Briefing
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European Parliament

Plastics in a circular economy
Opportunities and challenges

SUMMARY

Plastics pervade modern life; plastics production has been growing exponentially since the 1960s and is expected to double by 2036. Although there are over 1 000 types of plastic, 90 % of plastics are derived from virgin fossil fuels.

In Europe, post-consumer plastic waste is either incinerated with energy recovery (39 %), landfilled (31 %) or recycled (30%). It is estimated that half of the plastic waste recycled is treated in the EU, while the other half is exported for recycling.

The production and consumption of plastics today offer a series of benefits (in particular low production costs, durability and versatility) but also pose a number of problems (in particular loss of material value as a result of single use and low recycling rates, as well as ill-effects on nature, climate and human health). Marine litter and microplastics are a source of particular concern.

Several pieces of EU legislation apply to plastics and plastic waste, although implementation is incomplete. In 2015, the Commission identified plastics as one of the priority areas of the circular economy action plan, proposed new reuse and recycling targets for plastic packaging waste and pledged to adopt a strategy on plastics in the circular economy by the end of 2017.

A circular economy implies reducing waste to a minimum. Moving the plastics value chain in this direction would mean improving recycling, promoting reuse, and redesigning products, while taking into account the whole life-cycle of products. Although this could deliver opportunities (in particular enhanced security of supply, economic benefits and reduced pressure on the environment) there are also challenges (in particular weak economic incentives, technical issues and finance).

The European Parliament recognises the need to introduce specific measures on plastic waste in EU legislation and to value plastics as a resource.

Empty plastic bottles.

In this briefing:

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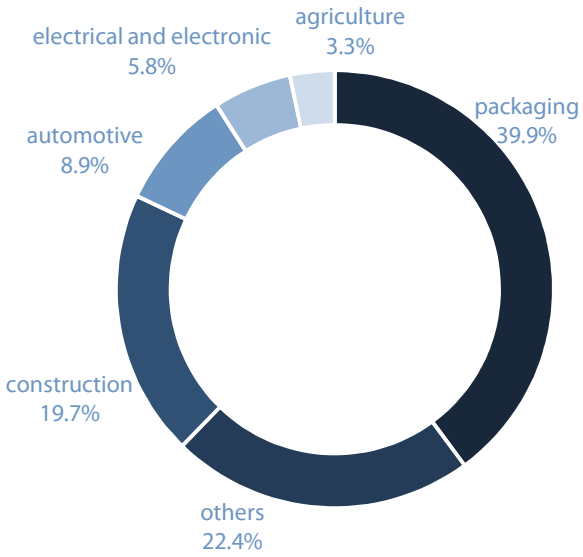
Background

Since they first entered industrial production in 1907, plastics have pervaded consumer goods and modern life. In 2014, 311 million tonnes of plastics were produced globally, 20 times more than in 1964. Plastics production is forecast to double by 2036 and almost quadruple by 2050. Demand for plastics in Europe was 49 million tonnes in 2015, with almost 40 % used in packaging (see Figure 1).

Industry figures indicate that the EU plastics sector (raw material producers, product manufacturers and machinery producers) employed 1.5 million people and generated a turnover of €340 billion in 2015. However, although plastics production in the EU has been stable in recent years, its share of the global market is decreasing.

Figure 1 – Plastics demand by sector (2015)



Data source: Plastics Europe, 2016. Data refer to EU-28, Norway and Switzerland.

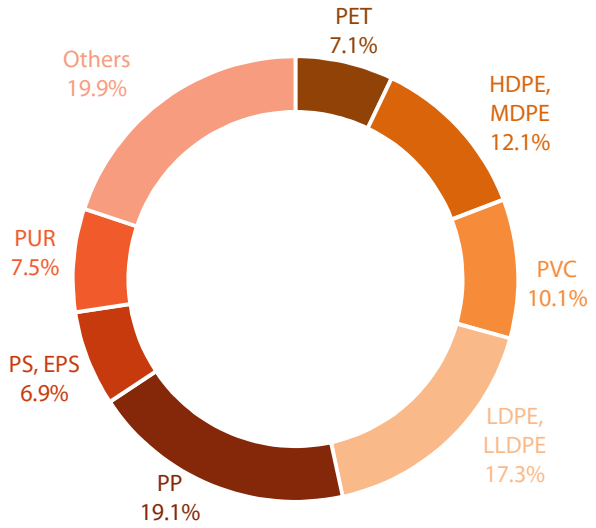
Plastics are derived from organic materials such as fossil fuels or cellulose. The two main processes used to produce plastics are polymerisation and polycondensation, both requiring specific catalysts. A 2016 report by the Ellen MacArthur Foundation, an organisation promoting the circular economy, indicates that 90 % of plastics are derived from virgin fossil fuels (representing about 6 % of global oil consumption) and predicts that the plastics sector will account for 20 % of total oil consumption by 2050.

Figure 2 – Examples of how the most common polymer types are used

Symbol	Polymer type	Examples of applications
1	PET polyethylene terephthalate	Soft drink and water bottles, salad trays.
2	HDPE high density polyethylene	Milk bottles, shampoo bottles, toys, houseware.
3	PVC polyvinyl chloride	Window frames, floor coverings, pipes, cable insulation.
4	LDPE low density polyethylene	Carrier bags, bin liners, packaging films.
5	PP polypropylene	Microwave-proof containers, automotive parts, food packaging.
6	PS polystyrene	Yoghurt pots, insulating packaging and building materials, plastic cutlery, protective packaging for consumer goods.
7	PUR polyurethane	Building insulation, pillows and mattresses, insulating foams.
7	other	Hub caps (ABS); optical fibres (PBT); eyeglasses lenses (PC); touch screens (PMMA); cable coating in telecommunications (PTFE); other applications in aerospace, medical implants, surgical devices, membranes, valves and seals, protective coatings, etc.

Sources: WRAP and Plastics Europe, 2016.

Figure 3 – Plastics demand by polymer (2015)



Data source: Plastics Europe, 2016. Data refer to EU-28, Norway and Switzerland.

There are thousands of types of plastic, commonly grouped into three broad categories: thermosets (hard and durable plastics used, for instance, in car parts), thermoplastics (easily moulded into packaging) and elastomers (soft plastics with rubber-like properties).[1] In 2015, polypropylene (PP) was the most used polymer in Europe (see Figure 3).

Industry figures indicate that in 2014, 25.8 million tonnes of post-consumer **plastic waste** was collected in the EU, Norway and Switzerland. Of this, 39.5 % was incinerated with energy recovery, 30.8 % was landfilled and 29.7 % was recycled, with large variations in plastic waste treatment methods among EU Member States.[2] In the past 10 years, the landfill share has declined while the share of energy recovery and recycling has increased.

Plastics **recycling** methods can be grouped into three broad categories:

- mechanical recycling in closed loops: these methods maintain the quality of materials (for instance recycling PET bottles into PET bottles) but require materials of like quality;
- mechanical recycling in open loops: these methods reduce the quality of materials (for instance turning PET bottles into fleeces or duvets); they are currently the most commonly used methods;
- chemical recycling: these methods involve breaking polymers down into monomers that can serve to produce new polymers; they remain little used, largely on account of the cost.

A significant share of **plastic waste** is **exported** outside the EU for treatment. A 2016 report for the European Commission estimates that about half of the plastics waste collected and recycled is treated in the EU, while the other half is exported, mainly to China. The Commission noted in 2013 that exports of plastic waste from the EU to third countries increased fivefold between 1999 and 2011. A 2014 report by the International Solid Waste Association notes that there is no conclusive evidence on the fate of plastics waste exported to China, where low-tech processes without environmental protection controls remain widespread in spite of recent investment.

The production and consumption of plastics today offer a series of benefits, but also pose a number of problems. The **benefits** of plastics stem mainly from their low production costs and undisputed functional properties such as durability and versatility. Plastic products contribute to quality of life in the modern world: plastic packaging preserves food and medicine, plastic is used to manufacture electronic devices and other consumer goods. As it is generally lighter than the alternatives, plastic can also help to reduce the greenhouse gas emissions from transport.

The **problems** posed by plastics production and consumption are twofold. First, material value may be lost as a result of single use and low recycling rates. This is especially true of plastic packaging: according to the 2016 report by the Ellen MacArthur foundation

mentioned above, 95 % of plastic packaging material value (about US$80-120 million annually) is lost after use. Second, plastics may have adverse effects on nature, the climate and human health, in particular because they can persist in the environment for hundreds of years. A 2014 report by the United Nations Environment Programme (UNEP) estimates that the environmental costs of plastics used in the consumer goods industry amount globally to over $75 billion annually and that 75 % of these environmental costs are generated at the manufacturing stage. Ecosystems, coastal and marine in particular, can be harmed by plastic litter (see text box for more details). The 2016 Ellen MacArthur foundation report notes that 390 million tonnes of carbon were emitted as part of plastics production (and consumption) in 2012, equivalent to about 1 % of the carbon budget, and that this share is expected to grow to 15 % by 2050 as a result of the projected increase in demand. There are concerns that some additives used in plastics, such as bisphenol A (BPA) or certain phthalates used in polyvinyl chloride (PVC), can have adverse effects on human health and the environment, mainly as a result of these substances being released from waste into the environment and subsequently transmitted to wildlife, with uncertainties about long-term exposure and cumulative effects. In addition, persistent organic pollutants can attach themselves to plastics in water and enter the food chain via marine fauna.

(Micro)plastics in the marine environment

About three quarters of the **marine litter** in the world's seas is plastic. Research published in 2015 suggests that, in 2010, 4.8 to 12.7 million tonnes of plastic, or 2 to 5 % of plastic waste generated, entered the oceans. A 2015 report by McKinsey, a consultancy, for the US-based NGO Ocean Conservancy estimates that there are now over 150 million tonnes of plastic in the seas, 20 % coming from ocean-based sources (such as fisheries), 60 % from uncollected waste or litter from land-based sources, and 20 % from collected plastic waste subsequently leaking into the ocean environment. It also notes that over half of global plastic marine litter from land-based sources originates in five Asian countries.[3] The 2016 Ellen MacArthur Foundation report estimates that without significant action, there may be more plastic than fish (by weight) in the sea by 2050. A 2014 study for the European Commission estimates that degradation as a result of marine litter costs the EU economy between €259 million and €695 million per year, affecting mainly the tourism and recreation sector (up to €630 million) and the fisheries sector (up to €62 million). Both sectors are also a source of marine litter.

Marine litter is made up, among other things, of **microplastics**, usually defined as pieces of plastic under 5mm across. Microplastics can originate from the degradation of larger plastic waste once exposed to the marine environment (so-called 'secondary microplastics') or be directly released in the environment as small particles (so-called 'primary microplastics'). Primary microplastics can be released intentionally (for instance when added as scrubbing agents in personal care products) or unintentionally (for instance through the abrasion of large plastic objects during manufacturing and use). A 2017 report by the International Union for the Conservation of Nature estimates that between 15 % and 31 % of microplastics (0.8 million to 2.5 million tonnes annually) could come from primary sources, and that primary microplastics come mainly from the laundering of synthetic textiles (35 %) and the abrasion of tyres while driving (28 %), with personal care products accounting for 2 %. Microplastics can be ingested by wildlife (for instance fish, shellfish and sea birds) potentially causing physical harm, affecting fertility and acting as a vector for toxins; microplastics can subsequently enter the food chain through seafood.

EU policy

Relevant legislation

Several pieces of EU legislation apply to plastics and plastic waste, including notably the following:

- **Waste Framework Directive**: this 2008 directive defines concepts relevant to the management of plastic waste, such as the 'waste hierarchy' (an ordered priority list of waste prevention and management options: 1) prevention, 2) preparation for re-use, 3) recycling, 4) (energy) recovery, and 5) disposal) and 'extended producer responsibility' (whereby producers take over the financial and/or organisational responsibility for collecting and taking back goods, as well as for sorting and treating them for recycling).
- **Directive on packaging and packaging waste**: this 1994 directive sets targets for the recycling of packaging waste, including plastic packaging (22.5 % of plastic packaging to be recycled back into plastics by 2008, except for Member States with a derogation).[4] The directive was amended in 2015 to require Member States to make sure that the annual per capita consumption of lightweight plastic carrier bags was reduced to 40 by 2025 and/or that consumers were not provided with these bags free of charge after December 2018.
- **Regulation on shipments of waste**: this 2006 regulation sets out procedures for transboundary waste transport, including to third countries.
- **Regulation on the registration, evaluation, authorisation and restriction of chemicals** (REACH Regulation): this 2006 regulation laying down the general framework on chemicals contains general provisions on authorisation (classifying certain substances as hazardous, possibly banning them to encourage their substitution with safer ones, and authorising certain uses of banned substances) and restriction (restricting the manufacture, placing on the market and/or use of certain chemicals) as well as specific provisions intended to facilitate the placing on the market of recycled materials. Although polymers are excluded from its scope, it covers additives used in plastics.
- **Regulation on classification, labelling and packaging** (CLP Regulation): this 2008 regulation aims to ensure that the hazards posed by chemical substances are clearly identified and communicated.

However, there are some gaps in the **implementation** of waste-related legislation. The Commission noted in a 2013 green paper that 'the hazards of plastic waste in the environment would be significantly lower if existing European waste legislation was properly implemented', and that 'insufficient enforcement of the waste shipment regulation results in illegal shipment of high quantities of waste outside the EU'. In its 2014 report on the 'fitness check' of the Packaging Waste Directive, the European Commission concluded that although the targets had generally been met, there were potential conflicts between packaging reuse schemes and recycling schemes. It noted a decrease in the market share of reusable household packaging, in apparent contradiction of the principles of the waste hierarchy.

The road ahead

In 2013, the European Commission presented a green paper on a strategy for plastic waste in the environment, aiming to launch a 'broad reflection on possible responses to the public policy challenges posed by plastic waste'. The paper presented a series of (not mutually exclusive) policy options.[5] The Commission followed up on this reflection in its 2015 circular economy action plan, where it identified plastics as one of five priority areas for action. On marine litter, in line with the United Nations Sustainable Development Goals, the Commission maintained an aspirational objective set in 2014 to reduce marine litter by 30 % by 2020. On packaging waste, the Commission proposed new reuse and recycling targets.[6] The Commission also pledged to adopt, by the end of 2017, a 'strategy on plastics in the circular economy, addressing issues such as recyclability,

biodegradability, the presence of hazardous substances of concern in certain plastics, and marine litter'.

A 2016 study for the European Commission on regulatory barriers to the circular economy identified poor implementation of the waste hierarchy (leading to relatively high landfill and incineration rates) as the main regulatory barrier to the recycling of packaging plastics. In a roadmap outlining the contents of the strategy on plastics in a circular economy, the Commission indicated it would be aimed at '(1) decoupling plastics production from virgin fossil feedstock and reducing its life-cycle greenhouse gas impacts, (2) improving the economics, quality and uptake of plastics recycling and reuse, and (3) reducing plastic leakage into the environment'.

Moving towards a circular economy

Plastics are an iconic example of the traditional, linear economic model, based on a 'take-make-consume-throw away' pattern. By contrast, a circular economy is a model based inter alia on sharing, leasing, reusing, repairing, refurbishing and recycling, where products and the materials they contain are highly valued, and where waste is reduced to a minimum.

A 2017 report by the Ellen MacArthur Foundation pinpoints three main drivers to make the plastics value chain more circular. These are, in order of importance: recycling with radically improved economics and quality; reuse systems; and a fundamental redesign of plastics to increase recyclability. A 2016 report by the Institute for European Environmental Policy identifies ten tools to increase circularity regarding plastics, including extended producer responsibility, bans on unnecessary and damaging products, economic incentives, transparency and labelling, awareness-raising, and litter clean-up. In this context, experts underline that the whole life-cycle of products needs to be taken into account when evaluating the environmental and economic benefits of options.

Moving towards circularity could bring both opportunities and challenges. **Opportunities** of a transition include:

- **enhanced security of supply**: a more circular plastics value chain could mitigate the risks associated with the supply of virgin oil feedstocks, such as price volatility and import dependency;
- **economic benefits**: further implementing the waste hierarchy could deliver economic benefits. The 2016 study on regulatory barriers mentioned above estimates that a 80 % recycling rate for plastics packaging could generate €700 million in savings (thanks to the increased use of secondary raw materials, which are approximately 10 % cheaper than primary materials) and notes that increased circularity bears a significantly higher job creation potential than incineration or landfill;
- **reduced pressures on the environment**: a more circular plastics value chain would reduce greenhouse gas emissions in manufacturing, with a positive impact on the climate. It would also reduce the amount of waste generated, with positive effects on (marine) littering, which would in turn help to limit biodiversity loss.

Challenges of a transition include:

- **weak economic incentives**: low oil prices may act as a disincentive to using secondary raw materials, and investing in recycling projects. An effective secondary plastic materials market would require a constant flow of recyclates meeting strict specifications at a competitive price compared with virgin feedstock. Furthermore, economic incentives to reuse (for instance through deposit schemes) are weak. The

2016 study on regulatory barriers indicates that costs for plastics collection, sorting and recycling can be higher than the value of the collected waste. The 2016 report by the Ellen MacArthur Foundation, meanwhile, estimates that 53 % of plastic packaging could be recycled economically and in an environmentally sound way today;

- **technical problems associated with plastics recycling**: the large number of polymers (some of them produced in low volumes) and the fragmented nature of the plastics market is a constraint. The mixing of different types of polymer and the presence of additives or other contaminants may affect the quality of recycling. The presence of legacy substances of concern in plastics and the absence of a common approach to dealing with them are also major challenges;
- **finance**: financing a transition towards circularity would require substantial investment. The 2016 study on regulatory barriers estimates that investment in the field of packaging plastics alone would be 'in the range of billions of euros'.

Bioplastics: bio-based and biodegradable plastics

Bioplastics are generally understood as encompassing bio-based and biodegradable plastics. Bio-based plastics are derived from plant matter (such as specifically grown crops or agricultural residues) rather than from fossil fuel. Biodegradable plastics are plastics that have the capacity to degrade in specific conditions; they include for instance 'oxo-degradable' plastics (plastics derived from fossil fuels where a metal-based additive accelerates fragmentation).

Advantages of bio-based plastics include reduced reliance on fossil fuel feedstocks as well as biodegradability and compostability under certain conditions. Disadvantages of bio-based plastics include higher production costs compared with conventional plastics, the need for land to grow specific crops (with potential impacts on food production and food security), the risk of exacerbating consumer carelessness, and the risk of cross-contamination with conventional plastic waste streams complicating recycling processes. On the specific issue of marine litter, a 2016 report by UNEP indicates that although bio-based plastics are generally biodegradable under specific conditions in terrestrial systems (for instance in composting plants), their rate of degradation in oceans is extremely slow. In its 2017 roadmap on the plastics strategy, the European Commission highlights the need to work on definitions and standards.

European Parliament

In its resolution of 14 January 2014 on plastic waste in the environment, the European Parliament recognised the need for specific measures on plastic waste in EU legislation and agreed that plastic waste should be treated as a valuable resource by promoting its reuse, recycling and recovery and by enabling the creation of an adequate market environment. Furthermore, it urged Member States and the Commission to take bolder steps in order to tackle illegal exports and the dumping of plastic waste, including stricter enforcement of the regulation on shipments of waste.

In its first reading position of 14 March 2017 on the review of the Packaging Waste Directive, the European Parliament proposed to raise the ambition level of targets for packaging waste, including plastics, and to require the Commission to develop, by 2018, quality standards for plastic waste entering the final recycling process.

Stakeholders' views

PlasticsEurope, an association representing plastics manufacturers, indicates that it supports an objective, technology-based strategy for plastics guided by circular economy principles. However, it warns against singling out specific polymers, highlights the need for multiple and diversified materials, and underlines the role of energy recovery.

European Plastics Converters, an association representing manufacturers of semi-finished and finished plastic products, welcomes the call for clearer standards and for a sustainability framework included in the Commission roadmap on the strategy for plastics. European Bioplastics, an association representing the bioplastics sector, sees the circular economy as an opportunity and calls for equal access to sustainable bio-based products, EU support for industries using biomass, and efforts to assess the use of biodegradable plastics in certain applications.

The European Environmental Bureau, a non-governmental organisation (NGO), criticises the Commission roadmap on the strategy for plastics for failing to address the root of problems posed by plastics and to propose adequate measures on marine litter. It calls for a focus on reducing and optimising the use of plastics, on enhancing producer responsibility and on phasing out hazardous chemicals in plastics. On bioplastics, a coalition of five environmental NGOs advocates among other things prioritising prevention and reduction, assessing the impacts of bioplastics, considering and improving standards, and establishing sustainability criteria.

Main references

Boucher, J., Friot, D., Primary microplastics in the oceans: a global evaluation of sources, International Union for Conservation of Nature, 2017.

Ellen MacArthur Foundation, The new plastics economy: rethinking the future of plastics, 2016.

Technopolis et al., Regulatory barriers for the circular economy: lessons from ten case studies, 2016.

Endnotes

[1] Of the polymer types listed in Figure 2, all are thermoplastics, except polyurethane (PUR) which belongs to thermosets category.

[2] While seven Member States landfill less than 10 % of plastic waste, nine Member States landfill over 50 %.

[3] China, Indonesia, the Philippines, Thailand and Vietnam.

[4] Sixteen Member States had derogations regarding the 2008 targets. For more details, see an overview of targets and derogations by Eurostat.

[5] Application of the waste hierarchy to plastic waste management; achievement of targets, plastic recycling and voluntary initiatives; targeting of consumer behaviour; a move towards more sustainable plastics; action on the durability of plastics and plastic products; promotion of biodegradable plastics and bio-based plastics; EU initiatives dealing with marine litter including plastic waste; and international action.

[6] The Commission proposed a reuse and recycling target of 55 % for plastic packaging waste by 2025. In mid-2017, the legislative procedure was still ongoing. For more details see D. Bourguignon, Circular economy package: Four legislative proposals on waste, EPRS, European Parliament, 2017.

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