



Sustainable Decision Making: *Designing for a Sustainable Future at Dow Chemical*

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The Dow Chemical Company

16 May 2013



Dow.com/innovation

Regional ACS Meeting, Mt. Pleasant, MI

I Waste Time and Money At Home



I Waste Time and Money At Home



I Waste Time and Money At Home



I Waste Time and Money At Home



I Waste Time and Money At Home

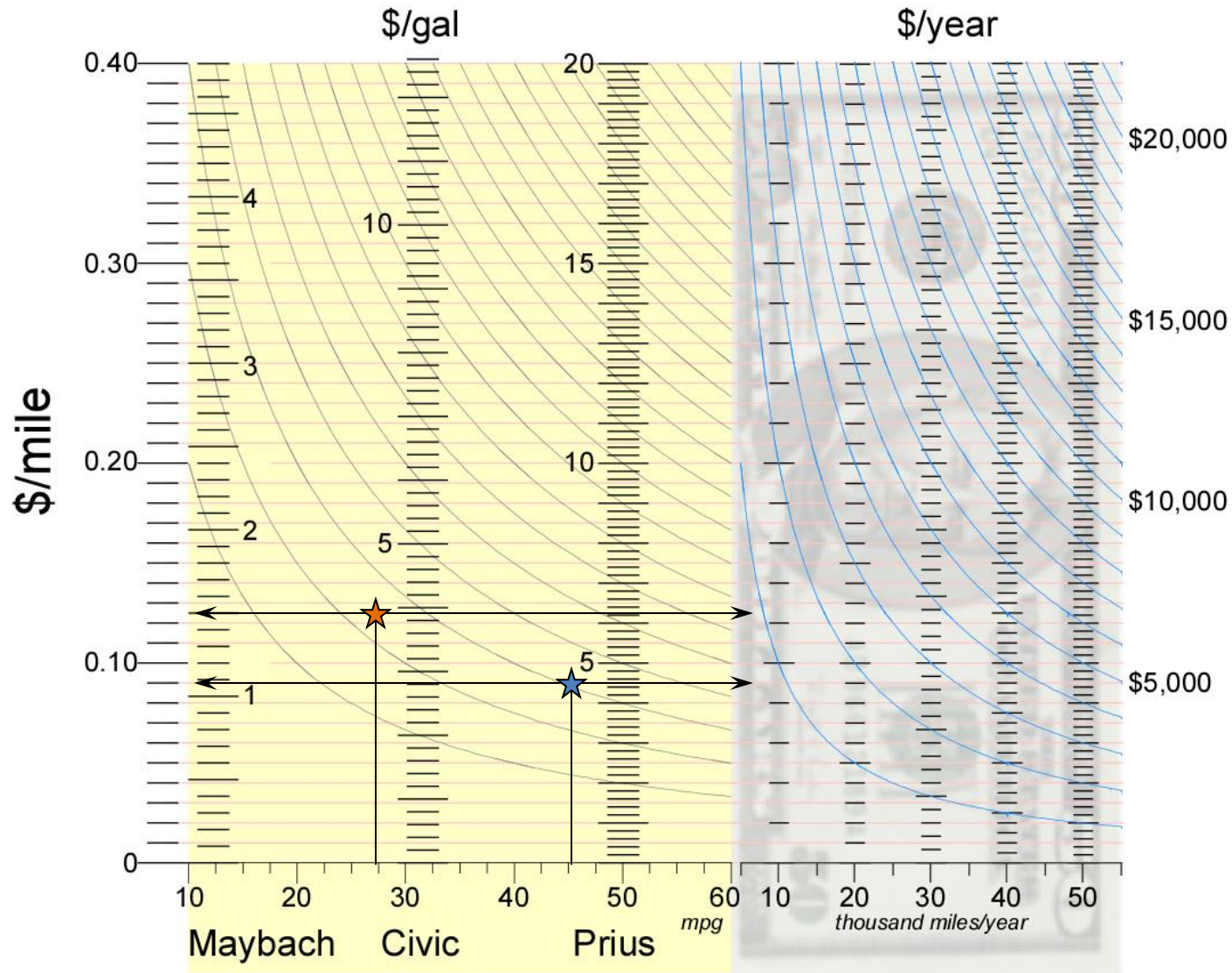


Energy
CERTIFIED

I Waste Time and Money At Home



I Waste Time and Money At Home



I Waste Time and Money At Home



I Waste Time and Money At Home



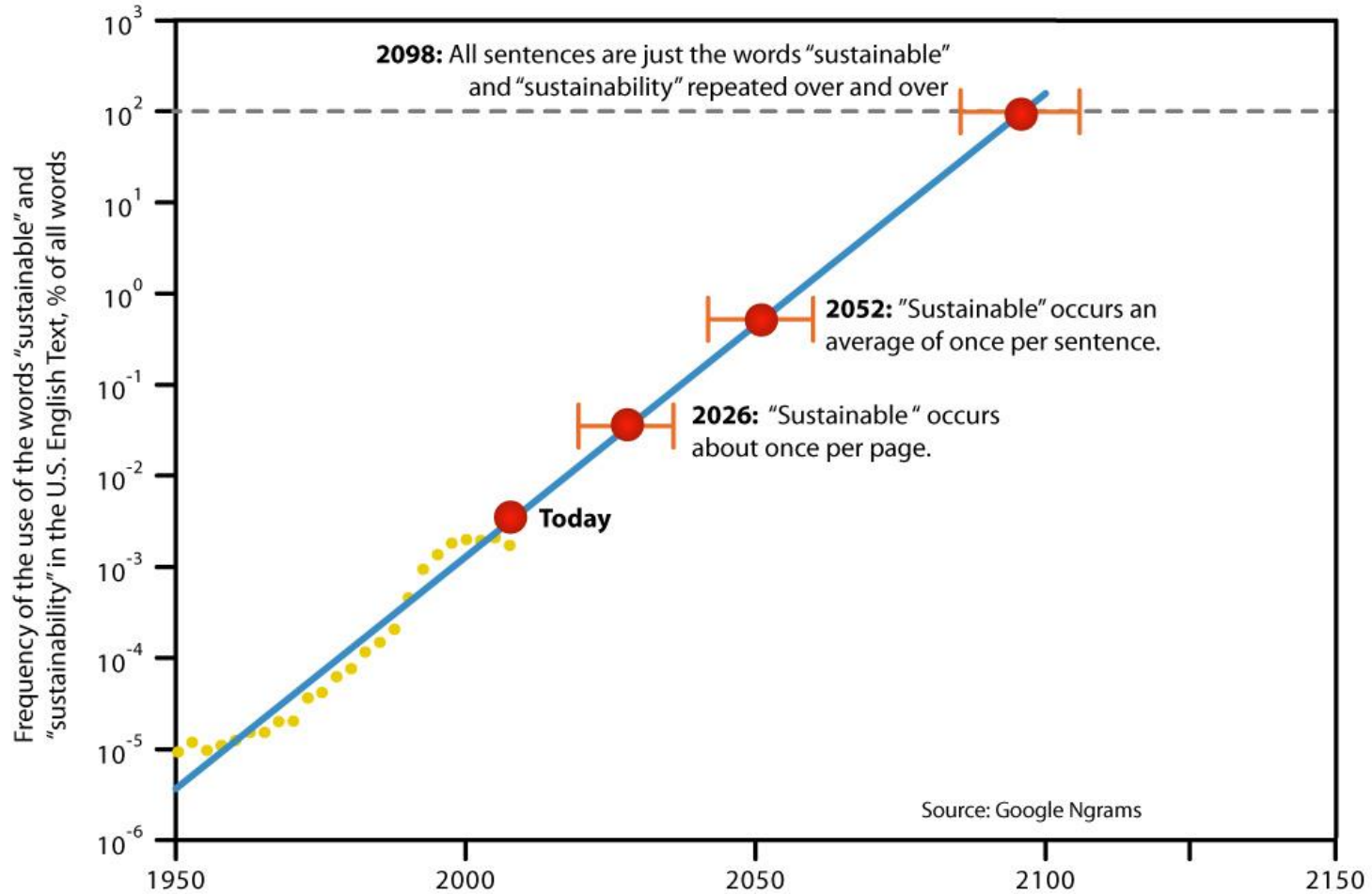
I Waste Time and Money At Home



I Waste Time and Money At Home



Sustainability is Unsustainable?

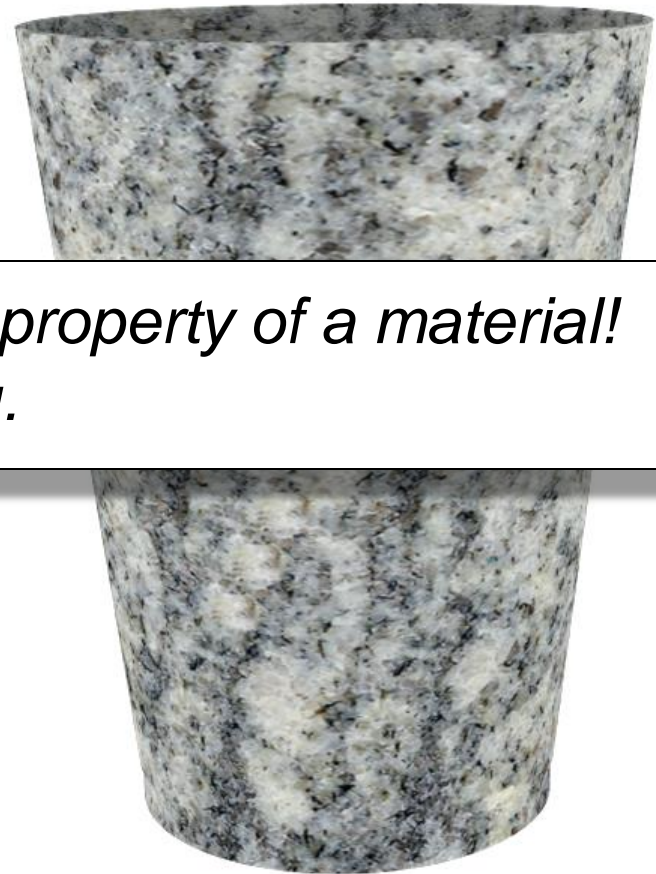
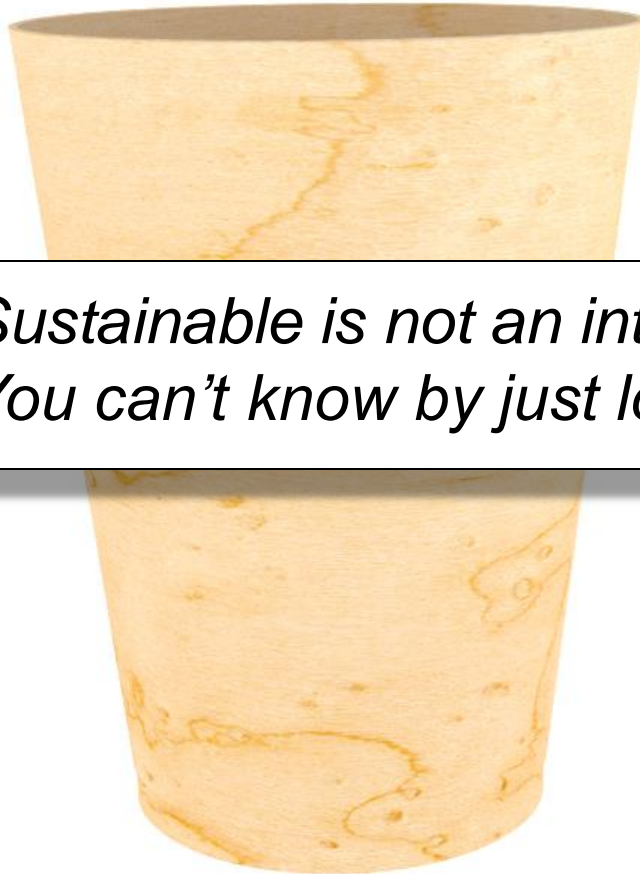


<http://imgs.xkcd.com/comics/sustainable.png>

Sustainable?



Is this Cup Sustainable?



*Sustainable is not an intrinsic property of a material!
You can't know by just looking.*

How about this one?

Return Shareholder Value

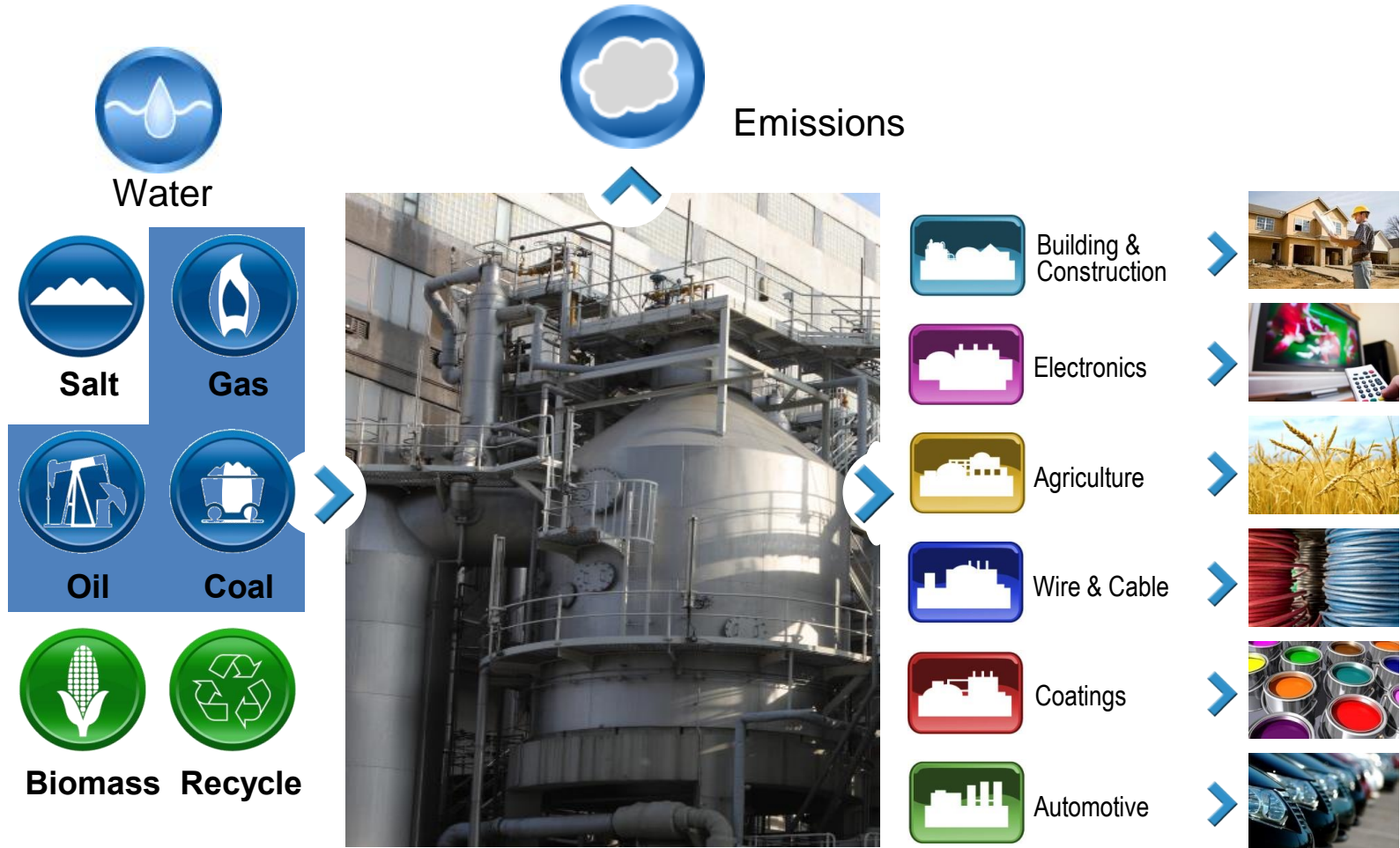
*I can't waste money
and time at work*



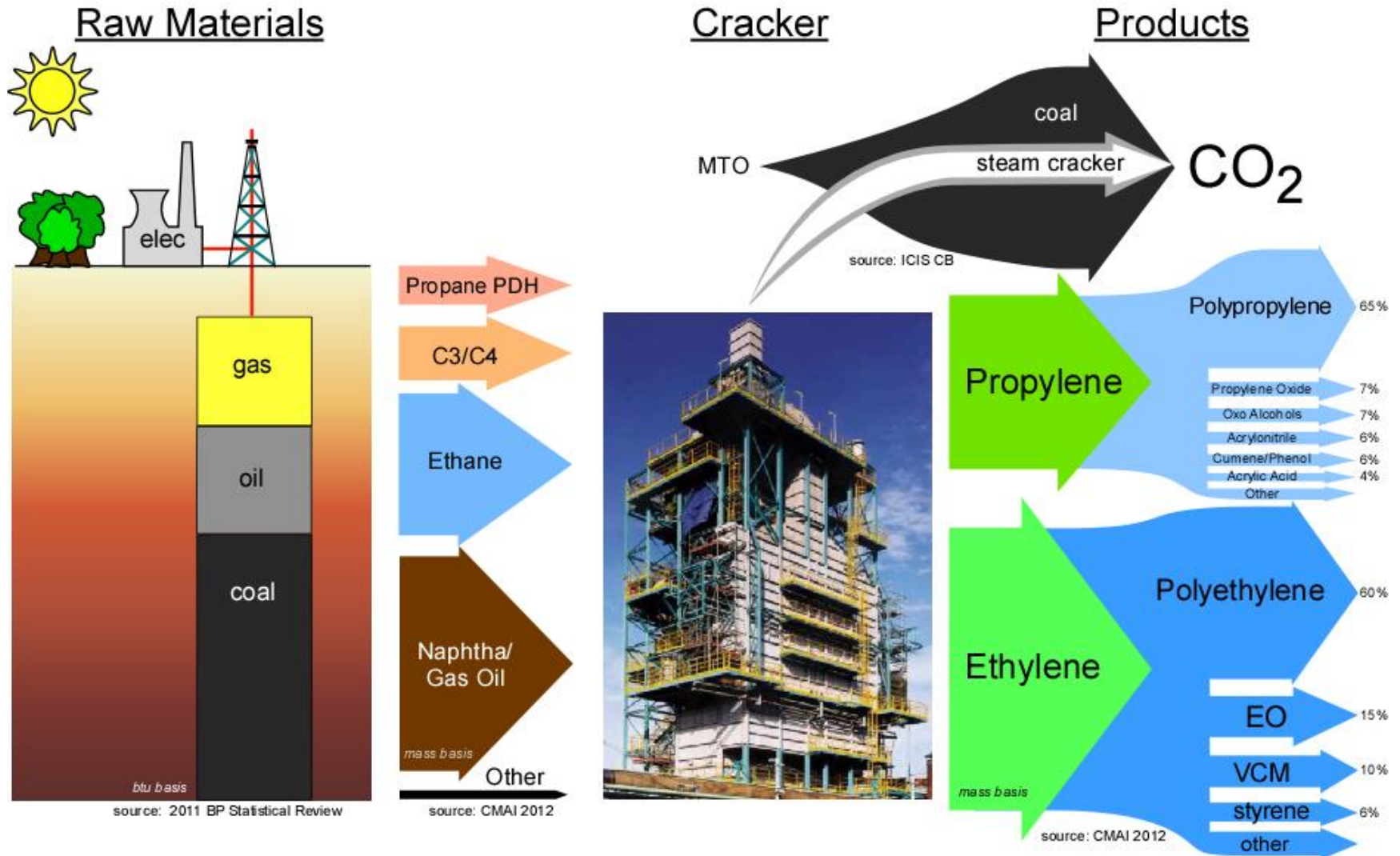
DOW

®

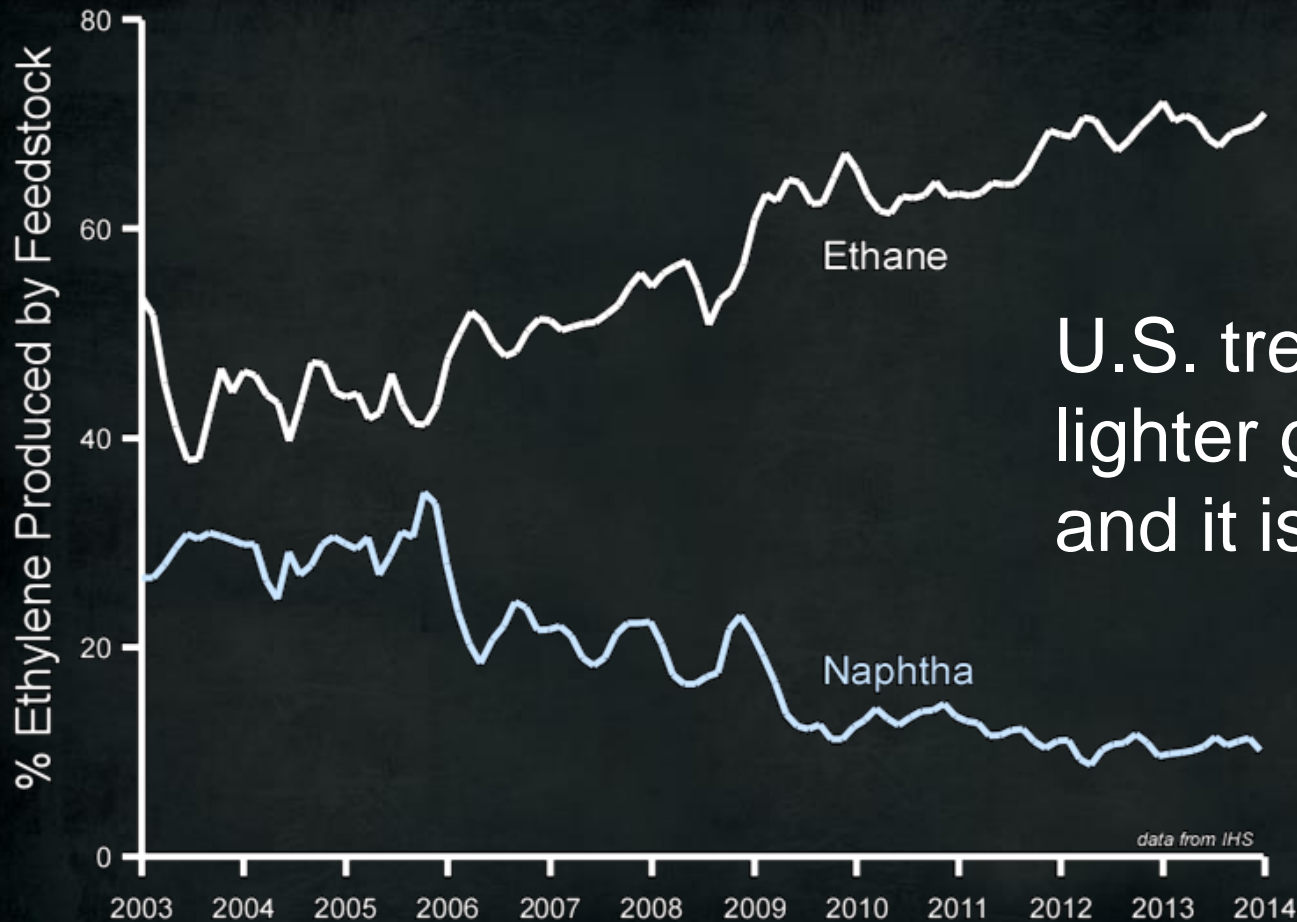
Chemical Industry Snapshot



Chemical Industry Snapshot

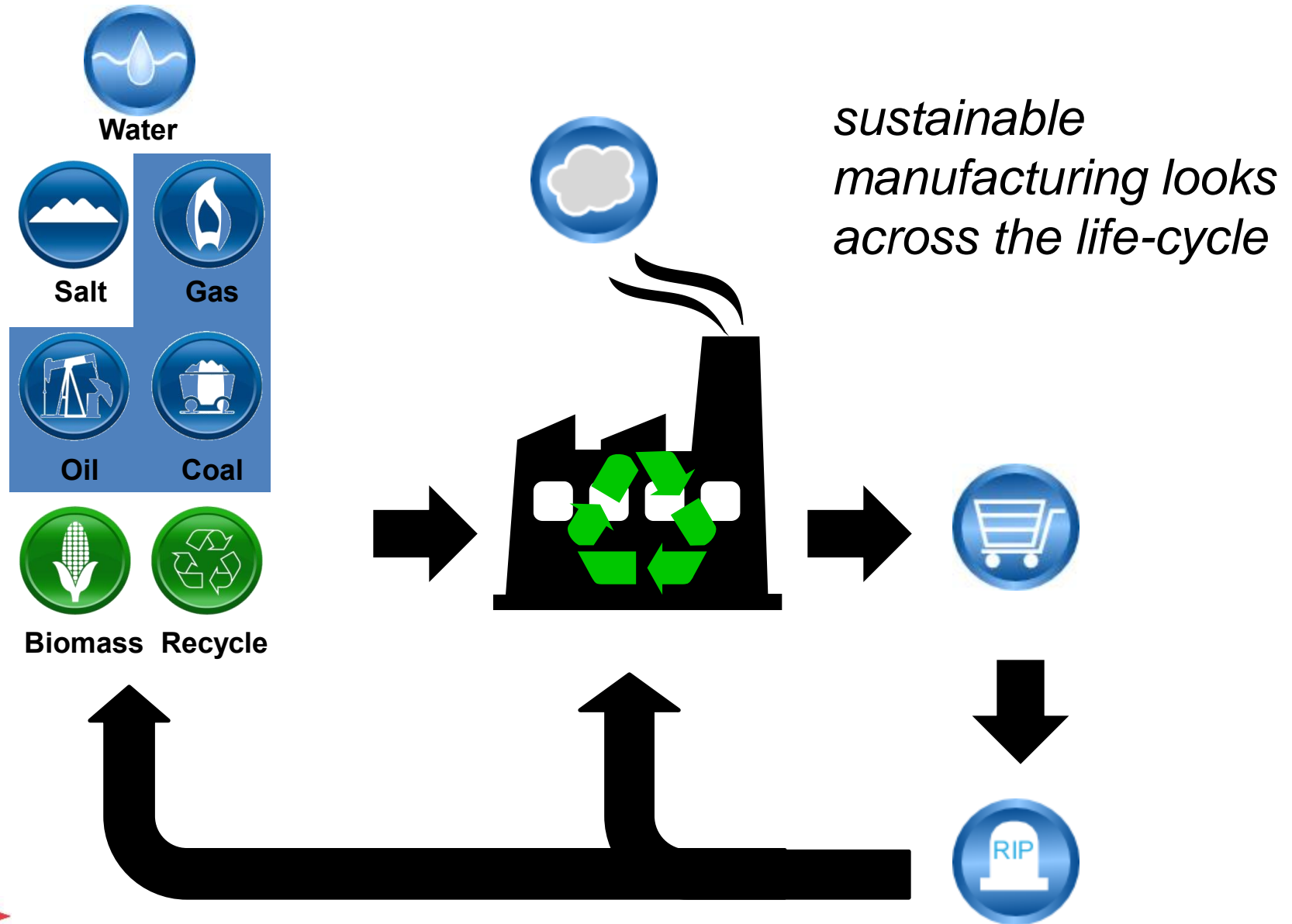


US Trend



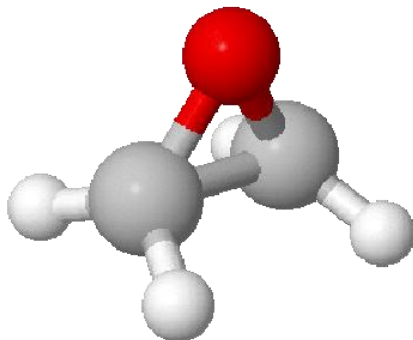
U.S. trend is toward lighter gas cracking and it is an old trend

Sustainable Manufacturing Requires Broader Look

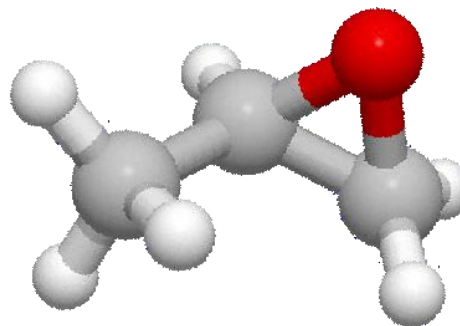


Epoxidation

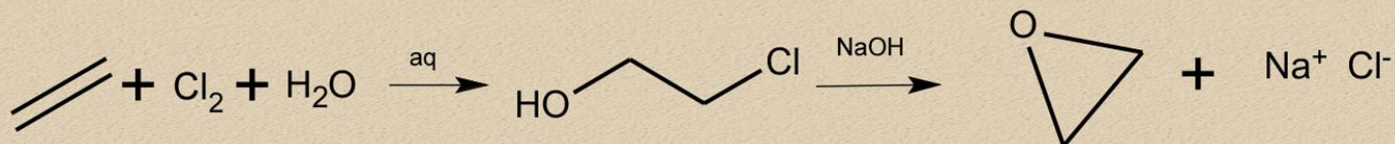
EO



PO

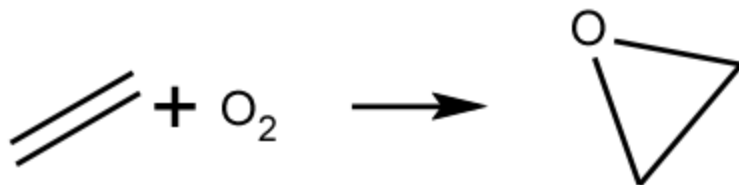


Chlorhydrin Ethylene Oxide



1915-1975

Direct Oxidation Ethylene Oxide



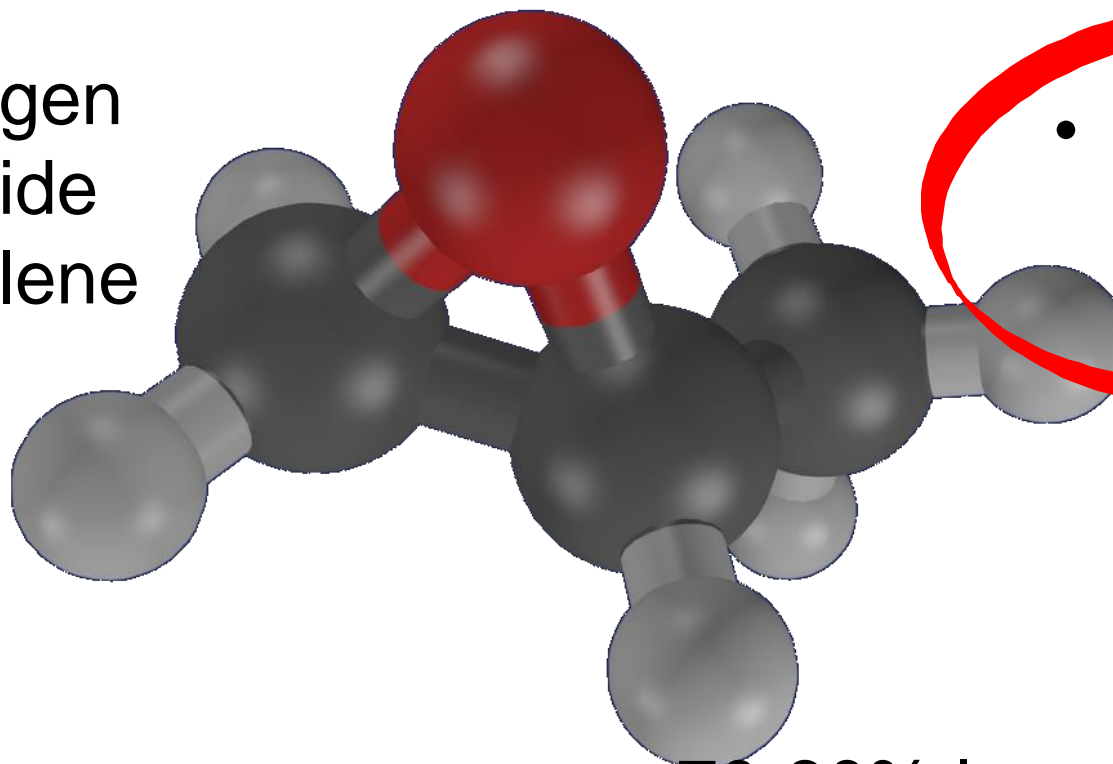
1937 →

Sustainable Manufacturing Examples: Catalysis

Propylene Oxide

Dow + *BASF*

- hydrogen peroxide
- propylene



- titanium silicate catalyst

- 70-80% less water
- 35% energy reduction

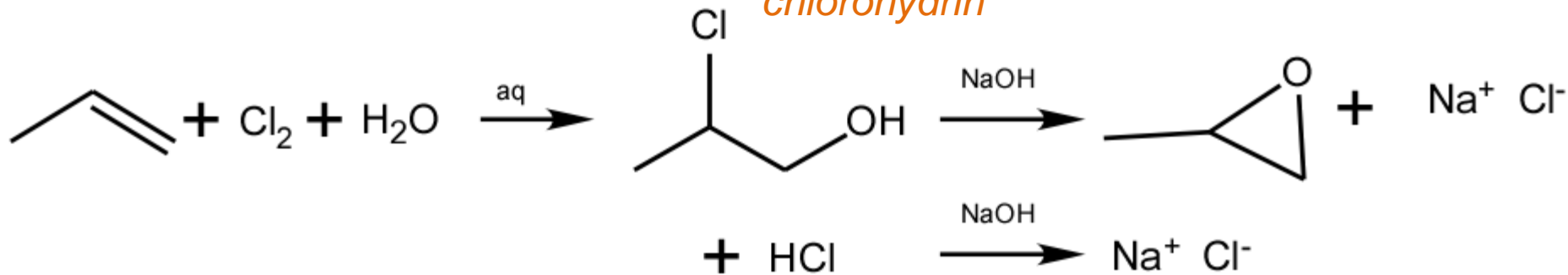


**GREEN
CHEMISTRY**



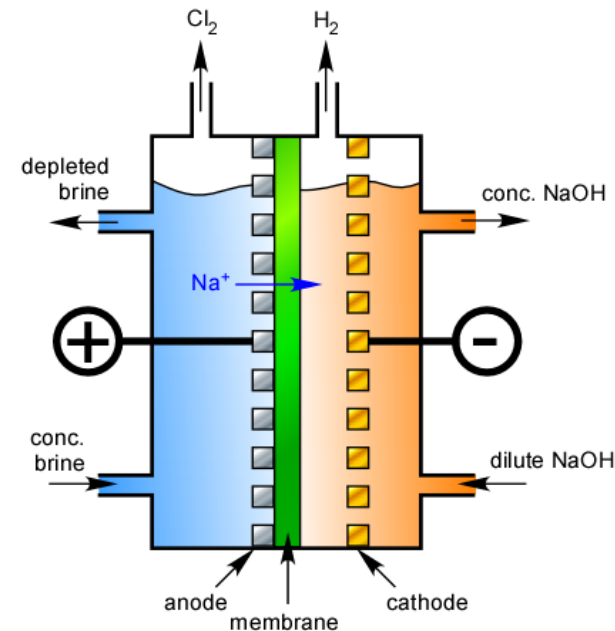
Chlorohydrin Process

Chlorohydrin Propylene Oxide *propylene chlorohydrin*

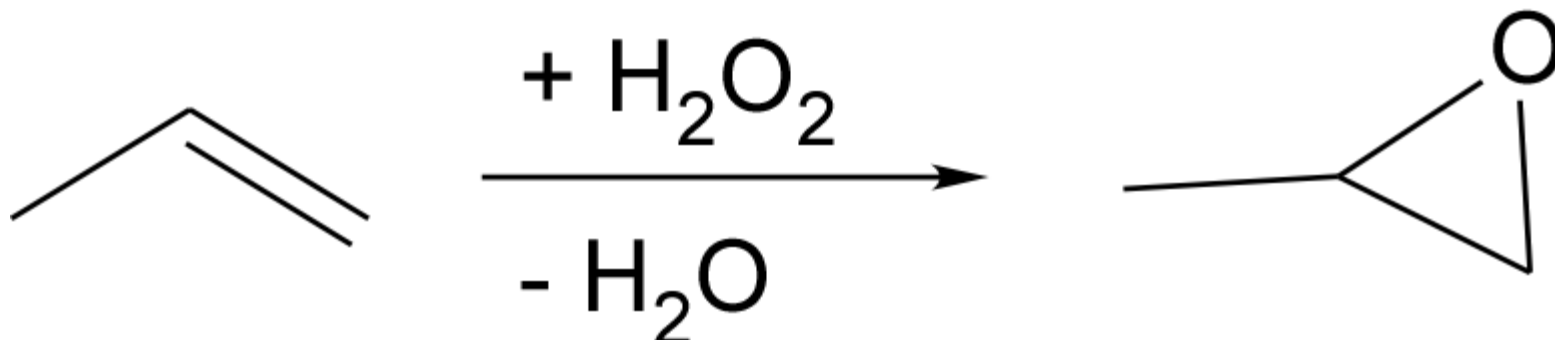


Issues:

- requires a chlorine plant
- chlorine is lost to an aqueous salt stream
- chlorinated co-products are produced
- brine for chlor-alkali is solution minded
- *difficult way to add oxygen*



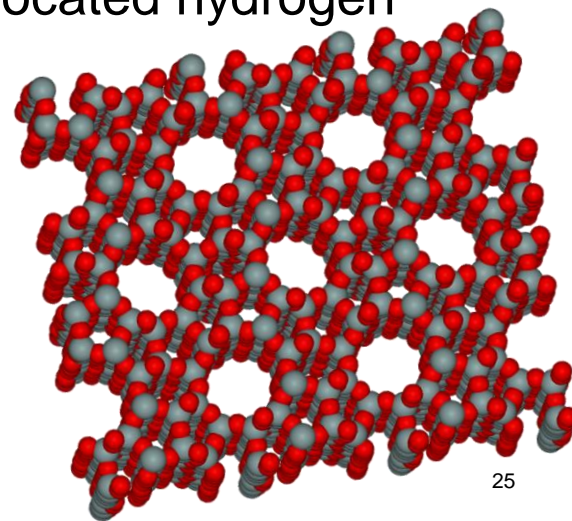
Improved PO Process - HPPO



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

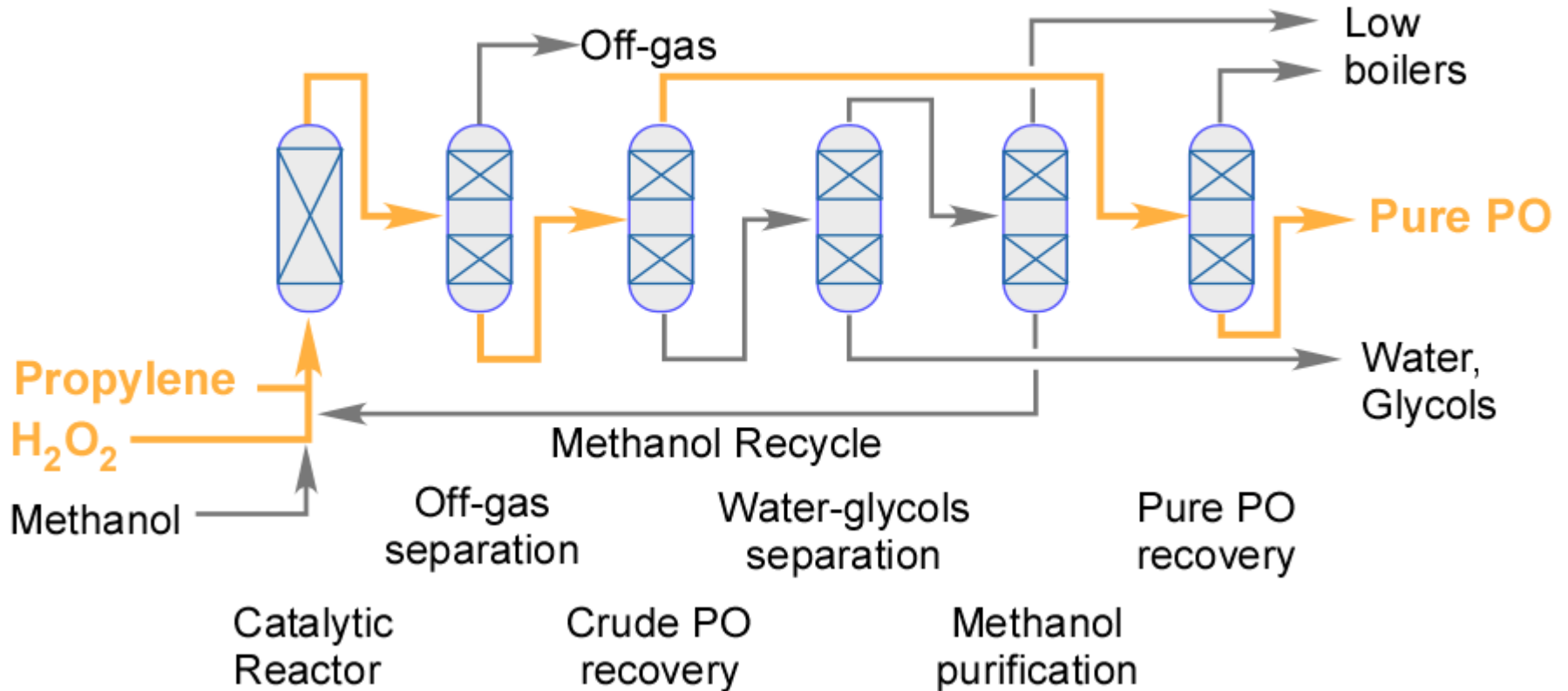
Peroxide provided as an aqueous solution from co-located hydrogen peroxide plant – *eliminate transportation*

Catalyst system enables the technology



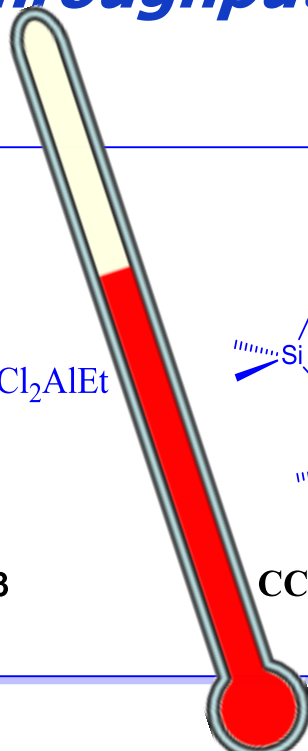
Process Flow Diagram

Simplified Process Flowsheet



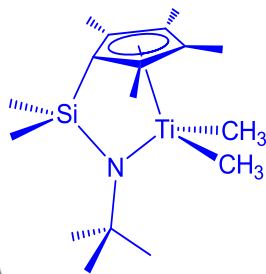
Sustainable Manufacturing Examples: Catalysis

Polyethylene: Higher Efficiency and Plant Throughput Through Improved Catalyst Design

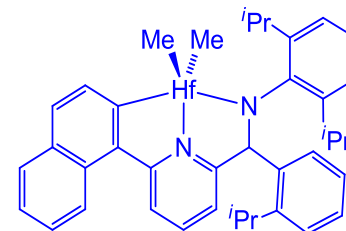
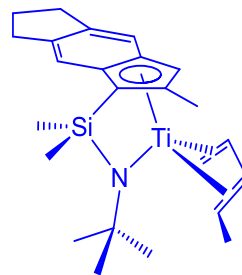
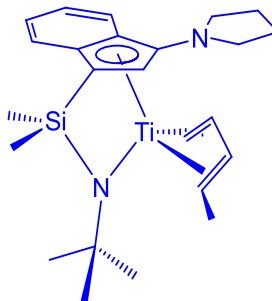


TiCl₄/MgCl₂/Cl₂AlEt

HEC-3



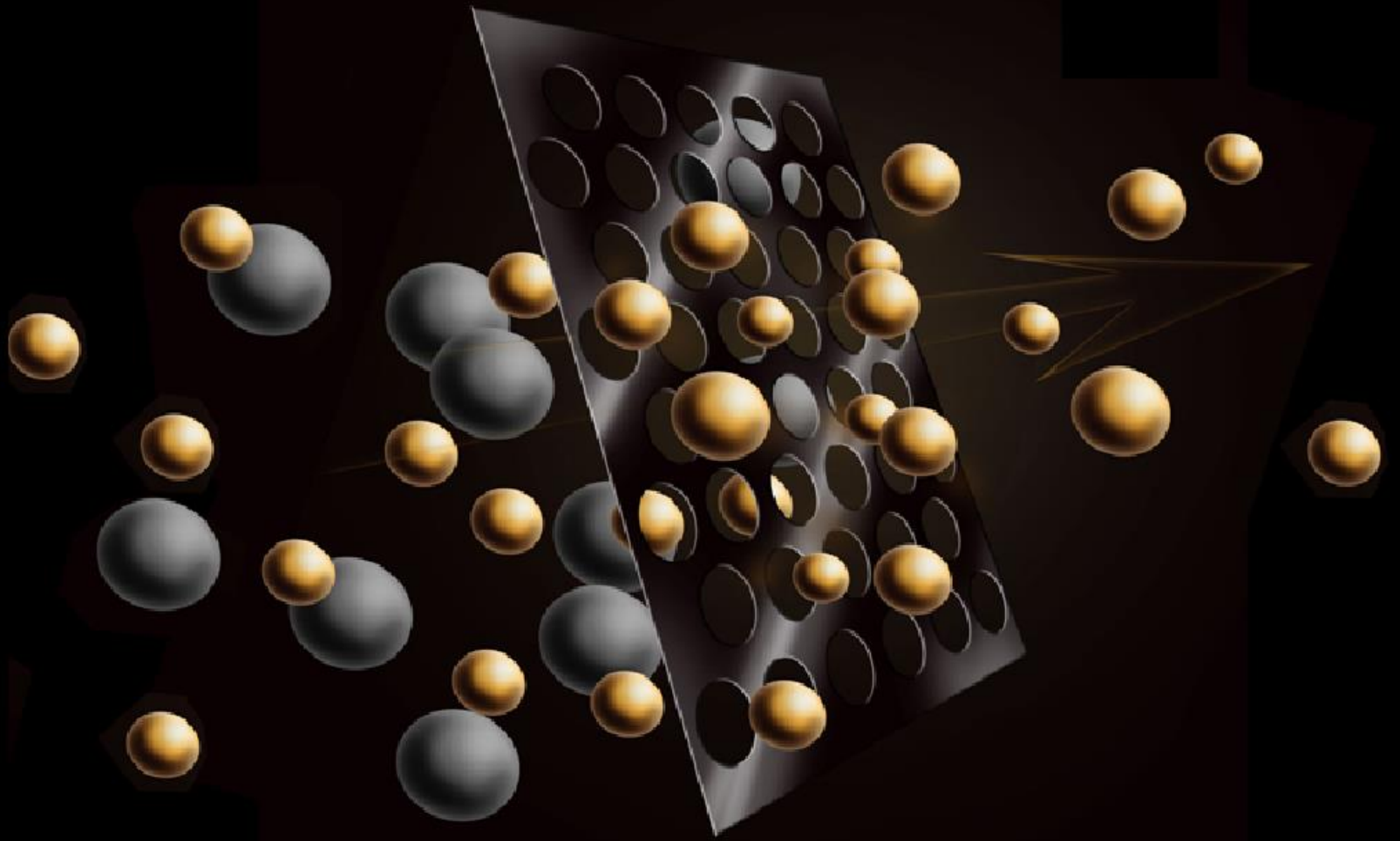
CCG-gen 1



gen n

Increasing Thermal Stability and Efficiency

Next Generation Manufacturing Processes



Demand for Bioproducts?



PANTENE PRO-V [natureFUSION]

UP TO **10X**
STRONGER HAIR*

FUTURE FRIENDLY™
NEW
PLANT-BASED BOTTLE
(up to 59% excluding cap)

*strength against damage vs. non-conditioning shampoo ©2011 P&G



**NEW
PLANT-BASED
BOTTLE**

(up to 59% excluding cap)

*strength against damage vs. non-conditioning shampoo ©2011 P&G



The pure, crisp taste of DASANI now comes in a better bottle. A bottle up to 30% made from plants that is still 100% recyclable.

DASANI.

Pure Taste in a Better Bottle

DASANI.

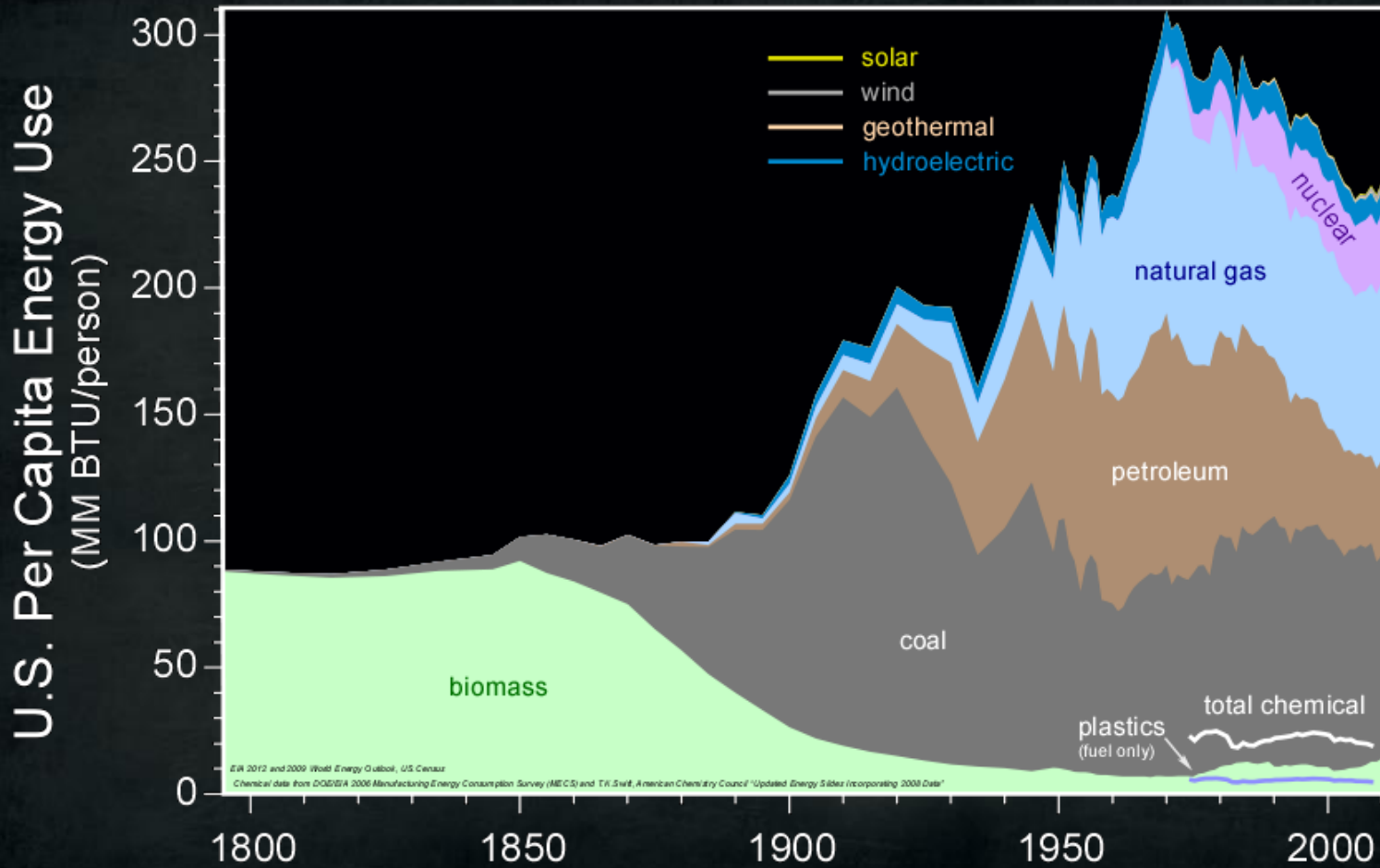
plantbottle®
Up to 30% made from plants
100% recyclable plastic bottle

Delta Airlines Napkin
April 2012

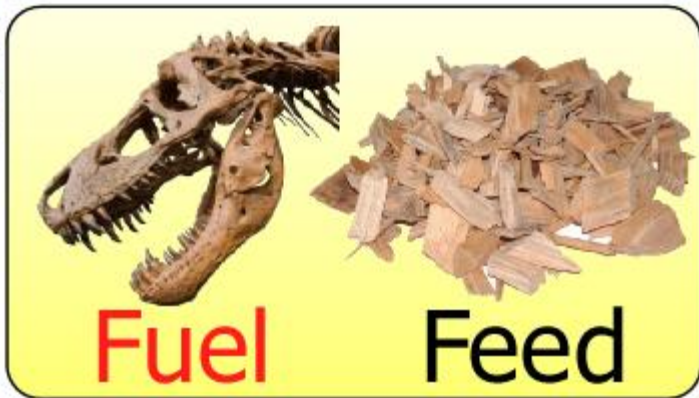
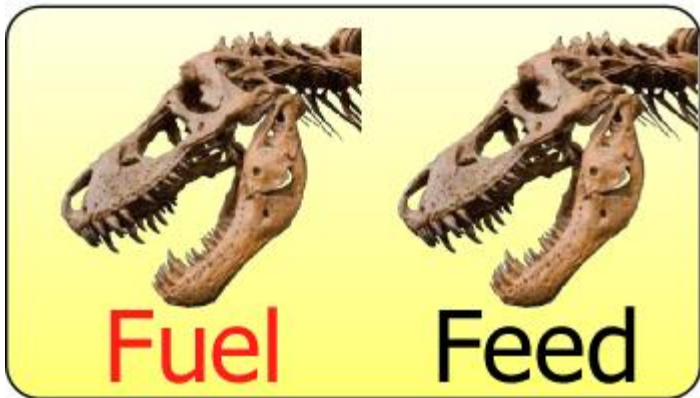
Midland Daily News
1 January 2012



Per Capita Energy Use



Two Carbon Flavors



What Impact?



PET



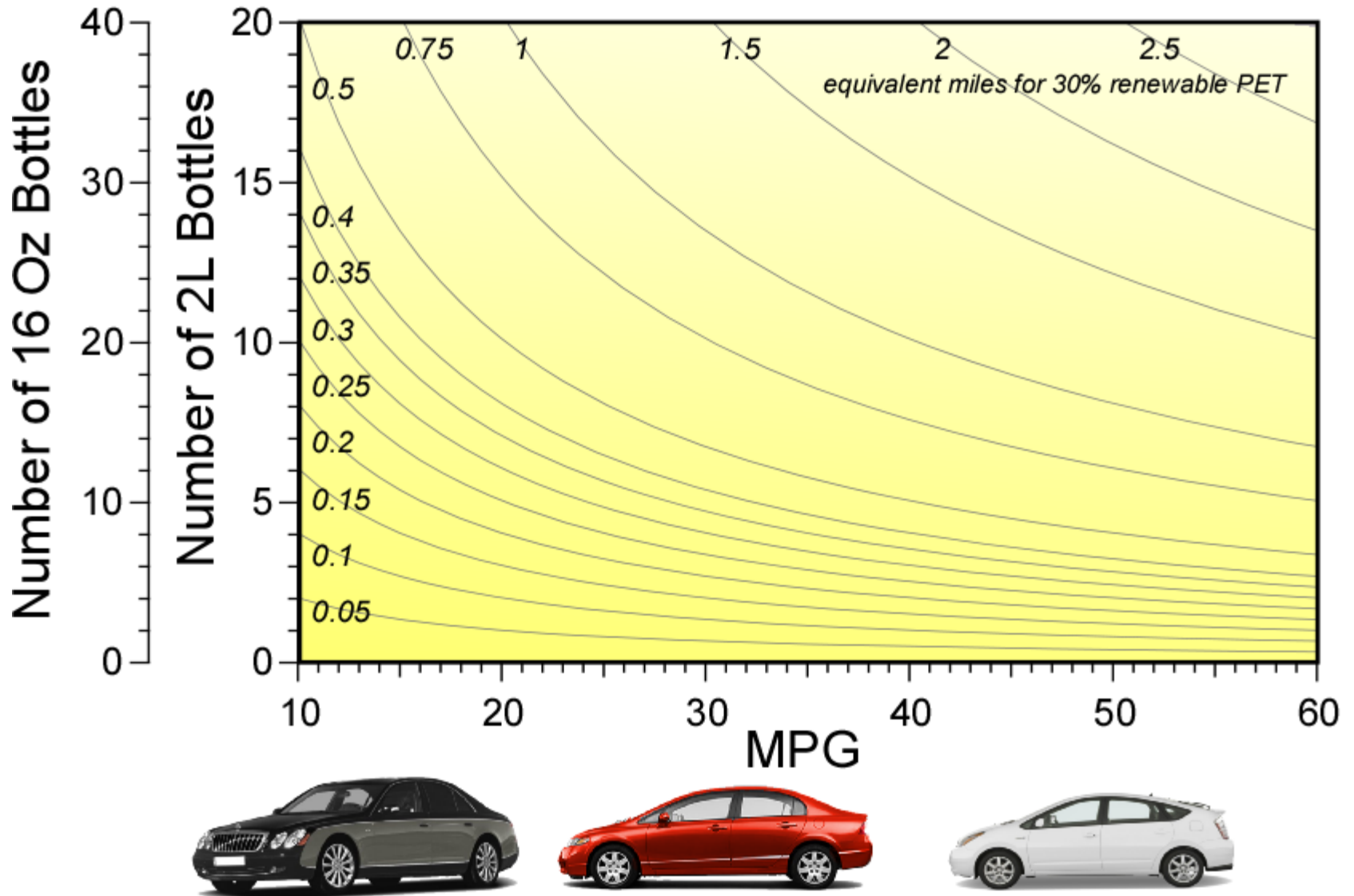
100% renewable PET (not yet available) would require ~80 2 L bottles to offset burning 1 gallon of gasoline or about 400 at today's 30%

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



FILMTEC™ Modules for Water



Energy savings on water purification

Process	Operating Energy Consumption (Kwh/m ³)	Customer Energy Savings 2005-2015 (Barrels of Oil-eq)
Multi Stage Flash (MSF)	13.5 - 25.5	242 million
Multi Effect Distillation (MED)	6.5 - 11	82 million
Reverse Osmosis	3 - 3.5	

Go After the 21,000 lbs



Go to
www.dow.com
for more information



THE LIGHTER SIDE OF WIND POWER.

Dow solutions are making turbines lighter and stronger. Our AIRSTONE™ and COMPROX™ resins are helping to create lighter, more durable wind blades. Making sustainable energy even more sustainable. Together, the elements of science and the human element can solve anything. *Solutions. The new optimism.*

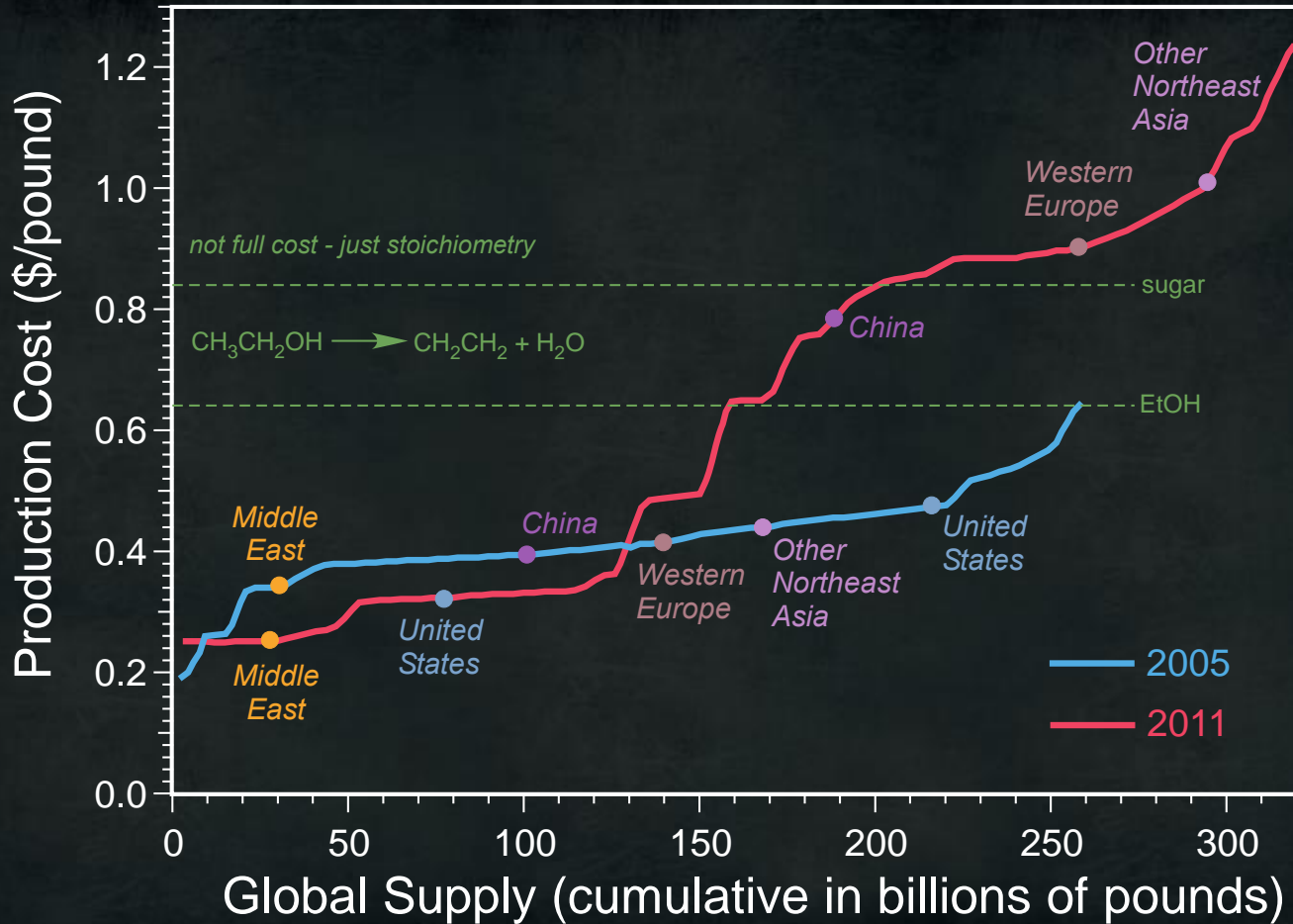


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The End

Questions?

Shale Gas Impact



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

Which is environmentally better?

A meat-eater in a Prius



A vegan in a Hummer