
**Background/objective**

Techno-economic analysis (TEA) of biorefineries allows researchers to compare and prioritize strategies for converting biomass to fuels and products. However, classic approaches to TEA are resource-intensive, computationally burdensome, dependent on proprietary software, and have little to no characterization of uncertainty and sensitivity. Researchers addressed these limitations by developing the Biorefinery Simulation and Techno-Economic Analysis Modules (BioSTEAM), an open-source, community-driven software in Python for the rapid design, simulation, and TEA of biorefineries under uncertainty.

**Approach**

- BioSTEAM implements a thermodynamic framework that enables rigorous mass and energy balances.
- All process specifications, design decisions, and scenario parameters in BioSTEAM can be dynamically specified, enabling flexible evaluation of biorefinery designs with rigorous uncertainty and sensitivity analyses.
- BioSTEAM was used to model lipid-cane and corn stover biorefineries; the results were compared to benchmark models built in Aspen Plus and SuperPro Designer, respectively.

**Results**

- BioSTEAM was able to evaluate biorefinery designs across a continuum of feedstock compositions under uncertainty. In total, 31,000 different biorefinery designs were evaluated in less than 50 minutes.
- The results of the lipid-cane and corn stover biorefinery models matched the benchmark models and, through sensitivity analysis, revealed key bottlenecks for research and development (R&D).

**Significance**

BioSTEAM provides an open-source, community-driven platform for rigorous TEA under uncertainty to prioritize R&D and drive the bioeconomy forward.