
Assessment of the International Trading Markets for Recycled Container Glass and their Environmental Implications



A study examining the best environmental option for container cullet recovered from the UK waste stream set in the context of international trade in this material.

Front cover photograph: Container Vessel

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Elements of this Report

This report and associated materials represent the final deliverables from the above project.

The report comprises three main elements:

The main report for the project.

Appendix B contains the compiled 'country profiles' for potential export / import opportunities considered under this project.

An environmental model (associated Excel worksheet – 'Cullet End Use environmental model'). This model was developed to run the scenario's shown in Section 4.0 of the main report. It also provides a tool which allows policy makers and practitioners to determine the environmental benefit / impacts associated with the use of cullet in different end uses.

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- O-I
- Department for Transport
- WRAP (Waste & Resources Action Programme)

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Executive Summary

The study clearly demonstrates that the best environmental option for container cullet recovered from the UK waste stream is its return to domestic container glass manufacturers for remelting. Unfortunately, the colour imbalance which exists between the glass being recovered and that being produced currently limits the amount of cullet that can be directed into domestic remelt.

Despite this colour imbalance the UK has driven its glass recycling rates from 21% in 1997 to over 50% in 2005. The “problem” of excess green glass has been met by the development of alternative end applications and by export to foreign container manufacturers. Whilst these alternative uses and exports assist the UK in meeting its EU Packaging and Packaging Waste Directive obligations, their net environmental effect was unclear and subject to some debate.

To address this information gap, the objective of this study is to provide stakeholders with a better understanding of the opportunities and risks associated with international trading markets for recycled glass and the environmental impact that the import/export market is having relative to use of cullet in the UK.

The study has three component parts:

- A forecast of the UK cullet market in 2008, 2010 and 2015.
- The identification of opportunities for international trade in cullet. Focus is placed on the export of green and the import of flint and amber cullet.
- The development of a model to evaluate the environmental benefits of three alternative end markets for cullet, namely:
 - Domestic remelt (UK container manufacture)
 - Foreign remelt (export of UK cullet to overseas container manufacturers)
 - Domestic aggregates

The study primarily focuses on the environmental costs and benefits of cullet use in these markets. Analysis and discussion of the commercial dimension of these markets is limited as, in comparison to the relatively fixed environmental measures, financial markets can be extremely variable with time and also subject to commercial deals and relationships.

A significant sensitivity affecting the findings of the study is the validity of previous work used to underpin the environmental model. A primary source in this respect was the 2003 Enviro report examining glass recycling life cycle carbon dioxide emissions¹. Whilst now 4 years old, it is believed that this work remains a sound basis for the current analysis, and the findings of this study are not materially affected.

It should be noted that multiple loop recycling of cullet for container manufacture is not captured in the environmental model.

Previous work¹ suggests that glass mineral wool (fibreglass) insulation has a similar carbon saving performance to remelt within the glass container process. A more detailed study would be needed to ascertain the actual carbon benefits from using cullet in these two markets, which is beyond the scope of this work.

The key findings from the current study are:

- CO₂ savings provide the most appropriate measure for comparison of the environmental benefits of the three chosen end applications. Table 1 shows the comparison between the three end applications based on the projected cullet recovery in the years 2008, 2010 and 2015. It also provides information relevant to policy makers on the climate change implications of each market.

Table 1. Potential Annual CO₂ Savings

¹ *Glass recycling – life cycle carbon dioxide emissions. A life cycle analysis report. Prepared for British Glass by Enviro. November 2003*

End application	Potential annual CO ₂ savings (tonnes)		
	2008	2010	2015
Domestic container remelt	481,000	510,000	695,000
Foreign container remelt	466,000	494,000	673,000
Domestic aggregates	0	0	0

The data demonstrate that transport emissions do not have a significant impact on the overall level of emissions savings attributable to use of cullet in glass manufacture. It is also evident that cullet going back into remelt, at home or abroad, has a significantly reduced carbon impact than using it in domestic aggregate manufacture. In terms of CO₂ savings, domestic remelt is the best option, with short haul foreign remelt, being a close second. Multi-loop recycling would further favour remelt applications, and as indicated above, this is currently most prevalent in container manufacture.

■ Several factors constrain the greater uptake of the preferred domestic container remelt route for cullet. The principal factor is the colour imbalance but other influences include:

- The quality of the cullet being produced from MRFs falling short of that required for use in remelt, container glass in particular. This represents a CO₂ saving opportunity loss, as such material is currently suitable only for less environmentally beneficial end uses such as aggregates.
- The lack of economic incentives to produce good quality cullet fit for container remelt.
- Simplistic weight based recycling targets being the basis of legislative drivers.

■ Meeting the recovery targets in 2008 will divert approximately 1.6 million tonnes of waste glass from landfill with a consequent saving of 1.8 million tonnes of virgin material, essentially irrespective of which end use is considered – container remelt, fibre remelt, or aggregates use. That is, landfill diversion and raw material savings are not key environmental differentiators between the different end uses.

■ Spain, Portugal, Italy and France represent the key opportunities for green cullet export at the current time and with the current market structures. However, some key markets, such as Spain, may be relatively short lived due to anticipated improvements in domestic recovery leading to self-sufficiency in green cullet. More distant export markets within Europe (e.g. Turkey) and the wider world (e.g. South Africa) exist and exports to these markets are a positive environmental option but are currently precluded on the basis of cost.

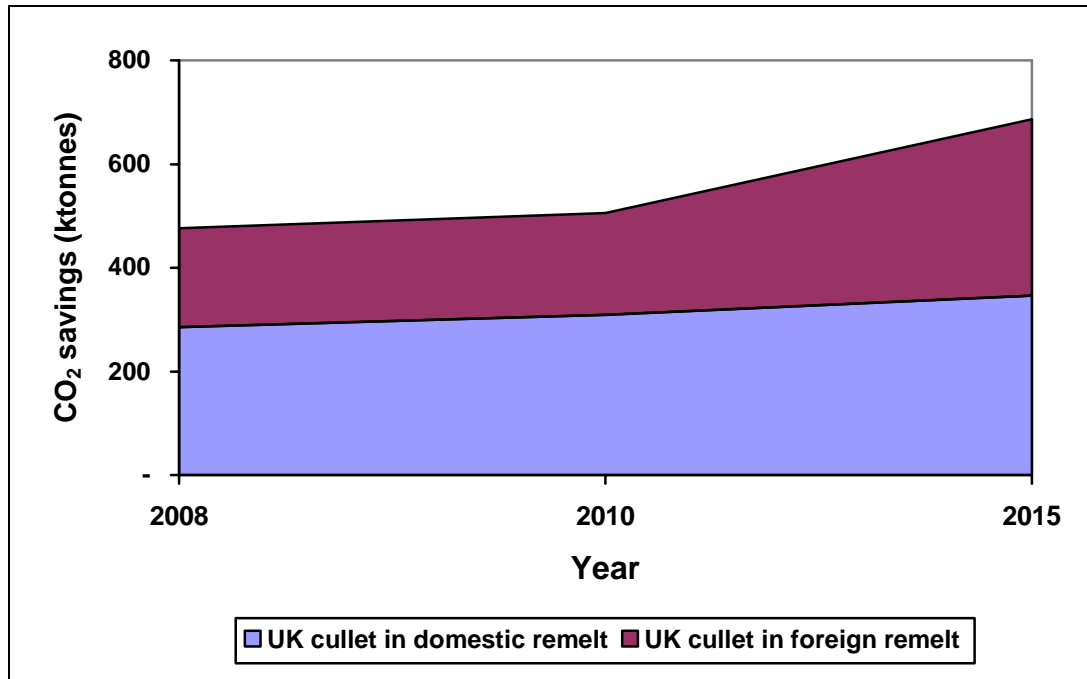
■ UK imports of flint and amber cullet have a positive environmental benefit as detailed in Table 2. Denmark, Ireland, France, the Netherlands and Sweden have been identified as the best import opportunities.

Table 2. Potential CO₂ Savings of Importing Cullet to fill the UK's Flint and Amber Shortfalls

Item	2008	2010	2015
Total imported cullet (tonnes)	479,000	508,000	485,000
Total CO ₂ savings (tonnes)	136,570	144,840	138,280
Total virgin material savings (tonnes)	550,850	584,200	557,750
Total material diverted from landfill (tonnes)	459,840	487,680	465,600

Assuming that the projected tonnages are sent for domestic container remelt and that surplus UK cullet is sent to foreign glass container manufacture, annual CO₂ benefits will exceed 475,000 tonnes in 2008 rising to over 680,000 tonnes by 2015. The growing importance of this export market is demonstrated in Figure 1.

Figure 1 Potential CO₂ Savings Assuming all UK Surplus to Foreign Re-Melt



In summary, this study has identified international trade opportunities for cullet for use in container remelt, principally in near Europe, and has demonstrated that recycling of container cullet back to furnace remains the best environmental option by a considerable margin, even when significant shipping distances are involved.

The availability of international trade opportunities represents a significant opportunity for the UK to reduce its CO₂ emissions and, at the same time, address the 'green imbalance'.

However, there is currently no UK policy, regulatory, economic or practical incentive for choosing the most environmentally favourable end applications and hence this opportunity is likely to be underexploited. To address this lost opportunity, UK policy should be reviewed such that it differentiates between different end uses for cullet on environmental grounds, and supports those most favourable uses i.e. domestic and foreign container or fibreglass remelt. Unless and until decision makers are better informed and incentivised the full benefits of cullet recycling will not be realised.

Recognising the above, the following recommendations are made:

- Policy tools which promote the most environmentally beneficial use of cullet should be developed, possibly including:
 - differential PRN value for different end uses dependent on their environmental benefit.
 - colour specific PRNs / recovery targets wherein PRNs are only issued for colour segregated or sorted cullet.
 - disqualification of low quality materials from MRF's and similar facilities from counting toward the achievement of local authority recycling targets.
- Further exploration of possible international trade opportunities identified under the study at a more detailed commercial level, possibly looking at policy tools to support trade with more distant destinations.
- Engagement of local authorities and policy makers in the use of the environmental model to assist in their decision making process.
- Development of a working group involving waste generators, collectors and processors to explore the barriers to using cullet from MRFs in high end applications, possibly including the development of a specification for the minimum pre-processing cullet quality suitable for processing into a form suitable for container and/or fibre re-melt applications and an associated MRF technology specification to meet this standard.
- Collation and maintenance of information on UK MRF output to inform future studies.
- Development of a robust methodology for assessment of the multiple loop benefits of closed loop recycling of cullet to container manufacture.

- Raise awareness of the opportunity which the fibreglass insulation market represents for mixed colour or green container glass.

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1.0 Background

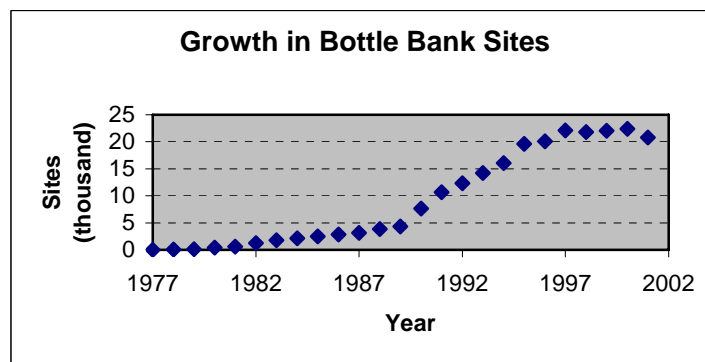
The commercial collection of glass, intended for recycling back to the manufacturers of bottles and jars (containers), began when the first bottle banks were introduced in Barnsley in 1977. The driving force and main beneficiaries of this recycling initiative were the glass container companies. The recovered glass (cullet) provided a cheap raw material that also gave significant savings in furnace melting energy.

The bottle bank system was steadily expanded to cover most of the UK. The 1,000th bottle bank site was commissioned in 1982. Whilst at this time there was no legal obligation to achieve recycling targets, the UK government, ever mindful of the growing call from the European legislators to improve environmental performance, actively encouraged the recycling effort.

In 1986 the British Glass Industry made a firm commitment to the British government that it would double the number of existing sites and reach a total of 5,000 by the year 1991; a target that was actually achieved in 1990. The bottle bank scheme was then expanded rapidly until by the year 1997 a total of 22,074 sites were in operation. Since that time the rate of expansion has ceased and the latest returns show an actual fall in the number of established sites.

At the beginning of 2002, some 20,796 bottle bank sites were established throughout England, Scotland, and Wales. Glass collection from these banks totalled 736,000 tonnes, equivalent to a recycling rate of 34% (of container manufacture).

Figure 2. The Establishment of Bottle Bank Sites 1977 – 2002



The growing political importance of environmental issues during the 1990's led to the introduction of several pieces of legislation which had and continue to have a profound influence on the level of recycling. The principal legislative drivers include:

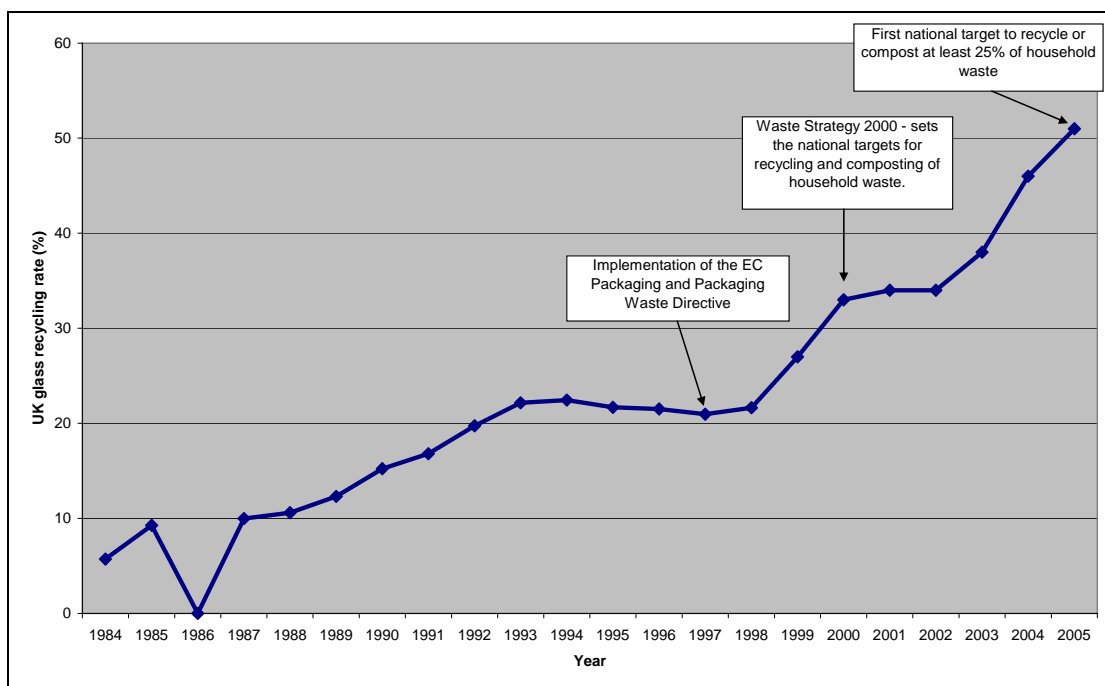
- The EC Packaging and Packaging Waste Directive (91/62/EC). The Directive was implemented in the UK through the Producer Responsibility Obligations (Packaging Waste) Regulations which came into force in the UK in March 1997. The next major target for the UK is to recycle at least 60% of glass packaging by 2008.
- The Waste Strategy 2000 set national targets to recycle at least 25% of household waste (by weight) by 2005, 30% by 2010 and 33% by 2015. The statutory recycling targets for local authorities have been implemented to meet these national targets.

Secondary legislative drivers include:

- The Landfill Tax Regulations 1996, No 1527. An environmental tax aimed at diverting waste from landfill and up the waste hierarchy.
- The Climate Change Levy, April 2001. An energy tax intended to encourage energy efficiency measures. This encourages the glass manufacturers to use cullet since it melts at a lower temperature than virgin materials and hence uses less energy.
- The Household Waste and Recycling Act 2003. This requires all local authorities in England to collect at least 2 types of recyclables by 31 December 2010.

The target-driven legislation for recycling is undoubtedly having the desired effect of increasing the total glass collected and the UK's glass recycling rate has grown from a modest 21% in 1997 to over 50% in 2005. Details of the improvements in the UK's glass recycling efforts are given in Figure 3.

Figure 3. Recovery and reuse of cullet in the UK 1984 - 2005²



The UK currently has the capacity to process approximately 3.5 million tonnes of municipal waste in around 95 materials recycling facilities (MRF's) and sorting operations, 25 of which can process over 50,000 tonnes per year.

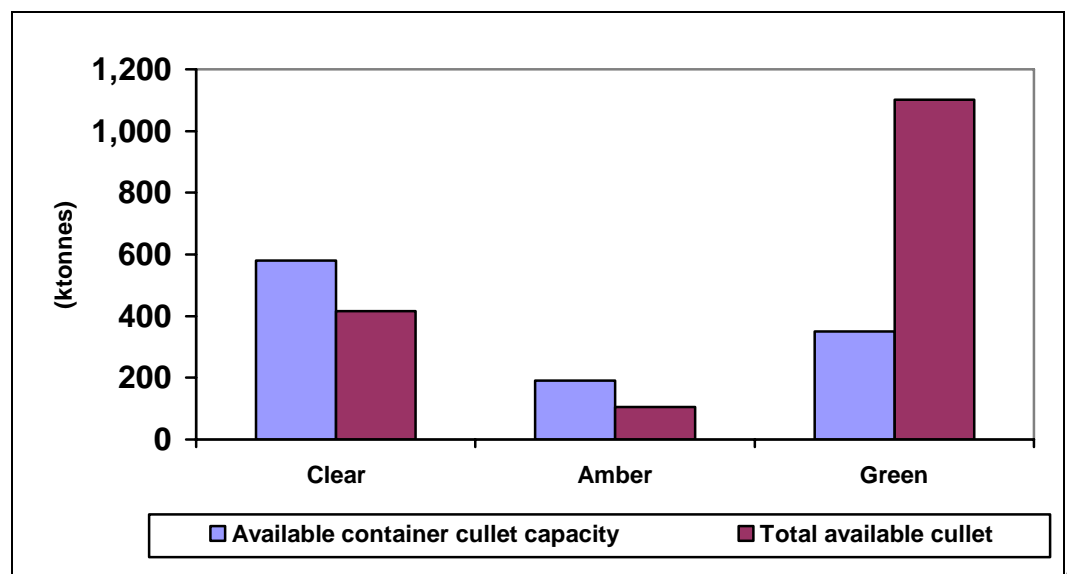
Traditionally, when less glass was recovered, it was simply returned to the container manufacturers for remelting. The cullet was generally colour separated and had low levels of contamination for which the glass manufacturers were willing to pay a reasonable price.

Unfortunately for the glass manufacturers increases in the recycling rate have been achieved by kerbside collection schemes which tend not to colour sort the glass. This trend toward mixed collection is understood to result from mixed collection being economically and logistically favourable for the responsible local authorities, whilst still meeting their recovery obligations. Mixed colour glass is only suitable for green glass manufacture: the domestic demand for which is limited. Similarly the growth in large MRF's also tends to encourage the trend to switch from colour separated glass to mixed collection. Modern MRF technology can achieve reasonably good separation efficiencies for glass, but the recovered material typically retains some extraneous materials and does not currently meet the stringent quality standards required by the glass manufacturing industry. At present the proportion of glass collected co-mingled with other waste for subsequent sorting at these MRF's is small.

Figure 4 shows the projected colour imbalance in 2008 with container cullet capacity remaining for clear and amber cullet but the availability of green cullet being three times greater than the demand from the UK container industry.

² Recovery and Reuse of glass cullet, 1984 – 2004. Defra. 8 Feb 2006. 2005 figure from British Glass.

Figure 4. Comparison of supply and demand for cullet within the UK container manufacturers ³



A direct consequence of this imbalance has been a move within the UK to develop alternative markets for the excess green and mixed coloured glass and to explore the potential for exporting the UK surplus to neighbouring countries

WRAP (Waste and Resource Action Programme) has been instrumental in developing alternative end markets to address this imbalance and the markets for cullet now include:

- Containers
- Fibre glass
- Aggregates
- Water filtration
- Abrasives
- Fluxing agent for bricks and ceramics
- Art/craft
- Export (for container manufacture)

As environmental awareness improves so more focus is being placed on the relative merits of the final uses for recovered glass. Increased emphasis is now being placed on resource efficiency with the carbon budget being at the forefront of measures as a result of the Kyoto Protocol and similar initiatives. As a consequence, rather than all the end markets for cullet being regarded as equivalent, the environmental benefits of each end application are being measured, compared and ranked in order of their environmental credentials.

This WRAP funded study has thus been commissioned to review three of these end markets, namely:

- UK container manufacture (UK remelt)
- UK aggregates production
- Export for foreign container manufacture

The main focus of the study is placed on the export market for cullet since little information is available regarding the extent of market opportunities or the net environmental benefits of exporting cullet. The proximity principle is often cited as a reason not to export cullet and the study will challenge this assertion.

Subsequent sections of this report will seek to estimate the amount of cullet that will be available for domestic remelting and for exports and/or alternative uses, based on the following forecasts:

³ *Maximising cullet additions in the glass container industry. Produced by British Glass for WRAP, 28th February 2006.*

UK melting capacities and the potential to utilise cullet supplies

The assumption that the mandatory recycling targets will be met

Forecasts of the glass waste stream and the quantities of cullet arising from the various collection sources.

1.1 Project Objectives

In the context of the preceding background this study sets out:

- To project the business as usual trends in UK end markets for cullet and collection methods in 2008, 2010 and 2015
- To identify and assess significant opportunities for international trade in cullet, primarily;
 - The export of green cullet from the UK, i.e. to countries with a demand for green cullet
 - The import of flint and amber to the UK, i.e. from countries with a surplus of flint and amber cullet.
- To develop an environmental model to evaluate the environmental merits of exploiting the international trade opportunities, including a comparison with domestic end applications, namely for use in;
 - Domestic glass container manufacture
 - Domestic aggregates manufacture
- To use the model to evaluate the environmental impacts associated with a number of possible market scenarios.

1.2 Terms of reference

The modelling under this study cannot be regarded as a Life Cycle Analysis (LCA) in its own right. Instead it will draw on existing literature, LCA studies and industry evidence to quantify the net environmental benefits of different end use applications.

The study will focus on 3 environmental measures;

- CO₂e balance⁴
- Diversion from landfill
- Savings in virgin raw materials (primary materials)

In the context of the report the export market will refer to material processed in the UK and exported to foreign container manufacturers. This is based on the feedback from the cullet processors that the majority of material currently exported follows this route. However, in the minority cases where material is exported in its raw state the environmental model can still be used to generate an estimate of net environmental effect.

Focus within the study is limited to 3 key applications;

- UK container manufacture (UK remelt)
- UK aggregates production
- Export for foreign container manufacture

Modelling will focus predominantly on the net environmental effect of recovering cullet through the three end applications.

2.0 UK Market Projections to 2015

⁴ CO₂e is an abbreviation of 'carbon dioxide equivalent' and is the internationally recognised measure of greenhouse emissions allowing simple comparison of the greenhouse impact of a variety of greenhouse emissions sources. There are many types of greenhouse gases, including the six gases controlled by the Kyoto protocol; carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), perfluorocarbons (PFC), hydrofluorocarbons (HFC) and sulphur hexafluoride (SF₆). Each of these gases has a different capacity to heat the atmosphere, referred to as their global warming potential (GWP). CO₂ has been assigned a GWP = 1, and for example the GWP of methane is GWP = 21. When greenhouse emissions are reported they are normally given as equivalent to a given volume of CO₂ - that is 'CO₂e'. e.g. 100 tonnes of methane is equivalent to 2,100 tonnes CO₂e. Using CO₂e as a measure of greenhouse emissions allows for comparing the greenhouse impact of a variety of greenhouse emissions sources. (Ref. http://www.soe-townsville.org/sml_windows/co2e.html)

2.1 The Supply of Cullet

2.1.1 The UK Waste Stream

Concern over the forecast growth of the UK's waste stream has led to urgent action to curb the growth. The efforts of WRAP and other agencies have instigated some projects, notably through lightweighting of glass containers, that will in themselves reduce packaging, but of more importance they have been successful in raising the waste issue up the political agenda. It is anticipated that these efforts will now have a significant effect on both the amount of waste entering the waste stream and that being recovered and recycled from it.

However, our currently used forecasts to 2015 still predict a continued rise in the amount of glass present in the waste stream. Data given below (Table 3) uses the DEFRA targets arising from the Producer Responsibility Obligations (Packaging Waste) Regulations 1997 and predicted packaging glass waste streams to 2010. This data has been combined with the glass industry's growth forecast to 2015 and a forecast for the amount of glass in the waste stream in 2015 has been produced. It is also anticipated that the EU imposed recycling target will be progressively increased.

Table 3. Packaging waste stream forecasts

UK Glass Packaging Waste Stream Forecasts			
Year	Total (million tonnes)	Target (%)	Target (million tonnes)
2008	2.7	60.5	1.6
2010	2.8	61.5	1.7
2015	3.5	66.0	2.3

2.1.2 Colour Sorted Glass

Colour sorted glass is principally collected by the traditional "bottle bank" system and also by a few kerbside schemes. The bottle bank system is however in decline as councils switch for operational reasons to kerbside collections which are increasingly offering only a colour-mixed service. Table 4 details the predicted collections of colour-sorted glass from bottle banks and colour-sorted kerbside schemes to 2015. The total glass collected from these sources is expected to decline by approximately 2% per year and the proportion of green glass will slightly increase as wine sales continue to outpace other foodstuffs. It is assumed that all this glass will go to the glass manufacturers for remelt who will pay a premium price for glass having good colour separation and low levels of contamination.

Table 4. UK Colour-Sorted Glass Collections to 2015

UK Colour-Sorted Glass				
Year	Flint (k tonnes)	Amber (k tonnes)	Green (k tonnes)	Total (k tonnes)
2008	183	48	224	455
2010	174	42	210	426
2015	150	35	200	385

2.1.3 Mixed-Colour Glass

Mixed colour glass is the usual product of municipal kerbside collections and from MRF's, although the quality of the latter often precludes any remelting option. Local authorities are increasingly turning to mixed-colour collection which they perceive as a cost effective option to meet their obligations under the Household Waste Act 2003.

As the container manufacturers' demand for glass is not satisfied by that arising from the colour sorted sources, the cullet processors augment the supply by colour sorting the mixed-colour glass. This mixed glass is predominantly green whilst the demand is for clear glass. Colour sorting the mixed glass thus rapidly satisfies the glass manufacturers' limited appetite for green glass but produces relatively small amounts of the desired flint glass.

For the purposes of this study it is assumed that the requirements of the container sector will determine the volume of recycled glass and that the processors will colour sort sufficient glass to meet the national packaging recycling targets. This will not be adequate to meet the container sector's demand for flint and amber glass but will produce a large surplus of green/mixed cullet that will be available for alternative uses or export.

Details of the predicted quantities of mixed-colour glass and the colour split after sorting are given in Table 5. It has been assumed that by 2015 the colour separation efficiency of the process will increase to allow a greater yield of flint glass. This is however somewhat tempered by the fact that by 2015 green glass would comprise slightly more of the waste stream. Further information on cullet collection and colour sorting is given in sections 4.1 and 4.2.3.

Table 5. Product of Mixed Glass after colour Sorting

Glass Produced from UK Colour-Mixed Glass				
Year	Flint	Amber	Green/Mixed	Total
	(k tonnes)	(k tonnes)	(k tonnes)	(k tonnes)
2008	180	83	916	1179
2010	208	92	1008	1308
2015	346	139	1494	1979

2.2 The Demand for Cullet

2.2.1 The UK Container Industry

Container manufacture represents the largest sector of the UK glass manufacturing industry. It is predicted that by 2008 the sector will be producing 2.4 million tonnes of product rising to over 3 million tonnes by 2015. The great majority of this glass finds use as packaging material for the food and drinks industries and much is exported, most significantly by the spirits producers. Large quantities of container glass are also imported into the UK as packaging for imported foodstuffs and drinks; in this instance imported wines being the most significant product. The outflow of flint glass for spirits coupled with the inflow of green glass for the wine trade produces a marked imbalance in the UK's waste stream which now contains more green glass than its domestic industry can process. Efforts to address this problem are in hand, notably the WRAP sponsored initiative to encourage bulk wine imports, and some improvement in this situation is foreseen as increases in bulk imports of wine and beer create a higher demand for domestically produced green glass.

Table 6 gives details of the anticipated size and colour profile of the UK container industry to 2015 and is based upon the forecasts made by the industry in response to various environmental requirements

Table 6. Forecast UK Container Production to 2015

UK Container Glass Production (million tonnes)				
Year	Flint	Amber	Green	Total
2008	1.53	0.41	0.52	2.46
2010	1.62	0.43	0.59	2.64
2015	1.83	0.46	0.76	3.05

As previously indicated the UK container industry is the principal user of processed cullet which it requires in a colour separated format. The container industry will continue to pay relatively high prices for good quality cullet and will be considered as the best outlet by the processor. The industry, in its returns to the climate change agreements, is predicting just over 3 million tonnes by the year 2015. The glass could in theory contain over 90% recycled content which would create a cullet demand of 2.7 million tonnes. In practice quality and colour issues limit cullet additions and the demand for cullet from container manufacturers is predicted to be 1.8 million tonnes by the year 2015. A forecast of the maximum demand by the container industry is given in Table 7.

Table 7. Maximum Cullet Demand by UK Container Industry

Maximum Cullet Demand – Container Industry (million tonnes)				
Year	Flint	Amber	Green	Total
2008	0.77	0.21	0.47	1.44
2010	0.81	0.21	0.53	1.55
2015	0.92	0.23	0.68	1.83

2.2.2 The Insulating Glass Fibre Sector

The UK insulation sector comprises 4 companies operating 6 plants as detailed below:

Table 8. UK Insulating Fibre Manufacturers

Company	Site	Product
Knauf Insulation	St Helens	Glasswool
	Queensferry	Rockwool
	Cwmbran	Glasswool
British Gypsum – Isover		Glasswool
Rockwool	Pencoed,	Rockwool
Superglass	Stirling	Glasswool

The Rockwool process melts basalt, other igneous rocks and some blast furnace slags to produce insulating material. No recycled glass is currently used in the process. However, the addition of glass to the process is considered technically feasible and it is postulated that such an addition could be accompanied by process changes which would result in significant energy savings. It is not however anticipated that these developments will come to fruition within the forecast timescale of this study and for the purposes of this report have been discounted.

The Glasswool process essentially melts a mixture of simple glass making minerals: sand, soda ash, limestone and some borates, again to produce an insulating material. Whilst glasswool is not chemically identical to common bottle and window glasses, the manufacturing process is able to accommodate relatively large proportions of these materials. Using recycled glass in the fibre process brings the same environmental benefits as in the container sector namely, fewer virgin raw materials required, less CO₂ produced and less energy needed to fuel the furnaces. Historically the fibre manufacturers have used plate cullet but, as colour is not an issue, the fibre manufacture, are well placed to recycle large quantities of less expensive mixed-colour container glass. A direct price comparison between the use of plate cullet and mixed container cullet is difficult as different quality standards apply and the use of container glass would generate PRN revenue. However, the move from plate to mixed colour container cullet should result in batch cost savings of at least £10 per tonne of cullet.

The principal disadvantage of cullet use is the level of contamination. Pieces of crockery and other ceramic material that are often found in recycled glass can cause significant disruption to the fibre manufacturing process. Pulverising the glass can significantly reduce the damaging effects of ceramic contamination as the smaller particle size are more readily assimilated into the melt or are even tiny enough to pass through the spinners. The pulverising process does however add cost and brings a small energy penalty.

Traditionally fibre plants have opted to use window glass recovered from glaziers, as this tends to have lower contamination levels than that found in glass originating from bottles and jars. The fibre sectors preference for flat glass cullet is likely to continue but increasingly the flat glass manufacturers will compete for this limited resource of high quality product. It is thus anticipated that the fibre producers will increasingly turn to container glass cullet although additional flat glass will become available as schemes to recover glass from building demolitions become more established.

The UK currently produces approximately 170,000 tonnes of glasswool per year and the fortunes of the industry are closely linked to those of the building sector. A detailed growth forecast for the sector was produced by the Office of Fair Trading after the referral of a proposed takeover within the sector by the Competition Commission. This forecast predicted the growth of the sector for the period 2003 to 2009 and gave upper, median and lower

annual growth rates of 11.3, 8.6 and 6% respectively. For the purposes of this report the lower value of 6% has been used (this figure is more consistent with data drawn from the sector's climate change agreement).

Coupled with this forecast in sector growth it has also been assumed that the amount of cullet from all sources used by the sector will grow incrementally from the present level of 40% to a figure of 80% by the year 2015. The resultant forecast for the sector output and demand for recycled glass are given below in Table 9. This shows that cullet demand for the fibre sector is predicted to rise to 223,000 tonnes by the year 2015.

Table 9 Predicted Cullet use by the Glasswool Sector

Year	Glasswool Production (tonnes)	Cullet Used (%)	Cullet Used (tonnes)
2006	170,000	40	68,000
2007	180,000	44	80,000
2008	190,000	49	93,000
2009	202,000	53	108,000
2010	215,000	58	124,00
2011	228,000	62	142,000
2012	241,000	67	160,000
2013	256,000	71	180,000
2014	270,000	76	205,000
2015	288,000	80	223,000

2.2.3 The Flat Glass Sector

The flat glass sector comprises 3 companies which collectively produced around 1 million tonnes of glass in 2005. Flat glass manufacturers have very stringent quality requirements for their external cullet supplies and will not use any container glass in their processes. Currently the supply of good quality flat glass is limited and the flat glass manufacturers are working to increase the supply. The amount of flat glass recycled by this sector has risen from a very small base and currently stands at approximately 70,000 tonnes per year. The domestic supply of relatively small quantities of flat glass is not considered to significantly influence the overall model for international cullet trade which is essentially based around container glass.

2.2.4 UK "Alternative" Uses Market

The growth of mixed colour collection and the technical difficulties of colour separation required for re-melting uses have resulted in more glass being diverted to alternative markets which includes aggregates, glass sand and abrasives. The market for these uses stood at 198,000 tonnes in 2001 and has grown by an average of 8% p.a. to 274,000 tonnes in 2005.

Assuming this growth rate continues the alternative markets could accommodate 380,000, 410,000 and 590,000 tonnes by the years 2008, 2010 and 2015 respectively. However, exports of furnace ready green/mixed cullet have also shown strong growth in recent years (>20% pa) and totalled 243,000 tonnes in 2005 (forecast 270 kt for 2006). As cullet for this export remelt market is expected to command a higher price than the domestic alternative uses markets, export growth is anticipated to be at the expense of the alternative uses.

Thus, assuming that the export market is more attractive than the domestic alternative market, and providing a more modest ongoing annual growth rate of 10% to 2010 and 5% thereafter, the predicted volumes for these potential end uses are given below in Table 10. Note – these figures do not incorporate predicted glassfibre demand.

Table 10 Predicted Markets for Surplus Green/Mixed Cullet

Predicted Markets for Surplus Green/Mixed Cullet				
Year	Total	Remelt	Export	Alternatives
	(1000t)	(1000t)	(1000t)	(1000t)
2008	1140	472	365	303
2010	1218	529	440	249
2015	1694	687	560	447

2.3 Predicted Opportunities for Cullet Trade

The following predictions are based on the container sector's requirements for colour-sorted glass which will initially be supplied from bottle bank and colour segregated kerbside collections. Additional mixed glass will then be reprocessed, sufficient to meet the packaging target which is considered to be the principal driver in this market. The additional colour sorted glass will still not satisfy the container sector's demand for flint and amber glass but will produce a large surplus of green and mixed glass which will be available for export and/or fibre production and "alternative" uses.

The forecasts for UK container industry's demand for cullet for the years 2008, 2010 & 2015 are given in Tables 11a, b, c respectively.

Table 11a Glass Supply and Demand Forecast for 2008

Glass Supply and Demand Forecast for 2008				
	Flint	Amber	Green/Mixed	Total
Year 2008	(k tonnes)	(k tonnes)	(k tonnes)	(k tonnes)
Glass from Colour Separated Sources	183	48	224	455
Glass from Mixed Sources	180	83	916	1179
Total Glass	363	131	1140	1634
Maximum Remelt Demand	767	205	472	1445
Surplus / Deficit	-404	-75	668	

Table 11b Glass Supply and Demand Forecast for 2010

Glass Supply and Demand Forecast for 2010				
	Flint	Amber	Green/Mixed	Total
Year 2010	(k tonnes)	(k tonnes)	(k tonnes)	(k tonnes)
Glass from Colour Separated Sources	174	42	210	426
Glass from Mixed Sources	208	92	1008	1308
Total Glass	382	134	1218	1734
Maximum Remelt Demand	811	213	529	1553
Surplus / Deficit	-429	-79	689	

Table 11c Glass Supply and Demand Forecast for 2015

Glass Supply and Demand Forecast for 2015				
	Flint	Amber	Green/Mixed	Total
Year 2015	(k tonnes)	(k tonnes)	(k tonnes)	(k tonnes)
Glass from Colour Separated Sources	150	35	200	385
Glass from Mixed Sources	346	139	1494	1979
Total Glass	496	174	1694	2364
Maximum Remelt Demand	917	229	687	1833
Surplus / Deficit	-420	-55	1007	

The analysis predicts that the continuing mismatch between the colour profile required by the glass melters and that supplied by the recycling industry will prevent the glass sector meeting the anticipated national recycling targets to 2015. The shortfall must then be met from glass used in alternative markets including fibre.

An ongoing surplus of green glass will be available for either export or for additional domestic use in the alternative markets e.g. aggregates abrasives, etc. By contrast the analysis predicts a continuing shortage of amber and flint cullet producing a market for the import of these commodities

3.0 Review of International market opportunities for Cullet Import / Export

3.1 The UK tonnage opportunity for cullet import / export

The preceding section has reaffirmed that from a UK container manufacturer's perspective, there exists now and projected forward an excess of green cullet and a shortfall in flint and amber cullet. Domestic competition for the cullet supply exists in the glass fibre and 'alternative use' markets.

Based on the figures in the preceding section and assuming that a possibly conservative 25% of fibre demand is met from container (as opposed to flat) glass sources, it is estimated that the net surplus of green / mixed cullet available for export will be:

Table 12. Estimated surplus of green / mixed cullet available for export

	Estimated green / mixed surplus cullet available for export (t)
2008	342,000
2010	409,000
2015	504,000

Even assuming that 100% of domestic fibre cullet demand is sourced from the container cullet stream the 2015 surplus remains at some 340 kt. As such the opportunity for green / mixed cullet export from the UK is expected to remain significant.

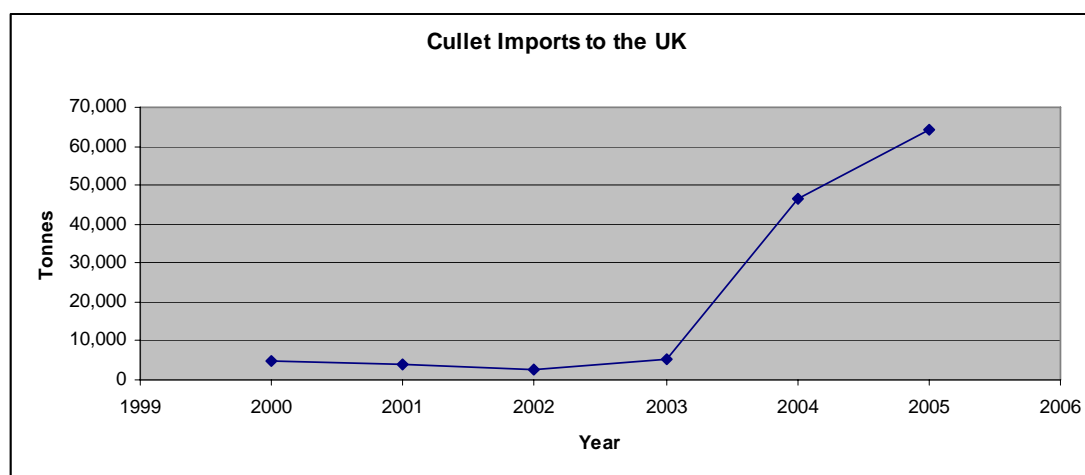
3.2 The Current UK Import / Export Position

The UK already engages in international trade in both cullet import and export. Data reported to British Glass indicates that the level of activity has risen significantly in recent years as shown below.

Imports

Figure 5 below shows the trend in cullet imports to the UK in recent years⁵.

Figure 5 Cullet Imports to the UK



Imports to the UK are in large part accounted for by imports from the Irish Republic associated with the closure of Irish Glass Bottle (IGB) in 2002, IGB having been the country's only domestic container manufacturer and thus major user of cullet. 2005 imports from the Irish Republic accounted for some 53,000 tonnes, thereby accounting

⁵ Note – this dataset was incomplete in the period 2000-2003 due to incomplete routine data returns. However, the general increasing trend is believed to be real, associated with the 2002 closure of IGB detailed in the main text.

for ~83% of all UK imports. Assuming as a worst case the Irish Republic's 2011 packaging waste target (60%) is just met, this may represent an additional ~20,000 tonnes of cullet available for export to the UK, of which roughly 50% is anticipated to be flint / amber glass (see also section 3.3.3.3).

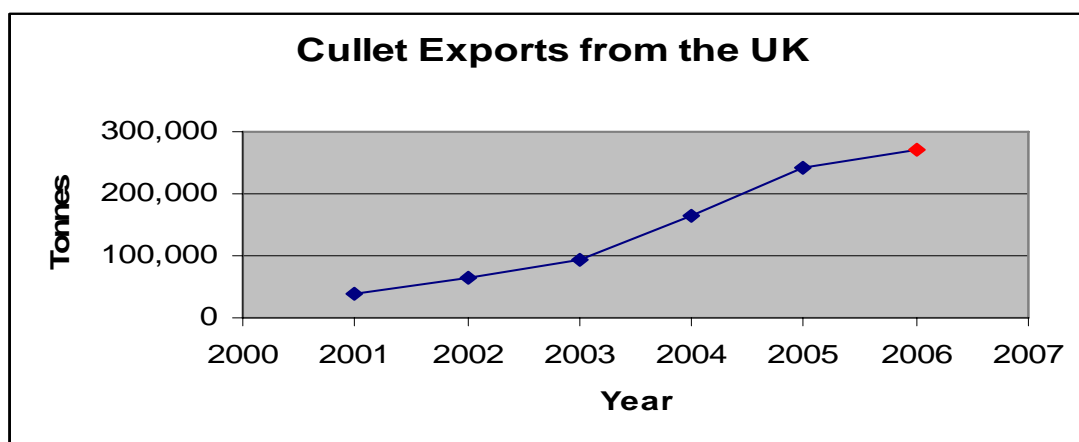
Anecdotal evidence suggests that other much smaller imports to the UK of flint / amber cullet have taken place from Scandinavia and Canada in recent years. Communications with the Swedish glass industry indicate that Sweden represents a continued flint import opportunity.

In the context of the current and forecast shortfall in flint and amber cullet for remelt in the UK, it is apparent that considerable scope remains for additional imports to the UK, particularly in respect of flint cullet.

Exports

Figure 6 shows that cullet exports have shown a steady year on year rise since 2001, and currently run at some 270,000 tonnes per annum.

Figure 6. Cullet Exports from the UK (Source: British Glass)



Note: 2006 figure based on data for 1st 6 months of 2006 and 2005 import pattern.

Cullet processors suggest that all exports lie in the green spectrum and are exported exclusively for remelt, predominately in a furnace ready condition, although it is understood that some cullet is exported directly from Welsh and Cornish ports as collected⁶. The dominant destination for exports is the Iberian Peninsula (>75%), with lesser exports to Italy and the Netherlands, although available data from different sources contains some contradictions in regard of quantity⁷. Greatest confidence is placed in data provided by British Glass, however, the source of these anomalies may warrant further investigation. Exports have also taken place to France and Argentina in the past.

The trend in cullet exports and the anticipated growth in surplus green cullet show the continued scope for increased export trade, subject to the availability of suitable markets; current export levels lie at just over 50% of the estimated 2015 green surplus.

⁶ Cory Environmental is now sending mixed glass collected in Cornwall directly to Portugal after bulking in approximately 2000 tonne loads (27.11.06 - <http://www.letsrecycle.com/materials/glass/news.jsp?story=6296>). Additionally, bulked cullet is understood to be exported direct from Welsh ports by another processor.

⁷ 2005 data for Spain suggests imports from the UK of 42,000 tonnes mixed/green and equivalent data for Portugal indicates no imports from the UK. This clearly presents a major mismatch between known UK exports to Iberia, established from British Glass statistics and discussions with UK glass processors, and claimed Iberian imports. The reason for this mismatch is not known with certainty. However Portugal does claim imports of some 147,000 from the Netherlands, Germany and Spain and it is believed possible that the origin of some of this tonnage may have been misattributed, possibly connected with import via Spanish and Dutch ports, although this is unconfirmed.

It is noted that separate recent work by Beyond Waste⁸ suggests that the Packaging and Packaging Waste Directive will result in exports rising to ~200kt per annum. However, this forecast has clearly already been exceeded.

3.3 Identification of Opportunities for Cullet Import / Export

A key element of the work involved identifying cullet import / export opportunities within Europe and the wider world with the potential to either:

- Import green cullet from the UK
- Export amber / flint cullet to the UK

The following sections consider:

- How candidate countries for investigation were identified
- The approach to data collection and data availability / quality issues
- Possible opportunities for cullet import / export in Europe and the wider world
- Future work

3.3.1 Identification of Candidate Countries

This area of work fell into two areas considering the UK's local market - Europe, and the wider world. The approach to identifying countries for investigation differs for these two categories and is outlined below:

Europe

A key for this project has been the identification of outlets for excess green cullet from the UK. On this basis European countries were ranked based on their green container manufacturing capacity, derived from British Glass 'factory files'. This approach identifies the following ranking for green manufacture within Europe; amber and flint capacities are included for completeness:

Table 13 Green glass container production capacity within Europe (for countries with >100kt capacity)

Rank (for countries with capacity >100kt)		Production Capacity - Tonnes				
		Green	% of total (for countries with capacity >100kt)	Flint	Amber	TOTAL (all colours)
1	France	1,852,375	37	1,343,200	219,000	3,414,575
2	Germany	698,975	14	2,396,225	868,700	3,963,900
3	Italy	491,325	10	1,315,825	284,700	2,091,850
4	UK	458,075	9	1,994,725	419,750	2,872,550
5	Spain	363,175	7	1,317,650	445,300	2,126,125
6	Netherlands	292,000	6	248,200	14,600	554,800
7	Portugal	259,150	5	514,650	54,750	828,550
8	Romania	171,550	3	204,400	36,500	412,450
9	Poland	153,300	3	219,000	171,550	543,850
10	Bulgaria	146,000	3	273750	36,500	456,250
11	Czech Rep	131,400	3	172280	204,400	508,080

⁸ 'Review of Recycling Capacity in Selected EU States and Regions', 2006, produced by Beyond Waste for EWM.

In addition, the following countries were examined on the basis of either access to data due to the availability of contacts through FEVE (the European Container Manufacturers' Federation), or as potential exporters of amber / flint glass highlighted by the project steering group (in particular Scandinavia): Belgium, Denmark, Eire, Greece, Norway, Sweden, Switzerland, Turkey

Wider World

Focus within the wider world has principally concentrated on exports of green cullet from the UK. An initial line of investigation was to consider the backhauling opportunities, i.e. exploiting the return journeys of vessels bulk importing raw materials to the UK as a means of exporting cullet with a low marginal environmental impact. However, further investigation of shipping modes identified that this preliminary approach did not reflect actual practise in which bulk carriers, most suited to cullet transport, actually drop off loads and then move to 'holding pools' for call off through brokers for further loads. That is, the ships generally 'hop' from port to port several times in a trip and do not perform simple return journeys.

Container ships do operate on a 'milk round' basis visiting ports on a schedule. However, container use is less suited to cullet transport on the dual bases of higher cost per tonne and the potential for cross contamination of other more sensitive loads. (Further information on actual shipping modes and associated environmental impact is found in section 4 considering development of the environmental model).

On this basis, this approach to identifying wider world opportunities was found to be unsuitable, with shipping options being much more 'open' than originally thought.

In consequence an alternative approach was used and the following countries / regions were selected for examination on the following bases:

Table 14 Countries Selected for Examination in the Wider World

Country(s) / Region	Basis for examination
Argentina, Australia, Chile, New Zealand, South Africa, USA (California)	New world wine producers, often exporting wine to the UK in green bottles and therefore having potential demand for green cullet.
China, India, South Korea	Rapidly growing economies with high resource demands.
North Africa / Middle East	Markets with ready access from/via the Mediterranean.
Brazil, Japan	Availability of data (through a wide cast data request)

3.3.2 Collection of Market Intelligence for Candidate Countries

Data Gathering

Key to identification of import-export opportunities has been the collation of data regarding the situation in different countries. This data falls into the following broad categories:

Table 15 Data necessary for cullet market forecasts

Data	Purpose
Glass waste stream, recovery rates and collection infrastructure	Identification of domestic cullet supply
Use of recovered cullet (export, remelt and alternative uses)	Domestic cullet supply consumption patterns.
The import and use of cullet	Existing external supplies
Container production and cullet quality requirements	To identify potential cullet demand (particularly green) and necessary quality
Forward Projections for the above	To assess market sustainability and emerging / disappearing markets,

Data collection and collation under the project has followed three main strands:

1. Collation of basic glass production / production capacity, remelt rate, waste stream, recovery and import / export data:

- The World Glass File
- FEVE Statistics Compendiums and Gazettes
- British Glass European and World glass container manufacturing intelligence; British Glass holds considerable intelligence on the container manufacturing industry globally in the form of 'factory files' which identify the capacity and colour of container furnaces in different countries.

Such data is available for a number of countries, principally within Europe. However, the completeness of this dataset varies significantly from country to country, and additionally deals very much at a 'macro' level. For example data on imports / exports, where available gives, no information on origin / destination or cullet colour.

2. European Questionnaire

A key planned source of data under the project was a questionnaire circulated to contacts held by British Glass Manufacturers Confederation, principally through FEVE. The content of this questionnaire is shown in **Appendix A**.

A. The form of the questionnaire follows the categories shown in the table at the start of this section.

The questionnaire was issued to contacts in some 11 countries. Responses were received from 6 countries representing a 55% return rate. Respondent countries were France, Italy, Portugal, Spain, Switzerland and Turkey, representing some key countries in respect of cullet trade. The completeness of responses was variable from weak to very comprehensive.

A second much simplified version of the questionnaire was circulated to a wide range of global contacts through the British Glass information service; this issue resulted in four responses from South Africa, Japan, Brazil and the Philippines.

3. Wider data search

The above approaches provided data of reasonable quality and completeness for some candidate countries whilst little or no data was available for others. In consequence, and to supplement the above activities, a much wider data search was undertaken, referring to sources including:

- Journal articles - from the glass / material press held in the British Glass library.
- A published market report forecasting global and regional cullet trade for 2006⁹. This report forecasts markets on the basis of macroeconomic and trade models to identify forecast importers and exporters of cullet. The output of this approach is country rankings based on forecast export / import market share. Dollar values are attributed to forecast markets giving a relative indication of activity levels. Henceforth in this report and within the country profiles described in the following section and appended to this report, this report is referred to as 'economic forecasting'.
- Web sources – wide cast web research based on a wide variety of official and other sources. These sources include robust sources such as country waste statistics on the Europa website through to more 'anecdotal' data, principally for countries with very poor data availability. All web sources referenced were visited in the period October to December 2006.
- Information from conversations with ad-hoc contacts / British Glass Manufacturers confederation staff.
- Trade Consulates – a wide cast cullet export / import trade enquiry letter was circulated to consulates. However, this received no responses.

⁹ 'The World Market for Glass in the Mass, Glass Cullet, and Other Waste and Scrap: A 2006 Global Trade Perspective', 2004, Icon Group Ltd.

Collation of Country Positions and Identification of Possible Cullet Import / Export Opportunities

Working from the above data sources a 'country profile' was collated for each country. This file performs two functions:

- It summarises the pertinent facts relating to each country
- Based on the above it provides commentary on the prospects for cullet import / export activity within that country.

Each country profile addresses the following areas:

- Basic country facts (population, EU membership status etceteras)
- Glass manufacturing industry overview
- Container industry overview
- Glass recycling infrastructure
- Current glass import / export activity
- Prospects for cullet import / export

These profiles contain significant statistical data and associated commentary qualifying and interpreting the raw statistical data. Necessarily, due to the variable (and sometimes conflicting) input data available for different countries, the strength of possible conclusions also varies from country to country. 'Country Profiles' for those countries considered are given in **Appendix B** of this report, split into two parts, considering Europe and the wider world in turn.

Data Availability and Quality

Official UK and British Glass / GTS sources provide comprehensive information regarding the glass industry and cullet position in the UK. However, availability of good quality, complete and reliable data for all candidate countries has proved a particular challenge under this project.

Generally, the best data is not surprisingly available for Western Europe, in particular questionnaire respondents. However even this data is subject to considerable data gaps and inconsistencies. For example, France (a questionnaire respondent) is unable to provide colour breakdown for its cullet waste stream, recovery or remelt, or indeed container production, without which determination of available cullet market proves difficult in the extreme.

Provision of forward forecasts by countries has also proved extremely limited. In the absence of such country generated forecasts, estimates must be made based on recovery targets (where applicable) in relation to current recycling rates. However, where recycling rates already approach or meet targets, or where no targets are applicable, this approach is not possible.

The data is also subject to inconsistencies. For example, Portugal claim no cullet imports from the UK whereas it is known from domestic sources that significant exports take place from the UK to Portugal. Similarly economic forecasting does not rank Portugal as a recipient of cullet within Europe, whereas official UK trade data (www.uktradeinfo.com) suggests exports to Portugal of ~27kt.

Such data gaps and inconsistencies necessarily impact on the level and certainty with which forecasts can be made.

Some candidate countries and regions have proven to have extremely limited or no data. For example, lack of data for the North African and Middle East regions has precluded any conclusions in respect of cullet trade opportunities under this project.

A final consideration is that whilst the project approach endeavoured to obtain current data, in some cases it was necessary to use data up to 4 years old due to lack of more current data. Given that situations often change quickly, where older data is used, it must be treated with a degree of caution.

Notwithstanding the above difficulties it is believed that reasonably secure conclusions can be offered for several candidate countries in respect of the opportunity they represent for cullet trade, or as targets for further investigation beyond the scope of this project.

3.3.3 Review of Possible Cullet Import / Export Opportunities - EUROPE

General Overview

Ranking of cullet export and import data for candidate countries (drawn from the country profiles) is given in the following tables. A similar review of cullet trade activity was reported by Reynolds¹⁰ in 2002, giving the position for a limited number of countries in the period 1990 up to 2000 and this is also shown for comparative purposes. Additionally, the European exporter and destination ranking drawn from the 2006 economic forecast is shown (top 7).

Table 16 Cullet Export Activity within Europe

	CULLET EXPORTERS (amongst candidate countries)	This Study / Tonnes & Rank	Reynolds (2002) / Tonnes	Reynolds Tonnage Ranking	Economic forecasting 2006 exporters ranking
1	Germany	300000	300000	1	2
2	UK	270000			3
3	Switzerland	172544	100000	3	6
4	Belgium	63000	200000	2	1
5	Denmark	55482			
6	Ireland	53140			7
7	Netherlands	50000	200000	2	5
8	Greece	10000 ¹¹			
9	Czech Republic	9298			
10	Spain	8000	0	5	
11	Portugal	5000			
12	Poland	693			
13	France	0	80000	4	4
14	Italy	0	0	5	

It is apparent from the above table that the position since 2000 has changed significantly. Due to growth in activity, the UK now ranks next to Germany in terms of exports and the number of significant players appears to have increased. For example, Ireland and the UK have emerged as market players since the earlier study. Additionally it would appear that exports from Belgium, Netherlands and France have dropped significantly, in France's case, to zero. The reason for this apparent change is unclear as in the case of all countries, the waste stream, recovery rate and remelt rate has not undergone significant change in the period.

¹⁰ 'European Glass Recycling Trends Impact on Raw Materials', 2002, A Reynolds, International Glass Journal, No.120

¹¹ 1998 data.

It is notable that the top exporters are represented by countries such as the UK and Germany, with colour imbalance issues, and countries such as Switzerland and Belgium where waste stream either approaches or exceeds production capacity; this effect was also previously noted by Reynolds.

The 2006 economic forecasting ranking broadly reflects that of the current study, but with the ranking of Belgium and Switzerland overstated and understated respectively. A more unexpected difference is again the 4th place ranking of France, currently understood not to export.

Table 17 Cullet Import Activity within Europe

	CULLET IMPORTERS (amongst candidate countries)	This Study / Tonnes & Rank	Reynolds (2002) / Tonnes	Reynolds Tonnage Ranking	Economic forecasting 2006 destination ranking
1	Italy	300000	100000	3	3
2	Netherlands	250000			1
3	Germany	234200	200000	2	7
4	Portugal	147000			
5	France	100000	400000	1	2
6	Czech Republic	77065			
7	Greece	72000 ¹²			
8	Spain	70000	~70000	4	6
9	UK	64125	<10000	5	
10	Denmark	40773			
11	Poland	25226			
12	Belgium	0			4
13	Ireland	0			
14	Switzerland	0			
	United States				5

It is again apparent from the above table that the position since 2000 has changed significantly. The top of the table is dominated by countries characterised by production levels in excess of domestic waste stream, exacerbated where recycling rates are low (e.g. Portugal), or due to colour imbalance issues (e.g. Germany)

Unsurprisingly, countries with excess domestic cullet supply such as Belgium, Ireland and Switzerland lie at the bottom of the table with no imports.

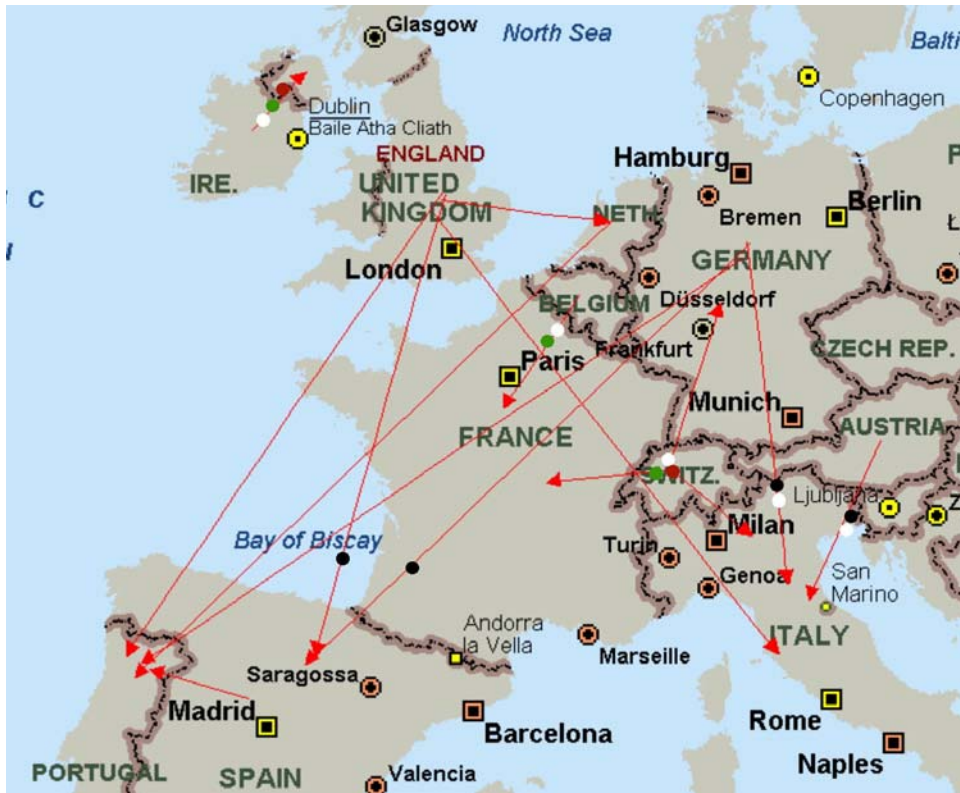
It is notable that with the exception of France, import levels have been maintained or increased.

The 2006 economic forecasting ranking broadly reflects that of the current study, but less well than for exports. The importance of Germany is understated whilst that of Belgium is overstated. Also, Portugal believed to be a significant importer is simply unranked. The 5th rank of the US as an export destination is also notable.

The following map summarises some of the principal known cullet flows within Europe based on substantiated data. Whilst economic forecasting suggests other cullet flows, these cannot be substantiated and are therefore not included. In a similar vein anecdotal evidence of imports to the UK from Canada and Scandinavia are unconfirmed and therefore not included:

¹² 1998 data

Figure 7 Principal Known Cullet Flows within Europe



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- Mixed
- Green
- Flint
- Amber

Opportunities for Export of Excess Green Cullet from the UK

As previously indicated, country profiles have been developed for candidate countries, found in **Appendix B**, addressing the following areas:

- Basic country facts (population, EU membership status etceteras)
- Glass manufacturing industry overview
- Container industry overview
- Glass recycling infrastructure
- Current glass import / export activity
- Prospects for cullet import / export

These profiles contain significant statistical data and associated commentary qualifying and interpreting the raw statistical data; for this reason, summary statistical data are not presented here, as it is felt that these would not offer a meaningful or useful picture of the position in each country. Rather, for detail relating to individual countries, reference should be made to Appendix B. For Europe, the profiled countries are: Belgium, Bulgaria, the Czech Republic, Denmark, Ireland, France, Germany, Greece, Italy, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland and Turkey.

Based on the country profiles the following table summarises those countries seen as presenting possible tonnage opportunities for export of excess green cullet from the UK. The table includes a brief commentary for each

identified country. Where possible the market size is indicated. However, as previously discussed, lack of colour split data and / or forecasts often precludes this possibility. Nonetheless, wherever possible an indication of likely market sustainability is given and where possible comment given on the economic viability of servicing such markets. Countries are given alphabetically, but where a country is seen as a key opportunity, this is noted.

Table 18 – Potential markets for green / mixed cullet exported from the UK		
Country	Estimated opportunity size	Comments
Bulgaria	Unquantified	Very limited data is currently available for this country. However, it is understood that the glass waste stream represents only ~17% of production capacity and as such it might be very tentatively concluded that even assuming a high recovery rate, a market for cullet imports may exist. However, it is suggested that any such need is more likely to be met by cullet exporting countries in the region. Additionally it has been indicated by UK cullet processors that with the current cost structure, export of cullet beyond Italy is not currently financially viable.
Czech republic	Unquantified	Recovery rates are high and exceed targets. However, similar to Bulgaria the waste stream is significantly less than domestic production (~30%). Taking into account current imports overall remelt rate is estimated at only ~35% suggesting considerable potential for further remelt of imported cullet. Indeed cullet (especially flint) is understood to be in short supply. Due to the already high recovery rate any market should be sustainable. However, similar to Bulgaria it is suggested that any additional market is more likely to be met by cullet exporting countries in the region such as Germany and Austria.
France KEY OPPORTUNITY	Unquantified	France already imports ~100,000 cullet per annum (80% flint, 20% green), believed to originate in Belgium / Switzerland. Further opportunities for import may exist however lack of colour split data prevents quantification. A move towards colour separated rather than mixed collection may improve the green cullet market and present an amber import opportunity. However recycling rates are currently only moderate, and with waste streams approaching production, if recycling rates were to significantly improve, this might reduce the need for imports. However, questionnaire data suggests an increase in recovery rate of only 1-2% to 2015. No forecast for import increases was offered in the questionnaire response. The geographical proximity of France to the UK favours this country as a trade partner on financial grounds.
Greece	Unquantified	Greece currently has very low recycling rates and thus offers a potential export market, however, due to relatively small scale container manufacture, the scale of any such market would also be limited. Additionally, as recycling rates improve (and with the absence of recovery colour split data as caveat), Greece could become nominally self sufficient in cullet making any green import market of limited life. Similar to Bulgaria, the cost of export from the UK currently precludes imports.
Italy KEY OPPORTUNITY	Unquantified	Italy currently has moderate recycling rates, approaching their 60% target. However even if high recycling rates were achieved domestic supply remains significantly less than production and therefore a sustainable export market may exist. However questionnaire data suggests that a better colour separated collection system is required to exceed 60% recovery. Significant imports (~300,000) already take place from Germany, Switzerland, Austria and the UK giving an overall remelt rate of ~50%. Lack of reliable colour split data precludes quantification of any opportunity.
Poland	Unquantified	Cullet waste stream volume approaches production, however recovery rates are currently low. Taking into account current cullet imports remelt rates are low at 20-30% tentatively suggesting (in the absence of colour split data) that an excess UK green export market may exist and indeed there would appear to be company level demand for increased cullet supply. However, as domestic recovery rates improve to meet packaging waste targets, this possible market may disappear. Similar to Bulgaria, additional import market may be best served by cullet exporting countries in the region, and exports from the UK are not currently financially viable.

<p>Portugal</p> <p>KEY OPPORTUNITY</p>	<p>190 kt by 2011 for all cullet colours (an increase of ~40kt)</p>	<p>Portugal already imports significant volumes of cullet from the UK and other countries, but still achieves only as moderate remelt rate of 30-40%. Production is considerably greater than the waste stream, suggesting a sustainable import market.</p> <p>By 2011/12 the country is forecasting to increase recovery rates to 60% associated with an increase in waste stream of 9% and alongside a growth in container production of some 40%. Best approximations suggest that this equates to a total import market of some 190 kt. However, lack of colour split data does not allow the green fraction of this potential market to be determined.</p>
<p>Spain</p> <p>KEY OPPORTUNITY</p>	<p>80-84 kt by 2015 for all cullet colours. (an increase of ~10-14kt)</p>	<p>Spain currently re-melts virtually all domestically recovered glass and imports additional cullet, there would appear to be a good opportunity for further export of excess UK green / mixed glass to Spain, to increase remelt rates in green production (currently ~62%). Given the status quo, an estimated potential market of some 110,000 tonnes exists to meet the aspirational green remelt target of 70%. Additionally, imports for alternative uses are forecast to show slight growth.</p> <p>However, given that Spain lies some way short of its packaging waste target, increases in internal recovery to meet target may make this market short lived. Approximate calculations based on the current colour split of manufactured and collected glass and forecast increases in domestic waste stream and production, and assuming the 60% recycling target is hit, suggest that by 2015 Spain should be self sufficient for green remelt (75%) and still some way short of its aspirations for cullet remelt ratios for flint and amber. These figures are before imports and thus do not bode well for the longevity of this market, however, it must be noted that these calculations necessarily embody some significant assumptions. The limited life of this market is supported by discussions with UK cullet processors (estimated at 5-8 years).</p> <p>Notwithstanding the above, questionnaire data forecasts an increase of 15-20% in imported cullet by 2015 which equates to a market of 80-84kt by 2015; the colour of these imports is not specified.</p>
<p>Turkey</p>	<p>Potential short term opportunity of 20 ktpa green / mixed</p>	<p>Based on available information, there may currently be some opportunity for export of green cullet to Turkey, conditional on transport economics. Green remelt is estimated at ~ 50% at the current time. An estimated market of 20,000 tonnes exists assuming this was increased to 70% green remelt, the country's aspiration.</p> <p>However, if and when currently low recovery rates (~24%) improve, with a forecast of 60% by 2014, Turkey is expected to be more than self sufficient in green cullet and as such any UK export market may be short lived. The country itself is forecasting no increase in imports (currently zero), due to lack of local regional supply and the inability to transport cullet cost effectively from western Europe. This latter point reflects the views of UK cullet processors.</p>

The above analysis suggests that a number of opportunities do exist within Europe, although some of these may be short lived as recovery rates improve. In most cases limited data does not allow most potential markets to be quantified. Possibly unsurprisingly, those key opportunities identified include those markets currently served by the UK, being located on the western Atlantic / Mediterranean seaboard.

At the current time, transport economics preclude the servicing of more remote markets within Europe. Exacerbating this transport issue, it is understood from UK sources that cullet often commands a lower price in the export market, and can be dependent on a good PERN¹³ price to make this business viable.

However, recognising the above issues there is growing incentive in the form of the EU Emissions trading scheme (EUETS) for European continental glass manufacturers to increase the level of cullet remelted in their furnaces,

The EUETS which started in 2005 is a 'cap and trade' greenhouse gas trading scheme in which obligated installations are allocated an annual CO₂ allowance in terms of tonnes of CO₂; if actual emissions exceed this cap, additional allowances must be purchased in a trading market to make up the shortfall, conversely, surplus allocation can be sold.

Container manufacture is one such obligated sector. The remelting of cullet offers two benefits in respect of the EUETS:

- It reduces the required melting energy and fossil fuel combustion CO₂ emissions in comparison with melting from virgin raw materials (carbonates and silica sand)
- It reduces 'process' CO₂ emissions resulting from the thermal decomposition of carbonates in virgin raw materials.

As such the EUETS offers glass melters a good incentive for increasing the cullet ratio in their furnace feedstock.

The trial phase of the scheme (phase I) runs from 2005-2007 and has suffered from an oversupply of allowances in the market. However phase II of the scheme running from 2008-2012 (the first Kyoto Agreement period) is expected to be subject to much tighter allocations which should incentivise container manufacturers to remelt more cullet, thereby stimulating international cullet trade.

Direct energy prices might have a similar effect, however, it is understood that continental energy prices have in recent years run at a lower level than in the UK.

Opportunities for Import of Flint / Amber Cullet to the UK

As previously discussed flint and amber cullet is currently in short supply in the UK due to the waste stream colour imbalance, and trend toward mixed colour collection. Based on the country profiles the following table summarises those countries seen as presenting possible tonnage opportunities for import of flint / amber cullet to the UK. The table includes a brief commentary for each identified country.

¹³ The UK Producer Responsibility Obligations (Packaging Waste) Regulations 1997 (implementing the 2004 Directive on Packaging and Packaging Waste) introduced the requirement for the supply chain for certain packaging materials (including glass) to recover a proportion of this waste to certain permitted end uses. In the case of glass permitted end uses **include** container and fibre manufacture, aggregates and glass sand. For each tonne of material recovered to a permitted end use, a 'PRN' (Packaging Recovery Note) is issued. For material exported for use in permitted uses a PERN (Packaging Export Recovery Note) is issued. A trading market in PRNs/PERNs exists and obligated companies must generate / purchase sufficient PRN/PERNs to cover their recovery obligation.

Table 19 Potential markets for flint / amber import to the UK

Country	Comments
Denmark	Limited data does not allow firm conclusions to be drawn. However, Denmark is a known exporter (and importer) of cullet. It is believed exports are probably to Germany. Recovery rates are ~100% and waste stream represents ~65% of production capacity. The country is believed to warrant further investigation beyond the scope of this project as an import opportunity,
Ireland	The UK already receives imports from Eire which has no domestic demand. Current imports (53kt) represent ~45% of the waste stream and virtually all recovered glass. As recovery rates increase, to meet / exceed target, a potential of up to an additional 60 kt may become available for import of which ~60% is believed to be flint / amber glass.
France	As indicated in the preceding table, it is tentatively suggested that as France moves further towards colour separated collection and amber fraction may become available beyond domestic needs. This cannot be substantiated due to lack of colour split data.
Netherlands	Data suggests that amber remelt rates are as high as 75% and that the country has recently exported ~20,000 t amber. As such the country warrants investigation as an amber import opportunity. It is understood that no flint export takes place.
Sweden	Waste stream exceeds manufacture and recycling rates approach 100%. It is understood that exports of flint have previously taken place to the UK. One contact made through this project is keen to explore opportunities for export of flint cullet to the UK in 2007

Whilst limited data precludes firm conclusions being drawn and from quantification of possible opportunities, it is believed that opportunities for flint / amber cullet import do exist and that these warrant further investigation beyond this project. All the identified countries are well positioned from a transport logistics / economics viewpoint.

Competition for cullet supplies / markets in Europe

Whilst potential opportunities for export / import have been identified in the preceding two tables, these opportunities are set in the context of a competitive market encompassing Europe and the wider world.

The main competing exporters of excess green cullet are believed to be Germany, for colour imbalance reasons, and Switzerland due to the country's small container manufacturing industry.

During research it has become apparent that the north eastern United States also appears to suffer from an excess of green cullet, and it is known that markets have previously been sought in Europe (Italy, Spain, Portugal and France). Indeed, 2006 economic forecasting ranks the US 5th in terms of competition for the European cullet market. In the longer term, as recovery rates improve it is believed that countries such as Greece and Turkey could start to become significant players in the export of green cullet beyond their domestic needs.

In terms of competition for available flint cullet, key competitors seeking to import for domestic remelt use are believed to be Germany, Italy, and to a lesser extent, the Czech Republic. No key competitors have been identified for the import of the available amber cullet supply.

Quality Requirements for Cullet Exported within Europe

An obvious consideration when looking at cullet export opportunities is that the quality requirements for processed cullet of export markets can be met. Information from UK cullet processors suggest that exports are made in a furnace ready condition.

Data was received from Portugal, Spain, Switzerland and Turkey in respect of cullet quality requirements; it is understood that Italy holds specifications for mixed colour and flint cullet, but these were not provided during the project.

Reasonably detailed information was provided by Portugal and Turkey, however data from Spain and Switzerland was of only a very general nature indicating that contamination is a consideration in respect of ferrous and non-ferrous metals, stones, ceramics and organic contamination and that particle size was also an issue.

A previous WRAP project 'Colourite'¹⁴ was concerned with actions to maximise cullet additions to container furnaces in order to yield maximum environmental benefit. One output from this project was the development of a furnace ready cullet specification. The specification includes a colour specification for flint, amber and green glass, agreed between glass manufacturers and glass processors and also, for information only, indicative contaminant levels.

Comparison of data provided by Portugal and Turkey against this specification is given below:

Colour

Information was provided by Turkey only.

Table 20 Comparison of Cullet Colour Specification in the UK and Turkey

Glass Production - Colour	Coloured contaminants			
	Flint	Green	Amber	Other
Flint	Min 97%	Max 1.5%	Max 2.5%	Max 1.0%
	Turkey 99%	Turkey 0.5%	Turkey 0.5%	
Green	Max 10%	Min 70%	Max 20%	Max 1.5%
	Turkey 10%	Turkey 85%	Turkey 5%	
Amber	Max 10%	Max 20%	Min 80%	Max 1.0%
	Turkey 5%	Turkey 5%	Turkey 90%	

The above data indicates that Turkey demands higher colour purity in respect of all cullet colours. The greatest difference is for green glass and suggests that if green glass was to be exported to Turkey further cullet processing would be required with implications for cost yield and CO₂ per tonne.

The UK does not currently export cullet to Turkey and as such it is not possible to comment on whether this specification is used in practise 'on the ground', however, there is no reason to disbelieve the information provided by the country.

In a broader sense it is known that countries such as Spain, Italy and France remelt a proportion of mixed cullet in their container production, and indeed, Spain classes 'green' exports from the UK as 'mixed'. On this basis it is reasonable to conclude that the colour purity requirements for exports of green cullet to these countries is less stringent than the requirements of the UK container manufacturers. Comment was not available from UK cullet processors on this point.

¹⁴ 'Colourite Project – Maximising Cullet Additions in the Glass Container

Industry', February 2006, written by GTS for WRAP.

Contaminants

Table 21 Comparison of Cullet Contaminant Specification in the UK, Portugal and Turkey

Contaminant	Maximum permissible level / wt%		
	UK	Portugal	Turkey
Moisture	2	Unspecified	Unspecified
Organic	0.3	0.05	0.04
Inorganic including refractory material	0.001	0.005	0.008
Ferrous metals	0.002	0.005	0
Non-ferrous metals	0.002	0.001	0.0005
Other glass types (Pyrex, crystal, ovenware, cooker top, plate, lighting, mirror, art, auto windscreen, opal, medical etc)	0.001	Unspecified	Unspecified
Heavy Metals	Unspecified	Unspecified	0

In general the specifications for Portugal and Turkey appear somewhat tighter than the UK specification, including a heavy metals limit for Turkey and again may have implications for supply to these markets.

The notable exception is inorganics which show a higher limit; discussions with UK processors suggest that the markets served by countries such as Portugal are better able to tolerate a higher degree of products defects associated with such contaminants.

Borosilicate / pyroceramic levels are not specified, however discussions with UK processors again suggests current export markets are less stringent in this regard. Discussions also indicate that when discussing trade opportunities with potential export recipients, the importance of not over-specifying cullet is highlighted as a means of controlling supply costs.

Size

Table 22 Comparison of Cullet Size Specification in the UK, Portugal and Turkey

Size (mm) UK Categories	Maximum Passing			
	A (Fine)	B (Coarse)	Portugal	Turkey
			≥50mm – 0%	
			≥41mm ≤ 3.5%	
				>40mm – 0%
>32	0.5%	5%		
>16	10%	50%		
>8	40%	45%		
>4	50%	25%		
			≤5mm - ≤5%	≤5mm - ≤15%
<4	40%	1%		

Direct comparison between the UK and Portuguese / Turkish specifications is not straightforward due to the UK distinction between coarse and fine cullet. However, all specifications are broadly similar with an indication that slightly coarser material is acceptable within the Portuguese and Turkish markets. This finding has no major implications for export supplies.

3.3.4 Review of Possible Cullet Import / Export Opportunities – Rest of the World

Beyond Europe country profiles have been developed for the following countries:

- New world wine producers: Argentina, Australia, Chile, New Zealand, South Africa, USA (California)
- Rapidly growing economies: China, India, South Korea
- Others - Brazil, Japan

The quality of data available for these countries is highly variable. For example, data for China has proved extremely difficult to obtain, whereas New Zealand offers a good range of data. As previously indicated North Africa and the Middle East were included as candidate regions for cullet trade, however, lack of data has precluded any meaningful analysis under this project.

The country categories above are discussed in the following sections.

New World Wine Producers

New Zealand - New Zealand suffers an excess of cullet beyond the needs of its domestic container manufacturers and is already understood to be exporting some of this excess and as such there is no prospect for export of excess green from the UK. Conversely, New Zealand is exporting flint in significant quantities and could potentially offer an import opportunity to the UK. However, the planned expansion of the domestic remelt capacity in 2007 may change this position, but the absence of colour split data does not allow firmer conclusions to be drawn.

In summary New Zealand is seen as a potential source of flint cullet for import to the UK warranting further investigation.

Australia - Container production and waste stream levels are closely matched suggesting that the country could nominally be self sufficient in cullet (with the caveat that waste stream colour split is not known). Only a moderate increase in recovery is targeted over the current ~41%. In addition, if imports are required to meet remelt demands, it is believed that New Zealand will be the ideal trading partner for Australia due to an excess of cullet in that country.

As such, Australia offers a poor prospect for export of green cullet from the UK. No conclusions can be drawn on opportunities for import to the UK of clear / amber cullet from Australia.

Argentina and Chile – Based on very limited data the recycling infrastructure and rate is understood to be very low in both countries and centres around ‘garbage pickers’. It is understood that the US ‘Container Recycling Alliance’ was hoping to establish green cullet export outlets in Chile and Argentina, these markets being seen as holding promise as steady outlets for American exports of green cullet as they are both large wine exporters. However, economic forecasting does not rank either country as significant in terms of export / import activity, although it is known that Berryman have exported green cullet to Argentina in the past. In terms of significance, Argentina has a considerably bigger container manufacturing industry than that of Chile, by a factor of ~4. Under this project it is only possible to tentatively suggest that these countries (and more probably Argentina) may offer an opportunity for export of excess green cullet from the UK.

United States (California) - Whether or not glass container and fibreglass plants in California still need more high-quality cullet is the subject of conflicting data. The state has a recycling rate comparable to the UK, but with a target of 80% which, if and when realised, should reduce the need for any imports to the state. Direct dialogue with the US Glass Packaging Institute suggests no significant demand exists.

Given gluts elsewhere in the country, it is tentatively proposed that any cullet demand will most probably be met through inter-state cullet trade without the need for imports from further a field, and as such the prospects for export of green cullet from the UK are poor.

South Africa - Due to current low recycling rates there would appear to be some opportunity for export of excess green cullet to SA (of the order of an estimated ~150 kt), however, this appears to be precluded even at a local regional level by cost at the current time. Given a rapidly rising recycling rate and if aspirations for 86% recovery by 2015 are realised, the country will become nominally self sufficient in cullet for remelt and therefore any such export market will be short lived.

Information from Consol suggests that the decision whether to import cullet will to a large extent be driven by the ability of their raw material suppliers to meet their growing demands. It is ventured by Consol that they might reach a situation in the medium term (5 years) where they will have to investigate the feasibility of importing cullet, but with no real feel for what colours and quantities. On this basis it is suggested that relationships be developed with Consol and a watching brief maintained.

In terms of amber / flint import to the UK, current low recycling rates preclude this. However, even when recycling rates improve, due to the close match between the colour split of production and recovery, all flint / amber arisings will find use domestically and as such no opportunity exists.

The above analysis suggests that the most probable opportunities for cullet trade with New World wine producers lies with the export of green cullet to South Africa and Argentina, however these prospects are tentative.

Rapidly growing economies

China and South Korea - the European glass manufacturing confederation CPIV (2006), identifies key competitors with the EU 25 in the glass container market as China (particularly dominant), South Korea and Taiwan (CPIV, 2006).

It was anticipated that China may offer a significant opportunity as a cullet export target. Published data for China is extremely limited, but economic forecasting suggests the country is a dominant exporter of cullet ranking first in the region and third in the world. In terms of global target markets China ranks only 12th behind the UK and Belgium. However, it is noted that WRAP have recently (December 2006) received a non-specific trade enquiry from a Chinese plastics reprocessor regarding glass and plastic imports from the UK; follow up of this enquiry lies outside this project. Additionally, China's growing role in glass manufacture is evidenced by commercial enquiries to the UK's trade association British Glass; in 2006 a glass specific trade delegation was hosted and assistance has also been requested in the specification of a major glass recycling plant in Hainan province. As such, it is suggested that a watching brief should be maintained on China as a potential trade partner. The forecast suggests that the dominant export destination from China is South Korea.

Data for South Korea is again extremely limited, however the country is understood to have a well developed recycling infrastructure and rate. It is believed that S Korea may offer a potential opportunity for export of excess green cullet from the UK. However, this opportunity is in the context that China is believed to be a major exporter to South Korea, and as such actual opportunity may be limited.

India – Data for India is very limited. Recycling is based around garbage pickers and recovery rates are believed to be poor. Data is insufficient to draw conclusions under this project.

Other Countries

Japan - Based on available information, and in the absence of colour split data, there would appear to be a shortfall of domestic cullet for use in remelt. This is in the context of already high recycling rates. However, due to the absence of information on the colour split of recovered and remelted glass this conclusion is at best tentative, with no feel for the colour of any possible shortfall.

However, there is apparently no cullet import / export activity at the current time, or indication that this position will change.

Japan is closely engaged in the 3Rs initiative and support of developing countries in the Asian region, as such it is postulated that any cullet trade is more likely to take place with those countries.

On this basis, it is not believed that Japan is a strong prospect for cullet import or export from / to the UK.

Brazil – The country currently imports 46kt cullet of which only 10,000 tonnes is used in container manufacture, despite relatively modest remelt rates. However, the country forecasts a ceiling for imports of 50kt pa by 2008. Unless the UK can 'break into' the existing market, prospects for cullet export to Brazil are poor. The country, which currently exports no cullet, does not expect this situation to change.

3.4 Summary of Import / Export prospects and future work in this area

It is apparent from the above analysis that there is already an active market in international cullet trade. Anecdotal data suggests that some of this trade, particularly intra-continental, is between factories in different countries owned by multi-national container manufacturers. However, due to its commercially confidential nature, information on such intra-company movements is very limited and un-quantified.

This study has identified potential opportunities for the UK in terms of cullet import / export principally lying within Europe with tentative export opportunities in Argentina, South Africa and South Korea. Such opportunities have been assessed at a macro, country level due to extremely limited company level data.

To further explore these opportunities it will be necessary to establish possible trading partners in the relevant countries to discuss potential markets at a more detailed and commercial level; dependent on country, such contacts may already exist. It has been previously noted that the more distant opportunities within Europe are precluded based on the basis of transport economics. In this context if there is a UK policy will for such trade to take place, it may be necessary for pricing mechanisms to be put in place to support such trade. One such possible mechanism might be the introduction of differential PRN/PERN values for different end use applications. Such a mechanism may support and add value to favourable end use applications. As previously indicated developments such as the carbon cap introduced by the EUETS is also anticipated to stimulate further demand for cullet amongst EU container manufacturers.

A key element which must be taken into account in development of export / import markets is certainty for UK processors in respect of the regulatory regime in which they will operate. Such operators naturally show reticence in committing to export contracts where any uncertainty exists regarding the value of those markets (for example if differential PRN/PERN values were to be introduced for different end use applications).

In this context it is suggested that actions based upon the findings of this and other reports must be quickly translated into policy tools which support desired outcomes and offer certainty to operators in making commercial decisions.

4.0 Development of an environmental model

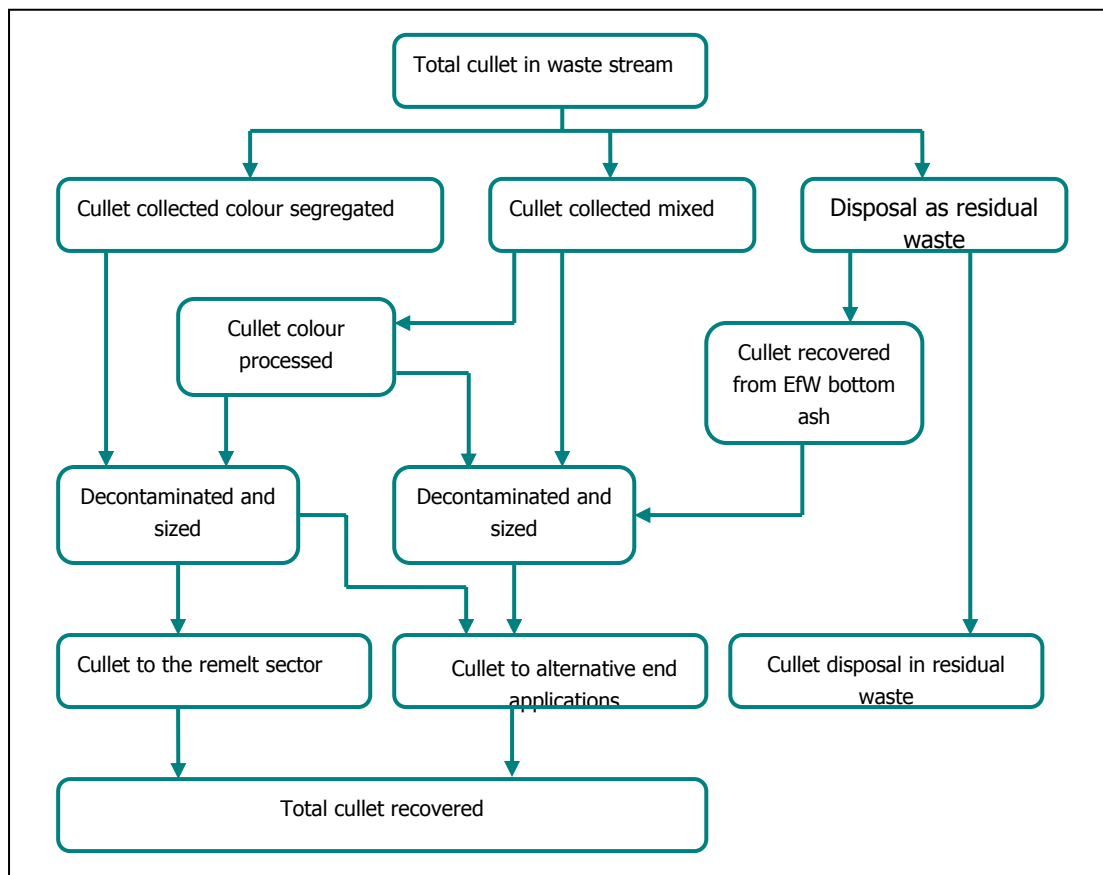
The preceding sections have identified that due to colour imbalance issues an opportunity exists for the export of surplus green / mixed cullet. It has further been identified that potential markets exist for such exports, and indeed significant export is already taking place.

However, the existence of a market does not necessarily equate to the servicing of that market making good environmental sense. As such a major output from this study has been the development of a model to compare the environmental benefits or dis-benefits of serving the various end markets for cullet collected in the UK.

The following section outlines the development of this model.

Figure 8 summarises the UK glass recovery system. The net environmental effect of recovery is influenced significantly by the recovery route taken and the end application. For example, the quality of the material collected dictates the level of processing needed to meet the requirements of the end applications and influences the level of yield losses.

Figure 8: Schematic of glass recovery in the UK



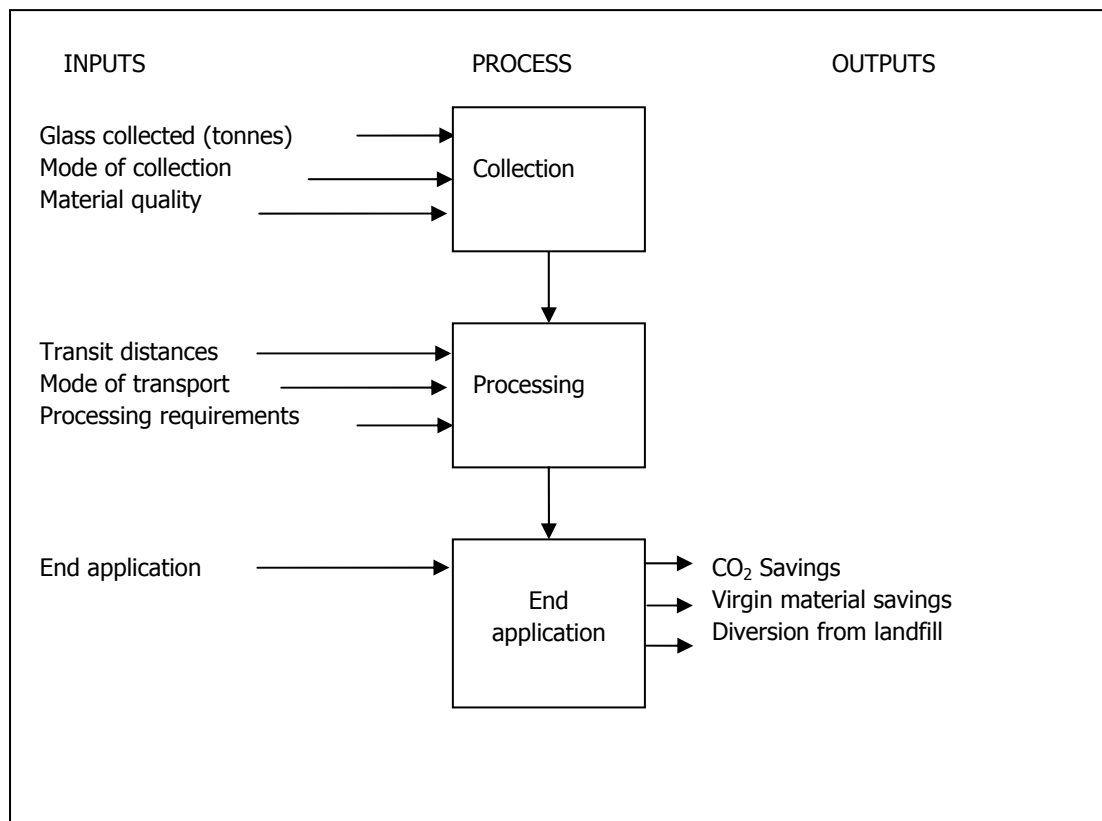
Source: A study into the interaction of imported wine bottles and the UK's cullet supply. GTS and Oakdene Hollins for WRAP. January 2006.

It should be noted that although cullet can be recovered from EfW bottom ash this currently represents a very small percentage of the total and the high level of contamination and the size, which is typically below the 0.95cm required for automated colour sorting, means that it is destined to go to the alternative, lower specification markets. This was discounted within the environmental model as a source of glass with possible remelt end market applications.

Figure 9 shows the required inputs (variables) and outputs from the environmental model. In summary, the user enters customised data such as the tonnage of glass collected, the mode of collection and transit distances and the model calculates the net environmental effect of sending the cullet to the three end applications under review, namely;

- Domestic container glass manufacture
- Domestic aggregates manufacture
- Foreign container glass manufacture

Figure 9. The inputs and outputs to the environmental model



This section is split into the 3 component parts shown in Figure 9 namely Collection, Processing and End application, describing the base data used to determine the model inputs and outputs. The model itself is provided as an Excel spreadsheet which is made available with this report; instructions for its application are included within the spreadsheet.

4.1 Collection

Collection in the context of this study refers to the disposal of glass containers in bring or bottle banks by householders or the kerbside collection of containers by local authorities or contracted waste management companies.

4.1.1 Kerbside collection

The British Glass Life Cycle Carbon Dioxide Emissions Study¹⁵ concluded that the transport impacts of kerbside collection of glass results in a CO₂ burden of 3kgCO₂/t. This was based on the assumption that kerbside collection was undertaken with a 5 tonne load of glass moved 15 miles @ 12 mpg. This assumption was regarded as reasonable in discussions held with a number of local authorities, glass processors and a major waste management company.

¹⁵ *Glass recycling – life cycle carbon dioxide emissions. A life cycle analysis report. Prepared for British Glass by Enviros. November 2003.*

4.1.2 Bring systems

A research project at the University of Southampton¹⁶ researched average car journeys to bring sites in Southampton. Their findings were that only 28% of trips were dedicated journeys, i.e. 72% of journeys did not incur additional environmental burden. The average return journey was found to be 0.267 miles with a CO₂ impact of 0.141kg/mile. Unfortunately, the study did not determine the average weight of each load. Table 22 shows the CO₂ calculations assuming average load weights of 3, 5, 7 and 9kg. The environmental burden of collection varies from 1.2 kgCO₂/t for loads of 9kg to 3.5 kgCO₂/t for loads of 3kg. For the model a figure of 3 kgCO₂/t was considered to be representative since a load of 3kg is equivalent to six wine bottles. In addition, this figure is in line with that of kerbside discussed in section 4.1.1. above.

Table 23. The CO₂ impacts of delivering glass to bring systems

Distance (Miles)	CO ₂ /mile (kg)	Load (kg)	Journeys / tonne	CO ₂ impact (kg/tonne)	Adjustment for dedicated journeys (kgCO ₂ /t)
0.267	0.141	3	333	12.5	3.5
0.267	0.141	5	200	7.5	2.1
0.267	0.141	7	142	5.4	1.5
0.267	0.141	9	111	4.2	1.2

4.1.3 Material quality

The quality of the input material in terms of contaminants, colour contamination and size has a significant bearing on the downstream processing requirements. For example, Figure 10 shows an example of the typical mixed glass recovered from a kerbside scheme. Colour sorting would be required for this material to be used for container manufacture (domestic and export) but not for fibre glass or aggregates. Yield losses of 4% would be anticipated for processing this into containers or furnace ready cullet and 1% yield losses for use in aggregates manufacture.

Figure 10. An example of the mixed cullet recovered from kerbside collection



Figure 11 shows a worst case scenario in terms of poor quality glass. This glass was recovered from a Materials Recycling Facility (MRF). The glass is heavily contaminated with foreign material and could not be processed into furnace ready material since yield rates would be too low and for container manufacture the material is too small to colour sort, i.e. less than the 0.95cm required for automated colour sorting. Currently the majority of the glass recovered from MRFs in the UK goes to the aggregates market¹⁷ with no glass from MRFs used in container

¹⁶ Analysis of energy footprints associated with recycling of glass and plastic – case studies for industrial ecology. University of Southampton, 2004.

¹⁷ Quality standards and efficiency. An international perspective. Bob Graham, Entec and David Dougherty, the Dougherty Group. The Materials Recovery Forum. 8th November 2006.

manufacture in the UK¹⁸. In the USA similar issues have been experienced with the recovery of glass from MRFs with up to 40% of the recovered glass being too small to colour sort¹⁹.

Figure 11. An example of poor quality cullet collected from a MRF



It is noted however that automated sizing of cullet can be incorporated into MRF design with material less than 0.95cm going to sand blasting and aggregates and material above 0.95cm of suitable size to be colour sorted and used in remelt²⁰.

Taking current UK practice into consideration, the model assumes all material from MRFs will be used in the manufacture of aggregates with a yield loss of 20%²¹.

Section 4.1. Summary of Environmental Model base assumptions:

Collection (kerbside and bring) incurs an environmental burden of 3kgCO₂/t

Yield losses of 4% arise during the processing of bring and kerbside glass for container manufacture.

Yield losses of 1% arise during the processing of bring and kerbside glass for aggregates manufacture

Yield losses of 1% arise during the processing of bring and kerbside glass for aggregates manufacture

Yield losses of 20% arise during the processing of MRF glass for aggregates manufacture

No MRF glass is used in container manufacture

4.2 Processing

4.2.1 Transport (Road)

Figure 12 shows the typical vehicles used to bulk haul cullet with average loads of 25 tonnes. Glass processors were consulted to determine fuel consumption (litres/km) during the bulk transfer stages within the process. Data on the volumes of glass recovered, fuel use and distance travelled were provided to enable this calculation to be

¹⁸ Mick Keogh, Berrymans. WRAP Glass Action presentation 7th December 2006.

¹⁹ Breaking down glass recovery. Paul J Smith. Resource Recycling September 2005.

²⁰ Quality standards and efficiency. An international perspective. Bob Graham, Entec and David Dougherty, the Dougherty Group. The Materials Recovery Forum. 8th November 2006.

²¹ Adam Day, Day Aggregates, WRAP Glass Action presentation 7th December 2006.

made and an average figure of 0.4 litres/km was established. Using standard conversion factors²² (1 litre of diesel fuel equates to 2.63 kgCO₂) and with 25 tonne vehicle loads the CO₂ impact per tonne km was calculated at 0.042kg. This figure is used within the model to calculate the kgCO₂/t of,

- Transport from bulking station to processor
- Transport from processor to end application

Figure 12. An example of the vehicles used to bulk haul cullet.



Source: www.recresco.co.uk

4.2.2 Transport (shipping)

The two methods of shipping cullet are via bulk carriers (Figure 13) or containers (Figure 14). Bulk carriers are the most common mode of shipping cullet. For example, Figure 13 shows cullet from the Recresco Southampton plant being loaded onto a vessel in Southampton Docks by conveyor. Open top containers can be used for cullet but the process of loading, typically using a grab or shovel system, can be far more labour intensive and costly. Figure 15 shows the simplicity of using the conveyor system with trucks tipping the cullet straight onto the conveyor. Figure 16 shows an example of the grab system used to load both bulk vessels (where conveyor systems are unavailable) and containers.

Figure 13. An example of a bulk carrier



²² Guidelines for company reporting on greenhouse gas emissions. Annex 1 – fuel conversion factors. Defra, July 2005.

Figure 14. An example of a container vessel.



Figure 15. An example of the conveyor system used to load vessels.



Figure 16. An example of the grab system used to load vessels.



The sizes of vessels vary considerably and the typical bulk vessels used for cullet are,

- Up to 4,000 tonne Coasters – for short haul domestic journeys and to Europe (e.g. Portugal).
- 10,000 tonne Coasters – for medium haul journeys (e.g. USA).
- 30,000 tonne bulk vessel – for long haul journeys (e.g. Australia).

For container vessels a 4639 TEU (Twenty foot Equivalent Unit) is representative.

Table 24 shows the CO₂ impacts per tonne of cullet for each of the 4 shipping modes. The analysis shows that containers cause the least environmental impact.

Table 24. Calculation of the kgCO₂/t per day impact of shipping via the four modes under review.

Shipping mode	Fuel type	Fuel use (t/day)		Fuel conversion factor	Total kgCO ₂ / tonne per day	
		At Sea	In Port		At Sea	In Port
4,000t bulk	MDO	5.5	0.4	3164	4.351	0.316
10,000t bulk	MDO	18	1.5	3164	5.695	0.475
30,000t bulk	MDO	48	5	3164	5.062	0.527
Container vessel ²³	IFO	72	0	3223	2.115	0.108
	MDO	1.1	38	3164		

Source: Fuel use data from Doug Perry. Ship Agencies UK.

Table 25 shows the transit times for each of the shipping modes from Felixstowe, the largest container port in the UK. Table 26 shows the port times for each shipping mode.

²³ Container vessels use a combination of MDO (Medium Diesel Oil) and IFO (Intermediate Fuel Oil). The calculations are based on 4639 containers (TEUs) per vessel and 24 tonnes of cullet per container.

Table 25. Transit times to selected reference ports.

Geographical Zone	Selected reference port	Transit Times by Shipping Mode (days)			
		4,000t Coaster @ 11 knots	10,000t Coaster @ 14 knots	30,000t bulk @ 17.5 knots	Container vessel @ 20 knots
Central Europe	Bremen (Germany)	1.3	1	0.8	0.7
Scandinavia	Göteborg (Sweden)	2.2	1.6	1.2	1.1
Russia	St Petersburg	5	3.9	3.1	2.8
Western Mediterranean	Lisbon (Portugal)	5	3.9	3.1	2.8
Eastern Mediterranean	Izmir (Turkey)	11.1	8.7	7	6.1
S. Africa	Durban	N/A	20.5	16.4	14.3
M. East	Jeddah (S. Arabia)	N/A	11.7	9.4	8.2
India	Mumbai	N/A	18.6	14.9	13
Far East	Tokyo (Japan)	N/A	33.1	26.5	23.2
Australasia	Melbourne (Australia)	N/A	32.9	26.3	23
NE N. America	Montreal (Canada)	N/A	9.6	7.7	6.7
SW N. America	Los Angeles (USA)	N/A	22.9	18.3	16
S. America	Valparaiso (Chile)	N/A	22	17.6	15.4

Source: calculated using the journey calculator at www.world-register.org/dist.htm and speeds provided by Doug Perry – Ship Agencies Ltd.

Table 26. Average time in port for the four shipping modes.

Shipping mode	Port time (days)
4,000 t Coaster	2.5
10,000t Coaster	10
30,000t bulk vessel	10
Container vessel	8

In addition, to shipping being used to export cullet it is also used by, for example, Recresco to bulk transfer material from processing plants to end markets. For example, Southampton Docks to Ellesmere Port. Transit times for such journeys are typically less than 2 days with port times of circa 2.5 days. The environmental model was developed to enable users to manually input this data.

4.2.3 Automated Colour sorting

The two container manufacturing end applications are colour sensitive and cullet processors supplying the container market have introduced colour sorting into their process as a means of accessing the mixed glass market. However, although this can generate additional tonnages for the container industry, the yield rates are lower than those achieved through source segregated cullet or kerbside sorted cullet.

Table 27 shows the yield rate calculations for 1 tonne of mixed cullet sent for automated three colour sorting. Twenty percent of the clear and amber cullet is lost at the initial screening stage due to being undersize. This is either used in the green furnace which is the least colour sensitive of the 3 colours, demand permitting, or will be sent to alternative applications. With current technology, the yield rate of the colour sorting process is 20% clear, 5% amber and 75% green and typically circa 200 kg of clear and 40 kg of amber are generated from the initial 1 tonne of mixed cullet. The remaining 760 kg will be a mix of green and residual glass which cullet processors have stressed can be used for containers. Unfortunately this shows that the colour sorting process compounds

the green glass imbalance since a comparison of the input and output weights shows a yield rate in excess of 100%, namely, 155% (760kg/492Kg x 100%).

Table 27. Yield rates from 1 tonne of cullet in the colour sorting process.

Colour	Colour mix of collected glass (kg)	Yield after initial screening (kg)	Yield from colour sorting (kg)
Clear	402	321	200
Amber	106	85	40
Green	492	594	760

Source: adapted from data from the Colourite study "maximising cullet additions in the glass container industry". Produced by GTS for WRAP. February 2006.

Table 28 shows the cullet colour specification for container glass production highlighting the significant difference between the permitted colour contamination for flint and green cullet, i.e. minimum requirement for flint container manufacture is 97% flint cullet but for green only 70% green cullet is required. However, the green/residual cullet being generated through colour sorting can fall short of the 70% limit, i.e. Table 26 shows that the 760kg of green/residual cullet contains a maximum of 492kg of green cullet (circa 65%). This results in either the need to mix the green/residual cullet from the colour sorting process with green glass collected colour segregated with a lower colour contamination or the initial screening losses are sent to alternative end applications.

Table 28. Cullet colour specification for container manufacture.

Glass production – colour	Coloured contaminants			
	Flint	Green	Amber	Other
Flint	Min 97%	Max 1.5%	Max 2.5%	Max 1.0%
Green	Max 10%	Min 70%	Max 20%	Max 1.5%
Amber	Max 10%	Max 20%	Min 80%	Max 1.0%

Source: Colourite study "maximising cullet additions in the glass container industry". Produced by GTS for WRAP. February 2006.

To compound this problem the low yield rate of amber cullet from the colour sorting process (Table 26, has led to the adoption of two colour automated sorting, i.e. sorting into flint and green with the amber cullet being incorporated in with the green. This both simplifies and speeds up the colour sorting process at the cost of further increasing the yield of green cullet.

On discussing this issue with a glass processor it was stressed that all the green/residual cullet from the colour sorting process can be used for container manufacture. The model will therefore make this assumption.

4.2.4 Additional processing

The British Glass LCA study estimated that electricity usage during recycled material preparation for the remelt markets ranged from 3 to 15 kWh/t or 1.29 to 6.45kgCO₂/t and used a standard figure of 6kgCO₂/t. On consulting glass processors it was considered appropriate to attribute 4kgCO₂/t to the processing of cullet that does not require colour sorting, i.e. all colour segregated glass for container use. A figure of 6kgCO₂/t was assigned where automated colour sorting is required, i.e. the colour sorting of mixed cullet for use in containers.

In addition, a figure of 2kgCO₂/t was considered appropriate for the processing of cullet for aggregates use. This is lower than the 4kgCO₂/t cited in the British Glass LCA but takes into consideration the lower quality requirement and hence reduced processing required when compared against the preparation of container feedstock.

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Section 4.2. Summary of Environmental Model base assumptions:

The environmental impact of bulk road transfer of cullet is 0.042 kgCO₂/tonne km

The environmental impact of shipping cullet is destination specific, see Tables 23, 24 and 25

Two colour sorting yields 80% green cullet and 20% flint

The environmental impact of processing cullet for remelt that does not require colour sorting is 4kgCO₂/t

Colour sorting incurs an additional CO₂ impact of 2kgCO₂/t

The preparation of cullet for aggregates use incurs 2kgCO₂/t

4.3 End application

4.3.1 Closed Loop recycling (container manufacture)

Numerous LCAs have been undertaken on the closed loop benefits of glass recycling compared with landfill. Table 28 shows the results of an LCA review undertaken by WRAP²⁴. The benefits can be seen to vary considerably from 280 kgCO₂/t to 2,030 kgCO₂/t.

Table 29. A comparison of the findings from existing LCA studies on glass

Study reference	Calculated kgCO ₂ /t benefit of closed loop recycling
Glass recycling – life cycle carbon dioxide emissions – a life cycle analysis report Enviro for British Glass 2003	314
Stage 2 report for life cycle assessment for paper and packaging waste management scenarios in Victoria. Melbourne, EcoRecycle 2001	480
Application to integrated waste management planning in Gupuzkoa (Spain) Int J LCA 9 (4) 272-280. 2004	480
Evaluation of costs and benefits for the achievement of reuse and the recycling targets for the different packaging materials in the frame of the packaging and packaging waste directive 94/62/EC. Brussels. European Commission 2003.	2,030
Waste management options and climate change. Final report to the European Commission. DG Environment 2001	280
Packaging and the environment – life cycle assessments of packaging materials – calculations of environmental impact, statens offentliga utredningar 1991:77	280
Solid waste management and greenhouse gases. A life cycle assessment of emissions and sinks. 2 nd edition EPA530-R-02-006 May 2002	320
Municipal waste life cycle assessment Appendix B: transport analysis and glass case study. Process safety and environmental protection. Volume 77 issue B5, 259-274. September 1999	467

The WRAP LCA review quoted with regard to the studies reviewed that;

“The results and interpretation of closed loop recycling have general validity, and they represent UK conditions well. The comparison of recycling versus landfilling was the most relevant to current UK waste management”.

²⁴ Environmental benefits of recycling. An International review of life cycle comparisons for key materials in the UK recycling sector. WRAP. May 06.

However, the British Glass LCA is the only one to focus on UK production and to provide inventory data for all stages of the life cycle, and is therefore the most suitable for use in developing a model which can be varied at several stages.

Table 30 shows the detailed results from the study of the use of cullet for domestic containers. It is noted that the results are identical for the export of cullet for foreign container manufacture with the exception of an additional 11 kgCO₂/t assigned to the transport by sea and 13 kgCO₂/t to transport from dockside to processor. The majority of CO₂ savings arise at the “glass melting and container production” stage, i.e. savings of 273 kgCO₂/t. This figure was slightly revised down in a further study²⁵ to 246 kgCO₂/t (185 kgCO₂/t in process CO₂ emissions due to the avoidance of the breakdown of the carbonates limestone, dolomite and soda ash and a 61 kgCO₂/t reduction in the thermo chemical heat required to promote the chemical reaction in the furnace). This revised figure, reducing the overall net effect shown in Table 28 from -314 kgCO₂/t to -287 kgCO₂/t, is used as the industry standard and therefore is used for the model.

Table 30. CO₂ life cycle emissions for container glass manufacture (kg CO₂/tonne). Virgin material versus recycled glass.

Source Materials	Virgin Materials	Recycled Glass
Extraction and production of raw materials	53	-
Transport raw materials to glass factory	6	-
Recycled material preparation	-	6
Glass melting and container production	779	506
Transport to disposal	5	-
Collection and transport to bulking site	-	3
Transport from bulking station to processor	-	13
Transport from processor to glass factory	-	1
CO ₂ e figure for life cycle	843	529
Net effect of substituting recycled materials for virgin per tonne	n/a	-314

Consequently, the net environmental effect of using recycled material for foreign container manufacture will also be revised from the -290 kgCO₂/t specified in the British Glass study to -263 kgCO₂/t.

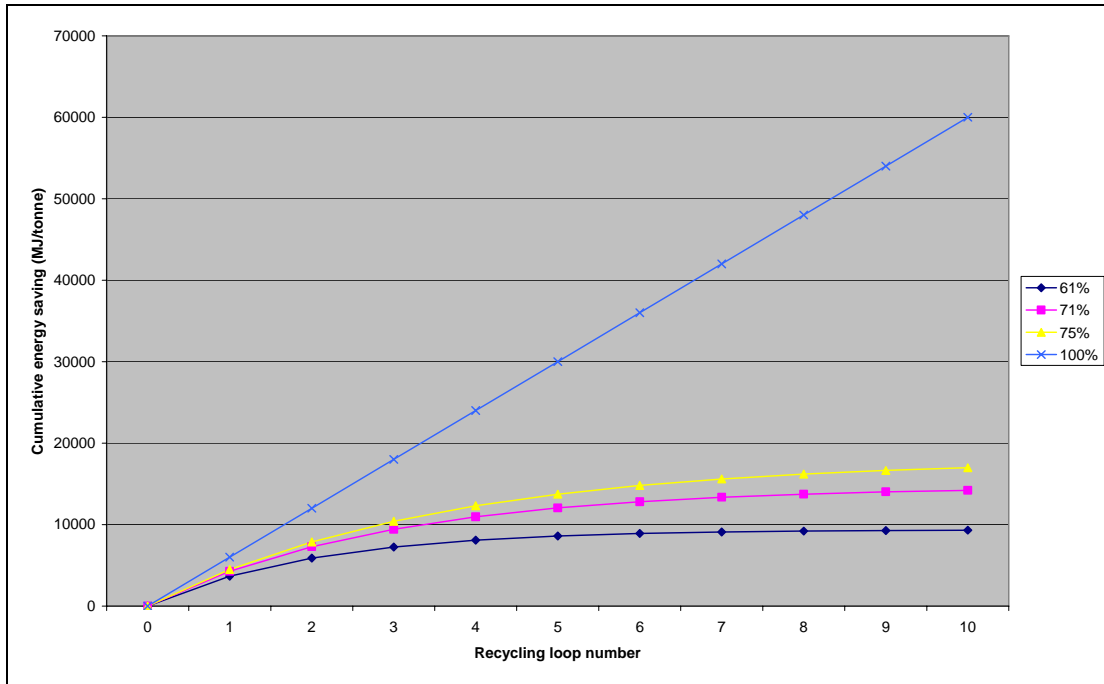
All the LCAs detailed in Table 28 have focussed on the single loop benefits of recycling. However when used in container manufacture the cyclical make, consume, recover, recycle nature of the process means that the same glass can be used and recycled repeatedly (multi loop) and hence the benefits of using cullet for containers extends beyond this first loop.

Figure 17 shows the results of a study estimating the environmental benefits of multi loop²⁶. Focus was placed on obligated business recovery rates of 61%, 71%, and 75% in line with the UK glass packaging recovery targets for 2006, 2008 and 2009 respectively. The 100% recovery scenario was added to highlight the maximum benefit that can theoretically be realised. It can be seen that with a recovery rate of 61% the multi loops increase benefits by a factor of 2.5.

²⁵ *A study of the balance between furnace operating parameters and recycled glass in glass melting furnaces. Glass Technology Services, September 2004.*

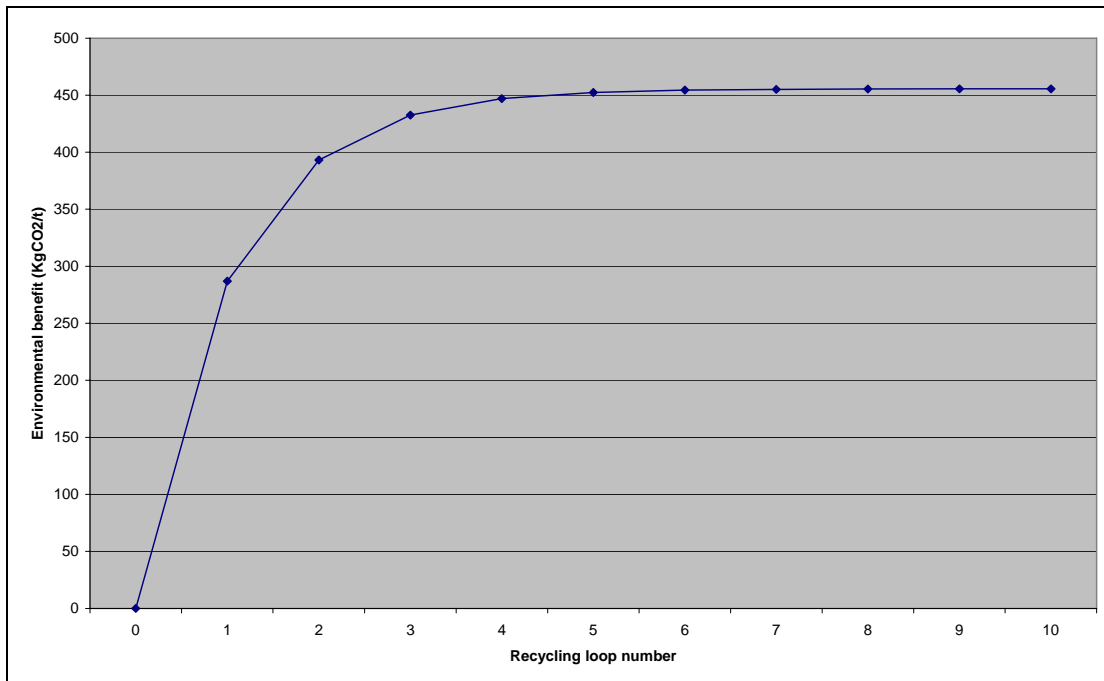
²⁶ *Dilemmas in optimising the environmental benefit from recycling: A case study of glass container waste management in the UK. Manchester Metropolitan University. Resources, Conservation and Recycling 45 (2005) 331 – 355.*

Figure 17. A projection of the multi loop benefits of closed loop recycling.



This study evaluates the maximum benefit if all glass was recovered through closed loop. However based on the proportion of glass being recovered through alternative markets, only approximately 37% of the glass in the material waste stream is likely to be recycled back into containers in 2008 and Figure 18 shows the revised multi loop plot. The environmental benefit increases from 287 kgCO₂/t for a single cycle to 455 kgCO₂/t for the multi cycle.

Figure 18. A projection of the multi loop benefits at 37% closed loop recycling .



Unfortunately, although the benefits from the multi cycles are clearly evident the difficulties arise in developing a robust methodology for modelling the benefits. The general consensus among LCA practitioners is that current methods of determining the benefits from multi loops require numerous assumptions to be made which undermine the robustness of the study. For example, the overall environmental benefit of recycling using a recovery rate of 37% (the anticipated recovery rate back into domestic containers in 2008) over 10 cycles is 455

kgCO₂/t whereas the benefit with a national recovery rate of 60% (the national target for 2008) would be 713 kgCO₂/t. It was therefore concluded that the single loop figure of 287 kgCO₂/t would be used within the model but a scenario would be developed to review the hypothetical benefits of multi loops.

4.3.2 Open loop

Table 32 shows the results of the LCA study for aggregates which showed the net environmental emissions to be slightly greater when using cullet to replace virgin aggregate.

Table 32. CO₂ life cycle emissions for aggregates manufacture (kg CO₂/tonne). Virgin material versus recycled glass.

Source materials	Virgin materials	Recycled glass
Extraction and processing of aggregates	4	-
Reprocessing	-	4
Transport to processor / reprocessor	3	2
Primary processing or reprocessing	5	5
Collection and transport to bulking site	-	3
Removal	2	2
Transport to disposal	2	2
CO ₂ e figure for life cycle	16	18
Net effect of substituting recycled materials for virgin per tonne	n/a	2

Further studies into the use of glass in aggregates, focussed at a regional level, suggest that there is an environmental benefit to using cullet as secondary feedstock for aggregates although not as significant as that of containers. For example, a study was undertaken to determine the environmental impact of the Days Aggregates Eco Site in London which, based on an "ecological footprint" approach, concluded that recycling glass into aggregates saves approximately 50 kgCO₂/tonne of glass reprocessed²⁷.

A study undertaken at the University of Southampton concluded that in Southampton²⁸;

"In terms of energy consumption, recycling is the preferred waste management option, even if a large proportion (but not all!) of this recycled glass is diverted [from landfill] for use as aggregates"

Manchester Metropolitan University reports²⁹ that a study undertaken in Manchester by EMERGE recycling concluded that 70 MJ/tonne of primary energy is saved when using cullet in place of virgin feedstock for aggregates and 6,000 MJ/tonne in the container industry.

A review of life cycle assessments on glass was undertaken for WRAP by the technical University of Denmark. The review of 11 studies concluded that³⁰;

"The type of recycling applied can be an important issue when determining the relative advantage of recycling compared to either landfilling or incineration. Hence, closed loop recycling seems superior to both incineration and landfilling in environmental terms, while recycling in e.g. aggregates or filtration media seems to be

²⁷ *The impact of the London Remade – Days aggregates eco site. WSP environmental Ltd and LEPU. March 2004.*

²⁸ *Analysis of energy footprints associated with recycling of glass and plastic – case studies for industrial ecology. University of Southampton, 2004.*

²⁹ *Dilemmas in optimising the environmental benefit from recycling: A case study of glass container waste management in the UK. Manchester Metropolitan University. June 2005.*

³⁰ *Strategic environmental review of waste management options – glass waste. Report for WRAP by the Technical University of Denmark. July 2005.*

disadvantageous. Consequently, generation of information on the life cycle wide environmental implications of alternative glass recycling options could be useful”

For consistency and since the study was undertaken at a UK wide level, it was considered appropriate to use the results of the British Glass study within the model. However, a scenario will be developed to review the effect of using cullet in aggregates manufacture using a net environmental effect of 50 kgCO₂/t.

4.3.3 Virgin raw material savings

It has been estimated that each tonne of glass returned to the melting furnaces reduces virgin material demands by 1.2 tonnes due to the losses through the carbonate dissociation process³¹. Assuming contamination rates of 4% this results in 1.15t of virgin materials being saved for every 1 tonne of cullet collected, i.e. 1.2t x yield rate (96%).

A study undertaken for WRAP by the University of Dundee³² reports that;

"Where the use of glass as an aggregate is to be assessed, the mass of glass required to replace a given volume of normal weight aggregate is used as the functional unit. Given that normal weight aggregate typically has a density of 2,600kg/m³ and glass typically has a density of 2,500kg/m³, 1 tonne of normal weight aggregate can be replaced with 962kg of glass”.

Therefore each tonne of cullet used saves 1.04 tonnes of virgin aggregate. This equates to 1.03 tonnes for every tonne of cullet collected via the kerbside or bring-scheme and 0.83 tonnes for every tonne of cullet collected through a MRF.

4.3.4 Diversion from landfill

For each of the end applications diversion from landfill is dependent on contamination rates and Table 33 shows the correlation.

Table 33. Cullet contamination rates

Collection method	Remelt		Aggregates	
	Contamination rate	Diversion from landfill	Contamination rate	Diversion from landfill
Non MRF	4%	96%	1%	99%
MRF	N/A	N/A	20%	80%

The environmental modelling assumptions associated with cullet end use are summarised below:

³¹ A study of the balance between furnace operating parameters and recycled glass in glass melting furnaces. GTS for Carbon Trust. September 2004.

³² Promoting best practicable environmental options for the commercially sustainable use of glass cullet in construction. University of Dundee, March 2004.

Section 4.3 Summary of Environmental model base assumptions. NB: An additional burden of 2 kgCO₂/t will be added where colour sorting is undertaken.

End market	British Glass LCA net emissions (kgCO ₂ /t)	Revisions made through new studies	Life Cycle phases to be converted to variables in model		Constant used in model (kgCO ₂ /t)	Diversion from landfill (% of glass collected)		Virgin material savings (% of glass collected)	
			Phase	net emissions (kgCO ₂ /t)		Non MRF	MRF	Non MRF	MRF
Containers	-314	-289	Transport from bulking station to processor	-13	-289-14=-303	96%	N/A	115%	N/A
			Transport from processor to glass factory	-1					
Export	-290	-263	Transport from bulking station to dockside	-13	-263-38=-301	96%	N/A	115%	N/A
			Transport by sea	-11					
			Transport from dockside to processor	-13					
			Transport from processor to glass factory	-1					
Aggregates	2	0	Transport to processor / reprocessor	-2	0-4=-4	99%	80%	103%	83%
			Transport to disposal	-2					

The base data assumptions developed in sections 4.1-4.3 above, have been developed into a model using an Excel workbook platform, available with this report.

The outcomes from applying this model to different scenarios are given in the following section.

5.0 Scenario testing

In this section the environmental model is used to compare the net environmental effect of the 7 alternative outcome options contained in the model (Table 34) in four scenarios, namely:

- Scenario 1: How do the seven options rank from a local authority perspective?
- Scenario 2: A review of the seven options using the UK market projections for 2008.
- Scenario 3: A review of the seven options using the UK market projections for 2010.
- Scenario 4: A review of the seven options using the UK market projections for 2015.

Table 34. The seven cullet recovery options reviewed in this study

Option	End application by cullet colour		
	Flint	Amber	Green
1	UK Containers	UK Containers	UK Containers
2	UK Containers	UK Containers	Aggregates
3	UK Containers	UK Containers	Export by 4,000t Coaster
4	UK Containers	UK Containers	Export 10,000t Coaster
5	UK Containers	UK Containers	Export by 30,000t Bulk Vessel
6	UK Containers	UK Containers	Export by Containership
7	Aggregates	Aggregates	Aggregates

5.1 Scenario 1: How do the seven options rank from a local authority perspective?

This scenario was undertaken from a local authority or waste collectors perspective, i.e. we have a quantity of glass and we wish to determine the most beneficial environmental recovery route. Table 34 shows the input quantities (Step 1 in the model) used within the scenario; these are based on the annual quantities received from a relatively large waste disposal authority. It is noted that the colour split was provided but the mode of collection has been split equally with the exception of mixed glass which it was assumed was collected through kerbside.

Table 35. Collection type and volumes used to represent the typical local authority

Collection type	Colour	Tonnage of cullet collected
Kerbside	Green	3,851
	Flint	2,300
	Amber	678
	Mixed	5,174
Bring / Bottlebank	Green	3,851
	Flint	2,300
	Amber	678
	Mixed	
MRF	Mixed	742
	Total	19,574

The bulk transfer distances (step 2 in the model) were taken from the British Glass LCA study, Table 36.

Table 36. Transport distances used to represent the typical recovery system from a local authority

Factor	Road Distance (kilometres)
Transport from bulking station to remelt processor	160
Transport from processor to glass (container) factory	16
Transport from bulking station to aggregates processor	48
Transport from aggregates processor to aggregates manufacturer	48
Transport from remelt processor to aggregates manufacturer	48
Transport from remelt processor to UK dockside	50
Transport from dockside in destination country to processor	160

5.1.1 Exporting to the nearest geographical zone

On the environmental model "Central Western Europe (Germany)" was selected from the pull down menu (Step 3).

Table 37 shows the results from the model. This shows that in CO₂ terms the use of cullet for UK container manufacture (Option 1) is best with a potential CO₂ saving of over 5,500 tonnes. The four export options (options 3 to 6) are clustered just behind this, highlighting their environmental potential in terms of being an alternative end application for the surplus green cullet. Using all the cullet for aggregate production would result in a lost CO₂ savings opportunity of 5,558 tonnes (Option 1 – Option 7).

Table 37 Scenario 1 results. Nearest export market

Option (see Table 33)	Mean CO ₂ savings (kgCO ₂ /t)	Total CO ₂ savings (tonnes)	Total virgin material savings (tonnes)	Total material diverted from landfill (tonnes)
1	284	5,557	21,657	18,079
2	99	1,932	20,853	19,028
3	274	5,360	21,657	18,079
4	271	5,312	21,657	18,079
5	272	5,326	21,657	18,079
6	276	5,408	21,657	18,079
7	0	-1	20,014	19,237

Aggregates do however represent the best option in terms of the diversion of material from landfill since it is the only option of the four applications that can process cullet from MRFs and it has lower yield losses. However, from a resource efficiency perspective, it is difficult to endorse this end application when it has such a negative relative impact on CO₂. It is therefore suggested that rather than endorsing the use of cullet as aggregate this finding highlights the need to avoid the collection of poor quality material through such processes as low technology MRFs. The 742 tonnes of glass collected through the MRF (Table 34) represents a 24kgCO₂ burden whereas if this was collected either mixed or colour segregated through kerbside or bring systems a CO₂ saving of over 217 tonnes would be realised.

5.1.2 Exporting to the furthest geographical zone

Table 38 shows the comparative net environmental effect of exporting cullet to the furthest market, i.e. the Far East. Unlike in Scenario 1 where the CO₂ impact of the four export markets was clustered, in this example the benefits are more dispersed. The use of 4,000 tonne Coasters for long haul shipping is not a viable option and hence Option 3 drops out. The other three modes of shipping do remain significantly CO₂ positive with the shipment by container being the most beneficial with a mean saving of 249 kgCO₂/t (Option 7).

Table 38. Scenario 1 results. Furthest export market

Option	Mean CO ₂ savings per tonne (kgCO ₂ /t)	Total CO ₂ savings (tonnes)	Total virgin material savings (tonnes)	Total material diverted from landfill (tonnes)
1	284	5,557	21,657	18,079
2	99	1,933	20,853	19,028
3	N/A	N/A	N/A	N/A
4	161	3,148	21,657	18,079
5	193	3,786	21,657	18,079
6	248	4,845	21,657	18,079
7	0	-626	20,014	19,237

Table 39. The net environmental effect (kgCO₂/t) of exporting cullet to each geographic zone.

Export destination	Mean CO ₂ saving (kgCO ₂ /t) using containerships
Central Western Europe (Germany)	276
Scandinavia (Sweden)	276
Russia (St Petersburg)	274
Western Mediterranean (Portugal)	274
Eastern Mediterranean (Turkey)	269
NE N. America (Canada)	269
Middle East (Saudi Arabia)	267
India	261
South Africa	259
South America (Chile)	258
SW N. America (Los Angeles)	257
Australia	248
Far East (Japan)	248

The above analysis clearly considers container ships. It is recognised that higher impact bulk ships are often used in such trade, but this study sets out to identify the most environmentally favourable option, and hence container ships are considered here. However, recognising this, the model associated with this work does permit analysis of the environmental impact associated with different shipping modes.

5.1.3 Increasing the environmental benefit of aggregates to 50 kgCO₂/t

This scenario ran the same data as section 5.1.2 but with the CO₂ benefit of aggregate use being increased to 50 kgCO₂/t (see section 4.3.2). Table 40 shows the results and it can be concluded that although this closes the gap between the options slightly, aggregates still remains the worst performer in CO₂ terms.

Table 40. Scenario 1 results. Increasing the CO₂ savings from aggregates to 50 kgCO₂/t

Option	Mean CO ₂ savings per tonne (kgCO ₂ /t)	Total CO ₂ savings (tonnes)	Total virgin material savings (tonnes)	Total material diverted from landfill (tonnes)
1	284	5,557	21,657	18,079
2	128	2,512	20,853	19,027
3	259	5,071	21,657	18,079
4	N/A	N/A	N/A	N/A
5	161	3,148	21,657	18,079
6	193	3,786	21,657	18,079
7	248	4,845	21,657	18,079
8	245	4,795	21,657	18,079
9	46	900	20,014	19,237

5.1.4 The impact on the net environmental effect of collecting cullet through MRFs

The objective of this analysis was to determine the environmental impact the collection of cullet through a MRF would have on the net environmental effect of the nine options. Table 40 shows the input data (Step 1 of the model). Each of the 5 sets of inputs was entered into the model and the CO₂ impacts derived. The transport distances were retained from Table 36 and the nearest export market was selected.

Table 41. Model input data for MRF analysis

Collection type	Colour	Quantity of cullet collected through a MRF (tonnes)				
		0%	10%	20%	50%	100%
Kerbside	Green	3,851	3,466	3,081	1,926	0
	Flint	2,300	2,070	1,840	1,150	0
	Amber	678	610	542	339	0
	Mixed	5,916	5,324	4,733	2,958	0
Bring / Bottlebank	Green	3,851	3,466	3,081	1,926	0
	Flint	2,300	2,070	1,840	1,150	0
	Amber	678	610	542	339	0
	Mixed	0	0	0	0	0
MRF	Mixed	0	1,957	3,915	9,787	19,574

Table 42 shows the impact the collection of cullet through a MRF has on the net environmental effect of each option. This shows that although the relative rankings of each option remain consistent the CO₂ benefit drops off dramatically. This clearly highlights the negative effects on recovery low technology MRFs can have.

Table 42. The impact on CO₂ of collecting cullet through a MRF (kgCO₂/t)

Option	The impact on CO ₂ of collecting cullet through a MRF (kgCO ₂ /t)				
	0%	10%	20%	50%	100%
1	295	266	236	148	0
2	100	90	80	50	0
3	269	242	215	134	0
4	284	256	228	142	0
5	282	254	226	141	0
6	283	254	226	141	0
7	287	258	230	144	0
8	255	229	204	127	0
9	0	0	0	0	0

5.1.5 The impact on the net environmental effect of increasing the transport distance from the bulking station to the remelt processor.

In this scenario the transport distance from the bulking station to the remelt processor was increased from 160km, as shown in Table 35, by 10%, 20%, 50% and 100%. Table 43 shows that even when doubling the distance from 160km to 320km the relative ranking of the seven options do not alter and only results in a 2.5% reduction in kgCO₂/t of such options as domestic container manufacture. This is a key finding for local authorities who have assumed that the "local" aggregates market is the best environmental option.

Table 43. The impact on CO₂ of increasing the transport distances (kgCO₂/t)

Option	The impact on CO ₂ of increasing the transport distance between the bulking station and the processor (kgCO ₂ /t)				
	0%	10%	20%	50%	100%
1	284	283	283	281	277
2	99	98	97	94	90
3	274	273	273	271	267
4	271	271	270	268	265
5	272	271	271	269	266
6	276	276	275	273	270
7	0	0	0	0	0

5.1.6 Accounting for the multi loop benefits of closed loop recycling

As stressed in Section 4.3.1. there is no recognised method for quantifying the multi loop benefits of closed loop recycling, especially when considering the additional benefits when exporting cullet for foreign container manufacture. However, this scenario examines the "possible" additional benefits using the following assumptions;

- The multi loop CO₂ savings when recovering cullet through UK container manufacture with a recovery rate of 60% is 713 kgCO₂/t.
- The multi loop CO₂ savings when recovering cullet through foreign container manufacture with a recovery rate of 60% is 657 kgCO₂/t.
- The multi loop virgin material savings when recovering cullet through UK container manufacture with a recovery rate of 60% is 2.852t/t.
- The multi loop landfill diversion savings when recovering cullet through UK container manufacture with a recovery rate of 60% is 2.3808t/t.

Table 44 shows the results of this analysis when exporting to Central Western Europe and Table 45 to the Far East. Unsurprisingly, the results show a significant increase in the benefits of closed loop recycling.

Table 44. The results of including the multi loop benefits of closed loop recycling when exporting to Central Western Europe

Option	Mean CO ₂ savings per tonne (kgCO ₂ /t)	Total CO ₂ savings (tonnes)	Total virgin material savings (tonnes)	Total material diverted from landfill (tonnes)
1	678	13,277	53,709	44,835
2	245	4,798	32,752	28,960
3	407	7,961	33,555	28,011
4	636	12,442	53,709	44,835
5	633	12,394	53,709	44,835
6	634	12,408	53,709	44,835
7	638	12,490	53,709	44,835
8	247	4,832	21,657	18,078
9	46	900	20,014	19,237

Table 45. The results of including the multi loop benefits of closed loop recycling when exporting to the Far East

Option	Mean CO ₂ savings per tonne (kgCO ₂ /t)	Total CO ₂ savings (tonnes)	Total virgin material savings (tonnes)	Total material diverted from landfill (tonnes)
1	678	13,277	53,709	44,835
2	245	4,798	32,752	28,960
3	407	7,961	33,555	28,011
4	N/A	N/A	N/A	N/A
5	523	10,230	53,709	44,835
6	555	10,867	53,709	44,835
7	609	11,927	53,709	44,835
8	247	4,832	21,657	18,078
9	46	900	20,014	19,237

5.2 Scenario 2. A review of market projections for 2008

This scenario uses the market projections detailed in Section 2 Table 11a with no mixed glass being recovered from MRFs. The same bulk transfer distances were used as in scenario 1, Table 36.

Table 46. The 2008 projected cullet recovery

Collection type	Colour	Tonnage of cullet collected
Kerbside	Green	
	Flint	
	Amber	
	Mixed	1,179,000
Bring / Bottlebank	Green	224,000
	Flint	183,000
	Amber	48,000
	Mixed	
MRF	Mixed	
	Total	1,634,000

Table 47 shows the results. This shows that if all the cullet recovered in 2008 could be used in domestic container manufacture (Option 1) then a saving of 480,000 tonnes in CO₂ and 1,800,000 tonnes in virgin materials would be achieved with a 1,500,000 tonnes diversion from landfill.

Table 47. The net environmental effects of the nine options in 2008

Option	Mean CO ₂ savings per tonne (kgCO ₂ /t)	Total CO ₂ savings (tonnes)	Total virgin material savings (tonnes)	Total material diverted from landfill (tonnes)
1	294	480,665	1,879,100	1,568,640
2	66	107,547	1,739,036	1,603,656
3	265	432,810	1,879,100	1,568,640
4	282	461,297	1,879,100	1,568,640
5	279	456,629	1,879,100	1,568,640
6	280	457,943	1,879,100	1,568,640
7	285	466,084	1,879,100	1,568,640
8	255	416,029	1,879,100	1,568,640
9	0	-52	1,683,020	1,617,660

However, this analysis does not take into consideration the supply and demand issues with regard to domestic container manufacture. Table 47 shows the analysis of the recovered volumes using the base data from Table 11a and the projected volumes that will be recovered through domestic container manufacture. This shows that 966,000 tonnes will be recovered through domestic container manufacture with a 668,000 tonne surplus of green / mixed cullet.

Table 48. Analysis 2008 base data

	Flint	Amber	Green / mixed	Total
Total recovered cullet	363,000	131,000	1,140,000	1,634,000
Projected cullet to domestic container manufacture	363,000	131,000	472,000	966,000
Surplus material for alternative end use	0	0	668,000	668,000

Table 49 shows the breakdown of the collection method for the 966,000 tonnes that will be used for domestic container manufacture, i.e. step 1 of the environmental model. This will generate a CO₂ saving of 284,535 tonnes, virgin material savings of 1,110,900 tonnes and divert 927,360 tonnes from landfill.

Table 49. The collection method for 2008 domestic container manufacture

Collection type	Colour	Tonnage of cullet collected
Kerbside	Green	
	Flint	
	Amber	
	Mixed	541,000
Bring / Bottlebank	Green	224,000
	Flint	183,000
	Amber	48,000
	Mixed	
MRF	Mixed	
Total		996,000

Table 50 shows the net environmental effect of sending the 668,000 tonnes surplus green / mixed material through the alternative end applications (options 2 to 9). This shows option 7 to be the best environmental option for the surplus cullet. Table 50 shows that when these benefits are combined with the benefits of sending the 966,000 tonnes to domestic container manufacture the benefits are not too far short of the theoretical best option of sending all cullet to domestic remelt, i.e. the theoretical best of 480,665 tonnes of CO₂ as opposed to 473,656 tonnes in Table 51.

Table 50. Analysis of the alternative options for surplus cullet in 2008

Option	Mean CO ₂ savings per tonne (kgCO ₂ /t)	Total CO ₂ savings (tonnes)	Total virgin material savings (tonnes)	Total material diverted from landfill (tonnes)
2	0	-21	688,040	661,320
3	255	170,078	768,200	641,280
4	279	186,381	768,200	641,280
5	275	183,710	768,200	641,280
6	276	184,462	768,200	641,280
7	283	189,121	768,200	641,280
8	255	170,078	768,200	641,280
9	0	-21	688,040	661,320

Table 51. The best combined option for cullet recovery in 2008

Activity	Tonnage	Total CO ₂ savings (tCO ₂)
Cullet use in domestic container manufacture	966,000	284,535
Use the surplus recovered cullet in the next best application – Option 7.	668,000	189,121
Total	1,634,000	473,656

In addition, the maximisation of cullet used in domestic container manufacture through the importing of flint and amber cullet can have additional net environmental benefits. Table 11a shows that a further 404,000 tonnes of flint cullet and 75,000 tonnes of amber cullet could be used. The importing of 479,000 tonnes of flint and amber cullet would result in a further CO₂ saving of 136,570 tonnes, virgin material saving of 550,850 tonnes and would divert 459,840 tonnes from landfill in the country of origin.

5.3 Scenario 3. A review of market projections for 2010

This scenario follows the same methodology as Scenario 2 with Table 52 summarising the results.

Table 52. The best combined option for cullet recovery in 2010

	Recovered domestic cullet			Import to domestic container manufacture
	Domestic container manufacture	Best alternative option (option 7)	Total	
Total cullet (tonnes)	1,045,000	689,000	1,734,000	508,000
CO ₂ saving (tonnes)	307,672	195,067	502,739	144,839
Virgin material savings (tonnes)	1,201,750	792,350	1,994,100	584,200
Diversion from landfill (tonnes)	1,003,200	661,440	1,664,640	487,680

5.4 Scenario 4. A review of market projections for 2015

This scenario follows the same methodology as Scenario 2 with Table 53 summarising the results.

Table 53. The best combined option for cullet recovery in 2015

	Recovered domestic cullet			Import to domestic container manufacture
	Domestic container manufacture	Best alternative option (option 7)	Total	
Total cullet (tonnes)	1,357,000	1,007,000	2,364,000	485,000
CO ₂ saving (tonnes)	399,196	285,097	684,293	138,281
Virgin material savings (tonnes)	1,560,550	1,158,050	2,718,600	557,750
Diversion from landfill (tonnes)	1,302,720	966,720	2,269,440	465,600

6.0 Conclusion and Discussion

This study has identified international trade opportunities for cullet for use in container remelt, principally in near Europe, and has demonstrated that recycling of container cullet back to furnace remains the best environmental option by a considerable margin, even when significant shipping distances are involved.

The total cullet demand for use in UK container manufacture is expected to approach 2 million tonnes by 2015.

The results demonstrate that transport emissions do not have a significant impact on the overall level of emissions savings attributable to the use of cullet in glass manufacture. It is also evident that cullet going back into remelt, at home or abroad, has a significantly better carbon impact than using it in domestic aggregate manufacture.

Maximising the quantities of cullet used in domestic remelt should be considered a primary objective for local authorities, glass processors and policy makers. The export of cullet to foreign container manufacturers represents a good alternative market for surplus green and mixed cullet. Complementing the use of the best environmental option with the alternative end applications can realise savings of over 470,000 tonnes in CO₂, 1.8 million tonnes in virgin materials and divert over 1.5 million tonnes from landfill.

However, comparatively the aggregates market represents a poor use of surplus cullet and could by 2015 represent a lost opportunity in CO₂ savings of 285,000 tonnes per year. It should be noted that this study has not assessed markets which are currently either less well developed or represent relatively small volumes e.g. filtration, grit blasting and as a fluxing agent in brick manufacture.

Table 54 summarises the significance of the attributes investigated within this study.

Table 54. Summary of attributes

Attribute	Significance	Comments
End application	Very high	The diversion from landfill and the virgin material savings do not vary significantly across the four end applications. However, aggregates can dramatically reduce realised CO ₂ savings.
Transport distance from bulking station to remelt processors	Low	Doubling the distance travelled from 160Km to 320Km causes only a 2.5% reduction in CO ₂ savings. This shows that from a CO ₂ perspective the proximity principle arguing the case for local aggregates is invalid.
Inclusion of multi loop	High	The inclusion of the multi loop benefits of closed loop recycling to container manufacture can have a significant positive impact on the overall environmental benefits and CO ₂ savings available from this application.
Increasing the net environmental effect of aggregates	Low	Increasing the net environmental effect to 50kgCO ₂ /t has no impact on the relative rankings of each of the four end applications reviewed in this study. That is, remelt remains the best environmental option.
Geographic proximity of export market	Medium	The CO ₂ savings from exporting cullet for foreign remelt in the Far East is 10% less than that of exporting to Central Western Europe.
Collection through UK MRFs	High	The use of MRFs as a source of cullet has a detrimental impact on CO ₂ savings and represents an environmental opportunity loss. For example, if 50% of cullet is collected through a MRF then the CO ₂ savings drop by 50% as currently this material is not suitable for re-melt due to high contamination levels.

This analysis has clearly shown the environmental benefits of international trade in cullet for container remelt, and that this trade is complementary to domestic container remelt. The additional environmental burdens associated with transporting cullet long distances do not outweigh the benefits.

This study has supported these findings by identifying potential (and in some cases realised) export and import trade opportunities, principally with close European neighbours, but also with other more distant possibilities such as Argentina, South Africa and South Korea. Some of these markets, such as Portugal should prove sustainable. However, other countries, such as Spain, whilst currently important could prove of limited life as they become self sufficient in cullet due to improved recovery rates associated with the Packaging and Packaging Waste Directive. In the case of many countries lack of availability of complete and robust information precludes quantitative forecasting of forward cullet markets. Whilst regrettable, the poor availability of such data is, in itself a notable finding of this study.

Some more geographically distant export opportunities such as Turkey, are financially precluded at the current time due to unfavourable transport costs and a regulatory regime which offers no incentive for serving these markets. For example, the packaging waste regulations currently offer no incentive to serve the more environmentally beneficial forms of recovery.

Available export opportunities are also set in the context of a competitive market with other countries such as Germany and Switzerland representing threats to UK export markets, and as recovery rates improve in other countries, other regional competitors may emerge.

This analysis highlights the need to treat cullet as a valued resource rather than a liability. To date, Government policies have predominantly focussed on the diversion of waste from landfill and in this context the study shows that there is no major difference across the options reviewed. However, looking forward CO₂ is now firmly on the agenda and this study shows that the recovery options taken must be considered carefully if the full environmental benefits of recycling cullet are to be realised. Currently local authorities and glass processors have little or no regulatory, financial or practical incentive for choosing the best environmental option.

The development of MRFs as a means of recovering cullet represents a potential threat to the achievement of best environmental cullet recovery if, as is the case at present, the quality of the recovered material is so poor that it can only be used for aggregates. The term MRF covers a multitude of different technologies and it is recommended that a review be undertaken to develop a minimum technology specification based on the ability to recover cullet to a quality acceptable to the re-melt markets. The required post processing quality for container manufacture is given in the voluntary quality specification resulting from the 'Containerlite' project (reference section 3.3.3.5). The formal PAS102³³ specification does offer post processing cullet quality requirements for a number of secondary cullet end use markets, but specifically does not include the quality required for container or fibre re-melt processes. This position may warrant review.

No dedicated specification exists for the minimum pre-processing cullet quality explicitly suitable for processing into a form suitable for container and/or fibre re-melt applications. Such a specification would offer criteria against which different collection and recovery technologies and approaches could be judged. The PAS101 specification³⁴ specifies different cullet quality grades, A to D, at delivery to the processors gate, but does not link these grades to specific end uses. It should also be noted that PAS101 does not take into account MRF glass, as this was not considered an issue at the time.

The study also shows that the collection of mixed cullet and its automated colour sorting has very little environmental impact when compared with the collection of colour segregated cullet.

It is suggested that mixed glass represents an economic rather than environmental issue. That is, the CO₂e penalty associated with colour separation of mixed glass is marginal in the context of the gross difference in total CO₂e 'budget' for re-melt and aggregates applications. As such, the use of mixed glass in non-container applications is likely to be on the basis that this is financially favourable, rather than precluded on the basis that it is environmentally unfavourable to colour separate for use in container manufacture.

Expanding on the above, in economic terms the difference between mixed and colour separated cullet is more stark than the marginal environmental impact. Processors for the container industry are able to pay a premium for the colour segregated cullet and can out bid the aggregates processors, and as such, colour separated cullet is most likely to find re-use in container manufacture. However, for mixed glass the price structure is similar for

³³ 'PAS102 - Specification for processed glass for selected secondary end markets', WRAP/BSI, May 2004.

³⁴ 'PAS 101 - Recovered Container Glass - Specification for quality and guidance for good practice in collection', WRAP / BSI, August 2003.

the aggregate and remelt markets and hence competition for mixed glass is tougher, and the probability of aggregate end use consequently increased, with an associated loss of environmental benefit.

To conclude, the study has found international trade opportunities for cullet for use in container remelt, principally in near Europe, and has quantified the benefits of such trade in environmental terms. It demonstrates that recycling of container cullet back to furnace remains the best environmental option. Within the tolerances of the Enviro study, there is little difference in the emissions savings attributable to the use of cullet in fibreglass and container glass manufacture, so both represent favourable remelt applications. However, currently there is limited recycling infrastructure for fibre which limits the added benefit of multiple loop recycling that is possible with container manufacture.

Other factors which need to be taken into account in any comparison of fibre and container glass markets include the fact that container glass may be recycled indefinitely without loss of quality; that containers typically have a short life whereas insulation is normally in use for more than a decade and that fibreglass may use mixed colour glass directly in the furnace.

In consequence the availability of international cullet trade opportunities represents a significant opportunity for the UK to reduce its CO2 emissions and, at the same time, address the 'green imbalance'.

Notwithstanding the above, there is currently no regulatory, economic or practical incentive for choosing the best environmental option and hence this opportunity is likely to be underexploited. To address this lost opportunity, UK policy should be reviewed such that it differentiates between different end uses for cullet on environmental grounds, and supports those most favourable uses i.e. domestic and foreign remelt markets.

7.0 Further work

This study has identified potential (and, in some cases, realised) cullet trade opportunities at a macro level.

To further explore these opportunities it will be necessary to establish possible trading partners in the relevant countries to discuss potential markets at a more detailed and commercial level. It has been noted above that the more distant opportunities within Europe (and further afield) are precluded on the basis of transport economics. In this context if there is a UK policy will for such trade to take place, it may be necessary for pricing mechanisms to be put in place to support such trade.

Additionally, a key element which must be taken into account in development of export / import markets is providing certainty for UK processors in respect of the policy and regulatory regime in which they will operate. In this context it is suggested that actions based upon the findings of this and other reports must be quickly translated into policy tools which support desired outcomes and offer certainty to operators in making commercial decisions.

In undertaking such policy review, care must obviously be taken in allowing policy changes to be fast tracked without undermining the long term investments and infrastructure developed by stakeholders such as local authorities and processors. Possible policy tools might include:

- Differential PRNs - The best environmental option receives the full PRN and the PRN allocation for lower value options is dependent on their environmental benefit.
- Colour specific PRNs / Recovery targets – PRNs only issued for colour segregated or sorted cullet.
- Potentially disqualifying low quality materials from MRF's and similar facilities from counting toward the achievement of local authority recycling targets.

The environmental model developed under this project represents a very effective and easy to use tool for assisting decision makers. It would therefore be beneficial for local authorities and policy makers to be engaged in the use of the model and more importantly to use the model to assist in the decision making process.

WRAP has undertaken some recent studies on material recovery from MRFs³⁵. However, the feedback from the cullet processors within this study is that the cullet that is currently recovered from MRFs is not fit for purpose in terms of its use for the high end applications, e.g. remelt. It is therefore recommended that a working group be set up involving waste generators, collectors and processors to explore the barriers to using cullet from MRFs in high end applications. This might include the development of a specification for the minimum pre-processing cullet quality suitable for processing into a form suitable for container and/or fibre re-melt applications and an associated MRF technology specification to meet this standard.

Additionally, whilst anecdotal information indicates that the number of MRFs in the UK is increasing, and that the volume of glass processed through such facilities is also increasing, there is little consolidated information on these trends. As such it is recommended that information on MRF output should be collated and maintained to inform future studies.

This study has tentatively quantified the multi loop benefits of closed loop recycling. However, it would be beneficial if a robust methodology was to be developed to quantify these benefits since, as can be seen in this study, they can be significant. In conjunction with this further work should be undertaken to better assess the relative environmental benefits of the fibreglass insulation and container glass markets

As the use of container glass in fibreglass insulation manufacture is relatively recent, awareness of the opportunity which this market represents for mixed colour or green container glass should be raised at a supply and policy level.

³⁵ www.wrap.org.uk/local_authorities/toolkits_good_practice/materials.html

Appendix A - European Recycling and Cullet Movement Questionnaire

Glass Recycling Survey 2005

Completed by:

Name:	Organisation:
Position:	Phone number:
Email address:	Date:

THE GLASS WASTE STREAM IN YOUR COUNTRY

1) What was the glass waste stream in 2005 (glass consumed or in circulation)?

	Tonnes in Waste Stream
Total	
Green Fraction	
Flint / Clear Fraction	
Brown / Amber Fraction	

2) In 2005 how many tonnes of container glass were collected for recycling?

	Tonnes Collected
Total	
Green Fraction	
Flint / Clear Fraction	
Brown / Amber Fraction	
Mixed Colour Fraction	

2a. What is the percentage (%) of container glass recycled on a National level? (as reported to the European Commission)

%

3) How is cullet collected?

Method	% of glass collected this way?	Tonnage or % collected colour separated?
Glass Banks/ Bring sites/ community recycling areas?		
Kerbside/ Door step?		

USE OF GLASS CULLET RECOVERED FROM YOUR WASTE STREAM

Export

4a. How many tonnes of RECOVERED cullet were exported?

	Recovered Tonnes Exported
Total	
Green Fraction	
Flint / Clear Fraction	
Brown / Amber Fraction	
Mixed Colour Fraction	

4b. What were the main destinations of exported glass?

--

4c. What was it to be used for?

--

Container Manufacture

5. How many tonnes of RECOVERED cullet were used in the manufacture of new containers?

	Recovered Tonnes used in Container Manufacture
Total	
Green Fraction	
Flint / Clear Fraction	
Brown / Amber Fraction	
Mixed Colour Fraction	

Other Uses

6a. How many tonnes of RECOVERED cullet were used in alternative uses **OTHER THAN** container manufacture? (e.g. aggregate, filtration sand).

	Recovered Tonnes used in Alternative Uses
Total	
Green Fraction	
Flint / Clear Fraction	
Brown / Amber Fraction	
Mixed Colour Fraction	

6b. What alternative uses was cullet used for?

--

6c. Are available alternative uses restricted in your country (e.g. by regulation / legislation)?

--

IMPORTS OF CULLET TO YOUR COUNTRY

7a. In 2005 how many tonnes of cullet were **imported** for use in the manufacture of new containers? From which countries?

	Imported Tonnes used in Container Manufacture	Country(s) of Origin
Total		
Green Fraction		
Flint / Clear Fraction		
Brown / Amber Fraction		
Mixed Colour Fraction		

7b. In 2005 how many tonnes of cullet were **imported** for **USES OTHER THAN** the manufacture of new containers?

	Imported Tonnes used in Alternative Uses	Country(s) of Origin
Total		
Green Fraction		
Flint / Clear Fraction		
Brown / Amber Fraction		
Mixed Colour Fraction		

7c. What alternative uses was cullet used for?

--

CONTAINER PRODUCTION

8) In 2005 how many tonnes of containers were produced?

	Tonnes Manufactured
Total	
Green Containers	
Flint / Clear Containers	
Brown / Amber Containers	

9) In **total** how many tonnes of cullet were used in container production (RECOVERED + IMPORTED)?

	Tonnes Recovered + Imported Cullet Used in Container Manufacture
Total	
Green Fraction	
Flint / Clear Fraction	
Brown / Amber Fraction	
Mixed Colour Fraction	

10) Are there any specifications that would determine the quality of processed glass? For example % of ferrous metals, particle size, colour mix

--

THE FUTURE ...

Recognising the difficulty of predicting an uncertain future, please give your best forecasts for future activity levels to 2015 in the following areas:

11) From 2005 levels, how much do you expect your **waste glass stream** to grow by 2015?

%	Please briefly outline the trends and assumptions underlying your percentage figure:
---	--

12) From 2005 levels, how much do you expect the tonnage of **cullet recovered for recycling** to grow by 2015?

%	Please briefly outline the trends and assumptions underlying your percentage figure:
---	--

13) What trends do you expect in cullet **collection methodology**?

Kerbside versus Bring?
Mixed versus Colour Separated?

14) From 2005 levels, how much do you expect the tonnage of **recovered cullet exported** to grow by 2015?

%	Please briefly outline the trends and assumptions underlying your percentage figure:
---	--

15) From 2005 levels, how much do you expect the tonnage of **recovered cullet used in alternative uses** to grow by 2015?

%	Please briefly outline the trends and assumptions underlying your percentage figure:
---	--

15a) What alternative uses, if any, do you expect to dominate alternative cullet markets in your country in the future?

16) From 2005 levels, how much do you expect the tonnage of **cullet imported for re-melting** to grow by 2015?

%	Please briefly outline the trends and assumptions underlying your percentage figure:
---	--

17) From 2005 levels, how much do you expect the tonnage of **cullet imported for other uses** to grow by 2015?

%	Please briefly outline the trends and assumptions underlying your percentage figure:
---	--

18) From 2005 levels, how much do you expect the tonnage of **container manufacture** to grow by 2015?

%	Please briefly outline the trends and assumptions underlying your percentage figure:
---	--

18a) What levels of cullet re-melt in container manufacture do you expect to be reached by 2015?

<u>Colour</u>	<u>% cullet in furnace feedstock</u>
<u>Green</u>	
<u>Flint / Clear</u>	
<u>Amber / Brown</u>	
Please indicate key factors affecting the above figures:	

19) Below, please give any other comments you feel are relevant:

Appendix B:

Country Profiles

This document compiles country profiles developed under this project for countries considered as candidates for cullet import / export. Full detail regarding development of the profiles and review of potential import / export opportunities is given in section 3 of the main project report (Part 1).

This document is split into two parts considering:

- Countries lying within Europe
- Rest of the World

Europe

This section contains country profiles for the following countries:

- Belgium
- Bulgaria
- Czech Republic
- Denmark
- Eire
- France
- Germany
- Greece
- Italy
- Netherlands
- Norway
- Poland
- Portugal
- Romania
- Spain
- Sweden
- Switzerland
- Turkey

8.0 Belgium

1. BASIC COUNTRY FACTS	
COUNTRY:	Belgium
Population / million:	10.4
Population Growth / %	0.2
GDP / US\$ bn :	371.4
Inflation / %:	2.1
EU Status:	Full member
Foreign Trade Commentary:	
Belgium is an open economy, which has been running external surpluses for several years, although they have been gradually falling.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / t	Principal Companies
Container	350,400	Gerresheimer 5; Saverglass 3; DuVerre 2
Flat		
Fibre		
Other		
Total	350,400	

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	47.9
Green %	18.8
Amber %	33.3
Markets Served:	Unknown
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	Unknown
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
Recovery rates have risen from 67% in 1995 to 90% in 2004 indicating that the recycling infrastructure is well developed. Some sources suggest that the recycling rate is as high as 97.5%. No information is available on mode of collection, colour split or remelt rates.		
		Data for Year
Waste Stream / tonnes	348889	2004
Recovered / tonnes	314000	2004
Recycling Rate	90%	2004
Packaging Waste Target	60%	By 31 st Dec 2008
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		

Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Based on economic modelling of the European region, Belgium is ranked as the greatest European exporter of cullet with key destinations being the Netherlands, France and Spain. Europa data suggests exports of ~63000 tonnes. Colour, destination and use is unknown.

Belgium is also ranked 4th in terms of cullet imports. However, Europa data suggests no imports.

		Data for Year
EXPORTS		
Volume / tonnes	63000	2004
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	0	2004
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Belgium is understood to be a major and net exporter of cullet. Due to limited data, it is not possible to reach definitive conclusions on import / export opportunities from a UK perspective, but as recovered tonnes approach produced tonnes, UK export prospects do not seem good. Anecdotal data also suggests prospects are poor.

9.0 Bulgaria

1. BASIC COUNTRY FACTS	
COUNTRY:	Bulgaria
Population / million:	7.7
Population Growth / %	-0.7
GDP / US\$ bn:	26.7
Inflation %:	5.3
EU Status:	New Member 2007
Foreign Trade Commentary: In 2005 exports of goods amounted to US\$11.7bn and imports of goods (cif) to US\$18.3bn. The current-account deficit was US\$1.4bn (5.8% of GDP) in 2004, but rose sharply to US\$3.1bn (11.7% of GDP) in 2005.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	0.46	Rubin, DF, Drujba, Kitka
Flat	0.60	
Fibre	0.01	
Other	0.06 (tableware)	Sisecam have a 54,000 tpa facility
Total	1.13	

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	273,750 (60%)
Green %	146,000 (32%)
Amber %	36,500 (8%)
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary: In August, 2004, Bulgaria's Ministry of Environment & Water licensed Ecobulpack as the country's second cooperative firm to collect & recycle packaging waste. Bulgaria generates 80,000 tonnes of <u>glass packaging</u> waste annually, according to the ministry. Under the Bulgarian Waste Management Act, which came into force in 2004, all traders & producers of packaged goods in the local market have to recycle 20% of all packaging they sell in 2004 or pay fees to the Environment Ministry. The share of recycled packaging will be increased to 50% by 2011. "In 2004, Ecobulpack will collect, utilise & recycle over 12,500 tonnes of waste packaging," the company said in a statement. This volume is expected to reach 60,000 tonnes by 2007, when Bulgaria hopes to join the EU. Ecobulpack was set up in 2004 as a non-profit enterprise by 34 firms. Ref: GMPA No 6, 2004.		
		Data for Year
Waste Stream / tonnes	80,000 total packaging waste	2004
Recovered / tonnes		

Recycling Rate		
Packaging Waste Target	60%	Date not known.
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Little known.

Economic forecasting within Europe does not rank Bulgaria as a exporter of cullet and only 20th as an export destination (representing 0.3% of the market).

		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Information is very limited making firm conclusions impossible within the scope of this project.

However, the glass waste stream represents only 17% of production capacity and as such it might be very tentatively concluded that even assuming a high recovery rate, a market for cullet imports may exist. However, this may be met by neighbouring countries.

10.0 Czech Republic

1. BASIC COUNTRY FACTS	
COUNTRY:	Czech Republic
Population / million:	10.2
Population Growth / %	0
GDP / US\$ bn:	124.3
Inflation %:	1.3
EU Status:	Full Member – Acceded 2004
Foreign Trade Commentary:	
After the fall of communism trade was reoriented to the West, with about 85% of the Czech Republic's exports now directed to the EU25. The country runs a trade deficit.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	0.51	Avirunion, a.s.(O-I), Vetropack
Flat	~ 1.0	St Gobain, Glavunion
Fibre	0.082	
Other	Drinking Glasses ~112 million pces per year 2003 (78,000t ,1999)	
Total	1.6	

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	34 (172,000t)
Green %	26 (131,000t)
Amber %	40 (204,000t)
Markets Served:	
Wine %	12% Wine/spirits
Food %	54% Food/milk
Beer %	34% Beer/mineral water/fruit juice (Vetropack 2005)
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
Recycling rates already exceed the country's packaging waste target. However, cullet is understood to be in short supply requiring some import.		
Flint cullet is believed to be in particularly short supply. It is understood that incentives are being developed for municipalities to improve their collection of waste glass and to separate it by colour.		
		Data for Year
Waste Stream / tonnes	159658	2004
Recovered / tonnes	110269	2004
Recycling Rate	69% (62% in 2003)	2004
Packaging Waste Target	60%	By 31 st December 2012

Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	30% average claimed by 1 company	
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Europa data suggest that in 2004, ~9000t were exported with imports of ~77,000. Economic modelling data for the European region ranks the country as 12th in terms of exports (to Germany, China and Slovakia) and 10th in terms of imports (from Austria, Germany and Hungary).

		Data for Year
EXPORTS		
Volume / tonnes	9298	2004
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	77065	2004
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Currently insufficient data to draw strong conclusions (particularly with respect to recovered colour split). However given that production is significantly greater than the waste stream / recovery rate some opportunity for export from the UK may exist. This is consistent with the fact that the country is already a significant importer of cullet.

11.0 Denmark

1. BASIC COUNTRY FACTS	
COUNTRY:	Denmark
Population / million:	5.4
Population Growth / %	0.3
GDP / US\$ bn:	259.2
Inflation %:	2.0
EU Status:	Full Member
Foreign Trade Commentary:	
<p>The economy is highly open, with Danish exports and imports accounting for 49% and 44% of GDP respectively. Trade with other countries, such as the US, has increased, and China is becoming a more important source of imports. However, an expanded EU remains the most important trading zone, accounting for 70% of exports and 72% of imports in 2005. The external balances are strong.</p>	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / t	Principal Companies
Container	211,700	Rexam
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	73,000
Green %	65,700
Amber %	73,000
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE	
Commentary:	
<p>Denmark is understood to operate a strong returnables system, with 98% of containers being re-usable, with a 98% return rate. http://en.wikipedia.org/wiki/Glass_recycling</p> <p>1999 data from the Danish Environmental Protection Agency suggests that refillable glass bottles, on average, make 30 trips. If these bottles were manufactured as single-use bottles, it would give an increase in waste glass of around 310,000 tonnes.</p> <p>For single trip bottles Denmark has a nominally perfect recycling rate (100%), and it assumed that the majority of this is remelted. http://mst.dk/udgiv/publications/2002/87-7972-027-7/html/kap03_eng.htm</p>	
	Data for Year
Waste Stream / tonnes	134,551
	2004

Recovered / tonnes	138,156	2004
Recycling Rate	~100%	2004
Packaging Waste Target	60%	By 2008
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)	Unknown	
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Little is known other than published EU waste statistics. These suggest that similar levels of imports and exports occur. It is suspected but not definitely known that waste may be exported for reprocessing and re-import, as Denmark may not be big enough to have its own recycling plants.

Economic forecasting across Europe does not rank Denmark as an exporter, and ranks it 11th in terms of imports (2.7% of total).

		Data for Year
EXPORTS		
Volume / tonnes	55,482	2004
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	40,773	2004
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Limited data does not allow conclusions to be drawn.

However, it is believed based on the balance of production and recovered tonnes that there is little prospect for export of green cullet to Denmark.

Whilst deemed quite unlikely, some opportunity for import of flint / amber cullet to the UK may exist, but this requires investigation beyond the scope of this project.

12.0 Eire

1. BASIC COUNTRY FACTS	
COUNTRY:	Eire
Population / million:	4.2
Population Growth / %	2.0
GDP / US\$ bn:	199.6
Inflation %:	3.5
EU Status:	Full Member
Foreign Trade Commentary:	
<p>In 2005 merchandise exports amounted to US\$103.1bn and imports to US\$65.4bn, giving Ireland the biggest trade surplus as a percentage of GDP in the OECD, except for oil-exporting Norway. Exports are dominated by foreign-owned firms in the technology and chemicals industry.</p>	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	0	Irish Glass Bottle (IGB) closed in 2001-2002.
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	
Green %	
Amber %	
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
<p>Glass containers deposited from households into the bottle bank network are transported for recycling to Rehab Recycle's plant in Dublin. The plant, located at Ballymount, is claimed as one of the most advanced recycling facilities in Europe, with a maximum reprocessing capability of 60,000 tonnes each year.</p>		
		Data for Year
Waste Stream / tonnes	120,000 estimated	2002
Recovered / tonnes	60,000	2002
Recycling Rate	50%	2002
Packaging Waste Target	60%	By 31 st Dec. 2011
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		

Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Due to the closure of IGB, Ireland now has no domestic remelt need and is a cullet exporter.

Consistent with this economic forecasting within the European region ranks Ireland 7th in terms of exports (3% of market) and 12th in terms of imports (2% of market).

		Data for Year
EXPORTS		
Volume / tonnes	53140	2005
Colour	All (30% flint, 27% amber, 43% green)	
Destination	UK	
Use	Remelt	
IMPORTS		
Volume / tonnes	0	
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Currently all collected glass of suitable quality is exported for reuse in the UK for remelt.

However, recovery rates are currently relatively low; if this were to increase, further opportunities for export to the UK (flint and amber) could exist.

Given the absence of any glass manufacturing in Ireland, there is no prospect for exports of green cullet from the UK.

13.0 France

1. BASIC COUNTRY FACTS	
COUNTRY:	France
Population / million:	60.6
Population Growth / %	0.4
GDP / US\$ bn:	2125
Inflation %:	1.9
EU Status:	Full Member
Foreign Trade Commentary:	
France is the fourth-largest exporter of goods and the third-largest exporter of services in the world. The value of goods exports in 2005 totalled US\$439.2bn, while the import bill reached US\$471.4bn, resulting in a trade deficit of US\$32.1bn.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	3.77	Saint-Gobain
Flat	1.15	BSN Glasspack
Fibre	0.22	
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	39.3
Green %	54.2
Amber %	6.4
Markets Served:	
Wine %	Wine + Beer 85%
Food %	15%
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas	47
Fuel Oil	33.2
Electricity	19.8
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
Glass recovery has run at 55-58% for a number of years and is only expected to rise by 1-2% by 2015, shadowing a forecast increase in the waste stream of 0-1%.		
Collection mode is split 80% bring / 20% kerbside and is understood to be largely colour mixed with colour separation to flint and 'green' fractions, although the trend is toward colour separated kerbside collection.		
		Data for Year
Waste Stream / tonnes	3400000	2005
Recovered / tonnes	1918000	2005
Recycling Rate	57%	2005
Packaging Waste Target	60%	By 31 st Dec. 2008
Flint Remelt / tonnes (%)	Yes – unquantified	2005
Green Remelt / tonnes (%)		

Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)	Remelt is believed to be dominated by green/amber mixed colour cullet to green glass	2005
Total Remelt / tonnes (%)	2261112 (60%)	2005
Glass to alternative Use / tonnes (%)	0. Flint / Green (Coloured) separation allows remelt => Alternative uses not required	2005
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

France is understood to be an importer of flint and green cullet (ranked 2 in economic models, from Belgium, Germany, Italy, Netherlands, Switzerland).

It is understood that green glass (collected by Berryman) has been exported to France (and Argentina) to be made into new bottles.

<http://www.woking.gov.uk/forum?message=0000456B7B04.C0A801C2.0000215A.00B9>

It was reported in 2001 that due to the north east US suffering from a glut of green cullet beyond the needs / demands of its own glass industry it was actively pursuing export markets and exploring opportunities in France (Spain, Portugal and Italy)

<http://www.nerc.org/bulletin/20010901.html>

Economic modelling of the European region suggests France also exports cullet to Spain, Belgium and the Netherlands (rank 4), but questionnaire data suggests this is not the case with all collected cullet being used domestically in remelt, both now and going forward.

		Data for Year
EXPORTS		
Volume / tonnes	0	2005 & 2004
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	100000 80000	2005 2004
Colour	80% Flint, 20% Green	2005
Origin	Flint: Belgium and Switzerland	
Use	Remelt	

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Preliminary results suggests there may be some potential for export of green cullet to France.

Additionally, as collection moves to colour separation at source, an amber fraction may become available for import to the UK due to the small percentage production of amber glass in France. An absence of colour split data precludes firmer conclusions.

14.0 Germany

1. BASIC COUNTRY FACTS	
COUNTRY:	Germany
Population / million:	82.5
Population Growth / %	0
GDP / US\$ bn:	2798
Inflation %:	1.6
EU Status:	Full member
Foreign Trade Commentary:	
In 2003-05 Germany was the largest exporter in the world. In 2005 exports amounted to US\$972.4bn, compared with the US's US\$894.6bn. German imports amounted to US\$783.1bn, resulting in a trade surplus of US\$189.2bn.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / t	Principal Companies
Container	3,963,900	BSN 16; Gerresheimer 13; Oberland 9; Nienburger 8; Heye 6; Weigand 3; Luner 3; Heinz 1; Thuringer 2; Noelle 1 Piesau 1 Rexam 3 SGD 2; Weck 1 Total = 68
Flat	1 553 085	
Fibre	726 122	
Other	486344	
Total	6729451	

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	60
Green %	18
Amber %	22
Markets Served:	
Wine %	Wine + Beer ~ 40%
Food %	
Beer %	
Melting Fuel Split / % by MWh:	Unknown
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
<p>Commentary:</p> <p>Data sources suggest recycling rates in the range 88-91% indicating a well developed recycling infrastructure.</p> <p>Recovery is dominated by bring sites (78%) with predominately colour separated collection (89%). The balance is collected colour separated from fillers in the form of end of life re-usable containers.</p> <p>Flat glass recycling: A network covering all regions has been established in Germany for the collection, treatment and reuse of waste flat glass. In 1998, 400,000/t waste architectural glass was produced, with 160,000/t of this being recycled (40%). From 95,000/t automotive glass, 19,000/t was recycled (20%)</p>		
		Data for Year
Waste Stream / tonnes	2835164	2004
Recovered / tonnes	2580000	2004

Recycling Rate	91%	2004
Packaging Waste Target	60%	By 31 st Dec. 2008
Flint Remelt / tonnes (%)	1230945 (56%)	2003
Green Remelt / tonnes (%)	796591 (69%)	2003
Amber Remelt / tonnes (%)	380579 (44%)	2003
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	2408115 (56%)	2003
Glass to alternative Use / tonnes (%)	78238	
Use:	Unknown	

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Germany exports ~ 250,000 tonnes pa of excess green cullet. Economic forecasting for the European region suggests key destinations of Italy, France, Belgium and the Czech Republic with a European export ranking of 2.

Internally flint supply-demand appears to be approximately in balance, however, there is a shortfall of some 20,000 tpa amber glass which could be imported..

Economic forecasting for the European region ranks Germany 7th in terms of imports from Switzerland, Czech republic, France, Italy and the Netherlands.

		Data for Year
EXPORTS		
Volume / tonnes	~200-250,000 (301200)	2006 anecdotal (2004)
Colour	Green	2006 anecdotal
Destination	Italy, France, Belgium, Czech Republic	2006 Economic Forecast
Use		Unknown
IMPORTS		
Volume / tonnes	Require ~20,000 amber (234200)	2006 anecdotal (2004)
Colour		
Origin	Switzerland	2006 Economic Forecast
Use	For Remelt	

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Germany is faced with a similar scenario to the UK, with oversupply of green cullet and shortfall in amber.

As such, prospects for green exports from the UK are poor as is the opportunity for import of amber / flint.

15.0 Greece

1. BASIC COUNTRY FACTS	
COUNTRY:	Greece
Population / million:	11
Population Growth / %	0.1
GDP / US\$ bn:	225.4
Inflation %:	3.4
EU Status:	Full Member
Foreign Trade Commentary:	
Merchandise exports amounted to US\$17.7bn in 2005 and imports to US\$52bn.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	197,100 Capacity (127,000 – 2003)	Valvanis Bros; Yioula Glassworks
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	146,000
Green %	51,100
Amber %	
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
<p>2005 – Greece is cited as being at least 15 years behind the rest of the EU in almost all areas of recycling and is unlikely to meet EU targets for 2006. In Athens recycling facilities are rare although recently the authorities have launched new schemes, however it is cited that the impact so far seems to be minimal. http://news.bbc.co.uk/2/hi/europe/4620041.stm</p> <p>New Bring bins in Athens are understood to contain for paper, aluminium, and glass/plastic (combined). http://betabug.ch/blogs/ch-athens/monthlist.html?year=2005&month=6</p> <p>Recycling rates remain modest at only 24% in 2004.</p>		
		Data for Year
Waste Stream / tonnes	130,000 (calculated)	2004 (FEVE)
Recovered / tonnes	31,000/t cullet	2004 (FEVE)
Recycling Rate	24%	2004 (FEVE)
Packaging Waste Target	60%	By 2011

Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	~45-50% (~60,000t)	FEVE
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Economic forecasting indicates that within the European region Greece ranks 18th in terms of exports representing 0.3% of the market, and is unranked in terms of imports.

However, data, albeit somewhat dated suggests that Greece is active in international cullet trade, particularly in terms of import.

		Data for Year
EXPORTS		
Volume / tonnes	10,000	1998 Ref: Glass
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	72,500	1998 ref: Glass Vol 75 p227
Colour		
Origin	48,000/t from Bulgaria 11,000/t from Italy 3,500/t from Portugal 1,000/t from Turkey	
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Data is limited and does not allow firm conclusions to be drawn.

It is tentatively suggested that at the current low recycling rates, a market for import of green cullet may exist, however, as recycling rates improve (and with the absence of recovery colour split data as caveat), Greece could become nominally self sufficient in cullet making any green import market of limited life.

16.0 Italy

1. BASIC COUNTRY FACTS	
COUNTRY:	Italy
Population / million:	58.1
Population Growth / %	0.1
GDP / US\$ bn:	1,667.9
Inflation %:	2.4
EU Status:	Full Member
Foreign Trade Commentary:	
In 2005 the value of exports of goods was US\$372.8bn and imports US\$372.7bn, giving a trade surplus of US\$100m.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	3.54 (2005) (3,42 Assovetro)	AVIR 17; Zignago 7; Bormioli 10; IVES 1; Saint-Gobain 14; Borma 1; Calp 3; Venete 2
Flat	1.0 (2000)	St Gobain 1, Pilkington 2, St Gobain/Pilkington JV 1, Glaverbel 2, Sangalli 1.
Fibre	0.13 (2000)	
Other	0.16 (2000)	
Total	4.83	

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	62.9
Green %	23.5
Amber %	13.6
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
<p>Commentary:</p> <p>CO.RV.VE is the Italian glass recycling consortium. It represents all the collectors and organises education activities in addition to performing collections.</p> <p>Quality is an issue - generally collection is colour mixed but some colour separated which tends to be green+amber and flint/half white which is then used to produce half white bottles. There is no flint cullet available in its own right and all flint is made from virgin materials.</p> <p>Recovery has risen steadily since 1997 and currently lies at ~ 60% having stabilised in the last few years. In practical terms all collection is mixed with 70% bring and 30% kerbside. The stated trend is slightly toward kerbside collection with more colour separation. It has been indicated that current remelt rates could not be exceeded without moving to increased colour separation.</p>

		Data for Year
Waste Stream / tonnes	2,117,000	2005
Recovered / tonnes	1210000	2005
Recycling Rate	57.2%	2005
Packaging Waste Target	60%	By 31 st Dec. 2008
Flint Remelt / tonnes (%)	378,000	2005
Green Remelt / tonnes (%)	(1,341,000)	2005
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)	1,341,000 t (unclear whether melted in amber / green)	2005
Total Remelt / tonnes (%)	1,719,000 (~50%)	2005
	Available information does not allow re-melt rates for individual colours to be determined.	
Glass to alternative Use / tonnes (%)	NA	
Use:	As inert for ceramic and bricks and aggregate for civil engineering (glass sand in early stages).	Regulation to control / restrict alternative uses is being finalised.

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Based on economic modelling for the European region, Italy is ranked 11th in terms of exports and 3rd in terms of imports. This is reflected in 2005 data which indicates negligible exports and significant imports split 2:1 mixed colour:flint.

Anecdotal data suggests that the UK already exports some green cullet to Italy

Italy, is cited as having a strong demand for glass. The December 1997 issue of Resource Recycling, noted that Internat Glass of Montreal, Canada had exported more than 50,000 tons of glass to Italy in the previous 18 months.

<http://www.epa.gov/epaoswer/non-hw/green/pubs/glass.pdf>

It was reported in 2001 that due to the north east US suffering from a glut of green cullet beyond the needs / demands of its own glass industry it was actively pursuing export markets and exploring opportunities in Italy (Spain, Portugal and France)

<http://www.nerc.org/bulletin/20010901.html>

		Data for Year
EXPORTS		
Volume / tonnes	negligible (possibly a small quantity of green glass) 0	2005 2004
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	300,000 259000	2005 2004

Colour	Flint 109,000 Mixed 191,000	2005
Origin	Germany, Switzerland, Austria	2005
Use	Remelt	

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Like the UK Italy has a shortage of flint cullet using all it collects for half white bottles. That is, no opportunity for flint import to the UK exists.

Based on limited information it is not clear whether or not an opportunity for green export exists, although some sources (now somewhat dated) suggest strong demand, and it is believed that some export from theUK already takes place.

Notwithstanding the above, rough calculation across green and amber production suggests a remelt rate in excess of 80% and suggests no export opportunity.

In summary it is concluded that Italy should be considered a potential candidate for export of excess green from the UK, and warranting further investigation beyond the scope of this report.

17.0 Netherlands

1. BASIC COUNTRY FACTS	
COUNTRY:	Netherlands
Population / million:	16.3
Population Growth / %	0.6
GDP / US\$ bn:	624.8
Inflation %:	2.5
EU Status:	Full Member
Foreign Trade Commentary:	
In 2005, with exports at US\$341.2bn and imports at US\$297.4bn, the Netherlands recorded a trade surplus of US\$43.8bn	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	1 – 1.3	BSN 5; Rexam 3; Heye 2
Flat	1.0	
Fibre		PPG Invested in 1.6 USD recycling plant
Other		
Total	2- 2.3	

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	45%
Green %	53%
Amber %	3%
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	90-91%
Fuel Oil	6-6.5%
Electricity	0.3% boost
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
<p>Commentary:</p> <p>Recovery rates are high lying between 76-81% in recent years. 98% of domestic cullet is collected via bring sites, of which 60% is colour separated. It is understood that there is approximately 1 bring bank for every 650 people. The remaining 2% is collected colour separated via kerbside collection.</p> <p>A significant proportion of glass (20% of total collected) is also collected from commercial premises.</p>		
		Data for Year
Waste Stream / tonnes	547368	2004
Recovered / tonnes	416000 (390,000)	2004 (2005)
Recycling Rate	76% (~71% calculated)	2004 (based on 2005 data)
Packaging Waste Target	60%	By 31 st Dec.2008
Flint Remelt / tonnes (%)	32% (48%)	2003 (2005 anecdotal)
Green Remelt / tonnes (%)	92% (82%)	2003 (2005 anecdotal)

Amber Remelt / tonnes (%)	20% (75%)	2003 (2005 anecdotal)
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	56% (53% - 700,000)	2004 (2005 - of which 310,000 is imported)
Glass to alternative Use / tonnes (%)	12000	2003
Use:	Aggregate	

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

The Netherlands are an importer and exporter of cullet:

IMPORTS

Anecdotal data suggests that imports are dominated by green and mixed cullet, with a lesser but significant import of flint cullet. Economic modelling for the European region suggests the Netherlands are rank 1 in terms of cullet imports from Belgium France and Germany.

Anecdotal data confirms that the UK sends a limited cullet tonnage to the country.

EXPORTS

Anecdotal data suggests that exports though of smaller scale than imports are dominated by amber and mixed cullet, with a lesser but significant export of green cullet. There are no exports of flint cullet

Economic modelling for the European region suggests the Netherlands are rank 5 in terms of cullet exports, to Belgium, the UK, France and Spain.

The reasons behind the reported import / export patterns are currently unclear.

		Data for Year
EXPORTS		
Volume / tonnes	50000 20000	Anecdotal 2006 2004
Colour	40% Mixed, 40% Amber, 20% Green	Anecdotal 2006
Destination		
Use		
IMPORTS		
Volume / tonnes	225000 (310,000) 0	Anecdotal 2006 (2006) 2004
Colour	18% Flint, 40% Green, 42% Mixed	Anecdotal 2006
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Given the apparent high percentage of remelt in green production there would appear to be little prospect for additional exports of excess green cullet to the Netherlands.

However, some opportunity would appear to exist for the import to the UK of amber cullet.

Given the high and stable recovery rates, it is suggested that any such market should have reasonable longevity.

18.0 Norway

1. BASIC COUNTRY FACTS	
COUNTRY:	Norway
Population / million:	4.6
Population Growth / %	0.6
GDP / US\$ bn:	295.5
Inflation %:	1.8
EU Status:	Non-member
Foreign Trade Commentary: Oil and gas output and changes in their prices greatly affect Norway's trade flows. The petroleum sector contributes more than one-half of total export revenue. High oil prices pushed up the merchandise trade surplus to US\$50.1bn in 2005, beating the previous record of US\$33.6bn in 2004.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / t	Principal Companies
Container	109,500	PLM / Moss Glaswerk
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	65,700
Green %	43,800
Amber %	
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
Norsk GlassGjenvinning AS is Norway's primary glass recycler. A new facility in 2002 processes 18/t mixed glass cullet per hour (clear). Green and clear is produced at a rate of 12/t hour. The cullet, mainly from container glass, comes from municipal collection systems. (ref: Int Glass Journal 120, 2002)		
It is understood that glass is collected using a bring igloo system, believed to be commingled with metal cans.		
Recycling rates are high.		
Norway also operates a returnable bottle system, but information on this is limited.		
		Data for Year
Waste Stream / tonnes	~ 46,000 (estimated)	1994
Recovered / tonnes	~33,000 (65-70% recovery)	1994-1995 http://www.glassmetall.no/cgi

		-bin/apeland/imaker?id=3529 http://www.iisd.ca/consume/norpro.html
Recycling Rate	81(-87%)	1998 http://www.foe.co.uk/resource/press_releases/20000314121853.html
Packaging Waste Target	Not applicable	
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	Believed to be up to 90%	2004 http://www.glassmetall.no/cgi-bin/apeland/imaker?id=4239
Glass to alternative Use / tonnes (%)	It is understood that glass is used in glass-concrete, glass insulations wool, sandblasting and in foam glass manufacture.	http://www.glassmetall.no/cgi-bin/apeland/imaker?id=4260
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Limited data. Economic forecasting ranks Norway 10th in terms of European exporters representing 1.4% of total exports. Norway is unranked in terms of imports.

		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Data is limited but high remelt rates suggest no prospect for export of excess green cullet to Norway. Also, given that production far outstrips the waste stream it is believed that all available flint cullet will be consumed in domestic remelt, giving little opportunity for export to the UK. The further investigation to consolidate these conclusions lies beyond the scope of this project.

19.0 Poland

1. BASIC COUNTRY FACTS	
COUNTRY:	Poland
Population / million:	38.2
Population Growth / %	-0.1
GDP / US\$ bn:	485.6
Inflation %:	2.7
EU Status:	Acceded 2004
Foreign Trade Commentary:	
The current-account deficit fell sharply in 2005 to US\$4.4bn (1.4% of GDP), as exports increased sharply and import growth remained restrained.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	1.0	OI 4; Rexam 4; Ardagh 3; Stoelzle 2
Flat	0.85	Pilkington 1 St, Gobain 1 Guardian 1
Fibre	0.20	St Gobain
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	40
Green %	32
Amber %	28
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	100%
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
Limited data available. Recovery rates currently modest. Mode of collection unknown. It is understood there is demand within the container industry for additional cullet.		
		Data for Year
Waste Stream / tonnes	914700	2004
Recovered / tonnes	250000	2004
Recycling Rate	27%	
Packaging Waste Target	60%	By 31 st Dec 2012
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	One company claims 20%	

	remelt (~43,000t in 2002) with a potential to remelt 500,000. A tender has been created for the construction of a recycling plant.	
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Economic modelling for the European region ranks exports as 24th (to Germany) and imports as 17th from Germany.

Europa data suggests that exports are trivial but that there are significant imports taking place. A prior informed consent procedure is in place for cullet import under the Basel convention.

		Data for Year
EXPORTS		
Volume / tonnes	693	2004
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	25226	2004
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Cullet waste stream volume approaches production, however recovery rates are currently low tentatively suggesting (in the absence of colour split data) that an excess UK green export market may exist. Indeed there would appear to be company level demand for increased cullet supply and some import is already taking place. However, as domestic recovery rates improve, this possible market may disappear.

At the current time there is no prospect of flint / amber export from Poland. Lack of recovery colour split data does not allow firmer conclusions to be drawn.

20.0 Portugal

1. BASIC COUNTRY FACTS	
COUNTRY:	Portugal
Population / million:	10.5
Population Growth / %	0.7
GDP / US\$ bn:	183.5
Inflation %:	3.2
EU Status:	Full Member
Foreign Trade Commentary:	
Portugal runs a significant structural trade deficit. In 2005 merchandise export revenue was US\$38.2bn and the import bill was US\$59bn, which widened the trade deficit from 2004.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	1.024 (1.428 by 2012)	Barbosa 6; Gallo 3; Barosa 3; Sotancro 3; Mondego 1
Flat	0.183	
Fibre	0.1	
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	61
Green %	29
Amber %	9
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	100% in terms of fossil fuel
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
Collection is dominated by mixed colour collection to bring banks. Recovery runs in the high 30s%, some way short of their packaging waste target.		
		Data for Year
Waste Stream / tonnes	399000 (435kt by 2011)	2005
Recovered / tonnes	156000 (261kt by 2011)	2005
Recycling Rate	39%	2005
Packaging Waste Target	60%	By 31 st Dec. 2011
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		

Total Remelt / tonnes (%)	384148 (37.5%) (303000 (30%))	
Glass to alternative Use / tonnes (%)	0. (20,000 t non- container cullet used in undefined use)	
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

IMPORTS

Imports for remelt have steadily climbed from 12,000 t in 1998 to 147,000 in 2005 (from Holland, Germany and Spain). Anecdotal data suggests that significant exports of green cullet from the UK already take place.

High level forecasts suggest that the market for imported cullet could increase by 40kt to 190kt by 2011-12.

It was reported in 2001 that due to the north east US suffering from a glut of green cullet beyond the needs / demands of its own glass industry it was actively pursuing export markets and exploring opportunities in Portugal (Spain, Italy and France)

<http://www.nerc.org/bulletin/20010901.html>

Surprisingly economic modelling for the European region does not rank Portugal as a cullet importer.

EXPORTS

Economic modelling for the European region ranks Portugal as 13th in terms of export. Country data suggests that only a small tonnage of cullet is exported for colour sorting an re-import.

		Data for Year
EXPORTS		
Volume / tonnes	5000t (for sorting and re-import)	2005
Colour	Assumed mixed	
Destination		
Use		
IMPORTS		
Volume / tonnes	147000	2005
Colour	Unknown	2005
Origin	Holland, Germany, Spain	2005
Use	Assumed re-melt due to absence of alternative uses.	

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Portugal may offer some opportunity for import of excess UK green cullet, indeed anecdotal evidence suggests that some export of green cullet from the UK is already taking place. However, given lack of information on remelt or import colour split this conclusion cannot be quantified or verified. i.e. it is unclear how much bigger this market might be, although high level forecasts suggest that the market for imported cullet could increase by 40kt by 2011-12..

21.0 Romania

1. BASIC COUNTRY FACTS	
COUNTRY:	Romania
Population / million:	21.6
Population Growth / %	-0.7
GDP / US\$ bn:	97.1
Inflation %:	18.3
EU Status:	New Member in 2007
Foreign Trade Commentary: In 2005 merchandise exports totalled US\$27.7bn and merchandise imports US\$37.3bn; the current-account deficit was US\$8.4bn, equal to 8.6% of GDP. Some 67% of Romania's exports go to the EU25.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	0.41	Yioula, Stimet, Stiom, Geosat, Stilart, Sticla, Stiaz
Flat	0.17	St Gobain
Fibre	0.02	
Other	0.03	
Total	0.63	

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	204,400t (50%)
Green %	171,550t (41%)
Amber %	36,000t (9%)
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
Anecdotal data suggests there is virtually no formal recycling infrastructure in Romania. However, re-usable bottles still seem to prevail and like other developing countries, scavengers / 'garbage-pickers' appear to be prevalent. http://szekely.blogspot.com/2006/06/recycling-in-romania.html		
Notwithstanding the above, some sources claim a glass recycling rate of ~97%. However, this data is considered highly suspect on two grounds – a. the lack of a recycling infrastructure, b. the waste glass volume (for 1997) which approaches that of the UK but with ~ 1/3 of the population. http://www.envir.ee/programmid/pharecd/soes/romania/html/waste/raspdes/activdes/valor.htm (1)		
		Data for Year
Waste Stream / tonnes	424,450 2,120,240 ???	2005 estimate 1997 (1)

Recovered / tonnes	2,053,870 ???	1997 (1)
Recycling Rate	97% ???	1997 (1)
Packaging Waste Target		
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

No data found.

Economic modelling does not rank Romania in terms of either glass imports or exports.

	Data for Year
EXPORTS	
Volume / tonnes	
Colour	
Destination	
Use	
IMPORTS	
Volume / tonnes	
Colour	
Origin	
Use	

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Lack of data does not allow conclusions to be drawn on import / export opportunities. However, lack of collection infrastructure suggests no current opportunity for flint / amber exports to the UK.

It is noted that Romania has resources of Sand and Soda Ash so there is possibility for returning green glass to these countries using the returning transporters of these products if and when demand increases for cullet.

22.0 Spain

1. BASIC COUNTRY FACTS	
COUNTRY:	Spain
Population / million:	44.1
Population Growth / %	1.9
GDP / US\$ bn:	1127.1
Inflation %:	3.3
EU Status:	Full Member
Foreign Trade Commentary: Merchandise exports rose to US\$194.5bn in 2005. Strong domestic demand resulted in a larger increase in imports, causing the trade deficit to widen to US\$85.6 in 2005.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / t	Principal Companies
Container	2,143,971	
Flat	2,700,000	
Fibre		
Other		
Total	4,843,971	

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	31
Green %	55
Amber %	14
Markets Served:	
Wine %	Wine + Beer = 38%
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	80%
Fuel Oil	5%
Electricity	
Other	15%

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
<p>Recycling rates have been relatively stable in the recent years in the range 30-40%, but have steadily climbed since 2000 reaching 45% in 2005. A current growth rates the 60% recycling would not be met until 2011.</p> <p>Collection is dominated by bring sites (80%) of mixed glass. 20% of glass is collected via kerbside of which 70% is colour separated. The trend is toward kerbside, (estimated to be 50% bring, 50% kerbside by 2015), and a move to colour separation is seen as essential within the next three years in order to meet melting requirements (production is expected to grow by 20% by 2015).</p> <p>The majority of recovered glass is used in domestic remelt, with a small proportion of being used in alternative uses (art glass, manual production, frits).</p>		
		Data for Year
Waste Stream / tonnes	1670000	2005
Recovered / tonnes	744599	2005
Recycling Rate	45%	2005

Packaging Waste Target	60%	By 31 st Dec. 2008
Flint Remelt / tonnes (%)	6%	2005 (forecast to rise to 20% by 2015)
Green Remelt / tonnes (%)	61% (assumed to be domestic green + mixed + imported mixed)	2005 (forecast to rise to 70% by 2015)
Amber Remelt / tonnes (%)	15%	2005 (forecast to rise to 30% by 2015)
Mixed Remelt / tonnes (%)	Into green	
Total Remelt / tonnes (%)	800,000 (37%)	2005
Glass to alternative Use / tonnes (%)	14000. Expected to grow by ~3% to 2015	2005
Use:	Artistic, manual production, frits with future move to road aggregate and 'specific landfills'	2005

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

EXPORT

Spain is not a major exporter of glass with only 8000t to Portugal (for remelt) and growth is not expected due to domestic remelt requirements. Economic modelling for the European region suggests Spain ranks only 14 in terms of export (to Ireland and France).

IMPORT

Questionnaire data indicates that Spain imports approximately 8-9% (70,000t) of its domestic remelt needs as mixed glass from the UK and Germany and this is forecast to grow by ~ 15-20% by 2015. Anecdotal data confirms that green exports from the UK do occur, and it is notable that these imports are classed as mixed colour in questionnaire responses.

It was reported in 2001 that due to the north east US suffering from a glut of green cullet beyond the needs / demands of its own glass industry it was actively pursuing export markets and exploring opportunities in Spain (Italy, Portugal and France)

<http://www.nerc.org/bulletin/20010901.html>

Economic modelling for the European region suggests Spain ranks 6TH in terms of import from France, Belgium, Netherlands, Portugal.

		Data for Year
EXPORTS		
Volume / tonnes	8000t	2005
Colour	Mixed	2005
Destination	Portugal	2005
Use	Remelt	2005
IMPORTS		
Volume / tonnes	70,000	2005
Colour	Mixed	2005
Origin	60% UK, 40% Germany	2005
Use	Remelt	2005

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Given that Spain currently re-melts virtually all domestically recovered glass and imports

additional cullet, there would appear to be a good opportunity for further export of excess UK green or mixed glass to Spain, to increase remelt rates in green production. Given the status quo, a market of some 110,000 tonnes exists to meet the aspirational remelt target of 70%. Additionally imports for alternative uses are forecast to show slight growth.

However, given that Spain lies some way short of its packaging waste target, increases in internal recovery to meet target may make this market short lived. Approximate calculations based on the current colour split of manufactured and collected glass and forecast increases in domestic waste stream and production, and assuming the 60% recycling target is hit, suggest that by 2015 Spain should be self sufficient for green remelt (75%) and still some way short of its aspirations for cullet remelt ratios for flint and amber. These figures are before imports and thus do not bode well for the longevity of this market, however, it must be noted that these calculations necessarily embody some significant assumptions.

Given high domestic demand, currently low flint and amber re-melt rates and the current mixed collection mode there is little prospect of imports of excess flint and amber cullet to the UK.

23.0 Sweden

1. BASIC COUNTRY FACTS	
COUNTRY:	Sweden
Population / million:	9.0
Population Growth / %	0.4
GDP / US\$ bn:	357.7
Inflation %:	1.5
EU Status:	Full member
Foreign Trade Commentary: In 2005, with exports estimated at US\$133.3bn and imports at US\$114.1bn, Sweden recorded an estimated trade surplus of US\$19.1bn	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / t	Principal Companies
Container	102,200	Rexam
Flat	500,000	Pilkington
Fibre		St Gobain, Isover
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	71
Green %	29
Amber %	0
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	Partial burn of fuel oil to be replaced with natural gas starting in 2007.
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary: Recycling rates are very high and consistent with collection based around bring sites. Information on colour separation and remelt rates is currently unavailable.		
		Data for Year
Waste Stream / tonnes	159,058	2004
Recovered / tonnes	164,813	2004
Recycling Rate	104%	
Packaging Waste Target	60%	31 st Dec. 2008
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		

Use:		
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4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Economic modelling for the European region ranks Sweden as 8th in terms of exports (to Denmark and Netherlands) and unranked in terms of imports.

Anecdotal data suggests excess flint cullet may become available for export in 2007 and that there may be interest in exporting to the UK.

Exports of cullet for remelt have been made in the past to Goole in ships of 2-3000 t capacity.

		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Given that the recovered cullet volume exceeds production, it is tentatively concluded (in the absence of colour split data) that no market for export of excess green from the UK exists.

It would appear some opportunity for flint cullet import to the UK may arise in 2007.

24.0 Switzerland

1. BASIC COUNTRY FACTS	
COUNTRY:	Switzerland
Population / million:	7.5
Population Growth / %	0.7
GDP / US\$ bn:	365.8
Inflation %:	0.8
EU Status:	Non member
Foreign Trade Commentary:	
In 2005 merchandise exports totalled US\$146.1bn, and merchandise imports were US\$141.3bn, resulting in a trade surplus of US\$4.9bn.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / t	Principal Companies
Container	87342 (2005 - FEVE) 123000 (2005 – Questionnaire)	Vetropack
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	9 - 2005
Green %	82 - 2005
Amber %	9 - 2005
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE

Commentary:

Recovery rates are very high at 95% of consumption and have been so for a number of years. 85% of glass is collected via bring banks, predominately colour separated. The remaining 15% comes from mixed kerbside collections. This situation is not forecast to change.

		Data for Year
Waste Stream / tonnes	323200t	2005
Recovered / tonnes	308000t	2005
Recycling Rate	95.4%	2005
Packaging Waste Target	NA	
Flint Remelt / tonnes (%)	~16% (~18260)	2005
Green Remelt / tonnes (%)	~63% (~63910)	
Amber Remelt / tonnes (%)	~8% (~9130)	
Mixed Remelt / tonnes (%)	0	
Total Remelt / tonnes (%)	77% (~91300)	2005
Glass to alternative Use / tonnes (%)	44300 (Mixed 80%, Green 20%)	2005
Use:	Gravel & sand, Foam Glass, Insulation	

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Due to much greater recovery tonnage than production, Switzerland is currently a (steadily growing) exporter of cullet for remelt. There are currently no imports although modest import activity took place up to 2002.

Cullet is known to be exported by barge from Basel.

Consistently, economic forecasting data within the European region ranks Switzerland 6th in terms of exports (to Germany and France – 5% of market) and 14th in terms of imports (0.8% of market).

		Data for Year
EXPORTS		
Volume / tonnes	172500	2005
Colour	Flint (20%, green 70%, amber, 10%)	
Destination	Germany, Italy, France	
Use	Remelt for container	
IMPORTS		
Volume / tonnes	0	2005
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

It appears that all internal cullet needs are met by domestic collection, most notably for green glass which reports a good remelt rate. As such there is no prospect for export of UK excess green cullet. Conversely, the country represents a key competitor to the UK in terms of cullet export.

Although some flint and amber glass is exported this already serves markets closer to home and thus does not represent a good import opportunity for the UK.

25.0 Turkey

1. BASIC COUNTRY FACTS	
COUNTRY:	Turkey
Population / million:	73.3
Population Growth / %	1.4
GDP / US\$ bn:	362.6
Inflation %:	26.9
EU Status:	In accession negotiations
Foreign Trade Commentary:	
In 2005 exports (fob) amounted to US\$76.9bn, while imports (fob) were US\$109.7bn, leaving a trade deficit of US\$32.8bn.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / t	Principal Companies
Container	535100 Expected to grow by 20% to 2015	Andalu Cam, Siseecam
Flat	76,6500	
Fibre	20,000	
Other	120,000	
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	65
Green %	17
Amber %	18
Markets Served:	
Wine %	
Food %	
Beer %	Dominant
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
<p>Commentary:</p> <p>Recovery comprises a combination of:</p> <ul style="list-style-type: none"> • Bring – 25% • Bottlers – 25% • Open Dump Areas – 50% <p>It is expected that separated colour bring will come to dominate.</p> <p>Recycling climbed significantly in the late 90s, stabilising at a relatively modest approximate 24% (recovery rates by colour estimated at flint 20%, green 24%, amber 46%). However, a 60% regulatory target is expected to be in place by 2014, presumably associated with anticipated accession. The waste stream is expected to grow by 20% to 2015 (as is production). Currently virtually all recovered cullet is used in remelt.</p>

		Data for Year
Waste Stream / tonnes	400000	2005
Recovered / tonnes	96000	2005
Recycling Rate	24%	2005
Packaging Waste Target	60% anticipated by 2014	
Flint Remelt / tonnes (%)	36500	2005
Green Remelt / tonnes (%)	46500	2005
Amber Remelt / tonnes (%)	13000	2005
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	96000 (18%) This figure is believed to be low with remelt closer to 150000 t and remelt rate of ~30% based on FEVE data	2005
Glass to alternative Use / tonnes (%)	~9000t Not expected to grow.	
Use:	Low quality tableware.	

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

There is understood to be no significant import or export activity at the current time. This is born out by economic forecasts.

It is indicated that cullet is rarely imported for re-melting. This is due to neighbouring countries having inadequate cullet collection infrastructure. More distant countries that could offer supply are considered to be not cost efficient for transport reasons.

Cullet export from Turkey is seen as being not cost efficient and is not forecast to grow. Economic forecasting for the European region does not rank Turkey in terms of import or export.

		Data for Year
EXPORTS		
Volume / tonnes	0	2005
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	0	2005
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Based on available information, there may currently be some opportunity for export of green cullet to Turkey, conditional on transport economics. Green remelt is estimated at ~ 50% at the current time. An estimated market of 20,000 tonnes exists assuming this was increased to 70% green remelt (the country's aspiration by 2015).

However, if and when recovery rates improve, Turkey is expected to be more than self sufficient in green cullet and as such any UK export market may be short lived. It is also expected that under such circumstances flint and amber arisings could be consumed internally, with no resulting excess for export.

Rest of the World

- Argentina
- Australia
- Brazil
- Chile
- China
- India
- Japan
- New Zealand
- South Africa
- South Korea
- USA

26.0 Argentina

1. BASIC COUNTRY FACTS	
COUNTRY:	Argentina
Population / million:	38.6
Population Growth / %	1.0
GDP / US\$ bn:	183.2
Inflation %:	10.1
EU Status:	Not applicable
Foreign Trade Commentary:	
High commodity prices helped boost merchandise export earnings to a US\$40bn in 2005, while import spending grew to US\$28.7bn, leading to a trade surplus of US\$11.3bn.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	1,157,050	Cristaalerias Hermano; Pellegrini; La Esperanza; Cristaleria de Cuyo; Carril Nacional; Envases Olimpia; Oscar Larradet; Berazategui; Isidori Vagge; SAIVF; Moya SA; Rigolleau
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	689,850
Green %	277,400
Amber %	189,800
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
Commentary:
Limited information.
In Argentina, the organization of street waste picker (<i>Cartoneros</i>) cooperatives began in 2002 as part of recyclables collection. These cooperatives are small in scale and restricted to isolated initiatives by industry, such as the beverage sector. http://findarticles.com/p/articles/mi_m0KWH/is_9_40/ai_92724940
The state of California has a program called 'Closing the Loop' for education regarding recycling from primary school to age 16-18 which has been adopted by at least three states

in Argentina (and also being considered by Chile). http://usinfo.state.gov/journals/itqic/0605/ijge/adams.htm		
		Data for Year
Waste Stream / tonnes		
Recovered / tonnes		
Recycling Rate		
Packaging Waste Target		
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

It was reported in 2001 that the US 'Container Recycling Alliance' was hoping to establish green cullet export outlets in South America. Argentina (and Chile) were considered to hold promise as steady outlets for American exports of green cullet because they are large wine exporters.

<http://www.nerc.org/bulletin/20010901.html>

It is understood that green glass (collected by Berryman) has been exported to Argentina (and France) to be made into new bottles.

<http://www.woking.gov.uk/forum?message=0000456B7B04.C0A801C2.0000215A.00B9>

A December 1997 article in Glass Industry, noted that 'Strategic Materials' was shipping green glass to Argentina (and Puerto Rico, Trinidad, Tobago, Mexico)

<http://www.epa.gov/epaoswer/non-hw/green/pubs/glass.pdf>

		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Whilst data on recycling infrastructure and current import / export markets is very limited, that information available suggests that Argentina may offer an export opportunity for green cullet from the UK.

Further investigation of this opportunity lies beyond the scope of this project.

27.0 Australia

1. BASIC COUNTRY FACTS	
COUNTRY:	Australia
Population / million:	20.4
Population Growth / %	1.1
GDP / US\$ bn:	711.0
Inflation %:	3.0
EU Status:	Not applicable
Foreign Trade Commentary: Revenue from exports of goods increased to US\$107bn in 2005, more than offsetting the expansion of imported goods to US\$120bn and pulling back the trade deficit to US\$13.8bn, from US\$18.2bn in 2004.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	1,182,600	ACI, AMCOR; Winemakers Glass (73,000/tpa)
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	481,800
Green %	511,000
Amber %	189,800
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
Australia has a moderate recycling rate of ~ 40%. More than 50% of collected glass originates from kerbside, with highest recovery of green glass. A future 2010 'Packaging covenant' target of 55% recovery will require an increase of 180,000 tonnes recovery.		
Source: Warwick Hassan, O-I Australia http://acor.org.au/presentations/Glass.pdf		
		Data for Year
Waste Stream / tonnes	850,000 – ~1000,000	2006 http://www.abc.net.au/science/features/recyclingreality/default.htm
Recovered / tonnes	350,000 (- 450000)	2006 (as above) 2004 (http://www.visy.com.au/divisions/category_page.aspx?

		did=1&sid=3&cid=89&scid=91)
Recycling Rate	41%	2006
Packaging Waste Target	Not applicable	
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	~40% (up to 80% in particular batches)	http://www.acipackaging.com/aciwww.nsf/FrameSet?OpenFrameset
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Little information.

It is understood that some cullet is imported from New Zealand, including flint.

Economic forecasting ranks Australia 2nd as an exporter of cullet in the Oceania region, with ~35% of the market, destined for Brazil.

	Data for Year
EXPORTS	
Volume / tonnes	
Colour	
Destination	
Use	
IMPORTS	
Volume / tonnes	
Colour	
Origin	
Use	

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Container manufacture production and waste stream levels are closely matched suggesting that the country could nominally be self sufficient in cullet (with the caveat that waste stream colour split is not known). With only a moderate increase in recovery targeted, the internal waste stream should easily be able to meet demand.

In addition, if imports are required, it is believed that New Zealand will be the ideal trading partner for Australia due to an excess of cullet in that country.

As such, it is believed that Australia offers a poor prospect for export of green cullet from the UK.

No conclusions can be drawn on opportunities for import to the UK of clear / amber cullet from Australia.

28.0 Brazil

1. BASIC COUNTRY FACTS	
COUNTRY:	Brazil
Population / million:	184.2
Population Growth / %	1.5
GDP / US\$ bn:	795.7
Inflation %:	8.7
EU Status:	Not applicable
Foreign Trade Commentary:	
Strong external demand and a more active export policy have contributed to booming export earnings since 2003: the trade surplus grew from US\$2.7bn in 2001 to US\$44.7bn in 2005	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	900 (2005)	Cisper; Nadir; Subrasa; Vidraria; Wheaton; Nadir; Anchieta; Rimisa; CIV; Inovisa; Vidroporto; Rio Crisper; Ambev
Flat	1.2m/t	(2004)
Fibre	100,000/t	
Other(tableware & special)	200,000/t	
Total	3.2M/t	

Ref : GMPA 1/2000

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	1.1m/t Capacity
Green %	650,000/t Capacity
Amber %	250,000/t Capacity
Markets Served:	
Wine %	
Food %	55%
Beer %	30%
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
Commentary:
Glass is collected via a combination of formal companies (60%) and scavengers etc. (40%).
Many cities in Brazil are developing projects with non-governmental organizations (NGOs) and with garbage pickers associations, resulting in environmental, social and economic benefits to the cities and also to the garbage pickers. They take responsibility for the collection, separation and sale of the recyclable material and for awareness raising among the population. The waste pickers collect the waste from homes and stock the recyclable material in specific locations, from where it is collected by trucks belonging to the city government and transported to the NGOs' warehouses for separation.

http://www.env.go.jp/recycle/3r/en/s_officials/03/01.pdf

The brands Hellmann's, AdeS, Omo and Rexona are working in partnership with one of Brazil's leading supermarket chains, Pão de Açúcar, to set up supermarket recycling stations. Customers are given colour-coded plastic bags when they shop at the store to help sort and carry their waste for recycling. Blue bags are used for paper, red for plastics, green for glass and yellow for metal. The bags also list the types of waste that can be recycled to help educate consumers. Since the project began in 2001, 101 recycling stations have been established across 17 cities in Brazil, working in partnership with 15 ragpicker' cooperatives. More than 10 000 tonnes of waste plastic, cardboard, toothpaste tubes and glass have been collected for recycling. The materials are used to make new products such as toys, garden seats, furniture, pen containers and household appliances.

<http://www.unilever.com/ourvalues/environmentandsociety/casestudies/packaging/brazilrecycling.asp> Recove

Overall recovery rates are moderate (but rising), but remelt rates are quite low at only 36%.

Returnables: In a bid to broaden its sales among lower income consumers, Coca-Cola has decided to go back to returnable glass bottles and re-launched the 1.25 liter bottle in the Rio de Janeiro market in mid May 2003. The new bottle is aimed at boosting sales among less well-off consumers, whom the company says would like to consume more soft-drinks but are put off by the price. The returnable bottle is priced at BRL 0.99 against BRL 1.80 for the PET packaging. (Glassonline June 2003)

		Data for Year
Waste Stream / tonnes	Unknown (739,000 estimated)	2005
Recovered / tonnes	340,000	2005
Recycling Rate	46% / 47% (a rise of 3% from 2002)	2004 http://www.brazzilmag.com/content/view/4138/ http://www.cempre.org.br/english/2006-03.php
Packaging Waste Target	NA	
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	320,000 (310k domestic, 10k import) → 36%	2005
Glass to alternative Use / tonnes (%)	30,000	2005
Use:	Unknown	

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

No cullet export currently takes place and this position is forecast to continue.

Imports of some 46,000 took place in 2005, with only 20% going to remelt. Imports are expected to reach a ceiling of 50kt by 2008.

Economic forecasting does not rank Brazil as a cullet exporter, and only 17th in terms of global target markets representing only 1% of that market.

		Data for Year
EXPORTS		
Volume / tonnes	0	2005
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	10,000 / 36,000	2005
Colour	Unknown	2005
Origin	Uruguay	2005
Use	Remelt / Alternative	2005

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

With current imports of 46,000t and a forecast import ceiling of 50,000 t by 2008, Brazil represents a very poor prospect for exports from the UK.

A continued forecast of zero exports suggests no opportunity for flint / amber import to the UK.

29.0 Chile

1. BASIC COUNTRY FACTS	
COUNTRY:	Chile
Population / million:	16.3
Population Growth / %	1.1
GDP / US\$ bn:	115.2
Inflation %:	2.6
EU Status:	Not applicable
Foreign Trade Commentary:	
<p>Chile's general import tariff rate is 6%, but its trade-weighted effective average tariff rate is below 2%, owing to tariff preferences granted through trade accords, most importantly free-trade agreements (FTAs) with the EU, the US, Canada, Mexico, South Korea and China. In 2005 exports reached US\$40.6bn and imports US\$30.4bn in fob terms.</p>	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	304,000	Cristaleras de Chile (80% market share); Cristaleras Toro; BO Glass
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	110,000
Green %	172,000
Amber %	22,000
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
<p>Commentary:</p> <p>Recycling in Chile is understood to be very poorly developed, with a 2002 glass packaging recycling rate of only 5 percent (Reuse/Recycle Volume 34, Number 11 November 2004)</p> <p>It is understood that the infrastructure is very limited centering around informal rubbish collectors (~178,000 people in the country work in this occupation - cachureros / cartoneros) - http://www.seas.columbia.edu/earth/wtert/sofos/Estevez_MStheses.pdf. http://ipsnews.net/news.asp?idnews=35446. It is also understood that Cristaleras de Chile have been / are involved in campaigns to promote glass recycling.</p> <p>The state of California has a program called 'Closing the Loop' for education regarding recycling from primary school to age 16-18 which is being considered by Chile.</p>

http://usinfo.state.gov/journals/itgic/0605/ijge/adams.htm (2005)		
		Data for Year
Waste Stream / tonnes		
Recovered / tonnes		
Recycling Rate		
Packaging Waste Target		
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:		
<p>It was reported in 2001 that the US 'Container Recycling Alliance' was hoping to establish green cullet export outlets in South America. Chile (and Argentina) were considered to hold promise as steady outlets for American exports of green cullet because they are large wine exporters.</p> <p>http://www.nerc.org/bulletin/20010901.html</p> <p>Economic forecasting suggests that in the Latin American region, Chile is insignificant in terms of both exports and imports ranking 9th (1.4% of market) and unranked respectively.</p>		
		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:		
<p>Very limited information is available, and there is no indication of cullet import / export activity at the current time.</p> <p>Given very low recycling rates, there may be some opportunity to export green cullet to Chile to support domestic container manufacture, but this is at very best a tentative conclusion. Additionally, due to the small size of the container industry, any possible likely market is likely to be limited.</p>		

30.0 China

1. BASIC COUNTRY FACTS	
COUNTRY:	China
Population / million:	1,307.4
Population Growth / %	0.6
GDP / US\$ bn:	2,224.9
Inflation %:	1.4
EU Status:	Not applicable
Foreign Trade Commentary:	
In 2005 merchandise exports were worth US\$762.7bn and imports stood at US\$660bn, resulting in a trade surplus of US\$102.7bn.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	6.7	Hangzhou Container Taiwan Glass Shanghai Bottle Co Tianjin Glass Beijing Glass Chengdu Glass Changchun Guangzhou Qinhunangdao Hangzhou Container Wu Xi Glass TT WMB Bottle Plant Shuangfeng Glass Zhenjiang Schott Pharma
Flat	12 (2002)	
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	52%
Green %	22%
Amber %	26%
Markets Served:	
Wine %	62%
Food %	24%
Beer %	5%
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	Understood to be significant
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE		
Commentary:		
<i>No information.</i>		
		Data for Year
Waste Stream / tonnes		
Recovered / tonnes		
Recycling Rate		
Packaging Waste Target		
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY		
Commentary:		
Little is known.		
<p>In autumn 2004 Valient Recycling (a subsidiary of Valpak) announced they were going to open a Chinese office to support its export operation which already has existing supply agreements with China (and several European Countries). The company planned to export in the region of 15,000 tonnes of material (unknown what mix) to China during the remainder of 2004. https://www.valpak.co.uk/nav/page1074a16.aspx</p> <p>Economic modelling ranks China 3rd (behind Belgium and Germany) in terms of supply into the international cullet market (principally to South Korea). In terms of target markets China ranks only 12th behind the UK (11th) and Belgium (8th and known to have poor prospects as an import market).</p>		
		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT		
Commentary:		
Based on very limited information, the prospects for China as a destination for excess green cullet from the UK appear poor.		

31.0 India

1. BASIC COUNTRY FACTS	
COUNTRY:	India
Population / million:	1,080
Population Growth / %	1.5
GDP / US\$ bn:	797.5
Inflation %:	4.0
EU Status:	Not applicable
Foreign Trade Commentary:	
<p>India's trade deficit rose to an estimated US\$47.2bn in 2005 in balance-of-payments terms, up from US\$28bn in 2004. Exports performed strongly, rising by 31% to US\$102.2bn, but imports soared by 41% to US\$149.4bn, largely owing to higher international oil prices and to demand for industrial inputs and consumer goods. The US remains India's largest trading partner, although China is India's leading supplier and its second-largest export market.</p>	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	1.5m/t	Hindustan; Gujrat; JG Glass (Brockway); Ace; Vitrum; Haldyn; Excel; Mahalakshmi; Mohan Breweries; Haryana; Victory Glass; Ramnath; Pragati; Cana; Allembic; Mohan Meakin; Neutral Glass; Bhagwati
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	919,800
Green %	193,450
Amber %	372,300
Markets Served:	
Wine %	20%
Food %	45%
Beer %	35%
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
Commentary:
Little Information.
India has a number of raw materials for the glass container industry but, at present, the country's manufacturers are progressively looking to improve their cullet utilisation to keep

production costs at a low level.

India is understood to re-use a significant proportion of containers due to the relative cost of new containers. (http://en.wikipedia.org/wiki/Glass_recycling)

Government of India has undertaken several initiatives at the state and national level to promote recycling of waste in the country, including the 'Solid Waste (Management & Handling) Rules'. A set of rules to promote classification, labelling and collection and recycling of containers and packaging has been drafted and is under discussion. In respect of recyclables like paper, glass, tin etc. which are sorted at homes, 13 to 20% of recyclables are again sorted from municipal solid waste collected by the concerned authorities.

A self organized chain of self employed individuals commonly known as Kabariwala have established a system of collection, segregation and recycling of papers, plastics, tin, glass etc.

http://www.env.go.jp/recycle/3r/en/s_officials/03/05.pdf

		Data for Year
Waste Stream / tonnes		
Recovered / tonnes		
Recycling Rate		
Packaging Waste Target		
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Little information.

Economic forecasting does not rank India as a significant exporter or importer of cullet.

		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Insufficient data to draw conclusions.

32.0 Japan

1. BASIC COUNTRY FACTS	
COUNTRY:	Japan
Population / million:	127.5
Population Growth / %	0.1
GDP / US\$ bn:	4560.2
Inflation %:	-0.4
EU Status:	Not applicable
Foreign Trade Commentary:	
Japan's merchandise trade surplus stood at US\$93.7bn in 2005, with exports of US\$568bn and imports of US\$474bn.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	1.5m/t	Yamamura Glass; Hiroshima Glass; Ishizuka; Nippon; Toyo; Asahi; Terumo; Dai-Ichi; Koa
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	50%
Green %	30%
Amber %	20%
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
Commentary:
<p>Recycling holds high profile in Japan and the country is active in the 3Rs initiative (reduce, reuse, recycle). The Government of Japan has enacted a set of laws governing the recycling of specific items, including the "Law for Promotion of the Sorted Collection and Recycling of Containers and Packaging," combined with the introduction of extended producer responsibility (EPR). It has also established a "Support scheme for Establishing a Sound Material-Cycle Society" in 2005, with the aim of establishing a sound material-cycle society supported by local communities and designed to promote the 3Rs through the establishment of waste treatment and recycling facilities.</p> <p>http://www.env.go.jp/recycle/3r/en/s_officials/03/06.pdf</p> <p>Cullet is collected from households by local government units. Local government units, bottlers and glass recycling companies collect from shops and restaurants. Waste boxes are</p>

located next to automatic vending machines.

Glass recovery rates are high at ~90% (by 2003) having risen steadily from ~60% in 1995, and the country also has in place a returnables system for beer, sake, milk and soft drinks of covering some 1.6mt glass containers.

Glass container collection will is expected to remain flat, or decrease slightly and use of returnable bottles is expected to continue a noted decline.

		Data for Year
Waste Stream / tonnes	1.4m/t (estimated)	2005
Recovered / tonnes	1.23m/t	2005
Recycling Rate	~90%	2003 (http://www.env.go.jp/recycle/3r/en/s_officials/03/06.pdf)
Packaging Waste Target	Not applicable	
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	790,000 tonnes (53%)	2005
Glass to alternative Use / tonnes (%)	120,000 tonnes	
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

No cullet was exported or imported from Japan in 2005 and available information suggests this position is not forecast to change.

Notwithstanding the above economic forecasting globally ranks 8th in terms of cullet exporting countries (representing 4% of the global market) and 3rd in terms of target markets (representing 11% of the global market).

These two sources of data clearly conflict.

		Data for Year
EXPORTS		
Volume / tonnes	0	2005
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	0	2005
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Based on available information, and in the absence of colour split data, there would appear to be a shortfall of domestic cullet for use in remelt. This is in the context of an already high recycling rates. However, due to the absence of information on the colour split of recovered and remelted glass this conclusion is at best tentative, with no feel for the colour of any

possible shortfall.

There is apparently no cullet import / export activity at the current time, or indication that this position will change.

Japan is closely engaged in the 3Rs initiative and support of developing countries in the Asian region, as such it is postulated that any cullet trade is more likely to take place with those countries.

On this basis, it is not believed that Japan is a strong prospect for cullet import or export from / to the UK.

33.0 New Zealand

1. BASIC COUNTRY FACTS	
COUNTRY:	New Zealand
Population / million:	4.1
Population Growth / %	1.3
GDP / US\$ bn:	108450
Inflation %:	2.5
EU Status:	Not applicable
Foreign Trade Commentary:	
Exports of goods rose to US\$20.5bn in 2004, but imports of goods grew faster, to US\$21.9bn, causing the trade deficit to widen to US\$1.4bn, from US\$458m in 2003. The deficit is likely to have widened further in 2005.	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	182,500 Capacity	ACI New Zealand
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	73,000
Green %	73,000
Amber %	36,500
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
Commentary:
<p>The country has a well developed recycling culture and infrastructure. Since 1999, 48 of the 74 (66%) Local Authorities in New Zealand have adopted a Zero Waste policy - most are aiming for Zero Waste by 2015.</p> <p>http://www.zerowaste.co.nz/default.nz.sm;jsessionid=1E39C83657301DEC7182A5A4C2ED6A7C</p> <p>The country already has a good recycling rate at ~ 66% and is suffering from a considerable excess of recovered cullet beyond the capacity of its own container industry; recovery runs at ~142% of remelt requirement. As such solutions are being urgently sought to cope with growing stockpiles of cullet, including alternative uses (e.g. as aggregate) and export.</p> <p>http://www.zerowaste.co.nz/assets/ZeroWasteUPDATEFebruary2006final.pdf</p> <p>http://www.scoop.co.nz/stories/PO0603/S00138.htm</p> <p>It is also noted that the domestic glass maker O-I is planning to expand its New Zealand</p>

operation (by some 60%) to support the rapid expansion of New Zealand's export wine industry, replacing container imports from the middle east and Asia. This measure is expected to reduce the current stockpiles of cullet. http://www.investmentnz.govt.nz/section/14237/15932.aspx?NewsType=recent http://www.zerowaste.co.nz/default,753.sm		
		Data for Year
Waste Stream / tonnes	150,000	2006 http://www.zerowaste.co.nz/assets/ZeroWasteUPDATEFebruary2006final.pdf
Recovered / tonnes	100,000	2006 (as above)
Recycling Rate	>65%	2006 (as above +) http://www.scoop.co.nz/stories/PO0603/S00138.htm
Packaging Waste Target	55%	By 2008 Under 'Packaging Accord'
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	70,000t	
Glass to alternative Use / tonnes (%)	Road aggregates and other uses being considered.	
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

<p>Commentary:</p> <p>It is understood that New Zealand currently exports ~ 25% of collected glass due to supply beyond domestic requirements, and that cullet stockpiles continue to grow (particularly in South Island). http://www.zerowaste.co.nz/assets/ZeroWasteUPDATEFebruary2006final.pdf</p> <p>Trials are soon to begin to evaluate the costs and logistics of the opportunity to ship high quality, clear glass cullet to South Australia (10,000tpa) for use by Potters Industries Australia in the manufacture of hemispherical glass beads, which are used to make reflective beads used in road markings http://www.zerowaste.co.nz/assets/UpdateJuly06.pdf http://www.zerowaste.co.nz/assets/UpdateMay06pdfoffWordformat.pdf</p> <p>Economic forecasting for the Oceania region ranks New Zealand as the number 1 cullet exporter representing some 66% of the local market, predominately exported to the US. It is unranked in terms of imports.</p>		
		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		

Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

New Zealand suffers an excess of cullet and is already understood to be exporting some of this excess.

As such, there is no prospect for export of excess green from the UK. Conversely, NZ is exporting flint in significant quantities and could potentially offer an import opportunity to the UK. However, the planned expansion of the domestic remelt capacity in 2007 may change this position, but the absence of colour split data does not allow firmer conclusions to be drawn.

In summary New Zealand is seen as a potential source of flint cullet for import to the UK warranting further investigation.

34.0 South Africa

1. BASIC COUNTRY FACTS	
COUNTRY:	South Africa
Population / million:	47.4
Population Growth / %	
GDP / US\$ bn:	
Inflation %:	
EU Status:	
Foreign Trade Commentary:	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	700 (2005)	Consol Glass (77% market share)
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	~35
Green %	~30-35
Amber %	~25-30
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
<p>Commentary:</p> <p>2005: Glass is collected via bottle banks (12,000t), Post industrial (end of life returnables - 30,000t) and Commercial waste glass collection / trading by SMEs (108,000t). Glass container imports and exports are of similar volume.</p> <p>The recovery rate is relatively low at ~20% (but this rises to ~65% when returnables are taken into account); recovery rate is forecast to rise to ~86% (600,000t) by 2015 and is currently rising at ~25% per annum. Further momentum is being created the recent introduction of the Glass Recycling Company (Pty) Ltd – a not for profit glass industry recycling initiative (see below) in addition to local authorities starting to take action on waste management and reduction principles.</p> <p>Consol buys in glass as mixed and then colour separates and decontaminates material through automated processing plants at its factories. Final split is roughly 35% flint, 30% green and 25% amber and 10% mixed that is blended into manufacturing of certain greens and amber. Because the colour split of collected glass is roughly the same as that of production the country does not suffer the colour imbalance seen in the UK.</p>

In 2005 the National Glass Recycling Forum and The Department of Environmental Affairs and Tourism (DEAT) launched a major national recycling campaign, aimed at managing the problem of waste glass in the environment and creating jobs. It aims to drive glass-recycling levels up from the current 20 % to 50% per annum in less than five years. A Memorandum of Understanding based on Extended Producer Responsibility has been agreed, which provides clear guidelines for the management of the new National Glass Recycling Initiative. This will be signed by all members of the National Glass Recycling Forum, which includes glass-packaging manufacturers, the extended producer/glass user chain, government (including DEAT), labour and recyclers, as well as industry and consumer groups. Funding of the National Glass Recycling Initiative, will be derived from a small environmental levy on all glass containers sold, as well as membership fees from participants and donations. Monies will be used to build capacity for future glass recycling through the development of waste glass collection infrastructure on a social basis, public awareness and education across the country.

The industry is driving glass recycling by agreeing on a model of self-regulation. Key to this was the set up of the Glass Recycling Company (Pty) Ltd, a non-profit company, governed according to the Memorandum of Understanding. This covers all areas of the recycling model including the funding mechanisms, as well as the various responsibilities across the manufacturer, producer/filler and user chain. The National Glass Recycling Initiative is based on the advanced repurchase system (ARS), which is similar to the United Kingdom PRN system.

South Africa also has a firmly established re-use glass system currently in place, which is based on the voluntary deposit system, strongly supported by many leading beverage producers.

http://www.consol.co.za/html/news_articles/Final_Recycling_release_19.06.05.doc

Only a small quantity of cullet is used in alternative uses.

		Data for Year
Waste Stream / tonnes	700,000 (~620,000 non returnable and 80,000 end off life returnables)	2005
Recovered / tonnes	150,000	2005
Recycling Rate	~21%	2005
Packaging Waste Target	Not applicable	
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	~150,000 (~21%)	2005
Glass to alternative Use / tonnes (%)	600t (abrasives), 500t (glazing), 100t (Decorative / Craft).	2005
Use:	See above	

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

Exports of containers to other countries in the southern African region (the Southern African Customs Union) are 'countered' by cullet imports from these countries which run at ~ 10,000 t. Imports from the Southern African region are expected to reach ~ 70,000t (from 10,000t current) by 2015, with distance and cost precluding further growth.

No export activity currently takes place or is forecast to take place in the future.

Economic forecasting does not rank South Africa as either a exporter or target market for

cullet trade.		
		Data for Year
EXPORTS		
Volume / tonnes	0	2005
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes	~9800	2005
Colour		
Origin	Namibia (5000t), Lesotho (1800t), Swaziland (600t), Mozambique (1200t), Botswana (1200t)	2005
Use	Remelt	

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Due to current low recycling rates there would appear to be some opportunity for export of excess green cullet to SA (of the order of an estimated ~150 kt), however, this appears to be precluded even at a local regional level by cost at the current time. Given the rapidly rising recycling rate and if aspirations for 86% recovery by 2015 are realised, the country will become nominally self sufficient in cullet for remelt and therefore any such export market will be short lived.

Information from Consol suggests that the decision whether to import cullet will to a large extent be driven by the ability of their raw material suppliers to meet their growing demands. It is ventured by Consol that they might reach a situation in the medium term (5 years) where they will have to investigate the feasibility of importing cullet, but with no real feel for what colours and quantities.

In terms of amber / flint import to the UK, current low recycling rates preclude this. However, even when recycling rates improve, due to the close match between the colour split of production and recovery, all flint / amber arisings will find use domestically and as such no opportunity exists.

35.0 South Korea

1. BASIC COUNTRY FACTS	
COUNTRY:	South Korea
Population / million:	48.3
Population Growth / %	0.6
GDP / US\$ bn:	787.6
Inflation %:	3.3
EU Status:	Not applicable
Foreign Trade Commentary:	
<p>Merchandise export revenue in 2005 rose US\$289bn, and the value of merchandise imports increased to US\$256bn. This gave a merchandise trade surplus for the year of US\$34bn, compared with US\$38bn 2004.</p>	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	1.1m/tonnes	Sam Kwang; Ansung; Doosan; Donga; Dongseo; Hanil; Hyundai; Ilhwa; Jinro; Pacific
Flat	800,000	
Fibre	67,000	
Other	CRT Glass unquantified	
Total	1,967,000	

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	372,500/t
Green %	234,000/t
Amber %	452,600/t
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
<p>Commentary:</p> <p>Little information is available. It is understood that glass recycling rates are good, standing at ~68-70% in 2002. Municipalities provide a free collection service for designated items like papers, metals and plastics so that it is easier to collect recycled products, however it is unclear whether or not this system includes glass.</p> <p>An extended Producer Responsibility system was introduced in 2003, superseding a waste deposit-refund system which was in operation from 1992 until 2002.</p> <p>The system covers 4 packaging materials (paper boxes, metal cans, glass bottles and synthetic resin packages)</p>

The 'Promotion of Saving and Recycling of Resources' Act and regulations on the standard for packaging materials & packaging methods of products have been in place since 1993, to reduce the packaging waste generated, which takes up about 37% of urban solid waste.

The Korean Ministry of Environment regulates packaging method to prevent excessive packaging. In 2005, "a guideline on environmentally friendly packaging" was made and distributed to encourage cooperation among producers making and using packaging materials. As a result of implementing this system, the packaging waste generated decreased by 20% from 62,940 tons/day in 1993 to 49,902 tons/day in 2002 despite the increase of economic size and population.

http://www.env.go.jp/recycle/3r/en/s_officials/03/09.pdf

		Data for Year
Waste Stream / tonnes		
Recovered / tonnes		
Recycling Rate	~68-70%	2002
Packaging Waste Target	Not applicable	
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)		
Glass to alternative Use / tonnes (%)		
Use:		

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

Commentary:

No direct information available.

Economic forecasting suggests that in global terms S Korea ranks 5th in terms of target markets, representing approximately 8% of the global market. Within the Asian region S Korea ranks 1st in terms of cullet imports (33%) and is the primary destination from China representing ~49% of their exports.

With the Asian region the country ranks 4th in terms of cullet exporters, representing ~2% of the market.

		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary:

Whilst data for the country is very limited indeed, it is believed that S Korea may offer a potential opportunity for export of excess green cullet from the UK. However, this opportunity is in the context that China is believed to be a major exporter to S Korea, and as such actual opportunity may be limited.

36.0 USA - California

1. BASIC COUNTRY FACTS	
COUNTRY:	USA (Note – analysis focuses on California due to this state’s role in the New World wine market).
Population / million:	~34 (Ca)
Population Growth / %	
GDP / US\$ bn:	
Inflation %:	
EU Status:	Not applicable
Foreign Trade Commentary:	

2. GLASS MANUFACTURING INDUSTRY OVERVIEW		
Glass Type	Production / mt	Principal Companies
Container	11.8M/t (US) California has 6 glass container plants. Estimated container plant production ~ 1.97mtpa	Anchor; Brockway;Kerr; OI; Saint-Gobain
Flat		
Fibre		
Other		
Total		

3. CONTAINER INDUSTRY OVERVIEW	
Production Colour Split:	
Flint %	5.5M/t US (47%)
Green %	3.1M/t US (26%)
Amber %	3.2M/t US (27%)
Markets Served:	
Wine %	
Food %	
Beer %	
Melting Fuel Split / % by MWh:	
Natural Gas %	
Fuel Oil	
Electricity	
Other	

4. GLASS RECYCLING INFRASTRUCTURE
<p>Commentary:</p> <p>California has a well developed recycling infrastructure and currently recovers ~ 58% of containers in circulation (2005). http://www.consrv.ca.gov/dor/Notices/Images/Biannual506.pdf Collection is principally by bring site (52%) followed by kerbside (43%) and other collection programmes (5%).</p> <p>California operates a redemption system for beverage containers under which bottles carry the California Refund Value (CRV), as an incentive to recycle. The goal of California’s program is to recycle at least 80% of all containers covered by the law. The popularity of single-stream curbside collection, where consumers place all recyclables in one bin, has increased the amount of broken, mixed-colour glass. California has standards for use of cullet</p>

which requires container makers to use >35% cullet in new bottles, or 25% if at least half their cullet is mixed colour. To direct more high-quality glass to the container industry, the Dept Conservation pays up to \$30/ton to local jurisdictions or companies that produce curbside-collected, colour sorted glass "substantially free of contamination.". A producer responsibility element in California's program provides additional support for recycling. Manufacturers pay a special processing fee when the cost of recycling is greater than the scrap value of a material; plastics and glass carry the fee. For 2006, certified glass recyclers receive nearly \$84/ton of CRV glass over and above the scrap value. The monies are intended to help recyclers recover their costs, but there is no legal requirement for how they are used.

Glass container and fibreglass plants still need more high-quality cullet, and wide spread adoption of single-stream recycling continues to challenge processors.

http://www.gpi.org/recycling/pdfs/JimHill_CA.pdf

		Data for Year
Waste Stream / tonnes	1,264,000 (calculated)	2004
Recovered / tonnes	708,000 (Ca) (Colour split: Mixed 38%, Flint 29%, Green 11%, Amber 22%)	2004
Recycling Rate	56% (Ca)	2004
Packaging Waste Target	(80%)	
Flint Remelt / tonnes (%)		
Green Remelt / tonnes (%)		
Amber Remelt / tonnes (%)		
Mixed Remelt / tonnes (%)		
Total Remelt / tonnes (%)	500,000 (Ca) Container (estimated 25%)	2005
Glass to alternative Use / tonnes (%)		
Use:	Bricks and tiles, Sand	

4. CURRENT GLASS IMPORT / EXPORT ACTIVITY

It has already been indicated above that current sources suggest continued demand for good quality furnace ready cullet in California.

Data on imports and exports is somewhat dated;

1996 - The demand for clear, brown, and green reprocessed cullet by California container manufacturers exceeded available supply resulting in import of cullet from out-of-state to meet demand. All glass cullet recovered in the state was consumed by either the state's glass container and fibreglass manufacturers, or was exported to glass container manufacturers in Mexico. <http://www.ciwmb.ca.gov/Publications/Markets/42197008.doc>

1996 - California exports of glass scrap and cullet were minimal, with Mexico and Japan being primary markets. In general, the weight of glass and its low value increased transportation costs beyond a reasonable return for most export markets.
(<http://www.ciwmb.ca.gov/Markets/StatusRpts/exports.htm#Glass>)

2001 - The north east US was suffering from a glut of green cullet (30,000 t) beyond the needs / demands of its own glass industry; 85% of the green glass being collected on the East Coast was being used as "alternate daily landfill cover" with another 15% used in aggregate applications. In consequence it was reported as actively pursuing export markets and exploring opportunities in Italy, Spain, Portugal and France and South America.

<http://www.nerc.org/bulletin/20010901.html>

Based on the above data, it is tentatively suggested that demand in California may be met by imports from elsewhere in the US.

Dialogue with the US glass packaging institute (and via them California's largest glass manufacturer indicates) indicates that no demand exists within the state. Strategic materials, the US's largest cullet processor has indicated that some green in the state is being used in fibreglass production due to limited demand from container manufacturers; the company was unaware of any inquiries regarding green import.

Economic forecasting ranks the **US** 4th in terms of global cullet exporters (representing ~13% of the market) and also 4th in terms of target markets (representing ~8% of the market). The value of exports is greater than that of imports.

		Data for Year
EXPORTS		
Volume / tonnes		
Colour		
Destination		
Use		
IMPORTS		
Volume / tonnes		
Colour		
Origin		
Use		

5. PROSPECTS FOR CULLET IMPORT / EXPORT

Commentary: (California)

Whether or not glass container and fibreglass plants in California still need more high-quality cullet is the subject of conflicting data. The state has a recycling rate comparable to the UK, but with a target of 80% which if and when realised should reduce the need for any imports to the state.

Given gluts elsewhere in the country, it is tentatively proposed that any cullet demand will most probably be met through inter-state cullet trade without the need for imports from further a field, and as such the prospects for export of green cullet from the UK are poor.

However, work to offer more definitive conclusions lies beyond the scope of this project.

Written by:



GTS

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