

# New Advances in Ethanol Processing

USDA 2008 Agricultural Outlook Forum  
February 21, 2008

Mark D. Stowers, Ph.D.  
Vice President, Research and Development  
POET

[mark.stowers@poetenergy.com](mailto:mark.stowers@poetenergy.com)  
[www.poetenergy.com](http://www.poetenergy.com)

# Presentation Outline

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

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

*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](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://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>

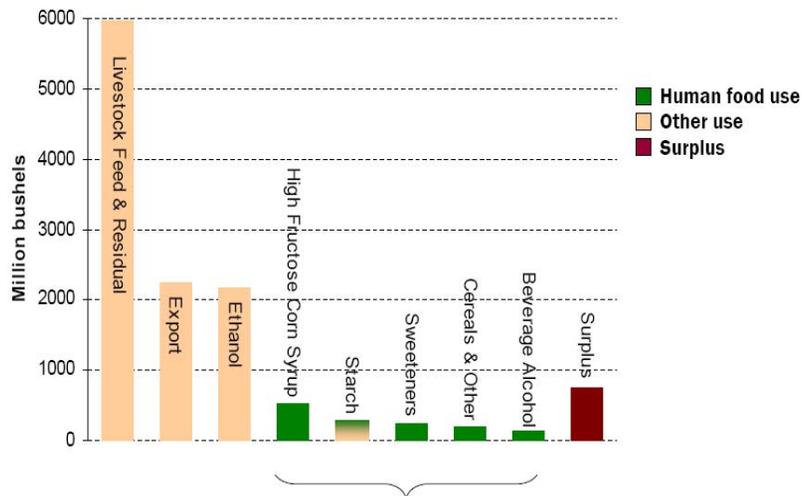
# Life Cycle Impacts

- 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. Scienceexpress, [www.sciencexpress.org](http://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*. Scienceexpress, [www.sciencexpress.org](http://www.sciencexpress.org).

# Crop Productivity

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

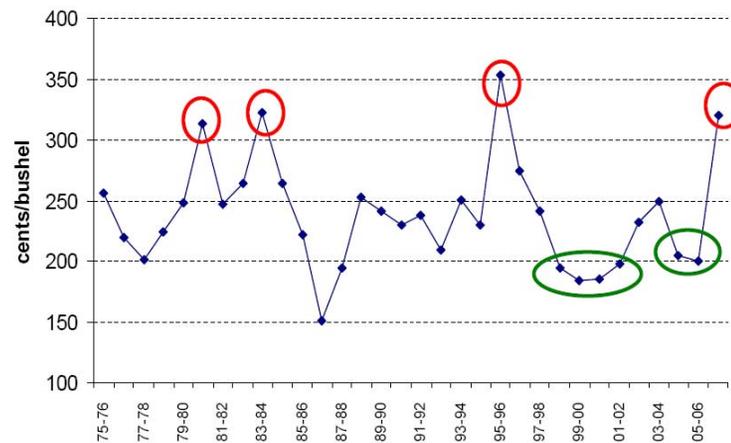
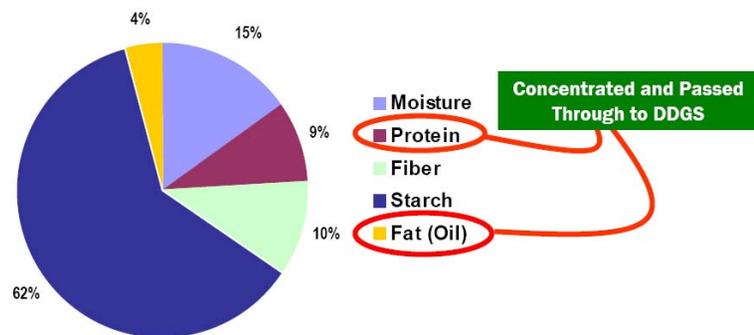
# Food, Feed and Fuel



Food uses = 11% of total



Components of Yellow Dent Corn

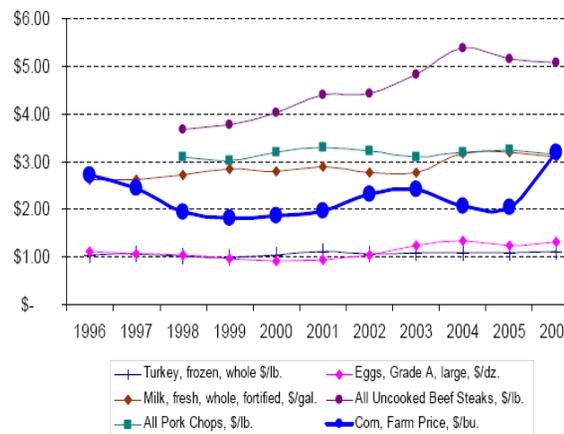


Corn prices averaged more than \$3.00 per bushel three times in previous 25 years

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



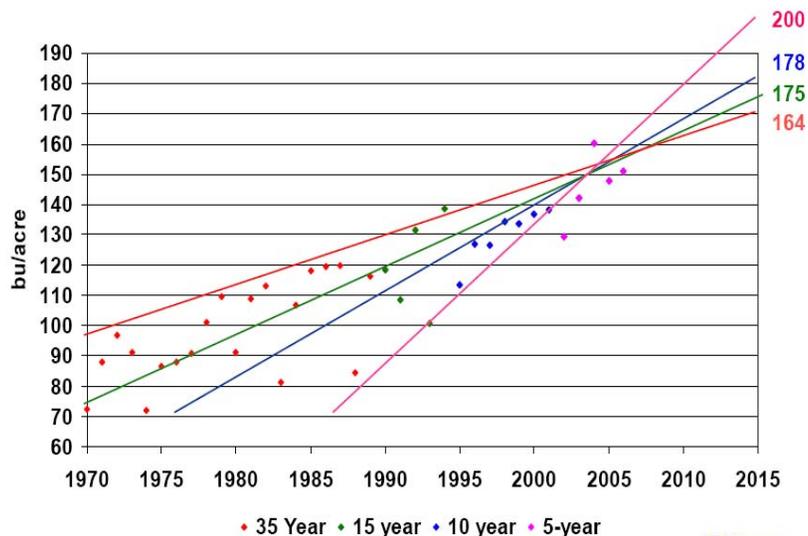
Retail Food Prices & Corn Price



Total corn demand up ~50% and ethanol demand up ~500% in this period

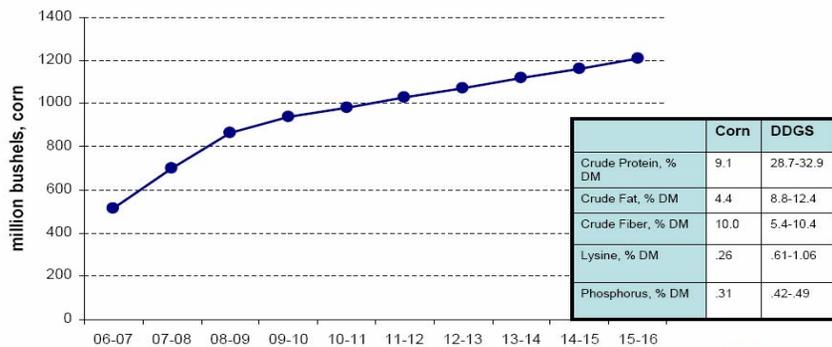
Sources: Bureau of Labor Statistics; USDA-ERS

# Acres, Yield, Feed and Fuel



## Distillers Grains Displacement in Feed Ratios

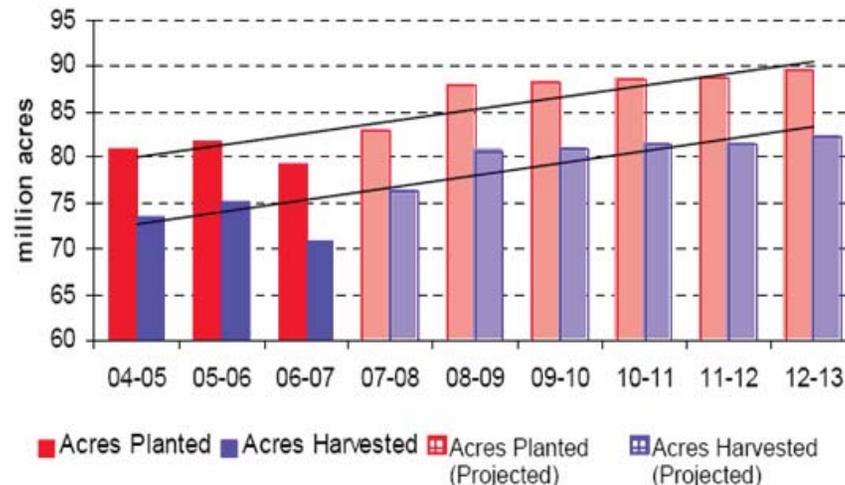
### Displacement of Corn



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

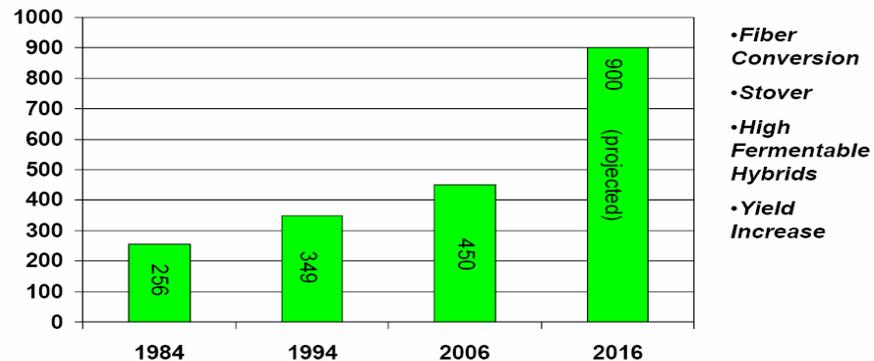


## U.S. Corn Acres, History and Forecast (ProExporter Network)



## Improved Ethanol Production Efficiency

(Gallons of Ethanol Per Acre of Corn)

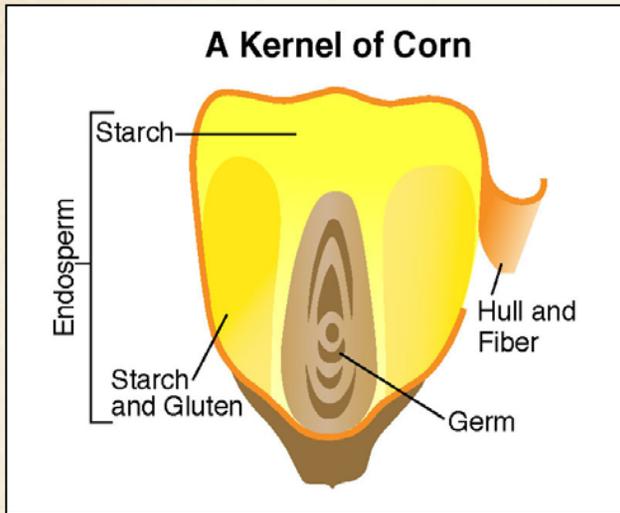


# Ethanol Process Improvements

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

# Plant Design and Construction



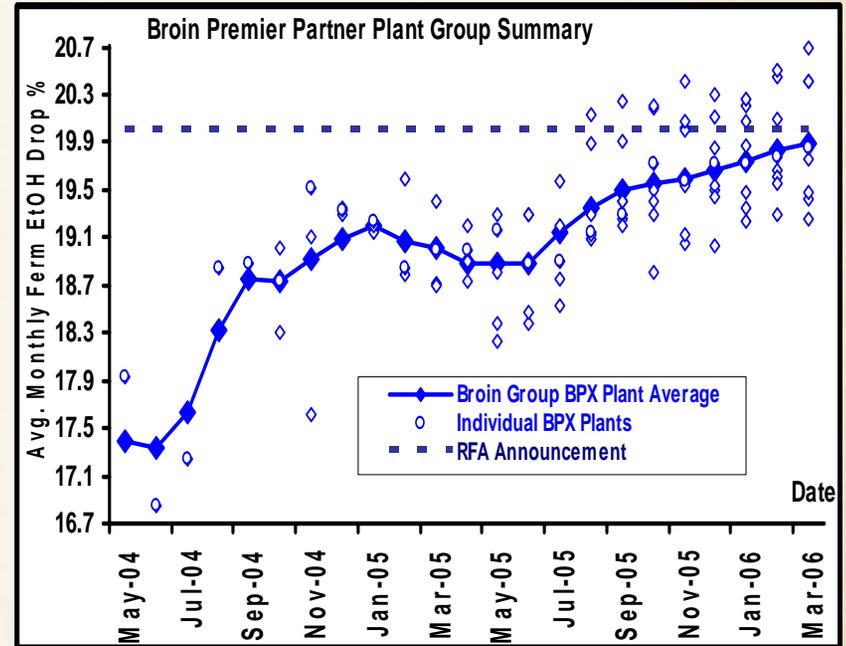
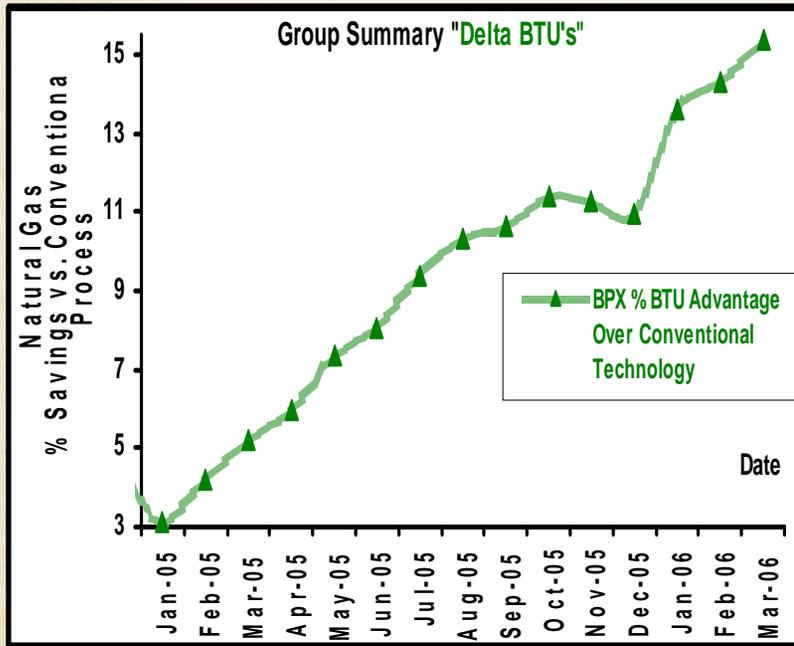


Dry corn fractionation producing endosperm, fiber and germ

# Grain Processing



# Starch Processing



Raw starch hydrolysis process without the need for cooking

POET Bio-Refining - Chancellor



## Cogeneration of energy

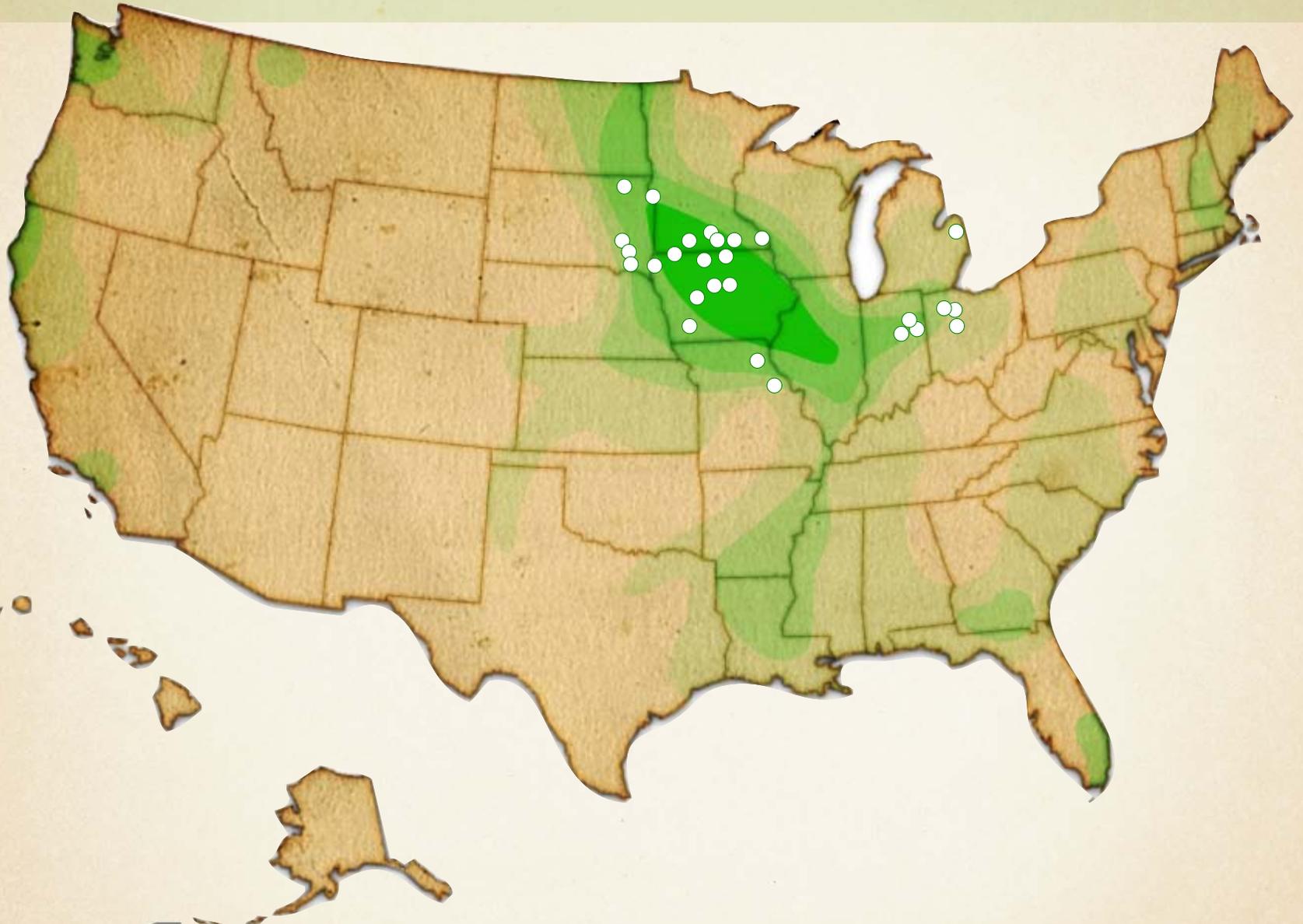
- Solid Fuel Boilers
- Anaerobic Digestors



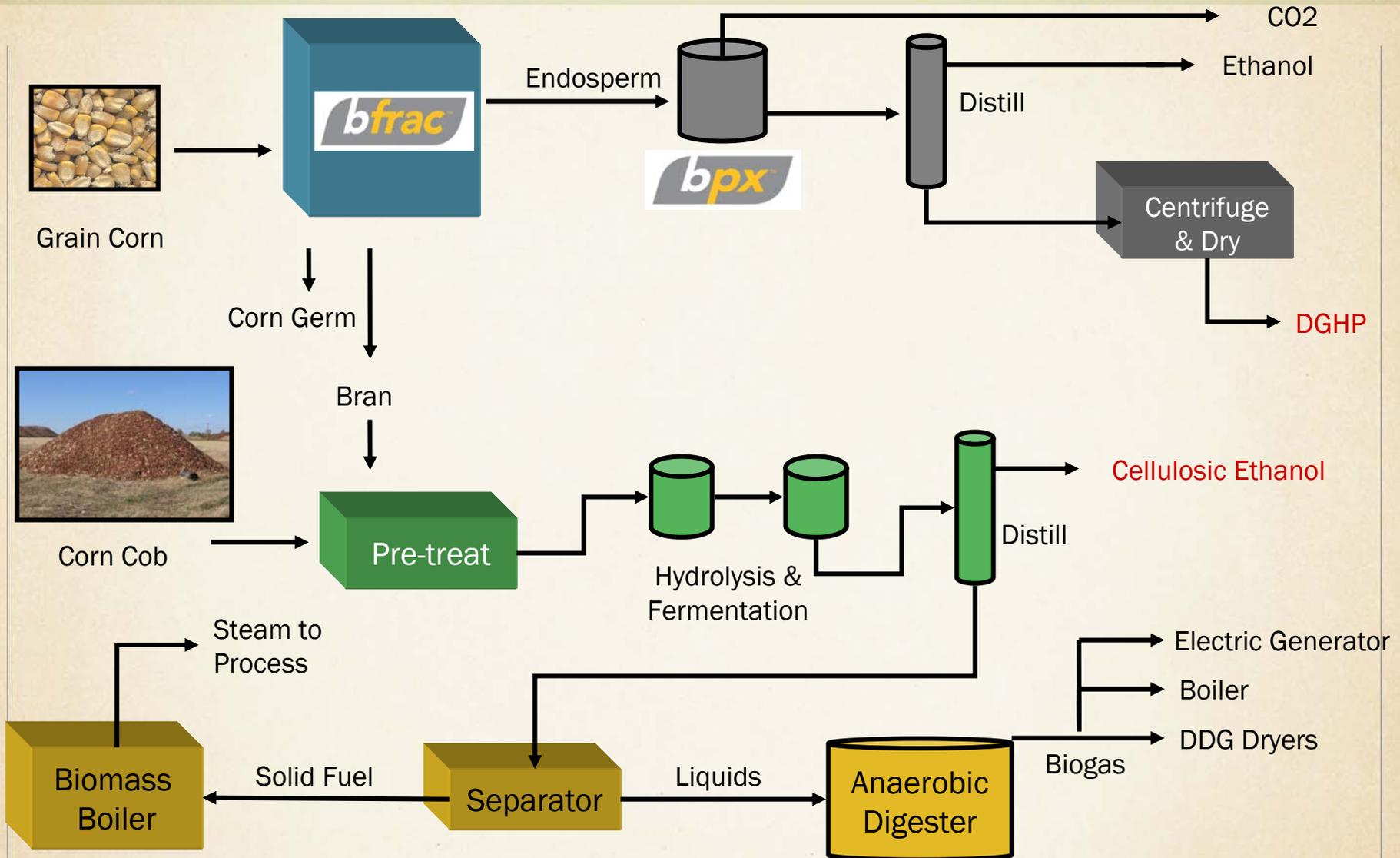
# Cellulosic Ethanol: Starts with Corn



# Where's the Biomass?



# Poet Integrated Corn Cellulose Biorefinery



FOET™  
Energy inspired.™