

# Evaluating Approaches to Lignin Valorization

## Background

- The valorization of lignin, a plant cell wall polymer once viewed as an impediment to the processing of biomass to fuels, chemicals, and materials, is now clearly recognized as a critical element and valuable co-product for the lignocellulosic bioeconomy. Rick Dixon (University of North Texas) was invited by *Annual Reviews* to lead a comprehensive review article on this topic and was assisted by Allen-Puente Urbina (NREL), Gregg Beckham (NREL) and Yuriy Román-Leshkov (MIT).

## Approach

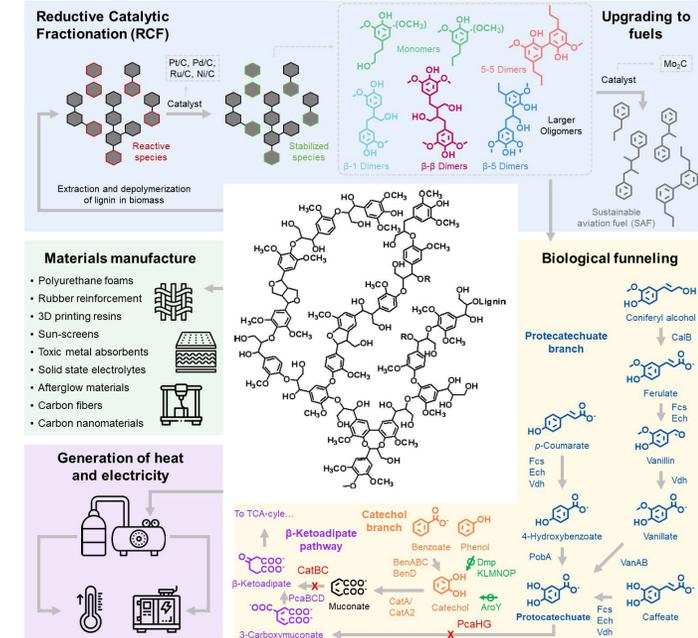
- This review explores opportunities at the intersection of lignin engineering and biorefining. Key areas include improving lignin extractability, engineering lignin in plants, and tuning lignin chemistry for material production or conversion into fuel blendstocks and other valuable products.

## Results

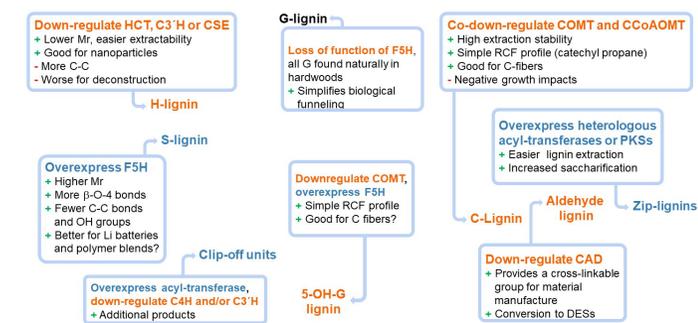
- The concept of lignin valorization was born mainly from economic arguments. We therefore concluded that, when developing a process for a large-scale application, even though it must be technically sound, it is essential to acquire further insights into its feasibility by assessing economic and environmental aspects.
- A major question for the future is, “because we can engineer lignin, do we need to”? TEA will help decide which combinations of innovations in plant genetics, agronomy, process engineering, catalysis, separations, and/or funneling technology are best for lignin valorization. For example, would the development of biological systems for cleavage of C–C bonds and equally efficient funneling of differently substituted monomers make engineering lignin composition unimportant? If the answer is yes, then lignin (plant) yield and possibly extractability become more important than composition.

## Significance

- The review concludes that a closer integration of plant biology and biorefining is crucial to address the above questions as we move to reduce humankind’s carbon footprint.



Approaches to lignin valorization



In planta engineering of the lignin pathway to generate “purpose-designed” lignins.

Dixon R.A. et al. *Annual Review of Plant Biology* (2024) 75:239–263, <https://doi.org/10.1146/annurev-arplant-062923-022602>