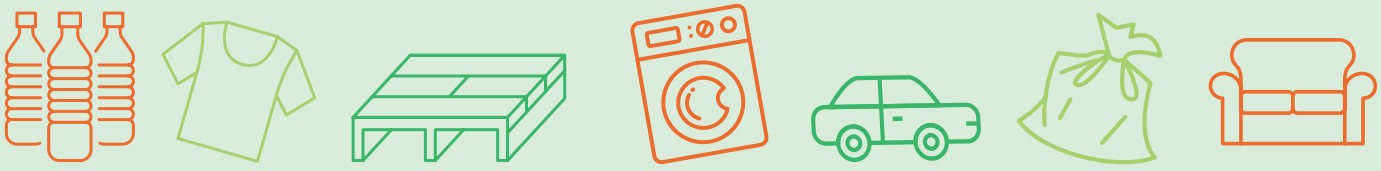
FOR BETTER NOT WORSE:
APPLYING ECODESIGN PRINCIPLES TO PLASTICS IN THE CIRCULAR ECONOMY



ECOS

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Executive summary

Plastic has quickly become one of the most ubiquitous materials used in products. Since the 1950s plastic boom, it has replaced steel in cars, glass and paperboard in packaging, cotton in clothes and wood in furniture. Plastic is cheap to produce and very versatile; it can be rigid or made to bend and stretch, and can be inherently durable.

However, concerns have risen considerably in recent years as plastic pollution levels reached unprecedented heights and plastic items accumulate in the environment and landfills, especially in developing countries.

The way we currently design, produce, consume and dispose of plastic is highly unsustainable and inefficient. In order to minimise the environmental footprint of one of the most widely used materials in countless products, plastic requires a comprehensive ecodesign approach. This approach has already been proven highly effective when implemented, even if only partially, in energy-related products using the Ecodesign Directive. This ecodesign principle should be applied to each individual sector which heavily uses plastic, namely packaging, construction, electronics, automotive, furniture and textiles.

There are drawbacks and risks associated to each part of the entire lifecycle of plastic. This is why it is crucial to rethink the place of plastic in our society, as well as develop the necessary tools and consolidate existing initiatives to provide solutions for a more responsible approach to plastic. It is no longer about being slightly less environmentally damaging, it is about fundamentally and comprehensively reshaping our policy as the EU plans its next steps in implementing its Circular Economy and Plastics Strategies, including the recently agreed Single Use Plastics Directive.

To help shape future priorities, this report, based on a scientific background study conducted by VITO in collaboration with Ökopol, provides a comprehensive analysis of the existing policy tools that can drive an ecodesign approach for plastic and products containing plastic, and identifies gaps and legislative needs.

At present, the EU efforts on integrating plastic in a circular economy rely on the objectives of different pieces of waste legislation, and recent first attempts at targeting product (eco)design through specific product policies. Future circular economy policies must develop beyond the current focus on recycling, and replicate across all plastic products the environmental principles such as those used under the Ecodesign Directive.

This report examines the existing measures and potentially relevant new approaches within a number of sectors which heavily rely on plastic, including packaging, construction, electronics, automotive, furniture and textiles. The study assesses a wide range of criteria and tools available in horizontal and product regulations, as well as the so-called soft tools such as standards, Extended Producer Responsibility (EPR) schemes and the EU Ecolabel. The report also looks at the potential of these tools for driving circularity and opportunities for extending promising solutions to other sectors.

Further to the analysis of the existing policy tools against their actual implementation and their potential for being mainstreamed, the report provides a set of four policy recommendations.

Our analysis has clearly shown that future circular economy actions will require a set of consistent policy decisions on plastic: Europe needs to develop a harmonised ecodesign approach, applied and adapted across different sectors.

Recommendations

Design products and systems for longer lifetimes

With only a few legislative tools sporadically including repairability and durability requirements, there is a need for a coherent policy framework to ensure that products and parts are made durable, repairable and reusable, and that the appropriate circular infrastructure is created to support demand for reuse, repair and remanufacturing.

Make products easier to recycle

Design for recycling is unevenly addressed by existing legislation. To allow for quality recycling and improved recycling rates, a comprehensive set of product requirements is needed: material formulation and combinations need to be simplified, eventual dismantling anticipated, and information on the location of key parts and components disclosed.

Close the loop through recycled content

To date, the only legislative tool that foresees mandatory recycled plastic content targets is the recently adopted Single Use Plastics Directive. Minimum recycled content requirements should be introduced widely to allow for multiple lives for recycled plastics. The traceability and verification of recycled content should be ensured through the development of reliable tools based on third-party assessment.

Focus on chemicals for circular products and materials

Addressing chemicals in plastic requires a structured policy focus. Substances of concern should be excluded more systematically through a circular approach to product policy and REACH regulation (Registration, Evaluation, Authorisation and Restriction of Chemicals). Information on additives in plastic should be gathered and used to make more informed design decisions to reduce exposure to harmful substances. Strict chemical content limits should be part of end-of-waste criteria for plastic and quality requirements for recycled plastic.

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1 Introduction

Plastic has quickly become one of the most ubiquitous materials used in products. Since the plastic boom in the 1950s, it has gradually replaced steel in cars, glass and paperboard in packaging, cotton in clothes and wood in furniture. Plastic is cheap to produce and very versatile; it can be rigid or made to bend and stretch, and can be inherently durable.

However, concerns have risen considerably in recent years as plastic pollution levels have reached unprecedented heights and plastic items continue to accumulate in the environment and landfills, especially in developing countries. Ocean plastic levels have reached great volumes. Between 1.15 and 2.41 million tonnes of plastic enter the ocean each year from rivers, creating alarming plastic garbage patches, the largest of which has been dubbed the seventh continent, and is estimated to range from twice the size of Texas to three times the size of France.

Most plastic stems from petroleum production, an industry with considerable environmental and social

impacts. More than 60 million tonnes of plastic are produced annually, and forecasts are for this amount to increase by a third by 2025. A wide range of chemicals is also used in plastic, with little data on their properties publicly available.

How we currently design, produce, consume and dispose of plastics is highly unsustainable and inefficient. As one of the most widely used materials in countless products, plastic requires a comprehensive approach, which will minimise its environmental footprint. There are considerable impacts throughout the entire plastic lifecycle, which is why it is crucial to rethink the place of plastics in our society, as well as develop the necessary tools and consolidate the existing initiatives, to provide solutions for a more responsible approach to plastic.

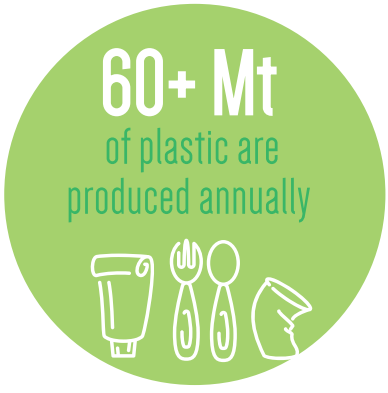
The EU Plastics Strategy aims to address a number of challenges related to this material, acknowledging that *there is an urgent need to tackle the environmental problems that today cast a long shadow over the production, use and consumption of plastics*[1]. This is in line with the objectives set in the EU's 7th Environmental Action Programme (7 EAP) entitled *Living well, within the limits of our planet*[2]. The global context for this work is the United Nations' Sustainable Development Goals and the Strategic Approach to International Chemicals Management (SAICM)[3]. The two latter documents aim to ensure sustainable consumption and production patterns, and environmentally sound management of chemicals and all wastes throughout their lifecycle[4].

The systemic change needed to achieve some of the 7 EAP objectives gave rise to a political focus on the circular economy[5]. The resulting Circular Economy Action Plan includes several measures covering the whole material cycle, from production and consumption to waste management and the market for secondary raw materials. The proposed actions aim to contribute to the transition to a circular economy by "closing the loop" of product lifecycles through an increase of recycling and reuse, benefitting both the environment and the economy[6].

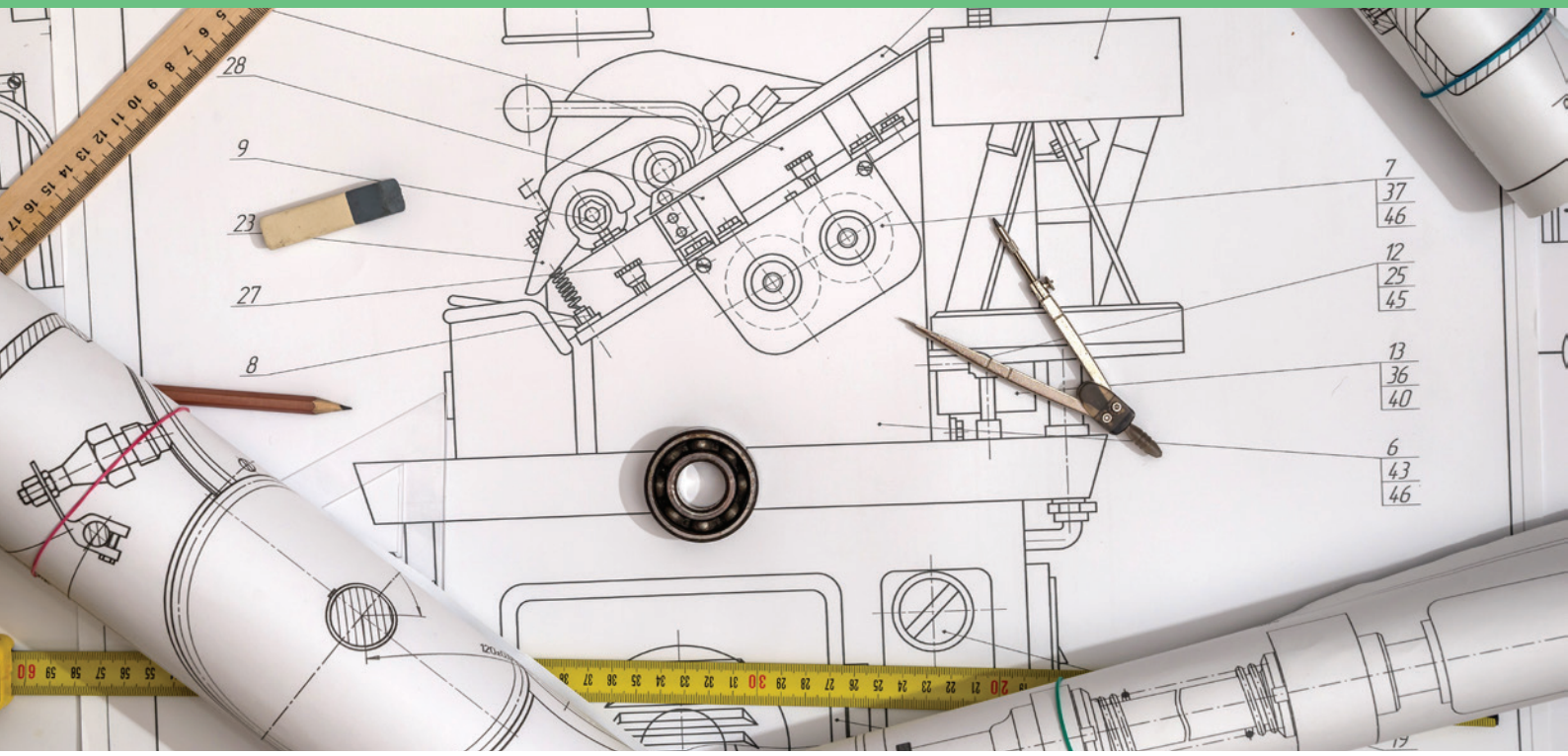
The role of plastic and products containing plastic in the transition to a circular economy is extremely important: how we design, produce and use them has a huge impact on the economy, society and the environment. By recirculating plastic products instead of throwing them out, not only is the value of products and components retained, but also the demand for virgin materials decreases, as does the energy demand and the production of (hazardous) waste. Additionally, this can lead to reducing other environmental impacts such as greenhouse gas emissions.

Smart design of products from the perspective of clean material cycles is another prerequisite for circularity: to reuse, refurbish or recycle products, we must be able to rely on the intrinsic safety of the materials from a health and environmental point of view. Avoiding the use of hazardous or persistent chemicals in products can increase the potential for their recyclability or reuse.

This report aims to help shape priorities of the EU Circular Economy and Plastics Strategies through a comprehensive analysis of the existing policy tools which could drive a more environmentally-sound design of plastic and products containing plastic. In addition to identifying the gaps and EU regulatory needs, the report puts forward a set of policy recommendations highlighting where action needs to be prioritised.



2 Ecodesign principles for plastic products



Prior to identifying tools that could drive a more environmentally-sound design of plastic and products containing plastic, it is essential to establish a common understanding of ecodesign principles as they can be applied to plastic products in a circular economy. Since clean material cycles are a key lever for circularity, the report also focuses on chemicals, why they are used in plastic and how they can be released into the environment.

Plastic in a circular economy

A closed loop economy[7] is not a new concept. It was already described by Walter Stahel in 1982. A vision of the circular economy and its strategies from a product perspective includes Stahel's four "R" loops: reuse/maintain, repair/recondition, remanufacture and recycle. It emphasises the importance and strength of the inner circles to maintain value in terms of product integrity, complexity and encompassed energy. To deliver a circular economy, product design should seek to ensure that products and components can be reused as much as possible, and material components of products can be easily recycled.

A recent European Commission report on plastic in the circular economy[8] explains that *product design requires that stakeholders co-operate, bring together knowledge and share the responsibility for creating a circular system*. In the case of plastic, these stakeholders include polymer producers, plastic compounders and converters, product designers, brands (product manufacturers), logistics companies, municipalities, collection and sorting organisations and plastic recyclers. More collaboration and transparent communication between these actors are needed if circularity is to become a reality.

Figure 1 illustrates the circular product and material lifecycle as applied to plastics.

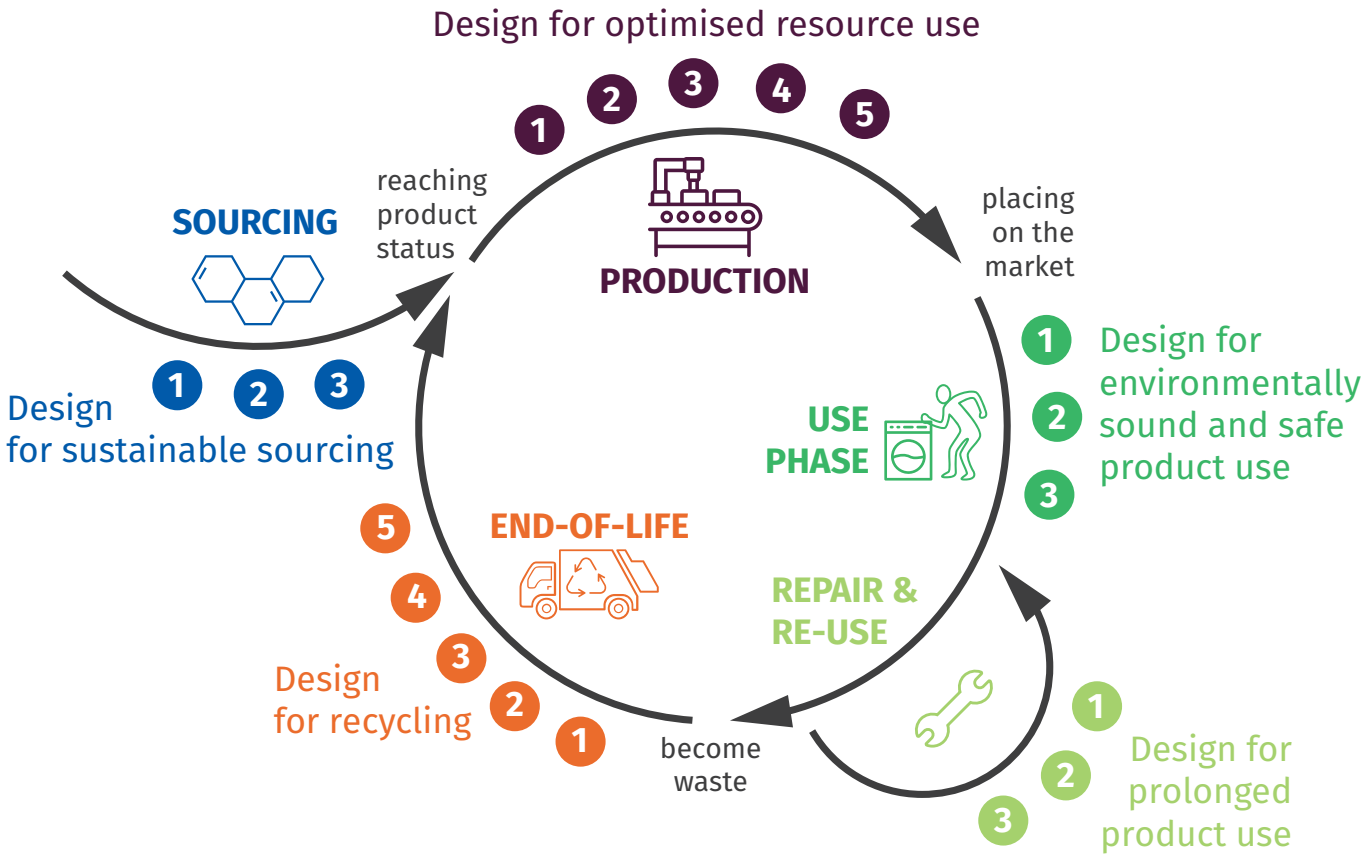


Figure 1: Circular product and material lifecycle

Product design heavily influences a product's lifecycle impacts and is crucial for connecting different stages along the lifecycle. In this context, product designers can explore different, complementary strategies: service-based consumption and products, better recyclability and recycling and/or prolonged product lifetime through durability, modularity and repairability.

This points to the importance of product policies, which should ideally steer the product designer and target all stages of the lifecycle of a product or material. Several strands of EU policy already address resource and material efficiency as well as sustainability of products with instruments that partially address aspects critical to the transition to a circular economy.

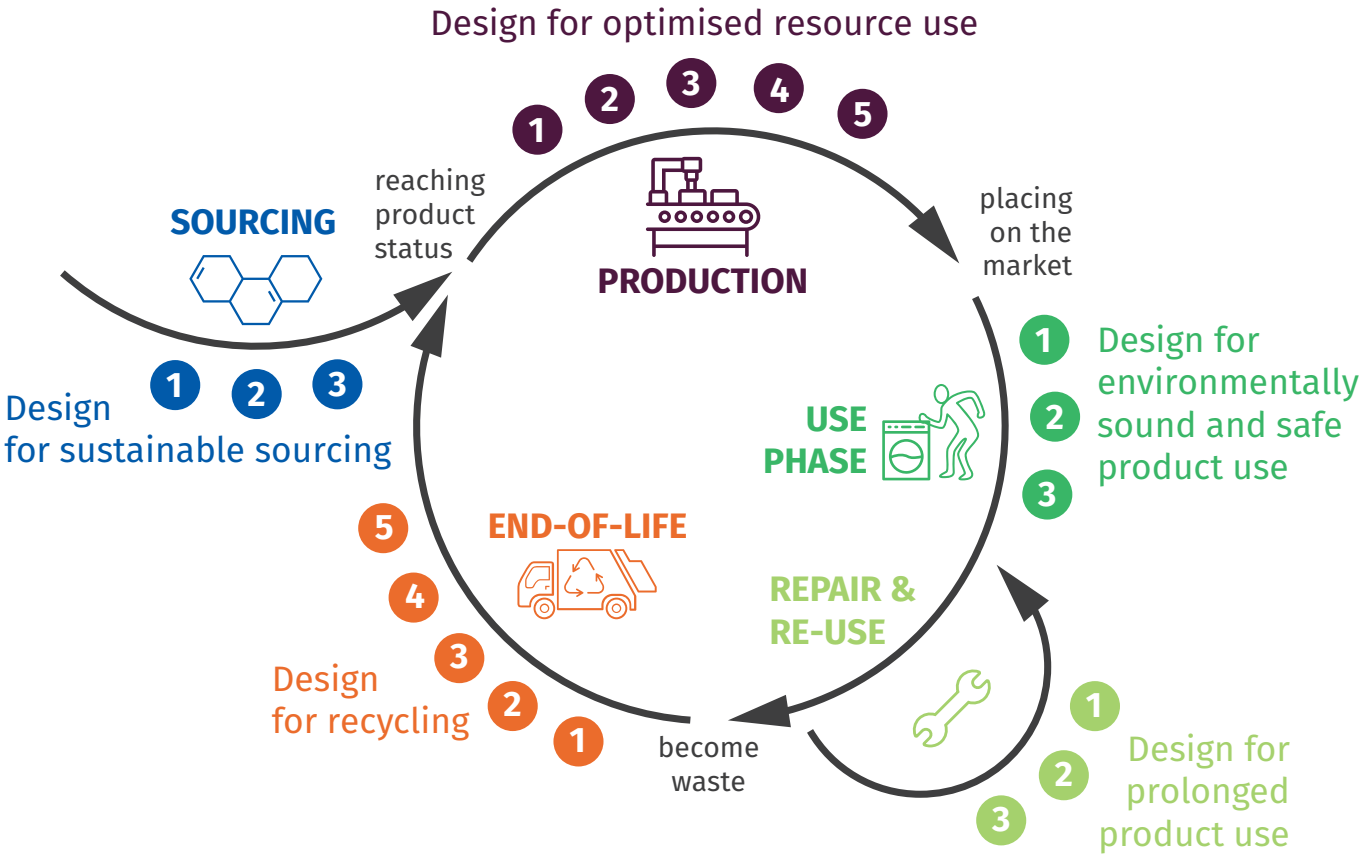
Ecodesign principles from a lifecycle perspective

Design choices have an impact on various stages of the material and product lifecycle. They are key drivers in enabling more circular products because they facilitate the introduction of novel business models, enable re-use and recycling and provide opportunities for integrating re-used parts or recycled material into new products.

For the purposes of this report, five main ecodesign principles are used which influence the various stages of the lifecycle of plastic:

- design for sustainable sourcing;
- design for optimised resource use;
- design for environmentally sound and safe product use;
- design for prolonged product use;
- design for recycling.

These are illustrated in Figure 2, and a more detailed outline of the principles is provided in Annex A.



Design for...

...sustainable sourcing

1. Virgin raw materials from sustainably managed production processes
2. Sourcing renewable raw materials from sustainably managed sources
3. Traceable recycled materials as secondary raw materials

...optimised resource use

1. Avoid unnecessary plastic use
2. Reduce amount of plastic material
3. Use recycled material not containing hazardous substances
4. Use of biobased plastic materials from sustainable sourcing
5. Use plastics with lower embedded energy

...environmentally sound and safe use phase

1. Minimise exposure to substances of concern during use
2. Minimise particle emissions during use
3. Minimise likelihood of littering

...prolonged product use

1. Reusable plastic containing products
2. Repairable plastic containing products, including modularity, easy disassembly and availability of spare parts
3. Durable and upgradable plastic containing products

...recycling

1. Collectable & sortable products
2. Easy dismantling of products
3. Use of recyclable polymers and polymer blends using existing recycling infrastructure
4. Targeted and informed re-use of specific technical properties including specific functional additives
5. Eliminate substances of concern

Figure 2: Ecodesign principles applied to plastic products

It should be noted that biomass as a raw material for plastic is included as an ecodesign approach in the study due to its potential to mitigate resource depletion in the long run. However, it cannot be considered that the substitution of fossil raw materials with sustainably sourced bio-based feedstock is an ecodesign approach in itself, if the following underlying issues are not addressed:

- The same biological resource and piece of land can be used to produce food, materials or energy. This calls for a prioritisation of the possible uses of biomass so as to maximise their environmental and social values. The so-called cascading use of biomass principle[9] indicates that food should be prioritised over materials, which can then offer a second useful life in the form of nutrients and, lastly, can be converted into bioenergy.

- More importantly, the overuse of biological resources altogether should be tackled. Biomass, and the resources needed such as land, water and nutrients to grow and convert such biological resources into useful products, are all limited and require time to grow and regenerate. Before considering the potential of biomass to mitigate resource depletion, it is important to define how much can be produced without going beyond the Earth's carrying capacity.

Spotlight on chemicals in plastic

Avoiding the use of hazardous chemicals in products is essential to increase the potential for recyclability or reuse of plastic products. This section describes why and when substances with hazardous properties are included in plastic products, and how humans and the environment may be exposed to these.

As illustrated in Figure 3, hazardous substances are introduced into plastics at various stages of the material lifecycle:

- The impurities originating from the raw materials used for plastic production are a first source of hazardous substances. Crude oil, for example, contains a mixture of substances including polyaromatic hydrocarbons, which are very persistent in the environment and can have carcinogenic effects in humans.

- Hazardous substances are also used during the production of polymers: monomers gained from crude oil on the one hand, are used to form new molecules of the later plastic; processing agents, on the other hand, facilitate the polymerisation process and are either bound to the polymer or are dissolved in the virgin polymer matrix.

- Technical properties of polymers can be adapted to the specific functional needs (e.g. UV resistance, fire resistance or bending properties) by including specialised additives. Besides their functional benefits, many of these additives also have hazardous properties.

- Hazardous substances can enter the polymer matrix of plastic products as a result of their use, e.g. packaging of hazardous chemicals. In this case the hazardous substances can migrate into the polymer matrix and make plastic recycling problematic.

- The cross-contamination between waste streams during the collection of plastic waste can also lead to the inclusion of hazardous substances.

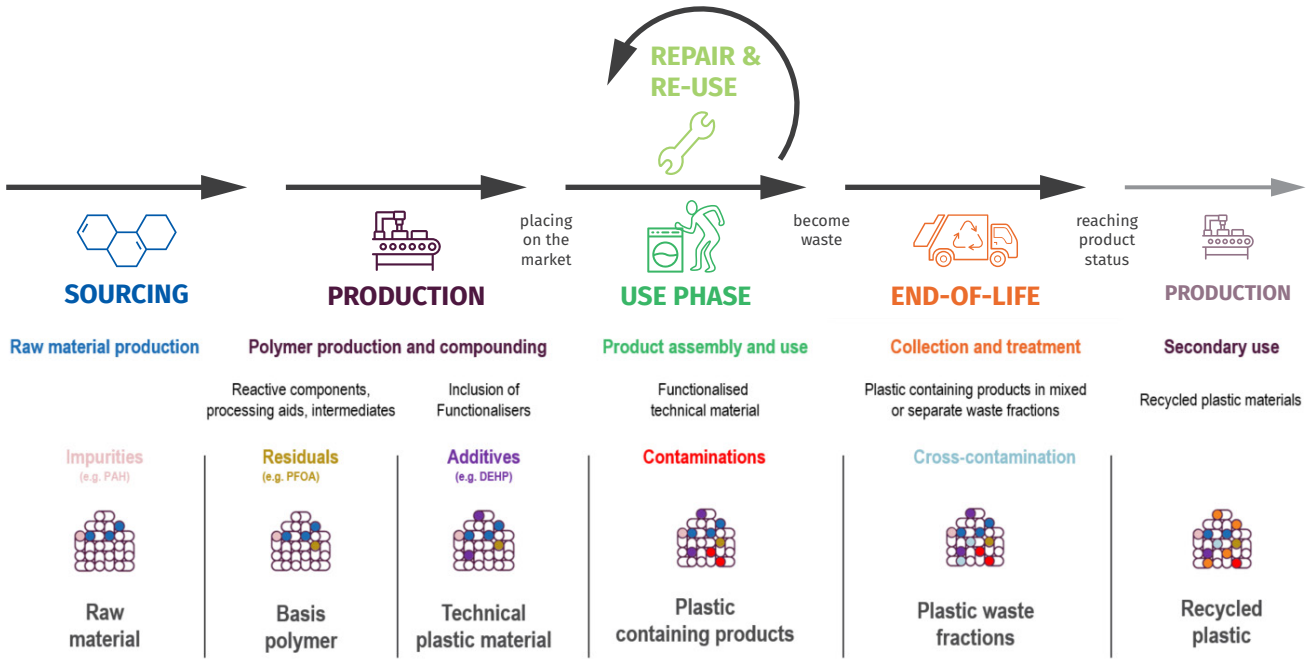


Figure 3: Pathways for hazardous substances in plastic materials

Most substances included in plastic have a certain potential to migrate from the polymer matrix, which can lead to human and environmental exposure to these substances. The European Chemicals Agency (ECHA) recently published a report on additives in plastic, in the context of the EU Plastics Strategy. For the first time, a list of substances used was made public, and according to ECHA *for many of these substances, there are significant uncertainties on hazard characteristics and on releases from plastic matrices*[10].

Human exposure may result from direct skin contact or via oral intake or inhalation of emissions from the product. Another route is the so-called exposure of "man via the environment". In these cases, the chemicals are emitted to the air, water or soil and are taken in from other sources such as food. These chemicals emitted to the environment can also have harmful effects on plants and animals, putting environmental health at risk for future generations.

3 Assessment of existing policy tools

The existing EU policy framework was analysed to identify tools that can contribute to the environmentally-sound design of plastics and products containing plastics. Several sector-specific, product-specific and horizontal legislative instruments were selected, as well as European standards (see Annex B for a detailed list of tools).

Sector-specific legislation was identified based on the sectors using high volumes of plastics: with more than 75% of plastic demand from the packaging, building and construction, automotive and electrical and electronic equipment sectors (Figure 4), these were prioritised. Furniture and textiles were added to this list as two other key sectors using plastic[11].

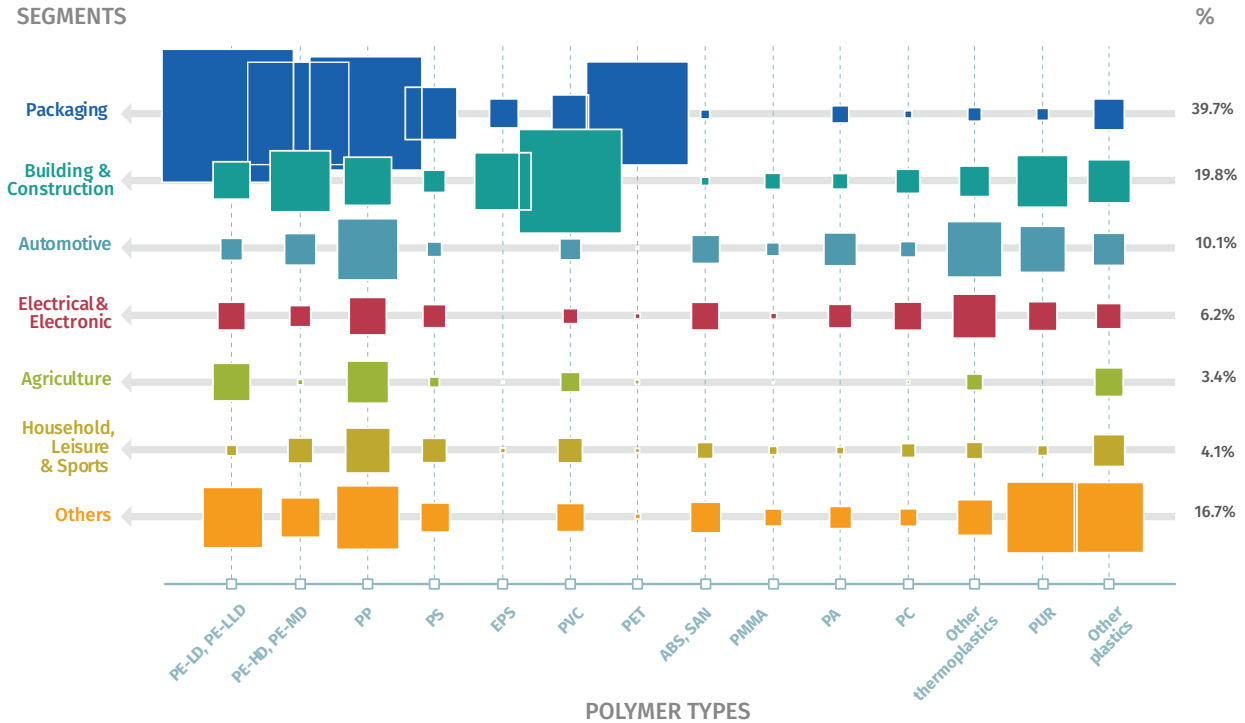


Figure 4: European plastic converter demand by segments and polymer types (2017)[12]

Source: PlasticsEurope Market Research Group (PEMRG) and Conversio Market & Strategy GmbH

The existing EU policy framework was assessed to see how the tools currently in use integrate the identified ecodesign principles as applied to plastic products. The next step was to identify how the implementation of the tools could be improved to unlock the remaining potential for plastic in a circular economy. The Ecodesign Directive's Voluntary Agreement (VA) on imaging equipment[13] was chosen as a case study to illustrate this methodology.

Case study: Voluntary Agreement on imaging equipment

ASSESSMENT OF THE TOOL

The Ecodesign Directive, which looks at reducing the environmental performance of products by setting minimum performance requirements, allows in certain cases for industry stakeholders to develop self-regulation initiatives called voluntary agreements.

While experience has shown that these, including the three voluntary agreements now in place, are less efficient than binding regulations applicable to all products, the imaging equipment voluntary agreement entails a number of resource efficiency requirements (see Figure 5) of relevance to this study. More concretely, it includes criteria on:

- Informing consumers of the percentage of post-consumer recycled plastic content, calculated as a percentage of total plastic (by weight) in each product;
- Using recyclable polymers: casing parts with a mass greater than 100g have to consist of one single polymer or a polymer blend. All plastic casing parts may only consist of up to four separable polymers or polymer blends;
- Availability of spare parts and ease of dismantling.

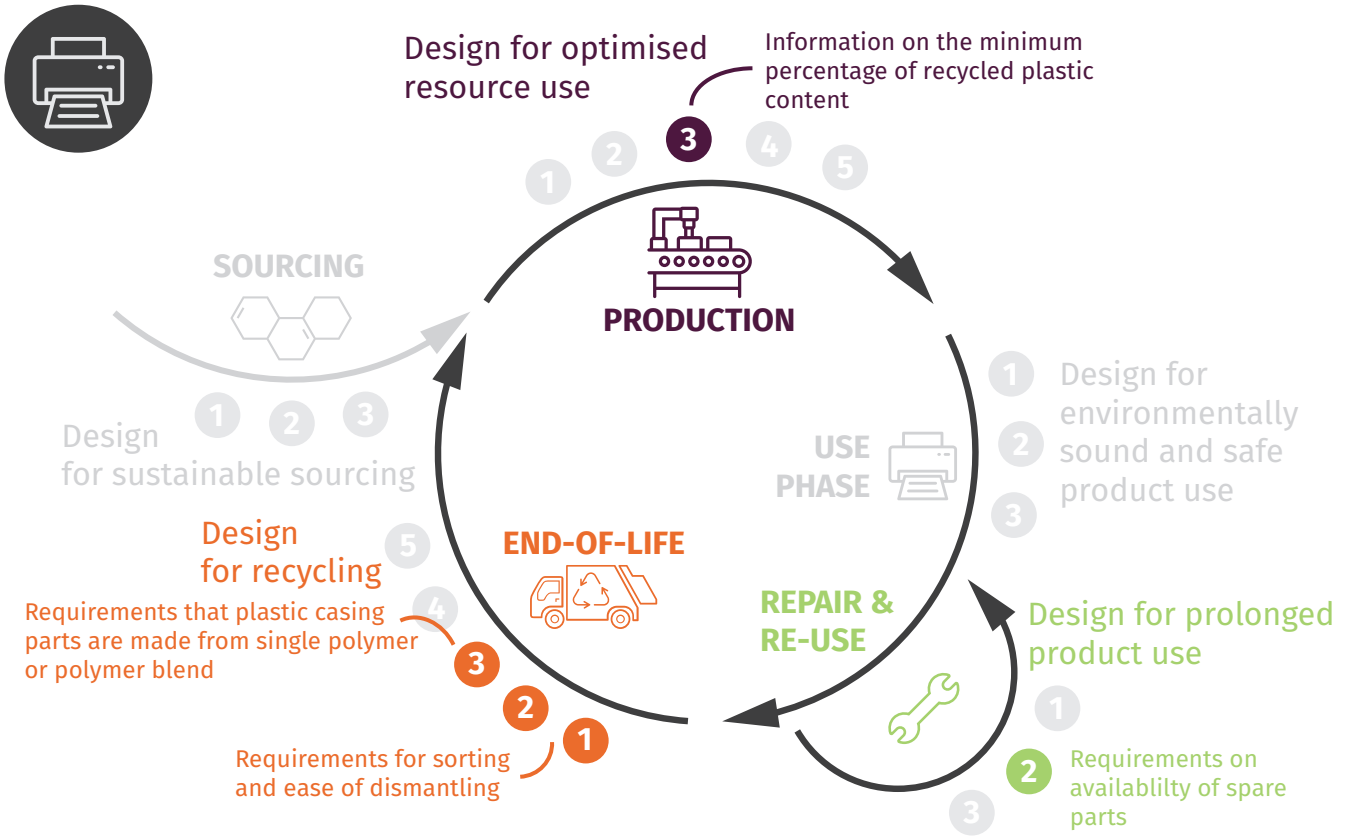


Figure 5: Existing ecodesign principles in the Voluntary Agreement on imaging equipment

After the analysis of the policy tools identified, it was concluded that the existing EU policy framework has a very fragmented approach to addressing material efficiency and chemical composition design requirements. Table 1 provides a visual intepretation of the assessment.

Detailed analysis

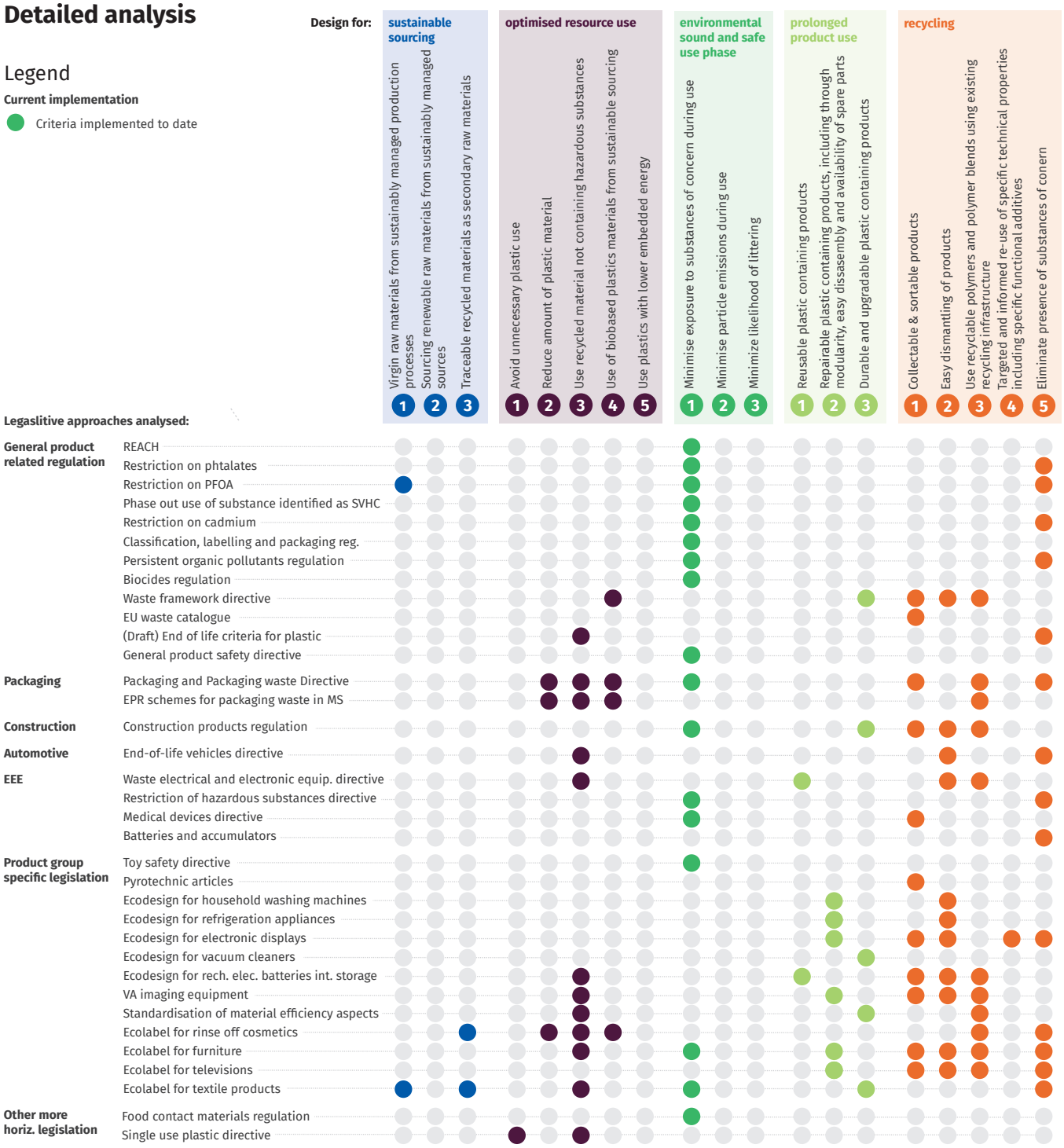


Table 1: Current implementation of ecodesign principles within the list of identified policy tools

ASSESSMENT OF THE TOOL'S POTENTIAL

Based on this review, suggestions for a deeper integration of ecodesign principles were identified according to two possibilities:

- A requirement currently included in some tools could be applied to others;
- Existing criteria could be strengthened.

Within the imaging equipment case study, we identified the relevance of a requirement currently implemented in the Ecodesign regulation on vacuum cleaners[14]: *the hose, if any, shall be durable so that it is still useable after 40 000 oscillations under strain*. Consequently, we concluded that targeting the functional lifetime of plastic parts could be applied to other products, via for example product-specific implementing measures under the existing Ecodesign Directive.

Similarly, the imaging equipment voluntary agreement, which requires communication of information on the percentage of recycled plastic content, could be applied to other product groups, and it could be strengthened at the same time. Indeed, it could be valuable to use this requirement as a "hook" for investigating and coupling a binding minimum recycled content requirement for specific plastic parts.

Following the same reasoning, the remaining potential for including requirements related to additional ecodesign approaches was identified and is illustrated in Figure 6.

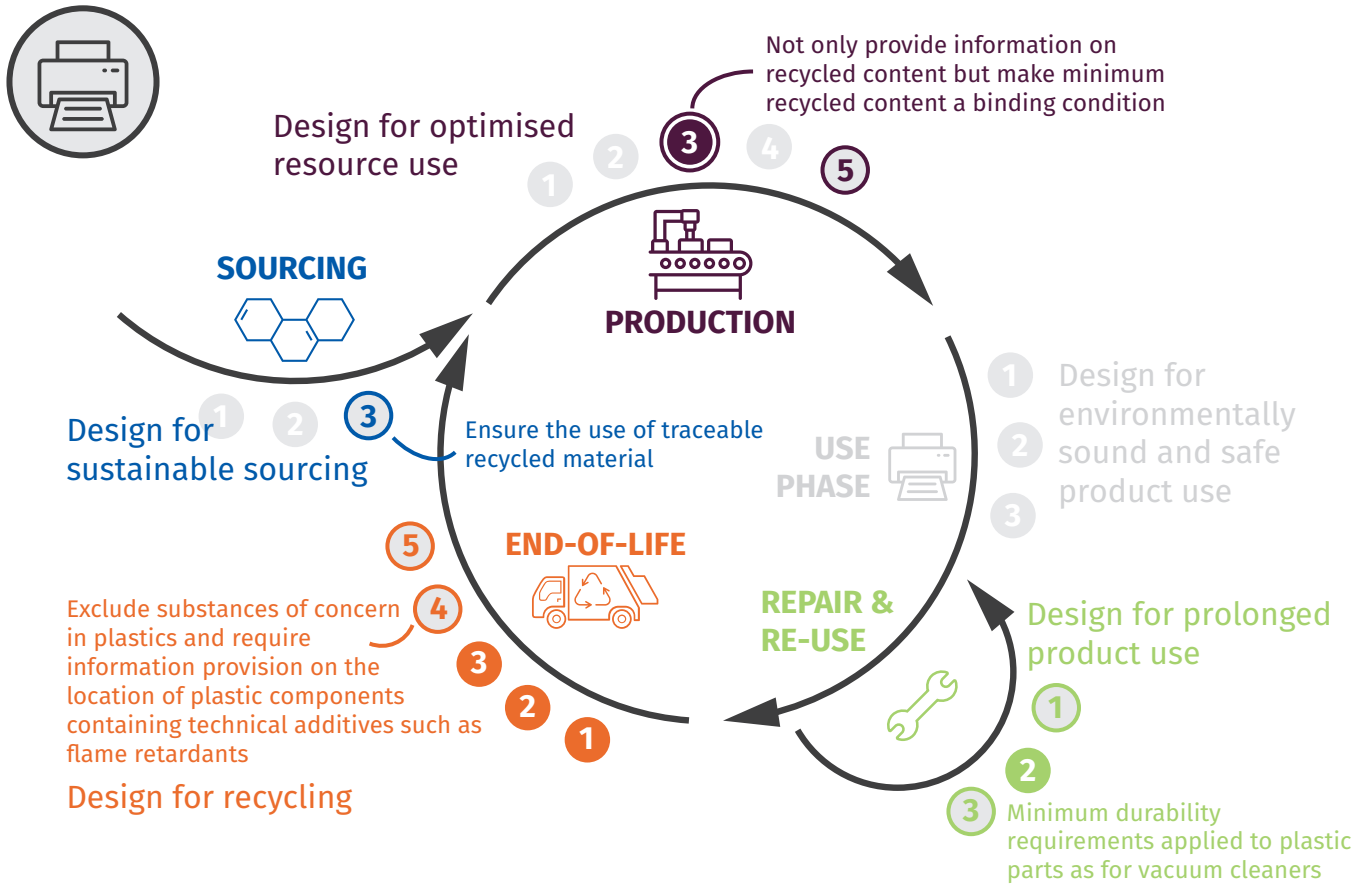


Figure 6: Remaining potential for ecodesign principles in the Voluntary Agreement on imaging equipment

All policy tools, voluntary standards and schemes listed in Table 1 were analysed according to the same methodology presented in the case study. The results of this assessment are illustrated in Table 2.

Detailed analysis

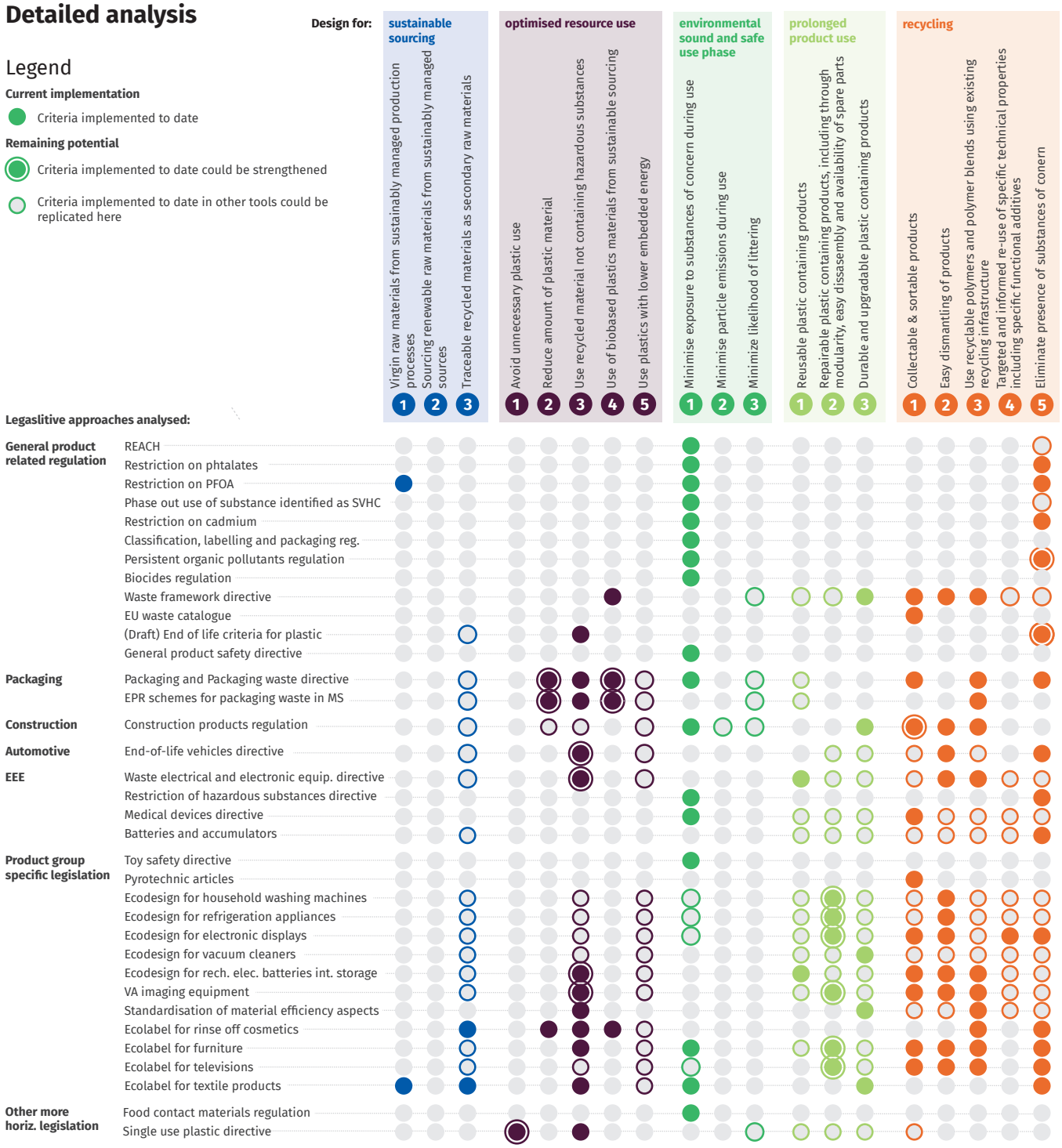


Table 2: Current implementation and remaining potential for including ecodesign requirements within the list of identified tools

Based on this analysis, we could extract a picture of current design requirements in place aiming to drive the circular economy of plastic.

Assessment of outcomes per design principle

Despite decades of occasional attempts at developing a coherent EU sustainable product policy – whether through Integrated Product Policy or Sustainable Consumption and Production and now through the Circular Economy – there is still little to show for the work delivered. The circular economy agenda could be a helpful lens through which to look at sustainability from a more targeted perspective, and therefore result in a more effective development of policy tools. Product design for circularity can address key issues of material health and sourcing, chemicals used in products, recycled content, and the ongoing work relating to durability (repairability, remanufacture, reuse, etc.). The overview below presents a picture of current design requirements in place aiming to drive the circular economy.

DESIGN FOR SUSTAINABLE SOURCING & OPTIMISED RESOURCE USE

Over the past years, several EU tools on products and waste have started to integrate considerations relating to the ecodesign approaches on sustainable sourcing of raw materials and optimised resource use. These include the End-of-life Vehicles (ELV) Directive, the WEEE Directive and the Ecolabel for furniture, which seek to promote the use of recycled content in new products. Plastic as a material is also quite frequently targeted, with specific criteria on the integration of recycled plastic content becoming more and more prominent in the existing policy tools.

The iconic Plastics Strategy includes a dedicated set of EU measures[15] to implement its objectives which include the uptake of recycled plastic. Examples of measures meant to support the industry's efforts to use more recycled plastic include:

- An evaluation of regulatory and/or economic incentives for the uptake of recycled plastic content, notably as part of revised criteria under the Packaging and Packaging Waste Directive, the Construction Products Regulation and the End-of-life Vehicles Directive;
- An updated framework for Food Contact Materials in order to enable the approval of additional recycled polymer grades;
- The development of quality standards for sorted plastics waste and recycled plastics by the European standards body CEN;

- Ecolabel and Green Public Procurement criteria that provide further incentive to use recycled plastic;

- A framework for an EU-wide industry pledging campaign to secure commitments on recycled plastic content in new products to ensure that by 2025 ten million tonnes of recycled plastic is incorporated into new products on the EU market.

To date, the only legislative tool requiring a binding minimum recycled content is the Single Use Plastics Directive. It sets a target of 25% of recycled plastic in PET bottles by 2025 and 30% in all plastic beverage containers by 2030[16]. Under the Ecodesign Directive, the voluntary agreement on imaging equipment[17] includes a requirement to provide consumer information on the use of recycled material.

The European Ecolabel, a voluntary tool, includes relevant criteria for a number of product groups that can drive the demand for recycled plastic content. On textile products[18] and on furniture[19], quantitative information on minimum recycled content is required. For textile products, *staple fibres shall at least contain 50% recycled PET*, and this requirement is coupled with the assessment and verification of the recycled content through third-party certification. Criteria for rinse-off cosmetics require a signed declaration of the recycled or renewable content of the packaging[20].

Current results of the industry pledging campaign indicate that while the commitments of plastic recyclers can easily reach the set target for 2025, the cumulated amount of recycled content uptake pledged by buyers of recycled plastic materials does not reach the ten million tonnes target. Plastic converters and manufacturers are reluctant to commit to ambitious amounts of recycled content due to a lack of certainty about the quality of plastic recyclates in the absence of common design guidelines and standards[21].

DESIGN FOR ENVIRONMENTALLY SOUND AND SAFE USE PHASE

The EU Plastics Strategy aims to follow up on the Commission Communication on the interface between chemical, product and waste legislation in order to improve the traceability of chemicals and to address the issue of legacy substances in recycled waste streams. The lack of information about substances of concern in products and waste has been discussed as the primary issue in the summary report of the EU public consultation[22] on this topic. Stressed by the United Nations[23], this alignment between chemicals, product and waste legislation has also been emphasized by the OECD as crucial for ensuring cross-border compliance regulating the use of substances of concern[24].

In order to limit exposure to hazardous substances, existing overarching chemical legislation such as REACH and the Persistent Organic Pollutants (POPs) Regulation as well as sector- or product-specific legislation (e.g. construction products, medical devices or toys) rely on two basic mechanisms:

- The restriction of substance use for polymer production or functionalisation of plastic materials;

- The limitation on the maximum content of hazardous substances.

However, current hazard control within plastic material loops still has several gaps and loopholes closely connected with the fundamental problems originating from missing information needed to identify existing risks in targeted and fact-based processes.

The functioning of all existing regulations relating to substances of concern in plastic products or during their production relies on the establishment and provision of strong data, understanding and information relating to the fact that a continued release, use or presence of a specific substance causes an “unacceptable” risk to society. However, the risk assumptions with regards to substance properties can be very broad, and data to support adverse effects on humans and the environment is often subject to interpretation and can be controversial. As a result, there are few horizontal, grouped measures taken to date when it comes to substances of concern in plastic.

In most cases, risks related to the use of specific substances in plastic must be demonstrated on a case-by-case basis to allow the setting of limits on their use or presence in plastic materials (e.g. DEHP in plasticised material in toys and childcare articles[25]). However, a number of elements are currently missing, such as a structured overview on additive substances, the functionalisation provided for the different types of polymers, respective typical amounts/shares needed and possible alternatives.

As stated earlier, the European Chemicals Agency (ECHA) and a number of market actors carried out for the first time a mapping exercise[26] on additives and it resulted in a set of interesting conclusions, for example on their possible release from the polymer matrix. Nevertheless, this can only be seen as a start, as much information on their use in technical material remains unknown.

DESIGN FOR PROLONGED USE

In its Ecodesign Working Plan 2016-2019[27], the European Commission stated that *Ecodesign should make a much more significant contribution to the circular economy, for example by more systematically tackling material efficiency issues such as durability and recyclability*. Since then, resource efficiency measures are to be systematically considered when developing or reviewing Ecodesign Directive implementing measures.

The present mapping and assessment have shown that several pieces of the product policy framework pursue durability objectives:

- The Ecodesign regulation for vacuum cleaners[28] is to date the only policy tool having a minimum durability requirement on a plastic part, i.e. the hose.

- Progressive repairability measures have been introduced in several Ecodesign Directive implementing measures in 2019. These include requirements on the availability of spare parts for a minimum number of years (e.g. refrigerating appliances[29]), the availability of repair and maintenance information (e.g. household washing machines, including a disassembly map or exploded view[30]); and the ease of disassembly of key parts (washing machines[31]).

- The EU Ecolabel, a tool targeting top performing environmental products, also includes requirements on the availability of spare parts for furniture[32].

Following its 2018 revision, the Waste Framework Directive[33] now sets general rules to improve the performance of Extended Producer Responsibility (EPR) schemes across the EU. EPR puts an obligation on producers to take operational or financial responsibility for the end-of-life phase of their products. In particular, EPR schemes can set levels of financial contributions paid by producers for their products according to their durability, repairability, reusability and recyclability as well as the presence of hazardous substances, thereby taking more of a lifecycle approach.

No examples of existing policy tools including requirements driving the design of reusable plastic-containing products have been identified. However, this objective is mentioned in the Ecodesign Directive preparatory study on rechargeable electrochemical batteries[34]. The European Ecolabel on furniture also includes a criterion requiring the provision of information to consumers on the best way to dispose of the product, ranked according to their impact on the environment, such as reuse, take-back initiatives by the product manufacturer, etc.

DESIGN FOR RECYCLING

The 2018 China ban on imports of plastic waste severely affected Europe's plastic waste management practices. With ever increasing inflows of plastic material and not many options to process them, increasing Europe's recycling capacity became a matter of urgency. As a result, the EU Plastics Strategy dedicated much of its focus to increasing plastic recycling rates and to building recycling infrastructure throughout the continent.

The Plastics Strategy also seeks to improve the quality of recycling, notably by improving product design[35]. Requirements for designing plastic to be recyclable are foreseen as part of the revision of the Packaging and Packaging Waste Directive, Ecodesign Directive measures, as well as through the follow-up to the European Commission communication on the interface between chemical, product and waste legislation in terms of traceability of chemical content.

Our mapping has shown that current policies and regulations aiming to facilitate the recycling of plastics through design requirements revolve around actions to help the identification, separation and sorting of plastic, including those containing specific additives such as flame retardants.

A recent Ecodesign Directive legislation on electronic displays[36] requires the marking of plastic components for any plastic heavier than 50g, as well as the indication of the type of polymer or polymer mix using standardised symbols and punctuation[37], and indication of the location of plastic parts containing flame retardants. In addition, halogenated flame retardants are excluded from casings and stands, a first for the Ecodesign Directive. Similarly, the EU Ecolabel criteria on furniture require marking of plastics with a weight above 100g, as well as the written specification of fillers, plasticisers or flame retardants present in proportions greater than 1% by weight.

Some Ecodesign product requirements also include design for dismantling, such as the regulation on household washing machines[38]. The voluntary agreement on imaging equipment goes further in that it sets a maximum of four separable polymers or polymer blends in plastic casing parts.

At national level, EPR schemes in France, Germany and Italy have introduced variations on producer fees according to the recyclability of their products[39].

4 Policy recommendations

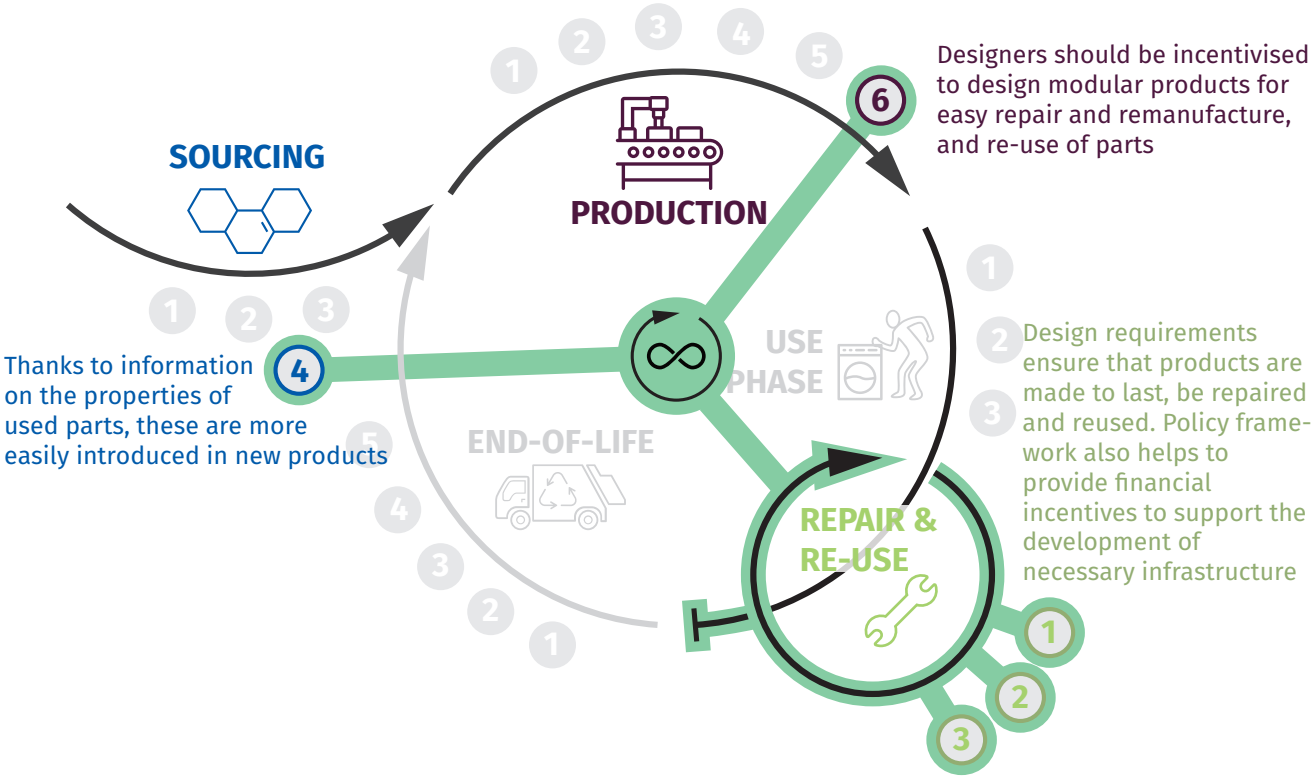
Based on the assessment, four clusters of policy recommendations were developed, which would pave a more effective way towards a circular economy:

- Design products and systems for longer lifetimes;
- Make products easier to recycle;
- Close the loop through recycled content;
- Focus on chemicals for circular products and materials.

While product durability, product recyclability and recycled content in products target specific aspects of the product lifecycle, chemicals in materials and products is a horizontal aspect key for unlocking the potential of the three others.

Given the focus on key products where plastic is currently used, most of the recommendations apply to the following sectors: packaging, building and construction, automotive, electrical and electronic equipment, furniture and textiles.

Recommendation I: Design products and systems for longer lifetimes



In its Circular Economy Action Plan[40] the European Commission states: *In a circular economy, products (...) have a long lifetime, due to a durable design. In case a product breaks, it is repaired. When a consumer no longer needs a product, it is passed on and reused by another consumer, or products are shared from the outset.* Yet measures to prolong product lifetime are still only sporadically implemented across various policy tools, with durability actually integrated for the most part in a few Ecodesign Directive individual product legislations, and the EU Ecolabel.

Durability is relevant to all product groups using plastic, and especially to furniture, textiles and construction products, for which significant legislative gaps remain. The positive precedents identified in the Ecodesign product regulations need to be applied to all key plastic-containing products, and not just be limited to a few energy-related products as is currently the case.

EU product policy needs considerable development and can be aided by experience from the Ecodesign Directive to know how to formulate requirements for different circularity aspects, as

well as recent experience from efforts on the Product Environmental Footprint for product-specific Life-Cycle Assessment (LCA) approaches. It is high time to export the ecodesign approach beyond the current narrow application and ensure that circular design requirements are implemented, particularly by:

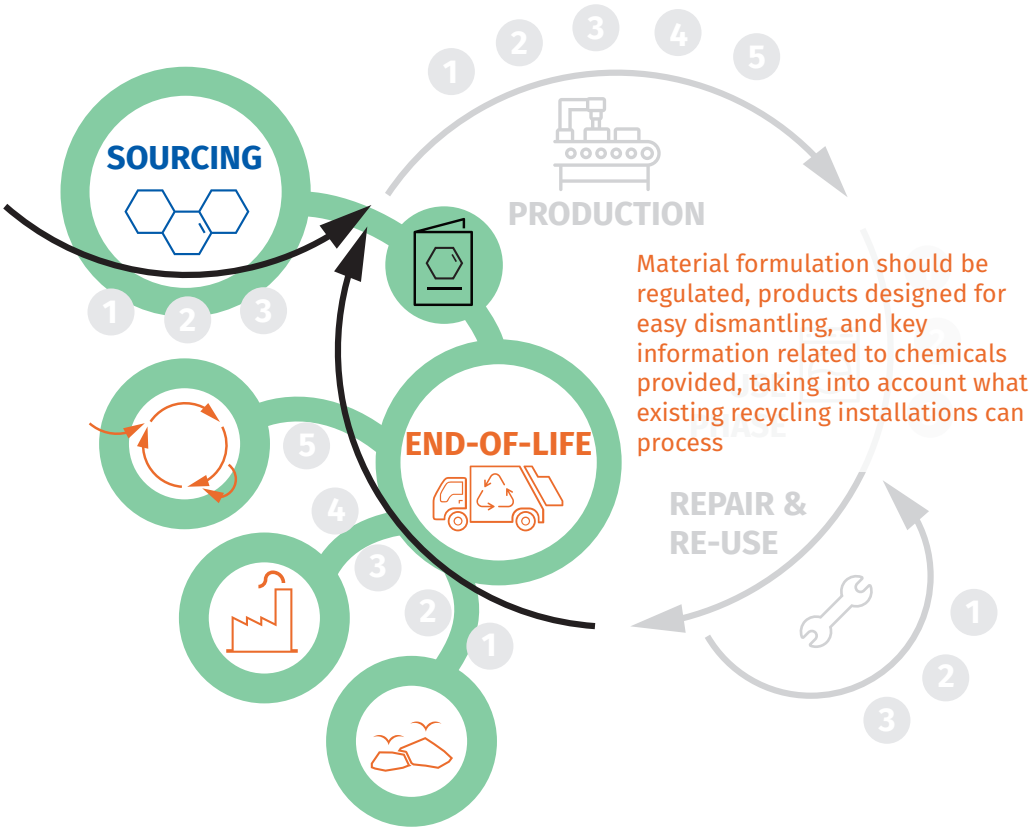
- **Ensuring minimum product durability** through durability requirements on most plastic products and parts as was done with the Ecodesign regulation on vacuum cleaners;
- **Guaranteeing repairability and modularity** to design products to be modular, with key parts being easily disassembled;
- **Facilitating reusability** through standardisation of products and parts per product type as was done for mobile phone chargers.

The realisation of such criteria would require the identification or development of assessment methods, notably to define how to assess product durability.

Product design for circularity will need to be mirrored by similar circularity efforts in relation to corporate business models and other market-based mechanisms that make circular business cases more obvious:

- **A dedicated reuse policy framework** is needed to support the development of the necessary reverse-logistics and infrastructure, including for example reuse centres and networks. EPR should be applied to mirror the level of re-usability, repairability, modularity and durability of products. A higher modulated fee could be applied for products which are to be recycled and these fees could serve to continue developing reuse infrastructure across the EU.
- **Demand for long lasting, repairable and reusable products** needs to be triggered, notably through public procurement criteria set to guide public authorities towards top products, as well as trustworthy labels for consumers.
- **Repair should become the norm** by providing all repair actors and end-user spare parts during a product's lifetime, technical documentation on products, and limiting repair cost through reduced levels of taxation or fiscal incentives.
- **Information on the specifications of the used parts** is needed to help reintroduce these parts into new products.

Recommendation 2: Make products easier to recycle



A circular economy needs to support the *quantity* and the *quality* of recycling, to boost confidence in the consistent supply of secondary raw materials as well as their quality. This confidence is important for both product manufacturers and citizens, to be able to trust the safety aspects of the materials used in production.

Supporting the quantity and quality of recycling demands EU policy requiring that products be made with secondary raw materials and be designed for easier recycling.

The Ecodesign Directive and the EU Ecolabel already provide examples of how to integrate key aspects of these in product requirements, such as the marking of plastic components[41], design for disassembly and dismantling, polymer composition, use of recyclable polymers[42] and availability of information on material composition.

There is much potential to further develop circularity by extending the existing requirements from one or several product groups to at least the other products forming the focus of this study, such as:

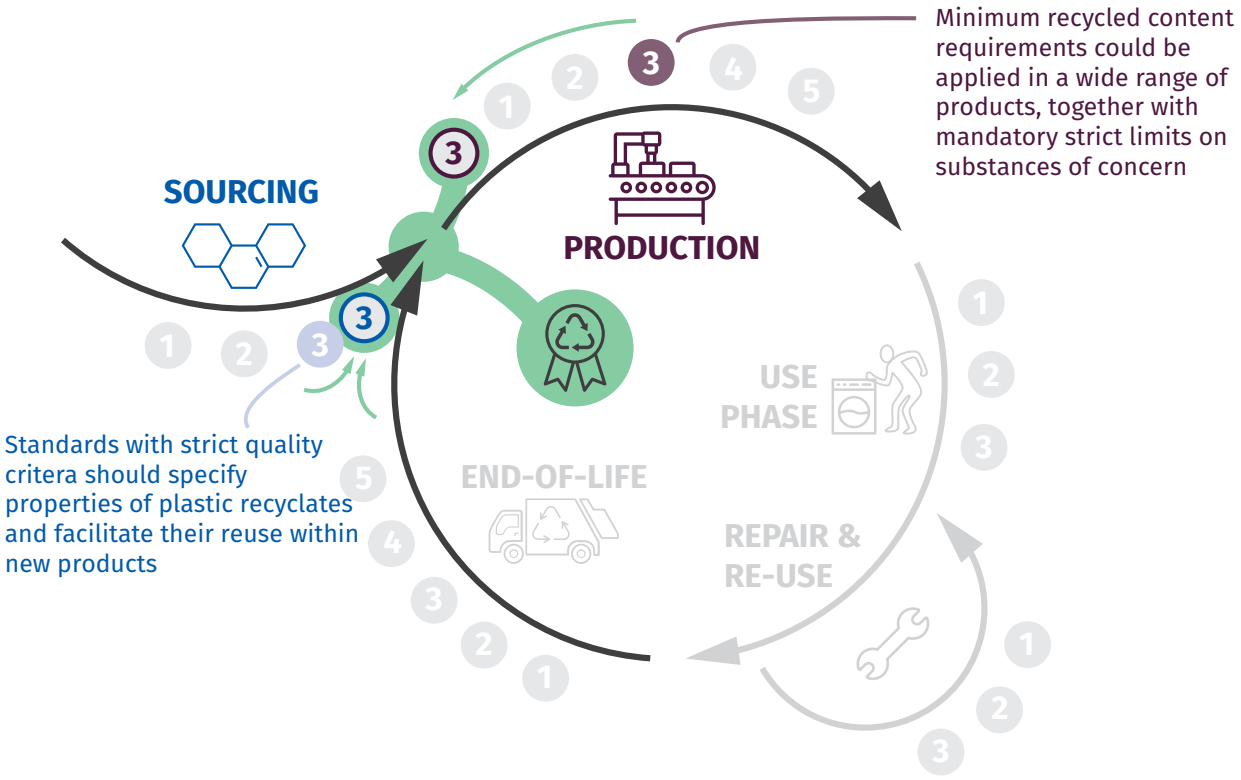
- **Polymer/material composition**: as for imaging equipment[43] and textiles[44], improved lifecycle environmental performance of certain products could be driven by limiting the types of polymers used in separately collected product groups. This could even evolve to consider replacing some plastics with other materials as part of material and chemicals considerations.

- **Dismantlability:** ease of dismantling requirements for imaging equipment and displays could be similarly applied to all other products considered in this study (with the possible exception of textiles).

- **Product circularity information:** mandatory requirements on provision of information such as the location on parts/components containing certain materials and substances, like with electronic displays and furniture, could be systematically envisaged. This information could help better identify how to responsibly manage the product: reuse, take-back initiatives, recycling, etc. There is also a strong link to potential chemicals-related developments elaborated in our fourth policy recommendation.

- **EPR and separate collection:** the way plastics waste is collected differs among municipalities and Member States. To be able to recover increased amounts of plastic material, there is a need to introduce EU-wide EPR guidelines as well as separate collection for specific product groups. Construction products merit particular attention.

Recommendation 3: Close the loop through recycled content



Most recent circular economy policy developments target the waste sector and are looking to create the necessary policy framework to improve Europe's recycling capacity, develop the necessary infrastructure and promote the use of recyclates in new products.

Recycled content in products can indeed help reduce pressure on natural resources, support the market for secondary raw materials and preserve embedded energy as part of circular value chains. The EU Plastics Strategy outlines a series of actions to boost the uptake of plastic recyclates as secondary raw materials, including future revisions of directives on packaging, construction products and end-of-life vehicles, as well as a dedicated industry pledging campaign. The Single Use Plastics Directive already requires a 90% collection rate of plastic beverage containers, and a mandatory recycled plastic content of 30% by 2030. Ecolabel criteria as well as some EPR schemes also include requirements related to recycled plastic content.

Based on these positive developments, EU policy could build on this to systematically introduce a mandatory minimum recycled content for plastic parts into the Ecodesign Directive and similar product legislation. This should be based on a sound, multi-criteria environmental assessment of available material or functional substitutes as the introduction of recycled plastic in products should not automatically support a continued use of plastic.

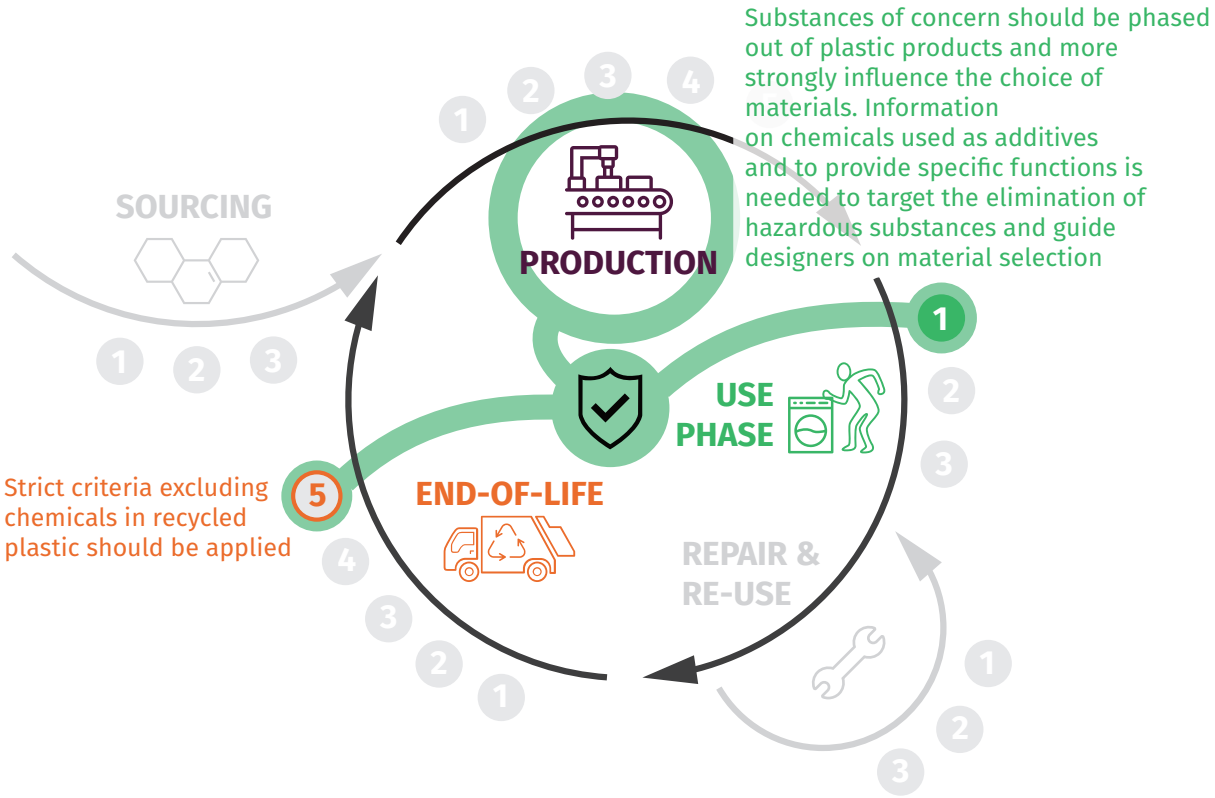
In a circular economy, potentially all products should aim to include a minimum amount of recycled content to maintain material value as long as possible within the economy and avoid the use of virgin natural resources. A selected range of products could be targeted as a start:

- IT products such as computers, smartphones, printers;
- white goods such as vacuum cleaners, kettles, washing machines;
- construction products such as pipes, windows and flooring;
- batteries, tyres and furniture.

The enforcement of such criteria requires a series of tools to support manufacturers in delivering the requirements:

- **Methodology for tracing and verifying recycled content levels:** certification schemes and standards based on traceability requirements and third-party verification should be further developed to verify the recycled content in products. Implementation of mandatory minimum recycled content could be based on the existing European standards on traceability aspects of plastic recycling[45] and on characterisation of plastics waste[46].
- **Developing categories of recycled plastic:** use of plastic recyclates in products could be further supported by establishing different categories of recycled plastics based on their technical properties and suitability for specific applications. The categories should also **specify strict limits on the presence of substances of concern** in such recycled plastics.
- **End-of-waste criteria for waste plastic:** these[47] have been repeatedly called for by many stakeholders and they are part of the Commission's conclusions[48] on the Plastics Strategy industry pledges.
- **Common design guidelines for plastic:** limited polymer grades per product type as well as **avoidance of specific chemical additives** in product formulations can help improve the quality of recycling and potentially deliver closed-loop recycling systems in the future.
- **Collection and sorting of plastic:** harmonisation of plastic materials accepted in European recycling systems is needed, including from construction and demolition waste to waste electronics and automotive parts. It can further contribute to obtain plastic recyclates of foreseeable properties and could be subject to a dedicated standardisation request towards the European standards organisations.

Recommendation 4: Focus on chemicals for circular products and materials



Chemicals aspects of EU circular economy efforts are less developed to date, but both the Council of Ministers[49] and the European Chemicals Agency (ECHA)[50] recognise the need for considerable effort in this area. Further work on circular economy action on the interface between chemicals, product and waste legislation, as well as on EU product policy is needed to take bold steps forward on other tools that limit exposure to hazardous substances. This work needs to be boosted by knowledge-gathering exercises such as has recently been delivered on additives in plastic[51].

Insufficient information about chemical content in material streams remains a bottleneck for the use of recyclates, affects the quality of recycled materials, may result in uncontrolled exposure of humans (especially vulnerable groups like children) and the environment to hazardous substances[52], and weakens consumer trust in products made from recycled materials.

Going forward, several chemicals-related needs linked to plastic (although many apply to other materials) will demand a more structured policy focus:

- **Strengthened chemicals aspects in product policy and ecodesign approach tools:** apart from the European Ecolabel, there is little product policy experience addressing chemicals aspects. The recent landmark Ecodesign decision to exclude halogenated flame retardants in electronic displays shows that chemicals need to and can be addressed. There is a potential to extend such exclusions to wider classes of chemicals and to envisage them across all products.

- **Structured data gathering on chemicals in plastic:** a comprehensive **overview on additives**, the functionalisation they provide according to polymer, typical amounts/shares, and possible alternatives would improve knowledge about additives used for technical plastic materials as this information is a prerequisite for any risk screening and informed, targeted regulatory activity.

- **Making REACH circularity-friendly:** work is needed to frame REACH within circularity, in order to prioritise substitution efforts and to drive elimination of hazardous chemicals in plastic, so that virgin and recycled plastics do not pose risk for human health or the environment. Authorisation exemptions need stronger justification than a given applicant's socio-economic situation, and better framing of exemptions considerations might avoid decisions such as allowing the endocrine disruptor DEHP in recycled plastic such as PVC.

- **Strict chemicals restrictions for recycled plastics:** linked to the recommendation on minimum recycled content, information gathering on chemicals in plastic needs to be fed into strict restrictions on end-of-waste (EoW) criteria for waste plastic and EU harmonised quality criteria standards for recycled plastic. EoW criteria should always apply to a substance or a mixture.

5 Conclusions

EU efforts on the circular economy clearly build upon the objectives, approaches and requirements of different pieces of waste legislation, while further "closing the loop" by starting to create a more coherent framework around product policy and related issues such as resource use and chemicals in products. A potential strength of the "circular" agenda is to sharpen the focus of activity through a more targeted lens than was previously done through "sustainable development" or "sustainability".

Future circular economy actions will need to set a path beyond the existing recycling objectives and tools, as well as extend beyond product policy tools such as the Ecodesign Directive and the European Ecolabel. Recent developments on material efficiency in the Ecodesign Directive and the stream of work on Product Environmental Footprint serve as examples of how progress can continue to be made.

Beyond applying the existing circularity requirements to other products, several activities should be prioritised to create more supportive framing conditions to facilitate the development of a circular economy.

Europe needs to develop a harmonised ecodesign approach to products, and apply and adapt it across different sectors, with coherence to other environmental objectives. An ecodesign approach needs to provide clarity to product manufacturers and distributors selling products on the EU market. This is best done through specific minimum product requirements providing the minimum performance levels of products to be allowed access to the EU market. Excluding poor performing products from the market remains one of the most effective ways of improving the EU's ecological footprint and changing consumer behaviour.

A circular economy needs circular infrastructure to make repair, reuse and remanufacturing easier and less costly. A systematic approach to building the reverse-logistics infrastructure will give more coherent structure to integration of circularity in end-of-life management legislation, which will need adapting to disentangle recycling activities from other "re- activities" higher up the waste hierarchy. Reflection on this key element of the circular economy might also identify more helpful solutions to the difficult question of what to do with products containing legacy substances than simply recycle and spread hazardous substances widely or incinerate. Other options are surely possible and deserve attention.

As a horizontal issue, chemicals in circular products and materials will need adapted lifecycle assessment tools to address the under-weighting of these issues compared to other, more easily quantifiable impacts. Chemicals management legislation will also need to be framed within circular economy needs, thereby reorienting the organisation of work (such as group restrictions, comprehensive information on chemicals) and affecting the decision-making process, as well as requiring a review of some decisions already taken (such as on DEHP in recycled plastics).

The quality of recycled plastic will need to be addressed through end-of-waste criteria and quality standards if confidence in recycled plastic is to be raised. The anticipated standardisation request on plastic remains an urgently needed puzzle piece in the circular economy of plastic.

Finally, further work is needed to better frame plastic circularity for certain products. A significant amount of plastic is used in construction products, furniture and textiles, with only construction products having a dedicated sectoral legislation in existence. Circularity in construction products would require a rethink on the design and implementation of the Construction Products Regulation, as part of a wider reflection on circularity in buildings, construction and demolition. As for furniture and textiles, these products have already been identified for potential sectoral legislation through the work on EU product policy in support of the circular economy. This work, however, needs to result in legislative proposals.

Next steps on circular economy are potentially numerous, but much work has already been done that can be built upon to take further steps on the journey. The new configuration of European institutions to come after the 2019 elections will not be starting from zero.

Annexes

Annex A

The Table below provides details on different ecodesign principles broken down into specific approaches for plastic and products containing plastic

Design principle	Design approaches	
Design for sustainable Sourcing (DfrS)	**Virgin raw materials from sustainably managed production processes**	e.g. sourcing of oil from sources without oil drilling in fragile eco-systems, likelihood of oils spills; sourcing from sources with meaningful environmental management systems in place
	Sourcing renewable raw materials from sustainably managed sources	e.g. avoiding food conflict, avoiding land-use changes, no sourcing from protected areas
	Traceable recycled materials as secondary raw materials	e.g. recyclers providing information about sources of recyclates and content of substances of concern (such as SVHC)
Design for optimised Resource use (DfoR)	**Avoid unnecessary plastic use**	e.g. by using non-material alternatives
	Reduce amount of plastic material	e.g. avoid over-packaging, over-design
	Use recycled material not containing hazardous substances	e.g. minimum recycled content
	Use of bio-based plastic materials from sustainable sourcing	more specifically: in the case where biobased plastic materials are used (e.g. to reduce use of fossil resources) the raw materials must originate from sustainably managed sources (see DfrS)
	Use of plastics with lower embedded energy	e.g. by using plastic types with lower cumulated energy demand (or virgin oil)

Design principle	Design approaches	
Design for environmentally sound and safe Use phase (DfsU)	**Minimise exposure to substances of concern during use**	e.g. using (old) plastic parts for stove heating in developing countries
	Minimise particle emissions during use	e.g by improving abrasion resistance
	Minimise likelihood of littering	e.g. by avoiding the need to separate small parts of the product before or during use
Design for prolonged Product use (DfpP)	**Reusable plastic containing products**	e.g. by designing at system level closed-loop take-back and re-use systems
	Repairable plastic containing products, including modularity, easy disassembly and availability of spare parts	
	Durable and upgradable plastic containing products	e.g. by increasing mechanical performance of plastic/-parts
Design for Recycling (DfR)	**Collectable and sortable products**	e.g. avoid paper sleeves or other materials covering the products surface in a way which hinders easy identification of a plastic product by the user
	Easy dismantling of products	e.g. use types of connections that allow separation of plastic parts under existing treatment conditions
	Use of recyclable polymers and polymer blends using existing recycling infrastructure	e.g. use of polymer types for which current recycling streams exist
	Targeted and informed re-use of specific technical properties including specific functional additives	e.g. re-use UV stabilised plastic for outdoor use
	Eliminate substances of concern	e.g. avoid SVHCs, avoid substances disturbing efficiency of recycling processes and secondary raw material quality

Annex B

The following policy tools were identified as relevant to plastic and included in the qualitative assessment

Policy tools selected for the mapping

GENERAL REGULATION	
Chemicals	**REACH regulation, including annexes with relevant restrictions and authorisations:** • Annex XVII Restrictions No. 51 (restriction on phthalates) • Annex XVII Restrictions No. 68 (restriction on perfluorooctanic acid (PFOA)) • Annex XIV Authorisation No. 4 (General ban of SVHC undermined by individual authorisations) • Annex XII Restriction No. 23 (restriction on cadmium)
	Classification, Labelling and Packaging (CLP) Regulation
	Persistent Organic Pollutants (POPs) Regulation
	Biocides Regulation
Waste	**Waste Framework Directive, including:** • EU Waste Catalogue • (draft) End of Waste criteria
Product Safety	**Product Safety Directive**
SECTOR-SPECIFIC LEGISLATION	
Packaging	**Packaging and Packaging Waste Directive, including:** • Recycling targets and monitoring rules • Extended Producer Responsibility[53] (EPR) schemes for packaging waste in Member States
Construction Product	**Construction Products Regulation**
Automotive	**End-of-life Vehicles Directive**
Electrical and Electronic Equipment	**Waste Electrical and Electronic Equipment Directive, including:** • RoHS Directive • Medical devices Regulation
Batteries	**Batteries and accumulators Directive**
PRODUCT GROUP SPECIFIC LEGISLATION	
	Toys Directive
	Pyrotechnical articles Directive
Ecodesign Directive[54]	**Relevant product-specific implementing measures:** • Household washing machines (2019) • Refrigeration appliances (2019) • Electronic displays (2019) • Vacuum cleaners • Rechargeable electrochemical batteries with internal storage (Preparatory study, 2019) • Voluntary agreement to improve the environmental performance of imaging equipment
	Standardisation of material efficiency aspects
Ecolabel Regulation	**Ecolabel Regulation, including:** • Criteria for relevant plastic product groups - Rinse off cosmetics - Furniture - Televisions - Textiles products

OTHER HORIZONTAL LEGISLATION
Food Contact Material Regulation
Single Use Plastics Directive
STANDARDS[55]
EN 1566 series Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Chlorinated poly(vinyl chloride) (PVC-C)
CEN/TS 14541:2013 Plastics pipes and fittings - Characteristics for utilisation of non-virgin PVC-U, PP and PE materials
CEN/TS 15534-2:2007 Wood-plastics composites (WPC) - Part 2: Characterisation of WPC materials
CEN/TS 16010:2013 Plastics - Recycled plastics - Sampling procedures for testing plastics waste and recyclates
CEN/TS 16011:2013 Plastics - Recycled plastics - Sample preparation
CEN/TS 16137:2011 Plastics – Determination of bio-based carbon content
CEN/TS 16295:2012 Plastics - Declaration of the bio-based carbon content
CEN/TS 16398:2012 Plastics - Template for reporting and communication of bio-based carbon content and recovery options of biopolymers and bioplastics - Data sheet
CEN/TS 16861:2015 Plastics - Recycled plastics - Determination of selected marker compounds in food grade recycled polyethylene terephthalate (PET)
prEN 17228 Plastics - Bio-based polymers, plastics, and plastic products - Terminology, characteristics and communication
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EN 15345 Plastics - Recycled Plastics - Characterisation of PP
EN 15345:2007 Plastics - Recycled Plastics - Characterisation of Polypropylene (PP) recyclates
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EN 15347:2007 Plastics - Recycled Plastics - Characterisation of plastics wastes
EN 15346 Plastics - Recycled plastics - Characterisation of PVC
EN 15348:2014 Plastics - Recycled plastics - Characterisation of poly(ethylene terephtalate) (PET) recyclates
CEN/TR 15353 Plastics - Recycled plastics - Guidelines for the development of standards for recycled plastics
EN ISO 16103:2005 Packaging - Transport packages for dangerous goods - Recycled plastics material
EN ISO 20200:2005 Plastics - Determination of the degree of disintegration of plastic materials under simulated composting conditions in a laboratory-scale test

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48. Staff Working Document from the European Commission, Assessment report of the voluntary pledges under Annex III of the European Strategy for Plastics in a Circular Economy, {SWD(2019) 91 final}, 2019.

49. http://files.chemicalwatch.com/Ministerletter.pdf

50. Jonathan Lopez, “Circular economy will require “heavy” investments in new chemicals -ECHA chief”, in Chemical Industry News, 2019.

51. see ECHA 2019 https://echa.europa.eu/documents/10162/13630/plastic_additives_supplementary_en.pdf/79bea2d6-8e45-f38c-a318-7d7e812890a1 and related database under https://echa.europa.eu/de/mapping-exercise-plastic-additives-initiative#table).

52. https://english.arnika.org/publications/toy-or-toxic-waste-an-analysis-of-plastic-products

53. Extended Producer Responsibility (EPR), to date, places an obligation on producers to take operational and/or financial responsibility for the end-of-life phase of their products. For electrical and electronic equipment, end-of-life vehicles or batteries, EPR schemes are required by the relevant EU directives. All but one Member State currently have measures on EPR for packaging in place, and this will become mandatory for all Member States from 2024 onward as a result of the 2018 revision of EU waste legislation. The revised Waste Framework Directive sets new general minimum requirements for EPR schemes to improve their effectiveness and performance across the EU. To limit the scope of the study, EPR schemes have only been included and analysed within the packaging sector.

54. To be noted that some Ecodesign product-specific measures were not adopted at the time this study was conducted.

55. This list was identified from a recent report produced by CEN on the request of the European Commission within the context of the Circular Economy Action Plan. The report “Identification of Potential Needs of Standardisation for “Sustainable Chemicals from Primary and Secondary Raw Materials Related to the Circular Economy Action Plan” was the result of an extensive mapping exercise on standards and other initiatives and their analysis for potential contribution to “sustainable chemicals”. To be noted that these standards have been listed as relevant (policy) tools. However, due to a limited access to their content they have not been included in the qualitative assessment.

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