

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



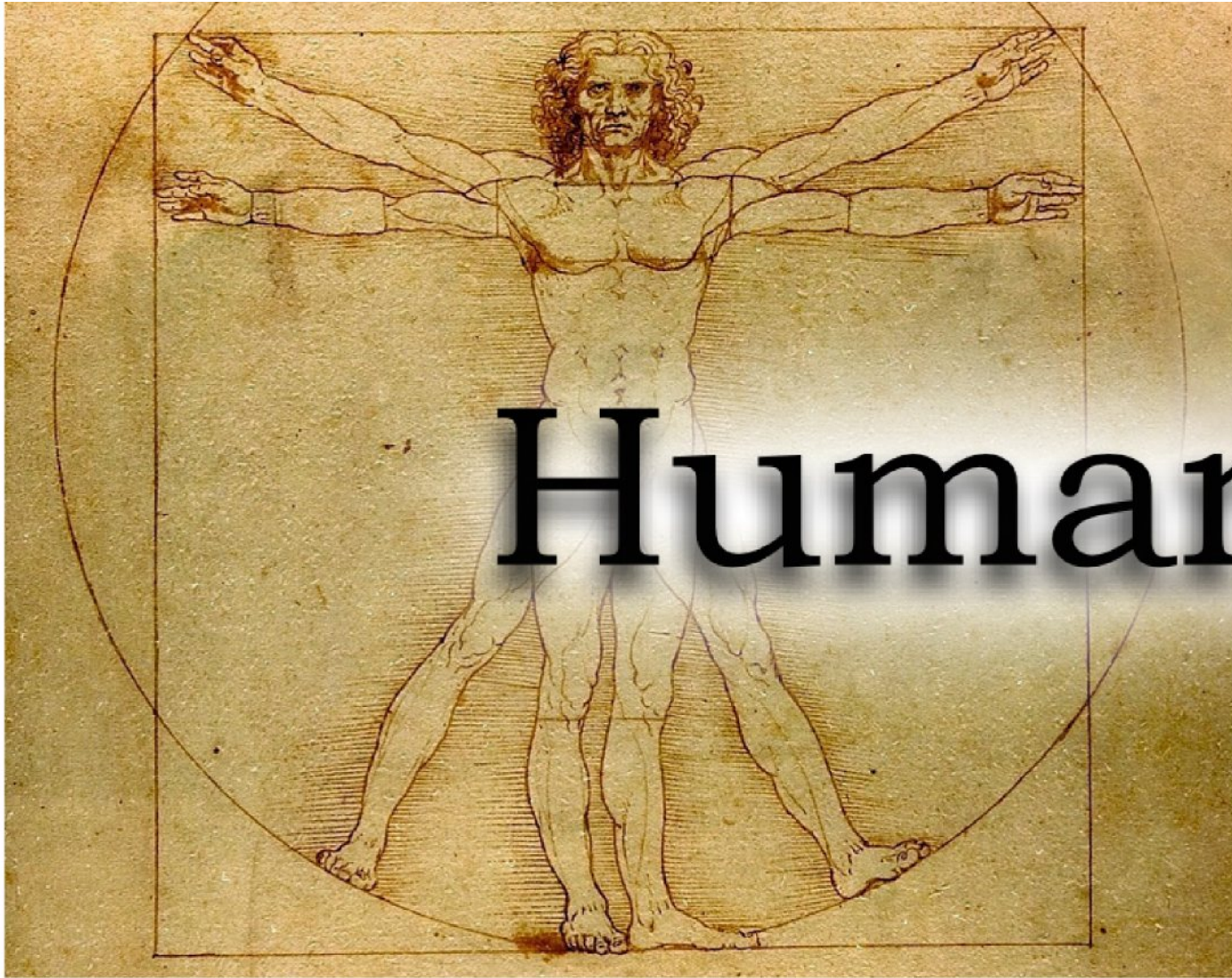
Mark Jones

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The Dow Chemical Company

25 July 2016



Karle
K¹⁹ 20
16 S¹⁶
Symposium



Human?

Collaboration encourages equal sharing in children but not in chimpanzees

Katharina Hamann¹, Felix Warneken², Julia R. Greenberg³ & Michael Tomasello¹

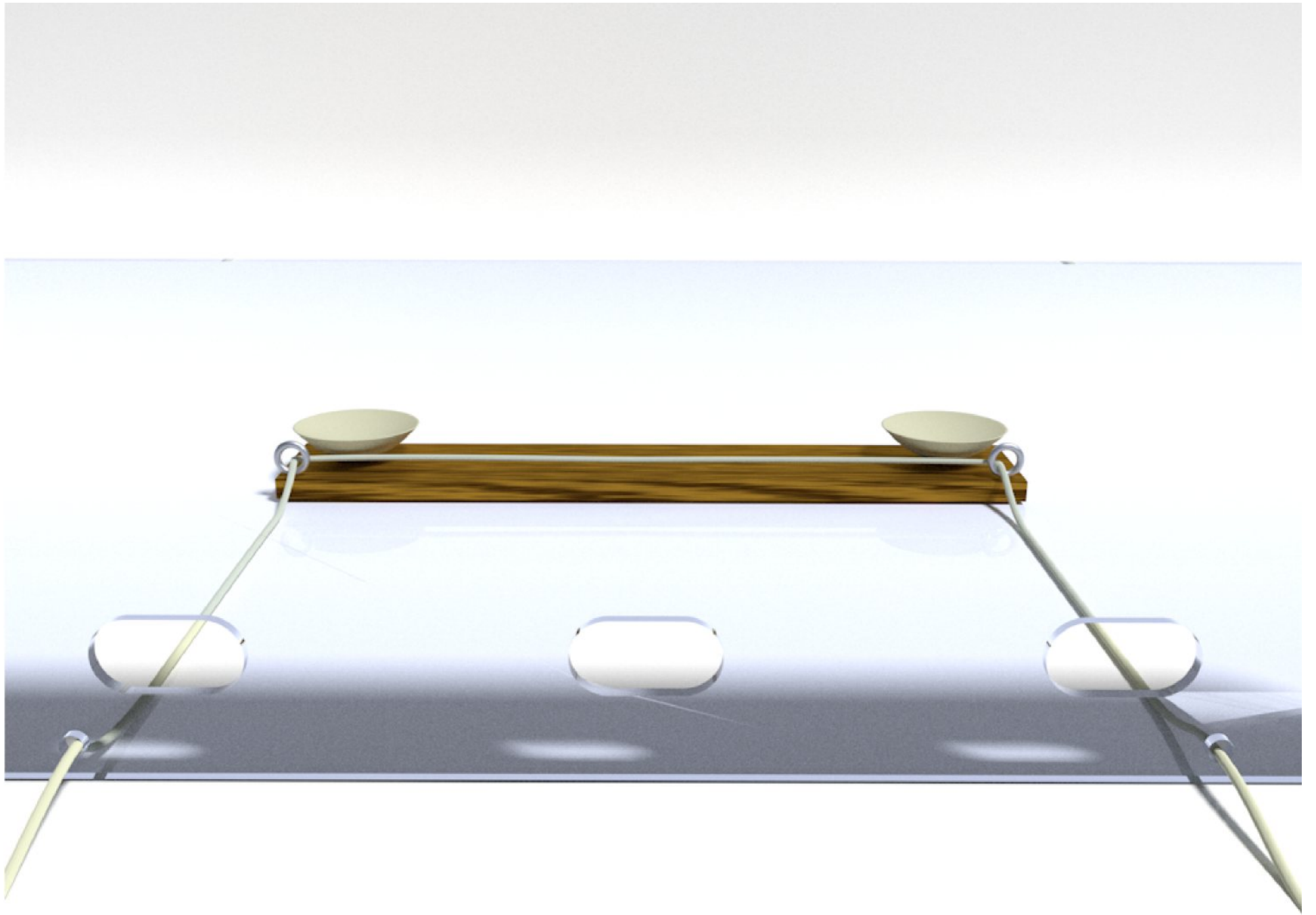
Humans actively share resources with one another to a much greater degree than do other great apes, and much human sharing is governed by social norms of fairness and equity^{1,2}. When in receipt of a windfall of resources, human children begin showing tendencies towards equitable distribution with others at five to seven years of age^{3,4}. Arguably, however, the primordial situation for human sharing of resources is that which follows cooperative activities such as collaborative foraging, when several individuals must share the spoils of their joint efforts^{5–8}. Here we show that children of around three years of age share with others much more equitably in collaborative activities than they do in either windfall or parallel-work situations. By contrast, one of humans' two nearest primate relatives, chimpanzees (*Pan troglodytes*), 'share' (make food available to another individual) just as often whether they have collaborated with them or not. This species difference raises the possibility that humans' tendency to distribute resources equitably may have its evolutionary roots in the sharing of spoils after collaborative efforts.

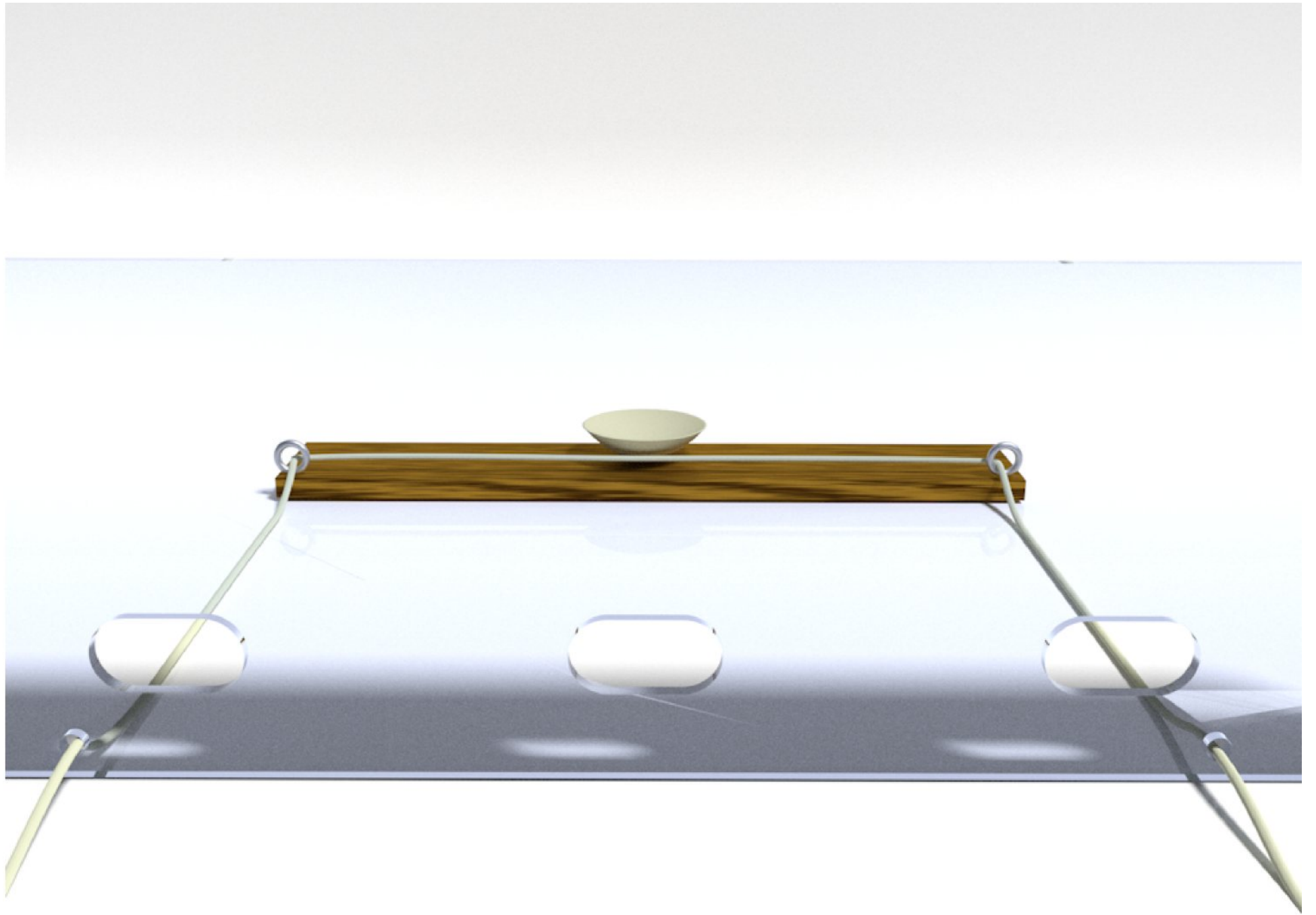
Among great apes, only humans are true collaborative foragers^{9,10}. Other apes forage in small parties, but they do not actively work together jointly to produce food—the only exception being chimpanzee group-hunting of monkeys^{11,12}. In contrast, humans in all societies produce significant portions of their food through collaborative efforts, even bringing the results of their labour back to some central location to share with other group members¹³. After group-hunting, chimpanzees mostly share only under pressure of harassment by others¹⁴ or else reciprocally with coalition partners¹⁵.

Human children actively share valuable resources with others to some degree from early in ontogeny. A fairly well-established pattern across cultures is that three- to four-year-old children tend to divide a windfall of resources unequally, keeping the majority for themselves^{16,17}. As the amount of shared resources decreases, the majority of children

they had to pull together to bring the board towards them. On each end of the board were two rewards (small toys) that could be accessed once the board had been pulled close enough. As the children pulled, one of the toys rolled to the other end of the board such that one child ended up with three toys and the other ended up with only one. In the control, 'no-work', condition, by contrast, as children entered the room the board with the toys was already at its end-state position, with three toys at one end and one at the other (Fig. 1b). The main result was that the 'lucky' child, who had gained three toys, made one of the toys available to the 'unlucky' partner, who had gained one, restoring equity, more often in the collaboration condition than in the no-work condition ($F(1, 22) = 21.85$ (analysis of variance), $P < 0.001$). The effect was similar for children of both ages (Fig. 2a).

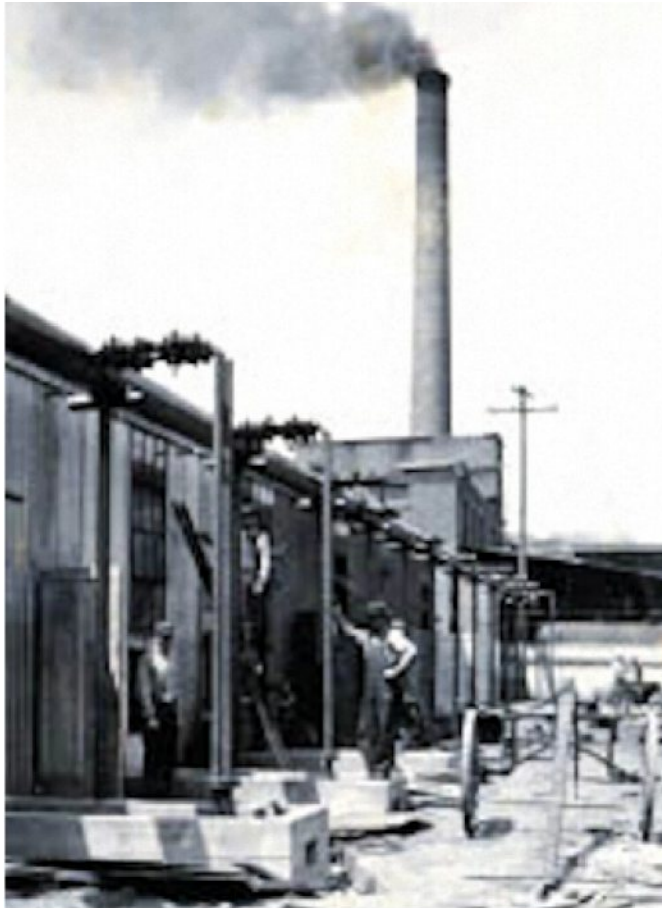
In this experiment, it was possible that from the beginning of the collaboration children viewed the rewards on their end of the board as belonging to them, such that when one reward rolled to the other end it was as if one of their possessions had been taken away (which was not the case in the no-work condition). In study 2, therefore, we presented pairs of two- or three-year-old children initially with four toys bunched together, so that an initial sense of possession was not an issue. In addition, we added a second control condition—the parallel-work condition—with a very similar set-up, in which each child pulled on a separate board with their own separate rope, to account for the fact that the collaboration condition required work whereas the original control condition (no-work) did not (Fig. 1c–e). Thus, if children are attentive to work effort in general and not to collaborative effort in particular, they should share similarly in the parallel work and collaboration conditions. However, in this study also, the three-year-old lucky child handed over one of the toys to the unlucky partner more often in the collaboration condition than in either of the two control conditions (no-work and parallel work). By contrast, the two-year-



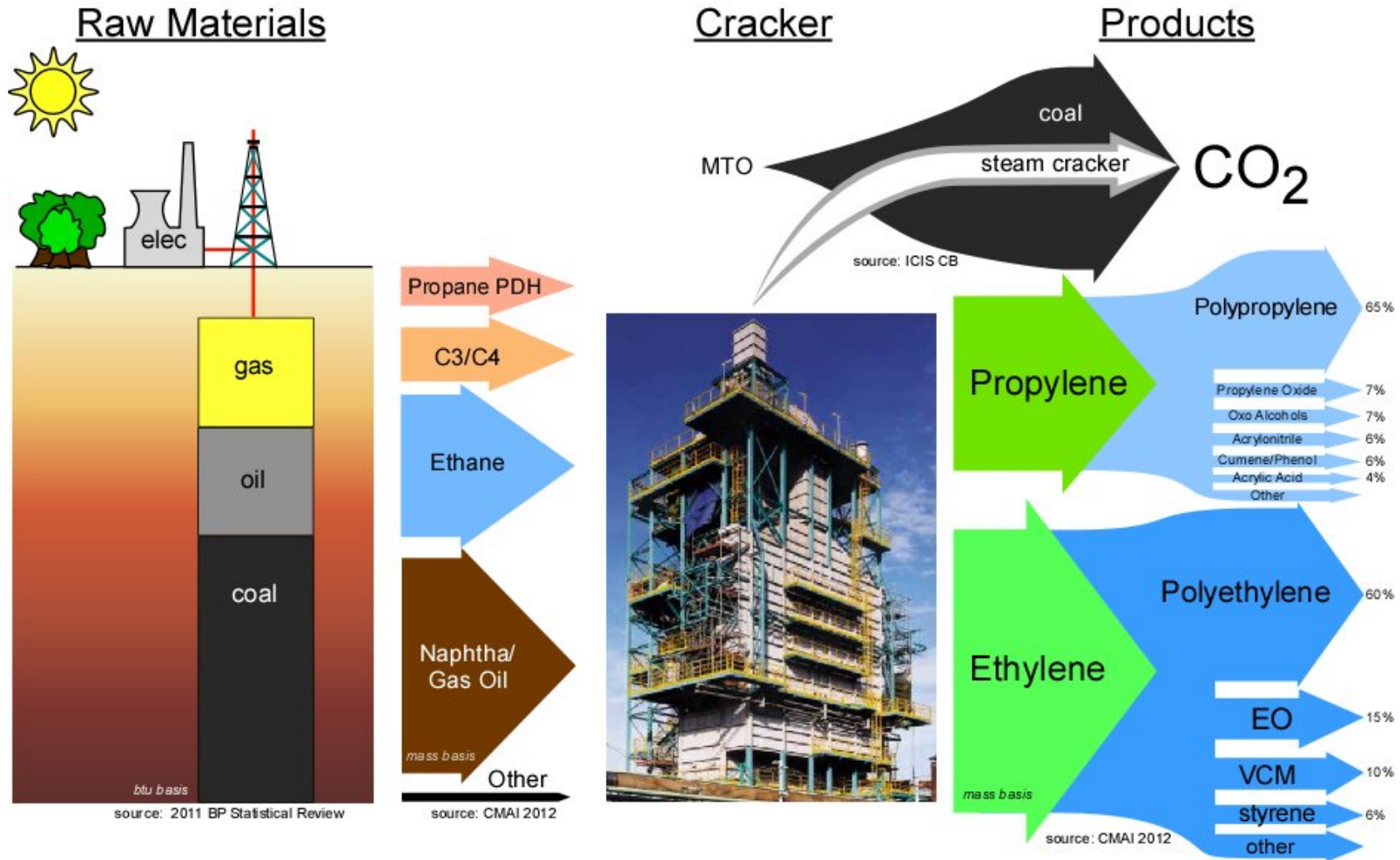




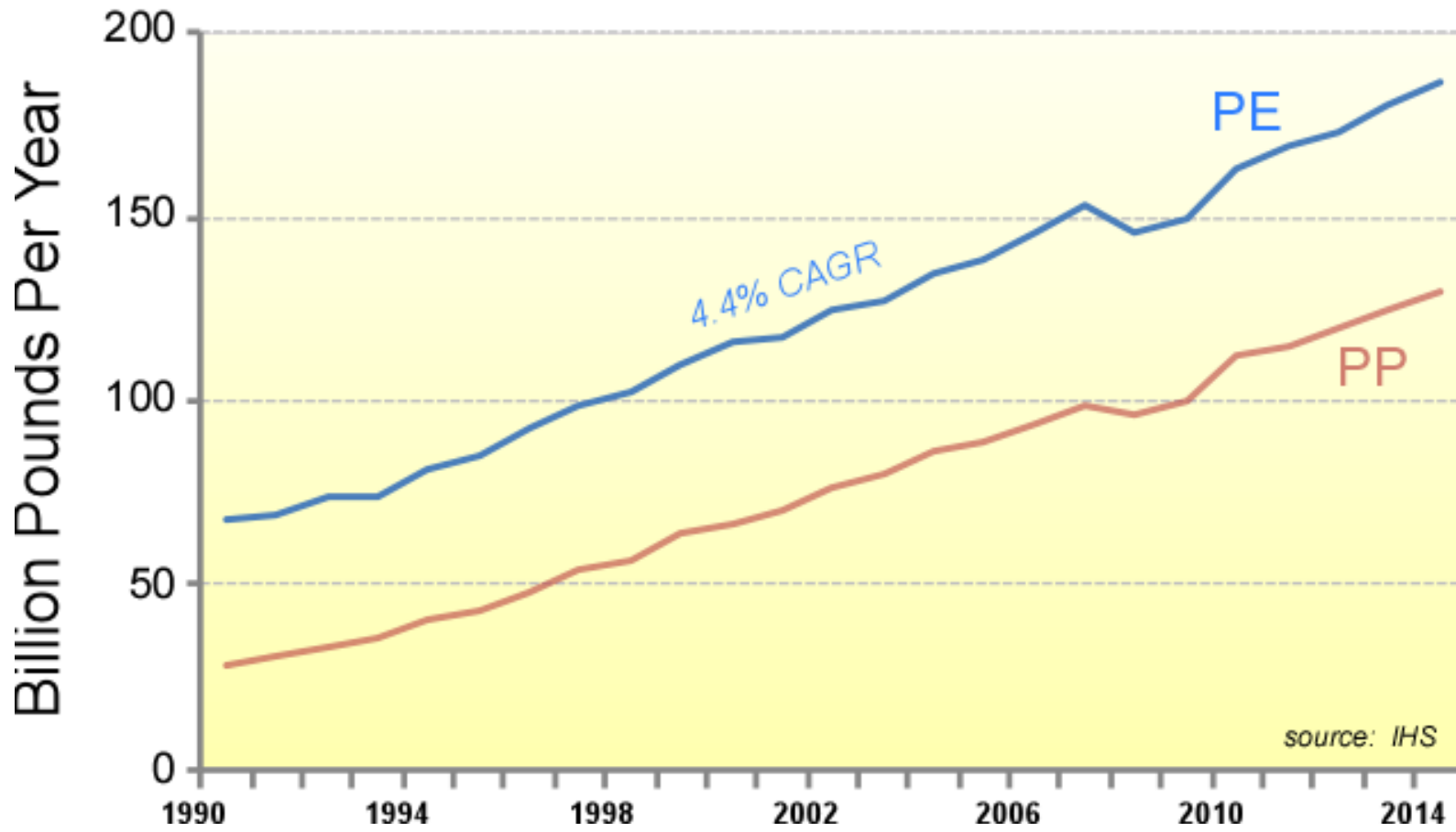
■ Birth of Modern Chemicals



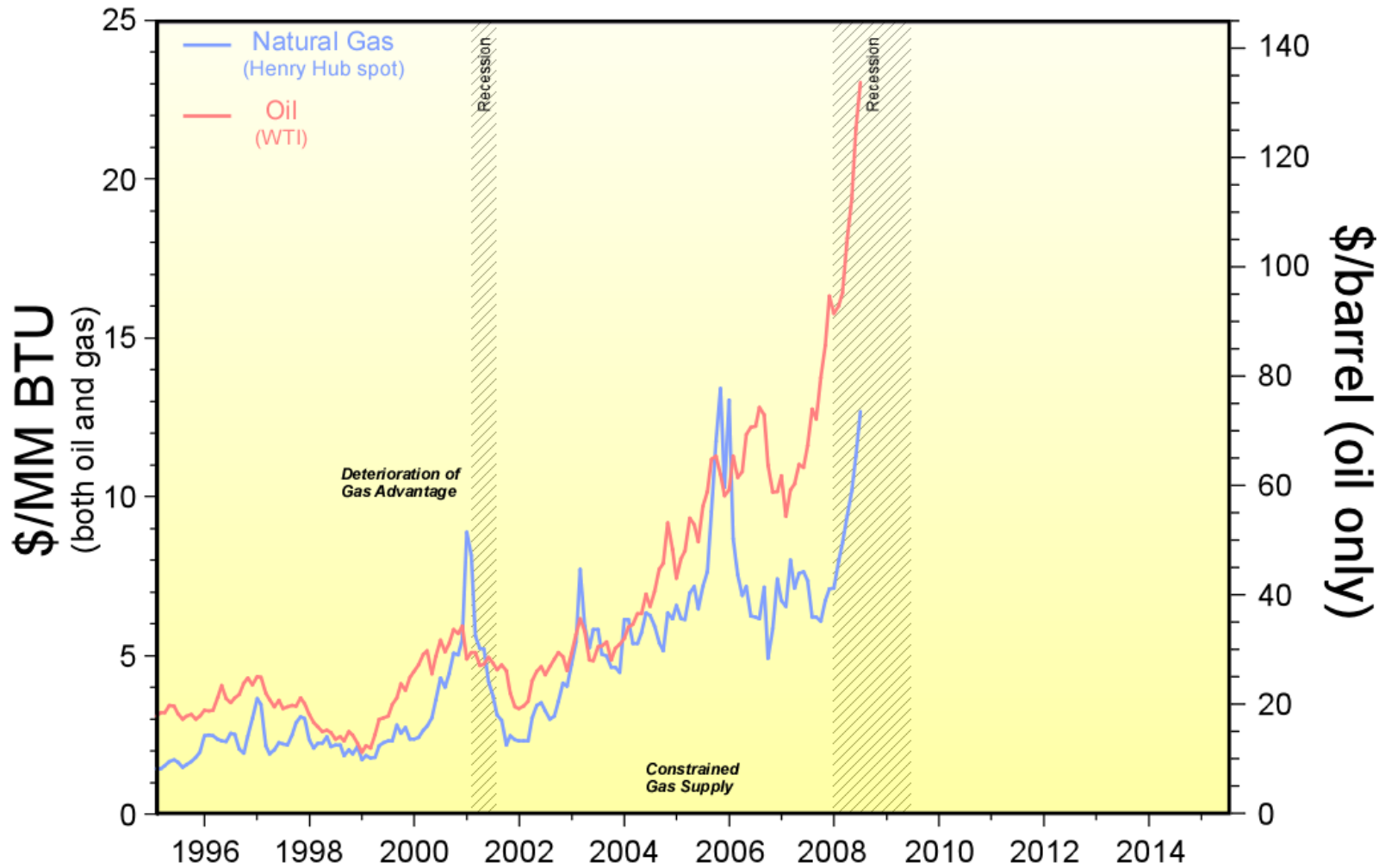
Chemical Industry Snapshot



■ Polyolefin Growth

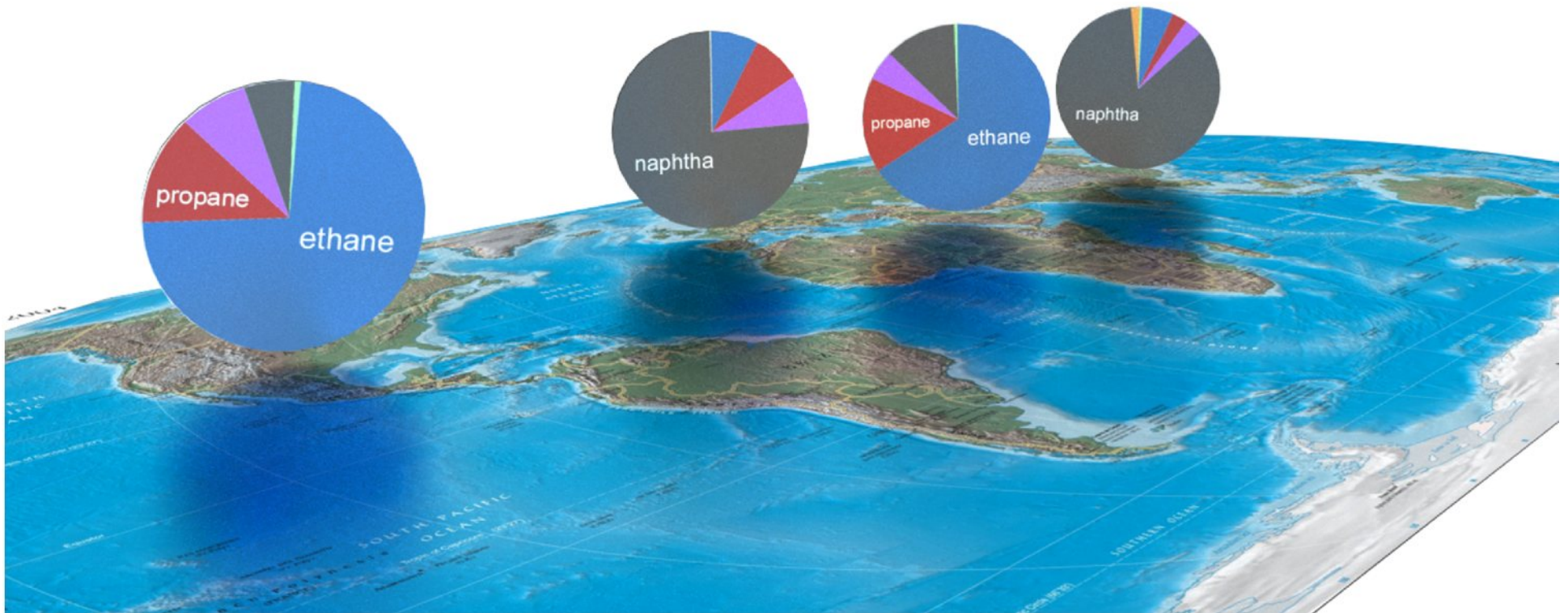


■ Our Previous Reality.....

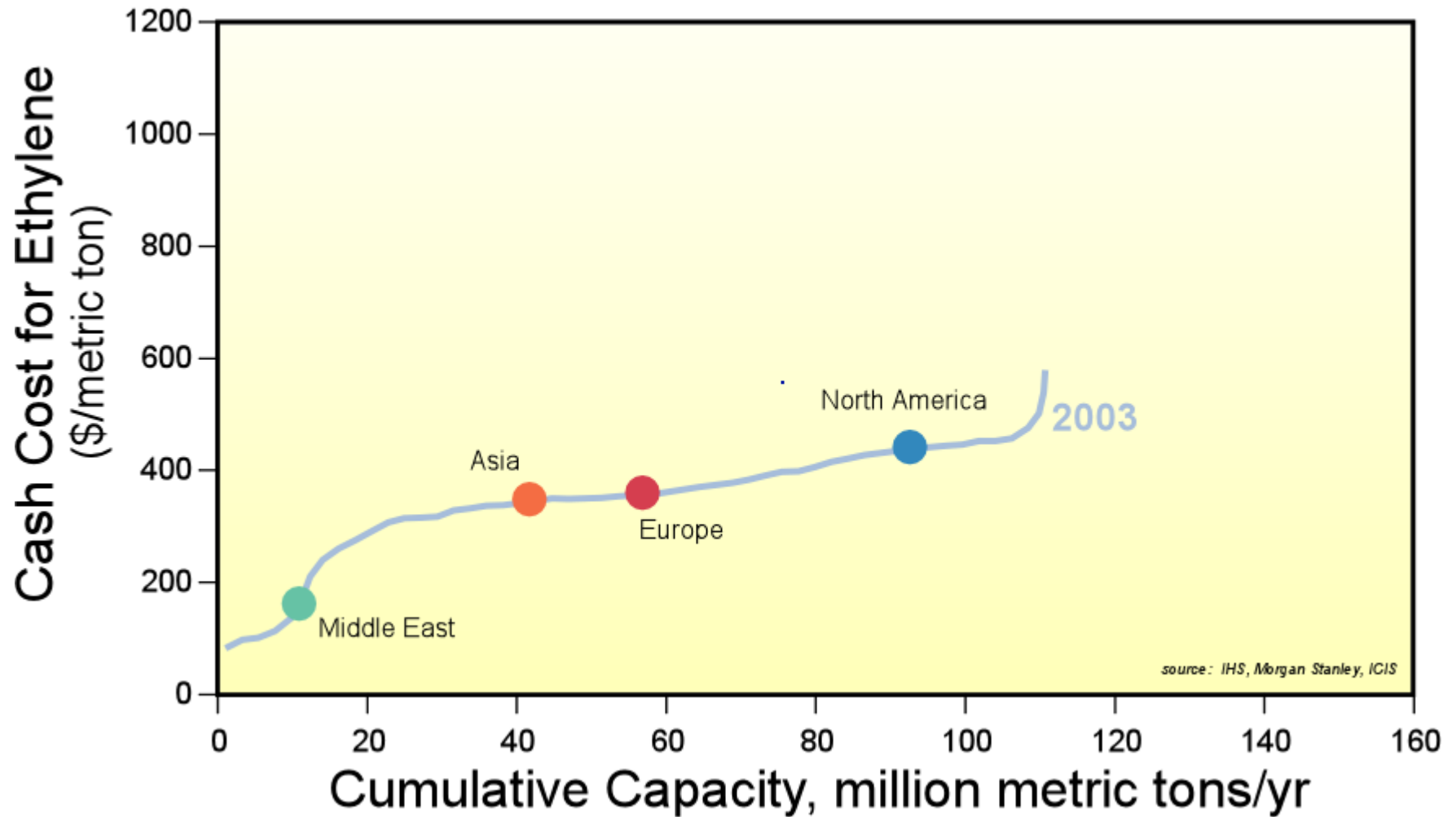


Global Feedstock Slates Differ

ethane propane butane naphtha MTO/CTO other



Ethylene Cumulative Supply - 2003

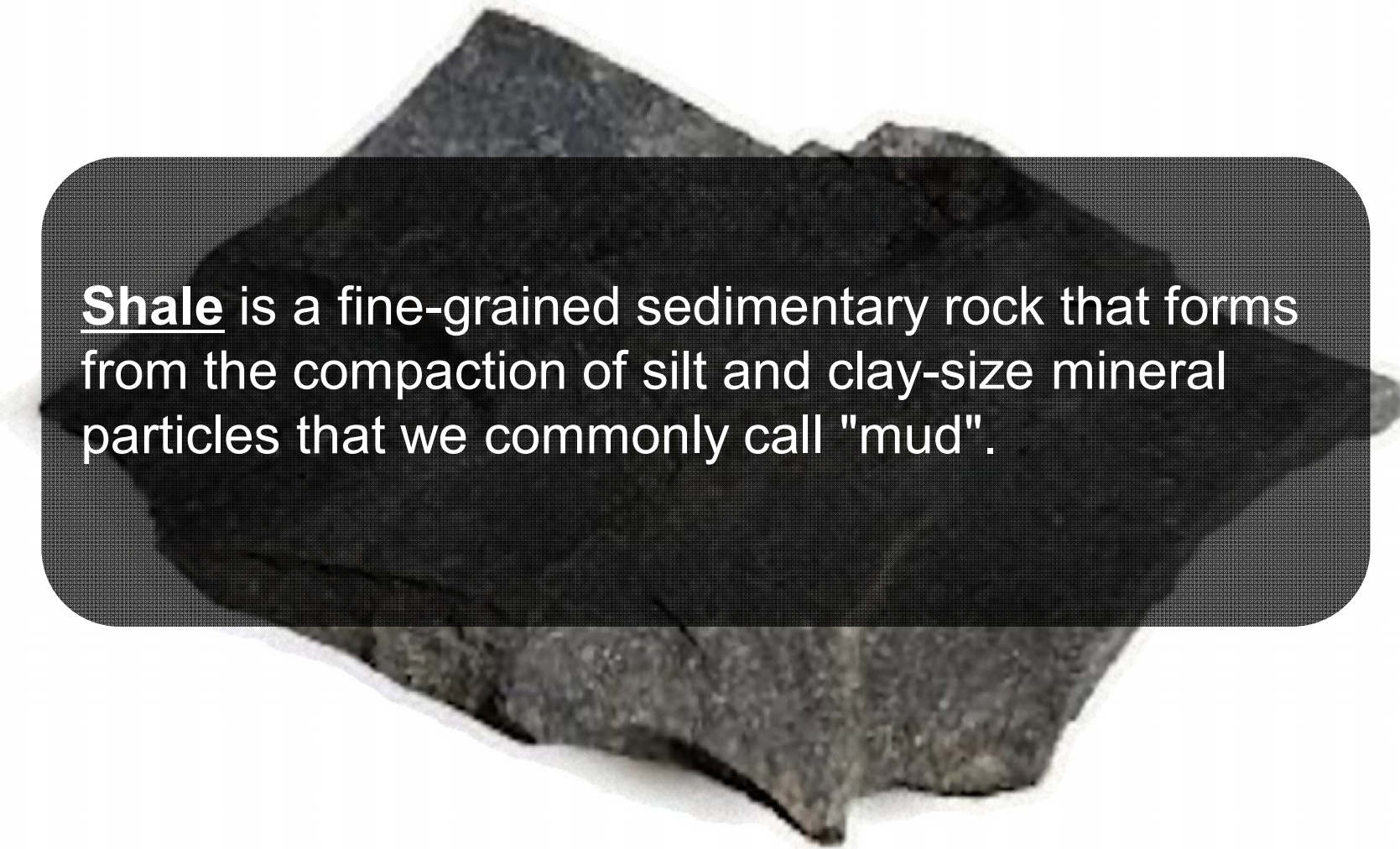


source: IHS, Morgan Stanley, ICIS

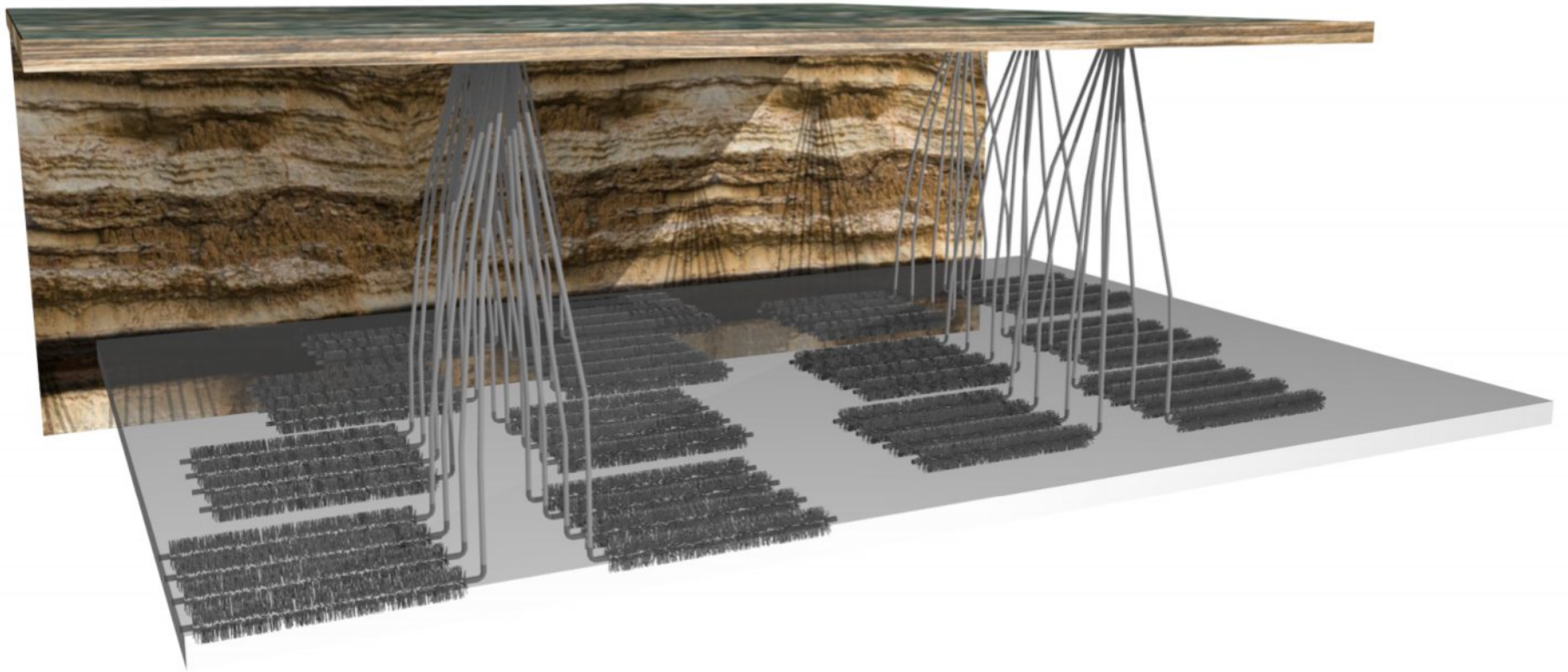




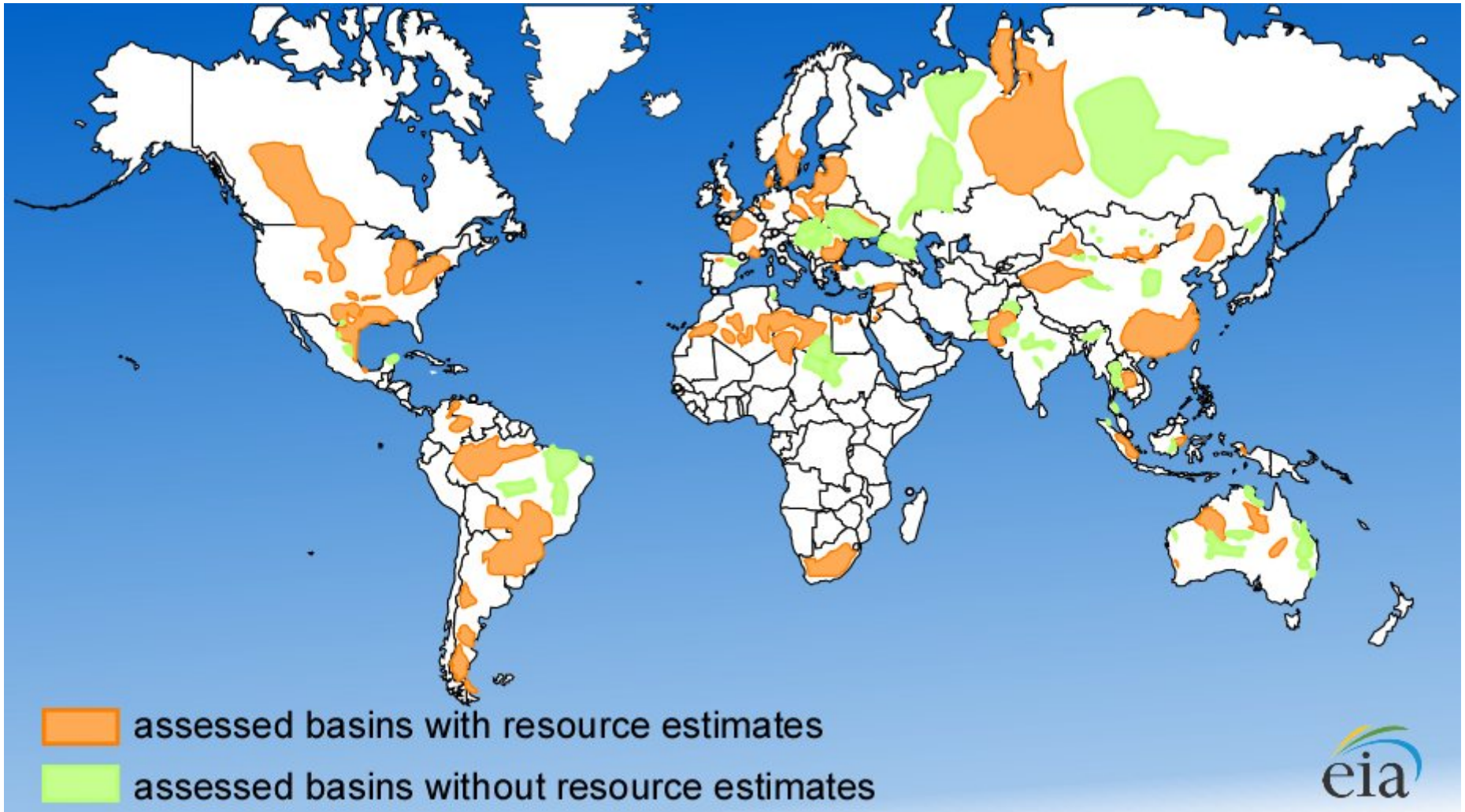




Shale is a fine-grained sedimentary rock that forms from the compaction of silt and clay-size mineral particles that we commonly call "mud".



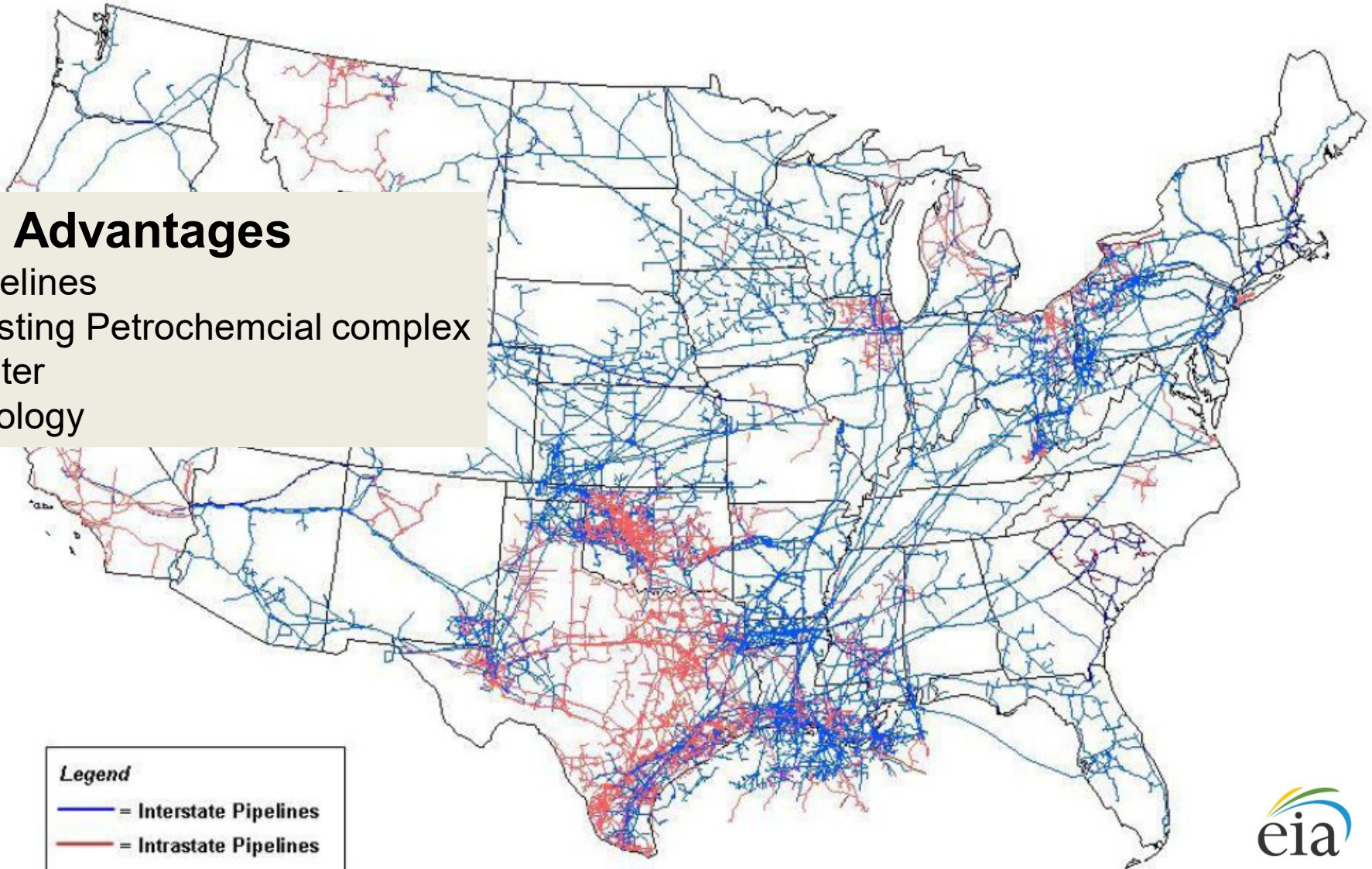
■ Mud Happened in Many Places



Robust Transmission Infrastructure

US Advantages

- Pipelines
- Existing Petrochemical complex
- Water
- Geology

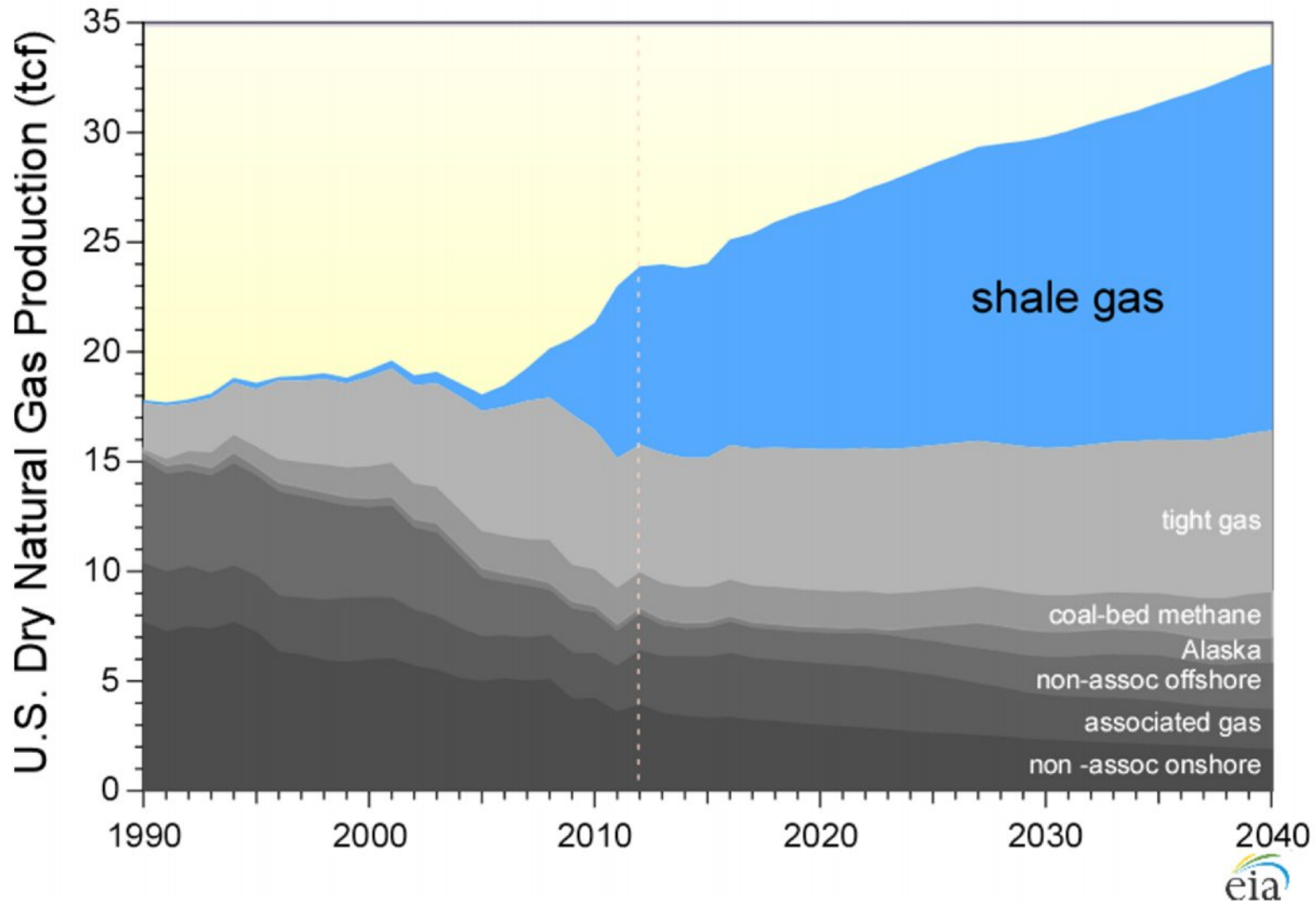


Legend

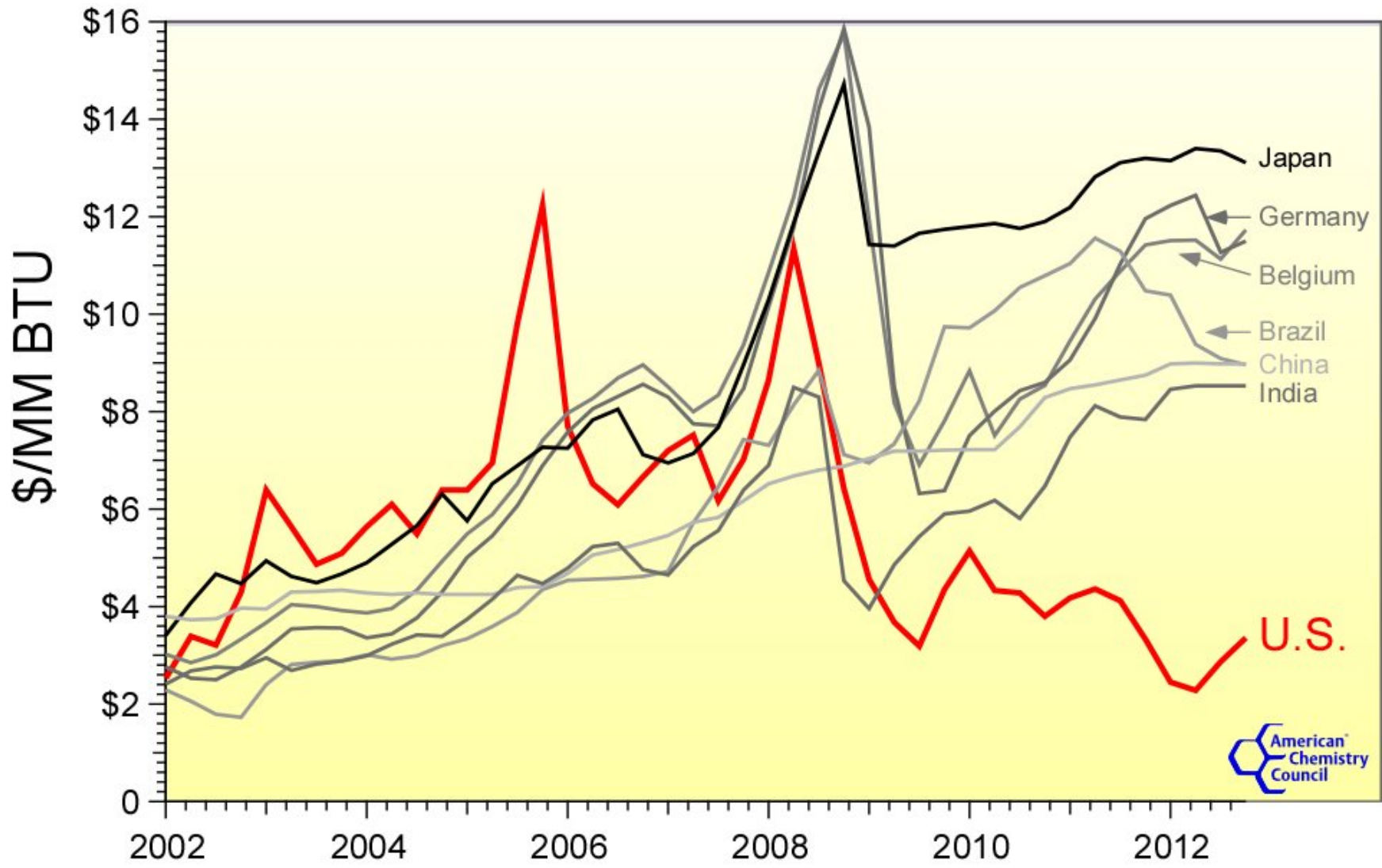
- = Interstate Pipelines
- = Intrastate Pipelines



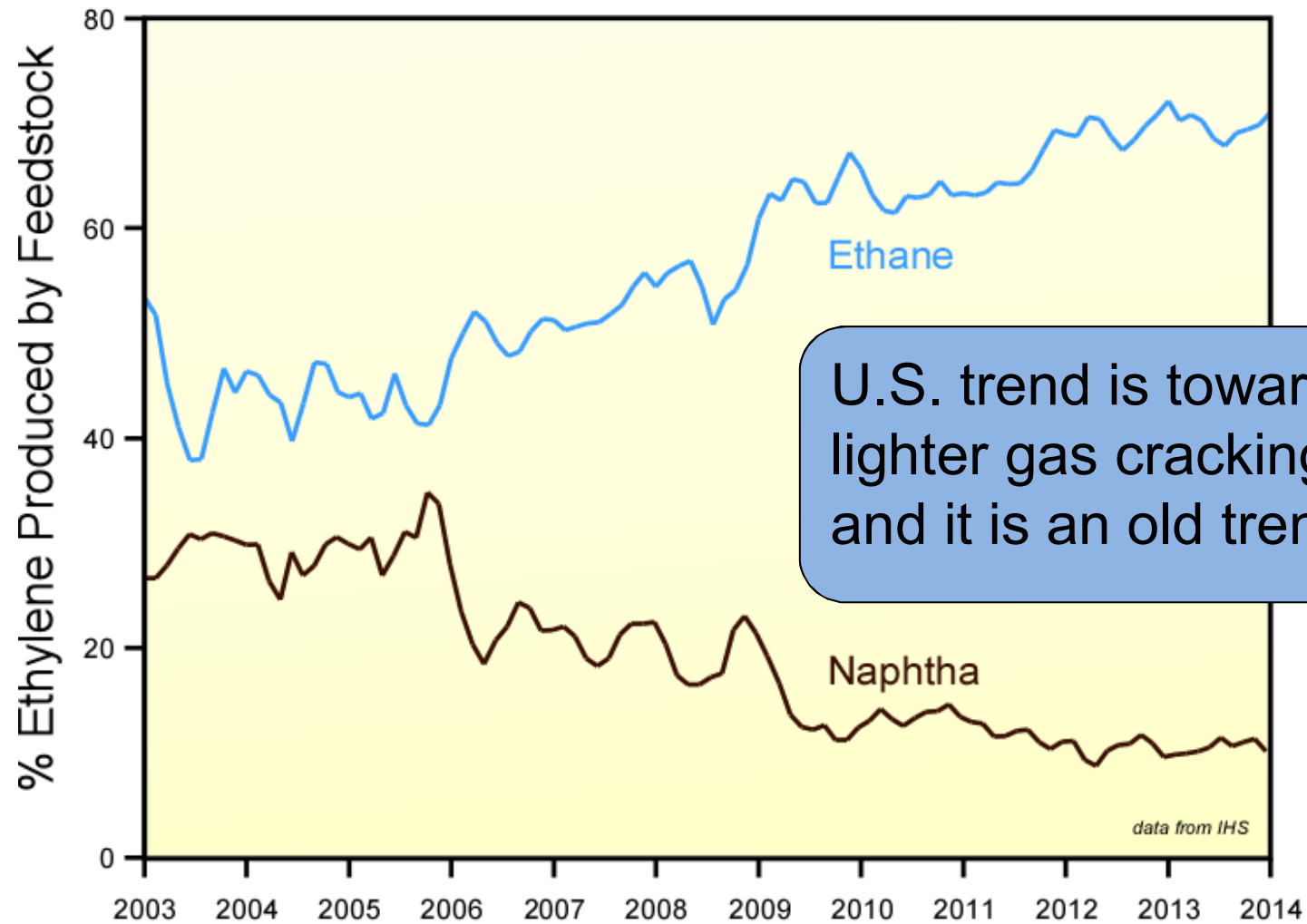
■ Shale Gas Growth



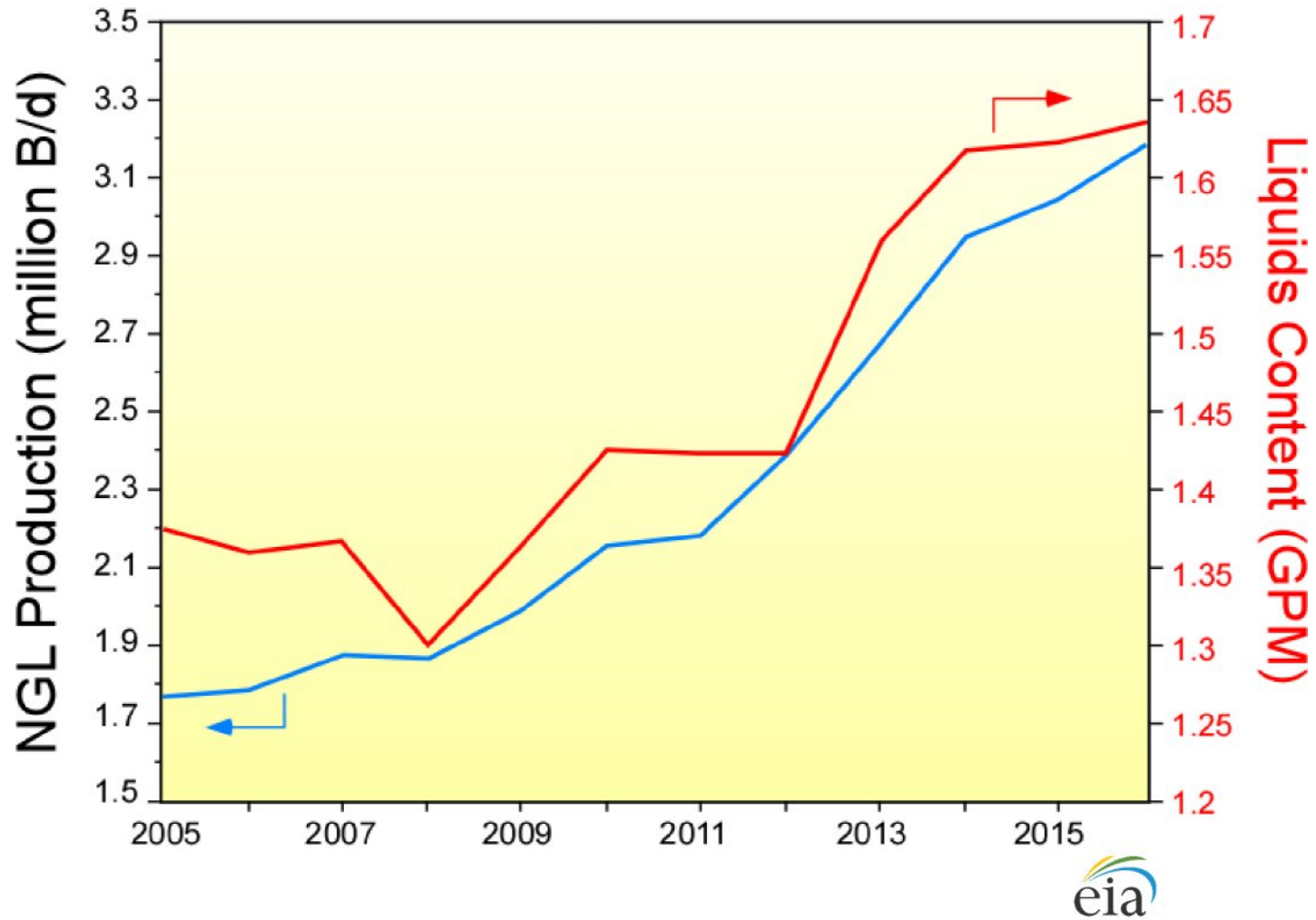
Global Gas Price



■ US Trend



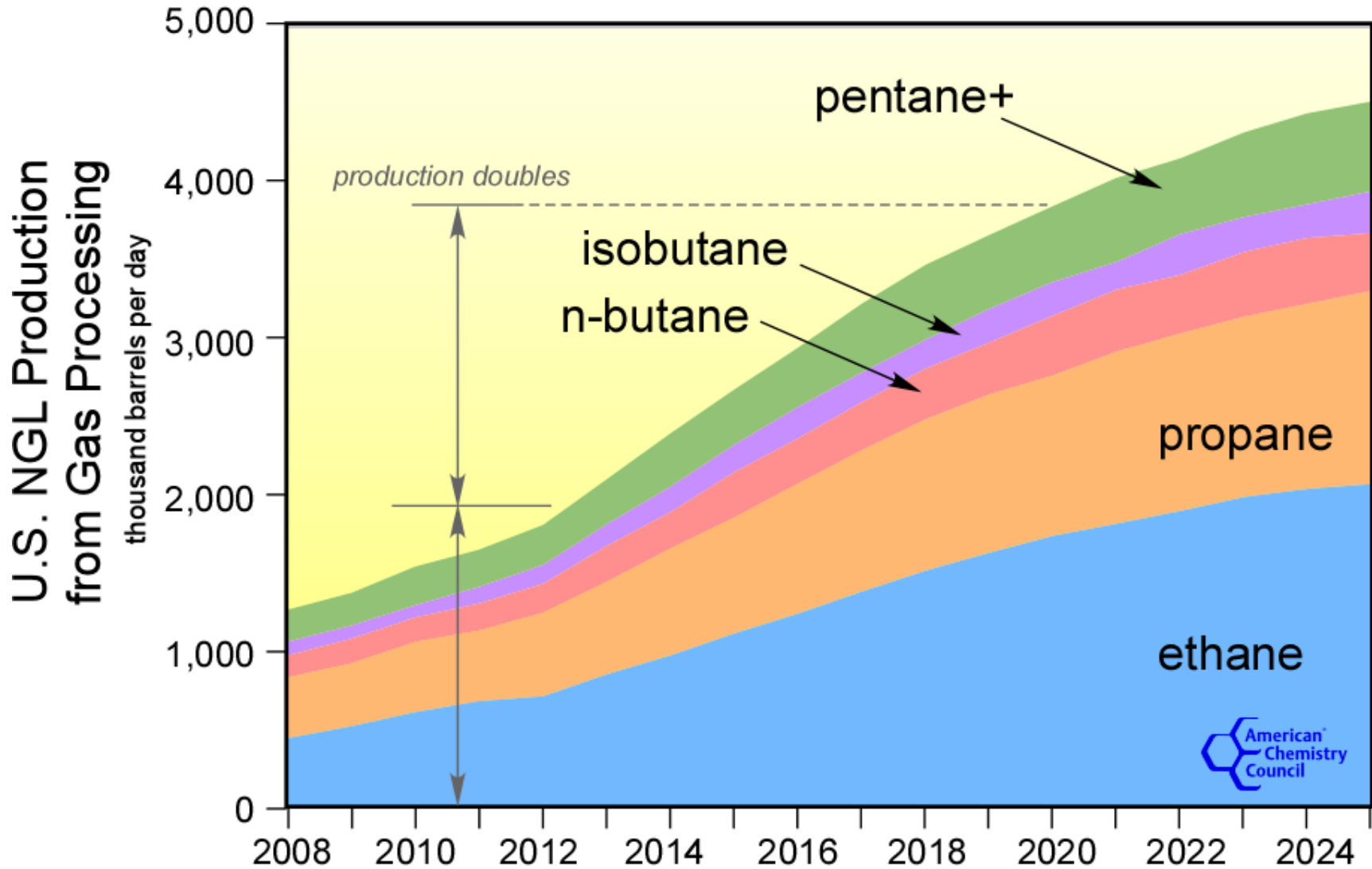
■ Growth in NGLs



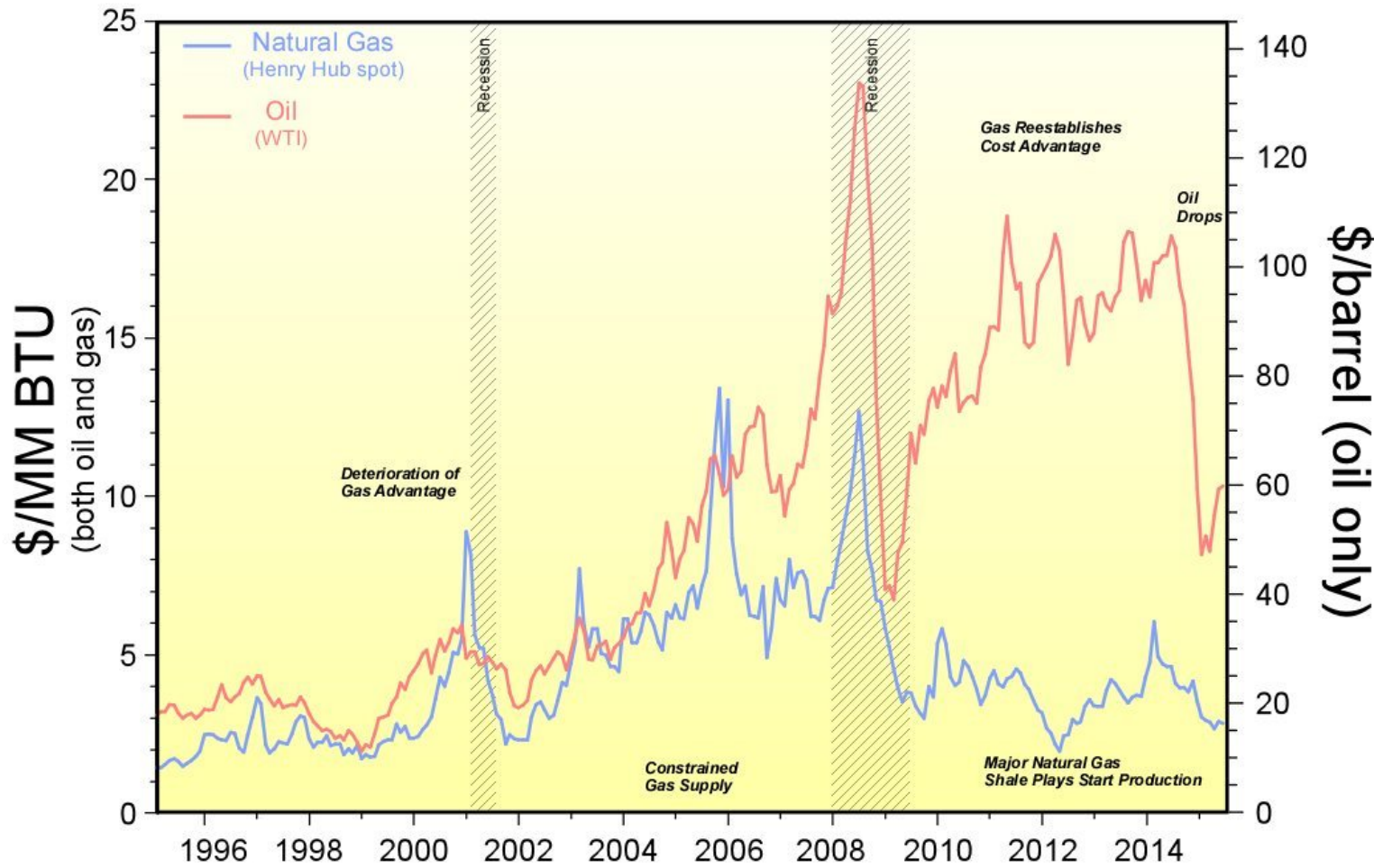
eia



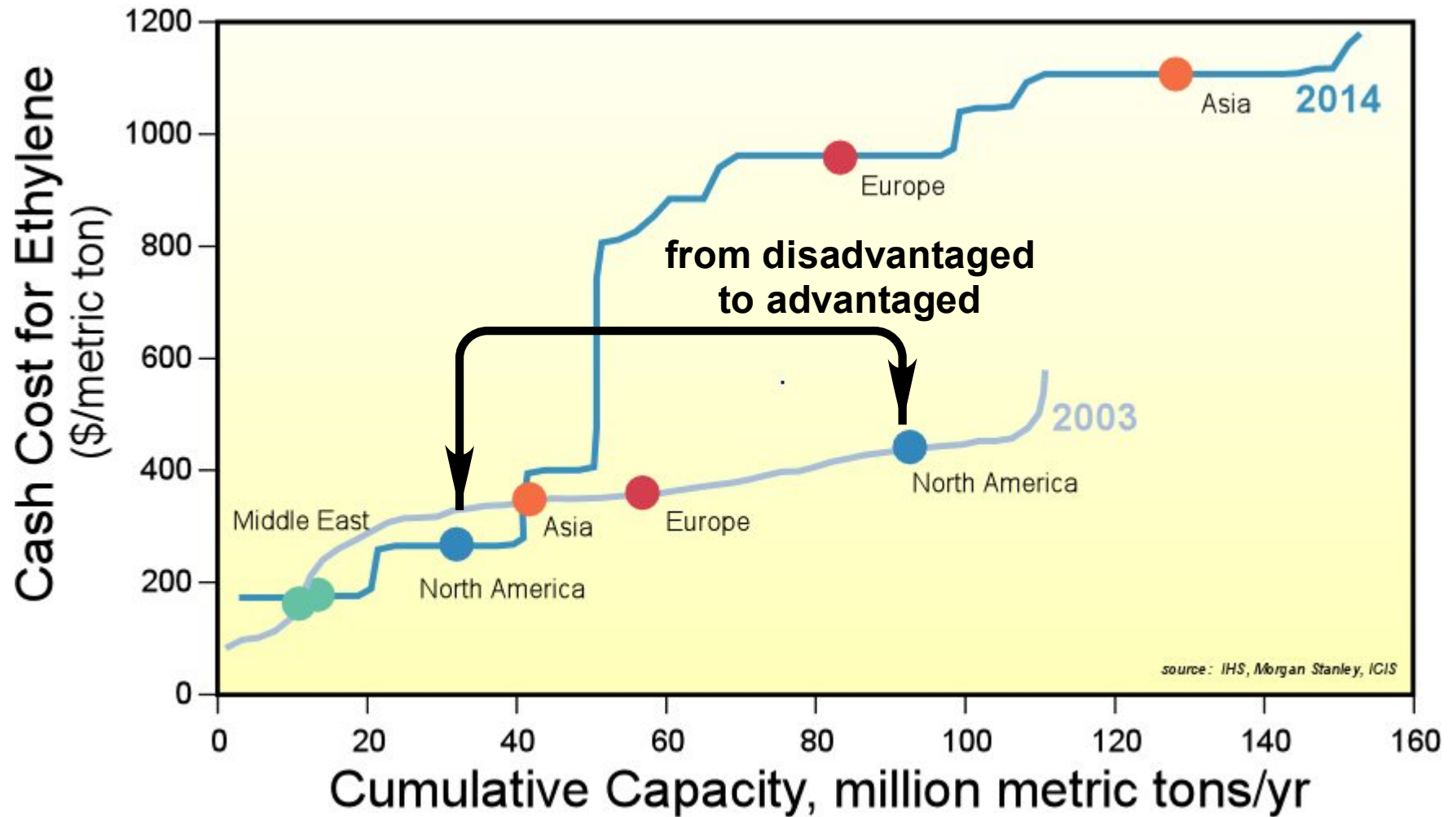
■ NGL Production Doubles by 2020



Energy Cost



■ Rapid Change



Live Long and Prosper



■ Economic Impact of Shale Gas

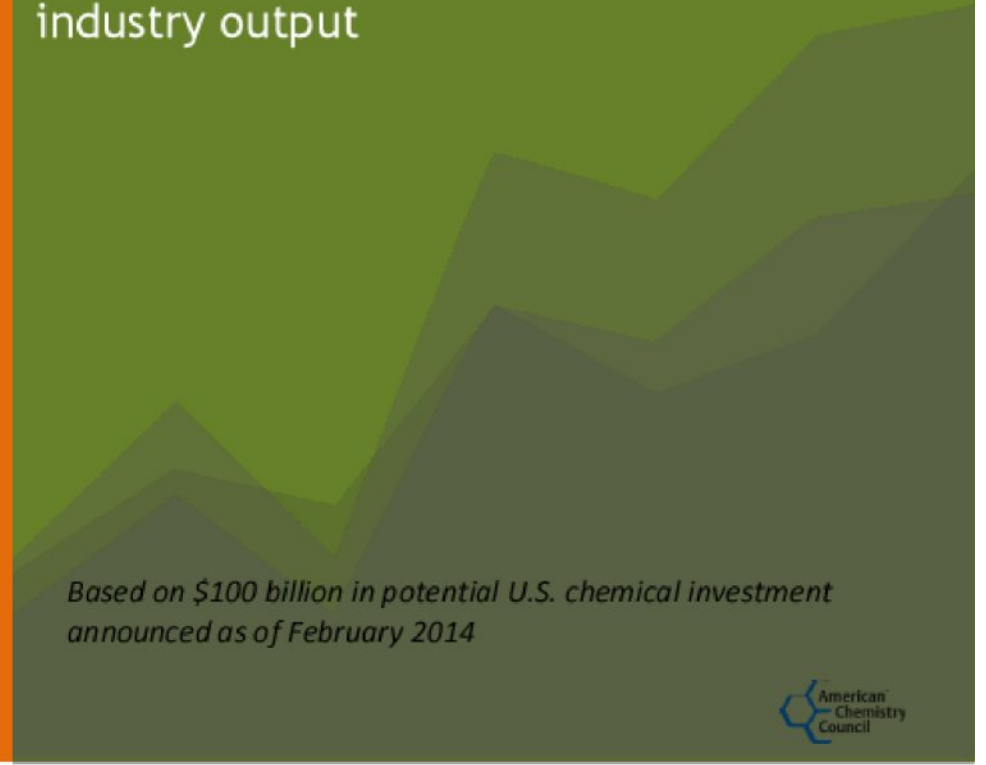
637,000

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

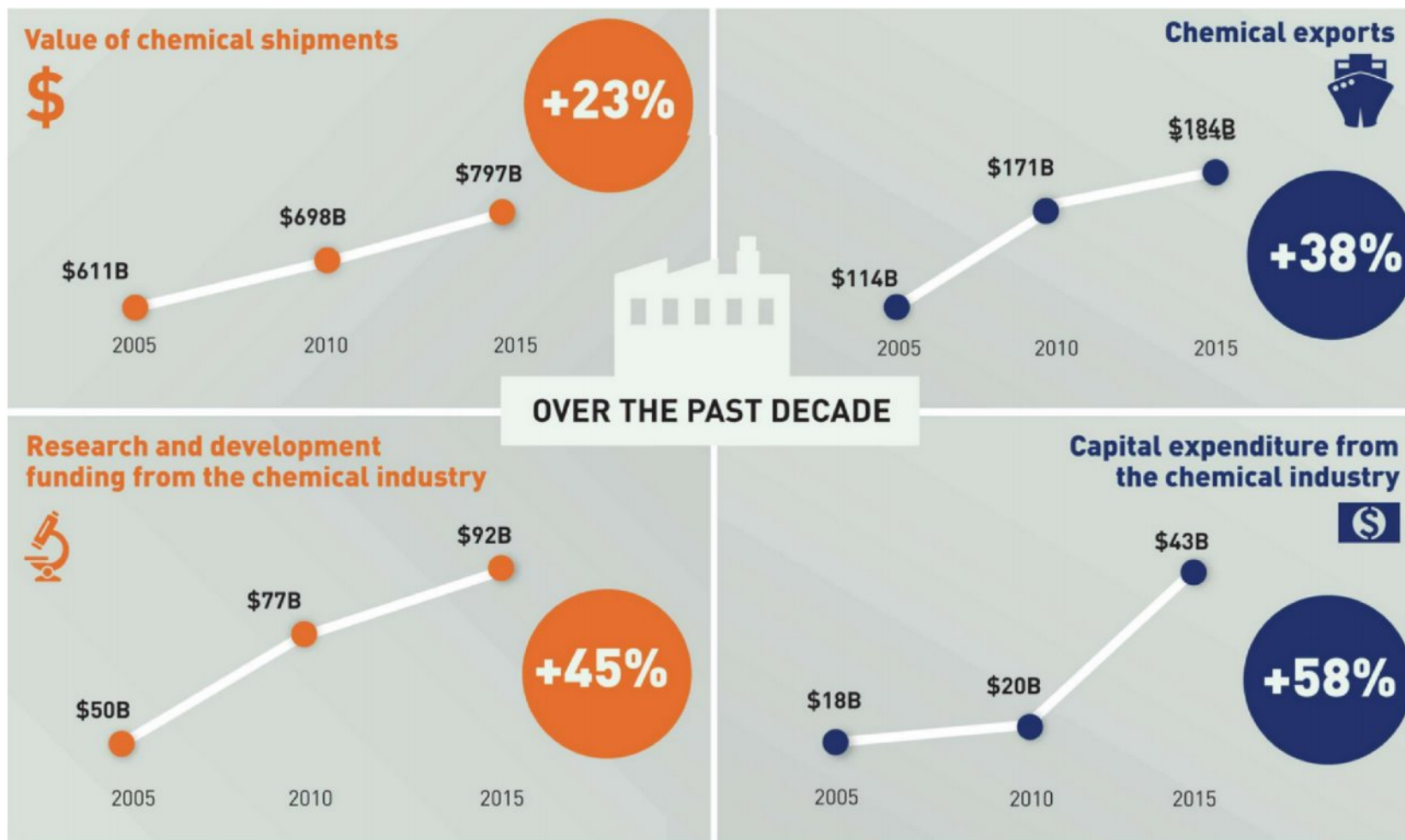


*Based on \$100 billion in potential U.S. chemical investment
announced as of February 2014*

Announced Projects



Industry Growth



■ Impact of Chemical Industry on R&D

\$93 billion

In 2015, American Chemistry invested \$93 billion in **research and development**, or more than **\$290 per person** in the U.S.



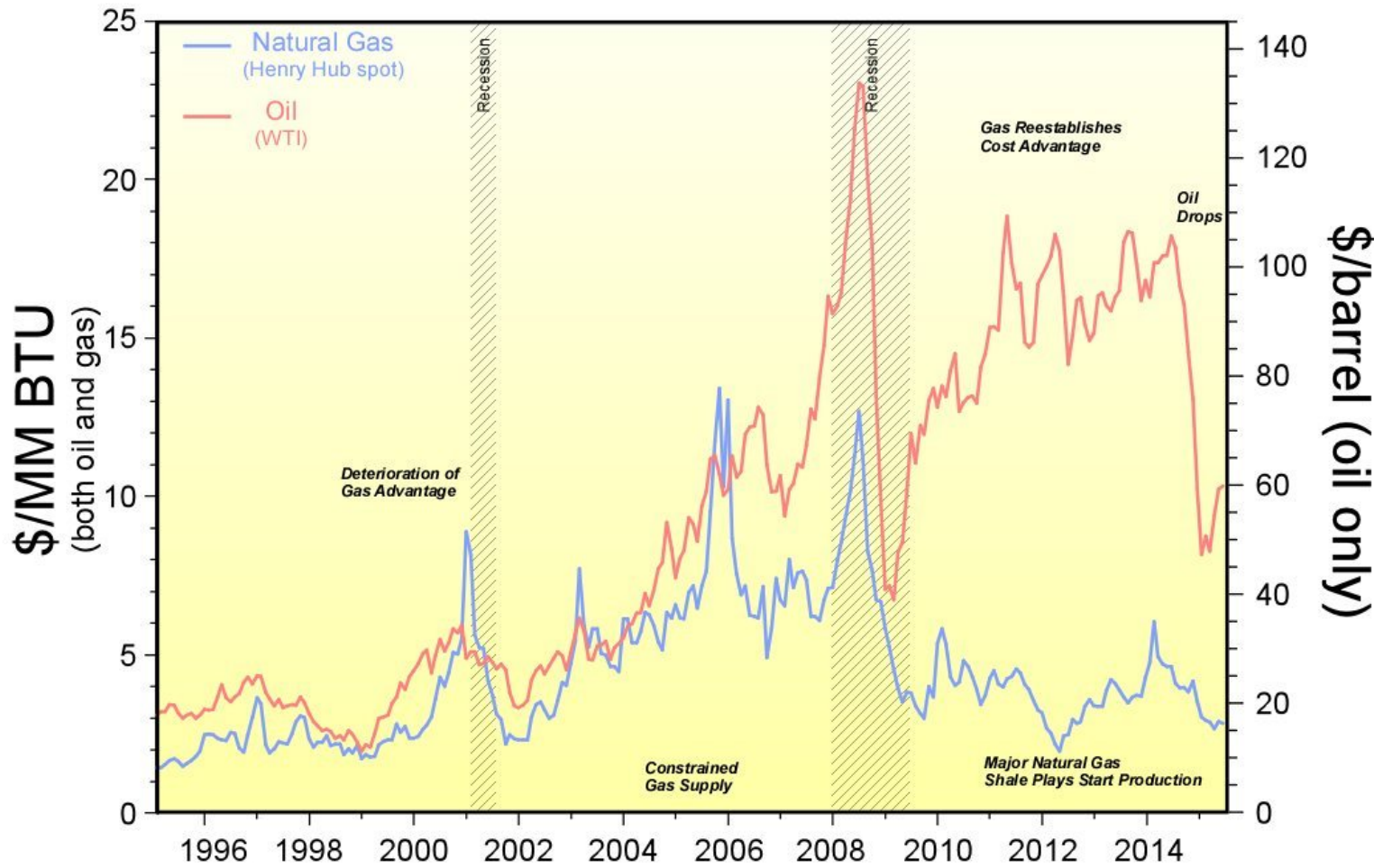
We invest more to innovate than the **electronic, automobile, and healthcare** industries.



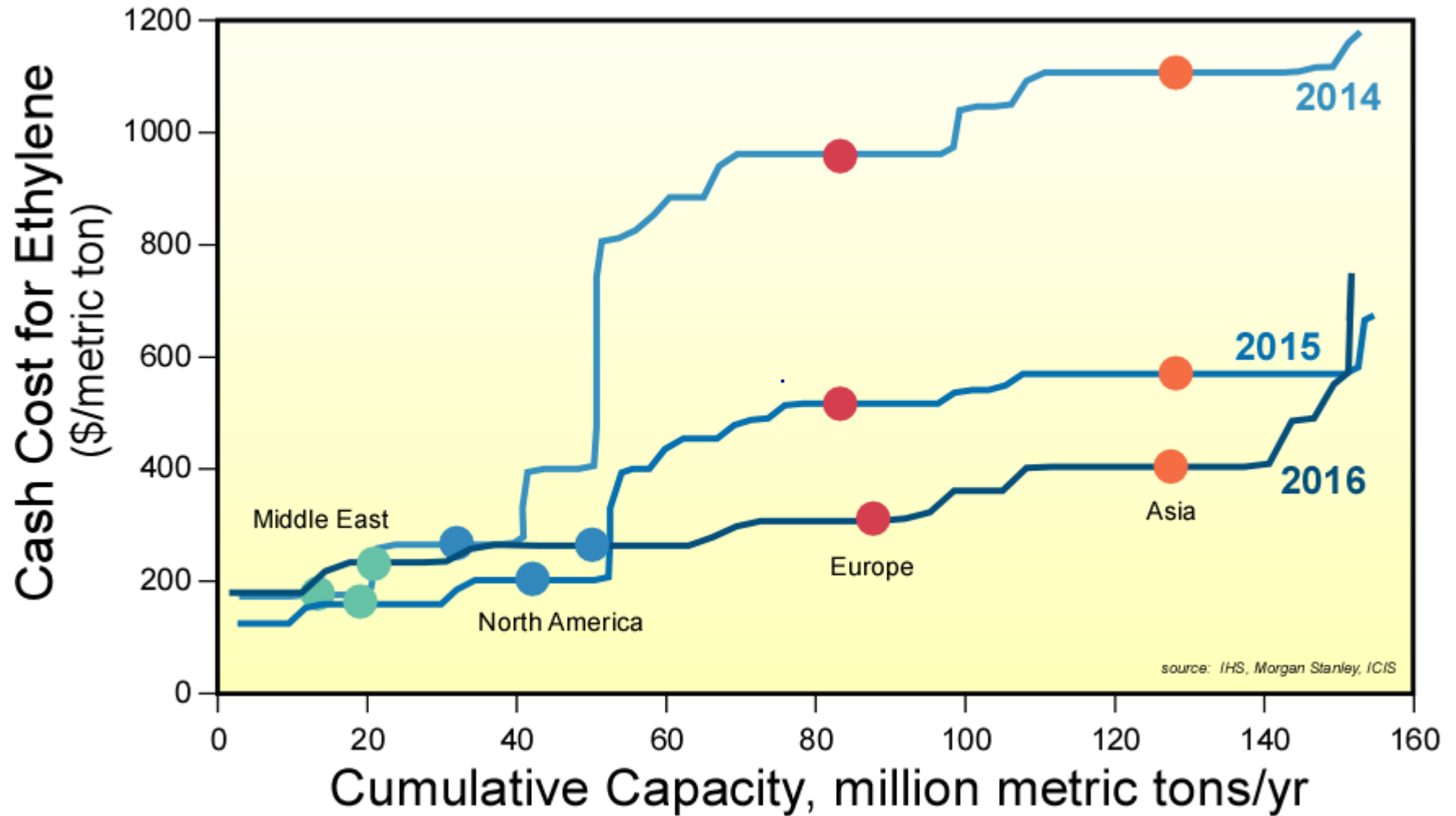
■ Exciting Times



Energy Cost



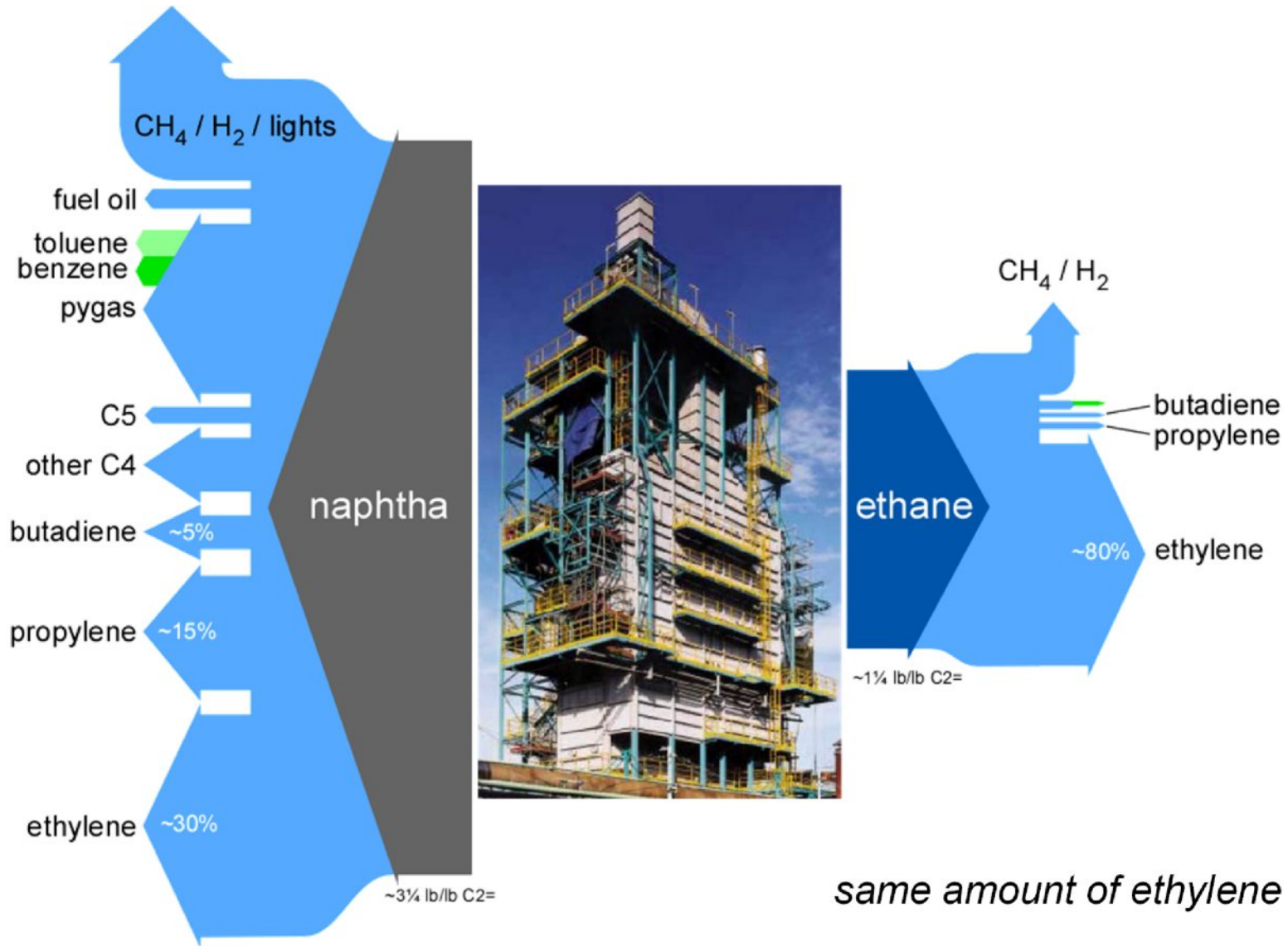
Falling Oil Prices



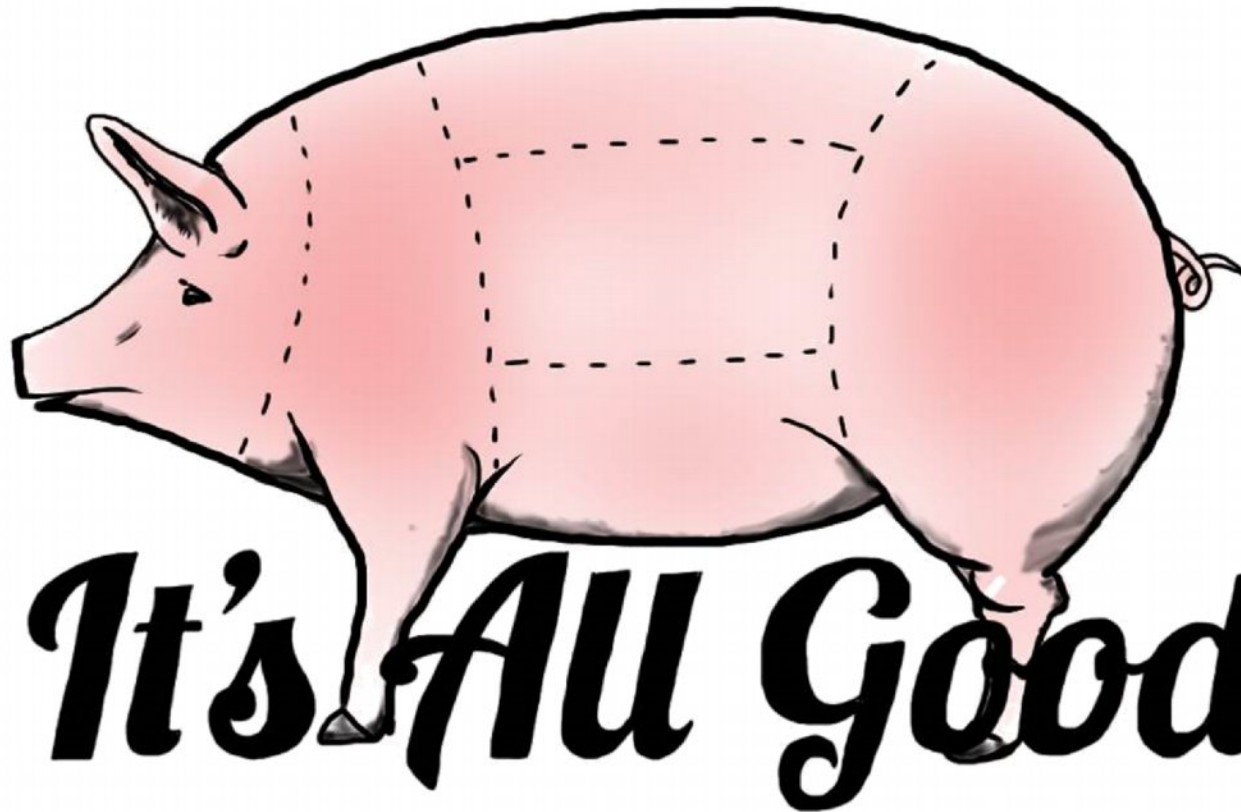
■ NGLs Still Advantaged In The U.S.



Naphtha vs Ethane Cracking Comparison



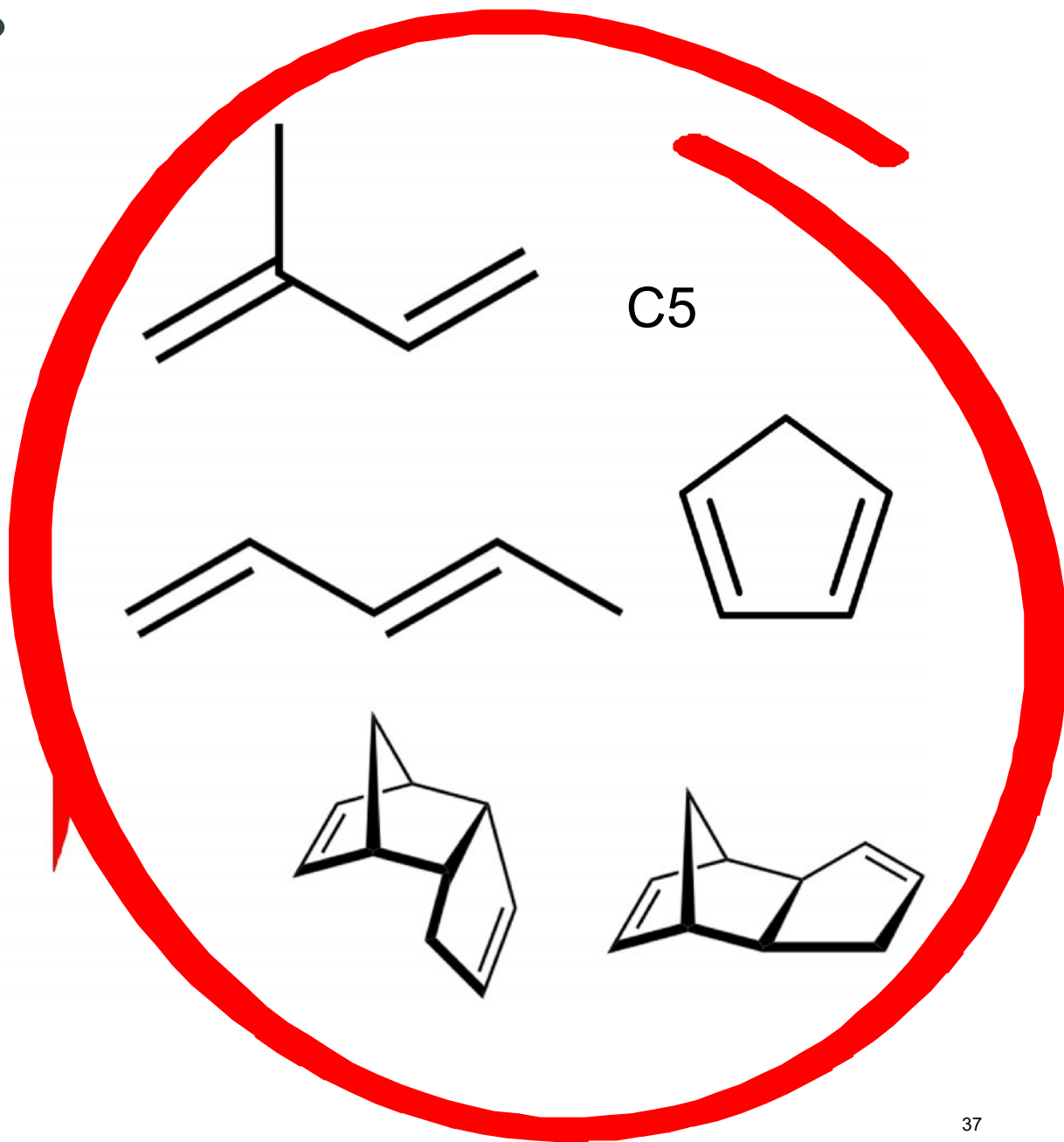
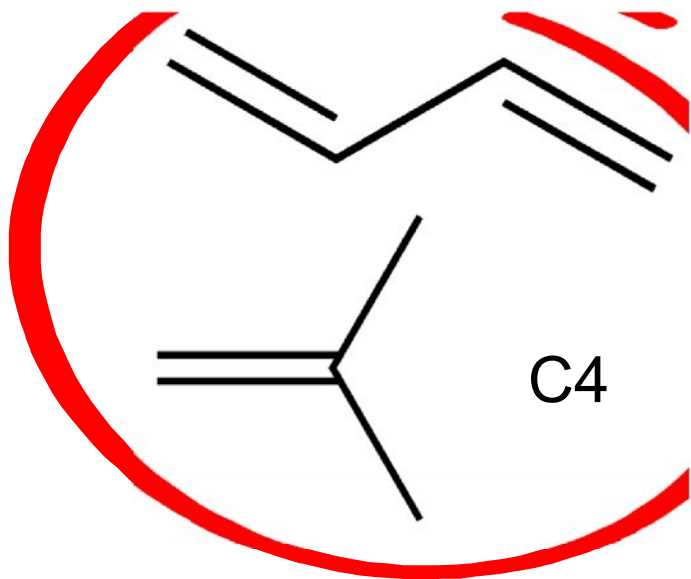
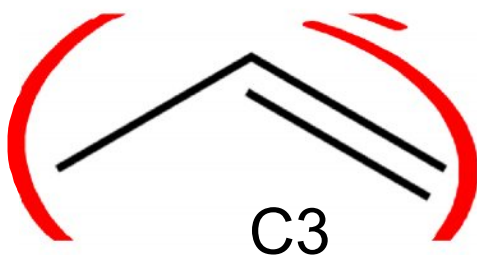
■ All Reaction Products Find Uses



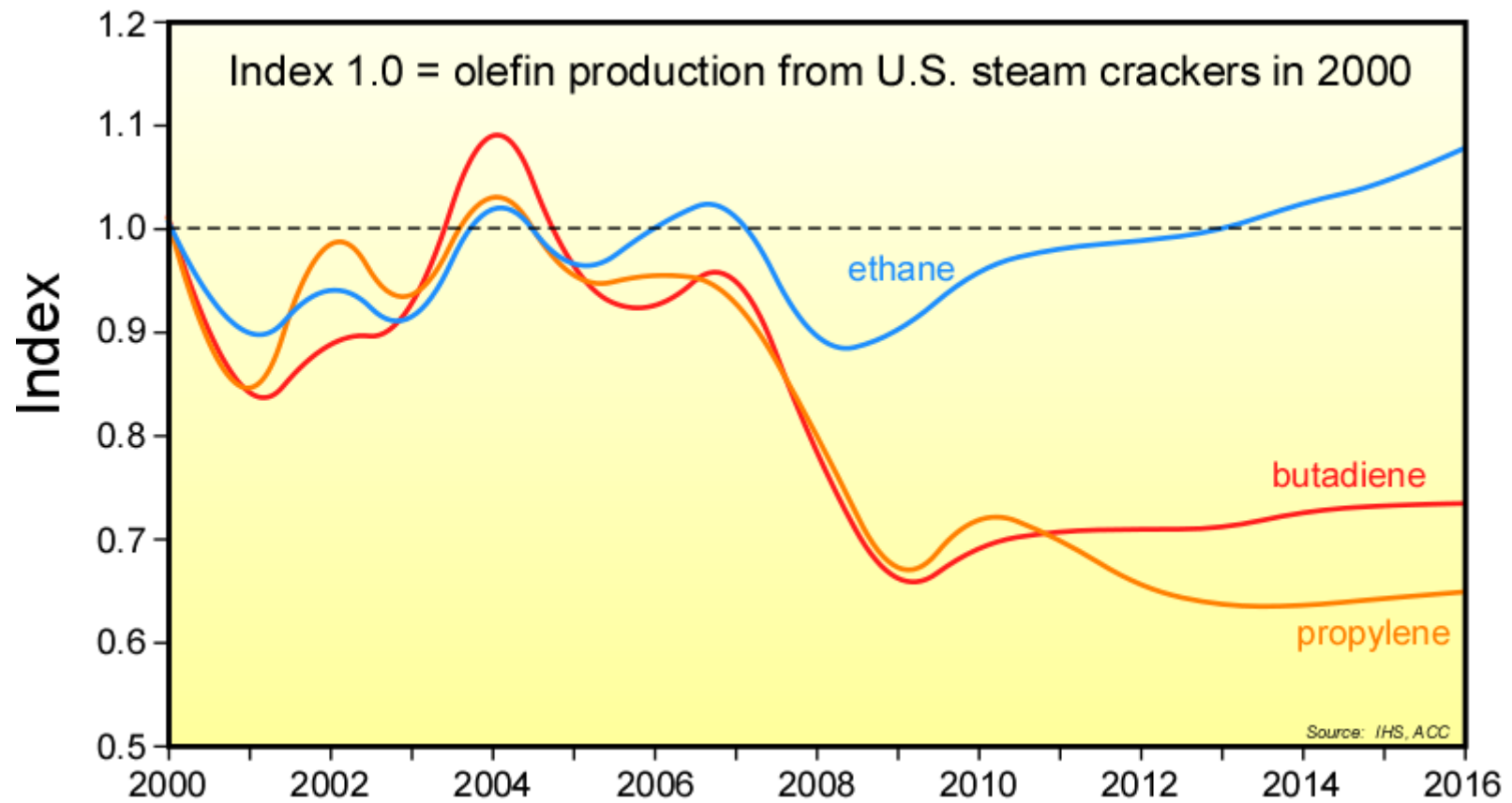
It's All Good!



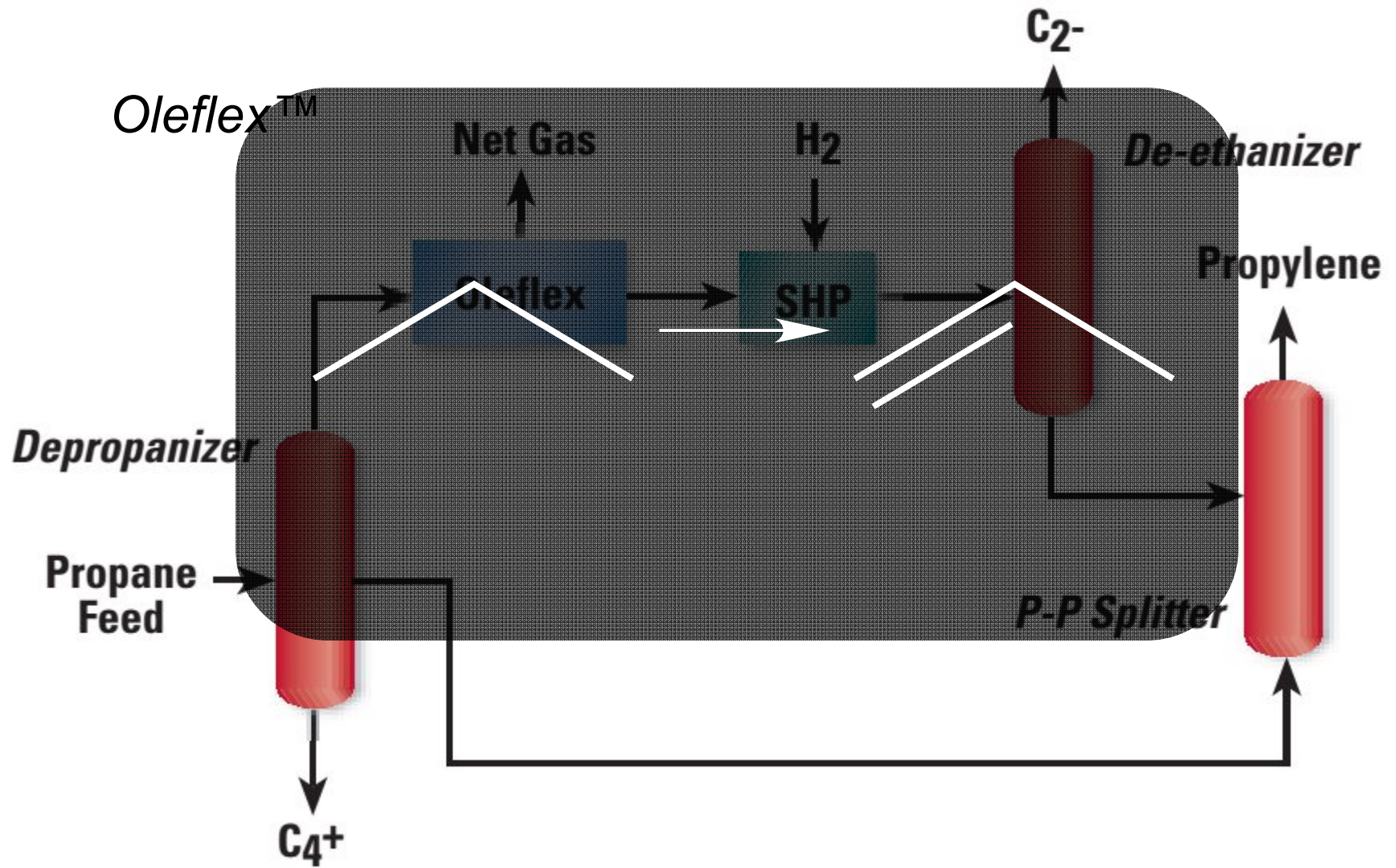
What's Gone Away?



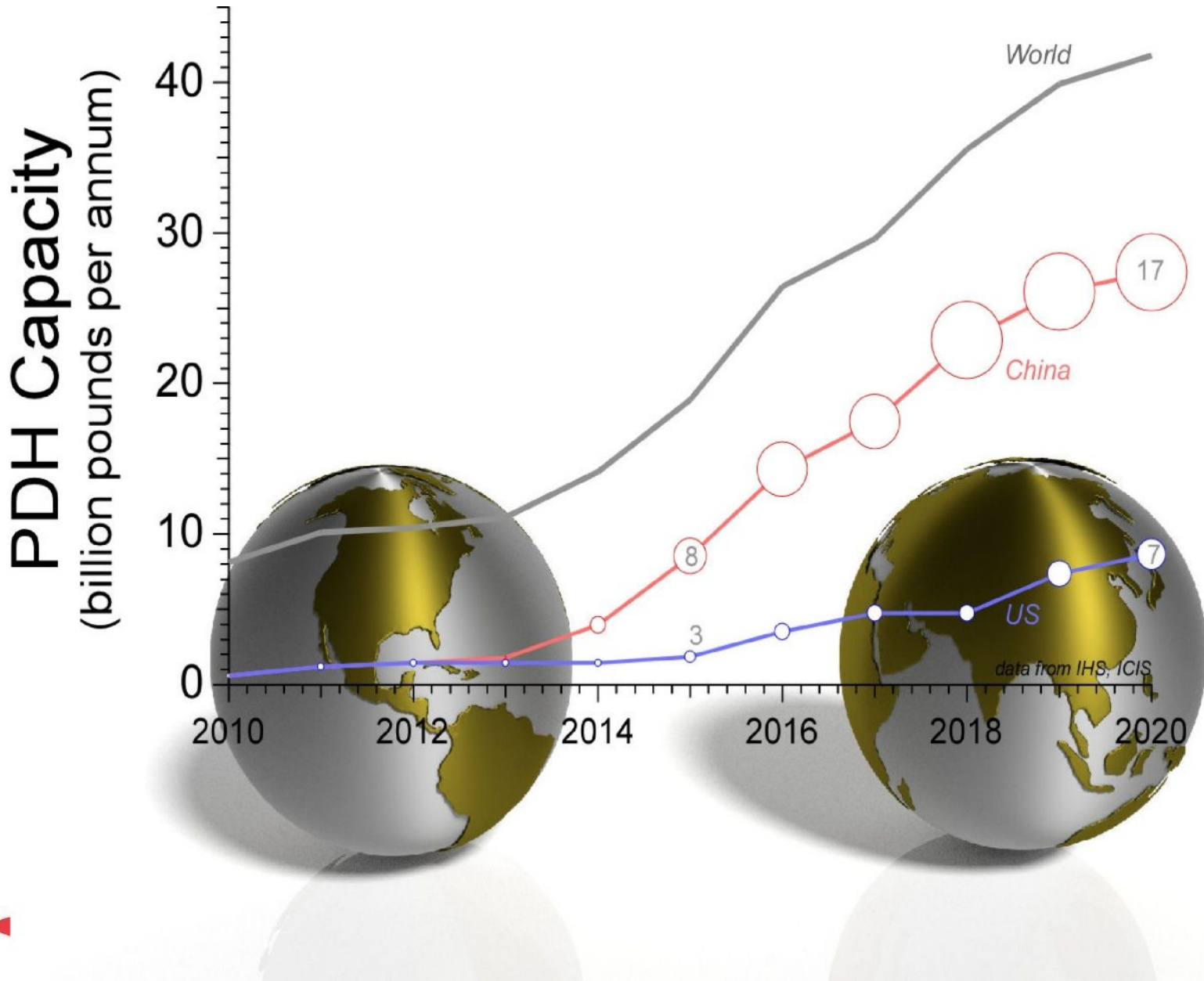
■ Production of C3/C4 Dropped



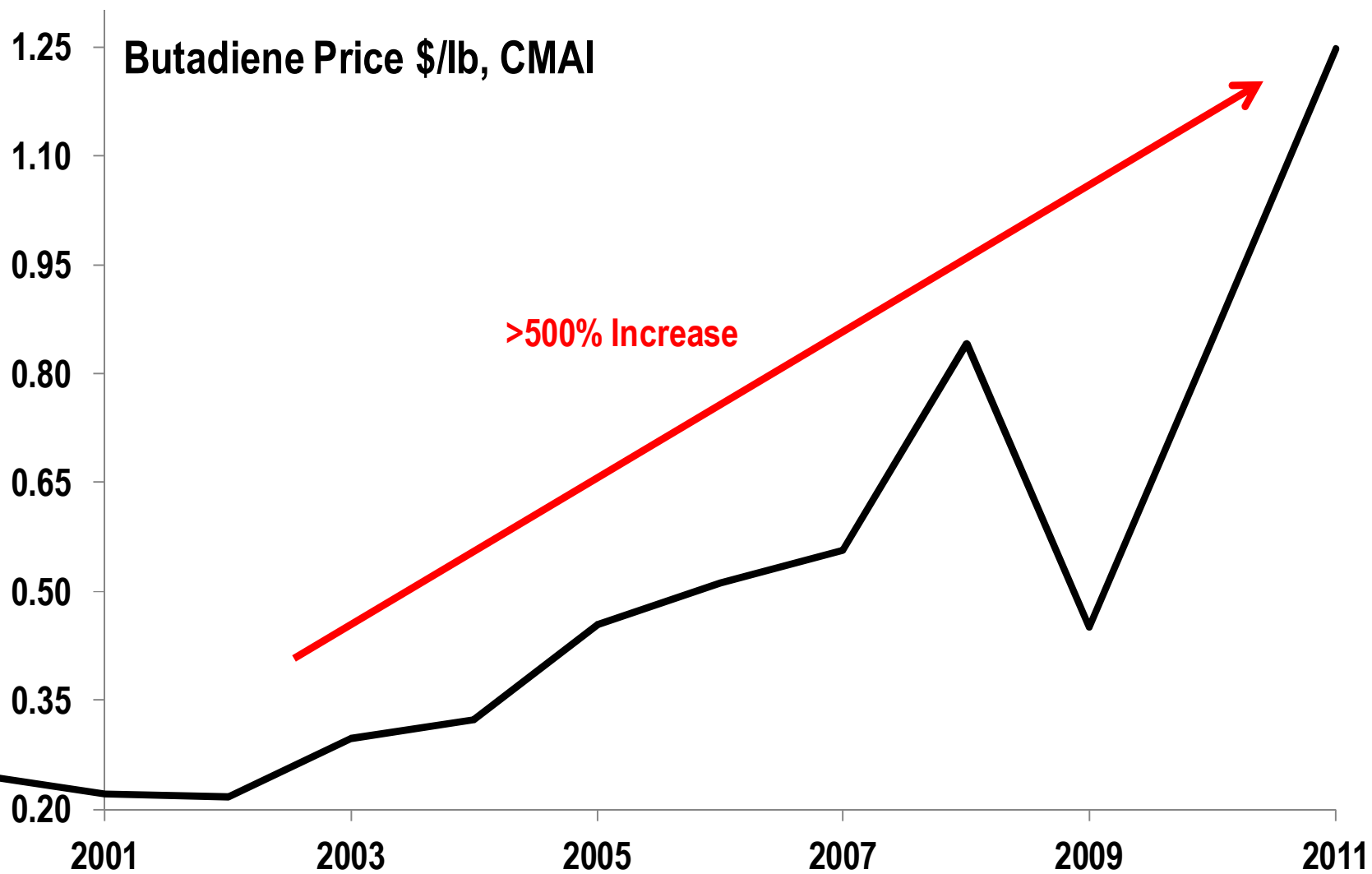
■ On-demand Propylene Production



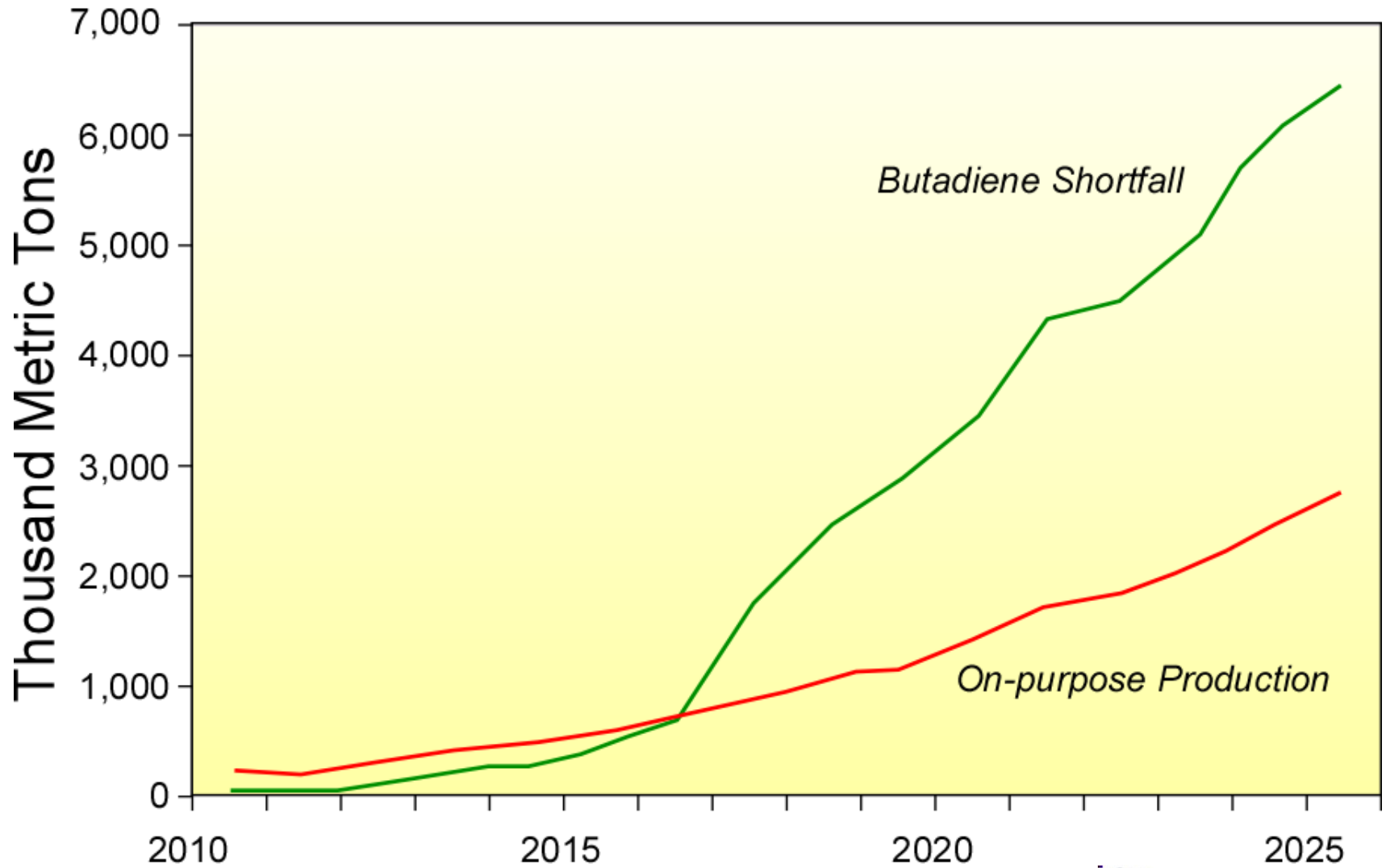
PDH



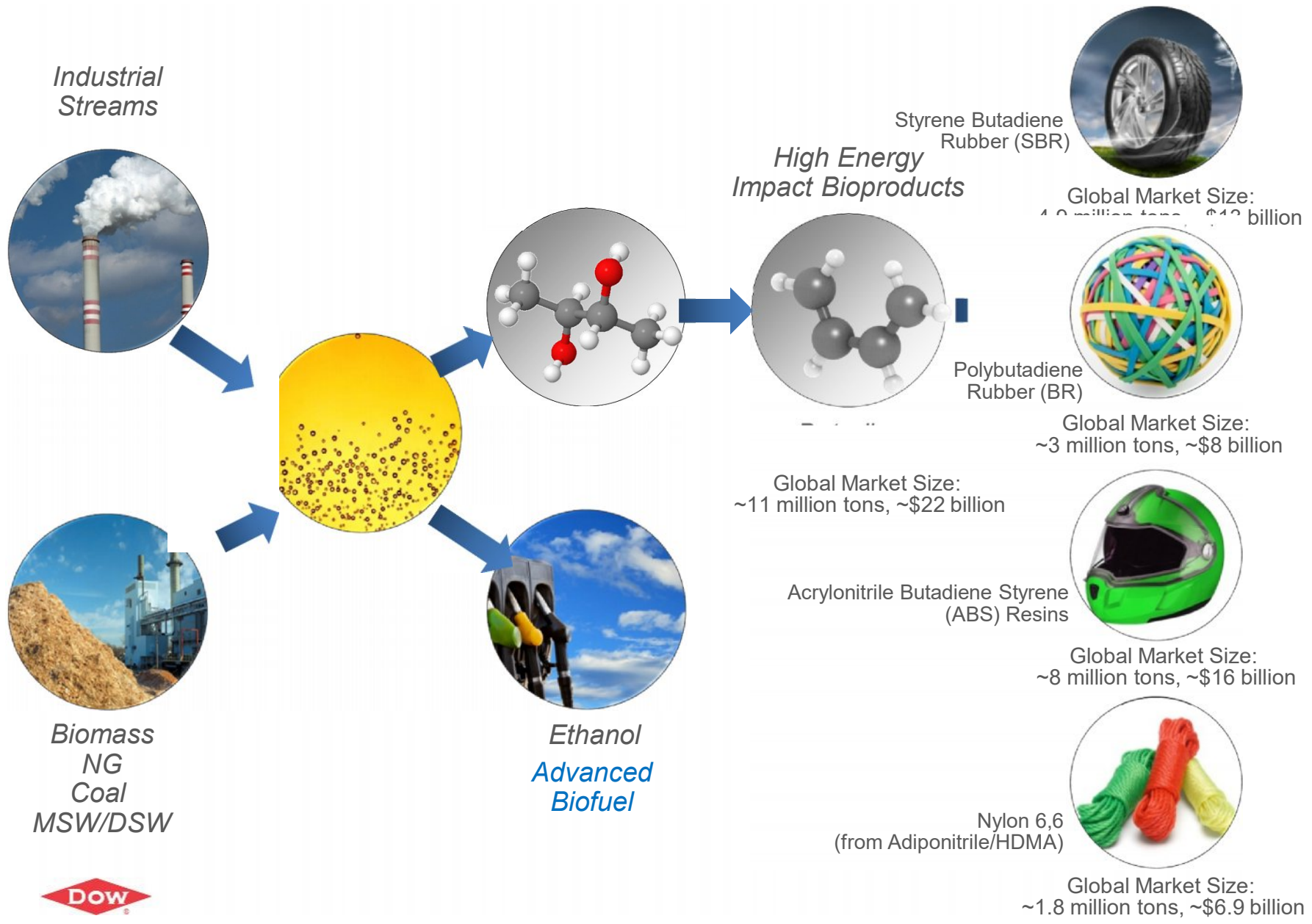
Butadiene Price Inflation



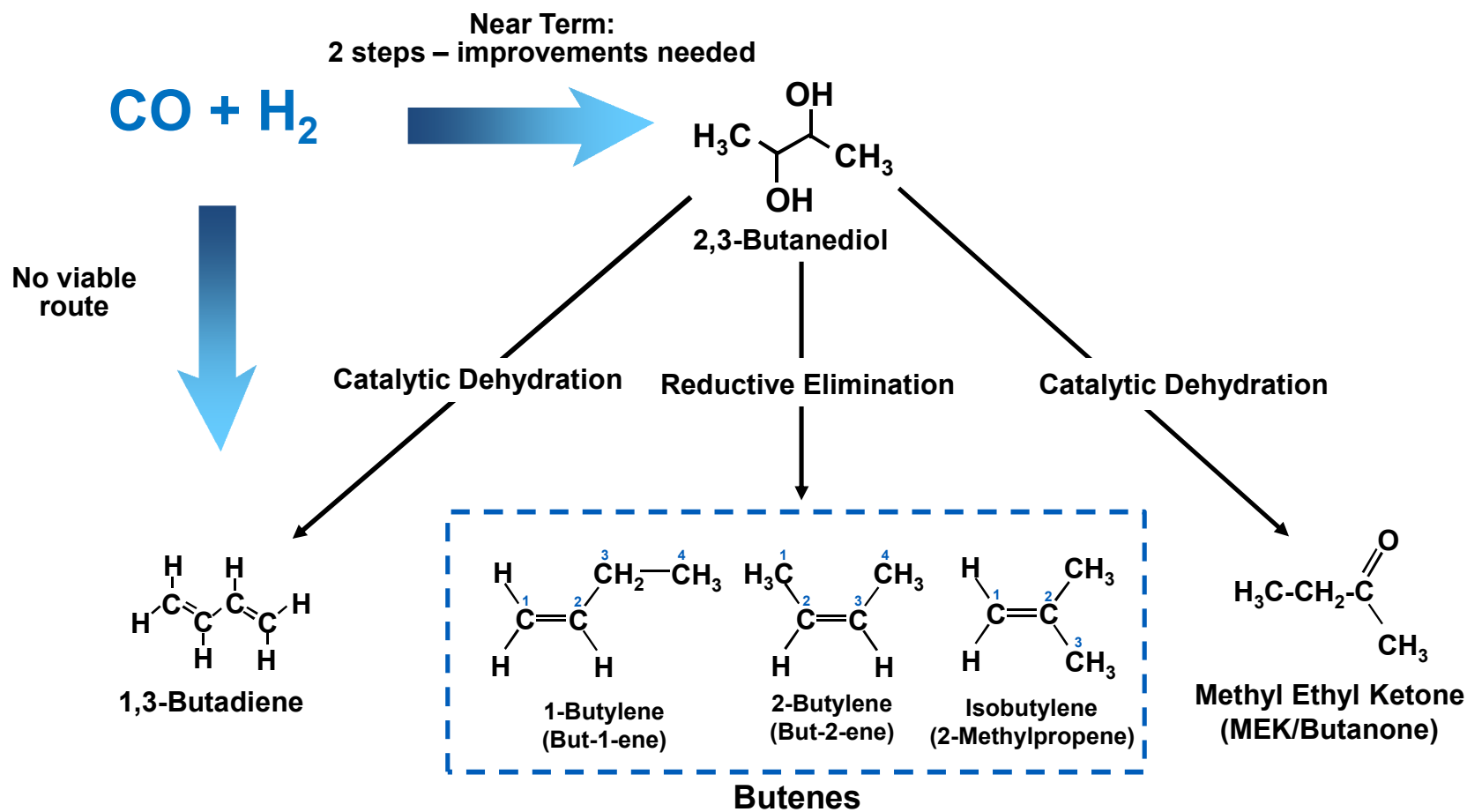
■ Butadiene Shortfall



Biology to Make C4



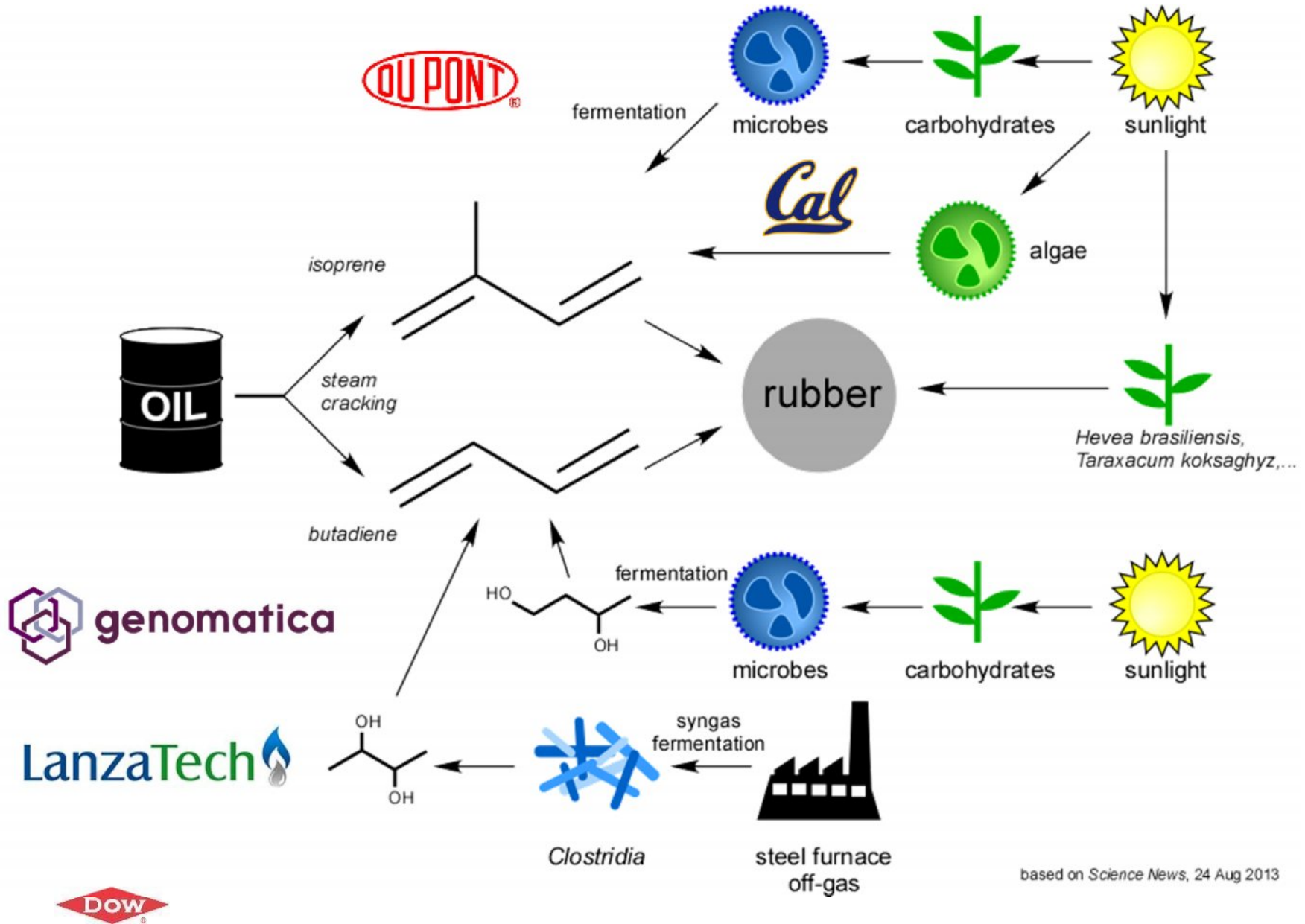
Route to Key C4 Chemicals



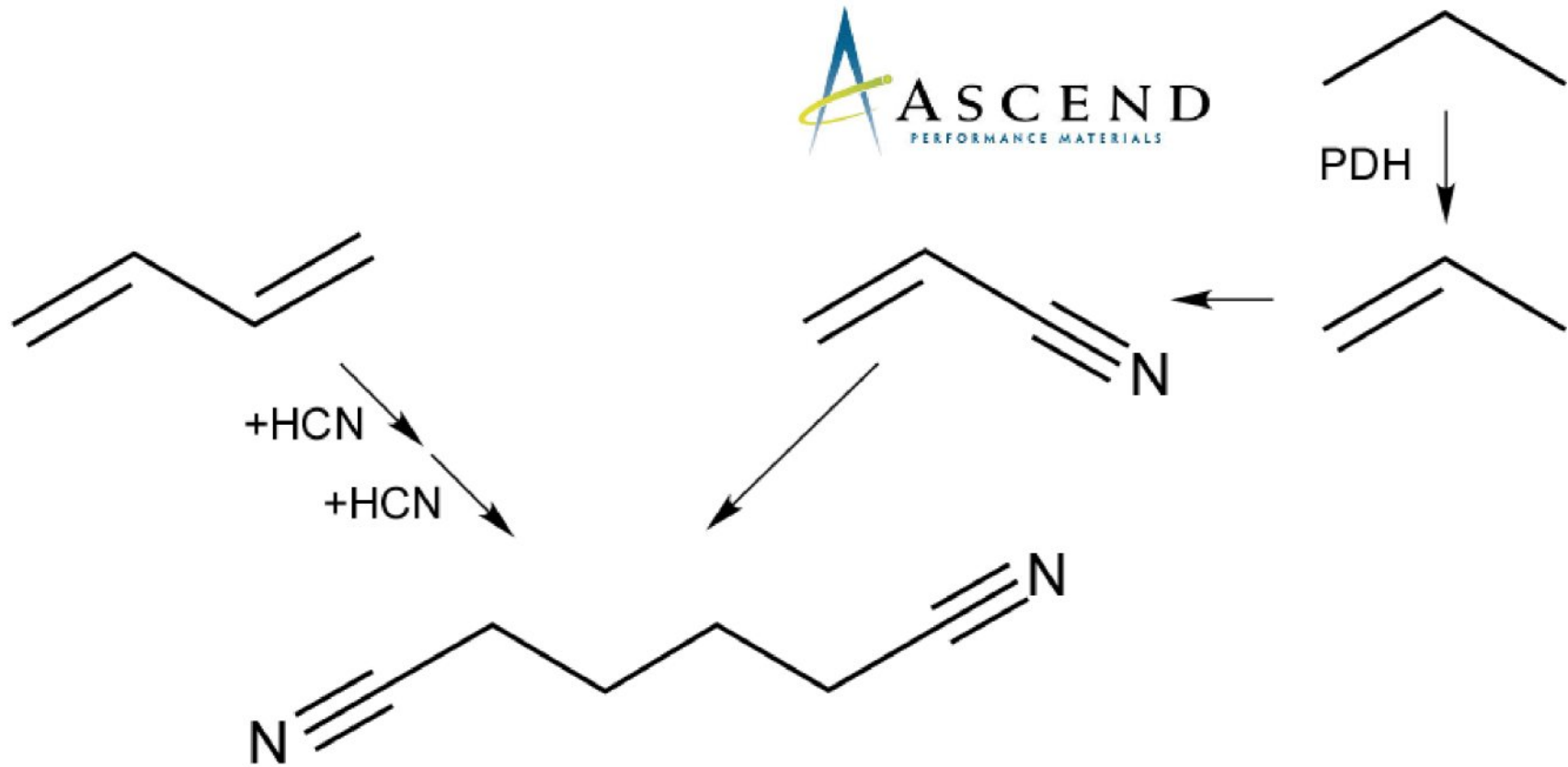
New Route to C₄'s without current supply challenges



Rubber Monomers



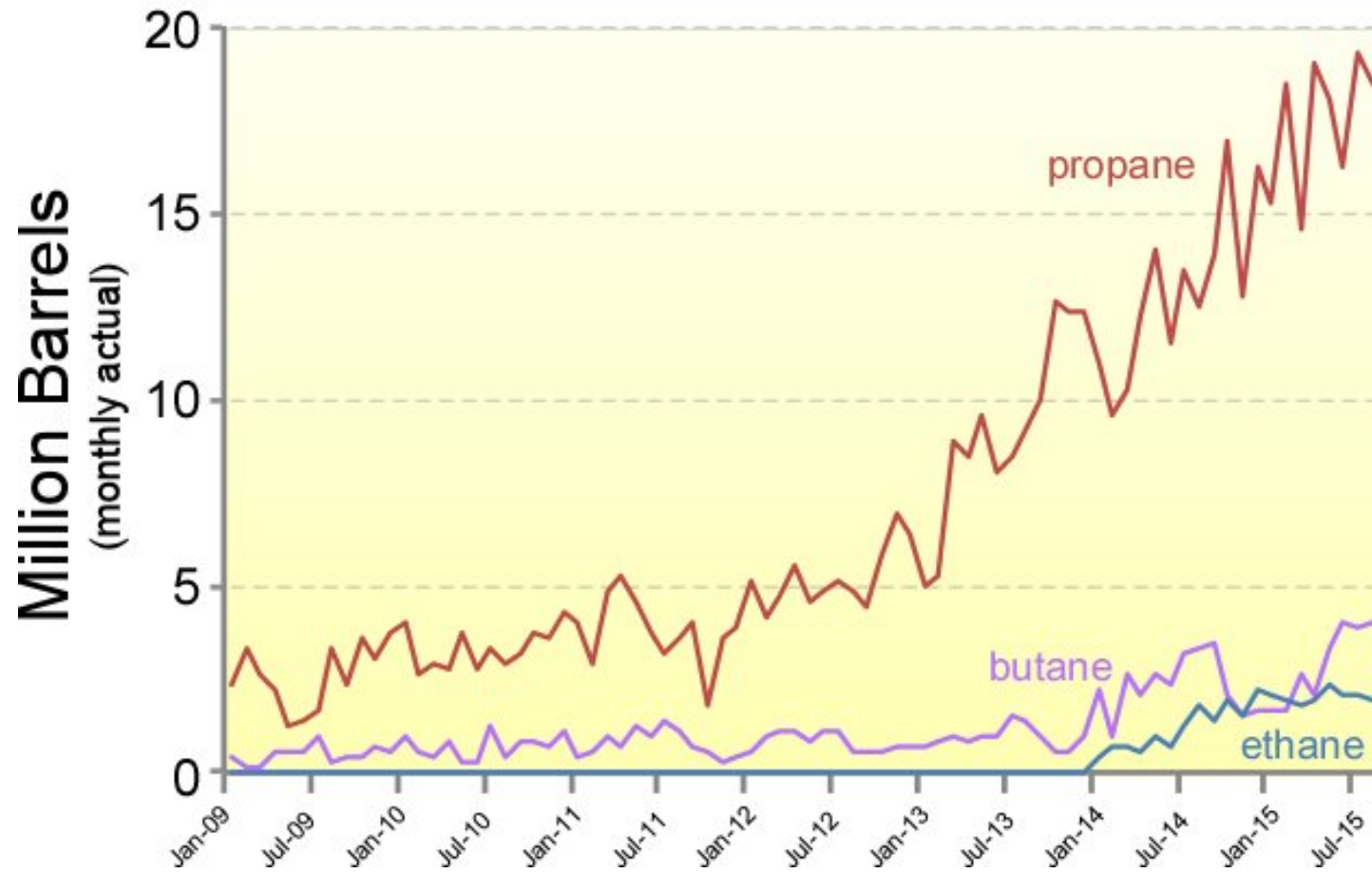
Adiponitrile



Does the name *Intrepid*
mean anything to you?



■ NGL Export



■ 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



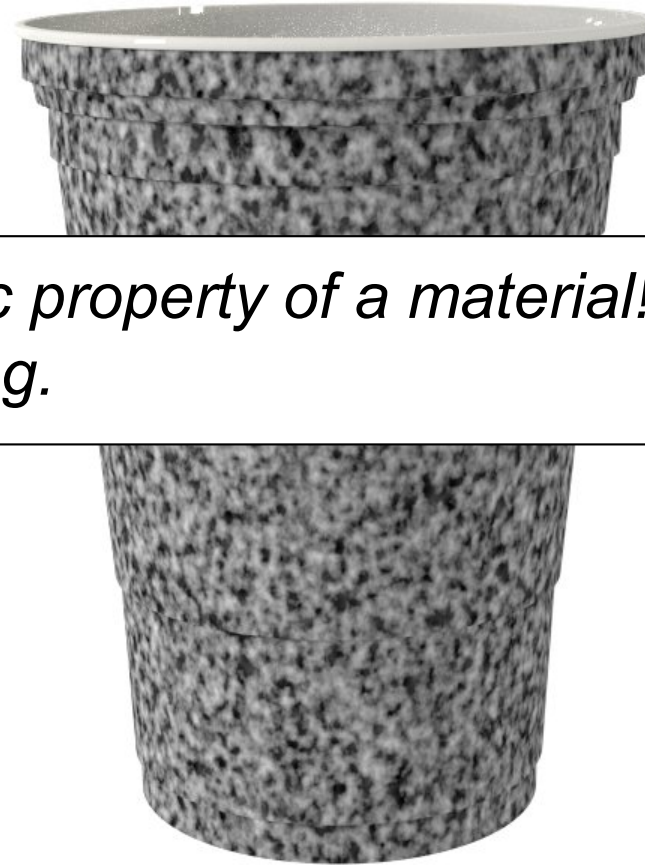
■ Sustainable?



■ Is this Cup Sustainable?

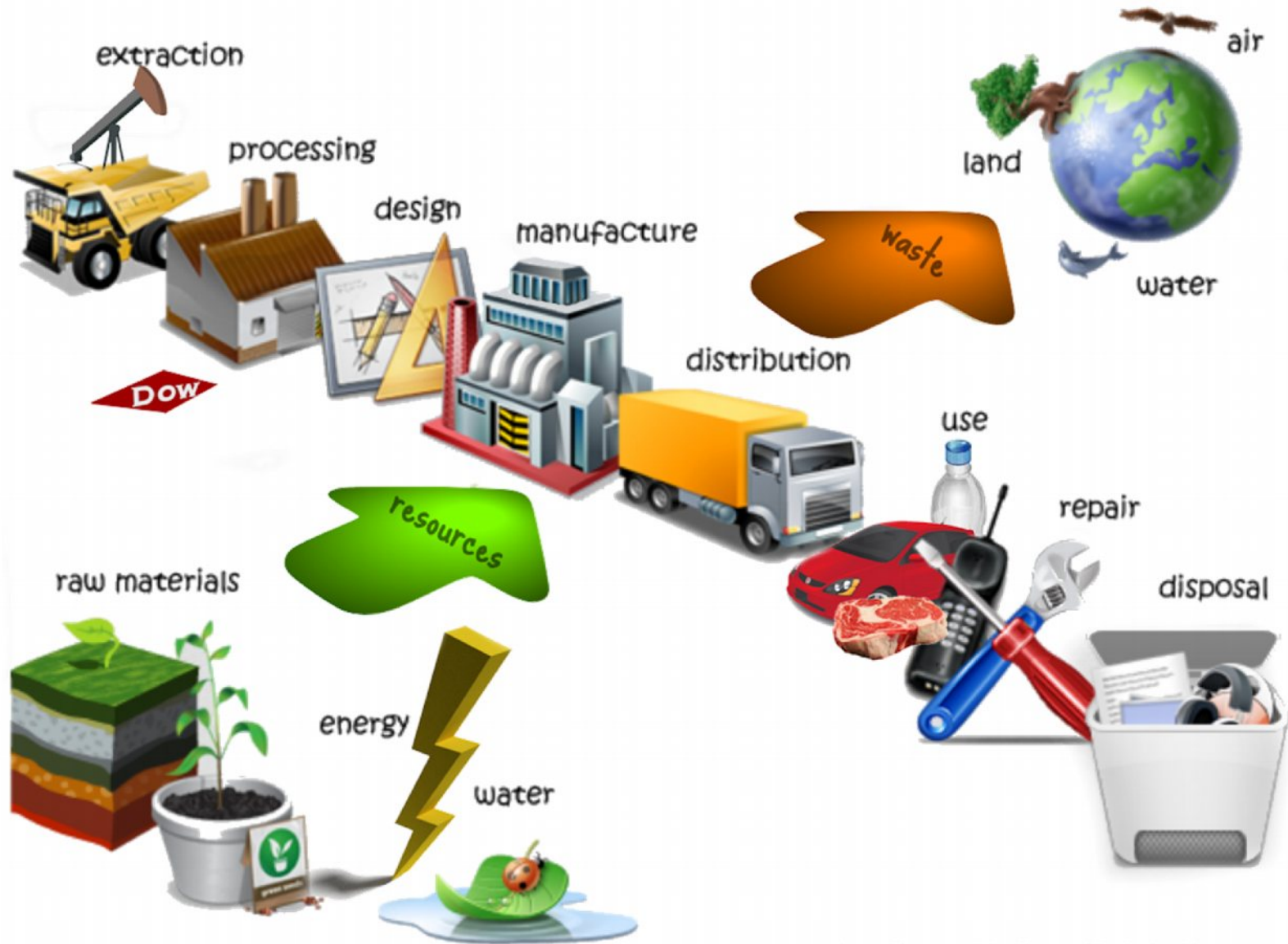


*Sustainable is not an intrinsic property of a material!
You can't know by just looking.*



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

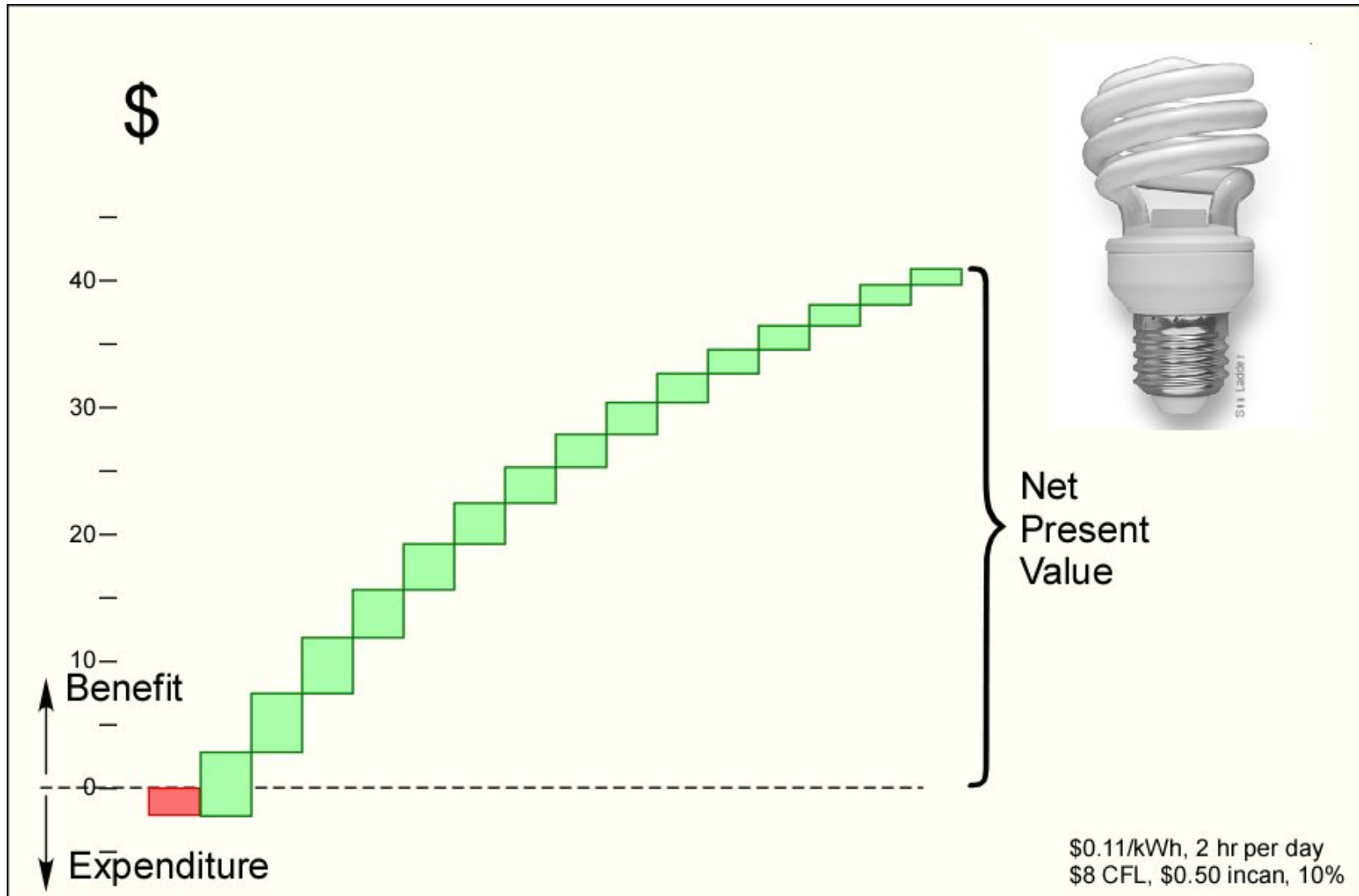
■ Embodied Fossil Energy



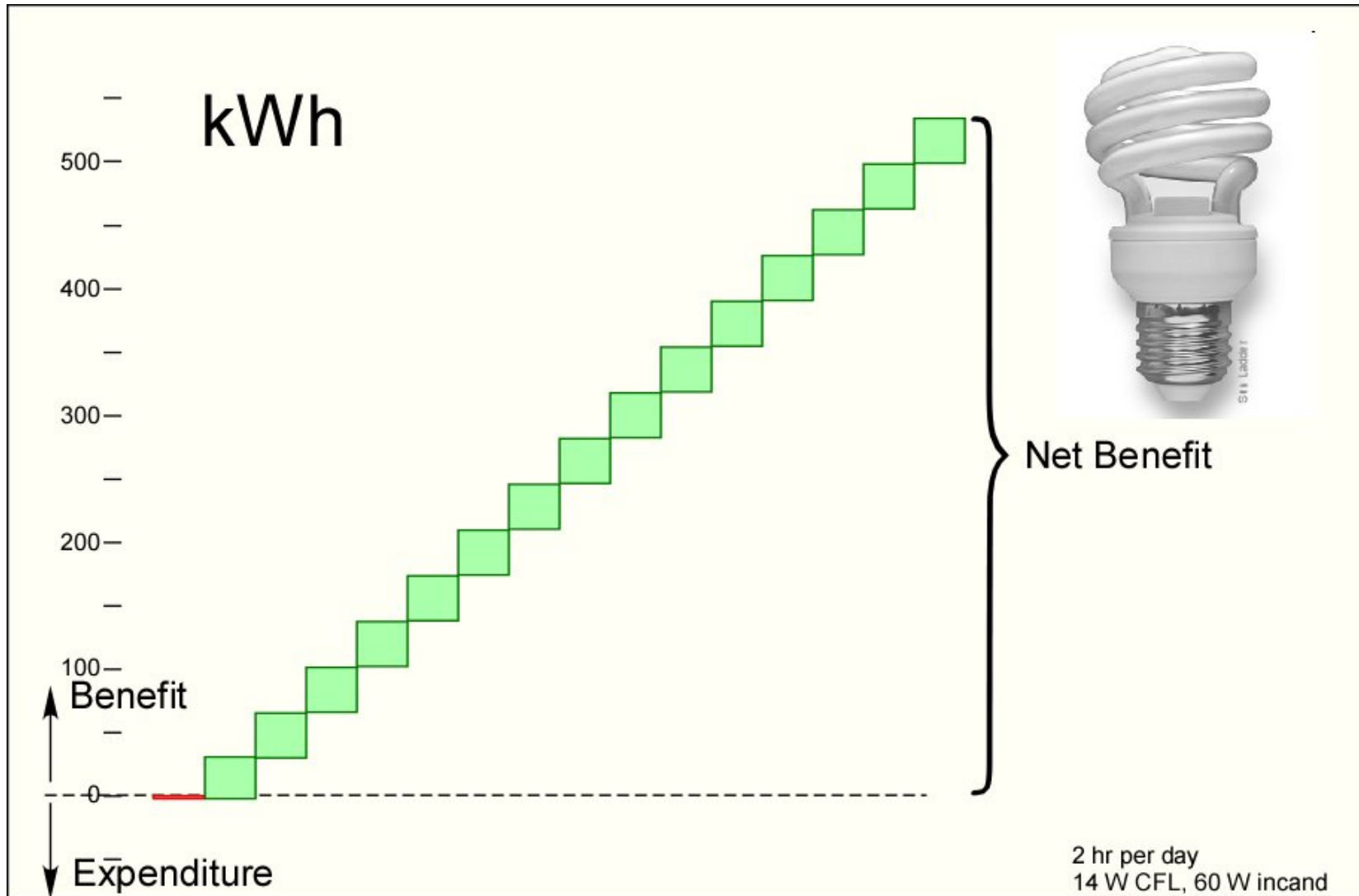




Financial Way of Looking At Benefit

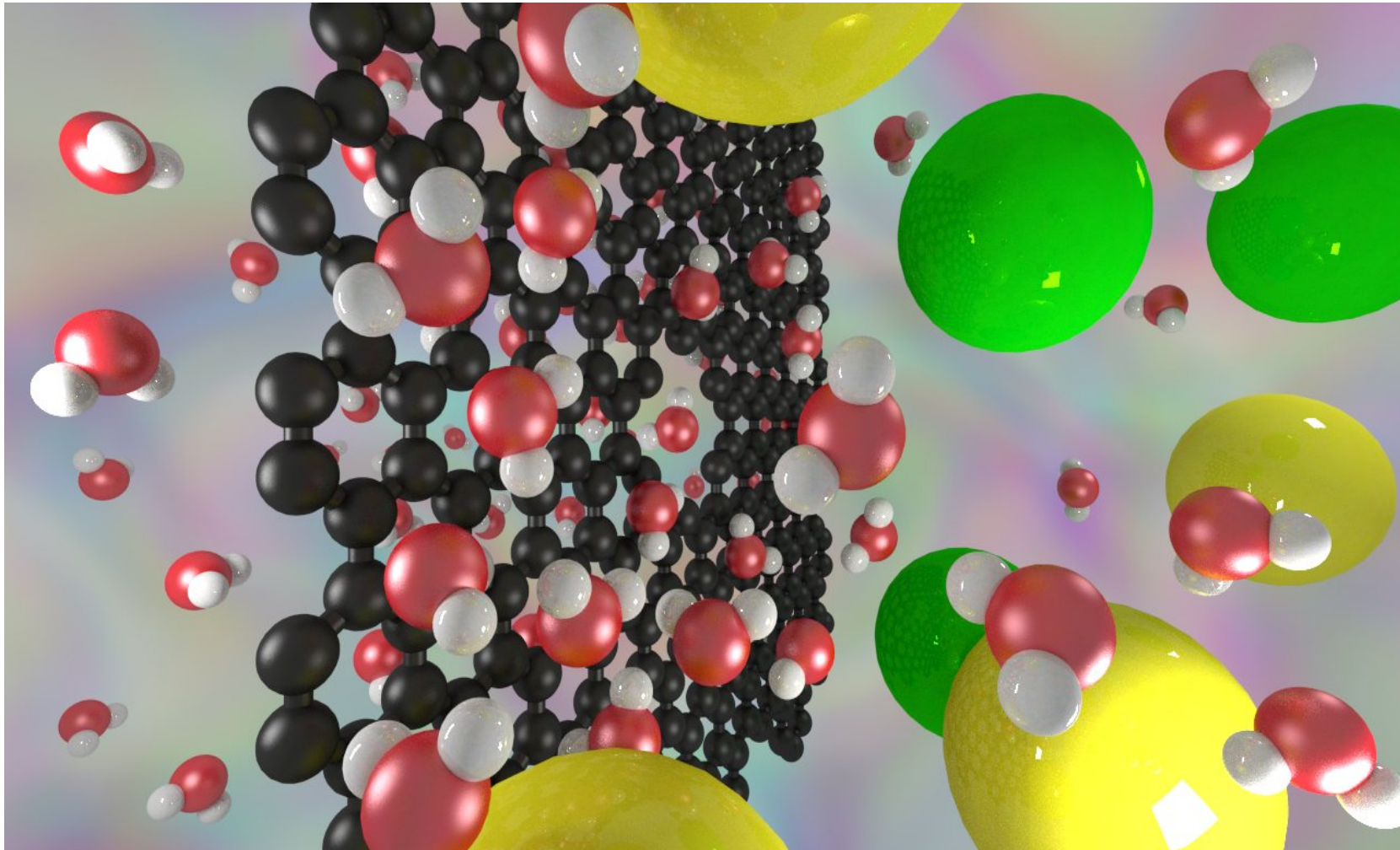


Why Not Sustainability?

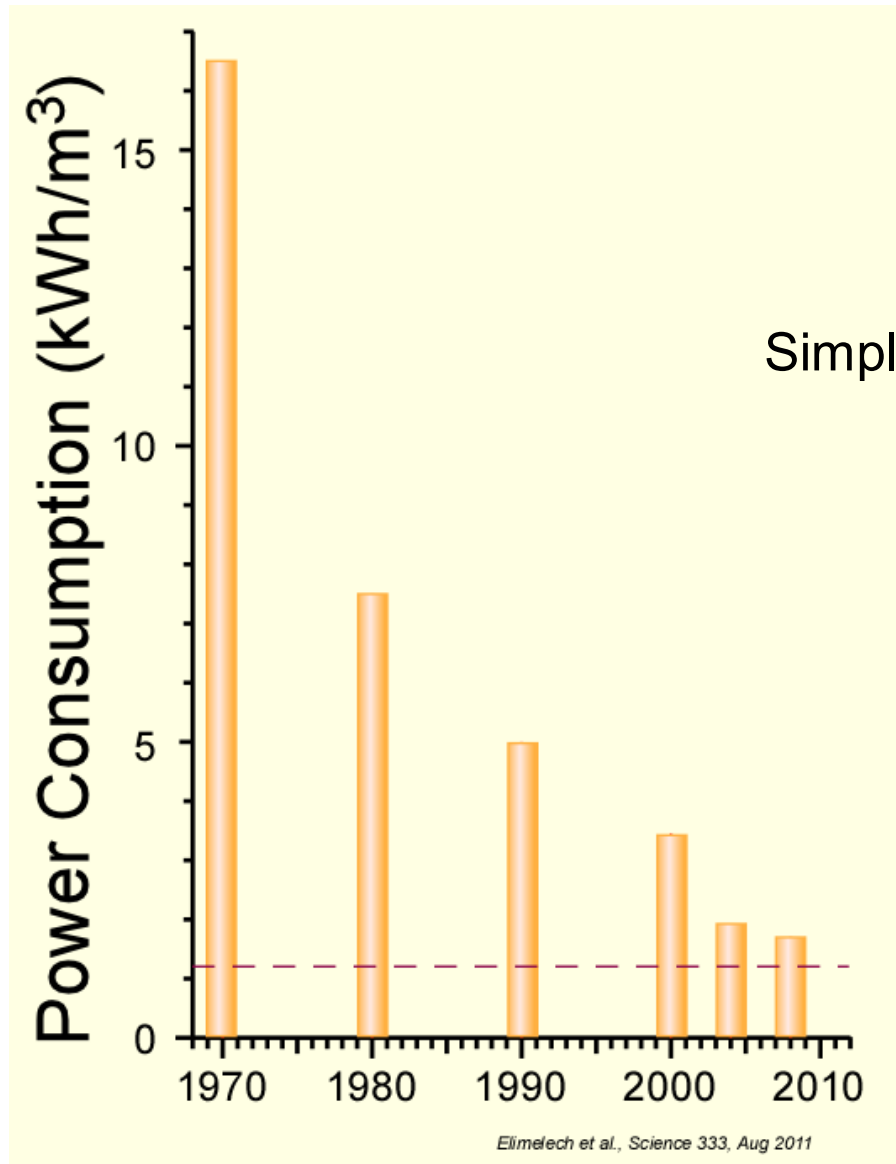




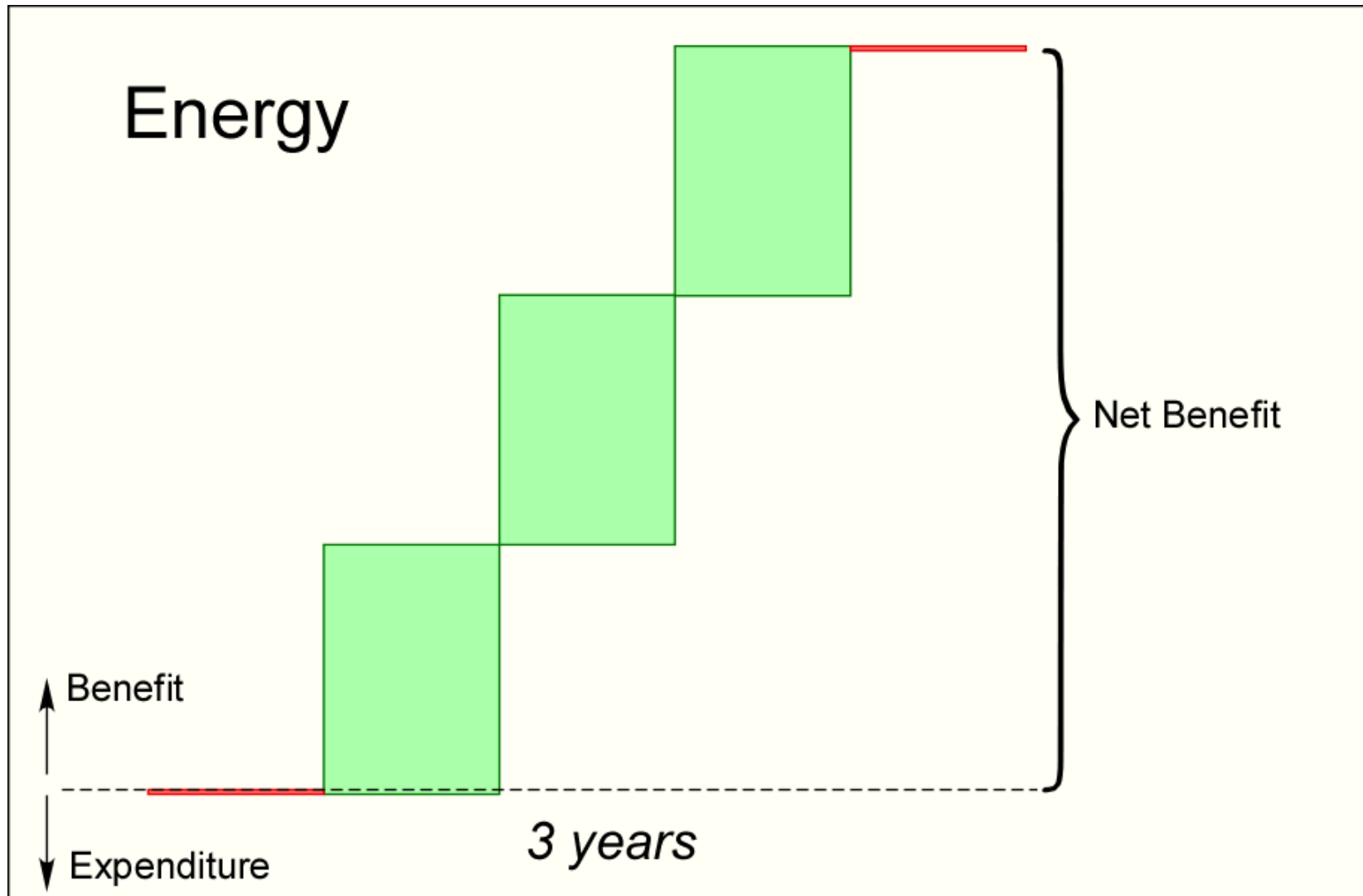
■ Misconceptions Demean Advances



■ Fresh Water Production



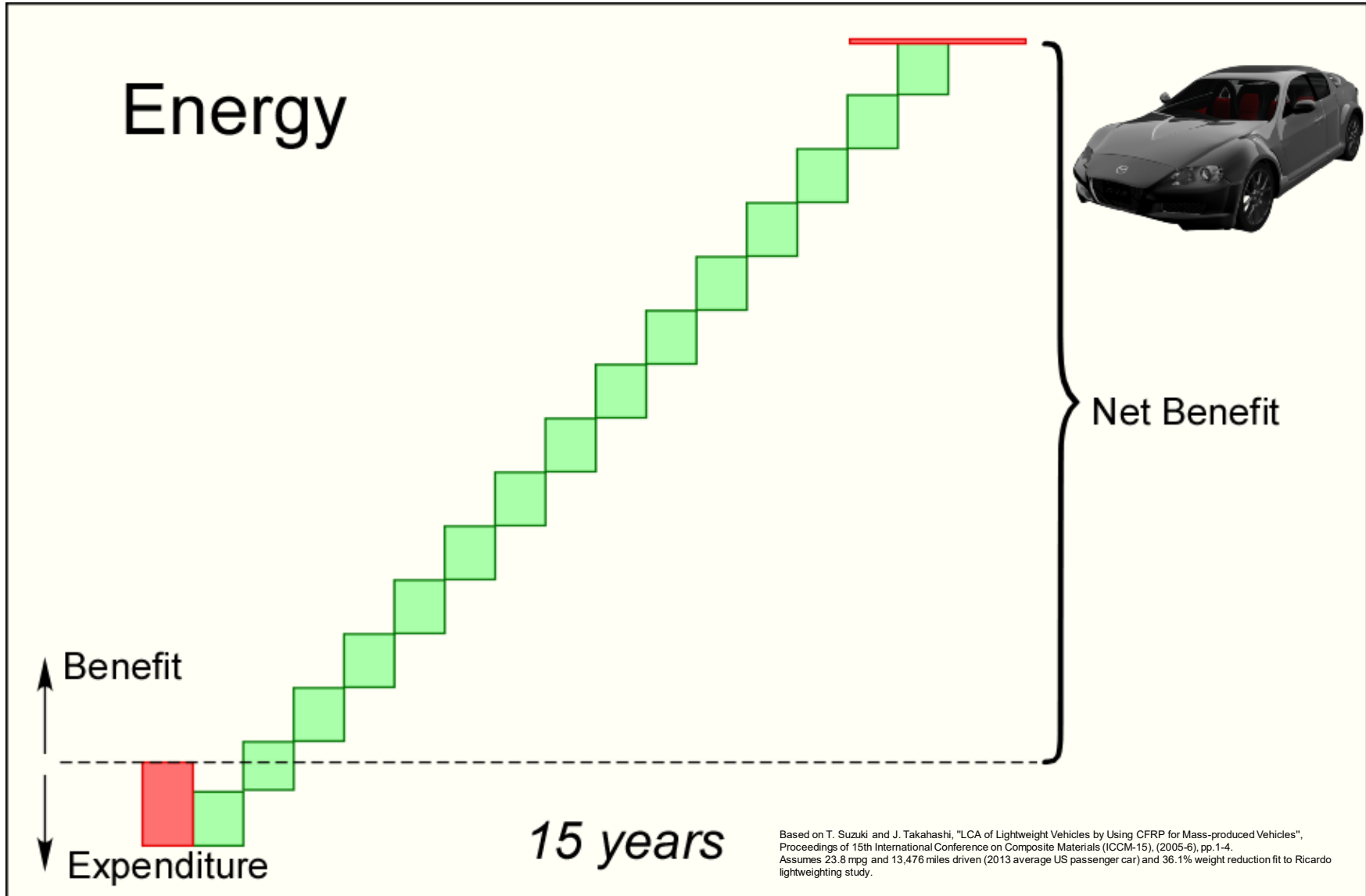
■ RO Cartridge Benefit



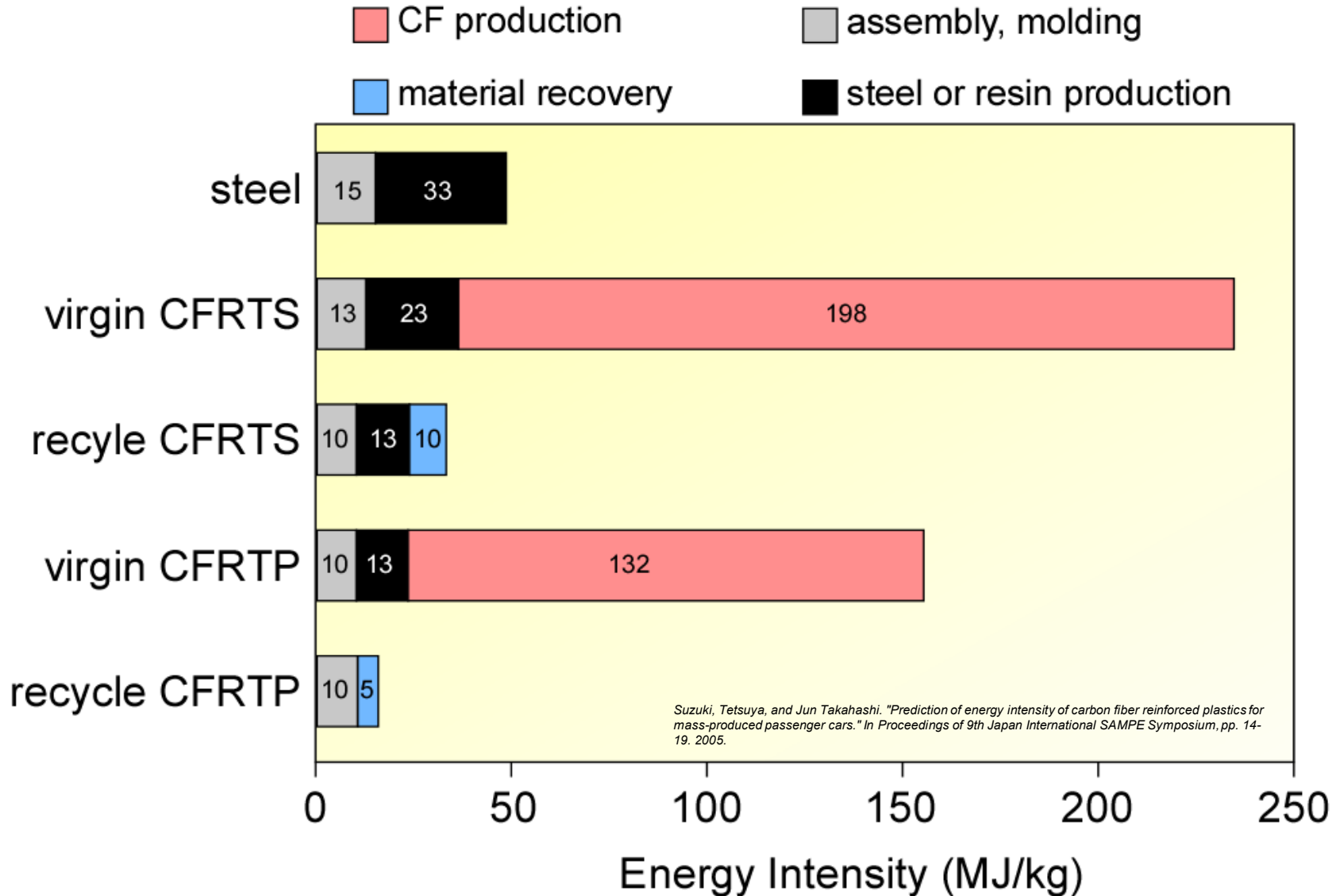
54.5 mpg



Carbon Fiber Benefit



■ Importance of Recycle

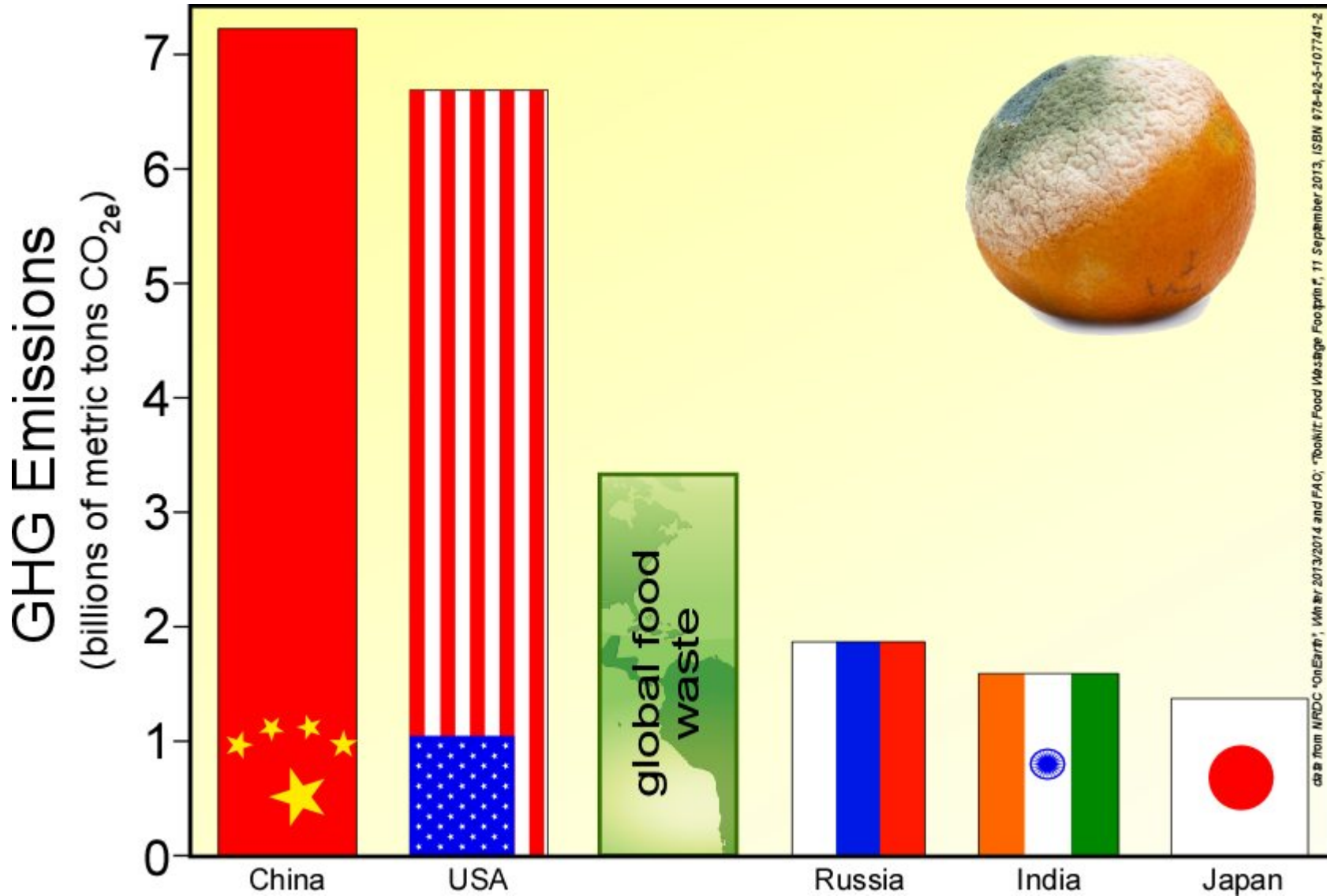


■ Packaging Addresses Global Challenges



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

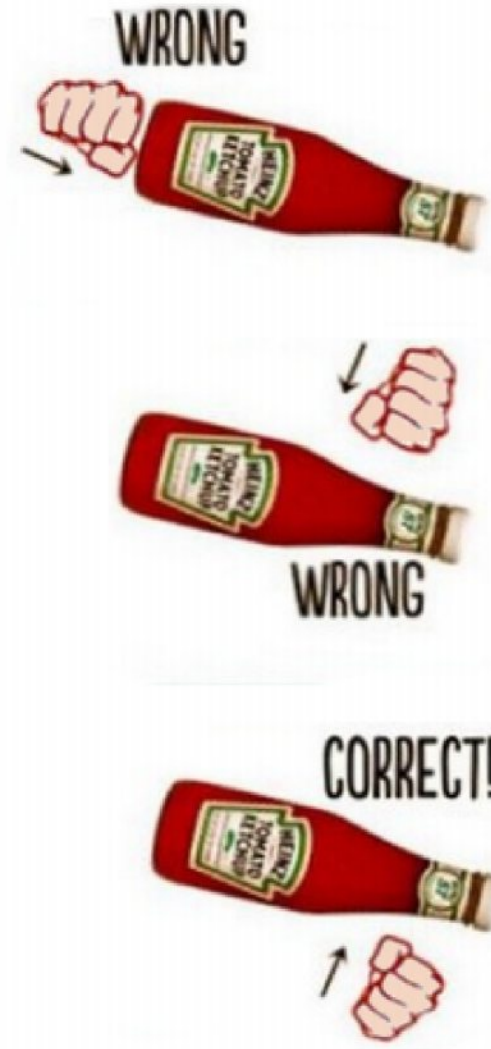
Food Waste



data from MRDC 'On Earth', Winter 2013/2014 and FAO, 'Toolkit Food Waste Message Footprint', 11 September 2013, ISBN 978-92-5-107741-2



■ Frustration with Packaging





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**

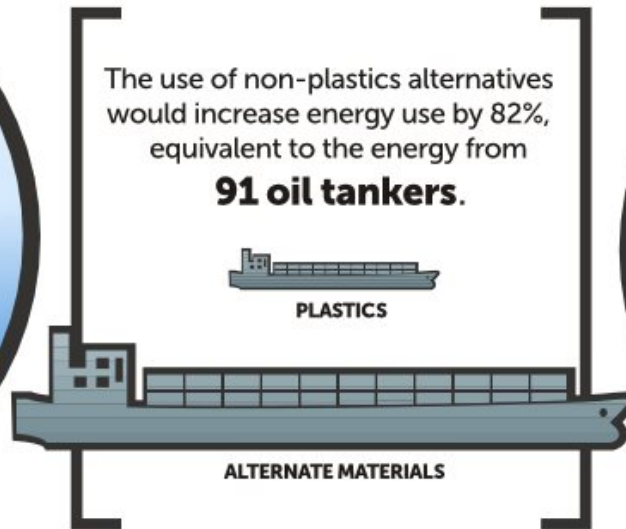
Using only a few grams of flexible plastic packaging extends the shelf life of a cucumber by more than three times.



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



■ LCA Studies on Packaging



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



■ Per Capita Energy Use

