

# Technology/Business Opportunities for the Forest Products Industry

Forest Products Techno-Business Forum  
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# Program Goals

Develop biorefinery-related technologies to the point that they are cost and performance competitive and are used by the nation's transportation, energy, chemical, and power industries to meet their market objectives

2005: Demonstrate an integrated process for fuels production from biomass

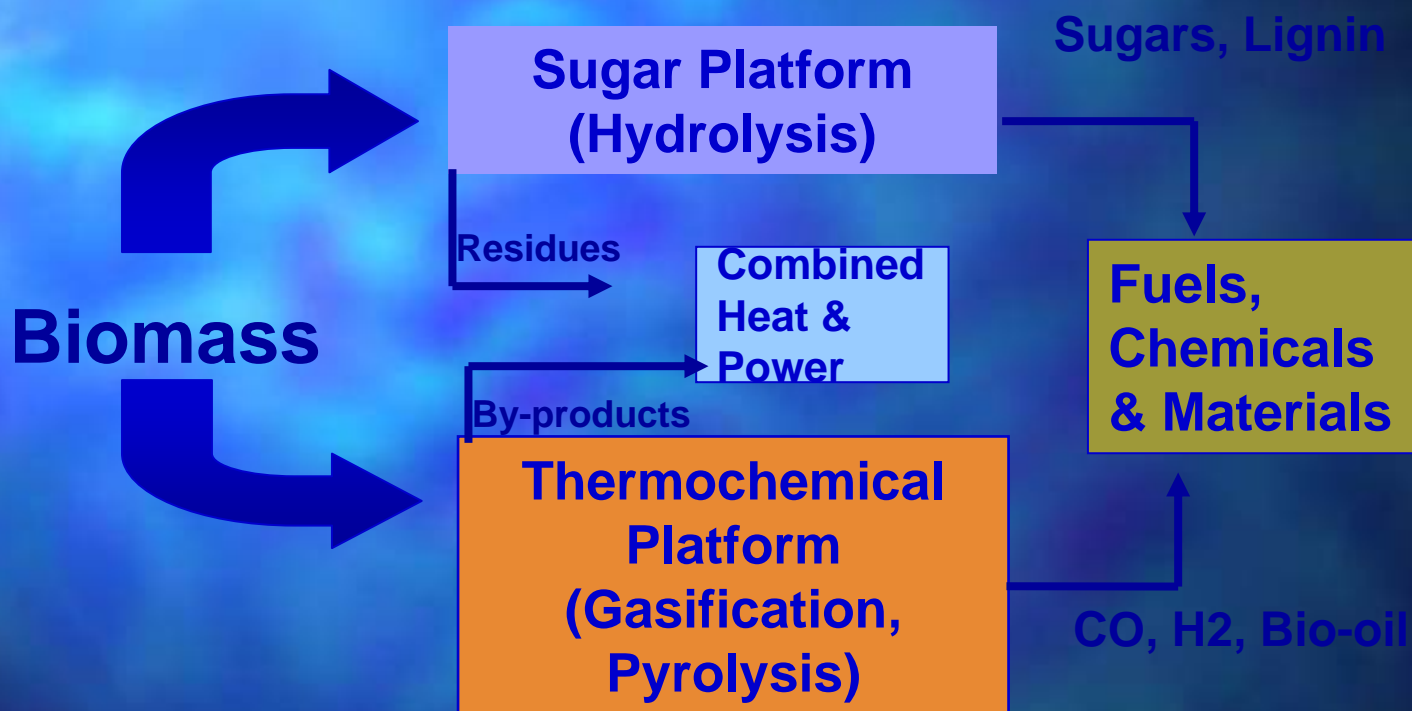
2007: Complete technology development necessary to enable start-up demonstration of a biorefinery producing fuels, chemicals, and power

2010: Help U.S. industry to establish the first large-scale biorefinery based on agricultural residues

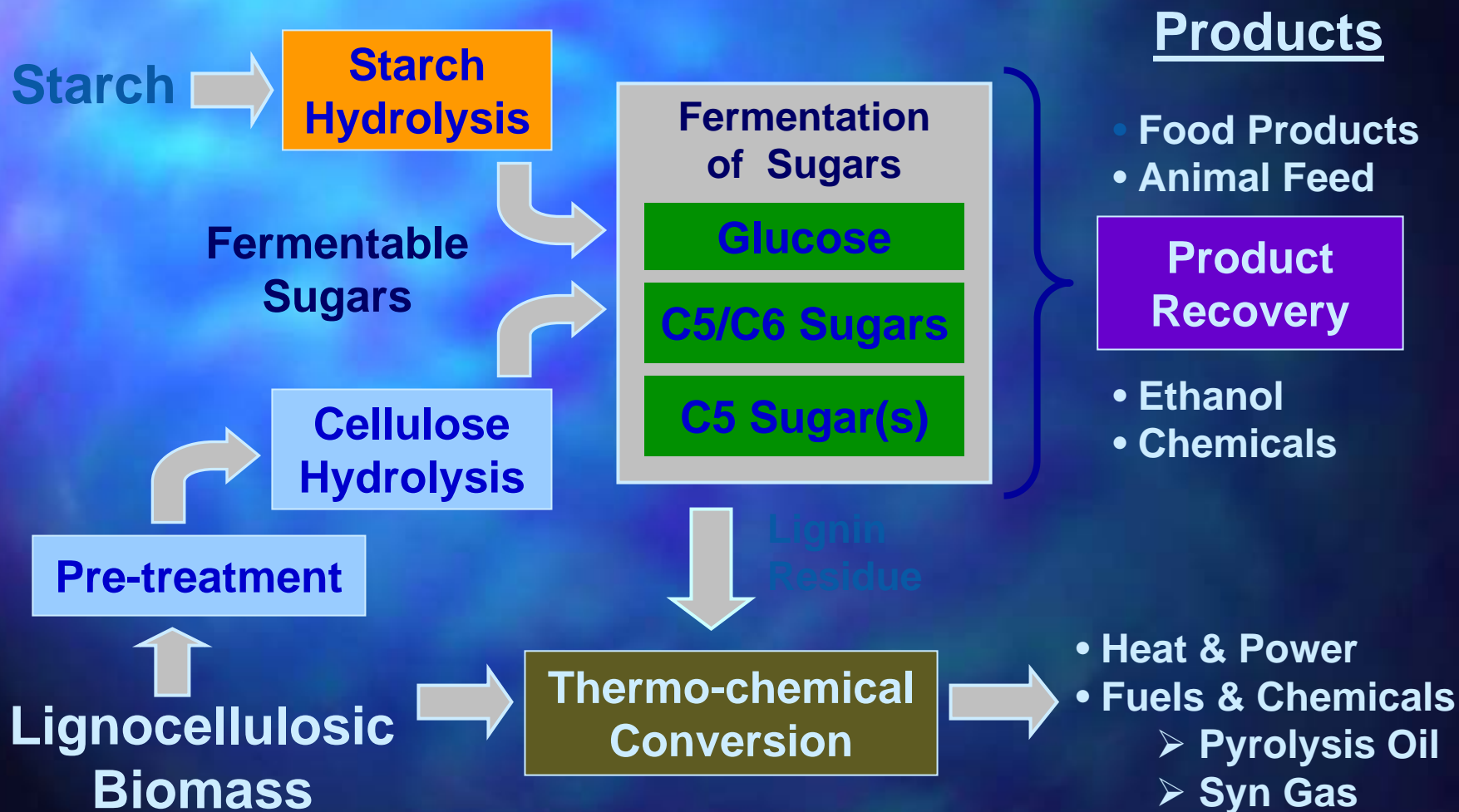
## Intermediate Targets

- **Syngas** - from \$6.14/GJ (2003 base case cost estimate) to \$5.01/GJ by 2010.
- **Sugar Feedstocks** - from \$0.14/lb (2003 base case cost estimate) to \$0.10/lb by 2012.
- Industrial viability of three commodity scale products by 2010.
- \$35 per dry ton for biomass feedstock 2010.

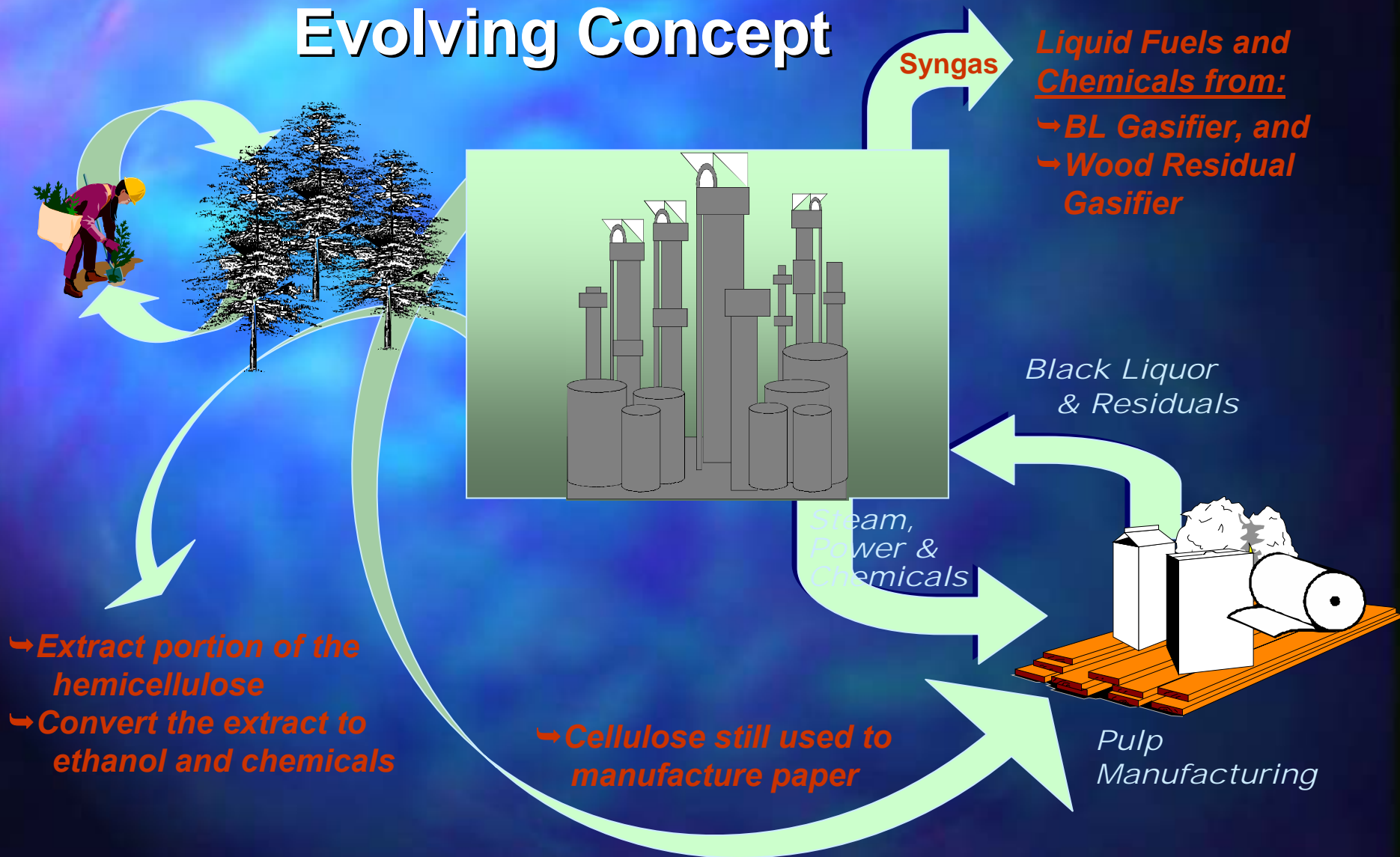
# Program R&D Focus



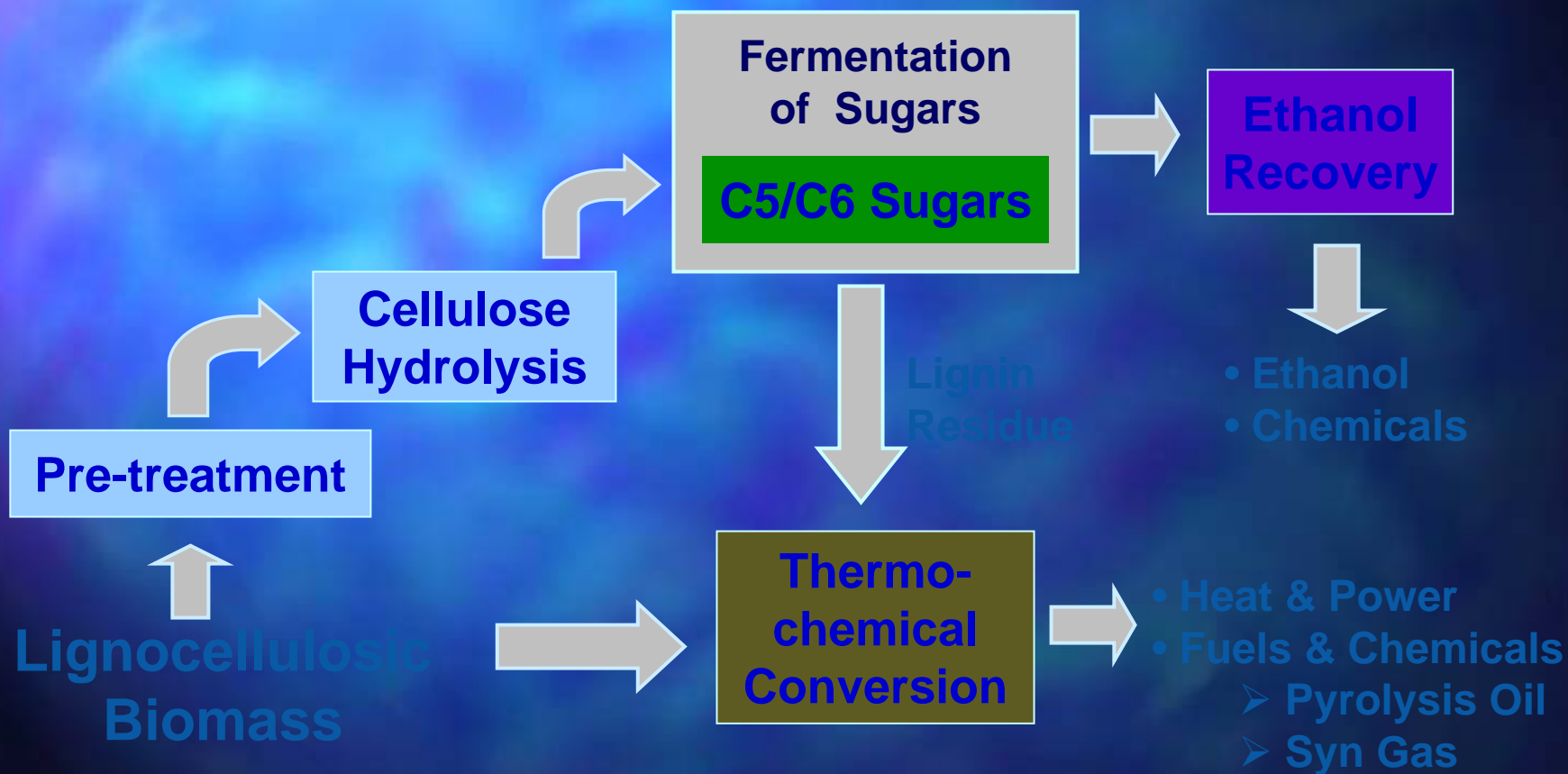
### Combine Platform R&D into an Integrated Biorefinery



# Forest Biorefinery (FBR) Evolving Concept



# Potential Elements of a “Pre-Digester” System for FBR



# Developing the Forest Biorefinery Plan

- Met with key stakeholders in the FP industry, academia, and national laboratories to provide input into the OBP's R&D technical plan for the forest biorefinery.
- The forest biorefinery plan is organized to fit OBP R&D focus areas:
  1. *Feedstocks*
  2. *Sugar Platform*
  3. *Thermochemical Platform*
  4. *Products*
  5. *Integrated Biorefineries*

# Feedstock Interface R&D

- The Program has identified several barriers in feedstock:
  - ✓ *The de-coupling of feedstock research from the Biomass Program to USDA must be revisited. It's vital that communications and coordination be maintained.*
  - ✓ *DOE and industry need to be proactive in working with the USDA to investigate the opportunity of the Healthy Forest Restoration Act of 2003 to provide feedstocks to forest biorefineries.*
  - ✓ *Research activities for sustainable forestry need to include hardwood species; e.g., willow, poplar and aspen; in addition to loblolly pine.*
  - ✓ *The potential for generating 2–3 times the current harvest production from forests with better harvesting techniques and management should be examined.*

# Sugars Platform

- Sugars Platform-related R&D seeks to maximize the conversion of the Pre-Digester hemicellulose component
  - ✓ *Extract up to 50%*
  - ✓ *Convert up to 80%*
- The extracted sugar mixture would subsequently be used to produce fuels and chemicals.
- Preserve the cellulose component for use as pulp and paper.

# Sugar Platform R&D Needs

- Cost-benefit analysis on the process cost and value of separating hemicellulose component from wood prior to the pulping process.
  - ✓ *Similar to the 2003 study performed by Larson et al on black liquor gasification.*
- Critical technical barriers are focused on the pretreatment
  - ✓ *Expected reduce cost of producing sugars from hemicellulose in a forest biorefinery*
- Need a cost effective pretreatment step to release hemicellulose sugars and preserve cellulose fibers for higher value uses by the forest biorefinery.

# Thermochemical R&D

- The Thermochemical Platform-related R&D seeks to increase the capability to:
  - ✓ *Produce low-cost intermediates (syngas and pyrolysis oils)*
  - ✓ *Produce low-cost on-site electricity and process heat and steam.*
  - ✓ *Integrate with conversion technologies to produce fuels/chemicals*
    - “Other Peoples Technologies”
  - ✓ *Develop unique & innovative conversion technologies*

# Thermochemical R&D Needs

- Identify a short list of “top” fuels and or chemical from syngas in FBR - then, develop a critical pathway.
- Rigorous analysis of the two gasification options.
- Thermochemical processing chemistry requires additional investigation to support the commercial demonstration program and facilitate the development and scale-up of advanced gasifiers and gas clean-up systems.
- Available clean-up technologies do not meet cost, performance, or environmental criteria.
- Develop new sensors, analytical instruments, and process modeling tools to optimize control systems for thermochemical technologies.
- Develop new product specification and standards, e.g., ASTM standards for pyrolysis oil since significantly different from petroleum-based oils.
- Demonstrate long-term catalyst effectiveness using fixed-bed catalysts in the presence of inorganic particulates for wet gasification.
- Long-term, economically acceptable integrated approaches need to be developed for BLG systems both in low and high-temperature reactors.

# Products Platform

- Biopower, biofuels, and bioproducts are all included in the OBP's R&D portfolio.
  - ✓ *The production of these biobased products will also contribute to meeting the technical goals of the Sugar and Thermochemical Platforms.*
  - ✓ *Comparable to a petroleum or petrochemical refinery*
- OBP will identify desirable products that can be produced from all components of biomass in a forest biorefinery.
  - ✓ *Specific products and relative amounts of the products will vary widely.*
  - ✓ *Specific products for specific markets requires industrial partners with a very clear understanding of the performance attributes and dynamics of the market.*
- Products R&D will optimize consumption of the biomass feedstocks in an integrated forest biorefinery in order to create additional economic value

# Products R&D Needs

- Different technical barriers exist depending on whether the fuel, chemical and power products will be produced from the outputs of the Sugars Platform or the Thermochemical Platform.
- Many possible end-products can be made from the outputs of these two platform,
  - ✓ *some having greater energy or economic impact potential than others.*

# Products R&D Needs

- For products in FBR from:
  - ✓ ***Sugar Platform***
    - improved biological catalysts to convert sugars to building block intermediates
    - improved chemical catalysts to convert sugars to building block intermediates
    - improved fundamental understanding of chemical reactions to products.
  - ✓ ***Thermochemical Platform***
    - cleanup technologies do not meet cost, performance or environmental criteria.
    - ensure that appropriate conversion technologies are available for producing chemicals and fuels from syngas.
  - ✓ ***General Products***
    - cost effective separations to recover and purify products from biomass.

# FBR Integration

- OBP is taking a systems integration approach
  - ✓ *Translate the technical successes from its other core R&D areas into a fully-integrated forest biorefinery.*
  
- Make improvements to existing technologies and applying them to existing biorefineries
  - ✓ *In tandem with developing and introducing emerging technology*
  - ✓ *Accelerate the testing of key technology components for emerging biorefineries in existing commercial operations.*

# FBR Integration R&D Needs

- **Control multiple product streams.**
- **Hot gas cleaning and turbine design and integration**
- **Understand how extraction of hemicellulose affects pulping.**
- **Cost-benefit analysis on the value of separating hemicellulose component from wood prior to pulping**

# FBR-Related Budget

- **FY06-FY10 funds will be requested to support the FBR technology development plan.**
  - ✓ ***FY06-increase FY05 budget by \$10M to support Products portfolio and a new solicitation for R&D related to forest biorefinery.***
  - ✓ ***FY07-FY08-Request additional \$10M/year to support core R&D and industrial partnership for the FBR***
  - ✓ ***FY08-Biorefinery Solicitation (\$40M) with major industry partner collaboration***

# FY05 Solicitations

## ■ Products-

✓ *Any work related to the biological conversions, chemical conversions or separations, for the production of building blocks or value added chemicals, and fuels.*

- Research to Develop Chemical Building Blocks
- University Research in Biomass Technologies
- <http://www.bioproducts-bioenergy.gov/default.asp>

## ■ USDA/DOE Joint Solicitation

# For more information...

- Visit the OBP's Web site at [www.eere.energy.gov/biomass](http://www.eere.energy.gov/biomass)
  - ✓ *Financial Opportunities*
    - Program Solicitations
    - USDA/DOE Joint Biomass Initiative Solicitations
  - ✓ *Multi-year technical plan/Current R&D*

For more information...

**BACK UP SLIDES**

# OBP Biorefinery Vision

**Lignocellulosic Biomass**

An integrated biorefinery makes use of:

- ✓ *Thermochemical conversion technology*
- ✓ *Biochemical conversion technology*
- ✓ *Existing technology*

