



Overview of US BioEnergy Market

West Virginia BioEnergy Forum

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**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

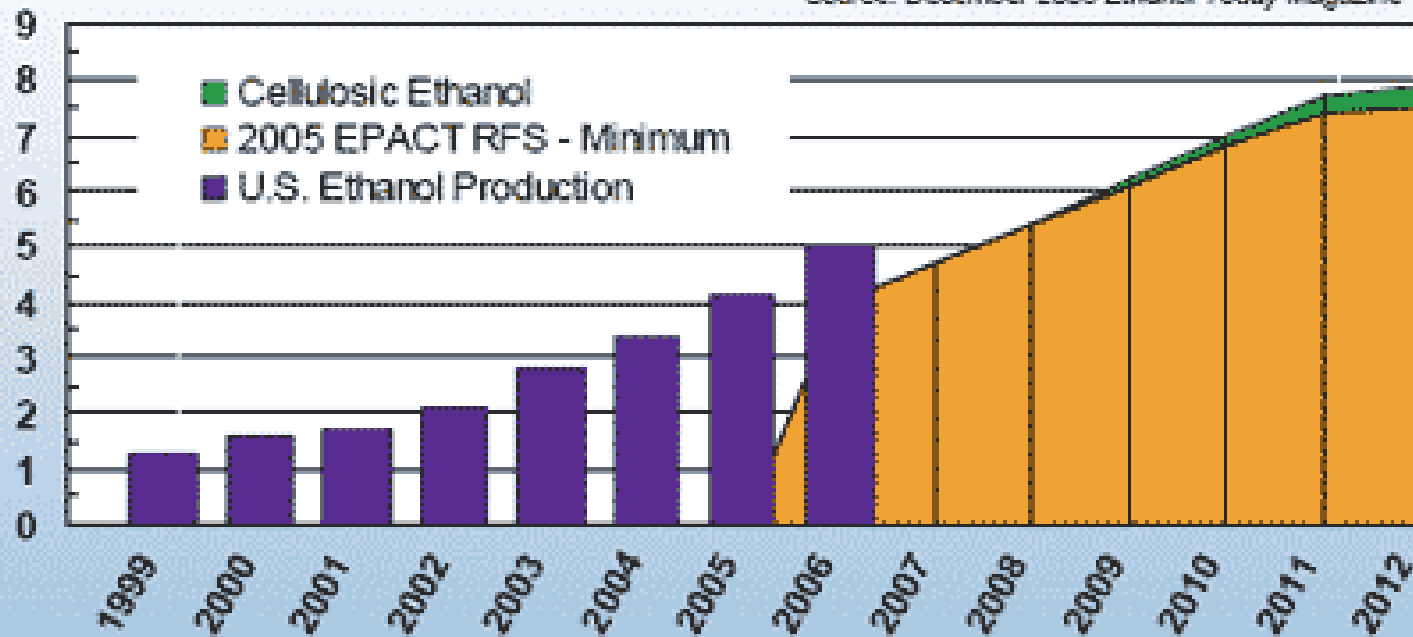
- **Liquid Transportation Fuels**
 - **Corn-based Ethanol (including other low lignin sugar producers)**
 - **Cellulosic Ethanol**
 - **Biodiesel**
- **Biomass Gasification**
 - **Syngas**
 - **Bio-Oils**
 - **Hydrogen**



Future of Ethanol

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

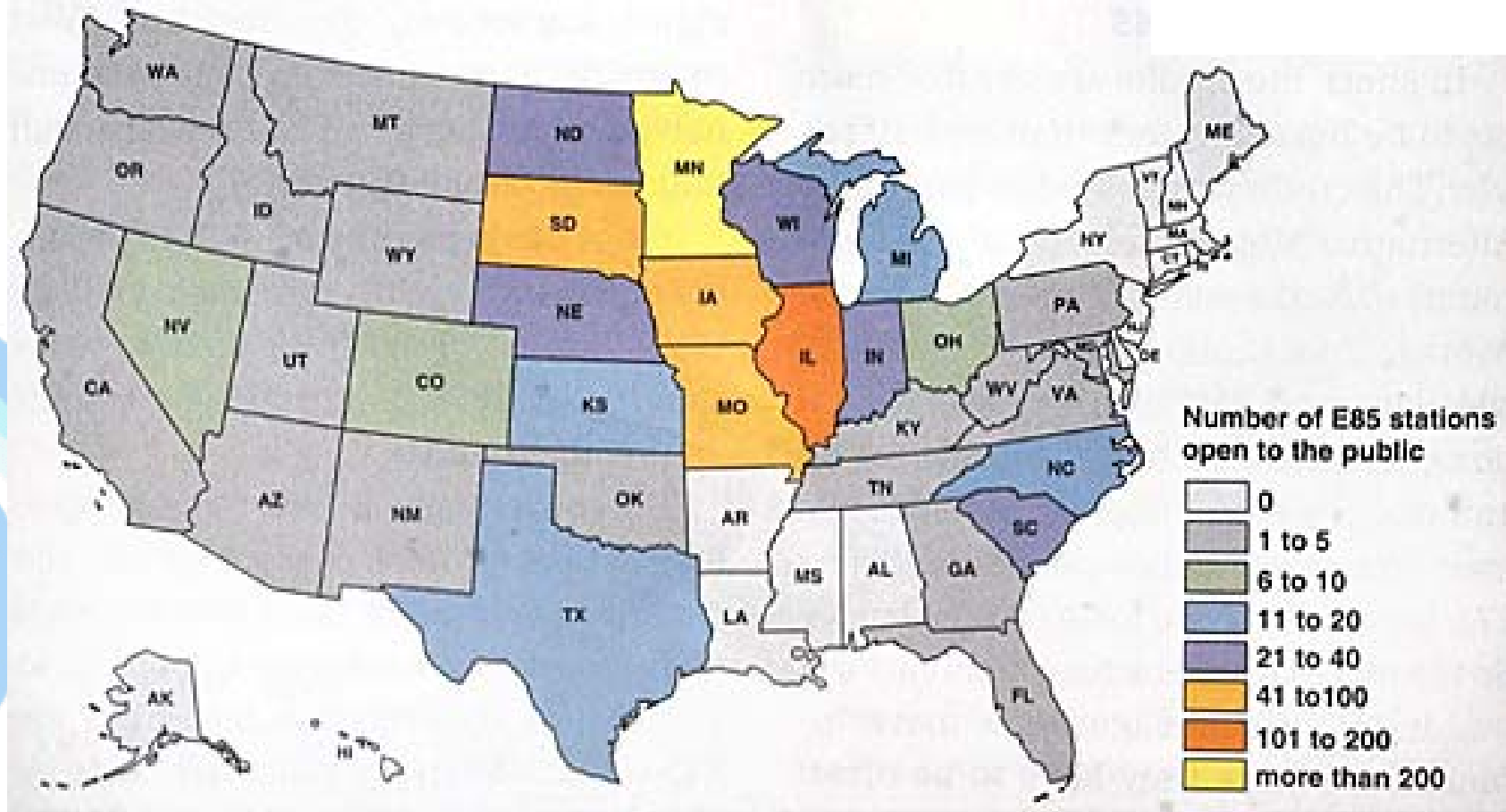
Source: December 2005 *Ethanol Today Magazine*



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

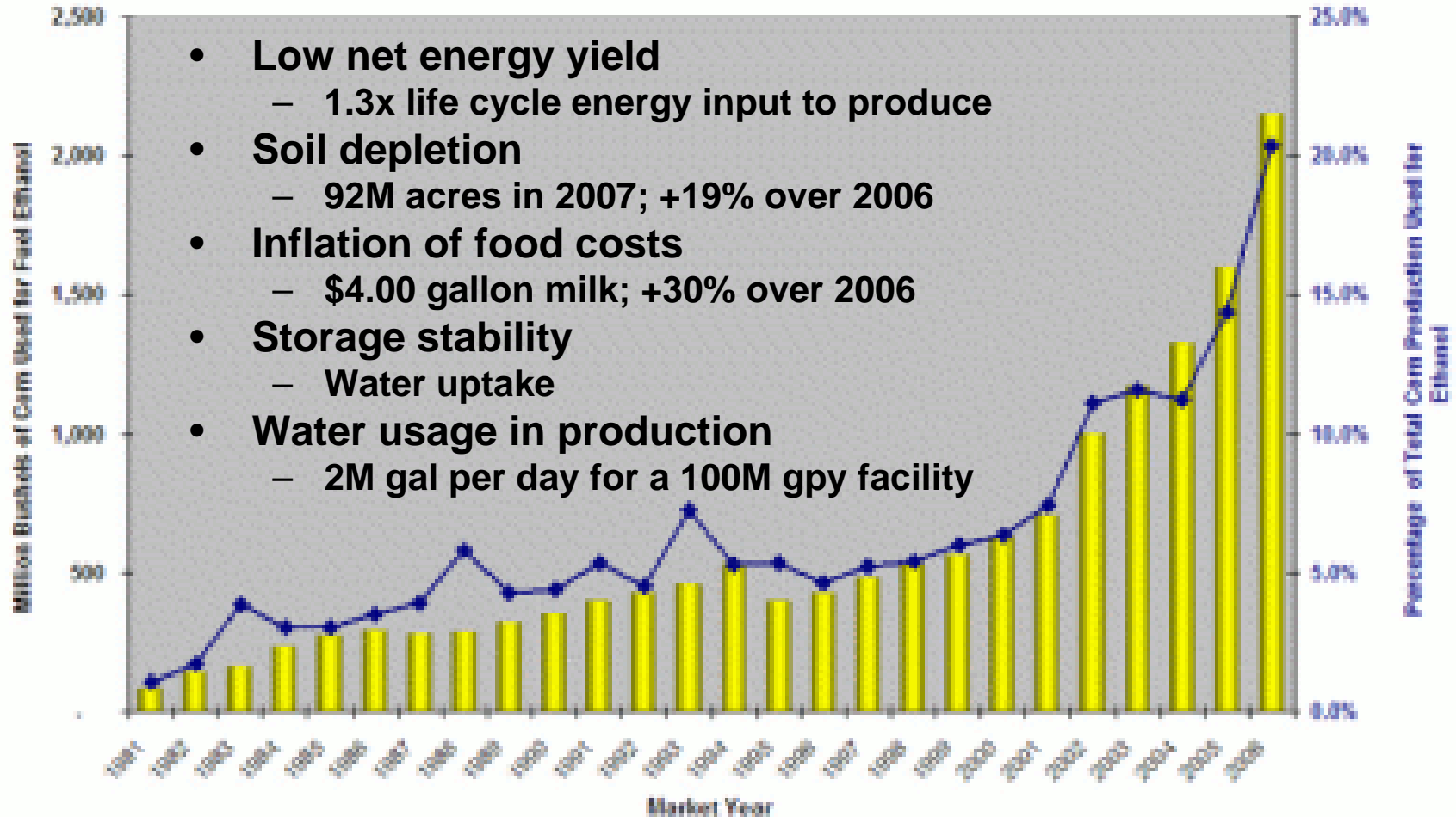
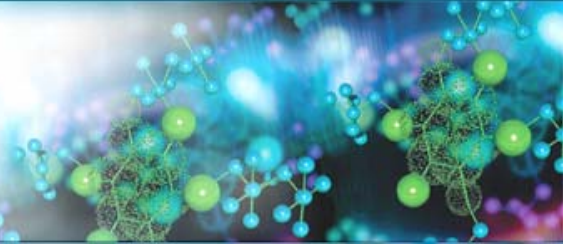
 NREL National Renewable Energy Laboratory

Ethanol Fueling Stations



Consumer Reports October 2006

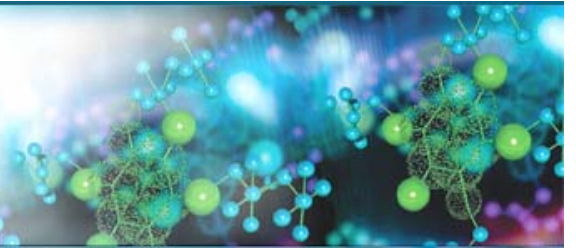
Issues with Corn-Based Ethanol



- **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

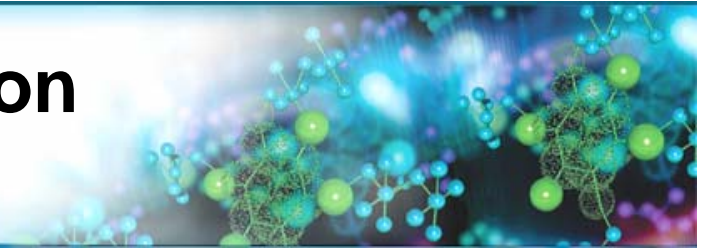
Advantages of Cellulose-Based Ethanol Over Corn-Based



- **Cellulose-based feedstocks can be grown cheaper.**
- **The potential supply is many times larger.**
- **There are many sources of these feedstocks: grasses, trees, municipal waste, waste wood, other waste streams, corn stover, bagasse.**
- **These feedstocks are not otherwise used for foods.**



Cellulosic Ethanol Demonstration Plants



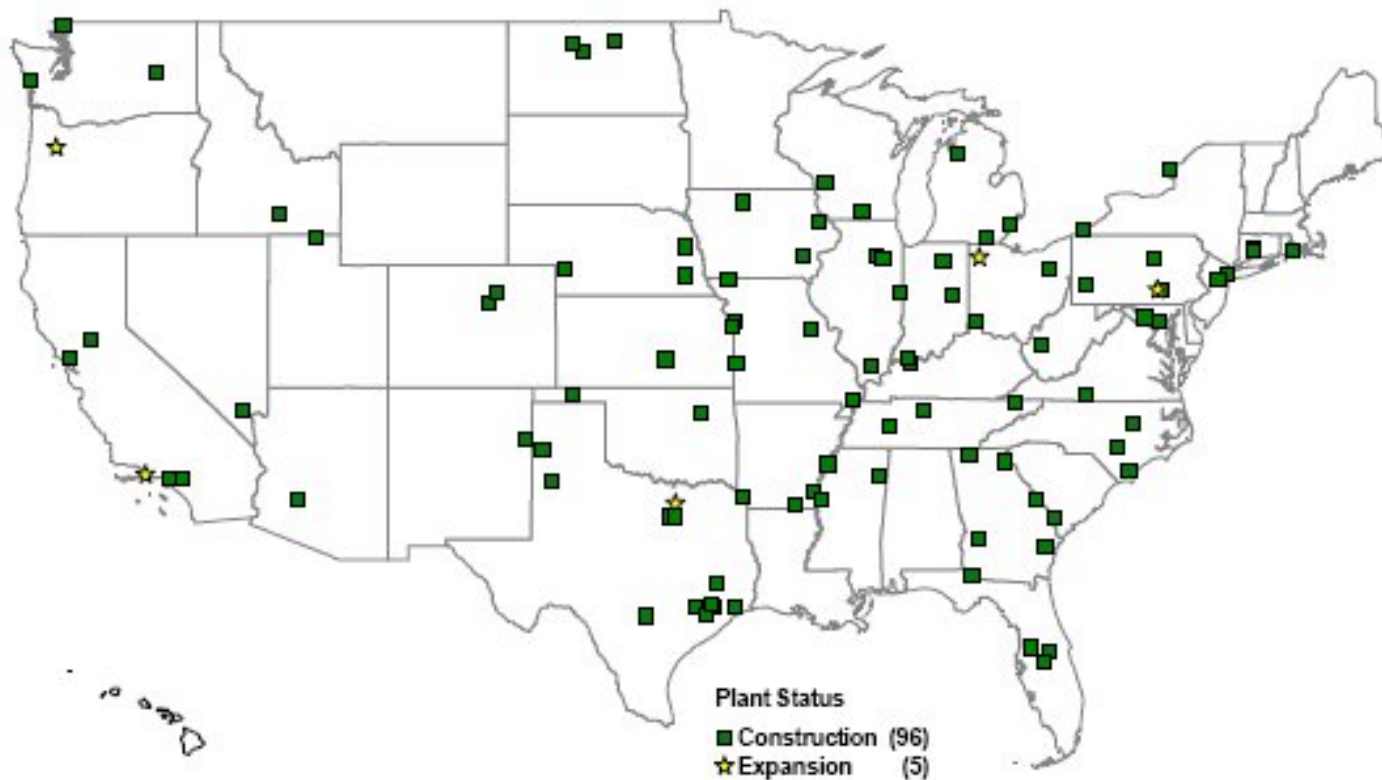
- **Locations**
 - 6 demonstration units throughout the Southeast (FL, GA, TN, MS, AL, NC)
- **Technologies**
 - Acid Hydrolysis
 - Enzymatic Hydrolysis
 - Organosolv Processes
- **Issues**
 - Rate to produce ethanol is slow
 - Conversion efficiency is low
 - Little existing infrastructure to collect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



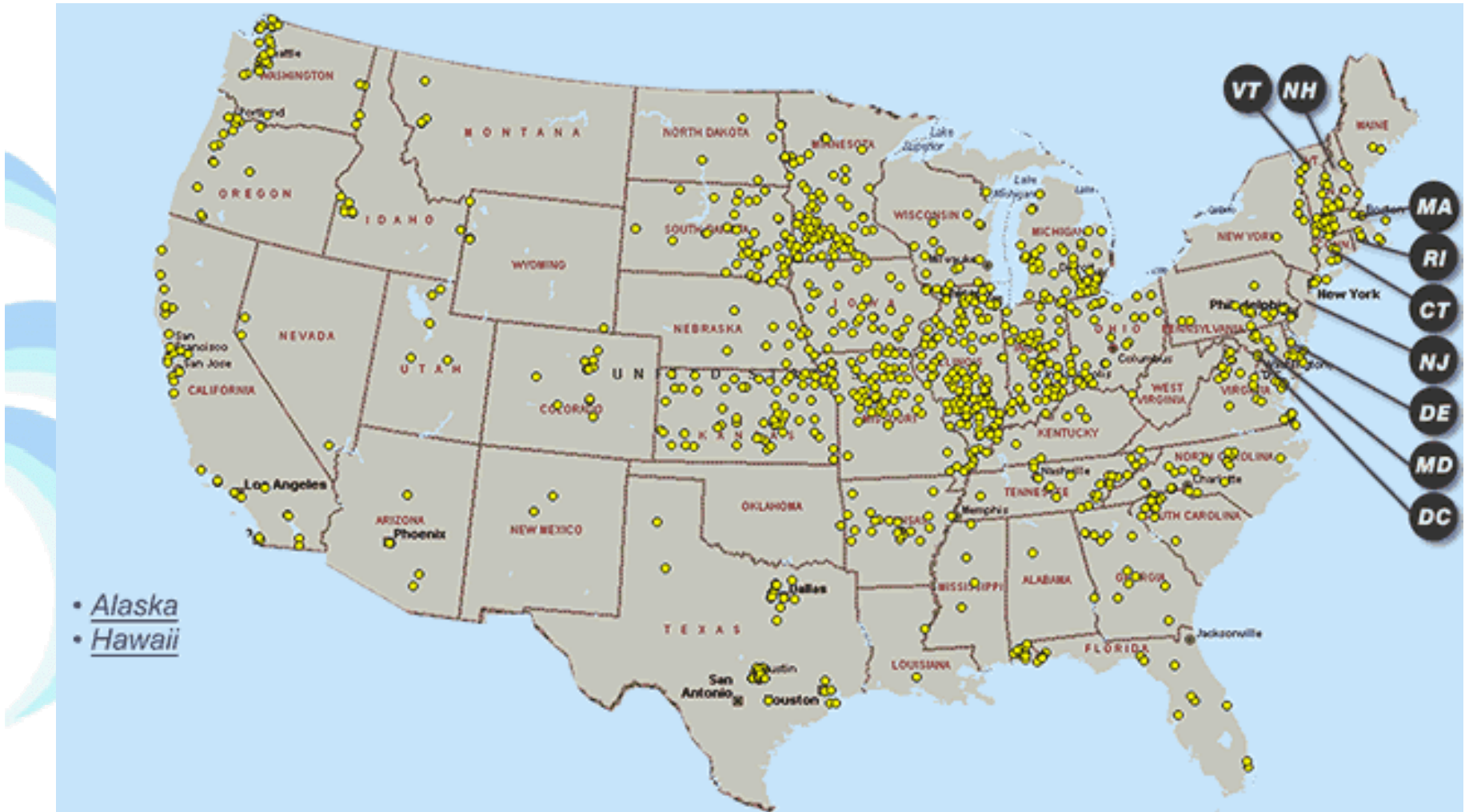
Biodiesel Production Facilities



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



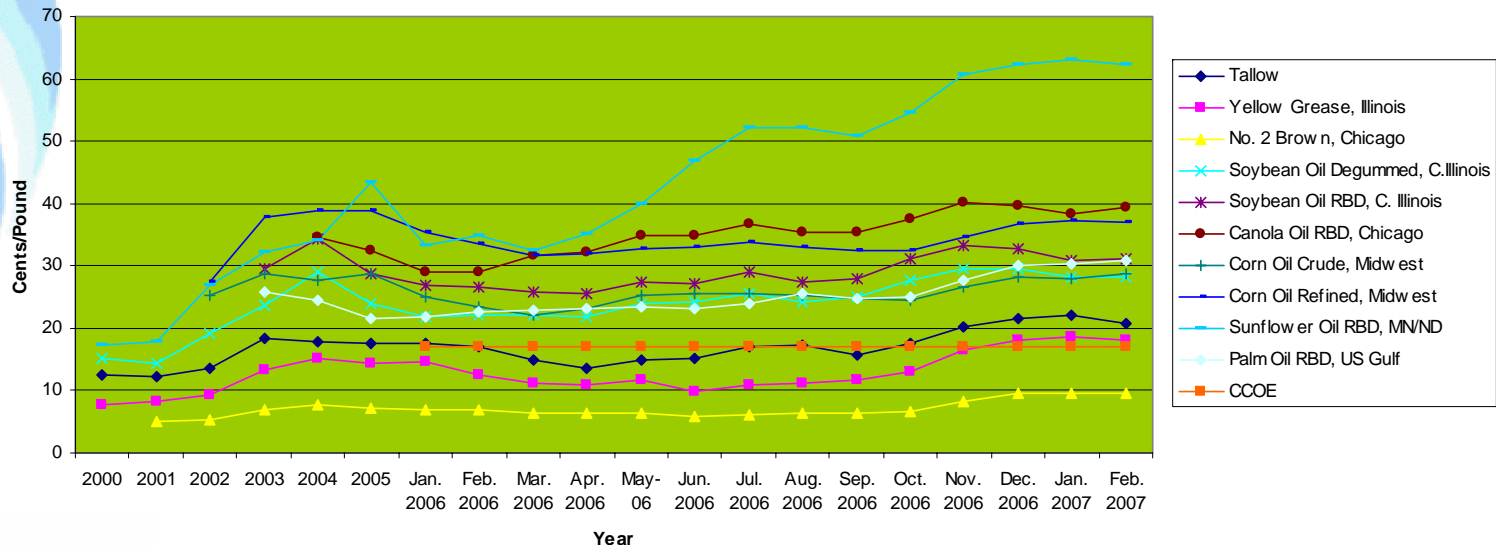
Biodiesel Fueling Stations



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
 - Methane 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**

