



Office of Science
U.S. Department of Energy

Biomass to Biofuels

Breaking the Biological Barriers to Cellulosic Ethanol: a joint research agenda

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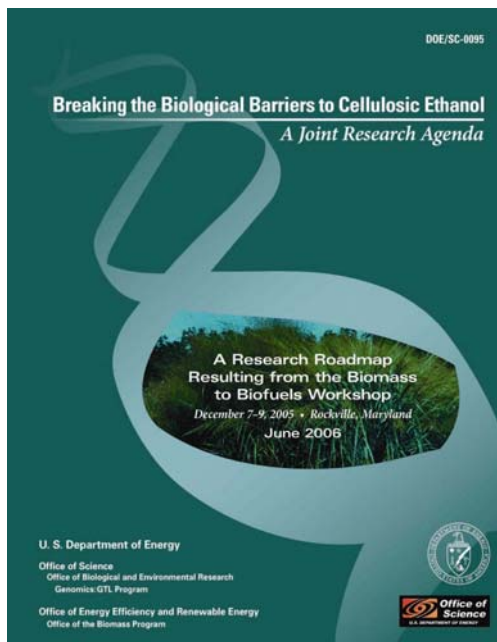
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Office of Science

Biomass to Biofuels Research Needs



A Joint DOE Planning Workshop

Office of Science

Office of Biological &
Environmental Research

Office of Energy Efficiency &
Renewable Energy

Office of the Biomass Program

www.doegenomestolive.org/biofuels/



Biomass to Biofuels workshop goals

- Define how work at the frontiers of science can enable the lignocellulose biorefinery industry.
- Define overarching technical challenges in the context of national & global energy policies
- Utilize consensus approach to define common sets of science and technology opportunities and barriers.
- Workshop product: Roadmap for new, coordinated research across DOE EERE and Office of Science.



Biomass to Biofuels Workshop Sessions

Session 1: Feedstock Genomics & Engineering

- Chairs: C. Somerville (Stanford), J. Tuskan (ORNL)

Session 2: Plant Cell Wall Deconstruction

- Chairs: M. Himmel (NREL) and M. Ladisch (Purdue)

Session 3: Biological Conversion of Sugars to Fuels

- Chairs: B. Davison (ORNL) and L. Ingram (Univ. of Florida)

Session 4: Crosscutting Science & Technology

- Chairs: H. Chum (NREL) and J. Fredrickson (PNNL)



Improving Feedstocks

Barriers

- Controlling cell wall composition for energy production
- Developing appropriate model systems to study energy crops
- Improving quantity and quality of perennial herbaceous and woody biomass crops
- Developing practices to make corn stover, crop residues and biomass energy crops a sustainable bioethanol feedstock



Transformational Challenges

- Development of a high productivity biodiesel crop
- Cell wall imaging tools

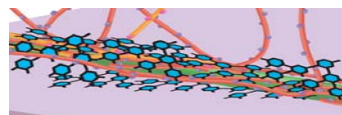
Courtesy of Steve Long et al



Improving Cell Wall Decomposition

Barriers

- Fundamental Physical and Chemical Factors Limiting the Enzymatic Hydrolysis of Biomass
- Improvement and Integration of Enzymes Deconstructing the Cell Wall Matrix and Microfibrils
- Metagenomics: Harvesting the Biochemical Potential of Microorganisms for Improved Biomass Conversion



Transformational Challenges

- Develop Predictive Computational Models for Biology
- Understand the Dynamics of Microbial Colonization of Decaying Biomass
- Advanced Imaging for Cell Wall Deconstruction Research



Improving Bioconversion

Barriers

- **Pushing the limits of biology for optimal ethanol producing strains**
 - Utilization of all sugars
 - Reduce inhibition by ethanol and hydrolyzate byproducts
 - Kinetics and volumetric productivity
 - Model-driven design of cellular biocatalysts, physiology and regulation
- **Advanced microorganisms for process simplification**
 - Proteomic and Genomic studies of industrial ethanol strains and process
 - Simultaneous saccharification and co-fermentation (SSCF)
 - Eliminate step for detoxification of pretreatment hydrolyzates
 - Combine cellulase production, cellulose hydrolysis, and fermentation

Transformational Challenges

- **Direct bioproduction of energy rich fuels**
- **Potential uses of CO₂ (fermentation byproduct) or syngas from gasification**
- **Engineered microbial communities for robust energy production**



Crosscutting Technology Needs

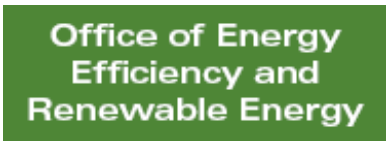
- Full complement of “omics’ technologies
- Rapid manipulation tools for novel organisms (microbes and plants)
- Computational science and biomolecular structure
- Modeling cellular processes
- Role of advanced imaging
- Role of HTP methods
- Biomass compositional analysis
- Challenges of data handling and access



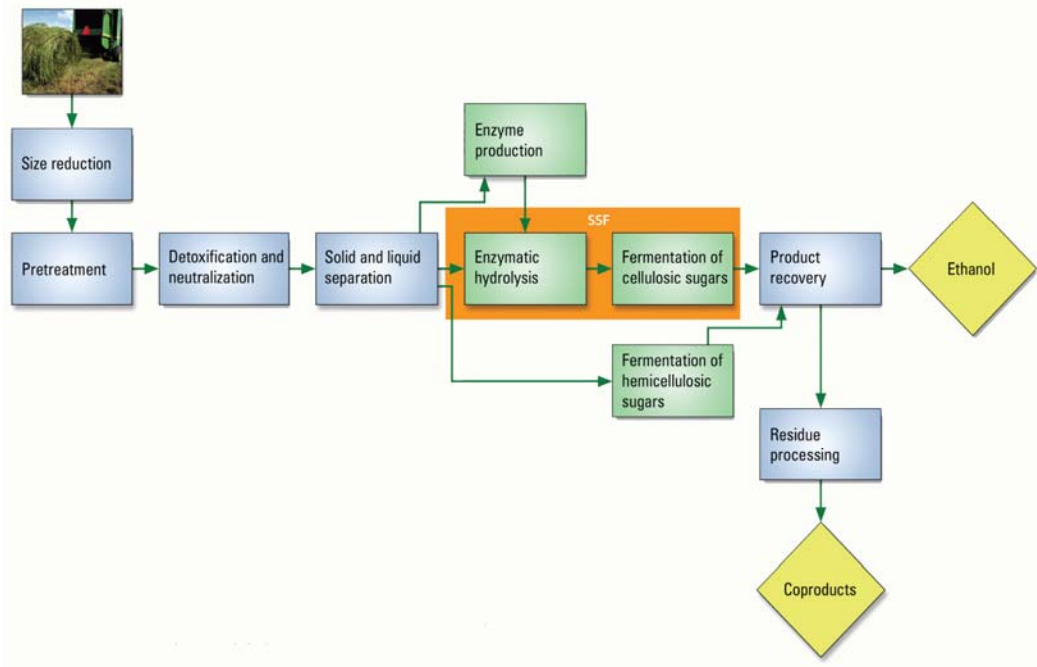
Biomass to Biofuels Workshop

General Biological Science Needs:

- Understand how plant cell-walls are synthesized and deconstructed
- Predictive understanding of microbial systems involved in biomass degradation & fermentation
- Genomics of biomass crop plants & soil microbial communities for sustainability

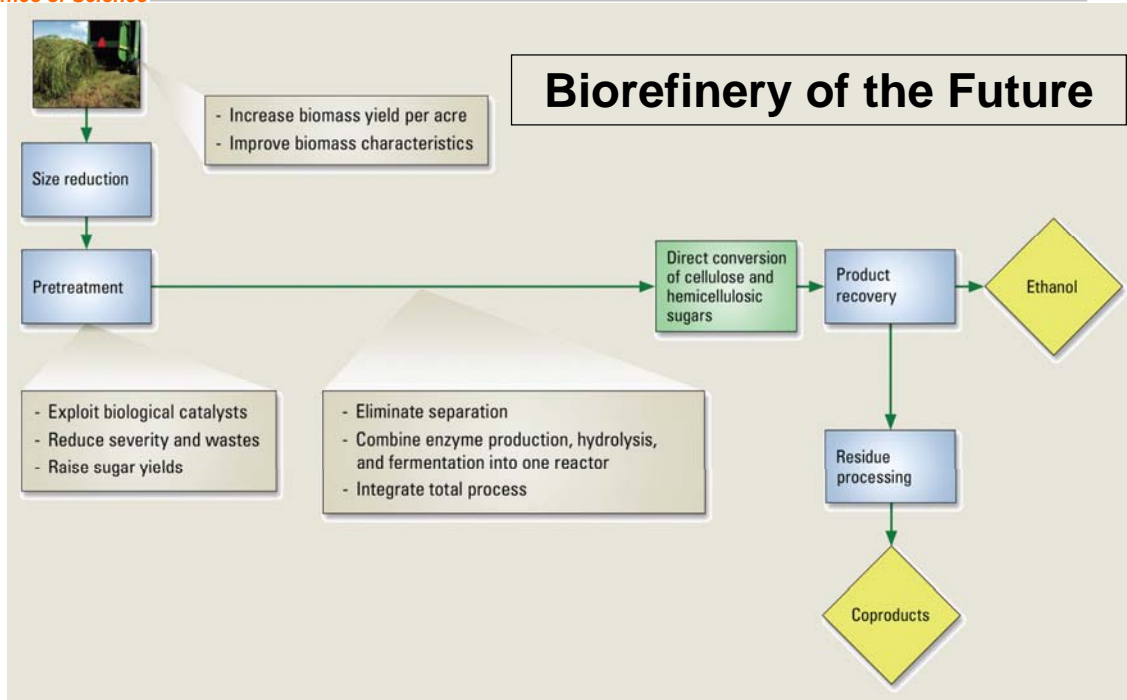


Current Cellulosic Ethanol Production





Improvements through Research



Science and EERE working together

