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Joint BioEnergy Institute

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A DOE Basic Energy Sciences
BioEnergy Research Center

Presentation to CA Energy Commission

January 13th, 2009

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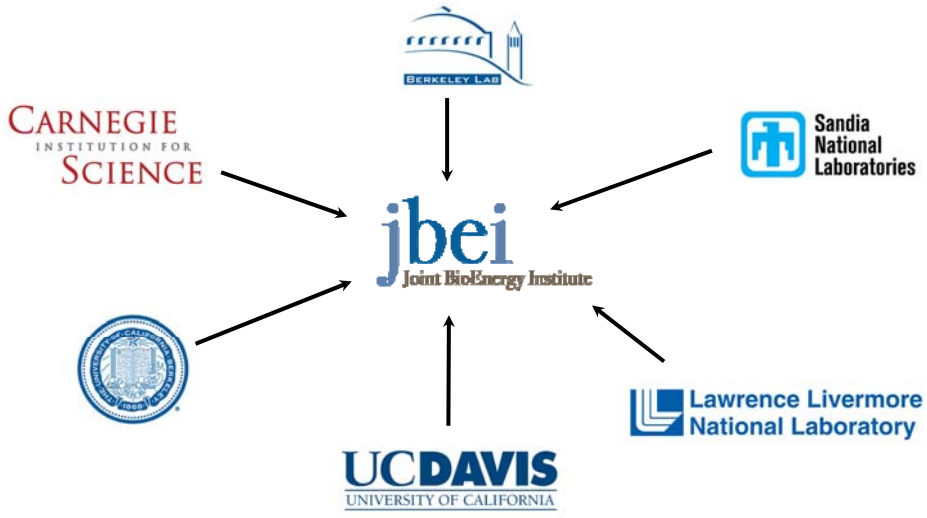
- Response to the Energy Independence and Security Act of 2007
  - Improve vehicle fuel economy
  - Set a renewable fuel standard : 36 Billion gallons of biofuels by 2022
- Call for 2 centers; 3 were funded
- Funding at $125M evolved into $134M

A University /National Lab Consortium

- Lawrence Berkeley National Laboratory
- Sandia National Laboratory
- Lawrence Livermore National Laboratory
- University of California Berkeley
- University of California Davis
- Carnegie Institution for Science at Stanford

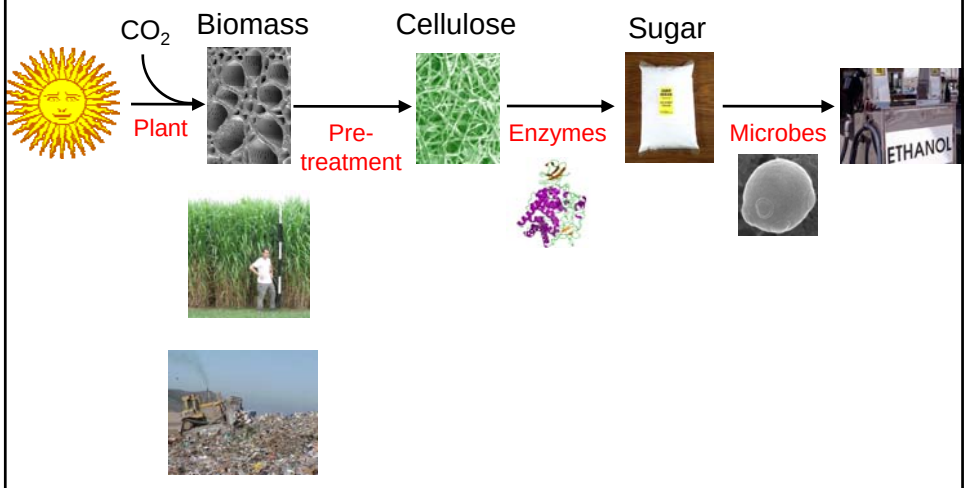
Partners at a single location



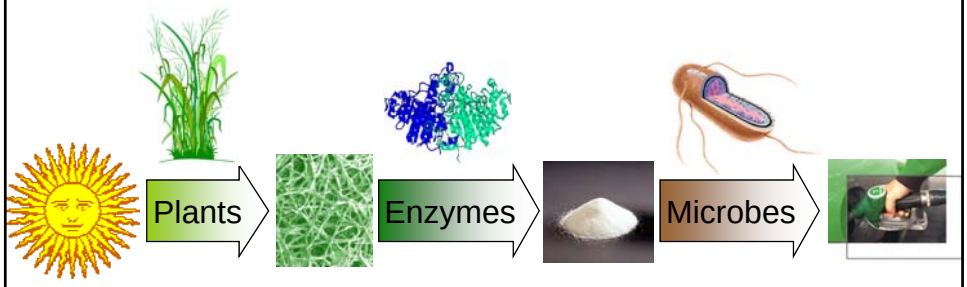
JBEI at a glance

- Start-up company approach
  - Highly focused research agenda
  - Single operation and facility
- Four Science and Technology Divisions
  - Feedstocks
  - Deconstruction
  - Fuels Synthesis
  - Cross-cutting Technologies
- Six Partners
  - Three DOE National Laboratories
  - Two Universities
  - One Foundation
- Industry Partnership Program
  - Underpin growth of the biofuels industry
  - Ensure technology transfer to biofuels industry

Production of fuels from lignocellulose

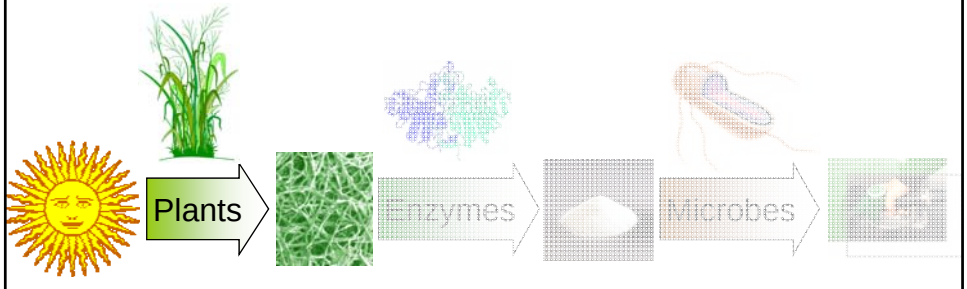


Technical Challenges



Lignocellulose Monomers

Some Key Challenges in Converting Lignocellulosic Biomass to Fuels

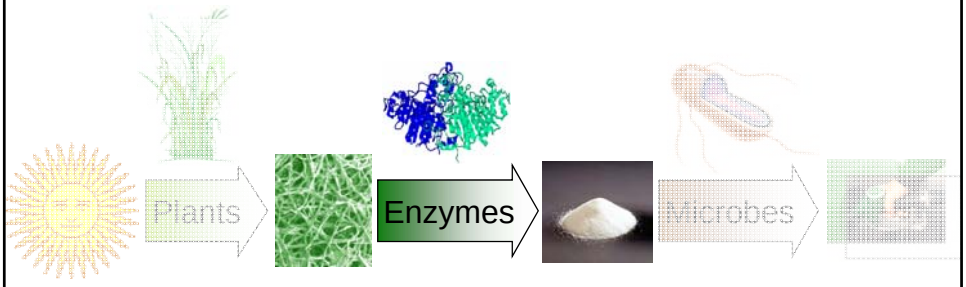


Lignocellulose Monomers

Challenges

- Cellulose and hemicellulose are occluded by lignin
- Lignin is recalcitrant to depolymerization
- Inhibitors released from biomass

Some Key Challenges in Converting Lignocellulosic Biomass to Fuels

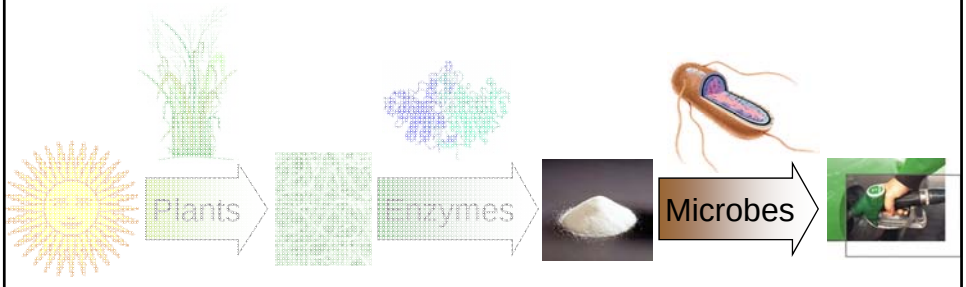


Lignocellulose Monomers

Challenges

- Lignocellulose is difficult to depolymerize
- Pretreatment methods form inhibitory by-products

Some Key Challenges in Converting Lignocellulosic Biomass to Fuels

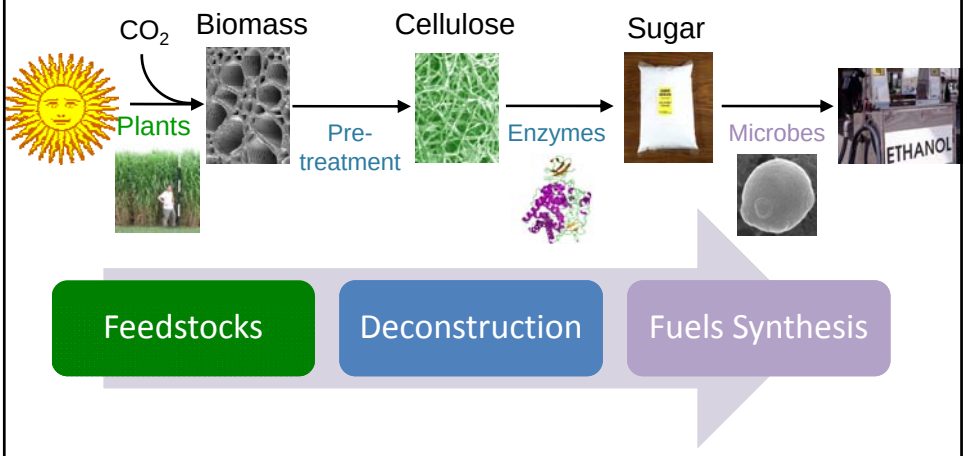


Lignocellulose Monomers

Challenges

- Existing biofuels (e.g., ethanol) are not optimal
- Organisms can only convert a part of the sugars to fuels
- Inhibitors released from biomass limit fuels production

JBEI's approach to address key challenges



Three Scientific Divisions and supporting Technologies

The Significance of Raw Material Costs

Biomass Source	Tons/acre	$/ton biomass	Sugar cost (cents/lb)
Miscanthus	25	65	~ 5
Poplar	10	100	~ 6.5
Corn	4.5		25
Sugar cane	35-75 (LA-HI)		11.6 (world price)

Product	lb glucose/gallon	Estimated $/gallon* (raw material only)
Ethanol	12.9	$3.22
Butanol	16.4	$4.10
Octane	19.2	$4.80

*Based on corn at 25 cents/lb.

Selling price is ~2X raw material cost (typical for commodity chemicals). Lignocellulosic biomass could be 5 times less expensive.

JBEI Research will

- Develop new biofuels that are miscible with gasoline and can be shipped in existing pipelines
- Have a higher energy content than ethanol
- Will not require changes to existing automobiles to accommodate higher-ethanol content fuels
- Use feedstocks that are bioenergy crops (switchgrass, Miscanthus, poplar), or forest & agricultural residues; not starch-based (e.g., corn)

JBEI accomplishments to date

- Fermentation of sugars to produce non-ethanol fuels such as C_{12} – C_{15} alkanes developed
- Biomass deconstruction using new solvents to produce sugars at high yields
- Modified bioenergy crops under development

Recommendations

- Cellulosic-based fuels will have lower costs & will not compete with starch-based food/feed crops
- Forest and agricultural residues can provide significant amounts of biomass
- Bioenergy crops could be grown on marginal lands
- Urban wood residues (e.g., MSW) can be converted with cellulose-to-fuels technologies

Recommendations

- Standards should not specify only ethanol as the biofuel (alternatives will be available)
- MSW conversion to biofuels requires further research
- Scale of CA biofuels use will determine feedstock sources
- Timeline for lignocellulosic biofuels implementation parallels S-06-06