

Biomass



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Office of the Biomass Program
Energy Efficiency and Renewable Energy

Source: Production and end-use data from Energy Information Administration, Annual Energy Review 2001
 *Net fossil-fuel electrical imports
 **Includes 0.2 quads of imported hydro
 ***Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.



- BioFuels Presidential Initiative
- Billion Ton Study
- Pathways and Platforms
- Energy Balance of Corn
- Establishing Regional Feedstock Partnerships
- Corn Stover Sustainability Study
- Perennial Crop Sustainable Attributes
- EERE/Office of Science Workshop
- Federal Collaboration – work with other agencies



President's Biofuels Initiative



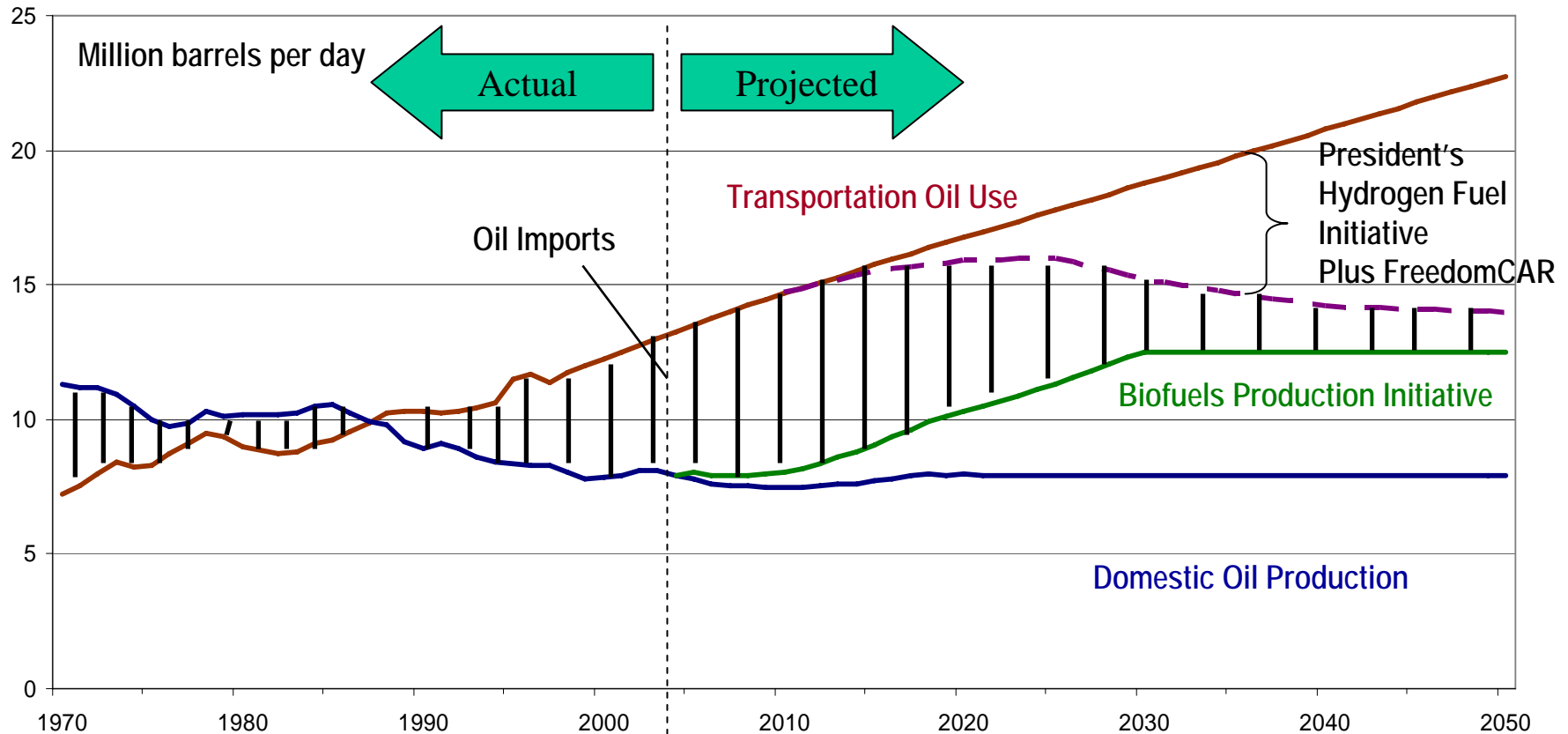
Replace more than 75 percent of our oil imports from the Middle East by 2025

2012 Goal: Fund additional research in cutting-edge methods of producing ethanol, not just from corn, but from wood chips and stalks, or switch grass. Our goal is to make this new kind of ethanol practical and competitive within six years.



EERE Program Goal:

Dramatically Reduce Dependence on Foreign Oil



Efficient use of our liquid transportation fuels is an objective. Augmenting the Supply of that liquid fuel from more than one energy source is critical!



"The mission of Biomass Program is to partner with U.S. industry to foster research and development on advanced technologies that will transform our abundant biomass resources into clean, affordable, and domestically-produced biofuels, biopower and high-value products. The result will be improved economic development, expanded energy supply options, and increased energy security"



- Investigate the Conversion of a much broader number of possible feedstocks
- The funding will also allow us to see just how far our effort to convert corn stover can be leveraged into other feedstock including other agricultural residues, grasses, and woody residues
- Develop regional feedstock partnerships to identify local opportunities for feedstock production and ethanol production



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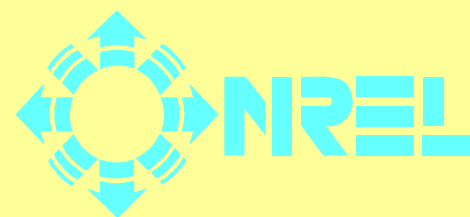
Billion Ton Study

Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply

April 2005



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United States Department of Agriculture

USDA FOREST SERVICE

100 Years of Caring for the land and serving people

United States Department of Agriculture
Agricultural Research Service



United States Department of Agriculture

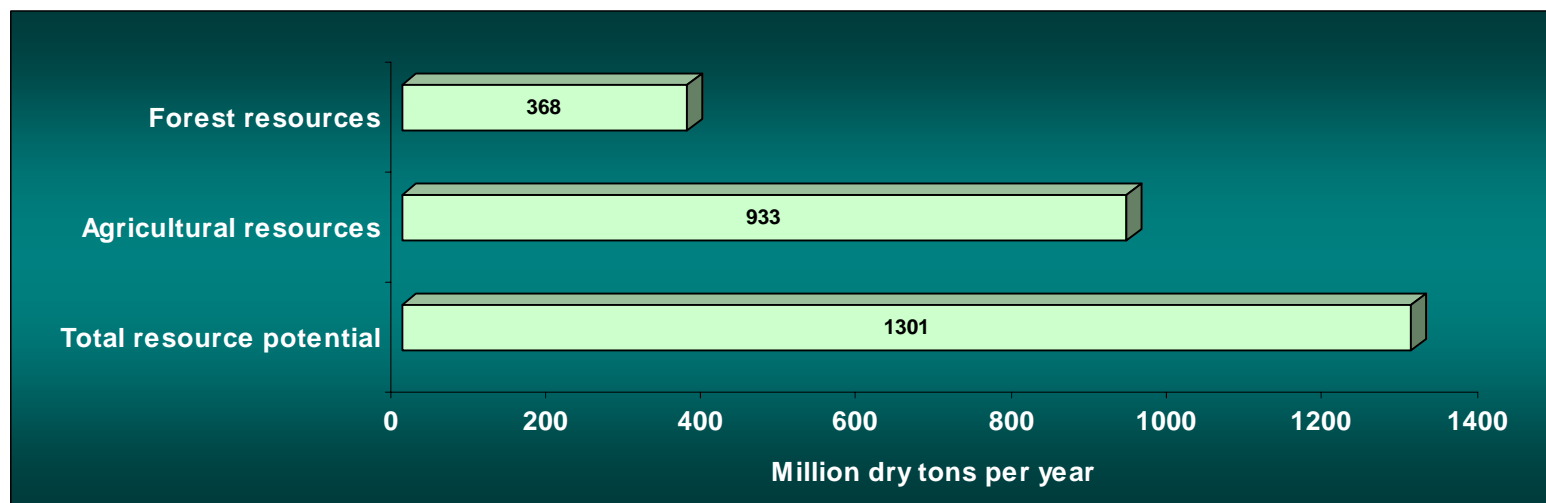
Office of the Chief Economist



Billion Ton Study

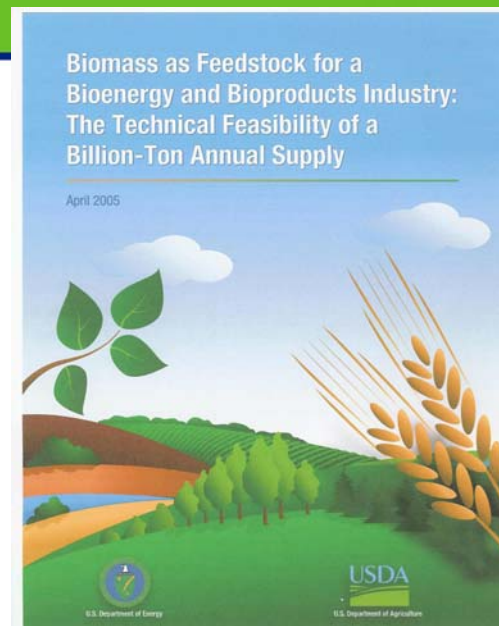
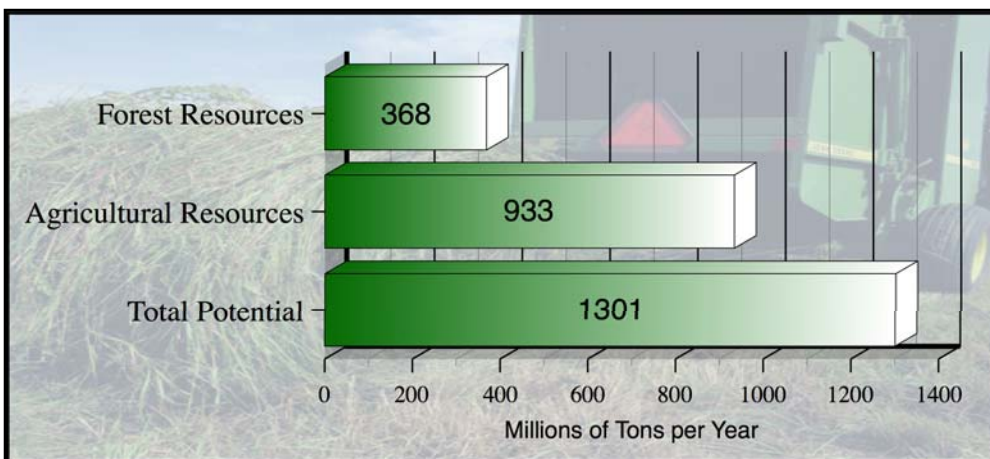
Are there sufficient resources to meet 30% of the country's petroleum requirements?

- Yes, land resources of the U.S. can sustainably supply more than 1.3 billion dry tons annually and still continue to meet food, feed, and export demands
- Realizing this potential will require R&D, policy change, stakeholder involvement
- Required changes are not unreasonable given current trends





Feedstock Resource Potential



“Billion Ton” study indicates that enough biomass is potentially available to displace > 30% of current U.S. petroleum consumption

But it requires variety of biomass types

- Agricultural lands
 - Corn stover, wheat straw, soybean residue, manure, switchgrass, poplar/willow energy crops, etc.
- Forest lands
 - Forest thinnings, fuelwoods, logging residues, wood processing and paper mill residues, urban wood wastes, etc.



Integrated Biorefinery



**Feedstock
production,
collection,
handling &
preparation**



Hydrolysis

Acids, enzymes

Sugars &
Lignin

Gasification

High heat, low
oxygen

Synthesis
Gas

Digestion

Bacteria

Bio-gas

Pyrolysis

Catalysis, heat,
pressure

Bio-Oil

Extraction

Mechanical,
chemical

Carbon-Rich
Chains

Separation

Mechanical,
chemical

Plant
Products

USES

Fuels:

Ethanol
Renewable Diesel
Hydrogen

Power:

Electricity
Heat

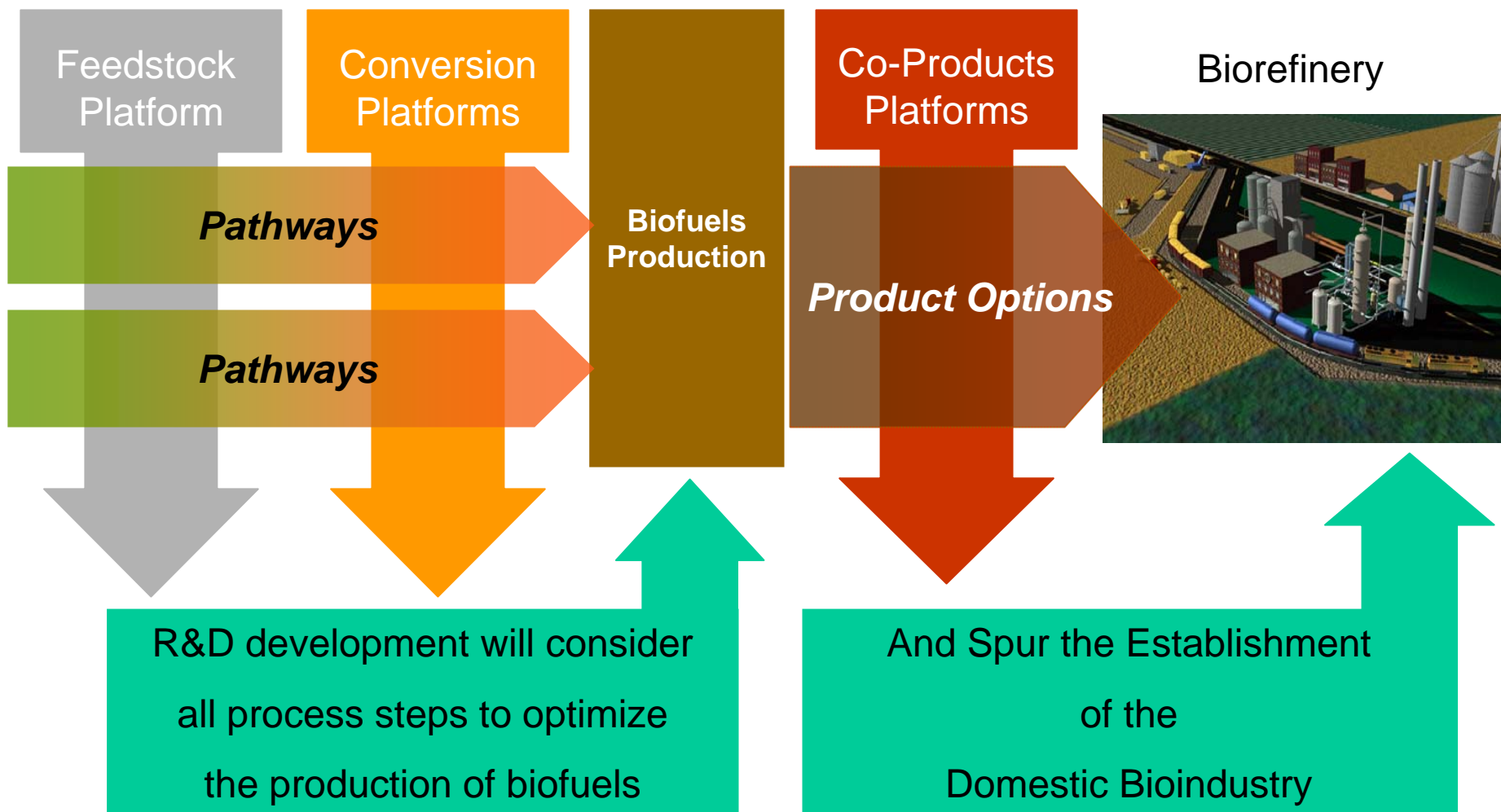
Chemicals:

Plastics
Solvents
Chemical
Intermediates
Phenolics
Adhesives
Furfural
Fatty acids
Acetic Acid
Carbon black
Paints
Dyes, Pigments,
and Ink
Detergents
Etc.

Food and Feed

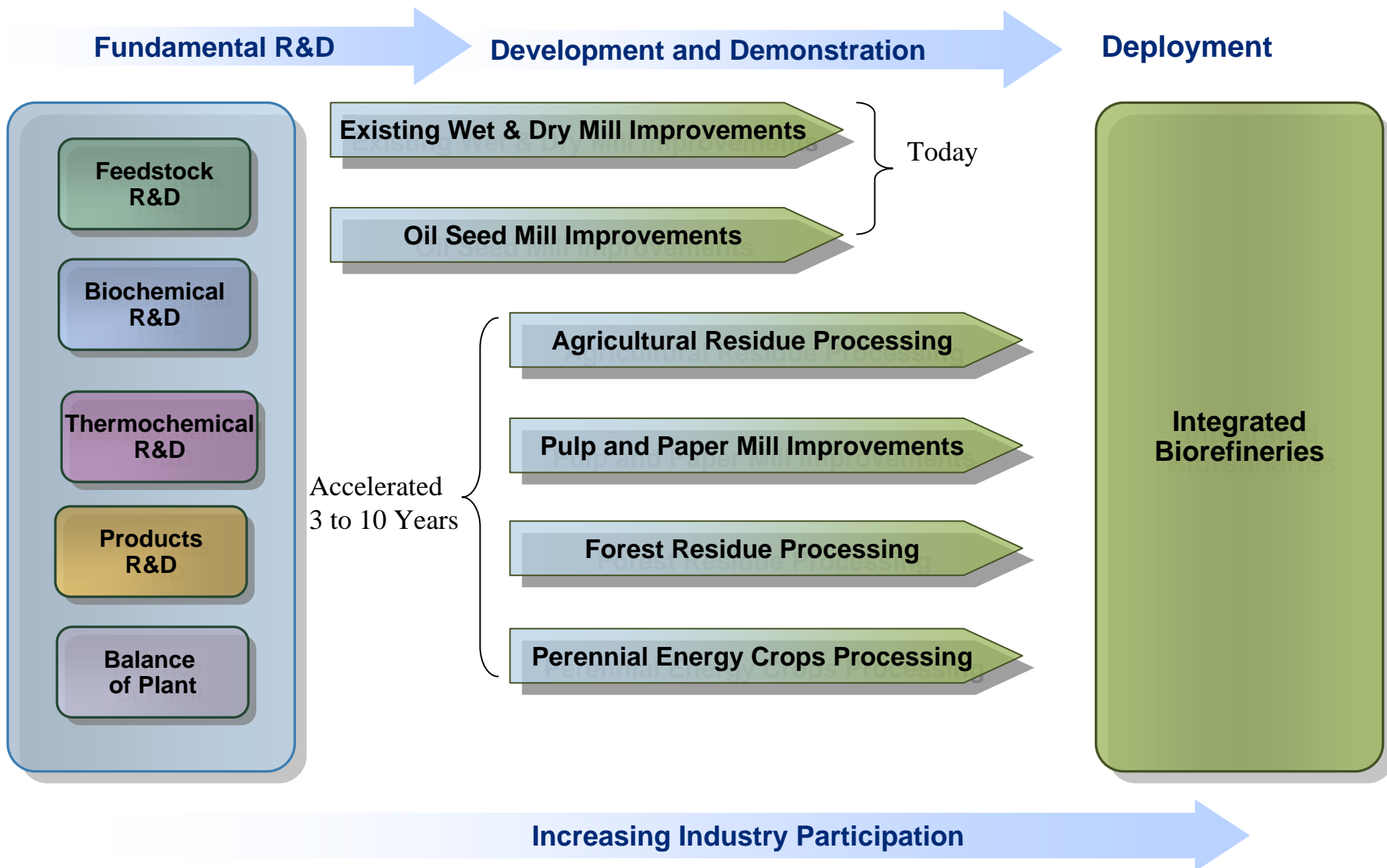


Pathway/Platform Matrix





R&D Platforms and Pathways



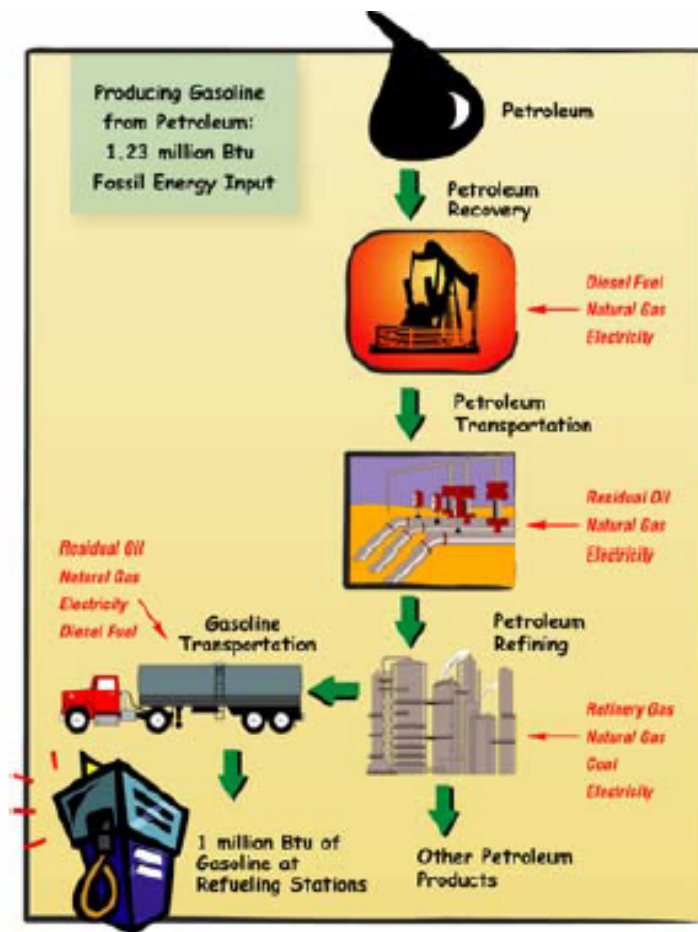
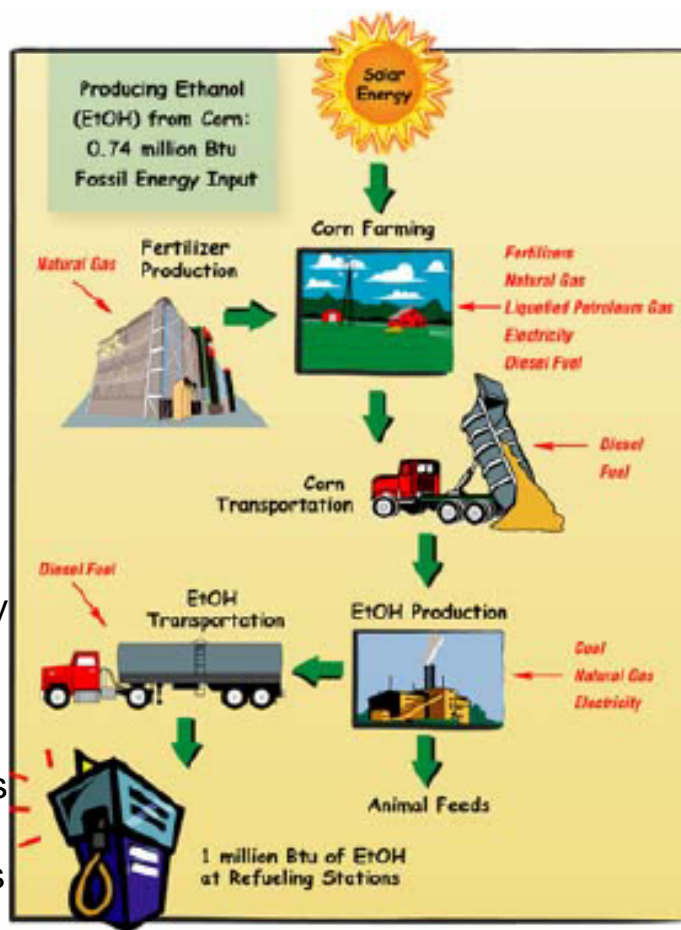


- Recent studies have suggested that biofuels, ethanol and biodiesel specifically, require more energy to produce than can be obtained from them.

Several studies refute this point:

- Argonne National Laboratory: Corn ethanol requires 26% less energy than it contains, while cellulosic ethanol requires 90% less.

- A joint DOE/USDA study by the National Renewable Energy Laboratory shows that soy-based biodiesel requires 69% less energy to make than it contains.





Regional Biomass Energy Feedstock Partnerships

- **Goal:** Establish Regional Feedstock Partnerships to develop, evaluate, and deploy sustainable biomass resource supplies with a clear understanding of economic analysis and market relationships for commercial development.
- **Strategy:**
 - Develop the Southeast Regional Partnership as a prototype for other regions
 - Identify regional contacts to serve on working groups in the following technical and non-technical areas:
 - Sustainable Agricultural and Forestry Residues
 - Sustainable Perennial Grass/Tree Development
 - Sustainable Feedstock Resource and Economic Analysis
 - Communication and Information Dissemination
- **Potential Participants:**

– Sun Grant Initiative	- NBSRP Regional Offices
– DOE	- Farm Bureaus
– USDA	- Land Grant Universities
– ORNL	- Other Universities
– INL	- R&D Partners
– Mississippi State University	- Biorefiners

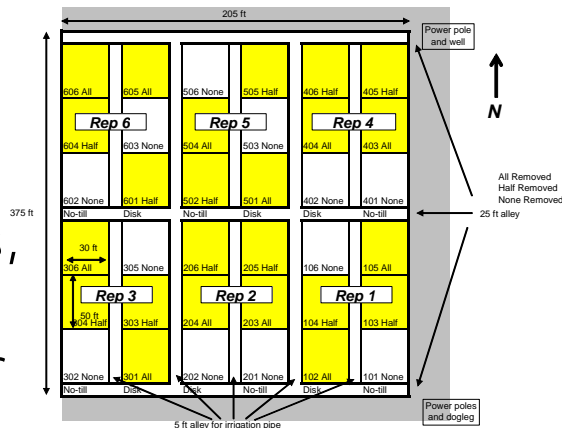


Corn Stover Removal Impact Assessment on Grain Yield

- Joint USDA and DOE project initiated in August 2005
- Objective – Assess impact of corn stover removal strategies, for use as a bioenergy feedstock, on subsequent year corn grain production

- Approach:

- Summarize existing published/unpublished data on residue removal impact on grain yields
- Initiate studies on stover removal strategies that will produce an acceptable biorefining feedstock



Nebraska
stover removal
research plot
design



Iowa stover
removal field
trials – High cut,
leaves most of
the stalk; Low
cut, removes
most stover



U.S. Department of Energy
Energy Efficiency and Renewable Energy
Tree Height (H)

ATTRIBUTES OF POPULUS

Soil Carbon-Amendment
0.6 dry tons/ac/yr
fine root turnover
1.0 dry ton/ac/yr
biomass accumulation

Perennial Cover
- Wind Erosion Control
up to 10H
- Water Erosion Control

Wildlife Habitat
- Winter Cover
- Early Spring

No Annual Feedstock
Storage Cost

No site disturbance
for 5-6 years

Low Chemical Input
<10 lbs. N/ac/yr

Removal of Agricultural
Chemical from Ground Water

Life History

Fast-growing perennials
Nine native species and
numerous hybrid clones

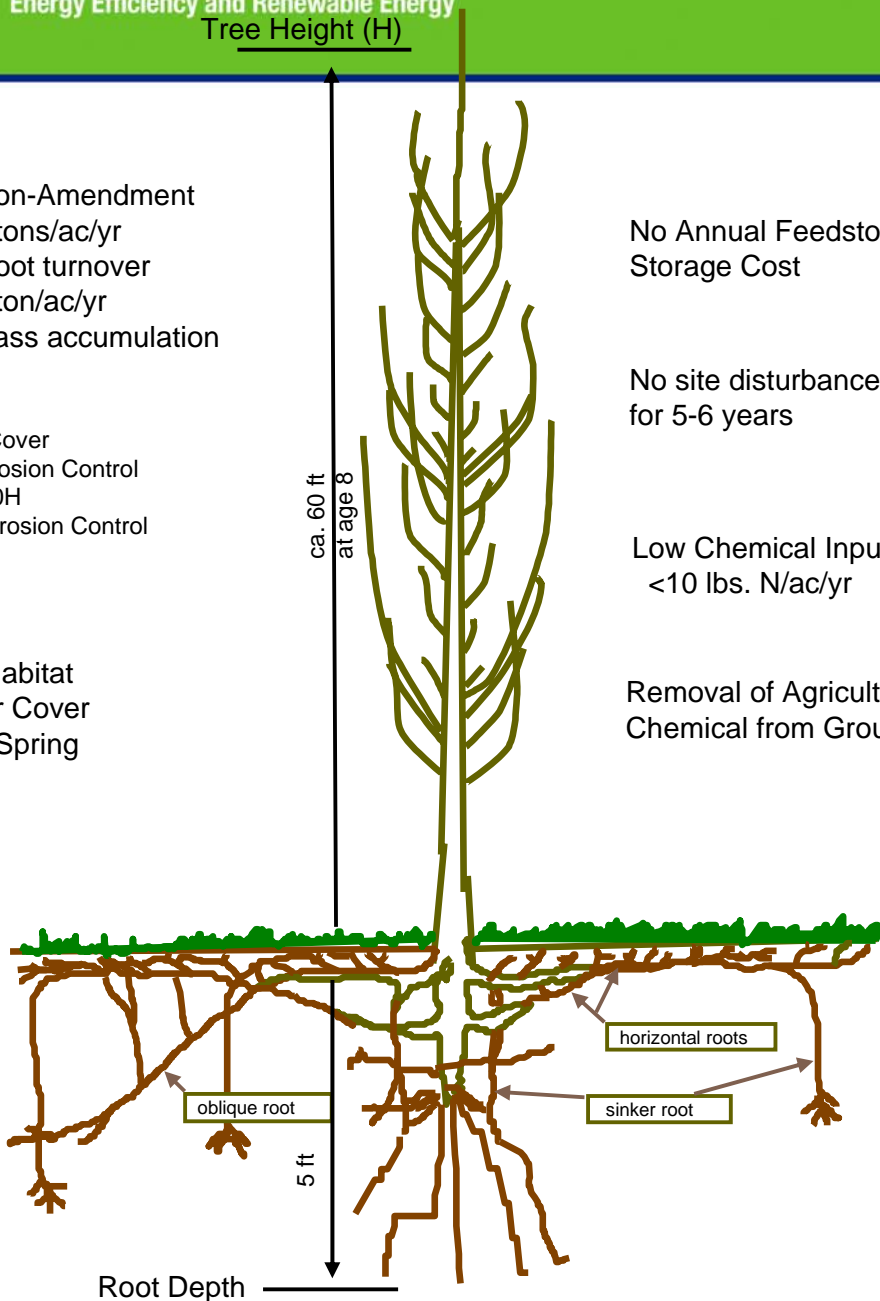
Cultural Practices

Short rotation forestry
on agricultural land

Productivity Potential

5 to 10 dry tons/ac/yr

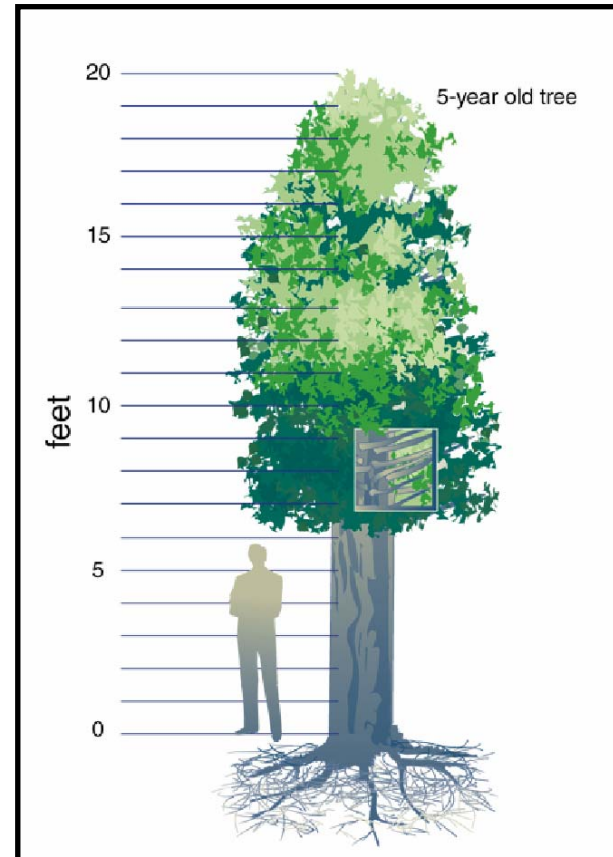
Native Range of All North American *Populus*





Conventional System vs. Domesticated System

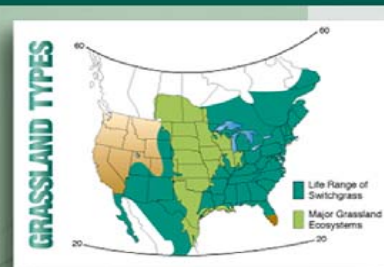
- 8' x 8' spacing
- \$0.21 / cutting
- 5 tons / ac / yr
- 8-year rotation
- default harvest cost
- \$51.42 / ton
- 4' x 8' spacing
- \$0.12 / cutting
- 13.5 tons / ac / yr
- 5-year rotation
- \$8 / ton harvest cost
- \$20.67 / ton





ATTRIBUTES OF SWITCHGRASS

- Native Prairie Species
- High Yield/Energy Gain
- Low Energy Input
- Widely Adaptable
- Improved Soil/Water Conservation
- Wetland Protection
- Reduced Agrochemical Use/Loss
- Increased Carbon Storage
- Excellent Wildlife Habitat
- Grow/Harvest like Hay
- Multiple Use on/off Farm





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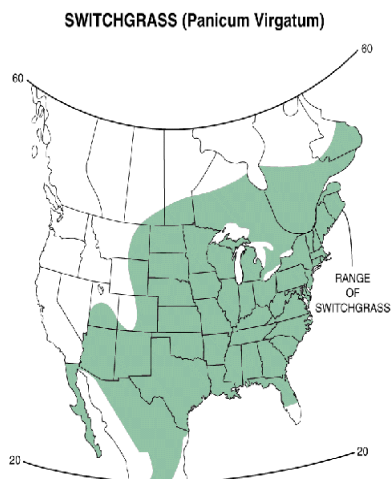




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Attributes of Switchgrass

- Native perennial grass - Farm-compatible - High yield and energy efficiency- Ecological and economic gains for agriculture

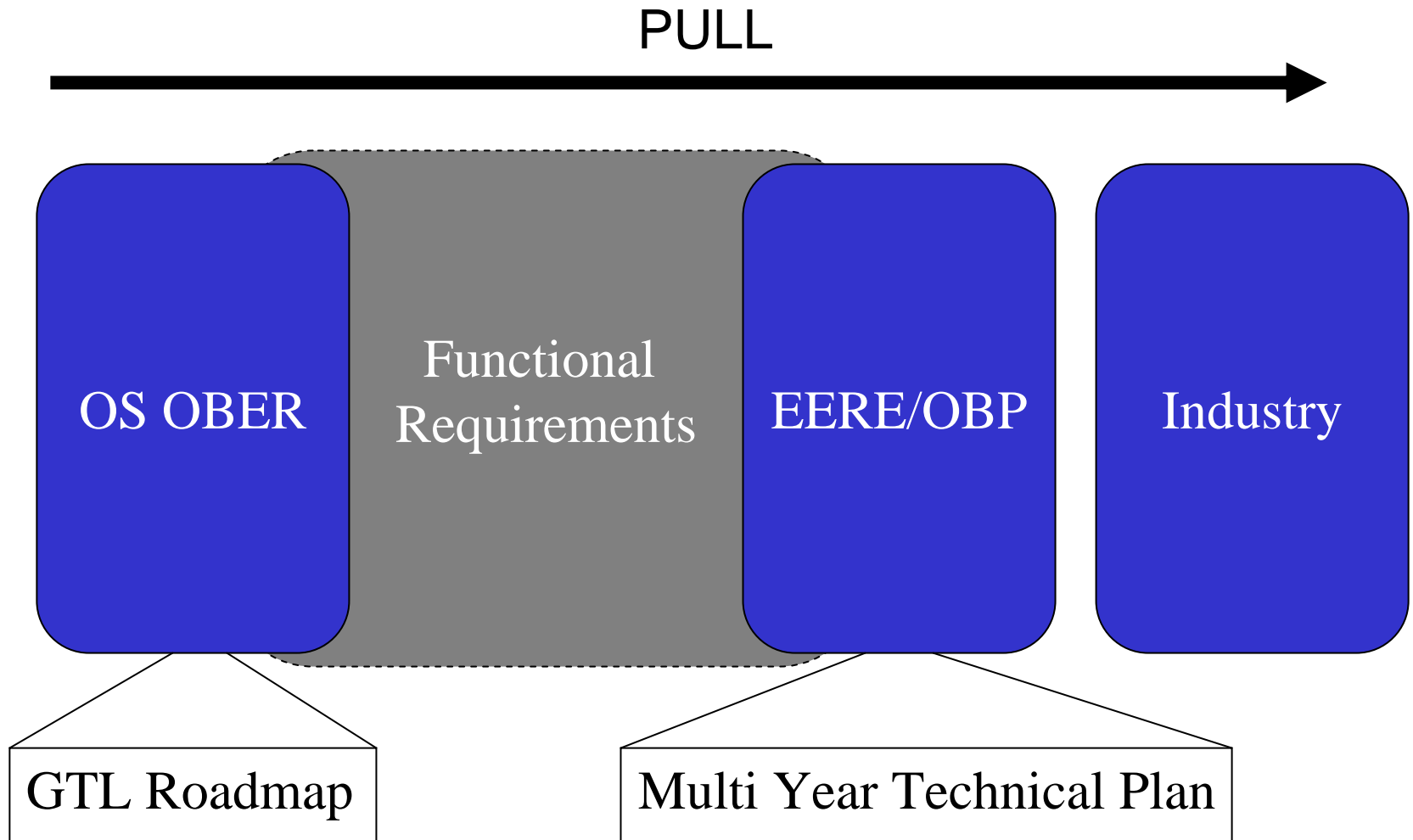




- White Paper – “Critical Challenges in Bioenergy for Applied and Fundamental Research at DOE – An Overview of Collaborative Opportunities”
- Workshop Sessions
 - Feedstock Genomics and Engineering
 - Plant Cell Wall Deconstruction
 - Biological Conversion of Biomass
 - Crosscutting



Strategy for Joint Workshop





- Healthy Forest Restoration Act of 2003, Title II
- Memorandum of Understanding (MOU) for Woody Biomass Utilization (DOE/USDA/DOI)
- MOU for Biomass to Hydrogen (DOE/USDA)
- Biomass Research and Development Act of 2000
 - Biomass R&D Technical Advisory Committee
 - Vision for Bioenergy & Biobased Products in the US
 - Roadmap for Bioenergy & Biobased Products in the US
 - Biomass R&D Board (DOE/USDA/DOI/EPA/NSF/OFEE)
- Farm Bill 2002, Title IX
 - Federal Procurement of Biobased Products (Section 9002)
 - Renewable Energy Systems and Energy Efficiency Improvements (Section 9006)
 - Biomass Research and Development (Section 9008)
 - Joint DOE/USDA Solicitation for FY 02, FY 03, & FY04
 - Continuation of the Bioenergy Program (Section 9010)
- Joint Projects
 - Joint USDA/DOE Feedstock Stage Gate Review
 - Billion Ton Feedstock Study (USDA/DOE)

