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ANNEX 1. Background Report - Barriers to sustainable design from a chemicals perspective for flexible food-grade plastic packaging

Series on Risk Management
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This is an Annex that was prepared as a background report to the workshop held in Paris, 20-21 September 2022.

This document is available in PDF format only. The workshop report is available under the cote ENV/CBC/MONO(2023)1.

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Series on Risk Management
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IOMC
INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS
A cooperative agreement among FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD

Environment Directorate

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Paris 2023

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This publication was developed in the IOMC context. The contents do not necessarily reflect the views or stated policies of individual IOMC Participating Organisations.

The Inter-Organisation Programme for the Sound Management of Chemicals (IOMC) was established in 1995 following recommendations made by the 1992 UN Conference on Environment and Development to strengthen co-operation and increase international co-ordination in the field of chemical safety. The Participating Organisations are FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD. The purpose of the IOMC is to promote co-ordination of the policies and activities pursued by the Participating Organisations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

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Note from the secretariat

This is an Annex to the report on the OECD Workshop on Flexible Food-Grade Packaging – Economic, Regulatory or Technical Barriers to Sustainable Design from a Chemicals Perspective – How Can Policy Makers Help?

Two background papers were developed to support the workshop discussions and are available as Annexes to the workshop report. Annex 1: Background Report - Barriers to sustainable design from a chemicals perspective for flexible food-grade plastic packaging – was developed by Partners for Innovation. Annex 2: Background Report - Government policies and regulations impacting the sustainable design of flexible food-grade packaging – was developed by Stena Circular Consulting.

The workshop report is available under the cote ENV/CBC/MONO(2023)1. The workshop report was endorsed for publication by the Working Party on Risk Management and is published under the responsibility of the Chemicals and Biotechnology Committee.

ANNEX 1. Background Report - Barriers to sustainable design from a chemicals perspective for flexible food-grade plastic packaging

Background paper for the workshop

Developed for the OECD by Ingeborg Gort, Jannes Nelissen & Flora Poppelaars | Partners for Innovation | April 2022

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EXECUTIVE SUMMARY

To guide worldwide policy discussions regarding solutions to lower barriers to sustainable design from a chemicals perspective, this study explores the industry perspectives on economic, technical, or regulatory barriers to this endeavour in the case of flexible plastic food grade packaging. This document was drafted to prepare the reader for a workshop on *'Flexible food grade packaging – economic, technical or regulatory barriers to sustainable design from a chemicals perspective – how can policy makers help?'* scheduled in May 2022.

Industry representatives in the flexible plastic food grade packaging value chain identified the following barriers and formulated a series of recommendations.

Economic barriers

- Low cost of virgin fossil material and high cost of recycled and renewable feedstock
- Limited supply of recycled & renewable feedstock
- Economic lock-ins due to past investments in infrastructures and machinery at the packaging, collection, sorting and recycling stages of the packed goods' life cycle.
- Highly sorted film packaging waste is economically unviable
- Lack of demand from brand owners and retailers
- Lack of demand and/or confusion from consumers
- Lack of funding

Technological barriers

- The use of secondary feedstock as raw material for food grade plastic film is limited due to contamination of the material in the previous use cycle or in the recycling process.
- Low quality of recycled food packaging film due to contamination through exposure or through design (e.g. inks and pigments, and barrier layers)
- No consensus on chemical recycling
- Issues with transparency on chemical composition
- Restrictions to the development of new materials
- Few technical benefits to biodegradable polymers

Regulatory barriers

- Lacking guidance for assessment and measurement (i.e. definitions, assessment methods, guidelines and indicators, and standards)
- Systemic barriers (i.e., national and international variations, and uncertainty over future regulations)
- Conflicting regulations

Recommendations

These economic, technical and regulatory barriers are addressed in policy and action recommendations outlined by the industry representatives.

Overcome economic barriers

- Level playing field costs of virgin fossil material versus recycled and renewable feedstock, and increase the supply of recycled and renewable feedstock (e.g. Extended Producer Responsibility (EPR) regulation extended to closed loop food grade plastic systems)
- Break economic lock-ins by avoiding uncertainties through information during policy development and subsidizing pilots
- Stimulate the demand from retailers and brand owners through for example eco-modulation or a smart plastic tax
- Stimulate the demand from consumers and avoid confusion with e.g. regulating sustainability claims and harmonizing collection instructions

Overcome technical barriers

- Increase the availability of food safe recycled plastic, for instance, by altering regulations to focus on hazardous substances or through digital water marking technology.
- Stimulate the development and selection of the most sustainable materials
- Improve transparency in the value chain through standardization, risk assessment and liability

Overcome regulatory barriers

- Prevent conflicting regulations by e.g. starting with measurable targets and striving for complementarity
- Harmonize regulations and policies regarding collection, sorting and recycling across regions
- Remove barriers for chemical recycling

Recommendations made by other initiatives are also summarized to complement the overview.

1. INTRODUCTION

1.1 BACKGROUND

Although plastics provide various benefits to society, the impact of its chemical components on human health and the environment must be considered. The OECD's recent Global Plastics Outlook showed that the current plastics economy is distant from circular. As the global annual production of plastics has doubled within two decades, plastic waste has more than doubled from 156 Mt in 2000 to 353 Mt in 2019 (OECD, 2022). The destination of this plastic stream was in majority sanitary landfills (50%), while a part of it ended in uncontrolled dumpsites, burned in open pits or leaked into the environment (22%), or incinerated (19%). Only the remaining part (9%) was finally recycled.

In 2018, the OECD organized a Global Forum on Environment focussed on 'Plastics in a Circular Economy: Design of Sustainable Plastics from a Chemicals Perspective' (OECD, 2018). The Global Forum aimed to incentivise a shift in sustainable chemistry thinking during product design by identifying good practices and a policy framework to reduce the environmental and health impacts of plastics. This initiative resulted in various background papers on the sustainability of plastics from a chemical perspective. Following this, additional work was conducted on considerations for sustainable design resulting in the publications 'A Chemicals Perspective on Designing with Sustainable Plastics: Goals, Considerations and Trade-offs' (OECD, 2021), and 'Case Study on Biscuit Wrappers' (OECD, 2021) and three additional supporting case studies (OECD, 2021) (OECD, 2021) (OECD, 2021).

As a next step to this work, the OECD examines the economic, technical and regulatory barriers of the considerations outlined in the 2021 publications and the potential policy solutions to incentivise more sustainable design from a chemicals perspective.

To this end, the case of flexible plastic food grade packaging is further studied. This case is particularly interesting for several reasons. First, it is (being) regulated in a large part of the OECD member countries restricting the use of specific chemicals in packaging in contact with food. Also, various industry initiatives have been launched in this sector to transition towards more sustainable and circular plastics. Finally, the seemingly simplicity of this type of packaging is deceitful as the food contact, shelf life of the packaged food and other health and environmental aspects already add complexity.

1.2 OBJECTIVE

The main objective of this study is to convey the industry perspectives of the economic, technical and regulatory barriers to a more sustainable design of flexible plastic food packaging from a chemicals perspective.

This background report is meant to guide worldwide policy discussions regarding solutions to lower economic, technical and regulatory barriers to sustainable design from a chemicals perspective. It serves as a preparation for a workshop on *'Flexible Food Grade Packaging – Economic, Technical or Regulatory Barriers to Sustainable Design from a Chemicals Perspective – How Can Policy Makers Help?'* scheduled for May 2022.

The active participation of industry representatives is sought for along the value-chain in the flexible plastic food grade packaging industry. To bring together these perspectives, the OECD commissioned Partners for Innovation to engage with industry stakeholders and analyse and report their insights.

1.3 SCOPE

The starting point of this study builds up on the 2021 publications.

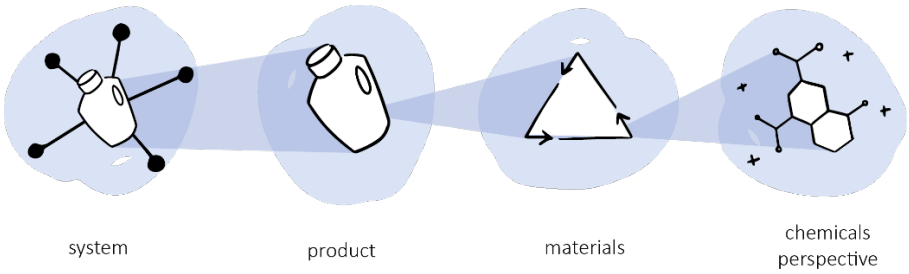
Chemicals perspective

The chemicals perspective encompasses various aspects:

- **Polymer class**: classification of polymers based on properties (e.g., thermoplastics or thermosets)
- **Polymer type:** a specific sort of polymer within a polymer class (e.g., PET or PP)
- **Grade:** a specific structure and molecular mass within a polymer type
- **Additives:** substances added to the polymer to improve its properties (e.g., pigment or flame retardant)
- **Blends:** combination of polymers (e.g., thermoplastic-thermoplastic blend)
- **Production residues:** substances that do not deliberately remain in the material (e.g., catalyst or monomer)
- **Non-intentionally added substances (NIAS):** substances that have not been deliberately added to the material or unplanned new substances resulting from contact to other materials (e.g., due to degradation substances that leach into the material)

Note that the chemical perspective is interrelated with system, product and material aspects as shown in Figure 1.

Figure 1. Relationship between system, product, materials and a chemicals perspective. The chemicals perspective is interconnected with design decisions made at a system, product and material level (OECD, 2021)



Sustainable plastics

As defined earlier by the OECD, sustainable plastics are "plastics used in products that provide societal benefits while enhancing human and environmental health and safety across the entire product life cycle" (OECD, 2018). They impede the creation of waste, toxins, and pollution from their inception to their next use or end-of-life. Sustainable plastics should thus have a lower impact on the climate, help promote a more circular economy and help meet the objectives of the United Nations Sustainable Development Goals.

Flexible plastic food grade packaging

The value chain selected for this study focuses on flexible plastic food grade packaging. Within this study's scope, this packaging type includes films, bags, and pouches filled with food meant for human consumption. They are usually made of a thin layer of materials like PE or PP.

1.4 OUTLINE OF THE REPORT

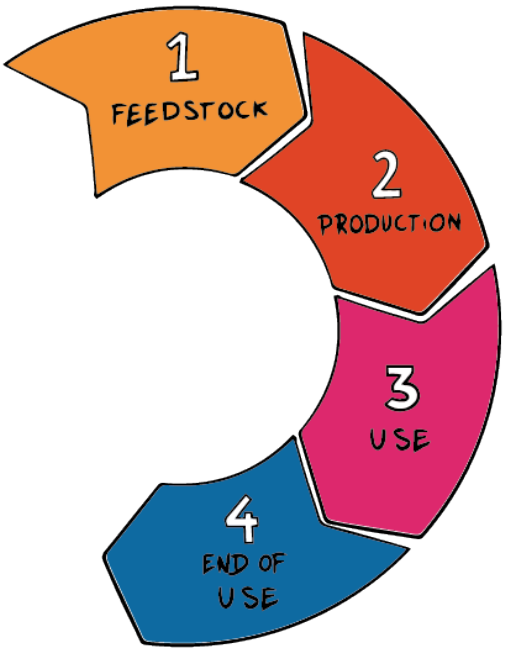
First, the methodology employed to generate the content of this report is documented (Chapter 2). Second, the challenges that industry faces along the design of sustainable flexible plastic food packaging are described. Although interconnected, barriers identified by the involved stakeholders along the value chain are clustered in three categories: economic (Chapter 3), technical (Chapter 4) and regulatory (Chapter 5) barriers. Finally, policy-related recommendations are provided to further improve the design of sustainable flexible plastic food grade packaging from a chemicals perspective based on discussions with the industry stakeholders (Chapter 6).

2. METHODOLOGY

2.1 OVERALL APPROACH

In collaboration with the OECD, industry representatives in the flexible plastic food grade packaging value chain were nominated across regions. The full list of participating stakeholders can be found in Appendix A.

The stakeholders in this value chain are defined as follows along the phases of the life cycle of the flexible plastic food grade packaging.



1. Chemical and polymer producers

Chemical and polymer producers make the chemical raw materials needed to produce flexible food grade packaging using primary, secondary or renewable feedstock.

2. Flexible food grade packaging manufacturers

Using these chemical raw materials, plastic converters produce films, bags, and other types of flexible food grade products. Fillers then package the food.

3. Retailers and brand owners

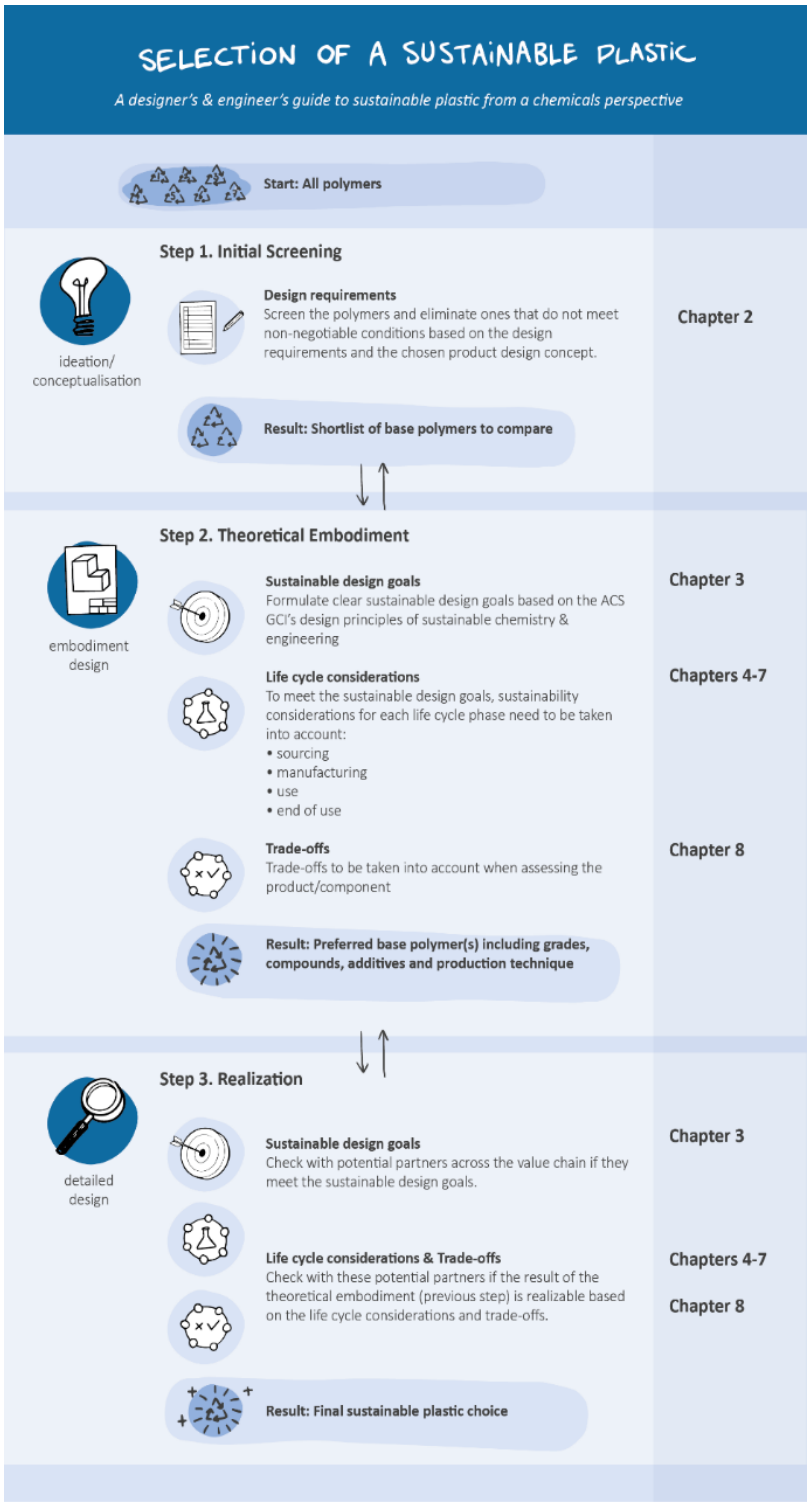
Retailers and brand owners offer their packaged goods to consumers who purchase and eat this food.

4. Waste managers

Collectors, sorters and recyclers gather the flexible food grade plastic packaging from the consumers or from production processes to ideally reprocess them in a sustainable and circular manner.

Through a series of workshops, the representatives were invited to follow the selection process of sustainable plastic outlined in the OECD publication (OECD, 2021), visualized in

Figure 2. Selection process of a sustainable plastic (OECD, 2021)



2.2 DATA COLLECTION

The data collection occurred in January to March 2022 during three workshops and individual calls. It was complemented with a brief literature review when references are indicated in this report. The OECD, workshop participants and additional industry representatives provided their feedback on the first draft of the report.

At the moment of writing, a total of 20 representatives were consulted across the value chain with knowledge from the market in Australia, Canada, the European Union, the United Kingdom, and the United States.

The workshops were held using MS Teams to communicate with the participants and Mural as collective digital whiteboard. Two design cases, namely flexible plastic food packaging for frozen green peas and assorted bread rolls, served as backdrop to the discussions. The first 2-hour workshop focused on the design requirements and sustainable design goals. Building on these requirements and goals, the second 3-hour workshop went into the considerations throughout the life cycle of the to-be-designed products. The last 3-hour workshop investigated the trade-offs within and between the life cycle phases. Economic, technical and regulatory barriers were identified along the way.
Individual calls were performed with missing links in the value chain (e.g. brand owner) who could not attend the workshops.

3. ECONOMIC BARRIERS

The economic barriers identified by the industry participants mostly relate to the low cost of virgin fossil material versus that of recycled and renewable feedstock, the limited supply of recycled and renewable feedstock, economic lock-ins, economically unviable highly sorted film packaging waste, the lack of demand from retailers and brand owners, the lack of demand/confusion from consumers and the lack of funding.

3.1 LOW COST OF VIRGIN FOSSIL MATERIAL AND HIGH COST OF RECYCLED AND RENEWABLE FEEDSTOCK

The industry participants emphasize the high productions costs of recycled and renewable materials compared with virgin fossil materials. Virgin fossil plastic is derived from fossil fuel-based chemicals such as petroleum and natural gas. 'Virgin' expresses the fact that the material has never been used before. They are also called 'primary fossil plastics'. Recycled plastic has been derived from previously made plastic (secondary) sources such as production scraps or post-consumer plastic waste. Renewable plastic is a form of plastic derived from renewable biomass like vegetable oil or corn-starch, preferably originating from waste streams. This plastic is biobased but is not automatically biodegradable or compostable.

The current oil extraction and processing costs are lower than the current costs of collecting, sorting, and processing recycled materials. The collection and sorting of flexible plastic food grade packaging is costly because of amongst other low volumes, contaminations and the size of the packaging (see Chapter 5 on technical barriers). Mechanical recycling of highly sorted streams of different films is economically not viable (yet) because no economy of scale can be reached.

Virgin fossil materials are also less costly than renewable materials. The cost difference is due to their relative scarce availability, which is linked to a lack of demand, creating a chicken-and-egg problem. In the case of both renewable and secondary feedstock, the value chain to process the feedstock into materials has yet to be made as efficient as the virgin fossil material value chain. The investment of established virgin fossil resin suppliers into renewable polymers and recycling technology and infrastructure can help overcome this barrier. However, healthy market forces should remain to drive down the costs of renewable and recycled plastics and not link the prices of these materials to those of virgin fossil plastics.

The difference in costs stands in the way of applying more recycled materials when retailers and brand owners have strict pricing demands for their packaging producers. In this case, virgin fossil material will be used over recycled material.

3.2 LIMITED SUPPLY OF RECYCLED & RENEWABLE FEEDSTOCK

The quantity and quality of the recycled and renewable feedstock supply must be improved. This barrier is interconnected with points 3.1, 3.3 and 3.5, as well as with the current system where food grade quality cannot be assured (see Chapter 4 on technical barriers).

- The availability of food-safe post-consumer recycled materials is rather minimal. Indeed, only recycled PET is available at a large scale. This feedstock, which foremostly comes from closed loop PET bottles from deposit schemes, is food grade. Other examples, such as

recycled HDPE from milk bottles in Australia, the United States and the UK are available in considerably smaller volumes. Although slowly building up, the market for recycled feedstock lacks the scale required based on the envisioned targets and waste stream access through which food grade compatible purity can be guaranteed.

- Retailers and brand owners demand a minimal availability of volume of packaging to secure a steady input of packaging for their consumers. This minimal volume cannot always be guaranteed for recycled plastics or 'other sustainable materials' (e.g., renewable feedstock, chemically recycled materials and 'secondary renewables' such as the reprocessing of cooking grease).
- To reach envisioned targets for recycled plastic applications, the gap between the current quality of food grade plastic recyclate and the demand from retailers, brand owners and consumers needs to be bridged. The demand side is further elaborated in point 3.5.

3.3 ECONOMIC LOCK-INS

Producing, processing, and using recycled or renewable materials may entail modifying and adapting production processes and collection infrastructures. However, over the past decades, stakeholders have optimized their part of the value chain. As a result, economic lock-ins are a barrier to further sustainable developments for flexible plastic food packaging. They are due to past investments in infrastructures and machinery at the packaging, collection, sorting and recycling stages of the packed goods' life cycle.

Investment cycles for packaging machines take approximately eight years (Bening, Pruess, & Blum, 2021). However, they may only be suitable for traditional virgin fossil materials and thus cannot deal with biobased or recycled material (e.g. slower speed due to slower sealing and thicker materials). The present situation with recycled material is a vicious circle. The low demand for recycled mixed plastic film keeps prices relatively low from a waste manager perspective, which leads to less investment, and thus leads to lower quality recyclate. As mentioned in point 3.1, from the manufacturer perspective, the costs of recycled material are still higher than for virgin fossil material, which does not stimulate higher demand. The lock-ins currently do not permit sorters and recyclers to make viable investments in sorting and recycling technologies.

This lock-in is exacerbated by the complexity of the value chain. Indeed, the composition and handling of films is so complex that an adjustment at one point in the value chain requires all others to adjust. Changes thus require actions throughout the system by various stakeholders.

3.4 HIGHLY SORTED FILM PACKAGING WASTE IS ECONOMICALLY UNVIABLE

To improve the quality of mechanically recycled plastics form flexible food packaging waste, a higher degree of sorting of the waste into different material streams is needed. It is currently economically unviable to sort plastic film in highly sorted recycling streams for each polymer, as is done for the common polymers in rigid plastic packaging. The variety in polymer composition in plastic films is too great, the mass of the packaging in proportion to possible contamination too low, and the required sorting steps too many. The economics can be improved when films are designed for sorting and recycling by moving towards mono-materials, and sorting technology is improved for more efficient sorting. Sorters do not invest in the technology as long as the chemical composition of the films varies too much and the demand for the low-quality recycled plastic is low. Converters and brand

owners will not commit to mono-material packaging as long as the films are not further sorted and will end up in a mixed waste stream.

3.5 LACK OF DEMAND FROM BRAND OWNERS AND RETAILERS

Although the production of sustainable flexible plastic food packaging is technically possible, requirements concerning costs, aesthetics, and possibly over-engineered properties can limit the selection of sustainable choices.

For instance, recycled materials for flexible plastic food packaging currently cannot always meet the aesthetic product criteria requested by retailers and brand owners. The same goes with long shelf-life expectations. The question is raised regarding the appropriate shelf life for food and whether current expectations (from retailers, brand owners and consumers) are not over engineered. This requirement may for example cause the use of barrier layers that can hinder the recycling of the plastic film (see Chapter 4 for technical barriers). What makes the most sense from a sustainable perspective considering the impact of food waste and consumer behaviour (e.g., perception of fresh)?

The higher costs of renewable materials compared to virgin fossil material (3.1) lead to less demand from retailers and brand owners in general. As a result, the supply of renewable material is not further developed at a large scale (3.2). On top of this, the sustainability of renewable feedstock is complex (e.g., not competing with food systems and impact on recycling process) and requires research.

Some retailers and brand owners have a list of internally banned materials limiting possibilities. However, these lists do not always appear to be fact-based. For instance, although not mandatory by law, they may voluntarily decide to only use plastics that are proven to be recyclable. This is based on company-wide sustainability policy but might disregard that in some applications recyclable plastics are not automatically the best solution (i.e., considerations in the OECD publication 'A Chemicals Perspective on Designing with Sustainable Plastics: Goals, Considerations and Trade-offs' (OECD, 2021)).

3.6 LACK OF DEMAND/CONFUSION FROM CONSUMERS

The requirements voiced by retailers and brand owners is linked to the expectations and needs from their consumers who will hopefully purchase and eat the packaged goods.

The requirements from consumers relevant to the subject of this report pertain foremostly to aesthetic and financial criteria. For example, due to technical barriers, transparent films are difficult to achieve with recycled flexible plastic food grade packaging. Discoloured transparent food packaging have yet to gain traction by consumers. Also, as recycled materials are more expensive than virgin fossil materials, the price of the packaged goods will reflect this.

Greenwashing has been identified as an important barrier by the participants. Greenwashing is "the act of misleading consumers regarding the environmental practices of an organization (firm-level) or the environmental benefits of a product or service (product/service-level)" (de Freitas Netto, Sobral, Ribeiro, & da Luz Soares, 2020). Navigating various sustainability claims as a consumer is intricate. As demonstrated by amongst other the OECD report 'Chemicals Perspective on Designing with

Sustainable Plastics: Goals, Considerations and Trade-offs', sustainable flexible plastic food grade packaging is the result of meticulous considerations throughout the life cycle phases from a chemical to a system level. Consumers do not know what to do as they are getting contradicting information depending on the source and location. Contradicting claims can lead to erroneous public perception, which in turn can spark the launch of less circular solutions to fulfil their needs and wants. For example, as paper has a better image than plastic in some cultures, this perception drove the replacement of plastic frozen food packaging by paper packaging with a plastic coating, which may impede recycling.

3.7 LACK OF FUNDING

As the costs and benefits of investing in sustainable solutions are not linearly linked to the investor, it is unclear how system change should be organized across the stakeholders in value chain (Bening, Pruess, & Blum, 2021). Note that everchanging legislative frameworks lead to uncertainties on the viability of investments in waste management solutions, which in turn impedes an improvement of the supply of recycled material. More on this in Chapter 5 on regulatory barriers.

Extended Producer Responsibility (EPR) in for instance the European Union requires producers and importers of flexible food grade packaging to pay a fee to finance the collection and processing of packaging waste. Although the height of this fee is typically publicly available, the way that these fees are spent to improve the system is perceived as rather opaque towards stakeholders in the value chain.

When they have the means, converters analyse the supply of recycled materials themselves. Industry participants indicated that they occasionally find banned chemicals. These contaminations can for example occur when small quantities of foreign packaging with other legislations have entered the batch. As the recycled material has to compete with virgin fossil material prices, recyclers do not always have the means to test at this small scale. They are relying on the quality of the delivered data and supply of to-be-recycled products.

Lack of sustained investment

Several contributors had examples of pilots with more sustainable packaging use, that were discontinued after the initial pilot. These were initiatives from brand owners and retailers with dedicated recycling of plastic film, the use of plastic from renewable feedstock, or chemically recycled plastics in packaging, usually with industry partners such as polymer producers or recyclers. The pilots are costly but show good intention by the initiators and can be used for green marketing and as a proof of concept. However, the investments to scale up after the pilot are deemed too high and the developments are discontinued.

4. TECHNICAL BARRIERS

Almost all technical barriers are related to recycling of plastic film or the use of recycled content in food grade plastic film. The industry representatives want to establish a circular economy in which secondary feedstock is used to create the plastic film, the film is recovered after use and will be recycled into raw material for new products. A distinction can be made between the use of recycled plastic from any source in the production of food grade plastic film (i.e., post-industrial recycled plastic or from after the use phase (i.e., post-consumer recycled plastic). Another distinction can be made between the use of recycled food grade film in new food grade film or in new non-food applications.

4.1 FOOD SAFETY OF MECHANICALLY RECYCLED PLASTICS

During the workshops and interviews, safety of the consumers was noted as the highest priority in the design process of food packaging film. The use of secondary feedstock as raw material for food grade plastic film is limited due to contamination of the material in the previous use cycle or in the recycling process. Currently the only food grade post-consumer recycled plastic (PCR) is sourced from selectively sorted waste streams that are recycled in dedicated recycling operations. PET from bottles in deposit refund schemes is the biggest source of food grade PCR. HDPE and PP are available in much smaller volumes from food containers in tightly controlled closed loops of food containers, usually in the business-to-business market.

To increase the availability of food grade PCR, contributors have proposed to shift the focus of the regulation on food contact materials. Instead of regulating the source and value chain of the recycled material, the material itself should be tested to be food safe. This should not lead to a compromise on food safety, thus more research is needed to ensure product safety with recycled content. Test standards for food safe recycled plastic should be developed. One brand owner expressed that they cannot accept any risk of contamination of mechanically recycled PP and PE and will thus only use chemically recycled feedstock for these polymers.

4.2 LOW QUALITY OF RECYCLED FOOD PACKAGING FILM

After use, the plastic food packaging film is commonly recycled in low-grade applications. If it is collected and sorted, it is sorted in a stream of mixed plastic film waste. The economic barrier to improved sorting has been discussed in point 3.4. The polymers in this mixed recycling stream have different properties and can't be recycled to high-grade applications. Because relatively little material is used in packaging film (compared to rigid packaging), small amounts of contaminations in and on the film result in relatively big contaminations in the recycling stream, creating lower quality recyclate and low yields.

Contamination through exposure

High-grade recycling of film packaging waste is further complicated by contamination of the material. This can be due to exposure to contaminants during the use phase and in the waste management process, such as food residues, other packaging materials and breakdown products from polymers and additives in the recycling process. Without dedicated sorting streams of food contact plastics without other plastic waste, the risk of non-intentionally added substances (NIAS in the recycled plastics is too high for the plastic to be used for food contact applications. For instance, non-food

contact additives from non-food contact packaging contaminate the combined recycling stream. In the OECD case study on biscuit wrappers (OECD, 2021), NIAS were identified as a food safety risk in flexible plastic packaging. This risk increases when recycled plastics are used due to contaminants such as inks and adhesives or breakdown products from the polymer itself. This issue was acknowledged by workshop contributors and interviewees. However, strategies to reduce this risk were not further discussed.

Contamination through design

Other contaminants to the recycling stream are added to the material in the design of the packaging. The main disruptors that were identified in the workshops and interviews were inks and pigments and barrier materials.

- Inks & pigments

While a minimum amount of ink is unavoidable to meet information and safety requirements, excessive printing and pigment use for marketing purposes impede recycling of the plastic packaging. Interviewed brand owners acknowledged this issue and their responsibility in overcoming the barrier. Washable inks that can be removed from the plastic in the recycling are seen as a solution. This requires investments from both the packaging producers in new inks, as from the recyclers in deinking infrastructure. Furthermore, the brand owners should collectively phase out inks and pigments that significantly affect the quality of the recycled plastics. Collective action is needed, as the prints and colours are used to differentiate between brands at the point of sale, all parties should make the same adjustments. In some cases a possible solution could be the use of easy removable sleeves or banderoles, which are printed instead of the film.

- Barrier layers

The use of barrier layers is another frequently mentioned restriction for recycling. These layers consist of other polymers than the main polymer of the film and are added specifically because their material properties are different. This is needed to prevent permeation of water vapor, oxygen, or odours through the film into the food, to prevent deterioration and food waste. However, these different material properties also impede the recycling of the plastic. Some converters and industry representatives have noted that with current technology the barrier requirements can be met with minimal use of barrier layers in the packaging film. Barrier layers that make up less than 10 mass percent of the film should be sufficient to meet barrier requirements and not impede recycling high-grade recycling of the packaging. Films with larger barrier layers are still used because the packaging is overengineered and shelf-life expectations for packaged food have increased. Not all contributors agreed with this statement. The use of barrier layers in the packaging is based on sustainability and economic considerations. These increased shelf-life requirements for the packaged food are for instance deemed necessary due to longer supply chains, rotation cycles of slower moving products, and the spread of production capacity over a year for products with a peak demand. The barrier performance of flexible packaging is an important solution to food waste and no sacrifice should be made on food waste reduction, all contributors and interviewees agree. Multiple polymer layers can also be added to increase strength of the packaging. This is required when product is hot when its filled, to decrease the amount of packaging material in the secondary and tertiary packaging, and to accommodate to fast filling lines.

Closed-loop mechanical recycling of food packaging film is not yet possible

In the two previous sections it has been discussed that the availability of food grade PCR is low and that mechanically recycled plastic from food packaging is of low quality. Establishing a closed loop in which recyclate from food packaging film is used in the production of new food packaging film is thus currently not possible. One industry representative noted that polyolefin film cannot be food safe mechanically recycled due to the chemical structure. The porous polyolefin films cannot be decontaminated in a recycling process and conclusively be proved to be fully decontaminated like for instance PET from the bottle recycling can. However, examples of recycled polyolefins that are accepted as safe food contact materials exist. For instance, HDPE from separately collected milk jugs in the UK and specific separately sorted rigid PP food packaging that is closed-loop recycled in business-to-business applications.

4.3 NO CONSENSUS ON CHEMICAL RECYCLING

Mechanically recycled food packaging film is of low quality and cannot be used as feedstock for new food packaging film. Chemical recycling was discussed in the workshops and interviews as an alternative to mechanical recycling and was broadly seen as a necessary piece in the puzzle to create sustainable plastic food packaging film. There was no consensus on what can be expected of chemical recycling in terms of economic viability and maturation of the technology.

Chemical recycling of food packaging plastic film has not been conducted on a scale large enough to see it as a reliable source of feedstock for new packaging production. This also creates uncertainty about the economic benefit of chemical recycling: it's not beneficial now, but will that change when used on large scale? Chemical recycling is not regarded as an all-encompassing solution that will also solve other barriers in recycling. There are chemical purification methods that can recycle specifically sorted packaging waste. This is a complementary solution to mechanical recycling that will lead to higher quality recycled plastics. And there are chemical recycling methods that are alternatives to incineration and landfilling of unrecyclable waste streams.

Two recent Lifecycle assessments (LCA's) showed the environmental benefits of chemical recycling of polyolefin films. Schwarz concluded that thermochemical recycling to monomers through pyrolysis results in lower overall CO_2-eq emissions than incineration and open-loop mechanical recycling (Schwarz, et al., 2021). Sphera has performed an LCA specifically on chemical recycling of mixed polyolefin food grade film on behalf of The Consumer Goods Forum (Viveros, Imren, & Loske, 2022). This assessment includes the whole life lifecycle of the production of polyolefin films made from chemically recycled polymers and recycled through pyrolysis as waste management option for the mixed films. This is compared with production of the film from virgin fossil polymers and incineration of the mixed plastic waste. They conclude that the chemical recycling route scores significantly better in terms of CO_2-eq emissions and fossil resource consumption. Both studies indicate that the studied technology has not completely matured yet and the validity of the results should be regarded in this light.
Some contributors point to the fact that chemical recycling of polyolefins through pyrolysis has technically been proven but is not economically viable currently. This makes this an economic barrier, not a technical one. Currently large investments are made in the industry to increase the output of chemically recycled plastics. These investments will drive down future costs. An industry representative notes that if the recycling targets for plastic packaging are increased, the market push of recyclable materials will create a market in which chemical recycling will be economically viable.

4.4 TRANSPARENCY ON CHEMICAL COMPOSITION

Experiences with transparency vary

Again, conflicting views were heard regarding transparency in the value chain about chemical composition of the plastic films. On one hand converters and raw material suppliers note that the flow of information regarding food safety between value chain partners is good up to the converters (packaging film manufacturers). These converters know that all components and intentionally added substances are certified. But once the material enters the hands of the consumers, there is no further traceability up or down the value chain. Information about the composition of the film is lost when the material enters the recycling. For improved recycling of the plastic at end of life, traceability of composition throughout the value chain is deemed necessary for both mechanical and chemical recycling routes. Recyclers benefit from knowledge about which polymers to target in recycling and about contamination by other substances in the film.
However, the experiences with transparency from suppliers vary. Some suppliers supply a lot more information on their product than they are required to, others cannot supply more than the certificates required by law and date and time of production of the batch. As an example, one contributor highlighted the issue of non-intentionally added substances (NIAS): suppliers are forthcoming with information about the intentionally added substances, but not about non-intentionally added substances. Few suppliers have given risk assessments of what could be in the product.

It is also noted that the converters assume that they have all the data but cannot be sure. The assumption is based on trust and certifications. Some contributors regard certifications as sufficiently transparent, while others point out that too many different certification standards and certifying bodies result in less transparency and leave room for misuse. Documentation that is provided by suppliers may also include disclaimers that deny any liability if the supplied information is incorrect. Traceability of the composition of the packaging seems to depend on the number of middlemen and size of the companies in the value chain. A company that collects information about mass, material, and recyclability of their packaging to supply to their EPR schemes noted that this is hard to assemble for the smaller suppliers. This regards basic information about the packaging, not even details of the chemical composition. Standardization of information, through a form or other medium, that can be supplied down the supply chain will benefit both the companies downstream in their information collection and smaller companies that have to deal with data requests.

Transparency will be increasingly important for food safety

When the use of secondary feedstock increases, transparency in the value chain is going to be increasingly important. Information about source of the secondary material, the recycling and decontamination routes, and NIAS risk assessment are important to assess food safety and might vary with developing markets. To improve transparency, the industry calls for the harmonization of traceability of the chemical composition throughout the value chain. However, caution is needed to protect confidentiality. It is acknowledged that regulating and policing transparency comes with challenges regarding assessment and measurement, administration and legal processes for regulators.

4.5 RESTRICTIONS TO DEVELOPMENT OF NEW MATERIALS

There is a demand for polymers with lower environmental impacts. For instance, through lower impacts at production, based on (sustainably managed) renewable feedstock, with better barrier

properties, or better recycling properties. However, these materials need to fit in the current value chain. In point 3.3 is discussed that current economic lock-ins prevent further sustainable development of food packaging film on a material level. In point 5.2 is discussed that uncertainty over future regulation restricts investment in development of new materials. Furthermore, on a technical level the complexity of the of plastic film production slows adoption of new materials as machinery at all the stakeholders in the value chain needs to be adapted.

The setup of sorting and recycling infrastructure is another barrier to development of new sustainable polymers. New plastics are judged on how well they can be sorted and recycled in the current system, while the system is designed to efficiently recycle only a limited number of commodity plastics. When new polymers are introduced, the previously listed barriers need to be overcome and a critical mass needs to be built to be accepted by recyclers. Up to that point they will be regarded as unrecyclable (and thus less sustainable) materials in EPR systems and in regulation. Converters, polymer producers and industry representatives believe that in the context of EPR systems and regulation, new polymers should be judged on their potential recyclability, not just on whether they can be recycled and sorted right now.

4.6 FEW TECHNICAL BENEFITS TO BIODEGRADABLE POLYMERS

There is a rising demand for biodegradable and compostable plastic packaging, mainly based on public sentiment about plastic waste and littering. Industry experts see few benefits to the use of these plastics. Please note the distinction here between biodegradable, compostable, and 'biobased plastics'.
Biobased plastics are plastics derived from renewable feedstock. They can be biodegradable or compostable but can also have the same properties as fossil-based plastics and can be recycled together. Biodegradability concerns breakdown of plastic waste in naturally occurring substances through the biological action of microorganisms. Biodegradable plastics can be biobased but can also be derived from fossil resources. Compostable plastics are plastics that biodegrade but under specific circumstances: either under the conditions in an industrial composting plant (Industrial compostable) or under the conditions in a compost heap (home compostable). In this section biodegradable and compostable plastics are discussed.

Most biodegradable plastics are industrially compostable only, such as PLA. The unique benefit of these films is that they can be disposed of through the compostable waste in theory. However, whether the films actually decompose as intended, depends on the size and thickness of the film and the time it gets to degrade which is hardly ever met by industrial composters. If the films are composted, they generally do not add nutrients to the compost but do increase the throughput making them unfavourable for composters. Biodegradable films cannot be regarded as a solution to littering, as the specific degradation conditions for each biodegradable polymer vary and do not match conditions in all the environments in which littered packaging waste ends up. Consumers can generally not make the distinction between biodegradable and recyclable films when disposing of their packaging. If the biodegradable films enter the recycling stream it will be another contamination to the mixed recycling stream. The currently available biodegradable polymers do not have the appropriate barrier properties that are required for food with long shelf-life requirements.

Contributors to the workshops and interviews have mentioned two instances when the benefits of compostable films offer the right solution. Primarily, as a packaging material for food from which a large share is going to be disposed of through composting. It was noted that the wasted food in such

a case is a bigger problem than the packaging. And secondly, as a solution to regional waste problems when other waste infrastructure is unavailable, but composting is.

5. REGULATORY BARRIERS

The consulted representatives voice various regulatory barriers to the development of sustainable flexible plastic food packaging from a chemicals perspective. The barriers pertain to the lacking guidance for assessment and measurement, system barriers, and conflicting regulations.
The categories were informed by Bening et al.'s study (2021).

5.1 LACKING GUIDANCE FOR ASSESSMENT AND MEASUREMENT

Definitions

Common definitions are missing for several key terms in the development of sustainable flexible plastic food packaging to create alignment between stakeholders in the value chain.

- A common clear definition of what 'recycled content' means is wanted. Does it, for instance, include or exclude post-consumer recycled plastic? The exact definition of the terms of 'pre-consumer material' and 'post-consumer material' vary in European and international standards. Definitions are expected in the upcoming EU Packaging Waste directive that could be used in other regions.
- A common clear definition of what 'recyclable' means is also lacking. A definition is being developed by the Circular Plastic Alliance that could be considered for use.
- Material exported for recycling is in many areas regarded as 'recycled' by regulators and in statistics. For hard-to-recycle material streams such as mixed flexible plastic waste, this leads to cheap export of the material to foreign facilities without oversight, instead of the more expensive local recycling. This export can result in illegal waste dumps by waste brokers who compete on price.
- A common clear definition of 'sustainable renewable feedstock' based upon life cycle considerations (e.g., not competing with 'higher' uses like food production) is lacking.

Assessing substances

The production of chemicals has increased fiftyfold since 1950 and is expected to further triple by 2050 ((European Environment Agency, 2018) cited in (Persson, et al., 2022)). An interesting tension emerges between the large number of substances and the need for regulations and policies. One can make a blacklist of prohibited substances, but it will be incomplete. One can make a green list of only allowed substances, but it will be too restrictive because there are so many different substances to test, list, and review, and that are continued to be developed.

Conflicting views were heard over the assessment of hazards in the design of plastic film. Contributors to the workshop and interviewees all listed consumer and worker safety as the highest priority in the design process. There was consensus on the notion that materials intended for use in food applications have to be demonstrated to be non-hazardous. Materials that have been studied on hazard potential are preferred over non-studied substances, but also that substances that are allowed by regulation can safely be used. When dealing with risk, a risk mitigation strategy is preferred over a risk avoidance strategy. However, it was acknowledged that not all substances used in the plastic film production are studied or can be studied due to the wide variety and continuing development. It was remarked that brand owners sometimes do stricter checks on food safety of the supplied packaging film and chain of custody than regulators do.

Plastic materials can be made of different layers kept together with adhesives, and they can be printed or coated. Industry representatives indicate that regulations are not clear enough on the use of adhesives, printing inks and coatings in plastics.
In the EU, general requirements to all food contact materials (FCM) and specific measures to some FCM and substances (including plastics and recycled plastics) are provided in the Framework Regulation (EC) 1935/2004. However, the current EU regulations are not clear enough on, for instance, the level of coating allowed. The issue is exacerbated by the fact that member states have allowed different levels of coating.

Guidelines and indicators

Linked to the clarifications of definitions, substance assessment and additives guidance, an alignment in large markets is needed on overall Design for Circular Economy (DfCE)/ Design for Sustainability (DfS) guidelines. Guidelines are seen as an opportunity (and not a threat) for the sector by the workshop participants, especially when the value chain stakeholders are driving them. Going further than guidelines, some representatives ask for common key performance indicators to measure and monitor the sustainable improvements. Workshop participants emphasized the need to look beyond the carbon footprint of the packaging and packaged goods and to consider other aspects such as eutrophication and water use.

Standards

The lacking guidance is especially noticeable at the end of use for sorters and recyclers. Shared standards and labelling would help them discern the composition of plastic packaging.
Also, consumers are often confused by inappropriate or misleading information on packaging. Non-governmental organizations and the industry can push for different interventions, which can make consumers lose trust in the process. Common certifications and/or standards for sustainably managed renewable feedstock and recycled feedstock are needed based on scientific reasoning.

5.2 SYSTEMIC BARRIERS

National and international variations

National and international differences impede more sustainable flexible plastic food packaging. Consumers have difficulties understanding collection requirements due to local differences in collection systems. In addition, multinational retailers and brand owners are active in various markets with their own national recycling targets, collection, sorting and recycling infrastructure and thus Design for Circular Economy (DfCE)/ Design for Sustainability (DfS) guidelines. Therefore, regulations should be harmonized in larger geographical markets. Note that even when regulations are harmonized as much as possible in a large region such as in the European Union, member states still have room for interpretation. This leads to differences within single regions.

Uncertainty over future regulations

Companies and organizations do not commit to large investments in technology as long as future regulations are unclear. A clear direction in regulation of plastic packaging is needed for large enough regions to steer technological development in that region and minimize investment risks.

5.3 CONFLICTING REGULATIONS

Interaction between targets

The interconnectedness of systems needs to be considered when developing regulations. For instance, high regulatory targets for recycling content in packaging make converters and brand owners turn to overall less sustainable solutions to meet the regulation. As a result, e.g., shampoo bottles are made from food safe recycled PET from closed loop beverage bottle systems, further deepening supply issues for food grade packaging.

6. RECOMMENDATIONS

The discussions on the barriers to sustainable flexible plastic food packaging sparked policy-related recommendations by industry representatives. These recommendations are meant to address the economic, technical and regulatory barriers. The categorization of the barriers is not as clear-cut as it seems. Note that they are interconnected with each other and dynamic over time. To overcome these barriers, recommendations must be approached holistically on a system level.

6.1 POLICY AND ACTIONS TO OVERCOME ECONOMIC BARRIERS

Level playing field between costs of virgin fossil material versus that of recycled and renewable feedstock & increase the supply of recycled and renewable feedstock

- Flexible plastic food packaging should be designed following common design guidelines to foster more cost-efficient and -effective collection and sorting (e.g., size and chemical composition minimizing contamination).
- Extend EPR regulations for closed loop food grade plastic systems to secure streams of food grade material and the funding of collection, sorting and recycling infrastructure. Within the EPR system, use a tariff differentiation on the waste management fee when using recycled films, recyclable films or non-recyclable films (eco-modulation).
- Availability of recycled plastic can be enhanced by stimulating both capacity and quality. These can be stimulated by subsidizing smart sorting technology (robotics) and advanced recycling technologies such as chemical recycling.
- Governments can help new technologies to scale up by issuing long term contracts with recyclers that ensure a stable environment for investments.
- Industry representatives in the study by Bening et al. (2021) advocated for the removal of fossil fuel subsidies and the development of a CO_2 tax on crude oil. One of the participants indicated that the establishment of chemical recycling infrastructure for circular plastic-to-plastic remanufacturing will need to be supported through subsidies, coming from plastic tax initiatives or redirecting funds that are now going to fossil fuel development. This could be extended to the funding of infrastructure for mechanical recycling and renewable materials.
- The incentives to increase recycling have to be based on quality and quantity of the recyclate. Otherwise, the market will have a large amount of recyclate that is unsuitable for use or is downcycled needlessly.

Break economic lock-ins

- Uncertainties about regulatory developments impede investments to improve the quantity and quality of recycled and renewable feedstock. For instance, upcoming regulations remain vague on the inclusion of chemical recycling or not. Some participants advocated for policy frameworks to recognise this type of recycling process.
- Subsidize pilots across the whole value chain in which adjustments are made to switch to mono-material packaging. The investment in time and resources is too high for individual stakeholders.

Stimulate the demand from retailers and brand owners

- Producers compete on demands regarding costs, looks, and over-engineered properties from retailers and brand owners. EPR fees and eco-modulation for sustainable or recyclable packaging film can create an incentive to compete on sustainability. See the OECD document Modulated fees for Extended Producer Responsibility schemes (EPR) for more insights on the topic (OECD, 2021).
- To increase the demand for recycled and renewable material, regulations should guide retailers, brand owners and consumers toward better choices. The Plastic Packaging Tax in the United Kingdom was discussed as potential solution. As of April 2022, UK manufacturers and importers of plastic packaging with less than 30% recycled plastic content will need to pay a tax (UK Government, 2021). Comparable legislation is expected in other European countries. On one hand, imposing a minimum non-fossil-based content requirement in packaging pushes the market to value recycled and renewable materials more and creates an incentive for more investment in required infrastructure. On the other hand, be mindful of trade-offs at play here. Note, for instance, that there are technical limits to recycling. Indeed, the same packaging cannot be recycled for infinity, meaning that virgin (fossil or biobased) or chemically recycled input will always be needed to some extent. Moreover, due to liability issues, some other sectors with compulsory recycled content targets may use the plastic food grade supply. This could exacerbate current supply issues for food grade plastic. Another consideration is, for example, that the use of recyclate may generally reduce the CO_2 footprint of the packaging, but this can be debated when using chemically recycled feedstock. On another note about a plastic tax, according to some participants, the paid tax should be explicitly spent on waste management improvement.

Stimulate the demand from consumers and avoid confusion

- By driving demand for recycled and renewable plastic packaging and through developments in the value chain, the price of the packaged good may in turn decrease. As a result, it may become a more financially interesting solution for consumers.
- To guide consumers in their purchase decisions and avoid misleading information on packaging, the labelling for sustainability claims could be standardised and harmonised on a large geographical scale.
- To guide consumers in their disposal decisions, collection instructions could also be standardised and harmonised on a large geographical scale.

6.2 POLICY AND ACTIONS TO OVERCOME TECHNICAL BARRIERS

Increase the availability of food safe recycled plastic

To increase the availability of food grade recycled plastic to be used in food packaging film, recommendations are made regarding regulation and policy to stimulate research and technology.

- Current regulation on food contact materials commonly regulates both the source and value chain of recycled material and presence and migration limits for hazardous substances. It is proposed that the requirements in regulation should only be set for the presence and migration limits of (potentially) hazardous substances. This allows for the use of more safe decontaminated recycled plastics that can currently not be used in food packaging due to the recycling route.
- To ensure food safety is not compromised with the proposed changes in regulation for food contact materials, testing for potentially hazardous substances and their migration should

be stricter and potential hazards should be better studied. New test standards for food safe recycled plastic should be developed.

- To improve sorting of food grade plastic from the recycling stream for recycling in food grade applications, digital water marking technology or artificial intelligence can be used. It is proposed that the development and roll out of such technologies is stimulated with financial instruments such as subsidies and tax reductions.
- Regardless of recycling route and food contact regulation, food residues in packaging film hamper high-grade recycling. More research is needed on how food residues can be more effectively cleaned for the waste plastic in recycling.
- Chemical recycling is regarded as necessary technology to at least replace a share of the currently low quality mechanical recycled plastic film, and potentially a solution to create closed-loop recycling of food grade plastic film. Further development and acceleration of use of the technologies should be stimulated.

Stimulate development and selection of the most sustainable materials

Selection of the safest and most sustainable materials for flexible packaging should be promoted and development and adoption of new more sustainable materials should be stimulated.

- Novel more sustainable polymers should not be required to fit the existing recycling infrastructure right away. Extended Producer Responsibility systems and regulation should allow polymers with demonstrable benefits to build critical mass. Waste infrastructure should be encouraged to adapt to sustainable alternatives to current commodity plastics.
- One harmonized reliable framework for risk assessment for all food contact materials should be developed. All food packaging materials should meet the same food safety demands.

Improve transparency in the value chain

A system should be set up to provide traceability of the chemical composition throughout the value chain, without losing confidentiality.

- Standardization of the form in which information is shared about the composition of the packaging in the value chain will increase transparency, ease decision making and dealing with data requests for value chain partners.
- The information shared in the value chain should include risk assessments for all materials and the source for renewable and secondary feedstock. It should also include reliable evidence that (a certain percentage of) recycled plastics are actually applied.
- Regulation should restrict how far liability about chemical composition and (food) safety can be denied in contracts and spec sheets.

6.3 POLICY AND ACTIONS TO OVERCOME REGULATORY BARRIERS

Harmonize regulations across regions, ensuring that the leeway for member states within these regions is minimized. This includes the following actions:

Prevent conflicting regulation

The regulation forming process should be more holistic to prevent conflicts in regulation.

- Start with measurable targets when composing regulation. What are the overall environmental goals of the region/country for the sector? In alignment with the scope and objectives of this report, the regulations should first focus on reducing the negative health

and environmental impact of plastic, including the use of the primary product and targeting food waste.

- Make sure that the different regulations are complementary. There should be better communication between regulating bodies when forming intersecting regulations. Note that not all parties can be perfectly satisfied with the outcome of the resulting compromise in regulation.
- Ensure that incentives and taxes do not encourage the externalisation of unsustainable practices such as environmentally detrimental production.
- Change competition laws that impede more sustainable flexible packaging. Within current competition laws, companies are not allowed to make collective agreements on the guaranteed demand for recyclates, which is needed to enable investments.

Harmonize regulations and policies across regions regarding collection, sorting, and recycling

- Common unambiguous Design for Circular Economy (DfCE)/ Design for Sustainability (DfS) guidelines are needed in regulations for the manufacturers.
- Research is needed to define the right size of regions to harmonize regulations and policies for. It is going to be a consideration between the number of different types of packaging that can be collected and recycled and the harmonisation of DfCE/DfS guidelines. In some areas it will not be economically viable or environmentally beneficial to collect, sort, and recycle all types of plastic packaging. Harmonisation of guidelines in these areas with guidelines in other areas where all packaging can be collected, sorted, and recycled will lead to trade-offs.
- A harmonized collection infrastructure within countries or even larger regions will help stakeholders in the value chain as well as consumers. This alignment could be further supported by labels for consumers with collection instructions and other interventions further explained in the point 6.1.
- Waste should not be allowed to be exported to regions where it is mismanaged. It should stay in regions where it is recycled and create good markets for recycled materials where it is geographically needed. However, regulations should not be too tight and block the markets for recycled materials.

Remove barriers for chemical recycling

- Accept chemical recycling as a suitable form of recycling in regulation, as long as the output of the process is feedstock for new polymer production.
- Accept a mass balancing approach in calculations of recycled content for chemically recycled plastics. Restrict this to an approach where fair allocation of the output is used, i.e. include the prevented consumption of raw materials for material production, not for energy generation.

6.4 POLICY RECOMMENDATIONS BY OTHER INITIATIVES

Interviewees and participants in the workshops point to other (industry) initiatives that they take part in. These initiatives have separately drawn up documents with their vision on how to improve the sustainability of flexible plastic packaging, with policy recommendations and steps that need to be taken by the industry. The subchapter deals with the recommendations made by these other initiatives that should not be overlooked in a broad policy discussion.

CEFLEX

CEFLEX is a collaborative initiative to create a circular economy for flexible packaging, representing 180 European companies, associations and organizations across the entire value chain. The vision of CEFLEX is to set up EPR systems in a way that the whole process of collection, sorting, and recycling is economically viable, the recycled plastics meet quality standards required for valuable end markets, and the price of the recycled plastic is competitive with virgin fossil plastics. To reach this, the following steps need to be taken:

1. Make inventory of all flexible packaging materials that enter the market and will be disposed of.
2. Understand end markets in which recyclates of these materials can substitute virgin fossil material in a valuable application. Know the volumes and required qualities for these applications
3. Create recycling pathways for the materials on the market so that the recycled material meets the quality requirements and the volumes meet the demand. This is done by adhering to design guidelines for the packaging materials, and creating the right recycling capacity. This includes expanding the mechanical recycling capacity and recognition of chemical recycling as recycling route.
4. Invest in sorting capabilities and capacity so that the available material can be sorted according to the recycling pathways.
5. All flexible packaging materials must be collected. Preferably separately sorted at the source, but combined with other packaging material waste. Recycling targets for the materials should be high.
6. The EPR fees should cover costs so that the price of recycled plastics is competitive with those of virgin fossil plastics and the whole process is economically viable. There should not be competition between EPR schemes, this drives down fees and creates a race to the bottom.

Circular Plastic Alliance

Over 300 private and public actors across the plastics value chains joined forces in the Circular Plastics Alliance (CPA) to increase the use of recycled plastics in Europe. The CPA is supported by the European Commission in the context of the European Plastics Strategy. The CPA aims to employ more than 10 million tonnes of recycled plastics in products and packaging in Europe each year by 2025. Note that the CPA has a broader scope than that of this report as it is including recycled plastics in products and packaging overall. Signatories made pledges for voluntary actions and commitments to reach this target (European Union, 2018). These actions are clustered in six categories.

1. **Design for Recycling.** Develop, update or revise Design for Recycling guidelines, contribute to CEN and industry standards updates on inter alia recyclability, and call for harmonized definitions of recyclability per product group to safeguard the single market.
2. **Collection and sorting.** Zero plastic waste to nature and zero landfilling of plastic waste, inform and raise awareness of consumers and businesses on zero littering, create an effective framework for separate collection and develop standardized methods to assess the quality of sorted plastic waste.
3. **Recycled content.** Increase the uptake of recycled plastics, call for voluntary pledges to use more recycled plastics, actively support European standards and guidelines on the quality of

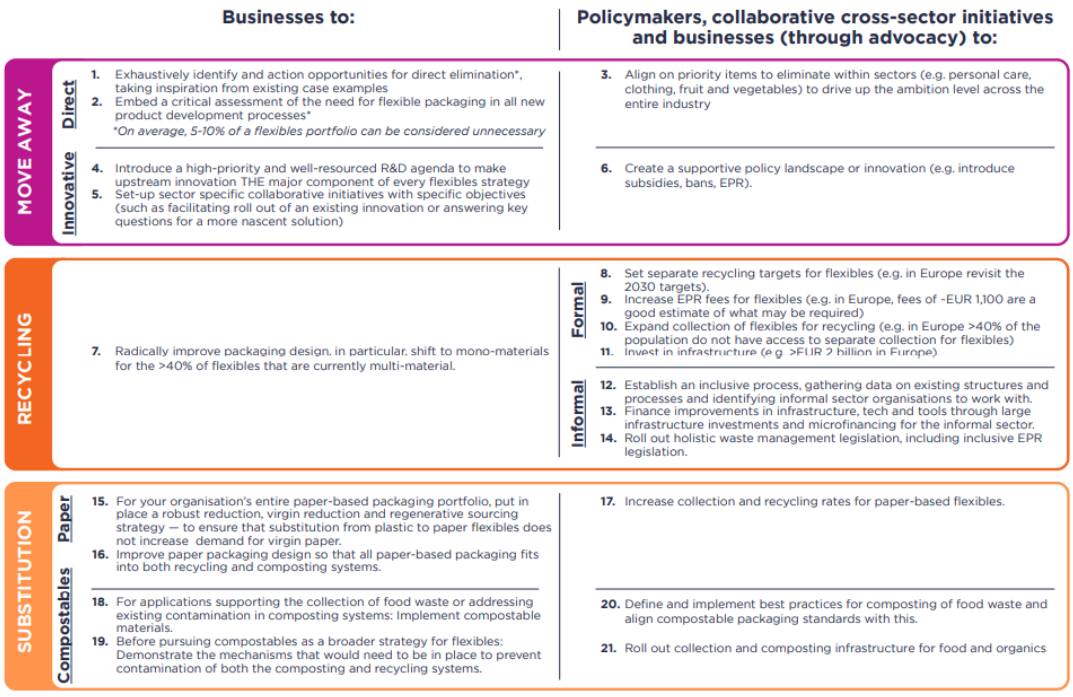
recycling and recycled material, and communicate and promote the positive value of recycled plastics in a circular economy.

4. **R&D and investments.** Define the R&D and investment needed including the scale up of chemical recycling, build an R&D agenda to overcome technological barriers to meet the market and regulatory needs, map obstacles to the needed investments, and invest according to the agenda and mapping.
5. **Monitoring.** Set up a harmonized voluntary system to monitor volumes of recycled plastics in European products.
6. **Governance.** Pursue action until 2025, a Steering Committee coordinates activities (among others), and communicate objectives and actions to the stakeholders and the public.

Ellen MacArthur Foundation | Flexible packaging

Over a thousand organizations collaborated on a common vision for circular plastics through the New Plastics Economy Global Commitment and the Ellen MacArthur Foundation's network of Plastics Pacts. Based on the input of more than 100 experts, 21 actions were identified within the Flexible packaging programme (see Figure 3). Note that flexible packaging is not limited to flexible plastic food packaging.

Figure 3. EMF Flexible Packaging 21 actions (Ellen MacArthur Foundation, 2022)



Flexible Packaging Initiative

The Flexible Packaging Initiative was started by Mars, Mondelēz International, Nestlé, PepsiCo and Unilever in early 2022. Participants of the open initiative commit to increase investments in a CE for flexible plastic packaging. They also aim to support public policy interventions to accelerate this European circular transition. Note that, here again, flexible packaging is not limited to flexible plastic food packaging. Five focus areas for action are defined (Flexible Packaging Initiative, 2022).

1. **Policy changes.** The companies call the European Commission and national governments to make policy changes with more ambitious recycling targets, a ban on landfill and keeping incineration to an absolute minimum.

2. **Collection.** The Initiative advocates the mandatory collection of all flexible packaging and simplification and harmonization of disposal instructions for European consumers.
3. **Waste management.** Extended Producer Responsibility (EPR) schemes should promote investments in sorting, which in turn will lead to more recycling.
4. **Highest quality of recycled material.** According to the Initiative, investments are essential in advanced recycling technologies to attain high quality food grade recycled material.
5. **Commitment to investing.** The companies made a pledge to themselves to increase investments in circular packaging design, new sorting and recycling technologies and eco-modulated EPR fees.

7. DISCUSSION

The authors of this background paper want to point out several complementary points to be considered during the May Workshop.

Selective representation

This document gathers barriers and recommendations raised by a selection of stakeholders across the flexible plastic packaging value chain during interviews, workshops and through written feedback (see participant list in the Appendix). As the results were not uniform due to the various roles, contexts and philosophies of the stakeholders, care was put in providing a sense to the reader of the different views of the stakeholders when they were not aligned. On top of this, the background material represents a select range of industry perspectives of stakeholders with sustainability ambitions and able to invest time in this initiative. Further research is needed with more industry participants.

Other valuable input

Not all questions could be answered within this project. For instance, what are the elements leading to the use of inks, pigments, and adhesives? What is their impact on the sustainability and what are the ways to safer inks, pigments, and adhesives? What are alternative regulatory requirements for labelling that do not off-set with recycling goals? For more details on inks and pigments, refer to the OECD case study on biscuit packaging (OECD, 2021). For more details on improving markets for recycled plastics, see the OECD report on the subject (OECD, 2018). The questions could be further discussed in the workshop in May.

Recycled and renewable materials and sustainability

One of the participants emphasized that flexible food packaging has been developed and optimized over decades. Some of the solutions are very effective and possibly the best options for the time being. Replacing virgin fossil materials with simply a recycled or renewable materials may not automatically achieve the sustainability improvements.

Complex systems

Production and consumption systems are complex: they are composed of a variety of parts that are interconnected, dynamic over time and cannot be predicted as they do not behave linearly. No prioritization was made in the recommendations, as the links between barriers and the effects of the recommendations on the systems need to be explored further.

Behavioural change

Although not explicitly mentioned by participants, more research is necessary on how behaviour can best be addressed. What helps with more sustainable consumer choices and actions during purchase, use and disposal (e.g. consumer acceptance of buying less vibrant packaging containing recycled materials)? What helps with creating behavioural change throughout organizations so that sustainable solutions are sought for throughout the chain of activities?

8. CONCLUSION

Building on the publications 'A Chemicals Perspective on Designing with Sustainable Plastics: Goals, Considerations and Trade-offs' (OECD, 2021), and 'Case Study on Biscuit Wrappers' (OECD, 2021), this study investigated how to design more sustainable flexible plastic food packaging from a chemicals perspective. Representatives along the value chain of flexible plastic food packaging reviewed the considerations throughout the life cycle of the packaging and examined barriers to increased sustainability performance.

The study of this seemingly simple product category has sparked considerable discussions amongst the stakeholders and exposed economic, technical and regulatory barriers encountered during the process. As these barriers are interconnected, policymakers must be aware of the intricacies of the sector to enable system change through carefully designed measures. This report provided further insight in the obstacles faced by the value chain and how they are linked to each other. It also offered potential policy solutions to incentivise more sustainable design of flexible plastic food packaging.

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APPENDIX A. INDUSTRY REPRESENTATIVES CONSULTED IN THIS STUDY

The following organizations and companies were consulted in the making of this report through the workshops, interviews and/or written feedback on the report.

Chemical and Polymer producers

- Dow Chemical
- ExxonMobil
- Qenos

Flexible food grade packaging manufacturers

- Flexible Packaging Europe
- NRK Verpakkingen
- St. Johns Packaging
- Trioworld

Retailers and brand owners

- Lidl
- Unilever

Waste managers

- Qenos
- Veolia

Other

- CEFLEX