; self-reliance

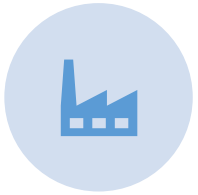
California is the largest consumer of both motor gasoline and jet fuel in the U.S. In 2020, California consumed over 11 billion gallons of gasoline and 5 billion gasoline gallon equivalent (GGE) of jet fuel.

Sanchez, D. & Gilani, H. 2021. *Advancing Collaborative Action on Forest Biofuels in California.*

What can green hydrogen bring?

- Benefits:
  - Workforce development and job creation
  - Healthier environment and forests
  - Regional economic development
- Challenges:
  - Transportation and space requirement
  - Development of centralized treatment facilities
  - Reliable long-term feedstock

Policy Support and Assistance



CA's plan to become the nation's largest clean hydrogen hub

California Building Code (CBC) allows mass timber buildings of up to 18 stories

Organizations: UC ANR, California Resource Conservation District (RCD), NRCS, etc.

Grant funding opportunities from USDA, USFA, CalFire, DOE, and others

Various policies that promote carbon storage, energy efficiency, wildfire prevention

Wood Facility Database

created in collaboration with IGIS

Find address or place

Status

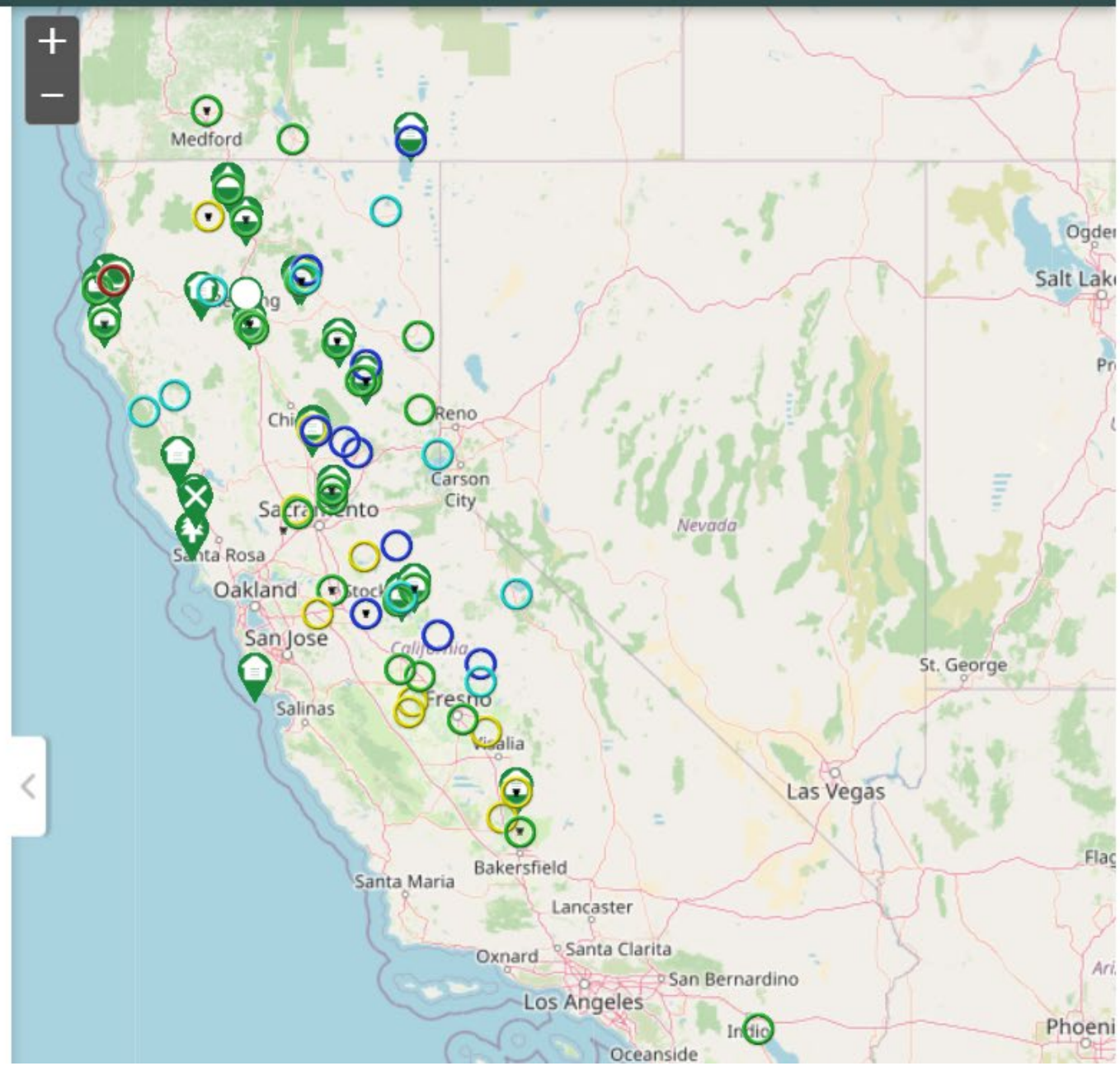
- Operational
- In Development
- Idle
- Proposal
- Closed

Facility Type

- Biomass Generator (Standalone)
- Biomass Cogeneration
- Large and Small Log Mill
- Large Log Mil
- Small Log Mill
- Fence Board Mill
- Peeler Mill
- Specialty/ Small Production Mill
- Post/Pole Mill
- Cedar Mill

Timber Production by County

Explore county-based timber production volume by clicking the graph icon on the bottom left of the map and following the prompts. Detailed instructions here



What's next?

- Institutional and stakeholders collaboration in innovation and exploring market opportunities
- Work with landowners to improve forest management strategies
- Workforce development in forestry, manufacturing, energy and utilities, etc.
- Develop regional facilities/hubs to receive raw materials from rural communities
- Demonstration projects to promote clean energy and renewable materials
- Find better options for byproducts


Woody Forest Products Manufacturing
This diagram conceptualizes the transformation of wood from the forest ecosystem into "end market products", or products one might interact with on a regular basis. Forest provide many benefits from recreational opportunities, to clean air and water. Woody biomass is but a small part of these services, but one that is deeply embedded in our everyday lives. Wood can build homes, print newspaper, and even power cellphones. This diagram will explain the complex pathways necessary to facilitate these everyday interactions with wood. Wood products generally follow these main steps:
Step 1: Source
Wood is grown and managed for in the forest ecosystem
Step 2: Raw Extract
Raw materials are extracted from the forest ecosystem
Step 3: Processing
Extracted material is reformed into an intermediate product for further processing or a final product.
Step 4: Intermediate
Products with limited consumer level use on its own is further manufactured into a final market product
Step 5: End Product
Final product is produced and made available for consumer use. See below for specific type definition
Solid connectors represent primary outputs
Dashed connectors represent secondary outputs or co-products
This is a product of the UC Berkeley Wood Resources Group (WRG) provided with funding support from the USFS R5 State and Private Forestry and from viewers like you. Last updated 7/24/15, RPS
University of California Agriculture and Natural Resources
Start Here!
Find out where wood comes from!
Peeler Log
Straight, high grade hardwood or softwood log clear of knots, branches, and other defect. Log lengths vary depending on end product need. Logs are peeled or sliced along the circumference to form veneer sheets.
Veneer Peeler/Slicer
Produces veneer sheets by slicing cants or peeling logs with a rotary lathe. Veneer end use determines product thickness from 3mm (decorative, high grade) to 6mm (low grade stock). Veneer sheets must be further processed with itself and other panel products to form wood panels.
Veneer Sheet
Sheet peeled along the circumference of a clear log. Veneers range in thickness depending on structural (thicker) or decorative (thinner) application and material type (i.e. costly hardwoods are usually used for decorative purposes).
Plywood
I-Joist
Electricity
Structural Composite Lumber
Smallwood Log
Roundwood exclusive of sawlogs and peeler logs, with structural qualities suitable for manufacturing into larger post or dimensional products. Higher value use for input materials than would be achieved through conversion into particulates.
Strander/Flaker
Wood Strands/Flakes
Small, flat wood particles of uniform dimensions and fiber direction along the plane of the flake similar to a miniaturized veneer slice. Distinct fiber direction is retained for manufacturing of structural oriented strand board, oriented strand lumber, and laminated strand lumber.
Oriented Strand Board
Wood Pellets
Direct Heat
Producer Gas
Management Residual
Chipper
Shavings
Bio-Oil
Wood Fiber Composite
Charcoal/Biochar
Wood Chips
Forest Ecosystem
Firewood
Soil Amendment & Mulch
Post & Pole
Wood Fiber
Paper Products
Cellulosic Ethanol
Fuel Log
Specialty Items
Sawlog
Post Peeler
Shaves material off small diameter logs to create a relatively uniform and clean primary product of posts and poles. Also produces chip and bark co-products.
Sawdust
Fine particulate co-product of sawing, grinding, or cutting operation. Pure wood material without non-wood contaminants (foliage, bark).
Fibreboard
Nanocellulose
Injection Molded Composite
Particleboard
Sawmill
Molding & Scrollwork
Lumber
Glued Laminated Timber
Furniture
All materials contained herein are intended for general education and information. Materials are free to distribute or use with reference to the University of California Wood Resources Group.
For more information, please visit us at:
ucanr.edu/woodybiomass
End products are grouped into the following color coded categories based on functional use.
Composite
Blend of wood particulates with non-woody materials including waxes, cements, adhesives, and plastics. Usually formed into specific shapes on the basis of engineering strength and end use requirements.
Energy
Wood products that are specifically manufactured for the purpose of generating heat to produce electrical power.
Landscaping
Materials used in outdoor applications ranging from aesthetic design, soil reinforcement, and even weed control
Lumber
Sawn lumber commonly used for building or construction uses. Typically directly sawn from forest output and only undergoes a single processing step.
Mass Timber
Engineered product with high strength and stability that can replace steel and concrete building materials. Mass timber can create wood shapes and sizes not found in traditional timber products.
Panel
Sheet based wood product. All have design specifications that vary strength and hydrophobicity. Can be used for aesthetic, design, or structural purposes.
Paper
Wood fiber based products typically produced in the form of rolls but may be shaped into a variety of products.
Remanufactured
Finished product built from taking an end market product and reprocessing it into another form.


Thank you!
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