

Supporting evidence and analysis

The case for greater consistency in household recycling



September 2016

About WRAP

WRAP is a not for profit organisation and registered charity whose vision is a world where resources are used sustainably. WRAP works with government, business and communities to deliver practical solutions to improve resource efficiency.

Our mission is to accelerate the move to a sustainable, resource-efficient economy by:

1. Re-inventing how we design, produce and sell products;
2. Re-thinking how we use and consume products; and
3. Re-defining what is possible through re-use and recycling.

This document provides the supporting evidence and analysis for building greater consistency in household recycling collections across England.

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- Advisory Committee on Packaging
- Anaerobic Digestion and Bioresources Association
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- British Retail Consortium
- Chartered Institution of Wastes Management
- Department for Communities & Local Government
- Department for Environment, Food & Rural Affairs
- Environmental Services Association
- Food and Drink Federation
- Green Alliance
- Local Authority Recycling Advisory Committee
- Local Government Association
- London Waste and Recycling Board / Resource London
- National Association of Waste Disposal Officers
- Recycling Association
- Resource Association
- WRAP

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Executive summary

Following a roundtable meeting in July 2015 between the Minister for Environment and Rural Affairs, and representatives from the waste and resource management industry, WRAP and industry was tasked with exploring the opportunities for greater consistency in household recycling in England. This was carried out within the context of the existing policy, regulatory and institutional framework and assuming a voluntary approach. The outcome is [A Framework for Greater Consistency in Household Recycling in England](#).

This document summarises the analysis and key supporting evidence that underpins the *Framework* and vision for greater consistency in household recycling:

“By 2025 packaging is designed to be recyclable, where practical and environmentally beneficial, and is labelled clearly to indicate whether it can be recycled or not. Every household in England can recycle a common set of dry recyclable materials and food waste, collected in one of three different ways. “

The benefits of delivering this Vision have been assessed through rigorous quantitative and qualitative analysis in terms of:

- Cost of service provision;
- Contribution to higher recycling;
- Improved quality of materials for reprocessing;
- Impact on householders in relation to increasing engagement in recycling and reducing confusion;
- Legal compliance, in particular confidence of compliance with the separate collection requirements of the Waste Regulations 2011 (as amended 2012); and
- Environmental benefits.

The focus is for a core set of materials to be collected; these are: paper, card, plastic bottles and other rigid plastic packaging, metal packaging, glass containers, food and beverage cartons, and food waste. These materials are already collected by most local authorities for recycling, but for some materials there are gaps in service provision. Together these core materials make up 60% of the household collected waste stream¹.

¹ The other key material is garden waste – 15% of collected waste from households – collections of garden waste are offered by 96% of local authorities with limited variation in service profile.



The opportunities to rationalise recycling collections focuses on three approaches reflecting current practices:

- Multi-stream with food;
- Two-stream (packaging co-mingled with fibres separate) and food separate; and
- Co-mingled (mixed dry recyclables) with food separate.

The achievement of greater consistency is a long-term ambition and is likely to be taken forward in a phased approach in order for it to be cost effective. While the ambition is for consistency across all property types, it is likely that there would be a focus on kerbside properties initially.

WRAP's analysis shows that greater consistency in household recycling has the potential to contribute the following benefits over the assumed 8-year transition period (2018/19 to 2025/26):

- **Financial benefits for local authorities:** The analysis indicates there is the potential for financial benefit to local government through more effective service design, increased diversion of waste from disposal and additional revenue from the sale of more recyclables. The overall level of benefit depends on how services rationalise around the framework proposed as individual authorities consider their current arrangements, local priorities and opportunities to make service changes. The analysis indicates that overall the vision for household collections can be achieved whilst delivering a financial benefit of the order of **up to £400 million over eight years**. However, delivering this level of financial benefit would be challenging, for a number of reasons and it may be difficult for some authorities to realise the benefits modelled. WRAP is working with a number of local authorities to assess the opportunities and business case for introducing more consistency locally. This includes the opportunity for cross boundary working and exploring other areas for potential savings;
- **Up to £478 million of materials** returned to the economy from the sale of dry recyclables.
- **Up to 11.6mt of materials and food waste collected for recycling**, adding approximately 7 percentage points to the household waste recycling rate for England.
- **13.2 million more households** (including those in flats) provided with a food waste collection service, and 11 million more households provided with a recycling service for the core set of dry recyclables.
- **Up to £33 million in reduced costs to reprocessors** from not having to remove contamination from materials before processing.
- **Up to 8mt of organic fertiliser** available to the agri-sector, with a nutrient value of £30 million



- Supplying around **682,000 homes with renewable energy** generating sales of up to £280 million a year, improving the UK's energy security.
- Improved environmental outcomes with up to **5.1mt CO₂e avoided**, benefiting the environment directly and supporting the UK's overall carbon budget targets.
- WRAP's evidence suggests that alongside well operated and communicated services, greater consistency in the materials collected for recycling is likely to result in better capture of target materials and less contamination of the recycling stream.

The *Framework* provides clear direction and outlines a number of actions across the supply chain to help fully realise these benefits. Realising the benefits will be challenging particular in the current context of continuing financial and budgetary pressures in particular for local government. By working together, all parties stand to benefit from more consistent household recycling.

The advisory group, initially formed to identify the opportunities and define the Framework, will continue to meet in order to support progress towards the long-term goal. It will also review the *Framework and Vision* to ensure that it remains progressive and reflects current situations and future changes.



Context for considering greater consistency

This document sets out the rationale for the *Framework and Vision for Greater Consistency* in household recycling, the benefits from greater consistency, why the opportunities outlined within the *Framework* have been put forward, and the time period over which action might reasonably be taken. Evidence is drawn from the work of WRAP and others, and considers the views of householders as expressed through surveys on waste and recycling.

The opportunities for achieving greater consistency in household recycling have been considered within the context provided by the current policy, regulatory and institutional framework. Action by local authorities and others across the supply chain will be voluntary.

Background

At a meeting in July 2015 between the Minister for Environment and Rural Affairs, and the resource and waste management sector, it was agreed that an advisory group should be formed to look into the opportunities for more consistent collections for household recycling in England, and to develop options for realising the potential benefits. This was an opportunity to explore the scope, benefits and challenges in moving towards a more coherent and consistent system for collecting and processing recyclable materials. In particular, the Government was keen to see how this could help deliver higher rates of high quality recycling (with associated environmental and economic benefits).

The advisory group, which met for the first time in September 2015, comprises of representatives of leading organisations from local government, the waste management sector, recyclers, brands and retailers, and independent think tanks.



The household waste recycling rate has quadrupled from 11% in 2000 to over 44% in 2014, largely due to the efforts of local authorities in expanding their recycling services and promoting recycling, and to industry investment in new sorting and processing infrastructure. The advisory group however recognised that barriers remain to realising the full resource value of waste, including increasing household recycling further.

11%

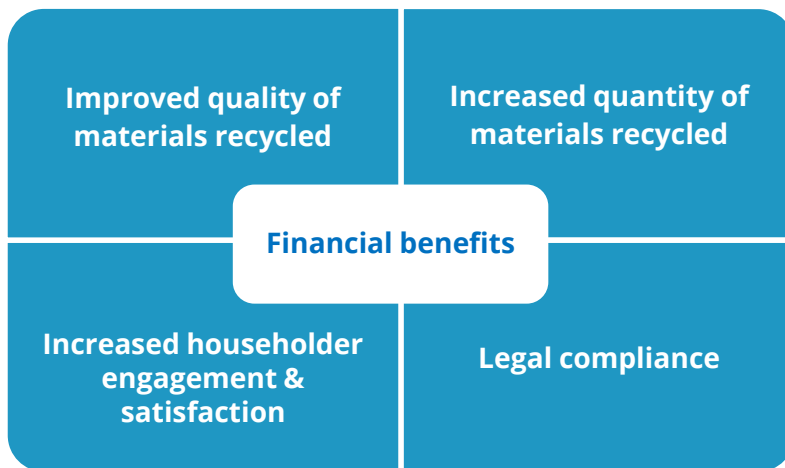
Recycling rate in 2000

There was broad consensus that greater consistency would need to deliver a number of benefits in order to contribute to addressing these barriers, as well as requiring the support of and generating action across the whole supply chain. The benefits identified are:

44%

Recycling rate in 2014

Figure 1: Key benefits to be delivered by greater consistency



- **Financial:** to provide a net financial benefit through optimising recycling collection service provision; increasing potential revenue; reducing costs; and providing opportunities to realise savings through joint working and procurement;
- **Increased quantity of materials recycled:** to contribute to the delivery of **higher recycling** and associated environmental and economic benefits;
- **Improved quality of material:** combined with an increase in the quantity of materials collected this will help to build more resilient secondary materials markets in the UK;
- **Increased householder engagement and satisfaction** leading to more effective recycling; and
- **Legal compliance**, in particular with the separate collection requirements of the Waste Regulations 2011 (as amended 2012).



Identifying the opportunities

The approach to identifying and assessing the opportunities for greater consistency broadly fell into two phases:

- Phase 1 defined the **scope** of consistency; developed the **analysis framework**; mapped **current provision** of household waste and recycling services; identified the key areas of **opportunity**; developed a model and undertook initial modelling of **options**; and identified the ways in which these could be addressed.
- Phase 2 involved **defining** the *Vision* for greater consistency and a *Framework* for **delivering** it. Building on the initial analysis the model and options were refined and three scenarios reflecting differing levels of consistency mapped across the available evidence.

The key evidence that has informed this analysis is listed in [Appendix A](#).

The analysis framework

An analysis framework was designed to consider each of the benefits identified by the advisory group. All costs and benefits were assessed through a combination of quantitative and qualitative analysis as follows:

- **Costs** – modelled costs of service delivery for different collection approaches and the transition costs from current collection approaches to the alternatives were considered. Potential opportunities for savings from joint working and procurement are informed by case studies, reports and feedback from local authorities, but have not been modelled. The modelling approach adopted is described in [Appendix D](#).
- **Contribution to recycling** – modelled contribution to the national recycling rate and the additional tonnes of materials available to reprocessors as a result.
- **Quality** – informed by a range of data and evidence including from WasteDataFlow, the WRAP managed Materials Facilities Portal, the Review of the Welsh Blueprint, Zero Waste Scotland, and reprocessors.
- **Public engagement and satisfaction** - assessed by drawing on available evidence including from WRAP's annual recycling tracker survey, research on barriers to recycling and consumer polling. Key evidence is summarised in [Appendix C](#).



- **Environment** – calculated based on the tonnes of materials and food waste diverted from disposal to determine the tonnes of CO₂ (eq) avoided.
- **Legal compliance** – commentary based on the requirements to demonstrate compliance with relevant legislation.

Figure 2: Summary of analysis methods

Costs	Quantity of material available for recycling	Material quality	Customer Engagement/ Satisfaction	Environment	Legal compliance
Modelled	Modelled	Assessed	Assessed	Quantified	Commentary



The opportunities

All components of local authority household waste and recycling collection services were mapped including waste streams, materials collected, method, containers (number, type, size and colour), collection frequencies, collection policies and communications. Those considered to offer more opportunity for introducing greater consistency were identified as:

- Materials collected (for recycling);
- Methods of collection; and
- Containers/containment.

Consistent set of materials collected for recycling

The *Vision* sets out an aspiration that all householders are able to recycle **a common set of materials** including **food waste**. Together these core materials make up 60% of the waste collected from households (residual and recyclables) as shown in Figure 3².

- Paper;
- Card;
- Plastic bottles;
- Plastic packaging - pots, tubs and trays;
- Metal packaging – cans, aerosols and foil;
- Glass bottles and jars;
- Food & beverage cartons; and
- Food waste.

60%

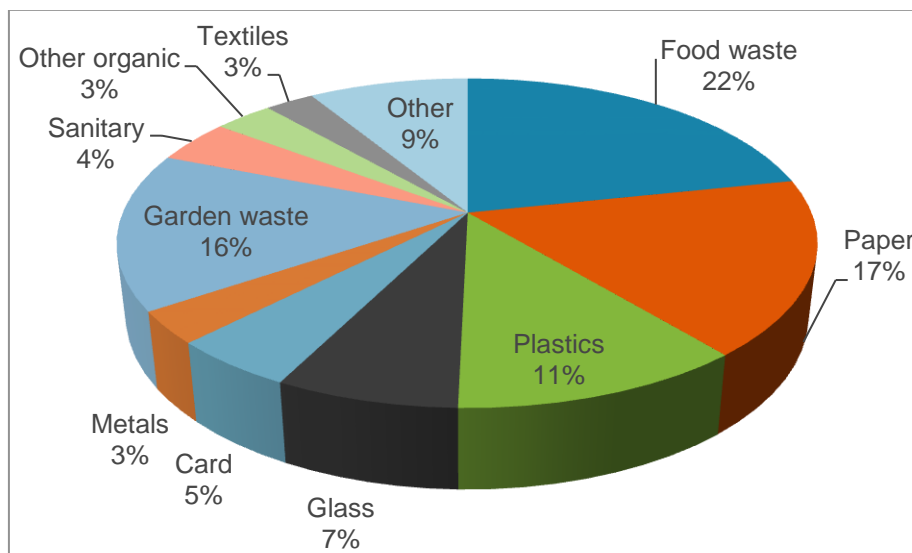
of collected household waste included in core set of materials

² Defra Waste Composition Data for 2010/11 – produced by Resource Futures.



Figure 3: Composition of household collected waste and recycling.

Source: Defra Waste Composition Data for 2010/11 produced by Resource Futures

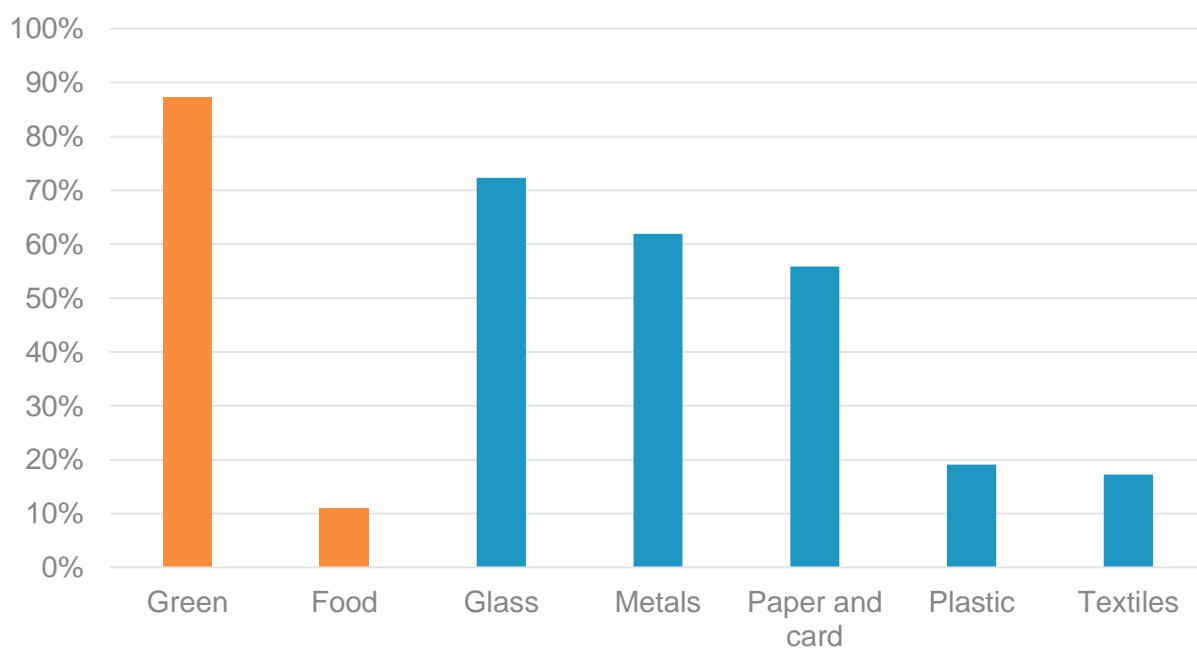


The rationale for this **set of core materials** is that most are collected for recycling by the majority of local authorities (see [Appendix B](#)), but there are gaps in service provision. In particular there are opportunities to extend collection provision for plastic pots, tubs and trays as well as food and beverage cartons, and to look at opportunities to reduce householder confusion over what materials can and cannot be recycled.

- **Plastic pots, tubs and trays** (PTTs) and food and beverage **cartons** (cartons) are collected by 72% and 64% of local authorities respectively (meaning that 67% and 63% of households respectively can recycle these materials). These materials are identified in consumer research as causing confusion; people are not sure whether they can recycle them or not (Appendix C). Where these materials are not collected locally for recycling they can be a source of contamination in the collected recyclables.
- Access to sorting capacity and the practicalities of handling the wide range of plastic packaging formats entering the waste stream were identified as barriers to further collection. With over two-thirds of local authorities collecting PTTs, finding sustainable end markets can be a challenge. There are end markets and applications available for UK collected plastics; recycling end markets are being developed for the main polymer types with considerable opportunities for polypropylene (PP). However very little used polystyrene (PS) packaging is recycled, and there is little or no end market demand for this material. Further opportunities to analyse packaging formats in relation to their recyclability and to assess the implications on sorting capacity of collecting more of these materials are identified in the *Framework*.



- Glass** – Since the mid-2000s the trend has been away from collecting recyclables at “bring sites”; this is for all materials including glass. From a peak of around 360,000 tonnes of glass collected at bring sites in 2007/08 the amount collected had reduced to just over 280,000 tonnes in 2014/15³. The total number of bring sites has also decreased in the past decade from over 19,000 in 2006/07 to 14,800 in 2014/15. The indication from local authorities is that with the continued expansion of household collections and pressures to reduce costs, bring banks are likely to reduce further in number. In contrast kerbside collection of glass has increased; 89% of local authorities now offer a kerbside recycling service and 86% of households have access to such a service. Most of the recent expansion in kerbside glass collections has been through adding glass to existing mixed dry recyclable (co-mingled) collections although both Defra and reprocessors advised against collecting glass and fibres together. This approach has implications for quality not only of the glass but of other materials, for sorting and for recovery rates. The considerations of adding glass to kerbside collections are addressed when looking at the options for greater consistency.
- Consumer surveys demonstrate room for improvement in recycling behaviours through **increasing the capture** of a range of materials such as aerosols, foil, specific types of plastic bottles, and by decreasing non-target recycling and contamination by non-recyclable materials (e.g. nappies)⁴. Even where services are operating there is the opportunity to increase the capture of many of the commonly recycled materials as shown in Figure 4.
 - Figure 4: Capture Rates by Material, England 2014/15 (analysis by WRAP)



³ Source: WasteDataFlow 2014/15

⁴ A summary of the key consumer evidence identifying the opportunities to improve capture and reduce confusion is provided in [Appendix C](#).



Food waste makes up a large proportion of collected residual waste (around 30%). Collecting it separately has the potential to divert significant quantities from disposal with a positive impact on recycling. A separate food waste collection is part of an effective service profile that includes reduced frequency residual waste collections. The significant investment in food waste processing plants (anaerobic digestions and in-vessel composting) in recent years means that capacity for treating separately collected food waste is available at competitive gate fees.

Kerbside collection of **garden waste** for composting is widespread (see [Appendix B](#)) and the composting of garden waste makes a significant contribution to the national recycling rate. The service is provided at the discretion of local authorities and can be charged for (46% of local authorities currently do charge for this service). It is a popular service that is highly valued by householders. Most authorities (96%) offer a service and these are fairly standard in design⁵. Therefore the opportunity to introduce greater consistency into garden waste collections was considered to be very limited. Because of this garden waste is not addressed by the *Framework*.

The core set of materials outlined within the *Framework* would be collected as a **minimum**. Some local authorities collect other materials from households for recycling such as plastic film, textiles, small waste electrical and electronic equipment (WEEE) and batteries. Over time the *Framework* will be reviewed to ensure that it remains progressive and reflective of, amongst other things, household waste composition, sorting and reprocessing technology, and end market demand for materials.

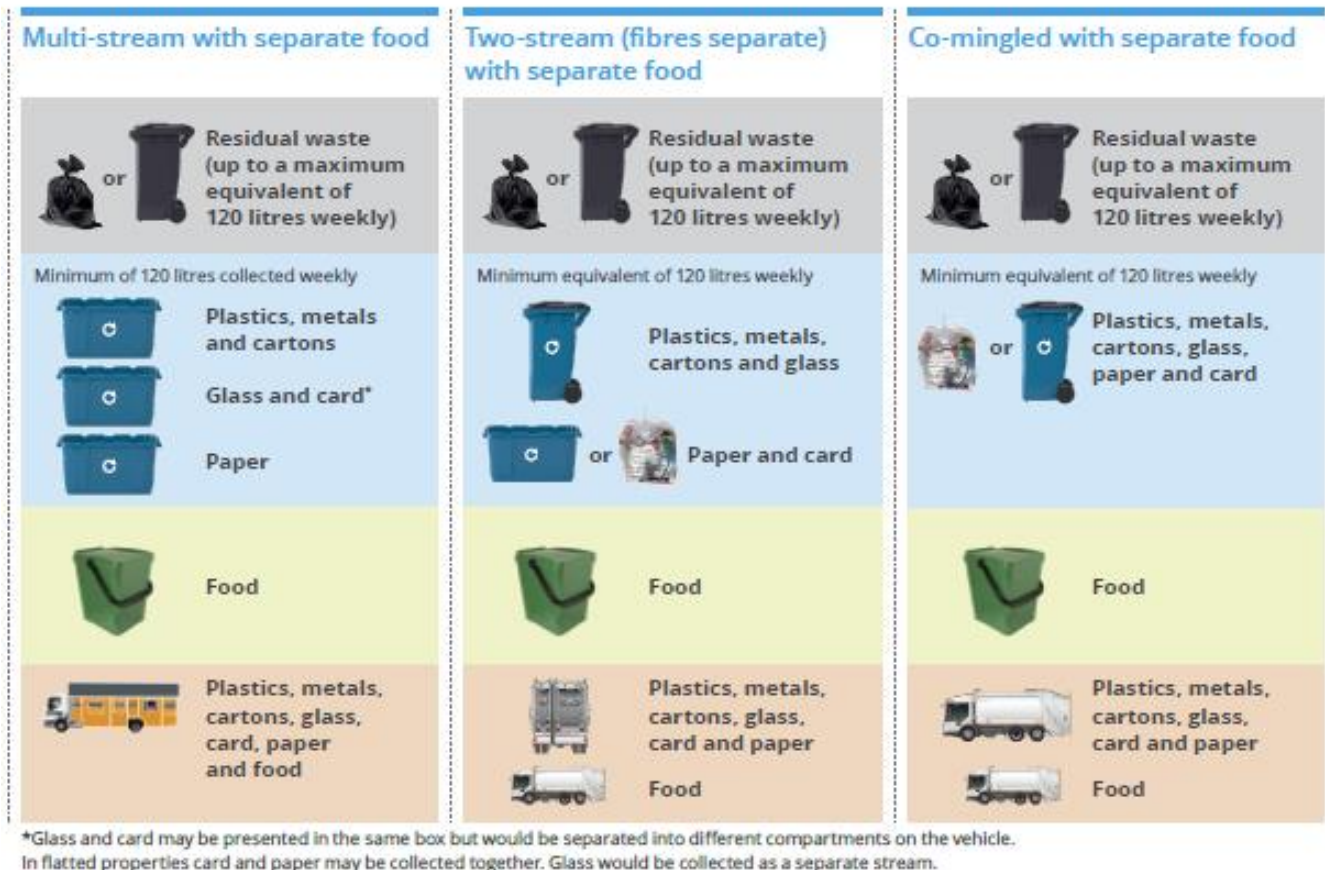
To support the collection of this common, core set of materials, a greater understanding by consumers of what items they can and cannot recycle and how they should present these items for recycling is required. This in turn requires greater consistency by waste management companies and reprocessors on what is accepted for recycling. WRAP is working with industry to develop guidelines to inform discussions between local authorities and their contractors and their communications with householders, as outlined in the *Framework*.

Fewer collection systems for recycling

A reduction in the approaches to how recycling is collected provides opportunities for efficiencies and cost savings, for example through cross boundary collections, as well as reducing householder confusion leading to more effective recycling. Using the analysis framework to evaluate the most common methods of collection, three collection methods were identified as set out in the *Framework* and described below. These systems allow flexibility to accommodate local circumstances and reflect investment that has been made in collection and sorting infrastructure. All include a separate weekly collection of food waste but each has a different approach to presenting and collecting dry recyclables. There are examples of each system operating in different local contexts.

⁵ Most collections are fortnightly using wheeled bins





Multi-stream with food: materials are presented for collection in four streams and separated into five compartments on the vehicle:

- Plastic packaging (bottles, pots, tub and trays), metal packaging (cans, aerosols and foil) and cartons;
- Glass containers and card (presented together in one container but separated at the kerbside by crews into different compartments on the vehicle)⁶;
- Paper; and
- Food waste.

All materials, including food, are collected weekly on a single pass multi-compartment vehicle. Financially, paper is the most important commodity and keeping it separate from other materials in order to keep it clean, dry and high quality is important. Card such as cereal boxes would be presented by the householder with glass in order to reduce the number of containers needed.

⁶ This reflects how materials are presented for collection under the Welsh Government's Collections Blueprint; the key being that to maximise income paper and card are presented separately and collected in different compartments of the vehicle. The priority for the paper industry is that fibres (paper/card) are kept separate from other materials.

Crews would separate the glass from the card at the kerbside and put it into a separate compartment of the vehicle. Presenting card for collection in this way is not considered to compromise quality as it is subsequently stored separately on the vehicle.

Cartons would be included in the same container as plastic and metal packaging. The reason for this is that if they are baled with cardboard it is unlikely that they will be recycled unless further sorting occurs. Cartons should be sorted at the kerbside into a separate compartment on the vehicle (which is unlikely given their volume), or manually removed at a later stage when separation of the plastics and metals occur. This also applies to co-mingled collection methods; once separated they can be recycled in the UK.

Two-stream (packaging co-mingled with fibres separate) with food separate: materials are presented for collection in three streams:

- Plastic packaging, metal packaging, glass and cartons as one stream;
- Paper and card (fibres) as one stream (both streams collected fortnightly in a split compartment vehicle); and
- Food waste collected weekly in a separate vehicle in all but the most rural areas.

Keeping fibres separate to glass once they are collected from householders is important for material quality. In this system, paper and cardboard are presented together in the same container and could either be sold as mixed paper at a lower price than would be achieved for paper alone, or could be sorted mechanically to separate the paper and card. Fibres are kept separate from other materials rather than glass in order to maximise revenue from the sale of materials. In addition, the payload of the collection vehicle is more efficient when fibres are collected separately compared to glass. Another benefit of separate fibres rather than glass is reduced noise, thereby reducing the risk of noise exposure by the crews. The packaging stream would require sorting at a Materials Recovery Facility (MRF).

Co-mingled (mixed dry recyclables) with food separate: materials are presented for collection in two streams:

- All mixed dry recyclables as one stream (collected fortnightly in a single compartment vehicle and sorted at a MRF); and
- Food waste, collected weekly in a separate vehicle in all but the most rural areas where it is collected with the recyclable stream one week and the residual waste on the alternating week.

This system has been widely adopted by local authorities however WRAP believes that the risk of not complying with the separate collection requirements of the Waste Regulations 2011 (as amended 2012) is greatest for this option owing to the potential for sub-optimal material quality for dry materials.



In each system dry recycling capacity for low rise (kerbside) properties is assumed in the modelling to be equivalent to at least 120 litres per week, food recycling capacity is 23 litres per week and residual waste capacity is restricted to a maximum equivalent to 120 litres per week.

Residual waste

As people recycle more, they require less residual waste capacity. **Where residual waste capacity is restricted, WRAP evidence indicates that recycling services perform better, and where frequency is reduced to fortnightly, waste services are more cost effective to deliver.**

WRAP's analysis shows that when there is an effective weekly containment capacity⁷ of 120 litres compared to 240 litres, there is an increase in recycling rate by 7.2±2.9 percentage points. This is due to increases in dry recycling yields and decreases in residual waste yields⁸. The cost difference ranges from an additional £9 to £27 per household per year, depending on the recycling scheme and the degree of rurality (geography) and deprivation⁹.

A national container colour scheme

An association of colours and containers has been suggested as a next step in improving public engagement, enabling messages and communications to be further streamlined. The basis of a national 'colour' scheme (for boxes, bags and bins) was considered by the advisory group. Adopting a national colour scheme is possible, however as the annual replacement rate for containers (particularly wheeled bins) is low the time period over which change might naturally occur would be considerable. Creating change more quickly is possible but at a cost considered to be prohibitive at the present time¹⁰. However, the aspiration of a national colour scheme for residual, recycling, food and garden waste containers to be adopted over time as systems change and containers are replaced was not dismissed outright and is to be given further consideration.

⁷ Effective weekly capacity is defined as either 120 litres collected weekly, or 240 litres collected fortnightly.

⁸ WRAP, 2015 [Analysis of recycling performance and waste arisings in the UK 2012/13](#)

⁹ WRAP, 2015 [Indicative Costs and Performance Analysis of Kerbside Collections](#)

¹⁰ [An initial estimate of transition costs, suggests that if all local authorities were to change containers in a single year, the cost would be around £317 million; if change was to occur over 10 years, the cost would be of the order of £29 million per year.](#)



The case for a more consistent approach to household recycling

Scenario modelling

WRAP's analysis has identified the potential for collections to harmonise around one or more of the three systems identified in Section 4, with a number of benefits to local authorities and others.

WRAP undertook initial modelling of options for more consistent collections across England by comparing 12 different scenarios as part of Phase 1. These scenarios looked at adding dry recyclable materials and food waste individually and in combination across different recycling collections at different frequencies. This analysis clarified three key scenarios for further modelling which are outlined in this section. Further detail on the approach to modelling is included in [Appendix D](#).

Under each scenario any of the core materials proposed that are not collected currently by a local authority have been added to the collection profile of that authority and modelled. In all cases food waste is modelled to be collected weekly and separate to garden waste. Residual waste is modelled to be collected fortnightly.

Scenario 1: Combination of Multi-stream with food, Two-stream (co-mingled packaging with fibres separate) and food separate and Co-mingled mixed dry recyclables with food separate.

This scenario assumes all local authorities remain on their existing dry recycling service except those collecting glass separately as part of a two-stream system; those authorities are modelled with fibres collected separately rather than glass. This scenario presents the least amount of change compared to current arrangements for collecting dry recyclables.

Scenario 2: Multi-stream with food and Two-stream (co-mingled packaging with fibres separate) with food separate

Local authorities operating a co-mingled mixed dry recyclables collection or two-stream dry recyclables collection with glass separate are modelled with two-stream with fibres separate. Those authorities operating multi-stream are modelled remaining on multi-stream.

Scenario 3: All Multi-stream with food

All (320) local authorities in England are modelled with a multi-stream with food collection.



Cost and financial benefit

With local authority budgets under ever increasing pressure, adoption of more consistent collection methods will only make sense if it is economically viable. Encouraging householders to participate in collection services and increasing the capture of recyclable materials is critical to achieving cost effective recycling and to sustaining services in the longer term.

Approach to modelling

As there is no standard national approach to reporting costs, standardised kerbside collection costs (developed by WRAP) appropriate to the geography and level of deprivation within each authority were applied to the scheme type known to be operating in each authority in the baseline year – 2014/15. The **baseline cost calculated for 2014/15 is £2.5 billion** and is for low and high-rise collection services **including residual waste, dry recyclables, food waste and garden waste where collected**. It does not include household waste recycling centres, bring banks, street sweepings, schools or commercial waste collections but it is net of treatment costs, gate fees and income from the sale of materials. All material values and gate fees are based on 2015/16 prices. The baseline recycling rate for 2014/15 is **44.6%**.

Flatted properties

The vision for greater consistency is for all householders, regardless of property type. However, the advisory group recognised that achieving greater consistency is likely to be made through step changes, potentially addressing kerbside properties first. In addition, confidence in the cost assumptions of providing recycling services to flats is lower than for kerbside services. For this reason changes to services in flats were modelled separately in order for the data to be analysed separately. The modelling results are therefore presented for each for the three scenarios twice once to reflect a scenario where services to kerbside properties are changed while services to flats remain as in the baseline and then to reflect changes to both kerbside properties and flats. Assumptions applied to flats are further explained in [Appendix D](#). WRAP is working with local authorities and their contractors to better understand costs of services to flats and data will be reviewed over time to reflect the latest and best understanding.

Garden waste

Total service costs (for the baseline and each scenario) include garden waste (where this is collected by a local authority). For local authorities collecting mixed food and garden waste currently, a separate weekly food waste service has been modelled in each scenario, along with a separate garden waste only service.



Timeframe for change

For modelling purposes, an 8-year transition period (2018/19 – 2025/26) is assumed. For modelling purposes only it has been assumed that local authorities who run services in-house would make changes in 2018/19. It is acknowledged that in practice change would happen at natural review points to suit individual local authorities' (such as when vehicles are to be replaced) and that this could be at any point during the assumed 8-year transition period. For local authorities who provide services via a contractor, it is assumed for modelling purposes that changes could be made either at the end of the current contract or after 7 years, whichever is soonest. All material values and gate fees are based on 2015/16 prices and no inflation has been assumed. Future waste arisings are assumed to increase in line with projected increase household numbers¹¹.

Modelling results

The total "business as usual" (no service change) cost over the modelled 8 year period is **£21.42 billion**. [Appendix D](#) provides a summary of the modelling approach and key assumptions. Key results are discussed in this section.

The results of the modelling for changes to kerbside properties show reduced costs for two of the three scenarios.

Figure 5: Modelling results for service changes to kerbside properties, with services to flats maintained as currently provided:

Number	Scenario	Cumulative net service cost (2018/19-2025/26)	Cost difference compared to 'business as usual'	% change from baseline
1	Multi-stream with food, Two-stream with fibres and food separate, and Co-mingled with food separate	£21.40bn	£21m saving	-0.1%
2	Multi-stream with food and Two-stream with fibres and food separate	£21.63bn	£202m increase	0.9%
3	All Multi-stream with food	£20.77bn	£658m saving	-3.1%

¹¹ Projected increases in household numbers by local authority area taken from DCLG estimates.



The greater financial benefit to be gained from the 'All Multi-stream with food' (**Scenario 3**) is due largely to the additional revenue from the sale of recyclables offsetting collection costs. It is also due in part to lower collection costs achieved from the co-collection of food and dry recyclables on the same vehicles, weekly¹². WRAP's modelling indicates that multi-stream dry recyclables with food collected on the same vehicle generally is the lowest cost option across all local authority rurality types, with costs up to £3.25 per household per year lower compared to a "business as usual" baseline¹³. **If all local authorities were to adopt this approach and collect from all low rise properties, there is a potential financial benefit of up to £658m¹⁴.** Multi-stream collections provide the greatest opportunity to increase income from the sale of secondary materials with up to £433 million in additional revenues from recycle sales possible over the 8 year period to 2025/26¹⁵ from low rise properties.

Where local authorities are modelled to collect the core set of materials from low rise properties but with minimal overall changes to collection profiles (**Scenario 1**), there is potential financial benefit of £21million¹⁶, with increased collection and handling costs more than offset by additional revenue from recycle sales and avoided disposal costs. Scenario 1 represents the least change in terms of collection systems but does assume that where glass is not collected as part of a co-mingled dry mixed recyclable collection then it is added to the existing service. If authorities are considering adding glass then other factors identified in the analysis framework must be considered, in particular, compliance with the Waste (England and Wales) Regulations 2011 (as amended 2012) (see section 5.7) and the impact on material quality. **The advice from reprocessors is that**

£433m

– the potential additional revenue from the sale of recyclable materials

¹² In Wales, services operating weekly multi-stream collection with food are the lowest cost service per household compared to other approaches to collection. *Eunomia (2016) Review of the Welsh Government's Collections Blueprint*

¹³ Cumulative 2018/19 to 2025/26, constant prices (no adjustment for inflation) relative to a business as usual baseline

¹⁴ Cumulative 2018/19 to 2025/26, constant prices (no adjustment for inflation) relative to a business as usual baseline

¹⁵ Cumulative 2018/19 to 2025/26, 2015/16 prices (no adjustment for inflation) relative to a business as usual baseline

¹⁶ Cumulative 2018/19 to 2025/26, constant prices (no adjustment for inflation) relative to a business as usual baseline



glass and paper should be kept separate. In addition, Defra's advice to local authorities ¹⁷ is to ensure that quality issues with paper and glass are addressed through effective implementation of the regulations.

Compared to the no-change 'Business as usual' case all three 'consistency' scenarios show an increase in vehicle, container and operating costs associated with the enhanced collections. However, they all also show a decrease in treatment / disposal costs. A large proportion of this is due to avoided disposal costs from the collection of the additional dry materials and food waste for recycling. Figure 7 shows for each scenario the cost difference compared to baseline.

As outlined previously, although the best available data has been used to model the impact of the consistency scenarios for flats as well as kerbside, there is significantly less confidence in the modelled costs. However, even with cautious costs applied, our modelling suggests that there could be **an opportunity for financial benefit in the scenario where all local authorities collect multi-stream** (Scenario 3).

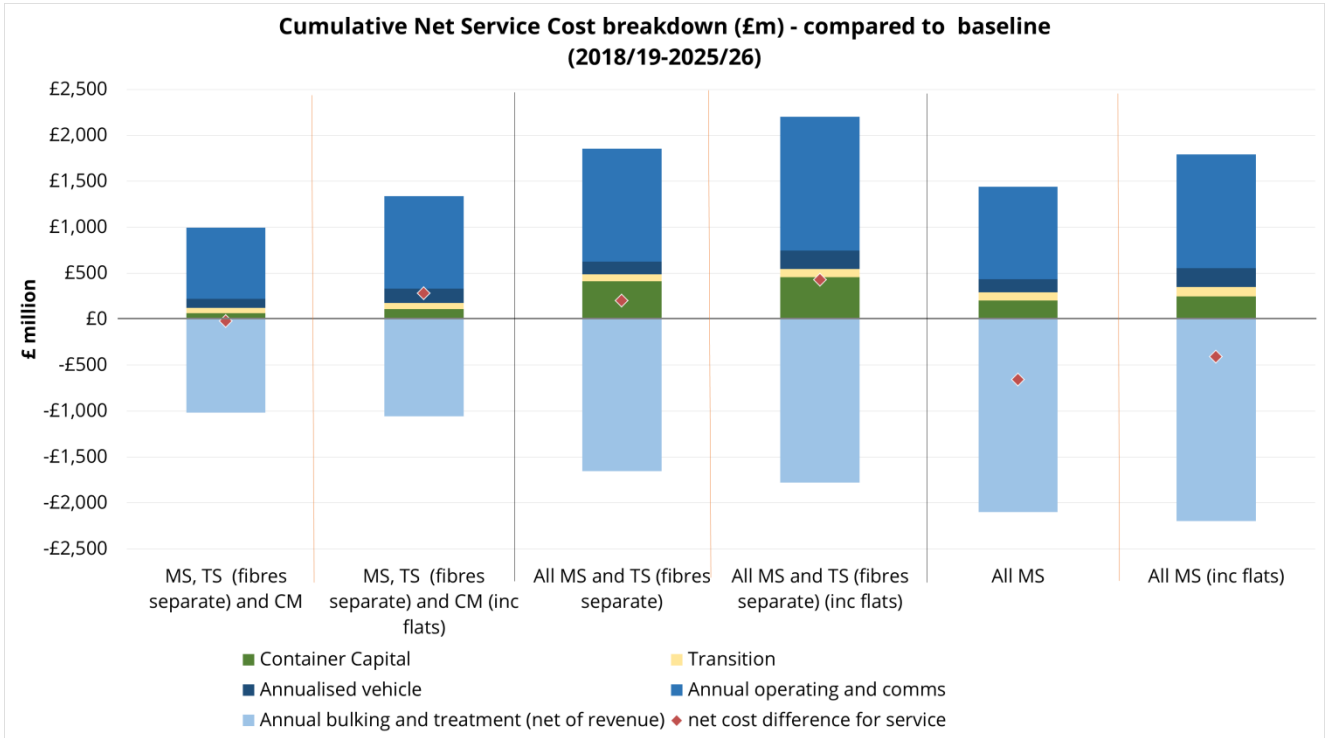
Figure 6: Modelling results for changes to kerbside properties and flats:

Number	Scenario	Cumulative net service cost (2018/19-2025/26)	Cost difference compared to 'business as usual'	% change from baseline
1	Multi-stream with food, Two-stream with fibres and food separate and Co-mingled with food separate with changes to flats	£21.7bn	£282m increase	1.3%
2	Multi-stream with food and Two-stream with fibres and food separate with changes to flats	£21.9bn	£426m increase	2.0%
3	All Multi-stream with food with changes to flats	£21.02	£408m saving	-1.9%

Figure 7: Cumulative Net Service Cost Breakdown (£m) - all scenarios

¹⁷ Letter from Defra Minister Lord de Mauley, October 2013





Key: Multi-stream with food (MS); Two-stream (fibres separate) with separate food (TS); Co-mingled with separate food (CM).

The proportion of authorities that could benefit financially

The modelling indicates that within each scenario some authorities are likely to benefit financially, while others may not depending on their existing service profile, for example authorities that do not currently collect food waste separately and already operate a reduced frequency (fortnightly) residual waste collection. Whilst the modelling has involved a ‘bottom up’ approach, inevitably ‘national average’ data has had to be applied to a number of assumptions hence the importance of individual local authorities considering the local business case; this would also provide the opportunity to explore the potential benefits of joint and cross boundary working which has not been part of the current modelling exercise.

The most financially beneficial scenario is multi-stream regardless of property type. Figure 8 outlines the number of authorities that would potentially see a cost increase/decrease and the range of those costs if all authorities were to collect all the core materials multi-stream from kerbside properties. In this scenario, 31% would benefit between 0 - £5 per household, 41% would benefit £5 to £20 and 9% would benefit between £20 and £40 per household.

In the multi-stream scenario with the service changes modelled for flatted properties as well as kerbside (Figure 9), **73% of authorities may see a financial benefit or remain cost neutral.**



In the scenario of least change (scenario 1) 55% would benefit financially with changes modelled for kerbside properties only (Figure 10). This drops to 40% when flats are included (Figure 11).

Figure 8: Range of change in costs of collection per household for multi-stream - Scenario 3 (changes to kerbside service only).

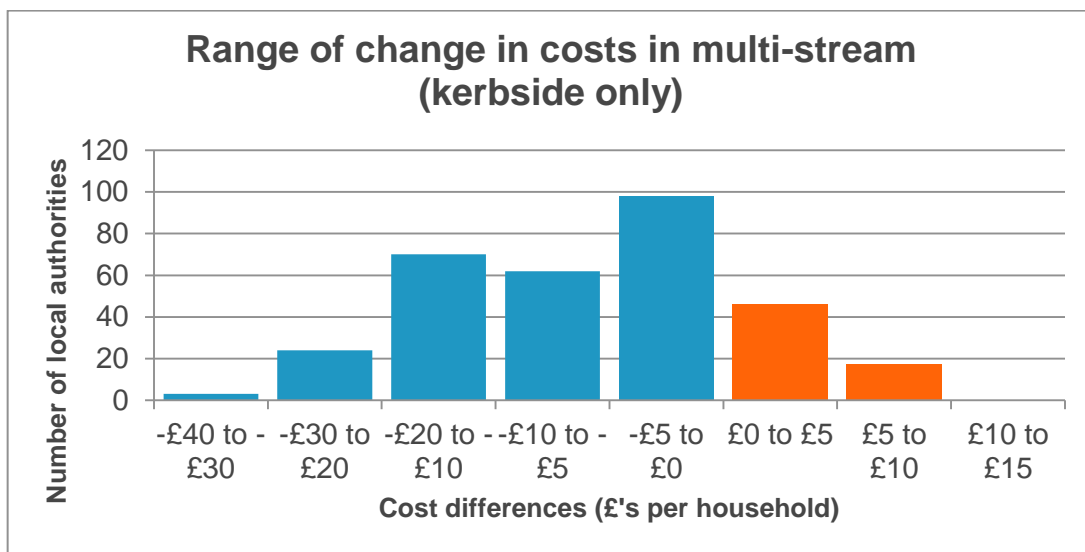


Figure 9: Range of change in costs of collection per household in multi-stream (changes to kerbside and flats). Scenario 3

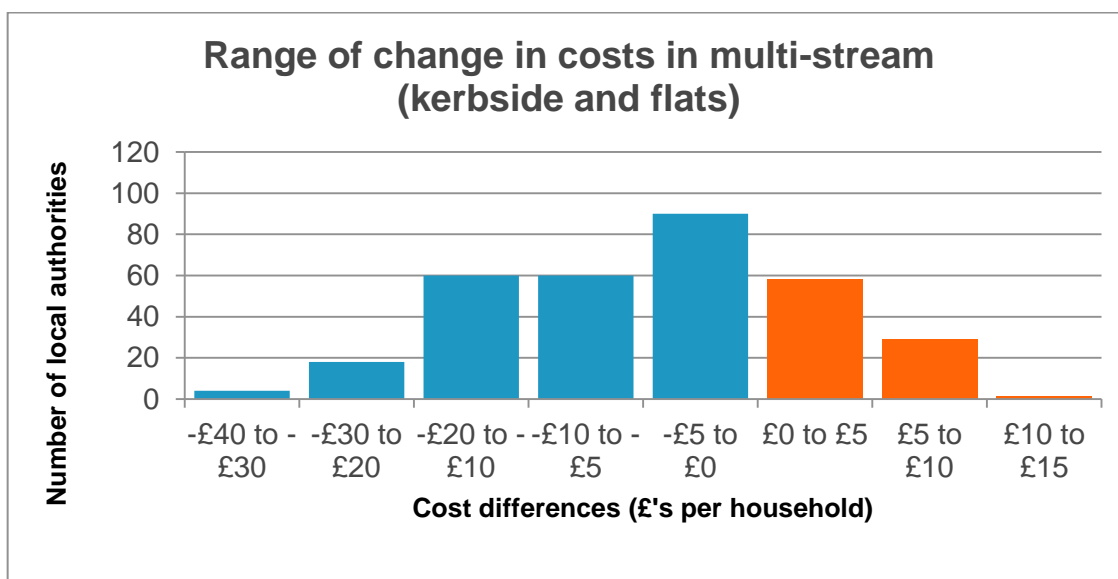


Figure 10: Range of changes in costs of collection per household in scenario 1 (changes to kerbside only).

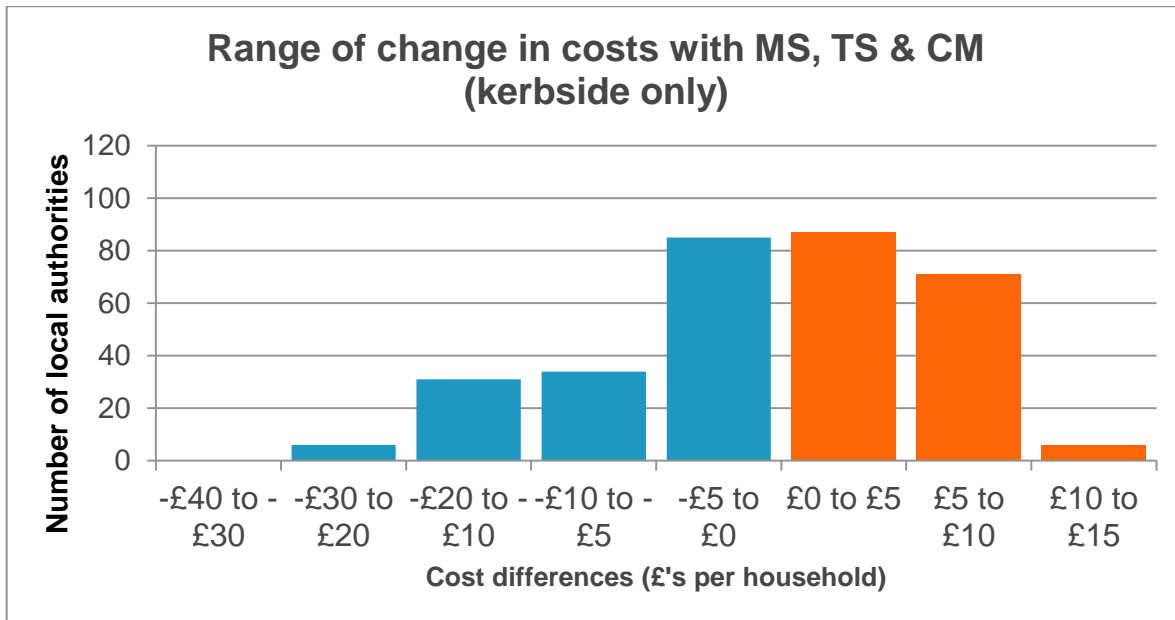
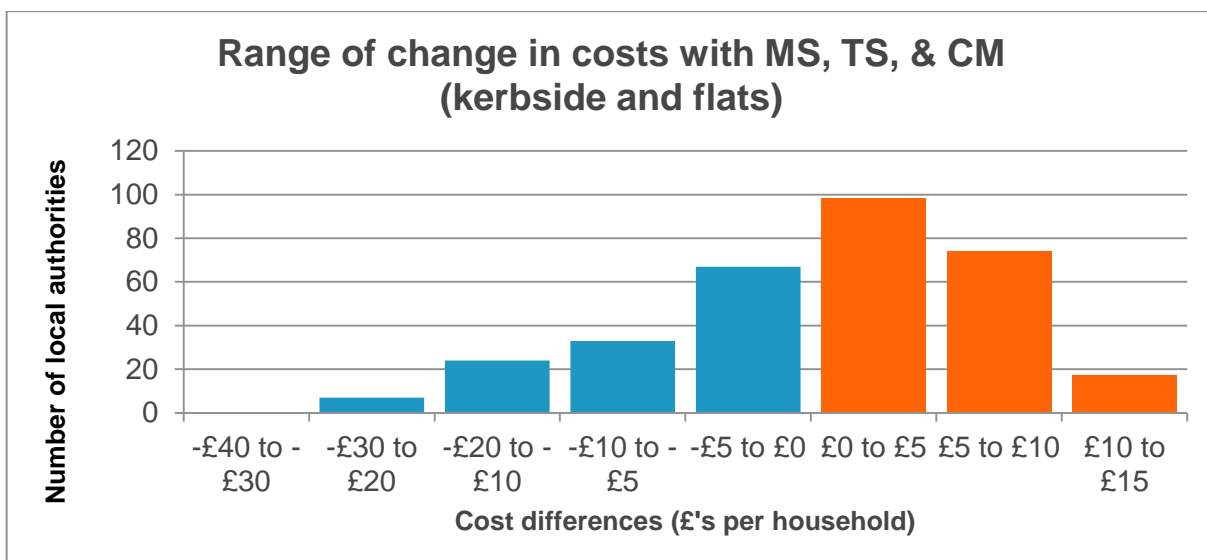


Figure 11: Range of changes in costs of collection per household in scenario 1 (changes to kerbside and flats)



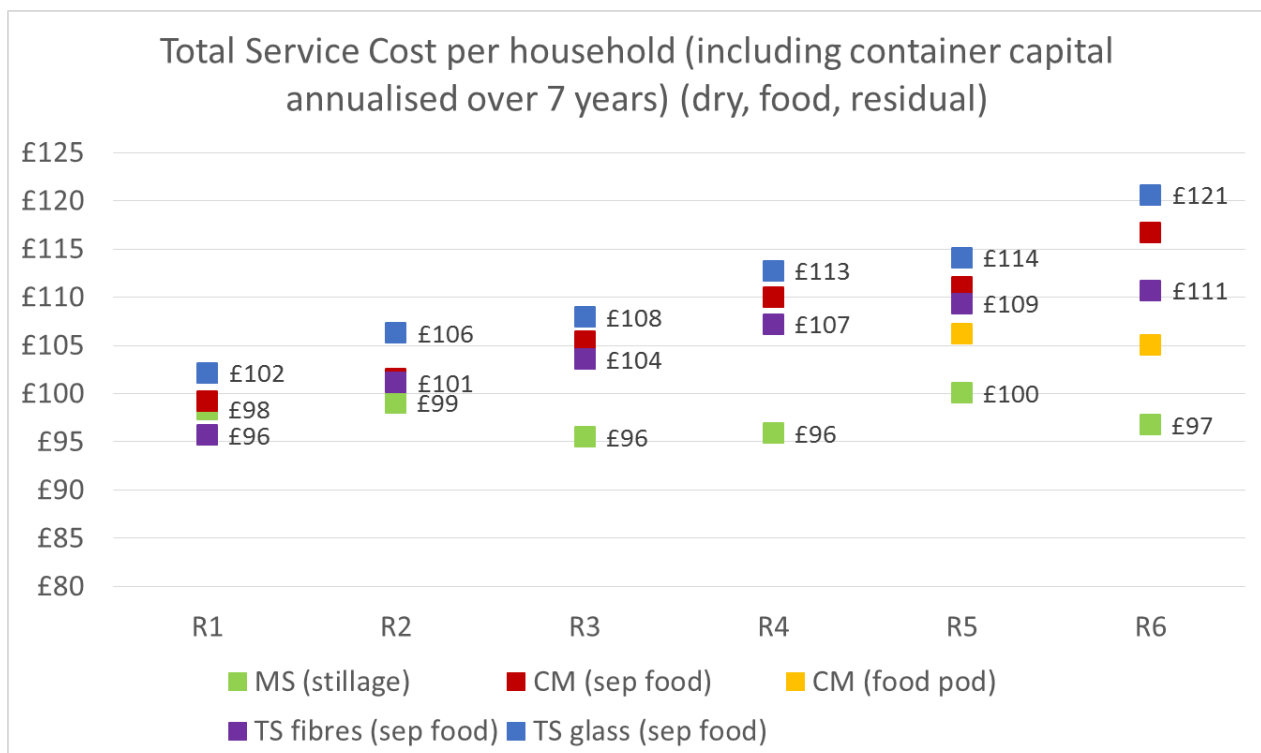
Costs per household

Indicative net total annual costs of collecting all core materials per household (kerbside, not flats) are mapped below across 6 rurality (geography and level of deprivation) groups (Figure 13). A description of the rurality groups and the number of local authorities that are classified within each are included in Figure 12:

Figure 12: Rurality definitions and number of local authorities in each group

Rurality	Number of LAs
R1 - Predominantly urban, higher deprivation	46
R2 - Predominantly urban, lower deprivation	43
R3 - Mixed urban/rural, higher deprivation	53
R4 - Mixed urban/rural, lower deprivation	49
R5 - Predominantly rural, higher deprivation	67
R6 - Predominantly rural, lower deprivation	68

Figure 13: Total annual service cost per household for different collection methods and across rurality groups



When collecting food waste alongside co-mingled mixed dry recyclables or two-stream collections of recyclables (as in Scenarios 1 and 2), in urban and mixed urban/rural settings, collecting with a pod Refuse Collection Vehicle (RCV) can be the highest cost option whilst a separate food waste vehicle tends to be mid-range. In rural settings, collecting with a pod RCV is a lower cost option compared to using specialist food waste collection vehicles.

Across nearly all rurality groups, when collecting all core materials including food waste, multi-stream is the most cost effective option. The exception is in predominantly urban areas with high deprivation where the modelled costs indicate two-stream with fibres separate is the most cost effective. Across all rurality groups, the modelling also indicates that collecting glass separately in a two-stream system is the highest cost option and this is the primary reason why this option is not included within the *Framework*.

Further opportunities for realising financial benefit from greater consistency

Rationalising service approaches provides an opportunity for local authorities to work together. Cross boundary working can generate savings in back office functions, service delivery costs, and through joint procurement. Partnership approaches identified by WRAP from case studies and other published information identify savings to local authorities in the range of 10-15% depending on local circumstances. Potential benefits from joint and cross boundary working have not been included in the national modelling but are being explored through a number of local business case projects. The local business case projects also enable other areas for potential savings to be explored such as shift patterns, crew deployment, pull out or use of slave bins, and residual waste restrictions. Demonstrating the business case for change at a local as well as national level is critical to achieving support for consistency and for change.

Increased recycling

WRAP's modelling shows that **if all local authorities were to collect the same core set of materials for recycling the overall recycling rate would increase by approximately 7 percentage points.** This would take the recycling rate for England from 44.6% in the baseline to over 51% by 2025/26. This amounts to an **additional 11.58mt** of dry recyclable materials and food waste diverted from disposal and available for recycling over the 8-year period to 2025/26 (relative to the 'business as usual' baseline) including flats (Figure 14).

Of this total additional tonnage collected, food waste contributes 8.4mt. This would require the 48% of local authorities who do not provide a food waste collection service to do so and for the 56% of households (13.2 million including flats) who do not currently have a food waste collection service to access a service. For the 20% of authorities currently collecting food waste with garden waste there is the opportunity to increase the capture of food waste by switching to weekly food only collections, while maintaining a collection service for garden waste.



Figure 14: Cumulative additional tonnes available for recycling 2018/19 to 2025/26

	Cumulative total additional tonnes	Dry materials	Food waste
Additional materials collected from <u>kerbside properties only</u>	10.84 mt	2.89 mt	7.95 mt
Additional materials collected from <u>kerbside and flatted properties</u>	11.58 mt	3.19 mt	8.40 mt

Food waste

WRAP's evidence consistently shows that separate weekly collections of food waste typically capture twice as much food waste per year compared to mixed food and garden waste collections. In addition, more food waste is captured through weekly collections when residual waste is collected fortnightly¹⁸.

Figure 15: Comparing average food waste yields across different service profiles¹⁹

	Average kgs of food collected per household per year	
	With residual waste collected weekly	With residual waste collected fortnightly
Separate weekly food waste collections	68kg	78kg
Weekly mixed food and garden collections	28.1kg	41.3kg
Fortnightly mixed food and garden collections	22.5kg	30.4kg

¹⁸ Source: [Performance analysis of mixed food and garden waste collection schemes](http://www.wrap.org.uk/sites/files/wrap/HH_food_waste_collections_guide_section_3_how_much_can_be_collected.pdf), WRAP 2010. Further information can be found at http://www.wrap.org.uk/sites/files/wrap/HH_food_waste_collections_guide_section_3_how_much_can_be_collected.pdf

¹⁹ Source: *Material splits in food waste collections*, WRAP 2014 (unpublished)



Dry recyclables

The contribution from dry recycling is around 3.2 million tonnes over the 8 year period (including changes to flats). This is the material available for recycling net of contamination (by either non-target materials or non-recyclable materials). All the scenarios modelled assume sufficient container capacity for recycling (minimum equivalent to 120 litres per week), collect the core set of dry materials and residual waste is restricted to 240 litres per fortnight. Therefore it is assumed that the additional material (excluding contamination) presented by householders for recycling does not change between scenarios²⁰.

This additional tonnage from dry recyclables results from modelling where local authorities could extend their recycling services to more households and where authorities could add new materials to their recycling service, for example, by extending collection services to the 33% of households who do not currently have access to recycling services for plastic PTTs²¹.

Improved material quality

Contaminated and poor quality material costs UK reprocessors more than £51 million each year²². Improving material quality is essential to safeguarding and developing the UK recycling sector. Since all materials are not reprocessed in the UK, it is also vital that the supply of recovered materials meets the requirements of UK exporters and overseas reprocessors in order to guarantee end markets. Greater consistency in materials collected will help to reduce contamination from non-target materials which in turn will reduce costs to reprocessors of 'cleaning up' or removing contamination from sorted materials prior to reprocessing. These costs potentially could be reduced by up to £33 million (cumulative between 2018/19 – 2025/26) if all local authorities were to collect multi-stream²³.

²⁰ A key finding from WRAP's analysis of recycling performance and waste arisings in the UK 2012/13 was that very little certainty can be applied in establishing a difference in recycling performance between dry scheme types <http://www.wrap.org.uk/content/factors-influencing-recycling-performance>. Other than the service features described the current analysis did not consider additional factors that might drive an increase in recycling performance.

²¹ Statistical comparisons between authorities with and without PTT in their dry recycling collection indicates that those collection authorities collecting this material tend to have higher recycling rates (Analysis of recycling performance and waste arisings in the UK 2012/13) <http://www.wrap.org.uk/content/factors-influencing-recycling-performance>

²² Resources Association, 2012 Costs of contamination.

²³ Cumulative 2018/19 to 2025/26, cost saving is derived from reduced contamination tonnages relative to the business as usual baseline in the 'All MS' scenario (scenario 3) and uses an indicative estimate of £15.76 per tonne cost saving to reprocessors taken from the 2012 study 'Costs of contamination report' by the Resources Association.



The importance of quality

Quality is one of the most important considerations for secondary material. Contamination (by non-target materials and moisture) is a key influencing factor for reprocessors when sourcing their material in domestic and overseas markets. By providing a consistent supply of high quality recovered materials, the UK can compete more effectively in domestic and export markets while also maximising the chances that the best prices possible from sales of recovered materials can be obtained by local authorities.

Commodity markets move in cycles so the revenue from the sale of recovered materials fluctuates substantially. The quality of recovered materials and their market value are strongly related. In general, higher quality recovered materials have higher value: sorted materials have higher market value across all types and grades of recovered materials²⁴.

While the balance of supply and demand will always determine market prices, the demand for higher quality material prevails across *all* market conditions, and for *all* materials. Most importantly, when market demand (and prices) drop, low quality recovered materials are left marginalised as buyers cherry pick higher quality materials.

Impact of greater consistency on material quality

Greater consistency in the materials collected should result in improved material quality. Evidence from the WRAP 2016 tracker survey indicates a relationship between the number of items collected for recycling and contamination; the fewer the number of items collected, the higher the likelihood of non-targeted recycling.

Changes in how recyclables are collected will also have an impact on material quality. Separating waste materials and preventing contamination at source helps to ensure that higher quality material is collected for conversion into high value products with sustainable end markets. This is the approach preferred under the Waste Regulations 2011 (as amended 2012).²⁵

WRAP's analysis^{26,27} shows that contamination levels in source separated collection systems are lower for all types of recovered materials, with a greater percentage of each material collected

²⁴ Based on average mid-point prices for recovered materials 2011 to 2015 from WRAP's Materials Pricing reports, the differential for sorted and graded material versus mixed materials are: for colour sorted versus mixed glass £12/t, for sorted paper/card versus mixed paper it is £21/t, for metal packaging versus mixed cans it is £171/t and for polymer sorted plastic bottles versus mixed polymer bottles it is £136/t

²⁵ Environment Agency, 2014 Separate Collection of Recyclables Brief Note, December 2014

²⁶ WRAP analysis of typical contamination rates based on 234 samples from 37 local authorities across England shows median contamination rates of 1.2% for paper, 4.7% for card, 0.9% for mixed paper/card, 1% for glass, 8.3% for metals, 2.6% for plastics based on data from 'Contamination in source-separated municipal and business recyclate in the UK 2013', 2014, ZWS. The weighted 'average' of the median contamination rates is 2.4%, with an indicative range as low as 1.6% to as high as 3.1%.



being recycled. This data is reflected in the assumption made for contamination for the 'All multi-stream' scenario (Scenario 3): 2% average contamination has been applied to the uplift in tonnage collected, with a range from 1% to 3.5% used in the scenario sensitivity analysis.

Whilst a move to consistency in the materials collected for recycling can be expected to reduce contamination by non-target materials (as more of these materials would be collected for recycling, such as PTTs), co-mingled mixed dry recyclable collections and two-stream dry recyclables do attract more contamination from non-recyclable waste. There is no evidence to suggest that this contamination would reduce simply as a result of authorities collecting a consistent set of recyclable materials. Therefore, assumptions have been made for average contamination in these systems of 12.5% and 8% respectively and applied to the uplift in tonnage collected ([Appendix E](#)). In practice this means that a higher collected yield is assumed for co-mingled and two-stream but the net yield available for recycling across all systems is assumed to be the same. Higher profile and consistent messages nationally as well as locally on what can and cannot be recycled and the reasons why will also be required.

Greater clarity and more engaged householders

Evidence relating to consumer attitudes and behaviours towards recycling ([Appendix C](#)) highlights a number of challenges for householders:

- Lack of recycling collections for materials they would like to recycle; and
- Confusion in what materials they can recycle locally and when they travel outside their local area (within England), owing to:
 - lack of knowledge on what can and cannot be recycled locally;
 - differences in what is collected in some areas compared to others; and
 - differences in the types and colours of containers in some areas compared to others.

WRAP's evidence shows that generally people want to do the 'right' thing²⁸ and that confusion is a key contributing factor to them putting non-target material in their recycling bin²⁹. In the latest tracker survey, similar to previous years, 73% of respondents indicated that they were uncertain about whether at least one or two materials could or could not be recycled. Just under half (46%) of all householders put the wrong item in the recycling bin because they are confused if it can be recycled or not and would rather 'play it safe' just in case it can be³⁰. There is low awareness

²⁷ Based on WRAP studies summarised in *Eunomia (2016) Review of the Welsh Government Blueprint*. Typical contamination levels in source separated collection systems versus co-mingled systems are 1.1% versus 15.5% for paper, 4.1% versus 12% for card, 0.4% versus 10.4% for glass, 2.9% versus 18.2% for plastics, 1% versus 2.5% for aluminium and 3% versus 6.2% for steel

²⁸ WRAP, 2015 Feedback provided at focus groups carried out to inform the refresh of the Recycle Now campaign

²⁹ WRAP. 2016 Recycling Tracker Survey 2016

³⁰ WRAP, 2015 3Rs Tracker Survey



amongst consumers of the implications of doing this, and often an assumption, particularly for single stream co-mingled (mixed dry recyclable) collections that the council must have to sort the materials anyway, and therefore will take care of any items incorrectly placed in the recycling bin³¹.

According to the ICM Poll (2016), 59% of respondents agreed (and 26% agreed strongly) with the statement "I would recycle more if I was less confused about what can and cannot be recycled"³². WRAP recycling tracker survey data also shows that the majority of people find on-pack recycling labelling useful and would like to see more packaging labelled to indicate whether something is recyclable or not³³. Survey evidence therefore suggests that by reducing confusion in what can and cannot be recycled the amount of material that is correctly captured in recycling collections will increase.

Evidence from the WRAP 2016 recycling tracker survey also indicates a relationship between the number of items that are collected for recycling and how accurately people recycle. The more items collected for recycling, the higher proportion of households categorised as 'top recyclers' (i.e. they put all the materials that are collected for recycling in the recycling container and none of the ones that cannot be). Conversely, the fewer the number of items collected, the higher the likelihood of non-targeted material being put in the recycling.

By proposing that a common set of materials are collected for recycling, including several of the materials that appear to cause more confusion, an assumption is made that greater consistency in materials collected will lead to less confusion which in turn will lead to higher levels of recycling. The assumptions in the modelling regarding yield are conservative and no additional uplift applied because all authorities are assumed to collect the same set of materials. Other factors are known to contribute to confusion, such as poor communications, disinterest on the part of the householder and quality of service delivery. Actions are proposed in the *Framework* to help with this including opportunities for more consistent messages delivered by a range of stakeholders, not solely local authorities, and a call to brands and retailers to label more of their packaging with meaningful consumer information as to whether it can or cannot be recycled (i.e. the materials/items are collected for recycling).

The WRAP Tracker Survey 2015, and many individual local authority surveys, indicates that satisfaction with recycling services tends to be relatively good regardless of the method of collection. The Tracker Survey (2015) shows that there are differences in levels of satisfaction, with co-mingled services rating an average of 7.5 / 10 compared to a rating of 7.0 / 10 for multi-stream collections. However, when consumers are asked about the most important elements of their recycling services³⁴, they are **most concerned that the service is regular and reliable**, that they are

³¹ WRAP, 2015 feedback at focus groups carried out to inform the refresh of the Recycle Now campaign

³² ICM Poll commissioned by WRAP, May 2016

³³ WRAP, 2016 Recycling Tracker Survey

³⁴ ICM Poll (2016) commissioned by WRAP and WRAP (2008), Household Waste Collection Commitment Report

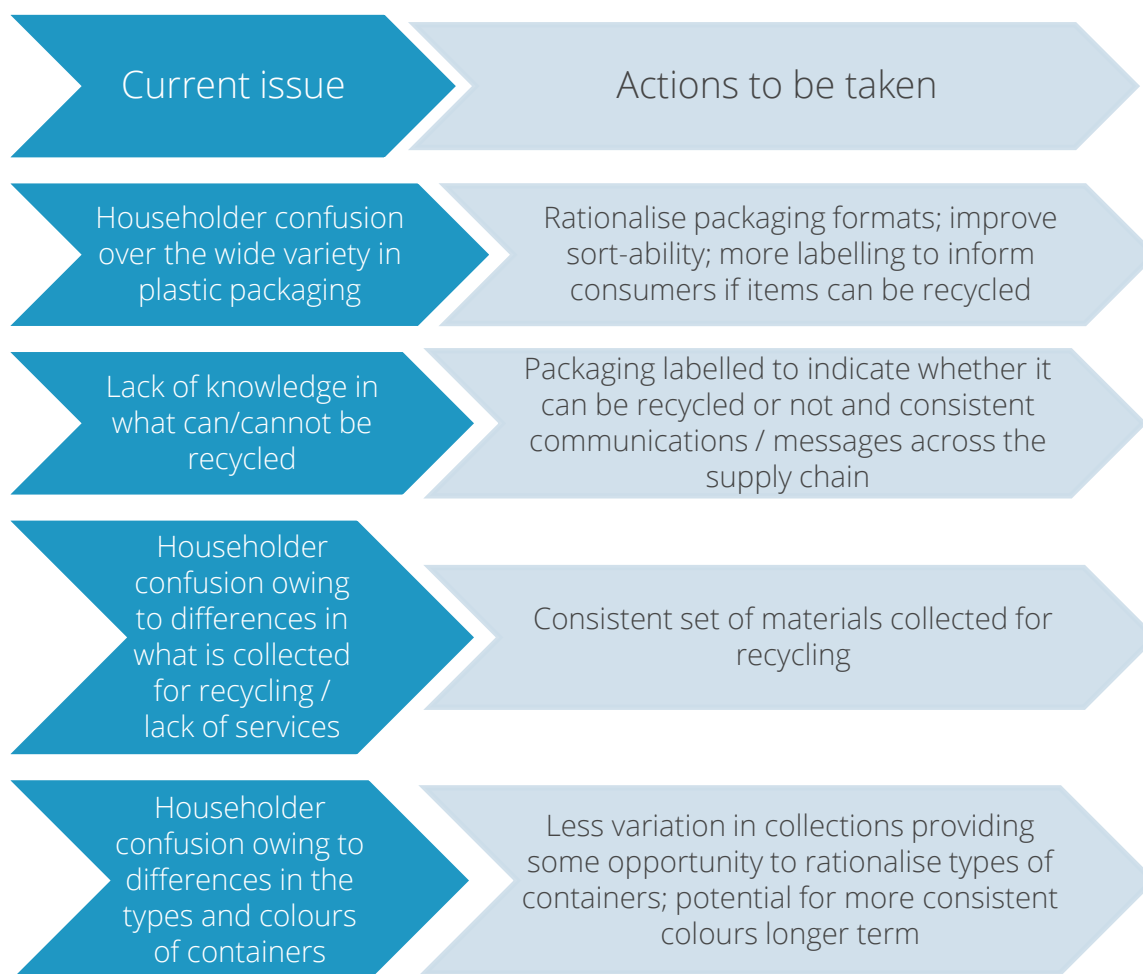


clear about what they can/cannot recycle and that they have sufficient capacity within their containers. The number of containers they are asked to sort materials into is considered of much less importance. All these elements have been considered in the development of the Framework.

Overall it is considered that greater consistency in the materials collected for recycling together with more labelling of packaging and consideration of the design of packaging in terms of its recyclability will help address some of these challenges and enable householders to recycle more.

Figure 16 provides a summary of key issues facing householders and the actions to be taken to address them as outlined in the *Framework*.

Figure 16



Environmental benefits

WRAP's analysis, based on the detailed scenario modelling, indicates that collecting a common set of materials, including a separate food waste service to all homes in England, and with greater consistency in collection systems, could divert (from disposal) up to an additional 11.58 million tonnes of dry recyclables and food waste³⁵ to recycling. This would reduce greenhouse gas emissions by up to 5.1 million tonnes CO₂ equivalent³⁶, and in doing so make a sizeable contribution to the UK's carbon budget targets.

Materials recovered from waste through recycling are an input to economic activity, as more materials are recycled there are net savings from energy usage compared to manufacturing products from virgin raw materials. The environmental benefits from recycling and recovery options for food waste and materials rather than disposal options (landfill or energy from waste) are a consequence of avoided emissions, avoided usage of energy/land/water and the avoided extraction and production of virgin materials.

In addition, there are wider environmental benefits resulting from the reduced impact on ecosystems, biodiversity, habitats and the natural environment.³⁷

Wider economic benefits

There are a number of wider economic benefits from moving towards greater consistency in both the range of materials collected, including food, and the systems in place to collect those materials.

5.1m

tonnes of CO₂
equivalent avoided

³⁵ Cumulative 2018/19 to 2025/26 relative to a business as usual baseline, of which 8.4Mt is food waste and 3.2Mt is dry recyclate.

³⁶ Cumulative 2018/19 to 2025/26 relative to a business as usual baseline, GHG factors for materials recycling and disposal are based on DEFRA / DECC (2016) Greenhouse gas reporting - Conversion factors, 2016 <https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting>

³⁷ The scenarios modelled do monetise the impact on GHG emissions from higher recycling and avoided disposal or factor in the economic benefits that would follow from such wider environmental benefits



WRAP's scenario modelling indicates an additional 8.4Mt of food waste (over the 8 year period relative to baseline and including flats) available to the organics industry from the provision of food waste collection services across England as part of a common approach. Greater surety and consistency of feedstock supply can contribute to reduced investor and operational risks to businesses operating anaerobic digestion (AD) facilities. AD facility operators in turn have the potential to generate up to £280 million in renewable energy sales³⁸, supplying around 682,000 homes³⁹ and improving the security of energy supply. It would also provide 8Mt of organic fertiliser⁴⁰ to the agri-food sector, with a nutrient value of £30 million⁴¹.

Collection of a common set of dry materials in a consistent way could yield up to £478 million more (net) revenue from the sale of these recovered materials⁴², with a positive contribution to the UK's trade balance where these are sold to overseas markets.

Greater consistency in materials and collecting them multi-stream can also reduce the amount of contamination and the cost it represents to re-processors who have to deal with it by up to £33 million⁴³. Surety and confidence from improved access to high quality recovered raw materials potentially enables greater recycling market resilience, stimulates innovation and investment in sorting and

682,000

homes supplied by
renewable energy

£478m

Potential income from the
sale of additional recovered
materials

³⁸ Cumulative 2018/19 to 2025/26 relative to business as usual baseline, the estimate assumes the energy potential from AD of food waste is 300kW per tonne, the market price is 10 pence per kW, no income from ROCs or FITs is assumed.

³⁹ Cumulative 2018/19 to 2025/26, assuming that the average domestic electricity consumption is 4.1MW per household per year.

⁴⁰ Cumulative 2018/19 to 2025/26 relative to business as usual baseline, assuming that 85% of AD feedstock input is available as digestate

⁴¹ Cumulative 2018/19 to 2025/26 relative to business as usual baseline, assumes that the market value of immediately available nutrients from digestate is £3.80 per tonne.

⁴² Cumulative 2018/19 to 2025/26 relative to business as usual baseline, at 2015/16 prices (no adjustment for inflation or quality) based on 2015/16 mid-point averages material prices ex-works for paper, card, mixed paper, colour separated and mixed glass from WRAP's Materials Pricing Report. Prices for cans, plastic bottles and plastic pots tubs and trays are modelled net of sorting costs.

⁴³ Cumulative 2018/19 to 2025/26, cost saving is derived from reduced contamination tonnages relative to the business as usual baseline in the 'All MS' scenario and uses an indicative estimate of £15.76 per tonne cost saving to re-processors from a 2012 study 'Costs of contamination report' by the Resources Association.



processing systems which will also likely follow from improved eco-design of packaging materials

Furthermore, because collection and recycling activities tend to be labour intensive relative to disposal activities, higher levels of recycling and roll out of food collection services will create more jobs directly with additional employment opportunities indirectly along the supply chain.

Legal compliance

From 1 January 2015 public and private waste collectors are required to collect at least paper, plastic, metals and glass separately for recycling. Regulation 13 of the Waste (England and Wales) Regulations 2011, as amended in 2012, also requires waste collection authorities, when making arrangements to collect such waste, to ensure this involves separate collection.

These requirements apply where separate collection is necessary to aid or to improve recovery (the 'necessity' test) and is **'technically, environmentally and economically practicable' (TEEP)**. Collectors are required to review their collection practices and consider carefully if and how they comply. They must keep records to provide an audit trail to support their decisions and in order to demonstrate compliance. Multi-stream collections of these materials will meet the requirements of the Regulations.

The collection of mixed dry recyclables either co-mingled or two-stream may be compliant only if it can be demonstrated that separate collection is not necessary to achieve good quality recyclables, or is not TEEP. The two-stream option considered in this analysis proposes fibres are collected separately from containers in order to maintain the quality of the paper/fibres. WRAP advises local authorities not currently collecting glass at kerbside to consider options that do not include the mixing of paper / fibres and glass.



Conclusion

Two key opportunities for introducing greater consistency into household recycling in England have been identified; these are in the materials collected for recycling and how they are collected. Collecting the core set of materials in no more than three standard approaches could increase the national recycling rate by up to 7 percentage points and provide financial benefits. Financial benefits to local authorities would depend on local circumstances, but predominantly would result from avoided disposal costs and additional revenue from the sale of material.

Considering all the elements of the analysis framework (quantity and quality of material collected, householder engagement, financial benefit, and compliance with regulations) WRAP concludes that **collecting all core materials in a multi-stream system is the most effective**. Whilst challenging to deliver financial benefits to local authorities could be up to **£408 million** over 8 years and material quality would be further improved resulting in additional benefits.

The analysis has informed the *Framework for greater consistency in household recycling in England*, which provides a clear vision and direction for retailers, brands, manufacturers, local authorities, waste management companies and reprocessors. While the *Framework* is voluntary, there are significant benefits to be had across the supply chain. There are challenges to be addressed, including the format of packaging placed on the market delivering the highest environmental benefit while being recyclable (and collected for recycling), supporting and encouraging consumers to recycle more and to do so effectively, and considering additional infrastructure for sorting and processing materials. Actions to help address these challenges are outlined in the *Framework*.

The *Framework* has been developed based on existing policy and regulation and taking account of current waste composition, collection infrastructure and technology. It is important that the *Framework* is reviewed and evolves over time to ensure it remains progressive and future proof. The advisory group, facilitated by WRAP, will be responsible for this.

7%

Increase in national recycling rate of 7 percentage points

£33m

Potential for reduced costs to reprocessors due to less contamination



Appendix A: Key evidence

The key evidence considered as part of this work includes the following:

- Eunomia (2016), Review of the Welsh Government Collections Blueprint
- Icaro (2011), Attitudes to Waste and Recycling
- ICM Poll (2016) commissioned by WRAP
- LGA (2008), Working Together on Waste
- LGA (2013), Wealth from Waste
- WRAP, Materials Facility Reporting Data (2015/16)
- Resource Association (2012), Costs of Contamination Report
- Resource Futures (2010/11) Waste Composition Data for Defra (2010/11)
- The Innovation Forum (2006), Joint Working in Wastes Management
- Defra, WasteDataFlow – Household waste and recycling data for 2014/15
- WRAP (2008), Barriers to Recycling at Home
- WRAP (2008), Household Waste Collection Commitment Report
- WRAP (2009), Food Waste Collection Trials
- WRAP (2010), Performance Analysis of Mixed Food and Garden Waste Collection Schemes
- WRAP (2014), Barriers to Recycling – review since 2008
- WRAP (2014, 2015 and 2016), Recycling Tracker Surveys
- WRAP (2015), Analysis of Recycling Performance and Waste Arisings in the UK 2012/13
- WRAP (2015), Indicative Costs and Performance Analysis of Kerbside Collections
- WRAP (2015/16), Annual Gate Fees Report
- WRAP (2016), annual survey and update of local authority collection scheme data for 2015/16
- Zero Waste Scotland (2014), Contamination in Source Separated Municipal and Business Recyclate in the UK 2013



Appendix B: Collections landscape in England for household waste (at June 2016)

There are 320 authorities in England with responsibility for providing recycling and waste collection services to households. The nature of these services and how they are delivered is a local decision taking account of many factors. Local authorities have invested in new services over the past 15-20 years in response to local priorities, geography, property types, availability of and access to sorting and treatment infrastructure, recycled materials markets and changing regulatory requirements.

There are a broad range of service profiles in operation with variations in collection configurations, frequencies of collection, and the sizes, types and colours of containers in use. Paper, card, metal cans, plastic bottles and glass are collected for recycling across all local authorities. Collections of garden waste for composting are also widespread and over the past 6-7 years collections of food waste for recycling have started to be introduced.

The following tables summarise key data relating to the current provision of household waste and recycling collection services⁴⁴.

⁴⁴ This information represents WRAP's best understanding of kerbside collections being operated by local authorities in England as of the 6th June 2016. Percentages on number of local authorities offering the collections do not include schemes that are offered to less than 5% of households in the authority (or less than 3,000 households whichever is lowest). This is so that the presence of collection trials does not skew the overall picture. Percentages on the number of households include all schemes.



Table B.1: Recycling service provision for key recyclable materials and food waste

Materials	% of LAs offering a collection	% of households offered a collection (low rise & flats)
Paper	100%	98%
Card	98%	97%
Plastic bottles	99%	97%
Plastic packaging - pots, tubs and trays	72%	67%
Glass	89%	86%
Metal packaging	100%	98%
Food & beverage cartons	64%	63%
All 'dry' materials	54%	49%
Separate food waste (i.e. food waste only)	32%	27%
Food waste collected with garden waste	15%	16%
LAs operating both schemes	5%	n/a
All food (separate + mixed)	52%	44%
All dry materials + separate food	22%	19%

Table B.2: Provision of kerbside garden waste collection schemes

Garden Waste Collection	% of LAs offering a collection	% of households offered a collection
Any garden waste collection ⁴⁵	95%	71%
Subscription (charged) garden waste collection	45%	29% ⁴⁶

⁴⁵ Garden waste collections offered by some authorities include food waste

⁴⁶ Some local authorities report the number of households offered the collection and some report the number of households subscribing to the service, therefore this is likely to underestimate the number of households offered a subscription garden waste collection.



Table B.3: Kerbside dry recycling collection scheme types operating in England

Kerbside collection schemes	% of LAs offering this service	Number of households receiving a collection
Multi-stream	23%	4.5M
Single stream co-mingled	51%	11.0M
Two stream co-mingled (glass plus other materials mixed)	12%	2.0M
Two stream co-mingled (paper/card with other materials mixed)	21%	5.0M

Table B.4: Residual waste collection frequency

Residual waste collection frequency	% of English LAs ⁴⁷	% of households
Weekly or more frequent	50%	36%
Fortnightly	73%	63%
3-weekly	1%	1%

⁴⁷ Percentages add up to greater than 100% because some authorities provide different frequencies of collection to different areas within the authority.



Appendix C: Summary of key evidence relating to householders' attitudes and behaviours in relation to recycling

For many people recycling is now an everyday activity and most householders are broadly happy with the recycling service they receive giving it an average score of 7.2 out of 10 in the recent Recycling Tracker Survey⁴⁸. Previous polling by the LGA in 2013 found that the proportion of households that were satisfied or very satisfied with their waste collection services was 86% and this broadly held irrespective of the frequency of residual waste collection⁴⁹.

Claimed levels of recycling are high for many of the materials now commonly collected for recycling, such as paper, card, glass and metal cans. However, according to the 2016 recycling tracker survey, approximately half⁵⁰ [of kerbside properties] are not recycling all they can and approximately one-third⁵¹ are putting non-target materials in their recycling bins.

Confusion

WRAP's evidence shows that generally people want to do the 'right' thing⁵² and that confusion is a key contributing factor to them putting non-target material in their recycling bin⁵³. In the latest tracker survey, similar to previous years, 73% of respondents indicated that they were uncertain about whether at least one or two materials could or could not be recycled.

⁴⁸ WRAP, 2016 Recycling Tracker Survey 2016.

⁴⁹ LGA, 2013 Wealth from Waste

⁵⁰ WRAP, 2016 Recycling Tracker Survey: 49% unweighted data slides 2016

⁵¹ WRAP, 2016: Recycling Tracker Survey 32% data tables 2016

⁵² WRAP, 2015 feedback at focus groups carried out to inform the refresh of the Recycle Now campaign

⁵³ WRAP, 2016 Recycling Tracker Survey 2016



Just under half (46%) of all householders put the wrong item in the recycling bin because they are confused if it can be recycled or not and would rather 'play it safe' just in case it can be⁵⁴. There is low awareness amongst consumers of the implications of doing this, and often an assumption, particularly for single stream co-mingled (mixed dry recyclable) collections that the council must have to sort the materials anyway, and therefore will take care of any items incorrectly placed in the recycling bin⁵⁵.

Many householders report being confused when they travel outside of their local area. 70% of respondents in a recent ICM poll⁵⁶ said that they were confused about what could and could not be recycled when they travelled outside of their local area for work, to visit family and friends or on holiday. Of these, a quarter said that they were frequently confused. And, of those who said they were confused, 65% said that they were confused about the range of materials collected, 62% were confused by the types of container and 50% by the colour of the containers.

Some items are more prevalently confusing for people. These include aerosol cans, plastic film, batteries, foil, carrier bags, plastic pots, tubs and trays and, food and drink cartons⁵⁷. Between a fifth and a quarter of households in England could be recycling foil and aerosols rather than putting them in the residual waste bin⁵⁸.

⁵⁴ WRAP, 2015 3Rs Tracker Survey

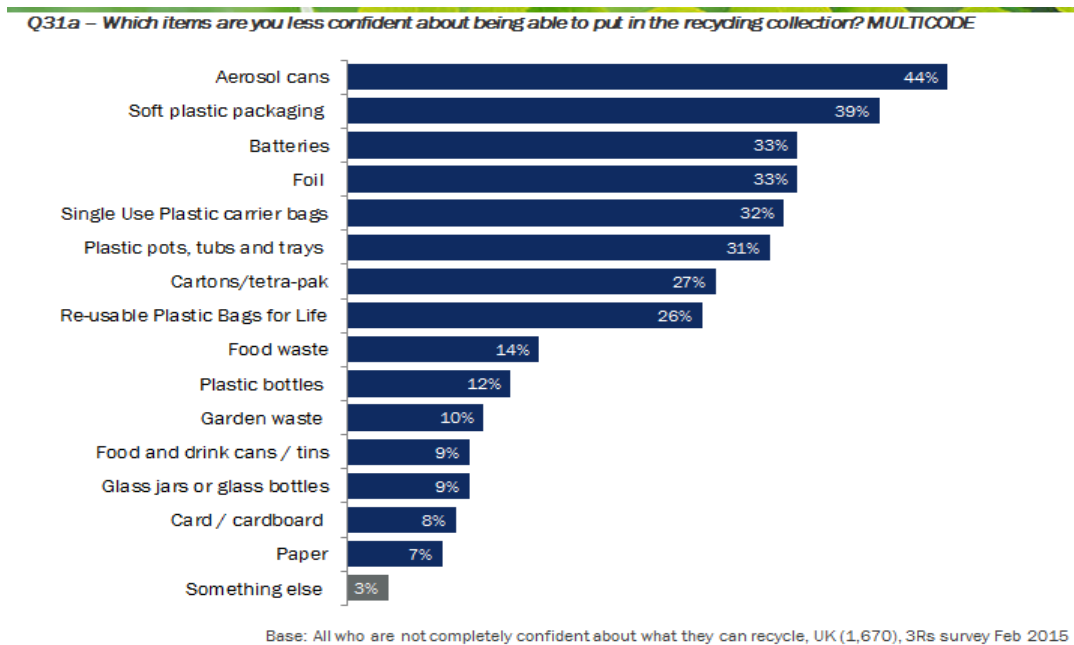
⁵⁵ WRAP, 2015 feedback at focus groups carried out to inform the refresh of the Recycle Now campaign

⁵⁶ ICM Poll commissioned by WRAP, May 2011. The sample size was 1771. It is representative of the England population, with quotas against standard demographics.

⁵⁷ WRAP, 2015 3Rs Tracker Survey

⁵⁸ WRAP, 2016 Recycling Tracker Survey



Figure C.1: Items people are less confident about being able to recycle at kerbside (UK data)⁵⁹

Access to services

In a recent ICM Poll, 77% of people who currently are unable to recycle plastic pots, tubs and trays at the kerbside said that they would like their council to offer that service and 38% stated they would like to be able to recycle food waste.

In previous consumer research in 2008 to inform the Household Waste Collection Commitment 15% of survey respondents said their service would be improved if more materials were collected for recycling. 11% listed the range of materials collected among the things they liked most about their service. Requests for a wider range of materials to be collected were often directed at particular materials, the most common (in 2008) being plastics and glass⁶⁰.

The consumer evidence also suggests that householders who have access to the most comprehensive recycling services are significantly more likely to be the most effective recyclers.

⁵⁹ WRAP, 2015 Recycling Tracker Survey

⁶⁰ WRAP, 2008 Household Waste Collection Commitment Report



Service design

Recycling services must be convenient for people to use if greater participation and the capture of more materials for recycling are to be achieved. Good communication is also vital, so that households understand what they can recycle locally, and how.

The WRAP Tracker Survey 2015, supported by many individual local authority surveys, indicates that satisfaction with recycling services tends to be relatively good regardless of the method of collection. The Tracker (2015) survey shows that there are marginal differences, with co-mingled services ranking an average of 7.5 / 10 compared to multi-stream of 7.0 / 10.

The ICM Poll sought to identify the key aspects of a recycling service that are important to people. When asked to rank a number of service features it revealed that most importance was placed on having a regular and reliable service.

The seven features of a recycling service respondents were asked to rank in order of importance (with seven being the LEAST important and one being the MOST important were):

- 1) Having a regular service
- 2) Having a reliable service
- 3) The council making it clear what can/cannot be included in the recycling collection
- 4) Having enough space/capacity in the recycling bin
- 5) The area is left clean and tidy after the recycling collection
- 6) Recycling containers are returned to the same place they were left for collection
- 7) Not having to separate recycling into multiple containers

The features that respondents were asked to rank were identified from previous consumer research including that undertaken by Brook Lyndhurst in 2008, which informed the Household Waste Collection Commitment⁶¹.

The key service features identified by respondents as being important (ranked in top 3) are having a regular and reliable service, being clear on what can/cannot be recycled and have sufficient capacity in the recycling container for all their materials. When presented in relation to other service characteristics people placed the least importance on not having to separate recycling into multiple containers, containers being returned to the point of collection, and the area left tidy.

⁶¹ WRAP 2008, [Waste Collection Commitment](#)



Table C.1: Percentage respondents ranking these factors as more important and percentage ranking these factors as less important (Sample size:1,771)

	Capacity / space	Not having to separate into multiple containers	Regular service	Reliable service	Containers returned to the same place	Area is clean and tidy	Being clear on what can/cannot be recycled
More Important (1-3)	41%	26%	74%	65%	23%	27%	44%
Less Important (5-7)	41%	65%	15%	19%	63%	57%	40%

Whilst co-mingled services are linked with a marginally higher ranking of satisfaction, other features of a service are important to householders. All of this was considered in the development of the Framework.



Appendix D: Scenario modelling

Approach

WRAP developed a sophisticated model reflecting for all local authorities individually their existing services and performance, housing stock, rurality, level of deprivation and where applicable collection contract end dates and review points. Overlaid were a number of assumptions including gate fees, material prices and contamination rates (based on recycling collection method). Using analysis on the costs and relative performance of collection systems and the impact of variables on levels of recycling, for example residual waste collection frequency and the collection of different materials, different scenarios could be applied to the model.

WRAP undertook initial modelling to assess potential opportunities for more consistent collections in October 2015, comparing 12 different scenarios. These scenarios looked at adding dry recyclable materials and food waste individually and in combination across different recycling collections (multi-stream, different variations of two-stream and co-mingled recyclables) at different frequencies. The analysis of this modelling clarified three key scenarios for further consideration.

These three scenarios were modelled with an updated scheme and performance baseline for 2014/15 that includes all authorities with household waste collection responsibilities in England (so to incorporate the most recent WasteDataFlow data available) and an updated cost baseline (reflective of the market in 2015/16).

The modelling was undertaken over an 8-year transition period – 2018/19 to 2025/26 and the following costs are included; no inflation has been assumed:

- Vehicles – annualised capital cost
- Containers - one-off capital cost at service change where a modelled service change requires difference containers
- Annual operating costs including communications
- Bulking and treatment /disposal costs net of income generated from the sale of recyclable materials - all gate fees and materials values are based on 2015/16 prices
- Transition costs where a service change is modelled – covering project management, roll out communications, re-routing, additional call-centre costs
- No inflation has been assumed.



The three scenarios are outlined below. In all scenarios all 'missing' dry materials are modelled where not currently collected by a local authority. Food waste is modelled if not collected. In all cases food waste is assumed to be collected weekly and separate to garden waste and residual waste is assumed to be collected fortnightly. The three scenarios were modelled including changes to flats in line with kerbside properties (although frequency of collection is assumed to be unchanged to flats) and with services to flats being maintained as currently provided with changes being applied to kerbside only. There are two key reasons for this. It is recognised that achieving greater consistency will be a step by step process and focus would likely be placed on kerbside initially. The second reason is because recycling services in flats are highly varied and less well understood and therefore confidence in the data is lower. WRAP is working to better understand this and figures will be updated when better data is available.

Scenario 1: Combination of all three systems - Multi Stream with food waste (MS), Two Stream (TS) with fibres and food separate and Co-mingled with food separate (CM)

The modelling assumes all local authorities remain on their existing dry recycling service except those collecting glass separately in a two stream system; these are modelled with fibres separate rather than glass. This option represents the least change compared to current arrangements for collecting dry recyclables.

Scenario 2: Multi-stream with food and Two stream with fibres and food separate

Local authorities operating a co-mingled mixed dry recyclables collection or two-stream collection with glass separate are modelled with two-stream with fibre separate. Those authorities operating multi-stream are modelled remaining on multi-stream.

The primary reason for fibres to be kept separate in a Two-stream system as opposed to glass is cost and quality. It allows an authority to benefit from the higher income for the fibre stream and the collection vehicles can achieve a more efficient payload.

Scenario 3: All Multi-stream with food

All (320) local authorities modelled with a multi-stream collection of dry recyclables with a separate food waste collection.

Key assumptions

Dry recyclables

Kerbside collected tonnages are extracted from WasteDataFlow for each authority and analysed to ascertain dry recycling yields, for each material, collected by local authorities. These yields are used to build up benchmark tables, with performance quartiles assigned for different scheme profiles based on recycling scheme type, recycling collection frequency, residual waste frequency and



rurality (including levels of deprivation) where there are sufficient data points available. These yields represent material *collected* from the kerbside and therefore include contamination.

The same benchmark tables are used to determine the yield for any new materials being added to a service. A contamination rate (see [Appendix E](#)) is applied to additional tonnage collected; the contamination rate varies by collection approach. Where an authority is modelled to move from weekly residual to fortnightly residual (and, in the case of switching to multi-stream, from fortnightly recycling to weekly recycling) the assumed uplift in performance is calculated from the benchmark tables.

Flatted properties

The assumed performance at flats is calculated in the same way as for kerbside properties. Flats are assumed to achieve collected dry yields equivalent to 50%, and food yields equivalent to 40%, of that achievable at kerbside properties.

In scenarios where there are changes to service provision for flats, the frequency of the collection (both for residual and recycling) is assumed to be unchanged.

Contribution to recycling rate

All the scenarios modelled are assumed to have sufficient container capacity for the core set of recyclables (minimum equivalent to 120 litres per week), therefore it is assumed that the quantity of recyclable material (excluding contamination) presented by the householder does not change between scenarios. Recycled tonnages (with contamination removed) are reported in WasteDataFlow under Questions 100 and 19. Where no service change is modelled for a local authority it is this tonnage, scaled up by a population increase that makes up the numerator of the recycling rate. Therefore, the local authority's current level of contamination (reported in WDF) is assumed to continue going forward. In the modelling if new materials are added to a service, the method of collection is changed, or residual frequency changes then collected yields are calculated based on their existing overall performance with a contamination rate applied (outlined in [Appendix E](#)) and yields for additional materials added.

A sensitivity test on the kerbside (only) scenarios was performed to show the impact on costs and performance if the amount of dry recyclable material set out was less than that assumed⁶². This was to reflect discussions with the advisory group to consider the impact of co-mingled options delivering higher yields. The sensitivity analysis resulted in a reduced financial benefit of the 'All multi-stream with food' (Scenario 3) to £422m and increased the cost for 'All Multi-stream with food and Two-stream with fibres and food separate (Scenario 2)' to £361m (in each case for the scenario excluding changes to flats). The contribution to the national recycling rate reduced to 5 percentage points.

⁶² Yields reduced in line with comparison of individual material yields from groups of authorities with different scheme types in 2014/15



Appendix E: Material quality and markets

Material quality

Preventing contamination at source can be cost effective. Multi-stream collections which tend to have lower contamination, and require fewer materials to be sorted, increase the chances that mixed materials are sorted cost effectively and revenue from materials are maximised, enabling greater opportunities for councils and waste companies to share financial risk, and reward from the sale of recyclable materials.

WRAP's analysis shows that contamination levels in source separated collection systems are lower for all types of recovered materials, with a greater percentage of each material collected being recycled. Typical contamination levels in source separated collection systems compared to co-mingled systems are 1.1% versus 15.5% for paper, 4.1% versus 12% for card, 0.4% versus 10.4% for glass, 2.9% versus 18.2% for plastics, 1% versus 2.5% for aluminium and 3% versus 6.2% for steel⁶³.

A 2014 Zero Waste Scotland study provides evidence (based on 2013 data) on contamination levels for five key recyclable materials - plastic, glass, metals, paper and card – in systems that separated materials at the point of collection (householder or kerbside). WRAP analysis of typical contamination rates based on 234 samples from 37 local authorities across England from the UK dataset is reported in the table below.

⁶³ Based on WRAP studies summarised in *Eunomia (2016) Review of the Welsh Government's Collections Blueprint*



Table E.1: Contamination rates for source separate collections in England⁶⁴ by material type, 2014

	Lower Confidence Limit ⁶⁵	Median	Upper Confidence Limit
Paper	1.0%	1.2%	1.4%
Card	2.8%	4.7%	6.6%
Mixed paper/card	0.6%	0.9%	1.3%
Glass	0.8%	1.0%	1.2%
Metals	5.3%	8.3%	11.3%
Plastics	1.6%	2.6%	3.6%
Weighted average	1.6%	2.4%	3.1%

A tonnage weighted 'average' of the median contamination rates for the five materials across local authorities in England is 2.4%, with an indicative range as low as 1.6% to as high as 3.1%. WRAP's modelling assumption for contamination in its scenarios for moving to a multi-stream collection is 2%, with a range as low as 1% to as high as 3.5% used in the scenario sensitivity analysis.

In 2012/13, between 0% and 27% of materials input to Materials Recovery Facilities (MRFs) was rejected and sent to waste to energy or landfill; that is, not sent for recycling. The median figure for MRF input material not sent for recycling was 6.4%, however the true figure is considered to be higher as this includes 8% of local authorities that report zero tonnes of material not sent for recycling.

MRF operators cite increased risk share due to falling commodity prices (reflected either by higher gate fees and/or lower rebates for material sales) and increasing contamination issues, and expect gate fees to continue to increase in the next year⁶⁶.

⁶⁴ WRAP calculations for England using the dataset from 'Contamination in source-separated municipal and business recyclate in the UK 2013', 2014, ZWS

⁶⁵ 95% upper and lower confidence intervals for the median

⁶⁶ WRAP Gate fees report, 2016



The contamination/reject rates applied in the modelling to the additional tonnages collected for recycling under the different scenarios are:

Scheme Type	Contamination assumption	Reasoning	Sensitivity low	Sensitivity high
Co-mingled Mixed Dry Recyclables	12.5%	Combination of published Environment Agency estimate, waste composition data and MF Portal indications	9%	15%
Two-stream dry recyclables	8%	From the limited number of available waste composition studies but backed up with the assumption that the mixed element of the two stream collection would be the same as co-mingled, whilst the separate stream would have a lower rate therefore overall rate is a combination of both streams.	6%	11%
Multi-stream	2%	Combining the outputs from the ZWS report and WDF with the understanding that some authorities report Q10 tonnages after bulking of the material (after inspection to remove visible contaminants).	1%	3.5%

Materials markets –overview of recent trends and modelling assumptions

Over the past twelve months virgin commodity prices have continued to fall, following the trend seen since markets peaked in 2011. Oil prices have declined by around 40%, metals prices are down by 19% and commodity food prices have declined by 7%. In broad terms prices have declined as the expansion in supply has outpaced growth in demand in many markets.

Commodity price fluctuations impact on the recycling sector in several ways. Operating costs are directly affected by the price of energy, fuels, equipment, materials and labour. In addition, the price of recovered materials going into reprocessing businesses depends on the balance of supply and demand, quality and movements in virgin commodity prices.

Some plastics reprocessors are particularly vulnerable to changes in market conditions due to their location in the middle of supply chain. They face higher operational costs as they cannot control quality or availability of recovered material inputs. They are also largely dependent on spot market prices for the products they sell, which can result in sharp fluctuations in revenue. They also face demand uncertainty because their products compete with virgin material.



Recovered paper and glass prices have been the least affected over the past year. Metals have seen market conditions deteriorate but have not been affected as much as plastics. The sharp drop in the price of steel and base metals such as copper has hit the UK scrap metal industry and a number of steel mills closed in 2015.

The materials revenue assumptions used in the modelling were updated for the Phase 2 modelling and are based on the 2015/16 average from WRAP's Materials Pricing Report. The figure for cans, plastic bottles and plastic PTT is a modelled price for the cost of sorting mixed cans and plastics at a transfer station/depot.



Material revenue - used on multi-stream and for options where dry recyclables are collected in two streams								
	Paper £/tn	Card £/tn	Mixed paper and card £/t	Cans £/tn	Mixed colour glass £/tn	Colour separated glass £/t	Plastic bottles £/tn	Plastic PTT £/tn
£/t	£76.00	£71.00	£57.00	£0.18	-£13.00	£4.48	£0.18	£0.18
Reference	<i>2015/16 MPR average ex-works - news and PAMS</i>	<i>2015/16 MPR average ex-works - OCC</i>	<i>2015/16 MPR average ex-works - mixed paper and board</i>	<i>Modelled sorting cost</i>	<i>2015/16 MPR average ex-works - mixed glass</i>	<i>2015/16 MPR average - weighted average ex-works of each glass colour</i>	<i>Modelled sorting cost</i>	<i>Modelled sorting cost</i>



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