From Biomass to Biofuels

- Does It Affect Food Price?

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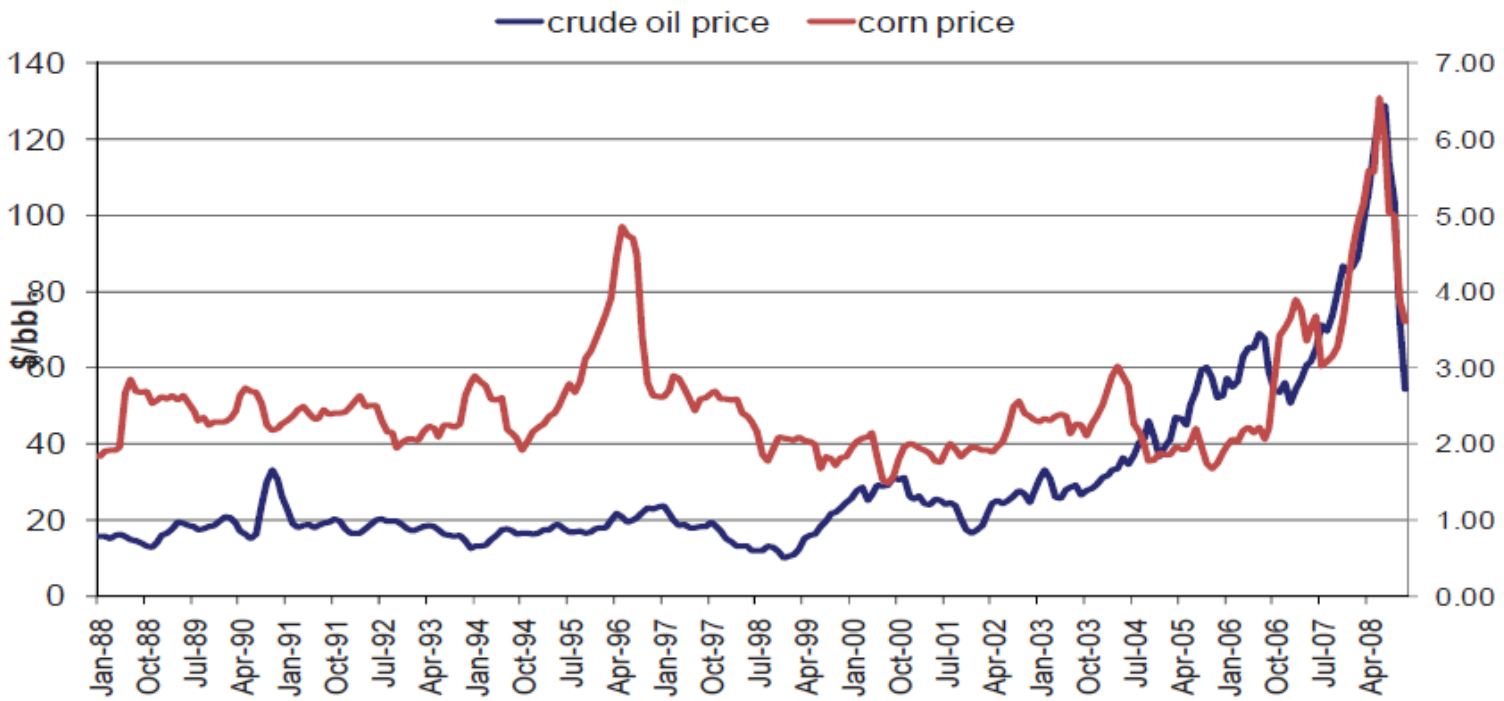
“What’s Driving Food Price?”

- Energy and agricultural markets were largely independent before 2006;
- World agricultural commodity consumption exceeding production growth, leading to very low commodity inventories;
- The decline in value of the U.S. dollar; and
- The new linkage between energy and agricultural markets.



Sources: Corn price, USDA; oil price, DOE/EIA, refiner composite crude oil acquisition price.

Wallace Tyner, Philip Abbott and Christopher Hurt , *What’s Driving Food Prices? March 2009 update*

“Ethanol’s Impact On Food Prices”

- Estimate corn prices, “driven by rapidly expanding” U.S. ethanol production, has increased U.S. retail food prices by $14 billion annually. The study reported by Iowa State University also projected the impact if season-average corn prices increased to $4.42/bu. over a 10-year period ending in 2016, and assuming crude oil prices ranged from $65-70/barrel. Given those assumptions, the impact on the commodities is projected against the $2/bu.” - *Corn & Soybean Digest*

“Oil, not ethanol, driving food prices”

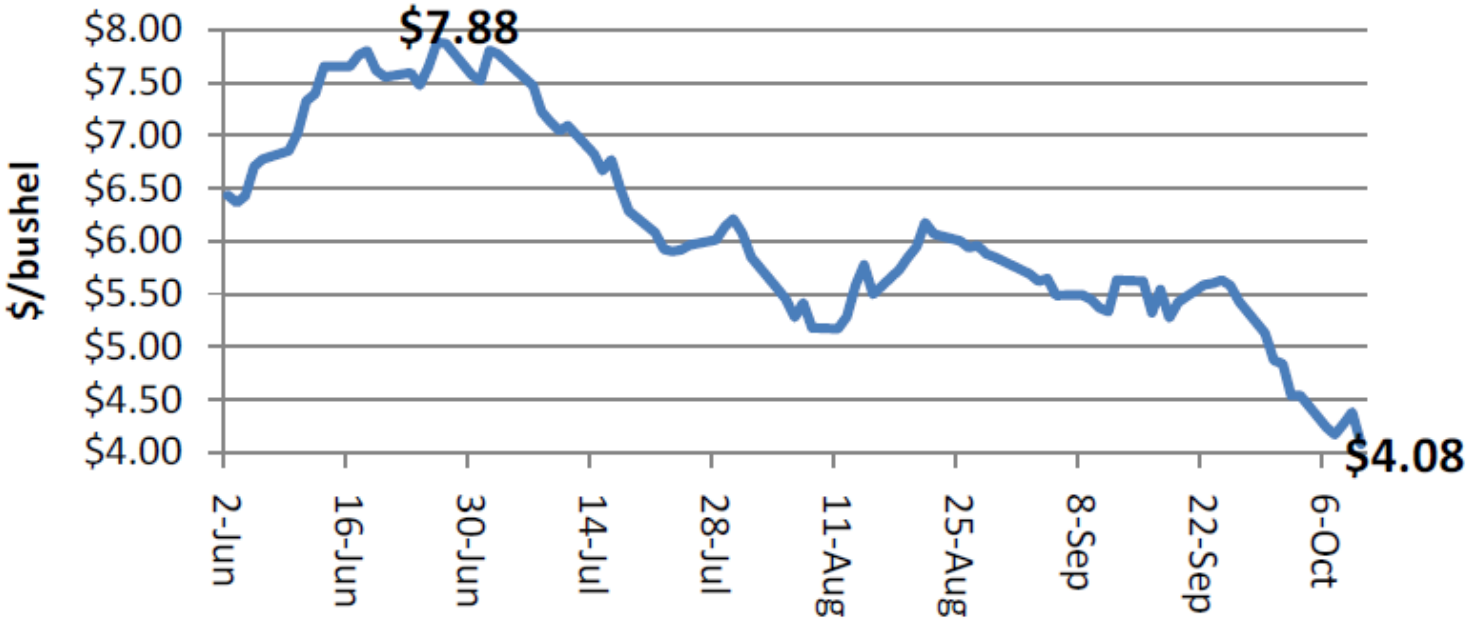
- “Of the 40% increase in food prices, about 3% can be attributed to food crops being used in biofuels. At least 8% can be attributed to rising costs of fuel used to grow and transport the crops from farms to the grocer.” *High Food Prices: Ethanol is Not the Problem*, Hank Green.
- Some congressional reports have estimated that ethanol has caused food prices to rise in the US <1% (0.5 – 0.8%)

Food Vs. Fuel – RFA reports

RFA is the Renewable Fuel Association, the ethanol trade organization in the US.

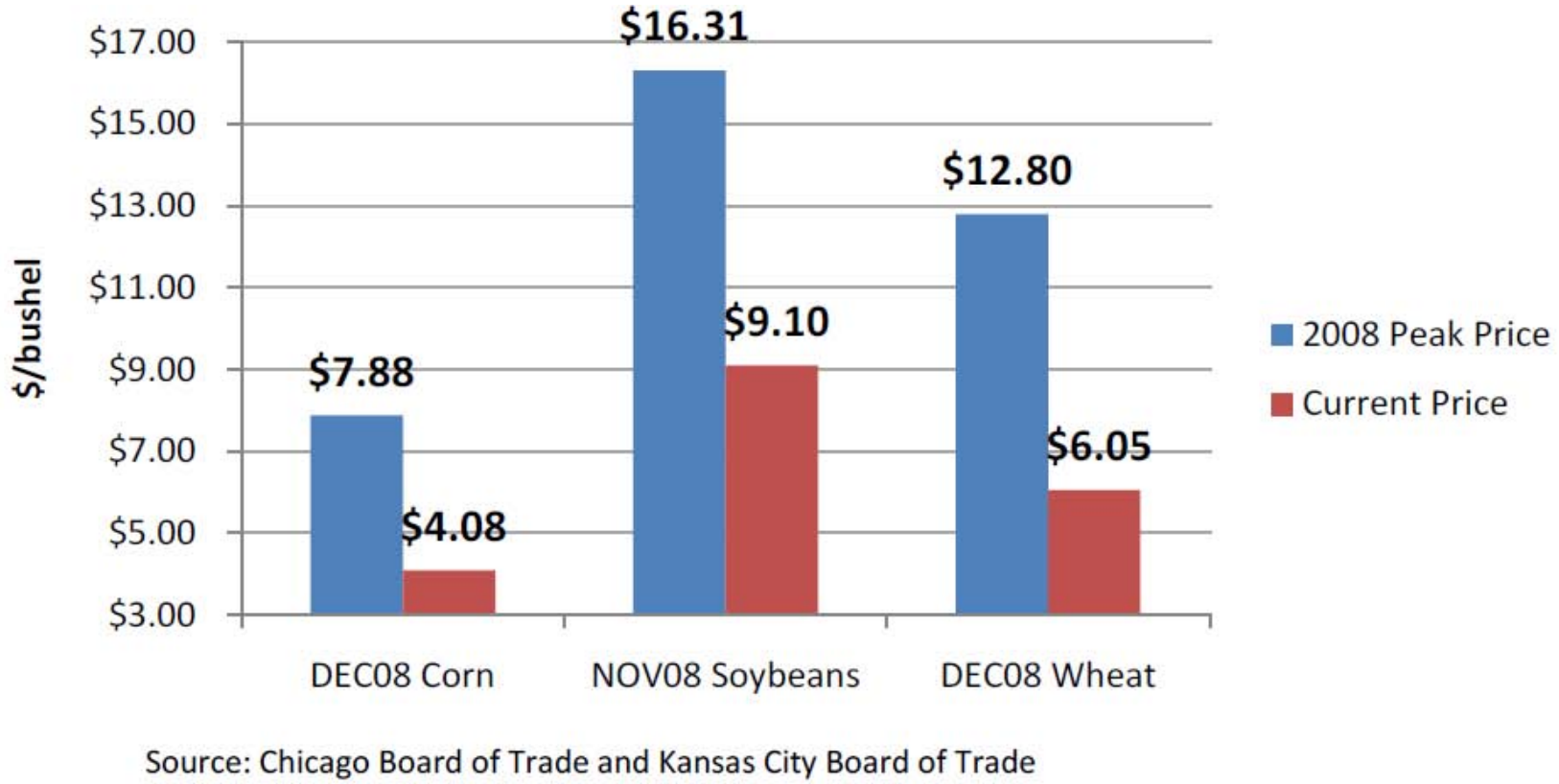
Figure 1. DEC08 Corn

CBOT Closing Price (June 2-Oct. 10)



Source: Chicago Board of Trade

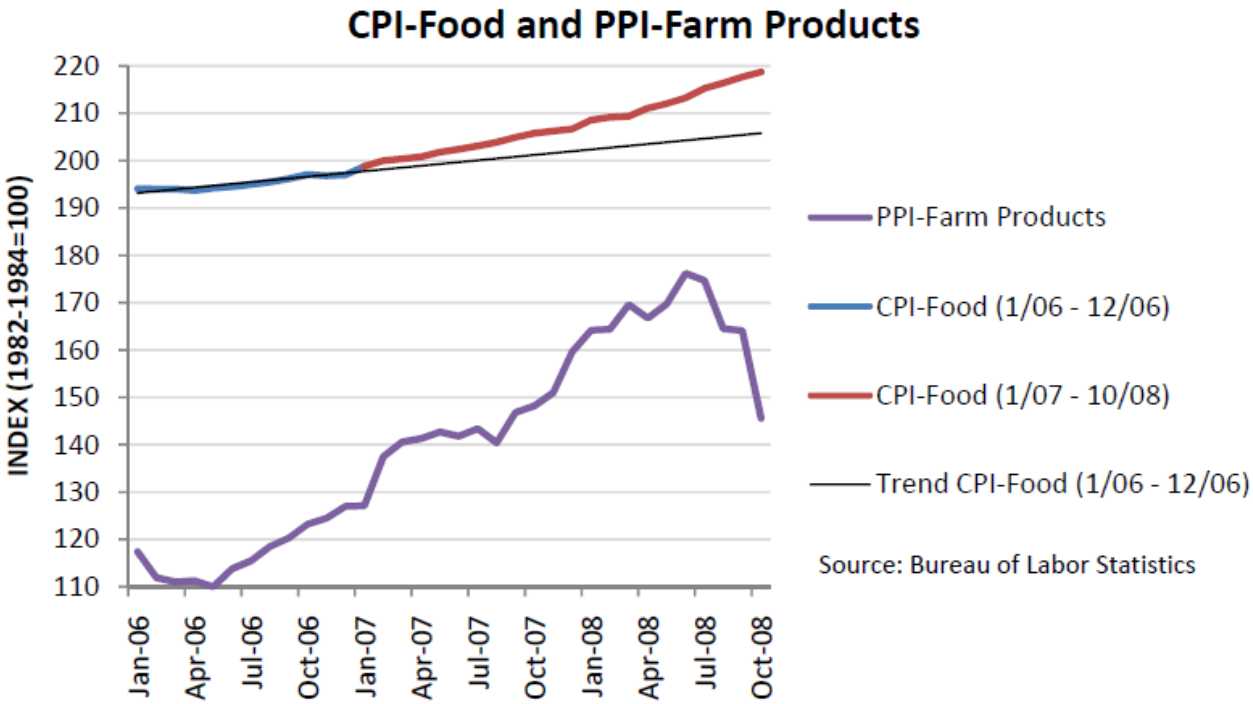
Food Vs. Fuel – RFA reports



Source: Chicago Board of Trade and Kansas City Board of Trade

2008 peak prices vs. current prices (Oct 10, 2008)

Food Vs. Fuel – RFA reports



As shown in the chart below, in early 2007, food prices began to accelerate faster than in previous years. Food companies blamed higher prices for corn and other farm commodities for the immediate increases in wholesale prices, which translated into higher retail prices. Big Food often suggests a “lag effect” exists before changes in commodity prices are reflected at the retail level (they say that’s why food prices haven’t come down, despite the plunge commodity prices). However, it is clear there was no “lag effect” in early 2007. When the producer price index (PPI) for farm products increased rapidly, food companies reacted quickly, as demonstrated by the accelerated trend in the consumer price index (CPI) for food. And as producer prices for farm products have dropped dramatically since June, food inflation continues to increase at a faster-than-normal rate.

Food Vs. Fuel – NREL/DOE Vision

- Advanced biofuels – using non-food resources
- No direct competition with food and feed supplies
- Indirect land use competition

U.S. National Commitment to Biofuels

EISA (Energy Independence & Security Act)

- **36 billion** gallons renewable fuel by 2022
  - **21 billion** gallons cellulosic + advanced biofuels

<u>Near-term</u> – Cost Goal

“Cost-competitive cellulosic ethanol”

- Cost-competitive in the blend market by 2012

<u>Longer-term</u> – Volumetric Goal

Biofuels and Sustainability

- Biofuels have great potential:
  - Potential biomass resource - 1.3 billion tons/year
  - Potential displacement for 50% of current gasoline
- Sustainability issues associated with large volumes of biofuels production:
  - land use
  - Water quality
  - GHG emissions
  - Socioeconomics

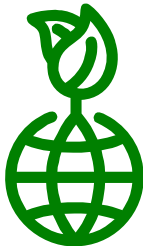
The total volumes of agriculture in the US is currently less than 1 billion tons/year

Corn Ethanol and Advanced Biofuels

- First generation – produced from corn grain
- Advanced biofurles – produced from non-food resources

Grain-based Ethanol

- Commercially available (no DOE research)
- Reduced GHG emissions
- Capacity constrained



Cellulosic Ethanol

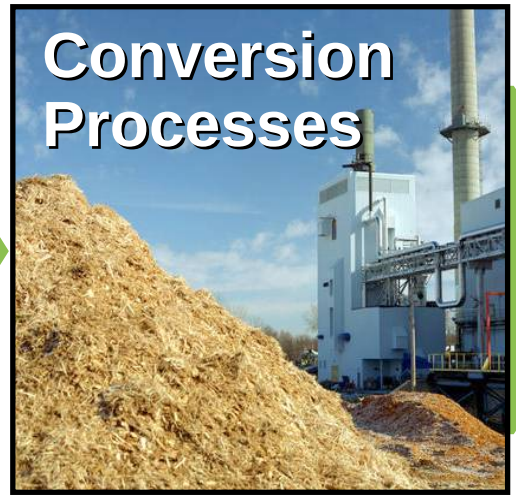
- DOE research ongoing
- Potential to lower GHG emissions >80%
- Uses biomass from waste and non-agricultural land

Other Advanced Biofuels

- Focus of newer DOE research
- Could minimize environmental footprint
- Energy content, fuel economy, and chemistry may be more similar to petroleum-based fuels

The Biorefinery Concept

- Trees
- Grasses
- Agricultural crops
- Residues
- Animal wastes
- Municipal solid waste



- Enzymatic fermentation
- Gas/liquid fermentation
- Direct microbial production of hydrocarbons
- Acid hydrolysis/ fermentation
- Gasification
- Combustion
- Co-firing
- Pyrolysis

Uses

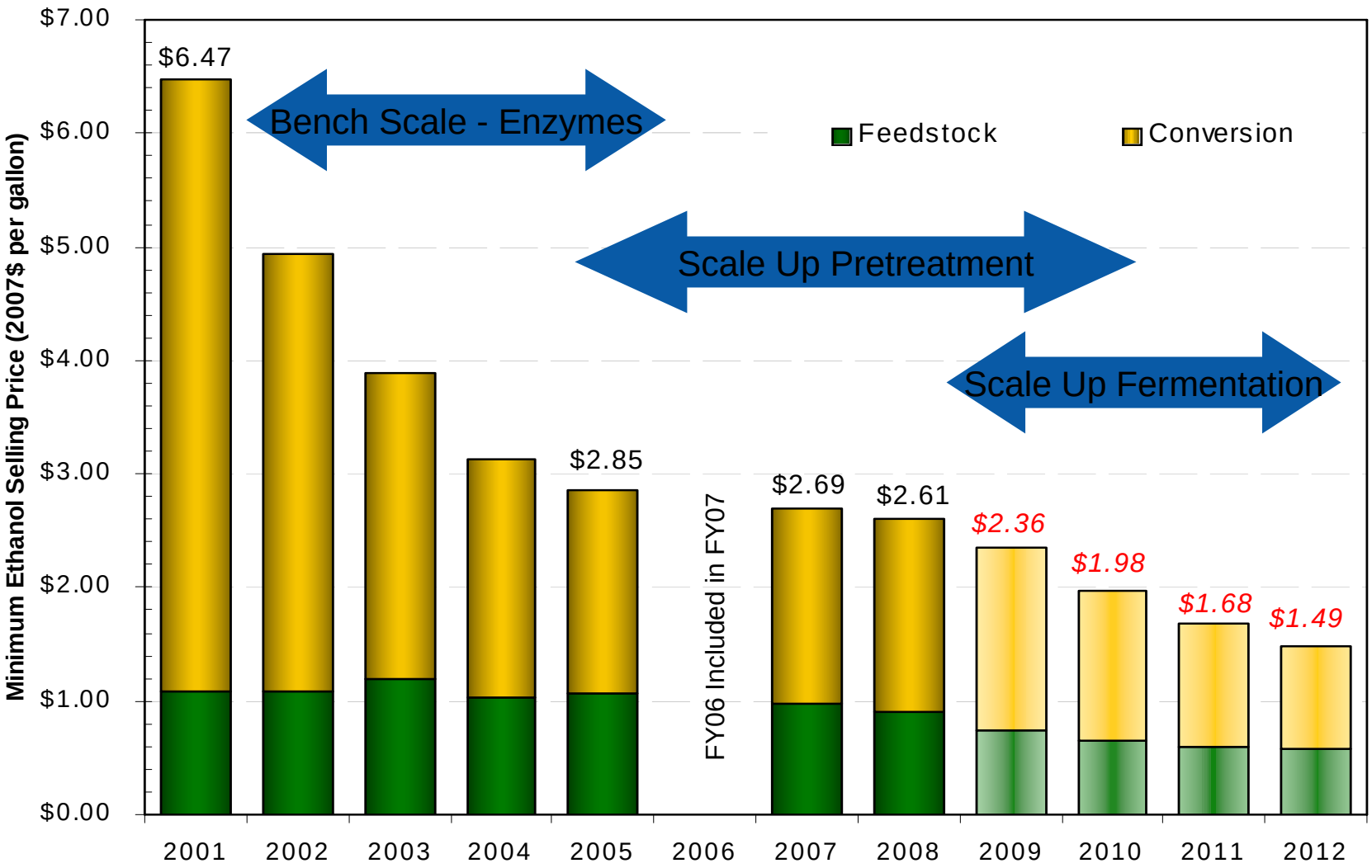
Fuels
- Ethanol
- Butanol
- Higher alcohols
- Green gasoline
- Renewable diesel
- Jet Fuel

Power
- Electricity
- Heat

Chemicals
- Plastics
- Solvents
- Chemical intermediates
- Phenolics
- Adhesives
- Furfural
- Fatty acids
- Acetic acid
- Carbon black
- Paints
- Dyes, pigments, and ink
- Detergents

Food and Feed

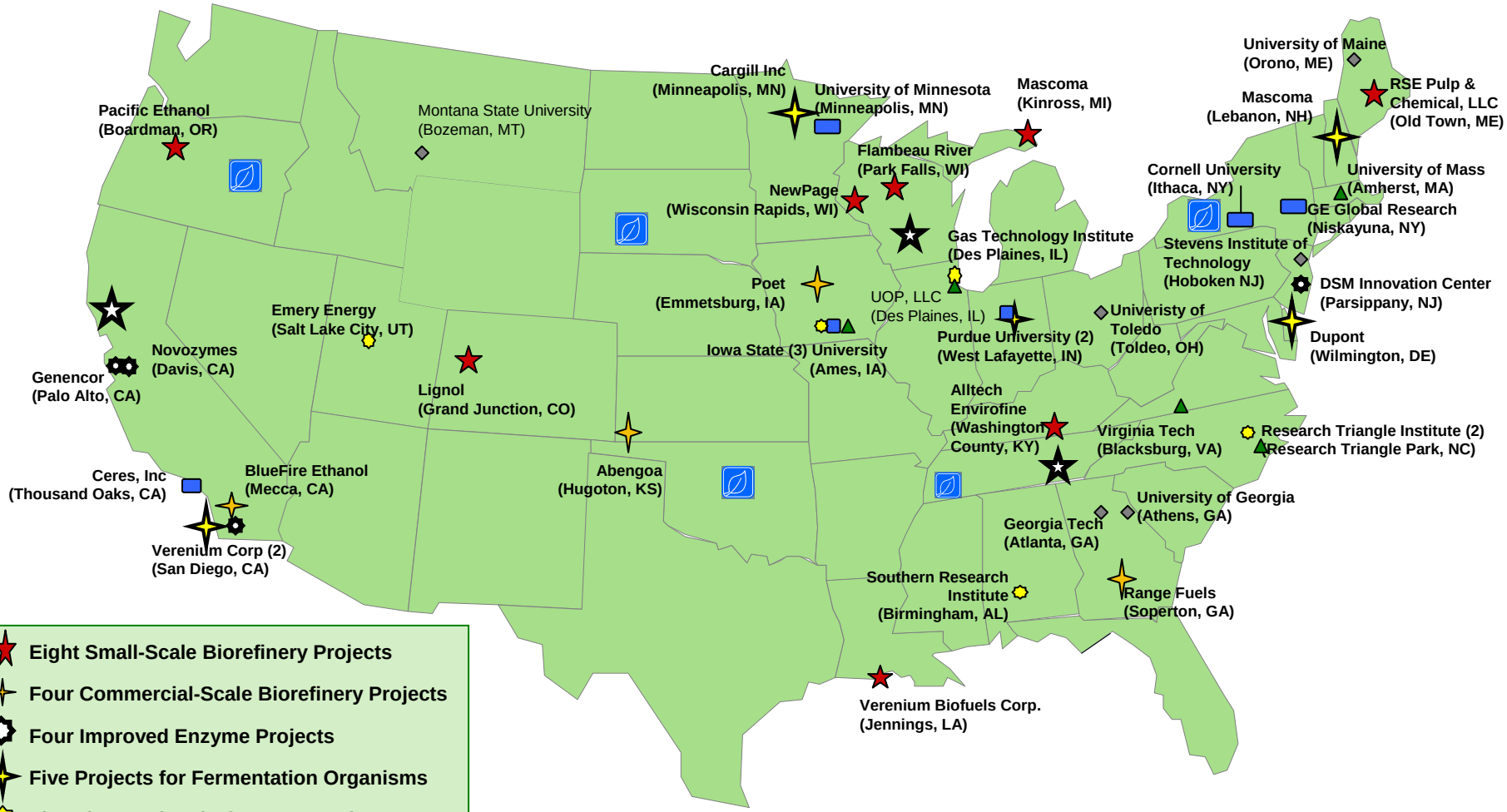
FY08 Biochemical State of Technology
(yr $2007 actual)



Ethanol Production

- Currently ethanol produced from corn grain is 9.4 bgy (billon gallons per year) in the US.
- It will increase to 14 bgy within several years
- 15 bgy is the maximum without significant impacts on the food products.
- Currently, cellulosic ethanol is critical to achieve the EISA goal (**36 billion** gallons renewable fuel by 2022).
- In the near-term, lower the price - $1.33/gallon (2007$) by 2012.
- In the long-term, increase the volume - **21 billion** gallons cellulosic + advanced non-ethanol biofuels.

Cellulosic Ethanol Production

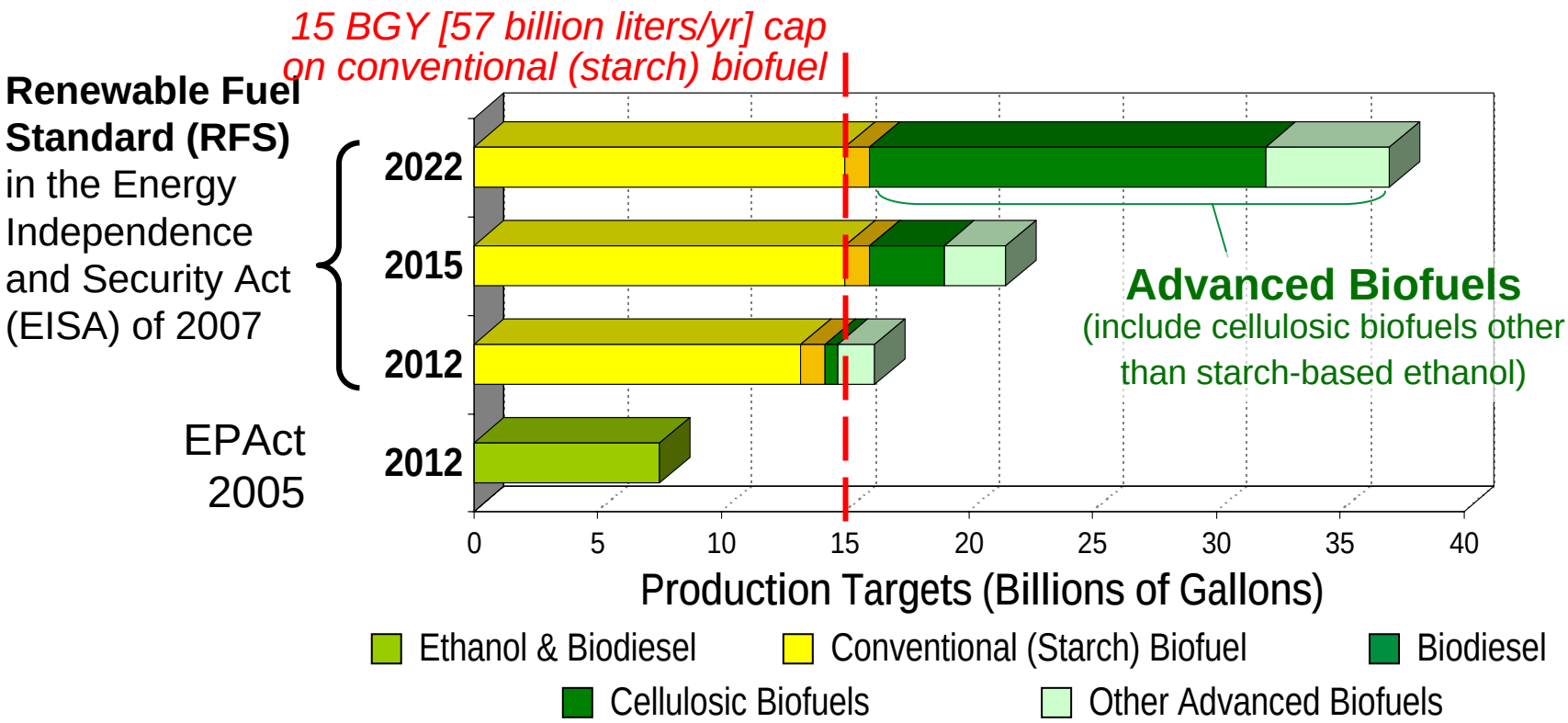


- Eight Small-Scale Biorefinery Projects
- Four Commercial-Scale Biorefinery Projects
- Four Improved Enzyme Projects
- Five Projects for Fermentation Organisms
- Five Thermochemical Syngas Projects
- DOE Joint Solicitation Biomass Projects
- Five Thermochemical Bio-Oil Projects
- Six University Conversion Projects

Regional Partnerships

South Dakota State Univ., Brookings, SD
Cornell University, Ithaca, NY
Univ. of Tennessee, Knoxville, TN
Oklahoma State Univ., Stillwater, OK
Oregon State Univ., Corvallis, OR

Cellulosic Ethanol and Non-Ethanol Biofuels



EISA defines ***Cellulosic Biofuel*** as "renewable fuel derived from any cellulose, hemicellulose, or lignin that is derived from renewable biomass and that has lifecycle greenhouse gas emissions…that are *at least 60 percent less* than baseline lifecycle greenhouse gas emissions."

EISA defines ***Advanced Biofuel*** as "renewable fuel, other than ethanol derived from corn starch, that has lifecycle greenhouse gas emissions…that are *at least 50 percent less* than baseline lifecycle greenhouse gas emissions."

Other Advanced Non-Ethanol Biofuels

- Ethanol has limitations: low energy content and not fully compatible with existing transportation fuel infrastructure
- Other non-ethanol biofuels are required, such as butanol, biodiesel, jet fuels
- Thermochemical conversion to intermediate liquids and or gases
- Aquatic Biofuels, such as microalgae and bio-oils – do not require arable land or fresh water

Sustainability of Advacned Biofuels

- Improve positive energy balance - four to six times less energy is required to produce advanced biofuels than that needed for corn ethanol production
- Reduce life-cycle GHG emmisions by over 85% compared to gasoline
- Issues: direct and indirect use of land, water
- Direct land use changes are caused by feedstock production
- Indirect land use changes occur in other countries through price signals of agriculture commodities

Renewable Fuel Standard (RFS) goals for biofuels penetration are based on specific GHG reductions from the fossil fuel it replaces.

Biomass-based diesel	50% reduction
Advanced biofuels	50% reduction
Corn grain-based ethanol	20% reduction
Cellulosic Biofuels	60% reduction

Summary

- Increasing corn ethanol production impacts food price inflation
- High food price is attributed more by oil than biofuels
- The current successful, goal-focused effort on cellulosic ethanol is on target towards achieving the US immediate objective, to displace oil, reduce greenhouse gases, and minimize food and feed price impacts.
- Non-ethanol advanced biofuels may address the potential sustainable issues associated with large volumes of biofuels production.

No matter what the facts are, we see research on biomass fuels as a way of avoiding this food vs. fuels debate almost all together

Thank You for the Opportunity

Are there any Questions ?