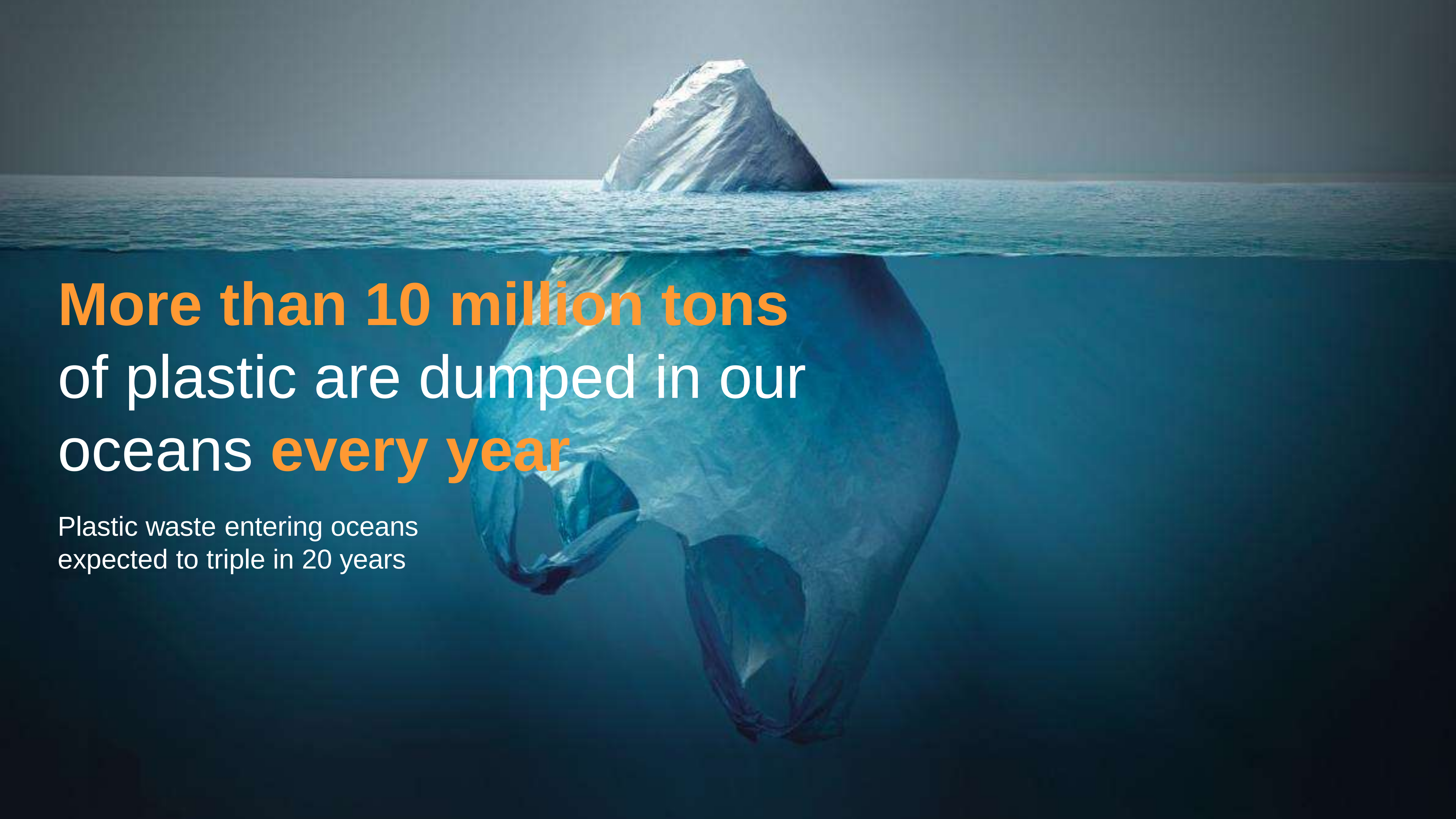
PLASTICS IN A CIRCULAR ECONOMY

Poreč, 22th Mai,
Simon Franko

Waste


„It’s only one toothbrush“
said 8 billion people.
1 GARBAGE TRUCK DUMPED IN OCEAN PER MINUTE


More than 10 million tons
of plastic are dumped in our
oceans every year
Plastic waste entering oceans
expected to triple in 20 years


380 million tons of plastic produced
<9% Gets Recycled


Global plastic waste set to almost TRIPLE by 2060
https://www.oecd.org/environment/global-plastic-waste-set-to-almost-triple-by-2060.htm

Most plastic waste in EU incinerated
CO_2 impact from plastics is huge

Globally, in this year alone, researchers estimate that the production and incineration of plastic will pump more than **850 million tonnes** of greenhouse gases into the atmosphere.

By 2050, those emissions could rise to 2.8 billion tonnes.

4% of the world's annual petroleum production is diverted to making plastic

Sustainable Carbon Cycles legislation in preparation by EC

Plastics?

What do all these things have in common?

They are polymers.

Plastics play an important role in a sustainable and resource-efficient economy

Packaging
Plastics ensure food safety and reduce food waste

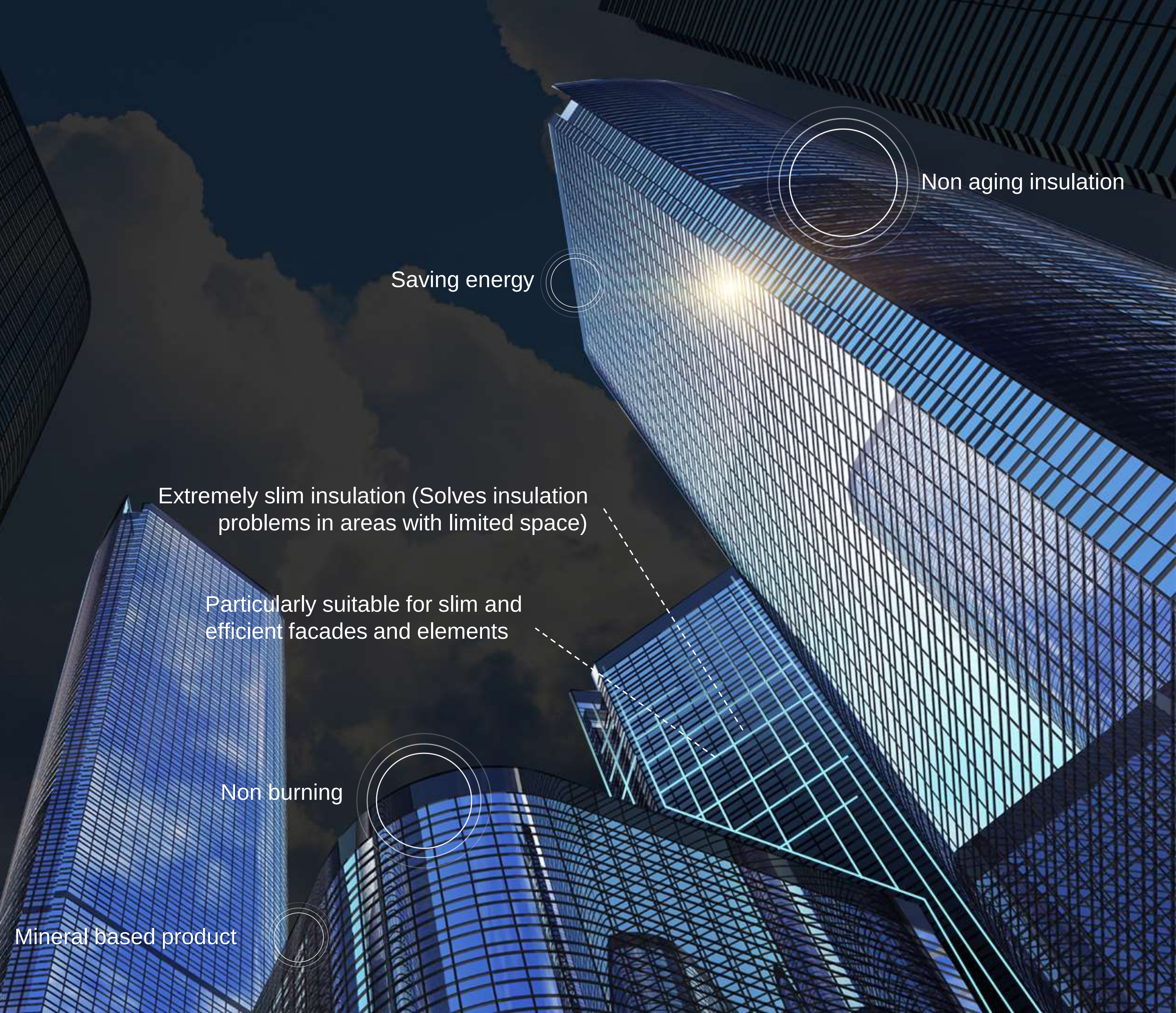
Automotive
Plastics ensure weight reduction, fuel-efficiency and safety

Building & Construction
Plastics ensure energy savings and long product life span

Global plastics production is 20x higher than in the 1960s, and is forecast to almost quadruple by 2050

Plastics are strong, durable, waterproof, lightweight, easy to mould, recyclables

all key properties for construction materials



IT’S THE **PLASTIC WASTE** THAT IS **BAD**

What can we do?

“Single-use plastic products” Directive (SUPD)

Prevent & reduce the impact of certain plastic products on the environment & human health

- Cotton bud sticks
- Oxo-degradable plastics
- Food and beverage containers made of EPS + EPS cups for beverages
- Beverage stirrers
- Balloon sticks
- Cutlery (forks, knives, spoons, chopsticks)
- Plates
- Straws

ERP example of waste tires

Used tires are recycled in two ways:

- Recycling (used tires give rise to new products - a new tire or other rubber product)
- Energy Recovery – as fuel

It takes approximately 83l of diesel to produce the synthetic rubber.
If disposed through incineration, 110kg of CO_2 is emitted per tire.
Tires are further one of the largest contributors to the growing amount of microplastics found in our oceans due to the shredding of synthetic rubber when they wear down.

1,8bn new tires + 4bn old tires each year. Incineration create 110kg/tyre of CO_2

Is incineration of waste tyres sustainable?

The idea of plastics degrading into the environment **should be abandoned.**

Recycling (mechanical, physical or chemical) is preferable to energy recovery in all pathways analyzed

KEEPING PLASTICS IN THE MATERIALS LOOP

MECHANICAL RECYCLING






Plastics waste recycling rates are **13x** higher when collected separately

[trinamiX Mobile NIR Spectroscopy Solution for Plastic Sorting / trinamiX (trinamixsensing.com)]

Main challenges of the mechanical recycling of plastics

>200MN TONS NOT-RECYCLED

Colour & smell

Cross polymer Contamination

Cost

Properties downgrades

Thermal and mechanical degradation

Currently used recyclates mainly limited in low **cost applications**

45% of post-consumer recycled plastics are used in **building and construction** applications.

Packaging applications represent the **second market** for post-consumer recycled plastics, followed by agriculture, farming and gardening.

ORGANICAL RECYCLING

Biodegradable and Compostable plastics

BASF has been researching biodegradable and bio-based polymers for more than 30 years.

ecovio® is a high-quality and versatile bioplastic from BASF. The primary advantages:
It is certified compostable and biobased.

Biodegradable: can be biodegraded by microorganisms

Compostable: used by microorganisms to generate energy and to form biomass

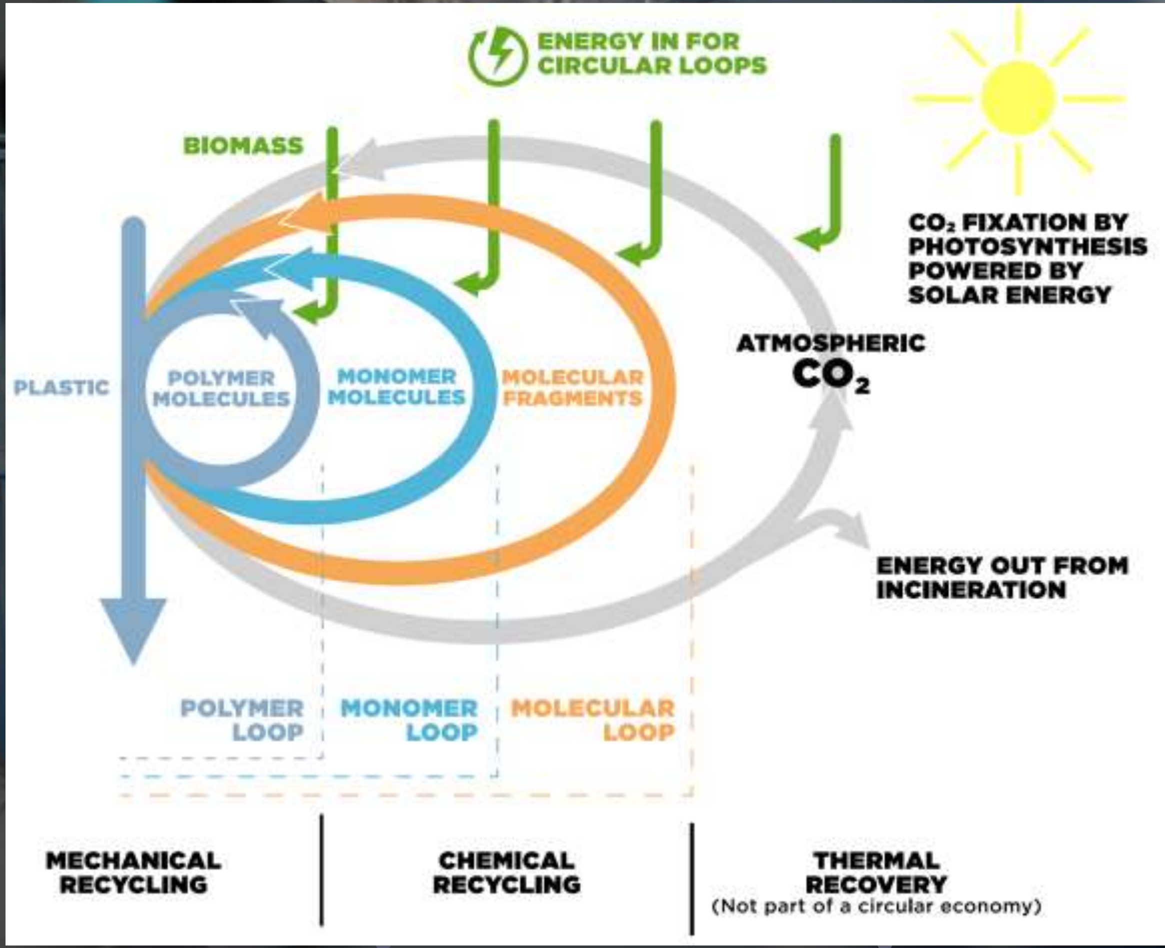
Bio-based: entirely made of renewable raw materials

Polymer loop
By mechanical recycling it is possible to recycle single-stream plastics like PET. The chemical structure of the plastics is not changed

Monomer loop
By breaking down plastics into their monomers new virgin-grade plastics can be generated. This is technically feasible for some polymer types only (e.g. PA)

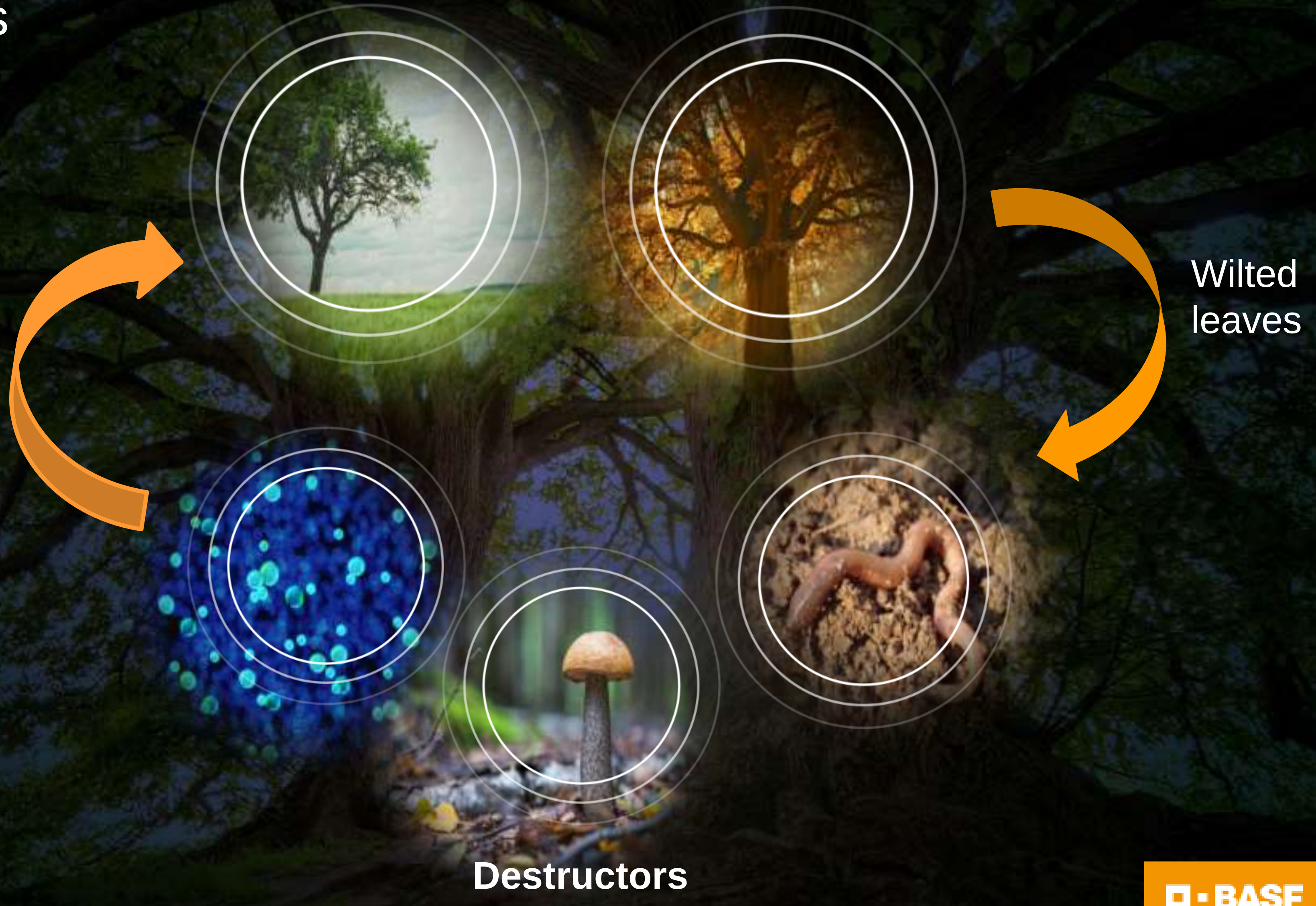
Molecular loop
By pyrolysis or gasification technologies plastics can be turned into their basic building blocks and used to produce all types of new virgin-grade plastics

CO_2 loop
Bio-based chemicals can be incinerated, and plants are growing by uptaking CO_2 from the atmosphere. From plants one can generate bio-based chemicals again. This is technically feasible for some chemicals



Recycling

Learning from trees



BASF
We create chemistry

Chemical recycling represents a missing link to close the loop

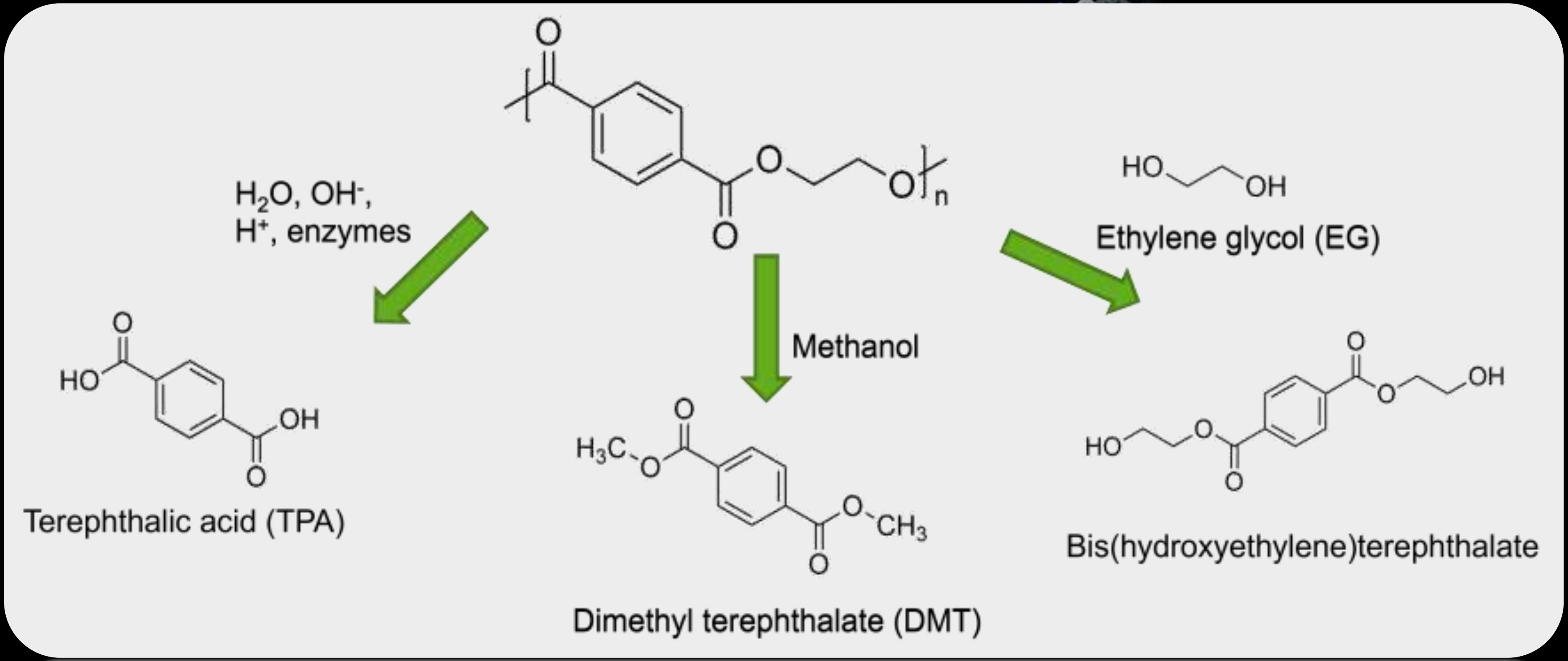
Complimenting the portfolio of options for resource recovery

Chemical Recycling

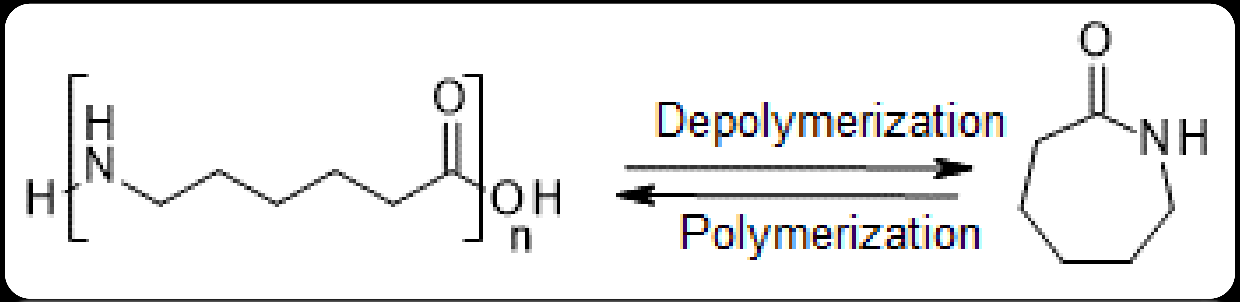
Chemical recycling – Depolymerization

Different re-monomerization routes for PET are available on an industrial scale

Hydrolysis, methanolysis and glycolysis are available on an industrial scale and useful for contaminated waste streams that cannot be recycled mechanically



Re-monomerization of polyamide 6 (PA6) to Caprolactam is already done in large scale



Recycling of PA6 is highly attractive as it is a polymer with a high carbon footprint (6,7t CO2 /t polymer in Europe)

Single cyclic monomer simplifies recycling and purification efforts

Three major techniques for PA6 depolymerization: hydrolytic, acidic and alkaline depolymerization

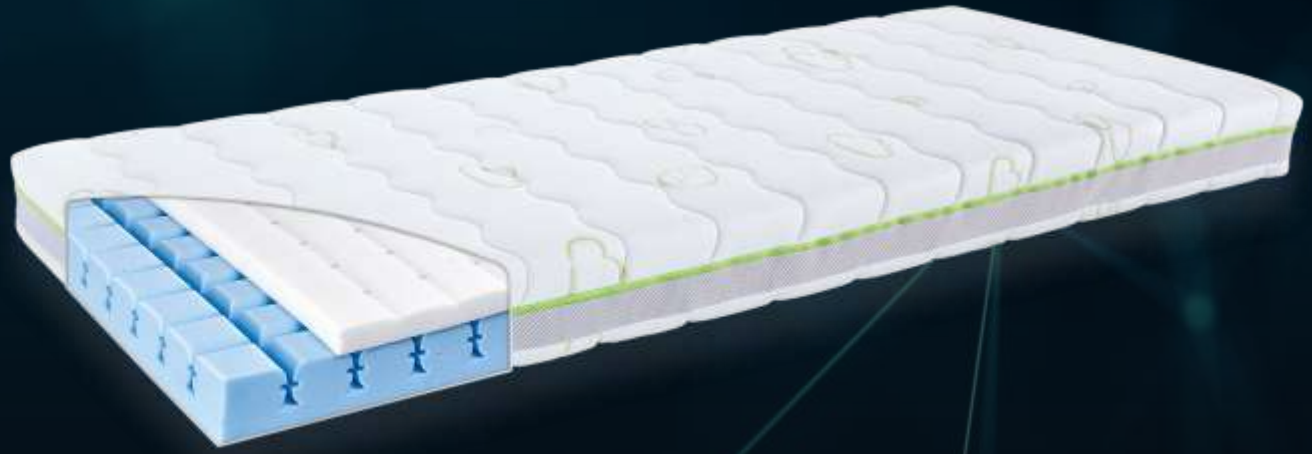
Putting the mattress waste problem to bed with **re-monomerization**

Every year in Europe, **30 million used mattresses are thrown away**

BASF aims to **recover high quality polyols** from old mattresses

How?

With a **Chemical Recycling process** that breaks down the flexible polyurethane foams and enables a closed loop



If this is state-of-the art why can't we just turn plastic waste back into its monomers?

To make #engineering plastics like polyamide or polyurethane from oil and gas, you need more than ten chemical plants!

It is amazingly challenging to de-polymerize a polymer. Plus, you need to separate all the additives, colorants and auxiliaries that turn a simple polymer into a durable customized plastic product.

You need to run more than ten different process #technologies.

all the chemicals and monomers are designed to react, however, plastics are designed to last.

Molecular loop: Chemical recycling one piece of the recycling puzzle

An efficient process to produce a secondary raw material for the chemical industry

About 70% of the mixed plastic waste can be converted into pyrolysis oil

Almost no external thermal energy used: Pyrolysis gas generates the energy required for the process

Only a small amount of the input materials are residues and must be incinerated

Plastics based on pyrolysis oil can achieve 100% identical quality as fossil-based plastics*

Mixed plastic waste** → **Pyrolysis** → **Pyrolysis oil** → **Purification** → **Naphtha substitute** →

Energy → Pyrolysis

Char

Side product

* under application of a mass balance approach

** from a sorting plant

Benefits of Chemical ReCycling

Complementary approach to existing recycling methods, thus overall recycling rates of plastic waste will be increased

Contributing to a circular economy as plastic waste is turned into feedstock for the chemical industry

Virgin quality products for demanding applications can be manufactured, e.g., food packaging or automotive parts

Solution oriented end-of-life option since redesigning plastic products to make them mechanically recyclable is not always feasible

Replacing fossil resources and **saving CO_2 emissions** against conventional plastics production

Supporting our customers in achieving their recycling targets

European plastics manufacturers plan to invest 2.6 bn€ by 2025, and 8bn€ by 2030, in chemical recycling. The production is estimated to increase to 1.2 million tonnes and 3.4 million tonnes of recycled plastics respectively

8 billion euros

are planned to be invested by

2030 in chemical recycling

+3 million tonnes

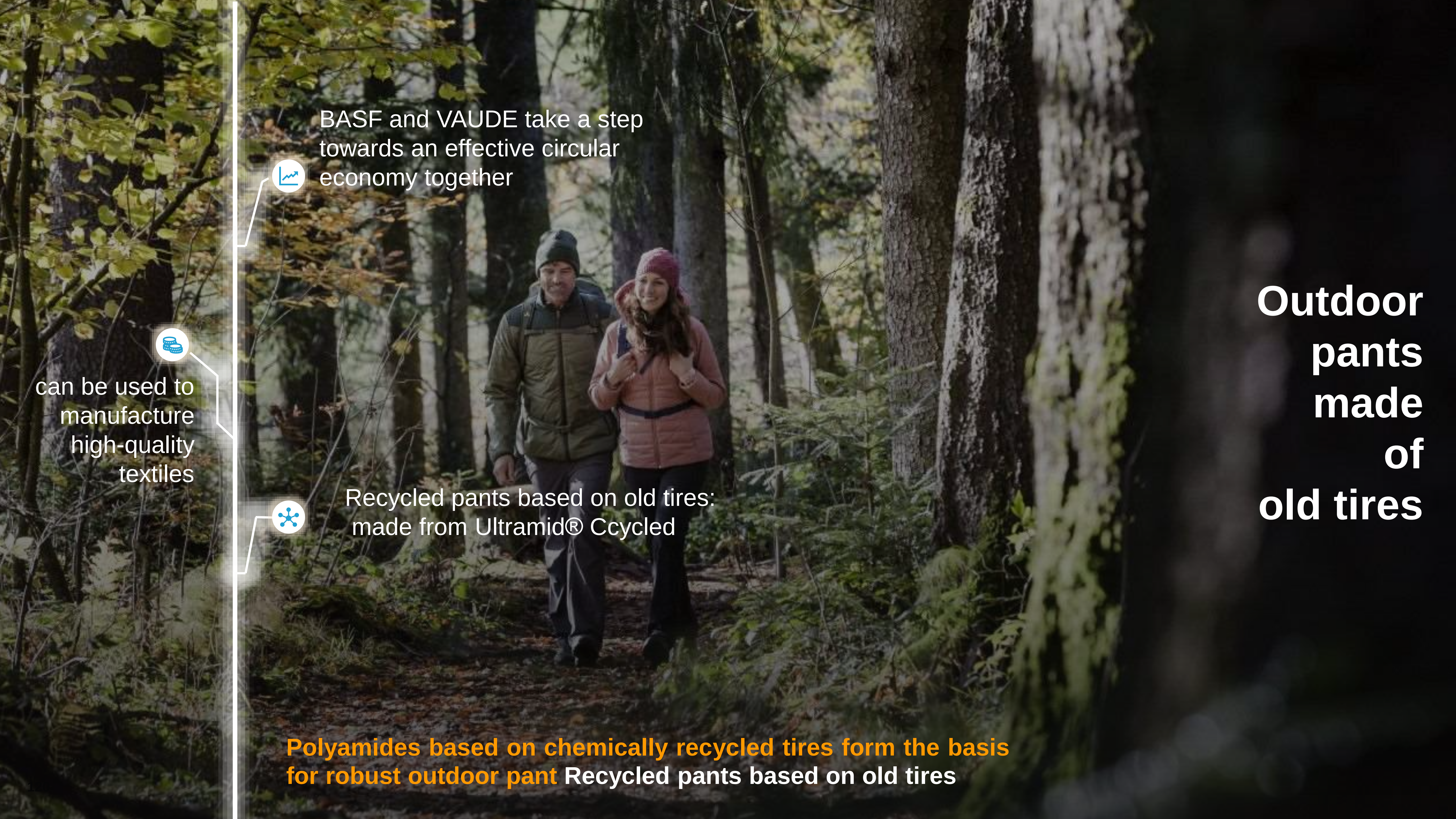
of recycled plastics are estimated to be produced

via chemical recycling

in 2030

Circular Plastics Alliance: A step closer to 10 million tonnes of recycled plastics (europa.eu)

Current situation @ business


BASF and VAUDE take a step towards an effective circular economy together
can be used to manufacture high-quality textiles
Recycled pants based on old tires: made from Ultramid® Ccycled
Outdoor pants made of old tires
Polyamides based on chemically recycled tires form the basis for robust outdoor pant Recycled pants based on old tires

Plastics & Circular economy

Replacing raw fossil resources with pyrolysis oil

The collaboration of BASF and Mercedes-Benz represents the first-time pyrolysis oil from scrap tires has been combined with biomethane.

1. Pyrolysis oil generated from used tires
2. BASF combines it with biomethane from agricultural waste
3. Combined they make virgin-quality plastic
4. Bow door handles for S-Class and EQE enter series production this year

Remaining
hurdles for Chemical Recycling

Is pyrolysis harmful to the environment?

No, it is not harmful when done properly.

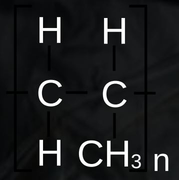
a technology to be adapted to the project
(feedstock type, tonnage, goal, product, budget)
and
compliant for all electrical, safety, and
environmental regulations.

The purification challenge

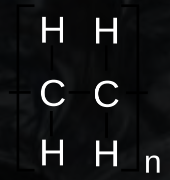
Feedstock from mixed plastic waste contains a variety of chemical structures.
Purification is needed to remove heteroatoms like **chlorine, nitrogen, or oxygen**.

Without heteroatoms

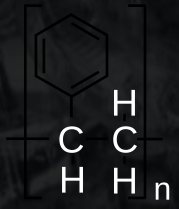
Polypropylene (PP)



Polyethylene (PE)

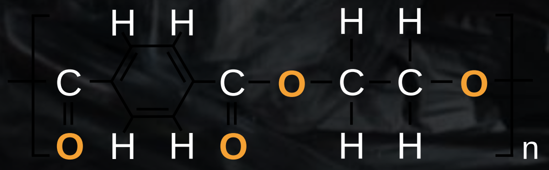


Polystyrene (PS) + EPS

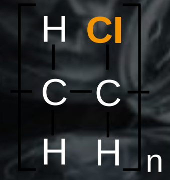


With heteroatoms

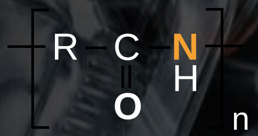
Polyethylene terephthalate (PET)



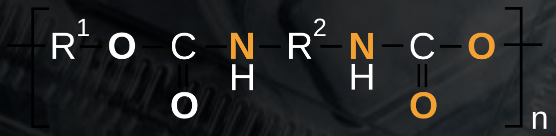
Polyvinyl chloride (PVC)



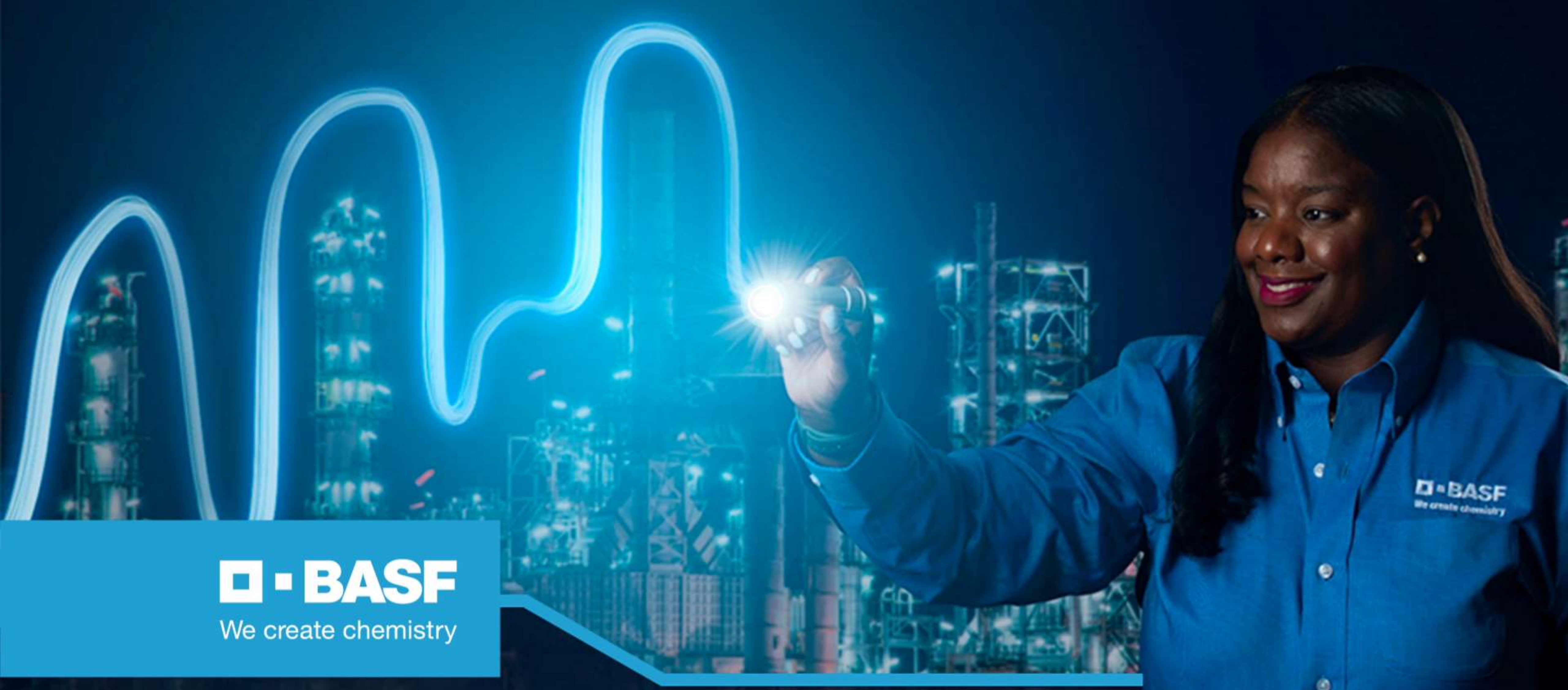
Polyamide (PA)



Polyurethane (PUR)



Heteroatoms from various waste sources
N, O, S, Cl, …



Collecting, sorting and recycling packaging is simply more expensive than producing virgin packaging.

Extended Producer Responsibility schemes?

Chemical recycling technology is ready for large scale industrial use

Challenges remain to make technology more broadly applicable and to meet demand

All major plastics producers have engaged in partnerships to overcome technical challenges

Challenge 1: Quality & Efficiency

Quality of pyrolysis oil is crucial for use as feedstock in chemical production network

Need for continuous improvement of pyrolysis & purification processes to

1) increase overall efficiency
2) to address a greater variety in quality of mixed plastic waste (purification)

Challenge 2: Volumes

Today's capacities of pyrolysis by far not sufficient to meet the demand

It is estimated that in the next twenty years several hundred chemical recycling plants will be required globally*

Partnering is Key

Example BASF & Quantafuel

Quantafuel owns a unique integrated process of pyrolysis of mixed plastic waste & purification of the resulting oil

Start-up of plant with a capacity of 16,000 tons in Q3 2020; optimization ongoing (according to plan)

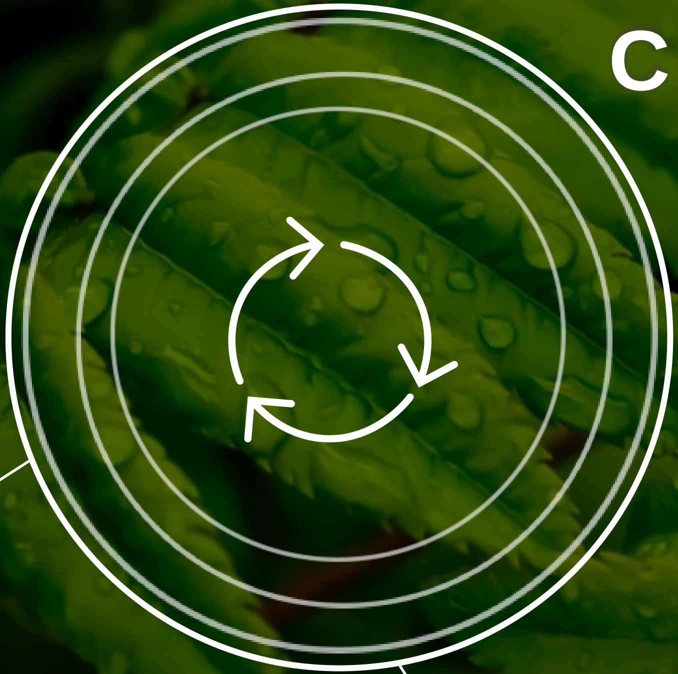
QUANTAFUEL

Long-lasting commitment to investment in chemical recycling capacities & technology is growing

Summary

RE-Carbonization

Carbon is the main element for many chemical products, as well as for a large variety of products varying from food to materials



C = LIFE

2. Carbon from plastic waste

With chemical recycling technologies, the industry has developed complementary solutions to mechanical recycling to recycle mixed or contaminated plastic waste that otherwise would be incinerated or sent to landfi

1. BioBased Carbon

Plants capture CO2 through photosynthesis while growing

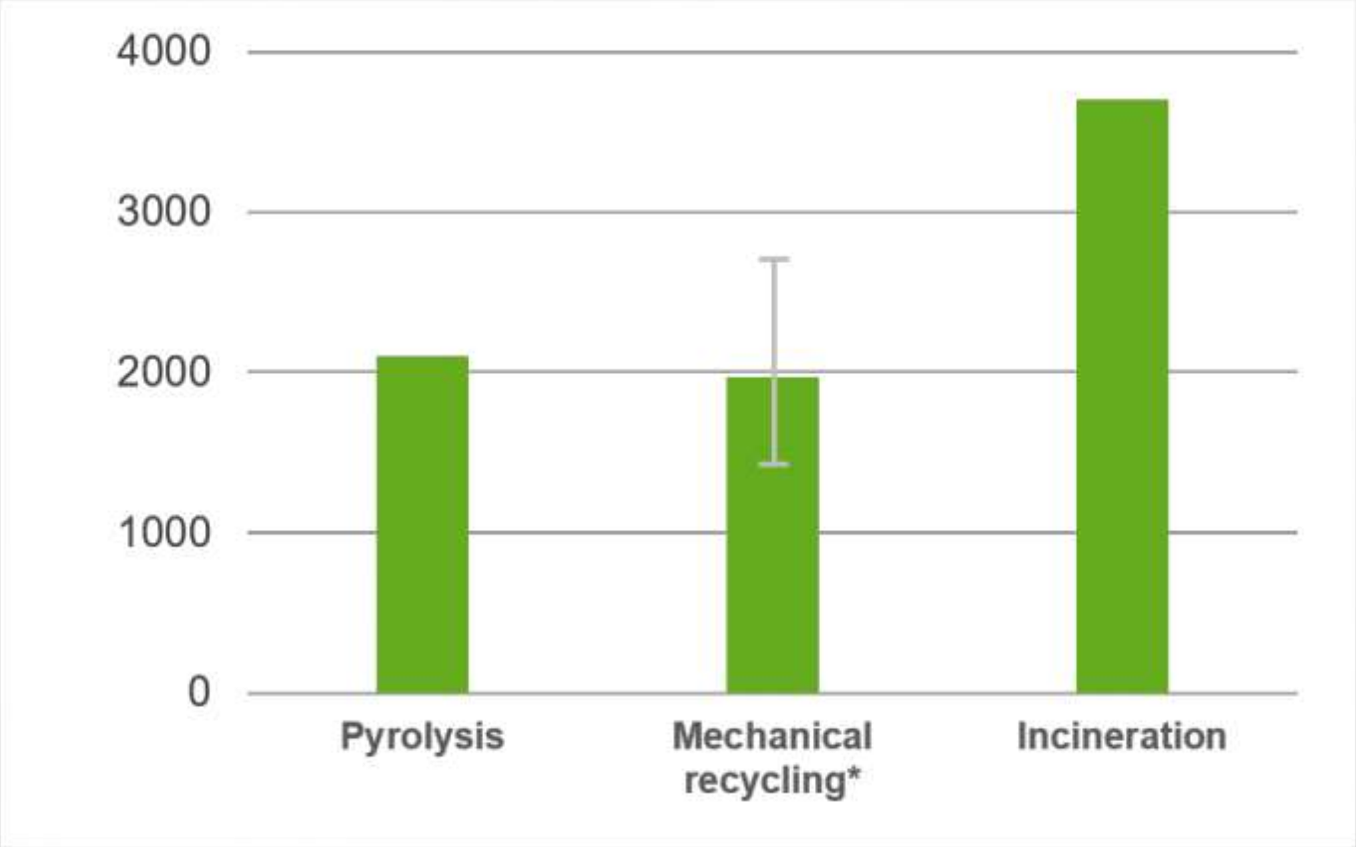
3. CO2

is the from industrial production emissionschemical valorisation of CO2™

Keep Carbon in the material loop!

Chemical recycling is an attractive alternative

CO_2 emissions [kg CO_2e/t product]



Chemical recycling technologies have **comparable GHG saving potentials than mechanical recycling**

Chemical recycling **saves GHG emissions in comparison to waste incineration**

COMPLEMENTARY TO MECHANICAL RECYCLING WE NEED CHEMRECYCLING TO REDUCE PLASTIC WASTE, REDUCE CARBON FOOTPRINT AND ENSURE QUALITY

PLASTICS ARE

100%

RECYCLABLE


Hvala
Simon Franko

The plastic waste arrives on site in bales – contaminated, multi-layer plastic such as flexible films and rigid trays that would otherwise have gone to incineration or energy-from-waste plants.

The bales are fed into the front-end sorting facility to remove any inorganic contaminants such as glass, metal or grit.

Organic contaminants such as food residue or soil are able to pass through the process.

The plastic is then shredded and cleaned, before being mixed with steam or heat’

Once this high-pressure system is depressurized and the waste exits the reactors, the majority of liquid flashes off as vapor.

his vapor is cooled in a distillation column and the condensed liquids are separated on a boiling range to produce four hydrocarbon liquids and oils: **naphtha, distillate gas oil, heavy gas oil and heavy wax residue**, akin to bitumen. These products are then shipped to the petrochemical industry.

As with other feedstock techniques, there is no down-cycling as the polymer bonds can be formed anew, meaning the plastics can be infinitely recycled.

With a conversion rate of more than 99%, nearly all the plastic turns into a useful product.