

Report

Kerbside Recycling: Indicative Costs and Performance



WRAP helps individuals, businesses and local authorities to reduce waste and recycle more, making better use of resources and helping to tackle climate change.

Front cover photography: Common materials collected at the kerbside

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Executive summary

The increase in national recycling rates achieved by local authorities since the publication of Waste Strategy 2000 has been impressive. The growth from 7% to 31% in 2006/07 has been achieved through a mixture of investment and ingenuity, but it has resulted in the creation of a number of different collection systems with many local variations. Although opinions about the merits of the different systems are often firmly held, there has so far been little objective evidence about their cost and effectiveness or about the quality of the material they produce or the implications for service standards to customers.

This report is intended to provide a systematic appraisal of the characteristics of the principal kerbside recycling collection systems looking at both their cost and effectiveness. WRAP will support this by further work looking at managing material quality within municipal recycling systems and how to underpin customer support for these new systems.

This report does not attempt to identify a “best value” or “best” system. All the evidence, and common sense, suggests that a range of systems will be needed to meet the varying circumstances within which local authorities provide recycling services. The report first identifies the characteristics of a good practice approach to the main recycling options and then models the relative cost of these approaches and their effectiveness. The underlying assumptions used in the modelling have been extensively tested with leading practitioners in local authorities, the waste industry and the reprocessing sector.

The study has focused on the three main kerbside collection systems currently operating: kerbside sort; single stream co-mingled; and two stream partially co-mingled. It examines a number of the main service variations in each category within two different local contexts.

The intention is that local authorities should use the information in this report to consider their actual costs in the light of predicted costs of a comparable good practice system. Because the underlying assumptions are set out, they should be able to identify the reasons for variations between their cost and the predicted values.

Although it is not the intention of this report to provide a definitive answer to the question “which is the best system for me?” by its nature it has identified some systematic differences in the options examined. These can be summarised as:

- In current market conditions kerbside sort schemes show lower costs – net of income from material sales - than single stream co-mingled schemes.
- The net costs of co-mingled schemes are heavily affected by MRF gate fees and the costs of kerbside sort by income from the sale of materials.
- Two stream co-mingled collections which keep paper separate from containers have similar net costs to kerbside sort schemes.
- There is little variation in material yields between the three main scheme types but, within schemes, variants which collect glass and have an alternate weekly collection of refuse exhibit the greatest diversion rates.
- Recycling collections are maximised when customers are provided with adequate capacity through more or larger containers and/or weekly collections of recyclable materials.
- There appears to be no systematic advantage for one recycling system based on the ‘urban or ‘rural’ nature of the areas served.

A report of this sort cannot say anything about the quality of the materials collected by the different systems. WRAP remains of the view that, with the current capacity of the sorting infrastructure, kerbside sort schemes offer the best prospect for achieving good quality materials. However, the technology for sorting materials is constantly improving meaning that improvements in MRF capabilities are possible where local authorities and MRF providers both work to achieve that. WRAP has a separate programme addressing quality issues in MRFs with a view to raising the quality of output to a level suitable for UK reprocessors to use for high value applications.

The present report is based on systems in which local authorities collect common recycled materials: paper, steel and aluminium cans, and in many cases card, plastic bottles, glass and textiles. We believe this to be a reasonable assumption since there is an observable convergence reported by local authorities around the collection of these materials as standard. This is a trend which is welcomed by customers.

As local authorities plan for the higher recycling levels set out in the Waste Strategy 2007, however, many will be looking at extending the range of materials to be recycled to include all of the above materials and others such as food waste, mixed plastics and carton containers. WRAP has projects in hand to look at further issues which will affect both the cost of recycling and residual waste services. WRAP intends to review and update the cost data contained in this report regularly and to extend the analysis to include other materials and waste streams (i.e. refuse and organics) and to account for the savings in disposal costs in overall system costs.

Acknowledgements

WRAP is very grateful for the time taken by local authority officers, collection contractors and materials reprocessors to provide comments and advice on the validity of modelling input values and outputs. WRAP would also like to thank the officers and contractors who took part in two WRAP organised Master Classes on good practice kerbside collections, for sharing their knowledge and experience on all aspects of collection operations.

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1.0 Introduction

A range of kerbside recycling systems is operated across England, with many variants. Around 44% of kerbside collection systems sort the recyclable materials at the kerbside, 35% collect the recyclables single stream co-mingled, 11% operate two stream partially co-mingled collections whilst the remaining 10% cannot be classified within these categories. The costs and performance achieved by a scheme will vary depending on the system type, its design and operation, and where it is operated. This report presents indicative costs for delivering different system types and highlights some of the key issues for consideration in order to deliver good practice performance.

1.1 Purpose of the report

WRAP has produced this document to disseminate the findings of a project that has used modelling to investigate the performance potential and costs of different collection and sorting systems and so establish what good practice can realistically deliver in different local contexts.

A modelling approach was adopted because of difficulties associated with obtaining consistent reported actual costs for collection services and because of the considerable variation in the current performance of kerbside recycling schemes making comparison of the costs of apparently similar schemes difficult.

The modelling is based on what can be achieved if common good practice attributes are applied to the main systems in operation. The modelling is also based on the materials that currently are most commonly collected at kerbside for recycling. Optimal performance and the routes to achieving optimal performance are not considered in this report.

The purpose of this report is twofold:

- 1 to provide 'benchmarks' against which local authorities can compare their actual costs and performance with the predicted cost and performance of a good practice system of the type they provide; and
- 2 to provide better information on the expected performance and costs of the main system types currently in operation in order to inform choices and local authority decision making.

1.2 Structure of the report

The report is set out in five sections. Chapter 2 describes the characteristics assumed for the purposes of this report of a good practice approach to the provision and operation of kerbside recycling services, and Chapter 3 outlines the approach adopted for the modelling. The remaining three chapters provide information on the costs and performance of the three main system types considered: kerbside sort; single stream co-mingled; and two-stream partially co-mingled, definitions for which are provided below:

- **Kerbside sort** systems are where materials are sorted by material type at the kerbside into different compartments of a collection vehicle.
- **Single stream co-mingled** systems are where materials are collected in a single compartment vehicle with the sorting of the materials occurring at a MRF (Materials Recovery Facility).
- **Two stream partially co-mingled** systems are where residents are required to separate materials into two categories, usually fibres (paper/ card) and containers (glass, cans and plastic bottles). Separate containers are provided for each category the contents of which are loaded into separate compartments on a twin compartment collection vehicle.

2.0 Characteristics of a good kerbside recycling collection scheme

A good scheme can be characterised by a number of attributes regardless of the way in which the materials are collected and sorted.

2.1 Common characteristics of a good scheme

A range of attributes need to be in place for the delivery of good kerbside recycling services, regardless of system type, in order to achieve maximum scheme usage and ensuring that material is collected cost effectively. A good service is one that achieves good yields through:

- high participation rates;
- high material recognition rates; and
- low contamination rates.

Participation, Recognition and Contamination Rates

Participation rate – the number of households who set out their container(s) at least once in three consecutive collection opportunities as a percentage of the total number of households provided with the service.

Recognition rate – the amount of a targeted material collected from participating households as a percentage of the total amount of the targeted material available from those participating households in the programme.

Contamination rate – the amount of non-targeted materials collected as a percentage of the total quantity of recyclable material collected or sorted.

A successful scheme is:

- easy to use;
- reliable;
- effectively communicated;
- flexible; and
- manages health and safety risks appropriately.

2.1.1 Easy to use

An easy to use and convenient recycling scheme will maximise how many people choose to participate and how effectively they participate. For a scheme to be easy to use and convenient it must:

- **Minimise the effort required for residents to engage with and use the service:** This means ensuring the set out requirements are not overly onerous and that changes to the service are few.
- **Provide residents with an appropriate method of containment:** This means taking account of the materials to be placed in the container, the nature of the local housing stock, where the container(s) is likely to be stored and how easy it is to set out for collection. A number of different containment methods may be required in an area to ensure the most appropriate methods are provided to all residents. It is good practice to consult with householders about their containment preferences, but it has to be borne in mind that mixing different types of container on one collection round has the potential to create health and safety issues for collection crews, for example, collecting sacks which are manually loaded on to a collection vehicle and wheeled bins which are placed on bin lifts and emptied automatically.
- **Provide adequate capacity:** The amount of container capacity provided to householders is affected by a number of factors:
 - the materials being collected;
 - the frequency of recyclables collection; and
 - the nature and frequency of other collection services, including residual waste, garden and food waste collections.

Failure to provide adequate capacity can result in recyclable materials being placed in the residual waste. For example, providing a single 55l box for a fortnightly collection of paper, glass, metal and plastic bottles will be inadequate. Fortnightly collections may require a total container capacity of around 140-180 litres subject to the size of household and other factors. If these materials are collected weekly a capacity in the region of 70-80 litres is required.

If additional capacity is available (i.e. extra boxes) to householders that may need it or if householders are able to leave additional recyclable materials alongside the prescribed container(s) as long as they are suitably contained it is good practice to make sure that householders are aware of these arrangements. The latter can be important if an authority operates a "no side waste" policy for residual waste.

- **Maximise the range of materials targeted** - A scheme that targets a wide range of materials is more effective than one that only targets a single or limited number of materials. Increasing the range of materials collected at the kerbside is likely to increase the capture rate of all materials (Hummel, 2005)¹.

2.1.2 *Reliable*

A reliable scheme will:

- limit changes to the set out requirements and the collection routine;
- ensure any changes are effectively communicated prior to introducing any change in the service;
- avoid/limit missed collections;
- rectify missed collections as soon as practicable;
- ensure that the containers are returned to the point of collection; and
- establish, publicise and enforce collection policies.

Recycling crews are the ambassadors of the service and well managed and motivated crews are absolutely critical to ensuring that a reliable and high quality service is delivered. Crews should be properly trained and provided with appropriate development opportunities. Collection policies should be followed consistently by the crews and they must be provided with support from management and supervisory staff to ensure effective implementation of these policies.

2.1.3 *Effectively communicated*

High levels of participation and material recovery can only be achieved if the public are engaged using effective communication. Effective communication involves:

- motivating residents to use the scheme - by providing relevant information about the benefits of recycling;
- informing residents how to use the scheme – by providing clear instructions about what, when and how;
- engaging with residents about problems/issues with the service – by including mechanisms for the public to provide feedback; and
- encouraging residents to continue using the scheme – through positive feedback and providing a reliable, high quality service.

WRAP Communications Guide:

<http://www.wrap.org.uk/downloads/communication-guide.f2db3083.pdf>

Local Awareness Communication Fund Case Studies:

http://www.wrap.org.uk/local_authorities/toolkits_good_practice/lacf_case.html

Brand in Action - Success Stories:

http://www.wrap.org.uk/old_recyclenow_partners/brand_in_action/success_stories/index.html

Also:

- Basic Design Principles
 - Guidance on Developing Collection Calendars
 - Design and Print Guidance for local authorities
- http://www.wrap.org.uk/local_authorities/toolkits_good_practice/index.html

¹ Hummel, Dr J, (2005) "Assessing the Impacts of Increasing the Range of Material Types Collected at the Kerbside". Available at www.wrap.org.uk

In addition to engaging the public, time taken to communicate and engage with collection crews and other frontline staff (e.g. call centre staff) can help provide understanding of issues and a sense of ownership, which in turn can result in a positive interface with the public.

2.1.4 Flexible

A good scheme needs to demonstrate flexibility in a number of different areas:

- **Flexible to meet local circumstances** – No two areas within a local authority are the same due to varying socio-demographics leading to varying waste generation and composition, and to housing type and space available for storing recyclables containers. Therefore local authorities should recognise genuine differences in household circumstances and not force “one size fits all” solutions. It may be necessary to vary systems to accommodate different local circumstances.
- **Flexible to change with time** – A good scheme should be designed to absorb or adapt to increasing quantities of recyclable materials resulting from increased participation and recognition.
- **Flexible to meet public demands** – As the public engage with recycling there is often a desire to recycle a wider range of materials at the kerbside than is currently collected. A good scheme should have the flexibility to add materials at a later date. This will have implications on:
 - the number and capacity of containers;
 - the number and capacity of vehicles;
 - bulking/sorting requirements;
 - communications; and
 - contractual arrangements.

2.1.5 Health and Safety

Whichever collection and sorting system is used a good practice operation should adopt good practice standards for the health and safety of operatives. Appropriate risk assessments should be undertaken when designing schemes and these should be reviewed and revised as necessary once operations commence. Specialist advice should be sought as necessary.

3.0 Approach

There were four main stages to this project:

3.1 Stage 1: Identification of the systems to be modelled

WRAP maintains information on the kerbside collection schemes operated by English local authorities. This information was used to produce a classification of kerbside recycling schemes based on key characteristics relating to both the methods of collecting recyclables and refuse. From this the most common systems in operation were selected. The key system configurations are shown below:

Table 1 Summary of Key System Configurations in England (as at July 2007)

	Recycling Container and Refuse Frequency	Total Number	% of English Authorities ²
Kerbside Sort	Sack and/or box, fortnightly refuse	59	17
	Sack and/or box, weekly refuse	95	27
	Total Kerbside Sort	154	44
Single stream Co-mingled	Wheeled Bin, fortnightly refuse	59	17
	Wheeled Bin, weekly refuse	24	7
	Sack and/or box, fortnightly refuse	7	2
	Sack and/or box, weekly refuse	31	9
	Total Single Stream Co-mingled	121	35
Two Stream Co-mingled	Sack and/or box, fortnightly refuse	17	5
	Sack and/or box, weekly refuse	20	6
	Total Two Stream Co-mingled	37	11

There are variations within these systems and the most common variations are considered in the modelling. These relate to:

- frequency of recycling collections;
- types of materials collected; and
- containment methods used.

3.2 Stage 2: Defining the local authority setting

The costs and performance of a scheme are affected by the area in which it is operated. To test the implications of different local authority areas, two local contexts – for the purpose of this report referred to as **urban** and **rural** - were defined to reflect in the main variations in housing density and travel distances. For the **urban** authority shorter distances to travel between properties were assumed thereby allowing larger round sizes compared to the **rural** authority where housing is less dense and hence fewer properties can be covered per round³. It has been assumed that compared to the **urban** authority, participation and recognition rates in the **rural** authority are 5% higher reflecting differences in socio-economic characteristics and deprivation levels.

² This excludes those systems that cannot be classified into a common system type and a very few authorities where WRAP holds no collection information

³ To provide context, the equivalent round sizes for wheeled bin refuse collections are 1,250 properties per vehicle per day for the urban authority and 900 properties per vehicle per day for the rural authority

3.3 Stage 3: Modelling

The costs and performance of the selected kerbside collection systems for recyclables were modelled by WRAP using the Kerbside Analysis Tool, KAT. KAT is a public domain model adopted by WRAP⁴ which allows users to make projections of kerbside collection infrastructure and associated standardised costs using default and user-defined values. The costs projected by KAT are standard costs based on the infrastructure required to deliver the service (e.g. vehicles and containers) and the costs of operating this infrastructure (e.g. vehicle maintenance costs, labour costs, etc)⁵. Assessing and projecting costs on a standardised basis enables the relative costs and performance of different system configurations to be compared.

KAT was chosen as it is a public domain model, it is used by WRAP in the delivery of advisory support to local authorities, and in a previous exercise conducted by WRAP it was shown to be amongst the most robust of the modelling tools available, on the basis of independent evaluation of the assumptions and standard inputs used by the models.

Each of the three selected system types was modelled for both local contexts (urban and rural). The materials targeted for collection vary by scheme type as follows:

- newspapers and magazines and mixed aluminium and steel cans for all schemes
- plus colour sorted glass for all kerbside sort schemes
- plus plastic bottles and cardboard for all co-mingled schemes
- plus plastic bottles, cardboard and glass for all two-stream schemes
- a single stream co-mingled option was modelled with glass as one of the targeted materials
- a kerbside sort option was modelled with plastic bottles as one of the targeted materials

In order to determine total collection and sorting costs MRF gate fees and income from the sale of materials have been included for each of the options as appropriate.

A workshop was held with selected WRAP Framework Contractors with experience of appraising and modelling collection systems to review and agree the values assigned to the key modelling parameters. All options have been modelled assuming good practice levels of performance. This means that participation rates, recognition rates and other key variables have been defined for each option and were not varied in the modelling.

In addition, a series of facilitated discussions were organised with local authority officers, materials reprocessors and collection contractors with experience of co-mingled and kerbside sort collections to identify the characteristics of a good practice system. The output from these discussions has informed the content of Section 2 of this report.

3.4 Stage 4: Testing of Assumptions and Modelling Outputs

The operational assumptions and initial modelling outputs were tested through discussions with service operators in the public, private and third sectors. The aim was to check the validity of the inputs and assumptions used in the modelling and to “reality-check” the model outputs. Input values and assumptions were then adapted and the modelling re-run, to reflect, as far as possible, the stakeholders’ feedback.

The outputs of the modelling are presented for each scheme type in Sections 4 to 6. These are:

- **yield of recyclables collected** - presented as kg/household/year;
- **capture rate** - presented as percentage of targeted materials collected from served households;
- **collection only costs** – presented as £ per household and £ per tonne (these are annualised costs); and
- **net cost of collection and sorting** - presented as £ per household and £ per tonne.

⁴ KAT is available at: www.wrap.org.uk/local_authorities/toolkits_good_practice. The development of KAT was supported by funding under the Landfill Tax Credit scheme.

⁵ Standard costs are not the same as a contract price an authority may pay a contractor to deliver a service on its behalf. For example, the costs of the following are not included within KAT: the cost of communications or promotions; the cost of contract management; discounting for bulk purchasing; discounting for a contract covering more than kerbside recycling; special vehicles for use in restricted access areas; any risk/ benefit sharing arrangements; collection of missed containers

Collection only cost – cost of collecting recyclables prior to any MRF gate fees or bulking costs being added or income from the sale of recyclables deducted.

Net cost of collection and sorting – cost of collecting recyclables plus bulking costs and MRF gate fees less any income from the sale of recyclables.

The modelled costs reported relate to recyclables only and do not include the cost of collecting residual waste. Local authorities may need to consider total system costs including residual waste collection.

A separate Annex is available to support this report, which sets out the modelling input values and key assumptions.

4.0 Kerbside Sorting

Kerbside sort systems are where materials are sorted by type at the kerbside into different compartments of a collection vehicle.

4.1 Overview

In kerbside sort systems, most materials are kept in separate streams on the vehicle and not compacted, though some material streams can be collected mixed, e.g. cans and plastic bottles. This is to reduce the picking time and increase the effective use of space on the vehicle.

An advantage of sorting the material at the kerbside is that contamination or materials that cannot be recycled can be identified and left in the container. If the reasons for this are explained, residents are provided with feedback on the correct use of the service. More importantly, this sorting ensures a high quality material for market. Typically the contamination in kerbside sort materials is less than 0.5%.

Common variations of kerbside sort collections in operation were modelled and the report sets out a discussion of these and other factors as follows:

- use of kerbsider and stillage vehicles (described below);
- adding textiles to the materials collected (stillage vehicle options only);
- collection only costs and net costs;
- impact of different recycling collection frequency – fortnightly and weekly;
- impact of refuse collection frequency – fortnightly and weekly; and
- impact of collecting plastic bottles.

4.2 Overall Results

The modelling results for all the kerbside sort options are presented for the **urban** authority in Table 2 and the **rural** authority in Table 3. Good practice performance of a 'typical' urban and rural authority has been modelled. Maximum or 'optimum' performance can be higher and may be being achieved by some authorities already. For each service configuration identified, the modelling has been conducted for the two main vehicle types used on kerbside sort systems, 'stillage' and 'kerbsider' vehicles⁶.

4.2.1 Kerbsider and stillage vehicles

Stillage vehicles are purpose built and comprise a number of cages or boxes for the different materials collected. Stillages are removed by fork lift truck and emptied at a recycling depot/bulking station. The modelling for stillage vehicles has been based on a 20m³ capacity vehicle.



Typical Stillage Vehicle



Sorting at the kerbside

⁶ WRAP is working on the design of a new style of collection vehicle to enable sorting at kerbside. A prototype vehicle is being built and will be trialled in summer 2008. Once the vehicle has been tested it is WRAP's intention to make the vehicle design more widely available.

'Kerbsider' vehicles allow loaders to sort materials into troughs mounted to the nearside of the vehicle. The troughs are hydraulically emptied into different compartments. Each compartment is tipped in turn at the bulking station.

The modelling for kerbsider vehicles has been based on a 28m³ capacity vehicle.



Typical "kerbsider" vehicle

Table 2 Kerbside Sort Systems Modelled for Kerbsider and Stillage Vehicle Options - Urban

Ref.	Refuse frequency	Recycling container	Recycling frequency	Materials Collected				Vehicle Type	Yield kg/hh/yr	Capture (%)	<i>Collection only</i> cost of recycling		<i>Net</i> cost of recycling	
				Paper	Glass	Cans	Plastic				£/hh/yr ⁷	£/tonne	£/hh/yr	£/tonne
KS1	Fortnightly	2 boxes + 1 lid	Weekly	✓	✓	✓		Kerbsider	137	73%	19.60	120.69	10.69	66.17
								Stillage	137	73%	18.04	111.09	9.13	56.52
KS2	Fortnightly	2 boxes + 1 lid	Fortnightly	✓	✓	✓		Kerbsider	124	66%	12.18	83.37	4.18	28.78
								Stillage	124	66%	12.35	84.57	4.36	29.98
KS3	Fortnightly	2 boxes + 1 lid	Weekly	✓	✓	✓	✓	Kerbsider	147	73%	22.76	130.69	12.75	73.56
								Stillage	147	73%	21.65	124.33	11.52	66.45
KS4	Weekly	1 box	Weekly	✓	✓	✓		Kerbsider	109	58%	14.09	109.16	7.02	54.69
								Stillage	109	58%	13.63	105.61	6.57	51.13
KS5	Weekly	1 box	Fortnightly	✓	✓	✓		Kerbsider	96	51%	9.61	85.01	3.44	30.56
								Stillage	96	51%	8.97	79.34	2.80	24.86
KS6	Weekly	2 boxes + 1 lid	Weekly	✓	✓	✓	✓	Kerbsider	117	58%	18.18	131.33	10.23	74.32
								Stillage	117	58%	16.94	122.39	8.90	64.62
KS7	Weekly	2 boxes + 1 lid	Fortnightly	✓	✓	✓	✓	Kerbsider	102	50%	13.73	113.79	6.85	57.06
								Stillage	102	50%	13.29	110.14	6.32	52.68

⁷ Cost per household served and not cost per participating household

Table 3 Kerbside Sort Systems Modelled for Kerbsider and Stillage Vehicle Options – Rural

Ref.	Refuse frequency	Recycling container	Recycling frequency	Materials Collected				Vehicle Type	Yield kg/hh/yr	Capture (%)	Collection only cost of recycling		Net cost of recycling	
				Paper	Glass	Cans	Plastic				£/hh/yr ⁸	£/tonne	£/hh/yr	£/tonne
KS1	Fortnightly	2 boxes + 1 lid	Weekly	✓	✓	✓		Kerbsider	188	81%	25.99	130.63	15.08	76.16
								Stillage	188	81%	25.74	129.36	14.82	74.88
KS2	Fortnightly	2 boxes + 1 lid	Fortnightly	✓	✓	✓		Kerbsider	168	72%	15.22	85.80	5.51	31.22
								Stillage	168	72%	16.46	92.76	6.74	38.17
KS3	Fortnightly	2 boxes + 1 lid	Weekly	✓	✓	✓	✓	Kerbsider	202	81%	28.95	135.66	16.68	78.55
								Stillage	202	81%	29.42	137.86	17.00	80.05
KS4	Weekly	1 box	Weekly	✓	✓	✓		Kerbsider	149	64%	22.22	140.92	13.59	86.62
								Stillage	149	64%	21.00	133.15	12.37	78.81
KS5	Weekly	1 box	Fortnightly	✓	✓	✓		Kerbsider	131	56%	14.12	101.82	6.55	47.45
								Stillage	131	56%	11.78	84.97	4.21	30.52
KS6	Weekly	2 boxes + 1 lid	Weekly	✓	✓	✓	✓	Kerbsider	160	64%	26.12	154.46	16.42	97.57
								Stillage	160	64%	25.63	151.55	15.80	93.93
KS7	Weekly	2 boxes + 1 lid	Fortnightly	✓	✓	✓	✓	Kerbsider	140	56%	17.95	121.39	9.51	64.65
								Stillage	140	56%	16.40	110.93	7.87	53.47

⁸ Cost per households served and not cost per participating household

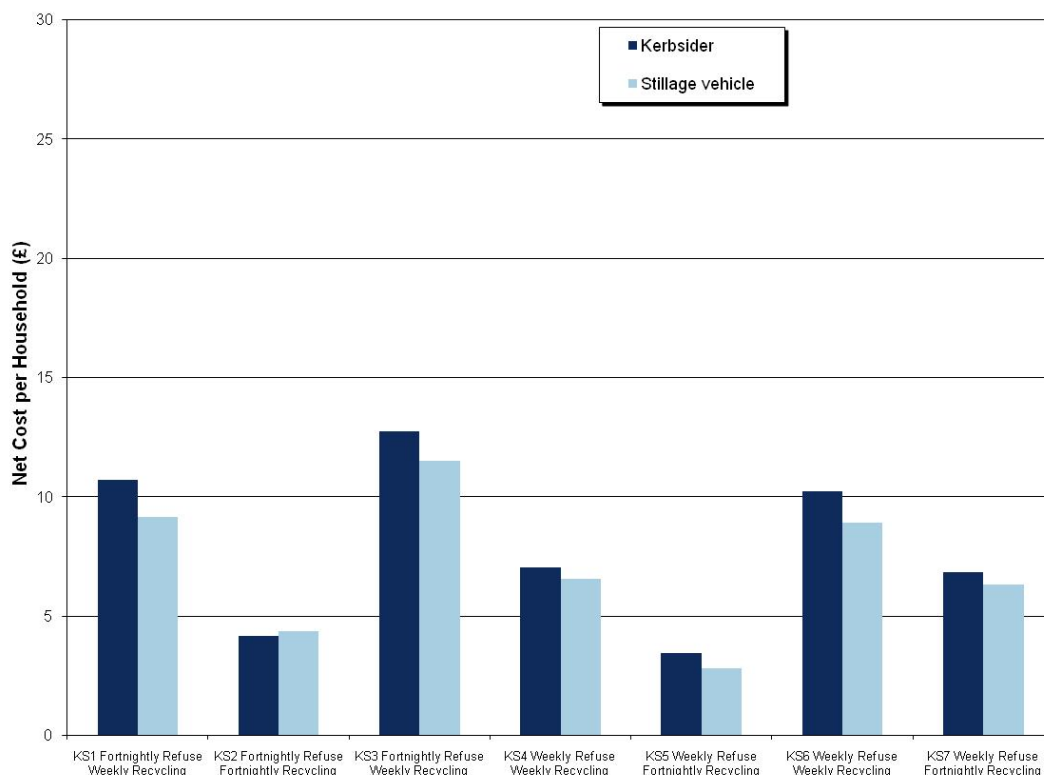
Stillage vehicles are generally cheaper to purchase and maintenance costs are low, although they do tend to have smaller capacities compared to others used for collecting recyclables. There can be some issues such as slower unloading times, open cages causing litter and limited space for promoting recycling/services on the side of the vehicle. There are perceived concerns of loaders sorting on the vehicle, dual side entry and inappropriate loading heights.

A kerbsider allows loaders to sort material on the nearside of the vehicle without climbing onto the vehicle. They can be less flexible in the type and range of materials that can be collected. For example, food waste cannot be added due to the unloading operation and potential for cross contamination with other materials. The maximum number of compartments is generally five, so it can be difficult to add new materials to existing rounds without mixing materials.

In general, when servicing the same area, more stillage vehicles are required as the vehicle capacity is smaller. The modelling has been based on a 20m³ stillage vehicle⁹ and a 28m³ kerbsider. The results in Tables 2 and 3 and Figures 1 and 2 show that the difference between the net cost per tonne of operating kerbsiders and stillage vehicles and the net cost per household are only marginal. For instance, for the urban scenarios the difference in net cost per household varies from 17p cheaper to £1.56 more expensive for kerbsider vehicles. For the rural scenarios, the difference in net cost per household is £1.23 cheaper to £2.34 more expensive for kerbsider vehicles. The reasons for these variations are complex and associated with the efficiencies assumed in KAT for vehicle loading and capacity – in other words how quickly the vehicles fill up before they need to tip.

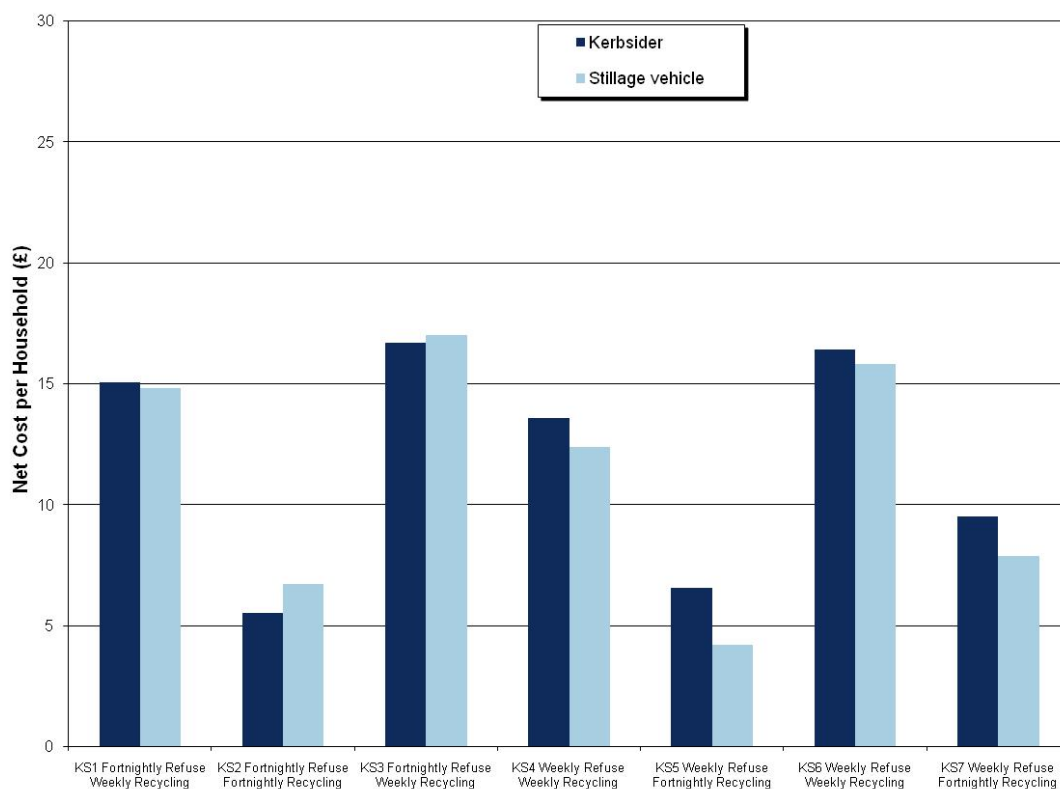
It is acknowledged that the difference in cost per household, multiplied by the number of households in an authority, could make a difference to overall contract price, but for the remaining discussion, an average of the results for the kerbsider and stillage vehicle options is shown.

Figure 1 Net cost of recycling per household for kerbsider and stillage vehicles - urban



⁹ There are some smaller capacity stillage vehicles in use (17m³) but in reality it is considered unlikely that these smaller vehicles will feature much in the future other than in a mixed fleet where there is a need for smaller vehicles to service restricted access areas.

Figure 2 Net cost of recycling per household for kerbsider and stillage vehicles - rural



4.2.2 Increasing Kerbsider volume from 28m³ to 33m³

The impact of increasing the volume of kerbsider vehicles is minimal and in most cases the collection costs associated with the larger vehicle are marginally higher (around 5 - 20 pence in the net cost per household/yr) due to the higher cost of purchasing a larger vehicle and higher running costs. The only case where there is a saving in the net cost per household is where refuse is collected weekly, recycling is fortnightly and plastic bottles are collected (KS7). In this case, the net cost per household reduces by £1.81 in the urban setting and £2.98 in the rural setting as a result of one less vehicle being required to deliver the service.

4.2.3 Adding Textiles to a Stillage Vehicle

Textiles (or other materials that arise in small quantities) can be added to a collection where stillage vehicles are used more easily than adding them to a collection where kerbsiders are used.

If textiles can be added to a scheme using stillage vehicles, without increasing the number of vehicles required, the net cost per household can reduce by around 70 pence. If an additional vehicle is required to handle the additional materials, then the additional cost per household is up to £1.50. In terms of impact on yield, the addition of textiles can increase yields by an average of 5.5 - 6.5 kg/hhd across all options.

4.2.4 Comparison of Collection only costs and Net costs

For kerbside sort options the difference between the *collection only* and *net costs* of recycling is a result of the revenue gained from the sale of the collected materials. The material revenues are considered to be reasonable average assumptions for the first quarter of the 2008 calendar year based on prices reported in the *Materials Pricing Report* which is published monthly by WRAP¹⁰. The following values were used in the modelling:

■ Clear glass	£29/tonne
■ Brown glass	£25/tonne
■ Green glass	£19/tonne
■ Mixed glass	£16/tonne

¹⁰ http://www.wrap.org.uk/businesses/market_knowledge/materials_pricing_reports/about_mpr.html

■ Plastic bottles (mixed polymers)	£110/tonne
■ Mixed cans	£142/tonne
■ News and Magazines	£68/tonne
■ Textiles	£110/tonne

Whether local authorities gain the full benefit of the value of the materials collected will depend on the contractual arrangements they have in place. For this study, it has been assumed that all the income from the sale of materials is applied to the service. It is recognised that markets are volatile and this assumption does not necessarily reflect the latest situation in all cases.

Naturally the net costs for all the kerbside sort options are lower than the collection only costs as shown in Figures 3 and 4, the difference at any point in time will be in direct relation to the proportion of income applied to the cost of operating the service. The cost effectiveness of each collection option modelled needs to be considered in light of the average yield collected per household. This is discussed later.

Figure 3 Collection only cost and net cost of recycling per household - urban

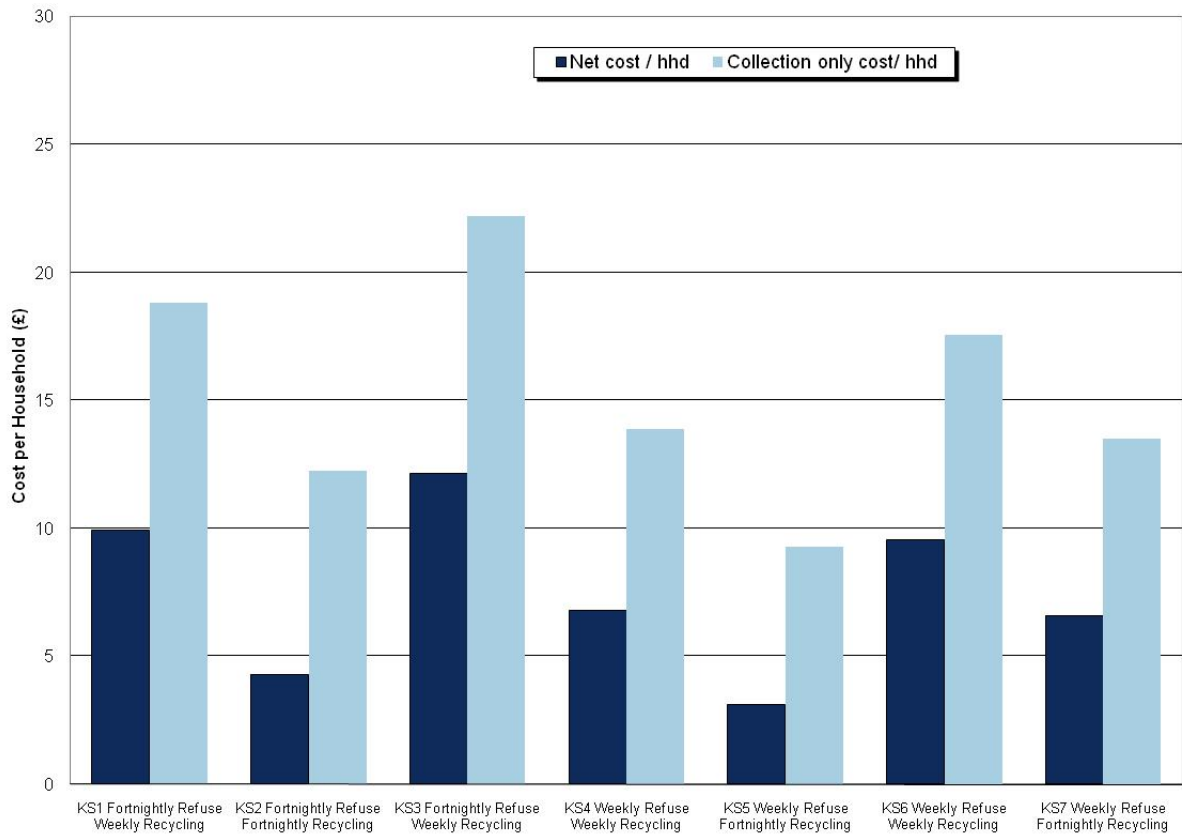
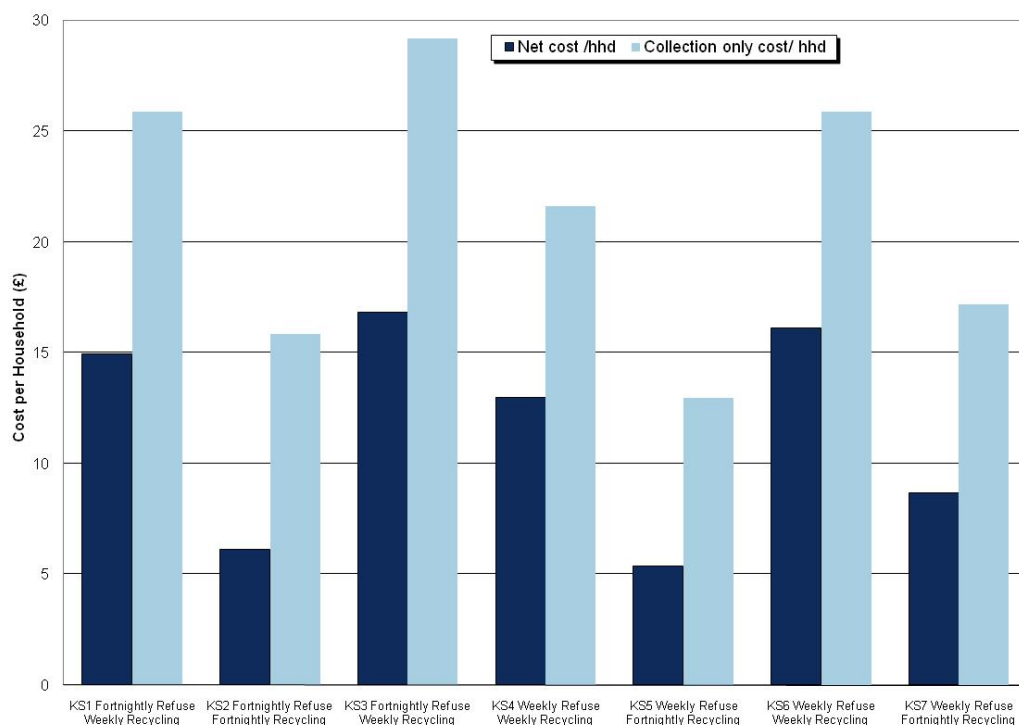


Figure 4 Collection only cost and net cost of recycling per household - rural



The net costs vary between the options modelled according to which materials are collected and also because of differences in assumed participation and recognition rates according to the frequency of both recycling and refuse collections. Participation and recognition rates were verified with environmental consultants, collection contractors and local authority officers. Figures 5 and 6 show that although net costs may be higher for options where the recycling collection is more frequent and plastic bottles are collected, higher yields are observed.

Figure 5 Net cost of recycling per household and yield per household - urban

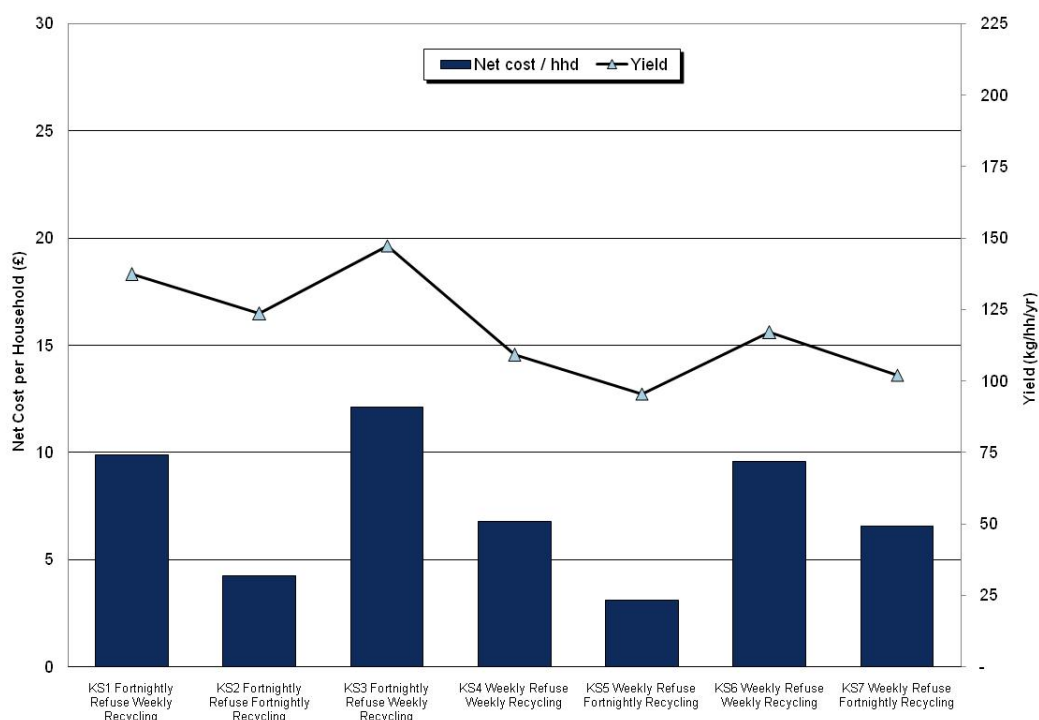


Figure 6 Net cost of recycling per household and yield per household - rural

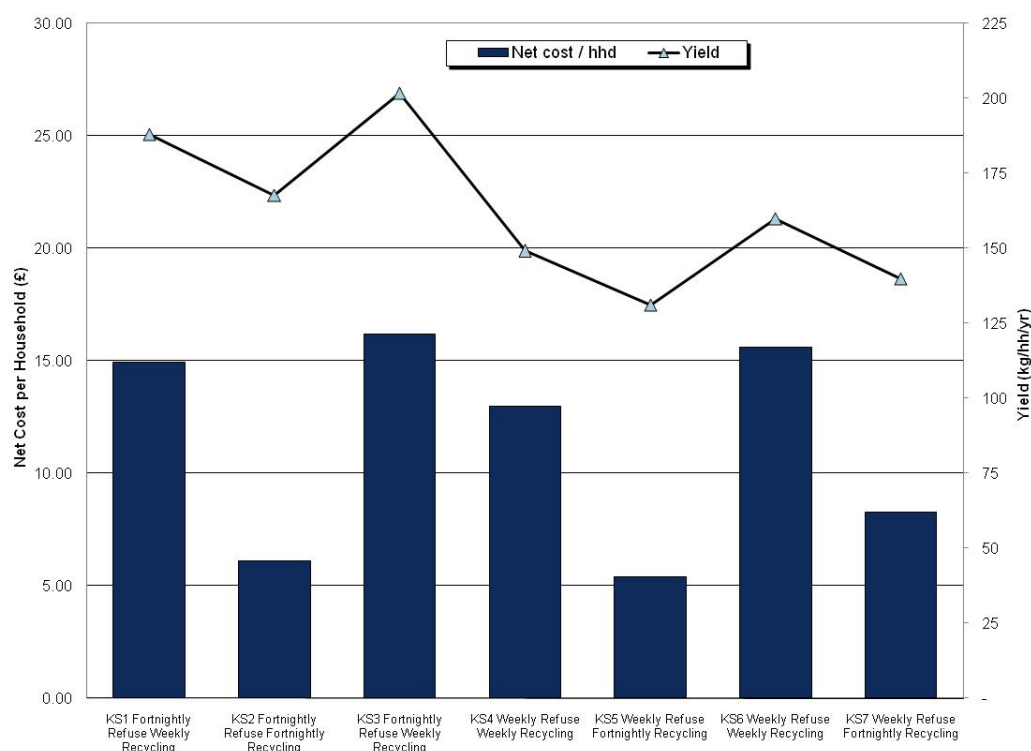


Table 4 shows the impact of increasing and decreasing the income received, by 20%, on the net cost per household for the different systems modelled. The lower net cost options e.g. KS5 and KS2 are much more sensitive to income price variations and net costs could be up to 40% more if materials income falls by 20%. Whilst the collection only cost of KS2 is higher than KS5, net costs for both systems are similar because yield in KS2 is higher and so collection costs are offset to a greater extent than for KS5 where yield is lower. The two effects combine to make net costs similar. The impact on the higher net cost options e.g. KS3 of a drop in materials revenue is an increase in net costs of 16% (rural) and 18% (urban). However, overall the ranking of the options in terms of net costs does not change and the impact is greatest on KS3. The converse is also true, net costs per household could drop by up to 40% if income increases by 20%.

Table 4 Impact of varying income from sale of recyclables on net cost per household

Option		Net cost of recycling per household (£/hh)					
		Urban			Rural		
		Base Assumption	20% Decrease in income	20% Increase in income	Base Assumption	20% Decrease in income	20% Increase in income
KS1	Fortnightly Refuse Weekly Recycling	9.91	11.86	7.97	14.95	17.33	12.57
KS2	Fortnightly Refuse Fortnightly Recycling	4.27	6.01	2.53	6.12	8.24	4.01
KS3	Fortnightly Refuse Weekly Recycling	12.13	14.32	9.94	16.84	19.52	14.16
KS4	Weekly Refuse Weekly Recycling	6.80	8.34	5.25	12.98	14.86	11.10
KS5	Weekly Refuse Fortnightly Recycling	3.12	4.47	1.77	5.38	7.03	3.73
KS6	Weekly Refuse Weekly Recycling	9.57	11.30	7.83	16.11	18.23	13.99
KS7	Weekly Refuse Fortnightly Recycling	6.59	8.09	5.08	8.69	10.53	6.85

4.2.5 Comparison of Rural and Urban Authorities

Round sizes (the number of properties a vehicle can service in day) for an *urban* authority in the model range from :

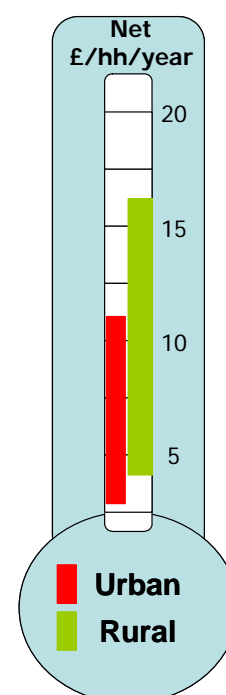
- 750 to 1,350 properties per day for a 20m³ stillage¹¹;
- 925 to 1,650 properties per day for a 28m³ kerbsider.

For a *rural* authority round sizes reduce to:

- 500 to 750 properties per day for a 20m³ stillage vehicle;
- 675 to 1,025 properties per day for a 28m³ kerbsider.

Due to the higher assumed participation and recognition rates, the yield per household in the rural context is approximately 35% higher than the same system operated in the urban context.

The range in the net cost per household in the urban context is £2.80 to £12.20/yr compared to £4.20 to £16.40/yr in the rural context. The higher cost is a result of the smaller rounds and the higher yields assumed for rural areas and hence the additional vehicles required.



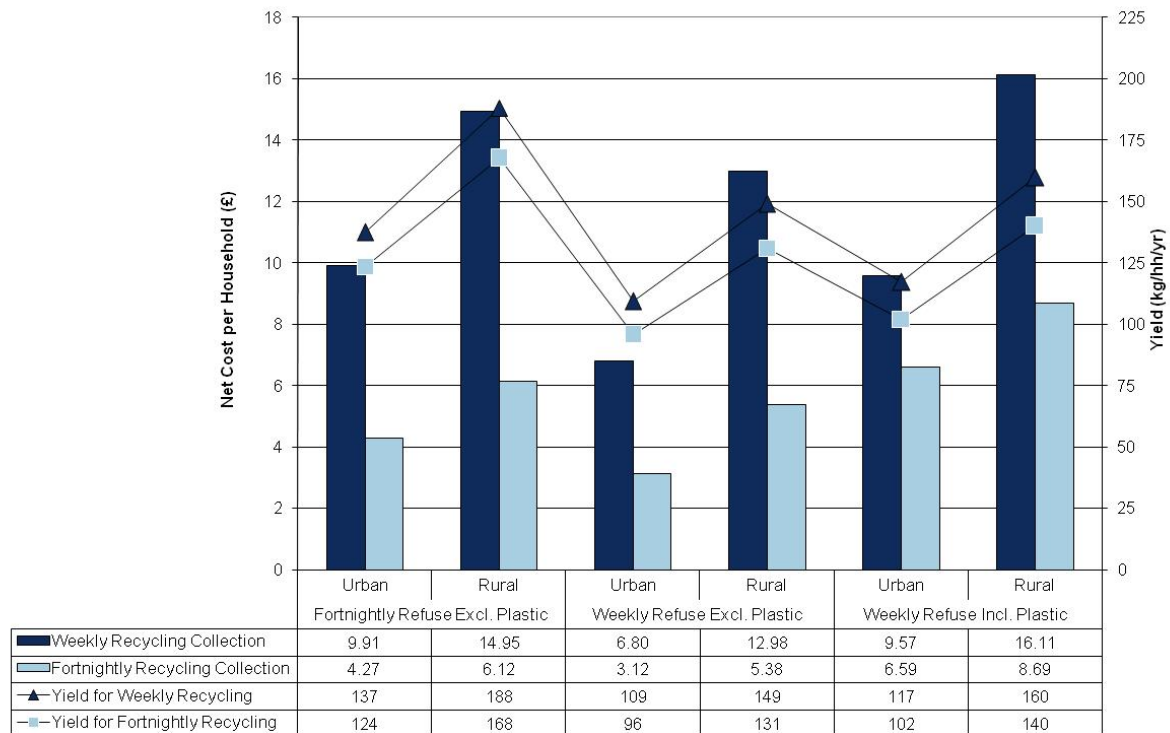
¹¹ Property and household numbers rounded to nearest 25

4.2.6 Impact of different recycling collection frequency

Fortnightly recycling collections are less expensive than those collecting recyclable material on a weekly basis, although the yield is higher from the weekly recycling collection. The difference in net cost per household between fortnightly and weekly recycling collections ranges from almost £3 to £5.60/yr in the urban authority and from £7.40 to £8.80 per household/yr in the rural authority. Higher participation and recognition rates have been assumed by WRAP (and verified by stakeholders) in the modelling of a weekly recycling collection service. These higher rates result in higher yields from weekly recycling collections compared to fortnightly recycling collections, which may help offset the overall costs via income generated by selling more recyclables. The difference in yield ranges from 13 - 20kg/hhd/yr depending on refuse collection frequency, authority type and inclusion or not of plastic bottles. The data are illustrated by Figure 7 below.

Collecting recycling weekly requires more vehicles but collecting fortnightly requires more loads. The greatest difference in costs occur for options with fortnightly refuse collections because for this study it has been assumed and verified that there will be higher participation and therefore greater quantities of recyclables to be collected. The greatest cost impact is in the rural context where travelling time between properties and to unload is assumed to be greater. This means that more vehicles have to be provided rather than increasing the number of loads per vehicle per day. In the urban options, due to less time spent travelling some rounds can fit in more loads per day which avoids the need for more vehicles.

Figure 7 Impact of Recycling Collection Frequency on Net Cost of recycling per Household – Urban and Rural

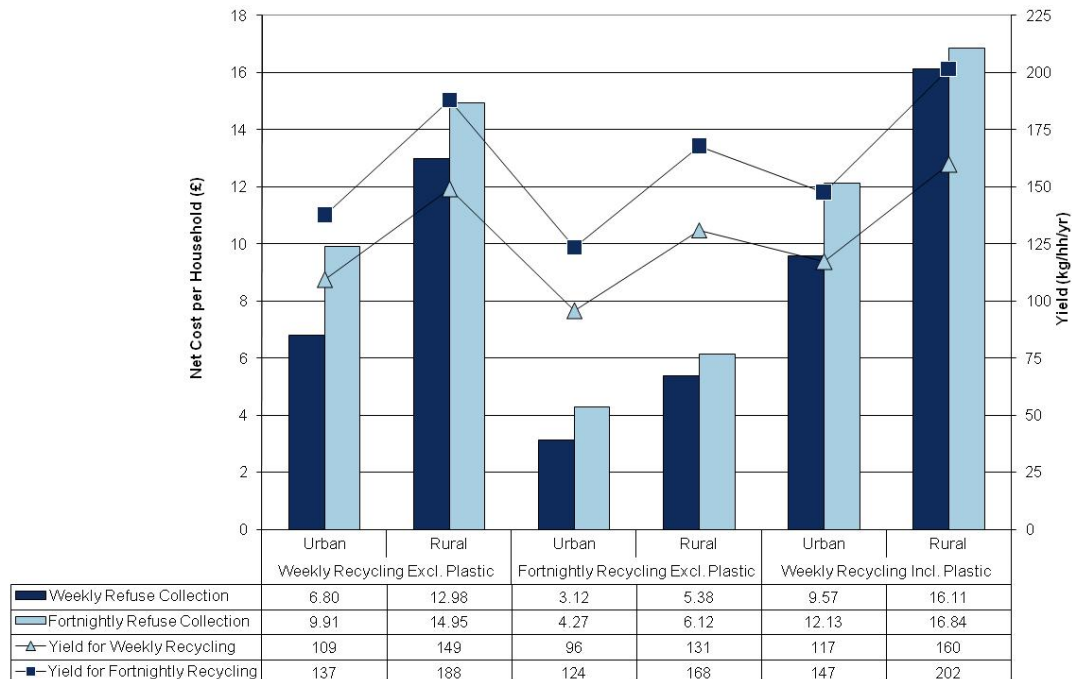


4.2.7 Impact of refuse collection frequency on recycling collection costs and yields

The impact of refuse collection frequency on the net cost of recycling is highlighted in Figure 8. In all the examples shown in Figure 8, reduced refuse collection frequency increases the net cost of the recycling collection from around 70p to just over £3 per household. This is because WRAP has used the assumption that the reduced residual waste capacity provided by a fortnightly refuse collection will increase participation, recognition and therefore total recycling yield, by up to an additional 42 kg/hhd/yr. Collecting more recyclable materials will result in higher recycling collection costs, however, it should be noted that refuse collection costs will reduce with fortnightly refuse collection resulting in the total service cost being lower than the total service cost with a weekly refuse collection.

The greatest difference in net recycling costs per household between refuse collected weekly or fortnightly, is observed for the urban authority collecting recycling weekly (including and excluding plastics). This is in part due to the way KAT calculates the numbers of vehicles required to collect the materials and for these comparisons an additional three kerbsiders or three stillage vehicles would be required.

Figure 8 Impact of Refuse Collection Frequency on Net Cost of Recycling per Household



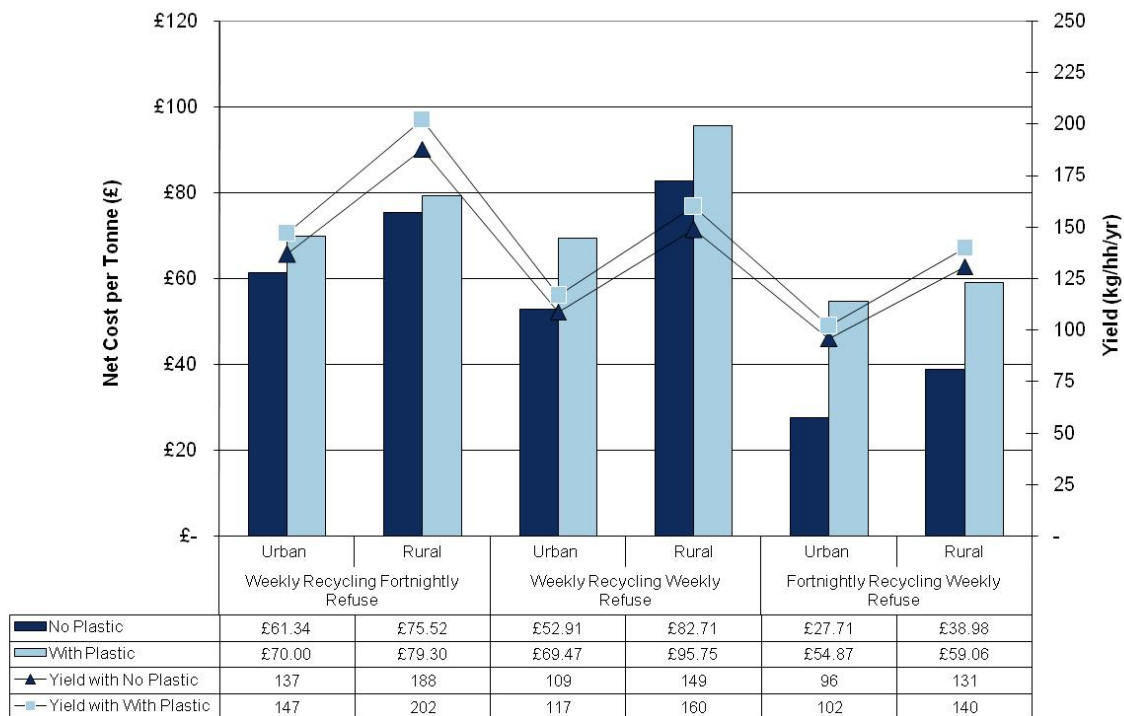
4.2.8 Implications of collecting plastic bottles

The cost benefit of collecting additional materials is often debated. A difference in the kerbside sort systems modelled is the inclusion/ exclusion of plastic bottles. The models show the cost of collections with and without plastic bottles where these are included from the outset. These do not necessarily reflect the expected impact and hence marginal cost of adding plastic bottles to an existing recycling scheme where the dynamics of the impact of householder communications, any changes to the scheme configuration, or the provision of an additional container will be different.

In all cases it is more expensive to collect plastic bottles (both on a net cost per household and net cost per tonne basis) but there is an increase in yield of up to 7%. In addition, it becomes more cost effective to collect plastic bottles when collection schemes are performing well, with higher yields being achieved as a result of good participation rates.

Figure 9 shows the net cost per tonne for the collection schemes modelled and assuming different refuse and recycling collection frequencies.

Figure 9 Net Cost per Tonne of Recycling – including and excluding Plastic Bottles



5.0 Single Stream Co-mingled Collections

Single stream co-mingled systems are where materials are collected in a single compartment vehicle with the sorting of the materials occurring at a MRF (Materials Recovery Facility).

5.1 Overview

Single stream co-mingled collections collect all recyclable material together usually in a single compartment vehicle or sometimes in the same compartment of a split vehicle where the recyclables are co-collected with refuse. These collections can be flexible on round design and can collect from more properties per round as they are not as constrained by spillage or compartment capacities for individual materials and materials are compacted. The most commonly used vehicles are standard Refuse Collection Vehicles (RCVs) and modelling of the co-mingled options was based on a 22m³ RCV with partial compaction (compaction ratio of 2:1). Good practice for co-mingled collections indicates that materials should not be over compacted during collection as this can impact on material quality and the efficiency of MRF sorting.



Advantages of RCVs for co-mingled include their flexibility, their ease of hire in the event of breakdown or unscheduled maintenance and their quick off-loading times.

Not all properties are suitable for co-mingled systems that provide a wheeled bin, especially if the co-mingled collection is part of a 3-bin system (i.e. one of refuse, one for organics and one for dry recyclables). Kerbside co-mingled systems can be combined with collections from multi-occupancy dwellings using communal 1100l bins, thus enabling the same system to be used across the whole authority area.

When assessing the cost of co-mingled systems, consideration should be given to all cost elements. The collection only costs are lower than similar kerbside sort options due to larger round sizes resulting from quicker collections. However, the net costs are higher once MRF gate fees and the cost of handling contamination (modelled at 10% in this study) are accounted for.

A range of the most common single stream co-mingled operations in England were modelled (see Table 1). The following common variations were also modelled:

- the inclusion of glass; and
- impact of contamination (i.e. collection of non targeted materials) on costs.

5.2 Overall Results

The overall results are presented in Table 5 with Figure 10 showing the **collection only** cost and **net** cost against the yield for the urban and rural authorities.

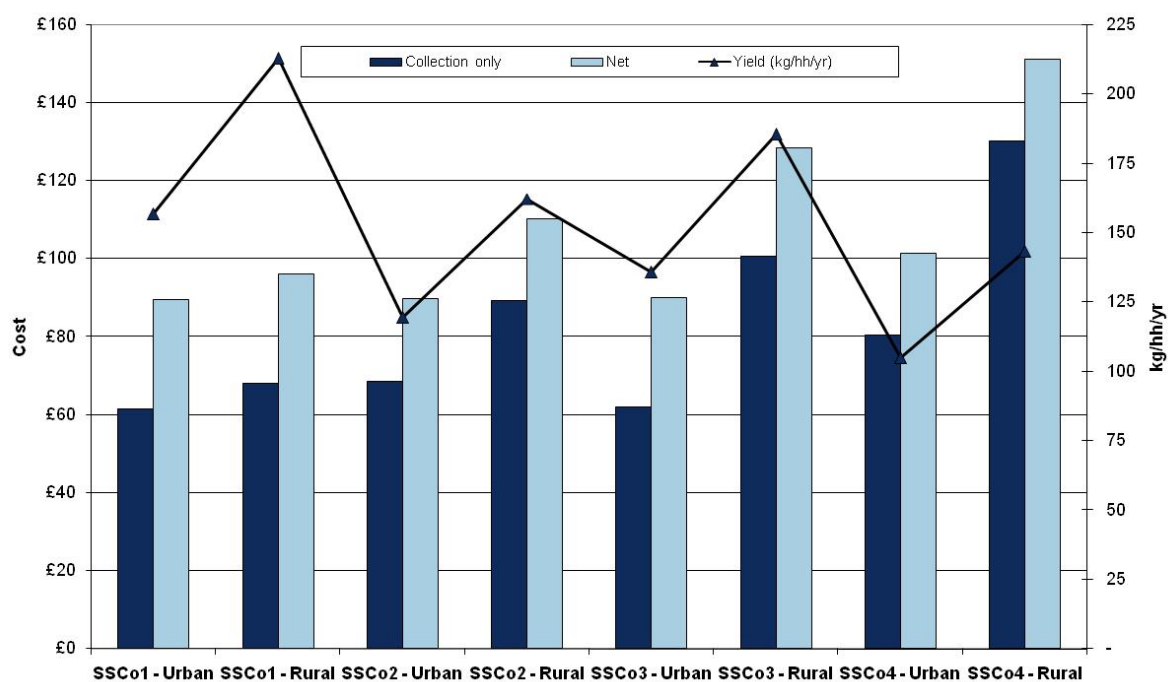
Table 5 Single Stream Co-mingled Recycling Systems Modelled – Costs and Yield Collected

Ref.	Refuse frequency	Recycling container	Recycling frequency	Materials Collected				Urban / Rural	Yield kg/hh/yr	Capture (%)	Collection only cost of recycling		Net cost collection of recycling+ sorting	
				Paper & Card	Glass	Tins	Plastic				£/hh/yr ¹²	£/tonne ¹³	£/hh/yr	£/tonne
SSCo1	Fortnightly	240 litre Wheeled Bin	Fortnightly	✓	✓	✓	✓	Urban	157	65%	11.35	61.55	17.02	92.35
								Rural	213	72%	15.22	68.00	22.12	98.80
SSCo2	Fortnightly	240 litre Wheeled Bin	Fortnightly	✓		✓	✓	Urban	119	64%	11.29	80.37	14.54	103.47
								Rural	162	71%	15.22	89.20	19.17	112.30
SSCo3	Weekly	Sack	Weekly	✓	✓	✓	✓	Urban	136	57%	9.91	62.00	14.83	92.80
								Rural	185	63%	19.62	100.50	25.63	131.30
SSCo4	Weekly	Sack	Weekly	✓		✓	✓	Urban	105	57%	9.91	80.29	12.76	103.39
								Rural	143	63%	19.61	130.05	23.09	153.15

¹² Cost per households served and not cost per participating household

¹³ Cost per tonne excluding contamination.

Figure 10 Collection only cost and net cost per tonne of recycling and yield



5.2.1 Comparison of Collection only costs and Net costs

The difference between the collection only cost and net cost per tonne for each option is due to the cost of sorting, assumed in the modelling to be reflected by the payment of a MRF gate fee. MRF gate fees vary across the country due to a number of factors including availability of capacity¹⁴. Based on the findings of a WRAP survey, *Gate Fees for Treatment and Disposal* which is soon to be published, the modelling assumed:

- a gate fee of £21/tonne without glass and £28/tonne with glass; and
- material revenues are accounted for in the gate fee.

The overall net cost of collecting and sorting single stream co-mingled materials is sensitive to the MRF gate fee. Whilst the impact of a higher or lower gate fee on the cost per tonne can easily be observed, the impact on the net cost per household may be less apparent. For the systems modelled, a variation in the gate fee of plus or minus £15 per tonne, has the effect of increasing or decreasing the net cost per household of between £1.75 and £3.50/yr.

In some cases revenue sharing mechanisms are in place so that the risk and reward of materials markets is shared between the council and the MRF provider. However, the benefits to any particular authority will depend on the contractual/income sharing arrangements in place. In some cases the benefits of materials income will be reflected in an adjusted gate fee.

5.2.2 Comparison of Rural and Urban Areas

Typical round sizes for a co-mingled collection using compaction vehicles with a capacity of 22m³ are between:

- 1,475 and 2,950 properties per day in an urban area. The large range takes account of both wheeled bin collections and sack collections – sacks take less time to collect than wheeled bins and hence more properties can be covered in a round¹⁵; and
- 1,025 and 1,350 properties per day on rural rounds.

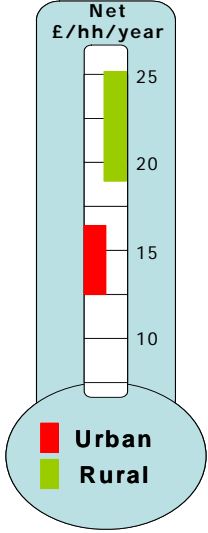
¹⁴ WRAP conducted a survey of gate fees for a range of waste treatment, processing and disposal facilities in late 2007. The MRF gate fees used in this study reflect the findings of this survey.

¹⁵ Property and household number rounded to nearest 25. The high round size for sack collections in particular is an output from the model which assumes optimised round sizes based on a 50% set out rate and also one person "pulling out" sacks ahead of the rest of the crew. It is recognised that in reality authorities would adjust their round sizes based on local knowledge.

Due to the higher modelled participation and recognition rates the yield per household in the rural area is approximately 36% higher than the same system operated in an urban setting.

In terms of net cost per household the range in the urban context is approximately £12.75 to £17.00 compared to £19.20 to £25.60 in the rural area.

The variance between the urban and rural costs is because there is a critical point, regardless of vehicle capacity, where the round size is limited by factors such as housing density and travel time. These factors are more significant within a rural environment.



5.2.3 Implications of collecting glass

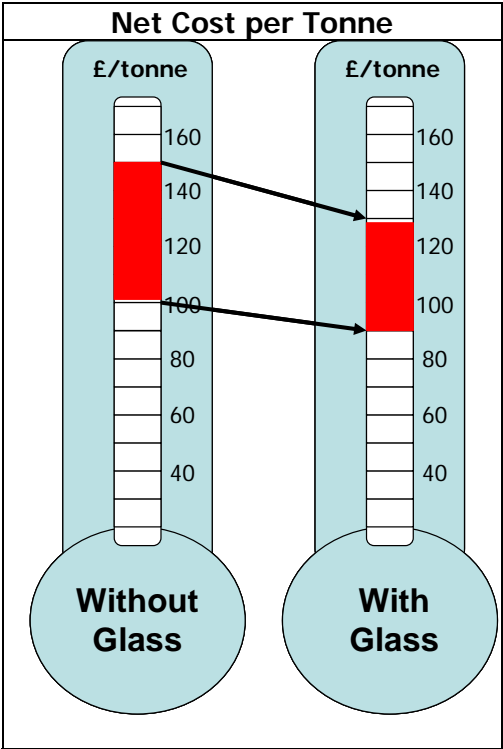
MRFs are designed to accept a specific range and mix of materials. Therefore the ability to add materials to a co-mingled collection, particularly glass, may be limited by the sorting capabilities of available MRFs.

With co-mingled systems, often the main difference between systems is whether or not glass is included. Currently UK MRFs accepting glass cannot sort glass to the quality standard required for remelt applications. At present, glass recovered at MRFs tends to go to lower value aggregates applications. WRAP has an on-going programme of work looking at improving the quality of materials recovered from MRFs, this includes glass.

The increase in yield resulting from collecting glass has the effect of reducing the net cost per tonne of targeted materials despite the fact that a higher MRF gate fee has been assumed. Collecting glass can increase the yields in a rural area by 42-51 kg/hh/yr and in urban areas by 31-37 kg/hh/yr depending on the residual waste collection frequency. This can result in a reduction in the net cost of collection of:

- around £11 per targeted tonne in urban areas; and
- between £14 and £22 per targeted tonne in rural areas.

The net cost per household is higher for the options that collect glass regardless of refuse and recycling collection frequency. When comparing the net costs per household served, these are higher for schemes collecting glass by around £2.50 per household/yr.



5.2.4 Impact of Contamination on Costs

Contamination (i.e. materials not targeted by the collection scheme) introduced by the householder can be a major issue in single stream co-mingled collections. The additional material being collected at the kerbside will increase running costs and displace space in the vehicle which could be taken up by recyclable materials. In addition gate fees will be paid on all the materials entering the MRF, i.e. material targeted by the scheme and any other non-targeted material (contamination) placed in the collection container by householders.

The combined effect of reduced vehicle carrying capacity and gate fee payments of a 10% contamination rate is to increase the net costs by the following amounts compared with a contamination rate of 1%:

- £1.80 to £2.80 per tonne in urban areas, and
- £1.90 to £2.60 per tonne in rural areas.

6.0 Two Stream Co-mingled Collections

Two stream partially co-mingled systems are where residents are required to separate materials into two categories, usually fibres (paper/ card) and containers (glass, cans and plastic bottles). Separate containers are provided for each category the contents of which are loaded into separate compartments on a twin compartment collection vehicle.

6.1 Overview

There are a smaller number of two stream partially co-mingled collection operations in England in comparison with the more common kerbside sorting and single stream co-mingled collections. They provide a viable compromise between kerbside sort and co-mingled systems addressing some of the primary concerns of co-mingled collections and kerbside sort operations, such as round size and retaining high material quality. This scheme type has been included, although the number of options is limited, as it is likely that it may become more common in coming years.

The systems in operation tend to collect a range of materials typically paper and card, glass, plastic bottles and mixed cans, and maintain material quality by keeping the two streams - fibres and containers - separate. Contamination in two stream collections is considered to be around 5% and this has been assumed in the modelling.

There are two main vehicle types used on two stream systems - '**Split Bodied RCV**' and '**Eurocycler**'. Some of the other vehicles available e.g. 'pod' vehicles are designed for different service profiles and not just for the collection of recyclables e.g. the co-collection of recyclables with other waste streams such as refuse or garden waste. For the purpose of modelling the use of a Split Bodied RCV has been assumed.

Split Body RCV - these are conventional RCVs with a split body i.e. the whole body is split vertically from the rear. The split varies depending on the materials targeted, usually a 50/50 split with fibres on one side and containers on the other. A 70/30 split can be used where fibres and only two container streams are collected.



6.2 Overall Results

The overall results are presented in Table 6 with Figure 11 showing the collection only costs and net costs per tonne against the yield collected.

In the modelling WRAP has assumed that material revenues from the sale of the separate fibre stream offset the MRF sorting costs and provide a net income to the service of £7 per tonne across all materials. This assumption is based on advice provided by waste management contractors and in line with supporting evidence from WRAP's soon to be published report on Gate Fees.

Figure 11 Two-stream partially co-mingled: net cost of recycling per tonne and yield

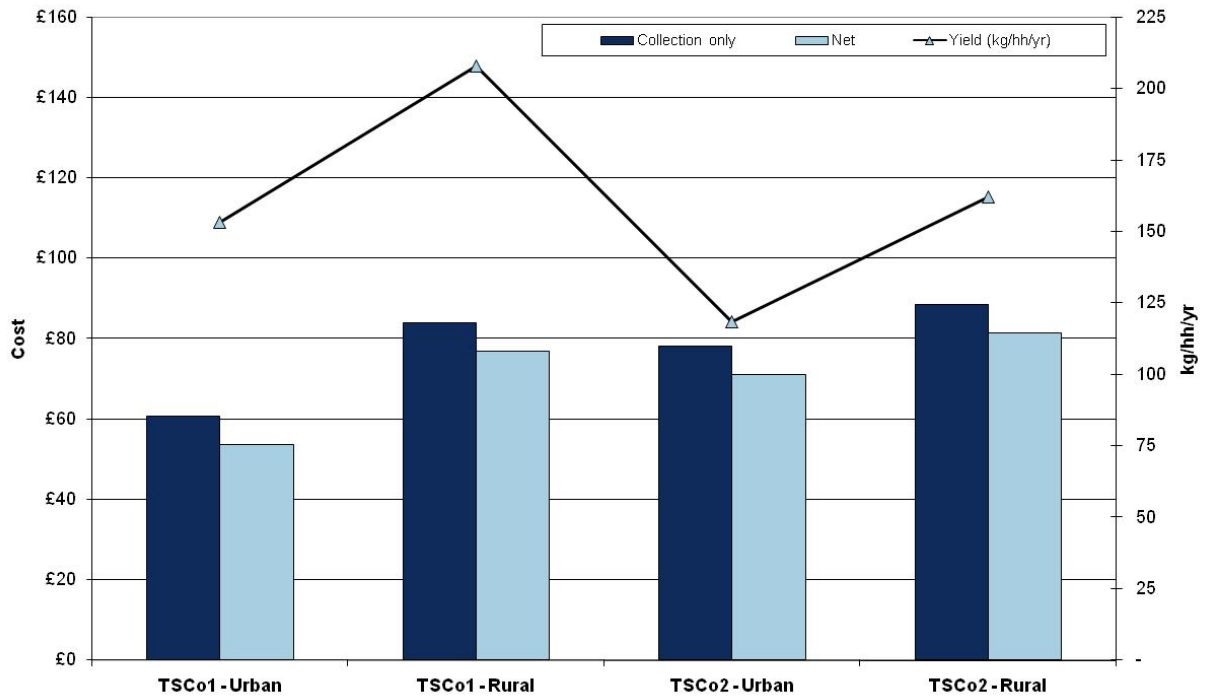


Table 6 Two Stream Co-mingled Recycling Systems Modelled – Costs and Yield

Ref.	Refuse frequency	Recycling container	Recycling frequency	Materials Collected				Urban / Rural	Yield kg/hh/yr	Capture %	Collection only cost of recycling		Net cost – collection of recycling + sorting	
				Paper & Card	Glass	Tins	Plastic				£/hh/yr ¹⁶	£/tonne ¹⁷	£/hh/yr	£/tonne
TSCo1	Fortnightly	2 boxes + 1 lid	Fortnightly	✓	✓	✓	✓	Urban	153	64%	10.95	60.77	9.68	53.77
								Rural	208	70%	18.34	83.84	16.81	76.84
TSCo2	Weekly	2 boxes + 1 lid	Fortnightly	✓	✓	✓	✓	Urban	118	49%	10.87	78.11	9.90	71.11
								Rural	162	55%	15.09	88.44	13.90	81.44

¹⁶ Cost per households served and not cost per participating household

¹⁷ Cost per tonne excluding contamination.

If a higher MRF gate fee is applied or higher revenues received, the net cost would increase or decrease accordingly. For example if an increase in income of £10 per tonne was obtained the net cost per tonne would decrease by £10 per tonne and the net cost per household would decrease by £1.80. This, of course, assumes that these variations can be applied directly to the service. This is an important point and relates to how contracts are structured and negotiated between local authorities and MRF service providers. Often such variations cannot be applied or applied only on annual reviews.

6.2.1 Comparison of Rural and Urban Areas

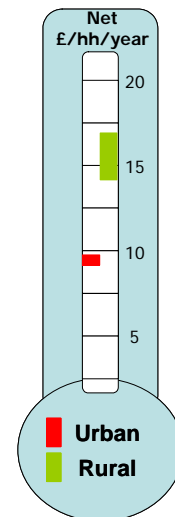
Typical round sizes for recycling collections are 1,475 properties per day¹⁸ for an urban area regardless of the refuse collection frequency, although the vehicle capacity is more effectively utilised when refuse collection is fortnightly. The refuse collection frequency does affect the round size when these systems are operated in a rural locality where they reduce to:

- 825 properties per day where a fortnightly refuse collection is operating; and
- 1,025 properties per day where a weekly refuse collection is operating.

The round size is smaller on rural rounds compared to urban rounds as a result of the higher yields achieved.

Due to the higher modelled participation and recognition rates the yield per household in the rural area is approximately 36% higher than the same system operated in the urban setting.

In terms of net cost per household per year the range in the urban area is £9.70 to £9.90 compared to £13.90 to £16.80 in the rural area for the options considered.

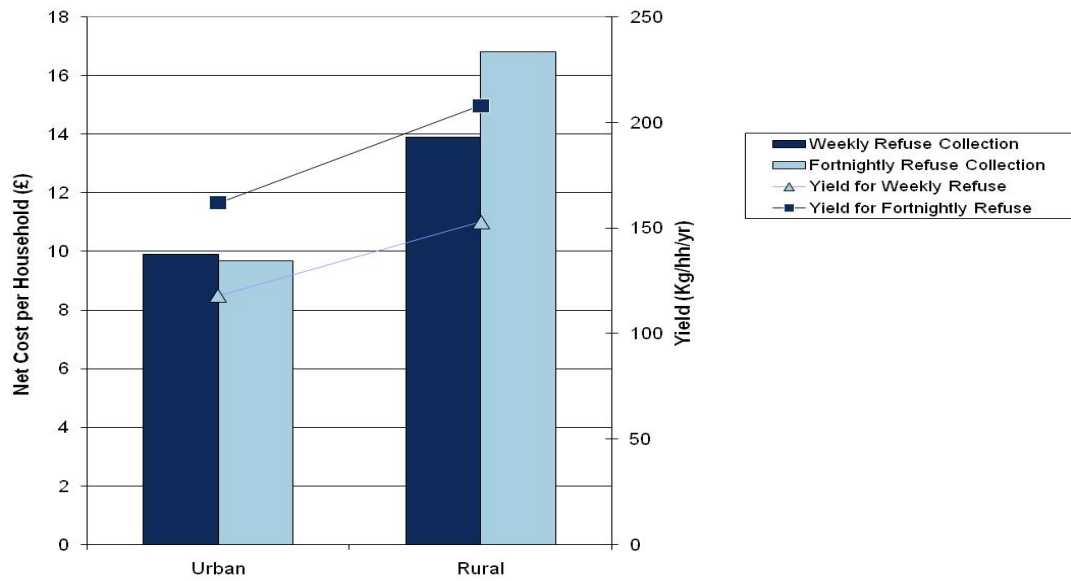


6.2.2 Impact of refuse collection frequency on recycling collection costs and yields

The impact of changing the frequency of refuse collection on the recycling collection costs per household is highlighted in Figure 12. Reduced refuse collection frequency has no real impact on the net cost in the urban authority because KAT calculates that no additional vehicle is required (5 recycling vehicles for each example) to collect the additional recycling tonnage. As for other examples modelled, it is assumed that restricting the capacity for residual waste will increase participation, capture and hence yield of recyclables per household. However in the rural authority, for the options modelled, there is an increase in the net cost per household of the recycling collection as a result of the higher yield collected per household. This requires an extra vehicle (5 vehicles for fortnightly recycling compared to 4 for weekly recycling), hence increasing the total cost. However it should be noted that refuse collection costs will reduce with fortnightly refuse collection resulting in the total service cost being lower compared to the total system cost if refuse is collected weekly.

¹⁸ Property and household number rounded to nearest 25

Figure 12 Impact of Refuse Collection Frequency on Net Cost of Recycling per Household



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