



INTERNATIONAL  
**BIOMASS**  
CONFERENCE & EXPO  
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# Scale Creates Challenges for Chemicals from Biomass

Mark Jones

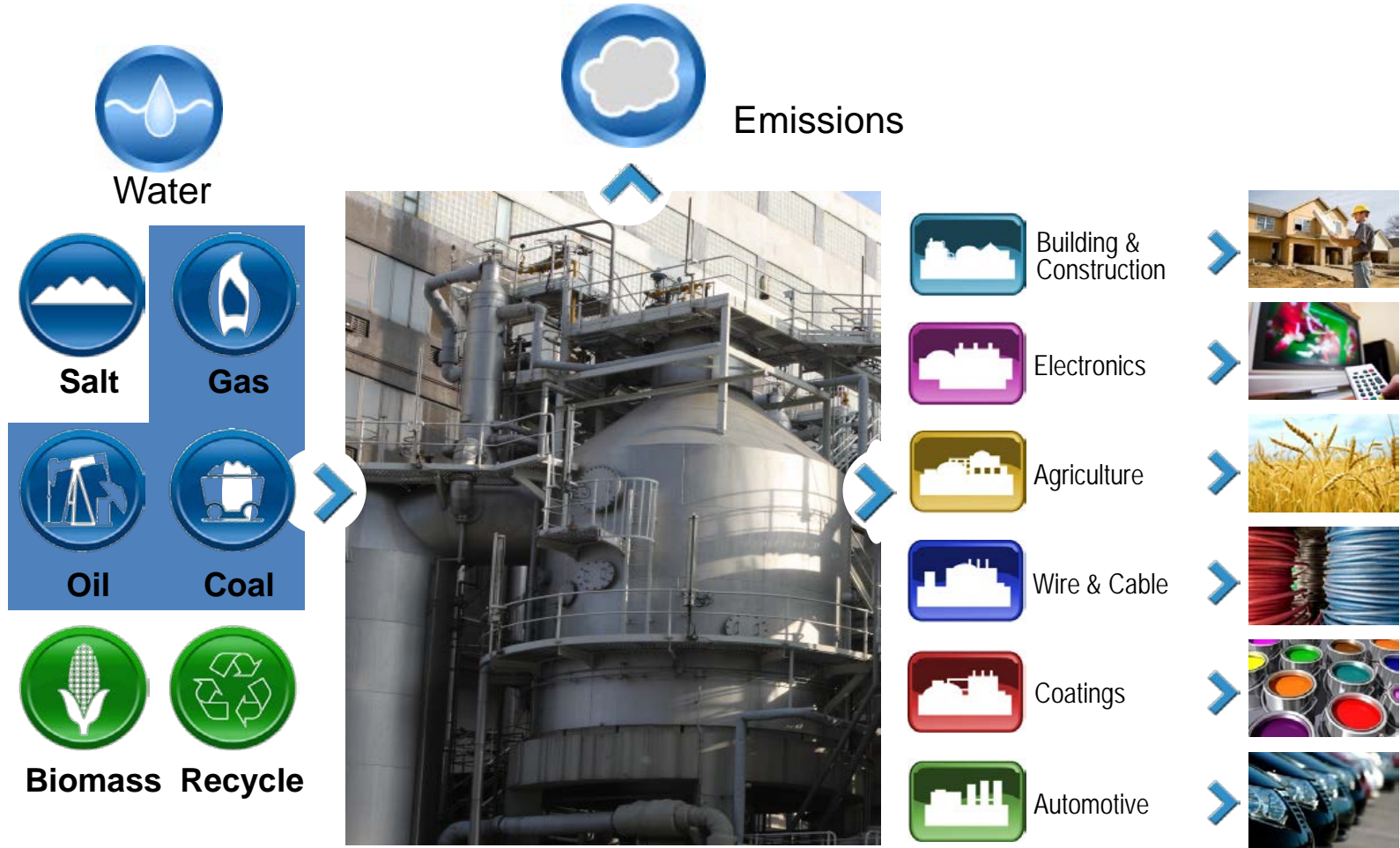
*Executive External Strategy and Communications Fellow*

The Dow Chemical Company



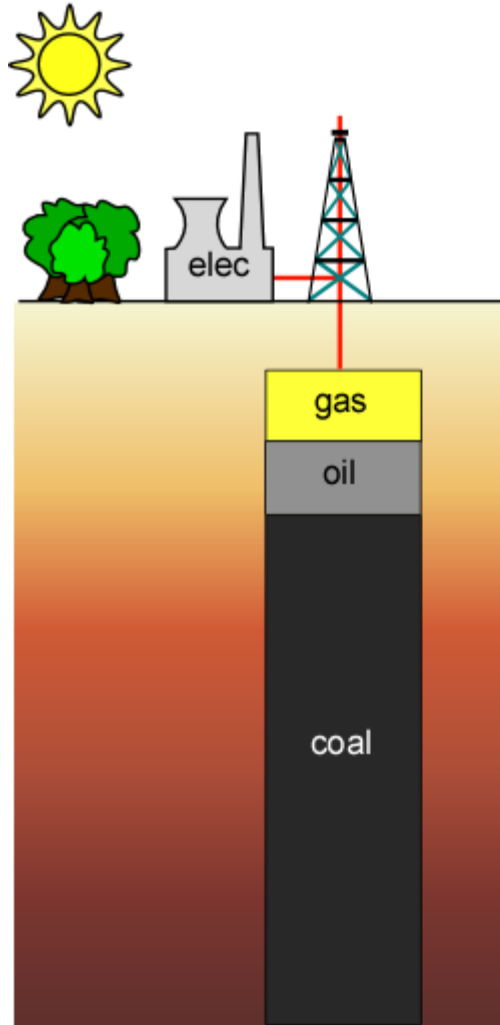
**DOW**®

# Chemical Industry Snapshot



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## Raw Materials



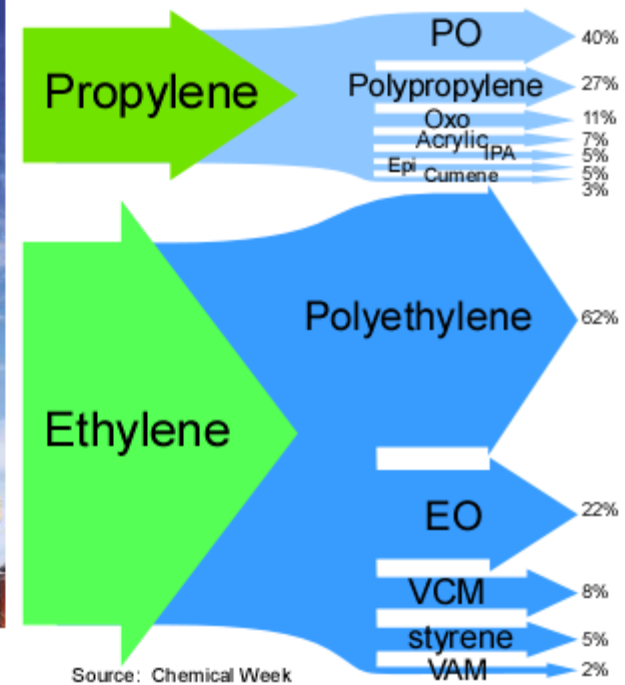
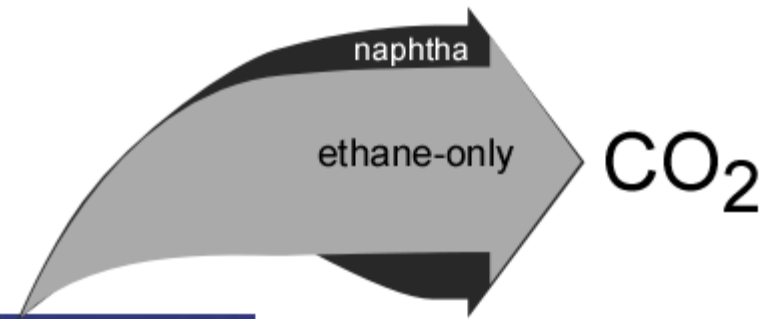
source: 2002 BP Statistical Review

## Cracker



source: SRI 29G

## Products



Source: Chemical Week

## What Unhealthy Looks Like

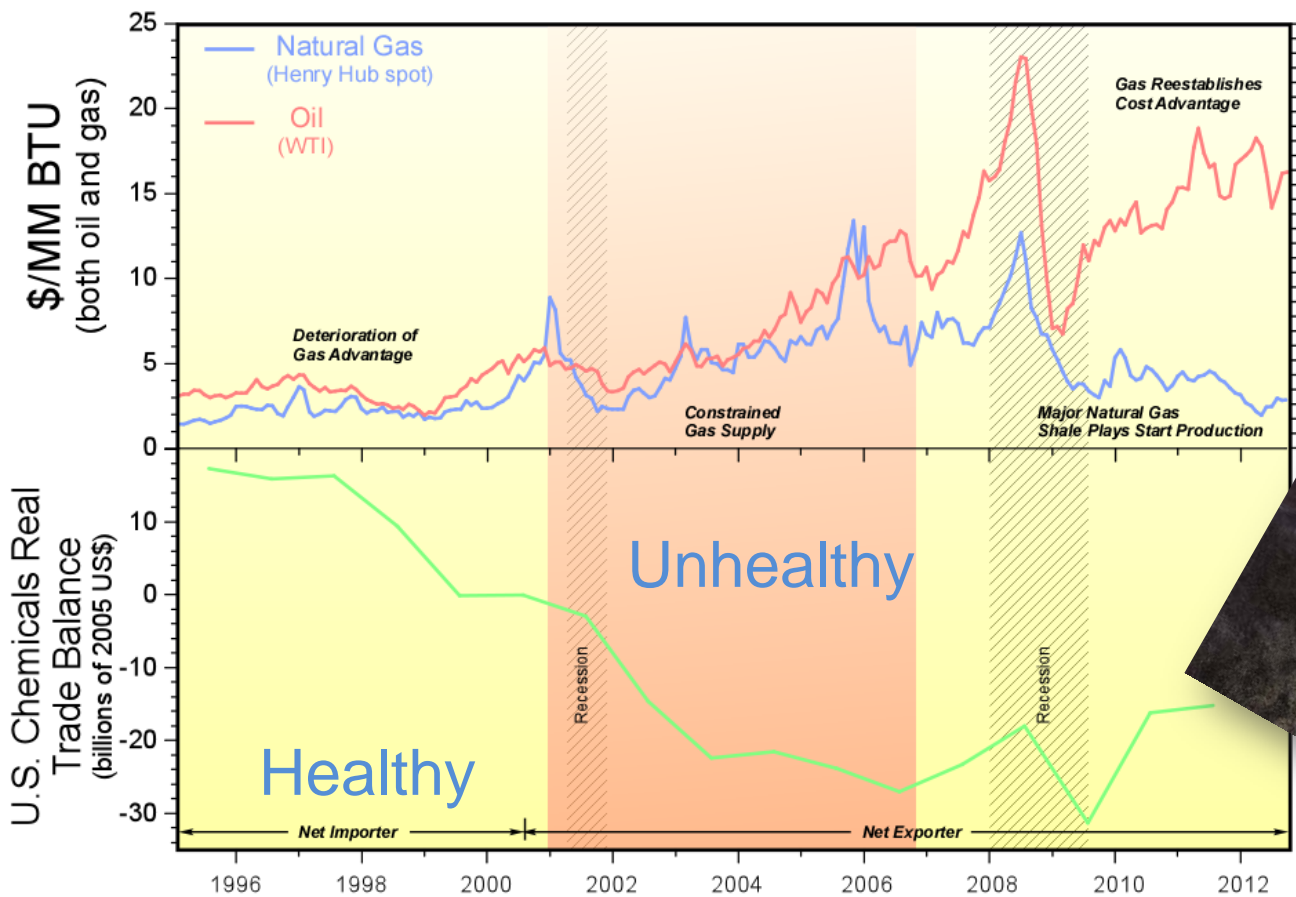
Healthy



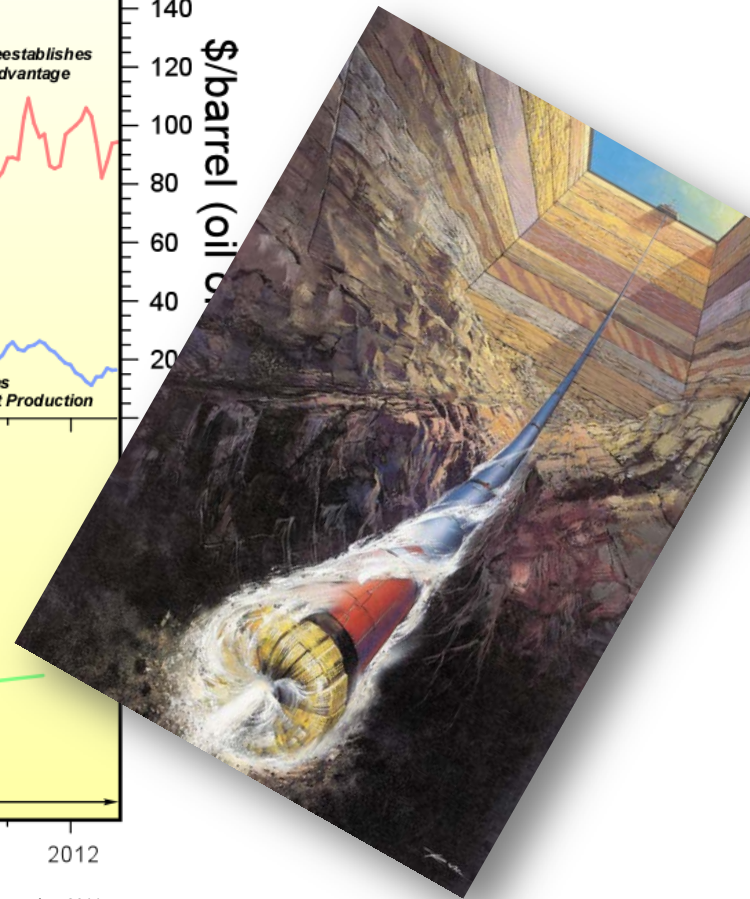
Unhealthy



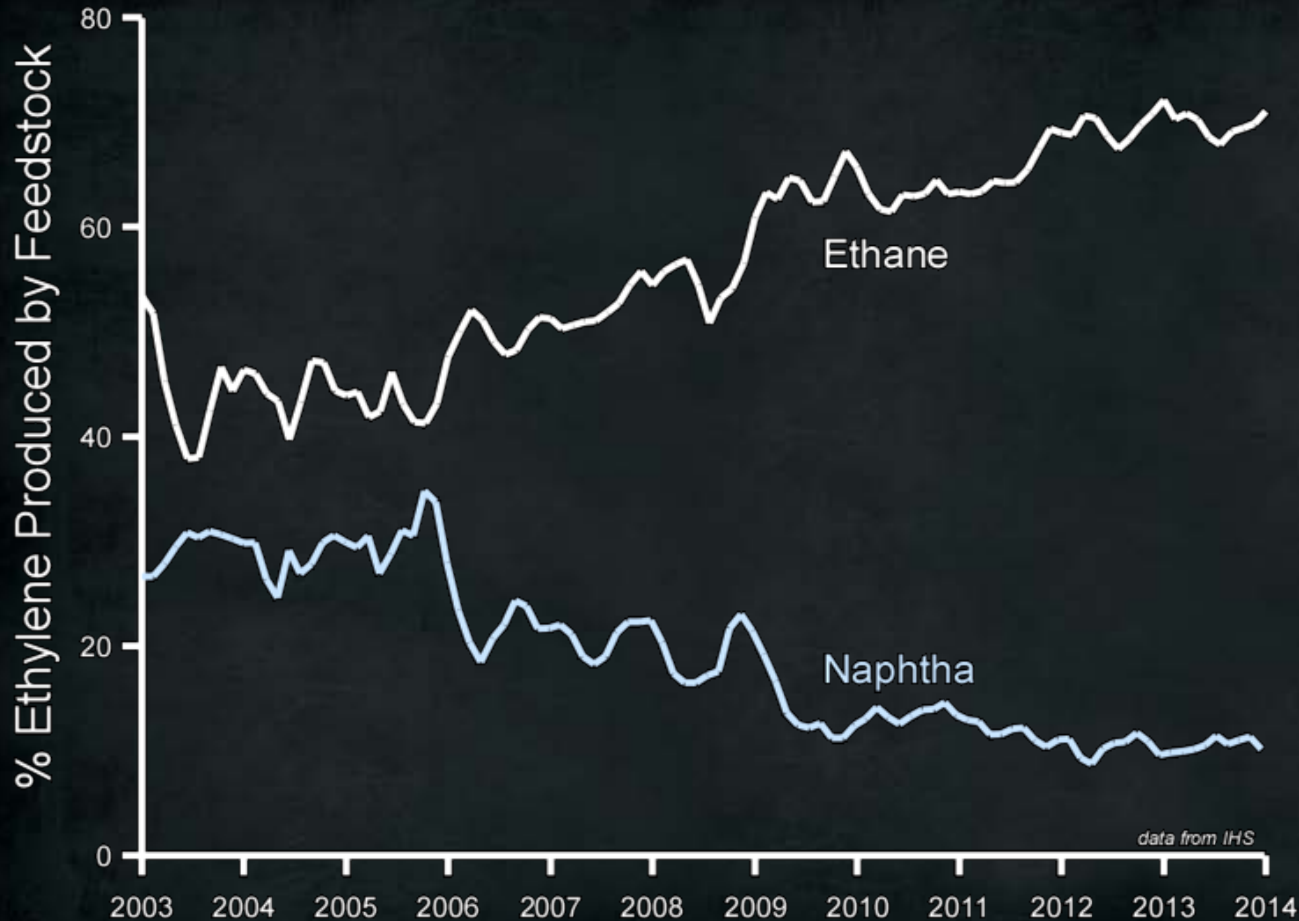
# Truism 1: Chemical Industry is Returning to Health



IHS Global Insight, "The Economic and Employment Contributions of Shale Gas in the US", prepared for America's Natural Gas Alliance, December 2011.



## US Trend

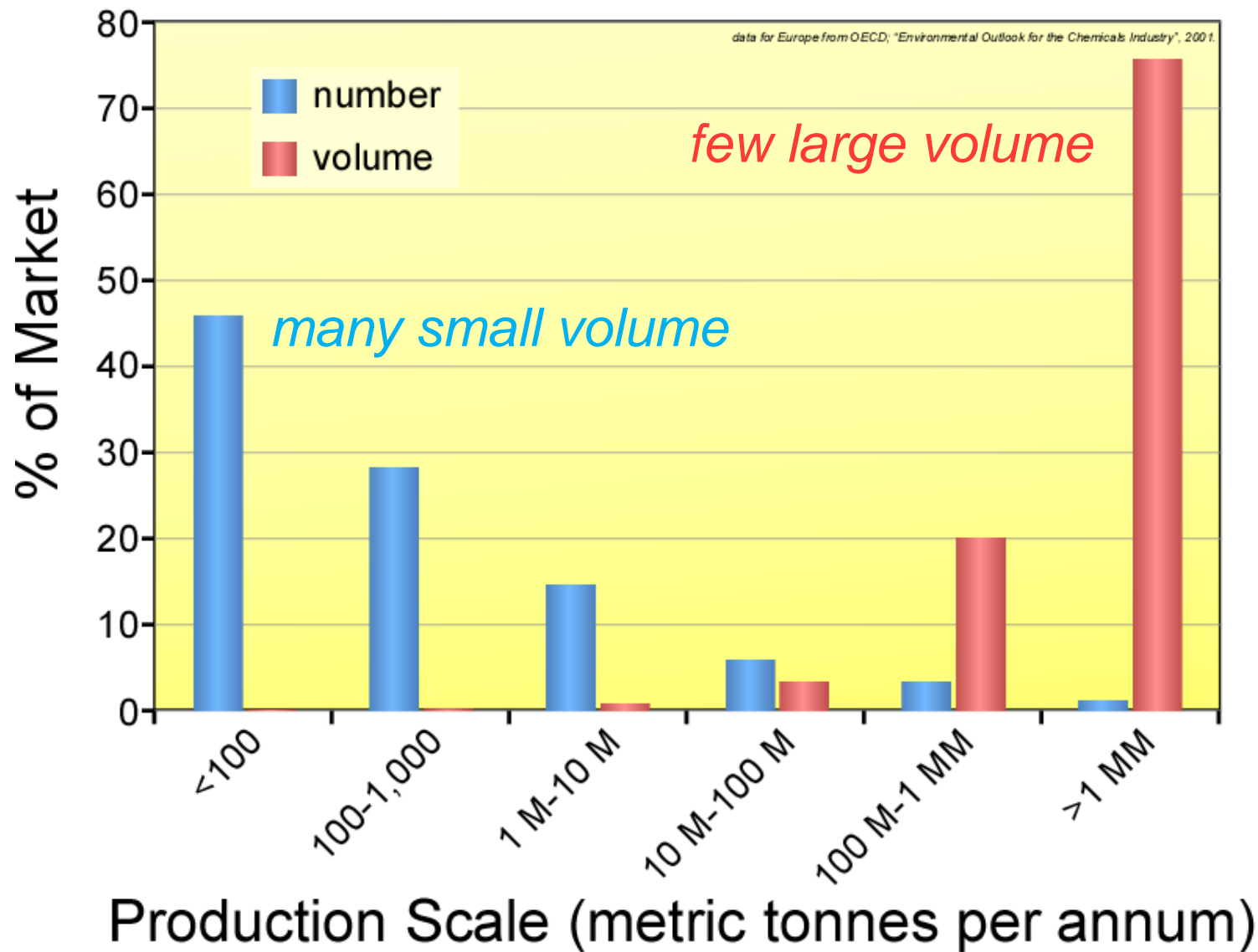


U.S. trend is toward lighter gas cracking and it is an old trend

Implications:

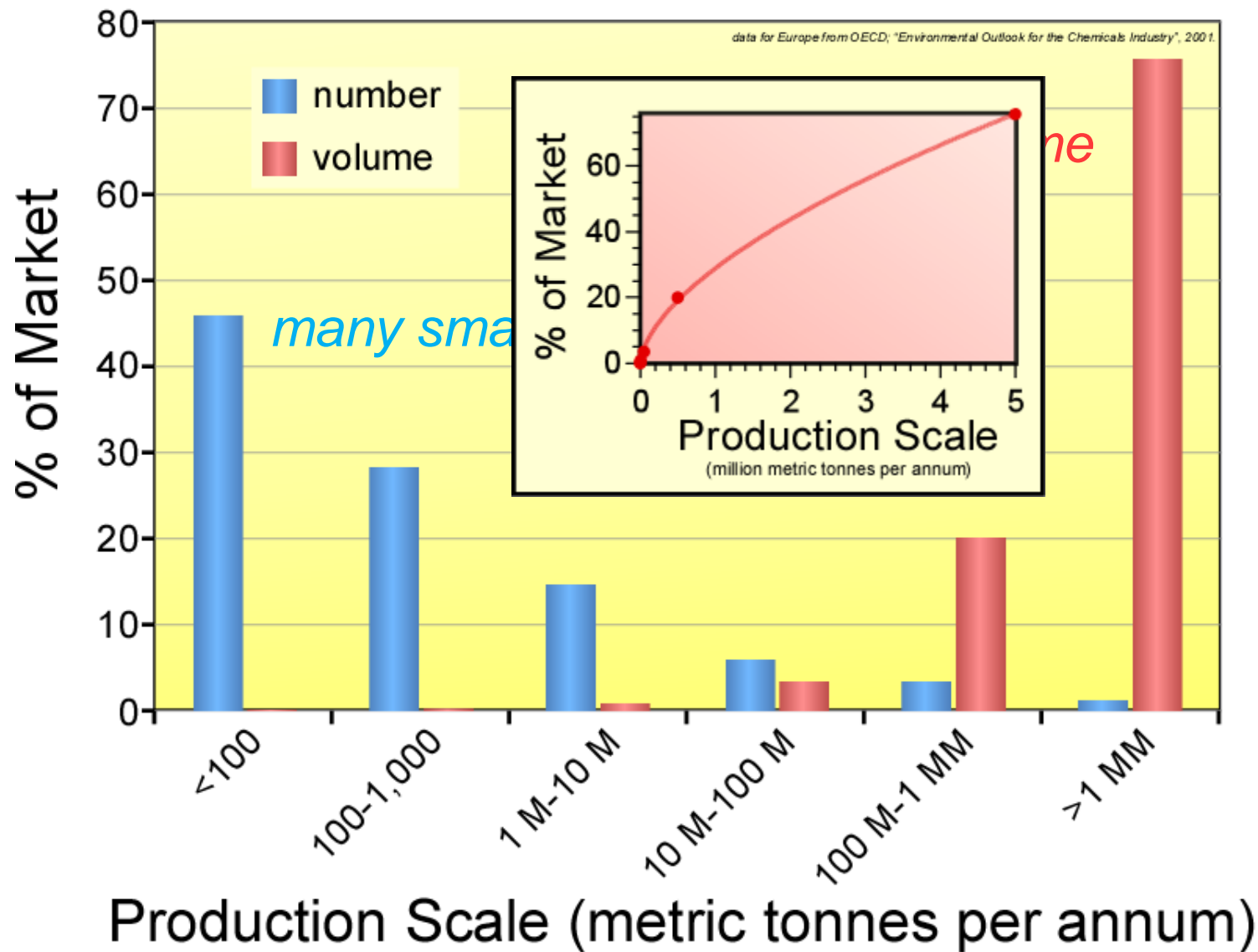
- less propylene
- less butadiene
- less benzene

## Truism 2: Scale Falls Quickly in Chemicals





## Truism 2: Scale Falls Quickly in Chemicals



## Truism 3

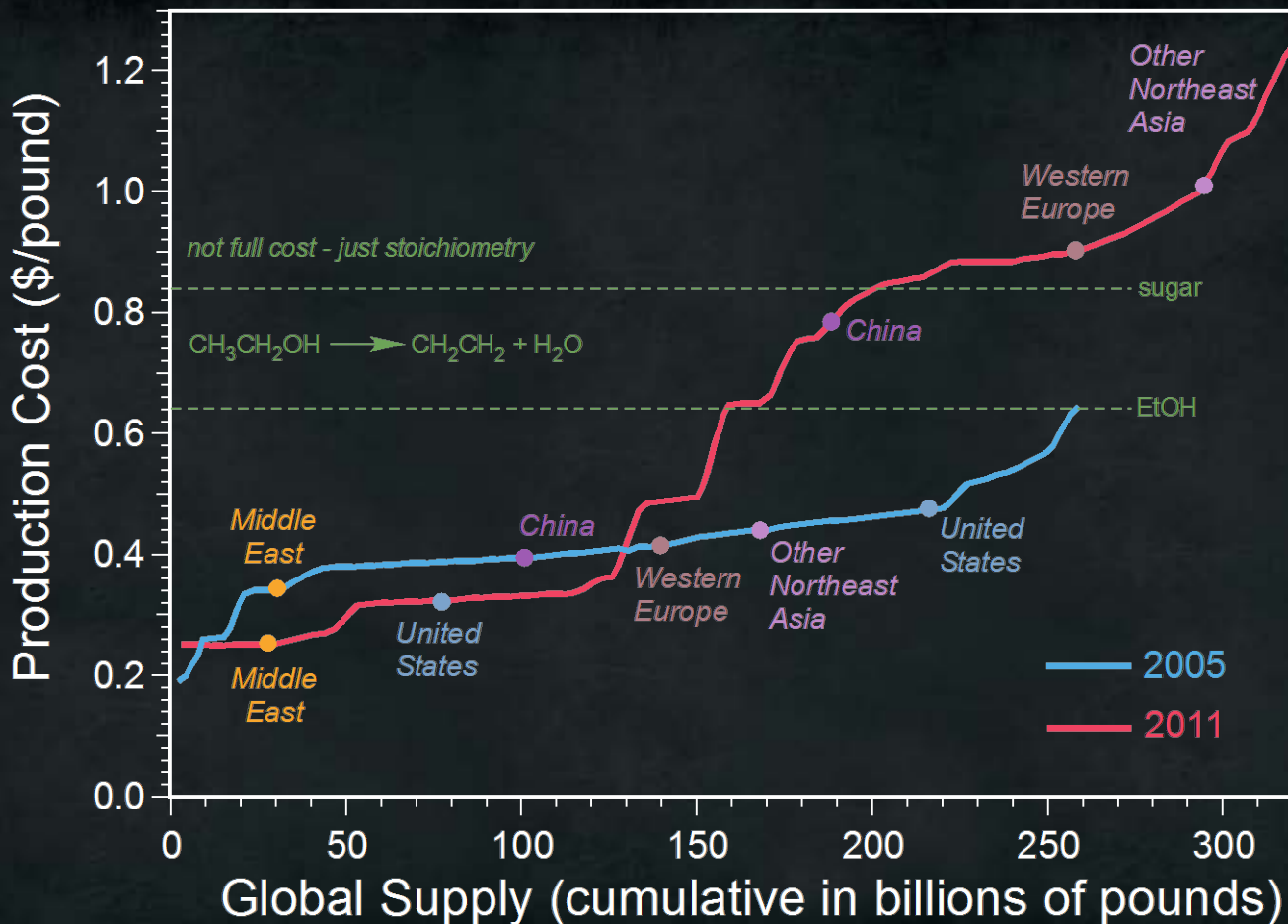
*A mixture containing a valuable chemical is not the same as a valuable mixture of chemicals.*

## Truism 4: Scale Always Wins



If you are moving mass around, scale reduces cost faster than experience.

# Fallacy 1: Bio Beats Fossil



Owen Kean and T.K. Swift, American Chemistry Council, "Industry-Transforming Natural Gas into Products", National Academy Forum on Unconventional Gas, 11 September 2012.

## Fallacy 2: Green Premiums

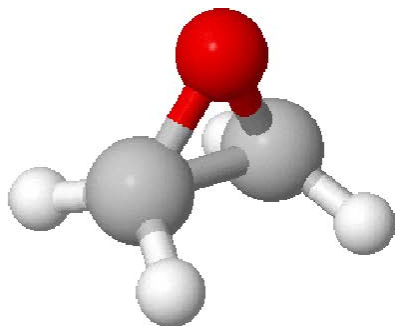
*Chemical markets are driven by cost and premiums are difficult to sustain.*

## Fallacy 3: Shut-down Economics

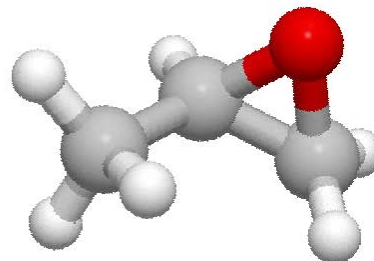
*It takes decades for superior technology to displace standing assets.*

# Epoxidation

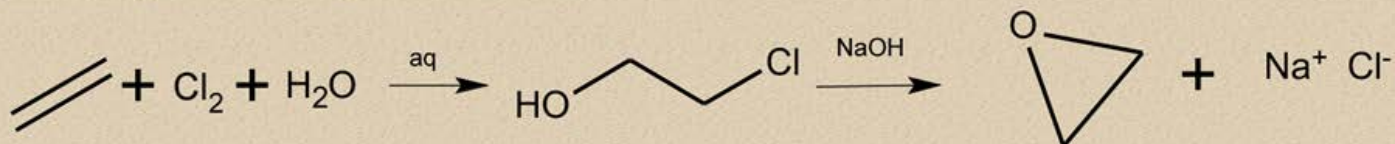
EO



PO

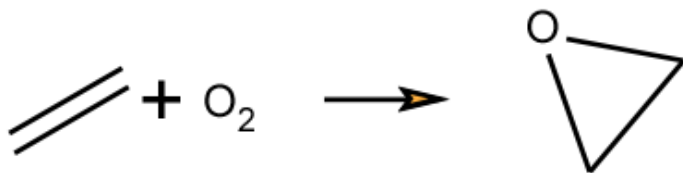


## Chlorhydrin Ethylene Oxide



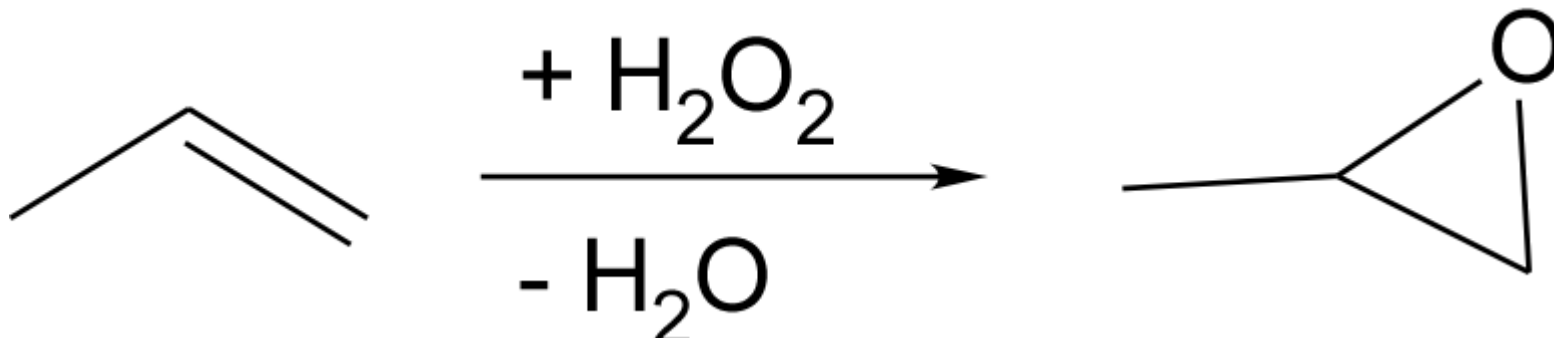
1915-1975

## Direct Oxidation Ethylene Oxide



1937 →

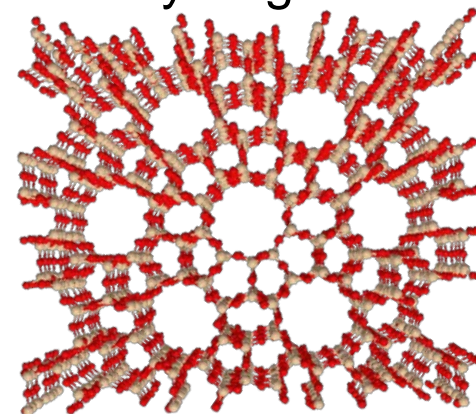
## Improved PO Process - HPPO



Hydrogen peroxide is the oxidant – *only water as coproduct*

Peroxide provided as an aqueous solution from co-located hydrogen peroxide plant – *eliminate transportation*

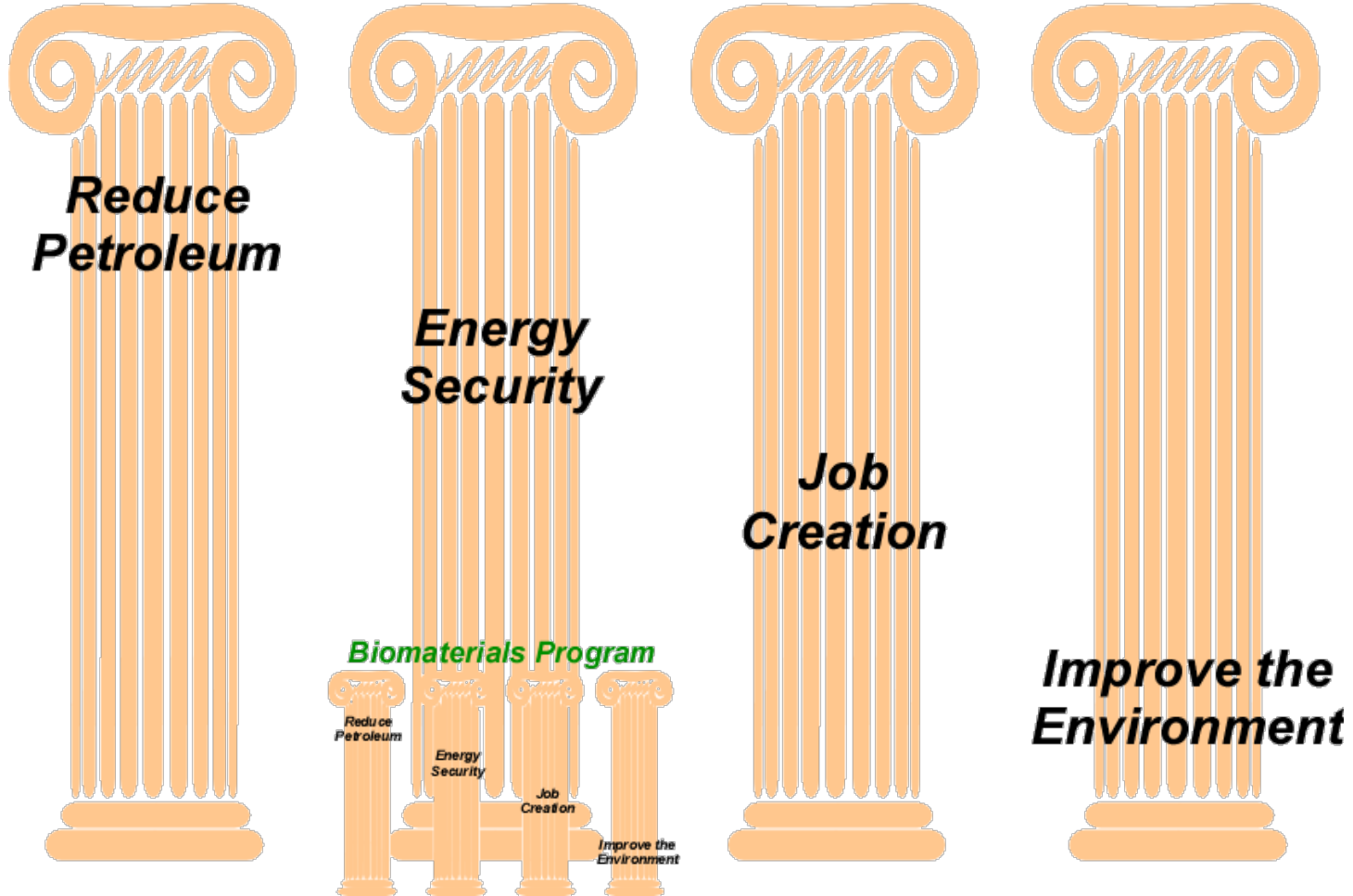
Catalyst system enables the technology



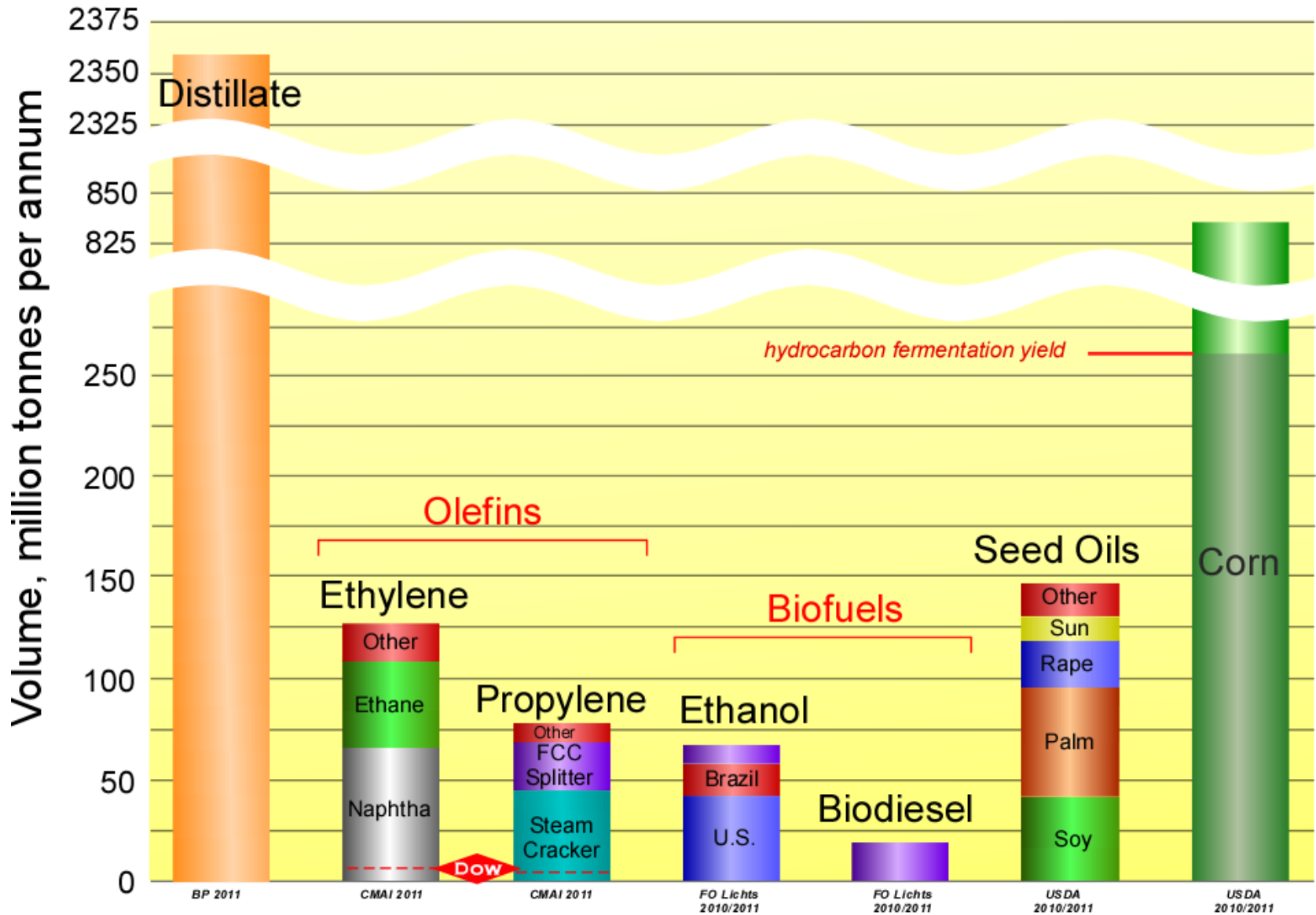


**Pivot to Biomaterials**

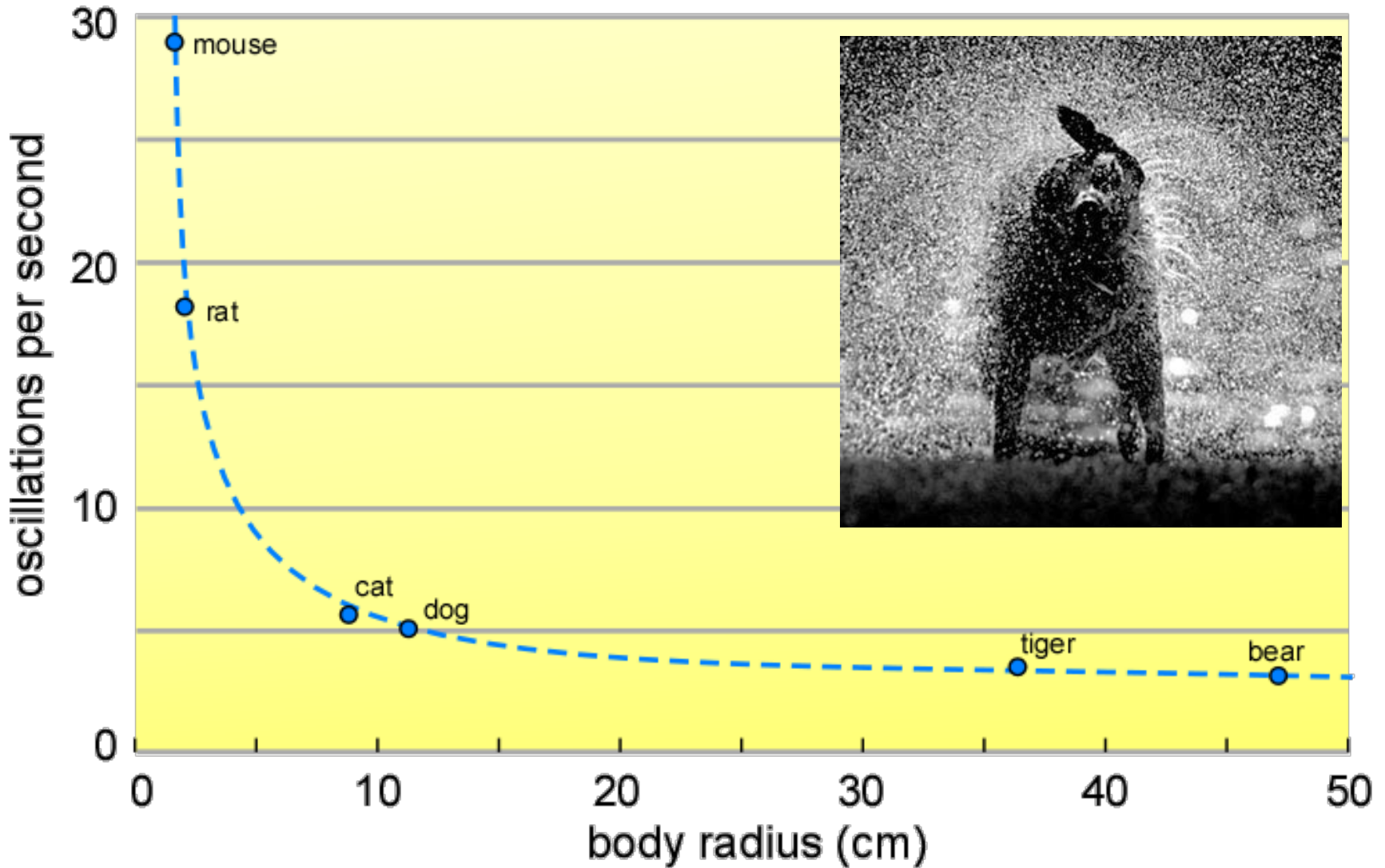
# ***Biomass Fuels Program***



# Global Commodity Production

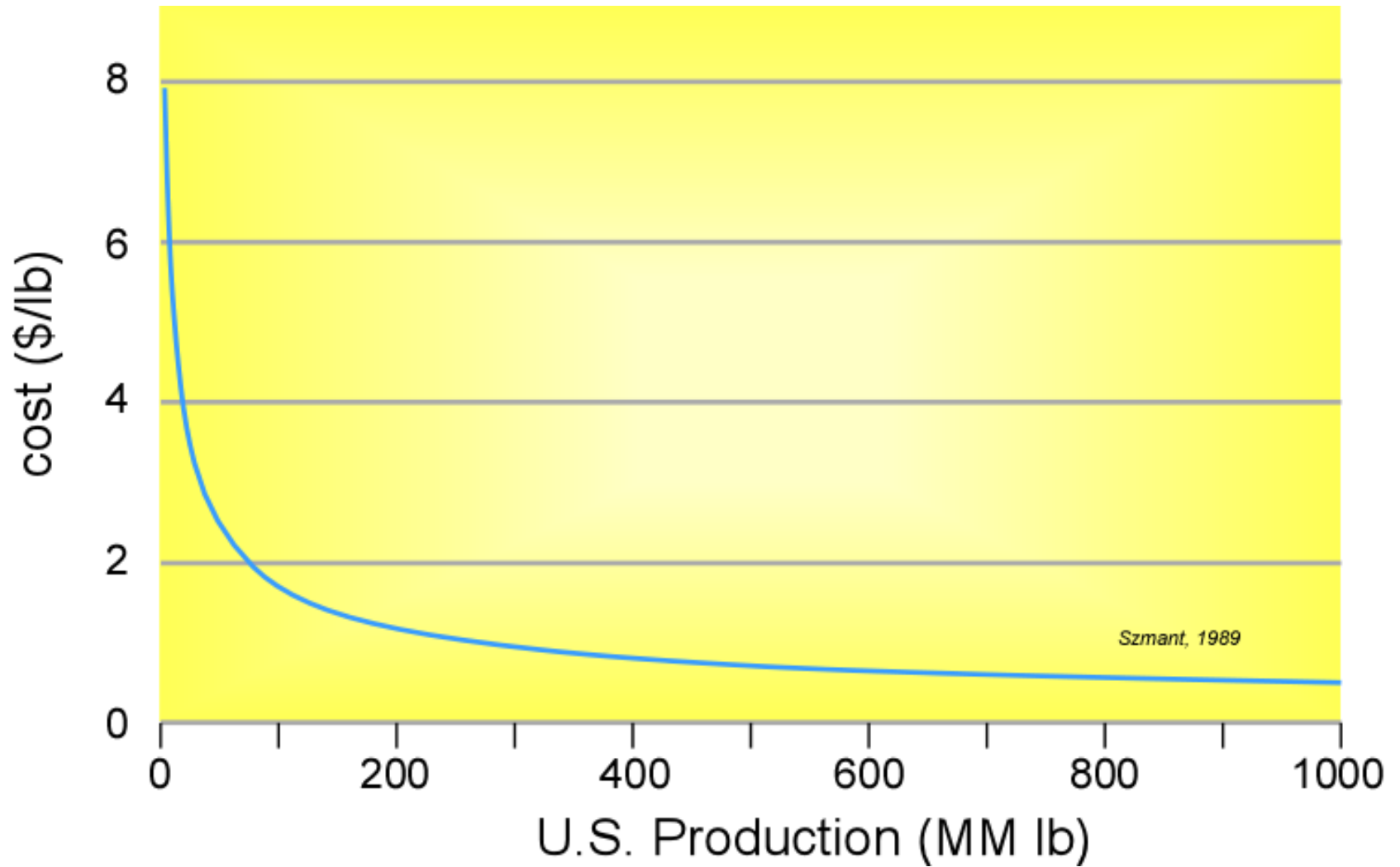


# Interesting Correlation

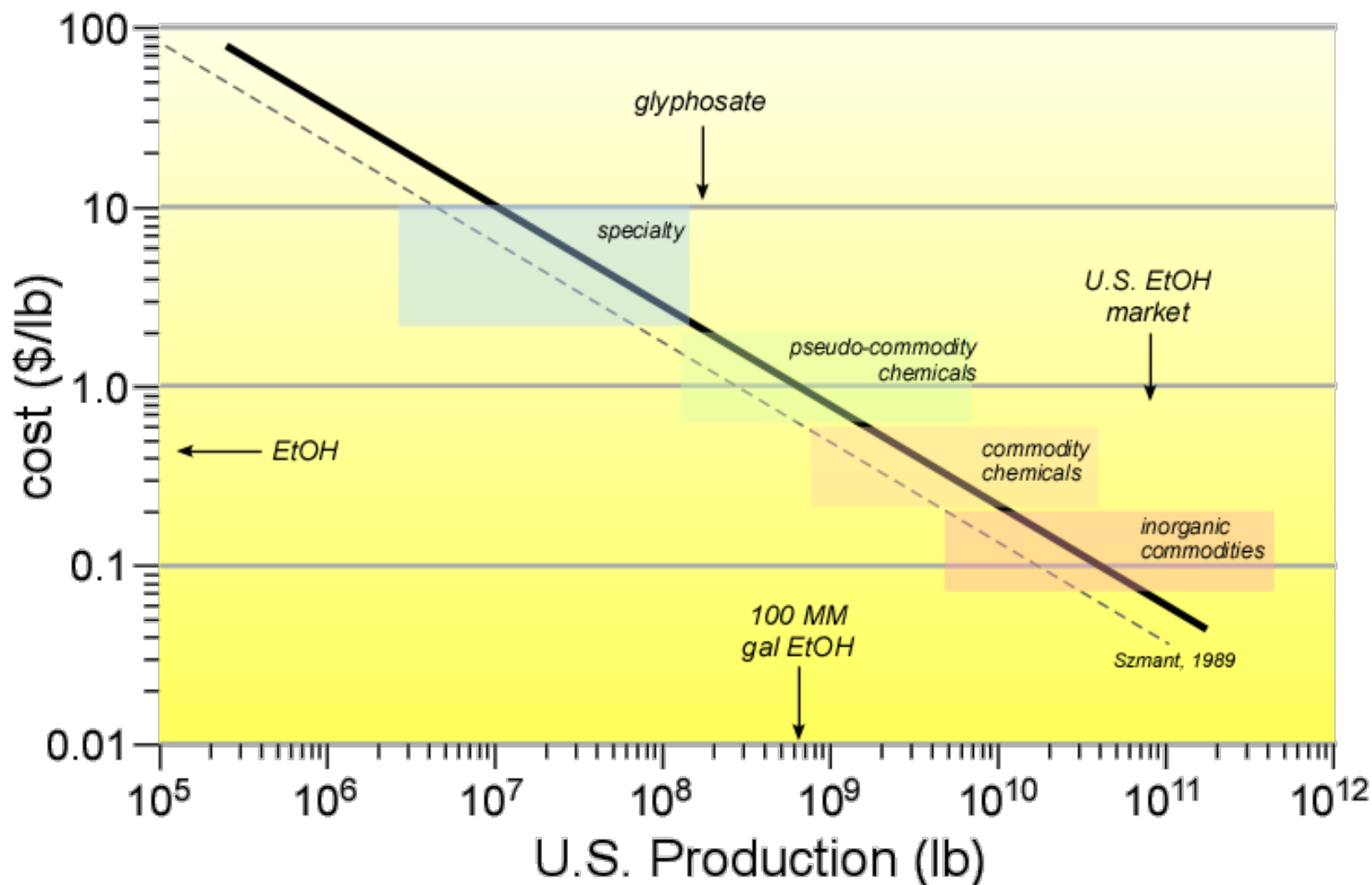


Andrew Dickerson, Grant Mills, Jay Bauman, Young-Hui Chang, David Hu, *The Wet-Dog Shake*, *Fluid Dynamics*, 15 October 2010.

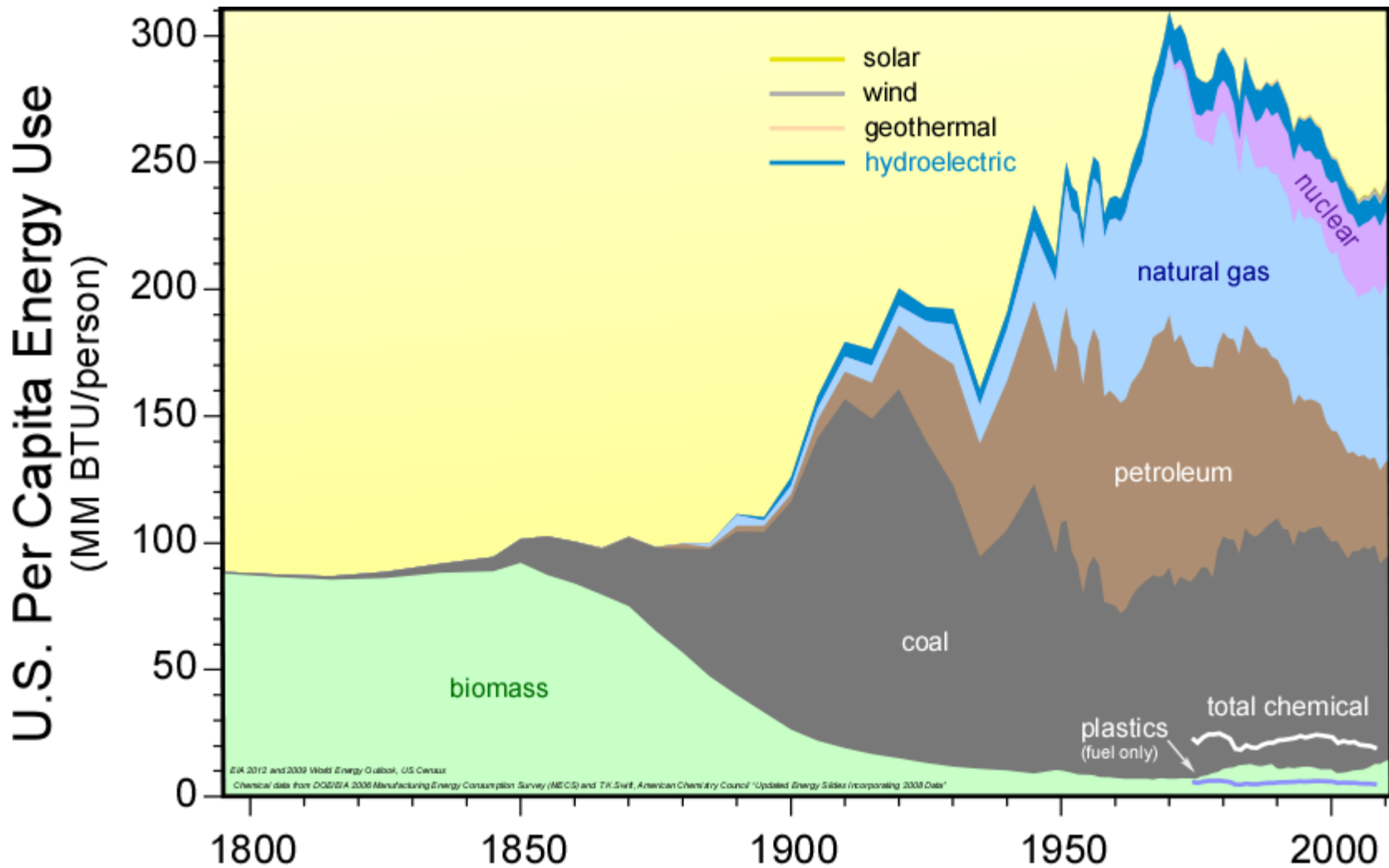
# Scale Matters!



# Most Common Version



# Personal Impact



## Plant Bottles



“At full capacity, it is estimated the facility will produce 500,000 metric tons of material per year. By using plant-based materials instead of non-renewable materials, the facility will remove the equivalent of 690,000 metric tons of carbon dioxide or the equivalent of consuming more than 1.5 million barrels of oil each year.”

Coca-Cola, 27 Sept 2012



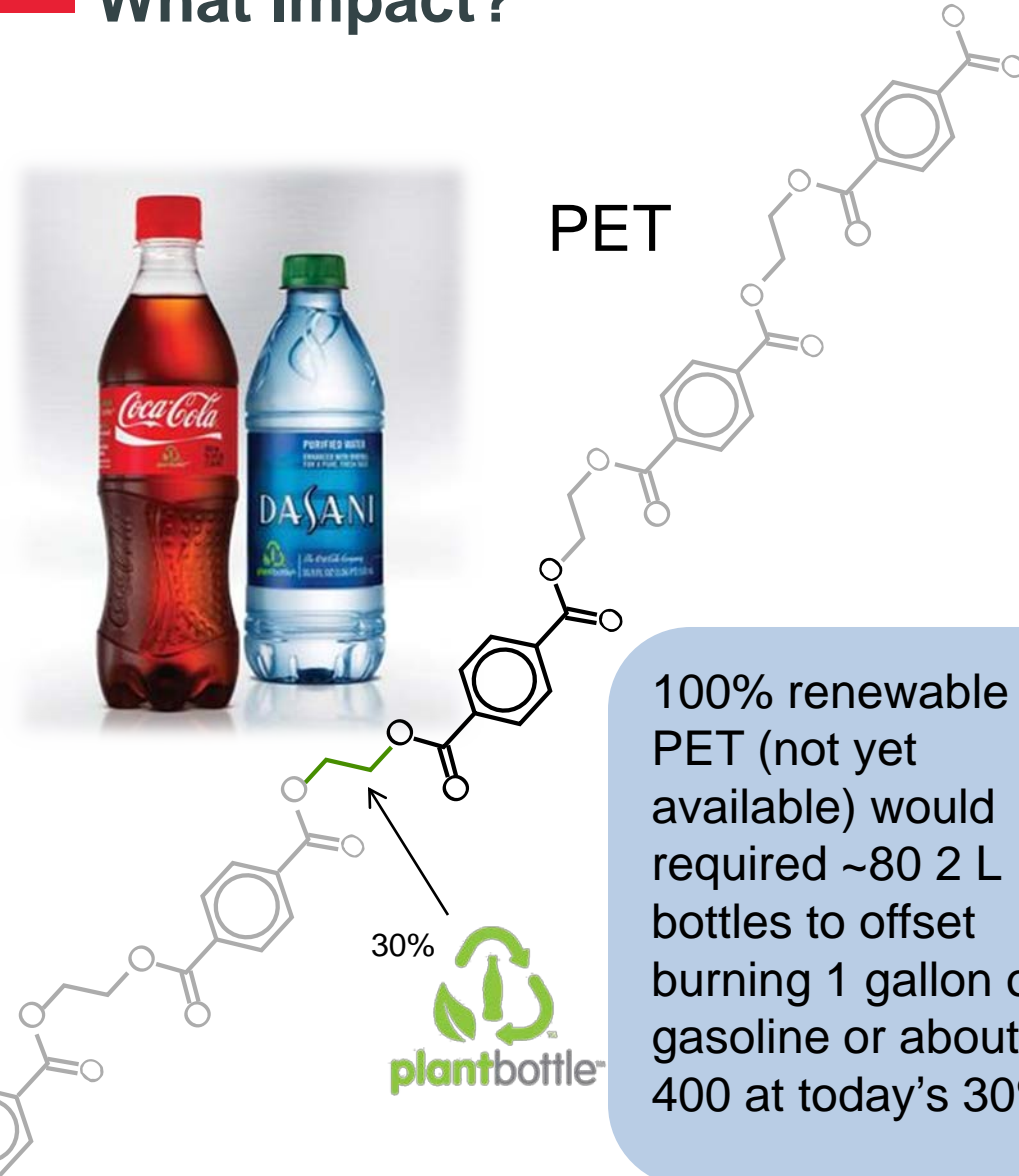
US consumption is 19 million barrels per DAY.  
World, 90 million.



# What Impact?



PET



30%



100% renewable PET (not yet available) would require ~80 2 L bottles to offset burning 1 gallon of gasoline or about 400 at today's 30%

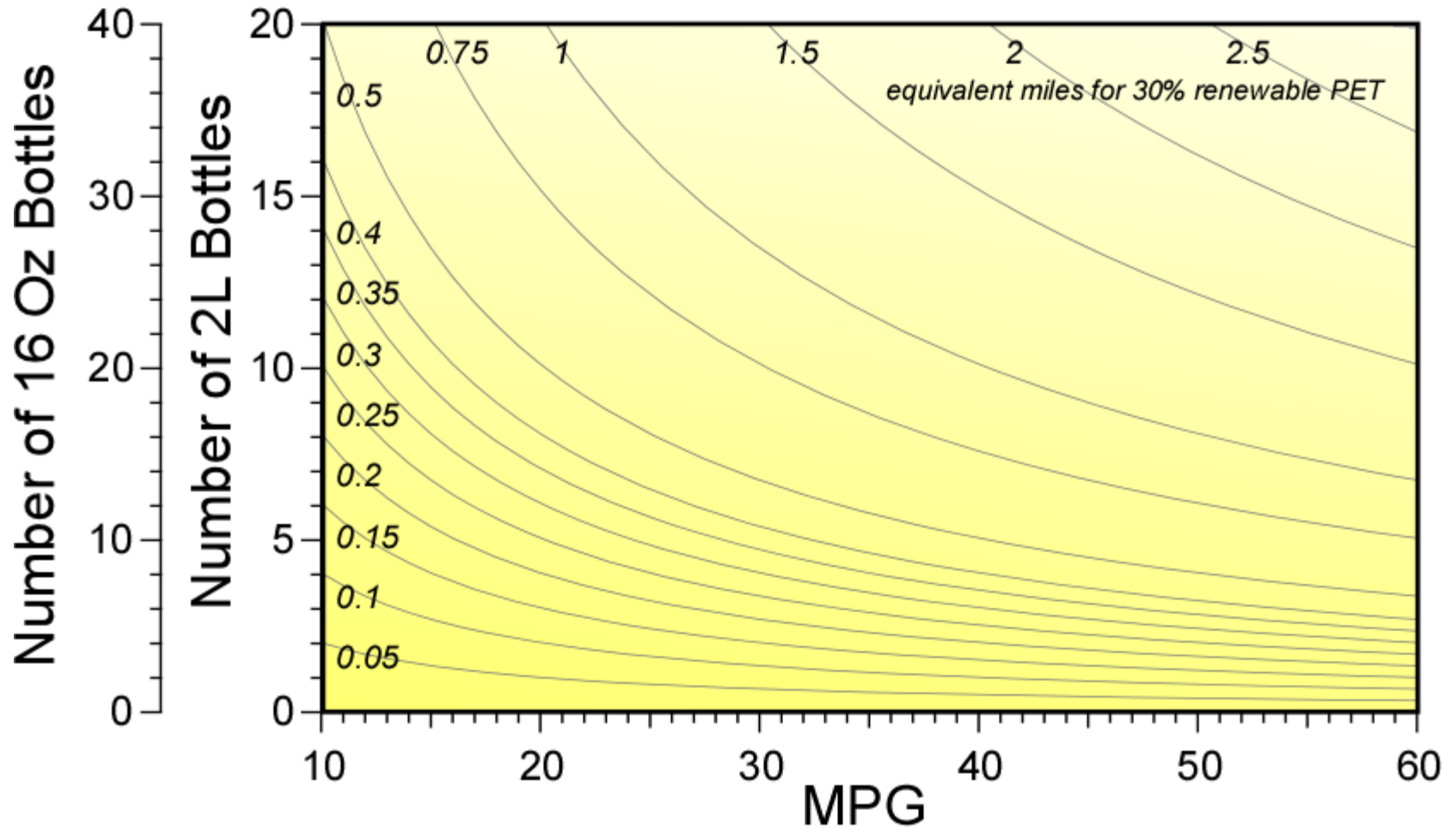
material	per capita consumption (lb/yr)
PET packaging	17
petroleum	6619
natural gas	8037
coal	6439
gasoline	2495
sand and gravel	13923
cement	512
iron ore	340
salt	403
beef	54.3
chicken	55.7

data from HIS, 2012 ERS USDA, 2011 National Mining Assoc., World Bank





# PET Comparison



# Path to the Future

