U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

U.S. Department of Energy Biomass Program

Growing A Robust Biofuels Economy

Office of Biomass Program

Biofuels Symposium
June 27 – 28, 2007

U.S. Presidential Commitment to Ambitious Biofuels Goals

Energy Efficiency & Renewable Energy

- Cost-competitive cellulosic ethanol" by 2012
- **"20 in 10"**
  - Reduce U.S. gasoline* use by **20%** by 2017 through…
    - **15%** reduction from new Alternative Fuels Standard at **35 billion** gallons/year
    - **5%** reduction from enhanced efficiency standards (CAFÉ)
- **"30 in 30"**
  - Longer-term DOE biofuels goal
  - Ramp up the production of biofuels to **60 billion** gallons
  - Displace **30%** of U.S. gasoline consumption* by 2030

* light-duty vehicles only

Biomass Program Mission

Energy Efficiency & Renewable Energy

Develop and transform our renewable and abundant biomass resources into cost competitive, high performance biofuels, bioproducts, and biopower.

- ***Partnerships***
- ***Policy***
- ***Interagency Coordination***

Collaborative R&D

Integrated Biorefineries: Systems Integration and Demonstration

Core activities accelerate the technological advances needed to support a domestic bioindustry producing cellulosic ethanol and other biofuels in integrated biorefineries.

Biomass Program Portfolio

Energy Efficiency & Renewable Energy

Removing barriers to large-scale production of cellulosic biofuels

Collaborative R&D

- **Feedstocks:** integration of feedstocks with conversion processes
- **Conversion Technologies:** biochemical and thermochemical

Integrated Biorefineries

- **Systems Integration:** feedstocks, conversion, biopower, infrastructure
- **Demonstrations:** pilot scale and commercial scale for diverse feedstocks

Infrastructure (New)

- Dispensers: UL E-85 certification, optimization of vehicle performance, and permitting

OBP organizes to deliver against barriers

Impacts of the Advanced Energy Initiative

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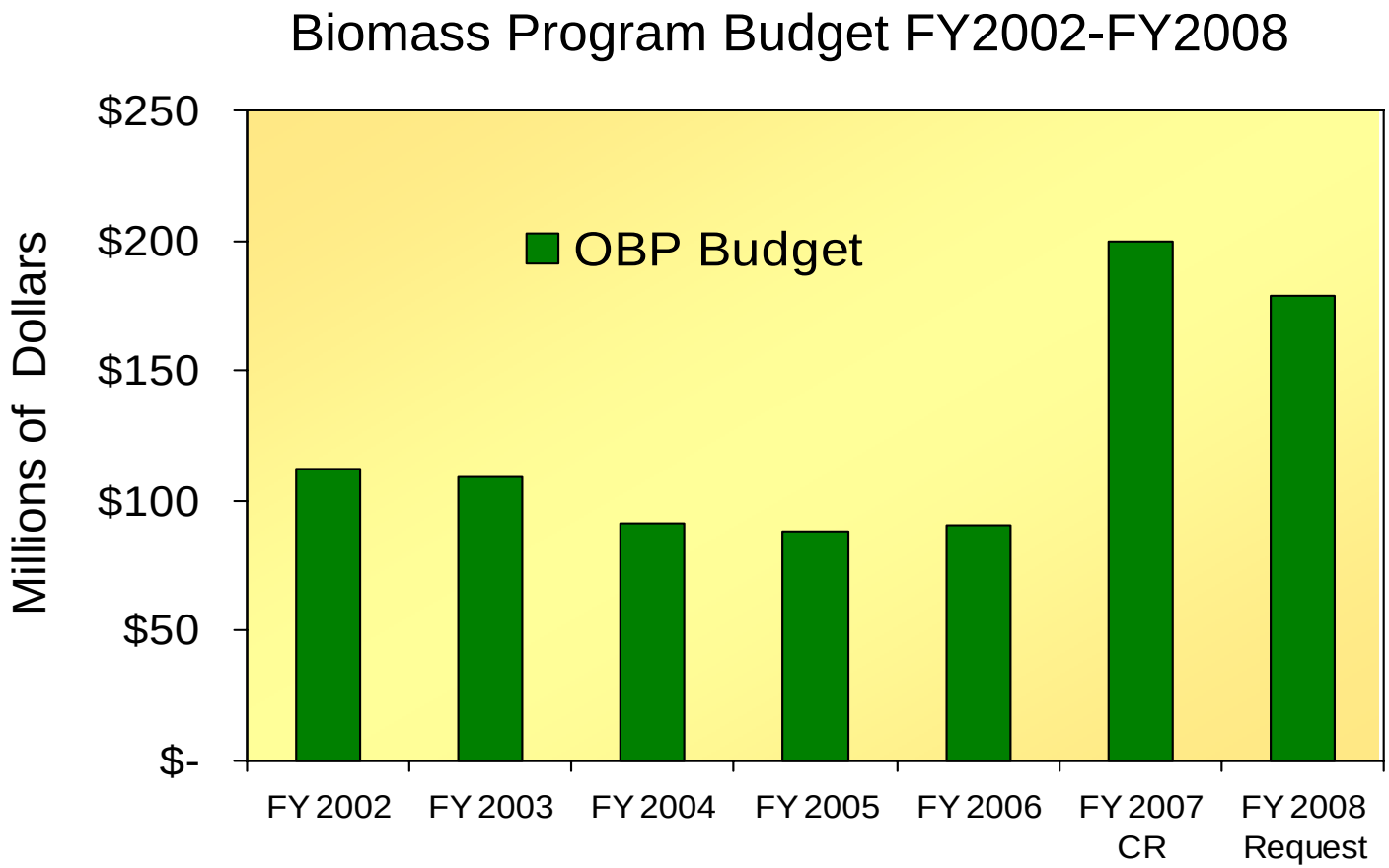
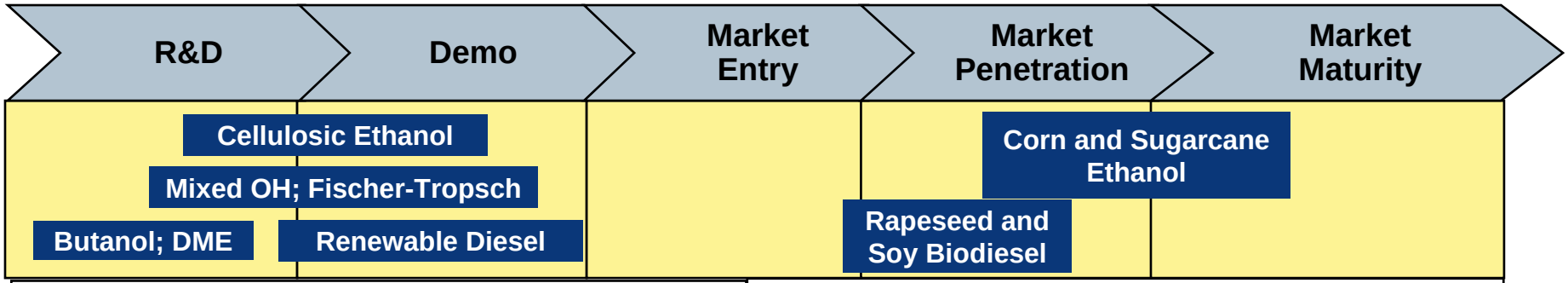


The Advanced Energy Initiative is providing a boost in funding for critical biomass technologies in FY 2007.

"First generation" biofuels are commercially developed technologies, but have high costs and limited scalability…

Energy Efficiency & Renewable Energy



2nd Generation Biofuels

- **R&D efforts are focused on**:
  - Increasing the range of feedstock from which to produce biofuels
  - Reducing biomass-to-liquid conversion costs
- **Two main technology platforms in development:**
  - *Biochemical pathway*: conversion of the cellulose to sugars and fermentation to alcohol fuels
  - *Thermochemical pathway*: gasification of biomass to syngas and synthesis to fuels
- **Commercial renewable diesel plants are under construction (e.g., Neste oil "NexBTL")**

1st Generation Biofuels

- ***Ethanol*** is a clean burning, high-octane alcohol fuel used as a replacement and extender for gasoline
  - Has been commercially produced since the 70s in the US and Brazil, still the market leaders
  - Corn ethanol is cost competitive (with no subsidies) with gasoline when crude oil is above $50/barrel ($30/brl from sugar cane)
- ***Biodiesel*** is a high-cetane, sulfur-free alternative to (or extender of) diesel fuel and heating oil
  - Commercialized in Europe in the 90's
  - Worst economics (and smaller market) than ethanol

Source: Navigant

Second generation" technologies aim to resolve these limitations

Future efforts will address obstacles to both biochemical and thermochemical routes to biofuels, support demonstrations, and resolve infrastructure issues.

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Barriers	Solutions
• High cost of ***enzymatic conversion***	• Continue R&D to ***improve the effectiveness and*** reduce the costs of enzymatic conversion (*this ties pretreatment to conversion)*
• Inadequate technology for ethanol ***production from mixed sugars derived*** from lignocellulosics	• Fund R&D on advanced fermentation micro-organisms (ethanologens)
• Technical constraints on thermochemical conversion processes	• Re-establish thermochemical conversion (gasification, pyrolysis) as a second path to success
• Demonstration/deployment of technology in integrated biorefineries	• Fund loan guarantees, sec. 932 biorefinery demonstrations, and 10% scale validation projects
• Inadequate distribution infrastructure for expanding markets	• Use interagency team to coordinate activities; form Regional Feedstock Partnerships

The expertise of the national laboratories and cutting-edge industrial partners is helping to solve major challenges to domestic biofuels.

Biomass R&D Board coordinates interagency efforts to achieve the President's biofuels goals.

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- Members elevated to Senate confirmed Presidential appointees
- Committed to monthly meetings
  - First meeting held on May 10
- Consensus to support the biofuels portion of the President's 20 in 10 as the Board goal
- Expanded membership to include USDA and DOE Science Offices (12 members)
- Develop Action Plan for the Biofuels and Bioproducts Economy by the fall 2007
  - National Biofuels Action Plan Workshop Summary Report as input
    - Inventories current federal biofuels activities and investments, IDs gaps and opportunities for cooperation

Members

- **USDA** — *co-chairs*
- **DOE** — *co-chairs*
- NSF
- EPA
- Interior
- Office of Science & Technology Policy
- Office of the Federal Environmental Executive
- DOT
- Commerce — *new members*
- Treasury — *new members*

The existing Biomass R&D Board provides a framework for continued interagency collaboration, and collaborative biofuels planning efforts.

Summary of Agency Activities from Planning Meeting*

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	DOE	USDA	DOI	DOC	EPA	NSF	DOD	DOT
Feedstock Production	• Genome Rsrch (NSF, SC) • Regional Partnerships (USDA) • Bioenergy Rsrch Ctrs.	• Genome Rsrch (NSF, DOE) • Regional Partnerships (DOE), Rgnl Inventory • Crop Mgmt, Viability • Lignocell. (ARS)	• Natural Resource Cnsrv. • Woody Biomass • Inventory		• Biomass Tech. Database • Urban Biofuel Init. • LCA (ORD)	• Genome Research (DOE, USDA)		• Crop Production & Sustainability (RITA)
Feedstock Logistics	• Feedstock Platform • Biofuels Infrastructure (EE) • F.S. Flexibility (SC)	• Harvest & handling • Integrated Feedstock Supply (ARS) • Wood to Energy (FS)	• Woody Biomass		• LCA • Waste to Energy (ORD)		• MSW & waste biomass pre-processing & handling	
Biochemical Production	• Biochemical • Products • Integrated Biorefinery • GTL (SC)	• Enzymes & inhibitors • Biocatalysts (ARS) • Biomass R&D Init (ORD) • Bioenergy (FSA)				• Immobilized Enzymes & conversion • Inorganic catalysts via hydrolysis		

•Shaded cells indicate area of agency research focus; level of effort or investment varies by agency.
**Table is a draft information summary.*

The Plan will map agencies' biomass activities and identify effective interactions.

Energy Efficiency & Renewable Energy

	DOE	USDA	DOI	DOC	EPA	NSF	DOD	DOT
Thermochemical Production	• Bio-oil reforming (EE)	• Ag residue gasification (CSREES) • Biorefinery (FS) • Waste conv. • Pyrolysis (ARS)		• Thermoch em. Fuels (NIST)	• Gasification • Bio-oil reforming • Biodiesel Emissions • Waste to Energy (ORD)	• Biomass Pyrolysis • Biomass Catalysis	• Wastewater Sludge Biodiesel, gasification	
Distribution	• Biofuels Infrastructure (OBP)			• Pipeline Infra-structure (NIST)	• E85 Infrastructure Analysis		• B20, E85 Fuel for govt	• E85 Infra-structure (RITA)
End Use	• Biofuels Infrastructure • Fuel Specs • Engine Optimization • Clean Cities (EE)	• Alt Fuels & Fleet Efficiency		• Fuel Quality & Standards (NIST)	• Air Permitting (ORD) • RFS (OAR) • Clean Diesel • Fuel Quality (OAR)		• Biodiesel Emissions Testing • Tactical Vehicles • Procurement	
Communications	• Commun-ications Plan • Clean Cities Outreach (EE)	• Biodiesel Board campaign • Farmer land, rsrce mgmt (DOI)	• via Cnsrv Districts & public • Farmer land, rsrce mgmt (USDA)	• Mfg & Svcs Energy Team • Economic Impact Analysis • Comm.eth anol	• Biodiesel Fed. Users Guide • Biomass Conv. Tech. Matrix (ORD)	• Bioroducts mfg & policy • K-12 curriculum • K-12 & adult informal education		

DOE Office of Science: Complementary Basic Research on Biomass

Energy Efficiency & Renewable Energy

- Fundamental research is critical to ensuring the development of cost competitive cellulosic ethanol and other biofuels from a variety of feedstocks
- Up to $375 million to fund three Bioenergy Research Centers to accelerate basic research on the development of cellulosic ethanol and other biofuels

•On June 26, Secretary Bodman announced selections

–Oak Ridge National Laboratory

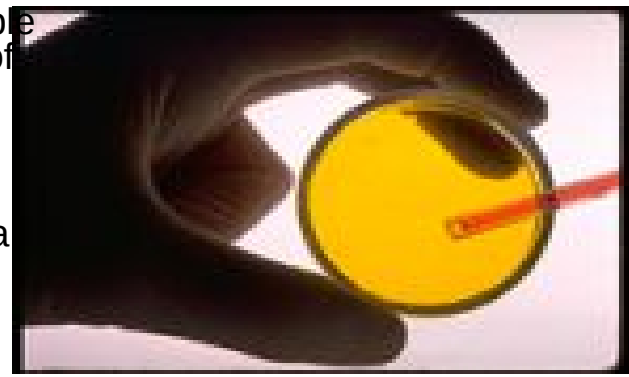
•Partners: Georgia Institute of Technology; National Renewable Energy Laboratory; University of Georgia; and the University of Tennessee

–University of Wisconsin

•Partners: Michigan State University; Pacific Northwest National Laboratory; Lucigen Corporation; University of Florida Oak Ridge National Laboratory; Illinois State University; and Iowa State University

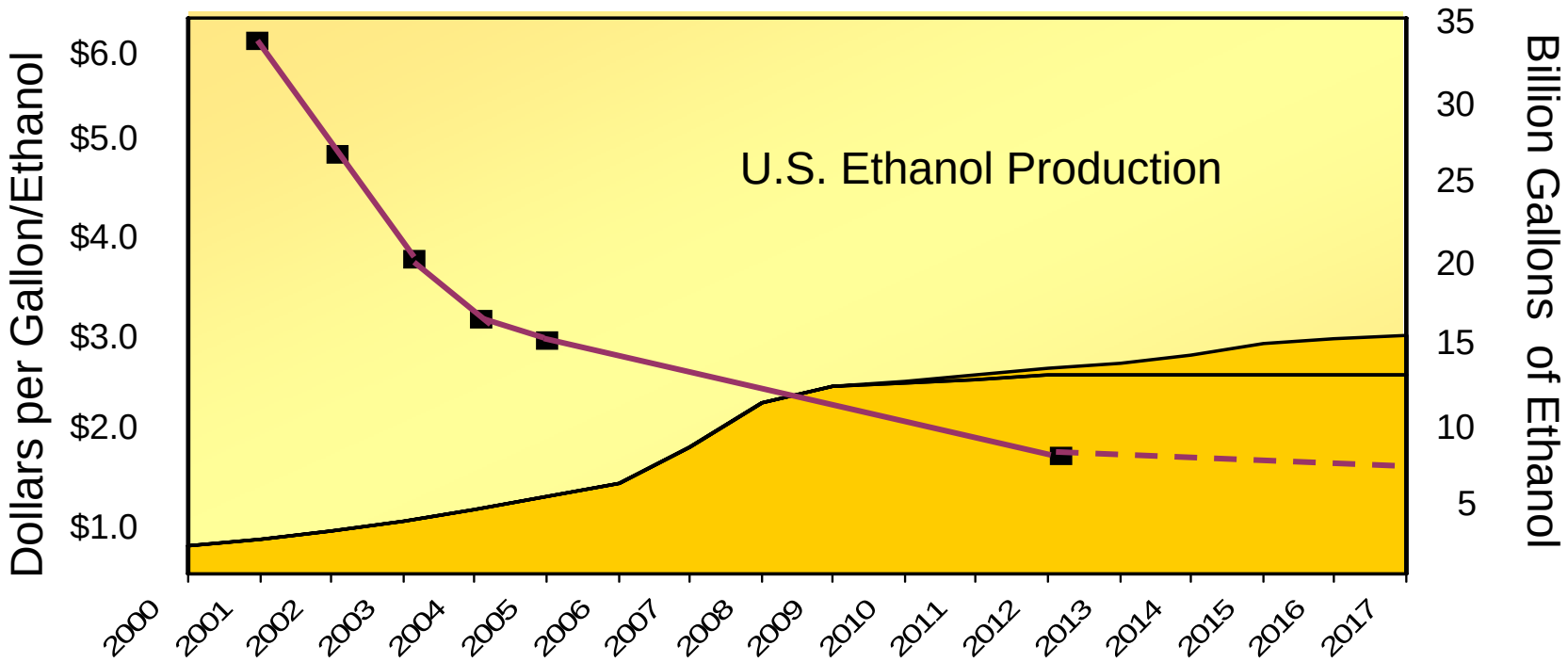
–Lawrence Berkeley National Laboratory

•Sandia National Laboratories; Lawrence Livermore National Laboratory; University of California - Berkeley; University of California - Davis; and Stanford University



Projected Cost of US Cellulosic Ethanol

Energy Efficiency & Renewable Energy



OBP RD&D Activities & Timeline

Biorefinery Demos

10% Scale Validation

Pre-Validation Integrated Biorefineries

IBRF

Commercial Ethanologen

1st Generation Feedstock, Biochemical, Thermochemical Core R&D

Adv. Feedstocks & Conversion Technology R&D

Supporting Materials

Policy Drivers & Incentives Supporting Biofuels

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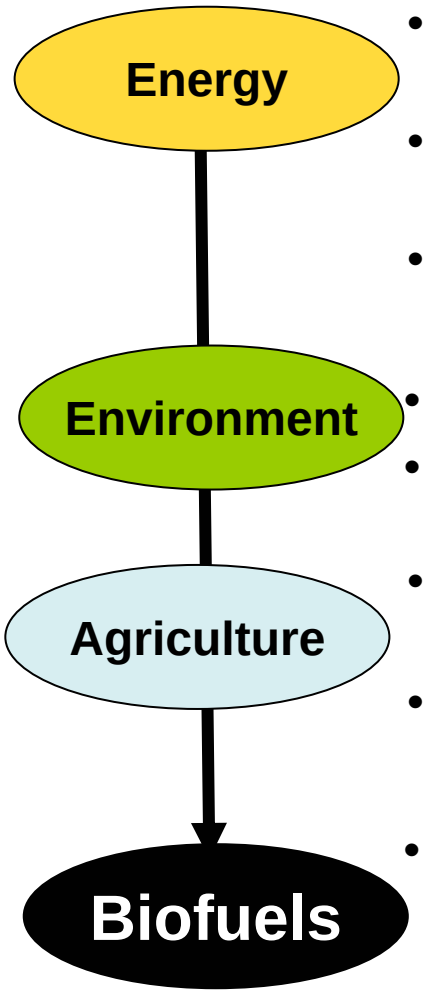

- Energy Security/ Political Tensions
- Resource Diversification
- Petroleum Prices/Volatility
- Climate Change
- Air Pollution
- Economic Development
- Farm Income
- **Ethanol is currently the most prevalent US biofuel**

Examples of Policies

United States

- Energy Policy Act of 2005 (federal policy)
- State tax credits, blend requirements…

Europe

- Tax credits: most common incentive
- EU set target for biofuels consumption (similar to RFS, but not a mandate)

Asia

- China, India, and Malaysia introducing policies to support biofuels
- Japan has tax credits in place

South America

–Brazil: Ethanol blending requirements in place and a requirement for biodiesel starting in 2008

Source: Navigant

Biofuels require a comprehensive & effective policy framework

Policies Accelerating Biofuels Production

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Energy Policy Act 2005 (EPAct 2005)

- Section 932: **Commercial Integrated Biorefinery**
  - Secretary Bodman recently announced six awards
  - $53 million in FY 2007 budget request
- Section 941: **Revisions to Biomass R&D Act of 2000**
  - *Vision* document released November 2006; updated *Roadmap* due May 2007
- Section 942: **Cellulosic Ethanol Reverse Auction**
  - Request For Information and Options papers completed
  - $5 million requested for FY 2008
- Sections 1510, 1511, and Title XVII: **Loan Guarantees**
  - DOE issued guidelines for the first Loan Guarantees under Title XVII in August 2006
  - Loans for conversion of Municipal Solid Waste and cellulosic biomass to fuel ethanol and other commercial byproducts also considered under this offering

EPAct 2005 goals are integrated into core technology priorities.

Section 932, Biorefinery grants

Energy Efficiency & Renewable Energy

Recently announced competitive selections providing up to $385 million over four years for cost-shared integrated biorefineries in six states

- **Abengoa Bioenergy Biomass of Kansas**
  - Capacity to produce 11.4 million gallons of ethanol annually using ~700 tons per day of corn stover, wheat straw, milo stubble, switchgrass, and other feedstocks
- **ALICO, Inc.**
  - Capacity to produce 13.9 million gallons of ethanol annually using ~770 tons per day of yard, wood, and vegetative wastes and eventually energy cane
- **BlueFire Ethanol, Inc.**
  - Sited on an existing landfill, with capacity to produce 19 million gallons of ethanol annually using ~700 tons per day of sorted green waste and wood waste from landfills
- **Broin Companies**
  - Capacity to produce 125 million gallons of ethanol annually (~25 percent will be cellulosic ethanol) using ~850 tons per day of corn fiber, cobs, and stalks
- **Iogen Biorefinery Partners, LLC**
  - Capacity to produce 18 million gallons of ethanol annually using ~700 tons per day of agricultural residues including wheat straw, barley straw, corn stover, switchgrass, and rice straw
- **Range Fuels (formerly Kergy Inc.)**
  - Capacity to produce 40 million gallons of ethanol annually and 9 million gallons per year of methanol, using ~1,200 tons per day of wood residues and wood based energy crops

To meet these ambitious goals DOE is undertaking several steps to hasten the commercialization of cellulosic ethanol

Energy Efficiency & Renewable Energy

- Increased funding for Biomass Program
- 2005 Energy Policy Act (EPAct), Section 932 – Commercial scale Biorefineries --- $385 million
- 2005 EPAct, Section 942 – Production incentive for cellulosic biofuels
- $375 MM for three new Bioenergy Centers of Excellence
- 2005 EPAct, Title XVII, Loan Guarantee Program
- $200 MM Solicitation for 10% of commercial scale biorefineries
- $27 MM Solicitation for advanced ethanologens
- Tax credit for installation of E85 pumps
- Incentives to produce Flex-fuel vehicles via Corporate Average Fuel Economy standards