Energy In Agriculture:
Managing the Risk

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RMA Risk Management Agency

The Economics of Energy Production In Agriculture

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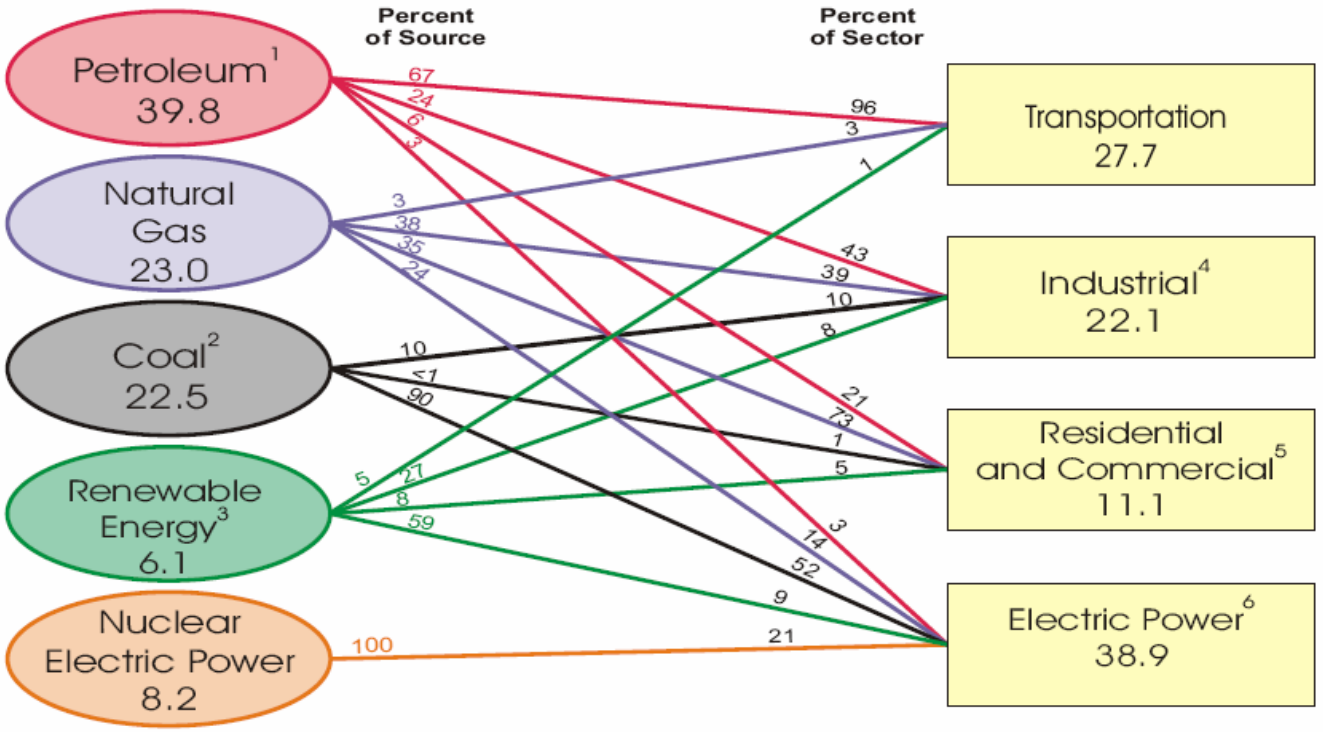
My comments will:

- document the current contribution agricultural renewables are making to the nation's energy supply,
- discuss the economics of energy production from agricultural renewables, and
- summarize some recent studies that estimate the amount of renewable energy agriculture could produce, and use them to speculate on agriculture's contribution in 2025.

U.S. Primary Energy Consumption by Source and Sector, 2004



[1]Excludes 0.3 quadrillion Btu of ethanol, which is included in "Renewable Energy."
[2]Includes coal coke net imports.
[3]Conventional hydroelectric power, wood, waste, alcohol, geothermal, solar, and wind.
[4]Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
[5]Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
[6]Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public.

Note: Sum of components may not equal 100 percent due to independent rounding.
Source: Energy Information Administration, *Annual Energy Review 2004*, Tables 1.3 and 2.1b-2.1f.

U.S. Energy Production from Renewable Sources, 2004

Renewables	Quads	Percent
Hydroelectric	2.275	44
Wood	1.989	33
Waste	0.560	10
Alcohol	0.296	5
Geothermal	0.340	5
Wind	0.143	2
Solar	0.063	1
Total	6.116	100

Source: DOE. Annual Energy Review 2004 Tables 10.2a and 10.2b

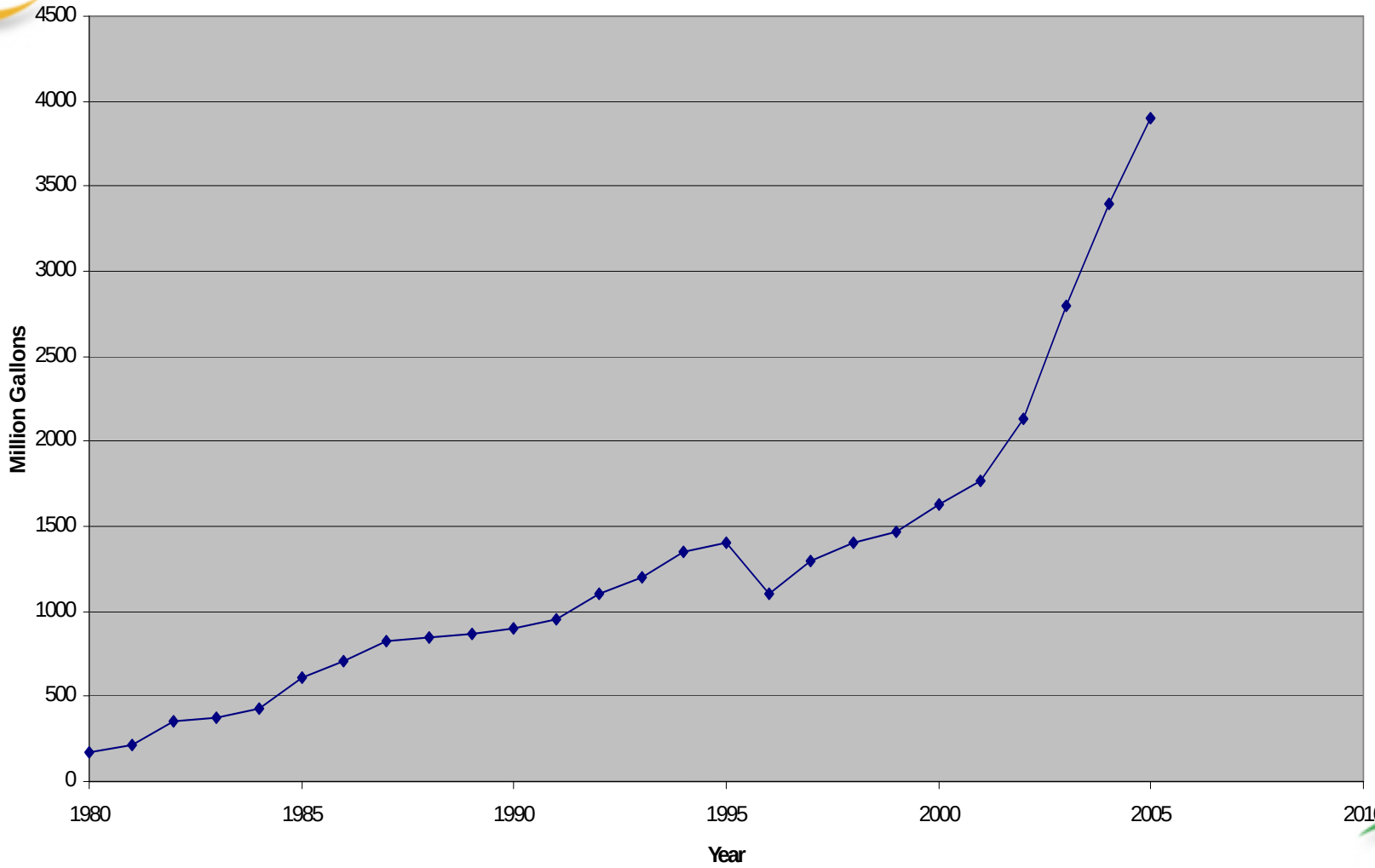
Electricity, Gasoline and Diesel Use During 2004 and the Proportion from Renewables

	2004 Consumption	Amount from Renewables	% from Renewables
Gasoline (Bill Gal.)	136.008	3.4	2.5
Diesel (Bill. Gal.)	42.525	0.025	0.06
Electricity (Bill. Kwh)	3,953	358.8	9.08
Hydroelectric		269.6	6.82
Wood		37.3	0.94
Waste		22.7	0.57
Geothermal		14.4	0.36
Wind		14.2	0.36
Solar		0.6	0.02

Source: DOE. *Annual Energy Outlook 2005*.Tables 5.13c and 8.2a

Ethanol

Ethanol Production Has Been Growing Rapidly



We expect to produce about 4.8 billion gallons in 2006, but current demand is very strong.

- How much ethanol is needed to replace MTBE and meet other blending demands?

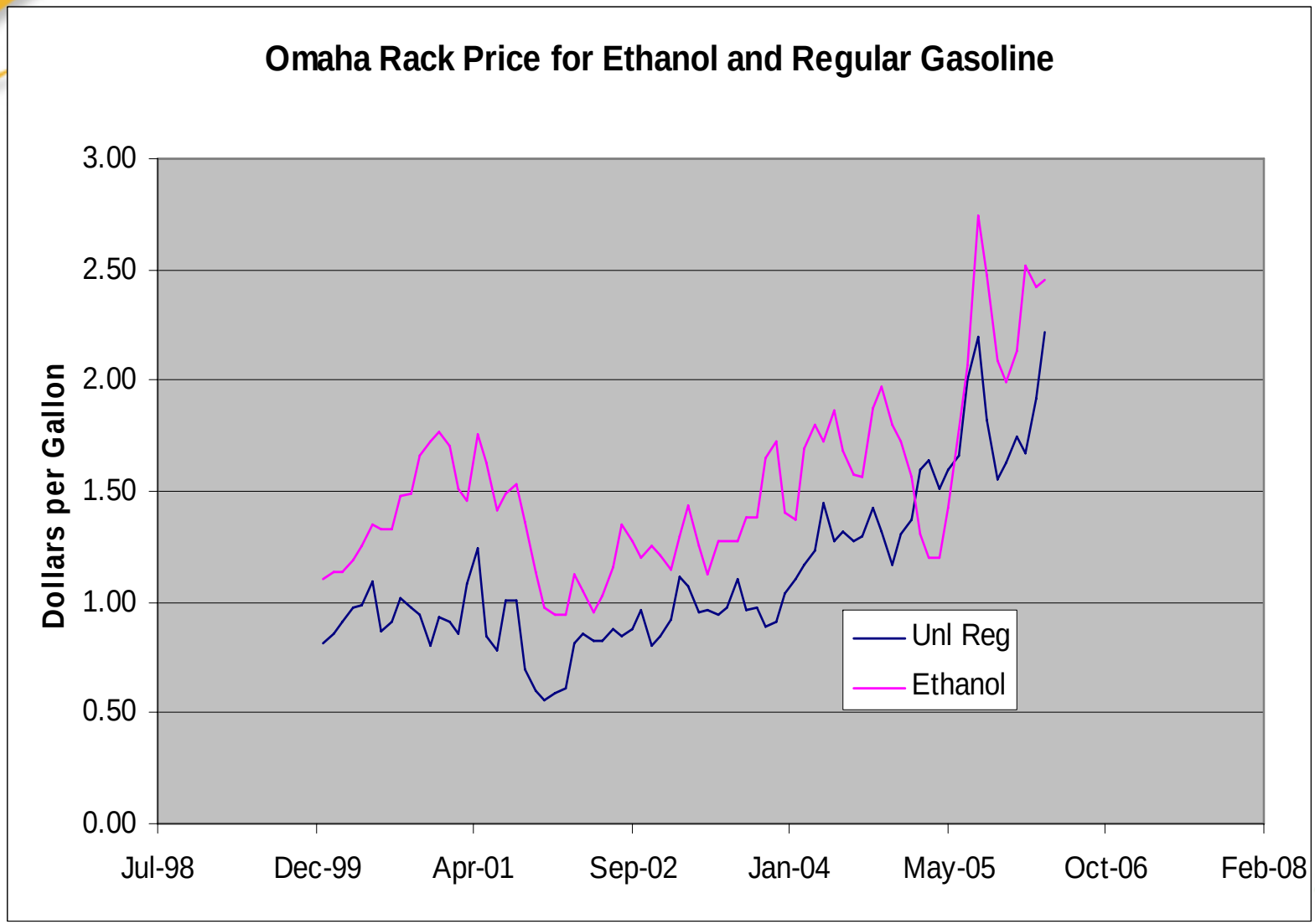
	Billion Gallons/Year
Ethanol production rate Nov. 2005	4.22
Additional needed to replace MTBE	1.99
Total	6.21

Source: EIA. *Eliminating MTBE in Gasoline in 2006.* Department of Energy, Washington, D.C. 02/22/06.

Expected Increase in U.S. Ethanol Production Capacity

	Annual Production Capacity
January 2006	4.34
January 2007	6.03
January 2008	6.91

Source: Developed fro testimony by Bob Dinneen, President of the Renewable Fuels Association, before the Environment and Public Works Committee, U.S. Senate, March 29, 2006.


Omaha Rack Price for Ethanol and Regular Gasoline
Dollars per Gallon
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Jul-98
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Unl Reg
Ethanol

As ethanol production expands, we can expect ethanol prices to return to lower levels.

- Wholesale price of regular gasoline = $0.036 + $.029(Price of Crude Oil/brl)

Crude Oil/Brl	Gasoline/Gallon	Ethanol w/$0.35 Premium
$40	$1.20	$1.55
50	1.49	1.84
60	1.78	2.13
70	2.07	2.42

- Some reasons ethanol's traditional premium may be reduced.
  - Energy Policy Act 2005 provides flexibility in the way refiners meet environmental requirements – no oxygenate requirement.
  - Conversion of MTBE production capacity to isooctene and isooctane production.
  - Blender's credit may be modified.
- A reason the premium may be maintained.
  - Consumer demand for renewable fuels continues to grow.

Our model to estimate the profitability of a dry mill ethanol plant suggests

- that without specific subsidies for the plant, the cost per gallon of denatured ethanol with corn at $2.00 per bushel and natural gas at $10.00 is $1.526 per gallon of denatured ethanol,

- the coproducts produced are 1 gallon of denatured ethanol, 6.4 pounds of DDGS and 6.4 pounds of CO2, and

- selling the DDGS at $.04 per pound gives a net cost of $1.27 per gallon of denatured ethanol.

The cost per gallon and profitability of the plant are very sensitive to

- Price of natural gas. Each increase of $1.00 per mmbtu raises the cost of ethanol $0.034 per gallon.

- Price of corn. An increase of $0.10 per bushel increases cost per gallon $0.0356.

Corn Price	Net Cost/ Gallon
$2.00	$1.27
2.50	1.45
3.00	1.63
3.50	1.80
4.00	1.98

Our work on economies of scale and alternative processing plant fuels suggests

- economies in investment and operating costs of about $0.035 per gallon of ethanol for NG plants as plant size increases from 50 to 100 mmgpy. The larger plants are expected to obtain additional economies in marketing, transportation and risk management.
- Investment and operating costs per gallon of ethanol for plants burning corn stover (@$50/ton) would be about $0.15 less than the cost with NG at $10 per mmbtu.
- DDGS at $66 per ton and corn stover at $50 per ton have the same cost per gallon of ethanol.
- Coal fired plants (w/coal at $1.80/mmbtu) have a cost advantage of $0.207 per gallon of ethanol compared to NG plants at $10/mmbtu.

Ethanol from Lignocellulosic Biomass

- Analysis based on Aden, *et.al. Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis for Corn Stover. NREL/TP-510-32438. 2002.*

- Plant designed to process 2,205 tons per day (2000 metric tons).

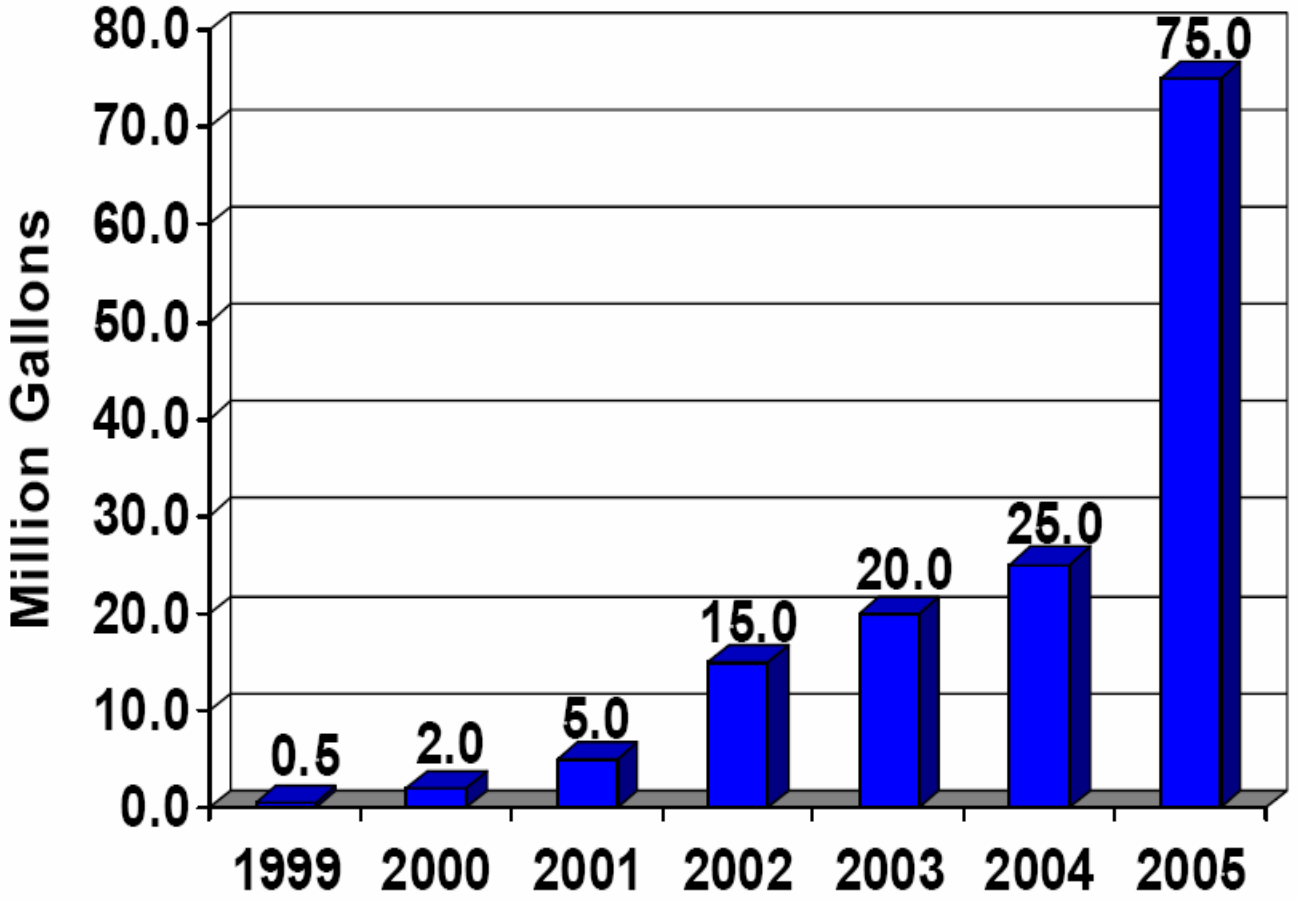
- Estimated costs are for the nth plant.
  - start up after 2010
  - project investment ($2005) of $250,797,000.
  - Operating costs of $81,200,800 including buying the biomass at $30 per ton.
- Production
  - Initial conversion rate of 67.8 gallons per ton.
  - Later conversion rate of 89.7 gallons per ton
  - Also produce 3.7 kWHper gallon of anhydrous ethanol, use 1.42 in the plant and sell 2.28 @ $.041

Estimated Production Cost per Gallon of Denatured Ethanol Produced From Lignocellulosic Biomass, based on Aden, et.al.

Conver-sion Rate	Cost of Feedstock	Enzyme	Plant Output Million Gallons / Year		Denatured	Investment
Gal/Ton	**$ / Ton**	**Cost / Gal**	**Anhydrous**	**Denatured**	**Cost/Gal.**	**Cost/Gal.**
Base Case						
67.8	30	0.10	52.3	53.4	1.52	4.70
		0.20			1.62	
	50	0.10			1.81	
		0.20			1.91	
Future Case 89.7	30	0.10	69.3	70.7	1.15	3.55
		0.20			1.25	
	50	0.10			1.37	
		0.20			1.47	

Biodiesel

Estimated US Biodiesel Production



Estimates of Biodiesel Production Costs

- Based on Hass, et. al. “A process Model to Estimate Biodiesel Production Costs.” Elsevier. 2005.
  - 10 million gallon annual capacity
  - continuous-process vegetable oil transesterification plant w/ ester and glycerol recovery.
  - Investment cost of $11.5 million.
  - Operating and capital costs of $0.505 per gallon
  - No credit for sale of glycerol.

Biodiesel Costs for a 10-Million Gallon Per Year Plant

Biodiesel From Soybean Oil Cost Per Gallon			Biodiesel From Yellow Grease Cost Per Gallon		
Degummed Soybean Oil $/lb.	w/o Tax Credit	w/$1.00/Gal. tax Credit	Yellow Grease $/lb.	w/o Tax Credit	w/$0.50/ Gal. Tax Credit
$0.15	$1.61	$0.61	$0.074	$1.07	$0.57
0.20	1.98	0.98	0.098	1.25	0.75
0.25	2.35	1.35	0.122	1.44	0.94
0.30	2.73	1.73	0.147	1.63	1.13
0.35	3.09	2.09	0.168	1.81	1.31

Biodiesel Demand

- Many niche markets including 400 fleets of vehicles associated with school districts, city and state governments, and federal agencies will grow to 6.5 million/year by 2010.
- State mandates – MN for 17 million/year.
- Potential demand as a lubricity agent for ultra-low sulfur diesel fuel, but industry has rejected the possibility.

Production Potential for Biodiesel

Oil Type	Million Pounds*	Million Gallons**
Soybean Oil	18,309	2,378
Corn Oil	2,436	316
Canola Oil	603	78
Other Vegetable Oils	1,489	193
Yellow grease & Grease	2,656	345
Lard	1,090	142
Edible Tallow	1,894	246
Inedible Tallow	3,696	480
Total Supply	32,173	4,178

*2000-2004 U.S. average production.

** Gallons computed using a conversation ratio of 7.7 pounds per gallon.

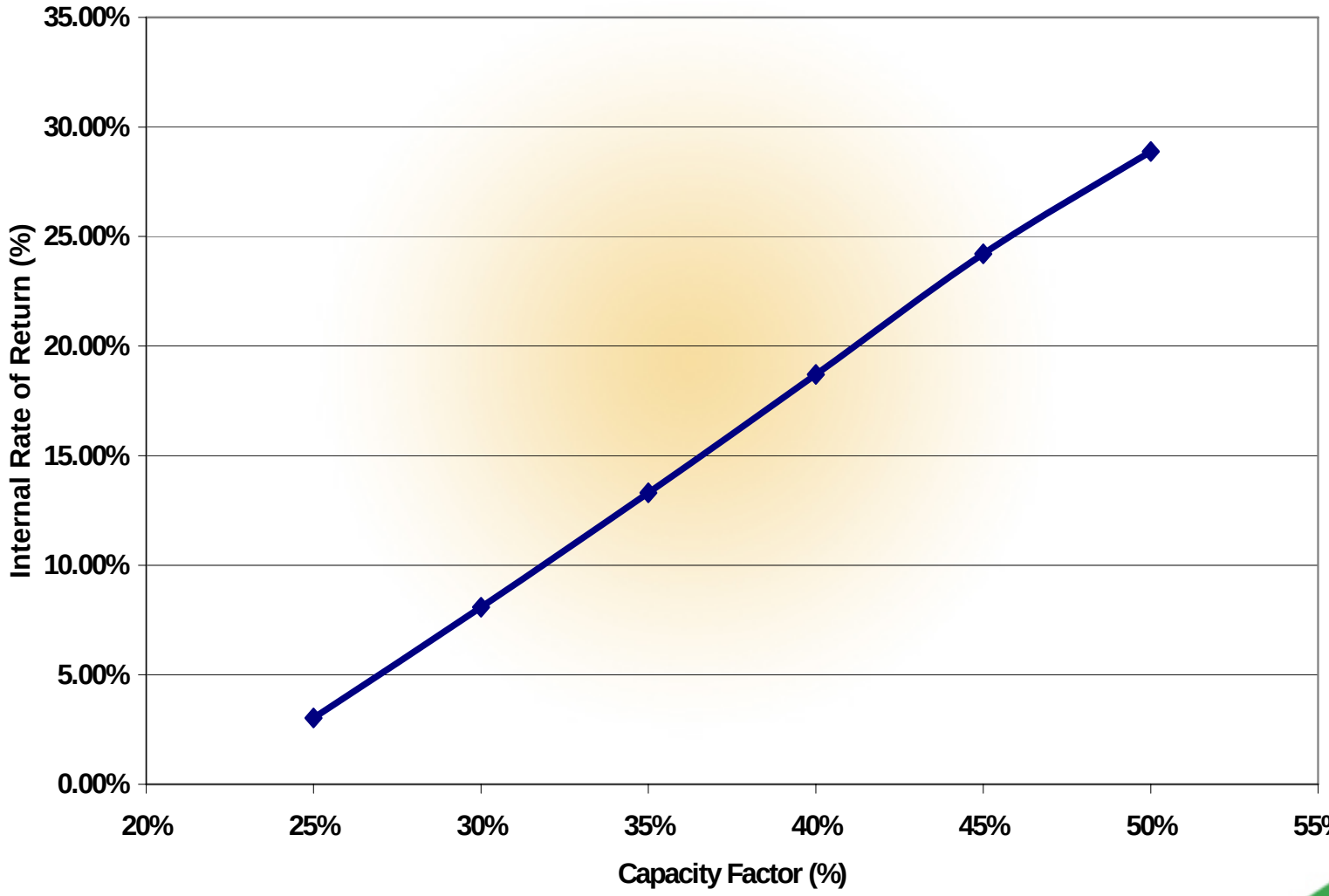
Electricity From Wind Power

- Production increased from 5.6 million megawatt-hours in 2000 to 142 million megawatt-hours in 2004.
  - Much of concentration in production is in the three west coast states and several midwestern states (MN, IA, CO, KS, NM, and TX).
  - Electricity from wind is noted as a clean resource, w/ no emissions of CO2, SO2, NOx.

- There is much potential for further development of wind power in central part of country, but development requires
  - transmission capacity
  - continuation of federal wind power tax credit

- DOE indicates wind is competitive with coal and gas combined cycle power generation.
  - Fuel price uncertainty is greater for coal and NG
  - Adding a carbon tax would probably tip the balance.

Internal Rates of Return for Wind Turbines with Capacity Factors 25-50%;
Assuming 3.3 cents paid per kWH, PTC of 1.9 cents and Typical Costs, Only.



Electricity From Methane via Anaerobic Digestion

- Anaerobic digestion involves the controlled breakdown of organic waste by bacteria in the absence of oxygen. Major agricultural opportunities include food processing wastes and manure.

- In mid 2004, EPA AgStar listed 41 digesters on livestock operations.

- A list of benefits include
  - electricity sales and offsets of electricity purchases,
  - use of digested solids for fertilizer and bedding replacement, and
  - odor control.

- Profitability of digesters is not well documented. A MN study indicates an electricity price of $.08 per kilowatt-hour would be required to break even without subsidies.

Potential Production From Agriculture Is Based on Three Studies

- Food and Agricultural Policy Research Institute. FAPRI 2006 U.S. Baseline Briefing Book. FAPRI-UMC Report #01- 06. University of Missouri, Columbia, March, 2006.

- De La Torre Ugarte, *et.al. The Economic Impacts of Bioenergy Crop Production on U.S. Agriculture.* USDA/OEPNU, Washington, D.C., 2003.

- Gallagher, P., *et. al. Biomass From Crop residue: Cost and Supply Estimates. A.E. Report 819. USDA/OEPNU, Washington, D.C. 2003.*

Ethanol and Biodiesel from Grain

- Ethanol production increases from 4.5 billion gallons in 2005/06 to 8.1 billion in 2015.
- Biodiesel production from soybean oil increases to 222 million gallons in 2015.
- Area planted to corn increases 4.2 million acres from 2006 to 2015, while soybean acreage decreases 1.8 million acres. Other increases in corn acres come from small grains.

Bioenergy Crop Production

- Production management scenario fixed ethanol from grain and introduced markets to purchase bioenergy crops .
- Model was solved for 2008. A total of 41.87 million acres shifted to bioenergy crops. 23.37 is from cropland. This results in corn and soybean acreage being reduced to 146.7 million acres, 9.6 million less than the FAPRI study.
- Expected bioenergy crop production is 188.1 million dry tons per year. I reduced this to be consistent with land use in the FAPRI study.

Biomass From Crop residues

- Study estimates supply functions for each of five regions.
- Industry supply is gross production minus amount needed for conservation, erosion control, and livestock feed.
- Estimated industry supply is 145.0 million dry tons.
- Estimate 90% (130.5 million tons) could be harvested & transported for $35/ton or less.

Estimated Production of Biomass for Energy in 2025

- **Land use was kept constant from 2015 to 2025 with output increasing based on trend yields.**

  - 4.5 billion bu. of corn for ethanol

  - 3.616 bill. Lbs. of soybean oil for conversion to 489 million gallons of biodiesel. Yellow grease and tallow would add 436 million gallons.

  - 176.9 million tons of bioenergy crops for conversion to ethanol and electricity

  - 177.1 million tons of crop residue for conversion to ethanol and electricity.

  - wind energy providing 6% of power consumption.

Summary of Bioenergy Supplies From Agriculture For 2025

Source	Units	Production			
		No. Units	Quads	% of 2004 Use	% of 2025 Use
Grain Ethanol	Bill. Gal.	13.5			
Lignocellulosic Ethanol	Bill. Gal.	32.4			
Total Ethanol	Bill. Gal.	45.9	3.49	33.7	26.3
Biodiesel	Mill. Gal.	925	.12	2.2	1.6
Lignocellulosic Electricity	Bill. Kilowatt Hrs.	73.8			
Wind Energy	Bill. Kilowatt Hrs.	329.5			
Total Electricity	Bill. Kilowatt Hrs.	403.3	3.73	10.2	7.3
Total			7.34	7.4	5.8

Thank You!

Energy Balance and greenhouse Gas Impacts of Ethanol and Biodiesel

	Energy Out/Fossil Energy Input	% GHG Reduction vs. Gasoline/Diesel
Gasoline	0.81	-
Ethanol from Grain	1.35	26
Ethanol from Cellulose	4.17	85
Diesel	0.91	-
Biodiesel from Soybean Oil	3.24	53

Sources: International Energy Agency. *Biofuels For Transport,* OECD, Paris, France, April 2004, Tables 3 & 7.

Michael Wang, " An Update of Energy and Greenhouse Emissions: Impacts of Fuel Ethanol," Center for Transportation Studies, Argonne National Laboratory, Feb. 8, 2005.