Effectiveness of the Essential Requirements for Packaging and Packaging Waste and Proposals for Reinforcement

Final Report and Appendices

Project conducted under Framework Contract No ENV.F.1/FRA/2014/0063

Written by Eunomia Research & Consulting Ltd, COWI, Adelphi, Ecofys (Navigant), Milieu
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Directorate B — Circular Economy & Green Growth
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ADDRESS COWI A/S
Parallelvej 2
2800 Kongens Lyngby
Denmark

TEL +45 56 40 00 00
FAX +45 56 40 99 99
WWW cowi.com

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EFFECTIVENESS OF THE ESSENTIAL REQUIREMENTS FOR PACKAGING AND PACKAGING WASTE AND PROPOSALS FOR REINFORCEMENT

FINAL REPORT

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Abstract

The European Commission commissioned a study to support its examination of the feasibility of reinforcing the essential requirements for packaging with a view to, inter alia, improving design for reuse and promoting high quality recycling, as well as strengthening their enforcement.

The work included six main components: (1) review of their effectiveness, including an analysis of trends in packaging waste composition/ volumes and identification of packaging types/ materials that pose specific challenges for recycling, (2) review of the adequacy and relevance of the current essential requirements with the objectives of the revised PPWD and the wider objectives of waste and circular economy policy, (3) identification of obstacles to their effective implementation and enforcement, (4) preparation of case studies on approaches that could prove useful in reviewing/ reinforcing the essential requirements with a view to identifying potential avenues for doing so, (5) identification and initial assessment of measures to reinforce the requirements including stricter definitions of recyclability/ reusability, and (6) extensive stakeholder consultation throughout the process.

Based on the above possible measures to make the requirements more operational and effective were developed and underwent a preliminary assessment. An initial proposal for grouping the most promising measures under three coherent options was made.

Résumé

La Commission Européenne a commandé une étude visant à contribuer à son examen de la faisabilité d'un renforcement des exigences essentielles en matière d'emballage en vue, entre autres, d'améliorer la conception pour la réutilisation et de promouvoir un recyclage de haute qualité, ainsi que de renforcer leur application.

Le travail comprenait six composantes principales : (1) examen de leur efficacité, y compris une analyse des tendances en matière de composition/volume des déchets d'emballage et l'identification des types/ matériaux d'emballage qui posent des problèmes spécifiques pour le recyclage, (2) examen de l'adéquation et de la pertinence des exigences essentielles actuelles avec les objectifs de la directive PPWD révisée et les objectifs plus larges des politiques en matière de déchets et d'économie circulaire, (3) identification des obstacles à leur mise en œuvre et à leur application effectives, (4) préparation d'études de cas sur les approches qui pourraient s'avérer utiles pour le réexamen/renforcement des exigences essentielles en vue d'identifier les possibilités de le faire, (5) identification et évaluation initiale des mesures visant à renforcer les exigences, y compris des définitions plus strictes de la recyclabilité/réutilisation, et (6) consultation approfondie des parties prenantes tout au long du processus.

Sur la base des éléments ci-dessus, des mesures éventuelles visant à rendre les exigences plus opérationnelles et plus efficaces ont été élaborées et ont fait l'objet d'une évaluation préliminaire. Une première proposition a été faite pour regrouper les mesures les plus prometteuses en trois options cohérentes.

Executive Summary

The Essential Requirements, which all packaging placed on the EU market needs to comply with, were first introduced in the Packaging and Packaging Waste Directive (PPWD – Directive 94/62/EC), as defined in Article 9 and Annex II. They relate to the manufacturing and composition of packaging, the reusable/ recoverable nature of packaging and hazardous materials to be minimised in packaging. These requirements, and the associated harmonised standards, have not changed substantially since their introduction, and previous studies have identified the Essential Requirements as potentially requiring further attention to improve packaging design, particularly in relation to the lack of recyclability of many packaging formats. In addition, the policy landscape has evolved significantly since the PPWD first established the Requirements; the 2018 revision of the PPWD included, in addition to a revision of the recycling targets for packaging waste, a mandate for the Commission to examine “the feasibility of reinforcing the essential requirements with a view to, inter alia, improving design for reuse and promoting high quality recycling, as well as strengthening their enforcement.”

This study supported the European Commission’s review of the effectiveness and shortcomings of the Essential Requirements, identifying potential measures for their reinforcement, and conducting a preliminary assessment of the likely impacts of these.

Synthèse

Les Exigences Essentielles, auxquelles tous les emballages mis sur le marché de l'UE doivent se conformer, ont été introduites pour la première fois dans la Directive relative aux Emballages et aux Déchets d'Emballages (Directive 94/62/CE), telle que définie à l'article 9 et à l'annexe II. Elles concernent la fabrication et la composition des emballages, la nature réutilisable/récupérable des emballages et les matières dangereuses à réduire au minimum dans les emballages. Ces exigences, et les normes harmonisées associées, n'ont pas changé de manière substantielle depuis leur introduction, et des études antérieures ont identifié les Exigences Essentielles comme pouvant nécessiter une attention supplémentaire pour améliorer la conception des emballages, notamment en ce qui concerne le manque de recyclabilité de nombreux formats d'emballage. En outre, le paysage politique a considérablement évolué depuis que la Directive Relative aux Déchets d'Emballages a établi les exigences pour la première fois; la révision de 2018 de cette Directive a inclus, outre une révision des objectifs de recyclage des déchets d'emballages, un mandat pour que la Commission examine "la possibilité de renforcer les exigences essentielles en vue, entre autres, d'améliorer la conception en vue de la réutilisation et de promouvoir un recyclage de haute qualité, ainsi que de renforcer leur application".

Cette étude a contribué à l’examen de la Commission Européenne de l'efficacité et les lacunes des Exigences Essentielles, d'identifier les mesures potentielles pour leur renforcement et de procéder à une évaluation préliminaire des impacts probables de celles-ci.

E.1.0 Review of the Effectiveness and Relevance of the Essential Requirements

The study commenced with a review of the effectiveness of the current essential requirements in light of the evolution of the policy landscape, including analysis of trends in packaging waste composition/ volumes and definitions of recyclability/ reusability. In addition to a review of the relevant legislation and previous studies evaluating the Essential Requirements, this included a survey to Member State experts regarding current practice and perceived shortcomings in the implementation and enforcement of the Essential Requirements. Data on packaging and packaging waste (from both publically available sources, like Eurostat, as well as market reports) were analysed to identify key trends in the packaging market. The findings of the review were tested in a workshop with a wide range of packaging industry stakeholders, including manufacturers, fillers, distributers, recyclers, NGOs, and trade organisations, etc.

The review found a ~10% increase in packaging waste generated (used as a proxy for packaging placed on the market) in the EU between 2007 and 2017, with food and beverage packaging accounting for two-thirds of total European packaging in terms of market share value. The dominant packaging material, by weight, is paper/cardboard, followed by plastic and glass. However, use of both plastic and paper/cardboard packaging has increased over the past 20 years, while some data indicated decreasing use (marginally) of metal and glass. Though the recycling rates of all four major packaging types have increased since the 1990s, these vary in 2017 from 42% (for plastic) to 85% (for paper/ cardboard) packaging recycled. The increases in plastic packaging thus relate to increased use of the least well recycled packaging material. The review also found evidence for several key trends in EU packaging waste composition and volumes, namely:

- Large market share of unrecyclable flexible film/pouch packaging;
- Demand for high barrier and composite materials which are difficult to sort/ recycle;
- Potential contamination of plastic/ biowaste stream with biodegradable /compostable plastics;
- Increase in packaging waste and issues of over-packaging associated with e-commerce;
- Increased use of design features that inhibit recyclability e.g. use of glues/ inks/ other additives, use of PVC, etc.; and
- Decrease in reusable packaging.

The trend analysis was accompanied by an assessment of relevant literature, Member State expert input, as well as Eunomia's own expert evaluation of the relevance of the Essential Requirements and the accompanying harmonised standards. The relevance of the Essential Requirements appears to be a critical weakness, as they do not reflect current prioritisation between and knowledge on end-of-life management options, do not sufficiently operationalise the conept of recyclability and do not necessarily account for the range of packaging types that are now placed on the market. Nor do they reflect current concerns regarding climate change, littering and plastics in the marine environment.

The current harmonised standards do not provide the added degree of clarity that is needed. If the Essential Requirements themselves were strengthened to include clearer definitions and metrics, the need for any accompanying Standards may be eliminated. They could, however, potentially still assist by elaborating on concepts that have been more clearly defined in a reinforced version of the Essential Requirements, and providing well-defined assessment procedures. If the Standards are retained, the presumption of compliance – effectively self-certification – should certainly be reviewed so that the roles and obligations of both Member States and producers are clearer.

The review concluded that, in summary, the effectiveness of the Essential Requirements is limited by:

- The minimal requirements, especially in the context of the EU's latest recycling targets and policy direction;
- Their vague nature which makes interpretation and enforcement difficult;
- A failure to reflect the different environmental impacts of the various treatment options (as recognised by the waste hierarchy);
- The opaque division of responsibility (between entities along the supply chain and with Member States), as well as the exclusion of the views of stakeholders further along the value chain – not least those responsible for collecting and processing waste;
- The Requirements have not been updated as packaging technologies have changed or knowledge of environmental and human harms has expanded;
- The presumption of compliance and implicit low priority status of the Essential Requirements.

E.2.0 Materials and Types of Packaging representing Particular Problems

Alongside the review of EU packaging trends, the available data were analysed to identify packaging types and materials that currently inhibit recycling/ reuse, using the criteria below -

- The packaging is less likely to be collected by streams being subjected to sorting for recycling;
- The packaging poses challenges to the majority of sorting systems;
- The packaging poses problems to recycling operations; and/or
- All of the above are magnified when the packaging is increasing in market share relative to other easily recyclable packaging.

The packaging materials/ types that were identified accordingly are listed below. A full rationale for the selection of these packaging types, alongside exemplar items, is provided in the main report.

- Multi-material packaging
  - Metallised plastic films, plastic-coated, or metallised cardboard, and small, multi-material packages
- Plastic packaging
  - Multi-Polymer flexible film packaging; Black Plastic (also to a lesser extent, dark coloured plastic which isn't black); Biodegradable plastics; Plastic Packaging with PVC components and all-PVC packaging; Shallow or flattened plastics; Additives which alter sorting; Plastics with optical brighteners; and additions to plastic bottles
- Glass Packaging
  - Glass bottles with additional parts
- Paper packaging
  - Paper cured with UV varnish/ varnish that breaks down into small particles; Paper with adhesives which plasticise; and Waxed Papers

E.3.0 Approaches to Achieve Required Level of Packaging Reuse and Recycling

Based on the preceding review, it was found that the measures and options to reinforce the Essential Requirements should focus on:

- Reflecting the waste hierarchy by promoting design for reuse or recycling;
- Clarity on packaging designs and materials that are likely to cause problems for waste collectors and processors;
- More strictly and explicitly defined requirements for waste prevention, with fewer derogations or mitigating options;
- Consideration of the role of compostable packaging, ensuring the Essential Requirements are aligned with the EU's current policy development on the use and value of certain compostables;
- Supporting the demand and supply of high-quality recycled material; and
- A well-defined enforcement procedure to replace the presumption of compliance, ensuring the roles and responsibilities of producers and authorities across Member States are clear.

A team expert brainstorm was then carried out to develop a longlist of measures that could meet the above objectives. The possible approaches to reinforcement considered in the longlist were: enforcement; technology; regulation; guidance; market; labelling; and supporting policy. The list was further informed by 18 qualitative case studies of approaches to packaging design changes that are currently being implemented by stakeholders and could be relevant to the Essential Requirements. The initial measures identified were then discussed with stakeholders and Member States at a workshop to assess their feasibility and likely impact. Position papers on these proposed measures were also invited and assessed prior to the workshop.

E.4.0 Proposed Options for Inclusion in Impact Assessment

Following the internal review of the possible measures and discussions key stakeholders as well as the Commission, shortlisting was undertaken to identify measures for further analysis. The analysis was informed by life cycle assessments of current packaging designs in 13 case studies, and targeted interviews with representative stakeholders. The final set of measures and the underlying analysis are described in detail in the body of the report.

As a key deliverable of this study, the measures were also bundled into a coherent and feasible set of options for reinforcing the Essential Requirements. These options, and the preliminary assessment of their impacts, may feed into the development of full an impact assessment for options to reinforce the Essential Requirements. Three key options were developed and proposed for inclusion in this Impact Assessment:

- Option 1: Essential updates;
- Option 2: More specific requirements, clearer decision making, improved monitoring and enforcement; and
- Option 3: Enhanced harmonisation and impact

In essence, the overall effectiveness of the package of measures increases across the options. Option 1 includes the absolutely essential updates needed to make the Essential Requirements coherent with

EU legislation and relevant to current needs. Option 2 provides for more specific measures related to different aspects of the Requirements, e.g. recycled content, e-commerce packaging, etc., whilst increasing the robustness of measures related to defining recyclable, waste prevention and reuse. Option 3 includes more stringent measures that are likely to achieve greater impact, and create further harmonisation of the requirements across the EU.

E.4.1 Option 1

This first option includes all the measures that are required to bring the Essential Requirements up to a minimum standard such that they are effective, coherent with other legislation and relevant to the current and future policy context. The first key update is to address the current issues with unrecyclable packaging, and so a requirement is set for all packaging to be recyclable or reusable. The requirement is operationalised through reference to a definitional mechanism, in this case using qualitative statements, however, packaging is still subject to a requirement for the weight and/or volume to be minimised to the absolute necessary amounts. The use of REACH to deal with any hazardous substances used in packaging other than those already included in Annex II is suggested for this option. In addition, a requirement is set that any reusable packaging must also be defined as recyclable, except in certain circumstances. There are also a range of requirements relating to defining terms and labelling conditions. These relate mainly to compostable packaging, but also labelling for reusable and recyclable packaging, to improve consumer understanding of packaging placed on the market. Finally, under this option, a Member-State level enforcement measure related to new packaging registries and self-certification is included. This is the minimum necessary to support compliance with the new requirements included within this option.

E.4.2 Option 2

This option includes further measures that are either more specific or more effective, and replaces some of the less effective, or more negative impact measures, included under Option 1. Firstly, whilst the new qualitative definition is maintained, the main approach to operationalising the definition of recyclable is through a combination of both design for recycling (DfR) and recycling rate approaches. The DfR approach, seeks to create both positive and negative lists of packaging types, relating to whether they can or cannot be placed on the market. Next, an additional requirement is set that requires producers to submit to a registry packaging to product ratios for each type of packaging placed on the market where these are above a certain threshold level. This may drive increases in material efficiency but will importantly provide useful data to enforcement agencies in their efforts to address inefficient use of packaging. Further specific requirements related to recycled content of packaging (a design guidelines standard) and restricting all substances of very high concern (SoVHC) are introduced.

This option also introduces some specific measures related to reuse. Firstly, a requirement for the Commission to request the CEN organisation to develop a Standard on effective reuse systems, to act as guidance or a benchmark for such systems to be developed across the EU, and secondly, a requirement for some types of transport packaging (which were thought to be highly suitable for reuse) to be placed on the market only if they are part of a reuse system. Measures targeting the use of e-commerce packaging may not be suitable for the Essential Requirements, with secondary legislation providing a more appropriate instrument - however, a measure was developed that would set a requirement for e-commerce traders, particularly the large multi-seller platforms, to include a label on each item making it clear to consumers how they might report unnecessary void space to a national authority. The rapidly evolving technology of digital watermarking is also targeted through an additional specific measure.

Finally, under this option, an enforcement measure related to specific reporting of compliance data to new packaging registries and auditing is included. This would provide a greater level of robustness to support compliance with the new requirements included within the revised Essential Requirements. A mandate to develop an EU packaging registry could be set in the PPWD or MS level registries could be used. The development of the EU registry would, however, ensure harmonisation with or replacement of existing national registries and/or reporting procedures for EPR schemes to avoid double reporting by suppliers.

E.4.3 Option 3

This option includes further measures that are more effective because they are more enforceable, particularly as the measures include some quantitative mechanisms that allow for clear and objective measurement of application. Firstly, whilst the new qualitative definition is maintained, the main approach to operationalising the definition of recyclable is through the recycling rate approach alone, where all packaging placed on the market has to prove it is above a threshold recycling rate for it to be deemed recyclable and therefore allowed onto the market (potentially within a given time frame). The next requirement sets legal thresholds for the ratio of packaging to product, rather than just reporting such ratios to a packaging registry. To build on the previous measure relating to recycled content, in this case, specific requirements are set relating to minimum recycled content levels for specific packaging formats. These are more likely to be targeted at plastic packaging (where markets for secondary raw materials are relatively mature) than other materials. A requirement is also set that limits the use of compostable packaging to specific applications where there is some added value only on the basis of clear criteria, to mitigate against the end of life management risks posed by these materials at present.

In terms of enforcement, the approach taken under this option would be to set up an EU body that grants authorisation for the placement of all packaging placed on the EU market. This would deliver the highest levels of enforcement of any approach considered here.

The table below summarises each of the three options described above in terms of their constituent measures. The likely impacts of each of these is assessed in the report.

Measures	Options		
	1	2	3
All packaging shall be reusable or recyclable as defined through the measures under the requirements specific to the reusable / recyclable nature of packaging.	✓	✓	✓
Recyclable defined by qualitative statements.	✓	✓	✓
Recyclable defined by a combination of both DfR and recycling rate approaches.		✓	
Recyclable defined by use of a recycling rate threshold.			✓

Measures	Options 1	2	3
In addition to the requirement to be reusable or recyclable, the packaging shall be designed not to exceed the minimum volume and weight necessary for the functionality under critical areas to be met.	✓	✓	✓
Amend EN 13428 to refine the critical areas that limit further reductions in the volume or weight of packaging and amend Annex II to make the use of the Standard compulsory, or include the relevant content in the Annex if it is not possible to mandate the use of Standards.	✓	✓	✓
Producers to report to central registry on the volume, weight and planar area ratios of packaging to product if, for either one of these three measures, the packaging exceeds a specified threshold percentage of the product.		✓	
Producers to report to central registry on the volume, weight and planar area ratios of packaging to product.			✓
Packaging must not exceed any of a set of threshold ratios of packaging to product established in terms of volume, weight and surface area.			✓
Maintain existing list of hazardous substances in Annex II, but rely on REACH, FCM regulation etc to adequately address the use of other hazardous substances in packaging.	✓	✓	✓
Include specific requirements to phase out the use of SoVHC in packaging through reference to Annex XIV of REACH.		✓	✓
All reusable packaging must be recyclable, unless there is a demonstrable robust case for an exemption.	✓	✓	✓
Guidance on effective reuse systems developed through reference to a European Standard.		✓	✓
Mandate reuse for some transport packaging.		✓	✓
Develop a new CEN Standard setting out a mandatory process to be followed to assess the potential to include recycled content.		✓	✓
Implement recycled content targets for specific formats.			✓
CEN Standard 13432 is updated to further specify the concepts of compostable and biodegradable packaging	✓	✓	✓
Commission to mandate CEN to update EN 13432 to ensure actual composting conditions are taken into account.	✓	✓	✓
Amend Annex II on the basis of the criteria to determine applications for which design for compostability can be considered to be of added value.			✓
Labelling packaging as reusable or recyclable.	✓	✓	✓
Labelling packaging as compostable	✓	✓	✓
Labelling of e-commerce packaging with stickers to highlight to consumers to report unnecessary void space to authorities in order to support enforcement.		✓	✓
European Commission to carry out a review in 2025 to assess the feasibility of digital watermarking technology with a view to adopt a legal requirement for its use.		✓	✓

Measures	Options 1	2	3
MS level registries – self-certification for compliance at a company level + third party auditing + EU rapid alert system.	✓		
MS / EU registry – some self-certification + some mandatory compliance reporting relating to more stringent measures + third party auditing.		✓	
EU body to certify all packaging registered.			✓

E.1.0 Examen de l'efficacité et de la pertinence des Exigences Essentielles

L'étude a commencé par un examen de l'efficacité des Exigences Essentielles actuelles à la lumière de l'évolution du paysage politique, y compris une analyse des tendances en matière de composition/ volume des déchets d'emballages et des définitions de la recyclabilité/réutilisation. Outre un examen de la législation pertinente et des études antérieures évaluant les Exigences Essentielles, cette étude comprenait une enquête auprès des experts des États Membres concernant les pratiques actuelles et les lacunes perçues dans la mise en œuvre et l'application des Exigences Essentielles. Les données sur les emballages et les déchets d'emballages (provenant de sources publiques, comme Eurostat, ainsi que de rapports sur le marché) ont été analysées afin d'identifier les principales tendances du marché des emballages. Les conclusions de l'étude ont été testées lors d'un atelier réunissant un large éventail de parties prenantes de l'industrie de l'emballage, notamment des fabricants, des remplisseurs, des distributeurs, des recycleurs, des ONG et des organisations commerciales, etc.

L'étude a révélé une augmentation d'environ 10 % des déchets d'emballages produits (utilisés comme indicateur des emballages mis sur le marché) dans l'UE entre 2007 et 2017, les emballages de produits alimentaires et de boissons représentant les deux tiers de la valeur totale des emballages européens en termes de part de marché. Le matériau d'emballage dominant, en poids, est le papier/carton, suivi par le plastique et le verre. Cependant, l'utilisation des emballages en plastique et en papier/carton a augmenté au cours des 20 dernières années, tandis que certaines données indiquent une diminution (marginale) de l'utilisation du métal et du verre. Bien que les taux de recyclage des quatre principaux types d'emballages aient augmenté depuis les années 1990, ils varient en 2017 de 42 % (pour le plastique) à 85 % (pour le papier/carton) des emballages recyclés. L'augmentation des emballages en plastique est donc liée à l'utilisation accrue des matériaux d'emballage les moins bien recyclés. L'étude a également mis en évidence plusieurs tendances clés dans la composition et le volume des déchets d'emballages de l'UE, à savoir:

- *Grande part de marché des emballages souples non recyclables en film/pochette,*
- *Demande de matériaux à haute barrière et de matériaux composites difficiles à trier et à recycler,*
- *Contamination potentielle du flux de plastiques/déchets biologiques par des plastiques biodégradables/compostables,*
- *Augmentation des déchets d'emballage et problèmes de sur-emballage liés au commerce électronique,*
- *Utilisation accrue de caractéristiques de conception qui empêchent la recyclabilité, par exemple l'utilisation de colles/encres/autres additifs, l'utilisation de PVC, etc.*
- *Diminution des emballages réutilisables.*

L'analyse des tendances a été accompagnée d'une évaluation de la littérature pertinente, de l'apport des experts des États Membres, ainsi que de l'évaluation par les experts d'Eunomia de la pertinence des Exigences Essentielles et des normes harmonisées qui les accompagnent. La pertinence des Exigences Essentielles semble être une faiblesse critique, car elles ne reflètent pas les priorités actuelles et les connaissances sur les options de gestion de la fin de vie, ne rendent pas suffisamment opérationnel le concept de recyclabilité et ne tiennent pas nécessairement compte de la gamme de types d'emballages qui sont actuellement mis sur le marché. Elles ne reflètent pas non plus les préoccupations actuelles concernant le changement climatique, les déchets et les plastiques dans l'environnement marin.

Les normes harmonisées actuelles n'apportent pas le degré de clarté supplémentaire qui est nécessaire. Si les Exigences Essentielles elles-mêmes étaient renforcées pour inclure des définitions et des mesures plus claires, la nécessité de normes d'accompagnement pourrait être éliminée. Cependant, elles pourraient encore être utiles en développant des concepts qui ont été plus clairement définis dans une version renforcée des Exigences Essentielles et en fournissant des procédures d'évaluation bien définies. Si les normes sont maintenues, la présomption de conformité - en fait l'autocertification - devrait certainement être revue afin que les rôles et les obligations des États Membres et des producteurs soient plus clairs.

L'examen a conclu que, en résumé, l'efficacité des Exigences Essentielles est limitée par:

- *Les exigences minimales, en particulier dans le contexte des derniers objectifs et orientations politiques de l'UE en matière de recyclage,*
- *Leur caractère vague qui rend l'interprétation et l'application difficiles,*
- *L'incapacité à refléter les différents impacts environnementaux des diverses options de traitement (tels que reconnus par la hiérarchie des déchets),*
- *La répartition opaque des responsabilités (entre les entités le long de la chaîne d'approvisionnement et avec les États Membres), ainsi que l'exclusion des points de vue des parties prenantes plus loin dans la chaîne de valeur - notamment celles qui sont responsables de la collecte et du traitement des déchets,*
- *Les exigences n'ont pas été mises à jour en raison de l'évolution des technologies d'emballage ou de l'élargissement des connaissances sur les dommages environnementaux et humains,*
- *La présomption de conformité et le statut implicite de faible priorité des Exigences Essentielles.*

E.2.0 Matériaux et types d'emballages représentant des problèmes particuliers

Parallèlement à l'examen des tendances de l'UE en matière d'emballages, les données disponibles ont été analysées pour identifier les types d'emballages et les matériaux qui empêchent actuellement le recyclage/la réutilisation, en utilisant les critères ci-dessous –

- *Les emballages sont moins susceptibles d'être collectés par des flux soumis à un tri en vue de leur recyclage,*
- *Les emballages posent des problèmes à la majorité des systèmes de tri,*
- *Les emballages posent des problèmes aux opérations de recyclage, et/ou*
- *Tous ces éléments sont amplifiés lorsque l'emballage augmente sa part de marché par rapport à d'autres emballages facilement recyclables.*

Les matériaux/types d'emballage qui ont été identifiés en conséquence sont énumérés ci-dessous. Une justification complète de la sélection de ces types d'emballage, ainsi que des exemples d'articles, est fournie dans le rapport principal.

- *Emballages multi-matériaux*
    - *Films plastiques métallisés, carton plastifié ou métallisé, et petits emballages multi-matériaux*
- *Emballages en plastique*

    - *Emballages en film souple multi-polymère, plastique noir (également dans une moindre mesure, plastique de couleur sombre qui n'est pas noir), plastiques biodégradables, emballages en plastique avec des composants en PVC et emballages tout PVC, plastiques peu profonds ou aplatis, additifs qui altèrent le tri, plastiques avec azurants optiques, et ajouts aux bouteilles en plastique*
- *Emballages en verre*
    - *Bouteilles en verre avec pièces supplémentaires*
- *Emballages en papier*
    - *Papier durci avec un vernis UV/vernis qui se décompose en petites particules, papier avec des adhésifs qui se plastifient, et papiers cirés*

E.3.0 Approches pour atteindre le niveau requis de réutilisation et de recyclage des emballages

Sur la base de l'examen précédent, il a été constaté que les mesures et options visant à renforcer les Exigences Essentielles devraient se concentrer sur:

- *Refléter la hiérarchie des déchets en encourageant la conception en vue de la réutilisation ou du recyclage,*
- *Clarté sur les conceptions et les matériaux d'emballage susceptibles de poser des problèmes aux collecteurs et aux transformateurs de déchets,*
- *Des exigences plus strictement et plus explicitement définies pour la prévention des déchets, avec moins de dérogations ou d'options d'atténuation,*
- *Prise en compte du rôle des emballages compostables, en veillant à ce que les exigences essentielles soient alignées sur l'évolution actuelle de la politique de l'UE concernant l'utilisation et la valeur de certains compostables,*
- *Le soutien de la demande et de l'offre de matériaux recyclés de haute qualité, et*
- *Une procédure d'exécution bien définie pour remplacer la présomption de conformité, garantissant que les rôles et les responsabilités des producteurs et des autorités dans les États Membres sont clairs.*

Un brainstorming d'experts de l'équipe a ensuite été mené pour élaborer une longue liste de mesures susceptibles d'atteindre les objectifs susmentionnés. Les approches possibles de renforcement envisagées dans la longue liste étaient les suivantes: application, technologie, réglementation, orientation, marché, étiquetage et politique de soutien. La liste a également été alimentée par 18 études de cas qualitatives sur les approches de modification de la conception des emballages actuellement mises en œuvre par les parties prenantes et qui pourraient être pertinentes pour les Exigences Essentielles. Les mesures initiales identifiées ont ensuite été discutées avec les parties prenantes et les États Membres lors d'un atelier afin d'évaluer leur faisabilité et leur impact probable. Des exposés de position sur les mesures proposées ont également été sollicités et évalués avant l'atelier.

E.4.0 Options proposées pour l'inclusion dans l'analyse d'impact

À la suite de l'examen interne des mesures possibles et des discussions avec les principales parties prenantes ainsi qu'avec la Commission, une présélection a été effectuée afin d'identifier les mesures à analyser plus en détail. L'analyse s'est appuyée sur des analyses du cycle de vie des emballages actuels dans 13 études de cas et sur des entretiens ciblés avec des parties prenantes représentatives. L'ensemble final de mesures et l'analyse sous-jacente sont décrits en détail dans le corps du rapport.

L'un des principaux résultats de cette étude est que les mesures ont également été regroupées en un ensemble cohérent et réalisable d'options pour renforcer les exigences essentielles. Ces options, et l'évaluation préliminaire de leurs impacts, peuvent alimenter l'élaboration d'une analyse d'impact complète des options visant à renforcer les Exigences Essentielles. Trois options clés ont été élaborées et proposées pour être incluses dans cette analyse d'impact:

- *Option 1: Mises à jour essentielles;*
- *Option 2: Exigences plus spécifiques, processus décisionnel plus clair, amélioration du suivi et de l'application; et*
- *Option 3: Harmonisation et impact accrus.*

En substance, l'efficacité globale du paquet de mesures augmente d'une option à l'autre. L'option 1 comprend les mises à jour absolument indispensables pour rendre les exigences essentielles cohérentes avec la législation de l'UE et adaptées aux besoins actuels. L'option 2 prévoit des mesures plus spécifiques liées à différents aspects des exigences, par exemple le contenu recyclé, les emballages pour le commerce électronique, etc., tout en renforçant la solidité des mesures liées à la définition des matières recyclables, à la prévention des déchets et à la réutilisation. L'option 3 comprend des mesures plus strictes susceptibles d'avoir un impact plus important et de créer une plus grande harmonisation des exigences dans l'ensemble de l'UE.

E.4.1 Option 1

Cette première option comprend toutes les mesures nécessaires pour porter les Exigences Essentielles à un niveau minimum tel qu'elles soient efficaces, cohérentes avec d'autres législations et adaptées au contexte politique actuel et futur. La première mise à jour clé consiste à traiter les problèmes actuels liés aux emballages non recyclables, et une exigence est donc fixée pour que tous les emballages soient recyclables ou réutilisables. Cette exigence est concrétisée par une référence à un mécanisme de définition, en l'occurrence des déclarations qualitatives, mais l'emballage reste soumis à l'obligation de réduire le poids et/ou le volume aux quantités absolument nécessaires. L'utilisation de REACH pour traiter toutes les substances dangereuses utilisées dans les emballages autres que celles déjà incluses dans l'annexe II est suggérée pour cette option. En outre, une exigence est fixée selon laquelle tout emballage réutilisable doit également être défini comme recyclable, sauf dans certaines circonstances. Il existe également une série d'exigences relatives à la définition des termes et des conditions d'étiquetage. Celles-ci concernent principalement les emballages compostables, mais aussi l'étiquetage des emballages réutilisables et recyclables, afin d'améliorer la compréhension par le consommateur des emballages mis sur le marché. Enfin, cette option prévoit une mesure d'exécution au niveau des États Membres concernant les nouveaux *registres d'emballages et l'autocertification. Il s'agit du minimum nécessaire pour favoriser le respect des nouvelles exigences prévues dans le cadre de cette option.*

E.4.2 Option 2

Cette option comprend d'autres mesures plus spécifiques ou plus efficaces, et remplace certaines des mesures moins efficaces ou ayant un impact plus négatif, incluses dans l'option 1. Tout d'abord, si la nouvelle définition qualitative est maintenue, la principale approche pour rendre opérationnelle la définition de la notion de "recyclable" consiste à combiner les approches de la conception en vue du recyclage et du taux de recyclage. L'approche de la conception en vue du recyclage vise à créer des listes positives et négatives de types d'emballages, selon qu'ils peuvent ou non être mis sur le marché. Ensuite, une exigence supplémentaire est fixée, qui oblige les producteurs à soumettre à un registre les rapports entre les emballages et les produits pour chaque type d'emballage mis sur le marché lorsque ceux-ci dépassent un certain seuil. Cela peut entraîner une augmentation de l'efficacité matérielle, mais fournira surtout des données utiles aux organismes de contrôle dans leurs efforts pour lutter contre l'utilisation inefficace des emballages. D'autres exigences spécifiques liées au contenu recyclé des emballages (une norme de lignes directrices en matière de conception) et limitant toutes les substances extrêmement préoccupantes sont introduites.

Cette option introduit également certaines mesures spécifiques liées à la réutilisation. Premièrement, la Commission doit demander à l'organisation CEN d'élaborer une norme sur les systèmes de réutilisation efficaces, qui servira de guide ou de référence pour les systèmes de ce type à mettre en place dans toute l'UE, et deuxièmement, certains types d'emballages de transport (considérés comme très adaptés à la réutilisation) ne doivent être mis sur le marché que s'ils font partie d'un système de réutilisation. Les mesures visant l'utilisation des emballages du commerce électronique peuvent ne pas convenir aux Exigences Essentielles, le droit dérivé fournissant un instrument plus approprié - toutefois, une mesure a été élaborée qui imposerait aux commerçants du commerce électronique, en particulier les grandes plateformes multi-vendeurs, d'inclure une étiquette sur chaque article indiquant clairement aux consommateurs comment ils peuvent signaler les espaces vides inutiles à une autorité nationale. Une autre mesure spécifique vise également la technologie en évolution rapide du filigrane numérique.

Enfin, cette option prévoit une mesure d'exécution liée à la communication spécifique de données de conformité aux nouveaux registres d'emballages et à l'audit. Cette mesure permettrait d'assurer un niveau plus élevé de robustesse pour soutenir la conformité aux nouvelles exigences incluses dans les Exigences Essentielles révisées. Un mandat pour l'élaboration d'un registre Européen des emballages pourrait être défini dans la Directive relative à la protection des travailleurs contre les déchets dangereux ou les registres au niveau des États Membres pourraient être utilisés. Le développement du registre Européen garantirait toutefois l'harmonisation ou le remplacement des registres nationaux existants et/ou des procédures de notification pour les systèmes de Responsabilités Elargies des Producteurs (REP) afin d'éviter une double notification par les fournisseurs.

E.4.3 Option 3

Cette option comprend d'autres mesures qui sont plus efficaces parce qu'elles sont plus faciles à appliquer, d'autant plus que les mesures comprennent certains mécanismes quantitatifs qui permettent de mesurer clairement et objectivement l'application. Tout d'abord, si la nouvelle définition qualitative est maintenue, la principale approche pour rendre opérationnelle la définition du terme "recyclable" consiste à utiliser uniquement l'approche du taux de recyclage, selon laquelle tous les emballages mis sur le marché doivent prouver qu'ils dépassent un taux de recyclage seuil pour être considérés comme recyclables et donc autorisés sur le marché (éventuellement dans un délai donné). L'exigence suivante fixe des seuils légaux pour le rapport entre l'emballage et le produit, plutôt que de se contenter de déclarer ces rapports à un registre des emballages. Dans le prolongement de la mesure précédente relative au contenu recyclé, des exigences spécifiques sont fixées en ce qui concerne les niveaux minimums de contenu recyclé pour des formats d'emballage spécifiques. Ces exigences sont plus susceptibles de viser les emballages en plastique (pour lesquels les marchés des matières premières secondaires sont relativement matures) que les autres matériaux. Une exigence est également fixée qui limite l'utilisation d'emballages compostables à des applications spécifiques où il y a une certaine valeur ajoutée uniquement sur la base de critères clairs, afin d'atténuer les risques de gestion en fin de vie que présentent actuellement ces matériaux.

En termes d'application, l'approche adoptée dans le cadre de cette option consisterait à mettre en place un organe de l'UE qui accorderait une autorisation pour la mise sur le marché de tous les emballages mis sur le marché de l'UE. Cela permettrait d'atteindre les niveaux d'application les plus élevés de toutes les approches envisagées ici.

Le tableau ci-dessous résume chacune des trois options décrites ci-dessus en termes de mesures constitutives. L'impact probable de chacune d'entre elles est évalué dans le rapport.

Mesures	***Options*** 1	2	3
Tous les emballages doivent être réutilisables ou recyclables tels que définis par les mesures prévues dans les exigences spécifiques à la nature réutilisable / recyclable des emballages.	✓	✓	✓
Recyclable défini par des déclarations qualitatives.	✓	✓	✓
Recyclable défini par une combinaison des deux approches de la conception en vue du recyclage et du taux de recyclage.		✓	
Recyclable défini par l'utilisation d'un seuil de taux de recyclage.			✓
Outre l'exigence de réutilisation ou de recyclage, l'emballage doit être conçu de manière à ne pas dépasser le volume et le poids minimum nécessaires pour que la fonctionnalité dans les zones critiques soit assurée.	✓	✓	✓
Modifier la norme EN 13428 afin d'affiner les zones critiques qui limitent les réductions supplémentaires du volume ou du poids des emballages et modifier l'annexe II pour rendre obligatoire l'utilisation de la norme, ou inclure le contenu pertinent dans l'annexe s'il n'est pas possible de rendre obligatoire l'utilisation des normes.	✓	✓	✓
Les producteurs doivent faire rapport au registre central sur le volume, le poids et les ratios de surface plane des emballages par rapport au produit si, pour l'une ou l'autre de ces trois mesures, l'emballage dépasse un pourcentage seuil spécifié du produit.		✓	

Mesures	***Options*** 1	2	3
Les producteurs doivent communiquer au registre central le volume, le poids et les rapports de surface plane de l'emballage par rapport au produit.			✓
L'emballage ne doit pas dépasser l'un des ratios seuils d'emballage par rapport au produit établis en termes de volume, de poids et de surface.			✓
Maintenir la liste existante des substances dangereuses de l'annexe II, mais s'appuyer sur REACH, la réglementation des matériaux en contact avec les denrées alimentaires, etc. pour traiter de manière adéquate l'utilisation d'autres substances dangereuses dans les emballages.	✓	✓	✓
Inclure des exigences spécifiques pour éliminer progressivement l'utilisation de SVHC dans les emballages en faisant référence à l'annexe XIV de REACH.		✓	✓
Tous les emballages réutilisables doivent être recyclables, à moins qu'il n'y ait des arguments solides et démontrables pour une exemption.	✓	✓	✓
Orientation sur les systèmes de réutilisation efficaces développés par référence à une norme Européenne.		✓	✓
Mandat de réutilisation pour certains emballages de transport.		✓	✓
Élaboration d'une nouvelle norme CEN établissant un processus obligatoire à suivre pour évaluer la possibilité d'inclure un contenu recyclé.		✓	✓
Mettre en œuvre des objectifs de contenu recyclé pour des formats spécifiques.			✓
La norme CEN 13432 est mise à jour pour préciser davantage les concepts d'emballages compostables et biodégradables.	✓	✓	✓
La Commission va mandater le CEN pour mettre à jour la norme EN 13432 afin de garantir la prise en compte des conditions réelles de compostage.	✓	✓	✓
Modifier l'annexe II sur la base des critères permettant de déterminer les demandes pour lesquelles la conception en vue de la compostabilité peut être considérée comme une valeur ajoutée.			✓
Étiquetage des emballages comme étant réutilisables ou recyclables.	✓	✓	✓
Étiquetage des emballages comme étant compostables.	✓	✓	✓
Étiquetage des emballages du commerce électronique avec des autocollants à mettre en évidence pour les consommateurs afin de signaler les espaces vides inutiles aux autorités afin de soutenir l'application de la législation.		✓	✓
La Commission Européenne doit procéder à un examen en 2025 afin d'évaluer la faisabilité de la technologie du filigrane numérique en vue d'adopter une obligation légale pour son utilisation.		✓	✓
Registres au niveau des États Membres – autocertification de la conformité au niveau de l'entreprise + audit par un tiers + système d'alerte rapide de l'UE.	✓		
Registre au niveau des EM / UE - une certaine auto-certification + certains rapports de conformité obligatoires relatifs à des mesures plus strictes + audit par un tiers.		✓	
Organisme de l'UE chargé de certifier tous les emballages enregistrés.			✓

1 Introduction

1.1 Background

The Essential Requirements, which all packaging placed on the EU market needs to comply with, were first introduced in the Packaging and Packaging Waste Directive (PPWD – Directive 94/62/EC), as defined in Article 9 and Annex II. The measures aim, as a first priority, to *prevent the production of packaging waste and, as additional fundamental principles, at reusing packaging, at recycling and other forms of recovering packaging waste and, therefore, at reducing the final disposal of such waste in order to contribute to the transition towards a circular economy.* The Directive also aims to harmonise national measures concerning the management of packaging and packaging waste, ensuring a high level of environmental protection and the functioning of the internal market. It includes within its scope primary, secondary and tertiary packaging.

These Requirements are specific to the manufacturing and composition of packaging, the reusable/ recoverable nature of packaging (either in the form of material recycling, energy recovery or composting) and the presence of noxious and other hazardous substances and materials to be minimised in packaging. For instance, with regard to the requirements specific to the manufacturing and composition of packaging the Directive (Annex II, para 1) states that *packaging shall be so manufactured that the packaging volume and weight be limited to the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and for the consumer.*

Producers must be able to demonstrate compliance with these requirements. One way to do this is by using harmonised European Standards, which give a presumption of conformity with the essential requirements. The harmonised standards currently cover prevention by source reduction, presence of four heavy metals (lead, cadmium, mercury and hexavalent chromium, Article 11 PPWD) minimisation of dangerous substances or preparation, reuse and recovery (material, energy and organic). For areas where no harmonised standards exist, compliance with the relevant national standards can also be used as a means to document the compliance with the essential requirements, following, inter alia, communication to the Commission of the national standards concerned. Member States are responsible for ensuring the enforcement of the essential requirements.

Article 9.5 of the revised Packaging and Packaging Waste Directive adopted in May 2018 stipulates that *By 31 December 2020, the Commission shall examine the feasibility of reinforcing the essential requirements with a view to, inter alia, improving design for reuse and promoting high quality recycling,* *as well as strengthening their enforcement. To this end, the Commission shall submit a report to the European Parliament and the Council accompanied, if appropriate, by a legislative proposal."*

The European Strategy for Plastics in a Circular Economy adopted by the Commission on the 16th of January 2018 included amongst the actions: *Preparatory work for a future revision of the Packaging and Packaging Waste Directive: Commission to initiate work on new harmonised rules to ensure that by 2030 all plastic packaging placed on the market can be reused or recycled in a cost-effective manner.*

Recognising that *weak demand for recycled plastics is another major obstacle to transforming the plastics value chain* it also indicated that this work should have as an objective the *assessment of regulatory or economic incentives for boosting demand for recycled plastics and reward more sustainable design choices.*

1.2 Evolving Policy Landscape and Problems to be Tackled

The policy landscape has evolved since the essential requirements were first established. In particular, the Commission committed itself to promoting a circular economy with its EU action plan for the Circular Economy, the co-legislators adopted ambitious municipal and packaging waste recycling targets, and, most recently, the Commission adopted a Strategy for Plastics in a Circular Economy, which foresees that by 2030, all plastic packaging should be reusable or recyclable, and laid the foundation for a new plastics economy where the design and production of plastics and plastic products fully respect reuse, repair and recycling needs, and more sustainable materials are developed and promoted. The Commission has also committed to creating a deeper and fairer Single Market by addressing restrictions in the retail sector (including e-commerce) and modernising the EU standards system to enhance cross-border trade.

The Commission's proposal for a Directive on the reduction of the impact of certain plastic products on the environment published on 28 May 2018 sets out actions to tackle the plastic items most found on European beaches, several of which are packaging. This proposal is now under consideration by the co-legislators.

Following the latest revision of the PPWD, by 2025, a minimum of 65% of packaging waste by weight shall be recycled; by 2030 this target shall increase to 70%. Material specific targets by weight for both 2025 and 2030 are provided for plastic, wood, ferrous metals, aluminium, glass and paper and cardboard. For plastic packaging, the 2030 recycling target is 55%. Reuse of sales packaging can be counted, up to 5 percentage points, towards the recycling targets.

The Commission's commitment to circular economy principles is echoed in the European Green Deal communication (published 11 December 2019) in response to the climate and environment – related challenges that the EU faces today.[1] The Green Deal sets out that 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"* and *"will develop a regulatory framework for biodegradable and bio-based plastics, and will implement measures on single use plastics".* The Green Deal further identifies a need for better implementation and enforcement of existing legislation, as well as "*new legislation, including targets and measures for tackling over-packaging and waste generation (*…) *legal*

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[1] European Commission (2019), *Communication on the European Green Deal*, accessible at https://ec.europa.eu/info/publications/communication-european-green-deal_en

requirements to boost the market of secondary raw materials with mandatory recycled content (for instance for packaging, vehicles, construction materials and batteries)". Finally, the Green Deal recognises a need to "*protect citizens and the environment better against hazardous chemicals and encourage innovation for the development of safe and sustainable alternatives"*.

Waste sorters and recyclers frequently complain that choices in the design and composition of packaging do not take account of the difficulties and costs of treatment as waste afterwards, and the consequences for the quality, purity and cost of recyclates (secondary raw materials). The growing importance of circular economy policies has led to increased pressure to boost re-use and recycling.

The development in the EU-27 of total packaging waste generation and of each of the main materials during the 2006-2017 period shows, albeit with various fluctuations, an increase in total packaging generated. In 2017 total waste generation of packaging materials per inhabitant in the EU peaked for the entire 2006-2017 period at 173 kg per inhabitant (up 10.5 kg per inhabitant compared to 2006).

Against this backdrop it has become important to explore possible options for reinforcing the essential requirements with a view to ensuring their adequacy in light of the revised PPWD recycling targets and the wider objectives of the European waste and circular economy policies and legislation including the Plastics Strategy.

Weaknesses of the essential requirements in their current form were already identified before these latest regulatory developments took place. In 2009, the Commission carried out a survey to assess compliance with the essential requirements in Member States. He results of the survey indicated little progress in monitoring and enforcement of the essential requirements at the level of the Member States. Member States, brands and packaging producers frequently request clarifications of the essential requirements, indicating that their broad nature can be overly abstract when applied to specific cases, which makes them difficult to enforce, and results in overall patchy implementation, not benefitting the environment and the internal market. The survey also found that the existing harmonised European Standards, due to the way they are set up and their content, may have encountered limitations in making the essential requirements better enforceable. Nevertheless, a follow up study carried out in 2011 and focusing on awareness and exchange of best practices on the implementation and enforcement of the essential requirements identified some interesting and promising initiatives in several Member States.

It is noted that packaging concerns all stakeholders throughout the whole supply chain, particularly if those chains are to become more circular. Essential requirements for putting packaging on the market affect product designers, packaging producers, brands, wholesalers and retailers, consumers, waste collectors, sorters and recyclers, materials suppliers, and enforcement authorities.

This study provides input to the European Commission's review of options to reinforce the Essential Requirements by:

› Identifying obstacles to the effective implementation and enforcement of the essential requirements and ways to overcome them;
› Analysing the adequacy and effectiveness of the Essential Requirements in meeting the objectives of the revised PPWD and the wider objectives of the European single market, waste and circular economy policies and legislation;
› Developing options for making the Essential Requirements more operational and effective in order to reach the objectives defined in the PPWD with an emphasis on ensuring a smooth functioning of the internal market, preventing the production of packaging waste including

through reuse, promoting recycling and reducing the final disposal of such waste. Options are also developed to implement the Plastics Strategy action that “by 2030, all plastic packaging placed on the EU market is reusable or easily recycled”. The essential requirements are also proposed to be made more implementable/ enforceable, through for example, increased precision, defining specific requirements for different packaging types, items, and/or materials, or design requirements, including possible restrictions of certain types, or chemical composition, of packaging from the market. and

› Identifying and quantifying, as far as possible, the economic, social and environmental impacts linked to different options on the basis of quantitative and qualitative evidence and estimation of the costs (including administrative costs) and benefits and their distribution.

This study is intended to contribute to the Commission’s broader policy-making; following the conclusion of this study, options for reinforcing the Essential Requirements are subject to a full impact assessment.

1.3 Approach to Study

The study comprised two key phases:

› Firstly, a review of the existing Essential Requirements, and
› Secondly, an appraisal of measures to reinforce the Essential Requirements.

The review took the outline structure of an evaluation, based on the Better Regulation Guidelines criteria of:

- Effectiveness;
- Efficiency;
- Relevance;
- Coherence; and
- EU added value.

A comprehensive programme of stakeholder engagement was designed for the study. This included a survey that was conducted with all Member State authorities (typically environment ministries and environment agencies) to seek further details on their current enforcement arrangements, instances of non-compliance with the Essential Requirements, any perceived obstacles to effective implementation and priorities for reinforcement.

Following this initial research, a stakeholder workshop was conducted in March 2019 with packaging manufacturers, fillers, distributors, recyclers, trade bodies and NGOs from across the Member States. During the workshop, views were sought on the existing implementation and enforcement of the Essential Requirements, and on stakeholders’ priorities for any future revisions. The workshop report summarising the discussions was circulated to stakeholders and is included in Annex 1 in the attached document.

The review of the existing Essential Requirements confirmed the need to make them more operational and enforceable, and to bring the Essential Requirements into line with more recent EU policy. A longlist of potential measures to reinforce the Essential Requirements was consequently developed based upon a comprehensive assessment of the literature, the outcomes from the evaluation methodology, the development of 18 case studies of specific packaging formats and position papers received from stakeholders. Input on the list of measures was also sought through a targeted workshop held in July 2019, with stakeholders who had submitted position papers on the subject in attendance (31 position papers were received in total).

A multi-criteria assessment process was conducted to identify the most suitable measures for reinforcing the Essential Requirements. This involved consideration of and consultation with the Commission regarding the likely implementation of the reinforcement measure (regulatory/ guidance/ market-based), its relevance within the Essential Requirements, the scope of likely impacts of the measure (environmental and economic, on different stakeholder groups) and the suitability of the measure in addressing the challenges and objectives identified for improving the Essential Requirements. The resulting short-list of measures was reviewed in-depth during two further workshops in July – one with stakeholders and one with Member States. The feedback obtained during these workshops was used to select the most feasible measures to be appraised during the final stage of the study.

The last phase of the project was to assess options for reinforcing the essential requirements. The measures selected based upon the shortlisting process was assessed through various means. The primary aim of the options appraisal was to focus on the design implications of the measures, and to produce feasible approaches for inclusion in the essential requirements. To develop the design of the measures, and understand key impacts, a range of one-to-one stakeholder interviews were carried out with experts across the value chain (see Appendix B for details). The responses from the stakeholders, and other sources of information, were used to provide qualitative appraisal of all of the proposed measures to reach preliminary conclusions as to their further consideration in a potential future impact assessment. In addition, further interviews were carried out to both build upon the abovementioned case studies and develop new cases relating to specific measures (74 interviews were carried out in total during the course of the study). These case studies provided targeted quantitative analysis of impacts to back up the conclusions.

The preliminary results of the appraisal were presented to over 100 stakeholders at a final workshop in October 2019. Following this, over 20 written responses on the workshop paper as well as position papers were received from stakeholders, and were used to fine-tune the design of the measures.

Finally, the measures were considered in discreet packages in order to develop draft options for consideration in any potential impact assessment to be carried out should the Commission want to consider legislative action following this first scoping study.

This report is structured according to the analyses carried out, as includes a range of appendices that provide further details. The report structure, therefore, is as follows:

- Section 2: Summary of Packaging Trends
- Section 3: Review of the effectiveness and shortcomings of current essential requirements
- Section 4: Development of Options
- Section 5: Appraisal of Proposed Measures for Reinforcement
- Appendices
  - A: Full Text of Essential Requirements
  - B: Stakeholders Interviewed
  - C: Existing Approaches to Defining Recyclability and Reusability
  - D: March 2019 and July 2019 Workshop Reports
  - E: Long List of Measures
  - F: Packaging Design Change Case Studies
  - G: Case Studies for Options Appraisal

2 Summary of Packaging Trends

As the Essential Requirements are intended to govern what sort of packaging can, and cannot, be placed on the market, it is instructive in the first instance to consider whether and how packaging has changed, and what types of packaging are currently placed on the market.

2.1.1 Method

In the sections which follow, some key data on the consumption of packaging, and generation of packaging waste, are outlined and the key trends identified. Analysis around the trends in weight of packaging items relates to the provisions in the Essential Requirements regarding waste prevention. The information provided has been synthesised from a number of sources. Eurostat data has been used for the EU-15 as data on packaging waste generation by material is available for these countries for the longest time series (from 1997 onwards), Eurostat data for the EU-28 has also been used for more recent years.[2, 3] This data has been used to understand the trends in packaging volumes, via assessment of packaging waste, at a high level.

To gain a more detailed insight, market report data has been used from Transparency Market Research (TMR).[4] The TMR report for the European packaging market was based on secondary research conducted by the company, covering annual reports, trade data and association data. Interviews were also conducted with those in the purchase and supply sides of the packaging sector (such as fillers, packaging producers and recyclers). The collected data then underwent a quality check before being analysed for the report. This data reflects B2B (business to business) packaging as well as B2C (business to consumer) packaging. Where TMR data has been used in this write up it reflects the situation beyond the EU-28 Member States, including countries within Europe but who are not Member States, such as Iceland and Russia. This is highlighted within the write up to ensure clarity, however it is assumed that the overall trends for the countries included in TMR data and for EU Member States will be similar, and thus TMR data provides a good proxy for EU28 trends. Adaptation of the TMR dataset to focus only on EU Member States was not possible.

2.1.2 Overview of the European Packaging Market 1990-2018

The European packaging market is growing. According to Eurostat ~81,000,000 tonnes of packaging waste was generated in 2007, and an estimated ~88,500,000 tonnes in 2017 – representing a 9% growth in tonnage of packaging waste generated in the EU in this period.[5] By proxy, this represents growth in packaging quantity placed on the EU market in this time. Further, the increase in packaging quantity is likely to be higher if considered on a unit basis. This is due to a strong trend for reduction in

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[2] Eurostat (2019) *Packaging waste statistics*, accessed 2 August 2019, https://ec.europa.eu/eurostat/statistics-explained/index.php/Packaging_waste_statistics#Generation_and_recycling_per_inhabitant

[3] Eurostat *Eurostat - Data Explorer - Packaging waste by waste management operations and waste flow*, accessed 25 April 2019, http://appsso.eurostat.ec.europa.eu/nui/show.do?lang=en&dataset=env_waspac

[4] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018

[5] Eurostat *Eurostat - Data Explorer - Packaging waste by waste management operations and waste flow*, accessed 18 December 2019, http://appsso.eurostat.ec.europa.eu/nui/show.do?lang=en&dataset=env_waspac

weight of packaging units meaning that the same tonnage in 2017 would represent a greater number of units of packaging than the equivalent tonnage in 2007. The trend in reducing package weight is explored further later in this section.

Food and beverage packaging accounts for around two thirds of total European packaging in terms of market share value[6,] and increasing demand for on-the-go processed food products has driven the market for single use flexible packaging.[7,8,9,10,11] The dominant packaging material, by weight, is paper/cardboard.[12,13] However, use of both plastic and paper/cardboard packaging has increased over the past 20 years.[14]

Eurostat data on packaging waste arisings for the EU-15, for whom a longer data series is available[15], also indicates the increasing use of plastic and paper/cardboard, and decreasing use (marginally) of metal and glass (Figure 2-2). While Figure 2-2 relates to absolute quantities, Figure 2-1 shows the more marked changes in relative market shares.[16] These two figures show that, while the amount of metal and glass packaging has reduced very slightly, these reductions are outweighed by the increase in plastic and paper/ cardboard.

Reporting requirements at the time the above Eurostat data were reported stated that composite packaging was to be reported as the dominant material in its composition and therefore the paper and board increase may relate to materials such as composite beverage cartons, of which a significant fraction is plastic (new reporting requirements are similar but a threshold is introduced), as well as to an increase in ecommerce and delivery to door which gives rise to increased household transit

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[6] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018

[7] (2019) *Trends and Opportunities Within the Snack Food Packaging Market*, accessed 2 May 2019, https://epacflexibles.com/trends-and-opportunities-within-the-snack-food-packaging-market/

[8] McKinsey & Company (2018) *Food Processing& Handling - Ripe for disruption?*, 2018, https://www.mckinsey.com/~/media/mckinsey/industries/advanced%20electronics/our%20insights/whats%20ahead%20for%20food%20processing%20and%20handling/mckinsey-on-food-processing-and-handling-ripe-for-disruption.ashx

[9] *'On-the-go' consumers driving sales of snacks across Europe - Digital Intelligence daily digital marketing research*, accessed 2 May 2019, http://www.digitalstrategyconsulting.com/intelligence/2018/04/onthego_consumers_driving_sales_of_snacks_across_europe.php

[10] *Food-to-go on the move to £23.5bn by 2022, IGD forecasts*, accessed 2 May 2019, https://www.igd.com/articles/article-viewer/t/food-to-go-on-the-move-to-235bn-by-2022-igd-forecasts/i/17287

[11] Skoda, E, Packaging Europe (2017) *On-the-go: the trend that's here to stay*, accessed 2 May 2019, https://packagingeurope.com/api/content/8a871398-a847-11e7-aa9a-121bebc5777e/

[12] Dominant packaging material as appears in packaging waste

[13] Eurostat *Eurostat - Data Explorer - Packaging waste by waste management operations and waste flow*, accessed 25 April 2019, Data for 2016 for the EU-28 http://appsso.eurostat.ec.europa.eu/nui/show.do?lang=en&dataset=env_waspac

[14] Transparency Market Research (2018) *Packaging Market*
Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026

[15] Data is available from 1997 onwards for the EU-15, and from 2005 onwards for the EU-28

[16] Eurostat (2017) *Packaging Waste Statistics*, http://ec.europa.eu/eurostat/statistics-explained/index.php/Packaging_waste_statistics

packaging.[17][18,19] An additional consideration for use of Eurostat data is that it is likely to under-report the true quantities of packaging used due to de minimis thresholds and free-riding.[20]

Across Europe (EU-28) recycling rates of the four main packaging types vary. On average, in 2017, 84% of paper and cardboard packaging was recycled, 42% of plastic packaging, 80% of metal packaging and 74% of glass packaging.[21,22] As such, increases in plastic packaging relate to increase in use of the least well recycled packaging material. Moreover, the new calculation rules for measuring recycling under the WFD and PPWD, are likely to impact on the plastics recycling rate more than the other materials by changing the point of measurement for what constitutes 'recycled'. However, recycling rates of all four major packaging types have increased since the 1990s, driven mainly by the packaging recycling targets in the PPWD, introduced in 1994.[23]

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[17] COMMISSION IMPLEMENTING DECISION (EU) 2019/665 of 17 April 2019 amending Decision 2005/270/EC establishing the formats relating to the database system pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D0665&from=EN

[18] *Packaging waste statistics - Statistics Explained*, accessed 25 April 2019, https://ec.europa.eu/eurostat/statistics-explained/index.php/Packaging_waste_statistics#Generation_and_recycling_per_inhabitant

[19] *E-commerce statistics - Statistics Explained*, accessed 26 April 2019, https://ec.europa.eu/eurostat/statistics-explained/index.php/E-commerce_statistics#E-sales_remain_stable_over_recent_years

[20]

[21] Recycling rates as reported to Eurostat, under the existing measurement method

[22] Eurostat *Eurostat - Data Explorer - Packaging waste by waste management operations and waste flow*, accessed 18 December 2019, http://appsso.eurostat.ec.europa.eu/nui/show.do?lang=en&dataset=env_waspac

[23] (1994) Directive 94/62/EC of 20 December 1994 on Packaging and Packaging Waste (OJ L 365, 31/12/1994)

Figure 2-1 - Change in Packaging Waste Arisings Relative to Packaging Material Proportions in 1997 (EU-15 Member States only)

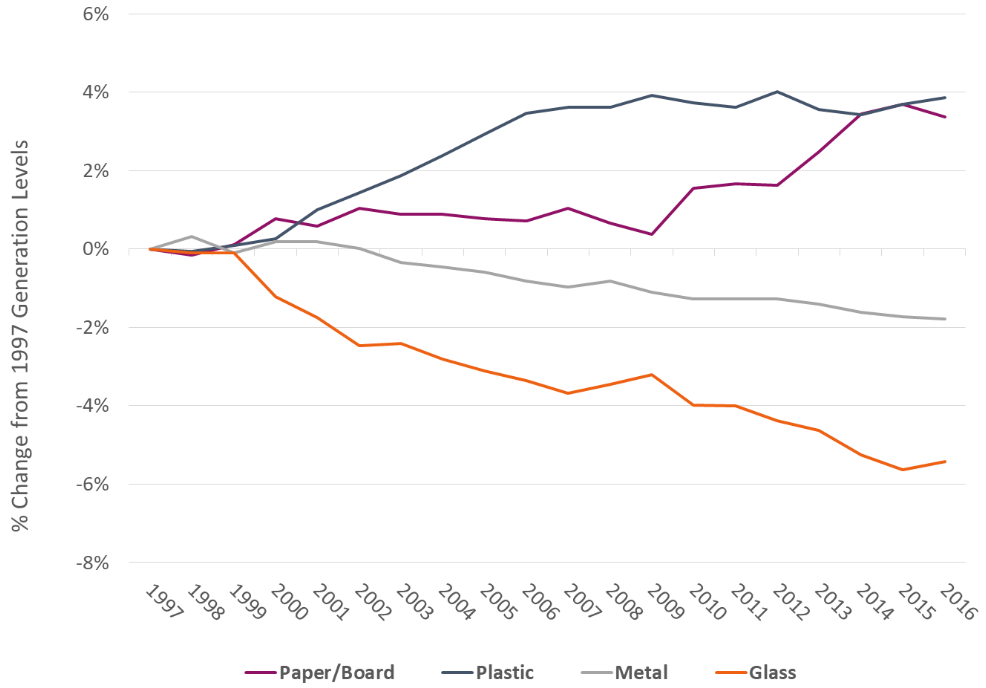
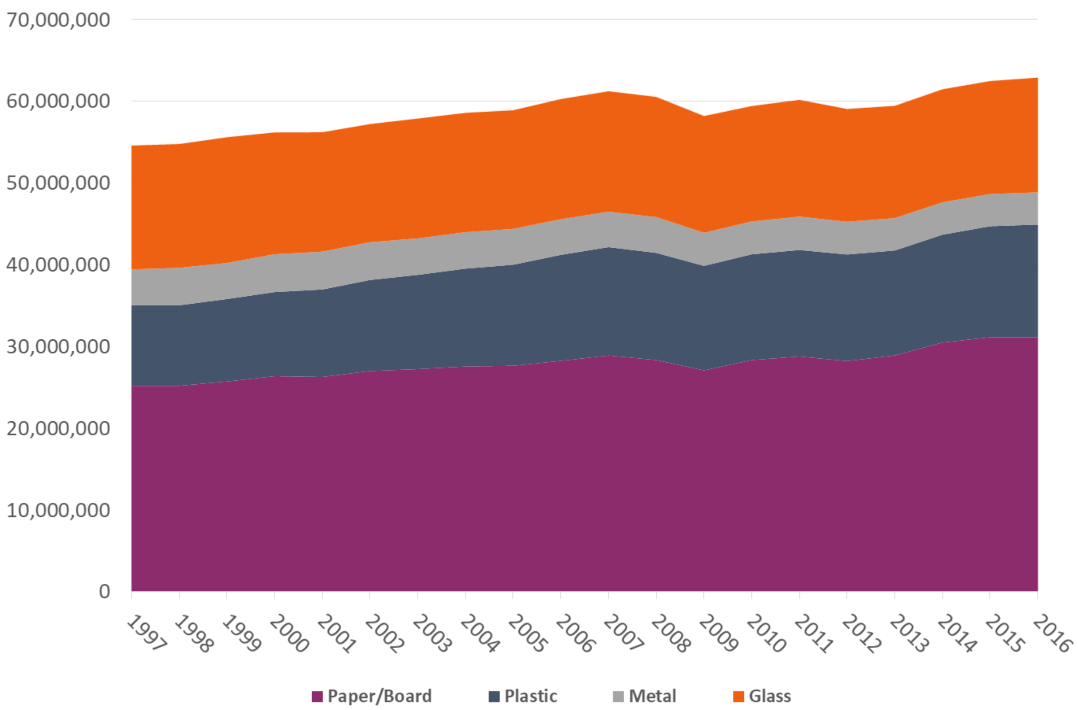


Figure 2-2 -Change in Packaging Waste Arisings by Tonnage (EU-15 Member States only)

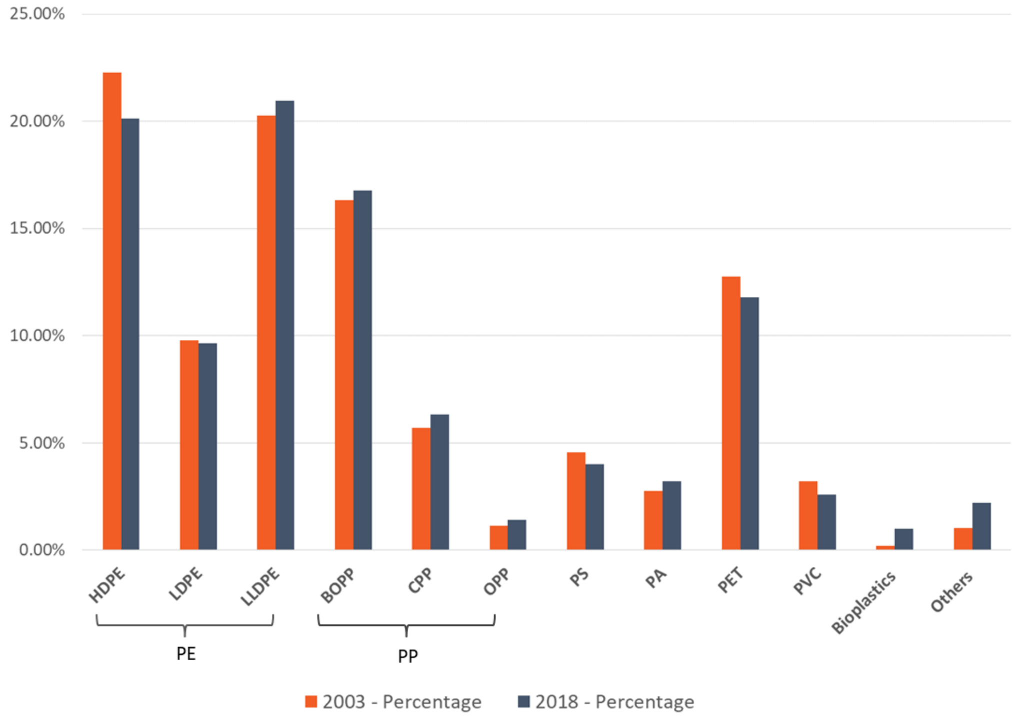


Within plastic packaging, the polymers or broader types (e.g. bioplastics) making up the packaging market are displayed in Figure 2-3 for 2003 and 2018. The most used polymers (by weight) have remained constant across the years shown, with HDPE, LLDPE, BOPP, PET and LDPE having the largest market shares.[24] PVC placed on the market has seen a 0.6% decrease in market share,

[24] TMR data used for this chart and commentary includes European countries beyond the EU-28

representing a 6% decrease in tonnage of PVC placed on the market in the fifteen year period. The market share of HDPE has also decreased, by 2.1%, whilst LLDPE has increased 0.7%. PET has also experienced a decrease in market share of 0.9%, however, as these indicators are all weight based, and the average weight of containers made from PET such as bottles has declined this may not necessarily correspond to a reduction in the number of PET packages placed on the market.[25]

Figure 2-3 - Composition of the plastic packaging market (2003, 2018)[26]



2.1.3 Weight of Packaging

A number of trends have been identified for the European packaging market and are discussed in the sections which follow. According to TMR data, a decrease in unit weight has been observed across all packaging types between 1990 and 2015.[27] This trend is explored in detail, and packaging types which have reduced significantly in weight are highlighted. Understanding changes in the weight of packaging units is important to understanding overarching trends in use of packaging, due to weight being the metric used for reporting.

It is not possible to state whether – or the extent to which – this trend has arisen as a result of the Essential Requirements, which require packaging to be manufactured so that weight and volume is limited to the minimum adequate amount to fulfil its purpose around safety, hygiene, and consumer acceptance. In part this understanding is limited by the resolution and time series of the data available. However, it is commonly accepted that there are other drivers to reduce the weight of packaging – not least financial, given that light-weighting will both reduce the amount of material to be bought and

[25] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018
[26] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018
[27] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018

reduce transport costs. This could well account for light-weighting that pre-dates the Essential Requirements. Indeed, there is some evidence to suggest that some packaging was reducing in weight prior to the beginning of the data series as available.[28] While it cannot be stated categorically that the Essential Requirements have not been a factor, it is clear that they are not the sole driver and that other considerations may have had a more significant influence.

In addition, the increase in flexible packaging and in use of high barrier and composite packaging materials is discussed. Increase in the use of bioplastics is also identified as a trend, as well as increased use of E-commerce packaging.

Across packaging types and applications, the unit weight of packaging has declined in the period 1990-2015. Figure 2-4 demonstrates the percentage decrease in unit weight of packaging for major packaging types between 1990 and 2015. Across all packaging[29] there was an average 26% decrease in unit weight, with some packaging types reducing by a considerably greater amount. Of the packaging types covered, all saw a reduction in unit weight over this period.

Reducing packaging weight can reduce the energy requirement for production and transport,[30] and reduces material usage per pack.[31,32] This section focusses on packaging where the same item has been redesigned to reduce weight, as opposed to instances where one packaging type has been substituted in lieu of a lighter option. As such, switches in packaging material which save weight are not covered – an example being packaging of wine in composite pouches, or bag in box packaging, instead of glass bottles.[33] This means that the data presented may underrepresent the full extent of weight reduction in packaging by excluding those instances of material switch.

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[28] Skuse, A. (2018) *Too much Packaging?*, accessed 17 June 2019, https://incpen.org/too-much-packaging/

[29] All packaging types as included in the Transparency Market Research Report.

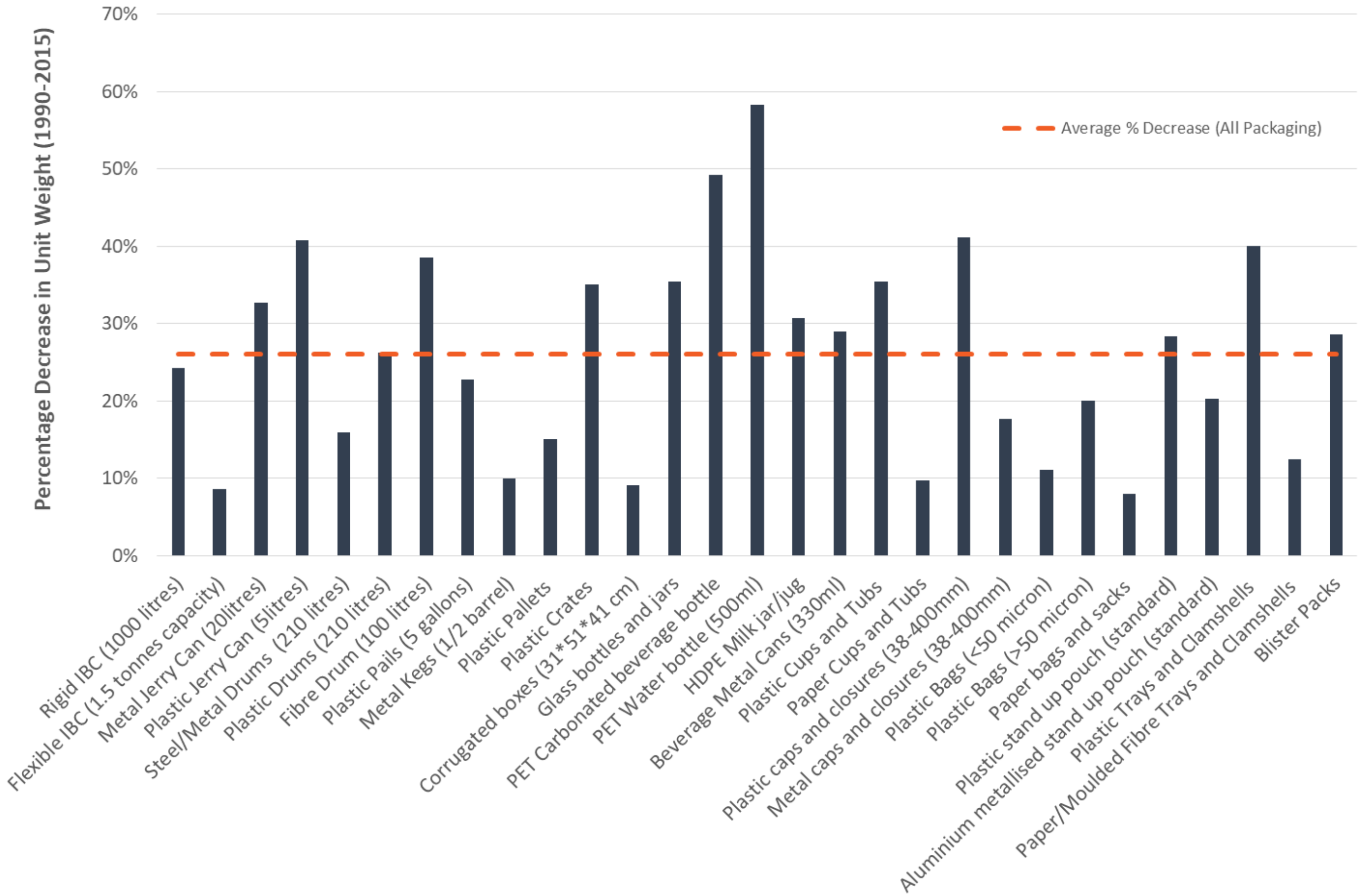
[30] WRAP (2007) *Raising the bar in PET bottle lightweighting: Research findings that achieved a new European lightweighting standard for carbonated drinks bottles made from PET*, 2007

[31] Randy Shaw (2016) *Lightweight Packaging: Benefits for Producers and Consumers*, accessed 29 April 2019, https://www.assemblies.com/lightweight-packaging-benefits/

[32] WRAP *Reducing weight, reducing cost: lightweighting can ends*, http://www.wrap.org.uk/sites/files/wrap/Heinz%20Case%20Study%2014329-01%202%20v21.pdf

[33] *Top Trends in the Beverage Packaging Market in Europe | Technavio | Business Wire*, accessed 26 February 2019, https://www.businesswire.com/news/home/20171031006327/en/Top-Trends-Beverage-Packaging-Market-Europe-Technavio

Figure 2-4- Percentage Decrease in Unit Weight of Packaging 1990-2015[34]



As an initial indicator, it can be seen that the decrease in weight has generally been greater for plastic packaging when compared to non-plastic packaging. Excluding composite packages, the percentage unit weight decrease for plastic packaging averages 32%, compared to 20% for non-plastic packages.[35] This trend has been highlighted in the discussion of individual groups of package types. Looking at packages where data is available for a plastic and non-plastic equivalent of the same item, the percentage weight decrease observed for the plastic package has been on average 13% greater – however, this data is only available for a limited set of packages.[36,37] In addition, smaller decreases in weight may have been observed in non-plastic packaging due to these packaging types being more mature in 1990 where the dataset begins, and hence there being less to gain from technological or design developments.

Beverage Containers

Beverage containers have seen the greatest decrease in unit weight as a group. Across the beverage container types listed in Figure 2-4, a 42% decrease in unit weight has been observed since 1990. Over the same period, the weight of glass bottles and jars has declined by 35% on average. The unit weight of PET water bottles, and PET bottles for carbonated drinks decreased by the greatest margins, with weights declining 58% and 49% respectively, relative to the 1990 baseline. This is a considerably greater weight reduction than the average observed across all the packaging types covered in the report (26%).[38]

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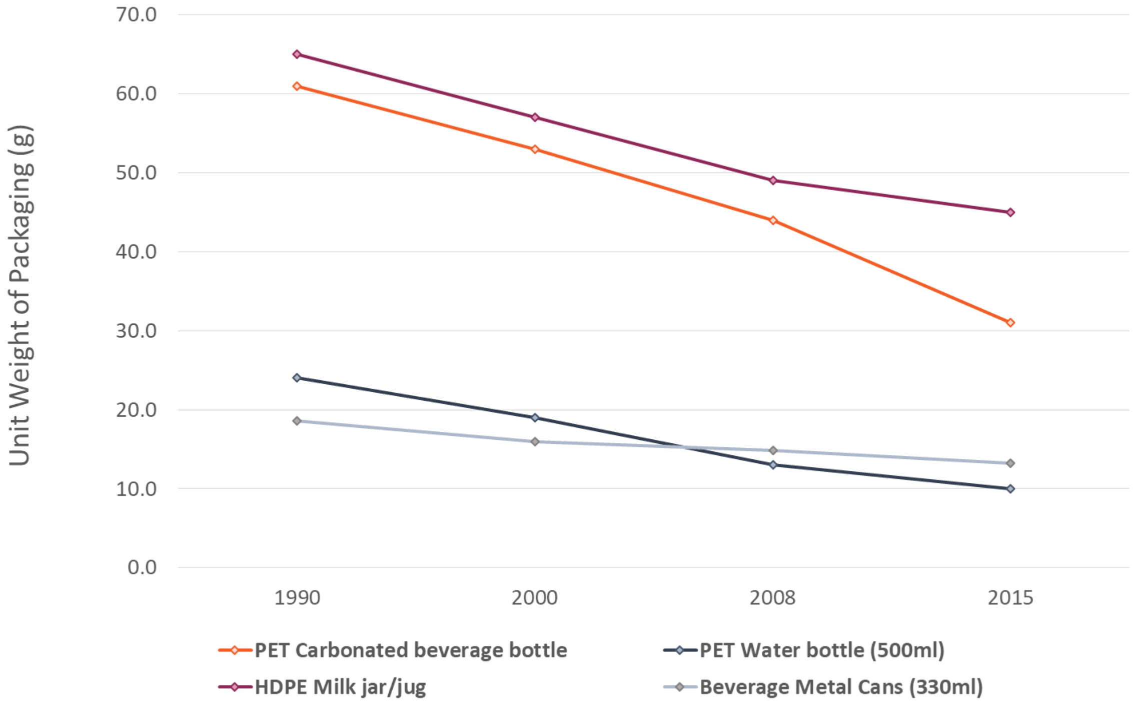
[35] Plastic packages included: Plastic drums, plastic pails, plastic pallets, plastic crates, PET bottles (carbonated and non-carbonated), HDPE milk jug/jar, plastic ups and tubs, plastic caps and closures, plastic bags, plastic pouches, plastic trays and clamshells. Non-plastic packages included: metal jerry cans, steel/metal drums, fibre drums, metal kegs, corrugated boxes, glass bottles and jars, metal beverage cans, paper cups and tubs, metal caps and closures, paper bags and sacks, paper/moulded fibre trays and clamshells

[36] Transparency Market Research (2019) *Europe Packaging Market: Industry, Size, Share, Growth, Trends and Forecast, 2003(A)–2018(E)*, 2019

[37] Figure based on data for beverage containers, trays and clamshells, drums, bags, cups, tubs, caps, closures, and pouches.

[38] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018

Figure 2-5 - Evolution in average unit weight of beverage packaging (1990-2015)[39]



The greater reduction for PET bottles may be in part due to light-weighting of water bottles being pursued from around 1990, with brand owners transitioning to selling water in PET, hence the data series showing close to the full scope of light-weighting that has occurred.[40] Additionally, there are a number of benefits of reducing weight in PET bottles that may have been a motivating factor for brand owners. For example, a lighter bottle is appealing due to reduction in consumption of PET resin, allowing cost and energy savings. Further, reduction in material usage has an additional benefit of reducing injection moulding cycle times, increasing operational efficiency. However, a more sophisticated bottle design may be required to maintain bottle rigidity with less material. The use of such designs have been facilitated by developments in production equipment – producing bottles which maintain properties required for filling and labelling at a lower weight. [41] Whilst loss of rigidity can be compensated for to some extent, there is likely a lower-weight limit for PET bottles which is both acceptable to the consumer, and functional for processing.[42] Finally, light-weighting may have been pursued in PET bottles as a result of environmental pressure – whether within brands, from retailers,

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[39] Glass bottles and jars are not included in the graph, given that the two categories were not separable in the market report and hence are not exclusively beverage containers. Glass bottles and jars reduced from an average unit weight of 240g to 155g in the 1990-2015 period.

[40] FoodBev Media. (2009) *Is lightweighting shaping the bottled water industry?*

[41] beveragedaily.com *Keeping light-weighted PET bottles user-friendly and safe: Sidel*, accessed 29 April 2019, https://www.beveragedaily.com/Article/2015/08/19/Keeping-light-weighted-PET-bottles-user-friendly-and-safe-Sidel

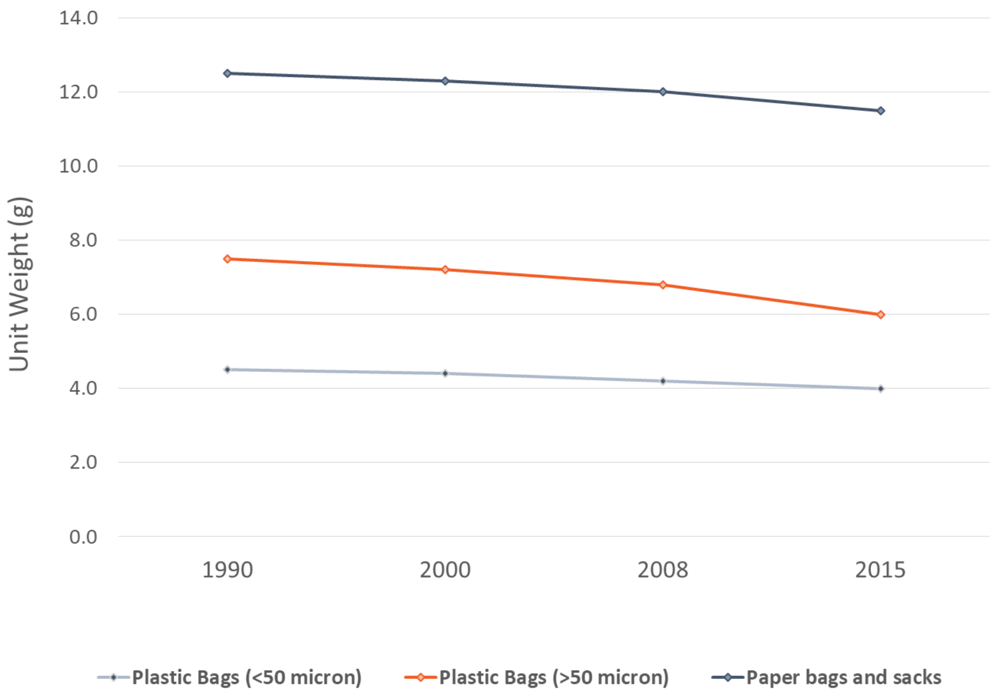
[42] FoodBev Media (2009) *Is lightweighting shaping the bottled water industry?*

consumers or elsewhere.[43] The weight reductions are discussed in greater detail for groups of packages of similar weight and similar type below. [44]

Bags

The weight of all bag types has decreased in the period 1990-2015 (Figure 2-6). However, the decrease observed in the weight of all the bag types listed has been less than the average decrease across all packaging types. The weight of plastic bags (<50 microns) decreased 11%, plastic bags (>50 microns) by 20% and paper bags and sacks by 8%.

Figure 2-6 - Evolution in average unit weight of bags (1990-2015)

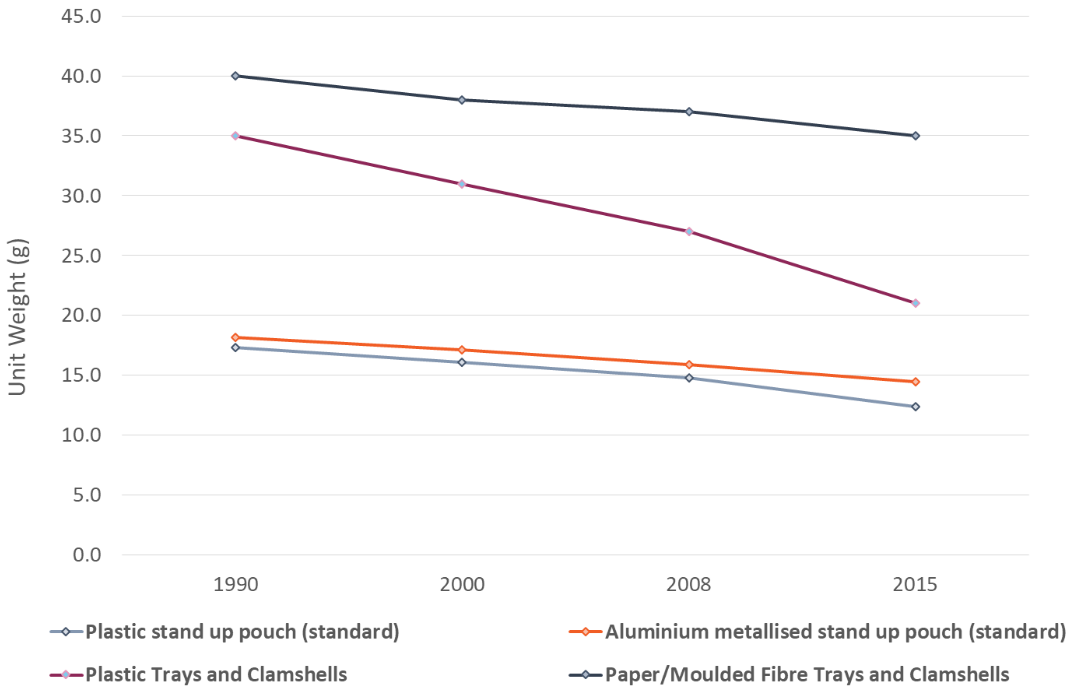


Pouches, Trays, and Clamshells

The decrease in unit weight across pouches, trays and clamshells was very close to the average decrease for packaging at 25% for the 1990-2015 period (Figure 2-7). Within this group of packages, the weight decrease observed for plastic packages has exceeded that of non-plastic packages. The greatest weight reduction within this group of packages is seen in plastic trays and clamshells, with a 40% unit weight reduction.

[43] FoodBev Media (2009) *Is lightweighting shaping the bottled water industry?*
[44] All data discussed in the following section is from the Transparency Market Research Report

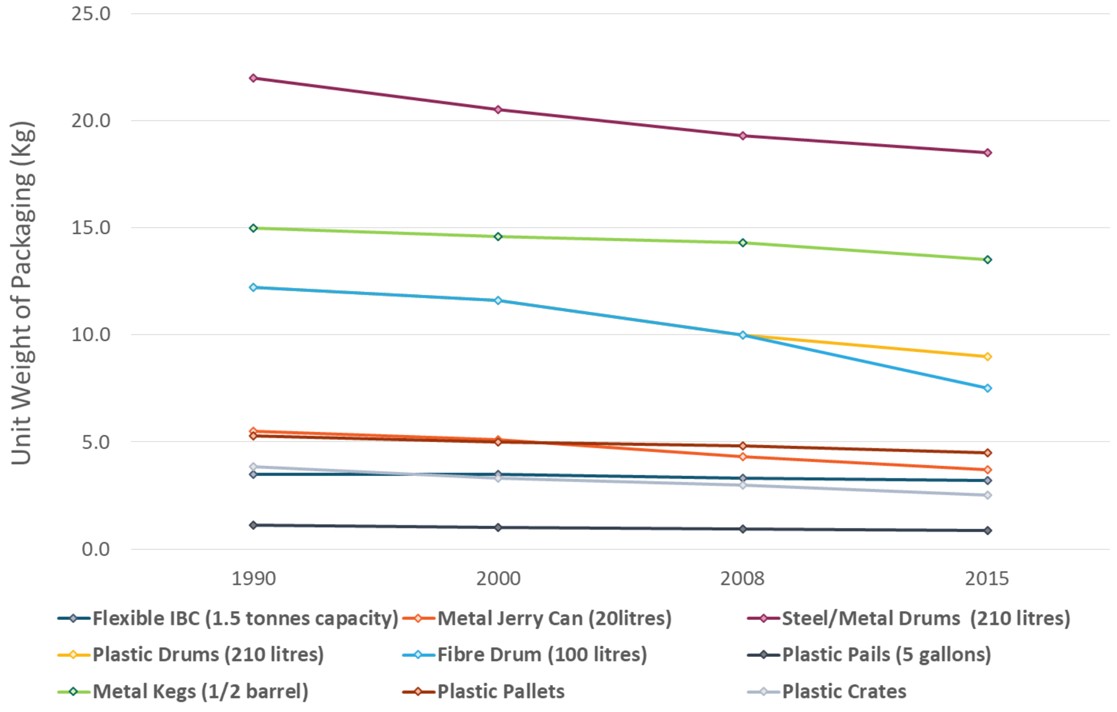
Figure 2-7 - Evolution in average unit weight of pouches, trays and clamshells (1990-2015)



Business to Business Packaging

The weight of all business to business packaging types has decreased in the period 1990-2015, this is shown in Figure 2-8. Some types of B2B packaging have decreased in weight by a greater than average amount. For example, plastic jerry cans decreased 41%, fibre drums 39% and metal jerry cans 33%. Elsewhere decreases have been less marked but still significant. The TMR report comments that there has been an increase in demand for lightweight shipping and logistical solutions from manufacturers and end users, driving this trend.

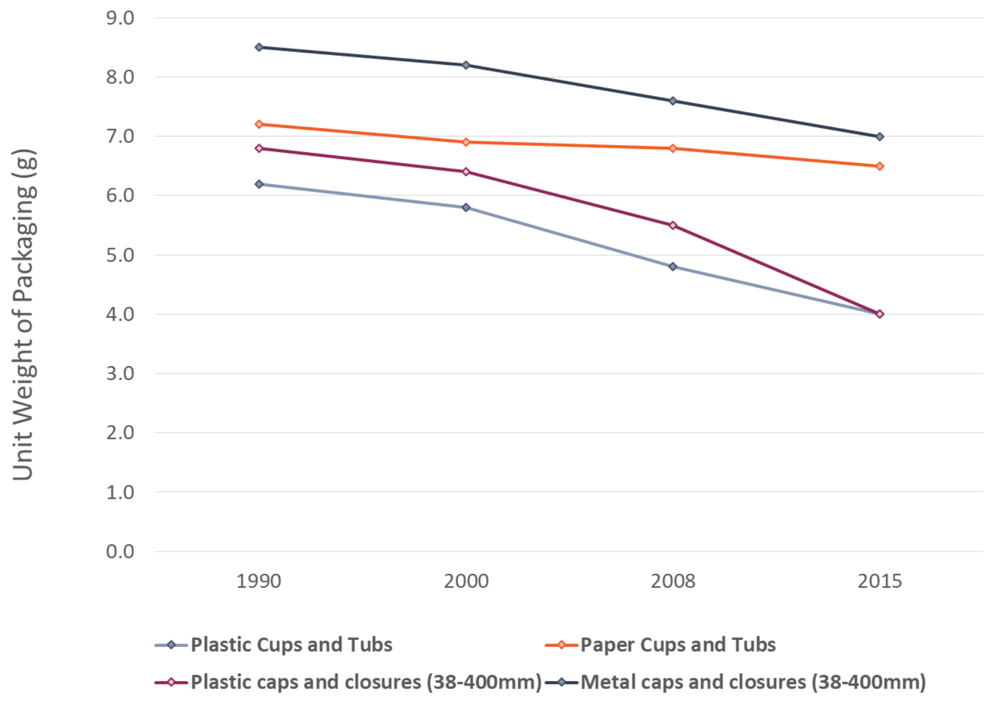
Figure 2-8- Evolution in average unit weight of Business to Business (B2B) Packaging (1990-2015)



Cups, Tubs, Caps, Closures

Across cups, tubs, caps and closures the decrease in unit weight of packaging has been 26.0%. This is the same as the average across all packaging types. However, within cups, tubs, caps and closures the weight decrease observed for plastic items has exceeded that of paper and metal equivalents with a 38% average unit weight decrease observed for plastic cups, tubs, caps and closures and a 14% decrease for metal and paper counterparts.

Figure 2-9 - Evolution in average unit weight of cups, tubs, caps and closures (1990-2015)



2.1.4 Main Additional Trends

This section considers the additional trends – not directly connected to the weight of packaging – that have been identified.

Increase in Flexible Packaging

Flexible packaging, which covers a range of packaging types, and includes composite packaging materials, has increased in tonnage placed on the market by 16% over the 2003-2018 period.[45,46] Composite, or multilayer, flexible packages can offer additional properties and be tailored to requirements as modified atmospheric packaging, through controlled release of packaged content, or other 'smart' packaging concepts which can be applied – increasing the functionality of the package beyond protecting and containing a product.[47] The wide range of uses of flexible packaging is driving the expansion of the flexible packaging market with faster growth compared to the rigid packaging market.[48] Over the 2003-2018 period, the quantity of rigid packaging placed on the European market increased 13% - compared to the 16% growth

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[45] Classification covers FIBCs, bags, sacks, pouches, sachets, wraps and other flexible packages – not restricted to flexible plastic packaging.

[46] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018

[47] *Get Ready for Smart Packaging | CPI*, accessed 26 April 2019, https://www.uk-cpi.com/blog/get-ready-for-smart-packaging

[48] Transparency Market Research (2019) *Europe Packaging Market: Industry, Size, Share, Growth, Trends and Forecast, 2003(A)–2018(E)*, 2019

for flexible packaging, both compared to their respective 2003 tonnages.[49] This likely represents an even greater increase when resolved to number of units placed on the market given the low-weight of many flexible packages.

Flexible packages such as pouches can be appealing to manufacturers, offering a higher filling and sealing speed when compared to rigid packaging. This can decrease the energy requirement at this stage of the process.[50] Materials used for flexible packaging can be integrated with other materials or additives to alter or enhance their barrier properties, something which may be especially valuable in the packaging of food products.[51,52] Flexible packaging has additional benefits for transportation due to its low weight and can require 70% less material (by weight) when compared to rigid packaging for the same quantity of goods.[53] In addition, size and shape of the package can reduce shelf space and transit space requirement. Combined, this has the potential to reduce the number of transport units required for transport of packaged goods and reduce the total weight transported.[54] As such, flexible packaging may offer manufacturers an economic advantage when compared with a rigid packaging alternative.

Demand for high barrier and composite materials

Linked to the rise in flexible packaging, the packaging market has seen an increase in demand for high barrier materials, driven by demand for food packaging which can increase the shelf life of products.[55] In addition, some advanced packaging approaches for food contact materials such as modified atmospheric packaging (MAP) and vacuum skin packaging (VSP) are only possible with the use of high barrier films which maintain the modified gas ratio inside the package, or which prevent gas permeability. Vacuum skin packaging is popular for meat and seafood products, as well as for ready meals.[56,57]

As such, there is increasing demand for packaging materials and composite packaging containing aluminium foil, EVOH, or polyamide which enhance barrier properties. Composite and multilayer materials can offer additional benefits such as good strength to weight ratio, and

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[49] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018
[50] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018
[51] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018
[52] *Flexible Packaging Applications* | *Pouch Partners*, accessed 26 April 2019, https://pouchpartners.com/flexible-packaging/applications/
[53] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018
[54] University, H.-W. (2018) *Ban on plastics could increase damage to planet*, accessed 26 April 2019, https://www.hw.ac.uk/about/news/2018/a-plastic-ban-could-increase-damage-to.htm
[55] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018
[56] Stella, S., Bernardi, C., and Tirloni, E. (2018) *Influence of Skin Packaging on Raw Beef Quality: A Review*, accessed 26 April 2019, https://www.hindawi.com/journals/jfq/2018/7464578/
[57] *Vacuum Packaging - an overview* | *ScienceDirect Topics*, accessed 26 April 2019, https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/vacuum-packaging

meet functional requirements which cannot be met with a single material.[58] However, these functional properties can come at a cost with composite packaging materials posing challenges to the majority of sorting systems and reprocessing systems at the point of recycling. This is discussed further in Section 1.2.4.

Decreasing reusable packaging

A report by Reloop from late 2019 provides a global overview of data regarding refillable bottles.[59] The following points provide a clear summary at the Global level, and is mirrored by specific data from countries within the EU:

- Worldwide, market share for Refillables has fallen from 34% to 20% 1999-2018.
- Of the top 20 countries with highest market shares [of refillable bottles], all had decreases in Market Share in the period 1999-2018.
- Sales data shows that sales of Refillables (in the 93 countries researched) grew by 1 Billion from 1999 to 2018. At the same time, the overall market for beverages has increased by 200 Billion.

A Commission report on the methodology for reporting on reusable packaging also includes some specific data from the Member States.[60] For example:

- The amount of reusable household beverage packaging in Belgium (as reported by Fost Plus) has decreased from around 1m tonnes per annum in 2000 to around 0.6m tonnes in 2016.
- Val-i-pac (also Belgium) does indicate a growth in reusable industrial and commercial packaging, however.
- In Germany, the market share of reusable packaging shrunk from 45.7% in 2012 to 42.8% in 2016.
- In Luxembourg, the proportion of reusable packaging reduced from 24% in 2009 to 19% in 2015.
- Data from Finland showed an increased in reusable packaging from the late 90s' to around 2007 but then a decrease by 10% to 2014.

Apart from some potential increases in reusable packaging in the commercial and industrial sectors, it is clear that the share of reusable packaging has been declining, particularly over the last 10-15 years.

Increase in bioplastics

The demand for bioplastics has grown substantially over the past 15 years, a trend which is expected to continue going forwards as bioplastics are used in new applications. Bioplastics covers bio based plastics (i.e. those which are not derived from crude oil) and biodegradable plastics, or plastics featuring both properties.[61] In Europe, bioplastic packaging has grown from

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[58] (2014) *Design Smart Material Guide - Composite Packaging*, 2014, http://www.helenlewisresearch.com.au/wp-content/uploads/2014/03/Composite-DSMG-082013.pdf

[59] https://www.reloopplatform.org/wp-content/uploads/2019/10/Reloop_Morawski_Global_Overview_of_Refillable_Bottles.pdf

[60] https://op.europa.eu/en/publication-detail/-/publication/9878e12a-1bc4-11ea-8c1f-01aa75ed71a1/language-en/format-PDF/source-112271086

[61] European Bioplastics *What are bioplastics?*

48,700 tonnes placed on the market in 2003, to 283,000 tonnes in 2018.[62] This represents an almost five-fold increase over the fifteen year period, although their total share of the plastic packaging market remains small at 1%. The increase is proportionally large given the relatively small quantity of these materials consumed in 2003.

This growth is expected to continue with European Bioplastics forecasting that the *global* market for *all* bioplastics will grow by 20% over the next five years.[63] Packaging does however make up the largest field of application for bioplastics, representing 65% of the *global* market in 2018 (~1.2 million tonnes).[64] Bio-based, non-biodegradable plastics, including bio-based PE, PET and PA made up ~56% of total global bioplastics production in 2017. Going forwards, additional capacity is due to come online in Europe in the coming years and will increase production of bio-based PE.[65] Consumption of bio-based plastics have been driven recently by a few large users, notably, Coca-Cola using bio-PET in its Plant Bottle.[66]

For biodegradable plastics, food packaging, disposable tableware and bags are the largest end use segment at present, and the major growth driver for biodegradable polymer consumption.[67]

Increase in E-commerce Packaging

A final trend over this period has been the increase in online shopping (E-commerce) and associated increase in packaging for delivery to households.[68,69] Exact data is not available as E-commerce packaging may take a number of forms including cardboard boxes, padded mail bags, or plastic mail bags to name a few. According to Eurostat, the percentage of individuals (aged 16-74) using the internet for ordering goods or services has grown from 30% in 2007, to 60% in 2018.[70] Several sources forecast the continued growth of E-commerce and associated

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[62] Transparency Market Research (2018) *Packaging Market - Europe Industry Analysis, Size, Share, Growth, Trends and Forecast, 2018 – 2026*, December 2018

[63] Hoffmann, C. *Global market for bioplastics to grow by 20 percent*

[64] European Bioplastics *New market data: The positive trend for the bioplastics industry remains stable* https://www.european-bioplastics.org/new-market-data-the-positive-trend-for-the-bioplastics-industry-remains-stable/

[65] Rosenheim, H., De, I., and Hyvedemm, S. *Bioplastics market data 2017*, Report for European Bioplastics, https://docs.european-bioplastics.org/publications/market_data/2017/Report_Bioplastics_Market_Data_2017.pdf

[66] Coca-Cola's 100% Plant-Based Bottle | Packaging Gateway https://www.packaging-gateway.com/projects/coca-cola-plant-based-bottle/

[67] *Demand For Biodegradable Plastics Expected To Surge* | *CleanTechnica*, accessed 26 February 2019, https://cleantechnica.com/2018/07/31/demand-for-biodegradable-plastics-expected-to-surge/

[68] Morganti, E., Seidel, S., Blanquart, C., Dablanc, L., and Lenz, B. (2014) The Impact of E-commerce on Final Deliveries: Alternative Parcel Delivery Services in France and Germany, *Transportation Research Procedia*, Vol.4, pp.178–190

[69] Falk, M., and Hagsten, E. (2015) E-commerce trends and impacts across Europe, *International Journal of Production Economics*, Vol.170, pp.357–369

[70] Eurostat, E.C. (2018) *Main tables - Eurostat - Digital Economy and Society*, accessed 28 February 2019, https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/main-tables

delivery to households in the future. [71,72,73] One source forecasts that E-commerce packaging will grow at a rate of 5.59% in the years to 2023 in Europe.[74] Such an increase is likely to be responsible, at least in part, for the increase observed already in paper/cardboard packaging.[75]

2.1.5 Characteristics of Packaging that may Inhibit Recycling

Overpackaging, the use of ‘excessive’ quantities of packaging for goods, is recognised as a problem. However, it can be difficult to produce objective metrics related to over-packaged products, so the focus here is on recycling and reuse.

The following conditions have been used to help identify which characteristics of packaging design may inhibit, at present, reuse and recycling, and increasing these levels further in future:

- **The packaging is less likely to be collected by streams being subjected to sorting for recycling**
  - This could be as a result of the item being consumed on-the-go and the packaging being therefore less likely to enter into a recycling collection. Additionally, this could mean that the package is more likely to be littered. Or,
  - This could be due to the package being especially small, flexible, lightweight, or likely to be highly contaminated with food/residue e.g. if the package is difficult to empty fully. Or,
  - Due to relying on consumer compliance/actions for the package to enter the recycling stream in the correct way – e.g. if there are many parts which need to be separated by the consumer prior to being placed in a recycling collection. Or,
  - If a recycling collection does not exist or is not common for the item.
- **The packaging poses challenges to the majority of sorting systems**
  - This condition will depend on the recycling infrastructure in the region or Member State in question.
  - Packaging poses challenges to the majority of sorting systems if its parts are made from different materials which are not easily separable (either by hand or mechanically) or made from different polymers (e.g. multi-polymer plastic packaging). Or,

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[71] Ecommerce Europe (2018) *The European Ecommerce Report 2018: relevant findings outlined*, 2018, https://www.eurocommerce.eu/media/159952/2018.07.02%20-%20Ecommerce%20report_annex.pdf
[72] *State of e-commerce: global outlook 2016-21*, accessed 28 February 2019, https://www.ipc.be/sector-data/e-commerce/articles/global-ecommerce-figures-2017
[73] (2018) *Packaging Trends 2019 | Protective & Transit Packaging | AirPack*
[74] *E-commerce Packaging Market in Retail Industry 2018 Ongoing Trends - Reuters*, accessed 29 April 2019, https://www.reuters.com/brandfeatures/venture-capital/article?id=34305
[75] *E-commerce boom fuels growth in corrugated packaging*, accessed 29 April 2019, https://www.packagingnews.co.uk/news/international/americas/e-commerce-boom-corrugated-26-08-2015

  - If use of one polymer, e.g. for labelling, is likely to lead to the packaging being mis-sorted into the wrong material stream and result in contamination. Or,
  - If colouring used in the packaging results in it not being “seen” by NIR sorting machinery.[76]

- **The packaging poses challenges to recycling operations**
  - If additives to the packaging result in the polymer (for plastic packaging) behaving differently in industry standard separation tests such as the float-sink test. Or,
  - If the extent of other materials or other polymers included in the packaging is above the tolerable limit for the process. E.g. in paper reprocessing there is generally a tolerable limit of ~3-5% for non-pulpables entering the stream which if exceeded is detrimental to recycling process. An example of such a non-pulpable is the plastic windows in envelopes which are part of packaging. Or,
  - If the packaging is economically unfeasible to reprocess, for example, the item can technically be recycled but there is a lack of demand for it as secondary material/end markets are lacking. This could also be the case where the packaging item is particularly small and yield per item is decreased, because the share of the market for a packaging item is so small that it is not economically viable to set up recycling infrastructure. Or,
  - If it is difficult to incorporate secondary material into new packaging, due to certain technical constraints e.g. use for food contact packaging. This is linked to the above as it is important to generate end markets for recycled packaging and create a ‘pull-through’ effect.

- **All of the above are magnified when the packaging is increasing in market share relative to other easily recyclable packaging**

Based on the above factors, characteristics of packaging that inhibit recycling have been identified through looking at industry guidance for packaging design and design for recyclability, and consideration of the challenges which arise using sources such as the 2016 Ellen MacArthur Foundation report[77] and previous work on beach/marine litter. Interviews with industry stakeholders were also conducted to help inform the information below. Table 2-1 contains the list of packaging characteristics that may inhibit recycling.
Sources used to inform this table were:

- Design of Rigid Plastic Packaging for Recycling (WRAP)[78]

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[76] This is not an exhaustive list of factors which results in a package posing challenges to the majority of sorting systems, but is indicative of the sorts of considerations made.
[77] Ellen MacArthur Foundation (2016) *The New Plastics Economy: Rethinking the Future of Plastics*, March 2016, https://www.ellenmacarthurfoundation.org/assets/downloads/EllenMacArthurFoundation_TheNewPlasticsEconomy_15-3-16.pdf
[78] Foster, S., Morgan, S., and East, P. (2013) *Design of Rigid Plastic Packaging for Recycling - Guidance Document*, 2013

- Plastic Packaging Recyclability by Design (ReCoup)[79]
- Refined methods and Guidance documents for the calculation of indices concerning Reusability / Recyclability / Recoverability, Recycled content, Use of Priority Resources, Use of Hazardous substances, Durability (JRC)[80]
- Recyclability of Paper Based Products (Eco Paper Loop / European
- Commission)[81]
- The Association of Plastics Recyclers Design Guide for Plastics Recyclability (APR)[82]
- Design Guidance: Best Practices for Recyclable Products and Packaging (Healthcare Plastics Recycling Council)[83]
- Confederation of Paper Industries (CPI) Guidelines – Paper and Board Packaging Recyclability Guidelines[84]
- Ten Common Rules of Design for Recyclability (DfR) for Plastic Packaging[85]
- RecyClass Reyclability Tool for Plastic Packaging (Plastic Recyclers Europe)[86]

Table 2-1 - Table of some of the key characteristics of packaging that may inhibit recycling

Packaging Type and Exemplar items	Reasoning
Multi-Material Packaging	
Metallised plastic films**:** ***Crisp Packets*** ***Pet food pouches***	**Less likely to be collected by streams being subjected to sorting for recycling**: On the go consumption may make this difficult for crisp packets. In many places there is no recycling collection for these items **Poses challenges to recycling operations:** Multi-material composite where the constituent materials are difficult to separate.
Plastic coated, or metallised cardboard**:**	**Poses challenges to recycling operations**: Provides a challenge to separate the plastic and

[79] BTF, and RECOUP (2017) *Recyclability by design*, 2017, http://www.recoup.org/p/130/recyclability-by-design

[80] Fulvio, A., Mathieux, F., European Commission, Joint Research Centre, and Institute for Environment and Sustainability(2012) *Integration of resource efficiency and waste management criteria in European product policies - second phase: refined methods and guidance documents for the calculation of indices concerning reusability Report n° 3. Report n° 3.*, Luxembourg: Publications Office

[81] EcoPaper Loop (2014) *Recyclability of Paper based Products - Guideline Document*, 2014

[82] Association of Plastic Recyclers (2018) *Full APR Design Guide: APR Design Guide for Plastic Recyclability*, 2018, https://plasticsrecycling.org/images/pdf/design-guide/Full_APR_Design_Guide.pdf

[83] *Design Guidance* | *HPRC*, accessed 19 February 2019, https://www.hprc.org/design-guidance

[84] Confederation of Paper Industries (CPI) (2019) *Paper and Board Packaging Recyclability Guidelines*, 2019, https://paper.org.uk/PDF/Public/Publications/Guidance%20Documents/CPI%20Recyclability%20Guidelines%20Final.pdf

[85] Borealis, and MTM Plastics (2018) *Ten Common Rules of Design for Recyclability (DFR) for Plastic Packaging*, 2018

[86] RecyClass Design for Recycling Tool (accessed 18th December 2019), https://recyclass.eu/

Beverage cartons ***Coffee cups***	metal layers from the fibre, such that all materials can be fully recycled. Technically feasible in specialised plants, not all pulping plants across the EU have the necessary equipment. Reprocessing can be hampered by inks and adhesives, water soluble inks and adhesives and paper coating agents. This increases expense of the process. CEPI guidance states: *Two-sided laminates such as beverage cartons and hard to recycle coffee cups should be collected and reprocessed separately.*
Small Multi-Material Packages: ***Yoghurt Pots*** ***Blister Packs***	**Less likely to be collected by streams being subjected to sorting for recycling**: Relies on consumers separating/sorting components E.g. for yoghurt pots there is a foil lid, paper/fibre label and rigid plastic pot. **Poses challenges to the majority of sorting systems**: For blister packs, foil covering bound to plastic backing with adhesive. **Poses challenges to recycling operations**: Small size, less efficient and economical to reprocess, so less revenue from recycling per item collected.
Plastic Packaging	
Multi-Polymer flexible film packaging**:** ***PET/PE Laminate*** ***PET/OPP/CPP Laminate*** ***Snack pouches*** ***Spouted pouches***	**Less likely to be collected by streams being subjected to sorting for recycling**: Collections for this material are limited at present. **Poses challenges to the majority of sorting systems**: Difficult to separate the constituent polymers (e.g. PE/PET). **Poses challenges to recycling operations**: If PE is reprocessed with PET the lower melt point causes imperfections in the finished product which can result in rejections or lower quality output. **Increasing in market share**
Black Plastic**:** **(Also to a lesser extent, dark coloured plastic which isn't black)** ***Black plastic food trays***	**Poses challenges to the majority of sorting systems**: Carbon black pigment prevents the pack being 'seen' by NIR technology. **Poses challenges to recycling operations**: Non-carbon black dark pigments still have low value and limited end markets compared to clear or light coloured rigid plastics (n.b. some end markets such as plant trays exist).
Biodegradable plastics**:** ***Biodegradable rigid plastic food container*** ***Biodegradable films***	**Less likely to be collected by streams being subjected to sorting for recycling:** Potential for consumers to place in the wrong collection containers if they are unsure whether a piece of packaging is biodegradable or not.

	Poses challenges to recycling operations: There is low tolerance for contamination with biodegradables. Biodegradable plastics have an immediate effect when the plastic is melted as they melt faster and create black spots in the film. Longer term, if included in products such as thick construction film, they may biodegrade during use. Recycling of a pure stream of some biodegradable plastics is technically feasible if correctly separated, but is not being practically implemented in Europe at a large scale at present (barring small scale PLA recycling in Belgium). **Increasing in market share.**
Plastic Packaging with PVC components and all-PVC packaging**:** ***PET packaging with PVC sleeve*** ***PVC packaging***	**Poses challenges to the majority of sorting systems:** Similar in appearance to PET and overlapping densities make separation difficult. **Poses challenges to recycling operations:** If not separated PVC generates acidic compounds during reprocessing which cause problems – ester depolymerisation reactions. Packaging which is all PVC is not widely recycled.
Shallow or flattened plastics**:** ***Items more two dimensional than three dimensional e.g. thin trays***	**Poses challenges to the majority of sorting systems:** Very shallow or flattened plastics may be mis-sorted in automatic sorting facilities with paper/cardboard fractions. **Poses challenges to recycling operations:** If mis-sorted it can contaminate the paper fraction. Mis-sorting also reduces plastic reprocessing yield and economic efficiency of plants.
Additives which alter sorting: ***Foamers/Fillers/additives which change density*** ***Sleeves with more than 60% coverage***	**Poses challenges to the majority of sorting systems:** Plastic regrind is sorted in a float/sink test based on density. Additives which change density to the extent of opposite behaviour in the float/sink test will lead to mis-sorting, contamination of streams etc. Sleeves with more than 60% coverage can lead to errors in identification of the material used for the container.
Plastics with optical brighteners	**Poses challenges to recycling operations:** Optical brighteners are detrimental to recycling as they create an unacceptable fluorescence when reprocessed.
Additions to Plastic Bottles: ***Paper labels on plastic bottles (e.g. PET/PP/HDPE)*** ***Metal Caps on plastic bottles***	**Poses challenges to recycling operations:** Paper labels on PET bottles pose challenges to recycling operations as paper becomes pulp in a caustic hot wash and is difficult to filter from the liquid.

(e.g. PET/PP/HDPE)	Individual fibres which travel through will degrade the quality of recycled PET. Metal caps and rings may not be easily separable and aluminium processed in a caustic wash will form aluminium hydroxide and contaminate the batch. In the case of PET this prevents use for food-grade applications.
Glass Packaging	
Glass bottles with additional parts ***Perfume bottles***	**Poses challenges to the majority of sorting systems:** Parts made from different materials may be difficult to separate. **Poses challenges to recycling operations:** Small springs from sprays can become jammed in recycling machinery where these are used (this is also true for plastic spray bottles with trigger mechanisms).
Paper Packaging	
Paper products cured with UV varnish or varnish which breaks down into small or microplastic particles	**Poses challenges to recycling operations:** Not readily removed by conventional de-inking process, and for those which break down into microplastics – can pollute waste water released.
Paper products with adhesives which plasticise	**Poses challenges to recycling operations:** Some adhesives on tape/labels and in binding of packaging have potential to soften or plasticise in heat and form “stickies” which end up on the finished paper and spoil performance.
Waxed Papers	**Poses challenges to recycling operations:** Wax cannot be removed by mill cleaning systems and passes onto the finished product. Silicone, greaseproof and glassine papers cannot be pulped and pass into the mill waste stream.

2.2 Conclusions

The most notable trends have been:

- A reduction in the unit weight of packaging;
- An overall increase in the amount of packaging;
- The increasing popularity of plastics (the least well recycled packaging material) and paper/ cardboard over metal and glass packaging;
- The increasing use of flexible and composite packaging;
- The increasing use of bioplastics.

In terms of the intentions of the Essential Requirements, while there has been a light-weighting trend, there is no evidence to directly link this to the Essential Requirements and it is notable that the overall weight of packaging waste has increased. It is also accepted that there are clear instances of “excessive” packaging – indeed, the Plastics Strategy commits the Commission to “look into the issue of over-packaging” – indicating that the requirement for packaging to be the minimum necessary volume and weight is not always met.

While the packaging formats considered in this section can generally be recycled, incinerated or biodegraded/ composted, it is notable that materials that currently have a lower recycling rate, or packaging that represents challenges to collect/ sort and/ or recycle, are increasingly popular. This has implications for the effectiveness of the Essential Requirements, the way in which they are written, interpreted and enforced, which are analysed in more detail in the following chapter.

3 Review of the effectiveness and shortcomings of current essential requirements

The study requires a review of the current effectiveness and shortcomings of the existing Essential Requirements, as well as a consideration of the appropriateness of the Essential Requirements in the context of the EU's broader policies and more recent commitments. While the Essential Requirements are referred to in Article 9 of Directive 94/62/EC – the Packaging and Packaging Waste Directive (PPWD) – and set out in more detail in Annex II of the PPWD, the Essential Requirements cannot be reviewed in isolation from the harmonised CEN Standards, adherence to which by producers enables a Member State to presume compliance. These are:

- EN 13427_2004 (the "umbrella standard")
- EN 13428_2004 (Prevention by source reduction)
- EN 13429_2004 (Reuse)
- EN 13430_2004 (Recycling)
- EN 13431_2004 (Energy Recovery)
- EN 13432_2000 (Biodegradation and composting)

The review has been informed by the EU's Better Regulation Guidelines on evaluations and fitness checks. Specifically, the Guideline's criteria were translated in the following criteria and questions:

1. **Effectiveness –** how successful have the Essential Requirements been in achieving or progressing towards the EU's objectives in the PPWD;
2. **Efficiency –** what resources have been used to achieve any outcomes resulting from the Essential Requirements and to what extent are any costs justified by the results;
3. **Relevance –** are the original objectives of the Essential Requirements still relevant to society's needs and problems;
4. **Coherence** – do the Essential Requirements complement and support other EU objectives and interventions; and
5. **EU-added value –** to what extent can any changes be attributed to the EU's intervention, rather than other factors, and what could alternatively have been better achieved at Member State level.

This review firstly involved a review of the wording of the Essential Requirements in Annex II and the accompanying CEN Standards. A literature review was then undertaken to provide an understanding of previously identified issues relating to the implementation and effectiveness of the Essential Requirements. Of particular relevance were a 2009 study completed by Arcadis for the European Commission into compliance with the Essential Requirements,[87] and a follow-up study two years later by BIO Intelligence Service.[88]

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[87] Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.

[88] BIO IS (2011) *Awareness and Exchange of Best Practices on the Implementation and Enforcement of the Essential Requirements for Packaging and Packaging Waste.* Report for the European Commission. 3rd August 2011.

The review has further been informed by primary research, including a stakeholder workshop with packaging industry representatives from across the EU (a more detailed summary of the workshop is provided in Appendix D) and a survey sent to the 28 Member States, plus Norway. To be efficient with stakeholders' time and to support a co-ordinated approach to the EU's packaging policy development, the survey and workshop included questions and discussions on Extended Producer Responsibility (EPR), conducted as part of another project for the European Commission relating to EPR for packaging and other products. 17 governments responded to the survey questions on the Essential Requirements.[89]

Against the Better Regulation Guidelines' five criteria, this chapter considers both the historic effectiveness of the essential requirements, and their current and future relevance, particularly in the context of the revised Waste Framework Directive (Directive 2008/98/EC), the revised Packaging and Packaging Waste Directive (94/62/EC), the new Single Use Plastic Directive (2019/904/EC) and the Strategy for Plastics in a Circular Economy (COM(2018) 28 final).

3.1 Effectiveness

There are two dimensions to the assessment of the effectiveness of the Essential Requirements: a review of the actual wording of Annex II and the accompanying Standards (relating to how operational they are and to their potential impact); and an assessment against the original objectives of the PPWD (to what extent have the Essential Requirements achieved what they set out to achieve.)

All Member States have fulfilled their obligations in terms of transposing the Essential Requirements into domestic legislation. As all Member States, along with members of the Single Market, are CEN members, the harmonised Standards have the status of national standards, although only the Czech Republic reports that the use of the Standards is mandatory.[90] Section 3.1.1 considers the use of the Standards in more detail but, firstly, the evidence provided by Member States on use, implementation and enforcement of the Essential Requirements and Standards is summarised below.

Evidence from Member States

Previous studies and the surveys conducted as part of this study indicate that the Standards are not widely used. The 2009 study by Arcadis concluded that the Standards were "formulated in a negative way", being used as evidence that no further action is needed. While some stakeholders, particularly producers, perceived this as beneficial, Member States such as Belgium reported that the Standards have had no effect.[91]

By 2009, only the UK, France, the Czech Republic and Bulgaria had developed enforcement procedures, but they did not have accompanying measures to monitor the effectiveness of the these procedures. Of these countries, only the UK and the Czech Republic had conducted

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[89] Responses were received from authorities in: Austria; Bulgaria; Croatia; Cyprus; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Latvia; Norway; Poland; Portugal; Sweden; and the UK.

[90] Professional Management (2018) *Implementation of PPWD in Eleven Selected EU Countries.* Report for the Swedish EPA. 19th October 2018.

[91] Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.

inspections in the recent past, indicating that enforcing and monitoring the Essential Requirements was not a priority for Member States. Although they did not have enforcement procedures, Austria and the Netherlands also reported that they had conducted inspections.[92]

Another study for the European Commission in 2011 concluded that "*No Member States have demonstrated that all packaging on their market is compliant with the Essential Requirements, and no Member States have been able to provide evidence that they do not need an enforcement mechanism*." It was, however, noted that industry had launched some voluntary initiatives, including integrating the Essential Requirements into product development.[93]

The 2019 survey responses received as part of this study corroborated the impression that there is little by way of Member State enforcement. Many Member States either did not answer the question relating to enforcement, or replied that they have no enforcement mechanisms in place. Countries such as Poland and Bulgaria reported that there is a body with responsibility for monitoring (the trade inspectorate in Poland's case), but they replied that the question on the number of inspections was not applicable.

Finland confirmed that it relies on the harmonised standards, with the Finnish Safety and Chemicals Agency (Tukes) the appointed market surveillance authority. Tukes has undertaken some inspections, but none of these were solely for the purpose of enforcing the PPWD. Notably, in terms of the Essential Requirements, Tukes is reported to focus on testing for the restricted hazardous substances, supporting the impression that the use of metrics implies a greater importance and/ or makes enforcement possible / easier. Finland did not report any incidence of non-compliance.

Sweden too confirmed that it relies on the harmonised Standards. Sweden, which has itself commissioned a study into Member States' implementation of the Essential Requirements, has transferred responsibility for enforcement from municipalities to the EPA, after concluding that enforcement is more effective at the national level. At the time of the survey for this study, the Swedish EPA had not commenced enforcement and there had not been any inspections in Sweden during the previous five years. The EPA explained that the focus was instead on providing guidance, which would be less time-consuming.

Like Sweden previously, local authorities in the UK (the trading standards departments) and Ireland are the designated enforcement authorities for the Essential Requirements. Although Member States are responsible for monitoring compliance under the Directive, the UK Government had no information relating to local authority inspections. In Ireland, local authorities have the powers to enter and inspect premises, serve notice on a company and require proof of compliance and prosecute any offences, with the EPA having supervisory control. Ireland reports that the local authorities' focus to date has been on recycling targets and participation in EPR compliance schemes, rather than the Essential Requirements. They also commented, however, on the importance of awareness raising and it seems that local authorities have produced templates and guidance on various aspects of the regulations.

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[92] Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.

[93] BIO IS (2011) *Awareness and Exchange of Best Practices on the Implementation and Enforcement of the Essential Requirements for Packaging and Packaging Waste.* Report for the European Commission. 3rd August 2011.

It seems that Austria is unusual, having conducted 60-100 inspections during the past year, for which the Ministry of Sustainability is responsible. The authorities did not, however, comment on whether these inspections had identified any instances of non-compliance.

Cyprus was the only Member State in the survey to report any compliance failures. The Cyprus Ministry of Agriculture, Rural Development and Environment is the competent authority, which, along with the EPR compliance scheme, checks for the concentration of heavy metals. The EPR scheme checks 40 samples from 11-15 companies per year and the Ministry has tested 160 samples over the last two years, identifying two cases where the concentrations of hazardous substances exceeded the permitted limits. The authorities issued instructions to repeat the testing and to cease imports of the packaging. They also notified the manufacturer, based outside Cyprus.

The survey responses indicated that, generally, the Essential Requirements are accorded a low priority. Sweden commented that the Essential Requirements "are not so well known or used" and "are hard to use because of their complexity". Finland has previously commented that evaluating compliance with the Essential Requirement is "challenging and sometimes also open to various interpretations".

In 2019, survey respondents generally indicated that the Essential Requirements have had little influence on packaging design, which would appear to cast doubt on both their effectiveness and relevance. Hungary commented the Essential Requirements have influenced packaging design to a "negligible" extent, noting that it is, in practice "*very difficult to prove that certain packaging does not meet the prescribed requirements and that is a main problem. It is only possible to prove compliance with the maximum content of heavy metals in packaging material.*"

When asked about barriers to implementation, Member States commented:

- The Essential Requirements are "very general, and it is not easy to assess in practice".
- "The requirements are so broad and diffuse which makes it hard for producers and enforcement authorities to know when producers fulfil the requirement and when not".
- There is a "lack of clarity" and "some Member States have experienced [difficulties] in legally enforcing them".
- Implementation relies on cooperation between a number of relevant parties.
- "Some of the requirements are too broad, thus there are no measurable parameters".
- "Most of the requirements are not demanding and difficult to accomplish".
- On "the wide variety of products with different characteristics", indicating that compliance would be more appropriate and/ or easier at the individual product level.
- The Essential Requirements are "hard to control and necessarily unspecific".
- It is "not practical for an inspection authority to check whether a minimum of material is used or not".

The key theme is clearly the vague nature of the Essential Requirements, which makes the legal requirements unenforceable in practice. Many of the themes emerging from this survey were also identified in the decade-old Arcadis study, not least the "vague nature of the Essential Requirements", the "lack of clarity over how to assess compliance" and the limited tools to challenge claims of compliance. The 2009 report also identified limited finances or staff as a reason for the limited enforcement activity, although, given the Essential Requirements' vagueness and the enforcement challenges this poses, it seems understandable that Member

States may not be motivated to prioritise resources for enforcement. This is backed-up by Arcadis identifying "low priority status" as another reason for the lack of enforcement.[94]

Similarly, the European Commission's Fitness Check concluded that the Essential Requirements are "imprecise" and that "a strengthening of the essential requirements could considerably enhance the Directive's useful effect."[95]

It seems clear from the literature review and stakeholder engagement that there is little pro-active compliance with, and enforcement of, the Essential Requirements. While this is likely to limit their impact, the very nature of the Essential Requirements restricts their effectiveness and the reasons for this are discussed in more detail below.

3.1.1 Assessment of the Standards

While the PPWD places responsibility on Member States for enforcing what can and cannot be placed on the market, the CEN Standards are intended for use by producers and places obligations on producers, rather than Member States. Article 9 allows Member States to presume compliance with all the Essential Requirements if the packaging complies with the Standards. According to EN 13427, this relies on the packaging supplier selecting "the appropriate assessment procedures for any particular packaging", depending on whether it is intended for reuse or one of the three recovery options. While EN 13427 recommends that the supplier incorporates the procedures into an existing management system, such as EN ISO 9001 EN ISO 14001, there is no obligation to do so. It is, therefore, for suppliers to assess whether their own packaging is compliant.

There is nothing in the Essential Requirements or the Standards relating to Member States' assessment of compliance with the Standards. In practice – as discussed in this chapter – the Standards are not necessarily used as much as the presumption of compliance would indicate and the presumption of compliance can instead be interpreted (by Member States and/ or producers) that little action is needed.

Prevention

Annex II states that "*Packaging shall be so manufactured that the packaging volume and weight be limited to the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and for the consumer*". Standard EN 13428 then provides a procedure for assessing compliance on prevention by source reduction. This procedure relies on identifying a "critical area", which is a specific performance criterion that prevents further reductions in the weight and/ or volume of packaging. There is little detail in the Standard about how to test and verify the critical area, but the performance criteria are specified as:

- Product protection
- Manufacturing process
- Packing/ filling process

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[94] Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.

[95] http://ec.europa.eu/environment/waste/packaging/index_en.htm; https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0209&from=EN

- Logistics
- Product presentation and marketing
- User/ consumer acceptance
- Information
- Safety
- Legislation
- Other issues

Defining “product presentation and marketing” as a critical area potentially gives suppliers significant latitude to claim that the volume of packaging is necessary, while “other issues” is an all-encompassing category and there is no guidance on who should adjudicate upon whether any “other issues” cited are appropriate. The concept of “consumer acceptance” is also contestable, with previous studies concluding it is “difficult to define or to evaluate”.[96] It should also be noted that “consumer acceptance” does not necessarily prevent reductions in the volume of weight of packaging, as consumers can be concerned by perceived ‘over-packaging’. Such alternative interpretations of “consumer acceptance” are not however always obviously reflected in packaging designs.

Section A.2 of the Standard explains that tests or studies will be used to identify the critical area: however, no further information is provided on what form these tests should take or how they are to be verified.

In short, “the minimum adequate amount” of packaging lacks the necessary clarity to be enforceable and this element of the Essential Requirements is unlikely to significantly determine what can and cannot be placed on the market.

Reusable Packaging

To be classified as reusable, packaging must meet three criteria set out in Annex II:

1. A number of rotations are possible in “normally predictable conditions of use”;

2. Processing “meet[s] the health and safety requirements for the workforce”; and

3. The packaging is recoverable when it becomes waste.

EN 13429 relates to reusable packaging and gives 3 possibilities for a reuse system:

- **A closed loop system** – in which packaging is circulated by a particular company or group of companies;

- **An open loop system** – in which packaging circulates amongst unspecified companies; or

- **A hybrid system** – in which the end-user retains the reusable packaging and uses auxiliary one-way packaging to refill it.

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[96] Arcadis (2009) A Survey on Compliance with the Essential Requirements in the Member States. Final Report for the European Commission.

There are no minimum requirements, either in Annex II or EN 13429, for the number of times the packaging can be used. This may well be because it will vary significantly for different types of packaging. However, it means that the Directive refers to “a number of trips” and the Standard to “a minimum number”, without any indication of what this could be or guidelines as to the number of rotations that could justify what may be additional weight for reusable packaging. Indeed, Annex II refers to when the packaging “is no longer” reused, rather than when it “cannot be” reused. While the packer/ filler is required to “take account” of the impact of the reconditioning process on the environment, no further detail is given on how to satisfy this requirement so it could potentially be interpreted as meaning that minimal consideration, or action, is needed. The criteria for a closed loop system do not, for instance, refer to the benefits of minimising the transport distance needed to complete a trip, which would significantly affect the environmental impact of a reuse scheme. It might be added, also, that the hybrid system being described does not need to rely on “one-way” auxiliary packaging: this, too, could be refillable if the reusable packaging is refilled at the refilling point.

Packaging Recoverable by Recycling

Annex II states that “*Packaging must be manufactured in such a way as to enable the recycling of a certain percentage by weight of the materials used into the manufacture of marketable products, in compliance with current standards in the Community. The establishment of this percentage may vary, depending on the type of material of which the packaging is composed*.” The meaning of this is unclear and has a number of possible interpretations: it could relate to the market as a whole and recycling targets for each material type, or it could refer to composite packaging and the percentage of components that are recyclable.

EN 13430 clarifies that suppliers must declare the percentage by weight of the packaging unit that is suitable for recycling – recognising that it may comprise some components that are not recyclable. There is, however, no minimum percentage or guidance as to what this could be and there seem to be no requirements for the non-recyclable components. Nor is it clear to whom suppliers must make this declaration; there is a suggested compliance statement in Annex C of the Standard, but this is only advisory and it seems unlikely that suppliers have routinely been asked to submit such a declaration to the regulatory authorities.

The Standard outlines the impact of each lifecycle phase on recyclability, with the design, manufacturing process, use, post-use collection and sorting affecting both the ability to recycle the packaging, and the packaging’s impact on the recycling process. It sets out how the end user must be able to empty the packaging of the product. Releases to the environment caused by the recycling of the packaging are to be taken into account.

The design process must “take into account” materials that are likely to create technical problems in the recycling process or in collecting and sorting, or to affect the quality of the recycled material, and whether components are separable. This does not, however, impose any conditions – strictly speaking, *considering* these impacts does not necessarily mean that the impacts are *avoided*. Selected materials should not cause “significant problems in recycling technologies”; however, recycling facility operators are, arguably, best placed to judge this and interpretations of “significant problems” could vary.

The Standard does refer to another Standard CR 13688:2000 (Packaging – Material Recycling – Report on requirements for substances and materials to prevent a sustained impediment to recycling), however this is out of date. Having been updated in 2008, it would not reflect the most up to date knowledge on recycling processes or more recent packaging innovations. It also adds to the possible bureaucracy and costs for producers, by requiring them to purchase and refer to another document.

EN 13430 recognises that the introduction of new materials and types of packaging to the market "may precede the introduction of appropriate recycling technologies", and that the "development and expansion of such recycling processes may take a period of time". The supplier consequently needs to be able to demonstrate that development is underway, and that there will be "industrial recycling capacity within a reasonable period of time" for their packaging to be classed as recyclable. The "reasonable period of time" is not defined so the interpretation of suppliers, Member States and the European Commission may vary. This could, for instance, apply to composite beverage packaging or to black plastic, which are theoretically recyclable, but for which the roll out of suitable recycling infrastructure in some Member States is limited. The Standard does not indicate who is responsible for ensuring that this actually happens, and monitoring whether the planned capacity is ultimately delivered. It simply states that developments in relevant technology should be monitored and recorded, but it is not clear whose responsibility this is, or whether the absence of such technology for a given period should trigger some form of action (none is specified).

Some sections of EN 13430 seem to be of limited practical assistance to producers. For instance, the Standard provides an example of a compliance summary statement and questions, but the wording of some of these questions is unclear and could be difficult to understand; nor are producers necessarily in a position to answer these questions, as indicated by the following examples:

- Does the design and control of components used and of the method of construction facilitate effective emptying?
- Does the design and control of the components used and of the method of construction facilitate the end-user role of separation, when necessary, to assist collection?
- Are any necessary systems of sorting, in preparation for the recycling process, suitable for the achievement of material recycling?

Packaging Recoverable in the Form of Energy Recovery

Annex II requires packaging that is intended for energy recovery at the end of life to have "a minimum inferior calorific value".

EN 13431 details the requirements for energy recovery in an industrial system and specifies that the inferior calorific value must be at least 5 MJ/kg. Packaging with an organic content of more than 50% by weight meets the requirement for energy recovery, while aluminium that is thicker than 50µm, or packaging that is more than 50% glass by weight, is ruled out. Otherwise, however, this effectively means that the vast majority of packaging – including all plastic packaging – satisfies the Essential Requirements.

The guidance largely relies on the Incineration Directive (Directive 2000/76/EC) for the standard conditions, and Directive 94/67/EC on the incineration of hazardous waste for dealing with the residues from incineration and the possibility of emissions from organic hazardous components. The Incineration Directive, however, was replaced by the Industrial Emissions Directive (Directive 2010/75/EU), so the Standard does not reflect more recent developments in EU policy.

Packaging Recoverable in the Form of Composting and Biodegradable Packaging

Under Annex II, packaging intended for composting should be "*of such a biodegradable nature that it does not hinder the separate collection and the composting process*", while biodegradable packaging should be "*capable of undergoing physical, chemical, thermal or biological decomposition*", producing "*carbon dioxide, biomass and water*". The 2018 revised Directive strengthened the language slightly by requiring that the compostable packaging "does not hinder" the separate collection and composting process rather than indicating that it "should not hinder" the process. The 2018 Directive was additionally amended to specify that oxo-degradable plastic does not count as biodegradable.

EN 13432 specifies the following criteria for compostable and biodegradable packaging:

- **Disintegration** – after 12 weeks in test scale composting conditions, less than 10% of material fragments are larger than 2 mm.
- **Aerobic biodegradability** – within 6 months, biodegradation of the test sample must generate at least 90% as much carbon dioxide as a control material (usually cellulose).
- **Anaerobic biodegradability** – within 2 months, at least 50% should have biodegraded (on the basis that, in commercial plants, there is a second aerobic stabilisation phase that allows for further biodegradation)
- The absence of any negative effect on the composting process.

As the European Commission's Fitness Check of five Waste Stream Directives noted, Annex II of the PPWD (the Essential Requirements) could create confusion – for Member States, suppliers and consumers – by not clearly differentiating between compostability and biodegradability.[97]

The essential shortcoming is that EN 13432 assumes certain conditions or practices will be used within the composting processes, but there are no accompanying standards for composting processes themselves, so there is no guarantee that these conditions will be met and the evidence is that these conditions are not replicated in actual composting facilities or AD plants. Indeed, another study for the European Commission is currently investigating the gaps between assumptions about composting in the Standards and practice in reality.

Implementation

The five standards listed above explain that they do not themselves provide a presumption of conformity but that EN 13427 "govern[s] the relationship" between the assessments for the various Standards.

EN 13427 notes that the five Standards are "not necessarily simultaneously applicable to the same unit of packaging" as they "can be mutually exclusive in some combinations and circumstances. While noting that compliance with the Essential Requirements will consequently

[97] http://ec.europa.eu/environment/waste/packaging/index_en.htm; https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0209&from=EN

require a “strategy” that takes account of the relationship, and potential contradiction, between the Standards, there is little guidance on this strategy or how to manage any trade-offs.

Conclusions from the Assessment of the Standards

While packaging is not always of the minimum volume and weight, the indeterminate caveats (such as allowing for “consumer acceptance” and “other issues”) make it difficult to demonstrate that a packaging item could be non-compliant. Additionally, packaging that is not suitable for reuse, recycling, biodegrading or composting – predominantly plastics that cannot be recycled – will be suitable for energy recovery. This means that all packaging types arguably comply with the Essential Requirements or, perhaps more pertinently, cannot be proven to be non-compliant. This does not necessarily mean that the Essential Requirements have been effective, but rather that the requirements have been formulated too imprecisely to be enforceable.

In terms of the trends identified in Section 2, there is nothing to directly link light-weighting to the Essential Requirements, while the increasing recycling rates are more likely to be linked to the explicit targets in the PPWD and the WFD rather than changes in design motivated by the Essential Requirements. The Essential Requirements have, however, arguably facilitated a situation in which plastic has the lowest recycling rate of the 4 material types, given that all plastic packaging – by virtue of its high calorific value – is classified as recoverable under the Essential Requirements. The decline in glass, meanwhile, indicates a decline in reusable packaging (although other packaging types are also reusable).

On the basis of the above analysis, the Standards have a number of shortcomings in both their content and their use. Their vague nature, which leaves much to interpretation, means the Standards are not well-designed to support a harmonised approach or to maximise their impact.

The Standard relating to waste prevention permits too many, loosely-defined mitigating factors that undermine both its intent and impact, while the inherent subjectivity makes the requirement difficult to enforce. The other Standards contain ill-defined concepts such as a “minimum number of trips” for reusable packaging and a “minimum percentage” for recyclable packaging, and provide no guidance as to how to “take account” of the impact of the reconditioning process on the environment or on what cause, and constitute, technical problems for the recycling process. Nor is the Standard relating to recycling equipped to deal with new types of packaging that is introduced to the market, for which the appropriate technologies are not – but could be in the future – in place. Meanwhile, the Standard on energy recovery is of limited value when most packaging – with notable exceptions – meets the minimum calorific value criterion. And the Standard on composting can only be used to indicate how the packaging responds on a certain environment, which is not always replicated outside test conditions.

The Standards are not specific or defined enough to allow an objective assessment of whether packaging does or does not comply. As such, they do not help Member States to determine what should, and what should not, be placed on the market.

There is, therefore, clear scope to clarify and strengthen the content of the Standards but any efforts to reinforce the Essential Requirements should also reflect on how the Standards are currently used. The Standards require suppliers to assess packaging and provide examples of assessment questionnaires and declarations, however there is no indication of how such declarations are to be used – to whom they are submitted or why.

Under the current Essential Requirements, there is a need for the Standards – or similar – because the text in Article 9 and Annex II contains little actual detail. However, the current Standards do not provide the added degree of clarity that is needed. If the Essential Requirements themselves were strengthened to include clearer definitions and metrics, the need for any accompanying Standards may be eliminated. They could, however, potentially still assist by elaborating on concepts that have been more clearly defined in a reinforced version of the Essential Requirements, and providing well-defined assessment procedures.

If the Standards are retained, the presumption of compliance – effectively self-certification – should certainly be reviewed so that the roles and obligations of both Member States and producers are clearer, to support a harmonised approach between Member States and to promote a more consistent approach from all packaging producers.

3.1.2 Assessment of Effectiveness against PPWD Objectives

The remaining part of this section considers how the manner in which the Essential Requirements and Standards are formulated affects their ability to deliver the four original objectives of the PPWD. These were to:

- Improve the quality of the environment;
- Protect human health;
- Protect resources; and
- Ensure the functioning of the internal market.[98]

Improve the Quality of the Environment

According to EN13427 (the “umbrella” standard), suppliers should aim to achieve “a reduction in environmental impact of packaging waste whilst ensuring the maintenance of function, safety and consumer acceptance”. As indicated above, “consumer acceptance” is a vague term that is open to interpretation, but its inclusion potentially implies that the attractiveness of the packaging is more important than its environmental impact.

The Essential Requirements do not reflect the different environmental impacts of the waste treatment options they endorse, as they put reuse, recycling, energy recovery and composting on an equal footing. While the Essential Requirements prioritise waste prevention (although this is constrained by giving precedence to consumer acceptance), the Essential Requirements are not equipped to address situations in which light-weighting can, on certain other measures, have a negative environmental impact by driving a switch to packaging that has higher carbon emissions, is less easily recycled or is more likely to be littered.

When referring to noxious and other hazardous substances, Annex II reinforces a focus on incineration and landfilling, and ignores the impact of hazardous substances on both the recycling process and the quality of recyclate. Similarly, Annex C of Standard EN 13431 on energy recovery states that “During the energy recovery process the heavy metal content is largely concentrated in the solid residues and the process therefore helps remove such elements from the circulating material streams and facilitate safe final disposal”. This will, however, depend on the metal in question and its boiling point. Mercury, for instance, could be

[98] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:l21207

emitted as a gas during the combustion process and this would affect the environmental outcomes.

The option for packaging waste to be recovered via energy recovery effectively means that the vast majority of packaging – including all plastic packaging – satisfies the Essential Requirements because it can be incinerated. This reduces the potential impact of the Essential Requirements to promote reuse or recycling.

To be recoverable by recycling, packaging only has to be designed so that “a certain percentage of the packaging materials can be claimed to be recyclable”; by not requiring a minimum percentage, the impact of the Essential Requirements, in terms of promoting design for recycling, could be limited. Nor does the fact that the packaging is technically recyclable mean that it is actually recycled and that the appropriate processing facilities are widely available. Indeed, previous studies have noted that “recyclable” could be replaced with “recycled” to indicate that there are collection and treatment facilities in place.[99]

Standard EN 13432 makes clear that it covers biodegradability in industrial treatment plants. This means that packaging is tested and certified as compostable in conditions that are not necessarily replicated in real-life conditions once it is placed on the market. As there are no standards for industrial composting processes, they will vary across plants and across Member States. The Standards are also generous in allowing six months; this will vary between Member States, but plants’ active phases could be just 3-6 weeks, while the post-composting stabilisation phase may be 2-3 months.[100] In the case of anaerobic biodegradation, it is not guaranteed that there will be a second, aerobic, phase even though the Standard assumes there will be.

Despite stating that the packaging should not damage the composting process or affect the quality of the resulting compost, biodegradable bags can cause problems for biogas plants as they do not breakdown within the average treatment period. Some plants automatically remove all types of bag from food waste – regardless of what they are made from and whether they are compostable – prior to treatment.[101] In this regard, the Standard is not proving effective and, arguably, it is not for the packaging supplier to determine in test conditions whether the packaging has “any observable negative effect on the [waste treatment] process”, as the treatment facilities themselves may be better placed to judge this.

Similarly, residues of plastic in digestate and compost can cause mechanical problems for agricultural equipment used to spread the digestate. Some, but not all EU countries have compost quality standards (PAS100[102] in the UK and the Quality Certification programme in

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[99] Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.
[100] Eunomia & Mepex (2018) Bio-Based and Biodegradable Plastics. An Assessment of the Value Chain for Bio-Based and Biodegradable Plastics in Norway. Report for the Norwegian Environment Agency. 30th November 2018.
https://www.miljodirektoratet.no/Documents/publikasjoner/M1206/M1206.pdf
[101] Eunomia & Mepex (2018) Bio-Based and Biodegradable Plastics. An Assessment of the Value Chain for Bio-Based and Biodegradable Plastics in Norway. Report for the Norwegian Environment Agency. 30th November 2018.
https://www.miljodirektoratet.no/Documents/publikasjoner/M1206/M1206.pdf
[102] http://www.qualitycompost.org.uk/standards/pas100

Italy[103]) and the extent to which they allow for plastic contamination varies. These problems have not been prevented by the Standard. It should also be noted that the increasing popularity of biodegradable plastics can pose additional challenges due to the risk that they contaminate recyclable plastics, and reduce the quality of recyclate.[104] As noted in the Commission's Plastics Strategy: "in the absence of clear labelling or marking for consumers, and without adequate waste collection and treatment, [the increasing market shares of plastics with biodegradable properties] could aggravate plastics leakage and create problems for mechanical recycling".

Protect Human Health

The Essential Requirements have arguably proved more effective in recognising the need to protect human health. Paragraph 1 of Annex II specifies that "packaging volume and weight be limited to the minimum adequate amount to maintain the necessary level of safety [and] hygiene", and neither Annex II nor the CEN Standards seek to compromise the functionality of packaging that is used to protect human health – such as food packaging. During the stakeholder workshop, some participants were keen to emphasise the importance of not disregarding functionality of packaging in any future revision of the Essential Requirements.

Moreover, by including in Article 11 specific limits for the heavy metal concentrations, there are clear metrics against which packaging can be monitored.

In contrast to the vague specifications for some of the other Essential Requirements, there is a clear methodology for heavy metals in CR13695-1:2000 and responsibility for measuring the presence of heavy metals is explicitly with the "packaging manufacturer". This, along with the numerical limits, arguably makes compliance, and enforcement, more straightforward. Indeed, the survey responses indicated that, where there is enforcement activity, this tends to be more focused on hazardous substances.

As discussed in Section 3.3, however, there is evidence that a much wider range of substances potentially present in packaging – beyond the four heavy metals – could pose a threat to human health.

Protect Resources

Protecting resources is one of the more direct objectives of the Essential Requirements, with Paragraph 1 of Annex II referring to the "minimum necessary volume and weight" and EN 13428 relating to prevention by source reduction. "The minimum adequate amount" and the "necessary level of safety and hygiene" are, however, subjective terms that are open to interpretation by packaging manufacturers, packaging fillers and enforcement organisations. As it is not possible to define "consumer acceptance", this clause could effectively be used to justify any volume of packaging.

Similarly, the inclusion of "packaging manufacturing process" in EN 13428 as a critical area that limits reductions in the weight and/ or volume of packaging potentially discourages innovation in

[103] http://www.compost.it/quality-certification-programme.html

[104] Eunomia & Mepex (2018) Bio-Based and Biodegradable Plastics. An Assessment of the Value Chain for Bio-Based and Biodegradable Plastics in Norway. Report for the Norwegian Environment Agency. 30th November 2018. https://www.miljodirektoratet.no/Documents/publikasjoner/M1206/M1206.pdf

manufacturing processes and may mean prevention efforts are restricted by current processes, rather than potential, improved processes. The same could potentially be said of including the "packing/ filling process". This also highlights that responsibility is shared along the supply chain. Moreover, allowing for "other issues" is a catch-all provision that gives the supplier complete freedom to specify what is needed.

While the Essential Requirements seek to minimise the volume of weight of packaging that is used, they do not refer at all to the use of recycled material and any consideration of recycled content is consequently also left out of the accompanying Standards; additionally promoting recycled content would protect virgin resources.

Functioning of the Internal Market

According to the European Commission's Fitness Check review, the Essential Requirements were the key mechanism to support the functioning of the internal market, because they "standardise what is marketable in the EU".[105] As the legal basis of the PPWD is the single market article in the treaty, rather than environment, Member States are not allowed to go beyond the standards set in the legislation. Hence, having adopted these "minimum standards" at EU level would have the effect of preventing every Member State setting their own requirements in relation to packaging. The findings of this study support this insofar as the majority of Member States simply refer to the use of the standards.

There is, however, a potential barrier to the internal market if the interpretation of the Standards varies, which might occur as they are vague in places and include compliance forms/ questionnaires, which are advisory rather than mandatory. Equally, one Member State may have sufficient recycling facilities for certain types of packaging, while the same technologies are not widely available in other Member States.

In a recent study for the Swedish Environmental Protection Agency, the UK reported that Annex II is interpreted differently depending on the Member State.[106] Almost a decade earlier, the UK had claimed that France does not take into account consumer acceptance, while France claimed it did.[107] These differing interpretations could potentially mean producers encounter restrictions in some Member States and not in others, however this seems unlikely, given that enforcement is so limited.

A strong message that emerged from the stakeholder workshop (which covered both the Essential Requirements and EPR reforms) was the need for harmonisation across Member States to support free movement, reduce the burden of compliance and prevent conflicting priorities. There was, however, no suggestion that this is not currently being achieved with the Essential Requirements.

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[105] European Commission (2014) *Commission Staff Working Document. Ex-post Evaluation of Five Waste Stream Directives*. 2nd July 2014. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0209&from=EN

[106] Professional Management (2018) *Implementation of PPWD in Eleven Selected EU Countries.* Report for the Swedish EPA. 19th October 2018.

[107] Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.

3.2 Efficiency

As Member States and producers generally rely on the presumption of compliance, the costs of the Essential Requirements are believed to be minimal. Indeed, EN 13427 recommends that the Standards are incorporated into management systems (such as ISO 9001 or ISO 14001), which would promote an efficient approach. Previous studies have indicated that the industry supported the existing Essential Requirements because they avoided technical and prescriptive details.[108]

The majority of Member State authorities responding to the survey reported that the cost burden on industry is either “low” or “very low”, and Sweden commented that they were not aware of any costs. One Member State did suggest, though, that the cost of buying the Standards “seem[s] to be an obstacle for some”. And it is questionable how much value some of the Standards offer.

In terms of cost to the authorities, five Member States categorised the costs as “average” and two as “very low”. Interestingly, Cyprus, which was one of the few countries to record actual inspections, marked the costs as “low.” Austria, with 60-100 inspections a year, was amongst those documenting the costs as “average”, indicating that they are not a significant drain on Member States budgets.

Despite the limited enforcement, there is potentially a risk that the Essential Requirements place an unnecessary administrative burden on some suppliers; EN 13431 provides a guide for assessing the net calorific value from the energy recovery process, however any assessment is arguably unnecessary for plastic packaging because it is known to have the required net calorific value.

Additionally, according to EN13427, compliance relies on the supplier, “in cooperation with all other entities in the packaging chain”; the supplier can be any entity along the supply chain and must retain records of assessment and any supporting documents for a minimum of two years after the packaging is placed on the market for the last time. This potentially means that every entity along the supply chain must complete the assessment and retain the appropriate paperwork, which may duplicate work. Given that different stages in the supply chain will be best placed to assess different aspects of the Standards, is it not clear if the final supplier in the chain has ultimate responsibility.

Given that the effectiveness of the Essential Requirements is in some respects rather limited, it should be questioned whether even the limited use of resources is justified or if revisions to the Essential Requirements could mean that the resources (of both companies and enforcement bodies) are used more cost-effectively.

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108 Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.

3.3 Relevance

Given that the Essential Requirements were first introduced in 1994 and the full set of CEN Standards was published in 2005, it is important to reflect on how relevant they are today and going forward.

The four aims of the PPWD are certainly still relevant. Improving the quality of the environment, although a rather vague objective, now has added importance, given the greater understanding of environmental challenges and the causes of environmental harm, with increasing public concern about the state of the environment. Much more is now known about the impact of climate change, how to mitigate it, and the risks of inaction, whereas climate change had little bearing on the Essential Requirements. Human health will always be a consideration for governments and producers and, since the Essential Requirements were written, knowledge of chemicals and substances that pose a risk to human health has expanded. While the Essential Requirements identify four heavy metals, there are 197 substances on the Candidate List of Substances of Very High Concern under the REACH Regulation[109] and the Chem Trust has identified 148 chemicals used in plastic packaging that are hazardous to human health and/ or the environment.[110] Globally, there is increasing pressure to increase resource efficiency, as recognised by EU and Member State recycling targets and circular economy package, while the total amount of packaging placed on the market continues to increase. And finally, the internal market is now much larger than it was in 1994, when there were only 12 Member States.

While the aims of the PPWD remain relevant – and the challenges implicit in these aims have grown in the intervening period – the Essential Requirements have not adapted to meet the rising challenges. The PPWD was revised in 2018 but there were few amendments to the Essential Requirements. This means that the Essential Requirements are not as relevant as they could be to today's society, in which, according to the UN Paris Agreement, "climate change represents an urgent and potentially irreversible threat to human societies and the planet and thus requires the widest possible cooperation by all countries".[111] The Essential Requirements do not reflect what is now known about the impact of resource use, recycling and incineration on climate change.

This is perhaps why the Essential Requirements arguably seem to be rather unambitious by today's standards. One survey respondent, a Member State enforcement body, confirmed they had evaluated the effectiveness of the Essential Requirements: "Yes the essential requirements and the standards is not used so much or not at all. The key factor when designing a packaging is cost, durability and the customers' wishes. The standards are complex and written in a very technical way which makes it harder for companies to use them." This appears to corroborate a conclusion from a previous study, which noted that, while the Essential Requirements in principle could be a "powerful instrument", in practice they have had

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[109] European Chemicals Agency (ECHA) (2019), *Candidate List of substances of very high concern for Authorisation (published in accordance with Article 59(10) of the REACH Regulation)*, accessed at https://echa.europa.eu/candidate-list-table
[110] ChemTrust (2018), *Hazardous chemicals and plastic packaging: what are the concerns?* Accessed at https://chemtrust.org/hazardous-chemicals-plastic-list
[111] UNFCCC webpage – The Paris Agreement, accessed at https://unfccc.int/process-and-meetings/the-paris-agreement/d2hhdC1pcy

"little positive effect on the way packaging has been developed and designed."[112] This suggests that they are not as relevant as they could be. It is arguable that, for most packaging materials, the Essential Requirements are largely inconsequential, given that plastic can be incinerated for energy recovery, metal and glass can be recycled and wood is recoverable.

The remit of the Essential Requirements also means they do not address some of the slightly wider but related issues arising from packaging design and packaging waste.

In terms of biodegradability and composting for instance, EN 13432 does not apply to home-composting, despite Article 22 of the Waste Framework Directive requiring Member States to encourage home composting. This means that home composting is likely to become increasingly relevant but it is not necessarily clear to consumers (or indeed packaging manufacturers and retailers) that packaging designed to be composted in line with the requirements of EN 13432 and put on the market labelled as 'compostable' is not suitable for home composting. France has previously reported that "EN 13432 is insufficient" and has consequently developed its own standards on domestic composting and indicated support for the development of an equivalent European standard.[113] As the Standard only relates to test conditions, compostable or biodegradable packaging that is littered is not necessarily any different to all other packaging that is littered; as such, the Standard is meaningless for the proportion of packaging that ends in any marine or terrestrial environment, despite this being an increasing concern to EU citizens and Member States.

Indeed, the Essential Requirements more generally do not include any consideration of how packaging design could affect the ease with which the packaging (or specific parts thereof) is littered and could remain in the terrestrial/ marine environment. Article 9 of the Waste Framework Directive requires Member States to "identify products that are the main sources of littering, notably in the natural and marine environments, and take appropriate measures to prevent and reduce litter from such products", and "aim to halt the generation of marine litter". The Plastics Strategy similarly emphasised the need to curb plastic waste and littering and, following on from this, the Single Use Plastics (SUP) Directive (Directive (EU) 2019/904) is explicitly part of the EU's efforts to prevent and tackle marine litter. Nothing, however, in the Essential Requirements helps Member States to do this; requiring packaging to be recoverable does not actually mean it is recovered and there is no suggestion that the design process should consider the risk that removable elements of the packaging are littered.

Similarly, the SUP Directive introduced recycled content targets for specific forms of packaging (plastic beverage bottles), recognising the need to reduce reliance on virgin resources and stimulate demand for high quality recycled material as part of the transition towards a circular economy. The Plastics Strategy refers to the need to establish a "market for recycled and innovative plastics… with clear growth perspectives as more products incorporate some recycled content" and envisages a four-fold demand for recycled plastics. The Strategy states that "Weak demand for recycled plastics is another major obstacle to transforming the plastics value chain. In the EU, uptake of recycled plastics in new products is low and often remains limited to low-value or niche applications."

[112] ICF & Eunomia (2018) *Plastics: Reuse, Recycling and Marine Litter.* Annex to the Final Report. 30th May 2018.

[113] Professional Management (2018) *Implementation of PPWD in Eleven Selected EU Countries.* Report for the Swedish EPA. 19th October 2018.

In neglecting recycled content, setting a very low bar to be classed as recyclable and allowing all plastics to be incinerated, the Essential Requirements – and accompanying Standards – neither simulate the demand or supply of recycled plastic.

3.4 Coherence

There is a question both over: how internally coherent the Essential Requirements are; and how they support wider EU policy and how consistent the Essential Requirements are with more recent interventions.

Internally, there is little guidance over how to address potential conflicts and contradictions. For instance, some packaging that has been re-designed to be lighter weight is also less easily recycled, but there is no indication in the Essential Requirements as to which should take precedence when waste prevention and recycling are mutually exclusive. Similarly, reusable glass packaging needs to be thicker – and consequently heavier – than glass packaging designed for single use. While the wording of Annex II arguably implies that discretion is to be used in interpreting the “minimum adequate amount”, the Essential Requirements and EN 13427 do not fully reflect the trade-off between weight and reusability/ recyclability.

By assigning responsibility for enforcement of the essential requirements to Member States in Article 9 (Essential Requirements) and to packaging producers in the Standards, responsibility for the Essential Requirements is shared, however there is no enforcement guidance for Member States and, along the supply chain, there is no explicit division of responsibility. Meanwhile, the role of other entities along the supply chain who are ultimately responsible for placing packaging on the market, such as food retailers – who may rely on disposable packaging – is largely overlooked.[114]

In terms of external coherence, the remainder of this section considers the adequacy of the Essential Requirements in light of the more recent policy developments, not least the introduction of the Waste Framework Directive (WFD) and the development of the EU Circular Economy Package.

Waste Hierarchy

One of the most critical weaknesses of the Essential Requirements is that, in pre-dating the WFD, the Essential Requirements fail to reflect the waste hierarchy. The 2018 amendment to Annex II – which added “in line with the waste hierarchy” to the section on reuse and recovery – simply served to highlight that reuse and recovery should be prioritised over disposal; there is no recognition that reuse takes precedence over recovery, or that recycling is preferable to energy recovery. This is true of both Annex II and the Standards, with EN 13427 simply requiring compliance with any one of the three Standards relating to recovery, implying that all forms of recovery are equal.

By providing both weak and vague criteria to be classed as recyclable and implicitly allowing all plastic packaging to be designed for energy recovery, the Essential Requirements have arguably facilitated the situation described in the Plastics Strategy: “Today, producers of plastic articles and packaging have little or no incentive to take into account the needs of recycling or

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[114] ICF & Eunomia (2018) *Plastics: Reuse, Recycling and Marine Litter.* Final Report for the European Commission. 30th May 2018.

reuse when they design their products." As such, the Essential Requirements do nothing to support the commitment in the Plastics Strategy: for all plastic packaging placed on the market in the EU to be designed so it is "either reusable or can be recycled in a cost-effective manner" by 2030.

Underlining the pre-eminence of reuse and recycling, Article 8a of the WFD on extended producer responsibility refers to design for recyclability and publishing information on "the extent to which the product is re-usable or recyclable" – notably excluding other forms of recovery. These EPR provisions and promotion of modulated fees in the WFD reinforce the perspective that there are degrees of recyclability, in contrast to the Essential Requirements, which present recyclability as a binary status – i.e. packaging (or a proportion of it) can either be theoretically recycled or not; there is nothing relating to whether it is cost-effective to recycle or would produce high quality recycled material, let alone a recognition that it is preferable to have a packaging unit that is 100% recyclable.

Energy Recovery

In addition to encouraging packaging to be designed so that it can be incinerated, EN 13431 does not reflect the classification of recovery operations in the WFD. Annex II of the WFD, on Recovery Operations, specifies that incineration facilities must have an energy efficiency of at least 0.60 or 0.65 (depending whether they were permitted before or after 31st December 2008). These WFD provisions mean that not all incineration is classed as energy recovery, but there is no reference to this in the Essential Requirements or in the Standard.

By providing automatic compliance for plastic (on the basis that it can be incinerated for energy recovery), the Essential Requirements do not support the circular economy package and the Commission's ambition to ensure that all plastic packaging placed on the EU market by 2030 can be reused or recycled, or the Plastics Strategy, which "lays the foundations to a new plastics economy, where the design and production of plastics and plastic products fully respect reuse, repair and recycling needs and more sustainable materials are developed and promoted".[115]

Nor do the Essential Requirements reflect the changes to Article 6 of the PPWD. Whereas previously Article 6 set a 50% minimum (and 65% maximum) for the weight of packaging that was to be *recovered* and only 25%-45% by weight of the totality of packaging materials in packaging waste that was to be *recycled,* the latest PPWD only includes *recycling* targets for 2025 (a minimum of 65%) and 2030 (a minimum of 70%). The latest recycling targets are consequently much more ambitious compared to when the Essential Requirements were written and there are no longer any targets for energy recovery.

Recycled Content

Article 8 of the WFD states that "Member States may take appropriate measures to encourage the design of products"... "that contain recycled materials". The Single Use Plastic Directive also includes a target of 25% recycled content for PET beverage containers by 2025 in order to promote the market uptake of recycled materials. However, there is nothing in the Essential Requirements that promotes the use of recycled content, even though this could increase the likelihood that recyclable material is recycled. Indeed, by allowing for the recovery of plastic

[115] European Commission (2018) *A European Strategy for Plastics in a Circular Economy*. 16th January 2018.

packaging through incineration, the Essential Requirements undermine the whole purpose of the SUP Directive. One Member State responding to the survey suggested that plastic requires more attention in the Essential Requirements “to meet the objective of preventing waste and increasing recycling”.

Reporting

The limited compliance and reporting procedures associated with the Essential Requirements contrast with Article 37 of the WFD. This details Member States’ reporting requirements, including annual reporting to the Commission on preparation for reuse and recycling. Additionally, Article 38 promotes information exchange and the sharing of best practice.

Although Article 12 and Annex III of the PPWD require reporting on quantities consumed, reused, recovered and disposed of, neither the Essential Requirements nor the harmonised standards include reporting progress or incidence of non-compliance. This could potentially also hinder sharing of best practice, which has been identified in the past as an area that could be improved.[116]

Compostable and Biodegradable Plastics

Another study for the European Commission, which has not yet reported, is investigating the use of compostable packaging. This follows the recognition in the Plastics Strategy that: “most currently available plastics labelled as biodegradable generally degrade under specific conditions which may not always be easy to find in the natural environment, and can thus still cause harm to ecosystems… In addition, plastics that are labelled 'compostable' are not necessarily suitable for home composting. If compostable and conventional plastics are mixed in the recycling process, it may affect the quality of the resulting recyclates.” This indicates that the lack of clear definition of the terms “biodegradable” and “compostable” in the Essential Requirements once again leaves them open to interpretation, with potentially negative environmental impacts. The Plastics Strategy accordingly emphasises the role of compostables in “some applications”, but there is nothing in the Essential Requirements that encourages consideration of when compostables might be appropriate, and when they might not be.

3.5 Achieved EU added value

The PPWD was introduced after some Member States had started to develop their own – potentially different and even contradictory – packaging rules, which could have presented challenges for the smooth functioning of the internal market. As such, there was a clear role for the EU to provide harmonised standards and a level playing field, in order to support the single market. Consequently, the Essential Requirements have prevented a proliferation of different rules governing what can and cannot be placed on the market in each Member State, which would have presented practical and financial obstacles for packaging producers. The absence of such barriers can consequently be attributed to the EU’s intervention and represents EU added value.

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[116] Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.

However, the impact of the Essential Requirements on packaging design is more questionable, and suggests the EU could have enhanced its value even further.

Europen (an organisation representing the packaging industry) reported a decade ago that 77% of companies had implemented the CEN Standards in some form.[117] It seems, however, that this was often a more informal approach of reflecting the ethos of the Standards in their internal procedures, rather than strictly and explicitly following the letter of the Standards. Tellingly, it was noted that "often companies do not even realise they are complying with the Essential Requirements", indicating that Member States' promotion of the standards and compliance inspections were limited.[118] This would seem to suggest that any positive action from producers cannot be attributed to the Essential Requirements. Indeed, at a workshop conducted for a 2018 study, a packaging expert working in the packaging supply chain reported that they were not aware of the Essential Requirements.[119] This may indicate that little progress has been made of the last decade, and seems to suggest that the Essential Requirements risk being a misnomer.

Member States responding to the survey for this study commented that the Essential Requirements have had little influence on packaging design, with one respondent explaining that the Essential Requirements "are not so well known or used".

A number of Member States replied that the Essential Requirements have influenced the levels of hazardous metals – indicating that the EU has added value in this regard – but Austrian experts contrasted this to the Essential Requirements' lack of influence on light-weighting and recyclability. Bulgarian experts proposed that the market and cost-effectiveness are the main drivers for packaging innovation. The experts from UK and Hungary agreed that other interventions, with the latter citing modulated EPR fees, have had more of an influence.

The Latvian experts, however, reported that the Essential Requirements have increased recyclability. Experts from Cyprus, which relies on imports, similarly noted that the Essential Requirements have positively influenced packaging design in some Member States, with knock-on effects for the packaging exported to Cyprus.

The European Commission's Fitness Check suggested that the PPWD – including the Essential Requirements – had "had no effect on the recycling rate in 7 out of 15 Member States", in part because many Member States had already adopted their own policies before the Directive was introduced.[120] This review process also, however, concluded that "recycling targets have been

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[117] Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.

[118] Arcadis (2009) *A Survey on Compliance with the Essential Requirements in the Member States*. Final Report for the European Commission.

[119] ICF & Eunomia (2018) *Plastics: Reuse, Recycling and Marine Litter.* Final Report for the European Commission. 30th May 2018.

[120] European Commission (2006), *Annex to the Report on the Implementation of Directive 94/62/EC on Packaging and Packaging Waste and its Impact on the Environment, as well as on the Functioning of the Internal Market*, accessed at http://ec.europa.eu/environment/waste/pdf/implementation_report_annex.pdf

an effective means of spurring recycling efforts in the Member States".[121] The Fitness Check attributed the attainment of recycling targets to EPR schemes and the use of economic instruments, rather than the Essential Requirements.

In general, the Essential Requirements have added little in terms of design for recyclability precisely because they are not written to promote one form of recovery over another. In terms of waste prevention, while there has been a light-weighting trend, there is no evidence to indicate that this trend can be attributed to the Essential Requirements. It is arguable that producers would in any case seek to minimise their packaging costs, balanced against the potential to use packaging as a marketing tool and a means of protecting the product.

As experts from Germany noted, there is a "very low cost to producers" associated with the Essential Requirements because the Requirements are "obvious and not demanding" and, as such, do "not have any strong effect today".

Some – but by no means all – Member States have adopted tools such as packaging prevention plans. The fact that the levels of packaging waste generated do not vary significantly, however, between Member States, may indicate that enforcement measures make little difference. It also, however, reflects the fact that many producers will be placing packaging on the market in several Member States, meaning that compliance activity in one country is likely to support compliance levels in other countries, which underlines the case for action at the EU level, particularly if smaller countries could otherwise find it difficult to influence multi-national companies.[122]

3.6 Synthesis of Findings

The revised PPWD requires the Commission to examine the feasibility of reinforcing the Essential Requirements with a view to "improving design for re-use and promoting high quality recycling, as well as strengthening their enforcement". This 2018 revision to the Directive thus implicitly recognises that the existing Essential Requirements are not well equipped to support these three objectives.

In terms of effectiveness, the Essential Requirements are difficult to implement and enforce because they leave so much to interpretation. And the effect on both the quality of the environment and protecting resources could be more significant if the Requirements were more

[121] European Commission website (2019), Environment>Waste>Packaging and Packaging Waste webpage at http://ec.europa.eu/environment/waste/packaging/index_en.htm; and European Commission (2014), *Ex-post evaluation of Five Waste Stream Directives Accompanying the document Proposal for a Directive of the European Parliament and of the Council reviewing the targets in Directives 2008/98/EC on waste, 94/62/EC on packaging and packaging waste, and 1999/31/EC on the landfill of waste, amending Directives 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EC on waste electrical and electronic equipment*, accessed at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0209&from=EN

[122] European Commission (2006), Annex to the Report on the Implementation of Directive 94/62/EC on Packaging and Packaging Waste and its Impact on the Environment, as well as on the Functioning of the Internal Market, accessed at http://ec.europa.eu/environment/waste/pdf/implementation_report_annex.pdf

ambitious. While the Essential Requirements in theory provide rules on what types of packaging can be placed on the market across the EU, their vague nature could potentially mean they pose a barrier to the functioning of the internal market, as interpretations could differ between Member States. There is, however, little evidence to suggest this is a problem because there is so little enforcement activity.

In terms of packaging trends, the Essential Requirements have not prevented 'over-packaging' or an increase in the amount of packaging waste generated; while there has been an undoubted light-weighting trend, this cannot be directly or solely attributed to the Essential Requirements. Nor are the Requirements equipped to address the popularity of packaging formats that are considered more difficult to recycle, the use of which has increased in recent years. Indeed, it is notable that, since the Essential Requirements were introduced, plastic packaging – the packaging material with the lowest recycling rate – has increased in popularity.

While it could be argued that the Essential Requirements have been effective because almost all packaging placed on the market is "recoverable", this is not necessarily a consequence of the Essential Requirements and could be said to be more by accident than by design. This review has indicated that the Essential Requirements' aims and purpose are not aligned with today's needs. In essence, the Essential Requirements are not effective because they are no longer as relevant as they could be.

Efficiency is not considered to be a major consideration at present, as the Essential Requirements need very little in the way of inputs. However, if the Essential Requirements were to be implemented as intended in the Directive, it is not clear if such resources would be justified by the limited impact any investment is likely to achieve while the Essential Requirements are formulated as they are.

The relevance of the Essential Requirements appears to be a critical weakness, as they do not reflect current knowledge on end-of-life management options, do not consider that there are degrees of recyclability and do not necessarily reflect the range of packaging types that are now placed on the market. Nor do they reflect current concerns regarding climate change, littering and plastics in the marine environment.

In terms of coherence, the Essential Requirements risk undermining the waste hierarchy and the circular economy agenda by being neutral on the recovery options and on reuse and neglecting recycled content and the impact the packaging design can have on the value of the recycled waste. The Requirements do not directly support the attainment of targets in the PPWD, and nor do they support the SUP Directive, the Plastics Strategy, or the EU's efforts to increase the recycled content of packaging. They are, therefore, proving inadequate in the broader policy landscape.

On the question of EU added value, the Essential Requirements have prevented the development of different packaging rules across the 28 Member States, which would have been an impediment to the smooth functioning of the internal market. There is, therefore, a clear argument for EU intervention to support a harmonised approach for packaging producers. The Essential Requirements have not, however, positively affected packaging design in any significant way so the value added by the EU could be greater if the Essential Requirements actively promoted improvements to packaging design rather than simply preventing different regulations.

These inherent weaknesses in the Essential Requirements – their lack of relevance and their lack of ambition – are perhaps partly why there is such little enforcement activity. The presumption of compliance seems to have been interpreted differently in various Member States, with markedly more enforcement activity in a limited number of Member States than in most. The harmonised Standards do not seem to have been extensively relied upon and a review of their content indicates that they do not provide the necessary degree of clarity to support the Essential Requirements and make them more concrete, operational, implementable and enforceable. The formulation of the current Essential Requirements relies on Standards that provide metrics, define concepts and detail an implementation procedure to support a uniform interpretation across Member States; the absence of these leaves producers without the necessary guidance to effectively follow the Essential Requirements and means interpretations could vary both within and between Member States.

In summary, the effectiveness of the Essential Requirements is limited by:

- The minimal requirements, especially in the context of the EU's latest recycling targets and policy direction;
- Their vague nature which makes interpretation and enforcement difficult;
- A failure to reflect the different environmental impacts of the various treatment options (as recognised by the waste hierarchy);
- The opaque division of responsibility (between entities along the supply chain and with Member States), as well as the exclusion of the views of stakeholders further along the value chain – not least those responsible for collecting and processing waste;
- The Requirements have not been updated as packaging technologies have changed or knowledge of environmental and human harms has expanded;
- The presumption of compliance and implicit low priority status of the Essential Requirements.

Consequently, options to reinforce the Essential Requirements should focus on:

- **Reflecting the waste hierarchy by promoting design for reuse or recycling;**
- **Clarity on packaging designs and materials that are likely to cause problems for waste collectors and processors;**
- **More strictly and explicitly defined requirements for waste prevention, with fewer derogations or mitigating options;**
- **Consideration of the role of compostable packaging and ensuring the Essential Requirements are aligned with the EU's current policy development on the use and value of certain compostables;**
- **Supporting the demand and supply of high-quality recycled material; and**
- **A well-defined enforcement procedure that replaces the presumption of compliance, and ensures the roles and responsibilities of producers and authorities across all Member States are clear.**

4 Development of Options

The problems that drove the EU to introduce the Essential Requirements a quarter of a century ago continue to provide an intervention logic today. This means Essential Requirements for packaging are still needed to:

- › Improve the quality of the environment;
- › Protect human health;
- › Protect resources; and
- › Ensure the functioning of the internal market.

However, the problems to be addressed have evolved due to changing packaging technologies, the expanding single market, an increased understanding of environmental issues and the strengthening of the EU's environmental acquis. Consequently, the review has indicated that a new approach to the Essential Requirements – how they are formulated, implemented and enforced – is needed.

In order to identify measures to reinforce the Essential Requirements, a wide-ranging long-list of options was firstly developed. This list was informed by:

- › The literature review and evaluation conducted at the outset of this study (in Section 3);
- › Stakeholder input from:
    - › The Member State survey undertaken in Task 2 (in Section 3);
    - › The stakeholder workshops for packaging manufacturers, fillers, distributors, recyclers, trade bodies, NGOs and others undertaken in Task 2 (Section 3, Appendix D); and
    - › Further one-on-one interviews with stakeholders who were unable to contribute to either the survey or the workshop (Section 3);
    - › Position papers received; and
    - › Brands, packaging producers, and other organisations that are currently already realising desirable outcomes that are relevant to the objectives of the Essential Requirements (Appendices F and G).

The resulting draft longlist of potential measures is included in Appendix E. The longlist is organised by relevant theme in the Essential Requirements (prevention, reuse, recycling, energy recovery, compostability, hazardousness, and cross-cutting), the evaluation categories, (effectiveness, efficiency etc.), and the type of intervention (guidance, enforcement, regulation etc.).

The possible approaches to reinforcement considered in the longlist were:

- Enforcement
- Technology
- Regulation
- Guidance
- Market
- Labelling

- Supporting policy

Whilst guidance could support implementation and enforcement of the Essential Requirements, it does not determine exactly what can and cannot be placed on the market in the EU, which is the purpose of the Essential Requirements. Similarly, supporting policies might help to achieve the objectives of the Essential Requirements, but would not necessarily help to determine market access.

Longlisted measures were selected for shortlisting on the basis of an assessment of their ability to address the shortcomings identified in the review of the Essential Requirements. This considered their applicability to law; enforceability; alignment with EU policy; feasibility; potential impact; and practicality. The shortlisting process was also informed by feedback from Member State experts, wider industry stakeholders and the Commission Steering Group.

As part of the study, 18 case studies were completed to identify existing examples of tools or approaches that have been used to improve the resource efficiency, reusability or recyclability of packaging. The case studies were identified through stakeholder suggestions and desk-based research and selected on the basis of their relevance to both the Essential Requirements and the objectives of this study, as well as the need to develop representative case studies based on the packaging sector, material type and stages along the supply chain.

A summary of the findings of these case studies is provided in Appendix F.1, with the full detail provided in the remainder of Appendix F. The case studies were used both to identify further possible measures and to assess the potential impact of identified measures.

4.1 Initial Selection of Measures

This section outlines the measures that were selected from the longlist to be discussed with Member States and stakeholders during Workshop 2. It does not represent the final shortlisted measures (which are detailed in Section 5), but rather an initial selection of measures that merited shortlisting, and/ or which might have needed to supplemented by additional measures.

In the following sections, the measures are grouped into categories according to the current text of the Essential Requirements.

4.1.1 Requirements specific to the manufacturing and composition of packaging

Measure	Rationale
Packaging shall be reusable or recyclable by 2030.	This removes the option to design packaging for energy recovery and aligns the Essential Requirements with the requirement in the Plastics Strategy for plastic packaging to be recyclable in a cost-effective manner by 2030. It also strengthens the requirement for plastic packaging by requiring all the packaging – not just an unspecified percentage of it – to be classed as recyclable.

Measure	Rationale
	Ultimately, the measure is intended to support the EU's transition to a circular economy and to support recycling and reuse targets.
Subject to the requirement to be reusable or recyclable, the weight and/or volume of packaging shall be minimised.	This is a necessary clarification in response to the new requirement for all packaging to be reusable or recyclable – providing more clarity on the waste prevention requirement by confirming that waste management at the end-of-life also needs to be taken into account. It also recognises that the minimum weight will be heavier if the packaging is designed to be reused rather than recycled.
Specify limits on the proportion of sealed air in the volume of e-commerce packaging.	The review identified e-commerce packaging as a specific area that could be suitable for legal limits to reduce the risk of over-packaging. The measure was developed in response to concerns that the current requirement intended to support waste prevention is too vague to be operational or enforceable. This would, therefore, provide a clear metric to support the packaging design process and compliance checks.
Include maximum ratios of packaging to product by volume or weight in the Annex for some specific formats.	This once again provides a quantifiable metric to support producers in complying with the Essential Requirements and enforcement agencies assessing compliance by providing a method to calculate the minimum volume and weight that is necessary. This would affect a wider range of packaging beyond e-commerce packaging, so would have a more significant impact if the ratio is set at the appropriate level.
Develop a standard that provides a process by which producers have to go through to maximise the recycled content of a packaging unit e.g. consideration of food contact, strength requirements etc.	As recycled content is not currently considered in the Essential Requirements, this would be added to support the use of recycled content in order to reduce reliance on virgin materials, support the attainment of recycling targets and promote the circular economy – bringing the Essential Requirements more into line with more recent EU policy. Following the assessment of the long-list of measures, specific recycled content targets were not considered appropriate. This measure instead would require designers to follow a procedure in order to maximise the potential recycled content and to recognise the limiting factors.

Measure	Rationale
Expand the hazardous substances list according to the definition proposed under the interface between chemicals, product and waste legislations	This is intended to reflect the improved knowledge about hazardous substances since the Essential Requirements were first introduced and to align the Requirements with more recent EU legislation, which is concerned with far more substances than just the four heavy metals.

4.1.2 Requirements specific to the reusable nature of packaging

Measure	Rationale
All reusable packaging shall be recyclable except in certain cases where the format provides significant added value for an exemption to be applied.	This is intended to prevent the use of packaging that is claimed to be reusable – but is not likely to be reused in reality – in order to avoid having to make the packaging recyclable. It is also recognised that packaging that is appropriately reused could still offer environmental benefits over single-use alternatives, even if it is not recyclable. It is therefore suggested that exemptions may be needed in specific, limited circumstances to avoid discouraging the use of reusable packaging (give that reuse is at the top of the waste hierarchy).
Mandate reusable packaging for certain formats / situations e.g. transport packaging.	Targets were considered – meaning that a certain percentage of packaging placed on the market would need to be reusable. However, this does not provide a clear demarcation of what can and cannot be placed on the market, which is the purpose of the Essential Requirements, as targets would mean that what can be placed on the market depends on what else is placed on the market. Instead, this measure would mandate that all packaging in certain categories must be designed for reuse and have a reuse system in place. The categories or formats chosen would depend on further analysis and impact assessments,
Include thresholds for the minimum number of trips, on average, that are required for in order for a package to claim itself to be reusable (or refillable).	This is to address the weakness of Annex II and EN 13429, which refer to “a number of trips” and to “a minimum number”, without any indication of what this could be or guidelines. Specifying a minimum number would ensure that the reusable packaging system is designed to

Measure	Rationale
	complete at least enough trips to justify the additional material that is often needed for reusable packaging.
Include a definition of reusable	While the Standard includes three types of reuse systems, the use of the Standard is not compulsory and interpretations of “reusable” can vary. Including a clear definition in the Essential Requirements could ensure that producers, consumers, retailers and enforcement agencies know what is required.

4.1.3 Requirements specific to the recoverable nature of packaging

Measure	Rationale
Clarify the definition of recyclable based on its current usage and minor modifications to the CEN Standard	This would be a relatively minor change that would, for instance, mean removing the reference to a minimum percentage by weight being recyclable.
Include a detailed definition of recyclable using design for recycling methods to restrict the use of low compatibility types	This recognises that interpretations of what is and is not recyclable differ between Member States and between producers and recyclers. The measure would consequently provide design criteria to restrict the use of materials, polymers, additives, adhesives and pigments that have been found to make packaging more difficult to recycle. This would provide producers with clear rules.
Include minimum quantitative thresholds to be met by packaging type - e.g. it achieves at least an average recycling rate of 20% across the EU	This would restrict packaging to the formats that have been proven to be recyclable by achieving a minimum recycling rate across the whole of the EU. This recognises that collection and processing facilities vary between Member States so using the recycling rate across the whole of the EU is intended to protect the single market.
Additional limits on biuret, inorganic arsenic and nickel use in compostable packaging.	This is intended to harmonise the Essential Requirements with EU policy on fertilisers to improve the quality of outputs from composting facilities.
Remove concept of biodegradable to focus on the concept compostable packaging	This is due to the lack of clarity within the text of the Essential Requirements about the difference between compostability and biodegradability.

Measure	Rationale
Include a clearer definition of, and requirements for, compostable packaging in the Annex	This would reduce the Essential Requirements' reliance on the CEN Standard (the use of which is not compulsory) and would be designed to ensure that packaging that is designed to be compostable would actually be compostable in more circumstances.
Only permit the use of compostable packaging for certain applications where it meets specific criteria	This would align the Essential Requirements with another study for the Commission on compostability, depending on the outcomes of that study and whether the recommendations are accepted.[123] The measure is intended to recognise that compostable packaging can add value in some applications – for instance when it increases the likelihood that food waste is collected or avoid packaging that would otherwise only be suitable for landfilling or energy recovery. In other applications, however, packaging that is designed to be recycled would be preferable in order to support the circular economy.

4.1.4 Other provisions relating to labelling and enforcement

Measure	Rationale
Mandatory labelling standards for compostable, recyclable and reusable packaging	This would demonstrate to consumers (and any enforcement bodies) how the packaging is intended to comply with the Essential Requirements and indicate the appropriate waste management option. The intention is to reduce the risk of contamination for processors.
Require producers (fillers) to self-certify by submitting an online compliance form to an EU packaging registry. **Registered producers/ fillers would be listed on a public register and Member States would be responsible for compliance checks.**	This moves the Essential Requirements beyond the current presumption of compliance by requiring producers to submit a declaration and providing a public register of packaging that has been registered. As now, any compliance checks would be the responsibility of Member States.

[123] "Relevance of biodegradable and compostable consumer plastic products and packaging in a circular economy"; Contract No. 07.0201/2019/798924/ENV.B.3

Measure	Rationale
Include a minimum number of independently certified audits per annum (as % of the market)	As the review indicated that there is little enforcement activity in most Member States at present, this would specify minimum requirements and mean that producers know they could face audits.
Strengthen the mandatory requirements for the compliance forms e.g. by requiring a recyclability assessment – validated by recyclers – to be placed in an EU public database.	This would build on the measure above relating to a compliance form by requiring producers to submit more evidence and removing some of the scope for subjectivity – as it would not rely on the producer's assessment of whether the packaging is recyclable.
Require producers to provide proof of recycling capacity within three years of placing a new format on the market, independently certified by third party (including representatives of recyclers).	This is intended to recognise that new packaging formats will be placed on the market, for which there will not immediately be recycling collections and/ or appropriate processors in place. Otherwise – if the definition of recyclable depended on a certain recycling rate across the EU – no innovative and novel packaging could be placed on the market. If the condition was not met in three years, the packaging would need to be withdrawn from the market.
MS authorities required to report cases of non-compliance with ER to an EU rapid alert system	This is intended to avoid the duplication of enforcement efforts across Member States and ensure that, once a case of non-compliance is identified, other Member State authorities are made aware so that they too can take action.
EU to set minimum penalties for non-compliance	This is intended to strengthen compliance with the Essential Requirements by introducing the threat of financial penalties, for which entities along the supply chain would be jointly and severally liable. This would depend on the Essential Requirements being made significantly clearer and more objective, to avoid the risk that producers are unfairly penalised.

Measure	Rationale
In the transition period between entry into force and application of the new requirements, the fees under EPR should already be eco-modulated in accordance with these requirements.	This recognises that the revised Essential Requirements will not come into force immediately because producers will need time to adapt their designs and manufacturing processes. EPR fees could provide a financial incentive for early compliance and additional funds to help build capacities.
An EU level body must provide explicit approval before a packaging format is placed on the market and the format would then be listed in a European Packaging Registry	This removes the risk of non-compliance and different interpretations of the Requirements, as packaging formats would need to be authorised. Exemption criteria would need to be applied.

4.2 Review of Initial Measures

The initial measures were discussed with stakeholders and Member States at a workshop to assess their feasibility and likely impact. Workshop participants were divided into five groups and the table below summarises their responses to each of the measures. A tick (✓) means broad agreement, a cross (✗) broad disagreement and a question mark (?) no broad consensus or uncertainty around the definition of the measure.

In summary:

- The requirement for all packaging to be reusable or recyclable was supported. In terms of timescales, there were some reservations around setting a deadline of 2025 rather than 2030;
- There was no clear consensus on whether the continued use of standards were needed or not;
- Measures related to compostable packaging, hazardousness and labelling were generally well supported;
- The areas which showed the most significant divergence of views around the proposed measures were 'Efficient use of packaging', 'Reusable packaging' and 'Recycled content', indicating that these measures were most in need of further consideration, or greater clarity;
- Views around the mechanisms for enforcement of the new requirements were also quite varied. Some participants stated that the proposed text was often too prescriptive (e.g. "mandate", "shall" etc); and
- The introduction of a "recycling hierarchy" within the waste hierarchy was put forward and supported by some stakeholders to promote "high quality recycling" as laid down in article 9 of the PPWD.

Participants were also asked to suggest any additional or alternative measures for reinforcing the Essential Requirements. Several suggestions of various types were made and many proposed that consideration of the functionality of packaging should be included within the Essential Requirements.

Secondly, there were suggestions relating to enforcement:

- Ensure imports to the EU comply with the ER through third party verification.
- Exchanges of good practices and information between Member States to facilitate enforcement.

Thirdly, a general principle relating to the nature or scope of the measures was highlighted:

- Coherence of the measures with existing legislation should be ensured (e.g. WFD, PPWD).

Finally, some supporting measures or concepts were proposed:

- Traceability of packaging through the value chain should be addressed through the Communication on options to address the interface between chemical, product and waste legislation.[124]
- Implementing landfill bans.
- Reducing incineration of packaging as much as possible.
- Requiring certain packaging formats to be designed for reuse (e.g. transit packaging).
- Implementing requirements for 'renewable content' if recycled content is included.

[124] https://ec.europa.eu/commission/publications/options-address-interface-between-chemical-product-and-waste-legislation_en

Table 4-1: Summary of stakeholder views on the initial selection of measures in Workshop 2

Measure	Summary View of Each Group					Synthesis and Points for Consideration
Headline Requirements						
Packaging shall be reusable and recyclable, or recyclable only [or compostable] in a cost effective manner by 2030	?		?	✓	✓	There was broad agreement to the principles of the measure, however, the reference to 'in a cost effective manner' was highlighted as confusing given the previous discussions around the definitions not relying on this term, as cost effectiveness would vary from one Member State to another. Therefore, suggesting that reference to this term should be removed. Some suggested that the requirement was more relevant to the Plastics Strategy than the whole PPWD.
+ bring forward deadline to 2025	?	?	✗	?	✓	There was less overall support for bringing such a deadline forward from 2030 to 2025. Some participants were concerned that 4-5 years from the implementation of the revised ER would be too short to allow for packaging and recycling systems to adapt, whereas others thought that this could be achievable and would increase the overall environmental benefits achieved. Some suggested that an impact assessment would be needed to determine the suitable date for the target. Some exemptions might be needed, equally some products could meet the target much earlier than others.
Subject to the requirement to be reusable or recyclable, the weight and/or volume of packaging shall be minimised	✓	✓	✗	✓	✓	Some participants thought that the reference to waste minimisation coming after reuse and recycling was contrary to the waste hierarchy and that the ordering should be considered. In general there was broad agreement for this approach, however it was noted that 'subject to' should also relate to main environmental hotspots of the package and key performance characteristics of packaging (e.g. product protection, safety, hygiene). In addition, it was

Measure	Summary View of Each Group					Synthesis and Points for Consideration
(recognising that the minimum weight will be greater if designed for reuse).						suggested that the scope of the requirement is constrained to within functional units or formats rather than incentivising weight minimisation by material substitution.
Remove option that allows the design of packaging to be suitable for energy recovery only.	✓	✓	?	✓	✓	There was broad support for this measure, although some participants stated their support would be subject to the requirement only coming in after any requirement for packaging to be recyclable was reached in 2030. In addition, another participant highlighted that some specific forms of packaging might have a critical use but only be suitable for energy recovery, suggesting an exemption approach might need to be considered in rare cases.
Specify new time limit for implementation of revised requirements. Up until this time the existing requirements will remain in force.	✓	✓	✓	?	✓	There was general agreement to this mainly administrative measure to set a new deadline for coming into force of the revised requirements.
Remove most existing standards and presumption of compliance (incorporating some key aspects into the Annex).	?	?	×	×	✓	Some uncertainty around the definition of the measure was clear from discussion with the groups. It was stated that the use of the term 'remove' in relation to CEN standards was confusing and worry was expressed that this would create a vacuum. The wording could be adjusted to '*incorporate* most existing standards' or 'remove *link/reference to* most existing standards'. Some participants supported keeping the principle of 'presumption of compliance' whilst others considered it necessary to remove in order to improve effectiveness and enforcement.

Measure	Summary View of Each Group					Synthesis and Points for Consideration
Efficient use of packaging						
Specify limits on the proportion of sealed air in the volume of e-commerce packaging	?	✓	✗	✓	?	Views were mixed on this measure specifically related to e-commerce packaging. Some viewed the scope as too narrow, whilst others appreciated the issue of inefficient air/void space in delivered parcels. It was also mentioned that the safety of the product could also be referenced (safety is achieved through use of void fillers, but void fillers can used to pad out the air space in boxes that are too large). The mandatory nature of the measure was also questioned.
Include maximum ratios of packaging to product by volume or weight in the Annex.	✗	?	✗	✓	✗	Overall less support for this measure than the one directly above. The main reasons seemed to be a concern that this might conflict with the performance requirements of the packaging e.g. safety, hygiene, product protection etc. Others notes that these performance characteristics can be subjective.
Reusable packaging						
Specify that reusable packaging systems must be designed to minimise the impact on the environment during its use.	✓	✓	✓	✓	✓	Clear agreement from all groups that this measure was supported.
Mandate use of ex-ante assessment approach for planned single-use packaging to determine	✗	?	✗	?	?	This measure did not have much support across the participants, although some were supportive. The main concerns related to the mandatory nature of the requirement and the nature of the methodology used to make such assessments. PEF was indicated as not being suitable by one group. Others questioned how this would be implemented in practice. In general,

Measure	Summary View of Each Group					Synthesis and Points for Consideration
whether reuse alternatives are an environmentally and economically viable option. Potentially including PEF, PREP type tool.						LCA was considered a too loose a tool to use, despite there being some international standards relating to its application. In addition, the potential administrative burden of the measure was highlighted as a concern.
+ reusable packaging must meet thresholds for the minimum number of trips.	?	✓	?	✓	✗	Agreement for this measure was mixed. Some participants were in favour, whilst others were unsure suggesting that concepts other than just the number of trips should be considered, or that criteria should be included to ensure the reusable packaging was 'better' than single-use (which could also relate to number of trips).
Recycled content						
Implement a mandatory standard that provides a process through which producers have to go to maximise the recycled content of a packaging unit e.g. consideration of food contact, strength requirements etc.	?	✓	✗	?	✓	Many participants seemed supportive, in principle, of an approach that helped producers increase recycled content in packaging. The 'mandatory' nature of the measure was, however, a grounds for disagreement, with some suggesting 'incentivising' the use of standards might be more appropriate. Others also suggested that any processes captured in the standards should relate to industry specific types of packaging. Furthermore, it was not well understood from the presentation of the proposal if recycled content should be per packaging unit – or – on 'recycling system level' (where policy targets already are set).

Measure	Summary View of Each Group					Synthesis and Points for Consideration
Recycled content targets for specific types of packaging, including 100% for some (e.g. flower pots).	×	?	?	✓	×	Whilst some supported the use of recycled content targets to create end markets, others suggested it would be suitable for some packaging materials and not others, or that the approach was too material specific for the ER. In addition, other participants questioned whether the ER was the right place for recycled content targets to be placed in European legislation. Others also raised uncertainty about the measure because 'specific types' of packaging were not defined, or mentioned about the inclusion of 'renewable content'.
Composting						
Biodegradable is removed to focus on the concept of compostable.		✓	?	✓	✓	There was broad agreement with this measure, with some participants highlighting that there was little knowledge available on this particular topic in the group. Some participants suggested that both should be included in the ER because they are linked. One group suggested that the term 'industrial' should be inserted into the definition of all measures in this section.
Include clearer definition of/requirements for compostable in the Annex.		✓	✓	✓	✓	Broad agreement on this measure with no specific comments.
Include requirement that only allows certain applications of compostable packaging, e.g. that meet specific criteria		✓	?	✓	✓	The broad agreement for this measure was caveated by one group stating that it was acceptable in principle as long as it did not limit innovation. Whilst another suggested that it was important for any compostable packaging to be clearly identifiable and separable from other packaging.

Measure	Summary View of Each Group					Synthesis and Points for Consideration
(as defined by compostability study).						
Hazardous substances						
Additional limits on biuret, inorganic arsenic and nickel use in compostable packaging.		✓	✓	✓	?	General agreement to this measure contingent for one group on understanding the significance of biuret. Reference to standard EN 13432 was also made.
Expand the hazardous substances list according to the definition proposed under the interface between chemicals, product and waste legislations.		✓	×	✓	✓	This measure was generally supported, however, the group that disagreed did so on the basis that the measure as it stands is written as a 'blank cheque' and the details of which hazardous substances were being proposed and how they related to packaging etc. Other participants suggested that the wording could be refined to focus on designing out hazardous substances rather than expanding a list of them.
Labelling						
Mandatory labelling standards for compostable,	✓	✓	✓	✓	✓	Clear agreement on this measure, though with some caveats. Several groups suggested that the wording of the measure should include some reference to the standards being harmonised at the

Measure	Summary View of Each Group					Synthesis and Points for Consideration
recyclable and reusable packaging.						EU level. It is also clarified that the standards being referred to have not yet been developed. It was also suggested that such labelling might not be needed for B2B applications.
Digital watermarking of all packaging by 2030 to facilitate sorting (e.g. Holygrail project type).		✓	?	?	✓	Some support for this measure, but one group indicated that an impact assessment of such technology would be needed first i.e. to ensure it was appropriate and there were no unintended consequences etc. Another that it might not be applicable to legislation yet as the concept is still under development.
Enforcement						
Producers (fillers) must self-certify by submitting an online compliance form as part of a register including indicators (based on template) to each MS authority where they are placing packaging on the market, where packaging manufacturers are obliged to provide necessary information to the fillers.		✓	✗	?	✓	Some participants that disagreed with many of the enforcement measures suggested that the new ER measures should be agreed first, and that enforcement of existing legislation under the WFD and PPWD should be considered first also. Other suggested that many of the enforcement measures were simply ‘impractical’. In particular, concerns focused on the too prescriptive approach of the enforcement options (e.g. “mandate”, “shall” etc) and the risk of creating an additional bureaucratic/ administrative burden, potentially counter-productive with regard to the objective of the review of the ER (i.e. to facilitate enforcement of the ER at national level). Moreover, there seemed to be some uncertainty around the definition and scope of these enforcement measures, whether they required each individual piece of packaging to be registered or whether general types could be registered under which specific pieces of packaging could be registered. However, there was more support for a new packaging registration system that was at least self-certified, although independent certification appeared to be a more preferred approach. This was

Measure	Summary View of Each Group					Synthesis and Points for Consideration
+ independent certification.	✓	✓	✗	✗	✓	subject to some caveats with some participants querying what 'independent' meant in practice, and who would pay for such certification.
Explicit approval from an authorised Member State authority before being placed on the market, considering list of exemptions: the packaging format will then be listed in a European Packaging Registry.	✗		✗	✗	✗	Explicit approval of packaging before being placed on the market by a Member State authority had the strongest level of disagreement out of any measure. Some noted that this type of system would be covered by EPR schemes. There was a slight increase in support, however, if the approval system was at EU level.
Explicit approval from an EU level body before being placed on the market, considering list of exemptions: the packaging format will then be listed in a European Packaging Registry.	?	?	✗	✗	?	
MS authorities to be required to report cases of non-compliance with			✓	✗	✓	Of those that responded to this measure there was some support, although it was noted that the 'product policy enforcement package' might not be the most suitable mechanism for this system.

Measure	Summary View of Each Group					Synthesis and Points for Consideration
ER to EU rapid alert system through linking to the product policy enforcement package.						
Mandate the setting of minimum penalties for non-compliance jointly and severally liable across the value chain.			×	×	✓	Some support for this measure, but no specific comments were given as to the reasons for disagreement.
In the transition period between entry into force and application of the new requirements the fees under EPR should already be eco-modulated in accordance with these requirements.	?		✓	✓	✓	Out of all the enforcement measures, the linking of measures in the ER to the modulation of fees under EPR received the strongest level of support.

4.3 Assessment of Measures against 'Problematic' Packaging

In addition to reviewing stakeholder feedback on the initial measures, the measures were assessed against the list of problematic packaging identified earlier in the study, to test their potential in addressing the issues posed by such packaging.

The study Terms of Reference points to the term 'problematic' packaging as a broad term to encompass any packaging that may not be contributing to meeting the key policy goals of the PPWD e.g. waste prevention, increased reuse, increased recycling and reduced hazardousness. The term must be considered in this context. The more challenging packaging formats or characteristics, in this respect, were identified in the initial evaluation phase of the study (see Section 2). The measures above that address these issues are set out in Table 4-2. This suggests that the issues identified should be addressed through the implementation of the proposed measures.

Table 4-2 Measures Addressing Identified Issues

Nature of Issue	Measures Addressing Issue
Characteristics of packaging that inhibit recycling – the report identified a range of packaging design characteristics that lead the packaging to not be recycled currently, or cause problems in the recycling process leading to contamination etc.	All packaging shall be reusable (and recyclable) or recyclable as defined through the measures under the requirements specific to the reusable / recyclable nature of packaging.
Inefficient use of packaging i.e. 'over packaging' – the term over packaging needs to be considered in the context of the overall product:packaging system and wider impacts. However, there were some clear cases of unnecessary use of packaging material.	In addition to the requirement to be reusable or recyclable, the packaging shall be designed not to exceed the minimum volume and weight necessary for the functionality under critical areas to be met. Amend EN 13428 to refine the critical areas Producers to report to central registry ratios if the packaging exceeds a specified threshold percentage of the product, and/or Packaging must not exceed any of a set of threshold ratios of packaging to product
Potential contamination of plastic / biowaste stream due to confusion around	CEN Standard 13432 is updated to further specify the concepts of compostable and biodegradable packaging

end of life management of biodegradable plastics	Amend Annex II on the basis of the criteria to determine applications for which design for compostability can be considered to be of added value. Labelling packaging as compostable.
Increase in packaging waste generation due to e-commerce and issues of over packaging associated with e-commerce – i.e. unnecessary void space in packaging delivered to consumers.	Labelling of e-commerce packaging with stickers to highlight to consumers to report unnecessary void space to authorities in order to support enforcement. *Define limits on the amount of sealed air in e-commerce packaging through secondary legislation.*[125]

[125] Not to be included in the Essential Requirements but other parts of the PPWD or other secondary legislation.

4.4 Conclusions

Following an internal review of the possible measures and discussions with Member State experts, stakeholders and the European Commission, it was concluded that the following measures would be taken forward for further analysis:

- All packaging to be reusable or recyclable, with 2030 a more realistic timeframe than 2025.
- The minimum volume/ weight of packaging should be contingent on the packaging being suitable for reuse or recycling.
- Packaging to product ratios.
- Limits on the amount of sealed air in e-commerce packaging.
- A standardised process for recycled content.
- Recycled content targets.
- Clarifying the concept of compostability.
- Limiting compostable packaging to certain applications.
- Including additional hazardous substances.
- Relying on REACH as a single source covering all substances of concern.
- Mandatory labelling requirements.
- Digital watermarking.
- A central packaging register.
- Specific enforcement procedures.

These measures, as well as a selected number of additional potential measures, were analysed during the final stage of the study. The analysis was informed by life cycle assessments of current packaging designs in 13 case studies, and targeted interviews with a representative cross-sample of stakeholders.

The final set of measures are discussed in more detail in the following chapter. The results of the case study LCAs are used to inform this discussion, and are referenced in subsequent according to the table below.

LCA Case Study Ref. No.	LCA Case Study Description	Relevant Section for Details
1	Solutions for increasing the recyclability of flexible pouches	Appendix G.2.1
2	Solutions for increasing the recyclability of black plastic	Appendix G.2.2
3	Moulded pulp fibres as an alternative for expanded polystyrene	Appendix G.2.3
4	Alternatives for PVC stretch wrap	Appendix G.2.4
5	More recyclable alternatives for multilayer wrappers	Appendix G.2.5
6	Reusable packaging for electric and electronic equipment	Appendix G.3.1

7	Reusability in cleaning products	Appendix G.3.2
8	Reusable e-commerce bags	Appendix G.3.3
9	The break-even point for reusable pallets	Appendix G.4.1
10	The break-even point for reusable beverage containers	Appendix G.4.2
11	The break-even point for reusable packaging in transport of electrical and electronic equipment (EEE)	Appendix G.4.3
12	Use of recycled content at design stage	Appendix G.5.1
13	Optimisation of void space in e-commerce packaging	Appendix G.5.2

5 Appraisal of Proposed Measures for Reinforcement

This section appraises the proposed measures for reinforcement of the Essential Requirements. The approach utilises quantitative analysis carried out through a range of case studies (see Appendix G), as well as qualitative assessment based upon literature review and stakeholder interviews. Each measure is firstly described, then the strengths and weaknesses are set out, following by the distribution of impacts, and finally the conclusion. The latter section includes a summary table that gives a view as to the nature, direction (positive or negative) and magnitude of impacts. The summary assessment is based upon both quantitative and qualitative analysis. The impact categories included are:

- GHG savings
- Material efficiency
- Recycling
- Reuse
- Economic costs
- Social impacts
- Enforceability

Symbols are used to indicate the direction and magnitude of impact, as follows:

- ↔ (No / very little overall impact or balance of impacts not determinable)
- n/a (Impact category not relevant to measure)
- ↗ (Low positive impact from baseline)
- ↗↗ (Medium positive impact from baseline)
- ↗↗↗ (High positive impact from baseline)
- ↘ (Low negative impact from baseline)
- ↘↘ (Medium negative impact from baseline)
- ↘↘↘ (High negative impact from baseline)

5.1 Requirements specific to the manufacturing and composition of packaging

The current Essential Requirements relating to the manufacturing and composition of packaging are summarised in the box below.

- "The minimum adequate amount" for safety, hygiene and consumer acceptance.
- "Produced and commercialised in such a way as to permit its reuse or recovery".
- Manufactured to minimise "the presence of noxious and other hazardous substances".

The proposed measures for reinforcing these Essential Requirements are discussed below.

All packaging shall be reusable or recyclable as defined through the measures under the requirements specific to the reusable / recyclable nature of packaging.

The overarching requirement for all packaging (i.e. of all materials, irrespective of the material, or combination of materials, they are made of) to be reusable or recyclable removes the option for energy recovery as a route to comply with the Essential Requirements and means the Essential Requirements are focused on the top three tiers of the waste hierarchy.

This means that paragraph 3(b) (relating to packaging recoverable in the form of energy recovery) would be omitted from the reinforced Essential Requirements. This is intended to improve the environmental impact of packaging waste management by ensuring it is designed to be recycled or reused, rather than incinerated, and reflects the current view of the waste hierarchy in Directives amended since the Requirements were developed.

This also means that paragraph 3(a) – relating to packaging that is recoverable in the form of material recycling – would need to be amended, in part to reflect the new definition of recyclable (discussed in more detail in section 5.3) but also remove the reference to only "a certain percentage by weight of the materials" being suitable for recycling. Under the reinforced Essential Requirements, all of the packaging – not only an unspecified percentage of some packaging – would need to be recyclable.

Strengths & Weaknesses

This brings the Essential Requirements into line with other EU waste policies (with the waste hierarchy placing recycling above energy recovery and the more recent removal of recovery targets). By requiring design for recyclability rather than recovery, this clarification also supports the attainment of recycling targets.

It is recognised that a proportion of packaging is still likely, in reality, to be incinerated. Removing the guidance on energy recovery further eliminates the need for a requirement on minimum calorific values, neither of which are likely to significantly affect the extent to which packaging is suitable for energy recovery.

On the other hand, the measure may be interpreted as qualifying the priority status of waste prevention in the waste hierarchy. However, this is considered a necessary step to reduce the amount of waste that is only suitable for residual disposal or energy recovery (and which cannot, in practical terms, be recycled), which undermines the circular economy. The change will also be needed to support the attainment of recycling targets, especially if these are further increased in the future. By requiring all packaging to be completely recyclable, the Essential Requirements will be better placed to support the EU's transition to a circular economy.

Distribution of Impacts

The measure could potentially have a significant impact on producers using packaging that is only suitable currently for energy recovery. However, this will largely be certain types of plastic packaging, which will in any event need to be re-designed to be reusable or recyclable in a cost-effective manner by 2030, in accordance with the Plastics Strategy. For plastic packaging, therefore, removing the option for energy recovery brings the Essential Requirements into line with existing EU policy and producers of packaging that is not currently widely recycled have indicated that they are already working on refining the designs so that it is recyclable.

Composite packaging could also be affected by this revision so investment may be needed to redesign this packaging and/ or to invest in collection and recycling processes so that more packaging meets the criteria for recyclability.

Manufacturers of flexible packaging are already developing more recyclable solutions and, based on their experience, a compliance deadline for 2030 will allow sufficient time to replace non-recyclable designs with recyclable alternatives. One manufacturer reported that their recyclable packaging had been in development for at least three years; this indicates that 2030 would be an appropriate timescale to agree and amend the Essential Requirements, to allow designers to develop packaging solutions that comply with the new definition of recyclable, to test the packaging's suitability (for instance, food packaging would need to be assessed for compliance with food contact legislation[126] and for the impact on shelf-life) and to actually replace the existing packaging on the market. Challenges still remain, however, to achieving recycling 'at scale' of food contact films, particularly PE, as current EFSA rules do not allow the material to be recycled into food grade applications.

To understand the likely nature of the impacts from this measure a range of LCA based case studies were carried out. These are presented in detail in Appendix G. Case studies were selected based upon several key packaging formats that are not well recycled today, and therefore likely to be defined as unrecyclable according to the proposed definitions (see Section 5.3).

LCA case study 1 (see A.1.0), concluded that mono-material flexible packaging performs better than multi-material alternatives in all of the studied environmental impact categories (except for land use, but this depends on assumptions about the current energy mix that would be replaced by energy recovered from packaging waste and, once the categories are weighted, the absolute impact value for land use is negligible). Significantly, the LCA found that replacing flexible packaging with a more recyclable alternative could reduce greenhouse gas emissions by 71%. When considering all the flexible pouches placed on the market across the EU, it is estimated that this could save 1.82 Mt of greenhouse gas emissions. While there would be R&D costs for producers in order to realise this benefit, industry has indicated that, generally, new equipment would not be needed to manufacture the new packaging formats. While the production of mono-material packaging is currently associated with higher costs, the cost differential is likely to reduce if the Essential Requirements lead to an increased demand for mono-material packaging, which would consequently support economies of scale in production. Another LCA case study 5 (see G.2.5) found that multilayer food wrappers could be replaced with mono-material food wrappers to deliver benefits in all impact categories (except for water use) at no additional cost.

Regarding flexible packaging in general, it was highlighted by some stakeholders during the workshops that a switch from lightweight unrecyclable packaging may increase carbon emissions, if replaced with heavier glass or metal containers. As long as there are lightweight alternatives available, as indicated by the case study, the switches might not necessarily have such implications given that cost factors will still be influencing a company's purchasing decisions. As long as the flexible alternatives are not significantly more expensive, the outcome

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[126] https://ec.europa.eu/food/safety/chemical_safety/food_contact_materials/legislation_en

might instead involve a switch to lightweight and recyclable alternatives, which, as pointed out above, could in fact save carbon emissions.

In LCA case study 2, the LCA investigations (see Appendix G.2.2) indicated that for carbon black packaging that cannot be detected by NIR, the pigment could be replaced to make black plastic easier to recycle and, consequently, lead to a potential 40% reduction in greenhouse gases. If the estimated 60kt of all black plastic packaging in the UK alone used a pigment that allowed the packaging to be more easily recycled, it is estimated that this could save nearly 115kt of CO_2eq. Emissions savings are likely to be multifold if translated the whole of the EU. The new pigment costs are higher than conventional black carbon pigment, but the extent of the differential may depend on the volumes required.

Similarly, LCA case study 3 (see LCA in Appendix G.2.3) found that moulded pulp fibre packaging performs better than EPS on all environmental impact categories studied, with the exception of land use and non-cancerous human health[127] impact indicators (which is due to the avoided electricity and heat production if it is assumed that the EPS in incinerated, but the impact depends on the assumptions about the current mix of the energy supply).

Likewise, LCA case study 4 found that if LDPE stretch wrap is used instead of PVC stretch wrap (which is more difficult to recycle), the LDPE performs better environmentally on most impact categories, particularly in terms of climate change and water usage. The production and logistics costs were found to be broadly similar (see LCA in Appendix G.2.4).

Companies such as Mars, Mondelez, Coca Cola and Colgate-Palmolive have already committed to making all of their packaging recyclable by 2025.[128] This demonstrates that some brands already consider the measure to be feasible but producers of other types of packaging and SMEs may need slightly longer to adapt their packaging lines than some of the larger multi-nationals.

The revision to the Essential Requirements – with the result that packaging designed for energy recovery is instead designed to be recyclable – is not expected to have a significant impact on retailers. Indeed, some retailers might welcome the measure as they may be the ones most often subject to critical comment from consumers regarding the nature of the packaging they use. For consumers, the change will provide more clarity when sorting their waste, as it can currently be difficult to distinguish between packaging that is suitable for recycling and packaging which, at present, and in their area, is not.

For waste collectors and processors, it should reduce the risk of non-recyclable plastic contaminating their waste streams. The measure does not prevent packaging from being sent for energy recovery but, if more packaging can be cost-effectively recycled, energy recovery facilities may find that some packaging waste they currently receive is instead diverted for

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[127] Examples of non-cancer health impacts in environmental LCA include dementia, cataract, ischaemic heart disease, cerebrovascular heart disease, chronic obstructive pulmonary disease, asthma, liver cirrhosis, nephritis and nephrosis, anencephaly, congenital heart anomalies, spina bifida. The main non-cancerous human health impact of this process comes from the waste of wood ash which is spread over agricultural land as manure. The emission of zinc to soil is largely contributing to non-cancerous human health impact.

[128] https://www.aim.be/wp-content/themes/aim/pdfs/AIM-Brands-Eco-Design_for-website-1.pdf

recycling. Consequently, there should be a shift in the distribution of costs, and investment, away from residual waste management, and towards recycling.

Conclusion

Amending the Essential Requirements to mandate that all packaging must be reusable or recyclable is considered a necessary step to support the circular economy and bring the Essential Requirements into line with changes that have been made to EU law.

The change will require some adaptations from producers and may entail some investment costs, however the available evidence indicates that the costs would not be prohibitive – especially as companies are already taking measures to phase out packaging that is clearly non-recyclable, and to develop new technologies that can recycle packaging which is not generally recycled today. The LCAs also indicate that the potential environmental benefits of the measure – in terms of climate impact and resource depletion particularly – could justify any increase in costs. Finally, the upcoming guidance on the modulation of fees under extended producer responsibility schemes for packaging is likely to reward the use of packaging that is more recyclable.

To be operational and enforceable, the measure relies on a clear definition of the terms “reusable” and “recyclable”, which are discussed below in Section 5.3.

Table 5-1 Summary

Impact category	Summary	Summary description
GHG savings	↗↗	Whilst the scope of products covered in the LCA case studies is not significant, of those undertaken all showed carbon reduction benefits.
Material efficiency	↔	No clear trend on material usage in packaging. Some case studies indicated a potential slight reduction in weight of packaging used whilst others showed an increase.
Recycling	↗↗↗	The measure would have a significant effect on increasing recycling due to unrecyclable packaging being ruled out of the market, including reducing contamination at recycling plants.
Reuse	n/a	
Economic costs	↘	There will be some financial costs for R&D, upgrading of recycling plants, alternations / new production equipment, but this initial assessment suggested they would not be highly significant.
Social impacts	↗↗	Consumers will benefit from increased recyclability of packaging as disamenity from not being able to recycle a given pack is removed.

Enforceability	↔	Depends on enforcement mechanism used (see below).

5.1.1 The Efficient Use of Packaging

The current Essential Requirements require "the packaging volume and weight be limited to the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and for the consumer." This is intended to support waste prevention by reduction at source, in accordance with the top tier of the waste hierarchy.

While the objective is relatively clear, the implementation of this requirement has proved more challenging because of its vague and subjective wording. There is little guidance for producers, fillers and regulators as to what constitutes the "minimum adequate amount" and the evaluation of the Essential Requirements concluded that the inherent subjectivity inhibits compliance and enforcement. Moreover, the supporting CEN Standard includes a long list of critical areas that would prevent further reductions in the packaging volume and/ or weight. Critically, this list includes the catch-all "other issues", which further limits meaningful implementation and enforcement of the requirement for source reduction. There is also some packaging placed on the market currently that is, generally, believed to exceed the minimum required for no obvious reason. Measures are, therefore, needed to reinforce this requirement and to promote waste prevention.

Over-Packaging

"Over-packaging" can be a subjective term and suggested examples of "over-packaging", "excessive packaging" or "over-engineered packaging" are often disputed by those who cite the critical functionality of packaging and the over-riding need to protect the product. During the course of this study, a small number of industry representatives questioned whether there is any over-packaging – given that cost considerations would be expected to drive reductions – and emphasised the environmental impact of product waste is greater than the environmental impact of packaging waste. However, the majority of stakeholders interviewed did agree – while commenting that "over-packaging" is difficult to define – that there are instances where packaging goes beyond what is necessary to protect the product. A comparison of some similar products available in shops also indicates that brands use very different amounts of packaging for the same type of product. There are also numerous examples on social media of consumers contacting companies to raise a question or complaint about what they perceive to be excessive packaging. Suggested examples from interviewed stakeholders included:

- E-commerce packaging
- Perfume packaging, particularly for premium brands (although others suggested that the packaging is part of the consumer experience)
- Toys
- Toothpaste
- Multi-packs (for unspecified products)
- Laundry detergents and cleaning products
- Men's shirts (which contrast to the more limited packaging for women's shirts)
- Sweets and biscuits (which may come individually wrapped inside larger packs to support 'on-the-go' consumption)

- Single serving packs, such as sachets
- Wrapped fruit and vegetables, especially those sourced domestically (although some stakeholders highlight the food waste prevention effects of such wrappings)
- Packaging with multiple, separate layers (e.g. a plastic tray wrapped in plastic film inside a cardboard box)
- Combinations of primary, secondary and tertiary packaging when considered all together
- Any packaging that is intended to serve as a marketing or promotional tool (although this is arguably permitted under the current Essential Requirements)
- Packaging to support on-the-go consumption

No specific examples, however, were provided and there was no general agreement on what does, and what does not, constitute over-packaging.

Zero Waste Europe offers the example of small items like USB sticks that come in packaging that can be more than 10 times larger than the actual product. Such a discrepancy in sizes would seem to draw into doubt whether the amount of packaging is necessary for product protection or, for instance, as an anti-theft device. In terms of anti-theft approaches, alternative approaches used by some retailers (particularly for high-value but small products) is to display on the shelves pieces of reusable card with a picture of the product, while the product itself is stored behind the counter. Zero Waste Europe also cite “Russian Doll” packaging used in e-commerce, whereby multiple boxes with fillers are used to ship one product.[129]

While packaging can have a role in product protection and extending the shelf-life of food to avoid food waste, particularly for fresh meat and vegetables, an IEEP report found that “plastic packaging is often heralded as a means of avoiding food waste but it has not provided a comprehensive solution. Growth in the application of plastic packaging has increased alongside the growth in food waste”.[130] Friends of the Earth has suggested that retailers should “re-think whether their long shelf-life requirements are creating the demand for non-recyclable packaging” and consider whether a shorter shelf-life for snacks like potato crisps would be acceptable.[131] This example of designing packaging to extend the shelf-life of products indicates that packaging could be classed as minimal in terms of weight but may still be considered “over-engineered” if the packaging is designed to achieve more than is strictly necessary. In the case of crisps packets, for example, it is not clear whether or not the longer shelf life offered by multilayer packaging options (compared to monolayer ones) is desirable, given that the resulting packaging is also more difficult to recycle – further research into such trade-offs in specific applications is required. During the stakeholder interviews, some agreed

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[129] *Wrapping your head around overpackaging - and taking action - Zero Waste Europe*, accessed 3 October 2019, https://zerowasteeurope.eu/2018/03/wrapping-your-head-around-overpackaging-and-taking-action/

[130] J.-P. Schweitzer, S. Gionfra, M. Pantzar, D. Mottershead, E. Watkins, F. Petsinaris, P. ten Brink, E. Ptak, C. Lacey and C. Janssens (2018) *Unwrapped: How throwaway plastic is failing to solve Europe’s food waste problem (and what we need to do instead)*. Institute for European Environmental Policy (IEEP), Brussels. A study by Zero Waste Europe and Friends of the Earth Europe for the Rethink Plastic Alliance. Accessed 19 December 2019 https://www.foeeurope.org/sites/default/files/materials_and_waste/2018/unwrapped_-_throwaway_plastic_failing_to_solve_europes_food_waste_problem.pdf

[131] *Turning a Walkers crisp packet into a bench is a start | Friends of the Earth*, accessed 3 October 2019, https://friendsoftheearth.uk/plastics/walkers-crisp-packet

that shorter “best before” dates or “use by” dates would not necessarily prove problematic, given that some food products have very long shelf-lives that could reasonably be reduced.

Supermarket chain Tesco appears to explicitly acknowledge that there can be instances of “excessive” packaging, having launched in August 2019 a “Remove, Reduce, Reuse and Recycle” plan and “committed to removing excess packaging”.[132] Similarly, Greenpeace examined companies’ commitments relating to packaging and points out that “at least three companies have mentioned that they will be committed to ‘take action to eliminate problematic or unnecessary plastic packaging by 2025’”. The evidence from retailers and producers, therefore, indicates that they themselves recognise that that the volume and/ or weight of packaging is not always “limited to the minimum adequate amount”. While the pledges indicate that companies are taking action to address this, the commitments are also a sign of the difficulties in complying with the current Essential Requirements to date and, arguably, the challenges packaging fillers have faced in determining what constitutes the “minimum adequate amount” for “safety, hygiene and acceptance” and consumers.

The proposed measures to promote the efficient use of packaging and support compliance are considered below, and include:

› Subject to the requirement to be reusable or recyclable, the packaging would then need to be designed to be the minimum volume and weight necessary;
› Amend EN 13428 to refine the critical areas that limit further reductions in the volume or weight of packaging and amend Annex II to make the use of the Standard compulsory, or include the relevant content in the Annex if it is not possible to mandate the use of Standards;
› Producers to report to central registry on the volume, weight and planar area[133] ratios of packaging to product if, for either one of these three measures, the packaging exceeds a specified threshold percentage of the product;
› All fillers to report to central registry on the volume, weight and planar area ratios of packaging to product & the Commission to review in three years the need for threshold ratios which must be met by all packages (by type);
› Packaging must not exceed any of a set of threshold ratios of packaging to product established in terms of volume, weight and surface area; and
› Define limits on the amount of sealed air in e-commerce packaging.

Measures

In addition to the requirement to be reusable or recyclable, the packaging shall be designed not to exceed the minimum volume and weight necessary for the functionality under critical areas to be met.

While there has been a move towards lighter-weight packaging, there has also been an increase in the amount of packaging that is not widely recycled. Producers have often faced a choice between reducing the weight of packaging and choosing a packaging format that is

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[132] *Tesco launches phase two of Remove, Reduce, Reuse & Recycle plan to suppliers*, accessed 4 October 2019, /news/2019/phase-two-remove-reduce-reuse-recycle/
[133] The surface area of irregular shaped products and/or packaging might be difficult to calculate. The planar surface area is the surface area as projected onto a plane. This should be more straightforward to calculate.

more likely to be recycled, but the current Essential Requirements offer no guidance to help inform this decision. Equally, reusable packaging often needs to be heavier than single-use packaging to make it more durable, but it is debatable whether this is sufficiently acknowledged by the current Essential Requirements. Consequently, this measure is intended to recognise that the minimum weight is likely to be greater if packaging is designed to be reused.

In addition, it is important to point out that the minimum weight has to be seen in the context of functionality under certain critical areas. These are discussed in the following measure. The context for the assessment is also the whole packaging system, including transportation and logistics. For example, some irregular shaped packaging might also be packed in a cardboard box to allow for efficient distribution in the supply chain. All these issues should be considered for an adequate assessment to be made.

By itself, the measure will not have a significant impact and it needs to be considered in conjunction with the requirement above for all packaging to be reusable or recyclable. The main objective is to ensure that packaging that has been defined as recyclable (see Section 5.3) is designed such that its weight is minimised within this context.

Strengths & Weaknesses

The key strength of this measure is that it provides flexibility to packaging designers to optimise their design decisions related to light-weighting, within the context of being recyclable. This measure also removes the lack of clarity over what would constitute “a certain percentage by weight”.

However, the measure does not provide any further clarity on how to determine what is the “minimum” “necessary”. As a result, it is still a subjective assessment of whether the packaging has been minimised, leaving scope for competing producers, for consumers and for regulatory authorities to make conflicting judgements.

Distribution of Impacts

This measure is not considered to be too restrictive for packaging designers and fillers or to place onerous requirements on SMEs, as it does not go beyond what is required currently. There may be some R&D costs for producers using packaging that is not currently suitable for reuse or recycling, so the impact would need to be considered in conjunction with the requirement for packaging to be reusable or recyclable.

The measure is not expected to have any impact on retailers. For waste collectors and municipalities that incur the costs of residual waste treatment, the measure is intended to avoid light-weighted packaging that is not cost effective to recycle and is not currently collected for recycling, although the current costs of landfilling are, generally, lower in the EU than the costs of recycling.

Conclusion

The weakness of this approach is that it does not offer any metrics or guidance to determine what is the “minimum necessary” volume or weight. Consequently, this is still open to interpretation and leaves a degree of ambiguity for producers, consumers and enforcement bodies. As such, this amendment to the Essential Requirements is the basic minimum change to clause 1 of Annex II, but additional measures would strengthen the requirement for the efficient use of packaging. However, the addition of such wording does provide industry with a useful indication of the policy's direction with relation to prevention of packaging waste. There is therefore sufficient justification to take this measure forward to the impact assessment phase, and it would apply to all packaging formats, regardless of the material or product.

Table 5-2 Summary

Impact category	Summary	Summary description
GHG savings	↗	Not quantitatively assessed but ensuring efficient use of packaging would lower carbon emissions.
Material efficiency	↗	Some potential reduction in material use, but the clause alone is unlikely to lead to significant design changes.
Recycling	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Reuse	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Economic costs	↘	There will be some financial costs for R&D but other costs are not expected to be significant.
Social impacts	↔	No clear social impacts.
Enforceability	↘↘	High level statements are not considered to be very enforceable due to the ability to interpret in different ways and no clear indicators / criteria for judging the packaging against the requirement.

Amend EN 13428 to refine the critical areas that limit further reductions in the volume or weight of packaging and amend Annex II to make the use of the Standard compulsory, or include the relevant content in the Annex if it is not possible to mandate the use of Standards.

EN 13428, relating to prevention by source reduction, is intended to assist producers in interpreting, and demonstrating compliance with, the requirement for packaging to be the “minimum adequate amount”. The review, however, indicated that the Standard does not provide the necessary degree of clarity and a number of “critical areas” limit the ambition of what can be achieved. The current inclusion of consumer acceptance, marketing, logistics operations and the manufacturing and filling processes as “critical areas” allows that these considerations take priority over the packaging's environmental impact. The provisions arguably do not reflect the apparent increase in consumer awareness of packaging waste, the other marketing and promotional tools at companies' disposal and the potential to adjust processes and operations along the supply chain.

An option, therefore, is to reduce the scope of the critical areas. Stakeholders consulted as part of this study generally agreed that product protection, hygiene and safety are fundamental considerations in packaging design. Many products also have mandatory labelling requirements (such as nutritional values for food products), which could affect the minimum surface area required.

In addition, there are potential useful functions of packaging design that would support recyclability. For example, peelable or removable labels or liners. Some increase in weight might be desirable to ensure easy removal of components for increased recycling.

Some stakeholders proposed the inclusion of 'consumer acceptance' on the basis that this referred to the ease of use of packaging (opening, extraction of product etc). However, it would not be good commercial practice to design packaging that was not accepted by consumers, so there are already sufficient commercial drivers to warrant exclusion of this from the list of critical areas.

The critical areas would, therefore, be limited to:

- Product protection;
- Hygiene;
- Safety;
- Legally required information; and
- Recyclability functions.

Strengths & Weaknesses

Restricting the critical areas to product protection, hygiene, safety and recyclability functions would prioritise the core function of the packaging. It does not impose strict restrictions on producers but allows a degree of latitude for designers to determine what is necessary. While the measure removes the catch-all option of "other issues", and subjective, loosely-defined concepts such as "consumer acceptance", what is needed to protect the product is still potentially open to differing interpretations. The Standard may, therefore, need to include additional guidance on this, particularly to address potential "over-engineering of packaging". In relation to the discussion above on "over-packaging", for instance, the measure leaves open the question of whether the packaging is needed to protect the product for a shelf-life of six months or two months.

Including legally-required information in the criteria recognises that there are some aspects to the packaging that are beyond the producer's control. The concept will, however, need to be carefully defined in the Standard to prevent large logos and marketing material from being classed as "information".

The intention behind making the use of the Standard compulsory, or including the relevant content in the relevant Annex to the PPWD, is to ensure all producers are following the same procedures and guidance and to try to limit the scope for differing interpretations.

Distribution of Impacts

For consumers, the critical functions of the packaging and their need for information on the product are protected. Some consumers could, however, notice a change with products where the packaging is considered part of the "experience". It has, for instance, been suggested that the packaging is part of the consumer experience with high-end perfumes. Brands and retailers could look at additional promotional tools beyond the packaging and work together if they choose to use in store-marketing devices.

The change could reduce the amount of material to be collected at the end-of-life, so there could be some reductions in waste management costs, but these are unlikely to be substantial.

Making the Standard compulsory, if this is indeed possible, would mean a financial cost for producers to purchase the Standard, but this would be a minimal cost when considered per unit of packaging produced. Many companies will also be able to incorporate the Standard into their internal management procedures. As the Standard would be used in all Member States, this requirement could also support the smooth functioning of the internal market. Amending the Standard itself will entail some costs and businesses and Member States would need to be consulted. Alternatively, including the relevant content in the relevant Annex to the PPWD itself would save any costs associated with purchasing Standards.

Conclusion

Removing the unwarranted critical areas highlighted through this study would be a basic first step. Consequently, European Standard EN 13428 should be amended to reflect these changes. It is difficult to quantify the impact of such a change to the Standard, however it seems prudent in order to ensure the focus of the reinforced Essential Requirements is on the critical functionality of the packaging and its environmental impact. The measure by itself may not, however, be enough to have a significant effect on packaging design.

Table 5-3 Summary

Impact category	Summary	Summary description
GHG savings	↗	Not quantitatively assessed but ensuring efficient use of packaging would lower carbon emissions.
Material efficiency	↗↗	Some potential reduction in material use, more so than the previous measure, but unlikely to be significant.
Recycling	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Reuse	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Economic costs	↘	There will be some financial costs for R&D and potentially the costs of purchasing the standard but other costs are not expected to be significant.
Social impacts	↘	Potentially minor impacts for consumers if recyclability is prioritised over consumer experience / branding.
Enforceability	↘	Critical areas are not considered to be very enforceable due to the ability to interpret in different ways and no clear

		indicators / criteria for judging the packaging against the requirement. They are, however, slightly more precise than the high level statement in the measure above.

Producers to report to central registry on the volume, weight and planar area ratios of packaging to product if, for either one of these three measures, the packaging exceeds a specified threshold percentage of the product.

Such a requirement does not impose any restrictions on the packaging design, but simply requires producers to record the ratio of packaging to product if such a ratio is over a threshold level. The central registry could be at national or European level.

Weight, volume and surface area have been chosen because the assessment of over-packaging will vary between product types and between packaging materials. Volume would consider over-sized boxes and multiple layers of packaging for a single product. Surface-area is included because of products that are packaged in blister packs with, for instance, a cardboard backing – the size of the cardboard would not be reflected in the volume ratio but would be reflected in a surface area ratio. The surface area of more complex shapes of either product of packaging might be challenging to calculate. Therefore, it is suggested to take the maximum 2D area on any plane for the ratio. Hence the term ‘planar area ratio’. In essence, this would be calculated by projecting the maximum area of the product and packaging onto a 2D plane and comparing the values to create the ratio.

The weight ratio would to a large extent depend on the material chosen. For instance, a glass bottle would have a much higher packaging weight to product weight ratio than a plastic bottle, but that does not mean the glass bottle represents over-packaging. Similarly, particularly heavy products would provide a low ratio simply because of the nature of the product, so the weight ratio is not necessarily as useful an indicator. However, it may be required in certain cases. Weight could be used when the volume and/or area ratios are difficult to calculate i.e. when the product or packaging is not a uniform shape. In addition, the 2D area ratio would not take into account the thickness of the cardboard, so weight would also be needed in this case.

The measure would apply to all packaging (of all materials and for all products) where there is a defined product:packaging combination. Packaging for application by the user (e.g. e-commerce delivery, food service packaging, parcel paper etc.) could not be attributed to a particular product at the point at which the packaging is placed on the market (PoM). Therefore, ratios could not be reported in that case. In addition, packaging for some liquid products e.g. water bottles, could be exempted from the requirement to report on volume and planar area ratios as these would be similar. It may be preferable for the weight threshold to be material specific to avoid the Essential Requirements indicating a preference for one material over another.

A threshold – under which fillers would not need to register their packaging – has been incorporated into the measure in part to avoid unnecessary data being recorded but, more significantly, to provide an incentive for producers to reduce the amount of packaging they use if they are under any of these thresholds. Currently, there are no sufficient datasets with packaging and products parameters (e.g. weight, volume, area) available to calculate the ratios, and suggest what the threshold levels might be. An analysis of the packaging market would need to be carried out and statistical data obtained, something beyond the scope of this study.

Strengths & Weaknesses

This measure does not impose any restrictions on what packaging cannot be placed on the market (providing it is registered), or a maximum ratio. Nor does it address potential over-engineered packaging. There are, however, challenges in setting and enforcing a maximum ratio (discussed below), which mean that requiring fillers to report on ratios only is likely to be a more practical solution.

In the short-term, requiring fillers to report on ratios would firstly have the advantage of ensuring that these factors are considered in the design phase (wherever they are not already doing so) and encouraging fillers to review whether the ratio could be reduced. As this measure would mean there is an additional administrative cost associated with placing packaging above the threshold on the market (i.e. having to register the weight/ volume and/or surface area ratios of their packaging) it may also encourage producers to consider reducing the ratio below the threshold if the effort associated with measuring and reporting the existing above-threshold ratio is greater than adjusting the design of the packaging. This measure could, therefore, have a tangible impact.

Secondly, the inclusion of a threshold would minimise the reporting burden for those companies using packaging that had already been minimised to a large extent and variation across the packaging format was low (e.g. PET bottles). Such a threshold would, however, require additional checks from enforcement agencies (see Section 5.6 on enforcement measures).

Distribution of Impacts

Reporting entails administrative costs for fillers that are likely to be proportionally higher for SMEs. Generally, however, the administrative costs are not thought to be significant – many fillers are already documenting the same or similar information internally and they have some existing reporting requirements under EPR arrangements (e.g. PoM). See Section 5.6 on enforcement measures for further information on the nature of the impacts from reporting the ratios to a compliance body.

There would also be some impact on packaging producers, in addition to the fillers (who ultimately place products on the market). This is in lieu of the need for them to provide packaging data to the fillers to enable them to complete the registry. In most cases, this impact is not likely to be significant as packaging producers already have access to some of the necessary data regarding specification of their packaging items, and are in a good position to gather additional data in this respect.

Maintaining a packaging register to which the ratios would be reported would incur costs for the European Commission and/ or Member States, which might be passed on to fillers if they were required to pay a registration fee when registering each new packaging format placed on the market. However, if costs are shared between every type of packaging placed on the market, these costs should be relatively low.

There are concerns about whether packaging imported from outside the EU would be registered and there is a question of who would be responsible for registering the packaging –

for instance the website on which the product is sold or the company dispatching the product. As these are similarly ongoing challenges with EPR and tax requirements, they should not be considered an obstacle specific to the Essential Requirements.

For consumers, it is possible that any registration fees would be incorporated into the retail price, but the same is true of EPR fees, for instance. The measure may also improve access to information for any consumers concerned about packaging waste, as some producers may choose to report publicly on their ratios and, even if this is not the case, consumers could contact fillers to ask for the information, as they will know that fillers do have it.

The measure is not expected to affect retailers (unless there is any obligation on them to check that packaging they sell is registered), or to have any direct impacts on waste collectors.

Conclusion

The measure is not, by itself, likely to have a significant and immediate environmental impact, but it would have some benefit by ensuring packaging fillers actively consider their ratios, which may lead to some design changes at the margin. It would be important to set the threshold at an appropriate level to provide a realistic incentive to reduce ratios. The benefit of a reporting threshold approach is that the threshold could be set lower than a threshold used to restrict certain packaging from the market (see below). The costs of the measures are not considered to be high – especially in the context of a packaging register being setup. As discussed below, however, the measure could be amended slightly to enhance its impact.

Table 5-4 Summary

Impact category	Summary	Summary description
GHG savings	↗	Not quantitatively assessed but ensuring efficient use of packaging would lower carbon emissions.
Material efficiency	↗	Some potential reduction in material use, but unlikely to be significant.
Recycling	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Reuse	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Economic costs	↘↘	There will be some financial costs for checking the ratios to firstly see whether they are above or below the thresholds, submitting such information to a registry and the operation of the registry.
Social impacts	↔	No clear social impacts.

Enforceability	↗↗	Relatively high degree of enforceability as the metrics are measurable, however, some measurements require some efforts to record.

All fillers to report to central registry on the volume, weight and planar area ratios of packaging to product & the Commission to review in three years the need for threshold ratios which must be met by all packages (by type).

This measure is similar to the one above apart from in two significant respects. Firstly, the threshold is removed so that all packaging fillers would have to report the product:packaging ratios. Secondly, this will enable the Commission to monitor packaging to product ratios**,** and trends over time, and to compare different packaging designs that serve the same purpose. The reporting allows for a form of benchmarking of best practice, and could help to stimulate resource efficient designs.

The measure provides data on current ratios and, over a number of years, any trends in terms of increases or decreases in the market, average ratios and any outliers. This would allow the European Commission to review whether there have been any improvements or whether additional interventions are justified. It is important that all packaging is registered – even those with the lowest thresholds – because these will help to indicate what is possible. The measure accordingly supports an evidence-based approach in the future and means that packaging is benchmarked against similar packaging, rather than against a limit set by an external regulator.

This measure is, therefore, considered appropriate to take forward in any potential future impact assessment. It has the added advantage of potentially encouraging fillers to take voluntary action now, if they know they can avoid the introduction of further regulatory measures by reducing their ratios as far as possible.

If the Commission subsequently decided to set ratios (either for all packaging or for specific types of packaging), the packaging register would provide the necessary evidence to determine an appropriate limit, or limits, based on the market minimum and averages. While there are no guarantees that the recorded ratios will indicate the appropriate maximum (as there is an implicit presumption that some packaging will be based on the minimum necessary for recovery only, which might be too light to enable full recycling), this does not appear to be a significant risk, especially given the size of the market for which data will be available and the measure does not preclude further investigations into the data recorded and the reasons for the current ratios.

Packaging must not exceed any of a set of threshold ratios of packaging to product established in terms of volume, weight and surface area.

As a more stringent measure than the one above, this would provide a quantifiable metric to remove the degree of subjectivity that undermines the existing approach to incentivising waste prevention in the Essential Requirements. This provides a means of defining and assessing unnecessary packaging and ensuring that the size of the packaging corresponds to the size of the product.

As discussed with the packaging registry measure above, ratios would be needed for weight, volume and planar area. The limits would need to be material specific to avoid deterring the use of glass or setting the threshold at such a high level as to be irrelevant for other materials. A glass beverage bottle, for instance, would have a very different weight to a plastic or metal container for the same volume. It should also be considered that some products may have different requirements – for instance chemicals may require thicker packaging for safety reasons. This would suggest that a weight-based ratio was needed for each type of both product and material.

Given that the Essential Requirements are intended to be the requirements with which all packaging must comply, any product specific ratios would need to be included in separate, product specific parts of Annex II of the PPWD, a separate annex or separate product specific legislation.

Strengths & Weaknesses

This provides absolute clarity on what would constitute unnecessary packaging under the Essential Requirements, reducing the likelihood of differing interpretations, both between competing producers/fillers and between producers/ fillers and regulators. It also supports the internal market because the ratio would be the same across all Member States. This consequently has the potential to support a level playing field between competing fillers, as they will all have the same ratio to meet so one cannot gain an unfair advantage with larger packaging to use for marketing purposes or to secure more shelf-space. Ratios could also support more efficient transport operations by identifying to fillers where further reductions in the volume or weight of packaging are possible.

Some stakeholders supported the introduction of a ratio for all types of packaging, observing that exemptions could be allowed for specific high-value products that require a greater degree of product protection (if reusable packaging is not an option). Others, however, expressed a view that the diversity of packaging means it would be too complex to set and assess an appropriate ratio for all packaging types. There is a question over how practical it is to set a suitable ratio, or specify a suitable algorithm, that could be applied to all packaging and adequately reflects the different vulnerabilities of products to breakage, light, air or moisture, or the safety and hygiene risks.

While e-commerce packaging was mentioned by several interviewees for this study, as being an area suitable for applying ratios, there was otherwise little consensus as to which types of packaging would, and would not, be suitable for ratios. Nor was there common agreement on whether ratios offer an appropriate way forward.

It is not considered feasible, for reasons of administrative cost, to set a specific ratio for every functional unit of packaging placed on the market, given the scale of the task this would represent for the European Commission and/ or for Member States to set and monitor. A more practical option, therefore, would be to set a ratio for selected packaging formats or products only. Some stakeholders, for instance, suggested that a ratio may be more appropriate for lower volume or value (i.e. relative to the product) packaging, where cost considerations are less likely to limit the amount of packaging used. However, it can be argued that packaging with a higher value (relative to the product) is only likely to be used when the packaging plays an integral role in the sale of the product (thereby justifying its higher value). Such packaging could be more likely to be overpackaged/ inefficient due to its role in marketing the product, and should therefore potentially be prioritised for this measure. Others commented that transport and business to business packaging could be considered for ratios.

There is, however, currently little evidence to indicate what packaging or product types would benefit from a ratio, or what an appropriate maximum would be. In order for a ratio limit to have meaningful impact, considerable research would be required to set the ratio at an appropriate level (e.g. at the level of granularity of a glass bottle) and to monitor compliance.

A ratio does not necessarily take into account the functionality of the packaging or reflect its overall environmental impact. It has also been argued that packaging designers and fillers are best placed to consider what amount of packaging is needed and to consider the benefits a certain packaging format provides along the supply chain. It is also possible that there could be ways around the ratio, which would limit any potential impact – for instance a weight ratio for plastic could potentially be achieved by switching to a lower density polymer.

Distribution of Impacts

This measure would require fillers to measure the ratios of their packaging and products, implying an administrative commitment. This does not, however, seem to require much work beyond what many companies are already doing, or what information packaging designers would already hold. A ratio would also require close cooperation between packaging designers and fillers to ensure that the packaging design process takes into account the volume and/ or weight of the product to be packaged. Such consultation and co-operation would, however, be likely to be needed regardless of the Essential Requirements. In the case of packaging that does not comply with any ratio, there would be additional research and development and manufacturing costs to ensure the packaging complies with the ratio.

It may also be more difficult for SMEs to tailor their packaging to meet specific ratios if they do not have bespoke packaging for their particular products. Fillers who, for instance, have a range of standard boxes to choose from would need to check whether those standard sizes will comply with the ratios for all packaging. Optimisation software and manufacturing machinery are available to help tailor boxes to size specifications. Although these entail capital costs, the ratio would reduce raw materials costs for packaging that currently exceeds a potential ratio.

For retailers, it is possible that ratios would allow them to plan more for how much space they will need in store rooms or on shelves and could avoid their staff having to handle unnecessarily bulky packaging, with the staff time this could entail. Where retailers incur the costs of disposing of secondary and tertiary packaging, any reductions in the volume or weight of packaging could reduce their waste collection costs if, for instance, fewer collections are needed.

The ratios of product:packaging need careful consideration in relation to food packaging, and the trade-off between packaging to extend shelf and over-engineered packaging. Anecdotal evidence from stakeholders suggests that a large proportion of plastic food tray packaging, for example, is being over specified by retailers based upon a cautious approach. If food packaging with multiple, separate, parts (e.g. a film-wrapped product in plastic tray contained within a cardboard box) does not meet the requirements for the volume of packaging, it is possible that shelf-lives would reduce if one or more parts had to be removed in order to comply with a ratio. Shorter shelf lives could require adjustments from distribution networks and retailers. This would need to be examined in more detail in any future impact assessment of such measure and indicates the importance of setting the limits at the appropriate level.

For consumers concerned about over-packaging, they may be able to measure whether the packaging complies with the Essential Requirements using the ratios and thresholds, and report the packaging to the appropriate authorities or submit a complaint to the company.

Considering the entire life-cycle of the packaging, the end-of-life treatment costs are not likely to reduce significantly. However, this measure seems more likely to target low-value materials and low-volume products. Packaging using high-value materials is more likely to be minimised currently due to cost considerations, so it seems unlikely that the measure will significantly reduce the use of high-value materials that waste processors currently collect for recycling.

Conclusion

It does not currently seem feasible to either set one generic ratio or a number of different ratios for specific product or packaging types, mainly because the evidence is not currently available to indicate whether a ratio is justified (i.e. it would have a clear beneficial impact) and at what level any ratios would be set, or for which types of packaging. The measure also starts with a presupposition that there is packaging to be measured, but the product may not actually need any packaging.

On balance, therefore, the measure should only be considered as an option for the future, after first requiring producers to report on their ratios to gather appropriate evidence (through either of the two measures above 1) reporting only above a threshold set through a one off statistical survey or 2) requiring all relevant packaging ratios to be reported) – not least because this avoids the risks of setting any maximum ratio at such a high level as to be irrelevant.

Table 5-5 Summary

Impact category	Summary	Summary description
GHG savings	↗↗	Not quantitatively assessed but ensuring efficient use of packaging would lower carbon emissions.
Material efficiency	↗↗	Setting of enforceable thresholds is likely to be effective at reducing material use.
Recycling	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Reuse	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Economic costs	↘↘	There will be some financial costs for setting the ratios, submitting such information to a registry and the operation of the registry.

Social impacts	↔	No clear social impacts.
Enforceability	↗↗	Relatively high degree of enforceability as the metrics are measurable, however, some measurements require some efforts to record.

Define limits on the amount of sealed air in e-commerce packaging through secondary legislation.

A survey of e-commerce executives found that 60% of them believe that more than a quarter of their packaging is empty space and research across product categories indicates that the empty space in e-commerce packaging ranges from 18% to 64%.[134] **E-commerce packaging was also cited by many interviewees as an area that is more prone to over-packaging than any other and it is an expanding market area**, with the sector growing by 11% in Europe in 2017, and 13% in 2018.[135] One suggested approach, therefore, is to define limits on the amount of sealed air in e-commerce packaging to avoid products being shipped to consumers in over-sized boxes.

E-commerce packaging has been selected because of the potential scale of the impact if improvements are made. It is likely that such a measure would require secondary legislation, given that the Essential Requirements themselves are intended to cover the rules as to what packaging is placed on the market not how third party fillers might pack boxes in the e-commerce setting.

Strengths & Weaknesses

As with the ratio, this measure adopts a more quantified and transparent approach than the current Essential Requirements. Setting appropriate limits would require further work and consultation with the e-commerce sector.

According to the LCA case study 13 (see Appendix G), an optimised box could generate greenhouse gas emissions savings of 13% and offers an improved environmental performance (ranging from 12% to 13% for all the impact categories considered, 13% for GHGs). Although transport was not considered in the LCA, reducing the volume of air being transported could improve the efficiency of logistics operations (meaning more packages can be transported at the same time or a smaller vehicle is needed). This would depend on the load factor of the vehicle but, according to estimates from the packaging company DS Smith, there are at least four times as many touchpoints in an e-commerce supply chain than a bricks and mortar supply chain, so the potential for environmental gains to be made is greater in the e-commerce sector.

On the downside, specifying the maximum volume of air could adversely affect the decision to opt for reusable packaging as opposed to single-use options. Reusable packaging (e.g. reusing a cardboard box to send an item) is, potentially, less likely to be perfectly optimised in e-

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[134] Forbes Insights & DS Smith (2018) *The Empty Space Economy*.
[135] (2018) *Ecommerce in Europe was worth €534 billion in 2017*, accessed 22 May 2019, https://ecommercenews.eu/ecommerce-in-europe-was-worth-e534-billion-in-2017/

commerce than single use alternatives. It has also been suggested that some SMEs re-use packaging they have received – this is not strictly packaging that is designed to be reused, but which the online retailer has chosen to reuse to reduce costs. In such cases, the packaging they have available to reuse might not comply with the limits, but would have a lower environmental impact than using virgin packaging that does comply. However, a significant proportion of e-commerce packaging is used by a limited number of large companies (e.g. Amazon, ASOS etc.), and so the measure should at least aim to target the packaging used by those companies.

Such a measure would also involve enforcement complexities, given that a significant proportion of e-commerce will originate outside the EU. If the product was purchased on a multi-seller platform there can also be challenges in identifying the entity responsible for complying with any legislation. Although the same is true of the existing Essential Requirements, the imposition of stricter conditions on the e-commerce sector specifically could exacerbate the scale of the current challenges and potential for compliant producers to be placed at a disadvantage.

There is also a question of who should be brought into the regulations – private individuals selling unwanted goods via an online platform are engaged in e-commerce and could be deterred from doing so if there are legal rules on the packaging they can use. Theoretically, this could discourage people from exchanging products for reuse. In reality, such individual sellers may be exempt (and online platforms could simply have an obligation to notify them of the Essential Requirements), but it can be difficult to differentiate between an individual selling unwanted goods and an individual earning a living from e-commerce sales. This may indicate a need for a de minimis threshold.

Distribution of Impacts

There is software available to assess the optimum packaging size and machinery that can manufacture boxes to tailored sizes, which would help producers to comply with this measure. There is a financial cost associated with this, but a company interviewed in LCA case study 13 estimates that the resulting reductions in packaging ultimately generate net savings, with overall packaging cost reductions of 11-55%.[136] There are also potential savings with shipping costs, if charges are based on dimensions. While this indicates that the raw material savings outweigh the investment costs of the software, the capital costs are likely to be disproportionately higher for SMEs. The case study also identified potential reductions in the number of staff required; while this generates financial savings for the businesses concerned, there is a potential wider social cost in terms of unemployment.

It could be difficult to measure the amount of sealed air and to allocate responsibility along the supply chain, given that the volume of air will be determined at the packing stage. One idea might be to make different actors along the supply chain jointly and severally liable to encourage cooperation across different actors. However, this needs to be explored further to identify possible cases in which the distribution of impacts associated with such shared liability

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[136] This included a reduced number of box sizes (stock reduction / higher order quantities of fewer sizes/ reduced administration); reduced voidfill (reduced voidfill materials, reduced packing time); reduced box size (reduced shipping costs, reduced space in logistics) and reduced damage (there is some evidence that having less space in the box reduced the risk of damage).

is linked to the distribution of influence between packers and fillers (e.g. if fillers were liable for the packaging producers placed on the market without having any influence over these choices, the burden of liability on them would not be equitable). It might be possible to mandate the use of multi-size boxes that can be folded to the appropriate size, but this would only reduce the amount of filler needed, and not the amount of material used in the outer packaging. It would also be difficult to know exactly which companies were utilising e-commerce methods and those that were not. This could, potentially, be information that would have to be supplied to the packaging registry — see Section 5.6 on enforcement measures (e.g. indicating that the company was involved in any e-commerce activities). Another possibility might be to have a certification type approach where packers have to certify to a certain standard that ensures, on average, void space is reduced to below threshold levels – as opposed to having to assess every packed product being shipped. Certification could be subject to compliance monitoring as per ISO standards.

Unlike many of the other measures, it is likely to be (online) retailers that are responsible for complying with the measures, rather than producers or packaging designers. There could, therefore, be costs for online retailers of adjusting their packaging and ensuring they are compliant in the future, which could be a more significant task if they sell a wide range of products. Steps would also need to be taken to clarify whether ultimate responsibility rests with an online platform or the third-party sellers using the platforms.

For consumers who are currently concerned about the amount of packaging they receive and are contacting e-commerce companies to complain, the measure should mean that they have less packaging to dispose of, or have an avenue for recourse if they believe the volume of air in their package exceeds the legal limit.

As the measure should lead to more optimised packaging and slightly less material, the costs for end-of-life treatment would be slightly lower, but the case study concluded that the impact on waste management costs would not be significant considering the entire lifecycle of the packaging.

Given the level of inter-Member State trade and imports to the EU, there is a strong case for intervention at the EU-level to support the internal market for e-commerce.

Conclusion

E-commerce sales are projected to continue growing so some solution should be sought and it is recommended that this measure is taken forward should an impact assessment of possible measures be carried out in the future, as there is clearly potential for the strengths and benefits to outweigh the weaknesses. While the Essential Requirements relate to all packaging placed on the market – and do not differentiate by sector, packaging material or product – secondary legislation under the PPWD could be considered to address the wider range of issues related to e-commerce packaging. Detailed consultation is needed with the packaging and e-commerce industry to develop a holistic set of long-term solutions to include in secondary legislation. For example:

- Limits on the proportion of sealed air
- Packer behaviour
- Box optimisation tools
- Standards for testing

- Reusable alternatives
- Delivery services' pricing mechanisms

This measure, therefore, is not considered appropriate for the reinforcement of the Essential Requirements. However, labelling of e-commerce packaging to facilitate enforcement could be considered within the context of the essential requirements and is discussed in Section 5.5.2.

Table 5-6 Summary

Impact category	Summary	Summary description
GHG savings	↗↗	LCA studies suggest GHG emission savings from such a measure.
Material efficiency	↗↗	Reducing void space would use less material and a quantified threshold might be effective if enforcement could be undertaken efficiently.
Recycling	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Reuse	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Economic costs	↘	There will be some financial costs for setting the thresholds and monitoring / enforcement. There will be some costs incurred in reducing void space (design, equipment etc) but these may be countered through material and logistics savings.
Social impacts	↗	Consumer disamenity associated with unnecessary void space will be reduced.
Enforceability	↗	The threshold based approach may be more enforceable than qualitative requirements only, however, enforcing the thresholds across multiple platforms with high variation in product:packaging combinations may be a challenge.

Summary

The following summarises the various measures relating to efficient use of packaging. The first two measures are essential updates to the wording of the existing requirements. However, it is clear that to gain an increased level of impact and enforceability additional measures requiring reporting or specific thresholds of packaging:product ratios to be met must be implemented. This will, though, attract a higher economic cost. The greatest impact would be where legal thresholds on packaging:product ratios are set and enforced.

Table 5-7 Summary

Measures / Impact category	…packaging shall be designed not to exceed the minimum volume and weight necessary for the functionality under critical areas to be met.	Amend EN 13428 to refine the critical areas	Producers to report to central registry ratios if the packaging exceeds a specified threshold percentage of the product.	Packaging must not exceed any of a set of threshold ratios of packaging to product
GHG savings	↗	↗	↗	↗↗
Material efficiency	↗	↗↗	↗	↗↗
Recycling	↔	↔	↔	↔
Reuse	↔	↔	↔	↔
Economic costs	↘	↘	↘↘	↘↘
Social impacts	↔	↘	↔	↔
Enforceability	↘↘	↘	↗↗	↗↗

5.1.2 Recycled Content

The Essential Requirements do not currently cover recycled content and the importance of reducing reliance on virgin materials. This contrasts with more recent EU policies, such as the Single Use Plastics Directive which includes requirements to increase the amount of recycled content in PET beverage containers. There may be an opportunity to support the attainment of recycling targets by increasing demand for recycled material through the Essential Requirements, although other mechanisms may be more appropriate.

There are challenges to incorporating more recycled content, which need to be considered for all of these potential measures:

- There is not always sufficient supply of the right quality recycled material.
- Recycled material may be more expensive than virgin material.
- Recycled plastic can have a different physical appearance – particularly in colour – to virgin plastic.

- Recycled material, such as plastic and cardboard, can have different mechanical properties to virgin material, so more material may be needed to provide the same level of mechanical strength.
- For materials like aluminium and steel, there is currently no mechanism for differentiating recycled material from virgin material, meaning it is not always possible to ascertain the actual recycled content of the packaging.
- For some products, not least food, there are legal restrictions on the material that can be used in contact packaging.

The measures that seek to support the increase of recycled content whilst taking the above issues into account include:

› Develop a new CEN Standard setting out a mandatory process for designers to assess the potential to include recycled content; and
› European Commission impact assessment to examine the suitability of recycled content targets for specific formats.

Measures

Develop a new CEN Standard setting out a mandatory process to be followed to assess the potential to include recycled content.

This approach does not include explicit targets but would introduce a standard process for designers to follow in order to assess whether they could increase the recycled content of their packaging.

While there is already a CEN Report (CR 13504) on *Packaging – Material Recovery – Criteria for a Minimum Content of Recycled Material*, this report does not appear to be widely known or used. The report set out the factors to consider in determining the potential recycled content, but concluded that “the basis for a mandatory stated minimum recycled content in packaging is considered unsound”. The report was, however, published in April 2000 and does not include an actual process to assess whether the potential recycled content has been maximised – as is recommended here – but focuses instead on the limiting factors. A further difference is that the process proposed to be followed in the context of the design and manufacture of packaging in this measure would be mandatory to ensure that the potential for recycled content is always considered.

This proposed process would take into account the follow key factors, as indicated through stakeholder consultation:

- The maximum possible recycled content that could be used;
- Alternative packaging formats that could integrate greater recycled content whilst delivering the same functionality;
- The potential impact of recycled content on the packaging’s visual appearance;
- The potential impact of recycled content on the packaging’s mechanical strength and flexibility; and
- Legal restrictions that limit the use of recycled content (such as in food-contact applications).

The proposed process to be followed in the context of the design and manufacture of packaging would be developed by CEN through consultation with the whole packaging value chain (e.g. designers, brands and recyclers). The process would be structured at least by material (including different polymers) but may need some further segmentation to focus on specific types of packaging and the precise nature of any issues. The standard would develop a set of protocols for packaging designers to work through in a staged manner. This would include, for example, initial design requirements, identification of opportunities for recycled content, reviewing existing cases of use, preliminary design, product testing and evaluation, review and design finalisation.

Strengths & Weaknesses

Specifying such a standardised procedure would allow packaging designers to balance the various trade-offs and to tailor the recycled content for the specific packaging material and application – meaning the packaging can be considered on a case-by-case basis. This implies a degree of subjectivity – which could be reduced by a well-defined Standard.

The Standard could also include conditions relating to the mechanical properties of packaging, to balance the risk of more raw material being used in order to increase the recycled content. Stakeholders have suggested that the mechanical properties of packaging can be more robust than strictly needed. One complication, however, is that packaging designers or manufacturers may not know at the design stage what mechanical properties will ultimately be required.

The standardised process would enable producers to take into consideration how significantly, and how detrimentally, the visual appearance is affected and whether this is an obstacle. The downside of this approach is that, like concepts such as “consumer acceptance”, it risks being a subjective judgement for designers, who may under-estimate what consumers are willing to accept. It is also questionable whether aesthetics should be prioritised above environmental considerations. Indeed, some stakeholders have indicated that they are willing to accept changes in the packaging’s appearance in exchange for enhanced environmental credentials. They also expressed a belief that consumer perceptions and priorities are changing, so the visual appearance may be less of a concern than it once was (and the increase in e-commerce might also affect this since consumers may be less strongly influenced by the appearance of the packaging).

As this approach avoids setting a static target, it allows more scope to reflect changes in other legislation. For instance, changes in food contact rules or new authorisations for recycling processes for food contact materials could result in increased availability of secondary materials meeting food grade quality requirements, which in turn would result in a need to update the Essential Requirements more frequently.

It can, however, be difficult to assess whether, and demonstrate how, a standardised process has been followed.

Distribution of Impacts

There will very likely be GHG savings from increasing the level of recycled content in packaging. Some figures are highlighted through LCA case study 12 (for full results in Appendix G).

There is a financial cost of developing the CEN Standard, which may be paid by producers if, as now, companies are charged for the new Standard. This would mean there is a one-off cost to purchase the Standard and an ongoing cost associated with adhering to the Standard and potentially reporting on how it has been followed. The impact of this could be minimised by incorporating the Standard into their existing design and management procedures.

There may also need to be more co-operation along the supply chain to determine exactly how the packaging will be used and what mechanical properties are needed.

This measure is not, however, likely to have any significant impacts on retailers or consumers. For waste processors, the measure may increase demand for recycled material, with the possible effect of increased prices for secondary materials. Over time, this could drive changes in collection processes if there is an increased demand for higher-quality material. There could be financial costs associated with this.

Encouraging packaging users to consider the potential for using secondary material at EU level could avoid potentially distorting the single market if different policies relating to recycled content were implemented across the Member States. It could also lead to improvements in Member States where the secondary materials market is less developed than in some other countries.

The Standard is more likely to be relevant for plastic packaging, and potentially cardboard/ paper packaging, than for metal and glass, given that it is easier to simply substitute recycled and virgin material for the latter two. As such, market conditions – availability and price – are more likely to be the limiting factors for the inclusion of recycled glass and metal. However, there are substantial and effective markets for recycled fibres across the EU. The area where stakeholders suggest most support is needed for secondary materials markets is plastic.

Conclusion

While there is no guarantee that a standardised process will achieve the desired, or optimum, results, this approach does reflect the potential complexities associated with increasing recycled content. There will, however, be challenges associated with demonstrating that the process has been followed – which would need to be done to ensure that all producers are compliant. If producers are required to register their packaging with a central registry, they could be required to submit a declaration demonstrating how they have followed the process.

Overall, the recommendation is to include a statement in the reinforced essential requirements for the Commission to request such a standard to be developed by CEN upon adoption.

Table 5-8 Summary

Impact category	Summary	Summary description
GHG savings	↗	GHG emission savings are expected from this measure. However, potentially not significant as the Standard would only act as design guidance not a mandate for certain levels of recycled content to be used.
Material efficiency	↔	Switching from primary to secondary material would not change the amount of material used, or not change it significantly.
Recycling	↗	For some materials, e.g. plastics, recycled content targets may act as a market pull mechanism and increase the levels of recycling in order for the required amounts of material to be sourced.

Reuse	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Economic costs	↘	There will be some cost to producing the Standard and for companies to utilise it and potentially proof compliance with it. However, these are not expected to be significant.
Social impacts	↗	Potentially slight consumer amenity achieved by those who value more environmentally friendly packaging.
Enforceability	↘	Has some challenges to enforcement as a Standard can be interpreted in various ways and would apply to each packaging format so could be labour intensive. Conversely, if a self-certification approach was taken enforcement action would be minor.

Implement recycled content targets for specific formats.

During the course of this study, the following types of packaging were identified as possible formats for which a minimum recycled content target might be most appropriate:

- Transport packaging
- E-commerce packaging
- Plastic (non-beverage) bottles
- PET trays/ containers
- Bottles for household cleaning products
- Paper packaging for dry foods
- Films not intended for food contact
- Plastic paint tins
- Packaging produced through sheet extrusion/ thermal forming
- Flower pots

These packaging formats and the potential level of recycled content could, therefore, be investigated during any future impact assessment on such a measure.

The majority of the packaging mentioned is made from plastic. This is not surprising, as the secondary material markets for other materials are already more mature, in general, so any new recycled content targets would likely be focused on plastics. The amount of recycled content that can be added to a type of packaging is quite variable and so has not been assessed here. However, it is worth noting that some producers have already set targets, which indicate the minimum that they consider to be feasible. For instance, L'Oréal cosmetics has set itself a 2025 target to ensure that 50% of its plastic packaging (by weight) is not made from virgin fossil plastics, by exploring the use of renewable content on top of its 40% post-consumer recycled content target by 2025, while Nestlé has a target of 25%-50% recycled content by 2025, depending on the packaging type.[137]

The initial review of measures highlighted that it may not be appropriate to include recycled content targets in the Essential Requirements themselves. It may, however, be appropriate to include targets for specific types of packaging in product-specific legislation, e.g. PPWD, or, as is the case with plastic beverage bottles, the SUP Directive.

Strengths & Weaknesses

If mandatory targets were introduced, this would ensure that recycled content is used (and, if the target is set at the right level, increased/ maximised), which has the advantages of reducing the use of virgin materials and ensuring that all producers are required to use some recycled content.

Recycled content targets do not necessarily, however, consider market conditions and whether there is sufficient supply of the required quality of recycled material. The market could be more complex where the materials are also used for products other than packaging, so one suggestion is that recycled content targets should be applied to 'the use of a material' or 'polymer', and not to the reintegration of material into packaging through the use of packaging application specific targets. In this case, the Essential Requirements may not be the most suitable tool through which such targets could be implemented.

Another consideration is the legal restrictions that can affect the use of recycled content, particularly in packaging used for food, cosmetics and toys. Food safety regulations, for instance, limit the possibilities to include secondary material and there is a limited supply of food-grade material due to the nature of the existing sorting systems. It has, however, been suggested that more clarity in the European Union rules under food contact legislation on functional barriers would help. It may also be that industry standards need to be reviewed to allow more scope for recycled content.

A potential drawback of setting targets for some low-end applications is that this could divert higher-grade material from other applications for which it is more appropriate/ will be more beneficial. For instance, food-grade rPET could be used for non-food contact PET trays or containers, simply because that is the only rPET available. If the rPET was used for beverage bottles or food packaging, it is more likely that it could be recycled in a closed-loop system to be used again in a high-value application. This is more of a concern if there is a shortage of supply.

The mechanical properties of recycled material can be a particular limitation for flexible and thin packaging materials. Uncertainties about the mechanical strength of packaging made from recycled material could be mitigated in some cases by using more material (as happens with cardboard boxes), but this would not necessarily support resource efficiency or mitigating carbon emissions. Similarly, an additional barrier layer could be incorporated into the packaging, but this could complicate the recycling process.

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[137] AIM(European Brands Association), *Brands – Drivers of Sustainability*, accessible at https://www.aim.be/wp-content/themes/aim/pdfs/AIM-Brands-Eco-Design_for-website-1.pdf

Food contact is a key issue when increasing the amounts of recycled material. Currently, food safety regulations limit the possibilities of including secondary material. Currently, the only recycled food-grade plastic that can be sourced is PET (because it has a much less absorbent structure than other polymers so stops migration of contaminants into the material itself) and the limited availability of recycled food-grade quality reduces the opportunities to increase recycled content. Other types of plastic can potentially be provided, but regulation remains a constraint. Supply is restricted because only a limited number of recycling facilities are authorised to deliver food-grade recycled material because the recycling process must be scientifically assessed by EFSA and subsequently be approved by the Commission. Additionally, existing collection systems are not necessarily designed to avoid contamination and support the degree of purity required for food-contact materials. What food-grade rPET that is available can sometimes be used for non-food contact packaging because of uncertainties over how the packaging will be used and a desire to maintain a degree of flexibility over the packaging's potential uses. Such considerations are, therefore, likely to limit the type of applications for which a minimum recycled content could be set.

It has been suggested by some stakeholders that focusing on recycled content can inhibit innovation and discourage consideration of new materials for which there is not yet a supply of recyclate. If targets apply to specific polymers, however, the latter issue would be less of a problem.

Distribution of Impacts

The LCA results clearly indicate the environmental benefits of replacing virgin material with recyclate, particularly for plastics, given the current, relatively low, recycling rates (See LCA case study 12 for full results in Appendix G.5). The LCA concluded that recycled materials perform significantly better than their virgin equivalents on almost all of the impacts assessed. (The impact assessment categories where virgin steel and HDPE performed better than their recycled equivalents were considered negligible when contextualised by normalisation.) Switching to recycled steel reduces the impact on climate change by around 80%, and emissions of particulate matter by circa 70%; for aluminium, the reductions of CO_2 are around 95% and for PET around 85%.

It is noted that recycled content use is already reported to be relatively high for packaging of some materials. For example, the average proportion of recycled content used in packaging across the EU in 2017 was estimated at 58% for steel packaging[138], ~55% for container glass (average of all colours)[139] and ~89% for corrugated paper packaging.[140] Subject to verification of these reported data, the environmental justification for further increasing recycled content use for packaging of such materials at present is therefore limited compared to that for some other materials (notably plastics) for which recycled content is currently limited. However, there will be some increase relating to PET bottles, for which a 30% recycled content target is in

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[138] APEAL (2019), web article *Recycled Content for Steel Packaging?*, accessed on 19th December 2019 at https://www.apeal.org/news2/recycled-content-of-steel-for-packaging/
[139] FEVE (2019), Position paper: "RECYCLED CONTENT AND GLASS PACKAGING", accessed on 19th December 2019 at https://feve.org/wp-content/uploads/2019/07/Recycled-Content-FEVE-Position-June-2019.pdf
[140] CEPI/ FEFCO (2018), *European Database for Corrugated Board Life Cycle Studies* (p16), accessed on 19th December 2019 at http://www.fefco.org/lca

place for 2030. There is, therefore, an environmental justification for increasing the use of recycled content in packaging and for plastic packaging in particular.

In cases where recycled material is more expensive than its virgin equivalent, producers' raw material costs would increase. However, if the supply of recyclate increases as the markets expand the price may actually fall. In addition, higher values for recycled material could have the effect of reducing net costs paid by producers to cover the costs of meeting recycling targets (as per the revised requirements for EPR schemes). These aspects would need to be assessed in the impact assessment.

The impact assessment would also need to investigate whether there is, or could be, sufficient demand to meet the increased supply and the potential risks if large producers have more purchasing power than SMEs. One concern, for instance, is that larger producers would buy a significant proportion of the available supply – either simply because of the minimum quantity they need to meet their targets or to demonstrate to their customers that they are going above and beyond their legal obligations. This in turn could increase the price of secondary materials and/ or reduce the availability of recycled material, which would make it more difficult and more expensive for smaller producers to meet their legal obligations.

In terms of visual appearance, recycled content could be more of an issue for producers using plastic if a particular colour is a central element of a product's branding.

The impact assessment would need to consider the reporting and evidence requirements for producers to demonstrate compliance with any targets, and the administrative burden this could entail. Stakeholders have pointed out that tracing recycled content through the supply chain can sometimes be a challenge, and proving the source was actually from recyclate. Some consideration would need to be given the mechanism for reporting on recycled content to ensure compliance with the targets was robust. It would also be another compliance criterion to check when packaging is imported to the EU and producers would need confidence that all their competitors are complying with the same requirements.

Some countries outside the EU have more stringent rules restricting the use of recycled content, so producers exporting to these countries may need to develop different packaging with different levels of recycled content to comply with different rules inside and outside the EU. This could, however, theoretically apply to any Essential Requirement; it demonstrates the value of action at the EU-level rather than Member State level, and it indicates the potential for the EU to be a global leader by demonstrating to other markets what is possible in terms of recycled content.

Any recycled content targets are not likely to affect retailers. Theoretically, if some recycled plastics have an altered appearance, consumers could raise concerns about how the product was stored, but such a scenario does not seem probable and the situation would be the same for all retailers. Similarly, there will not be a significant impact on consumers; some may notice a slight change in appearance, but this can be easily explained. Plus, as noted above, producers' voluntary recycled content commitments are partly in response to consumers' concerns about reliance on virgin materials.

For waste collectors and recyclers, any targets are likely to increase demand for recycled material, which could promote investment in collection and processing facilities. Equally, this could reduce the amounts of packaging that municipalities collect in residual waste if more types of packaging are regarded as having value.

Conclusion

Recycled content targets have been found to be an effective tool in other EU interventions, not least the SUP Directive, and the LCA conducted as part of this study has indicated that replacing virgin material with recycled content could have significant environmental impacts. There are, however, potential unintended consequences that would need to be investigated further in an impact assessment.

While the Essential Requirements are not the most suitable forum for product-specific targets, the review indicates that there is a strong case for considering targets for specific materials and packaging formats in a European Commission impact assessment. As such targets would not address all packaging, it is recommended that this measure is pursued in tandem with the one above regarding a recycled content Standard for all packaging.

Table 5-9 Summary

Impact category	Summary	Summary description
GHG savings	↗↗↗	GHG emission savings are expected from this measure. They would be higher as the changes would be more certain from specific targets as opposed to design guidance only.
Material efficiency	↔	Switching from primary to secondary material would not change the amount of material used, or not change it significantly.
Recycling	↗↗	For some materials, e.g. plastics, recycled content targets may act as a market pull mechanism and increase the levels of recycling in order for the required amounts of material to be sourced.
Reuse	↔	No anticipated effect over and above the requirement for all packaging to be reusable / recyclable.
Economic costs	↔	It is not clear at this stage where the balance of economic costs would lie. There would be costs for R&D, potentially changing manufacturing equipment, and monitoring and enforcement, however, these could be outweighed by decreased material costs versus primary material.
Social impacts	↗	Potentially slight consumer amenity achieved by those who value more environmentally friendly packaging.

Enforceability	↗	A quantitative target would be more enforceable than qualitative guidance, however, measuring recycled content can be a challenge.

Summary

The following summarises the various measures relating to the use of recycled content in packaging. Recycled content targets may be more effective and enforceable than a design process in a Standard. However, the balance of economic costs are not straightforward to assess and so have not been considered at this stage.

Table 5-10 Summary

Measures / Impact category	Develop a new CEN Standard setting out a mandatory process to be followed to assess the potential to include recycled content.	Implement recycled content targets for specific formats.
GHG savings	↗	↗↗↗
Material efficiency	↔	↔
Recycling	↗	↗↗
Reuse	↔	↔
Economic costs	↘	↔
Social impacts	↗	↗
Enforceability	↘	↗

5.1.3 Hazardousness

The Essential Requirements include limits for four heavy metals. Since the requirements came into force in 1994, however, knowledge of substances of concern has expanded significantly. Examples of hazardous chemicals found in packaging include:[141,142]

- Recycled card (e.g. mineral oils such as MOAH, MOSH)
- Chemically treated pallets (e.g. methyl bromide)
- Metal can liners (bisphenols, such as BPA or BPS)
- PVC packaging (phthalates, such as DEHP or BBP)
- Grease proof barriers (Per- and polyfluoroalkyl substances (PFAS) such as PFOS)
- Polystyrene foam (PAHs or Vinyl Benzene)
- Further plastics - noting that polymers are not addressed by REACH

Additionally, the regulatory framework has evolved, with the development of the REACH Regulation (EC Regulation 1907/2006) and the European Chemicals Agency, as well as EC Regulations 1935/2004 and 2023/2006 relating to Food Contact Materials and the European Food Safety Authority. These instruments have been designed with the aim to ensure that such substances don't cause human health issues, including when used in packaging.

The two measures considered here capture the extent to which new requirements are introduced into the essential requirements or whether these existing regulatory mechanisms are used to meet the needs of European legislators, in terms of keeping the population safe from hazardous substances. They are:

- Rely on REACH, FCM regulation etc. to adequately addressed the use of hazardous substances in packaging; and
- Include requirements to phase out the use of SoVHC in packaging through reference to Annex XIV of REACH.

Maintain existing list of hazardous substances in Article 11 of PPWD, but rely on REACH, FCM regulation etc to adequately address the use of other hazardous substances in packaging.

In order to avoid duplicating monitoring, reporting and enforcement measures – as well as a new list of substances that could relatively quickly become out-of-date – the list of hazardous substances in the Essential Requirements could be maintained as is. Going forward, the REACH regulations would be used as the main framework for all products, including packaging.

Strengths & Weaknesses

The REACH regulations are updated more regularly than the Essential Requirements and producers have procedures in place for complying with REACH and, where applicable, the FCM regulations. Compliance is likely to be supported by including all the restrictions relating to hazardousness in once piece of legislation so that manufacturers have a clear point of reference and there is a single, nominated body responsible for the regulations. This approach

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[141] https://www.ciel.org/wp-content/uploads/2019/02/Plastic-and-Health-The-Hidden-Costs-of-a-Plastic-Planet-February-2019.pdf

[142] https://www.sciencedirect.com/science/article/pii/S0048969718338828#f0015

had support from various stakeholders that were interviewed. However, concern from other stakeholders was raised regarding the adequacy of the approach and reported lack of enforcement with existing regulations. [143,144,145]

Distribution of Impacts

The responsibility for keeping REACH up to date lies with the European Chemicals Agency, whereas the responsibility for keeping the essential requirements up to date lies with DG Environment. The costs of maintaining the list of hazardous substances would therefore shift from DG Environment to ECA.

The impacts relating to compliance should be limited as all companies should already be reviewing REACH to ensure their products are compliant. However, the impacts would clearly relate to how the scope of new requirements that limit the use of certain substances evolve and what the costs might be of making any necessary changes.

Conclusion

Given the support for this measure by a number of stakeholders and the potential efficiency gains, it would seem important to include it for further analysis.

Table 5-11 Summary

Impact category	Summary	Summary description
GHG savings	n/a	
Material efficiency	n/a	
Recycling	↗	Potentially could support increased recycling through removing inhibiting substances from the waste stream.
Reuse	n/a	
Economic costs	↔	It is not clear what additional costs would be incurred as REACH should be operating anyway. It may be that a more specific focus on packaging would lead to increased costs from the status quo.
Social impacts	↗	Potential health impacts from restricting hazardous substances from use in packaging.

[143] European Environmental Bureau news page, META (2018), *A Third of Chemicals Break European Safety Laws*, accessible at https://meta.eeb.org/2018/10/12/breaking-a-third-of-chemicals-break-european-safety-laws/

[144] HEAL (Health and Environment Alliance) (2019), *Food Contact Materials and Chemical Contamination*, accessible at https://www.env-health.org/wp-content/uploads/2019/06/Food-Contact-Materials-Briefing-Health-and-environment-Alliance-HEAL-PRINT_final-1.pdf

[145] ChemTrust (2019), *Five key principles for future EU regulation of chemicals in food contact materials*, accessible at https://chemtrust.org/5-key-principles-fcm/

Enforceability	↔	In principle should be enforced through REACH, however, some stakeholders have suggested enforcement through REACH might not be comprehensive.

Include specific requirements to phase out the use of SoVHC in packaging through reference to Annex XIV of REACH.

The Communication "Options to address the interface between chemical, product and waste legislation" highlights some of the challenges related to the presence of hazardous chemicals in products, particularly information asymmetries which exist along supply chains and the issue of substances of concern in virgin and recycled materials.[146]

Whilst the abovementioned measure was well supported by industry representatives, concern from other stakeholders was raised regarding the adequacy of the approach and reported lack of enforcement with existing regulations. Moreover, the Staff Working Document of the Interface Communication includes policy options under the issue "Design for circularity" including: "the use of dedicated product specific legislation… to introduce requirements for substances of concern".[147]

Consequently, the essential requirements could be used to restrict the use of any SoVHC (listed in the REACH candidate list for eventual inclusion in Annex XIV) from the market until full product specific legislation had been introduced and any limit levels set following full impact assessment.

Strengths & Weaknesses

This approach would follow the precautionary principle, which may be valuable in the longer term given the toxic and accumulative nature of certain chemicals used in packaging. This could be done by adding an explicit requirement for final products to not contain substances on the REACH "candidate list" by a specified date. The date this restriction would come into force would need to be subject to a full assessment to ascertain whether it could be achievable by the time the essential requirements are enacted, or a later date is needed to allow for adaptation (e.g. 2025, 2030). In the interim, a requirement could be set to ensure any packaging placed on the market containing SoVHC are fully reported to a compliance packaging registry (see Section 5.6).

Distribution of Impacts

The restriction of SoVHC from use in packaging would impact on packaging producers. The extent of such impacts could not be obtained in the context of this scoping study, but should be assessed further in future analyses.

Conclusion

The concern about the reliance on REACH and consideration of the precautionary principle suggests that this measure should be carried forward for further assessment.

[146] https://ec.europa.eu/docsroom/documents/27321
[147] SWD, p.11 https://ec.europa.eu/docsroom/documents/27321

Table 5-12 Summary

Impact category	Summary	Summary description
GHG savings	n/a	
Material efficiency	n/a	
Recycling	↗	Potentially could support increased recycling through removing inhibiting substances from the waste stream.
Reuse	n/a	
Economic costs	↔	It is not clear what additional costs would be incurred as REACH should be operating anyway. It may be that a more specific focus on packaging would lead to increased costs from the status quo.
Social impacts	↗↗	Potential health impacts from restricting SoVHC from use in packaging.
Enforceability	↗	Including a specific requirement in the PPWD to rule out such substances may lead to a greater level of enforcement than relying on REACH alone.

Summary

The following summarises the various measures relating to the use of hazardous substances in packaging. Whilst relying on existing chemicals related regulations may be a straightforward option, to gain further certainty that SoVHC will be adequately tackled it may be valuable to include a specific requirements for their phase out in packaging in the Essential Requirements themselves.

Table 5-13 Summary

Measures Impact category	Maintain existing list of hazardous substances in Article 11 of PPWD, but rely on REACH, FCM regulation etc to adequately address the use of other hazardous substances in packaging.	Include specific requirements to phase out the use of SoVHC in packaging through reference to Annex XIV of REACH.
GHG savings	n/a	n/a

Material efficiency	n/a	n/a
Recycling	↗	↗
Reuse	n/a	n/a
Economic costs	↔	↔
Social impacts	↗	↗↗
Enforceability	↔	↗

5.2 Requirements specific to the reusable nature of packaging

Unlike the waste hierarchy, the Essential Requirements are neutral at present on the choice between reuse and recycling. Moreover, there is a limited extent to which the essential requirements, which relate to access to the market, can drive shifts between single use and reusable packaging. Other policies instruments are more suitable to that aim, and should be considered further by the Commission and national governments. The focus here, has been on ensuring that all reusable packaging is recyclable and how reusable should be defined, as well as providing guidance for effective reuse systems, as opposed to dictating how the market should change. The measures considered are:

› All reusable packaging must be recyclable, unless there is a demonstrable robust case for an exemption
› Guidance on effective reuse systems developed through reference to a European Standard; and
› Impact assessment to examine possibilities to mandate reuse for transport packaging.

Measures

All reusable packaging must be recyclable, unless there is a demonstrable robust case for an exemption.

The robustness of the definition of reusable could be more or less important depending on what rules are agreed regarding whether all reusable packaging should also be recyclable. The way in which the requirement is stated in the Plastics Strategy – 'reusable or recycled in a cost-effective manner' – suggests packaging must be either one or the other, in that if a piece of packaging was reusable, it might not have to be recyclable. There is a risk, therefore, that non-recyclable packaging is placed on the market, claiming to be reusable, even though the number of times the packaging is actually reused is very low. This may be because the item is, for example, not very durable; a term also not defined in the legislation. If packaging did not have to be recyclable as well, or didn't meet the definition, then it would be important to ensure the packaging claiming to be reusable was durable enough to be used for many trips, or uses. Indeed, many of the definitions of reuse / reusable make reference to the multi-use or iterative nature of the item.

Strengths and Weaknesses

First, it is worth highlighting that, in so far as is possible, any definition of 'reusable' should be unambiguous. Many of the definitions reviewed contain subjective terms such as 'a number of rotations', 'used repeatedly' or 'in normally predictable conditions' (see Appendix C). The inclusion of these terms leaves too much room for interpretation, and therefore, inconsistency in the application of the definition, and renders the definition unenforceable. More effective definitions tend to include a higher level of detail, and potentially, quantitative measures, in order to provide clarity on what qualifies as recyclable.

For example, a broad qualitative definition could be:

› 'the physical properties and characteristics of the packaging must enable a number of trips or rotations in normally predictable conditions of use'; or

› 'packaging, which has been conceived and designed to accomplish within its life cycle a minimum number of trips or rotations, is refilled or used for the same purpose for which it was conceived, with or without the support of auxiliary products present on the market enabling the packaging to be refilled' (WFD).

However, these would be challenging to enforce, a key problem with the existing essential requirements. To increase the strength of the definition a minimum number of trips or rotations could be specified through reference to a specific number of trips or rotations. For example:

› 'a reusable glass bottle is one that is refilled or used for the same purpose for which it was conceived and achieves a minimum of X trips or rotations within its life cycle'

The number of trips for different packaging groups or specific types of packaging would need to be determined through a technical working group and harmonised at the European level. Such a definition would therefore include consideration of the fact that reusable packaging can have a more beneficial environmental footprint than single-use packages (due to the avoided production of new packaging and avoided disposal or recycling). However most reusable packaging may require different material types and/or a greater weight of material to increase the durability of the packaging during its longer lifecycle.

It is therefore necessary to determine how many times a package needs to be reused to have an environmental benefit compared to a disposable, single-use package, thereby offsetting the potentially greater resource intensity of reusables in the production phase. The point, or number of trips, at which the environmental impacts of the reusable system are lower than a single-use system is referred to as the break-even point.

Several case studies (9, 10 and 11) were carried out during the course of the study to assess the break-even point of reuse systems relating to number of cycles based upon LCA studies (see Appendix G.4). The three case studies, and key findings, were:

- **Case Study 9 - The break-even point for reusable pallets (Appendix G.4.1):**
  - The findings of this case study show that the break-even point for wooden pallets is about 23 reuse times and for plastic pallets about 47 reuse times. Actual reuse of pallets is estimated to be 25 times for wooden pallets and 50 times for plastic pallets. It appears that the actual number of times a pallet is reused is very close to the break-even point for pallets (although it should be noted that the break-even points mentioned here are from on one source only).

- **Case Study 10 - The break-even point for reusable beverage containers (Appendix G.4.2):**
  - The break-even point for reusable beverage systems versus single-use bottles clearly range depending on several assumptions of an LCA (breakage rates, distance to refill facilities etc.). This being said, the break-even point for glass and PET is approximately 1-2 refills. Both PET and glass bottles can be used many more times before they are degraded, therefore the break-even point is within the lifetime of reusable beverage containers. For an improved environmental impact, reusable beverage containers could be adopted in place of single-use ones and could have the largest potential for implementation in the water, carbonated soft drink, and beer sectors.

- **Case Study 11 - The break-even point for reusable packaging in transport of electrical and electronic equipment (EEE) (Appendix G.4.3):**
  - If EEE transport packaging were mandated to be reusable, the minimum number of trips would be at least 3 to achieve an overall environmental benefit. This is reasonable considering current reusable packaging on the market is used 15-40 times.

Whilst there are only a few data points, the analysis in the case studies suggests that the break-even points, based upon LCA analysis, are above the actual number of uses in practice. Moreover, for a couple of studies the actual usage rates are significantly higher than potential break-even points (even taking the large variances that might occur due to other factors, distance, etc.).

Distribution of Impacts

There are various drivers that support the rationale for this outcome. For example, where industrial reuse systems are in place there is a strong economic incentive to maximise the use of resources within the system for a given cost. Therefore, there should be no disincentive to maximise the number of trips / uses or claim otherwise. In this case, a further definition of reusable packaging is not needed.

If producers are required to change their packaging in order to comply with the Essential Requirements, they may also consider replacing their existing non-recyclable single-use packaging with a reusable alternative. The LCAs in case studies 6, 7 and 8 concluded that the reusable alternatives examined performed better in all impact categories considered. If, for example, all washing machines sold across the EU were packaged with reusable packaging, 500kt of CO_2eq could be saved annually (see case study 6 in Appendix G.3.1). While reusable packaging is generally more expensive than single-use packaging on a per-item basis, the reusable packaging can produce costs savings when considered on a per-trip basis and once product damage is considered – as the reusable alternatives examined in the LCA offered more product protection than the single-use equivalents.

Reusable packaging could entail additional logistics costs, but would reduce waste management costs, compared to single-use alternatives, because it can be used more often before disposable.

If the reusable packaging involved the consumer refilling the packaging they have bought previously – as with the reusable cleaning products examined in the LCA for case study 7 (see Appendix G.3.2) – retailers may need to adapt their business models if sales switch to concentrate refills. There is also the potential to reduce marketing costs, however, if the consumer has to return to the retailer if they want to buy a refill.

With e-commerce packaging, switching to a reuse system (see Appendix G.3.3) was found in case study 8 to reduce climate change, particulate matter and photochemical ozone formation by 63%, 25%, and 56% respectively and, on a per trip basis, the reusable bags were either the same price or cheaper than their disposable alternatives.

For packaging sold for consumers to reuse themselves, there may be a greater need to define a minimum number of uses as there could be an incentive to claim such products as reusable to sell at a higher cost. However, the actual technical specifications of the packaging might be such that the item is only used a few times before it cannot be used again, or many fewer times than a competitor's product. A shopping bag over 50 microns claimed as a 'bag for life', a trigger spray with concentrated pod refill or a piece of single use cutlery, for example. Technical testing requirements could be mandated, related to e.g. tensile strength, puncture resistance, dynamic loading, impact resistance etc., and limits set on a case by case basis. However, this may be costly and provide a disincentive for the uptake of reuse. Moreover, there are also commercial drivers to keep the issue in check. If customers complain that the bags for life keep breaking after a few uses the retailer may ask the supplier to make the product more durable, for example. Given that the share of reusable packaging reported is very low and declining in most applications[148] and current drivers incentivising the uptake of reusable packaging are limited, there is not a strong rationale to define reusable consumer packaging according to its expected number of uses if it was also recyclable (as packaging has to be either recyclable or reusable).

There are likely to be some cases where reusable packaging cannot be recyclable for technical reasons, and so an exemption procedure would have to be incorporated into the Essential Requirements and any exempt packaging listed in the Annex to the PPWD or other related legal document. This list would have to be updated on a periodic basis. An example of this case is that of chemically treated wooden pallets used to transport industrial chemicals and the like. The chemical treatment renders the pallet unrecyclable, however, the pallet may be used multiple times. In these cases it would indeed be important for a clear definition of reusable

[148] Based on data from Finland and Denmark voluntarily reported to Eurostat for the year 2011 (assessed in Eunomia for European Commission (2014), *Impact Assessment on Options Reviewing Targets in the Waste Framework Directive, Landfill Directive and Packaging and Packaging Waste Directive" - Appendix 12 –The Implications of a Combined Recycling and Reuse Target in the Packaging Directive*)

packaging to be applied based upon a minimum number of trips. Otherwise the packaging may not be reused many times and subsequently not recycled either.

Conclusion

The reference to European Standard EN 13429 ‘Reuse’ should be maintained to provide the definition of reusable packaging. Specified minimum thresholds for the number of trips of reusable and recyclable packaging should not be included in the Essential Requirements. If future European policies were to seek to significantly increase the levels of packaging reuse this approach should be reviewed to assess whether a more defined methodology is required.

An exemption procedure for non-recyclable reusable packaging should be developed as specified above, with a requirement for a minimum number of trips to be defined to ensure adequate durability of such non-recyclable packaging.

Table 5-14 Summary

Impact category	Summary	Summary description
GHG savings	↗	Quantitative assessment indicates that for the specified case studies reusable packaging can deliver more GHG savings than single use. If the packaging were to be recycled rather than disposed of further GHG savings would be realised.
Material efficiency	n/a	
Recycling	↗	The measure would support increased recycling, but as the market share of reusable packaging is not significant overall the contribution would be limited.
Reuse	↔	The measure would not necessarily affect the amount of reusable packaging on the market either way.
Economic costs	↔	It is not clear what the balance of economic costs might be for this measure without detailed analysis.
Social impacts	↗	Consumers may gain amenity from knowing that their reusable packaging items were also being recycled.
Enforceability	↗	The recyclable definition would be enforced through the mechanisms set out below, of which some are more enforceable than others. The other aspect to be enforced would be the minimum number of trips for non-recyclable reusable packaging. As this would be a quantitative measure it supports enforceability, however, gaining the necessary data for enforcement may present some challenges.

Guidance on effective reuse systems developed through reference to a European Standard.

There is currently little guidance on how to design a reuse system to optimise the environmental impact (which will depend on *inter alia* the number of trips and the logistics operation in place). The 2018 revisions to the PPWD mandated the Commission to reinforce the Essential Requirements with a view to, inter alia, "improving design for reuse". This point was mentioned by various stakeholders during the course of the study. Recent analysis by the Rethink Plastic Alliance, for example, has identified enabling conditions for effective reuse systems, which include:[149]

- Durable, universal and recyclable reusable container design (including the number of cycles);
- System infrastructure requirements - DRS for reuse is a priority;
- Hygiene requirements and liability; and
- Public engagement.

Consequently, the Commission could request for the standards authority CEN to produce such guidance, or incorporate it into European Standard EN 13429 'Reuse'.

Strengths & Weaknesses

Developing a standard to provide guidance on how to implement effective reuse systems has the advantages of being adaptable (not prescriptive such that variances in systems across the EU could be taken into account), and providing a standard reference point for industry. The standard would help support the development of reuse systems by providing a clear basis for how they could be designed, potentially encouraging the development of systems that would not otherwise have been implemented due to a lack of knowledge and understanding.

However, design guidance in such standards can only be voluntary, and so the impact might be limited. In addition, several stakeholders have highlighted that the methodology for developing European Standards does not adequately engage civil society. This should be addressed in any process to develop guidance on reuse as citizens are key agents in their success.

Distribution of Impacts

The main impacts associated with the development of a standard would be the costs associated with developing it. It may involve significant effort from stakeholders to contribute and finalise such a standard. The impacts would be mainly distributed across those contributing to its development, e.g. the Commission, technology suppliers, packaging designers, brands, civil society organisations etc. The overall impact level would be expected to be low/medium.

Conclusion

In conclusion, the potential introduction of design for reuse systems guidance should be considered further.

Table 5-15 Summary

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[149] https://rethinkplasticalliance.eu/wp-content/uploads/2019/10/bffp_rpa_reusable_solutions_report.pdf

Impact category	Summary	Summary description
GHG savings	↔	Not clear of significant changes in GHG emissions, however, if reuse systems were more effective it is likely that GHG emissions would be reduced.
Material efficiency	n/a	
Recycling	n/a	
Reuse	↔	The measure would not necessarily affect the amount of reusable packaging on the market either way.
Economic costs	↔	It is not clear what the balance of economic costs might be for this measure without detailed analysis.
Social impacts	↗	Consumers are likely to gain if reuse systems are more effective and convenient, and hygiene issues are adequately addressed.
Enforceability	↔	Voluntary design guidance in a high-level standard would not be straightforward to enforce due to the broad nature of the instrument. However, this would also mean that enforcement effort and costs would be low.

Mandate reuse for some transport packaging.

A number of stakeholders proposed that a life cycle assessment (LCA) is needed to determine whether single-use or reusable packaging is preferable and one option was for producers to undertake an ex-ante assessment if they are considering single-use packaging. There is, however, no undisputed methodology for such assessments and concerns were raised about the administrative burden it would place on producers.

Instead, mandating reusable packaging for certain applications of transport packaging (e.g. crates, pallets etc., not cardboard boxes) has been identified as a more feasible and suitable option. This is partly because there are already distribution networks and potential take-back mechanisms in place, and also because transport packaging may require less cleaning after each trip than some consumer packaging. A detailed assessment of impacts would be needed to assess the feasibility of this and the environmental benefits. The environmental impacts will depend on the amount and type of material used for reusable packaging, compared to single-use packaging, and the distance it is transported after the initial use to complete the trip.

Once again, secondary legislation may be needed if reusable packaging is to be mandated for transport packaging, given that the Essential Requirements are generic requirements for all packaging.

Strengths & Weaknesses

Mandating reusable transport packaging would reduce the amount of single-use packaging and would impose the same requirements on all producers/ distributors. There is little ambiguity or scope for different interpretations and this follows the waste hierarchy in promoting reuse above recyclability.

The LCA case study 6 (see Appendix G.3.1 concluded that returnable protective packaging for electrical appliances would save 6.5 kgCO2eq per trip compared to a single-use alternative, with the reuse option performing better in all of the impact categories assessed. The specific packaging assessed in the LCA has been used in trials for more than 40 cycles, so has significant potential to reduce raw material use, even once the additional weight to make the reusable packaging more durable is taken into account.

The LCA case study 9 (see Appendix G) similarly concluded that reusable transport pallets have a lower climate change impact than single-use alternatives, not least because they were used more than 60 and 80 times (depending on the material used). The LCA also concluded that the break-even point – the number of trips needed to justify reusable over single-use packaging – is lower than the maximum number of trips the reusable packaging could be used for. The environmental impact will, however, depend on how far, and how, the packaging is transported after use. If a distributor is transporting it back to a distribution hub to which they would be returning in any case (i.e. reverse logistics), any adverse impact is minimised.

Electric vehicles could also potentially be used for transport at the local or regional level. However, the logistics are more complex, and potentially more environmentally costly, if the product is imported from outside the EU and the packaging has to be sent back to a manufacturer in Asia, for example. The level of cross-border trade arguably strengthens the case for intervention at the EU-level to support the single-market.

Distribution of Impacts

Reusable packaging is already relatively common in some business to business applications – such as industrial pallets – indicating that it is feasible. For producers not currently using reusable packaging, there will be R&D and capital costs to obtain the appropriate reusable packaging. As the packaging can be reused several times and is more durable – additionally offering more product protection and reducing losses from damages – there are potential net savings for producers. Additionally, the Essential Requirements could help to strengthen the market for reusable packaging solutions, which could help to offset R&D costs for packaging designers.

There will be costs associated with cleaning the returned packaging/ preparing it for reuse and transporting it back to the distribution hubs. The costs of this will depend on the packaging used and the location of the hubs.

For SMEs, it may take proportionately more time to arrange a reuse system, but this might be out-sourced to a distribution company. The efficiency savings – from the reduced need for packaging and the reduced losses – could also be proportionately greater for SMEs.

For retailers, there could be some additional costs associated with the staff time needed to prepare the packaging for collection. Staff will in any case, however, have to unload and unpack goods when they are delivered so the additional time associated with handing back the packaging may be minimal. There is the advantage for retailers of passing responsibility for the waste management to their suppliers, so this could reduce their waste management costs by reducing the amount of single-use packaging to be stored and disposed of.

Generally, the costs of waste management would be reduced – because there is less waste to manage. The costs could, however, shift if different materials are used for the reusable packaging compared to single-use packaging: in the LCA, the costs were transferred from paper recyclers and waste incinerators to plastic recyclers.

There is not expected to be a significant impact on consumers. There are, however, potential benefits if the reusable, more durable packaging reduces the likelihood that goods are damaged during transportation. This is equally a potential benefit for retailers, as they would not necessarily have identified the damage before selling the product.

Conclusion

It is important to consider measures that promote reuse, given that this ranks above recycling in the waste hierarchy. As the Essential Requirements are specifically about the basic requirements for access to the market, it is not considered possible within this particular policy to restrict access to the market based only on whether the packaging is reusable. This does not mean that there is not a role for the EU and/ or Member States to develop additional policies to promote reuse. For example, it is not appropriate for the Essential Requirements to set a target for the amount of packaging that should be designed for reuse – because this would mean that whether or not packaging is eligible to be placed on the market will vary over time and depend on the rest of the market – but such targets could be considered elsewhere.

Transport packaging, however, seems to be a suitable, broad enough starting point for mandating reuse without requiring major changes in distribution or retail systems. The single-market and the high level of trade between Member States strengthens the case for intervention at the EU level with regards to transport packaging, enhancing the *EU's added value*. If only some individual Member States imposed a requirement on transport packaging, this would not have the same results and could be difficult to comply with and enforce, given that some products' supply chains will cross a number of borders. It would also likely constitute a barrier to the free circulation of goods and as such run counter a key objective of the PPWD.

The impact assessment would need to examine the potential costs in more detail and determine the extent of the potential environmental benefits. This would not require an amendment to the Essential Requirements at the current time, but the text may subsequently need to be amended if an assessment of the impacts of such a measure indicated that mandating the use of certain types of reusable tertiary packaging was overall justifiable.

Table 5-16 Summary

Impact category	Summary	Summary description
GHG savings	↗	As indicated in the measures above reuse systems can save GHG emissions. However, given the limited scope and already reasonably well-established system for reusable transport packaging the impact may be limited.

Material efficiency	n/a	
Recycling	n/a	
Reuse	↗	The measure would increase the levels of reuse but, as above, given the limited scope and already reasonably well-established system for reusable transport packaging the impact may be limited.
Economic costs	↔	It is not entirely clear what the balance of economic costs might be for this measure, however, reuse systems can save money as they reduce the use of single use packaging. Further detailed analysis would be required.
Social impacts	↗	Reuse systems often require labour to operate, so employment could increase. Particularly for lower skilled workers.
Enforceability	↗↗	Given the precise nature of the measure it should be straightforward to enforce.

Summary

The following summarises the various measures relating to the use of reusable nature of packaging. As comprehensive measures to increase the levels of reusable packaging (e.g. reuse targets) are not implementable through the Essential Requirements, the measures here are limited in their impact. However, no major downsides have yet been identified. Therefore, it would be valuable to consider all these measures for reinforcement of the Essential Requirements.

Table 5-17 Summary

Measures / Impact category	All reusable packaging must be recyclable, unless there is a demonstrable robust case for an exemption.	Guidance on effective reuse systems developed through reference to a European Standard.	Mandate reuse for some transport packaging.
GHG savings	↗	↔	↗
Material efficiency	n/a	n/a	n/a
Recycling	↗	n/a	n/a
Reuse	↔	↔	↗

Economic costs	↔	↔	↔
Social impacts	↗	↗	↗
Enforceability	↗	↔	↗↗

5.3 Requirements specific to the recyclable nature of packaging

The existing essential requirements include the following condition to be met by those placing packaging on the market i.e. suppliers:[150]

- "A certain percentage by weight" must be recyclable if the packaging is intended for recycling;

As concluded in section 5.1, this should be replaced by a requirement for all packaging placed on the market to be recyclable by 2030, not just a "certain percentage by weight". Both existing and proposed requirements rely on a definition of 'recyclable' in order to be operationalised. Firstly, it is important to highlight the difference in the terms 'recyclability' and 'reusability', as opposed to 'recyclable' and 'reusable'. The call within the Plastics Strategy is that all plastic packaging can be reusable or recycled in a cost-effective manner: whilst the terms 'reusability' and 'recyclability' are suggestive of a measure of the degree to which packaging can be recycled or reused, the call within the strategy suggests a binary definition where material either does, or does not comply with a definition of 'reusable or recyclable in a cost-effective manner'. In order to respect the proposed measure for reinforcing the Essential Requirements, and the call in the Strategy, a point of delineation is required between what does, or does not comply with the definitions of 'reusable' and 'recyclable'.

The existing definition of recyclable packaging is operationalised through reference to European Standard EN 13430 "Packaging - Requirements for packaging recoverable by material recycling". This standard is mainly oriented around providing a check-list for designers to work through when considering how packaging placed on the market might be designed with recyclability in mind. However, the following adapted wording is the closest to what might be considered elements of a definition of recyclable:

The construction, composition, combinations and separability of components of packaging shall ensure that the packaging is compatible with the specifications of related recycling technologies and takes into account:

[150] EN 13427 includes "Supplier" as the 'entity responsible for placing packaging or packed product on the market', with the note that: the term "supplier" in normal usage can relate to various points in a supply chain. For the purpose of this standard it relates to any point in the supply chain where a transaction relating to packaging or packed product takes place.

- *substances or materials that are liable to create technical problems in the recycling process;*
- *materials, combinations of materials or designs of packaging that are liable to create problems in collecting and sorting before material recycling;*
- *the presence of the amount of substances or materials that are liable to have a negative influence on the quality of the recycled material;*

as referenced in CR 13688.

Standard CR 13688 includes some examples of components of packaging that negatively affect the recycling processes by main packaging material type, but not a comprehensive list.

The above suggests that packaging is recyclable if it can be collected, sorted and reprocessed without causing problems for the necessary systems and does not negatively influence the quality of the recycled material. As discussed in Section 2.1.5, evidence suggests that there are multiple different functional units of packaging that do cause problems for the collection, sorting and recycling processes, and do negatively affect the quality of the recycled material. This suggests that there are two key considerations here. Firstly, the nature of the definition itself, and secondly, how the definition is operationalised in practice. In the existing case, design considerations related to the recyclable nature of packaging are made with reference to a self-certification process within a voluntarily applied European Standard.

A different approach is therefore required. This was supported by the majority of stakeholders during the interim workshops of the study (see Appendix D for the report from the second stakeholder workshop). Both the definition and means to be operationalised were considered; indeed, they are both strongly interlinked. The nature of the definition determines how it would be operationalised, and the nature of the method determines how effective the definition is in practice.

The existing approach of suppliers self-certifying with qualitative statements provided in a voluntarily applied European Standard was not considered as it has been proven to be ineffective. A range of approaches was developed through the study and tested with stakeholders at the aforementioned workshop. The objective of the assessment was to seek to define a methodology that had a clearly defined approach, facilitated enforcement and was feasible from an operational and cost perspective. The three main methods considered were qualitative statements with increased enforcement, design for recycling (DfR) criteria and quantitative metrics.

The views from the participants of the second stakeholder workshop suggest that the approach to defining recyclable should take the following into account (though there was no clear consensus on the importance or priority of one or other aspects across the participants):

- Ensure minimum scope for variable definitions across the Member States to minimise fragmentation of the single market;
- Balance specificity and enforceability with administrative burden;
- Allow consideration of and adaptability to new technologies to ensure innovation is not hampered;
- Setting the right balance between prioritising equal treatment of materials and targeting specific materials where the need to increase recyclability is more wide spread and/or complex;

- Ensure packaging's functionalities and performance are not hampered;
- The chosen approach is harmonised with (likely) approaches to setting EPR fees in order to minimise disruption; and/or
- Coherence with other legislation.

Regarding all approaches, it is clear that if the methods were applied at the Member State level they may differ because of differences in recycling infrastructure at the Member State's level. This would result in different decisions being made on what was recyclable and what was not. This fragmentation of the single market is not an outcome that is desired. Therefore, the geographical scope of the approaches to defining recyclable have been considered at an EU level only. There is some risk of defining recyclable at the EU level. If a piece of packaging was defined as recyclable but the infrastructure in a Member State was not yet available, it might lead to confusion for citizens. However, this could be tackled through appropriate labelling e.g. 'check availability of local recycling infrastructure' etc. Equally, this could lead to a drive to improve the infrastructure in place. Further details on approaches to labelling are given in Section 5.5.1.

Any of the new approaches to defining recyclable packaging should be specified in the Essential Requirements itself. The use of Standard EN 13430 'Requirements for packaging recoverable by material recycling' is therefore no longer required for such a purpose and reference to it should be removed in this context. However, there are features of the standard that could still help packaging designers think about design for recyclability so it could be considered how the standard might be updated to remove unnecessary elements (e.g. proving compliance with 'a certain proportion' of the packaging needing to be recycled) and update the design guidance more broadly.

The various measures relating to how recyclable could be defined are now explored further in the following sections, and include:

- Recyclable defined by qualitative statements only.
- Recyclable defined by use of design for recycling methodologies to define positive and negative lists of packaging.
- Recyclable defined by use of a recycling rate threshold.
- Quantitative scoring mechanism e.g. Cyclos HTP.
- Recyclable defined by a combination of both DfR and recycling rate approaches.

Measures

Recyclable defined by qualitative statements.

The first potential approach to defining recyclable seeks to utilise qualitative statements only. The objective is to clearly set out rules for the suppliers of packaging to adhere to. A review of definitions of recyclable was carried out (see Appendix C). The following sets out some of the definitions from the review and others highlighted by stakeholders during the study:

- *Classify packaging as 'recyclable' if it meets the definition set in ISO 18604 standard on packaging material recycling, as well as the criteria set in Article 6(a) of the PPWD for calculating actual recycling. Recyclable packaging would then be defined as packaging which "can be diverted from the waste stream through available processes and* *programmes and can be collected, processed, and returned to use in the form of raw materials or products".*

- *A clear and harmonized definition of "recyclable" packaging based on the applicable standards and in line with Article 6a of the PPWD for calculating recycling targets. In other words, packaging which enters recycling operations for reprocessing into products, materials or substances (after the preliminary operations referred to in Article 6a(b)) would be recyclable.*
- *The ER should include a clear definition of recyclability which is material neutral and factual. The criteria for recyclability specified in the harmonised standard EN 13430 provides a broadly agreed basis (e.g. the ability of the packaging material to be collected, sorted and recycled–see above for the definition encompassed in the EN standard).*
- *Each packaging format has to be:*
  - *1. collectable,*
  - *2. sortable,*
  - *3. recyclable (technically/protocols) and*
  - *4. this has to happen in practice and "at scale" somewhere in the world.*
  - *The last criterion was defined with the intentions to exclude*
    - *a. mere theoretical assessments*
    - *b. political drivers*
- *Recyclability is the capacity of a material to substitute primary raw materials. It measures the qualitative and quantitative ability of a product to substitute primary raw materials in the post-use phase via the material-specific process chain. Recyclability means that packaging waste is collectable and sortable via existing and sufficiently supplied collection and sorting infrastructure and that individual materials can be efficiently and effectively separated in the waste management chain. The process generates recyclates of such a quality that they can find a market, effectively replacing equivalent virgin material in a 1:1 ratio. The reprocessability of the separated packaging materials must enable recirculation in existing end markets.*
- *The recyclability of a plastic product is defined as its ability to be collected, sorted and recycled in an efficient and economical way to produce new raw materials for use in the production of new products.*
  Additionally, to be considered recyclable, a plastic product must meet four conditions:
    - *I. The product must belong to a family or segment of plastics that can be collected for recycling.*
    - *ii. The product must be sorted and aggregated into defined streams for recycling processes.*
    - *iii. The product must be compatible with existing industrial recycling processes or will have to be available in sufficient quantities to justify operating a new recycling process.*
    - *iv. The recycled plastic must necessarily become a raw material that is used in the production of new products.*

  Innovative materials must demonstrate that they can be collected and sorted in sufficient quantities, must be compatible with existing industrial recycling processes or will have to be available in sufficient quantities to justify operating new recycling processes.

The majority of the definitions are material neutral and suggest that recyclable packaging is such that it replaces primary materials through actual recycling and sale on secondary materials markets, not just in a theoretical sense i.e. the ability of a material to 'reacquire' the properties and economic value that it had in its virgin state. To do this, references are made to the ability of the packaging to be collected, sorted and recycled through relevant industrial processes, and that the material is of sufficient quality to find a market i.e. whether the packaging is regarded as valuable material in the recycling process (not simply tolerated within the specifications of the respective recycling technology). It is also pointed out that the definition of recycling should be aligned with the new calculation rules in Commission Implementing Decision (EU) 2019/665.[151]

The capture of materials relates both to the nature of the collection system in place, and how well the service is used. It could be argued that these elements do not influence whether an item is *recyclable*, but rather, determines whether it is *recycled* or not in a given location, or the extent to which it is recycled. It is clear, however, that if a packaging item is not collected at all, or in the appropriate stream, it is far less likely to be recycled.

Whilst not mentioned in these definitions, the objective stated in the Plastics Strategy suggests recycling should be in a 'cost-effective manner'. In principle, all packaging might be considered 'recyclable' if enough time and money were available to spend on the process (from collection through to final reprocessing). It may, therefore, relevant to consider the economic viability of recycling the packaging item on a commercial scale. If a particular type of packaging is only placed on the market in small quantities, or if it is very difficult to separate into individual material factions, it may not be cost-effective for businesses to invest in technology to sort or reprocess it. In this scenario, even if a process to recycle the packaging did exist is theory, in reality it is likely that only a very small proportion of that packaging placed on the market would be recycled. However, what is considered cost-effective in a given Member State will be dictated, in large part, by the nature of policies, including targets, which are in place, and would implicitly result in disharmonised definitions across the Member States, precisely because what is cost effective in one Member States may not be cost effective in all other Member States. Therefore, as adhering to economic criteria might not be appropriate, it seems necessary to ensure the definition avoids the use of this term. Moreover, cost effective recycling is, in effect, a consequence of the recycling targets, and the setting of such targets does take cost effectiveness into account in the required impact assessment, so cost effectiveness is already being taken into account. Therefore, it is recommended not to include reference to recycling in a 'cost effective manner' in the definition of recyclable.

The majority allow, it would seem, for a package to be considered as recyclable if it is recycled somewhere, at an undefined scale – although one definition does mention 'industrial' recycling processes, possibly intending to imply a larger scale. This would mean that a package that is not widely recycled owing to the expense incurred in recycling it could meet the definition by being recycled on a small scale in a specific location, such as a single trial technology with limited capacity.

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[151] Commission Implementing Decision (EU) 2019/665 of 17 April 2019 amending Decision 2005/270/EC establishing the formats relating to the database system pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (notified under document C(2019) 2805) (Text with EEA relevance.), https://eur-lex.europa.eu/eli/dec_impl/2019/665/oj/eng

Therefore, other stakeholder definitions – such as that proposed by the Ellen MacArthur Foundation in its Global Commitment – make reference to 'at scale' being required:[152]

A packaging (1) or packaging component (2,3) is recyclable if its successful post-consumer (4) collection, sorting, and recycling (5) is proven to work in practice and at scale.

Notes

1. In the context of a 2025 timeframe and the Global Commitment, a package can be considered recyclable if its main packaging components, together representing >95% of the entire packaging weight, are recyclable according to the above definition, and if the remaining minor components are compatible with the recycling process and do not hinder the recyclability of the main components. Otherwise, only the recyclable components of a package (or the recyclable parts of components - see footnote 3) can be counted towards achieving this commitment, and only when other components do not hinder or contaminate their recyclability. Examples

- *If a bottle and its cap are recyclable, the packaging can be claimed to be recyclable if it has a label (<5% of total weight) that does not hinder the recyclability of the bottle and cap.*
- *If that same bottle has a label that hinders or contaminates the recycling of the bottle and cap, the entire packaging is non-recyclable.*
- *If a package has (a) certain component(s) that are not recyclable and that make up >5% of the total packaging weight (e.g. 12%) and that do not hinder or contaminate the recycling of the remaining recyclable components of the package, then only that recyclable part (e.g. 88%) can be counted towards this commitment. Longer-term, the aim should be for all packaging components (e.g. including labels) to be recyclable according to the above definition.*

2. A packaging component is a part of packaging that can be separated by hand or by using simple physical means (ISO 18601), e.g. a cap, a lid and (non in-mould) labels.

3. A packaging component can only be considered recyclable if that entire component, excluding minor incidental constituents (6), is recyclable according to the definition above. If just one material of a multi-material component is recyclable, one can only claim recyclability of that material, not of the component as a whole (in line with US FTC Green Guides and ISO 14021).

4. ISO 14021 defines post-consumer material as material generated by households or by commercial, industrial and institutional facilities in their role as end users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. It excludes pre-consumer material (e.g. production scrap).

5. Packaging for which the only proven way of recycling is recycling into applications that do not allow any further use-cycles (e.g. plastics-to-roads) cannot be considered 'recyclable packaging'.

6. ISO 18601:2013: A packaging constituent is a part from which packaging or its components are made and which cannot be separated by hand or by using simple physical means (e.g. a layer of a multi-layered pack or an in-mould label). (Ellen McArthur Foundation).

The EMF definition introduces some additional elements to those highlighted above. For example, the functional unit of packaging could be considered recyclable if its main packaging components together represent >95% of the entire packaging weight, and if the remaining minor components are compatible with the recycling process and do not hinder the recyclability

[152] https://www.ellenmacarthurfoundation.org/assets/downloads/Global-Commitment-Document-to-download-on-website-2.pdf

of the main components. Other stakeholders have suggested a range of 90-95% as a suitable threshold. The compatibility of components with recycling processes is already referred to by EN 13430 with reference to Standard CR 13688 (last updated in 2008), as discussed above. This approach is valuable as there are many components within a functional unit of packaging that are required but may not be recyclable themselves e.g. glues, labels etc. Setting a threshold allows for some flexibility which may be necessary to avoid a significant proportion of the packaging market being defined as unrecyclable (which may be the case if 100% of all packaging, including components, had to be recyclable). However, a clear definition of what components are, or are not, compatibly with the recycling process, and do, or do not, hinder the recyclability of the main components is needed e.g. Standard CR 13688 or DfR guidelines.

A further element of the EMF definition is as follows:

> *Packaging for which the only proven way of recycling is recycling into applications that do not allow any further use-cycles (e.g. plastics-to-roads) cannot be considered 'recyclable packaging'.*

The principle is similar to the recycling hierarchy approach as suggested by a range of stakeholders (e.g. APEAL, Eurofer, Eurometaux, European Aluminium and FEVE).[153] Whilst there is a desire by many to bring weight to the definition of 'high quality', stated in the WFD as being a key aspect of the definition of recycling, it is not clear that the essential requirements could be so strongly linked to the use of the secondary raw material. Moreover, some 'lower quality' end routes may be needed at certain points in time to provide markets for recyclate if demand for 'higher quality' material falls below supply. Consequently, market-based instruments may be preferable for supporting the shift to higher quality end applications than the essential requirements that are only updated on a periodic basis.

Innovative packaging design that adds value over and above existing formats may require certain treatment. Some of the more detailed definitions above point to such packaging being classified as recyclable if a commitment is made to develop a sufficient level of recycling infrastructure within a certain time horizon. Some stakeholders suggested that, given the dynamic nature of the market, producers could be required to provide proof of recyclability within three years, verified by third party, with withdrawal of the packaging and penalties attached if they cannot do so. The necessity for a time period in which infrastructure for innovative packaging would need to be developed is highlighted in the existing European Standard EN 13430:

> *"The development and marketing of new packaging materials and systems, typically giving functional and environmental benefits may precede the introduction of appropriate recycling processes. It is recognised that the development and expansion of such recycling processes may take a period of time. Provided that the supplier can demonstrate that there is development leading to the availability of industrial recycling capacity within a reasonable period of time it may be appropriate during this period to classify such packaging as recyclable."*

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[153] https://www.apeal.org/position-paper/joint-metals-and-glass-position-paper-on-the-essential-requirements-for-packaging/

This recognises the fact that infrastructure is unlikely to be developed until a certain amount of packaging is being placed on the market. If innovative packaging had to be highly recycled from day one, this would most likely exclude such packaging from entry to the market based upon the above i.e. the development and expansion of necessary recycling processes may take a period of time.

Taking the above points into account, the following qualitative definition is proposed:

> *Recyclable packaging is that which can be effectively and efficiently separated from the waste stream, collected, sorted and aggregated into defined streams for recycling processes, and recycled at scale through relevant industrial processes such that it is turned into a secondary raw material, in line with Article 6a of the PPWD for calculating recycling targets, and of a sufficient quality that it can find end markets to replace the use of primary raw material. Innovative packaging placed on the market that requires new infrastructure to be developed shall be recycled at scale within a certain period of time. At least 95% of the functional unit of packaging shall be recyclable according to this definition, with the remaining minor components compatible with the relevant recycling process and not hindering the recyclability of the main components, through reference to CR 13688.*

In terms of the mechanism to operationalise the definition, this measure proposes to incorporate the above definition into the Essential Requirements themselves and make it mandatory, as opposed voluntary through reference to EN 13430. This would set a consistent legal basis for the definition of recyclable across the EU. The reference to and use of Standard CR 13688 would need to be mandatory, or the content of Standard CR 13688 would need to be defined within the Essential Requirements, implementing act or commission decision (whatever is the more relevant comitology, recognising the frequency in which this would need to be updated). The definition would form the basis of any enforcement activity and be used by regulatory agencies to ensure compliance. In effect, presumption of compliance with a voluntary standard would be removed, and replaced by a more rigorous process – a range of possible enforcement approaches are outlined in Section 5.6.

Strengths & Weaknesses

To understand the strengths and weaknesses of the measure the outcomes of the analysis of ‘qualitative definitions’ from the stakeholder workshop (see Appendix D) summarised in Table 5-18. The analysis relates well to the definition proposed above. The definition sets basic principles that are to be followed, is material neutral, can help achieve coherence with other European legislation, is flexible and is adaptable to innovation.

It is clear, however, that there are certain tensions between applicability, ease of agreement and room for innovation, and enforcement and fragmentation of the EU market due to divergent interpretations. These tensions are derived from the ambiguity of certain words in the definition. Whilst broad definitions can encompass certain variations in packaging design, waste management practices in the Member States, market conditions etc., the inclusion of ambiguous terms leaves too much room for interpretation, and therefore, inconsistency in the application of the definition. For example, the definition still includes terminology such as ‘effectively’, ‘efficiently’, ‘at scale’, ‘relevant’, ‘sufficient’, ‘a certain period of time’, ‘compatible with’ or ‘not hindering’. All these terms leave significant room for interpretation and application across the Member States. Whilst guidance and support in application of the definitions would be provided, it still may result in different decisions being made on what was recyclable and what was not in different Member States. This fragmentation of the single market is not an outcome that is desired.

Table 5-18 Strengths and Weaknesses of Qualitative Definition as Defined during Second Stakeholder Workshop

Strengths	Weaknesses
› **Sets basic principles** › **Can help achieve coherence with other legislation and standards** › **Applicable to all materials i.e. material neutral** › **Inclusive geographic scope** › **Could support functioning of the internal market as does not depend on available facilities** › **Flexible and adaptable to innovation** › **In-line with a potential objective of ER to facilitate enforcement at the national level**	› **Lots of room for different interpretations across the Member States** › **Could lead to market fragmentation if interpretations vary widely between Member States** › **Lack of / low enforceability (some pointed out that enforceability might be strengthened through other actions)** › **Could limit innovation / be slow to implement if it takes a long time to come to a consensus about whether a format is in line with the definition or not** › **Lowest common denominator approach** › **Requires some further defining of what the minimum available infrastructure might be** › **Lack of / no ambition level**

The definition also relies, in part, to reference to a further description of what minor components are compatible with the relevant recycling processes and do not hinder the recyclability of the main components. For example, through reference to Standard CR 13688. CR 13688 is not a complete list but just a general guidance with some examples, so would be subject to a reasonable high degree of interpretation. Therefore, to be effective, these further definitions may need to be clearly defined and updated regularly to take innovation in packaging and/or recycling systems into account. Relying on what is effectively guidance on recycling processes to inform a legally binding definition could also be problematic. Consequently, legally defined lists of disruptive components may need to be implemented. This approach is discussed further below in the next measure.

In terms of the approach to operationalising the definition, there is no mechanism in the definition itself to support its implementation. Therefore, the success of application relies on how well it is interpreted and enforced. This would clearly depend on the nature of the enforcement mechanisms put in place—see section 5.6.

Distribution of Impacts

The distribution of impacts related to the requirement for all packaging to be recyclable by 2030 is outlined in Section 5.1, and related to compliance with the requirements in Section 5.6. This section assesses the impacts, and how they are distributed, related to the design and implementation of the methodology itself.

The main costs associated with producing the qualitative definition would be resource from the Commission and input from stakeholders in the form of consultation. The overall impact level would be expected to be low. If Standard CR 13688 were needed to be updated, this would require resource from CEN and related stakeholders. In this case, the impact of the measure may be higher. The costs are distributed across targeted stakeholders that are part of the packaging and packaging recycling industries.

Conclusion

The introduction of the qualitative definition proposed within the measure would seem important to, at least, set a revised common understanding of what recyclable packaging is expected to be. However, the weaknesses in ambiguity of language suggest that the measure alone is not enough to sufficiently reinforce the Essential Requirements. This view was supported by the majority of stakeholders during the course of the study. Consequently, more robust, approaches are considered below.

Table 5-19 Summary

Impact category	Summary	Summary description
GHG savings	↔	Not clear what GHG impact there might be.
Material efficiency	↔	Not clear what impact there might be, but design for recycling can affect material choice and the amount used.
Recycling	↔	Not clear what the recycling impact might be.
Reuse	n/a	
Economic costs	↘	Some costs associated with creating the definition and proving compliance. The costs of compliance would depend on the approach to enforcement (see below).
Social impacts	↔	Not clear what the social impact might be.
Enforceability	↔	Some improvement from existing approach, but still not easy to enforce against high-level qualitative statements of this nature if an appropriate degree of impact is required i.e. easy to not enforce if no effect is required.

Recyclable defined by use of design for recycling methodologies to define positive and negative lists of packaging.

An alternative method to defining recyclable packaging could be to use design-for-recycling (DfR) criteria to set a list of recyclable or non-recyclable formats. For example, the RecyClass

Platform method from Plastics Recycling Europe (see below). Or the approach taken by the German packaging register to define recyclability requirements (see below).[154]

154 https://www.verpackungsregister.org/fileadmin/files/Mindeststandard/Mindeststandard_VerpackG_2019.pdf

Figure 5-1 RecyClass Platform

	YES **Full compatibility –** **materials that passed the testing protocols with no negative impact** **OR** **materials that have not been tested (yet), but are known to be acceptable in PET recycling**	**CONDITIONAL** **Limited compatibility –** **materials that passed the testing protocols if certain conditions are met** **OR** **materials that have not been tested (yet), but pose a low risk of interfering with PET recycling**	**NO** **Low compatibility –** **materials that failed the testing protocols** **OR** **materials that have not been tested (yet), but pose a high risk of interfering with PET recycling**
Container	PET		PLA; PVC; PS; PETG
Size			
Colours	transparent, light colours	transparent, dark colours	opaque; metallic
Barrier	SiOx coating; carbon plasma-coating; PA multilayer with no tie layers; PTN alloy;	EVOH multilayer with < 3 wt% EVOH and no tie layers; PA multilayer with tie layers; monolayer PA blend; PGA multilayer ;	EVOH multilayer with >3 wt% EVOH or tie layers
Additives		UV stablilisers; AA blockers; optical brighteners; oxygen scavengers	bio-/oxo-/photodegradable additives; nanocomposites
Closure Systems	PE; PP; all with density <1 g/cm³		materials with density >1 g/cm³ (e.g. highly filled PE; metals);non-detaching or welded closures)
Liners, Seals and Valves	PE; PE+EVA; PP; foamed PET; all with density <1g/cm³	silicone with density <0.95g/cm³	materials with density >1 g/cm³ (e.g. PVC, silicone, metals)
Labels	PE; PP; OPP; EPS; foamed PET or PETG; all with density <1 g/cm³	lightly metallised labels (density <1 g/cm³); paper	materials with density >1 g/cm³ (e.g. PVC; PS; PET; PETG; PLA); metallised materials; non-detaching or welded labels
Sleeves	sleeves with partial bottle coverage in PE; PP; OPP; EPS; foamed PET or PETG; all with density <1 g/cm³	sleeves translucent for IR detection in PE; PP; OPP; EPS; foamed PET or PETG; all with density <1 g/cm³	materials with density >1 g/cm³ (e.g. PVC; PS; PET; PETG); metallised materials; heavily inked sleeves; full body sleeves
Tamper Evidence Wrap	PE; PP; OPP; EPS; foamed PET or PETG; all with density <1 g/cm³		materials with density >1 g/cm³ (e.g metal; PVC; PS; PET;PETG); metallised materials
Adhesives	water or alkali soluble in 60-80°C.	hot-melts	pressure-sensitive labels; self adhesive labels
Inks	non toxic; follow EUPIA Guidelines		inks that bleed; toxic or hazardous inks
Direct Printing	laser marked	production or expiry date	any other direct printing
Other Components	base cup, handles or other components which are separated by grinding and float/sink - all with density <1 g/cm³; PET		materials with density >1 g/cm³ (e.g. metal, RFID tags); non-detaching or welded components

Source: Plastics Recyclers Europe

Figure 5-2 Mindestandard – German Packaging Registry

Plastic packaging					
1	2	3	4	5	6
Material group	**Group no./ sort no.**	**Good material description**[12]	**Disqualification**	**Recyclable material**	**Notes on availability**
Film	310	System-compatible articles made from plastic film, surface area > A4 in size, like bags, carrier bags and shrinkwrap, including ancillary components such as labels, etc.	Aluminised plastics are disqualified	LDPE (PO) portion	
PP	324	Rigid, system-compatible plastic articles made from PP, ≤ 5l in volume, like bottles, trays and cups, including ancillary components such as closures, labels, etc.	Sealant cartridges are disqualified	PP (PO) portion	
PE	329	Rigid, system-compatible plastic articles made from PE, ≤ 5l in volume, like bottles and trays, including ancillary components such as closures, labels, etc.	Sealant cartridges are disqualified	HDPE (PO) portion	

Source: https://www.verpackungsregister.org/fileadmin/files/Konsultationsverfahren/Mindeststandard____21_VerpackG_public_hearing.pdf

The EMF definition also makes reference to the use of DfR:

> *'The available technical design-for-recycling guidelines by organisations such as APR, PRE, EPBP, RECOUP and others bring a more technical and in-depth analysis of design for recycling prerequisites. As such, these guidelines are complementary to the 'recyclable' definition of this appendix, and businesses are encouraged to refer to and apply these design-for-recyclability guidelines.'*

However, these design-for-recycling guidelines are still considered 'guidelines' in the application of the definition as proposed by EMF. In the approach proposed in this measure, the lists would be mandatory and developed through some form of technical committee. The basis of the lists would be design features (e.g. colour, barrier, label etc.) as opposed to by functional unit of packaging or format (e.g. 300ml PET clear bottle, with label X and cap Y), which would be unmanageable due to the number of permutations of functional units on the market. The lists could comprise of two elements:

1. Firstly, a **negative list** of incompatible or disruptive components that hinder recycling processes. This would be similar to the 'LOW compatibility' or 'red' lists in the DfR guidelines; and

2. Secondly, a **positive list** of criteria that define what types of packaging can be allowed on the market.

In terms of the **negative list**, there are some aspect of packaging design that many stakeholders have identified as being disruptive to recycling. Therefore, in order to shift the market away from these disruptive elements, in the shorter term, and support the achievement of the PPWD targets, the most disruptive elements that significantly impact the recycling processes should be included in the **negative list**. This list would apply to any supplier of packaging placing packaging on the market, whether SME or not. The **negative list** could include hazardous substances, such as SoVHC, depending on the measure related to the hazardousness of packaging (see Section 5.1.3).

The **positive list** of packaging types would set out what packaging was not disruptive of recycling processes. This list would provide simple direction to companies as to what packaging they can use that is definitely recyclable. The **positive list** should be based upon the elements of the generalised definition of recyclable packaging, given in the measure above, with specific consideration given to each key packaging type. The method to define the list would primarily be based upon technical discussion of the committee, but could also be complemented by quantitative metrics, such as recycling rates or scoring methods, to provide additional considerations as to what should be included in the list (see the following measures for further details). This list would cover the main types of packaging that are on the market at the point the list was defined. Methods for managing innovation in packaging design are set out below.

Whilst the **positive list** could simply be the inverse of the **negative list**, and so all packaging would fall on one or other list, it may be important to define both to allow the system to work efficiently, particularly when considering approaches to allowing for innovation (see below). This may also be important because incompatibility with recycling processes is not necessarily a binary (yes/no) function. For example, certain components or chemicals etc only become incompatible over certain thresholds. However, the thresholds may only be applicable if the total market share of packaging with certain disruptors is low. For example, as discussed by the European PET Bottle Platform in its DfR guidelines relating to use of Nylon-MXD6 (a type of polyamide (PA) resin used in a multi-layer construction):[155]

- *Data supplied from tests carried out according to the EPBP testing protocol demonstrated that processing conditions and bottle performances are not affected by high levels of Mitsubishi Gas Chemical co-injected bottles, if the co-injected bottle is used only under the following conditions:*
  - *the preform must be injected so that the MXD6 layer is only in the bottle wall with a maximum of 5% Nylon-MXD6;*
  - *the bottle must be 3-layer construction with no tie layers;*
  - *the concentration of these bottles is limited at a level up to 2% in the PET bottle market.*

The testing protocols indicate a threshold of <5% resin is compatible, but only if the concentration in the overall PET bottle market is <2%. The guidance goes on to say that if the use of Nylon-MXD6 co-injected PET bottles becomes more widespread, there will a negative effect on the colour properties of the clear / light blue PET recycling stream (e.g. yellowing). In this case, the use of co-injected MXD6 should be limited to coloured PET bottles only.

In addition, DfR guidelines for paper suggest compatibility is a linear not discreet function in certain cases, for example the following statements from CPI / WRAPs DfR guidance document:[156]

- *The industry favours peelable liners and windows*
- *The industry prefers to receive adhesives that do not plasticise at temperatures of 35 degrees celsius and above*
- *The industry would prefer not to receive cured UV varnished or varnishes that breakdown into molecules with microplastic properties*
- *Moisture resistant papers can be dealt with by mill systems but are not preferred feedstock and may not be fully recycled.*

This suggests that a simple delineation between recyclable and unrecyclable may not be straightforward. Not least as the use of certain slightly incompatible components may be highly valued by some suppliers and therefore challenging to remove completely. However, to define as recyclable certain components that, to some extent, disrupt recycling processes may also pose some risk. A means to address this challenge, and also to help avoid prolonged procedures in coming to a firm agreement on the allocation of all packaging to one of only two lists, could be to define the two **positive and negative lists** for the most clearly compatible and non-compatible design features only. In between these two lists, packaging could be designed that did not meet all the conditions of the **positive list** but, of course, did meet all the conditions of the **negative list**. These types of packaging could be added to either list during the course of future updates. In order to mitigate any risks, as well as incentivise the industry to maximise alignment with the **positive list**, it is suggested to mandate more stringent reporting

[155] https://www.epbp.org/design-guidelines/products

[156] https://paper.org.uk/PDF/Public/Publications/Guidance%20Documents/CPI%20Recyclability%20Guidelines%20Final.pdf

requirements for any packaging that did not meet all the requirements of the **positive list**. The mandatory reporting mechanism could be to ensure the details of such packaging were reported to packaging registries in full and copied, or flagged, to national regulatory agencies, whereas proving compliance as a **positive listed** packaging type could be through self-certifying only—see further description of the proposed enforcement measures in Section 5.6. The overarching approach is summarised in Table 5-20. In essence, what this implies, though, is that the definition of recyclable packaging is any packaging that is not on the **negative list**.

Table 5-20 Summary of DfR Methodology

Packaging	Recyclable?	Allowed to be PoM?	Inhibitors	Compliance
On positive list*	Yes	Yes	None	Self-declare
On neither list*	Yes	Yes	Some	Report to registry
On negative list	No	No	High	n/a

** An alternative approach would be to have one positive list that included everything not in the negative list but a 'positive +' sub-section of the positive list would be developed relating to the currently best performing recyclable packaging, where these formats would be excluded from mandatory full reporting to the packaging registry. Any packaging type not on the '+' list would have to report in full.*

However, the objective, over time, is to minimise the packaging items that are not captured in either list. So, this mechanism is more to deal with the challenges with changing designs and systems to shift away from current solutions that inhibit recycling but would not be severe enough to warrant immediate inclusion on the **negative list**. Therefore, the objective should be for all packaging to be captured on the **positive** or **negative lists** by 2030.

The use of modulated EPR fees is also linked to this concept. The lowest fees should be charged for packaging which meets the DfR criteria in the **positive list**, and fees should be modulated for the remaining packaging (**negative list** design features are not allowed in any case) to provide incentives to reduce the amount of packaging that does not fully meet **positive list** criteria.

Before the scope and content of the lists are considered in more detail, it is worth outlining the potential approach to how the lists are developed and updated. The lists would be developed through a technical committee and updated on a periodic basis. The lists could be developed in an annex to the Directive, to be updated through a Comitology procedure, or developed in an implementing act, or other suitable legally binding document.

Exact structure and roles and responsibilities of the committee are not determined here, but could include the European Commission, packaging industry, recycling industry, civil society etc. In any case the committee would need to be chaired by an independent person or authority. The structure of the committee should be matched to its objectives and required outputs.

Testing may be needed to determine the level of compatibility of a given type of packaging in the recycling process and therefore which list it should be included in. This would have to be carried out by the industry and the results reported to the committee.

In terms of the approach to operationalising the definition, this would be through the production and publication of the above-mentioned lists. The negative list could be first defined as soon as possible after entry into force of the Directive or at least from 2025. The initial positive list could be defined in 2027, to allow time for suppliers to produce packaging that would meet the selection criteria of the list, coming into full effect from 2030. Regulatory authorities would then employ various enforcement measures to ensure the packaging being placed on the market met the conditions of the lists, and was therefore fully recyclable, by 2030. Different approaches to enforcement are set out in Section 5.6.

Lists would be defined for all material types, to be material neutral, but would be created by developing material / sector / category focused lists (as appropriate) in order to account for the specificities of packaging across the whole market, and in particular the variations in different recycling processes. The potential structure and requirements of such lists by the main packaging material types are given some consideration below.

Glass Packaging

European Standard CR 13688 only makes the following comments regarding the impact on recyclability of design of glass packaging:

- *Closures and capsules should be easily separable from the glass packaging to allow source separation by the user.*
- *Labels and sleeves of paper, plastics or aluminium foil, are generally accepted in the recycling process.*

A report on DfR for glass packaging also confirms the potential disruption to the glass recycling process from certain closures, caps and labels, but do not state they should be eliminated completely to ensure the package is recyclable.[157] However, it does mention that radio-frequency identification (RFID) tags should be avoided. These are a type of tracking system that uses smart barcodes in order to identify items through emitting radio waves of a certain frequency when the tag is activated through an electronic reader. Because they are stuck to the bottles and cannot be mechanically removed during the recycling process, the metal can disrupt the smelting process and cause blemishes in glass products manufactured from secondary raw material. This is also mentioned in the WRAP design for recyclability guidelines.[158] However, the use of RFID tags is not currently at all significant so this is unlikely to be posing a particular problem.

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[157] https://www.kidv.nl/6256/closing-the-loop-design-for-recovery-guidelines-glass-packaging.pdf?ch=DEF

[158] http://www.wrap.org.uk/sites/files/wrap/Packaging%20and%20Recyclability%20Nov%2009%20PRAG.pdf

From this, it appears as though there are no major design features that are not compatible with the recycling process for glass, and therefore all glass packaging would be defined as recyclable in the **positive list**. There may be some value in including RFID tags in the **negative list**.

Steel Packaging

European Standard CR 13688 only makes the following comments regarding the impact on recyclability of design of steel packaging:

› *Metallic components of steel packaging (steel/aluminium) do not need to be separable.*
› *Organic components (caps, sleeves) should preferably be easily separable by the user.*
› *No limitation for packaging design.*
› *Most of steel packaging applications are mono-material. When aluminium is used in combination with steel in packaging design, it does not have any adverse effect on the steel recycling process.*

From this, it appears as though there are no design features that are not compatible with the recycling process for steel, and therefore all steel packaging would be defined as recyclable in the **positive list**. There are no design features that warrant inclusion in the **negative list**.

Aluminium Packaging

European Standard CR 13688 only makes the following comments regarding the impact on recyclability of design of aluminium packaging:

› *Foil laminates require specifically adapted separation and recovery processes which allow for material recycling and/or incineration with energy recovery.*
› *Separation normally involves the recovery of the aluminium fraction using a thermal process which results in the destruction of the laminating ply, with an associated energy or by-product recovery.*

Such foil laminates are not generally recycled today. Whether they are included on the positive list or not could depend on the extent to which they are recycled at scale by 2030.

In addition, it is also known that some aluminium beer cans contain plastic 'widgets' that create head when pouring from the can similar to pump pouring from a keg i.e. non-aluminium components are included in the functional unit of packaging (e.g. plastic) that may be removed through thermal as opposed to mechanical processes before smelting. These are not considered to hinder the recycling process, however.

From this, it appears as though there are no major design features that are not compatible with the recycling process for aluminium, and therefore all, or potentially the majority, of aluminium packaging would be defined as recyclable in the **positive list**. It remains to be seen whether foil laminates warrant inclusion in the **negative list** or not.

Paper / Board Packaging

The design guidelines in European Standard CR 13688 mention that adhesive tapes, RFID tags, metal stitches, and other fasteners, non-paper labels and various other packaging adjuncts, that are not usually removed prior to delivery to the recycling operation, are effectively separated either in the initial re-pulping process itself for the larger components, or in the initial screening of the pulp. It also states that it is unusual for the components described to disintegrate into particles small enough to interfere with the paper making process. In addition, the Standard flags potential issues with laminated e.g. plastic coated paper and paper impregnated with waxy substances. More recent design guidelines highlight the same points, but provide some further detail. These are described in more detail below.

In February 2019 the British Confederation of Paper Industries (CPI) and WRAP published some paper and board packaging recyclability guidelines.[159] Towards the end of this study, in December 2019, CEPI, ACE, CIPTA and FEFCO released European paper DfR guidelines.[160]

Firstly, there is a question as to the scope of the lists within the paper / board sector and whether any sub-categorisation is needed. For example:

- Corrugated cardboard boxes
- Carton board
- Liquid packaging board (e.g. beverage cartons)
- Paper (wrappings etc)

Whilst the majority of paper / board products are recycled in similar processes the quality of secondary raw material produced is impacted differently depending on certain design features that might vary fairly significantly between key types. Therefore, setting rules for the whole market may create too weak conditions for some types to accommodate the needs of others, or eliminate certain packaging formats from the market if conditions relate to the most stringent tests. For example, the CPI guidance indicates that a maximum of 5% of any packaging should be non-paper (e.g. plastic laminates), however, the non-paper content of beverage cartons is around 25%. Beverage cartons are recycled at scale across the EU, however, so based upon this consideration they should be categorised as recyclable packaging. To support this conclusion it is helpful to consider the European guidelines, that include ACE, where there are no such thresholds under the 'Regarding metal or plastic laminates' section. Only statements relating to only using the amounts of non-paper material that are absolutely necessary and making the separation of components as easy as possible i.e. the European paper guidelines are not defining beverage cartons as non-recyclable.

The European paper DfR guidelines are potentially too vague or broad in places to translate verbatim to the **positive or negative lists**. Therefore, some further granulation or specificity may need to be developed. An initial view of a potential **positive list** is as follows:

- Regarding metal or plastic laminate
  - Plastic lamination layers do not readily degenerate or break into very small pieces in the pulping stage
  - Lamination occurs on one side only

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159 https://paper.org.uk/PDF/Public/Publications/Guidance%20Documents/CPI%20Recyclability%20Guidelines%20Final.pdf

160 http://www.cepi.org/recyclability_guidelines

- A tear-off facility is provided for plastic facing components
- Liners and windows are peelable
- Windows are easily detachable, thin, lightweight solutions

- Regarding alternative barriers from new technologies, for example polymer dispersion coated barriers and direct metallisation: when designing alternative barriers, refer to recognised recyclability test methods and test at paper recycling mills to verify performance on the following aspects:
  - The paper fraction of the packaging breaks down into single fibres when pulped within a specified time frame
  - Polymers and other sealing agents can be removed from the fibre in the conventional screening process
  - Polymers, sealing agents and application processes can be dealt with efficiently by the paper mill process and effluent water systems and do not compromise the finished product, the production process or the environment whilst being recycled
  - Direct metallisation: Metallic and other inorganic coatings applied via vacuum deposition shall not hinder the repulping process and shall be capable of being screened out

- Regarding coatings and varnishes
  - Varnishes and coatings are water soluble and not UV cured
  - Use varnishes that break down into large, discrete particles only, as opposed to small fragments or molecules with microplastic properties

- Regarding inks
  - Use mineral oil free inks in accordance with the industry commitment[161]
  - No metallic components in the ink formulation
  - For producers of food contact packaging, follow the Food Contact Guidelines for the Compliance of Paper and Board Materials and Articles.[162] Producers of inks should follow EUPIA's guidance for food contact inks.[163]
  - No more than 30% of the external surface area has metallic block printing

- Regarding adhesives
  - Adhesive amount less than X% of total packaging weight
  - No "soft" adhesives such as those adhesive tapes and self-adhesive labels with an adhesive film that cannot be separated in the recycling process
  - Adhesives are cold set, curable or water-soluble i.e. do not plasticise at temperatures of 35 degrees Celsius and above
  - Adhesives are intended for food contact application, regardless of whether packaging is food contact or not (to reduce accumulation of critical substances)

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161 http://www.cepi.org/system/files/public/documents/pressreleases/recycling/2011/Food_contact_and_mineral_oils-20111208-00001-01-E.pdf

162 Food Contact Guidelines for the Compliance of Paper and Board Materials and Articles (http://www.cepi.org/food_contact_guidelines)

163 https://www.eupia.org/key-topics/food-contact-materials/good-manufacturing-practice-gmp

  - For producers of food contact packaging, follow the Food Contact Guidelines for the Compliance of Paper and Board Materials and Articles.164 Adhesives producers should follow FEICA's guidance for a food contact status declaration for adhesives.165

- Regarding the use of chemicals
  - Use chemicals that have no tendency to accumulate in fibres over several recycling cycles
  - Do not use substances of very high concern unless an authorisation is granted for the specific use

As discussed above, many of the design features of paper packaging are acceptable or at the worst not preferred, and are not suggested to be eliminated completely i.e. made part of the **negative list**. However, there are a few specific areas mentioned in the CPI guidelines. Consequently, at least some minimum limits for non-paper constituents could be set to capture the lowest compatible packaging designs, and in which some research and testing certain threshold for other features could be set by the industry to provide some minimum standards. These suggest the possible elements of a **negative list** for paper packaging:

- Gift wrap containing glitter
- Plastic laminates:
  - >5% content for non-liquid packaging board
  - >25% content for liquid packaging board
- Packaging with more than X% of the external surface area with metallic block printing
- Papers with wax impregnation / coating over a concentration of X%

Plastic Packaging

European Standard CR 13688 includes some basic elements related to design for recycling, including mention of labels, adhesives, laminates, density etc. However, DfR guidelines have come a long way since the standard was developed, so it is more relevant to focus on these more recent documents. Firstly, however, it is valuable to consider the structure of any DfR list used for plastics given the much broader range of materials (i.e. polymers) and applications in the packaging industry. Recycling processes tend to be quite specific to individual polymers, so the minimum level of categorisations could be by polymer type. However, a broader category of polyolefins (including multiple polymers) could be used as many of the recycling process compatibility issues are common. There are also a whole range of design considerations to be taken in accordance with the various formats of packaging e.g. rigids, bottles, drums, trays, flexibles, blister packs, colour etc. So, the lists could be defined on this basis also. As the recycling processes are driven by polymer type it may be most suitable to structure the lists by polymer then format, for example:

- PET
  - Bottles
  - PET thermoformed trays
- PE

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[164] Food Contact Guidelines for the Compliance of Paper & Board Materials and Articles (http://www.cepi.org/food_contact_guidelines)
[165] http://www.feica.eu/our-priorities/key-projects/food-contact.aspx

  - Containers
  - Flexible films
  - Pots, Tubs, Blisters & Trays
- PP
  - Containers
  - Flexible films
  - Pots, Tubs, Blisters & Trays
- Others (flexible/ rigids, OPS, PVC, XPS…)

Given the number of lists that may be required, they are not all considered in detail, but some general considerations and a detailed case study for one packaging type are presented.

In terms of the **negative list**, the following design features and/or type of packaging that disrupt current recycling processes have been highlighted by various stakeholders during the course of the study:[166]

- Incompatible and inseparable combinations of polymer types, barrier layers, dyes and adhesives
- Sleeves of different polymer types to main body
- Sleeves that are difficult to remove
- Black plastics that cannot be identified in sorting plants
- High levels of pigmentation
- Non-washable inks
- Gassing inks
- Dark coloured inks
- PVC
- Full body printed labels

Regarding polyolefins, Borealis has produced a '10 codes of conduct' document that provides guidelines to suppliers to ensure that packaging is compatible with recycling processes.[167] These could be used to develop the **negative** and/or **positive lists**.

Other DfR guidelines also provide examples of what could contribute to both types of list. A good practice example of this has been produced by the European PET Bottle Platform (EPBP).[168] This platform included both suppliers and recyclers to develop guidelines for PET bottle designers to take into account. The outcomes of the collaboration resulted in product type specific DfR criteria. An example for transparent clear / light blue PET bottles is given in

Figure 5-3. The positive and negative lists could refer to the YES (green) and NO (red) columns respectively, however, it may be decided that upon investigation that some of the design features in the CONDITIONAL (orange) column should be include in either list.

[166] List defined through research during the course of the study, interviews with stakeholders, literature etc.
[167] https://www.borealisgroup.com/news/borealis-promotes-design-for-recyclability-with-ten-codes-of-conduct-for-polyolefins
[168] https://www.epbp.org/design-guidelines/products

Figure 5-3 DfR Criteria for transparent clear / light blue PET bottles

	YES Full compatibility – materials that passed the testing protocols with no negative impact OR materials that have not been tested (yet), but are known to be acceptable in PET recycling	**CONDITIONAL** Limited compatibility – materials that passed the testing protocols if certain conditions are met OR materials that have not been tested (yet), but pose a low risk of interfering with PET recycling	**NO** Low compatibility – materials that failed the testing protocols OR materials that have not been tested (yet), but pose a high risk of interfering with PET recycling
Material	PET		PLA; PVC; PS; PETG
Size			smaller than 4 cm (when compacted) or larger than 5 liters
Colours	transparent clear; transparent light blue	- -	other transparent colours; opaque; fluorescence; metallic
Barrier	SiOx plasma-coating	carbon plasma-coating; PA multilayer with <5 wt% PA and no tie layers; PGA multilayer ; PTN alloy	PA multilayer with >5 wt% PA or tie layers; monolayer PA blend; EVOH
Additives		UV stablilisers; AA blockers; optical brighteners; oxygen scavengers	bio-/oxo-/photodegradable additives; nanocomposites
Closure Systems	PE; PP; all with density <1 g/cm³		materials with density >1 g/cm³ (e.g. highly filled PE; metals); non-detaching or welded closures
Liners, Seals and Valves	PE; PE+EVA; PP; foamed PET; all with density <1 g/cm³	silicone with density <0.95 g/cm³	materials with density >1 g/cm³ (e.g. PVC, silicone, metals)

Labels	PE; PP; OPP; EPS; foamed PET or foamed PETG; all with density <1 g/cm³	lightly metallised labels (density ≤1 g/cm³); paper	materials with density >1 g/cm³ (e.g. PVC; PS; PET; PETG; PLA); metallised materials; non-detaching or welded labels
Sleeves	sleeves with partial bottle coverage in PE; PP; OPP; EPS; foamed PET or foamed PETG; LDPET; all with density <1 g/cm³	sleeves translucent for IR detection in PE; PP; OPP; EPS; foamed PET or foamed PETG; LDPET; all with density <1 g/cm³ (INTERIM: Twin-perforated sleeves for household and personal care)	materials with density >1 g/cm³ (e.g. PVC; PS; PET; PETG); metallised materials; heavily inked sleeves; full body sleeves
Tamper Evidence Wrap	PE; PP; OPP; EPS; foamed PET or foamed PETG; all with density <1 g/cm³		materials with density >1 g/cm³ (e.g metal; PVC; PS; PET; PETG); metallised materials
Adhesives	water or alkali soluble in 60-80°C	hot-melts ; pressure-sensitive labels	
Inks	non-toxic; follow EUPIA Guidelines		inks that bleed; toxic or hazardous inks
Direct Printing	laser marked	production or expiry date	any other direct printing
Other Components	base cup, handles or other components which are separated by grinding and float/sink - all with density <1 g/cm³; unpigmented PET		materials with density >1 g/cm³ (e.g. metal, RFID tags); non-detaching or welded components; coloured PET;

Source: EPBP

Plastics Recyclers Europe has developed a wider range of DfR guidelines for plastic packaging, with the same approach taken to define the respective lists. To provide a user-friendly approach to accessing the guidelines, the RecyClass tool was developed.[169] The various guidelines include:[170]

- PE Coloured Flexible film
- PE Transparent Flexible film
- PP Coloured Flexible film
- PP Transparent Natural Flexible film
- PE-HD Coloured Containers
- PE-HD Natural Containers
- PP Coloured Containers
- PP Natural Containers
- PO (polyolefin) Pots, Tubs, Blisters & Trays
- PET thermoformed trays clear transparent (to be recycled even in food applications)

Other DfR criteria for plastic packaging have also been produced. As indicated in Section 2.1.5.

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[169] https://recyclass.eu/

[170] https://plasticsrecyclers.eu/downloads

The range of DfR guidelines for plastic packaging that have already been developed could be used as the basis for producing the positive and negative lists. The content of such lists are not suggested here due to the number of variations and complexity of the issues, but the example references given can be reviewed to assess the type of design features that are more or less compatible with plastic recycling processes, and therefore what might be included in the lists in future.

Implementation Time-frame and Allowances for Innovation

It would be important to ensure that there were clear allowances for innovation in such an approach. Whilst not all innovation leads to desirable economic, environmental and social areas outcomes, new packaging designs can add value to the economy, reduce overall environmental impact and increase consumer satisfaction. Therefore, some mechanisms for adapting the lists in response to innovation would be required. This is important, as the lists would be defined on existing recycling processes. A good case study in this respect is carbon black trays. Currently, the recycling rate of these trays is very low and incompatible with existing recycling technologies. In this case, black trays may end up in the **negative list** of packaging and excluded from the market. However, innovation in colourant and sensor-based technologies is ongoing and may result in high levels of recycling of such packaging in future. Consequently, the packaging would be defined as recyclable and thus suitable for inclusion on the **positive list**.

This challenge could be approached by providing enough time after initial development of **negative list** until the lists became mandatory requirements for what could be placed on the market or not, and if they were revised such a time. For example, if the lists were defined in 2022, and some packaging types were highlighted as potentially unrecyclable, they could be provisional placed on the **negative list** if the industry indicated strong innovation activities were taking place. The lists could be redefined in 2028, giving six years for technical innovation to occur, and provisional decisions finalised. In addition, this would provide five years of design changes driven by modulation of fees that would come in from 2023. The final lists would then set the requirements for all packaging to recyclable by 2030.

In terms of the **positive list**, if this did not cover all packaging not on the negative list there would be some room for innovation here. If it did, sufficient time would need to be given from announcement until finalisation of the list to allow for suppliers to respond and produce packaging that would meet the requirements of the list that it might not currently do, because it might be early in the product development lifecycle. The actual implementation of the **positive list** would not occur until 2030, after the list itself was finalised in perhaps 2027. It would be updated every three years to allow for new innovative packaging to be added. This would give time for packaging producers to adapt and ensure their packaging was suitable for including in the positive list by the time the assessment came round in 2027. Each time the positive list was renewed companies would have three years to comply with the changes i.e. if an item is removed from the green list.

Stakeholders also suggested that innovative materials could be allowed onto the market as long as the fees under EPR were high enough to pay for the necessary investments in infrastructure to be able to sort and recycle them effectively. This could be a mechanism for allowing innovation. The level of fee could also depend on national availability of necessary recycling infrastructure. However, some suggested that this ‘penalisation’ of access to market could still stifle innovation if it were not promoted or support through other channels.

Exemptions from both lists may need to be applied at any point when the lists were being defined. This would seek to ensure that packaging with critical functionality, for example in the healthcare sector, could remain in use, even if it could not be defined as recyclable.

Strengths & Weaknesses

The strengths and weaknesses of DfR criteria approaches in general were discussed at the second stakeholder workshop. These are summarised in Table 5-21. A key strength of the approach considered here is the more precise and robust nature of the method to defining recyclable, which would render it more effective than qualitative statements alone. The specificity would allow detailed consideration of what characteristics of packaging actually deem it to be recyclable or unrecyclable at a material specific level. This is potentially important given the wide range of materials, products, recycling processes and compatibility issues that have been identified. The approach, therefore, could avoid some of the issues related to ambiguity of broad qualitative definitions, as highlighted above. Linking the approach to the methodology for fee modulation used by EPR schemes would maximise the positive effects of both policy mechanisms; however, only if systems for compliance were also aligned—see enforcement section (5.6) for more details—to avoid duplication of efforts by suppliers. There have been some successes in bringing the whole value chain together to optimise packaging design for recycling (e.g. EPBP, CEFLEX etc.). The use of DfR criteria would clearly need cross value chain collaboration, which would bring additional benefits from pooling of ideas and expertise where it may not have happened otherwise. It may also help encourage innovation once the boundaries have been clearly defined. In addition, the clearly specified lists of what would be defined as recyclable could aid enforcement activities.

The potential downsides to the approach are that, being too prescriptive, certain uses of packaging are penalised, either from a functionality, cost or environmental perspective. There was also some concern from stakeholders that this would limit innovation. The suggested approaches to accommodating innovation should help mitigate this concern, and as long as the approach to defining the lists includes packaging designers and suppliers the aforementioned competing demands should be accommodated. A further weakness in relying on technical committees to define such lists is the administrative effort and potentially lengthy time taken to come to a consensus. It is important, therefore, that the committees are run by independent authorities who can make final decisions and that there is an efficient and swift appeals process. Moreover, this weakness would be more of an issue if the **positive** and **negative lists** were defined to incorporate all potential packaging placed on the market. If this were the case, gaining cross value chain consensus would be more challenging. If the lists focused on defining the definitively unrecyclable, and therefore excluded packaging, and the most recyclable packaging only, consensus would be less challenging and quicker to achieve. As mentioned above, the remaining packaging would be subject to more detailed and mandatory reporting requirements related to its design, composition, materials etc. (as well as being influenced by modulated EPR fees based upon recyclability).

Table 5-21 Strengths and Weaknesses of DfR Criteria Approach to Defining Recyclable as Discussed during the Second Stakeholder Workshop

Strengths	Weaknesses

› **'Badly designed' products would be taken out of the market (those for which there is no infrastructure, market or have disruptive characteristics e.g. non-compatible)** › **Supports high quality recycling if e.g. hazardous chemicals are not included, or products are designed for the material to be recycled multiple times, or packaging is simplified** › **Aligns actors across the value chain (e.g. designers, brands, recyclers etc.)** › **Encourages innovation if a value chain approach is taken, gives a clear guide as to where the direction should go and helps to design cost-efficient infrastructure** › **Could link enforcement to EPR schemes / modulated fees approaches**	› **Risk of too prescriptive design rules** › **Might / will impact innovation if too prescriptive / material specific** › **Possible overlap with EPR fee modulation needs consideration** › **Enforceability** › **May not consider packaging functionalities e.g. safety, hygiene etc.** › **DfR is not equivalent to 'eco-design' so the approach does not consider sustainability more broadly** › **Risk of downcycling**

Distribution of Impacts

The distribution of impacts related to the requirement for all packaging to be recyclable by 2030 is outlined in Section 5.1, and related to compliance with the requirements in Section 5.6. This section assesses the impacts, and how they are distributed, related to the design and implementation of the methodology itself.

The main cost associated with this measure is that of producing and updating the lists on a periodic basis. Setting up and running a technical committee would imply some reasonable costs, particularly at the start. The process should become more efficient over time and therefore the cost of updating the lists every three or so years should fall over time, and probably plateau. The nature of the costs would include the administration of the committee, organisation of technical meetings, tests needed to determine the quality of recyclate from various compositions of packaging to determine its recyclability, the production of technical reports and the lists themselves. The distribution of costs would depend on the composition of the committee, but would be expected to fall on the Commission, the packaging producers and the packaging recycling industry, in the main. The costs are distributed across targeted stakeholders that are part of the packaging and packaging recycling industries. The overall impact level would be expected to be medium/high.

Conclusion

Whilst there are likely to be costs to develop and maintain the lists used to define recyclable packaging, the costs are mainly distributed on producers who have a responsibility for the packaging they place on the market, and the recyclers who will benefit from more recyclable packaging being in the waste stream (higher yields, increased quality, lower disposal costs etc.). Moreover, the effectiveness of the measure in ensuring packaging is actually recyclable will be significantly higher than the broad qualitative definition alone. This is particularly relevant for plastic packaging where the greatest shift from unrecyclable to recyclable is likely to occur. This will support the increase in recycling rates over time and deliver associated environmental benefits (see summary in of these in Section 5.1).

Table 5-22 Summary

Impact category	Summary	Summary description
GHG savings	↗	As the measure is more enforceable more recyclable packaging would be expected so there may be GHG savings.
Material efficiency	↔	Not clear what impact there might be, but design for recycling can affect material choice and the amount used.
Recycling	↗	As the measure is more enforceable more recyclable packaging would be expected so there may be an increase in overall recycling.
Reuse	n/a	
Economic costs	↔	Not clear what the balance of costs might be. Some costs associated with creating the definition and proving compliance. The costs of compliance would depend on the approach to enforcement (see below). Recyclable packaging may be more expensive or cheaper, the costs of waste management might be cheaper than disposal of unrecyclable packaging.
Social impacts	↗	As the measure is more enforceable more recyclable packaging would be expected so there may be an increased consumer amenity, and potentially more jobs.
Enforceability	↗	Clear DfR standards would be enforceable. Some effort in creating the standards and monitoring packaging against them would be required.

Recyclable defined by use of a recycling rate threshold.

It could be argued that the most important factor determining whether a piece of packaging could be claimed as ‘recyclable’ or not is whether it is actually recycled. Therefore, a quantitative definition of recyclable could be developed based on a product category or product level basis. For example, the definition would be ‘packaging is recyclable where it is recycled over a certain threshold (e.g. 20%) across the EU’. As mentioned above, an EU wide approach only is considered as Member State level recycling rates would be highly variable and the varying definition would distort the single market.

This would clearly require data on the amounts placed on the market and recycled of a much more granular level of categorisation than currently exists. The Ellen MacArthur Foundation New Plastics Economy Global Commitment also makes a link to the use of recycling rates as a quantitative means of defining ‘at scale’.

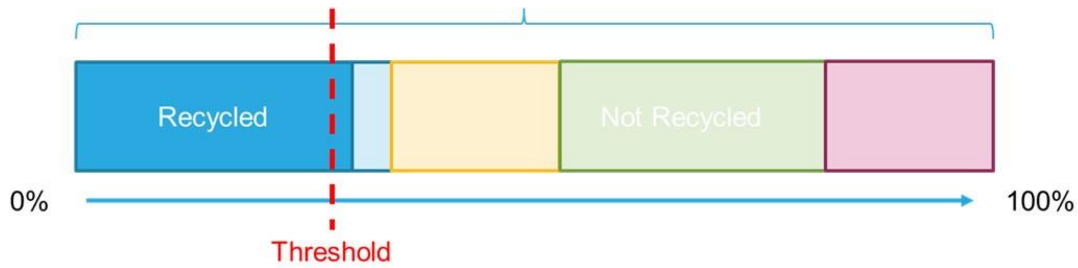
> *'One metric to determine to what extent these prerequisites are in place, and, therefore, if recycling of a certain packaging works in practice and at scale, would be the actual recycling rate. However, data on recycling rates by packaging type is very scarce and, therefore, does not yet allow for a fully quantified metric to be developed.'*

EMF is currently investigating this approach further as a quantitative means to defining 'recycling at scale', to support the robustness of their definition used in their global commitments.[171]

The most important aspects to consider are the production of data needed to calculate the recycling rate (i.e. the denominator and numerator) and what level of granularity of categories of packaging are to be used. In terms of the data, the tonnage of packaging **placed on the market** (the denominator) is already being submitted to EPR schemes, although at a more aggregated level of categorisation. These categories are increasing in number due to the introduction of modulated fees (with the driver to more accurately apply the costs of recycling based upon the format specific costs rather than the average). Nevertheless, producers should either already have or relatively easily be able to access the weight of packaging for specific products sold in the majority of cases.

The more challenging aspect is the production of data related to the amounts **recycled** (the numerator) of a given category. There is a clear trade off here between the level of granularity and effort involved in gathering the data. If the category is too wide there could be a whole range of different formats within it, some of which could be recyclable some of which not. In this case, the threshold could just be met but the remainder could be unrecyclable other formats. This is exemplified by Figure 5-4. Each block of colour represents a different format (e.g. blue, yellow, green, purple) within one larger category. The threshold for the category can be met if just one format is highly recyclable and recycled (the blue format). The other formats do not have to be recycled at all to meet the threshold, seriously disincentivising the driver to design them to be 100% recyclable. This would not achieve the aims of the measure.

Figure 5-4 Example of Threshold Issue Related to Broad Categorisation



If the category is too narrow, the effort involved in identifying a small amount of waste in the overall recycling stream could be highly significant. If each permutation of material, adhesive, label, ink etc. were considered, there may be hundreds of thousands or a million categories to calculate the recycling rate for. The number could be reduced if the categories did not distinguish between formats with small quantities of disrupting material, by including a

[171] https://www.ellenmacarthurfoundation.org/assets/downloads/Global-Commitment-Document-to-download-on-website-2.pdf

requirement that at least 95% of the packaging had to be recyclable, for example. Even so, there may still be hundreds to tens of thousands of design features and respective categories.

The method to produce the data on the amounts recycled would have to be aligned with the new calculation rules on recycling.[172] In practical terms, some sampling of the recycling stream would have to be carried out. Under the new rules some sampling is likely to have to be carried out at the input and output of recycling plants in order to identify the amount of packaging and non-packaging materials that are recycled. These sampling surveys could potentially be expanded to include a greater level of granularity to produce data at the category level.

The production of such data is potentially something that could be mandated through relevant statistical regulations. However, it would still need to be measured or estimated. Currently, the amount of waste in the recycling stream that would need to be sampled to produce an estimate at a format level to a reasonable level of statistical accuracy, relates to the proportion of the waste stream that the specific category makes up. If the proportion is small, the number of samples needs to be higher. The number of samples could be reduced using stratification methods, using strata such as: material, region, collection system, recycling technology, consumption indicators (GDP) etc. To test the potential scale of the sample size a scenario was considered where 35 million tonnes of packaging waste were being recycled across the EU. Using some statistical methods, it was estimated that if there were 1,000 categories then the sample size would need to be 20,000 to 30,000 tonnes. This estimate can be scaled, so for 100 different categories, the sample size would be 2,000 to 3,000 tonnes, and 10,000 categories, 200,000 to 300,000 tonnes of samples.

The size of the samples needed appears to be prohibitive if a detailed level of categorisation were needed. Separating the samples out into a significant number of fractions would also add considerable cost. For some specific categories which comprised a larger proportion of the market it may be feasible to carry out the sampling in a more cost-efficient manner, as the sample would be smaller and the segregation into one or a limited number of fractions would be much quicker.

The sampling would certainly be more cost effective if the categories were broader, but as stated above, there would be a reasonably high likelihood that this would result in a large proportion of the category remaining unrecyclable. The threshold could be increased significantly but the more obvious instrument to achieve the same effect would simply be to increase the recycling target and drive the increase in recyclable packaging in that way.

Looking forwards, however, there are new technologies being developed that would make identification of recycled amounts by the individual functional unit of packaging highly efficient, and thus the production of data much more cost effective and achievable. The approach would utilise digital watermarking technology and sensor equipment to register the number of individual functional units of packaging sorted through sorting plants. This type of technology is in the development stage, but likely to be commercially operational by 2021-2022 (see further details in Section 5.5.3). If the total number of packs sorted could be combined with average pack weights, the total weight of material recycled could be calculated. This would allow functional unit specific recycling rates to be calculated. As the technology is not yet fully

[172] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02005D0270-20190426&from=EN

developed it is not suggested to recommend the method to define recyclable packaging as yet, but after the proposed technology review clause in 2025 (again, see Section 5.5.3) it may be valuable to evaluate the potential application of the methodology to help define recyclable using functional unit specific recycling rates in future.

In terms of the approach to operationalising the definition, the means are implicit in its design. Where a recycling rate were shown over the threshold level the packaging would be defined as recyclable, if not it would be defined as unrecyclable. The time period over which the packaging would have to be shown to reach the threshold would need some consideration. If enough lead in time were given before 2030, systems could adapt over that period so that packaging not currently recycled at the threshold level could be recycled enough by that point in time. For new packaging formats placed on the market after 2030, if the packaging had to show compliance within a year of first being placed on the market this may provide a barrier to entry. If the packaging could be recycled through existing infrastructure this may not be so much of a problem as long as it had been tested to work effectively in such systems. It becomes more challenging when new infrastructure is required. There would be some reluctance to invest in new infrastructure to recycle packaging before it was placed on the market in case, for whatever reason, the development and launch ended up being cancelled. In this case, the investment in the new infrastructure would be wasted. Alternatively, infrastructure investment may be more palatable if a certain volume of the new packaging were already being placed on the market. However, the packaging then may not be being recycled in the short term.

To help avoid the situation where packaging was placed on the market for a certain period of time and was found to miss the threshold, Member States could apply an additional penalty. In addition, the same format could not be reintroduced for a period of X years after missing the threshold test.

Strengths & Weaknesses

The strengths and weaknesses of quantitative metric approaches in general were discussed at the second stakeholder workshop. These are summarised in Table 5-23. The key strengths of the approach considered here is that being a target-based approach it is clearly measurable at a given point in time. As it is measurable against a threshold it is more objective and more easily operationalised and enforced (data dependent) than other approaches. It also provides a reasonable amount of flexibility for the packaging industry as it is not a prescriptive 'how' but more a target to work within. In addition, because the definition is based upon actual performance it gives an incentive for investment in recycling systems to ensure the threshold levels are met.

In terms of the weaknesses, one the main issues is the trade-off between the segmentation of the market into smaller more targeted categories for a target to be applied, and the effort involved in obtaining data on the amounts recycled. If a large number of categories were used the reporting burden could be highly significant. The effort involved would be less if recycling rates for a limited number of categories were to be calculated. As pointed out above, if the definition is based upon current recycling rates only, this could hamper innovation if there were not some mechanism to allow for new infrastructure to develop over a period of time such that the threshold rate could be proved. The stakeholders also expressed some concern over the challenge of agreeing and setting the threshold level itself. In addition, it was pointed out that a quantitative metric does not take quality into account. Likewise, it does not take into account the fact that there is scale of compatibility with recycling processes, as discussed above under the DfR approach. For example, 50% of a packaging format might be recyclable but cause a lot of issues in the recycling process to limit yields for itself and other packaging types.

Table 5-23 Strengths and Weaknesses of Recycling Rate Approach to Defining Recyclable as Discussed during the Second Stakeholder Workshop

Strengths	Weaknesses
› **Target driven** › **Time dependent** › **Not prescriptive on 'how'** › **Measurable (would need to be in-line with rules on measuring recycling)** › **Clearly enforceable** › **Could act as communication tool** › **Can be more objective, depending on methodology used** › **Could be 'fast' with value chain reacting accordingly** › **Could be defined at different levels (e.g. format, type etc.) although unlikely that it could be at the level of each specific packaging item** › **Provides an incentive for infrastructure to be developed**	› **Not a level playing field across Member States if country specific (hence diverging) recycling rates were used with no homogeneous result** › **Hampers innovation if based on current technologies and infrastructure** › **Relevance of the quantitative indicators or metrics used to define recyclable** › **Difficult to agree on threshold levels** › **Quantity doesn't necessarily reflect quality [of recycling]** › **Burden of enforcement / monitoring if too prescriptive** › **Threshold could depend on municipalities' available infrastructure (collection, sorting and recycling)** › **Would need to be material / individual type based (so less inclusive)** › **Would need support on 'how' to reach the target for the approach to be effective** › **Might overlap with PPWD legal targets** › **Disregards LCA outcome, no evidence** › **Does not consider packaging functionalities**

Distribution of Impacts

The distribution of impacts related to the requirement for all packaging to be recyclable by 2030 is outlined in Section 5.1, and related to compliance with the requirements in Section 5.6. This section assesses the impacts, and how they are distributed, related to the design and implementation of the methodology itself.

Whilst there would be some cost to the Commission from developing the framework in a legal text, the main cost associated with the method would be that of producing the necessary data. Firstly, the PoM data would need to be submitted by producers in total weight placed on the market. Information on average unit weights may need to be gathered if not already available. The more significant costs would relate to obtaining on the weight of packaging recycled by category. Unless discreet recycling systems are used (e.g. a deposit refund system for beverage containers), or new innovative digital watermarking technology is mandated for all packaging, it is likely that detailed analysis of the composition of the recycling stream would be required. The burden may be higher for the recycling industry as this is the point at which the sampling surveys would need to be carried out. However, could be funded by those responsible for proving compliance i.e. the producers. The overall impact level would be expected to be medium/high.

Conclusion

There could be some significant benefits to utilising a quantitative metric such as a recycling rate threshold to define recyclable packaging. However, to operationalise such a mechanism requires market segmentation at a reasonable level of granularity, and that poses challenges for obtaining the necessary data. Whilst there is a general shift towards greater visibility and detail of waste management information, the costs of data production need to be assessed in detail to verify whether it may be a suitable measure to reinforce the definition of recyclable packaging at this point in time and that efforts required would be proportionate also in comparison to the two other approaches to defining recyclable packaging. As indicated above, however, producing recycling statistics for individual formats with reasonable market shares may be more cost effective so could be considered as a means of proving whether packaging was recyclable or not on a case by case basis.

Table 5-24 Summary

Impact category	Summary	Summary description
GHG savings	↗	As the measure is more enforceable more recyclable packaging would be expected so there may be GHG savings.
Material efficiency	↔	Not clear what impact there might be, but design for recycling can affect material choice and the amount used.
Recycling	↗	As the measure is more enforceable more recyclable packaging would be expected so there may be an increase in overall recycling.
Reuse	n/a	
Economic costs	↘	Not clear what the balance of costs might be. Some costs associated with creating the definition and proving compliance. The costs of compliance would depend on the approach to enforcement (see below), however, until digital watermarking introduced cost of surveys may lead to overall negative cost impact. Recyclable packaging may be more expensive or cheaper, the costs of waste management might be cheaper than disposal of unrecyclable packaging.
Social impacts	↗	As the measure is more enforceable more recyclable packaging would be expected so there may be an increased consumer amenity, and potentially more jobs.

Enforceability	↗	A quantitative approach would be enforceable. However, gathering the required data to calculate threshold levels may be complex in the short-term.

Quantitative scoring mechanism e.g. Cyclos HTP.

In the absence of suitable recycling rate data, an alternative approach to defining whether packaging was recyclable could be to use a similar methodology to that used by Institute Cyclos-HTP (Institute for Recyclability and Product Responsibility), a German company that specialises in the examination and verification of recyclability of packaging items.[173]

For 13 core material types, Cyclos-HTP has developed a standard process chain outlining each stage required to recycle the material (from collection to sorting and reprocessing). The packaging item in question is assigned to a material type, and is then assessed and scored against the technical specifications at each stage (see Figure 5-5 for an overview of the assessment criteria). For example, materials requiring separation by NIR technology are tested for detectability, and scored accordingly:

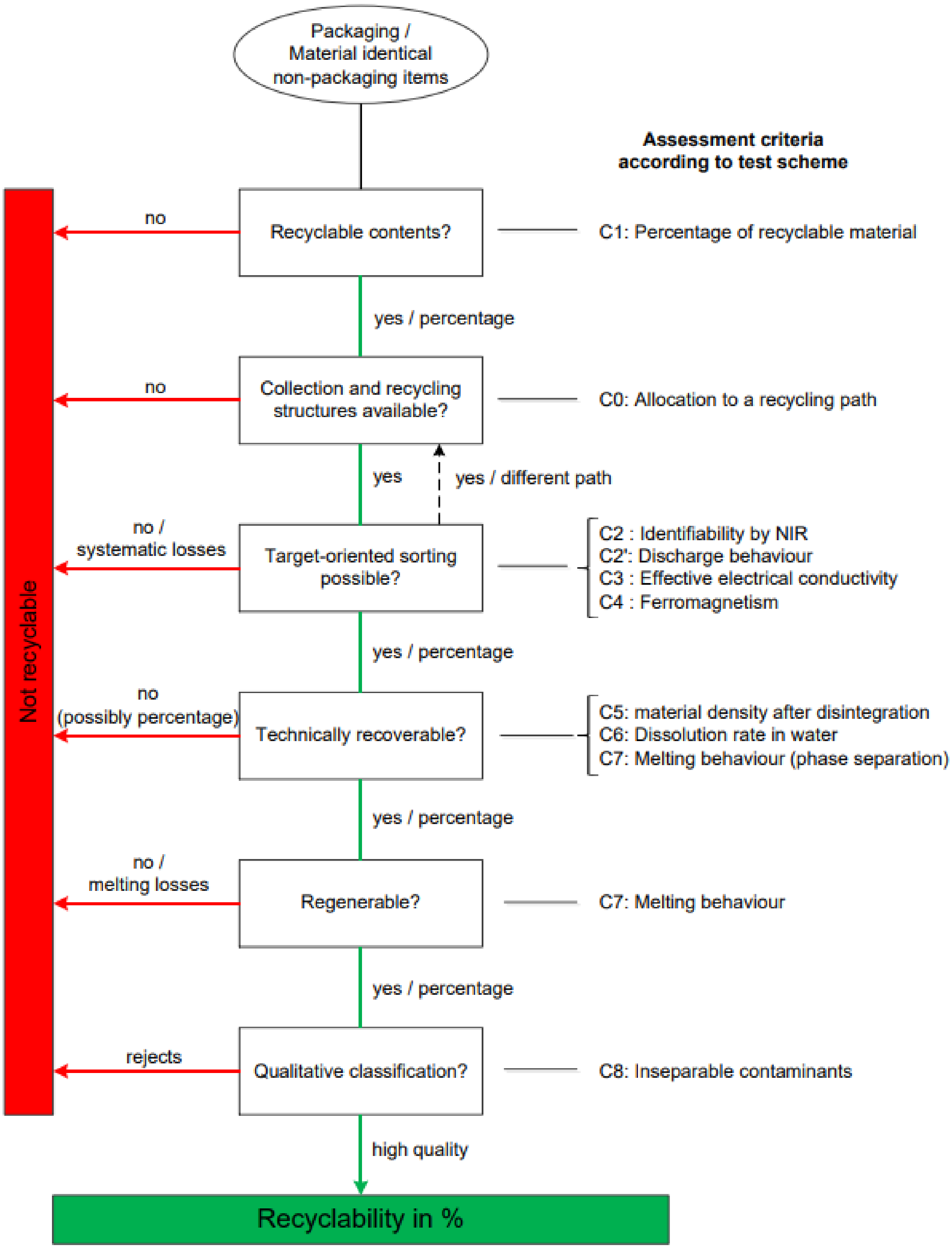
› items receive a score of 0 if considerable labelling or dark colours prevent unambiguous detection;
› a score of between 0.25 and 0.75 if correct identification depends on the position of the item; and
› a score of 1 if unrestricted identifiability is achieved.

Scores for individual stages are multiplied together to reach an overall recyclability score of between 0 and 100 (if the result is not 0, the packaging is classified as recyclable).[174] An alternative approach could be to define a threshold above 0 to define whether packaging was recyclable or not.

The approach to operationalising this measure is inherent in its design. Packaging would be scored using the methodology and defined as recyclable or unrecyclable.

[173] http://cyclos-htp.de/en/home/utility-pages/home/
[174] Löhle, S., and Institute of Cyclos-HTP (2017) Verification and examination of recyclability

Figure 5-5 Cyclos HTP Process Flow



Source: Löhle, S., and Institute of Cyclos-HTP (2017) Verification and examination of recyclability

Strengths & Weaknesses

This type of methodology might be reasonable to apply against a backdrop of a relatively homogenous recycling infrastructure. This is far from being the case across the EU at present, although, as Member States implement collection services required to meet future recycling targets some degree of convergence will occur, particularly to meet the higher rates. However, even if this was to occur, it remains the case that sorting capabilities vary widely across specific facilities, and for a wide range of reasons (not least, the amount of material being sorted relative to 'design optimum'). As discussed previously, the metric would most likely have to apply at the EU level to avoid different definitions of recyclable for a given piece of packaging between Member States, leading to distortion of the single market. However, in this case packaging could be defined as recyclable if any collection and sorting infrastructure exists, meaning that it could be defined as recyclable if only actually the case in one Member State but not the rest. Consequently, if packaging were placed on the market in another country with insufficient infrastructure consumers would not be able to recycle it in practice, which could erode trust in the system from consumers and producers a like.

It may also be the case that using this methodology (or something similar) to assess the recyclability of each packaging format placed on the market could have relatively high administrative costs, and in principle, the assessment would need to be amended whenever the 'common infrastructure' changed, or whenever modifications were made to packages.

Even so, the approach has much to recommend it. Such an approach could, for example, also be used to highlight to packaging designers and fillers the design formats, and changes therein, which were likely to be subject to higher and lower fees where the modulation of fees is based on what is actually recycled. Indeed, if the data capture system was improved, then it should be possible to develop a schematic flow chart of where packaging with specific features creates problems for recycling processes. Given that this has been a key issue in the past (the apparent lack of appreciation of the effects of design changes on the likelihood of a material being recycled), such a scheme could be a very valuable education tool even if it was not used as the basis for assessing recyclability.

Distribution of Impacts

The distribution of impacts related to the requirement for all packaging to be recyclable by 2030 is outlined in Section 5.1, and related to compliance with the requirements in Section 5.6. This section assesses the impacts, and how they are distributed, related to the design and implementation of the methodology itself.

There would be some cost to the Commission for producing the metric and associated guidelines. The more significant cost would be in the application of the metric across the packaging sector. This would depend on the level of granularity to which packaging were defined and assessed upon. The overall impact level would be expected to be medium/high.

Conclusion

Whilst there are a lot of benefits of utilising a quantitative metric of this nature, the use of it to define recyclable at the European level may not be suitable.

Table 5-25 Summary

Impact category	Summary	Summary description
GHG savings	↔	Not clear what GHG impact there might be.
Material efficiency	↔	Not clear what impact there might be, but design for recycling can affect material choice and the amount used.

Recycling	↔	Not clear what the recycling impact might be.
Reuse	n/a	
Economic costs	↘	Some costs associated with creating the definition and proving compliance. The costs of compliance would depend on the approach to enforcement (see below).
Social impacts	↔	Not clear what the social impact might be.
Enforceability	↘↘	Challenges with implementing and enforcing at the EU level.

Recyclable defined by a combination of both DfR and recycling rate approaches.

There were various views from stakeholders that a combination of the three suggested approaches might be an optimal solution in practice, to deal with the weaknesses of each. For example, to ensure that innovation was supported a mechanism would be included where new packaging that has proven to be recycled above a threshold level (for example 20%) within three years of entering the market would automatically be included in the positive list, and circumvent the technical committee. A methodology for proving the recycling rate, including how it is aligned with the new calculation rules, should be developed by the Commission or perhaps through a new CEN Standard. The onus and cost of proving the recycling levels would be on those placing the packaging on the market. This approach would be most relevant if the lists in the DfR method were comprehensive i.e. all packaging had to be defined as either on the positive or negative list.

In this case there would be three elements to the definition:

1. The broad qualitative statements defining recyclable in general;
2. The DfR approach used to define comprehensive positive and negative lists; and
3. A recycling threshold mechanism to allow producers to prove their packaging was recyclable within a given time period to be included on the positive list.

Strengths & Weaknesses

The strengths of this combined measure would be that it combines the most effective elements of different approaches. It could be more defined and enforceable through using the DfR approach, but also provide flexibility to the industry to clearly define packaging as recyclable using the recycling rate threshold approach where they provided the evidence to support such claims.

The overall complexity of the mechanism is slightly greater than for other measures, however.

Distribution of Impacts

The impacts relate to the different parts of the definition, e.g. DfR, recycling threshold, and the impacts of these are discussed above. When utilised in the way presented here the costs of using the recycling threshold approach would be lower and distributed specifically on those wanting to prove compliance using this approach, rather than spread over a broader range of actors.

Conclusion

There are potential benefits from seeking to utilise key elements of different approaches to defining recyclable in order to optimise the methodology. It is recommended to keep this approach, or similar, in consideration during further assessment of potential measures to reinforce the Essential Requirements.

Table 5-26 Summary

Impact category	Summary	Summary description
GHG savings	↗	As the measure is more enforceable more recyclable packaging would be expected so there may be GHG savings.
Material efficiency	↔	Not clear what impact there might be, but design for recycling can affect material choice and the amount used.
Recycling	↗	As the measure is more enforceable more recyclable packaging would be expected so there may be an increase in overall recycling.
Reuse	n/a	
Economic costs	↔	Not clear what the balance of costs might be. Some costs associated with creating the definition and proving compliance. The costs of compliance would depend on the approach to enforcement (see below). Recyclable packaging may be more expensive or cheaper, the costs of waste management might be cheaper than disposal of unrecyclable packaging.
Social impacts	↗	As the measure is more enforceable more recyclable packaging would be expected so there may be an increased consumer amenity, and potentially more jobs.
Enforceability	↗↗	A mixed DfR / quantitative approach would be enforceable. The mixed approach should improve enforceability.

Summary

The following summarises the various measures relating to the use of reusable nature of packaging. As comprehensive measures to increase the levels of reusable packaging (e.g. reuse targets) are not implementable through the Essential Requirements, the measures here are limited in their impact. However, no major downsides have yet been identified. Therefore, it would be valuable to consider all these measures for reinforcement of the Essential Requirements.

Table 5-27 Summary

Measures / Impact category	Recyclable defined by qualitative statements.	Recyclable defined by use of design for recycling methodologies to define positive and negative lists of packaging.	Recyclable defined by use of a recycling rate threshold.	Recyclable defined by a combination of both DfR and recycling rate approaches.
GHG savings	↔	↗	↗	↗
Material efficiency	↔	↔	↔	↔
Recycling	↔	↗	↗	↗
Reuse	n/a	n/a	n/a	n/a
Economic costs	↘	↔	↘	↔
Social impacts	↔	↗	↗	↗
Enforceability	↔	↗	↗	↗↗

5.4 Requirements specific to the recoverable nature of packaging

The current Essential Requirements mandate that, if packaging is not designed to be reusable, it must be suitable for one of four recovery options, as summarised in the box below:

- The packaging must have a minimum inferior calorific value if intended for energy recovery;
- The packaging must "be of such a biodegradable nature that it does not hinder the separate collection and the composting process" if intended for composting; or
- The packaging must "be capable of undergoing physical, chemical, thermal or biological decomposition" if designed to be biodegradable.

The first point is now no longer relevant as packaging intended only for energy recovery has been effectively eliminated with the requirement for all packaging to be recyclable or reusable. The second points relate to definitions of compostable and biodegradable packaging.

Measures

CEN Standard 13432 is updated to further specify the concepts of compostable and biodegradable packaging and the interlinkages between them.

It is recommended that reference to the **concept of biodegradable packaging in Annex II of the Essential Requirements is removed, except where incorporated within the context of the definition of compostable packaging,** and that greater emphasis is placed on **a revised definition of compostable packaging to reflect real composting conditions.** In revising the Essential Requirements, the **Commission should also mandate CEN to update EN 13432**.

Following feedback from stakeholders it was considered more appropriate that the concept of biodegradable should not be eliminated, but “merged” with composting. As provided by CEN standard EN 13432, biodegradability and compostability are conceived as one because:

› Biodegradability, refers to the property of the material;

› Compostability, refers to the end-of-life of that material.

Eliminating the word biodegradability could open a regulatory gap on the term, which is not in line with the Single Use Plastics Directive that provides a definition of “biodegradable plastics”, and that could lead to an unregulated approach to the labelling of biodegradable packaging”.

Strengths and Weaknesses

We have previously reviewed the shortcomings of the current definitions of compostability and biodegradability in the Essential Requirements and associated Standard EN 13432, in respect of a lack of clarity causing confusion among stakeholders.

This measure should address this confusion, recognising that the term “biodegradable” refers only to the physical property of materials to break down over time, in the absence of any further specification of acceptable conditions or a timeline within which biodegradation is deemed desirable. It therefore has no meaning in a policy context, without further specification of the context in which packaging should biodegrade in order to meet the Essential Requirements. Accordingly, it has been proposed that the current separate requirement for biodegradable packaging in the Essential Requirements be removed, and instead incorporated within the requirement for compostable packaging instead. This will also ensure greater alignment with the existing EN 13432, as well as continued coherence with other relevant EU legislation that that makes reference to the term “biodegradable”.

Distribution of Impacts

At present, biodegradability of packaging is usually claimed for packaging that is industrially compostable. In cases where the packaging is biodegradable in the open environment, in principle, it can be expected to degrade even faster in controlled composting conditions.

Therefore, the impact of the measure is not expected to be significant for the majority of packaging producers, albeit there will be a need for relabelling/ certification of some packaging products in these cases. For a few producers, whose packaging is currently labelled as biodegradable but which is not currently compostable, the measure will have a more significant impact, requiring them to update their packaging to reflect the revised requirements.

The change is not expected to have a significant impact on retailers. For consumers, the change should provide more clarity when sorting and disposing of their waste, as the adoption of the criteria should reduce confusion regarding the compostability of products and make the available end of life routes for such packaging clear.

For waste collectors and processors, it should save costs associated with contamination of biowaste to be treated in composting facilities or AD plants and the associated need for additional sorting effort, and could also reduce the potential for littering of items that are wrongly thought to biodegrade in natural environments.

Conclusion

The measure is necessary to rectify the problematic market trends that have emerged as a result of the confusion and lack of clarity in requirements for packaging designed to be recoverable by composting.

The use of the terms compostable and biodegradable have introduced two separate requirements for the same packaging, over the years. This has caused confusion among the concepts of biodegradability and compostability. The initial suggestion was that reference to the concept of biodegradable packaging defined in CEN Standard 13432 is removed or further specified so that there is a clearer definition, or there is a greater emphasis on the defining compostable packaging.

Table 5-28 Summary

Impact category	Summary	Summary description
GHG savings	↗	No quantitative assessment but may shift some ‘biodegradable’ packaging from disposal to composting which could deliver GHG savings.
Material efficiency	n/a	Not clear what impact there might be, but design for recycling can affect material choice and the amount used.
Recycling	↗	No quantitative assessment but may shift some ‘biodegradable’ packaging from disposal to composting which could increase recycling rates.
Reuse	n/a	
Economic costs	↔	Not clear what the balance of costs might be. Composting may be cheaper than disposal routes.

Social impacts	↗↗	Potentially increases consumer understanding of packaging waste management.
Enforceability	↗	Should increase the enforceability of these requirements through addressing ambiguity.

Commission to mandate CEN to update EN 13432 to ensure actual composting conditions are taken into account.

Earlier in the report we reviewed the shortcomings of the current definitions of compostability and biodegradability in the Essential Requirements and associated Standard EN 13432, in respect of the gaps between assumptions about composting conditions in the Standards and practice in reality.

In line with this assessment, revising the Essential Requirements to reflect the need for compostable packaging to be able to be treated within actual composting conditions will greatly improve the effectiveness of the instrument and give a clarity regarding a need for EN 13432 to be updated similarly. However, more detailed consultation with industry is needed to determine how the wording in the Essential Requirements, as well the associated Standard, can be made more relevant for existing composting facilities.

In addition, a detailed impact assessment would be necessary to identify the scale and scope of impacts of such changes on compostable packaging producers (who may be required to redesign/ recertify their products), retailers, consumers and waste operators (who may benefit from reduced confusion in waste sorting and disposal and heightened alignment of packaging with acceptance criteria at composting facilities).

Table 5-29 Summary

Impact category	Summary	Summary description
GHG savings	↗	No quantitative assessment but may shift packaging from disposal to composting or improve the effectiveness of composting processes which could deliver GHG savings.
Material efficiency	n/a	Not clear what impact there might be, but design for recycling can affect material choice and the amount used.
Recycling	↗	No quantitative assessment but may shift packaging from disposal to composting or improve the effectiveness of composting processes which could increase recycling rates.
Reuse	n/a	
Economic costs	↔	Not clear what the balance of costs might be. Composting may be cheaper than disposal routes.

Social impacts	↔	Not clear what any social impacts might be.
Enforceability	↔	No clear impact on enforceability as the nature of the mechanism is the same, just the limit values.

Amend Annex II on the basis of the criteria to determine applications for which design for compostability can be considered to be of added value.

While the reinforced Essential Requirements should retain the option for compostable packaging, it is **recommended that they are amended to additionally reflect criteria for which design for compostability can be considered to be of added value** when compared to reuse or other end of life applications. An ongoing European Commission study to assess the Relevance of Biodegradable and Compostable Consumer Plastic Products and Packaging in a Circular Economy proposes the following criteria for consideration:[175]

These centre around two key headline criteria:

1 There should be environmental benefits to using compostable plastics over alternatives – this leads to several sub-criteria that relate to the means or the conditions in which such benefits could be realised.

1.1 This application could not have been designed for reuse or recycling/would not undergo material recycling if designed for recycling

1.2 The use of compostable plastic for this specific application can be expected to significantly increase the capture of bio-waste compared to non-compostable alternatives

1.3 Through the use of LCA or similar environmental assessment tool it can be demonstrated that compostable plastic is the preferred material for this particular application.

2 There should be no (direct or indirect) reduction in the quality of the compost - relates to compost quality, but goes beyond the proposed mandatory requirement for the material itself to focus on the wider consequences. This is supported with two sub criteria identifying scenarios where non-compostable plastic contamination is not increased or is even reduced.

2.1 The use of compostable plastic for this application does not lead to consumer confusion and subsequent increasing contamination with non-biodegradable plastics.[176]

[175] "Relevance of biodegradable and compostable consumer plastic products and packaging in a circular economy"; Contract No. 07.0201/2019/798924/ENV.B.3
[176] It is possible to require the whole product group to be designed for composting to avoid the coexistence of compostable with non-compostable materials within the same application.

2.2 The use of compostable plastic for this application can be expected to significantly reduce the contamination of compost with non-compostable plastics (from this application) compared with current practice

Strengths and Weaknesses

Such additional criteria should help answer the question of the extent to which biodegradability/ compostability of packaging (plastic in particular) is beneficial in the context of wider circular economy. This includes consideration of the feasibility of generally applied standards and criteria for (home-)composting in the EU context, and the potential impact of an increase in such products on the reuse and recycling of non-biodegradable products, as well as any benefits when compared to the use of other non-plastic biodegradable materials.

A preliminary assessment in the aforementioned study found that criteria would likely identify compostable materials to be of added value for applications such as fruit labels, biowaste bags and teabags, in large part due to the fact that they are never recycled and will regularly end up in biowaste (with the conventional plastic elements becoming contamination) and can help increase the capture of biowaste. Conversely, applications such as single use bottles, cups, tubs and trays were not found to be beneficial uses of compostable plastics as they do not help capture biowastes, are likely to cause consumer confusion and contamination, and are most likely to end up as litter (where they are unlikely to be composted).

However, for a large range of compostable packaging items currently available in the EU market, the assessment was inconclusive, showing mixed/ unconfirmed results. While the results of this criteria testing could change depending upon the specific scenario in each Member State and therefore cannot be universally applied or conclusions drawn that are true in every circumstance, it was concluded that the criteria are sufficiently robust to be effectively applied at the level of the application design.

For example, for trays used for fast food, whether it is beneficial to make the product out of compostable plastic entirely depends upon the circumstances. The three scenarios assessed were; a situation where the packaging ends up in litter bins and likely residual waste; a close system where reuse is not possible (likely to be niche circumstances) and; a closed system where reuse is possible i.e. a canteen with washing facilities. Only the closed system where reuse is not possible is likely to be a beneficial application for compostable plastic for this product. Where reuse is available, there are no benefits in terms of the criteria being tested against.

Distribution of Impacts

The measure could potentially have a significant impact on producers by recognising the added value provided by compostable materials in meeting circular economy goals for only a limited number of particular applications, and for some only in specific policy contexts, and clarifying those instances in which this is not the case.

The change is not expected to have a significant impact on retailers. For consumers, the change should provide more clarity when sorting and disposing of their waste, as the adoption of the criteria should reduce confusion regarding compostability (and in some cases recyclability) of products.

For waste collectors and processors, it should reduce the risk of non-recyclable or non-compostable packaging contaminating their relevant waste streams.

Conclusion

While the reinforced Essential Requirements should retain the option for compostable packaging, it is recommended that they are amended to reflect criteria which would help to determine in which instances design for compostability can be considered to be of added value.[177] In addition, it may also be possible to explicitly define those applications which should be allowed and those which should not.

Table 5-30 Summary

Impact category	Summary	Summary description
GHG savings	↔	Not clear what GHG impacts might be.
Material efficiency	↔	There is likely to be a change in material efficiency between compostable and non-compostable packaging but further detailed assessment would be required to understand whether it led to increased or decreased efficiency.
Recycling	↗	Not clear what the recycling impacts might be, but reduced contamination might slightly increase the amounts of material recycled.
Reuse	n/a	
Economic costs	↔	Not clear what the balance of costs might be.
Social impacts	↗↗	Increased clarity for consumers on disposal routes for packaging.
Enforceability	↗↗↗	Clear definition of what is allowed and what is not would be straightforward to enforce.

Summary

The following summarises the various measures relating to the use of recoverable nature of packaging. Whilst the effects of the measures on GHG savings, increased material efficiency, recycling and reuse are not significant, there would appear to be some social benefits from increased clarity of how compostable packaging is defined and used. Moreover, the measures are enforceable. Some further work during the impact assessment would be needed to assess the economic costs in more detail.

[177] "Relevance of biodegradable and compostable consumer plastic products and packaging in a circular economy"; Contract No. 07.0201/2019/798924/ENV.B.3

Table 5-31 Summary

Measures / Impact category	CEN Standard 13432 is updated to further specify the concepts of compostable and biodegradable packaging	Commission to mandate CEN to update EN 13432 to ensure actual composting conditions are taken into account.	Amend Annex II on the basis of the criteria to determine applications for which design for compostability can be considered to be of added value.
GHG savings	↗	↗	↔
Material efficiency	n/a	n/a	↔
Recycling	↗	↗	↗
Reuse	n/a	n/a	n/a
Economic costs	↔	↔	↔
Social impacts	↗↗	↔	↗↗
Enforceability	↗	↔	↗↗↗

5.5 Requirements on Labelling

5.5.1 Labelling Packaging as Reusable, Recyclable or Compostable

Labelling packaging as reusable or recyclable.

Consumers play a key role in the effectiveness of any packaging recycling system. Consumer engagement and understanding are crucial to improving recycling rates, and thus it is important to identify the barriers to this. Indeed, in an international comparison study conducted by RECOUP, it was found that uncertainty about what types of plastics are accepted for recycling was the most commonly cited issue in both Germany and the UK, and was also significant in Poland.[178]

[178] RECOUP (2017) *Plastics Recycling Consumer Insight Research, An International Comparison*, November 2017, http://www.recoup.org/p/275/publications

Central to such uncertainty, is the recycling information provided on product packaging and labels. While recycling targets increase in ambition, recycling rates have grown relatively sluggishly and a number of studies point to consumer confusion around labelling as a primary factor. Research by The Grocer in the UK for instance, showed that 42% found on-pack recycling labels hard to understand, including 9% who said that it was 'very difficult', and only 11% who said it was 'very easy'.[179]

Sources of confusion include both the number of labels, some of which look similar but do not mean the same thing, and symbols providing misleading information. Commonly highlighted points of confusion include:

- The Green Dot: RECOUP's 2019 study into consumer plastic recycling behaviour found that all respondents were misled by the Green Dot, incorrectly referring to the logo as meaning that the packaging was recyclable.[180] The Green Dot is used across Europe to show that producer has paid a tax towards recovering and recycling packaging. It is possible therefore for an item of packaging to be labelled as 'Not recyclable' but to also bear the Green Dot (because it's also sold in Germany for example).

- The Mobius Loop: an international icon which shows that at item can be recycled somewhere in the world but may not actually relate to the consumer's local area. The Mobius Loop however, can be confused with Resin Identification Codes for plastic packaging, which were designed for recycling centres, not consumers.[181] In a UK survey by the consumer group Which? 26% of respondents did not know what to do with packaging bearing the Mobius Loop.[182]

- In 2015, the 'Triman' icon was also introduced in France in order to harmonise separate collection systems and show items which household packaging items are covered by an EPR recovery chain.[183] The logo consists of three parts: a human silhouette which represents the consumer; three arrows which symbolise sorting to allow for better waste treatment; circular background which symbolises recycling.

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[179] Farrell, S. (2019) *Consumers confused over plastic recycling, research shows*, accessed 11 November 2019, https://www.thegrocer.co.uk/plastic/consumers-confused-over-plastic-recycling-research-shows/597987.article
[180] RECOUP (2019) *Research Study Into Consumer Plastic Recycling Behaviour*, accessed 11 November 2019, https://www.mrw.co.uk/download?ac=3153941
[181] Szaky, T. (2015) *Consumers are confused about recycling, and here's why*, accessed 11 November 2019, https://www.packagingdigest.com/sustainable-packaging/consumers-are-confused-about-recycling-and-heres-why150223
[182] Walsh, H. (2019) *The plastic people still recycle incorrectly – and does it really matter? – Which? News*, accessed 11 November 2019, https://www.which.co.uk/news/2019/09/the-plastic-people-still-recycle-incorrectly-does-it-matter/
[183] The Connexion (2015) *Do you know what this icon means?*, accessed 11 November 2019, https://www.connexionfrance.com/French-news/Do-you-know-what-this-icon-means

- The Tidyman logo: developed by Keep Britain Tidy, the logo encourages people to pick up litter, yet is often mistaken for a sign of recyclability. The symbol of a man putting a bottle in a bin surrounded by a triangle however, marks glass which should be recycled.[184]

Figure 1: Common symbols on plastic food and drink packaging[110]

Symbol	Meaning
RECYCLE WITH CARRIER BAGS AT LARGER STORES / NOT AT KERBSIDE; FILM / Not Yet Recycled; TRAY / Check Locally	The On-Pack Recycling Labels (OPRL) tell you whether you can recycle packaging in the UK. They are based on local councils' recycling collections and services.
	The Mobius Loop is an international symbol that simply tells you that somewhere in the world it is possible to recycle the packaging material. If there's a number in the centre this gives the recycled content of the packaging.
	The Green Dot is not a recycling symbol. It's used in some European countries to show that the producer has paid a tax towards recovering and recycling packaging.
®	The 'Seedling' is a European-wide label which tells consumers that the material is a bio-plastic which can be composted by industrial processors.

Furthermore, 'Which?' (a consumer magazine) investigated recycling labels on 46 of the most popular own-brand items from 11 major supermarkets in the UK, found that 42% of the items was either not labelled or was labelled incorrectly, with all supermarkets making mistakes in how they had labelled products.[185]

Ultimately, packaging labelling is an important source of information for consumers and is a key component of recycling habits. This is reflected in the findings of a UK survey of over 6000 people, in which 59% of respondents wanted 'clear and definitive labelling' on packaging.[186] Moreover, confusion was reduced when packaging bore recycling labels from the On Pack Recycling Label (OPRL) scheme.

Strengths and Weaknesses

The majority of stakeholders supported new measures to **harmonise the approach to labelling packaging as reusable, recyclable or compostable**. This is to ensure consumers

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[184] Adams, C., and Knapton, S. (2019) *Bring in laws to force companies to make recycling labels simpler, MPs told*, accessed 11 November 2019, https://www.telegraph.co.uk/news/2019/07/03/bring-laws-force-companies-make-recycling-labels-simpler-mps/

[185] The Environment, Food and Rural Affairs Committee (2019) *Plastic food and drink packaging*, September 2019, https://publications.parliament.uk/pa/cm201719/cmselect/cmenvfru/2080/2080.pdf

[186] WRAP (2019) *INCPEN & WRAP: UK survey 2019 on citizens' attitudes & behaviours relating to food waste, packaging and plastic packaging*, July 2019, http://www.wrap.org.uk/sites/files/wrap/Citizen-attitudes-survey-food-waste-and-packaging.pdf

across the EU are met with a common set of symbols on all packaging to maximise understanding and the effectiveness of them.

Moreover, the standardisation process would **only allow the symbol to be used if the packaging met certain criteria**. The criteria used to define recyclable or reusable packaging outlined above would be used as the basis for allowing the symbols to be used. For example, the registry within a database could be contingent upon the criteria being met and therefore the allowance of the label's use. This could aid enforcement of those measures; although there always be a risk that the symbol could be copied and used fraudulently without the piece of packaging being registered.

Distribution of Impacts

The measure is likely to have some impact on packaging manufacturers and fillers due to the effort involved in updating their package labelling to comply with the revised requirements.

It is unlikely that there will be any impact on retailers, while this will make it easier for consumers to sort their packaging appropriately and increase recycling rates (including by reducing contamination) for waste operators.

Conclusion

The proposed approach for reinforcing the Essential Requirements, therefore, is to **include a legal requirement for a) the use of labels relating to reusable or recyclable to only be used if the packaging meets the relevant definitions and b) a minimum standard of the label itself**. For example, by setting some specific parameters related to the format of the label, the size, wording, symbol etc. It is expected that the approach to defining the minimum standard would need to be included in a separate Commission study, before developing further guidance or legal requirements, as is the approach to defining the minimum standard for labelling of non-flushables (e.g. wet wipes) under the SUP Directive.

Table 5-32 Summary

Impact category	Summary	Summary description
GHG savings	↗	Slight increase in recycling might be expected along with associated GHG savings.
Material efficiency	n/a	
Recycling	↗	Slight increase in recycling might be expected.
Reuse	n/a	
Economic costs	↔	Not clear what the balance of costs might be. Increased upfront cost in adding labelling may be countered through reduced costs of contamination.
Social impacts	↗↗	Increased clarity for consumers on recycling potential and routes for packaging.

Enforceability	↗↗↗	Clear definition of labelling requirements defined would be straightforward to enforce.

Labelling packaging as compostable.

Biodegradable and compostable packaging is becoming increasingly widespread. At present, labelling of such products is typically confusing for consumers, often not providing specific instructions for disposal or bearing messaging which is technically incorrect. In order to understand the extent to which this labelling is misleading, Eunomia analysed such packaging across Europe.[187] This involved sampling products, gathering images from stakeholders and online searches. The aim of the investigation was to assess the clarity of the labelling, checking against criteria including (but not limited to):

- Does the product clearly state that it is biodegradable/compostable?
- If claimed to be compostable, does the product clearly distinguish between home and industrial composting?
- If stated to be 'biodegradable', does the product clearly define the environments in which it biodegrades in?
- Does the product clearly state which waste stream it should go in?

The results found that the majority of labels assessed have certifications and state whether they are biodegradable/ compostable, however they often do not clearly distinguish between home and industrial composting. The majority of labels also do not clearly state which waste stream the product should go in, and, perhaps most worryingly, they do not define the environments they biodegrade in (if labelled as biodegradable). Further bad practice examples involved encouraging irresponsible behaviour such as littering, and mistranslation. Not only is the messaging around compostability complex, but this is compounded by the regional specificity for products sold across Europe.

There are also issues with using the term 'biodegradable' on packaging when no further information about the environments they degrade in is provided, as there is no common definition or reference material/product. Given the relative infancy of biodegradable packaging in the market, there are a lack of consumer studies on the topic. Of the existing studies, the potential link between biodegradability labelling and littering tends to be highlighted, although there is a lack of conclusive empirical evidence that correlates the marketing of biodegradable plastics with an increase in the tendency to litter. This is because no such studies have been undertaken, rather than evidence being present to the contrary. Several studies do however point towards a perception amongst consumers that 'biodegradable' is a virtuous aspect of a product and that littering such an item would be less impactful.

A focus group from Scotland in 2007 for instance, showed that most participants felt that it was acceptable to litter 'biodegradable' items as these were seen as harmless – although

[187] Eunomia (2019) *Relevance of Biodegradable and Compostable Consumer Plastic Products and Packaging in a Circular Economy*, Draft Report to DG Environment of the European Commission

participants did not distinguish between organic food waste and biodegradable plastics.[188] This study appears to suggest that the driver for littering is not apathy, but misinformation.

In a more recent Scottish study, in response to the question, "I'm more likely to litter when the item I'm holding is biodegradable", 22.6% of the respondents agreed or strongly agreed, while the remainder, 77.4% disagreed or strongly disagreed. Those who agreed to any extent scored more highly with regard to self-reported littering behaviour, suggesting that perhaps the propensity for biodegradable litter to promote littering behaviour is greater amongst those that are already more likely to litter.[189]

Strengths and Weaknesses

There have been some concerns raised regarding the unregulated approach to **labelling packaging as biodegradable or compostable**.[190] Labelling of these products on the market can generally be very confusing to consumers. One common example of bad practice is when a product is described as '100%' compostable – with no explanation what this means or guidance on which waste stream is appropriate. It is also often used when a product has not been certified to be home compostable. This can be very misleading, and the layperson could even think that this means the item can be littered and degrade in a short timeframe.

The majority of stakeholders therefore supported new measures to **harmonise the approach to labelling packaging as reusable, recyclable or compostable.** This is to ensure consumers across the EU are met with a common set of symbols on all packaging to maximise understanding and the effectiveness of them. This will make it easier for consumers to sort their packaging appropriately and increase recycling rates (including by reducing contamination). As mentioned above, Standard EN 13432 will be revised to include new standardised definitions of these terms. The **use of such a label would therefore be contingent on meeting these standards**.

It is also worth noting, that this measure raises the wider issue of disaggregating the factors which influence recycling behaviour and littering. Whilst labelling plays a significant role, a range of internal and external factors influence behaviour such as existing personal and social attitudes and norms.

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[188] Keep Scotland Beautiful (2007) Public attitudes to litter and littering in Scotland, *cited in* Brook Lyndhurst (2013) *Rapid Evidence Review of Littering Behaviour and Anti-Litter Policies*, Report for Zero Waste Scotland, 2013, http://www.zerowastescotland.org.uk/sites/files/zws/Rapid%20Evidence%20Review%20of%20Littering%20Behaviour%20and%20Anti-Litter%20Policies.pdf

[189] Brook Lyndhurst (2015) *Public Perceptions and Concerns around Litter*, Report for Zero Waste Scotland, 2015, http://www.zerowastescotland.org.uk/sites/files/zws/Litter%20Insights%20final%20web%20March%2015.pdf

[190] Eunomia (2019) *Relevance of Biodegradable and Compostable Consumer Plastic Products and Packaging in a Circular Economy*, Interim Report to DG Environment of the European Commission

Distribution of Impacts

The measure is likely to have some impact on packaging manufacturers and fillers due to the effort involved in updating their package labelling to comply with the revised requirements.

It is unlikely that there will be any impact on retailers, while this will make it easier for consumers to sort their packaging appropriately and increase recycling rates (including by reducing contamination) for waste operators.

In terms of the potential impact of this measure on reducing littering, there is a lack of conclusive empirical evidence that conclusively correlates the marketing of biodegradable/compostable plastics with an increase in the tendency to litter – this is because no such studies have been undertaken, rather than evince being present to the contrary. Some empirical evidence suggest that labelling a product like 'biodegradable' or 'compostable' may be seen by some people as a technological solution removing responsibility form the individual, and several others point to a perception amongst consumers that 'biodegradable' or 'compostable' is a virtuous aspect of a product and that littering such an item would be less impactful.

Conclusion

The proposed approach for reinforcing the Essential Requirements, therefore, is to **include a legal requirement for a) the use of labels relating to compostable to only be used if the packaging meets the relevant definitions and b) a minimum standard of the label itself, which only allows the use of the term compostable not biodegradable**. For example, by setting some specific parameters related to the format of the label, the size, wording, symbol etc. It is expected that the approach to defining the minimum standard would need to be included in a separate Commission study, before developing further guidance or legal requirements, as is the approach to defining the minimum standard for labelling of non-flushables (e.g. wet wipes) under the SUP Directive.

Table 5-33 Summary

Impact category	Summary	Summary description
GHG savings	↗	Slight increase in composting might be expected along with associated GHG savings.
Material efficiency	n/a	
Recycling	↗	Slight increase in composting might be expected.
Reuse	n/a	
Economic costs	↔	Not clear what the balance of costs might be. Increased upfront cost in adding labelling may be countered through reduced costs of contamination.
Social impacts	↗↗	Increased clarity for consumers on recycling potential and routes for packaging.

Enforceability	↗↗↗	Clear definition of labelling requirements defined would be straightforward to enforce.

5.5.2 E-commerce Packaging Labelling

Labelling of e-commerce packaging with stickers to highlight to consumers to report unnecessary void space to authorities in order to support enforcement.

In order to support the objective to reduce the amount of unnecessary air space in e-commerce packaging, **any packaging used specifically for e-commerce should be required to include a clear label on the front or side that alerts the consumer to record the delivery in a national enforcement database if they think it is over packaged**. Dedicated e-commerce packaging could have the label printed on, whereas SMEs using other non-specific boxes could use stick on labels. The senders and the delivery companies could both be fined by regulatory agencies it they are caught delivering without such a label, so the delivery companies would act as monitors and not pick up parcels from suppliers without labels in order to avoid the risk of getting fined themselves. The enforcement database could be run and funded by the national EPR scheme.

Strengths and Weaknesses

The measure will support the enforcement of other measures related to increasing packaging efficiency (including packaging:product ratios and sealed air limits) by increasing consumer awareness of the issue, providing a database of packaging producers/ fillers whose products are not in compliance, and encouraging innovation among producers and fillers. However, it will not directly address the issue of over packaging.

It is noted that the effectiveness of the measure in this regard will depend on the level of uptake by consumers, i.e. a lack of consumer records of over packaging could simply be a result of consumer indifference to/ lack of awareness of the issue as opposed to a lack of over packaging in the market. Similarly, it is likely that in some cases, consumers will perceive a product to be over packaged when, from a technical perspective, it is already as efficient as possible due to a need for additional functionality/ durability to protect/ transport the product itself. The records in the database will therefore have to be subject to additional verification before any enforcement activity can take place.

Finally, the long term effectiveness of the measure will rely on the continued cooperation of consumers, who, over time, may either become desensitised to the new labelling, or who may find no change to previously reported over packaging of a product resulting in the impression that recording over packaging has no impact and a cessation of reports of over packaging.

Distribution of Impacts

The measure will impact e-commerce providers/ retailers by requiring them to place additional labelling on the items they send out. This may be associated with some cost, as retailers may, in turn, require their packaging suppliers to modify their packaging in order to incorporate the new labels and or/ modify their packaging in order to provide more efficient solutions to retailers. In addition, delivery companies will be impacted by the added responsibility for monitoring such labelling, though this should require marginal effort since delivery companies already check a range of labelling on parcels before accepting them. It is unlikely that there will be an impact on consumers, besides an increased awareness of the issue of over packaging.

Conclusion

The proposed approach for reinforcing the Essential Requirements, therefore, is to include a requirement for **any packaging used specifically for e-commerce to include a clear label on the front or side that alerts the consumer to record the delivery in a national enforcement database if they think it is over packaged**. This would include the setting of some specific parameters related to the format of the label, the size, wording, symbol etc.

Table 5-34 Summary

Impact category	Summary	Summary description
GHG savings	↗	Resultant decrease in unnecessary packaging might be expected along with associated GHG savings.
Material efficiency	↗	Resultant decrease in unnecessary packaging might be expected.
Recycling	n/a	
Reuse	n/a	
Economic costs	↔	Not clear what the balance of costs might be. Increased upfront cost in adding labelling may be countered through reduced costs of material use.
Social impacts	↗↗	Increased amenity for consumer who are frustrated with parcels being delivered with lots of unnecessary void space.
Enforceability	↗↗	Clear definition of labelling requirements defined would be straightforward to enforce. However, monitoring may be more complex.

5.5.3 Digital Watermarking

European Commission to carry out a review in 2025 to assess the feasibility of digital watermarking technology with a view to adopt a legal requirement for its use.

Part of the approach to considering changes to labelling requirements included a review of the status of tracer-based sorting[191] and digital watermarking[192] technologies and the potential feasibility for requiring their use through the Essential Requirements. The assessment was based upon interviews with two leading partners of the HolyGrail project: Procter & Gamble and TOMRA Sorting GmbH.

This was a pioneering project investigating how plastic packaging integrated with chemical tracers or watermarks can help improve recycling rates by increasing the segregation of packaging types. A number of different tracer/marker technologies have been developed and there is a risk of fragmentation and inefficiency. Therefore, the Holy Grail project also aimed to engage and align stakeholders along the entire value chain on a single global standard or at least a handful of compatible standards for tracer or marker based sorting.

If implemented, the technology has the potential to help address the difficulties in sorting multilayer and black packaging and in differentiating between food and non-food packaging, for example. This is important to ensure a higher level of recycled content can be included in food contact materials. There are other advantages as it would remove the need for bar codes on the labels and could speed up scanning times at retailer check-outs. An assessment of traceability approaches for inclusion in the Essential Requirements is provided below.

Strengths and Weaknesses

While research into TBS systems has been ongoing since the 1970s, a lack of stakeholder coordination was cited by stakeholders as the reason for the lack of market implementation of TBS, which is nonetheless readily available as an add-on to existing sorting technology. Digital watermarking on the other hand, is a relatively newer system that has only recently begun to be investigated through a number of pilots (the most notable of which is being undertaken in the US by Walmart in cooperation with Digimarc).

A trial of TBS carried out in the UK under the Plastic Packaging Recycling using Intelligent Separation technologies for Materials (PRISM) project identified several positive results, including greater efficiency in sorting and recycling, as well as improved quality and uses in recycling (including for food packaging). However, stakeholders noted that in cases where the tracer was applied to the product itself (not just the sleeve) the persistence of the tracer in the material after recycling posed a risk of accumulation, and potentially, contamination of all

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[191] Tracer-based sorting (TBS) refers to the addition of fluorescent pigments to plastic packaging items– these are only visible under certain special light conditions at the sorting plants, which aids quick sorting into the relevant recycling lines. They are added in such concentrations that they do not impact the appearance of the product or its mechanical properties, and can be used to record a variety of information, for example, regarding the type of plastic, critical additives, and also, brand details. The amount of information that can be communicated by tracers is restricted to the number of tracers, and the way they are combined. The tracers used are usually Rare Earth Elements (REE) such as europium (Eu), or terbium (Tb), and there is only a finite list of these elements.

[192] Digital watermarks are invisible, optical codes, roughly the size of a postage stamp that can be integrated into the artwork on the packaging label (shrink sleeve, in-mould label, paper or other material) or physically incorporated as a subtle pattern embossed in the plastic itself, usually in a repeated tiled manner. They are analogous to an invisible barcode and can hold large amounts of data, such as material composition, original contents, and suitability for recycling. They are only detectable by specialised cameras added onto sorting lines, as well as barcode scanners and smart phones.

recycled polymer, implying on one hand an unsustainable process of chemistry addition, and on the other, posing particular concerns for the food industry.

It was highlighted that in some cases the issue can be resolved by adding the tracer only to packaging sleeves, and then recycling without the sleeve, though stakeholders concluded that tracer based technologies have remained generally unsupported due to the potential issues with adding further chemicals into the packaging.

Digital watermarking is not associated with similar challenges, and was described as having the additional advantage of multiple possible applications across the value chain. This includes potentially replacing barcodes and reducing scanning times for retailers at check-out counters, allowing for an array of consumer engagement opportunities in terms of product information awareness, and providing new options for material sorting, with greater efficiency, higher recyclate quality, and more use of recyclates possible (including for food packaging).

Distribution of Impacts

There appears to be strong support from the packaging, retail and recycling industries for digital watermarking. The technology is currently being used by Walmart in the United States, but it was found not to be at a commercially ready scale as yet. The HolyGrail 2.0 project, aiming to test the feasibility of commercial implementation of digital watermarking, is now underway with a much broader range of stakeholders in the consortium, including brands and retailers.

The costs are likely not too be prohibitive when compared with the capital costs of expanding mechanical sorting capabilities at plants, with just a licensing fee to the technology company providing the watermark and the cost of installing add-on modules linked to existing infrared sorting units. It is noted, however, that there is a need to test the costs of large scale implementation across the supply chain.

Conclusion

It was considered too early for inclusion in the Essential Requirements by stakeholders, as further research and trials need to be carried out. There is an expectation the system might be implementable by industry in 2021. However, it was stated that further technology advancement might be needed before mandatory adoption through the Essential Requirements. There was some support for seeking voluntary adoption, through Horizon 2020 funding or other means.

The proposed approach for the revision of the Essential Requirements, therefore, is to **include a statement encouraging the uptake of the technology in a voluntary manner** in the short term. A statement should be included in the Essential Requirements to the effect that a **review will be carried out by the Commission in 2025 to assess the feasibility for adoption in them as a legal requirement** following a full impact assessment.

Table 5-35 Summary

Impact category	Summary	Summary description

GHG savings	↗	Digital watermarking could help increase recycling and reduce contamination in future which would lead to GHG savings.
Material efficiency	↔	Unclear if there would be any impacts on material efficiency.
Recycling	↗	Digital watermarking could help increase recycling and reduce contamination in future.
Reuse	↗	Digital watermarking could help support reuse schemes in future.
Economic costs	↔	Not clear what the balance of costs might be in future. Increased upfront cost in adding labelling may be countered through reduced waste management costs.
Social impacts	↗↗↗	Increased amenity for consumers in future in terms of improved scanning of products at retail outlets, and improved understanding of packaging through associated augmented reality applications used to provide information on individual products:packaging.
Enforceability	↗↗↗	Clear definition of potential requirements in future would be straightforward to enforce.

Summary

The following summarises the various measures relating to the use of labelling on packaging. Whilst the effects of the measures on GHG savings, increased material efficiency, recycling and reuse are not significant, there would appear to be some social benefits from increased clarity for consumers on the nature and waste management routes for packaging. Moreover, the measures are enforceable. Some further work during the impact assessment would be needed to assess the economic costs in more detail.

Table 5-36 Summary

Measures / Impact category	Labelling packaging as reusable or recyclable.	Labelling packaging as compostable.	Labelling of e-commerce packaging	European Commission to carry out a review in 2025 to assess the feasibility of digital watermarking technology with a view to adopt a

				legal requirement for its use.
GHG savings	↗	↗	↗	↗
Material efficiency	n/a	n/a	↗	↔
Recycling	↗	↗	n/a	↗
Reuse	n/a	n/a	n/a	n/a
Economic costs	↔	↔	↔	↔
Social impacts	↗↗	↗↗	↗↗	↗
Enforceability	↗↗↗	↗↗↗	↗↗	↗↗

5.6 Enforcement/ compliance

5.6.1 Overview

The enforcement of the existing Essential Requirements was highlighted as lacking during the evaluation phase of the study. To ensure that any new measures are effective, appropriate enforcement mechanisms need to be introduced to ensure compliance. The existing approach, in the main, is to rely on presumption of compliance with a set of European Standards. As several of these are being superseded through setting of requirements directly in Annex II of the PPWD, the approach is no longer valid for all measures, so a new approach is required.

Table 5-37 indicates the changing role of the CEN standards based upon the measures previously described; it should be noted that the comments specifically relate to compliance with the Essential Requirements and do not consider whether the standards are used for other purposes. If the existing standards need to be maintained, new standards could be created based upon the old ones and references made to the new codes in the revised Essential Requirements. Stakeholders have pointed out that civil society's input on developing the current standards was limited, and so the procedures for developing future standards relating to the new measures should be remedied to ensure they reflect inputs from all stakeholders.

Table 5-37 Future Role of the CEN Standards with Respect to the Essential Requirements

Standard	Future Role
EN 13427 – the Umbrella Standard	The intention is that Annex II of the PPWD provides producers with the necessary level of detail to effectively comply with the Essential Requirements. The reporting requirements will be included in legislation and the evidence needed to demonstrate compliance will

	be provided in a compliance form from the EU Packaging Registry. The Standard will therefore not be needed to implement and enforce the Essential Requirements.
EN 13428 – Prevention by Source Reduction	This is still required to provide guidance on reducing packaging to the minimum adequate amount and procedures for calculating rations (which are to be reported to the EU Packaging Registry). The Standard may need to be amended to refine and define the critical areas (unless they are included in Annex II itself).
EN 13429 – Reuse	This is still required to define reuse within the Essential Requirements. Producers can be required to submit information to the packaging registry to demonstrate that a reuse system in place and steps have been taken to minimise the environmental impact of the reconditioning process.
EN 13430 - Recycling	As the Essential Requirements themselves are to include a clear definition of recyclable packaging and set out how this is to be assessed, there will no longer be a need for this Standard in relation to the Essential Requirements.
EN 13431 – Energy Recovery	It is proposed that energy recovery is removed as an option from the Essential Requirements, so this Standard will no longer be needed.
EN 13432 – Biodegradation & Composting	The Standard to determine what is compostable is still needed, however the Standard is based on optimal conditions that do not always reflect reality. Further stakeholder engagement and a detailed impact assessment are needed to determine how the Standard can better reflect the infrastructure available for compostable packaging.
New Standard – Recycled Content	A new Standard on a procedure to maximise the potential recycled content of packaging should be developed for packaging that does not have specific recycled content targets.
New Standard – Packaging Nomenclature	A new Standard for describing and categorising different types/formats of packaging should be developed to allow for a common reference point across the supply chain and to support data gathering.

Firstly, it is helpful to set out what the enforcement requirements might be for the various measures, and what information might be needed to prove compliance and how that information might be made available. The enforcement mechanisms of relevance suggested during the course of the study include self-certifications, third party auditing and/or implementation of a registry. In addition, to support compliance, the suggested approach in EN 13430 to setup a system to monitor and track changes and improvements in the recycling systems and related technologies could be fully implemented, to ensure packaging designers have clear visibility of the conditions they would need to be designing for. The standard suggests the following:

> *"Establish a system designed to ensure that new developments in the relevant technology for the recycling of the material used in packaging are monitored, recorded and that such records are available to the design function."*

This would help operationalise a definition based upon qualitative statements only that suppliers were self-certifying against. These approaches are included in the table as relevant.

Table 5-38 Enforcement Needs and Information Requirements

Enforcement Need	Information Requirement	Potential Approach(es)
To monitor product / packaging ratios	That all packaging:product ratios meets certain threshold limits The value of the packaging:product ratios for given products (depends on measure i.e. whether all report or only if over threshold level)	Self-certification at company level to registry and auditing Submissions of ratios to registry for packaging: product combinations
Whether the packaging meets the definition of recyclable or not	Depends on type of definition: that the packaging meets the requirements of the definition; information on composition to monitor DfR requirements (depends on if on **positive list** or not), category specific recycling rates	Monitor development of recycling infrastructure Self-certification at company level to registry and auditing Submission of data / recycling rate to registry by category
Whether the packaging meets the definition of reusable or not	That the packaging is compliant with European Standard EN 13429 'Reuse'	Self-certification at company level to registry and auditing
If packaging is for dedicated e-commerce use enforcement information labels have been applied	That the label has been applied correctly	Self-certification at company level to registry and auditing Information supplied to registry (e.g. technical sheet showing label etc.)
Whether recycling/ compostability etc. labels are within spec	That the label has been applied correctly	Self-certification at company level to registry and auditing

Enforcement Need	Information Requirement	Potential Approach(es)
		Information supplied to registry (e.g. technical sheet showing label etc.)
Compliance with design for recycled content procedure in new European Standard	That the packaging is compliant with the new European Standard on design for recycled content	Self-certification at company level to registry and auditing
Compliance with recycled content targets	That all packaging meets the targets The amount of recycled content for given products	Self-certification and Auditing Submissions of recycled content proportions to registry
That the packaging does not contain hazardous substances as specified through reference to REACH etc.	That the packaging does not contain restricted hazardous substances	Self-certification and Auditing Submission of technical data with chemical composition to registry

The following sections provide more information about existing registries at national or EU level that could serve as an inspiration or models for setting up a compliance registry for packaging.

5.6.2 Existing national level packaging registries

Germany

LUCID[193] is the recently introduced German registry to implement the country's packaging law. Any company that is using packaging when selling goods in Germany must register themselves in a centralised system and provide information on packaging quantities, as well as producing data reports. Registration is free. Registers are available for viewing by the general public. Information from the register will be used to help to calculate the financial contribution of producers to costs for disposal of packaging.

[193] Homepage: https://www.verpackungsregister.org/
The information about LUCID summarised in this section is based on the following sources:
FAQs explaining the system in detail, produced by the new centre for packaging: https://www.verpackungsregister.org/information-orientierung/hilfe-erklaerung/faq/
'How-to-guide to the Packaging Act for Manufacturers' (PDF available in English): https://www.verpackungsregister.org/de/information-orientierung/hilfe-erklaerung/themenpapiere/
Explanatory videos (available in English): https://www.ionos.com/digitalguide/websites/digital-law/verpackg-a-guide-to-german-packaging-law/
https://www.youtube.com/channel/UCjqzfKn6hT4AGJXogWJZewA?view_as=subscriber

The system is based on the Packaging Act (VerpackG), which came into force in January 2019. This Act created a new centralised office to manage a packaging register collecting data on actors and the quantities of packaging that they put on the German market. It uses a principle of product responsibility, meaning that producers using packaging must take disposal of the product into account when choosing the packaging that they will use for a product.

The new Act replaces the previous Packaging Ordinance (VerpackV) that had been in place since 1991 and that transferred responsibility for disposal of certain packaging materials to industry away from municipal authorities. This principal of extended producer responsibility for packaging is symbolised in Germany and other EU countries by the Green Dot. In Germany, the Packaging Ordinance brought about the creation of the ‘dual system’, where special waste collection paid for by industry collects waste packaging that has the Green Dot on it, which must be put in yellow bins. A major problem with the previous act was that there was a high proportion of free riders who did not contribute sufficiently to payment for waste collection.

The new Act forces all initial distributors of packaging to register themselves in a centralised system, LUCID, giving brand names, tax number and the company number. They receive a registration number from LUCID, which must be used to participate in the Dual System. Given that the Dual System is obligatory, those that do not have a registration number cannot distribute or use packaging materials. All initial distributors are subject to the principal of extended producer responsibility and must contribute to waste collection through the dual system. The centralised registry database provides a public record of all packaging introduced, meaning that no company can avoid contributing to waste collection costs and that these costs can be calculated in proportion to the amount of waste generated by a company. This could have a dissuasive effect on packaging use and thereby reduce packaging use.

Initial distributors are defined as the entity that fills packaging with a product which typically reaches a private consumer and places it on the German market for the first time. It also includes companies based both abroad and in Germany who import packaged products to Germany. Online retail and mail orders are included. Producers of empty packaging are exempt, apart from those producing ‘service packaging’, which refers to packaging that is first filled by the final distributor at the point of sale to the consumer (coffee cups, shopping bags, bread bags).

Companies must also provide information on the packaging materials used and the quantities of packaging, by material, put onto the German market. Under the previous legislation this information was already provided as part of the dual system, but now it must also be sent to the centralised packaging office and will be publicly available. Those companies that place more than a certain threshold weight of packaging on the German market (e.g. 30,000 kg for metals and plastics) must have the amount independently inspected and certified. The LUCID register is publicly available and therefore seen as a means of increasing transparency.

United Kingdom

In the UK, packaging producers also have to register themselves in a registry based on certain conditions. Producers meeting these conditions (described below) must either join a compliance scheme or register as a packaging producer in the **National Packaging Waste Database (NPWD)**[194]. The information that producers need to submit to the NPWD includes:

- Contact details and business information – this covers information such as turnover, company registration and status;
- Packaging data – this covers:
  - main packaging activity;
  - any secondary packaging activities;
  - method for estimating how much packaging was handled in the previous year;
  - the amount (in whole tonnes) of packaging supplied to the next stage in the packaging chain or sold to the end users;
  - any packaging that is imported and any packaging around goods that are imported;
  - materials that have been exported.

Producers whose main activity is selling packaged goods also need to provide their customers with data about: return, collection and recovery systems used; role in reusing, recovering and recycling packaging; and the meaning of recovery and recycling symbols on the packaging.

This registration requirement stems from the implementation of the producer responsibilities that define ‘obligated packaging producers’ who must register and meet their packaging waste recycling and recovery responsibilities. This obligation applies to producers, or groups thereof, which handled 50 tonnes of packaging or packaging materials in the previous calendar year, have a turnover of more than GBP 2 million per year and carry out the following activities:

- raw material manufacture – produce raw materials for packaging manufacture;
- packaging conversion – convert raw materials into packaging;
- packing/filling – put goods into packaging or put packaging around goods;
- selling – supply packaged goods to the end user;
- importing – import packaged goods or packaging materials from outside the UK;
- service provider – a business that supplies packaging by hiring it out or lending it;
- supply – supply packaging or packaging materials at any stage in the chain or to the final user of the packaging.

Based on the entered data, the NPWD then automatically provides information about the producer’s recovery and recycling obligation. The producers registered are then responsible for meeting their recovery and recycling obligations, obtaining and submitting evidence of compliance (unlike compliance schemes, which take on the legal responsibility to meet the recovery and recycling obligations and submit a certificate of compliance (CoC) on behalf of their members). Therefore, producers registered with the NPWD need to obtain from accredited reprocessors and exporters evidence of waste packaging recycling and recovery equal to the weight of their obligation in the form of electronic packaging recovery notes (ePRNs) and electronic packaging export recovery notes (ePERNs) for the waste packaging they recycle or recover. The NPWD generates a CoC that must be confirmed and signed by the producer before it is officially submitted to the database. There are penalty fines for producers which fail to meet their obligations or provide false or misleading information.

[194] Homepage: https://npwd.environment-agency.gov.uk/Public/PackagingHome.aspx
The information about NPWD summarised in this section is based on the following source:
UK Government Guidance on packaging producer responsibilities: https://www.gov.uk/guidance/packaging-producer-responsibilities

The costs to producers registering with the NPWD are slightly higher than for those which decide to join approved compliance schemes:

Type of company	Registration fee on NPWD	Registration fee for compliance scheme
Producer/single company	GBP 776	GBP 564
Small producer*	GBP 562	GBP 345

*Small producers are those whose turnover is: between GBP 2 – 5 million; or less than GBP 2 million but who are part of a company group with an obligation.

Source: https://www.gov.uk/guidance/packaging-producer-responsibilities

Estonia

A similar system to that of the UK exists in Estonia[195]. Producers responsible for packaging waste can join one of three Producer Responsibility Organisations (PROs) that focus on general packaging or must pay a charge for their packaging (as do PRO members when packaging targets are not met). This system has helped increase the recovery and recycling of packaging waste but some problems persist. For instance, there are challenges with data accuracy, waste leakage, free riding and PRO fee rates and government oversight and enforcement need to be strengthened. One of the initiatives taken in this direction is audit requirements for data to be submitted in the national registry.

To improve data quality and accuracy, the Estonian Ministry of Environment requires independent audits of companies participating in packaging waste PROs; this requirement is applicable for companies above a certain threshold so that compliance costs for small and medium-sized enterprises (SMEs) are reduced. All companies must keep a record of the amount of packaging used and the type of packaging. As of 2015, any company that places more than 100kg of plastic packaging or 200kg of other packaging on the Estonian market per year must organise for an audit of their accounts to be done by a third-party. According to the Estonian Packaging Act, audits can be carried out by 'sworn auditors' whose reports of the verified data need to be issued before companies make their submissions to the national packaging registry.

The **Estonian 'packaging register'** is a state database where data on the packaging of goods placed on the market, generated packaging waste, reuse and recovery of packaging waste and compliance with recovery targets are submitted, stored and processed. The Ministry of the Environment, the Environmental Inspectorate and the Tax and Customs Board have the right to examine the source documents of the reported data.

All packaging producers, packaging waste handlers and companies placing packaged goods on the market must keep consistent records on the weight of packaging material by the types of packaging and packaging material. They need to hold data about:

› produced empty packaging and imported and exported empty packaging;
› packaging of packaged goods and imported and exported packaging of packaged goods;
› packaging of goods placed on the market;
› generated packaging waste;

[195] The information about the approach used in Estonia summarised in this section is based on the following sources: OECD Environmental Performance Reviews, Estonia 2017: https://www.oecd-ilibrary.org/sites/9789264268241-11-en/index.html?itemId=/content/component/9789264268241-11-en&mimeType=text/html
Estonian Packaging Act (English version): https://www.riigiteataja.ee/en/eli/ee/Riigikogu/act/524102014004/consolide

› reusable packaging;
› packaging waste recovered in Estonia and imported and exported packaging waste;
› packaging containing heavy metals.

Packaging companies that have not transferred their obligations to a recovery organisation must submit verified data to the 'packaging register' concerning:

› the weight of reusable packaging;
› the weight of packaging of the goods placed on the market;
› data on the recovery of packaging waste.

5.6.3 Existing EU-level registries for other policies

REACH registration procedure

The REACH Regulation[196] provides for the phased registration of chemical substances already placed on the market and pre-registered before 2008, by the following deadlines:

- By 30 November 2010, the following should be registered:
  - substances manufactured or imported in quantities of 1,000 tonnes or more per year;
  - substances meeting the criteria for classification as carcinogenic, mutagenic or toxic for reproduction (CMR) manufactured or imported in quantities of one tonne or more per year;
  - substances meeting the criteria for R50/53, e.g. very toxic to the aquatic environment manufactured or imported in quantities of 100 tonnes or more per year;

- By 31 May 2013: substances manufactured or imported in quantities of 100 tonnes or more per year should be registered;
- By 31 May 2018: substances manufactured or imported in quantities of one tonne or more per year should be registered.

In order to fulfil their registration obligations manufacturers and importers of chemical substances must:

› provide data on the substances they manufacture or import;
› use this data to assess the risks related to these substances; and
› develop and recommend appropriate risk management measures to control these risks.

To that end they must prepare a registration dossier in IUCLID format[197] and submit it to the European Chemical Agency (ECHA) via REACH-IT[198]. The registration information requirements depend on the tonnage band of the substance. In order to avoid duplication of animal testing and ensure efficiency and limited cost in the registration system, data sharing and joint submission is required for similar substances.

Once a registration dossier has been submitted, ECHA undertakes a 'completeness check' and assigns a registration number when the dossier is complete. Then ECHA issues an invoice through REACH-IT with a deadline for payment (e.g. EUR 33,699 for substances above 1,000

[196] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency.
[197] The management of the IUCLID format is done by the European Chemicals Agency (ECHA) in collaboration with the OECD. ECHA's mandate originates from REACH Article 111.
[198] REACH-IT is the central IT system that supports Industry, Member State competent authorities and the European Chemicals Agency to securely submit, process and manage data and dossiers.

tonnes). ECHA and the Member States then evaluate the information submitted by registrants. Evaluation under REACH includes two types of evaluations:

- Dossier evaluation: ECHA conducts compliance checks of at least 5 % of registration dossiers for each tonnage band.
- Substance evaluation: Member States evaluate certain substances to clarify whether their use poses a risk to human health or the environment by requesting where necessary further information from the registrants of the substance to verify the suspected concern.

European Product Database for Energy Labelling (EPREL)

As of 1 January 2019, suppliers (manufacturers, importers or authorised representatives) are required to register their appliances in the European Product Database for Energy Labelling (EPREL)[199], before selling them on the European market. It is expected that in early 2020, consumers will be able to search the product database for energy labels and product information sheets as well.

EPREL has been set up following the requirements of Article 12 of Regulation 2017/1369[200], which tasked the Commission with the establishment of a product database by the beginning of 2019. The purpose of this database is to: support the market surveillance authorities in their responsibilities and enforcement activities; provide the public with information about products placed on the market and their energy labels and product sheets; and to provide the Commission with up-to-date energy efficiency information about products for the review of energy labels.

The product database should consist of a public part and an online database available to the public and a compliance part accessible only to Member State surveillance authorities and the Commission. According to Annex I of Regulation 2017/1369, suppliers should provide the following information to the database:

- Public part – contact details and other identification of the supplier; the model identifier; the energy label in electronic format; the energy efficiency class(es) and other parameters of the label; the parameters of the product information sheet in electronic format.
- Compliance part - the model identifier of all equivalent models already placed on the market; the technical documentation as specified in Article 12(5).

Summary

There are existing national or EU registries that can serve as models for establishing national registries or a European Packaging Registry:

- In Germany, any company that is using packaging when selling goods in Germany must register themselves in the centralised system LUCID, free of charge, and provide information on packaging materials and quantities, as well as producing data reports.
- In the UK, companies meeting certain thresholds and not participating in existing compliance schemes must register in the NPWD and provide information about the amount of packaging supplied, imported or exported. Registration fees apply.
- In Estonia, all companies must keep a record of the amount and type of packaging used and those not participating in PROs need to submit information about the weight of the

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[199] EPREL summary: https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/european-product-database-energy-labelling_en

[200] Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU.

packaging recycled and recovered in a national registry. Compliance is confirmed by audits from 'sworn auditors'.

› At the EU level, potential examples could be the REACH registration process, which requires manufacturers and importers of chemical substances to submit data on substances to ECHA, and the new EPREL database for electrical appliances, which asks manufacturers to provide information about the energy label and product information of the appliances.

5.6.4 Potential Features of a Packaging Compliance Registry

This section provides a brief analysis of the suitability of the existing national or European level approaches for a European Packaging Registry. Due to limitations in the quantitative information available for costs and benefits, the following assessments focused on the general feasibility and suitability of the approaches. Analysis is informed by interviews and a survey carried out with stakeholders from the packaging supply chain and those operating registries.

Registration

The national systems reviewed differ in their approach to the registration process. For instance, registration with the national database entails a financial fee in the UK (higher than fees that companies might pay when participating in accredited compliance schemes) while registration to LUCID is free of charge in Germany. Charging a registration fee could constitute a financial burden to companies but at the same time it could finance the operation and maintenance of the registry, or even the authority employed to oversee it.

The need for companies to register is usually determined based on a number of conditions such as the size of the company and/or the volume of packaging put on the market. In order to reduce the burden and potential costs on SMEs the existing national approaches have defined thresholds below which companies can be excluded from the registration requirements. This could be a suitable approach also for a European Packaging Registry as it can ensure the companies with the largest share of packaging waste meet their responsibilities while burdens on SMEs are minimised.

Information to be provided in the registry

The approaches currently employed by some Member States are similar in the type of data they require producers to provide. Information about the volume and composition of the different types of packaging used or handled is expected to be readily available to companies due to extended producer responsibility policies. Therefore, compiling the information that might be required for a European Packaging Registry could be expected to cause minimal additional burden on companies. On the other hand, proposed guidance relating to EPR schemes is suggesting that all producers report to the EPR scheme, albeit with an option for Member States to introduce a de minimis threshold for smaller producers to report less that larger producers.

Responses from stakeholders contacted suggested that companies already have information on weight and material composition. This information would likely be held as part of participation in extended producer responsibility schemes. It would also be necessary for companies that must prove that packaging is compliant with rules on food contact materials. It was pointed out that whilst larger companies would be well-informed about packaging throughout the supply chain and give strict specifications to suppliers, SMEs may have less information and less ability to dictate specifications to other parts of the value chain.

Some stakeholders raised the question of intellectual property. It was suggested that some companies would consider some information about packaging content to be sensitive and not wish to share this with competitors; this would particularly be the case for packaging suppliers. The above case studies, however, provide some examples of where confidential or sensitive data has been handled suitably by the authorities and through registries. So it would seem that there are practicable solutions to this issue.

In terms of the content of such a registry, this relates to the reporting requirements. These were set out in Table 5-38. The registry should include, at least, the following elements as shown in Table 5-39.

In certain cases, companies should register the types of packaging they use. There is no standard nomenclature for describing and categorising different types/formats of packaging. This should be developed through a European Standard or other means to act as a common reference point.

Table 5-39 Potential Structure and Scope of Registry Content

Description of Content	Scope	Requirement for Submission
Packaging and product weight, grammes	Individual functional unit of packaging / product	All packaging; or Packaging over a threshold ratio only
Confirmation of compliance with definition of recyclable	Company level	All packaging
Technical data sheet related to the composition of the packaging	Individual functional unit of packaging	Packaging not on the **positive list** of recyclable packaging
Recycling rate, %	Individual functional unit of packaging	Self-declaring only
Confirmation of compliance with definition of reusable	Company level	All reusable packaging
Confirmation of compliance with e-commerce labelling and example of label applied	Company level	All dedicated e-commerce packaging

Description of Content	Scope	Requirement for Submission
Confirmation of compliance with recyclable, compostable etc. labelling and example of label applied	Company level	All packaging
Confirmation of compliance with potential recycled content design standard	Company level	All packaging
Level of recycled content in packaging, %	At the level the potential targets are defined at	Packaging within scope of potential targets only
Confirmation of compliance with requirements on hazardous substances	Company level	All packaging
Technical data sheet with chemical composition	Individual functional unit of packaging	Any packaging with SoVHC in the material

In addition, it would be important for the registry to be harmonised with the needs of reporting on packaging placed on the market to EPR schemes to ensure no duplication of efforts. The scope of the data requirements would relate to how reporting for EPR and Essential Requirements compliance through a registry were best integrated. There are a number of potential options:

› Firstly, each system only reports on what they require for their own purposes with any overlaps reported in one of the other. The overlapping information is passed between the organisations as required;

› Secondly, the compliance information required for EPR schemes is fully incorporated into the registry and any EPR scheme in the country can access relevant information for its purposes e.g. amounts PoM for generating invoices for payment of fees etc.;

› Thirdly, the EPR schemes collect any information needed for compliance with the Essential Requirements (see above). The EPR schemes then pass the necessary information to the registry or the EPR schemes database is the registry itself. National enforcement agencies would then access the related compliance parts of the database;

› Finally, all compliance information for both the EPR schemes and Essential Requirements is submitted once to an EU registry. The national EPR schemes and regulatory agencies would then access the EU registry for the data they required.

At this stage it appears feasible for data to be reported to a registry from EPR schemes in order to minimise compliance efforts of producers. This should be a straightforward transmission of data from one entity to another which is now standard practice. Confidentiality issues can be addressed (as mentioned above).

Strengthening Compliance relating to Self-certification

One approach to compliance is through a system of self-certification. In this case, suppliers report to the registry that they are in compliance with the relevant rules (as outlined in the table above). Whilst this is relatively efficient for the industry, there is a risk that some entities self-certify but without actually taking the relevant actions into account, or their packaging does not meet the requirements. This could be done intentionally or unintentionally. Therefore, to support the enforcement of the Essential Requirements some further actions are required.

For example, companies could be obliged to provide independent and verified evidence that they have complied with their obligations. In the UK and Estonia, such evidence can be provided by independent accredited entities or auditors. However, it is not clear to what extent companies bear the financial costs associated with engaging independent auditors. Surveyed stakeholders mentioned that third-party auditors are already used to aid participation in extended producer responsibility systems in some Member States. It was also mentioned that large companies often already use external auditing to verify recycled content in packaging. The EMAS certification for packaging materials also requires a third-party audit. Requirements on the scale and/or frequency of auditing could be set e.g. 5% of the market each year, or every company every 5 years.

In addition, a requirement to set minimum ‘effective’ penalties for non-compliance as jointly and severally liable (i.e. each partner) across the value chain would incentivise all actors to ensure the packaging was within the legal requirements.

Finally, to strengthen enforcement an EU rapid alert system could be setup to transfer information regarding non-compliant packaging between Member States. It has been suggested that the new market surveillance regulation (Regulation (EU) 2019/1020) could be extended to cover packaging for this purpose. Other suggestions include implementing this in the context of the product policy enforcement package. In essence, the system would quickly share incidents on non-compliance with the Essential Requirements with other Member States. Data on the type of packaging, producer, brand, and nature of compliance failure would be shared. These data could then help national authorities check for similar types of packaging within a given Member State.

Management at EU level

As several of the enforcement requirements relate to EU wide approaches there may be the case for an **EU wide packaging registration system to aid compliance.** This could work in two ways. A bottom up approach where Member States have individual registries which feed data up to an umbrella system that aggregates data only. Or a top down approach where the EU registry is the primary portal for data management, which could then be fed down to national level registries. There are several advantages of an EU-wide registry. Firstly, producers would only have to submit data returns across the EU once and avoid the efforts and costs associated with submitting data to different registers in multiple Member States. This would compensate for the additional time that would be required to submit more data per packaging item than is currently required. Secondly, smaller Member States have limited capacity for developing their own databases so there may be gaps if the bottom up approach were taken. Under the top down approach there would be no reason why national governments could not maintain their own databases, and potentially save effort by receiving relevant data from the EU registry.

The two existing EU level registries that could serve as blueprints for a similar registry on packaging concern the REACH registration procedure and the EPREL. Even though the latter could be considered a useful example as it sets specific data requirements for manufacturers and suppliers of appliances, it has been established only recently (the public part is not even online yet) and experience with its effectiveness is not available. In addition, stakeholders consulted pointed out that replicating the EPREL model in the packaging context could be challenging due to the much higher number of 'entries' that may have to be made for packaging products, compared to the number of models of electrical appliances, but this would depend on the enforcement measures finally chosen (and the level of granularity of packaging types in the new Standard on packaging nomenclature). In some cases, this might mean including all individual packaging into a common database, and in others collecting data by materials, chemistry, formats or producers only.

The REACH registration process, on the other hand, has existed for a longer time and the following table provides a brief assessment of its main features as a potential model for a European Packaging Registry:

REACH registration features	Potential good practice for a EU packaging registry	Comments
Phased registration based on tonnage threshold	Yes	- A EU registry on packaging could also be based on a tonnage/volume threshold of packaging placed on the market per year with a phase-in system where major 'producers' of packaging will have to register first and then the remaining ones thereafter. - Under a certain threshold of packaging placed on the market, maybe be limited to reduce administrative burden (e.g. SMEs)
Different level of information requirements based on tonnage threshold	Yes	- Information on packaging (e.g. volume/material) should be very simple to generate compared to information that might be required for DfR or hazardous substance reporting.
Specific EU agency monitoring registration with the support of Member States	Yes	- An EU agency could be created to monitor registration on packaging and build/operate an EU data base. - Such an agency could be much smaller than ECHA which is the world's leading regulatory authority on the safe use of chemicals and ensures the consistent implementation of four EU pieces of legislation on chemicals including REACH and has over 500 staff.
Registration fee based on the volume of substances placed on the market as a major part of the ECHA budget	Yes	- A yearly registration fee calculated based on the volume/mass of packaging placed on the market would be a potential source of income to support the budget of an agency in charge of the EU registry on packaging. This would limit the involvement from Member States.

REACH registration features	Potential good practice for a EU packaging registry	Comments
A unique EU data base on registered substances available online with non-confidential information on chemical substances (e.g. substance identity, hazard classification, guidance on safe use, precautionary measure)	Yes	- An EU data base on information of packaging placed on the market by 'packaging producers' would provide comprehensive data (e.g. volume/mass/type of material) on packaging by 'producers' across the EU. This would enhance consumer awareness on packaging and influence their purchasing decisions.

Asked about potential organisations that might be best-placed to run an EU-wide packaging registry, stakeholders consulted suggested a range of European-level bodies. These included DG Environment and DG GROW from the European Commission, the JRC, Eurostat and the European Environment Agency (EEA). It was suggested that these organisations would be able to keep information private, given that some companies would be against publishing the information submitted to the registry, in the event that the registry was not public. Several responses highlighted that the organisation chosen must be credible, trustworthy and non-political. Also suggested was that the body should be independent, financed by stakeholders, and linked to the EU.

Finally, a more stringent approach was suggested whereby all packaging would have to be certified by a European body before it could be registered in any registry and allowed to be placed on the market. This might be akin to ECHA, for example, which checks all chemicals registered in the database.

Other features

An important aspect of existing registries is the possibility to provide consumers with information about the packaging they use. In this respect, the EPREL approach could serve as an example. Even though the public part of the database is not yet available, a European Packaging Registry could make certain non-commercially-sensitive information about the registered packaging available to the public.

5.6.5 Suggested Approaches for Reinforcing the Essential Requirements

For all of the potential measures described above, the legal basis for the requirements could be made in Article 9 of the PPWD on Essential Requirements.

In terms of the nature of the measures proposed, three variants have been constructed based upon the different approaches discussed above. They reflect the requirements of different proposed measures of the Essential Requirements themselves, particularly around conditional reporting obligations, but also staged by level of overall effectiveness in achieving compliance. The three variants are outlined below.

MS level registries – self-certification for compliance at a company level + third party auditing + EU rapid alert system.

A mandate for Member States to develop a national packaging registry will be set in the PPWD. Suppliers will register with the registry in whatever way Member States chose to harmonise the system with reporting to EPR schemes. Member States will be responsible for checking that packaging placed on the market in their country is registered on the database and the information declared is accurate. Third party auditing of the supplier's compliance will be carried out according to certain conditions (e.g. 5% of registrations per year), and Member States could then impose fines for non-compliance. Member States can share information regarding non-compliance using a newly develop EU rapid alert system.

Strengths and Weaknesses

Member States have the most autonomy in enforcement system design under this approach. Third party auditing will help to raise compliance. The EU rapid alert system would enable sharing of information regarding non-compliant packaging formats in order to aid compliance across the EU.

However, self-certification is not a full-proof means of enforcement. Moreover, third party auditing may only cover a fraction of the market (e.g. 5%), so there is still a high likelihood that non-compliant packaging will be placed on the market. Those companies responsible for placing packaging on the market would have to register with registries in all Member States which would take some effort.

Distribution of Impacts

The main costs will be associated with setting up and running a registry and funding the third party audits. These costs could be recovered through fee payments by packaging producers, and so the burden would fall specifically on those placing packaging on the market, as opposed to other actors. Self-certification would significantly limit the overall costs on producers.

Conclusion

This approach represents the minimum that may be required to deliver an acceptable level of compliance with the Essential Requirements, however, the effects are not guaranteed. It is worth considering this measure as a bare minimum requirement, but further analysis would need to be carried out to assess whether it would deliver minimum levels of compliance or not.

Table 5-40 Summary

Impact category	Summary	Summary description
GHG savings	n/a	
Material efficiency	n/a	
Recycling	n/a	
Reuse	n/a	
Economic costs	↘	Limited additional costs due to reliance on self-certification and limited third party auditing.

Social impacts	↔	Potentially limited enforcement effects unlikely to deliver any social benefits, nor deliver costs.
Enforceability	↘	Self-certification and limited third party auditing not likely to be very effective at enforcing compliance.

MS / EU registry – some self-certification + some mandatory compliance reporting relating to more stringent measures + third party auditing.

A mandate to develop an EU packaging registry could be set in the PPWD or MS level registries could be used. The development of the EU registry would, however, ensure harmonisation or replacement of existing national registries and/or reporting procedures for EPR schemes to avoid double reporting by suppliers. The reporting requirements are more stringent, relating to the more comprehensive measures around waste prevention, defining recyclable, proving recycling content, proving labelling requirements and submitting data on chemical composition relating to SoVHC. These data can be used by national enforcement agencies to aid compliance e.g. through identifying outliers etc. Third party audits would still be carried out to aid compliance. If the registry would cover the whole of the EU an EU rapid alert system would not be required.

Strengths and Weaknesses

Under this measure self-certification is significantly reduced, with producers having to report specific information to the registry in order to prove compliance. This will greatly increase the potential for monitoring and enforcement. If an EU wide registry were implemented producers may only need to submit data to one European entity not multiple entities in many Member States, which would reduce costs.

Auditing of the submitted data to the registry would still need to be undertaken. This may miss some packaging types that, although were submitted to the registry, were ultimately still non-compliant with some of the Essential Requirements.

Distribution of Impacts

The main costs will be associated with setting up and running a registry, funding the third party audits, producing / submitting data to the registries and auditing the data. These costs could be recovered through fee payments by packaging producers, and so the burden would fall specifically on those placing packaging on the market, as opposed to other actors.

Conclusion

This approach to enforcement would provide a more robust mechanism for enforcing the Essential Requirements. The use of MS or EU level registries would need to be assessed further in the impact assessment to properly understand the magnitude and distribution of costs.

Table 5-41 Summary

Impact category	Summary	Summary description

GHG savings	n/a	
Material efficiency	n/a	
Recycling	n/a	
Reuse	n/a	
Economic costs	↘↘	Some additional costs due to third party auditing, operation of registries and submission of data.
Social impacts	↗	Higher levels of enforcement would reduce non-compliant packaging placed on the market which may increase the amenity of consumers concerned about environmental issues.
Enforceability	↗↗	Mandatory reporting of information to registries and auditing would provide a good level of compliance enforcement.

EU body to certify all packaging registered.

The final case would deliver the highest levels of enforcement of any approach considered here. As above, the requirement for establishment of such a body would be set in the PPWD. The body would utilise the EU wide packaging registry, as per the measure above, however, registration with the system would be required for each and every packaging item, not simply just the registration of the company itself that places packaging on the market. Agents working for the body would then certify whether the individual functional unit of packaging was in full compliance with the Essential Requirements on a case by case basis, according to a standard approach. Packaging would only be allowed onto the market if it had met the required conditions and been registered in the EU registry. Proof of registry (e.g. using a unique ID code) could be printed on the packaging to aid market surveillance and enforcement activities which would still be carried out by national enforcement agencies.

Strengths and Weaknesses

Reviewing all packaging placed on the market through a single entity would deliver the highest level of compliance possible, perhaps near 100% compliance with the Essential Requirements.

However, because the approach would require all packaging to be certified prior to being placed on the market, this would require a significant effort. It may also lead to delays in producing being allowed to place packaging on the market if there were not sufficient capacity to deal with the flow of new requests for certification.

Distribution of Impacts

The main costs will be associated with setting up and running a registry, producing / submitting data to the registries and carrying out the certifications. These costs could be recovered through fee payments by packaging producers, and so the burden would fall specifically on those placing packaging on the market, as opposed to other actors. A quantitative analysis of costs could not be carried out at this stage, but the effort may be considerable. However, this would need to be compared against the potential benefits in a full impact assessment.

Conclusion

Whilst this measure appears highly stringent, it represents the highest level of compliance possible, so it is of value to include in further analysis.

Table 5-42 Summary

Impact category	Summary	Summary description
GHG savings	n/a	
Material efficiency	n/a	
Recycling	n/a	
Reuse	n/a	
Economic costs	↘↘↘	Likely to be fairly significant costs associated with running an EU wide certification body of this nature.
Social impacts	↗↗	Higher levels of enforcement would reduce non-compliant packaging placed on the market which may increase the amenity of consumers concerned about environmental issues.
Enforceability	↗↗↗	Checking all packaging placed on the market would deliver the highest level of compliance enforcement possible.

5.7 Proposed Options for Inclusion in Impact Assessment

One of the key objectives of the study was to develop a coherent and feasible set of options for reinforcing the Essential Requirements. These options are based upon the individual measures that have been appraised during the course of the study, and are outlined above. This section sets out three key options that combined various combinations of the measures. These are:

- Option 1: Essential updates
- Option 2: More specific requirements, clearer decision making, improved monitoring and enforcement
- Option 3: Enhanced harmonisation and impact

In essence, the overall effectiveness of the package of measures increase across the options. Option 1 includes the absolutely essential updates needed to bring the Essential Requirements in coherence with other European legislation and made relevant to current needs. Option 2 provides for more specific requirements related to different aspects of the Essential Requirements, e.g. recycled content, labelling, e-commerce packaging, hazardousness components etc., whilst increasing the robustness of various measures related to defining recyclable, waste prevention and reuse. Option 3, includes measures that are more stringent and therefore likely to achieve greater impact, as well as creating further harmonisation of the requirements across the EU. The development of the options is now described in further detail.

5.7.1 Option 1: Essential updates

This first option includes all the measures that are required to bring the Essential Requirements up to a minimum standard such that they are effective, coherent with other legislation and relevant to the current and future policy context. These are summarised below in Table 5-43 and Table 5-44. The first key update is to address the current issues with unrecyclable packaging, and so a requirement is set for all packaging to be recyclable or reusable. The requirement is operationalised through reference to a definitional mechanism, in this case using qualitative statements. However, packaging is still subject to a requirement for the weight and/or volume to be minimised to the absolute necessary amounts. To strengthen the understanding of what is necessary and what is not, the critical areas, which effectively provide exemptions for further reductions in the weight and/or volume are refined to focus on the most necessary aspects only, i.e.:

- Product protection;
- Hygiene;
- Safety;
- Legally required information; and
- Recyclability functions.

The use of REACH to deal with any hazardous substances used in packaging other than those already included in Annex II is suggested for this option. In addition, a requirement is set that any reusable packaging must also be defined as recyclable, except in certain circumstances.

However, if an exemption were to be allowed the packaging must be designed to meet a minimum number of uses, as specified by a requirement in Annex II.

Table 5-43 Summary Impacts of Measures under Option 1 (A)

Measures / Impact category	All packaging shall be reusable or recyclable as defined through the measures under the requirements specific to the reusable / recyclable nature of packaging.	Recyclable defined by qualitative statements.	In addition to the requirement to be reusable or recyclable, the packaging shall be designed not to exceed the minimum volume and weight necessary for the functionality under critical areas to be met.	Amend EN 13428 to refine the critical areas that limit further reductions in the volume or weight of packaging and amend Annex II to make the use of the Standard compulsory, or include the relevant content in the Annex if it is not possible to mandate the use of Standards.	Maintain existing list of hazardous substances in Article 11 of PPWD, but rely on REACH, FCM regulation etc to adequately address the use of other hazardous substances in packaging.	All reusable packaging must be recyclable, unless there is a demonstrable robust case for an exemption.
GHG savings	↗↗	↔	↗	↗	n/a	↗
Material efficiency	↔	↔	↗	↗↗	n/a	n/a
Recycling	↗↗↗	↔	↔	↔	↗	↗
Reuse	n/a	n/a	↔	↔	n/a	↔
Economic costs	↘	↘	↘	↘	↔	↔
Social impacts	↗↗	↔	↔	↘	↗	↗
Enforceability	↔	↔	↘↘	↘	↔	↗

Table 5-44 Summary Impacts of Measures under Option 1 (B)

Measures / Impact category	CEN Standard 13432 is updated to further specify the concepts of compostable and biodegradable packaging.	Commission to mandate CEN to update EN 13432 to ensure actual composting conditions are taken into account.	Labelling packaging as reusable or recyclable.	Labelling packaging as compostable.	MS level registries – self-certification for compliance at a company level + third party auditing + EU rapid alert system.
GHG savings	↗	↗	↗	↗	n/a
Material efficiency	n/a	n/a	n/a	n/a	n/a
Recycling	↗	↗	↗	↗	n/a
Reuse	n/a	n/a	n/a	n/a	n/a
Economic costs	↔	↔	↔	↔	↘
Social impacts	↗↗	↔	↗↗	↗↗	↔
Enforceability	↗	↔	↗↗↗	↗↗↗	↘

Next, there are a range of requirements relating to defining terms, requirements and labelling conditions. These relate mainly to compostable packaging, but also labelling for reusable and recyclable packaging. These new requirements will support other measures and improve consumer understanding and acceptability of packaging placed on the market, and are enforceable.

Finally, under this option, an enforcement measure related to new packaging registries and self-certification is included. This is the minimum necessary to support compliance with the new requirements included within this option. A mandate for Member States to develop a national packaging registry would be set in the PPWD. Suppliers would provide information to the registry in whatever way Member States chose to harmonise the system with reporting to EPR schemes (i.e. for efficiency, suppliers would provide relevant data once either with the EPR scheme or the registry and the information would be passed automatically between both systems). Member States would be responsible for checking that packaging placed on the market in their country is registered on the database and the information declared is accurate. Third party auditing of the supplier’s compliance would be carried out according to certain conditions (e.g. 5% of registrations per year), and Member States could then impose fines for non-compliance. Member States can share information regarding non-compliance using a newly developed EU rapid alert system.

The measures under Option 1 would therefore be:

- All packaging shall be reusable or recyclable as defined through the measures under the requirements specific to the reusable / recyclable nature of packaging.
- Recyclable defined by qualitative statements.
- In addition to the requirement to be reusable or recyclable, the packaging shall be designed not to exceed the minimum volume and weight necessary for the functionality under critical areas to be met.
- Amend EN 13428 to refine the critical areas that limit further reductions in the volume or weight of packaging and amend Annex II to make the use of the Standard compulsory, or include the relevant content in the Annex if it is not possible to mandate the use of Standards.
- Maintain existing list of hazardous substances in Annex II, but rely on REACH, FCM regulation etc to adequately address the use of other hazardous substances in packaging.
- All reusable packaging must be recyclable, unless there is a demonstrable robust case for an exemption.
- CEN Standard 13432 is updated to further specify the concepts of compostable and biodegradable packaging
- Commission to mandate CEN to update EN 13432 to ensure actual composting conditions are taken into account.
- Labelling packaging as reusable or recyclable.
- Labelling packaging as compostable.
- MS level registries – self-certification for compliance at a company level + third party auditing + EU rapid alert system.

5.7.2 Option 2: More specific requirements, clearer decision making, improved monitoring and enforcement

This option includes further measures that are either more specific or more effective, and replaces some of the less effective, or more negative impact measures, included under Option 1. These additions and replacements are now described, and are summarised in Table 5-45 and Table 5-46.

Firstly, whilst the new qualitative definition is maintained, the main approach to operationalising the definition of recyclable is through a combination of both design for recycling (DfR) and recycling rate approaches, which may not be the most stringent but seeks to mitigate some of the downsides with the more comprehensive application of each method on their own. Next, an additional requirement is set that requires producers to submit to a registry packaging to product ratios for each type of packaging placed on the market where these are above a certain threshold level. This may drive increases in material efficiency, but will importantly provide useful data to enforcement agencies in their efforts to address inefficient use of packaging. The use of thresholds focuses the reporting burden on the least efficiently designed packaging producers only.

The next specific requirement relates to recycled content of packaging. This is an area omitted from the existing Essential Requirements. Requirements would be set for a) the Commission to request that the European standards organisation (CEN) develop a Standard that sets out a process for packaging producers to follow when designing new packaging that seeks to maximise the level of recycled content and b) producers to follow the new Standard and prove compliance with it. This would provide some impetus for industry to actively consider recycled content in packaging whilst avoiding some of the potential downsides of regulatory targets on recycled content – these are, however, included in Option 3 below.

In terms of hazardous substances, a specific requirement relating to substances of very high concern (SoVHC) is also included under the option. This builds upon the reliance of REACH procedures alone, and sets a specific requirement in law for the phase out of SoVHC, which may not happen solely under the direction of REACH.

One of the main objectives of the review of the Essential Requirements was to support the increase in reusable packaging. Therefore, this option introduces some specific measures related to reuse. It is noted that reuse targets or other instruments are not suited for inclusion in the Essential Requirements, other instruments would be required. However, two requirements could be set within them. Firstly, a requirement for the Commission to request the CEN organisation to develop a Standard on effective reuse systems, to act as guidance or a benchmark for such systems to be developed across the EU. This could encourage the implementation of reuse systems by reducing barriers relating to lack of information. The development of the Standard should include all stakeholders i.e. civil society. Secondly, some aspects of transport packaging were thought to be highly suitable for reusable packaging to be used. Therefore, a requirement is set for certain types to be placed on the market only if they are part of a reuse system.

In the evaluation phase of the study, e-commerce packaging was identified as an area of concern, particularly the extensive use of unnecessary void space. Measures targeting the use of e-commerce packaging, i.e. packaging of items, may not suitable for the Essential Requirements, what focus on the nature of packaging that can or cannot be placed on the market. It has been suggested, therefore, that secondary legislation may be the most appropriate instrument for addressing this issue. However, a measure was developed that would set a requirement for e-commerce traders, particularly the large multi-seller platforms, to include a label on each item making it clear to consumers how they might report unnecessary void space to a national authority. This could help identify the main sources of the problem and allow authorities to apply penalties.

Table 5-45 Summary Impacts of Additional Measures under Option 2 (A)

Measures / Impact category	Recyclable defined by a combination of both DfR and recycling rate approaches.	Producers to report to central registry on the volume, weight and planar area ratios of packaging to product if, for either one of these three measures, the packaging exceeds a specified threshold percentage of the product.	Develop a new CEN Standard setting out a mandatory process to be followed to assess the potential to include recycled content.	Include specific requirements to phase out the use of SoVHC in packaging through reference to Annex XIV of REACH.	Guidance on effective reuse systems developed through reference to a European Standard.	Mandate reuse for some transport packaging.
GHG savings	↗	↗	↗	n/a	↔	↗
Material efficiency	↔	↗	↔	n/a	n/a	n/a
Recycling	↗	↔	↗	↗	n/a	n/a
Reuse	n/a	↔	↔	n/a	↔	↗
Economic costs	↔	↘↘	↘	↔	↔	↔
Social impacts	↗	↔	↗	↗↗	↗	↗
Enforceability	↘	↗↗	↘	↘↘	↔	↗↗

Table 5-46 Summary Impacts of Additional Measures under Option 2 (B)

Measures / Impact category	Labelling of e-commerce packaging with stickers to highlight to consumers to report unnecessary void space to authorities in order to support enforcement.	European Commission to carry out a review in 2025 to assess the feasibility of digital watermarking technology with a view to adopt a legal requirement for its use.	MS / EU registry – some self-certification + some mandatory compliance reporting relating to more stringent measures + third party auditing.
GHG savings	n/a	↗	n/a
Material efficiency	n/a	↔	n/a
Recycling	↗	↗	n/a
Reuse	n/a	↗	n/a
Economic costs	↔	↔	↘↘
Social impacts	↗	↗↗↗	↗
Enforceability	↔	↗	↗↗

The rapidly evolving technology of digital watermarking is also targeted through an additional specific measure under this option. The technology is not yet commercialised, but potentially has a highly significant value to the industry. Therefore, to ensure that the potential legal requirement for widespread use of this technology is not delayed until the next full revision of the Essential Requirements, a clause is included in the current revision setting out a requirement for the Commission to carry out a full review of digital watermarking technology in 2025 to appraise whether it is suitable for a legal mandate to be set that would require its use on all packaging.

Finally, under this option, an enforcement measure related to specific reporting of compliance data to new packaging registries and auditing is included. This would provide a greater level of robustness to support compliance with the new requirements included within the revised Essential Requirements. A mandate to develop an EU packaging registry could be set in the PPWD or MS level registries could be used. The development of the EU registry would, however, ensure harmonisation or replacement of existing national registries and/or reporting procedures for EPR schemes to avoid double reporting by suppliers. The reporting requirements are more stringent, relating to the more comprehensive measures around waste prevention, defining recyclable, proving recycling content, proving labelling requirements and submitting data on chemical composition relating to SoVHC. These data could be used by national enforcement agencies to aid compliance e.g. through identifying outliers etc. Third party audits would still be carried out to aid compliance. If the registry would cover the whole of the EU an EU rapid alert system would not be required.

The measures under Option 2 would therefore be:

- All packaging shall be reusable or recyclable as defined through the measures under the requirements specific to the reusable / recyclable nature of packaging.
- Recyclable defined by qualitative statements.
- Recyclable defined by a combination of both DfR and recycling rate approaches.
- In addition to the requirement to be reusable or recyclable, the packaging shall be designed not to exceed the minimum volume and weight necessary for the functionality under critical areas to be met.
- Amend EN 13428 to refine the critical areas that limit further reductions in the volume or weight of packaging and amend Annex II to make the use of the Standard compulsory, or include the relevant content in the Annex if it is not possible to mandate the use of Standards.
- Producers to report to central registry on the volume, weight and planar area ratios of packaging to product if, for either one of these three measures, the packaging exceeds a specified threshold percentage of the product.
- Develop a new CEN Standard setting out a mandatory process to be followed to assess the potential to include recycled content.
- Maintain existing list of hazardous substances in Annex II, but rely on REACH, FCM regulation etc to adequately address the use of other hazardous substances in packaging.
- Include specific requirements to phase out the use of SoVHC in packaging through reference to Annex XIV of REACH.
- All reusable packaging must be recyclable, unless there is a demonstrable robust case for an exemption.
- Guidance on effective reuse systems developed through reference to a European Standard.
- Mandate reuse for some transport packaging.
- CEN Standard 13432 is updated to further specify the concepts of compostable and biodegradable packaging
- Commission to mandate CEN to update EN 13432 to ensure actual composting conditions are taken into account.

- Labelling packaging as reusable or recyclable.
- Labelling packaging as compostable.
- Labelling of e-commerce packaging with stickers to highlight to consumers to report unnecessary void space to authorities in order to support enforcement.
- European Commission to carry out a review in 2025 to assess the feasibility of digital watermarking technology with a view to adopt a legal requirement for its use.
- MS / EU registry – some self-certification + some mandatory compliance reporting relating to more stringent measures + third party auditing.

5.7.3 Option 3: Enhanced harmonisation and impact

This option includes further measures that are more effective because they are more enforceable. Particularly as the measures include some quantitative mechanisms that allow for clear and objective measurement of application. These additions and replacements are now described, and are summarised in Table 5-47.

Firstly, whilst the new qualitative definition is maintained, the main approach to operationalising the definition of recyclable is through the recycling rate approach alone, where all packaging placed on the market has to prove it is above a threshold recycling rate for it to be deemed recyclable and therefore allowed onto the market (potentially within a given time frame). Whilst this would be the most objective approach it would also require the greatest depth of information on recycling by packaging types. Currently, this may be a challenge as it would likely require large, comprehensive audits of the waste stream at recycling plants. However, in future, if digital watermarking technology becomes fully commercialised, this would allow for format specific recycling rates to be calculated relatively straightforwardly.

The next requirement sets legal thresholds for the ratio of packaging to product, rather than just reporting such ratios to a packaging registry. This allows for a much more robust mechanism for enforcing requirements relating to inefficient use of packaging. The threshold ratios would have to be set at a relatively precise level of granularity of packaging format to be effective. It may be pragmatic to target these thresholds at specific format types only where inefficient use of packaging was found to be the largest and/or most varied.

The following requirement builds upon the previous measure relating to recycled content. In this case, specific requirements are set relating to minimum recycled content levels for specific packaging formats. As discussed during the assessment phase of the study, these are more likely to be targeted at plastic packaging than other materials (where markets for secondary raw materials are buoyant).

The use of compostable packaging has been found to be both beneficial in some applications but also cause issues relating to contamination if not appropriately managed at the end of life. In order to mitigate these risks more strongly, a requirement is set under the option that limits the use of compostable packaging to specific applications where there is some added value only. Further work needs to be done to define what such criteria should be.

In terms of enforcement, the approach taken under this option would be to setup an EU body that grants authorisation for the placement of all packaging that is placed on the market. This would deliver the highest levels of enforcement of any approach considered here. As above, the requirement for establishment of such a body would be set in the PPWD. The body would utilise the EU wide packaging registry, as per the measure above, however, registration with the system would be required for each and every packaging item, not simply just the registration of the company itself that places packaging on the market. Agents working for the body would then certify whether the individual functional unit of packaging was in full compliance with the Essential Requirements on a case by case basis, according to a standard approach. Packaging would only be allowed onto the market if it had met the required conditions and been registered in the EU registry. Proof of registry (e.g. using a unique ID code) could be printed on the packaging to aid market surveillance and enforcement activities which would still be carried out by national enforcement agencies.

The measures under Option 3 would therefore be:

- All packaging shall be reusable or recyclable as defined through the measures under the requirements specific to the reusable / recyclable nature of packaging.
- Recyclable defined by qualitative statements.
- Recyclable defined by use of a recycling rate threshold.
- In addition to the requirement to be reusable or recyclable, the packaging shall be designed not to exceed the minimum volume and weight necessary for the functionality under critical areas to be met.
- Amend EN 13428 to refine the critical areas that limit further reductions in the volume or weight of packaging and amend Annex II to make the use of the Standard compulsory, or include the relevant content in the Annex if it is not possible to mandate the use of Standards.
- Producers to report to central registry on the volume, weight and planar area ratios of packaging to product.
- Packaging must not exceed any of a set of threshold ratios of packaging to product established in terms of volume, weight and surface area.
- Develop a new CEN Standard setting out a mandatory process to be followed to assess the potential to include recycled content.
- Implement recycled content targets for specific formats.
- Maintain existing list of hazardous substances in Annex II, but rely on REACH, FCM regulation etc to adequately address the use of other hazardous substances in packaging.
- Include specific requirements to phase out the use of SoVHC in packaging through reference to Annex XIV of REACH.
- All reusable packaging must be recyclable, unless there is a demonstrable robust case for an exemption.
- Guidance on effective reuse systems developed through reference to a European Standard.
- Mandate reuse for some transport packaging.
- CEN Standard 13432 is updated to further specify the concepts of compostable and biodegradable packaging
- Commission to mandate CEN to update EN 13432 to ensure actual composting conditions are taken into account.
- Amend Annex II on the basis of criteria to determine applications for which design for compostability can be considered to be of added value.
- Labelling packaging as reusable or recyclable.
- Labelling packaging as compostable.
- Labelling of e-commerce packaging with stickers to highlight to consumers to report unnecessary void space to authorities in order to support enforcement.
- European Commission to carry out a review in 2025 to assess the feasibility of digital watermarking technology with a view to adopt a legal requirement for its use.
- EU body to certify all packaging registered.

Table 5-47 Summary Impacts of Additional Measures under Option 3

Measures / Impact category	Recyclable defined by use of a recycling rate threshold.	Packaging must not exceed any of a set of threshold ratios of packaging to product established in terms of volume, weight and surface area.	Implement recycled content targets for specific formats.	Amend Annex II on the basis of criteria to determine applications for which design for compostability can be considered to be of added value.	EU body to certify all packaging registered.
GHG savings	↗	↗↗	↗↗↗	↔	n/a
Material efficiency	↔	↗↗	↔	↔	n/a
Recycling	↗	↔	↗↗	↗	n/a
Reuse	n/a	↔	↔	n/a	n/a
Economic costs	↘	↘↘	↔	↔	↘↘↘
Social impacts	↗	↔	↗	↗↗	↗↗
Enforceability	↗	↗↗	↗	↗↗↗	↗↗↗

EUROPEAN COMMISSION

Effectiveness of the Essential Requirements for Packaging and Packaging Waste and Proposals for Reinforcement

Appendices

ENV.F.1/FRA/2014/0063

Directorate-General for Environment

ADDRESS COWI A/S
Parallelvej 2
2800 Kongens Lyngby
Denmark

TEL +45 56 40 00 00
FAX +45 56 40 99 99
WWW cowi.com

EUROPEAN COMMISSION, DG ENVIRONMENT

MARCH 2020

EFFECTIVENESS OF THE ESSENTIAL REQUIREMENTS FOR PACKAGING AND PACKAGING WASTE AND PROPOSALS FOR REINFORCEMENT

APPENDICES

FRAMEWORK CONTRACT ENV.F.1/FRA/2014/0063

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CONTENTS

Appendix A Full Text of Essential Requirements

The Packaging and Packaging Waste Directive (PPWD) was introduced to improve the quality of the environment, protect human health, protect resources and ensure the functioning of the internal market. The Directive includes the Essential Requirements, which are particularly relevant to the functioning of the internal market, as they relate to what packaging can and cannot be placed on the market. The Essential Requirements are set out in Article 9 and Annex II of the Directive. The relevant text is included in the two boxes below.

Article 9 (PPWD) – Essential Requirements

1. Member States shall ensure that three years from the date of the entry into force of this Directive, packaging may be placed on the market only if it complies with all Essential Requirements defined by this Directive including Annex II.

2. Member States shall, from the date set out in Article 22 (1), presume compliance with all Essential Requirements set out in this Directive including Annex II in the case of packaging which complies:

(a) with the relevant harmonized standards, the reference numbers of which have been published in the Official Journal of the European Communities. Member States shall publish the reference numbers of national standards transposing these harmonized standards;

(b) with the relevant national standards referred to in paragraph 3 in so far as, in the areas covered by such standards, no harmonized standards exist.

3. Member States shall communicate to the Commission the text of their national standards, as referred to in paragraph 2 (b), which they deem to comply with the requirements referred to in this Article. The Commission shall forward such texts forthwith to the other Member States. Member States shall publish the references of these standards. The Commission shall ensure that they are published in the Official Journal of the European Communities.

4. Where a Member State or the Commission considers that the standards referred to in paragraph 2 do not entirely meet the Essential Requirements referred to in paragraph 1, the Commission or the Member State concerned shall bring the matter before the Committee set up by Directive 83/189/EEC giving the reasons therefor. This Committee shall deliver an opinion without delay. In the light of the Committee's opinion, the Commission shall inform Member States whether or not it is necessary to withdraw those standards from the publications referred to in paragraphs 2 and 3.

5. By 31 December 2020, the Commission shall examine the feasibility of reinforcing the Essential Requirements with a view to, inter alia, improving design for reuse and promoting high quality recycling, as well as strengthening their enforcement. To that end, the Commission shall submit a report to the European Parliament and to the Council, accompanied, if appropriate, by a legislative proposal.

ANNEX II (PPWD)

ESSENTIAL REQUIREMENTS ON THE COMPOSITION AND THE REUSABLE AND RECOVERABLE, INCLUDING RECYCLABLE, NATURE OF PACKAGING

1. Requirements specific to the manufacturing and composition of packaging

— Packaging shall be so manufactured that the packaging volume and weight be limited to the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and for the consumer.

— Packaging shall be designed, produced and commercialised in such a way as to permit its reuse or recovery, including recycling, in line with the waste hierarchy, and to minimise its impact on the environment when packaging waste or residues from packaging waste management operations are disposed of.

— Packaging shall be so manufactured that the presence of noxious and other hazardous substances and materials as constituents of the packaging material or of any of the packaging components is minimized with regard to their presence in emissions, ash or leachate when packaging or residues from management operations or packaging waste are incinerated or landfilled.

2. Requirements specific to the reusable nature of packaging

The following requirements must be simultaneously satisfied:

— the physical properties and characteristics of the packaging shall enable a number of trips or rotations in normally predictable conditions of use,

— possibility of processing the used packaging in order to meet health and safety requirements for the workforce,

— fulfil the requirements specific to recoverable packaging when the packaging is no longer reused and thus becomes waste.

3. Requirements specific to the recoverable nature of packaging

(a) Packaging recoverable in the form of material recycling

Packaging must be manufactured in such a way as to enable the recycling of a certain percentage by weight of the materials used into the manufacture of marketable products, in compliance with current standards in the Community. The establishment of this percentage may vary, depending on the type of material of which the packaging is composed.

(b) Packaging recoverable in the form of energy recovery

Packaging waste processed for the purpose of energy recovery shall have a minimum inferior calorific value to allow optimization of energy recovery.

(c) Packaging recoverable in the form of composting

Packaging waste processed for the purpose of composting shall be of such a biodegradable nature that it does not hinder the separate collection and the composting process or activity into which it is introduced.

(d) Biodegradable packaging

Biodegradable packaging waste shall be of such a nature that it is capable of undergoing physical, chemical, thermal or biological decomposition such that most of the finished compost ultimately decomposes into carbon dioxide, biomass and water. Oxo-degradable plastic packaging shall not be considered as biodegradable.

Additionally, Article 11 of the PPWD specifies maximum concentration levels for 4 heavy metals (lead, cadmium, mercury and hexavalent chromium).

The Essential Requirements mean that Member States should only permit packaging to be placed on the market that:

1.1 is demonstrably of the minimum necessary volume and weight;

1.2 does not exceed the specified heavy metal concentration limits;

1.3 has a reuse system in place if the supplier claims it is designed to be reusable; and

1.4 is suitable for either recycling, energy recovery, composting or biodegradation.

While the PPWD places this responsibility on Member States, it is packaging suppliers who must be able to demonstrate compliance. Member States can presume compliance with the Essential Requirements if packaging suppliers use the harmonised standards. These are:

1.5 EN 13427_2004 (the “umbrella standard”)

1.6 EN 13428_2004 (Prevention by source reduction)

1.7 EN 13429_2004 (Reuse)

1.8 EN 13430_2004 (Recycling)

1.9 EN 13431_2004 (Energy Recovery)

1.10 EN 13432_2000 (Biodegradation and composting)

CR 13695-1:2000 and CR 13695-2 detail how to verify the heavy metal content, in accordance with Article 11.

The Standards provide suggested checklists for suppliers and EN 13427 recommends that the Standards are incorporated into internal management systems (such as ISO 9001 or ISO 14001).

Appendix B Stakeholder Engagement

Table A-1 List of Stakeholders Contacted and Nature of Engagement

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Wohnig	Klaus	APK AG	Y			
Vandewal	Frank	ACE Belgium, Recarton Belgium/ Tetrapak		Y		Y
Klepper	Carl Dominik	AGVU Arbeitsgemeinschaft Verpackung + Umwelt	Y			
Stephan	Rosgen	AGVU Arbeitsgemeinschaft Verpackung + Umwelt				Y
Kreutzer	Daniel	ALDI Sued	Y			
Carpentier	Annick	Alliance for Beverage Cartons and the Environment (ACE)	Y	Y	Y	Y
Ibelli	Luca	Alliance for Beverage Cartons and the Environment (ACE)	Y	Y		Y
Papageorgiou	Thomas	Anamet / Sepan (Greek recycler/ association)	Y			
Claus	Steve	APEAL (Association of European Producers of Steel for Packaging)	Y	Y		
MacDomhnaill	Ruaidri	APEAL (Association of European Producers of Steel for Packaging)	Y	Y		
Van Maercke	Alexis	APEAL (Association of European Producers of Steel for Packaging)	Y	Y	Y	
Rösgen	Stephan	Arbeitsgemeinschaft Verpackung + Umwelt e.V. (AGVU)	Y			Y
ter Morsche	Robert-Jan	ArdaghGroup	Y			
		ASOS				Y
Sinkovec	Ales	Avisa partners			Y	
Arratia	Ramon	Ball packaging	Y	Y		

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Bierth	Claudia	Ball packaging	Y	Y		Y
Bunte	Christine	BASF	Y	Y		Y
Schmidt	Anke	BASF				Y
Rosenbaum-Lin	Dong	BASF				Y
Kujat	Christof	BASF				Y
Baum-Rudischhauser	Anne	BDE (Federal Association of German Waste, Water and Raw Material Management)	Y			
Longo	Eugenio	Borealis Group	Y	Y		Y
Freijo	Juan José	Brambles				Y
Scourti	Nicole	BRITISH AMERICAN TOBACCO	Y			
Houlder	Graham	CEFLEX	Y			Y
Legrand	Thierry	CEN				Y
Cerreira Da Cruz	Marc-Antoine	CEN-CENELEC	Y			Y
Leberle	Ulrich	CEPI	Y	Y		Y
Darut	Axel	CITEO	Y			
Fournel	Valentin	CITEO	Y			
Lujan	Tatiana	Client Earth	Y			
van Bochove	Hans	Cokecce (Coca Cola Europe)	Y			
Fuso Nerini	Amanda	CONAI	Y	Y		Y

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Møller Meilstrup	Julius	Confederation of Danish Industry	Y			
Faenza	Chiara	Co-op Italia				Y
Maier	Volker	COTY Inc				Y
Hagelund	Lisbet	Danish Chamber of Commerce	Y			
Hurley	Alexander	Dept of Communications, Climate Action and Environment	Y			
Schmitz	Helmut	Der Grüne Punkt	Y			Y
van Halteren	Markus	Der Grüne Punkt	Y			Y
Denison	Ursula	Der Grüne Punkt				Y
Schulz	Christina	Der Grüne Punkt		Y		Y
Allgeuer	Thomas	DOW chemical Europe	Y			
Geraghty	Kate	DOW chemical Europe	Y	Y	Y	Y
Beaulaton	Juliette	Dr2Consultants	Y			
Clayson	Peter	DS Smith	Y			Y
Giovannetti	Romina	Ecoembes	Y			
ten Wolde	Arthur	Ecopreneur	Y	Y		Y
Popescu	Ioana	ECOS	Y			
Yserd	Nathalie	Eco-systèmes (ESR)	Y			
Arditi	Stéphane	EEB	Y	Y		

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Schweitzer	Jean-Pierre	EEB	Y	Y		Y
Guichard	Emmanuel	Elipso	Y	Y		Y
Naber	Gerald	Ellen MacArthur Foundation				Y
Schembri	Ariana	Environment & Resources Authority (ERA)	Y			
Antvorskov	Helle	Environmental agency of Denmark	Y			
Rindegren	Jakob	Environmental Services Association (ESA)	Y			
Sicard	Sophie	EuRIC, PAPREC	Y	Y		
Dornheim	Nick	EuroCommerce	Y	Y		Y
Slupek	Kamila	Eurometaux		Y		
Borg	Agnes	EuropaBio	Y			
Labberton	Maarten	European Aluminium Association (EAA)	Y	Y		Y
Vangeel	Filip	European Association of Plastics Recycling & Recovery Organisations (EPRO)	Y			
Lange	Kristy-Barbara	European Bioplastics	Y	Y		
von Pogrell	Hasso	European Bioplastics	Y			
Schneider	Eva	European Brands Association (AIM)	Y			Y
Mourette	Aurore	European Federation for Waste Management and Environmental Services (FEAD)	Y			
Phillips	Juliet	European Investigation Agency (EIA)	Y			
Setien	Elisa	European Manufactuers of EPS (EUMEPS)				Y

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Sterrantino	Silvia Freni	European Plastics converters (EUPC)	Y			Y
Bonvillan	Denis	European recycling industries' federation (EuRIC)	Y	Y		
Katrakis	Emmanuel	European recycling industries' federation (EuRIC)	Y			
Freegard	Keith	European recycling industries' federation (EuRIC)				Y
Raiteri	Umberto	European Recycling Platform	Y			
Botta	Valeria	European Retail Round Table	Y			
Freni Sterrantino	Silvia	European Plastics Converters	Y			
Riou	Gwendoline	EUROPEN	Y	Y		Y
Janssens	Virginia	EUROPEN		Y		Y
Rouault De La Vigne	Albane	Excelrise	Y			
Quoden	Joachim	EXPRA	Y			
Oledzka	Gosia	ExxonMobil	Y			
Yves	Decelle	FEAD	Y	Y		
HALBY	Marion	FEDEREC (French federation of recycling industries)	Y			
Kazashka-Hristozova	Krassimira	FEFCO - AISBL	Y	Y		Y
Ska	Baudouin	FERVER	Y			
Davidsson	Bengt	FEVE – The European Container Glass Federation	Y	Y		
Duquet	Jean-Paul	Flexible Packaging Europe (FPE)	Y	Y		Y

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Aufdemkamp	Guido	Flexible Packaging Europe (FPE)				Y
Plainemaison	Valérie	FNADE	Y			
Degallaix	Laura	Food Drink Europe	Y	Y		Y
LÓPEZ	Patricia	Food Drink Europe	Y	Y		Y
Diercxsens	Phillipe	Food Drink Europe, Danone	Y			Y
De Santis	Massimo	Free Pack Net Holding Sagl	Y			Y
Moronval	Fabrice	French Ministry for the Ecological and Inclusive Transition	Y			
Bolger	Meadhbh	Friends of the Earth Europe	Y			
Schmidt	Isabell	German Association for Plastics Packaging and Films (IK Industrievereinigung Kunststoffverpackungen e.V.)	Y			
Wasserbauer	Konrad	Greiner Packaging International	Y			
Marrone	Michelle	Gualapack				Y
Von Reitzenstein	Elisabeth	Independent Retail Europe	Y	Y		Y
Linde	Anders	ISO TC122	Y			
Fischer	Thomas	Landbell AG	Y			
Roudeix	Richard	Lyondell Bassell (LYB)			Y	
Hery	Bruno	Lyondell Bassell (LYB)			Y	
Banez Romero	Juan Manuel	Mars	Y			Y
Yates	Colin	Mars				Y

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Hermeler	Imke	Metal Packaging Europe	Y	Y	Y	
Pazicky	Milan	Metal Packaging Europe	Y	Y		
Billiet	Stijn	Milliken Europe BVBA	Y	Y		Y
Milinov	Virna	Ministry of Environment and Energy (Directorate for Environmental Impact Assessment and Sustainable Waste Management)	Y			
Stulgyte	Ieva	Ministry of Environment of the Republic of Lithuania	Y			
Zuke	Laura	Ministry of Environment of the Republic of Lithuania	Y			
Blauberg	Tarja-Riitta	Ministry of the Environment Finland	Y			
Bazil	Petr	Ministry of the Environment of the Czech Republic	Y			
Wronn	Judith	Mondi Group				Y
Scriba	Dr. Michael O. E.	mtm plastics (part of borealis group)	Y			Y
Veras	Vanya	Municipal Waste Europe	Y			
Vetere	Mariagiovanna	NatureWorks BV	Y			
Liebenspacher	Franz	Nestle	Y			Y
Weber	Johannes	Nestle				Y
Degli Innocenti	Francesco	Novamont	Y	Y		
La Scola	Paolo	Novamont SpA	Y			
Mittelham	Stephanie	Orgalim, Europe’s Technology Industries	Y			
Bracke	Roeland	OVAM	Y			

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Webb	Simon	P&G/ AIM European Brands Association	Y		Y	Y
Rakowski	David	PA Consulting - delivers machines/ tech for pack formating/ manufacture	Y			
Neubrock	Manuel	PAPACKS GmbH				Y
Neumann	Arno	PAPACKS GmbH				Y
Laermann	Michael	PAPACKS GmbH	Y	Y	Y	Y
Dag	Tahsin	PAPACKS GmbH				Y
Ricard	Sebastien	Paprec Group	Y		Y	
Crépet	Christian	PETcore Europe	Y		Y	
Pohl	Denis	PFS Public Health – Environment	Y			
Millet	Herve	Plastics Europe	Y			
Romano	Antonello	Plastics Europe	Y			
Furfari	Antonino	Plastics Recyclers Europe	Y	Y		Y
Waibel	Chaim Gabriel	Plastics Recyclers Europe	Y	Y		
Pawelec	Jakub	Polish Chamber of Waste Management/ Polska Izba Gospodarki Odpadami	Y			
Barczak	Piotr	Polish Zero Waste Association	Y			
Spencer	Venetia	Polyolefin Circular Economy Platform (PCEP)	Y			
Rohaan	Gerard	Pooling Partners				Y
Moens	Roeland	Pooling Partners				Y

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
de Belder	Gian	Proctor and Gamble (P&G)				Y
Melchior	Arno	Reckitt Benckiser				Y
Larsson	Anna	Reloop Platform	Y	Y		
Morawski	Clarissa	Reloop platform		Y		
Hellgren	Jonne	RePack				Y
Foster	Jason	Replenish				Y
Hodecek	Peter	Rohstoff Handel			Y	
Schmuck	Siegfried Anton	SCIAENA	Y			
Schuer	Eddy	Serred	Y	Y		
Pastor	Rocío	Sigfito Agroenvases, S.L.	Y			
Koch	Lars	Sony	Y			
Nony	Jean-Marc	Sphere (also chairman of subcommittee 4 CEN - packaging)	Y		Y	
Kathmann	Jens-Otto Hugo	Styrenics Circular Solutions (AISBL)	Y		Y	
Couder	Nicole	Suez	Y		Y	
Rasmussen	Peter	Suomen Uusiomuovi Oy/ Finnish Plastics Recycling Ltd	Y		Y	
Goransson	Malin	Swedish EPA	Y			
Chelmecki	Michal	Synthos - Styrenics	Y			Y
Krzysztof	Zarnotal	Synthos - Styrenics				Y

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Lalani	Mustan	Tetra Pak	Y			
Von Wiren-lehr	Sabine	Tetra Pak	Y		Y	Y
Gavilan	Ignacio	The Consumer Goods Forum				Y
Clausdatter Worsøe	Katinka	The Danish Chamber of Commerce	Y			
Vol	Julia	TIPA	Y			Y
Schifter	Julia	TIPA				Y
Priesters	Jurgen	TOMRA	Y			
Van-roost	Herman	Total refining and chemicals	Y			
Fábregas Almirall	Alexis	Toy Industries of Europe (TIE)	Y			
Vogt	Lars	Toy Industries of Europe (TIE)	Y			
Sahin	Fatma	Unilever	Y			
Huysman	Francis	Valipac vzw	Y			
Mansuy	Michael	Veolia	Y			
Pfund	Renaud	Veolia/ EuRIC/ FEDEREC	Y			
Pedrini	Camilla	Versalis (Eni)			Y	
Glaz	Timothy	Werner Mertz	Y	Y		Y
Schau	Alexander	Werner-Mertz		Y		Y
Condamine	Pierre	Zero Waste Europe	Y			

NAME	FIRSTNAME	ORGANISATION	NATURE OF ENGAGEMENT			
			Workshop	Position paper	Survey (invitees)	Interview/ Case Study
Copello de Souza	Larissa	Zero Waste Europe	Y			
Simon	Joan-Marc	Zero Waste Europe	Y			

Appendix C Existing Approaches to Defining Recyclability and Reusability

Table A-2 Table for Definitions of Reusability and Reuse

Source / Definition Suggestion	Definition
ISO 22628:2002 [1] **Road vehicles - Recyclability and recoverability - Calculation method**	**Reusability** Ability of component parts that can be diverted from an end-of-life stream to be reused [ISO 22628, 2002]
Packaging and Packaging Waste Directive's Essential Requirement specific to reusable packaging[2]	**Requirements specific to reusable packaging** The following requirements must be simultaneously satisfied— a) the physical properties and characteristics of the packaging shall enable a number of trips or rotations in normally predictable conditions of use, b) possibility of processing the used packaging in order to meet health and safety requirements for the workforce, c) fulfil the requirements specific to recoverable packaging when the packaging is no longer reused and thus becomes waste.
Packaging and Packaging Waste Directive 94/62/EC[3]	**Article 3 – Definitions** (…) 2a. "reusable packaging" shall mean packaging which has been conceived, designed and placed on the market to accomplish within its lifecycle multiple trips or rotations by being refilled or reused for the same purpose for which it was conceived;
The Law Dictionary[4]	**Reusability of a component**

[1] https://www.evs.ee/products/iso-22628-2002
[2] European Commission Directive 94/62/EC: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1536752510742&uri=CELEX:01994L0062-20180704
[3] European Commission Directive 94/62/EC: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1536752510742&uri=CELEX:01994L0062-20180704

[4] The Law Dictionary *Reusability*, accessed 26 February 2019, http://thelawdictionary.org/recyclable-material/

<table>
<tr><th>Source / Definition Suggestion</th><th>Definition</th></tr>
<tr><td></td><td>The way an item can be used repeatedly compared to a one-use item.</td></tr>
<tr><td>Mathematical model of reusability – Murayama et al., 2004[5]</td><td>Reusability of a component

“probability that a product having been used for a time period t ends its life in the following unit time (i.e., in the interval between t and t+1) but the component included in it is reusable.”

Reusability of a product

“a probability that a product having been used for a time period t ends its life in the following unit time but the product is reusable.”</td></tr>
<tr><td>SEPA Guidance Note - Reuse Activities and Waste Regulation[6]</td><td>“The key question is whether there is certainty that the item will actually be reused even if some repair or refurbishment is required. European case law has ruled that reuse must be a certainty, not a mere possibility, for an item to be classed as non-waste.”

SEPA define 5 situations which they use to assess certainty of reuse;

› “No change of ownership
› Direct Reuse - transfer of ownership is direct from one user to another user
› Indirect Reuse with checking - ownership transfers to a third party before passing on to its new owner, however items are checked prior to, or at the point of, acceptance.” They state that checks would generally cover;
    › “Condition – whether the item is an acceptable condition for reuse
    › Functionality and requirement for repair – whether the product is fully functional; if repair is required then this must be economically viable</td></tr>
</table>

[5] Murayama, T., Yamamoto, S., and Oba, F. (2004) Mathematical model of reusability, paper given at IEEE International Symposium on Electronics and the Environment, 2004. Conference Record. 2004, May 2004
[6] Scottish Environment Protection Agency (2017) *SEPA Guidance - Reuse activities and waste regulation*, accessed 26 February 2019, https://www.sepa.org.uk/media/219772/wst-g-051-reuse-activities-and-waste-regulation.pdf

Source / Definition Suggestion	Definition
	› Technical requirements – whether the product meets all technical requirements for its sale /use. › Marketability – whether a market exists for the product" › "Indirect reuse without checking - third party accepts items with no prior checks to give certainty of reuse › Exporting for reuse outwith the UK"
Taxonomy, Definition, Approaches, Benefits, Reusability Levels, Factors and Adaption of Software Reusability: A Review of the Research Literature[7]	**Reusability** Reusability is the likelihood a piece of source code that can be adapted and used again to add new functionalities with minor or no changes.

Table A-3 Definitions for Recyclability / Recyclable

Source / Definition Suggestion	Definition
Villalba *et al* 2002[8]	**Recyclability** The ability of a material to reacquire the properties that it had in its virgin state, where virgin state refers to the material in its purest form before being processed or shaped for a specific use. Anything less than that can be measured as a degree of its recyclability, defined as recycling index (R).
Maris & Froelich; Critical analysis of existing recyclability assessment methods for new products in order to define a	**Recyclability** A product's recyclability is the capacity of a product and a reference network to restore the materials, the technical properties and the economic value close to those of its origin when a product arrives at its end of life.

[7] *Taxonomy, Definition, Approaches, Benefits, Reusability Levels, Factors and Adaption of Software Reusability: A Review of the Research Literature - SciAlert Responsive Version*, accessed 26 February 2019, https://scialert.net/fulltextmobile/?doi=jas.2014.2396.2421

[8] Villalba, G., Segarra, M., Fernández, A.I., Chimenos, J.M., and Espiell, F. (2002) A proposal for quantifying the recyclability of materials, *Resources, Conservation and Recycling*, Vol.37, No.1, pp.39–53

Source / Definition Suggestion	Definition
reference method (REWAS 2013)[9]	
ISO standard 22 628 on recyclability calculation and vehicle recovery[10]	**Recyclability** The capacity of components, materials or both to be removed from the end-of-life flow to be recycled. The recyclability rate is the percentage of the mass of a new vehicle that can be recycled, reused or both. Recyclability rate includes recycled material and reused components.
Hopewell et al 2009; Plastics recycling: Challenges and Opportunities[11]	**Recyclability** Recyclability is the potential rather than the actual amount [of packaging/an item] that can be recycled.
The Law Dictionary[12]	**Recyclability** The ability of waste materials to be captured and separated from the waste stream for conversion into a new item or reused in the same capacity.
CEN Standard: EN 13430:2004: Requirements for packaging recoverable by material recycling.[13]	**Recyclability** For material recyclability of packaging/packaged products on the market to be claimed, the supplier must: Ensure that the packaging design takes account of the recyclability of the materials from which it is produced Control selection of raw materials used in production packing/filling operations and where practicable collection/sorting operations to ensure that they do not adversely affect recycling processes,

[9] Maris, E., and Froelich, D. CRITICAL ANALYSIS OF EXISTING RECYCLABILITY ASSESSMENT METHODS FOR NEW PRODUCTS IN ORDER TO DEFINE A REFERENCE METHOD, p.17

[10] *ISO 22628:2002(en), Road vehicles — Recyclability and recoverability — Calculation method*, accessed 28 February 2019, https://www.iso.org/obp/ui/#iso:std:iso:22628:ed-1:v1:en,ISO (2006) *ISO 14044 Environmental management - Life cycle assessment - Requirements and guidelines*, 2006

[11] Hopewell, J., Dvorak, R., and Kosior, E. *Plastics recycling: challenges and opportunities*, http://rstb.royalsocietypublishing.org/content/364/1526/2115.short

[12] *What is RECYCLABILITY? definition of RECYCLABILITY (Black's Law Dictionary)*, accessed 28 February 2019, https://thelawdictionary.org/recyclability/

[13] *Standards and Legislation*, accessed 28 February 2019, https://repak.ie/for-business/members/current-repak-members/prevent-and-save/standards-and-legislation/

Source / Definition Suggestion	Definition
	Ensure that the design of packaging makes use of materials or combinations of materials that are compatible with known and relevant recycling technologies (innovative packaging can be classified as recyclable provided the supplier is satisfied that recycling infrastructure really is being developed), Establish a system to ensure that new developments in relevant recycling technologies are monitored and recorded and that such records are made available to the design function, Take account of the potential change in releases to the environment that will result from introducing the used packaging to the recycling process.
An introduction to packaging and recyclability, November 2009, Packaging Resources Action Group PRAG)[14]	**Recyclability** The ability of a pack to be readily recycled.
JRC Technical Report: Integration of resource efficiency and waste management criteria in European product policies – Second phase[15]	**Recyclability** ability of waste product to be recycled, based on actual practices. *Also* **Recyclability Rate** Ratio of recyclable product mass to total product mass (calculation method included in report).
Mars [16] **Packaging materials innovation for sustainability: Our Approach**	**Recyclability** the ability to recycle; and recovery – recycling in practice.

[14] PRAG (2009) *An introduction to Packaging and Recyclability*, 2009, http://www.wrap.org.uk/sites/files/wrap/Packaging%20and%20Recyclability%20Nov%2009%20PRAG.pdf

[15] Fulvio, A., Mathieux, F., European Commission, Joint Research Centre, and Institute for Environment and Sustainability(2012) *Integration of resource efficiency and waste management criteria in European product policies - second phase: refined methods and guidance documents for the calculation of indices concerning reusability Report n° 3. Report n° 3.*, Luxembourg: Publications Office

[16] (2018) *Mars: Sustainable in a Generation Plan*, 2018, https://www.mars.com/docs/default-source/Sustainabile-In-A-Generation/2018-report/1803_mars_sigp-report.pdf

Source / Definition Suggestion	Definition
Institute cyclos-HTP[17]	**Recyclability** Recyclability can be defined as qualitative and quantitative behaviour of a product in the post-use phase via the respectively specific process chain to primary raw material substitution. This means that it must be possible to collect the material using existing collection facilities and to sort it in a qualified manner. Its reprocessability must enable recirculation.
Ball Packaging	**Recyclability** Recyclability is the capacity of a material to substitute primary raw materials. It measures the qualitative and quantitative ability of a product to substitute primary raw materials in the post-use phase via the material-specific process chain. Recyclability means that packaging waste is collectable and sortable via existing and sufficiently supplied collection and sorting infrastructure and that individual materials can be efficiently and effectively separated in the waste management chain. The process generates recyclates of such a quality that they can find a market, effectively replacing equivalent virgin material in a 1:1 ratio. The reprocessability of the separated packaging materials must enable recirculation in existing end markets.
ACE, CEPI, CITPA, FEFCO	**Recyclability** The ER should include a clear definition of recyclability which is material neutral and factual. The criteria for recyclability specified in the harmonised standard EN 13430 provides a broadly agreed basis (e.g. the ability of the packaging material to be collected, sorted and recycled).
Procter + Gamble[18]	**Recyclable** "In the absence of a globally aligned definition of 'recyclable,' our definition goes beyond the technical ability to recycle an item and calls for a recycling system to be operational at scale with viable collection, recovery, and end markets in place. By 2025, all of our major packaging platforms will be recyclable or reusable."
Plastics Recycling Europe and the Association of Plastic Recyclers[19]	**Recyclable** A product is only deemed recyclable if it meets the following four conditions: › the product must be made with a plastic that is collected for recycling, has market value and/or is supported by a legislatively mandated programme;

[17] Löhle, S., and Institute of Cyclos-HTP (2017) Verification and examination of recyclability
[18] (2018) *Procter & Gamble reveals packaging sustainability strategy*
[19] *July 12, 2018 - APR Press Release*, accessed 28 February 2019, https://plasticsrecycling.org/news-and-media/824-july-12-2018-apr-press-release

Source / Definition Suggestion	Definition
	› must be sorted and aggregated into defined streams for recycling processes; › can be processed and reclaimed or recycled with commercial processes; and › becomes a raw material that is used in the production of new products.
EllenMacArthur Global Commitment	**Recyclable** A packaging (1) or packaging component (2,3) is recyclable if its successful post-consumer (4) collection, sorting, and recycling (5) is proven to work in practice and at scale. Notes 1. In the context of a 2025 timeframe and the Global Commitment, a package can be considered recyclable if its main packaging components, together representing >95% of the entire packaging weight, are recyclable according to the above definition, and if the remaining minor components are compatible with the recycling process and do not hinder the recyclability of the main components. Otherwise, only the recyclable components of a package (or the recyclable parts of components - see footnote 3) can be counted towards achieving this commitment, and only when other components do not hinder or contaminate their recyclability. Examples o If a bottle and its cap are recyclable, the packaging can be claimed to be recyclable if it has a label (<5% of total weight) that does not hinder the recyclability of the bottle and cap. o If that same bottle has a label that hinders or contaminates the recycling of the bottle and cap, the entire packaging is non-recyclable. o If a package has (a) certain component(s) that are not recyclable and that make up >5% of the total packaging weight (e.g. 12%) and that do not hinder or contaminate the recycling of the remaining recyclable components of the package, then only that recyclable part (e.g. 88%) can be counted towards this commitment. Longer-term, the aim should be for all packaging components (e.g. including labels) to be recyclable according to the above definition. 2. A packaging component is a part of packaging that can be separated by hand or by using simple physical means (ISO 18601), e.g. a cap, a lid and (non in-mould) labels. 3. A packaging component can only be considered recyclable if that entire component, excluding minor incidental constituents (6), is recyclable according to the definition above. If just one material of a multi-material component is recyclable, one can only claim recyclability of that material, not of the component as a whole (in line with US FTC Green Guides and ISO 14021). 4. ISO 14021 defines post-consumer material as material generated by households or by commercial, industrial and

Source / Definition Suggestion	Definition
	institutional facilities in their role as end users of the product which can no longer be used for its intended purpose. This includes returns of material from the distribution chain. It excludes pre-consumer material (e.g. production scrap). 5. Packaging for which the only proven way of recycling is recycling into applications that do not allow any further use-cycles (e.g. plastics-to-roads) cannot be considered 'recyclable packaging'. 6. ISO 18601:2013: A packaging constituent is a part from which packaging or its components are made and which cannot be separated by hand or by using simple physical means (e.g. a layer of a multi-layered pack or an in-mould label). (Ellen McArthur Foundation)**.**[20]
BASF	**Recyclable** A clear and harmonized definition of "recyclable" packaging based on the applicable standards and in line with Article 6a of the PPWD for calculating recycling targets. In other words, packaging which enters recycling operations for reprocessing into products, materials or substances (after the preliminary operations referred to in Article 6a(b)) would be recyclable.
Food Drink Europe	**Recyclable** Classify packaging as 'recyclable' if it meets the definition set in ISO 18604 standard on packaging material recycling, as well as the criteria set in Article 6(a) of the PPWD for calculating actual recycling. Recyclable packaging would then be defined as packaging which "can be diverted from the waste stream through available processes and programmes and can be collected, processed, and returned to use in the form of raw materials or products".

[20] https://www.ellenmacarthurfoundation.org/assets/downloads/Global-Commitment-Document-to-download-on-website-2.pdf

Appendix D Workshop Reports

D.1 March 2019 Workshop Report

D.1.1 Introduction

This workshop was part of two European Commission studies relating to packaging:

1 A study on the effectiveness of the Essential Requirements and proposals for reinforcement; and
2 A study to support the preparation of the Commission's guidance for Extended Producer Responsibility (EPR) Schemes.

The workshop involved representatives from across the packaging industry and non-governmental organisations from a range of Member States. It was an opportunity to share information with stakeholders, and for stakeholders to discuss the direction of the two studies at an early stage.

A background paper was sent to participants two days before the meeting. Stakeholders commented that more time would have been appreciated to allow participants to best prepare for the workshop discussions.

This is a summary of the workshop discussions; the presentations used during the day accompany this note.

D.1.2 Overview

An overview was given of the two studies, including the interactions between EPR, the Essential Requirements and wider EU waste policy. The scope to consider "recyclability" and "reusability", rather than the binary concepts of being "recyclable" or "reusable", was also discussed.

The Essential Requirements study is looking at the effectiveness of the Essential Requirements to date and potential for their reinforcement including through revisions in the Packaging and Packaging Waste Directive (PPWD).

The EPR study looks to support the preparation of guidance for existing law, under Article 8a of the Waste Framework Directive (WFD). The work covers packaging, WEEE and batteries, as well as a few additional product groups, and will generate guidance on "necessary costs", "equal treatment", fee modulation and enforcement (namely prevention of free-riding).

The studies are to be completed in 2019 to support the following timeline:

- Commission Report on review of the Essential Requirements potentially accompanied by a legislative proposal by end 2020. (Note that any legislative proposal would be made subject to a prior Impact Assessment)
- Implementation of Article 8a WFD by 2023.
- The PPWD's packaging recycling targets for 2025 and 2030.

- The Commission's target for plastic packaging to be reusable or recyclable in a cost effective manner by 2030.

This workshop was the first stage of engagement. There will be ongoing one-to-one discussions and interviews and stakeholders were invited to send position papers or further information, or to request a meeting with the project leads.

Related to the Essential Requirements study, 15 case studies will be developed over the next few months, looking at both best practice packaging and examples that are less likely to support high recycling rates. There will be two other workshops to (1) help finalise options to be modelled in the Essential Requirements study and (2) feedback on the results from both studies.

D.1.3 Key Trends, Problematic Packaging and the Effectiveness of the Essential Requirements

The following points were included in the workshop presentation.

Key Trends

- Packaging generation has been increasing in absolute terms and on a per capita basis
- E-commerce packaging accounts for a growing share due to the increase in use of the internet to buy goods.
- There has been a trend towards lightweighting; between 1990 and 2015, all packaging types have decreased in weight per unit, with an average decrease of one third.
- There has been a shift away from glass and metal packaging towards paper, board and plastic. The use of bioplastics has also increased.
- Recycling rates for some materials are much higher than for others. Recycling in overall percentage terms has increased, and packaging recovery has increased slightly. Recovery for plastic packaging has seen a more marked increase.
- There is no EU-wide data on reuse, but market reports indicate that single use packaging has been on the rise while reuse has declined.
- Hazardous substances in packaging are believed to be declining.
- There is increasing demand for technical material that provides a barrier.

Problematic Packaging

- "Problematic packaging" is difficult to define but it primarily refers in this context to packaging that is less likely to achieve high recycling rates because it is more difficult to:
  - collect (perhaps because it is easily littered);
  - sort (for instance because of its colour or small size); and/ or
  - recycle (due to additives or contaminants, or little demand/ use for the material).
- Some aspects of what is problematic to recycle are more widespread or more fundamental than others.
- Generally, the use of "problematic packaging" is on the increase, relative to more easily recyclable packaging.
- Can include inefficient packaging use, so the issue is how the material is used rather than the packaging type itself (e.g. overpackaging).

Effectiveness of the Essential Requirements

- It is difficult to produce metrics on waste generation and prevention, with a number of possible methodologies being proposed.
- Previous research has indicated that cost reduction has been the main driver for packaging waste prevention through lightweighting. This is accompanied by environmental benefits through reduced resource use both for making and transporting the packaging.

- The Essential Requirements have arguably a facilitated a situation in which incineration rates have increased more than recycling rates. Incineration with energy recovery increased by 9% between 1997 and 2002, slightly more than the 8% increase in recycling.[21]
- Member States have relied heavily on presumed compliance (limited enforcement of the Essential Requirements), while limits for hazardous substances are more easily operationalised.
- It is hard to define concepts such as "consumer acceptance", on which the Essential Requirements rely.
- The Essential Requirements do not reflect changes in waste legislation.
- The Essential Requirements were considered as part of the 2018 review of the Packaging and Packaging Waste Directive but there were no substantial revisions.

D.1.4 Discussion

Participants raised the following points during the subsequent discussion. This section reflects the various viewpoints that were raised and does not indicate a consensus position.

A theme that was raised on a number of occasions was the importance of a harmonised approach across Member States and the interaction with collection infrastructure and sorting technologies and recycling infrastructures.

The need to take into account packaging together with the packaged product, hence to not overlook packaging's functionalities was also supported by stakeholders on a number of occasions during the workshop.

Stakeholders welcomed the coordinated approach taken on both topics (guidelines for EPR fee modulation and the effectiveness of the Essential Requirements for packaging).

Problematic Packaging

- A number of participants considered that "problematic packaging" is an inappropriate term. It was noted that terminology such as "harder to recycle" may be less open to misinterpretation.
- "Problematic packaging" does not necessarily take into account the purpose of packaging; for instance the key driver in the food sector is food safety. As such, it was suggested that the functionality and life-cycle footprint of the packaging should be taken into account.
- "Problematic packaging" is also a concept which may stifle investments and innovation as it does not take into account ongoing and upcoming innovative solutions.
- It was proposed that the focus should also be on sorting technologies, recycling infrastructure and consumer behaviour, not just packaging design.
- Similarly, it was suggested that infrastructure matters in relation to "cost-effectiveness" in the sense that if there is an overcapacity for incineration this also has implications on cost effectiveness or recycling in a given country. Cost effectiveness may have to factor in the different environmental impacts from different types of end of life treatment.
- Packaging may be classified as problematic in some countries (e.g. because there is no infrastructure for separate collection, sorting and/or recycling of this packaging) but not in others. Thus, there is a need to consider the interaction with the collection and, sorting and recycling systems. Recycling infrastructure and technologies will be different in 2025 compared to today, and EPR provides an opportunity to improve infrastructure.
- The paper industry distinguishes between material that is recyclable in standard processes and material that requires a special process.

[21] Report from the Commission to the Council and the European Parliament on the implementation of directive 94/62/ec on packaging and packaging waste and its impact on the environment, as well as on the functioning of the internal market [SEC(2006) 1579]

- Chemicals of concern should be taken into consideration and the Commission's Communication on options to address the interface between chemical, product and waste legislation needs to be considered in this context.

Definitions

- If the intention is to design for a circular economy, rather than to simply meet targets, then circularity should form part of the definition of recyclability, including the extent to which it provides recycled content for to substitute virgin materials in new packaging or products.
- The distinction between packaging being 'technically' recyclable and the costs of recycling that packaging is an important one.
- "Cost-effectiveness" depends on the benchmark used; the cost of recycling can be compared to other waste treatment options, but the costs of these depend on Member State policies and capacities, albeit a more harmonized standard is intended over time.
- A hierarchy of recycling could recognise whether the packaging can be subject to closed loop recycling into an equivalent (e.g. bottle to bottle) or the material cascaded to other applications that still displace virgin material.

Essential Requirements

- The lightweighting trend respects the waste hierarchy by prioritising prevention, through reduction of material use. But this can make it more difficult, or less cost effective, to recycle. Reference was made that this serves the first level of the waste hierarchy (prevention).
- Some of the CEN Standards developed to prove compliance with the Essential Requirements contain a higher level of precision and clarity in terms of definition — such as related compostability — and as such, are more straightforward to use and enforce.
- There is room to improve the enforcement of the Essential Requirements in most Member States. Enforcement of the Essential Requirements by Member States could be improved through the development of European or national guidance.
- Guidance for the enforcement of the Essential Requirements should be at the Member State level, given differences in the level of investment of sorting technologies. It was pointed out that sorting technologies are different because the level of investment has been different in Member States, not because packaging and technologies differ widely from state to state. Others noted the need to balance harmonisation and differentiation.
- Producers comply with the Essential Requirements, even if they are not explicitly referring to the Essential Requirements as a driver for consideration of recyclability, waste prevention etc.
- The study and related future work should not stifle innovation, so the Essential Requirements should not be too prescriptive.
- It was stated that the Essential Requirements should serve the legal objectives of the Packaging and Packaging Waste Directive.
- Some participants suggested the Essential Requirements have proven effective as they are generally complied with and there are examples of industry improving the recyclability of its packaging/ reducing packaging.
- It is important to consider trade-offs between levels of the waste hierarchy (prevention vs recycling). For example, lightweighting does not necessarily support circularity. On the other hand, new design requirements as laid down in the draft Single Use Plastics Directive (e.g. tethered caps for single-use plastic beverage containers) will increase packaging weight whilst reduces littering.
- Packaging serves multiple functions which must not be overlooked. The design of packaging consists of finding the right compromise between packaging's ability to fulfil all these functions and environmental considerations.
- Separability of materials is an important factor to be considered.
- A flexible approach allows for innovation, e. g. via regular revision of systems (example: German packaging law).
- Different routes of recycling should be feasible → technology neutrality.
- A revision should take into account functionality and circularity. Perceived "over-packaging" may be designed to extend shelf life.
- Black plastic may not be easy to recycle using current technologies, but black plastic can incorporate recycled content and technological advancements (e. g. black pigments which do not interfere with IR sorting) could mean it is more easily processed in the future.

- Improved communication with design teams could help.
- Need to harmonise terminology across the Waste Framework Directive, the Packaging and Packaging Waste Directive and the Standards.
- Standards are vague and do not include metrics.
- A life-cycle approach is needed to consider transport and cleaning requirements for reuse.
- The packaged product’s life-cycle (e.g. transport, shelf-life, food waste) also needs to be considered. Changes to packaging design can have environmental consequences for other stages of a packaged product’s life-cycle.
- Chemical recycling was discussed. While some stakeholders stressed the potential benefits for e.g. recycling materials which cannot be mechanically recycled and for producing virgin quality, others stated that scalability and LCA benefits (energy balance) need to be proven.

D.1.5 Potential Reinforcement of the Essential Requirements

The workshop presentation highlighted the following points for discussion.

- The Essential Requirements are to be reinforced with a view to, inter alia, improve design for re-use and promote high quality recycling, as well as strengthening their enforcement (PPWD, Article 9.5)
- The Essential Requirements should also support the aspirational target for all plastic packaging to be reusable or recyclable in a cost effective manner by 2030, but there are different interpretations of “cost effective manner”.
- There is a question of how general or specific the Essential Requirements should be.
- There needs to be some process for allow for innovative new packaging to be placed on the market.
- Options for reinforcing the Essential Requirements include:
  - Supporting measures for the existing Requirements, such as economic incentives, performance indicators, awareness raising and packaging prevention plans.
  - Revision of the CEN Standards.
  - Reformulating the Essential Requirements in the Packaging and Packaging Waste Directive.
  - Developing EU and/or national guidance to help Member States better implement and enforce them.

D.1.6 Discussion

Participants raised the following points during the subsequent discussion.

- Essential Requirements and EPR are two sides of the same coin so there needs to be a co-ordinated approach and harmonised definitions. EPR can provide an economic instrument to support the Essential Requirements.
- Cost effectiveness cannot rely on municipalities alone, given that it is a value chain. It should reflect a shared responsibility.
- In a circular economy, the focus should be on increasing the proportion of material that is placed back on the market — through material recycling — and achieving this in a cost effective manner (with reference to the commitment in the EU Plastics Strategy for all plastic packaging to be recyclable in a cost effective manner by 2030).
- Up-front investment in infrastructure, knowledge and end-markets will reduce costs in the long-run but it is not clear how best to take account of this initial investment.
- Some producers are keen to know that certain types of packaging will not be banned or made prohibitively expensive because it needs to be considered as part of a life-cycle approach.
- There was some support for the existing flexible approach on the basis that it has not prevented improvements, but it was recognised that enforcement could be improved. A flexible approach would also allow for ongoing and future innovation.

- The Essential Requirements can be incorporated into green public procurement.
- Harmonisation requires a general, not too prescriptive, approach.
- Industry is in favour of harmonization in order to preserve access to the internal market. It has to be seen what can be achieved with a current flexible and decentralised approach foreseen under the EPR and what are the themes that need to be regulated with the Essential Requirements.

D.1.7 Conclusions

Throughout the discussions, a number of participants emphasised the importance of harmonisation across Member States to support free movement, reduce the burden of compliance and prevent conflicting priorities. It was also noted that capacities, technologies and costs will vary between Member States, which may support a more flexible approach, underpinned by consistent principles.

In terms of the Essential Requirements study, there was a concern that the term “problematic packaging” may neglect functionality and wider considerations beyond the ease of recycling and hamper innovation. It was suggested that some of the packaging types identified as ‘problematic’ may have higher recycling rates in some Member States. The existing use of the Standards was not a major focus of the discussion but, as previous studies have highlighted, it was noted that enforcement of the Essential Requirements could be improved. A number of participants commented that packaging innovation should not be stifled and that the study needs to take into account the potential for recycling technologies to be further developed.

D.2 July 2019 Workshop

D.2.1 Introduction

The stakeholder workshop of 9th July 2019 was part of a European Commission study relating to the Essential Requirements (ER) packaging needs to comply with in order to be allowed to be put on the EU market: a study on the effectiveness of the Essential Requirements and proposals for their reinforcement. Whilst the ERs relate primarily to packaging design, this is with the view to ensure the packaging, when it becomes waste, is managed in-line with the waste hierarchy, so the scope of the study covers design and waste management issues.

The workshop involved representatives from across the packaging value chain, from material and packaging producers to brands, as well as non-governmental organisations. It was an opportunity to gather input from stakeholders regarding the development of key definitions and potential measures to be scrutinised and assessed more closely in the final appraisal phase of the study.

A background paper was sent to participants one week before the meeting.

This is a summary of the workshop discussions: the presentations used during the day accompany this note.

D.2.2 Definitions

Firstly, a brief presentation was given outlining several approaches to defining 'reusable and recyclable in a cost effective manner' – key terms that will require clear definitions in the revised ER if, as suggested in the Plastics Strategy, they are to be used to delineate what may or may not be placed on the market after a specified date. Participants pointed out that the rationale for the review of the ERs stated in the PPWD was 'improving design for reuse and promoting high quality recycling'.

In addition, whilst the 'reuse' definition was presented it was not part of the main discussion during the workshop. The workshop participants were then divided into 5 groups to discuss 3 main types of definition (generic, quantitative and design for recycling-type). The strengths and weaknesses of each type were recorded, and are now synthesised in the table below.

Strengths	Weaknesses
'Generic' type definition i.e. concise, open wording etc.	
› Sets basic principles › Can help achieve coherence with other legislation and standards › Applicable to all materials i.e. material neutral › Inclusive geographic scope › Could support functioning of the internal market as does not depend on available facilities › Flexible and adaptable to innovation › In-line with objective of ER to facilitate enforcement at the national level	› Lots of room for different interpretations across the Member States › Could lead to market fragmentation if interpretations vary widely between Member States › Lack of / low enforceability (some pointed out that enforceability might be strengthened through other actions) › Could limit innovation / be slow to implement if it takes a long time to come to a consensus about whether a format is in line with the definition or not › Lowest common denominator approach › Requires some further defining of what the minimum available infrastructure might be › Lack of / no ambition level
'Quantitative' type definition i.e. relates to a quantitative metric	
› Target driven › Time dependent › Not prescriptive on 'how' › Measureable (would need to be in-line with rules on measuring recycling) › Clearly enforceable › Could act as communication tool › Can be more objective, depending on methodology used › Could be 'fast' with value chain reacting accordingly › Could be defined at different levels (e.g. format, type etc.) although unlikely that it	› Not a level playing field across Member States if country specific (hence diverging) recycling rates were used with no homogeneous result › Hampers innovation if based on current technologies and infrastructure › Relevance of the quantitative indicators or metrics used to define recyclable › Difficult to agree on threshold levels › Quantity doesn't necessarily reflect quality [of recycling] › Burden of enforcement / monitoring if too prescriptive › Threshold could depend on municipalities' available infrastructure (collection, sorting and recycling)

Strengths	Weaknesses
could be at the level of each specific packaging item › Provides an incentive for infrastructure to be developed	› Would need to be material / individual type based (so less inclusive) › Would need support on 'how' to reach the target for the approach to be effective › Might overlap with PPWD legal targets › Disregards LCA outcome, no evidence › Does not consider packaging functionalities
'Design for Recycling' type definition i.e. bottom up inclusion or exclusion of different elements of packaging design	
› 'Badly designed' products would be taken out of the market (those for which there is no infrastructure, market or have disruptive characteristics e.g. non-compatible) › Supports high quality recycling if e.g. hazardous chemicals are not included, or products are designed for the material to be recycled multiple times, or packaging is simplified › Aligns actors across the value chain (e.g. designers, brands, recyclers etc.) › Encourages innovation if a value chain approach is taken, gives a clear guide as to where the direction should go and helps to design cost-efficient infrastructure › Could link enforcement to EPR schemes / modulated fees approaches	› Risk of too prescriptive design rules › Might / will impact innovation if too prescriptive / material specific › Possible overlap with EPR fee modulation needs consideration › Enforceability › May not consider packaging functionalities e.g. safety, hygiene etc. › DfR is not equivalent to 'eco-design' so the approach does not consider sustainability more broadly › Risk of downcycling

Some further comments from the participants are as follows:

- The generic type was highlighted as creating certain tensions between applicability, ease of agreement and room for innovation, against enforcement and fragmentation of the EU market due to divergent interpretations.
- Some participants suggested that the quantitative approach could be 'fast', although the right solution might not always be achieved through this approach if due consideration is not at the same time given to the design.
- Innovative materials that might be in the 'red' DfR category could be allowed onto the market as long as the fees under EPR were high enough to pay for the necessary investments in infrastructure to be able to sort and recycle them effectively. This could be a mechanism for allowing innovation. Level of fee could also depend on national availability of necessary recycling infrastructure. Some suggested that this 'penalisation' of access to market could still stifle innovation if it were not promoted or support through other channels.
- One group summarised their views that generic and quantitative approaches have been around thus far but have not delivered expected results, so the DfR approach should be given some consideration. However, it was not clear how this approach could be delivered by the Directive.

- In the plenary, there was some discussion around ensuring the DfR definition was linked to modulated fees under EPR schemes to ensure they are linked and the approach was efficient.
- There were various views that a combination of the three suggested approaches might be an optimal solution in practice, to deal with the weaknesses of each. Comments were also made as to how EPR fees could be leveraged to ensure funds are built up to develop the necessary reuse and recycling infrastructure during the early years of new packaging being placed on the market that is not 100% compatible with existing infrastructure.
- There was, however, concern raised that any DfR based approach must include all actors in the value chain, that the setting of thresholds for any quantitative approaches would be challenging and the question of who would be setting the rules was flagged. It was also pointed out that one of the objectives of the ER update is to encourage implementation and enforceability at the Member State level, so approaches to definitions should take this into account.
- Recyclability also depends on the collection, sorting and recycling infrastructure in a country. Hence, a participant suggested that there could be a defined minimum infrastructure established in each MS.
- The general definition of recyclable with the recycling hierarchy type approach related to the concept of ‘high quality recycling’ was supported in some groups.

The views from the participants suggest that the approach to defining recyclable should take the following into account (though there was no clear consensus on the importance or priority of one or other aspects across the participants):

› Ensure minimum scope for variable definitions across the Member States to minimise fragmentation of the single market;
› Balance specificity and enforceability with administrative burden;
› Allow consideration of and adaptability to new technologies to ensure innovation is not hampered;
› Setting the right balance between prioritising equal treatment of materials and targeting specific materials where the need to increase recyclability is more wide spread and/or complex;
› Ensure packaging’s functionalities and performance are not hampered;
› The chosen approach is harmonised with (likely) approaches to setting EPR fees in order to minimise disruption; and/or
› Coherence with other legislation.

The further development of the definition throughout the remainder of the study will consider these points to ensure the definitions are designed in the most optimal manner.

D.2.3 Potential Measures and Options

A brief presentation of the approach to developing the options was given, followed by a description of each of the measures and how the options were structured. In the same groups as the previous discussion on definitions, the participants then recorded which measures they broadly agreed or disagreed with, and where there was a variety of opinion, or uncertainty around the definition of the measure. The reasons why there was disagreement around the inclusion of a particular measure were recorded. The participants were also invited to suggest additional measures not included under the Options.

The table in Section 4.2 of the main report shows which outcomes were recorded for the different groups and synthesises key messages. A tick (✓) means broad agreement, a cross (✗) broad disagreement and a question mark (?) no broad consensus or uncertainty around the definition of the measure.

In summary:

- The headline requirements were generally supported, with some reservations around setting a deadline of 2025 for all packaging to be reusable and/or recyclable rather than 2030;
- There was no clear consensus on whether the continued use of standards were needed or not;
- Measures related to compostable packaging, hazardousness and labelling were generally well supported;
- The areas which showed the most significant divergence of views around the proposed measures were ‘Efficient use of packaging’, ‘Reusable packaging’ and ‘Recycled content’, indicating that these measures were most in need of further consideration, or greater clarity;
- Views around the mechanisms for enforcement of the new requirements were also quite varied. Some participants stated that the proposed text was often too prescriptive (e.g. “mandate”, “shall” etc); and
- The introduction of a “recycling hierarchy” within the waste hierarchy was put forward and supported by some stakeholders to promote “high quality recycling” as laid down in article 9 of the PPWD.

As noted above, participants were also asked to suggest any measures for reinforcing the ER. Several suggestions of various types were made. Firstly, one measure that could be captured specifically in the ER itself is summarised:

› Consideration of the functionality of packaging within the ER.

Secondly, aspects related to enforcement were given:

› Ensure imports to the EU comply with the ER through third party verification.
› Exchanges of good practices and information between Member States to facilitate enforcement.

Thirdly, a general principle relating to the nature or scope of the measures was highlighted:

› Coherence of the measures with existing legislation should be ensured (e.g. WFD, PPWD).

Finally, some supporting measures or concepts were proposed:

- Traceability of packaging through the value chain should be addressed through the Communication on options to address the interface between chemical, product and waste legislation.[22]
- Implementing landfill bans.
- Reducing incineration of packaging as much as possible.
- Requiring certain packaging formats to be designed for reuse (e.g. transit packaging).
- Implementing requirements for 'renewable content' if recycled content is included.

D.2.4 Potential Impacts

During the final part of the workshop, the 5 groups discussed the key changes they expect as a result of the various measures and the potential consequences that should be addressed in the impact assessment. The responses for 6 specific types of measures, plus the impacts of reinforcing the ERs more generally (in the first row), are summarised in the table below.

The key changes in the first column indicate the broad differences that were anticipated to result from the proposed measures, compared to the current Essential Requirements. The second column indicates further potential implications that would need to be examined in more detail during the options appraisal. Refer to the table above for examples of the kinds of measures that were explored under each broad type highlighted below.

Key Changes Anticipated	Issues to be Addressed in the Impact Assessment
Cross-cutting Measures for Reinforcement of the ER	
› The waste hierarchy would be supported more than it is by the current Essential Requirements – at least for Recycle > Energy Recovery. › Reusable or bulk packaging might be used more than at the moment. › Recycling rates may increase. › Littering would decrease.	› Whether recycling rates will increase › Environmental considerations to be assessed for the whole life-cycle of the packaging › Whether it will lead to switch in packaging material › Whether the revisions will hamper innovation › Preserving the integrity of the internal market › Coherence with existing legislation (including on chemicals, FCM etc.) › Whether imports/ exports are negatively affected › The potential for overly bureaucratic enforcement › Packaging functionalities negatively affected if some packaging is taken off the market › Too detailed definitions risk making it difficult for companies to implement and for authorities to enforce

[22] https://ec.europa.eu/commission/publications/options-address-interface-between-chemical-product-and-waste-legislation_en

Key Changes Anticipated	Issues to be Addressed in the Impact Assessment
	› Economic costs for companies (e.g. for SMEs; change in production lines will require investment) › Prevention aspect (on top of the waste hierarchy) is not well addressed and need to look at overall environmental impact › Potential for huge social and economic changes need to be assessed for all stakeholders along the value chain, including SMEs › The time dimension is critical: need to allow the appropriate timescales for changes
Design for Recycling	
› The quality, consistency and availability of material for recycling may improve. › Design for recycling requirements could provide more clarity for designers and improve alignment along the value chain. › It could promote more innovation in packaging design and technologies. › It could encourage a systems approach that gives more consideration to the infrastructure that is currently available and would be needed in the future. .	› Duplication of effort versus what is already being done on a voluntary basis by value chains › Lack of attention on reuse and reduce › Additional investments needed › Not meeting DfR requirements implies penalties › Reduced GHG emissions and less dependency on fossil fuels › More jobs
Detailed Definition at EU Level & Restrictions on Compostability Types	
› Such measures would impose new market restrictions › The measures may lead to price changes › The quality and quantity of secondary raw materials may increase. › The measures could reduce the amount or residues and packaging that is disposed of.	› Impact on CO_2 and other environmental impacts of alternatives › Impact on prices › Impact on SMEs/ fairness of economic impacts
Definition of Recyclable	
› Defining recyclable could provide more legal certainty › There could be more of a standardised approach across Member States.	› Freezing the status quo and hampering innovation › Market disruption
Enforcement Options	
› Could provide a level playing field for packaging types and a more consistent approach across Member States. › Changing the enforcement options is likely to reduce free-riding	› Level of bureaucracy and economic burden

Key Changes Anticipated	Issues to be Addressed in the Impact Assessment
2025 Deadline	
› An earlier deadline would require significant investment › Waste management in Member States would need to become a higher priority. › Bringing forward the deadline would accelerate the awareness-raising process	› Not ready for market › Acceleration might bring negative consequences/ wrong decisions
Minimisation of Packaging	
› Producers would work to further reduce the weight of their packaging.	› Inconsistent application of current LCA methodologies across Member States › Need to solve allocation issues › Need to standardise LCA methodologies › Need to ensure that packaging's functionalities are not hampered

The discussions therefore indicated that participants tended toward the view that the options under consideration should be thoroughly assessed as part of an impact assessment preceding the publication of the legal review of the ER.

Options should lead to more support for the waste hierarchy and a more consistent approach between the ERs and wider EU policy, as well as, potentially, improved environmental outcomes (subject to analysis). The revised Requirements could also be more implementable and enforceable. It was, however, highlighted that more consideration needs to be given to waste prevention and reuse and more specifically that the new Essential Requirements should clearly come across as prioritising these aspects, in line with the waste hierarchy.

As in the previous discussions, the functionality of the packaging, the scope for future innovation, the safeguard of the Internal Market and the environmental impact of the packaging across its whole life-cycle or the wider collection and recycling supply/value-chain were highlighted as issues to be considered in the 'options appraisal'. One group also referred to the need for ERs for collection/ sorting/ recycling infrastructures, as well as for packaging design.

A key theme throughout the discussions was the need to consider the economic impacts on businesses along the supply chain, and especially the regulatory and financial impact on SMEs.

Appendix E Long List of Measures

Table A-4 Long list of measures

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Effectiveness and EU added value	Arcadis 2009	Develop a European Enforcement Body to negotiate with multinational companies, coordinate enforcement and inspection	Helps smaller Member States in particular that find it difficult to influence multi-national companies. Could avoid duplicating efforts across different Member States.	Enforcement
1: Cross-cutting	Efficiency & EU Added Value	BIO IS 2011	Establish an EU rapid alert system to enable non-compliance in one country to be recorded centrally and to be notified to all other Member States	Would enable non-compliance in one country to be recorded centrally and shared with other Member States. This could support smaller countries facing enforcement challenges with large multi-nationals and avoid duplication of enforcement efforts.	Technology
1: Cross-cutting	EU added value	Evaluation	Require Member States to report annually on compliance activities and documented cases of non-compliance.	Supports information exchange on enforcement options and non-compliance packaging that could be marketed in several Member States. Encourages Member States to consider the enforcement steps they are taking.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Effectiveness	Arcadis 2009	Provide guidance to Member States on enforcement, including proposed indicators to assess the success of national implementation and enforcement	Essential Requirements place obligations on Member States, not producers, but it is not always clear to Member States how they should enforce the Standards. Indicators could help this and support harmonised implementation. Top down indicators relate to data on packaging and products placed on the market and packaging waste collected. Proposed bottom-up indicators include selecting a basket of representative products, which the Member State then assesses for compliance with the Standards. This would also provide consistency for producers across Member States.	Guidance
1: Cross-cutting	Effectiveness	Arcadis 2009	Include in the Essential Requirements metrics for Member States to assess and support the success of national implementation and enforcement, including a minimum number of independent inspections.	Essential Requirements place obligations on Member States, not producers, but it is not always clear to Member States how they should enforce the Standards. Indicators could help this and support harmonised implementation. Unlike the guidance approach above, this	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
				would require Member States to take ensure there is a minimum number of compliance checks etc. each year.	
1: Cross-cutting	Efficiency	Stakeholders	Provide Standards free of charge	May increase the use of the Standards and means producers have access to guidance on the meaning of the Essential Requirements free of charge.	Guidance
1: Cross-cutting	Effectiveness	Arcadis 2009	Mandate the use of the Standards for companies.	May increase use of the Standards, improve their usability and provide a format for compliance checks.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Effectiveness	Arcadis 2009	Develop awareness raising and implementation advice and support for producers	Producers are not always aware of, or clear on, their obligations under the Essential Requirements, how to implement them and how compliance can be assessed.	Guidance
1: Cross-cutting	Effectiveness	Arcadis 2009	Provide guidance to producers support a strategic, more joined-up approach at the start of the decision making process. E.g. rather than designing anti-theft packaging for high-value, small products, the products could instead be sold from behind the counter.	Producers are not always clear on their obligations, so this would could increase their understanding. It would also look at whether the packaging is needed in the first place, rather than jumping to the weight or volume of the packaging or the material used. Unclear how this would work in practice or whether it would provide clarity on what can and cannot be placed on the market.	Guidance
1: Cross-cutting	Effectiveness	BIO IS 2011	Introduce advisory compliance indicators for different stages - filling indicator (maximum weight or volume of packaging: product ratio); secondary materials indicator (minimum percentage of recyclable material); recycling efficiency indicator (list of	Provides metrics for assessing compliance, which are currently lacking and expands beyond existing requirements to include recycling efficiency	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
			materials that hinder the recycling process)		
1: Cross-cutting	Effectiveness	BIO IS 2011	Mandate compliance indicators for different stages - filling indicator (maximum weight or volume or packaging: to product ratio); secondary materials indicator (minimum percentage of recyclable material); recycling efficiency indicator (list of materials that hinder the recycling process). Limits/ targets would need to be specified.	If can be operationalised, provides metrics for assessing compliance, which are currently lacking and expands beyond existing requirements to include recycling efficiency	Regulation
1: Cross-cutting	Effectiveness	Case studies	Provide guidance on a carbon metric to inform material choice and reuse/ recycling options	Provides a way to balance reuse, recycling etc. and inform material choices.	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Effectiveness	Arcadis 2009	Include a standardised way to measure the packaging's carbon footprint and to reflect this in the modulated EPR fees	This would provide an additional tool to inform, and financial incentives to promote, eco-design and decisions relating to material and reuse.	Market
1: Cross-cutting	Effectiveness & Relevance	Case studies	Amend the Essential Requirements to require the design process to follow an LCA methodology	Potentially provides an objective guide to inform packaging decisions and, for instance, compare light-weighting, reuse and recycling options. However LCA methods are contested.	Regulation
1: Cross-cutting	Coherence	Evaluation	Incorporate the waste hierarchy into the umbrella standard	Rather than being neutral on the choice of reuse, recycling and energy recovery, this would make clear the order of priority. As the Standards are not mandatory, this would not necessarily have the force of regulation.	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Effectiveness & coherence	Arcadis 2009	Mandatory labelling requirements to be certified by third party. Would need to recognise different degrees of compliance - I.e. whether the packaging is designed for energy recovery or recycling and, if the latter, how recyclable it is.	Means there is an independent party to check for compliance - packaging that has not been accredited by the organisation cannot be placed on the market. Would mean all companies actively consider the Essential Requirements in their design decisions and could mean there is commercial pressure to improve packaging if companies have to declare the extent to which they comply with the Essential Requirements. However, energy recovery may not be an option in the reinforced Essential Requirements.	Labelling
1: Cross-cutting	Effectiveness and efficiency	Stakeholders	Introduce a conformity declaration, similar to the RoHS conformity declaration. Or letter of compliance for producers to complete.	Means all companies are required to demonstrate compliance; this is more straight-forward if there is a single standard form and formal procedure for producers to use in all Member States and it is easier for Member States to monitor. Sweden is considering introducing a letter of compliance.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Effectiveness	Stakeholders	Link the Essential Requirements to EPR fees	Linking to modulated EPR fees could provide more clarity over how to implement the Essential Requirements and favoured packaging options/ packaging that is easier to recycle. It could also mean the EPR schemes assist Member States in monitoring compliance.	Market
1: Cross-cutting	Effectiveness	Evaluation	Set minimum penalties for non-compliance packaging.	The threat of financial penalties could encourage more producers to ensure their packaging is demonstrably compliant.	Market
1: Cross-cutting	Effectiveness	BIO IS 2011	Extend Ecodesign Directive to include packaging	Would provide clearer indicators if the Directive applied to packaging as well as energy-using products, with accompanying labelling	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Effectiveness	Stakeholders	Introduce a process flow: Is the packaging 1) Excessive?; 2) Hazardous?; 3) Separately collected?; 4) Reusable with minimum number of trips, recyclable or compostable? Begin the design process again if they cannot give the right answer for all of these. This would include adding "subject to it being suitable for reuse or recycling" to paragraph 1 of Annex II so the packaging is the minimum volume and weight, providing it can still be reused or recycled.	Provides guidance on how to use the different Standards and how to balance potential trade-offs. E.g. if it is light-weight but not recyclable, the weight should be re-visited. It also enhances the requirements in order to be classed as reusable or recyclable, and rules out design-for-energy recovery.	Regulation
1: Cross-cutting	Effectiveness & Relevance	Stakeholders	Apply the 2030 target on plastics (reusable or recyclable in a cost-effective manner) to all packaging formats	Levels the playing field for all packaging and prohibits incineration	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Coherence	Stakeholders	All packaging should be suitable for reuse or recycling within the EU	In 2016, 37% of plastic collected for recycling was exported out of the EU. This requirement could support higher quality collections and recycling, expanding the end markets for the recycled material.	Regulation
1: Cross-cutting	Efficiency	Arcadis 2009	Apply the Essential Requirements to individual products and their packaging. So not all shampoo packaging has to comply with prevention, providing the ratio of packaging to product is going down across the producers' shampoo range. However, average targets can lead to anomalies and limit the ambition of the Essential Requirements.	Industry has suggested that the requirements for minimisation (and a possible packaging to product ratio) should apply at the level of the product range.	Guidance
1: Cross-cutting	Effectivenes s	Case studies	PEF/ OEF Guidelines - include a harmonised methodology to calculate the environmental footprint of the packaging/ organisations. The PEF method would be most appropriate for packaging due to the product focus.	This would provide a benchmarking tool for packaging companies to show exemplar cases or identify scope for improvement. An environmental footprint limit could be specified, above which packaging cannot be placed on the market. This could	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
				also link to EPR fees, with packaging exceeding the minimum requirements benefitting from a lower fee.	
1: Cross-cutting	Effectiveness & coherence	Case studies & stakeholders	Ecolabel criteria - packaging has to comply with specified criteria, covering whole of the packaging's life-cycle (from raw material extraction to disposal) and can then display eco-label	Stimulates co-operation across the supply chain; calculates the carbon footprint of the packaging through its lifecycle; can include specific requirements.	Labelling
1: Cross-cutting	Effectiveness	Case studies	Require Member States to provide fiscal incentives for SMEs to innovate in packaging design.	While financial incentives could prove effective, this is beyond the scope of the Essential Requirements, is not necessarily within the remit of the European Commission and will not help to determine what can be placed on the market.	Market

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Effectivenes s	Case studies	Develop a packaging benchmarking system with results published in order to stimulate competition and innovation across producers. Would also include measures to reduce the number of components in packaging.	This could support continuous improvements, but is not operationally enforceable within the Essential Requirements.	Guidance
1: Cross-cutting	Effectivenes s	Case studies	Introduce a product level carbon tax to incentivise low-carbon solutions.	Provides a financial incentive, however not likely to be within the remit of the Commission and this is not directly linked to what can and cannot be placed on the market.	Market
1: Cross-cutting	Effectivenes s	Case studies	Require the development of guidance tools for enforcement officers.	Could improve the enforcement of the Essential Requirements, support a standardised approach across the EU and suggest to manufacturers that the Essential Requirements are more likely to be enforced.	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Coherence	Stakeholders	Introduce a high-level, industry-wide body responsible for the control and management of the transition to a circular economy. Body to include representatives of packaging producers, waste collectors, recyclers and public authorities.	This brings together the different actors in the value chain, however this is beyond the scope of the Essential Requirements.	Co-ordination
1: Cross-cutting	Effectivenes s	Stakeholders	Require Member States to detail their market surveillance procedures and activities.	Clarifies how compliance with the Essential Requirements will be monitored, however it does not necessarily improve enforcement activities.	Enforcement
1: Cross-cutting	Coherence	Stakeholders	Require modulated EPR fees to be displayed on the packaging.	This provides a mechanism to recognise that some packaging is more recyclable etc. than others and could mean producers take into account reputational as well as financial considerations. However this relies on decisions on modulated fees, which could vary between Member States - harmonised packaging would	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
				require clear EU rules on different fee categories.	
1: Cross-cutting	Relevance	Stakeholders	Include targets for bio-based materials if recycled content is not appropriate.	Recognises that bio-based materials could be an alternative, particularly for food-contact packaging and reduces the use of certain virgin materials.	Regulation
1: Cross-cutting	Effectiveness	Stakeholders	Require labelling on the disposal route the packaging has been designed for.	Provides information to consumers to increase the likelihood that the packaging is sorted appropriately. And may mean producers consider the reputational impact.	Regulation
1: Cross-cutting	Coherence and relevance	Stakeholders	Revise quality rules under food contact legislation to ensure there is a functioning and timely approval process for the use of recycled plastics in food contact materials and include bio-based material options.	Supports the use of recycled or bio-based content, however not strictly within the remit of the Essential Requirements.	Supporting policy

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
1: Cross-cutting	Effectiveness and coherence	Stakeholders	Update the CEN standards	The Standards have not been updated for some time, however the first task is to reinforce the Essential Requirements and then consider what changes are required in the Standards (in the options where they are retained).	Guidance
1: Cross-cutting	Effectiveness	Stakeholders	Allow for application-specific instruments in product-specific legislation.	Recognises that the Essential Requirements are seeking to address a broad range of packaging and that this has, until now, necessitated a general approach. Compliance and enforcement may, however, be more difficult if the Essential Requirements simply direct to other pieces of legislation.	Supporting policy
1: Cross-cutting	EU added value	Stakeholders	Provide EU workshops on implementation and enforcement of the Essential Requirements.	Provides more clarity over how to implement and enforce the Essential Requirements, but does not guarantee improvements. Could be something to consider once the Essential Requirements have been revised.	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
2: Prevention	Effectiveness	Arcadis 2009	Develop and clarify the concept of "consumer acceptance" in Standard EN 13428	The "concept is considered the central obstacle for proper implementation and enforcement". The concept should be adapted to "consumer use" - e.g. allowing for packaging like six-pack rings that make it easier for the consumer to carry the packaged product.	Guidance
2: Prevention	Effectiveness	Evaluation	Remove provisions for "consumer acceptance" in requirements for minimising volume and weight. And remove all critical areas apart from "product protection" and "safety" from Standard EN 13428	Removes objective terms that raise enforcement challenges; raises the priority of waste prevention; and focuses on the key mitigating criteria highlighted by stakeholders in the workshop	Regulation
2: Prevention	Effectiveness	Stakeholders	Two possible formulae for preventing excessive packaging - surface area to volume ratio [√(2&surface of packaging cm^2)/√(2&volume of packaged goods cm^3); or Packaging Impact Ratio, required for the Ecolabel on rinse off cosmetics: PIR= (W + (Wrefill x F) + N + (Nrefill x F)) / (D + (Drefill x F))	Provides a clear way of assessing compliance with the minimal weight/ volume requirement (if combined with a target or guidance on acceptable levels). The PIR, for refillable packaging, takes into account the design of the auxiliary packaging. Such ratios do not indicate whether	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
				any packaging is necessary in the first place.	
2: Prevention	Effectiveness	Evaluation	Introduce maximum ratio of packaging to product by volume or weight	Provides clarity for producers and an objective metric against which Member States can measure compliance. Ratios do not measure whether any packaging is needed in the first place.	Regulation
2: Prevention	Effectiveness	Case studies	Specify limits on proportion of sealed air in the volume of e-commerce packaging	Provides a metric against which to measure compliance with the minimum volume requirement. Difficult to apply to all types of packaging; e.g. it would not address vacuum-packed bananas etc..	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
2: Prevention	Effectiveness	Stakeholders	Overall packaging waste arisings should be reduced to no more than 127 kg/capita/year by 2025 and 64 kg/capita/year by 2030, as compared to 2016 levels (170kg per person in 2016. range: 55kg-221kg)	This provides metrics for the minimisation requirement, which is otherwise difficult to interpret and enforce. However, some countries are already exceeding the proposed 2030 target, indicating there is potential to reduce packaging waste beyond the proposed target. And there are no guarantees that all companies make equal efforts. Nor is the packaging necessarily recyclable.	Regulation
2: Prevention	Effectiveness	Evaluation	Require Member States to introduce a packaging tax based on the weight of packaging, varied by material, the virgin content and the recycling rate achieved.	Provides a financial incentive to producers and a requirement for Member States to enforce, and also promotes recycled content.	Market
2: Prevention	Effectivenes s	Case studies	Require brand owners to offer a certain percent of their liquid products as concentrated refills.	This provides a practical way to reduce packaging volume and weight, however it relates to the product rather than the packaging and does not clearly determine what can and cannot be placed on the market.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
2: Prevention	Effectiveness	Case studies	Set a maximum ratio of the volume of water to the volume of active ingredients for specific liquid products.	This promotes concentrated liquids where appropriate and provides a clear rule to reduce the volume of packaging, however this requirement relates to the product itself, rather than the packaging so not clear if possible in the PPWD.	Regulation
3: Energy Recovery	Effectiveness & coherence	Evaluation	Replace all references to "recoverable" with "reusable or recyclable". Remove all sections relating to energy recovery.	This is needed to bring the Essential Requirements into line with more recent EU policies and recognises that recycling and reuse take precedence over energy recovery.	Regulation
4: Reuse	Effectiveness	Evaluation	Change "take account" of to "minimise" the impact of the reconditioning process on the environment	Strengthens the wording of the Standard to minimise the environmental impact of reconditioning for reuse. As "minimise" is still open to interpretation, the effect is more likely to be advisory.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
4: Reuse	Coherence	Evaluation	Remove the reference to "one-way" auxiliary packaging and specify that it must be reusable or recyclable	Prevents the sale of single-use non-recyclable packaging to provide refills for reusable packaging in the hybrid reuse system.	Regulation
4: Reuse	Effectiveness	Stakeholders	Specify a minimum number of trips for reusable packaging, which will depend on packaging type. EU Ecolabel for rinse-off cosmetics sets default number of refills for plastic at 5	Provides a metric for assessing reuse options and recognises that reusable packaging needs to be use a certain number of times to justify the additional weight.	Regulation
4: Reuse	Effectiveness	Arcadis 2009	Oblige distributor sector to offer alternative reusable packaging when they provide single use packaging	Places clear responsibilities on distributors. The Czech Republic and Portugal have promoted reusable packaging. This does not ensure that customers take-up the option but this could reduce businesses' waste collection costs, which could incentivise them to choose the reuse option.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
4: Reuse	Effectiveness	Stakeholders	Reusable packaging should have a share of at least 30% of the market by 2030 for all primary packaging, and of at least 70% for beverage packaging	This provides a clear target, against which performance can be measured and prioritises the top of the waste hierarchy. Reuse systems have proven to work for beverage containers and beverage containers represent a significant proportion of single-use packaging. This may fit better in the broader Packaging Directive and not clear if it would allow some companies with a high reuse proportion to "subsidise" others.	Regulatory
4: Reuse	Effectivenes s	Case studies	Mandate public / retailer awareness campaigns to promote reuse for certain packaging formats with low recycling rates or high levels of consumption, such as e-commerce packaging.	This reflects the influence retailers and consumers can have in packaging design, however it is not operationally enforceable or directly relevant to the Essential Requirements.	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
4: Reuse	Effectivenes s	Case studies	Guidelines to encourage reusable e-commerce packaging - providing best practice examples.	Would encourage distributors to consider reuse options, however guidance will not determine what can and cannot be placed on the market and this approach does not guarantee that reusable packaging will increase.	Guidance
4: Reuse	Effectivenes s	Case studies	Ban single-use plastic packaging for certain product sectors, such as cleaning products.	Wil increase the amount of reusable packaging for some commonly used products for which empty containers could be taken to the retailer to refill.	Regulation
4: Reuse	Effectivenes s	Case studies	Introduce standard sizes for returnable transport packaging.	Could make it easier to circulate reusable packaging (in an open loop system).	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
4: Reuse	Effectiveness	Case studies	Require reusable transit packaging in certain scenarios, for example between an organisation's own sites or where other closed loop logistics arrangements are practical.	Provides circumstances in which reusable packaging must be used.	Regulation
4: Reuse	Effectiveness	Stakeholders	Mandate a complete ex-ante technical, social, environmental, and economic analysis, in order to assess the environmental and economic viability of reuse options.	Provides a procedure for choosing reuse or recyclability.	Regulation
5: Recycling	Effectiveness	Evaluation	Provide guidance on the "minimum percentage" that is to be recyclable.	The regulations refer to a "certain percentage" without indicating a minimum.	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Relevance	Evaluation	Provide guidance to encourage consideration of removable components that could be littered	May help to improve packaging design to reduce littering, which could particularly benefit plastic packaging producers given cost coverage requirements in the SUP Directive.	Guidance
5: Recycling	Effectiveness & Coherence	ICF & Eunomia 2019	Replace "certain percentage by weight" in 3 (a) with "complete recycling".	So that the packaging unit is recyclable (allowing for reasonable loss rates) rather than only a percentage.	Regulation
5: Recycling	Effectiveness & Coherence	ICF & Eunomia 2019	Amend paragraph 2 of Annex II to state "Packaging shall be designed, produced and commercialised in such a way that it is either suitable for reuse or recycling in a cost -effective manner". The reference to packaging being "incinerated or landfilled" would consequently need to be removed from paragraph 3 of Annex II, along with clause 3(c).	Removes options for energy recovery so that the Essential Requirements only endorse the top 3 tiers of the waste hierarchy, and supports SUP Directive requirement for all plastic packaging to be suitable for reuse or recycling. The cost effective requirement not only reflects the SUP Directive but indicates that there need to be facilities for the material to be recycled at scale and widespread collection and sorting capacities.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness	Evaluation	Include a clear definition of "recyclable" in the text of Annex II	This is currently too open to interpretation. Would need to distinguish between being "technically" recyclable and being recycled in practice and cost-effectively.	Regulatory
5: Recycling	Effectiveness	Arcadis 2009	Replace "recyclable" in the Standard with "recycled" or "operationally recyclable"	This would require the recycling that is theoretically possible to happen in reality. The concepts are potentially still open to interpretation	Regulation
5: Recycling	Effectiveness	Evaluation	Include decision criterion to assist with the trade-off between material use and recyclability	To make clear that, first and foremost, the packaging must be recyclable and then the minimum possible weight and volume.	Regulatory

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness	Evaluation	Encourage Member States/ producers to consult recycling/ composting facilities on what causes "significant problems in recycling technologies" and require guidance on materials that are more easily and more cost-effectively recycled, and those that are less so.	If processors' views are taken into account in design, the recycling process and quality of outputs could be improved	Guidance
5: Recycling	Effectiveness	Evaluation	Require Member States/ producers to consult recycling/ composting facilities on what causes "significant problems in recycling technologies"	If processors' views are taken into account in design, the recycling process and quality of outputs could be improved	Regulation
5: Recycling	Effectiveness	Stakeholders	A preference should be given to closed-loop recycling, into the same or other high value products	Open-loop down cycling can result in a significant loss of quality and value of the recyclate, so is less likely to reduce the demand for virgin materials.	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness & Coherence	Canadian Bill proposal - https://resource-recycling.com/recycling/2019/05/14/canadian-bill-would-put-strict-limits-on-packaging-design/	Include a list of recyclable materials, and combinations of materials, which are subject to a lower EPR fee due to their recyclability	As a common concern is that the Essential Requirements are vague - making them difficult to comply with and difficult to enforce- this would provide explicit guidance. In addition to the list of materials, there may need to be restrictions on how the approved materials can be used in combinations.	Market
5: Recycling	Effectiveness	Canadian Bill proposal - https://resource-recycling.com/recycling/2019/05/14/canadian-bill-would-put-strict-limits-on-packaging-design/	Include a list of recyclable materials from which packaging can be made	As a common concern is that the Essential Requirements are vague - making them difficult to comply with and difficult to enforce- this would provide explicit guidance.	Regulation
5: Recycling	Effectiveness	Evaluation	Add requirement to incorporate highest possible proportion of recycled content, with targets depending on the material	Supports the original objective of the PPWD to protect resources, supports the market for recycled materials and reflects the WFD and SUP Directive endorsement/ targets for recycled	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
				content. Wold need to specify targets for each type.	
5: Recycling	Effectiveness	Evaluation	Prohibit the use of additives that alter sorting - foamers, fillers, sleeves with more than 60% coverage	Additives that change the density of the packaging can distort the float/ sink test and mean the packaging is mis-sorted and contaminates waste streams, while sleeves can cause material identification errors.	Regulation
5: Recycling	Effectiveness	Evaluation	Prohibit the use of multi-material packaging that cannot be separated into different components	This means more multi-material packaging will be more easily recycled and avoids disputes over what can and cannot be recycled.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness	Evaluation	Prohibit the use of PVC	PVC is difficult to sort due to its similarities with PET, it is difficult to reprocess and it is not widely recycled. Action at the EU level would provide more certainty for Member States and packaging companies over what constitutes compliance and reduce contamination of PET.	Regulation
5: Recycling	Effectiveness	Evaluation	Prohibit the use of pigments that cannot be detected by NIR	The use of carbon black pigment makes the plastic difficult to sort and, consequently, difficult to recycle. Dark plastics also have a low value on the secondary market, so end markets are more limited. A regulatory approach at EU level removes uncertainty over what is "difficult to recycle" so makes compliance and enforcement easier.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness	Evaluation	Prohibit plastics with optimal brighteners	Optical brighteners mean the packaging is difficult to reprocess, reducing the likelihood that the packaging will be recycled.	Regulation
5: Recycling	Effectiveness	Evaluation	Prohibit Additions to Plastic Bottles: Paper labels on plastic bottles (e.g. PET/PP/HDPE)	These additions make the packaging difficult to process, so wither reduce the recycling rate and/ or risk contamination.	Regulation
5: Recycling	Effectiveness	Evaluation	Require multi-material packaging to be easily separated	This means more multi-material packaging will be more easily recycled and avoids disputes over what can and cannot be recycled.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness	Stakeholders	All packaging put on the market should be designed for reuse or recycling, be separately collected and its production material should be sustainably sourced	Explicitly promotes design for recycling and requires packaging to not only be technically recyclable but also to have a collection system in place. The requirement for sustainable sourcing, while potentially a subjective term, is likely to promote recycled content.	Regulation
5: Recycling	Effectiveness	Evaluation	Specify a time limit for the development of suitable recycling processes to qualify "reasonable period of time"	Still allows period of time for recycling technologies to be developed but avoid indefinite waiting period.	Regulation
5: Recycling	Effectiveness	Evaluation	Make compliance statements/ questionnaires mandatory where the Standards are used and improve wording to make clearer and reflect the degrees of recyclability	The questionnaire is not as easy to understand as it could be; making it mandatory would harmonise compliance procedures and ensure producers give due consideration to the various issues.	Regulation
5: Recycling	Effectivenes s	Case studies	Introduce a European label for sustainable packaging, to verify both the recyclability of the	Encourages manufacturers to go beyond the Essential Requirements, but is not within	Labelling

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
			product and the level of recycled content.	the remit of the Essential Requirements.	
5: Recycling	Effectiveness	Case studies	Restrictions on use of minerals oils (MOSH and MOAH) in paper/board packaging.	To increase recyclability.	Regulation
5: Recycling	Effectiveness	Stakeholders	Prohibit direct printing on plastic packaging and require labels to be removable by the consumer.	This avoids inks that could contaminate the recycling process and de-value the material	Regulation
5: Recycling	Effectiveness	Stakeholders	Require plastic sleeves used to label plastic containers to be made from the same resin	These avoids labels that contaminate the recycling process or need to be processed differently. However, it does imply that labels will be plastic, whereas they could be made of recycled paper and sleeves may not be necessary in the first instance.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectivenes s	Stakeholders	Mandate a negative marking on packaging that is not completely recyclable to indicate that it should be sorted differently.	Reduce the risk of contamination and could put pressure on manufacturers to make their packaging recyclable, if they have to declare to consumers that it is not. This could be used in options where not all packaging is required to be recyclable/ reusable, or where derogations are allowed.	Labelling
5: Recycling	Effectivenes s	Stakeholders	Prohibit the use of additives and colours in plastic packaging.	These de-value the material and a ban makes clear what can or cannot be used.	Regulation
5: Recycling	Effectivenes s	Stakeholders	Recyclability assessed in working industrial conditions so not about what's theoretically recyclable.	This would feed into the definition of recycling.	Regulation
5: Recycling	Effectivenes s	Stakeholders	Introduce a recycling hierarchy to reflect whether the packaging can be recycled multiple times and produce high quality.	This may promote the use of materials that can be recycled multiple times, however it may be more appropriate for modulated EPR fees as this does not necessarily dictate what can/ cannot be placed on the market.	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness	Stakeholders	Develop a mandatory assessment of recyclability through a harmonised standard, based on real behaviour in sorting and recycling plants.	This would provide more clarity over how to comply with and enforce the recyclability requirements, however the focus is on the Essential Requirements themselves, rather than the Standards.	Regulation
5: Recycling	Effectiveness & EU added value	Stakeholders	Require producer to provide proof of recycling capacity within three years, verified by third party. If they cannot do so, the packaging must be withdrawn from the market and Member States could apply an additional penalty.	Recognises that recycling technologies may not be immediately available for new packaging but provides clarity on the appropriate timescales and on responsibilities for monitoring developments.	Regulation
5: Recycling	Effectiveness	Stakeholders	Require producers to publish a mandatory recyclability assessment, demonstrating how it meets the minimum criteria for recyclability. This would be published on an EU database.	This provides clarity over how to demonstrate and assess compliance; publishing on an EU-wide database promotes an efficient approach by avoiding duplication of efforts in different Member States.	Regulation
5: Recycling	Effectiveness & coherence	Stakeholders	Include a reference to the definition of "recycling" in Article 3(17) of the WFD	This links to the other measures relating to a definition of recyclable.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness & coherence	Stakeholders	Define "recyclable" based on the applicable standards and in line with Article 6a of the PPWD (packaging that enters a recycling operation should be considered as recyclable).	This links to the other measures relating to a definition of recyclable - could be used in a lower option. Definition should not just be based on inputs to the recycling operation, as some packaging is removed at a later stage and treated as contamination.	Regulation
5: Recycling	Effectiveness & EU added value	Stakeholders	Issue guidance to Member States on different recycling technologies.	Supports a more harmonized acceptance procedure and emphasises that packaging cannot be considered in isolation from processing technologies. However, the impact of guidance will be limited.	Guidance
5: Recycling	Effectiveness	Stakeholders	Recyclable if 95% by weight is recyclable in practice and the remaining components do not hinder the recyclability of the main components.	Provides clarity on what percentage of the packaging should be recyclable but allows scope for multi-material packaging. However, this relates to the materials themselves, rather than to the combination of materials.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness	Stakeholders	The packaging is not classed as recyclable if the process results in material that cannot be used in further use-cycles.	This promotes high-value or closed loop recycling, however it is not clear if producers could determine this at the design stage.	Regulation
5: Recycling	Effectiveness	Stakeholders	Promote RecyClass and Plastics Recyclability Evaluation Protocols - online tools to evaluate recyclability.	Provides some clarity to producers on what is considered recyclable, however guidance is less effective than mandating their use.	Guidance
5: Recycling	Effectiveness	Stakeholders	Introduce a recyclability ranking for packaging to help identify how the packaging could be improved.	Recognises that some packaging is more recyclable than others and could drive higher standards above a basic minimum, but this does not determine what is placed on the market.	Guidance
5: Recycling	Effectiveness	Stakeholders	Include "access to recycling" in definition of recyclable.	Provides a more operational definition of recycling by requiring the appropriate collections and facilities to be in place.	Regulation
5: Recycling	Effectiveness	Stakeholders	Require Member States to develop a national recyclability database to determine what can and cannot be recycled.	This provides clearer rules for producers but it does not support a harmonised approach.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
5: Recycling	Effectiveness	Stakeholders	Require food-grade packaging to be sorted and recycled in a closed loop.	Promotes high value material to support recycled content requirements, however it relates more to the processing than to what packaging can be placed on the market.	Regulation
5: Recycling	Effectiveness	Stakeholders	Ban the use of glues that contaminate the recycling process.	Reduces contamination and provides clarity on what substances can be used, but not clear how practical this is in reality.	Regulation
5: Recycling	Effectiveness	Stakeholders	Introduce "Permanent Materials" as a new resource category to recognise that some materials can be recycled indefinitely.	May encourage the use of more easily recyclable materials but does not determine what can be placed on the market.	Guidance
6: Composting & Biodegradation	Coherence	Evaluation	Refer in the Standard to Fertiliser Regulation limits on toxic contaminants in outputs from composting facilities. As well as lead, cadmium, mercury and hexavalent chromium, this includes limits on biuret, inorganic arsenic and nickel	This will harmonise the Standard with EU policy on fertilisers and help to improve the quality of outputs so that the resulting compost is more usable.	Guidance

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
6: Composting & Biodegradation	Effectiveness	Evaluation	Provide guidance on standards for composting facilities	This could help to support more universal facilities and increase the likelihood that packaging that biodegrades in test conditions will biodegrade in reality.	Guidance
6: Composting & Biodegradation	Effectiveness	ICF & Eunomia 2018	Add to3 (c) "Where such packaging is treated through anaerobic digestion, then unless the digestion process facilitates the degradation of the packaging, the digestate shall be subject to an aerobic step designed to ensure that the quality of compost is maintained."	Provides some minimum standards for AD processes and improves the quality of outputs	Regulation
6: Composting & Biodegradation	Effectiveness & EU added value	Evaluation	Require clearer labelling for biodegradable plastic and instructions for sorting and processing	Reduces the likelihood that biodegradable plastics will contaminate plastics intended for recycling and increase the likelihood that biodegradable packaging is correctly collected and processed. Action at EU level means producers would only need one logo for each Member State	Labelling

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
6: Composting & Biodegradation	Effectiveness & coherence	Evaluation	Link the Essential Requirements to criteria being developed for the European Commission relating to the circumstances in which compostable/ biodegradable packaging is appropriate to use.	Will mean that the Essential Requirements are in line with other EU policies; recognises that design for recycling is generally preferable to designing for biodegradability but that biodegradable plastics can add value - in increasing the amount of organic waste that is separately collected.	Regulation
6: Composting & Biodegradation	Effectiveness & EU added value	Evaluation	Introduce standards to assess whether the packaging is suitable for home composting (or require to label compostable packaging that is not suitable for home composting)	Extends the applicability of the Standard and, with the WFD promoting home composting, will increase the likelihood that packaging biodegrades in domestic settings (also supporting coherence). Action at EU level provides a harmonised approach for multi-national companies.	Regulation
6: Composting & Biodegradation	Effectiveness	Case studies	Require element of multi-layer packaging that is not recyclable to be compostable.	Allows for multi-material packaging but should reduce the likelihood that it is incinerated or disposed of. However this measure is not required if all packaging is required to be	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
				reusable, recyclable or compostable.	
6: Composting & Biodegradation	Effectiveness	Case studies	Include in the ER a clearer definition for compostable packaging that can be effectively composted in existing systems.	Removes confusion between compostable and biodegradable packaging	Regulation
6: Composting & Biodegradation	Coherence	Stakeholders	Define compostable and biodegradable in line with the definition in the SUP Directive.	May provide more of a distinction between compostable and biodegradable packaging and brings the Essential Requirements into line with more recent EU policy.	Regulation
6: Composting & Biodegradation	Effectiveness	Stakeholders	Require non-recyclable flexible food packaging to be made from compostable plastics.	Provides an option for not all packaging to be recyclable, however, this would be achieved anyway by a more general requirement for all packaging to be reusable, recyclable or compostable.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
6: Composting & Biodegradation	Effectiveness & relevance	Stakeholders	Include a definition of organic recycling - the aerobic (composting) or anaerobic (biomethanization) treatment, under controlled conditions and using micro-organisms, of the biodegradable parts of packaging waste, which produces stabilized organic residues or methane. Landfill shall not be considered a form of organic recycling.	Recognises that there are weaknesses to the current requirements for compostable/ biodegradable packaging.	Regulation
7: Hazardous Substances	Effectiveness & coherence	Arcadis 2009	Amend clause 3 of paragraph 1 to "prevent" the presence of noxious and other hazardous substances in recycled material as well as emissions, ash and leachate.	The current focus on the presence of hazardous substances in emissions, ash or leachate reflects the dominance of landfilling and incineration in 1994. It should be explicit that these substances should be avoided in recycled materials too. The current requirement is only to "minimise" their presence. Would need to clarify how this is implemented and enforced in practice.	Regulation

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
7: Hazardous Substances	Effectiveness & relevance	Stakeholders	Expand hazardous the substances list according to the definition proposed under the interface between chemicals, product and waste legislations.	Updates the hazardous substances to reflect more recent EU legislation.	Regulation
7: Hazardous Substances	Effectiveness	Stakeholders	Provide guidance on the wider range of substances of concern, requiring transparency on chemical composition and requiring EPR fees to be modulated based on the presence of a longer list of hazardous substances to encourage packaging that is "benign by design".	The Chem Trust has identified 148 chemicals used in plastic packaging that are hazardous to human health and/ or the environment. This would also support a more joined-up approach with EPR legislation and provide financial incentives	Market
7: Hazardous Substances	Efficiency	Arcadis 2009	Promote the use of technology, like the XRF (x-ray fluorescent) gun to inspect for hazardous substances	Used by Belgian authorities; can reduce the time and cost of assessing heavy metals content	Technology

Key Area	Evaluation Type	Original Source	Measure	Rationale for Long List	Reinforcement Type
7: Hazardous Substances	Effectivenes s	Stakeholders	Require producers to provide information on the composition and chemical traceability (holy grail project).	Improved data collection will increase the uptake of plastic recycling.	Regulation

Appendix F Packaging Design Change Case Studies

F.1 Overview of Packaging Design Change Case Studies Analysed

Table A-5 Summary of Case Studies

Case Study Type	Objectives	Potential Relevance to the Essential Requirements
Design Criteria		
Ecodesign Criteria	Minimise the environmental impact of a product or service during its life-cycle at design stage	Use of eco-tools to develop guidance or standards on design of packaging, or provide systematic approaches for adjudicating on packaging that can and cannot be placed on the market. Stronger monitoring and enforcement of the existing requirements. Further strengthening of the linkages between Annex II and the standards. Procedure to develop the criteria to be met by energy using product category under the Ecodesign Directive i.e. how the procedure can be applied to develop any criteria needed relating to packaging under the ERs such as in defining whether a piece of packaging is recyclable or not.
Ecolabel Criteria	Products have to comply with some specific criteria that cover the whole product's life-cycle, including raw material extraction, production, packaging, transportation, use, and disposal.	Stimulate cooperation across the supply chain (e.g. raw material suppliers, producers, transportation, etc). Calculate the carbon footprint of products throughout their lifecycle. Specific requirements: use mono-material, eliminate black plastics.

Case Study Type	Objectives	Potential Relevance to the Essential Requirements
		Produce guidelines on preventing waste, using recycled content, choosing recyclable packaging, promoting uptake of reusable formats etc.
Recyclability Guidelines	To encourage designers to take into account recyclability early in the design process.	Use recyclability guidelines to act as guidance for producers to ensure packaging meets the Essential Requirements. Use recyclability guidelines as a formal mechanism in the Essential Requirements for defining recyclable packaging, and hence what is allowed onto the market and what is not. Contributing to developing a positive or negative list of elements of packaging that could be used in packaging design or should be eliminated. Commitment for packaging to be recyclable, by format, material or all packaging. Recycled content targets (e.g. PET bottles, 25% recycled content by 2025). Link modulation of fees under EPR schemes to the Essential Requirements.
PEF/ OEF Guidelines	A harmonised methodology for the calculation of the environmental footprint of products and organisations (PEF / OEF). The PEF method is most relevant for packaging because it has a product focus whereas the OEF has an organisation focus.	Providing an environmental based approach for determining what packaging designs should be allowed onto the market or not. Providing a benchmarking tool for packaging companies to show exemplar cases or identify the need to improve performance. Form the basis of a quantifiable methodology for defining ‘reusable’ or ‘recyclable’.

Case Study Type	Objectives	Potential Relevance to the Essential Requirements
Material Switch/ Reduction to Prevent Waste		
Optimisation of E-commerce Packaging	Innovation within packaging supply chain offer to achieve an increase in operational efficiency and reduce costs. This resulted in both waste prevention, by reducing the quantity of material used and by reducing the filler material used, and resulted in a reduced transport requirement and hence reduction in transport emissions.	Guidelines on how to create business cases for optimisation of e-commerce packaging. Develop mandatory limits on the percentage of an e-commerce package which is shipping air. Classify packages based on their percentage shipping air and label them as such in a way similar to an eco-label. Incorporate shipping air requirements into a CEN standard on e-commerce packaging which would require a protocol to be followed.
Light weighting E-commerce Packaging	To reduce costs and GHG emissions associated with shipping lighter packaging.	Process for incentivising increases in recycled content. Harmonised approach for assessing the trade-offs between light weighting and recyclability.
Removal of Recyclability Disruptors (multi-materials)	Innovative solutions for the number of components in packaging being reduced while still maintaining or even improving functionality and performance. This example highlights increased recyclability and lightweighting via switching away from	Requiring Member States to provide fiscal incentives for SMEs to innovate in packaging design. Develop a packaging benchmarking system with results published in order to stimulate competition and innovation across producers. Require national sector / material innovation plans to be implemented, similar to those required by the Dutch Packaging Agreement.

Case Study Type	Objectives	Potential Relevance to the Essential Requirements
	difficult to recycle multi-material packaging.	Better enforcement of the Essential Requirements to stimulate innovation. Improve the definition of recyclability to incorporate specific aspects such as the difficulty in separating mixed material packaging (i.e. elements that hamper recycling processes).
Switch to Flexible Pouches	Increased transport density leading to reduced GHG emissions and costs.	Design guidelines or protocols in a CEN standard to ensure producers assess the trade-offs between light-weighting and recyclability in a common and consistent way.
Reuse		
Returnable E-commerce Packaging	The approach for reusable packaging demonstrates one of the possible ways to reduce the environmental impact of e-commerce packaging by creating reusable and returnable packaging, while ensuring that online retailers do not bear the financial and logistical burden. The changes have resulted in waste prevention as well as reduction of carbon footprint (i.e. from manufacturing and use phases).	Public / retailers awareness campaigns are mandated for certain packaging formats with low recycling rates or high levels of consumption, such as e-commerce packaging. Guidelines to encourage the reusability of e-commerce packaging, e.g. in a form of presenting how this can be achieved in practice through best cases. Setting a specific target for reusability of e-commerce packaging by 2030.

Case Study Type	Objectives	Potential Relevance to the Essential Requirements
Reusable Consumer Packaging	Highlights the benefits of reusability and concentrated solutions, both of which can be scaled beyond the current scope. The concept of a concentrated solution that is diluted by the user can be applied to any product that contains a large fraction of water, which is true for most cleaning products, other liquid products, and some chemicals.	Setting a maximum ratio of the volume of water to the volume of active ingredients for liquid products. Requirements for brand owners to offer a certain percent of their liquid products as concentrated refills. Certain single-use packaging by material type, such as plastic, or by product sector, such as cleaning products could be banned. Requirements for a minimum number of reuses could be set by material or product type. Modularity could be integrated in the ERs by allowing multi-materials if the packaging is modular and if the independent parts can either be reused or recycled.
Reusable Transport Packaging	Environmental but also economic benefits for introducing returnable protective packaging for transport/ storage to enable circular thinking within an organisation by eliminating packaging waste, reducing environmental impact of damaged goods and potentially allow for more innovative and sustainable product design. This could further support the development of new circular business	Standardise sizes for returnable transport packaging. Require reusable transit packaging in certain scenarios, for example between an organisation's own sites or where other closed loop logistics arrangements are practical.

Case Study Type	Objectives	Potential Relevance to the Essential Requirements
	models, such as a 'charge per use' business model.	
Material Switch/ Increase to Increase Recyclability		
Compostable Consumer Packaging	To provide a solution to the lack of recyclability of multi-material pouches, particularly for food-based applications. The compostable packaging is designed to meet the same specifications as standard pouches, but can be composted at the end of life.	Specific requirements for the use of compostable packaging, such as setting a specific requirement in a form of share of multi-layer packaging that has to be compostable. Set a clear definition for compostable packaging and ensure that it can be effectively composted in existing systems. Support the increased awareness of the consumers of how to dispose of compostable packaging e.g. through standards on labelling.
Optimisation of Transport Packaging	Shift from an environmentally disadvantageous transport packaging solution used for the transport of perfume bottles to a more sustainable one made of moulded pulp while maintaining technical integrity.	Integrate LCA results, or at least some elements of life-cycle-based thinking, to consider the packaging's entire life cycle as a design process requirement. Introduce a European label for sustainable packaging, to verify both the recyclability of the product and the level of recycled content. Introduce a product level carbon tax to incentivise low-carbon solutions.
Greater Material Use to Improve Recyclability	Changes in the design of aluminium closures to make them more suited for handling together with glass to	Introduce in the Standards a protocol for driving cross value chain collaboration to ensure packaging design takes end of life considerations into account.

Case Study Type	Objectives	Potential Relevance to the Essential Requirements
	enhance recyclability relative to other materials.	
Mono-material Design	To ensure that flexible pouches were recyclable.	Mandatory requirement for pouches to be made of mono-material. Harmonisation of definition of recyclable.
Removal of Disruptors to Increase Recyclability		
Use of Colourants	Identifying drivers behind a move away from carbon black plastic packaging as companies employ different approaches (alternative pigments/ sortable black pigments) to replace it with options that allow for the recycling of the packaging.	Phase out black plastics that are not detectable by NIR sorting equipment.
Testing non-intentionally added substances (BASF)	Following EU regulations related to non-intentionally added substances (NIAS) strict testing regimes were introduced.	NIAS added to lists of substances of concern.
Use of Recycled Content	Efforts to optimise the amount of recycled content in secondary/transportation packaging for food products. This applies for the paper and board packaging as well as	Restrictions on use of minerals oils (MOSH and MOAH) in paper/board packaging. Assess the regulations related to use of recycled content in food contact packaging.

Case Study Type	Objectives	Potential Relevance to the Essential Requirements
	some plastic packaging that is not directly in contact with food.	Requirements for certain levels of recycled content in secondary and tertiary packaging. Protocols to stimulate cross value chain working to encourage the use of 'as much recycled content as possible'. Set specific timeframes for when the packaging that is placed on the market should be reviewed by producers against certain criteria. Required guidance tools for enforcement officers to be developed.

F.2 Analysis of Packaging Design Changes Case Studies

The following case studies are included in the Appendix:

- Eco-design Packaging Guidelines: Integrating eco-design considerations into packaging
- Recyclability Guidelines: Improving recyclability of packaging
- EU Ecolabel: Vivi Verde approach to integrating sustainability into packaging
- Product Environmental Footprint Method (PEF): A measuring method for environmental performance of products, including packaging
- Optimisation of Ecommerce Packaging (DS Smith): Innovation in Cardboard Ecommerce Packaging to Increase Supply Chain Efficiency
- Lightweighting of E-Commerce Packaging (ASOS): Switching cardboard boxes for plastic mailing pouches
- Mono-material Trigger Spray (Reckitt Benckiser): The move towards a more recyclable and functional trigger spray
- Switch to Flexible Pouches: Drivers behind the increased use of flexible packaging, particularly in the food sector
- E-commerce reusable packaging (RePack): Improving reusability of packaging for e-commerce
- Increasing reusable packaging (Replenish): Reusable cleaning product bottles with concentrated refill pods
- Free Pack Net: Increasing reusability of packaging for domestic appliances
- Compostable Packing (TIPA): Innovative compostable packaging solutions for food packaging
- Closing Material Loops for Tertiary Transport Packaging (PAPACKS): Recyclable transport packaging tray made from recycled moulded pulp
- Aluminium Closures: Increase recycling potential of closures through material substitution
- Mono-material Design (Mondi and Werner-Mertz): Recyclable monomaterials to replace multimaterial packaging
- Colourants: Different approaches to replacing undetectable carbon black plastic packaging
- Testing non-intentionally added substances (BASF): Testing non-intentionally added substances (NIAS) in plastics
- Increasing recycled content (Mars): Introducing more recycled content into secondary packaging

F.3 Eco-design Packaging Guidelines

Integrating eco-design considerations into packaging

Nature of Case Study	*Eco-design of packaging*
Packaging Sector	*Consumer packaging*
Packaging Material	*Plastic, Aluminium, others*
Type of Stakeholder	*National Packaging Consortium; Trade Association of European converters;*
Geographic scope	*EU & Australia*
Date	*CONAI: 2013 - ongoing* *RPC Group: 2018 - ongoing* *Borealis: 2018 - ongoing* *Australia's PREP tool: ongoing*

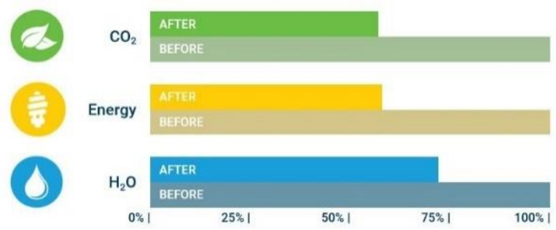
Nature of Intervention

This case study examines three different eco-design guidelines/tools by CONAI, RPC Group and Australian PREP. Furthermore, this study presents one example of the application of eco-design to a product packaging by Borealis.

Eco-design aims to minimise the environmental impact of a product or service during its life-cycle. Incorporating sustainability into the design stage can lead to minimizing such impacts while still fulfilling the functions of products and satisfying the customer needs. In the case of packaging, the eco-design approach can lead to reduced embodied energy and material use, reduced transport impact, less waste generation and increase the reuse and recycling rate of packaging.

CONAI, the National Packaging Consortium in Italy, has developed an Eco-Tool that calculates the environmental impact of packaging for its members to facilitate eco-design. The tool calculates the impact of newly redesigned packaging by comparing it to the original packaging, using a Life Cycle Analysis (LCA) approach.

Figure 1 CONAI's Eco-Tool's illustration of environmental improvements



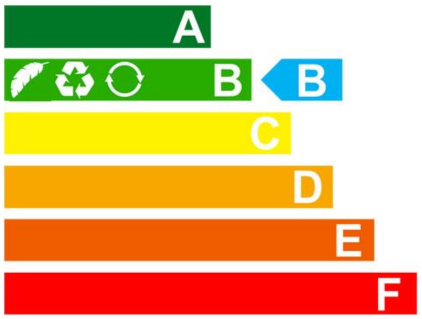
The tool is used to assess the Prevention Award, which is an annual CONAI competition that rewards redesign actions aimed at reducing the environmental impact of packaging. CONAI's members have been able to participate since 2013.

The results of the calculation of the Eco Tool are the reduction of the environmental impact of three main criteria: water consumption, energy use and CO_2 (as illustrated in Figure 1). The tool assesses several parameters: the type of material, the production processes (e.g. use of electricity and water), the packaging weight, the number of reuses, the type of components, and the number of packs transported on a standard size pallet. For products scoring a high recyclability, CONAI has an extra indicator assessing the reduction of the secondary raw materials consumed. Members can therefore also assess monetary savings by raw material savings.

As means to guide producers to achieve high scores on the eco tool, recyclability guidelines were developed in cooperation with universities. CONAI also provides active e-mail support to its members on improving the sustainability of their packaging.

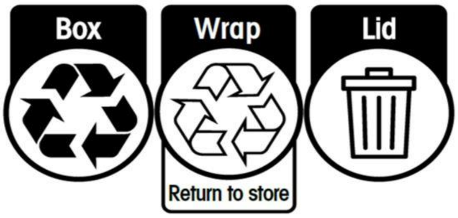
RPC Circular Grading Tool is another example of integrating the eco-design approach into packaging. RPC Group is a design and engineering company in plastic products in packaging and non-packaging markets. The Grading Tool is a grading system that allows customers to compare the sustainability elements of their packaging and select a more sustainable option. It was developed to show the implications of design decisions on the suitability of the packaging for the Circular Economy and was originally intended to be used in presentations to customers.

Figure 2 RPC Group's Circular Grading Tool



The tool uses a similar presentational approach as the EU Energy Label, where the products are graded based on their energy efficiency from A to F (see Figure 2). The tool consists of a graduated, coloured scale that shows the recyclability of the packaging (based on the Plastic Recyclers Europe Recyclass definitions) and a series of symbols indicating if the pack has been light weighted, made reusable, etc. Overall it is designed to give a clear and simple overview of how sustainable the design is.

Figure 3 Australian Recycling Label (use to be confirmed)



Another example, outside the EU, is the Australian **PREP tool** - Packaging Recyclability Evaluation Portal. PREP offers design solutions for brand owners and packaging designers. It is a programme through which companies can optimise their packaging for recycling through eco-design criteria. These are integrated into the system as well as knowledge about the existing collection/sorting/recycling capacities, and can be used by packaging designers/brands. These guidelines help the packaging designers/brands to improve the recycling characteristics of their products. There is a plan to add reusability in the future.

In addition, PREP identifies suitable instructions and symbols to allow households to effectively sort their waste (see Figure 3). This can result in increased recycling as consumers better understand what to do with the packaging at the end of its life.

Introducing mono-material design into a reusable product as a way to achieve optimised circularity of packaging is an approach taken by **Borealis.** In partnership with Bockatech they've developed an injection moulded light weighted foam reusable cup. It is only made from polypropylene and therefore easily recyclable – worldwide. Avoiding the use of single-use plastics through reusable products can be burdensome to consumers, as it requires bringing a reusable cup for or returning a used cup after each purchase. Borealis & Bockatech removed this consumer dilemma through its mono-material cup design, which can either be disposed and recycled locally or reused. Borealis also have a 10 codes of conduct document for design for recycling which is also of relevance.[23]

Assessment of Effectiveness

CONAI's assessment system allows its members to measure the environmental performance of redesigns. It is focused on the Italian market and is available for the CONAI members.

In terms of effectiveness of the tool, CONAI does not have the exact numbers of the companies that have been using the tool. However, the organisation highlighted a growing interest from the companies to participate in the Prevention Award and such use the tool.

RPC Group increased the impact of their tool by engaging RPC's customers, showing the implications of design choices that were less sustainable but easily rectified.

The Circular Grading Tool has been widely used across the whole business. The result is that RPC has many products, in manufacture or in development, that are more sustainable (e.g. a fully recyclable lipstick) than the original specifications would allow. Further, the tool is used for all internal design work, comparing RPC designs to those of competitors. The guidelines, based on widely accepted criteria that apply across all packaging, are targeted at everything that is manufactured within RPC. In addition, with rapidly developing technologies it must be ensured that the tool stays updated with the latest innovations and thinking. At the same time, the tool needs to stay simple. For RPC circularity can mean different things: it is not always only about recyclability but also about reducing weight (or increasing weight potentially, where reuse is required) and having less components in the product.

The tools like the **Australian PREP** is relatively new and therefore the effectiveness is difficult to assess.

All these tools allow for improved understanding on how a more sustainable and better recyclable packaging can be developed (CONAI, RPC, PREP tool).

Transferability to the Essential Requirements

Both RPC's and CONAI's eco-tools were developed by the packaging industry or together with the industry and other actors. This demonstrates an increasing interest of the different market participants in working together to improve sustainability of packaging. By guiding packaging designers and producers on how to design more sustainable packaging, these eco-tools also help to increase compliance with the Essential Requirements.

Similar tools to the RPC's Circular Grading or CONAI Eco-Tool could be further developed and scaled to other markets/industries. For example, RPC is now cooperating with the British Plastics Federation to develop a similar online tool. These market driven tools could support the integration of sustainability early in the design process, ensuring that more sustainable options are selected.

The Essential Requirements could further support the integration of eco-design approach in a form of voluntary guidelines

23 https://www.borealisgroup.com/news/borealis-promotes-design-for-recyclability-with-ten-codes-of-conduct-for-polyolefins

or through the use of positive / negative lists to define ‘recyclable’. Such guidelines could further elaborate on potential trade-offs of different options, e.g. reusability of packaging vs weight or recycled content vs weight.

Other views from stakeholders suggested that a stronger enforcement and monitoring of implementation of the requirements can help to improve the eco-design of packaging.

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Jeroen Frederix – Borealis

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F.4 Recyclability Guidelines

Improving recyclability of packaging

Nature of Case Study	*Design criteria*
Packaging Sector	*Consumer products packaging*
Packaging Material	*Plastic, paper, carton and other*
Type of Stakeholder	*Industry associations*
Geographic scope	*EU*
Date	*UNESDA/RECOUP: 2011- ongoing* *CEPI/FEFCO: 2019 autumn* *Eco-Emballages, 2012 -ongoing* *Design4Recycling: (to be confirmed)*

Nature of Intervention

This case study examines four different recyclability guidelines covering various packaging materials. The main purpose of these guidelines is to encourage designers to take into account recyclability early in the design process.

One of these guidelines is the **UNESDA/ RECOUP Design Guide for PET Bottle Recyclability**. UNESDA, the Union of European Soft Drinks Associations, has developed in 2011 the 'Code of Conduct on PET bottles recyclability' that encourages its members to adhere to the EPBP's Design Guide for PET Bottle Recyclability. The guide was developed by RECOUP in co-operation with relevant industry associations and experts.[24] The objective of the guide is to encourage packaging designers to integrate specific criteria to facilitate recycling. For example, the guide discourages the use of materials that impede the PET recycling process.

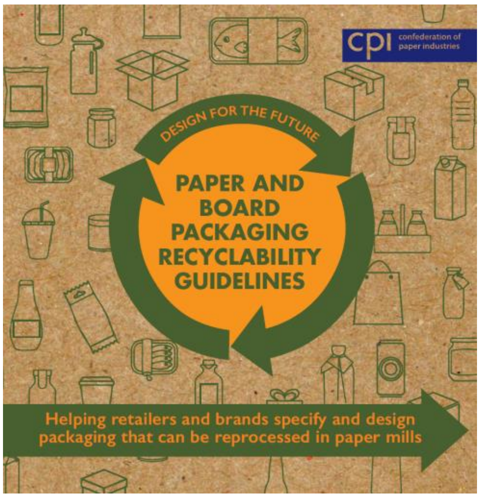
Another example of industry guideline are **CEPI/FEFCO's recyclability guidelines for paper packaging**. CEPI, the Confederation of European Paper Industries, FEFCO, the European Federation of Corrugated Board Manufacturers, and several industry associations (represented in the European Paper Recycling Council) were preparing the recyclability guidelines that help to specify and design packaging that can be effectively recycled by the paper industry at the time of writing. The guidelines will focus on a wide range of paper based packaging and various recycling solutions [these were published before finalised of the report, see http://www.cepi.org/recyclability_guidelines].

For the UK market, similar guidelines have already been developed in collaboration with WRAP. The guidelines are designed to encourage recyclability of the packaging using the standard pulping technology. The guidelines advise on use of plastic, coating, pealable solutions, varnishes and curable varnishes, adhesive, etc. For example, the guidelines recommend minimizing plastic content attached to any paper or board packaging with industry's preference of no

24 http://www.recoup.org/

more than 3% by weight. The guidelines are also developed in an easy-to-use form of tips for designers and retailers.

Figure 1 Confederation of Paper Industries Guidelines (use of picture to be confirmed)



Design4Recycling developed by Der Grüne Punkt also supports the recyclability of packaging. It is an approach that particularly focuses on the design stage of the packaging. Design4Recycling identifies a number of factors that are beneficial for recyclability. These factors include among other things light colouring for plastics, use of monomaterials, optimizing labelling and closure solutions, and separability of components.

Another example of encouraging recyclability is through a differentiation of fees for packaging. **Eco-Emballages** (from 2017 - CITEO), the French Extended Producer Responsibility (EPR) scheme modulates fees for packaging according to recyclability. The fee modulation consists of a basic fee (based on weight and type of packaging material) and an eco-modulation. The eco-modulation is based on a **bonus/malus approach** to incentivise eco-design and recyclability of packaging. The system rewards recycling-friendly packaging and penalizes the difficult to recycle packaging. Different criteria are used for rewarding (reduction bonus, awareness bonus) or penalizing (malus) the packaging producer. For example, a 50% penalty on the fee can be imposed if the packaging cannot be recycled or a maximum bonus of 24% is used for packaging if it is associated with awareness raising initiatives.[25] See also Eunomia study on guidelines for extended producer responsibility schemes.

Assessment of Effectiveness

UNESDA represents the non-alcoholic soft drinks sector (e.g. still drinks, carbonates, fruit drinks), including such companies like Coca-Cola, Pepsico, Red Bull and Nestle as well as industry trade associations. Pending on the credibility of commitment by its members, the recyclability guidelines will have a significant impact on the recyclability of beverage packaging. In addition to that, UNESDA recently set a target that 100% of soft drinks plastic packaging shall be recyclable and that specifically PET bottles shall have 25% recycled content by 2025. This further reaffirms the commitment of the beverage industry and will have a positive effect on recyclability of PET packaging.

CEPI represents the forest fiber and paper industry with 495 companies operating more than 900 pulp and paper mills in Europe. Recyclability has been and still is an important aspect for the industry, given the industry's high environmental footprint and ease of recycling, investing significant resources into recycling facilities for paper and board. The recycling rate of paper is one of the highest, reaching 82.1% in 2017. The majority of available paper packaging is readily recyclable. However, a small share of packaging (e.g. multi-layer laminates with water resistant properties)

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[25] IEEP (2017) EPR in the EU Plastics Strategy and the Circular Economy: A focus on plastic packaging.

can be challenging to recycle. It can be expected that this more complex paper packaging market will grow further in the future. Thus, it becomes crucial to ensure that the recyclability of the complex paper packaging is taken into account by packaging designers and the potential for new materials and techniques explored. As noted above, CEPI is working on EU wide recyclability guidelines that will cover a wide range of paper packaging. The guidelines for the UK market were presented in February 2019, and as such, it is too early to assess their effectiveness. However, it should be noted that there was a strong demand from the retailers and brands for such guidelines to be developed.

Under the **Eco-Emballages** (CITEO), eco-fee modulation covers household packaging in France. This creates clear economic incentives for packaging producers to integrate eco-design approach and improve recyclability. However, there are no evidence identified on the effectiveness of the eco-fee modulation approach. In 2017, Eco-Emballages merged with Ecofolio, creating a new organisation called CITEO that combined two Producer Responsible Organisations, as such covering a wider scope of packaging.

Transferability to the Essential Requirements

The recyclability guidelines presented in this case study support integration of eco-design thinking and recyclability early in the packaging design process. This ensures that the recyclability is considered before the packaging is placed on the market.

To support the eco-design approach and ensure recyclability, the Essential Requirements could strengthen the importance of design considerations early in the process. This could be supported through developing packaging material specific guidelines on ecodesign and recyclability – could be used for the positive / negative lists used to define ‘recyclable’, see Section 5 of the main report. Existing guidelines or those currently being developed could be utilised, e.g. CEPI for paper and board, UNESDA for PET packaging, etc. In addition, the guidelines presented in this case study were developed by the industry or in close co-operation with the industry and relevant experts, ensuring that the technical elements of the packaging are taken into account. Thus, continuous collaboration with the key stakeholders to develop and revise guidelines or requirements would be beneficial.

If a stricter approach to reinforce the Essential Requirements were preferred, specific requirements for recyclability could be set. For instance, in case of PET packaging for beverages, a 100% recyclability target by 2025 is already endorsed by the industry. These targets could be developed in close collaboration with the industry. However, some of the stakeholders call for the Essential Requirements to be material neutral, i.e. unbiased towards packaging materials.

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Design4Recycling, link

Innovative bonus-malus system for increased rates of recyclability in the packaging industry, France, link

UNESDA, link

WRAP, Recycling Guide, link

F.5 EU Ecolabel

Vivi Verde approach to integrating sustainability into packaging

Nature of Case Study	Design criteria
Packaging Sector	*Primary packaging for household products*
Packaging Material	*Plastic, paper, other*
Type of Stakeholder	*Retailer*
Geographic scope	*Italy / Global*
Date	*1998 – ongoing* *Vivi Verde – 2009 - ongoing*

Nature of Intervention

This case study examines the EU Ecolabel criteria for packaging and its application illustrated by the Coop Italia and their Vivi Verde product line.

Established in 1992, the EU Ecolabel is awarded to the products and services that meet high environmental standards throughout their life-cycle in a given product category. In order to be awarded the EU Ecolabel, products have to comply with some specific criteria that cover the whole product's life-cycle, including raw material extraction, production, packaging, transportation, use, and disposal. These criteria are developed for different product categories, e.g. personal care products, cleaning, clothing and textile products, electric equipment, paper products, etc. Packaging is one of the criteria that is assessed under the EU Ecolabel. For example, for packaging of detergents and cleaning products, the label examines four different sub-criteria, including product sold in spray bottles, packaging take-back systems, weight/utility ratio and design for recycling. More specifically, all packaging should be designed to facilitate effective recycling, i.e. avoiding potential contaminants and incompatible materials that can harm separation or reprocessing or to reduce the quality of recyclate.[26]

Since 1998, Coop Italia has been selling a variety of products that were awarded the EU Ecolabel.

Coop Italia is the largest retail chain in Italy with a strong commitment to sustainability. Coop Italia has a 14.8% market share in Italy with 2,100 stores as well as major distribution across Europe, Asia, and the United States. Coop is the first company in Europe to be awarded the SA8000 Social Responsibility certification. The certification guarantees that all brand-name products are designed and produced in an ethical way.

As part of their sustainability effort, in 2009, Coop Italia developed its own eco-brand called **Vivi Verde**. Vivi Verde line offers different food and non-food products that follow the highest environmental standards.

[26] EU Ecolabel User Manual for Detergents and Cleaning Products (2018).

Currently, there are around 750 different products, majority of which is food products. Around 12 different products under Vivi Verde are awarded with the EU Ecolabel, mainly detergents, all-purpose cleaners, toilet paper and tissues. With regard to packaging, Vivi Verde focus on simplicity of their packaging – mono-material of packaging is preferred, black trays in the materials have been eliminated, and reduced size of packaging to avoid so-called overpacking is applied.

Figure 1 Vivi Verde non-food product line

The EU Ecolabel products have experienced successful sales and sound market share growth over the last 10 years. Coop Italia actively seeks to increase engagement with this label as consumers trust the product line and the label. Visibility of the EU Ecolabel on their products and in stores is very important to promote awareness of it together with Vivi Verde.

Reasons Driving the Change

Since the awarding of the certification of the EU Ecolabel in 1998, Coop has seen an uptake and consumer appreciation for the Ecolabel products. The market growth for Coop is one of the drivers for the company to pursue the Ecolabel and expand it to other products.

Figure 2 Vivi Verde food product line

The success of its first EU Ecolabel paper product prompted Coop to commit to the scheme and continue to expand its product range.

In addition to the consumers demand in the products, the environmental considerations and sustainability played an important role in the adoption of Vivi Verde product line. To ensure that sustainability is taken into account in their products, Coop cooperates with their supply chain (e.g. raw material suppliers, producers, transportation, etc). For example, Coop Italian calculates the carbon footprint of their products throughout their lifecycle, as such putting pressure on the suppliers to improve efficiency in production processes.

Transferability to the Essential Requirements

In general, the same approach and design that has been used in Coop Italia on their eco-brand could be used on different products in other markets and Member States. The logic of Vivi Verde design could be followed elsewhere as they focus on simplicity of their packaging – mono-material of packaging is preferred, black trays in the materials have been eliminated, and reduced size of packaging to avoid so-called overpacking is applied. Coop Italia promotes use of recycled content and recyclable packaging. The company uses internal guidelines to support sustainability of the packaging.

The Essential Requirements could potentially support or refer to the EU Ecolabel requirements for specific product groups. However, it should be noted that EU Ecolabel is awarded to products that meet high environmental standards throughout their life-cycle. Thus, the packaging is not the primariy focus of the Ecolabel, but it remains an important element for some product categories. The EU Ecolabel provides a number of relevant criteria within packaging for different product groups. For example, within detergents and cleaning products, the guidelines set up specific requirements for packaging that could be further referred to in the Essential Requirements. The Eco-label guidelines provide an example among other things on how to demonstrate that spray bottles can be refilled and reused. This approach could be further applied to the Essential Requirements.

In addition, similar types of guidelines/ manuals as exist for the EU Ecolabel could be further developed to support the Essential Requirements. It was mentioned by the company that common guidelines endorsed by the European Commission would be beneficial and could harmonise the approach towards sustainable packaging.

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F.6 Product Environmental Footprint Method (PEF)

A measuring method for environmental performance of products, including packaging

Nature of Case Study	*Methodology for environmental performance*
Packaging Sector	*Primary, secondary and tertiary*
Packaging Material	*All materials*
Type of Stakeholder	*All types*
Geographic scope	*Europe*
Date	*Pilot phase 2013-2018* *Transition phase 2019-2021*

Nature of Intervention

DG Environment has worked together with the European Commission's Joint Research Centre and other European Commission services towards the development of a harmonised methodology for the calculation of the environmental footprint of products and organisations (PEF / OEF). The PEF method is most relevant for packaging because it has a product focus whereas the OEF has an organisation focus. The PEF method measures the environmental impact of 16 impact categories[27] and has been extensively tested and improved in the period 2013 – 2018. The PEF method is applicable to all products and packaging materials sold in Europe.

The PEF method offers a standardised and consistent way for companies to calculate the environmental performance of their own products or packaging and compare it to their peers. The costs vary depending on whether a PEFCR is already available or not.

17 Product Environmental Footprint Category Rules (PEFCR) have been published at the end of the pilot phase. These PEFCRs include specific calculation rules and data for the product category in scope. There is not a specific PEFCR on packaging, but packaging is included in the PEFCRs as part of the product system.

[27] Climate change, ozone depletion, human toxicity (cancer and non-cancer effects), particulate matter, ionising radiation, photochemical ozone formation, acidification, eutrophication (terrestrial, freshwater, marine), ecotoxicity freshwater, land use, water use, resource use minerals and metals, resource use fossils.

The PEF method is a measuring method for the environmental impact of products, including packaging, and as such does not influence packaging changes directly. However, to improve the environmental performance of their products, companies will analyse the obtained results and look for ways to reduce the environmental impact of their products, including the packaging. The specific calculation rules for packaging could also steer the way in which companies improve the environmental performance of their packaging, e.g. the allocation factor of a certain packaging material may drive the company to use recycled content and/or to produce recycled material.

Assessment of Effectiveness

PEF calculation rules

The PEF method includes specific calculation rules for packaging and end-of-life of packaging.

- European average packaging datasets are provided that can be used when a PEFCR does not require the use of primary data;
- Specific rules are provided for calculating the reuse rate of packaging.

The PEF method has detailed rules for end-of-life modelling, called the Circular Footprint Formula, which facilitates consistent calculation of the environmental performance of products (and packaging) in various end-of-life situations. Default values and specific calculation rules are provided for most of the parameters of the Formula for the end-of-life modelling of packaging:

- The allocation factor of burdens and credits between supplier and user of recycled materials. The value of the allocation factor depends on the market situation.
- The ratio between quality of outgoing secondary material and quality of primary material
- Recycled content of packaging
- Recycling output rate of packaging material

The PEF method includes the calculation of a benchmark. The benchmark is the environmental performance of the representative product for the specific product category, e.g. the environmental performance of 1 litre of milk. The benchmark includes the packaging of the product. Comparing various products of the same product category to a benchmark will show which products (and packaging materials) are performing better or worse than average, the latter of which would be a trigger for improving the environmental performance.

PEF implementation

Potential fields of application for the PEF method and results are:

- Optimisation of processes along the life cycle of a product
- Support of product design minimising environmental impacts along the life cycle
- Communication of life cycle environmental performance information on products (e.g. through documentation accompanying the product, websites and apps) by individual companies or through voluntary schemes
- Schemes related to environmental claims, in particular ensuring sufficient robustness and completeness of claims
- Reputational schemes giving visibility to products that calculate their life cycle environmental performance
- Identification of significant environmental impacts in view of setting criteria for ecolabels
- Providing incentives based on life cycle environmental performance, as appropriate

Currently, the PEF and OEF method are in the transition phase, which is the period between the end of the Environmental Footprint pilot phase (2018) and the possible adoption of policies implementing the methods (~2021). During this phase, new PEFCR/OEFSR will be developed, existing PEFCR/OEFSR will be implemented, and methodological improvements can be made. Participation in the transition phase is voluntary for companies.

A stakeholder workshop took place to discuss potential future policy applications for the Environmental Footprint methods in 2018. Potential policy options are Ecolabel, Green Public Procurement, Eco-Management and Audit Scheme (EMAS), or a new policy option on green claims. However, there is currently no further clarity on this.

Transferability to the Essential Requirements

The PEF method could support the reinforcement of the Essential Requirements (ER) by providing insight into the environmental benefits and trade-offs of certain packaging interventions. This would provide clarity on the interventions that have the greatest positive environmental and could be used as an indicator to prioritise which amendments are included or excluded from the ERs. It could also provide a way for the Commission, or companies themselves, to benchmark the environmental performance of different packaging producers. A benchmark makes competition more visible and concrete for packaging producers. It clearly identifies the leaders who should be sharing best practices and incentivises laggards to improve their packaging and keep up with the competition.

The PEF methodology could also help to clarify the definition of the current requirements included in the ERs, or those to be added in the future. The ERs have been criticised for having vague definitions of ‘recyclable’ or ‘reusable’ and could be quantitatively rather than qualitatively defined using the PEF method. This would leave little room for different interpretations by different parties and would thus strengthen the ERs.

References

Product Environmental Footprint (PEF) Guide and Organisation Environmental Footprint (OEF) Guide (2013).
2013/179/EU Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations

Product Environmental Footprint Category Rules Guidance. Version 6.3 - May 2019

F.7 Optimisation of Ecommerce Packaging

Innovation in Cardboard Ecommerce Packaging to Increase Supply Chain Efficiency

DS Smith	**Nature of Case Study**	***The use of packaging material per unit has reduced while ensuring recyclability***
	Packaging Sector	*Secondary Packaging*
	Packaging Material	*Cardboard*
	Type of Stakeholder	*Packaging Producer*
	Geographic Scope	*DISCS – Implemented in UK and the Netherlands, expanding to other European countries.* *Made2Fit – Not yet implemented, will initially focus on Europe and North America*
	Date	*DISCS – Production started in 2017* *Made 2 Fit – Launching in 2019* *eBro – Phase 1 launched in 2019*

Nature of Intervention

This case study focusses on innovations in ecommerce cardboard packaging, used to deliver products ordered online to consumers at home, or via collection points. Ecommerce is increasing with the sector growing by 11% in Europe in 2017, and 13% in 2018.[28] With it, there is an increase in the packaging required for this purpose. Ecommerce supply chains differ from those for products sold in 'bricks and mortar' shops in that the package may travel through several more touchpoints in the same delivery packaging before arriving with the consumer. DS Smith estimates that bricks and mortar supply chains average five touchpoints, compared to a minimum of 20 in the ecommerce journey, with associated haulage occurring between those points. Consumers may also return the product in the package via a similar chain. As such, ecommerce packaging needs to be durable to allow for the complex and varied distribution methods.

Figure 1 Made 2 Fit Automated system

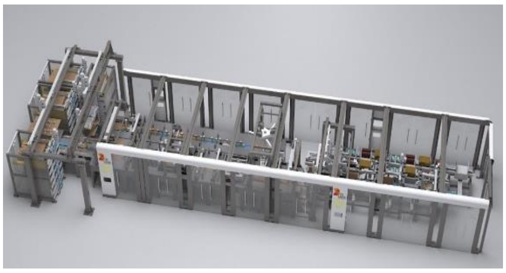
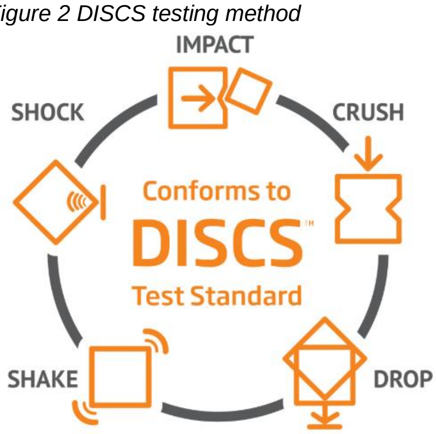


Figure 2 DISCS testing method



In addition, whereas a consignment of products to a shop for resale will be a known

[28] (2018) *Ecommerce in Europe was worth €534 billion in 2017*, accessed 22 May 2019, https://ecommercenews.eu/ecommerce-in-europe-was-worth-e534-billion-in-2017/

quantity and combination of items, consumers ordering from online marketplaces are free to choose any combination of items - resulting in varied requirements for outer packaging. DS Smith recognised that the unique nature of ecommerce was resulting in sub-optimal packaging and low efficiency in the supply chain. Their research found that 50% of ecommerce packaging was more than a quarter empty, with the average empty space in toy packaging at 52%.

In addition, ecommerce is a growing sector, hence the problem was set to increase. Due to the use of standard size boxes for delivery to consumer, many products were being packaged in boxes too large for them resulting in significant “shipping air” – that is – void space within the package as transported which is not used by the product. In addition, large quantities of filler materials were being used to minimise damage to small products packaged in large boxes – both increasing the material use, and the need for consumers to separate constituent items for recycling.

Working to solve this problem, DS Smith developed three interventions. **DISCS** is a testing process developed for packaging that creates high performing ecommerce specific solutions. DISCS (Drop, Impact, Shock, Crush, and Shake) consists of five pieces of equipment which replicate a part of the product journey and provide real world testing. The tests look to replicate the stresses experienced in a typical ecommerce supply chain.

Further, **eBox Range Optimiser (eBro)** was developed, which is a software application designed for ecommerce which analyses, then recommends, the optimum box range for product packaging. Based on input information about the product portfolio and sales data, eBro simulates the optimal number of boxes for the product portfolio, determining the optimal dimensions. In addition, it can recommend the best fitted box for each order to achieve the highest fill rate. DS Smith estimates that use of eBro results in an overall packaging cost reduction of 11-55%.

Finally, **Made 2 Fit** looks to create right-size packaging and is in the final stages of testing before being implemented. The automated version is a machine designed for high throughput e-tailers which creates a box of the right, tailored size, for a given selection of items. This can create 10 million different box size combinations, at a rate of 800 boxes per hour. There is also a manual version which looks to cater to small producers with relatively small packages. This can create 39 different package sizes from three blank cardboard templates – mini, small and medium. Made 2 Fit looks to resolve the issues arising from sellers not knowing what selection of items a consumer will order, and allows them to be flexible to the selection ordered. By creating the right-size package for the products, Made 2 Fit will reduces the shipping air down to an average of 0.126L per box, and reduce the overall box volume by 43%. Made 2 Fit can be used with eBro and the packaging provided is DISCS tested.

Reasons Driving the Change

The changes DS Smith has made, and are making, to ecommerce packaging have been driven by an aim to increase operational efficiency. Following realisation of the growth in demand for their ecommerce packaging, and the inefficiencies of using traditional standard sized boxes, DS Smith looked to optimise the system. DS Smith had the capacity to develop the technology required for Made 2 Fit in house, and worked with an external provider to develop the algorithm for eBro based on information from DS Smith. Investment was required to develop both of these interventions. However, DS Smith see the interventions as value creation solutions, which reduce costs to the customer, and hence, there was a case for investment.

Cost of the supply chain is minimised through these interventions, feeding into a reduced cost to the consumer. Through optimising the package size, the number of packages per shipping consignment or container is maximised, resulting in a reduction in the total number of shipping units required across the supply chain. DS Smith estimates a saving of 0.11€/box on transport. In turn, reducing the package size results in both a lower requirement for filling material and for the cardboard for the package material itself - meaning that these costs are also reduced. Reducing empty space can also minimise damage to product and hence reduce the number of returns to retailer and the associated loss in product value. A similar result is achieved through applying eBro and ensuring that the optimal package is used from a selection of options. A major saving is also made through reduction in labour required using automated Made 2 Fit. Based on shipment of 3,000,000 boxes per annum, DS Smith estimate that the labour requirement for packing would reduce from 40 staff down to 5 or 6. The automisation achieved using Made 2 Fit, and associated capacity to rapidly fulfil orders, is also appealing due to the flux in demand for ecommerce. For example, suppliers are required to fulfil a larger number of orders at peak times such as Christmas and Black Friday with competition to provide fast turnaround minimising time between order placement and delivery.

Transferability to the Essential Requirements

The interventions as described have followed market forces. DS Smith identified an opportunity for innovating within their packaging supply chain offer which would achieve an increase in operational efficiency and reduce costs. The changes have resulted in both waste prevention, by reducing the quantity of material used and by reducing the filler material used, and resulted in a reduced transport requirement and hence reduction in transport emissions.

It could be possible to adapt the Essential Requirements in such a way so as to encourage or require other providers of similar services to reduce the amount of packaging in a similar way. However, given that the interventions also make sense economically for businesses and the barriers to their introduction are minimal it may be that a softer approach such as the development of guidance would be effective. Such guidance could encourage others to follow a similar approach, minimising the package size used and outlining a procedure to follow in developing right-size packaging.

If a harder approach is required, it may be possible to develop requirements of limits on the percentage of an ecommerce package which is shipping air, needing packer-fillers and producers to collaborate to ensure packaging is functional and appropriate for the product in question. However, such limits would be difficult to enforce, and may also be challenging to measure. This is still an option, and a quantitative standard or ratio for product to shipping air would provide a robust basis for enforcing the requirement. Equally, in the case of automated package selection, limits on shipping air could be set for machines to follow.

As an alternative, it may be possible to classify packages based on their percentage shipping air and label them as such in a way similar to an eco-label. This could benefit from generating consumer awareness of the issue, which is already increasing with 39% of online shoppers concerned by excess packaging.[29] From this classification, targets could be set for the proportion of packages which achieve certain standards. Another

[29] Marlena Skrzyniarz (DS Smith) - Making sustainable packaging the e-commerce differentiator. Presentation at the Packaging Waste and Sustainability Forum 2019. Originally from: E-Commerce Packaging Survey, Mintel, 2018

option would be to incorporate such requirements into a CEN standard on ecommerce packaging which would require a protocol to be followed.

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F.8 Lightweighting of E-Commerce Packaging (ASOS)

Switching cardboard boxes for plastic mailing pouches

asos discover fashion online

Nature of Case Study	*Improvement in environmental performance from material shift*
Packaging Sector	*Secondary packaging*
Packaging Material	*Plastic*
Type of Stakeholder	*Retailer*
Geographic scope	*Global*
Date	*2016- ongoing*

Nature of Intervention

ASOS, a British online fashion and cosmetic retailer, reduced the amount of cardboard boxes used by switching to plastic mailing bags for shipping their products. Plastic mailing bags now represent 92% by number of the packages they use, with over 59 million plastic mailing bags used per year, compared to 5 million cardboard mailing boxes.[30]

The plastic bags are lighter than the cardboard boxes so reduce raw material use and reduce the weight and volume of shipping. ASOS concluded from a cradle-to-grave assessment that this change in packaging results in a 60% reduction in greenhouse gas emissions.[1] It is noted that the methodology and assumptions that drove this finding were not available for further assessment. The bags are made of low density polyethylene (LDPE) with 25% recycled content, and are technically recyclable. ASOS serves a global market beyond Europe, thus it varies whether LDPE bags are actually being recycled in the countries they serve.

The objective of the change in packaging was multifold. The plastic mailing bags have a better environmental performance, but also offer cost savings. Plastic is a less expensive material than cardboard on a weight basis, and lowers the costs of shipping because it is lighter and less bulky. This is significant for the e-commerce industry as shipping costs play an important role in business models.

The change in packaging required a change in packaging suppliers, but this was not seen as a big challenge. There were also no significant risks perceived with the introduction of the packaging, and

[30] ASOS, *Corporate Responsibility,* https://www.asosplc.com/corporate-responsibility/our-business/packaging-and-waste

consumers did not voice concerns after its introduction.

Reasons Driving the Change

The change in packaging was largely triggered by the cost savings of the plastic packaging. This was complemented by the apparent improved environmental performance. In addition, ASOS has a corporate responsibility team focused on sustainability of their products, with a large focus on packaging waste specifically. There are several packaging waste pilot projects they have launched that work towards increased reuse, increased recycled content of packaging, and other interventions. ASOS noted however, that life cycle assessment results and conclusions in general can highly vary depending on methodological choices. This leaves room for debate on the greenhouse gas savings or other environmental benefits that companies claim based on the assessments they perform.

ASOS finds the circular economy very relevant to their practices, and are also experiencing a demand for more sustainable products, as their main customer demographic is consumers in their 20's, who ASOS believes are more eco-conscious. They question, however, whether these consumers would accept an increase in costs for improved sustainability of packaging.

Another, less significant driver is ASOS' general ambition to remain one step ahead of policy. Like many companies, ASOS wants to be aware of future policy that may affect their business so they can proactively work towards compliance. In the UK for example, where ASOS is based, the government announced in 2018 a new tax to be introduced on the production or import of plastic packaging that does not include at least 30% recycled content.[31] This announcement triggered ASOS to begin increasing the recycled content of their plastic bags and find new suppliers in preparation for the new tax. It is unclear whether these new bags will be available for distribution only in the UK, or more widely across their global markets.

Collaboration amongst the corporate responsibility team, procurement team, and supply chain team was needed to implement the change in packaging. A multidisciplinary team was seen as key to consider and balance the priorities of each department, such as environmental performance, costs, and logistics efficiency.

Transferability to the Essential Requirements

Since many companies want to have a clear view as to the direction of future policy, and can take a long time to make changes to comply with new policy, it would be beneficial to such firms for a clear steer as to the likely direction of future policy to be given. These could be added as non-mandatory, but highly encouraged requirements or recommendations. By including them as a recommendation, companies would be aware that this topic may be introduced in the coming years, and could begin investigating new solutions before it becomes a stringent requirement.

With the Essential Requirements (ERs) this could mean, for example, that although strict requirements for recycled content of packaging are not currently included, it could have already been added as a recommendation. These recommendations could give companies an indication of what concepts may be included in the next updated version of the policy. This would

[31] GOV.UK, *Single-use plastics: Budget 2018 brief*, https://www.gov.uk/government/publications/single-use-plastics-budget-2018-brief

give them ample time for R&D and other activities that are necessary to prepare business practices for new policy. However, clear communications regarding such recommendations and the implications for future policy direction would need to be set.

ASOS also noted that environmental benefits are not always straightforward to quantify for packaging. The ERs could address this issue by providing a standardised methodology for measuring environmental benefits for companies to use to quantify their compliance with the ERs and fairly compare themselves with competitors. It could also be used to quantify and consider the trade-offs of packaging choices, such as improving lightweighting but decreasing recyclability, or increasing raw material use for increased reusability. The methodology could also be used to quantify and clarify the now openly interpreted definitions for requirements that are a part of the ERs.

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ASOS.

F.9 Mono-material Trigger Spray (Reckitt Benckiser)

The move towards a more recyclable and functional trigger spray

Nature of Case Study	***Improvement in environmental performance from material shift and recyclability***
Packaging Sector	*Primary*
Packaging Material	*Plastic*
Type of Stakeholder	*Product Manufacturer*
Geographic scope	*Global*
Date	*2018*

Nature of Intervention

Reckitt Benckiser has developed a new TS6 trigger spray, in collaboration with Guala Dispensing, that is easier to recycle and more functional than the previous design. The trigger spray was introduced in 2018 and will be rolled out globally over the next year and a half. It is primarily used in cleaning product lines for liquid sprays.

The main objective of the new design was to improve the functionality and spray performance of the trigger spray. The trigger design was over 15 years old and was due for a redesign. A smaller, but complementary objective was to improve the environmental sustainability of the trigger. Reckitt Benckiser has set a target of 100% of their products being reusable or recyclable by 2025, and this new design helps them to reach this target.

The new trigger spray was able to meet both objectives. It has an increased technical performance including a more consistent spray force and pattern, wider area coverage by product, and further elimination of leaks related to dribbling and fatiguing. Previously, the trigger spray system had metal and glass components which damaged the blades of shredders in the recycling process and also contained difficult to recycle polyoxymethylene (POM) plastic. All components are now plastic and POM has been replaced by polypropylene (PP), thus improving the recyclability. The new trigger spray is also 6-13% lighter which reduces raw material use and emissions from transport.

Developing the new packaging solution initially faced challenges with higher costs but were slowly overcome with progress made in R&D. One factor that helped to drive down costs was the reduced number of components in the new design. This R&D did however require investment. The largest investment was needed from the supplier to purchase new injection molding and assembly equipment. Reckitt Benckiser also had to provide investments for R&D and adjusting their capping equipment.

Both parties were willing to make these investments as there were very few perceived risks associated with the change in packaging. There were no major aesthetic changes to the trigger spray to negatively influence consumer choices, but a few consumer tests were conducted to test this and the function of the new design.

Reasons Driving the Change

One of the many reasons Reckitt Benckiser was able to develop this new packaging solution is due to the close and long relationship with their supplier, and the supplier's willingness to innovate, despite the many changes in manufacturing processes and equipment needed for the new design. Reckitt Benckiser is also the world's biggest supplier of trigger sprays and could positively leverage their large demand.

Another driver of change was the pressure to innovate because the trigger spray design was over 15 years old and in need of updating. Reckitt Benckiser also regularly benchmarks their product performance against competitors, and were motivated to improve the functionality of the trigger spray. In tandem, they wanted to improve the recyclability of the trigger spray to align with their sustainability goals. Reckitt Benckiser emphasised the need for such momentum for this project, as hurdles are faced quite regularly, and a long term vision is needed to move things forward.

The implementation of the new design required internal collaboration with many different departments such as product engineering, marketing, and procurement. Since the trigger spray involves over 16 factories worldwide, there was also extensive communication and coordination needed amongst them. The technical project leader in packaging development also had to work in close collaboration with R&D while procurement performed the negotiation with suppliers. Reckitt Benckiser largely pays the success of this project implementation to having a multi-disciplinary team with diverse perspectives and skill sets. In contrast, they commented that policy, and specifically the Essential Requirements (ERs) did not play a large role in the new packaging. Although ten years ago the ERs were enforced for some of their other types of packaging, they have not experienced any enforcement of the ERs since.

Transferability to the Essential Requirements

Typically different materials serve different functions for packaging, but this case study shows that there are innovative solutions for the number of components in packaging being reduced while still maintaining or even improving functionality and performance. This example highlighting increased recyclability and lightweighting could be scaled to a number of other packaging markets. Switching from difficult to recycle multimaterial packaging to more recyclable packaging is not limited to trigger sprays and could be applied to all types of mixed material packaging. In many cases, reducing the amount of components in packaging can also reduce costs. The barrier is the initial investment and inertia needed for innovation to explore packaging alternatives. This barrier could be overcome with appropriate policy measures. Innovation funds could be created for smaller companies that lack the capital and risk appetite to test a new product design. Innovation could also be triggered by benchmarking packaging of different manufacturers, which could be made either public or private. The laggards would be motivated to innovate if their lack of competitiveness was made more visible and the leaders could provide good examples of what manufacturers should be working towards.

Reckitt Benckiser noted that a long term vision was a factor for success, so innovation could also be spurred through the ERs by requiring packaging producers to develop a strategy or roadmap with future environmental goals. Potentially similar to the sector and material innovation plans required by the Dutch Packaging Agreement (Raamovereenkomst verpakkingen).[32]

They also noted that the current ERs were not a trigger of change because they are weakly enforced. If the ERs were enforced more stringently, this could also push companies to innovate new packaging solutions for where they do not comply.

Another weakness of the ERs is the definition of recyclability. They require "a certain percentage by weight" to be recyclable, however, this still does not explicitly address the difficulty of separating multiple materials for recycling. Although a trigger spray with metal and glass components is theoretically recyclable in its parts, these components when mixed hamper the recycling process. Recyclability should thus not only be measured on a percent by weight basis, but should also incorporate the ease of separating and recycling the different components.

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F.10 Switch to Flexible Pouches

Drivers behind the increased use of flexible packaging, particularly in the food sector

Nature of Case Study	*Trade-off between recyclability and light-weighting*
Packaging Sector	*Food packaging*
Packaging Material	*Plastic*
Type of Stakeholder	*Packaging producer, product distributor*
Geographic scope	*Global*
Date	*2009- ongoing*

Figure 1 Pouches for Sainsbury's fish meals

Source: FFP 2018.

Nature of Intervention

Recent years have seen a switch in the food packaging industry towards flexible pouches for various products such as sauces, baby food, coffee and fish or other meals to be placed in the oven inside their packaging. Use of pouches now extends to products such as olives or beverages such as fruit juice or wine.

One of the major benefits of this switch is a significant reduction in the weight of packaging compared to more conventional forms of packaging such as rigid bottles and containers. In food markets, flexible packaging now accounts for around 50% of all packaging used, in terms of units. However, in terms of weight, it accounts for around 17% of all packaging.[33]

Flexible packaging also requires less energy and materials for production. Some of the flexible pouches use one kind of material for the entire package, whereas conventional packaging would use several different components. One of the biggest benefits, however, is transport density, as many more of these packs can be transported on a pallet load than an equivalent cylindrical bottle or jar, reducing food miles.

The major drawback of the switch to pouches is that they are currently not recyclable in most of the EU, whereas heavier alternatives may be, including all components. The overall carbon impact therefore has to be considered in terms of whether the often far lower weight offsets the general lack of recyclability and the consequent use of landfill or energy from waste at end of life.

Several different examples of a move to this type of pouch packaging exist. FFP Packaging Solutions designed a flexible stand-up pouch for takeaway fish meals for

[33] Interview with Flexible Packaging Europe.

Sainsbury's (Figure 1). The pack can be cooked in the oven as a whole and reduces package weight compared to standard ready meal packages (tray/ sleeve/ film). While a traditional pack for ready meals weighs around 25g to 35g and comprises different components requiring additional supply chain management, the new pack weighs approximately 8g, with some variation depending on the size.[34]

Another example concerns the packaging of baby food, particularly a shift from thermoformed plastic tubs and glass jars to multilayer plastic pouches. The Nest Collective's 'Cheer Pack' pouch is used for mashups and organic baby food. It is a laminated pouch with three layers: polyester, aluminium foil and polyethylene. The cited benefits of these pouches are that they are tamper evident, can be hot-filled and sealed so the product no longer needs to be frozen. In addition, the weight of the packaging has decreased compared to a conventional pack.[35]

Sealed Air developed the 'Cryovac FlexPrep' solution for condiment dispensing (Figure 2). This innovation for packaging in the food service industry aims at replacing large rigid plastic tubs and glass containers of condiments or sauces with flexible pouches which can then be used with a custom made reusable dispenser. As a result, material use, package weight and costs for shipping are reduced, and shelf life can be increased as condiments do not need to be transferred to different containers.[36]

Figure 2 Cryovac FlexPrep dispense system

Source: Sealed Air website.

Huhtamaki Flexible Packaging have developed different types of award-winning pouches including the 'Refilly' pouch for coffee and the 'Straight'n'Easy' package for sausages. 'Refilly' is made of four aluminium-based laminates creating a light 20g round pouch that can fit in the usual coffee cans and reduce the waste volume.[37] The 'Straight'n'Easy' pouch has a multilayer design of aluminium barrier and Huhtamaki's Terolen film and is lighter than the can used for the sausage packaging previously (~4 times lighter when empty, ~5 times lighter once filled). Furthermore, interviewees highlighted that no water needs to be added to the product with this packaging, as was the case when the can was used, representing a further resource saving in their view. Shelf life is also secured due to the aluminium barrier.[38]

This development in packaging is an example of a trade-off, where the move towards non-recyclable plastic packaging is offset by reductions in the amount of resources used, both in terms of energy and materials – though independent analysis and data to verify this is lacking.

[34] FFP 2018 'Lightweight oven pouches first for the chilled aisle with Sainsbury's Fish'.

[35] Packaging World 2010 'Pouch format is baby food 2.0'.

[36] Sealed Air 'Cryovac FlexPrep' website.

[37] AluFoil 2016 'Refill pack for coffee is totally refreshing'.

[38] AluFoil 2017 'New straight opening pouch brings sausage pack savings'.

Analysis of Drivers

Several drivers have been identified as pushing retailers to switch to pouch packaging.

The major driver is price. Flexible packaging requires less material use than more traditional forms of rigid packaging, and the reduction in the amount of materials used is reflected in the reduced price of the packaging. Savings in operational costs can also be made from the ease of adapting filling lines to different sizes of flexible packaging. Printing costs are also potentially reduced, in that smaller quantities of a given print design can be produced in comparison to other types of packaging. Nevertheless, there is a significant initial investment required to adapt filling lines to flexible packaging from rigid packaging. However, in some cases the reduced cost of the packaging may not be large enough to offset the high investment cost needed in the production lines.[39]

Another important driver identified is the perceived attractiveness of flexible packaging for the consumer. In particular, retailers consider flexible packaging is associated with being modern, and gives them the opportunity to differentiate from other products in rigid packaging that could be considered more traditional.[40] Furthermore, the pouch packaging takes up less space on shelves compared to conventional packaging for similar food items.[41]

Whilst the environmental aspect is not one of the major drivers of the switch to pouches, flexible packaging can be considered to offer advantages when looking at the lifecycle impact of packaging. A life cycle analysis report by IFEU, commissioned by Flexible Packaging Europe, found that flexible packaging could significantly decrease the amount of primary packaging waste and the amount of energy and material needed for production. This in turn reduces its carbon footprint. The report found that these benefits offset the material loss occurring as a result of non-recyclability of the packaging.[42] This finding could not be critically assessed further due to a lack of information about the assumptions and quantitative data inputs analysed.

It has also been argued that further resources could be saved thanks to the reduced weight of the packaging as more of these packs can be transported and stored in warehouses compared to conventional packaging, reducing the associated energy use and costs. Moreover, some producers report that the flexible packaging has created new possibilities for preserving some food items in pouches without the need to add water, which may offer additional resource savings.[43] It is also worth noting that, while the packs can offer very good shelf life, lower packaging costs may result in slightly higher levels of food consumption which is not of benefit.

In terms of recyclability, there are changes in design being developed to allow pouch recyclability and initiatives to help improve collection and reprocessing. CEFLEX, an initiative launched by companies in the value chain aims to develop flexible packaging that is more circular. The initiative aims to ensure there will be collection, sorting and reprocessing infrastructure for flexible packaging across

[39] Interview with Flexible Packaging Europe

[40] Ibid.

[41] FFP 2018 'Lightweight oven pouches first for the chilled aisle with Sainsbury's Fish'.

[42] IFEU 2016 'Resource efficient packaging'.

[43] AluFoil 2017 'New straight opening pouch brings sausage pack savings'

the EU by 2025 and develop a market for the recycled materials.[44]

Summary of the drivers:
- Cost savings from lower material use and more efficient production;
- Attractiveness and marketability of product; and
- Reduced carbon footprint over lifecycle.

Transferability to the Essential Requirements

The Essential Requirements (ER) have limited potential to affect some of the major drivers behind the move towards more flexible packaging and pouches, particularly the lower costs and higher perceived attractiveness of the packaging.

Nevertheless, the ER could influence considerations related to the environmental impacts of the packaging, including recyclability. Any potential change to the ERs will need to consider the trade-offs and seek to balance lower material use, and carbon impact, with the packaging's disadvantages, i.e. in that it is not collected and/or recycled and has the potential to cause plastics litter and marine pollution.

The industry has recognised the importance of improving the recyclability of flexible packaging, however, industry stakeholders believe that the ER should be flexible enough to allow innovation in the sector, especially concerning packaging types are not currently recyclable but could become so in the future. Last but not least, the trade-off offered by flexible packaging and its various impacts should be studied in a targeted and independent way in order to provide concrete proof for the possible resource savings and carbon footprint reductions compared to traditional packaging that can be recycled.

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[44] Flexpack 2019, 'Sustainability' and interview with Flexible Packaging Europe.

F.11 E-commerce reusable packaging (RePack)

Improving reusability of packaging for e-commerce

Nature of Case Study	***Reuse of packaging***
Packaging Sector	*E-commerce, tertiary packaging*
Packaging Material	*Plastic*
Type of Stakeholder	*Packaging Producer*
Geographic Scope	*EU and USA*
Date	*2013 - ongoing*

Nature of Intervention

This case study focusses on reusability of e-commerce packaging for online retailers and their customers. The case study presents a company called RePack, a Finnish start-up that creates reusable packaging from recycled materials and provides returnable packaging service for online retailers.

In Europe, the e-commerce sector grew by 11% in 2017 and 13% in 2018, and it is expected to continue growing.[45] E-commerce produces significant amount of packaging waste, which consists predominantly of cardboard boxes, single-use plastic bubble wrap and expanded polystyrene. The growing e-commerce sector means that the need for packaging will also increase.

To address this issue of packaging waste, RePack developed returnable and reusable packaging, which was inspired by the Finnish deposit refund system for bottles. RePack packaging can be purchased for around EUR 3.50 and then returned - shipped back to the RePack returns hub. The price of RePack packaging depends on the size of the packaging and the preferences of the webstores that provide this packaging option, e.g. some webstores offer RePack packaging option for free for their loyalty club members. The price includes the whole cycle of the packaging, covering its production, return, cleaning and redistribution. The packages are made from recycled polypropylene and come in three sizes as shown in Figure 1. When the packaging is empty, it is designed to be easily folded to the size of a letter that would fit any mailbox around the world and to be simply sent back, free of charge.

Figure 1 RePack types of packaging

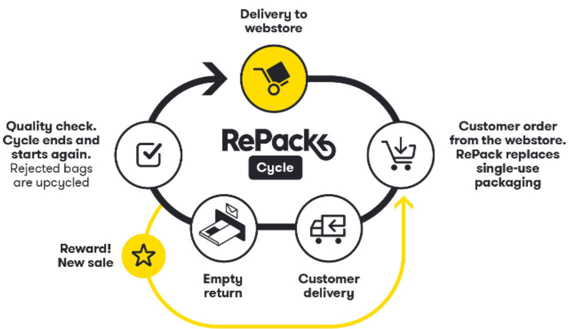
There is also an economic incentive to return the packaging. Through RePack voucher platform, customers are rewarded for each returned packing by receiving a

[45] https://ecommercenews.eu/ecommerce-in-europe-was-worth-e534-billion-in-2017/

voucher with a promotion for their next purchase. For example, some webstores offer up to 10% discount on their next purchase. RePack highlights that up to 60% of RePack vouchers are claimed.

The system has around a 95% return rate. The lifetime of the packaging does not have a specific limit, but it is usually used around 20 times. When packaging gets damaged, RePack uses it as a test material for further improvements and innovation. In future, RePack plans to upcycle used packaging into new products. Geographically, RePack cooperates with e-commerce companies in 14 countries, including USA and EU.

Figure 2 RePack System



Reasons Driving the Change

The main driver for creating the reusable and returnable packaging for RePack is the growing volume of packaging waste associated with increasing e-commerce sales. It is expected that e-commerce will become the largest retail channel in the world by 2022. With the rise of online shopping, the packaging waste can become an issue. In the EU, 69% of internet users shopped online in 2018. Globally, it is predicted that online retail sales will continue to grow by almost 20%.[46]

In 2018, around 30,000 RePacks were used, including new and old packs. This could be equivalent to up 600,000 items of single-use packaging that have been prevented from use (as on average one RePack is used at least 20 times).

Furthermore, it was calculated that RePack reduces up to 96% of total packaging waste and it reduces the carbon footprint by up to 80% compared to disposable packaging.[47]

In recent years, environmental awareness of issues relating to single use packaging has increased. Customers' demand for more sustainable packaging turned into a new driver for RePack to continue with their reusable packaging. It is without a doubt that sustainability is a selling point. For RePack the year 2018 was particularly successful in terms of scalability. One of the reasons behind this success is considered the EU policy incentive to eliminate single-use plastics, which lead to change in public awareness.

Nevertheless, adoption of this reusable and returnable packaging does not place a financial burden on businesses. RePack provides cost neutrality for online retailers, as the costs associated with the RePack option are covered by the customer. Another obstacle could be inadequate space for online retailers to store their reusable package. In case of RePack, the company takes care of the packaging and its storage as part of their services. The webstores order packaging when they need it. The minimum order is 100 bags per size.

Increased focus on circular economy and sustainability forces retailers to look for more sustainable packaging options. For instance, e-commerce giants such as

[46] Euromonitor International (2017), https://blog.euromonitor.com/e-commerce-is-the-fastest-growing-global-retail-channel-through-2022/

[47] https://www.originalrepack.com/files/RePack_&_CO2%20.pdf

Amazon.com or Chinese retailer JD.com have started introducing a new initiative for optimizing packaging. JD.com developed a new program offering their customers, for free, a choice of reusable box applied to small and medium-sized parcels. As is the case with RePack, customers are rewarded with loyalty points, which can be exchanged for products on JD.com. However, in contrast to the RePack model, customers return their packaging to a delivery personnel after receiving their order. The box could be use approximately ten times.[48]

Transferability to the Essential Requirements

The approach for reusable packaging presented in this case study demonstrates one of the possible ways of how to reduce the environmental impact of e-commerce packaging. RePack creates reusable and returnable packaging, while ensuring that online retailers do not bear the financial and logistical burden. The changes in packaging introduced by RePack have resulted in waste prevention as well as reduction of carbon footprint (i.e. from manufacturing and use phases).[49] As demonstrated by American Amazon.com or Chinese JD.com, there is a potential for increasing the use of returnable and reusable packaging in e-commerce.

The Essential Requirements could potentially further reinforce the reusability of packaging from e-commerce. This could be achieved in a form of specific requirements or following a softer approach by promoting reusability in e-commerce.

A stricter approach with the specific requirements could be introduced by, for example, setting a specific target for reusability of e-commerce packaging by 2030. This could encourage introduction of new business models for returnable and reusable packaging. Naturally, this has to be developed in close collaboration with the industry as well as examining all impacts (intended and unintended) of introducing more reusable packaging. The nature of the product that is being packed may be an important consideration. For the time being, RePack is cooperating only with the clothing industry as their products are soft and do not need a high level of protection. Their packaging must be able to fold into a letter size and therefore it does not provide sufficient protection to very fragile objects. This should be taken into account, in case the requirements for reusability are introduced. However, as demonstrated by the Free Pack Net case study, the reusable packaging can actually be used to provide more protection to products such as domestic appliances.

In addition to that, it has been noted by RePack that, the degradation of single-material packaging by putting a label on it, or a stamp of a different material should be avoided, as this can make the returnable packaging difficult to recycle. To avoid reducing the recyclability of returnable packaging, cooperation throughout the supply chain (e.g. with postal services) may be needed.

If a softer approach were preferred, the Essential Requirements could encourage the reusability of e-commerce packaging, e.g. in a form of guidelines and presenting best cases how this can be achieved in practice. It could also be valuable to build awareness around the advantages of reusable packaging among online retailers and public.

[48] JD, New Reusable Package Initiative: https://jdcorporateblog.com/jd-com-launches-new-reusable-package-initiative/

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F.12 Increasing reusable packaging (Replenish)

Reusable cleaning product bottles with concentrated refill pods

Nature of Case Study	*Switch to reusability*
Packaging Sector	*Primary*
Packaging Material	*Plastic*
Type of Stakeholder	*Packaging Producer*
Geographic scope	*Global*
Date	*2018*

Nature of Intervention

Packaging designer and producer Replenish has developed reusable cleaning product bottles that use concentrated refill pods. The most recent version, Replenish 3.0, was launched in late 2018. Replenish collaborates with brand owners such as Amazon who introduced their new product line using the Replenish Refill Smart platform, coined the Clean Revolution, in early 2019.[1]

The Replenish Refill Smart platform works as follows: the customer purchases a reusable plastic cleaning product bottle, as pictured. When the cleaning product is finished, a refill pod with concentrated cleaning solution is attached and diluted with water. The pod, currently made of low density polyethylene (LDPE) and weighing just over 100 grams, can be used to make 6 bottles worth of cleaning solution and is recyclable once finished. The reusable bottle is made of polypropylene (PP) and is also recyclable at the end-of-life.[50] The modularity of the bottle was an added feature of Replenish 3.0 so that it can be recycled into its parts. The new line also offers full customizability, and customers can choose colours or even upload digital images to be printed on their bottles.

The objective of this packaging solution for Replenish, and for some of their brand partners, is to increase the environmental performance of packaging. By having customers keep the bottle and reusing it rather than purchasing a new one, this reduces raw material use and greenhouse gas emissions from production and transport. In addition, using a concentrated refill pod also reduces raw material use and avoids the shipping of unnecessary water and bulk.

Despite the environmental benefits, many challenges are faced in convincing companies to adopt a refillable system and changing their business models. Although there is an economic benefit for these

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[50] Packaging Digest (March 2019) : Amazon chooses refillable packaging for Clean Revolution https://www.packagingdigest.com/sustainable-packaging/amazon-chooses-refillable-packaging-for-clean-revolution-2019-03-19

companies, it is not always apparent with the metrics they use to measure profit. Since companies cannot charge as high of a price for a refill pod as they can for an entirely new bottle, the return per product weight is lower. However, this metric does not capture the overall gross profit margin. Although the price charged per gram of product is lower, there are savings from reduced material use by not having to produce an entirely new bottle, and savings from reduced shipping. Concentrated refill pods drastically reduce both weight and volume of shipping, and these savings could potentially be passed on to the customer. Changing a business model, however, has many perceived risks and creates uncertainty for businesses.

Reasons Driving the Change

For Replenish, the driver of Replenish 3.0 was the improved environmental performance of a refillable system, as their company mission is to fix the problem of disposability of consumer packaging and reduce plastic waste. For some of their brand partners, sustainability ambitions are also the motive for adopting reusable packaging. Amazon, for example, has specifically been working on packaging since 2008 with the introduction of their Frustration-Free Packaging Program. This initiative aims to offer more sustainable packaging that is right sized, reduces packaging, reduces damages, is made of recyclable materials and is easier to open.[51]

Replenish has found that sustainability is not always enough for companies to adopt their packaging platform. The driver for companies without voluntary sustainability targets instead switch to reusable packaging because they believe it offers a better product to their customer. With Replenish 3.0 for example, the reusable bottle is of a higher quality than a disposable one. More importantly, customers can customize it to their liking, which cannot be offered by disposable bottles. In addition, reusable bottles can increase brand loyalty; when customers purchase a reusable bottle, they are locked into the product in a sense in that they have to continue to purchase refill pods from the brand owner. This can also help to reduce marketing costs.

Replenish 3.0 has initially been driven by ecommerce brand partners. For ecommerce, concentrated solutions can provide substantial savings in distribution and shipping to end consumers. For brick and mortar shops, however, concentrates have a disadvantage because refill pods are smaller and less visible. This gives a lesser shelf presence and also leaves more space for competitors.

Transferability to the Essential Requirements

This packaging solution has a large potential and can be expanded to other products and markets. Replenish 3.0 highlights the benefits of reusability and concentrated solutions, both of which can be scaled beyond the current scope. The concept of a concentrated solution that is diluted by the user can be applied to any product that contains a large fraction of water, which is true for most cleaning products, other liquid products, and some chemicals. Replenish envisions their solution can be used in multiple product categories including beauty, personal care, beverage, pet, garden, and industrial and household cleaning. In the US alone, there are 40 billion containers to which Replenish believes refillable concentrates could be applied. Although this solution is first being launched in the growing market of ecommerce, it could also be sold in brick and mortar shops.

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[51] (2019) *Amazon Certified Frustration-Free Packaging Programs*, https://www.amazon.com/b/?&node=5521637011

Reusability or refillability is an even more versatile concept that could be expanded to a greater range of packaging. In this case study it is the customer that refills the product by adding water, but the same concept of refillability could also be extended to other non-liquid products. This would be most easily applied in ecommerce because it has the added advantage of shipping directly to the customer. Customers could ship back reusable packaging to be refilled at a centralised facility. Some companies are already piloting similar initiatives with the Loop platform.

The concepts of concentrated solutions and reusability could be integrated into policy through various approaches. Concentrated solutions do not currently gain much attention in packaging discussions, however they present an easy and scalable solution to prevent the unnecessary transport of the bulk and weight of water. They could be explicitly incorporated to the Essential Requirements (ER) by setting a maximum ratio of the volume of water to the volume of active ingredients for liquid products. However, safety concerns would also need to be taken into consideration where relevant. Brand owners could also be required to offer a certain percent of their liquid products as concentrated refills.

Although reusability is already a part of the ERs, it could be further strengthened. Similar to the ban on certain single-use plastics by 2021 in the context of the Single Use Plastics Directive (2019/904), certain packaging could be banned as single-use and require a minimum number of reuses. [52] It could either be a requirement by material type, such as plastic, or by product sector, such as cleaning products. For packaging that cannot entirely be reused, modularity could also be integrated so that parts of the packaging can be reused, such as is the case for Replenish 3.0. Since the bottle is modular, the body can be reused while the refillable pod can be replaced. Modularity could be integrated in the ERs by allowing multimaterials if the packaging is modular and if the independent parts can either be reused or recycled.

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Jason Foster – Replenish - CEO

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F.13 Free Pack Net

Increasing reusability of packaging for domestic appliances

Nature of Case Study	Reuse
Packaging Sector	*Tertiary packaging (transport/ storage) for household electrical products*
Packaging Material	*Plastic*
Type of Stakeholder	*Packaging producer*
Geographic scope	*Global*
Date	*2012 - ongoing*

Nature of Intervention

This case study focuses on Returnable Protective Packaging (RPP, sometimes called Returnable Transit Packaging or RTP) for domestic appliances developed by Free Pack Net. The company provides sustainable returnable packaging (referred as RPP) to manufacturers and retailers. The RPP is made of plastic and is adaptable to the products for which it has to be used for (see Figure 1).

Each RPP model is quality certified by TUV. It lasts for at least 20 cycles and can be recycled afterwards and used to produce new returnable packaging. This creates a closed loop system that minimises the use of raw materials.

Free Pack Net focuses on improving the efficiency of the supply chain through manufacturing, logistics, reusable rental markets and services. The company provides different offers to cater for manufacturers and retailers and their needs, including short and long-term renting of RPP. Free Pack Net takes care of the reverse logistics to provide customer convenience. Product development has involved the close collaboration with the manufacturers and retailers to ensure that the product meets their needs and offers tangible benefits.

Figure 1 Free Pack Net Returnable Protective Packaging

Key to this is that the packaging system provides better product protection than more traditional systems to reduce product damage during transportation. As such there is an additional incentive to use the system, over and above the environmental benefits.

The robust nature of the RPP also potentially allows product designers more flexibility to innovate. For example, if a washing machine no longer needs to withstand certain transit loads, lighter and/or alternative materials could be used, potentially in favour of a more sustainable design. This could further encourage the rethinking of the design of products.

Figure 2 Example of Free Pack Net RPP

The strength of the RPP also allows more optimised storage of white goods in a warehouse, with more stable and higher stacking being possible without damage (the unit can withstand a compression load of 1200 kg), and thereby increasing warehouse utilisation.

Reasons Driving the Change

The main reason for developing the RPP system was the increased interest from manufacturers in using more sustainable packaging options for white goods (washing machines, fridges, dishwashers etc.). The white goods market is a large international market and the items are mostly) made to standard sizes, making it easier to develop a standardised system.

The market is also dominated by large global players with established logistic systems and global operation centres, allowing, for integration of the reverse logistics approach. Most importantly there is a problem to solve since significant losses occur due to damages (5% to 8% of goods) during transportation, with a significant impact on profit.

In addition there is political and consumer pressure on manufacturers and retailers to reduce their carbon footprint from packaging and eliminate waste. A stronger focus on circular economy and sustainability is encouraging manufacturers and retailers to rethink their approach towards packaging.

While the environmental benefits are clear, the most significant aspect remains the cost driver. RPP allows for overall cost reduction whilst also eliminating waste and reducing net CO_2 emissions.

According to Free Pack Net, the price of the RPP per use (over 20 cycles) is approximately the same as standard disposable packaging, when aspects such as reverse logistics and repair and replacement of the RPP are taken into account. The cost benefit comes from the reduction in damages and in the improved warehouse utilisation.

Transferability to the Essential Requirements

As demonstrated by this case study, there are not only environmental but also economic benefits for introducing this type of packaging. RPPs enable circular thinking within an organisation by eliminating packaging waste, reducing environmental impact of damaged goods and potentially allow for more innovative and sustainable product design. This could further support the development of new circular business models, such as a ‘charge per use’ business model.

Free Pack Net addresses tertiary packaging (transport/ storage), targeting white goods as there is a market for this type of packaging. The RPP could be further applied to other electric and electronic products with similar supply chains, e.g. TVs, computers, etc.

It may be possible to adapt the Essential Requirements in such a way so as to encourage or require reusable transit packaging in certain scenarios, for example between an organisation's own sites or where other closed loop logistics arrangements are practical.

In some sectors the cost benefits alone may be sufficient to encourage greater use of RPPs. Further awareness raising using good practical examples, combined with collaborative industry projects (manufacturers, retailers, packaging producers), would certainly be beneficial to build a business case around the advantages of RPPs. As indicated by Free Pack Net, this is important as manufacturers are often not fully aware of how RPPs can be introduced and made cost effective.

Overall, the coherence between the Essential Requirements and other relevant Directives (EPR, Ecodesign, Energy Labelling) should be further pursued to ensure that the potential of circularity is fully exploited.

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F.14 Compostable Packing (TIPA)

Innovative compostable packaging solutions for food packaging

Nature of Case Study	***Material choice to increase compostability***
Packaging Sector	*Primary packaging for household products*
Packaging Material	*Compostable packing*
Type of Stakeholder	*Packaging producer*
Geographic scope	*United States, Europe and Australia*
Date	*2010 - ongoing*

Nature of Intervention

This case study examines the application of compostable material for flexible plastic packaging used in the food sector. Flexible plastic packaging can be divided into two categories: mono-materials – used for plastic shopping and produce bags – and multi-material – used for most long-life food packaging. Multi-material plastic packaging (e.g. plastic and aluminium) is used to preserve the safety and quality of food. Due to its nature, the multi-material plastic packaging is often difficult to recycle. In the UK, only 4% of all flexible plastic packaging (i.e. consumer film) is recycled.[53] In addition, plastic packaging is often contaminated with food waste, which makes the recycling option difficult, and as such, the contaminated packaging often ends up being incinerated or landfilled.[54]

TIPA is a compostable packaging producer established in 2010, which aims to address the challenge of multi-material plastic packaging. TIPA has a vision to take on the flexible plastic packaging industry by offering non-hazardous, sustainable packaging through the use of a blend of compostable polymers.

Figure 1 TIPA's packaging for snacks, cereals and other food products

According to TIPA, the main focus for the company is multi-material packaging types as they assert that these are almost entirely non-recyclable. TIPA packaging is compostable and used for food products, such as fresh produce, coffee, snacks, granola bars, as well as apparel and magazine packaging, etc. TIPA packaging is designed to mimic organic matter such as orange or avocado peels with the same end-of-life approach. In other words, many TIPA packaging types break down under the same composting conditions as regular food waste.[55] For example, their packages for fresh produce are certified as home compostable, while their laminated packaging needs to be composted in an

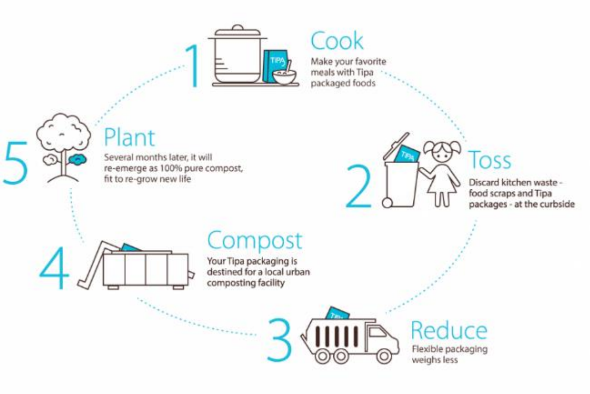
[53] http://www.wrap.org.uk/content/plasticflow-2025-plastic-packaging-flow-data-report

[54] Ricardo Energy & Environment. (2019). Plastics in the Bioeconomy. ED 12430

[55] https://tipa-corp.com/

industrial facility. TIPA packaging comply with EN 13432 and ASTM D6400 standards for industrial composting.

Figure 2 TIPA's packaging cycle from consumers to back to nature



With regard to the functionality of TIPA’s compostable packaging, it aims to be comparable to conventional plastic packaging in terms of durability, transparency, sealability, printability and flexibility. Their products are partially bio-based meaning that a proportion or all of the products are made up of biomass. For example, their fresh produce bag is 20-30% bio-based with characteristics almost identical to a conventional plastic bag. One of the main challenges TIPA is striving to address is ensuring that their compostable plastic packaging has the same shelf-life as conventional flexible plastic. To solve this challenge, their plastic is made from a blend of polymers that each tackle a different technological requirement.

TIPA envisions not only to be a key market player, but also a leader in the packaging industry. In 2016, the UK brand Snact officially announced its shift to using TIPA packaging for its Fruit Jerky. Further, TIPA partially supplies to Ekoplaza, a Dutch grocery chain that aims to have biodegradable packaging comprise 75% of its total packaging. TIPA operates in a niche market in which they hope to see more competition as compostable packaging becomes more and more accepted.

Reasons Driving the Change

The need for major changes in the current packaging industry motivated TIPA’s founder to seek alternative options for flexible plastic packaging. The company’s founder was particularly concerned with the issue of single-use plastics and its implications on the environment. The fact that the majority of multi-material plastic is not recycled, was the motivation to develop an alternative solution. That solution had to be not only a more sustainable option, but also had to have the same properties as conventional plastic packaging, optimising the mechanical, optical, functional and use properties for consumers.

To ensure technical feasibility and scalability of the compostable packaging, TIPA’s packaging had to be used on the same converting and sealing machinery as conventional plastic packaging. This was a major factor in developing the compostable packaging, as the requirement for new type of machinery would be a barrier for the industry’s uptake of their packaging. This technological consideration can limit the associated investment cost with purchasing TIPA packaging. One setback regarding machinery is that TIPA packaging may not necessarily be printed with the same technology as is used for plastic, which creates an additional cost for TIPA packaging buyers. TIPA stresses, though, that their devotion to research and development aims to make the packaging applicable to already existing technologies.

Larger institutions can help to finance technological R&D as well as spread institutional awareness. For instance, the retail company Walmart has put effort into supporting compostable packaging by introducing programmes that focus on shifting to recyclable or compostable packaging. In 2017, TIPA received USD 11 million in Series B financing from the Hearst Corporation to expand their market share and technology innovation of packaging.

In addition, TIPA estimates that their highest potential for scalability is in the market for savoury and salty snacks that use laminated products. This is another sector in which TIPA hopes to utilise its R&D funds. One major challenge for TIPA is the magnitude of the conventional plastic packaging industry. It has existed for many years before the compostable packaging industry, which creates a challenge for companies to compete on price.

Transferability to the Essential Requirements

In line with the waste hierarchy, the recyclability of the plastic packaging without significantly downgrading its quality (downcycling) is a preferred option. However, as in the case of multi-material plastic packaging for food, where its nature limits recyclability, some argue composting may be an option. Composting provides a more sustainable solution to disposal of packaging comparing to landfilling, especially where energy recovery is not available. However, it is also important to note that some compostable packaging cannot be recycled and thus cannot be mixed with recyclable plastic. Mixing compostable packaging with recyclable plastic can contaminate the recyclable input.

To ensure sustainability of this approach, composting systems at a household level or municipality level are needed. Currently, the composting systems on a global scale are limited and differ across countries and regions. The lack of composting systems as well as limited awareness of the consumers on what to do with compostable packaging can be perceived as the main challenges when ensuring sustainability of compostable packaging.

In regard to the reinforcement of the Essential Requirements for Packaging and Packaging Waste, if it was confirmed that compostable plastic packaging produced the some benefits as compost, the requirements could support the use of compostable plastic packaging for difficult to recycle applications. This could be achieved through, for example, a specific requirement for the use of compostable packaging or through an encouragement to introduce compostable packaging for certain applications.

If a stricter approach is preferred, it could be achieved through setting a specific requirement in a form of share of multi-layer packaging that has to be compostable. However, it is important that the functionality of the multi-material flexible food packaging is maintained (e.g. no impact on food safety and hygiene). It is also important to define what compostable packaging entails and ensure that it can be effectively composted in the existing systems.

If a softer approach is preferred, the ER could encourage the use of compostable packaging where recycling or energy recovery are not possible or too costly. For example, in the UK, a voluntary collaborative agreement called UK Plastics Pact across the entire packaging supply chain was designed to address packaging waste.[56] The agreement sets a target that 70% of packaging should be recyclable, reusable or compostable by 2025.

Finally, supporting the increased awareness of the consumers of how to dispose of compostable packaging is crucial. For example, TIPA collaborates

[56] Ricardo Energy & Environment. (2019). Plastics in the Bioeconomy. ED 12430

with other brands and companies to make sure that consumers are directly aware of the product and how they are able to dispose of it. In a recent collaboration with Waitrose & Partners, a UK grocery store, one main objective was to ensure that consumers were made aware of the fact that their bananas came in an entirely compostable bag.[57]

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F.15 Closing Material Loops for Tertiary Transport Packaging (PAPACKS)

Recyclable transport packaging tray made from recycled moulded pulp

Nature of Case Study	***Switching to fully recyclable, biodegradable and compostable moulded pulp transport packaging made from recycled materials***
Packaging Sector	*Tertiary packaging (transport) for perfume flasks*
Packaging Material	*Moulded pulp*
Type of Stakeholder	*Perfume manufacturer & packaging producer*
Geographic scope	*Tray pallets are applied at COTY's factory in Cologne*
Date	*Concept was first developed in 2016, since 2018 tray pallets are integrated into the transport process*

Nature of Intervention

Efforts for minimising adverse environmental impacts of packaging were traditionally limited to consumer and retail packaging in the primary or secondary packaging sector; however, in recent years growing concerns over the environmental impacts of certain types of tertiary packaging have led companies to rethink their existing supply chains.[58] . Verghese & H. Lewis demonstrates how pursuing more sustainable packaging solutions along the value chain can be integrated into a company's production process. This is illustrated by the case study of COTY Inc, a leading perfume manufacturer. COTY shifted from an environmentally disadvantageous transport packaging solution used for the transport of perfume bottles to a more sustainable one: the PAPACKS tray pallet.

Prior to changing to the PAPACKS trays, perfume flasks were placed into transport packaging composed of two materials: first, a polymer based flat tray was used to hold the flasks in place, while a second component made out of cardboard ensured the structural stability of the transport packaging. This is illustrated in the figure 1 below. As COTY realised that this generated a large amounts of mixed packaging waste and always resulted in some of the packaging being incinerated at the end of life, its research department was tasked to search for more environmentally friendly packaging solutions. In 2016, the COTY engineering department approached PAPACKS, a sustainable packaging

[58] K. Verghese & H. Lewis (2007) Environmental innovation in industrial packaging: a supply chain approach, International Journal of Production Research, 45:18-19, 4381-4401, DOI: 10.1080/00207540701450211; accessed 29/04/2019 at https://www.tandfonline.com/doi/abs/10.1080/00207540701450211

company based in Cologne. Offering a combination of research & development, consulting services and production, PAPACKS was contracted by COTY to assess the technical feasibility of using trays based on moulded pulp. At the time PAPACKS had already worked on projects of integrating their moulded pulp technology into packaging concepts.

In a series of collaborative consultation meetings PAPACKS designed a concept tray which fit the technical requirements for transporting bottles to COTY's factory sites. As a result, they jointly developed the COTY tray pallet. As a material input for the moulded pulp, PAPACKS utilises a combination of scrap paper (including used PAPACKS trays), as well as plant based fibres from biogas plants, which are reclaimed from the solid phase of fermented residues. All the fibres originate from recycled plant residues, which can vary depending on the input composition of the biogas plant. Upon extraction, the fibres are then purified and directly utilised in the fibre casting process.

Figure 1 PAPACKS trays (left) compared to conventional packaging trays previously used by COTY (right)

The bottles are placed onto the trays, which are adjusted to each specific shape of the flasks and subsequently transported to the COTY factory sites, where the bottles are filled. Here the flasks are separated from the tray and the empty trays are brought to a shredding machine in a fully automated process. The shredded material is then used as input material for new PAPACKS trays or is fed into the recycling system as wastepaper. In this, the packaging materials continue to circulate in a closed-loop system. In principle, the trays could also be reused; in this case however, they would need to be transported back to COTY's production site. Due to the large volumes of empty trays, life cycle costing calculations suggest that it is less CO_2-intensive and more economical to shred the trays on site, press them into bales of secondary raw materials and send them back to the PAPACKS production site. This system could be further optimised by feeding the shredded tray materials into a fibre casting machine next to the shredder, from which new moulds could be produced on site. This would reduce CO_2 emissions even further and is currently considered for implementation by COTY.

The trays were integrated into COTY's production process in 2018. They are currently applied to all perfume-products in the factory site in Cologne. One of the more significant changes to the process line is the provision of trays by COTY directly to supplier of the bottles. This enables COTY to optimise the environmental impacts of the entire process chain, and results in a net decrease in contracting costs because the packaging and subsequent disposal services are directly provided by COTY. Consequentially, the successful implementation has led COTY and PAPACKS to explore expanding the packaging solution to other factory sites, thus replicating the current collaboration.

Direct integration saves additional water and CO_2. LCA calculations suggest savings of 706.97 tonnes of CO_2-eq per year by switching from PP-based trays to PAPACKS trays made from moulded pulp. For more information about the environmental benefits, please refer to table 1 below. According to production data provided by PAPACKS, the moulded pulp is also fully recyclable and compostable.

Table 1 LCA for COTY's packaging systems

Emissions per tonne of material				
Amount	Unit	Material	CO_2-eq	Unit
1	tonne	PP	1.6998	tonnes
1	tonne	PAPACKS	0.7996	tonnes
Emissions for COTY's annually required amount				
Material		CO_2-eq		
Plastic tray*		1,334.75 tonnes		
PAPACKS*		627.88 tonnes		
Savings		706.97 tonnes		

**weight of trays is comparable*

Reasons Driving the Change

At the core of the collaboration between COTY and PAPACKS was COTY's desire to redesign the packaging process in order to achieve higher standards of material efficiency and lower CO_2 emissions. COTY found that waste from packaging for transporting daily production amounted to three containers of mixed plastic waste.

From the start both COTY and PAPACKS were committed to develop more efficient transport processes, which would shift away from the use of single-use plastic material towards utilising secondary resources in a closed-loop fashion. Despite this intrinsic motivation concerns about compliance with potential upcoming legislative changes to the Packaging and Packaging Waste Directive (PPWD) also played a role in COTY's decision making. More specifically, expectations were that stricter obligations for packaging would be put in place with regards to recyclability and biodegradability.

Moreover, opportunities for cost reduction were identified and highlighted as an important reason for the implementation of moulded pulp trays in the process line. However, the savings potentials only emerged *during* the consultation meetings and subsequent design process. As such PAPACKS was able to achieve a decrease in total costs for packaging of 25%. This cost reduction stems from the reduced packaging waste and lower product cost. In addition, the potential for generating additional revenue by selling the shredded trays as secondary resources at end-of-life was highlighted.

An important factor which facilitated this change was that the PAPACKS tray could be easily integrated into the existing process line. Existing machinery, such as shredders, did not have to be specifically adjusted to the moulded pulp materials and were suitable to be used in the processing cycle of the new trays.

As the project demonstrated, the moulded pulp trays can be easily integrated into existing production lines and can have an immediate effect on the environmental impacts and further reduce packaging cost. Hence, COTY and PAPACKS both expressed that they currently strive to replicate the successful integration of the moulded pulp trays at COTY's other production sites in Europe.

Transferability to the Essential Requirements

Existing Essential Requirements by the PPWD and other legal frameworks only played a minor role in the decision making process.

The PAPACKS tray performs very well in regards to the life cycle impacts (specifically CO_2-emissions) when compared to alternatives. As of yet, life cycle assessments (LCA) are not yet integrated into the current Essential Requirements. According to PAPACKS representatives, considering the packaging's entire life cycle within the Essential Requirements would incentivise changes towards circular packaging options on a broader scale. Hence, integrating LCA results or at least some elements of life-cycle-based thinking could support the use of moulded pulp trays in the tertiary packaging segment.

However, since the PAPACKS tray is exclusively used for transporting purposes, the environmental benefit on the life cycle of the end-product (e.g. the perfume) is not immediately evident. Therefore it would be beneficial if legislators acknowledged efforts to re-design specific components of the value chain to achieve complete circularity within their processes, through either the Essential Requirements or other legislative instruments. One frequently mentioned solution was the possible introduction of a European label for sustainable packaging, which could verify both the recyclability of the product and the fact that it originates from recycled material. This could serve as an indicator for packaging which is able to accomplish circularity by leveraging demand from customers of packaging solutions.

Notably, another legislative instrument which could support the circular approach of PAPACKS would be a carbon tax paid per product; this would disincentivise the application of carbon-intensive solutions (e.g. single-use plastics) and packaging, which cannot be reused or recycled at the end of life. At the same time low-carbon solutions (e.g. packaging made from recycled materials) would gain an economic advantage. Considerations for low-carbon packaging may also be considered for the revision of the Essential Requirements and would encourage transformations across the entire packaging industry.

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Michael Laermann – Reason &Rhyme - Sustainability and Communications Consultant

Volker Maier – COTY Inc. - Chief Technology Officer

F.16 Aluminium Closures

Increase recycling potential of closures through material substitution

Nature of Case Study	Trade off of recyclability versus weight
Packaging Sector	*Primary packaging for beverages*
Packaging Material	*Aluminium*
Type of Stakeholder	*Advocacy group representing manufactures of aluminium closures and key producers of aluminium cans, foil sheets, and recyclers of aluminium*
Geographic scope	*Global*
Date	*Primary 2009 and on going*

Nature of Intervention

This case study focusses on closures of aluminium used for beverage containers and the recycling potentials of using aluminium closures compared to other alternatives, such as cork or plastic stoppers. Aluminium closures, or bottle screw caps, are made of aluminium sheets of around 0,2 millimetres, which is deep drawn and potentially lacquered with an inner liner (potentially containing aluminium foil) placed at the bottom of the cap for sealing. In general aluminium is representing 85-90 % of the weight of the closure, the remaining part is mainly made up of plastic used to seal the closure.

Aluminium closures can be used for all types of glass containers, but the main markets are for drinks (spirts, wine and water). For food products, aluminium closures are mainly used for oil and vinegar. Aluminium closures are also used for pharmaceuticals. The closing system is the most common system for spirits and for oil and vinegar, when they are marketed in glass bottles.

Aluminium closures can be used multiple times on the same bottle, but when the bottle is disposed of, so is the aluminium closure. Collection for recycling can be made both within the mixed aluminium packaging fraction or as part of the glass packaging collection stream. Typically, aluminium closures are used on glass bottles, but can in some cases also be used together with PET plastic bottles. The typical alterative is made of cork. Extraction of aluminium from the glass packaging collection stream is relatively easy and the high value of aluminium supports the economic incentives to increase recycling. As a result, separate collection systems for aluminium closures are not necessary to ensure a high recycling rate as it is for cork stoppers.

The high recycling value of aluminium provides strong incentives for the industry to improve recycling rates and recyclability of aluminium closures. A high recycling rate can namely be a strong argument for using aluminium closures instead of alternative closing systems and can improve the economic performance of the waste handling sector. Therefore, the industry is partnering with stakeholders of the aluminium value chain to increase recycling rates and ensure changes along the value chain to support increased recycling.

Figure 1 Aluminium closures for wine

One major result of this cooperation are changes in the design of aluminium closures to make them more suited for handling together with glass. Changes have included making collars longer, to ensure they are detected in the recycling process.

The collection of aluminium closures can be integrated into the collection of glass packaging waste and cooperation with the glass industry helps to facilitate synergies between recycling of glass and aluminium i.e. avoid aluminium providing difficulties in the recycling of the glass material and at the same time ensure efficient handling of the aluminium in the glass waste stream. Therefore, the industry cooperation also resulted in information campaigns like the campaign "leave the cap on", to make consumers return aluminium closures together with the bottle and avoid that aluminium closure instead are disposed of in the general waste bin have also been deployed in several countries, like Denmark, Poland, or the United Kingdom.

At last, there is a cooperation with several national packaging recovery organisations (e.g. the Green Dot) to improve collection, sorting and recycling of the closures. For example, sorting guidelines were developed to help consumers dispose of used closures in the right way depending on the local waste management system. Again, the high economic value of aluminium is the main driver to improve the recycling rates of aluminium closures.

Reasons Driving the Change

The use of aluminium closures has increased strongly over the latest 10 years and have captured market shares from traditional closure systems. The two main drivers for the development has been the lower price compared to alternatives and efforts to prevent spoilage of drinks and economic loss from drinks spoilage. For wine, the risk of wine spoilage is reduced from a loss of up to 5 % for other cork stoppers down to less than 0.5 % when using aluminium closures.

Over time environmental concerns have become a growing driver, and the high recyclability of aluminium closures is an important driver for wine producers increasing demand for aluminium closures. The importance of aluminium closures in reducing waste of food by preventing food spoilage and the environmental benefits of reduced food waste is also becoming a driver. The applicability of the product to existing waste collection streams, being it collection of aluminium packaging or as part of the collection of glass packaging also helps drive demand by wine producers.

Other drivers for the development relate to other market features, such as allowing for safety features like anti-counterfeiting, anti-refilling, tamper-evidence. It also allows for easy opening and effective reclosing without the use of any tools.

The existence of the Essential Requirements for packaging did not in itself play an important role in the adaptation of the packaging. However, the light weight and high recyclability makes aluminium closures a relevant solution to comply with the Essential Requirements and in this way, help foster an increased demand for the solution.

Transferability to the Essential Requirements

The potential for further scaling up the measure for spirts, oil and vinegar is limited as aluminium closures are already making up an important share of the total market.

For wine there is a potential for further scaling up the measure. Aluminium closures are well suited for all types of glass bottles and new application for glass bottles can increase the potential for aluminium closure. There can also be a case for increased application of aluminium closures on PET plastic bottles, where aluminium closures in some cases can be preferred for environmental reasons. The potential for aluminium closures for PET bottles is more uncertain as it's currently a less common solution.

The Essential Requirements must support a reduced overall environmental footprint and not only consider subparts of the full lifecycle. The sustainability of the packaging not only depends on the packaging design itself, but also behaviour when disposing the packaging and the infrastructure for collection, sorting and recycling. Continued work on the entire system is therefore important, which also is exemplified by the cooperation in the supply chain to improve the recyclability of aluminium closures. This could be further reflected in the Essential Requirements.

The underlying case demonstrates that if the economic value of a potential recyclate is sufficiently high, waste separation can be simplified for consumers, as the separation is economically feasible in waste treatment facilities. Economic value further provides strong incentives for industries to ensure commonality of key design features that improve recyclability of packaging.

At last, the case shows that the environmental cost of an increase in packaging weight can be offset by improvements in recyclability. Packaging design may therefore benefit of considering its environmental impact from a circular, rather than linear perspective.

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F.17 Mono-material Design (Mondi and Werner-Mertz)

Recyclable monomaterials to replace multimaterial packaging

Nature of Case Study	*Increase in recyclability and lightweighting*
Packaging Sector	*Primary*
Packaging Material	*Plastic*
Type of Stakeholder	*Packaging producer/Product Manufacturer*
Geographic scope	*Global*
Date	*2019*

Nature of Intervention

Werner-Mertz, in collaboration with packaging producer Mondi, developed a recyclable monomaterial polyethylene (PE) pouch to replace hard to recycle multimaterial bottle. Previously, the bottle was composed of a mix of PE and polyethylene terephthalate (PET) plastic which is not recycled by the majority of recycling companies. Over the past four years, this was solved by working with Mondi to develop a new monomaterial packaging solution. Werner-Mertz will introduce the new packaging to the European market in autumn 2019 and it will be used in their Frosch product line, for laundry detergent refill pouches, and for other household cleaning products. The Mondi monomaterial PE laminate used for this pouch, called BarrierPack Recyclable, has an even wider range of potential applications. With a functional moisture barrier, it can be used for dry food, food ingredients, personal care and pet care applications.

For Werner-Mertz, the objective of the packaging solution was to improve the environmental performance. The pouch not only uses 60% to 70% less material than the plastic bottle it replaces, but also has detachable decorative panels that can be fully recycled, and to a high quality. The new packaging also has a handle and no-spill out spout which are important for retaining the function of the previous bottle. Mondi had similar motivations to produce their new plastic laminate and recognises the growing demand from their brand-owner customers for more recyclable packaging. Although brand owners started to make commitments to sustainability nearly eight years ago, Mondi has only recently observed these companies making roadmaps and starting to take action.

The co-development of this new packaging solution required years of R&D and extensive communication across the entire value chain to overcome technical and economic challenges. Although the same equipment could be used to manufacture the packaging, the steps in processing had to be adjusted and made more precise. Since the new packaging only uses a single material, one layer of PE has to fuse to the other layer without deforming it. Investments were needed to fund this R&D and overcome the technical hurdles that were presented. This proved to be challenging because investors did not always share the same sustainability vision. To communicate the environmental and other benefits of the new packaging design, a short film was produced by Mondi and Werner-Mertz to educate these investors. This use of media helped to show the benefits in simple terms and proved effective.

As a brand owner, the risks associated with the new packaging for Werner-Mertz are the changes of the aesthetics and feel of the product. Brand recognition is important for consumers, and the change in look could have potential negative effects on consumer choices. It is also unknown how the new packaging will behave in full scale production and whether the same efficiency ranges can be achieved. However, the company is willing to take on these perceived risks in return for the positive environmental benefit and potential long term economic benefit.

Reasons Driving the Change

The change in packaging design was largely driven by Mondi and Werner-Mertz's shared institutional visions of sustainability. The support from the Werner-Mertz CEO and the senior management team was one of the many conditions for the success of the project. Despite the many hurdles faced throughout the process, this shared vision, combined with a clear commercial demand for more sustainable products, helped to maintain the momentum and justify the extra effort needed to overcome challenges. The commercial angle was especially true for Werner-Mertz's Frosch product line, as it is marketed as eco-friendly. Mondi sees more and more companies such as this who are making sustainability commitments. Recyclable plastics are specifically being driven by the increasing interest in the circular economy and initiatives such as the New Plastics Economy of the Ellen MacArthur Foundation.

The development of the new packaging solution required the collaboration of several different stakeholders. In the early stages, the core development team, consisting of Mondi and Werner-Mertz members, spoke to actors across the entire chain of recycling, including recycling companies, sorting companies, and resin manufacturers to discuss how the new packaging would be dealt with throughout the entire system. It was initially challenging to involve these unmotivated parties resistant to change, but was also crucial to ensure that the packaging could be, and would be, recycled within the current mechanical recycling system.

As Werner-Mertz is a medium sized company, innovation can have financial constraints, however, the capital expenditure was seen as a necessary investment. Werner-Mertz hopes that other large companies follow suit and that costs decline as sales increase. Mondi found one of the challenges to be the length of time it takes for brand owners to transition to a new type of packaging. Co-development of a new product can take years before it is introduced to the market. Mondi owes part of the wider success of the BarrierPack laminate to the winning of several awards, including the 'Best Technology Innovation in Plastics Recycling' in 2018. These awards helped Mondi to gain more attention and traction.

Transferability to the Essential Requirements

The concept of recyclable PE monomaterials can be scaled to numerous other packaging markets. Mixed PE and PET and other mixed plastics can be found in various packaging markets, and in most cases could be shifted to a monomaterial plastic without compromising functionality. Mondi has also developed a recyclable monomaterial PE pouch that has both a moisture and oxygen barrier approved for food contact, thus can also be applied in the food packaging market.

The main driver of change for Mondi and Werner-Mertz was corporate sustainability ambitions, but monomaterials could also be incentivised through policy. The current recyclability requirement of the Essential Requirements (ER) is seemingly not strong enough to trigger innovation. To create a shift to monomaterials for purer streams and increased recyclability, a firm regulatory or financial incentive is needed. The ERs could be changed to include a requirement that all plastic packaging is monomaterial, unless it is proven that multiple materials are needed for a specific function. By making monomaterial plastic the default, it would require companies to put more effort in proving the necessity of using mixed plastics, and perhaps even make them question whether monomaterial solutions are feasible and available.

However, considering the financial barriers for innovating monomaterial solutions, a financial incentive might also be needed. This could be applied through various instruments, such as EPR fee modulation to reflect recyclability or taxes on less recyclable packaging.

As was highlighted by Mondi, the definition of “recyclable” also needs to be harmonised across all Member States. Most companies operate in more than one Member State and the lack of a consistent definition complicates effective packaging design. The ERs need to thus be clearer and more specific with the definition of recyclable. When developing this definition, it is crucial to involve all actors along the packaging value chain and involve all parties from the recycling system, as highlighted by this case study.

One of the success factors was the communication between recyclers, the manufacturer, and resin producers from the outset. It is important that all parties are consulted and can agree upon a consistent and practical objective that improves recyclability in a practical sense without diminishing product protection.

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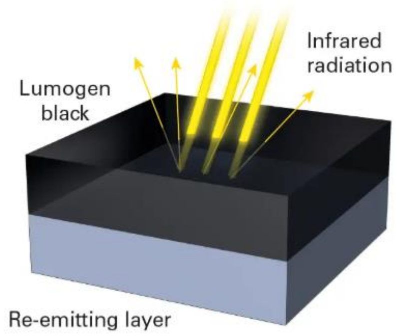
F.18 Colourants

Different approaches to replacing undetectable carbon black plastic packaging

Colourants	*Increase in recyclability (design/ manufacturing/ recycling process)*
Packaging Sector	*Food packaging*
Packaging Material	*Plastic*
Type of Stakeholders	*Packaging producer; product distributor*
Geographic scope	*Global*
Date	*2008 - ongoing*

Figure 1 Black pigments developed by BASF



Source: New Scientist, 2018.

Nature of Intervention

Black plastic is particularly common in trays used for ready meals. The black pigment most commonly used in food trays is called carbon black. This pigment does not reflect the near-infrared radiation (NIR), which is the most commonly used technology by automatic detectors to identify recyclable materials. Therefore, carbon black plastics is impossible to sort and later recycle because it is unrecognised by the commonly used sorting machines. Instead, the carbon black pigment absorbs the rays emitted by the detectors and the packaging remains undetected.[59] This means that plastics with carbon black pigment leave the sorting process classed as residue and unrecyclable material, despite being recyclable, and end up in landfill or energy recovery.

Given the ubiquity of NIR detectors in material recovery facilities and plastic recovery facilities, the undetectability of carbon black coloured plastic by them is problematic, particularly given that it is widely used in the food packaging market.

Several solutions to this situation exist:

- Invest in detectors that are capable of recognising carbon black plastic;
- Use plastics of alternative colours;
- Use black pigments that are detectable by the existing NIR technology used in material recycling sorting processes.

The first option of upgrading detectors in recycling plants is unlikely to be popular given that the detectors capable of recognising carbon black are considerably more expensive than existing NIR detectors. For instance, medium infrared spectrum (MIR) scanners cost around five times more than NIR ones.[60] Examples of the other two options are explored in this case study.

[59] Plastic Zero project 2014, 'Carbon Black Plastic: Challenges and ideas for environmentally friendly alternatives'.

[60] WRAP 2011, 'Development of NIR Detectable Black Plastic Packaging' and Plastic Zero project 2014, 'Carbon Black Plastic: Challenges and ideas for environmentally friendly alternatives'.

Using alternative colours of plastic involves several considerations on the part of the manufacturer of the final product to be packaged. On the cosmetic side, the colour of the packaging can be an important part of brand image. Changing the colour could potentially have an impact on the relationship of the consumer with the product. There are also technical elements that come into play, which should be carefully considered in any decision to change the colours of the packaging. For instance, this could be any changes in the properties of the plastic depending on its colour such as alterations to its tolerances or its propensity to shrink. However, as demonstrated by Nestle, changing the colour of the packaging is possible. For example, the company switched the colours of its noodles cups and Nescafe lids to alternatives that can be detected in sorting infrastructure and recycled.

Figure 2 Nestle products with non-black packaging

Source: EUROPEN, 2019.

Some producers will, however, prefer not to move away from black plastics completely. Black plastics are particularly appreciated by food producers because they are considered to provide a high contrast with the colour of their contents, and therefore make food more colourful and attractive. They are also effective in hiding elements of food that might be seen as undesirable, such as liquid from meat, which would be more visible in a pale-coloured tray.[61] Certain brands are keen to use black plastic because it is a colour associated with their visual identity.[62] Carbon black plastic is also relatively cheap compared to alternatives made with other colourants.[63]

Nevertheless, alternative black pigments exist. BASF produces black-coloured pigments: Sicopal and Lumogen, which have been shown to reflect near infrared rays, and therefore be detectable by NIR scanners (Figure 1). Sicopal has long been produced by BASF, particularly for use in construction materials, and it has recently been approved for food contact. Consequently, the company decided to explore its use in packaging, given its reflective characteristic. Tests with NIR scanners have found that Sicopal pigment is able to reflect infrared rays, making the black plastic package detectable by NIR scanners and ultimately recyclable. Independent tests by WRAP, a UK-based charity working in resource efficiency, described Sicopal pigment as being more economically viable for food packaging, which, due to the relatively low value of its contents, requires low-cost pigments. Nevertheless, the Sicopal pigment was estimated to cost around eight times more than conventional carbon black pigment and could add 15% to the materials cost of the packaging.[64]

Analysis of Drivers

The key driver behind both approaches for replacing carbon black plastic packaging has been its problematic recycling and the associated environmental impacts. This is in turn linked to brands' policies to improve the environmental impacts of their products and packaging and a growing consumer awareness and demand for packaging with limited negative impacts on the environment.

Regarding its decision to swap carbon black plastic for other colours of plastic,

[61] Plastic Zero project 2014, 'Carbon Black Plastic: Challenges and ideas for environmentally friendly alternatives'.

[62] Ibid.

[63] Patel, R. 2019 'Black plastic: the black sheep in the recycling industry'.

[64] WRAP 2011, 'Development of NIR Detectable Black Plastic Packaging'.

Nestle describes a process that took at least 2-3 years from the original decision to change to full implementation. The process formed part of internal goals for corporate social responsibility where Nestle wished to improve its impact on the environment. A key component of these goals was the elaboration of a 'black list' of packaging types[65] that would gradually be phased out. Given that carbon black plastic is not recyclable using NIR scanners, the company decided to use alternatives. In this sense, the decision was influenced by the fact that the vast majority of plastic sorting centres use NIR scanners, which therefore required the company to change its packaging to be detectable in such sorting centres.

The decision was also made because of a general move away from darker plastics due to their lesser value and quality when recycled. Realisation of the decision to change from carbon black plastic involved actors from the whole value chain. Part of the decision involved important discussions about the change from black to another colour of packaging that consumers may have previously associated with the colour black.

BASF report being contacted by potential and existing clients to ask about whether recyclable black plastic is possible. These businesses are searching for a black pigment for plastics that is food safe and detected by NIR scanners. Therefore, BASF sees a market demand, particularly in the food packaging sector, for a solution that allows companies to continue to use black plastic while also responding to expectations about the recyclability of plastics.

The reasons for demand from clients are multiple. Particularly important is the growing awareness and concern among consumers regarding the impact of single-use plastics on the environment. Consumers increasingly want to be able to recycle packaging materials and producers are conscious of consumers looking for icons on packaging that show that the packaging is recyclable. Some producers have also made public commitments regarding the recyclability of their packaging and need to adhere to these commitments. BASF report interest in the Sicopal pigment for markets in Europe, North America and Asia, as many clients ask for a global solution for their packaging. There is currently a drive for alternatives to carbon black in Europe, especially the UK, where a 'Plastics Pact' to only use plastics that can be sorted for recycling by 2020 was set up in 2018.[66] Even though the Sicopal pigment is more expensive than carbon black plastic (according to WRAP (2011) this could be around eight times more), BASF noted that clients are ready to pay more and appreciate the added value of the packaging being recyclable.

Transferability to the Essential Requirements

The Essential Requirements have the possibility to influence the key driver behind the move away from carbon black plastic packaging as companies employ different approaches to replace it with options that allow for the recycling of the packaging.

The Essential Requirements could be altered to ensure that black-coloured plastic is recyclable. There are two main advantages of this solution to black packaging. The first, in comparison to the replacement of black packaging with alternatives in other colours, is that it allows food manufacturers to continue to use black plastics for their packaging. This may be particularly important for certain brands that have built a strong image association with black, or producers of certain products

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[65] https://www.nestle.com/asset-library/documents/media/press-release/2019-january/nestle-action-tackle-plastic-waste-negative-list.pdf

[66] MRW 2019, 'Pact begins to banish black plastic'.

that benefit from the dissimulation properties of black packaging.

The second advantage is that it makes use of the NIR infrastructure that is already in place in most material recovery facilities and plastic recovery facilities. Given that investment in new types of detector technologies would be costly and unlikely to happen in the short term, this compatibility would allow the recyclability of black plastics to change very quickly.

Last but not least, both the recycling of black packaging made from alternative pigments to carbon black and the recycling of packaging with other colourants require well-developed infrastructure for waste collection, sorting and recycling to be in place. In the absence of a well-functioning waste management system, recyclability requirements for certain types of problematic packaging would be less effective. For instance, Nestle highlighted the necessity of appropriate recycling infrastructure in order for their packaging to actually be recycled. The company pointed out the logic that regardless of the recyclability of their packaging, it would not be recycled if the material recovery facilities do not exist or are insufficiently developed. They also noted that harmonisation at EU level between the different Member States concerning the requirements for different types of packaging could aid the recycling of products that are produced for numerous countries within the EU market.

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F.19 Testing non-intentionally added substances (BASF)

Testing non-intentionally added substances (NIAS) in plastics

BASF The Chemical Company	**Nature of Case Study**	***Elimination of substances of concern not covered by the Essential Requirements***
	Packaging Sector	*Primary*
	Packaging Material	*Plastic*
	Type of Stakeholder	*Raw Material Supplier*
	Geographic scope	*Global*
	Date	*2011*

Nature of Intervention

The chemical company BASF is a leading supplier of pigments for plastics. BASF has a large portfolio of pigments for highly sensitive applications such as food contact materials (FCM). In the past, chemical structure was one of the only decisive factors when choosing colorants for packaging. Since 2011, non-intentionally added substances (NIAS) have been included to be evaluated when considering the safety of the use of a colorant in plastics articles. NIAS are chemicals that are present in FCM but have not been purposely added during the production process. They can be grouped in to the categories of side products, breakdown products, and contaminants. Since these substances can migrate into food and have unknown risks, they have been regulated to ensure consumer safety.[67] In 2011, the EU introduced NIAS into the Commission Regulation (EU) No 10/2011 which requires FCM manufacturers to ensure the NIAS safety of their products.

As a pigment producer, BASF was obliged to comply with these regulations as of 2011. They perform extensive safety testing and have invested significant resources to comply with the standards set in the EU regulation.

BASF plays an important role with NIAS safety because they are very upstream in the plastic production process. It is important that they produce as pure and stable a pigment as possible so that their downstream customers' packaging is compliant as well. Their role has become even more critical with increased recycling ambitions. Stable and durable pigments are needed so that they do not degrade and produce NIAS during the recycling process. If recycled plastic is to be used for food

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[67] Food Packaging Forum, *Non-intentionally added substances,* https://www.foodpackagingforum.org/food-packaging-health/non-intentionally-added-substances-nias

contact, this material still needs to be NIAS compliant for its second life before it can be put on the market. If not, it can only be used in less sensitive applications that do not involve food contact.

Reasons Driving the Change

The main driver for BASF to start NIAS testing was the policy established in 2011. In addition, BASF started NIAS testing because customers wanted better and purer products for processing. In the past, regulations have changed quite regularly, so many of these companies want to also be prepared for change in future regulations.

Transferability to the Essential Requirements

NIAS testing is most relevant to food packaging because this is the area of greatest concern. One could argue that NIAS testing could also be relevant to other packaging markets such as personal care and cosmetics as these products come in close contact with the skin and body.

NIAS could be added to the Essential Requirements (ER) in the same way that hazardous and noxious substance are to be minimised with regard to their presence in emissions, ash or leachate when landfilled or incinerated. NIAS, however, are more relevant for recycling than for incineration or landfilling.

The ER's could include that FCM should be recyclable to a degree that it retains all FCM requirements, including NIAS requirements. This would mean that all food packaging would need to be recyclable to a high enough quality to be compliant again to be used in food packaging. The addition of this requirement would stimulate recycling of materials to a high quality rather than a downgrading of materials. The limitation here would be the technical feasibility of such a requirement.

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Gwendoline Riou- EU Public Affairs and Communications Manager - EUROPEN

F.20 Increasing recycled content (Mars)

Introducing more recycled content into secondary packaging

MARS		
	Nature of Case Study	***Use of recycled content***
	Packaging Sector	*Secondary/ transportation packaging for food*
	Packaging Material	*Paper and board, plastic*
	Type of Stakeholder	*Manufacture and packaging producer*
	Geographic scope	*Global*
	Date	*Mid 1990s – 2012/2013, ongoing efforts to optimise recycled content*

Nature of Intervention

This case study focuses on the recycled content for food and drinks packaging. The study presents Mars efforts to optimise the recycled content in its secondary packaging.

Since mid-1990s, Mars has been striving to optimise the amount of recycled content in its secondary/transportation packaging for food products. This applies for the paper and board packaging as well as some plastic packaging that is not directly in contact with food. Mars does not use recycled content for the plastic-based materials that are not yet approved for food contact use.[68]

Mars uses secondary packaging for their food products (e.g. chocolate bars) and pet care products. The main purpose of the secondary packaging is to protect the product and its primary packs, ensuring that the product reaches the costumer in the best condition possible. Thus, ensuring the same functionality of the packaging with the recycled content may lead to a heavier packaging comparing to the packaging made from virgin materials. In 2012/2013, the company reached the maximum of recycled content (around 95%) for their paper and board packaging.

One of the initial challenges with introducing more recycled content was a lack of high-quality recycled input material. However, the availability of recycled input has increased with the time. Another important aspect of ensuring success of such packaging is that it could be produced as well as labelled on the same type of machineries as the conventional pack would. This was also the case for Mars. In addition, it was important to ensure that the print quality is similar to conventional packaging to ensure that the packaging is attractive to customers.

Figure 1 Example of Mars secondary packaging (to be confirmed)

[68] In the EU, the European Food and Safety Authority (EFSA) issues scientific opinions on whether the recycled materials can be used in contact with food without posing health concerns, on the basis of Regulation (EU) No 282/2008.

Reasons Driving the Change

One of the main drivers for introducing more recycled content in their packaging was the market forces (i.e. competition and price) and the desire to stay at the leading-edge of technology and material design. An important aspect of staying ahead was optimising the resources used as well as sustainability of their packaging, focusing on material use, resource efficiency, recycling and others. To be pioneers in sustainable packaging, they decided to increase the recycled content of their packaging. In addition to that, in 2008 the company introduced the objectives of reducing materials, using as much recycled content as possible and rethinking the design of packaging. To achieve this, Mars collaborates through European Organization for Packaging and the Environment (EUROPEN) across the supply chain to improve the sustainability of their packaging.

The existence of Essential Requirements further facilitated the optimisation of the packaging, in terms of size, fill, space, etc.

Overall, the use of recycled content is a common practice for the paper and board packaging, as it makes economic sense for the companies. However, there are still a number of risks that can undermine the use of recycled content in paper packaging in the future. One of the risks is the quality of recycled paper materials available due to presence of mineral oil. Mineral oil can be found in newspaper and magazine print (in mineral oil-based inks) and it is started to be recognised as a substance of concern. In 2012, EFSA stated that mineral oils are common and can come from various sources. It also emphasised that exposure to mineral oils (MOSH and MOAH) are of potential concern.[69] The restrictions placed on existence of mineral oil could limit the amount of recycled content that can be used in packaging in the future. To avoid any potential contamination with mineral oil, Mars does not use the recycled materials for primary packaging that is in direct contact with food.

In terms of use of recycled plastics in packaging, the same challenge of contamination of food is prominent. The safety assessment of recycled content in packaging that comes in direct contact with food should be performed.

Transferability to the Essential Requirements

One of the main challenges in scaling-up the use of recycled content is within the plastic packaging, especially within the primary food packaging. The main challenge there is that there are restrictions on what can be used for packaging that comes in contact with food. This is done to ensure hygiene and food safety. Mars is actively working on finding new technologies to increase the recycled content within plastics. This is done through collaboration with different stakeholders throughout the supply chain. The main forum for this collaboration is provided by the EUROPEN, where organisations can come together and discuss the challenges and solutions to address them.

In terms of paper and board packaging, the market forces have supported the introduction of recycled content, and as such, it may not be needed to introduce a strict requirement for recycled content into the Essential Requirements. In addition to that, the potential challenge of food safety and hygiene may play a crucial role in determining what type of recycled input material can be used in packaging. However, if a strict approach is preferred,

[69] EFSA's Scientific Opinion on Mineral Oils Hydrocarbons in Food (2012), link.

the requirement of recycled content should be used for secondary and tertiary packaging and should strive the balance between recycled content and functionality of packaging. For some paper-based packaging that require strength, e.g. paper sacks, significant amount of virgin fibre, if not 100%, is needed. Thus, the requirement should not be applicable for all packaging and should take into account the functionality of the packaging. Another potential approach could be to encourage 'as much as possible recycled content' within different materials and packaging types. Here, particular role could play the EUROPEN, which brings different stakeholders together. Through EUROPEN forum, a better understanding of where recycled content can be maximised could be achieved.

Rethinking the design of packaging could also be encouraged by the Essential Requirements. The specific timeframes could be established for when the packaging that is placed on the market should be reviewed. This would encourage brands and retailers to re-evaluate their packaging taking into account the use of recycled content and other relevant criteria.

Mars principles are fully aligned with the Essential Requirements. The company closely follows the requirements set-up in the Packaging and Packaging Waste Directive. One of the main areas for improving the Essential Requirements identified by the company is their enforcement. As Mars is driven by market forces, enforcement of the requirements becomes crucial for them. The company is competing with other brands in terms of the size of a product, attractiveness of the packaging, etc. In this case, a larger size of packaging may look as there is more product, and as such can undermine the competition. If there are companies that do not adhere to Essential Requirements, it can undermine the ones that do and their ambition towards improving sustainability of their packaging. Thus, enforcement of the Essential Requirements becomes an important aspect.

In the UK, Denmark and Czech Republic, authorities have issued some guidance documents on enforcement of the Essential Requirements. In the UK, the Guidance Tool for Enforcement Officers was developed to assess whether a packaging/company is compliant with the requirements on minimising packaging, re-use and recovery, and presence of hazardous substances. The tool provides the Enforcement Officers with the process for assessing compliance by providing relevant questions that help to obtain the necessary information on compliance and help to make an assessment. The effectiveness of this approach could be further explored and potential for scaling up to other countries assessed.

References

Interview with Mars

Interview with EUROPEN

EFSA's Scientific Opinion on Mineral Oils Hydrocarbons in Food (2012), link.

EUROPEAN: https://europen-packaging.eu/

Mars sustainable packaging: https://www.mars.com/sustainability-plan/healthy-planet/sustainable-packaging

Mars website and internal presentation provided: https://www.mars.com/

The Packaging Essential Requirements Regulations (PERR) Guidance Tool for Enforcement Officers, UK

Appendix G Case Studies for Options Appraisal

G.1 Methodology for calculating environmental impacts of packaging

Life Cycle Assessments (LCA) were performed to quantify the environmental impacts of different types of packaging considered in the case studies. Elements of the Product Environmental Footprint (PEF) method of the European Commission were used where relevant.[1,2] For more information on the PEF method see *Task 3 D.4 Product Environmental Footprint Method (PEF) in Appendix F*. The PEF method builds upon the ILCD (International Reference Life Cycle Data System) Handbook and was tested in the pilot phase from 2013-2018. The LCA studies were modelled in the LCA software SimaPro 9.0. The impact assessment element of the PEF method was used as implemented in SimaPro "EF method (adapted)". The most important methodological choices are described below.

Comparison of packaging baseline and alternative

When choosing the baseline and alternative packaging, a search for packaging types with identical functions was done to make a fair comparison. If the functions differ slightly, this is mentioned in the case study.

To quantify the environmental benefits of the alternative packaging compared to the baseline packaging, a simplified LCA approach was used that focused on the life cycle stages where the two packaging types differ the most. Figure A-1 shows how this approach works for the example of flexible plastic stand up pouches. In this example, only the environmental impact of raw material production and the end-of-life treatment were quantified and compared since these are the life cycle stages that differ. The difference in packaging manufacturing was considered negligible in all case studies as the environmental impacts of manufacturing versus raw material production is typically small.

Figure A-1 Example lifecycle of baseline and alternative flexible plastic stand up pouches. Check marks indicate differences between the baseline and alternative and x's indicate no or negligible differences.

STAGES	Raw Material Production	Packaging Manufacturing	Use	Collection and Transport	End-of-life
Baseline	PET, PE				90% incinerated 10% landfilled
Alternative	PE				70% recycled, rest 90% incinerated 10% landfill
Environmental Impact Difference	✓	X	X	X	✓
Cost Impact Difference	✓	X	X	X	✓

Data collection

Activity data, e.g. the amount and type of materials used, were obtained in interviews with packaging producers, retailers using the packaging, and through statistics and literature.

Activity data was linked to data from databases to model the life cycle and to calculate the related emissions and resource use. For most processes, we used the Ecoinvent database as these data are of good quality and are generally representative for Europe. Using one database consistently also ensures that the same methodological choices are made throughout the case studies. The specific datasets used are provided in each case study.

European specific Ecoinvent processes were selected where possible, either RER (Europe), Europe without Switzerland, or Switzerland (CH).

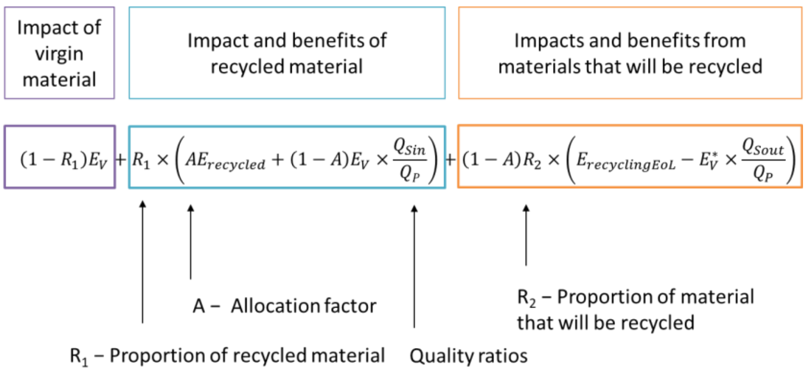
<u>Allocation of environmental impacts from waste treatment</u>
Waste treatment processes, like recycling and incineration with energy recovery, are typically processes that belong to two product life cycles. The recycling process belongs both to the packaging that is being recycled and to the product life cycle using the recycled material as an input. Incineration with energy recovery belongs to both the packaging that is being incinerated and to the use of the energy generated. There are different allocation approaches to split the environmental impact of the recycling process between the two life cycles with different rationales behind these approaches. The choice of allocation is very important because it can strongly influence the results. Waste treatment is also a very important life cycle stage for the case studies we conducted.

The PEF method of the European Commission includes the Circular Footprint Formula (CFF) and addresses the allocation of end-of-life processes. The CFF has been extensively discussed, and has been agreed upon following discussions with a large number of stakeholders in recent years. This formula was, therefore, used in the case studies.

Figure A-2shows the material part of the CFF. The environmental impacts and benefits of recycling are divided by the packaging that is being recycled and the product life cycle that uses the recycled material. Allocation includes the following factors:

- A general allocation factor (A) which depends on the market situation, i.e. is there a large demand and low supply of recycled materials or the other way around, or an equilibrium;
- The ratio between quality of outgoing secondary material and quality of primary material (Q_{Sout}/Q_p);
- Avoided use of virgin material.

Figure A-2 Circular Footprint Formula - Materials



Parameters of the CFF - Material:

A: allocation factor of burdens and credits between supplier and user of recycled materials
Q_{Sin}: quality of the ingoing secondary material
Q_{Sout}: quality of the outgoing secondary material
Q_p: quality of the primary material, i.e. quality of the virgin material
R_1: the proportion of material in the input to the production that has been recycled from a previous system
R_2: the proportion of the material in the product that will be recycled (or reused) in a subsequent system
$E_{recycled}$: specific emissions and resources consumed arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation processes
$E_{recyclingEoL}$: specific emissions and resources consumed arising from the recycling process at end of life (EoL), including collection, sorting and transportation processes
E_v: specific emissions and resources consumed arising from the acquisition and pre-processing of virgin material
E^*_v: specific emissions and resources consumed arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials

Default values as provided in Annex C of the PEFCR Guidance 6.3 were applied per material type (https://ec.europa.eu/environment/eussd/smgp/PEFCR_OEFSR_en.htm). Table A-6 shows the default values used in the case studies. $E_{recycled}$, $E_{recyclingEoL}$, E_v and E^*_v are taken from Ecoinvent; specific processes used are indicated in the case studies.
Recycling rates at end-of-life (R2) vary per case study and argumentation is provided per case study. The following main rationale is used, but deviations are possible per case study:

- Packaging that is designed for recycling is assumed to be recycled 70% at end-of-life, because it is a high recycling rate and 100% is not considered feasible in 2030. For one case study (moulded pulp fibre), an 85% recycled rate was assumed for the recyclable packaging because this is the 2030 recycling target;

- Packaging that is not designed for recycling is assumed to be recycled by the 2030 recycling rate targets as included in the Packaging and Packaging Waste Directive (PPWD), except when the packaging is very difficult to recycle (e.g. multilayer materials). Recycling rates of PPWD: 55% for plastics, 30% for wood, 80% for ferrous metals, 60% for aluminium, 75% for glass, and 85% for paper and cardboard.

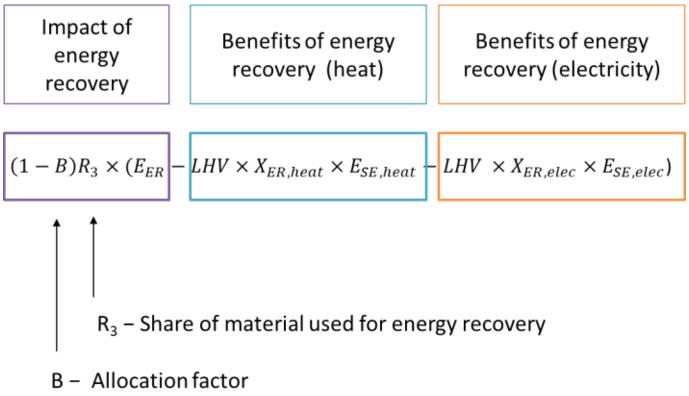
Table A-6 Overview of default values for the CFF used in the case studies (Materials)

Packaging material	A	R1	R2	Q_{Sout}/Q_p	Q_{Sin}/Q_p
High density polyethylene (HDPE)	0.5	0	Varies per case study	0.9	0.9
Low density polyethylene (LDPE)	0.5	0	Varies per case study	0.75	0.75
Polyethylene terephthalate (PET)	0.5	0	Varies per case study	0.9	0.9
Polypropylene (PP)	0.5	0	Varies per case study	0.9	0.9
Cardboard	0.2	Varies per case study	Varies per case study	1	1

Expanded polystyrene (EPS)	0.5	0	Varies per case study	0.9	0.9
Recycled polypropylene (rPP)	0.5	1	Varies per case study	0.9	0.9
Polyvinyl chloride (PVC)	0.5	0	Varies per case study	0.9	0.9

Figure A-3 shows the energy part of the CFF. The full environmental impact and benefit (avoided energy generation) of the incineration process are allocated to the packaging being incinerated. Using the information from Annex C of the PEFCR Guidance 6.3, all incineration in Europe makes use of energy recovery.

Figure A-3 Circular Footprint Formula - Energy



Parameters of the CFF - Energy:

B: allocation factor of energy recovery processes: it applies both to burdens and credits. B is zero by default for current PEF studies.

R_3: it is the proportion of the material in the product that is used for energy recovery at EoL.

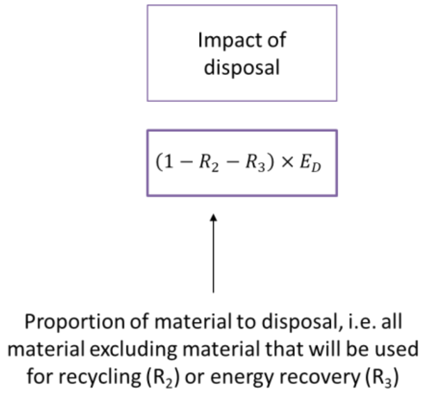
E_{ER}: specific emissions and resources consumed arising from the energy recovery process (e.g. incineration with energy recovery, landfill with energy recovery, …)

$E_{SE,heat}$ and **$E_{SE,elec}$:** specific emissions and resources consumed (per functional unit) that would have arisen from the specific substituted energy source, heat and electricity respectively

$X_{ER,heat}$ and **$X_{ER,elec}$:** the efficiency of the energy recovery process for both heat and electricity

LHV: Lower Heating Value of the material in the product that is used for energy recovery

Figure A-4 Circular Footprint Formula - Disposal



Parameters of the CFF - Disposal:

R_2: the proportion of the material in the product that will be recycled (or reused) in a subsequent system

R_3: the proportion of the material in the product that is used for energy recovery at EoL

E_D: specific emissions and resources consumed arising from disposal of waste material at the EoL of the analysed product, without energy recovery

Waste disposal in Europe in 2030 was modelled as follows:

- **Incineration/landfill ratio:** the 2030 targets of the revised legislative proposal on waste were used: 10% landfill and 90% incineration for all waste that is not being recycled.
- **Environmental impact of landfilling:** The environmental impacts of landfilling were modelled by using Ecoinvent landfilling processes for specific materials. These processes all represent the situation in Switzerland; European landfilling processes are not available. These processes assume that there is a landfill gas and leachate collection system.
- **Environmental impacts of incineration:**
    - ***Impact of incineration:*** The environmental impacts of incineration were modelled using Ecoinvent datasets on incineration processes for specific materials.
    - ***Benefits of energy recovery:*** According to Eurostat, nearly all waste incineration facilities recover energy. Based on the Circular Footprint Formula, the benefits of energy recovery from waste incineration (avoided energy generation) should be allocated to the product life cycle that provides the waste. The net energy produced during waste incineration, and the related environmental benefits, were taken from Ecoinvent datasets for specific materials, as different materials generate different amounts of energy and emissions. For the incineration of all plastics studied, Ecoinvent assumes a gross electrical efficiency of 15.84% and gross thermal efficiency of 28.51%. The equivalent values for wood are 13% and 25.6%. In all cases of disposal, a default value of B=0 was used and 100% of benefits from energy recovery generated by incineration were allocated to the packaging (i.e. was credited with displacing electricity and heat). The Ecoinvent process for heat chosen was *Heat, district or industrial, natural gas {RER}| market group*. For heat, there is no average European fuel mix in Ecoinvent, thus 100% natural gas is assumed since this is the dominant heating fuel used in Europe. For electricity, an electricity mix was created that is assumed to replace the electricity

generated by waste incineration in 2030. The mix represents an emission factor for climate change of 150 gCO_2e/kWh.

Environmental impact assessment method

Emissions and resource use were translated to impact categories by applying the recommended impact assessment methods of the Environmental Footprint method. The impact assessment methods of the PEF method 2.0 were used as implemented in SimaPro "EF method (adapted)". These impact assessment methods are considered to be state-of-the-art approaches. As impact assessment methods are still under development, the PEFCR Guidance 6.3 indicates the robustness of the various impact assessment methods, ranging from I (robust) to II and III (less robust/interim).

To simplify the interpretation of the results, we report a subset of impact categories in the case studies, as shown in Table A-7. This subset represents the most relevant impact categories for the studied packaging materials. The most relevant impact categories were selected by calculating the weighted environmental impacts for all packaging materials studied, and by selecting the 8 impact categories with the highest score. The normalisation and weighting sets that were used were the ones as recommended by the PEF method (see PEFCR Guidance 6.3, Annex A), and as applied in SimaPro. Please note that the weighting was done considering *all* impact categories that are a part of the PEF method, thus the weighting factors in the table do not sum to 100. For each case study, the robust impact categories are highlighted orange in the result graphs, the less robust/interim ones are presented in grey.

Table A-7 Overview of default values for the CFF used in the case studies (Weighting Factors)

Impact category	Indicator	Unit	Recommended default LCIA method	Source of characterization factors	Weighting Factors
Climate change	Radiative forcing as Global Warming Potential (GWP100)	kg CO_2eq	Baseline model of 100 years of the IPCC (based on IPCC, 2013)	EC-JRC, 2017	21.06
Particulate matter	Impact on human health	disease incidence	PM method recommended by UNEP (UNEP 2016)	EC-JRC, 2017	8.96
Photochemical oxidant formation	Tropospheric ozone concentration increase	kg NMVOC eq	LOTOS-EUROS model (Van Zelm et al, 2008) as implemented in ReCiPe 2008	EC-JRC, 2017	4.78
Human health (non-cancerous)	Comparative Toxic Unit for humans	CTU_h	USEtox model (Rosenbaum et al, 2008)	EC-JRC, 2017	2.13
Human health (non-cancerous)	Comparative Toxic Unit for humans	CTU_h	USEtox model (Rosenbaum et al, 2008)	EC-JRC, 2017	1.84

Impact category	Indicator	Unit	Recommended default LCIA method	Source of characterization factors	Weighting Factors
Land use	Soil quality index	Dimensionless (points)	Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)	EC-JRC, 2017	7.94
Water use	User deprivation potential (deprivation-weighted water consumption)	m^3 world eq	Available WAter REmaining (AWARE) as recommended by UNEP, 2016	EC-JRC, 2017	8.51
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)	MJ	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002	EC-JRC, 2017	8.32

References

1. Product Environmental Footprint (PEF) Guide and Organization Environmental Footprint (OEF) Guide (2013). *2013/179/EU Commission Recommendation of 9 April 2013 on the use of common methods to measure and communicate the life cycle environmental performance of products and organizations*

2. Product Environmental Footprint Category Rules Guidance. Version 6.3 - May 2018

G.2 Case Studies Relating to Recyclability

G.2.1 Solutions for increasing the recyclability of flexible pouches

Nature of Case Study	***Recyclability***
Packaging Sector	*Primary*
Packaging Material(s)	*Plastic*

Introduction

The use of flexible packaging in Europe has increased across several sectors in the past years. Stand up pouches, which represented 8% of flexible packaging in 2018, saw a growth of 13% between 2006 and 2018, amounting to 23.6 billion units consumed in Europe.[1] Most of these pouches are composed of several material types and/or layers, with each layer serving a different function such as a moisture or oxygen barrier. Although multilayer packaging can enhance functionality, it is difficult to recycle due to both technological and economic constraints of separating these materials at the end-of-life. As a result, the majority of multilayer packaging is currently incinerated or landfilled in the EU.

The recyclability of flexible packaging could be increased in two ways:

1. **By a change in product design:** Designing mono-material packaging will lead to more homogenous waste streams which can be recycled in existing (mechanical) recycling facilities. With mechanical recycling, the polymer waste is physically processed by shredding, solving, or melting.
2. **By a system change:** Making chemical recycling an integral part of waste treatment within Europe. With chemical recycling of multilayer packaging, the polymer is turned back into its hydrocarbon component or monomer and can be used as a raw material to produce new polymers.

Mechanical recycling is much more prevalent than chemical recycling; for reference, in Germany in 2015 only 1.7% of packaging waste was chemically recycled whereas 39.4% was mechanically recycled (the remaining 58.8% incinerated for energy recovery). Although innovative chemical recycling solutions are progressing, most technologies have not yet been implemented at commercial scale. [2] As mechanical recycling of flexible mono-material pouches can be applied at large scale in the short term, this case study explores the environmental and cost impacts of changing the product design by shifting from mixed material to more easily recycled mono-material flexible packaging.

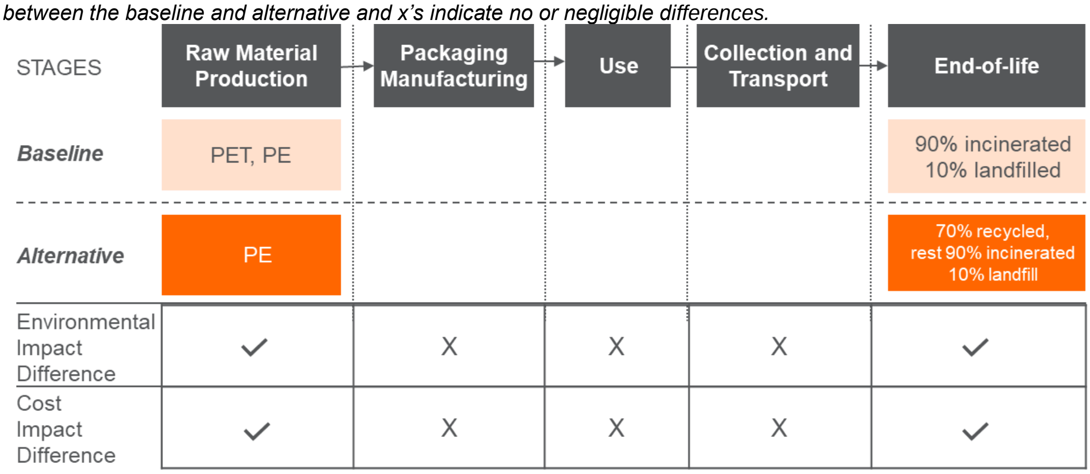
Lifecycle

A flexible laundry detergent stand up pouch is chosen as the type of packaging to study. The following two packaging types are compared:

Packaging	Description
Baseline	Multi-material laundry detergent flexible pouch consisting of two types of plastic: polyethylene (PE) and polyethylene terephthalate (PET).
Alternative	Mono-material PE laundry detergent flexible pouch, as highlighted in the Mondi/Werner-Mertz case study. (*reference to task 3 Mondi and Werner-Mertz case study in Appendix F)*.

The lifecycles of the two packaging types are very similar but differ in the raw material production and end-of-life (see Figure A-5). The baseline packaging requires both PE and PET production whereas the alternative only requires PE. Although the packaging is manufactured using slightly different processes (e.g. mono-material packaging has tighter temperature windows in production and does not require a lamination step, avoiding the use of solvents) it is assumed that the differences in manufacturing are negligible within the entire lifecycle. Similarly, differences in packaging weights are considered to have a negligible impact on collection and transport for disposal. The significant difference of lifecycles is the end-of-life; due to its difficulty to recycle, the multi-material packaging is assumed to be disposed of as other non-recycled municipal solid waste based in 2030 targets as included in the revised legislative proposal on waste (10% landfilling and 90% incineration with energy recovery). Since the alternative is mono-material and more easily recycled, it is assumed to be recycled at a rate of 70%.

Figure A-5 Lifecycle of baseline and alternative flexible plastic stand up pouches. Check marks indicate differences between the baseline and alternative and x's indicate no or negligible differences.



Methods

A simplified LCA was performed to quantify the difference in environmental impacts between the two packaging types. The LCA focused on the life cycle stages where the two packaging types differ the most, i.e. where the largest differences in environmental and cost impacts are expected.

The functional unit was one use of a laundry detergent stand up pouch, from raw material production to end-of-life.

Data and assumptions

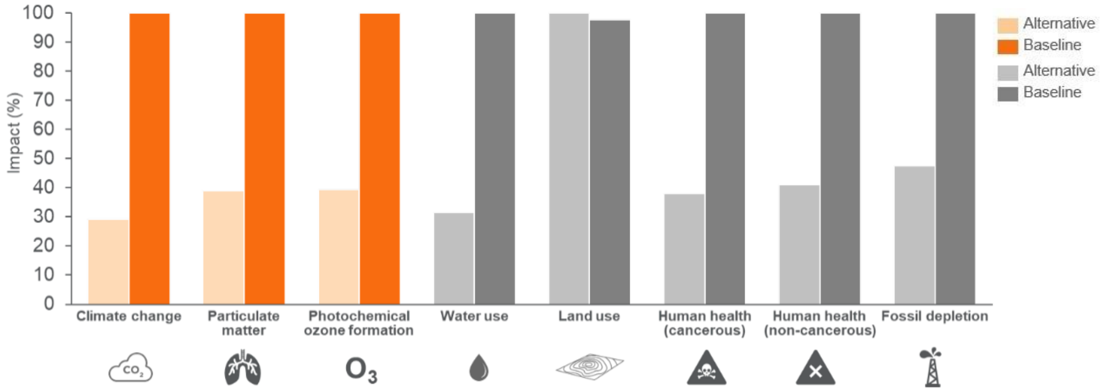
Packaging	Parameter	Data input	Data source/ assumption
Baseline	Weight	22.5 g	Interview packaging producer[4]
	Material composition	19.8 g virgin LDPE 2.7 g virgin PET	Interview packaging producer[4]; Ecoinvent data of 1) PE, low density, granulate, production {RER} 2) PET, granulate, amorphous, production {RER}
	End-of-life treatment	90% incineration 10% landfilling	Revised legislative proposal on waste; Ecoinvent data of 1) incineration waste PE {CH} 2) sanitary landfill waste PE {CH} 3) incineration waste PET {CH} 4) sanitary landfill waste PET {CH}
Alternative	Weight	12.4 gram	Interview packaging producer[4]
	Material composition	12.4 g virgin HDPE	Interview packaging producer[4]; Ecoinvent data of 1) PE, high density, granulate, production {RER}
	End-of-life treatment	70% recycling	Assumption; Ecoinvent data PE, high density, granulate, recycled {Europe without Switzerland}

Environmental Impacts

The alternative mono-material packaging performs better than the baseline in all of the studied environmental impact categories except for land use (see chart below). However, the absolute impact value for land use is so small when the impact categories are weighted that this difference is negligible. In terms of climate change, the mono-material packaging results in a 71% reduction in greenhouse gases (GHGs), or 68.5 gCO_2eq per laundry detergent pouch. This is primarily due to the alternative packaging being recycled at a rate of 70% at the end-of-life. Although recycling requires energy and other inputs, these impacts are less significant than the avoided impacts from the production of virgin plastics. The impacts of recycling are also far lower than the GHG impacts of incinerating or landfilling the pouches. The energy produced from the incineration of the baseline multi-material packaging does displace partially fossil based heat and electricity, but also emits 2-3 $kgCO_2eq$ when combusted since it is a petroleum-based product. Similarly, for fossil resource depletion, the alternative performs better because of the virgin plastics avoided by recycling the pouch.

The alternative also has a better performance in human health for the same reasons as GHG emissions. Since the production of plastics has negative impacts on human health, the recycling of the alternative prevents the production of virgin plastics. The partial incineration of the baseline plastic pouch also contributes to its higher impact in this category, but to a lesser extent than production of the plastic. Lastly, the alternative packaging performs better in particulate matter with a 61% reduction because of the (partially) avoided virgin HDPE production considered from recycling of the pouch.

Figure A-6 Environmental impacts of baseline and alternative packaging. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Cost Impacts

Manufacturing costs

- **Equipment costs**: The costs for new equipment would depend on the technology used for the mono-material packaging. According to the industry, in most cases new equipment does not need to be purchased as the processing of multi-material and mono-materials are fairly similar. Process parameters with existing equipment can be modified. For example, mono-material pouches require a different film recipe with a narrower temperature and production window, but only require more precise control of existing equipment. This means that equipment costs would be largely unaffected by this switch in packaging.
- **R&D**: There would also be costs associated with R&D of new mono-material packaging for the packaging manufacturer or designer. For example, packaging producer Mondi had to find investors to fund the R&D of their mono-material PE Barrier Pack technology.

Industry experts have commented that there is currently a price premium for mono-material packaging. Although an exact cost difference could not be provided, it is less than double the costs of conventional multi-material pouches. However, they believe that that costs are likely to reduce as production scales from this currently niche market of sustainable brands to more mainstream and higher volume production. It might be noted that depending on how Member States choose to modulate fees under EPR, a higher price for mono-material pouches might be offset somewhat by lower fees paid by users.

Logistics costs

Since the baseline and alternative packaging are the nearly same weight and the same volume, there is no significant difference in costs for logistics or transport.

End-of-life treatment costs

The EU-28 average annualised capital and operational landfilling costs for waste management companies is €34.30 per tonne of waste treated. For incineration with electricity and heat recovery, it is €129 per tonne, with a profit of €28 per tonne from electricity production, resulting in net costs of €101 per tonne.[5] The net cost for recycling plastic is likely to be several hundred euros per tonne, however, this number can vary because the selling price of recycled plastics will differ depending on the quantities processed and the quality of the recycled plastic produced, so it is not possible to estimate an actual figure with the available data.

Since landfilling is cheaper than recycling, switching from the baseline to alternative packaging in a Member State (MS) still treating some or most waste by landfilling could raise costs for disposal. But in a MS with mostly incineration, switching from incineration to recycling would not have a large increase in waste treatment costs. However, the price of plastic waste is likely to be more volatile since it depends on the supply and demand of plastic waste material as well as crude oil prices (since this influences the price of the virgin plastic), and electricity and heat prices are likely to be more stable.[6] This means that the net costs of recycling are consequently more volatile than net costs of incineration.

Conclusions

Environmentally, the mono-material packaging is a better alternative than hard to recycle multi-material packaging. The mono-material packaging is more beneficial in all examined environmental impact categories (except for land use, but the absolute impact when weighted is negligible), with the greatest benefits in climate change, water use, and cancerous human health.

If mono-material packaging replaced all flexible stand up pouches in the EU consumed in 2030 (assuming a continued growth rate of stand-up pouches of 1% from 2018-2030, and 70% recycling achieved), this would translate into 1.82 Mt of greenhouse gas savings. This impact could be even greater if extended to mixed materials other than stand up pouches, which only represent a small part of the flexible packaging market and an even smaller part of mixed material packaging market. It is important to note that a laundry detergent flexible pouch does not have humidity or oxygen barriers, thus is one of the simpler applications to switch from multi to mono-material. There are much larger technological hurdles for switching retort pouches (food packaging made from a laminate of flexible plastic and metal foils), for example, to mono-materials.[4]

Switching from multilayer to mono-material pouches may have a small cost impact for packaging manufacturers, which could then be passed onto retailers and ultimately consumers. However, as the use of mono-material packaging increases, the costs are likely to fall.

References

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2. Kaiser, K. et al. (2018). Recycling of Polymer-Based Multilayer Packaging: A Review. https://doi.org/10.3390/recycling3010001
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4. Personal communication with monomaterial packaging producer.
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G.2.2 Solutions for increasing the recyclability of black plastic

Nature of Case Study	*Recyclability*
Packaging Sector	*Primary*
Packaging Material(s)	*Plastic*

Introduction

Black plastic packaging is most commonly used in food packaging as it can mask colour and imperfections and provide a high contrast to make food more colourful and attractive. However, black pigments can also negatively affect the recyclability of the plastic. The conventional carbon black pigments used to colour the plastic gives very little radiation and the plastic is subsequently unsortable by Near Infrared (NIR) technology that is widely used in material recovery facilities. Since such black plastic has not, thus far, been sorted from mixed streams, the majority of it has instead been landfilled or incinerated. In UK alone, it is estimated that households dispose of 30,000-60,000 tonnes per year of black plastic packaging.[1]

The recyclability of black plastic packaging could be increased in two ways:

1. **By a change in product design:** Designing pigments that are detectable by NIR can ensure that black plastics can be properly sorted with current plastic recycling technologies. Alternatively, different coloured plastics that are detected by NIR could instead be used.
2. **By a system change:** Upgrading detectors in recycling plants that can detect carbon black such as medium infrared spectrum (MIR) scanners, digital watermarking e.g. Holy Grail Project (see Section 5.5 of the main report).

MIR scanners cost around five times more than NIR ones, so it is unlikely that recycling facilities will invest in these without subsidies.[1] Black pigments that are detectable by NIR are already commercially available and are produced by companies such as BASF and Colour Tone, so this change in product design is more probable. This case study will thus explore the environmental and cost impacts of shifting from conventional carbon black pigments to alternative black pigments that are detectable by NIR.

Lifecycle

A common application of black plastic in packaging is for food contact trays, so this is chosen as the product to study. The following two packaging types are compared:

Packaging	Description
Baseline	Black plastic food tray with carbon black pigment
Alternative	Black plastic food tray with pigment detectable by NIR

The lifecycles of the two packaging types are very similar and only significantly differ in the end-of-life (see Figure A-7). Raw material production is different for carbon black pigments and alternatives. For example, BASF's Sicopal pigment is an inorganic pigment that uses metal oxides and reactions are performed at lower temperatures than carbon black pigments. However, pigments are only roughly 0.5% of plastic packaging, so this difference in pigments is considered to be negligible in the total product and its entire lifecycle (*reference to task 3 BASF case study, there are 2, not NiAS study in Appendix F)*. At the end-of-life, it is assumed that the baseline packaging cannot be sorted for plastic recycling and is instead disposed of as other non-recycled municipal solid waste based on 2030 targets as included in the revised legislative proposal on waste (10% landfilling and 90% incineration with energy recovery). Since the alternative black plastic trays can be properly sorted, they are assumed to be recycled at a rate of 70%.

Figure A-7 Lifecycle of baseline and alternative black plastic food trays. Check marks indicated differences between the baseline and alternative and x's indicate no or negligible differences.

STAGES	Raw Material Production	Packaging Manufacturing	Use	Collection and Transport	End-of-life
Baseline	C-PET Carbon black pigment				90% incinerated 10% landfilled
Alternative	C-PET Alternative pigment				70% recycled, rest 90% incinerated 10% landfill
Environmental Impact Difference	X	X	X	X	✓
Cost Impact Difference	X	X	X	X	✓

Methods

A simplified LCA was performed to quantify the difference in environmental impacts between the two packaging types. The LCA focused on the life cycle stages where the two packaging types differ the most, i.e. where the largest differences in environmental and cost impacts are expected.

The two trays were assumed to have the same weight of 21 g, as this was the industry average for a plastic tray in 2015.[2] The functional unit was one use of a black plastic food tray, from raw material production to end-of-life.

Data and assumptions

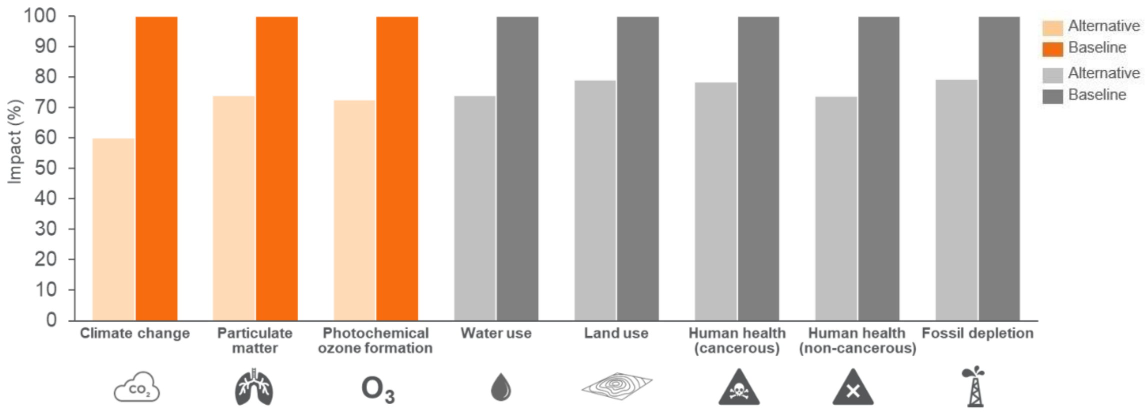
Packaging	Parameter	Data input	Data source/ assumption
Baseline	Weight of tray	21 g	Average weight of plastic tray in 2015[2]
	Material composition	100% crystallinePET	Ecoinvent data of PET, granulate, bottle grade, production {RER}
	End of life treatment	90% incineration 10% landfilling	Revised legislative proposal on waste; Ecoinvent data 1) incineration waste PET, {CH} 2) sanitary landfill waste PET {CH}
Alternative	Weight of tray	21 g	Average weight of plastic tray in 2015[2]
	Material composition	100% crystalline PET	Ecoinvent data of PET, granulate, bottle grade, production {RER}
	End of life treatment	70% recycling	Assumption;

	Ecoinvent data of PET, granulate, bottle grade, recycled {RER};

Environmental Impacts

The alternative packaging performs better than the baseline in all impact categories. In terms of climate change, the alternative results in a 40% reduction in greenhouse gases (GHGs), or 40 gCO_2eq per black plastic tray. This is due to the alternative packaging being recycled at the end-of-life; although recycling requires energy and other inputs, these impacts are lower than the avoided impacts from the production of virgin plastics. The alternative's climate change impact is also lower because the baseline packaging is largely incinerated at the end-of-life, resulting in GHG emissions.

Figure A-8 Environmental impacts of baseline and alternative packaging. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Cost Impacts

Manufacturing costs

Pigment costs: According to one study, the alternative Sicopal pigment was estimated to cost €18.36/kg, around eight times more than conventional carbon black pigment, and could add 15% to the cost of materials for the packaging. The alternative pigment produced by Colour Tone has been estimated to cost €10.43/kg, four times the price of conventional carbon black pigment.[1] Personal communication with alternative pigment producers, however, estimated the cost of alternative pigments to be only 2.5 times the cost of carbon black pigments. The actual cost impact may also depend on the volume of packaging produced; as production scales, costs are lowered.

R&D: Although it was not quantified in this case study, there are also costs for pigment producers associated with R&D of new pigments.

Logistics costs

Since the baseline and alternative packaging are the same weight and volume, there is no difference in costs for logistics or transport.

End-of-Life treatment costs

The EU-28 average annualised capital and operational landfilling costs for waste management companies are €34.30 per tonne of waste treated. Incineration with electricity and heat recovery costs are €129 per tonne, with a profit of €28 per tonne from electricity production, resulting in net costs of €101 per tonne.[3] The net cost for recycling plastic is likely to be several hundred euros per tonne, however, this number can vary because the selling price of recycled plastics will differ depending on the quantities processed and the quality of the recycled plastic produced, so it is not possible to estimate an actual figure with the available data. This means that the incineration or landfilling of plastic trays most likely has lower costs for waste management companies than recycling. As a result, switching from the baseline to alternative packaging could possibly raise costs for disposal by switching from less costly incineration and landfilling to recycling.

Conclusions

The recyclable black plastic trays perform slightly better than the non-recyclable black plastic trays in all impact categories, except for land use, and human health (cancerous and non-cancerous). The largest environmental benefit comes from a reduction in greenhouse gas emissions. The recyclable black plastic tray results in a slightly worse environmental performance in the impact categories of human health and land use (although the impact on land use is negligible when the environmental impact results are normalised and weighted). However, this conclusion is very sensitive to the impact of the assumed fuel mix of the electricity and heat that incineration of plastic avoids. As the EU fuel mix becomes cleaner with the expansion of renewables in future years, the avoided human health impacts by incineration will become smaller.

If the estimated 60,000 tonnes of black plastic packaging in the UK alone were recycled at a rate of 70% with new pigments, this could achieve a GHG savings of over 115,000 tonnes CO_2eq. If this figure was translated to all of the European Union, emissions savings could be multifold larger.

At the moment, costs for the new pigments are higher, but could decrease when the scale of production increases. Similarly, there could be a possible increase in costs for waste management of the black plastics since landfilling is the cheapest option. However, EU waste legislation is slowly restricting landfilling, and this end-of-life option will only decrease in future years. Since incineration and recycling have similar costs, a switch in packaging would not result in large cost increases for waste management companies.

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G.2.3 Moulded pulp fibre as an alternative for expanded polystyrene

Nature of Case Study	*Recyclability*
Packaging Sector	*Secondary*
Packaging Material(s)	*Expanded polystyrene (EPS)*

Introduction

Expanded polystyrene is primarily used in packaging for food and for cushioning heavy high value goods like electronics during transport (33% and 57% of EPS packaging use respectively). Although it is a highly functional and lightweight packaging material, its low density also makes it expensive to recycle. The volume to weight ratio of EPS is very high and the collection, transport, handling, and processing for recycling is therefore costly. As a result, EPS is typically disposed of rather than recycled. In 2017 in the EU, 388 kt of EPS waste was generated, of which only 32.7% was recycled; 35% was incinerated and 32.7% landfilled.[1]

The recyclability of EPS could be increased in two ways:

1. **By a change in product design:** EPS could be substituted with another material that serves the same function. Moulded pulp fibre is an EPS alternative that has similar properties but can more easily be recycled.
2. **By a system change:** The recycling infrastructure for EPS could be changed by building compression facilities where the EPS is decreased in volume before transport and further processing.

The system change may not be enough to accelerate the recyclability of EPS; because EPS is so porous, it easily absorbs contaminants which also inhibit recycling. In addition, the Single Use Plastics Directive will ban the use of EPS for food and beverage packaging, so it will need to be replaced with biodegradable and recyclable alternatives. This study thus focuses on a change in product design to moulded pulp fibre. Not only is moulded pulp fibre typically made from recycled material such as newspaper and corrugate, it can also be recycled with paper streams which have a much higher recycling rate than EPS in Europe, at 85%.[2]

Since EPS is commonly used in the transport of electronics, this case study explores the environmental benefits and costs of shifting from EPS to moulded pulp fibre for the transport of a small electronic item.

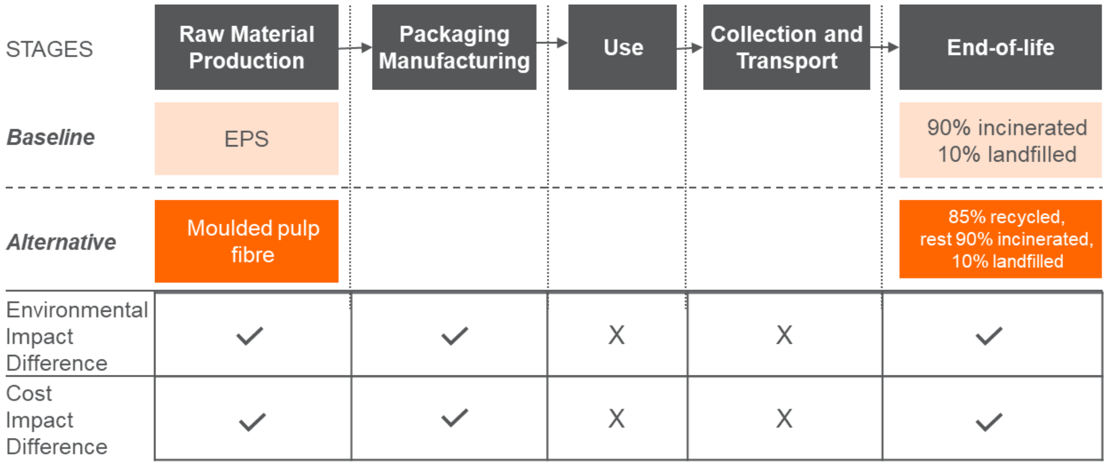
Lifecycle

This case study compares the following two packaging types:

Baseline/alternative	Description of packaging type
Baseline	Expanded polystyrene packaging used for transport of a small electronic product
Alternative	Moulded pulp fibre packaging used for transport of a small electronic product

The cardboard box in which the electronic item is shipped was not considered in this LCA as both packaging types would use a box of the same volume and weight. The lifecycles of the two packaging types differ in the raw material production and also end-of-life (see Figure A-9). Since EPS is difficult to recycle, it is assumed to be landfilled at a rate of 10% and incinerated with energy recovery at a rate of 90%, reflecting the 2030 targets as included in the revised legislative proposal on waste. The moulded pulp fibre alternative is assumed to be recycled at a rate of 85%, reflecting the PPWD recycling target for cardboard.

Figure A-9 Lifecycle of baseline and alternative packaging for the transport of a small electronic item. Check marks indicate differences between the baseline and alternative and x's indicate no or negligible differences.



Methods

A simplified LCA was performed to quantify the difference in environmental impacts between the two packaging types. The LCA focused on the life cycle stages where the two packaging types differ the most, i.e. where the largest differences in environmental and cost impacts are expected.

Since there is no Ecoinvent data for moulded pulp fibre, the recycling process for newsprint paper was used as a proxy. This is a fair comparison because the production of moulded pulp fibre is essentially the repulping of paper which is also done with paper recycling. Moulded pulp fibre does require energy for drying after it is moulded, but this is also the case for paper production which is included in this Ecoinvent process.[4] It is assumed to be made of 100% recycled paper as this is typical for moulded pulp fibre.

The functional unit studied is cushioning used in one transport of a small electronic item from raw material production to the end-of-life. A weight of 200 g EPS and 300 g of moulded pulp fibre was assumed. This assumption comes from the fact that these materials have similar cushioning properties. Moulded pulp fibre is 15 times denser than EPS but is assumed to replace EPS on a 1:10 volume basis. The difference in transport throughout the lifecycle is considered to be negligible because the impact from transport is insignificant in comparison to the end-of-life and raw material production.

Data and assumptions

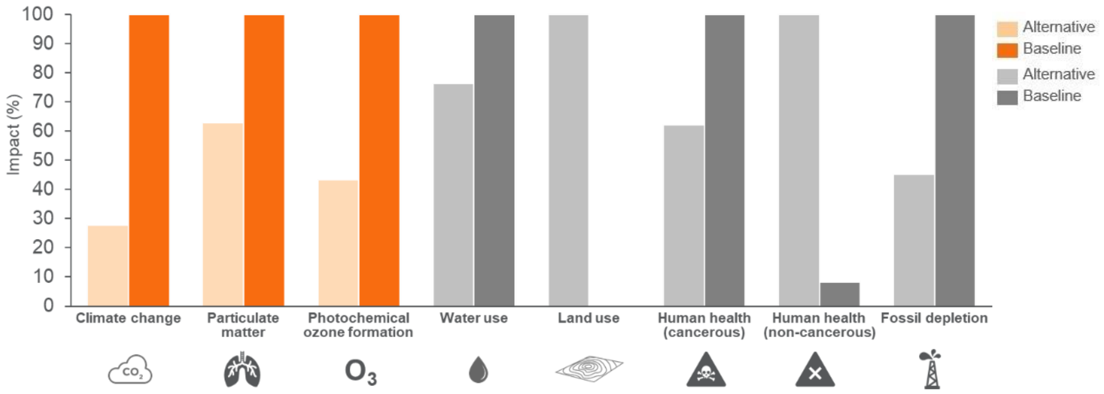
Packaging	Parameter	Data	Data source/ assumption
Baseline	Weight	200 g	Assumption
	Material composition	100% EPS	Ecoinvent data of polystyrene, expandable, {RER}
	End of life treatment	90% incineration 10% landfilling	Revised legislative proposal on waste; Ecoinvent data of 1) incineration waste polystyrene {CH} 2) sanitary landfill waste polystyrene {CH}
Alternative	Weight	300 g	Assumption
	Material composition	100% moulded pulp fibre (100% recycled content)	Ecoinvent data for paper, newsprint, recycled {Europe without Switzerland}
	End of life treatment	85% recycling	2030 recycling rate targets PPWD; Ecoinvent data for paper, newsprint, recycled {Europe without Switzerland};

Environmental Impacts

The moulded pulp fibre alternative performs better in all environmental impact categories studied, with the exception of land use and non-cancerous human health. The baseline has such a small non-cancerous human health impact because the incineration of EPS is credited with avoiding electricity and heat production. This is the same reason that the baseline has such a small land use impact, but land use is not as significant an impact category if the categories are weighted. Climate change is a more significant and a more robust impact category, and in this regard the moulded pulp fibre packaging performs 72% better than EPS. This is because EPS production is GHG intensive as well as the 90% incineration of EPS at the end-of-life. The emissions from moulded pulp fibre production and recycling are far lower.

The reason that moulded pulp fibre performs better in photochemical ozone formation is because EPS production has an ozone impact whereas moulded pulp fibre production does not. For fossil resource depletion, EPS raw material production is also the reason that EPS performs worse; EPS is petroleum based whereas moulded pulp fibre is bio-based. Moulded pulp fibre does still deplete some fossil resources for energy in the pulping and drying process but uses a biogenic feedstock.

Figure A-10 Environmental impacts of baseline and alternative packaging. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Cost Impacts

Manufacturing costs

It is difficult to estimate the cost difference between the two products.

Logistics costs

Transport costs would depend on whether transport is charged on a weight or dimensional weight basis. Since EPS has such a low density, on a weight dimensional basis it would be more expensive for transport, but less expensive if done purely on a weight basis. Either way, the weight difference between the two packaging types is small compared to the total weight of the product being transported and would not influence costs to a high degree.

End-of-Life treatment costs

Most EPS in Europe is landfilled or incinerated. The EU-28 average annualised capital and operational landfilling costs for waste management companies are €34.30 per tonne of waste treated. Incineration with electricity and heat recovery costs are €129 per tonne, with a profit of €28 per tonne from electricity production, resulting in overall costs of €101 per tonne.[5]

Moulded pulp fibre is recycled with paper streams, and paper is a highly recycled material in Europe. Approximately 3.2 million tonnes of recycled paper is traded monthly (compared to 0.7 million tonnes plastic) at an average price of €137 per tonne.[6] The net costs for recycling paper would be less than the traded price but exact figures could not be obtained. By changing from EPS to moulded pulp fibre in packaging, this would shift costs from waste incinerators and landfill operators to paper recyclers, the differential is not clear but the costs could be in the same order of magnitude.

Conclusions

The moulded pulp fibre alternative performs better in all environmental impact categories with the exception of land use and non-cancerous human health. The reason the EPS has such little impact on non-cancerous human health is because it is credited with avoided electricity and heat production from the incineration of EPS. This is the same reason that the baseline has such little land use impact, but land use is not as significant an impact category when the categories are weighted.

Changing from EPS to recyclable moulded pulp fibre packaging could help increase recycling rates of packaging waste and reduce related environmental impacts. If moulded pulp fibre replaces EPS packaging for the transport of a small electronic appliance, this can save 860 g CO_2eq. If scaled to the 388 kt of EPS waste generated in the EU in 2017, this could reduce emissions up to 1,6Mt CO_2eq. Such a switch in packaging would shift the burden of waste treatment within the waste management system from landfill and incinerator operators to paper recyclers.

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G.2.4 Alternatives for PVC stretch wrap

Nature of Case Study	*Recyclability*
Packaging Sector	*Tertiary*
Packaging Material(s)	*Polyvinyl chloride (PVC)*

Introduction

Polyvinyl chloride (PVC) represented 10.2% of plastics in Europe in 2017, with the majority of this used in the building and construction sector, and a smaller fraction for packaging.[1] PVC has been considered by some to be a controversial material in the past decades because of its effects on human health and the environment from its production and waste treatment.[2] It was once the most globally used polymer for shrink film packaging material but has since been largely replaced by polyethylene (PE) and polyolefin (POF) films.[3] It is also used in other applications such as rigid PVC clamshell packaging and stretch wrap, however, PVC packaging is problematic to recycle because of the low quantities on the market, at approximately 200,000 tonnes per year.[4] It is present in such low levels in mixed plastic waste that it is considered a contaminant. In addition, it sinks in water, as does PET, so is hard to separate in plastic recycling systems. As a result, most of it is landfilled or incinerated.

The recyclability of PVC packaging could be increased in two ways:

1. **By a change in product design:** PVC packaging could be substituted in most applications with other easier to recycle plastics, such as PE.
2. **By a system change:** Recycling of PVC could be accelerated with financial incentives specifically for PVC. It could also be collected in its own plastic waste stream.

Changing the product design is arguably an easier shift as there are existing alternatives and PE recycling infrastructure is already largely in place. Since the majority of PVC is used in construction, a system change would also more likely be driven by PVC in this sector rather than packaging. As such, this case study explores the environmental benefits and costs of shifting from PVC to PE, using stretch film as the product application example. Stretch films are used in a wide array of applications including wrapping of pallets for transport of goods.

Lifecycle

This case study compares the following two packaging types:

Packaging	Description
Baseline	Polyvinyl chloride (PVC) stretch wrap
Alternative	Low density polyethylene (LDPE) stretch wrap

The lifecycles of the two packaging types are fairly similar and only significantly differ in the raw material production and end-of-life. Since PVC packaging is difficult to recycle, it is instead assumed to be disposed of as other non-recycled municipal solid waste; it is landfilled at a rate of 10% and incinerated with energy recovery at a rate of 90%, reflecting the 2030 targets as included in the revised legislative proposal on waste. The alternative PE packaging is easier to recycle, thus is assumed to be recycled into PE pellets at a rate of 70%.

Figure A-11 Lifecycle of baseline and alternative clamshell packaging. Check marks indicate differences between the baseline and alternative and x's indicate no or negligible differences.

STAGES	Raw Material Production	Packaging Manufacturing	Use	Collection and Transport	End-of-life
Baseline	PVC				90% incinerated 10% landfilled
Alternative	LDPE				70% recycled, rest 90% incinerated 10% landfilled
Environmental Impact Difference	✓	X	X	X	✓
Cost Impact Difference	✓	X	X	X	✓

Methods

A simplified LCA was performed to quantify the difference in environmental impacts between the two packaging types. The LCA focused on the life cycle stages where the two packaging types differ the most, i.e. where the largest differences in environmental and cost impacts are expected.

It was assumed that the two wraps have the same weight. The functional unit was thus 500 g of stretch wrap used for the wrapping of pallets, from the raw material production to end-of-life. The data inputs and assumptions are shown in the table below. It is important to note that there are two types of PVC production processes: emulsion and suspension. Suspension was chosen for this study since 80% of PVC production uses this process.[7] Ecoinvent also does not have the recycling of low-density PE, thus high-density PE was used as a proxy as this is the closest alternative.

Data and assumptions

Packaging	Parameter	Data input	Data source/ assumption
Baseline	Weight	500 g	Assumption
	Material composition	PVC	Ecoinvent data of polyvinyl chloride, suspension polymerised, {RER}
	End-of-life treatment	90% incineration 10% landfilling	Revised legislative proposal on waste; Ecoinvent data of 1) incineration waste PVC {CH} 2) sanitary landfill waste PVC {CH}
Alternative	Weight	500 g	Assumption
	Material composition	Virgin LDPE	Assumption; Ecoinvent data of packaging film, low density PE, {RER}
	End-of-life treatment	70% recycling	Assumption; Ecoinvent data PE, high density, granulate, recycled {Europe without Switzerland}

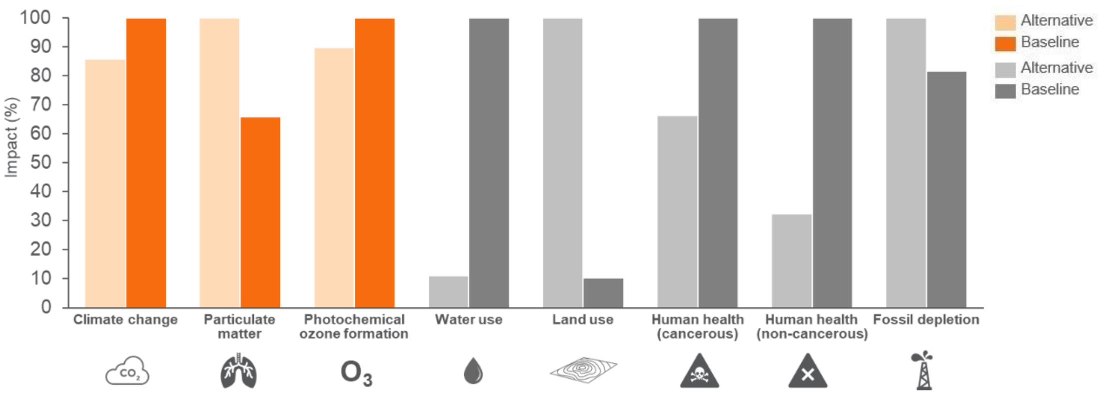
Environmental Impacts

LDPE stretch wrap performs better environmentally than PVC stretch wrap in most impact categories, but there are trade-offs for some impact categories like fossil depletion, particulate matter and land use. The PVC stretch wrap performs better than the PE stretch wrap with regards to fossil resource depletion because it is partially incinerated and is therefore credited with avoiding electricity and heat production which are partially generated by fossil fuels. For particulate matter, the alternative performs 34% worse because LDPE packaging film production has a 1.48 higher impact factor than PVC.

Although LDPE has a higher greenhouse gas emission intensity than PVC (on a weight basis) for raw material production as well as greenhouse gas burdens associated with the recycling process, it performs 14% better in terms of climate change because it is partially credited with the avoidance of virgin LDPE production when it is recycled.

Water scarcity has the largest difference between the baseline and alternative. The PVC packaging uses more than 8 times more water than LDPE because PVC production is far more water-intensive than LDPE production. Although the difference in land use appears drastic on a percent difference basis, it is so small on an absolute basis that it can be considered negligible. It is important to note that the results are sensitive to the decision to assume the suspension production process, as the emulsion process has a lower global warming potential.

Figure A-12 Environmental impacts of baseline and alternative packaging. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Cost Impacts

<u>Manufacturing costs</u>

It is estimated that the costs for producing raw materials and the stretch wrap are similar for PVC and PE.

<u>Logistics costs</u>

Since the baseline and alternative packaging are the same weight, there is no difference in costs for logistics or transport.

<u>End-of-Life treatment costs</u>

The EU-28 average annualised capital and operational landfilling cost for waste management companies is €34.30 per tonne of waste treated. For incineration with electricity and heat recovery, it is €129 per tonne, with a profit of €28 per tonne from electricity production, resulting in overall costs of €101 per tonne.[6] The net cost for recycling plastic is likely to be several hundred euros per tonne, however, this number can vary because the selling price of recycled plastics will differ depending on the quantities processed and the quality of the recycled plastic produced, so it is not possible to estimate an actual figure with the available data.

Conclusions

LDPE stretch wrap performs better environmentally than PVC stretch wrap in most impact categories. This is because it is assumed that 70% of the LDPE stretch wrap will be recycled at end-of-life, avoiding the production of virgin LDPE. In reality, stretch wrap like other flexible packaging is recycled at a low rate of around 20%. Still, LDPE stretch wraps should be used instead of PVC because there is better infrastructure for LDPE recycling. Since the amount of PVC in the market is so low in Europe, there is no financial incentive to build the infrastructure to recycle it. Therefore, applications in which PE or PET alternatives can replace PVC should switch to these material types.

The costs for waste treatment would remain largely unchanged. The real costs would be for MSs that do not currently have collection and technologies for film recycling to invest in this infrastructure.

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G.2.5 More recyclable alternatives for multilayer wrappers

Nature of Case Study	***Recyclability***
Packaging Sector	*Primary*
Packaging Material(s)	*Multilayer films*

Introduction

Composite, or multilayer, flexible packages can offer additional properties that increase the functionality of the package such as good strength to weight ratio and other functional requirements that cannot be met with a single material.[1,2] However, these functional properties can come at a cost, with composite packaging materials posing challenges to the majority of sorting systems and reprocessing systems at recycling facilities. The separation of multilayer films is technically and economically challenging. For example, separating metal layers from plastic layers to produce pure streams for processing is technically difficult. Multilayer packaging also typically consists of very thin and light layers, so the profit of selling recycled material does not cover the cost of separation.

The recyclability of multilayer film packaging could be increased in two ways:

1. **By a change in product design:** In some cases, multilayer films can be replaced by mono-material films, thus enabling them to be mechanically recycled as a single material stream.
2. **By a system change:** Although multilayer multi-material films cannot currently be recycled with mechanical recycling, they can theoretically be recycled through chemical recycling.

Mechanical recycling is much more prevalent than chemical recycling; for reference, in Germany in 2015, only 1.7% of packaging waste was chemically recycled whereas 39.4% was mechanically recycled (the remaining 58.8% incinerated for energy recovery). Although innovative chemical recycling techniques are progressing, most technologies have not yet been implemented at industrial scale.[3]

Chemical recycling technologies are still in their infancy and costly, thus it is only mechanical recycling that will be applied at large scale in the short term. Consequently, this case study explores the environmental benefits and costs of shifting from multilayer to mono-material packaging. A food wrapper is used as an example since food and beverage packaging represents most of packaging in Europe. In addition, food packaging is one of the most demanding types of packaging because of restrictions of packaging with food contact. Paper alternatives can only be used in some food packaging with low barrier requirements, so mono-material oriented polypropylene (OPP) was chosen as the example alternative. OPP provides similar functionalities as multilayer films and is already used commercially.[4]

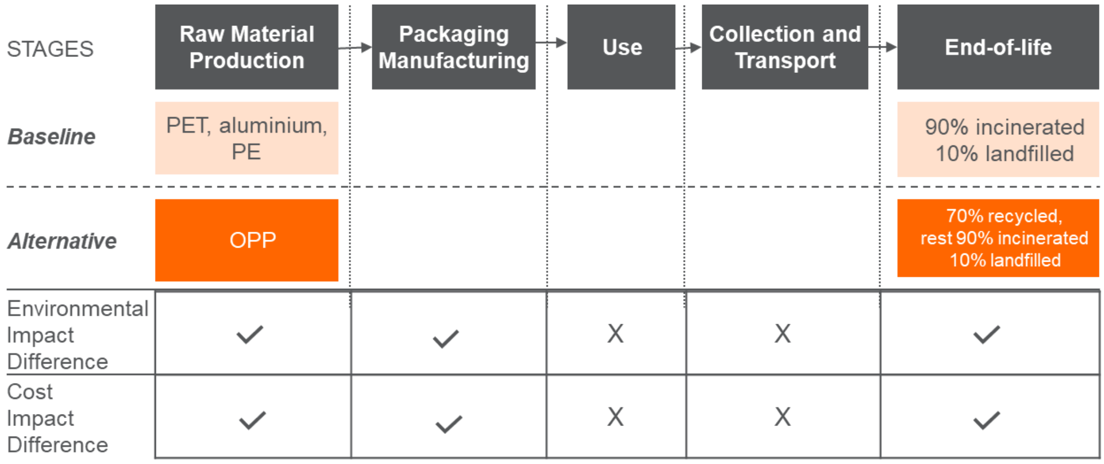
Lifecycle

This case study compares the following two packaging types:

Packaging	Description
Baseline	Multilayer food wrapper of PE, PET and aluminium
Alternative	Mono-material OPP food wrapper

The lifecycles of the two packaging types differ in the raw material production and end-of-life (see Figure A-13), affecting both environmental and costs impacts. One of the most common multilayer combinations is PE, PET, and aluminium, thus the baseline packaging is assumed to require the production of these materials while the alternative wrapper only requires OPP as a raw material. The other difference in the lifecycle is the end-of-life; due to its difficulty to recycle, the multilayer packaging is assumed to be disposed of as non-recyclable municipal solid waste. This is 10% landfilling and 90% incineration with energy recovery which reflects the 2030 targets as included in the revised legislative proposal on waste. Since the alternative wrapper has been designed for increased recycling, it is assumed to be 70% recycled.

Figure A-13 Lifecycle of baseline and alternative wrappers. Check marks indicate differences between the baseline and alternative and x's indicate no or negligible differences.



Methods

A simplified LCA was performed to quantify the difference in environmental impacts between the two packaging types. The LCA focused on the life cycle stages where the two packaging types differ the most, i.e. where the largest differences in environmental and cost impacts were expected.

The functional unit was one use of a food wrapper from raw material production to end-of-life. Ecoinvent does not contain a process for metallised films for packaging to model the aluminium layer in the wrapper, thus aluminium alloy $AlMg_3$ was used as the closest proxy. This choice influences the results as raw material production is a significant part of the total lifecycle environmental impacts. The alternative wrapper was assumed to be slightly lighter compared to the baseline (1.2 vs. 1.5 g) since it is a mono-film. This assumption also affects the results as raw material production is a significant part of the total lifecycle environmental impacts. However, the impact of recycling is greater than the uncertainty of this assumption. Lastly, Ecoinvent does not contain data for recycling polypropylene, so recycled polyethylene was used as a proxy. Although polypropylene has a higher melting point than polyethylene and may require higher energy inputs for melting during the recycling process, the Association of Plastic Recyclers states that the "HDPE/PP recycling processes are nearly identical".

Data and assumptions

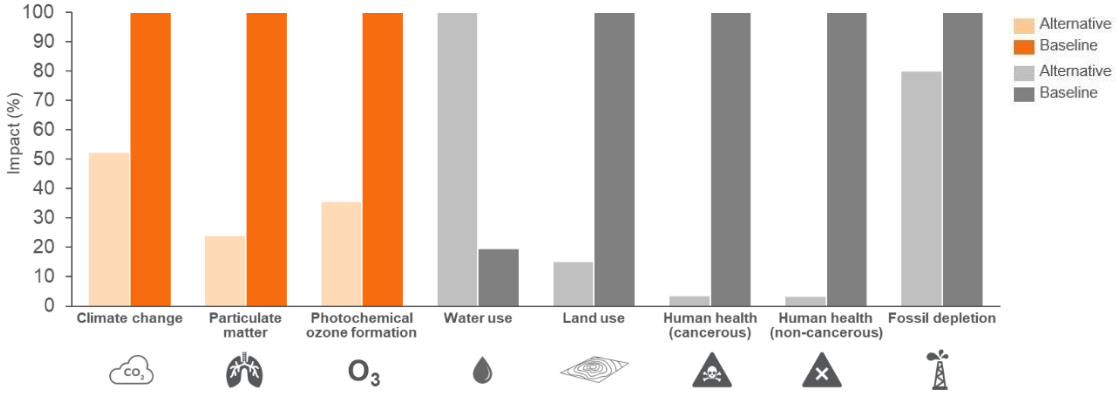
Packaging	Parameter	Data	Data source/ assumption
Baseline	Weight wrapper	1.5 g	Assumption
	Material composition	33% PET 33% Aluminium 33% PE	Assumptions based on interview[4]; Ecoinvent data 1) PET, granulate, amorphous, {RER} 2) Aluminium alloy, AlMg3, {RER} 3) PE, low density, granulate, {RER}
	End of life treatment	90% incineration 10% landfilling	Revised legislative proposal on waste; Ecoinvent data of 1) incineration waste PE {CH} 2) sanitary landfill waste PE {CH} 3) incineration waste PET {CH} 4) sanitary landfill waste PET {CH} 5) municipal incineration scrap aluminium, {CH.5*.45} 6) sanitary landfill waste aluminium, {CH}
Alternative	Weight wrapper	1.2 g	Assumption
	Material composition	Oriented polypropylene	Assumptions based on interview[4]; Industry data 2.0 oriented polypropylene film
	End-of-life treatment	70% recycling	Assumption; Ecoinvent data **PE**, high density, granulate, recycled {Europe without Switzerland}

Environmental Impacts

The alternative wrapper performs better than the multilayer wrapper in all impact categories except for water use. The alternative utilises more water because the OPP production process is nearly four times more water-intensive than the production of all materials in the multilayer film. For cancerous human toxicity, the baseline packaging performs worse mostly due to aluminium production as well as the production of PE and PET. For fossil resource depletion, the production of PET, PE, and aluminium is more fossil-intensive than OPP production, resulting in higher impacts. The end-of-life of the baseline packaging has less of an effect on fossil resource depletion.

The end-of-life has a slightly more significant impact for climate change. The incineration of the PE and PET in the multilayer wrapper results in more GHG emissions than the heat and electricity it is assumed to displace. Consequently, the baseline performs 48% worse than the alternative in climate change. The alternative packaging saves 3.4 g CO_2eq in comparison to the baseline.

Figure A-14 Environmental impacts of baseline and alternative packaging. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Cost Impacts

Manufacturing costs

According to insight from packaging experts in the industry, there is no cost increase with OPP wrappers compared to multilayer. Since the OPP wrapper does not require lamination in the processing, the costs are on par with conventional packaging. This packaging is also becoming more and more popular, so the industry expects that costs to decrease in the coming years. It is rather the technological know-how of retailers that is the barrier for adopting the mono-film. Since it is extremely light and thin, it is a more difficult material to handle in processing.[3]

Logistics costs

There is no cost difference in logistics. Since the baseline and alternative packaging are the same weight and volume, there are no added costs in logistics or transport.

End-of-Life treatment costs

The EU-28 average annualised capital and operational landfilling costs for waste management companies is €34.30 per tonne of waste treated. For incineration with electricity and heat recovery, it is €129 per tonne, with a profit of €28 per tonne from electricity production, resulting in net costs of €101 per tonne.6 The net cost for recycling plastic is likely to be several hundred euros per tonne, however, this number can vary because the selling price of recycled plastics will differ depending on the quantities processed and the quality of the recycled plastic produced, so it is not possible to estimate an actual figure with the available data.

Conclusions

Each food wrapper switched from multilayer to OPP mono-film can save 3.4 g of CO_2eq. Although the individual impact appears relatively small, multilayer films are largely used for food packaging, and food and beverage packaging accounts for around two thirds of total European packaging. It is true that mono-film is limited in that it cannot be used for all food products, such as those with ultra-high barrier (oxygen, moisture, etc) needs. However, it can be used for products with normal to high barrier needs, meaning it can replace a significant proportion of food product packaging, and even non-food applications. By switching non-recycled multilayer films to mono-films designed for recycling, the potential for GHG savings, reduction of fossil fuels, and human health benefits is substantial.

A caveat stressed by many industry interviewees is that recycling of packaging does not only rely on designing packaging for recycling but building the waste management infrastructure to ensure that it is truly recycled in reality. Shifting from non-recycled multilayer to mono-films designed for recycling will cause a shift in waste management costs from waste incinerators to plastic recyclers, although the net costs are fairly similar. This will require more focus on building infrastructure for plastic recycling.

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G.3 Case Studies Relating to Reusable Packaging

G.3.1 Reusable packaging for electric and electronic equipment

Nature of Case Study	***Reusability***
Packaging Sector	*Tertiary*
Packaging Material(s)	*All*

Introduction

In Europe, over 90 million white goods appliances are sold each year; the majority of these are transported with disposable packaging.[1] White goods are large electrical items used domestically, such as refrigerators or washing machines that are typically white in colour. Conventional transport packaging for these goods consists of a cardboard box with expanded polystyrene inserts and wood for protection, which is then wrapped in polyethylene for protection from moisture. All of these materials are single-use and need to be disposed of or recycled after the appliance is delivered to the user.

An alternative to this conventional packaging is returnable protective packaging (RPP) as highlighted in the Free Pack Net case study *(Reference to task 3 D11 – Free Pack net in Appendix F)*. With this system, a reusable polypropylene (PP) packaging shell with expanded polypropylene (EPP) inserts is used by appliance manufacturers for transport to the retailer and user. After delivery, the packaging is collapsed and sent back to the nearest suitable factory to clean before being redistributed back to the appliance manufacturers. This is considered as one rental cycle, and the packaging undergoes approximately 20 rental cycles before it reaches its end-of-life.

This case study explores the environmental and cost impacts of switching from disposable conventional packaging for a laundry machine to a reusable system.

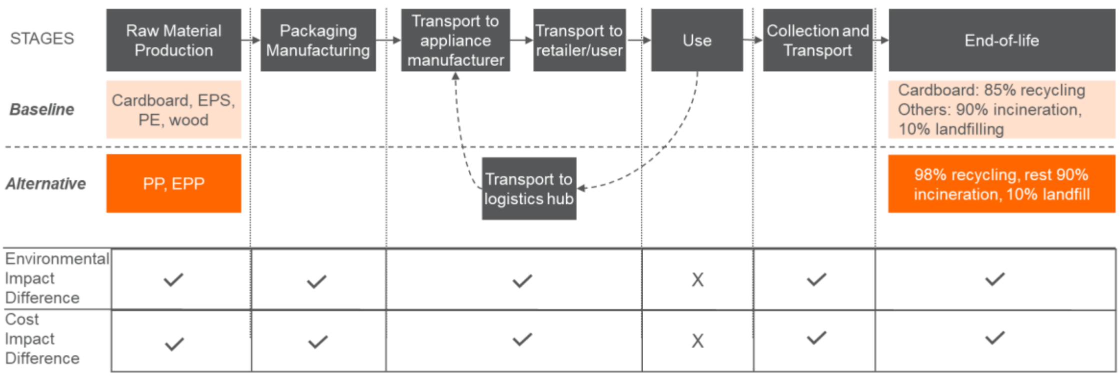
Lifecycle

This case study compares the following two packaging types:

Packaging	Description
Baseline	Cardboard box with expanded polystyrene and wood inserts and polyethylene wrapper for transport of a washing machine
Alternative	Reusable polypropylene packaging with expanded polypropylene inserts for transport of a washing machine

The lifecycles of the two packaging formats differ significantly. They require different raw materials to produce, the alternative packaging has additional transport in its reverse logistics, and both are treated differently at the end-of-life. The baseline packaging at the end-of-life after a single use is assumed to have 85% of the cardboard recycled, in line with the PPWD 2030 target for cardboard. The other materials are assumed to be disposed of as other non-recycled municipal solid waste. This is 10% landfilling and 90% incineration with energy recovery which reflects the 2030 targets as included in the revised legislative proposal on waste. The alternative reusable packaging only reaches its end-of-life after 20 uses and the only additional transport considered for the reusable packaging is the transport from the user back to logistics hub, and this is assumed to be 250 km by truck. At the logistics hub, the RPPs are quality checked before they are sent back to the appliance manufacturer. Although the RPP is heavier than the disposable packaging, packaging is only a small fraction of total weight compared to the appliance, thus the difference in transport to the appliance manufacturer and transport to retailer/user is considered negligible. The RPP is assumed to be recycled at a rate of 98% after its 20 uses. This recycling rate is higher than the PPWD recycling target because the RPP is recycled by the operating company rather than by consumers.

Figure A-15 Lifecycle of baseline and alternative packaging for a single use of transporting a washing machine. Check marks indicate differences between the baseline and alternative and x's indicate no or negligible differences.



Methods

A simplified LCA was performed to quantify the difference in environmental impacts between the two packaging types. The LCA focused on the life cycle stages where the two packaging types differ the most, i.e. where the largest differences in environmental and cost impacts are expected.

The functional unit chosen for the LCA was *one trip* of a laundry machine, from raw material production to end-of-life. Since the RPP can be used 20 times, only one needs to be produced for 20 trips, whereas 20 single-use packaging need to be produced for 20 trips. Similarly, after one trip of the single-use packing, it needs to be treated for disposal, whereas this only occurs every 20 trips for the RPP. The data inputs and the assumptions are stated in the table below. It is important to note that Ecoinvent does not contain data for recycling polypropylene, so recycled polyethylene was used as a proxy. Although polypropylene has a higher melting point than polyethylene and may require higher energy inputs for melting during the recycling process, the Association of Plastic Recyclers states that the “HDPE/PP recycling processes are nearly identical”.[2]

Data and assumptions

Packaging	Parameter	Data	Data source/ assumption
Baseline	Weight	900 g cardboard 300 g PE	Assumption based on confidential LCA study[1]

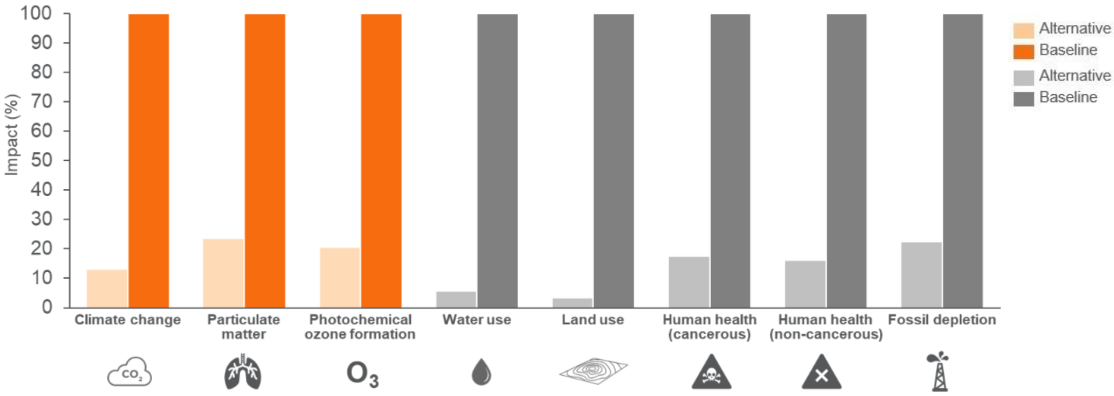
		300 g wood 1000 g EPS	
	Material composition	Cardboard PE Wood EPS	Assumption based on confidential LCA study[1]; Ecoinvent data 1) corrugated board box {RER} 2) PE, high density, granulate, {RER} 3) cleft timber, market for {Europe without Switzerland} 4) Polystyrene, expandable, {RER}
	End of life treatment	Cardboard: 85% recycled Others: 10% landfill, 90% incineration	Revised legislative proposal on waste; Ecoinvent data 1) paper, newsprint, recycled, {Europe without Switzerland} 2) incineration waste PE, {CH} 3) sanitary landfill waste PE, {CH} 4) incineration waste PS, {CH} 5)) sanitary landfill waste PS, {CH} 6) incineration waste wood, untreated, {RER} 7) sanitary landfill, waste wood, untreated, {CH}
	Reuse rate	1	Assumption single-use
Alternative	Weight	8 kg PP 300 g EPP	Assumption based on LCA study[1]
	Material composition	Polypropylene	Assumption based on FreePackNet; Ecoinvent data PP, granulate, {RER}
	End of life treatment	98% recycled	Assumption; Ecoinvent data ***PE,*** high density, granulate, recycled {Europe without Switzerland}
	Reuse rate	20	Assumption based on FreePackNet[1]
	Return rate	100%	Assumption
	Transport hub to appliance manufacturer	250 km	Assumption; Ecoinvent data for transport, freight, lorry 16-32 metric ton, euro5, {RER}

Environmental Impacts

The RPP performs better environmentally in all impact categories considered. The alternative performs better in terms of climate change largely because of the reduced amount of raw material production needed per trip. Nearly 80% of emissions for the baseline packaging arise from the production and disposal of EPS that is used per trip. This also shows that the LCA is highly sensitive to the assumed weight of EPS. Yet even if this weight were halved, the reusable packaging would still perform better in terms of emissions. Overall, the RPP saves 130 kgCO_2eq per 20 trips (6.5 kgCO_2eq per trip) compared to the baseline.

The RPP performs better in terms of fossil resource depletion for similar reasons as climate change, and again, EPS has the highest impact. This is also true for particulate matter; the impact from the baseline is largely caused by EPS production. For the RPP, particulate matter impact arises from the additional truck transport to return the RPP. The results are sensitive to the assumed distance from the transport hub to the appliance manufacturer as well as the reuse rate of the RPP, however it is clear that the alternative performs significantly better than the baseline. This conclusion would likely remain true even if larger transport distances or lower reuse rates were assumed.

Figure A-16 Environmental impacts of baseline and alternative packaging. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Cost Impacts

Manufacturing costs

- There is a price premium for the RPP compared to single-use packaging. Single-use packaging could be estimated at €5/ unit, and with the average production cost of a white good appliance to the manufacturer at €100-120 /appliance, packaging accounts for approximately 5% of the total costs. Free Pack Net claims an overall cost savings of €10-40 /unit, but this includes eliminated damages. Since RPP is more protective than disposable options, it has savings from prevented damage to the appliance. For example, the biggest appliance manufacturer in the UK experiences 15% in damages to their TVs.[1]
- **R&D:** There are costs associated with R&D for new reusable packaging for the packaging manufacturer or designer. FreePackNet, for example, spent over €5 million in developing their solution.[1]

Logistics costs

There are added costs for the reverse logistics of the RPP as it has the additional transport from the packaging user to the logistics hub. This case study assumed that the mode of transport was by road (truck), although many white goods appliances are probably shipped from outside Europe and transported via ocean or air freight. The distances and mode of transport would greatly influence what the added costs of transport would be.

End-of-Life treatment costs

The EU-28 average annualised capital and operational landfilling costs for waste management companies is €34.30/ tonne of waste treated. For incineration with electricity and heat recovery, it is €129/ tonne, with a profit of €28/ tonne from electricity production, resulting in net costs of €101/ tonne.[5] The net cost for recycling plastic is likely to be several hundred euros per tonne, however, this number can vary because the selling price of recycled plastics will differ depending on the quantities processed and the quality of the recycled plastic produced, so it is not possible to estimate an actual figure with the available data. Switching from the baseline to the RPP would likely have a savings in costs for waste treatment. Although the RPP is more than three times heavier than the disposable packaging, it has to be disposed of 20 times less frequently than the baseline assuming it can be reused 20 times. The costs would however be shifted from paper recyclers and waste incinerators to plastic recyclers as the RPP is composed primarily of PP.

Conclusions

Switching to reusable packaging for the transport of white goods appliances is beneficial from an environmental standpoint. Assuming each trip of an RPP can save 6.5 kg CO_2eq and considering the sale of 90 million appliances in Europe, reusable packaging for these appliances could amount to a savings of 585,000 tonnes CO_2eq. This is a potential overestimate for several reasons. Firstly, not all white goods appliances sold in Europe can use RPP. For appliances imported from outside of Europe, one-way packaging is most logical because the reverse logistics would be difficult if the packaging had to be returned all the way back to a manufacturer in Asia, for example. Reusable systems are most logical for intra-Europe deliveries where transport distances can be kept lower. Secondly, this LCA considers a 100% reuse rate whereas a fraction of the RPPs can be lost or damaged in the lifecycle. It could also be a potential underestimate for other reasons. This LCA does not consider the additional protection that RPP can provide over disposable packaging, and prevention of damaged goods. It also assumed that RPP is used 20 times, whereas trials have tested more than 40 cycles.[1]

Reusable packaging in such an application is still a very niche and immature market, however costs are arguably not the barrier to adopting RPP. Although there are added costs for the RPP and the reverse logistics, Free Pack Net claims there are savings of €10-40/ unit overall. In addition, there would be savings in waste management costs due to less frequent end-of-life of RPP.

References

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G.3.2 Reusability in cleaning products

Nature of Case Study	*Reusability*
Packaging Sector	*Primary*
Packaging Material(s)	*Plastic*

Introduction

In the household cleaning products and other packaging sectors, refillable products offer the opportunity to reduce packaging waste. Such an example is the Replenish case study presented in Appendix F. The Replenish Refill Smart platform is a cleaning product line that sells refillable cleaning product bottles with concentrated refill pods. The customer first purchases a reusable plastic cleaning product bottle. A refill pod with concentrated cleaning solution is then attached to the modular bottle and the user adds water to dilute the solution. Each refill pod can be used for up to 6 uses.

The refillable bottle needs to be more durable, thus uses more material to withstand multiple uses. There is also the added transport of the concentrated refill pods. The impact of these needs to be compared to a conventional single-use bottle to determine the effects on the environment and on costs. This case study consequently investigates the environmental and cost impacts of switching from single-use PET cleaning product spray bottles to a reusable system such as the Replenish product.

Lifecycle

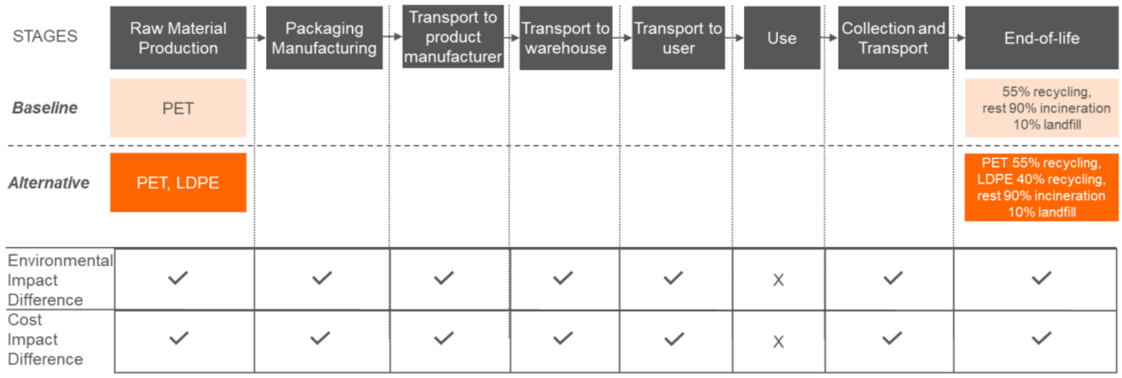
This case study compares the following two packaging types:

Packaging	Description
Baseline	Single-use PET spray bottle
Alternative	Reusable PET spray bottle with low density polyethylene (LDPE) concentrate refill pods

The lifecycles of the two packaging types differ significantly on a single use basis. The baseline and alternative spray bottle are both made of PET, however the alternative has a concentrated refill pod made of LDPE. The baseline PET bottle is produced, transported, and recycled after every use. The alternative bottle only needs to be produced, transported, and recycled every 30 uses and the refill pod every 6 uses. This implies that on a per use basis, there are environmental and cost differences in each lifecycle stage except for the use of the packaging (see Figure A-17).

The baseline packaging is assumed to be recycled at rate of 55% to reflect the 2030 PPWD recycling target for plastics and the remaining 40% is disposed of as other non-recycled municipal solid waste based on 2030 targets as included in the revised legislative proposal on waste (90% incineration, 10% landfilling). The alternative PET bottle is assumed to have the same end-of-life. Since LDPE is recycled at a lower rate than PET, it is assumed to only be recycled at a rate of 40%. The non-recycled PET and LDPE are assumed to be incinerated at a rate of 90% and 10% landfilled to reflect 2030 targets as included in the revised legislative proposal on waste.

Figure A-17 Lifecycle of baseline and alternative cleaning product bottles for a single use. Check marks indicate differences between the baseline and alternative and x's indicate no or negligible differences.



Methods

A simplified LCA was performed to quantify the difference in environmental impacts between the two packaging types. The LCA focused on the life cycle stages where the two packaging types differ the most, i.e. where the largest differences in environmental and cost impacts are expected.

The functional unit chosen was *one use* of a standard cleaning product spray bottle of 946 ml (32 oz.). The refillable bottle was assumed to weigh 90 g compared to 60 g for the baseline since it has to be more durable for its multiple uses. Both bottles were assumed to be empty when transported 200 km by truck from the packaging manufacturer to the cleaning product manufacturer. The baseline bottle was assumed to be full when transported 500 km by truck from the cleaning product manufacturer to the distribution warehouse, whereas the alternative is empty. Again, the baseline bottle was assumed to be full when transported 500 km by truck from the distribution warehouse to the user, whereas the alternative is empty. Both the baseline and alternatives were assumed to be empty when transported 100 km by truck from the user to the recycling centre. These transport distances are meant to represent typical distances for the EU but could vary significantly between Member States. The weights of the full versus empty bottle and refill pods were calculated using the density of water and volumes of the containers. Lastly, Ecoinvent does not cover the recycling of low-density PE, so high-density PE was used as a proxy as this is the closest alternative. Similarly, there is no recycling process for bottle grade PET, so recycling of amorphous PET was used as a proxy as this is the closest alternative.

Data and assumptions

Packaging	Parameter	Data	Data source/ assumption
Baseline	Weight	60 g bottle empty 1 kg bottle full	Assumption based on industry average
	Material composition	100% PET	Assumption based on industry average and expert interview; Ecoinvent data for PET, granulate, bottle grade {RER}
	End of life treatment	55% recycling	2030 recycling rate targets PPWD;

			Ecoinvent for inventory data PET, amorphous, recycled {Europe without Switzerland}
Alternative	Weight	90 g bottle empty 20 g refill pod empty 110 g refill pod full	Assumption based on industry average and Replenish interview[1]
	Material composition	100% PET bottle 100% LDPE refill pod	Assumption based on Replenish interview[1]; Ecoinvent data for 1) PET, granulate, bottle grade {RER} 2) PE, low density, granulate, {RER}
	End of life treatment	PET: 55% recycling LDPE: 40% recycling	2030 recycling rate targets PPWD and assumption; Ecoinvent data for 1) PET, amorphous, recycled {Europe without Switzerland} 2) PE, high density, granulate, recycled {Europe without Switzerland}
	Reuse rate refill pod	6 times	Replenish interview[1]
	Reuse rate bottle	30 times	Assumption: 5 pods used per bottle

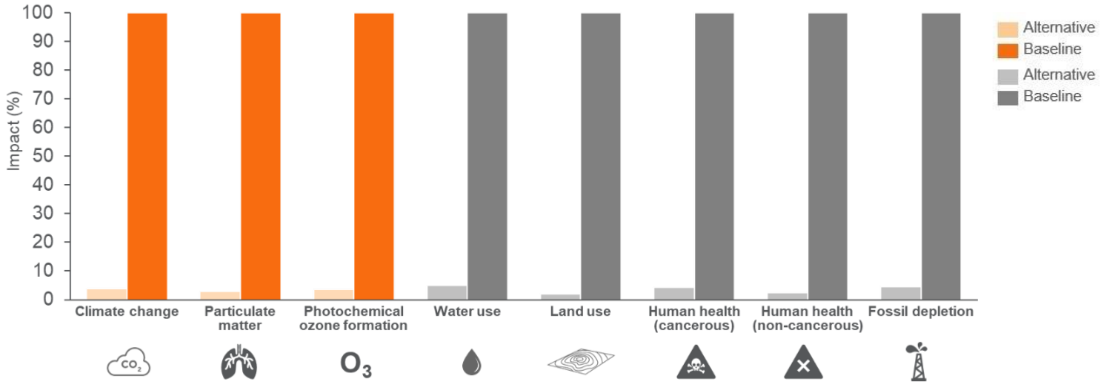
Environmental Impacts

The alternative packaging performs considerably better environmentally than the single-use cleaning product bottle in all examined impact categories. For the three most robust impact categories of climate change, particulate matter, and photochemical ozone formation, the alternative results in reduction of 96%, 97%, and 97% respectively. There are many reasons for the alternative's large reduction in climate change impact. Firstly, the reusable bottle is only produced every 30 uses, and the refill pods only every 6 uses, so the burdens from production and recycling are less. A larger effect is the additional transport that is required for the single-use product. Not only is the product shipped more frequently (with every use compared to every 30 uses for the alternative), but it is also heavier to transport because unnecessary water is shipped. With the reusable packaging with the concentrated refill pod, the bottle is shipped empty from the packaging manufacturer to the user, and the users adds water themselves.

Similarly, for particulate matter, the alternative performs better because less material needs to be produced and recycled on a per use basis and requires less and lighter transport on a per use basis.

It should be noted that the reuse rate of 30 times for the bottle is a sensitive assumption. Environmental benefits will be smaller when assuming a lower number of reuse times. Yet the environmental benefits are so high that a lower reuse rate would still most likely have an environmental benefit. In addition, the transport distances and mode of transport assumed in this model can highly affect the results. The difference between the alternative and baseline would be less significant if transport distances were shorter. Conversely, assuming air freight instead of road freight would increase the difference in environmental impact between the two products.

Figure A-18 Environmental impacts of baseline and alternative packaging per use. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Cost Impacts

Manufacturing costs

The Replenish spray bottle is heavier than the single-use bottle which may lead to higher costs. It is also likely that the manufacturing costs for the Replenish bottle are higher, because it allows users to add customisable designs to their bottles, and the bottle is modular. However, the number of reuses is likely to make the packaging cheaper on a per-use basis compared to a single-use bottle.

Reusable cleaning product bottles with concentrate refills require a change in business models for retailers. A refill pod that can be used 6 times cannot be sold for the same price as 6 bottles of cleaning product bottles. There can however be lower marketing costs for a retailer since the customer is locked in once they purchase a reusable bottle. If the product is sold in brick and mortar stores rather than online, there is an added complication in that a refill pod has lesser shelf presence than a larger bottle, so there are many aspects to consider with the business model.

Logistics costs

The alternative packaging does have added costs for transporting the concentrate refill pods once every 6 uses. Though overall, the single-use bottle has greater transport costs since it is shipped more frequently than a reusable bottle, and is full of the cleaning product, thus is heavier for some of the journeys.

End-of-Life treatment costs

Since the reusable cleaning product bottle only needs to be treated every 30 uses, and the refill pod every 6, there is a cost saving for waste management companies compared to the baseline.

Conclusions

Reusable cleaning product bottles with concentrated refill pods offer a large improvement in environmental impact compared to single-use cleaning product bottles. This is largely due to two factors: i) the reusable bottle and refill pod only need to be produced and recycled every 30 and 6 uses respectively ii) the reusable product requires less transport on a tonne-kilometre basis since the bottle is empty for two of the transport legs, rather than full. The first factor shows that reusability does indeed have an environmental benefit in this application. The second factor shows that the avoidance of shipping unnecessary water in certain products can also have an additional environmental benefit. Each reusable cleaning product bottle can save nearly 11 kg CO_2eq compared to 20 single-use bottles, although this number is very sensitive to the transport distances, modes of transport, and reuse rate assumed. This concept of refillable bottles with concentrate refills can even be expanded beyond the household cleaning sector to any product that contains water.

Refillable bottles can also be a logical switch from a cost perspective. It does require a shift in business models of retailers and a shift in mind-set of users who will have to invest more upfront in a refillable bottle (with potential future savings), but there are savings to be made in logistics per use. Additionally, the cost for waste management companies would also be lower since less waste has to be treated overall.

References

1. Interview with Jason Foster, CEO of Replenish

G.3.3 Reusable e-commerce bags

Nature of Case Study	*E-commerce reusability*
Packaging Sector	*Tertiary*
Packaging Material(s)	*Plastic*

Introduction

E-commerce is expected to increase in the coming years, with some forecasts predicting a global annual growth of 5.6% to 2023.[1] This growth in e-commerce means a consequent growth in packaging of all material types. With many shipping companies changing from weight-based pricing to dimensional weight-based pricing, e-commerce has seen a rise in flexible plastic mailing pouches, as they reduce both the weight and more importantly the volume of the package.[2] Many of these pouches are made of low-density polyethylene (LDPE) which is not recycled at as high a rate as other plastics such as high-density polyethylene (HDPE), PE, and PP. The EU recycling rate for LDPE is only 20%, with 13% of LDPE arising from household packaging.[3]

The low recycling rate of these mailing pouches could be addressed in two ways:

1. **By a change in product design:** Thin LDPE mailing bags could be substituted with more durable and reusable mailing pouches that can be recycled at the end-of-life.
2. **By a system change:** The recycling rate of LDPE could be improved through increased collection rates and separation of post-consumer plastic waste to reduce contamination.[3]

A change in product design to a reusable option is arguably the better option considering reusability is higher in the waste hierarchy than recycling. Some products are already available on the market such as reusable mailing bags made from recycled polypropylene (*reference to task 3 RePack case study in Appendix F)*. This case study will thus explore the environmental benefits and costs of shifting from single-use LDPE mailing pouches to reusable pouches made from recycled polypropylene (PP).

Lifecycle

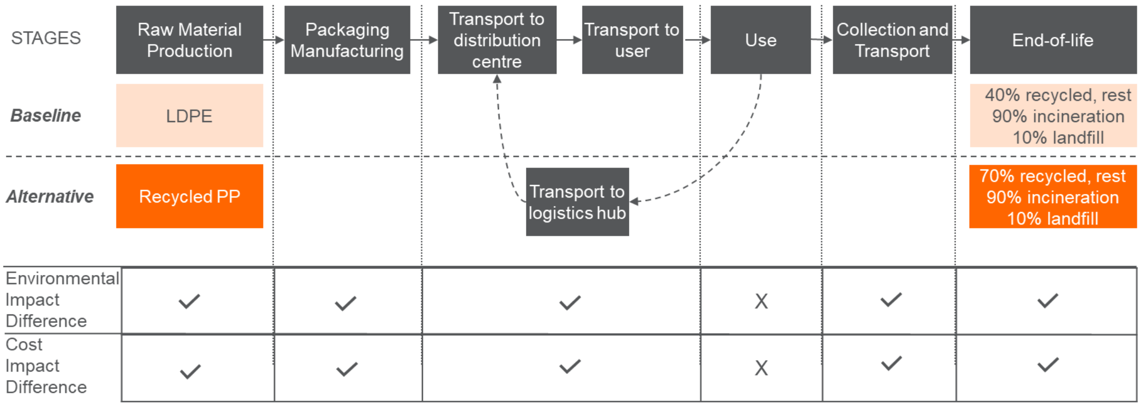
This case study compares the following two packaging types:

Packaging	Description
Baseline	Single-use LDPE mailing bag
Alternative	Reusable mailing bag made from recycled polypropylene

The two packaging types have very different lifecycles. They require different raw materials to produce, the alternative packaging has additional transport in its reverse logistics, and they are treated differently at the end-of-life. The baseline packaging at the end-of-life after a single use is assumed to be recycled at a rate of 40%. This is below the 55% PPWD 2030 recycling target for plastics because LDPE is more difficult to recycle than other plastics such as PET bottles.

The alternative reusable packaging only reaches its end-of-life after 20 uses and is assumed to be recycled at a rate of 70%. The only additional transport considered for the reusable bag is the transport from the user back to logistics hub. This is where the bags are quality checked before they are sent back to the e-commerce distribution centre, and this leg of transport is assumed to be 500 km by truck.

Figure A-19 Lifecycle of baseline and alternative mailing bag for a single use. Check marks indicate differences between the baseline and alternative and x's indicate no or negligible differences.



Methods

A simplified LCA was performed to quantify the difference in environmental impacts between the two packaging types. The LCA focused on the life cycle stages where the two packaging types differ the most, i.e. where the largest differences in environmental and cost impacts are expected.

The functional unit chosen for the LCA was one trip of a mailing bag, from raw material production to end-of-life. Since the reusable bag can be used 20 times, only one bag needs to be produced for 20 trips, whereas 20 single-use bags need to be produced for 20 trips. Similarly, after one trip the single-use bag the bag needs to be treated for disposal, whereas this only occurs every 20 trips for the reusable bag.

The data inputs and the assumptions are stated in the table below. It is important to note that Ecoinvent does not contain data for recycled polypropylene, so recycled polyethylene was used as a proxy. Although polypropylene has a higher melting point than polyethylene and may require higher energy inputs for melting during the recycling process, the Association of Plastic Recyclers states that the "HDPE/PP recycling processes are nearly identical".[4] It is also important to acknowledge that although RePack uses recycled PP, it cannot be verified for certain with the resin manufacturer that the resins are truly recycled. Ecoinvent also does not have the recycling of low-density PE, thus high-density PE was used as a proxy as this is the closest alternative. Lastly, the baseline packaging weighing of 10 grams is an educated assumption based on the fact that the average plastic grocery bag (thicker than 50 micron) weighs 6 grams, and the mailing pouch is assumed to be slightly heavier.[8]

Data and assumptions

Packaging	Parameter	Data	Data source/ assumption
Baseline	Weight	10 g	Assumption
	Material composition	Low density polyethylene (LDPE)	Assumption based on ASOS case study; Ecoinvent data PE, low density, granulate {RER}

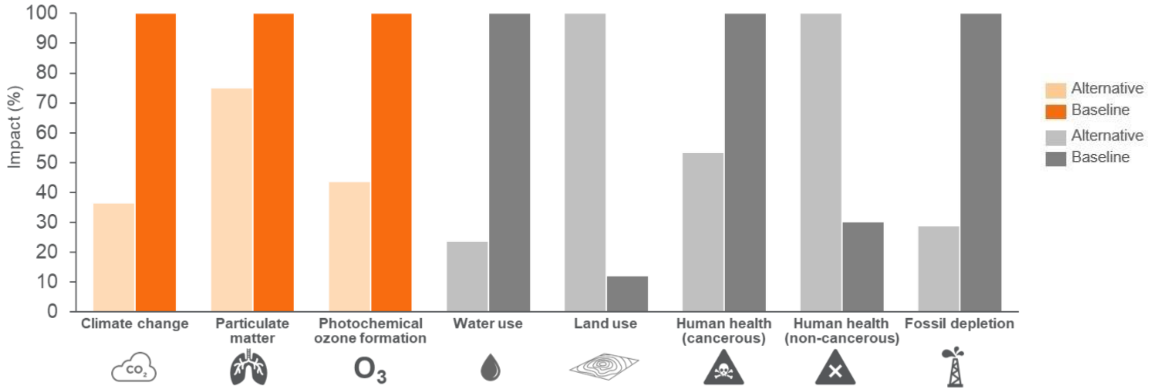
	End of life treatment	40% recycled 6% landfilled 54% incinerated	Assumption and Revised legislative proposal on waste Ecoinvent data 1) PE, high density, granulate, recycled {Europe without Switzerland} 2) incineration waste PE, {CH} 3) sanitary landfill waste PE, {CH}
	Reuse rate	1	Assumption single-use
Alternative	Weight	80 g	Assumption based on RePack reusable envelope
	Material composition	Recycled polypropylen e	Assumption based on RePack reusable envelope; Ecoinvent data ***PE,*** high density, granulate, recycled {Europe without Switzerland}
	End of life treatment	70% recycled	Assumption; Ecoinvent data ***PE,*** high density, granulate, recycled {Europe without Switzerland}
	Reuse rate	20	Assumption based on RePack
	Recovery rate	100%	Assumption
	Transport hub to distribution centre	500 km	Ecoinvent data for transport, freight, lorry 16-32 metric ton, euro5, {RER}

Environmental Impacts

The reusable packaging performed better than the single-use packaging in all impact categories except for non-cancerous human health and land use. The reusable bag performs worse in non-cancerous human health and land use because of the additional truck transport of the packaging being returned from the user to the logistics hub. Although the percentage differences appears large, in absolute terms it is nearly negligible.

For the three most robust impact categories, climate change, particulate matter, and photochemical ozone formation, the reusable bag performs far better than the single-use bag with reductions of 63%, 25%, and 56% respectively. The reductions are largely caused by the same phenomenon; since the reusable packaging is made of recycled PP, the only burdens that are allocated to it are the burdens of recycling rather than the burden of virgin production. Additionally, 20 single-use bags need to be produced compared to 1 reusable bag for 20 trips. In regard to climate change, the LDPE bag has added emissions from partial incineration which are larger than the avoided emissions it is credited with for displacing heat and electricity. Lastly, the baseline packaging uses more water because of the virgin production of LDPE.

Figure A-20 Environmental impacts of baseline and alternative packaging. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Cost Impacts

Manufacturing costs

There is a price premium for the alternative packaging compared to the baseline. Single-use bags range from €0.10 – €0.50 per unit depending on the volume, whereas a reusable envelope made of recycled polypropylene is more in the range €0.50 – €1.00 per unit.[5] This means that per trip, the reusable bags are on par or even cheaper than disposable ones. For the reusable bag company however, the packaging costs are only a small driver of overall costs compared to logistics.

Logistics costs

The largest differences between the baseline and alternative are in the transport costs. For reusable packaging to be profitable, the transport from the user to the logistics hub and then back to the e-commerce retailer is the largest driver of costs. This of course depends on the distance between the user and the nearest logistics hub, which can vary depending on the reuse system.

End-of-life treatment costs

Since the reusable mailing bag only needs to be recycled every 20 trips, the waste treatment costs are presumably lower than the waste treatment costs for 20 single-use bags. For incineration with electricity and heat recovery, costs are €129/ tonne, with a profit of €28/ tonne from electricity production, resulting in overall costs of €101/ tonne.[7] The net cost for recycling plastic is likely to be several hundred euros per tonne, however, this number can vary because the selling price of recycled plastics will differ depending on the quantities processed and the quality of the recycled plastic produced, so it is not possible to estimate an actual figure with the available data. Overall, costs of end-of-life management per tonne might increase, but the product is used multiple times so the relative end-of-life costs would certainly go down.

Conclusions

The reusable packaging performs better in most environmental aspects, and results in a 415 g CO_2eq saving per shipment. This figure is sensitive to many assumptions in the LCA study, such as the transport distance from the user to the logistics hub, the recycled content of the reusable bag, and the 100% return rate. Transport distances could be greater (although 500 km is already on the conservative side), recycled content of resin cannot be completely verified with manufacturers, and return rates are lower in reality, around 75%.[5] Regardless, with e-commerce growing in Europe, the impact of switching to reusable packaging will only grow. Reusable packaging alternatives could even be applied to packaging outside of the e-commerce sector.

Switching to reusable packaging also makes sense from a cost perspective. There are no significant costs in manufacturing and waste treatment, rather it is the cost of transport for reverse logistics that is most relevant, and only for the reusable packaging providers. With RePack's model, the bag is shipped back to the logistics hub via post, but other options are being explored. Customers could alternatively return mailing bags back to supermarkets or retail stores (as is done with beverage bottle deposit systems) where they can be aggregated – reducing the environmental and cost impacts of transport back to the logistics hub.

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G.4 Case Studies Relating to the Minimum Number of Trips for Reusable Packaging

G.4.1 The break-even point for reusable pallets

Nature of Case Study	*Reusability*
Packaging Sector	*Tertiary*
Packaging Material(s)	*Plastic* *Wood*

Introduction

Reusable pallets used in the transport and storage of products can have a more beneficial environmental footprint than single-use pallets due to the avoided production of new pallets and avoided disposal or recycling. Like most reusable products, reusable pallets may require different material types and a greater weight of material to increase the durability of the pallet during its longer lifecycle.

These impacts need to be considered to determine how many times a pallet needs to be reused to have an environmental benefit compared to a disposable, single-use pallet. The point, or number of trips, at which the environmental impacts of the reusable system are lower than a single-use system is referred to as the *break-even* point.

This case study investigates the break-even point of reusable versus single-use pallets.

Lifecycle

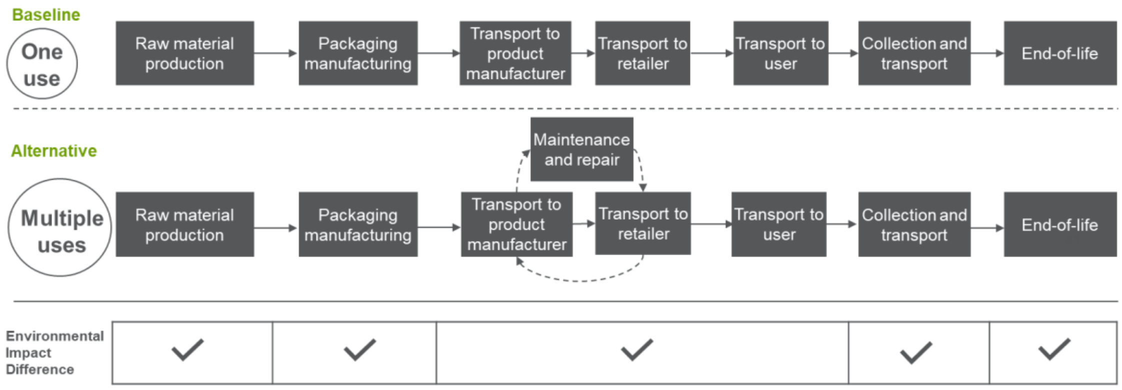
This case study compares the following two packaging types:

Packaging	Description
Baseline	Single-use pallets
Alternative	Reusable plastic and wooden pallets

It is important to note that single-use and reusable pallets tend to transport different types of products. Single-use pallets are meant for lighter goods whereas reusable pallets can transport heavier goods. Single-use pallets are often tailor-made to their purpose and differ in weight, size and material compared to reusable pallets. This means that the function of reusable and single use pallets differ slightly. This is an important limitation when comparing the two types of pallets.

The lifecycles of the two packaging types are very similar and only vary in the number of uses. Reusable pallets also have the added steps of being transported back to a manufacturer and require occasional maintenance and repair. As illustrated in Figure A-21, it is expected that the environmental impact of a reusable pallet differs from the single-use pallet in each life cycle stage due to the reuse of the pallet.

Figure A-21 Lifecycle of baseline and alternative beverage containers.



Methods

A literature review of existing life cycle assessments (LCAs) focusing on reusable and single-use pallets was conducted to compare estimated break-even points. The only impact category considered was global warming potential (GWP), which is limited in scope but provides for a single and simple break-even point.

When comparing different LCAs it is important to consider that the break-even points can vary depending on many assumptions and parameters, including:

- Weight and type of material of the pallet
- Disposal option of the single-use pallet
- Number of times the pallet is reused and the pool size
- Supply chain distances
- Impacts associated with repair of pallets

Environmental Impacts

One LCA study comparing reusable and single-use pallets of different material types in Australia concluded that reusable pallets of all studied material types have a lower impact on climate change than single-use pallets considering 1,000 customer trips, carrying the same load, as the functional unit (see Table A-8). Reusable softwood pallets have the lowest impact on climate change, followed by reusable hardwood pallets (used 83 times), reusable plastic pallets (made of recycled HDPE and used 63 times), single-use softwood pallets (used twice), with single-use cardboard pallets having the highest impact on climate change. The single-use pallets perform the worst because 1,000 single-use cardboard pallets and 500 single-use softwood pallets need to be manufactured compared to only 12-16 of reusable pallets. The break-even point for the reusable pallets thus would range from 23 for wooden pallets to 47 times for plastic pallets.[1]

Table A-8 Climate change impact of single-use and reusable pallets[1]

	Climate change kg CO_2eq	Number of reuse times	Number of pallets needed per 1000 trips
Softwood – reusable	599	83.3	12
Hardwood – reusable	730	83.3	12
Plastic – reusable	1.637	62.5	16
Soft wood – single use	1.079	2	500
Cardboard – single use	12.296	0	1000

The actual reuse of pallets is estimated to be 25 times for wooden pallets and 50 times for plastic pallets.[2] We can therefore conclude that the actual reuse times of pallets is very close to the break-even point for pallets, and consequently environmental benefits are not considered large.

It is important to consider the assumptions behind the break-even point. In this study, it is assumed that the single-use pallets are landfilled 25% by weight and 75% is assumed to be mulched up for particleboards, used for landscape mulch or animal bedding, or combusted for energy. Changing this end-of-life scenario of single-use pallets can consequently change the break-even point of the reusable pallet. The end-of-life situation can be different in Europe, compared to Australia. Another assumption of the plastic reusable pallet is that it is made of recycled HDPE. If it were instead assumed to be made of virgin HDPE, the reusable plastic pallet would perform better environmentally and would lower the break-even point for reusability.

Conclusions

The findings of this case study show that the break-even point for wooden pallets is about 23 reuse times and for plastic pallets about 47 reuse times. Actual reuse of pallets is estimated to be 25 times for wooden pallets and 50 times for plastic pallets.[2] We can therefore conclude that the actual reuse times of pallets is very close to the break-even point for pallets, and consequently environmental benefits are not considered large. However, it should be noted that the break-even points are based on one source only.

References

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G.4.2 The break-even point for reusable beverage containers

Nature of Case Study	*Reusability*
Packaging Sector	*Primary*
Packaging Material(s)	*Polyethylene terephthalate (PET)* *Glass*

Introduction

Refillable beverage containers provide an opportunity to reduce packaging waste, however volumes are slowly declining in Europe. In Western Europe specifically, there were only 40.2 billion refillable beverage units sold in 2015 compared to 63.2 billion in 2000.[1] The sectors with the largest market implementation for refillable bottles are water, carbonated soft drinks, and beer. Refillable beverage systems can have a more beneficial environmental footprint than one-way systems because of the avoided production of new beverage containers and avoided disposal or recycling of the container. However, reusable containers may use more material or different material types to increase the durability of the product to withstand its several uses. The transport, cleaning, and refilling of beverage containers in a refillable system also have associated environmental impacts. These impacts need to be considered to determine how many times a beverage container needs to be reused to have an environmental benefit compared to one-way packaging. The point, or number of refills, at which the environmental impacts of the refillable system are lower than a one-way system is referred to as the *break-even* point.

This case study investigates the break-even point for reusable beverage containers of a reusable system versus single-use. For refillable beverage containers, the two main material types used are plastic (typically PET) and glass, thus these were the two material types studied.

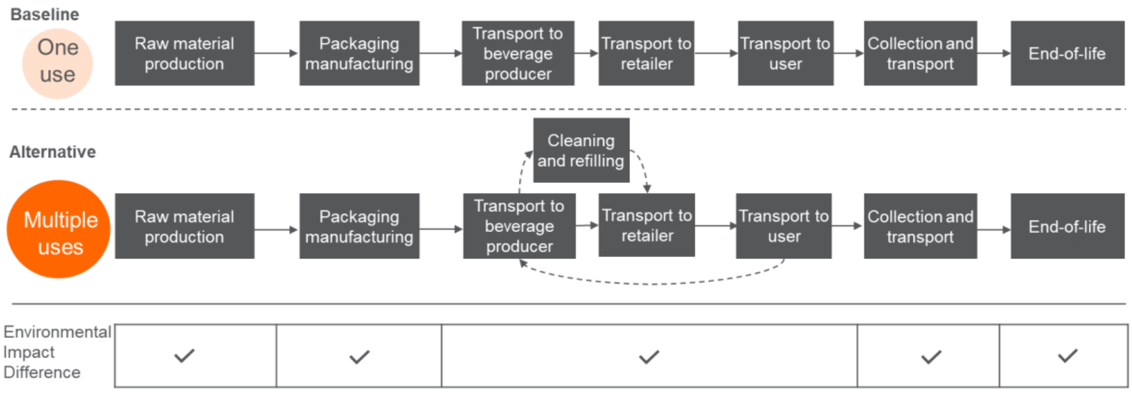
Lifecycle

This case study compares the following two packaging types:

Packaging	Description
Baseline	Single-use PET and glass bottles
Alternative	Reusable PET and glass bottles

The lifecycles of the two packaging types are very similar, but vary in the number of times of use. The single-use container is used once whereas the reusable container is transported back to the beverage producer where it is cleaned and refilled before being transported back to the beverage retailer for subsequent uses.

Figure A-22 Lifecycle of baseline and alternative beverage containers. Environmental impact difference considered over entire lifetime of the beverage container rather than a single use.



Methods

A literature review of existing life cycle assessments (LCAs) focusing on refillable PET and glass beverage containers was conducted to compare estimated break-even points. The only impact category considered was global warming potential, which is limited in scope but provides for a single and simple break-even point.

When critically assessing LCAs, it is important to consider that the break-even points can vary depending on many assumptions and parameters including:

- Weight and type of material of the container
- Disposal option of the one-way container
- Number of times the reusable container is refilled and the pool size
- Supply chain distances
- Impacts associated with washing and repair/replacement of reusable containers

The conclusions of LCAs thus cannot always be directly compared if these types of assumptions differ and this was taken into consideration when comparing results.

Environmental Impacts

Of the several LCA studies conducted on refillable beverage containers, the general conclusions upon which they agree are:[2,3,4]

- Refillable beverage systems have a lower environmental footprint
- Refillable beverage systems have a better environmental footprint in supply chains with short transport distances and high recovery rates (rate that containers are collected back after use)

In one study comparing refillable versus one-way PET and glass beverage containers, the break-even point for PET and glass was determined to be after 1-2 refills.[5] Although glass bottles are typically heavier than PET bottles, they has a lower break-even point than PET in this study because the production of glass is very energy intensive, thus avoiding glass production with refillable bottles prevents greater GHG emissions. It is important to note that the environmental benefit of refill systems declines and plateau after a certain number of uses (7-9 uses). This is because broken containers need to eventually be replaced with new virgin containers.

The assumptions behind the break-even point need to be considered as different assumptions could result in a higher or lower break-even point. This study assumed a collection and recovery rate of bottles of 100%, whereas the rate is lower in reality and would consequently increase the break-even point. For example, even in deposit systems that have some of the highest recovery rates, only 77% of refillable PET bottles are recovered.[6] It was also assumed that 100% of PET and glass bottles in the one-way system are recycled. If it were instead assumed that only a fraction of bottles were recycled, as is the case in reality, refillable systems could perform even better environmentally, and the break-even point could perhaps be even lower. Most recent data shows that 74% of glass is recycled in the EU (although this figure is not specific to reusable bottles) and only 57% of PET bottles .[9,10] If these recycling rates were instead used, this would change the break-even point.

In practice, glass bottles can be refilled up to 50 times and PET bottles up to 15 times.[6] Experts who developed LCA guidance for calculating product environmental footprints of packaging agreed on 20 uses as the standard to be used for refillable glass bottles in pools owned by companies and 30 uses for pools operated by third parties.[7] As a comparison, another PET refillable bottle producer estimated that refillable bottles only need to be replaced after 20 trips.[8] Despite the range of claimed number of uses, it is evident that the break-even point is far below the maximum number of trips the bottles can technically complete before degrading.

Conclusions

The break-even point for reusable beverage systems versus single-use bottles clearly range depending on several assumptions of an LCA. This being said, the break-even point for glass and PET is approximately 1-2 refills. Both PET and glass bottles can be used many more times before they are degraded, therefore the break-even point is within the lifetime of reusable beverage containers. For an improved environmental impact, reusable beverage containers should be adopted in place of single-use ones and could have the largest potential for implementation in the water, carbonated soft drink, and beer sectors.

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G.4.3 The break-even point for reusable packaging in transport of electrical and electronic equipment (EEE)

Nature of Case Study	*Reusability*
Packaging Sector	*Tertiary*
Packaging Material(s)	*All*

Introduction

In Europe, the electrical and electronic equipment (EEE) market is expected to reach €346 billion in 2019. The majority of these electronics are transported with disposable packaging, which needs to be disposed of or recycled after the appliance is delivered to the user. Reusable packaging for EEE transport cannot only avoid disposal but can also have a more beneficial environmental footprint because of the avoided production of new materials after one use. However, reusable packaging may use more material or different material types to increase the durability of the product to withstand its several uses. The transport, cleaning, and redistribution in a reuse system also have associated environmental impacts. These impacts need to be considered to determine how many times reusable transport packaging needs to be reused to have an environmental benefit compared to single-use packaging. The point, or number of uses, at which the environmental impacts of the reusable packaging are lower than a single-use alternative is referred to as the *break-even* point.

This case study investigates the break-even point for reusable packaging for EEE transport versus single-use packaging.

Lifecycle

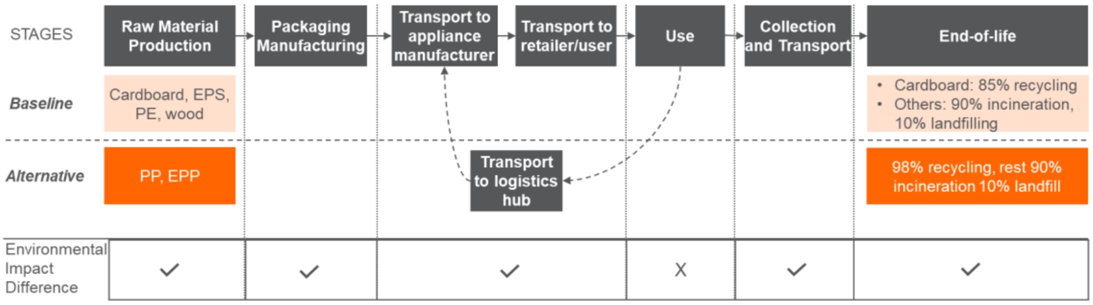
The reusable packaging outlined in the electric and electronic equipment case study (see section G.4.3) was used to model the lifecycle and calculate the break-even point. It was assumed that conventional packaging for EEE transport typically consists of a cardboard box with expanded polystyrene (EPS) inserts and wood for protection and is wrapped in polyethylene (PE) for protection from moisture. Reusable packaging available on the market, such as the Free Pack Net case study is made of polypropylene (PP) with expanded polypropylene (EPP) inserts.

This case study compares the following two packaging types:

Packaging	Description
Baseline	Single-use packaging for EEE transport including cardboard, expanded polystyrene (EPS), wood, and polyethylene (PE) film
Alternative	Reusable polypropylene packaging for EEE transport with expanded polypropylene (EPP)

The lifecycles of the two packaging types are shown in Figure A-23.

Figure A-23 Lifecycle of baseline and alternative packaging for EEE transport.



Methods

Since reusable EEE transport packaging is not widely available on the market, there are no LCAs that exist in public literature to compare this option to single-use options. Free Pack Net has an LCA conducted by a third party for their own purposes, but details cannot be publicly disclosed. However, insights from this LCA were used to conduct a high-level LCA, as further detailed in the reusable packaging for electric and electronic equipment case study in section G.3.1). The geographical scope of this LCA is Europe.

It is important to consider that the break-even point can vary depending on many assumptions and parameters including:

- Weight and type of material of the packaging
- Disposal option of the single-use packaging
- Number of times the reusable packaging is used and the pool size
- Supply chain distances
- Impacts associated with washing and repair of reusable packaging

These need to be taken into consideration when evaluating a break-even point.

Environmental Impacts

According to the high-level LCA performed, the break-even point for reusable EEE transport packaging is 3 uses. If the reusable packaging is only used twice, the environmental impact of the entire lifecycle is more burdensome than using two single-use packaging. This is assuming a distance of 250 km from the user back to the appliance manufacturer and could vary depending on this assumption. Regardless, the break-even point is far lower than the actual reuse rate of reusable EEE transport packaging. A conservative estimate for the number of times of reuse is 15, but Free Pack Net has also held trials that served up to 40 uses before reaching the end-of-life.

Conclusions

If EEE transport packaging were mandated to be reusable, the minimum number of trips should be at least 3, as there would be no environmental benefit if it were used a lower number of times. This is reasonable considering current reusable packaging on the market is used 15-40 times.

This break-even point is only relevant for packaging transported by road, and other modes such as rail, ocean, or air would need to be assessed independently.

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G.5 Case Studies Relating to Manufacturing and Composition

G.5.1 Use of recycled content at design stage

	Nature of Case Study	*Recyclability, e-commerce, etc.*
	Packaging Sector	*No specific sector*
	Packaging Material(s)	*Key packaging materials for various applications*

Introduction

This case study focuses on the environmental benefits of using recycled content in packaging materials. Using recycled content in some packaging – particularly food and drink applications (which makes up at least 70% of household packaging) – is not possible in many cases due to, for instance, restriction following from EFSA assessments. This limits the use of recycled content significantly, but it can still be used in a wide range of other applications. Recycled content is already used by many packaging manufacturers, but the percentage could be substantially increased for some materials.

Lifecycle

This case study compares the virgin (baseline) and recycled (alternative) material of the following key materials:

- Steel
- Aluminium
- Cardboard/paper
- Glass
- Plastics (PET, HDPE)

The lifecycles of virgin and recycled materials are very similar but differ in raw material production (see Figure A-24). For virgin materials, the raw material production includes the acquisition of the raw materials from nature (forestry for wood used for paper, iron ore extraction for steel, etc.) and the production of the material itself (paper, or steel). For recycled materials, it includes waste collection, sorting, and the recycling process, and the production of the material itself.

The quality of recycled materials can be lower than the quality of the virgin material for different reasons. The waste stream may contain contamination, e.g. mineral oil can be found in waste paper (newspaper and magazine printpaper can contain fossil-based inks), which decreases the quality of the recycled paper and the possible applications. It could also be that waste streams contain mixed materials leading to downcycling (plastics). The recycling rate in Europe varies by type of packaging material, and seems to be the highest where the quality of the recycled material is equivalent to the virgin material (steel, aluminium, cardboard, paper and glass). Plastic packaging has the lowest recycling rate, but plastics are also downcycled in most cases, except for PET bottles with SSP – recycling (see Table A-9).

Figure A-24 Lifecycle of baseline and alternative.

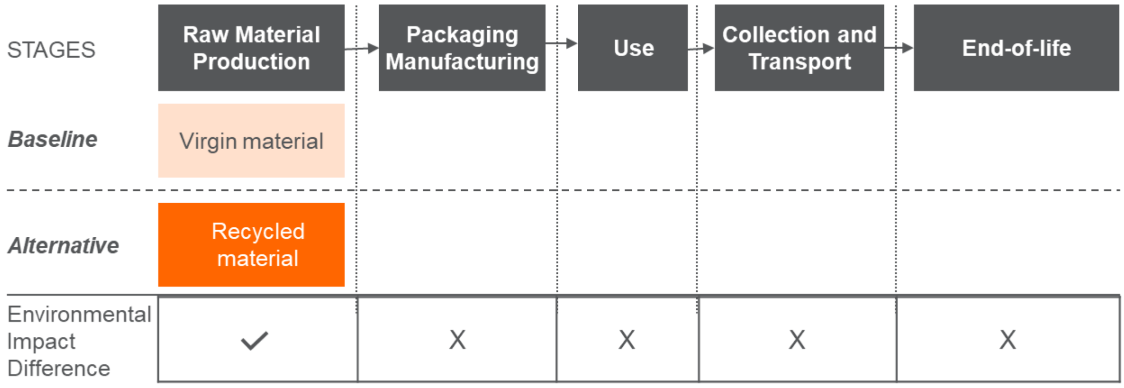


Table A-9 Recycling rate and loss of quality for various materials in Europe

Material	Recycling rate in Europe[1] (%)	Quality of recycled material / quality of virgin material[1]
Steel	74%	1
Aluminium	69% (Cans, closures, trays) 43% (Liquid beverage carton)	1
Cardboard	75%	0.85 (when fibre losses are not taken into account) 1 (when fibre losses are taken into account)
Paper		
Glass	66%	1
Plastics	42% (PET bottle)	1 (PET – SSP recycling) 0.9 (PET mechanical recycling)
	No values reported (PE, PP, EPS, PVC, HDPE, LDPE)	0.9 (PP) 0.9 (HDPE) 0.75 (LDPE film)
	43% (Liquid beverage carton)	

Methods

A simplified LCA was performed to quantify the environmental benefits of recycled material compared to virgin material. The LCA focuses on the raw material extraction (or waste collection and recycling) and material production only. The life cycles were modelled in the software SimaPro.

Data and Assumptions

Baseline/ alternative	Material	Data	Data source
Baseline	Virgin steel	1 ton	Ecoinvent, steel low alloyed, converter {RER}
	Virgin aluminium	1 ton	Ecoinvent, aluminium wrought alloy, aluminium ingot primary {GLO}
	Virgin glass	1 ton	Ecoinvent, packaging glass, green, without cullet {GLO}
	Virgin PET	1 ton	Ecoinvent, PET, granulate, bottle grade, production {RER}

	Virgin PE	1 ton	Ecoinvent, polyethylene, high density, granulate {RER}
Alternative	Recycled steel	1 ton	Ecoinvent, steel low alloyed, electric {RER}
	Recycled aluminium	1 ton	Ecoinvent, wrought alloy, treatment of aluminium scrap, post-consumer, prepared for recycling, at remelter {RER}
	Recycled glass	1 ton	Ecoinvent, packaging glass green, 83% glass cullets {RER}
	Recycled PET	1 ton	Ecoinvent, PET, granulate, bottle grade, recycled {RER}
	Recycled PE	1 ton	Ecoinvent, polyethylene, high density, granulate, recycled to generic market for high density PE granulate {Europe without Switzerland}

Environmental Impacts

The Figures below show the environmental benefits of recycled packaging materials compared to virgin packaging materials. Overall, recycled packaging materials have a much lower environmental impact than virgin materials, and increasing the percentage of recycled content in packaging materials will lead to significant environmental benefits. It should be noted that the figures show the environmental benefits of shifting from 100% virgin to 100% recycled packaging materials, while most packaging materials contain a certain percentage recycled content at present. A detailed description of the findings is listed below:

- **Steel:** Recycled steel performs better in all relevant impact categories. The use of recycled steel reduces the impact on climate change by ~80%, the impact on fossil depletion by ~70% and the impact on particulate matter by ~70%. The impact on human health is negligible after normalisation and weighting. Resource use, minerals and metals is the most important impact category after weighting (not included in the figure) and recycled steel performs far better than virgin steel (~95% less impact on resource use, minerals and metals).
- **Aluminium:** Recycled aluminium performs better in all impact categories compared to virgin aluminium. The use of recycled aluminium reduces the impact on climate change, fossil depletion and particulate matter by ~95%.
- **Glass:** Recycled glass performs better in all impact categories. The use of recycled glass reduces the impact on climate change by ~30%, the impact on fossil depletion by ~15% and the impact on particulate matter by ~10%.
- **PET:** Recycled PET performs better in all impact categories. The use of recycled PET reduces the impact on climate change by ~85%, the impact on fossil depletion by ~90% and the impact on particulate matter by ~85%.
- **HDPE:** Recycled HDPE performs better in all relevant impact categories. The use of recycled HDPE reduces the impact on climate change by ~65%, the impact on fossil depletion by ~85% and the impact on particulate matter by ~60%. The impact on land use and human health is negligible after normalisation and weighting.
- **Corrugated board box:** Corrugated board boxes are ~75% recycled at present. It is not common to use 100% virgin corrugated board boxes; therefore this comparison was excluded from the study.

Figure A-25 Environmental impacts of virgin versus recycled steel. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.

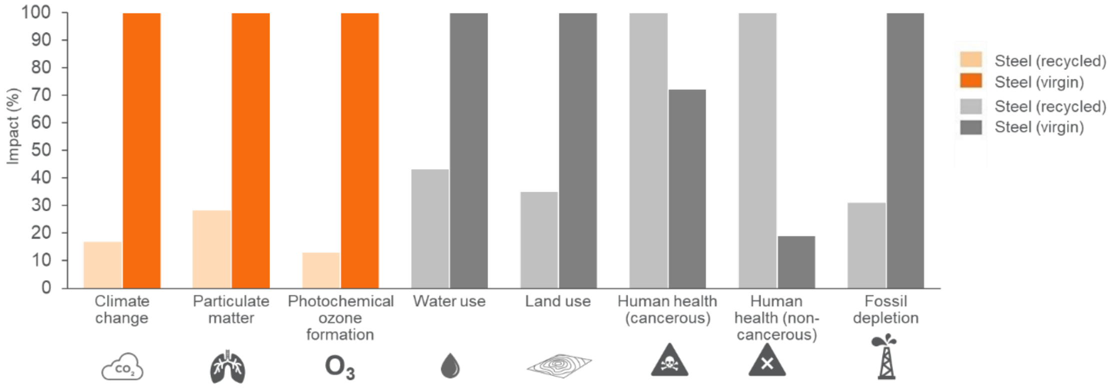


Figure A-26 Environmental impacts of virgin versus recycled aluminium. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.

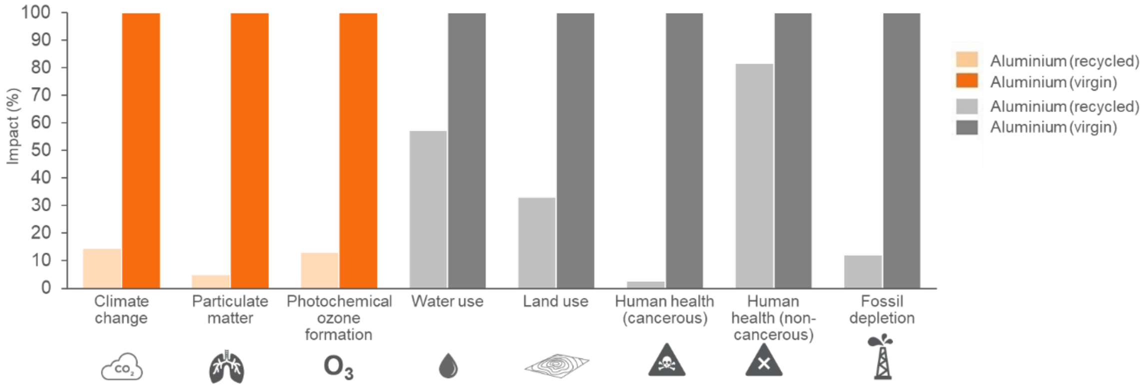


Figure A-27 Environmental impacts of virgin versus recycled glass. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.

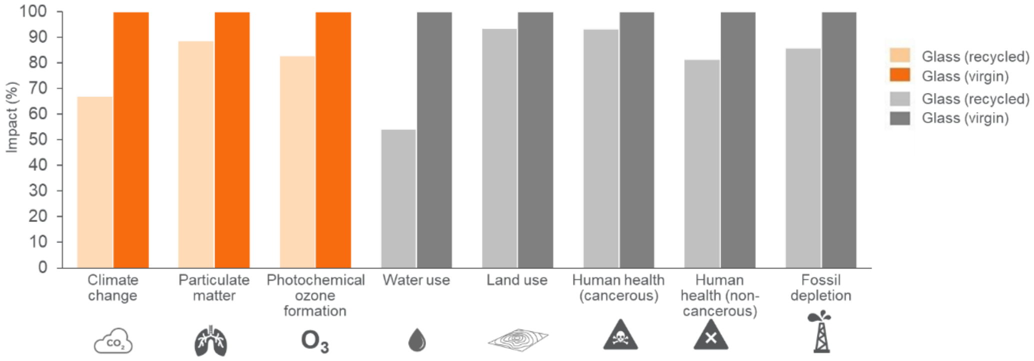


Figure A-28 Environmental impacts of virgin versus recycled PET. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.

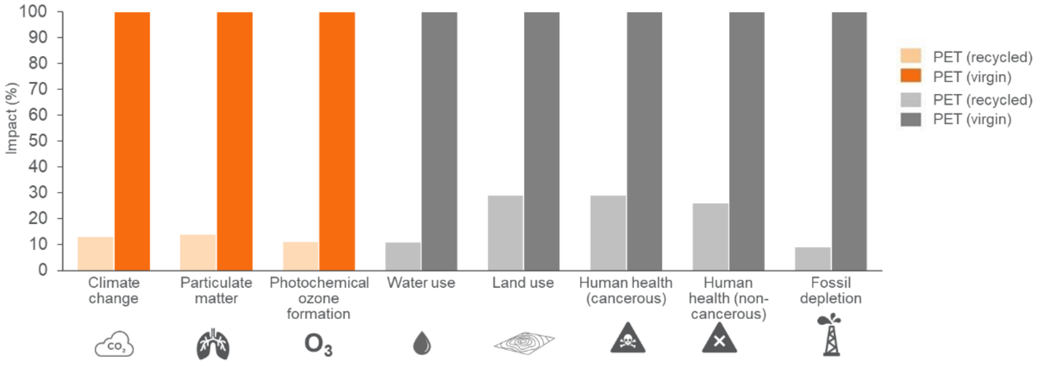
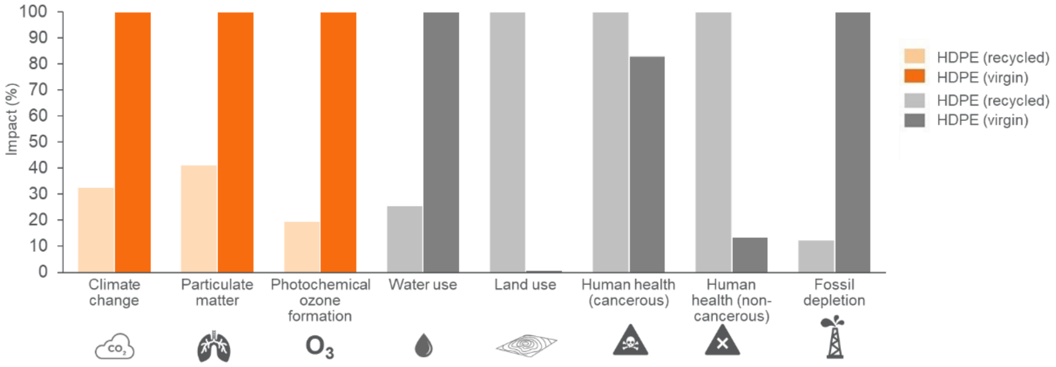


Figure A-29 Environmental impacts of virgin versus recycled HDPE. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Conclusions

Recycled packaging materials have a much lower environmental impact than virgin materials, and increasing the percentage of recycled content in packaging materials will lead to significant environmental benefits. Increasing the current – relatively low – recycling rates for plastics will lead to a significant reduction in environmental impacts, especially the impact on climate change, fossil depletion and particulate matter. Due to regulatory restrictions to safeguard food safety[70], the use of recycled content in food packaging is more difficult, which would lead to fewer possibilities for food packaging.

References

1. Product Environmental Footprint Category Rules Guidance. Version 6.3 - May 2019, Annex C.

[70] https://ec.europa.eu/food/safety/chemical_safety/food_contact_materials/legislation_en

G.5.2 Optimisation of void space in e-commerce packaging

Nature of Case Study	***E-commerce***
Packaging Sector	*Tertiary*
Packaging Material(s)	*All*

Introduction

E-commerce experienced an 11% growth in Europe in 2017 and is expected to grow in the coming years.[1] This growth in e-commerce is likely to mean a consequent growth in packaging and packaging waste. One way to reduce this waste is to optimise the size of packaging to fit the need of a product, and research shows that there is room for significant improvement in this area. Packaging company DS Smith found that 50% of e-commerce packaging is more than a quarter empty, with the average empty space in toy packaging at 52%. Optimising void space in packaging not only reduces the amount of packaging waste to be treated but reduces the environmental impact from transporting oversized packages. DS Smith estimates that bricks and mortar supply chains average five touchpoints, compared to a minimum of 20 in the ecommerce journey, so transport is significant.

Packaging sizes can be optimised using software that can then recommend the optimum box range for product packaging. There is also machinery that can produce boxes of tailored sizes in millions of different size combinations in an automated, high throughput process. This case study explores the environmental and cost impacts of implementing such solutions that optimise packaging sizes in e-commerce.

Lifecycle

This case study compares the following two packaging types:

Packaging	Description
Baseline	Non-optimised cardboard box with HDPE film air pillows
Alternative	Optimised cardboard box with 43% less volume with HDPE film air pillows

The optimised cardboard box is assumed to have 43% less void space as this is the reduction claimed by DS Smith's Made 2 Fit packaging size solution (*reference DS Smith case study in Appendix F*).

The lifecycles of the two packaging types are very similar (see Figure A-30). They differ only in the amount of void space, thus the volume for transport, as well as a reduced amount of HDPE air pillow production used as a filler in the packaging and slightly reduced amount of cardboard.

The end-of-life treatments are the same for both packaging but are considered to have both environmental and cost impacts because of the slight difference in material waste. The cardboard is assumed to be recycled 85% to reflect the PPWD 2030 recycling target for cardboard. The HPDE air pillows are recycled at a rate of 40% since this thin and light plastic is more difficult to recycle and will therefore have a lower recycling rate than the 55% 2030 target for plastic recycling in the PPWD.

Figure A-30 Lifecycle of baseline and alternative e-commerce cardboard box packages. Check marks indicate differences between the baseline and alternative and x's indicate no or negligible differences.

STAGES	Raw Material Production	Packaging Manufacturing	Transport to distribution centre	Transport to user	Use	Collection and Transport	End-of-life
Baseline	Cardboard HDPE air pillow						Cardboard: 85% recycled HDPE: 40% recycled
Alternative	6% less cardboard 43% less HDPE air pillow						• 100% recycled
Environmental Impact Difference	✓	X	X	✓	X	X	✓
Cost Impact Difference	✓	X	X	✓	X	X	✓

Methods

A simplified LCA was performed to quantify the difference in environmental impacts between the two packaging types. The LCA focused on the life cycle stages where the two packaging types differ the most, i.e. where the largest differences in environmental and cost impacts are expected.

DS Smith claimed a 43% in box volume reduction, which corresponds to 6% less cardboard material by weight (using the volume to surface area ratio of an average sized box of 44x40x45 cm and 140 g). It is assumed that a 43% reduction in box volume consequently results in a 43% reduction in air pillows used for filling and cushioning, since less space needs to be filled. The volume reduction is also assumed to translate to a 43% reduction in transport to the user since trucks could have a greater load capacity with boxes containing less air, i.e. more boxes can fit in a truck for shipment.

Since recycled cardboard is not available in Ecoinvent, recycled newsprint paper was used as a proxy. The filler is assumed to be 100% virgin HDPE, the typical material type used for air pillows.

Data and assumptions

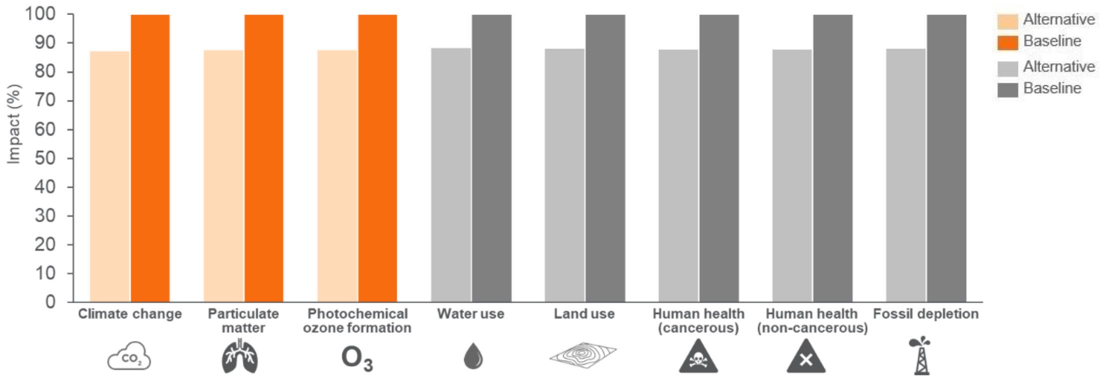
Packaging	Parameter	Data	Data source/ assumption
Baseline	Weight	140 g box 5 g filler	Assumption based on medium sized cardboard box (44x40x45 cm * density)
	Material composition	Cardboard Virgin HDPE	Ecoinvent data of 1) corrugated board box, {RER} 2) PE, high density, granulate {RER}
	End of life treatment	Cardboard: 85% recycled HDPE: 40% recycled	2030 recycling rate targets PPWD and assumption; Ecoinvent data of 1) paper, newsprint, recycled {Europe without Switzerland} 2) PE, high density, granulate, recycled {Europe without Switzerland}

	Transport to user	200 km	Ecoinvent data for transport, freight, lorry 16-32 metric ton, euro5, {RER}
Alternative	Weight	131.6 g box 2.85 g filler	Assumption based on DS Smith 43% volume reduction
	Material composition	Cardboard Virgin HDPE	Ecoinvent data of 1) corrugated board box, {RER} 2) PE, high density, granulate {RER}
	End of life treatment	Cardboard: 85% recycled HDPE: 40% recycled	2030 recycling rate targets PPWD and assumption; Ecoinvent data of 1) paper, newsprint, recycled {Europe without Switzerland} 2) PE, high density, granulate, recycled {Europe without Switzerland}
	Transport to user	200 km	Ecoinvent data for transport, freight, lorry 16-32 metric ton, euro5, {RER}

Environmental Impacts

The alternative packaging achieves an improvement of 12-13% in environmental performance for all impact categories. For climate change, each optimised box has an 13% GHG savings, or 29.4 g CO_2eq.This is because slightly less cardboard and HDPE has to be produced for boxes that have been reduced in size. This also consequently means that less cardboard and HDPE needs to be recycled at end-of-life of the packaging. Although the optimised box has lesser void space and more boxes can fit in a truck shipment, this is lesser driving factor as transport has 30 times less impact than the production and recycling of materials.

Figure A-31 Environmental impacts of baseline and alternative packaging. Coloured bars indicate most robust impact categories and grey bars indicate less robust impact categories.



Cost Impact

<u>Manufacturing costs</u>

There is an added cost for purchasing the packaging optimisation software. However, since less material needs to be produced for smaller boxes, there are savings in manufacturing costs for raw materials. DS Smith estimates that the use of their void optimisation software, eBro, results in an overall packaging cost reductions of 11-55%, so the raw material savings outweigh the added software cost.

A potential major saving can also be made through reduction in labour required by using automated machinery such as DS Smith Made 2 Fit. Based on the shipment of 3,000,000 boxes per year, DS Smith estimates that the labour requirement for packing would reduce from 40 staff down to 5 or 6.

Logistics costs

Depending on whether shipping is charged on a weight or volume basis, there are savings in logistics. For example, DS Smith estimates savings in transport of €0.11 per box. Reducing empty space can also minimise damage to the product and hence reduce the number of returns to retailer and the associated loss in product value.

End-of-Life treatment costs

Since the optimised packaging has slightly less material, the costs for end-of-life treatment would be slightly lower but would not be significant considering the entire lifecycle of the packaging.

Conclusions

Optimising the size of packaging in e-commerce to better fit products has a small but beneficial environmental impact. In terms of global warming potential, an optimised box can have savings of 29.5 g CO_2eq. This study focus on road transport of packages, however if aviation were instead considered, the GHG savings would be even greater as air freight is far more GHG intensive than truck freight.

Data is not available for the number of e-commerce cardboard box shipments in Europe, but growth in e-commerce is expected, and optimising the size of packaging could have a large and growing environmental benefit.

As for costs, optimising packaging sizes is beneficial along the entire value chain. Although there are added costs for investing in size optimisation software or equipment, there are savings to be realised in raw materials, manufacturing, and transport. Therefore, optimising packaging sizes is a simple but beneficial requirement. This case study focuses on e-commerce, however optimising packaging size could be applied to all packaging for a larger impact.

References

1. E-commerce Packaging Market in Retail Industry 2018 Ongoing Trends - Reuters, accessed 29 April 2019, https://www.reuters.com/brandfeatures/venturecapital/article?id=34305

G.6 Absolute LCA results from the case studies

The table below shows the absolute LCA results from the case studies.

Impact Category	Climate change	Respiratory inorganics	Photochemical ozone formation, HH	Water scarcity	Land use	Cancer human health effects	Non-cancer human health effects	Resource use, energy carriers
Unit	kg CO2 eq	kg NMVOC eq	disease inc.	m3 depriv.	Pt	CTUh	CTUh	MJ
Flexible pouches: baseline	0.097	1.98E-09	2.00E-04	0.016	0.033	5.45E-10	1.23E-09	1.184
Flexible pouches: alternative	0.028	7.68E-10	7.88E-05	0.005	0.034	2.07E-10	5.03E-10	0.563
Black plastic: baseline	0.101	3.02E-09	2.09E-04	0.031	0.350	1.13E-09	6.38E-09	1.324
Black plastic: alternative	0.061	2.23E-09	1.52E-04	0.023	0.277	8.81E-10	4.70E-09	1.049
EPS: baseline	1.191	2.27E-08	2.17E-03	0.537	-0.020	7.12E-09	1.08E-08	12.705
EPS: alternative	0.332	1.43E-08	9.41E-04	0.410	51.156	4.43E-09	1.31E-07	5.724
Stretch wrap: baseline	1.719	3.07E-08	4.85E-03	5.537	0.973	2.02E-08	1.37E-07	23.801
Stretch wrap: alternative	1.476	4.65E-08	4.36E-03	0.610	9.371	1.34E-08	4.45E-08	29.145
Multilayer wrapper: baseline	0.007	6.18E-10	2.02E-05	0.002	0.021	2.15E-10	1.28E-09	0.098
Multilayer wrapper: alternative	0.004	1.49E-10	7.20E-06	0.009	0.003	7.96E-12	4.21E-11	0.079
Mailing bag: baseline	0.655	1.56E-08	1.60E-03	0.121	0.294	4.34E-09	7.48E-09	10.201
Mailing bag: alternative	0.239	1.17E-08	6.97E-04	0.029	2.422	2.32E-09	2.48E-08	2.928
Size optimisation: baseline	0.232	1.41E-08	7.14E-04	0.160	26.345	2.81E-09	7.41E-08	3.636
Size optimisation: alternative	0.203	1.23E-08	6.27E-04	0.142	23.254	2.47E-09	6.53E-08	3.209
Laundry: baseline	149.875	3.90E-06	3.34E-01	75.823	3838.251	1.02E-06	8.33E-06	2028.917
Laundry: alternative	19.514	9.18E-07	6.83E-02	4.373	130.189	1.80E-07	1.35E-06	456.772
Cleaning product: baseline	11.388	5.71E-07	3.52E-02	2.679	104.243	1.23E-07	1.21E-06	177.365
Cleaning product: alternative	0.436	1.69E-08	1.23E-03	0.136	2.139	5.31E-09	3.09E-08	8.037

The table below shows the absolute LCA results comparing 1 kg of virgin material and 1 kg of recycled material.

Impact Category	Climate change	Particulate matter	Photochemical ozone formation	Human health (non-cancerous)	Human health (cancerous)	Land use	Water us	Resource use, fossil
Unit	kg CO2 eq	kg NMVOC eq	disease inc.	CTUh	CTUh	Pt	m3 depriv.	MJ
Virgin steel	2,37	1,18E-02	2,02E-07	4,64E-07	4,88E-07	12,78	0,57	23,95
Recycled steel	0,40	1,56E-03	5,74E-08	2,41E-06	6,73E-07	4,51	0,25	7,47
Virgin aluminium	17,67	5,50E-02	1,30E-06	2,93E-06	9,21E-07	46,63	2,54	160,18
Recycled aluminium	0,79	2,67E-03	4,13E-08	4,40E-07	9,51E-09	11,02	0,53	8,82
Virgin glass	1,29	4,53E-03	1,31E-07	1,37E-07	1,59E-08	22,24	0,37	15,34
Recycled glass	0,86	3,75E-03	1,16E-07	1,11E-07	1,48E-08	20,78	0,20	13,16
Virgin PET	3,36	9,96E-03	1,45E-07	2,79E-07	5,31E-08	16,77	1,53	74,44
Recycled PET	0,44	1,13E-03	2,05E-08	7,26E-08	1,55E-08	4,90	0,17	6,78
Virgin HDPE	2,12	8,60E-03	7,66E-08	1,14E-08	1,50E-08	0,06	0,58	71,16
Recycled HDPE	0,69	1,69E-03	3,16E-08	8,37E-08	1,80E-08	7,85	0,15	8,83

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