

# COLLECTION AND RECYCLING OF HOUSEHOLD PLASTIC FILM PACKAGING

A review of the current status of the household plastic film packaging recycling supply chain, incorporating collection options and emerging markets

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# INTRODUCTION

## Background

The efficient collection, separation and recycling of plastic packaging film produced by households, comprising carrier bags and primary product packaging, is challenging due to the wide range of incorporated materials and end use applications. At present there are limited UK market applications for this material, supported by sorting infrastructure that has been specifically set up to target plastic films as an output stream. As a result household plastic film is commonly viewed by MRF operators and plastic reprocessors as a contaminant of the higher value paper & card or rigid plastic packaging streams, for which UK markets have become established in recent years. Despite the challenges, viable collection options do exist, including Front of Store Recycling (FOSR) at supermarkets and investment in UK reprocessing capacity is progressing. This is expected to increase the viability of collection and recycling options for this high profile waste stream in the future.

Many retailers provided FOSR points for carrier bags at larger stores prior to the introduction of the On-Pack Recycling Label (OPRL) which retailers helped to develop and continue to support, for example, through the acceptance of a wider range of packaging films at existing FOSR points.

Despite various initiatives plastic film remains a highly visible component of the household residual waste stream that is only currently captured at low levels for recycling.

## Scope of this document

This document is intended to inform local authorities and other collectors of the challenges associated with sorting and recycling household plastic film. It includes background information on the material and quantities arising as waste in the UK, an overview of existing collection approaches and sections on the challenges and emerging opportunities associated with sorting, reprocessing and establishing UK markets for this material.

### Communications

Owing to the wide range of material types, properties and end use applications for plastic films, clearly communicating what can and cannot be recycled, and why, is challenging. Throughout this document we have introduced information on Communications as a recurring theme within text boxes.

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# HOUSEHOLD PLASTIC FILM

## Market overview

Valpak and WRAP recently produced two studies to further the recovery and recycling of plastics in the UK.

Packflow 2017 estimated that total plastic packaging consumed in the UK in 2011 was 2.5m tonnes. The Plastic Packaging Composition Report (2013) provided a breakdown of this total by format and polymer type. This study estimated 1.1 million tonnes of plastic film consumed in the UK each year. This is approximately 44% of all plastic packaging. The study further estimates approximately 560,000 tonnes of this is consumer plastic film.

The Plasflow 2017 Report (2013) used a range of sector-specific data, including the Composition Report, to map the flows of plastic packaging from consumption to collection, sorting, reprocessing and final end markets. The study found consumer film and rigid plastic packaging to be two of the largest untapped sources of recyclable plastic.

Both studies identified a need to improve data capture for household plastic film.

## Material overview

Film products tend to be categorised either by their composite materials or by broad product groups. The Packaging and Films Association (PAFA) uses three broad product definitions summarised below with respect to their use in household packaging applications<sup>2</sup>:

- **Plastic film:** generally made and used as sheet material such as stretch and cling wrap for food protection and packaging;
- **Plastic bags:** all types of bags from consumer items such as sandwich/freezer bags to carrier bags provided by retailers; and
- **Plastic pouches:** these typically are used in food packaging and usually are sealable and strong enough to be self-supporting.

Plastic film is used as packaging for a large range of domestic products sold by retailers, including bakery, confectionery, coffee, dairy, dried foods, fresh produce and home and personal care. The material helps keep products fresh, thus extending their use-by date and preventing contamination when handled. A range of polymers is used to produce film packaging, a number of which are detailed in Table 1.1, along with their example uses (derived from the PAFA website and BPF website<sup>3,4,5</sup>). It is difficult to determine the amount of each polymer type used by the sector due to the variability in packaging film characteristics but based on the information gathered it appears that polyethylene (PE), both as low and high density PE, is the most common.

1. <http://www.wrap.org.uk/node/14026>  
 2. [www.pafa.org.uk/products/films-bags-pouches](http://www.pafa.org.uk/products/films-bags-pouches).

3. PAFA, Raw Materials- Polymers, <http://www.pafa.org.uk/environment/recycle>  
 4. PAFA, Cellulose, <http://www.pafa.org.uk/materials/cellulose>  
 5. BPF, Bio-based and Degradable Plastics, [http://www.bpf.co.uk/Topics/Biobased\\_and\\_Degradable.aspx](http://www.bpf.co.uk/Topics/Biobased_and_Degradable.aspx)

# HOUSEHOLD PLASTIC FILM

**Table 1:** Main polymers used to produce film packaging, their properties and example uses

Polymer Types	Properties	Example Uses
Nylons (Polyamides) PA	Semi-crystalline and generally very tough materials with good thermal and chemical resistance.	Boil-in-the-bag food packaging and some peel-off film lids
Polyvinyl Chloride (PVC)	Compatibility with many different kinds of additives - PVC can be clear or coloured, rigid or flexible.	Cling film and sandwich cartons
Polyethylene (Low Density) LDPE	Translucent, very tough, weatherproof, good chemical resistance, low water absorption.	Carrier, long-life and food bags; heavy duty sacks and films
Polyethylene (High Density) HDPE	Flexible, translucent/waxy, weatherproof, good low temperature toughness (to -60°C), good chemical resistance.	Carrier bags; food wrapping material
Polypropylene (PP)	Resilient, good chemical resistance, durable, buoyant, multiple impact resistance, remains stable in temperature range of 40°C-120°C.	Durable packaging and transparent films.
Polyethylene terephthalate (PET)	Good barrier properties against oxygen and carbon dioxide, good chemical and UV resistance. Remain stable up to 220°C.	Roasting bags, used in multi-layer films, laminated films
Biodegradable polymers	Derived from natural and renewable (non oil) sources such as wood (cellulose), vegetable oils, sugar and starch.	Compostable sacks for food waste, some carrier bags



## HOUSEHOLD PLASTIC FILM CONT.

Composite plastic films used for the packaging of food can be manufactured from layers of different polymers and may be bonded with other materials such as aluminium foil. Additives can be applied to, for example, seal in moisture. Barrier properties created in packaging films are important to ensuring product quality and maximising shelf-life through providing, for example, the ability to reclose the package to maintain freshness.

Biodegradable plastics and degradable plastics are a relatively recent market development. The former are made primarily from biologically sourced materials such as sugar cane. The most popular biodegradable plastic is Polylactic Acid (PLA). Oxo-degradable plastics are conventional polymers with additives promoting degradation over time. Mechanical recycling is technically feasible for some biodegradable and oxo-degradable plastics where these streams are kept separate from the conventional plastic stream, however, this does not happen at present because volumes are too low to make recovery economic.

### Communications

Anecdotally, the terms “biodegradable” and “compostable” printed on films made from bio- and oxo-degradable plastics have caused confusion for residents who are unaware if these materials are accepted for recycling.

Clarity is important as there are potential issues arising from mixing these materials with conventional film types which affects the ability to produce new recycled products. For example, an oxo-degradable product feedstock is not appropriate for recycling into applications that require ongoing structural integrity within open environments, e.g. pipe work or damp proof membranes.

In order for the industry to manage biodegradable, compostable and recyclable polymers it is important that householders can clearly differentiate between them. This presents a considerable communications challenge. Until these materials can be managed and facilities can accept them, local authorities should not target these materials.

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# COLLECTION

## Overview

The two primary routes for the collection of post-consumer household films are via front of store recycling points (generally located at larger supermarkets) and through local authority kerbside recycling schemes. Overall the collection infrastructure is limited at the present time, due in part to a lack of UK processing capacity for recovered films, but also to due to the particular challenges involved in collecting and then separating film when collected mixed with other materials. Typically there is a lack of data on material capture and yields that can be expected.

## Front of Store Recycling (FOSR)

Front of Store Recycling remains the management route of choice for, particularly, single use carrier bags at present. The range of household plastic film packaging covered by the OPRL<sup>6</sup> and recyclable via FOSR has increased as a result of a cross retailer initiative by Asda, The Co-operative Food, Morrisons, Sainsbury's, Tesco and Waitrose. The outcome of this initiative is a new label developed exclusively for film plastic with the message 'recycle with carrier bags at larger stores – not at kerbside'. The new label is applicable to PE films that meet quality criteria and covers products from bakery, breakfast cereal, household goods, grocery produce, multi-pack shrink film and more recently newspaper and magazine wrap. WRAP has produced a [case study](#) on the new label for FOSR film collection which provides more detail on uptake by retailers and product manufacturers.<sup>7</sup>

6. A list of members is maintained on the On-Pack Recycling Label website (<http://www.oprl.org.uk/>)  
 7. <http://www.wrap.org.uk/sites/files/wrap/Case%20study%20on%20increase%20usage%20of%20the%20OPRL%20on%20plastic%20films.pdf>  
 8. [http://www.recyclenowpartners.org.uk/local\\_authorities/download\\_area/other\\_advertising.rma#oprl](http://www.recyclenowpartners.org.uk/local_authorities/download_area/other_advertising.rma#oprl)

It is currently estimated that around 4,500 UK stores have FOSR provision for single use carrier bags and other plastic film. The level of provision of FOSR facilities for these materials varies between retailer chains, with store size being the common factor influencing provision. Collection points are more often located at or near store entrances rather than in the car park-based recycling areas. Additionally some retailers are providing plastic bag take back through their home delivery service. Films collected at FOSR points tend to be bulked with those arising at 'back of store'.

Many local authorities signpost residents via their websites to retailer outlets that provide FOSR facilities. These include Lambeth, Bristol City, Craven, Cambridge City, North Lincolnshire, Wirral and Kensington & Chelsea.

## Communications

WRAP's research has found that there is a general lack of awareness of FOSR facilities and the range of plastic films that can be recycled. FOSR points are provided by many supermarkets but their promotion varies. When considering options for both collecting household plastic films at the kerbside and/or signposting residents to FOSR facilities local authorities are advised to familiarise themselves with the OPRL scheme and maintain up-to-date details of those stores with facilities in their area. WRAP has developed resources for local authorities to promote household plastic film packaging collections via supermarket FOSR. These are available on the Recycle Now Partners' site. This information can be found in the Local Authority download area under the heading of Other Advertising Material<sup>8</sup>.



OPRL Labelling examples

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# COLLECTION

## Kerbside

WRAP estimates that 71 local authorities in the UK collected household plastic film packaging at the kerbside in 2011/12. This includes 58 authorities in England, 8 in Wales and 5 in Scotland. Further research indicates that a lesser number actively target films in the dry recycling collections, i.e. in certain cases it may be tolerated rather than promoted.

As rigid plastic packaging (for example) has been incorporated into kerbside recycling schemes, downstream sorters and reprocessors have observed an associated increase in household plastic film packaging. This may be through association, e.g. as residents have recognised that a wider array of plastics can be recycled, or because pots, tubs and trays commonly incorporate covering film layers and lids. In WRAP's guidance on the collection and sorting of household rigid plastic packaging<sup>9</sup> the advice is to keep films separate from rigid plastic packaging and not include these in kerbside collections. Films should be accepted where downstream sorting, reprocessing and end markets are configured to handle these materials.

Where local authorities are collecting this stream for recycling the range of plastic film materials actively targeted is diverse. It ranges from a single material (most commonly carrier bags) to a number of specified materials (in addition to carrier bags) such as bubble wrap, magazine wrappers, shrink wrap, cereal bags, frozen food bags, bin liners, plastic wrap and cling film.

Operational approaches to collecting plastic films vary depending on the type of kerbside scheme in place.

## Multi-Stream kerbside sort

Less than 30% of local authorities collecting household plastic film packaging in 2011/12 operated multi-stream collections. One authority is West Oxfordshire. In this case the authority collects what it terms 'flyaway' plastics such as carrier bags, polythene, small clear food packaging, bubble wrap, cling film and compost bags. Residents are requested to bulk their flyaway plastics in a plastic bag and place these in their recycling box for collection. These bags are bulked into a larger tote sack which is hung from the vehicle. When this is full it is either left at a location on the round for collection or dropped off at the depot for baling. Once baled the plastic film is sent to a UK reprocessor.

Powys County Council also collects plastic films via a box recycling scheme and has recently trialled a number of new vehicle types (facilitating a greater level of kerbside sorting). When tipped into compacting compartments on the vehicle with other plastic packaging Powys observed operational issues with films accumulating around mechanical parts. Hence options for positively sorting and storing films separately on multi-compartment vehicles should be considered when adding this material or when specifying new recycling fleets.

9. [http://www.wrap.org.uk/sites/files/wrap/Rigid\\_Plastics\\_Guide.pdf](http://www.wrap.org.uk/sites/files/wrap/Rigid_Plastics_Guide.pdf)

# COLLECTION

## Co-mingled

It is more common for films to be included in co-mingled than multi-stream collections, but only where the downstream MRF can, or is prepared to, accept the material. Examples of local authorities providing co-mingled collections incorporating plastic films include Cheshire East, Leicester City, Basildon, Ceredigion, Hertsmere, Isle of Wight and South Holland. Within this list are authorities who use either wheeled bins or sacks to collect co-mingled dry recyclables.

This study found that bagging of films is not favoured in co-mingled collections due to the risk of contrary materials being hidden in plastic bags and due to processing difficulties at the MRF. Additionally one collection contractor believes that adding a layer of complexity to the instructions given to residents on the presentation of materials, for example targeting some plastic films but not others, would result in reduced overall capture rates.

None of the questioned authorities operating co-mingled collections identified any issues (such as littering) arising from the collection of films.

One authority commented that its contractor's MRF experienced difficulties in processing the volume of films it received (as the material had high recognition levels amongst its residents) due to the facility not being optimised to separate films as a separate stream. As a result the output film was mixed with other streams, for example paper and plastic bottles, reducing the income received by the authority. This had a significant impact on the service's budget.

## Communications

The wide range of film types present in the market makes it very difficult to clearly communicate target and non-target materials for recycling. The terminology used by local authorities to illustrate the acceptability of materials in its services is diverse (for example the almost interchangeable usage of cellophane, shrink wrap and plastic film) and this reduces householder recognition, potentially resulting in the incorrect consignment of the material to either the recycling collection or residual waste.

Local authorities take different approaches to preventing food-contaminated films from being collected for recycling. Some authorities do not accept specific films because their usage may include contact with food whereas others will permit the material but with the instruction that all materials must be clean and free from food debris.

From a communications perspective it may be more effective to either target a single film type for collection (e.g. plastic carrier bags) or to accept all films, as something in between is likely to confuse service users. However, at present there is a lack of evidence on the underlying economics to support this.

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# SORTING

## Overview

Where dry recyclables are collected co-mingled and the target mix includes plastic films it is necessary to separate these and other light, two dimensional (2D) materials, such as paper and card, from all three dimensional (3D) materials. This includes rigid plastic packaging such as bottles and pots, tubs and trays. Plastic films must be further separated from other 2D materials into a distinct stream.

Plastic films cannot be reprocessed with rigid plastics so film and rigid plastics must be separated if these materials are to be recycled, however the sorting infrastructure in the UK has (to date) been developed for sorting rigid 3D plastics, not 2D films. This means that most MRFs and PRFs (Plastic Recovery Facility) are not designed to separate film plastics from either a mixed material stream or a mixed plastics stream.

## Technical challenges

The presence of the other light 2D materials in the co-mingled stream presents a significant technical challenge to sorting plastic films in MRFs. The use of suction systems to extract these lighter materials from a co-mingled stream does not separate the individual 2D material types, meaning plastic films may contaminate the higher value 2D fibre (paper and card) streams. Until recently the standard procedure has been to hand-pick plastic film material at an early stage in the MRF sorting line as a way of improving the quality of the paper and card streams.

If paper and card are collected separately from plastics (and other containers), such as within two stream systems, it is possible to use 2D/3D separation techniques to isolate film from the rigid plastic materials, again at the start of the process flow at a MRF. However, it is important to note that in this situation although the container stream is theoretically free of paper and card, in practice the process is likely to need to cope with a certain amount of paper and/or card contamination. This would normally require an initial 2D/3D separation stage with the resulting 2D fraction (predominantly films) being further sorted using a near-infrared (NIR) separator to isolate any film/card contamination that is present.

Analyses of the composition of input feedstock at three MRFs sorting mixed rigid plastics (excluding films) found that plastic films make up about 3-4% of the material by weight, whilst paper and card represent 64-80%<sup>10</sup>. It is the high proportion of paper and card compared to film that presents the main challenge when trying to achieve a relatively pure film output. The mechanical similarities between paper/card and film (i.e. thin, flat, light 2D materials) make automatic separation difficult, with NIR detection further hampered by materials overlapping on the processing belt. Even if separation efficiencies of up to 80% were achievable by automatic methods, the greater quantity of paper and card in the input feedstock means that the amount of these materials left after sorting would be in the same order of magnitude as the plastic film. Hence automatic separation is currently only routinely undertaken when paper and card are at low levels in the feedstock to begin with.

Plastic film is very light and prone to disturbance by draughts and air movements when on a belt. Some MRFs have found that the presence of plastic films can result in higher downtime and maintenance periods to remove plastic film that is 'plugging' (blocking) the apertures in trommel sorting equipment and also to remove film which has wrapped around the shafts of screen sorting systems.

10. A financial assessment of recycling mixed plastics in the UK. WRAP 2009

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Because of the issues MRF operators either must install additional separation systems to deal with plastic films or increase the level of manual picking undertaken. In light of these additional costs, exporting lower grade plastic waste (including films) to countries (commonly China) where manual labour is much cheaper may be considered a preferred option by the processor. The export controls applicable to a shipment of waste are dependent on the exact composition of a load, down to polymer level in the case of plastics, and also the country of destination.

The Environment Agency determines export controls on a case by case basis. In the case of exports of mixed polymer (fully polymerized LDPE, HDPE, PP and PET) films from a household or commercial source to China, providing the shipment can be classified as B3010<sup>11</sup> and the level of contamination is below 0.5%<sup>12</sup> then the shipment may be able to go to China under Green List Controls on Annex VII documentation. However, in line with Chinese Government requirements if the contamination is above 0.5% and the films are fully or partially of a household source the shipment may be classified as Y46<sup>13,14,15</sup> and therefore would be prohibited for export to China or any other non-OECD country<sup>16</sup>.

### Sorting technologies

Technologies have been developed that should significantly improve the ability to separate and process film from co-mingled dry recyclable streams as market demand and value increase<sup>16</sup>.

11. [http://www.environment-agency.gov.uk/static/documents/Business/Consolidated\\_waste\\_list\\_ver5.pdf](http://www.environment-agency.gov.uk/static/documents/Business/Consolidated_waste_list_ver5.pdf)

12. Contamination includes plastic and other materials not included within the definition of B3010 this includes other recyclates, food, insects and moisture.

13. Y46 – 'And from Annex II of the Basel Convention (categories of waste requiring special consideration) – Y46 Waste collection from householders. Unless appropriately classified under a single entry in Annex III.

- **Bag splitting** is a process whereby bags of recyclable materials are split automatically and the contents metered onto a conveyor for downstream separation, rather than the whole bag being shredded at the start of the MRF process. As the bags are opened and the material is separated without shredding or compressing, downstream separation is more effective. This is more effective for film material as it leaves the majority of film at a size where it can be identified and sorted downstream (either manually or automatically), whilst also providing some cleaning action via separation.
- **Ballistic separation** is a technology that works well with relatively free-flowing materials. Materials are moved up a sloping screen with a number of oscillating rotating paddles. The incline is set so that the rolling 3D material (such as plastic bottles) falls back downwards, whilst the circular action of the paddles 'pushes' the flat 2D material up the screen, resulting in efficient separation of these material types. The machine also assists with mechanical cleaning and removal of fines, as the oscillating action of the paddles liberates fine contamination (mainly dirt and organics) and removes it through perforations in the paddles. Current separation efficiencies will vary between 75-90% dependent on feedstock and technology provider.
- **Air separation.** Loose material is fed into a constant air stream, normally from a conveyor. The heavy material falls through the air stream onto a discharge conveyor, whereas the light material is caught in the air stream and conveyed along a duct, over a diverter plate or rotating drum. Any residual light material is then separated from the air stream through a device known as a rotary lock or rotary valve. The air stream can also be filtered to remove any particulates if the air is to be emitted to atmosphere. As with ballistic separation, efficiencies will vary between 75-90% dependent on feedstock and technology provider.

14. [http://www.environment-agency.gov.uk/static/documents/Business/Consolidated\\_waste\\_list\\_ver5.pdf](http://www.environment-agency.gov.uk/static/documents/Business/Consolidated_waste_list_ver5.pdf)

15. <http://www.oecd.org/general/listofocdmemberscountries-ratificationoftheconventionontheoecd.htm>

16. Film reprocessing technologies and collection schemes. WRAP, 2012

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## SORTING CONT.

### Sorting technologies cont.

- **Size reduction.** Some film recycling processes include size reduction to standardise the size of the film pieces prior to further processing. Large single shaft shredders are typically used.
- **Optical sorting** using NIR light has distinct advantages over ballistic and air separation as it distinguishes between film and other light 2D materials such as paper. NIR light is shone at the conveyor belt - differing wavelengths are reflected according to the material that the light hits. A sensor above the belt determines the material type from this 'fingerprint' of wavelengths and instructs a row of air jets to fire out any material that it has been programmed to search for. This is established technology for sorting rigid plastics but is still fairly new for sorting films and has a number of difficulties to overcome. Large film items are difficult to eject efficiently from the conveyor using air jets. Films also tend to overlap other items on the conveyor leading to mis-sorts. Furthermore black film materials (e.g. bin bags) do not reflect light so are not detected by the sensors. Nonetheless, the latest generation of NIR film sorters is capable of achieving separation efficiencies close to those achieved by rigid plastic NIR sorters.

WRAP conducted sorting and processing trials using variants of NIR sorters to establish the viability of separating and recycling plastic films from the UK household co-mingled recyclable waste stream and these technologies may help overcome some of the issues highlighted above. Co-mingled recyclables from two UK local authorities were processed to produce a 2D fraction containing fibre materials and plastic film (approximately 6.6% film content). The NIR sorters used in the trial were of particular interest because of additional technology that creates a linear airflow along an enclosed conveyor belt to minimise movement of lightweight items on the belt and thereby improve NIR detection and sorting. This approach proved effective and by using two NIR sorters in sequence it was possible to extract the majority of the household PE film<sup>17</sup>.

Contamination and moisture are also important factors in sorting plastic film since they determine whether the material can be cleaned cost-effectively for reprocessing. They can also impact on the effectiveness of automatic separation technologies (described above). Studies have found that contamination and moisture comprised 13% of the content in film from co-mingled recyclable streams and 20% of the content in film from a residual waste stream. Although these can readily be dealt with by washing and drying at later stages, their presence means that any film reprocessor ends up with a reduced final yield of plastic; in effect the reprocessor is paying for the water and contamination in their film feedstock from the MRF.

Plastic film reprocessing is covered in the following section and in detail within the separate WRAP report on film reprocessing technologies and collection schemes<sup>18</sup> across Europe.

17. WRAP 2013. Processing trials for post-consumer film waste. IMT006-004

18. <http://www.wrap.org.uk/sites/files/wrap/Film%20reprocessing%20technologies%20and%20collection%20schemes.pdf>

# REPROCESSING

## Overview

As discussed in the previous section on Sorting, the existing materials sorting infrastructure in the UK has been developed for handling rigid 3D plastics and cannot cope with sorting a 2D film fraction from 3D materials. Consequently, effective film separation and reprocessing requires dedicated equipment and facilities. Current UK film reprocessing facilities use predominantly agricultural or commercial and industrial (C&I) films, which generally are thicker, made with one polymer and are relatively clean. However, this situation is at the point of changing as dedicated reprocessing plants for household film waste are being developed in the UK (see Market), with a number of such facilities already operating in Europe.

## Stage 1 – Shredding

The first reprocessing stage is shredding, which for plastic film presents a number of technical challenges compared to other recyclable materials. Film is flexible and difficult to tear. It has a tendency to wrap around shredding equipment, causing poor performance or blockages. Therefore, special equipment designs are often needed to deal specifically with film streams. Problems can also be alleviated somewhat by feeding the material on rolls or in bales. A typical film shredder will size-reduce material down to about 40mm with a throughput of approximately 2.5 tonnes per hour.

## Stage 2 – Cleaning

The next stage is to clean the film of contaminants and to dry it. Post-consumer household film can present particular challenges for cleaning because of food contamination and, more importantly, the presence of adhesive printed labels on some of the films. Cleaning approaches include:

- **Dry cleaning.** Plastic film is subjected to significant mechanical stress by high speed rotating paddles within a confined space. This breaks down any paper present into a fibrous 'fluff' which is removed through a perforated screen along with any other contamination. The screen is kept clean by a rotating brush scraper which forces the fluff and dirt that is separated into an auger for removal from the unit. The advantage of this process is that it eliminates the use of water or chemical agents for cleaning and does not have the liquid waste disposal issues and associated costs of alternative wet cleaning processes. Dry cleaning will remove 80-90% of contamination.
- **Wet washing.** A typical film washing plant consists of several stages; the primary stage is size reduction, to ensure a consistent particle size for subsequent processing. This is usually carried out by a wet granulator, which also has the effect of beginning the washing process, after which the film is transported through a friction washer/dryer. The film is then fed into a tank containing either hot water or (rarely) a hot caustic solution and agitated; this removes labels from the film and dissolves the glue. A screw press conveyor is then used to mechanically squeeze more water out and a hot air or friction drying system is used to reduce the moisture content to below 2-3% so that it is suitable for extrusion. Wet washing can produce a very clean film stream from a suitable feedstock, and can even produce acceptable results with high levels of contamination. This technology does use large amounts of water and a separate treatment plant is needed to deal with the effluent. Wet washing is widely used in Europe for cleaning film waste, but currently there is only a small number of active plants using this technology in the UK.

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## Stage 3 – Extrusion

Once cleaned, film can be re-extruded for subsequent use in end-product manufacture. This is also challenging however as the low bulk density of the material can make high throughputs difficult to achieve. Therefore the material must first be agglomerated and increased in density to maximise the possible throughput. The melted plastic is then passed through one or more mechanical filters in order to remove any material that has not melted. Films will often be contaminated with organics such as fats and oils that also need to be removed and this is often achieved during the extrusion process. These contaminants boil off at the high temperatures needed to melt the plastic and are captured in degassing chambers. However, this must be done carefully in order to allow all the contamination to be removed. Finally the melt is extruded to either pellet or end product such as sheet or film. In a facility that incorporates manufacturing the melt can be fed directly to make a final product. Using filters and degassing chambers, modern film extruders can cope with up to about 3% 'soft' contamination (for example paper) and can also handle significant organic contamination such as fats and oils.

Contamination is one of the major issues in processing household plastic film packaging since producing a usable product is completely dependent on removing as much extraneous paper and other contaminants as possible. The quality of the final product also depends heavily on the feedstock; a feedstock of mixed films will extrude satisfactorily but the produced pellet will be of variable quality and will most likely have limited applications.

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# MARKET

## Current perspective

There is a limited UK market currently for recycled household plastic film packaging and most of this material goes to landfill, energy from waste or may be exported for reprocessing.

The major export market for recycled film is China with most (legitimate) material coming from agricultural and C&I sources. There it is hand sorted to remove contaminants, labels are cut out and the film is washed, dried and extruded to pellet.

As was noted in the section on sorting, unless shipments of mixed film can be classified as B3010 with a level of contamination below 0.5%, export to China is likely to be prohibited. So although it is an important market for agricultural and C&I materials, export to China cannot be used as a waste management route for post-consumer household plastic film packaging collected from the UK unless it meets the aforementioned criteria. Nonetheless, household film is still being sent to China from the UK and local authorities need to be aware of this and to seek assurances and evidence from their contractors that the material is only going to appropriate destinations and end-uses. The supply chain for the movement of recyclates is often convoluted and lacking transparency, when seeking assurances from contractors this must include both brokers in the UK and abroad in order to ensure the exact final destination of all waste exports are known<sup>19</sup>.

## Emerging outlets

Trials undertaken by WRAP show there is good potential for developing household plastic film packaging recycling and processing to create viable end-products in the UK<sup>20</sup>.

- Production of refuse sacks.** Post-consumer film was separated from kerbside waste at a new MRF in the UK using an optimised NIR sorting system. Baled high-purity film was then sent to a specialist facility in Austria and processed into LDPE pellets. Similarly, a mixture of FOSR collected film (mostly customer carrier bags) and back of store film were collected from supermarkets in the UK and reprocessed to LDPE pellets at the same facility. The resulting material from both these sources was then successfully used to manufacture refuse sacks. This was achieved to the same product specification as their existing products, except with some minor technical issues that would be resolved by further trials. This was a good demonstration of the viability of using UK sourced household film for products and CeDo in the UK manufactured refuse sacks from post-consumer film. However, as refuse sacks already incorporate recycled content this outlet would not involve household film replacing virgin polymers in the manufacturing process, but replacing one source of recyclate for another.

19. [http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT\\_7532\\_71b814.pdf](http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_7532_71b814.pdf)

20. <http://www.wrap.org.uk/content/recycling-post-consumer-film-trials>

## MARKET CONT.

### Emerging outlets cont.

- Manufacture of panel boards.** Material from both kerbside and supermarket (FOSR) sources was tested in two separate methods for making panel boards. The supermarket waste was first processed to produce LDPE agglomerate which was then used by Centriforce to manufacture 12mm panels by an extrusion method. The resultant products met Centriforce's specifications for hoarding panels, although it was noted that when the initial film feed only underwent a minimal hand pick the final boards had a lower quality finish due to more contaminants remaining in the feedstock. The minimal hand pick in this case involved the removal of larger pieces of contamination; a more thorough hand pick of the film material to remove contaminants was necessary to achieve a quality comparable with the manufacturer's typical feedstock. The more thorough hand-picking was not considered to be economically viable for commercial production.

Protomax also produces PE panels, but their products combine a core layer with an outer skin to give a smooth finish. This process does not require the feed film material for the core to be pelleted or agglomerated beforehand. The supermarket film and lower purity kerbside film were both tested in this process, which requires a proportion of rigid PP waste to be added before the mixture is processed to make the panel cores. Again the final products were found to be of a satisfactory standard. The advantage of this manufacturing process is that it enables lower purity feed material to be used since the addition of an outer skin layer means that impurities in the core material do not affect the visual appearance of the final product.

21. <http://www.wrap.org.uk/content/recycling-aluminium-plastic-laminated-tubes-and-pouches>

### PlasRecycle

PlasRecycle is a new entrant into the UK plastic films reprocessing market. PlasRecycle has been set up with £10.7 million of finance from a combination of private and public financial support to build a large-scale post-consumer film recycling plant based in London. The project is scheduled for plant installation in summer 2013, with first-off production in Q3 of 2013. Target feed material will be baled post-consumer films from MRFs and output will be recycled PE plastic resin. Start-up tonnage is around 20,000 tonnes per annum with plans to double capacity and start to build a second plant in the North of England later in 2013.

### Developments

There are other potential uses for waste film being developed that do not aim to specifically produce a recycled plastic for inclusion in new products, but nonetheless could have considerable environmental benefits.

- There is evidence that processes are available for laminate films (plastic/aluminium composites) that can recover the aluminium<sup>21</sup>, resulting in around half the carbon emissions needed to produce an ingot of aluminium compared to production from the bauxite process.
- Another potential use for film waste is in the production of liquid fuels. Tokarz, a Polish company is successfully using catalytic depolymerisation of PE, PP and polystyrene directly from MBT waste (or other sources) without any pre-processing to produce a mixed gas oil/gasoline liquid fuel. WRAP and Zero Waste Scotland commissioned an initial assessment to investigate whether plastic film waste from an anaerobic digestion (AD) facility could be used as a feeder material for this process. The AD material could not be used directly and needed to be separated, washed and dried, but the tests demonstrated that a 45-50% yield should be possible from a starting material that still contained 20% paper and dirt and 15% moisture content.

## MARKET CONT.

- Cynar plc has developed a process of liquefaction, pyrolysis and distillation to produce fuel oils from plastics. Sita UK plans to use this technology to develop ten processing plants across the UK. Each plant will be capable of processing 20 tonnes of plastic a day, producing up to 19,000 litres of fuel. The feedstock for this process has to be washed, dried and size-reduced before it can be used. The first such process of this type in Avonmouth, Bristol is due to be commissioned and operational by the end of 2013.

### Communications

With the development of conventional and alternative markets the need for feedstock will increase. It is important that all the links in the plastic films supply chain are aware of the emerging material requirements and specifications so that collection, sorting and processing systems can adapt to opportunities in good time.

MRFs installing sorting technologies that support film separation are unlikely to be able to handle a large influx of films in one go, instead requiring this to be increased over time (due to physical constraints on material throughput). Such an approach will allow MRFs to optimise their sorting systems and for output specifications to be agreed with the emerging end markets.

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The previous sections of this document have provided information on the recycling of post-consumer plastic film – the collection options available, the challenges involved in sorting and separating film plastics, and the work by WRAP and others in testing new sorting technologies and in developing new applications and markets for recovered films. Whilst export, particularly to China, provides the main route currently to recycle post-consumer plastic films, the situation is changing with investment in the UK's first dedicated post-consumer plastic bag and film recycling plant due to come on-stream in London later in 2013 and with plans for a further plant in the north of England thereafter.

With kerbside recycling services in most UK local authorities now providing for collections of key packaging materials and paper, there is demand to see a wider range of materials collected including more challenging materials such as plastic film (incorporating carrier bags, shrink wrap, cling film, bubble wrap etc.) – a material that can be highly visible in the residual waste stream. Where rigid plastic packaging is accepted in kerbside schemes, there is evidence of higher levels of (non target) plastic film in the recycling stream suggesting some association on the part of householders. However, many plastics reprocessors view plastic film as a contaminant of higher value rigid plastics, for which outlets and markets are more developed.

For local authorities there are a number of issues to consider in relation to plastic films:

### Front of Store Recycling (FOSR)

- Many larger supermarkets – it is estimated around 4,500 – provide facilities at or close to their main entrances for shoppers to deposit films for recycling. These points were initially introduced for the collection of plastic carrier bags but with the advent and expansion of the On-Packaging Recycling Label (OPRL) the range of films collected at these facilities has widened. These are accessible and convenient facilities and local authorities are advised to familiarise themselves with the OPRL scheme and the facilities available in their areas and to provide details to their residents. Artwork is available from WRAP to assist.

### Co-mingled collection and sorting

- Of those councils currently collecting films at the kerbside the vast majority do so co-mingled with other materials. The inclusion of household plastic film packaging in kerbside collections should be determined by the technical ability of the MRF that sorts the recycle. As described in this document plastic films present a number of technical challenges in the post-collection sorting process. In the environment of the MRF, films become entangled in equipment causing blockages increasing machinery downtime. Manual sorting of films at MRFs remains a preference.

### Untargeted film contamination

- Where untargeted film is present in the dry recycling stream in relatively small quantities it may be tolerated by the MRF but genuine markets for it to be recycled may not exist.

### Multi-stream collection

- Relatively few multi-stream recycling schemes target household plastic films with more research required to assess performance (e.g. capture, costs) and operational good practice going forward.

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## Targeted film

- The wide range of film types available and the different terminology used to describe them means it can be difficult to communicate target and non-target plastic films for recycling. If authorities are in a position to collect film plastics then it may be more effective to either target a single film type for collection (e.g. plastic carrier bags) or to accept all films, as something in between is likely to confuse service users.

## Bio and oxo-degradable polymers

- Bio and oxo-degradable polymers can be a contaminant to conventional polymer-based recyclates as they restrict reprocessing options. Until householders can clearly differentiate between compostable and non-compostable films and composting facilities are in a position to accept them, local authorities are advised not to target these materials for recycling.

WRAP funded trials have proved the feasibility of separating and recycling plastic film packaging from a UK MRF and investment in new reprocessing capacity is being made. However, until this new capacity comes online and MRFs are genuinely configured to separate films, FOSR represents the preferred collection route for this material.

Where local authorities may be in a position to consider adding plastic film to collections, they should confirm with their MRF operator that plastic film can be effectively sorted from other materials and that markets exist for the sorted film plastic. Where both of these criteria cannot be met local authorities are advised not to target plastic films in their kerbside collections and instead encourage residents to make use of FOSR or other bring-based facilities.

WRAP will keep this advice under review as the infrastructure and markets for sorting and reprocessing plastic films continue to develop.

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Term	Definition
Biodegradable plastics	Biodegradable plastics are plastics that will decompose in natural aerobic (composting) and anaerobic (landfill) environments.
Bioplastics	Plastics that are biobased, biodegradable, or both.
Compostable plastics	Plastics that are capable of undergoing biological decomposition in a composting process.
Co-mingled recycling collections	The collection from the household of a range of recyclable materials in a single compartment vehicle or a single compartment on a split vehicle. These are sorted at a Material Recovery Facility.
Front of Store Recycling (FOSR) facilities	Collection points for (in this case) plastic films located at or near the store entrance.
Material Recovery Facility (MRF)	A facility which is designed to process source separated/co-mingled dry recyclables is sometimes referred to as a 'clean MRF' (as distinct from a 'dirty MRF', which handles co-mingled wastes including putrescible materials).
Multi-stream kerbside sort	The collection from the household of recyclable materials that are sorted at the vehicle into individual materials.
NIR (near infrared) sorting	A technique to distinguish between different plastic types by recognising a light intensity reading which is unique for each polymer. The NIR sensor then triggers air jets which separate the selected polymer streams.
On-Pack Recycling Label (OPRL)	The OPRL is a label found on the packaging of some products summarising information about the recyclability and composition of the packaging.
Oxo-degradable plastics	Oxo-degradable plastics are materials that have additives to accelerate the degradation process in the right conditions.
Rigid plastic packaging	In this case rigid plastic packaging refers to the pots (such as yoghurt pots), tubs (such as margarine tubs) and trays (such as ready meal trays) which can be collected as a stream for recycling.

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