Chemicals from Biomass:
Path to Perdition or the Promised Land?

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SEC Disclosure Rules

Some of our comments today may include statements about our expectations for the future. Those expectations involve risks and uncertainties. Dow cannot guarantee the accuracy of any forecasts or estimates, and we do not plan to update any forward-looking statements if our expectations change. If you would like more information on the risks involved in forward-looking statements, please see our annual report and our SEC filings.

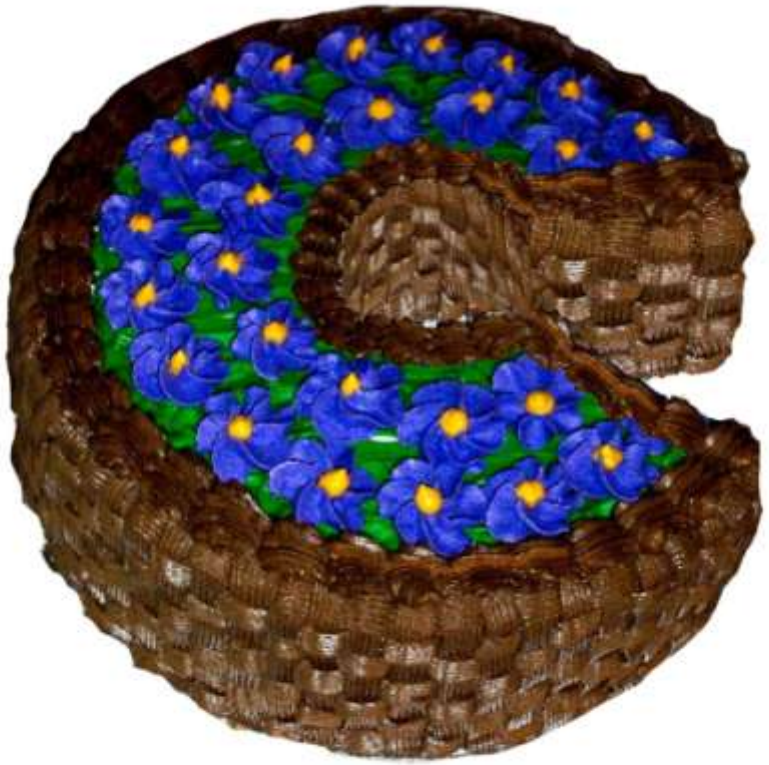
In addition, some of our comments reference non-GAAP financial measures. Where available, a reconciliation to the most directly comparable GAAP financial measures and other associated disclosures are provided on the internet at www.dow.com/financial.

Messages

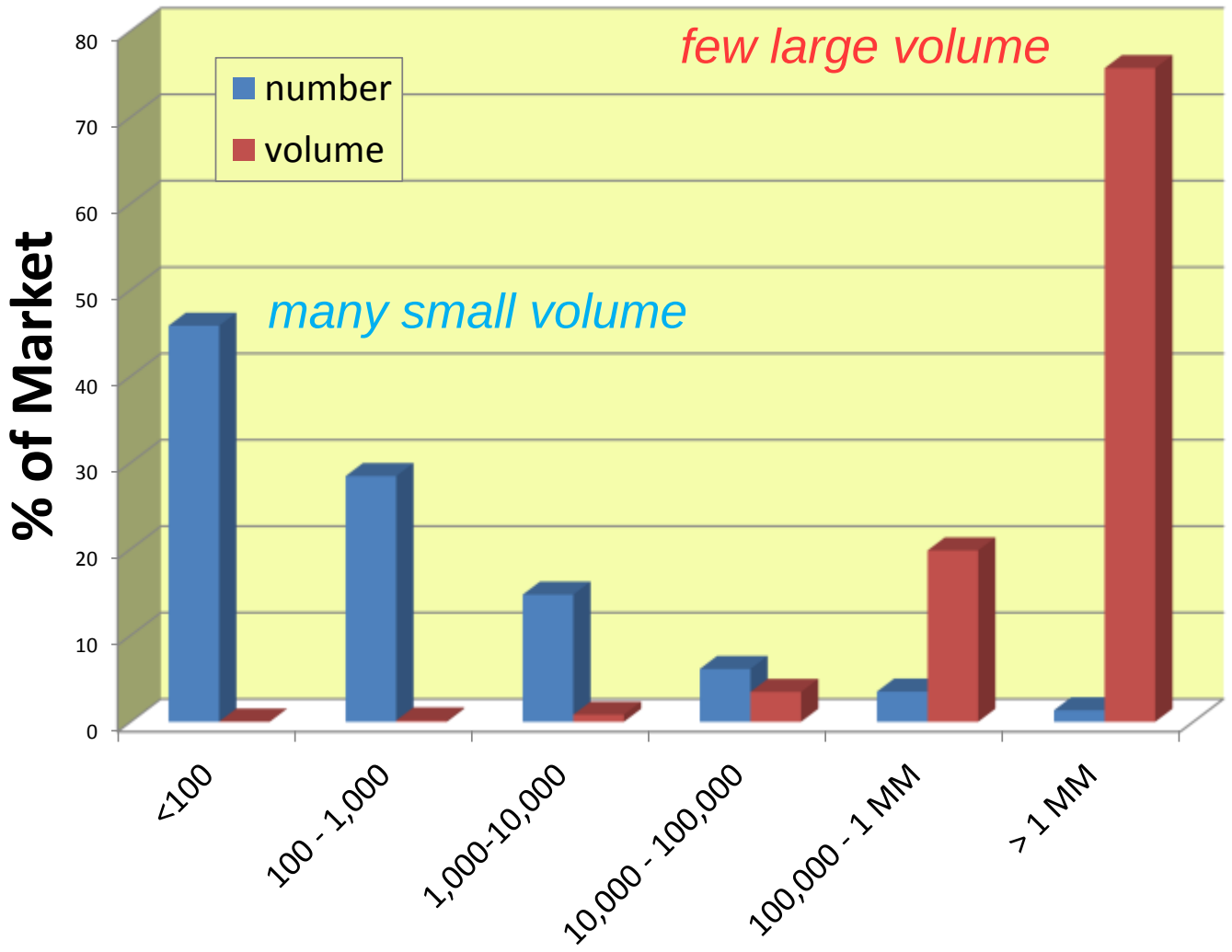
- the U.S. chemical industry is predominantly based on indigenous natural gas
- a mixture containing a valuable chemical is not the same as a valuable mixture of chemicals
- “cheap” feedstocks don’t always lead to cheap chemicals especially if scale is a limiting factor

Chemical Industry Overview

- industry statistics can be misleading
  - Top 50 chemicals include inorganics and air gases
  - government stats include fertilizer production
- consider only the industry sells *decorated carbon*



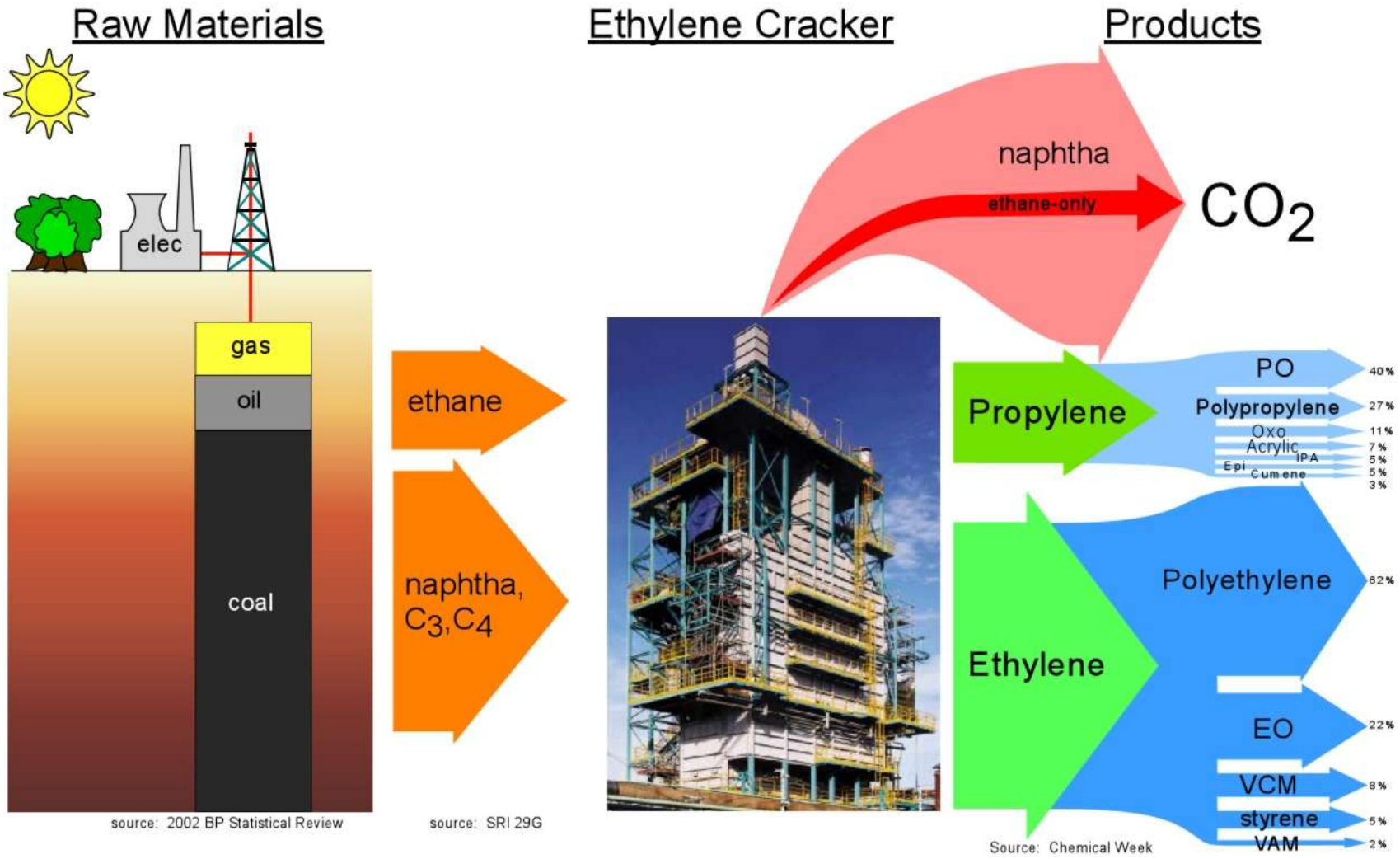
Chemical Industry



Production Scale (metric tonnes per annum)

data for Europe from OECD; "Environmental Outlook for the Chemicals Industry", 2001.

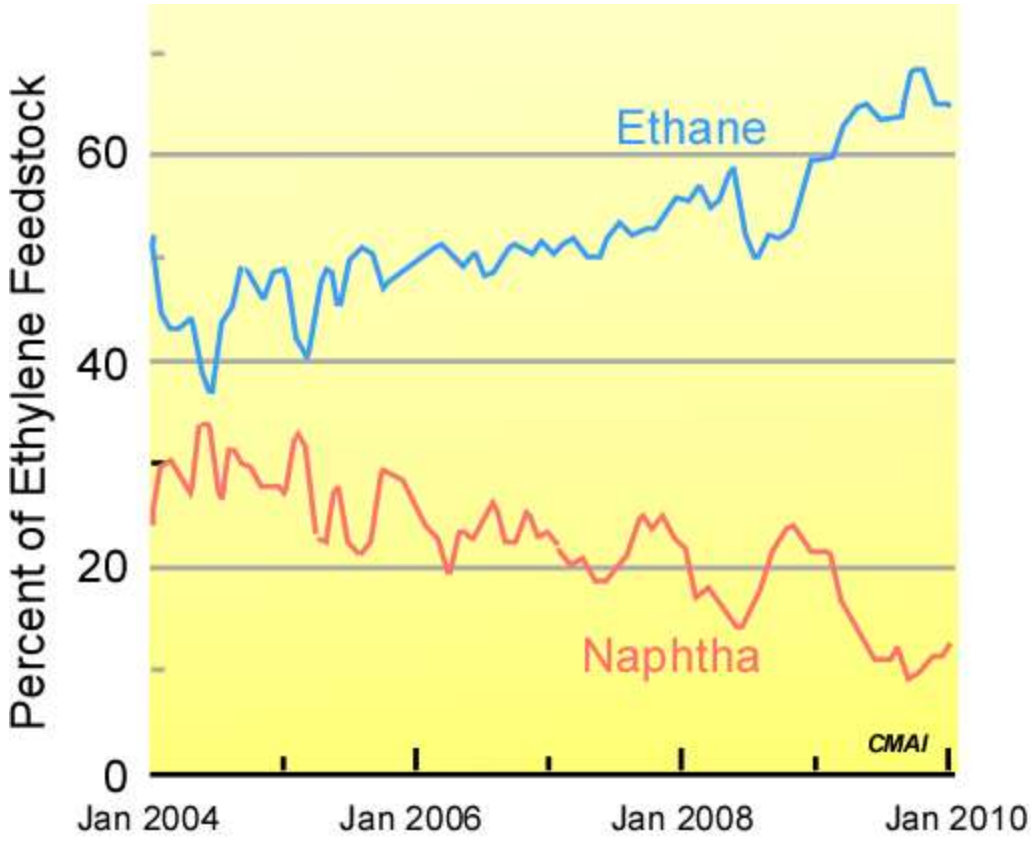
Chemical Industry

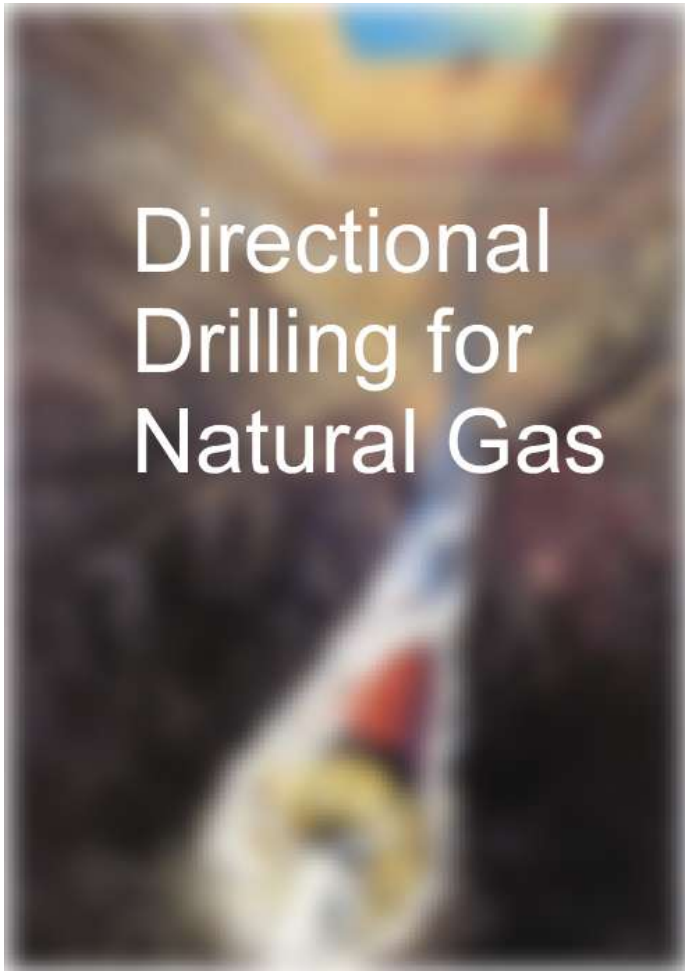



R.I.P.
U.S.
Chemical
Industry
1776-2008

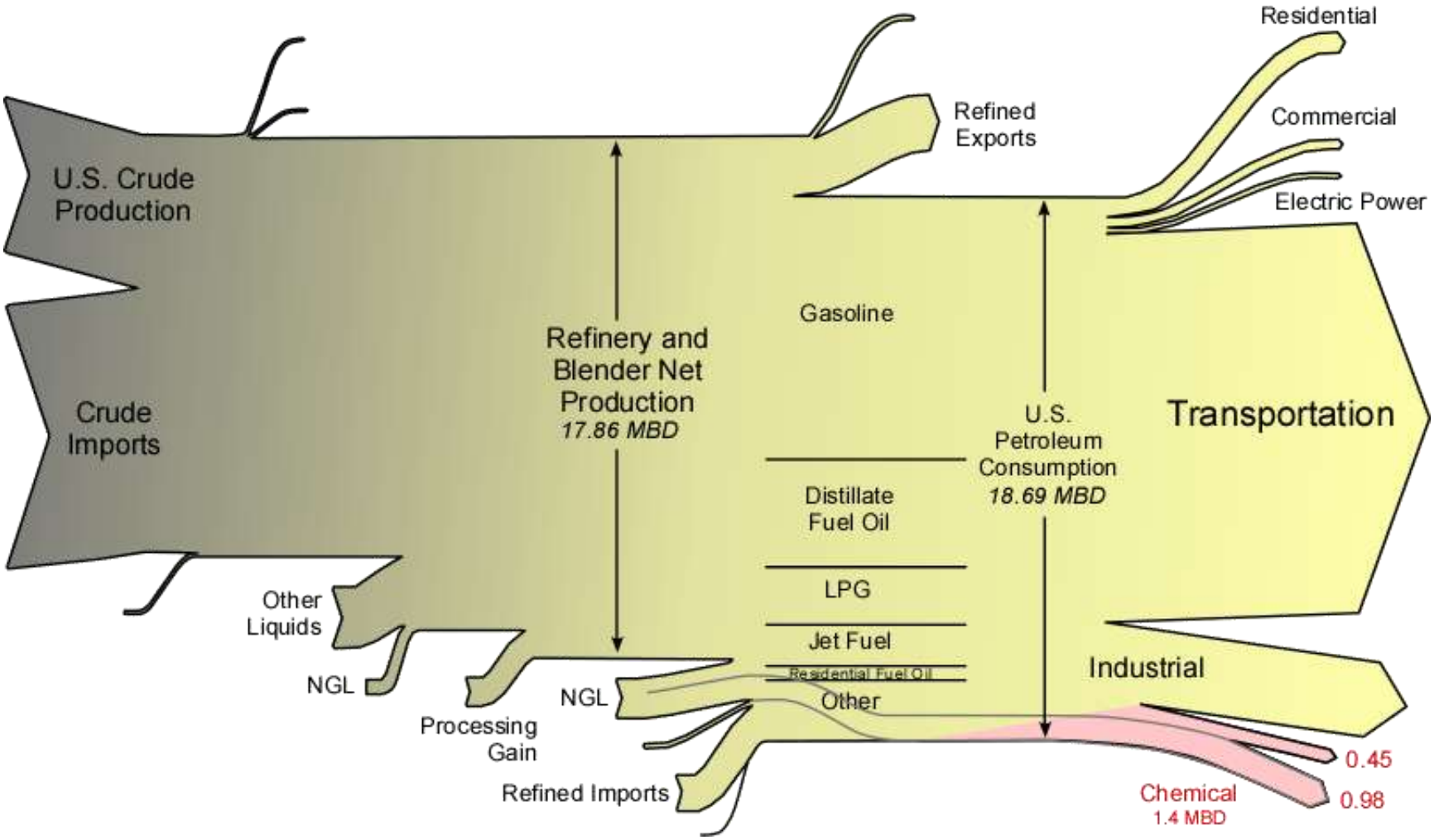

IT'S ALIVE!
IT'S ALIVE!
CHEMICAL INDUSTRY

Shale Gas Revitalizes the Industry



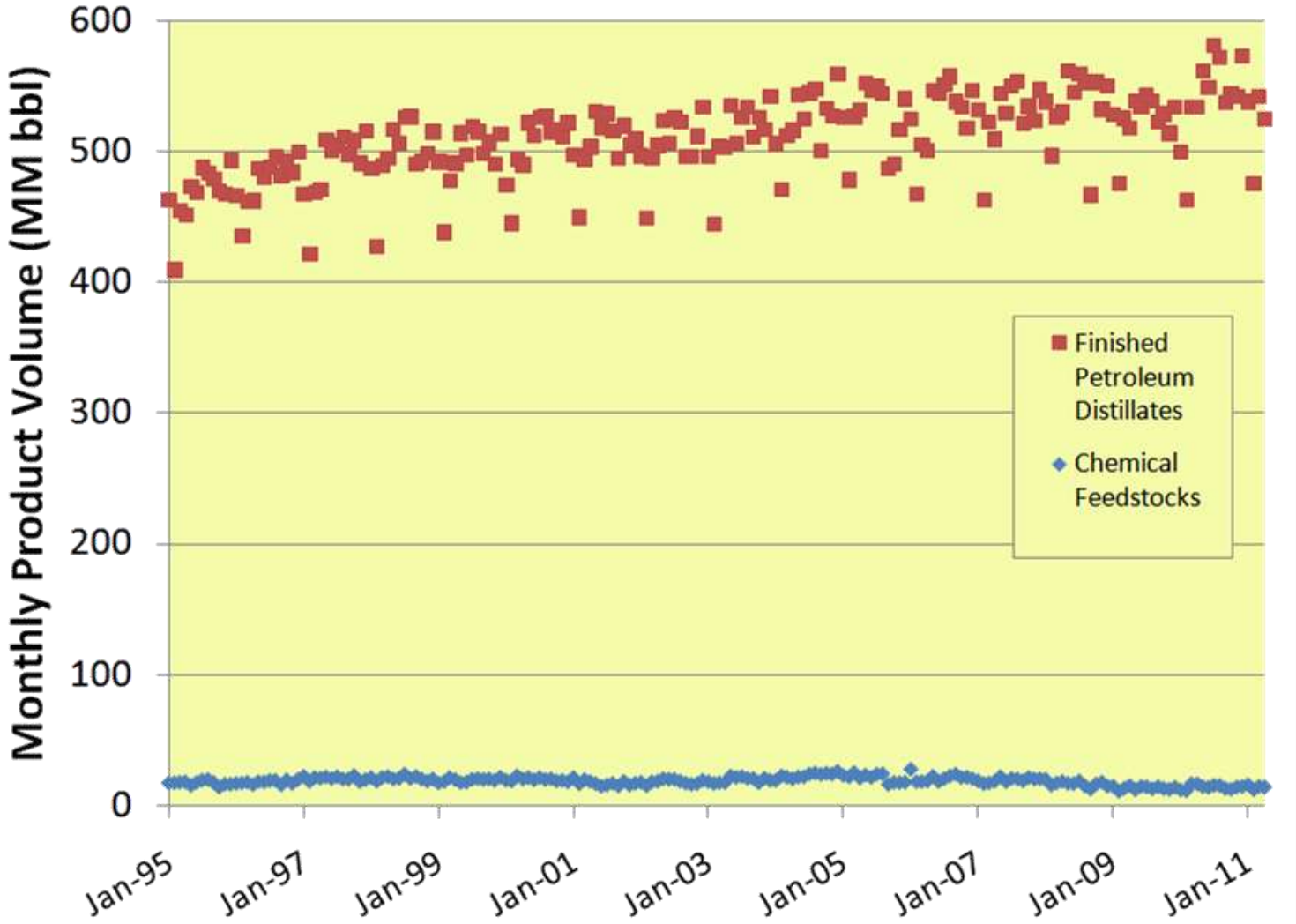


Petroleum Flow 2009

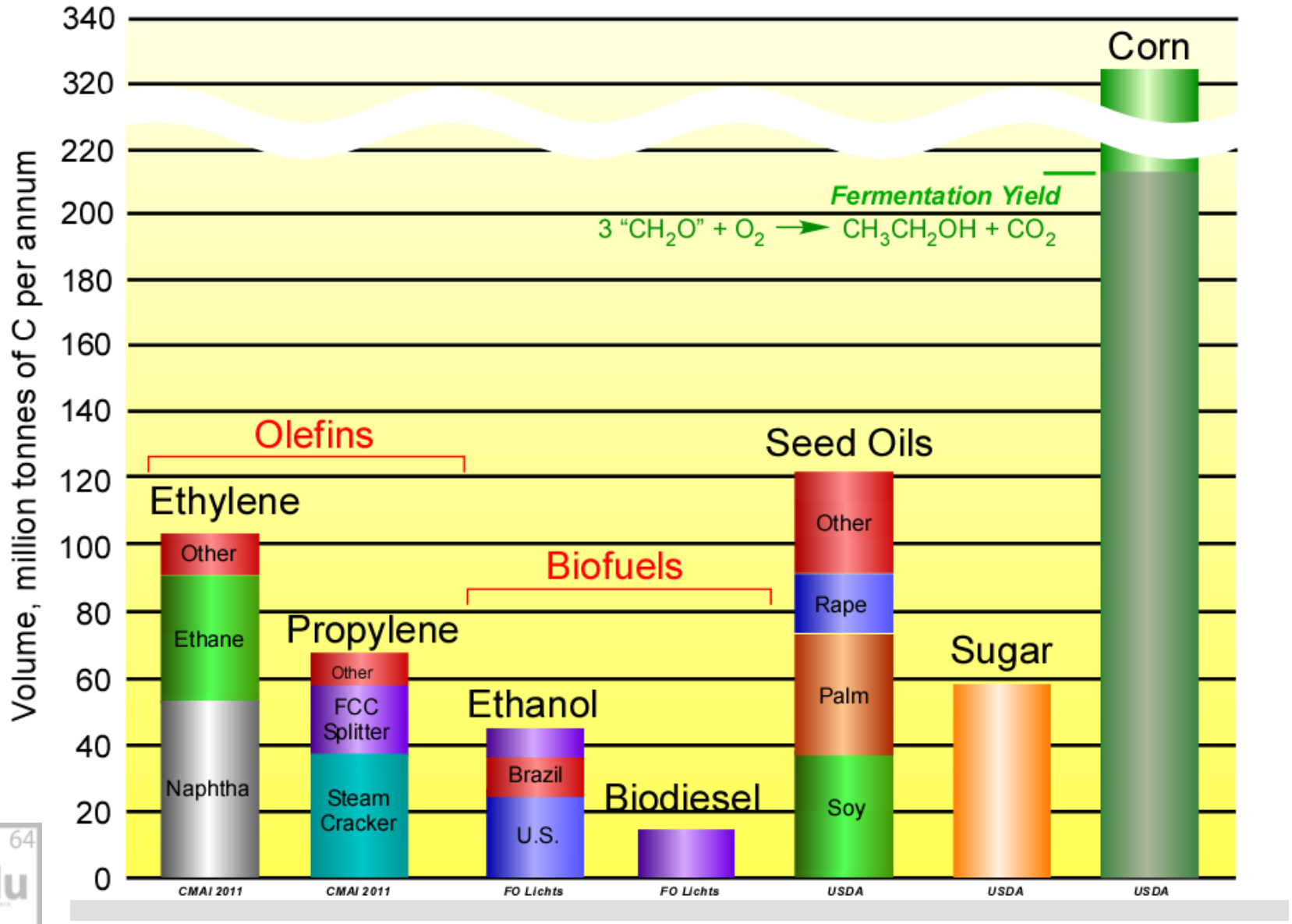


EIA, "Annual Energy Review 2009", August 2010, DOE/EIA-0384(2009) and Sean Davis, "SRI Petroleum Liquid Feedstocks", June 2010

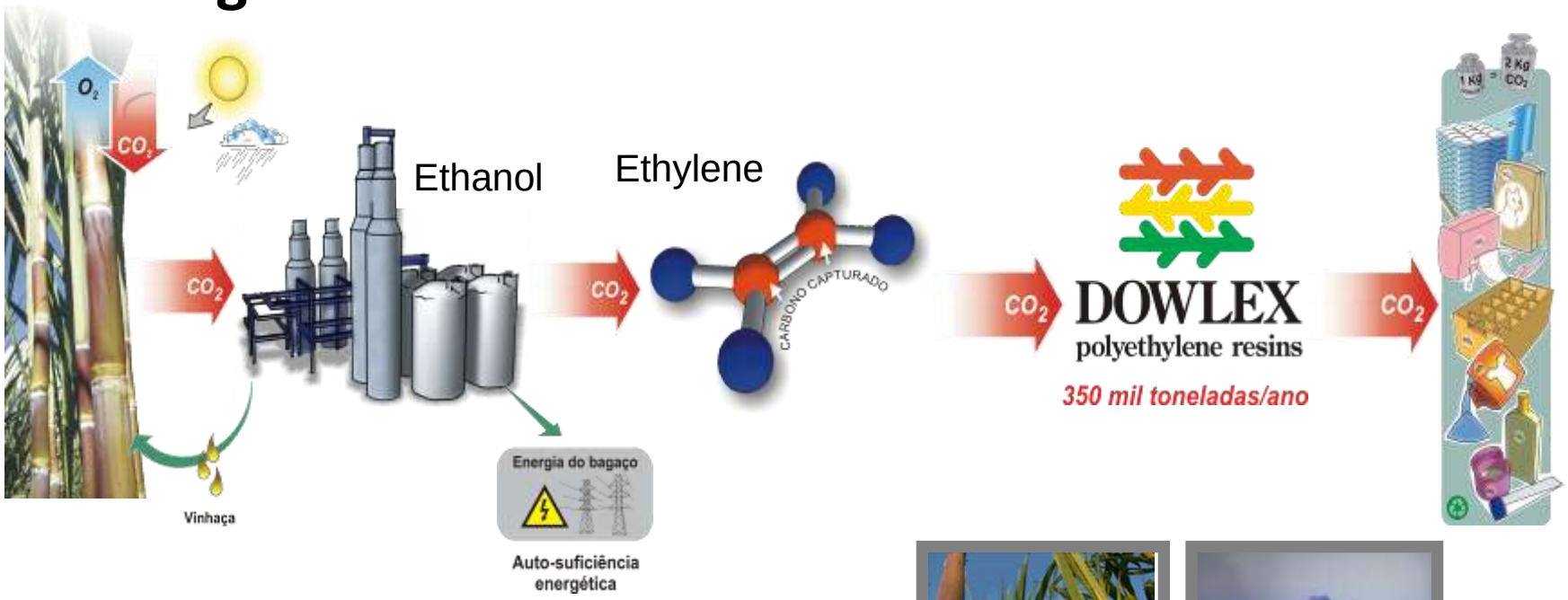
Feedstock Flows from Petroleum



Global Commodity Production



Making Chemicals from Biomass- Cane to LLDPE

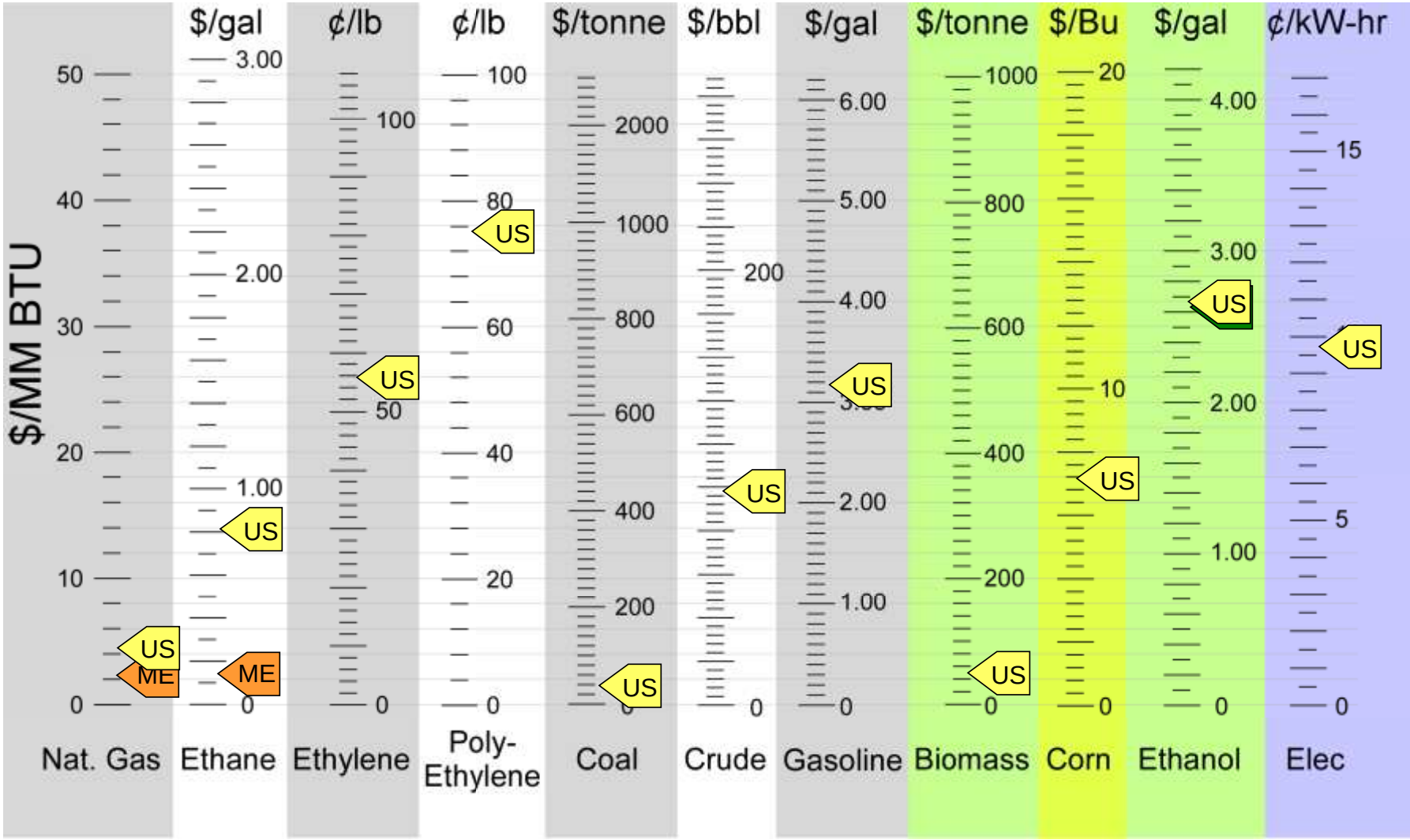


Fully-integrated facility in Brazil
Utilizes state-of-the-art Dow polymerization catalysis

<< http://www.thekernelburner.com/>>

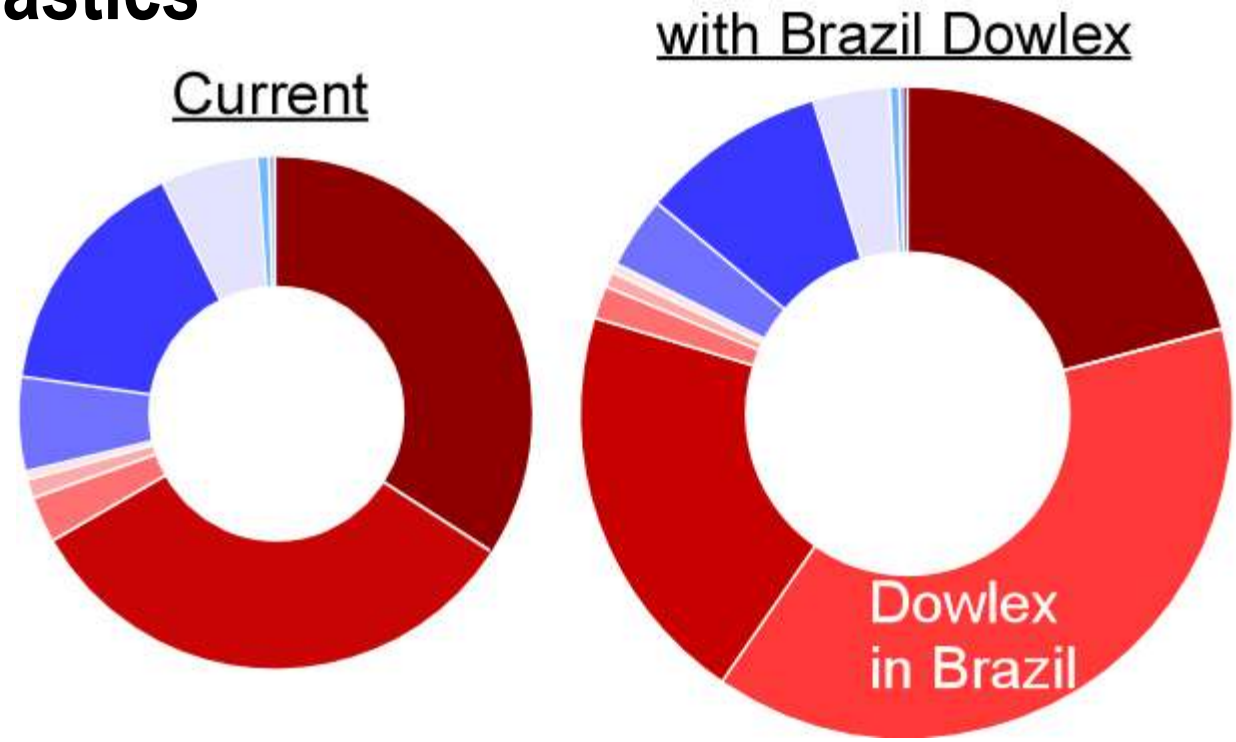
http://www.maximheat.com/

Feedstocks are Energy



July 15, 2011

Bioplastics

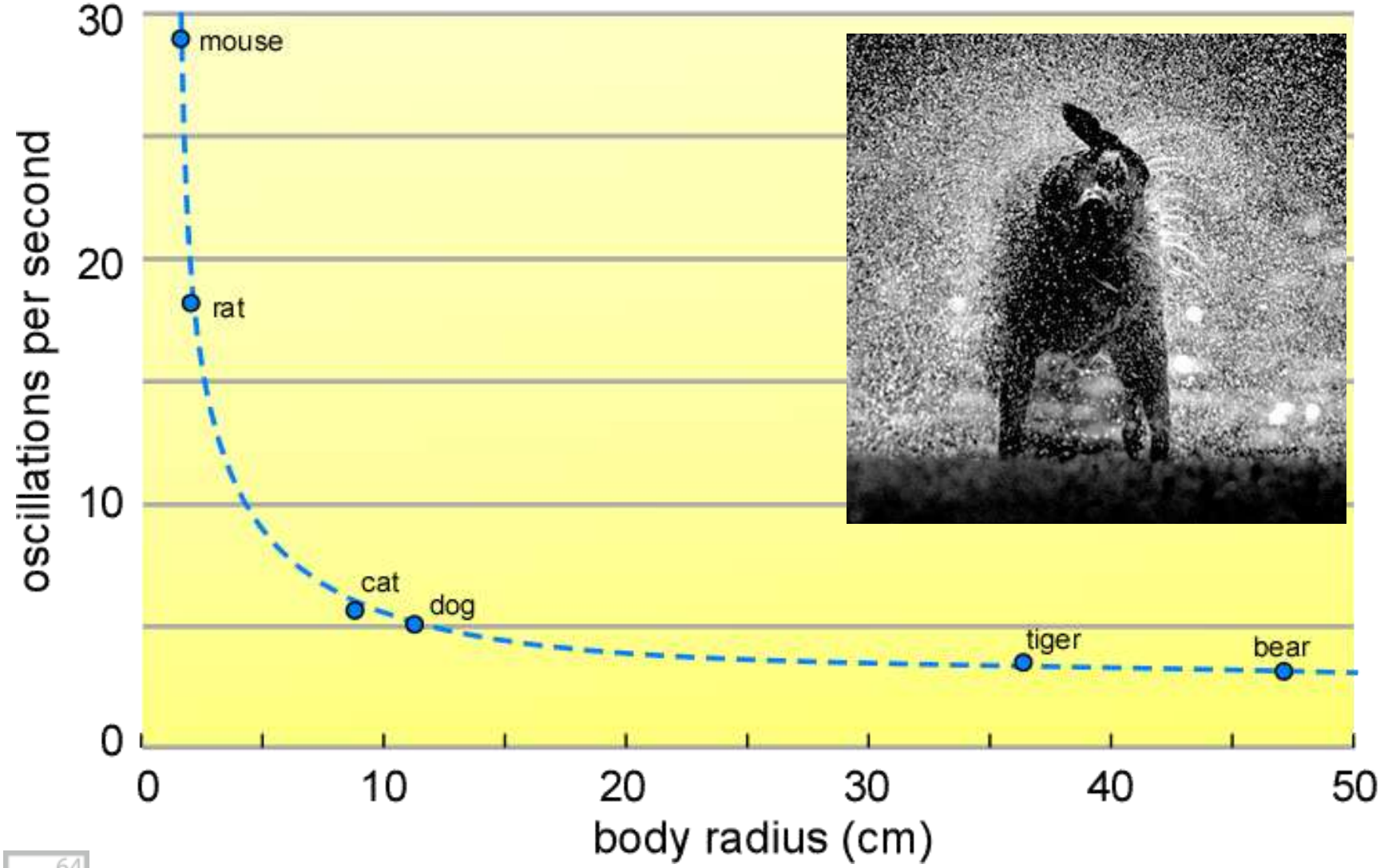


	Current		with Bzl LLDPE	
	tpa	%	tpa	%
PLA	207002	34.0	207002	21.6
Bzl LLDPE	-	-	350000	36.5
Bio-PE	200000	32.8	200000	20.8
PLA blends	18000	3.0	18000	1.9
cellulose der.	8000	1.3	8000	0.8
bio-urethanes	2720	0.4	2720	0.3

	Current		with Bzl LLDPE	
	tpa	%	tpa	%
regen cellulose	36000	5.9	36000	3.8
PHA	93051	15.3	93051	9.7
bio-polyamides	36500	6.0	36500	3.7
starch blends	5075	0.8	5075	0.5
bio-TPE +	3000	0.5	3000	0.3
Bio-PC	300	0.0	300	0.0

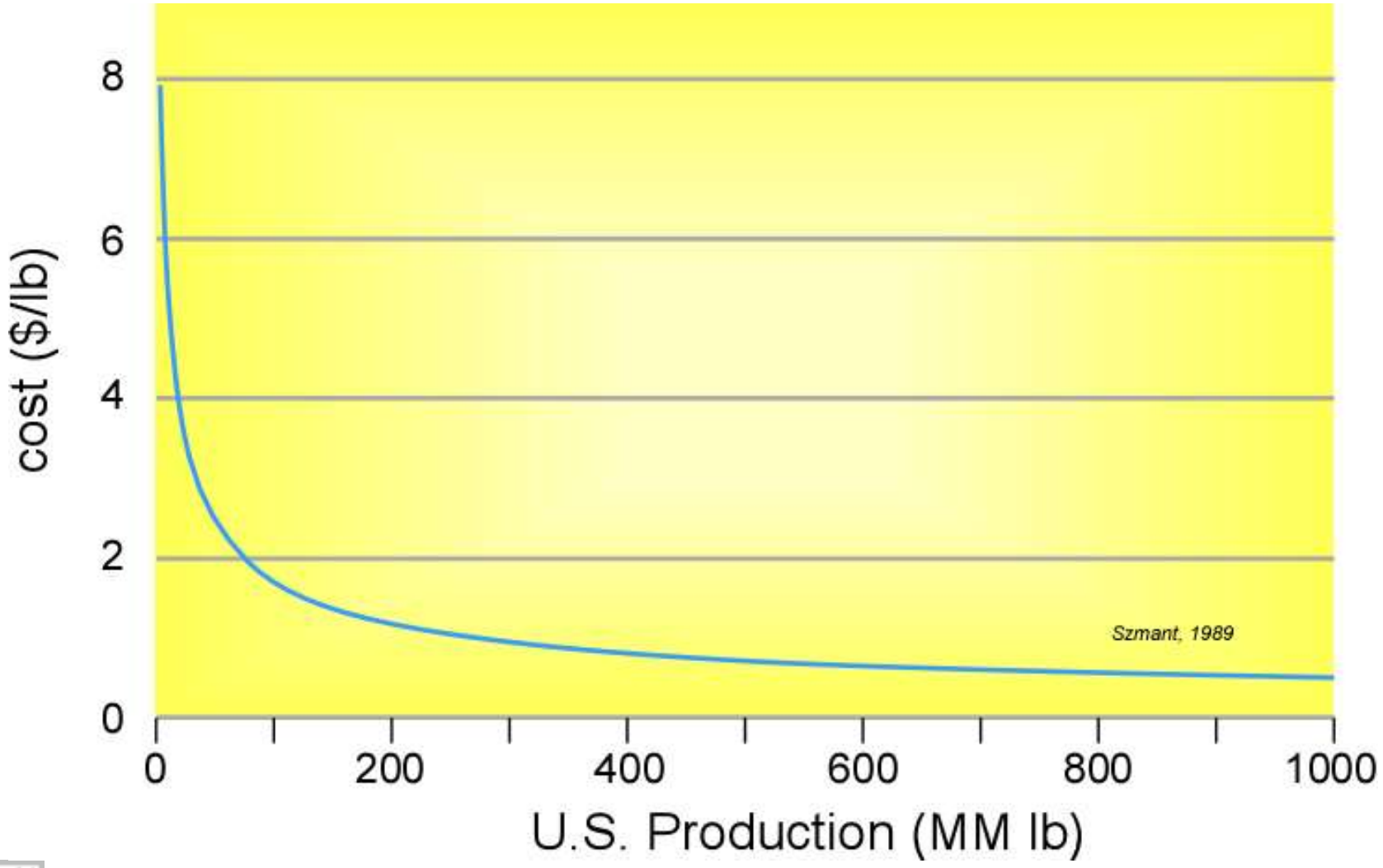
European Bioplastics, "Driving the Evolution of Plastics", April 2011

Interesting Correlation

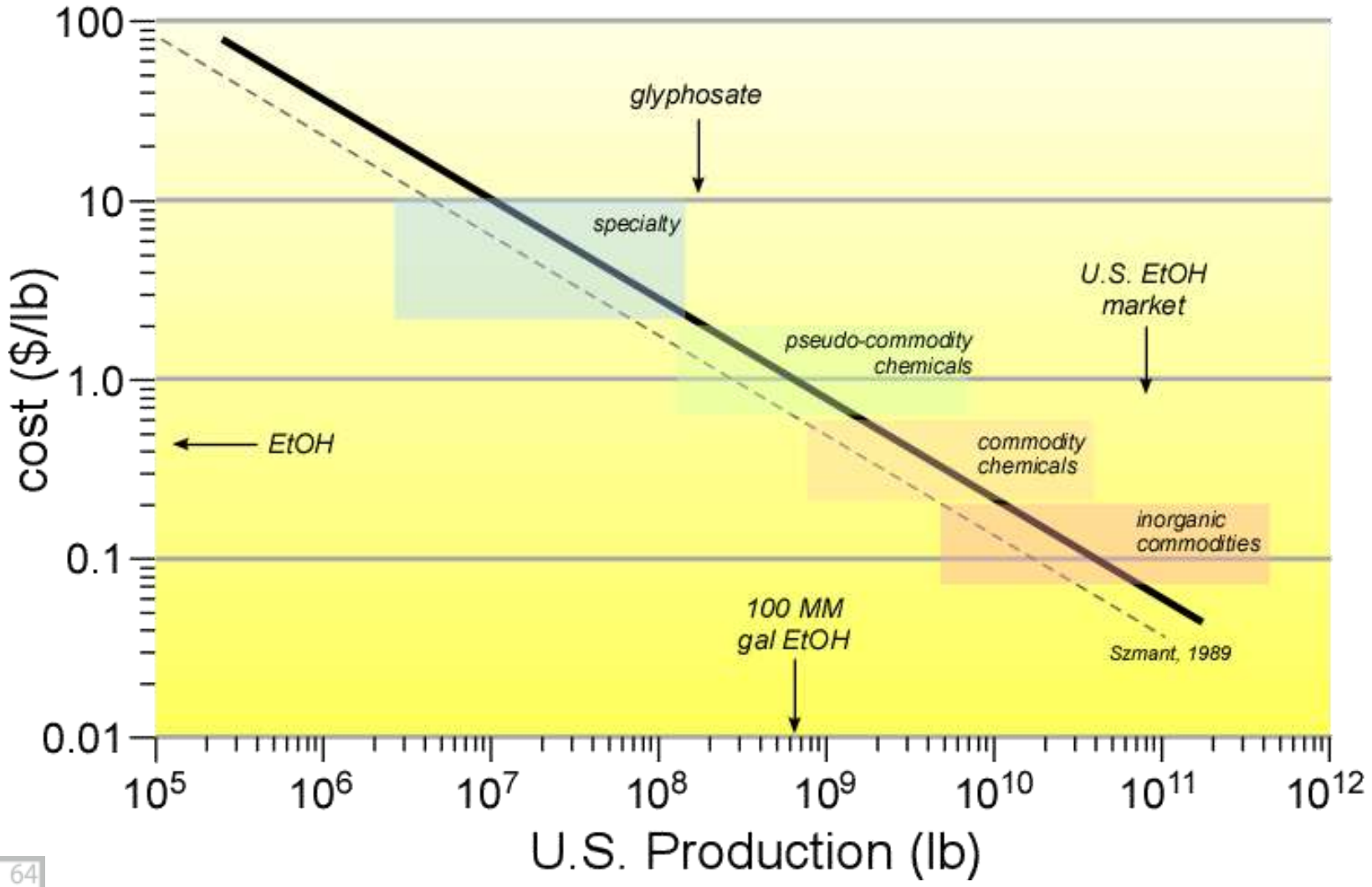


Andrew Dickerson, Grant Mills, Jay Bauman, Young-Hui Chang, David Hu, The Wet-Dog Shake, Fluid Dynamics, 15 October 2010.

Scale Matters!

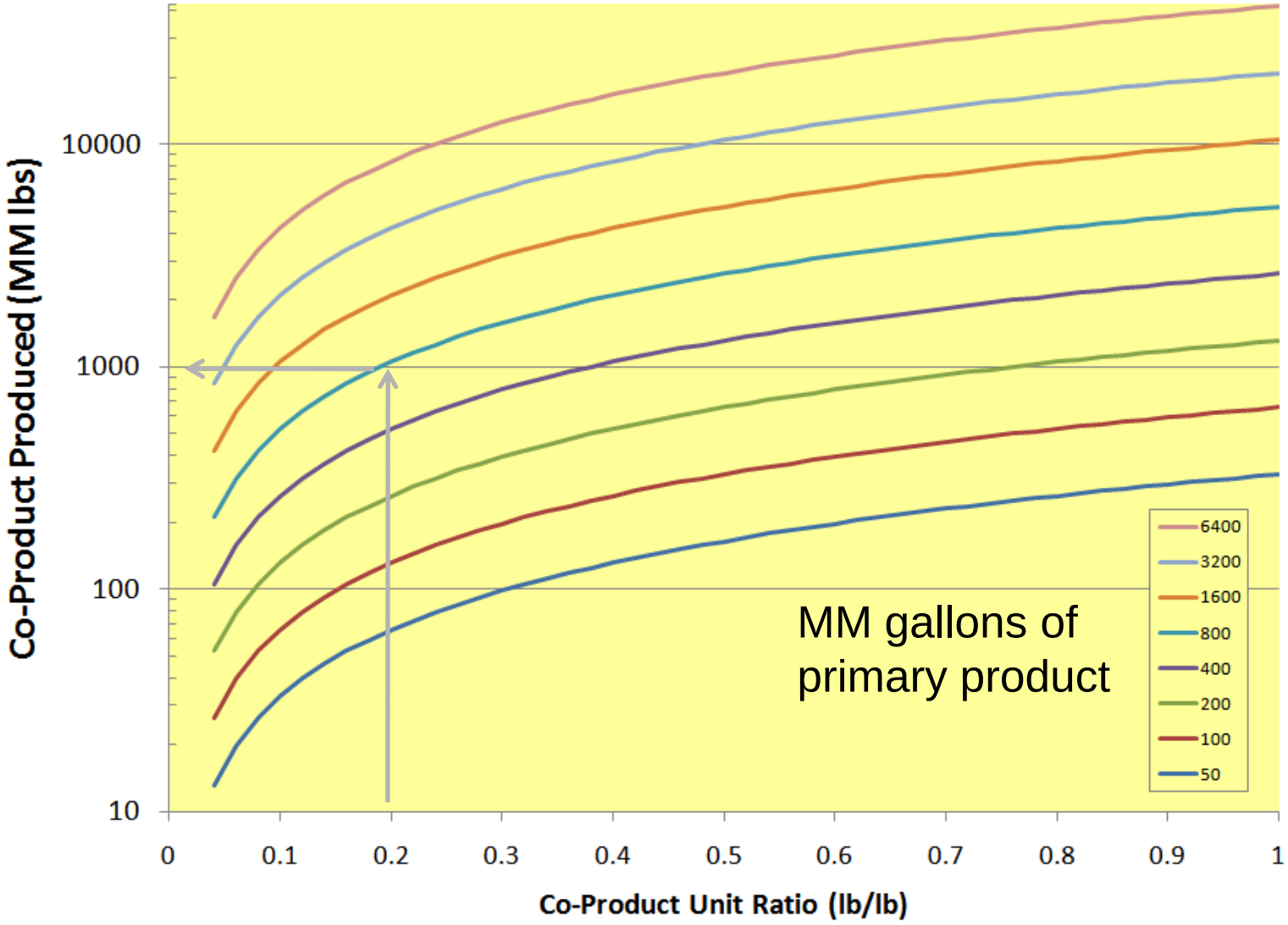


Most Common Version



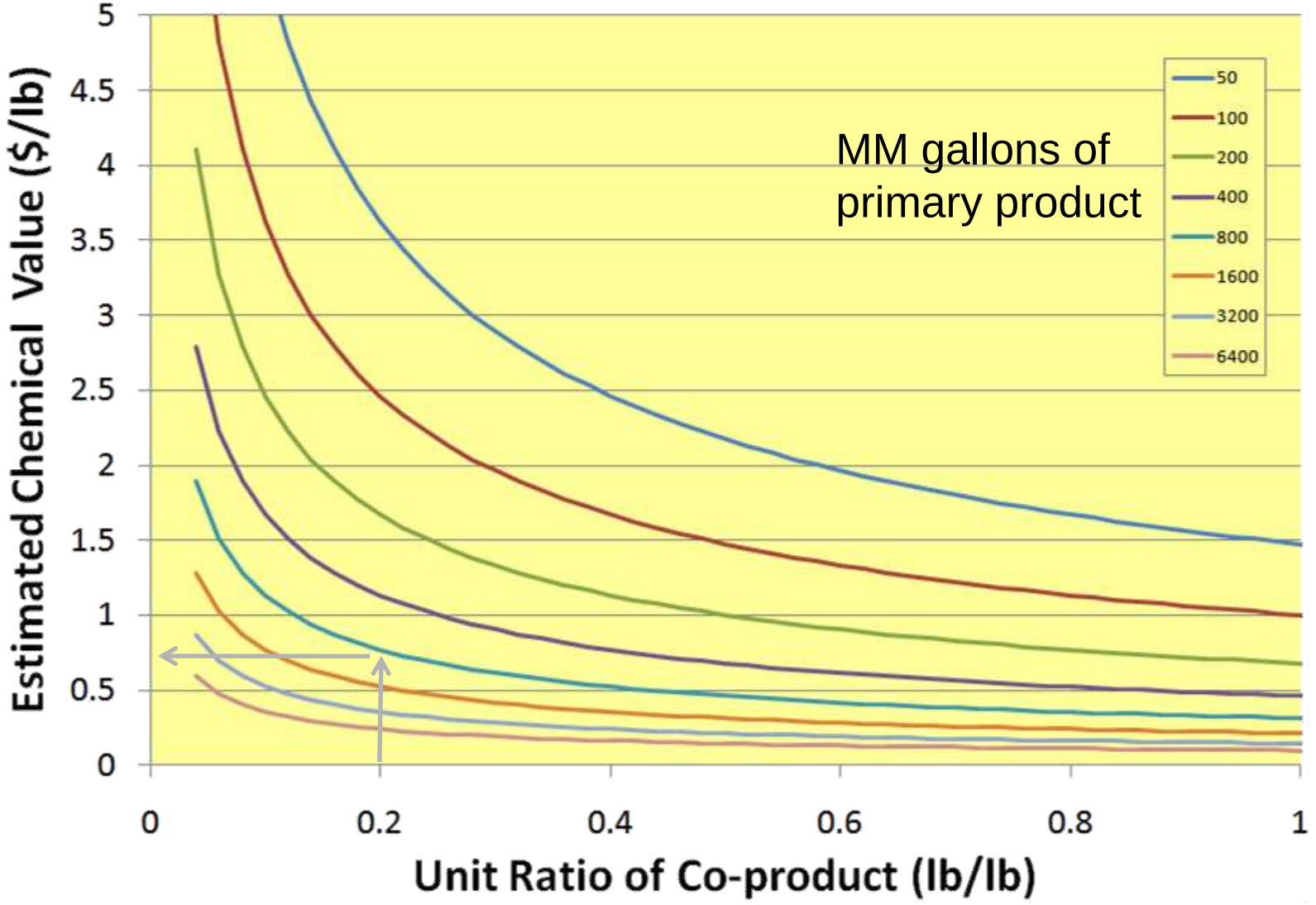
Implications

20% coproduct at 800 MM gallons is 1 B lbs

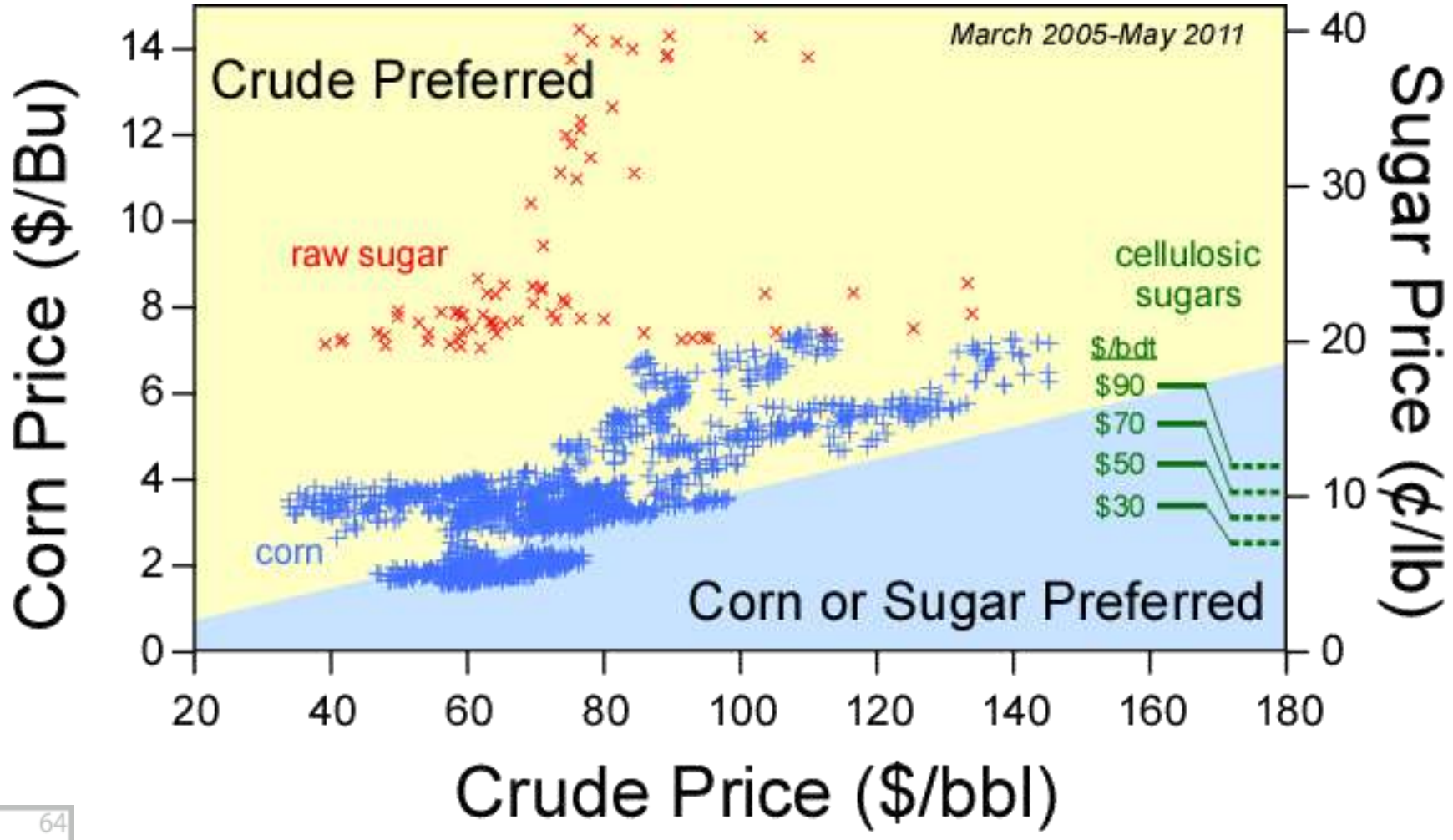


More Implications

20% coproduct at 800 MM gallons is ~$0.75/lb

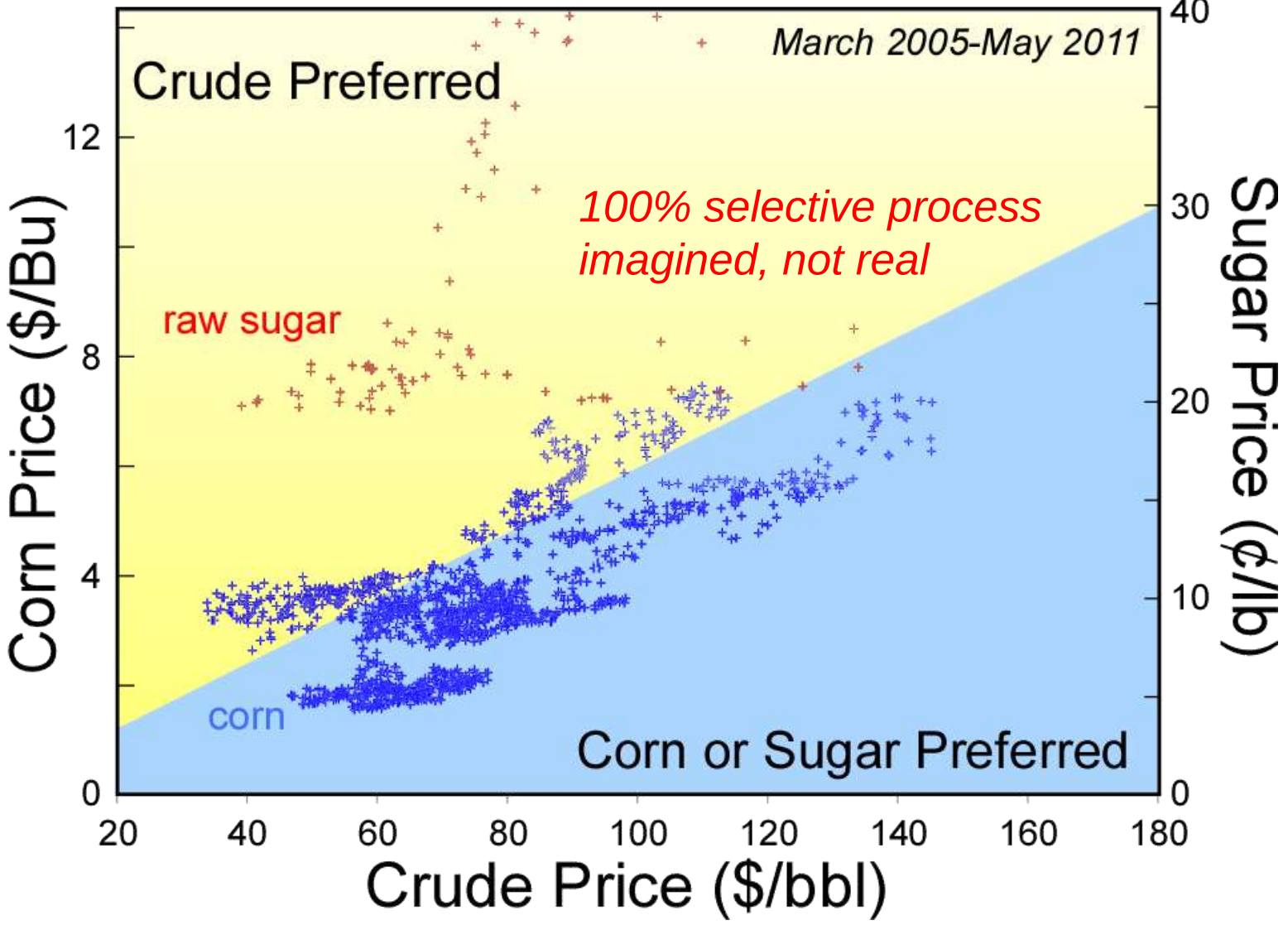


Ethylene Raw Material Cost – *Fossil or Bio?*



modeled after Chemical Marketing Resources (cmrhoutex.com)

p-Xylene Raw Material Cost



modeled after Chemical Marketing Resources (cmrhoutex.com)

What works in bioproducts?

- nature prepares the molecule:
  - nature puts it in the right oxidation state (*kind of carbon*)
  - nature makes the right molecular structure for the end application(*shape of carbon*)
  - nature makes enough that recovery is economical
- technical risk to serve market is low
  - identical biomaterial for established markets
  - fossil and bio parity in market

Summary

- the U.S. chemical industry is predominantly based on indigenous natural gas
  - this raises the bar for cost-effective competition
- a mixture containing a valuable chemical is not the same as a valuable mixture of chemicals
  - separations frequently drive plant capital and opex
- “cheap” feedstocks don’t always lead to cheap chemicals especially if scale is a limiting factor
  - chemicals more reduced than biomass and removal of oxygen atoms is costly

Additional Info and Notes

Mark Jones

27 July 2011

Abstract

The U.S. chemical industry a vital part of the U.S. economy. It is a $720 B enterprise making essential products that end up in 96% all manufactured goods. The industry uses both fossil and renewable resources to make products today. Bioproducts are receiving active interest due to consumer demand, industry interest in improved materials and interest from the biofuels community in making “high value chemicals”. Several inescapable principles must be dealt with in order to successfully navigate chemical production from biomass. These include:

- natural gas drives the chemical industry and halcyon days are expected due to shale gas
- biomass and biologically derived materials can be expensive raw materials for chemical production
- a mixture containing a valuable chemical is not the same as a valuable mixture of chemicals.

It is dangerous to assume that chemical production can save an economically challenged biofuels process. Repurposing a fuel for chemical use or garnering more value from co-products both are fraught with peril. Cautious optimism, rather than unbridled optimism, is in order as emphasis shifts towards bioproducts.

US Chemical Industry

- American Chemistry Council reports << http://www.americanchemistry.com/Jobs/EconomicStatistics/Industry-Profile/Industry-Facts/Chemistry-Industry-Facts.pdf>>
- 96% of all manufactured goods are enabled by chemistry
- Chemical industry has sales of over $720 billion
- Employs 800,000 people nationwide

US Chemical Industry

- Produce 19% of the world's chemicals - #1
- Exports of chemicals account for 10 cents of every dollar of total merchandise exports
- spend $49 B on R&D

Dow Chemical

- over $53 B in sales
- diversified portfolio of specialty chemical, advanced materials, agrosciences and plastics businesses
- a global workforce of about 46,000 with approximately 21,000 in the US.
- Over 7000 R&D Employees
- >$1.6B Budget

Dow Chemical

- committed to U.S. manufacturing
- Dow CEO Andrew Liveris chairs the Obama Administration's Advanced Manufacturing Partnership << http://www.businesswire.com/news/home/20110624005345/en/Liveris-Named-Co-Chair-U.S.-President-Obama%E2%80%99s-Newly>>
- invested over $600 MM in past 5 years on USGC olefins supply chain
- announced billions more investment in restarts and new capacity in April

Biomass Program Goals

- A viable, sustainable domestic biomass industry that produces renewable biofuels, bioproducts and biopower, enhances U.S. energy security, reduces our dependence on oil, provides environmental benefits including reduced greenhouse gas emissions, and creates economic opportunities across the nation.
- from website, 20 July 2011

Ethanol barrels

- Thursday, July 14, 2011
- **CME: Ethanol Averaged 872,000 Barrels/Day**
- **550,000 Barrels Oil Eq / Day**
- US - Ethanol production for the week ending July 8 averaged 872 thousand barrels per day. This is down 32 thousand barrels per day (-3.54 per cent) vs last week and up 51 thousand barrels per day (6.21 per cent) vs last year.
- Total ethanol production for the week was 6.104 million barrels, down 224 thousand barrels vs last week and up 357 thousand barrels vs last year. Corn used in last week's production is estimated at 91.56 million bushels.

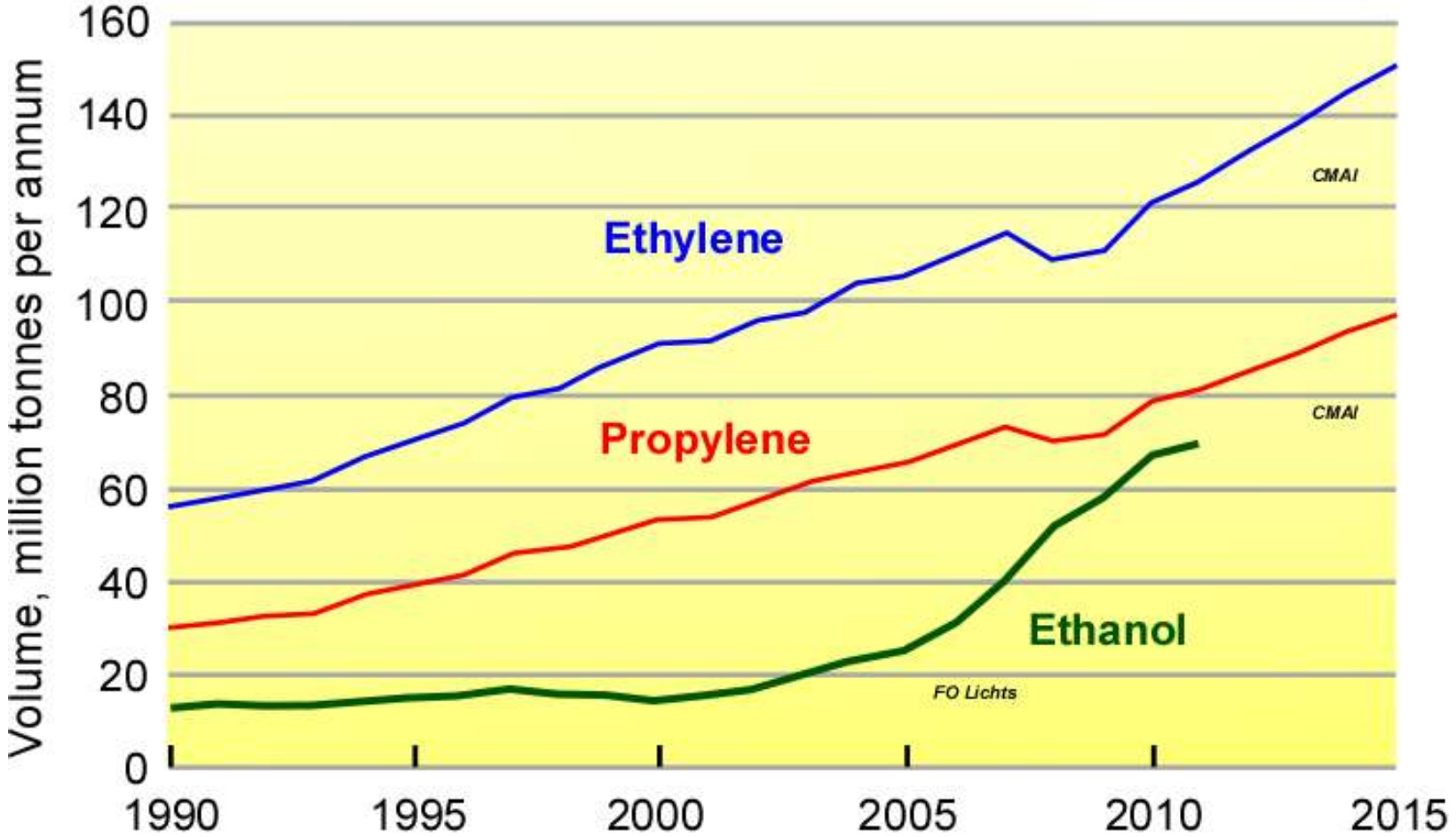
  This crop year's cumulative corn used for ethanol production for this crop year is 4.15 billion bushels.

  Corn use needs to average 116.16 million bushels per week to meet this crop year's USDA estimate of 5.05 billion bushels.

Chemical Supply

- Science 31 July 1981:
- Biomass as a Source of Chemical Feedstocks: An Economic Evaluation
- B. O. Palsson, S. Fathi-Afshar, D. F. Rudd and E. N. Lightfoot
- It is suggested that the raw materials and technology exist for basing a major fraction of the U.S. chemical industry on four fermentation products, used in the proper portions: ethanol, isopropanol, n-butanol, and 2,3-butanediol. The primary route for introduction of these materials is dehydration of the alcohols and diols to olefins, which would cause little disruption of the existing industry downstream from the olefins. The proposed substitution has the advantages that it would provide a smooth transition toward renewable feedstocks, while decreasing dependence on fossil sources of organic material and use of toxic materials. However, to make these materials attractive as feedstocks or intermediates in chemical production, their current prices must be substantially reduced. Even with the optimum mix, their large scale utilization will only occur at about 20 to 40 percent of their estimated chemical prices.

Bio vs. Chemicals



Product Recovery

- separations are expensive!

  “Exact figures may be hard to come by, given the complexity of the chemical industry, but separation processes have been estimated as accounting for somewhere between 40% and 70% of its capital and operating costs.”

  Spear, Mike; "Stretching separation choices", Chemical Processing, February 2006, pages 18-22.

- separations, especially distillations, scale very well
  - biomass to still, not still to biomass

Harry Szmant Books

- Organic Building Blocks of the Chemical Industry, October 26, 1989
  - has power law relationship expressed and a great explanation of scale
- Industrial Utilization of Renewable Resources: An Introduction, March 1, 1986