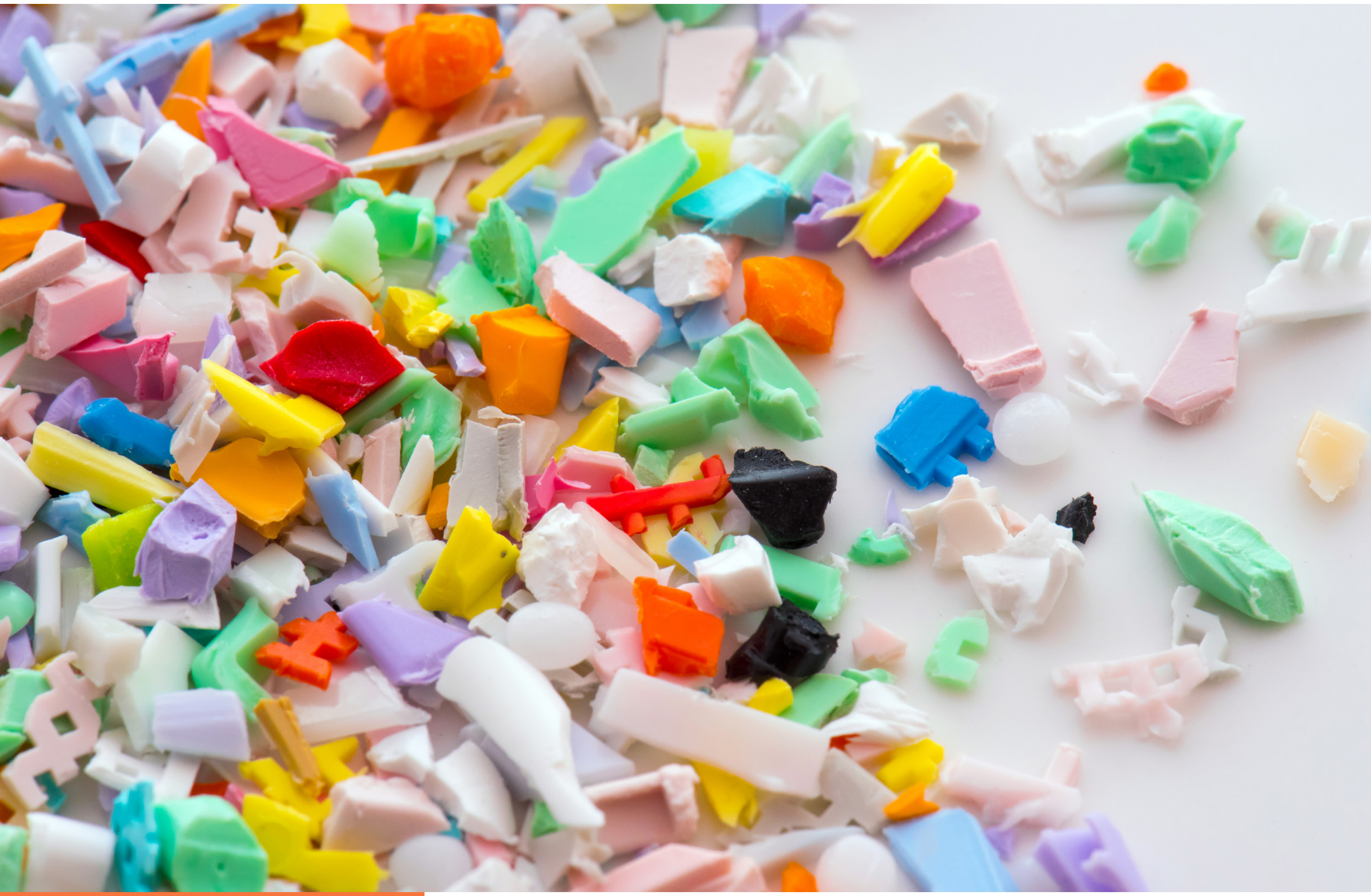
Falling into place:

what future for plastic recycling in a circular and toxic-free economy?

Recommendations for EU policymakers, standardisers and manufacturers



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About ECOS

ECOS - Environmental Coalition on Standards is an international NGO with a network of members and experts advocating for environmentally friendly technical standards, policies and laws. We ensure the environmental voice is heard when they are developed and drive change by providing expertise to policymakers and industry players, leading to the implementation of strong environmental principles.

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Executive Summary

To support the European climate neutrality ambition and respect planetary boundaries, **plastic products should follow a real circular economy hierarchy**. This means prioritising value retention within closed-loop systems, as well as waste prevention strategies to avoid material consumption in the first place. Unfortunately, in the case of plastic waste, energy recovery remains the most common way of disposal, closely followed by landfill.

Recycling, and particularly plastic recycling, is not a panacea to our overuse of natural resources. It requires energy, additives[1] and material inputs. We cannot continue our addiction to plastics and simply recycle our way out of the biodiversity and climate crisis.

Recycling does, however, have an important role to play in closing the loop, once prevention and reuse options, such as refillable packaging, have been exhausted. In the EU, the European Plastics Strategy envisioned that by 2030 more than half of European plastic waste would be recycled and all plastic packaging put on the EU market would be either reusable or recycled in a cost-effective way. At a horizontal level, the Waste Framework Directive sets the target to prepare for reuse and recycling at least 55% for post-consumer waste generated in the EU by 2025, 60% by 2030 and 65% by 2035[2].

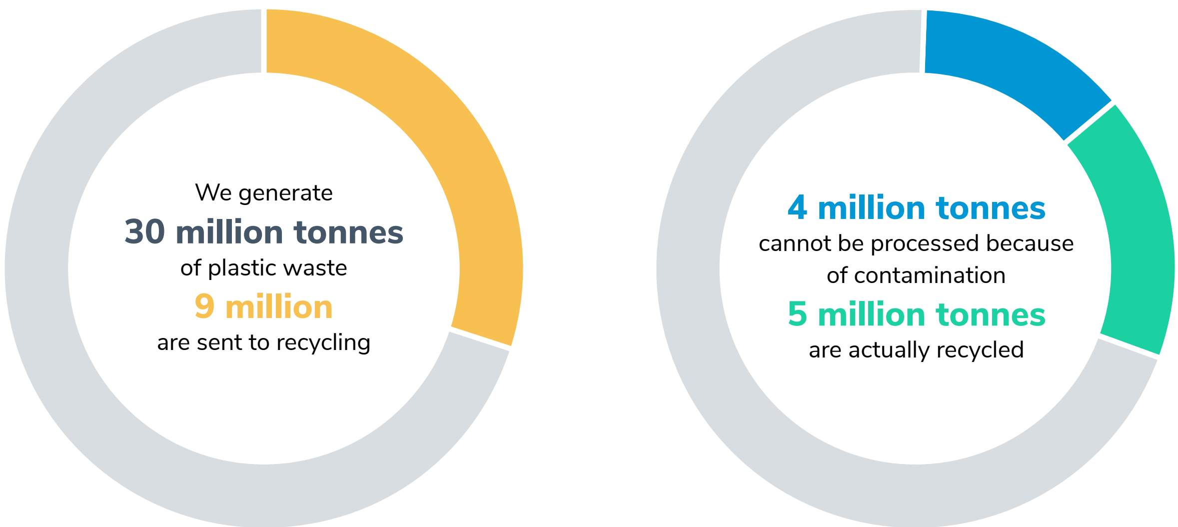


Figure 1: EU Plastic waste recycling figures.

Unfortunately, this scenario is still far from reality: **EU's linear economy produces 58 million tonnes of plastic per year and generates 30 million tonnes of plastic waste, of which only 9 million (30%) are collected for recycling**[3]. Out of this, 4 million tonnes cannot be processed because of contamination and additive contents, as well as mixed, low-grade plastic streams. As a result, only 5 million tonnes of plastic are actually recycled. In addition, most plastics are collected from industrial sources, so are not considered *post-consumer plastic*[4]. Finally, half of the plastic waste collected for recycling is exported to be treated in countries outside of the EU[5], sometimes even dumped in developing countries, or mysteriously 'lost' at sea[6].

This leaves us with a set of uncomfortable questions: What to do with all this discarded plastic? What if it is contaminated by legacy chemicals? How to close the loop in a sustainable way? Much needs to be done in order for plastic collection, sorting and recycling in Europe to improve. Ideally, recycling should maintain or improve material quality[7], enabling high-value applications rather than downcycling (lower quality and lower value).

The solution to realising a circular and toxic-free economy is complex but attainable, and plastic recycling is an important element here. We need an integrated value chain approach as well as rigorous standards. Our paper provides clear recommendations for policy-makers, standardisers and product designers, on how to deal with the complex issue of plastic recycling, and close the loop for plastic waste.

Here is a snapshot of our recommendations:

Set circular design principles	Foster plastic waste recycling by setting circular design principles for plastics in the different sets of EU legislation – principles such as toxic-free by design, banning all substances meeting the criteria from the Classification, Labelling and Packaging (CLP) Regulation and substances of very high concern (SVHC) from the REACH Regulation, ban substances hampering reuse and recycling, while increasing transparency through 'plastic passports';
Eliminate market barriers and greenwashing	Remove market barriers to the uptake of recycled pastics through a tax on the use of virgin plastics and an effective ban of plastic exports; increase plastic recycled content for longer-lasting products, while debunking the chemical recycling myths and eliminating dubious accounting practices;
Set ambitious standards	Mandate the review of European standards or the creation of new standards based on an ambitious EU regulatory direction, capitalising on the existing CEN and CENELEC standards;
Focus on product lifecycle	Require product manufacturers to consider the full lifecycle of their plastic products, including the sorting and recycling steps, from the design stage on.

European policymakers need to take an ambitious lead

The 2020 Circular Economy Action Plan (CEAP2) mentions several (potential) policy actions that, to a certain extent, could address recycling challenges. In general, they are steps in the right direction but they are neither concrete nor fast enough. More detail is urgently needed, as well as translation into concrete measures to be implemented as soon as possible.

New measures aiming to increase the uptake of recycled plastics will be crucial, and European policymakers should ensure they apply proper risk management based on the precautionary principle (see below). This section will explore a number of crucial needs that must be addressed at policy level if we are to make plastic recycling effective.

Circular design requirements need to consider not only the first life of plastic products, but also the impacts of using recycled plastics in all potential future lives. This means **putting an end to design practices** impeding plastic recycling, or preventing potential exposure of workers, consumers and ecosystems to substances of concern in recycled materials and recycling processes, through **more stringent regulation on chemicals**.

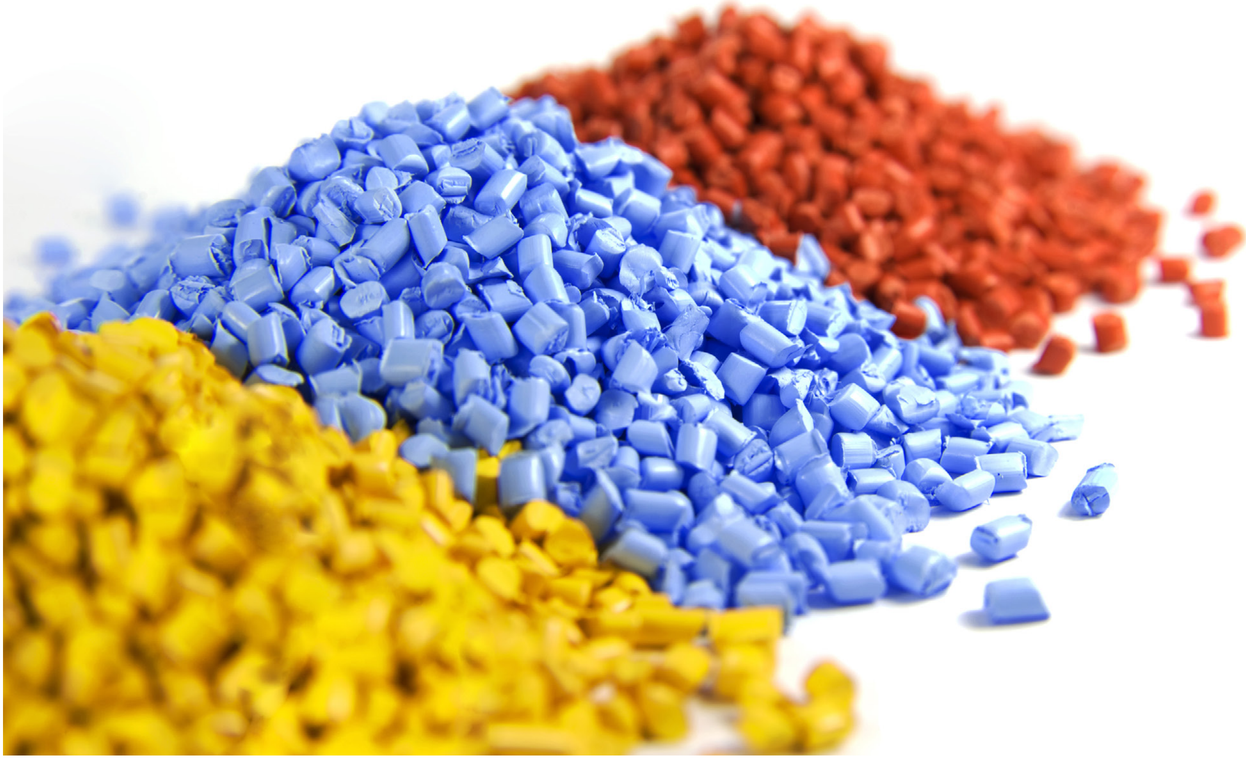
Additionally, a high level of **traceability** through digital 'plastic passports' is required in order to share information on the origin of plastic products, as well as their durability, composition, reuse and end-of-life management.

Stimulating the integration of recycled plastics will require a combination of 'push' and 'pull' mechanisms: 'push' through a tax on the use of virgin plastics and effective ban of plastic exports; 'pull' through the increase of plastic recycled content for longer-lasting products. This should also involve debunking the chemical recycling myths and eliminating dubious accounting practices used in mass balance methods.

This systematic application of the precautionary principle should drive defining ambitious design requirements for plastic products, ensuring safety for use and recycling, enabling information access, as well as tackling market barriers and preventing greenwashing.

Precautionary principle

As set out in Article 191 of the Treaty on the Functioning of the European Union (TFEU), the **precautionary principle** is a risk management approach, whereby 'if it is possible that a given policy or action might cause harm to the public or the environment and if there is still no scientific agreement on the issue, the policy or action in question should not be carried out.' It is also based on the principles that 'preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.' In other words, the lack of scientific data shall not be used as an excuse for postponing measures that help prevent environment degradation. Hence, such alternative measures should be considered, and any uncertainties further explored.



1. Circular design principles

To reach the European goals set in the European Plastics Strategy and waste legislation, thorough circular design principles to ensure plastic waste can be mechanically recycled will be paramount. **Today, even if plastic is collected for treatment, more than 80% cannot be reused or recycled due to faulty design or chemical contamination**. Proper recycling of plastic packaging is particularly impeded by incompatible and inseparable combinations of synthetic polymers (and other materials such as labels or sleeves) as well as the use of chemical additives[8].

Our 2019 report on applying ecodesign principles to plastic formulates a number of **circular design principles** that should be followed by policymakers and companies. It is crucial that plastic be made of **homogeneous polymer streams, without substances of concern, of a colour easy to be recycled, with minimised and separable labels and sleeves, as well as minimised printing, with the use of non-toxic, non-metallic and washable ink**[8] (see further recommendations in section 3 and Annex II).

At the end of its long useful life, waste plastic products should be separated at source in order to avoid mixing and fouling. The review of existing waste-related directives, e.g. the Packaging and Packaging Waste Directive, can support a **separate collection of clean streams of the same material, for instance through** deposit-return schemes (e.g. DRS for PET drink bottles in Norway, Germany, Lithuania, and possibly in the UK). These help achieve the highest rates of separate collection – around 90% in European countries with DRS – and reduce the amount of drink containers that end up in the ocean by up to 40%. DRS can support clean separate collection of other products and packaging.

What is more, **the 'dirty quartet'**, formed by the polluting PVC, PC, PS and PUR, **should be gradually phased out**, considering their impractical polymer behaviour and need for compatibilisers, multiple treatment steps to actually be recycled, lack of separate collection infrastructure, high potential for leaching chemicals throughout their life-cycle, and more. They should especially be eliminated in consumer applications, such as packaging or fast fashion, where better alternatives exist (e.g. reusable packaging).

2. Transparent information and more stringent limits for chemicals

Policymakers need to urgently tackle the persistence of legacy chemicals that pose a threat to human health and the environment when recycled plastic is used as secondary material. The EU Chemicals Strategy for Sustainability clearly defines **substances of concern** as those problematic in a circular economy, i.e. substances that have a chronic effect on human health or the environment (Candidate list in REACH and Annex VI to the Classification, Labelling and Packaging (CLP) Regulation), **as well as those hampering reuse and recycling for safe and high quality secondary materials**.

For a truly sustainable plastic product policy, **material and product passports for all plastic and plastic products will be essential, including a full list of chemical substances present**. This would ensure transparency and traceability of chemical aspects throughout the entire value chain. It is especially important as recycled plastics usually contain higher levels of hazardous chemicals due to their material properties (e.g. intrinsic contaminants and material degradation), chemicals accumulation, or previous uses of the plastic products[9].

In addition, limit values should be made more stringent. The European 2022 Sustainable Products Initiative should support this by requiring all products to be **toxic-free by design and banning all substances meeting the CLP** ('Classification, Labelling and Packaging'[10]) **and SVHC** ('Substances of Very High Concern'[11]) **criteria under REACH**. This would be coherent with the EU 2020 Chemicals Strategy for Sustainability's 'safe and sustainable-by-design approach'.

It is worth mentioning that current EU legislation does prohibit recycling of hazardous substances, such as certain flame retardants and lead in PVC[12]. In principle, recyclates[13] should meet the same chemical requirements as new products, which is why, during the recycling process, sorting systems remove contamination and (most) plastic fractions containing hazardous substances, which are then disposed of through incineration. However, some substances of concern may still remain, because most state-of-the-art recycling processes cannot guarantee 100% clean materials. Legal derogations, therefore, allow for higher limit values for specific applications and substances (e.g. DEHP and cadmium[14]) under certain conditions. The recycling industry argues that without these exemptions, the recycling of WEEE and PVC plastics would be impossible. However, we believe that these exemptions should provide grounds to ban such substances in consumer products by design.

3. Eliminating market barriers and greenwashing

Another crucial challenge, besides technical and quality aspects, is posed by the existing market barriers to plastic recycling. At the moment, there is still insufficient demand[15] for recyclate and the (fluctuating) price for recyclate often cannot compete with the lower price of virgin material. In 2018, the European Commission launched an EU-wide pledging campaign to ensure that, by 2025, ten million tonnes of recycled plastics from post-consumer waste find their way into new products on the EU market each year. However, we believe that other measures, such as a tax on the use of virgin plastics, would be much more effective in stimulating the market for recycled plastics.

EU policies should also help prevent exports of plastic waste outside of Europe, and instead support intra-EU recycling. In 2018, 'nearly a third of the EU's reported plastic packaging recycling rate [was] achieved through shipments to non-EU countries for recycling'[16]. The European ban on most plastic waste shipments introduced in January 2021, as per the UN Basel Convention amendments, can partially counter this. But this will not be quite enough as EU plastic exports have shifted from China and Hong Kong to other countries such as Malaysia and Turkey, and illegal exports have, in fact, grown. The EU should send a strong signal to improve the management of all plastic waste in Europe with an ambitious review **of the EU Waste Shipment Regulation**.

As regards market incentives, CEAP2 foresees **mandatory requirements on recycled plastic content for several products** to provide an additional market push. This can contribute to the goal of closing the loop if the chain-of-custody method for calculation, verification, and reporting of recycled content is credible and trustworthy. The segregation of recycled feedstock helps ensure highest reliability level in this regard. When not possible, the mass balance method can be used, but it can only be reliable when proportionally allocating recycled content to production outputs, discounting efficiency losses, and as long as its calculation rules are transparent, and a third-party assesses manufacturers' green claims. Transfers of recycled content between recycling process outputs, sites or countries undermine such claims. Furthermore, only recycled materials from post-consumer waste should be taken into consideration.

False solutions should by no means become the way forward to increase the uptake of recycled plastics. The most worrisome statement in the CEAP2 concerns the so-called chemical recycling[17], which is regarded as a technological innovation with the potential to enable the recycling of problematic waste streams which cannot be treated by mechanical recycling. However, the proponents of chemical recycling seem to overlook the fact that it uses a lot of energy and chemicals, is usually inefficient, produces hazardous waste[18], and resembles energy recovery much more than it does a proper recycling process[19].

Consequently, new legislation on recycling, for example for packaging waste, should focus on **recycling technologies that are commercially available at scale and in practice**[20] – or could be available in the short term (e.g. within 2 years) – and set ambitious performance thresholds. As for research investments and subsidies, they should rather be invested in prevention, circular design and reuse strategies.

European standards should be revised according to ambitious EU rules

Today, the absence of ambitious EU requirements – or implementing measures – for plastic recycling in the major user sectors, i.e. in packaging, buildings and construction, automotive, as well as electrical and electronics, hinder the uptake of recycled plastics. Besides legislation, harmonised standards from the European Standardisation Organisations CEN and CENELEC have the potential to support this uptake. Nevertheless, such standards should be developed to build upon existing and future work at the EU level in these sectors, not to supplant or replace such work. **Regulatory direction is thus needed from the EU to rule out certain product design features that prevent or impede plastic recycling** (see *further recommendations in* Annex II). Standards should then be developed accordingly.

The European Plastics Strategy referred to European quality standards to strengthen the market for secondary materials and increase confidence that recycled plastics meet manufacturer needs. There already exist generic standards[21] that formulate guidelines for the recovery and recycling of plastic waste. Several specific standards also set the minimum information requirements about the material composition of sorted plastics waste, the quality of recyclates and integration of recycled plastics (e.g. based on existing tools such as EasyD4R[22] or RecyClass), the relevant test methods, as well as the quality control system[23]. They aim to facilitate further use of plastic recyclates by characterising recycling input and output.

However, these standards simply list potential impediments to plastic recycling in general terms; they most certainly do not help eliminate them. That said, several recent developments in new CEN standards – or standards in progress – are moving in the right direction - a small number of examples follows below.

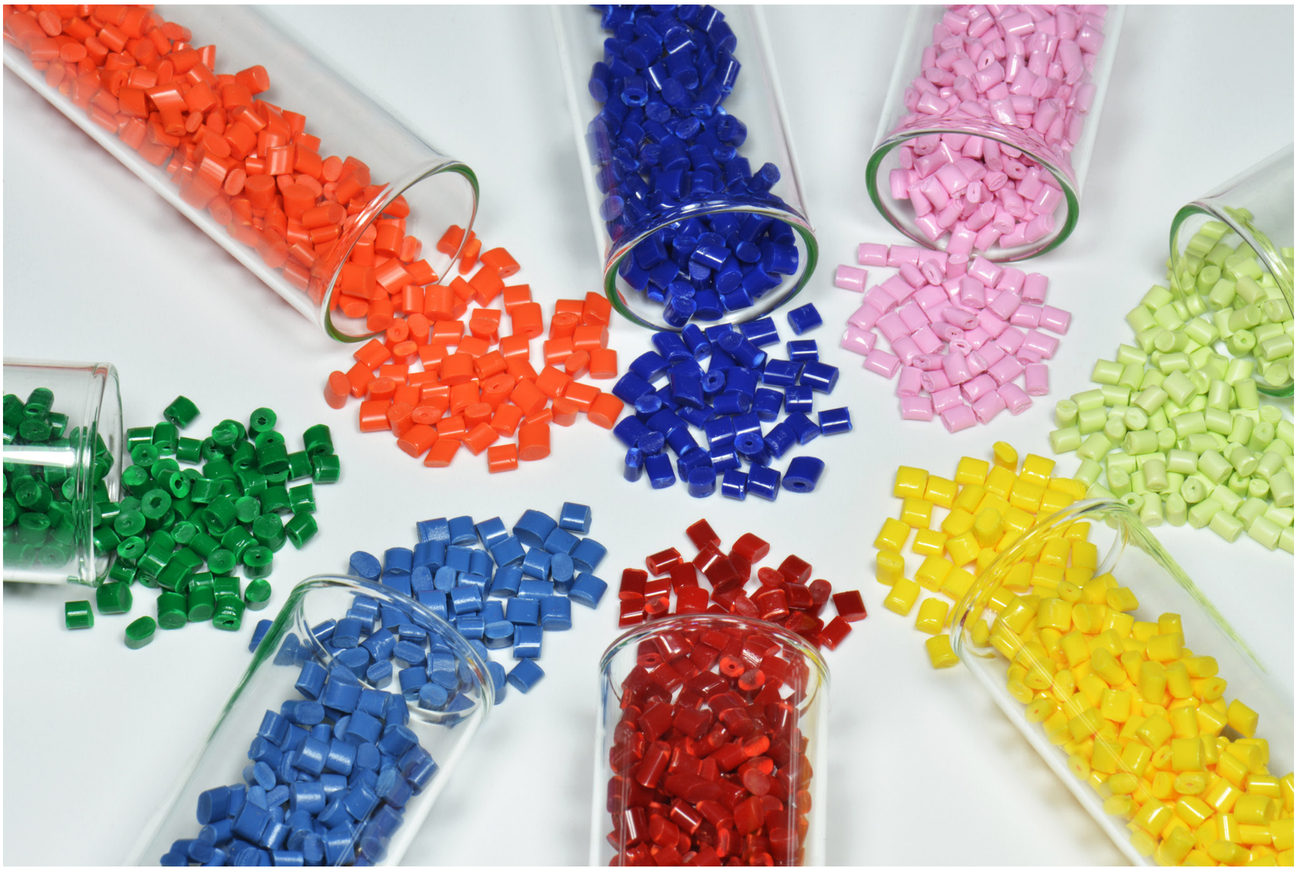
The recent European standard developed for closed-loop recycling of un-plasticised PVC for windows and doors (EN 17410:2021) recommends their **recyclability and modularity, as well as separability of parts, to be considered and tested during design – even by excluding materials contaminating the recyclate**. It also advises to trace the necessary information on the material properties, including of the embedded chemicals. Yet, this standard does not oblige manufacturers to design windows and doors for end-of-life recycling. This is why further EU legal rules are essential.

Another interesting progress towards plastic recycling is the development of quality standards for sorted plastic waste in packaging. It will define the **minimum requirements a plastic packaging quality grade must fulfil**. This will not only concern the plastic composition, but also a *minimum required level of targeted materials, and a maximum acceptable level of impurities, and a description of their treatment*. It will also include information on prohibited materials that impede recycling and limits for non-plastic components. These projects should align with the future EU legal material use bans and limits, such as in the revised Packaging and Packaging Waste Directive.

In addition, different standard projects aim to define the **technical functionalities required for recycled plastics to be incorporated into new products**. They should include information on the properties relevant for determining the quality of plastic recyclates and 'desired typical values' for specific product families and the most common polymers. Even though this is complex, a *proper assessment of the loss in technical functionality of recycled plastics [is essential] in order to determine the best possible circular route for this important material*[24]. Hence, these projects should add in information on the **substitutability of**

recycled plastics per type of polymer or application type, based on their mechanical and processability properties.

Finally, standards can also help monitor the quantity of recycled plastics in the market by detailing the methodology to measure collected and sorted plastics waste as well as recyclers and converters inputs and outputs. However, the standard on plastic recycling traceability and recycled content (EN 15343:2007[25]) is too loose and is planned for review by in 2022. This is yet another example where the standard's review must be **adapted to the upcoming EU rules, in this case on the calculation, verification and reporting of recycled content**.



Products and material designers should integrate features favouring plastic recycling

Today's recycling arena is not an impressive sight at all. Though there are around 79 unique plastic material types commercially available on the market[26], **only a handful of polymer types are actually recycled**. In fact, global data is available only for HDPE, PET and small amounts of PP[27]. Those that are recycled come mostly from construction sector waste, and are recycled through closed loop collection and systems, or self-regulated sector-level voluntary systems. Other materials recycled in low volumes are PA, PC and ABS, coming from sources such as post-industrial waste or through closed loop recovery and recycling systems due to regulatory demands (e.g. WEEE regulation demands recovery and recycling of EEE equipment which includes ABS or PC/ABS or PS).

At experimental scale, chemical recycling is tested for PA, PS/EPS and PUR, but we have already demonstrated that **products or materials should not be designed for chemical recycling** since the understanding of this process is only just emerging, it is energy- and emissions-intensive, while economic viability is not clear.

To improve this situation – and dramatic improvement is needed – product designers and engineers should consider the full product lifecycle, from cradle to grave, including the sorting and recycling steps. They should especially address the challenges of toxic-free design for clean material cycles, as described below.

First, end-users of *recycled* plastics expect similar features and experience as in the case of *virgin* plastics. In short, all plastics, recycled or virgin, should meet the expected technical requirements, be consistent in terms of quality and riskless supply, and be available at best possible cost.

To meet all three requirements in a straightforward way, we strongly recommend **including as much separable mono-material content in a product as possible**, already at the design stage. The more homogenous the plastic product is, the easier it will be to separate the materials it is made from, which will result in cleaner sorting and easier recycling.

In addition, it is crucial to **ensure quick and explicit identification of the types of materials contained in a plastic product**. Today, packaging must present an appropriate, durable and visible marking[28] that helps identify and classify the material type (e.g. through embossed marking). Beyond packaging, individual plastic components of a complex product should be marked with material type, i.e. with universal resin identification codes that explicitly identify the material.

Moreover, designs should, wherever possible, **avoid combinations of non-plastic material types**, such as metal clips, moulded inserts, overmoulding with fabric or non-plastics or different plastic types. When unavoidable, the products or materials should be designed in a way that the multi-materials completely fall apart from each other when shredded and are easily separable in any of the downstream unit operations such as magnetic separation, eddy current separation, density separation or through near infrared optical sorters.

Sleeves, stickers or inks that may deteriorate the quality of recovered plastics should be avoided whenever possible and should only be used when absolutely necessary in the products or materials of any plastics application sector. When unavoidable, they should be designed in a way that the sleeves, stickers or inks completely detach from the targeted commodity when shredded and are easily separable in downstream unit operations such as magnetic separation, eddy current separation, density separation, through near infrared optical sorters, washing, elevated temperature washing or in chemical wash.

Specific recommendations per material type are detailed further in Annex II.

Annex I
Plastic recycling glossary

- Recycling of plastic waste results in **material recovery**, which contributes to saving resources such as raw materials, water and energy.

According to the Global Plastics Outreach Alliance, a plastic product is recyclable when it is:
a) Made with a plastic that is collected for recycling and has market value,
b) Can be sorted and aggregated into defined streams for recycling processes,
c) Can be processed and reclaimed/recycled with commercial recycling processes,
d) The recycled plastic becomes a raw material for the production of new products.

- **Mechanical recycling** has been long established and is quite effective for many types of plastic waste such as bottle PET, PP, PE from packaging and HIPS, ABC, PC, PP from WEEE/automotive. The process, consists of many sub-steps such as (coarse and fine) shredding, washing, separating, drying and, if necessary, extrusion into new pellets (with melt filtration).
- **Chemical recycling and physical recycling, such as solvent-based purification**, could be complementary to mechanical recycling but clear definitions and requirements are needed to ensure that it neither undermines more circular approaches higher in the waste hierarchy, nor leads to adverse environmental impacts. The input should be efficiently degraded using contaminated plastics, never plastics coming from separate collection fit for mechanical recycling, and the output should be limited to new plastics – i.e. excluding fuels. The chemical recycling processes should also be available at scale and in practice throughout the EU to be considered.
- **Plastic recycling** - particularly of household waste which consists of many different product types (bottles, trays, etc.) with different purposes and design - is always accompanied by physical and quality-related losses of the original material, due to the presence of non-plastic materials, other polymer types and (potentially hazardous) chemicals. This leads to **material degradation** and means that the number of times that a product can be recycled is limited.
- It will take years, if not decades, for **legacy chemicals** to be completely phased out from plastic products that were placed on the market in the past. An example is Polystyrene foam used for building insulation containing the flame retardant hexabromocyclo-dodecane (HBCDD), which is today classified as a substance of very high concern under REACH and persistent organic pollutant under the UNEP Stockholm convention, that will be released in the future in large quantities during renovation and demolition work.
- **Closed loop recycling** enables plastic materials to be recycled for their original product application, e.g. bottle-to-bottle PET, often based on take-back systems and reverse logistics. It can achieve high-quality recyclate because manufacturers know exactly what the chemical composition of the plastic is. However, most recycling relies on open-loop processes which enable a wider variety of applications (e.g. recycling of PET bottles into textile products).

Annex II

Product design features which favour plastic recycling

Specific recommendations:

Material Type	Sector and examples	Recommended Guidelines
Low-density polyethylene (LDPE)[A&B, C]	**Packaging**[a] Flexible films [Retail carry bags1, Heavy duty shipping sacks, box liners, storage bags, shrink bundling, towel-tissue overwrap, stretch films, bar wraps, tray wraps, ream wraps, lay flat pouches, stand-up pouches, retort pouches] **Agriculture**[b] Mulching and Silage films	**Packaging** • Target for mono-material at least >95%. • Modern material recovery facilities are not designed to capture smaller packaging like single serve sachets, so a size of at least 50 X 50 mm packaging is recommended. • Avoid any non-compatible layers, EVOH tie layer is tolerable, and barrier additives or layers like SiOx, AlOx in the polymer matrix; if possible, avoid PA, aluminium or any metallic barrier layers. • Make sure any additives used to enhance the properties would still retain the overall density less than 0.97 g/cm3, i.e. could be separated using float/sink method in post-use unit operations. • Aim for packaging with no print, but if unavoidable, direct print or laser print is recommended with washable ink and no metallic inks are advised. • Additional labels on the packaging are to be avoided, if not aim for label of same material as the packaging or paper labels with water soluble adhesives. PP/OPP labels are non-tolerable labels and labels that would increase the density above 1 g/cc. • Avoid multiple folds or corners in the packaging that might prevent easy release of product from the packaging. **Specific points for agriculture** • Thickness > 25 microns, • Harmonised colour coding for agriculture films.

Material Type	Sector and examples	Recommended Guidelines
High-density polyethylene (HDPE)[A&B]	**Packaging[a]** Necked bottles [milk bottles, detergents, motor oil, crates, pallets, containers, tubes] **Agriculture[b]** Nets, bale wraps and protections **Construction[b]** Pipes, rotational molded tanks, park benches	**Packaging** • Target for mono-material at least > 95%. • Modern material recovery facilities are not designed to capture smaller packaging or products, so a size no less than 50 mm is recommended at least in any 2 dimensions. • Avoid any non-compatible layers, EVOH tie layer is tolerable, and barrier additives or layers like SiOx, AlOx in the polymer matrix; if possible, avoid PA, aluminium or any metallic barrier layers. No PVC/PVDC. • Make sure any additives used to enhance the properties would still retain the overall density less than 1 g/cm3, i.e. could be separated using float/sink method in post-use unit operations. • Aim for packaging with no print, but if unavoidable, direct print or laser print is recommended with washable ink at selective temperature and no metallic inks. • Additional labels on the packaging are to be avoided, if not, aim for label of same material as the packaging or paper labels with water soluble adhesives. PP/OPP labels are non-tolerable labels and labels that would increase the density above 1 g/cc.

<table>
<tr><th>Material Type</th><th>Sector and examples</th><th>Recommended Guidelines</th></tr>
<tr><td rowspan="2">Polyethylene terephthalate (PET)[A&B]</td><td>Packaging[a]
Bottles, thermoformed trays, films</td><td rowspan="2">Packaging
Target for mono-material at least > 95%, combination of co-polyesters like PETG, PET-GAG and combination with other polymers like PVC/ PVDC, PLA should be avoided.
Colourless transparent bottles and thermoformed trays are ideal. Though shades of blue or green are regularly used, those are a hinderance in generating quality recyclate through the recycling process. May end up in downcycled applications, like textile fibres.
Avoid carbon black, opaque, fluorescence or metallic colours.
Barrier polymer content or coating < 5% of the total weight of the packaging. Restrict to known barrier layers of 3-layer PA structure, plasma coating of SiOx, Cox, PGA, PTN. EVOH and 5-layer PA are identified as problematic.
Additives like UV stabilisers, anti-blocking agents, optical brighteners should not decrease the density below 1 g/cc.
Any sleeves used should not exceed more than 50% of the total surface area since it hinders the near infra-red sensors in the recycling unit operations. The sleeves density must also be less than 1g/cc so that it is easily separable, i.e. PP, OPP, PE. For long established products, sleeves could be avoided and the brand names could be simply embossed through the mould.
Ideally no print or sleeves. But when used, adhesives and ink should be non-toxic and water-based or processed in alkaline at a temperature range of 60-80°C.
Avoid unnecessary cuts, grooves, corners, that hinder easy emptying of products from the packaging.</td></tr>
<tr><td>Textile[b]
Polyester fabrics</td></tr>
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Material Type	Sector and examples	Recommended Guidelines
Polypropylene (PP)[A&B]	**Packaging[a]** Container, Tubs, caps & closures, BoPP films, bottles	**Packaging** • Target for mono-material at least > 95%. • Natural colour is preferred but if coloured, then preferred colours are the colours easily recognisable in separation and recycling processes. • Size of at least 50 X 50 mm packaging is recommended if it is flexible packaging; size no less than 50 mm is recommended at least in any 2 dimensions for rigid packaging or other than flexible flat packaging. • Barrier polymer content or coating < 5% of the total weight of the packaging. Restrict to known barrier layers like EVOH tie layer. • Additives like UV stabilisers, anti-blocking agents, optical brighteners should not decrease the density below 1 g/cc. • Make sure the labels and sleeves do not increase the overall density higher than 1 g/cc. • Water-based label adhesives and inks are recommended, i.e. water soluble adhesives and inks processed at selective temperatures.
	Agriculture[b] Twines	
	Construction[b] Films and sheets	
	Electrical and Electronic Equipment (EEE)[b] Dishwashers, dryers, food processing appliances, vacuum cleaners	
	Automotive[b] Bumpers, body side panels, majority car interiors – dashboard, cup holders, map pockets, center consoles, glove boxes, door panels	
Polyvinyl chloride (PVC)[A&B]	**Construction[b]** Window profiles, roller shutters, doors, kitchen tops, floor tiles, plumbing pipes	**General recommendations** • Explicitly identify the material type using universal resin identification codes (according to ISO 114692016) or spell out the material if it is one of No. 7 'Other' material or special material type. • Only to be used when the unique characteristics of the material property is in functional demand. For example, PVC might be the possible choice of material for cable application due to its self-extinguishing characteristics rather than for shower curtains or for bed spread cover packaging. • Before selecting an application, please **check for the local availability of a recycling system for this particular material type**. Does a recovery and recycling system exist for this particular material? If not, what other options exist at end-of-life for this material type? Should this be registered with any specific collection or recycling methods and associations? Are the consequences clearly understood if this product or packaging with this particular material type end up in waste-to-energy or cement kilns?
	Medical[b] Storage bags, tubes	
	EEE[b] Wires and cables	
Polystyrene / Expanded Polystyrene (PS/EPS)[A&B]	**Packaging[a]** Cups, trays, dairy packaging, clamshell containers, cutleries, party plates and drink cups, EPS shipping boxes for perishable goods	
	EEE[b] Refrigerator interiors	
	Construction[b] Insulation	

Material Type	Sector and examples	Recommended Guidelines
Polyurethane (PUR)[A&B]	**EEE**[b] Cooling appliances insulations	**General recommendations** • Explicitly identify the material type using universal resin identification codes (according to ISO 114692016) or spell out the material if it is one of No. 7 'Other' material or special material type. • Only to be used when the unique characteristics of the material property is in functional demand. For example, PVC might be the possible choice of material for cable application due to its self-extinguishing characteristics rather than for shower curtains or for bed spread cover packaging. • Before selecting an application, please **check for the local availability of a recycling system for this particular material type**. Does a recovery and recycling system exist for this particular material? If not, what other options exist at end-of-life for this material type? Should this be registered with any specific collection or recycling methods and associations? Are the consequences clearly understood if this product or packaging with this particular material type end up in waste-to-energy or cement kilns?
	Automotive[b] Seat Paddings	
Others Acrylonitrile butadiene styrene (ABS), Polycarbonate (PC), Polyamide (PA), etc. [A&B]	**Automotive**[b] HVAC systems (ABS), side mirror housings (ABS, SAS), Bushings (PA)	
	Construction[b] See through shields (PC), windowpanes (PC)	
	Automotive[b] HVAC systems (ABS), side mirror housings (ABS, SAS), Bushings (PA)	
	EEE[b] Appliance housing (ABS), mobile phone housings (PC/ABS blends)	

a Recovery and collection for recycling for this particular sector through existing municipal plastics waste collection system, Deposit Return Schemes, and Extended Producers Responsibility systems.

b Recovery and collection for recycling for rest of the sector through sector specific special collection system through Deposit Return Schemes, and Extended Producers Responsibility systems. If any product has more than ~80% of plastics by weight or by volume should have an established end-of-life program and reporting to relevant authorities.

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A. The Design for Recycling guidelines, Recyclass, Plastics Recyclers Europe. Accessed as of Nov. 2021 https://recyclass.eu/recyclability/design-for-recycling-guidelines/

B. Eco-design recommandations, Comite´ Technique pour le Recyclage des Emballages Plastiques (COTREP). Accessed as on Nov. 2021 https://www.cotrep.fr/en/technical-study/#tools

C. Film Recycling Investment Report 2017, The Closed Loop Foundation. Accessed as on Nov. 2021 https://www.closedlooppartners.com/foundation-articles/investment-opportunities-in-film-plastic-recycling/

Notes

1 Recycled plastics may have to be mixed with additives such as fillers, pigments, stabilizers etc. to prepare a compound ready for extrusion (in contrast to virgin plastics which are usually ready to use). Although this improves the technical functionality, it may undermine the material health.

2 The WFD contains no specific recycling targets on plastic waste, but on recycling in general. By 2020, the preparing for reuse and recycling shall be min. 50% by weight for plastic from households and possibly from other sources similar to waste from households.

3 Material Economics, "the Circular Economy a Powerful Force for Climate Mitigation", 2018.

4 60% of European recyclers are dependent on industrial plastic waste, 16% on municipal solid waste and the remainder on both. August 2020. "The European recycling landscape—the quiet before the storm?".

5 In 2019, the EU also exported 150 000 tonnes of plastic waste each month, mainly to Malaysia and Turkey. European Environmental Agency Briefing. July 2020. "The plastic waste trade in the circular economy".

6 About 100,000 tonnes of plastic from EU countries ends up in the sea every year from coastal land areas alone. Seas at Risk, "Single use plastic and the marine environment summary report", 2017.

7 In terms of chemical, physical and mechanical quality.

8 See also ZWE-ECOS-RPa joint paper, "Designing for real recycling, not plastic lock-in", 2021.

9 Geueke B., Groh K, Muncke J., "Food packaging in the circular economy: Overview of chemical safety aspects for commonly used materials", 2018.

10 As laid down in Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures and related guidance.

11 See further details in ECHA guidance.

12 Some PVC plastic waste – for example from old PVC window frames – contains lead, a (neurodevelopmental) health hazard which is no longer used in new PVC produced in the EU. https://chemtrust.org/pvc-lead-dirty-circular-economy/ . See also HCWH report, "The polyvinyl chloride debate: Why PVC remains problematic material", 2021.

13 They comprise ground materials, regrinds, regenerates/compounds and agglomerates/compactates.

14 Because of their environmental benefits (energy-efficiency of cadmium) and the 'impossibility' of substituting DEHP.

15 The demand for recycled plastics currently accounts for only around 6% of total plastics production in EU.

16 ECA, "EU action to tackle the issue of plastic waste", 2020.

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18 B. Beeler and L. Bell, IPEN, "Plastic Recycling Schemes Generate High Volumes of Hazardous Waste", 2021.

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RPA Europe report for ECHA, "Chemical Recycling of Polymeric Materials from Waste in the Circular Economy", 2021.

20 Ellen MacArthur Foundation, "The new plastics economy global commitment – reporting guidelines for business signatories", 2019. ECOS, ZWE, RPa, HCWH and EEB, "7 steps to effectively legislate on chemical recycling", 2020.

21 E.g. ISO 15270:2008, Plastics — Guidelines for the recovery and recycling of plastics wastes; CEN/TR 15353:2007, Plastics - Recycled plastics - Guidelines for the development of standards for recycled plastics; CEN/TR 13688:2008, Packaging - Material recycling - Report on requirements for substances and materials to prevent a sustained impediment to recycling, table 4 – "Plastics".

22 The software evaluates the recyclability of packaging based on its composition and the individual weight proportions of the respective components: basic materials, closures, labels, colours, etc. The tool assesses the suitability for identification during sorting, and for processing during recycling. Tested by the Fraunhofer Institute for Environmental, Safety and Energy Technology.

23 E.g. EN 1534X-series.

24 Demets R., Van Kets K., Huysveld S., Dewulf J., De Meester S., Ragaert K., "Addressing the complex challenge of understanding and quantifying substitutability for recycled plastics." November 2021, Resources, Conservation and Recycling 174. It lists five mechanical characteristics – "strength, stiffness, toughness , ductility and impact strength" – and one processing characteristic – "ease of flow".

25 EN 15343 Plastics Recycling Traceability & Assessment of Conformity and Recycled Content. Suppliers of recycled materials provide the information through a traceability data sheets which includes information on the type, origin and characteristics of the waste (before and after processing).

26 Top 26 Markets for Plastics, International Association of Plastics Distribution. Accessed as on Nov. 2021. https://www.iapd.org/IAPD/Training/Top_26_Markets.aspx

27 The feasibility of circular economy for plastics in the US, Paula Leardini, Webinar from Independent Commodity Intelligence Services (ICIS), 2021.

28 Packaging and Packaging Waste Directive 96/62/EC, article 8, and Commission Decision 97/129/EC establishing the identification system for packaging materials.

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