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**Optimizing biorefinery strategies for use with lignin valorization**

Modeling analyses identify general insights and technical advances needed to make lignin valorization economically attractive.

**The Science**

Biorefineries typically burn lignin as a source of heat and power, despite the fact that this complex aromatic heteropolymer has the potential to yield bioproducts of considerable value. In this paper, Great Lakes Bioenergy Research Center (GLBRC) scientists studied biorefinery strategies that couple lignin valorization subsystems with the conversion of biomass to liquid fuels, with a goal of exploring the advances and conditions necessary to make lignin valorization technically and economically viable. The researchers developed an optimization model to evaluate the impact of various technical, economic, and energy parameters related to lignin valorization on the optimal biorefinery configuration and minimum fuel cost.

**The Impact**

This work represents a valuable advance in understanding the economics and energy efficiency of lignocellulosic biorefinery strategies that employ lignin valorization. The analysis establishes technology targets that have to be met to make lignin valorization economically attractive. These results, coupled with the identification of appropriate lignin-derived products and development of economical separation technologies for bioproduct recovery, will help accelerate the development of lignin valorization technologies.

**Summary**

The researchers used process synthesis through superstructure optimization to study different biorefinery configurations under a variety of constraints. They performed thousands of optimizations to evaluate the impact of four critical parameters for lignin valorization: energy requirement of conversion and bioproduct recovery, conversion efficiency to bioproducts, production cost, and bioproduct selling price. Results indicate that under certain scenarios, the optimal biorefinery strategies with lignin valorization tend to be energy deficient, suggesting that different biomass pretreatment strategies may need to be selected under these conditions. Further analysis evaluated how improvements in combinations of the selected parameters can lead to lower cost for a thermal-neutral biorefinery. Rather than assess specific lignin-derived products, the analysis established targets in terms of the four key parameters with a goal of identifying general insights into crucial areas of improvement for viable lignin valorization. Detailed techno-economic analyses that include assessment of the impact of uncertainty in the key parameters can follow once specific compounds and detailed production processes, including viable separation and bioproduct recovery, are identified.

**Contacts (BER PM)**

N. Kent Peters  
Program Manager, Office of Biological and Environmental Research  
[kent.peters@science.doe.gov](mailto:kent.peters@science.doe.gov), 301-903-5549

**Corresponding Author**

Christos T. Maravelias   
University of Wisconsin–Madison  
[christos.maravelias@wisc.edu](mailto:christos.maravelias@wisc.edu)

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**Publications**

K. Huang, P. Fasahati, and C.T. Maravelias. “System-level analysis of lignin valorization in lignocellulosic biorefineries.” *iScience* (2020) **23**, 100751 [DOI: 10.1016/j.isci.2019.100751]

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