What is bioplastic? - Is bioplastic the answer?

Hasso von Pogrell, Managing Director, European Bioplastics
NORDISK BIOPLASTFÖRENING: Copenhagen, 27 February 2020

European Bioplastics' definition of bioplastics

BIOPLASTICS

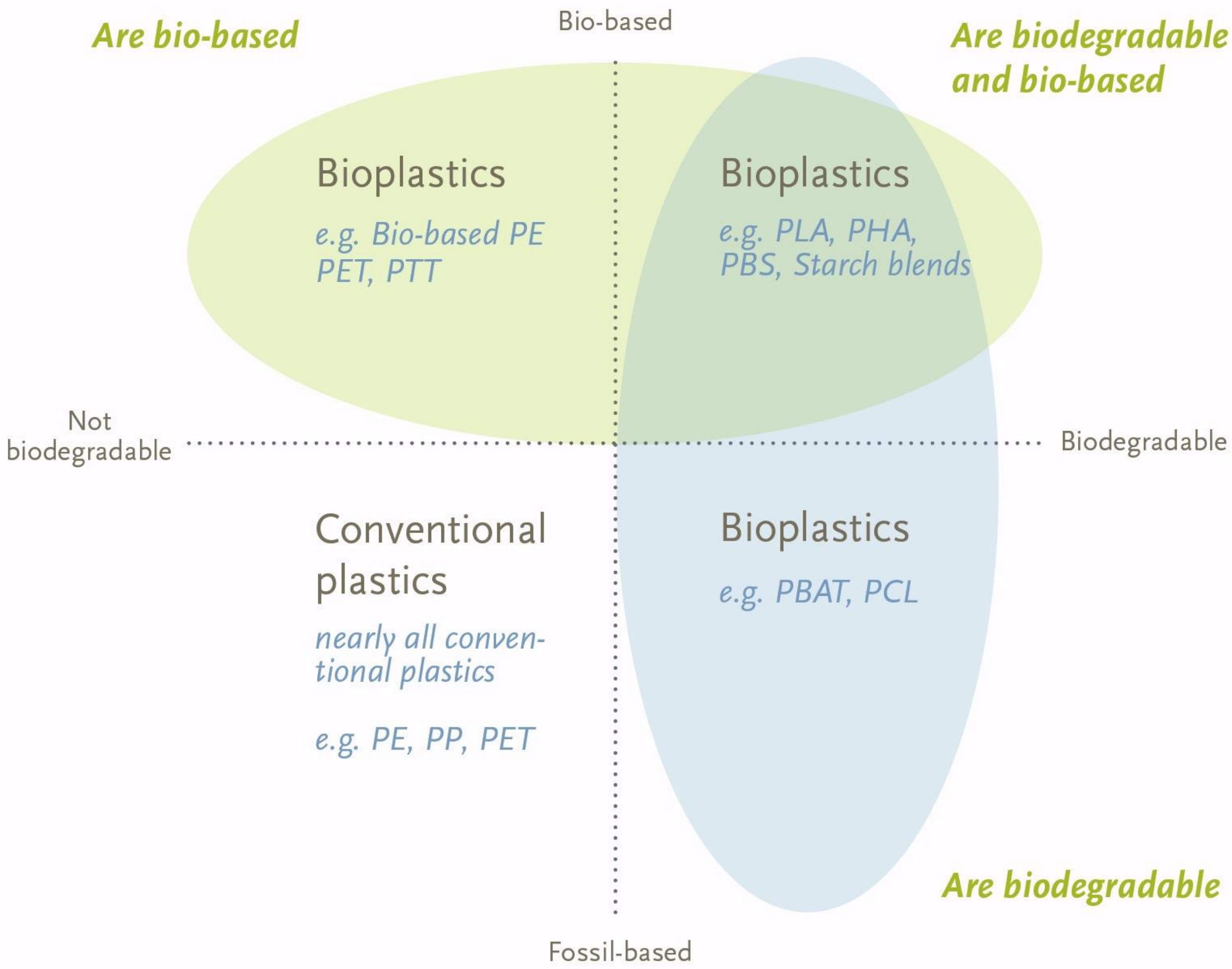
are

bio-based
e.g. bio-PE

biodegradable
e.g. PBAT

or both
e.g. starch blends

Bioplastics are bio-based, biodegradable or both.
(European Bioplastics)



Bioplastic materials and relevant manufacturers

biodegradable / compostable

Synthetic polyesters
(e.g. BASF)

Polycaprolactone PCL
(e.g. Perstorp)

bio-based AND biodegradable / compostable

Polylactide PLA
(e.g. NatureWorks, Corbion/Total, Futerro)

Starch based materials
(e.g. Novamont, Sphere-Biotec, Kuraray)

Cellulose based materials
(e.g. Futamura)

PLA compounds / blends
(e.g. BASF, FKuR)

Polyhydroxyalkanoate PHA
(e.g. Danimer Scientific, Kaneka, BIO-FED)

Polybutylene succinate PBS
(e.g. Mitsubishi, Succinity)

bio-based (durable)

Bio-PDO based polymers
(DuPont)

Bio-based PE
(Braskem, Neste)

Bio-based PET
(e.g. Coca-Cola, Toray, Far Eastern New Century)

Polyamides PA
(e.g. Arkema, BASF)

PEF
(e.g. Avantium)

Bio-based PUR
(e.g. Bayer)

Bio-based PP
(Neste)

Bio-based, non-biodegradable

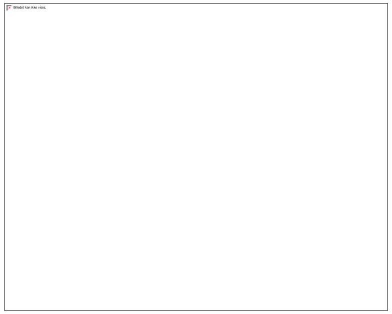
Polyethylene (PE)

- <u>Resources:</u> ethylene building block is made from ethanol produced by fermentation of agricultural feedstock (e.g. sugarcane)
- <u>Final product:</u> identical to fossil-based PE
- <u>End-of-life option</u>: (mechanical) recycling
- <u>Applications:</u> packaging, carrier bags, shrink film, etc.

Polypropylene (PP)

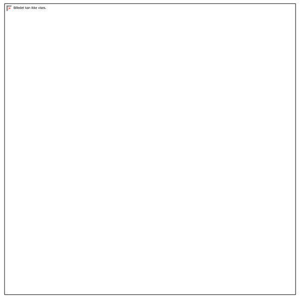
- <u>Resources:</u> waste and residue oils and fats
- <u>Final product:</u> identical to fossil-based PP
- <u>End-of-life option</u>: (mechanical) recycling
- <u>Applications:</u> packaging, carpets, etc. (very versatile).

Bio-based, non-biodegradable



Polyethylene terephthalate (PET)

- Partially bio-based
- Resources: monoethylene glycol (MEG) derived from sugarcane
- Final product: identical to fossil-based PET
- End-of-life option: mechanical recycling
- Applications: beverage bottles, but also films and fibres



Polyethylene furanoate (PEF)

- 100% bio-based: FDCA (from Fructose) and bio-MEG
- Final product: Higher barrier to oxygen, carbon dioxide and water vapour than PET
- End-of-life option: recycling
- Applications: beverage bottles, but also films / fibres

Bio-based <u>and</u> biodegradable

Starch, TPS (thermoplastic starch)

- <u>Resources</u>: corn, wheat, potatoes, tapioca, etc.
- <u>Final product</u>: raw starch destructured (extruder), addition of flexibilizers and plasticisers
- <u>Properties</u>: High humidity absorbance
- **<u>Starch blends</u>** e.g. with biodegradable polyesters as PBAT, polycaprolactone (biodegradable) or with polyolefines (non-biodegradable)
- <u>Applications</u>: carrier bags, cups, cutlery, coatings etc.

Amylose

Amylopectin

Bio-based and biodegradable

Polylactic Acid (PLA)

- Resources: D- and/or L-lactic Acid (produced by fermentation)
- Properties: can be varied by ratio of isomers and molecular weight
  - > High transparency, scratch resistance, good oxygen barrier, well suitable for printing;
  - > Potentially brittle, high hydrophilicity, low heat deflection; yet these properties can be improved by using in blends;
  - > High-heat resistant PLA polymers available;
  - > Can be processed by extrusion, injection moulding, etc.;
  - > Substituent material for PP and polyester.
- End-of-life options: compostable (EN13432), but more and more durable applications
- Applications: packaging, catering service ware, toys, consumer and office products, etc.

Bio-based and biodegradable

Polybutylene succinate (PBS)

- Resources: bio-based succinic acid and bio-based 1,4 butanediol
- Properties: flexible, melting point >100° C
  - > Blends with other biodegradable polyesters
  - > Substituent material for PP and PE (similar properties)
- End-of-life: industrial compostable (EN 13432)
- Applications: food packaging, service ware, agriculture, office products,

Biobased and biodegradable

Cellulose-based materials

- **Natureflex** = regenerated cellulose
- Successor of cellophane with superior biodegradability properties
- Feedstock: wood (FSC certified)
- Final product: Thin transparent film
- Great barrier properties to air/oxygen, mineral oils, bacteria; aroma protection -> food packaging
- End-of-Life: biodegradable in different environments (industrial/home composting)

- **Cellulose acetate** = modified cellulose
- Used in fibre and film applications, but also for durable applications as e.g. eyeglass frames

Biobased <u>and</u> biodegradable

Polyhydroxyalkanoates (PHA)

- <u>Industrial production</u>: microbial fermentation of sugar/glucose
- <u>Final product:</u> Used pure, blended or as additive to modify other polymers such as PLA
- <u>End-of-life option:</u> compostable (EN13432 and home), also marine biodegradable (certified by TÜV Austria but NO EoL option!)
- <u>Applications</u>: Used in packaging, coatings, hygiene products

Biodegradable, but not bio-based

Polybutylene adipate terephthalate (PBAT)

- Fossil-based, but will be at least partially bio-based in the future
- Can improve the functionality of renewable raw materials (e.g. PLA, starch)
- <u>End-of-life</u> option: biodegradable in compost plant (in accordance with EN 13432, ASTM D6400)
- <u>Applications</u>: agriculture (mulch films), cling wrap films, coatings for packaging, breathable films in hygiene applications

What bioplastics are NOT…

Oxo-degradable plastics:

- Do not meet requirements for industrial and/or home compostability
- Conventional plastics with metal salt additives
- Very few positive biodegradation results obtained

Enzyme-mediated degradable plastics:

- Very few data on biodegradation
- Conventional plastics with organic additives

Source: O.W.S. "Benefits and challenges of bio- and oxodegradable plastics – a comparative literature study", August 2013

NO BIOPLASTIC !!!

Source: Endseurope.com

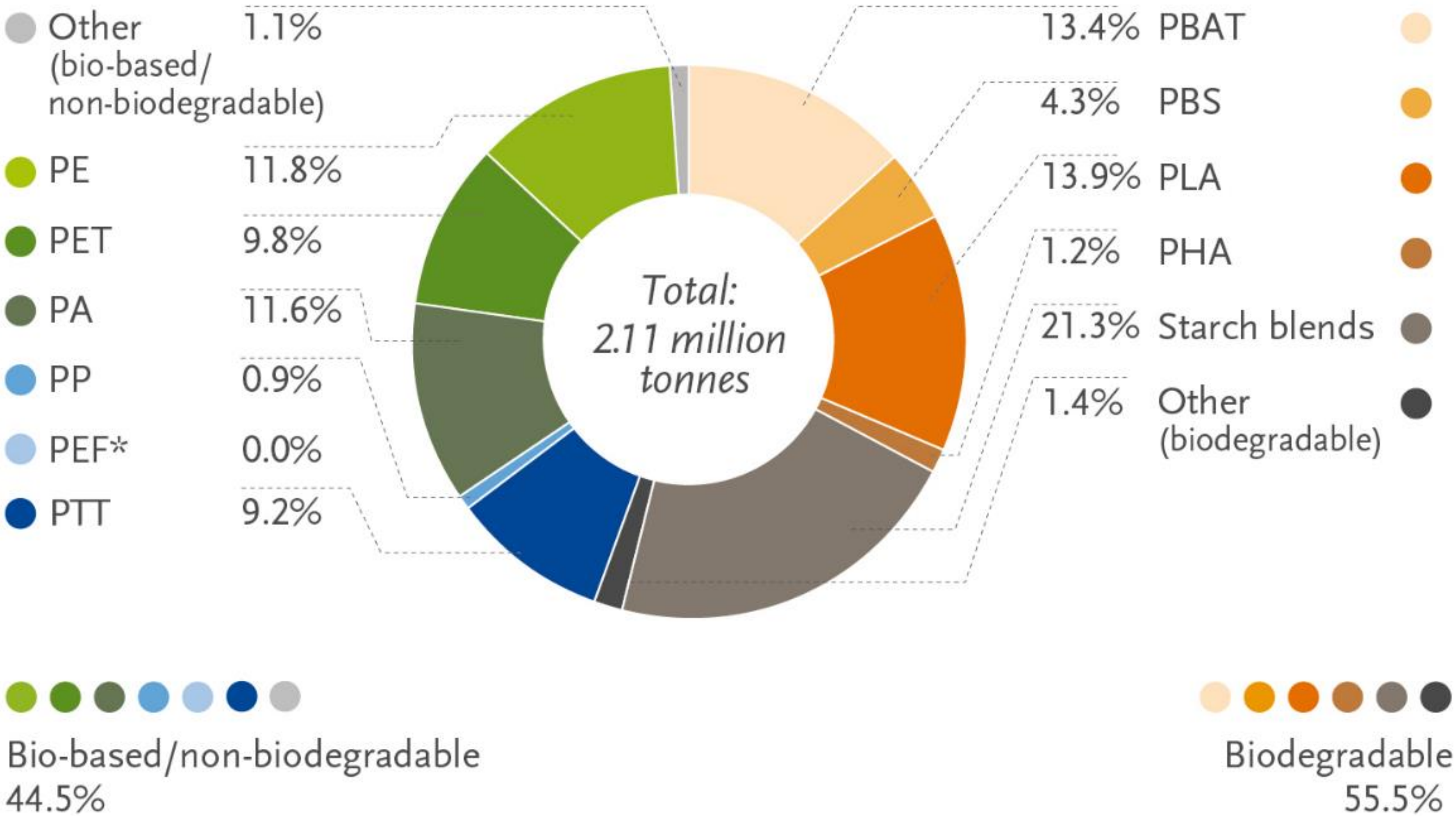
Source: www.plasticbiz360.com

Processing technologies for bioplastic materials

- Bioplastics are suitable for all standard processing technologies, such as
  - > lamination
  - > thermoforming
  - > injection moulding
- No special machinery is required
- In most cases, the process parameters of the equipment simply have to be adjusted to the individual specification of each polymer

Image: Wentus Kunststoff GmbH

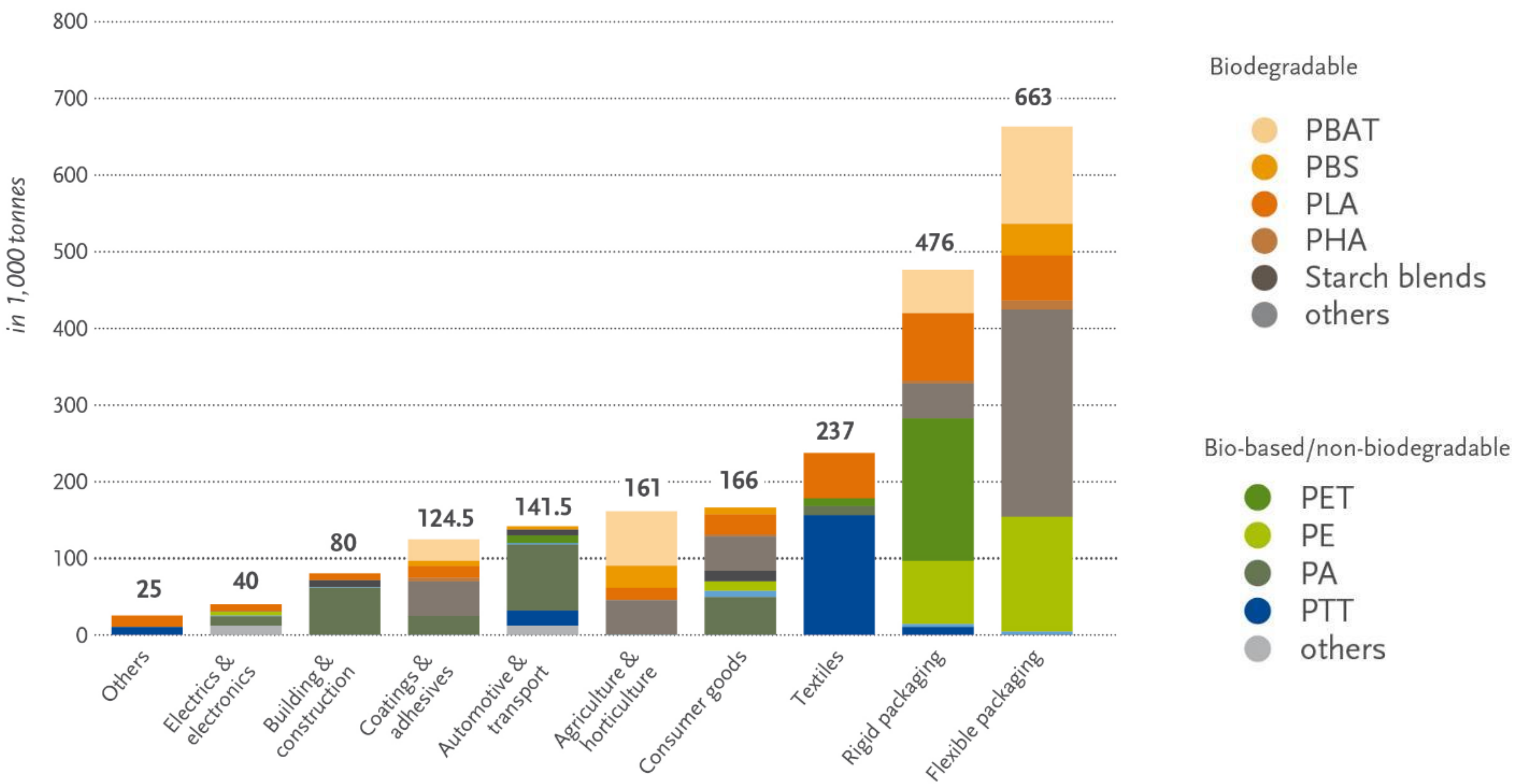
Global production capacities of bioplastics 2019 (by material type)



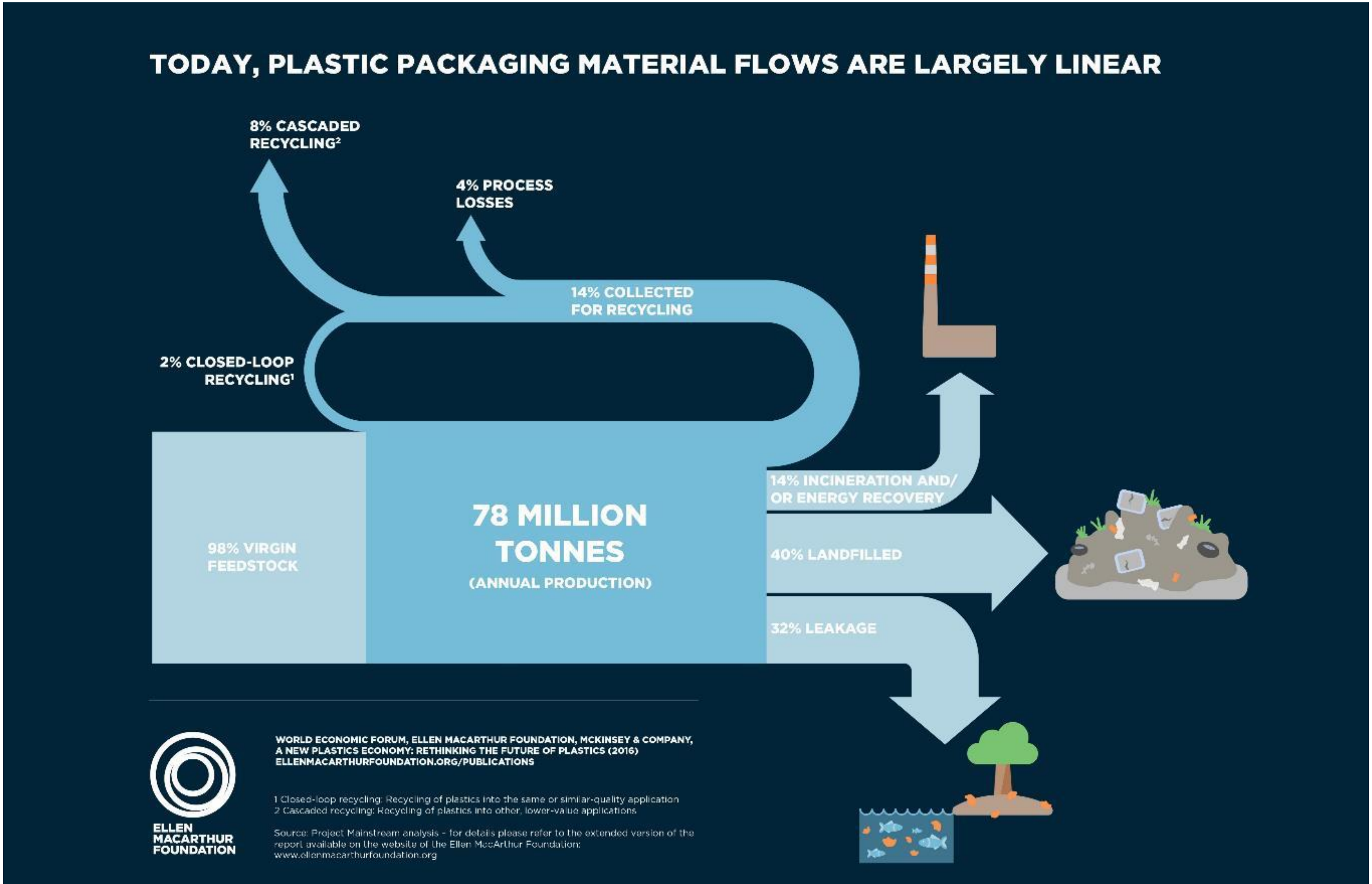
*PEF is currently in development and predicted to be available in commercial scale in 2023.

Source: European Bioplastics, nova-Institute (2019)
More information: **www.european-bioplastics.org/market** and **www.bio-based.eu/markets**

Global production capacities of bioplastics 2019 (by market segment)



Myths and facts about recycling of packaging



Myths and facts about biodegradable /compostable plastics

Myth

Biodegradable plastics certified according to EN 13432 need only to prove 90% biodegradation.

That means that up to 10% need not to biodegrade and are liable to remain as microplastics in the compost.

Fact

The 90% biodegradation rate refers to the conversion of the carbon (C) into carbon dioxide (CO_2).

However, given that up to 40% of the C is converted into new biomass, the requirement of 90% CO_2 conversion poses a high barrier, as this can only be achieved if part of the newly built biomass is mineralized again.

Myths and facts about biodegradable /compostable plastics

Myth

Biodegradable plastics certified according to EN 13432 need 6, respectively 3, months to biodegrade / disintegrate in industrial composting facilities.

But because modern composting facilities mostly allow for an active rotting phase of only between 3 to 6 weeks, the tested materials or product will not biodegrade in time.

Fact(s)

This timeframe sets the boundaries for the maximum thickness of a product to be certifiable according to EN 13432.

However, the thickness of most products sent in for testing and certification is far below the certifiable thickness.

In the case of biowaste bags, the thickness is often in the range of 5-10% of the certifiable maximum thickness. This means that they will completely biodegrade in just a few weeks.

Myths and facts about biodegradable /compostable plastics

Myth

Biodegradable plastics disturb mechanical recycling

Fact(s)

- Bioplastics production capacities well below 1% of overall plastic production
- 60% bio-based durable and recyclable (“mostly drop-ins”)
- 40% biodegradable products (mainly flexible packaging) intended for biowaste collection
- Pre-sorting always necessary to avoid contamination and widely available (NIR)
- Potential contamination rate is near zero
- Contamination rate of up to 3% rarely poses a problem

Myths and facts about biodegradable /compostable plastics

Myth

Composting of biodegradable waste bags and other (flexible) packaging provides no added benefit to the compost.

The intrinsic calorific value of composted plastics is lost to incineration with energy recovery ("cold incineration").

Fact(s)

Per se, these statements are correct.

However, the purpose of biodegradable plastics is to allow for better and more collection of biowaste (less odour, better hygiene) and to divert biowaste from ending up in incineration and landfills.

Myths and facts about biodegradable /compostable plastics

Myth

Paper bags and newspaper as biobin liners are a more sustainable solution to collecting biowaste than biodegradable biowaste bags.

Fact(s)

Paper waste bags and newspaper are often made from recycled paper and, therefore, contain (unknown) legacy chemicals and inks.

Tested according to EN 13432, they will often not pass the necessary eco-toxicity requirements.

Often, paper waste bags can be coated with a PE film for moisture barrier properties. This renders them non-biodegradable and therefore, they contaminate the compost.

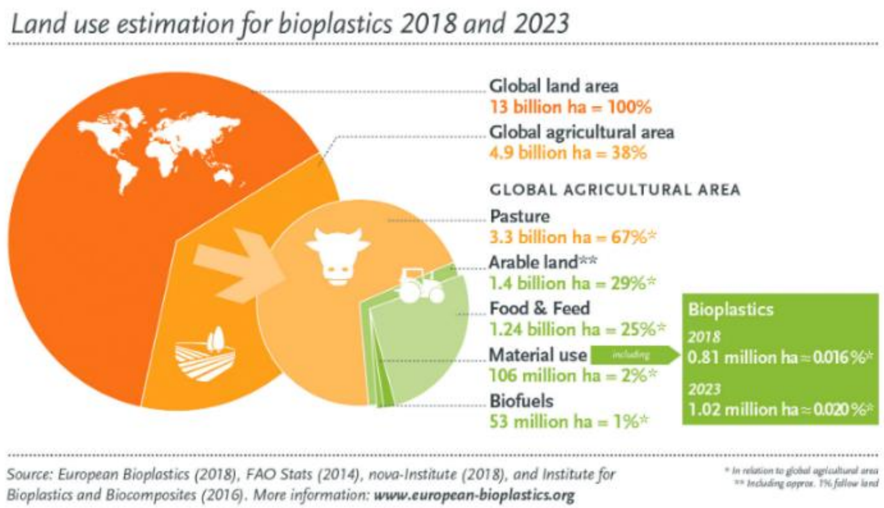
Myths and facts about bio-based plastics

Myth

Bio-based plastics made from edible crops (1st gen. feedstock) pose a threat to the world-wide supply of food and feed.

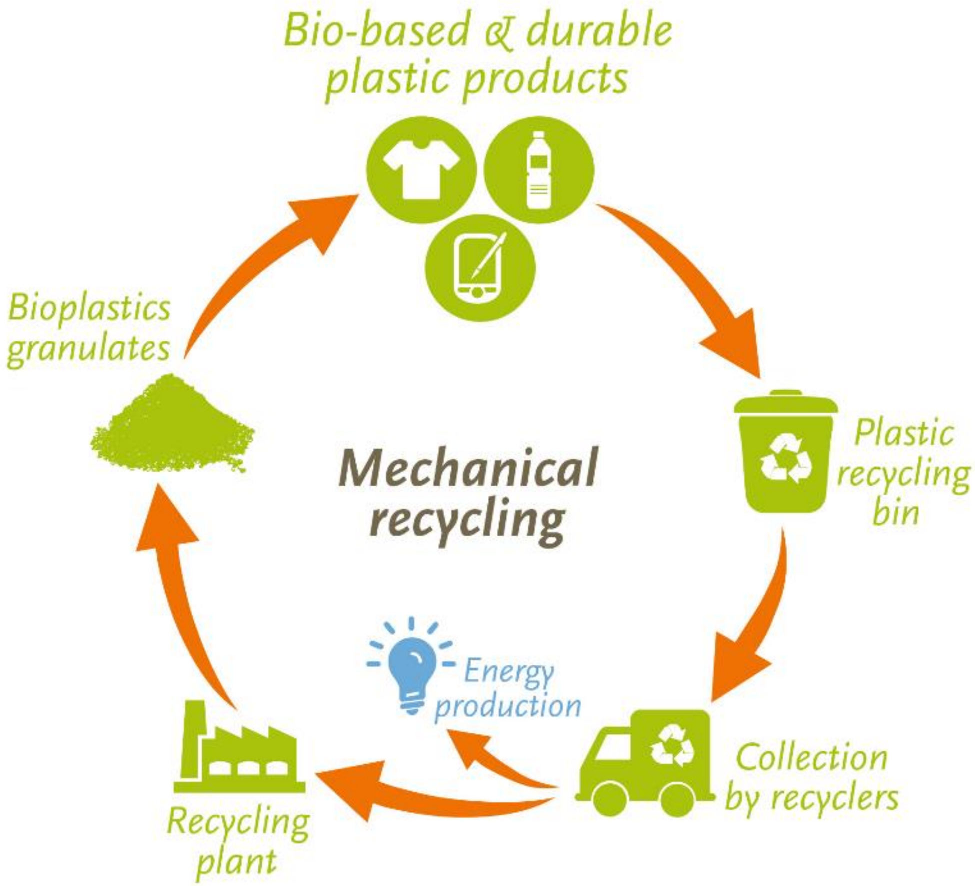
Fact(s)

- The competition is not for the crop itself but for the land used to grow it.
- 1st gen. feedstock most efficient



- Plant based proteins still available for food and feed

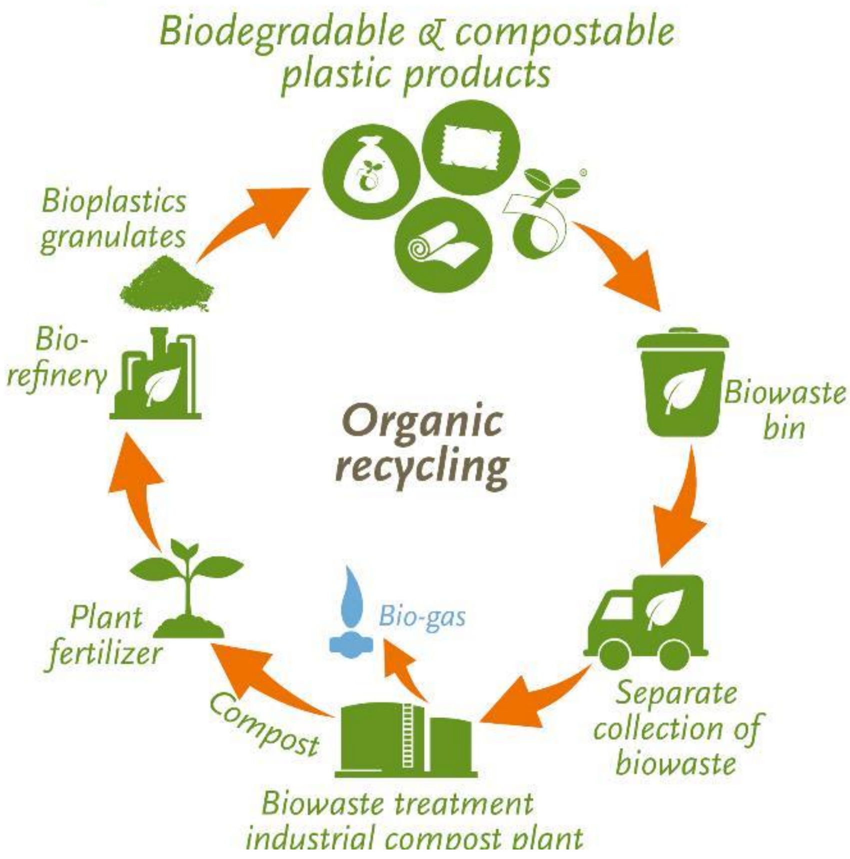
Mechanical recycling of bioplastics plastics – Status quo



- Current market share < 1%
- Drop-ins and also new materials can be recycled
- Sorting by the means of NIR works well
- Compostable applications not intended for mechanical treatment

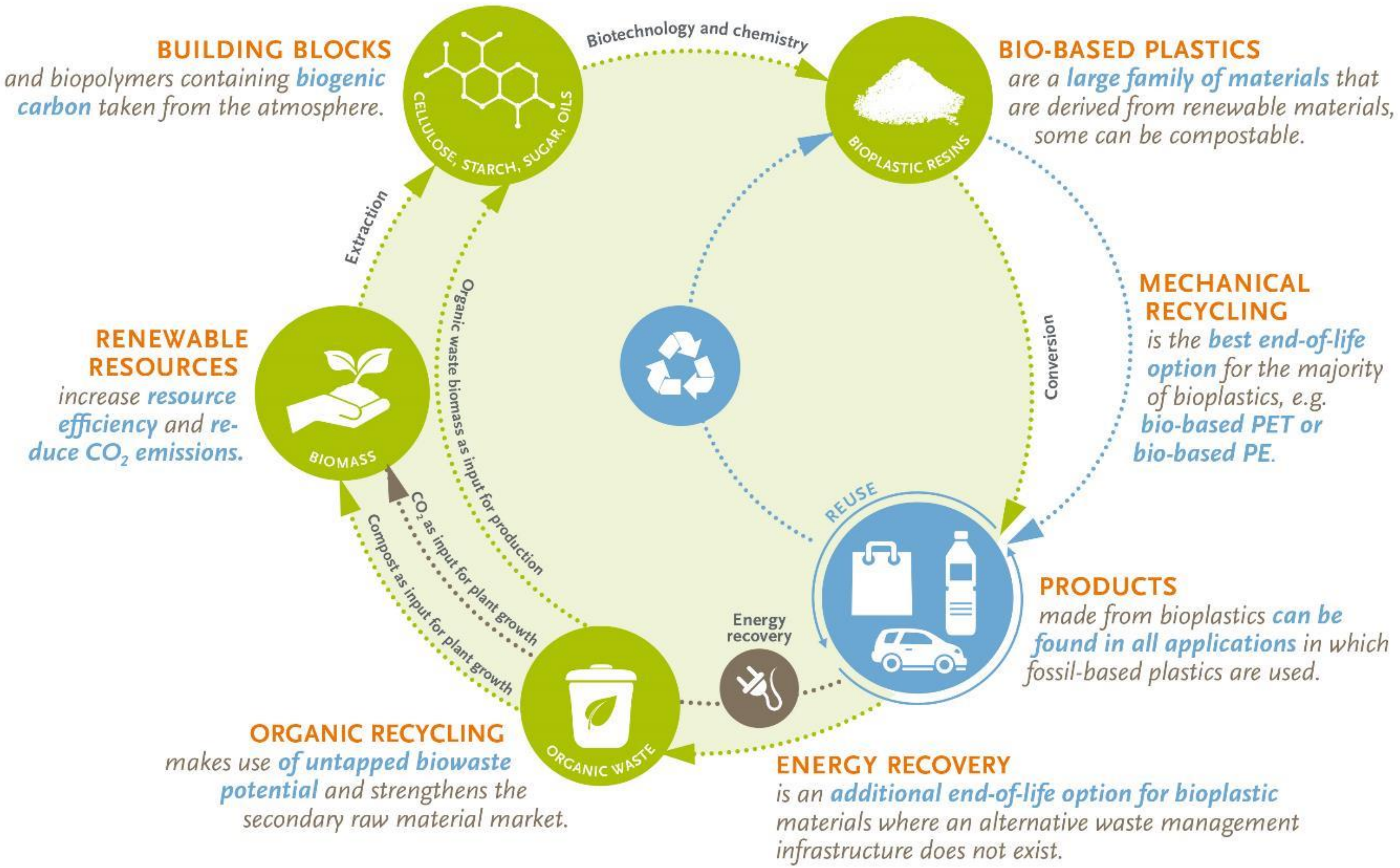
Compostable plastics – Added value for the circular economy

- Optimisation of the separate collection of bio-waste
- Diversion of bio-waste from other waste streams
- Reduction of impurities in the organic waste collection
- Provision of raw material for industrial purposes (organic fertilizer/compost, bioplastic feedstock)
- Support of biogas production (anaerobic digestion)



Demands for "biodegradability in the environment" divert attention from the concept of circularity!

Bioplastics life cycle model – Closing the carbon loop



Thank you!

Hasso von Pogrell
European Bioplastics e.V.
Marienstr. 19-20, D- 10117 Berlin (Mitte)

Phone. +49 (0) 30 28482 357
Fax +49 (0) 30 28482 359
pogrell@european-bioplastics.org

http://www.european-bioplastics.org
http://twitter.com/EUBioplastics