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

MARK JONES
CREATIVE DIRECTOR
MJPhD, LLC

30 March 2022





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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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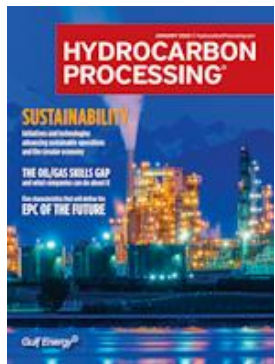


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SUSTAINABILITY DEFINITION



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



WHAT IS THE BEST DEFINITION?



1. The process of managing available resources, investments and technologies to maintain and optimize operations for greater safety, reliability, efficiency, and environmental and social awareness.
2. Meeting our own needs without compromising the ability of future generations to meet their own needs.
3. The ability to continue a defined behavior indefinitely.
4. Wondrously complicated.

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



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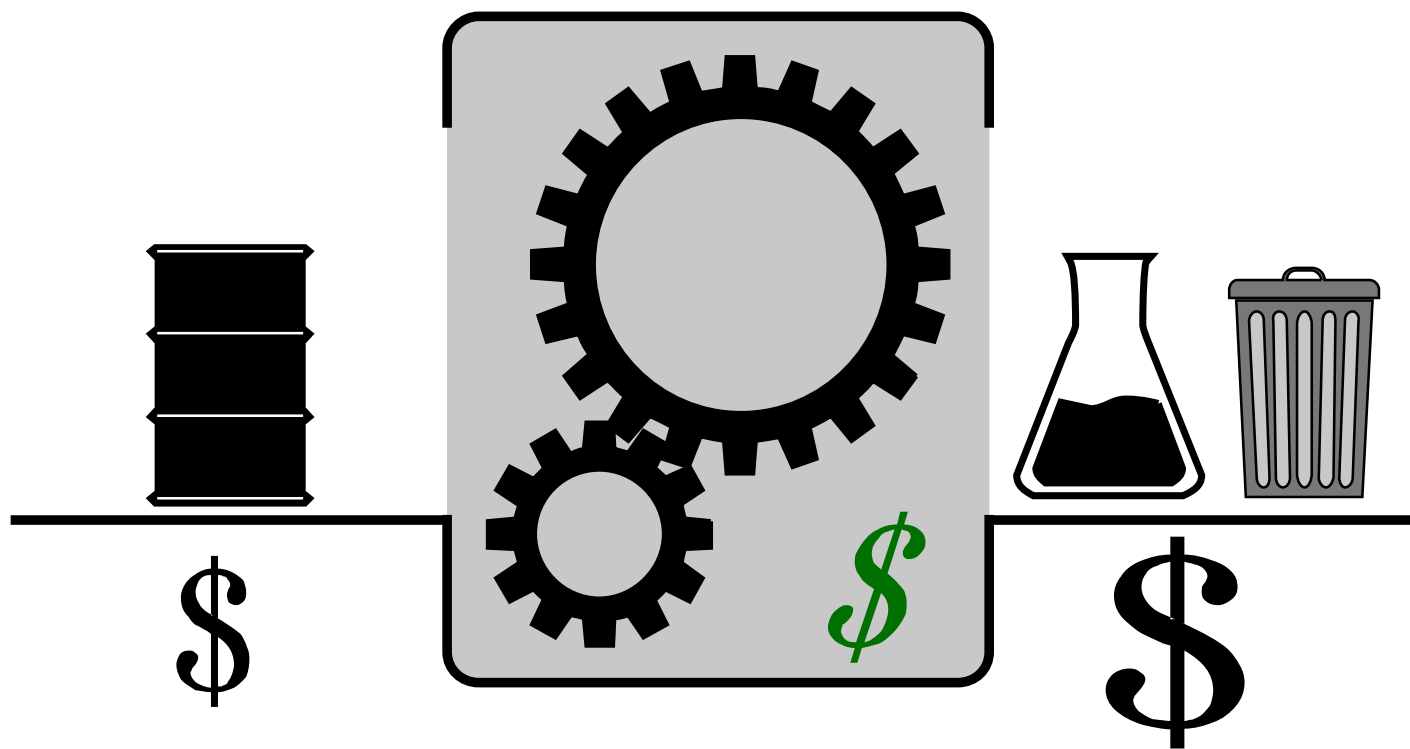
UN SUSTAINABLE DEVELOPMENT GOALS



UN SUSTAINABLE DEVELOPMENT GOALS

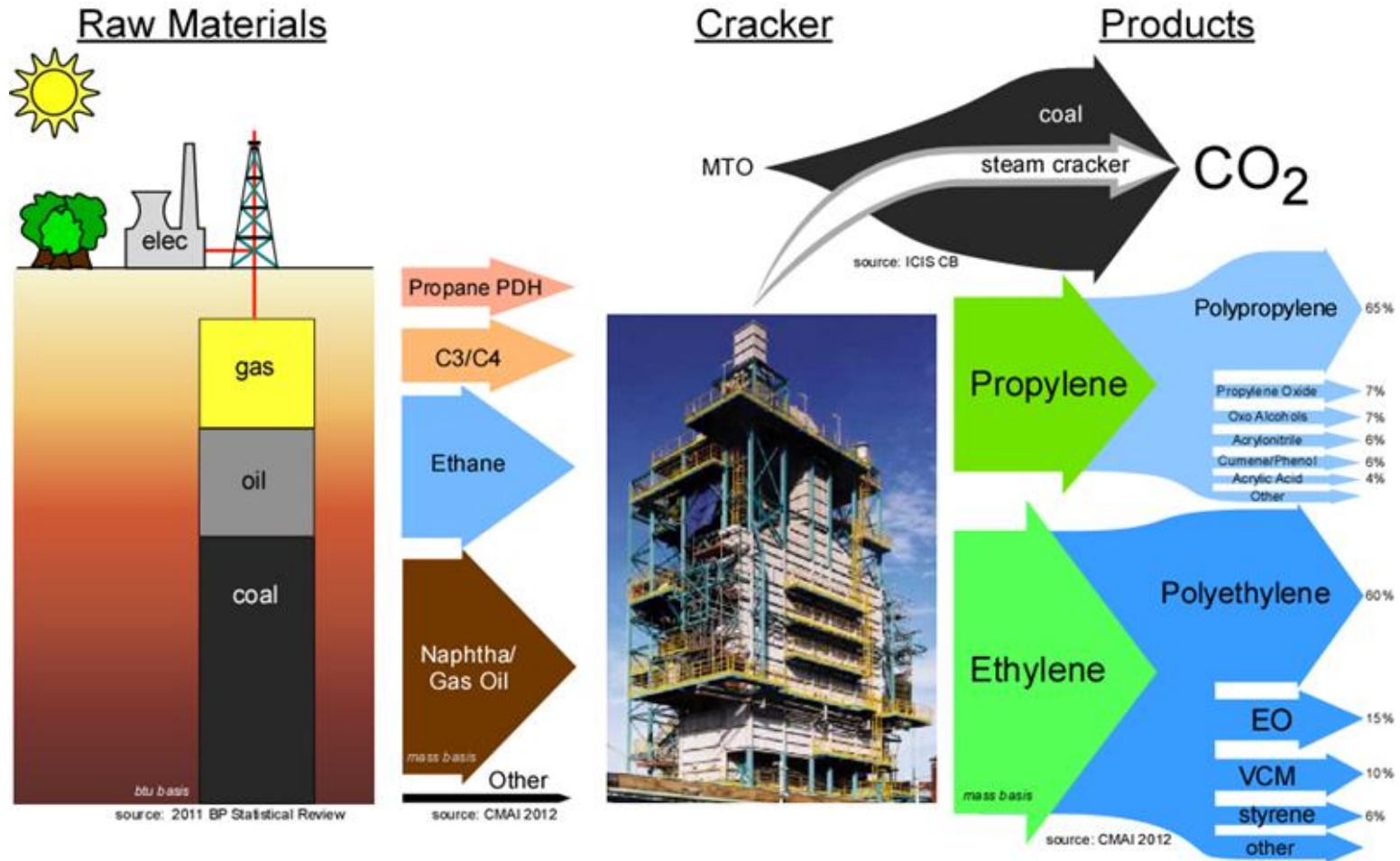


SIMPLIFIED CHEMICAL INDUSTRY



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MODERN CHEMICAL INDUSTRY

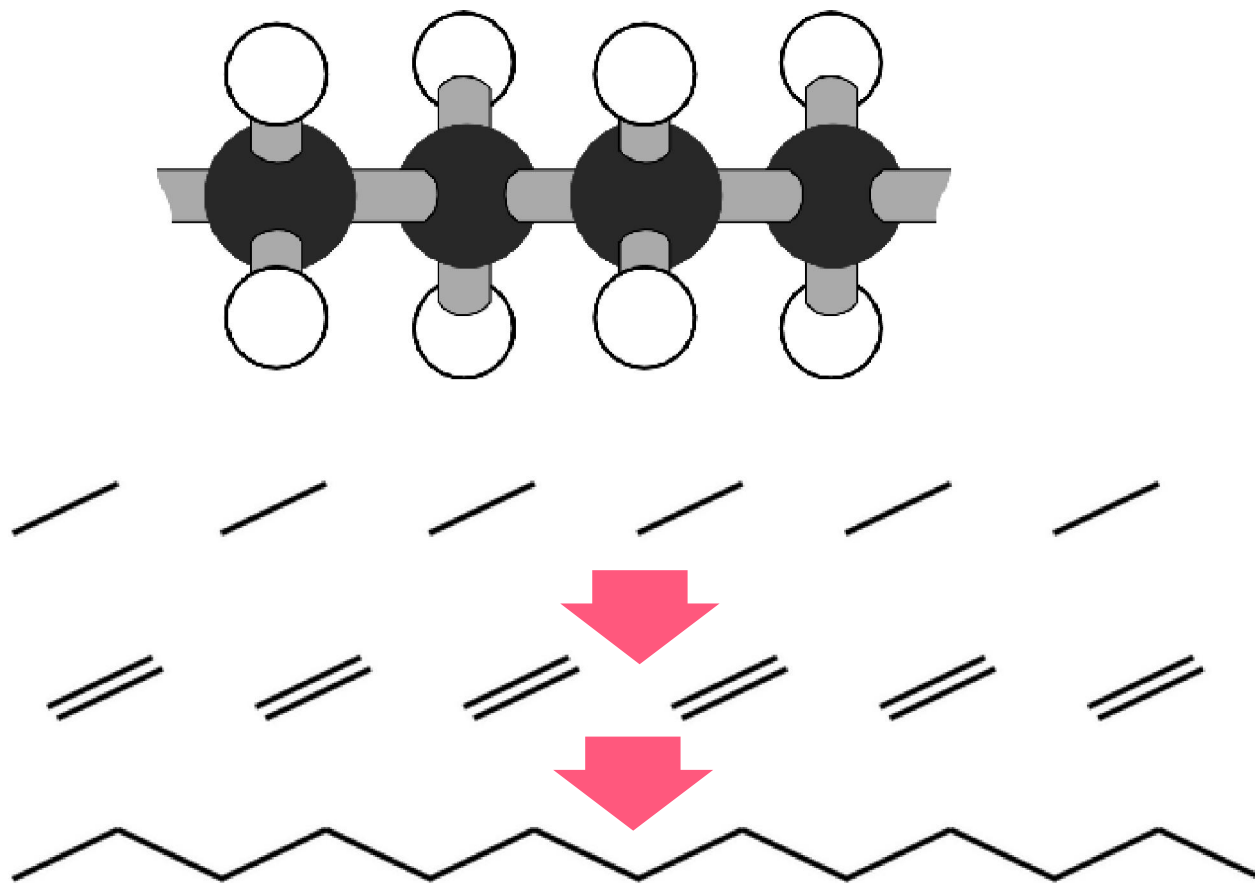


ROUGH INDUSTRY MASS BALANCE



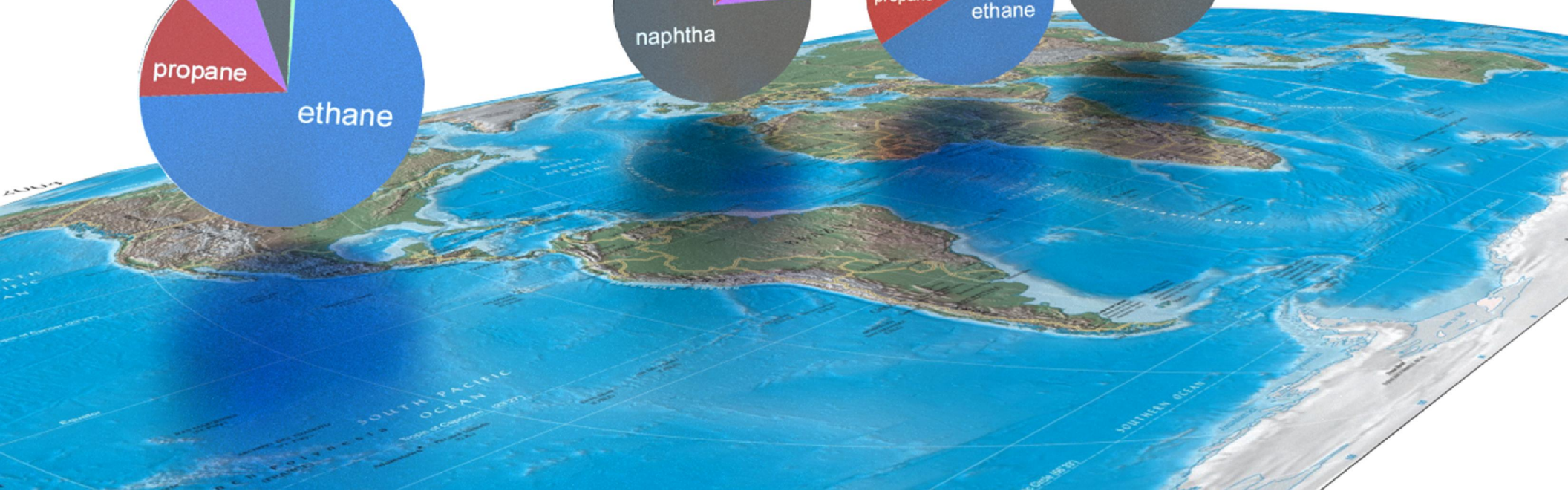
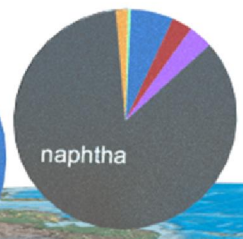
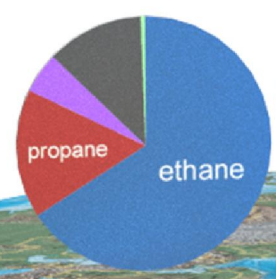
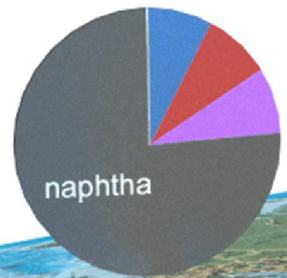
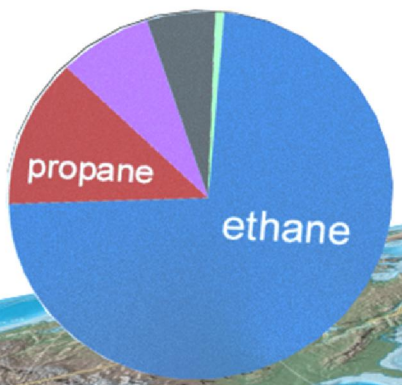
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CHEMICAL TRANSFORMATION

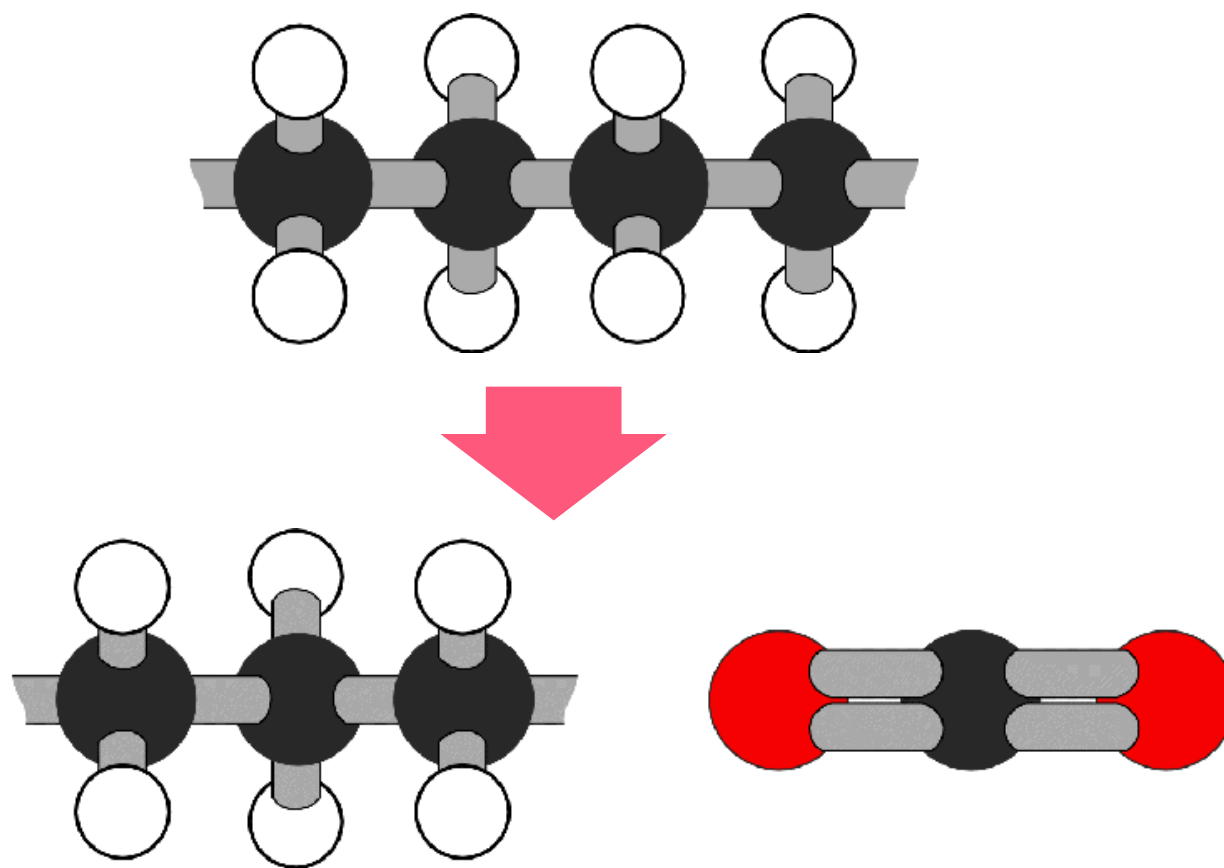


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■ ethane ■ propane ■ butane ■ naphtha ■ MTO/CTO ■ other

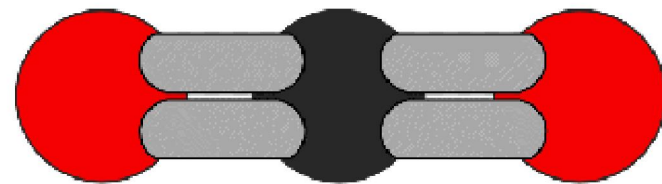
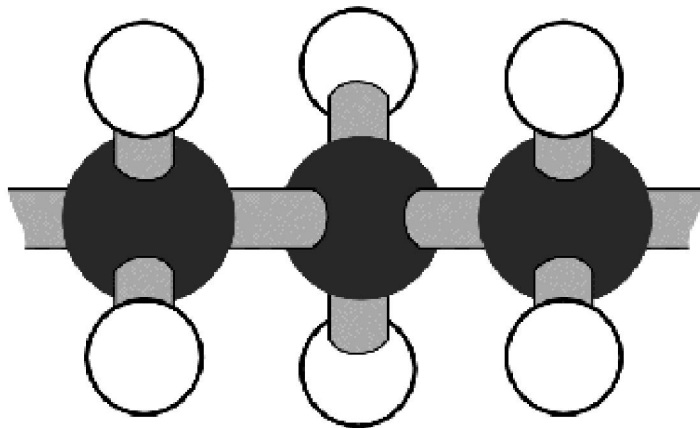


ROUGH MASS BALANCE



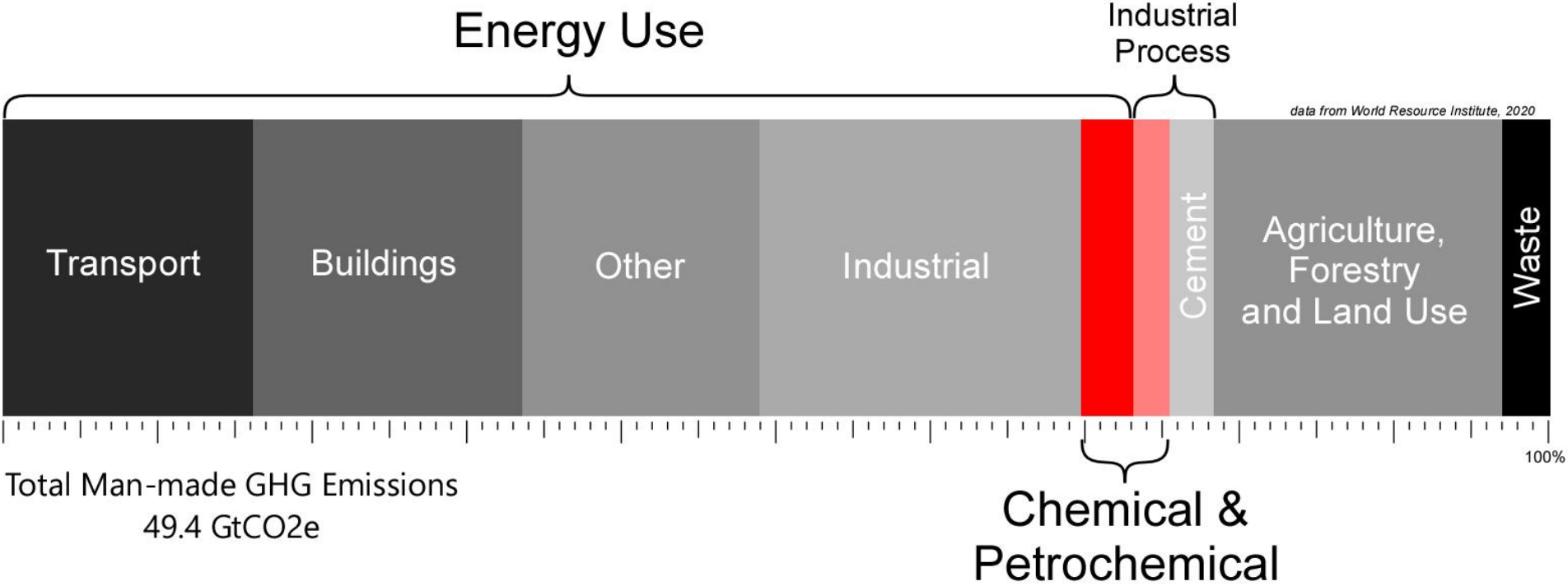
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IMPLICATIONS

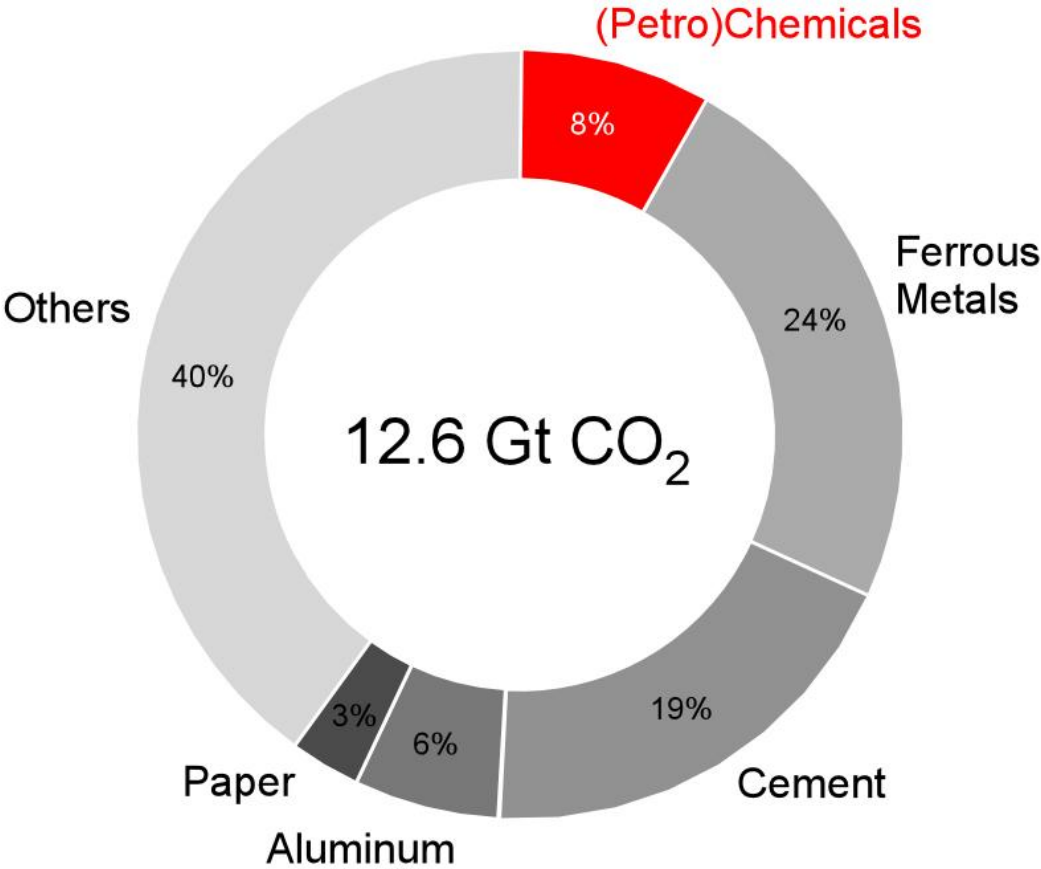


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CARBON FOOTPRINT OF INDUSTRY

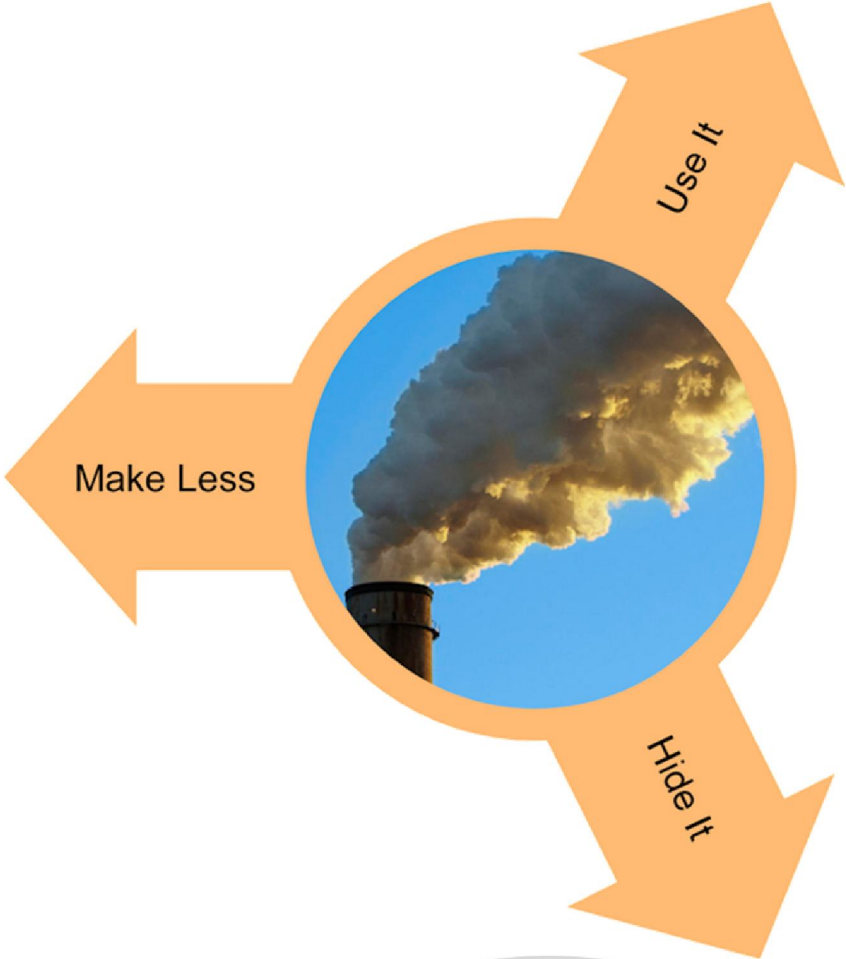


GLOBAL CO2 EMISSIONS FROM INDUSTRY



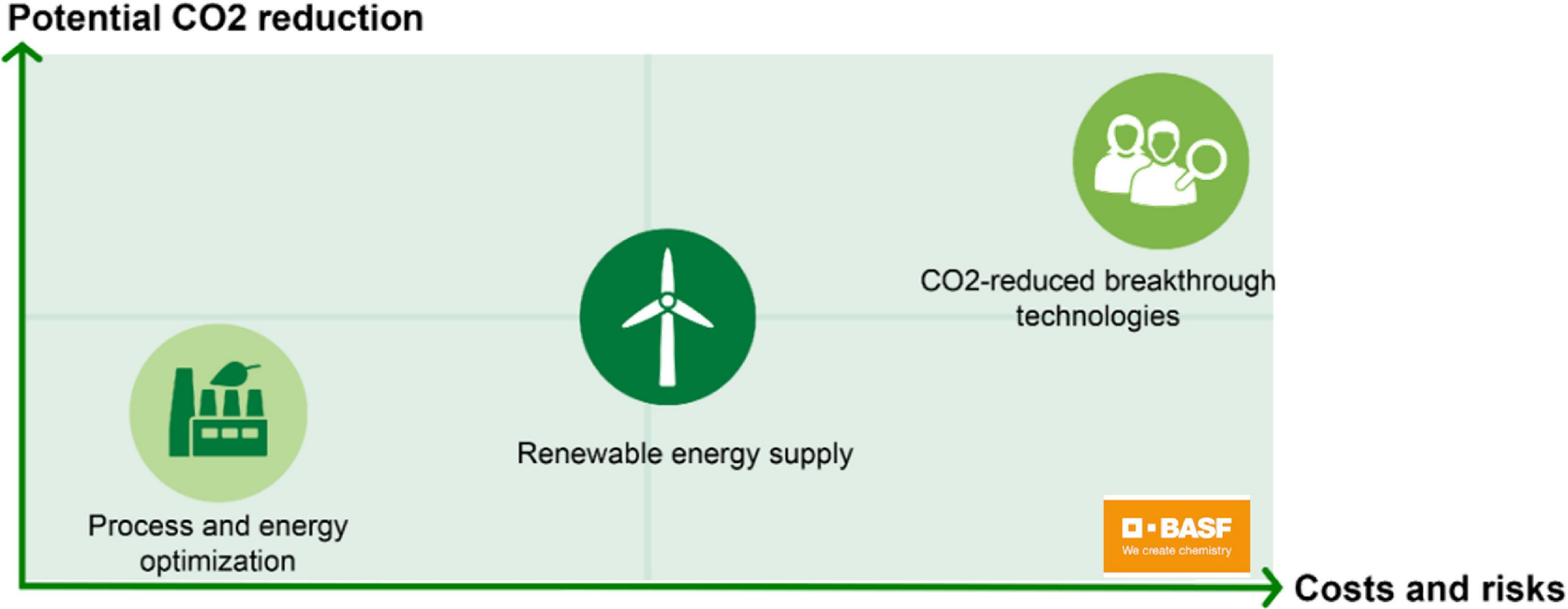
Martin Brudemuller, BASF at the World Economic Forum, 21 Jan 2020

OPTIONS FOR CO₂



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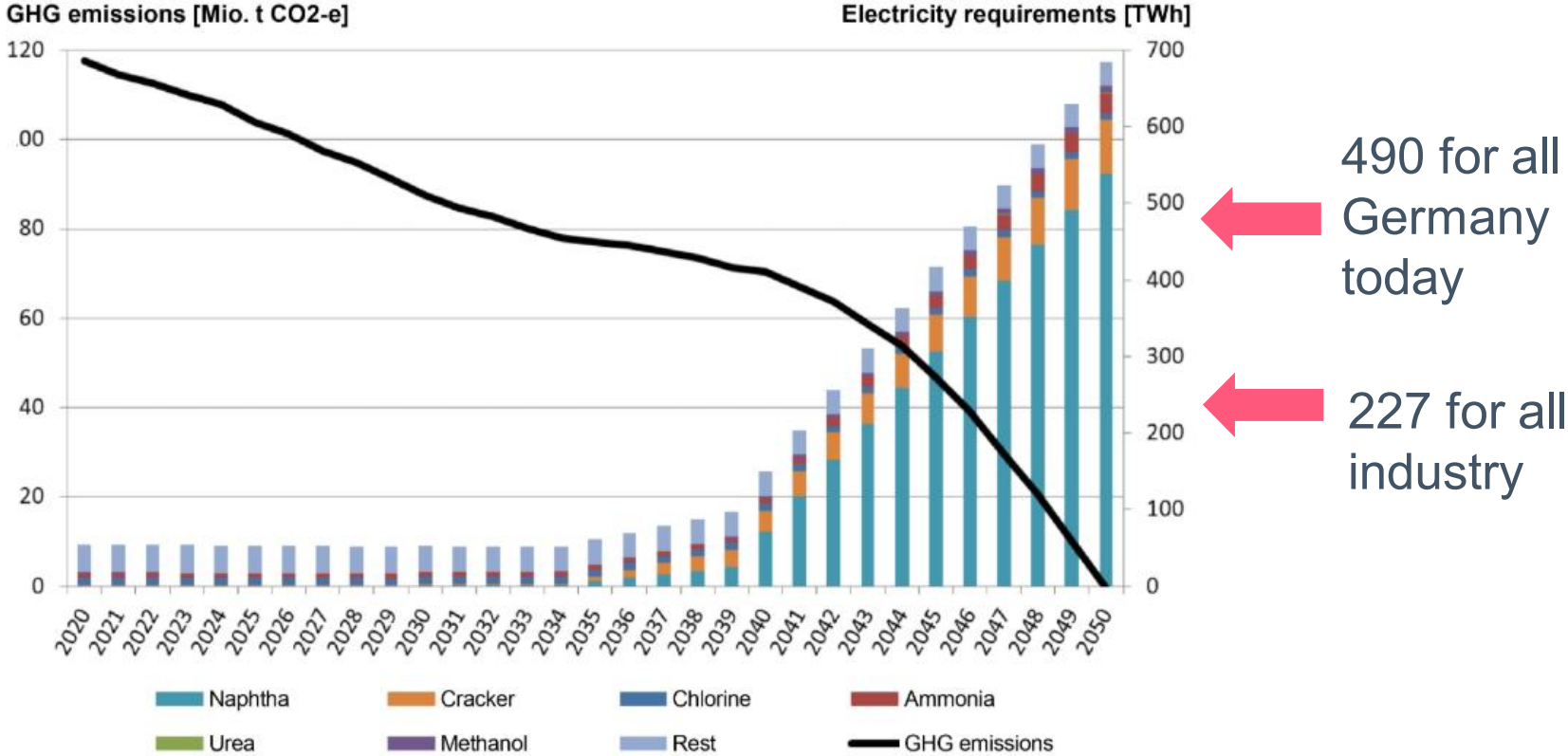
POTENTIAL SOLUTIONS FOR DIRECT EMISSIONS



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



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.



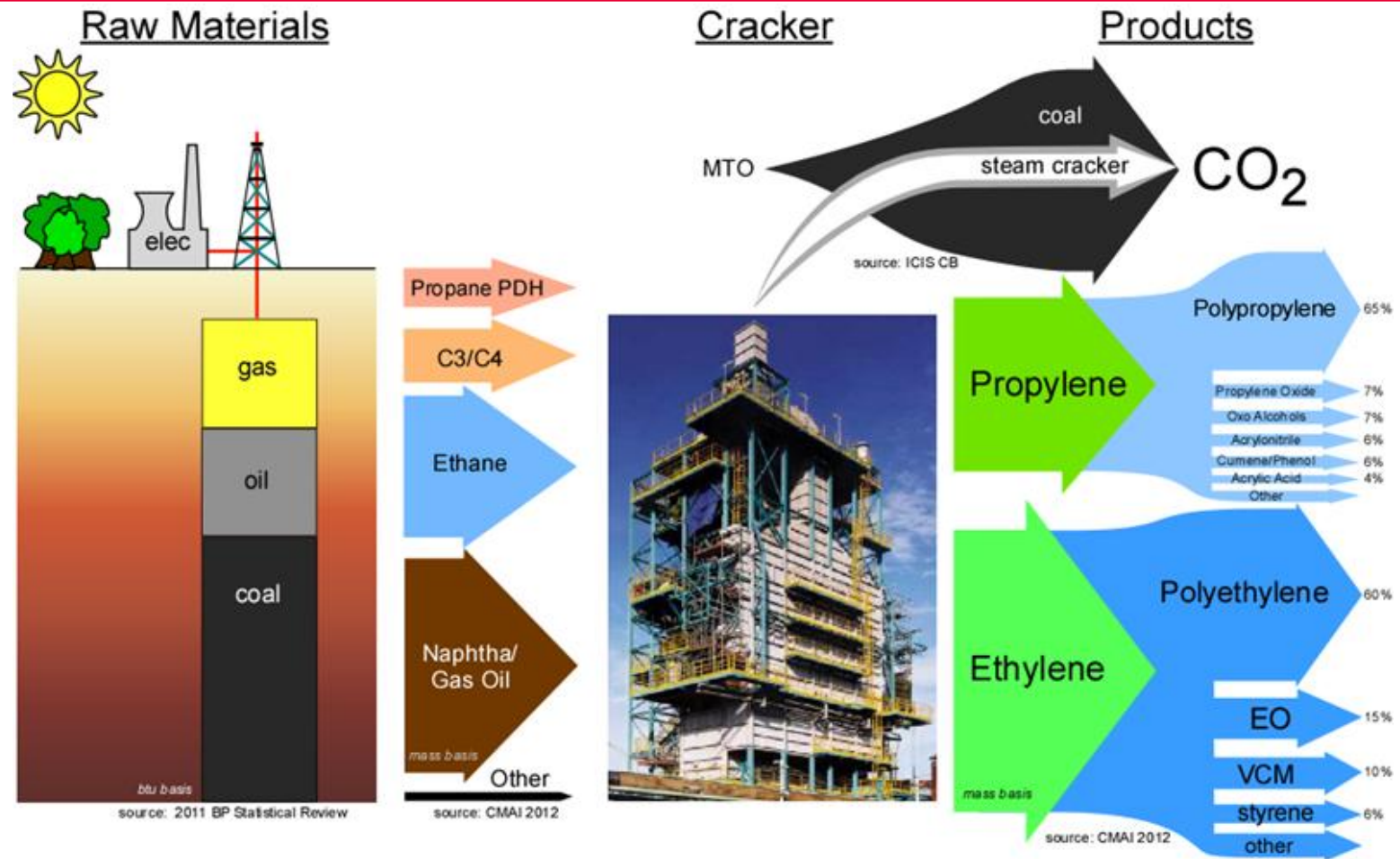
SINGLE-USE

adj (ˈsɪŋɡəlˌjuːs)
made to be used
once only

#CollinsWOTY

Collins
Pioneers in dictionary publishing since 1819

MODERN CHEMICAL INDUSTRY



OCEAN PLASTIC

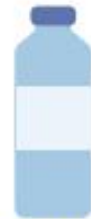


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2014

2050

PLASTICS PRODUCTION

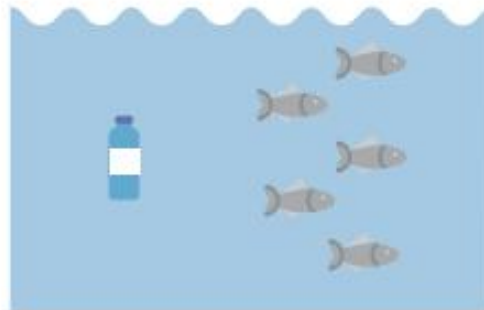


311 MT

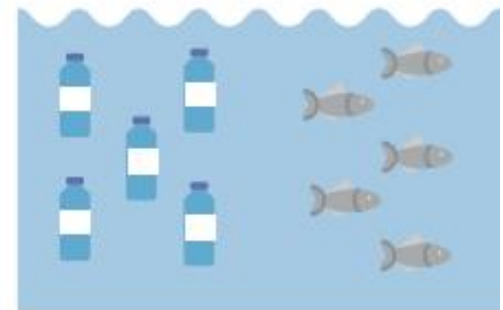


1,124 MT

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



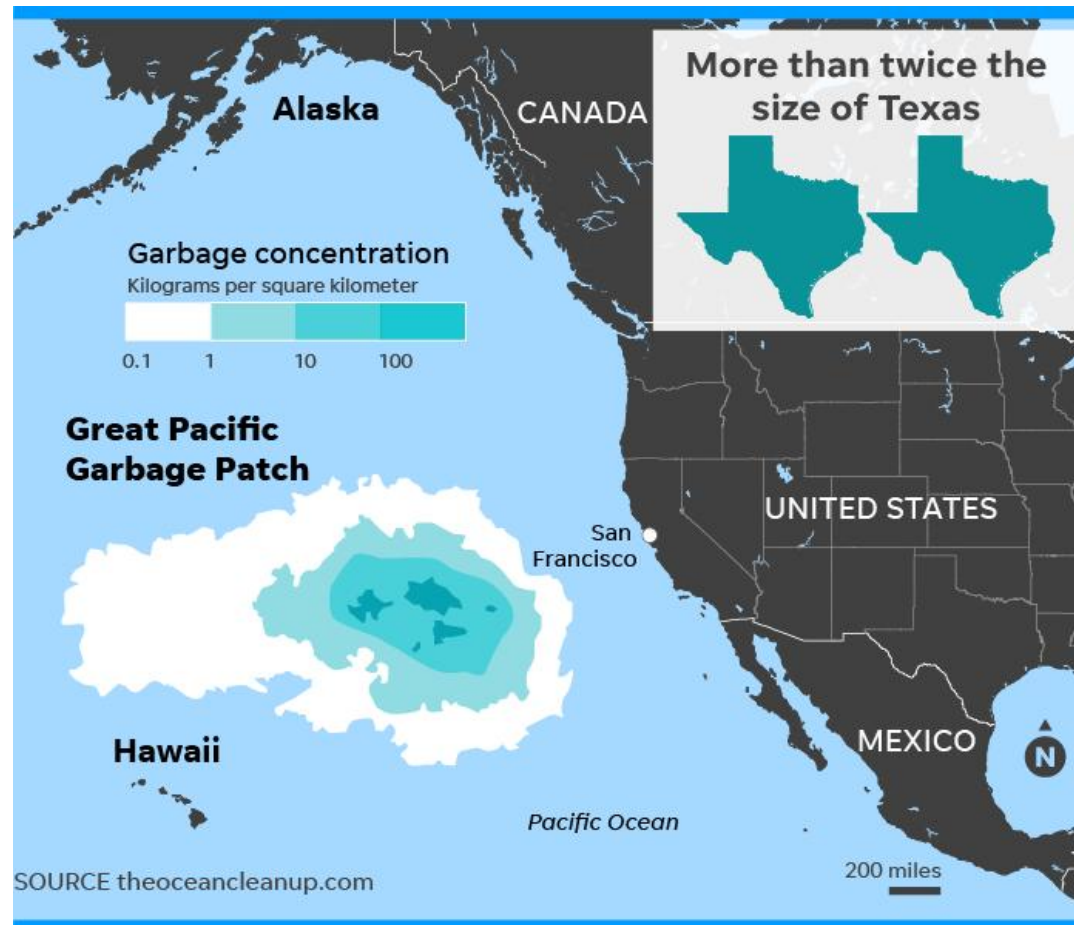
1:5

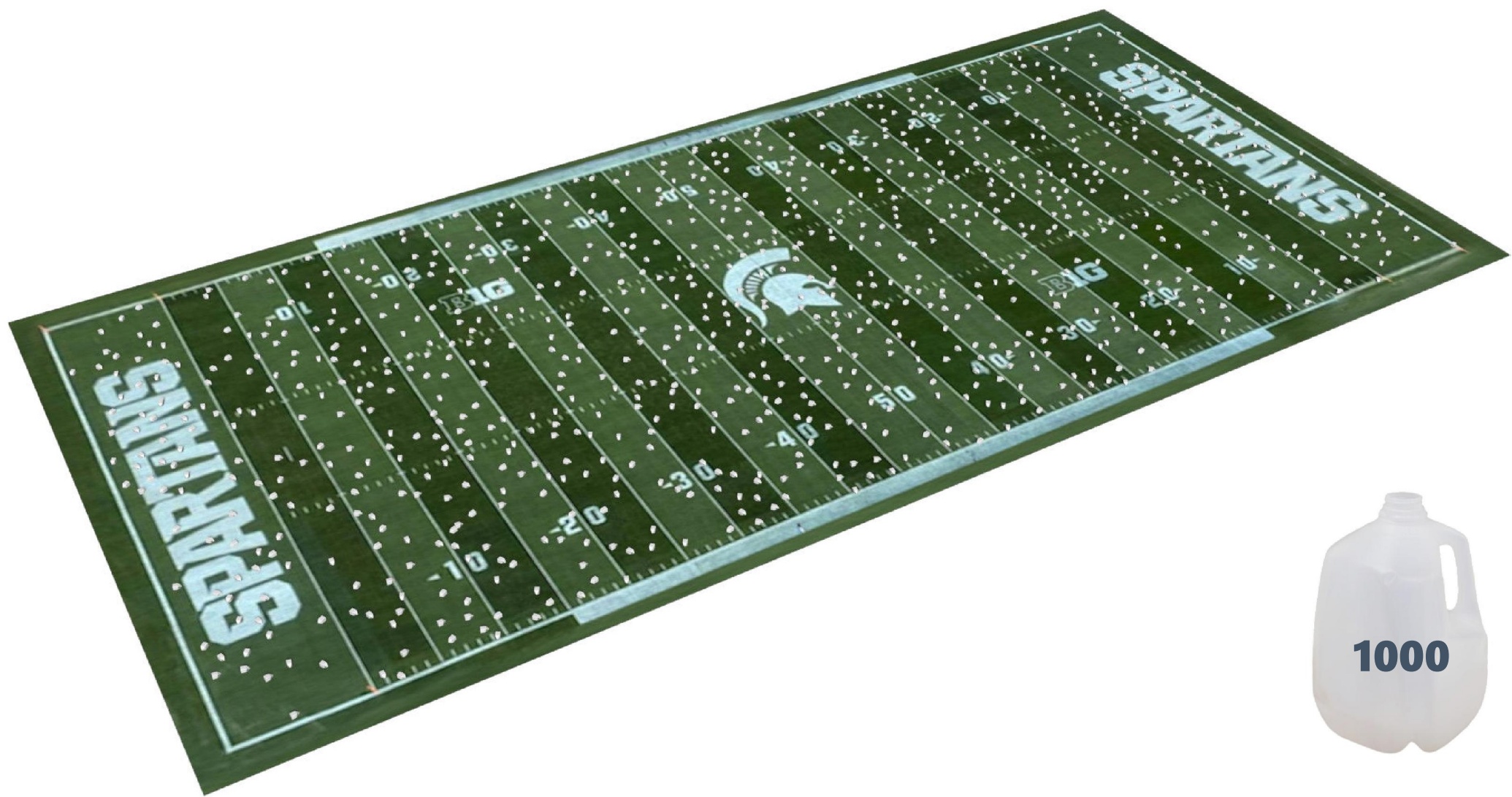


>1:1

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THE PACIFIC GYRE





1000







100







10





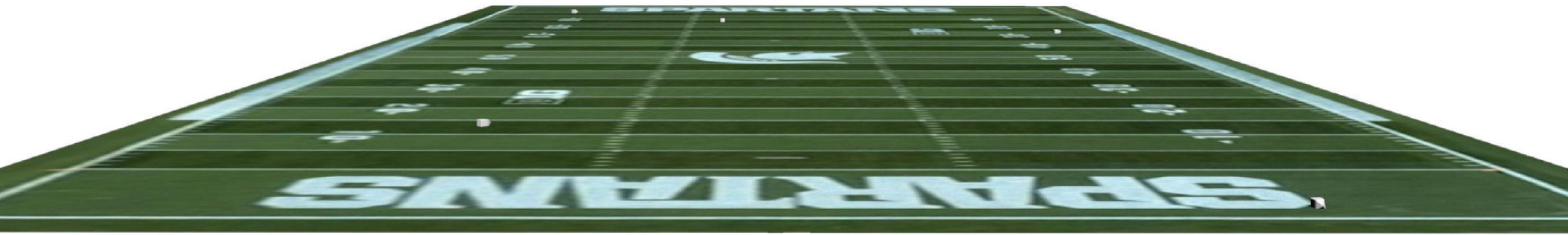


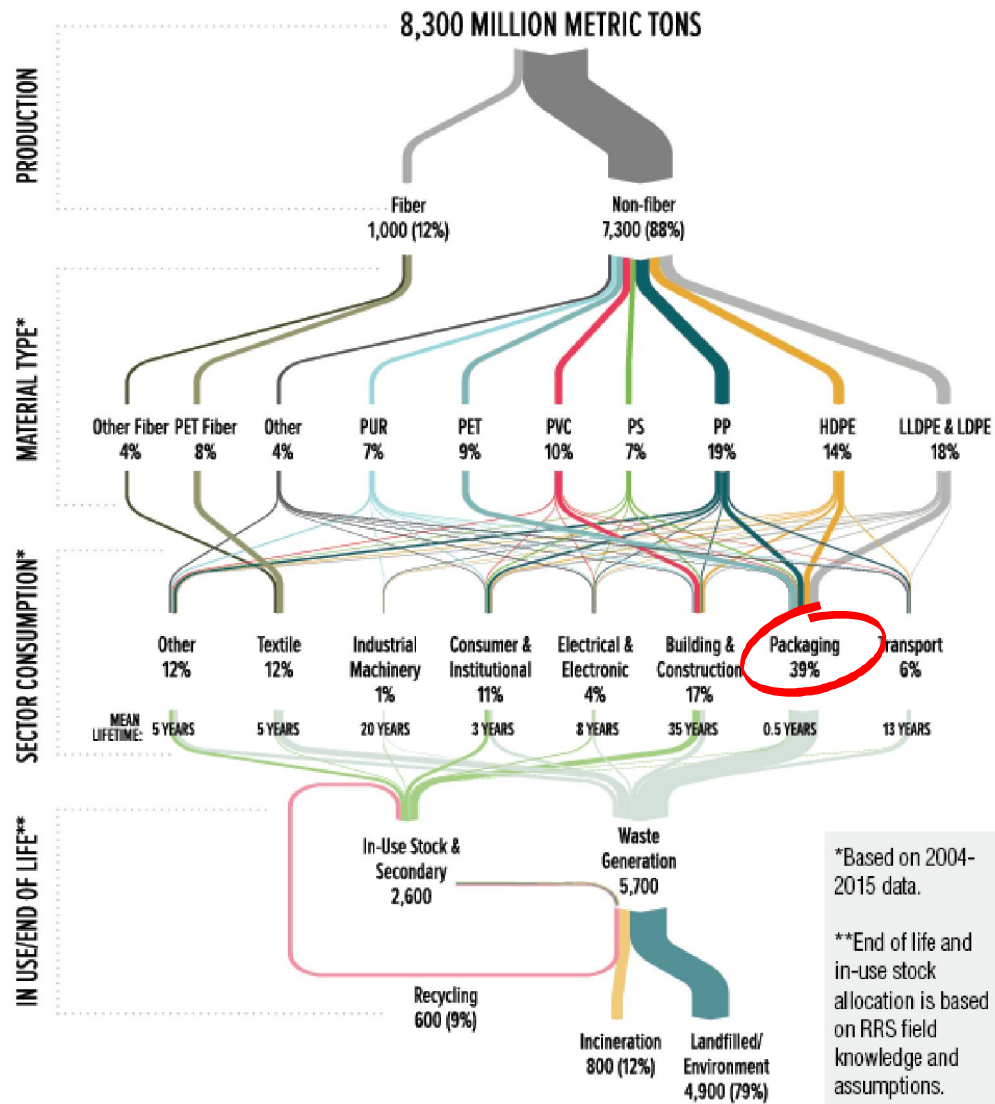


<https://media.greenpeace.org/archive/Arctic-Sunrise-s-Enters-the-Great-Pacific-Garbage-Patch---Web-Video--Clean--English--27MZIFJWHRHRH.html>

In The Pacific Gyre At Point of Highest Plastic Concentration







PLASTIC PROVIDES BENEFITS

Shelf-life Comparison

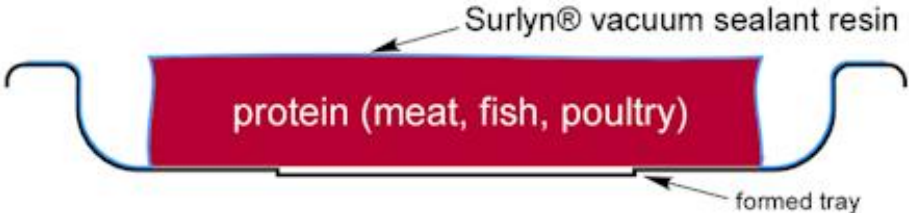
VSP with Surlyn®

21-35 days

MAP

12-15 days

stretch-wrap
3-5 days



PLASTIC PROVIDES BENEFITS



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ALTERNATIVES COST MORE

\$98 Billion



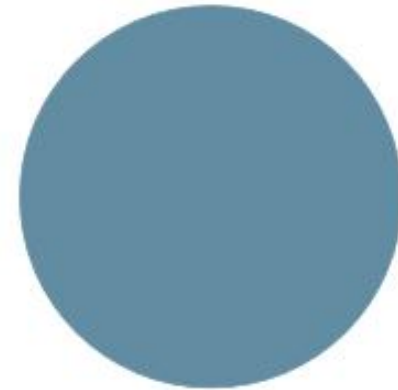
More Sustainable Plastic

\$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.

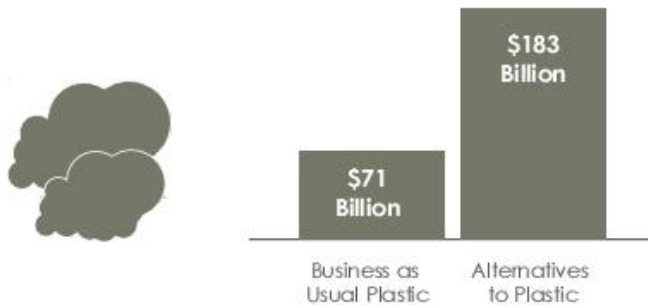
Source: Trucost

Source: American Chemistry Council TRUCOST report

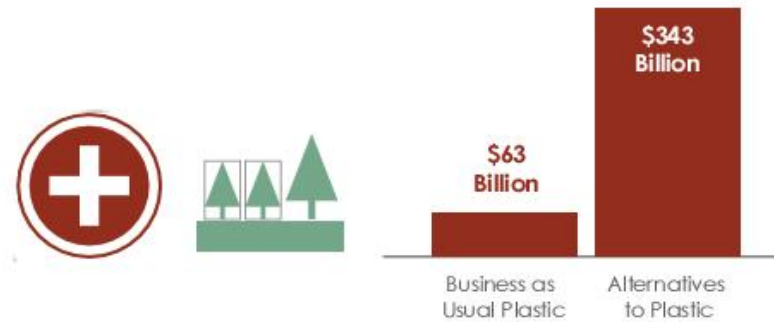
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ALTERNATIVES HAVE HIGHER ENVIRONMENTAL COSTS

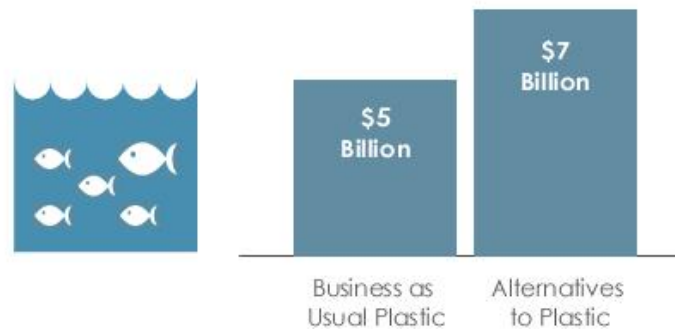
Climate change



Damage to the health of humans and ecosystems



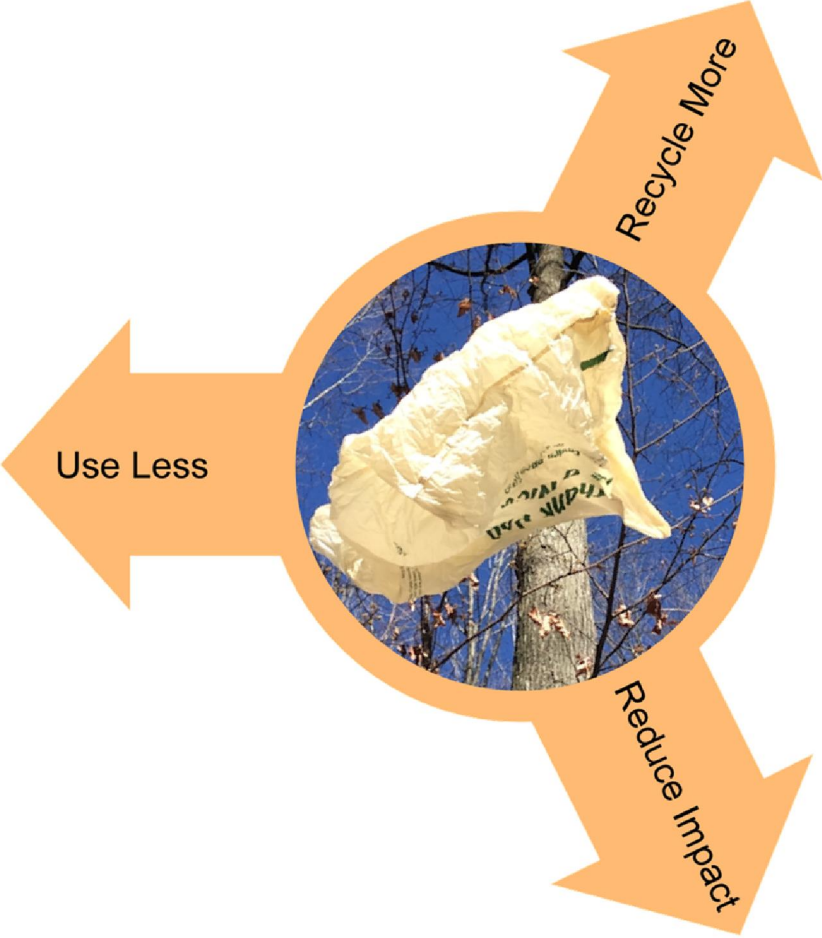
Damage to the oceans



All dollar values are in USD
Source: Trucost

Source: American Chemistry Council TRUCOST report

POSSIBLE SOLUTIONS



WASTE REDUCTION HIERARCHY



USE LESS WITH MORE EFFICIENT PACKAGING



EDISON AWARDS'
2015



2015
R&D 100 Winner

EDIBLES

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

Rice & Grains
Breakfast Cereal
Dry Baking Products
(flour, sugar, etc.)
Ground Coffee
Snack foods

NON-EDIBLES

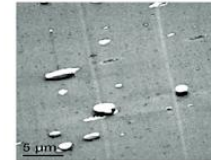
Paint & Coatings
Detergents &
Cleaning Products
Motor Oil & Fuel
Additives
Seeds
Cat Litter
De-icer Pellets
Fine Aggregates
(filter sand, etc.)

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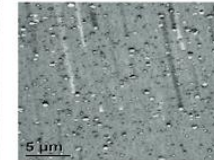
ENABLE RECYCLING



Transmission Electron Microscopy

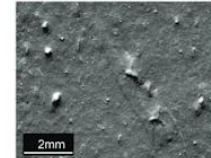


No Compatibilizer
Large EVOH domains

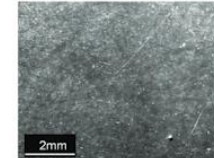


XUS 69 108.01⁽¹⁾
Modifier Polymer
Small, uniform EVOH domains

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.
⁽²⁾Trademark of The Dow Chemical Company

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PROVIDE ALTERNATIVES



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RECOVER



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DISAPPEAR



Case Study



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WHICH IS MOST VALUABLE



~2¢



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RECYCLING PRICES

0.61¢

0.01¢

9.16¢

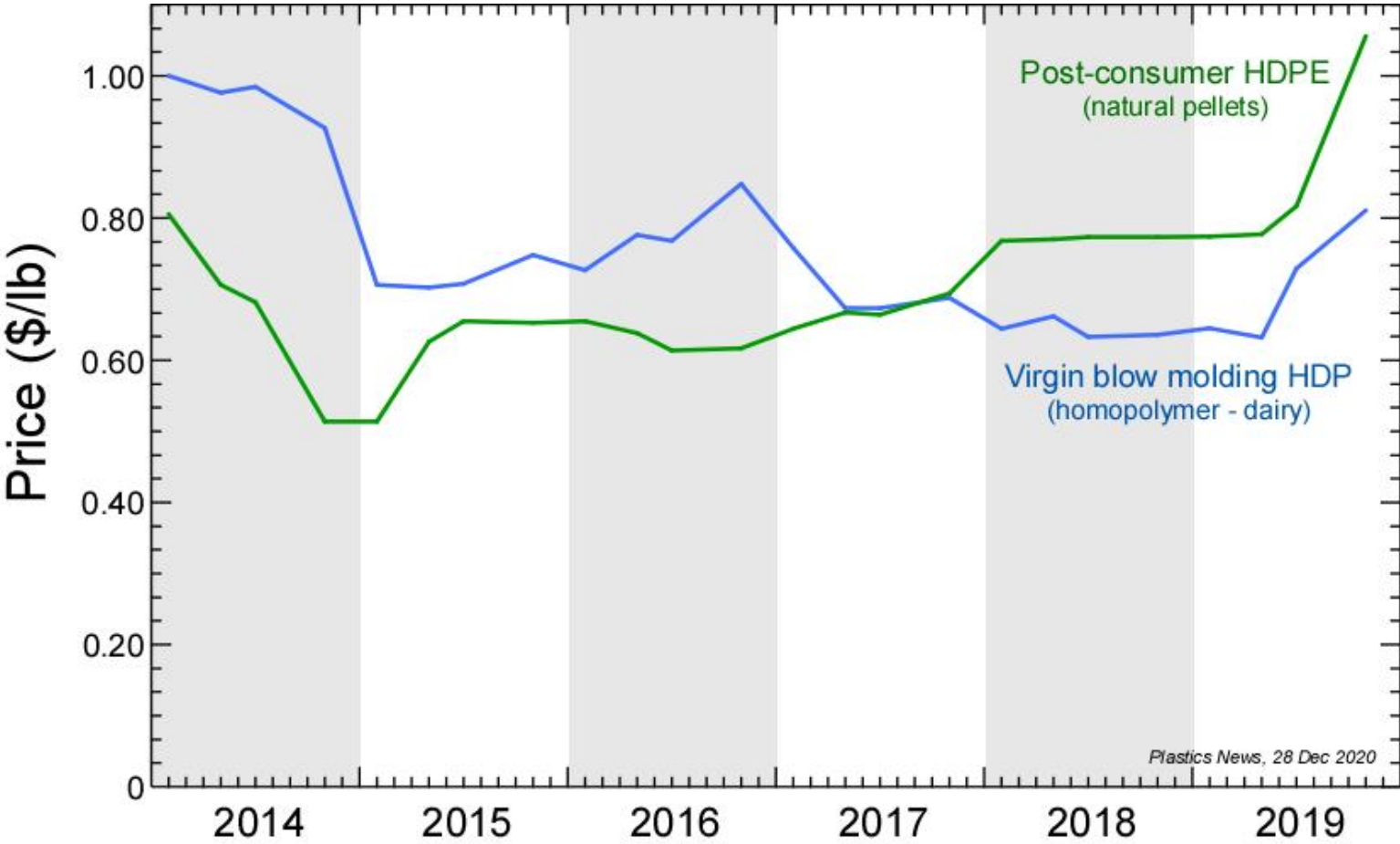
0.22¢

0.20¢



~2¢

GOOD NEWS



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DOWNCYCLED PET



MORE DOWNCYCLED CONTENT



COMFORTGEL

Gillette
CustomPlus®
3

1063A17400

40°
PIVOT

SAME GREAT SHAVE,
MADE WITH
**60% RECYCLED
PLASTIC HANDLE**

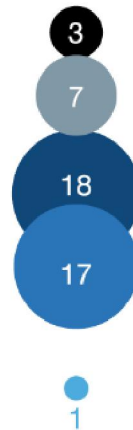
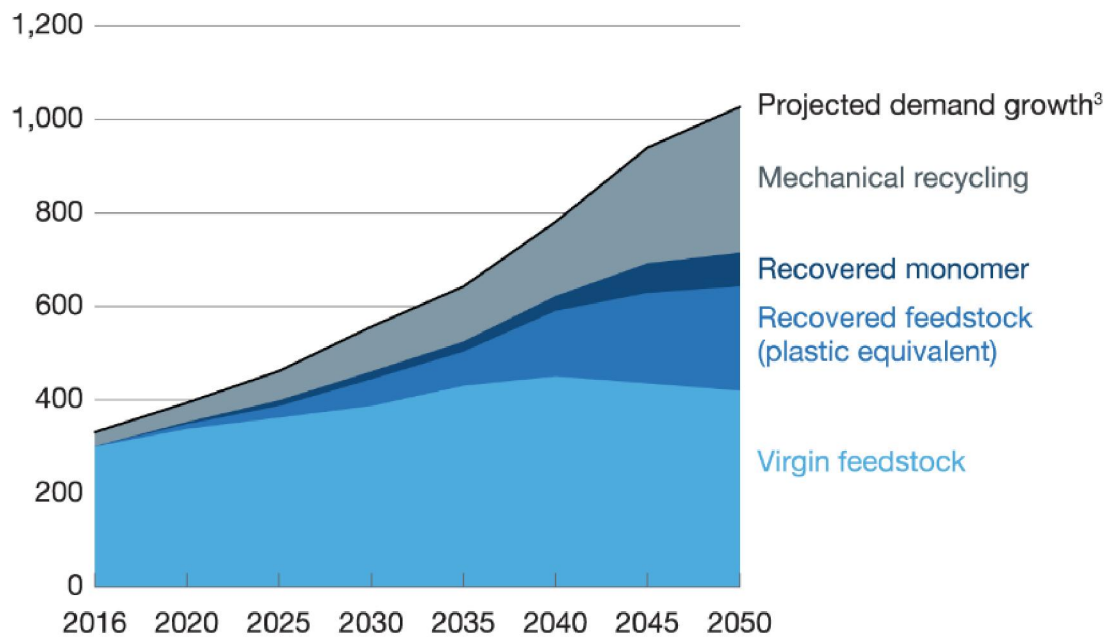
The advertisement features a blue background with a green horizontal band at the bottom. On the left, a Gillette razor is shown with a blue water droplet icon above it labeled 'COMFORTGEL'. In the center, a yellow recycling symbol is overlaid on the razor's head, which is labeled '40° PIVOT' and '3'. To the right, the 'Gillette CustomPlus 3' logo is displayed, with the product code '1063A17400' below it. The main text at the bottom of the green band reads 'SAME GREAT SHAVE, MADE WITH 60% RECYCLED PLASTIC HANDLE'.

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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

CAGR 2016–50,² %



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%.

CAUTIONARY TALE OF UNINTENDED CONSEQUENCES



Thomas Midgley, Jr.

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WHAT IS THE SAFE LEVEL?



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LEAD RELEASE FROM METALS PROCESSING



Cu production → 13,000 tons of Pb



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