



# GLBRC

**Great Lakes Bioenergy Research Center**



**U.S. DEPARTMENT OF  
ENERGY**



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**GLBRC Director & UW-Madison Professor of Bacteriology**

**Joint Legislative Council**

**Special Committee on Biofuels**

**August 19, 2008**

**[www.glbrc.org](http://www.glbrc.org)**



## Biofuels 101

Fuels derived from a biological source

- Wood or pelletized biomass to burn (heat, energy grid)
- Biomass (starch, sugars)-derived ethanol for liquid transportation
- Oils/hydrocarbons (soybean, algal farms, starch-derived sugars, etc)
- Anaerobic digesters (methane)
- Waste water treatment (methane, hydrogen, electricity)



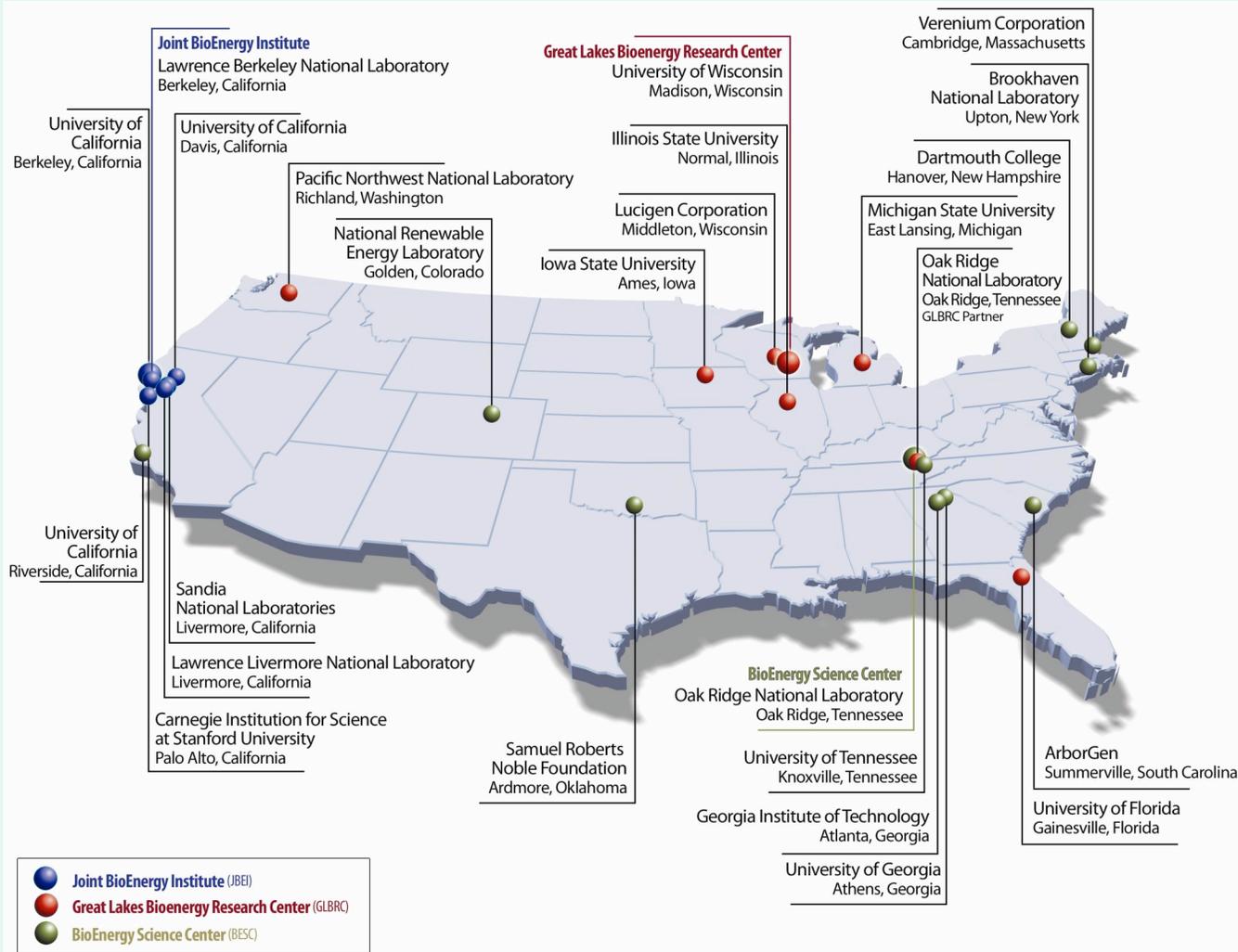
## Why is there interest in biofuels?

- **Diversify & scale** energy sources (micro- to macro-solutions)
- **Reduce dependence** on fossil fuels
- Create a **decentralized/local biomass-driven economy**
- **Decrease carbon cost or footprint** of energy grid
- **Improve environmental and health** status of the planet & its occupants
- National/Global **security**



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## Who are we?

- 1 of 3 DOE-funded Bioenergy Research Centers
- ~\$135M@ from 2007-2012

# Bioenergy Research Center Challenge



DOE/SC-0095

**Breaking the Biological Barriers to Cellulosic Ethanol**  
*A Joint Research Agenda*

**Called for establishment of “Bioenergy Research Centers (BRCs)”**

**A Research Roadmap  
Resulting from the Biomass  
to Biofuels Workshop**  
*December 7-9, 2005 • Rockville, Maryland*  
June 2006

U. S. Department of Energy

Office of Science  
Office of Biological and Environmental Research  
Genomics:GTL Program

Office of Energy Efficiency and Renewable Energy  
Office of the Biomass Program



<http://genomicsgtl.energy.gov/biofuels/b2bworkshop.shtml>

## How did we get here?

**“Billion Ton” Challenge:** cut fossil fuel use for transportation fuels by 30%

➤ Need to convert 1 billion tons of plant (cellulosic) biomass to ethanol per year

Nation produces ~1.3 billion tons of cellulosic biomass/yr (crops, grasses, trees, etc)



High energy/value products

- Liquid fuels (ethanol, biodiesel, hydrocarbons, others)
- Energy sources (hydrogen, electricity)
- Chemical feedstocks (precursors)

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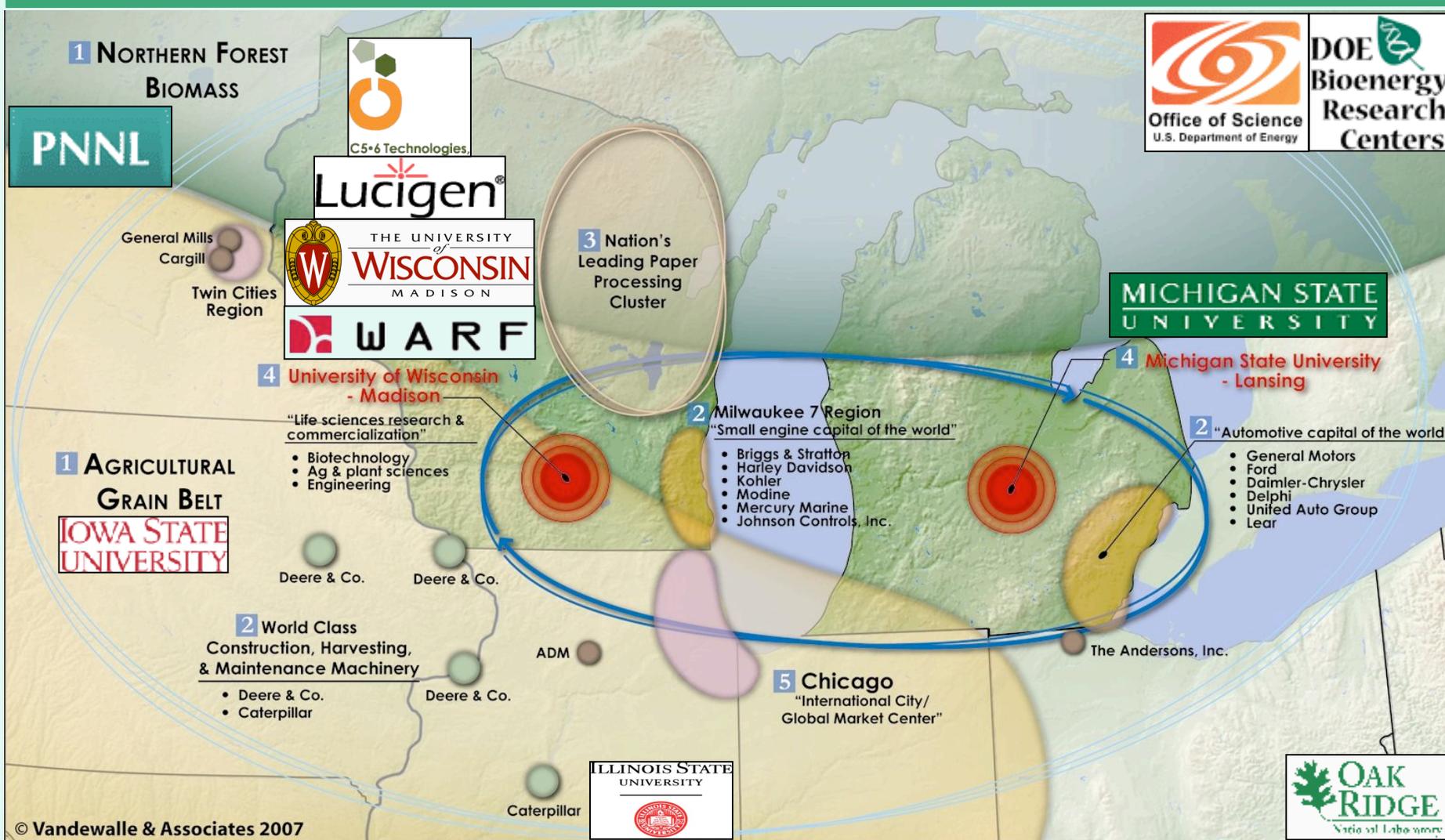


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Additional partners

## DOE Office of Science

- Joint Genome Institute (high-throughput DNA sequencing & informatics; BER) <http://www.jgi.doe.gov/>
- Jacquard Opteron cluster hosted by the National Energy Research Scientific Computing (high-performance computing, ASCR) <http://128.55.6.34/nusers/resources/jacquard/>
- BACTER institute (computational biology training grant, ASCR) <http://www.bacter.wisc.edu/index.html>

## States of Michigan & Wisconsin

- **Facilities (UW-Madison) and additional faculty (MSU & UW-System)**
- **Patent and Licensing Team**
- **GLBRC Technology Transfer Working Group**

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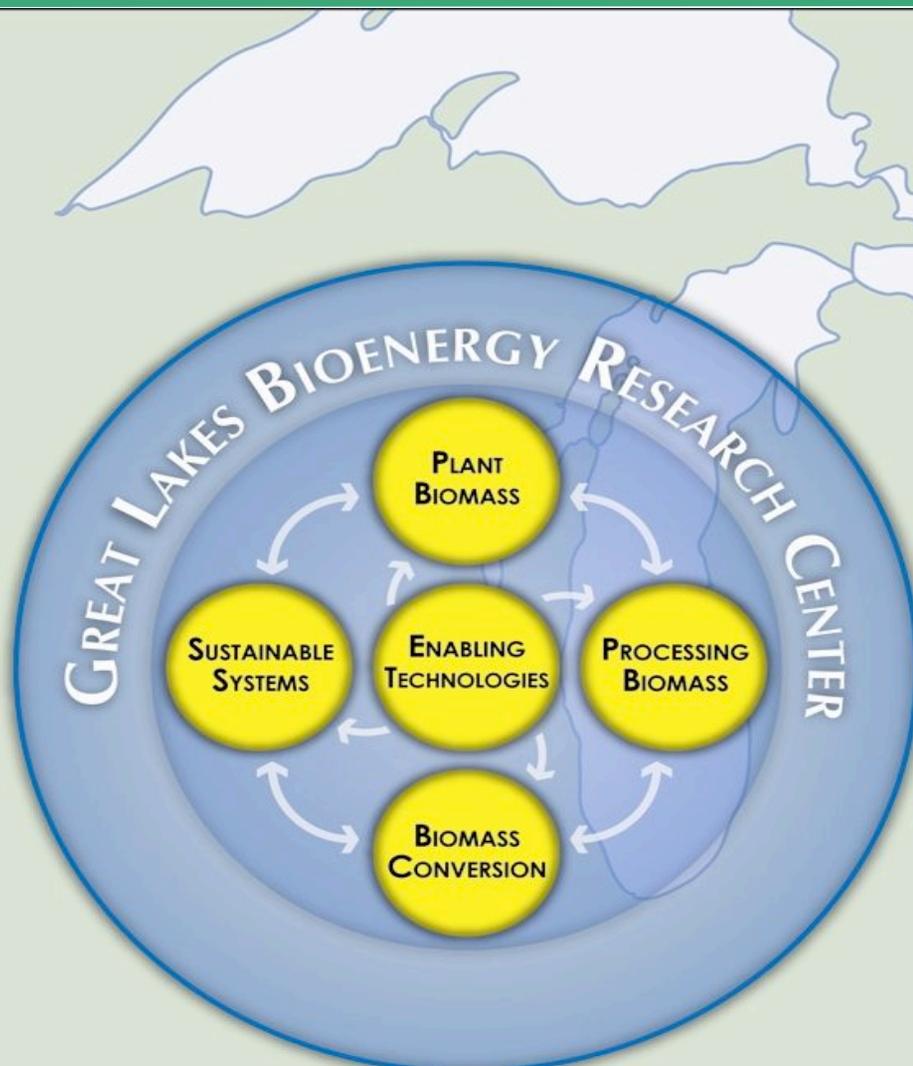


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## Integrated programs

- Improve plant biomass
- Improve biomass processing
- Improve conversion of biomass to energy products
- Improve sustainability of biofuels pipeline
- Genome-enabled science
- Informatics & modeling
- Education & Outreach



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## Improved Plant Biomass

**Objective:** understand biochemical & regulatory pathways at a level needed to **divert plant carbon into more digestible polymers:**

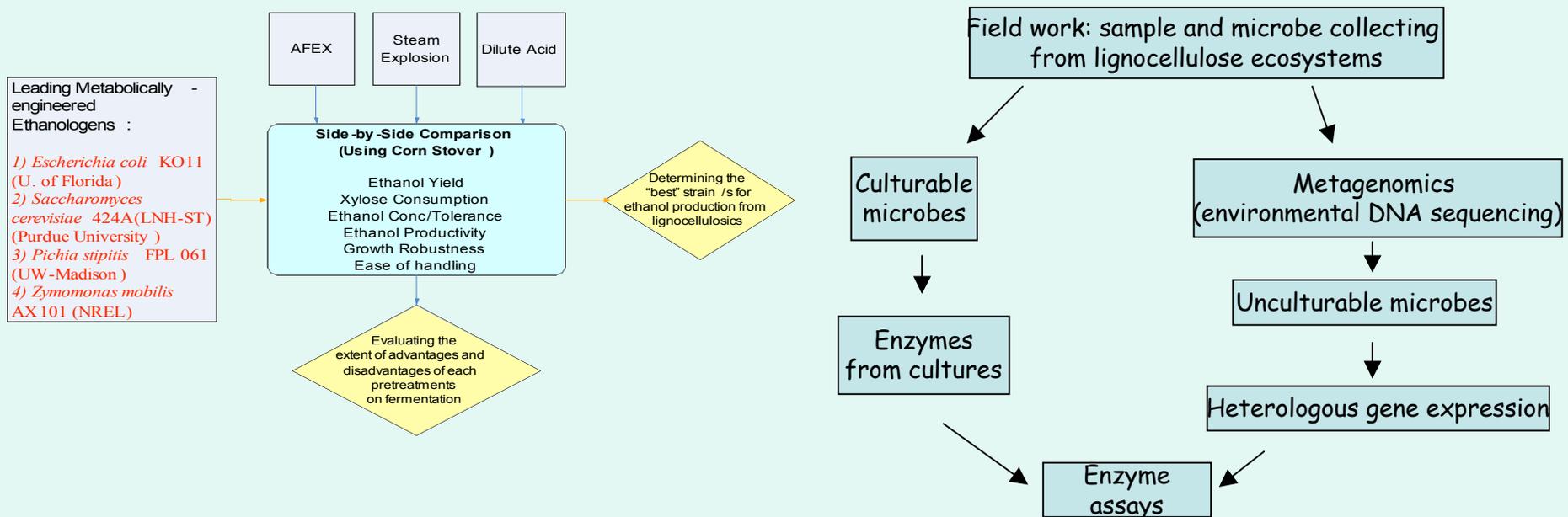
- Modified cellulose, hemicellulose & lignin
- Fructans and other digestible carbohydrates
- Oils/hydrocarbons
  
- **genome-based knowledge** to accumulate energy rich, polymers
  - modified cellulose
  - altered hemicellulose
  - softened lignin
  - oils
- interrogate **model systems** to acquire this knowledge
- inform **application to bioenergy crops (corn, grasses, trees, etc)**

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## Improved Biomass Processing

**Objective:** improve conversion of plant cell walls into fermentable or chemically-convertible materials by

- **analyzing range of plants & pretreatment conditions**
- **discovery & application of improved enzymes**



**Enhanced digestibility**

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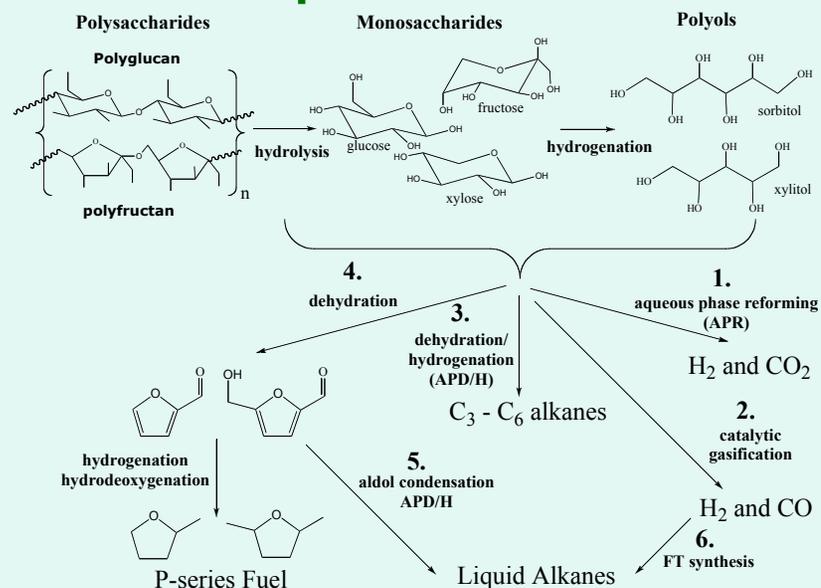
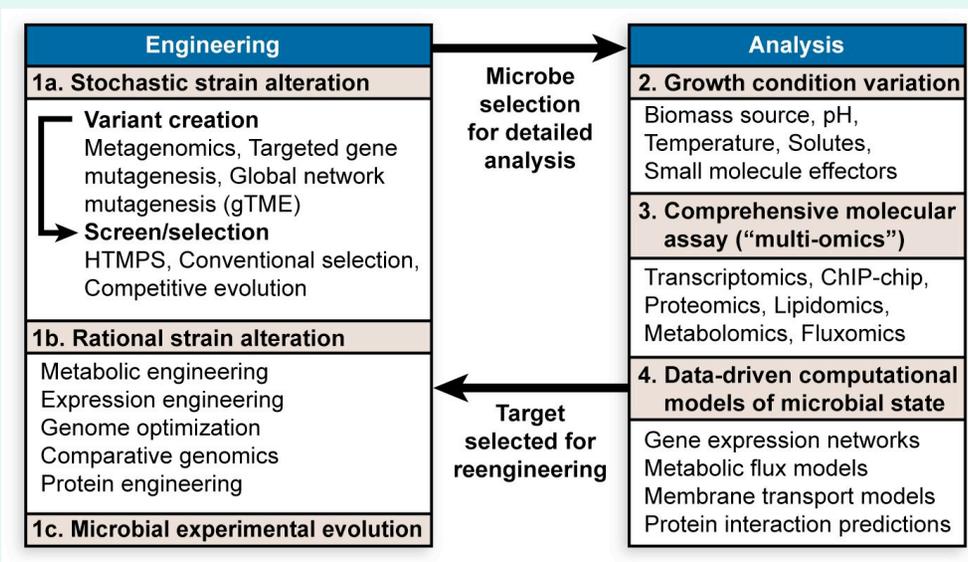
**Bioprospecting**

## Improved Biomass Conversion

**Objective:** improve methods for **converting plant biomass into materials that can replace fossil fuels**

- ethanol & other liquid fuels (bacteria & yeasts)
- hydrogen (bacteria)
- chemical feedstocks (bacteria & yeasts)

## Biological & chemical conversion platforms





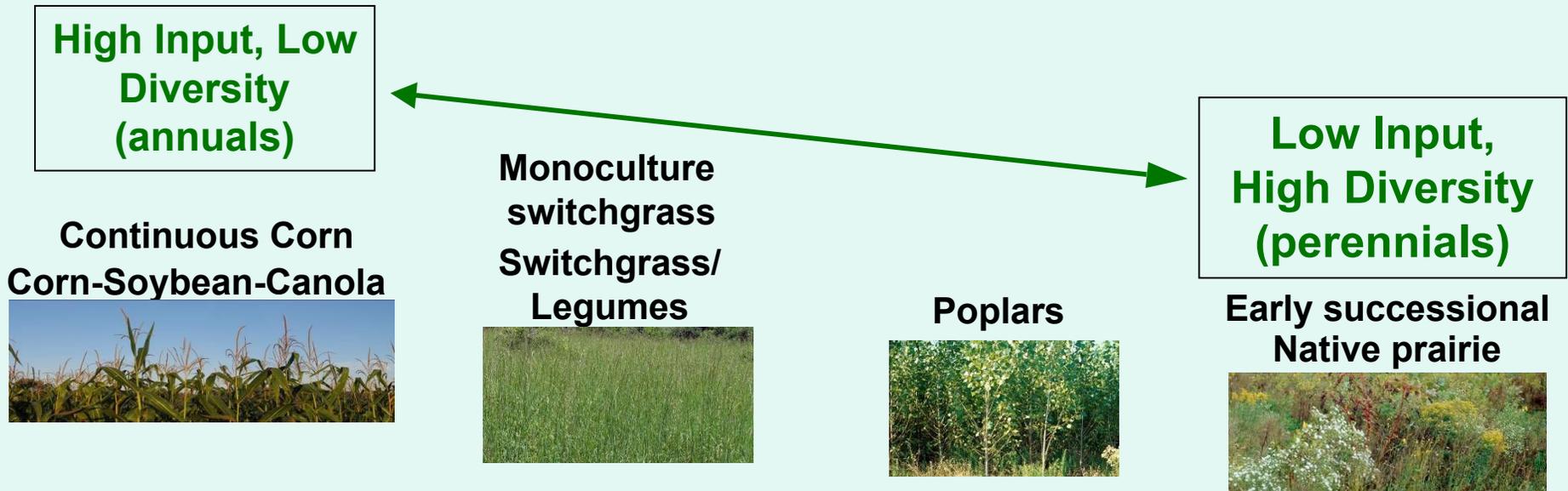
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## Sustainable Bioenergy Practices

**Objective:** develop **economically viable & environmentally responsive ecological, agricultural & life cycle practices**



Overcome bottlenecks in agricultural, industrial, & behavioral systems to

- **Improve carbon neutrality and greenhouse gas mitigation**
- **Improve ecosystem services (e.g. water, soil & air quality, biodiversity, pest suppression, land use)**

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## Bioenergy education & outreach

- **Workshops & educational modules** for K - 12 teachers, technical colleges & public on carbon chemistry, sustainability, biodiversity
- Public talks/workshops/**communications** program (NPR, etc.)
- Inform farmers, municipalities & other **members of the community** about bioenergy practices
- **Exhibits** on biomass & bioenergy (aka- “Bioenergy Discovery Center”)
- Bioenergy **seminars** and topics in **biology, engineering & computational courses or labs** (partnering with BACTER and others)
- **Summer research programs** for undergraduates from other campuses; including major URM institutions
- **Attract graduate students** from highly rated programs

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## GLBRC Deliverables

- New blends of **transportation fuels** for tomorrow's engines
- New ways for families, industries or municipalities to **cut energy costs**
- New **local, scalable, diversified bioenergy** strategies
- New **jobs & technologies** to keep energy dollars in State, region & nation
- New **markets for agricultural or renewable** products & services
- New **energy management, conservation & sustainability** practice
- New programs to **inform population, students, & stakeholders**

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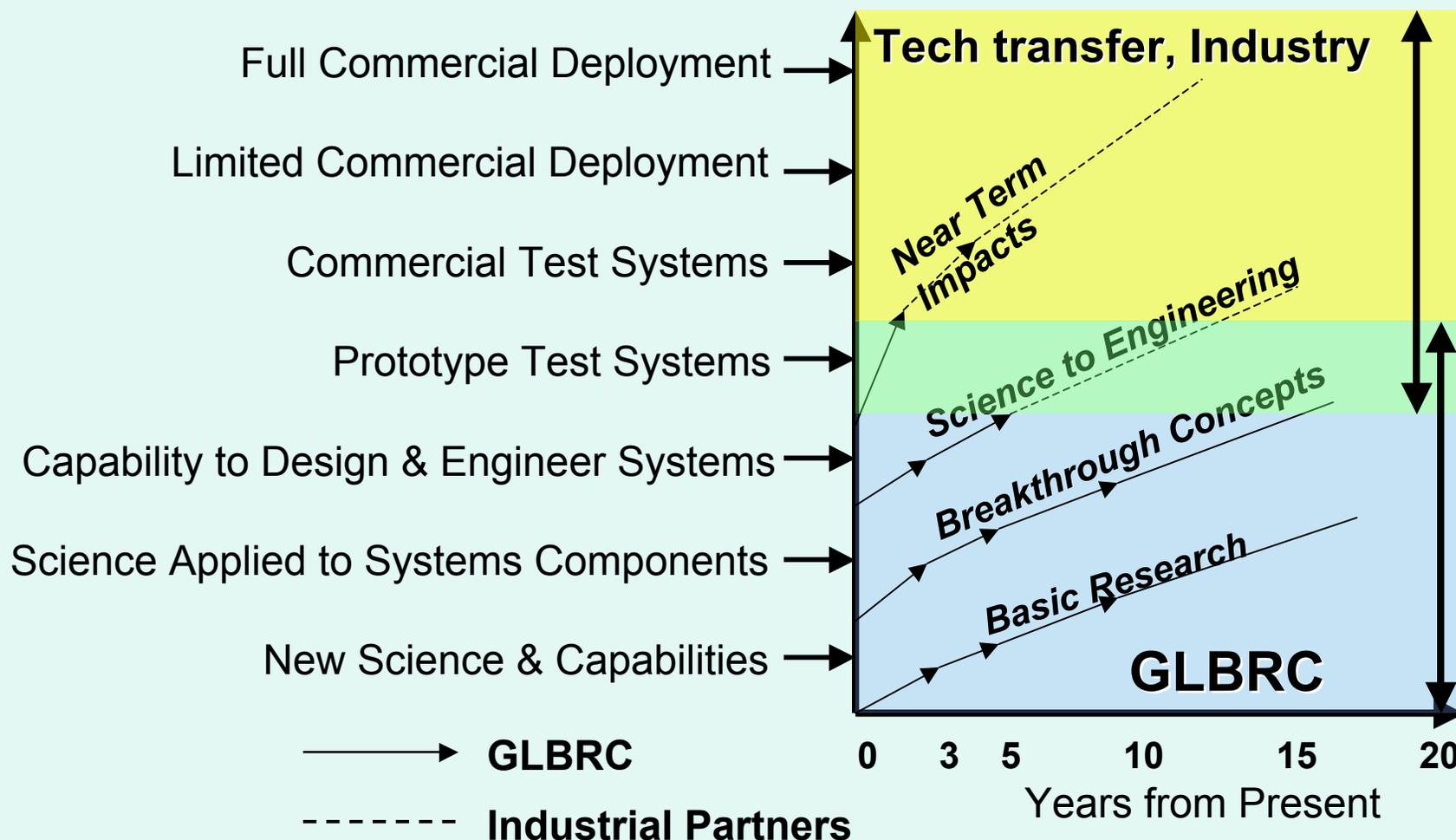
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## How do we deliver these products?

5-10 X Resources per step! →



# Wisconsin Bioenergy Initiative

Collaborating to generate a new bioenergy economy

# Bioenergy

Wisconsin Bioenergy Initiative [www.wisconsinbioenergy.com/](http://www.wisconsinbioenergy.com/)



COLLEGE OF AGRICULTURAL  
AND LIFE SCIENCES  
University of Wisconsin-Madison



- UW-System (UW-Madison & other campuses); Technical Colleges, State of Wisconsin (OEI, DNR, DATCAP, Commerce, others); private sector
- Growing other parts of the bioenergy landscape

[www.wisconsinbioenergy.com](http://www.wisconsinbioenergy.com)



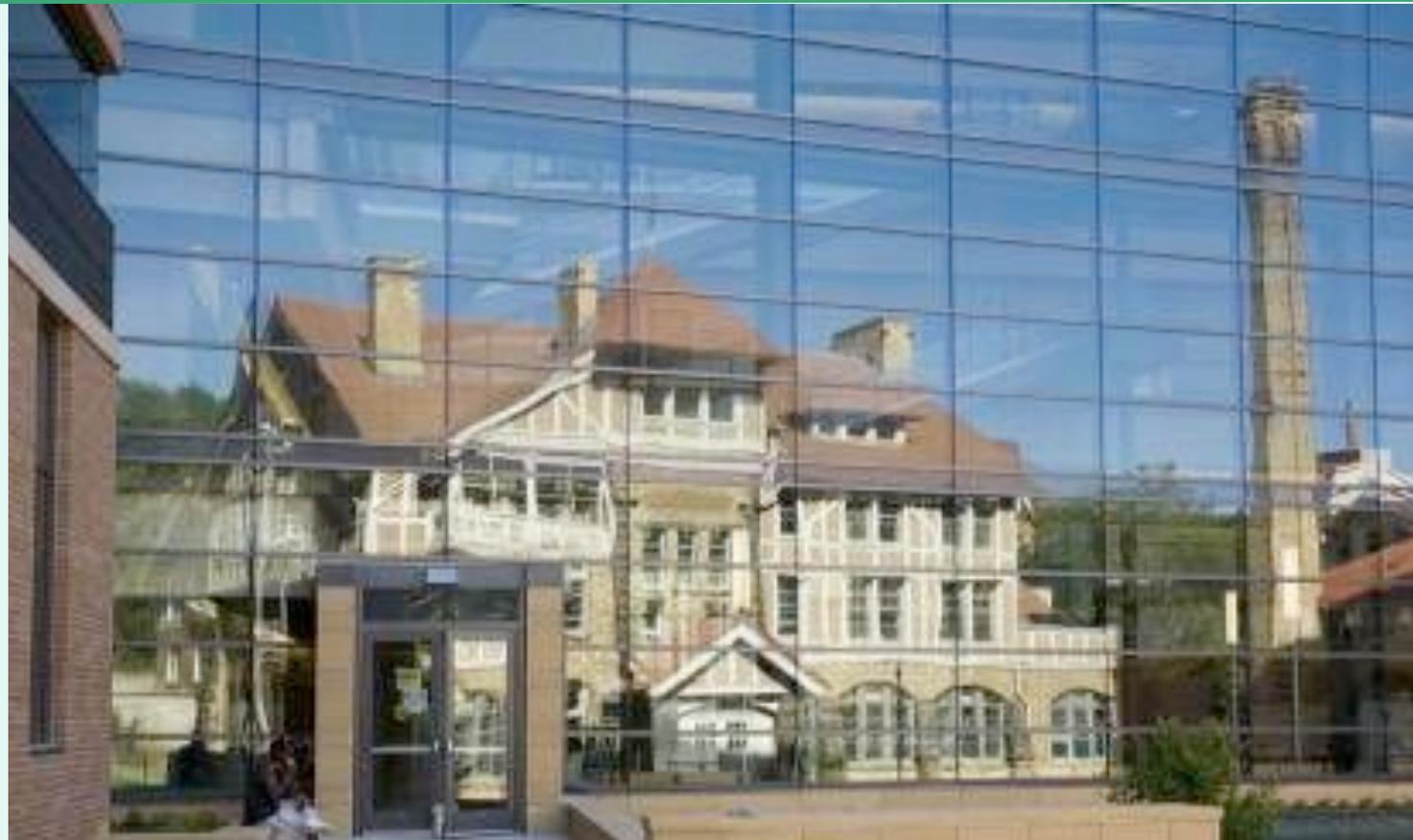
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Wisconsin Bioenergy Initiative  
University of Wisconsin System



***Bioenergy:  
A new (& obvious) venue for the Wisconsin Idea***  
**[www.glbrc.org](http://www.glbrc.org)**