Biomass Vision and Roadmap Update

Current status of process

1

What is the Vision Statement?

- *The Vision for Bioenergy and Biobased Products in the United States was created in 2002*
- *It established far-reaching goals to increase the role of biobased energy and products in our nation's economy.*
- *It represented the collective vision of the Biomass Research and Development Technical Advisory Committee established by the Biomass R&D Act of 2000.*

2

Vision Timeline

- Workshop: 11/05
  - 22 experts from industry, government, academia
  - Held at Argonne National Lab
  - Round table discussion to update goals & major challenges
- Peer Review: 1/06
  - 25 experts – 19 responses
  - Electronic submission of comments/edits
- Board Review: 4/06
  - EPA, DOE, USDA, NSI, DOI, DOT, OSTP, OFEE
- Final Vision: 6/06

3

Post Vision Workshop Agenda

- Obtained Technical Advisory Committee input on Vision Executive Summary.
- Follow-up analysis and peer review carried out to ensure targets were valid in relation to available feedstocks, conversion technologies, etc.
- Developed draft Vision by December 31, 2005.
- Final Vision will be submitted by April 2006.

4

Post Vision Workshop Agenda cont.

- The updated *Vision* does not change the original 2010 goals but recognizes that in some cases the U.S. is not on track to meet them.
- The *Vision* makes minor changes to its 2020 and 2030 goals and establishes 2015 goals which describe the types of activities that must occur to reach that goal and move down the path to the aggressive targets for 2020 and 2030.

5

Original Vision Goals

	2001	2010	2020	2030
BioPower Biomass share of electricity & heat demand in utilities and industry	**3% (2.7 quads)**	**4% (3.3 quads)**	**5% (4.0 quads)**	**5% (5.0 quads)**
BioFuels Biomass share of demand for transportation fuels.	**0.5% (0.15 quads)**	**4% (1.3 quads)**	**10% (4.0 quads)**	**20% (9.5 quads)**
BioProducts Share of target chemicals that are biobased.	**5%**	**12%**	**18%**	**25%**

6

Updated Vision Goals

Vision Goals							
	Units	2000	2004	2010	2015	2020	2030
Biopower	Market share (%)	4	4	4	5.5	7	7
	Consumption (Quadrillion Btu)	2.2	2.1	3.1	3.2	3.4	3.8
Biofuels	Market share (%)	0.7	1.2	4	6	10	20
	Consumption (million gasoline-equivalent gallons)	1	2	8	13	23	50
Bioproducts	Production (billion lbs)	12.4	17.6	23.7	26.4	35.6	55.3

7

What is the Roadmap?

- The Biomass R&D Act of 2000 called for the USDA and DOE to jointly carry out a biomass research and development initiative in the areas of biofuels and bioproducts.
- It also established the Biomass R&D Technical Advisory Committee to advise on the technical program.

8

Roadmap Update Process

- Roadmaps will be planned by Regional Chairs with BCS/DOE support
- Roadmaps will incorporate regional experts pertaining to the Roadmap categories: Feedstocks, Processing and Conversion, Product Uses and Distribution, Public Policy
- Workshops will be facilitated by BCS

9

Regional Roadmap Workshops

- Update Roadmap language
- Incorporate New federal/state activities
  - Renewable Fuels Standards
    - Produce 7.1 million gallons of ethanol by 2012
  - Biofuels Initiative
    - Decrease cost to $1.05 per gallon of ethanol by 2010
    - Displace 40 million gasoline equivalent gallons by 2030
- Revisit path towards achieving Vision Goals
- Invitation only with regional experts

10

Roadmap Timeline

- Midwest Regional Roadmap
  - Chair: Tom Binder, ADM
  - Chicago, IL, April 11-12, 2006
- West Regional Roadmap
  - Ralph Cavalieri, Washington State
  - Sacramento, CA, August 8-9, 2006
- East Regional Roadmap
  - Douglas Hawkins, Rohm & Haas
  - New York, Fall 2006

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Why have a Roadmap?

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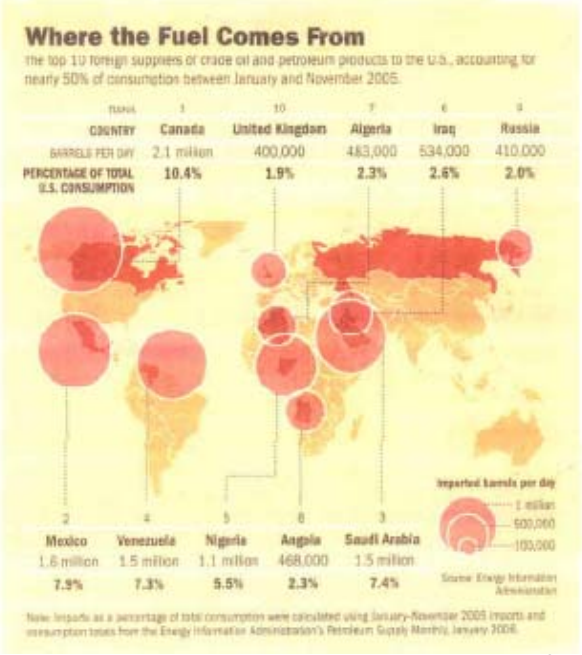

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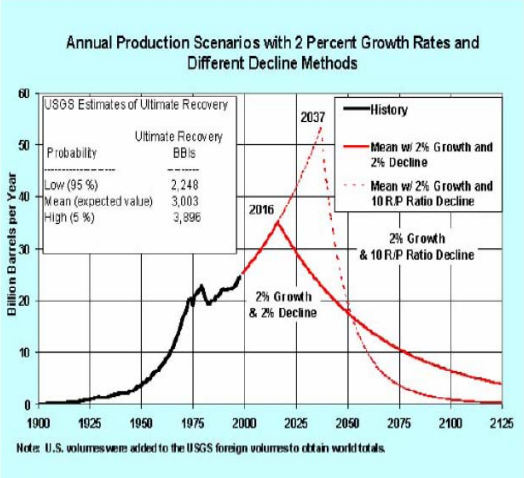
What is beyond Peak Oil?



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Energy consumption in 2050 three times larger than today

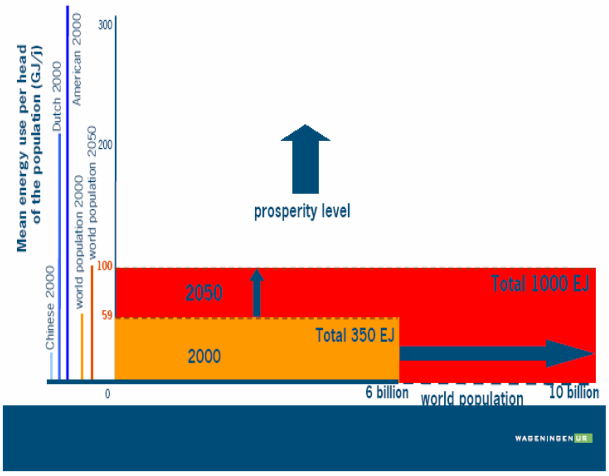

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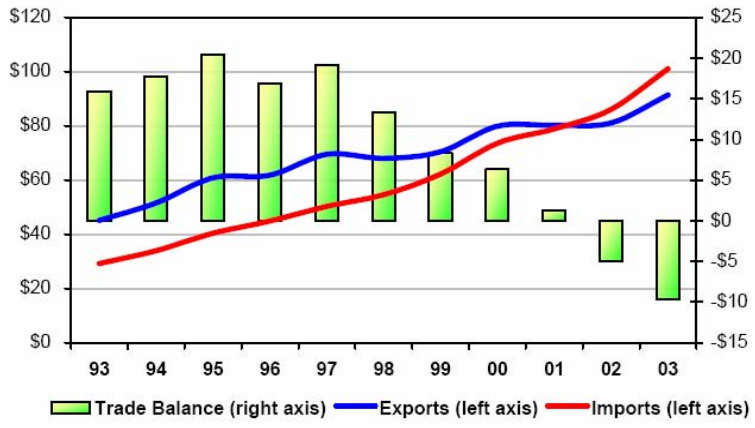
Figure 1
US Trade in the Business of Chemistry
($ Billions)



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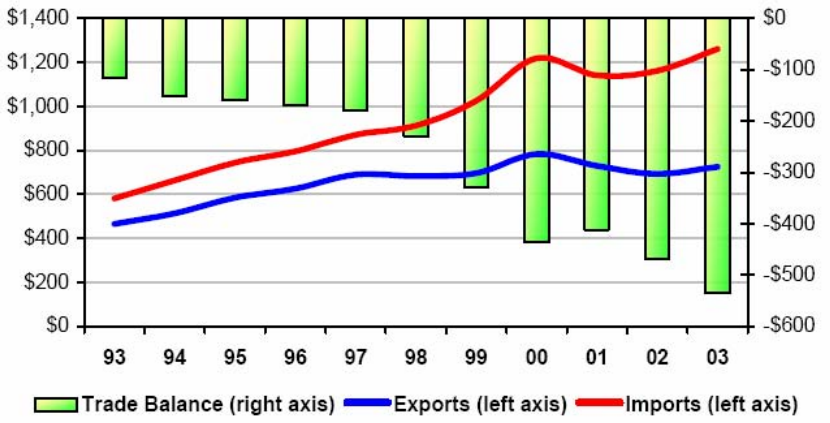
US Trade in Goods with the World ($ Billions)



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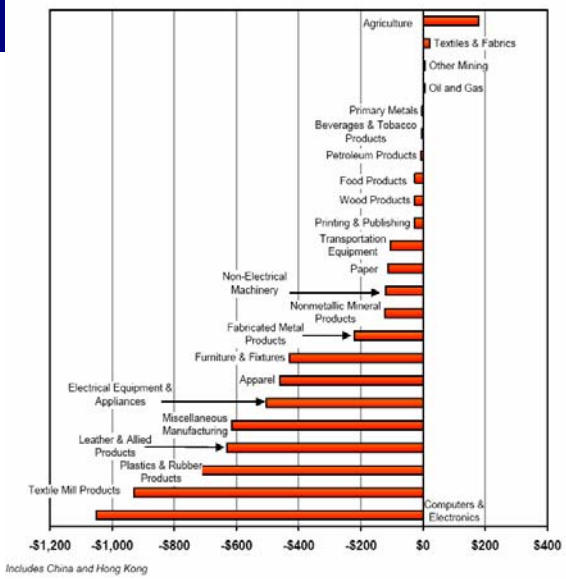
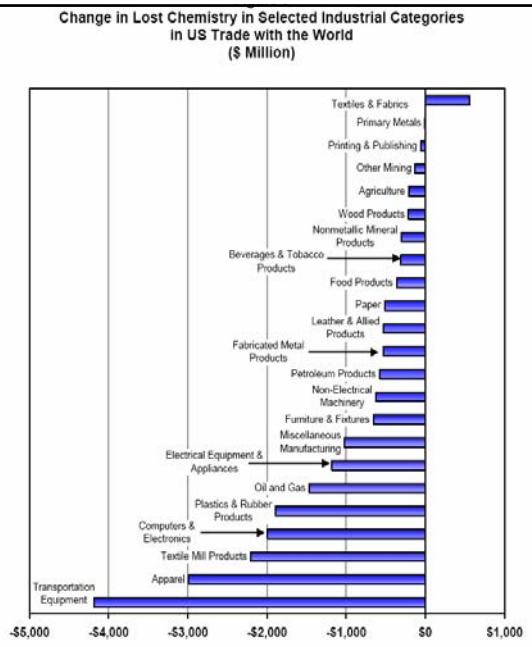
Change in Lost Chemistry in Selected Industrial Categories in US Trade with China* ($ Million)



Includes China and Hong Kong

18



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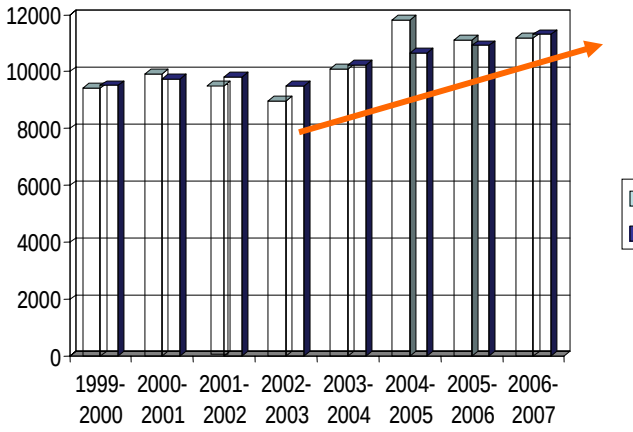
What role can biomass play?

20

Corn Production and Use: 1999-2006



NCGA

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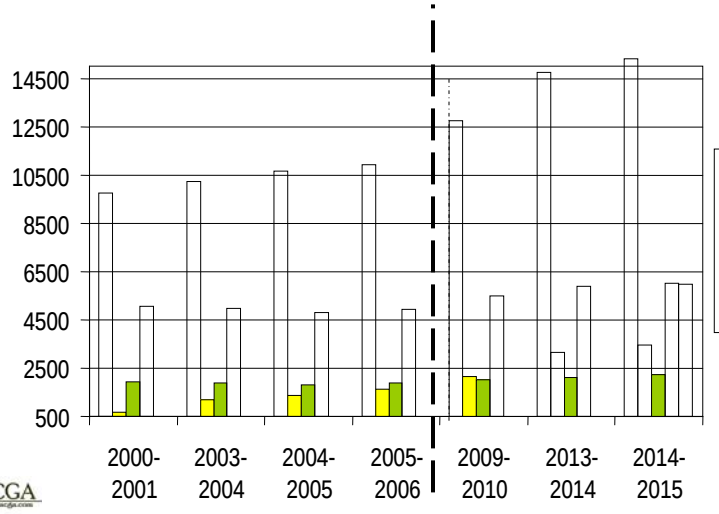
Corn Use – 1999-2015



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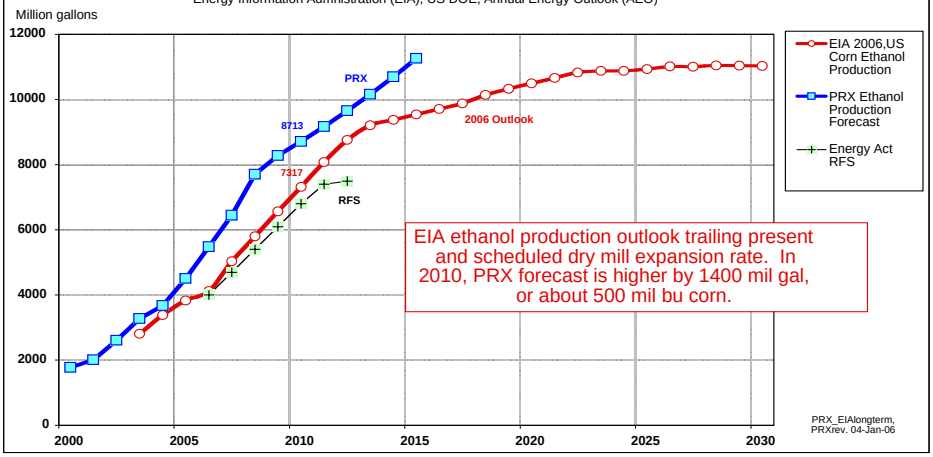
US CORN ETHANOL PRODUCTION, with PRX ESTIMATE

Energy Information Admnistration (EIA), US DOE, Annual Energy Outlook (AEO)



According to the EIA:

"The AEO2006 reference case includes only those sections of EPACT2005 (the recent Energy Bill) that establish specific tax credits, incentives, or standards—about 30 of the roughly 500 sections in the legislation."

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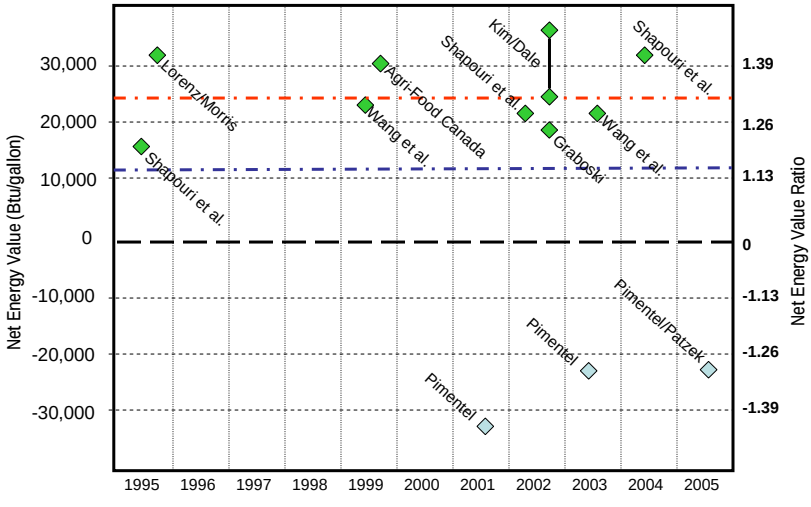
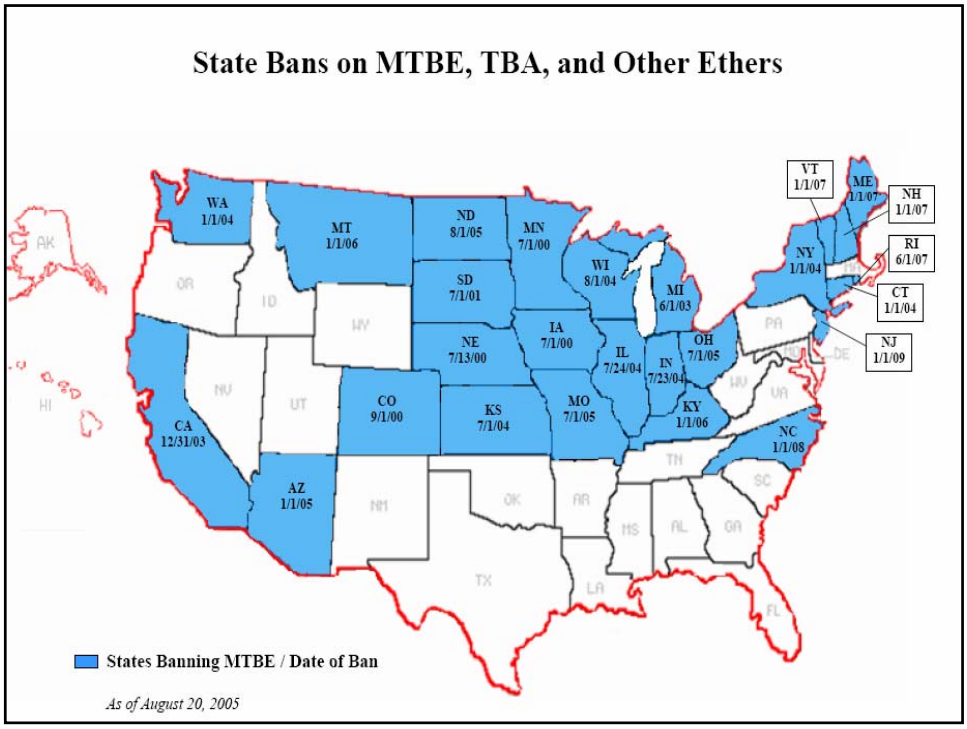
Comparative Results of Ethanol Energy Balance Studies 1995-2005

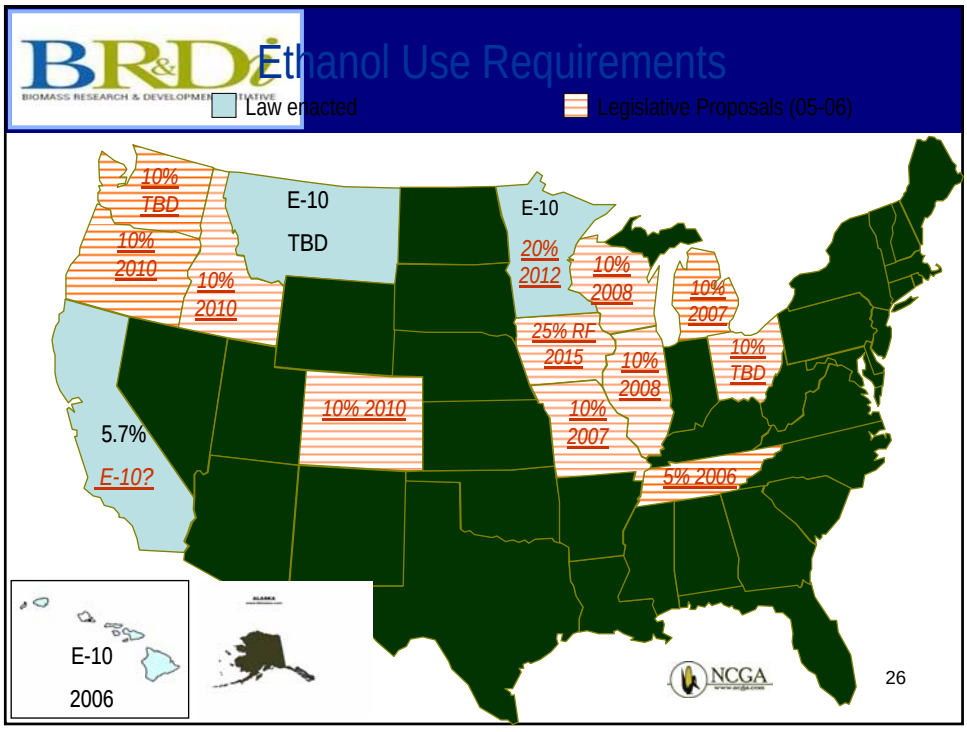


Sources: Office of Energy Efficiency and Renewable Energy (U.S. Department of Energy) ; Dale, Bruce, Michigan State University, presentation at World Congress on Industrial Biotechnology & Bioprocessing, Orlando, Florida, April 22, 2005.

NCGA www.ncga.com

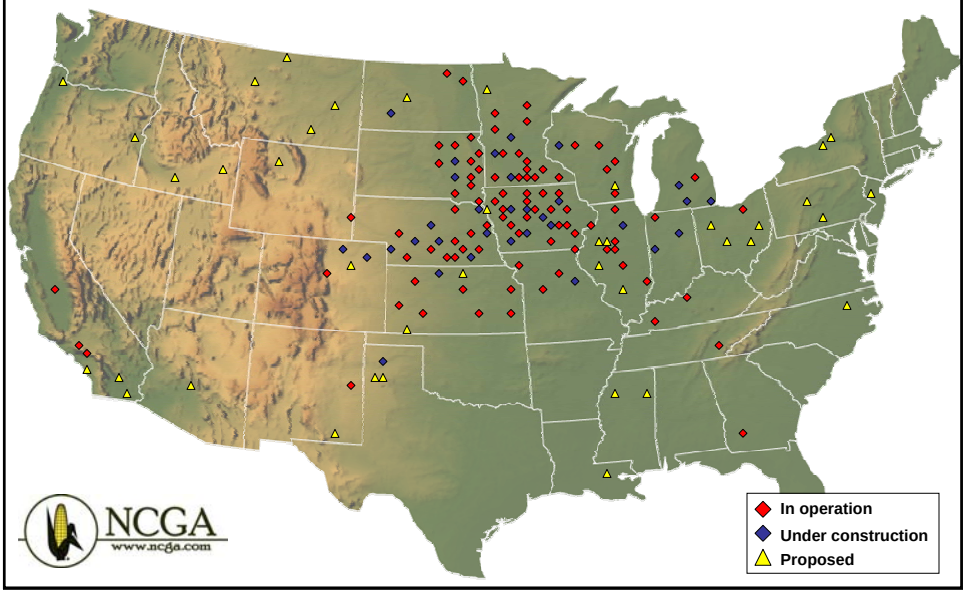
For more information, call the National Corn Growers Association at (636) 733-9004 or go to www.ncga.com


State Bans on MTBE, TBA, and Other Ethers
WA 1/1/04
MT 1/1/06
ND 8/1/05
MN 7/1/00
SD 7/1/01
WI 8/1/04
MI 6/1/03
NY 1/1/04
VT 1/1/07
ME 1/1/07
NH 1/1/07
RI 6/1/07
CT 1/1/04
NJ 1/1/09
OR
ID
WY
NE 7/13/00
IA 7/1/00
IL 7/24/04
IN 7/23/04
OH 7/1/05
PA
NV
UT
CO 9/1/00
KS 7/1/04
MO 7/1/05
KY 1/1/06
WV
VA
CA 12/31/03
AZ 1/1/05
NM
OK
AR
TN
NC 1/1/08
SC
MS
AL
GA
TX
LA
AK
HI
States Banning MTBE / Date of Ban
As of August 20, 2005

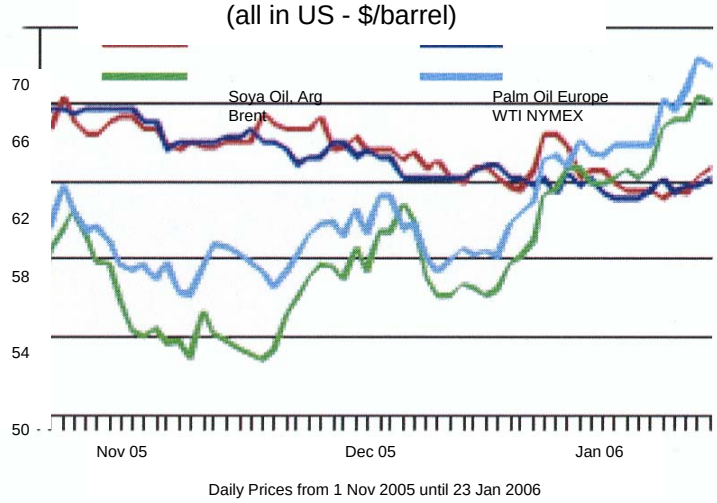

Ethanol Use Requirements
Law enacted
Legislative Proposals (05-06)
10% TBD
10% 2010
10% 2010
E-10 TBD
E-10
20% 2012
10% 2008
10% 2007
25% RF 2015
10% 2008
10% 2007
10% TBD
10% 2010
5.7% E-10?
5% 2006
E-10 2006
NCGA
26

U.S. Ethanol Plants

AS OF: December 2005



Prices of Crude Mineral Oil & Veg. Oils (all in US - $/barrel)



Daily Prices from 1 Nov 2005 until 23 Jan 2006

*Oil World

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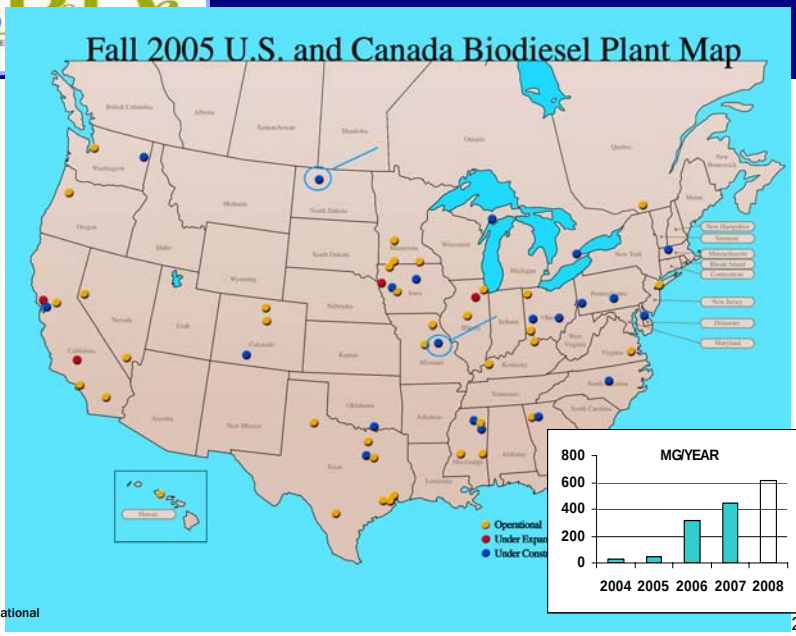

BBI International

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Biodiesel USA

	Production
	Gal/Year
2000	1,989,400
2001	6,437,200
2002	8,814,600
2003	18,400,000
2004	18,900,000
2005	100,000,000*

Source CCC Data

*Estimate

30

US Soy Oil Consumption

- Crop Year 2004 Approx. Production 18.7 B lbs
- 7.5 billion pounds of biodiesel derived from soy oil would represent approximately 40% of current total soy oil demand. This would be 1 billion gallons or 2% of diesel demand.

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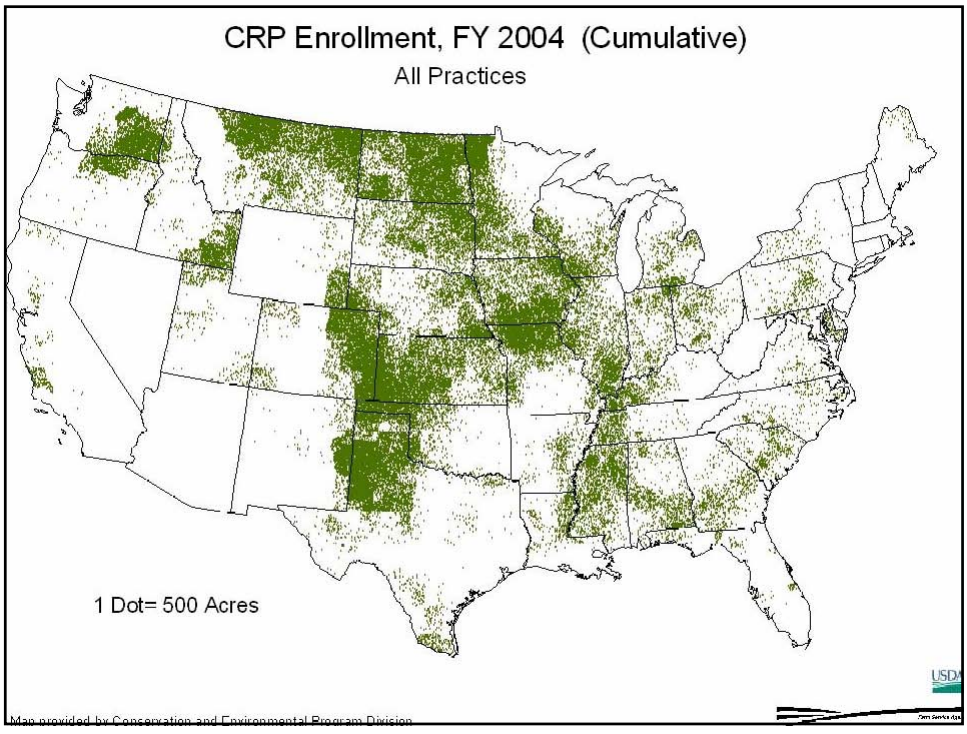

US Soy Oil Consumption

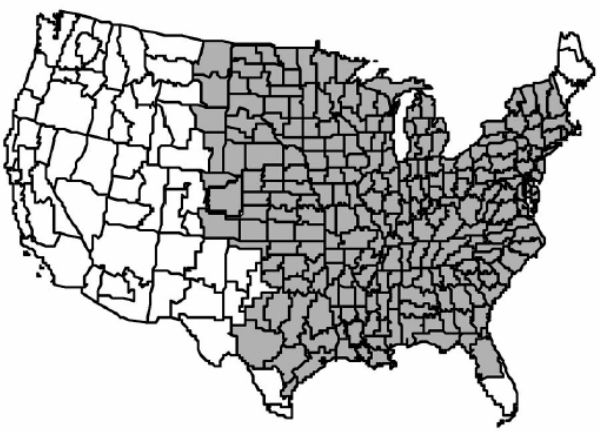

Figure 1. Switchgrass production regions (switchgrass can be grown in regions other than those included in the analysis, but yield and production practices data are lacking for these regions).

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Walsh, M. et al. *Environmental and Resource Economics* **24:** 313–333, 2003.

Figure 2. Hybrid poplar production regions (hybrid poplar can be grown in regions other than those included in the analysis, but yield and production practices data are lacking for these regions).

Walsh, M. et al. *Environmental and Resource Economics* **24:** 313–333, 2003.

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Figure 3. Willow production regions (willow can be grown in regions other than those included in the analysis, but yield and production practices data are lacking for these regions).

Walsh, M. et al. *Environmental and Resource Economics* **24:** 313–333, 2003.

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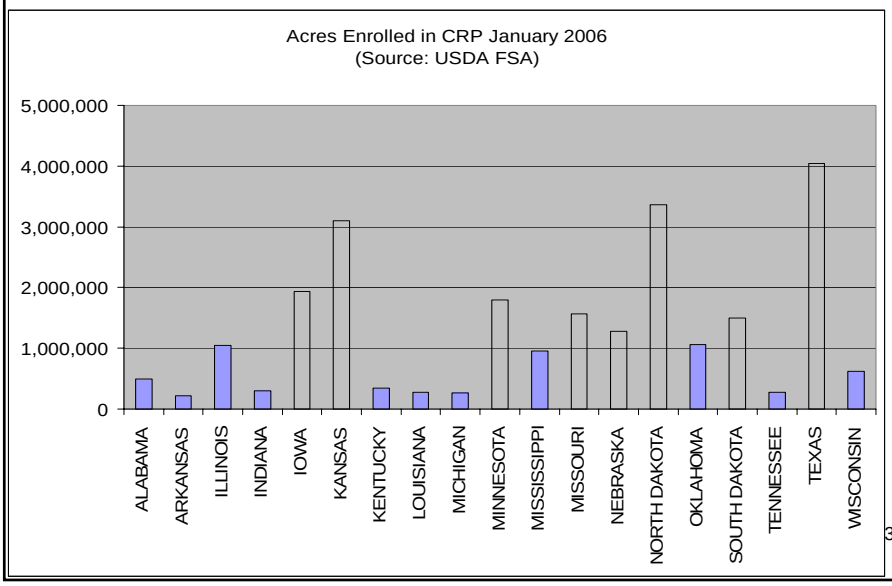

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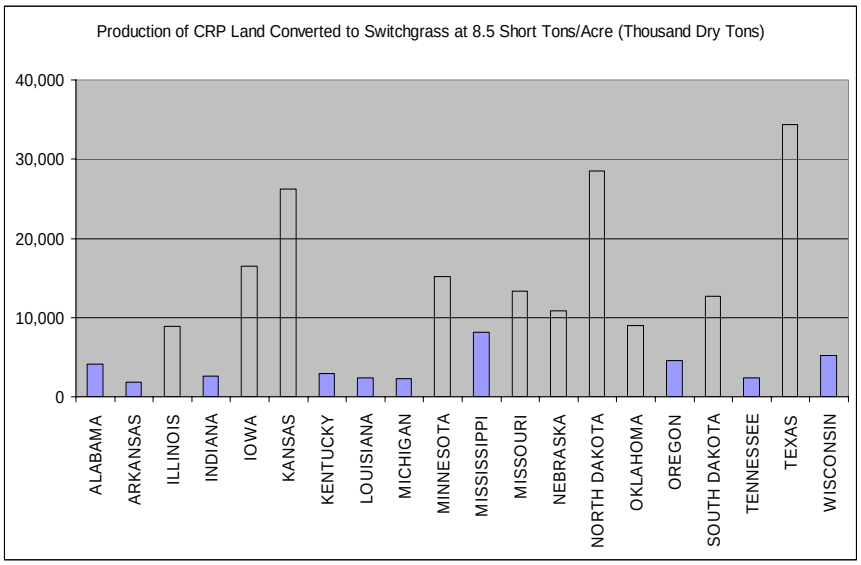

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Bioenergy Crops?

What is the short term potential in the Central region?

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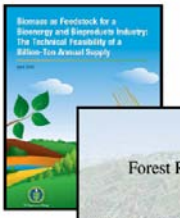
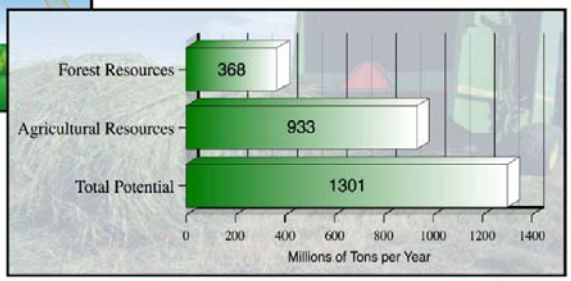
U.S. Biomass Resource Assessment



- Updated resource assessment - April 2005
- Jointly developed by U.S. DOE and USDA
- Referred to as the "Billion Ton Study"



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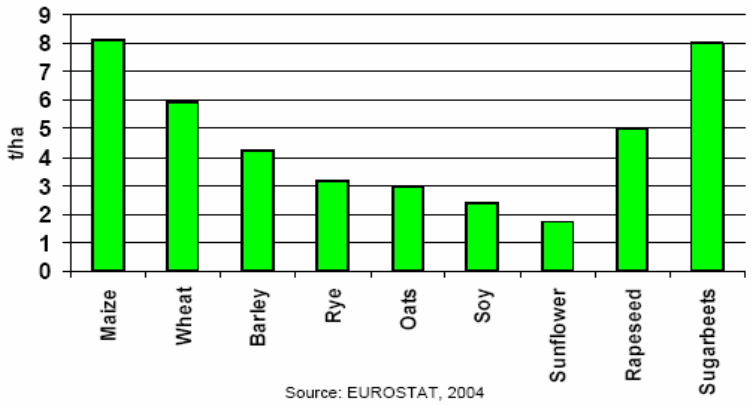
Crop yields



Source: EUROSTAT, 2004

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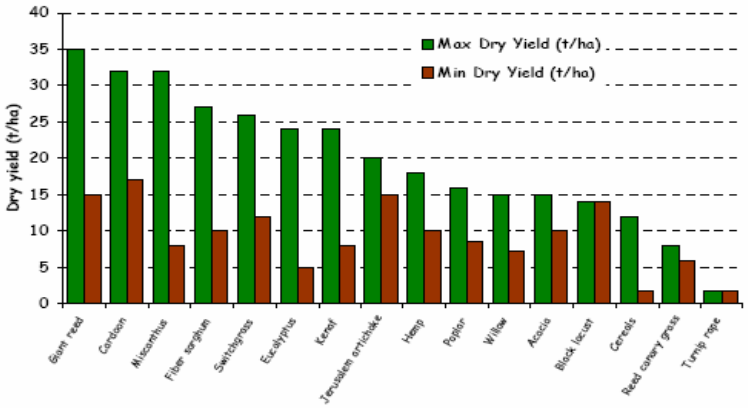
Yielding potential of energy crops in EU25



EC project: Altener Biomass in the Mediterranean

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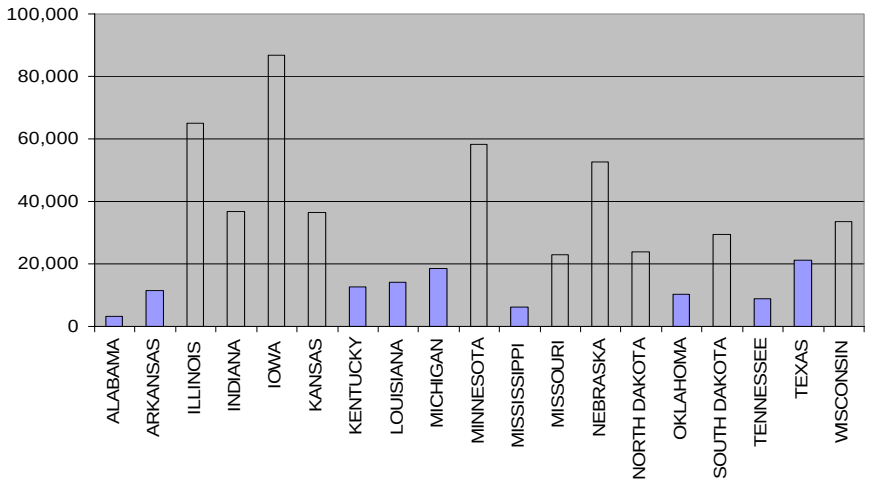
Production for Top Four Crops of Each State - 2005 (Thousand Tons)
(Source: Adapted from USDA NASS)



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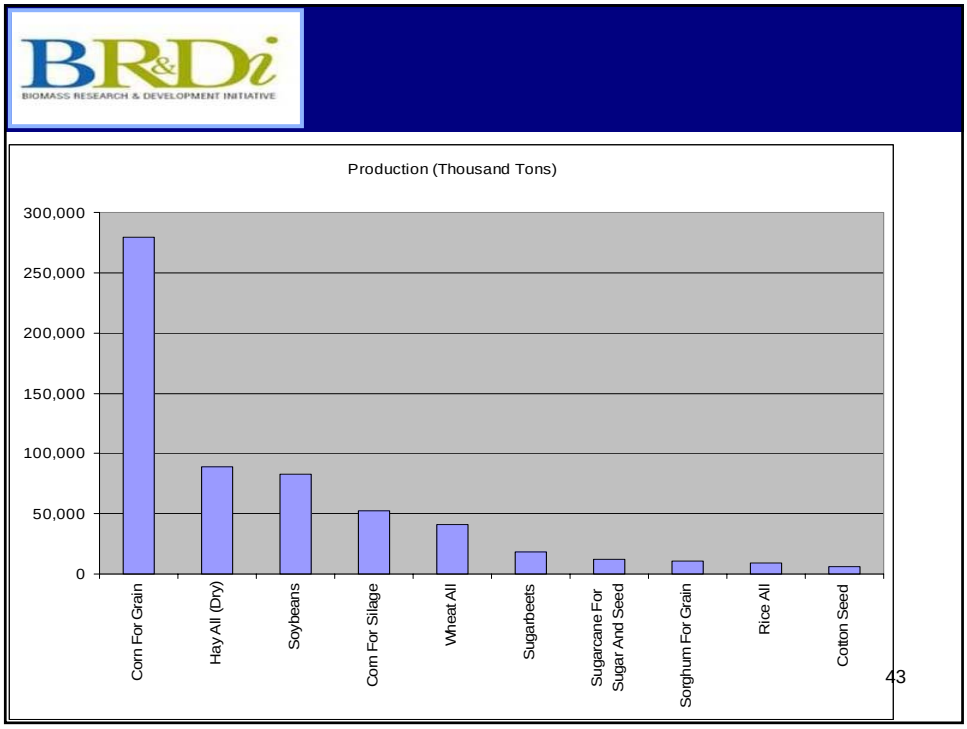
Production (Thousand Tons)
300,000
250,000
200,000
150,000
100,000
50,000
0
Corn For Grain
Hay All (Dry)
Soybeans
Corn For Silage
Wheat All
Sugarbeets
Sugarcane For Sugar And Seed
Sorghum For Grain
Rice All
Cotton Seed

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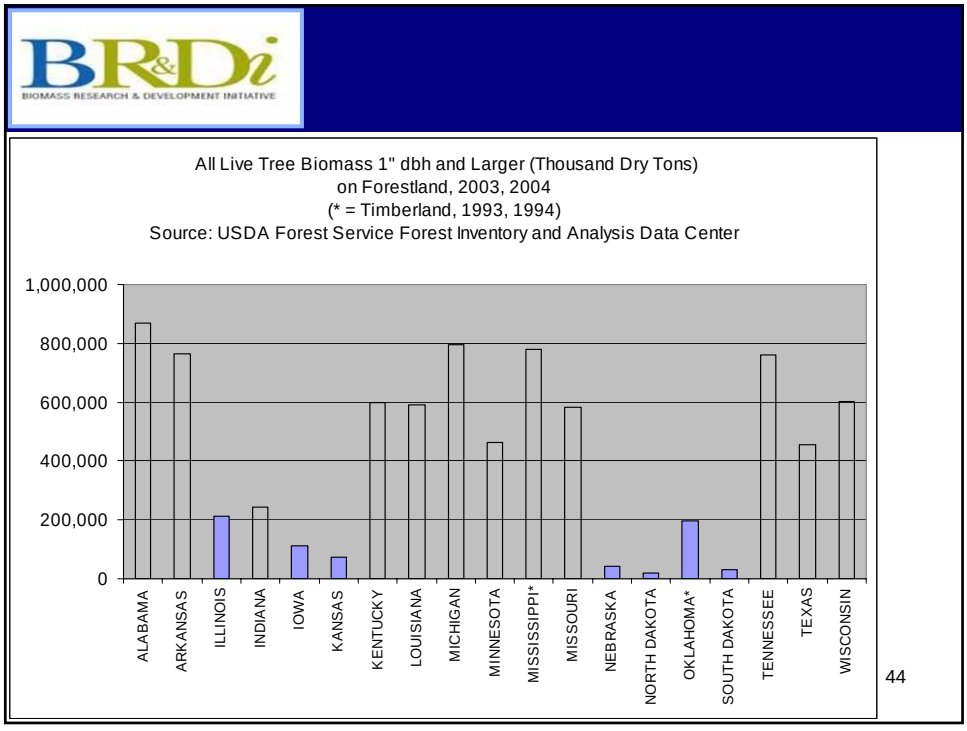
All Live Tree Biomass 1" dbh and Larger (Thousand Dry Tons)
on Forestland, 2003, 2004
(* = Timberland, 1993, 1994)
Source: USDA Forest Service Forest Inventory and Analysis Data Center
1,000,000
800,000
600,000
400,000
200,000
0
ALABAMA
ARKANSAS
ILLINOIS
INDIANA
IOWA
KANSAS
KENTUCKY
LOUISIANA
MICHIGAN
MINNESOTA
MISSISSIPPI*
MISSOURI
NEBRASKA
NORTH DAKOTA
OKLAHOMA*
SOUTH DAKOTA
TENNESSEE
TEXAS
WISCONSIN

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What conversion technologies are available?

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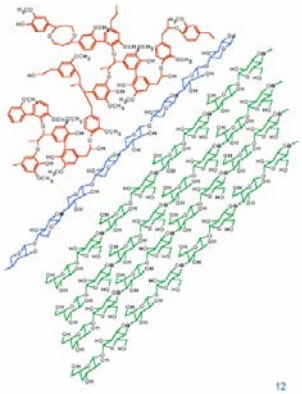
Non-Edible Constituents of Biomass

Lignin: 15%–25%
- Complex aromatic structure
- Very high energy content
- Resists biochemical conversion

Hemicellulose: 23%–32%
- Xylose is the second most abundant sugar in the biosphere
- Polymer of 5- and 6-carbon sugars, marginal biochemical feed

Cellulose: 38%–50%
- Most abundant form of carbon in biosphere
- Polymer of glucose, good biochemical feedstock



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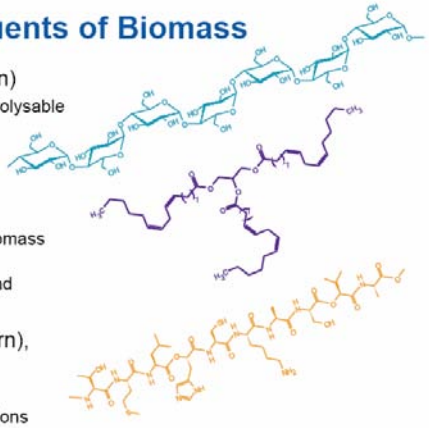
Edible Constituents of Biomass

Starch: 70%–75% (corn)
- Readily available and hydrolysable
- Basis for existing U.S. "biorefineries"

Oil: 4%–7% (corn), 18%–20% (soybeans)
- Readily separable from biomass feedstock
- Basis for oleochemicals and biodiesel

Protein: 20%–25% (corn), 80% (soybean meal)
- Key component of food
- Chemical product applications



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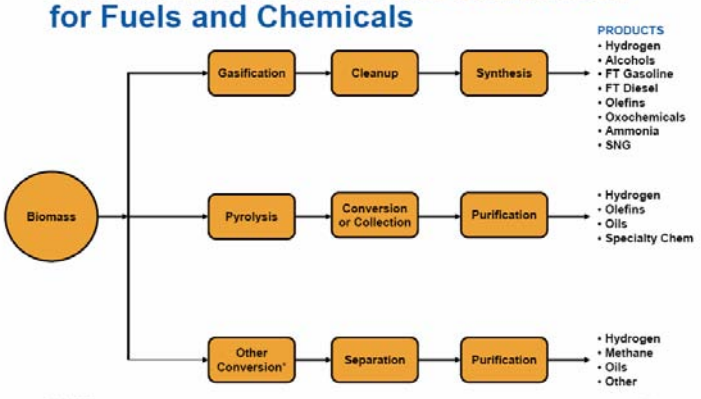
Biomass Thermochemical Conversion for Fuels and Chemicals



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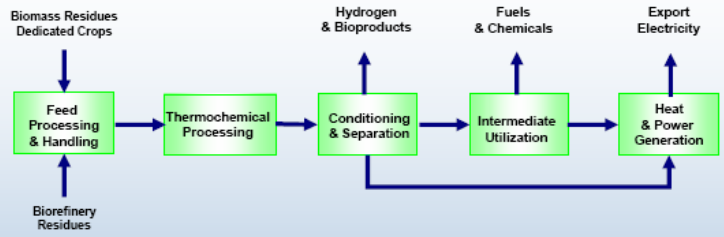
Biomass Thermochemical Conversion to Fuels and Chemicals



- Integrate biomass gasification and gas cleanup and conditioning unit operations with existing and developing high pressure fuels synthesis processes
- Leverage a century of C1 chemistry developed for fuels and chemicals synthesis
  - High pressure (10-1000 bar)
  - high temperature (100-500°C)
  - Catalytic
  - Exothermic (thermal control and heat integration)
- Validate syngas quality – gas cleanliness and CO/H_2 ratio

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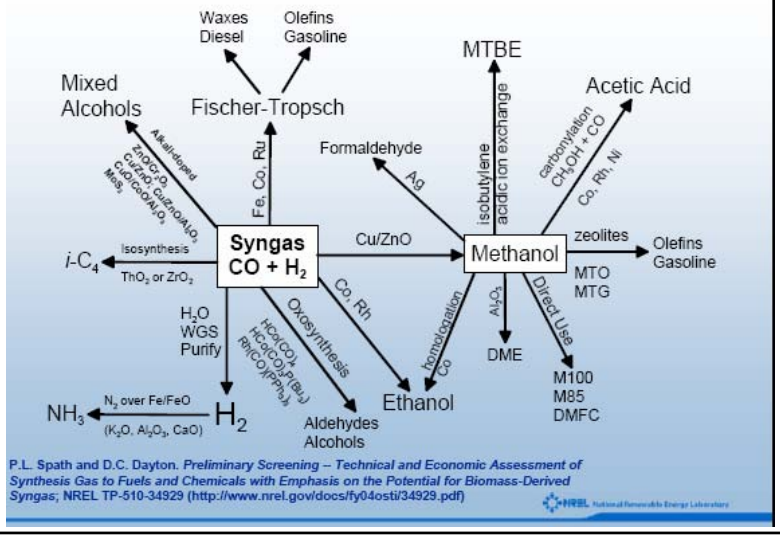
Summary of Syngas-to-Liquids Processes



P.L. Spath and D.C. Dayton. *Preliminary Screening – Technical and Economic Assessment of Synthesis Gas to Fuels and Chemicals with Emphasis on the Potential for Biomass-Derived Syngas*; NREL TP-510-34929 (http://www.nrel.gov/docs/fy04osti/34929.pdf)

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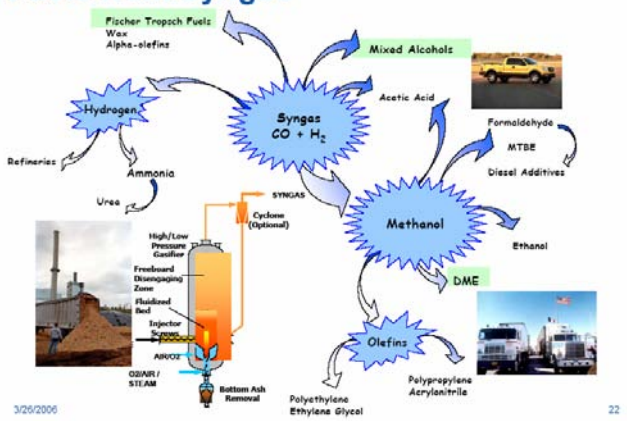
Fuels from Syngas



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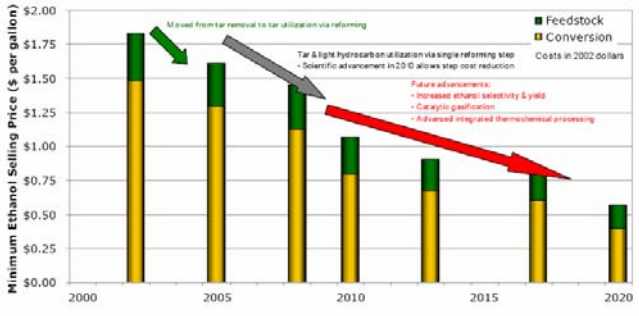
Ethanol From Thermochemical Mixed Alcohols



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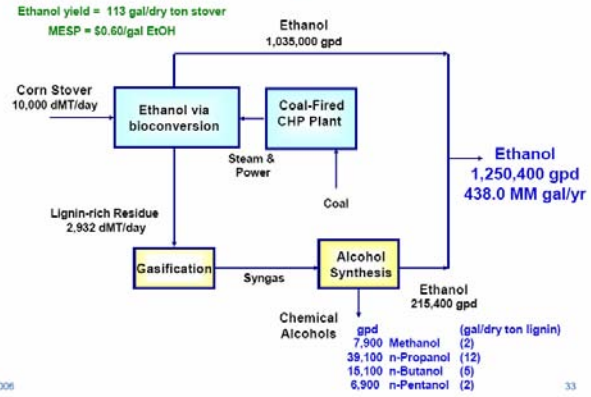
Integrated Biorefinery



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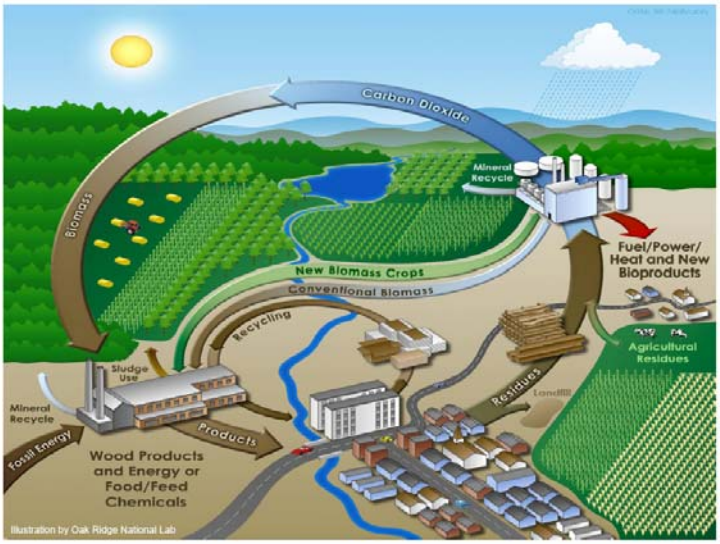

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