CABBI
CENTER FOR ADVANCED BIOENERGY AND BIOPRODUCTS INNOVATION

Spatial Optimization of Multiscale Biorefinery Deployment for a Diversified Bioeconomy in the United States

Background/Objective

Strategic biorefinery siting is critical for a diversified bioeconomy, yet industry, policy, and research often focus on either large-scale biofuel plants or smaller-scale specialty bioproduct facilities, with limited coordination across scales. The study addresses this gap by modeling biorefinery deployment spanning a 28-fold difference in capacity.

Approach

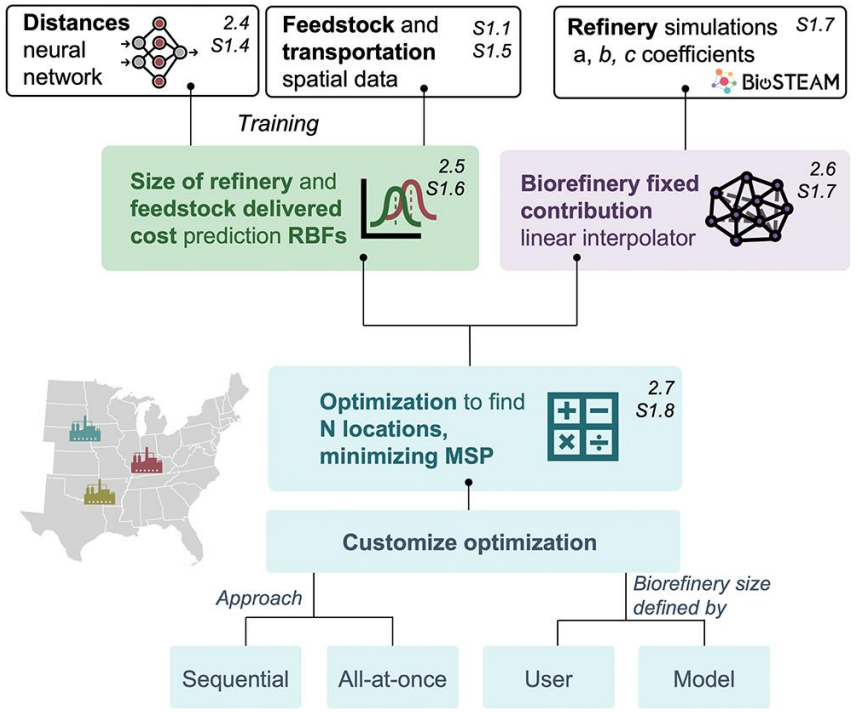
Researchers developed an open-source, spatially explicit framework integrating techno-economic analysis with logistics and refinery cost surrogate models to evaluate multiscale miscanthus-derived biorefineries across the rainfed U.S. for the production of ethanol, succinic acid, lactic acid, potassium sorbate, and acrylic acid.

Results

The findings show that overall costs change little as feedstock density increases, while transport distances decrease by ~30 to 67% (~100 km) and siting flexibility improves. Specifically, a 5-fold feedstock density increase (2% to 10% of suitable land) reduces minimum selling prices by <10% (e.g., 0.27 USD·gal^{-1} for ethanol). This limited economic sensitivity suggests dense planting is not required for competitive deployment, particularly for smaller-scale facilities. Representing collection areas as irregular rather than circular expands the feasible space under low-density scenarios. While large-scale refineries anchor regional supply chains, smaller facilities retain spatial flexibility even when large refineries are established.

Significance/Impacts

These findings highlight the importance of spatial representation and multiscale coordination for robust, regionally tailored biomanufacturing networks to support rural economies without extensive land conversion.



Overview of the modeling framework used to identify optimal biorefinery locations minimizing MSP

Bianco et al. 2026. "Spatial Optimization of Multi-Scale Biorefinery Deployment for a Diversified Bioeconomy in the United States." *Environmental Science & Technology*. DOI: 10.1021/acs.est.6c07048.