THE UNIVERSITY OF ARIZONA
Natural Resource Users Law & Policy Center

Forest Biomass Utilization and Valorization

Turning a Restoration Challenge into Economic Opportunity



THE CHALLENGE

Treatment activities under the Four Forest Restoration Initiative (4FRI) are creating an immediate "biomass bottleneck". The large volumes of low-value woody material produced during restoration efforts exceeds the capacity of existing markets, driving up treatment costs and threatening the financial security of the forest products industry. As 4FRI scales restoration up to 40,000 acres annually, expanding markets for this material is critical to sustaining restoration efforts.

KEY TAKEAWAY

Arizona's forest restoration efforts are generating more low-value woody biomass than existing markets can utilize. Developing new products and industries for this material is essential to sustaining and scaling long-term forest restoration.

FOUR FOREST RESTORATION INITIATIVE (4FRI)

Collaborative landscape-scale restoration effort in Northern Arizona to treat 2.4 million acres of ponderosa pine and mixed conifer forest using prescribed fire and mechanical thinning.

- **Reduce risk of unnaturally severe wildfires**
- **Restore fire-adapted forests**
- **Support wildlife and plant diversity**

WHERE DOES THE BIOMASS COME FROM?

Per Acre Treated (Estimated)



25
GREEN TONS
Merchantable Small & Medium Diameter Logs



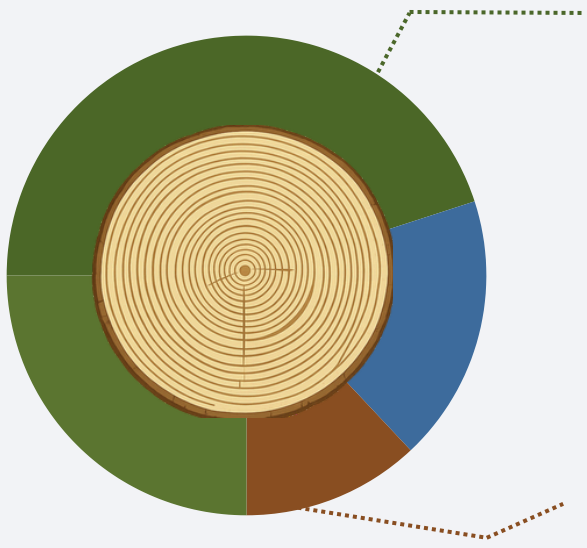
17
GREEN TONS
Forest Residual Biomass
(branches, tops, stumps, non-merchantable timber)



10
GREEN TONS
Sawmill Residuals
(sawdust, chips, bark)

WHAT IS WOOD BIOMASS?

Wood is a form of lignocellulosic biomass, made up of three main components.



65-70%
CELLULOSE & HEMICELLULOSE
Complex polysaccharides that can be broken down into simple sugars.

18-35%
LIGNIN
Complex polymer that provides structural support and resistance to decay and stress.

<5%
EXTRACTIVES
Small amounts of resins, oils and other compounds.

Most biomass valorization solutions seek to exploit these macromoluecules to produce biofuels and other bioproducts

VALORIZATION PATHWAYS: WHAT CAN WE DO WITH FOREST BIOMASS?

WOOD COMPOSITES
Engineered panels and structural wood products made by bonding wood strands, particles, or fibers with adhesives.



WOOD PLASTIC COMPOSITES
Thermoplastic polymers reinforced with wood fibers. Used in decking, construction, auto, packaging, and consumer products.



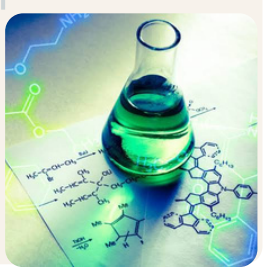
DENSIFIED WOOD ENERGY
Pellets and briquettes made by compressing woody biomass. Used to generate heat and electricity.



THERMOCHEMICAL CONVERSION
Uses heat and chemicals to convert biomass into biochar, syngas, bio-oil, and other fuels and chemicals.



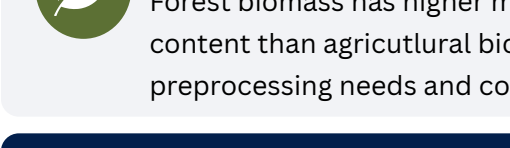
BIOCHEMICAL CONVERSION
Uses microbes and enzymes to convert biomass into sugars and then into biofuels. (e.g. ethanol, biogas) and other bioproducts.



THERMOCHEMICAL CONVERSION: PATHWAYS TO ENERGY AND BIOPRODUCTS

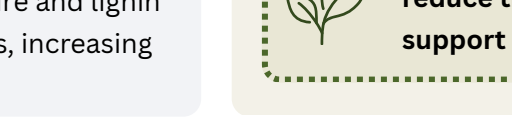
DIRECT COMBUSTION

The most common form of thermochemical conversion. Produces heat and electricity with lower greenhouse gas emissions than fossil fuel plants and can be further mitigated with carbon capture.



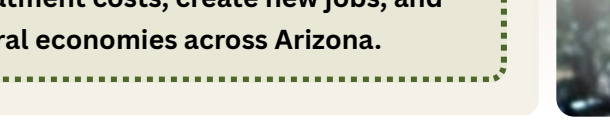
GASIFICATION

Biomass is dried, shredded, and fed into a gasifier with steam, air, and oxygen to produce syngas and tar. Syngas is cleaned and refined into biofuels.



HYDROTHERMAL LIQUEFACTION

Biomass is converted to biocrude in high-pressure (4-22 MPa) water at high temperatures (300-400 C). The biocrude is refined into petroleum-derived fuels.



PYROLYSIS

Thermal decomposition of biomass at 300-800 C in the absence of oxygen produces biochar, bio-oil, and syngas. Product proportions depend on feedstock and reactor design.



CHALLENGES TO SCALING UP

HIGH COSTS
Production costs can exceed those of fossil fuels in regions with low fossil fuel prices.

LIMITED MARKETS
Limited demand and market development for advanced biofuels, biochar, and bioproducts.

FEEDSTOCK & LOGISTICS
Securing consistent biomass supply and managing collection, transport, and storage.

TECHNOLOGICAL MATURITY
Many technologies are still emerging and face scale-up and reliability risks.

HIGHER MOISTURE CONTENT
Forest biomass has higher moisture and lignin content than agricutlural biomass, increasing preprocessing needs and costs.

TODAY: CONVENTIONAL UTILIZATION PATHWAYS

Much of the material generated from forest operations and wood manufacturing is still managed through disposal or low-value uses.

FOREST OPERATIONS

- Pile burning
- Firewood (e.g. NFF Trees for Life)
- Mastication
- Lop and scatter
- Habitat Structures

WOOD MANUFACTURING

- Animal bedding
- Landscaping
  - Mulch
  - Potting soil
  - Soil amendments
- Pulp and paper

Expanding utilization of low-value biomass can reduce treatment costs, create new jobs, and support rural economies across Arizona.

CONCLUSIONS

Meeting restoration goals under 4FRI requires the continued development and expansion of markets for low-value forest biomass.

The biomass buildup is not simply a technology challenge. Policies that address long-term feedstock certainty, access to capital, transportation economics, permitting, and market-development will help determine which valorization pathways can become commercially viable in Arizona.

By treating woody biomass as a resource rather than a waste product,
Arizona can build a more resilient forest economy and healthier forests for future generations

Visit the NRULPC Website