Agile Technoeconomic and Life Cycle Assessments at the CBI

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Project Goals: The Center for Bioenergy Innovation (CBI) vision is *to accelerate domestication of bioenergy-relevant, non-model plants and microbes to enable high-impact innovations at multiple points in the bioenergy supply chain.* CBI will address strategic barriers to the current bioeconomy in the areas of: 1) high-yielding, robust feedstocks, 2) lower capital and processing costs via consolidated bioprocessing (CBP) to specialty biofuels, and 3) methods to create valuable byproducts from the lignin. CBI will identify and utilize key plant genes for growth, composition and sustainability phenotypes as a means of achieving lower feedstock costs, focusing on poplar and switchgrass. We will convert these feedstocks to specialty biofuels (C4 alcohols and C6 esters) using CBP at high rates, titers and yield in combination with cotreatment or pretreatment. And CBI will maximize product value by *in planta* modifications and biological funneling of lignin to value-added chemicals.

TEA quantifies the impacts that research and development (R&D) breakthroughs and discoveries have on the economic viability of an integrated process. Technoeconomic analyses (TEA) is a highly supportive research tool which can identify drivers and metrics to reduce the overall costs, as well as outline the lowest cost potential, of an integrated system. Life cycle assessments (LCA) explores the key sustainability metrics critical to ensure that an underlying integrated process offer an environmentally beneficial design, which is the ultimate desired outcome when pursuing biomass-derived fuels and chemicals. The combined application of TEA and LCA allows for understanding the tradeoffs and benefits of both economics and sustainability in these integrated systems.

The overall objective of the Economic and Sustainability Team is to quantitatively assess the impact that the CBI R&D will have on the reduction of costs and scale-up risks for the integrated production of biomass through conversion to fuels. CBI will employ agile TEA and LCA to investigate the drivers of phenotypes and process conversion metrics on the integrated system design. The analysis tools and studies developed in this project will support research prioritization to ensure that the ongoing basic science being performed by the CBI is targeted toward de-risking technology bottlenecks and overcoming critical economic and technical barriers in order to accelerate growth of the bioeconomy. Our goal is to develop analyses that not only support the mission of the CBI, but also to release such tools as user-friendly guides to help direct and inform the broader biofuels community.

The biggest challenges to evaluating economic and sustainability drivers in an integrated fashion are that 1) the underlying models and tools used for the evaluations typically require a subject matter expert to properly utilize these tools, 2) these models and tools often require expensive licenses to operate, and 3) these models are not rigorously integrated. The analysis team will work to reduce these challenges by developing first-of-a-kind integrated, agile analytical tools to provide a prioritized order of magnitude ranking of the potential impacts of CBI research on industrial cost and sustainability barriers. Specific illustrative integrated scenarios will then be compared to the robust specialized rigorous approaches. By applying a holistic assessment of the design, these TEAs and LCAs will provide rapid feedback to experimentalists and will serve as a decision-making tool for dynamic project management. This poster will outline the approach and the models to be incorporated.

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