WORKSHOP

2021

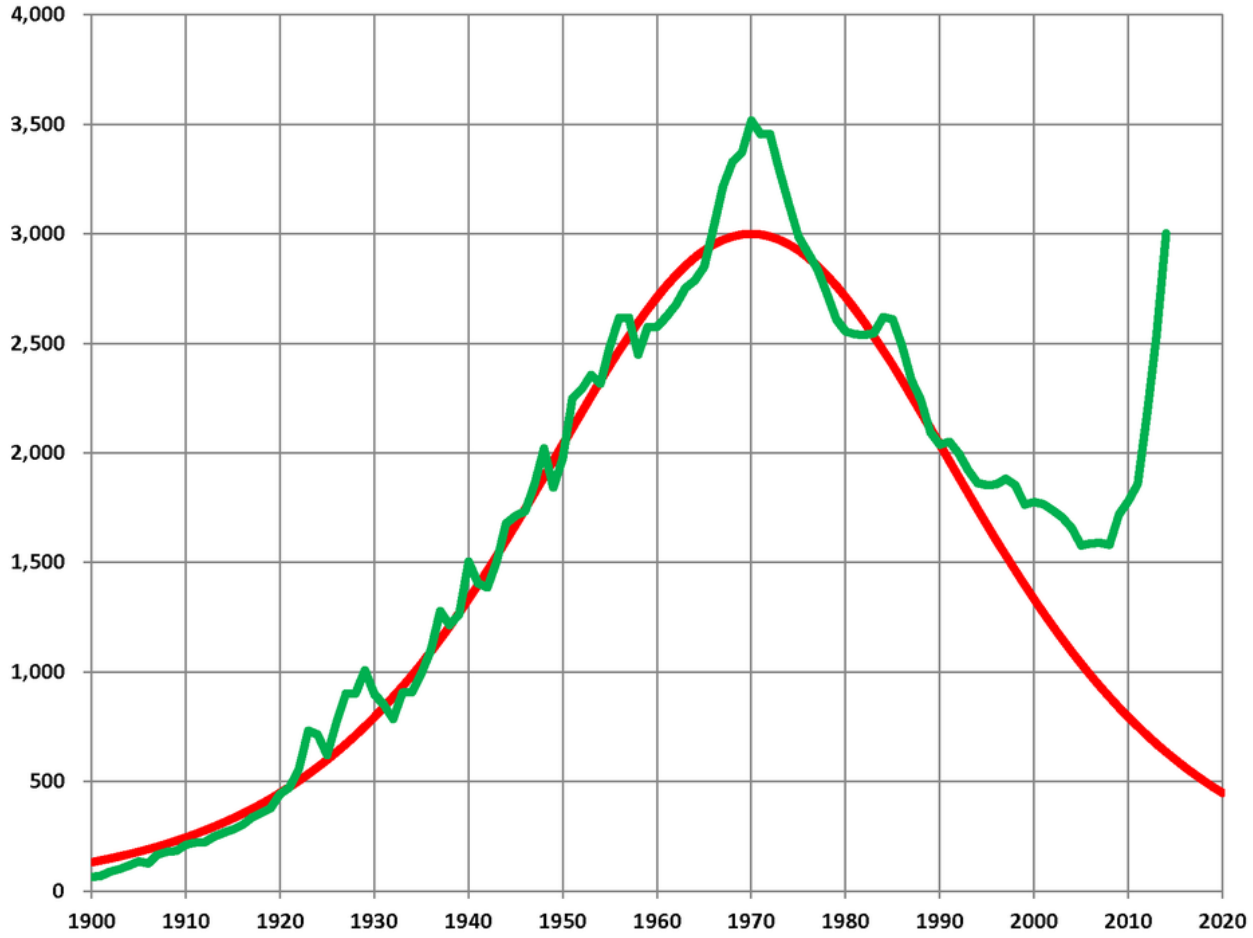
BIOBASED MATERIALS RESEARCH: ADVANCES FROM ECOFUNCO AND BIONTOP EUROPEAN PROJECTS

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 837863. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

SUSTAINABILITY in ORGANIK KIMYA

Cansu Akarsu - Davide Moscatelli

Why Renewable?

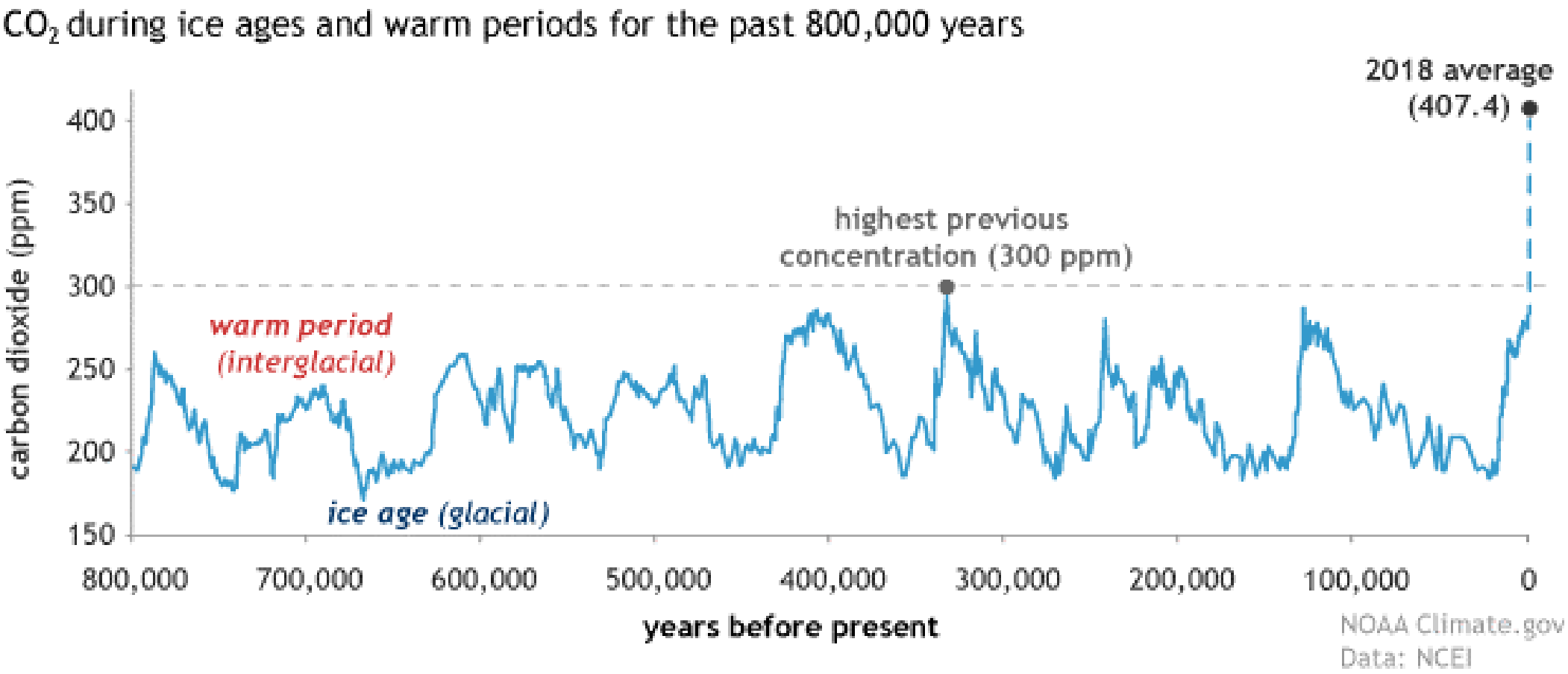


We are approaching the end of easily accessible oil and some experts claim that the era of the cheap oil may be ending.

The so called unconventional oil are more carbon laden and higher in toxic impurities. They tend to be heavy, complex and locked up deep in the earth, tightly trapped between or bound to sand, tar and reck.

They can be processed into petroleum products but impure feedstock requires large energy input to upgrade.

Because of Pollution



What we can do?

OIL PRODUCTION: 93 MBbl/day → MORE THAN 170 t/second

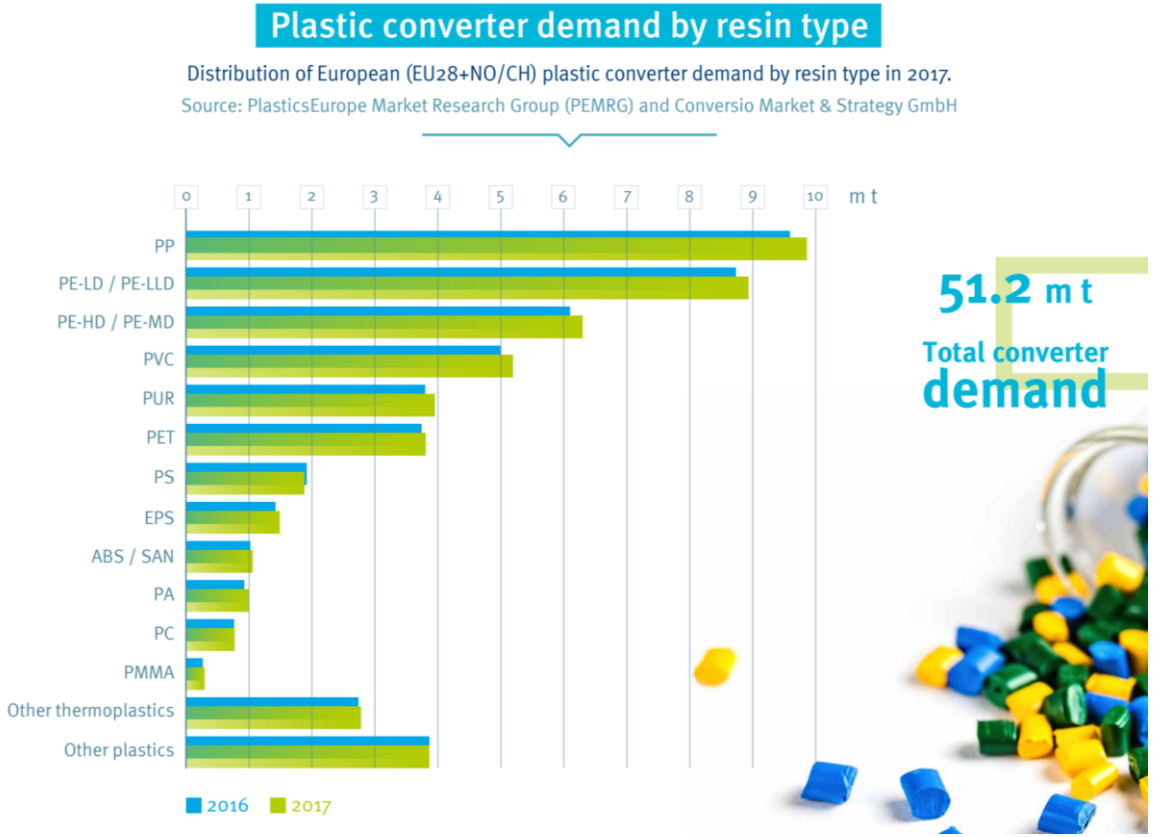
- **Oil →** **ROAD** **50.1%**

Petrochemicals	**14.3%**
Residential	**9.2%**
Aviation	**7.8%**
Marine	**3.4%**
Electircity Generation	**2.3%**
Domestic	**1.7%**
Other Uses	**11.2%**

→ 4% goes into Plastic

IEA, «Production of crude oil including lease condensate», 31.3.19

Something about Plastic



PLASTIC PRODUCTION: 348 Mt/year

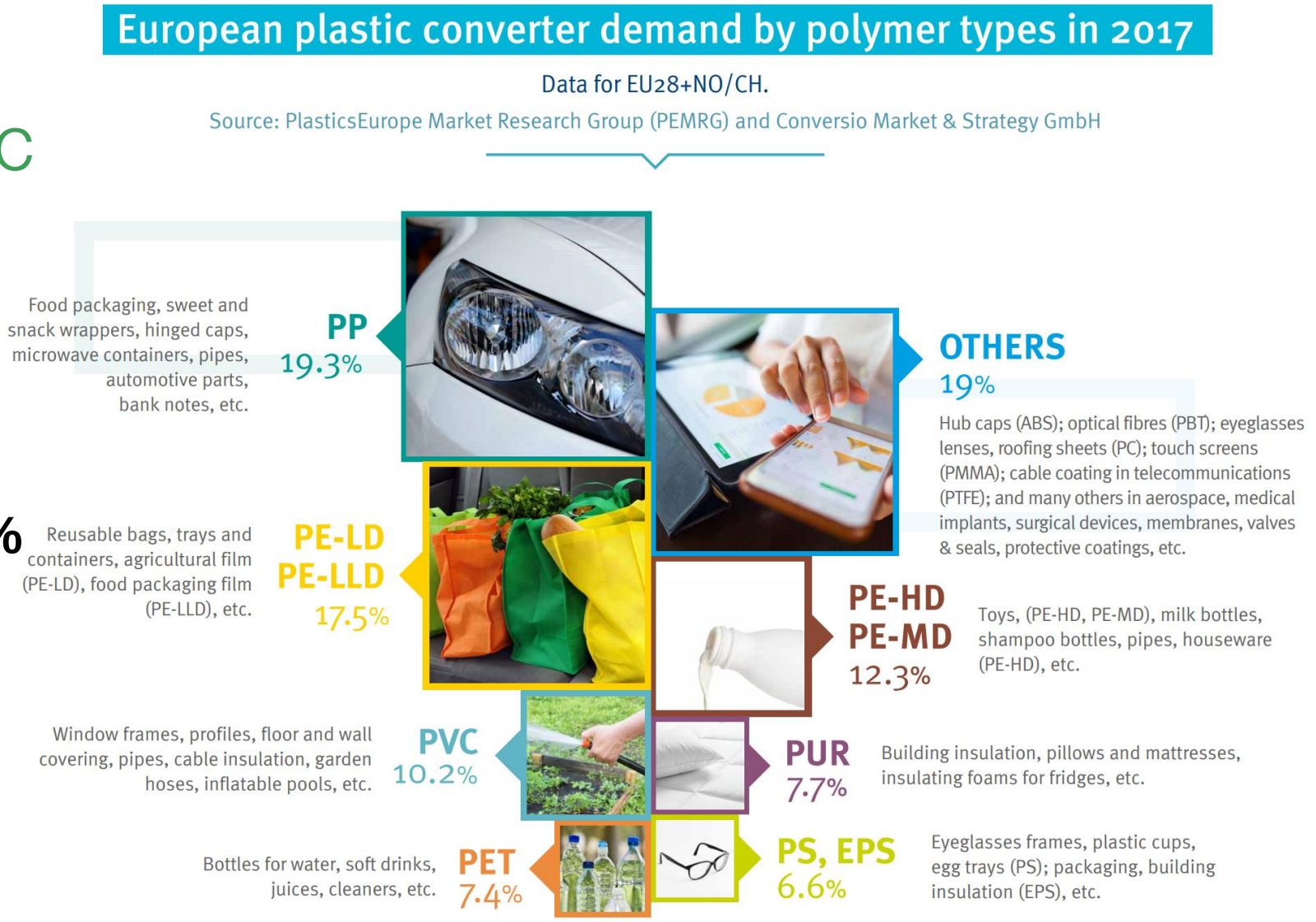
PP	**68 Mt**
LDPE	**64 Mt**
PP&A films	**59 Mt**
HDPE	**52 Mt**
PVC	**38 Mt**
PET	**33 Mt**
PUR	**27 Mt**
PS	**25 Mt**
Additives	**25 Mt**
Others	**16 Mt**

Something…
more about plastic

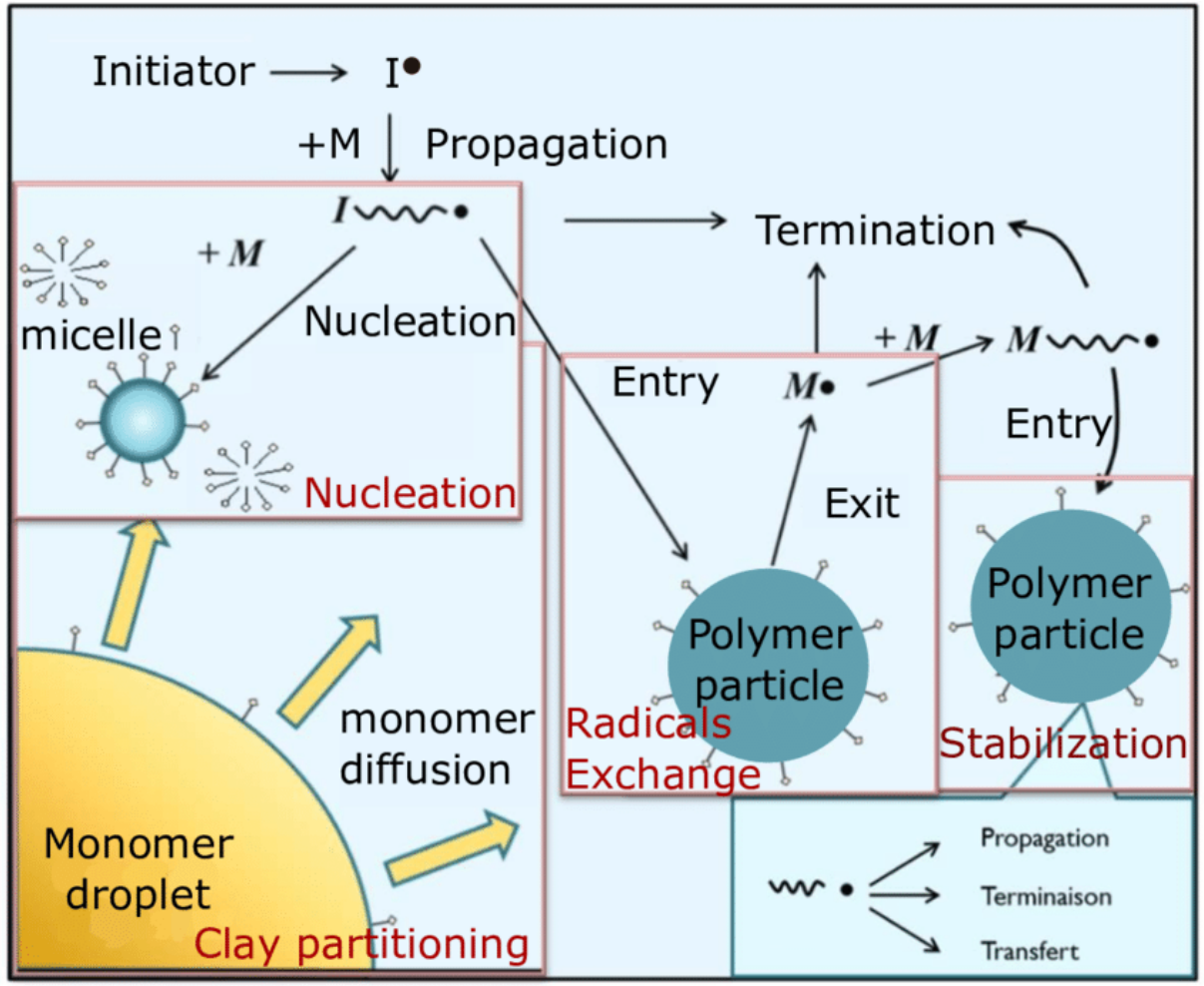
Acrylics-St-VAc max 45 %
Latexes Market → 10 Mt

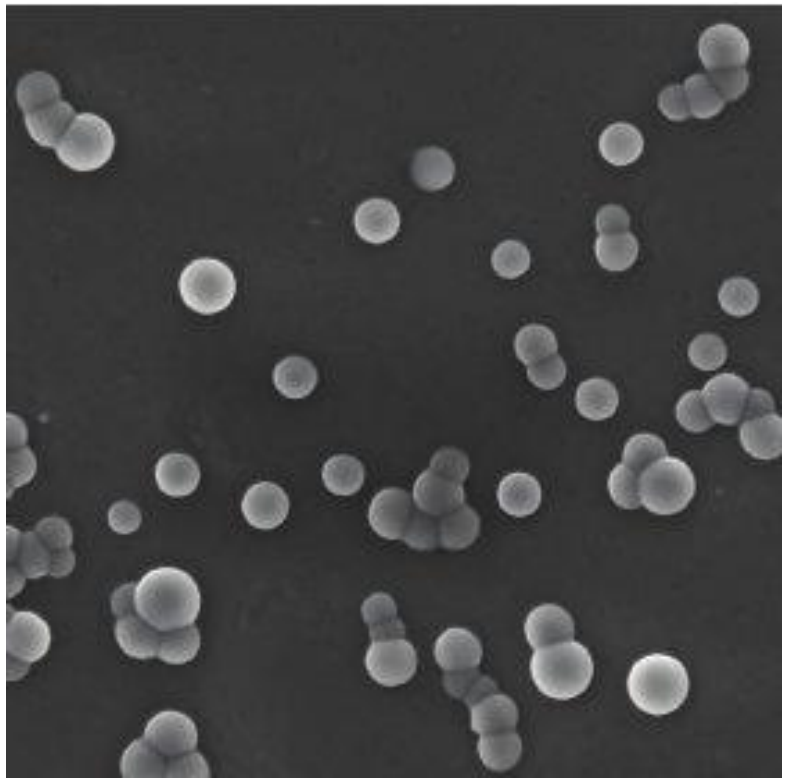
Latex Acryilic-St-VAc → 3 % plastic

% of oil that goes in OK product market → 0.12%



Emulsion Free Radical Polymerization





Sustainability in Organik Kimya

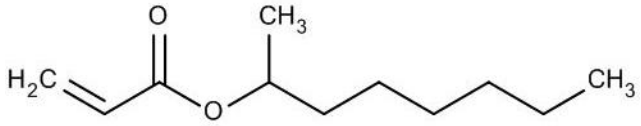
Bio-Based: products are fully or partially made from biological resources, rather than fossil raw materials.
They are not necessarily compostable or biodegradable.

Bio-Degradable: refers to the ability to get decomposed in due time by the action of micro-organisms such as bacteria or fungi biological (with or without oxygen) while getting assimilated into the natural environment. Not all of them are Compostable.

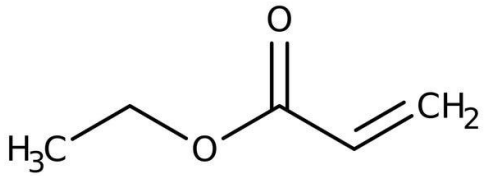
Bio-Compostable: products are biodegradable, but with an added benefit. That is, when they break down, they release valuable nutrients into the soil, aiding the growth of trees and plants.

Bio-Mass Balance: production methods of this kind save valuable resources and reduce CO_2 emissions at the same time and contributes to the use of renewable raw materials in integrated production system.

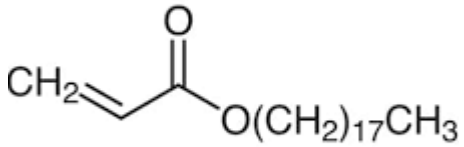
Bio-Based



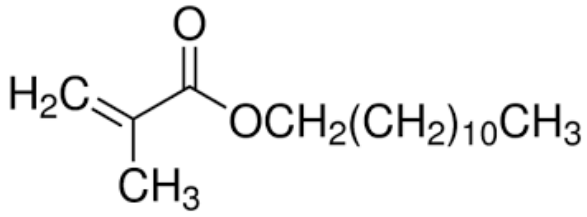
2-Octyl Acrylate Bio



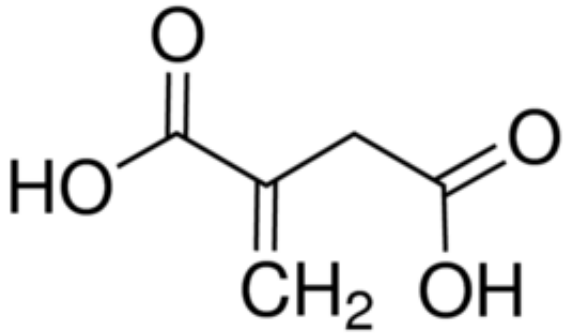
Ethyl Acrylate Bio



Stearyl Acrylate

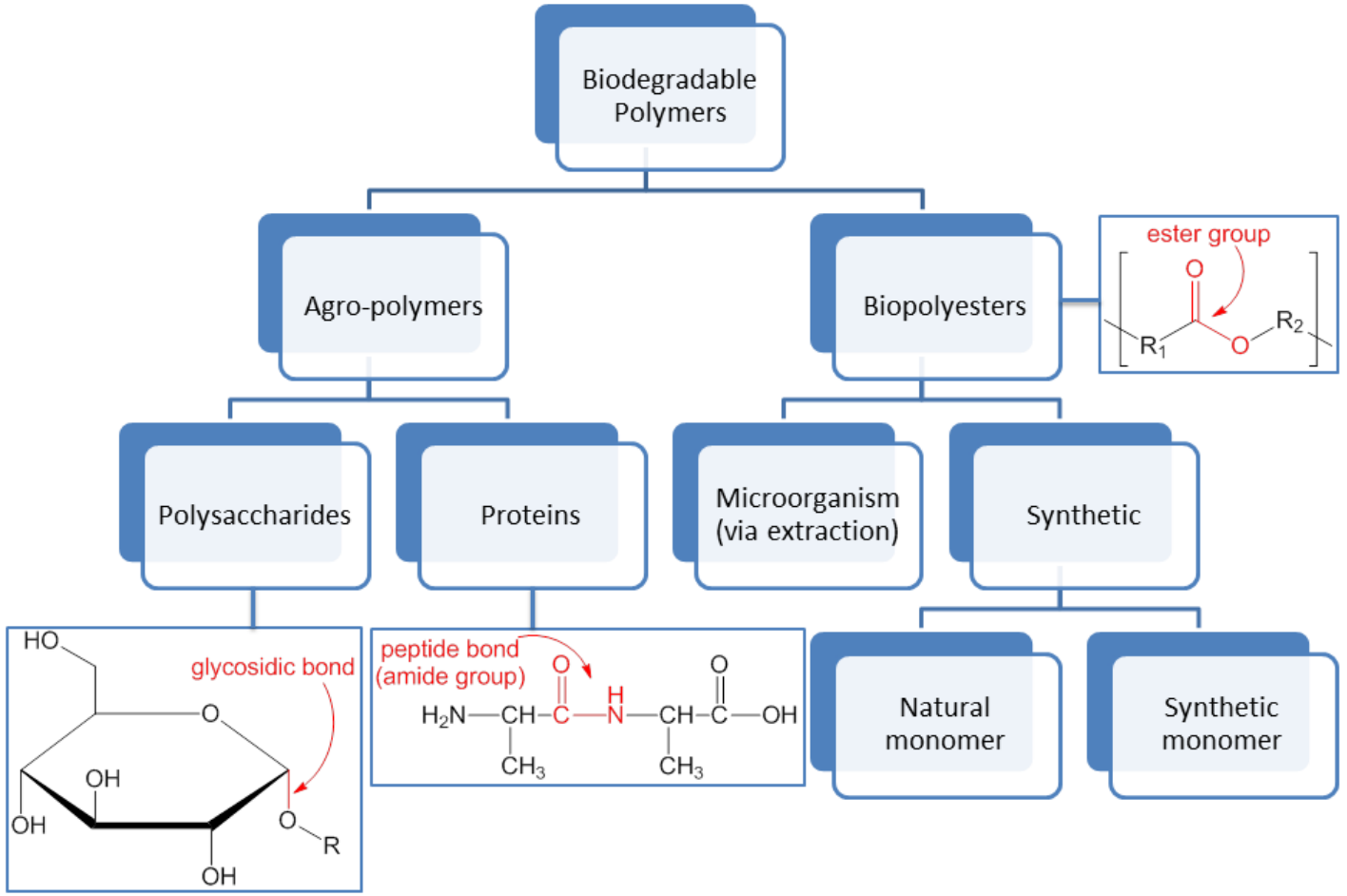


Lauryl Acrylate/Methacrylate



Itaconic Acid

Biodegradable Polymers



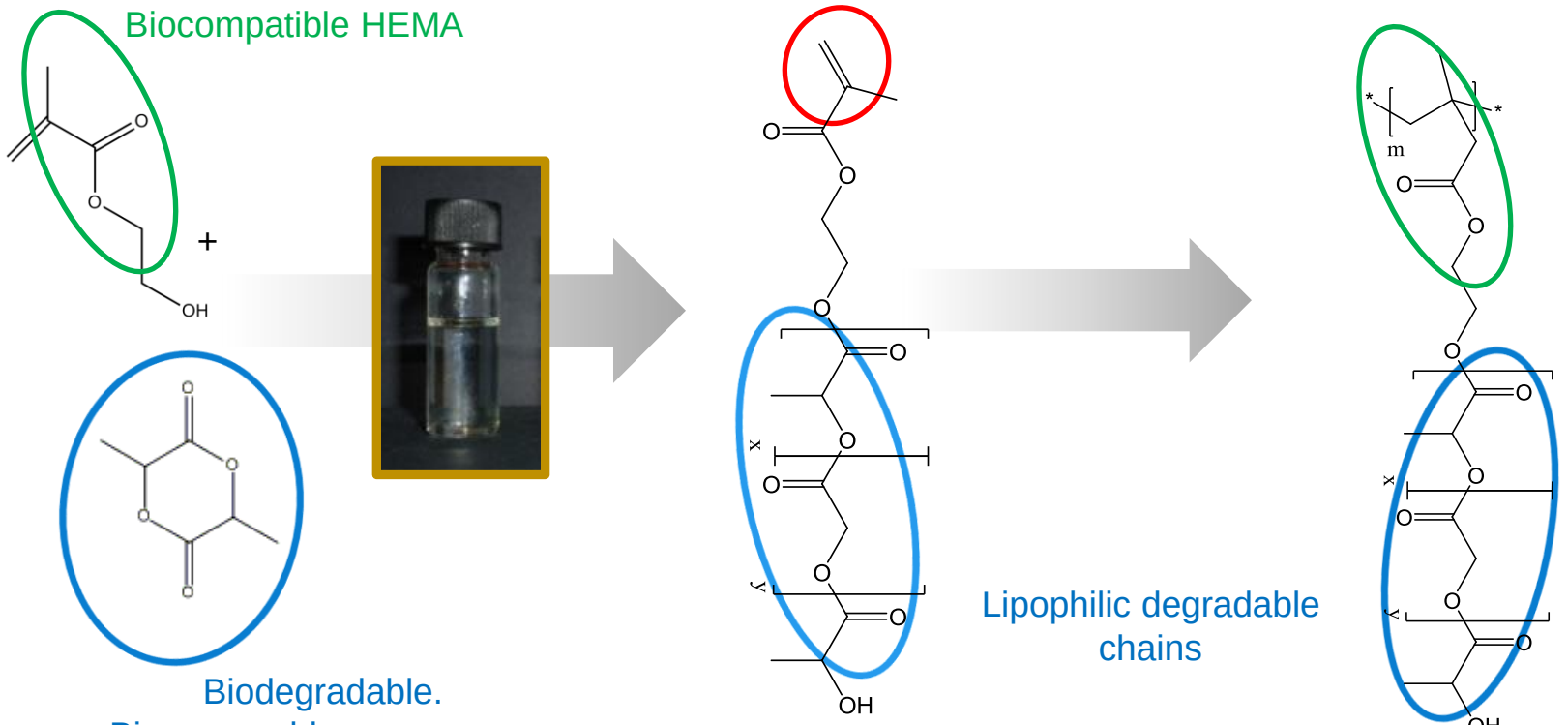
Biodegradable Polymers

1. Ring Opening Polymerization

2. Free Radical Polymerization

End Vinyl Group

Biocompatible HEMA



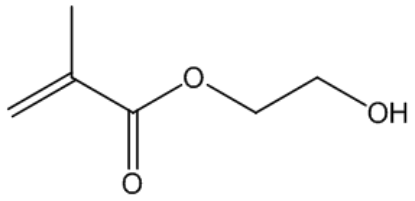
Biocompostable Polymers

Composting is the process of breaking down organic waste by microbial digestion to create compost. Compost has many beneficial uses including improving and fertilizing soil. To go through a composting process, organic waste requires the right level of heat, water, and oxygen. In a pile of organic waste, there are millions of tiny microbes that consume the waste, transforming the organic materials into compost. In order to claim that a product is fully compostable, the product has to meet all the requirements in the European Norm EN 13432 and/or the US Standard ASTM D6400.

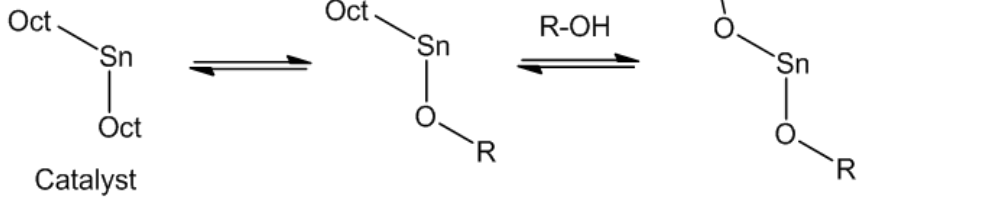
According to the European Standard EN 13432, a compostable material must have the following characteristics:

- Biodegradability, acceptance level is 90%, which must be reached in less than 6 months.
- Disintegrability, that is, the fragmentation and loss of visibility in the final compost (absence of visual contamination). This is measured with a composting test (EN 14045). The test material is degraded, together with organic waste, for 3 months. After this time, the compost is sieved with a 2 mm sieve. The residues of test material with dimensions higher than 2 mm are considered as not having disintegrated. This fraction must be less than 10% of the initial mass.
- Absence of negative effects on the composting process. This is checked with a composting test.
- Low levels of heavy metals (below the predefined maximum values)

Biocompostable Polymers: Ring Opening Polymerization

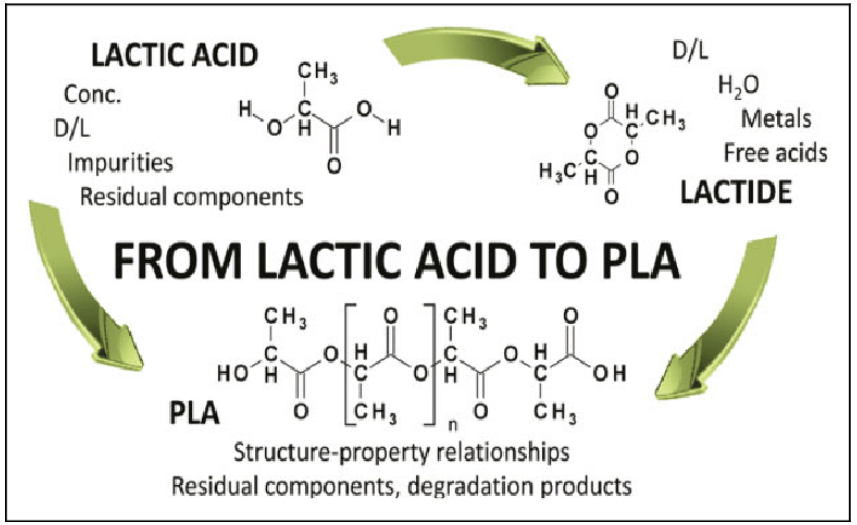


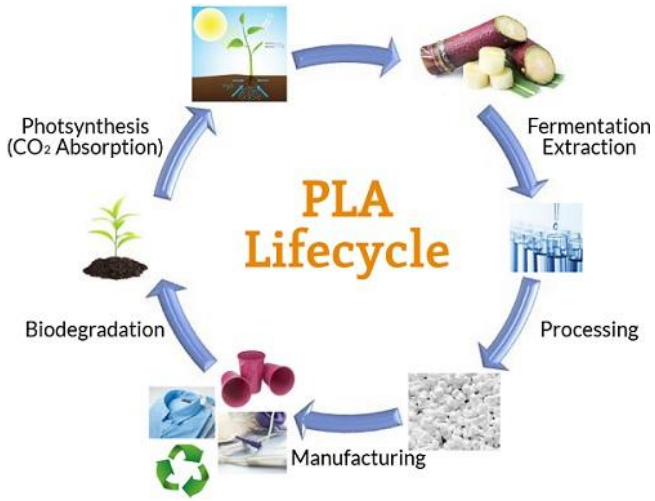
Co-catalyst (R-OH)

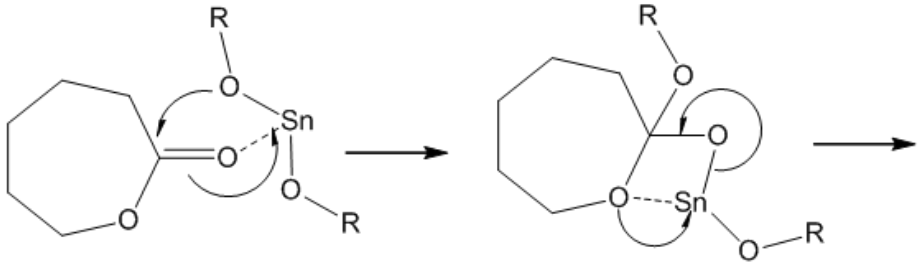


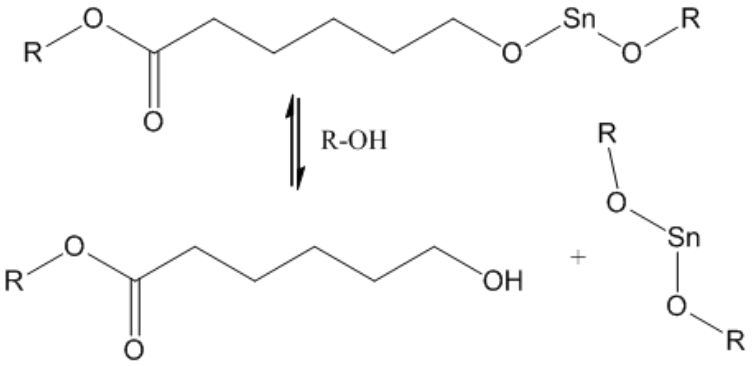
Catalyst
(FDA approved)

Alkoxide (activated catalyst)

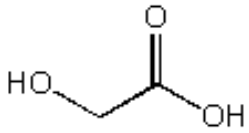




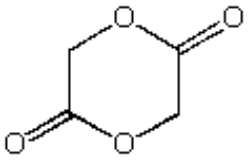




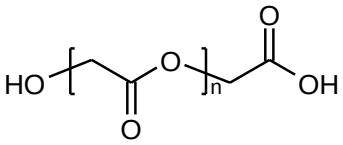
Biocompostable Polymers



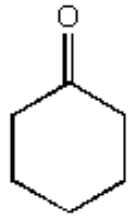
Glycolic Acid



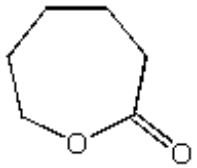
Glycolide



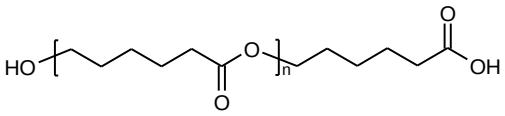
Poly Glycolic Acid (PGA)



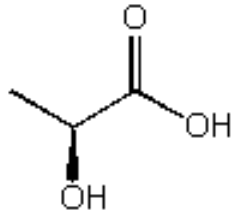
Cyclohexanone



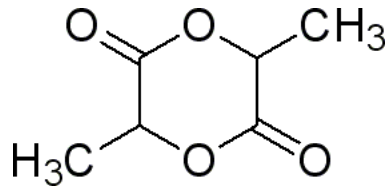
ε-Caprolactone



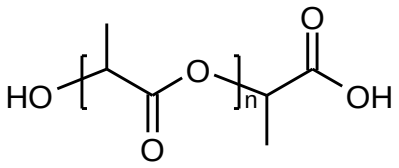
Poly Caprolactone (PCL)



Lactic Acid

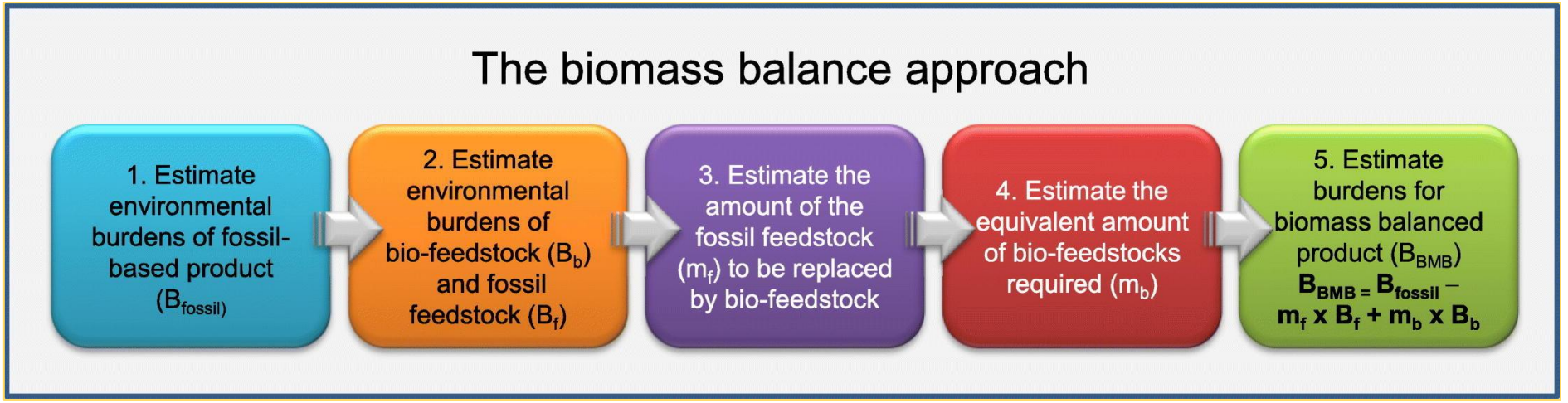


Lactide



Poly Lactic Acid (PLA)

Bio-Mass Balance Approach (BMB)



BMB is driven by the need to reduce greenhouse gas emissions and dependence on fossil resources

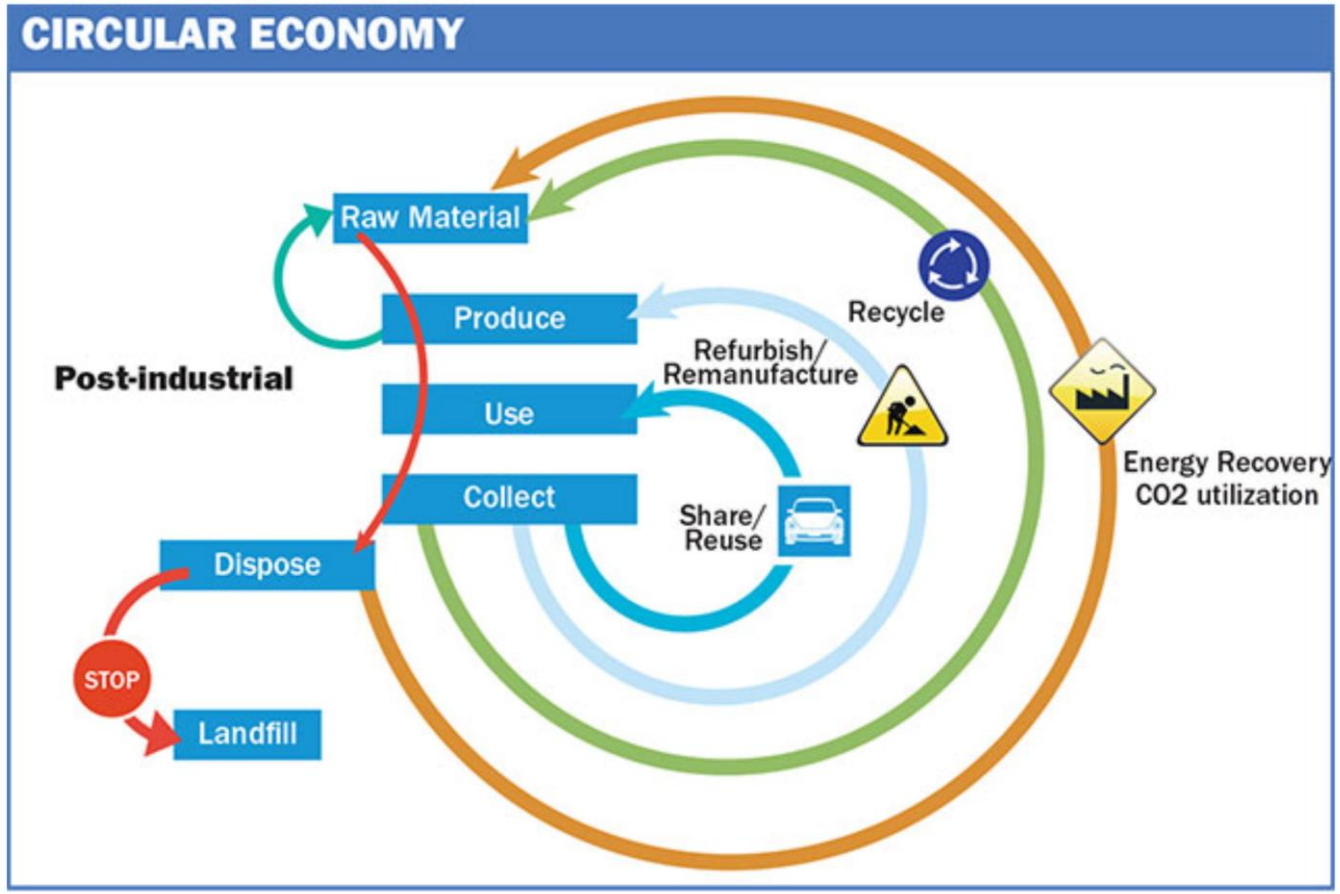
BMB products do not necessarily contain biomass material but can contribute to sustainable sourcing and production of bio-based products in the supply chain without any performance loss in comparison to the same products derived from fossil resources.

Bio-Mass Balance Approach (BMB)

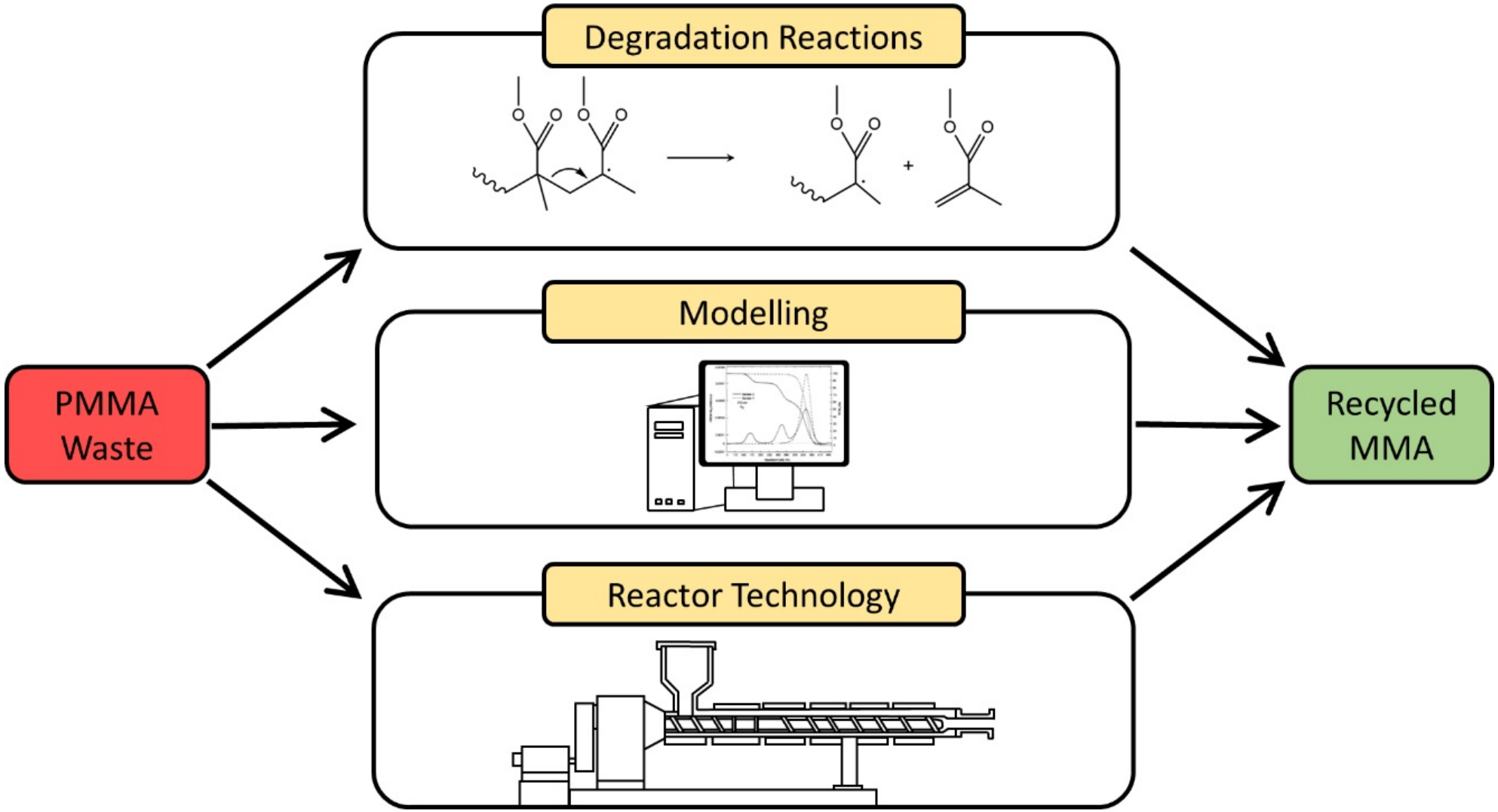
Fossil resource and greenhouse gas savings can be claimed when certified biomass is co-fed with fossil raw materials into a highly efficient interlinked production network. BASF and partners have developed a novel biomass balance certification standard for chemical synthesis. It offers a reliable response to customers and end consumers who are increasingly interested in solutions that are based on renewable feedstock without compromising resource efficiency and performance. The new standard describes how renewable feedstock is attributed to a given sales product. Existing products can thus be derived from biomass and provided with third-party certification.

Krüger C., Kicherer A., Kormann C., Raupp N. (2018) Biomass Balance: An Innovative and Complementary Method for Using Biomass as Feedstock in the Chemical Industry. In: Benetto E., Gericke K., Guiton M. (eds) Designing Sustainable Technologies, Products and Policies. Springer, Cham. https://doi.org/10.1007/978-3-319-66981-6_12

Recycled Monomer: MMA



- World production around 4 mln mt/year
- Approx 50% for the synthesis of bulk PMMA
- Second largest application: paints-coating-adhesives
- Approx. 10% of PMMA is collected for recycling


Degradation Reactions
Modelling
Reactor Technology
PMMA Waste
Recycled MMA

Thank you!