

# Realising the value of recovered glass



# Welcome to the recycled glass Market Situation Report, the first of a series of reports examining current economic conditions in the markets for recovered materials.

This report considers how the UK market for recovered glass (cullet) in the UK has been impacted over the past year or so by developments in the UK glass manufacturing sector, changes in collection trends, and changes in the prices of cullet and packaging recovery notes (PRNs). In addition, the report focuses on the challenges presented by the trend towards mixed colour collection and how these might be addressed.

Key themes to emerge from the glass recycling sector in 2006 are:

- growth in the UK's glass packaging recycling rate slowed;
- there was little change in the volume of cullet remelted for container manufacture despite higher production;
- prices for colour-separated cullet increased slightly;
- industry contacts suggest that shortages of high quality colour-separated cullet were growing;
- an increase in mixed colour collections probably contributed to this scarcity; and
- as a result, there is a need for the market to focus on ways to increase the quantity of high quality colour-separated cullet.

## Did you know?

33%

**Glass containers produced in the UK have an average recycled content of 33 per cent.**

365,000

**Glass recycling saved around 365,000 tonnes of CO<sub>2</sub> emissions in 2005, equivalent to taking more than 100,000 cars off the road.**

£

**Typical prices (as at end Dec 2006):**

**Clear cullet:**

**£27-£33 per tonne**

**Amber:**

**£24-£29 per tonne**

**Green:**

**£12-£18 per tonne**

**Mixed glass:**

**£10-£17 per tonne**

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**Paper Spring 2007**



**Plastic Summer 2007**



# Market analysis

## Recent developments in the UK glass manufacturing sector

The glass manufacturing industry has been faced with challenging economic conditions over the past year. Margins have been squeezed (Graph 1) as input costs have risen, while output prices have been constrained by competition from imports. As a result, a number of glassmaking facilities have closed and a number of jobs lost. One of the main factors impacting on margins is the price of gas, which accounts for around one quarter of glass manufacturing costs. Gas prices were both high and volatile in 2006, averaging around 50 pence per therm – 50 per cent more than in 2005. Gas prices fell below 30 pence per therm towards the end of 2006, but they are expected to rise again over the winter, as is the usual seasonal pattern.

Despite the challenging conditions, British Glass data suggest that container glass production grew by around 10 per cent in the year to September 2006. In part this reflects the operation of the new furnace at the Quinn factory in Cheshire, however other manufacturers have also reported growth in production. Production of amber glass, in particular, grew strongly partly due to the resurgent popularity of cider bottled in amber bottles. Flat glass and glass wool production have also grown over the past year, reflecting demand from the automotive and construction sectors respectively.

In 2006, production of amber glass grew strongly – partly due to the resurgent popularity of cider in amber bottles.



## Did you know?

# 1.31

1.31 million tonnes of container glass were recycled in 12 months to September 2006, compared with 1.26 million tonnes during 2005 and 1.05 million tonnes in 2004.

# +50%

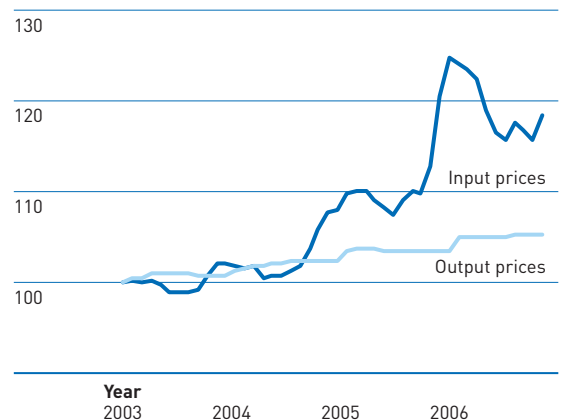
Over half of glass containers entering the waste stream in 2005 were recycled, compared with only one third in 2002.

# 750,000

750,000 tonnes of glass were remelted for container production in the UK in the past year.

**Graph 1: Glass manufacturing input and output prices**

January 2003=100



Source: ONS Producer Price Indices

## Background on the UK glass manufacturing sector

The UK's glass manufacturing sector produces around 3.3 million tonnes of glass per annum, and has an estimated turnover of around £1.8 billion (Table 1).

Almost two thirds of this – by volume – is container glass, in particular bottles and jars for the food and drinks industry. Around 7.5 billion containers were produced in 2005, over 60 per cent of which were clear containers. An additional 800,000 tonnes of glass containers are imported, primarily in the form of filled wine bottles.

Flat glass manufacturers produce about 750,000 tonnes of glass a year, of which almost three quarters goes into glazing products for buildings. Glass wool manufacture is estimated to be around 300,000 tonnes, more than two thirds of which is glass wool for insulation.

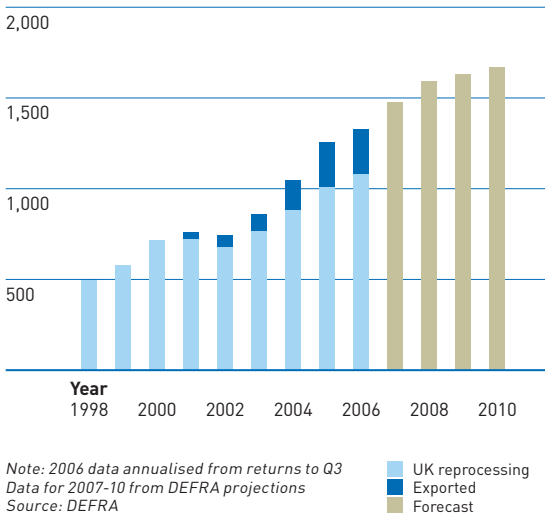
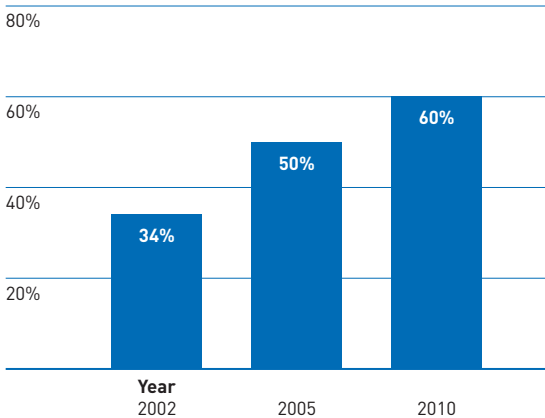
**Table 1: UK glass manufacturing industry**

Glass type	Volume thousand tonnes	Estimated turnover £ millions
Container glass	2,100	680
Flat glass	750	320
Glass wool	300	470
Other	150	380
<b>Total</b>	<b>3,300</b>	<b>1,850</b>

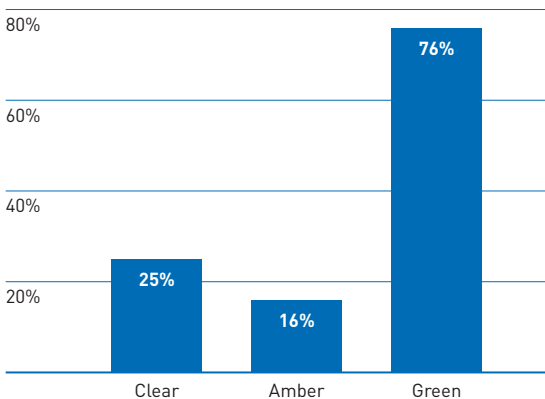
Note: Data are for 2005 or the most recent available data  
Sources: British Glass, ONS and WRAP estimates

**Graph 2: Glass packaging recovery and recycling**

thousand tonnes

**Graph 3: Glass packaging recycling rate**

Sources: DEFRA and NPWD

**Graph 4: Glass packaging recycled content**

Source: British Glass

**Glass recycling in the UK**

The vast majority of the glass recycled in the UK is container glass. Container glass recycling has more than doubled over the past five years (Graph 2), with the recycling rate reaching 50 per cent in 2005 compared with 34 per cent in 2002 (Graph 3). By comparison, German glass recycling rates were estimated to be over 90 per cent in 2004, and Europe as a whole averages over 60 per cent.

An estimated 1.3 million tonnes of container glass was recycled in the twelve months to September 2006, with the majority going into closed-loop recycling within the container manufacturing sector. However, the increase in the volume of glass recovered was relatively small compared with that seen in previous years. By 2010, 1.68 million tonnes of glass will need to be recycled in order to meet the EU packaging directive target, an increase of 420,000 tonnes from the 2005 level, and there is some concern within the industry as to whether the target can be met.

The most popular and environmentally beneficial way to recycle glass is to remelt it to produce more glass. Around 750,000 tonnes of recovered container glass was remelted for domestic container manufacture in the twelve months to September 2006, some 20,000 tonnes more than in the previous year. However, the increase partly reflected the rundown of stockpiles of cullet accumulated during 2005, and cullet consumption in Q3 2006 was about 30,000 tonnes lower than in Q3 2005. Market anecdote suggests that the recent decline in cullet consumption reflects a shortage of sufficiently high quality material.

The recycled content of UK-produced glass containers was slightly lower in 2006 than in 2005, reflecting these supply constraints. Clear containers currently have a recycled content of around 25 per cent, while green containers contain over 75 per cent cullet (Graph 4). This difference partly reflects the UK's colour imbalance: green glass accounts for only about 20 per cent of UK container production but almost half of cullet collected, because the UK tends to import (wine-filled) green bottles and export (spirits-filled) clear bottles. Moreover, green glass manufacture has a greater tolerance for colour impurity than either amber or clear glass, which makes it easier

to achieve a higher recycled content. In principle, green containers could contain up to 90 per cent cullet, while clear and amber containers could have up to 50 per cent.

Not all of the cullet recovered in the UK can be remelted for domestic container manufacture. Because of the high levels of imported wine bottles, green glass recovery sometimes outstrips domestic green furnace capacity. In addition, some of the cullet recovered does not meet the high quality standards required for remelt applications.

Almost 250,000 tonnes of high quality green cullet was exported for closed-loop recycling in continental Europe in the year to Q3 2006, about 20,000 tonnes more than in the previous year.

Both flat glass and container cullet are used in the manufacture of glass wool insulation. Total cullet consumption in the glass wool industry is estimated to have increased by 50 per cent over the past two years, to around 150,000 tonnes in 2005. Industry contacts indicate that container cullet is more economically attractive than flat glass, partly because of the PRN revenue than can be obtained. High quality mixed or green cullet can be used because colour composition is not critical.

The remainder of the container glass recycled – around 280,000 tonnes in 2005 – is used in alternative markets, largely as a coarse aggregate substitute in road construction or concrete manufacture. Other alternative markets include using crushed glass in sports turf applications, grit blasting, as a fluxing agent in brick manufacture or as a filtration medium.

Flat glass manufacturers are estimated to have used around 100,000 tonnes of flat glass cullet in 2005. Owing to the high quality requirements for flat glass, most of this was sourced from downstream processing plants, rather than post-consumer glass. Around 60,000 tonnes of post-consumer flat glass was remelted for container manufacture.

There is limited scope to use other types of glass – for example CRTs and lighting glass – in some of the alternative markets. However, the volumes recycled are relatively low, so this report does not consider them in further detail.

**Cullet and PRN prices**

Prices for clear and amber cullet are higher than those for green and mixed colour, owing to their relative scarcity and reflecting their value to the container

manufacturing sector. By contrast, prices for mixed and green cullet depend on demand from marginal users such as aggregates companies.

The price paid for a batch of cullet will depend on geography, volume and quality. Typical delivered prices are around £30 per tonne for clear cullet and £27, £15 and £13 per tonne for amber, green and mixed cullet respectively.

Prices for colour-separated cullet were slightly higher in 2006 than in 2005 (Graph 5). This probably reflected a combination of higher energy prices – which increase demand for cullet owing to the energy savings that can result from remelt – and anecdotal evidence of shortages of high quality, colour-separated glass that may have been exacerbated by the trend towards mixed colour collection. Looking forward, these factors should continue to provide support to clear and amber cullet prices.

Prices for green and mixed cullet are influenced by movements in packaging recovery note (PRN) prices because the cost-effectiveness of using cullet in alternative markets derives in part from the PRN revenue.<sup>1</sup> Although the price for high quality green cullet is likely to be supported by export demand, the outlook for mixed cullet prices is unclear given the increase in mixed colour collection.

Spot PRN prices have continued to be volatile in 2006 (Graph 6). In early 2006, prices rose to their highest level in more than three years reflecting the view that DEFRA's target for 2006 could be challenging. However, relatively few transactions occurred at these prices. PRN prices fell sharply in mid-2006 following the release of DEFRA statistics which implied that less recovery – and hence fewer PRNs – would be required to achieve the year's target. Prices picked up towards the end of the year as it became clear that growth in glass recovery had slowed.

A fall in PRN prices can lead to declining profitability in the glass reprocessing sector. It may also lessen the incentive for manufacturers to use recycle rather than virgin materials (assuming no change in their relative prices). In addition, a lower PRN price implies a fall in the marginal cost faced by packers, fillers and retailers of using additional packaging.

However, PRN price volatility only affects companies making transactions in the spot market and around three quarters of PRN purchases are made

under long-term contracts. In 2005, average contract PRN prices were lower than spot prices, though the reverse seems probable for 2006.

### Environmental benefits of glass recycling

Recycling glass for containers saves both energy and raw materials and as a result leads to lower CO<sub>2</sub> emissions. Remelting cullet uses 25 per cent less energy than making glass from raw materials and each tonne of cullet saves 1.2 tonnes of raw materials from being extracted. Exporting glass to Europe for remelt in the container industry and using cullet as a feedstock for glass wool insulation also have significant, albeit not as large, environmental benefits.

Remelting cullet into container glass in the UK saved around 250,000 tonnes of CO<sub>2</sub> emissions in 2005.<sup>2</sup> If export and glass wool are included, the savings rise to around 365,000 tonnes of CO<sub>2</sub>, equivalent to taking more than 100,000 cars off the road.

Alternative markets for recovered glass also yield environmental benefits. For example, using glass as a fluxing agent in brick manufacture offers energy savings of up to 20 per cent, while using a tonne of recycled glass as a filtration medium can reduce CO<sub>2</sub> emissions by 1200 kg per annum. There are limited CO<sub>2</sub> benefits to using recycled glass as an aggregate. However, the aggregates industry is able to reduce raw material extraction by using cullet otherwise destined for landfill.

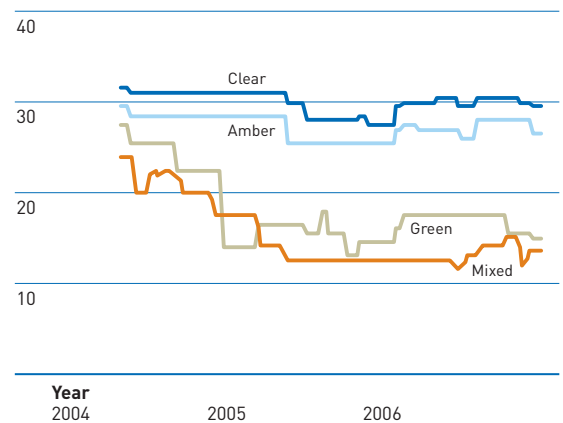
### The challenges ahead

A key challenge facing the glass industry is how to address the trend towards mixed colour collection, which now accounts for around half of the cullet recovered and is reportedly leaving some glass manufacturers facing shortages of high quality, colour-separated cullet.

Mixed cullet can be colour sorted if it is of sufficiently high quality and is not contaminated with organic matter. However, most existing sorting facilities in the UK separate only clear cullet and not amber cullet, although some three-colour sorting capacity became operational in 2006. The requirement for additional cullet is also being partly met through higher imports. In the first three quarters of 2006, 73,000 tonnes of cullet was imported – double the level in the same period of 2005.

Graph 5: Glass cullet prices

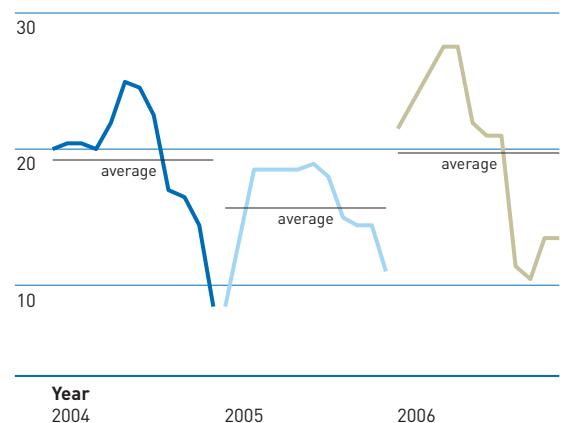
£ per tonne



Source: Materials Pricing Report, midpoints of range

Graph 6: Glass PRN prices

£ per tonne



Source: LetsRecycle.com



Glass cullet can be used in the production of bricks.

<sup>1</sup> For an overview of the PRN system see, for example, [www.letsrecycle.com/legislation/packaging\\_waste.jsp](http://www.letsrecycle.com/legislation/packaging_waste.jsp)

<sup>2</sup> Sources: Enviro (2003), 'Glass recycling – life cycle carbon dioxide emissions', published by British Glass, November 2003 and Carbon Trust (2005), 'Energy use in the glass container industry', [www.carbontrust.co.uk/energy](http://www.carbontrust.co.uk/energy). Some Life Cycle Assessments suggest that the CO<sub>2</sub> benefit may be higher.

# The trend towards mixed colour collection: A closer look

## Current situation

Collections of mixed colour glass have increased sharply over the past two years such that mixed glass now comprises almost half of all glass collected. The increase largely reflects the roll out of local authority kerbside collection schemes around the country, although commercial glass collections also tend to be colour-mixed. This trend presents a challenge to the container manufacturing sector which requires colour-separated cullet.

Although almost all local authorities now have kerbside dry recyclable collection schemes, only around two-thirds of them collect glass. Very few materials recovery facilities (MRFs) accept glass at present, which means that glass cannot be collected co-mingled, and collecting glass separately can be expensive. However, glass has been added to more kerbside schemes as pressure on local authorities to meet their recycling targets has intensified. Around 300 local authorities had kerbside glass collection schemes by mid-2006, compared with 84 in 2002. The number is expected to increase further over the next few years.

The volume of glass collected at kerbside matched that collected at bring sites for the first time in 2005/06 (Table 2). In England, kerbside collections of glass have more than doubled in the past two years, whereas bring site collections have fallen slightly (Table 3). Nevertheless, it is striking that bring collections have not fallen further, and that a substantial fraction of bring-site glass is collected by local authorities who also offer kerbside collections.

Valpak research<sup>3</sup> suggested that two-fifths of municipal glass collected in 2004/05 was mixed colour. Around half of kerbside glass was colour-mixed, compared with around a third of bring-site glass. However, DEFRA data and market anecdote suggest that local authorities are increasingly turning towards mixed colour collections, mainly because they are operationally cheaper than colour-separated collections. So it is likely that an even higher proportion of glass is now collected colour-mixed.



Almost half of the glass collected in 2005 was colour mixed, up from about two-fifths in 2002.

**Table 2: Glass recovered from the municipal waste stream (2005/06)**  
thousand tonnes

Region	Kerbside	Bring/CA sites	Other	Total
England	377	382	8	<b>768</b>
Scotland	36	37	1	<b>74</b>
Wales	25	17	5	<b>47</b>
Northern Ireland	4	10	0	<b>14</b>
<b>Total</b>	<b>442</b>	<b>446</b>	<b>15</b>	<b>903</b>

Note: Kerbside/bring split for Scotland is estimated  
Sources: WasteDataFlow and SEPA

## The challenge

In 2005/06, 1.26 million tonnes of container glass were recycled. By 2010, 1.68 million tonnes of glass will need to be recycled in order to meet DEFRA's packaging targets, an increase of over 400,000 tonnes from current levels. To achieve this, it is likely that around 1.3 million tonnes of container glass will need to be recovered from the municipal waste stream, compared with around 900,000 tonnes in 2005/06.

Given the environmental benefits of domestic remelt, it makes sense to maximise the amount of cullet used in container manufacture. British Glass research<sup>4</sup> suggests that the container industry currently has the capacity to absorb up to 1.2 million tonnes of cullet per annum. By 2010, it could conceivably use almost 1.5 million tonnes. The container sector could therefore absorb almost all of the additional clear and amber cullet collected by 2010, and perhaps an additional 100,000 tonnes of green cullet.

However, it is likely that the majority of the additional cullet recovered will be mixed glass. Even if there is no further trend towards mixed colour kerbside collection, an additional 200,000 tonnes of municipal mixed colour glass will probably be collected by 2010. If the trend continues, a significantly higher volume of municipal mixed glass may need to be processed. Additional glass collected from the commercial waste stream is also likely to be mixed colour.

The challenge therefore is how best to ensure that the additional cullet recovered can be colour separated to be suitable for remelt. There are two main ways in which this might be achieved:

- Promoting colour-separated collections; and
- Introducing further colour sorting capacity.

## Co-mingled, mixed colour and colour-separated collections

Bring sites offer high quality colour-separated cullet at a low collection cost. However, this comes at the expense of lower volumes. Capture rates for high-value, high-demand clear cullet in particular, are lower at bring sites than from kerbside collections. Although there might be scope to increase the density of bring sites, the increasing ubiquity of kerbside collections may make it difficult to increase collections from this route.

Anecdotal evidence suggests that the highest quality cullet from kerbside collections is obtained by collecting glass on a colour-separated basis. Glass collected colour-mixed in a separate compartment is, in turn, of higher quality than glass collected co-mingled with other recyclables. Higher quality glass can achieve higher revenues but collection costs will also be higher.

<sup>3</sup> Source: Valpak (2006), 'Opportunity for local colour separation facilities for glass containers', published by WRAP, April 2006.

<sup>4</sup> Source: British Glass (2006), 'Colourrite project – maximising cullet additions in the glass container industry', published by WRAP, February 2006.

**Table 3: Indicative tonnage of glass collected by English local authorities**

thousand tonnes

Collection	2003/04			2005/06		
	Colour-separated	Mixed colour	Total	Colour-separated	Mixed colour	Total
Kerbside	80	80	160	190	190	380
Bring	260	130	390	255	125	380
Commercial	0	10	10	0	10	10
<b>Total</b>	<b>340 (61%)</b>	<b>220 (39%)</b>	<b>560</b>	<b>445 (57%)</b>	<b>325 (42%)</b>	<b>770</b>

Note: Bring sites are assumed to be 25% mixed colour, kerbside schemes and commercial schemes are assumed to be 50% and 100% mixed respectively. The table assumes that these proportions hold in both periods (ie that existing collection schemes were not switched to mixed colour).

Sources: DEFRA and WRAP estimates

At present, less than 10 per cent of local authorities collect glass co-mingled with other dry recyclables, but this proportion is expected to grow as national recycling targets become more ambitious and the number of MRFs with capacity to process glass increases. A key issue with co-mingled collection is quality control. If the cullet is crushed too finely – either en route to the MRF or during the sorting process – contaminant removal (e.g. of glass-ceramics such as Pyrex) and colour sorting become very difficult. A further problem with co-mingled collections is resistance from paper manufacturers, as glass fragments can become embedded in the paper and damage paper-making machinery. It is important that the future generation of MRFs addresses these concerns.

#### Colour sorting facilities

Many of the major glass processors supplying the container manufacturing industry have already installed colour separation facilities. This technology allows processors to take mixed colour cullet and separate it into single colour streams.

At present, the UK has five operational colour sorting facilities. The fifth – a Recresco plant in Cheshire – became fully operational at the end of 2006. The combined capacity of these facilities is estimated to be 700,000 tonnes per annum, compared with around 500,000 tonnes per annum of mixed glass currently recovered from the municipal and commercial waste streams. This suggests that there is sufficient colour separating capacity at present, but that more is likely to be required by 2010.

Much of the existing colour-sorting capacity is designed to sort clear glass from the residual material (two-colour sort). As mixed colour collections increase, it will become more attractive for glass reprocessors to invest in more sophisticated three-colour sorting technology, so that valuable amber cullet can also be extracted.

The majority of the existing facilities are located close to container manufacturers in order to achieve the economies of scale required to make them commercially viable. However, a recent Valpak study concluded that there may be scope to add an additional colour sorting facility in the south east or south west of England. A facility located in an area that collects a high volume of mixed glass would be able to transport the more valuable colour-separated glass to container manufacturers, while the residue could be used in local alternative markets.

#### Relative costs

There are limited data on the relative costs of kerbside collections and colour separation facilities. However, the available evidence suggests that there is not a strong economic case in favour of either solution. The overall energy/carbon balance of the different systems has not been studied at all.

Colour sorting at a colour separation facility is estimated to cost around £12-£18 per input tonne. The capital costs of a 100,000 tonne facility are estimated to be around £3 million, while operating costs are around £10 per tonne.<sup>5</sup> This estimate has been corroborated by market sources.

The incremental costs of colour separating at the kerbside are thought to be broadly similar. ESYS (2006) estimated that colour separating at the kerbside could add 10 to 15 per cent to the operating costs of a collection scheme.<sup>6</sup> Taken in conjunction with British Glass (2002) estimates of the total cost of kerbside colour-sorted collection schemes,<sup>7</sup> this suggests that kerbside colour sorting could cost £14-£20 per tonne more than collecting mixed glass in a separate compartment. Co-mingled collections were estimated to be 10 to 20 per cent cheaper than collecting glass in a separate compartment, including MRF gate fees.

Experts from the glass industry have indicated that current colour sorting technology is capable of processing MRF-derived glass for remelt. However, they have noted that the financial and energy costs associated with this may be prohibitive, as the facility would be required to operate at a much slower throughput in order to achieve the necessary quality.

#### Conclusions

Around half of the glass recovered for recycling is mixed colour. It is likely that this proportion will increase further as national recycling targets become more demanding and glass is included in more kerbside schemes.

Mixed glass can be colour sorted by commercial facilities, so long as it has not been compacted. It is likely that additional three-colour sorting capacity will be required to sort the increased volume of mixed glass expected by 2010.

Quality considerations mean that separate collection of glass is preferable to co-mingled collection. Nevertheless, if, as seems likely, the momentum towards co-mingled collection continues, it is important that this is coupled with improvements in MRF technology.

<sup>5</sup> Valpak (2006), *op cit*.

<sup>6</sup> ESYS (2006), 'The costs and operational implications of kerbside glass collections', published by WRAP, March 2006.

<sup>7</sup> British Glass (2002), 'Kerbside collection of glass', published by WRAP, June 2002.

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Banbury, Oxon  
OX16 0AH

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Fax: 01295 819 911  
E-mail: [info@wrap.org.uk](mailto:info@wrap.org.uk)

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