

MJPhD

CHICKEN AND BROKEN GLASS: DRIVING THE CHEMICAL INDUSTRY TO A MORE SUSTAINABLE FUTURE

MARK JONES
CREATIVE DIRECTOR
MJPhD, LLC

17 April 2023





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glass is nature's safest container

Glass is open, honest, **transparent**.
It lets you see exactly what your baby is eating.

Glass is the ultimate in **sustainability**.
And it's endlessly recyclable.

Made from **pure**, natural minerals,
glass doesn't interact with your food at all.
So you know you're feeding your baby
only real fruits and vegetables.



Try Beech-Nut® real food for babies.
glasslife.com | #chooseglass

“Glass is nature’s
safest container”

“Glass is the
ultimate in
sustainability”

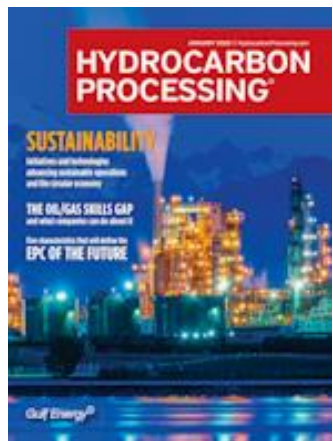


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SUSTAINABILITY DEFINITION



The process of managing available resources, investments and technologies to maintain and optimize operations for greater safety, reliability, efficiency, and environmental and social awareness.



SUSTAINABILITY DEFINITION



Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs.

Brundtland Commission



SUSTAINABILITY DEFINITION



Sustainability is the ability to continue a defined behavior indefinitely. Environmental sustainability is the ability to maintain rates of renewable resource harvest, pollution creation, and non-renewable resource depletion that can be continued indefinitely.

thwink.org



SUSTAINABILITY DEFINITION



Sustainability is wondrously complicated. Every person will give you a slightly different definition of sustainability. That's because sustainability really can be applied to almost anything in life.

Arizona State University School of Sustainability



SUSTAINABILITY DEFINITION



Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs.

Brundtland Commission



THREE PILLARS OF SUSTAINABILITY



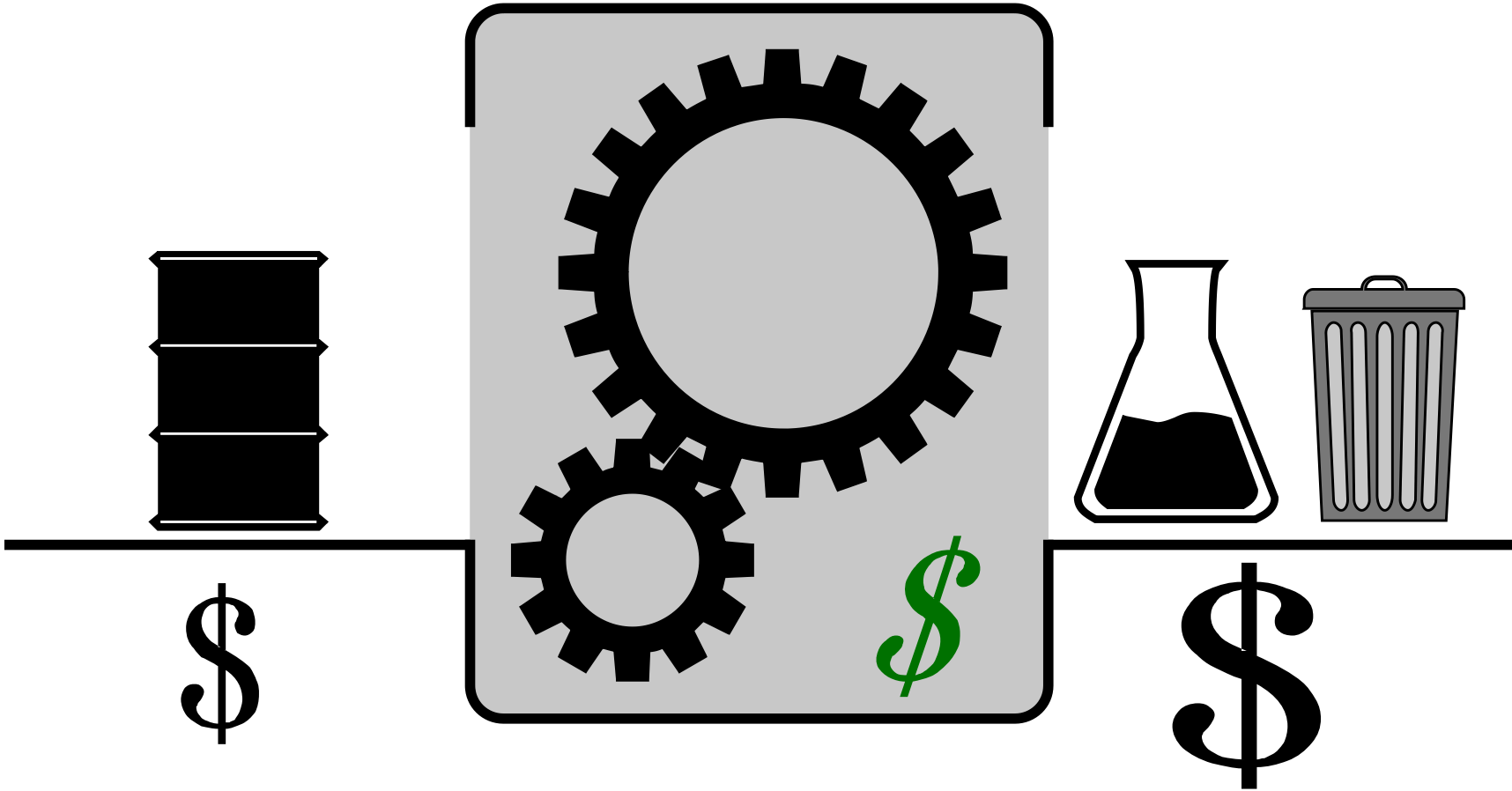
UN SUSTAINABLE DEVELOPMENT GOALS



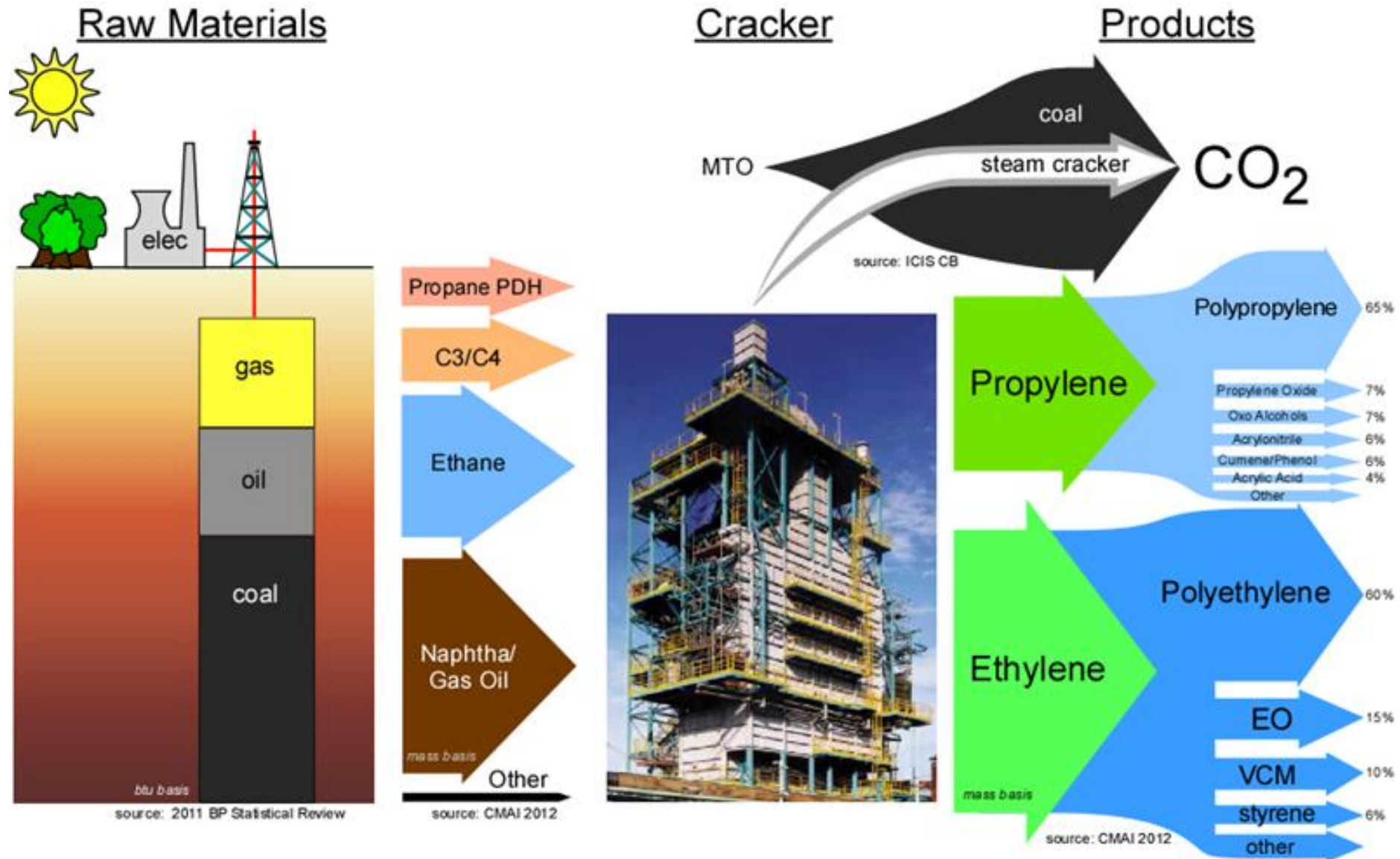
UN SUSTAINABLE DEVELOPMENT GOALS



SIMPLIFIED CHEMICAL INDUSTRY



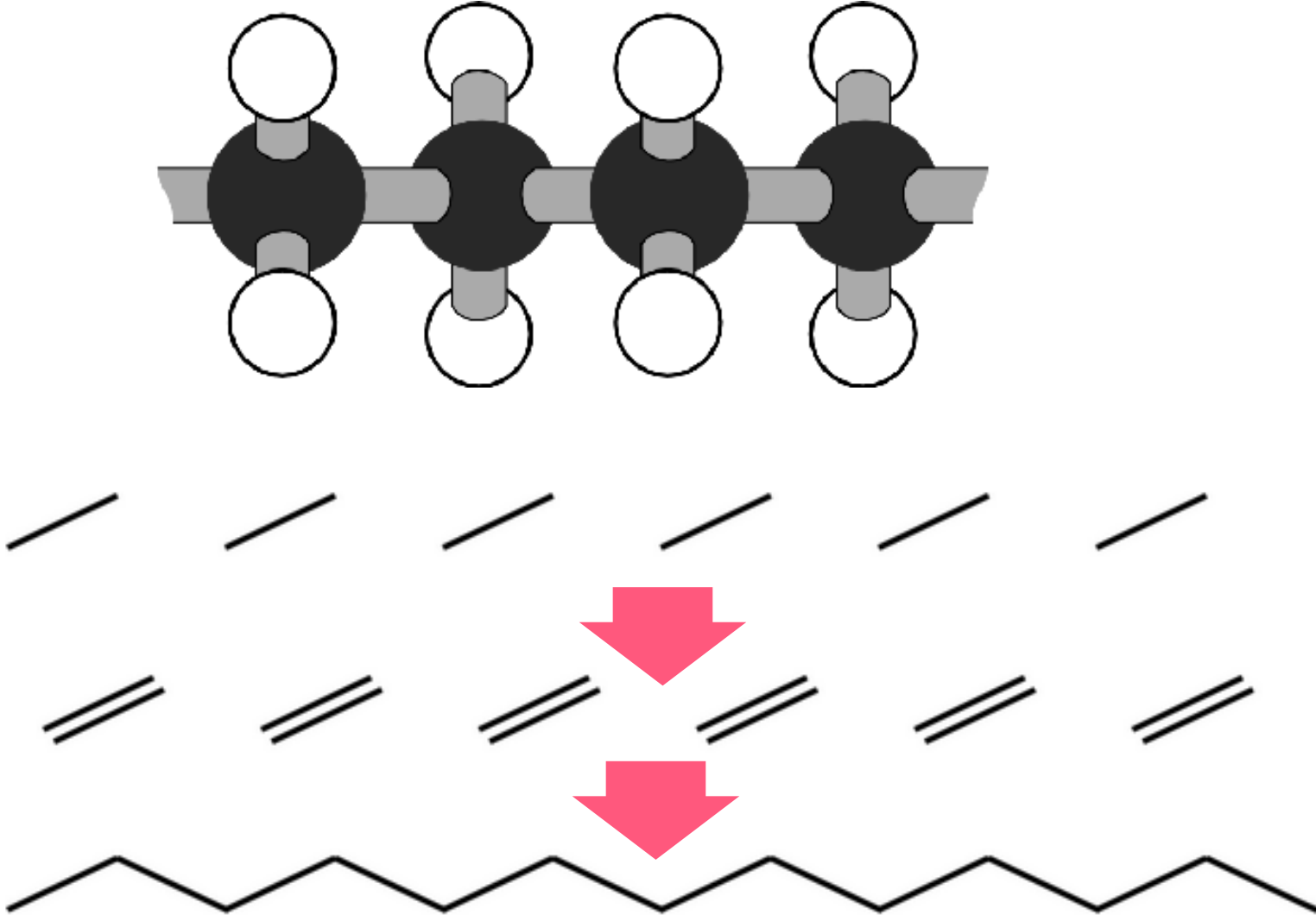
MODERN CHEMICAL INDUSTRY



ROUGH INDUSTRY MASS BALANCE

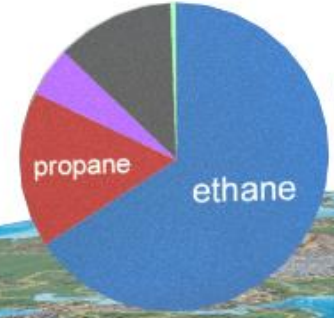
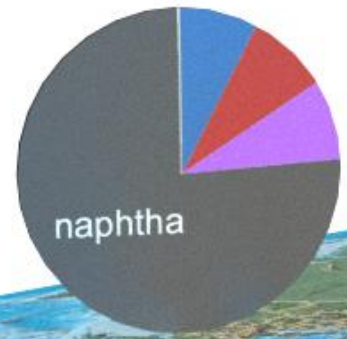
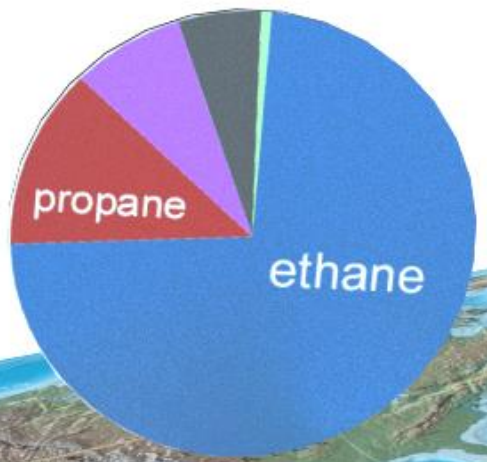


CHEMICAL TRANSFORMATION

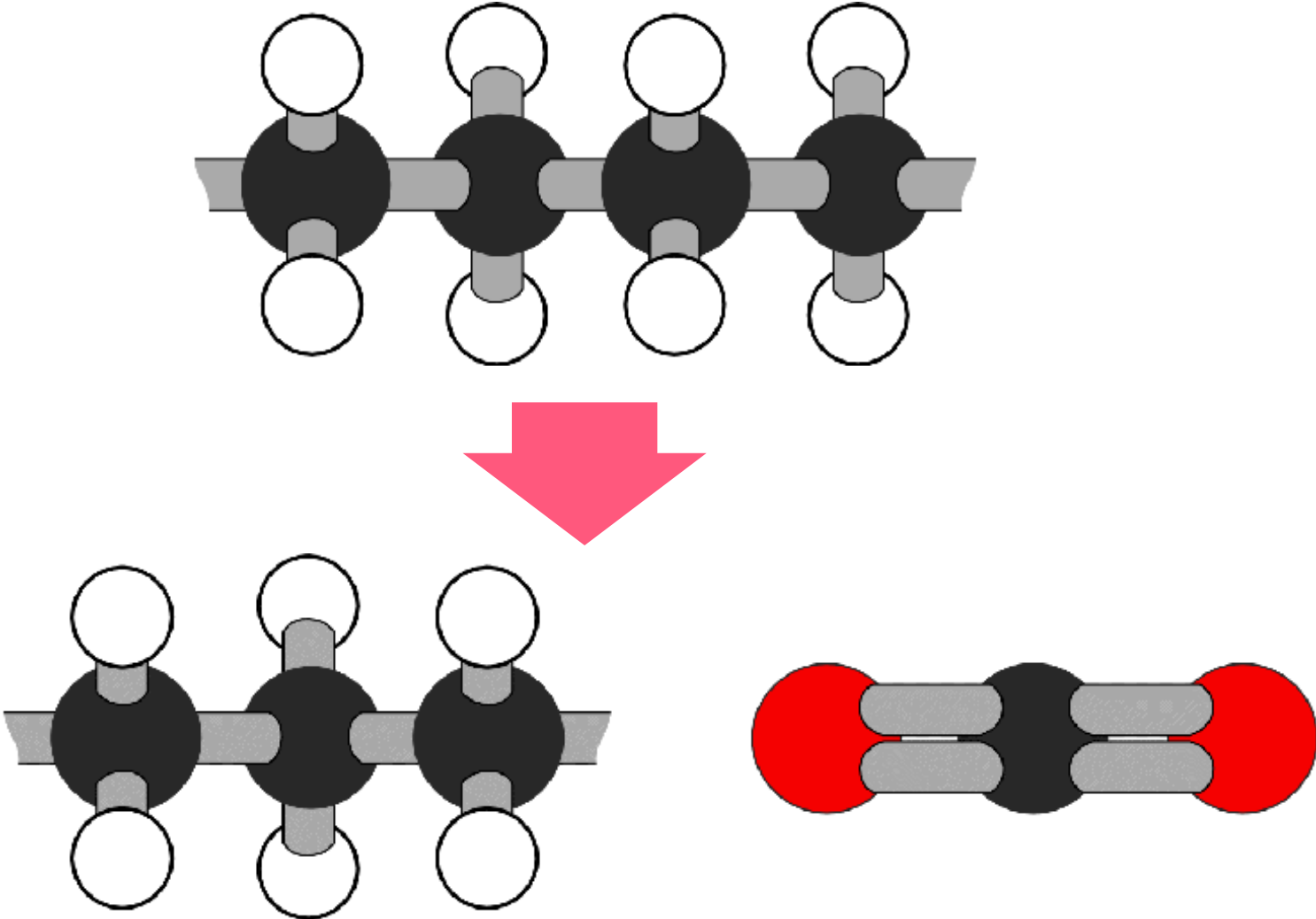


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■ ethane ■ propane ■ butane ■ naphtha ■ MTO/CTO ■ other

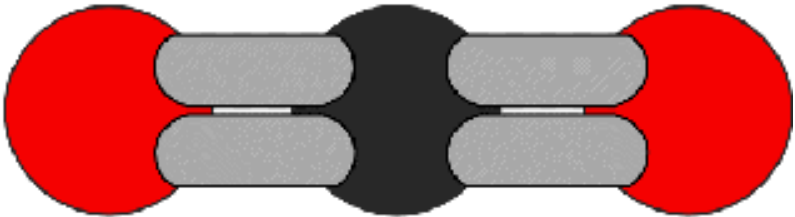
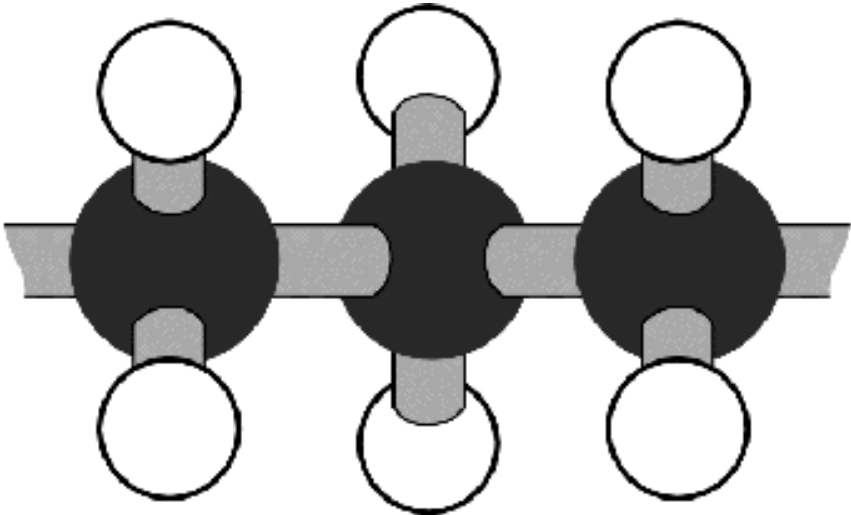


ROUGH MASS BALANCE

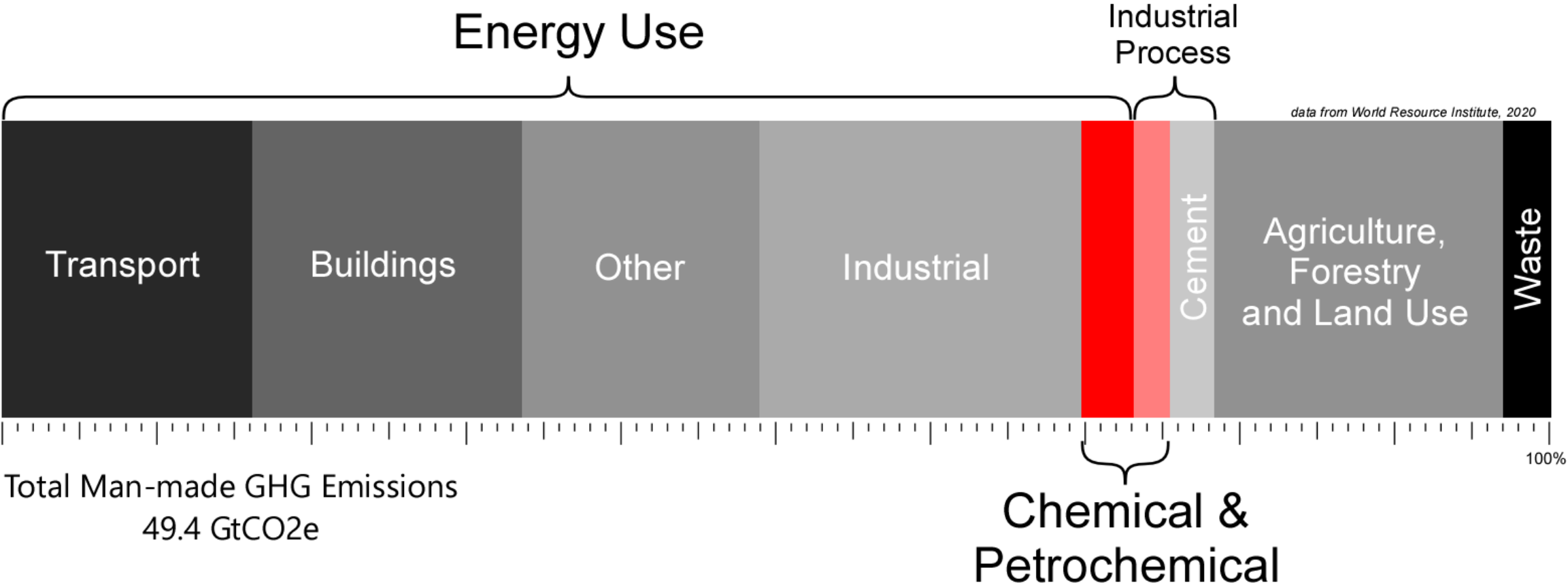


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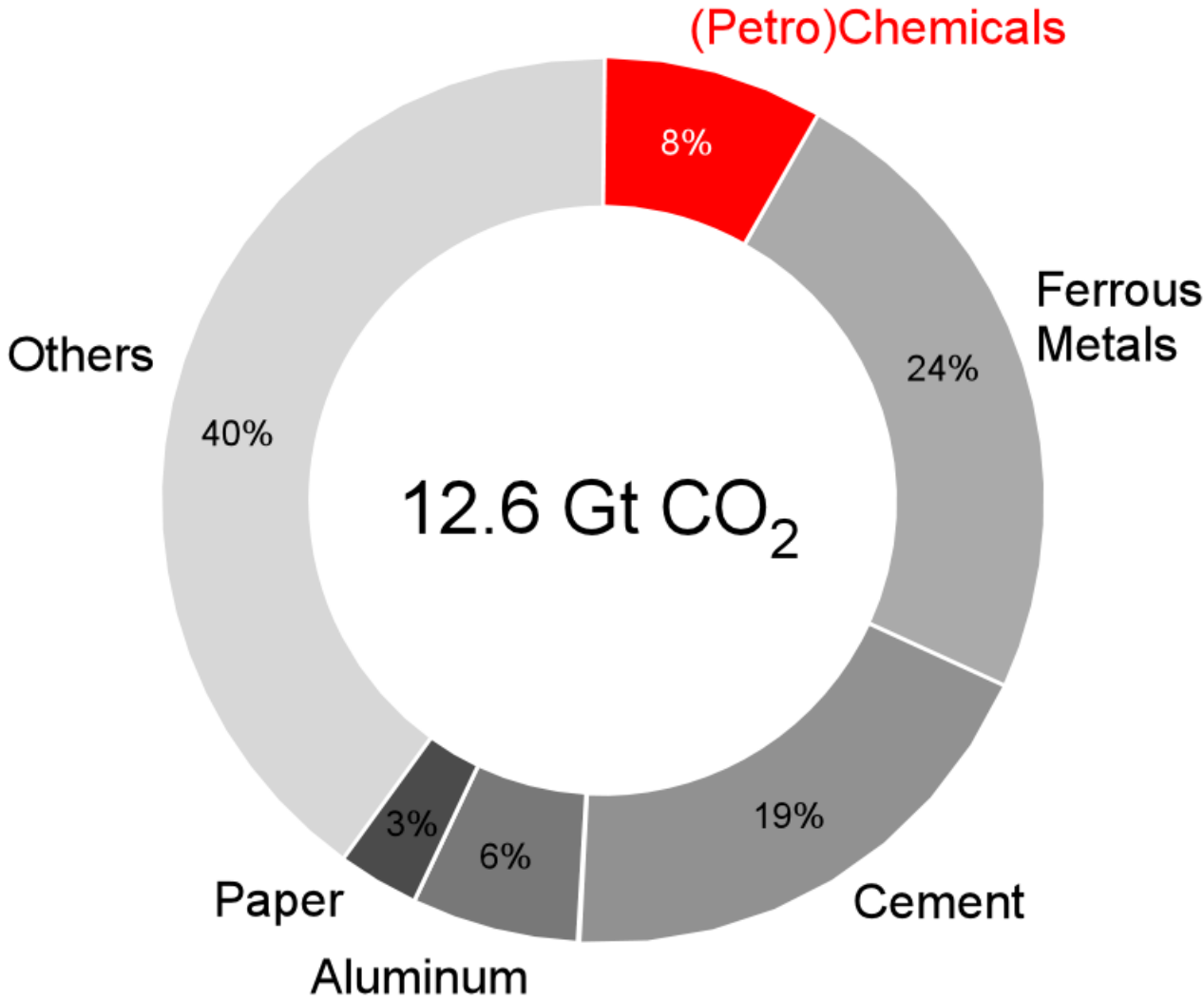
IMPLICATIONS



CARBON FOOTPRINT OF INDUSTRY

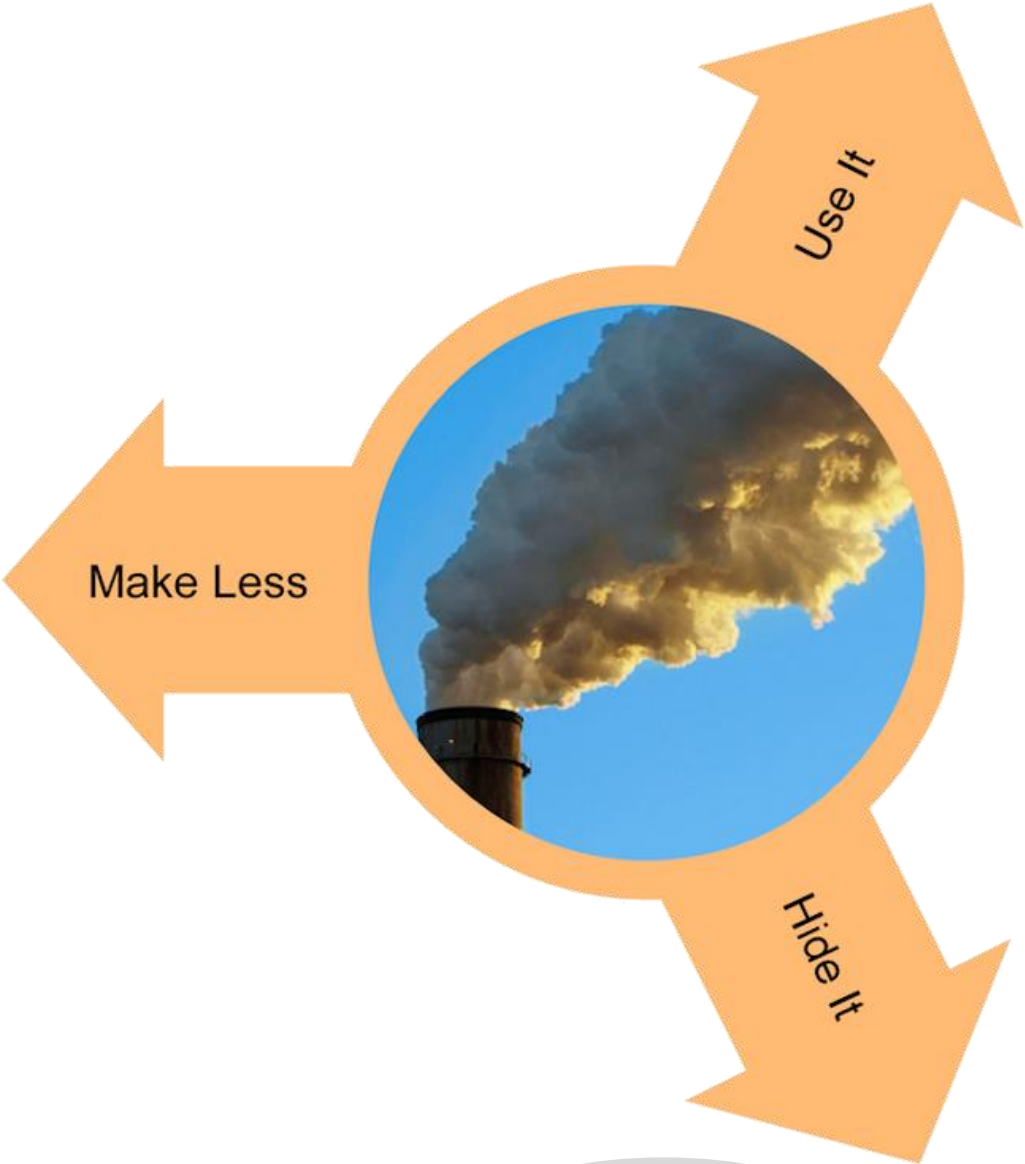


GLOBAL CO2 EMISSIONS FROM INDUSTRY

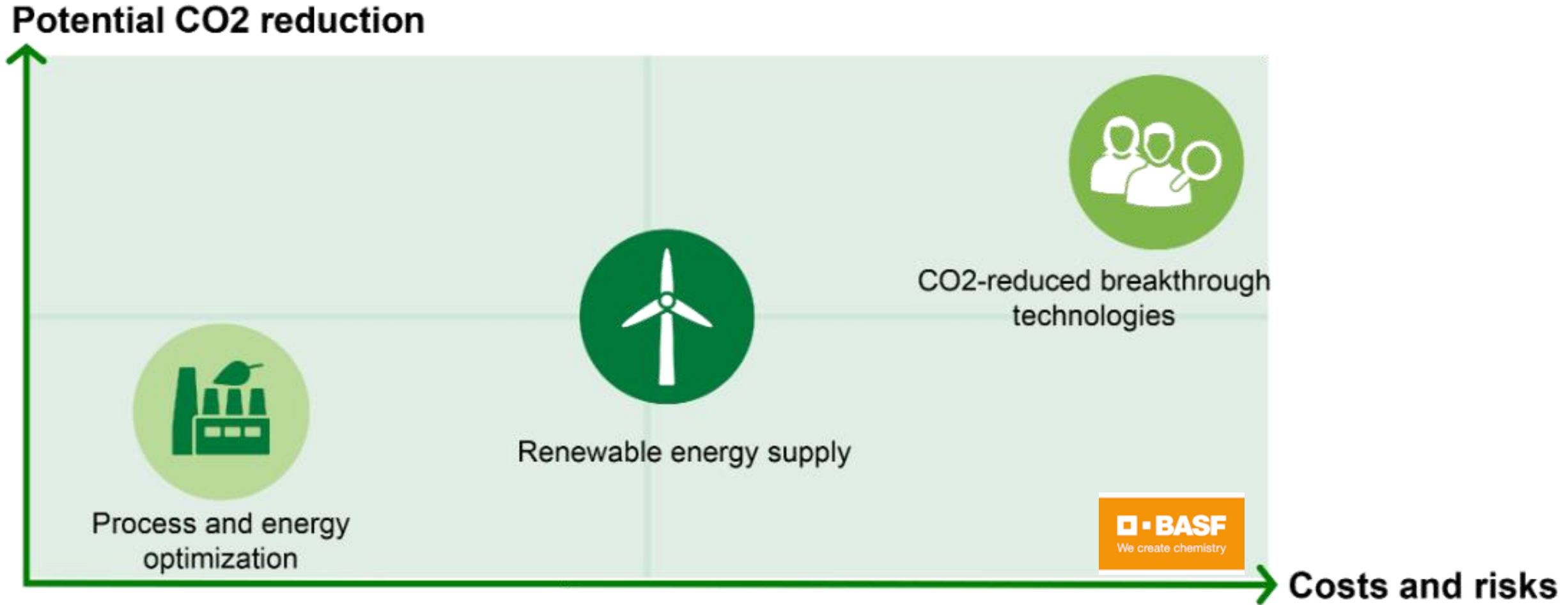


Martin Brudemuller, BASF at the World Economic Forum, 21 Jan 2020

OPTIONS FOR CO₂



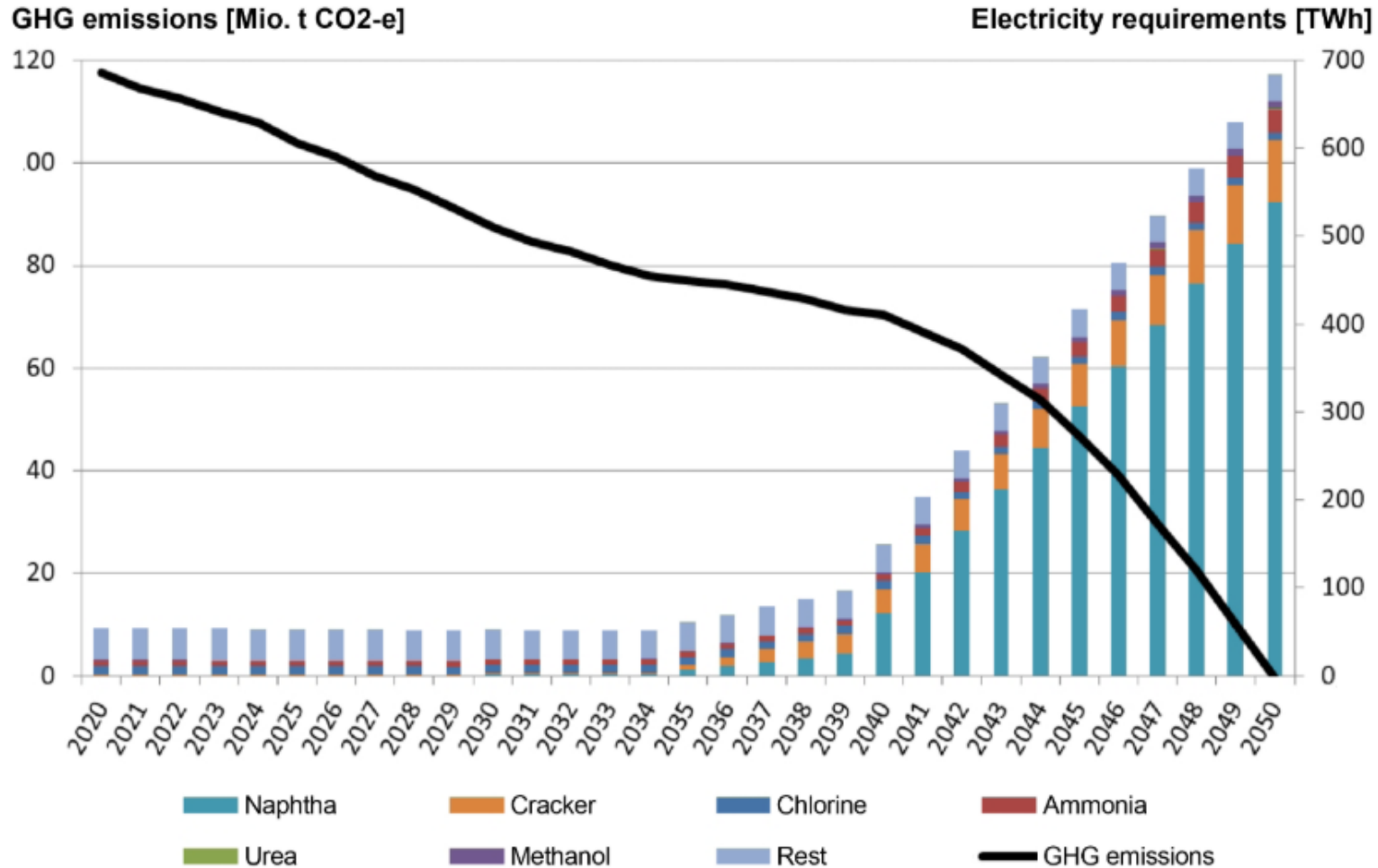
POTENTIAL SOLUTIONS FOR DIRECT EMISSIONS



Martin Brudemüller, BASF at the World Economic Forum, 21 Jan 2020

PLAN FOR ZERO EMISSIONS

Electricity requirements to achieve greenhouse gas neutrality in the German chemical industry



490 for all Germany today

227 for all industry

Martin Brudemüller, BASF at the World Economic Forum, 21 Jan 2020

MAIN FOCUS AREAS-2020 UPDATE



Protect the Climate >>



Stop the Waste >>



Close the Loop >>

THE COLLINS WORD OF THE YEAR 2018 IS...

SINGLE-USE

'**Single-use**', a term that describes items whose unchecked proliferation are blamed for damaging the environment and affecting the food chain, has been named Collins' Word of the Year 2018.

Single-use refers to products – often plastic – that are 'made to be used once only' before disposal. Images of plastic adrift in the most distant oceans, such as straws, bottles, and bags have led to a global campaign to reduce their use.

The word has seen a four-fold increase since 2013, with news stories and images such as those seen in the BBC's Blue Planet II steeply raising public awareness of the issue.



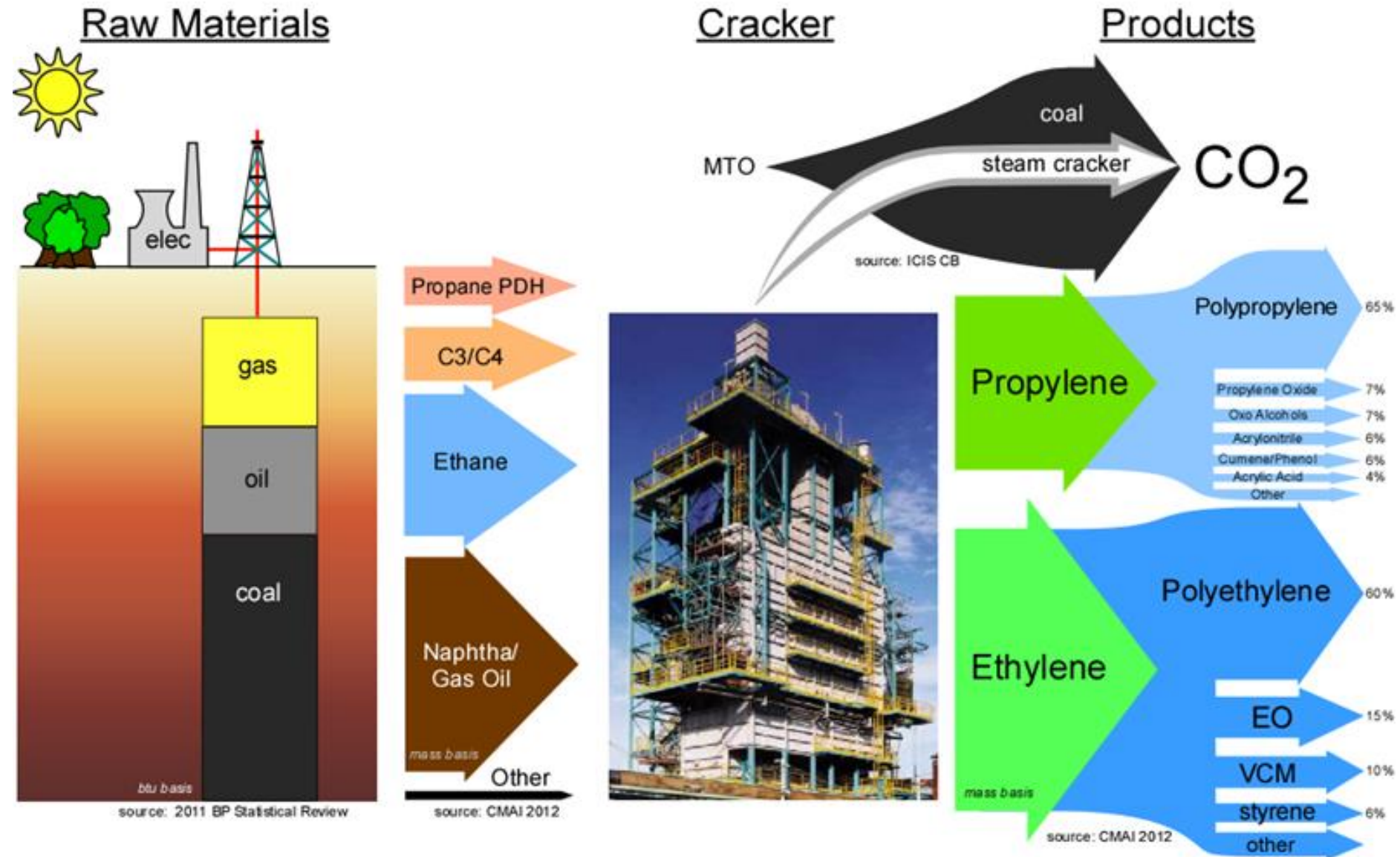
SINGLE-USE

adj (sɪŋgəlˈjuːs)
made to be used
once only

#CollinsWOTY

Collins
Pioneers in dictionary publishing since 1819

MODERN CHEMICAL INDUSTRY



OCEAN PLASTIC



2014

2050

PLASTICS
PRODUCTION

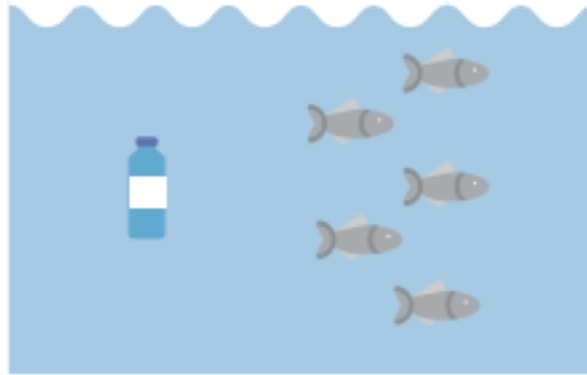


311 MT

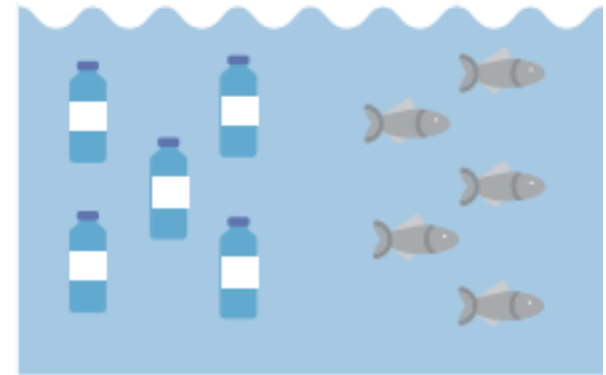


1,124 MT

RATIO OF PLASTICS TO
FISH IN THE OCEAN
(BY WEIGHT)

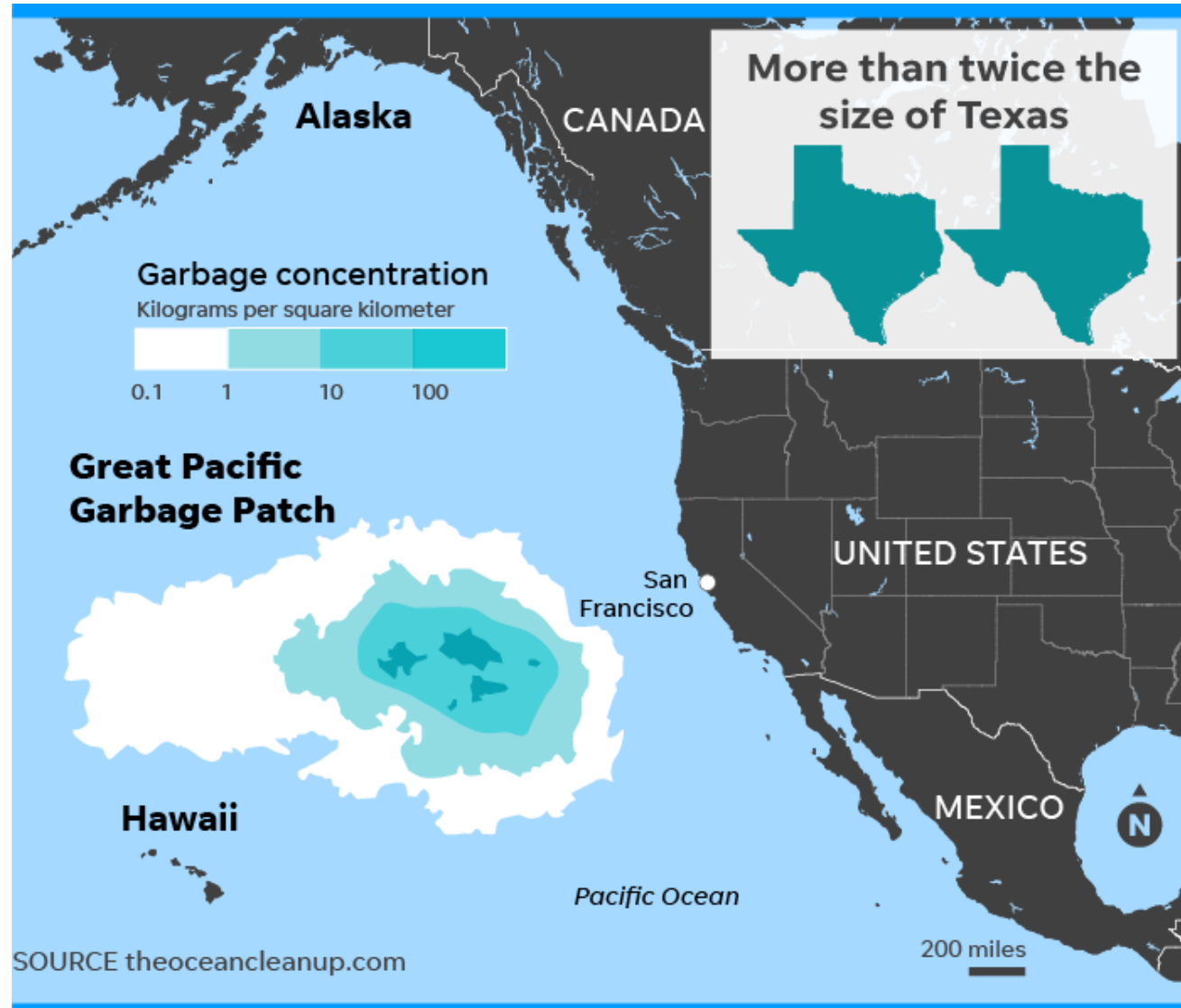


1:5



>1:1

THE PACIFIC GYRE





1000



500



200



100











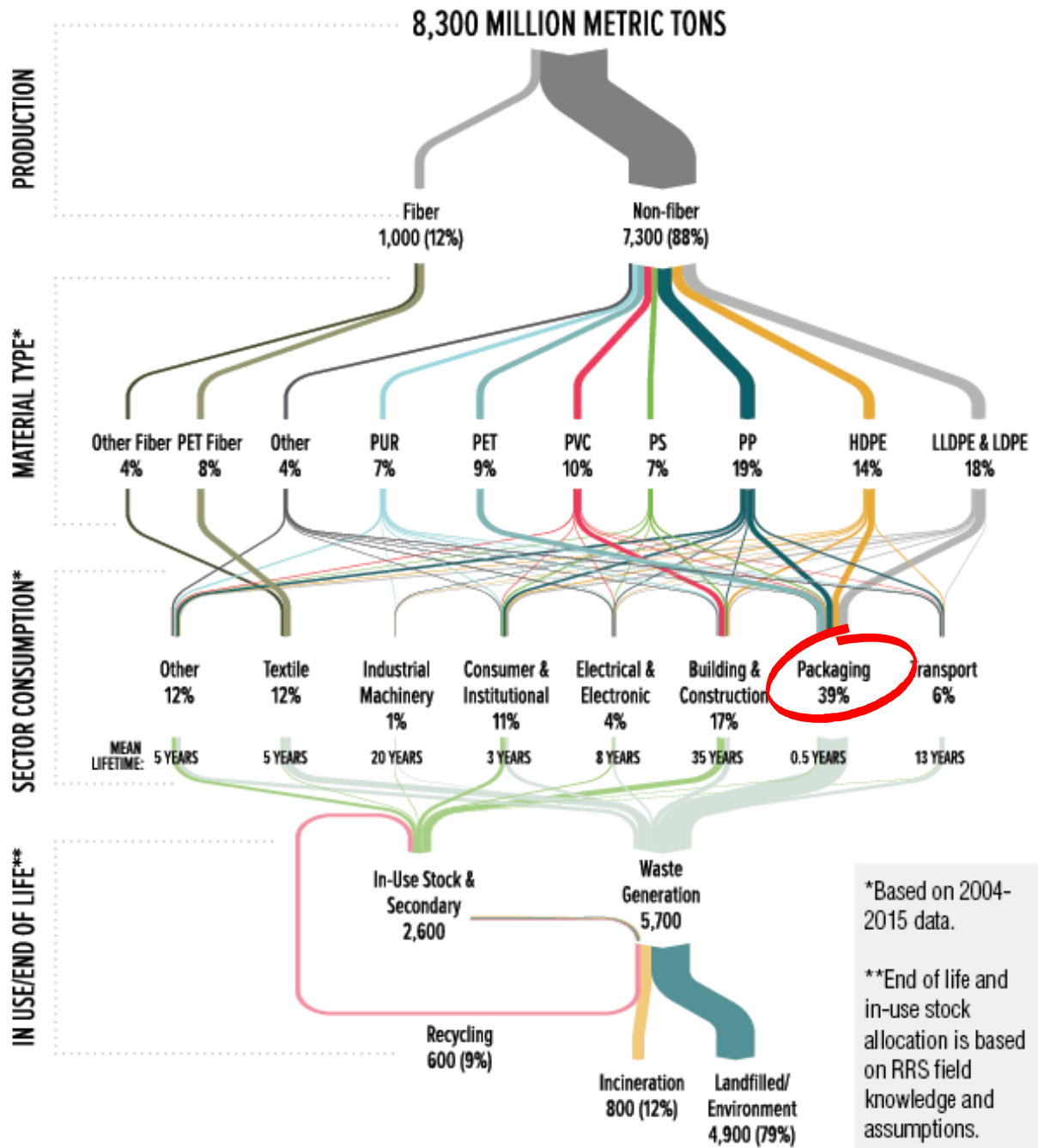




In The Pacific Gyre At Point of Highest Plastic Concentration







*packaging
39%*

*Based on 2004-2015 data.
**End of life and in-use stock allocation is based on RRS field knowledge and assumptions.

PLASTIC PROVIDES BENEFITS



PLASTIC PROVIDES BENEFITS



ALTERNATIVES COST MORE

\$98 Billion



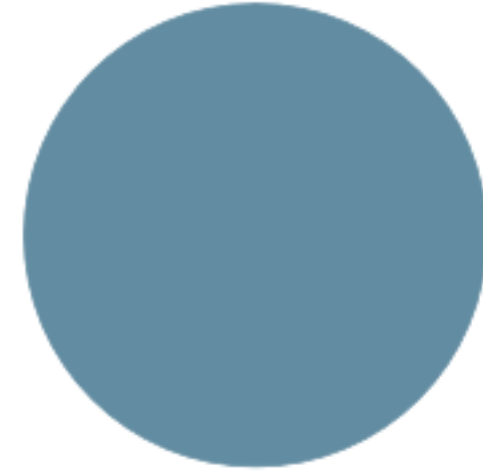
More Sustainable Plastic

\$139 Billion



Business as Usual Plastic

\$533 Billion



Alternatives to Plastic

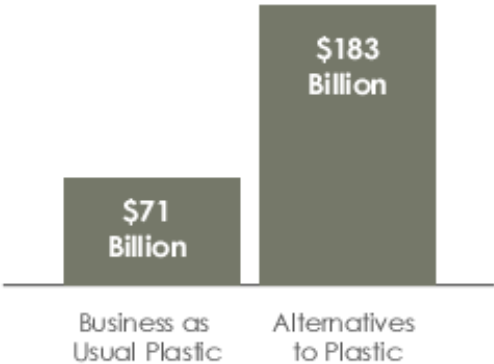
The cost of using alternative materials is approximately four times that of using plastic (in a business as usual scenario). We're producing more and more consumer goods, so choosing the material that creates the least impact is important.

Source: Trucost

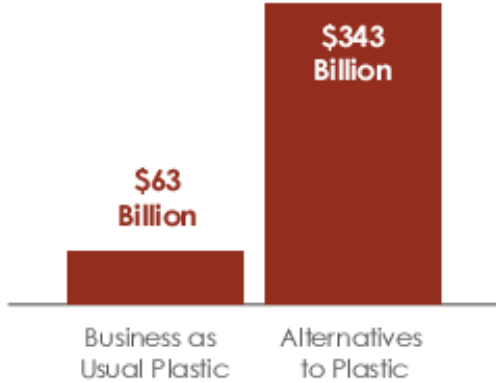
Source: American Chemistry Council TRUCOST report

ALTERNATIVES HAVE HIGHER ENVIRONMENTAL COSTS

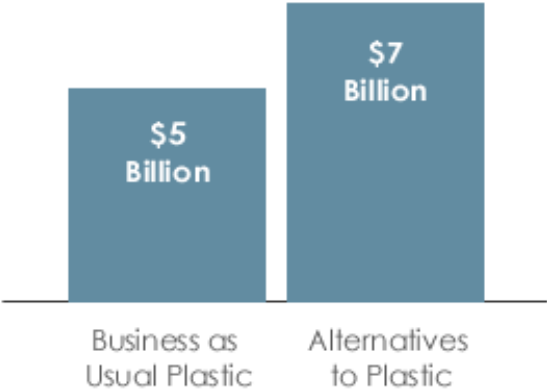
Climate change



Damage to the health of humans and ecosystems



Damage to the oceans

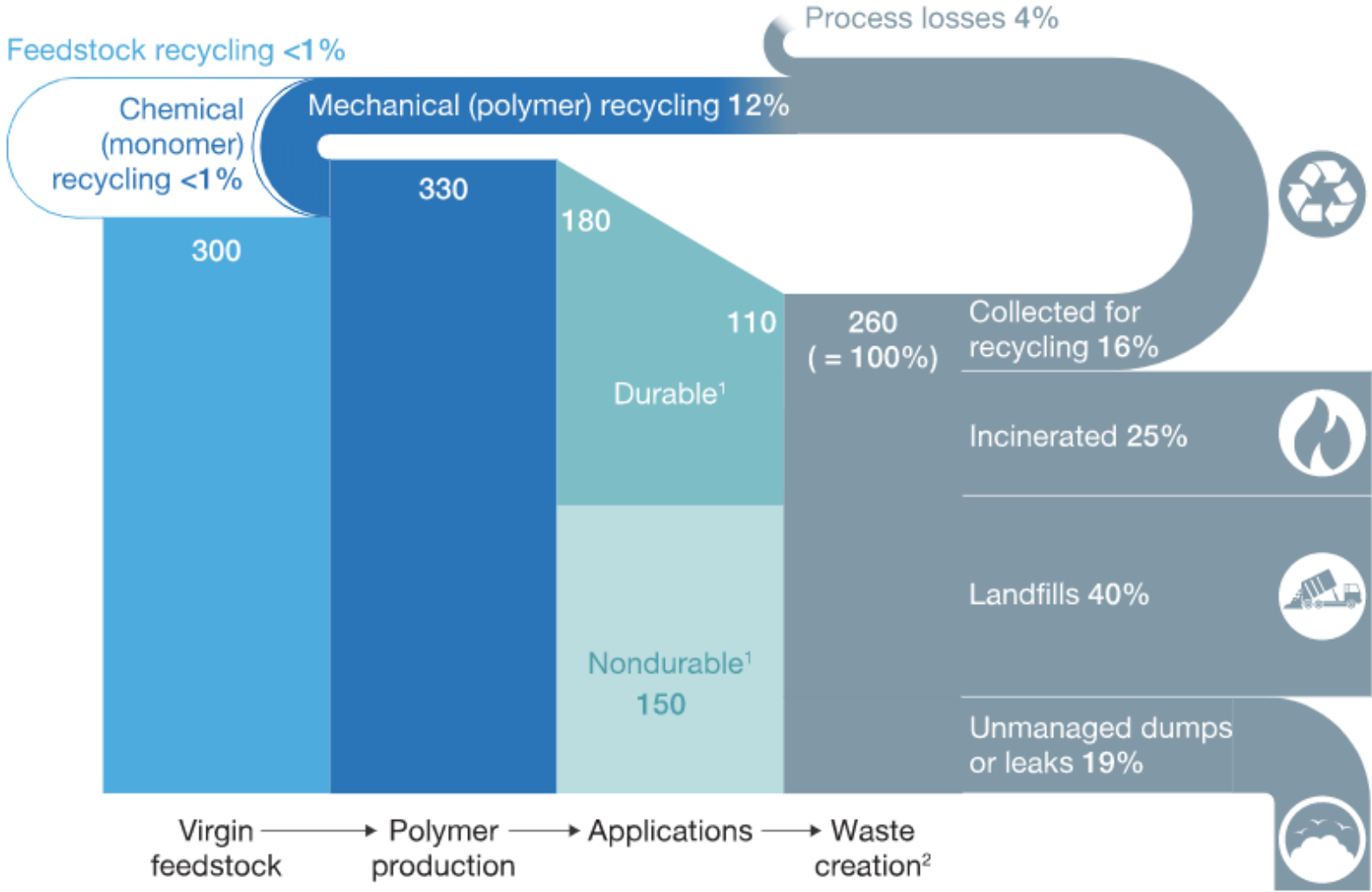


All dollar values are in USD
Source: Trucost

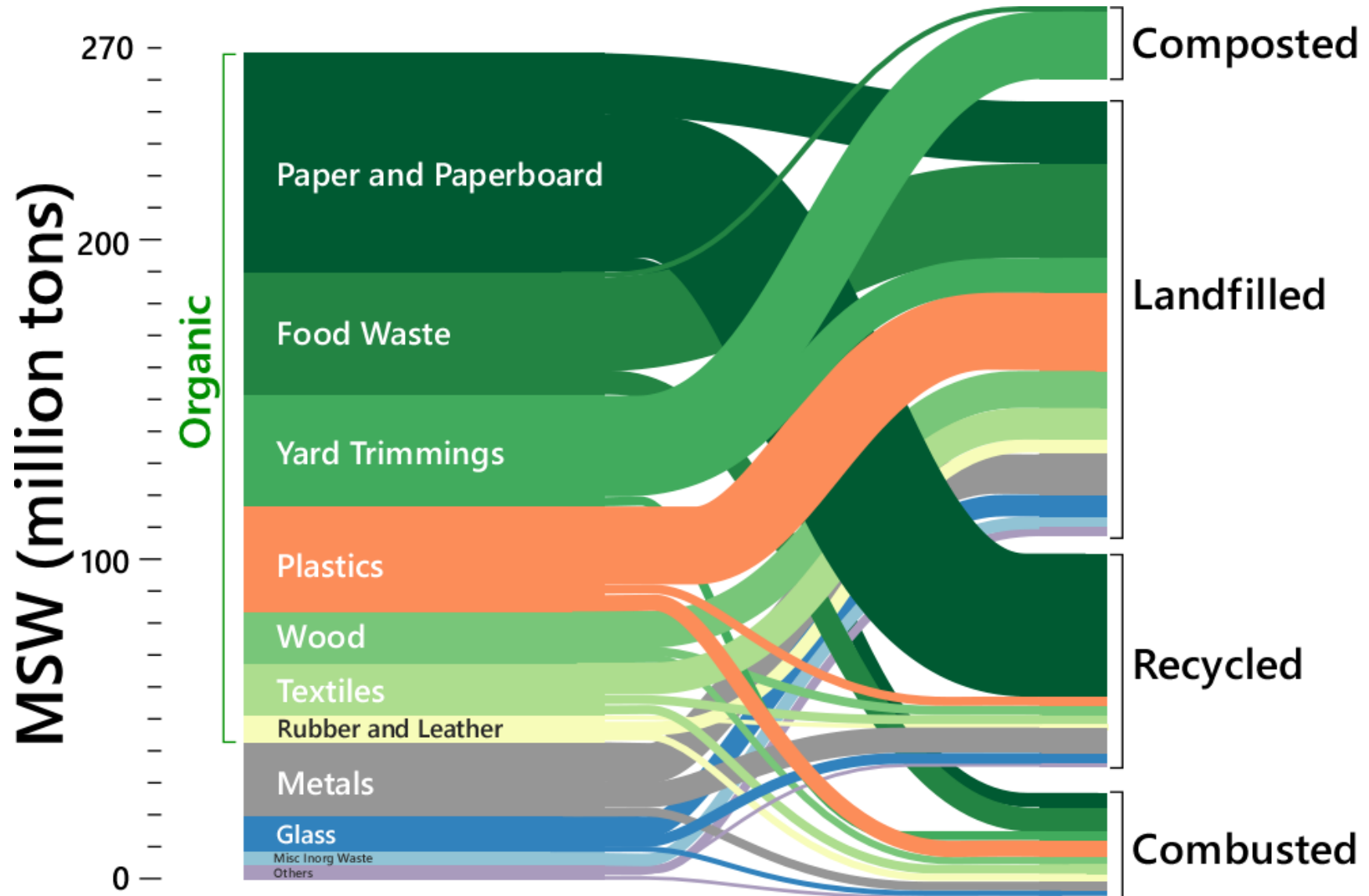
Source: American Chemistry Council TRUCOST report

WHERE DOES PLASTIC GO?

Global polymer flows, millions of metric tons per annum, 2016¹



U.S. TRASH

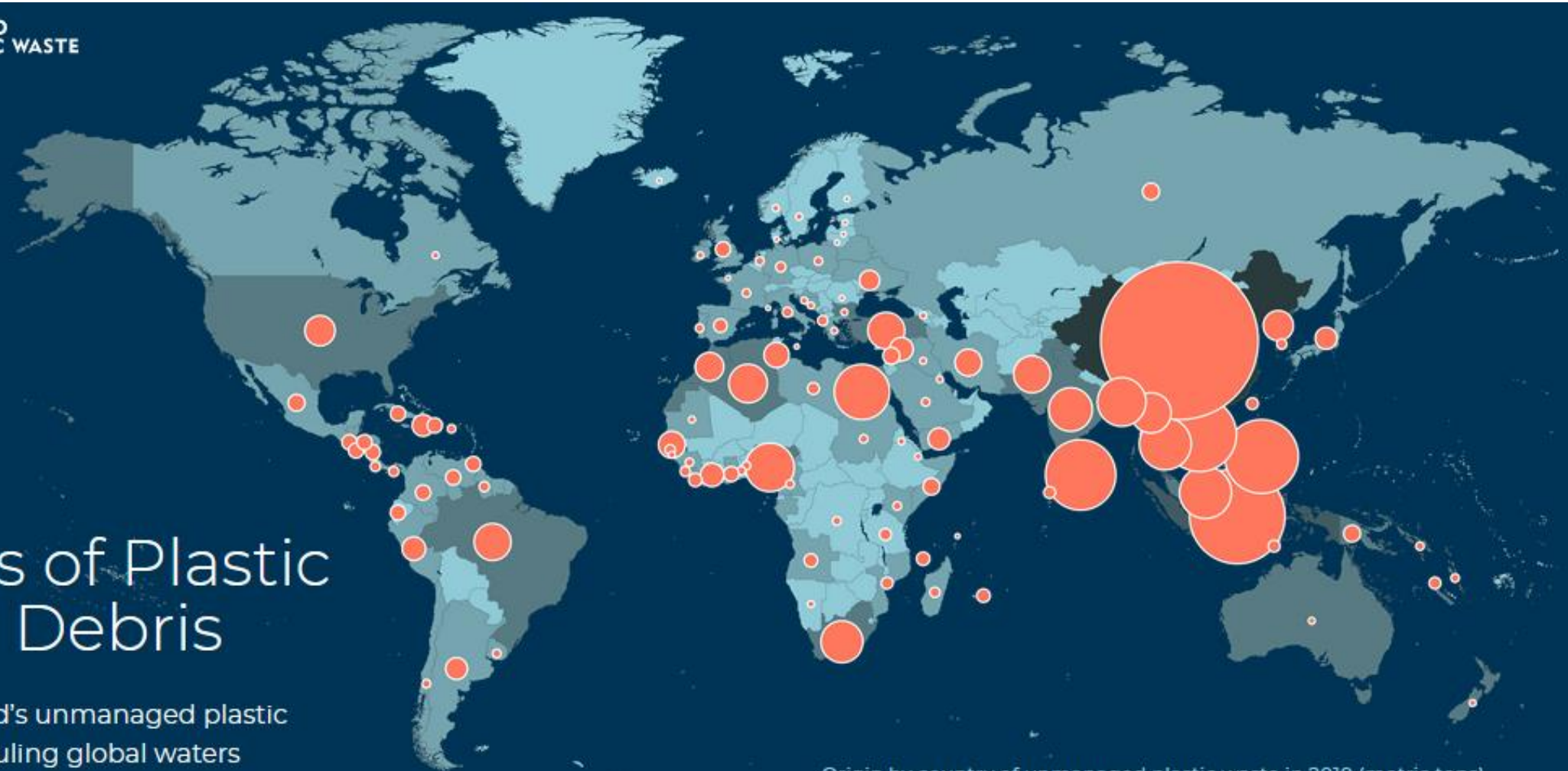


SOURCE OF OCEAN PLASTIC



Sources of Plastic Marine Debris

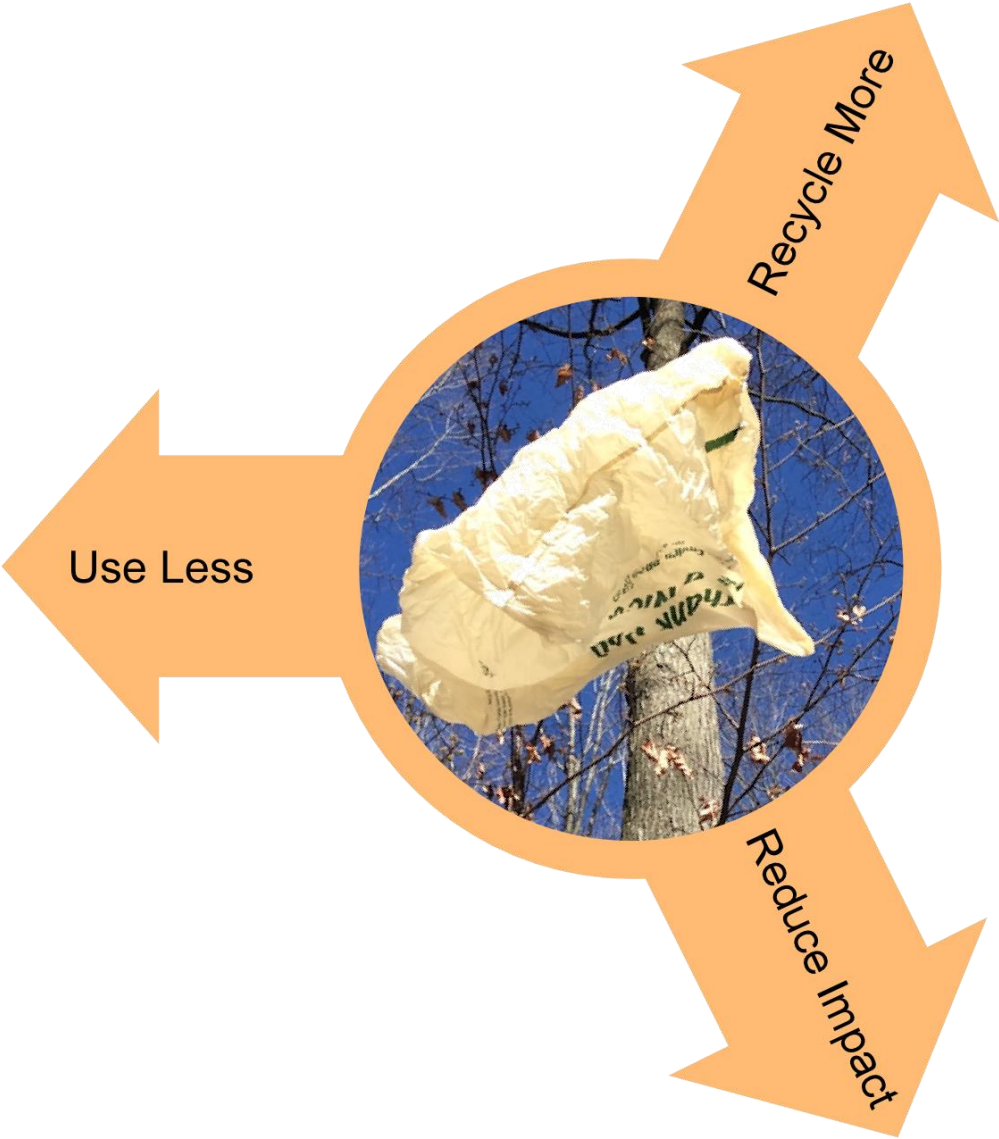
Much of the world's unmanaged plastic waste ends up fouling global waters



Origin by country of unmanaged plastic waste in 2010 (metric tons)

Sources: Science; University of Georgia; University of California; Sea Education Association

POSSIBLE SOLUTIONS



WASTE REDUCTION HIERARCHY



USE LESS WITH MORE EFFICIENT PACKAGING



EDIBLES

Edible Oils
Ketchup & Other
Condiments
Sauces
Soups
Honey & Syrups
Water & Juices
Dry Pet Food
or Treats

NON-EDIBLES

Paint & Coatings
Detergents &
Cleaning Products
Motor Oil & Fuel
Additives
Seeds
Cat Litter
De-icer Pellets
Fine Aggregates
(filter sand, etc.)



EDISON AWARDS
2015



2015
R&D 100 Winner

ENABLE RECYCLING

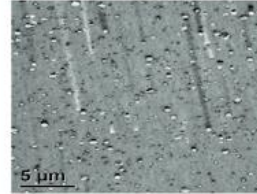


**R&D
100**
54 Years of Innovation

Transmission Electron Microscopy

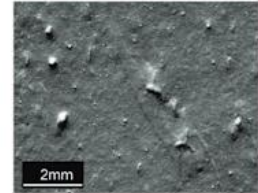


No Compatibilizer
Large EVOH domains

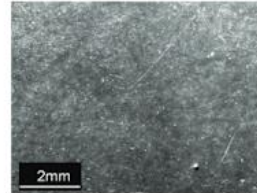


XUS 69 108.01⁽¹⁾
Modifier Polymer
Small, uniform EVOH domains

Optical Microscopy



No Compatibilizer
Large EVOH domains



XUS 69 108.01⁽¹⁾
Modifier Polymer
Small, uniform EVOH domains

Retain™
polymer modifier by **Dow**



⁽¹⁾Dow estimate per overall barrier figures from *Barrier Materials 2012-2015 Market Report*, Allied Development, 2013.
™Trademark of The Dow Chemical Company

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PROVIDE ALTERNATIVES



RECOVER



DISAPPEAR

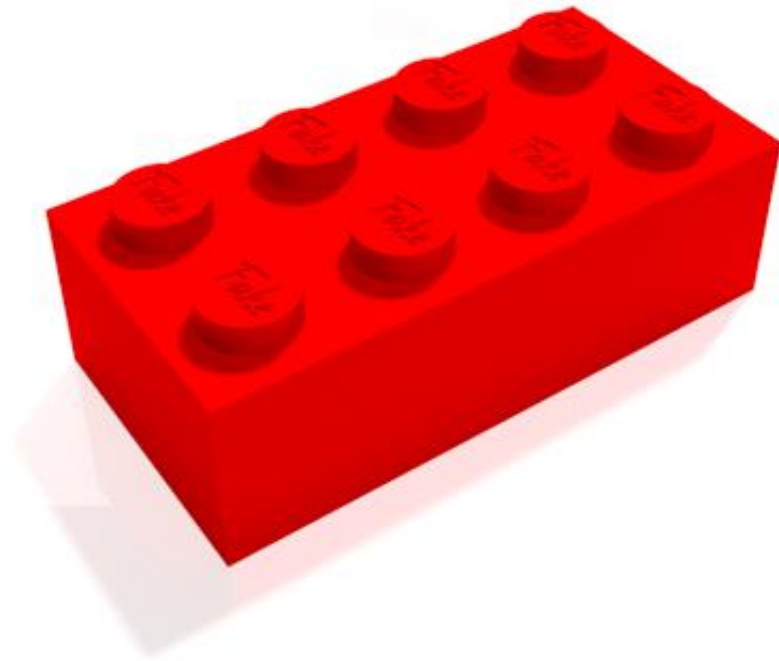


Case Study

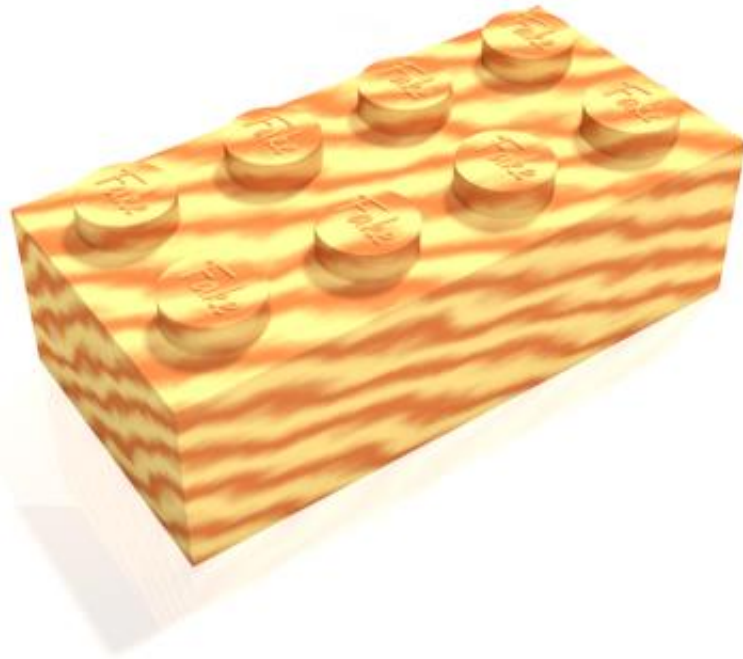


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LEGO SEARCHES FOR ABS REPLACEMENT



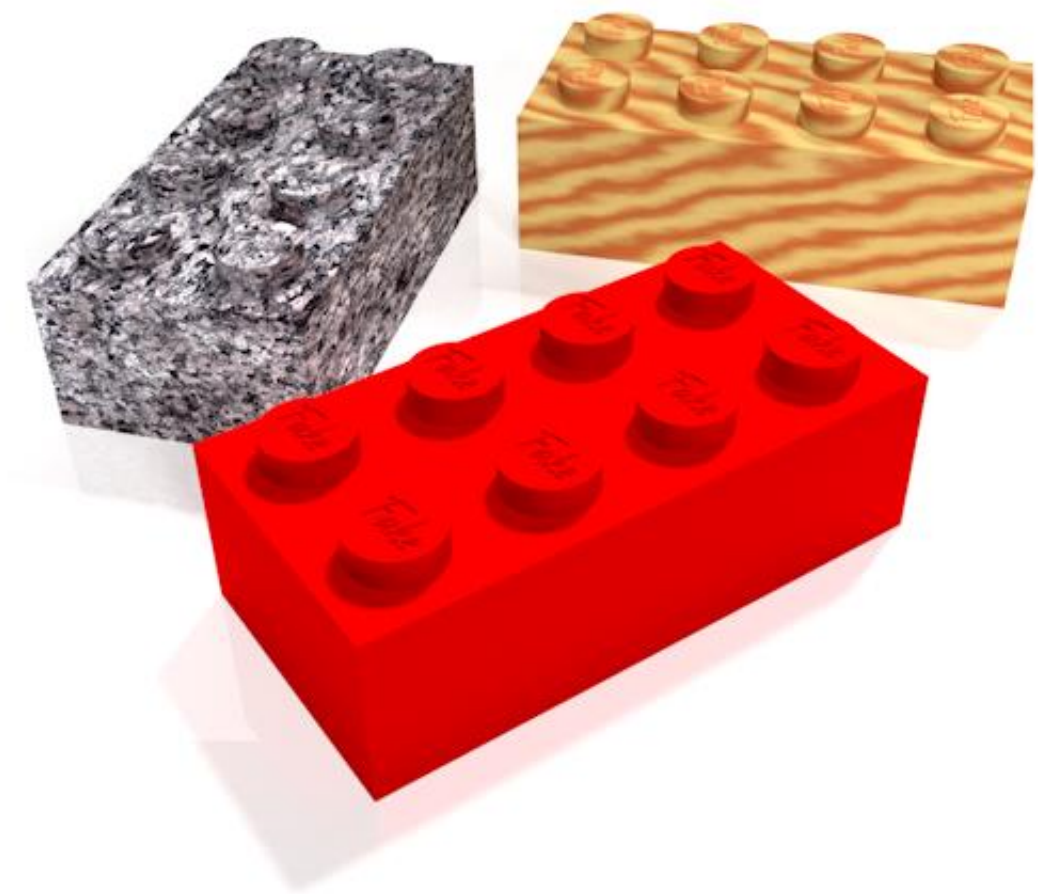
WOOD?



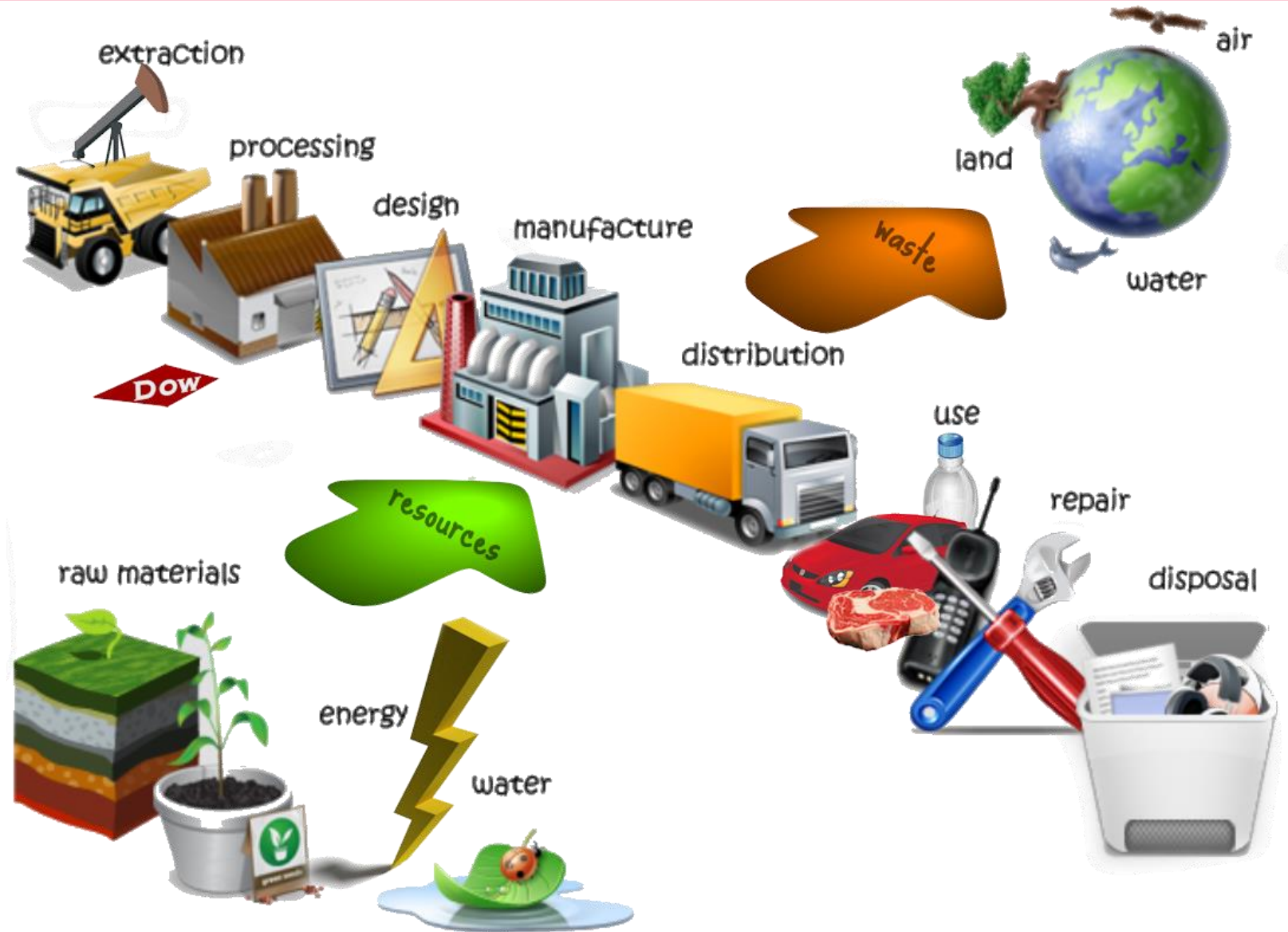
GRANITE



WHICH IS MORE SUSTAINABLE

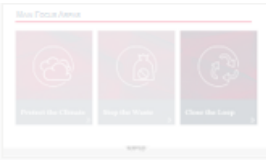


EDUCATION



adapted from sustainable-graphic-design.blogspot.com

LOTS OF BRICKS



MAIN FOCUS AREAS



Protect the Climate >>

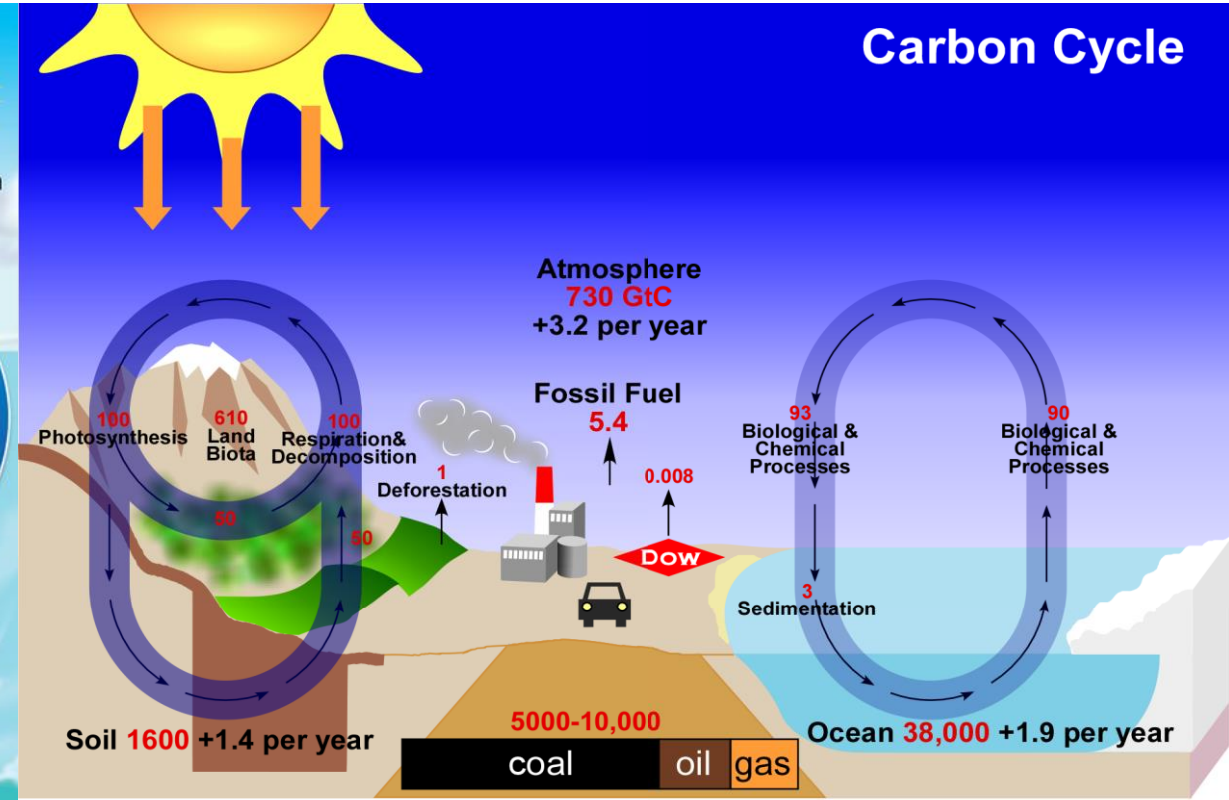
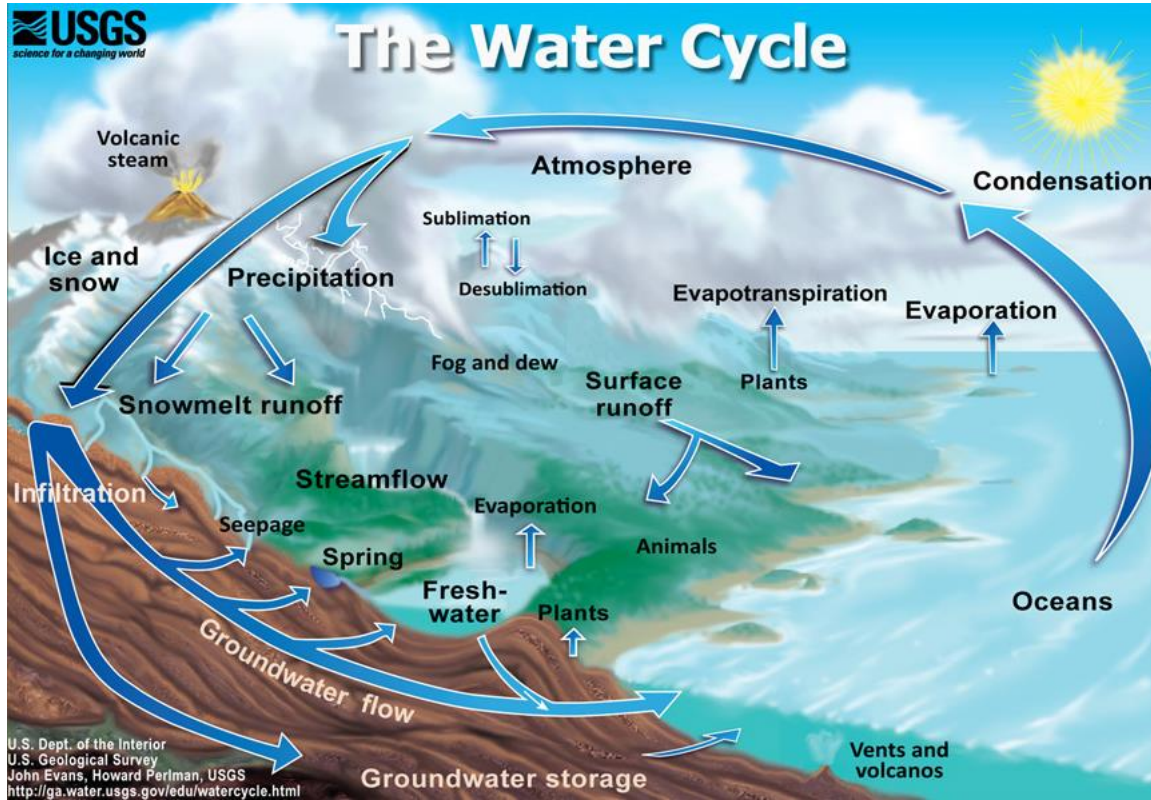


Stop the Waste >>

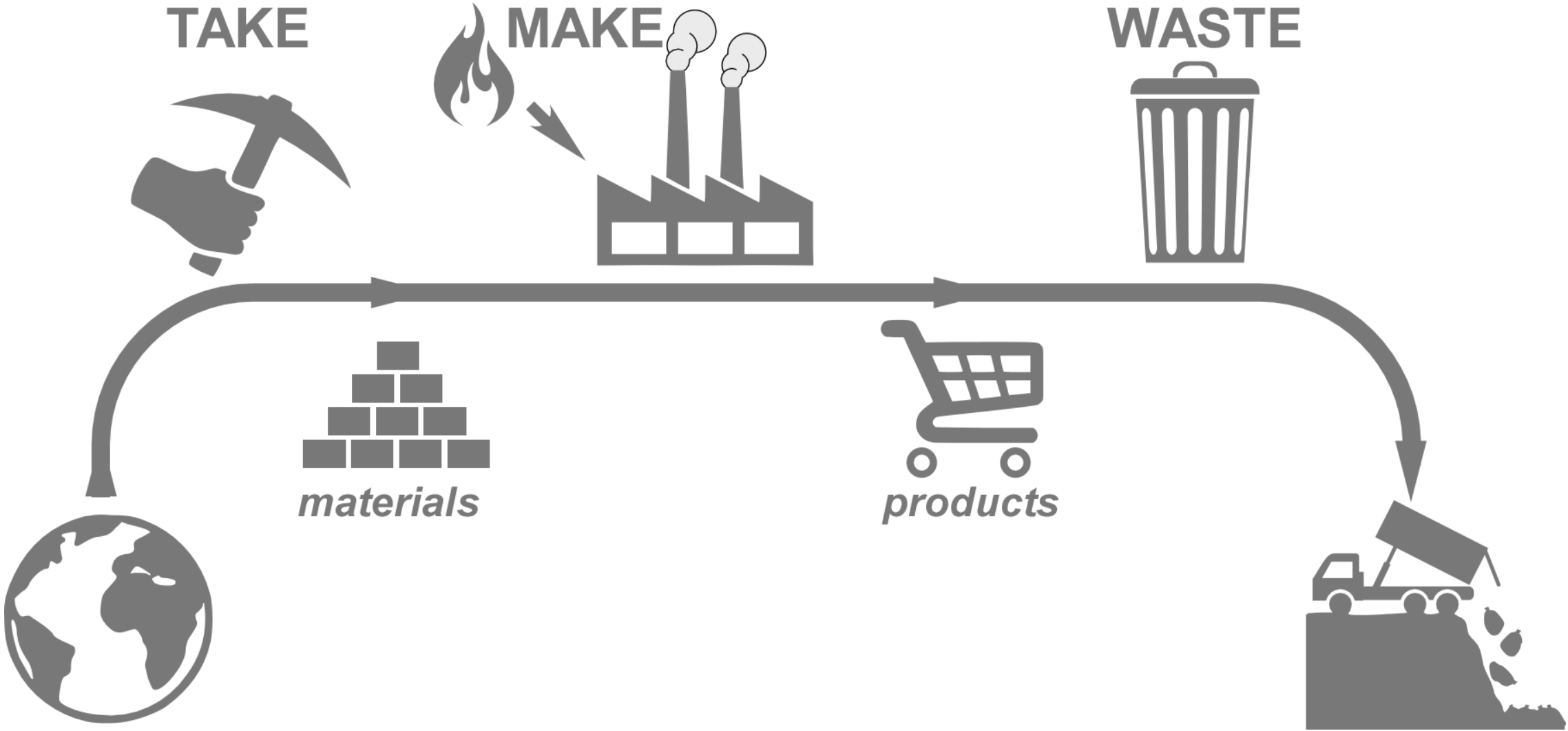


Close the Loop >>

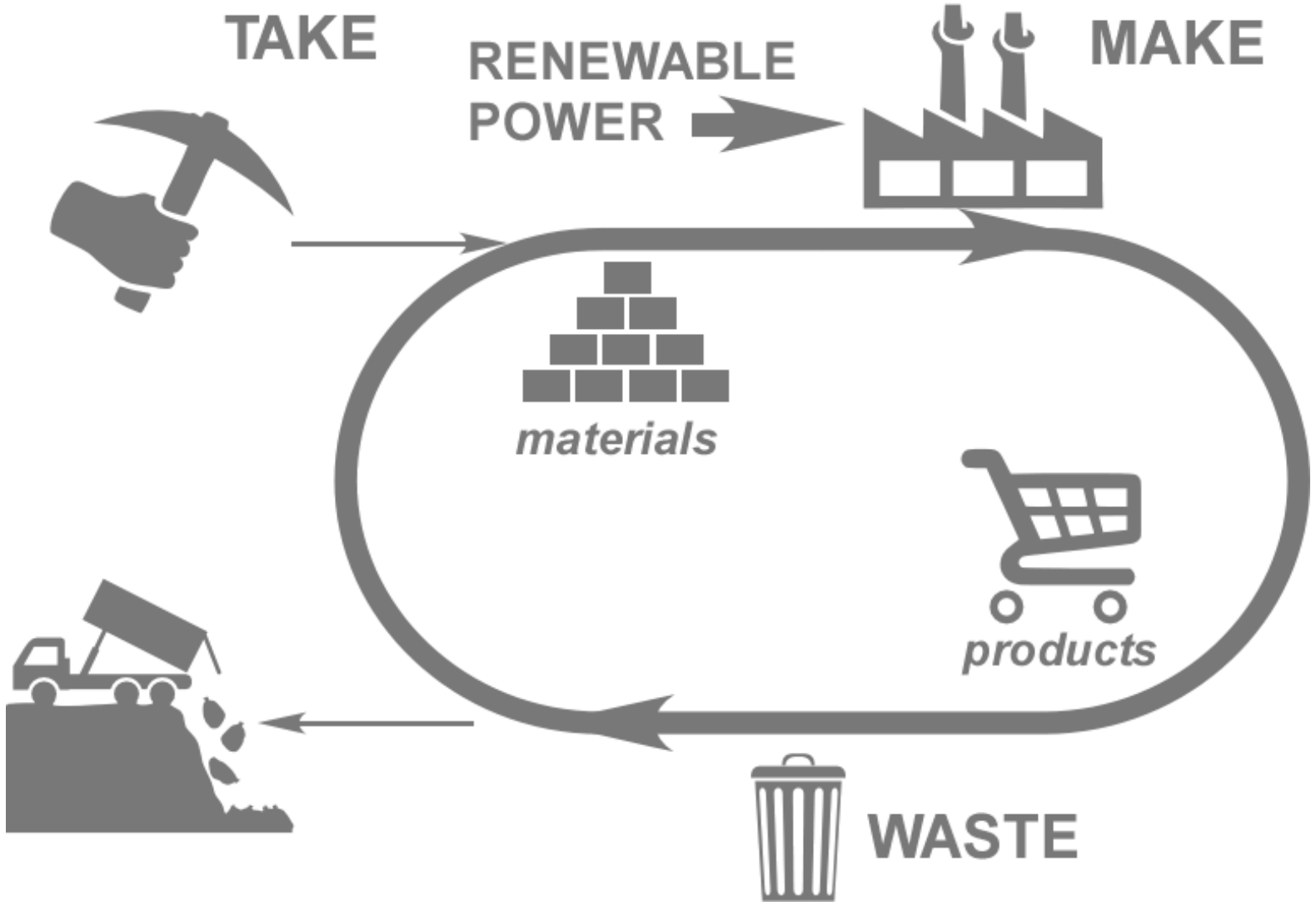
NATURAL CYCLES



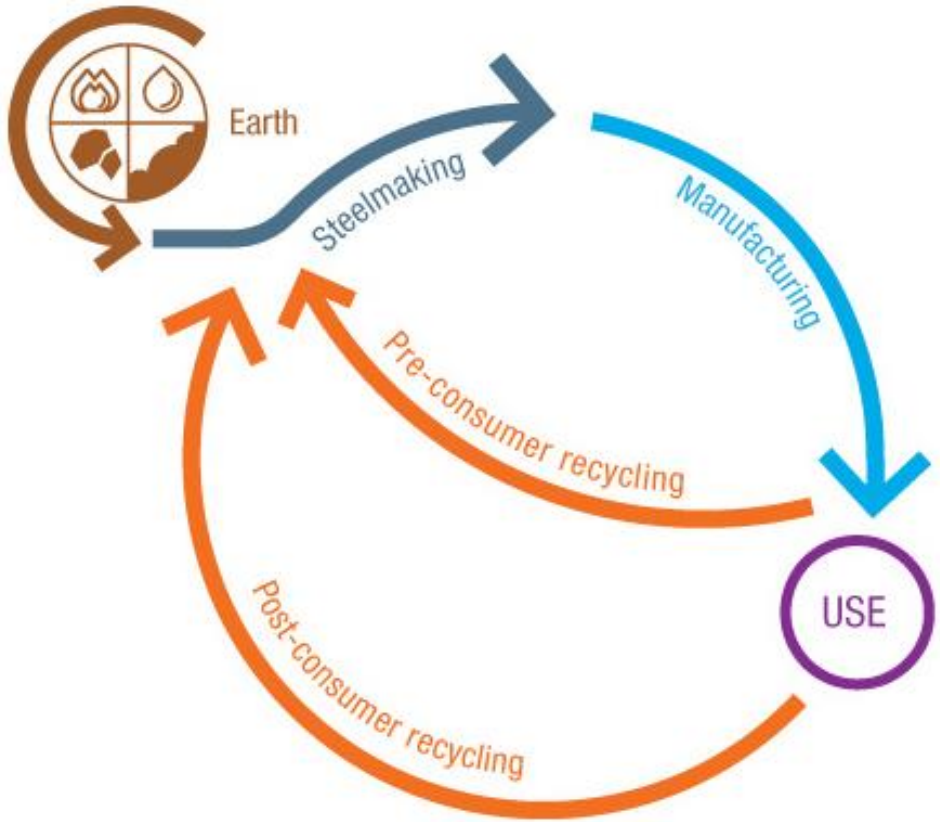
LINEAR ECONOMY



CIRCULAR ECONOMY



SUCCESSFUL CIRCLES



Steel attributes — Benefits of steel recycling

- 

Infinite recycling without loss of properties
- 

Permanent material
- 

Easy magnetic separation and recovery

- Raw materials conservation



One tonne of steel recycled saves on average :
 1,400 kg iron ore
 740 kg coal
 120 kg limestone
- 70% Energy saving



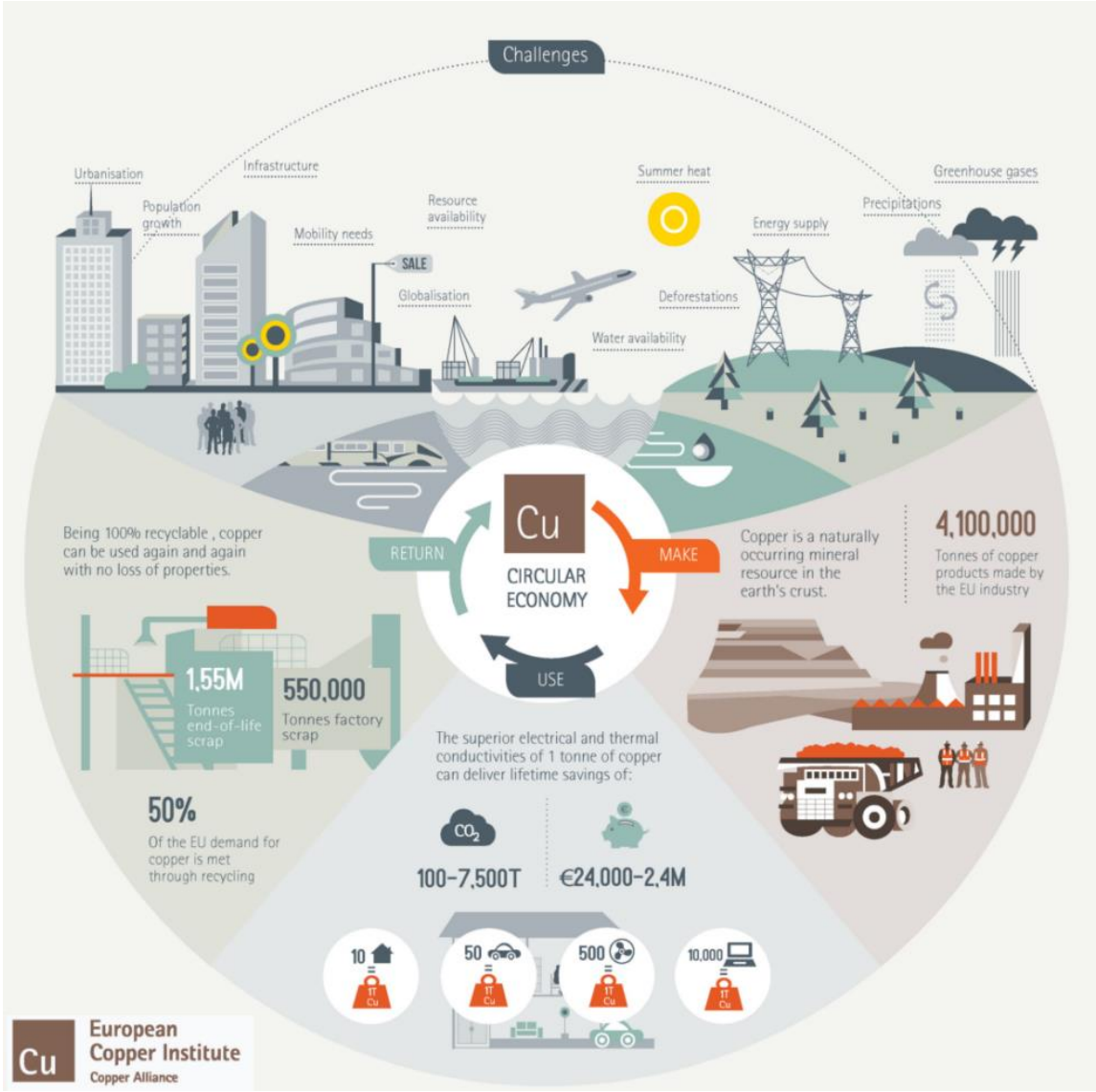
Recycling a single steel can saves :
 1 laundry load, or
 1 hour TV, or
 4 hours lighting (60 watt bulb)
- Job creation



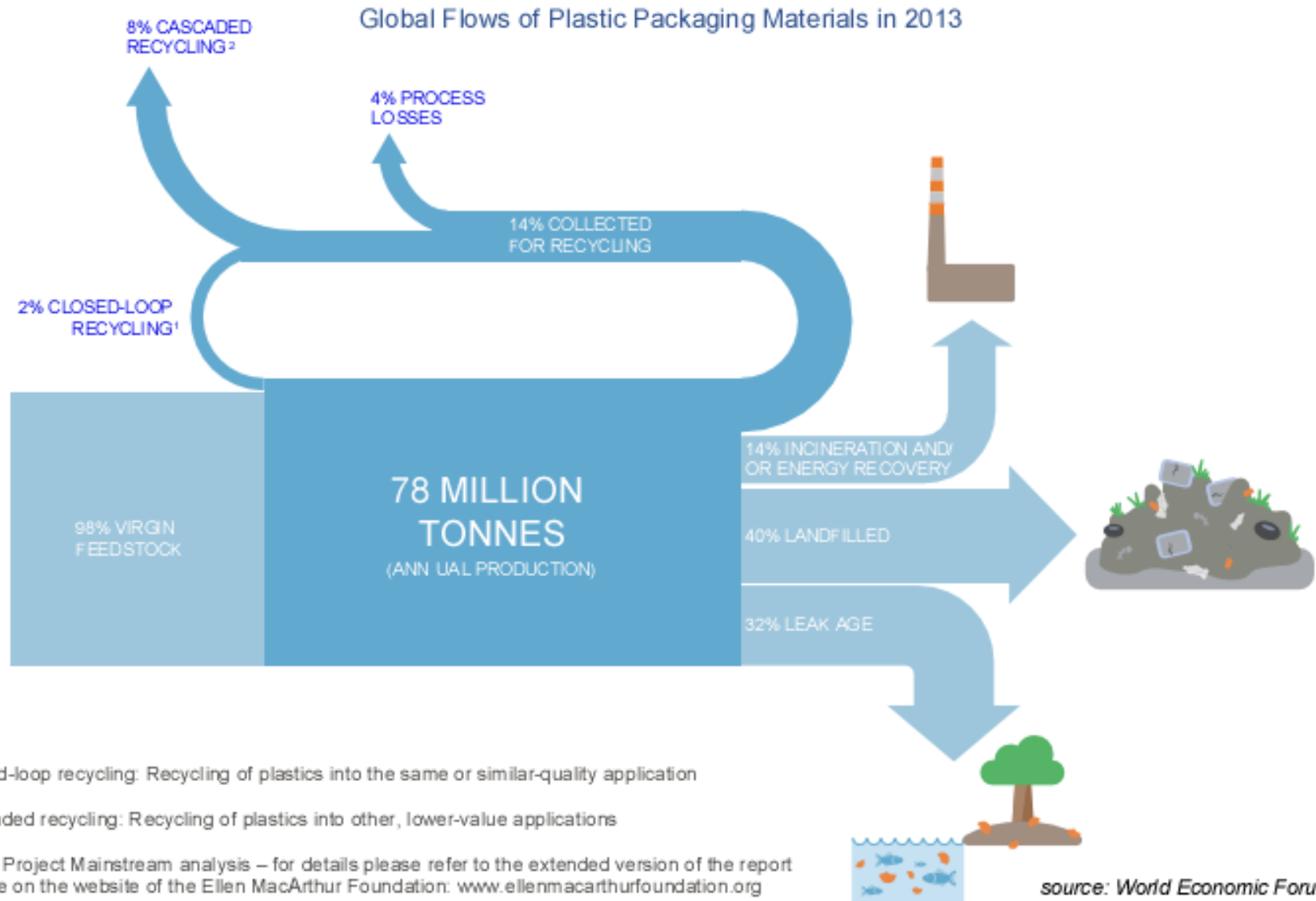
Jobs required for scrap collection, separation and recycling

<http://circulareconomy-worldsteel.org/>

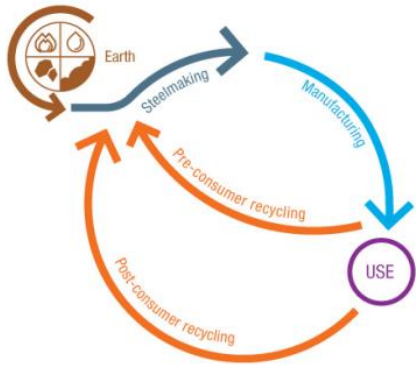
SUCCESSFUL CIRCLES



PROBLEMATIC CIRCLES



WHAT IS MISSING



- Steel attributes — Benefits of steel recycling**
- Infinite recycling without loss of properties
 - Permanent material
 - Easy magnetic separation and recovery

Raw materials conservation

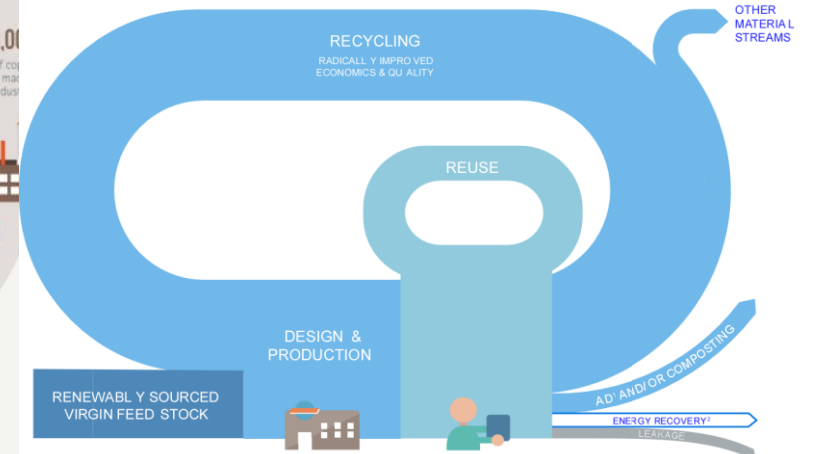
One tonne of steel recycled saves on average:

- 1,400 kg iron ore
- 740 kg coal
- 120 kg limestone

Recycling a single steel can saves:



1 CREATE AN EFFECTIVE AFTER-USE PLASTICS ECONOMY



3 DECOUPLE PLASTICS FROM FOSSIL FEED STOCKS

2 DRASTICALLY REDUCE THE LEAKAGE OF PLASTICS INTO NATURAL SYSTEMS & OTHER NEGATIVE EXTERNALITIES

Source: The New Plastics Economy – Rethinking the future of plastics

WHICH IS MOST VALUABLE



RECYCLING PRICES

0.61¢

0.01¢

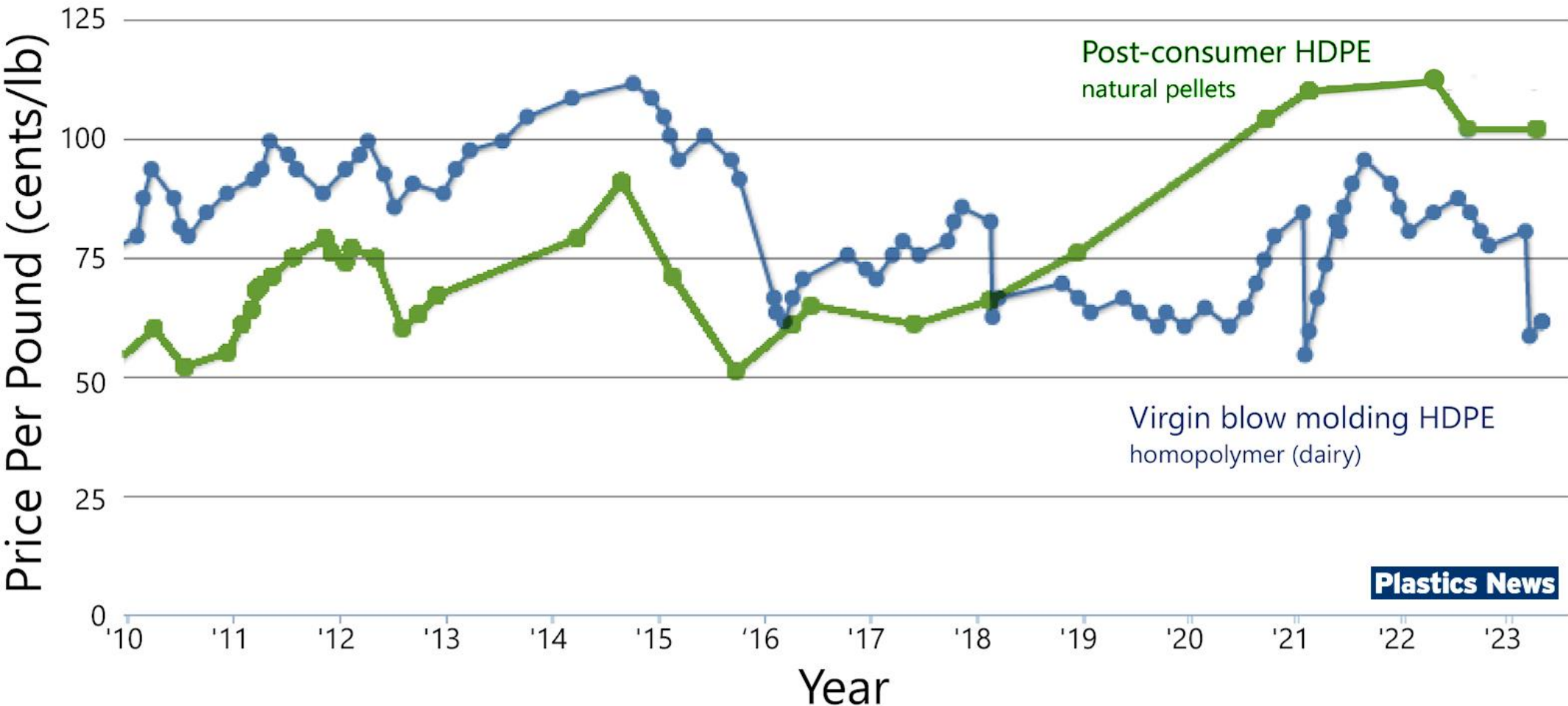
9.16¢

0.22¢

0.20¢



GOOD NEWS



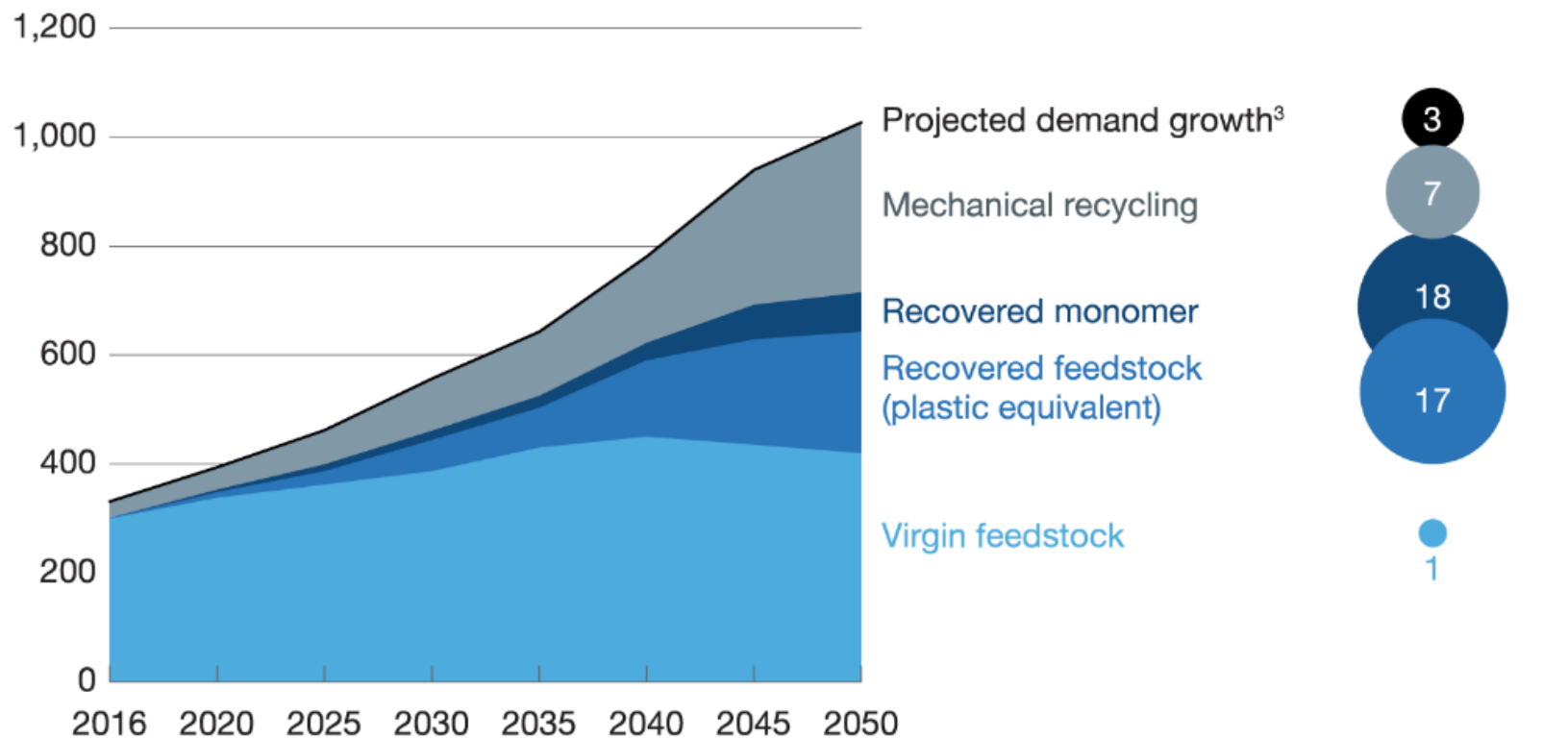
Plastics News

DOWNCYCLED PET



By 2050, nearly 60 percent of plastics production could be based on plastics reuse and recycling.

Global polymer demand 2016–50 and how it could be covered, millions of metric tons¹



¹Scenario based on a multi-stakeholder push to boost recycling, regulatory measures to encourage recycling, consistent progress on technologies, and \$75-per-barrel oil price.

²Compound annual growth rate. Mechanical recycling limited by downcycling and applicable materials, monomerization limited by applicability to condensation polymers only, pyrolysis limited by likely rise in input costs.

³After demand reduction, assuming annual global GDP growth of 3.1%.

BIG CHANGES – ONLY POSSIBLE WITH CHEMISTRY



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LEAD RELEASE FROM METALS PROCESSING



Cu production → 13,000 tons of Pb

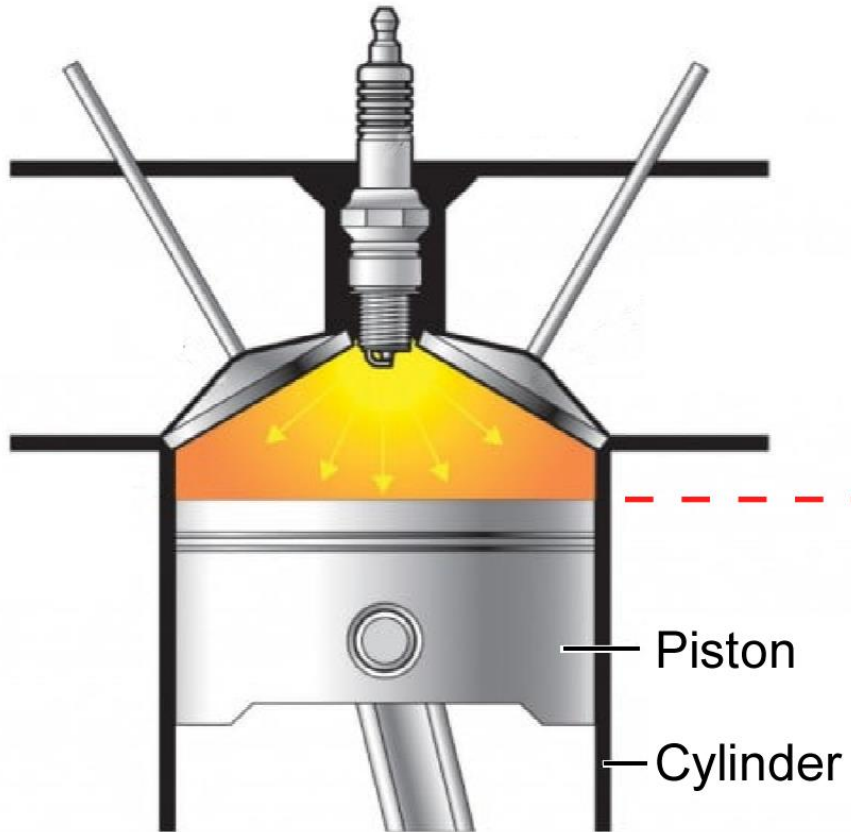
CAUTIONARY TALE OF UNINTENDED CONSEQUENCES



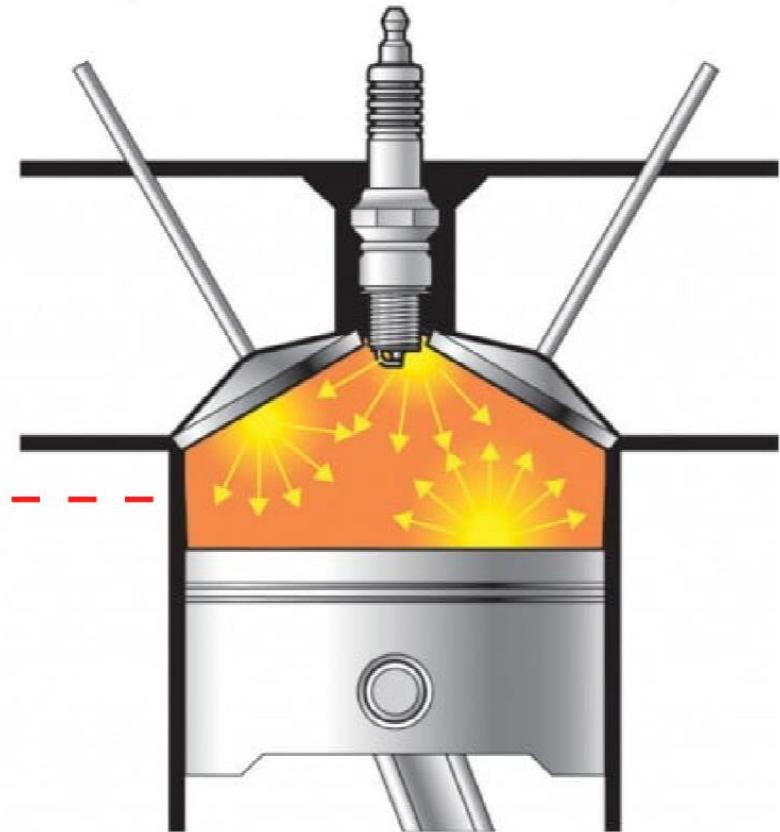
Thomas Midgley, Jr.

KNOCKING

Normal Combustion



Knocking
(premature combustion)



TEL stops knock at 1 part per thousand



Ethanol requires 10%



Tetraethyl lead . . . **THE REASON WHY
AMERICA'S CARS ARE BEING TUNED UP
. . . NOT DOWN !**

DO YOU KNOW that if it weren't for the universal availability of high anti-knock gasoline every modern auto engine would have to be tuned-down . . . the spark retarded to eliminate "knock" or "ping"?

But today oil refiners have a way of making vast quantities of high anti-knock gasoline economically. By just adding a small amount of anti-knock fluids containing *tetraethyl lead* to each gallon of gasoline they can produce fuels that actually permit motor service men

to *tune-up* a car . . . *advance* the spark to give better performance and mileage.

Since the oil industry has made this "leaded" gasoline generally available to the motorist, there have been two important results:

1. Automobile engineers in designing new cars can take advantage of the inherent advantages of high-compression engines requiring high anti-knock fuels . . . for they know that such fuels can be purchased anywhere in the United States and Canada.

2. Cars now on the road can be tuned-up for greater power and economy.

So, from the standpoint of both present and future needs, it is easy to see why it has been said that "Tetraethyl lead is almost as important as gasoline itself!"

THIS MONDAY NIGHT TUNE IN ON "TUNE-UP TIME" (featuring *Antes Kardavits* and his Orchestra, *Tommy Mann* or *Master of Cerimoles*, *Ray Thompson* and her Rhythmic Singers. Colored by Broadcasting System, 8 P. M., E.S.T.)

ETHYL GASOLINE CORPORATION, manufacturer of anti-knock fluids used by oil companies to improve gasoline



MAKING THE FARMER'S IRON HORSE WORK HARDER...

...tetraethyl lead!



ONLY FOUR YEARS AGO there were no high-compression tractors in the United States. Until then tractors were built with low compression engines in order to burn the poorest grade of fuel sold. Most farmers thought that this was the way to "economize."

But in 1933 oil refiners made "leaded" regular gasoline generally available... that is, gasoline which has been improved by the addition of anti-knock fluids containing tetraethyl lead.

So tractor engineers began to experiment with high compression engines designed to take advantage of this new, better fuel. They ran practical tests on farms and tractor proving grounds. They discovered that Farmer Jones, with a high compression tractor, could pull three plows instead of two, that he could operate in a higher gear and get more work done in the same time, or that he could pull the same equipment on four gallons of fuel instead of five.

Today twelve tractor manufacturers sell high compression tractors designed to use "leaded" gasoline. Thousands of these tractors are now in use. And a recent national survey indicated that nearly three out of every four farmers who are planning to buy a new tractor will buy a high compression tractor.

Tetraethyl lead has helped the farmer's iron horse work harder... just as it has the automobile owner to get greater power and economy from his car.

Ethyl Gasoline Corporation
manufacturer of anti-knock fluids used by oil companies to improve gasoline

THIS MONDAY NIGHT tune in on "Tune-Up Time"
Columbia Broadcasting System, 7 p. m., E.S.T.; 6 p. m., C.S.T.;—9 p. m., M.S.T.; 8 p. m., P.S.T.



Even the man in the moon wouldn't know for certain when the war is going to end. But one thing you can be sure of—as long as American soldiers, sailors and airmen are in action, the best gasoline America can produce will be with them in the fight.

Today, the manufacture of combat gasoline is taking the cream of the U.S. petroleum industry's production, plus most of the Ethyl fluid manufactured. That's why gasoline at home must still be limited both as to quantity and quality.

But when final Victory is achieved, you can look forward to getting unlimited quantities of top-quality Ethyl gasoline again—Ethyl that will bring out the best performance of any car.

Ethyl

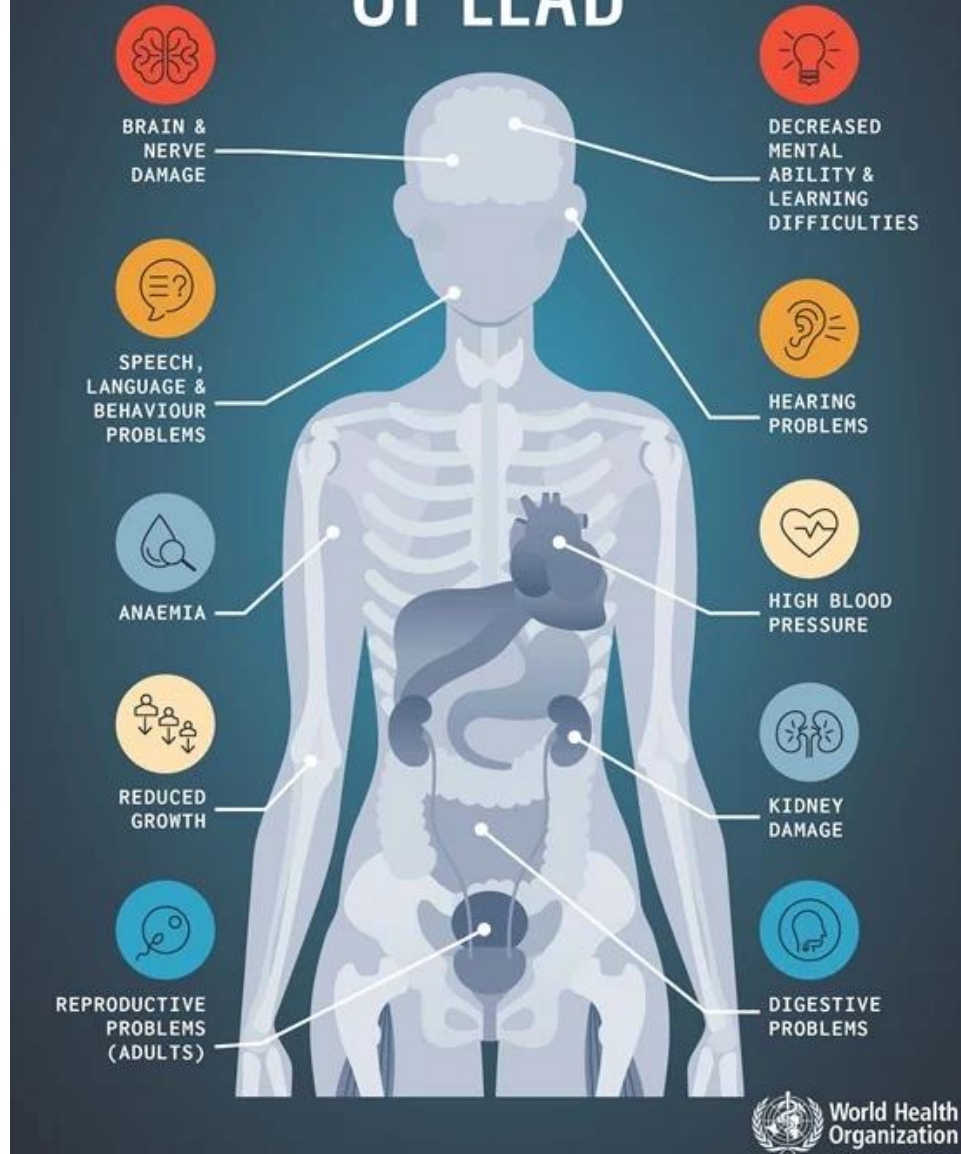


CORPORATION

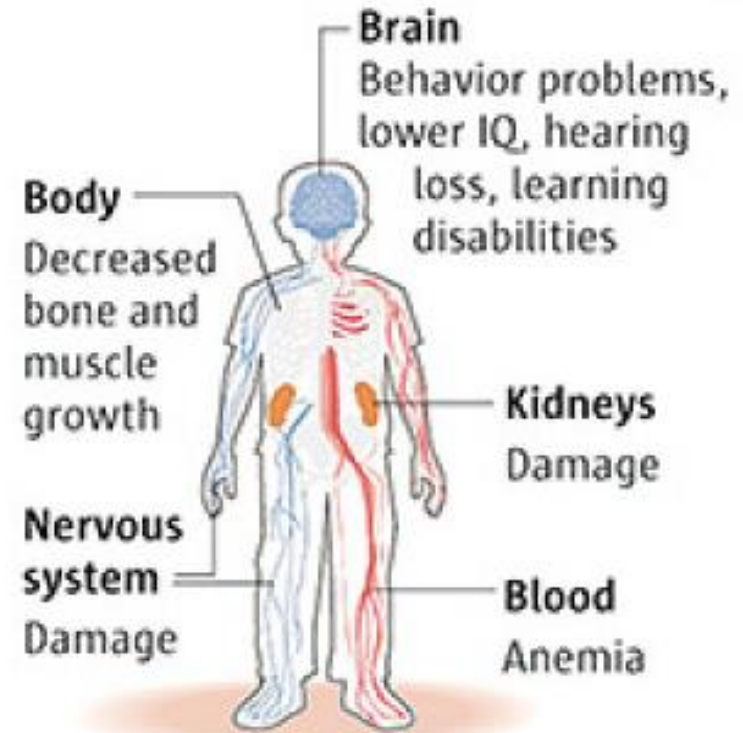
Chrysler Building, New York 17, N. Y.

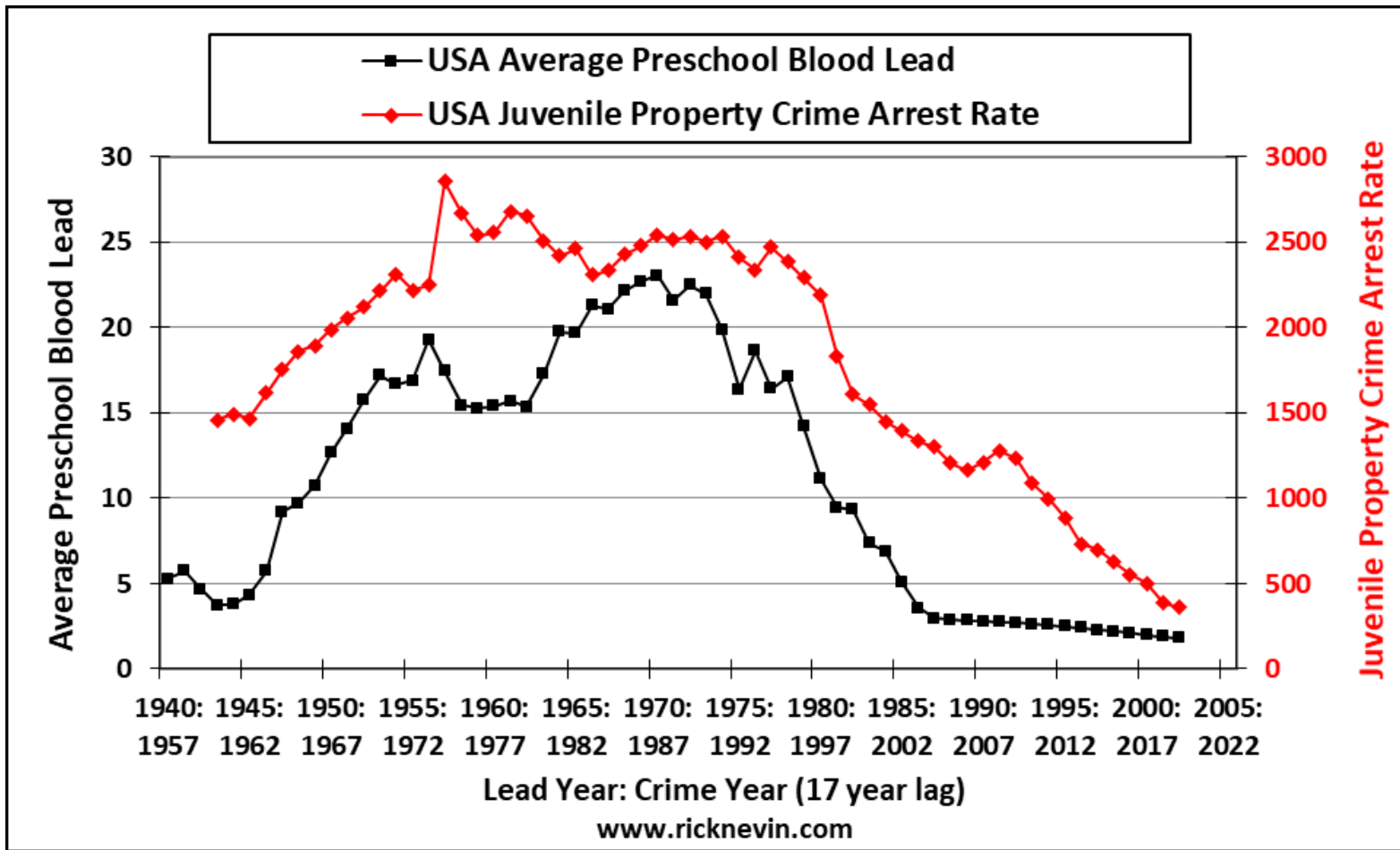
ETHYL IS A TRADE MARK NAME

THE TOXIC EFFECTS OF LEAD



CHILDREN





A timeline of lead reduction

1970

CDC sets acceptable blood-lead level of **40 µg/dL**

1973

EPA mandates a phaseout of leaded gasoline

1978

CPSC bans residential lead paint

1991

CDC sets acceptable blood-lead level of **10 µg/dL**

1996

EPA eliminates lead from **some** U.S. motor fuel

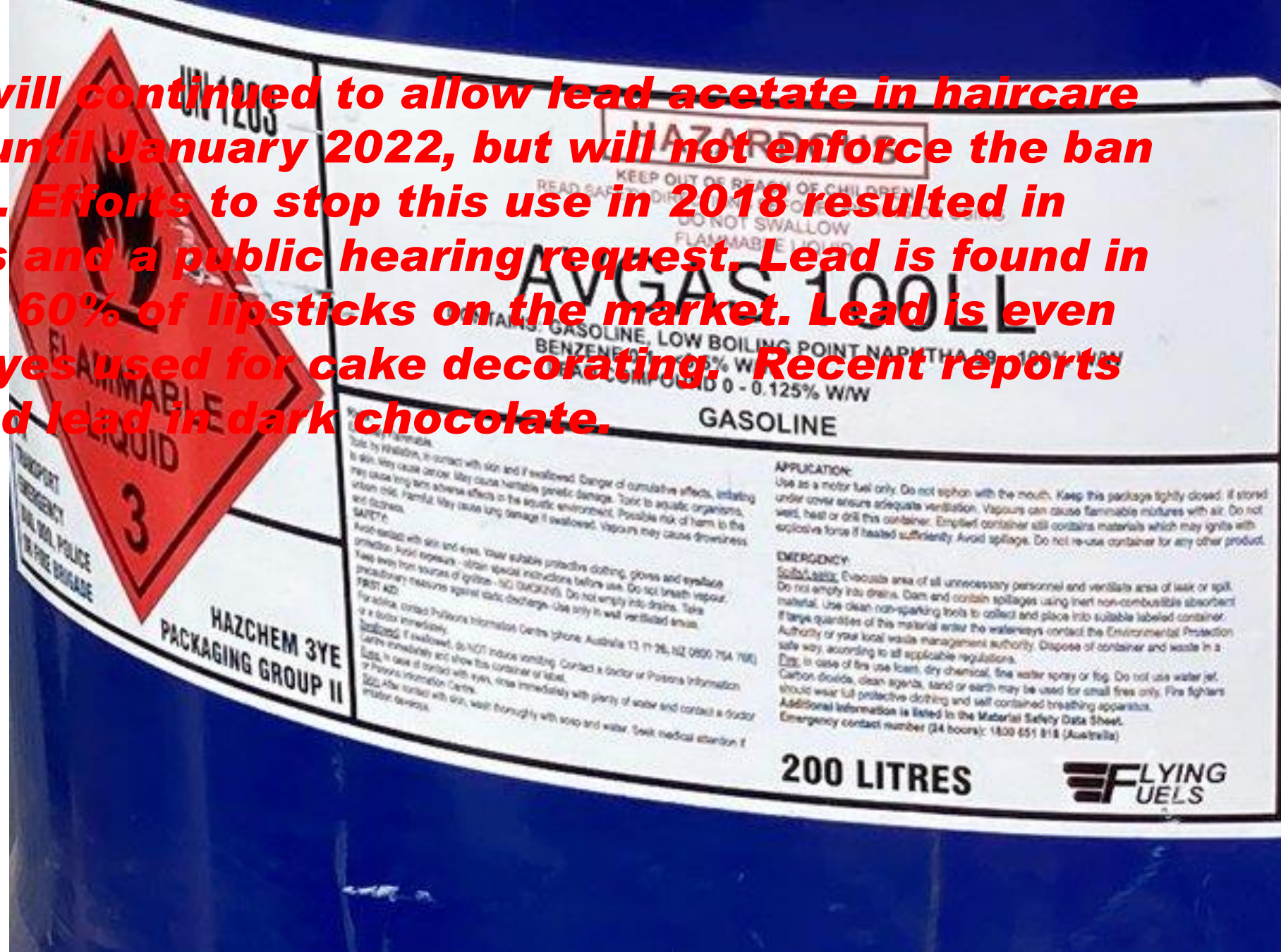
2012

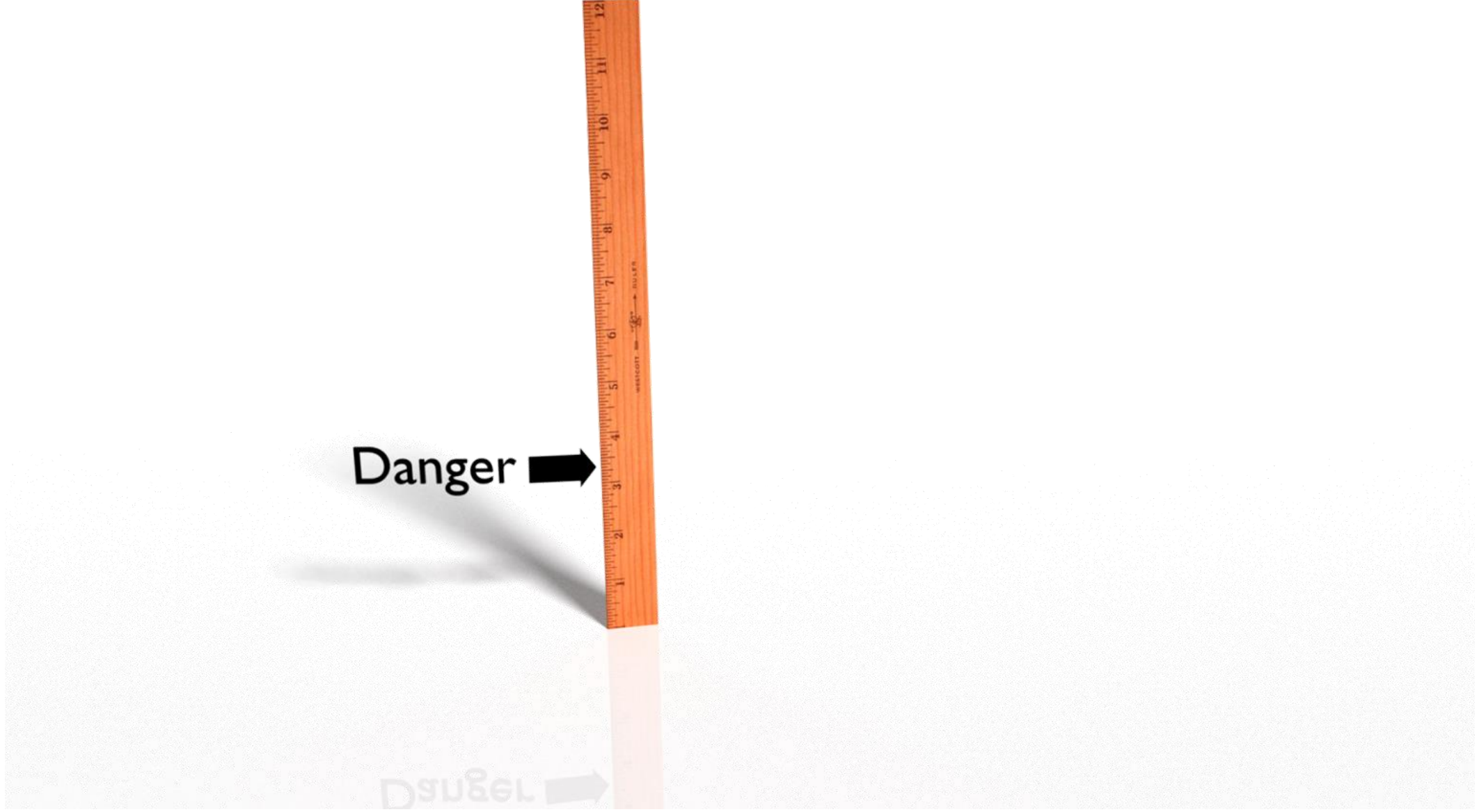
CDC describes blood-lead level of **>5 µg/dL** as elevated

WHAT IS THE SAFE LEVEL?



The FDA will continue to allow lead acetate in haircare products until January 2022, but will not enforce the ban until 2023. Efforts to stop this use in 2018 resulted in objections and a public hearing request. Lead is found in more than 60% of lipsticks on the market. Lead is even found in dyes used for cake decorating. Recent reports of elevated lead in dark chocolate.





Danger



Danger



Danger →

**Risk
Tolerance** ←



Danger →

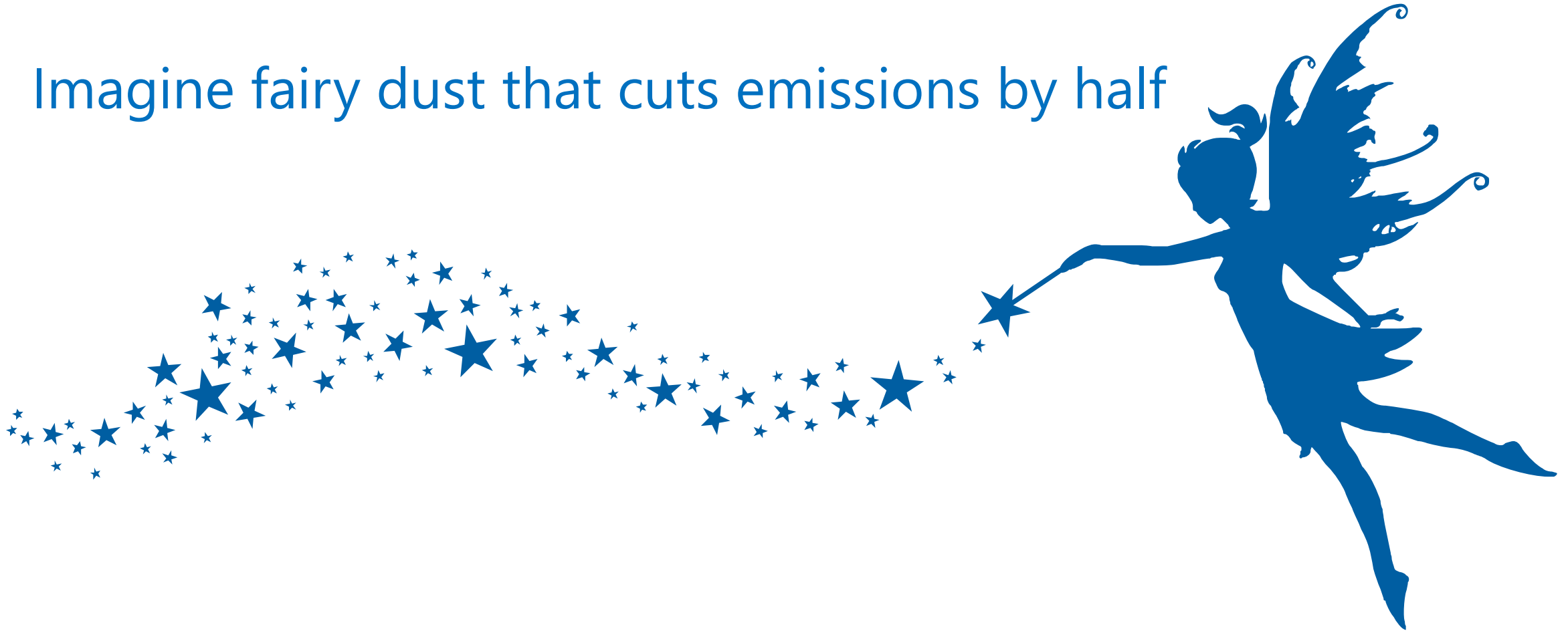
← **Risk Tolerance**

Benefit ↓





Imagine fairy dust that cuts emissions by half



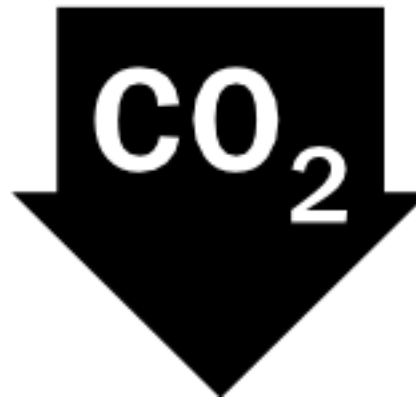
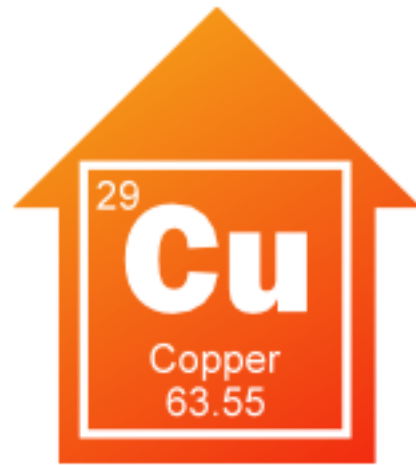
Could it contain lead?

2030



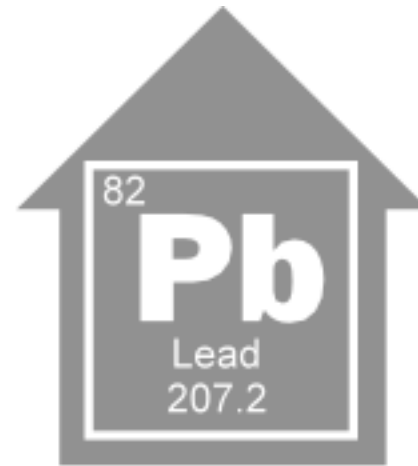
7.5%

2.8 B kg

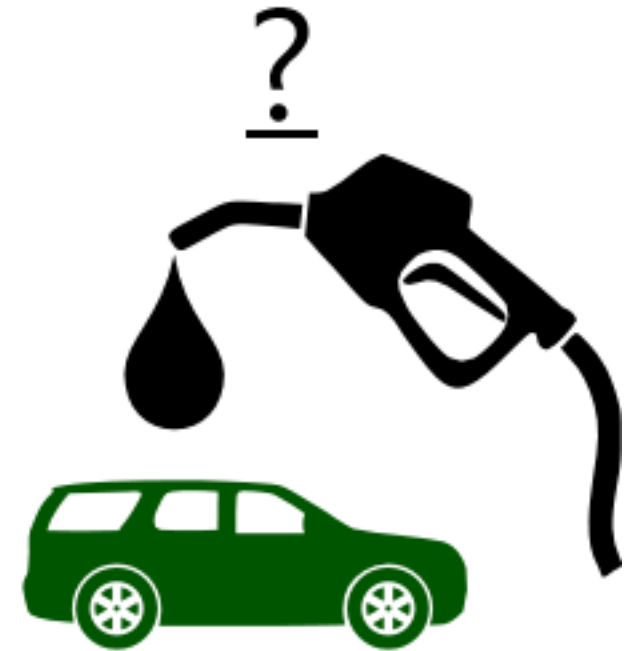


225 million tons

~2 tons



~8g/ton



~80 ppm

Little Orma, Ryan V Denturo

Safe
Sustainable
Toxic
Carcinogenic



TRAIN DERAILMENT WITH TOXIC, FLAMMABLE, CARCINOGENIC CARGO



EAST PALESTINE, OHIO



EARLIER VINYL DERAILMENT



EARLIER VINYL DERAILMENT



NTSB Accident Report RAR1401, "Conrail Freight Train Derailment with Vinyl Chloride Release Paulsboro, New Jersey", November 30, 2012



NTP

IARC

- Ethanol known to be human carcinogen
grp 1: carcinogen
- Wood Dust known to be human carcinogen
grp 1: carcinogen
- Soot known to be human carcinogen
grp 1: carcinogen
- Vinyl Chloride known to be human carcinogen
grp 1: carcinogen
- Progesterone reasonably anticipated human carcinogen
grp 2b: possible carcinogen
- Tobacco Smoke known to be human carcinogen
grp 1: carcinogen
- Caprolactam grp 4: non-carcinogenic

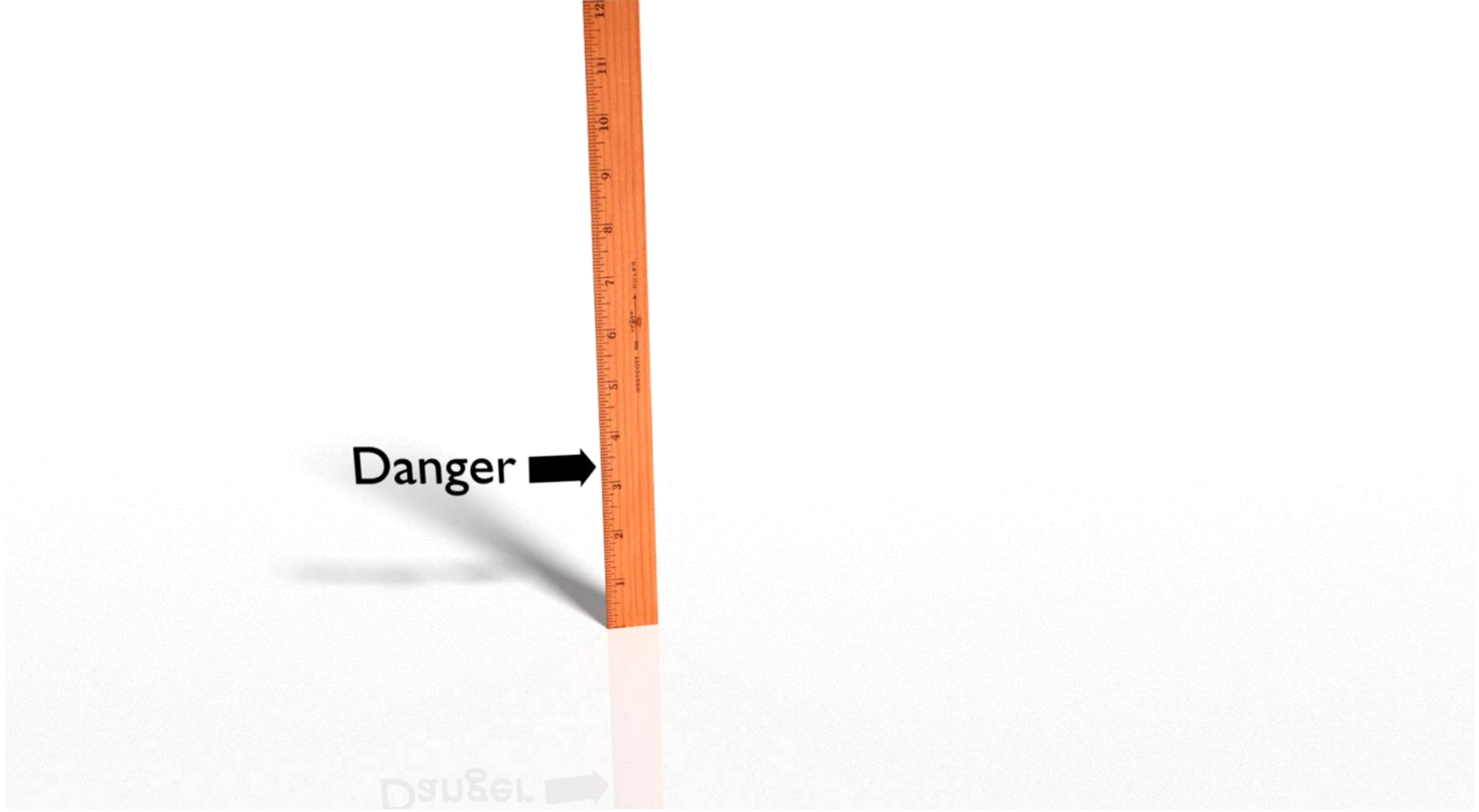
National Toxicology Program (NTP) and the International Agency for Research on Cancer (IARC) maintain lists of carcinogens.

Safe

Sustainable

Toxic

Carcinogenic



Danger



Danger



Danger →

**Risk
Tolerance** ←



Danger →

← **Risk Tolerance**

Benefit ↓





MJPhD