Open-source techno-economic models for decision-making in biorefining research and development

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Advances in biorefining process usually provide numerous routes, with many options in terms of unit operations, operational parameters, and products/by-products. Techno-economic models (TEA) have become the gold standard to assess emerging technologies in biorefining. Although TEA models are valuable in determining the feasibility and scalability of these technologies, they are often conducted at the end of projects. In addition, these models are rarely shared openly, thus limiting their applicability. Combining TEA modeling throughout the research and development process allows for a prompt and integrated approach that optimizes the use of resources and provides targets for the biorefining processes. Open-source models promote transparency and collaboration and provide a platform for future standardization of techno-economic assessment for biorefining.

Here, we present examples of TEA models developed in Python for different biorefining processes. First, we developed a superstructure model to compare different lignin valorization routes with biological upgrading. The model evaluates different feedstocks, fractionation, depolymerization, and biological upgrading processes and optimizes the routes to maximize the net present value of the biorefinery. Multi-objective optimization has also been used to simultaneously minimize greenhouse gas emissions. Second, we present a TEA model for the assessment of anaerobic co-digestion of lignocellulosic biomass using BIOSTEAM, an open-source bioprocess simulation software. These models evaluate different feedstocks, scales, and business models. These models allow for dynamic updates and improvements, fostering a more collaborative approach to biorefining research and development. The availability of open-source TEA models is expected to accelerate innovation and decision-making processes in the biorefining industry.