

# Changes in the Energy Market and their Impact on the Chemical Industry

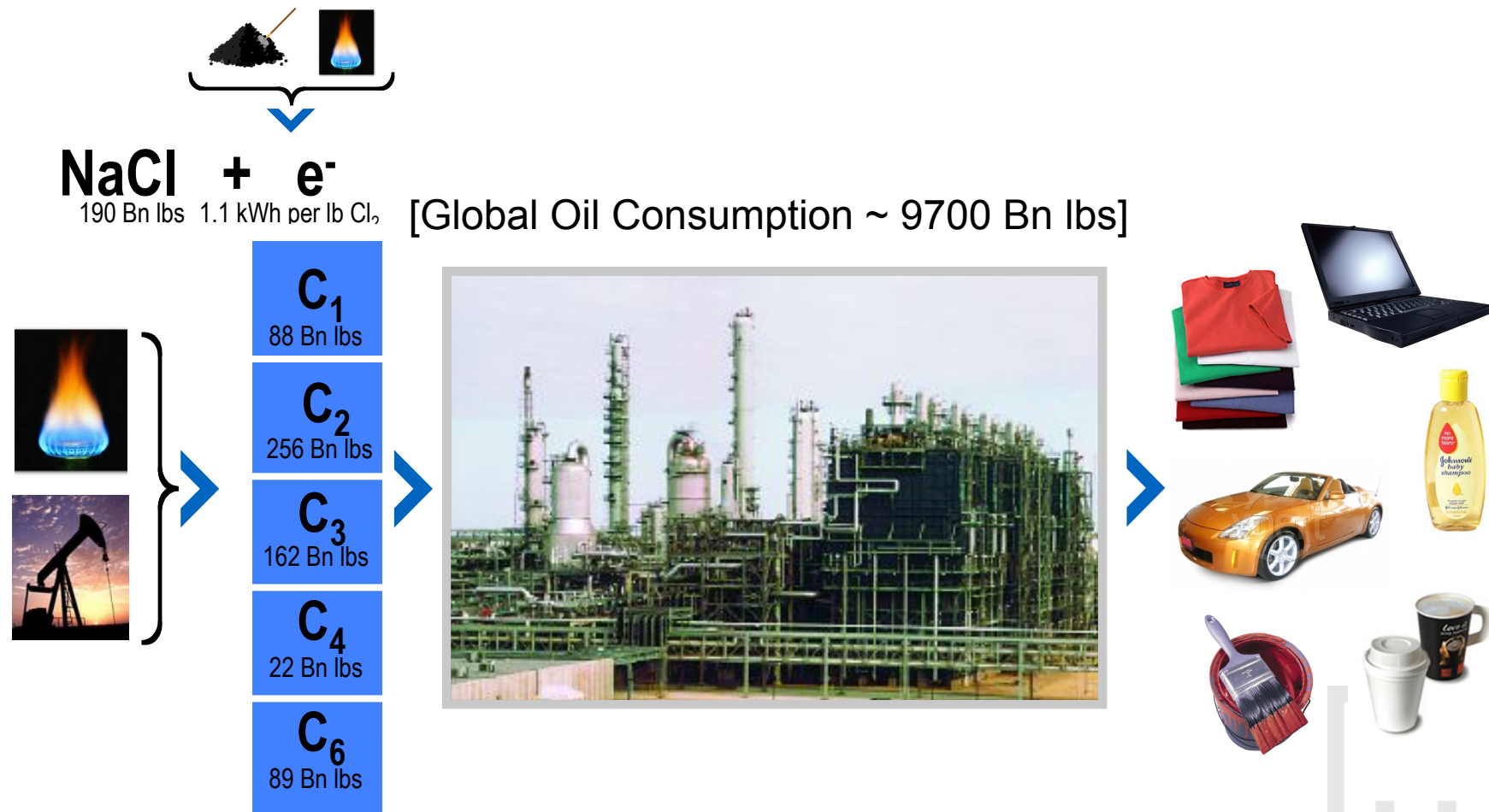


**William F. Banholzer, PhD**

Executive Vice President & Chief Technology Officer  
The Dow Chemical Company

# Our Industry

Turning Feedstocks Into Essential Products

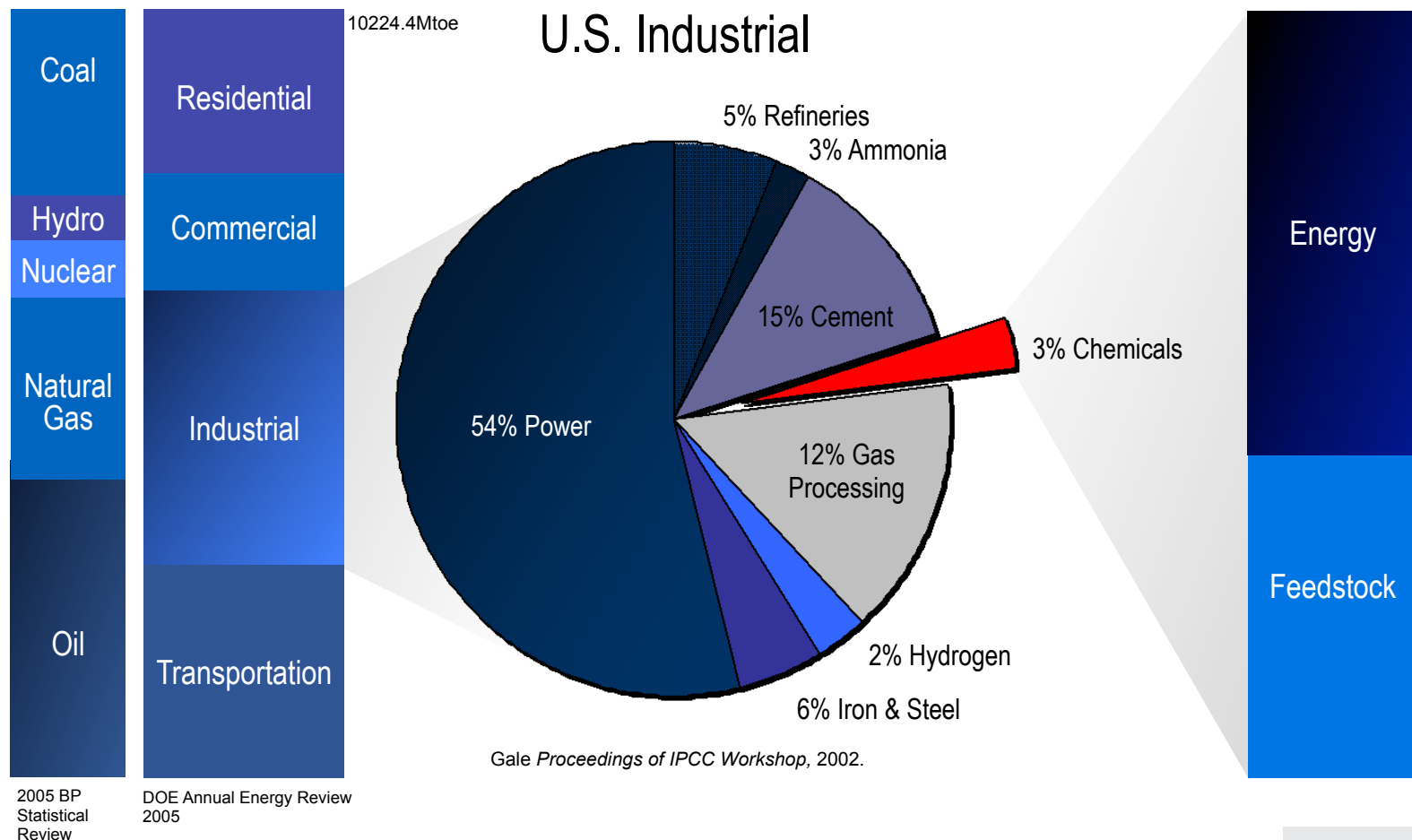


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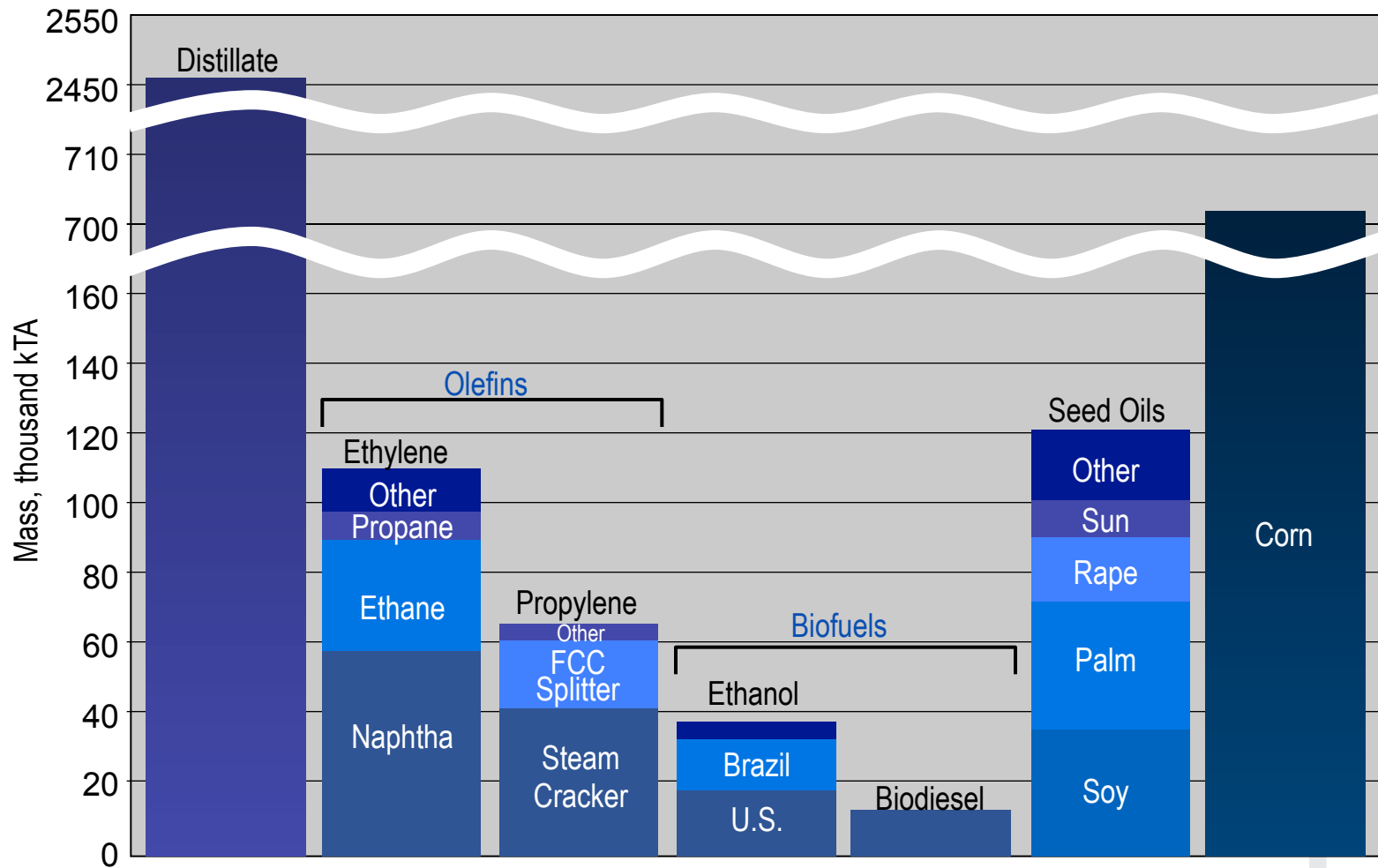
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# Chemicals & Energy



*The chemical industry consumes energy in order to transform carbon fuels into functional materials*

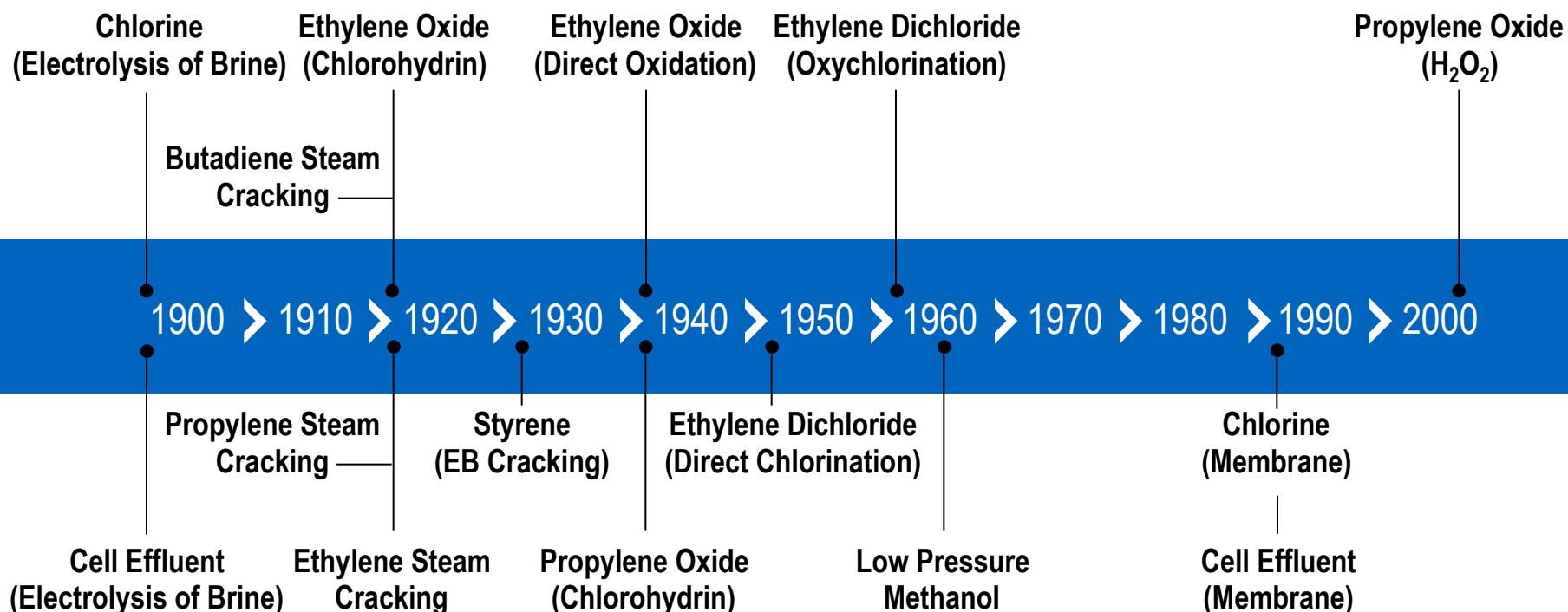
# Global Carbon Flows





# Basic Raw Material Transformations

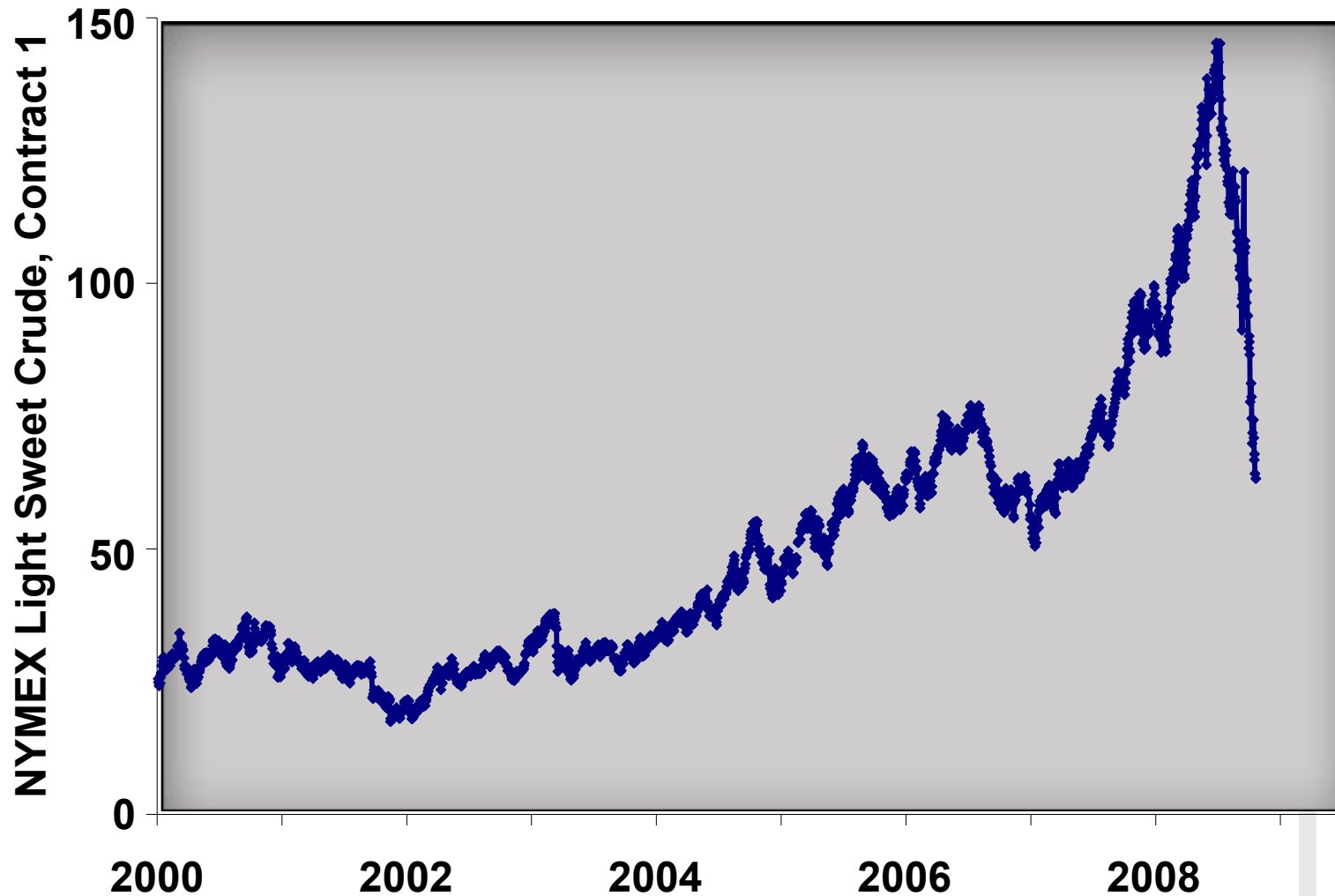
Technology is Decades Old



Lots of ideas, limited success

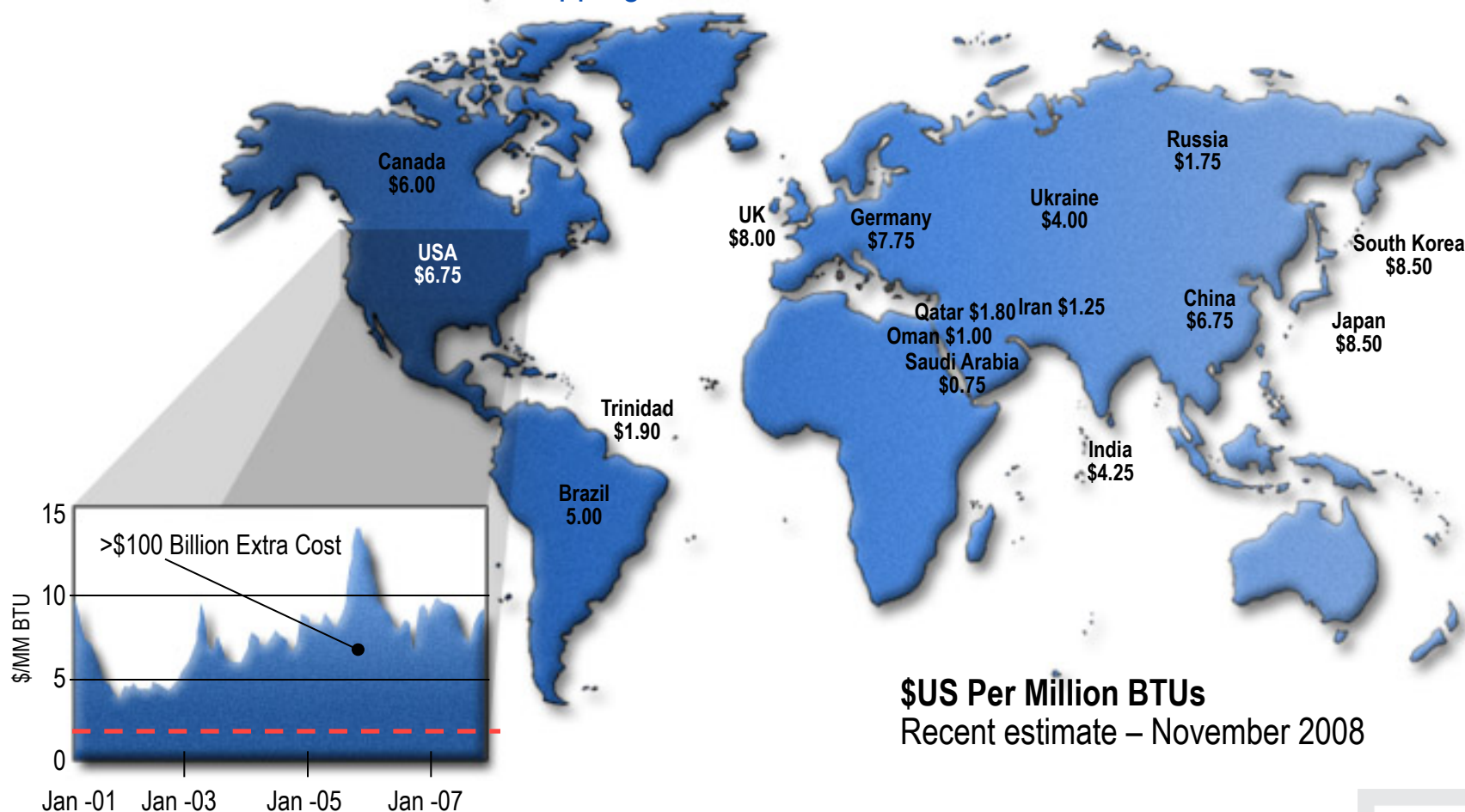


# Energy Volatility – It's Been a **Rough** Decade



# Regional Price Differentials: Natural Gas

Lack of a Global Market Due to Shipping, Other Factors



**\$1 increase = \$3.7 Billion Annual Incremental Cost to the U.S. Chemical Industry**



# U.S. Drilling Debate

**U.S. News & World Report**  
**U.S. News**  
 JUNE 5, 2006

## Shifting Public Opinion On Offshore Oil Drilling.

Despite their problems, the Republicans still can't be counted out. That became clear when GOP leaders, including Bush and McCain, Democrats off guard with the 1981 moratorium on U.S. drilling. There has been little serious drilling in recent years, but rising gasoline prices may be making the public more receptive. A recent Gallup Poll found that 60 percent of Americans would support drilling in the nation's coastal and wilderness areas currently closed to exploration — to reduce gasoline prices and if the drilling is conducted under strict environmental guidelines.

Opening up these new areas to drilling could reduce prices quickly or even produce new oil for many years. But in political terms, the GOP may have found a way to identify with motorists who have a hard time affording gas that costs more than \$4 per gallon and action from Washington. Democrats see reducing America's dependence on foreign oil as a lot more than additional drilling and will require conservation, use of alternative energy, and many other steps that the GOP has embraced.

**The Washington Post**  
 Obama Signals Support for Wider Offshore Drilling.  
 ORLANDO, Aug. 1 — Sen. Barack Obama suggested on Friday that he could accept an expansion of offshore oil drilling as long as it was part of a broader package of measures that would free the logjam of energy bills in Congress.  
 "My interest is in making sure we've got the kind of comprehensive energy policy that can bring down gas prices," Obama, the presumptive Democratic presidential nominee, said in an interview with the Palm Beach Post. "If, in the end, we have to compromise to get that done, I'm willing to do it. I don't want to be so rigid that we can't get anything done."

**Los Angeles Times**  
 Bush lifts executive ban on off-shore drilling.  
 President Bush made it official today, signing the memorandum lifting the executive ban on off-shore drilling. His move has no direct effect: Congress still has a ban imposed on drilling on the Outer Continental Shelf.  
 But what the president's decision does is this: It puts new pressure on Congress to act in the face of gasoline costing more than \$4 a gallon. The president took to the Rose Garden and made his message clear.  
 "I have issued a memorandum to lift the executive prohibition on oil exploration in the OCS. With this action, the executive branch's restrictions on this exploration have been cleaned away. This means that the only thing standing between the American people and these vast oil resources is action from the U.S. Congress.  
 "Now the ball is squarely in Congress' court," he added. House Speaker Nancy Pelosi (D-San Francisco), had this to say in a written statement: "Once again, the oilman in the White House is echoing the demands of Big Oil."  
 She said: The Bush plan is a hoax. It will neither reduce gas prices nor increase energy independence. It just gives millions more acres to the same companies that are sitting on nearly 60 million acres of public lands and coastal areas.

**The Washington Post**  
 Oil Search Would Be Part of 'Comprehensive Energy Policy' at Lower Prices.

# Off Limits U.S. Natural Gas Reserves

Most untapped reserves are:

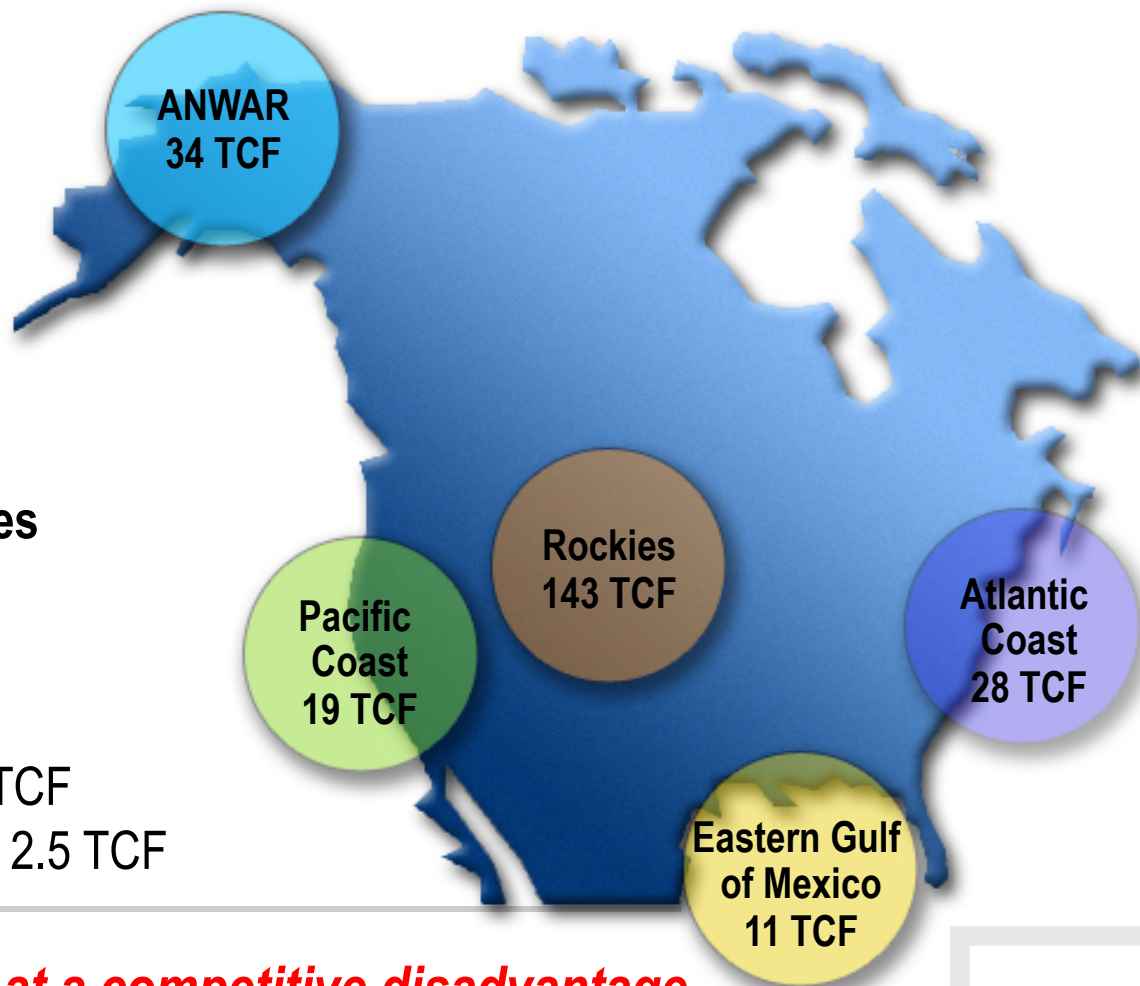
- Legally off limits OR...
- De facto off limits OR...
- Federal lease regulations bring cost and timing issues

Source: PFC Energy (consultant)

Annual:

U.S. Consumption = 22 TCF

U.S. Chemical Consumption = 2.5 TCF

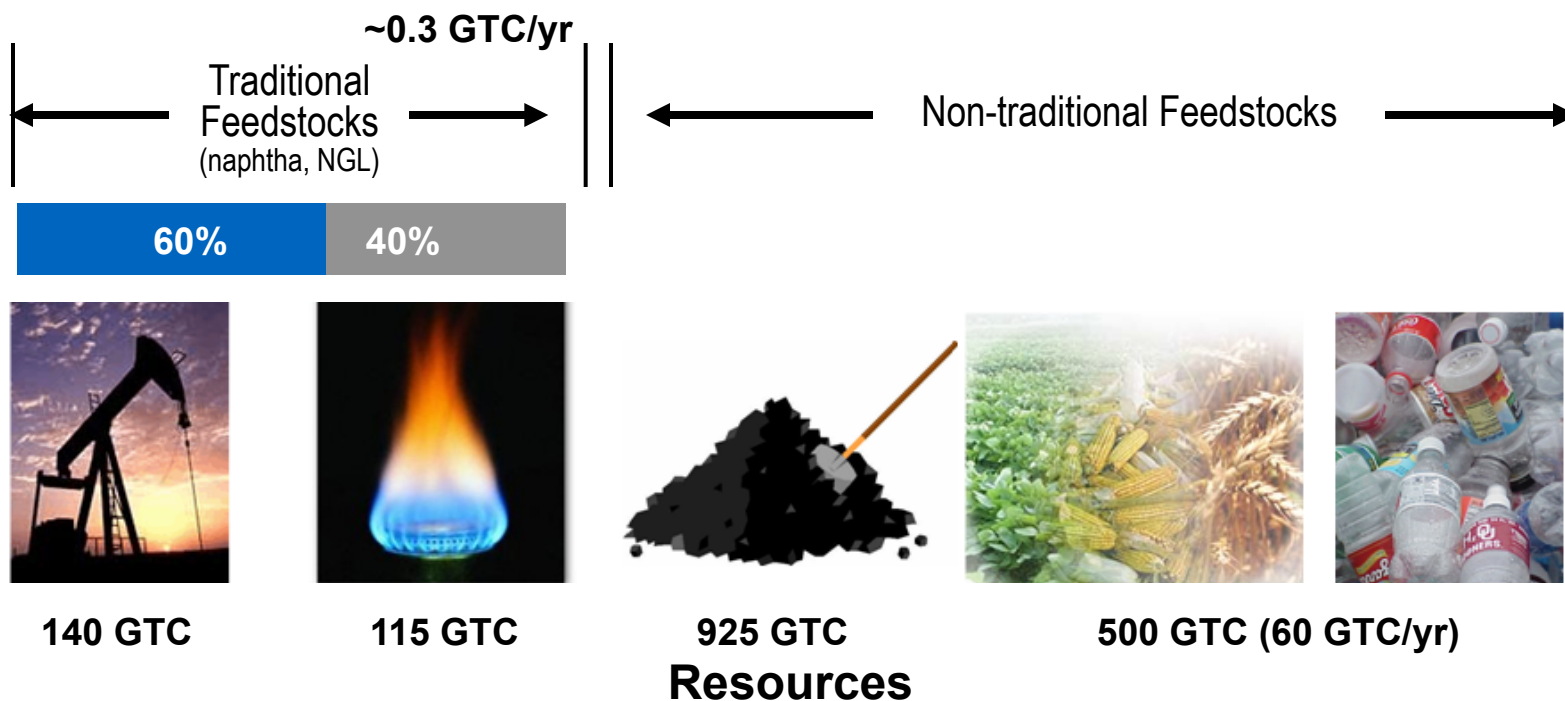


***U.S. industry is at a competitive disadvantage***

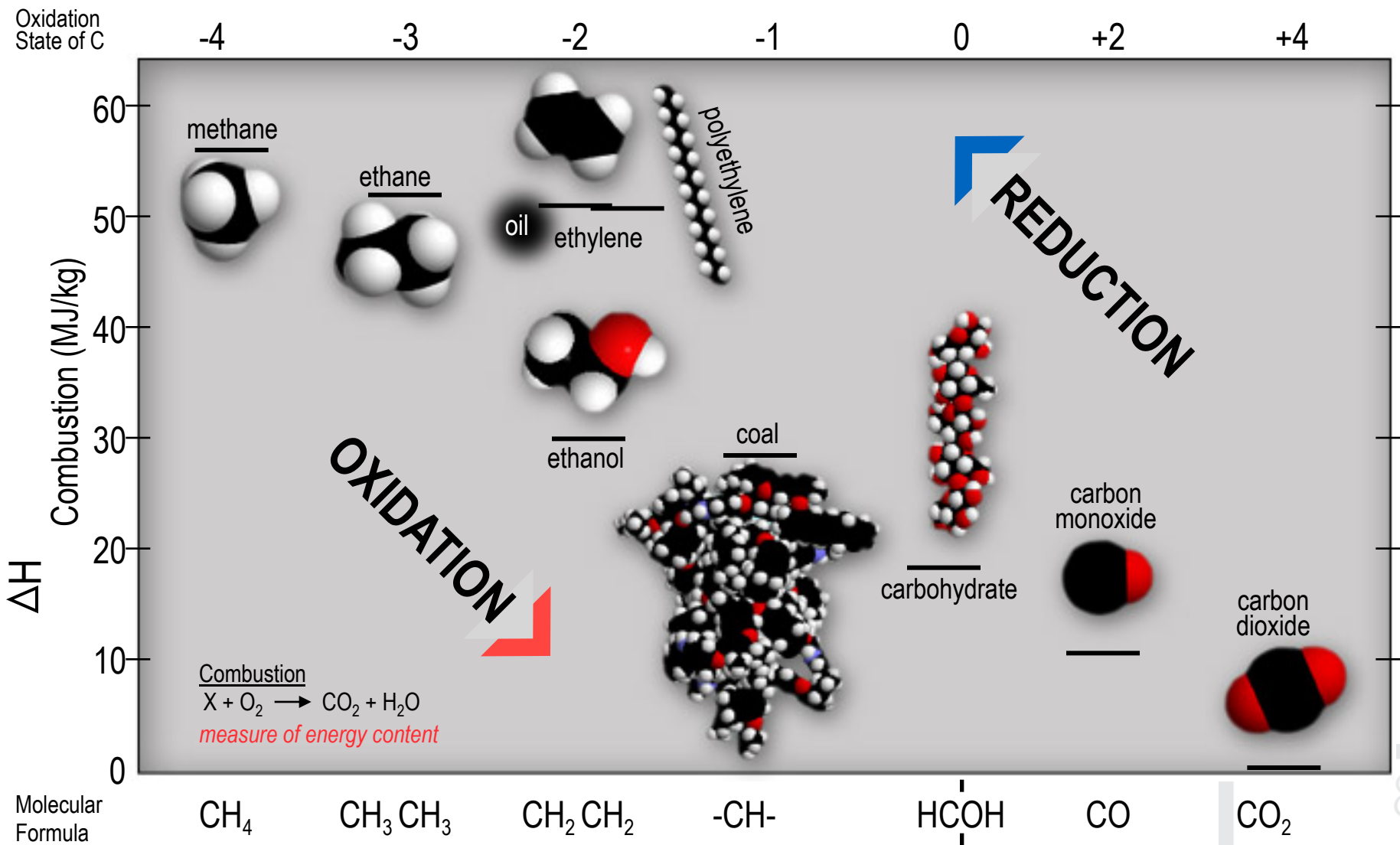


# Comparing Feedstocks

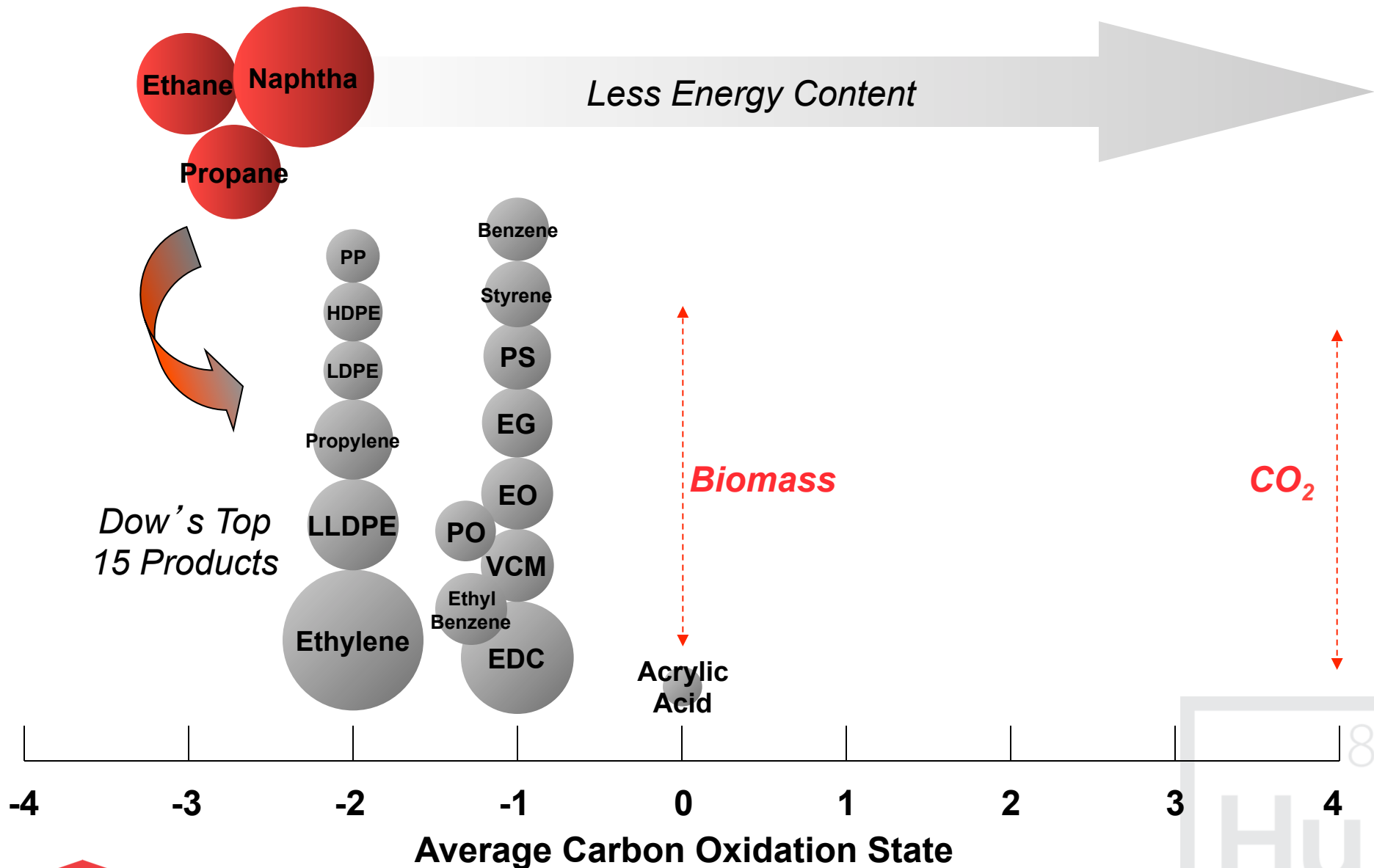
Access to prime olefins is key. Consider thermodynamics, price per unit energy, energy density, and tradeoff between capital and variable cost.



# Energetics of Feedstocks

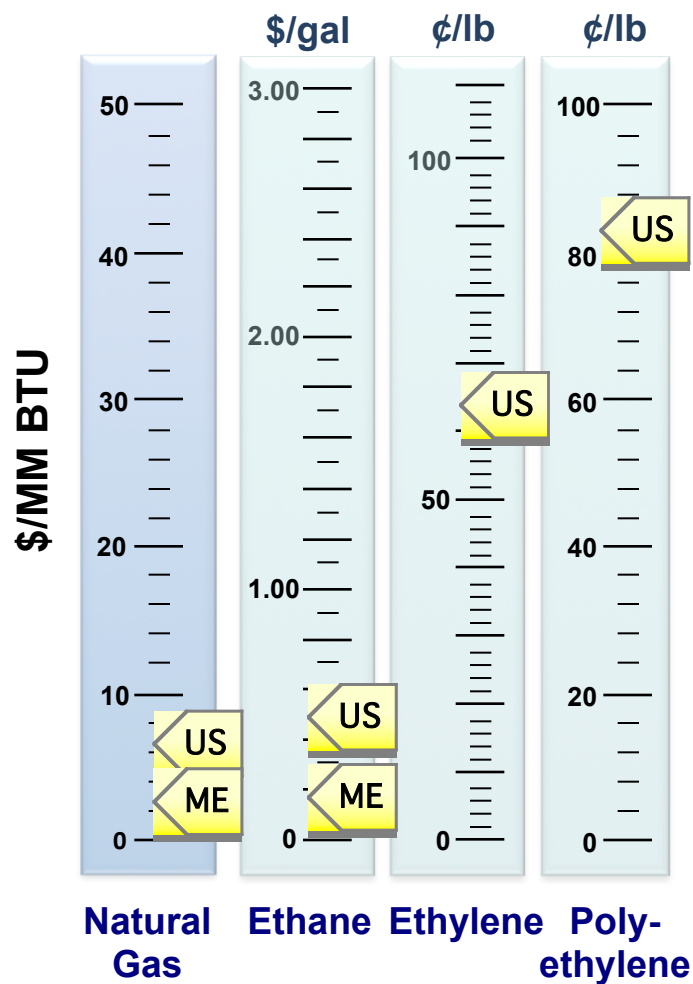


# Largest Raw Materials & Products

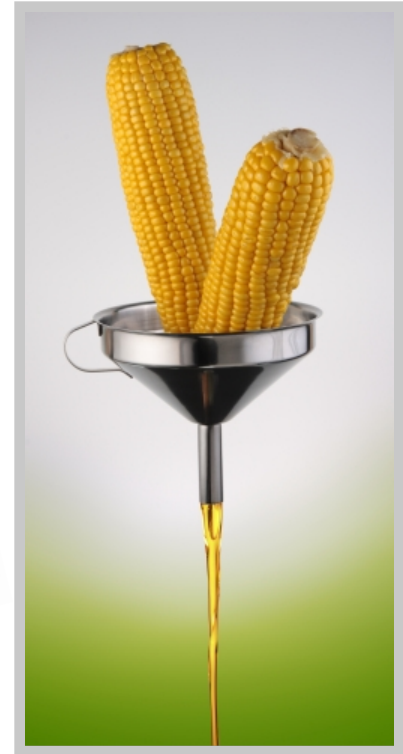




# Price Per Unit Energy

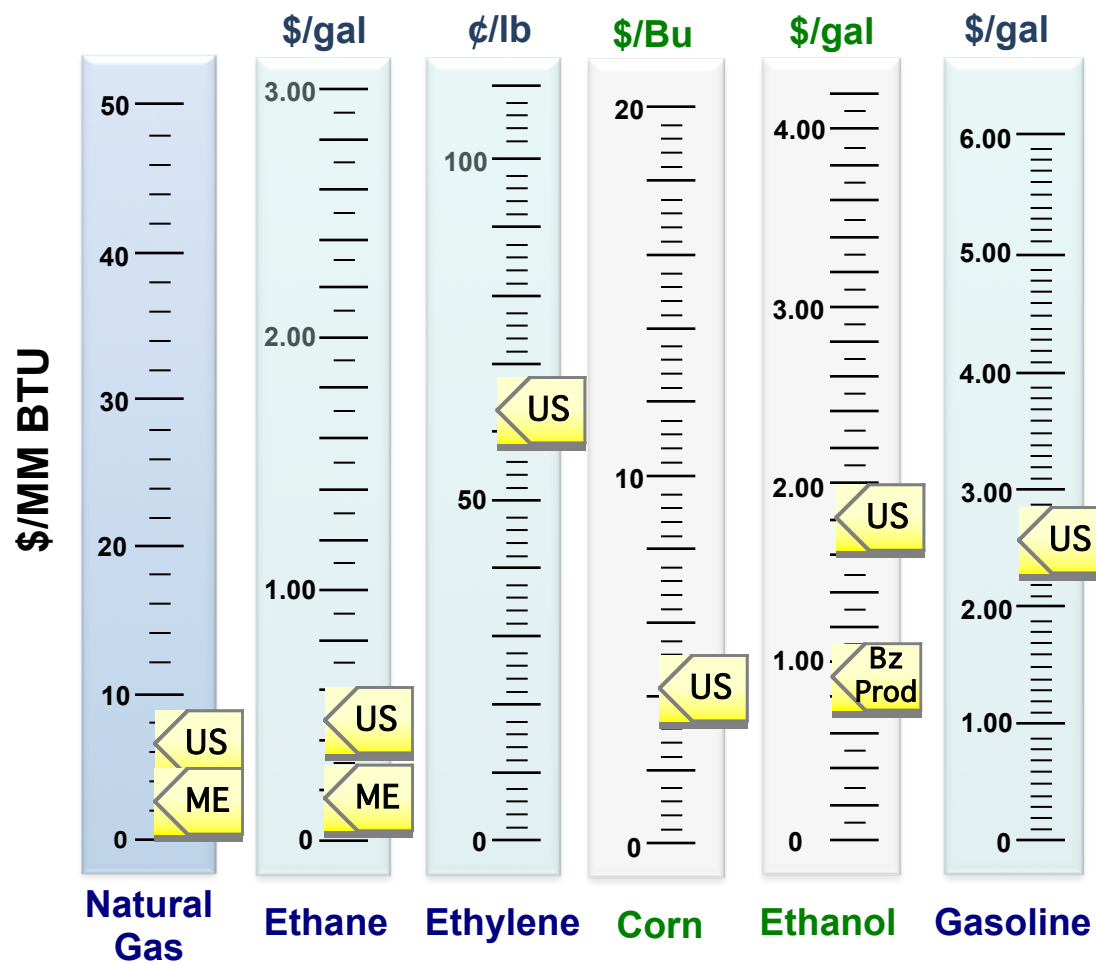


# Corn Ethanol Debate

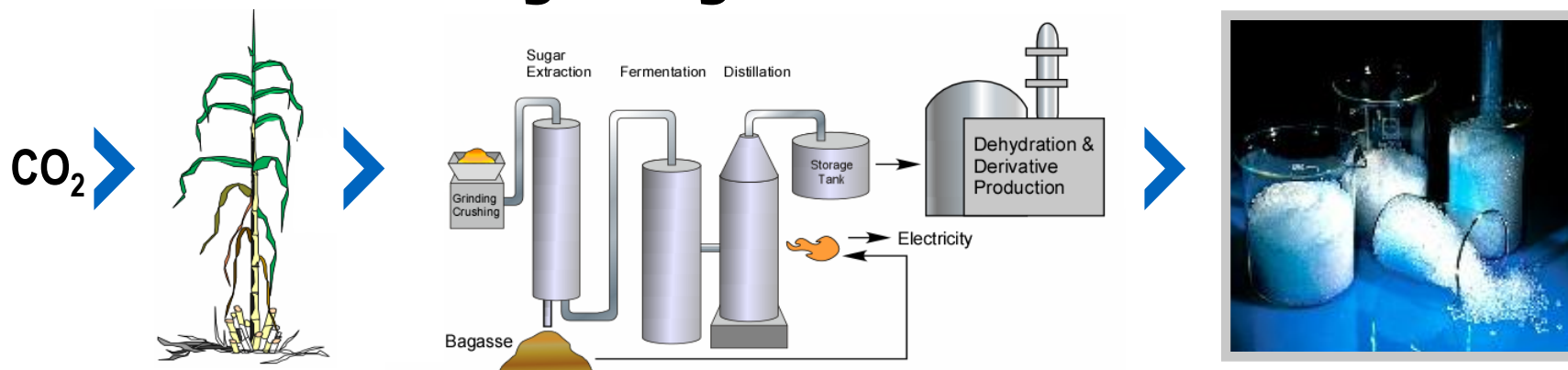


## How will ethanol affect chemicals?

# Ethylene Precursors



# Ethanol to Polyethylene in Brazil



	DuPont Bio-PDO (Serona®)	NatureWorks™ PLA	Dow/Crystalev JV
<b>Plant Scale</b>	45 kTA	140 kTA	<b>350 kTA</b>
<b>Fermented Product</b>	1,3-Propanediol	Lactic Acid	Ethanol
<b>Key Processes</b>	Fermentation, Condensation Polymerization	Fermentation, Oligomerization, Ring-Closing, & Ring-Opening Polymerization	Fermentation, Dehydration, Polymerization
<b>Initial Product</b>	PDO/TPA Copolymer	Polylactic acid	Ethylene, Polyethylene, Copolymers
<b>Flexibility</b>	Moderate	Low	High

(CRYSTAL EV



Ethylene

PE

EO

VCM

Styrene

VAM

PDO

PLA

Dow  
Crystalev  
JV



# Benchmarking Land Use

## Dow Brazil Plant



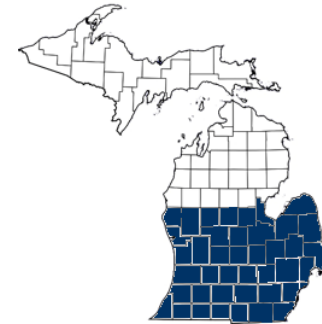
**Bay County**

## Dow LLDPE Capacity



**Seven Local Counties**

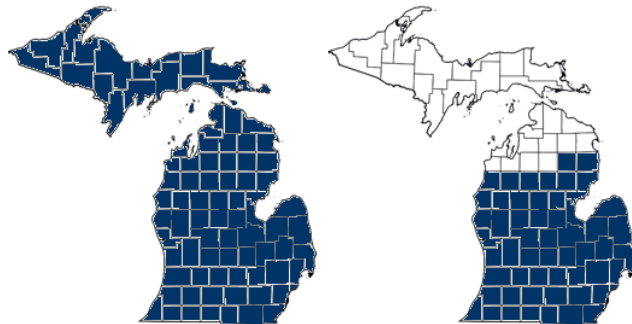
## Global LLDPE Capacity



**0.43 X Michigan**

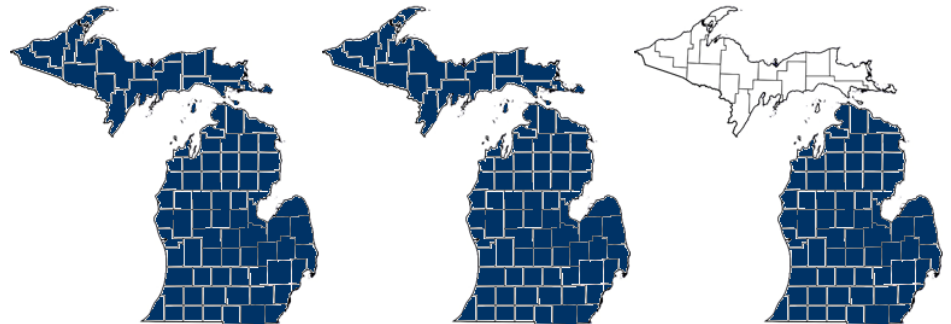
## ***Assumes Brazil Cane Yields***

## Global Polyethylene



**1.6 X Michigan**

## Global Ethylene

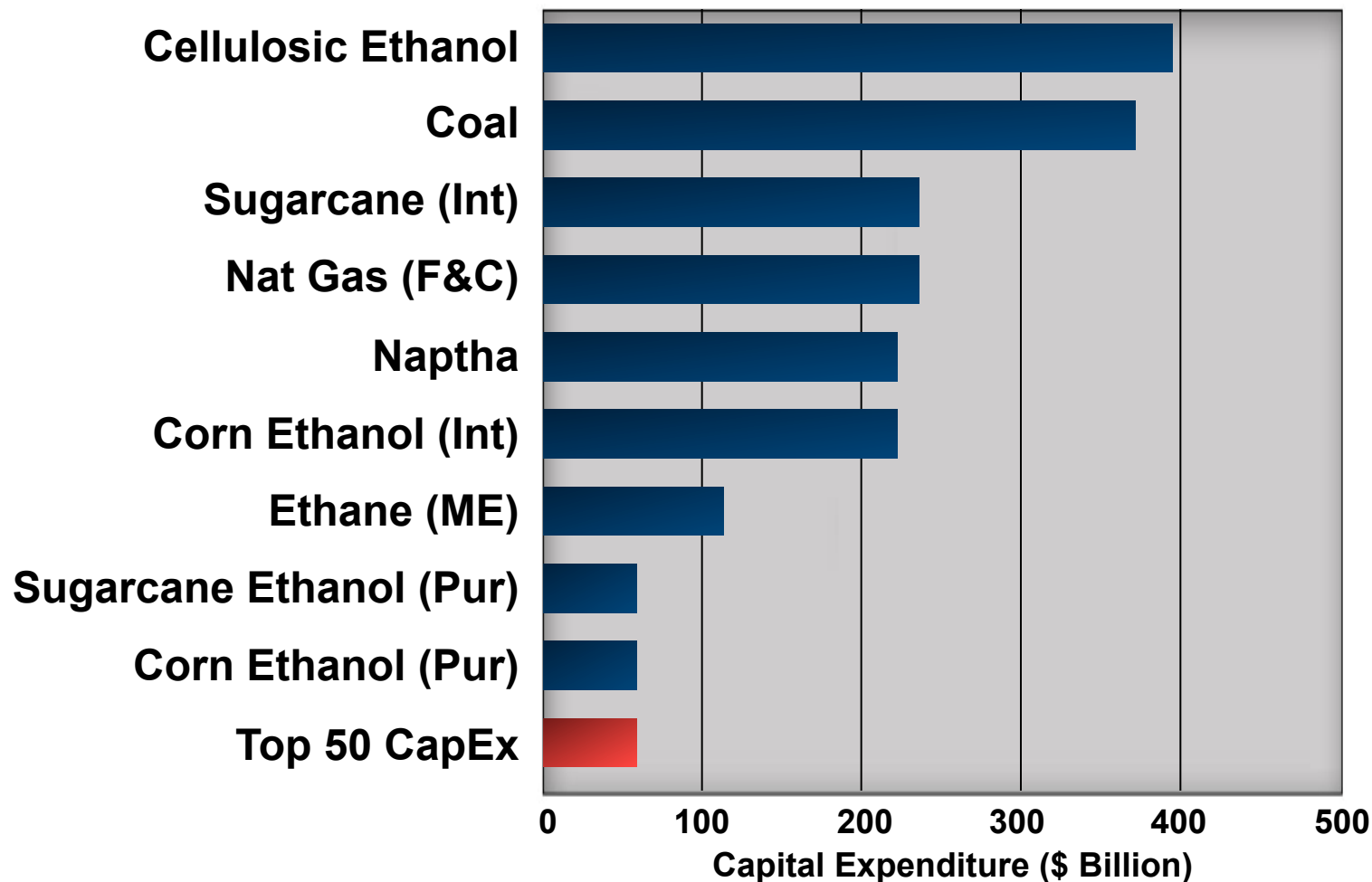


**2.7 X Michigan**

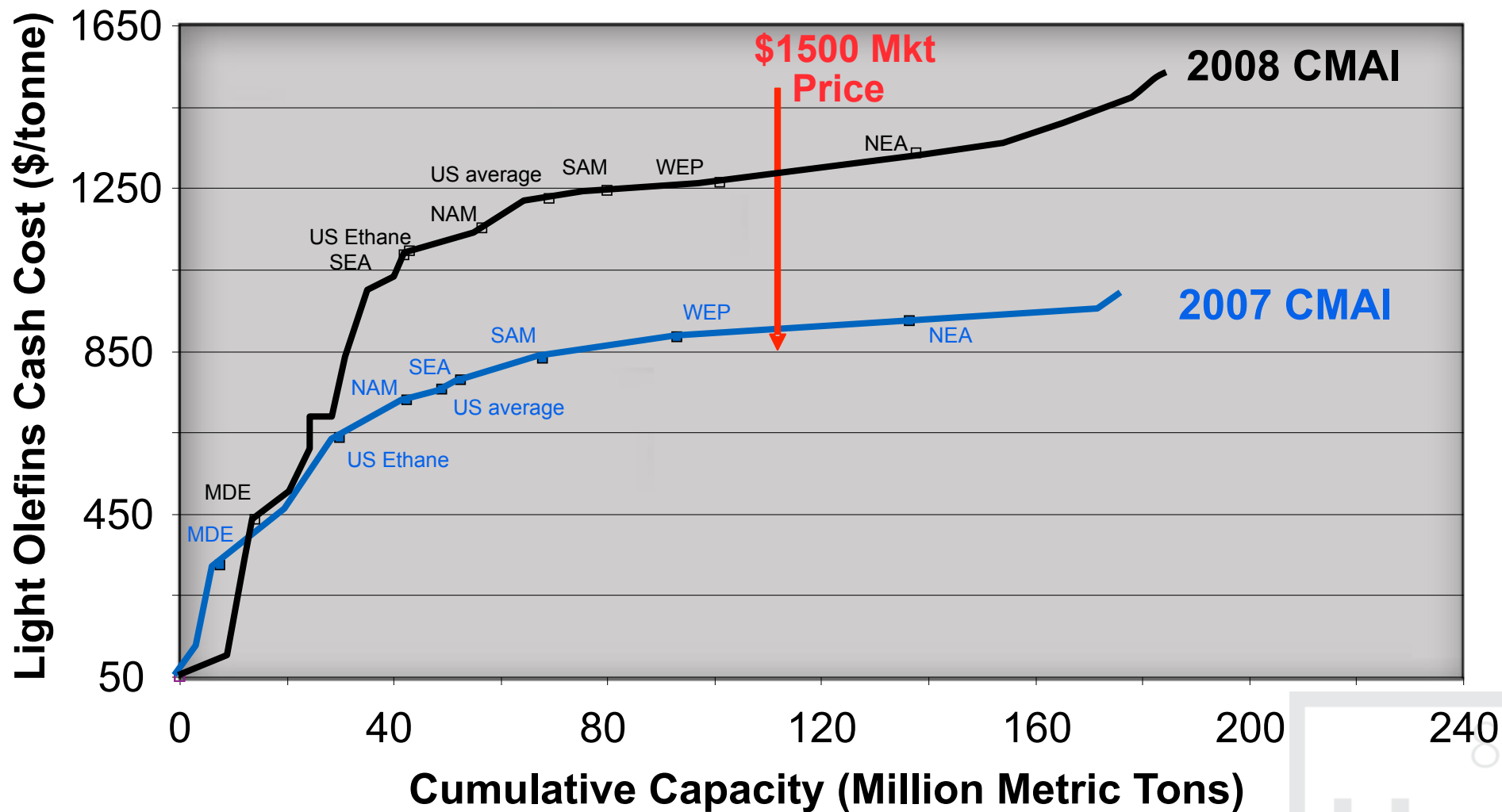




# Replacing Global Ethylene



# Light Olefins Cost Curves



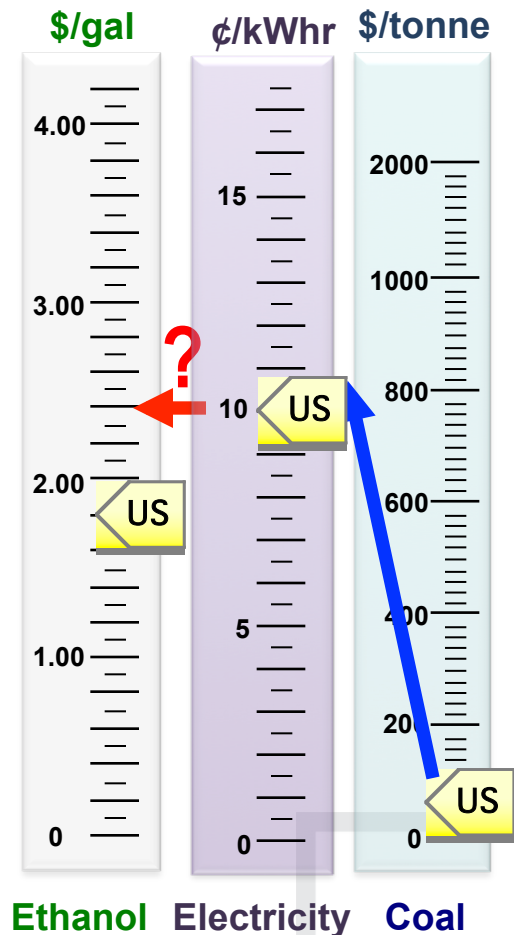
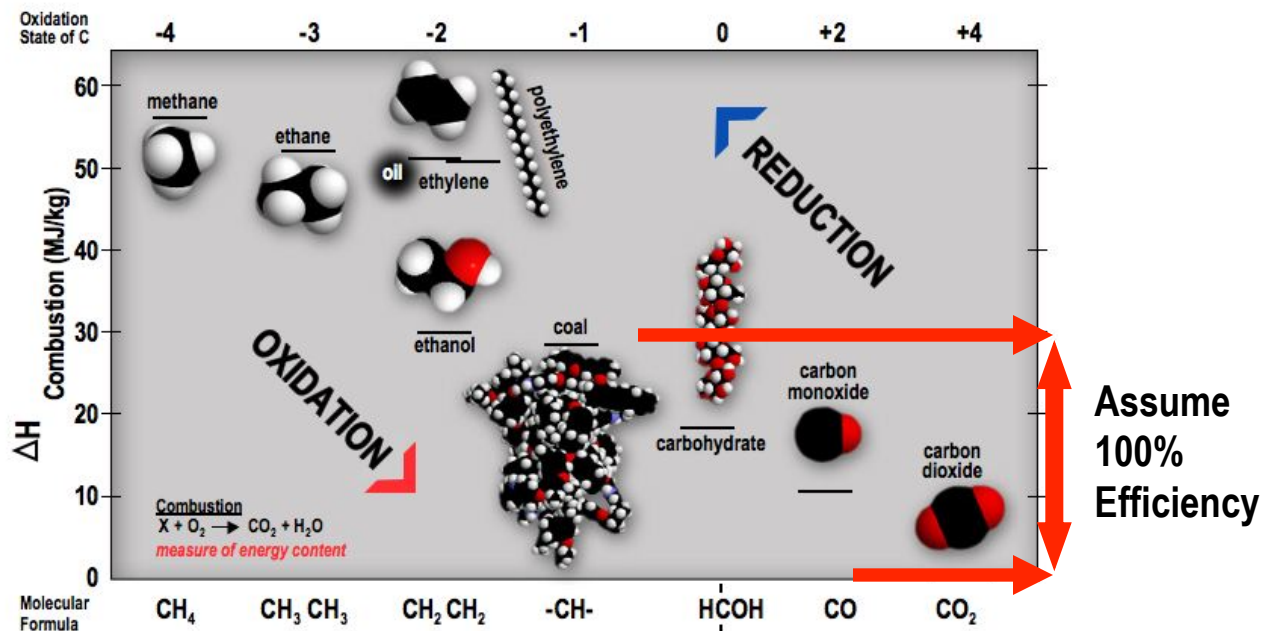
# CO<sub>2</sub> To Chemicals?





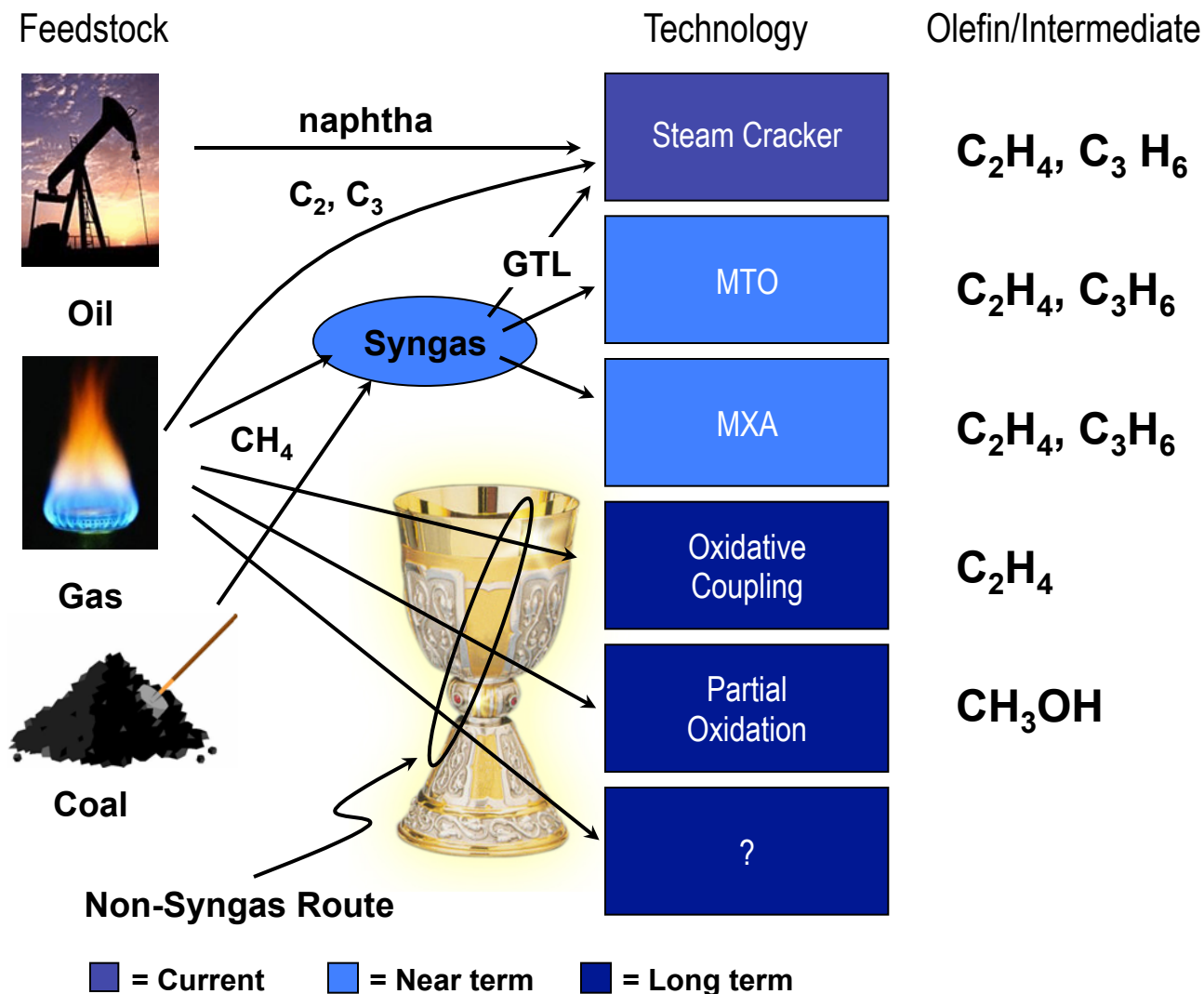
# Some High Level Considerations

Solar at \$0.22/kWhr and conversion efficiency of 50% yields ~ \$11/gallon ethanol

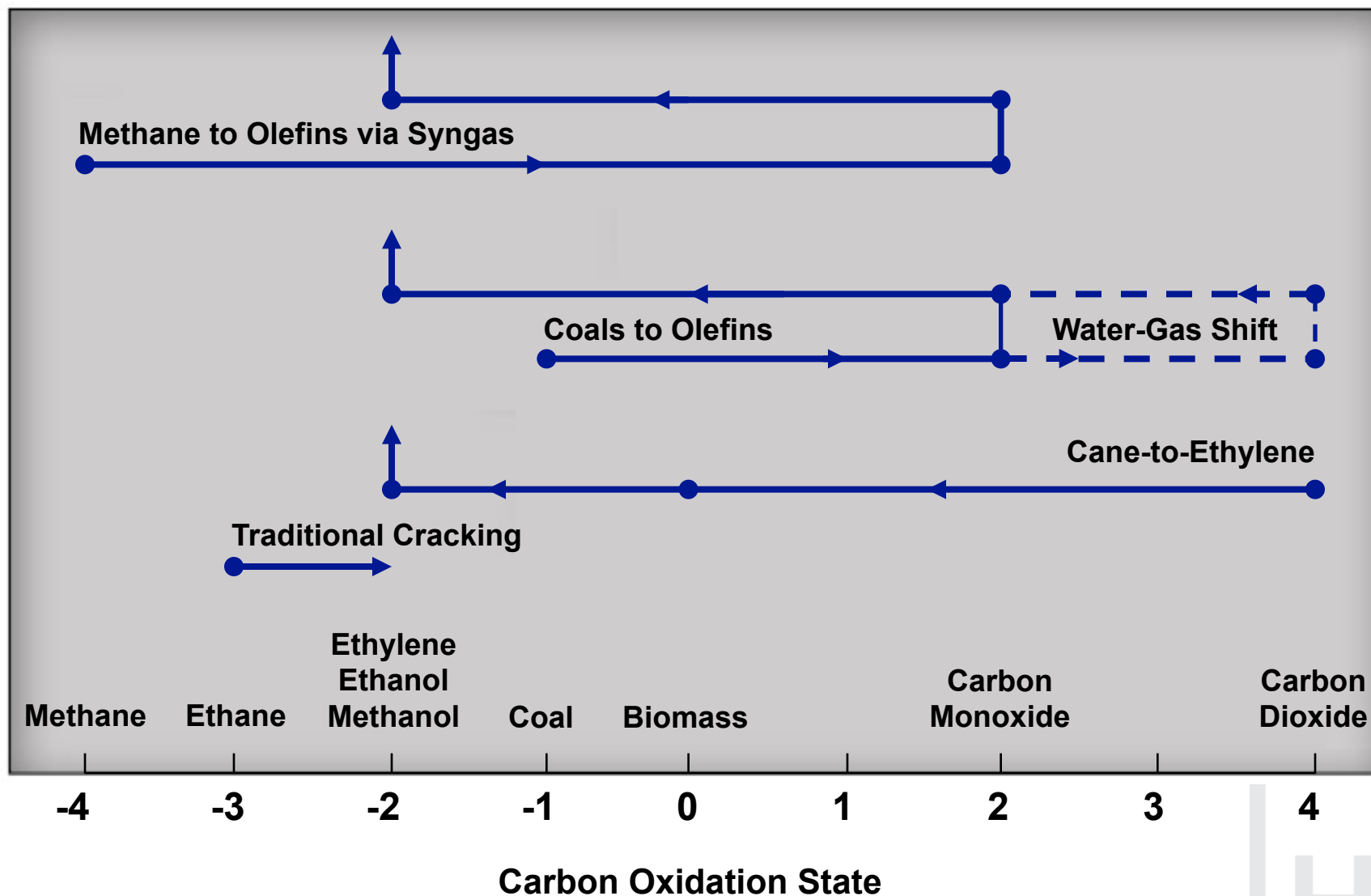


*You make electricity from fuels,  
not the other way around*

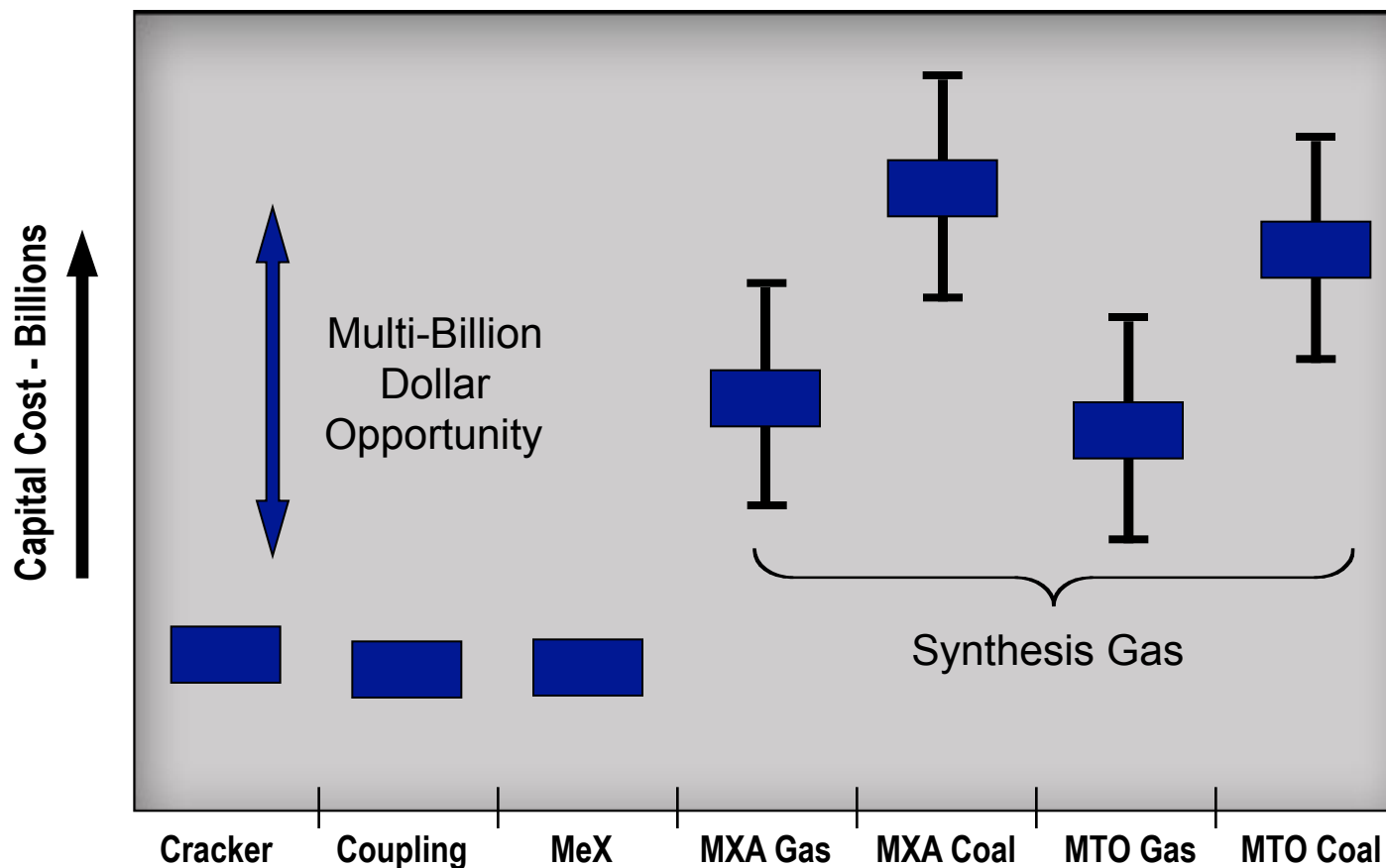
# Technology Options: Fossil



# Oxidation State Whiplash



# Capital Cost of Various Options





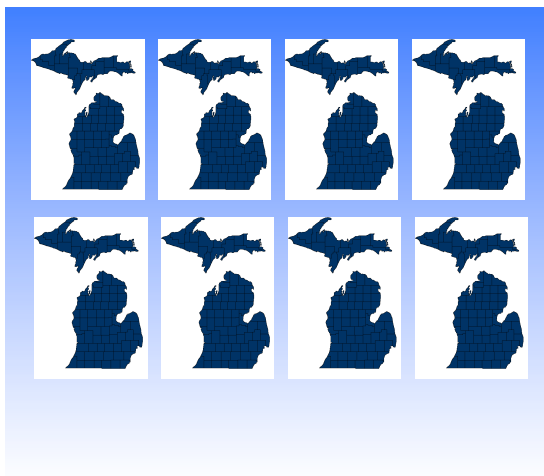
*“I’d put my money on the sun and solar energy. What a source of power! I hope we don’t have to wait until oil and coal run out before we tackle that.”*

*— Thomas Edison*  
**The year – 1931.**



# Three Trillion Miles Per Year – Option

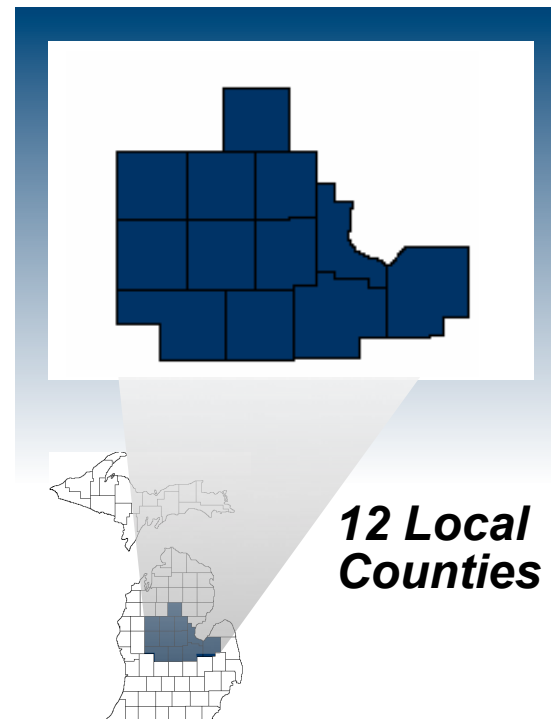
## Corn Ethanol



## Soy Biodiesel

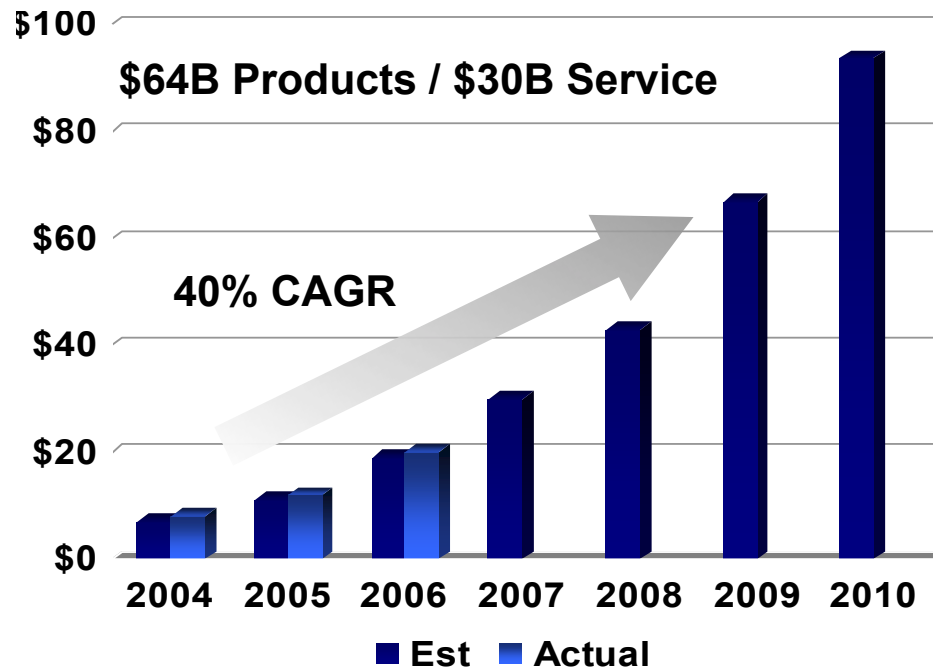


## Solar/Electric

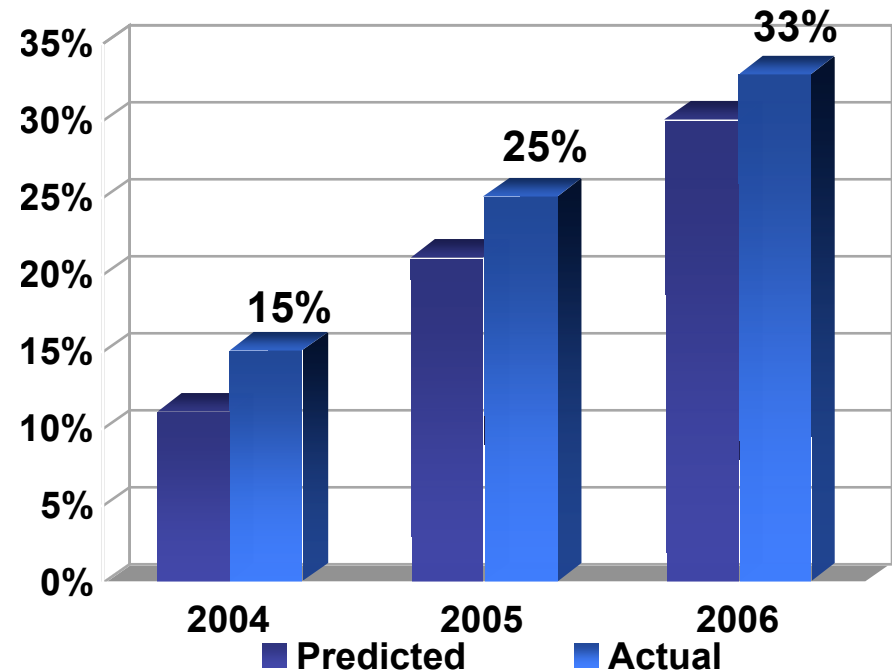


# Explosive Growth in Photovoltaics

## Global PV System Revenue (\$B)



## Industry Average Operating Margin



**Profit Pool 2010E: \$40B**

Source: Photon Consulting, July 2006, Sept 2007



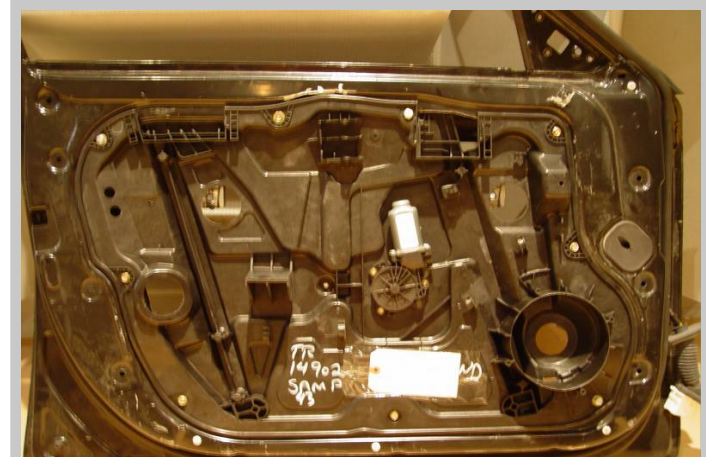
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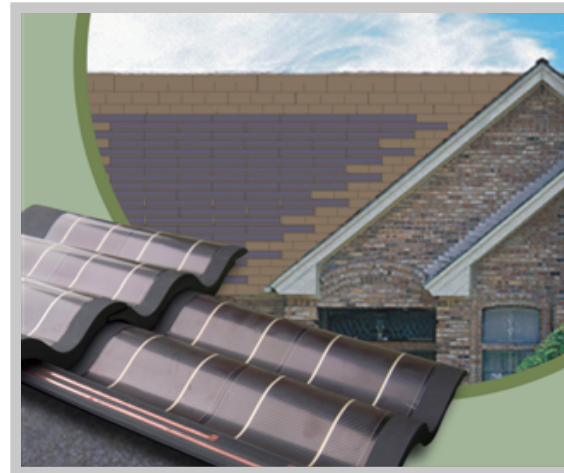




# Doing for PV What Plastics Did for Automotive



**Weight Savings = 1.5 lbs per door**  
**Elimination of 50 parts**





# Strategic Fit for Dow

## Core R&D/Energy

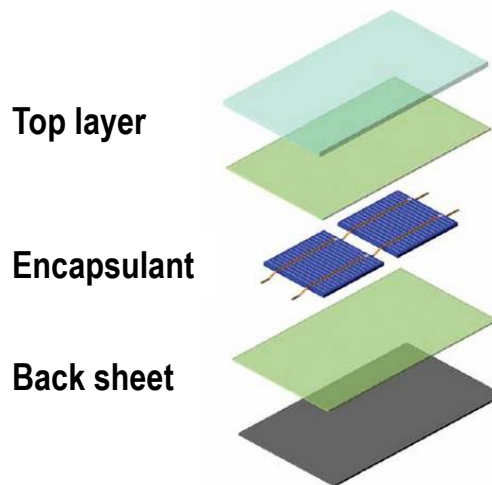
- Thin film processing
- Mfg. process optimization



**Market need:**  
Low Cost PV modules

## Dow Plastics /Specialty Films

- PV packaging
- Back sheet, EVA replacement



**Market need:**  
Specialty films

## Dow Building Solutions

- BIPV commercial roofing
- BIPV residential roofing

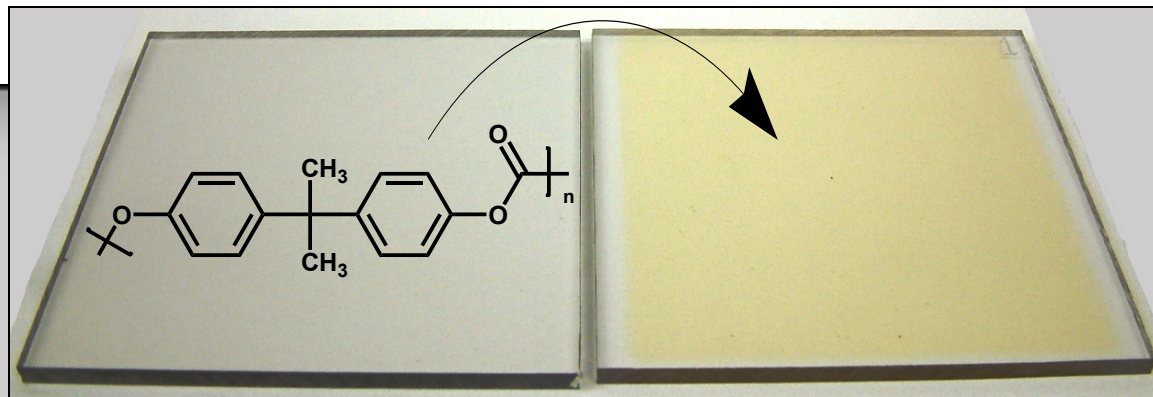
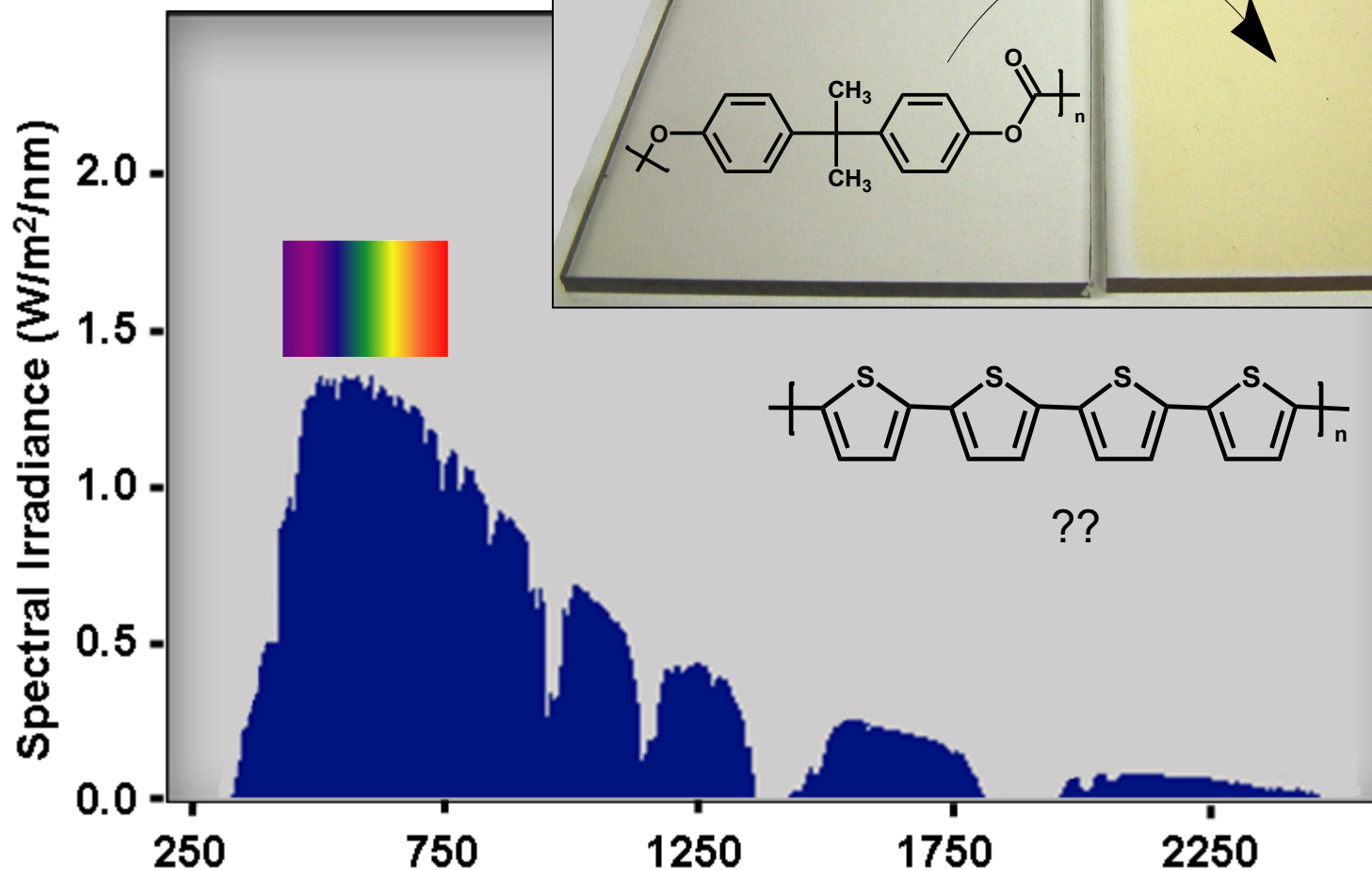


**Market need:**  
Flexible solar PV roofing product



# Organic PV? Aromatics Don't Weather Well!

UV Light, H<sub>2</sub>O



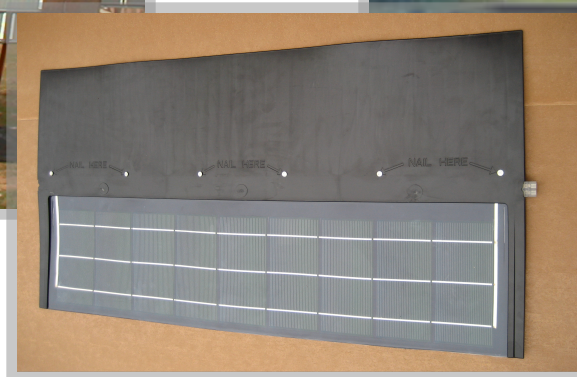
# Recent Progress



1 kW Array



Easy Installation



Shingle prototype



# Thank You

## Dow Research & Development



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