GACERE
Global Alliance on Circular Economy and Resource Efficiency

Circular Design of Plastic Products

Policy Brief

Executive summary

Design of products is broadly recognized as one of the drivers of sustainability. A well-designed product can function better, last longer, and impact the environment less. Plastic products are no exception, whether in the packaging sector or others (e.g., fisheries, agriculture, textiles, mobility, construction). **Circular economy models aim to ensure that products and materials in circulation retain the highest possible value and eliminate waste and pollution by design.** In this context, circular design has an immense potential to address the plastic pollution crisis.

A legally binding instrument to address this issue is currently being negotiated under the Intergovernmental Negotiating Committee (INC) on plastic pollution and is now in the form of a revised zero draft. The **Global Alliance on Circular Economy and Resource Efficiency (GACERE)** and its member countries have seen the need to support the INC negotiations by recompiling existing knowledge and best practices on circular design.

This policy brief is intended to be a tool for delegates and negotiators in the INC process, but also a reference point for all members and stakeholders. It aims at prompting readers with good ideas, as well as methods to materialise them in the upcoming instrument and beyond. The objective of this policy brief is to provide an overview and suggestions on potential approaches to the establishment and scaling up of criteria for circular design of plastic products. Circular design can be seen as a key, secure way to prevent and reduce plastic pollution by enabling necessary change in the approach to the design, production and management of plastic products. This brief is intended to **inform the INC process without prejudging the outcomes of the negotiations**.

Circular design of products is presented as an opportunity to move away from material-intensive and wasteful value chains, towards models that privilege the retention of the product's value, including the economic value, along its whole life cycle and following the waste hierarchy principles. This paper shows significant achievements in policies and commitments. Such examples are drawn from GACERE country and partner experience and are not intended to be exhaustive.

Circular design approaches and criteria can inform specific sections of the revised draft of the instrument. Key ideas regarding the establishment of circular design criteria include, for example, the following: (i) **approaches should be tailored and specific** to different phases of the lifecycle and objectives (production, consumption, end-of-life management); (ii) **horizontal criteria** for products sharing similar characteristics should be complemented with **sectoral criteria**; (iii) all criteria should consider their viability in terms of **supporting infrastructure** and funding, also according to national circumstances; and (iv) criteria should be **measurable and transparent**, and must be based on a holistic approach incorporating a scientific basis.

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Executive summary continued

In this paper, circular design criteria are presented and subdivided into the following areas: (i) design for reduction and optimization; (ii) design for prolonged use and reuse; (iii) design for repairability and refurbishability; and (iv) design for recyclability. The brief covers circular design suggestions applicable particularly in the plastic packaging sector, but is also aimed at inspiring action in a wide range of sectors utilising plastic products. **Design for reduction and optimization** centres around the idea that the same result can be obtained with less material, for example when the service provided by a plastic product can be achieved without using plastics, or when the volume of plastics can be reduced while preserving a product's quality. **Design for prolonged product use and reuse** leverages and promotes a number of models that move away from single-use plastics. In this case, circular design focuses on ensuring products are suitable for multiple uses, and can be easily cleaned by the user or returned for bulk processing (cleaning, non-destructive disassembly and reassembly, etc.). **Design for repairability and refurbishability** builds on the previous considerations to further ascertain how certain products can be designed in a way that makes repairing them easy, also via disassembly and replacement of certain parts without elimination of the entire product, by minimising interdependence of a product's components and its proneness to contamination. **Design for recyclability** adds to and complements all of this by making sure that, at the end of its lifecycle, the product can ultimately be recycled. In this context, the underlying idea is that the type of plastic should be suitable for recycling – here a good design can be supported by excluding non-recyclable materials, additives, composite materials, etc. In addition, and equally important, plastics should be recyclable 'in practice' and 'at scale', considering the infrastructure available not only at the national level but also internationally. These criteria should be supported by the inclusion of recycled content in the design phase and a common uptake of the recyclate in the market creating the incentive to move away from virgin plastic.

Different actors in the plastic value chain are involved in the adoption of circular design criteria. For instance, material developers and producers can ensure that the design of products mainstreams innovative circular design approaches. Their choices can be influenced by transparency requirements, restrictions, incentives, and policies in general. Hence, **a stepwise and inclusive approach for the adoption of such criteria in the instrument is proposed**: first, the establishment of overarching design criteria based on the approaches described; second, an approach that paves the way for the determination of sector- or product-specific criteria by future decision-making bodies, liaising with standardisation institutions.

Crucially, circular design approaches and criteria cannot take root unless a number of enabling actions are addressed at the same time. Emerging **Extended Producer Responsibility (EPR)** schemes envisage boosting the application of circular design principles with reliable financial streams. **International cooperation** is presented as a way to address both the intrinsic cross-boundary aspect of circular product design and the different financial and technical capacities of countries.

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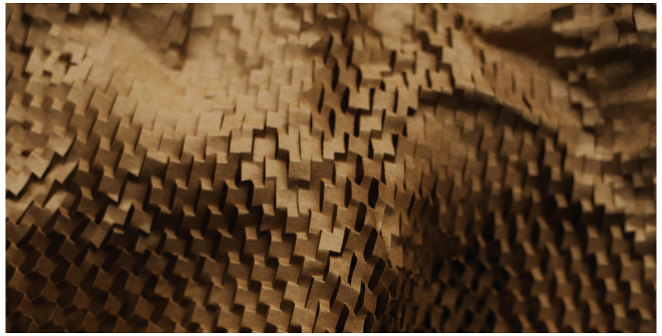

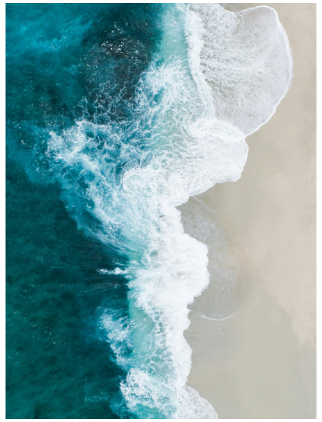

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Introduction

The negotiations on an international, legally binding instrument on plastic pollution, including in the marine environment, have been ongoing since November 2022 with the goal of conclusion by the end of 2024. In view of finalization of the negotiations on the instrument by the end of 2024, a draft text provided by the INC Chair is to be considered by the committee ahead of INC-4 and the further process. Proposals include mechanisms and processes for the identification and adoption of sustainable design criteria, justified by the fact that a significant share of all product-related environmental impacts are determined during the design phase of a product.

If a product is designed to be reused, repaired or refurbished, the value added is higher than the case of a product designed to be recycled.

Today, plastic products are designed to be replaced frequently and involve high use of fossil-based virgin plastics. Their characteristics and the surrounding infrastructure may result in leakage or loss in the environment. Significant energy and resources must then be used in order to produce and distribute new products, and unnecessarily costly systems are required for collection and disposal of old ones. It remains challenging for economic operators and citizens to make the necessary behavioural shift and opt for sustainable choices in relation to plastics materials and products, given that relevant information and affordable options are often lacking. This leads to missed opportunities for human health, the environment and value-retaining operations as well as limited demand for secondary materials and presents an obstacle to the adoption of sustainable models.

Plastic packaging in particular is the single greatest source of plastic waste and pollution, resulting in around 40% of the world's total plastic waste in 2019. Without significant policy changes, plastic waste is projected to almost triple by 2060 [1] with a high risk of leakage into the environment.

A comprehensive circular economy approach can address the root causes of plastic pollution, and contribute to the global efforts to combat the triple planetary crisis (climate change, biodiversity loss and pollution), while delivering economic, environmental, and social benefits [2]. Previous GACERE papers have explored the nexus between circular economy and the triple planetary crisis [3] [4], as well as the potential for green recovery [5]. The latest scientific analysis shows that a circular economy approach across the whole plastics life cycle is most effective in avoiding plastic pollution, while offering the best economic, employment, and climate outcomes [6] via incorporation of upstream measures.

In particular, circular design can help us keep plastic products in the economy for longer, by addressing most of the actions mentioned above, and has the potential to retain the highest economic value of a plastic product. In other words, if a product is designed for multiple reuse, repair, or refurbishment, the value added is higher than that of a product designed only to be recycled after single use. Even a product that is designed to be reused, repaired or refurbished, will require a design that incorporates recyclability criteria, to make sure that it can be recycled at the end of its lifecycle.

This policy brief intends to provide clarity on concepts and approaches to address circular design from the perspective of the Global Alliance on Circular Economy and Resource Efficiency (GACERE) and its member states. In particular, it aims at providing useful inputs for delegates, negotiators and stakeholders working towards the new legally binding instrument, without prejudging the negotiations.

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1. Overview of Key Concepts

The concepts provided in the context of this section and elsewhere in this brief are not meant to be prescriptive, but rather are intended to set the basis for a common approach to circular design and reconcile different narratives by identifying and highlighting the points they have in common. As such, GACERE members recognize the variety of experiences within the Alliance and beyond its membership, and the contribution they can make to enrich the discussion.

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Work by the Ellen MacArthur Foundation [7], the UNEP circularity platform [8] as well as available scientific literature [9] [10] [11] identifies circular design as a way to prevent the creation of waste and pollution, circulate products and materials at their highest value and regenerate nature from the start. Such a concept echoes and builds upon the principles of ecodesign [12], ecological design and innovation [13], and design for sustainability and the environment [14].

In a circular economy, upstream innovation means that rather than working out how to deal with a product at its end-of-life, the focus is on the upstream phases of a product's life cycle in order to prevent waste and pollution from being created in the first place [15]. These strategies are in line with the waste management hierarchy [16], where reduction and value retention processes such as reuse strategies are prioritised over recycling. Some plastic products can be replaced with others that perform the same function with a lower environmental impact, or the choice may be made not to use them altogether [17]. Still, we will want to make sure that all plastics that we do use are kept in circulation for as long as possible, ensuring products are reused, refurbished and recycled and that we keep them in the economy and out of the environment.

It is possible to consider a variety of circular approaches, as outlined in the next sections, that make it easier to effectively tackle plastic pollution. The overarching idea is to reduce demand for the inflow of virgin materials as much as possible, while ensuring that the leakage of plastics into the environment is limited to a minimum, by recirculating the products and the materials, and keeping them in our economies for as long as possible [18]. To ensure a level playing field and thereby build industry resilience and adaptability, it is important to be clear on the approaches to the establishment of circular design criteria. In particular, it is necessary to verify what each approach is able to achieve, based on its potential to divert plastics from waste streams and its suitability for adaptation to national circumstances. A prioritization of all the possible approaches explored may be the first step towards establishment of harmonised standards, terminologies, and transparent methodologies.

- Wherever relevant, **reduction and optimization** should be the preferred solution. In particular, solutions that allow obtention of the same result with less plastic material should be explored, without compromising the user experience or safety aspects.
- When this is not possible, then **prolonged product use and reuse** should be explored as the preferred solution (or 'inner loop' in circular economy terms), reducing the need for single-use plastic products, including packaging [19]. Based on the International Organization for Standardization (ISO) definition, reuse is tailored to the use of a product more than once in its original form [20].
- Closely related to reuse are the concepts of **repair and refurbishment** and other value retention processes, which can apply to some plastic product categories. These approaches extend the lifespan of products and reduce the need for virgin resources.
- **Recycling**, which is less efficient because it has less potential to preserve the original value of the product and requires significant additional resources and energy for reprocessing, comes into play at the end of the product's useful life, stimulating the replacement of virgin materials in new product design and manufacturing. This approach saves greenhouse gas emissions from improper waste management including open burning of waste, reducing the need for virgin materials, while limiting leakage into the environment.

2. Mainstreaming circular design in policies and commitments

It is estimated that a significant share of all product-related environmental impacts are related to the design phase of a product [21]. These impacts are influenced by the source and volume of the materials used, how effectively the product can be recirculated in the system after its use (i.e., reused, repaired, refurbished, recycled), and how it may impact human health (i.e., not using harmful chemicals), environment and the ecosystem (i.e., how it behaves if it leaks into the environment).

The key facts and figures in this section predominantly focus on plastic packaging, as the demand for plastic packaging is set to double over the coming two decades, making it increasingly impossible to keep this increased flow of plastics in the economy and out of the environment [22]. In the paragraphs below, we will explore how policies and specific initiatives, such as the Global Commitment and the Plastics Pacts Network are helping to stimulate specific advancements in the field of circular design of plastic packaging products. While voluntary action programmes to date have demonstrated what is possible with concerted actions around the circular design of plastic packaging and similar voluntary actions for other plastic products could contribute to the transition towards a circular economy for plastics, policies and rules at the global level are necessary to create a level playing field and achieve significant positive change at the required accelerated pace.

It is important to note that these are a few examples amongst several other existing efforts including local initiatives that focus on circular design of plastics products and efforts to stop plastic waste and pollution.

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2.1 Policy in actions

Several countries have understood the importance of committed policy actions in the field of plastics and specifically incentivized change in the design of products. The prominent issue of single-use plastics was the first to make its way through national legislations around the world.

The Ecodesign for Sustainable Products Regulation (ESPR) of the EU establishes a framework to set ecodesign requirements for specific product groups to significantly improve their circularity, energy performance and other environmental sustainability aspects.

Rwanda was among the first countries to introduce a ban of single-use plastic bags already in 2008. In recognition of the achievements of the law and the importance of introducing a more comprehensive framework, the law was updated in 2019 to expand its scope to all single-use plastic products [23]. Several other countries have adopted similar legislation.

Another significant early mover was **China**, which prohibited the production and use of plastic bags as early as 2007. However, as online commerce was on the rise in the following years, a need to revisit the regulation in a more pragmatic way emerged, also in light of the promising data that came out of the first years of application of the regulation. In 2020, a new policy was adopted to promote a gradual ban of different kinds of non-degradable, single-use plastics between 2020 and 2025 [24].

Similar endeavours have been undertaken by other countries in different regions, such as **Ecuador** [25]. As more and more countries create legislation and policies targeted at these objectives, the scope of such interventions has also expanded to establish compliance regulations and measures in some cases.

The Ecodesign for Sustainable Products Regulation (ESPR) of the **European Union** (EU) establishes a framework to set ecodesign requirements for specific product groups to significantly improve their circularity, energy performance and other environmental sustainability aspects. It will enable the setting of performance and information requirements for almost all categories of physical goods placed on the EU market (with some notable exceptions, such as food and feed). For groups of products that share sufficient common characteristics, the framework will also allow the setting of horizontal rules.

The framework will allow for the setting of a wide range of requirements, including on:

- product durability, reusability, upgradability and repairability the presence of substances that inhibit circularity
- energy and resource efficiency
- recycled content
- remanufacturing and recycling
- carbon and environmental footprints
- information requirements, including a Digital Product Passport

It is estimated that by 2030, the new sustainable products framework will lead to 132 mtoe of primary energy savings, which corresponds to roughly 150 billion cubic metres of natural gas.

The rules proposed under the ESPR will apply to all products placed on the EU market, whether produced inside or outside the EU. Because of their impact on third countries, the EU has committed to compliance with international trade rules and to providing support to other countries on a shift towards more sustainable products. New measures such as the Digital Product Passport (DPP) will also be developed in an open dialogue with international partners to ensure that they help remove trade barriers for greener products and lower costs for sustainable investments, marketing and compliance.

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2.2 Global Commitment (GC)

The New Plastics Economy Global Commitment (GC) unites over 1,000 organisations, of which 250 are businesses, representing 20% of all plastic packaging produced globally, and 55 governments which represent more than one billion people across five continents [26]. GC signatories are committed to concerted actions across the plastic packaging life cycle, adhering to agreed definitions and metrics [27].

Among the diverse progress areas, business signatories have more than doubled the share of post-consumer recycled (PCR) content in their plastic packaging from ~4.7% in 2018 to ~11.7% in 2022, compared to a 1% increase in the global market as a whole – thereby avoiding more than two million tonnes of greenhouse gas emissions per year, and keeping one barrel of oil in the ground every two seconds. The increased use of recycled plastics has helped stabilise virgin plastics use amongst GC signatories, avoiding nearly three million tonnes of virgin plastics production a year compared to business as usual [28].

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250+
Businesses within the GC

1 billion+
people are represented by the signatory governments of the GC

More than doubled
the share of post-consumer recycled (PCR) content in their plastic packaging

2 million tonnes+
of greenhouse gas emissions per year avoided

2.3 The Plastics Pacts Network

The Plastics Pact Network, convened by the Ellen MacArthur Foundation and the UK charity Waste and Resources Action Programme (WRAP), is a network of national and regional (multi-country) initiatives bringing together key stakeholders to implement solutions promoting a circular economy for plastic, tailored to each geography.

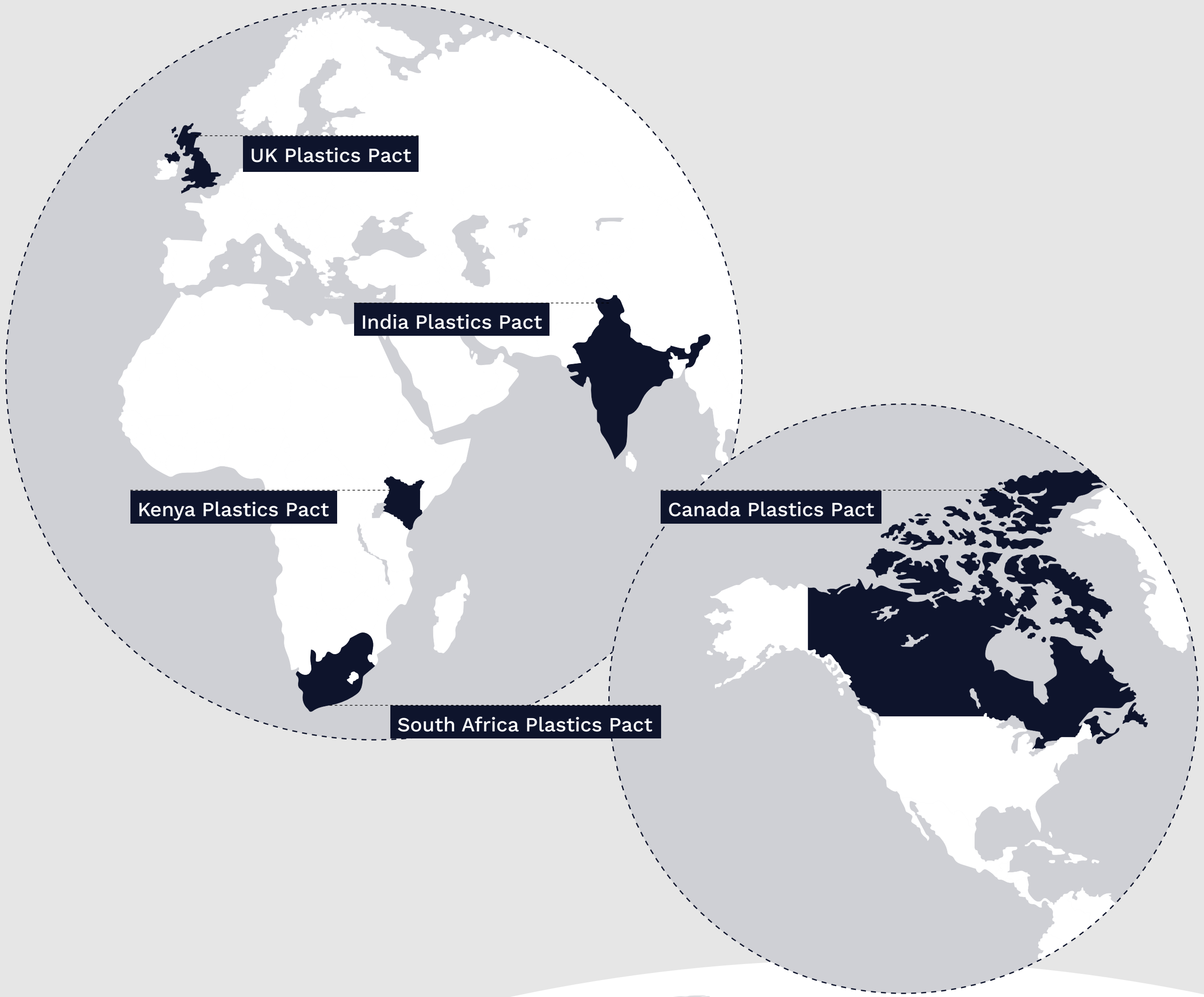
The network includes national plastic pacts in the UK, France, Chile, South Africa, Portugal, the US, Poland, Canada, Colombia and India, and regional pacts include the Australia, New Zealand, and the Pacific Islands (ANZPAC) Plastics Pact. In several plastics pacts around the world, which focus on plastic packaging, pact business signatories from across the plastic value chain have developed and agreed to follow specific guidance on recyclability, driving action on various countries, as discussed below.

UK Plastics Pact

Based on the guidance provided on polymer choice and recyclability, 71% of plastic packaging is estimated to be recyclable. Narrowing the range of the polymers used for plastic packaging is expected to drive an increase in the efficiency and effectiveness of the UK recycling system, while helping reduce confusion amongst citizens about what can be recycled [26]. The biggest gains in recyclability have been made in rigid plastic packaging due to the reduction of non-recyclable polystyrene and multi-material packaging: 94% of rigid plastic packaging is now recyclable, compared to 81% in 2018, and hard-to-recycle components such as non-NIR-detectable colours and PVC have fallen by 96% [29].

India Plastics Pact

The India Plastics Pact has developed guidance for non-food-grade contact HDPE bottles, rigid packaging, and food-contact-grade PET bottles. It is expected that this design guidance will help avoid the use of materials or combinations of materials that might create problems in collecting, sorting or recycling HDPE bottles. Decisions made at the design level by brands will facilitate change across the entire country because more HDPE containers will enter the “highly recyclable” category. Guidelines will also help brands and packaging manufacturers achieve their EPR targets and allow good practices to percolate down via supply chains [30].



Kenya Plastics Pact

The Kenya Plastics Pact members have made progress towards achieving the first Pact outcome, by collectively establishing the Design Guidelines for Recyclability in Kenya, with the first version focusing on PET bottles, HDPE bottles and jars. These design guidelines for recyclability aim to provide clear recommendations to decision-makers on how to design plastic packaging to ensure compatibility with Kenya’s current and projected mechanical recycling infrastructure [31].

South Africa (SA) Plastics Pact

Several actors have been involved in the development of Packaging Guidelines related to “recyclability by design for packaging and paper in South Africa” and will continue to be involved in the process to align the SA Plastics Pact work with the guidelines. The SA Plastics Pact has also committed to working closely with the SA Initiative to End Plastic Waste in the Environment. The SA Plastics Pact has committed to being part of the evolution of the South African EPR system, to align with new developments and assist in meeting the national targets set in the EPR regulations and schemes. In South Africa, over 20,000 tonnes of high-density polyethylene (HDPE) enters the market per year of which over 17,000 tonnes are recycled. HDPE is the plastic with the highest recycling rate in South Africa with over 75% of HDPE milk and beverage bottles recycled in 2019. This is a direct result of design for recycling within the South Africa Plastics Pact. Brand owners and retailers have a key role when specifying the design of their products [32].

Canada Plastic Pact (CPP)

In 2022, the CPP introduced a version of the Golden Design Rules (GDRs) for Plastics Packaging for adoption by members, aiming to drive innovation and scalable actions that will result in less plastics packaging overall and easier-to-recycle plastics packaging. The GDRs have gained traction, with 52% of Signatories embracing the design rules. Additionally, more than half have taken proactive steps to ensure effective implementation, such as establishing compliance processes and providing training for packaging engineers. Of the 52% of Partners who have adopted the GDRs, all of them plan to ensure all packaging adheres to the GDRs, including new packaging innovations [33].

2.3 The Plastics Pacts Network continued

ANZPAC Plastics Pact

The ANZPAC Plastics Pact represents the complete plastic value chain in the context of which the majority of Australian and New Zealand ANZPAC members are using The Packaging Recyclability Evaluation Portal (PREP), an online tool that assesses how packaging will perform in the Australian and New Zealand resource recovery systems [31]. It addresses many factors that can impact recyclability, including packaging shape, size, weight, inks, and adhesives, as well as the materials used. For every item of packaging, PREP considers these factors, along with the availability of collection services, and how the packaging will behave in a mechanical recycling facility (MRF) and in subsequent processing facilities. The PREP process provides an education loop between the design and the end-of-life of packaging in the Australian and New Zealand recycling systems [34].

2.4 Other examples of significant achievements

Japan's approach is a combination of regulatory and voluntary approaches:

- **Framework to promote circular product designs:** Based on the Act on Promotion of Resource Circulation for Plastics, which came into effect in April 2022, a design guidance on plastic products was formulated as a public notice. Businesses have a general responsibility to follow the guidance in their product designs. Furthermore, this law also includes a certification scheme (under development) for excellent circular product designs). Certified products can be promoted in sales and given priority in government procurement.
- **Voluntary eco-design guidelines for plastic containers and packaging:** The Plastic Packaging Recycling Council (PPRC) has been formulating a voluntary action plan since 2006, and has reviewed progress every year. The PPRC has also compiled eco-design guidelines for plastic containers and packaging. The guidelines compile elements to be considered, such as design philosophy (reduce, reuse, recycle, renewability, safety and LCA) and considerations at each stage of the life cycle (raw material, manufacturing, transportation, use [filling], distribution/sale, consumption, and disposal/recycling). The PPRC compiles and publishes (incl. searchable pages) good practices of eco-design containers and packaging of member companies.
- **Bottle-to-bottle high-quality PET bottle recycling:** The Council for PET Bottle Recycling compiles voluntary guidelines for product design, including the requirement that only PET resin be used for raw material with no colouring. This makes high-quality PET bottle recycling possible. In Japan, thanks to the product design taking into account recyclability, 94.4% (550kt) of PET bottles are collected, and 86.9% (506kt) are recycled. In particular, 29.0% (169kt) are reproduced as PET bottles.

In Japan:

94.4%
(550kt) of PET bottles are collected

86.9%
(506kt) of PET bottles are recycled

29.0%
(169kt) are reproduced as PET bottles

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by GACERE or the United Nations.

3. Approaches and criteria for circular design and performance in the international legally binding instrument

As the negotiations of the Intergovernmental Negotiating Committee (INC) on development of an international legally binding instrument on plastic pollution, including in the marine environment, progress, delegates and observers may wish to take stock of the existing approaches and criteria for the circular design of plastic products. Circular design is expected to play a pivotal role in the future instrument, and has already been included in the revised draft text of the instrument [35], in particular in Part II, paragraph 5 (especially sub-paragraph 5a) and Annex C (especially Part I) thereof.

Circular product design has the potential to address the plastic pollution problem, taking into consideration the whole lifecycle of plastic products. This section will explore the approaches regarding the establishment of criteria, and will then delve deeper into some of these criteria, with the ultimate objective of informing the negotiations by means of clear examples.

Photo by Javardh on Unsplash

3.1 Approaches for the establishment of product design criteria

Harmonised design approaches and requirements are key to ensuring safe circulation of plastics at scale by driving consistency, ensuring a level playing field, reducing operation and compliance costs for companies, and mitigating potential value chain frictions [36].

Distinguishing between design criteria for different objectives and phases of the plastics value chain is essential.

To establish globally harmonised design and performance criteria for plastics products the following guidelines could be considered:

- Distinguishing between design criteria for **different objectives** and phases of the plastics value chain. Such criteria are distinct and it is important to consider them separately [37]. Further explanations on this issue are provided below.
- Aligning design requirements for products with requirements for **functioning systems and infrastructure** (e.g., collection systems, infrastructure for reuse or recycling) to ensure effective implementation of the design criteria and circulation of the product at the necessary scale in the economy.
- Establishing criteria which are **horizontal** across products which have common features and/or for **specific** sectors and products, taking into account varying applications, compositions and collection and reuse/recycling system setups.
- Linking a support mechanism that will provide **ongoing sufficient funding** for collection, sorting and processing of plastic products such as Extended Producer Responsibility (EPR) schemes for plastic products.
- Ensuring transparency around the chemical and material composition of plastic products through minimum information disclosure requirements. **Information disclosure** requirements should cover the polymers and chemical composition of plastic packaging and other plastic products to ensure that plastic products are safe to be produced, used, reused, and recycled.
- A **recyclability assessment method**, including global and regional thresholds when a 'technically recyclable' plastic product or packaging is to be assessed as being 'recycled in practice and at scale', or identified as to be phased out if no sufficient recycling infrastructure is available or foreseen to be available based on experience from other regions.
- **Comprehensive life cycle assessments** (LCAs) can be used as a tool to assess the environmental and health impacts of plastic products and their alternatives across their full life cycles, from raw material extraction, through production and use, to end-of-life management. Basic standards and methodologies for LCAs should be defined in order to ensure consistency (e.g. around boundaries, approaches to data uncertainty and quality, environmental impacts considered) and avoid misinterpretation and misrepresentation of data and results. For example, basic standards for LCAs, such as ISO 14040 and 14044 as a minimum, should be defined to ensure consistency, taking into consideration different circumstances that may orient the results of LCAs, such as the assumptions and national context.

In terms of process, the following elements are required.

- **Clear starting points -** There are starting points and stakeholder alignment at the national or regional level in various geographies (in particular focused on design for recycling in the packaging sector) which could be used as a basis to develop globally harmonised design criteria for plastic products (including packaging) where relevant, such as guidelines for PET bottles across different regions [38][39].
- **Prioritization -** A phased approach that starts from those applications that contribute the most to plastic pollution and/or which are commonly found in the environment as pollution or present the highest risk of leaking into the environment, such as the plastic packaging sector, and then moving towards lower priority sectors. The plastic packaging sector is the single largest source of plastic waste, creating around 40% of total plastic waste today, and it is projected to almost triple by 2060 [40].

Photo by Erik Mclean on Unsplash

3.2 Design for reduction and optimization

To achieve a circular economy, we need to make sure that all materials that enter the economy are utilised in the most efficient way. Reduction and optimization must be considered major priorities for the circular design of plastic products including plastic packaging. The underpinning idea of design for reduction and optimization is that excessive use of plastic material does not necessarily enhance the user experience, but does cause negative environmental impacts.

- In terms of reduction, standardised design criteria can be applied to reduce the volume of plastics, especially virgin plastics, in products with plastic content. Necessity would be measured per application and in terms of weight, volume and size of plastic content. Such a design approach would mean limiting the volume and weight of plastic per product according to the absolute necessary level [41].
- In the case of optimization, rethinking the packaging, product and business model from the point of view of the service would promote the innovation-driven exclusion of plastics use, while maintaining or enhancing user experience and therefore optimising the service provided. Optimization is particularly relevant in the case of plastic packaging. The work of the Ellen MacArthur Foundation inspires different approaches to optimization* [42]: a direct approach and an innovative approach. While the direct approach assesses the necessity of the plastic packaging itself**, the innovative approach finds new ways to achieve the delivery of a service, whereby packaging may not be needed***.

The underpinning idea of design for reduction and optimization is that excessive use of plastic material does not necessarily enhance the user experience, but does cause environmental impacts.

3.2.1 Design criteria for optimization and reduction

The following criteria can be provided for optimization and reduction of plastics in products:

* Based on the existing framework from the Ellen MacArthur Foundation, packaging is eliminated while user experience is maintained or enhanced via the upstream approaches of direct elimination and innovative elimination.

** A good example from the plastic packaging sector could be the removal of unnecessary plastic packaging, such as film packaging on multi-buy items and clothing.

*** Innovative optimization could target the final product itself (e.g., the liquid product contained in plastic packaging could be designed as a solid product, so that it does not require the packaging) or the way it is handled (e.g., adapting the storage conditions for vegetables in supermarkets can be a good alternative to protective plastic foil).

Reduction

- **VOLUME AND WEIGHT PER PRODUCT –** Reducing the use of plastics used per product while maintaining functionality, performance and safety without compromising recyclability.

Photo 1 by Micheile Henderson on Unsplash
Photo 2 by Cottonbro Studio on Pexels

Optimization

- **DIRECT APPROACH –** Plastics that do not serve an essential function, such as protection, communication and efficiency, are excluded altogether.
- **INNOVATIVE APPROACH –** Plastics that serve an essential function may still be excluded, as long as the essential service is being achieved in a different way. Upstream innovation allows this to be achieved, without negative unintended consequences caused by use of plastics. It is also important to ensure that innovative optimization efforts do not unintentionally become a potentially regrettable material substitution effort causing graver consequences than the original solution.

More specific recommendations can also be drawn up for plastic packaging [43]:

- **HEADSPACE, PACKAGING LAYERS AND OVERWRAPS –** Eliminating excess headspace for all packaging types, limiting physically detachable packaging layers that do not serve an essential function and reducing plastic overwraps can significantly lower plastic consumption.
- **BUSINESS-TO-BUSINESS REDUCTION –** Reducing virgin plastic use in business-to-business plastic packaging, covering all plastic packaging which does not reach the consumer.

3.3 Design for prolonged use and reuse

Moving from single use to reuse models presents one of the biggest opportunities to reduce plastic pollution. It is estimated that moving to reuse models in the case of plastic packaging can help achieve a reduction of over 20% in total annual plastic leakage into the ocean by 2040 [44]. Adopting reuse models at scale can play a critical role in not only tackling plastic pollution, but also in significantly reducing virgin material use, greenhouse gas (GHG) emissions, and water consumption. The critical role of reuse is recognized by initiatives such as the Global Commitment, which identifies scaling reuse as one of the pivotal hurdles that must be overcome to unlock the change needed to effectively address plastic pollution [45].

Reuse systems circulate a plastic product or a plastic packaging as a whole in its integral form and are distinct from recycling. Reuse is a crucial part of promoting the longevity of plastic products and thereby reducing waste generation [46]. Optimised reuse with high circulation rates is more material-efficient and could displace significant amounts of single-use items and lower the probability of plastic pollution for all types of plastics products, including but not limited to plastic packaging.

Priority product segments can be identified on the basis of the existence of reuse systems and for categories where there is a high level of opportunity for design standardisation. As an example for plastic packaging, the University of Portsmouth identifies six potential sectors where reuse systems can be rolled out [47]. These sectors include bottled beverages, on-the-go and on-site food and beverages, e-commerce, home and personal care, and business-to-business (B2B).

Individual countries and businesses alone cannot realise the shift to reuse systems at a global scale without supportive legislation applied consistently across markets. To unlock design for reuse, reuse systems will require a globally coordinated approach to create the market conditions for supply chain cooperation, infrastructure harmonisation, and an economic level playing field [48].

It is estimated that moving to reuse models in the case of plastic packaging can help achieve a reduction of over 20% reduction in the total annual plastic leakage to the ocean by 2040.

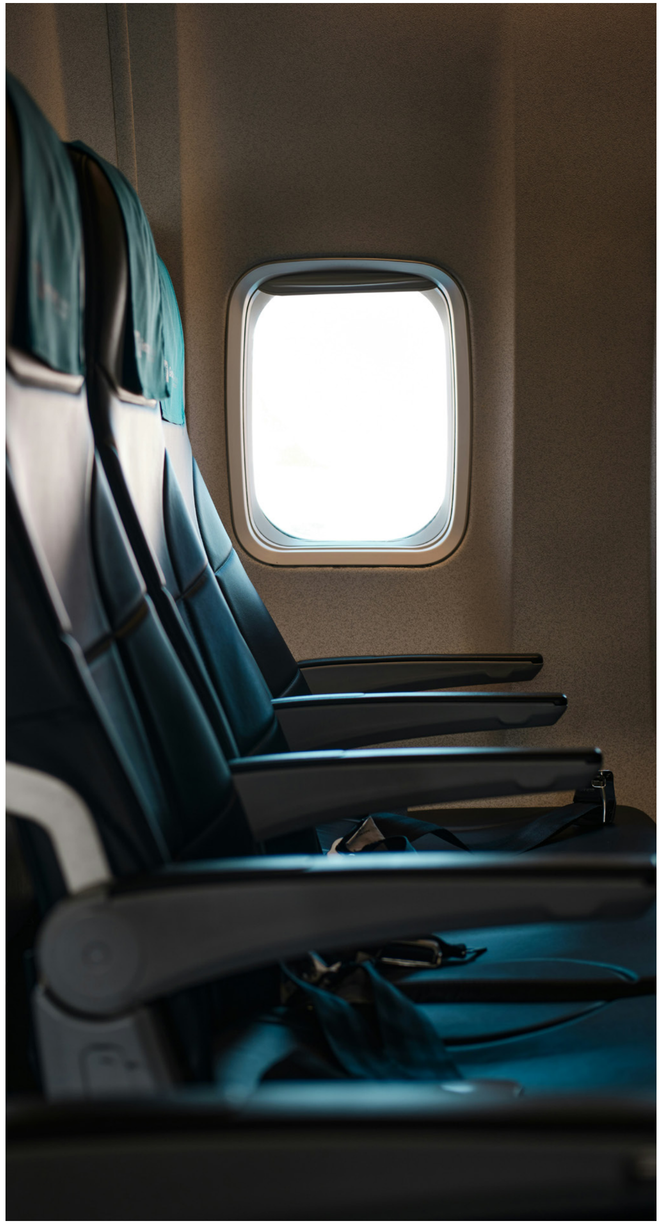
3.3.1 Types of reuse systems

Specifically in the context of plastic packaging, the Ellen Macarthur Foundation refers to the following four types of Business-to-Consumers (B2C) reuse models, encompassing both return and refill [49]. This framework can form the basis for the development of criteria and adoption of different reusable packaging systems that have the potential to be integrated in different sectors. Return and refill systems already available in some market segments and countries can be scaled up more broadly whilst making sure that the local context is taken into consideration.

- **Refill at home:** Users refill a reusable container at home with refills either delivered to the door or bought in a shop. Users retain ownership of the main packaging and are responsible for cleaning it. Existing examples around the globe include, and are not limited to, cleaning products delivered in concentrate or tablet format and a sodastream for making sparkling water at home.
- **Refill on the go:** Users refill the reusable packaging at a dispensing point away from home, such as in a store. Users retain ownership of the reusable packaging and are responsible for cleaning it. Existing examples around the globe include, and are not limited to, beverages, vending machines or bulk sales for household essentials and grocery shopping.
- **Return from home:** Users subscribe to a delivery and collection service that allows them to return empty packaging from home. A business or service provider then takes care of the cleaning and redistribution of the packaging. Existing examples around the globe include, and are not limited to, take-away food and beverages.
- **Return on the go:** Users purchase a product in a reusable container and return the packaging at a store or drop-off point after use. The packaging is either cleaned where it is returned or a business or service provider takes care of the cleaning and redistribution process. Existing examples around the globe include, and are not limited to, e-commerce packaging and bulk dispensing for personal care products.

Photo by Bluewater Sweden on Unsplash

3.3 Design for prolonged use and reuse continued



3.3.2 Design criteria for prolonged product use and reuse

There are general design criteria to support the objective of increasing the reusability of plastic products [50]. It is important to emphasise that reusable products are only a component of a reuse system. The reusable product needs to be produced, (re) filled in the case of plastic packaging, used, collected, cleaned, and transported multiple times. The uptake of reuse should be coupled with health, hygiene safety, and quality standards to ensure safe reuse systems. These aspects need to be taken into consideration during the design phase.

The below criteria provide an overarching framework including design for plastic products in general, whilst some additional specific criteria can be elaborated at a sectoral level.

- **FIT FOR MULTIPLE USE –** In the design phase, the possibility and viability of prolonged product use and reuse instead of single use needs to be assessed as a priority. In order to be fit for multiple use, a product should have good strength and durability characteristics.
- **SPECIFICITY –** Design choices should be made specific to the target reuse model, incorporating all the life cycle stages of the reusable product.
- **SAFETY –** Design and composition, including chemical substances, should take into consideration safety requirements for health and the environment for repeated use, including, but not limited to, potential issues with the release of microplastics over a long life cycle.
- **EASE OF CLEANING –** In order to make sure that a product can continue being used, it is essential to allow thorough and simple cleaning. Products should be, for instance, dishwasher-safe and designed to be fit for disassembly for cleaning [51].
- **EASE OF STORABILITY –** Design of the shape, including packaging, should make it easy to stack and store.
- **REASSEMBLY –** Design for reuse should enable non-destructive disassembly and reassembly at end-of-life.

These criteria should be supported with clear product labels on reusability aspects with the aim to encourage reuse based on recognised international and harmonised standards, as well as reuse-model-specific information. Consumers may also be reluctant to reuse plastics when they have health concerns; therefore safety of reuse should be prominently assured.

3.3.3 Enablers of prolonged use and reuse systems incorporating plastic products

A recent study from the Ellen MacArthur Foundation found that collaboration is key to making the economics work and maximising the environmental opportunity for return-based reusable plastic packaging [52]. The study also shows that the higher the scale of reuse system implementation and level of collaboration, the higher the environmental benefits in terms of GHG emissions material and water savings, as well as potential economic benefits, compared to single use packaging. The study identified three key performance drivers of reuse systems in the context of return-based reusable packaging.

1. **Scale and shared infrastructure:** Sharing infrastructure, such as collection, sorting, cleaning, and transportation, provides economies of scale. Perhaps the most important example of shared infrastructure is collection, not only to share costs, but also to provide customers with a consistent and seamless experience. Having to interact with separate packaging and multiple collection streams could be a barrier for customers.
2. **Packaging standardisation and pooling:** Standardising packaging for certain product types can significantly increase the efficiency of sorting, cleaning and storing, while pooling packaging can dramatically decrease transport distances and the associated emissions and costs. Labels and closures can be used to differentiate brands and product lines.
3. **High return rates:** By incentivising return and providing a frictionless customer experience, companies can increase return rates. Getting the packaging back from customers is key for these types of business models to work. All actors must work together to achieve high return rates.

The Ellen MacArthur Foundation work and several other studies [53][54] show that key enabling conditions for the scaling of plastic product reuse, including packaging, are as the following:

- Setting reuse targets on a sectorial level supported by standardised measurements and incentives.
- Defining minimum performance objectives such as rotation cycles, retention time and return rates.
- A level of harmonisation of product designs including requirements and standards at a universal level, especially in the case of packaging, to enable shared infrastructure fits.
- Establishing shared infrastructure covering collection, sorting, cleaning and transportation.
- Making the economics work via policies such as EPR and other policy instruments.
- Facilitating pre-competitive collaboration in compliance with laws and regulations for streamlined logistics and infrastructure.

Photo by Sofya Kholodkova on Unsplash

3.4 Design for repairability and refurbishability

Designing for repairability and refurbishability are important measures that promote technical feasibility and cost-effectiveness related to repairing products, thereby preventing plastic waste generation.

This extends the life of these products, reduces waste and its related costs, and conserves resources, keeping materials in the economy longer. The concept of design for repairability or refurbishability can also be correlated with the concept of 'right to repair', which has been introduced to empower consumers with the choice to repair a product instead of replacing it altogether [55]. When establishing guidance or rules for repairability and refurbishability, it is important to consider durable and modular materials, replaceable parts, and accessibility for the user or consumer, so that they may take the desired actions. In the case of plastics, design for repairability and refurbishability criteria mainly apply to more complex products, already designed for multiple uses. In this sense, they go hand-in-hand with design for prolonged use criteria. The effectiveness of design measures related to repairability and refurbishability also relates to the availability of infrastructure (businesses and services providing such operations) and instruments promoting such activities. It is therefore equally important to involve stakeholders in the development of guidance and requirements, and in the process of establishing criteria.

3.4.1 Design criteria for repairability and refurbishability

Based on the approaches described above, the following criteria can be recommended [56][57]:

- **SEPARABILITY AND ACCESSIBILITY OF COMPONENTS –** Components should be assembled in a way that does not create interdependence and allows them to be accessed and replaced individually.
- **AVAILABILITY OF SPARE PARTS –** Spare parts should be made available or ideally be already available on the market.
- **PROTECTION FROM CONTAMINATION –** The product should be designed in a way that protects it from being contaminated. In particular, the most valuable components should be protected.
- **COMPLETE RESTORATION –** Once repaired, products should return to a comparable level of performance.

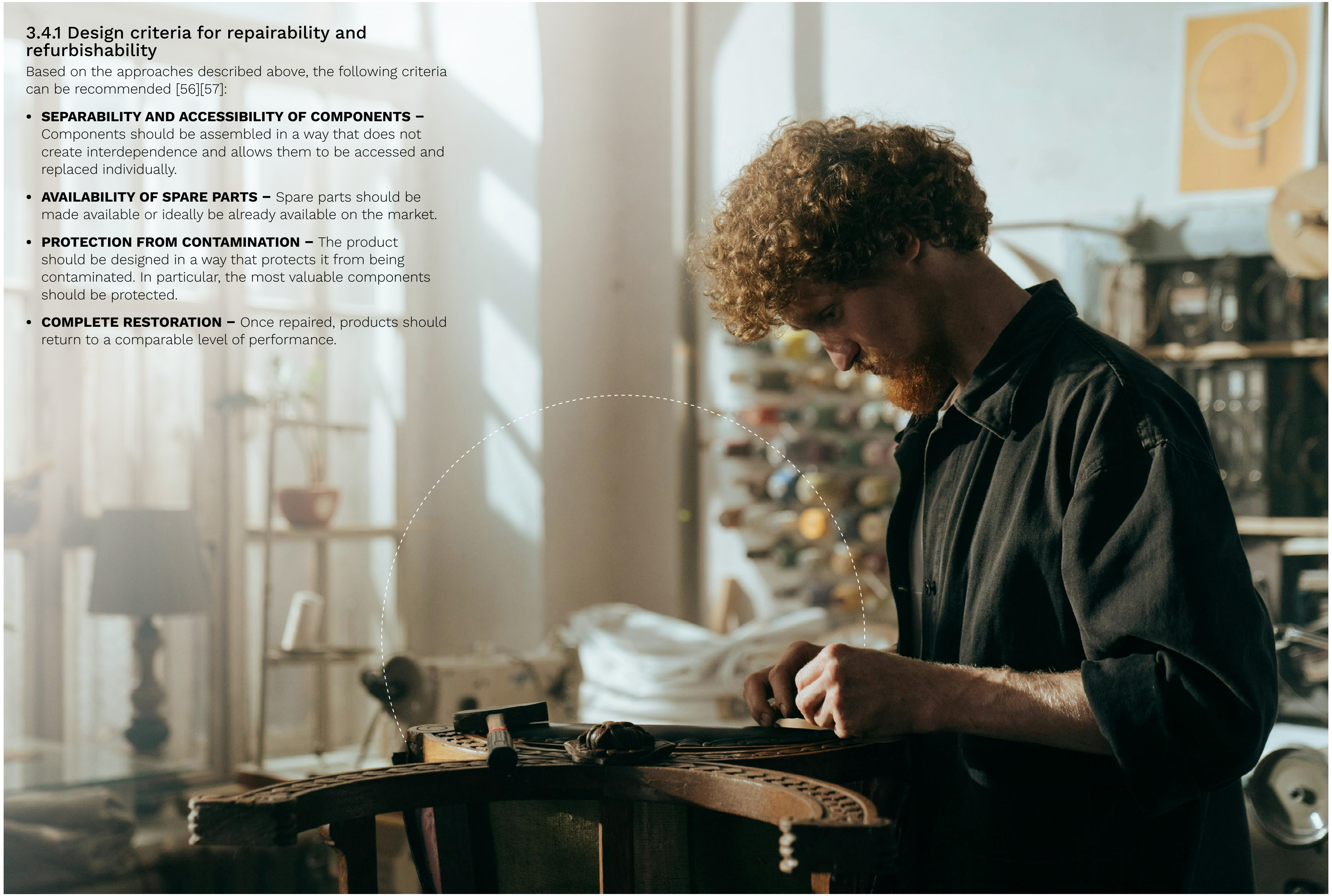


Photo by Cottonbro Studio on Pexels

3.5 Design for recyclability

Based on a study by UNEP, it is estimated that only 21% of plastic today is economically recyclable [58]. Recyclability also has several definitions globally, hence, to better serve the principles of circular design it is important to provide a holistic overview of the existing definitions, as well as explore the concepts of technical recyclability and recyclability 'at scale and in practice'.

3.5.1 Technical recyclability

The first step is to ensure that plastic products are 'designed for recycling' or 'technically recyclable'. This means that a recycling technology has been tested and demonstrated for the plastic product, but does not necessarily mean that it is available where needed, or that the item is recycled in practice. Many guidelines already exist for this, and while there are some differences between them, they are broadly aligned across the world [59]. A few examples of these guidelines for plastic packaging include: The Consumer Goods Forum Golden Design Rules [60], The Association of Plastic Recyclers (APR) Design Guide [61], the China National Resources Recycling Association's "General guidelines for the evaluation of plastics products" [62], the Indian Plastic Pact Design Guidance [63], the Australian Government's National Plastics Plan [64], Plastics Recyclers Europe's RecyClass Guidelines [65], and Japan's Guidelines for the Design of Plastic-Containing Products [66]. This high level of alignment on what 'technically recyclable' means is an important starting point, but is not enough by itself. It also needs to be proven that a plastic product can be recycled 'in practice' and 'at scale'.

3.5.2 Recyclability in practice and at scale

While agreeing on what 'design for recycling' or 'technically recyclable' means is an important first step, if a plastic product ultimately is not recycled 'in practice' and 'at scale', the environmental benefits of product design building on 'technical' recyclability requirements will not materialise [67].

'In practice' means that in multiple regions, which collectively represent a significant and diverse geographical area and population, it is proven that the collection, sorting, and recycling system (from consumer to recycled material) achieves recycling of a significant share of all packaging of that type placed on the market.

'At scale' [61] means that recycling of a certain packaging type needs to be proven to work in practice in multiple regions, collectively representing a significant and diverse geographical area and population, so that the practice is replicable. The proof needs to be more substantial than that suggested by a pilot project or a small region.

The 'in practice and at scale' approach is already used by more than 130 large businesses in the Global Commitment to assess the recyclability of their plastic packaging portfolio. In the Global Commitment, and according to a 2025 timeframe, the recyclability of a packaging design is proven 'in practice and at scale' if the packaging achieves a 30% post-consumer recycling rate in multiple regions, collectively representing at least 400 million inhabitants [69]. The EU proposal for a Packaging and Packaging Waste Regulation (PPWR) also acknowledges the need to go beyond just design for technical recyclability. It sets an objective for all packaging to be recyclable 'at scale', meaning packaging must be collected, sorted, and effectively recycled through infrastructure in an operational environment [70].

Photo by Lukasz Rawa on Unsplash

21%
of plastic is economically recyclable

130
large businesses in the Global Commitment use the 'in practice and at scale' approach to assess the recyclability of their plastic packaging portfolio

3.5 Design for recyclability continued

3.5.3 Impact of global plastic products and waste flows

Circular design is about treading a thin line between what is technically possible and what is practically realistic to keep materials circulating in the economy. Plastic flows across international boundaries through trade in plastic products and plastic waste. Plastic products and packaging are globally traded commodities, and may therefore become waste in countries other than the country of export. According to the UN Conference on Trade and Development (UNCTAD), global exports of plastics or goods made from plastic have more than doubled in value since 2005, passing the $1 trillion benchmark in 2018 and reaching nearly $1.2 trillion in 2021 [71].

Trade in plastic waste has increased 8.9-fold in the past three decades, with developed countries in Europe and North America the leading exporters of plastic waste, and developing countries becoming the main importers of plastic waste for recycling [72]. The design criteria for circularity should therefore be mindful of the circumstances in the country where the plastic waste is likely to be processed to avoid unintended consequences, including leakage into the environment. Plastic waste is often exported to developing countries that do not have in place the necessary recycling infrastructure to manage the imported materials in an environmentally sound manner. It is important to note that even if there were no plastic waste exports to developing countries, countries with limited waste management infrastructure might still import large amounts of plastic products (including packaging in imported products) that would become waste and would need to be managed domestically. Circular design criteria should therefore be mindful of the flow of products around the globe and the likely conditions under which products will be sorted, dismantled, and disaggregated. For example, while near-infrared spectroscopy may be widely available for sorting of materials in the Global North, sorting is mainly performed by hand in the Global South. Similarly, shredding and granulation equipment is widely used to reduce the size of the product in most countries, but there are still instances of shredding by hand in several regions including Africa.

Photo 1 by Patricia Valério on Unsplash
Photo 2 by Erik Mclean on Unsplash

3.5.4 Design criteria for recyclability

Considering both technical recyclability and recyclability in practice and at scale, sorting, processing and recycling requirements should be based on the following criteria [73]:

- **MATERIAL COMBINATION AND SELECTION –** Use of one type of plastic polymer is the optimum solution, but if different kinds of plastic polymer types are necessary, then plastic products that can be separated mechanically should be supported by on-pack information. Plastic types with different densities that are easily separated in water are also preferred over plastic types that cannot be separated by water, in which case they should at least be compatible.
- **SEPARABILITY OF COMPOSITE MATERIALS –** Such materials should ideally disintegrate into components of different density during mechanical shredding or granulating which can subsequently be separated in the washing stage. Designs with materials that cannot mechanically be separated should be avoided. If composite materials are necessary on account of the function to be fulfilled by the packaging, then thin layers that do not impair recyclability are preferred. Thick layers lead to coating residue which impairs the quality of the recyclate.
- **MATERIAL IDENTIFICATION –** All plastic components should contain a clear material identification code. All polymers in use must be clearly identified.
- **COLOUR –** Un-pigmented polymers have the highest recycling value. Solidly printed plastic fields and films with high ink coverage must be avoided. Printing must be avoided on un-coloured plastics.
- **ADDITIVES –** Use of additives should be avoided or limited where possible as it often renders plastics non-recyclable. It also changes the density of the materials, resulting in ineffective separation during mechanical recycling.

More specifically, for plastic packaging a set of criteria can be developed [74][75]:

- **Labelling, printing and adhesives –** In general, labels should enable the recognition of the underlaying polymer. Labels made from materials that are different from those of the pack are acceptable if the density differs sufficiently for technical separation. Sleeves and wraparound or collar labels are acceptable only if they are stuck to the container at a few points and can be separated without any residue if water-soluble adhesives are used. Paper labels are acceptable if they are attached with water-soluble adhesive and do not pulp in the washing process. Use of decorative or protective finishes like foil, lacquers and coatings should be minimised. Hazardous substances, including heavy metals, should be avoided in printing ink.
- **Laminate films or multi-layer packaging –** While there are cases where films could replace containers, thereby significantly reducing the amount of plastics used as well as decreasing GHG emissions because of the reduced weight, laminated, composite and multilayer packaging is often not possible to recyclable, and so it should be excluded if possible and only be considered if other options do not result in the same service.
- **Sleeves –** Use of material of a different kind for printed sleeves offers the opportunity to colour and decorate the surface of the product, without contamination of the main material. However, such materials need to allow identification of the packaging container material by ensuring a sufficient degree of uncovered surface, and involve the use of non-bleed inks, to ensure there is no contamination of recycling streams.

3.6 Additional considerations for circular design and performance

In addition to circular design approaches and criteria, additional considerations are necessary. Performance and information requirements should not be considered in isolation. To be effective, they must be embedded in a circular economy framework, guided by three drivers of value creation:

- **Increase the utilisation of each product by providing a sharing-economy experience to users, such as borrowing, lending, etc.**
- **Consider cascading uses for the product and its components and materials.**
- **Ensure safe chemical and material choices that are compatible with the circular economy, enabling the regeneration of natural systems and the recirculation of materials without creation of hazardous legacies.**

Photo by Teona Swift on Pexels

3.6.1 Safe, sustainable, recycled and renewable material choices

Circular design should incorporate recycled content requirements in order to ensure a viable market for recycled plastics from recyclable plastic products, as the inclusion of recycled content in the design phase and a common uptake of the recyclate in the market create the incentive to move away from virgin plastic. Setting minimum post-consumer recycled content targets related to the product, at sectoral level, based on a standardised approach and calculations method is essential. Quality, safety and quantity of the recycled content as well as its cost are equally important to ensure circular design of plastic products. Based on the guidelines from Plastic Recyclers Europe and the Association of Plastic Recyclers, the following criteria can be proposed for recycled plastic content in plastic products [76]:

- Made of plastic that is collected for recycling, has a market value and/or is supported by a legislative mandated program
- Sorted into a defined and existing stream for recycling
- Processed and recycled with commercial recycling processes
- Transformed into a raw material used in production of new items
- Considered safe for human health and the environment upon recycling

Lastly, circular design should also stimulate the use of renewable materials that are regeneratively produced without causing any negative environmental effects such as impacting land use and biodiversity or societal externalities. A circular economy drastically reduces our reliance on virgin raw materials, in particular when these are fossil-based. A product made from fossil-based resources works against the principle of decarbonising the economy. Therefore, the design criteria could consider requirements on material sourcing that contribute to regenerating, rather than depleting, natural systems, for example by introducing sourcing criteria stipulating that products be made from renewable feedstocks and be produced through agricultural practices with nature-positive outcomes, keeping in mind that LCAs can serve as a guide in the choice of preferable alternatives. It is essential that there be clear sustainability requirements on renewable feedstocks to avoid any negative environmental and societal impacts.

3.6.2 Information requirements

Availability of information is essential to permit full capitalization on the potential of a product design. If there is no information available relevant to the sustainability of a given plastic material or product, this might lead to missed opportunities for maximum value retention along the value chain. With such information available, competent authorities will be able to assess compliance of a given product or material with established criteria. There is a need to establish a basis for consumers and public authorities to compare products with regard to their environmental sustainability, enabling consumers and public authorities to make sustainable choices (e.g. on public procurement). Information on repairability and durability plays a key role in enabling consumers to engage in sustainable consumption patterns. Availability of appropriate information should also contribute to improved collection and sorting rates for relevant product groups, in particular for those for which a significant reuse and refurbishment potential exists (for example by facilitating information on take-back schemes through financial incentives and deposit-refund systems, databases of drop-off points, end-of-life information on the value of the product, and best practices related to proper disposal). There has been growing concern that claims regarding recyclability of products may not reflect actual conditions of the infrastructures available in a specific context. Improving information and transparency can have an immediate impact on consumers' willingness and ability to responsibly handle plastic waste [77].

Digital information linked to a product can provide information about environmental sustainability. This information can be accessible by for example scanning a data carrier and can include attributes such as durability and repairability, recycled content or availability of spare parts. It may help consumers and businesses make informed choices when purchasing products, facilitate repairs and recycling, and improve transparency about products' life cycle impacts on the environment. So-called product passports also help public authorities better perform checks and controls.

Online information about the products can also be made available for consumers and businesses. This can be in the form of solutions that allow the user to navigate in view of identifying the information needed, and include information about the product structure, methods for repairing, removal and replacement of parts, name/id of product/parts materials and information about steps to take when managing the product as waste. Such information and guidelines can also recommend that producers establish internal systems ensuring the availability of such information throughout the value chain, as well as the necessary personnel to implement designs in accordance with these guidelines and to provide a broader understanding and active disclosure of information on the status of product design for plastic circularity. In addition, certification schemes for plastic products that excel in sustainable design can be considered in combination with public procurement measures.

4. Scaling up circular design throughout the value chain through the new international legally binding instrument

Regulations and provisions of the upcoming instrument will have an influence not only on policy makers' choices, but on all the stakeholders along the whole value chain. If ambitious, clear, and applicable provisions are included in the text, such actors will react in a quicker and coordinated manner, and will ultimately reap higher benefits from the circular economy transition.

4. Scaling up circular design throughout the value chain through the new international legally binding instrument continued

Designers at various levels (material developers, producers, retailers) can take active decisions and adopt circular economy principles from the early phases. In this sense, decision trees based on the waste hierarchy principles and the criteria outlined above can be helpful [78]. Guidance from the OECD has also pointed to the concept of Sustainable Design Goals as a way to bring in different perspectives and tackle the challenges and trade-offs arising from the whole lifecycle of products [79]. In order to develop products, buildings and services that function within closed-loop resource flows, designers need to address the entire life cycle including the design, production, use and waste phases, in a simultaneous and coherent way. This requires designers to assume a holistic and systematic approach to problem-solving and to, for example, anticipate how a product might function and change over time. Research has indicated that design for circularity requires a shift from object-centric thinking to a more system-based and function-based design approach, in which designers have to take on the role of solution providers rather than object creators.

Material developers have a responsibility to ensure that their innovations adhere to circularity principles and material standards. One way of fulfilling this could be through the provision of data for informed decision-making in the plastics value chain, which could take the following forms, for example:

- Providing ‘circularity data sheets’ (similar to material safety data sheets) including information on plastics and chemicals (additives, processing agents, etc.) used.
- Meeting material standards also by ensuring that products are certified, when this is appropriate.

Producers have influence over material selection, combinations, form and product design, and additives used in the production of plastic products. Producers also cover the producers of intermediate products, such as polymer producers and plastic converters. Producers could operate within the boundaries and scope set forth in the following forms:

- Circularity standards and performance criteria for product design
- Restrictions on the use of specified materials and combinations of materials, including in certain applications
- Restrictions on the use of certain material combinations and composite materials
- Standardized approaches for material thickness, strength and quality of components
- Targets for phasing out non-recyclable material combinations and composites
- Recycled content requirements for certain final products and intermediate products; the intention is that polymer producers, and not only the manufacturers of the end product, comply with performance or information requirements on recycled content
- Transparency requirements regarding the chemical and material composition of plastic products including intermediate products

Photo by Annie Spratt on Unsplash

Brand owners and retailers are key influencers in the value chain. These actors should be empowered and required to:

- Make informed decisions about product and packaging choices linked to design criteria.
- Educate consumers and create consumer awareness.

This could be achieved through standards relating to printing, labelling, use of adhesives and ease of emptying.

Other stakeholders, more downstream in the value chain, can influence upstream choices, also guided by circular economy-oriented policies.

At the **procurement** level, harmonised approaches can help pull the market towards more ambitious, innovative and large-scale product and service offerings in response to public demand. Green Public Procurement (GPP) in this context is a very good example of procurement of products and services with a reduced environmental impact throughout their life cycles. The European Commission has proposed minimum GPP criteria and targets in sectoral legislation [80]. The Green Purchasing Guidelines of Japan’s public procurement system take into account circular economy aspects and a database promotes a variety of products that meet the requirements [81][82].

Consumers/civil society should be empowered to make informed decisions about plastic products, plastic-containing products and plastic packaging, in particular by enhancing the transparency of products. This relates (but is not limited to):

- Composition of plastic products
- Recycled content
- Reusability
- Repairability
- Recyclability
- Safe end-of-life management options

Policymakers across all levels of government will be key to creating the enabling conditions by ensuring a level playing field, supporting investments for the necessary infrastructure and fostering collaboration throughout the value chain. It is essential that structural reforms of economic instruments be implemented to shape the right economic conditions for a circular economy.

4.1 A stepwise approach in the instrument

Globally, the **legally binding instrument** could enable more circular design in plastic products by establishing the necessary conditions for the operators throughout the plastics value chain. A stepwise, tailored approach can yield promising results in the long term while enabling different actors to adapt.

Value chain actors need common overarching design criteria, or performance characteristics, which can guide the production of plastics and plastic products.

First, value chain actors need common **overarching design criteria**, or performance characteristics, which can guide the production of plastics and plastic products. These can be characteristics like reduction and optimization, reusability and prolonged lifetime, repairability and refurbishability, recyclability, etc., as described in the previous sections. Such criteria can be established as a core part of the legally binding instrument but can also be adapted or reflected in guidelines or legislation at the national level.

Second, **specific criteria for the relevant sectors, products, or product groups**, have emerged as an essential tool for the systematisation of scattered information and to ensure that circular design finds a concrete application. These criteria need to be more detailed and tailored to the relevant applications, and support the overarching criteria in the instrument. Depending on the outcome of the negotiations and the framing of the provisions of the new instrument, such criteria could be developed through technical committees or other sub-bodies. Similar models of preparing and reviewing technical elements or annexes are to be found in other multilateral agreements, and will allow the future decision-making body of the instrument to progress work on sectors, products, product groups or applications that the members/parties may want the instrument to cover. Any specific elements/criteria developed by technical workstreams under the future instrument should be considered by the future decision-making body (such as the COP). Subject to the outcome of the negotiations and the priorities determined by the future decision-making body of the instrument, examples of sectors and product groups can include, but should not be limited to: packaging, fisheries and aquaculture, agriculture, textiles, transportation/mobility, and construction.

The INC may also want to consider the role of standardisation bodies and the possibility of voluntary approaches by businesses and industry, as well as how they could complement and support the product design provisions of the future instrument.

Photo by NOAA on Unsplash

5.
Other elements relevant to the uptake of circular design models

After having explored approaches to criteria on circular design, we have analysed which actions and stakeholders can support their scale-up. Taking into account the broader picture and the text of the instrument currently under negotiation, the wide uptake of circular design criteria to a global level will require the harmonization of circular design criteria and policies at the national and international levels.

Additional elements of the instrument are closely connected to the circular design of plastic products: considerations on non-circular elements which can hinder the circular design of plastic products; EPR schemes as a highly relevant policy instrument; and international cooperation as a way to ensure that policies are connected, inclusive, promote best practices and models, and leave no one behind. This section will explore these additional elements.

Photo by cactusfotografia.pixieset.com

5.1 Excluding non-circular elements

Designing for circularity requires a systematic approach to adding circular design elements as well as avoiding aspects which can hinder the circularity of plastic products. In this context, global alignment on the criteria to determine which type of plastics should or could be excluded from certain applications to enhance their circular potential would provide businesses with the additional clarity and confidence they need to accelerate their efforts towards promoting alternative solutions [83].
In conjunction with reduction, scaling up reuse models and recycling infrastructure for the remaining plastics to work at scale, would allow a systemic shift to a circular economy. These considerations may comprise chemicals and polymers with the potential to have an adverse impact on human health or the environment at any stage of the plastic life cycle and properties that may hinder safe and environmentally sound management of products, including their reusability, repairability, recyclability and disposal.

In conjunction with reduction, scaling up reuse models and recycling infrastructure for the remaining plastics to work at scale, would allow a systemic shift to a circular economy.

Based on existing literature [84][85], the criteria used to determine problematic, avoidable, and unnecessary plastic products could be further elaborated under the instrument. Without entering into the details or intending to prejudge such negotiations, it is crucial to underline some of the elements to be considered, when determining whether a plastic product and its composition are to be classified in one of the categories listed below, also taking into consideration the specific use of the plastic product.

- It contains, or its manufacturing requires, hazardous chemicals that pose a significant risk to human health or the environment.
- It contains elements that make it impossible for the product to be reused.
- It hinders or disrupts the recyclability of other items.
- It has a high likelihood of ending up in the natural environment and/or a high potential of harming the environment or animal species, because of its size, shape or other physical characteristics.

Photo by Anna Wangler on Unsplash

5.2 Extended Producer Responsibility (EPR) systems

Extended Producer Responsibility has traditionally been a policy approach that makes producers responsible for their products when they reach the post-consumer stage of their life cycle. It has been widely used for electronics, packaging, vehicles, and tyres. There are now efforts to further expand the scope of EPR in order to address additional product groups, product design and further impact categories. GACERE has covered EPR systems in the context of a circular economy in a dedicated webinar and a report [86].

Photo by Ethan Bodnar on Unsplash

EPR has been successful in delivering better waste collection and recycling in several countries, and for the product groups where it has mostly been applied. EPR has successfully contributed to: (i) shifting end-of-life (EoL) management costs of products from the public sector to producers; (ii) increasing separate collection of waste that can be problematic when mixed into the general waste stream; and (iii) increasing material recovery rates [87].

New and more recent forms of EPR are working towards a longer product design and lifespan by differentiating EPR fees per product based on recyclability, reusability, repairability or durability criteria [88]. Increasing the lifespan of products slows material use throughout the economy and it also leads to avoidance of waste [89].

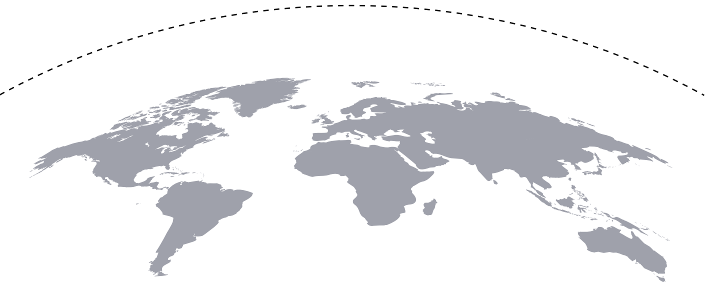
- **Product design:** EPR has the potential to provide producers with incentives for the design of reusable or more easily recyclable products [90]. The creation of effective product design incentives requires careful modulation and greater specificity of EPR fees. This approach – called eco-modulation or advanced fee modulation – enables the rewarding of products designed for improved circular design aspects such as improved end-of-life management (e.g. recyclability) and inclusion of recycled content through lower fees. Several countries are implementing fee modulation, for example Chile, Canada and Belgium [91]. Currently, some countries are also exploring innovative EPR policies to encourage reuse. Consideration of these non-traditional aspects can help integration of circular approaches in the design phase of plastic products and increase awareness of end-of-life management of plastic products. EPR also has the potential to provide cover for litter clean-up costs of plastic products.
- **Coverage of more product groups:** There are efforts to further improve the approach to address additional product groups which use plastics, such as fishing gear, tobacco product filters, and textiles. This could affect the future design of these plastic products. Covering these non-traditional products can enable reconsideration of the circular design of plastic products to reduce plastic waste and keep them in the economy and out of the environment.

Greater transparency through EPR enables better monitoring, benchmarking and comparison in product design and waste management. Financing and financial flows must be transparent and involved institutions should be disclosed. Results of the monitoring, which should be made publicly available, can, for example, include: collection, recycling and reuse rates achieved by EPR schemes; fees charged to producers, costs incurred and resale revenue; identification of anticompetitive practices by producers, PROs, and waste management companies; and monitoring of compliance with targets [92].

EPR has the potential to provide producers with incentives for the design of reusable or more easily recyclable products.

5.3 International cooperation

To ensure a global uptake of circular design principles, countries will need to work in a synergistic and coordinated manner. Particular attention must be given to countries that have limited financial and technical capabilities, as they will need growing support in their transition to a circular approach to plastics [93].



International cooperation can build on existing initiatives and programmes, and align them with the best available science and technology and the principles set forth in the treaty under discussion. To ensure maximum effectiveness, new initiatives include the possibility of taking stock of already successful projects and programmes, to amplify their impact [94].

International cooperation is key to addressing issues in the global plastic value chains. **These value chains are becoming increasingly interconnected** and require coordinated action among countries to combat plastic pollution and promote circular design. The Global South can play a prominent role, as many of the value chains that generate plastic products begin in Global South countries. At the same time, plastic value chains also end in the Global South, because of, among other factors, the export of plastic waste from Global North countries. It is also the Global South that suffers the harshest consequences of plastic pollution. Several actions can be taken in the context of international cooperation to promote a circular design of plastic products. International organizations, funds, local and international NGOs, businesses, and other entities have worked on some of these topics:

1. Stimulating consistent and effective policies at the national or regional level
2. Promoting local solutions, including indigenous knowledge, for a circular economy
3. Targeting SMEs to promote and spur the use of alternative materials, the adoption of new business models, and the implementation of circular product design approaches
4. Developing circular design capacities through technical assistance and technology transfer
5. Enhancing public actors' capacities to verify the conformity of products, especially newly designed products
6. Expanding shared infrastructure for reuse, by means of harmonized approaches and standards, and by promoting a fair share of costs
7. Working on the supply chain of multinational companies to ensure sustainability at all levels
8. Facilitating access to finance, to green existing processes and stimulate innovation
9. Raising awareness of the benefits of the circular economy, and addressing skill gaps.

For the instrument to be effective and be implemented, member states will need to support an **adequate provision of funding to international cooperation initiatives** that target all the levels mentioned above.

A comprehensive circular economy approach across the whole plastics life cycle is most effective in avoiding plastic pollution, offers the best economic, employment and climate outcomes [95], and presents opportunities for developed and developing countries alike. Policies, both national and international, will be essential to **maximize the socio-economic benefits from the transition to a circular economy for plastic products**. They include support for establishment of the necessary infrastructure and enabling a more harmonised approach to circular design of plastic products.

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