



Overview of US BioEnergy Market

West Virginia BioEnergy Forum

August 3, 2006



**Chemical and Environmental
Technologies**



Health and Life Sciences



**Advanced Engineering
Systems**

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BioEnergy Will Be Part of Future

Biopower is well-positioned to take advantage of growing environmental and clean energy concerns

Climate Control

Urban Air Quality

Energy Diversity

Jobs in Rural Areas

Forest Management

Solid Waste Management

Overview of Bioenergy

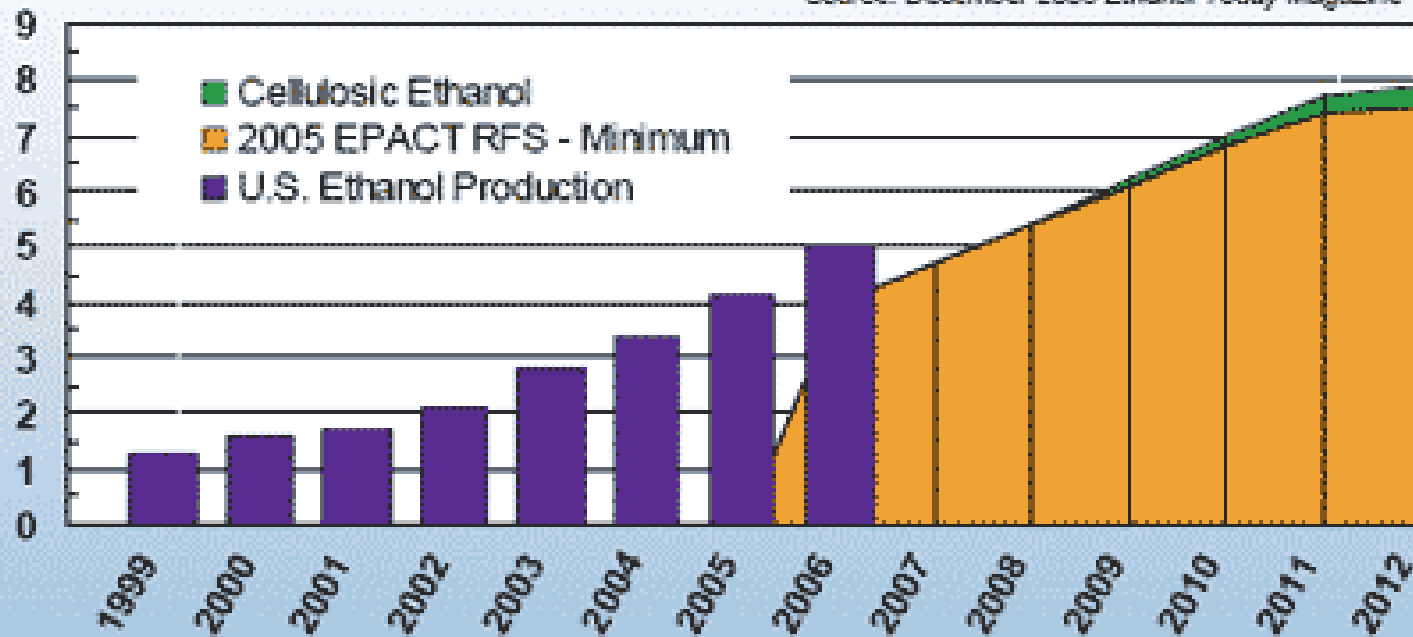
- **Liquid Transportation Fuels**
 - **Corn-based Ethanol (including other low lignin sugar producers)**
 - **Cellulosic Ethanol**
 - **Biodiesel**
- **Biomass Gasification**
 - **Syngas**
 - **Bio-Oils**
 - **Hydrogen**



Future of Ethanol

Actual and Projected U.S. Ethanol Production 1999-2012
Billion Gallons of Production

Source: December 2005 *Ethanol Today Magazine*



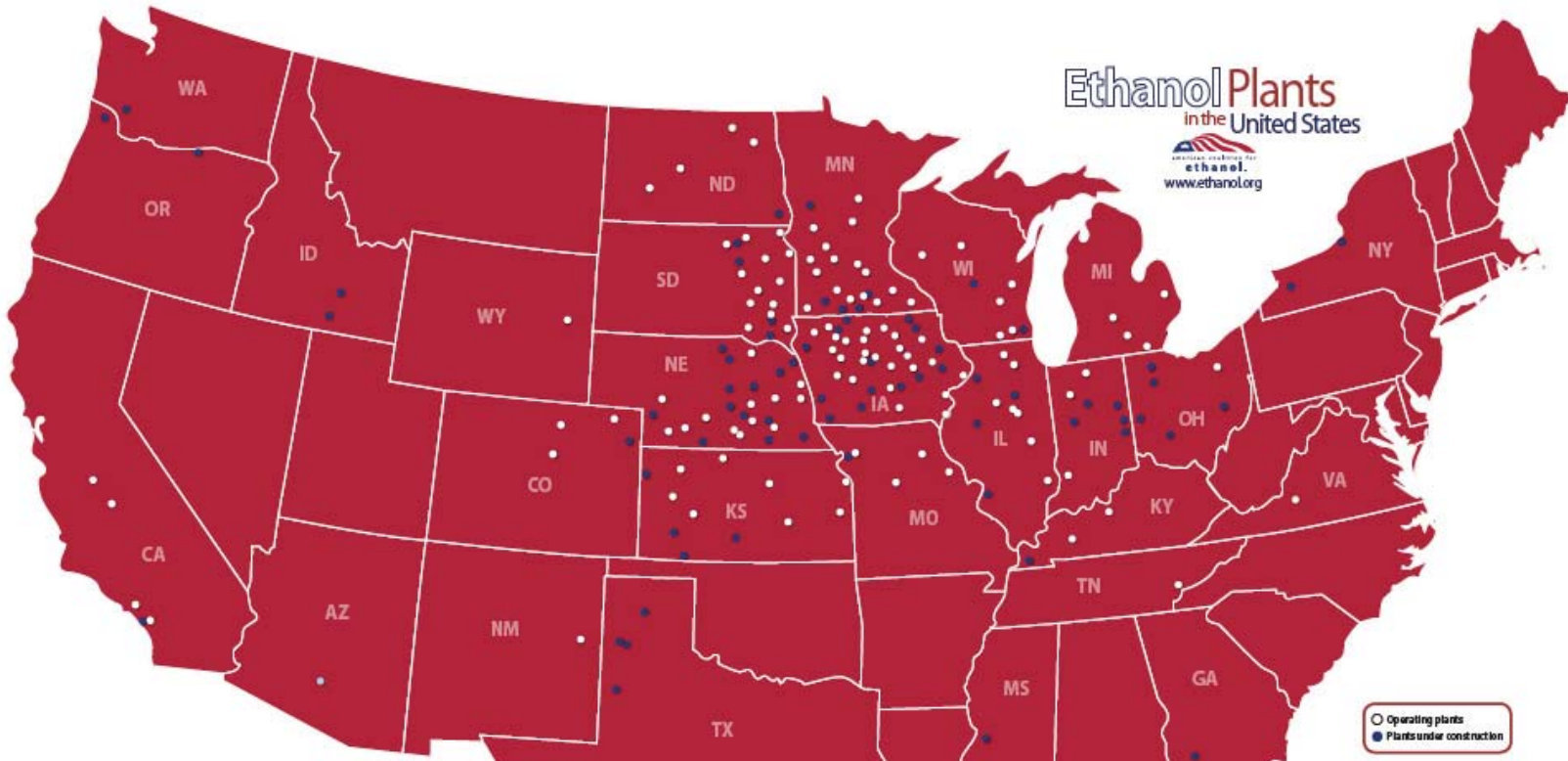
- Renewable Fuels Standard mandates 7.5 billion gallons by 2012
- Total US gasoline market ~140 billion annual gallons

 NREL National Renewable Energy Laboratory

US Ethanol Plants

Ethanol Plants
in the United States

www.ethanol.org



Plants Under Construction *mtpg = million of gallons per year

Plant	State	Capacity (mtpg)	Start Date
Allegany Bioenergy of Kentucky	Kentucky	100	Summer '07
Albion Energy, LLC	Miss	300	Spring '08
Albion Energy, LLC	St. Angele	1A	Winter '07
Albion Energy, LLC	Illinois	300	Fall '07
Albion Energy, LLC	Illinois	110	Winter '07
Albion Energy, LLC	California	110	Spring '08
Albion Energy, LLC	Albion	300	Summer '07
Albion Energy, LLC	Mississippi	300	Fall '07
Albion Energy, LLC	Illinois	300	Summer '07
Albion Energy, LLC	West River	300	Spring '08
Albion Energy, LLC	Iowa	24	Spring '08
Albion Energy, LLC	Illinois	30	Spring '08
Albion Energy, LLC	Illinois	55	Fall '07
Albion Energy, LLC	Illinois	110	Spring '08
Albion Energy, LLC	Illinois	60	Spring '08
Albion Energy, LLC	Illinois	300	Summer '08
Albion Energy, LLC	Illinois	300	Spring '08
Albion Energy, LLC	Illinois	30	Spring '08
Albion Energy, LLC	Illinois	54	Spring '08

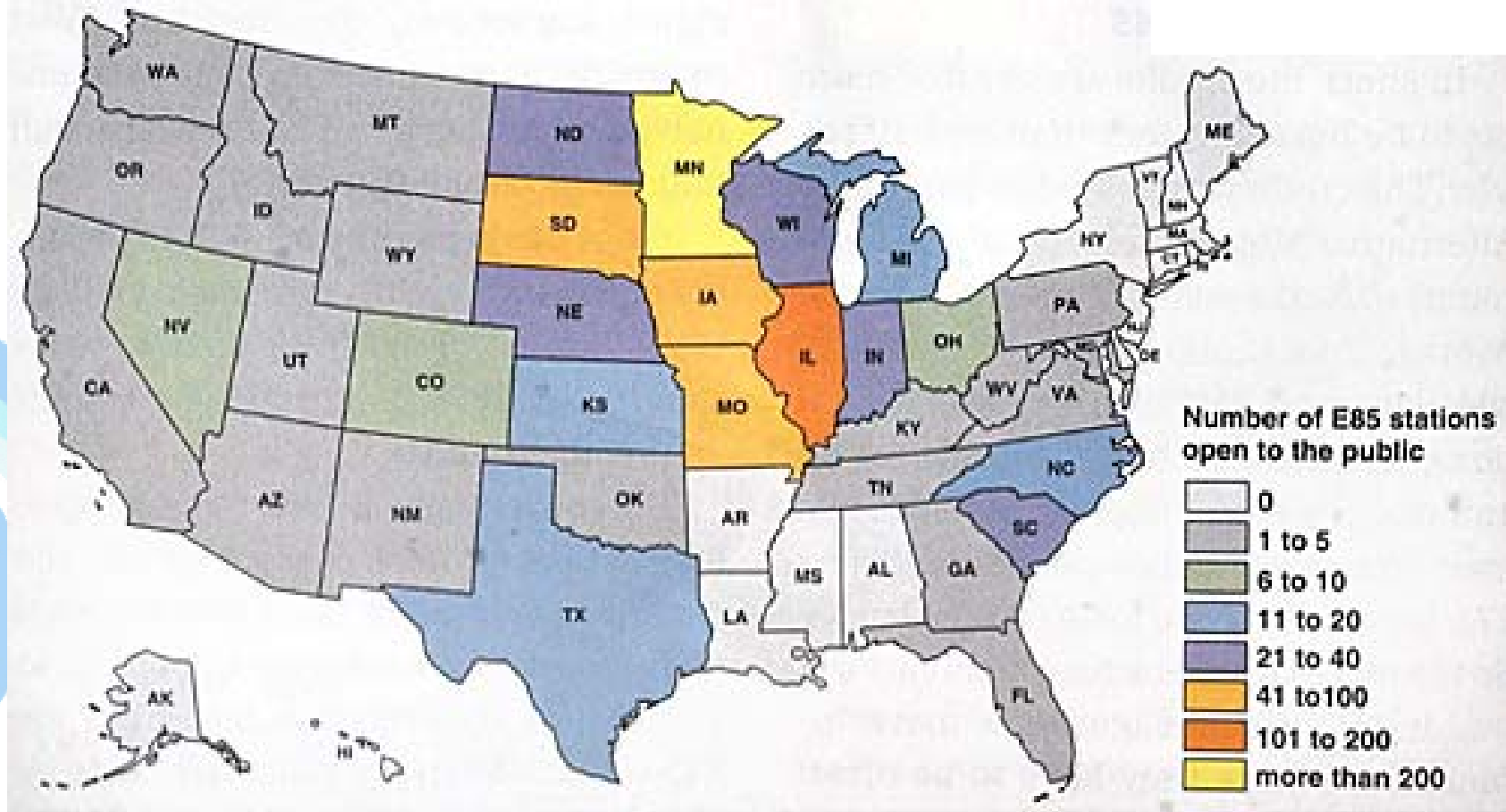
Plant	State	Capacity (mtpg)	Start Date
Central Illinois Energy Cooperative	Illinois	77	Summer '07
Central Indiana Ethanol, LLC	Indiana	40	Spring '07
Central Indiana Ethanol, LLC	Indiana	60	Winter '07
Central Indiana Ethanol, LLC	Indiana	1A	Summer '08
Central Indiana Ethanol, LLC	Indiana	30	Spring '08
Central Indiana Ethanol, LLC	Indiana	30	Winter '07
Central Indiana Ethanol, LLC	Indiana	50	Fall '07
Central Indiana Ethanol, LLC	Indiana	300	Spring '08
Central Indiana Ethanol, LLC	Indiana	55	Fall '07
Central Indiana Ethanol, LLC	Indiana	55	Fall '07
Central Indiana Ethanol, LLC	Indiana	50	Fall '07
Central Indiana Ethanol, LLC	Indiana	50	Summer '07
Central Indiana Ethanol, LLC	Indiana	300	Winter '07
Central Indiana Ethanol, LLC	Indiana	44	Summer '07
Central Indiana Ethanol, LLC	Indiana	40	Summer '07
Central Indiana Ethanol, LLC	Indiana	40	Fall '07
Central Indiana Ethanol, LLC	Indiana	300	Winter '07
Central Indiana Ethanol, LLC	Indiana	44	Spring '07
Central Indiana Ethanol, LLC	Indiana	300	Fall '07
Central Indiana Ethanol, LLC	Indiana	60	Spring '08

Plant	State	Capacity (mtpg)	Start Date
Midwest Ethanol, LLC	Alaska	40	Spring '08
Midwest Ethanol, LLC	Alaska	200	Winter '07
Midwest Ethanol, LLC	Alaska	15	Summer '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	15	Winter '07
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08
Midwest Ethanol, LLC	Alaska	200	Spring '08

Plant	State	Capacity (mtpg)	Start Date
Support Ethanol, LLC	Alaska	20	Fall '07
Support Ethanol, LLC	Alaska	100	Summer '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08
Support Ethanol, LLC	Alaska	100	Spring '08

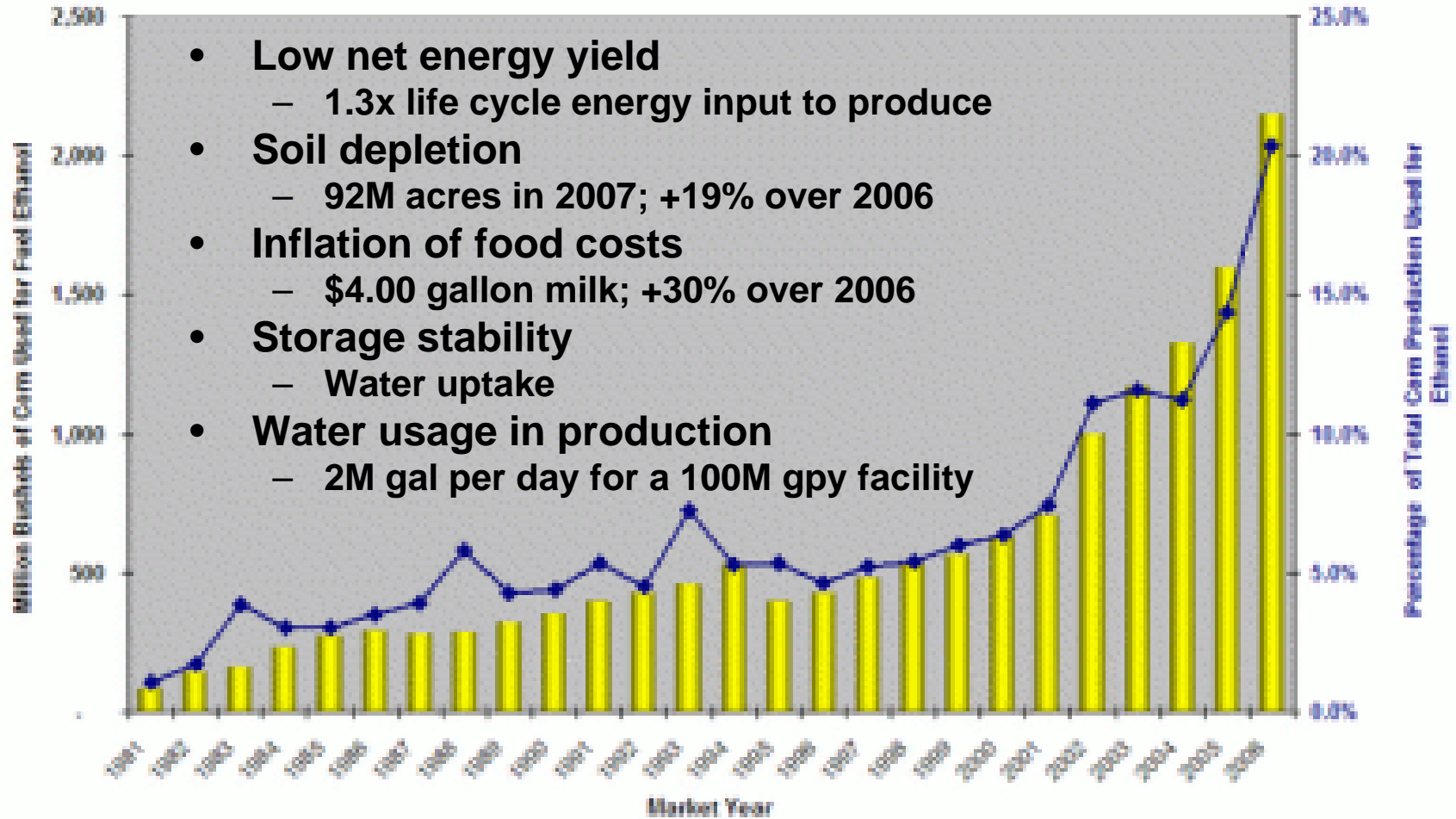
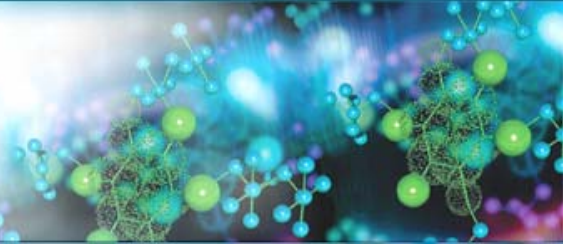


Ethanol Fueling Stations



Consumer Reports October 2006

Issues with Corn-Based Ethanol



- **Low net energy yield**
 - 1.3x life cycle energy input to produce
- **Soil depletion**
 - 92M acres in 2007; +19% over 2006
- **Inflation of food costs**
 - \$4.00 gallon milk; +30% over 2006
- **Storage stability**
 - Water uptake
- **Water usage in production**
 - 2M gal per day for a 100M gpy facility

Source: USDA



Cellulosic Ethanol Demonstration Plants



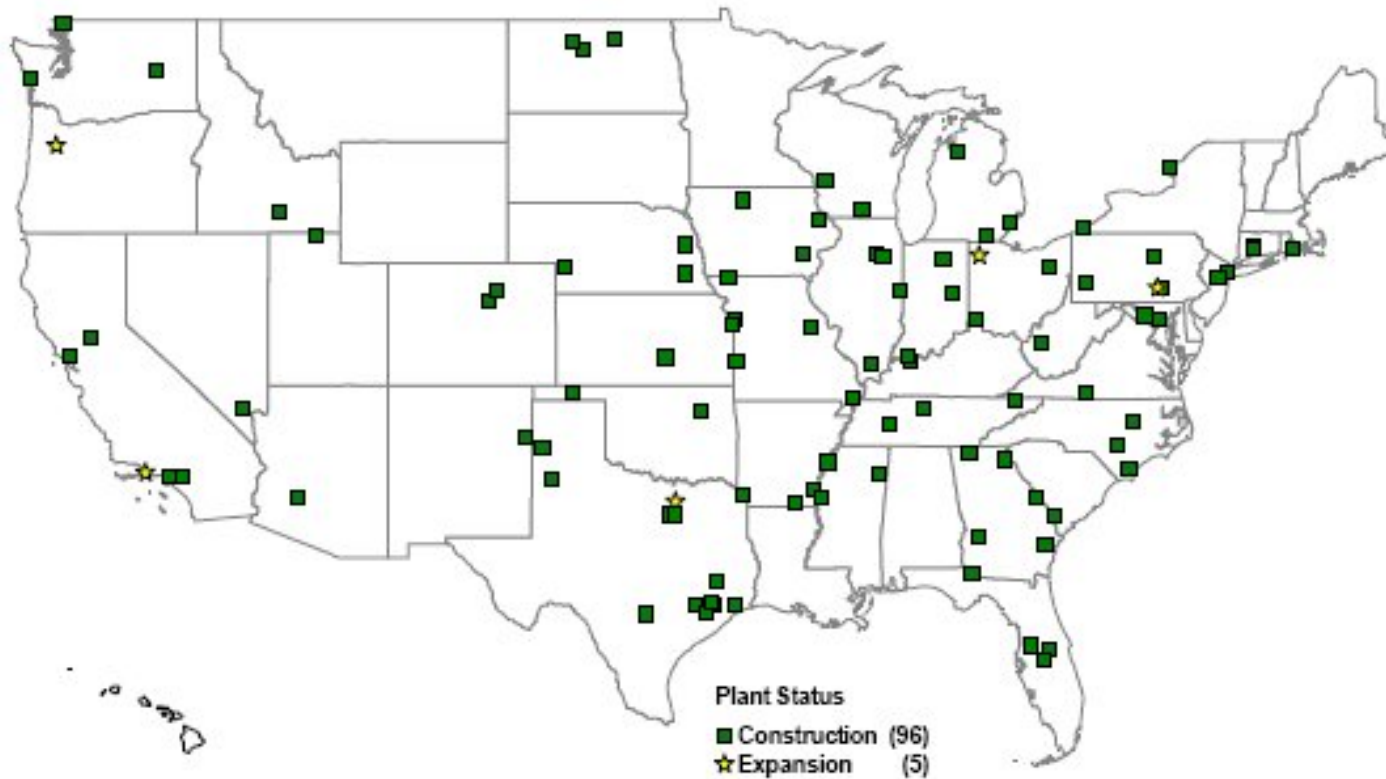
- **Locations**
 - 6 demonstration units throughout the Southeast (FL, GA, TN, MS, AL, NC)
- **Technologies**
 - Acid Hydrolysis
 - Enzymatic Hydrolysis
 - Thermochemical Processes
- **Issues**
 - Rate to produce ethanol is slow
 - Conversion efficiency is low
 - Little existing infrastructure to collect and transport cellulosic materials



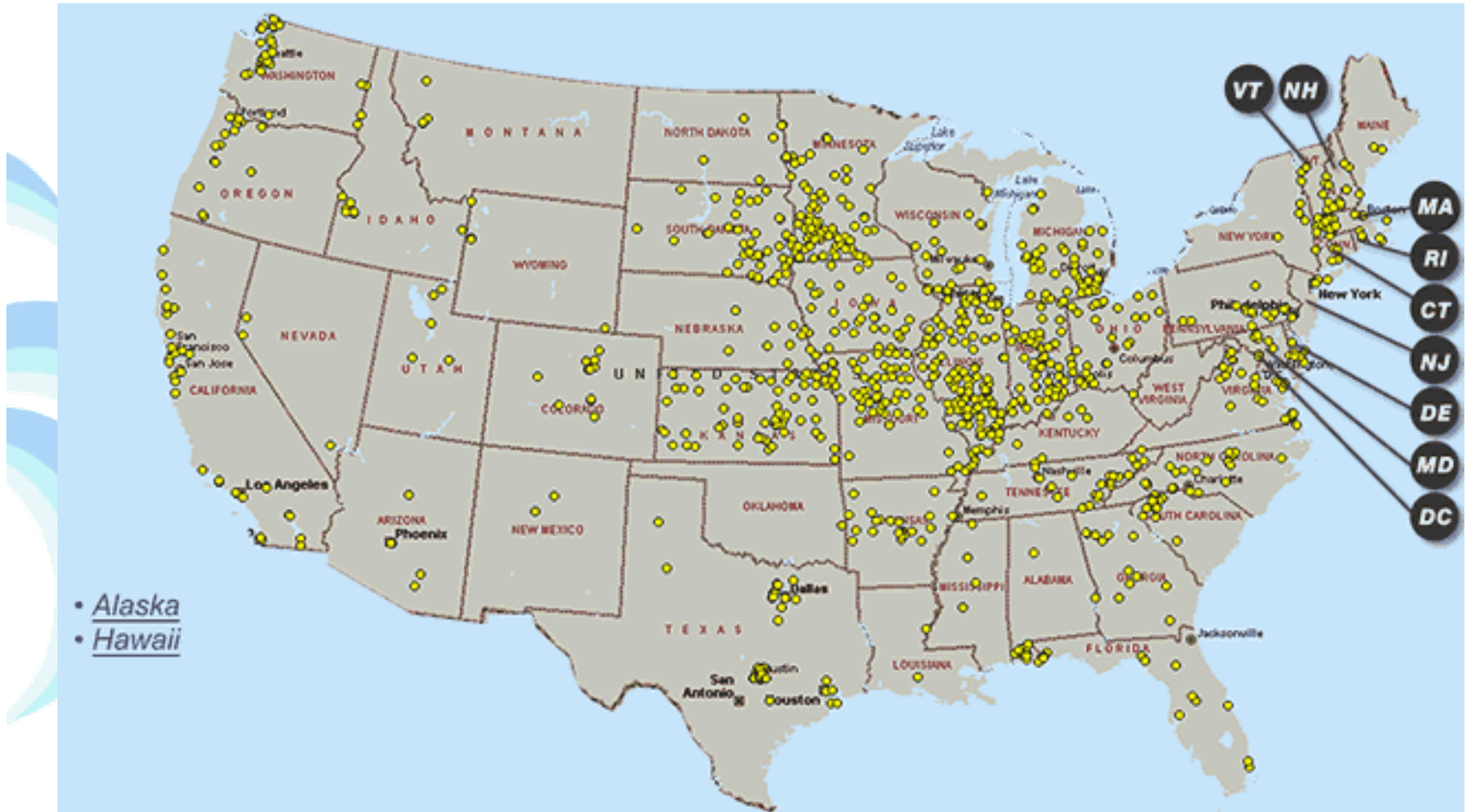
Biodiesel Production Facilities



Biodiesel Production Plants Under Construction or Expansion (June 7, 2007)



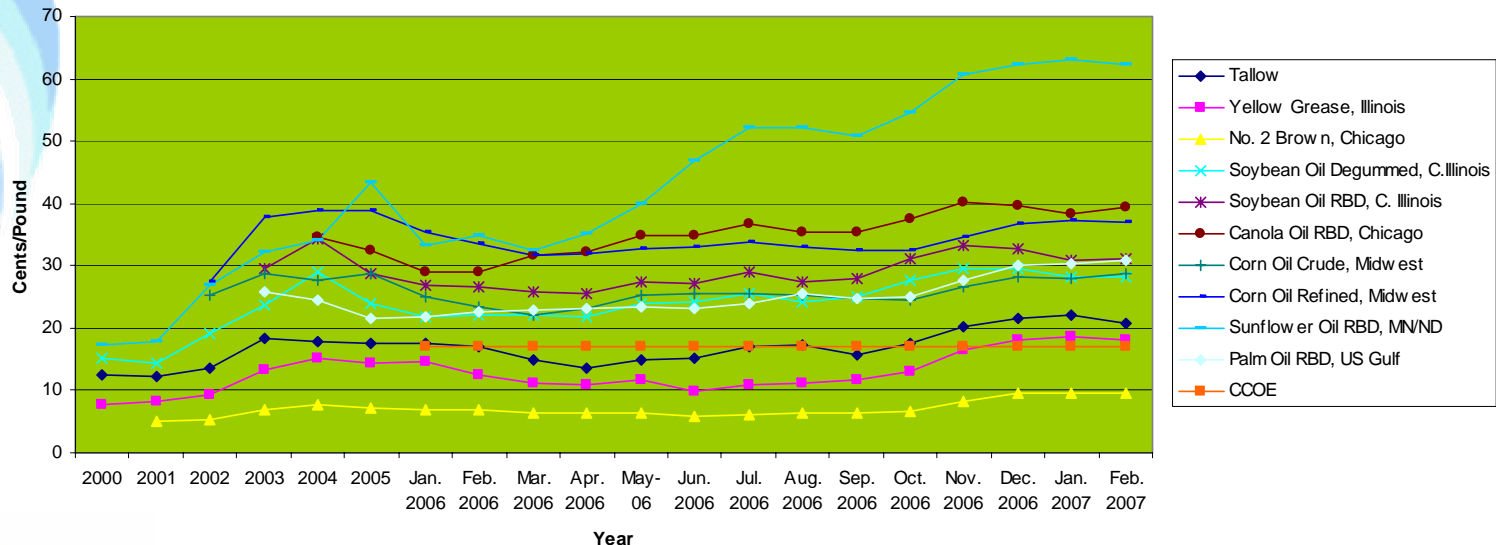
Biodiesel Fueling Stations



Issues with Biodiesel Production

- **Single feedstock plants**
 - Most biodiesel plants in US use refined soy oil
- **Feedstock supply**
 - ADM, Cargill and Bungee control 80+% of soy oil crushing in US
- **Feedstock costs**

Market Sizing - Feedstock Pricing



Further Biodiesel Issues

- **Production quality**
 - At lower temperatures, off-spec biodiesel begins to solidify
 - ASTM 6751 specification seeks to provide consistency in product quality
 - BQ-9000 is a process quality standard
 - Few plants have achieved BQ-9000
- **Consistent supply**
 - Distributors require consistent supply at or below the wholesale price for petro-diesel
 - 20% of biodiesel plants in US were shut down in 2006 due to feedstock cost/availability
- **Tax incentive economics**
 - Without the \$1.00 federal blending tax credit, the biodiesel market can not be economically viable at current petro-diesel prices

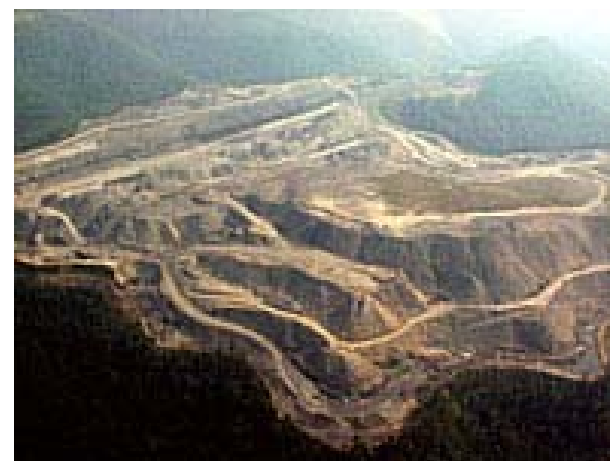
Biomass Gasification

- **Locations**
 - Some facilities co-located with pulp and paper facilities
- **Technologies**
 - Complete gasification
 - Fast pyrolysis
 - Slow pyrolysis
- **Limitations**
 - Bio-oil stability
 - Syngas may not be pipeline quality



Land Application of Pyrolysis Char

- **Pyrolysis char has been found to be an excellent soil amendment**
 - Increases carbon content in soil
 - Slow release of nutrients (years)
 - Provides host site for beneficial microbial content
- **Demonstration in Australia on depleted soils have been excellent**



EPRIDA/JUGA BIO-CONVERSION CENTER

Conclusions

- **West Virginia is late to the game**
 - No ethanol facilities
 - 2 biodiesel facilities (1 under construction + 1 planned)
 - Few commercial ethanol filling stations
 - No commercial biodiesel filling stations
 - Little production of ethanol and biodiesel feedstocks
 - No state mandates or incentives
- **West Virginia policy makers must create an environment that encourages the production and distribution of biofuels**
- **West Virginia may have a brighter future in biomass gasification and cellulosic ethanol**

