Flying the Future: Advanced Aviation Fuels at the Joint BioEnergy Institute (JBEI)

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ABSTRACT

The vision of the Joint BioEnergy Institute (JBEI, www.jbei.org) is that bioenergy crops can be converted into economically viable biofuels and renewable chemicals. JBEI's mission is to establish the scientific knowledge and new technologies in feedstock development, deconstruction and separation, and conversion needed to transform the maximum amount of carbon available in bioenergy crops into biofuels and bioproducts. When fully scaled, JBEI's technologies will enable the production of replacements for petroleum derived gasoline, diesel, jet fuel, and bioproducts. In doing so, JBEI will reduce the nation's dependence on fossil fuels, significantly reduce the amount of carbon added to the atmosphere, reduce contamination of the environment, and provide the scientific tools and knowledge required to transform the bioenergy marketplace. It has been estimated that the USA has the potential to generate a billion tons of renewable biomass annually. Overcoming biomass recalcitrance in terms of achieving efficient and affordable biomass deconstruction remains a significant obstacle in the biochemical conversion of biomass to biofuels and bioproducts that must be addressed. JBEI has established world-class and differentiated expertise in the use of ionic liquids (ILs), a novel class of room temperature molten salts that are tunable, fit-for-purpose biomass pretreatment solvents that can generate high yields of intermediates from a wide range of bioenergy crops, including the sorghum and poplar lines being studied and developed at JBEI. One challenge commonly associated with the use of ILs are the related costs of using them and their efficient recovery and recycling. To address this challenge, we are focused on the development of low-cost volatile protic ILs that can be readily recovered and recycled through distillation after use. Another significant focus of our current efforts is on developing and demonstrating efficient abiotic and biotic technologies that depolymerize lignin into high yields of bioavailable intermediates suitable for conversion by JBEI's microbial hosts into biofuels and bioproducts. To replace a significant fraction of petroleum-derived fuels and chemicals with cost-competitive, renewable biofuels and bioproducts, industry needs microorganisms that can convert all biomass components efficiently, including aromatics from lignin. JBEI has established world-class and differentiated expertise in the engineering of microorganisms to produce drop-in biofuels and bioproducts as well as novel bioproducts with differentiated properties. Our top biofuel target is isoprenol (3-methyl-3-butene-1-ol) as it is a valuable drop-in diesel blendstock, can be upcycled into the advanced aviation fuel dimethylcyclooctane (DMCO), and is an important precursor of several commodity chemicals, such as isoprene. As we want to maximize the overall carbon conversion efficiency of bioenergy crops, JBEI has focused on two microbial hosts that have been demonstrated to be able to co-metabolize sugars and lignin-derived intermediates, *Pseudomonas putida* and *Rhodosporidum toruloides*, and produce a targeted range of sustainable aviation fuels, such as DMCO.

Keywords: *Biomanufacturing; Ionic liquids; Synthetic biology; Bioenergy; Advanced aviation fuels*

Biography

Dr. Blake Simmons serves as the Chief Scientific and Technology Officer and Vice President of the Deconstruction Division at the US Department of Energy's Joint BioEnergy Institute (JBEI) in Emeryville. After earning his BS in chemical engineering from the University of Washington, Dr. Simmons continued his studies at Tulane University and received his doctorate in the same field. Dr. Simmons worked as part of the Senior Management team at Sandia National Laboratories for 15 years, most recently serving as the Senior Manager of Advanced Biomanufacturing as well as the Biomass Program Manager. He joined Lawrence Berkeley National Laboratory in February of 2016 as the Division Director of Biological Systems and Engineering. He is an Adjunct Professor at the University California-Berkeley and the University of Queensland in Australia. His expertise includes advanced biofuels, renewable chemicals, biomanufacturing, ionic liquids, abiotic-biotic interfaces, biomass pretreatment, enzyme engineering, biofuel cells, templated nanomaterials, microfluidics, desalination, and biomineralization.