

BioSTEAM and the prioritization of research, development, and deployment pathways for the conversion of plants to products

*Jeremy S. Guest (Levenick Professor and Director)
Levenick Center for a Climate-Smart Circular Bioeconomy
University of Illinois Urbana-Champaign
3221 Newmark Civil Engineering Laboratory, 205 N. Mathews Ave (M/C 250)
Urbana, IL, 61801-2352 USA
jsguest@illinois.edu*

Industries are seeking technological solutions that will meet societal needs in a way that is financially viable while supporting the pursuit of broader goals for sustainability (e.g., resource circularity, carbon neutrality, equity). This transition has become a catalyst for research and development, but a critical challenge to achieving rapid and transformative innovations has been the expansive landscape of technology development pathways and the lack of a transparent and consistent framework to target investment.

This presentation will focus on the prioritization of research, development, and deployment (RD&D) pathways for the conversion of renewable resources into bioenergy and bio-based products. Using a structured methodology – Quantitative Sustainable Design (QSD) – we integrate process design, simulation, techno-economic analysis (TEA), and life cycle assessment (LCA) under uncertainty to elucidate drivers of system sustainability, identify performance gaps, evaluate tradeoffs and optimize across alternatives, and assess context-specific implications of technology advancement and deployment. Leveraging examples from the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI), we will focus on the conversion of perennial grasses (*Miscanthus*, switchgrass, sugarcane) and agricultural residues to biofuels (sustainable aviation fuel [SAF]) and bioproducts (e.g., 3-hydroxypropionic acid [3-HP], triacetic acid lactone [TAL]), including the exploration of opportunities for the integration of decarbonized processes with existing infrastructure (e.g., co-processing of SAF). In addition to demonstrating specific potential pathways to advance the circular bioeconomy, this presentation will introduce an open-source process simulator, BioSTEAM, and a portfolio of packages available to simulate emerging conversion technologies and feedstock-to-product pathways.