

# U.S. Department of Energy Biomass Program

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May 2008



# EISA 2007: New Targets & More

## New Renewable Fuel Standard

- Expand use of renewable fuels to 36 billion gallons annually by 2022
- Cellulosic biofuels component
  - 0.5 billion gallons by **2012**
  - 3 billion gallons by **2015**
  - 16 billion gallons by **2022**

## Longer-Term Goal (30 X 30)

- Displace 30% of US gasoline consumption by 2030 with biofuels (60 billion gallons)



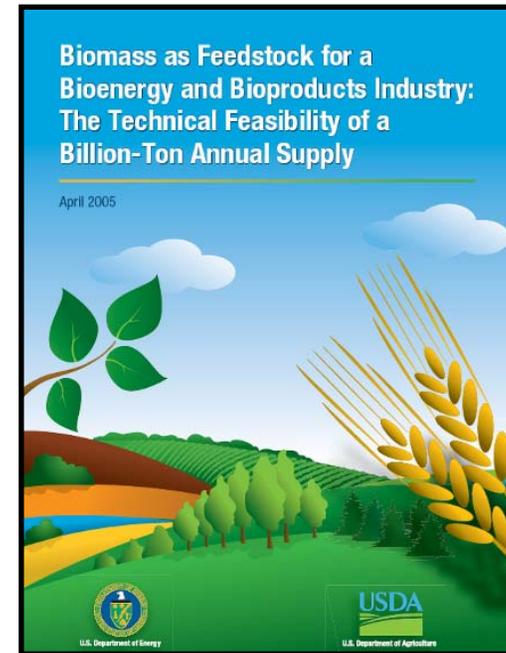
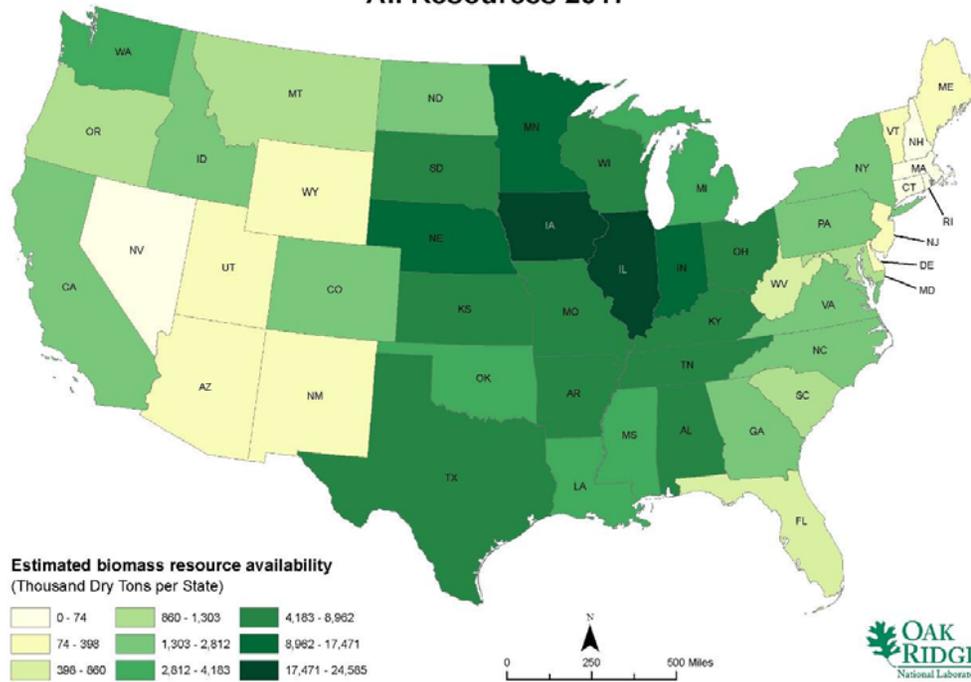
*Ramp-up of biofuel production will require innovative and focused policies for infrastructure and feedstocks*

# Biomass Resources Adequate to Meet RFS

Interim Update to the *Billion-Ton Vision Report*



All Resources 2017



By 2017, forest and cropland resources can yield 23-30 billion gallons of cellulosic biofuels



# DOE Biomass Program Mission

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

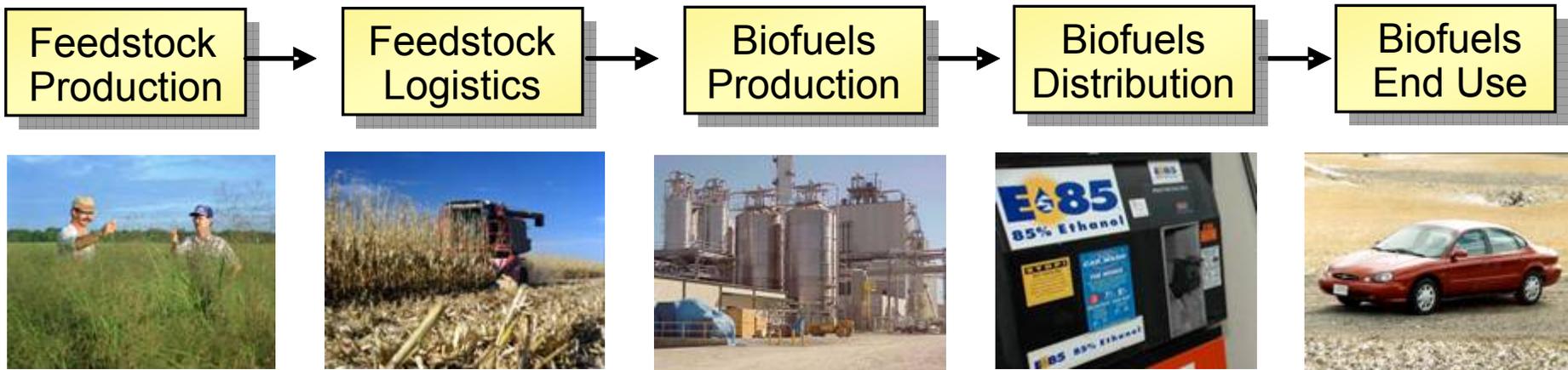
Focus on targeted research, development, and demonstration

- Support through public and private partnerships
- Deploy in integrated biorefineries



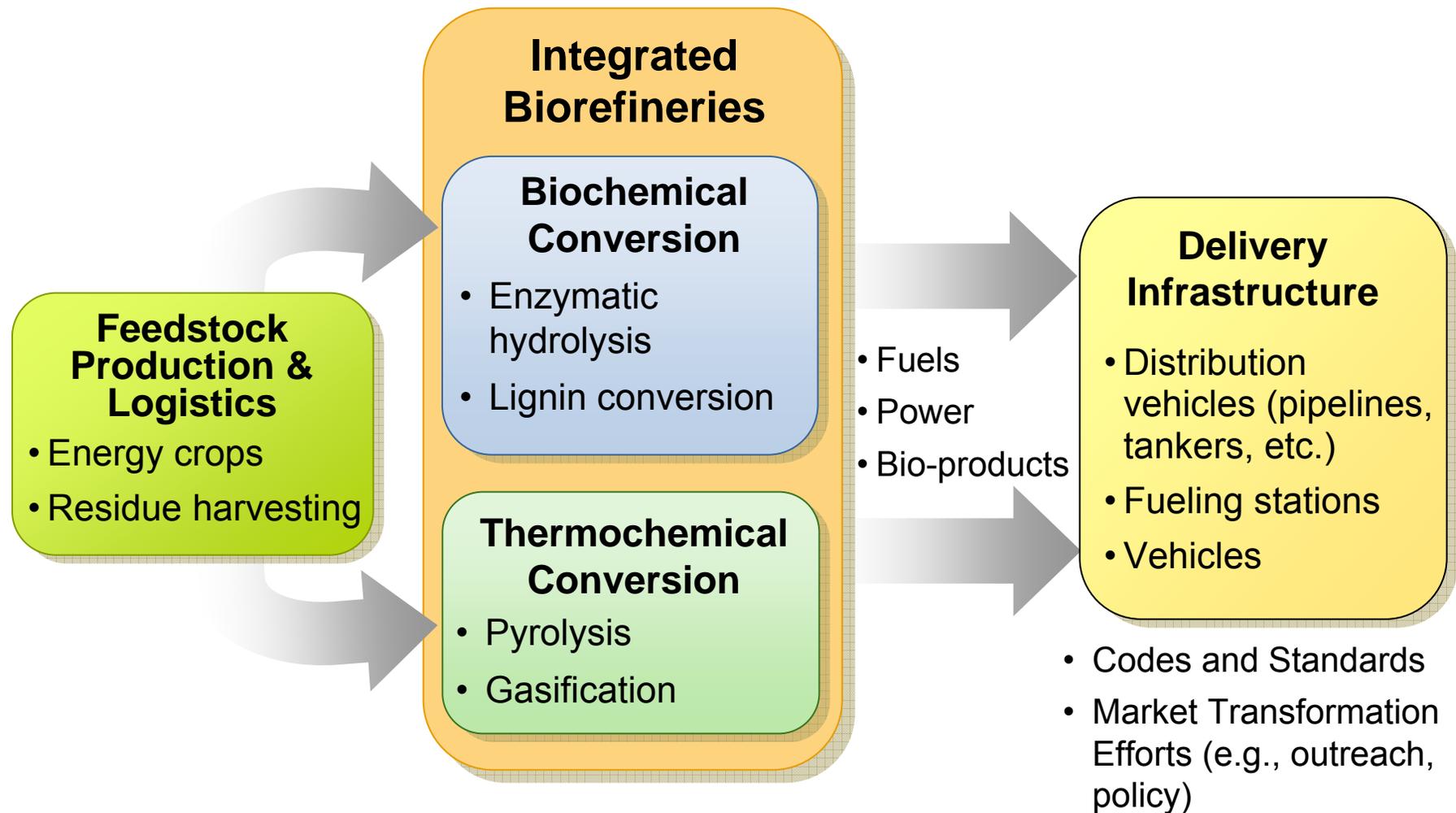


# Challenges Across Entire Supply Chain



- **Cellulosic Ethanol:** Primary focus of the program.
- **Alternative Light-Duty and Diesel Replacement Fuels:** A scoping study is underway to help prioritize future work on additional alternate fuels that require governmental support and can significantly contribute to achieving the President's goal.

# Two Major Paths to Convert Biomass Today



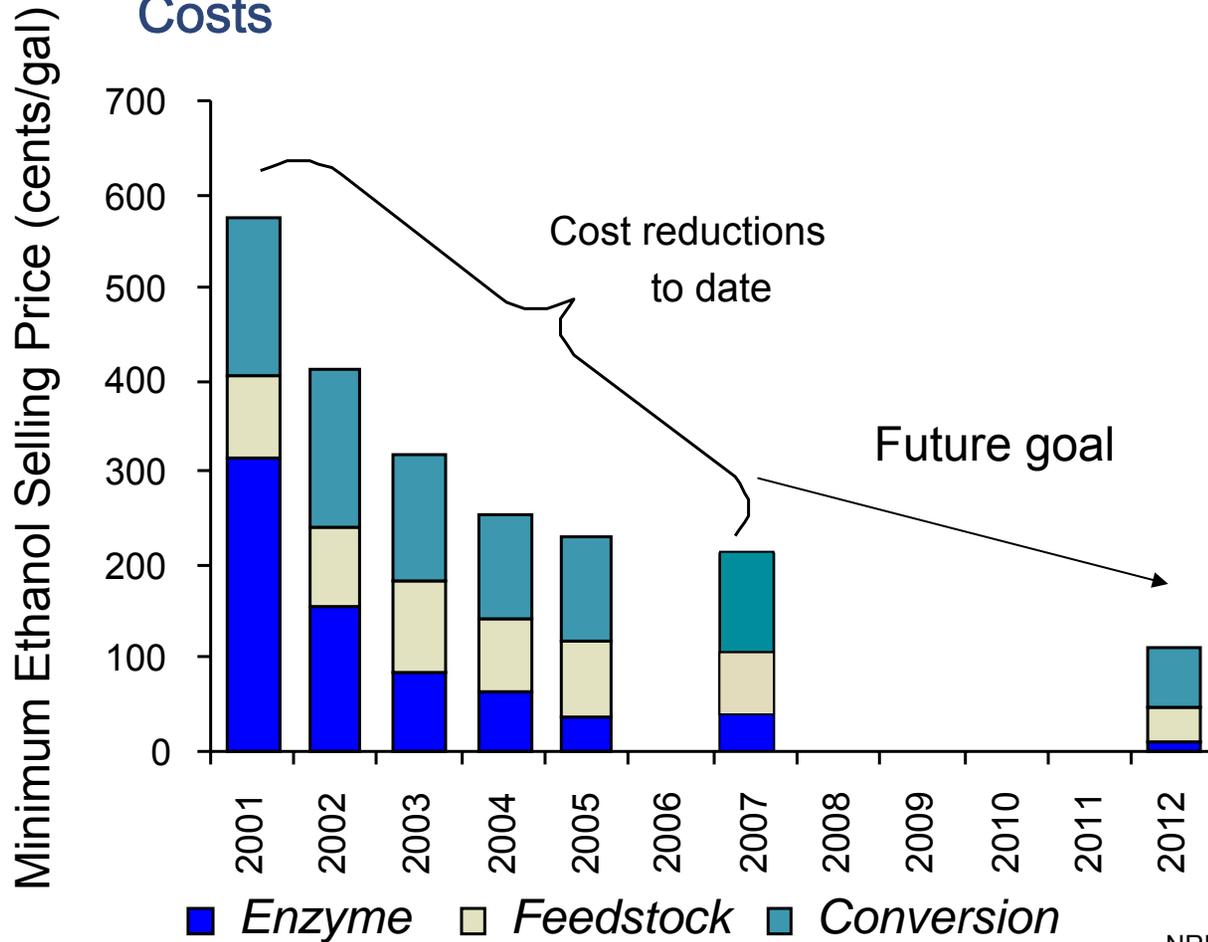
Success relies on simultaneous development of the supply, conversion, and demand infrastructures for cellulosic ethanol.

# Reducing Cost of Cellulosic Ethanol

Modeled Ethanol Cost for “nth Plant”



## Historical and Projected Cellulosic Ethanol Costs



*In order for biofuels to succeed in the US and world-wide, they must be both cost-competitive and sustainable.*

NREL Modeled Cost

**Cost-competitive in the blend market by 2012**



# Leveraging Partnerships to Achieve Goals



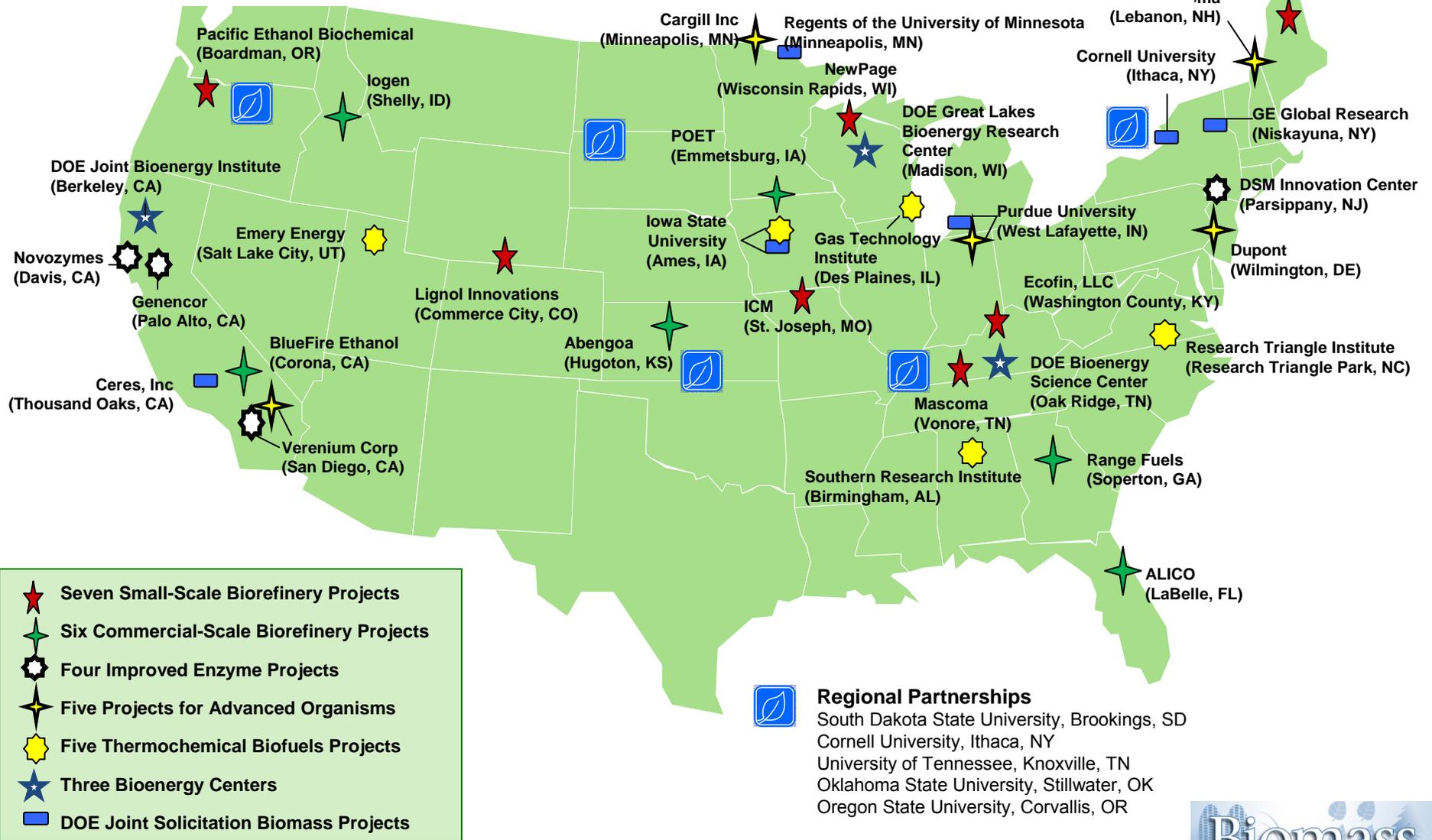
- **Commercial-Scale Biorefineries (up to \$385 million)**
  - Six cost-shared, integrated biorefinery demonstration projects to produce 130 million gallons of cellulosic ethanol in 5 years using variety of conversion technologies and cellulosic feedstocks
- **10%-Scale Biorefinery Validation (up to \$200 million)**
  - Seven cost-shared, integrated biorefinery demonstrations using cellulosic feedstocks to produce renewable fuels; one-tenth of commercial scale
- **Ethanologen Solicitation (up to \$23 million)**
  - Five selected research teams working on microorganisms
- **Enzyme Solicitation (up to \$33.8 million)**
  - Creating highly effective, inexpensive enzyme systems for commercial biomass hydrolysis; second phase: cellulase development with cost-sharing industry partners
- **Thermochemical Conversion (up to \$7.75 million)**
  - Integration of gasification and catalyst development
- **Joint DOE-USDA Solicitation (\$18 million)**
  - Biomass R&D Initiative: 20 awards announced March 2008



# Major DOE Biofuels Project Locations



## Geographic, Feedstock, and Technology Diversity



# Intermediate Blends Testing: An Alternative Approach to Market Penetration



- E10 market will be saturated within a few years – once ethanol supply reaches 13-14 billion gallons.
- DOE and EPA working together to assess feasibility of intermediate blends in allowing greater penetration of ethanol as part of fulfilling new RFS
- DOE studying intermediate ethanol blends (allocated \$2.1 million in FY07 and \$12.5 million in FY08).
- The DOE test program is evaluating --
  - Vehicle exhaust and evaporative emissions
  - Catalyst durability and aging
  - Cold-start operation and drivability
  - Fuel-system and catalyst materials compatibility
- DOE is also evaluating impacts of higher ethanol blends on small engines
  - Currently testing leaf blowers, line trimmers, pressure washers, and small generator sets
  - Launching expanded test plan for marine engines, all-terrain vehicles, and motorcycles in summer 2008 with input from industry.

Production is Not Enough -- Need Market Penetration



# Our Commitment to Sustainability

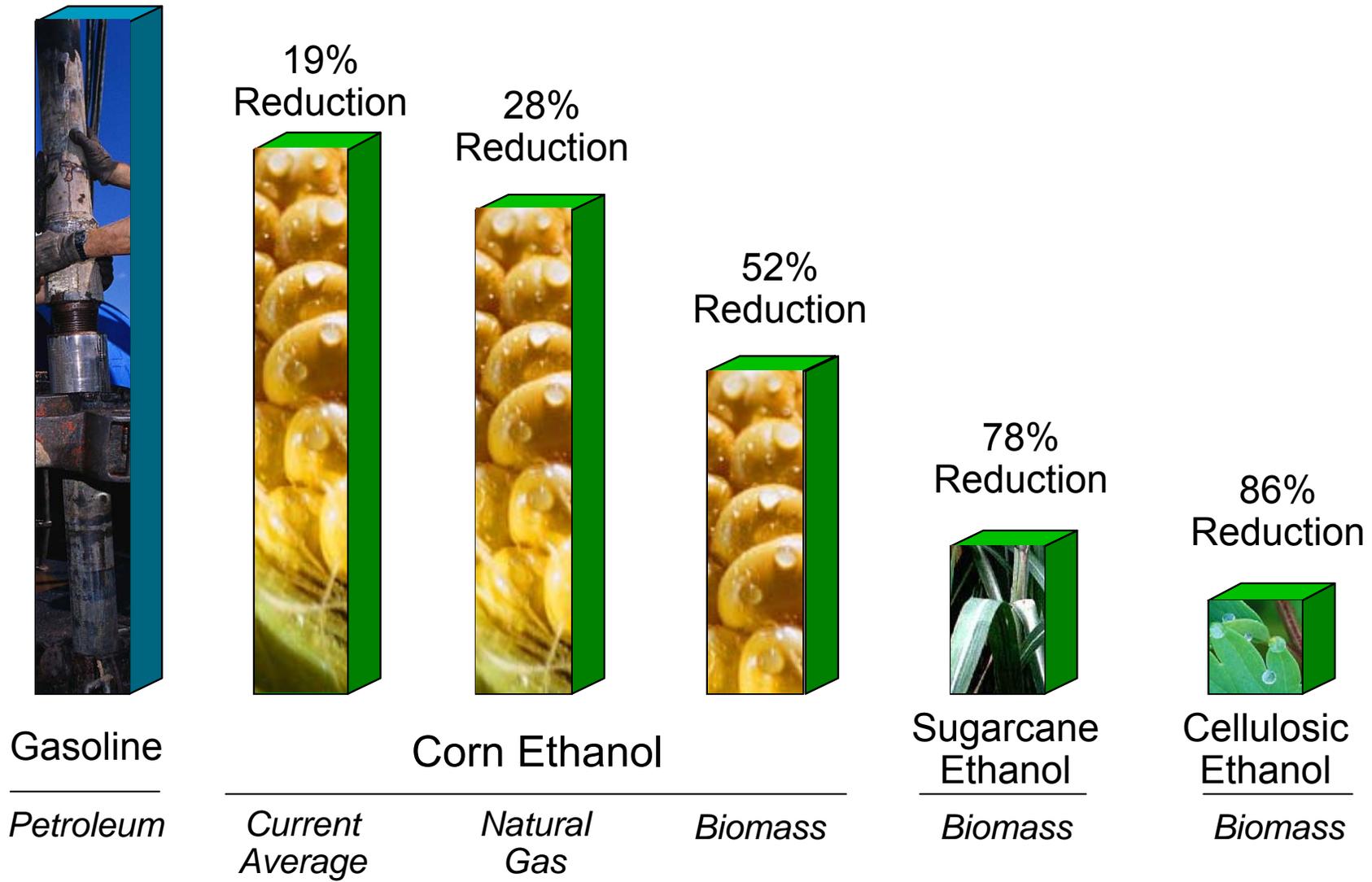


EERE is committed to developing the resources, technologies, and systems needed for biofuels to grow in a way that enhances the health of our environment and protects our planet. To that end, we are working to...

- Develop diverse, non-food feedstocks (e.g., switchgrass, sorghum) that require little water or fertilizer
- Foster sustainable forestry practices (e.g., advanced harvesting techniques) to enhance forest health
- Selectively harvest biomass components while leaving adequate soil nutrients
- Assess life-cycle impacts of major scale-up in biofuels production, from feedstocks to vehicles, addressing:
  - land use and soil health
  - water use
  - air quality issues
  - impacts on greenhouse gas (GHG) emissions



# Lifecycle Greenhouse Gas Emissions Associated with Different Fuels



Sources: Wang et al, *Environ. Research Letters*, May 2007; Wang et al, *Life-Cycle Energy Use and GHG Implications of Brazilian Sugarcane Ethanol Simulated with GREET Model*, Dec. 2007.



# DOE Current Work on Sustainability



- **Biodiversity (\$1.1 million)**

Working with Conservation International to conduct pilot studies to identify best land to locate biofuel crops worldwide while preserving biodiversity

- **Climate Change (\$675k)**

NREL is conducting a life cycle assessment of replacing 30 percent of gasoline use in the U.S. with biofuels by 2030

- **Indirect Land Use (\$200k)**

Argonne National Laboratory and Purdue University are refining models that can analytically address international land use change issues due to increasing growth of biofuels

- **Feedstock Production (\$6.5 million)**

Conducting in-field studies to determine best location for energy crops in collaboration with USDA, the Sun Grant Initiative universities, and other regional partners (\$6.5 million)

- **Water (\$250 k)**

Argonne and NREL are conducting LCA of water demand for biofuels production over the lifecycle in comparison to corn ethanol, sugar cane ethanol, and competing petroleum fuels (\$250K)

- **National Bioenergy GIS (\$1.5 million)**

ORNL, ANL, INL, UC-Davis and others are developing a national scale GIS-based framework to assist in the analyzing the economic and environmental impacts of feedstock, biorefinery, and infrastructure development options.



# Some Facts about Ethanol...

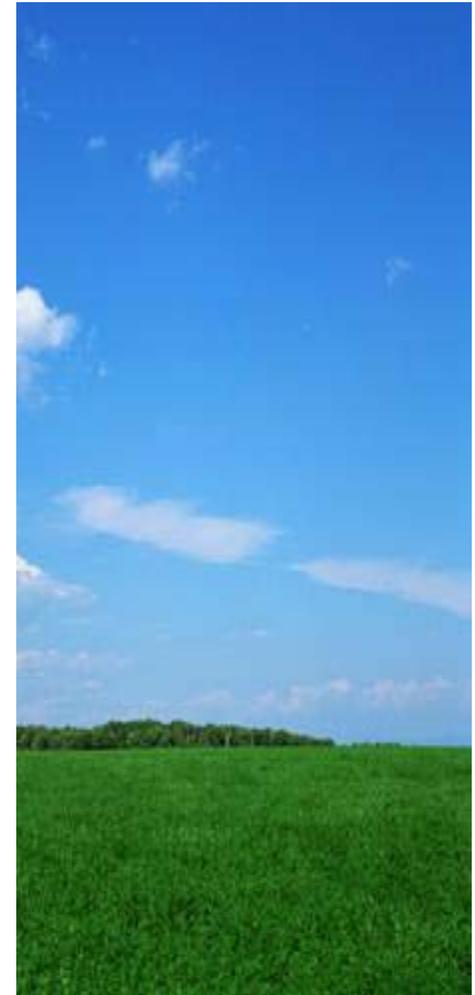


- Gas prices would be significantly higher without ethanol in the market.
  - Merrill Lynch “15% reduction”
- Increases in ethanol production are not driving food shortages and prices increases in the market today.
  - High oil prices
  - Increasing demand from developing economies
  - Speculative fund activities
  - Drought in key producing areas
  - Asian industrialization and urbanization encroaching on farm land
- Ethanol is helping reduce our nation’s dependence on foreign oil and improve our trade balance.
  - In 2007, the U.S. imported 65% of its crude oil supplies at a cost of more than \$333 billion, accounting for more than 45% of the record trade deficit.
  - In 2007, U.S. production of 6.5 billion gallons of ethanol helped to reduce foreign petroleum imports by 4.3 billion gallons and reduce the U.S. trade deficit by \$9 billion.

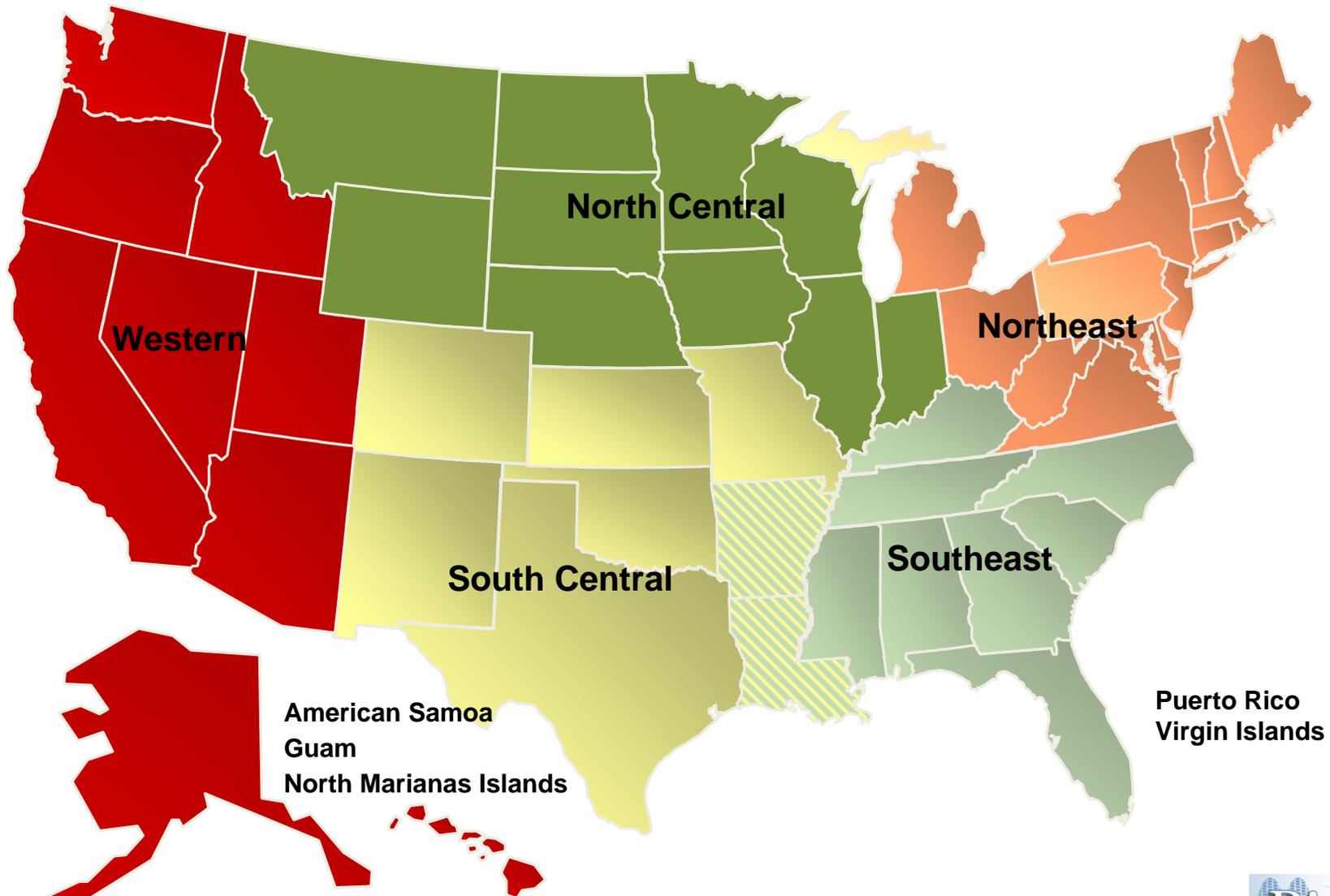
# We Need Balanced Analysis, Constructive Dialogue, and Smart Policies



- DOE and the recently passed *Energy Independence and Security Act of 2007* call for sustainable biofuels.
  - EISA requires GHG reductions and periodic reevaluation.
- The US can encourage land use policies that restrict development of ecologically sensitive lands.
- DOE and the State Department are working to address global sustainability issues with international partners, including environmental organizations, industry, and others.
  - Sustainability requires careful assessment of all impacts on water, land use, GHG, fertilizer use, and socio-economic issues.
  - Global standards for sustainable development, if well crafted, could promote adherence to best practices in developing biofuels industries.



# Regional Feedstock Partnership/Sun Grant Initiative Regions



For more information: <http://www.sungrant.org/Feedstock+Partnerships/>





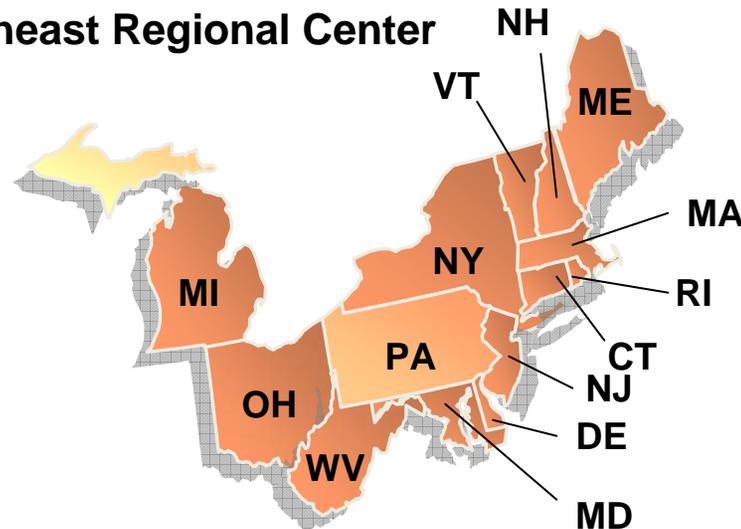
# Metropolitan DC Area

## CORNELL UNIVERSITY - Northeast Regional Center

<http://www.nesungrant.cornell.edu>  
(607) 255-5544

Larry P. Walker  
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[cfj4@cornell.edu](mailto:cfj4@cornell.edu)



## UNIVERSITY OF TENNESSEE – Southeast Regional Center

<http://sungrant.tennessee.edu>  
(865) 946-1130

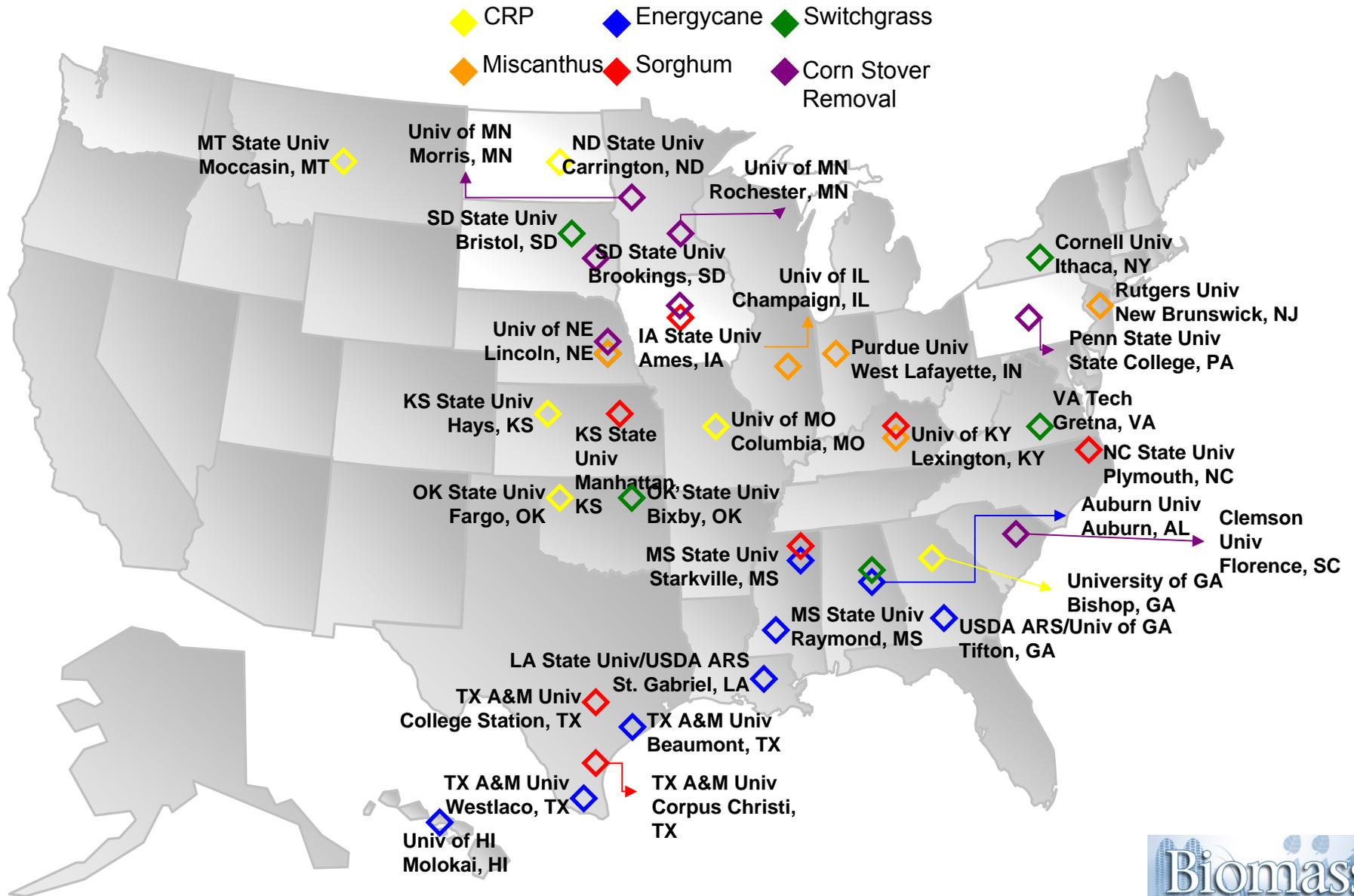
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# Regional Biomass Energy Feedstock Partnership 2008 Bioenergy Crop Trials (38)





# Information Resources

- Office of Biomass Program
- Tel: 202-586-5188.
- Web Site: <http://www1.eere.energy.gov/biomass/>
- EERE Info Center - [www1.eere.energy.gov/informationcenter](http://www1.eere.energy.gov/informationcenter)
- Alternative Fuels Data Center - <http://www.eere.energy.gov/afdc/fuels/ethanol.html>
- Bioenergy Feedstock Information Network - <http://bioenergy.ornl.gov/>
- Biomass R&D Initiative – [www.biomass.govtools.us](http://www.biomass.govtools.us)
- Grant Solicitations - [www.grants.gov](http://www.grants.gov)
- Office of Science - <http://www.er.doe.gov/>

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# EXTRA BEYOND HERE

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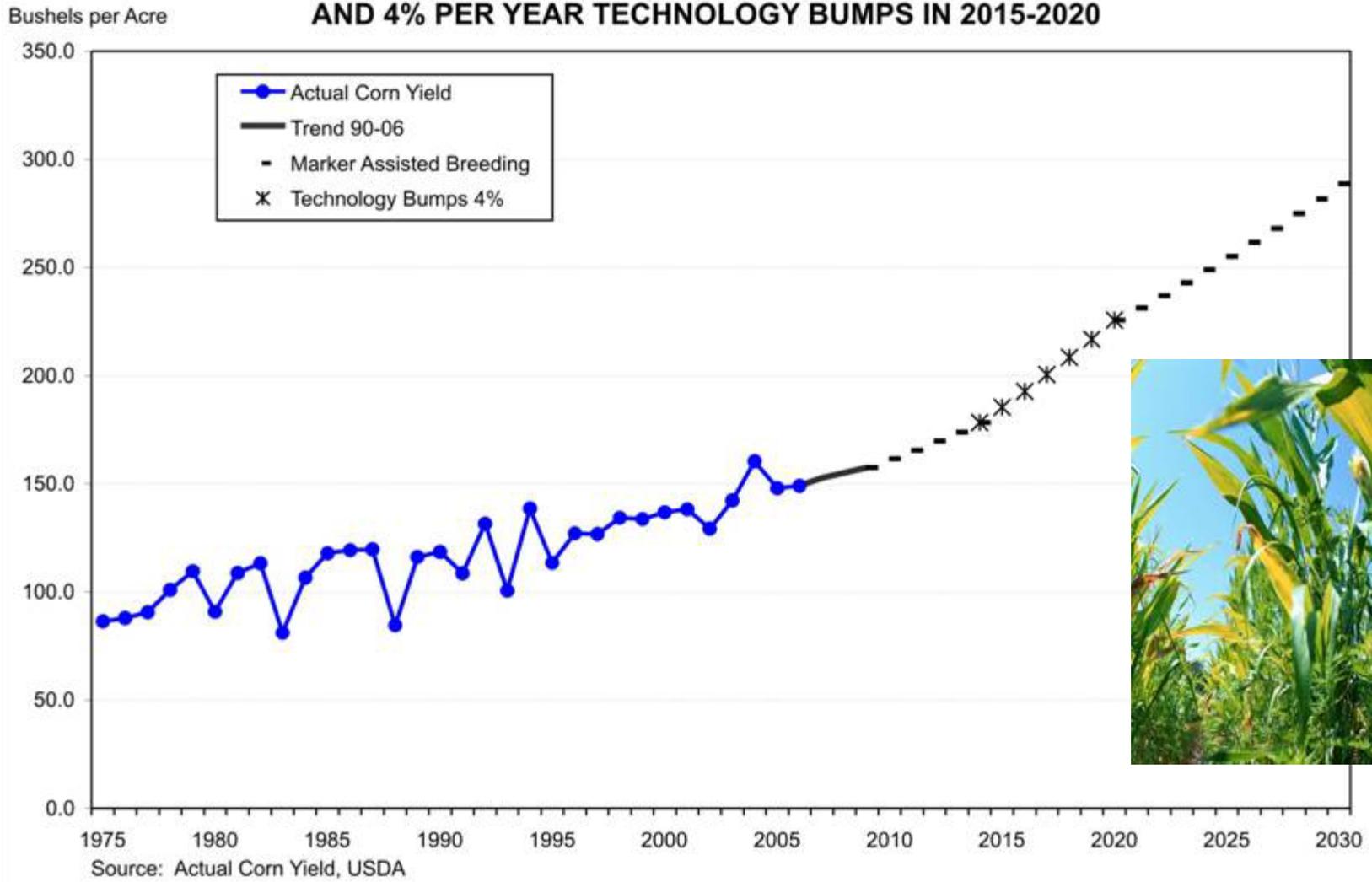


Biomass

# Corn yield improvements minimize land use impact of corn-based ethanol



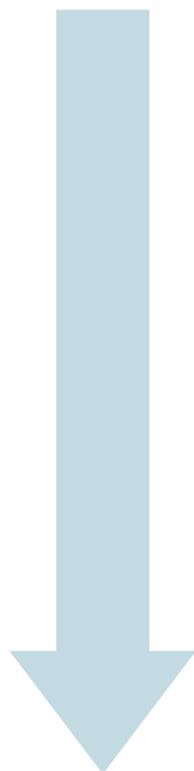
**AVERAGE CORN YIELDS WITH MARKER ASSISTED BREEDING  
AND 4% PER YEAR TECHNOLOGY BUMPS IN 2015-2020**



# Biofuels Beyond Ethanol



**Today**



**Future**

**Ethanol** – as a blending agent from either grain or cellulosic material from Ag and/or Forestry industry

**Biodiesel** – Transesterified vegetable oils blended with diesel

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**Green Diesel** – fats, algal oils, waste oils, or virgin oils converted to low-sulfur diesel in petroleum refinery

**Higher alcohols** – examples include: butanol, mixed alcohols, higher carbon alcohols (C5- and greater)

**Fischer-Tropsch Liquids** – and other products from syn gas including methanol, dimethyl ether, etc

**Pyrolysis Liquids** – alternative feedstock to petroleum refinery or gasification facility

**Methanol derived fuels** – Methanol to gasoline technology, dimethyl ether and other products

**Other fuels** – Liquid transportation fuels from sugars/oils refinery not discussed or yet envisioned



## Interagency Effort

- Multi-agency effort to coordinate and accelerate all Federal biobased fuel and products research and development
- Mandated under the Biomass Research & Development Act of 2000, further revised by Energy Policy Act of 2005 (Sec 937)
- BRDI coordinating bodies
  - Biomass R&D Board, a cabinet-level council co-chaired by DOE and USDA (also includes **DOI, DOT, EPA, DOC, DOD, NSF, Treasury, OFEE, OSTP, OMB**), will complete a draft National Biofuels Action Plan by Spring 2008.
  - Biomass R&D Technical Advisory Committee – 30 senior individuals from industry, academia, state government



# Roadblocks for Biofuels & Biomass



## Market Barriers

- Lack of cellulosic feedstock market
- High capital costs for cellulosic ethanol production facilities
- Fragmented, inefficient supply chain
- Inadequate feedstock, distribution and end use infrastructure

## Technical Barriers

- High cost of cellulosic feedstock collection
- High cost of enzymes and organisms
- Thermochemical pathways not optimized for biofuel production
- Validation of fully integrated large scale systems

## Steps Taken

- EISA helps establish a market demand for cellulosic biofuels
- Cost-shared commercial and pilot scale biorefinery projects reduce costs in initial projects and will jump-start industry expansion by validating approaches
- R&D projects target cost reductions in enzyme production, processing techniques, and other costly components in supply chain

## Additional Policy Options

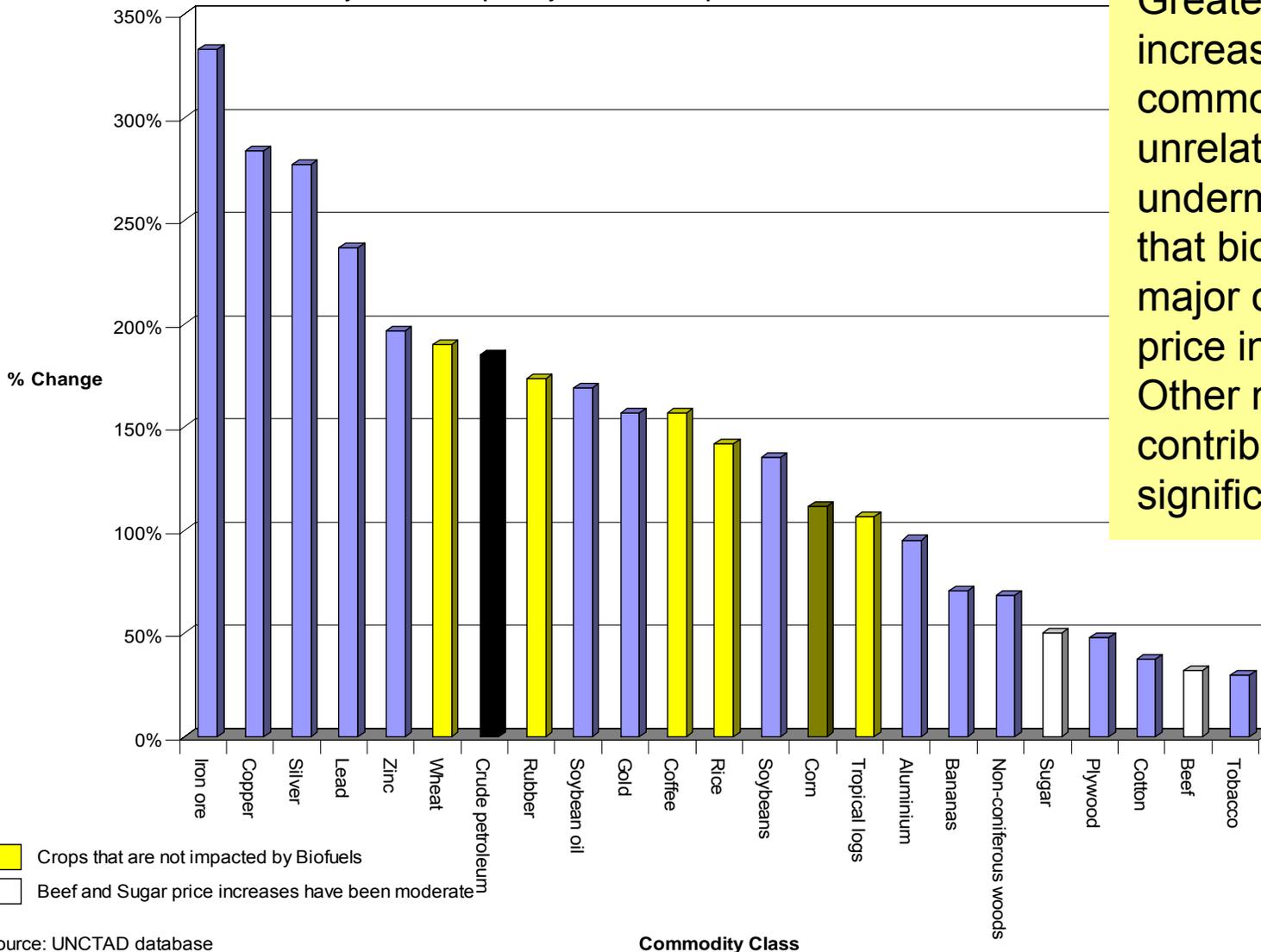
- Create incentives for cellulosic biomass suppliers
- Expand loan guarantee program for biofuel facilities to biofuels infrastructure
- Remove barriers to E10 nationwide, e.g. specs, logistics
- Enable blends between E10 and E85
- Address E85 incentives and barriers
- Target full FFV fleet penetration
- Develop Infrastructure codes and standards

# Corn Price Increases < Increases in Many Other Commodity Prices



**Commodity Price Trend 2003-2008**

All Commodity Classes are up - Many non-biofuel Crops have increased far more than corn



Greater price increases in commodities unrelated to biofuels undermine the claim that biofuels are the major cause of corn price increases. Other market factors contribute more significantly to price.

Source: UNCTAD database

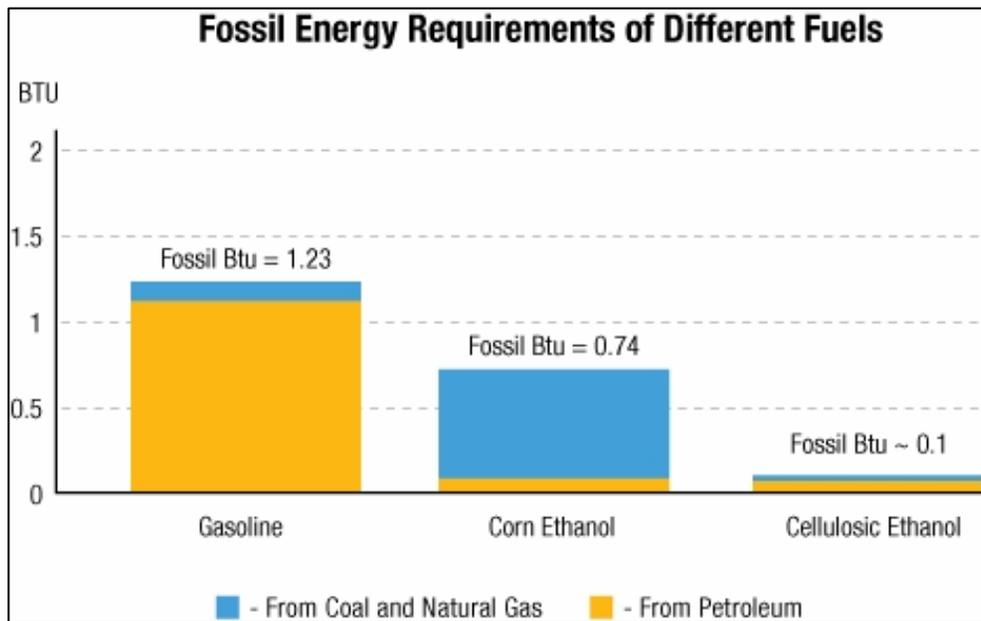


# Energy Balance



**Myth:** More energy goes into producing ethanol than it delivers as a fuel.

**Fact:** Each gallon of corn ethanol today delivers about one-third more energy than the amount of fossil energy used to produce it.



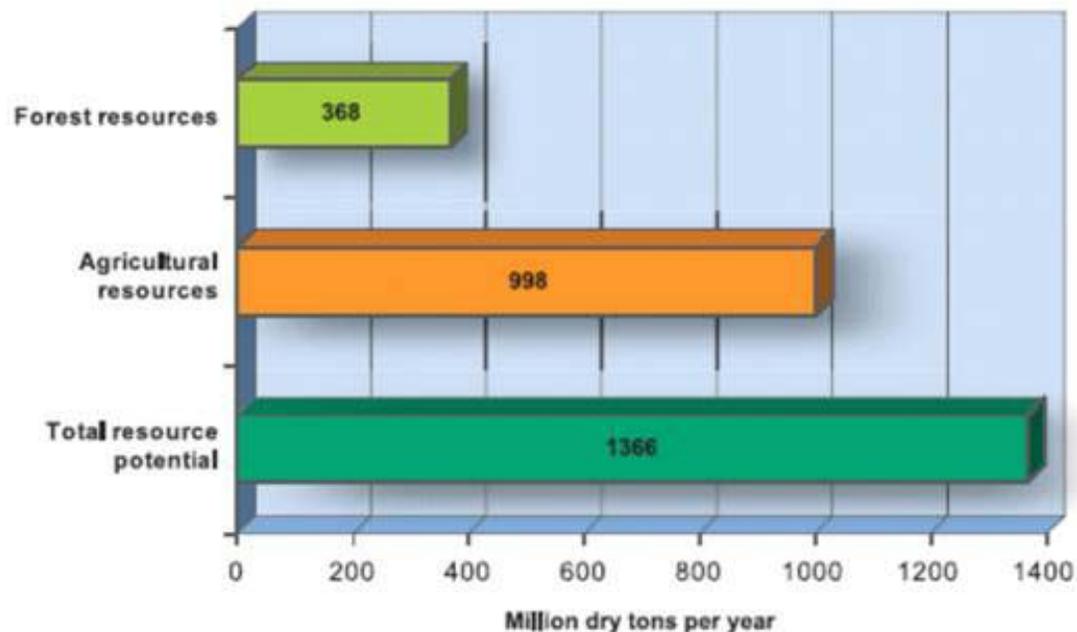
- Over the last 20 years, the amount of energy needed to produce ethanol from corn has significantly decreased because of improved farming techniques, more efficient use of fertilizers and pesticides, higher-yielding crops, and more energy-efficient conversion technology.
- Most studies that claim a negative energy balance for ethanol fail to take into account the energy contained in the co-products.

# Adequate Biomass Resources



## *Are There Sufficient Biomass Resources to Replace 1/3 of the U.S. Petroleum Requirements?*

- Yes, land resources can provide a sustainable supply of more than 1.3 billion dry tons annually and still continue to meet food, feed, and export demands (USDA baseline)
- Realizing this potential will require R&D, policy change, stakeholder involvement
- Required changes are reasonable given current trends and time for biorefinery scale-up and deployment



**We need only about one-third of the land identified in DOE/ORNL study to produce the entire 36 billion gallons required by 2022.**



# Food vs. Fuel<sup>1</sup>

**Myth:** Biofuels are responsible for increasing food prices worldwide.

*World Bank Chief: Biofuels Boosting Food Prices--"While many are worrying about filling their gas tanks, many others around the world are struggling to fill their stomachs. And it's getting more and more difficult every day."*

*British Prime Minister expresses concern over biofuel's impact on world food supply; wants the issue of high food prices and the link to biofuel production to be on the agenda of the G8 summit in Japan in July.*

**Fact:** Many factors are causing an increase in food prices including more expensive energy and fertilizer, droughts, urbanization, diet changes in emerging economies as well as export bans and a weak dollar.

*European Commission (José Barroso): biofuel production "not significant" as a cause for rising food prices*

*German environment minister Sigmar Gabriel : "There are other factors crucial for rising food prices. The big competition is not between the use of biomass for energy and food but between feed and food."*

<sup>1</sup>All of the comments above were printed in April 2008 news stories

# Feedstocks for Today and Tomorrow



## Today

- Grains (corn, sorghum, wheat)
- Oilseeds and plants (soybeans)

## Tomorrow

- Agricultural residues (stalks, stems, other crop wastes)
- Energy crops (switchgrass, miscanthus, poplar, willow)
- Forest resources (wood waste, forest thinnings, small-diameter trees)
- Oilseeds and oil crops (Jatropha, rapeseed)
- Green wastes (urban wood wastes, sorted municipal solid waste)

