New Advances in Ethanol Processing

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Presentation Outline

- Transportation Fuels Supply and Demand
- Recent Events
- Crop productivity
- Ethanol Production Technology Advances
- Summary

Transportation Fuels Supply and Demand

- Global Drivers
  - GDP growth
  - Vehicle penetration
  - Fleet fuel economy
- US Drivers
  - Government policy
  - Commercial economics
  - Technology solutions
- Recent Events

Energy Independence and Security Act of 2007

Key Component -- to reduce America's dependence on oil by:

- Increasing the supply of alternative fuel sources by setting a mandatory Renewable Fuel Standard (RFS) requiring fuel producers to use at least 36 billion gallons of biofuel in 2022.
- Reducing U.S. demand for oil by setting a national fuel economy standard of an average of 35 miles per gallon by 2020 – which will increase fuel economy standards by 40 percent and save billions of gallons of fuel.

With $100 barrel oil the US spends $1.25 billion per day for OPEC and Mideast oil…

https://www.whitehouse.gov/news/releases/2007/12/20071219-1.html

Optimal Ethanol Blend-Level Investigation

- Using four 2007 model vehicles
  - Toyota Camry, a Ford Fusion, and two Chevrolet Impalas, one flex-fuel and one non-flex-fuel.
- Based on EPA Highway Fuel Economy Test
- All of the vehicles got better mileage with ethanol blends than the ethanol's energy content would predict
  - three out of four actually traveled farther on a mid-level ethanol blend than on unleaded gasoline
- “Optimal blend level" of ethanol and gasoline – E20 to E30
- Significant reductions in emissions
  - Carbon dioxide, nitrogen oxides, carbon monoxide and nonmethane organic gases

DOE funded study to the University of North Dakota Energy & Environmental Research Center and the Minnesota Center for Automotive Research
http://www.ethanol.org/news/index.php?newsid=25
http://www.ethanol.org/pdf/contentmgmt/ACE_Optimal_Ethanol_Blend_Level_Study_final_12507.pdf

Transportation Fuels Supply and Demand

- Fuel prices
  - 68% cost of gasoline is crude oil
  - Gasoline pricing expected to increase through 2008 ($3.14/gallon) and begin decline in 2009 ($3.03/gallon)
  - $3.07/gallon (2/4/08 - Chicago)
- Ethanol
  - 9 billion gallons and 11.1 billion gallons for 2008 and 2009 respectively
  - $2.27/gallon (2/7/08 - Illinois)
- Flex Fuel Vehicles
  - 6,000,000 today in US; 2,000,000 per year by 2010
  - 50% of new cars in US by 2012
  - 85% of all new cars in Brazil; 72% saturation by 2020
- 2022 – RFS – 25% of our transportation fuel demand

http://www.eia.doe.gov; http://www.ethanolmarket.com/fuelethanol.html;http://www.ethanol-gec.org/information/herwick_gm_1-27-05.ppt; http://climate.weather.com/articles/flexfuel050607.html; https://www.whitehouse.gov/news/releases/2007/12/20071219-1.html

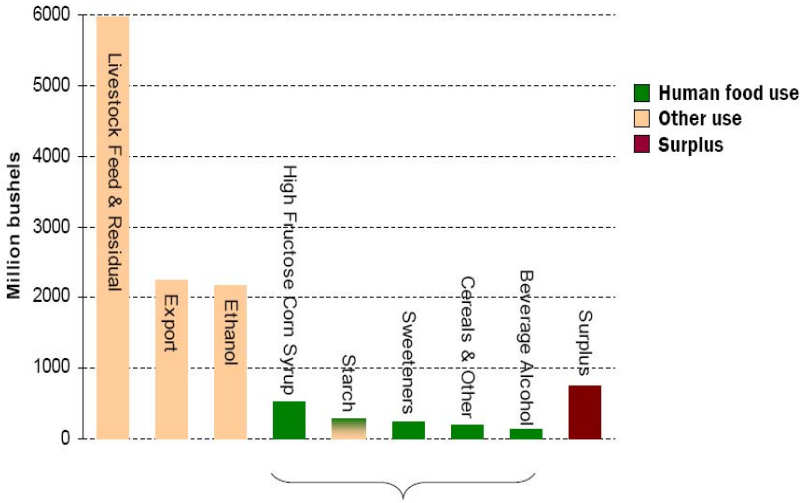
Life Cycle Impacts

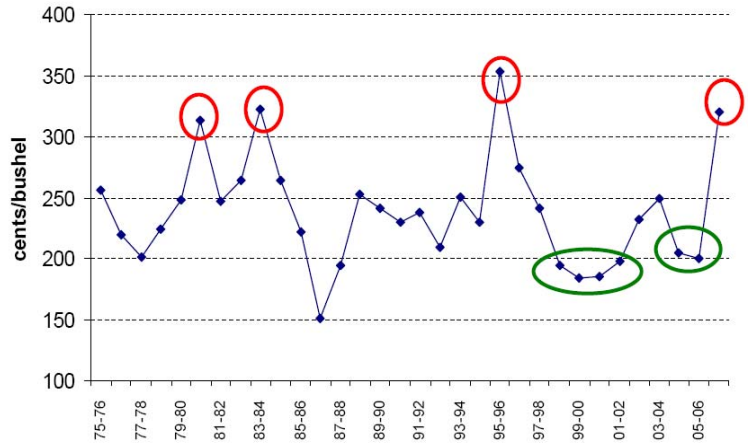
- Different plant types have distinctly different energy and greenhouse gas emissions effects.
- The use of wood chips can reduce greenhouse gas emissions by 52%.
  - Wang, et al. 2007. *Life-cycle energy and greenhouse gas emissions of different corn ethanol plant types*. Environmental Research Letters 2: 1-13.
- Different scenarios for land use have different impacts on greenhouse gas reductions when applied to biofuels
- Recovery of agricultural residues and use of degraded farmland would minimize habitat destruction, competition with food and carbon removal.
  - Fargione, et al. 2008. Land clearing and biofuel carbon debt. Sciencexpress, www.sciencexpress.org.
- Focus biofuels production on existing croplands and encourage use of feedstocks from waste products and carbon poor land and fall harvests of grasses from reserve lands
  - Searchinger, et al. 2008. *Use of US croplands for biofuels increases greenhouse gases through emissions from land use change*. Sciencexpress, www.sciencexpress.org.

Crop Productivity

- Food, Feed and Fuel
- Acres, Yield, Feed and Fuel

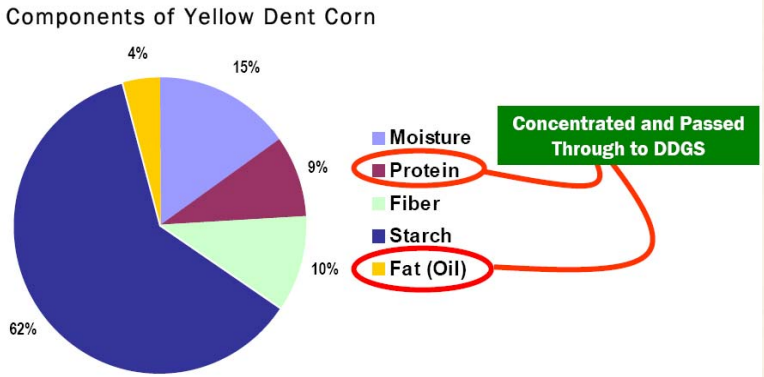
Food, Feed and Fuel

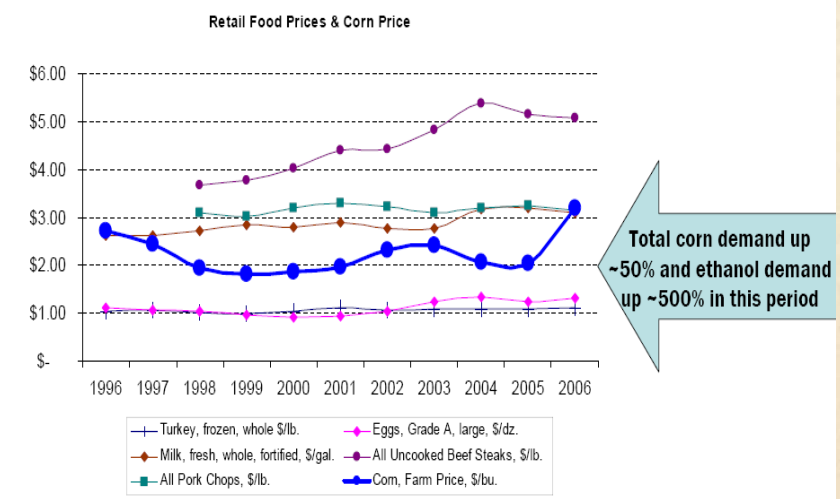




Corn prices *averaged* more than $3.00 per bushel three times in previous 25 years

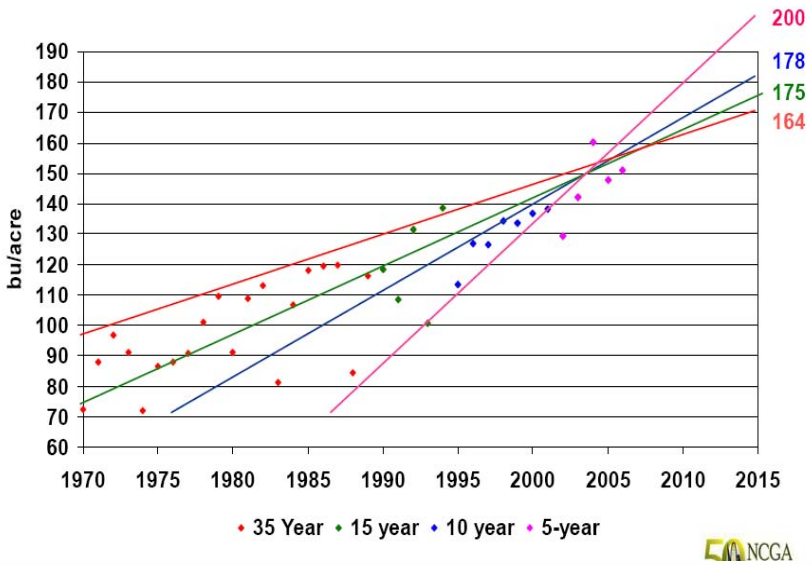
Source: USDA, ERS; 06-07 is midpoint estimate from JAN 07 WASDE

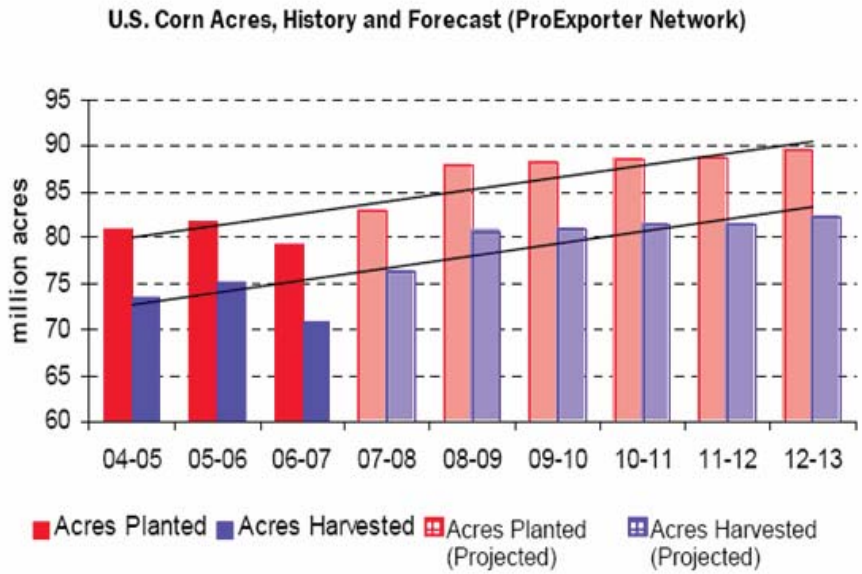




Sources: Bureau of Labor Statistics; USDA-ERS

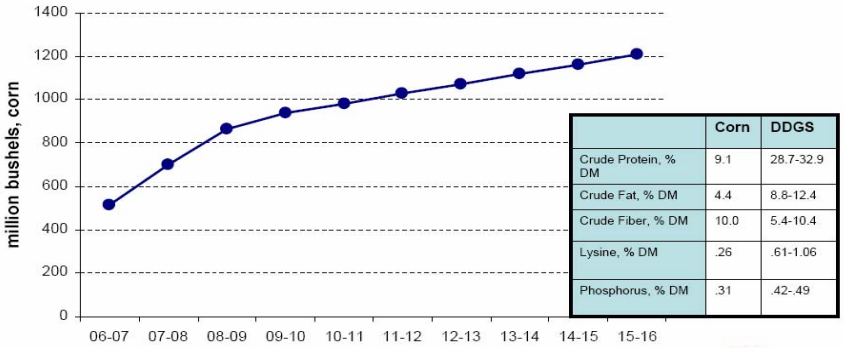
Acres, Yield, Feed and Fuel





Distillers Grains Displacement in Feed Rations

Displacement of Corn



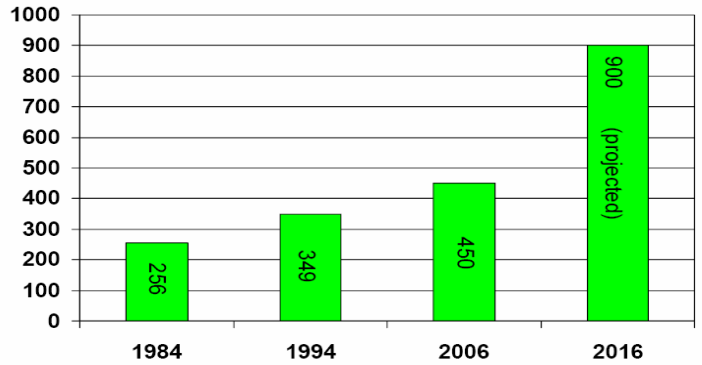
	Corn	DDGS
Crude Protein, % DM	9.1	28.7-32.9
Crude Fat, % DM	4.4	8.8-12.4
Crude Fiber, % DM	10.0	5.4-10.4
Lysine, % DM	.26	.61-1.06
Phosphorus, % DM	.31	.42-.49

Sources: DDG Displacement, PRX; DDGS profile, U. of Minn.; DGHP, Broin Cos.

NCGA 1957-2007

Improved Ethanol Production Efficiency

(Gallons of Ethanol Per Acre of Corn)



- *Fiber Conversion*
- *Stover*
- *High Fermentable Hybrids*
- *Yield Increase*

NCGA 1957-2007

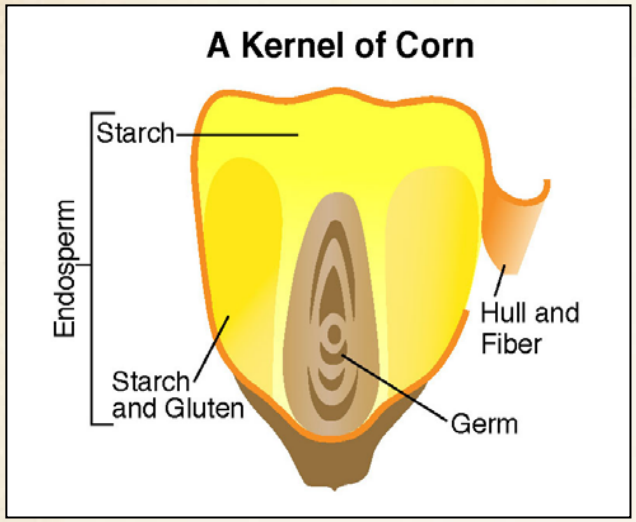
Ethanol Process Improvements

- Plant design and construction
- Grain processing
- Starch processing
- Alternative energy
- Cellulosic ethanol

Plant Design and Construction

POET Energy inspired.™

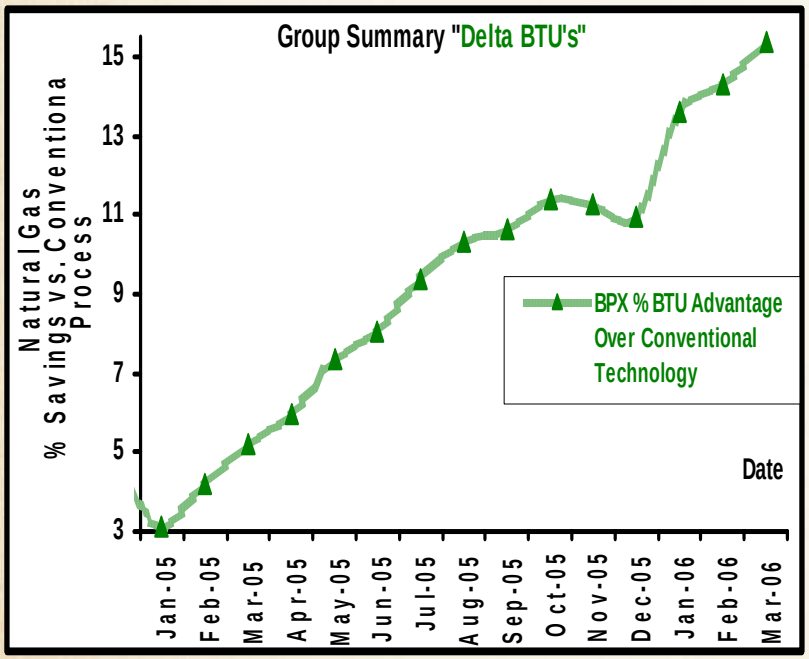
Corn Fractionation

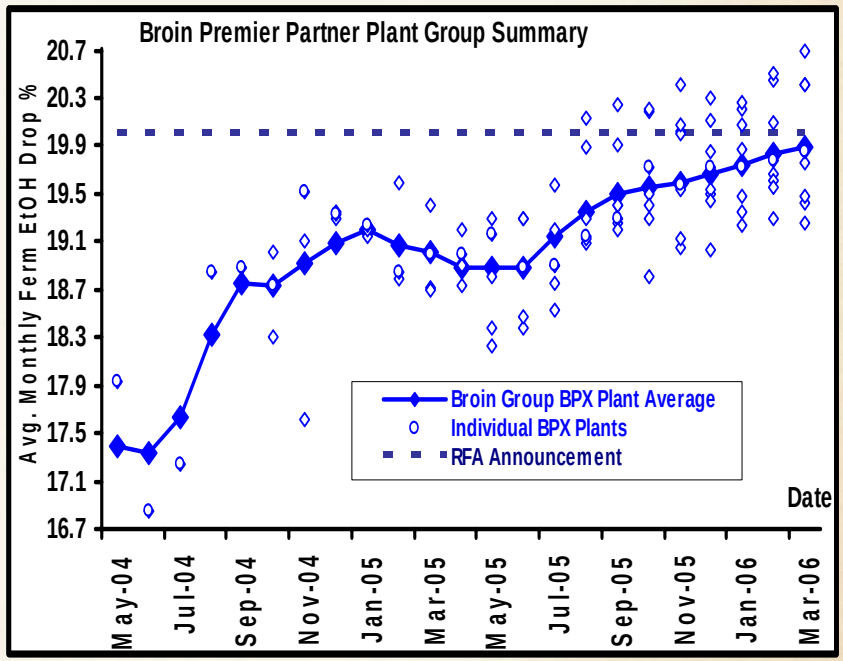


Dry corn fractionation producing endosperm, fiber and germ

Grain Processing

Starch Processing





Raw starch hydrolysis process without the need for cooking

Alternative Energy

Cogeneration of energy

- Solid Fuel Boilers
- Anaerobic Digestors

Cellulosic Ethanol: Starts with Corn

Where's the Biomass?

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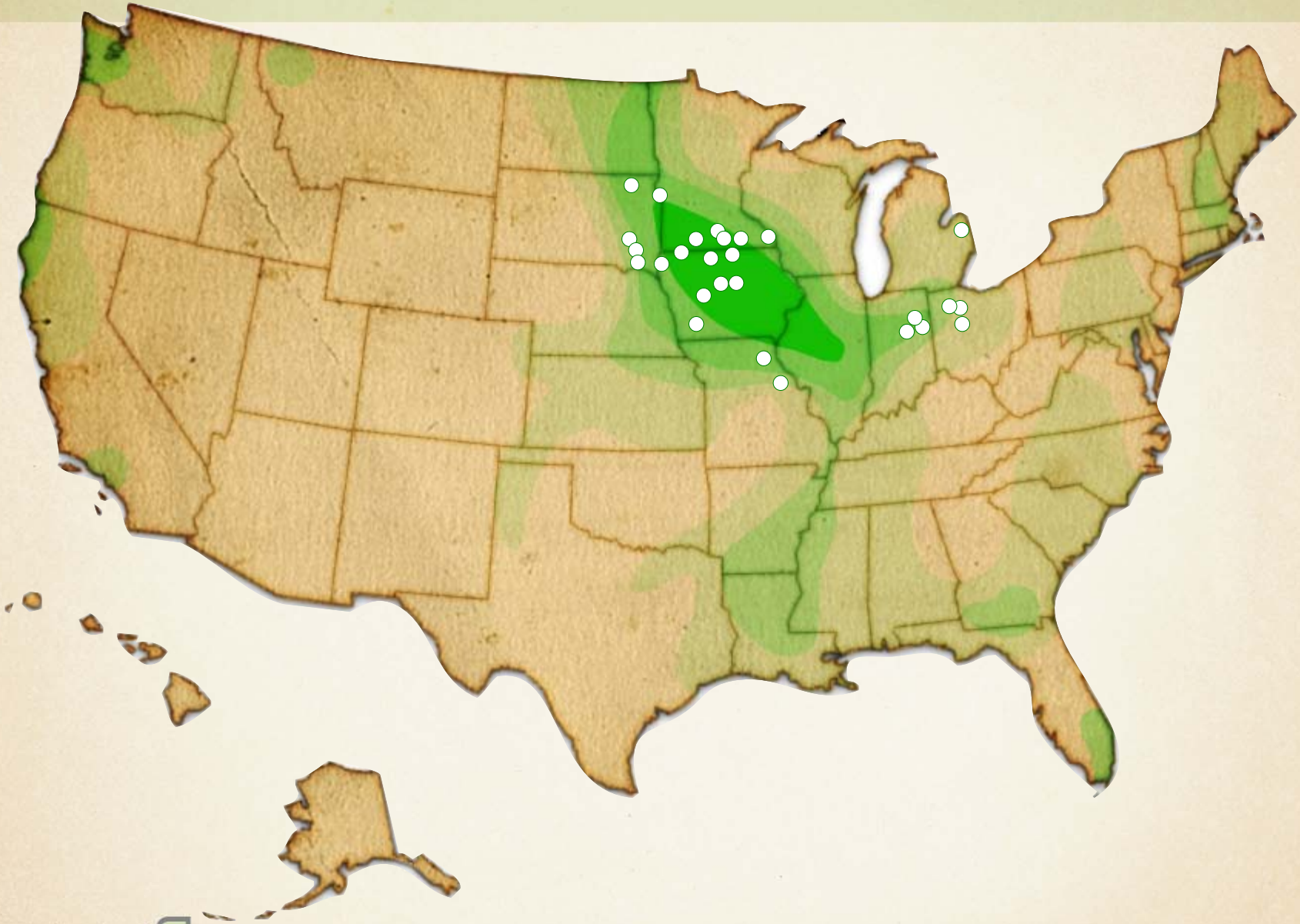

Poet Integrated Corn Cellulose Biorefinery

Grain Corn

bfrac

Endosperm

bpx

CO2

Ethanol

Distill

Centrifuge & Dry

DGHP

Corn Germ

Bran

Corn Cob

Pre-treat

Hydrolysis & Fermentation

Distill

Cellulosic Ethanol

Steam to Process

Biomass Boiler

Solid Fuel

Separator

Liquids

Anaerobic Digester

Biogas

Electric Generator

Boiler

DDG Dryers


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