

# Understanding plastic packaging and the language we use to describe it

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PLASTICS  
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The way a plastic is designed to behave alongside what material it's made from, affects what it can be used for as well as how it can be recycled and disposed of at the end of its life.

With plastics top of the sustainability agenda many companies are looking at alternatives to conventional plastic typically used for packaging applications.

However, there is potential for the language that we use to describe plastics to be confusing: with the different material types of plastic – fossil-based or bio-based; how plastic is described and referred to – conventional plastics or bioplastics; and, how plastic behaves – non-biodegradable, biodegradable or

compostable – and the effect these factors have on how it's collected and disposed of.

Understanding the terms that we use to describe plastics is essential to ensure that the right materials are used in the right applications, and so that all plastics are recycled in the right way and pollution of the environment is prevented.

This document is aimed at anyone who is interested in understanding the complexities around different types of plastic.

This document sets out to clarify the differences between the materials used to make plastic packaging, the way plastics can behave and, the terminology used to describe plastics.

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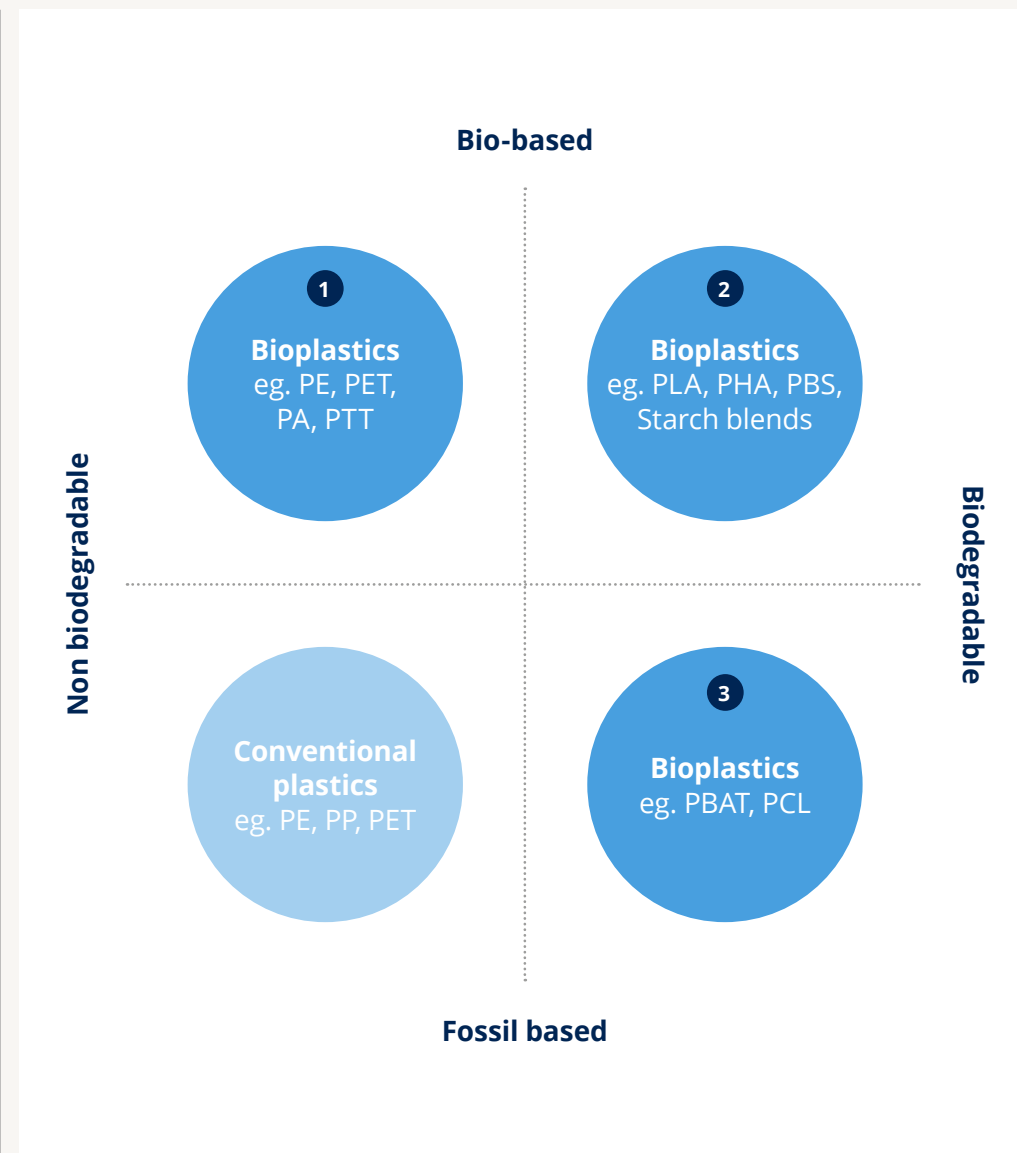
Plastic can be made from fossil-based or bio-based materials. Both can be used to make highly durable, non-biodegradable plastics, or plastics which either biodegrade or compost.

The nature of the material used to make a plastic or the term used to describe it does not necessarily dictate the way it will behave at the end of its life e.g. a bio-based plastic or bioplastic does not automatically mean it will biodegrade.

This diagram demonstrates the complexity of the term bioplastics; which refers to a diverse family of materials with differing properties – there are three main groups:

- 1 Bio-based or partially bio-based non-biodegradable plastics such as bio-based PE or PP
- 2 Plastics that are both bio-based and biodegradable, such as biodegradable PLA and PHA or PBS or PBS
- 3 Plastics that are fossil-based and biodegradable, such as PBAT

See glossary for acronyms.



# Material type

## Fossil-based plastic

Made from a wide range of polymers derived from petrochemicals. Fossil-based plastic packaging is generally long lived, durable and non-biodegradable; this is what's referred to as conventional plastics. However, fossil-based plastic can also be designed to biodegrade and this type is considered a bioplastic.



## Bio-based plastic

Made using polymers derived from plant based sources e.g. starch, cellulose, oils, lignin etc.

Bio-based plastic is the term used for any plastic made from bio-based polymers, and refers to the source from which the plastic is made, not how the material will function.

Bio-based polymers can be used to make plastic packaging that behaves like conventional plastic and is long lived, durable and non-biodegradable. It can also be used to make biodegradable and compostable plastics. Both types are referred to as bioplastics (see diagram on page 2).



# Behaviour and features

All plastics, regardless of whether they are fossil-based or bio-based, can be designed to behave in three ways:

## Non-biodegradable

Is durable and lasts for years.

It has high strength and can be used in low weight applications.

## Biodegradable

Breaks down in a defined period of time.

It can now be made with similar strength, plasticity and elasticity properties of non-biodegradable plastics, and made into products using the same technologies (e.g. film processing or moulding).

The fact that a plastic is described as biodegradable does not mean that it should be freely released into the environment in an uncontrolled manner. The speed, method and nature of biodegradation differs between materials and users should question the behaviour of biodegradable materials before using them in any application.

## Compostable

Can meet EN13432 or a comparable standard for compostable packaging so that the material decomposes/ biodegrades in industrial composting conditions. Materials that meet an appropriate home composting standard can be composted in home composting systems.

It can have similar strength, plasticity and elasticity properties to non-biodegradable plastics and can be made into products using the same technologies (e.g. film processing or moulding).

*Importantly, not all biodegradable plastic is compostable, but all compostable plastic is biodegradable.*

# Suitability for recycling

The way a plastic is designed to behave dictates its suitability for recycling – not whether it is fossil-based or bio-based.

## Non-biodegradable

**Non-biodegradable** packaging plastics can be recycled, if collected and sorted into separate material reprocessing streams.

The route for recycling or disposal must not compromise other recycling routes. Non-biodegradable plastics entering the composting processes can contaminate the final product.

## Biodegradable

Currently **biodegradable** plastics cannot be recycled in the same way as non-biodegradable plastic.

It **must** be separated from non-biodegradable plastic streams and dealt with separately. If not, it causes problems during the recycling process.

**Biodegradable** packaging needs to be clearly labelled and easy for citizens to identify, separate and correctly dispose of. The route for treatment and disposal must not compromise other existing recycling routes. Biodegradable packaging can only be composted when it meets the appropriate composting standard.

## Compostable

**Compostable** plastics can be composted at industrial scale composting facilities or, in some cases, may be suitable for home composting. It is vital that only compostable plastics are sent to these routes as non-compostable plastics can contaminate the final compost produced.

**Compostable** plastic packaging needs to be clearly labelled and easy for citizens to identify, separate and correctly dispose of in an appropriate collection and recycling scheme for compostable plastics. The route for recycling compostable packaging must not compromise non-biodegradable recycling routes.

# UK treatment and disposal routes

	Non-biodegradable	Biodegradable	Compostable
Recycling	✓	✗	✗
Energy from waste	✓	✓	✓
Landfill	✓	✓	✓
AD	✗ <sup>*</sup>	✗ <sup>*</sup>	✗ <sup>+++</sup>
Composting	✗	✗ <sup>**</sup>	✓

*\* Any non-biodegradable, biodegradable or compostable packaging sent to wet AD systems that do not include a composting step for the treatment of digestate in the UK will be removed during pre-treatment of the feedstock material and sent to landfill or energy from waste.*

*\*\* Plastic packaging can only go to industrial composting if it complies with the EN13432 compostable standard or a recognised home composting specification. It can only be composted at home if it complies with a recognised home composting specification.*

*++ Compostable packaging can be accepted at dry AD systems that can process the material fully or at wet AD sites where the process includes a composting step for the treatment of the separated digestate fibre.*

# Environmental impact

Any plastic that evades appropriate collection and treatment that escapes into the environment has the potential to have a long-lasting impact on the environment.

## Non-biodegradable plastic packaging

Conventional plastic debris has been shown to accumulate in inland waters and marine environments. The impact of this is now being widely discussed.

There is very limited information on the impact of conventional plastic in soil-based environments, though it is clear that plastic fragments will persist for long periods of time.

## Biodegradable and compostable plastic packaging

There is a lack of clarity concerning standards that define the biodegradability of biodegradable or compostable plastics in any environment. There is a particular lack of evidence on the behaviour of these materials in water, and there is a need to understand biodegradation at lower temperatures. Therefore, it is very difficult to accurately assess environmental impact of biodegradable and compostable plastic packaging.





# Carbon footprint over life cycle

Life Cycle Assessment is a complex technique to quantify the environmental impact of a single product over its whole life cycle.

For greenhouse gas emissions from all types of plastic, studies show that raw material extraction, production, and waste disposal contribute most to emissions. Bio-based plastics usually have a lower carbon impact in their extraction and production phase.

Where conventional plastics enter energy from waste facilities, they emit greenhouse gases, which can be higher than combusting coal or natural gas to generate the same amount of energy. In landfill they are considered inert.

The opposite is true for biodegradable plastics, which has the potential to give rise to methane under landfill conditions, but in energy recovery are considered carbon neutral (short cycle emissions).

Compostable plastics contribute to compost structure, but contain no nutrients (NPK).

**For all plastics, recycling generates the lowest emissions at end of life.**



# Glossary

## Biodegradable

A product that can be broken down by microorganisms (bacteria or fungi) into water, naturally occurring gases like carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) and biomass. Biodegradability depends strongly on the environmental conditions: temperature, presence of microorganisms, presence of oxygen and water. The biodegradability and the degradation rate of a biodegradable plastic product may be different in the soil, on the soil, in humid or dry climate, in surface water, in marine water, or in human made systems like home composting, industrial composting or anaerobic digestion ([www.ows.be](http://www.ows.be)).

## Compostable

Compostable materials are materials that break down at composting conditions. Industrial composting conditions require elevated temperature (55-60°C) combined with a high relative humidity and the presence of oxygen, and they are in fact the most optimal compared to other everyday biodegradation conditions: in soil, surface water and marine water. Compliance with EN 13432 is considered a good measure for industrial compostability of packaging materials.

## Home composting

Home composting creates conditions with much lower and less stable temperatures than industrial composting. There is no CEN standard for plastics that are suitable for home composting but several countries have developed and applied national standards for testing and certifying of home compostable materials.

## PBAT and PBS

Polybutylene adipate terephthalate and Polybutylene succinate – two biodegradable polyesters (Muthuraj et al 2014).

## Recycling

Material recycling is defined in European standard EN 13430 and EN 16848 (adapted from ISO 18604) as the reprocessing of a used product material into a new product. Plastic which after use can be collected, sorted and reprocessed into new products is called mechanical recycling. Another option is chemical recycling where materials are broken down to monomers which can be used again for the production of polymer.

## PE

Polyethylene – a type of resin and a polyolefin and one of the world's most widely produced synthetic plastic. High density PE is used for milk bottles, bleach, cleaners and most shampoo bottles. Low density PE is used for carrier bags, bin liners and packaging films (WRAP 2018).

## PHA

Polyhydroxyalkanoate – A naturally occurring family of biodegradable polyesters (NNFCC 2018).

## PLA

Polylactic acid – A biodegradable polyester produced from lactic acid, used in wide range of serviceware products and as filament for 3D printing (NNFCC 2018).

Industry example: PG Tips is using PLA for their tea bags (NNFCC 2018).

## Glossary

### PP

Polypropylene – a recyclable polyolefin that is commonly used for margarine tubs, microwaveable meal trays, also produced as fibres and filaments for carpets, wall coverings and vehicle upholstery (WRAP 2018).

### PTT

Polytrimethylene terephthalate is a type of polyester that differs from the common one polyethylene terephthalate (PET) as it contains one more methylene group in the aliphatic chain that links the terephthalic moiety (European Commission Joint Research Centre 2013).

### PET

Polyethylene terephthalate is a type of resin and a form of polyester; it is commonly labelled with the code on or near the bottom of bottles and other containers. PET has some important characteristics such its strength, thermo-stability, gas barrier properties and transparency. It is also lightweight, shatter-resistant and recyclable (WRAP 2018).

### PA

Polyamides (Nylon) comprise the largest family of engineering plastics with a very wide range of applications. Polyamides are one of the major engineering and high performance plastics because of their good balance of properties. Polyamides are very resistant to wear and abrasion, have good mechanical properties even at elevated temperatures, have low permeability to gases and have good chemical resistance, good dimensional stability, good toughness, high strength, high impact resistance, good flow.

### Starch blends

The majority of bio-based plastics are currently manufactured using starch as a feedstock (c.a. 80% of current bio-based plastics). The current major sources of this starch are maize, potatoes and cassava. Other potential sources include arrowroot, barley, some varieties of liana, millet, oats, rice, sago, sorghum, sweet potato, taro and wheat (BPF 2018).

### PLC

Polycaprolactone is a biodegradable polymer that is suitable for applications requiring years of stability. In recent years it is becoming of increased interest to manufacturers of medical devices and drug delivery particles (polysciences.com 2018).

# References

Defra (2015) 'Review of the standards for biodegradable plastic carrier bags'. Available at: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/485904/carrier-bag-biodegradable-report-2015.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/485904/carrier-bag-biodegradable-report-2015.pdf) (Downloaded on the 26/01/2018).

PAS600:2013 Bio-based products. Guide to standards and claims <https://shop.bsigroup.com/ProductDetail/?pid=000000000030262005>

DEFRA (2011) study on plastic bags can be found here and a figure illustrating the global warming potential of each type of bag included in that study is included at the end of this table. (Defra [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/485904/carrier-bag-biodegradable-report-2015.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/485904/carrier-bag-biodegradable-report-2015.pdf))

WRAP (2010) Environmental Benefits of Recycling 2010 update <http://www.wrap.org.uk/content/environmental-benefits-recycling>

WRAP (2010) Life cycle assessment of example packaging systems for milk <http://www.wrap.org.uk/sites/files/wrap/Final%20Report%20Retail%202010.pdf>

Umweltbundesamt (German Federal Environment Agency) (2013) Study of the Environmental Impacts of Packagings Made of Biodegradable Plastics <https://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/4446.pdf>

Piemonte, Vincenzo & Gironi, Fausto. (2012). Bioplastics and GHGs saving: The land use change (LUC) emissions issue. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*. 34. 1995-2003. 10.1080/15567036.2010.497797.

Bioplastics diagram based on the European Bioplastics version <https://www.european-bioplastics.org/bioplastics/materials/>

Wageningen Food & Biobased Research (2017): *Biobased and biodegradable plastics – Facts and Figures* – see link below [https://www.wur.nl/upload\\_mm/e/6/8/113a1607-0925-4829-b864-f0e6a5fc79c5\\_170419%20Report%20Bio-based%20Plastic%20Facts.pdf](https://www.wur.nl/upload_mm/e/6/8/113a1607-0925-4829-b864-f0e6a5fc79c5_170419%20Report%20Bio-based%20Plastic%20Facts.pdf)

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