A critical view on packaging recycling and reuse in the European Circular Economy

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Executive summary

On behalf of The European Federation of Corrugated Board Manufacturers (FEFCO), VTT Technical Research Centre of Finland Ltd. has conducted a study to investigate packaging recycling and reuse and their role in a European circular economy. The study stresses that packaging should not be considered from a waste management perspective only, but the role of packaging, its functionality, performance and the overall sustainability, should be emphasized. It is of utmost importance that packaging is designed to be "fit for purpose", thus reducing waste generation by protecting the product it contains and minimizing overpackaging.

The current European Union packaging policies emphasize the circular economy approach, including intensifying recycling and increasing reuse. Paper and cardboard packaging material is not only renewable, but the packaging waste is also successfully recycled at a recycling rate of 84.2%. This is the highest recycling rate of all packaging materials in Europe and notably exceeds the regulatory targets.

The overall increase in the amount of packaging waste has led to intensified waste prevention highlighting reuse. Due to the inherit complexity the uptake of reusable packaging systems may involve increased costs and sustainability-related challenges. Packaging reuse in cases that involve long transport distances and crossing borders, high hygiene requirements or business to consumer interfaces create unnecessary complexity, increased costs, and negative environmental impacts. Corrugated packaging is an adaptable and hygienic single-use option that is produced from a renewable source and is recycled effectively at the end of its life to produce new corrugated packaging.

Packaging plays a significant role in avoiding both food waste and other types of waste. Approximately 97% of the environmental footprint of a packaged food product is linked to stages of the value chain other than packaging.

There is a clear need for different types of packaging and the packaging materials should be chosen to fit the purpose. Thus, both recyclable single-use and reusable options have a role to play to ensure sustainable and safe supply chains.

Future policies need to adopt a systems perspective addressing the entire life cycle of packaging, whether recyclable single-use or reusable, and should address the indirect and direct impacts on the environment, consumer behaviour, and performance of production systems. The following policy recommendations summarize the key aspects and actions needed to ensure sustainable and safe supply chains and transport of products globally in the future:

1. Being fit for purpose should be a key requirement for all packaging design and guiding regulations
2. Packaging should always be considered together with the packaged product
3. Recyclable single-use and reusable packaging should be considered in the legislation as complementary solutions
4. Sustainability performance of packaging entails multiple factors – not just waste generation
5. More data should be collected on packaging reuse
6. Stakeholder collaboration and consultations are vital to reach optimal and realistic decisions
7. Environmental policies should encourage innovation

Glossary

B2B A transaction or business conducted between one business and another, such as a wholesaler and retailer.

B2C A process of selling products and services directly between a business and consumers who are the end-users

tCO_2e Tonne of carbon dioxide equivalents

EPPA European Paper Packaging Alliance

EGD European Green Deal

EU European Union

GHG Greenhouse gas

HDPE High-density polyethene

LCA Life Cycle Assessment

LDPE Low-density polyethene

PP Polypropene

Reusable packaging
: Packaging which has been conceived, designed, and placed on the market to accomplish multiple trips or rotations within its lifecycle by being refilled or reused for the same purpose for which it was conceived (EU Directive 2018/852)

Recycling
: A recovery operation by which waste materials are reprocessed into products, materials, or substances whether for the original or other purposes, including the reprocessing of organic material but excluding energy recovery (EU Directive 2008/98)

Sustainable packaging
: Packaging that is 1) beneficial, safe & healthy for individuals and communities throughout its life cycle, 2) meets market criteria for performance and cost, 3) is sourced, manufactured, transported, and recycled using renewable energy, 4) optimizes the use of renewable or recycled source materials, 5) is manufactured using clean production technologies and best practices, 6) is made from materials healthy throughout the life cycle, 7) is physically designed to optimize materials and energy, and 8) is effectively recovered and utilized in biological and/or industrial closed loop cycles (Sustainable Packaging Coalition, 2011)

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1 Introduction

On behalf of the European Federation of Corrugated Board Manufacturers (FEFCO), VTT Technical Research Centre of Finland Ltd. has conducted a study to investigate the recycling and reuse of packaging and its role in a European circular economy. The circular economy is the key waste management strategy in current European Union policies. In practice, recycling is the most common way to manage packaging waste. This approach has been particularly successful for paper and cardboard packaging waste, which has the highest recycling rate of all packaging materials in Europe. In 2019, the recycling rate for paper and cardboard was 82.3% in Europe (Eurostat, 2021), thus exceeding the regulatory target for 2025, which stand at 75%. However, this is not the case with all packaging materials. Low recycling rates particularly concern plastic packaging, of which only 41% was recycled in the EU in 2019 (Eurostat, 2021).

The negative environmental impacts caused by plastics litter in rivers, seas, and on land due to the uncontrolled management and discarding of packaging waste, for example, has led to implementation of more stringent environmental policies in the EU. These regulatory actions aim to prevent direct and indirect detrimental impacts of litter on the economy, environment, and well-being of citizens. In this context, packaging reuse has been highlighted as the solution to address environmental problems and related consumer concerns.

The concern over impacts of the uncontrolled management of packaging waste should not, however, cause policy makers to overgeneralize the issues at hand and their solutions, especially considering the wide range of packaging materials. Additionally, it should be kept in mind that 97% of the environmental footprint of a packaged product is linked to stages of the value chain other than packaging. Packaging plays a significant role in avoiding food waste, for example. There is a clear need to account for different types of packaging and the packaging materials should be chosen to fit the purpose.

This white paper analyses the role of recyclable and renewable packaging compared to reusable packaging within the European Green Deal.

2 Intensification of packaging waste prevention and reuse ambitions in EU policies

The European Green Deal (EGD) sets out the sustainability transformation needed to tackle the severe challenges related to climate change and environmental degradation (European Commission, 2019a). This growth strategy aims to transform the economy, including production and consumption, to better address planetary boundaries. The European Commission acknowledges that increasing packaging waste generation and related pollution, particularly related to plastics, as well as increasing CO_2 emissions are key environmental challenges. In line with the Green Deal, the Commission has addressed this challenge in several strategies including the European Strategy for Plastics in a Circular Economy (European Commission, 2018a), Circular Economy Action Plan (CEAP) (European Commission, 2020a), and directives such as the Directive on Single-use Plastics (SUPD) (European Commission, 2019b) and Directive on Packaging and Packaging Waste (PPWD) (European Commission, 2018b).

Principles of EU waste policies

Many of the current policy approaches designed to tackle the environmental challenges caused by packaging production and consumption emphasize a circular economy as a key solution (see e.g. Sundqvist-Andberg & Åkerman, 2021). The circular economy approach is based on the waste hierarchy, which has been a guiding principle of EU waste policies for a long time. The principle prioritizes waste prevention and reuse over recycling, followed by recovery as energy over disposal as landfill. However, although it is expected that following the waste hierarchy will lead to the most resource-efficient and environmentally sound choice, several LCA studies show different results. For this reason, the concept of life cycle thinking has been introduced into waste policies. A Life Cycle Assessment (LCA) is recommended by the European Commission to support decision-making in the area of waste management and to identify the most environmentally sound options (European Commission, 2016). It can help policy makers understand the benefits and trade-offs they face when making decisions on waste management strategies.

Growing packaging waste generation

While the improved waste hierarchy approach, ensuring any action has an overall benefit compared to other options, has been applied for a few years in the EU, some of the recent EC policies seem to focus on waste prevention and reuse. This has been especially true in the case of packaging. For example, the new CEAP emphasizes prevention and reuse and suggests a sustainable product policy to promote the circular design of products and prioritizes reducing and reusing materials before recycling them (European Commission, 2020a). While the importance of packaging within food systems and global trade is acknowledged in the EU, recent policies in line with the CEAP, such as the recent Farm to Fork strategy, still aim to reduce packaging (European Commission, 2020b).

One reason for these recent policy actions is the increasing packaging waste generation within the EU that the Commission aims to curb. Despite an ongoing trend in Europe of reducing the packaging weight, the amount of packaging is increasing overall (Eunomia, 2020). In fact, according to Eurostat (2021), over a 9-year period, packaging waste grew by 17% (79.3 million tons in 2019). Several reasons contribute to this growth, such as increased online sales, economic growth and the shift towards disposable packaging (Eunomia, 2020). For example, in Finland, changes in packaging taxation led to a notable decrease in the use of refillable beverage bottles (Nurminen, 2017).

Box 1. Balancing between packaging recycling and reuse ambitions

The improved waste hierarchy approach, which is based on life cycle thinking, aims to ensure that a selected action has a higher overall benefit compared to other available options. Therefore, while packaging reuse has gained increasing attention in the European policy discourse, the role of recycling is acknowledged alongside reuse. For example, in the EGD where the Commission will develop requirements to ensure that all packaging in the EU market is reusable or recyclable in an economically viable manner by 2030 (European Commission, 2019). In addition, the Commission has identified that bio-based recyclable packaging '*could represent an opportunity to promote renewable sources for the production of packaging, where shown to be beneficial from a life cycle perspective*' (European Commission, 2018b).

Recycling sets the foundation for material circulation in the circular economy

The efficient circulation of materials is a prerequisite for a well-performing circular economy. The European Commission has amended the Directive on Packaging and Packaging Waste (PPWD) (European Commission, 2018b) and has set tighter recycling targets for all packaging and strengthened the extended producer responsibility to ensure that the recycling targets are reached. For example, by the end of 2030:

- 70% by weight of all packaging waste, and
- 85% by weight of paper and cardboard packaging waste should be recycled.

Recycling has been particularly successful for paper and cardboard packaging waste, which has the highest recycling rate of all packaging materials in Europe due to investments in related infrastructure. Already in 2018, the recycling rate for paper and cardboard was 84.2% in Europe (Eurostat, 2021), exceeding the regulatory targets (75% by 2025). However, this is not the case for all packaging materials. Low recycling rates particularly concern plastic packaging, which only reached 41.4% in the EU in 2018 (Eurostat, 2021).

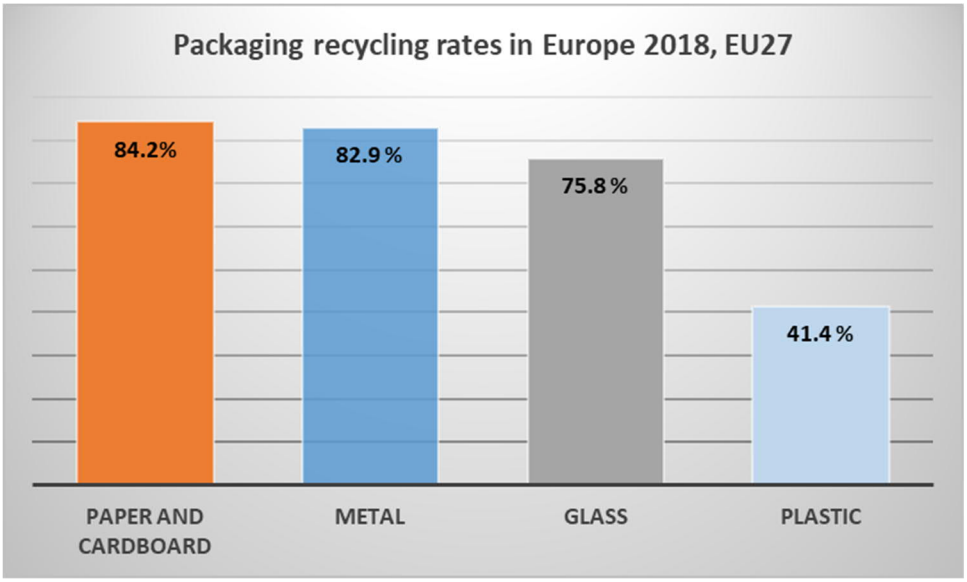


Figure 1. Packaging recycling rates in the EU, 2018 (Eurostat, 2021).

Packaging reuse as a proposed approach to packaging waste prevention

The EU policies emphasize the role of packaging waste prevention as the most efficient way to reduce environmental impacts and as a way to improve resource efficiency (see e. g. the revised Packaging and Packaging Waste Directive: Directive 2018/852 amending Directive 2008/98/EC on waste and SUP directive (2019/904)). In this context, packaging reuse is seen as a solution. For example, the SUP directive (EU Directive 2019/904) aims to reduce the amount of certain single-use plastics products and related litter in Europe. The directive sets a precedent by banning products from the market or demanding substantial consumption reduction only based on plastic content.

In addition, Article 5 of the revised Packaging and Packaging Waste Directive (PPWD) sets obligations for Member States to take actions to increase the share of reusable packaging placed on the market, as well as set up systems to reuse packaging (European Commission, 2018). While this directive emphasizes packaging waste prevention and encourages increasing the share of reusable packaging on the market, it also acknowledges and promotes recycling and other forms of packaging waste recovery. So far, the directive does not currently set any quantitative targets for reuse. However, the Commission has initiated the revision of the directive to reinforce the essential requirements for packaging, to ensure reuse and recycling, increase recycled content and improve enforceability. The initiative will envisage measures to tackle over-packaging and to reduce packaging waste further (European Parliament, 2020). During the revision mandates on reusable packaging, particularly transport packaging, have also been suggested (Eunomia, 2020).

For packaging reuse to reduce waste generation, it is vital that all reusable packaging also be recyclable (Eunomia, 2020) and can be recycled in an economically feasible way. However, it is important to remember that environmental problem shifting may take place with reusable packaging when the reuse systems scale up from the current market niches. Today, there are only a limited number of reuse systems on the market, and the impacts of the wider uptake on sustainability are still unknown.

Environmental policies ignore the role of packaging in other waste prevention

Current reuse and reduction policy ambitions fail to address the important role of packaging in global supply chains. Packaging can contribute to sustainability in several ways by protecting the product, facilitating handling, and communicating key messages. Through these functions, packaging can reduce product waste, improve transport and handling efficiency, lower CO_2 emissions and reduce risks of human health hazards (Lindh et al. 2016). That is to say, packaging designed to be *"fit for purpose"* can reduce waste generation noticeably by protecting the product it contains. The environmental impact of packaging is considered marginal compared to the overall impact of the product and its supply chain, for example in food systems (see Box 2).

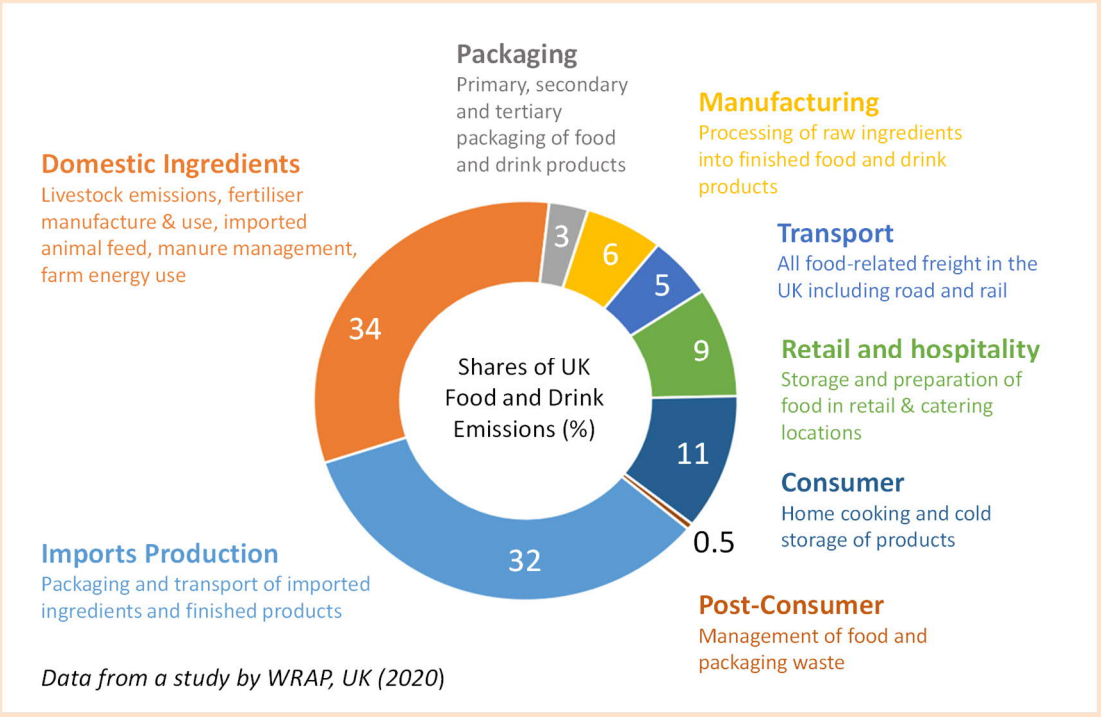
A limitation of the Commission's current policy approach is that it seems to treat packaging mainly from the waste management perspective and perceive it as a/n (un)necessary evil that needs to be reduced. This approach fails to consider the role of packaging, its functionality and performance. Therefore, future policies need to take a systems perspective and address the entire life cycle of packaging, whether recyclable single-use or reusable, and consider consumer behaviour and performance of production systems (e.g. UNEP, 2020).

To get to the economy of scale, reusable packaging needs standardization. However, especially in the food context, it has been noted that a larger range of packaging sizes that better meet the varied demands of different households may affect shopping and cooking behaviour (e.g. Williams and Wikström 2011). It is important to analyze whether there is a risk that food losses will increase if the packaging design changes. The overall environmental impact will most certainly increase if food losses do, even if the impact from the packaging decreases.

Box 2. The environmental impact of packaging and food losses

The global food system, from production to consumption, including processing, transport and packaging, is responsible for a third of global anthropogenic greenhouse gas emissions (Crippa et al., 2021). The share of packaging production and waste management of these emissions is minor. It is estimated that packaging production accounts for 3–5% of all GHG emissions (Crippa et al., 2021; WRAP, 2020). Yet, packaging plays an important role in the food system as it can not only reduce food waste but can also lower the overall environmental impacts (Silvenius et al. 2014).

In some cases, a slight increase in the weight or amount of packaging can reduce food waste. For example, meat, cheese, or food items with typically high losses such as bread, create higher environmental impacts, such as climate emissions, when wasted. It is important to analyse the risk of increasing food losses when the packaging design changes when aiming to decrease packaging waste, which is the main intention of the Packaging and Packaging Waste Directive of the European Union.



3 Recycling of fiber-based packaging enables the efficient reuse of fibers

When aiming for sustainable packaging, the use of renewable or recycled materials should be optimized (Sustainable Packaging Coalition, 2011). The material used for corrugated board is both renewable and recyclable. Paper and board packaging has a recovery rate of 91.7% and a recycling rate of 84.2% (Eurostat, 2021), making it the most recycled packaging material among all packaging materials. Additionally, the recycled content of corrugated packaging is particularly high and, in some cases, it can even be made from 100% recycled materials. By recycling corrugated packaging, the industry reuses the fibers and thus prolongs the life of its main raw material. Used corrugated cardboard is therefore a vital raw material for the recycling industry operating in a well-functioning internal market for high quality secondary raw materials and thus supporting the EU Circular Economy objectives.

Box 3. Fiber reuse is higher than believed

Fibers that make up cardboard and carton board can be recycled more than 25 times with no significant loss in quality (Putz & Schabel, 2018) and integrity (Eckhardt, 2021). The use of renewable, sustainably sourced virgin fibers positions corrugated packaging in the bio-cycle sphere (Ellen MacArthur Foundation, 2019) within the circular economy. The industry continues to innovate to ensure sustainable, safe, and hygienic packaging for the future. The reuse of fibers up to 25 times without loss of integrity and with a competitive environmental footprint (Ramboll, 2022) make corrugated packaging a comparative alternative to reusable plastic containers.

The recycling of paper starts with used packaging which is processed in well-established systems. The process most often involves mixing used fiber-based packaging with water and chemicals. The disintegrated material is then strained through screens, which remove plastics and other contaminants. The pulp can be mixed with the required proportion of virgin fiber to achieve the desired strength (typically less than 20%) and used in new packaging production.

Corrugated cardboard is locally produced in Europe. Often made from locally available recycled materials, transportation costs for manufacturing remain lower than if the materials are imported or freighted long distances. The used corrugated packaging is then recycled in standard paper mills to produce recycled material for new packaging, creating a perfect closed loop model in line with EU circular economy policies.

Although designed for long-term use, reusable packages will eventually end up as waste, due to inherent losses in the collection schemes, breakage etc. Plastics are the main material used in reusable packaging, a material whose recycling rate ranges between 26% and 52% in European countries. This wide range can be explained by national differences in collection schemes, available infrastructure, and consumer behaviour (Plastics Europe, 2021). However, a substantial share still goes to incineration with energy recovery or is landfilled.

Box 4. The circular economy in action

Recycling of fiber-based packaging creates a perfect closed loop model and is not limited to the fibers. One example involves paper mills, working with the local municipal authority, that take recycled water from the local wastewater treatment plant to supply the paper machine at the mill. The process effluent is then passed through the effluent treatment plant at the mill, generating biogas for use in the cogeneration unit. The effluent is further processed to remove sludge with the partially cleared effluent water returned to the local wastewater treatment plant—and so the process starts over, assuring a 100% closed loop for recycled water (International Paper in Spain).

4 Is packaging reuse a plausible way to improve sustainability?

Environmental sustainability is highly case dependent

The aim of the circular economy is to contribute to sustainable development by maintaining a circular flow of resources, by regenerating, retaining, or adding to their value. Similarly, the waste hierarchy is a recommendation that aims to promote the most resource-efficient and environmentally sound choice. To reveal an optimal solution both approaches require an overall sustainability assessment. The assessment may indicate that closing material loops require too many additional inputs and energy or that departing from the waste hierarchy could lead to better environmental outcomes.

To determine which packaging alternatives, single use or reused, lead to most sustainable strategies, several life cycle thinking based comparative studies have been conducted (see Appendix 1: Table 2). The results of these studies vary. One of the main reasons for different outcomes rests on the selected goal and scope of the studies. Some studies focus on the transportation of a specific product (e.g. vegetables), while others cover the wider spectrum of e-commerce. The geographical area analyzed may vary from a small, limited region to international long-distance transport and the market from B2B to B2C. Additionally, the impacts evaluated range from the carbon footprint to broader environmental impacts, with some studies even including economic aspects.

In addition, there are multiple factors in the packaging system itself that affect the sustainability performance (Figure 2). What raw materials are used (recycled/virgin renewable fiber or LDPE/HDPE/PP) and where are they produced? What is the package quality, weight, and format? What is the lifetime and number of rotations of reusable package? How are the logistics including back haul from the point of sale? What kind of storing operations are needed? What are the requested packaging hygiene and safety standards and the sanitation processes consequently needed? All questions need to be evaluated before policy decisions are taken.

Figure 2. Examples of factors affecting the sustainability performance of (reusable) packaging.

According to LCA studies, the manufacturing phase of packaging is one of the main contributors to the overall environmental impacts, but substantial benefits are shown from reductions of the package weight Comparative Life Cycle Assessment (LCA) – Packaging solutions for the food. Together with the package format these do not only affect the impacts of the production phase of packaging but also the loading efficiency of the containers. Avoiding oversized packages has clear benefits. The most relevant factors, however, are the number of uses of the re-usable package, logistics aspects including the transport distance, and the potential sanitation processes needed for hygiene reasons. There is a breakeven point of reuse cycles needed to reach better sustainability performance than a single-use package. This point is always case specific. Unfortunately, publicly available data on current reuse times to allow independent evaluation is still limited. Moreover, washing of reusable packages substantially increases the environmental impacts. A hot spot analysis prepared for e-commerce shows the complexity and the most significant hot spots in the logistic chain (Di Salvo, 2021).

The end of life of the packaging material makes a difference in the overall environmental performance. While carton boards are efficiently recycled, reusable packaging eventually ends up as waste due to losses, breakages, and deterioration. If a major part of this is incinerated, it will cause unwanted fossil-based carbon emissions. Therefore, the focus of the Commission on increasing reuse does not fully consider the end of life of reusable options.

Renewable material and energy sources represent a key part of climate change mitigation. Renewability as such is an inherent characteristic of bio-based fibers that is not revealed in LCA results and must be highlighted separately. Packaging materials from renewable and fossil origins should also be treated within their respective environmental principles, as shown in Ellen MacArthur's technical circular economy for renewable raw materials and non-renewables (Ellen MacArthur Foundation, 2019).

Box 5. Comparing environmental impacts of food transport packages

A recent LCA study, commissioned by the FEFCO, on B2B transport packaging solutions for the food segment compared the environmental performance of recyclable single-use corrugated board boxes (CB) and reusable plastic crates (RPC) used for delivering fresh food products in B2B cases in Europe. The study concluded that in comparison to the multiple-use plastic crates the recyclable CB system had a better environmental performance in 10 environmental impact categories out of 15 including climate change, fossil resource use and water use. In addition to the impacts coming from the production of plastic products the washing of RPCs plays a significant role in many impact categories.

Based on RPC industry expert opinions, the plastic crates were assumed to be used 24 times before disposal in the study. The evaluation show that the number of rotation times required to achieve better climate performance compared to CB would be at a range of 60–70 (Ramboll, 2022).

Key business constraints

The uptake of reusable packaging requires careful planning to minimize the business risks and increased costs related to a more complex supply chain. Benefits could be achieved if used in correct applications/industries,

but for many businesses single trip packaging will be a better option. Getting a reusable packaging loop set up and operational requires careful planning and support from key business stakeholders, customers and suppliers. Additionally, sustainability targets can be met only if the required number of rotations is reached,

Costs relating to reuse

Reusable packaging systems involve an upfront investment by the packaging company or the service provider. This initial investment required by companies to shift from single-use to reusable systems is substantial, often making single-use products cheaper than reusable ones (e.g., no costs for washing, return logistics, etc.) (e.g. Brazao et al., 2021). At the same time, publicly available estimations of the long-term cost savings realized by businesses that do implement reusable systems are very rare. There are indications that reusable packaging systems come with higher costs, of which the most important factors are the return process and loss of containers in the cycle (Zimmermann & Rödig, 2021). The high cost of reusable packaging is currently one of the main reasons for some key players to continue using recyclable single-use options like corrugated boxes (expert interviews).

In addition to the higher initial investment, other investments required to establish reuse systems include the (intermediate) storage of packages, washing, repair and transportation. For retailers, the additional space and hygiene requirements for receiving and storing reusable containers, or for dispensers, may be a barrier (Coelho et al., 2020). Furthermore, the need for maintenance and cleaning of dispensers is an additional activity that creates issues within current retail concepts, which may also introduce health risks and liabilities, e.g. due to contamination or spoilage through improper use or cleaning of bulk dispensers. Moreover, the issue of higher water consumption for reusable packaging compared to single-use packaging is one that is frequently raised when comparing the impacts of these systems.

It should be noted that in practice, packaging reuse systems require an additional reserve of reusable packaging to guarantee the continuous supply of goods across the EU. This is to hedge against theft, breakage, allowing for washing etc. and means that an increased number of reusable packaging should be in circulation to guarantee a continuous supply of goods.

Deployment

At this point, several packaging service provider start-ups are entering the market with the first reuse systems in partnership mainly with food service companies. Additionally, big brands have piloted reusable packaging over the last few years, but such programs still make up a small share of global packaging manufacturing. Cumulatively, less than 2% of major brands' plastic packaging was reusable as of 2019 (Ducharme, 2021).

Utilizing pooling systems can help a company scale up and reduce its transportation impacts by making use of local distribution centers and cleaning facilities. The results of some studies indicate that reusable packages are more promising if variability in delivery operation and demand are small and if long-term business commitments can be made (Na et al., 2019). The use of reusable packaging is difficult to justify in situations where distances are long, volumes are low, or both, making the cost of returning containers too high.

Existing reuse systems are also application specific. Until now, most experiences from reusable systems are from B2B systems. As B2C reusable packaging systems have only recently begun evolving, public information

about their economic and environmental sustainability is very difficult to find. From the service providers' point of view, the key impact factors are the return rate, number of cycles and the cost of logistics. From the consumers' point of view, convenience is the major factor regarding package handling, intermediate storage (at home) and return (e.g., CITEO, 2021). Deposit return schemes have been seen to be essential to achieve decent return rates. Examples from bottle recycling indicate that the return rate is only half in systems without incentives when compared to deposit-based systems (Eunomia, 2020; Linnenkoper, 2021). Reusable packages have been seen to be most feasible for products and companies with frequent and regular sales, such as home-deliveries of groceries subscription sales (expert interviews). Challenges and costs increase when packages are transported across borders possibly demanding additional compliance due to different country rules. The fact that returned packaging needs storage space brings in extra constraints (expert interviews). The role of the consumer should not be underestimated. It has been seen that reuse systems deployed in B2C environments require incentives for consumers to return the packaging in the condition needed for reuse. When engaged in several reuse systems, this will limit the consumer's convenience.

The impact of package design

Standardization of reusable packaging is essential to introduce reusable packaging at scale. This would make logistics more efficient for companies and carriers and facilitate automation. Indeed, the lack of standardization in reusable packaging makes the market less efficient and more costly. Standardized pallets and crates make the overall supply chain more efficient for some product groups, even though any particular use might be less optimal from the product volume and size point of view. In such cases, the use of reusable (standardized) packaging may lead to oversized packages, which may result in higher transportation costs and a higher environmental footprint for the transportation (expert interviews).

Box 6. Packaging for e-commerce

The issue of packaging has been at the core of the ongoing discussion about sustainability in e-commerce. Compared to the overall packaging sector, only a small share of packaging is used in e-commerce, but the growth rate is high. E-commerce approximately doubled between 2019 and 2020 (Interpack 2020). It is an issue influenced by tangible challenges, such as the protection of goods during delivery, which of course also represents a concern in terms of sustainability and the need to protect goods from being returned and unrepairable.

Reusable packaging systems in e-commerce have encountered some challenges, mainly to do with the issue of scalability. Whereas the system functions well on a smaller scale, companies have encountered considerable additional logistical costs, which must be considered before introducing a system at the company or sector-wide level. Additional actions from businesses include the integration of packaging into the IT systems of web shops ensuring that the content of the shopping cart, be it one or several products, also fits into a standardized reusable bag or container.

Generally, e-buyers have high expectations concerning the environmental aspects of the packaging (scoring second after protective qualities functionality), but less than 10% remember seeing a sorting order on the package. Additionally, a third of e-buyers reuse their packages for their own purposes. Finally, based on a study in France, plastic pouches tend to be less reused than carton boards (CITEO, 2021).

Food safety and hygiene cannot be compromised

The principal role of food packaging is to ensure the adequate protection of the food from outside influences and damage. The packaging must preserve food safety and quality during the processing steps of transport, distribution, and storage thereby reducing food loss and waste.

The risks of increased foodborne disease associated with the shift towards the use of reusable food service-ware has been pointed out, for example in an EPPA study (McDowell, 2020). The inherent higher complexity of reuse packaging systems (multi-location cleaning, sanitation, storage, and transport) may also make it more difficult to track and suppress outbreaks of food borne illness and/or carry out related food product recalls. A number of studies have reported increased risks of cross contamination of foodborne illness when the use of single-use items is reduced at the retail-service-consumer interface (MacDowell, 2020; Lopez-Galvez et al., 2021), relating to failure in the quality assurance of necessary cleaning processes. However, hygiene risks are not a new problem and, in theory, high hygienic standards for reusable items can be achieved. The hygiene risk created by replacing single-use packaging in the food industry is also largely dependent on the food in question and the type of packaging.

Research indicates that corrugated cardboard makes fruit and vegetables remain fresh longer as the delicate produce is cushioned between the layers of paper. A study by the University of Bologna showed corrugated board keeps fruit fresh up to three days longer by reducing contamination compared to storage in plastic containers (Siroli et al., 2017).

The legislative push away from single-use plastics has pushed innovation in new antimicrobial packaging material and surfaces, washing and logistic systems which also aim to reduce the contamination risks in reusable packaging systems (Eagle 2019). That said, research indicates that carton board packages are less prone to spreading cross contamination compared to plastic containers (PP) (Lopez-Galvez et al 2021). There are still several issues and uncertainties that can have a negative impact on the sustainability of packaging reuse and related systems. Figure 3 presents some of the emerging governance challenges.

Monitoring and verifying packaging reuse

It is difficult to set binding targets for packaging reuse without a clear understanding of the current reuse levels.

This would require setting up a system to identify, measure and verify the flows of reusable packaging in Europe.

However, setting up such a system requires resources and may increase the administrative costs and burden.

Assessing sustainability impacts

The sustainability performance of a packaging system is dependent on multiple factors and is highly case specific.

A comprehensive life cycle thinking based sustainability assessment is a necessity to compare alternative options.

While fibre-based packaging such as corrugated board complies with most of these criteria, there are still many uncertainties regarding the sustainability of reusable packaging.

Increasing complexity and costs of packaging systems

Setting up well performing reuse systems requires several changes to current systems and is likely to increase the complexity and cost.

Compared to single-use packaging, the uptake of reusable packaging also requires behavioural change, and incentives are needed not only to motivate but also to retain users.

Standardization is suggested to reduce the inherit complexity of reuse systems, but it may have a negative impact on packaging functionality and how well it fits to purpose.

Figure 3. Emerging governance challenges related to the uptake of packaging reuse systems.

5 Recommendations to policy makers

1. Being fit for purpose should be a key requirement for all packaging design and guiding regulations

   The Commission and industry aim to achieve circularity and climate neutrality goals. One way to prevent negative environmental impacts is to avoid product losses, which can be achieved by designing packaging to be fit for purpose. Packaging that is designed to effectively contain and protect the product across the supply chain will prevent overpackaging and underpackaging and prevent waste of both the product and packaging.

2. Packaging should always be considered together with the packaged product

   Packaging exists for a reason: to protect, preserve and provide information about the product it contains. Packaging has a much lower environmental impact when compared to the packed product itself. It is essential that policy makers recognize the functions of packaging, in protection and product/food waste prevention. The Commission's impact assessment should not address packaging only, but also consider packaging in association with the products it protects throughout their life cycles.

3. Recyclable single-use and reusable packaging should be considered in the legislation as complementary solutions

   The environmental performance of a packaging system must be assessed on a case-by-case basis. This means first assessing the applications and markets where reuse or recyclable single-use provide the best solution. Recyclable single-use and reusable packaging are beneficial for different applications and situations and should therefore be considered complementary solutions. Policy makers should continue to aim for the best environmental and economically viable outcomes.

4. Sustainability performance of packaging entails multiple factors – not just waste generation

   Multiple factors affect the sustainability performance of packaging. Special attention should be paid to the short lifetime or small number of rotations of reusable packages, long distance transportation and additional washing processes needed to meet hygiene standards. These conditions tend to increase the cost and environmental impacts of reusable packages, favoring single-use packaging made of renewable and recyclable materials.

5. More data should be collected on packaging reuse

   To support evidence-based policy making, there is a need to gather objective information on packaging reuse, including data on packaging return rates and the number of actual use cycles. This information is needed by both policy makers and business actors to evaluate and improve economic and environmental sustainability.

6. Tight stakeholder collaboration and consultations are vital for making optimal decisions

   There is a need to develop decision support models that consider the most optimal packaging (single-use or reusable) systems in various industries and business. This should be done in

collaboration with key stakeholders (e.g. producers, trade, retail, logistics providers) across the various supply chains to get realistic insights and to prevent unintended consequences to the economy or environment.

7. Environmental policies should encourage innovation

   Policy design should allow a level playing field for industry to innovate and develop solutions that rely on eco-design and comply to reuse and recycling targets of the climate neutral and sustainable, circular economy.

6 Conclusions

The circular economy leads the waste management strategy in the current European Union policies emphasizing the optimized use of renewable or recycled materials. Paper and cardboard packaging material is not only renewable, but the packaging waste is also successfully recycled at a rate of 84.2%. This is the highest recycling rate of all packaging materials in Europe and notably exceeds the regulatory targets. Not all packaging materials are recycled as efficiently as cardboard, the recycling rate of plastics, for example, being only ca 42%. The negative environmental impacts caused by packaging waste are mainly related to the production and incineration of fossil-based packaging materials and plastic litter due to uncontrolled management and discarding.

Packaging should only not be treated from a waste management perspective, but the role of packaging, its functionality and performance should also be equally emphasized. It is of the utmost importance that the packaging is designed to be “fit for purpose”, thus reducing waste generation by protecting the product it contains and minimizing overpackaging.

The increasing amount of packaging waste has led to increased focus on waste prevention, highlighting reuse options for packaging. Due to its complexity and other business constraints, the uptake of reusable packaging systems involves increased costs and sustainability related challenges. It is evident that there are applications where reusable packages are not economically or sustainably feasible solutions; particularly, cases that involve long transport distances and crossing borders, which have high hygiene requirements, a business to consumer interface that creates unnecessary complexity, increased costs and increased environmental impacts. In such cases, a recyclable single-use option might be more economically and environmentally sound.

Both recyclable single-use and reusable options have a role to play to ensure sustainable and safe supply chains. They should be considered complementary, not competing, solutions. Future policies need to take a systems perspective addressing the entire life cycle of packaging, whether recyclable single-use or reusable, and indirect and direct impacts on the environment, consumer behaviour, and performance of production systems.

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Appendix 1. Methods

The analytical approach in the white paper is qualitative. This kind of approach fits a topic well that is evolving and changing over time.[1] The data used in this study consists of written documents in electronic format and expert interviews. Purposive and iterative sampling[2] was used to identify and select relevant interviewees (Table 1). A semi-structure interview protocol was applied to obtain in depth data and ensure flexibility. The interviews, 10 in total, were conducted through videoconferencing. The data was collected from June 2021 to November 2021. The written documents included academic papers, grey papers, and company web pages.

Table 1. List of interviewees

Type of organization	Number of organisations	Number of interviewees
Industry Association	3	5
Policy maker	2	3
Retailer	1	1
Packaging material producer	7	13
Reusable packaging provider	1	1
Logistics provider	1	1

Table 2. List of reviewed studies

Title	Authors	Year
Climate-smart returnable crates have replaced over two billion packages	Svenska Retursystem	2021
Carbon Footprint of Food packaging	Fraunhofer	2018
Comparative Life Cycle Assessment of different pouches and alternative packaging systems for food (Pasta Sauce and Olives) on the European market	ifeu	2021
Life Cycle Assessment for eco-design of product–package systems in the food industry—The case of legumes	Del Borghi, A., Strazza, C., Magrassi, F., Taramasso, A.C., Gallo, M.	2018
Collaborative Report on Sustainability and e-Commerce	ECOMMERCE EUROPE	2021
Paper and cardboard — recovery or disposal?	European Environment Agency	2006

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Sustainability of reusable packaging–Current situation and trends	Megale Coelho, P. M., B Corona, B., Roland ten Klooster, R., Worrell, E.	2020
Limited climate benefits of global recycling of pulp and paper	van Ewijk, S., Stegemann, J. A. and Ekins, P.	2021
Understanding and improving the e-commerce packaging sorting process	CITEO	2021
A comparative study of the environmental and economic characteristics of corrugated board boxes and reusable plastic crates in the long-distance transport of fruits and vegetables.	Universitat Politecnica de Valencia	-
Comparison of Carton and Plastic Packaging Sustainability	Barker, T. Truffula Ltd.	2018
THE RISE OF REUSABLE PACKAGING UNDERSTANDING THE IMPACT AND MAPPING A PATH TO SCALE	Fashion For Good	2021
Reusable Packaging Solutions	PRESCOUTER	-
Carbon Footprint of Packaging Systems for Fruit and Vegetable Transports in Europe	Fraunhofer	2018
Reusable Packaging and COVID-19 Policy Paper	Zero Waste Europe	2020
Statistics of trips of Returnable Plastic Crates for fresh Fruits & Vegetables	Gesellschaft für Verpackungsmarktforschung	2009
The Future of Ecommerce: How Ecommerce Will Change in 2021 and Beyond	Roach, A.	2021