Sustainable biomanufacturing of materials and chemicals in circular forest bioeconomy system

Sudhagar Mani
School of Chemical, Materials, and Biomedical Engineering, University of Georgia, Athens, GA;
email: smani@uga.edu

Abstract

The transition to a circular forest bioeconomy requires sustainable biomanufacturing approaches that effectively utilize underused and unmechanizable forest biomass and residues including bark, needles, branches and juvenile wood into high-value materials and chemicals. This presentation outlines a systems-level framework for integrating forest-based biomass fractionation with circular biomanufacturing pathways with cascading and circular biomanufacturing pathways to produce a wide range of consumer products, fuels and chemicals.

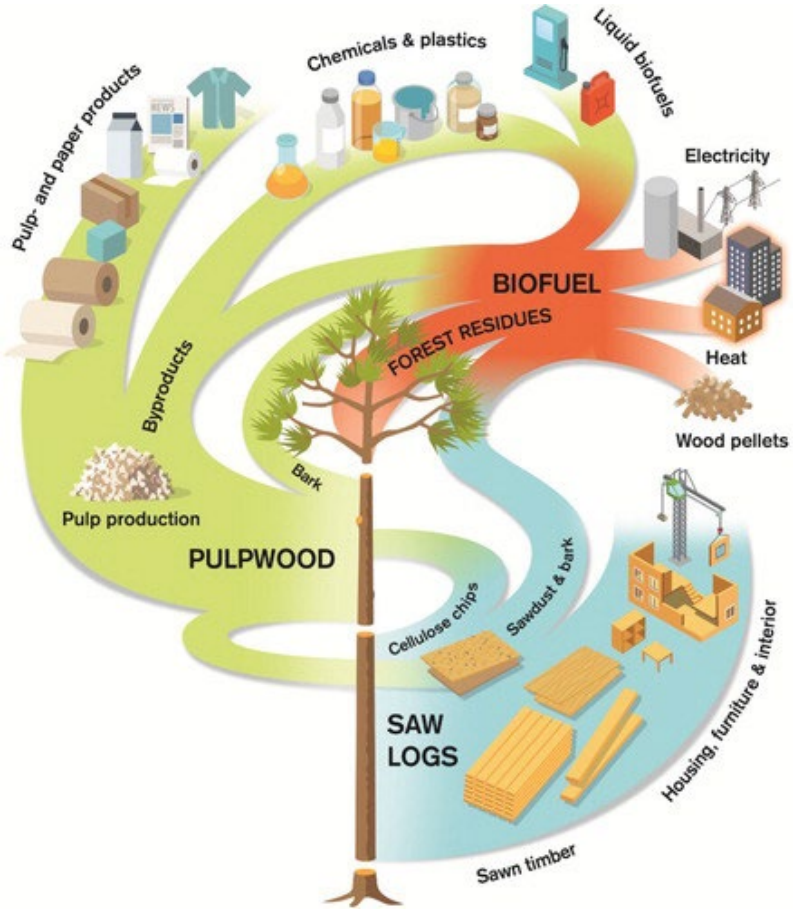
Traditional forest industries, including sawmills and pulp mills, have focused on producing building materials and paper, tissue products. While these operations generate substantial waste streams, some of which are used for heat and power, significant opportunities exist to upgrade these residues into higher value applications. In addition, forest residues are often left in the forest land causing forest fire or burned to generate heat and power can instead be fractionated into high-value feedstock streams for developing advanced materials, bioplastics, chemicals and fuels.

The growing demand for bio-based or bio-derived products is driven by their lower carbon footprints and potential to replace fossil-derived alternatives such as plastics, packages, and other consumer products. However, the increased production of biodegradable forest products without a shift from linear economic mindset of take-make-waste may still result in significant waste generation. Therefore, the future forest industries must adopt sustainable circular bioeconomy principles: keeping materials in longer use, enhancing forest biomass utilization efficiency, minimizing wastes, driving regional economic growth while regenerating natural resources. Cascading use strategies that maintain biomass quality throughout the product life cycle are essential to achieve the circularity goals. This presentation will explore the challenges and opportunities of applying circularity into forest biomanufacturing systems and highlighting emerging examples of circular forest products in building a sustainable bioeconomy in the U.S.

Speaker Bio:

Sudhagar Mani is a Professor of Engineering from the School of Chemical, Materials, and Biomedical Engineering, College of Engineering, University of Georgia (UGA). He received his Ph.D. in Chemical and Biological Engineering from the University of British Columbia, Canada. His primary research focus is on applying circular bioeconomy principles to Agriculture, food, forestry, and bioenergy systems to design, evaluate and produce sustainable biofuels, biochemicals, and bioproducts. His research is also focused on machine learning modeling of

biomass preprocessing and conversion technologies such as biomass densification, torrefaction, and pyrolysis pathways to produce biofuels and biochemicals. His team applies GIS-based supply chain modeling, techno-economic analysis (TEA), and life cycle assessment (LCA) tools to evaluate the sustainability and circularity of bioenergy systems. His team applies a life cycle assessment framework to various circular agricultural systems with regenerative practices to evaluate the carbon intensity of climate-smart commodities. His recent projects include application of machine learning tools for predicting biorefinery performances, investigation on climate-smart, carbon-neutral agriculture systems, biodegradation mechanism of biopolymers such as PLA, PHA and natural polymers such as nanocellulose and chitosan, and hydrophobic coating of packaging films. He and his research team have published more than 100 referred journal articles, proceedings, book chapters, and patents and presented more than 200 international and national conference presentations. He is also an elected fellow of the American Society of Agricultural and Biological Engineers (ASABE) and the Editor-in-Chief of ASABE Professional Society Publications. He is a member of TAPPI and the Conference Chair of TAPPI's International Bioenergy & Bioproducts Conference (IBBC) – (2021-2023).



Valorization of forest biomass into consumer products, energy, and materials