Plastic Recycling Factsheet

EuRIC AISBL – Recycling: Bridging Circular Economy & Climate Policy

01

Introduction

02

Plastics and its uses

03

Plastics Recycling Industry – Current status and challenges

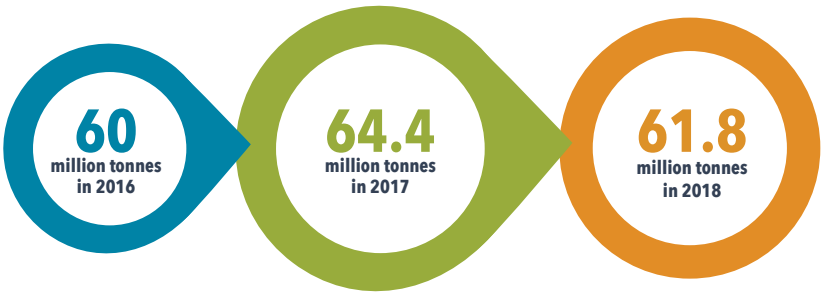
04

How to further promote plastics recycling in Europe

01 Introduction
Moving towards a circular economy for plastics

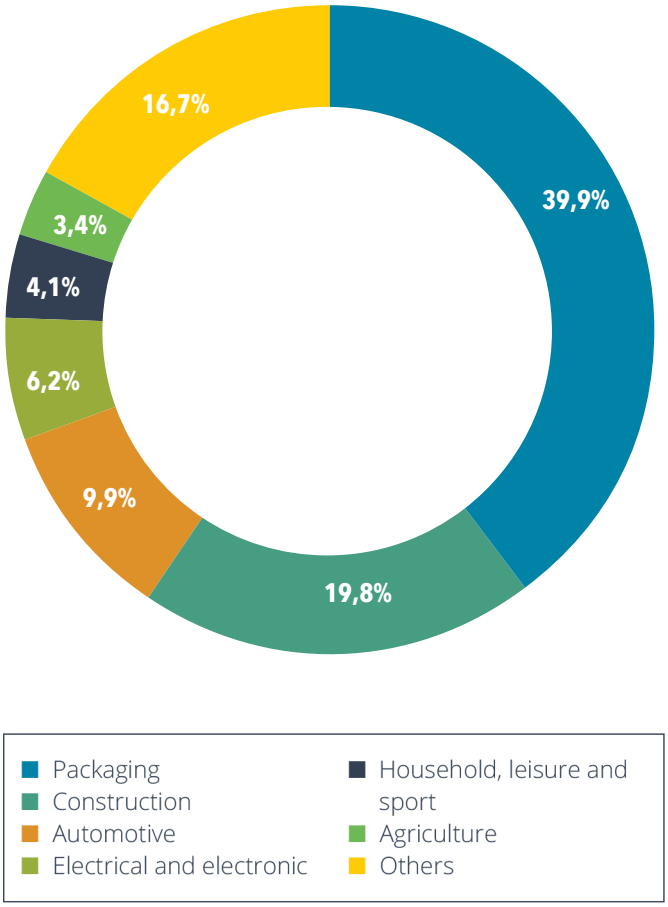
Annual global plastic production has increased from 2 to 380 million tonnes since 1950 and is projected to double by 2035 and almost to quadruple by 2050[1,2]. In addition, global consumption of plastics has increased more than 20 times in the last 50 years, and it is estimated to double again by 2034 if action is not taken[3].

European plastics production[4,5]



Despite Europe is one of the most advanced regions regarding plastics collection and recycling, recycling rate is still at 30%[3]. European countries lack the capacity to manage increasing amounts of plastic waste in circular and sustainable ways[1].

European plastics demand in 2018[5]



Main challenges to increase plastics recycling capacity across Europe

- Need for **recycled content targets** to pull end-markets for recycled plastics.
- Lack of **market and fiscal-based incentives** rewarding the significant environmental and social benefits of the recycling activity, be it in terms of energy & Greenhouse Gas (GHG) emissions savings or job creation in Europe.
- Lack of **financial resources** to improve the overall waste management infrastructure.
- Insufficient implementation of **strict separate collection obligations** to increase plastics' quality.
- Insufficient harmonization of the **legislative framework** to boost the implementation of targets for recycling and recycled content, to control and restrict **illegal waste exports to countries lacking infrastructure for proper treatment** and further **contribute to products eco-design** .
- Utmost need to **improve design for recycling** for all products made of or incorporating plastics.
- **Lack of interface between waste and chemicals legislation, with substances of concern** posing a systemic problem to a proper assessment of safe plastics recycling streams, taking into consideration actual risks based on suitable end-uses.

Plastics & Circular Economy

From the 30 million tonnes of plastic collected in 2016 in Europe, 8.4 million tonnes (27.9%) were recycled, while 3.1 million tonnes (10.3%) were exported outside Europe, 11.3 million tonnes (37.3%) were used for energy recovery, and 7.4 million tonnes (24.5%) were disposed in landfills[3].

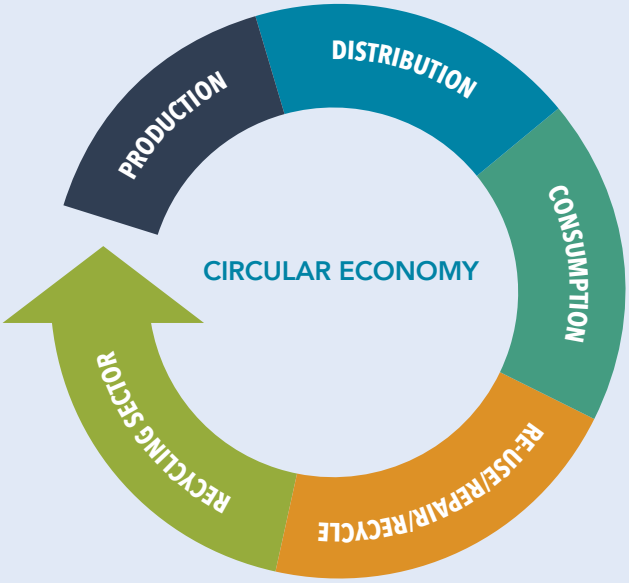
Plastics represent a serious waste-handling problem with only 10% of the plastic waste generated worldwide being recycled. The remainder follows a **linear economy** model, involving disposal or incineration[6].

LINEAR ECONOMY

Plastics recycling is instrumental to close the loop of the **circular economy** by re-introducing into the economy high-quality plastic recyclates incorporated into new products.

Plastics sector and the circular economy - Key benefits [7]

- Increased recycling rates
- Decrease the use of natural resources
- Reduce CO_2 emissions
- Controlled exports
- Stable markets

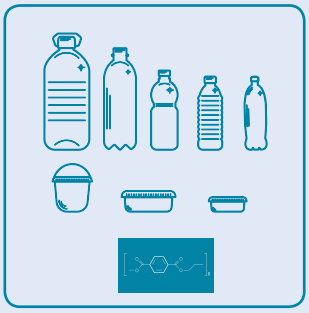


02 Plastics and its uses
2.1 Commodity plastics

Not all the plastics are equally recycled. It will depend not only on its characteristics but also on the additives that are contained in those plastics (e.g., chemicals, fibres, etc). Furthermore, collection processes are one of the main limiting factors to further increase the amount of plastics that can be recycled. The most common commodity resins and recyclability challenges associated to them are[8,9,10]:

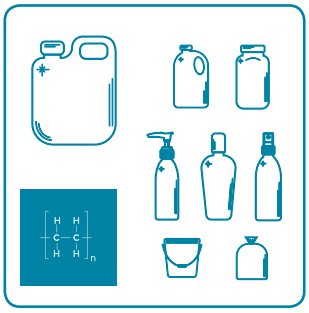
POLYETHYLENE TEREPHTALATE (PET/PETE)

- PET is a dimensionally stable thermoplastic with excellent machining characteristics. It is clear, tough and solvent resistant. Commonly present in: beverage bottles, microwavable trays, and fibres for clothing.
- PET items are highly recyclable, however, proper collection is instrumental to avoid cross-contamination from other materials (e.g., colorants).



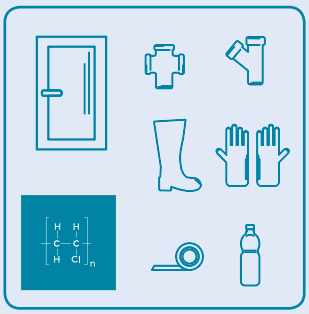
HIGH-DENSITY POLYETHYLENE (HDPE)

- HDPE is a versatile, high-impact, lightweight thermoplastic with an excellent chemical resistance and high tensile strength. Commonly present in: milk and detergent bottles, plastic bags, toys, pipes and furniture.
- Although HDPE is highly recyclable, only 10-15% is recycled in Europe as, due to its softness, it needs to be sorted from harder fractions of plastics before treatment.



VINYL/POLYVINYL CHLORIDE (V/PVC)

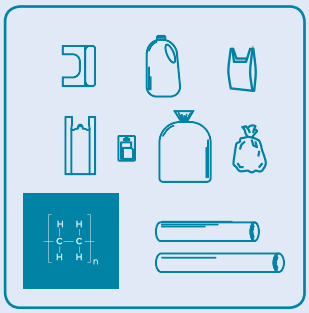
- High corrosion resistant plastic, hard, rigid, can be clear, can be solvent welded. Commonly present in: blister pack/clamshell packaging, shampoo bottles, meat packaging, cables, inflatable pools, and window frames.
- Easy to separate by conventional processes, however recycling is limited due to the presence of some additives (e.g., chlorine, cadmium, lead).



4
LDPE

LOW-DENSITY POLYETHYLENE (LDPE)

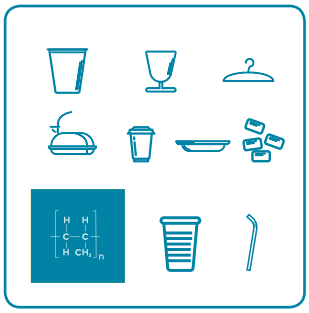
- Soft flexible plastic with excellent abrasion, chemical and impact resistance. Commonly present in: squeezable bottles, shrink wrap, bread bags, frozen food bags, wire and cable applications.
- Generally recyclable however, due to its softness, it needs to be previously sorted from harder fractions of plastics and treated in adequate recycling processes.



5
PP

POLYPROPYLENE (PP)

- It is an economical, lightweight thermoplastic that offers high corrosion, abrasion and impact resistance. Commonly present in: yogurt and margarine containers, bottle caps, ketchup bottles, food packaging, reusable containers and plant pots.
- PP items are highly recyclable, however recycling is limited due to difficulties in collection, contamination and mixture with other materials (e.g., colorants).



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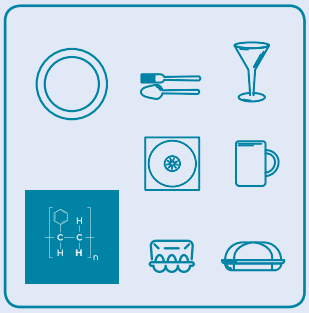
PS/EPS

POLYSTYRENE (PS) AND EXPANDED POLYSTYRENE (EPS)

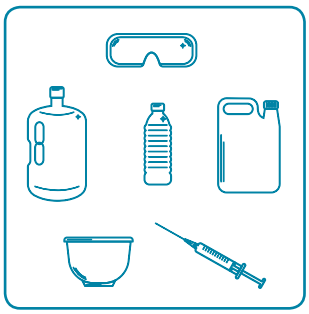
- While PS is clear, glassy, rigid, brittle, opaque and melts at 95°C, EPS is foamed, lightweight, energy absorbing and heat insulating. Commonly present in: meat/poultry trays, plastic foam cups/plates, CD cases, plastic cutlery, eyeglasses frames, video and CD cases, and egg boxes.
- Generally recyclable, however its low density makes it difficult to process through conventional recycling processes.



OTHERS

MISCELLANEOUS PLASTICS

- Other plastics such as bioplastics or plastics formed by a combination of resins or multi materials of unknown composition (e.g., oven baking bags, some reusable water bottles, plastics for automotive, aircraft, medical parts, etc.).
- Rarely recycled as they are not compatible with conventional recycling processes due to the variability of its properties.



2.2 Plastics for packaging

Plastics for packaging help to keep the content of the packaging safe and prevent it from contamination, particularly when talking about food packaging. They are mainly consumed for:

FOOD PACKAGING

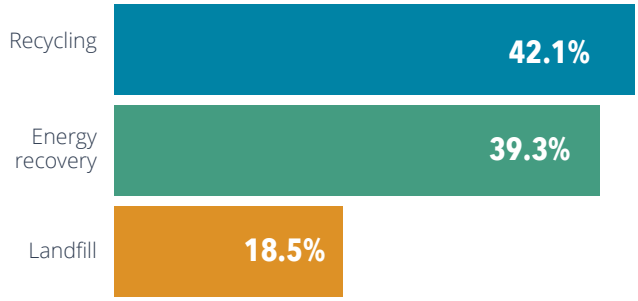
GOODS SAFETY AND TRANSPORT

Most of those items have been designed to be used only once - Single Use Plastics -

Plastics for packaging is a priority area when it comes to design for recyclability. Today they account for about 60% of post-consumer plastic waste[12].

Between 2006 and 2018, the quantity of plastic packaging waste has increased by 19% in Europe, from 14.9 million tonnes to 17.8 million tonnes[5]. Ranging between 26-52%, more than half of the countries in Europe have plastic packaging recycling rates above 40%. Czechia, Spain and Netherlands are on the top of the list with rates close to 50%[5].

Recycling is the first option for packaging waste in Europe[5]



Since 2006[5]...

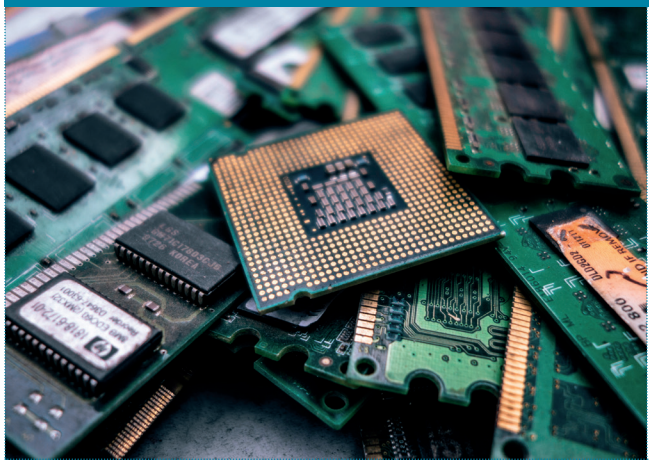
- Recycling of plastic waste from packaging has increased by 92%.
- Energy recovery from plastic packaging waste has increased by 84%.
- Landfilling of plastic packaging waste has decreased by 54%.

2.3 Engineering plastics

Engineering plastics are designed to provide better mechanical and thermal properties than the commodity plastics (presented before). They are mostly used for the automotive and by electrical and electronic equipment (EEE) sectors.

AUTOMOTIVE AND TRANSPORT SECTOR

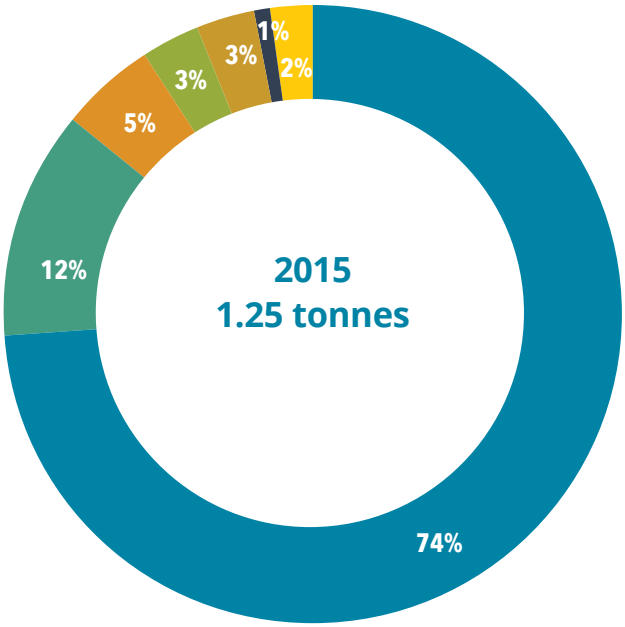
EEE SECTOR



Use of plastics in the automotive and EEE sector in the past few decades has increased sharply. Thanks to their **improved properties**, namely, abrasion resistance, chemical resistance, impact strength, electrical properties, and operating temperature amongst others, engineering plastics contribute significantly to innovation in the automotive and the EEE sectors.

Plastic is the second most commonly-used material in vehicles after metals[13,14,15]

- Roughly 50% of the volume of modern cars is made of plastic.
- Plastics represent 12-17% of the vehicle weight (over 150-200 kg).
- It is expected that by 2020, 18% of a vehicle's weight will be made up of plastics.
- The fraction of recycled plastics used in modern cars can achieve up to 26.2 kg per car.



- Metals
- Polymers
- Elastomers
- Glass/Ceramic
- Liquids
- Natural materials
- Other

Engineering plastics can help lowering the overall weight of a vehicle

Reducing vehicle weight by 10% (i.e., around 0.1 tonnes), improves fuel efficiency by 6-8%, and reduces GHG emissions by the equivalent of combusting more than 2.7 million gallons of gasoline over the life of the vehicle[14]. Furthermore, lowering the overall weight of a vehicle by 10 kg can cut CO_2 emissions by 1 g/km[16].

Types of engineering plastics[17,18,19,20]

PUR/PU

Polyurethane is a highly versatile plastic material commonly used in the automobile industry (e.g., seat cushions) to reduce vehicle weight improving fuel efficiency. Its excellent sound-absorbing, vibration-dampening and shock-absorption qualities contribute to higher comfort and safety levels.

ABS

Is a thermoplastic copolymerisate made from **acrylonitrile**, **butadiene** and **styrene** monomers. Harder than PET but with lower thermal stability, shows very good electrical insulating properties. Mostly used in handle elements in automotive industry.

PC

Besides their properties to be easily worked, molded and thermoformed, **polycarbonates** are characterized by high strength, rigidity and hardness. In contrast to their low chemical resistance, they are very resistant to weather and UV radiation. Some PC grades are highly transparent and therefore suitable to be used in optical components, CDs and DVDs, lenses, safety screens, solar panels, and aircraft windows.

PA

Polyamides are amongst the most important technical thermoplastics, far better known by its trade name **nylon**. They are conventionally used in mechanical applications under high toughness and abrasion resistance, such as sliding materials and large scale gears. PA components ensure smooth, low-noise, low-vibration running.

PBT

Polybutylene terephthalate can be extensively modified to make it suitable for an enormous variety of electrical and electronic applications. It offers stiffness, toughness, heat resistance, electrical insulation, friction and wear resistance, and excellent surface finishes.

There is a great potential for the recycling of engineering plastics…

- Between 2000 and 2008 the demand for polymers used in the EEE sector has been growing annually by 0.1 million tonnes. Today, the European demand in this sector exceeds 3 million tonnes[4].
- Engineering plastics today are the third most widely used material (16.1%), after packaging (39.9%) and building & construction applications (19.8%)[5].
- The use of technical plastics in the automotive sector in Europe has doubled in the last 20 years[7,14].
- In 2020, produced engineering plastics from recycling End-of-Life (EoL) products (i.e., automotive and EEE) is projected to increase to up to 2.5 million tonnes in Europe, while projected engineering plastics demand for the same year will reach close to 2.8 million tonnes[21].
- In 2016, Europe generated 6.4 million tonnes of End-of-Life vehicles (ELV), which accounts for at least 645,000 tonnes of plastic waste[2].
- The natural resources needed to produce automotive plastics represent 0.3% of global oil consumption[16].
- The amount of plastic waste collected from Waste Electrical and Electronic Equipment (WEEE) (households appliances) in Europe in 2015 was about 0.36 million tonnes[1].
- Out of 1.2 million tons of plastic collected from WEEE, 75% is exported and roughly 0.3 million tonnes are handled by specialized recycling facilities in Europe[21].

However, the lack of design for recycling coupled with the use of additives render engineering plastics' recycling complex. Hence, state-of-the-art processes are needed to produce high-quality recycled polymers.

2.4 Plastics from construction and demolition

Construction and demolition waste in Europe[29,30]:

- Is the most significant waste stream accounting for over 350 million tonnes/year.
- Consists of various materials, including concrete, bricks, gypsum, wood, glass, metals, **plastic**, solvents, hazardous substances (e.g., asbestos, PCBs, etc.) and excavated soil.
- Has a high potential for re-use and recycling, since plastics have a high resource value and/or can be readily recycled.

Despite plastics in construction and demolition waste represent less that 0.5%, they account for 1.7 million tonnes from which only a 26% it is recycled.

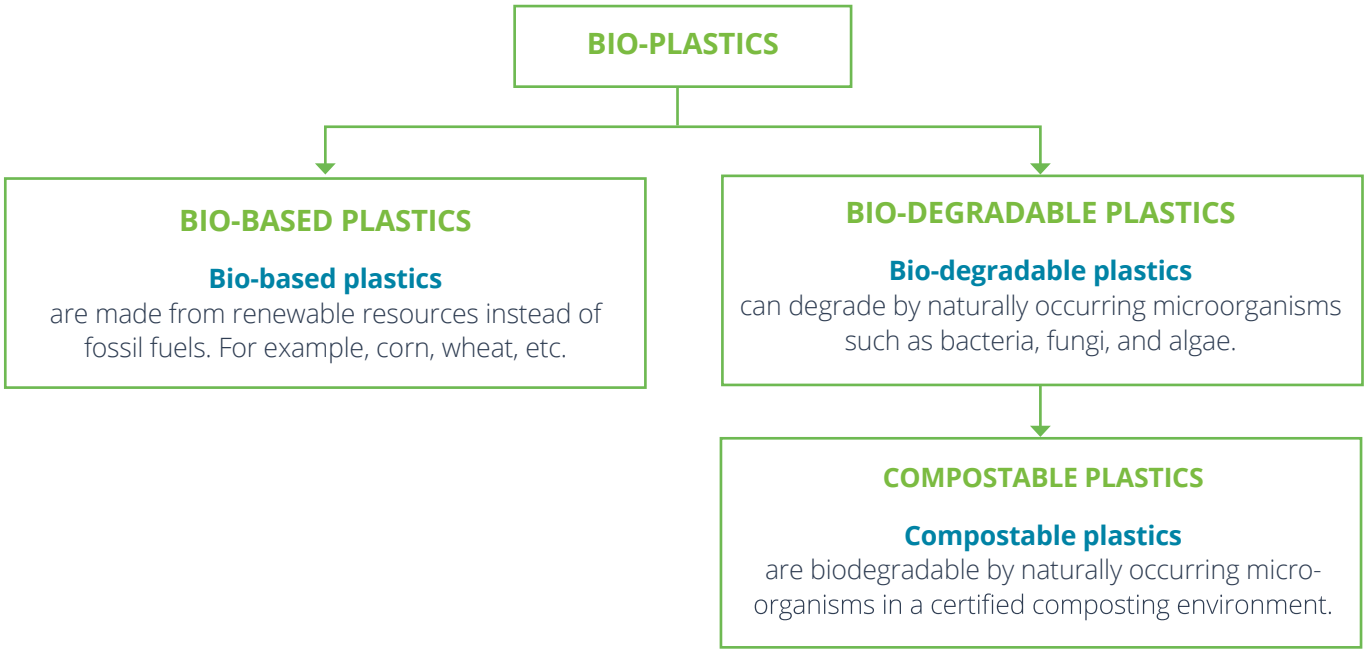
Building & construction post consumer plastic waste generation EU 28+2 in 2018 (in thousand tonnes)[31]:

Type of plastic	Total waste generation	Total recovery	Total recovery	
			Mechanical Recycling (%)	Energy recovery (%)
LDPE	90	70	27	51
HDPE	225	164	24	49
PP	130	95	23	50
PS	30	21	7	64
EPS	140	95	9	59
PVC	910	683	34	41
Miscellaneous	235	172	7.5	65.5
Total	1,760	1,300	25	47.5

Recovered plastic can be used back in construction or in many other applications.

2.5 Bio-plastics

The presence of bio-plastics in the market is growing led by the increasing demand for sustainable products by consumers and brands. Yet bio-plastics can raise major issues for recycling or composting and are not the most sustainable solution. Based on their characteristics, bio-plastics can be classified into the following main groups:

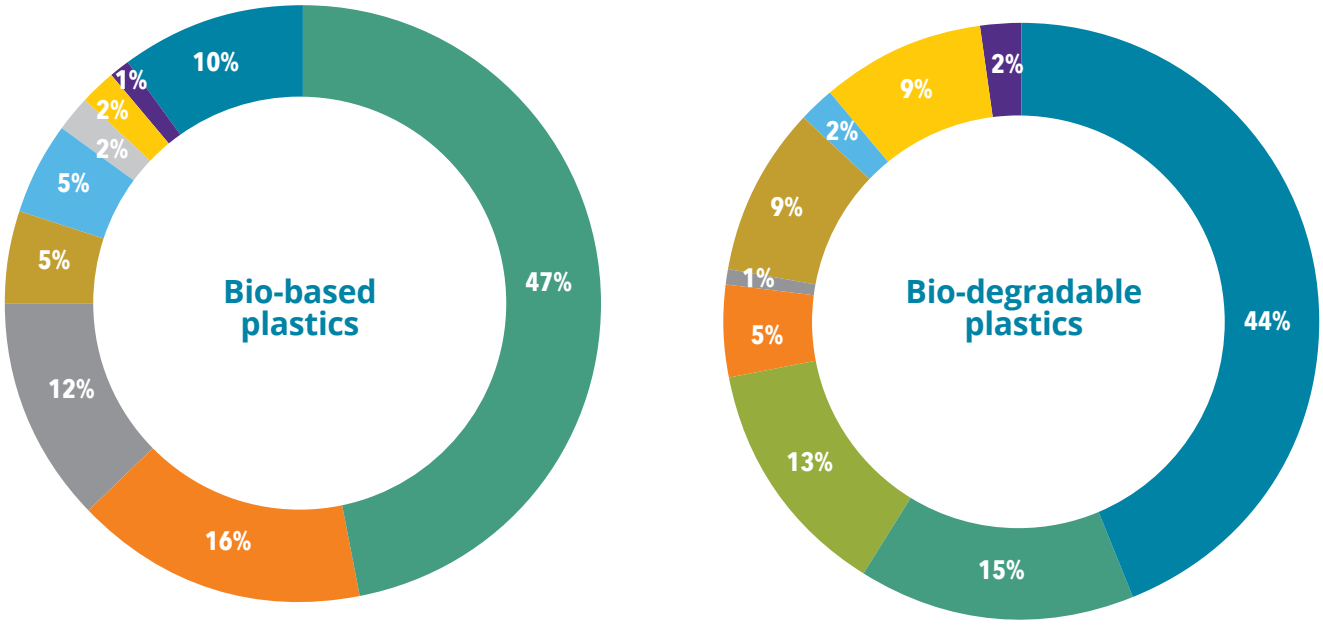


- While the majority of **bio-based plastics** are **recyclable** by conventional processes, **bio-degradable and compostable plastics** are mostly **non-recyclable**, thus providing no added value in a circular economy and conventionally sent to landfilling or incineration processes.
- **Bio-based plastics** does not necessarily mean the product is **bio-degradable** or **compostable**

Currently, bio-plastics (incl. bio-based and bio-degradable) represent about 1% of the close to 380 million tonnes of global plastic produced annually[23,24] and are predicted to grow by more than 15% over the next five years[25]. Asia is the major productor of bio-plastics, with a share of more than 50% in 2018[26]. Despite the European market for bioplastics is currently limited by the lack of economic and policy measures[26], its share is predicted to grow up to 30% by 2024[25].

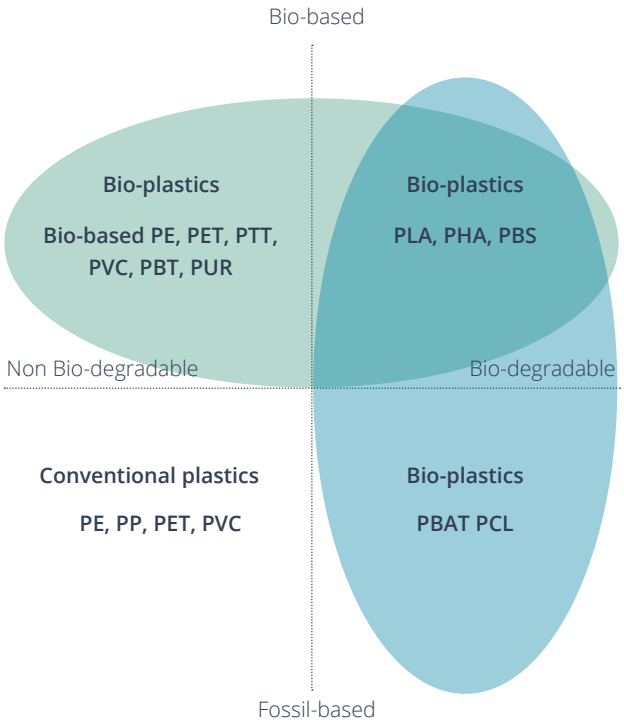
Furthermore, although the predicted market growth, the land use share for bio-plastics will remain at only around 0.02% (4.8 billion hectares), which indicates there is no competition between renewable feedstock for food and the production of bio-plastics[25].

Main uses of bio-plastics (2018)[26]



Bio-degradable and compostable plastics do not contribute to a circular economy and their presence in the plastics stream **can harm the recycling process**, therefore, they need to be sorted out in advance. On the other hand, **bio-based plastics** that can be mechanically recycled contribute to[24]:

- **Saving fossil fuels** by counting on renewable feedstock (e.g., corn and sugar beets, castor oil plants, switch grass, or perennial cultures, such as cassava and sugar cane).
- **Reducing the dependence on volatile energy markets**, as bio-based plastics are not affected by oil price volatility.
- **Reducing GHG emissions** due to plant CO_2 absorption as they grow.



Standards and Certifications of Bio-plastics[27,28]

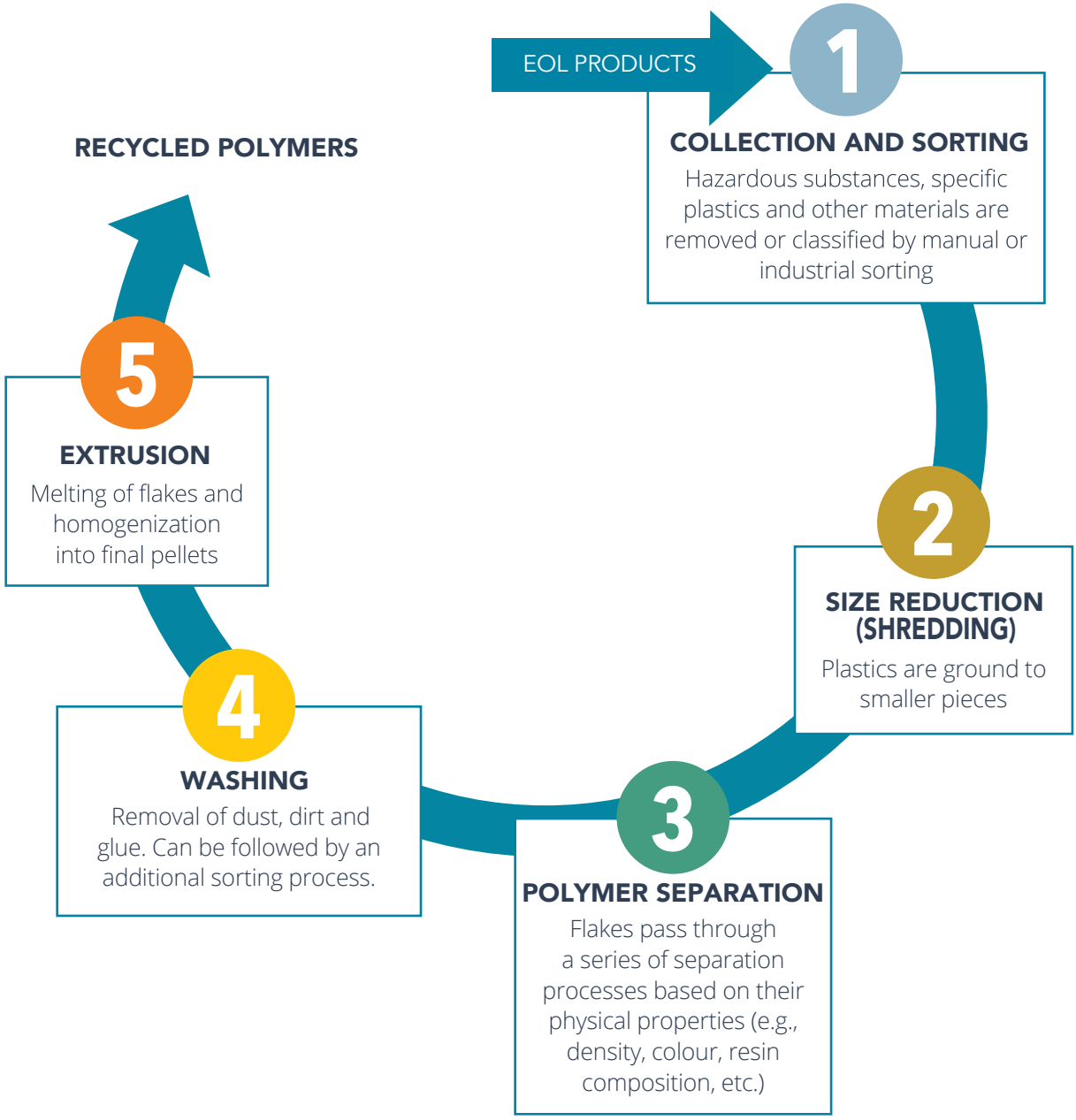
In addition, due to the similar appearance of bio-plastic products and conventional plastic items, they cannot be easily differentiated by the consumer. Standardized indicators and certification labels have been developed to give consumers transparent information:

TYPE	INDICATOR	CERTIFICATION
BIO-BASED	**Bio-based carbon content** EN 16640 - Bio-based products – Determination of the bio-based carbon content. **Bio-based mass content** – Complementary to 14C-method. EN 16785 - Bio-based products – Bio-based content.	Belgian Certifier Vinçotte German Certifier DIN CERTCO
BIO-DEGRADABLE	**No standard available specifying the specifying the degradability conditions** for bio-degradable plastics – further information about the timeframe and level of degradation must be specified.	Belgian Certifier Vinçotte In soil Marine German Certifier DIN CERTCO In soil
COMPOSTABLE	ISO 17088 – Specifications for compostable plastics. EN13432 – Requirements for packaging recoverable through composting and biodegradation. EN 13432 - Packaging. EN 14995 - Plastics. ASTM D6400 - Standard specifications for labeling of plastics designed to be aerobically composted in municipal or industrial facilities. ASTM D6868 - Standard specifications for biodegradable plastics used as coatings on paper and other compostable substrates.	Belgian Certifier Vinçotte German Certifier DIN CERTCO

03 Plastics Recycling Industry – Current status and challenges

3.1 The plastics recycling process

A summarized scheme of the plastics recycling process is represented below. When considering the recyclability of plastics, **separated collection** of different plastic categories reduces complexity of the plastic mixtures, leading to higher output qualities.



3.2 Environmental benefits[5,32,33,34,35]

- Recycling one tonne of plastics can avoid the emissions of 2.5 tonnes of CO_2 when produced from virgin materials, and 2.7 tonnes of CO_2 emissions if incinerated.
- PET recycling saves 83% of energy and 70% of CO_2 emissions compared to PET produced from virgin materials.
- For each tonne of PVC recycled, two tonnes of CO_2 are saved. Indeed, in 2018, 740,000 tonnes of PVC waste recycled contributed to save 1.5 million tonnes of CO_2 going into the atmosphere.
- The energy demand from recycled PVC is typically between 45% to 90% lower compared to its production from virgin materials.
- Since 2006, the amount of plastic waste sent to recycling has doubled. Particularly, between 2016 and 2018. However, over 25% of plastic post-consumer waste was still sent to landfill in 2018.

3.3. Economic importance[5,12,33,36,37]

- While plastics production from primary sources in Europe has decreased from 2016 to 2018 by 13%, plastics recycling has increased by 4.8%. For example, in 2018 around 740,000 tonnes of PVC were recycled in Europe, 15.6% more than in 2017, and it is expected to increase close to 800,000 tonnes by 2020.
- The 740,000 tonnes of PVC recycled in 2018 contributed to the creation of more than 1,500 direct jobs in recycling plants in Europe. By 2030, sorting and recycling capacity in the European recycling industry is expected to significantly increase, leading to the creation of 200,000 new jobs.
- In 2015, the Commission proposed the target of recycling at least 55% of all plastics packaging in Europe. That means that more than 10 million tonnes of recycled material need to be absorbed by the end-markets. Compared to 2014, this corresponds to more than twice the amount of the total recycled material and to about one third of the plastic used in the different end-markets.

3.4 International trade[1,2,5]

- Plastic waste exports outside Europe have decreased by 39% from 2016 to 2018.
- From the 9.5 million tonnes collected in Europe to be recycled in 2018, 81% were recycled inside Europe, while 19% was exported and recycled outside Europe.
- In early 2019, Europe exported around 150,000 tonnes of plastic waste per month. This figure was about twice as high in 2015 and 2016 - up to 300,000 tons monthly - when exports went to China and Hong Kong primarily.
- Trade to China changed from almost zero in 2000 to slightly more than one million tonnes of plastic waste in 2017, but returned to very low levels in 2018 due to the ban implemented by the country on the import of plastic waste. The volumes of plastic waste exported to China and Hong Kong from Europe in 2018, were 96% and 73% lower respectively, compared to 2015, while the opposite occurred in other countries, with Turkey and Indonesia recording the most significant increases, 1,295% and 485% respectively.

04 How to further promote plastics recycling in Europe

4.1 European targets for plastic waste recycling

Revision of the Waste Framework Directive (WFD) (Directive 2008/98/EC)

The revision of the WFD includes the following targets for recycling:

- 50% municipal waste preparing for re-use/recycling target to be achieved by 2020.
- 55% municipal waste preparing for re-use/recycling target to be achieved by 2025.
- 60% municipal waste preparing for re-use/recycling target to be achieved by 2030.

Packaging and Packaging Waste Directive (PPWD) (Directive 94/62/EC – Amended by Directive EU/2018/852)

The amendment of the PPWD includes the following targets for recycling:

- By December 31st 2025 at least 65% weight of all packaging waste is recycled.
- By December 31st 2030 at least 70% weight of all packaging waste is recycled.
- By December 31st 2025 at least 50% weight of all plastic waste is recycled.
- By December 31st 2030 at least 55% weight of all plastic waste is recycled.

Single Use Plastics (SUP) Directive (Directive EU 2019/904)

Targets for recycled content for PET beverage bottles with a capacity of up to three litres (incl. caps and lids):

- From 2025, contain at least 25% recycled plastic.
- From 2030, contain at least 30% recycled plastic.

Member States shall take the necessary measures to ensure the separate collection for recycling of PET beverage bottles with a capacity of up to three litres (incl. caps and lids):

- By 2025, of an amount of waste SUP products equal to 77% of the amount placed on the market.
- By 2029, of an amount of waste SUP products equal to 90% of the amount placed on the market.

Declaration of the Circular Plastics Alliance (CPA)

The CPA endorses the ambitious target that by 2025 at least 10 million tonnes of recycled plastics should find their way into products in Europe each year.

Circular Economy Package

1) Proposal amending Directive 2008/98/EC

Key elements of the revised waste proposal include:

- A common European target for recycling 65% of municipal waste by 2030.
- A common European target for recycling 75% of packaging waste by 2030.

2) Extended Producer Responsibility (EPR) Schemes

EPR for packaging is a policy approach that extends the producer's responsibility for a manufactured product to also include its management after it has been used by consumers (incl. reuse and recycling).

3) European Strategy for Plastics in a Circular Economy

Fix a common European target for recycling 55% of plastic waste by 2025.

4.2 How to further enhance plastics recycling in Europe to promote the shift towards a circular economy

To support the increased inflow of materials to be recycled, **investments** are needed to improve the **waste management infrastructure.**

The control, traceability and substitution of substances of concern with **alternatives suitable for recycling** from plastic production, would contribute to **plastics circularity.**

A consistent legislative framework that ensures a **sustained demand for recycled material** by promoting the implementation of **targets for recycling and recycled content**, alongside with **product eco-design, while** controlling and **restricting landfill and incineration.**

Strict separate collection of plastics waste collection and improved sorting systems to boost **quality** and ultimately increase the **amount of recycled plastics in Europe.**

Pulling the demand for recycled polymers thanks to **recycled content targets** and **incentives rewarding recycling's environmental benefits** and **the use of recycled plastics in products.**

Reducing unprocessed plastic waste exports outside Europe, particularly to countries with less robust environmental protection systems, will contribute to keep the **circularity of those plastics within Europe** while **protecting the global environment** and reducing negative climate impacts. Additionally, having clear categories distinguishing **green listed plastic waste** from non-green listed falling under the Basel Convention, will help to preserve legal certainty of plastic waste shipments for recovery purposes.

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