

Biofuels 2015 - Development of advanced biofuels and biomass conversion technologies at the Joint BioEnergy Institute

Blake A Simmons,
Rothamsted Research, UK

Today, carbon-rich fossil fuels, primarily oil, coal and natural gas, provide 85% of the energy consumed in the United States. Fossil fuel use increases CO₂ emissions, increasing the concentration of greenhouse gases and raising the risk of global warming. The high energy content of liquid hydrocarbon fuels makes them the preferred energy source for all modes of transportation. In the US alone, transportation consumes around 13.8 million barrels of oil per day and generates over 0.5 gigatons of carbon per year. This has spurred intense research into alternative, non-fossil energy sources. The DOE-funded Joint Bioenergy Institute (JBEI) is a partnership between seven leading research institutions (Lawrence Berkeley Lab, Sandia Labs, Lawrence Livermore Lab, Pacific Northwest National Lab, UC-Berkeley, UC-Davis, and the Carnegie Institute for Science) that is focused on the production of infrastructure compatible biofuels derived from non-food lignocellulosic biomass. Biomass is a renewable resource that is potentially carbon-neutral. Plant-derived biomass contains cellulose, which is more difficult to convert to sugars. The development of cost-effective and energy-efficient processes to transform cellulose and hemicellulose in biomass into fuels is hampered by significant roadblocks, including the lack of specifically developed energy crops, the difficulty in separating biomass components, low activity of enzymes used to hydrolyze polysaccharides, and the inhibitory effect of fuels and processing byproducts on the

organisms responsible for producing fuels from monomeric sugars. This presentation will highlight the research efforts underway at JBEI to overcome these obstacles, with a particular focus on the development of an ionic liquid pretreatment technology for the efficient production of monomeric sugars from biomass.

Biomass can be changed over into a few valuable types of vitality utilizing various procedures (transformation innovations) which are depicted in this section. Bioenergy is the term used to portray vitality got from biomass feedstocks. A few handling steps are required to change over crude biomass into valuable vitality utilizing the three primary procedure advancements accessible: bio-substance, thermo-compound, and physio-synthetic. Bio-concoction transformation includes two essential procedure choices: anaerobic processing (to biogas) and maturation (to ethanol). For the thermo-substance transformation courses, the four primary procedure choices introduced here are pyrolysis, gasification, burning, and aqueous preparing. Physio-concoction transformation comprises mainly of extraction (with esterification) where oilseeds are squashed to extricate oil.

Bioenergy comprises of strong, fluid, or vaporous energizes which can be gotten from the accessible advances. Fluid energizes are regularly utilized in transportation vehicles, however can likewise be utilized in fixed motors. Strong fills are legitimately combusted to acquire warmth, force,

or CHP. Vaporous fills can be applied to the full scope of end-employments.

A few variables influence the decision of change process including the sort, amount, and qualities of biomass feedstock, end-use prerequisites, natural guidelines, financial aspects, area, and task explicit components. It is the structure where the vitality is required and feedstock accessibility decides the procedure course. How biomass transformation advances are actualized and worked will influence the GHG outflows that may emerge from their utilization. This section hence traces the fundamental change advancements accessible to give a review of where potential GHG discharges may emerge and to give references to increasingly nitty gritty GHG evaluations. Since there are a wide assortment of feedstocks, pre-handling, preparing, and end-utilize choices accessible, here we give setting to the LCA specialist of the contemplations of outflows sources from the distinctive biomass change pathways.

Change of biomass to vitality is attempted utilizing three primary procedure innovations: bio-substance, thermo-compound, and physio-concoction. ... Inside thermo-substance transformation, the four principle process choices are burning, pyrolysis, gasification, and liquefaction Biomass can be utilized to make warmth, power, or joined warmth and force (CHP). In the event that there are applications for both the warmth and force yields, a CHP framework can arrive at a lot higher by and large efficiencies (up to 80%) than power creation alone and is apparently the most financially savvy utilization of biomass (ENVINT Consulting 2010). CHP frameworks yield more warmth than power, anyway the extent and grade of the warmth

for is subordinate upon the transformation innovation chose. To change over biomass into valuable vitality, the biomass should first be combusted, either by direct ignition or gasification combustion¹. Direct ignition includes combusting the biomass in an evaporator that disintegrates steam or another working liquid. The working liquid would then be able to be utilized for warming purposes, or then again can create power in a turbine or steam motor. Steam turbines that work on the thermodynamic Rankine cycle are the most well-known technique for power age from biomass, anyway they are progressively reasonable for enormous scope applications and experience a drop in productivity when utilized for applications under 10 MW (ENVINT Consulting 2010). Steam motors are commonly viewed as fitting for power age under 1 MW. The Organic Rankine Cycle (ORC) turbine is another option power creation cycle that is more qualified to applications under 5 MW (ENVINT Consulting 2010). An ORC turbine works a lot of like a steam turbine, anyway similarly low temperatures result from the utilization of a natural liquid in spot of steam (70C to 300C) (Envirolink Northwest, North Vitality Associates Limited. n.d.). ORC turbines can frequently be worked without a confirmed steam administrator, making them progressively perfect for use in far off networks. Gasification-burning is a further developed technique for burning where the biomass is first changed over to a syngas by confining the measure of oxygen accessible and thermally breaking down the biomass. The syngas can at that point be combusted straightforwardly to disintegrate a working liquid, or combusted in an inside burning motor (ICE) to produce power

Biography

Dr. Simmons joined Sandia National Laboratories in 2001 as a Senior Member of the Technical Staff, serving as a member of the Materials Chemistry Department. He participated on and led a variety of projects, including the development of cleavable surfactants, enzyme engineering for biofuel cells, microfluidics, and the synthesis of silicate nanomaterials. He was promoted to Manager of the Energy Systems Department in 2006. The primary focus of the department was the development of novel materials-based solutions to meet the nation's growing energy demands. He is one of the principal co-investigators of the Joint Bioenergy Institute (JBEI, www.jbei.org), a \$259M, ten-year DOE funded project tasked with the development and realization of next-generation biofuels produced from non-food crops. He is currently serving as the Chief Science and Technology Officer and Vice-President of the Deconstruction Division at JBEI, where he leads a team of 43 researchers working on advanced methods of liberating fermentable sugars and lignin from lignocellulosic biomass. He is also the Senior Manager of Biofuels and Biomaterials Science and Technology at Sandia, where he also serves as the Biomass Program Manager. He has over 220 publications, book chapters, and patents. His work has been featured in the New York Times, the Wall Street Journal, the San Francisco Chronicle, and the KQED televised science program Quest..

basimmons@lbl.gov