Sustainability and Its Impact on the Chemical Industry

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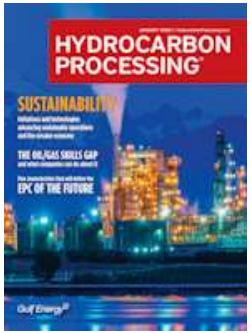
The Dow Chemical Company.

30 January 2020

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?

37% 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.

63% 2. Meeting our own needs without compromising the ability of future generations to meet their own needs.

0 3. The ability to continue a defined behavior indefinitely.

0 4. Wondrously complicated.

blue text = poll results

Sustainability Definition

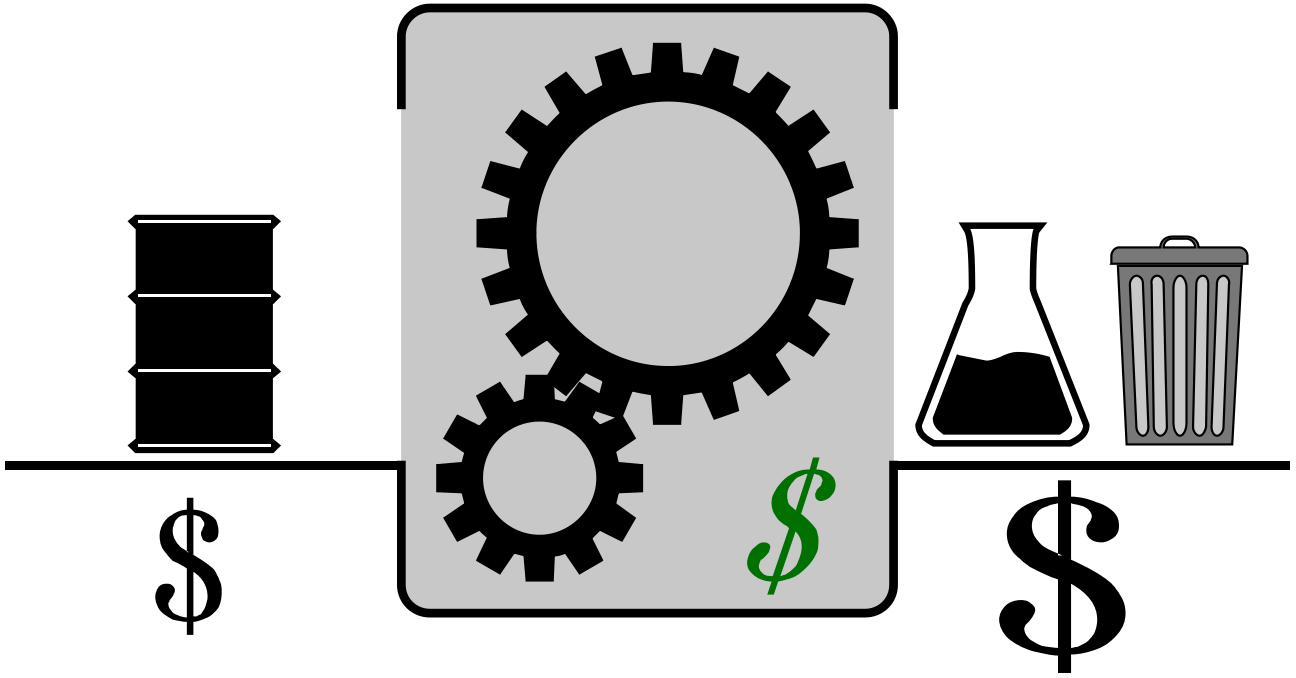
Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs.

Brundtland Commission

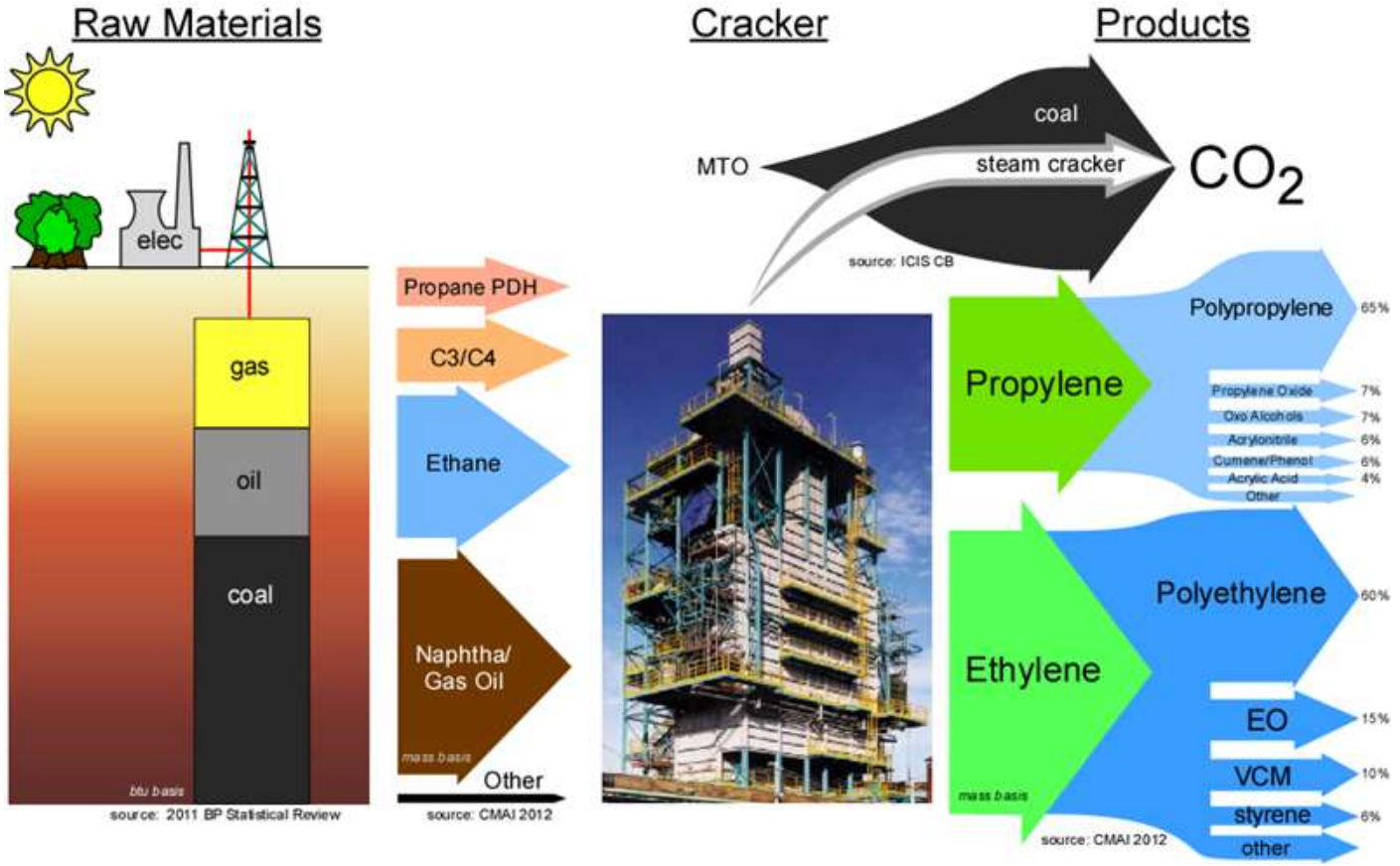
Three Pillars of Sustainability

UN Sustainable Development Goals

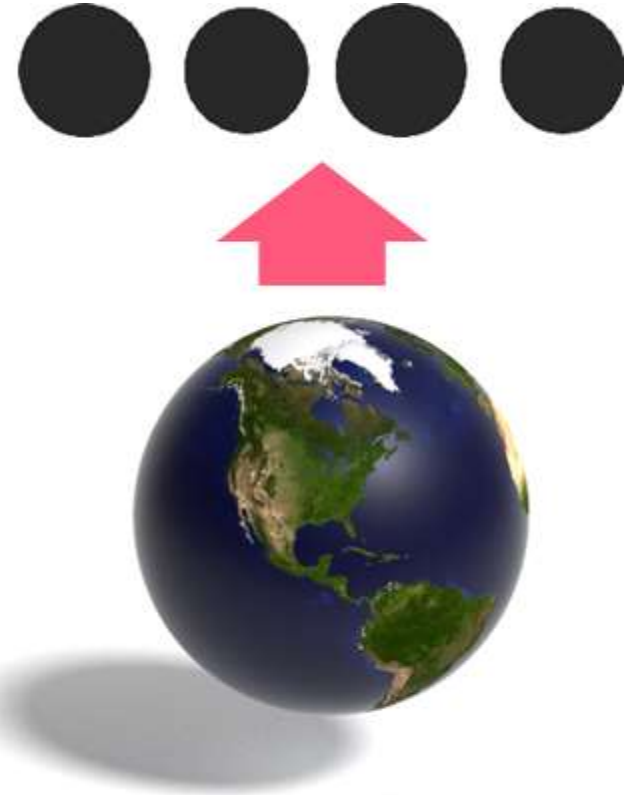
Simplified Chemical Industry



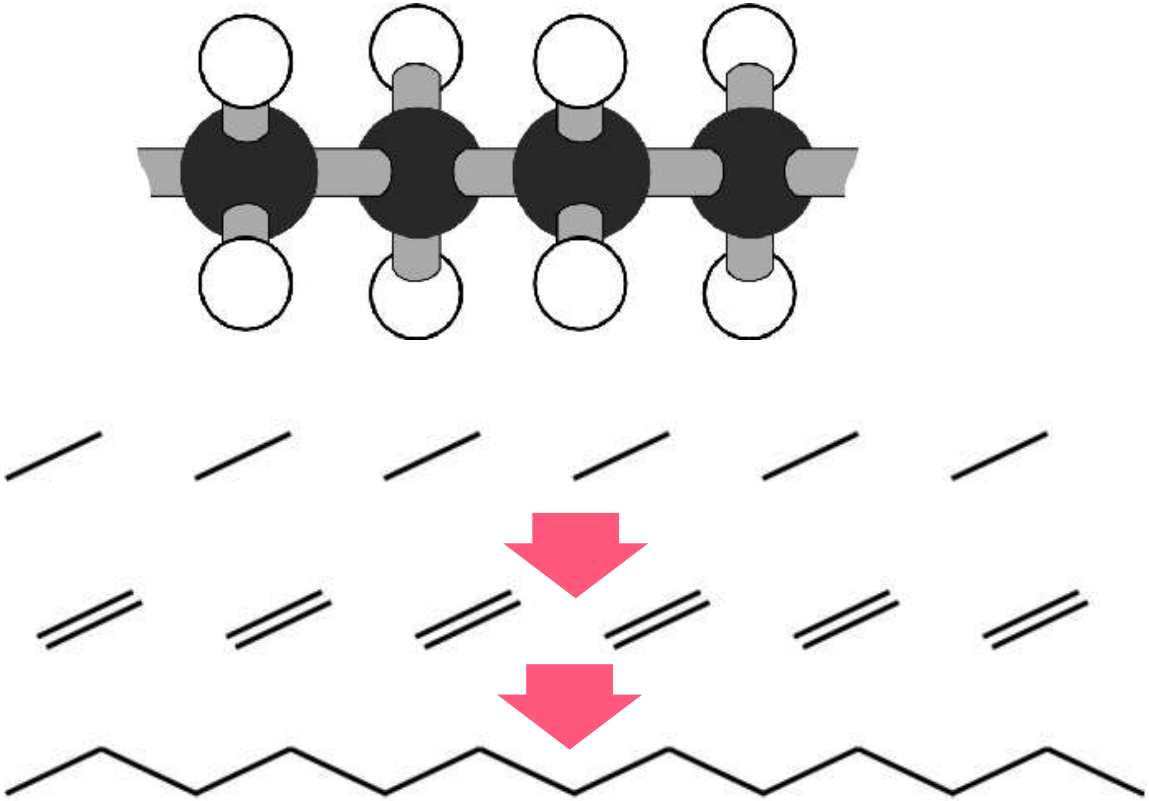
MODERN CHEMICAL INDUSTRY

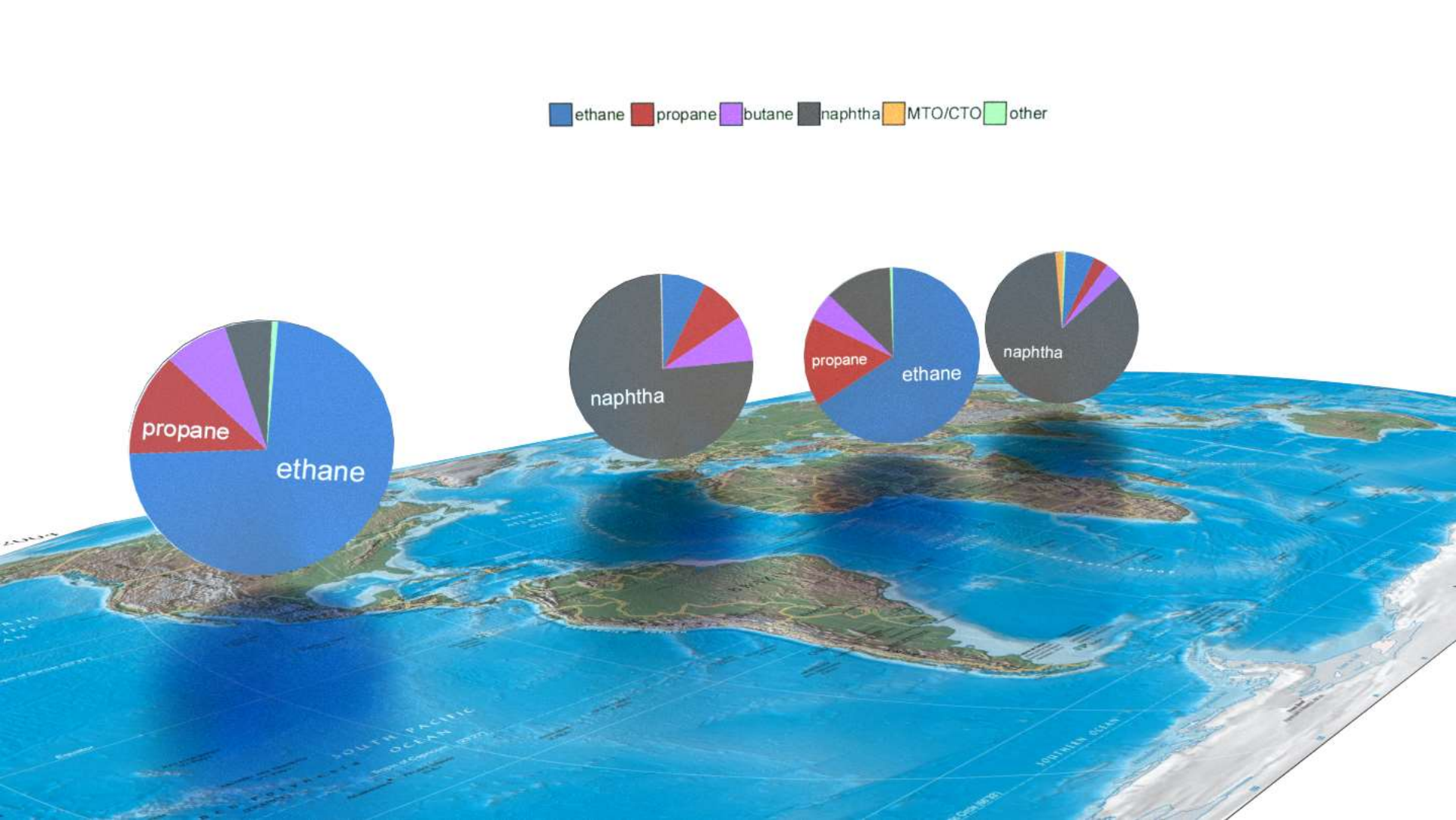


Rough Industry Mass Balance



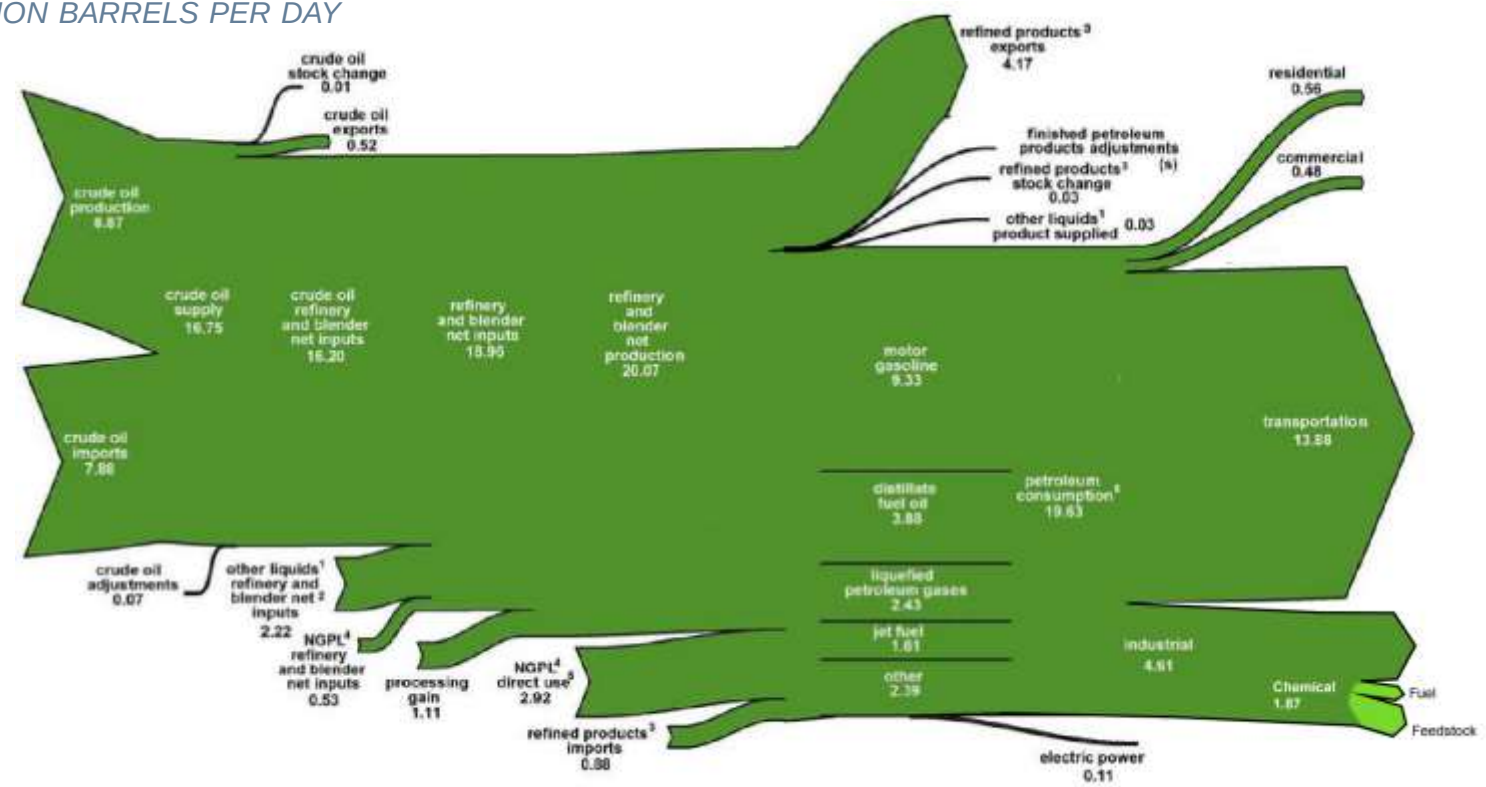
CHEMICAL TRANSFORMATION




ethane
propane
butane
naphtha
MTO/CTO
other
propane
ethane
naphtha
propane
ethane
naphtha
SOUTH PACIFIC OCEAN
NORTHERN OCEAN

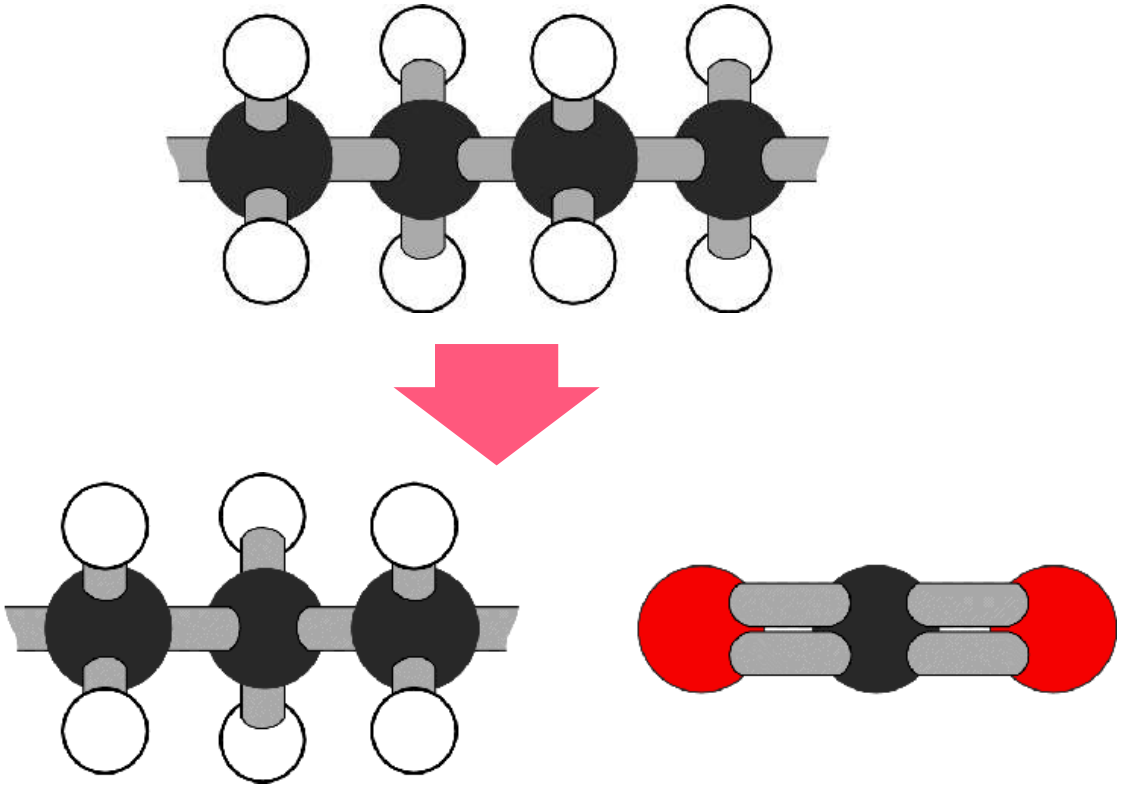
US Petroleum Flow, 2016

IN MILLION BARRELS PER DAY

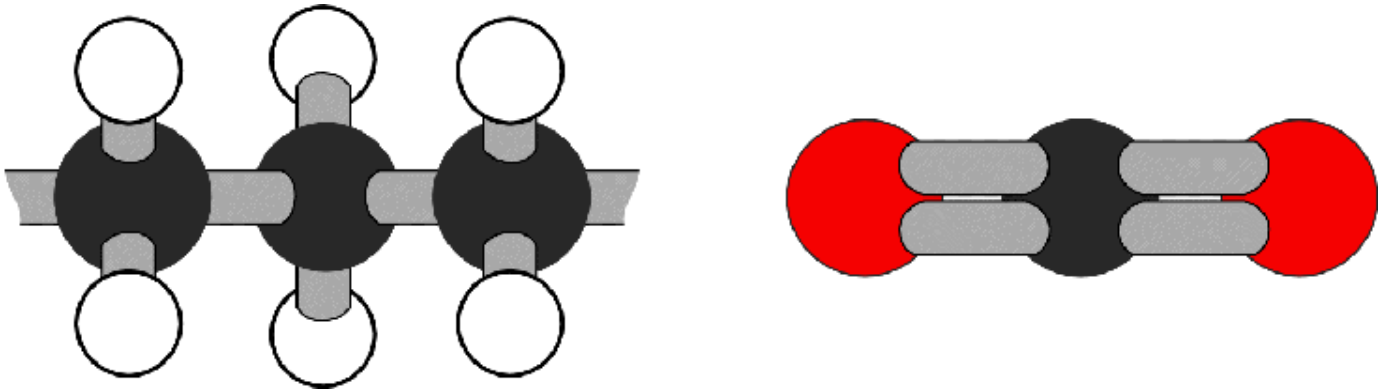


EIA Monthly Energy Review, September 2017 (Release Date: September 28, 2017)
Lippe, Dan; *Oil & Gas Journal*, 4 Sept 2017, pg 82.

Rough Mass Balance



IMPLICATIONS



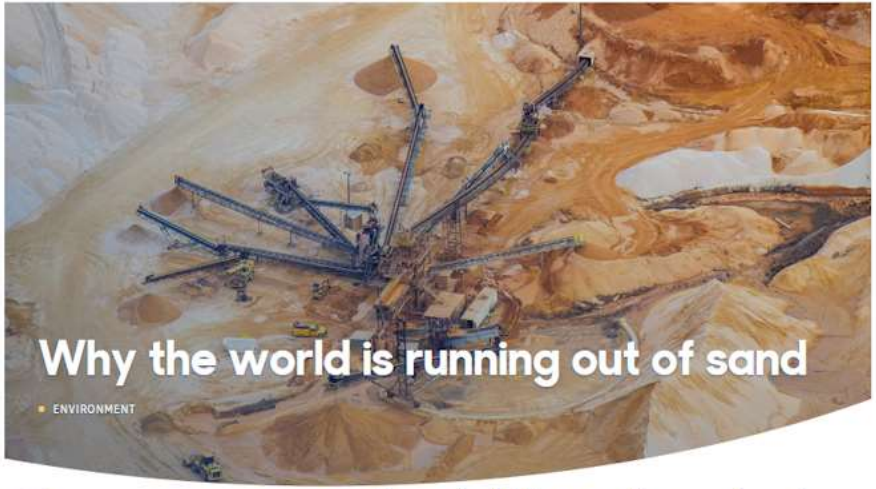
FOOTPRINTS

SAND FOOTPRINT

The World is Running Out of Sand

The little-known exploitation of this seemingly infinite resource could wreak political and environmental havoc

BBC FUTURE



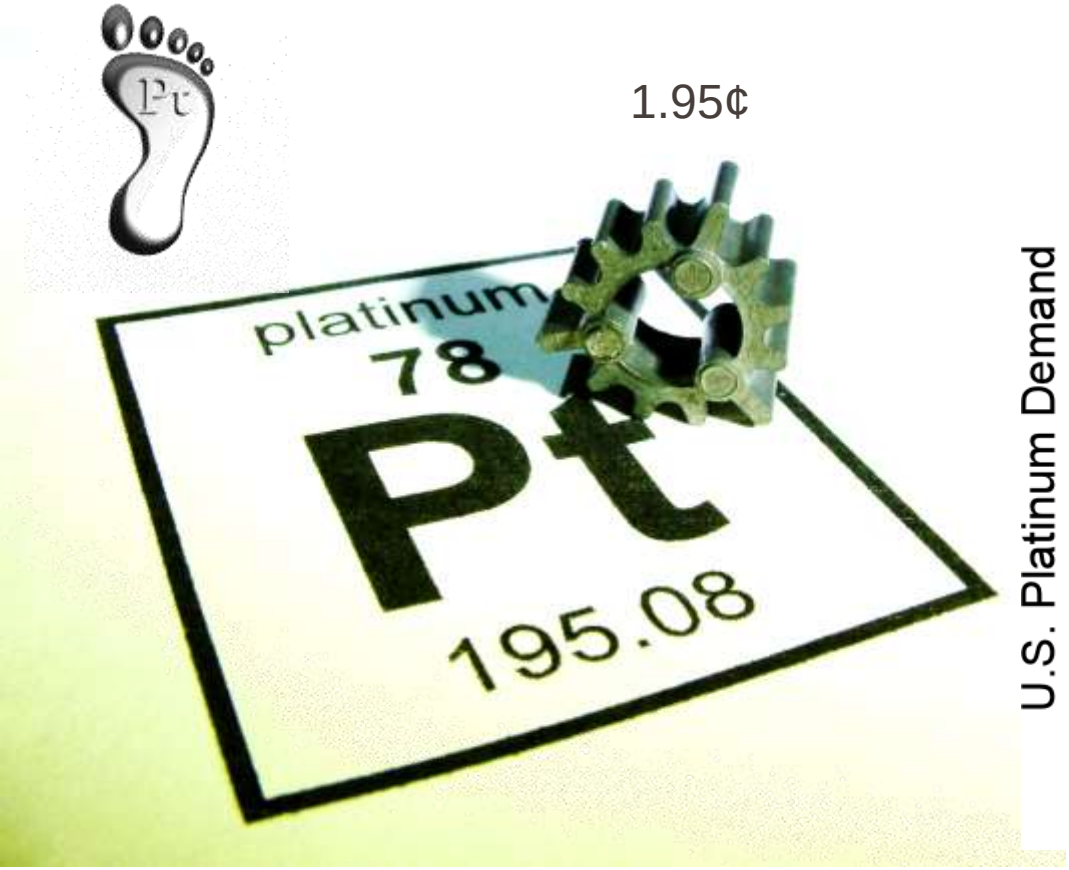
By Vince Beiser
17th November 2019

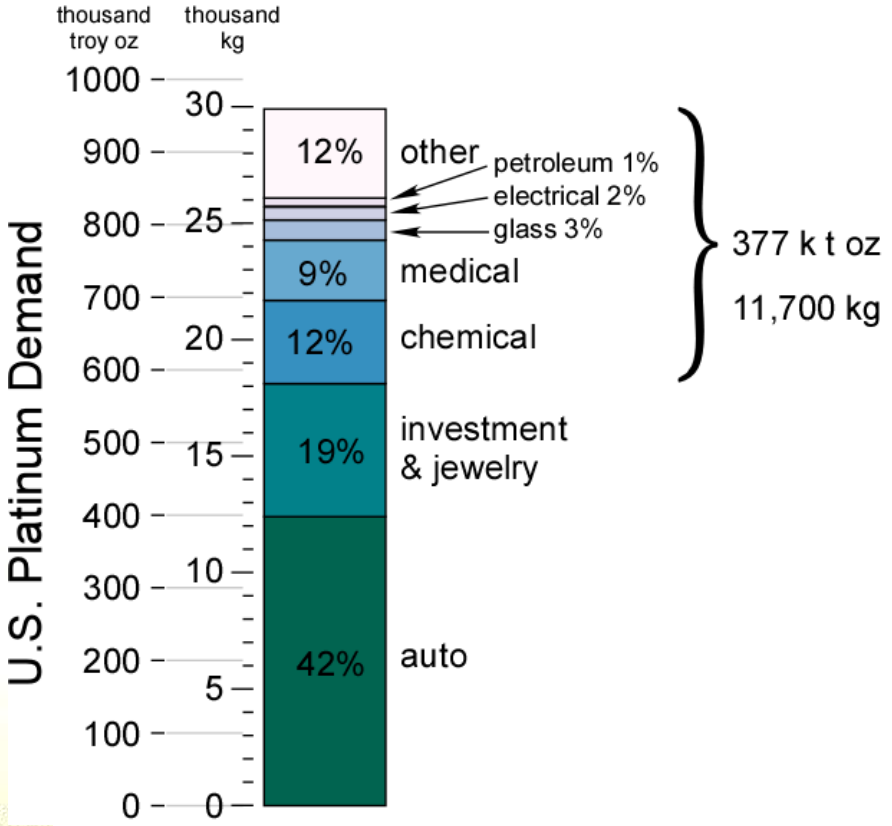
It may be little more than grains of weathered rock, and can be found in deserts and on beaches around the world, but sand is also the world's second most consumed natural resource.

Granite Footprint

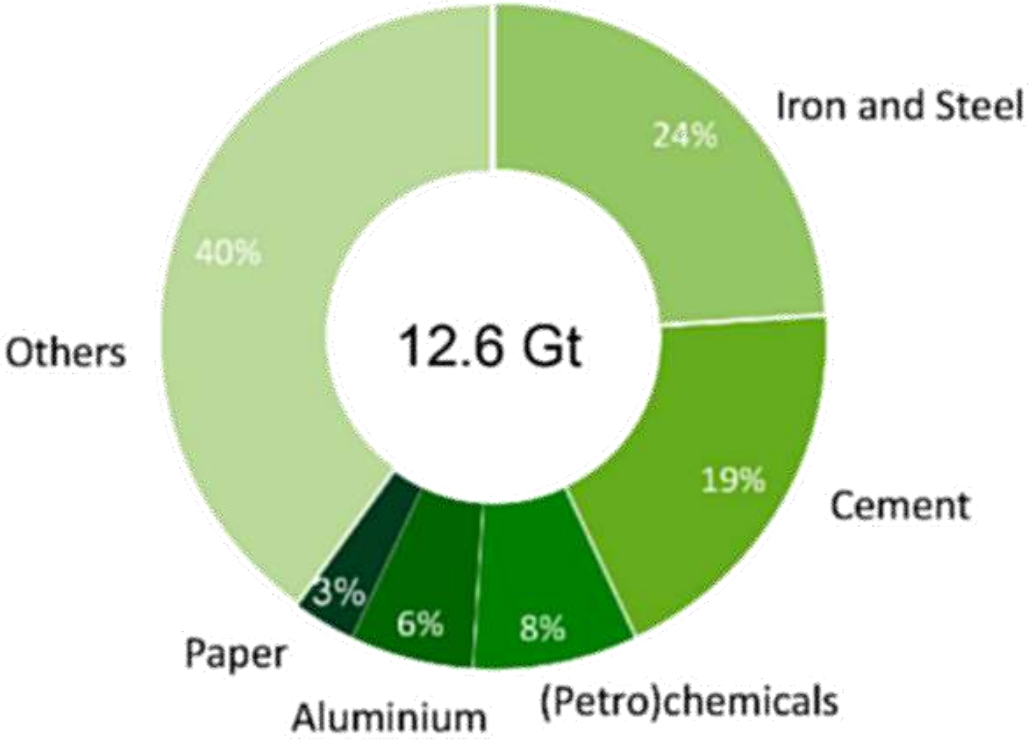
DIVERSION

Platinum Footprint



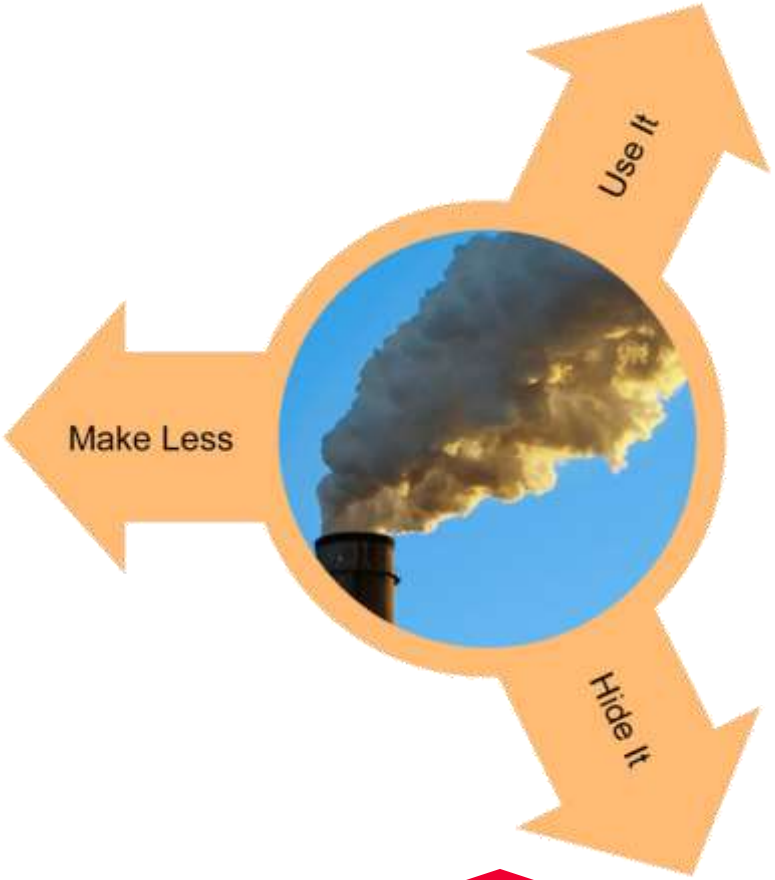


GLOBAL CO2 EMISSIONS FROM INDUSTRY

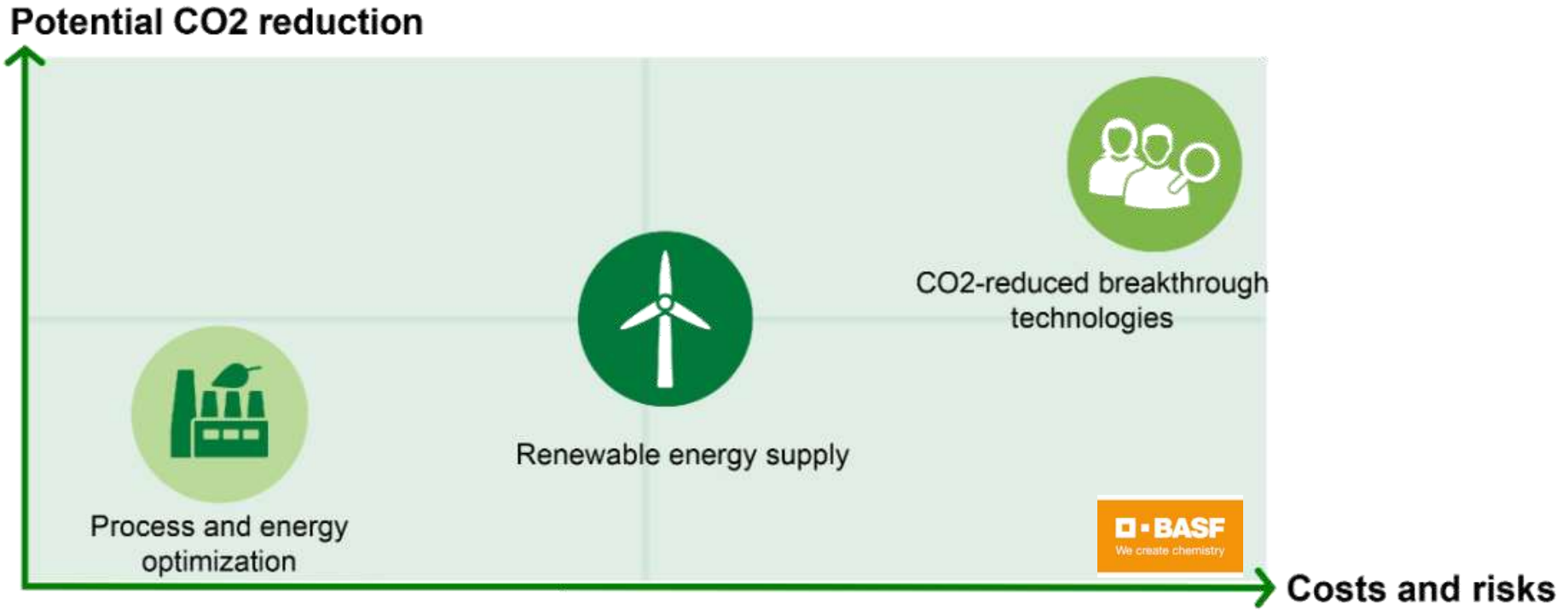


Martin Brudermüller, BASF at the World Economic Forum, 21 Jan 2020

Options For CO_2



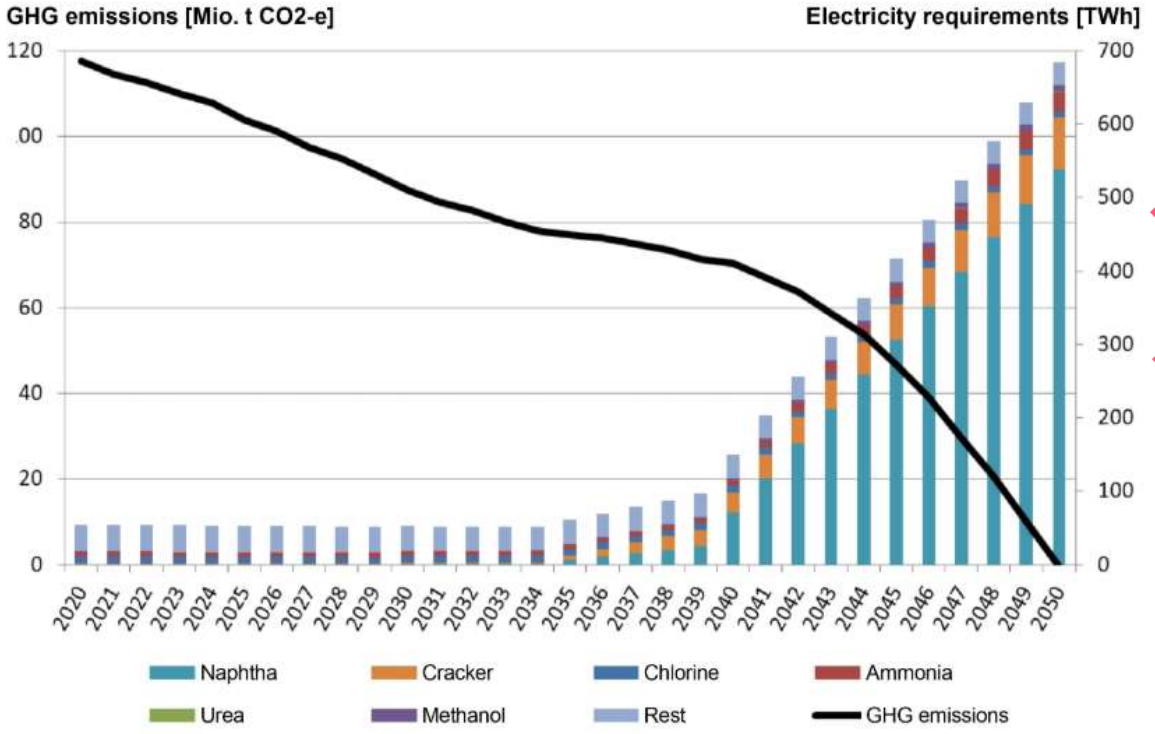
Potential Solutions For Direct Emissions



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

490 for all Germany today

270 for all industry

Bad Omen

THE COLLINS WORD OF THE YEAR 2018 IS...

SINGLE-USE

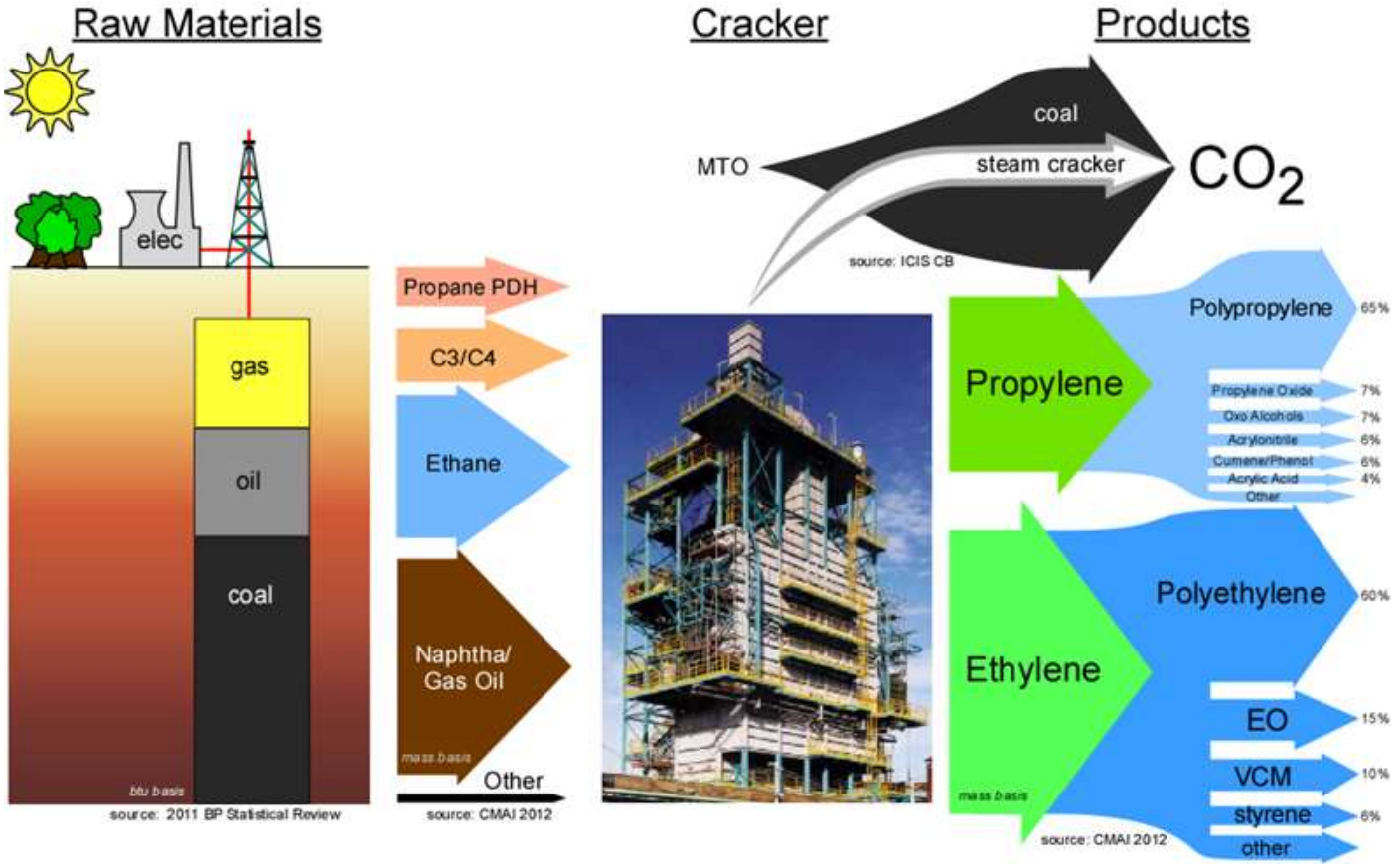
'Single-use', a term that describes items whose unchecked proliferation are blamed for damaging the environment and affecting the food chain, has been named Collins' Word of the Year 2018.

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.

Collins
Pioneers in dictionary publishing since 1819

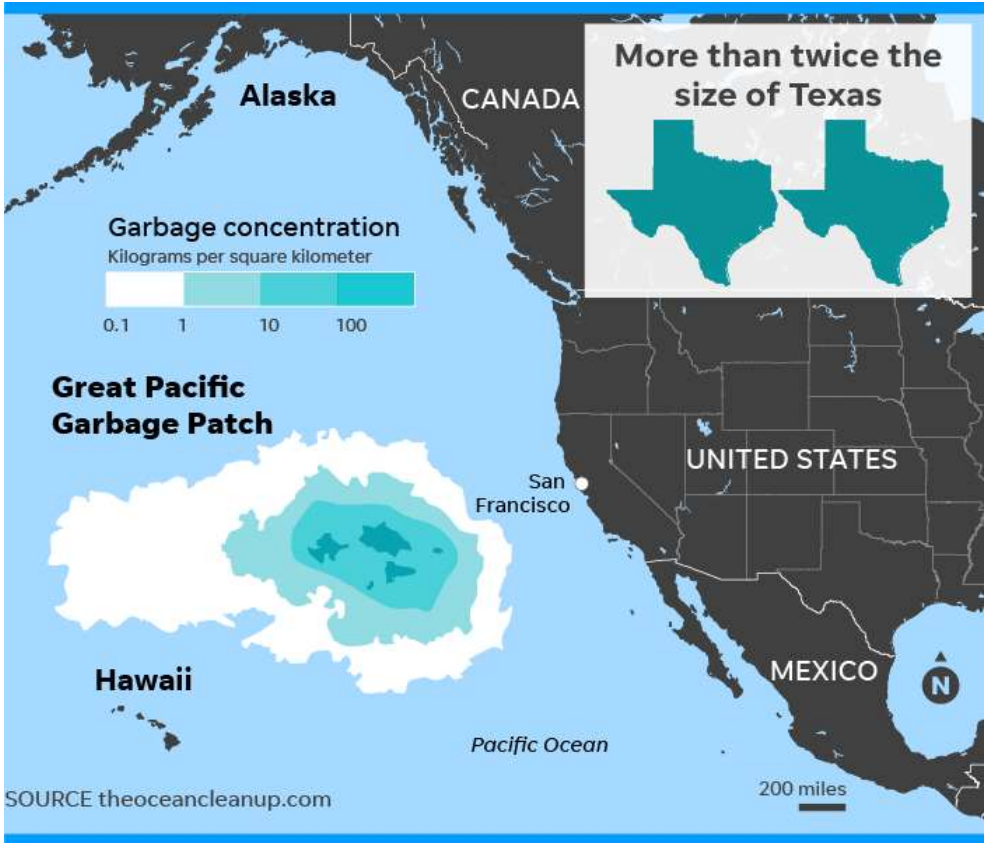
MODERN CHEMICAL INDUSTRY



Ocean Plastic

Source of Ocean Plastic

THE PACIFIC GYRE

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1

Gyre Concentration In Milk Jugs Per Football Field

17% 1. 1000

20% 2. 500

41% 3. 200

4. 100

13% 5. 50

6. 20

7. 10

9% 8. 5

9. 2

10. 1

blue text = poll results

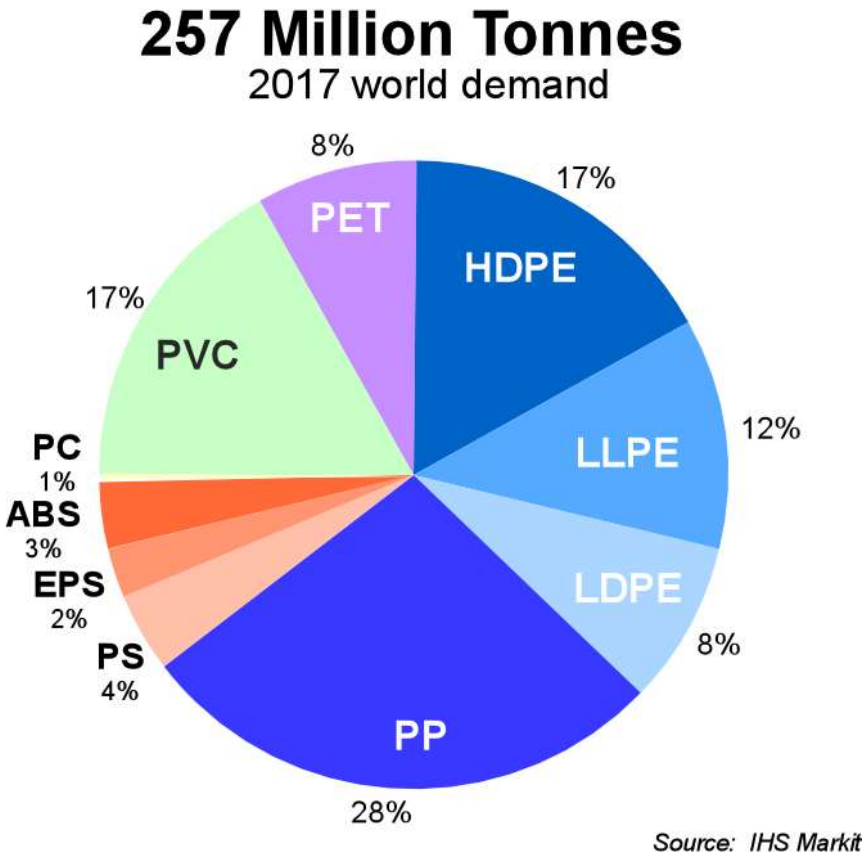
In The Pacific Gyre At Point of Highest Plastic Concentration

https://www.youtube.com/watch?v=DonEongTrQQ

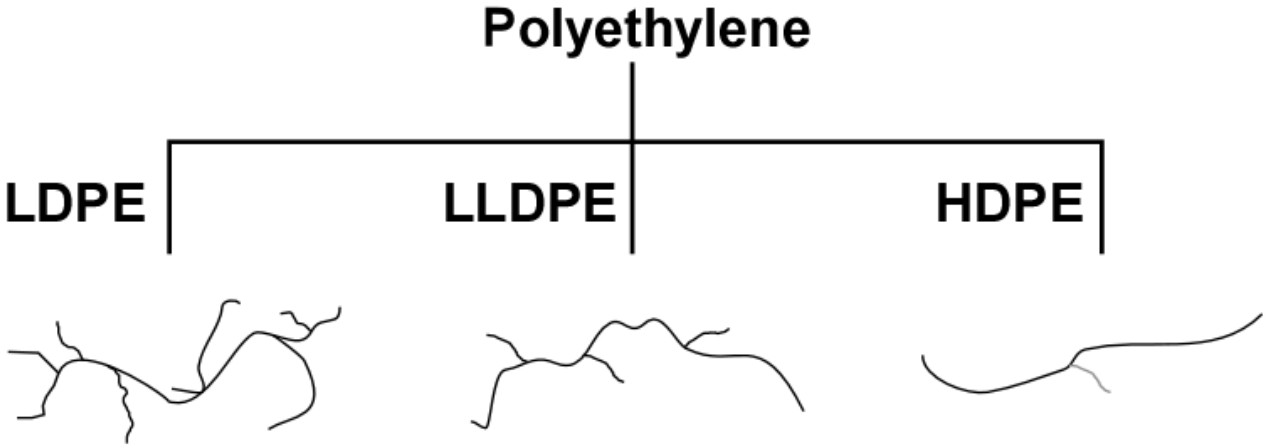
5


5

LOTS OF POLYMERS MADE



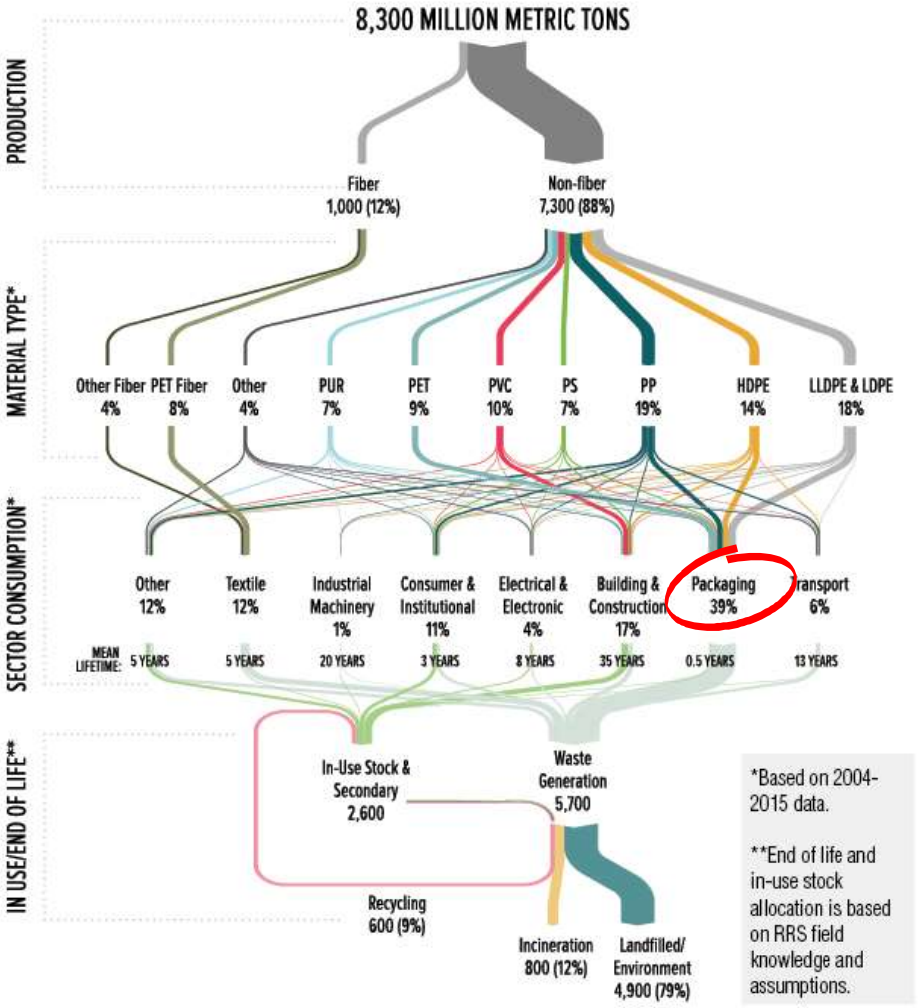
Three Kinds of Polyethylene



LDPE	LLDPE	HDPE
high-pressure radical polymerization	catalytic co-polymerization of ethylene and α-olefin	organometallic catalysis
lots of branching	controlled branching	limited branching
low density polyethylene	*linear low density polyethylene*	*high density polyethylene*

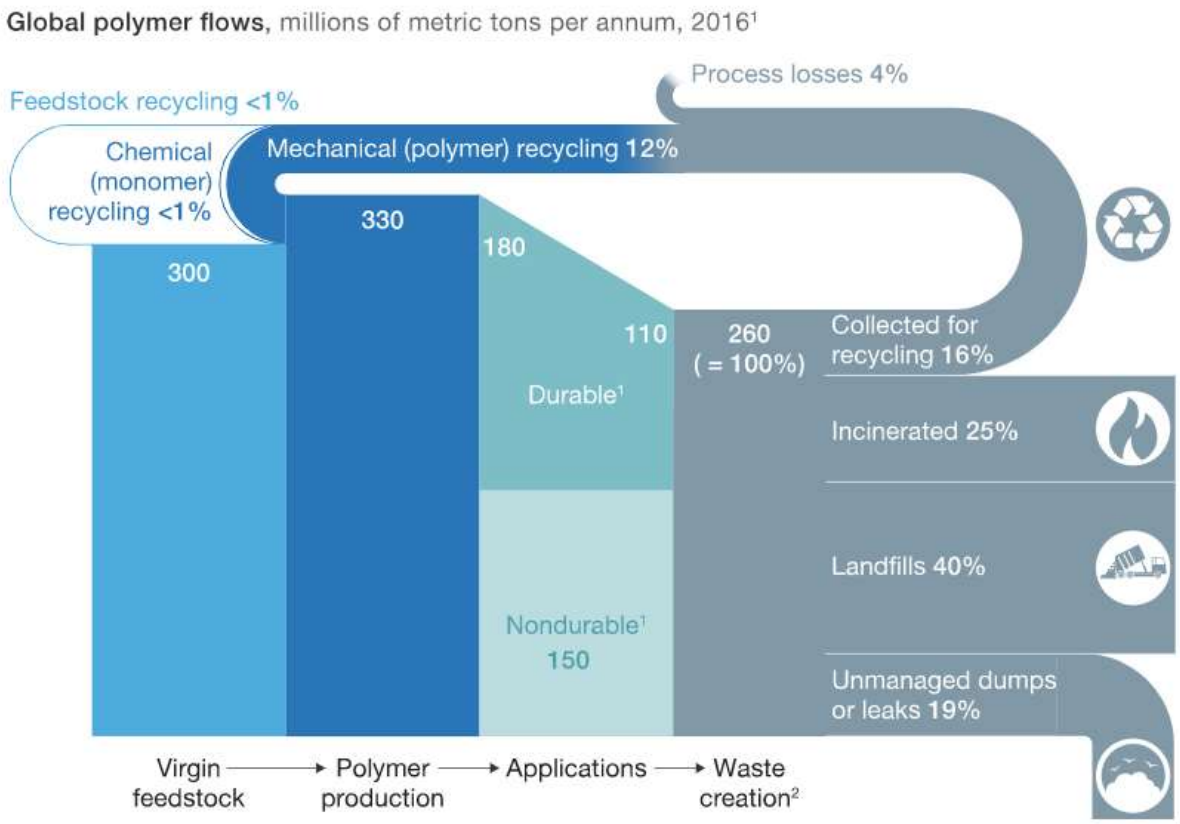
GROWING >GDP


Billion Pounds Per Year
200
150
100
50
0
1990
1994
1998
2002
2006
2010
2014
PE
PP
4.4% CAGR
source: IHS

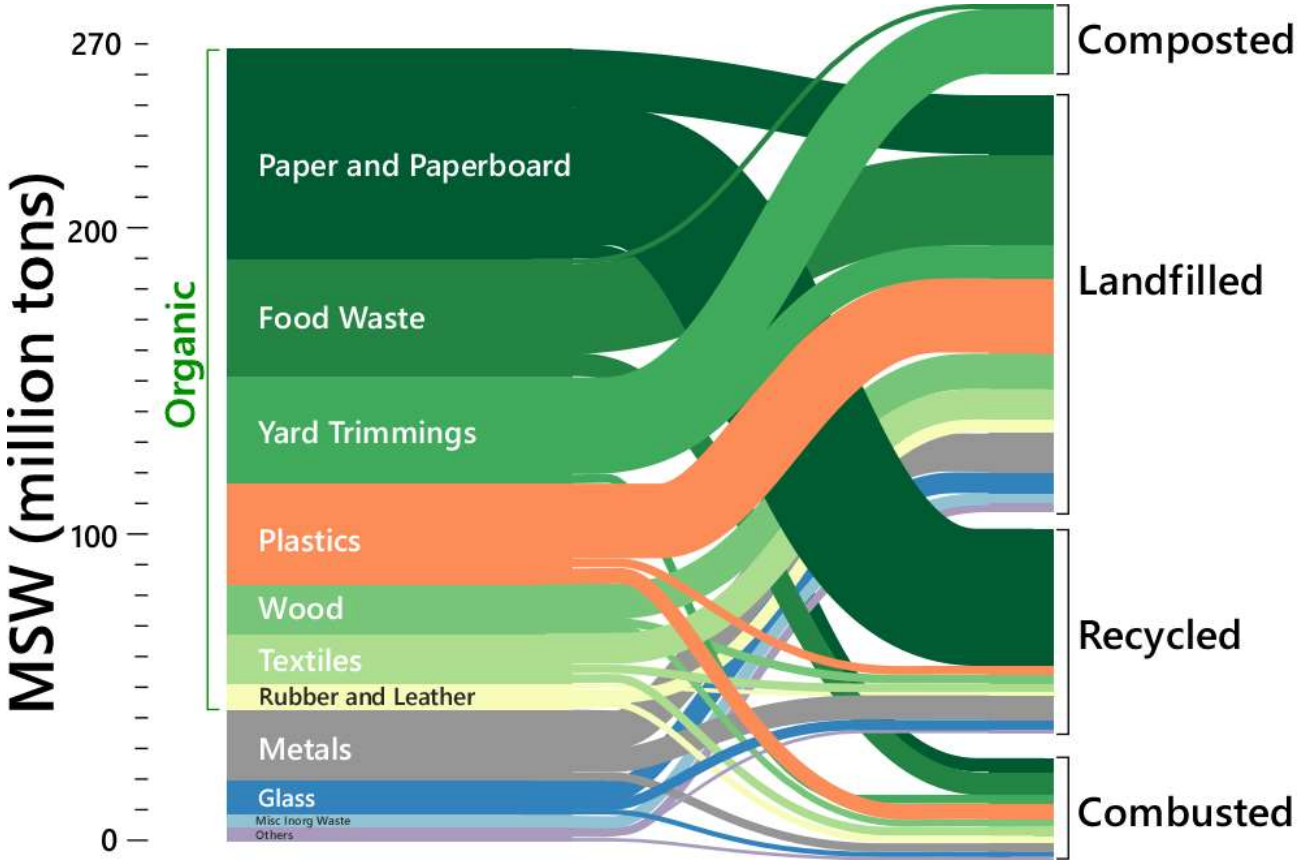


packaging 39%

WHERE DOES PLASTIC GO?



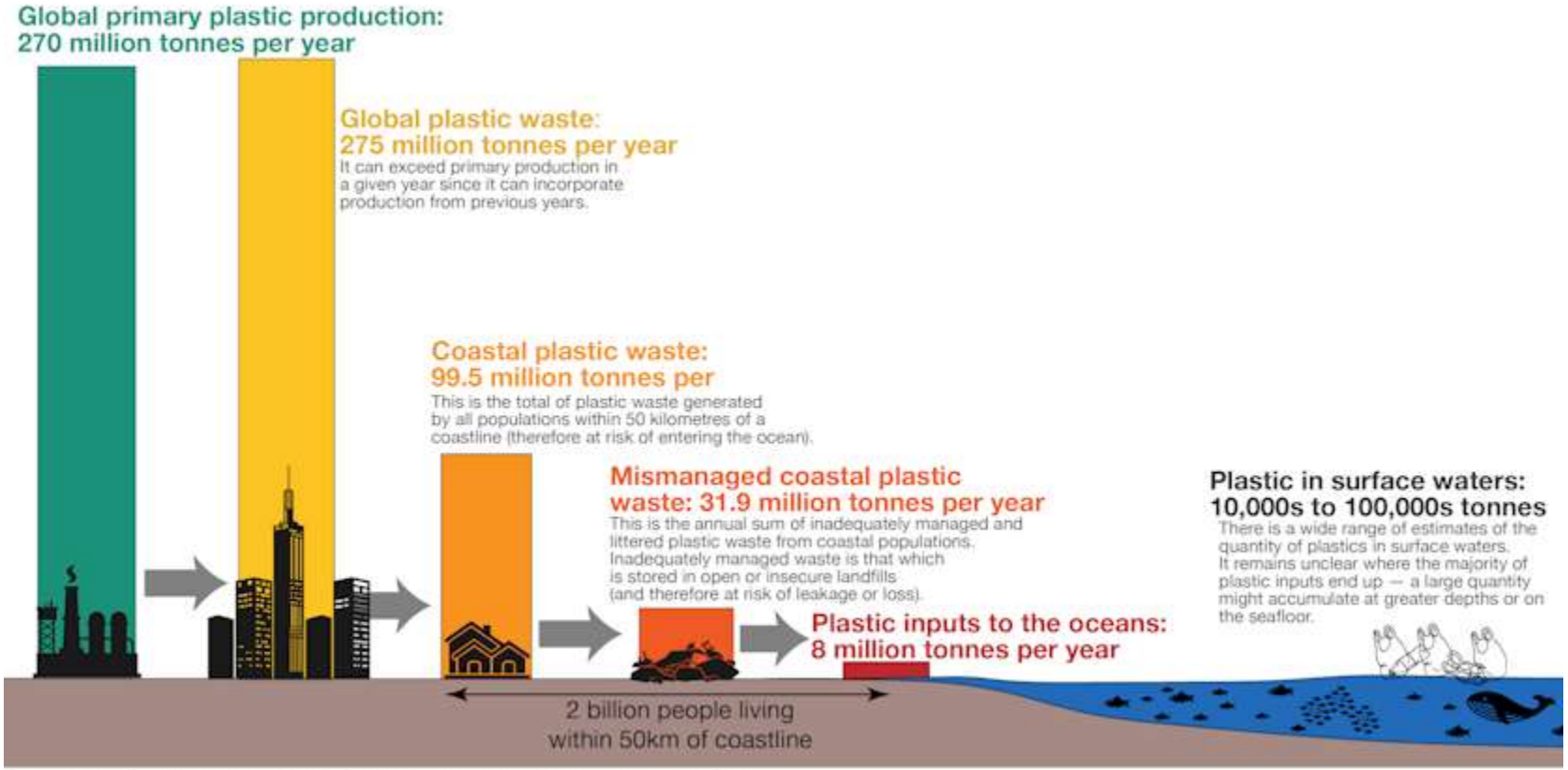
U.S. TRASH


MSW (million tons)
270
200
100
0
Organic
Paper and Paperboard
Food Waste
Yard Trimmings
Plastics
Wood
Textiles
Rubber and Leather
Metals
Glass
Misc Inorg Waste
Others
Composted
Landfilled
Recycled
Combusted

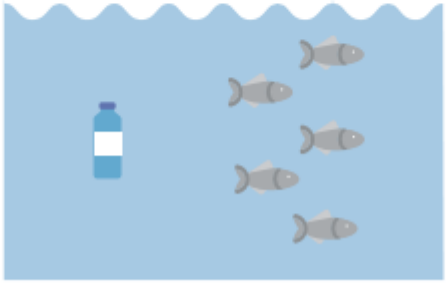
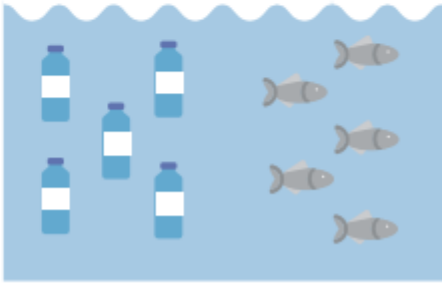
The pathway by which plastic enters the world's oceans

Our World in Data

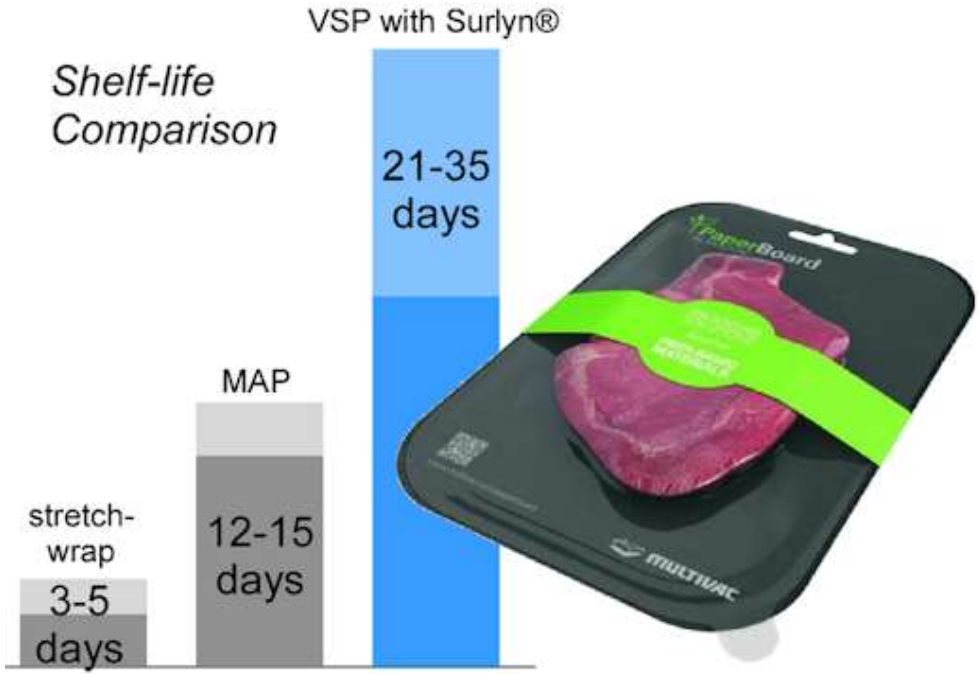
Estimates of global plastics entering the oceans from land-based sources in 2010 based on the pathway from primary production through to marine plastic inputs.

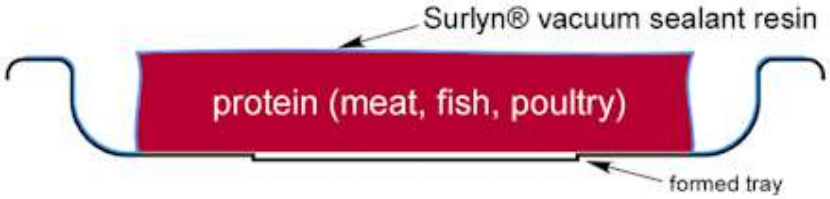


Source: based on Jambeck et al. (2015) and Eriksen et al. (2014). Icon graphics from Noun Project.
Data is based on global estimates from Jambeck et al. (2015) based on plastic waste generation rates, coastal population sizes, and waste management practices by country.
This is a visualization from OurWorldinData.org, where you will find data and research on how the world is changing.

	2014	2050
PLASTICS PRODUCTION	 311 MT	 1,124 MT
RATIO OF PLASTICS TO FISH IN THE OCEAN (BY WEIGHT)	 1:5	 >1:1

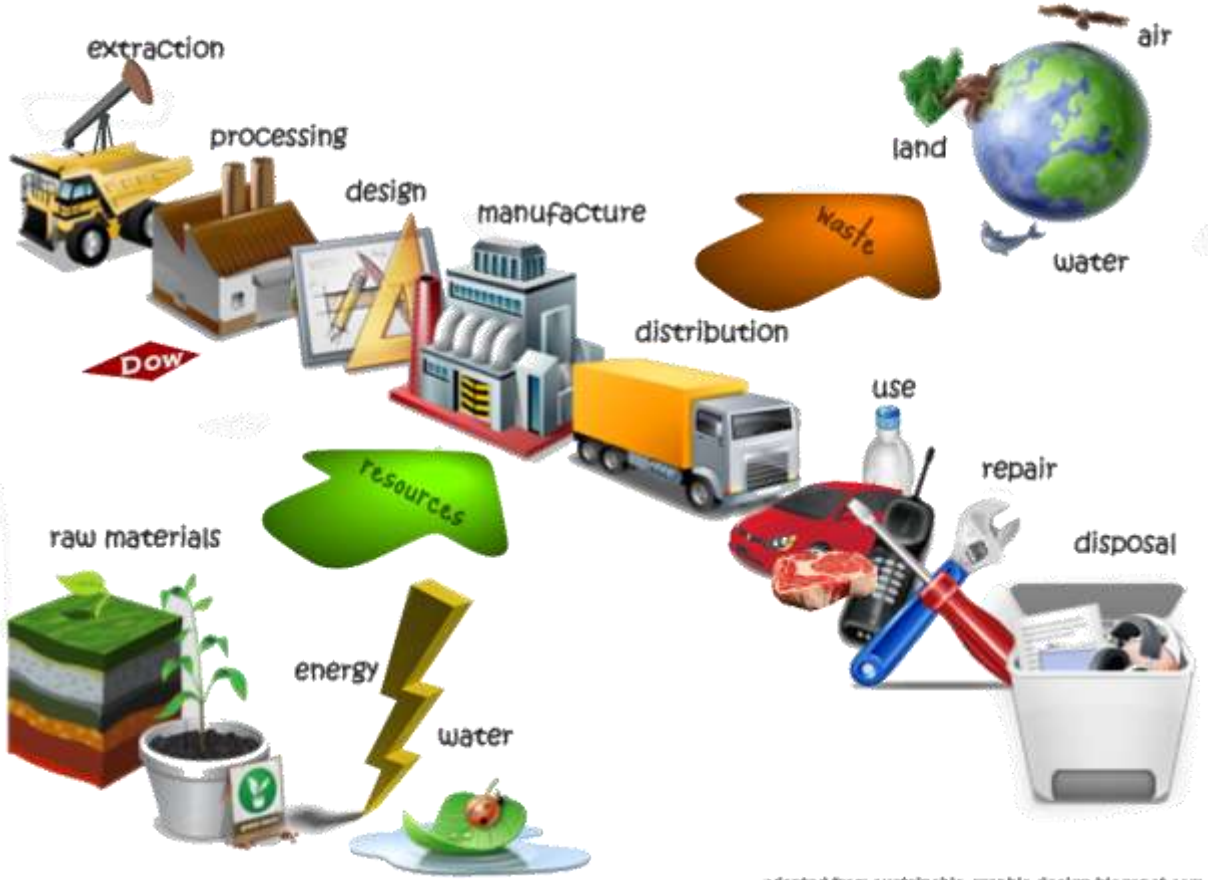
PLASTIC PROVIDES BENEFITS





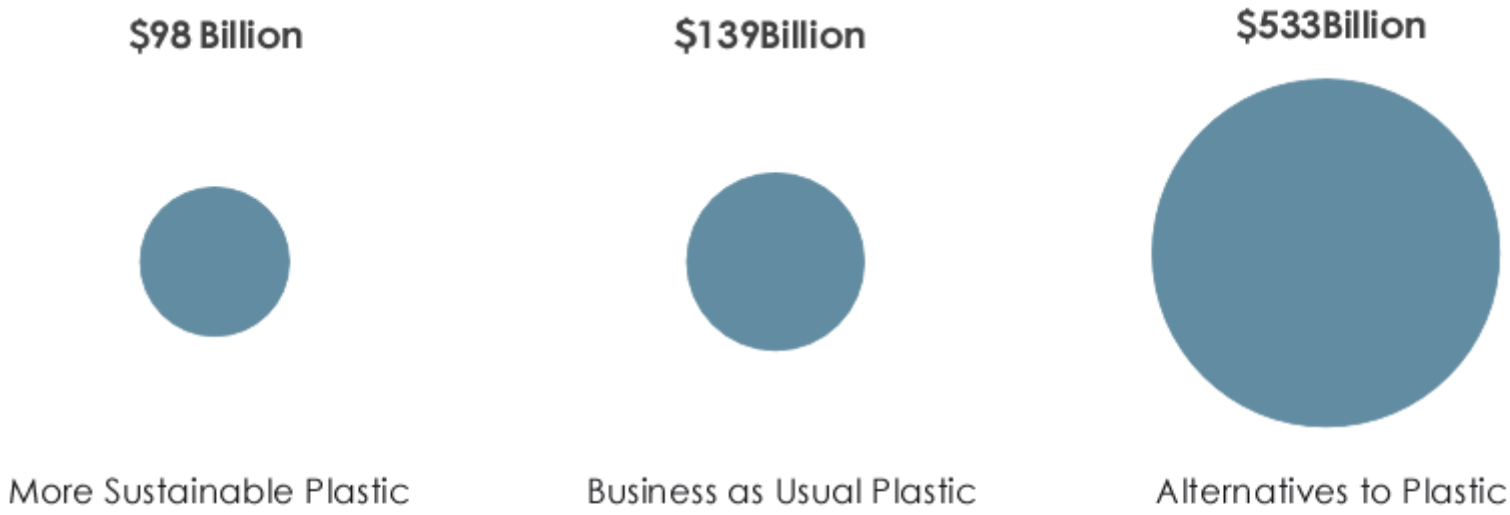
Plastic Provides Benefits

EDUCATION



adapted from sustainable-graphic-design.blogspot.com

ALTERNATIVES COST MORE



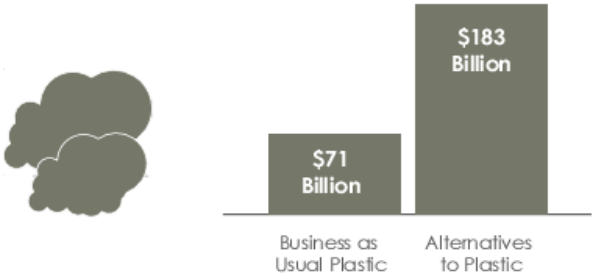
The cost of using alternative materials is approximately four times that of using plastic (in a business as usual scenario). We're producing more and more consumer goods, so choosing the material that creates the least impact is important.

Source: Trucost

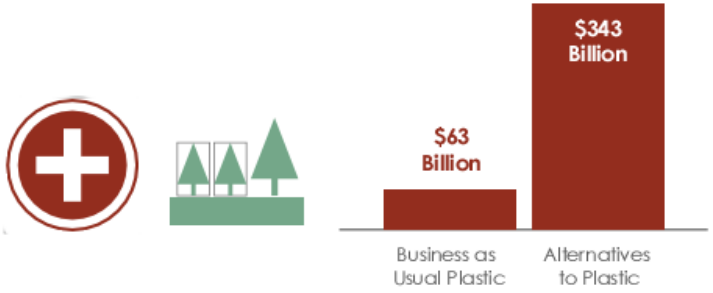
Source: American Chemistry Council TRUCOST report

ALTERNATIVES HAVE HIGHER ENVIRONMENTAL COSTS

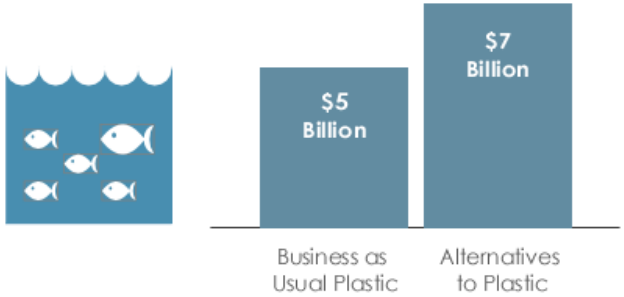
Climate change



Damage to the health of humans and ecosystems



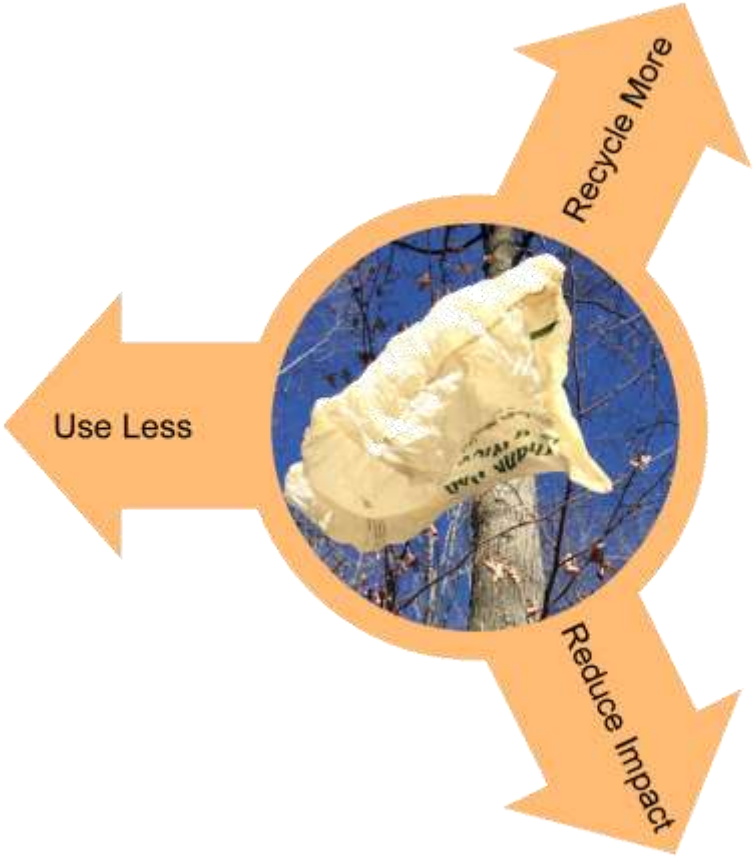
Damage to the oceans



All dollar values are in USD
Source: Trucost

Source: American Chemistry Council TRUCOST report

Possible Solutions



USE LESS WITH MORE EFFICIENT PACKAGING

EDIBLES		NON-EDIBLES
Edible Oils	Rice & Grains	Paint & Coatings
Ketchup & Other Condiments	Breakfast Cereal	Detergents & Cleaning Products
Sauces	Dry Baking Products (flour, sugar, etc.)	Motor Oil & Fuel Additives
Soups	Ground Coffee	Seeds
Honey & Syrups	Snack foods	Cat Litter
Water & Juices		De-icer Pellets
Dry Pet Food or Treats		Fine Aggregates (filter sand, etc.)

EDISON AWARDS
2015

R&D 100
2015
R&D 100 Winner

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

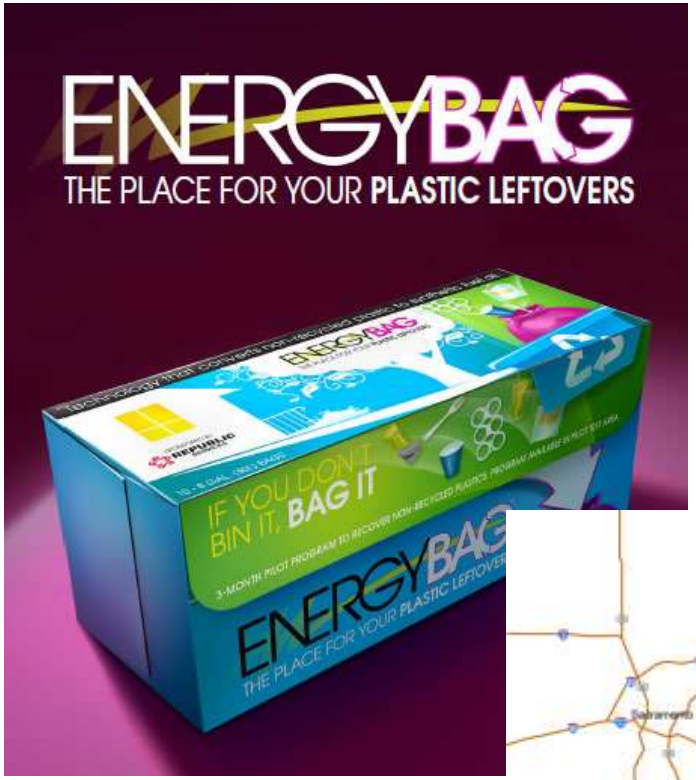
Space Saving
- Ships and Stores Flat when Unfilled

Waste Reduction Hierarchy

ENABLE RECYCLING

Provide Alternatives

RECOVER


ENERGYBAG
THE PLACE FOR YOUR PLASTIC LEFTOVERS
IF YOU DON'T BIN IT, BAG IT
3-MONTH PILOT PROGRAM TO RECOVER NON-RECYCLED PLASTICS
ENERGYBAG
THE PLACE FOR YOUR PLASTIC LEFTOVERS

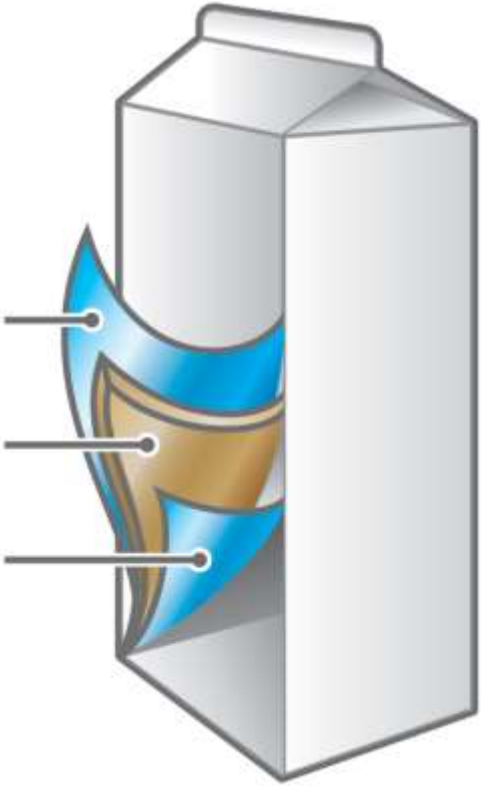

Citrus Heights
2 mi


Hefty
ENERGYBAG
NON-RECYCLED PLASTICS
COLLECTION PROGRAM
20

DISAPPEAR

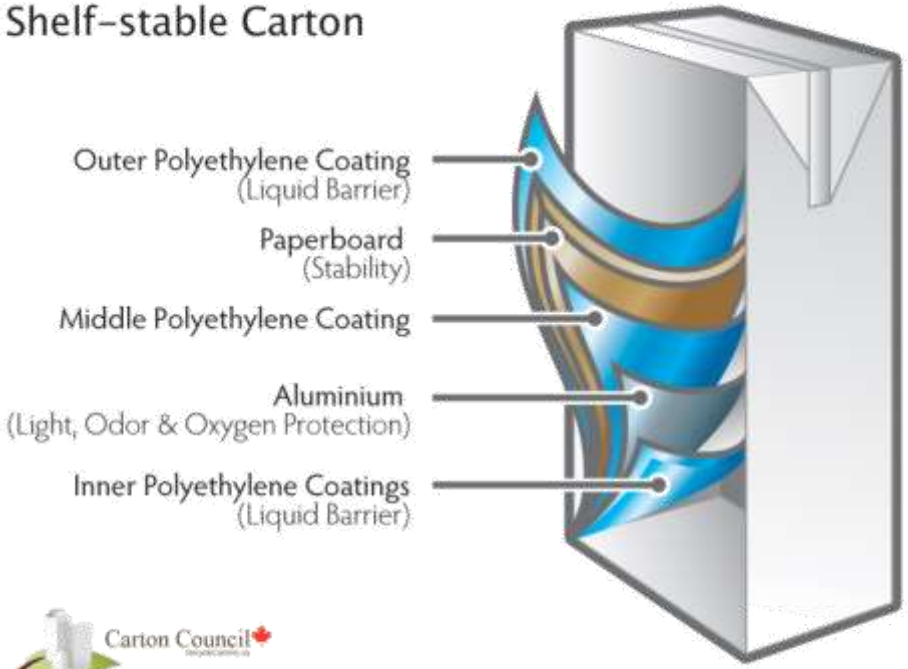
RECYCLING ISSUES

Refrigerated Carton



Carton Council

Shelf-stable Carton



Carton Council

Recycling is Diverted to Landfill

WHICH IS MOST VALUABLE







~2¢

Which Is Most Valuable?

1. newspaper
2. toilet paper roll
3. HDPE milk jug
4. steel can
5. glass bottle
6. PET water bottle
7. Pt catalyst disk

poll results lost

Recycling Prices

0.61¢

0.01¢

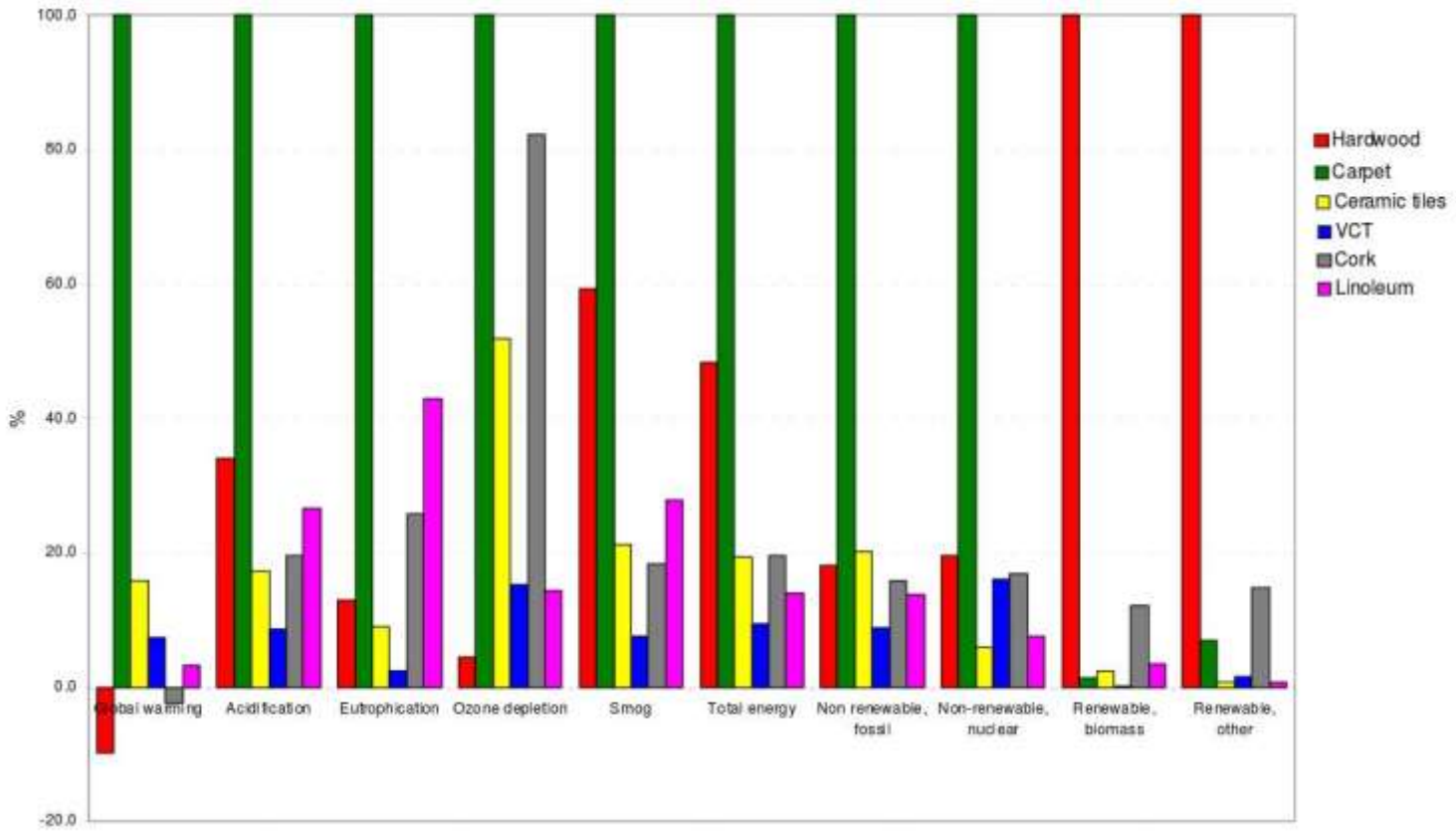
~2¢

9.16¢

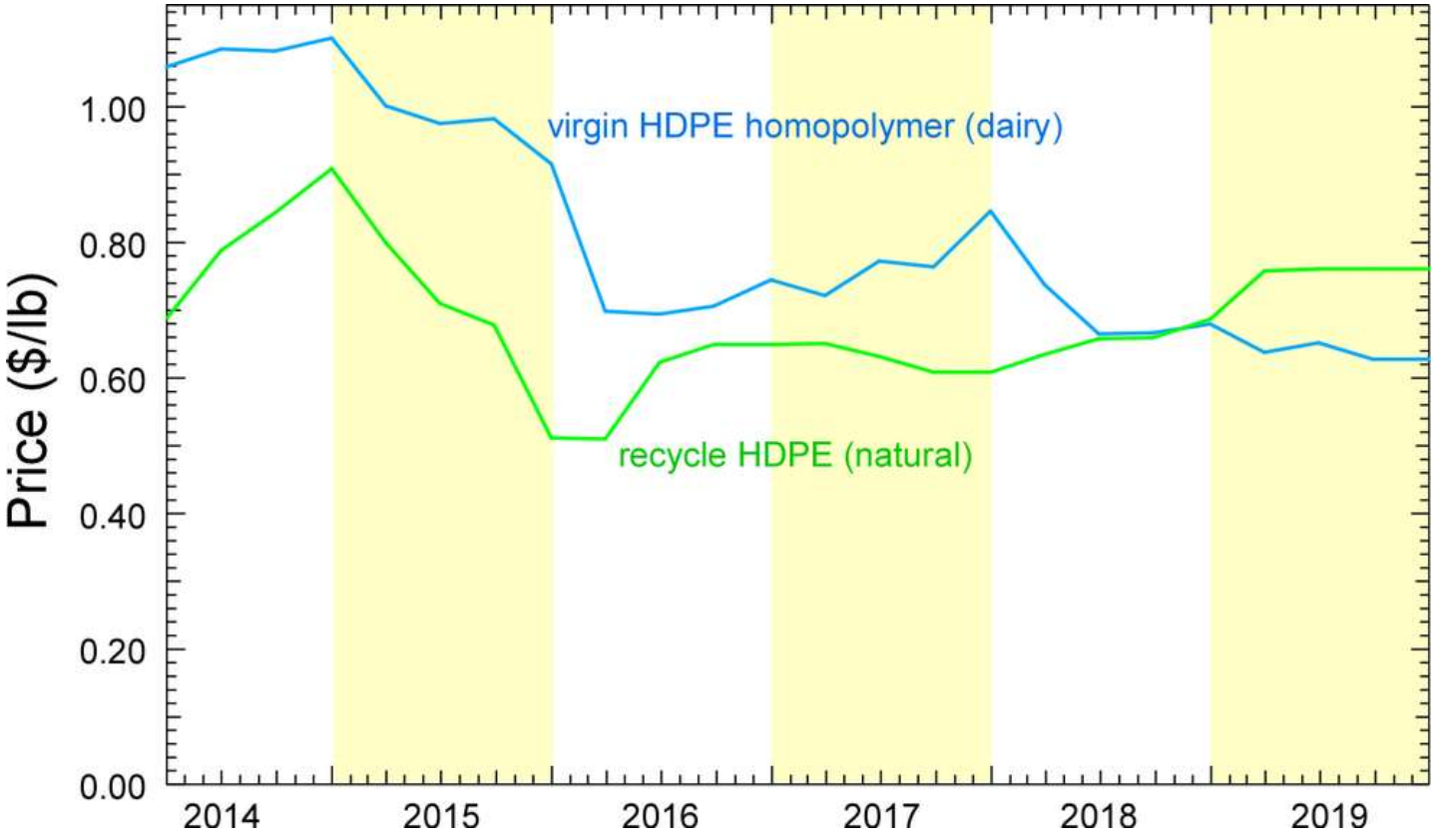
0.22¢

0.20¢

TYPICAL LIFE CYCLE ASSESSMENT



GOOD NEWS


virgin HDPE homopolymer (dairy)
recycle HDPE (natural)
Price ($/lb)
1.00
0.80
0.60
0.40
0.20
0.00
2014
2015
2016
2017
2018
2019

QUESTIONS

Seek

Together™