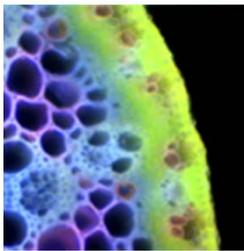


Overview: Bioenergy Workshop

held on

June 23-24, 2014

Renaissance Marriott Hotel
Washington, DC



N. Kent Peters, Ph.D.

Program Manager

Biological Systems Science Division

Department of Energy

Office of Biological & Environmental Research (BER)



U.S. DEPARTMENT OF
ENERGY

Office
of Science

Office of Biological
and Environmental Research

Bioenergy Funding in BER

- BER supports basic research in bioenergy
 - Three Bioenergy Research Centers (BRC)
 - Annual Plant Feedstocks through joint FOA with USDA
 - Genomic Science FOA on bioenergy-relevant microbes and microbial systems
 - National Laboratory Biofuels Science Focus Area (SFA) programs
 - Biosystems Design projects
 - SBIR grants

Bioenergy Research Center Program

- BER supports basic research in bioenergy
- Original Goals of the BRCs
 - Feedstocks
 - Enhance Deconstruction
 - Fuel Synthesis (lignocellulosic ethanol → advanced biofuels)
 - Enabling Technologies
 - Technology Transfer
- Annual reviews document success of BRCs at meeting stated goals
- BRCs finishing year 7 of a second 5-year funding period
- Need to define the state-of-the-science, and remaining gaps and barriers to inform BER future of funding basic bioenergy research

Workshop Participants

- Co-Chairs
 - Dr. Kristala Jones-Prather, Massachusetts Institute of Technology
 - Dr. Erich Grotewold, Ohio State University
- 45 Participants
 - 4 Industry
 - 7 DOE National Laboratories
 - 34 Academic institutions



Workshop Organization

- Presentations with Break-Out Discussions
- Speakers
 - Chris Somerville, Energy Bioscience Institute, University of California - Berkeley
 - Maureen McCann, Purdue University, C3Bio
 - Greg Stephanopoulos, MIT
 - Jay Keasling, JBEI, LBNL
 - Lee Lynd, BESC, Dartmouth University
 - Ken Keegstra, GLBRC, Michigan State University
 - Michael Martin, Monsanto Corporation

Workshop Organization (cont)

- Break-Out Discussion Groups
 - Biomass Development
 - Thomas Brutnell – Danforth Center
 - David Braun – University of Missouri
 - Deconstruction of Biomass
 - Birgitte Ahring – Washington State University
 - Michael Ladisch, Purdue University
 - *Specialty Fuels*
 - Terry Papoutsakis, University of Delaware
 - Ryan Gill, University of Colorado
 - *Bioproduct Development*
 - Elizabeth Hood, Arkansas State University
 - Brent Shanks, Iowa State University

Expected Workshop Outcomes

- A report with
 - An assessment of the current state-of-the-science with regard to the production of advanced cellulosic biofuels and bioproducts,
 - Identification of remaining scientific and technical barriers to the establishment of a sustainable domestic next generation biofuels and bioproduct commercial sector,
 - Information and perspectives to inform BER's bioenergy program goals.

Findings - Biomass Production

- Advances
 - Identification of genes involved in cell wall biosynthesis and their regulation
 - Demonstrated ability to genetically engineer biofuel crops for reduced recalcitrance and greater sugar yields
 - Demonstrated genetic engineering to alter lignin composition and hydrolizablilty
- Gaps and Barriers
 - Further work needed to optimize lignocellulosic biofuel and bioproduct crops
 - Continue work on switchgrass, Miscanthus, energy cane and poplar, to name the most prominent
 - Improve biofuel traits through a combination of selection of natural variants, genotype assisted breeding, and genetic engineering
 - Prioritized traits include reduced recalcitrance, water and nutrient recycling, and delayed flowering

Findings - Deconstruction

- Advances
 - Several effective pretreatment technologies
 - Better understanding of plant cell wall structure and origins of recalcitrance
 - Promise shown by consolidated bioprocessing with engineered thermophiles
 - Effective enzymes farming using metagenomics, genomic sequencing and gene synthesis
- Gaps and Barriers
 - Need for standardized biomass samples to use for comparative analysis
 - Better analytical tools for characterizing the lignocellulose and the break-down intermediates
 - Need deconstruction streams that provide for fermentable sugars as well as valorization of lignin
 - Establish a basic toolbox for lignin catabolism

Findings – Specialty Biofuels

- Advances
 - Engineered microbes with higher conversion efficiencies and greater inhibitor tolerance
 - Engineered thermophile to make lignocellulosic ethanol without pretreatment
 - New tools for synthetic biology and metabolic engineering resulting in an expanded suite of accessible molecules beyond ethanol to serve as biofuels or their precursors
- Gaps and Barriers
 - Selecting the appropriate targets, based on meaningful evaluation of the accessible markets, remains a challenge
 - Methods to test thousands of variants of a pathway in a high throughput manner will greatly impact the rate of discovery and optimization
 - It remains difficult to predict the performance of a microbe in industrial scale fermentation from benchtop scale experiments

Findings - Biomass Bioproducts

Gaps and Barriers

- Separation technologies- lack cost effective extraction of manufactured product or raw material
- Inadequate integration of manufacturing with the fuel production site
- Inadequate compositional analysis of potential byproduct streams
- Lack of efficient, stable and scalable biocatalysts for desired bioproducts
- Lack efficient and economical continuous processes
- Lack flexible process technology to accommodate multiple feedstock sources
- Lack synthetic biological and/or chemical chassis that only require minor modification for a range of bioproducts

Summary and Future Directions

- Continued support for biofuel crop development
- Continued support for improved deconstruction
- Expand to include specialty fuels and bioproducts
 - Replace petroleum as starting material for carbon-neutral production
 - Pathway to aromatics through less toxic intermediates than benzene and toluene
 - An infinite diversity of new products
- Continued value in vertical integration

Closing Comments

- An Executive Summary is available in the back of room etc.
- Draft report is back in the hands of the co-chairs before sending to professional editor/publisher

The End