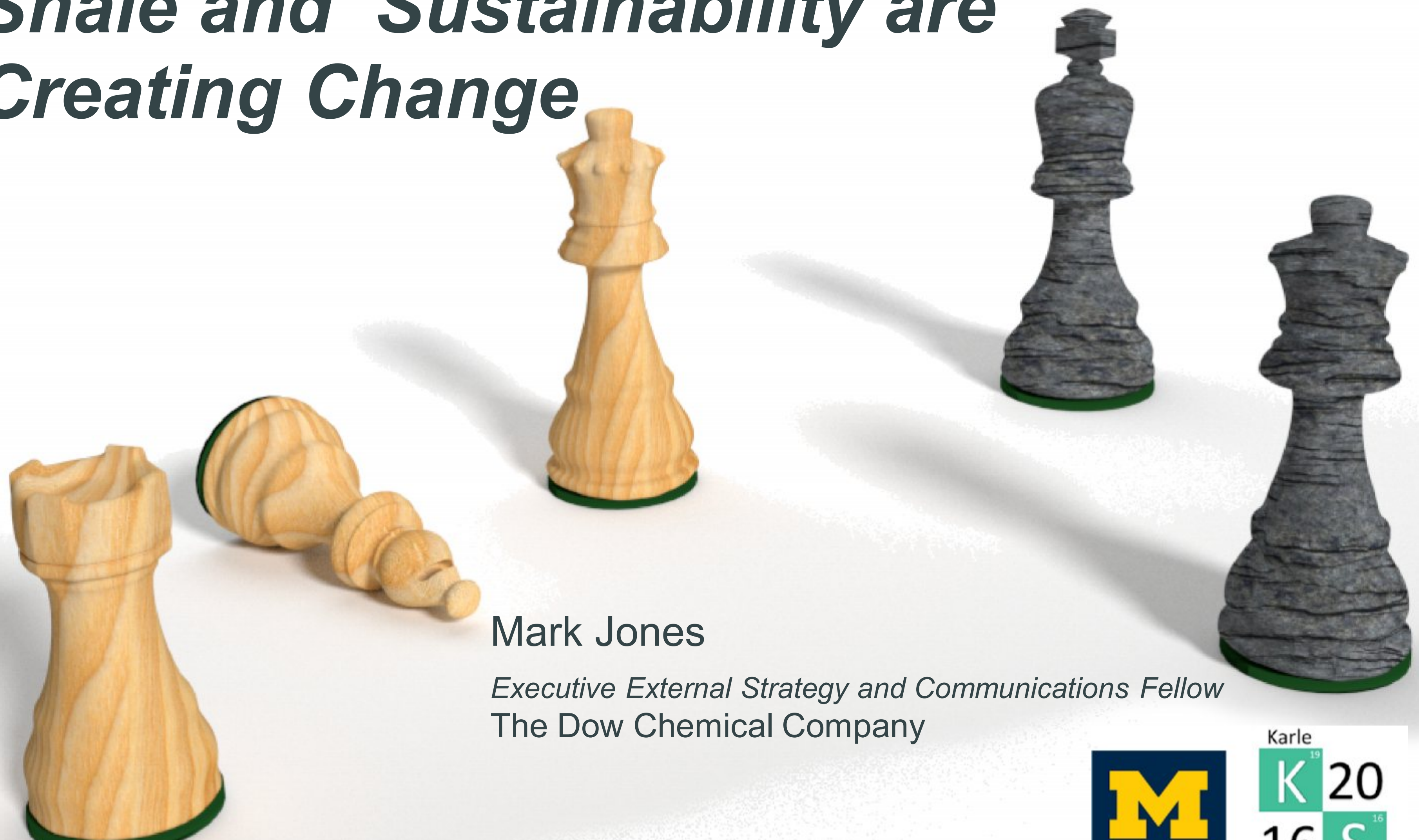
Forces Shaping the Chemical Industry:
Shale and Sustainability are Creating Change



Mark Jones

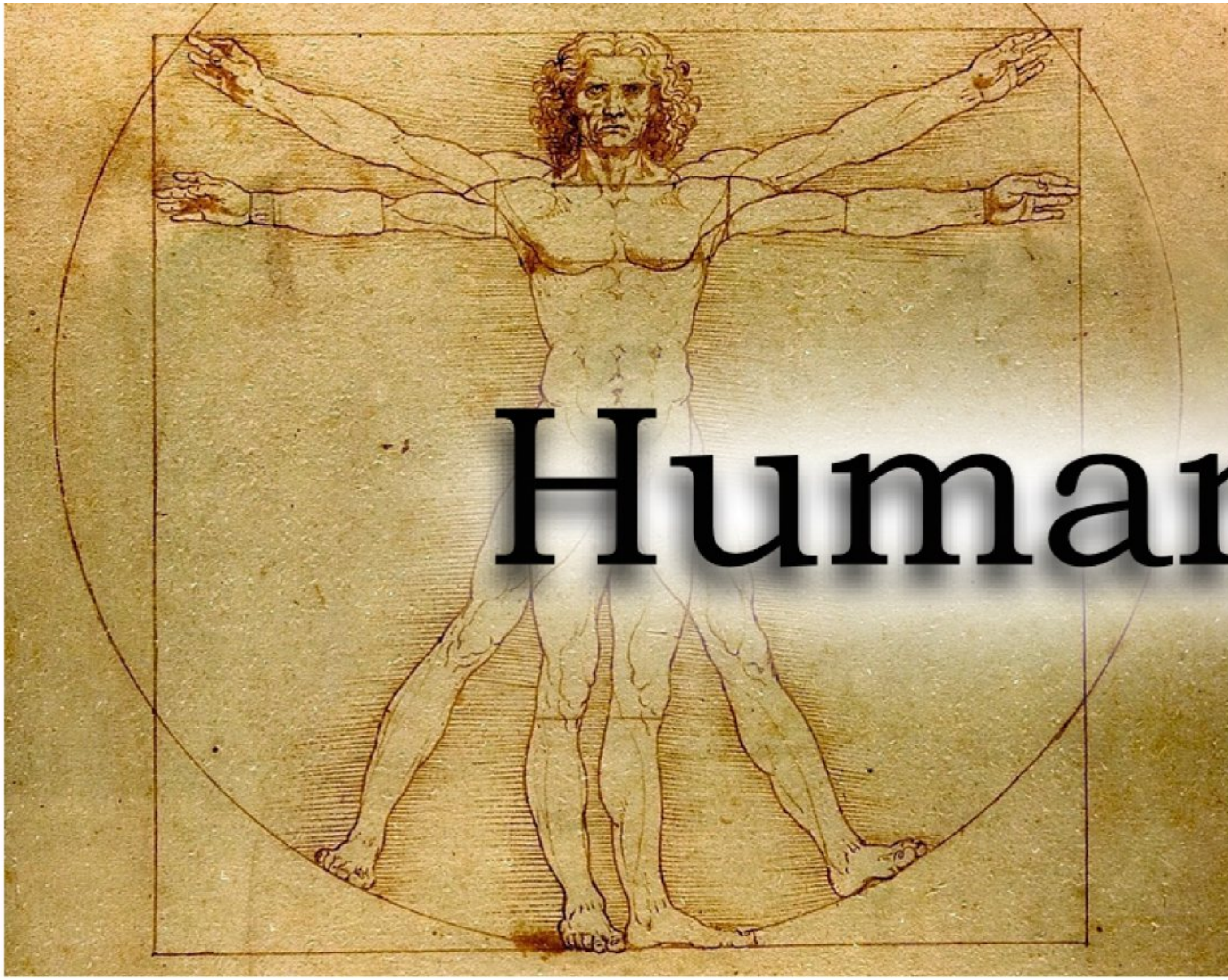
Executive External Strategy and Communications Fellow

The Dow Chemical Company

CHEMISTRY

Karle 2016 KS Symposium

25 July 2016



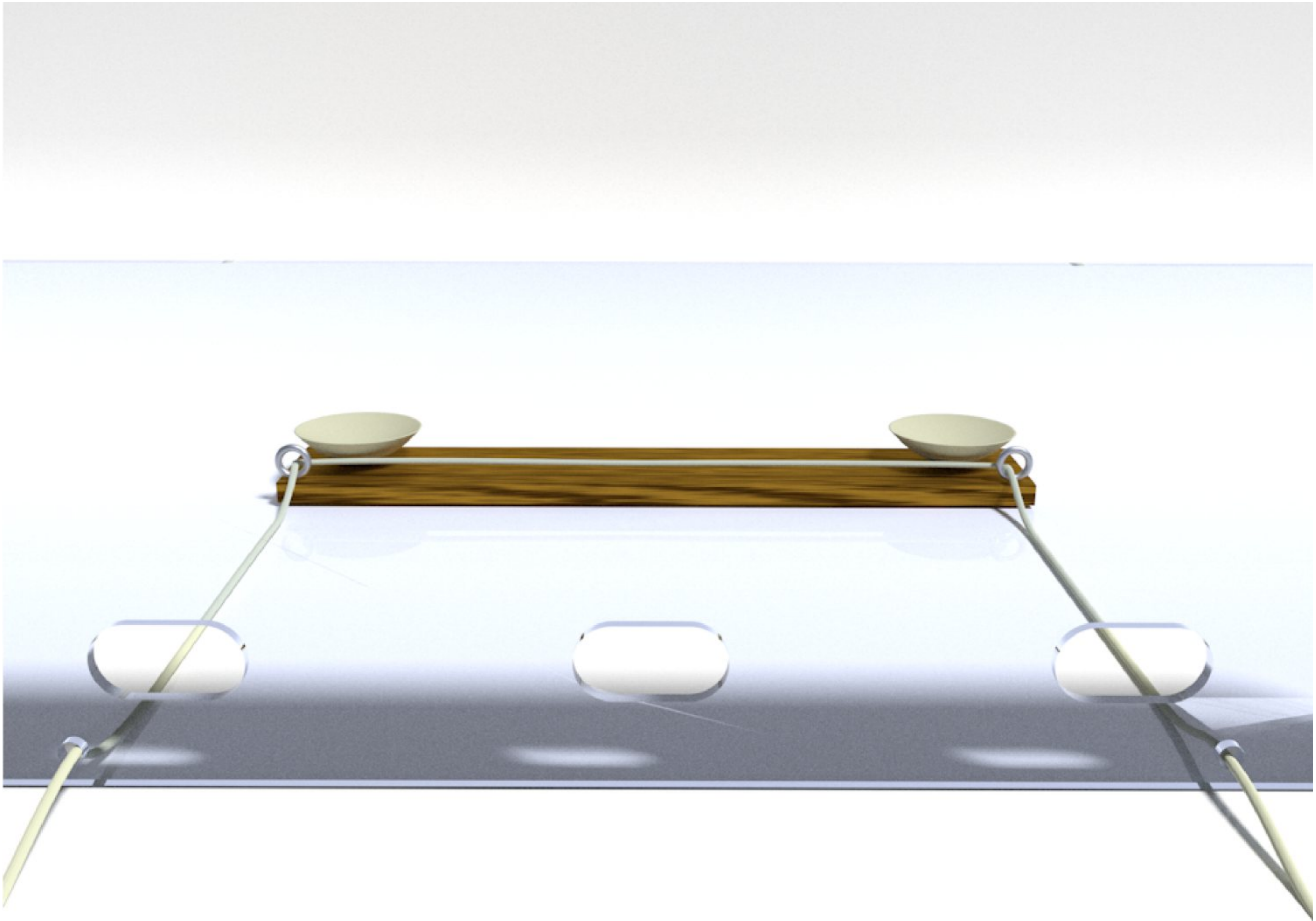
Human?

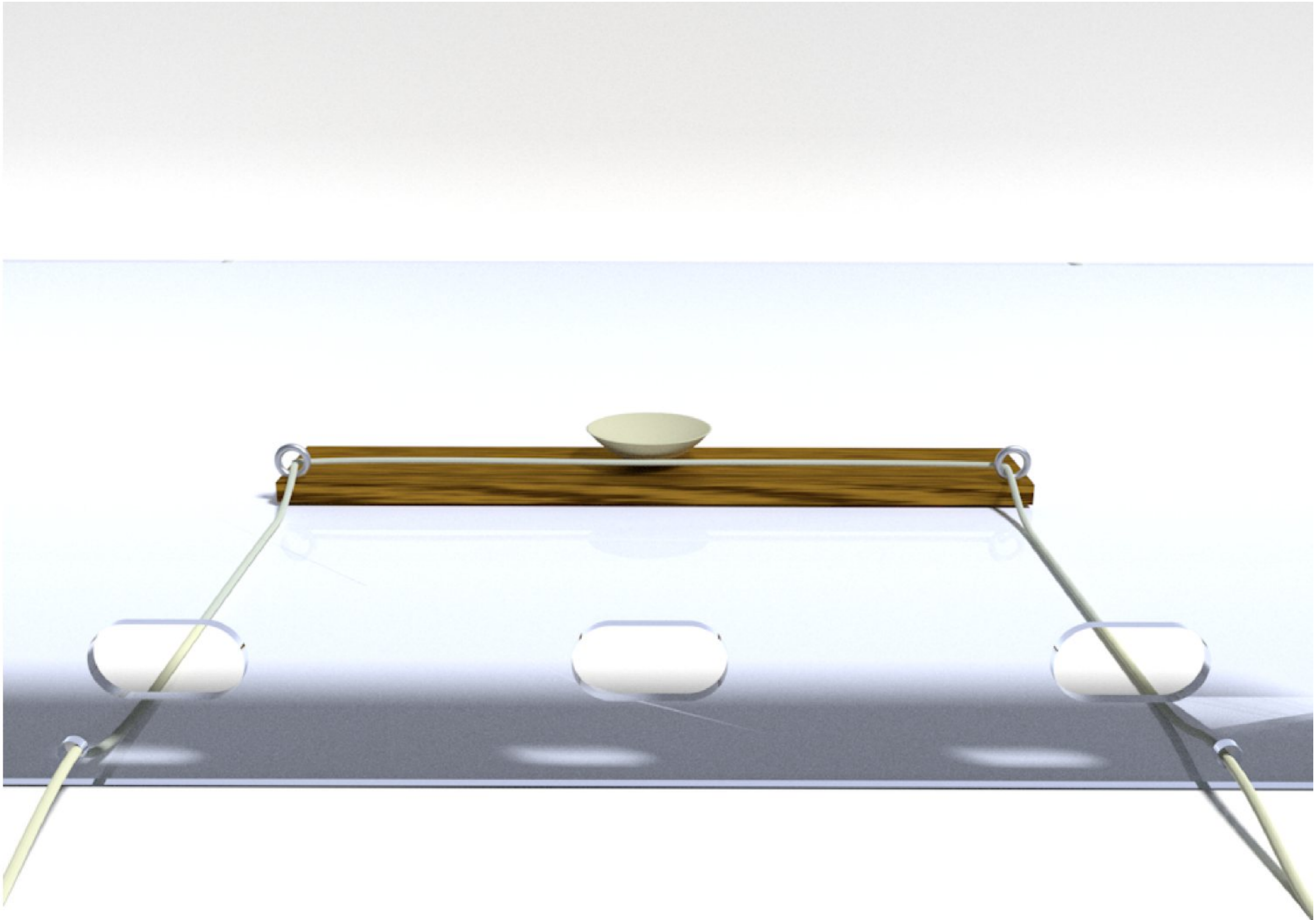
LETTER

doi:10.1038/nature10278

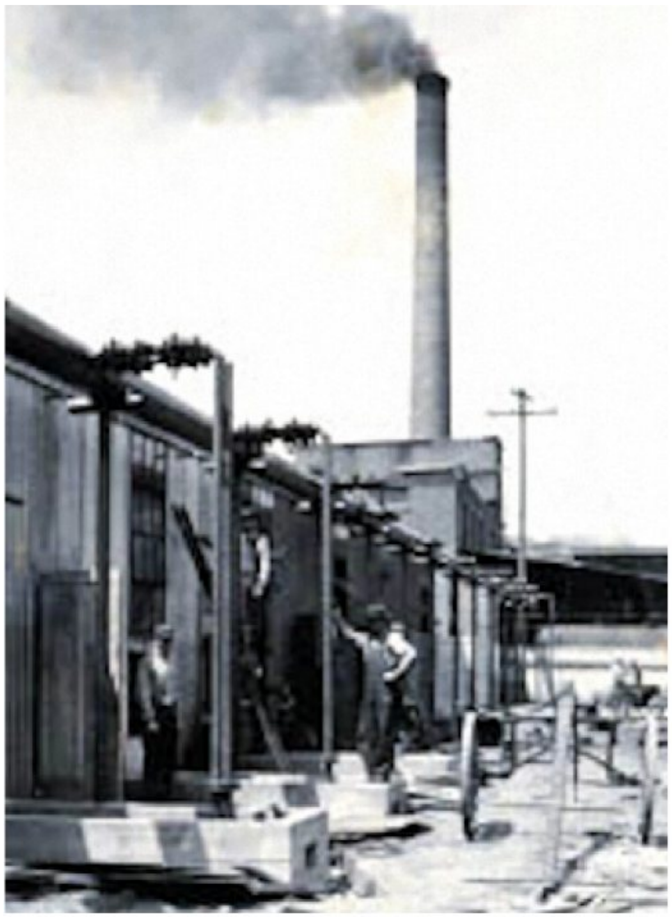
Collaboration encourages equal sharing in children but not in chimpanzees

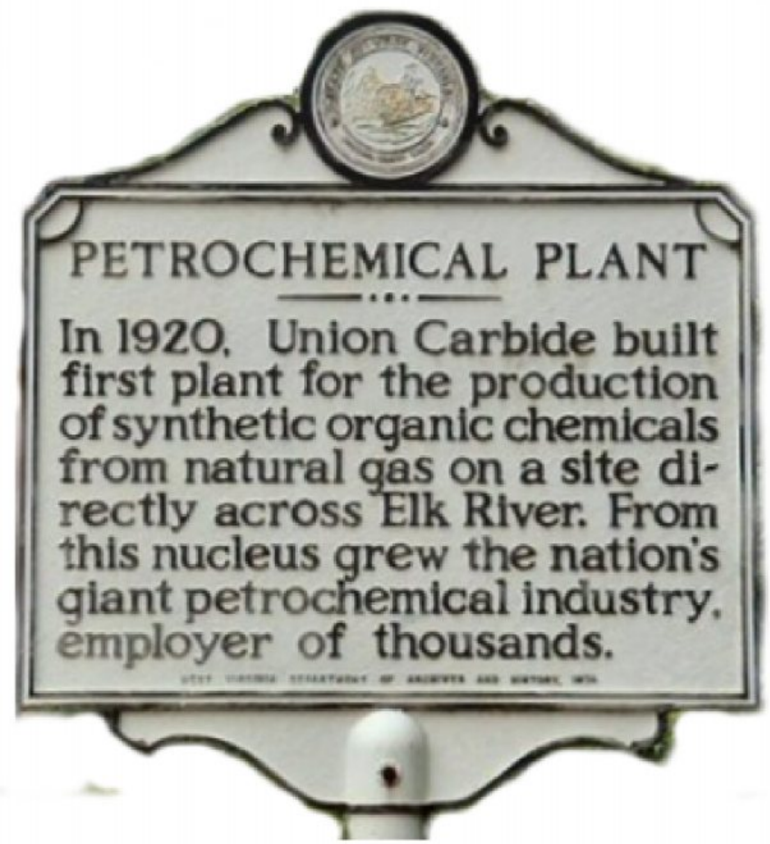
Katharina Hamann[1], Felix Warneken[2], Julia R. Greenberg[3] & Michael Tomasello[1]



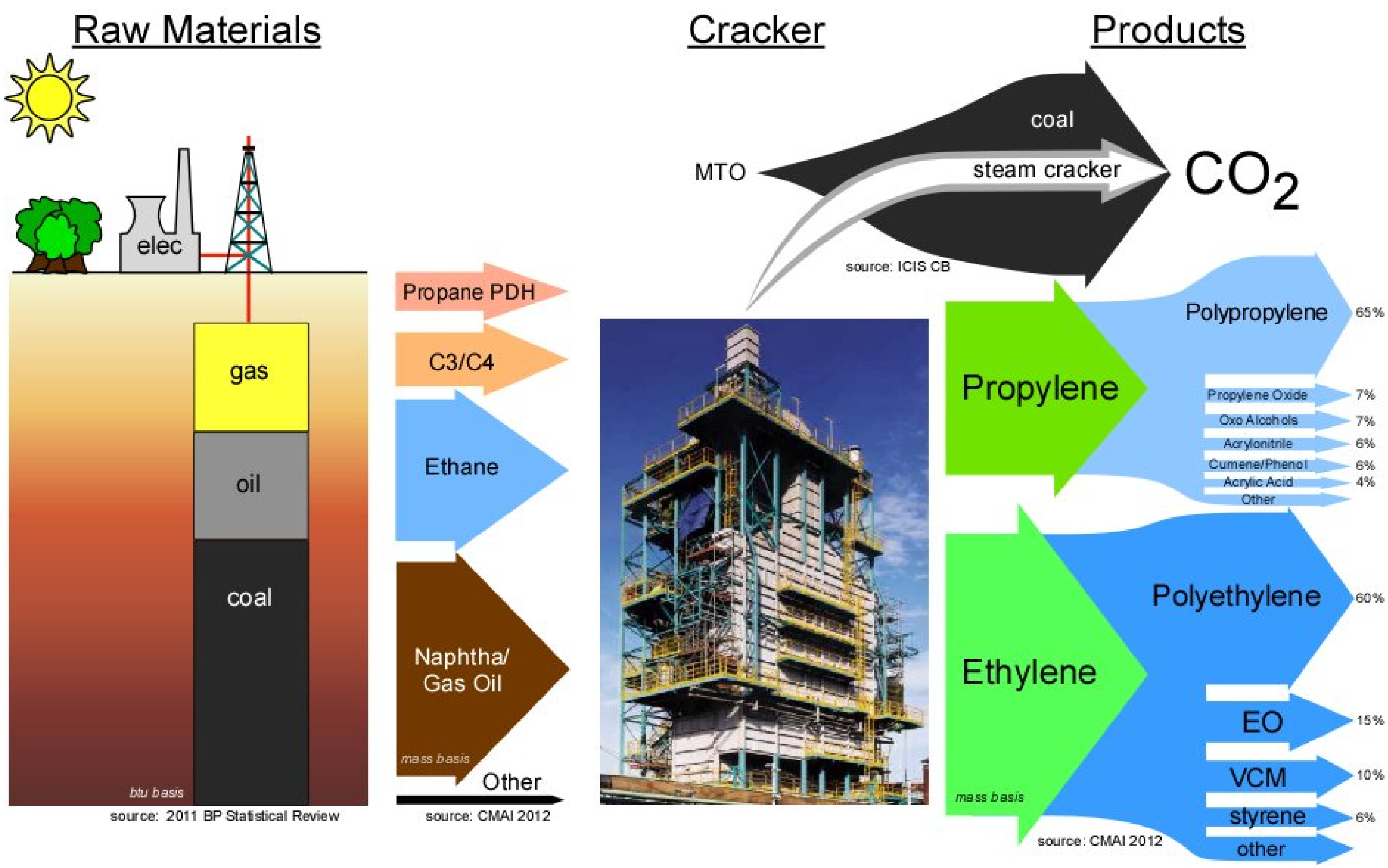


Birth of Modern Chemicals

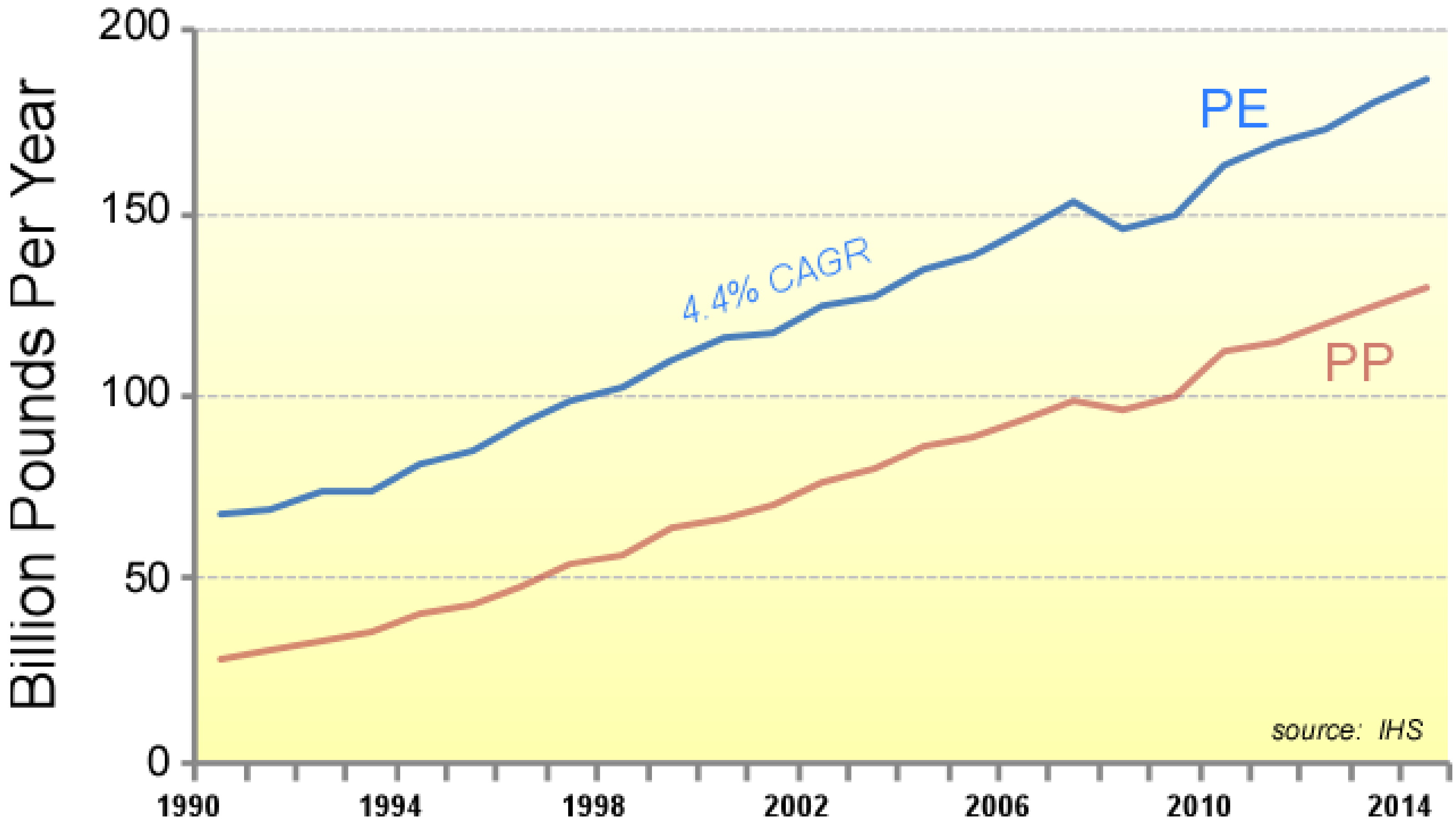




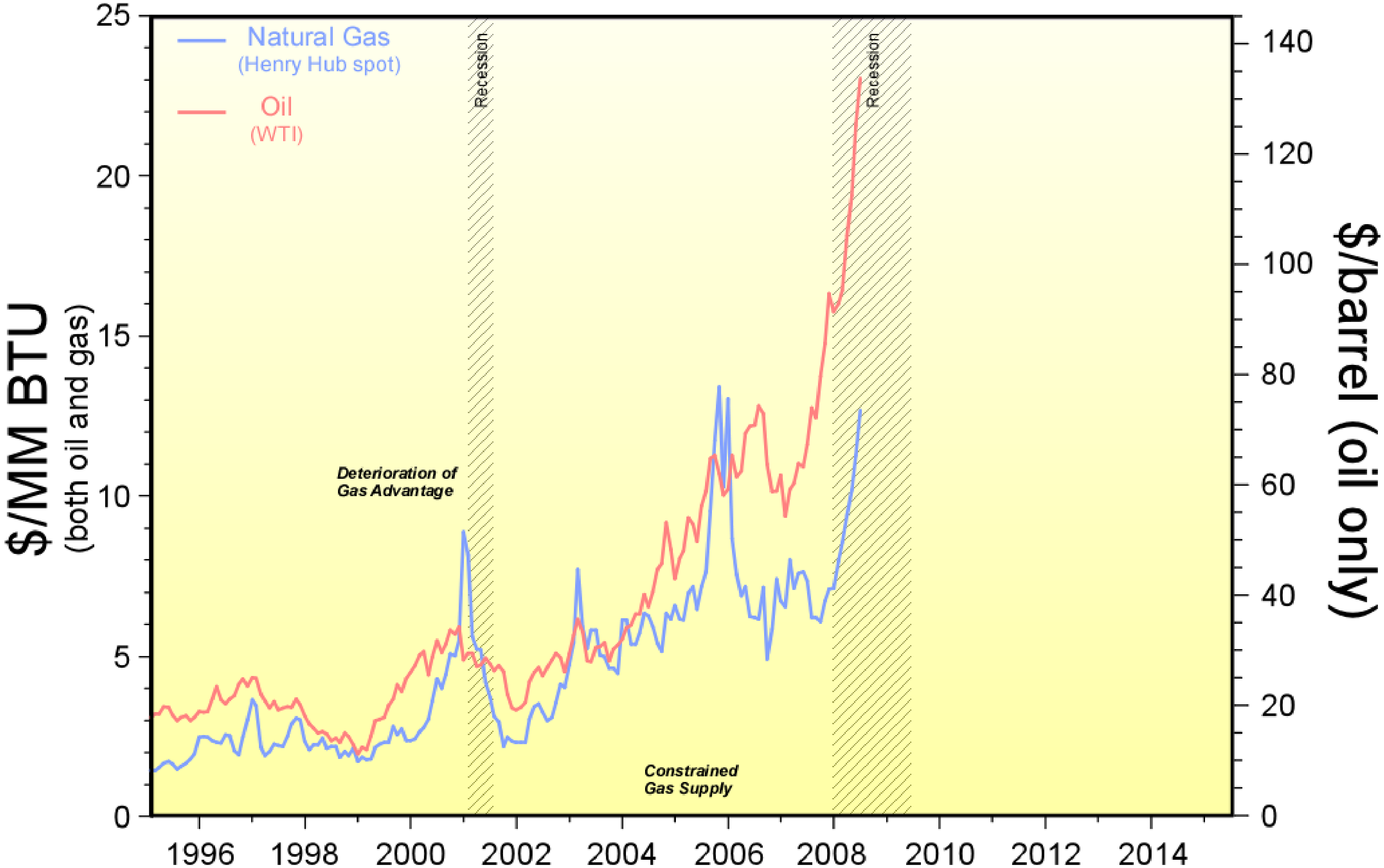
Chemical Industry Snapshot



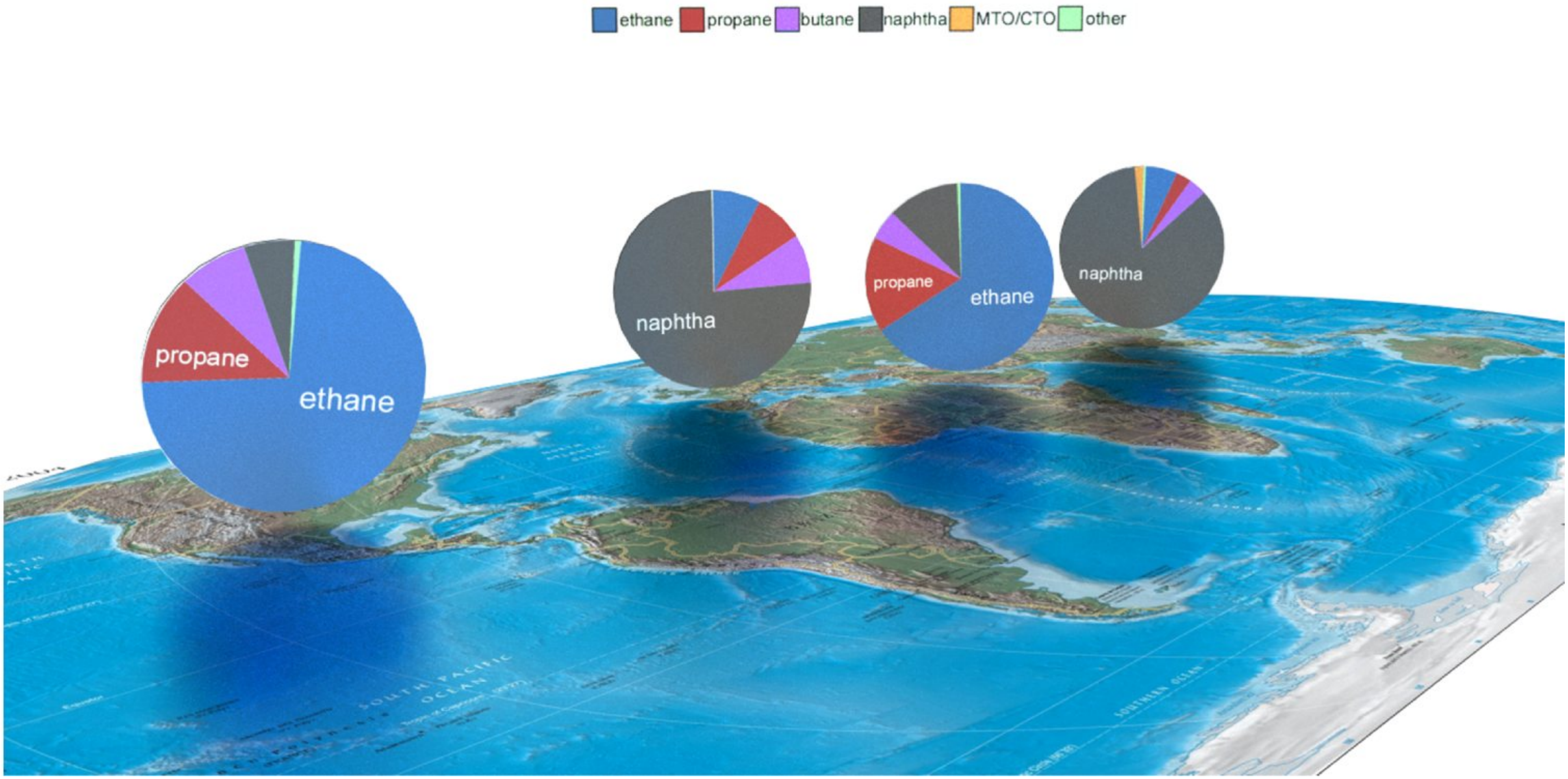
Polyolefin Growth



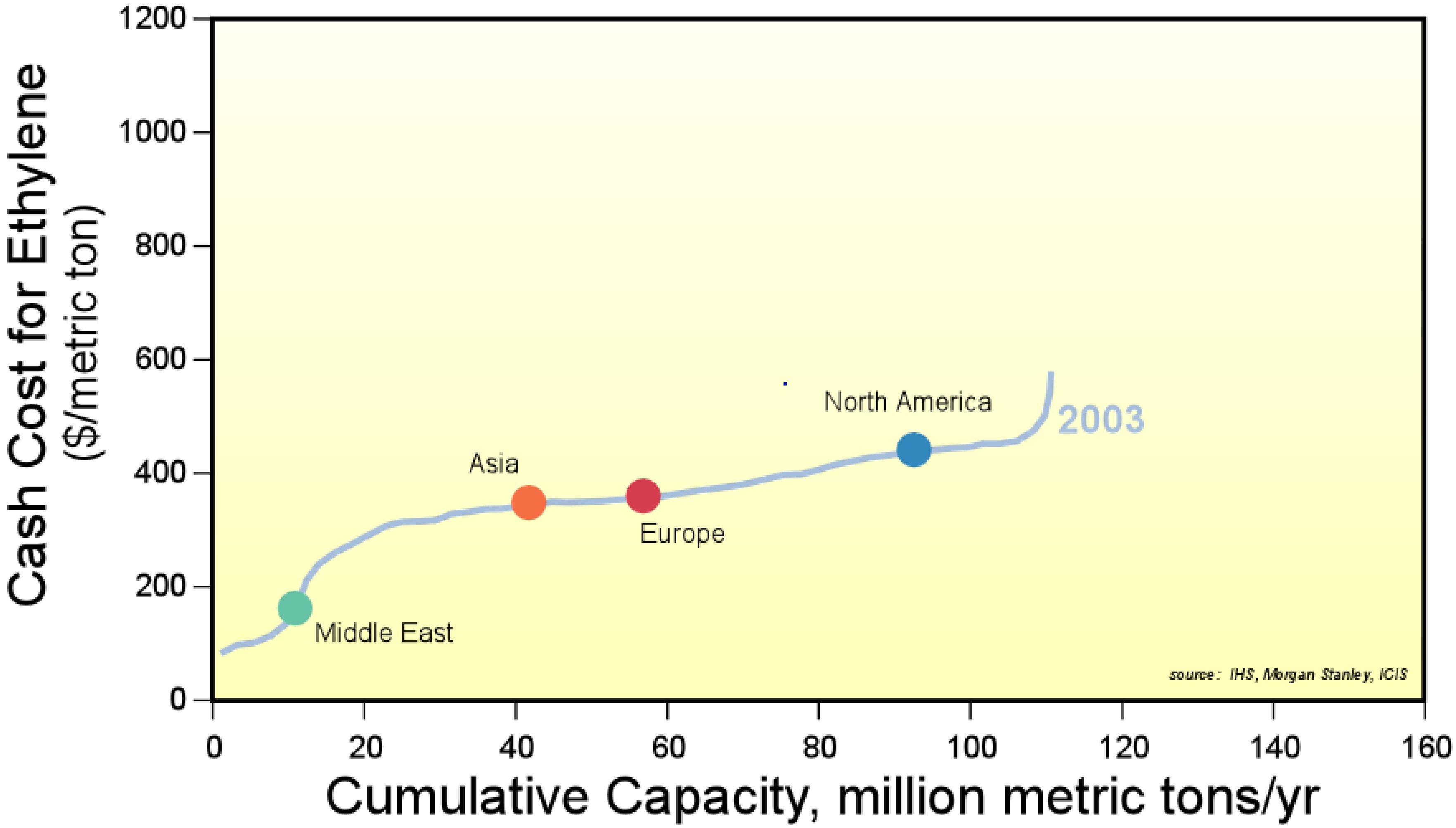
Our Previous Reality…..



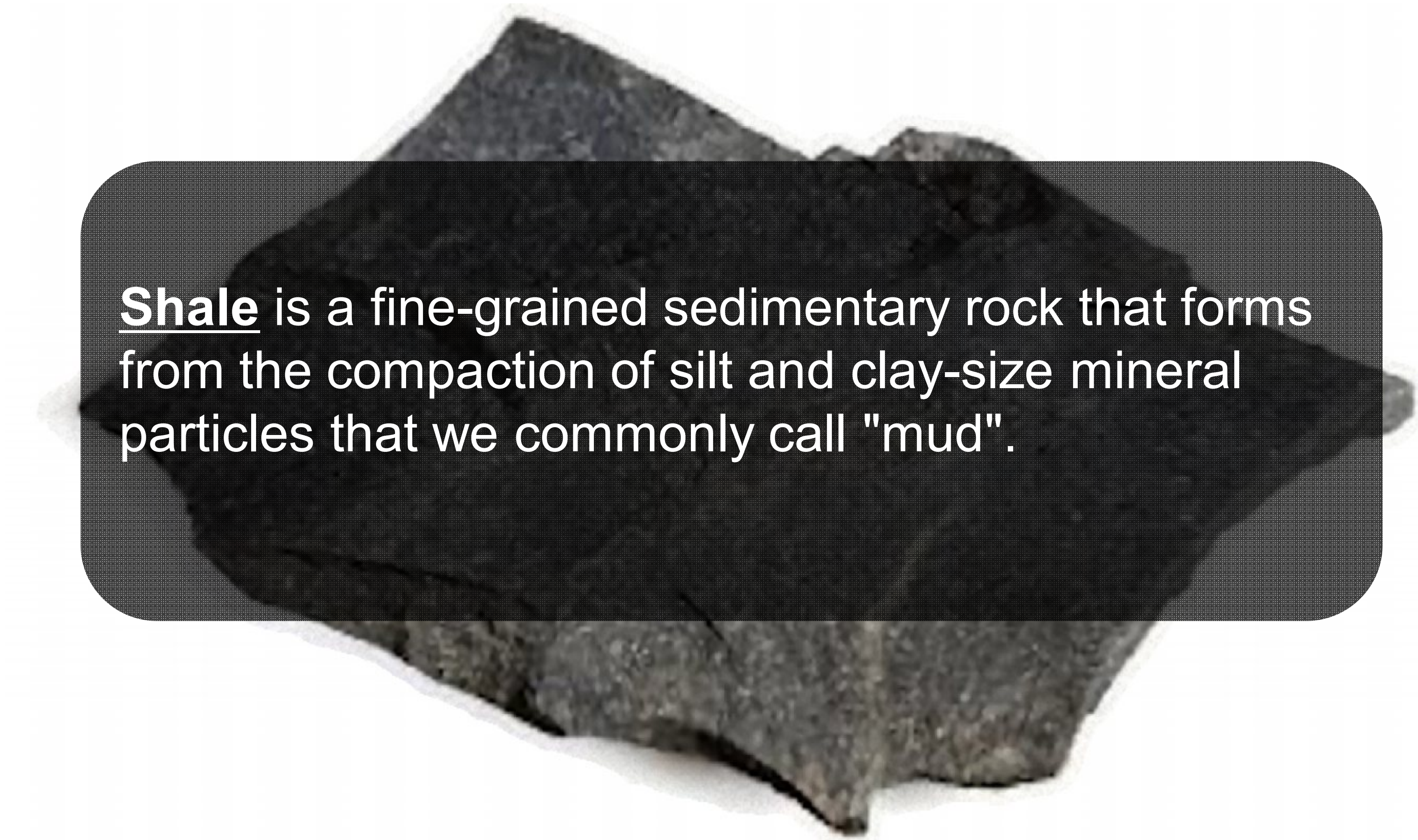
Global Feedstock Slates Differ



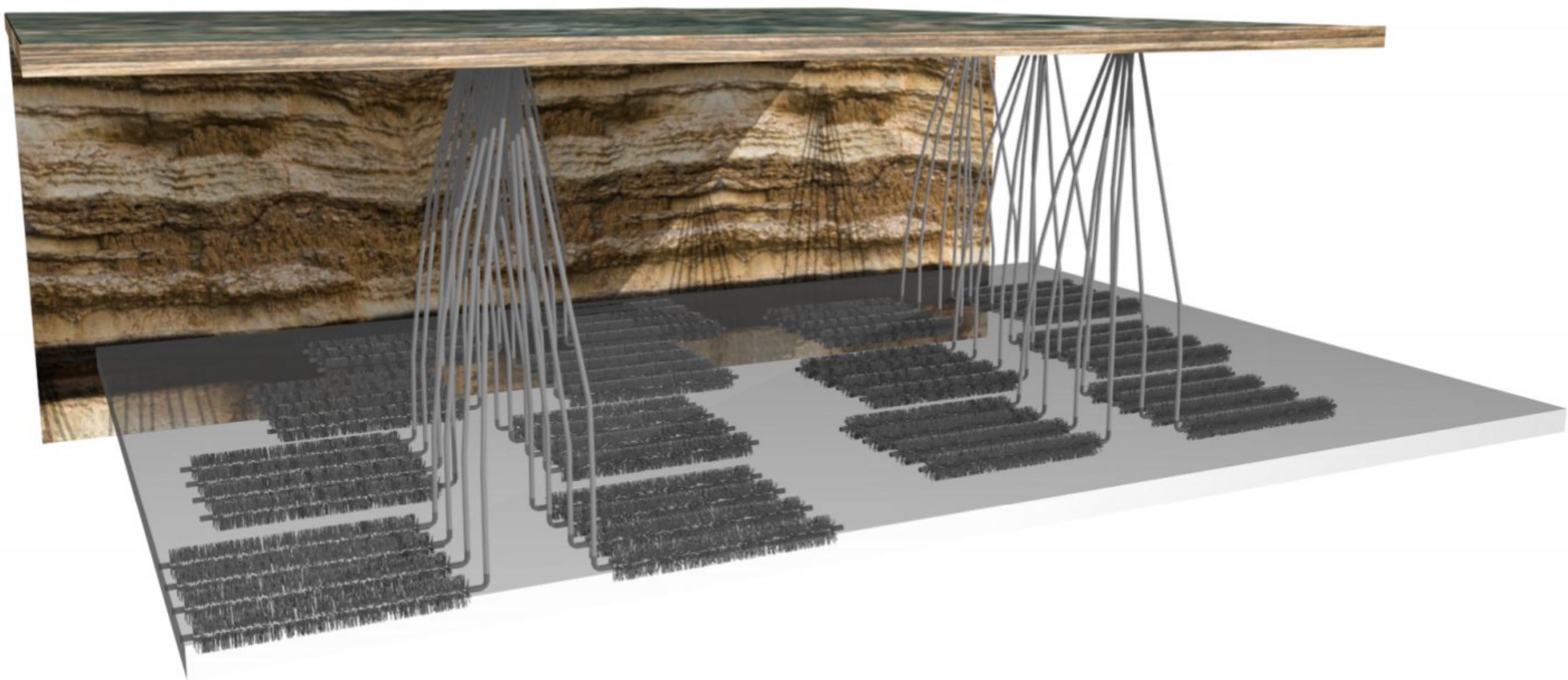
Ethylene Cumulative Supply - 2003



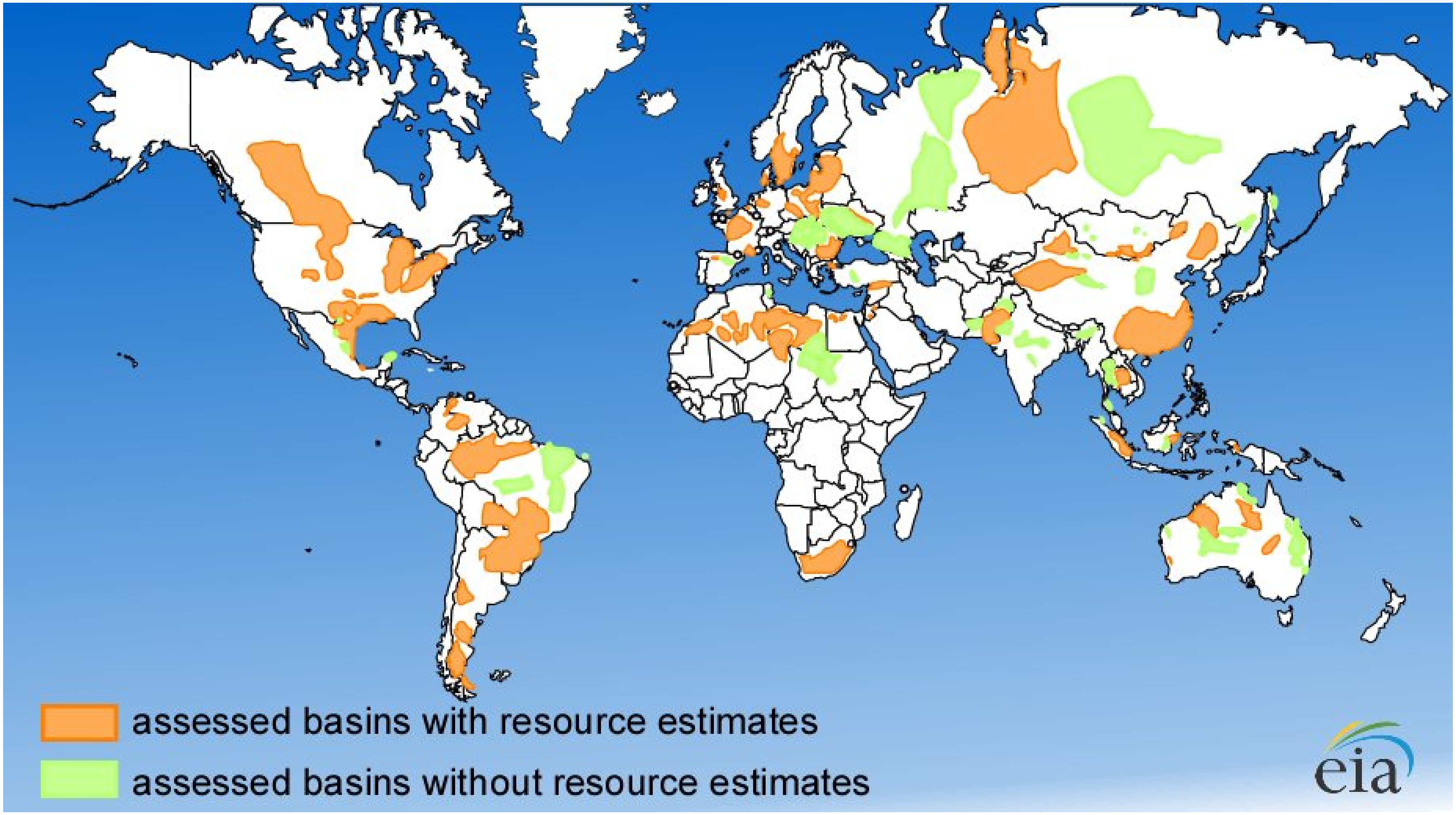

R.I.P.
U.S. CHEMICAL
INDUSTRY
1776-2008



Shale is a fine-grained sedimentary rock that forms from the compaction of silt and clay-size mineral particles that we commonly call "mud".



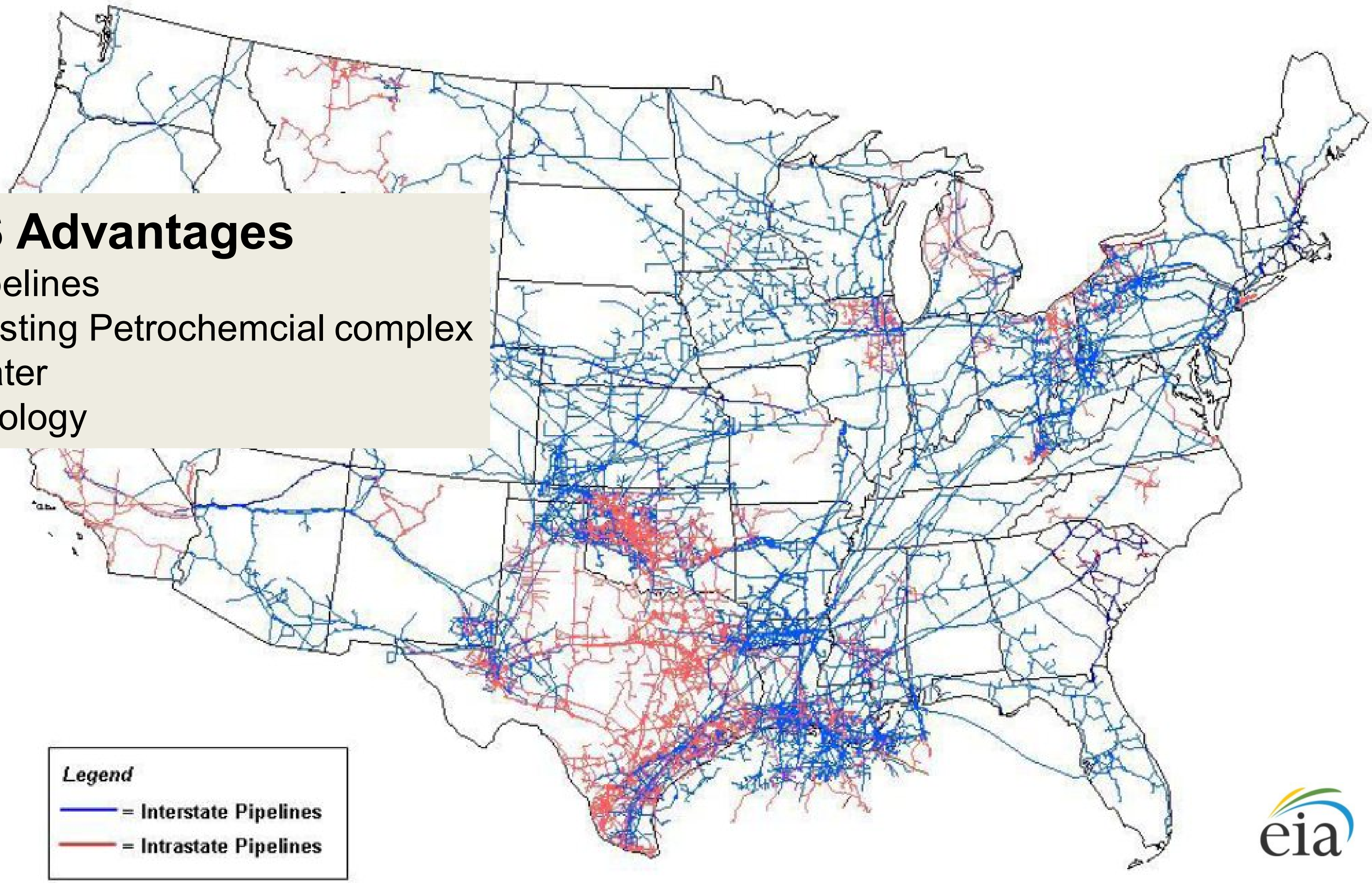
Mud Happened in Many Places



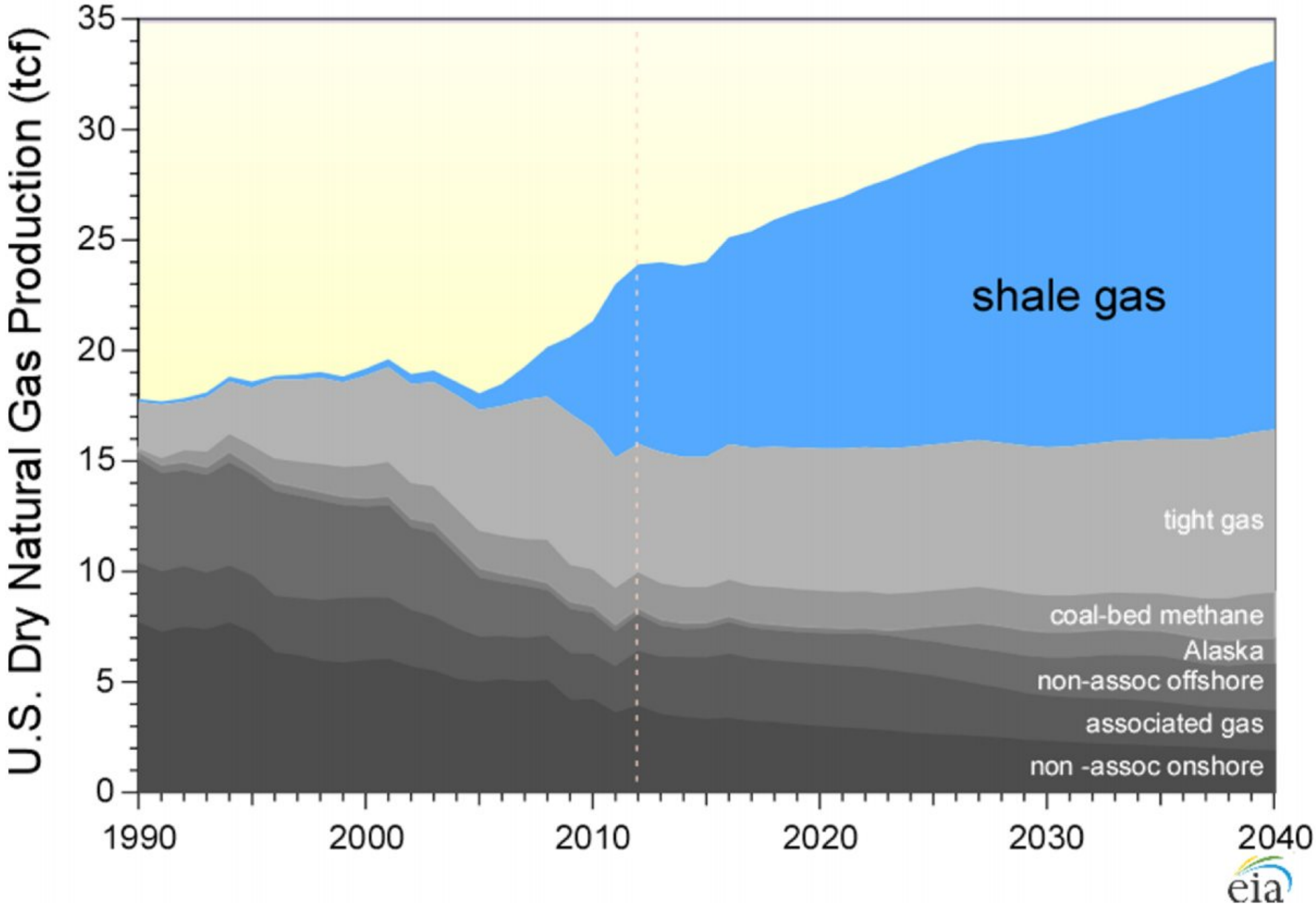
Robust Transmission Infrastructure

US Advantages

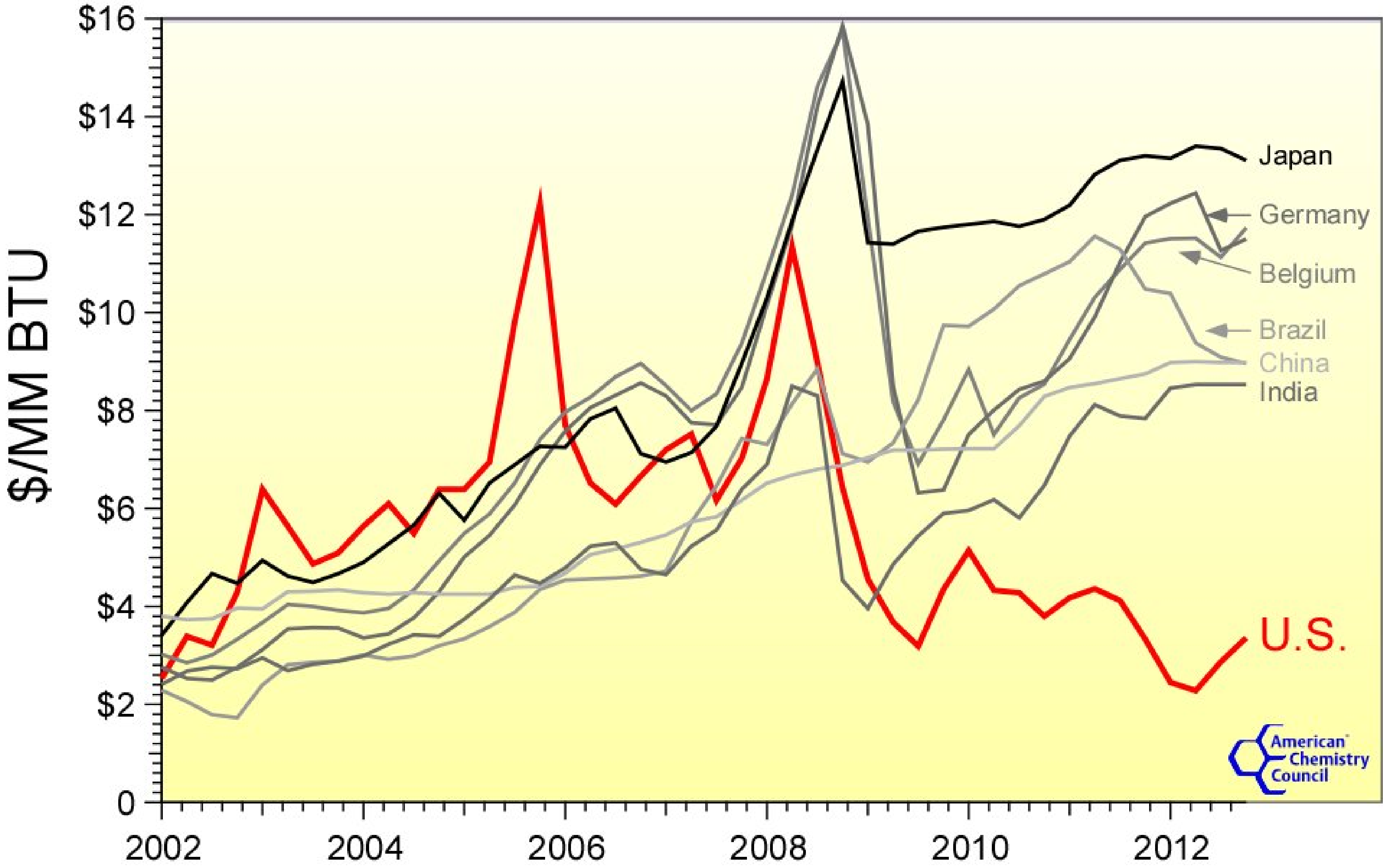
- Pipelines
- Existing Petrochemcial complex
- Water
- Geology



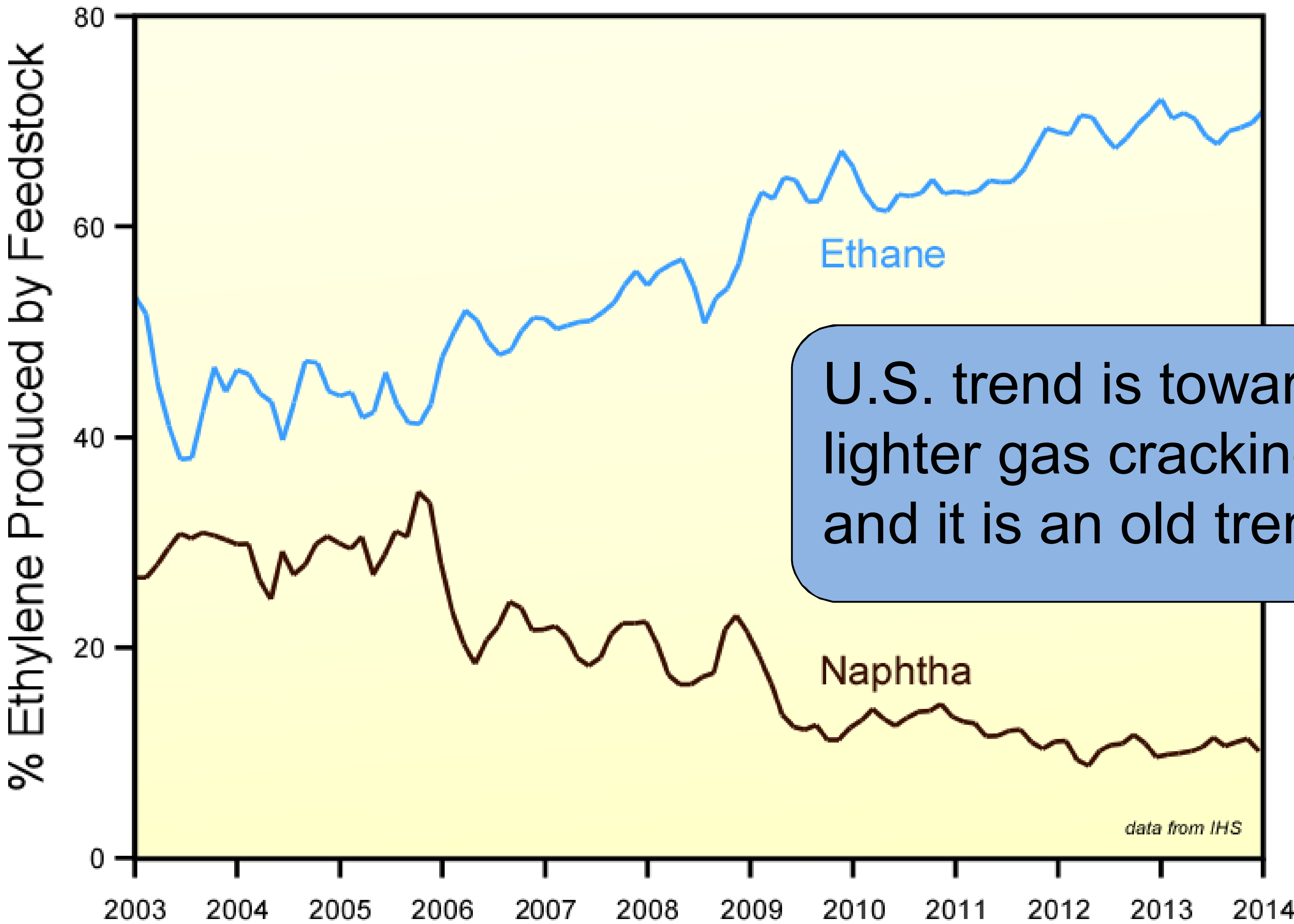
Shale Gas Growth



Global Gas Price

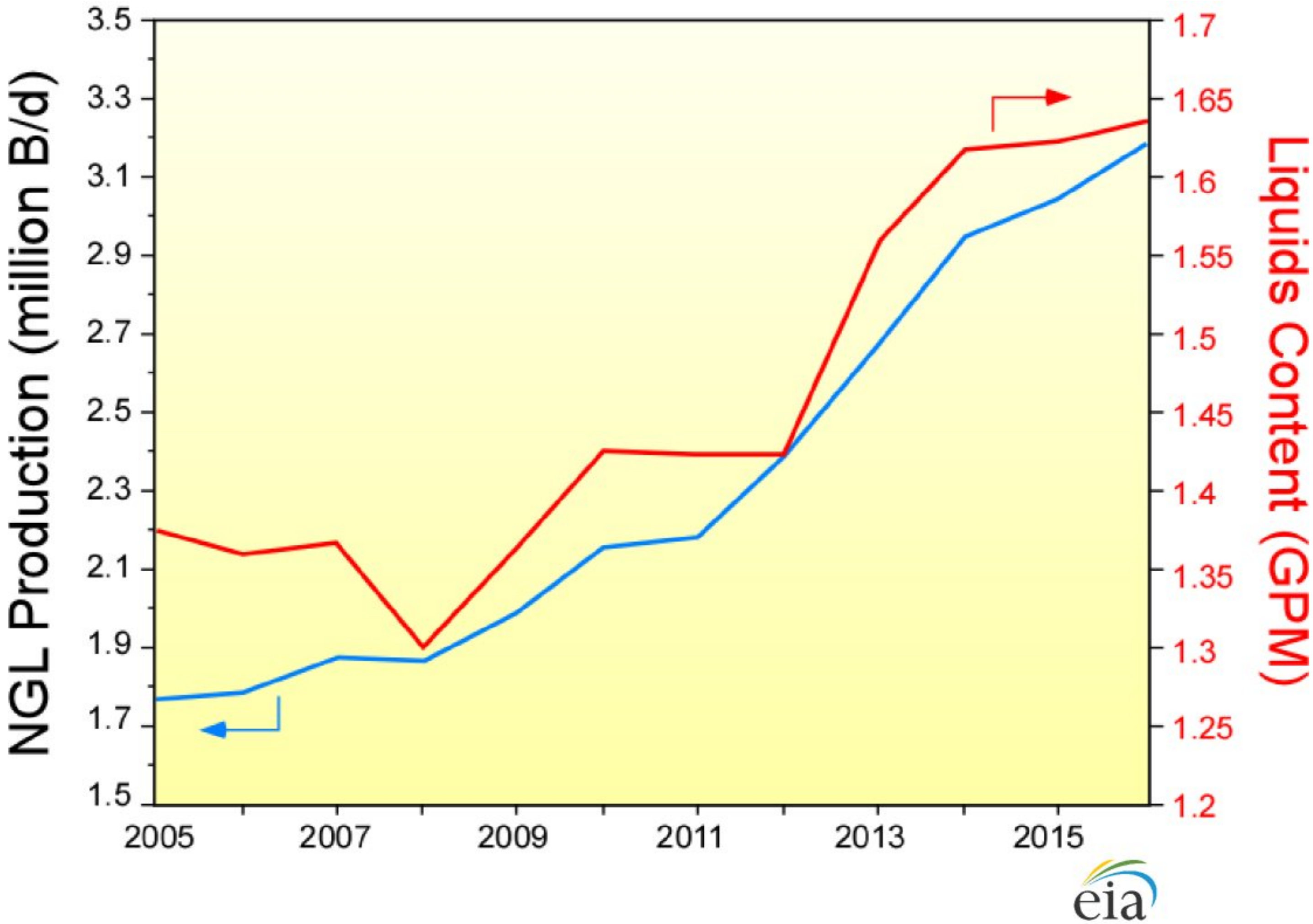


US Trend

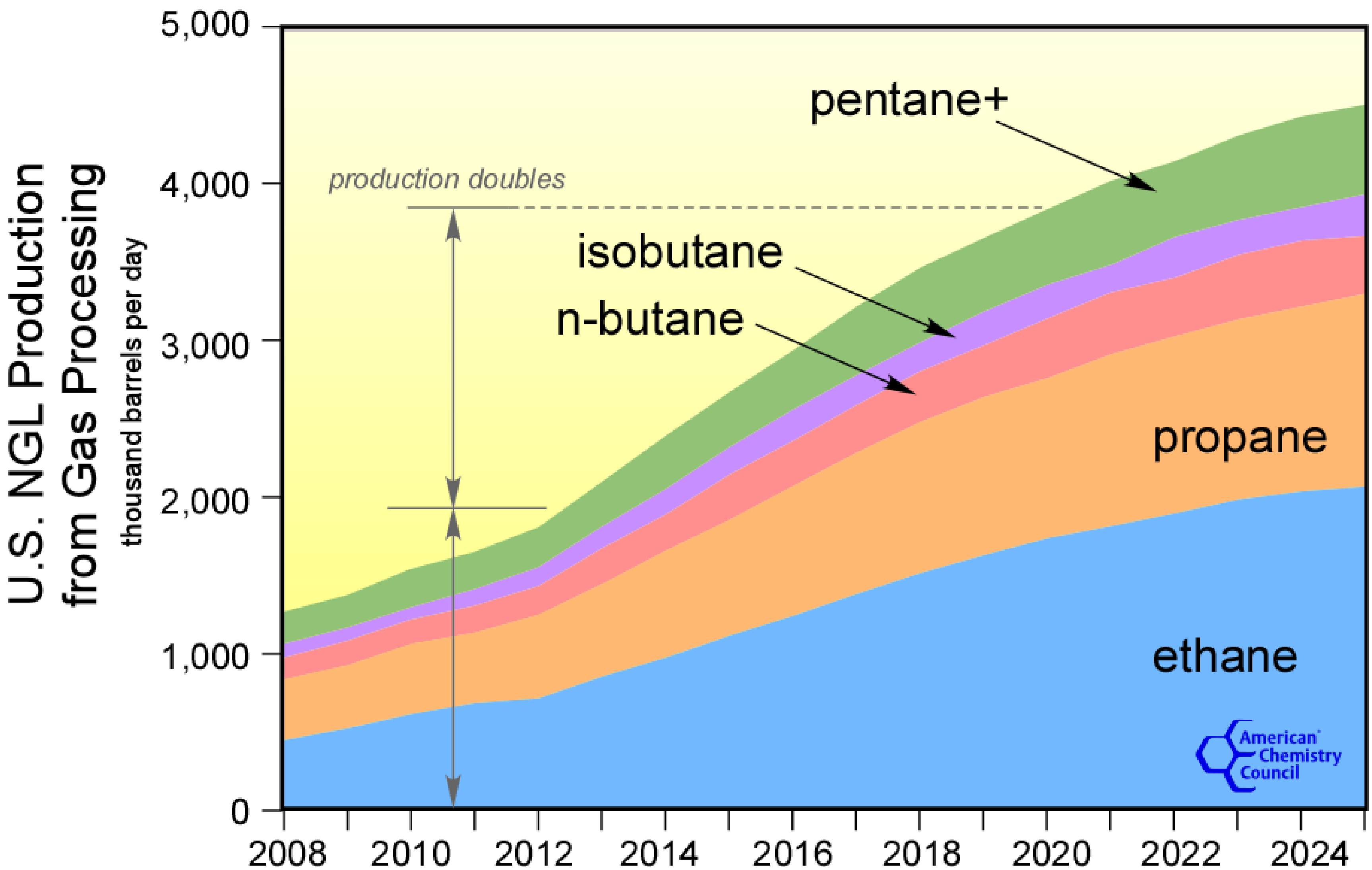


U.S. trend is toward lighter gas cracking and it is an old trend

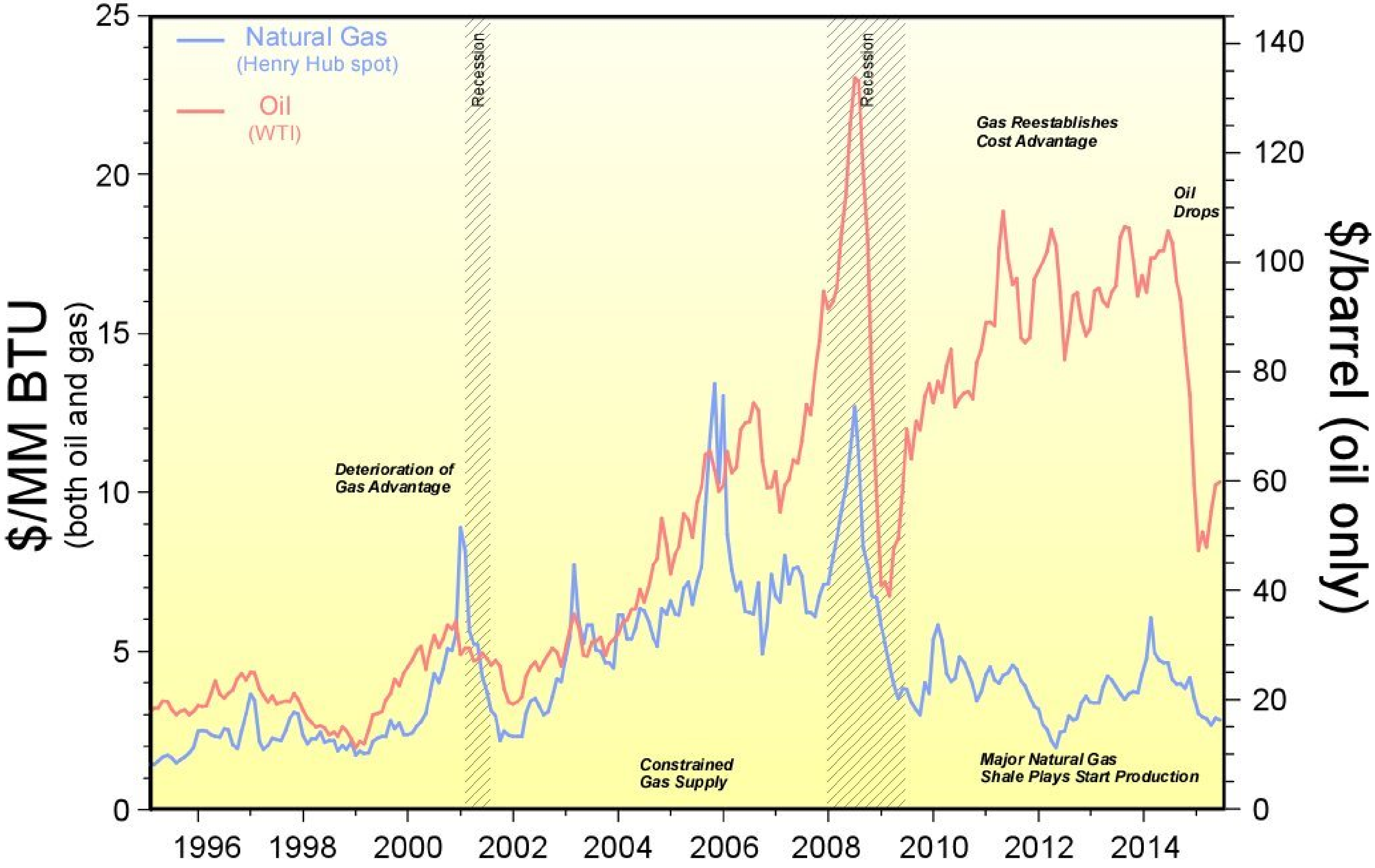
Growth in NGLs



NGL Production Doubles by 2020

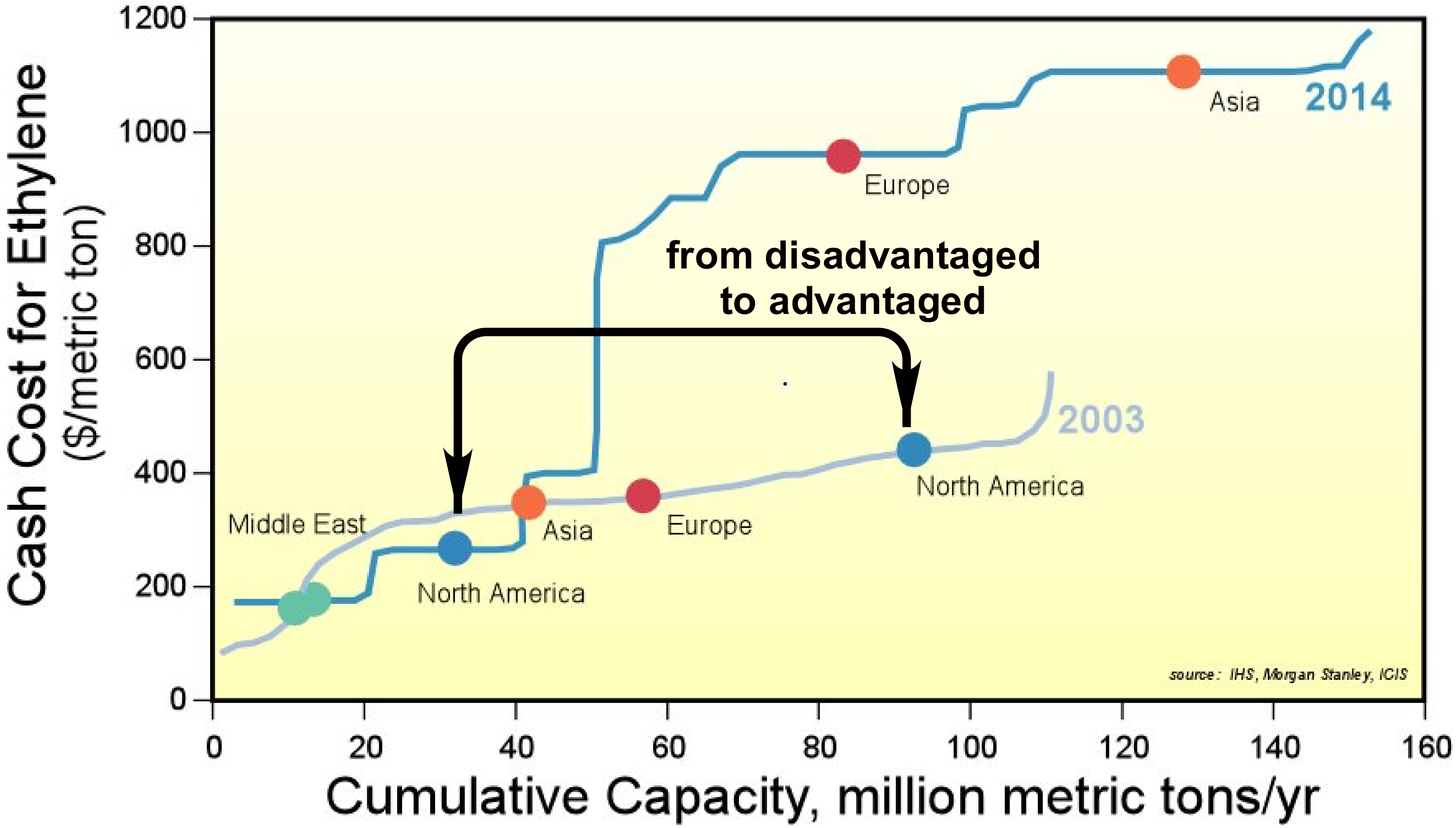


Energy Cost



Natural Gas
(Henry Hub spot)
Oil
(WTI)
Recession
Recession
Gas Reestablishes
Cost Advantage
Oil
Drops
Deterioration of
Gas Advantage
Constrained
Gas Supply
Major Natural Gas
Shale Plays Start Production
$/MM BTU
(both oil and gas)
$/barrel (oil only)
0
5
10
15
20
25
0
20
40
60
80
100
120
140
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

Rapid Change




Live Long and Prosper

Economic Impact of Shale Gas

637,000

Permanent NEW jobs by 2023 throughout the U.S. economy from $81 billion in new chemical industry output

$243 billion

Permanent NEW U.S. economic output by 2020 from $81 billion in new chemical industry output

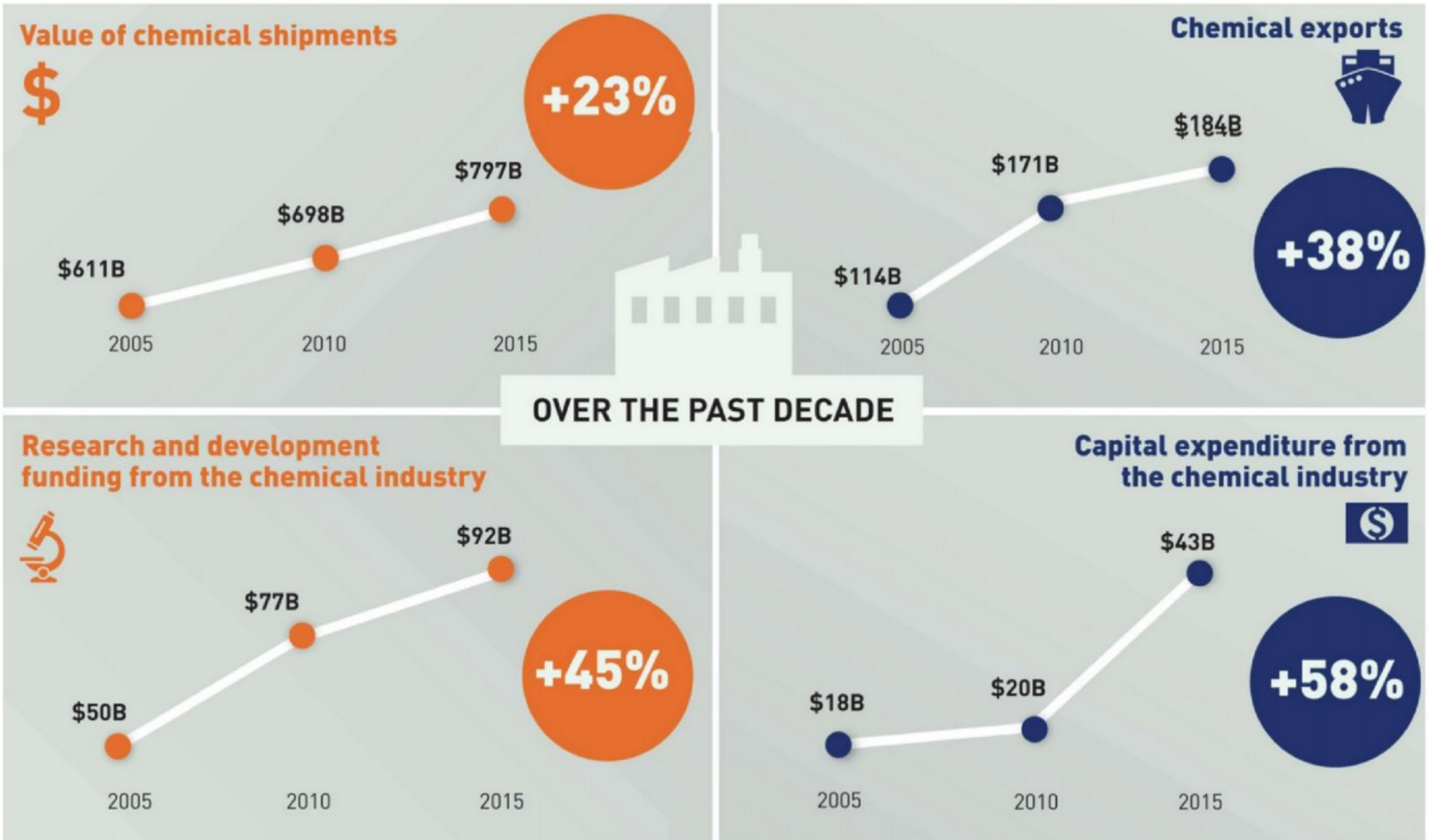
Based on $100 billion in potential U.S. chemical investment announced as of February 2014

American Chemistry Council

DOW

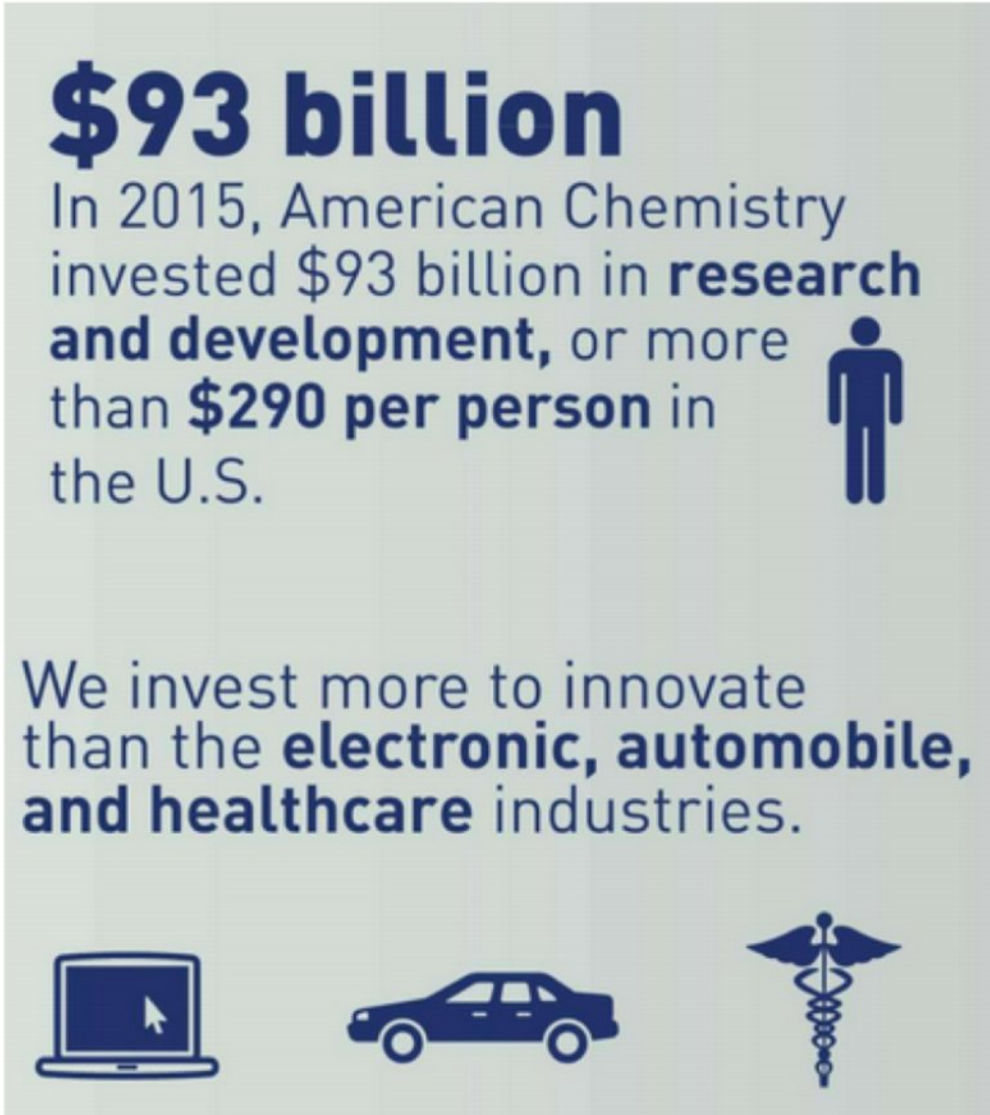
Announced Projects

Industry Growth



American Chemistry Council

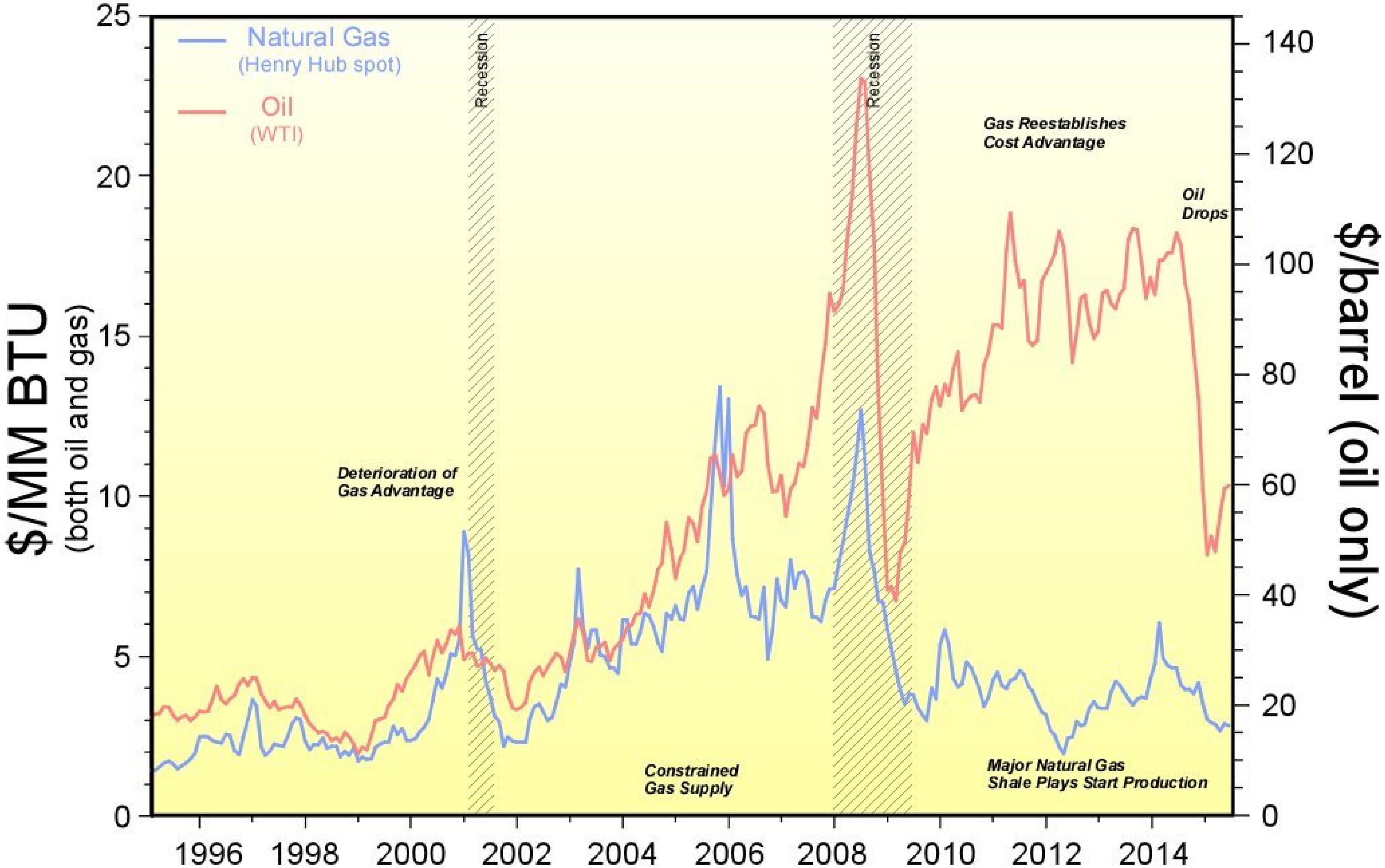
Impact of Chemical Industry on R&D



American Chemistry Council

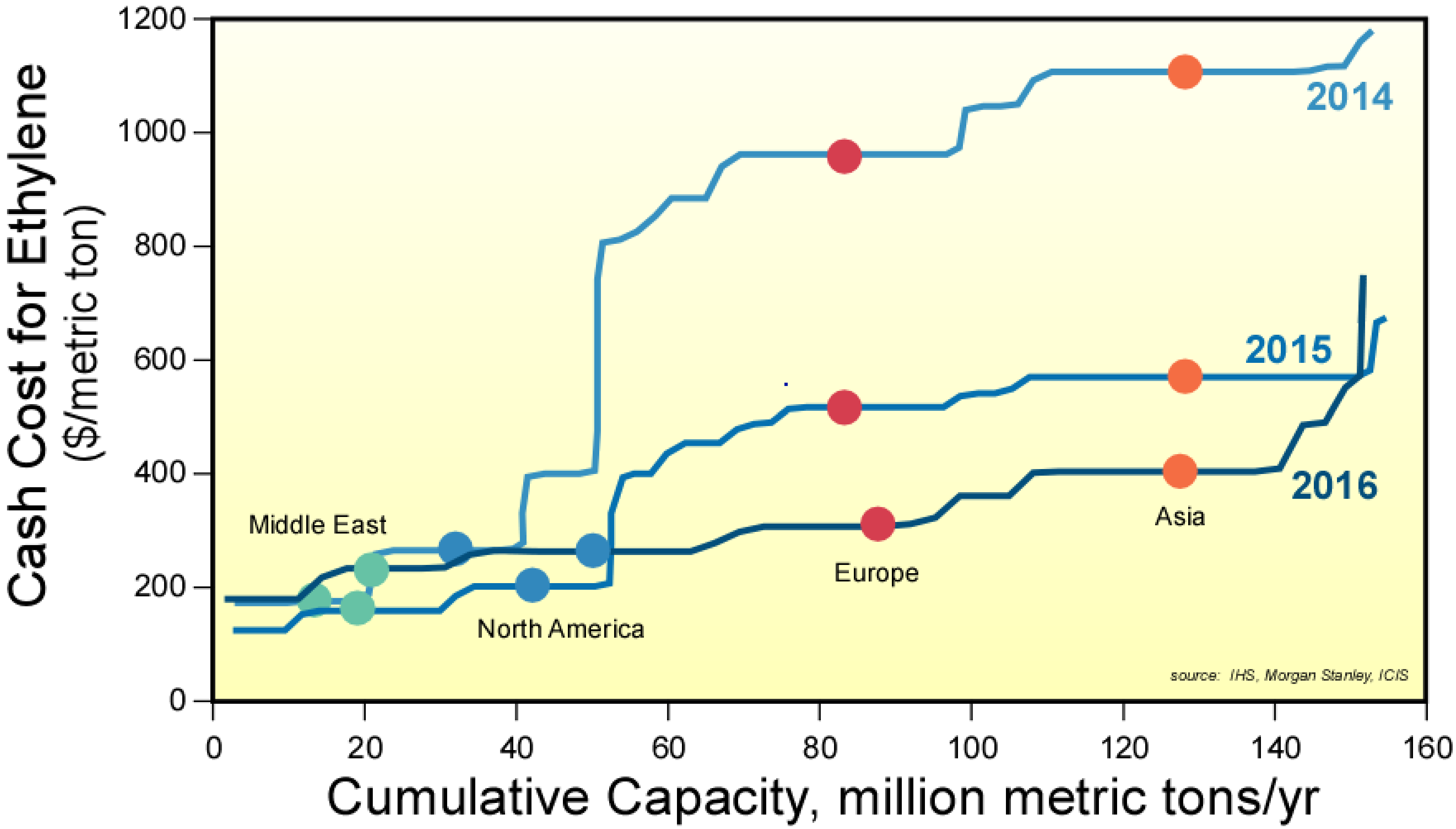
Exciting Times

Energy Cost



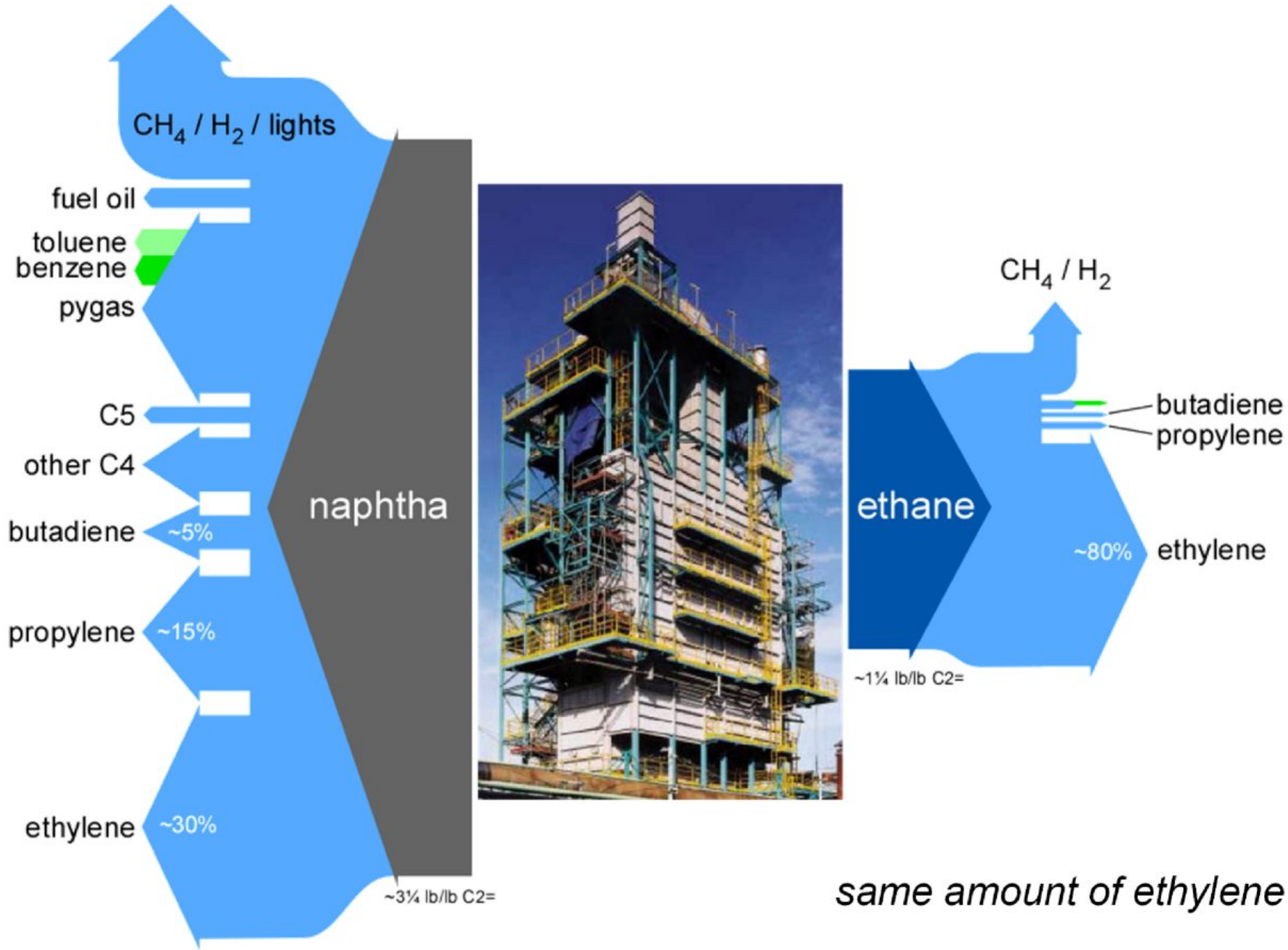
Natural Gas
(Henry Hub spot)
Oil
(WTI)
Recession
Recession
Gas Reestablishes
Cost Advantage
Oil
Drops
Deterioration of
Gas Advantage
Constrained
Gas Supply
Major Natural Gas
Shale Plays Start Production
$/MM BTU
(both oil and gas)
$/barrel (oil only)
25
20
15
10
5
0
140
120
100
80
60
40
20
0
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

Falling Oil Prices



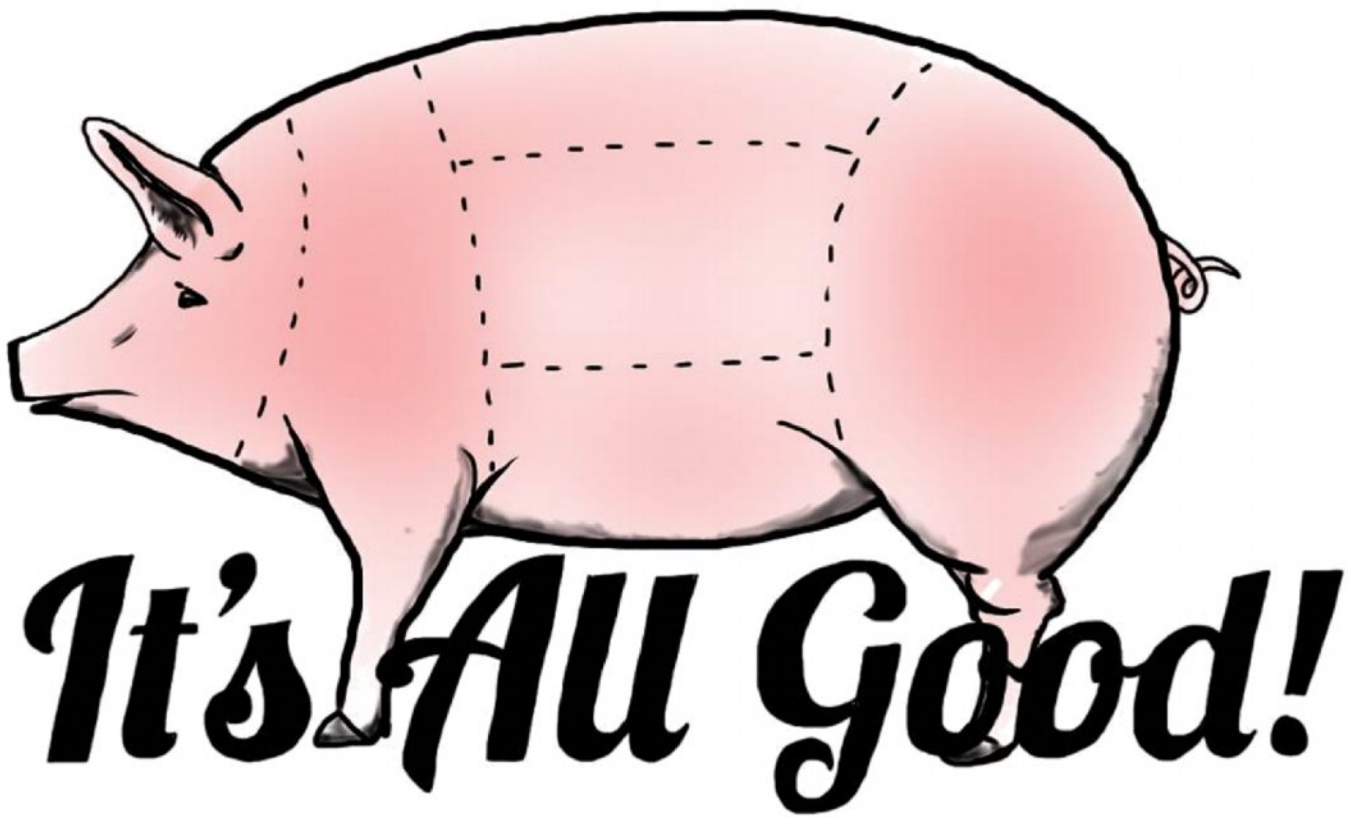
NGLs Still Advantaged In The U.S.

Naphtha vs Ethane Cracking Comparison

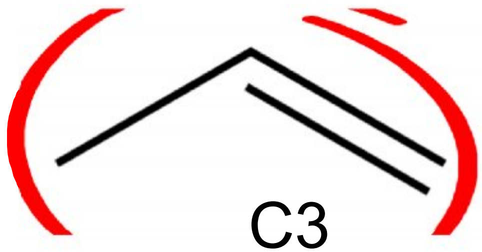


same amount of ethylene

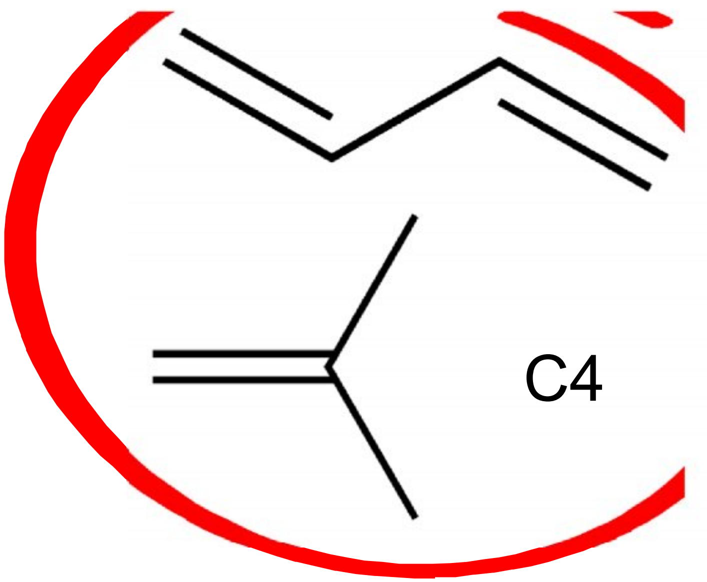
All Reaction Products Find Uses



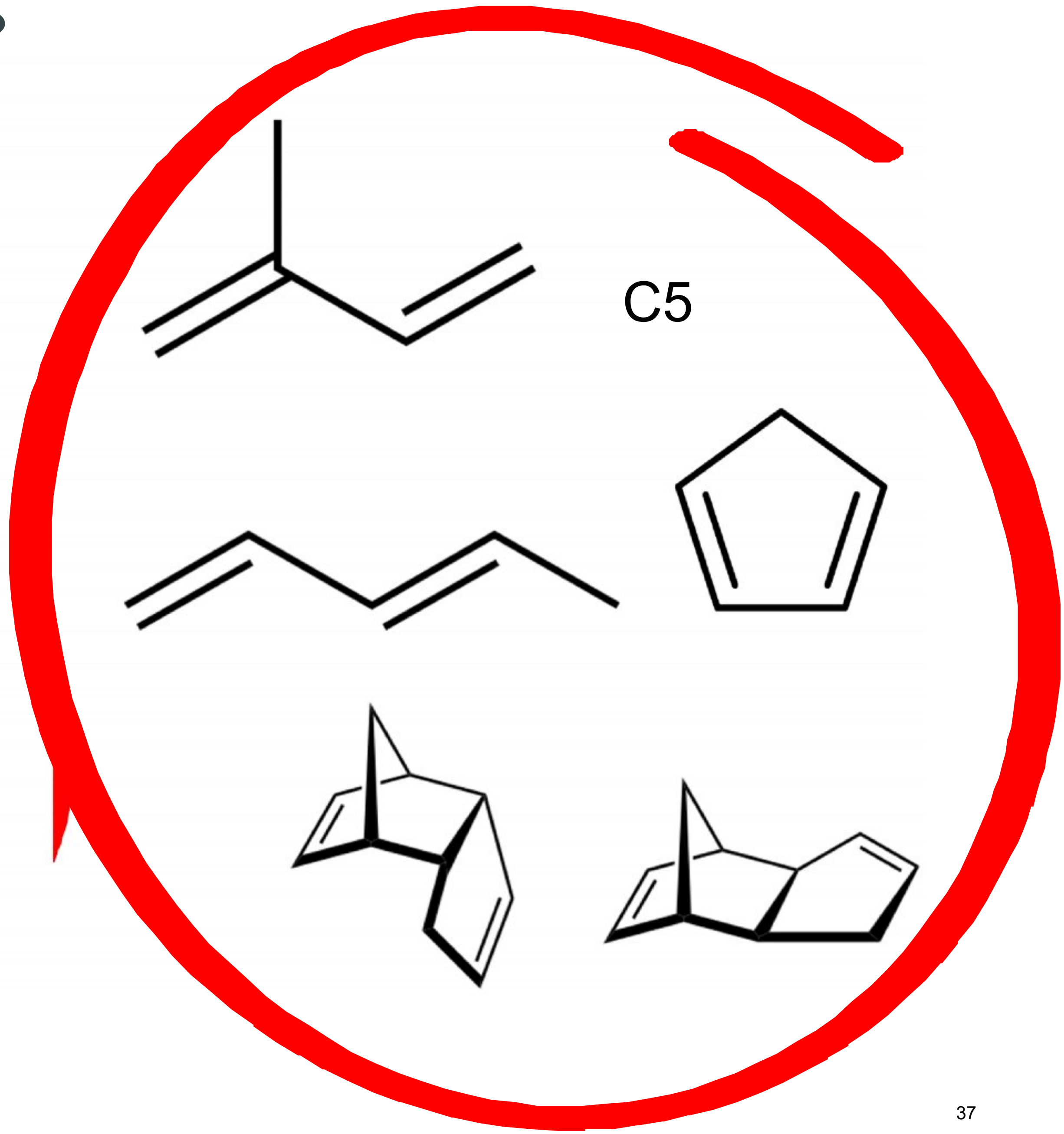
What's Gone Away?



C3

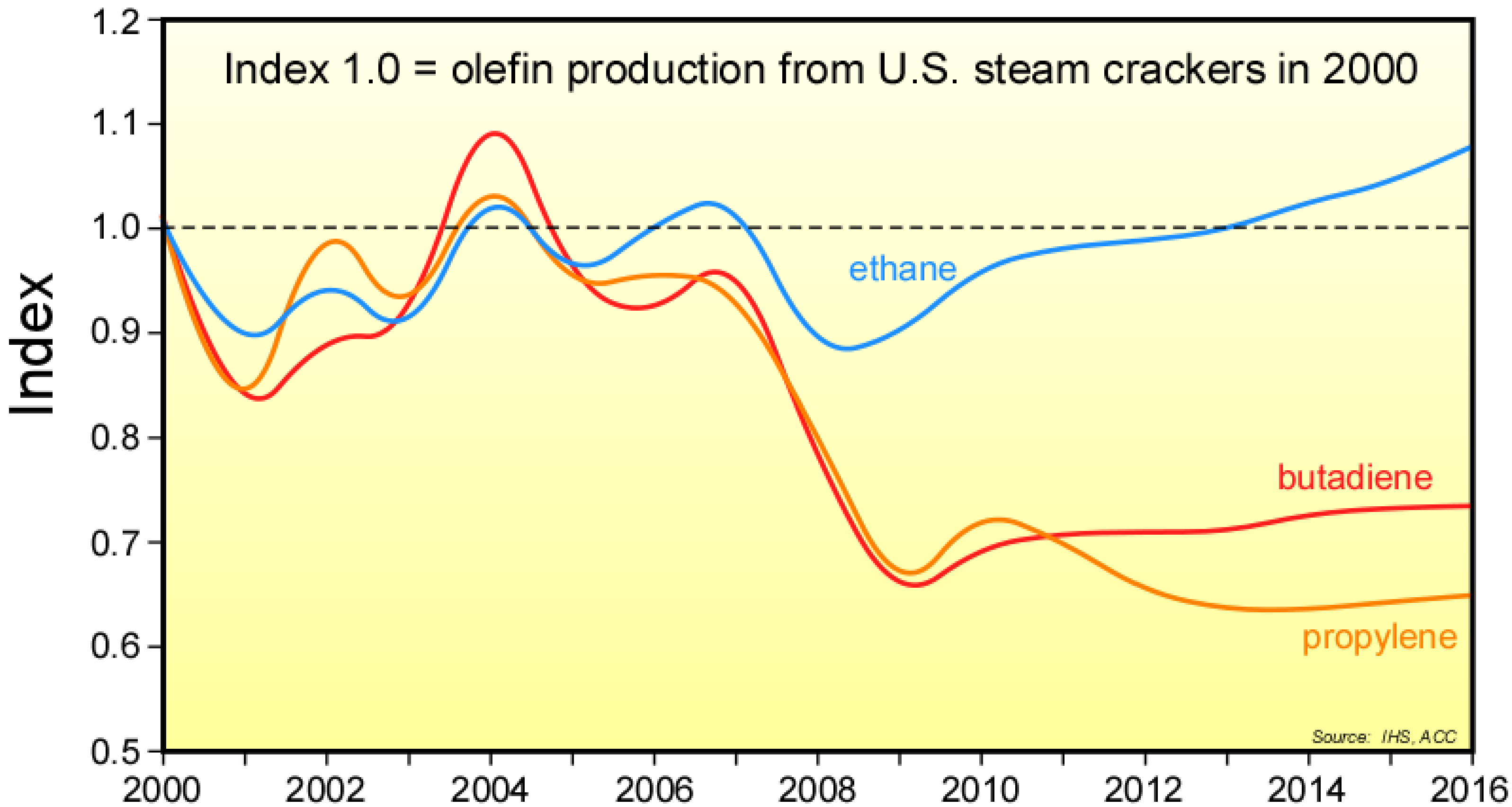


C4

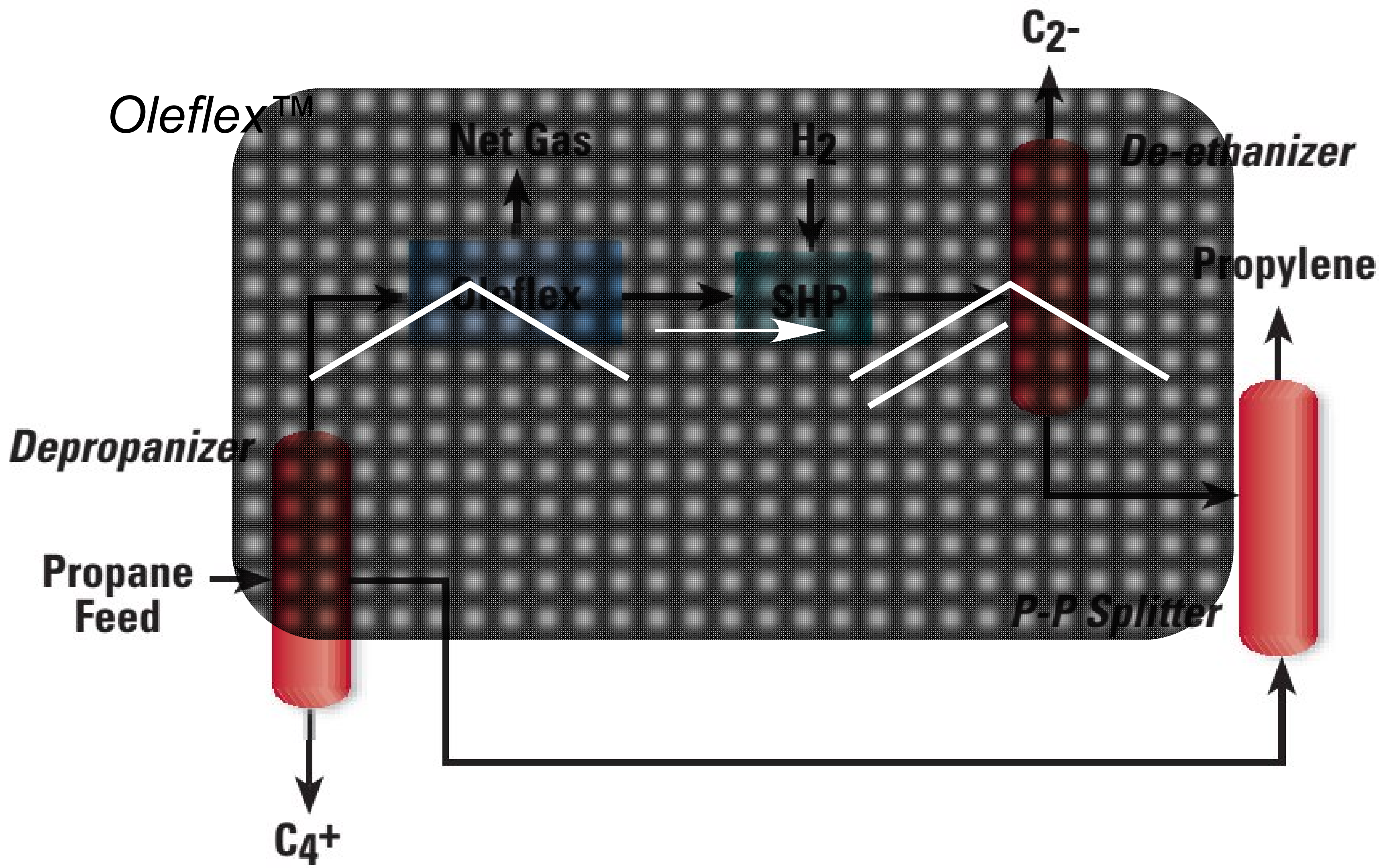


C5

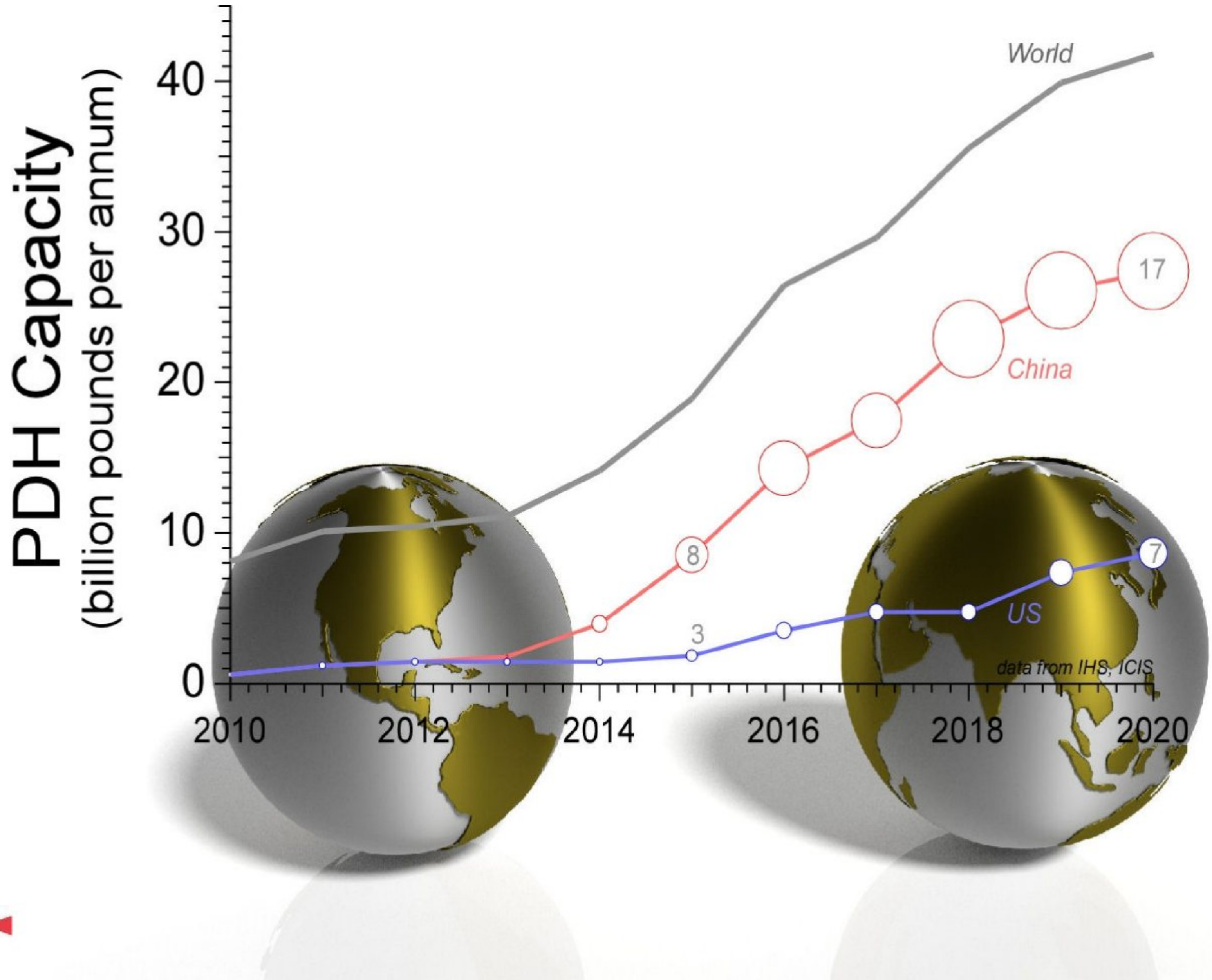
Production of C3/C4 Dropped



On-demand Propylene Production

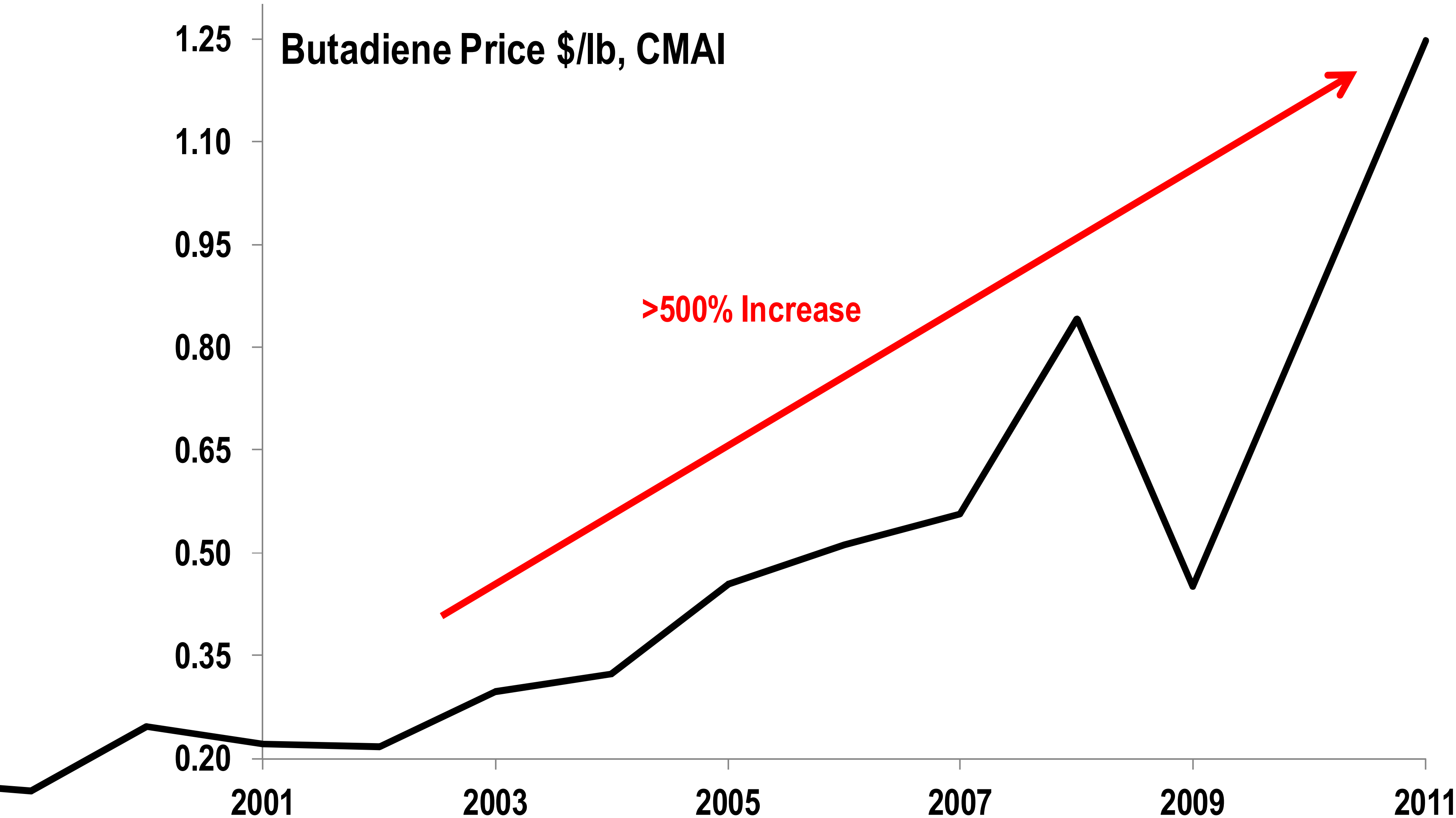


PDH

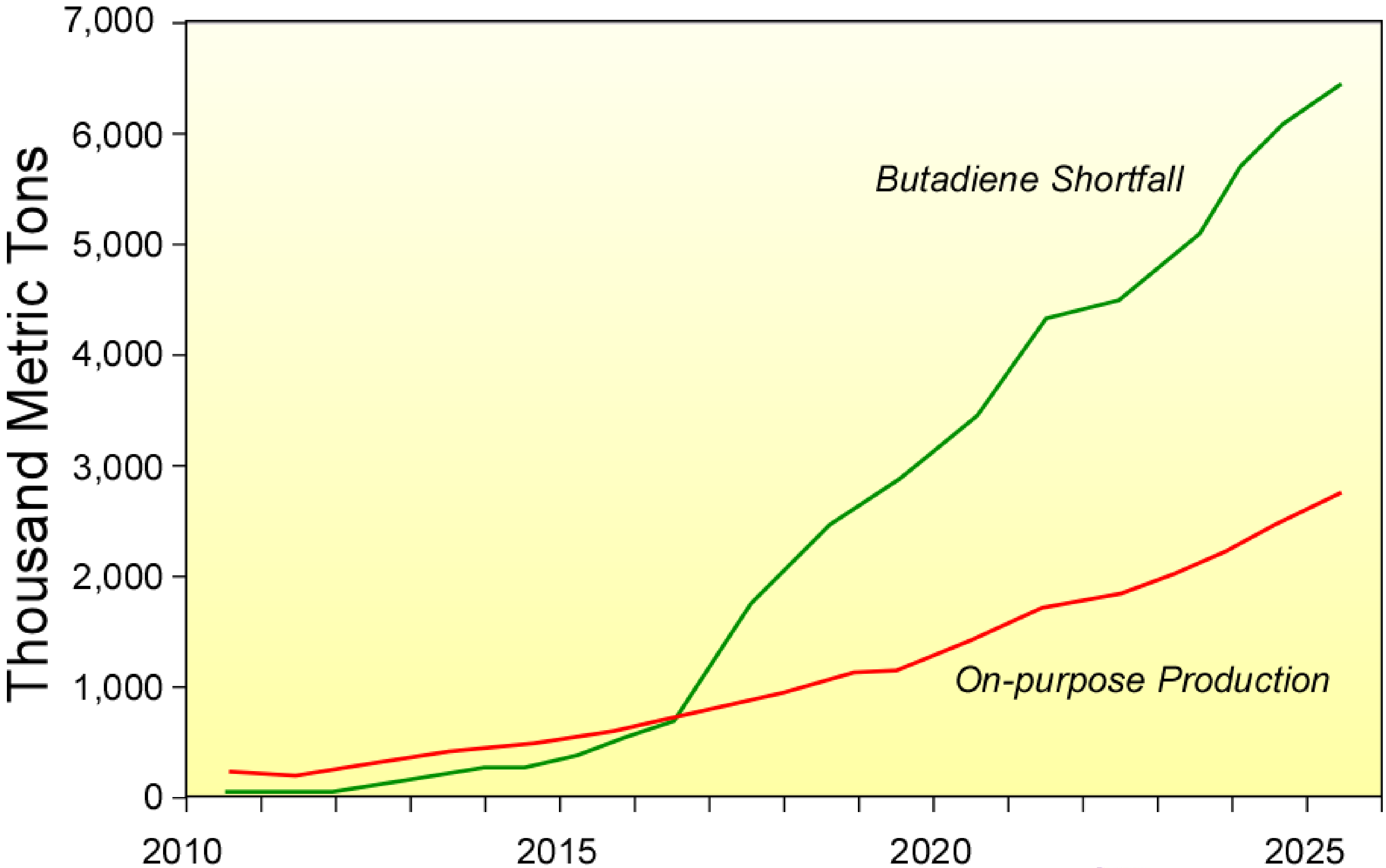


PDH Capacity
(billion pounds per annum)
0
10
20
30
40
2010
2012
2014
2016
2018
2020
World
China
US
17
8
3
7
data from IHS, ICIS

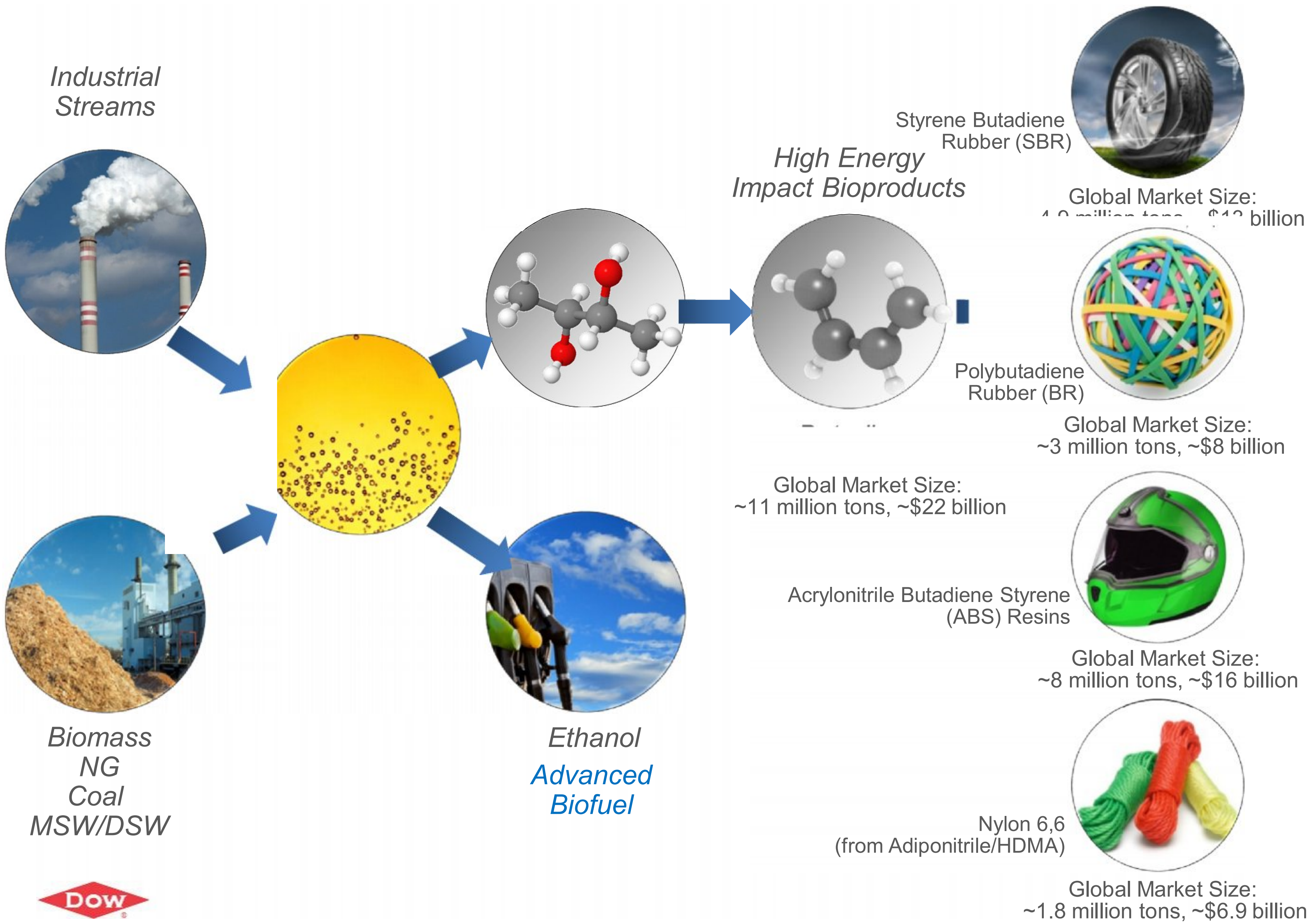
Butadiene Price Inflation



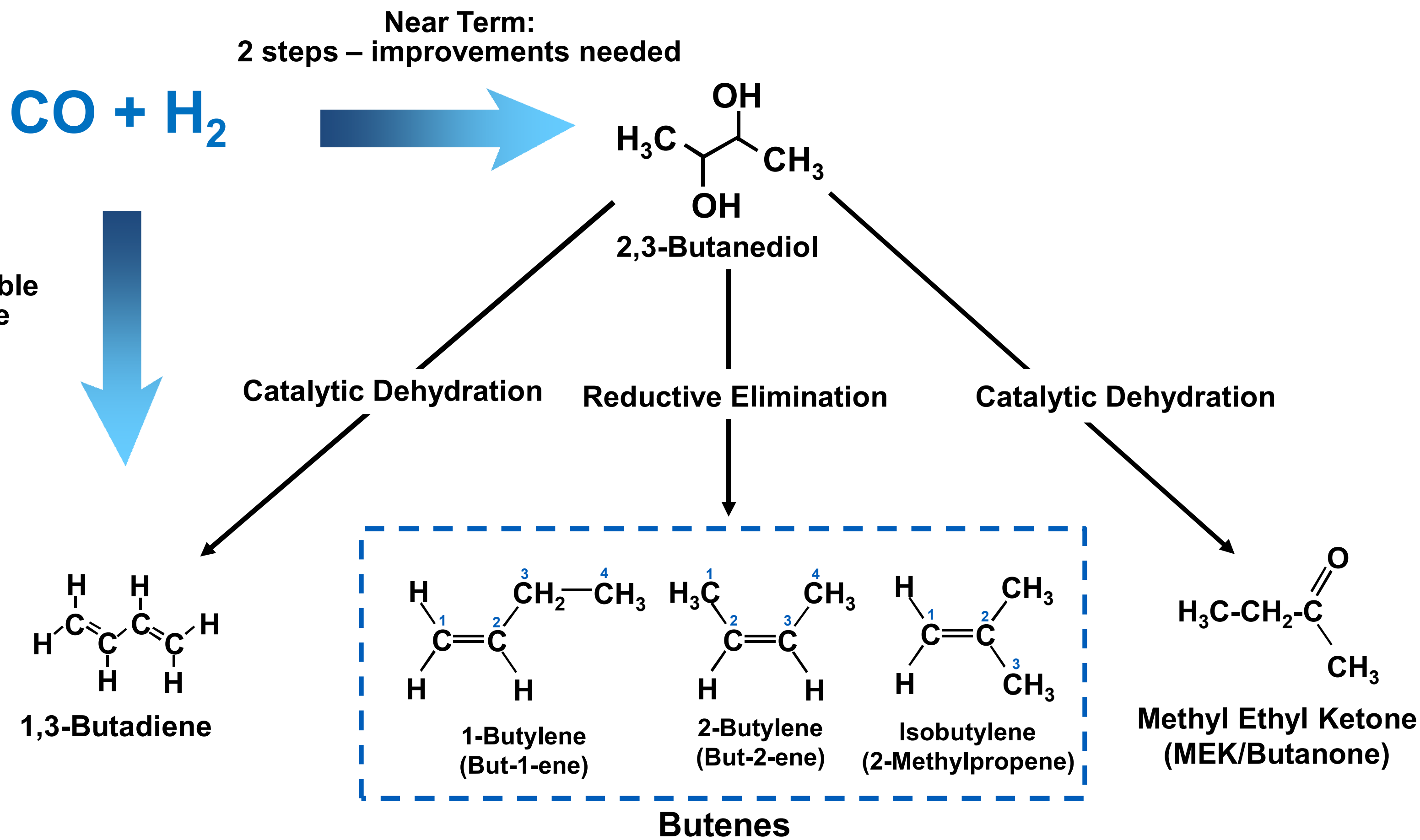
Butadiene Shortfall



Biology to Make C4

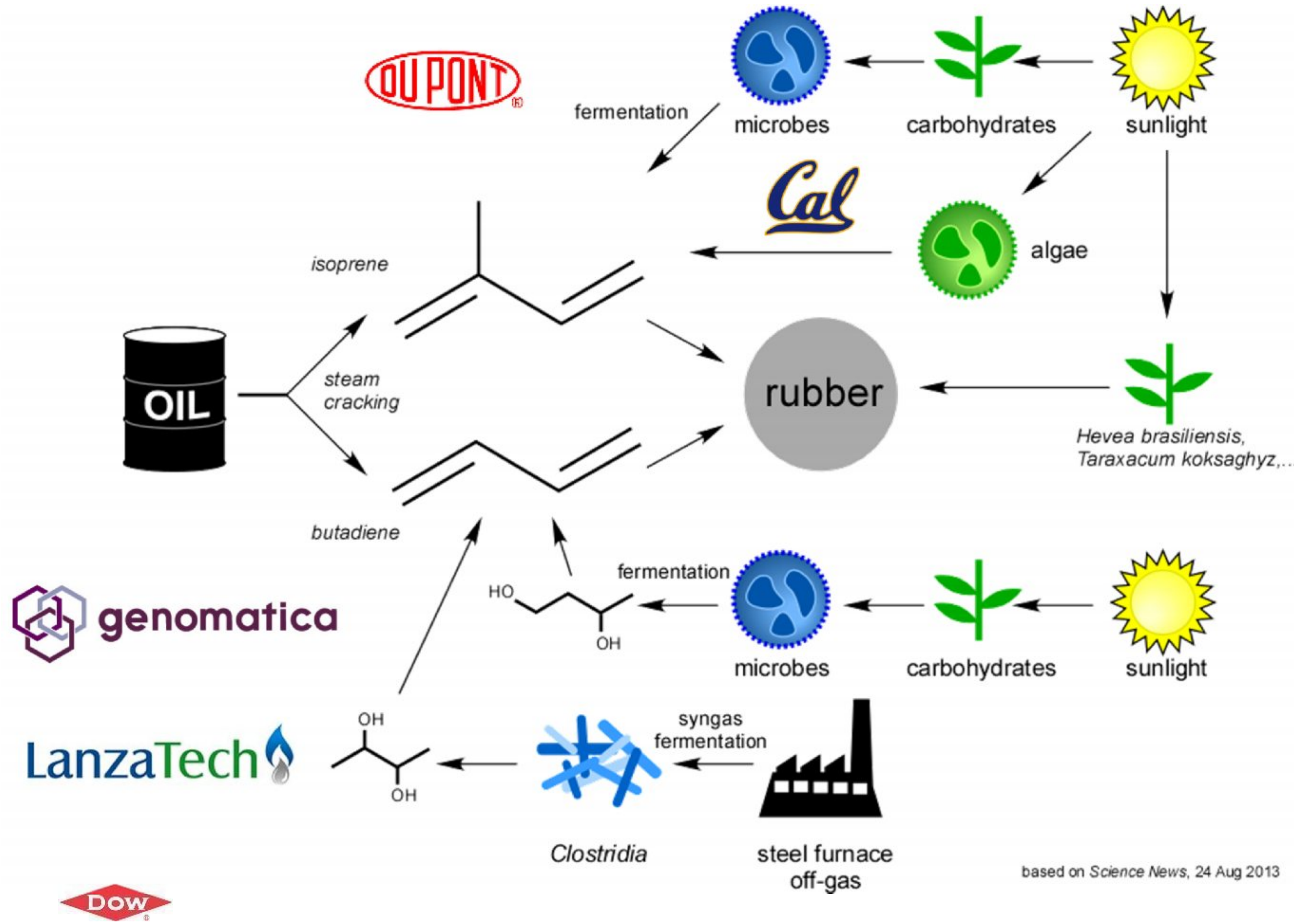


Route to Key C4 Chemicals

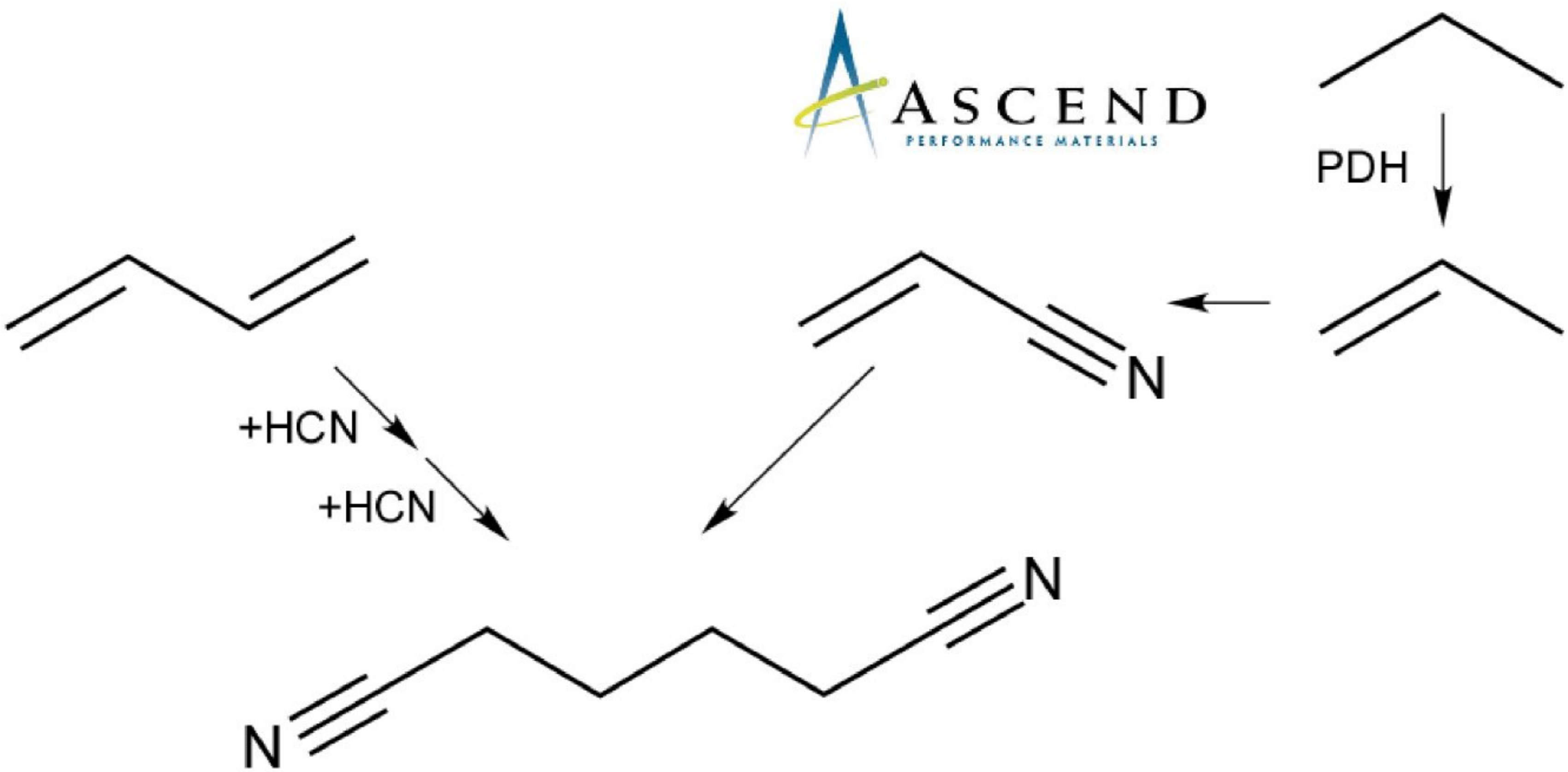


***New Route** to C_4's without current supply challenges*

Rubber Monomers

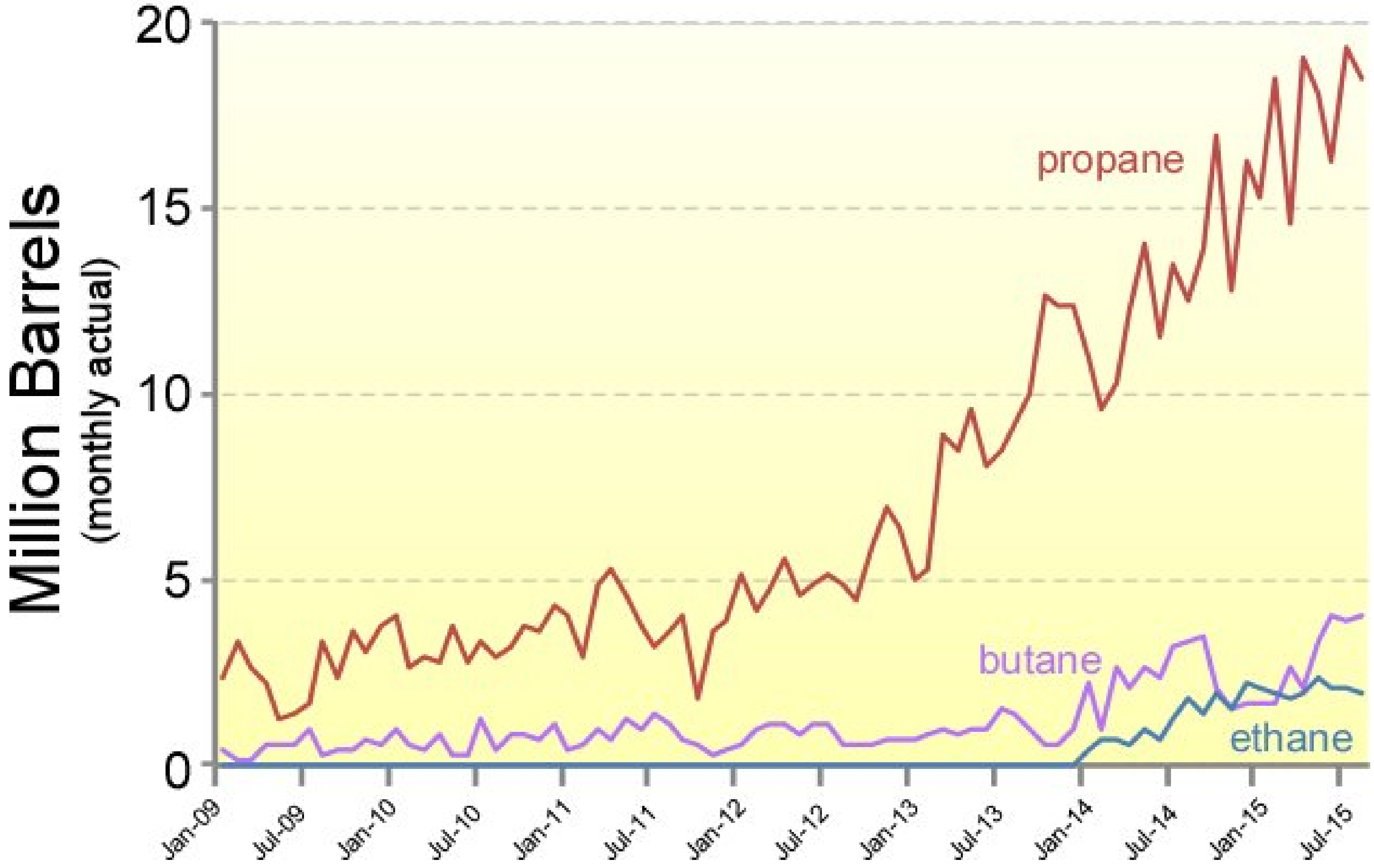


Adiponitrile



Does the name *Intrepid* mean anything to you?

NGL Export

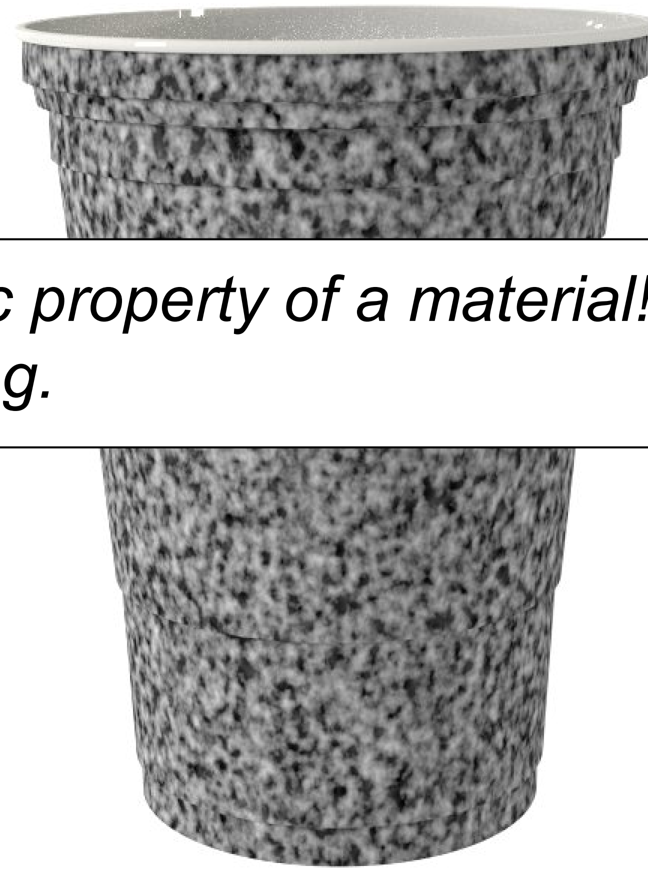

Million Barrels
(monthly actual)
20
15
10
5
0
propane
butane
ethane
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15
Jul-15

Ethane Export


2025 Sustainability Goals
Leading the Blueprint
Delivering Breakthrough Innovations
Advancing a Circular Economy
Valuing Nature
Increasing Confidence in Chemical Technology
Engaging Employees for Impact
World-Leading Operations Performance
DOW

Sustainable?

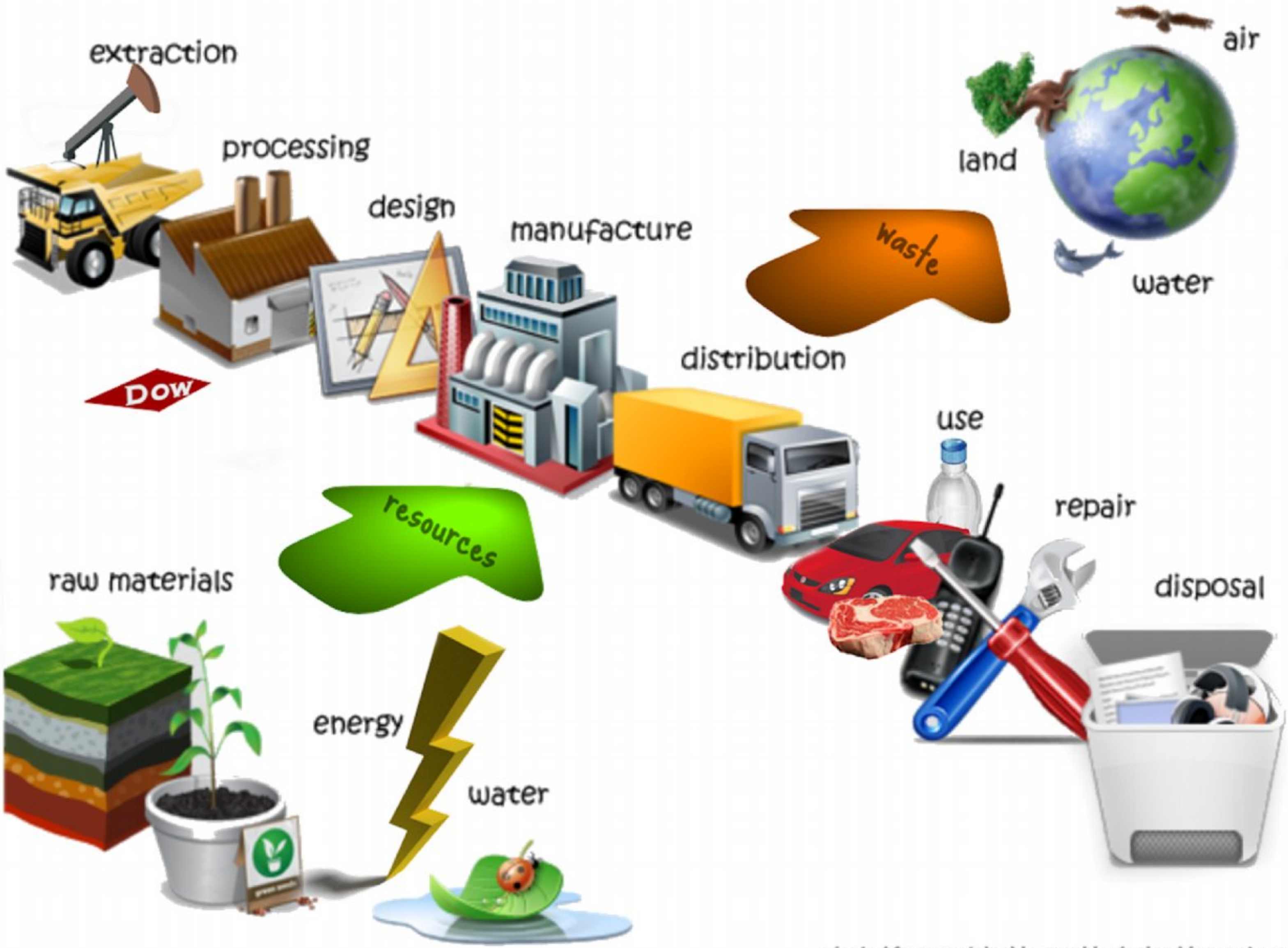
Is this Cup Sustainable?



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

How about this one?

Life Cycle Assessment



adapted from sustainable-graphic-design.blogspot.com

Which is more sustainable?

plastic

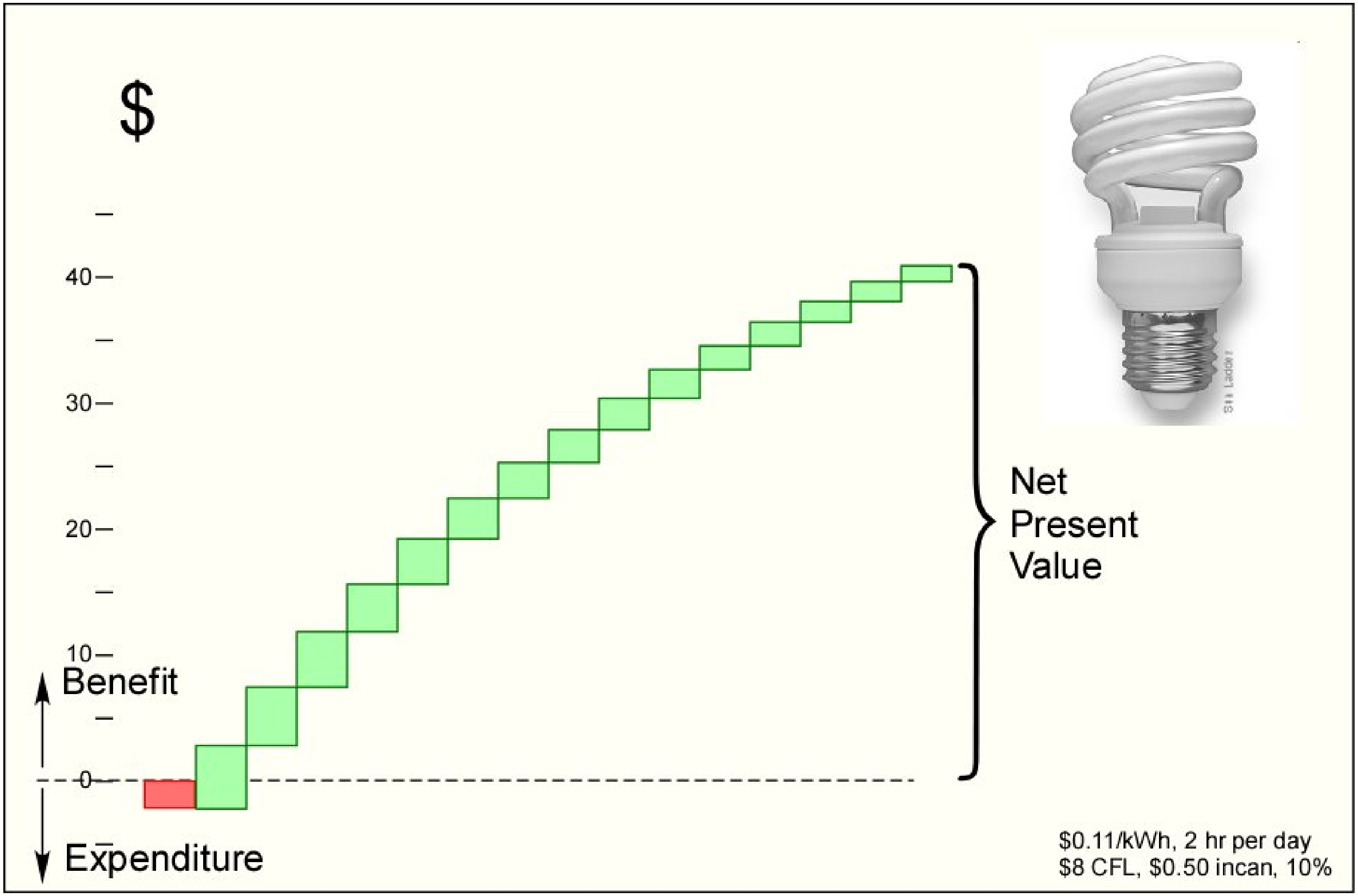
paper

Which is more sustainable?

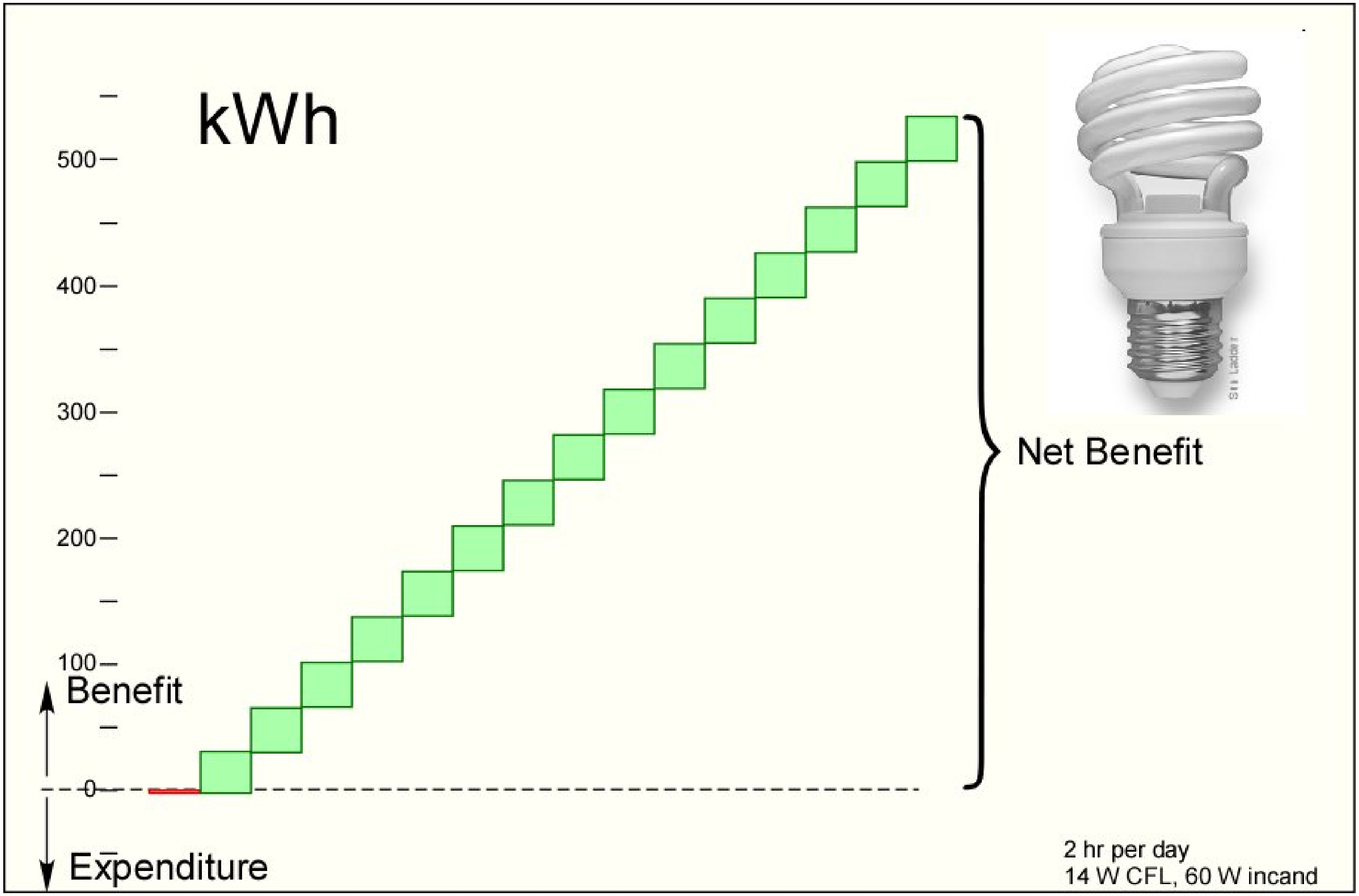
A vegan in a Hummer

Embodied Fossil Energy

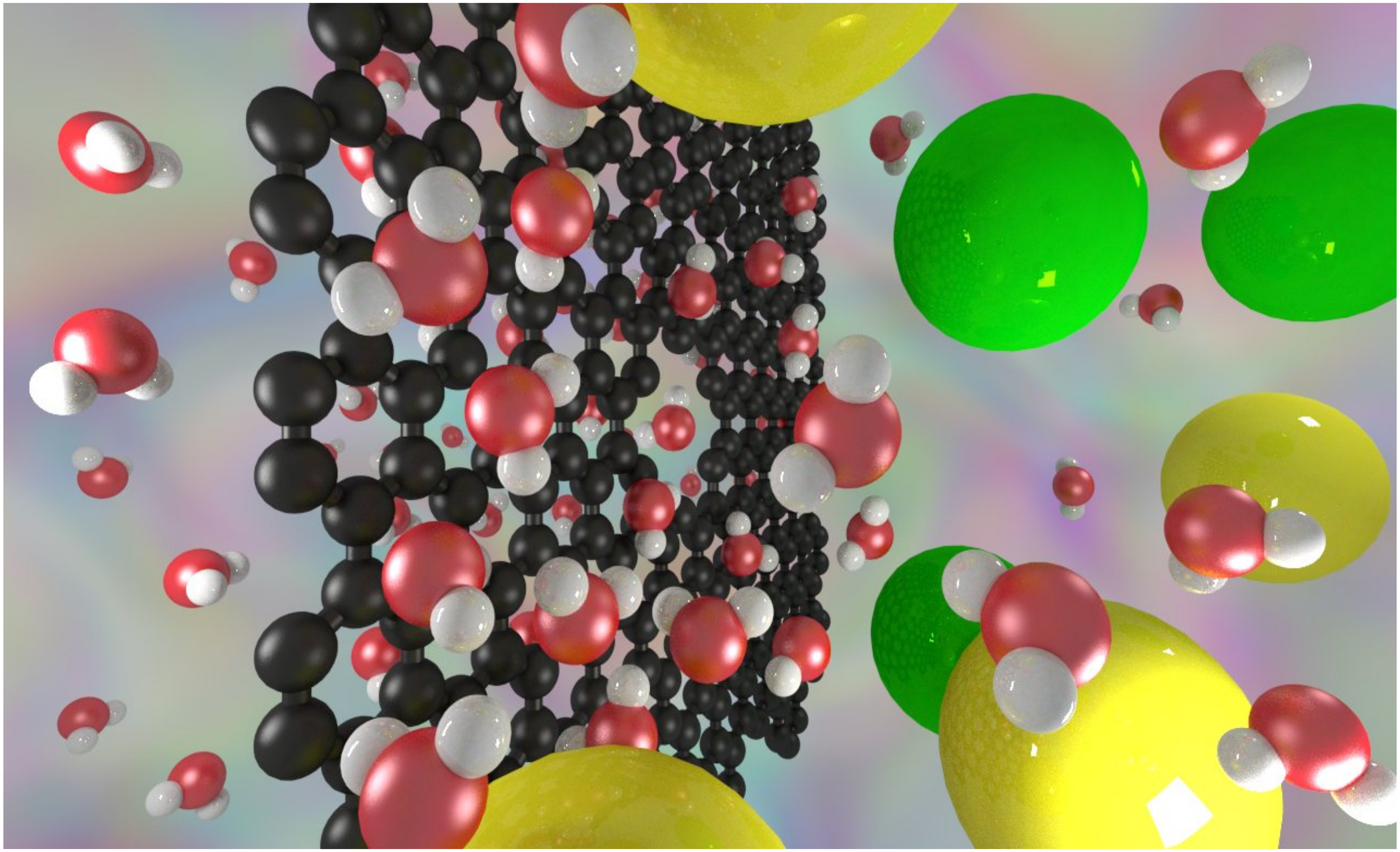
Financial Way of Looking At Benefit



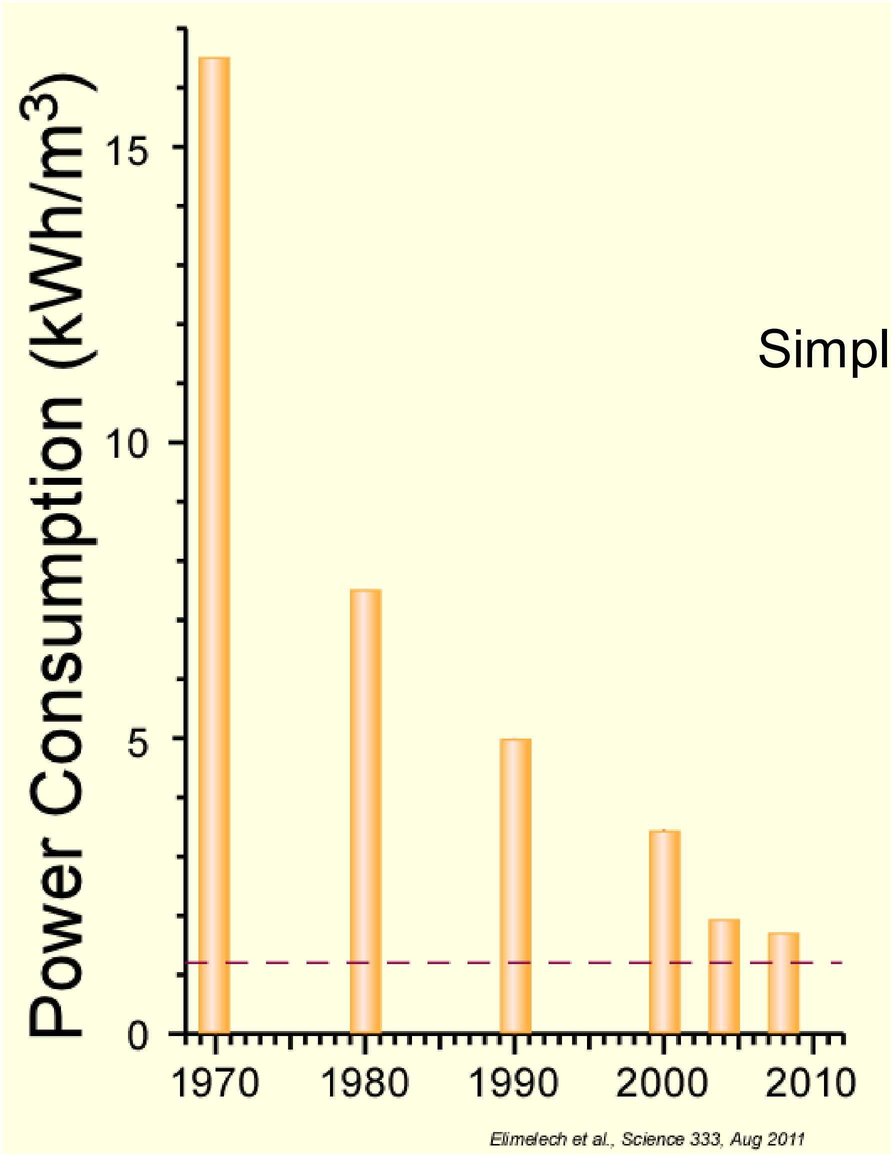
Why Not Sustainability?



Misconceptions Demean Advances

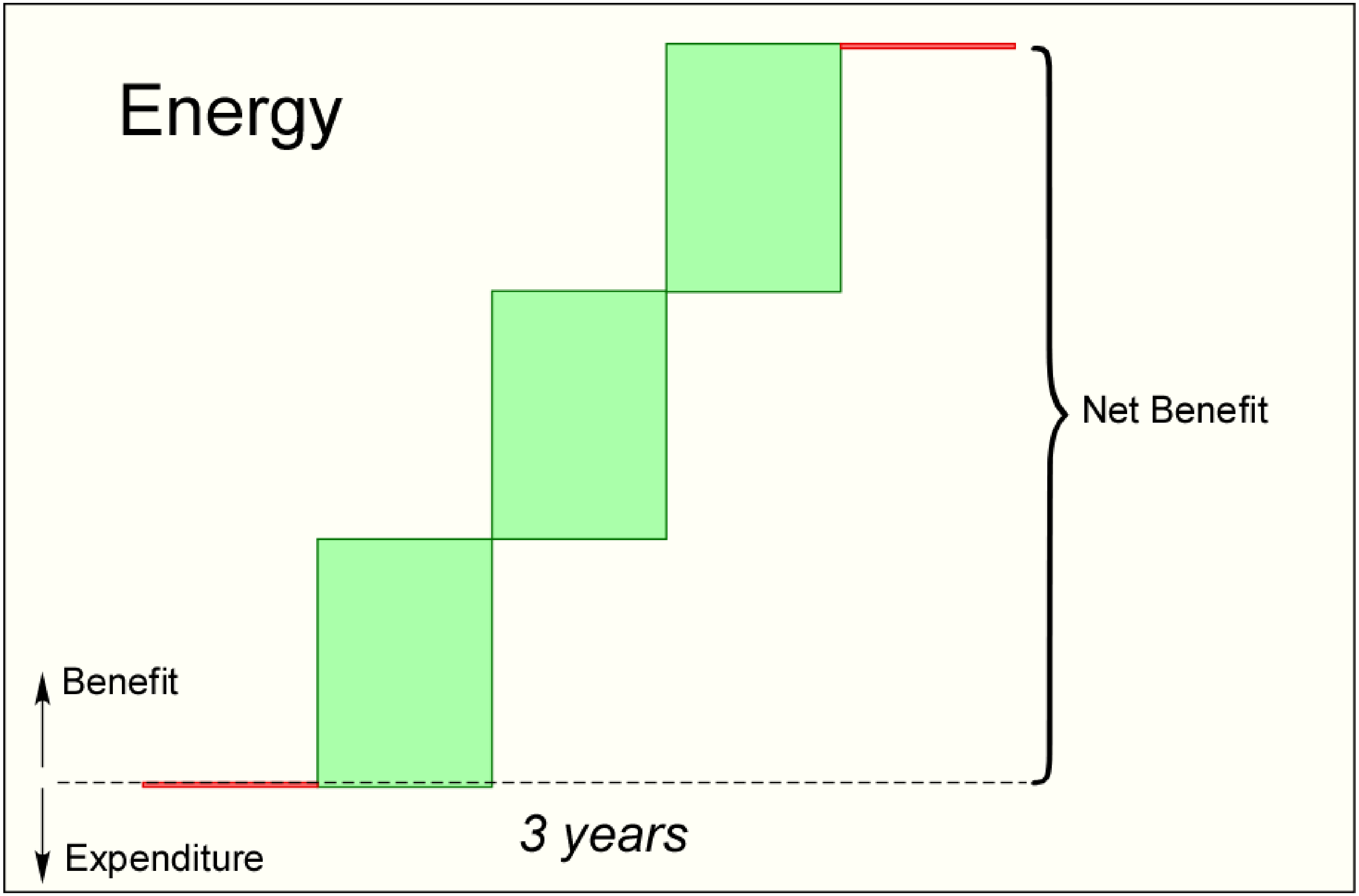


Fresh Water Production



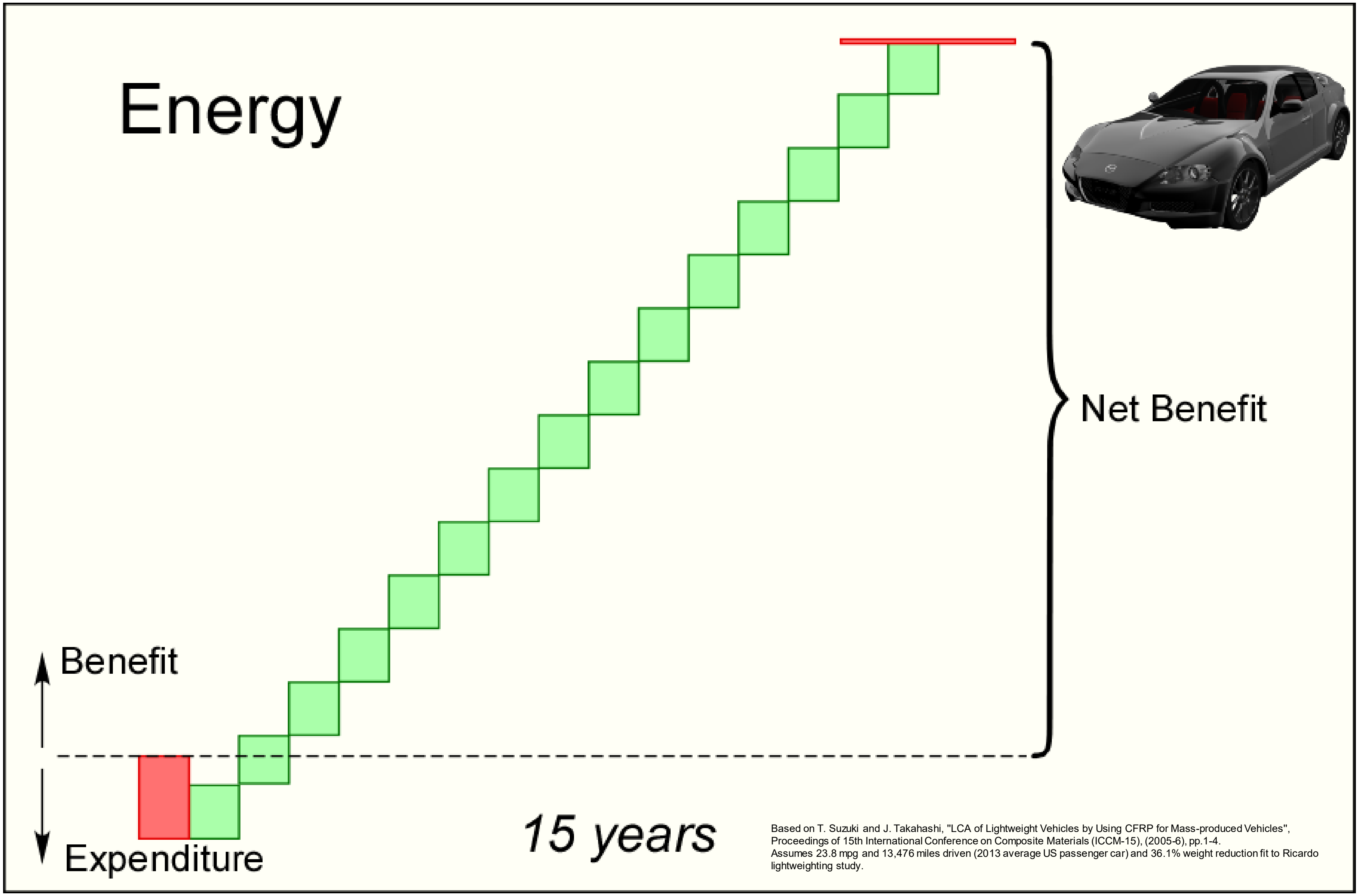
Simple Distillation ~600 kWh/m^3

RO Cartridge Benefit

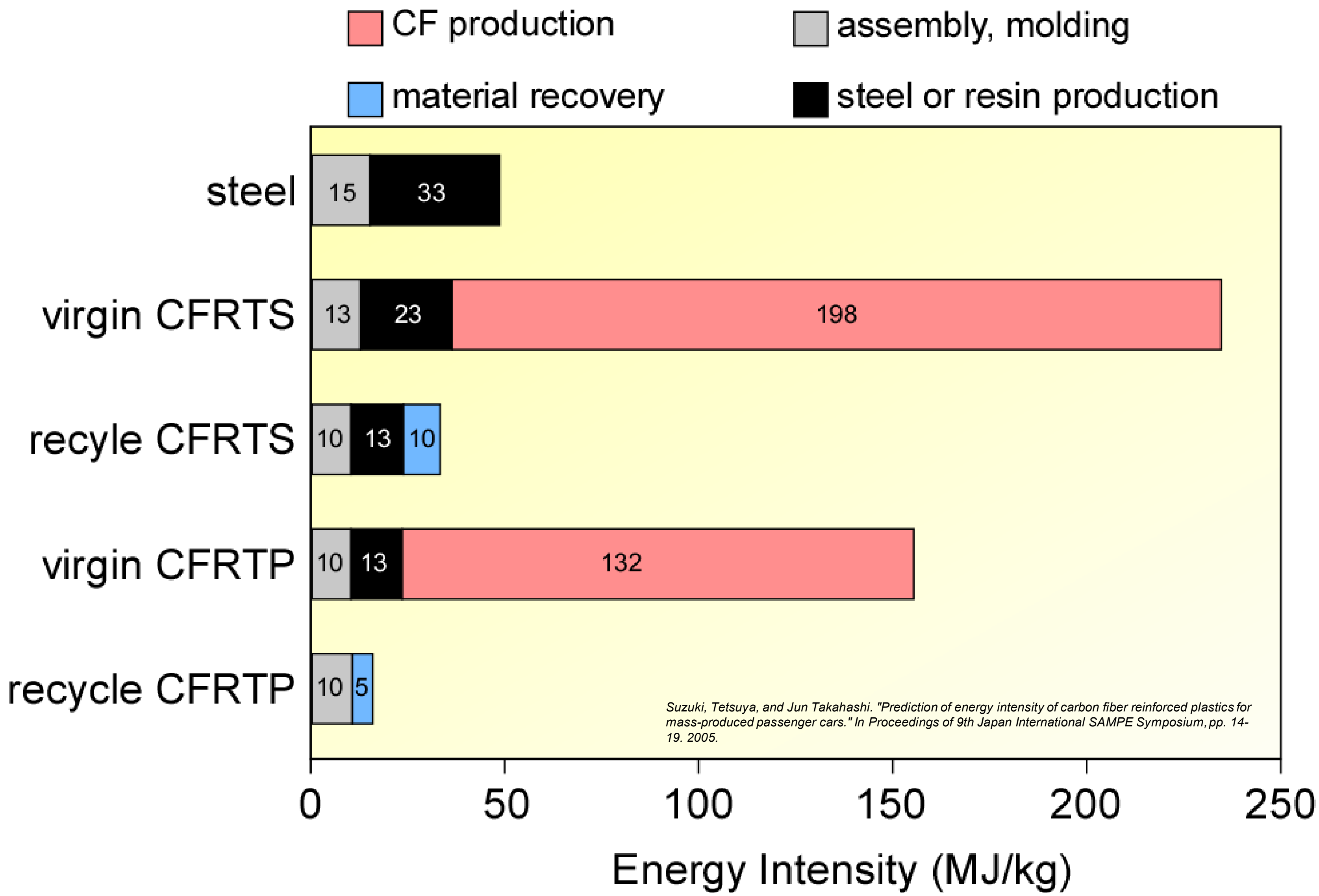


54.5 mpg

Carbon Fiber Benefit



Importance of Recycle

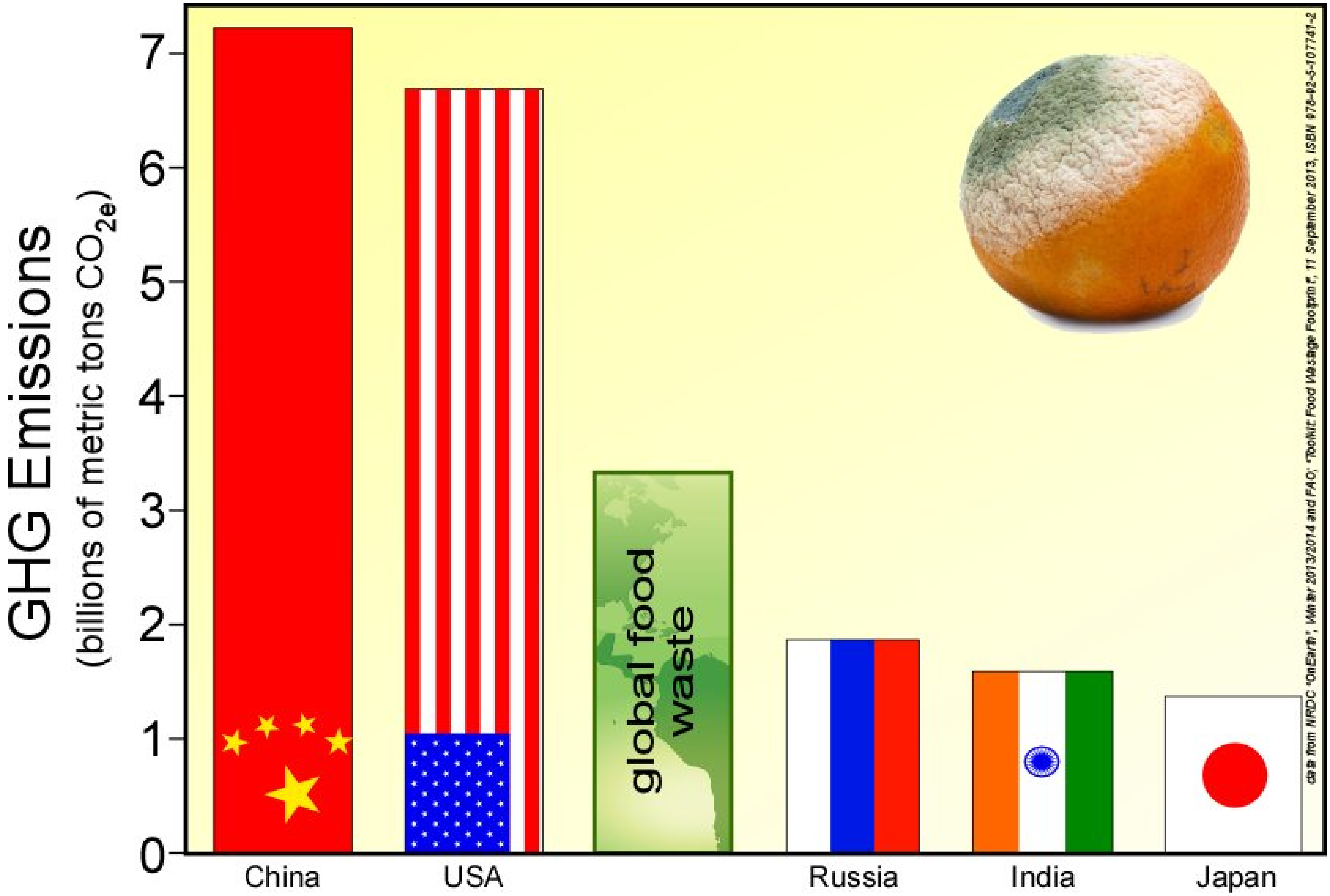


Suzuki, Tetsuya, and Jun Takahashi. "Prediction of energy intensity of carbon fiber reinforced plastics for mass-produced passenger cars." In Proceedings of 9th Japan International SAMPE Symposium, pp. 14-19. 2005.

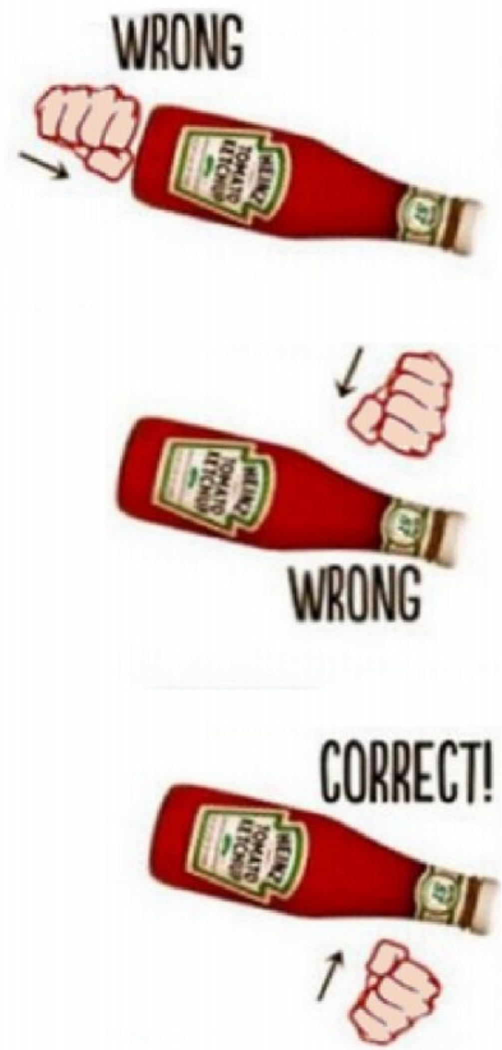
Packaging Addresses Global Challenges

30-40% food grown is wasted.
Much of it to spoilage.

Food Waste


GHG Emissions
(billions of metric tons CO_{2e})
0
1
2
3
4
5
6
7
global food waste
China
USA
Russia
India
Japan
data from NRDC "OnEarth", Winter 2013/2014 and FAO; "Toolkit: Food Wastage Footprint", 11 September 2013, ISBN 978-92-5-107741-2

Frustration with Packaging




✓ Same Heinz
✓ Great Low Price
HEINZ
ESTD 1869 ESTD
TOMATO
KETCHUP
57 VARIETIES
GROWN NOT MADE
NET WT 10 OZ (283g)

Flexible Packaging Is More Sustainable Packaging

Re-Closable Cap
- Precision pouring
- Maximum filling content utilization

Flexible Design
- Four Print Surfaces
- Superior drop resistance
- Reduce excess head space
- Improved dispensing
- Collapses easily

Top and Bottom Handles
- Easy handling

Cubic Shape
- Shelf Stable & Maximizes Shipping Efficiency

Space Saving
- Ships and Stores Flat when Unfilled

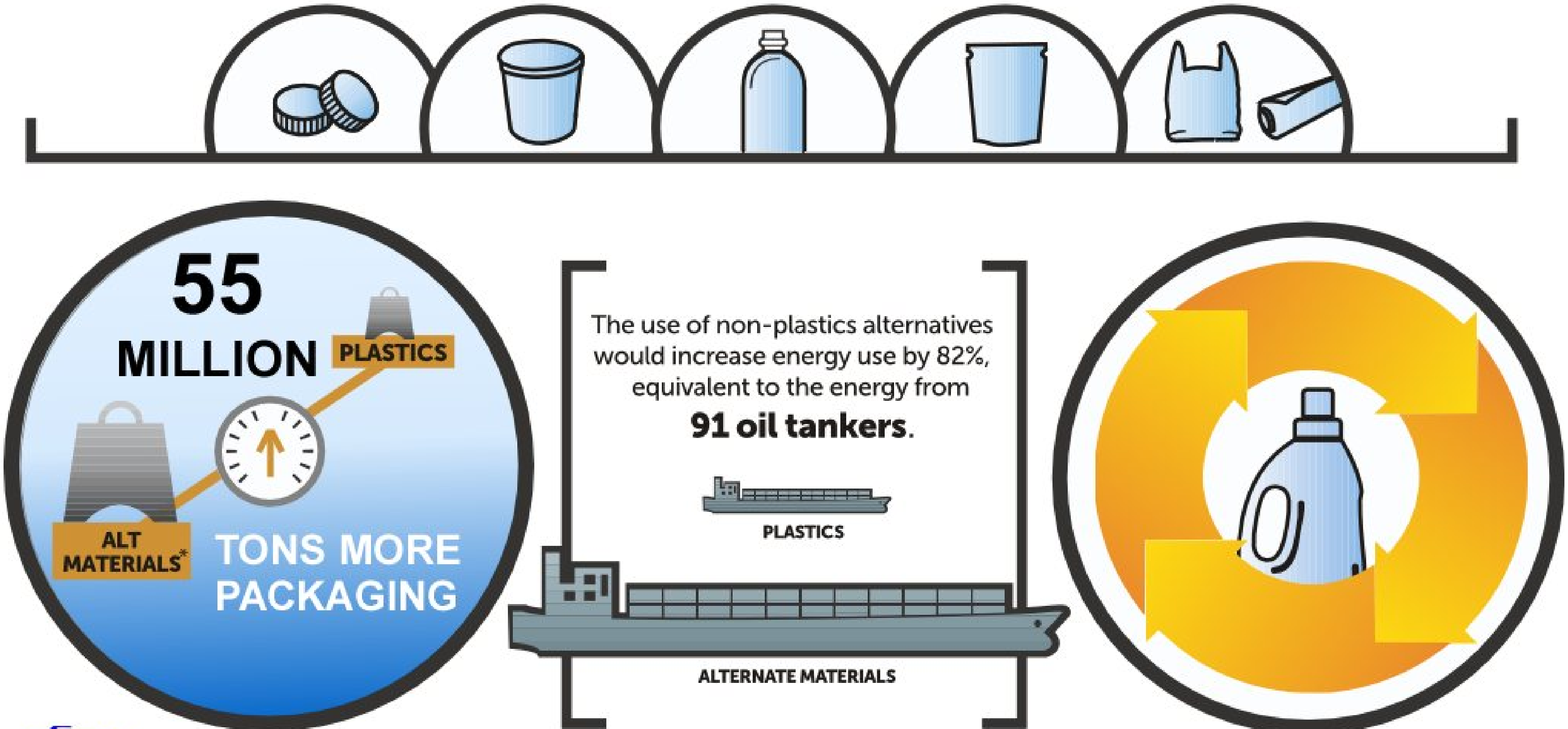
Flexible packaging helps increase shelf life

Using only a few grams of flexible plastic packaging extends the shelf life of a cucumber by **more than three times.**

FLEXIBLE PLASTIC PACKAGING
HELPS IN-STORE WASTE
REDUCE
3 percent to under 1 percent
BY INCREASING
SHELF LIFE

Source: Incpen

LCA Studies on Packaging



American Chemistry Council

Most plastics can be recycled

Stand-up pouch packaging reduces waste and brings energy savings

Package Type	Contents	Impact per 100 oz Cereal		
		Landfill Discards* (g)	Process GHG** (kg CO^2 Eq)	Total Energy** (MJ)
Paperboard and HDPE Liner	11 oz	380.0	.861	12.1
Stand-Up Pouch	12 oz	117.5	.265	9.25

Reduction vs Box	
Landfill Discards	**68%**
GHG	**69%**
Energy	**23%**

Flexible Packaging Examples

greenerpackage.com

nestle-shop.ch

Waste Reduction Hierarchy

Explore New End of Life Options

Per Capita Energy Use