



FLEXIBLE POLYETHYLENE RECYCLING IN EUROPE

ACCELERATING THE TRANSITION TOWARDS CIRCULAR ECONOMY



TABLE OF CONTENTS

ABOUT PLASTICS RECYCLERS EUROPE	3
INTRODUCTION	4
PE FILM PRODUCTION IN EUROPE	5
RECYCLING DATA	6
Where are we today?	6
Challenges of PE films recycling	7
RECYCLING TECHNOLOGIES	9
Collection	9
Sorting	10
Recycling process	11
HOW TO INCREASE THE CIRUCLARITY OF PE FILMS?	12
Increased quality, collection and sorting	12
Design for recycling for PE films	13
Compatibility Check: Recycling of PE films	14
Design for Recycling Guidelines	14
Why design for recycling is key?	16
Case study: pouches	17
WHAT'S NEXT? THE FUTURE OF PE FLEXIBLE PACKAGING	18
CONCLUSION	19

ABOUT PLASTICS RECYCLERS EUROPE

Plastics Recyclers Europe (PRE) was established in 1996 with the purpose of developing and promoting plastics recycling in Europe. Via its decennial presence in Brussels and an extensive membership, PRE acquired considerable knowledge and expertise on policy measures to improve the circularity of plastics.

PRE represents mainly recycling companies reprocessing plastics from various waste streams including post-consumer and post-industrial streams. Reprocessing includes operations such as sorting, shredding, grinding, washing and extrusion. They transform plastic waste into high quality materials that can be used by converters in the production of new articles.

PRE is a key stakeholder in the process of formulating, monitoring and evaluating the EU policies that impact plastics recyclers. It promotes the use of quality plastic recyclates and offers concrete advice on how to develop innovative products and packaging with design for recycling. Through the implementation of EuCertPlast², PRE has been promoting the harmonization and development of a pan-European standard for plastics recyclates. The organisation supports the transition towards the circular economy in Europe.

INTRODUCTION

Flexible packaging is one of the most widely used materials by brands in a whole range of applications starting with food and ending with non-food ones. Plastic film has an outstanding strength to weight ratio that makes it a perfect fit for a number of products. This is specifically true for polyethylene (PE) film thanks to its flexibility, resistance and lightweight. It is a perfect solution for saving transportation costs and protecting the product while providing for material minimization benefits.

Flexible packaging is a sustainable option for reduced resources use. Additionally, with today's technologies at the end of its life, it can be recycled and used again in high-end applications.

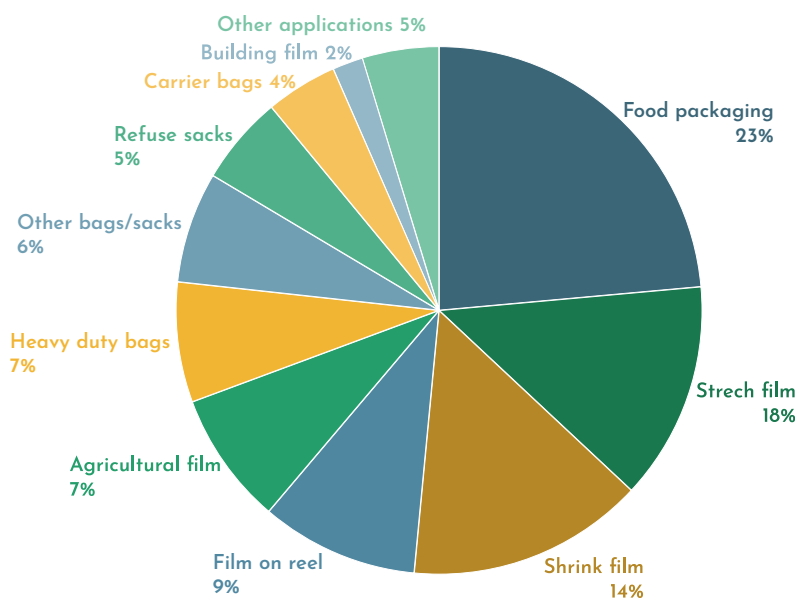
“ PLASTIC FILM WASTE IS STILL PERCEIVED AS A DEMANDING AND DIFFICULT STREAM TO TREAT, HOWEVER, WE IN EUROPE HAVE PROVEN THAT EVEN STRETCH FILM RECYCLING IS POSSIBLE. NONETHELESS, TO REACH FOR THE ADDITIONAL QUANTITIES FROM POST-CONSUMER PACKAGING WE NEED A STRONG COMMITMENT OF THE VALUE CHAIN TO WORK TOWARDS MAKING THIS MATERIAL FULLY SUSTAINABLE.”

*Ton Emans,
President, Plastics Recyclers Europe*



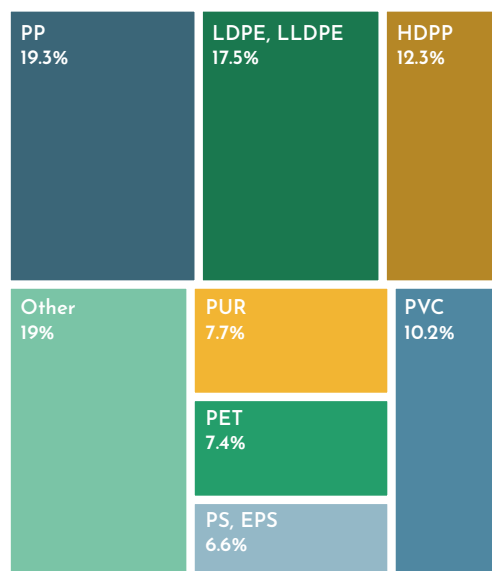
PE FILM PRODUCTION IN EUROPE

LDPE/LLDPE Shares in Main Applications (%)



Low-density polyethylene (LDPE) and linear low-density polyethylene (LLDPE) are among the most widely used polymers in the packaging segment. LDPE is a light and versatile product that is the first-choice material in the manufacture of films, followed by high-density polypropylene (HDPE) and polypropylene (PP). The major outlet for low-density polyethylene is food packaging: in production of wrappers and packets, cling film as well as other types of packaging like stretch and shrink film, film on reel, heavy duty bags, refuse sacks, pouches and carrier bags. Other applications include packaging for personal care products including for example tubes.

2017 European Plastic Converters Demand



The total converters demand for LDPE/LLDPE in the EU has a share of around 17%¹ and together with PP and HDPE, two other polymers from the polyolefins group, they have a total share of roughly 50%. The EU converters' demand for PE film remains stable in the last decade at a level of around 9 million tonnes².

Flexible packaging is commonly used in food applications as it provides for, apart from protecting goods, increased shelf life of products and helps avoid excessive food waste. Additionally, in comparison to other types of packaging, it uses much less material which translates into using fewer resources and adds to its environmental benefits.

¹ Plastics the facts - Analysis of European plastics production, demand and waste data. Plastics Europe. 2018.

² Plastics the facts - Analysis of European plastics production, demand and waste data. Plastics Europe. 2018.

³ Polyethylene film extruders in Europe. AML. 2017

RECYCLING DATA

Whereas the EU demand for LLDPE/LDPE remains stable, worldwide production is on the rise. The recycling capacity for this stream has been growing significantly over the past few years. In 2015⁴, the European total capacity was 1.5 million tonnes and in 3 years this amount increased by 66%, to 2.5 million tonnes. The EU recycling rate for this material is roughly 20% and the biggest streams are: commercial and retailer waste (43%), followed by production waste (23%), agricultural waste (17%), and household packaging (13%). The EU Members States with the highest recycling rates of PE flexible packaging are: Spain (18%), Germany (17%), Italy (13%), Poland (10%) and France (6%), with nearly two-thirds of Europe's installed recycling capacity.

Where are we today?

“THE GROWING TREND IN THE RECYCLING OF PE FILM SHOWS THAT WE CAN SUCCEED IN MAKING THIS MATERIAL CIRCULAR. HOWEVER, TODAY NUMBER OF CHALLENGES STILL REMAIN AND WE NEED TO CONTINUE THE STRIVE TO TRANSFORM THE WAY THESE PLASTICS ARE PRODUCED, COLLECTED AND RECYCLED.”

*Lukas Intemann,
Managing Director, Ecoplast, Borealis Group*

The recycling of this stream has accelerated as more municipalities are widening the types of products that are included in the waste management schemes. Traditionally, mostly rigid plastics used to be collected as they were easy to handle and are less contaminated in comparison to very light films. The new EU recycling target of 55% by 2030 obliges to further increase the collection rates and respectively the recycling capacities for this stream. Additionally, the Chinese ban, as well as the subsequent bans introduced by other Asian countries, is an opportunity to retain these valuable materials and to recycle them within EU according to the highest environmental and health & safety standards.

⁴ Plastics Recyclers Europe Recyclers mapping 2018.

Challenges of PE films recycling

Although recycling of PE films continues to expand, there are still a number of challenges that need to be overcome for the industry to be successful with its end of life treatment. This is particularly the case of post-consumer waste which is difficult to collect and recycle due to higher geographic dispersion, higher organic contamination, extensive on-packaging printing, moisture and UV barriers as well as multilayer and multi-material packaging that hamper recycling.

Low collection rates & low quality of input materials

One of the first challenges is the waste collection destined for recycling as its rates today remain low. Fully implemented separate collection schemes for household waste will increase the quality of the material destined for recycling and subsequently its yield. This will need to involve establishing harmonised schemes across all the Member States. The collection of all plastic packaging in a unique household separated stream is preferred as it decreases contamination and optimises the efficiency of the process.

Additionally, measures and incentives to ban landfill must be enforced to retain the maximum of the resource. Implementing an improved monitoring framework for EU-exports would provide for a more transparent and reliable information on the waste market .

Lack of design for recycling

Increasingly complex packaging, that is put on the market, is another major challenge of this stream. To give an example, multilayer packaging (e.g. laminates) usually contains barriers which are not compatible with the chemical properties of LLDPE/LDPE and during the recycling process negatively impact the colouring and the purity of the final recyclate. This as a consequence reduces range and value of its applications. Additionally, combining LLDPE/LDPE with different materials (typically paper or aluminium) and polymers makes it challenging or impossible to recycle. Ill-designed packaging that is not easy to empty, and therefore often highly organically contaminated, also negatively affects the technical performances and visual aspect of the recyclate. Multi-material packaging can be discarded during the sorting stage (and usually gets incinerated) or, if correctly sorted, impact negatively the input material destined for the recycling process and the quality of its output. Paper, aluminium, or other polymers welded with LDPE cannot be separated in the sorting, nor in the pre-treatment steps of the recycling process and, as a consequence, are extruded together with LLDPE/LDPE.

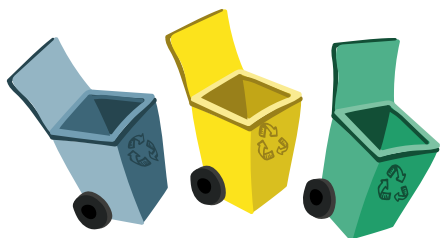
Constant quality variation in the properties of the recyclate de facto alters its performance and increases the processing costs of recycling. This consequently has an impact on the price and fluctuations in the qualities as well as quantities available on the market. LDPE today is already used in closed loop systems which means that it can go back to the same or similar applications (e.g.: bin bags, carrier bags). Still, considerable amounts of rLDPE are used in niche applications like street furniture (benches) as well as various types of panels, shelving and drainage systems which are less demanding in terms of the properties of the recycled material.

It is estimated that around 50% of the rLDPE/LLDPE put on the market today could be used in film applications if there would be sufficient demand for it.

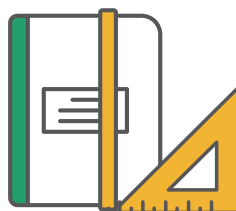
Evolution of the recycling technologies

Although the advancements in recycling and sorting technologies have greatly improved in the past years more investments as well as research & development is needed to continuously enhance the quality of recycled material.

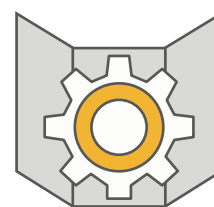
Challenges of PE Film Recycling



LOW COLLECTION RATES
& LOW QUALITY OF
INPUT MATERIALS



LACK OF
DESIGN FOR RECYCLING



EVOLUTION OF
RECYCLING
TECHNOLOGIES

It is indisputable that as long as the major hurdles in recycling including low collection rates, insufficient sorting, excessive contamination and lack of design for recycling are not addressed, reaching for higher recyclate quality and recycling rates are put at risk.

RECYCLING TECHNOLOGIES OF PE FILMS

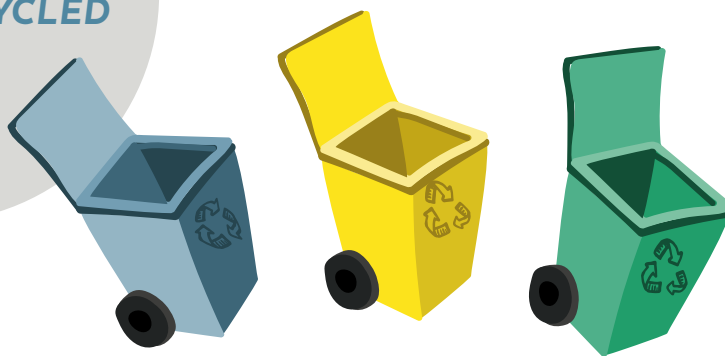
The overall recycling rates in this stream are on the rise. The European plastics recycling sector has been developing very dynamically over the last decade. However, it requires further scaling up on all levels.

Household collection and sorting technologies play an important role in ensuring increased efficiency and performance of a properly functioning waste management system.

Collection

Typically, post-consumer packaging film waste (e.g. films, carrier bags, stretch films, wrappers, etc.) is collected from households together with other packaging materials via kerbside or co-mingled systems. It is then transported to a sorting centre, where different material streams (per polymer) are defined to be later on sent to recycling facilities. It is estimated that around 62% of household and commercial PE flexible film is collected in Europe, 21% from households and 41% from the commercial stream.

**IF IT'S NOT COLLECTED,
IT'S NOT RECYCLED**



Sorting

“THE PAST DECADE IS THE WITNESS TO TREMENDOUS CHANGES IN THE SORTING AUTOMATION. THIS IS THE CASE FOR THE OPTICAL TECHNOLOGIES WHICH ENABLE TODAY TO SORT WASTE BY POLYMER, TYPE, COLOUR AND APPLICATION LIKE FOOD CONTACT WITHIN AN EXTREMELY SHORT TIME. SORTING PLAYS A CRUCIAL ROLE IN DEFINING AND ENHANCING THE QUALITY OF THE DIFFERENT WASTE STREAMS.”

*Jean Henin,
Chairman and CEO, Pellenc ST*

Advanced, automatized sorting installations and technologies play a crucial role in today's solid waste management systems. They ensure efficiency and are a guarantee for financially viable processes by yielding the highest quality output material. This is particularly true for the lightweight fraction which used to be more difficult to collect. In an optimal sorting centre, plastic packaging is automatically sorted through a series of consecutive steps which are refining the streams. Contamination is separated out while the material is sorted according to polymer type (and optionally, where required by colour).

In a sorting centre, the separately collected packaging is first screened. The importance of screens is due to the fact that polymer types of items larger than certain sizes (typically larger than an A4 page), were more easily recognised than smaller items. The screens would separate smaller items into the mixed waste fractions. Technological developments have since made polymer recognition much more effective and efficient, allowing for more concentrated targeted streams. Therefore, the size of packaging has a decreasing impact on the final quality of the sorted waste. Screened packaging later passes through metal detection and eddy current separators, that remove any ferrous and non-ferrous metals, which constitute contamination of the waste stream.

The material then passes through wind shifters, which separate light fractions from heavier ones, and ballistic separators, which separate 2D fractions (flat items) from 3D fractions (heavy and rolling items). After these steps, the material is further refined using Near-Infrared (NIR) technology. NIR separates the LDPE film from other films and plastics in the light and 2D fractions. The rigid plastics, on the other hand, are separated into PP, PE, PET and PS streams. The material can go through more than one sorting operation or be further refined by colours and product types which means that transparent LDPE film can be separated from the coloured LDPE film. Certain applications such as food contact require very high purity levels and are subject to European quality standards. In that case, the collected material undergoes several sorting and decontamination steps both in the sorting facilities, as well as in recycling plants.

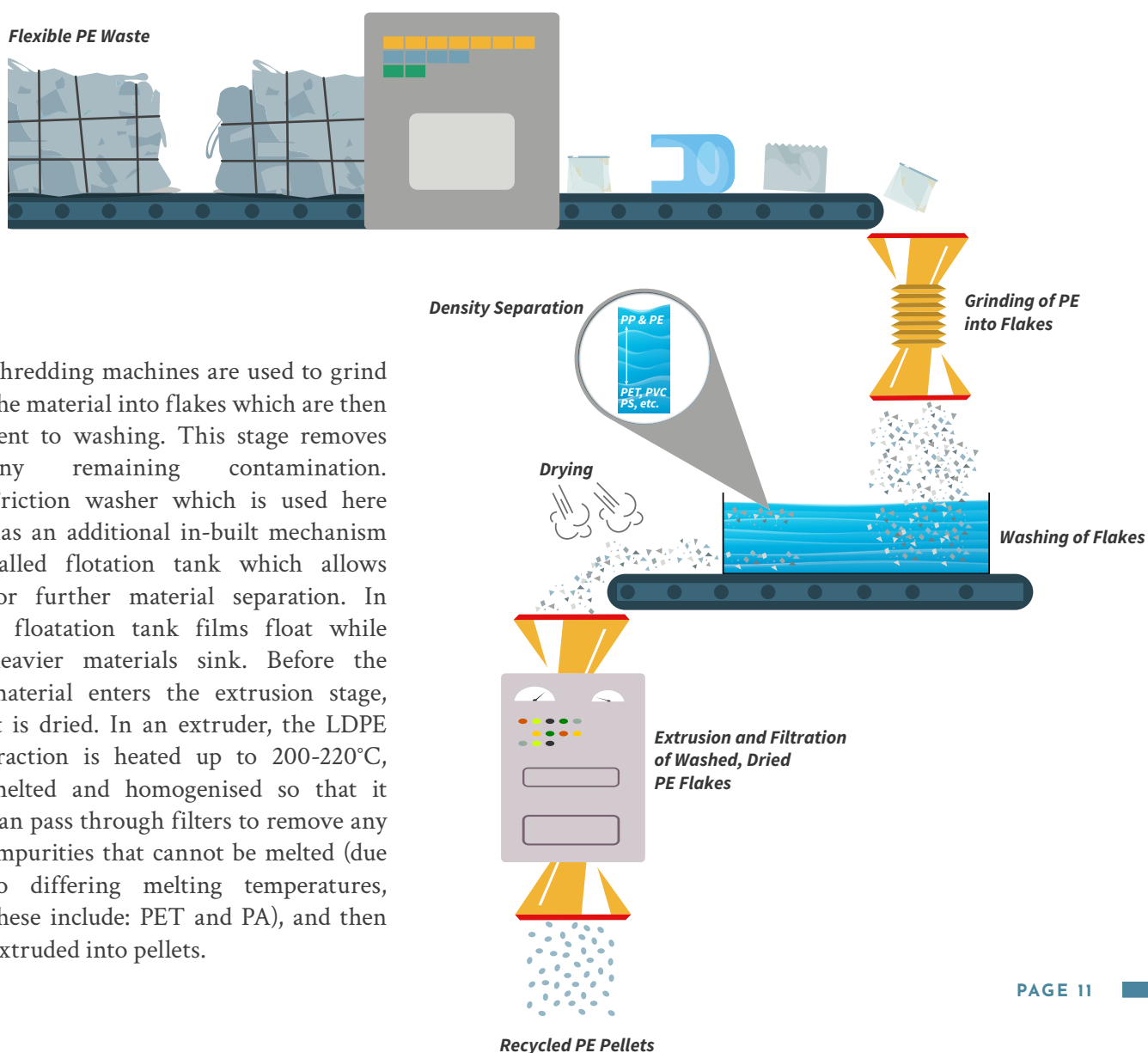
Additionally, remaining materials which are sorted out during the operation are either fed back to the system to improve the material recovery or discharged and sent, along with other contaminants and impurities, to incineration plants for energy recovery.

Once the different streams are separated, sorted LDPE films are compressed and baled for transportation purposes.

Recycling process

At the recycling plant, the waste is unbaled and additionally refined. LDPE films are further separated from other flexibles such as multilayers, black film, metallised plastics and paper labels which were not sorted out at the sorting centre. This is required as the specified materials will downgrade the output material in case they pass to the melting and extrusion phase. It must be underlined, however, that the current technologies cannot sort out all the innovations that are put on the market. After that, the size of the waste needs to be reduced in order to pursue the consecutive steps.

Simplified overview of a flexible PE recycling process



Shredding machines are used to grind the material into flakes which are then sent to washing. This stage removes any remaining contamination. Friction washer which is used here has an additional in-built mechanism called flotation tank which allows for further material separation. In a flotation tank films float while heavier materials sink. Before the material enters the extrusion stage, it is dried. In an extruder, the LDPE fraction is heated up to 200-220°C, melted and homogenised so that it can pass through filters to remove any impurities that cannot be melted (due to differing melting temperatures, these include: PET and PA), and then extruded into pellets.

HOW TO INCREASE THE CIRCULARITY OF PE FILMS?

Increased, quality collection and sorting

Collection schemes vary immensely across Europe, to an extent where often in one single Member State a multitude of different systems are present. Therefore, harmonised collection and sorting processes at the EU level are a must. Separate collection schemes should be implemented in all Member States to increase the quality and quantity of collected waste. In particular, collection schemes will determine the level of contamination found in the streams entering the sorting centres, and later the recycling process. Sorting can be disrupted due to excessive contamination, this will automatically lower quality and therefore the range of applications that the material could be used in. Alternatively, additional sorting steps might be required to sort out specific materials, making the process lengthier and more energy intensive. To give an example, in a household collection system where packaging is mixed with another type of waste, like organic waste, contamination presence is significantly higher. On the other hand, separately collected plastic provides for much purer streams, increasing the efficiency and decreasing the cost of subsequent reprocessing steps.

Establishing separate schemes for post-consumer plastic waste and therefore creating a separate stream (including polymers like PE, PET, HDPE and PP) will lower contamination levels, increase the performance and quality of sorting centres and contribute to the production of high-quality recyclates.

Harmonised, separate and increased collection across Europe is, therefore, a must and needs to be further supplemented with landfill ban on plastic waste and controlled waste exports.

Introducing measures like standard sorting practices as well as guidelines for bales quality checks are needed in order to complement this harmonisation.

Design for recycling for PE films

Properly designed, recyclable plastic packaging retains high value at the end of its useful life and can be repurposed to produce new products. Ill-designed products cause difficulties during sorting and are incompatible with recycling processes. As a consequence, this type of packaging strongly reduces the efficiency of the recycling process, its technical performances, quality of recycled material, and cost-efficiency of reprocessing. Specific design for recycling guidelines must be followed when manufacturing a product and when introducing any kind of innovation on the market. RecyClass⁵ is an initiative which works towards advancing recyclability of plastic packaging via carrying scientific analyses of the impact of the different substances and materials on recycling. The findings are used to continuously update, on the basis of the technical data, a set of design for recycling guidelines per type of polymer and type of product. For PE film specifically, RecyClass published a standard laboratory methodology: ‘Recyclability Evaluation Protocol.’⁶

“THE RECYCLASS EVALUATION PROTOCOLS AIM TO ESTABLISH A STANDARDISED METHODOLOGY TO ASSESS AND MEASURE ON A LAB SCALE THE IMPACT OF INNOVATIVE PACKAGING IN THE EXISTING RECYCLING STREAMS. THIS IS CRUCIAL IN ORDER TO SUPPORT INNOVATIVE PACKAGING ALIGNED WITH THE CIRCULAR PLASTICS ECONOMY, FULLY COMPATIBLE WITH THE RECYCLING PROCESS.”

*Paolo Glerean,
Chairman, RecyClass*

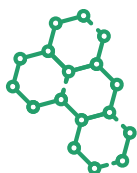


⁵ RecyClass - www.recyclass.eu

⁶ <https://plasticsrecyclers.eu/sites/default/files/2018-09/RecyClass%20Recyclability%20Evaluation%20Protocol%20for%20PE%20Films%2006-09-2018.pdf>

COMPATIBILITY CHECK: RECYCLING OF PE FILMS

Design for Recycling Guidelines⁷



Polymer - main packaging body

PE-LD, PE-LLD, PE-HD

Mono-materials are preferred - main body is made of LLDPE, LDPE, with additional elements of the packaging (where applicable or required e.g. closures/caps/spouts/valves/zips) made of HDPE.

Other polymers like PET and PVC heavily disrupt the recycling process due to their chemical incompatibilities with PE.



Colours

Unpigmented, transparent or translucent

Unpigmented material has the highest value for recycling as it ensures the clear/light colour of the final output. This, in turn, guarantees better quality and a wider set of applications in which the recycled material can be used. With dark colours, it is impossible to go back to light/semi-transparent colours.



Barriers & Coatings

Barrier or coating constitutes usually a thin layer of a substance which is impossible to be separated from the main polymer during a recycling process. The main barriers used in PE flexible packaging are Polyamide (PA), Ethylene Vinyl Alcohol (EVOH), Polyvinylidene chloride (PVDC) and Polyvinyl chloride (PVC). The use of PA, PVC and PVDC are prohibited. The use of Ethylene Vinyl substances is conditional as this functional barrier is thermally unstable and quickly degrades during the extrusion phase, impacting the colouring of the output material. Other barriers that have to be avoided are foaming agents and aluminium. Metallised films disrupt the recycling process, as they can create holes or black spots in films during blown film extrusion.

⁷ The guidelines are based on the materials that have been tested or known to be acceptable in PE film recycling.

COMPATIBILITY CHECK: RECYCLING OF PE FILMS



Additives

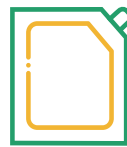
Films containing additives like chalk, talc powder or marble, which change the density of the polymer should not be used, as they will be discarded for incineration during the recycling process (density separation). Additives concentration should not exceed 0.97g/cm³.



Inks

Inks should be avoided and wherever used they must be non-toxic⁸, non-hazardous and non-bleeding.

Inks impact the discolouration of the material.



Labels

PE labels

PE labels are allowed and, conditionally, the PP ones.

Metallised or any other types of labels (including paper ones) are not compatible with recycling. Non-compatible labels will impact the yield. Additionally, any glues must be water soluble.



Adhesives

They must be water soluble (at a temperature range of 40-60°C). It is important that the adhesives are fully removable, as they can otherwise disrupt the recycling process and the quality of output material.



Direct printing

Unpigmented, transparent or translucent

Laser marking is preferred whereas extensive printing (over 50%) of the body surface of packaging should be avoided due to low compatibility with recycling. Direct printing cannot be removed during the recycling process, causing the formation of gels in the recycle, and downgrading the mechanical properties of the recycle in its further applications.

⁸ More information: <http://www.eupia.org>

COMPATIBILITY CHECK: RECYCLING OF PE FILMS

Why is Design for Recycling Key?

The design of plastic packaging controls to a large extent the degree to which a packaging can be recycled. The structures and materials which are incompatible with mechanical recycling cause a number of disruptions in a recycling line. This may vary from clogging and damaging recycling equipment to heavy input material losses, to downgrading of the recyclate (i.e. discolouration, loss in performance and chemical properties, impact on the visual aspect). Materials that heavily impact film recycling are biodegradable (e.g. PLA), compostable but also oxo-degradable⁹ plastics. It was proven that 2% of biodegradable material found in the LDPE recycling stream will decrease the quality of recyclates. Moreover, it is impossible to sort out these materials either at a sorting centre or in a recycling facility. Due to their diverging chemical composition from that of traditional plastics, they cause holes and specks in the recyclates and pose a risk in the utilisation of recycled materials in high-value applications. Separate collection has to be established for these materials as well as standardised labelling for consumers to avoid confusion.

This applies as well to multi-material packaging (which consists of several material types like plastic, aluminium, paper etc., e.g.: laminates), as it is highly detrimental for recycling due to the impossibility of separation of the different layers. Additionally, usage of multi-layered material packaging is specifically alarming for the recycling process as it represents around 20% of all the flexible packaging put on the European market.

The incompatibility of certain structures or innovations of flexible packaging with recycling will hamper the transition towards circular plastics and eventually the circular economy. Without quality recycled material that can be used in loops circularity of plastics cannot be achieved.

Improving packaging design and matching its functionality with recyclability would improve the recyclate quality and offer to the market a standardised raw material comparable, application per application, with the virgin resins.

⁹ Oxo-degradable plastics will be banned, according to the *Report From The Commission To The European Parliament And The Council on the impact of the use of oxo-degradable plastic, including oxo-degradable plastic carrier bags, on the environment*, 16.1.2018, COM(2018) 35 final

CASE STUDY: RECYCLABLE POUCH

Pouches are the new, lightweight alternative to the rigid packaging. They are used more and more frequently for example for food packaging, detergents or personal care products. However, many of these products are today unrecyclable due to multi-material or multilayer structures that are used in their manufacture. Traditionally, pouches are designed considering the aspects like preservation of the taste and the properties of the product without finding a balance between its functionality and recyclability. Today a typical pouch structure couples LDPE layer with a PET or PA layer (ready-made meals, cheese, meat) to improve its mechanical properties. This may involve as well sandwiching a layer of aluminium (packaging for coffee, peanuts, pet food) or of EVOH (hand soap) to improve the barrier effects. All these solutions create disruption in the recycling process and strongly downgrade the quality of the recyclate. However, alternatives, that marry the functionality and recyclability aspects for this type of packaging, do exist.

Main Body

LDPE/LLDPE; Mono-material

Closure

Unpigmented PE is preferred;
Unpigmented PP is permissible in some cases. Safety seals should not leave foil or adhesive residues on PE parts.

Label

Unpigmented PE is preferred to maximise the recycling yield and avoid contamination. PP labels should be used only if its weight ratio to the main PE body is minimal. Paper and PVC labels must be avoided, as they cannot be efficiently separated from the PE stream.

Colour

Transparent PE has the highest recycling value; unpigmented pouches are highly recommended. Coloured pouches are permissible to some extent.

Barrier

Use of non-PE layers is strongly discouraged, as they cannot be removed in conventional recycling processes. Use of other substances (e.g. EVOH) or materials (e.g. PET and PA) contaminates the output material and limits recyclates use in high-quality applications.

Printing & Inks

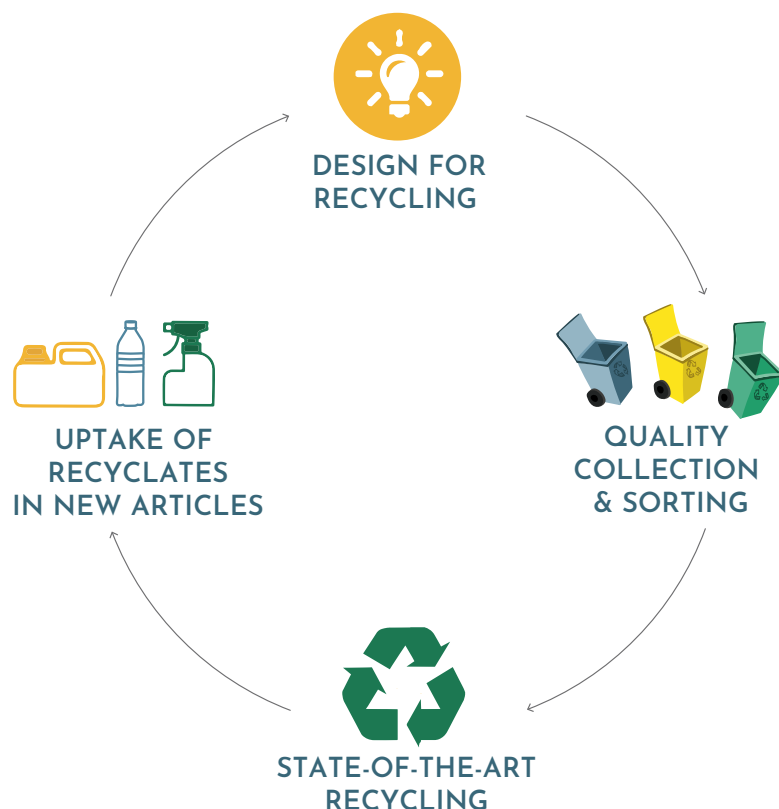
Direct printing, other than bar code and expiry date, contaminates the quality of recyclates.

Inks must be non-toxic and non-bleeding to avoid contamination



WHAT'S NEXT?

FUTURE OF PE FLEXIBLE PACKAGING



Taking into consideration the current recycling rate of LLDPE/LDPE in Europe, which is roughly 31%, there is an enormous potential lying in the recycling of this polymer. Specifically, with the current production and consumption rates in Europe, it is possible to recycle from 5 to 6 times more quantities of the post-consumer fraction in comparison to what is recycled today. The same applies to the commercial waste stream whose rates could be increased by around 30%. This increase is conditioned however by the increased collection and sorting as well as higher quality of the input material.

Manufacturing a new flexible packaging with the design for recycling considerations must become the new standard of the industry. Any innovation in PE film, before being put on the market, must be previously tested to ensure that it can be collected in an aggregated stream, efficiently sorted and recycled back into high-quality material. Design for recycling should guarantee the recyclability of PE flexible packaging while allowing for innovation for this product. Only by following and complying with these simple steps we can safeguard and further boost the recycling of PE film in Europe. This, in turn, will increase the credibility of the whole value chain.

Moreover, further investments in the collection, sorting and advanced recycling technologies as well as advancing the current infrastructure by among others increasing recycling capacities is a must. Refined streams, where the mixed polyolefins are progressively declining, need to be established and maintained according to the EU standards. The traditional waste streams need to be enhanced to ensure the circularity of packaging waste.

CONCLUSION

The new EU legislative measures introduced by the reviewed Waste Package, the Plastics Strategy and the Single Use Directive oblige the industry to take immediate and decisive steps in production and waste management of plastics packaging. It is indispensable to look into ways of increasing the collection rates of the material that is currently either landfilled or incinerated. The new targets can be achieved only if we are reaching beyond the low hanging fruit. Therefore, working towards a safe, light and functional packaging while ensuring its recyclability at the end of its life is a must. The industry must re-evaluate the design of packaging by creating design innovations that on one hand provide a plastic product with the required properties in a variety of applications, but on the other hand provide for superior recycling properties. Supporting design-for-recycling and manufacture of recyclable plastics articles is becoming a must if we are to satisfy the increasing market demand for recycled plastics.

The real transformation for the stream can be achieved by working collaboratively including brand owners, retailers, film producers and packaging converters to find the solutions for the main bottlenecks. Furthermore, the decision makers are crucial in creating a legislative framework that would foster conditions for the sustainable and fully circular plastics recycling in Europe. This work needs to be geared towards advancing the collection and recycling of flexible packaging to further improve the environmental credentials and the global sustainability of this packaging type.



making plastics circular

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