Creating markets for recycled resources

R&D Final Report: Glass

A Study into the Interaction of Imported Wine Bottles and the UK's Cullet Supply

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SERVING THE WORLD OF GLASS

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Executive Summary

Glass is an important packaging material having many advantages including the ability to be fully recyclable. Recycling glass back to the furnaces saves valuable raw materials, reduces energy consumption and lowers emissions of CO_2. The UK container manufacturers are keen to recycle glass (cullet) through their furnaces and are actively involved in the recycling effort. The UK container industry melts approximately 2 million tonne of glass per annum and the UK's waste stream holds around 2.5 million tonnes of glass. Thus, at a first glance the industry should be able to satisfy most of its needs from recycled glass. Unfortunately, several factors prevent this desirable outcome: the glass manufacturer's need for colour sorted glass and differences between the colour profiles of the UK's glass manufacturing capacity and those found in the waste stream presenting the major obstacles. The imbalance in the supply and demand for green glass is of particular concern. The waste stream contains almost 1 million tonnes of green glass yet the UK's container furnaces produce just 400,000 tonnes of it.

Wine bottles contribute significantly both to the waste stream and the green glass excess. The UK is the world's largest importer of wines with annual consumption exceeding 1000 million litres. Much of this wine arrives bottled in green glass. Approximately half of this wine is shipped from the New World; Australia and California being the leading exporters. An alternative, growing and more environmentally friendly option is to ship the wine in bulk and bottle the product in the UK. A further option which would help address the green imbalance would be to persuade the wine importers to bottle their UK bound wines in flint glass wherever possible.

This study was commissioned by the Waste and Resources Action Programme (WRAP) which was established to promote sustainable waste management. WRAP has identified that the trade in wine was a major contributor to the domestic waste stream and the colour imbalance. The study has quantified these contributions and analysed the implications of various actions that could be encouraged to improve the utilization of waste glass; in particular those measures that would allow the glass to be recycled through the melting furnace, which is considered to be the best environmental option.

The study concluded that "bulk containerisation" has the greatest potential benefit on cullet recovery in the UK. These benefits are maximised if the required wine bottles are subsequently produced in the UK. The UK has the necessary glass bottle manufacturing capacity and it is anticipated that the required filling capacity will be installed as demand increases. Filling the wine in UK produced green bottles would have the great benefit of increasing the demand for green cullet. Bulk shipping also reduces the environmental impact of transport, bringing significant CO_2 savings as fewer containers and thus ship voyages are required.

Persuading wine producers to bottle their product in flint rather than green glass has the second largest impact in terms of UK cullet. An increase in the proportion of flint bottles in the waste stream would greatly assist the operators of the colour sorting facilities on which the container manufacturers are increasingly reliant for the supply of clear glass. The study considered the impact this option would have on the producer country's glass industry and conclude that in most cases it would have little or no negative impact.

Wine bottles tend to be heavy. The study found large variations in weights of wine bottles; the heaviest being almost 1 kg, the lightest being under 300g and the average being 535g. Thus there exists an enormous potential to reduce the amount of glass packaging in the waste stream simply by encouraging the wine producers to obtain the lightest possible container.

Traditionally, wine has been bottled in green glass rather than clear as it offers better protection from UV light, prolonged exposure to which can impair the taste of the wine. The study investigated technical solutions to this problem and found that commercially available solutions in the form of organic coatings and plastic sleeves have been developed. The researchers also postulate that a more elegant solution could be achieved by imparting UV protection to clear glass by small additions of rare earths to the melting process.

The study concluded that there were great benefits to, and no major obstacles against, encouraging both the bulk importation of wine and the conversion of imported bottles to clear glass. Over 70 percent of wine by volume is sold through the off-license trade of which the major supermarkets account for over 80%. The major retailers where thus identified as the best route to progress any changes which it is believed will be wholly consistent with their obligations under the Courtauld Commitment.

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1 Introduction

Waste glass has many potential uses but its return to the melting furnaces represents perhaps the best environmental option saving significant quantities of both raw materials and energy. However, at the current time there is an imbalance in the colour mix between the waste glass being recovered and that required by our domestic container glass manufacturers who comprise the largest sub-sector of the industry. Wine imports, which arrive in predominantly green bottles, contribute significantly to this imbalance. This project seeks to redress that balance by investigating the impacts of encouraging a number of changes to the supply chain. Specifically the project will consider:

- The impact of a switch by wine importers from the use of green to flint bottles
- The impact of a switch by wine importers to bulk shipments of wine that is to be subsequently bottled in the UK.

The study will identify the implications for the UK wine trade, container production and the effects on the domestic waste stream should an increase in the flint content of waste stream result. The impacts of such a change on the New World will also be considered.

The Waste and Resources Action Programme (WRAP) was established to promote sustainable waste management. WRAP recognises the colour profile of glass arising from the various waste glass collection schemes does differs markedly from that needed by the glass melters who constitute an important outlet for the recovered material. WRAP has thus commissioned this study which seeks to quantify the contribution of wine imports to the colour imbalance and investigate sustainable measures that could address the imbalance.

2 Scope of the Study

The study is limited to wines originating from the "New World" which will be defined as California, Australia, New Zealand, Chile, Argentina, Uruguay and South Africa. The study will focus on the high volume low cost products that comprise the bulk of the trade and are considered to be more pliant in respect to changes to packaging and image.

3 The UK Wine Market

3.1 Overview

The UK is the world's largest importer of wines. In 2004 Mintel estimate that the UK wine market had retail value of around £7.6 billion; a value that represents a growth of 31% since 1999. While French wines are still dominant in the UK on-trade (pubs, bars, hotels and restaurants), the grip of French wines in the mainstream retail market (price range of £2.99 - £7.99) is being strongly challenged by Australia. In fact, according to AC Nielsen, Australia now tops the UK retail market followed by France, then USA. Details of leading wine importing countries are given in Figure 1.

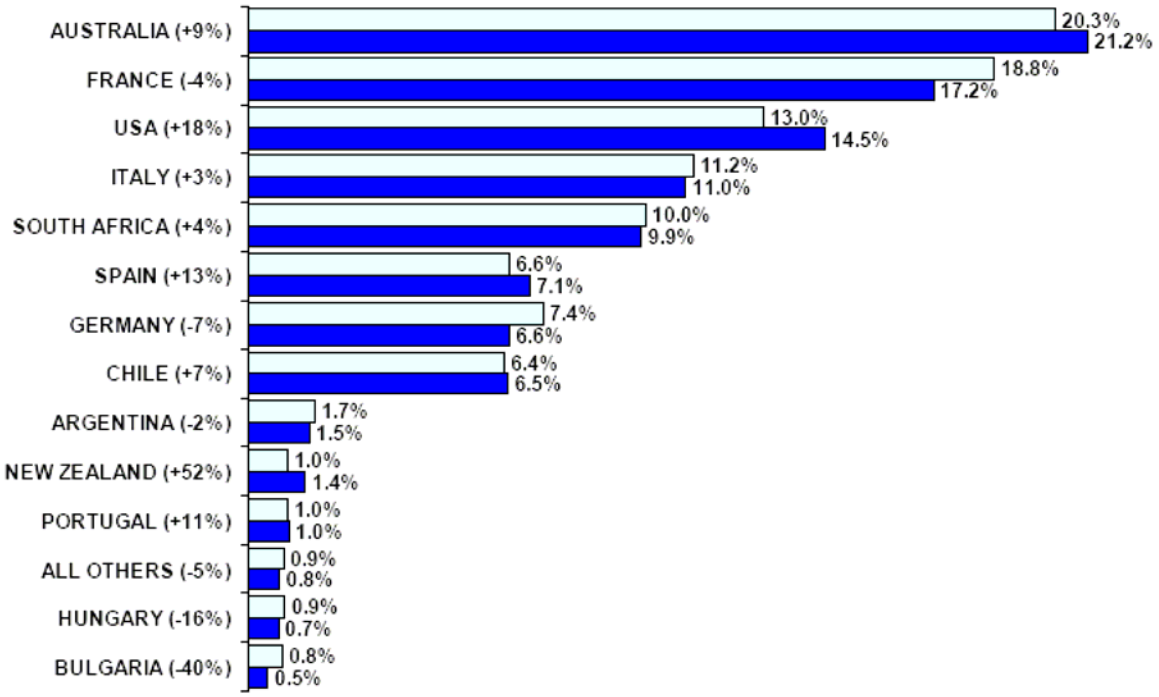


Figure 1 Market Share of Off Sales – by Country of Origin

Wine is produced in several categories but "still" wines represent the overwhelming majority of those consumed in the UK and are the focus of this study.
Details of UK wine consumption by the more significant classifications are given below in Table 1.

	2001		2002		2003	
	Mill litres	£ million	Mill litres	£ million	Mill litres	£ million
Still Wine	951	1,487	1,028	1,600	1,110	1,700
Sparkling Wine	41	221	51	273	64	307
Flavoured/Vermouth	13	14	13	10	15	15

Source of Data: H.M. Customs and Excise (Imports less Exports)

Table 1 UK imports of wine by type

Of the still wines the popularity of the red varieties has increased in recent years and it now outsells its white counterparts. Details of the volumes and colour of wine imported from the major new world producers are given below in Table 2.

UK Wine Imports 2003			
(Units million litres)	Red	White	Total
Total UK imports	515	493	1008
Australia	106.7	98.9	205.6
USA	66.7	49.3	116.0
S Africa	39.1	55.3	94.4
Chile	40.0	28.8	68.8
Argentina	10.6	6.7	17.3
N Zealand	1.7	11.4	13.1
New World (sub-total)	264.9	250.3	515.2
(%)	51.4	50.8	51.1

Table 2 UK wine imports by country of origin (2003)

The astonishing increase in consumption of wine in the UK has been accompanied by a similar rise in the variety of brands available at accessible prices. The ten leading brands are listed below in Table 3.

Ranking	TOP 10 Wine Brands in the United Kingdom	Country of Origin	Volume On trade (m litres)	Volume Off trade (m litres)
1	Stowells	Various	30	16
2	E&J Gallo	USA	40	4
3	Blossom Hill	USA	38	4
4	Jacobs Creek	Australia	34	6
5	Hardys Stamp	Australia	22	4
6	Kumala	South Africa	19	1
7	Rosemount	Australia	14	3
8	Banrock Station	Australia	13	2
9	Piat d'Or	France	12	2
10	Hardys VR	Australia	10	1

Table 3 Leading brand owners – UK wine trade

The above list is perhaps remarkable as it includes only one "traditional" French or Italian wines. The success of "New World" wines is generally ascribed to the fact that they offer an easy-to-drink consistent product with user-friendly identification and packaging. Wines from South Africa, Chile, Argentina and New Zealand are continually increasing their market penetration. In particular, according to Customs & Excise data, UK imports from Argentina increased by 49 percent in 2003 over the previous year.

Currently new product development is going in two directions: one is to offer better, premium wine to encourage consumers to trade-up; the other is to offer new, consumer-friendly packaging formats. Screw-cap bottles are successfully replacing cork; and organic and fair-trade wines look set to be growth areas.

Domestic wine production in the UK is minimal due to the variable climate. According to the Wine Standards Board, there are around 380 vineyards in England and Wales, covering about 800 hectares. This production represents only 0.01 percent of UK wine consumption.

The majority of wine is filled in the country of origin, most commonly in 75cl bottles. However an increasing trend is to bulk ship the product and fill closer to the final destination. Currently some 22% of the fast growing Australian imports are shipped in bulk.
In terms of actual glass bottles Mintel (2003) estimate that the imports from the New World filled some 468 million bottles compared with a combined total of 468 million bottles from wines produced by France, Italy, Spain and Germany.

Wine in the UK is sold through either "on-license" or "off-license" premises. An On-License authorizes an outlet to sell alcoholic beverages for consumption on the premises, whereas an Off-License authorizes an outlet to sell alcoholic beverages for consumption away from the premises.

Over 70 percent of wine by volume is sold through the off-license trade. Off-license outlets include specialized wine/alcoholic beverage stores and general grocery stores, including the major supermarkets. As illustrated in the table below, the distribution of off-license sales can be divided up roughly into one-quarter specialist wine/alcoholic beverage shops and three-quarters supermarket outlets. Whilst supermarkets represent only 23% of the estimated 46,000 off-licences they account for over 80% of sales. On the whole, the supermarkets are price-driven - seeking to reach the all-important price points of £3.99 - 4.49. However wine is now increasingly being considered as a so-called "destination" product i.e. one that attracts customers to one particular outlet rather than another and to this end tends to receive a disproportionate amount of promotion.
Details of the size of the off-trade are given in Table 4

Outlet Type	Sales £ million	Market Share %
Supermarket	2,533	83
Off licences/specialists	518	17
Total	3,051	100

Source: AC Nielsen/The Drinks Pocket Book, 2004

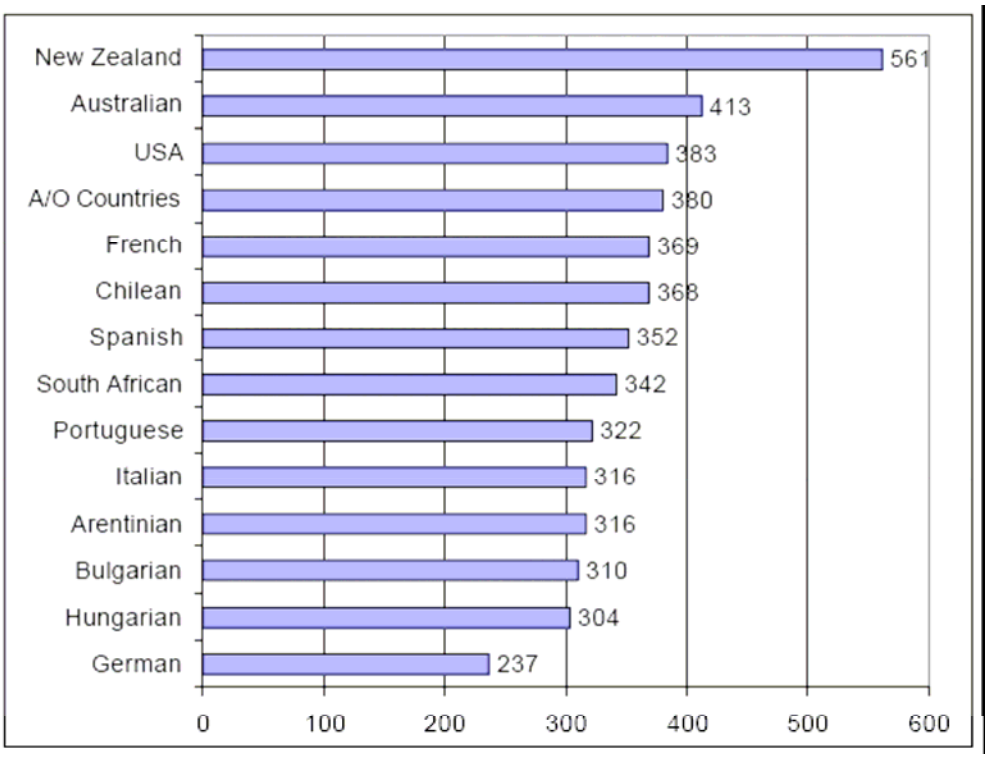
Table 4 Sales of Still Wines from Off-Licenses by Outlet Type [2004]

By contrast the specialist wine chains tend to seek points of difference across a wider price range and offer more premium wines which experienced a near 6% growth in 2004.
Large volume orders for UK supermarket chains and off-license chains are placed with UK agents and distributors, who in turn order from the required country source on the chain store's behalf. It is not usual for the UK agent to hold the goods upon entry to the UK; instead they ensure that they reach the designated distribution depot of the chain customer.

Larger wineries may have their own UK office, which again does not hold stock, but rather fills orders for the UK chains. This gives the wine company increased control so as to ensure a quality and consistent service to the store group.

The supermarket chains deserve much of the credit for the growth of the UK wine market and supplied 54% of the nation's retail volume in 2002. Off-trade sales grew more quickly than on-trade sales between 1998 and 2002, and continue to dominate the market. In this retail sector, multiple specialists are currently losing share to the multiple supermarkets and are likely to lose more to the new breed of convenience stores, also run by the supermarkets (e.g. Tesco Metro, Sainsbury's Local). Similarly, it is likely that smaller, independent off-licenses will continue to find their market share under pressure (while still growing overall volume) from the convenience store formats of the multiple supermarkets.

Figure 2 is compiled from details taken from a survey conducted in UK supermarket chains and shows the average retail price being asked for 75cl bottle of wine from the leading supplier countries (values shown in pence).



Source: AC Nielsen

Figure 2 Average Price per 75cl Bottle by Country of Origin

The consolidation evident within the UK and, indeed, the global, drinks business means that many retail outlets, afraid of losing share, often end up replicating their product ranges and buying from the same suppliers. They rely on selling points such as price, pack size or availability. As the big brands and companies continue to grow larger, the individuality of certain wines and vineyards is slowly disappearing.

In the on-trade the independents are managing to hold on to their market share better than the retail trade. However, it is steadily being eroded since the percentage share of the independent on-trade in 1998 was 78%, in 2002 it had fallen to 73%. There has been a vast improvement in the quality and range of wines offered in pubs, although some are still guilty of paying little attention to wine sales. While the availability and range of wine in the restaurant sector has greatly improved, some restaurants continue to charge inflated prices.

Details of the size of the on-trade are given in Table 5.

Outlet Type	Sales £ million	Market Share %
Multiples	799	32
Managed Pub Chains	490	20
Leased/Tenanted Pubs	309	12
Independents	1,682	68
Pubs	240	10
Clubs	177	7
Hotels	387	16
Other Bars	150	6
Restricted [1]	728	29
Total	2,481	100

Source: AC Nielsen/The Drinks Pocket Book, 2005

Table 5 Still Wines in On-Licenses by Outlet, 2003

1 Establishments where sales are restricted to residents or bona-fide diners only

3.2 New World Producers

3.2.1 Australia

The UK is Australia's largest market for its wine exports with some 257 million litres of still wine being exported in the 12 months to October 2005. The wine had a value of approximately £920,000,000.
Australian wines now comprise over 24% of the UK market and relegating French imports to second place. The leading Australian exporters by volume are listed below in table 6 with their leading brands:

Leading Exporters –by Volume	Brands
Southcorp Wines	Lindemans, Penfolds, Rosemount
BRL Hardy	Hardys, Banrock Station
Orlando Wyndham Group	Jacob's Creek
Beringer Blass	Wolf Blass, Jamieson's Run, Yellowglen
Casella Wines	Yellow tail
Cranswick Premium Wines	Cranswick Estate, Salisbury,
McGuigan Simeon Wines	McGuigan, Miranda, Tempus
Riverina Estate	Marsanne
Miranda Wines	Miranda High Country, Mirrool Creek,
Angove's	Maxwell, Tullock, Mount Riley

Table 6 Leading Brand Owners – Australian

The volume of exports to the UK has been growing rapidly in recent years increasing some 22% since 2002. Red wine constitutes the larger market and is also growing at a faster rate (+32% since 2002) compared to the more modest growth of the white wine (+11%). The wine is predominantly shipped in bottles although bulk shipments are increasing and currently account for 24% of the total equivalent to 60 million litres. Shipments of "soft packed" wine have yet to make an impact and currently comprise approximately 0.3% of the market.
Details of Australian imports are given in Figure 3

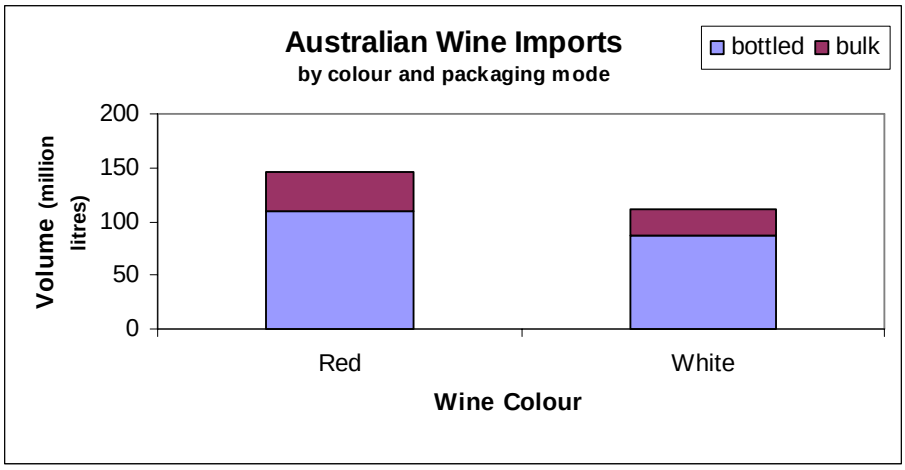


Figure 3 Australian Wine by colour and mode of delivery

The majority of Australian wine is destined for the off-trade; in excess of 70% of all wine consumed is sold via this route. Data obtained from Nielsen provided details of the best selling brands sold in 75cl bottles. Of

the 93 brands some 31 were of Australian origin. In total these 31 brands accounted for some 155 million units (75 cl bottles) and would have a combined weight of some 83,000 tonnes. Details covering the top 10 best selling Australian brands are given below in Table 7 and these are seen to account for 116 million bottles or 62,000 tonnes of glass.

Off-Trade		
Brand	**Bottles (million)**	**Glass Weight @ 535g/unit (tonnes)**
JACOBS CREEK	32.6	17,441
STAMP	13.2	7,062
CREST	13.0	6,955
BANROCK STATION	10.4	5,564
VR	10.2	5,457
BIN SERIES	9.9	5,297
VOYAGE	7.4	3,959
DIAMOND BLENDS	7.2	3,852
NOTTAGE HILL	6.3	3,370
CAWARRA	6.0	3,210
Subtotal	116.2	62,167

Table 7 Leading Australian Wine Brand (off-trade)

Corresponding data on the smaller on-sales market identifies that the leading brands contributed approximately 11 million bottles (6,000 tonnes)

Australian wine shipped in bottles thus accounts for approximately 200 million litres which, if all bottled in 75cl containers, would require approximately 250 million units. A (limited) survey of the weights of the bottles used by the Australian wine brand owners found that the average weight of the bottles was 535 g within a range of 410g to 580g. Thus, assuming that all the bottled wine is shipped in 75cl bottles, the maximum weight of glass (all colours) is approximately 135,000 tonnes per annum.
A survey of the leading Australian brands available in the UK found that the great majority (~90%) were bottled in green glass, a reflection of the glass manufacturing capacity dedicated to the wine growing region. Thus it is inferred that the Australian contribution to the UK's green glass excess is of the order of 120,000 tonnes per annum.

3.2.2 South Africa

The UK is South Africa's main export market for wine with some 107 million litres being delivered in 2004. South African Wine Industry Statistics (SAWIS) provide data on wine production and on the mode of packaging and the delivery of exports. The latest figures available relate to the year 2003 during which bulk deliveries accounted for some 29% of all exports which would equate to some 31 million litres supplied to the UK market.
Table 8 provides details of the leading brands as supplied to the off trade and their sales volumes.
The great majority of South African wine is sold in relatively heavy green bottles having an average weight of 510g. Assuming that 76 million litres of wine (total imports less bulk supply) is supplied by bottles having a similar profile to the leading brands then imports amount to approximately 100 million bottles with a combined weight of 50,000 tonnes.

Leading South African Brands (Off trade only)	Sales Litres	Number of bottles
Kumala Zenith	18,131,604	23,812,576
Arniston Bay	4,628,570	6,164,605
First Cape	1,961,224	2,614,952
Roberts Rock	1,603,253	2,137,640
Out of Africa	1,286,477	1,715,267
KWV	1,119,752	1,493,009
Glaan	988,692	1,318,255
Kgeisje	817,843	1,090,451
Two Oceans	744,229	992,288
Long Mountain	615,733	820,957
Shamwari	530,459	707,272
Total	32,427,836	42,877,272

Table 8 Leading South African Wine Brands (off-trade)

3.2.3 California

The UK is the leading export market for the US with 2004 sales experiencing a 20% increase to142 million litres. Sales of red wine are predominant with an approximate 60/40 split in their favour over the white varietals. The majority of the produce is sold as packaged table wine, sales of which grew by 19 percent during 2004. Bulk wine sales however are an increasingly important area as California wineries realised cost savings by exporting their finished bulk wine and bottling it abroad and this trade experienced an 87% expansion and currently account for approximately 15% of sales.

Table 9 provides details of the leading brands as supplied to the off trade and their sales volumes.

Leading Californian Brands (Off trade only)	Sales Litres	Number of bottles
Blossom Hill	36,481,138	48,639,241
Sierra Valley	27,086,049	36,060,855
Echo Falls	6,356,530	8,436,343
Stowells	5,524,040	7,304,855
Rivercrest	4,759,465	6,345,955
Paul Masson	4,580,914	6,107,876
Sundial	2,439,052	3,252,070
Sycamore Canyon	2,238,895	2,985,194
Turning Leaf	1,748,230	2,325,177
Turner Road	1,561,983	2,082,631
Corbett Canyon	1,543,855	2,058,448
Total	94,320,151	125,598,645

Table 9 Leading Californian Wine Brands (Off trade)

A (limited) survey of Californian wine revealed that a significant proportion of the wine, both red and white, was bottled in clear glass and that the average weight of the bottles was 484g. An assumption of total bottled imports of 120 million litres delivered in 75cl bottles of 484g unit weight would equate to total glass imports of 77,000 tonnes of which some 55,000 tonnes (70%) is estimated to be green glass.

3.2.4 Chile

Chile is the World's fifth largest exporter of wine and the UK represents one of its principal markets with exports of around 70million litres in 2003. Exports to the UK in 2004 grew by 25% in volume and by 30% in value which is contrary to the trends elsewhere as retail pressure is reducing the unit costs of wine. Sales of red wine are predominant with an approximate 60/40 split in their favour over the white varietals. The majority of the produce exported to the UK arrives as bottled table wine. Bulk Chilean wine has a long established market in the US where it is used to fortify other wines. The UK is also the recipient of an estimated volume of 10 million litres Chilean bulk wine much of it destined for supermarket "own brand" labels.

Table 10 provides details of the leading brands as supplied to the off trade and their sales volumes.

Leading Chilean Brands (Off trade only)	Sales Litres	Number of bottles
Isla Negra	5,289,211	7,050,416
Cyt Casillero Del Diablo	2,381,913	3,175,863
35 South	2,641,802	3,522,402
Conosur	1,892,599	2,278,939
Errazuriz	1,414,082	1,885,430
Total	13,619,607	17,913,050

Table 10 Leading Chilean Wine Brands (off trade)

The majority of the imported bottled Chilean wine arrives in green bottles having an average weight of around 500g. Using an import value of 60 million litres bottled in 75 cl units the estimate for glass inflow is 40,000 tonnes the majority of which is green glass.

3.2.5 New Zealand

New Zealand is a relatively small importer to the UK with sales of around 15 million litres of which almost 90% is white.
Wine is supplied to the UK in both bottled and bulk form although no data on the relative split could be sourced. The majority of wine bottled in New Zealand comes in green bottles due to the limited production facilities in the country.
Table 11 provides details of the leading brands as supplied to the off trade and their sales volumes.

Leading New Zealand Brands (Off trade only)	Sales Litres	Number of bottles
Montana N.Z.	3,033,378	4,044,371
Oyster Bay	1,194,087	3,539,824
White Cloud	1,278,954	3,157,574
Montana N.Z. Classic	956,339	2,660,076
Private Bin	336,994	1,262,916
Marlbrough	281,971	886,797
Totals	7,081,723	15,551,558

Table 11 Leading New Zealand Wine Brands (Off trade)

New Zealand's contribution to the UK's green glass excess will be necessarily small and, in the absence of reliable data on bulk imports, a simple estimate based on the total volume of wine being supplied in typical green glass bottles produces a value of 10,000 tonnes glass imports per annum.

3.2.6 Argentina

Despite producing almost five times more wine than its Chilean neighbour Argentina is currently a relatively small wine exporter with UK sales of around 17 million litres. Sales of red wine are predominant with an approximate 60/40 split in their favour over the white varietals. Wine is supplied to the UK in both bottled and bulk form although no data on the relative split could be sourced. The majority of wine bottled in Argentina is packaged in green bottles due to the limited production facilities in the country.
In the absence of reliable data on bulk shipments the quantity of green glass is estimated to be of a similar order to that of New Zealand i.e. 10,000 tonnes per annum.

3.3 Own Brand Labels

UK consumers buy the majority of their wine, almost two-thirds, from supermarkets, and of that the bulk is sold by just three - Tesco, Sainsburys and Asda (owned by Wal-Mart). Furthermore about 60 per cent of all the wine sold in multiple retailers is sold when offered on promotion at a 'special' discount. The proportion of bottles on the major retailer's shelves that do not come from one of the big companies (which continue to get bigger) has shrunk markedly in the last five years. When the retailers initially began to sell wine it was used as a product that would promote the message that supermarkets were selling a better quality of life. Today's emphasis is simply on profits, margins and volumes, and a certain homogenisation of the product. Supermarket wines are now given an artificially inflated 'regular price' to add notional lustre to the discount involved in the promotional price at which they sell virtually all their volume. This is a relatively new development; three or four years ago supermarkets were still offering interesting wines but in a competitive environment and the consumer could take advantage of a wide range of wines at low prices. Today the choice is an alternating cycle of low prices – mainly on heavily promoted branded wines.
Effectively big suppliers are now paying to rent shelf space from the supermarkets; however this has had an effect on the supermarkets' own-label wines which have shrunk from representing 90 to about 30 per cent of the retailers' wine sales.

Details of the current sales of supermarket own brand sales are given below in Table 12.

Sales of wine by 75cl bottle – Period 10/03/04 - 10/01/05		
Outlet	Volume 1000x	%
Total Sales	359,321	100
Own Label	111,205	31
Tesco	43,890	39.5 (of own brand)
J Sainsbury	21,905	19.7
Asda	19,809	17.8
Lidl	5,857	5.3
Aldi	4,923	4.4
Co-Op(Inc Alldays)	3,850	3.5
M&S	3,307	3.0
Sommerfield	2,849	2.6
Morrisons	1,299	1.2
Waitrose	1,288	1.2

Source: AC Nielsen

Table 12 Supermarket own brand wine

The data above covers an eleven month period. Using a notional bottles weight of 500g the annual contribution of own brand wines to the glass waste stream would be approximately 55,000 tonnes.

4 New World Wine Production and Glassmaking Capacities

4.1 Australia

4.1.1 Wine Production

The Australian wine industry dates back to the beginning of European settlement in the early 1800's. However, it was not until after the Second World War that a significant industry emerged, assisted by the rapid influx of post-war migrants from continental Europe. Wine is now Australia's fastest growing agricultural industry, ranking as the ninth largest in value terms. Australia has mastered easy-drinking wine due to forward thinking and pragmatic wine making. Even Old-World growers in the South of France listen to Australian winemakers.

Vineyards are mainly situated in the south east of the country in South Australia, Victoria, New South Wales and Tasmania. Western Australia also has vineyards. Area planted to wine grapes has increased from 63,000 hectares in 1991/92 to 146,000 hectares in 2003/04. The main grapes grown are Shiraz and Cabernet Sauvignon for red and Riesling, Chardonnay and Semillon for white.

Large companies dominate Australia's wine industry. The biggest firms are the Hardy Wine Company, Southcorp, McGuigan Simeon Wines, Orlando Wyndham, and Beringer Blass.

The Australian Bureau of Agriculture and Resource Economics (ABARE) forecasts production for 2005/06 at 12.8 million hectolitres (MHL), slightly up on the previous year's production, but below the record figure of 12.88 MHL in 2003/04.

In the past 20 years exports have grown from 0.08 to over 600 million litres, a meteoric rise of over 7500%. Forecasts for the coming year are 7.6 MHL, a 14% rise on the previous year's exports of 6.66 MHL. The UK is the most popular destination for exports, followed by the US and Canada, as shown in Table 13. In 2004 39% of wine exported went to the UK.

	2002	2003	2004
UK	2,168,677	2,034,630	2,548,807
US	1,188,398	1,627,985	1,873,795
Canada	213,196	280,795	394,916
Other	1,146,128	1,423,837	1,642,651
TOTAL	4,716,399	5,367,247	6,460,169

Table 13 Australian wine export destinations (HL)

References: Australia Wine Annual Gain Report, 2003, USDA Foreign Agricultural Service.
Australia Wine Annual Gain Report, 2004, USDA Foreign Agricultural Service.
Hugh Johnson's Wine Book 2003, Mitchell Beazley, London, UK
Jancis Robinsons Wine Course, 1997, BBC Books, London, UK

4.1.2 Glass Manufacture

Glass making in Australia is dominated by O-I Asia Pacific (formerly ACI) which operates 5 plants and 16 furnaces. In response to the rapid growth of the wine industry and its demand for bottles the glass container industry has commissioned new capacity. In May 2002 O-I opened the world's largest glass plant dedicated to the production of wine bottles. The plant, built in Adelaide, currently operates 3 large furnaces all

producing green glass of different shades; plans to commission a fourth furnace are under active consideration.

The demands of the wine industry were also directly responsible for a second new facility being built in the wine growing region. In September 2002 the packaging company Amcor opened a new facility at Gawler near the Barossa Valley capable of producing over 200 million bottles annually. Demand in the region is such that the company estimates that 41% of its capacity will be taken up servicing wine filling facilities within just 20 km of the glass plant. The Amcor site operates a single furnace producing green glass which is targeted at the premium segment of the wine industry.

An increase in demand for flint glass would thus not be welcomed by these two operators. Total Australian exports to the UK are the equivalent of approximately 250 wine bottles which roughly equates to the annual output of a single large furnace. If large numbers of suppliers to the UK were to change their preference to flint glass, O-I Asia Pacific would be in a position to respond to the change in demand and undertake a colour change on one of their 3/4 furnaces. Such a change presents no technological challenges and can be achieved at little cost. A change in colour would however be more problematic to the Amcor operated single furnace site.

Any change from green to flint would however have significant implications for the local cullet collection infrastructure. As the region currently only produces green glass there exists no local drivers to colour separate any glass recovered from the waste stream. Whereas green furnaces are able to process large quantities of mixed colour glass, flint furnaces are limited to predominantly flint cullet and thus need a colour separated glass collection scheme. Thus a change to producing flint glass, the majority of which will be destined for export, would create difficulties for the glass plant in obtaining cullet and any flint furnace would be forced to operate at relatively low cullet levels. Furnaces operating at low cullet levels consume more energy, require more raw materials and produce more CO_2 from the increased fuel and raw materials use. However to some extent the remaining green furnaces would be beneficiaries as their share of the local glass arisings would increase. Currently the Australian container industry achieves a recycling rate of approximately 50% so the conversion of a furnace to flint glass would not result in a glut of green glass. The overall impact on the local communities is therefore considered to be minimal.

Flint wine bottles can and are being manufactured in Australia but these are being produced in plants located several hundred miles away and thus their transport to the wine growing regions incur significant cost and environmental penalties. A move from green to flint by the UK, which represents the largest export market, would initially be met by bottles produced at distant sites but as demand grew local economics would eventually result in a dedicated flint furnace for the region.

Figure 4 provides details of the wine making regions and the location of Australian glass manufacturing plants.

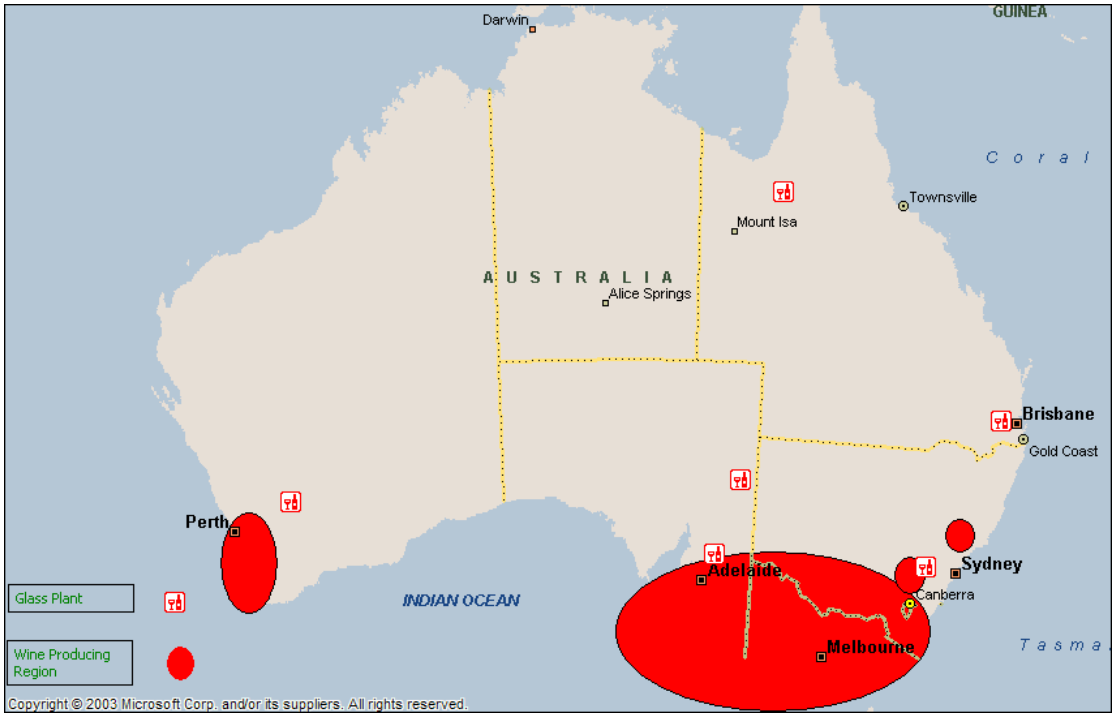


Figure 4 Australian Wine Regions and Glass Manufacturing Sites

4.2 United States

4.2.1 Wine Production

In the colonial and post-colonial period up through the middle of the 19th Century, the wine industry in the United States was relatively tiny, with almost all of the meagre consumption satisfied by imports. Although there was some development in the latter half of the 19th century, wine production in North America only began to develop significantly with the expansion of the California industry early in the 20th century. After the prohibition era from 1920 to 1932, the industry needed to be recreated. In a sense, the industry was reborn in the early 1970s with an aggressive movement towards higher quality.

Although wine is made throughout the country California is the major wine producing area with 90% of the total US wine production. In 2004 the total area in California planted to vines was 473,000 acres. Zinfandel, Cabernet Sauvignon and Pinot Noir are the most popular red grape varieties, with Chardonnay and Colombard for white grapes. In 2001 wine production was 3.1 million tons, which was 8% lower than production in the peak year of 2000. Internationally the US ranks fourth in wine production after France, Italy and Spain.

The US exported 7.9 million hectolitres in 2004, as in Table 14. The value of US wine exports was US$449.7 million in 2004. The top export destination for US-produced wine in 2004 was the United Kingdom, which accounted for 32% of US total wine exports. The UK has been an increasingly important trading partner for wine, with exports increasing from US$17.4 million in 1989 to more than US$299 million in 2004. Canada was the second most important export destination with US$123.8 million. Other top export markets for US wine include Japan, The Netherlands, and Germany.

	Volume (mL)		Value US$	
Year	2003	2004	2003	2004
UK	212.8	299.1	119.0	142.9
Canada	112.1	123.8	59.6	66.1
The Netherlands	74.7	85.6	33.7	33.2
Japan	60.7	82.1	37.8	71.3
Others	160.7	203.7	99.1	136.2
TOTAL	621.0	794.3	349.2	449.7

Table 14 Export volume and values

4.2.2 Glass Manufacture

California still retains a large glass container manufacturing base despite some recent closures. The region is served by 3 plants: 2 operated by Saint Gobain, and single sites operated by Owens Illinois and Gallo Glass.
The Gallo plant has a direct link with E J Gallo wineries and is able to produce over 1 billion bottles in a full range of colours.
The Californian local authorities are also keen to encourage recycling and the infra-structure is well developed and subsidised in some areas. Whilst the manufacture of wine bottles represents a significant quantity of glass the size and diversity of production capacity in the region will not be disrupted by a switch from green to flint.

Figure 5 provides details of the wine making regions and the location of Californian glass manufacturing plants.

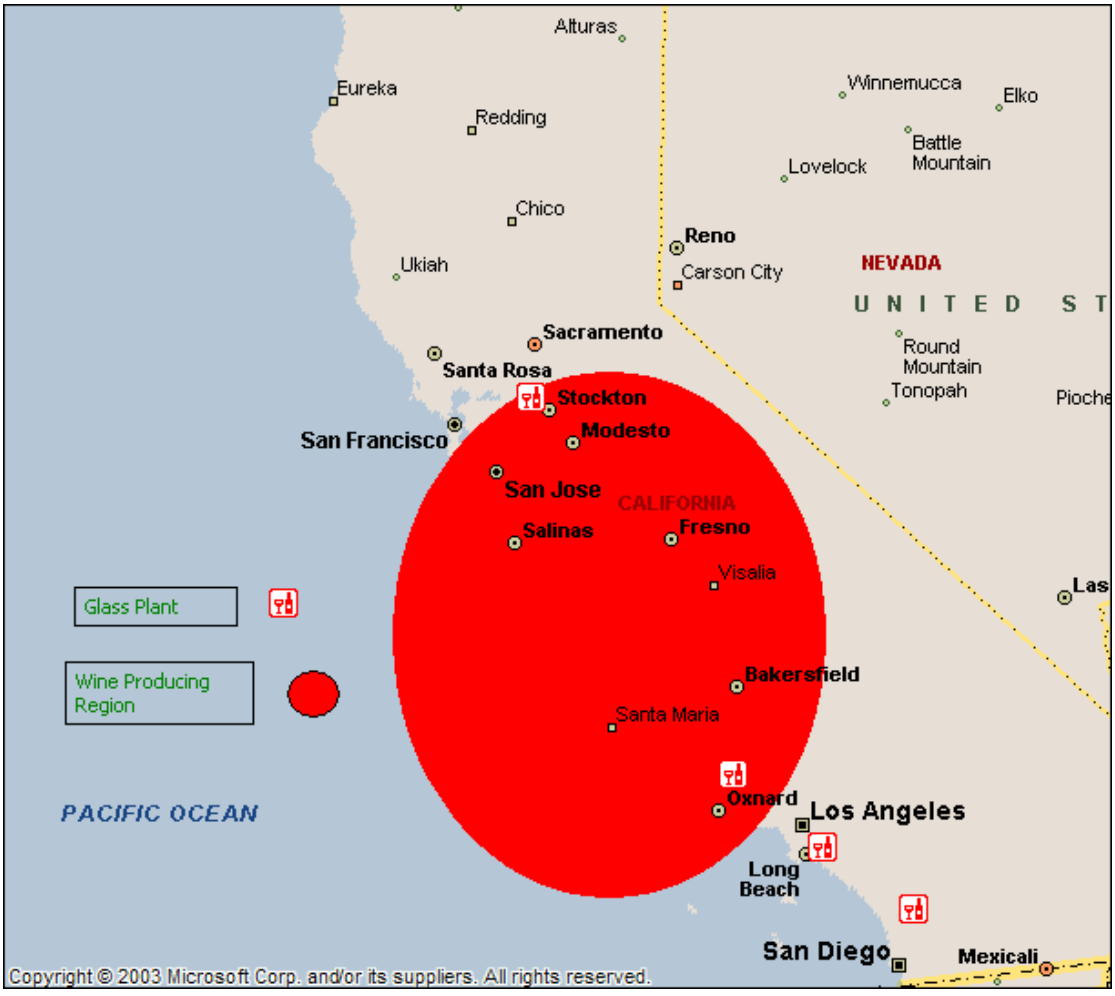


Figure 5 Californian Wine Regions and Glass Manufacturing Sites

4.3 South Africa

4.3.1 Wine Production

South Africa has a long wine making history going back 350 years. But it is only in the past 12 years since the abolishment of apartheid that South Africa has been able to compete in the emerging New World wine market.

Wine making centres on the Western Cape area, especially in the towns of Stellenbosch and Paarl. 100,000 hectares were planted to wine grapes in 2004, a 2% increase from the previous year. The main grapes of the region are pinotage for red and chenin blanc for white. Most of these are used for cheap supermarket wine, mainly white, but sights are being set on the higher quality wine market.
Talk in wine circles is that South Africa is the New World manufacturer most likely to be able to challenge Australia in the production of high quality low priced wines for export.

The South Africa Wine Industry Information & Systems (SAWIS) estimate production for 2005 to be 1.157 MT, an 11.8% decrease from the previous year, due to severe drought and scattered heavy rains.
Despite low production South Africa's wine exports are expected to grow by 12% compared to last year. The majority of wine is exported to the EU, with the UK receiving 37% of exports, The Netherlands 17% and Germany 11%. KWV International handles 70% of South Africa's exports. Details of the leading export destinations are given in Table 15.

Export destination	Volume (HL) 2003	Volume (HL) 2004
UK	940,432	967,486
The Netherlands	452,722	450,964
Germany	187,276	299,411
Sweden	108,471	166,212
Others	640,462	732,121
Total	2,329,363	2,616,194

Table 15 South African wine exports (HL)

References:

South Africa Wine Annual Gain Report, 2004, USDA Foreign Agricultural Service.
www.sawis.co.za, South Africa Wine Information and Systems
Hugh Johnson's Wine Book 2003, Mitchell Beazley, London, UK
Jancis Robinsons Wine Course, 1997, BBC Books, London, UK
Tim Atkin, The Observer, 6 November 2005
South Africa Competitor Report Horticultural Products, USDA Foreign Agricultural Service

4.3.2 Glass Manufacture

Glassmaking in South Africa is dominated by 2 companies: Consol and Nampak. The companies have a joint glass making capacity of approximately 730,000 tonnes per annum.

Consol Glass is the larger manufacturer having a 77% share of the market. The company operates four glassworks situated in Pretoria, Bellville, Wadeville (Germistone) and Clayville (Midrand).
Consol Glass is managed as two entities, namely glass packaging (Belleville, Clayville and Wadeville factories) and Consol Speciality Glass(Proprietary) Limited which focuses on producing a full range of colours for the beverage, food, pharmaceuticals and cosmetics industries, as well as a limited amount of tableware.

Nampak operate a single plant located at Roodekop, Gauteng. This plant operates two furnaces and having 8 production lines with a combined output of approximately 175,000 tonnes of glass p.a.

Waste glass is collected throughout Southern Africa and some 1,200 bottle banks have been installed in urban towns throughout the country to assist in domestic recoveries. Glass collections are performed through appointed agents via the Glass Packaging Industry. Details of the South Africa's waste glass collection efforts are given in Figure 6.

Until recently all glass recycling was undertaken by Enviroglass who colour sorted the glass by manual means. However new "state of the art", glass processing plant has recently been commissioned as a joint venture between Consol and Nampak. The new facility uses the latest high resolution cameras to colour sort

the glass. Consol in particular are very actively promoting the collection of glass in populated areas and have seen an increase in 50% in the glass collected from the Western Cape. The commissioning of the new processing plant was accompanied by accusations of price fixing from Enviroglass and the matter was referred to the S.A Competition Commission.

Currently the recycling rate is approximately 14% or 105,000 tonnes per year. As South Africa has the ability to manufacture in a range of glass colours and as it also has a reasonably well developed glass recycling infrastructure with the ability to colour sort it is not envisaged that a shift to flint glass will pose any environmental or social problems.

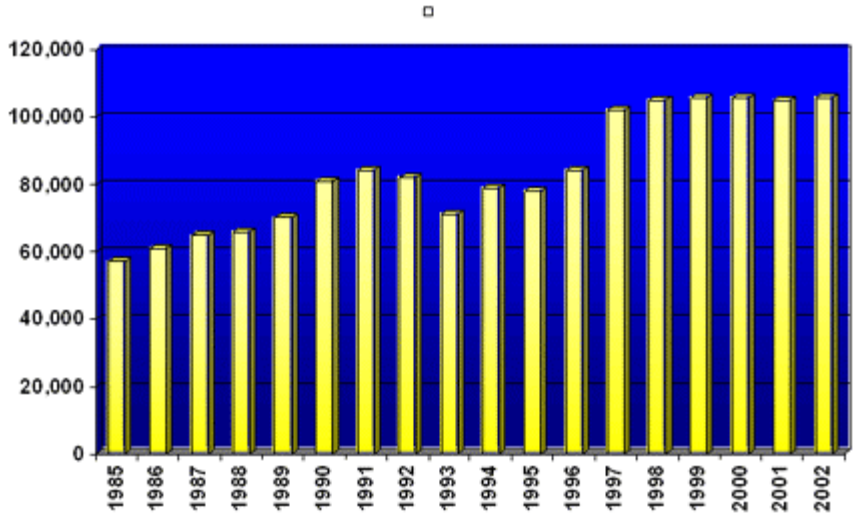


Figure 6 South Africa – Container Glass Recycling Rates

Figure 7 provides details of the wine making regions and the location of South African glass manufacturing plants.

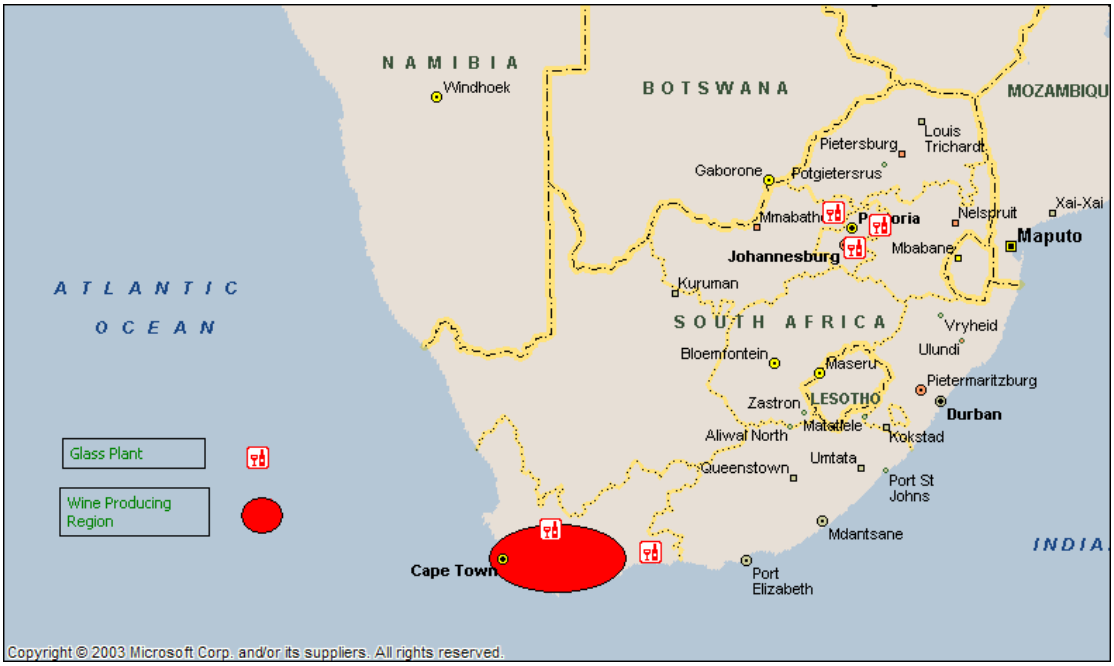


Figure 7 South African Wine Regions and Glass Manufacturing Sites

4.4 Chile

4.4.1 Wine Production

Chilean wine production dates back the mid-1550's and was introduced by Spanish missionaries who wanted table and sacramental wines. In the nineteenth century Chile became independent of Spanish rule and began to import cuttings of the great Bordeaux varietals. They were thus able to produce a superior class of wines

The return to a democratic government in the1980's saw the large international producers eager to invest in Chile's great agricultural potential. The new companies invested heavily in modern technology and revitalized and replanted vineyards. Twenty-five thousand acres of premium plantings, particularly Cabernet Sauvignon, Merlot and Chardonnay, were installed in the period 1987-1993. Dramatic results ensued and by 1999 Chilean exports had a value in excess of $500 million.

The Chilean Ministry of Agriculture estimate a total planted area of vines of 113,000 hectares of which some 76% are red varieties. The number of wineries has increased from 25 to over 120 in the last ten years. Chile's total volume of exportable wine is expected to continue to expand in the coming years.

Traditionally wineries sourced their grapes from all over the country, but in recent years Chile has begun to demarcate its vineyard regions into a system of controlled viticultural areas. Thus, the labelling of modern Chilean wines will carry the name of one of these areas. Basically, these named areas are the valleys formed by rivers flowing east from the Andes to the sea.

Chile's wine exports for 2005 are projected to continue to grow, as foreign demand for good quality, low priced wine remains strong. According to industry sources, Chile has become the tenth largest wine producer and fifth largest exporter in the world. New developing markets, like China, are expected to be an important factor for further expansion of exports. Improvements in quality and continued low prices also are expected to spur overseas demand.

Chile traditionally exports both bottled and bulk wine. Although an increasing number of wineries are making a big effort to increase premium-bottled wine exports, bulk wine grew 50% faster than bottled wine in 2004. Nevertheless, bottled wine represented close to 60% of total wine exports. Currently, there are more than 70 Chilean wineries exporting. Over 60% of Chile's total yearly production is exported, supplying more than 100 countries.

Chile's main export market for wine continues to be the EU, US and China. Details of its wine exports by type are given in Table 16 and by value and export destination in Table 17.

Kind / Year	2002	2003	2004
Sparkling	7,856	7,934	1,323
Bottled	2,248,624	2,402,569	2,759,664
Bulk	1,304,038	1,610,733	1,974,820
TOTAL	3,560,518	4,021,236	4,745,807

Table 16 Chilean Wine Exports (HL)

Country	Quantity (1000 Hectolitres)				Value (Thousand US dollars)		
	2002	2003	2004		2002	2003	2004
U.K.	602.9	665.9	840.1		118,002	127,835	159,262
U.S.	548.5	529.7	578.6		130,460	126,012	145,003
Germany	292.4	440.8	539.3		30,107	41,134	55,060
Denmark	253.5	303.0	336.2		31,008	42,300	50,850
Canada	328.9	329.8	331.0		38,029	43,800	19,744
China	231.8	291.1	304.2		10,713	13,427	17,960
France	149.0	160.1	206.1		14,305	16,035	39,021
Japan	121.7	136.0	173.9		28,258	28,108	32,843
Netherlands	95.7	121.6	150.7		20,766	26,111	32,843
Ireland	91.0	101.6	120.8		26,776	30,156	36,517
Brazil	62.5	76.3	116.4		12,005	17,047	25,386
Others	800.6	865.3	1048.5		149,611	168,067	265,509
TOTAL	3560.5	4021.2	4745.8		610,040	680,032	845,170

Table 17 Wine Exports by Value and Country of Destination

Reference
USDA Foreign Agricultural Service, GAIN Report Number: CI5011

4.4.2 Glass Manufacture

Cristal Chile is the main glass container manufacturing in Chile. Wine bottle production is a growth area due to the increase of wine exports.
No national infrastructure exists for the collection and return of glass to the domestic melters. Reuse of bottles for domestically consumed wine is common.

Figure 8 provides details of the wine making regions and the location of Chilean glass manufacturing plants.

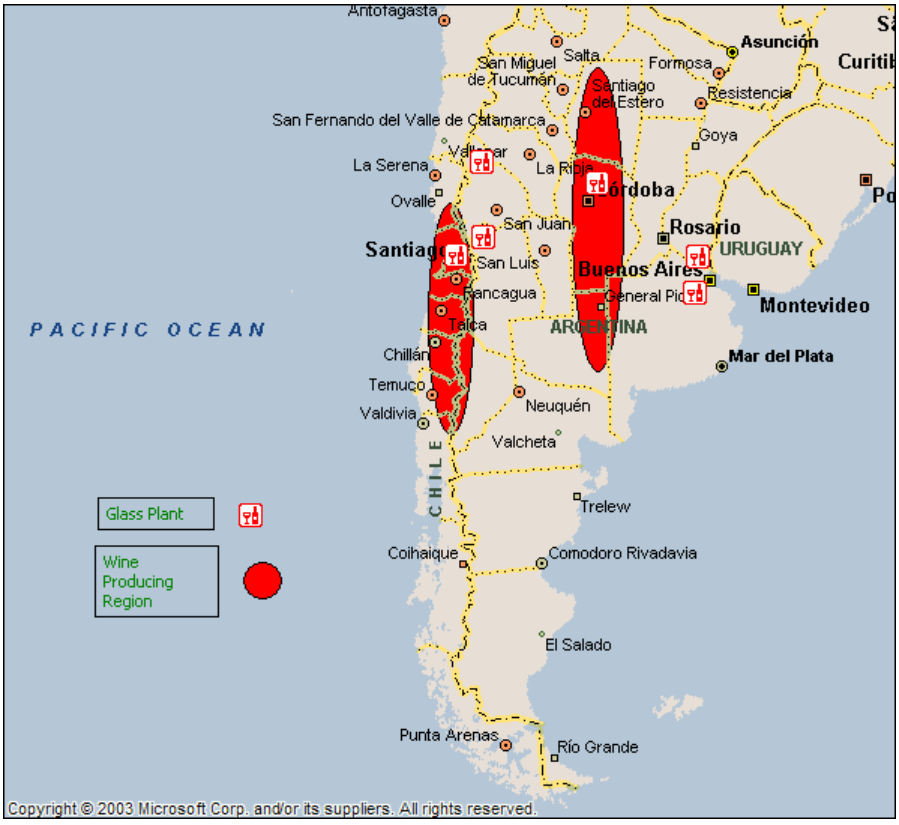


Figure 8 Chilean Wine Regions and Glass Manufacturing Sites

4.5 New Zealand

4.5.1 Wine Production

Over the past 20 years New Zealand has made a name for wines of a quality no one had anticipated. New Zealand wines have been described as combining "the well preserved pure fruit flavours of New World winemaking with the natural grape acidity associated with northern Europe". The Marlborough region in particular is producing Sauvignon Blanc wine to rival the best the Loire has to offer.

Marlborough, Hawke's Bay and Gisborne are the three big wine producing areas. In 2004 18,112 hectares of vines were producing wine, a 14.6% increase from 2003. White wine grape varieties account for the majority of vines planted. In 2004 the major varieties grown were Sauvignon Blanc (33.1%), Chardonnay (20.3%) and Pinot Noir (18.2%).

In 2004 119.2 million litres of wine were produced, an increase of 116% on 2003 and 34% on 2002. Exports have also grown by 14.6% up to 31.1 million litres in 2004, as shown in Table 18. The export value did not rise as much, only by 7.3% at NZ$302.6. White wine accounted for 80% of exports in 2004, and red wine only 10%. The top countries for exporting to are UK, USA and Australia.

Volume (ML)	2002	2003	2004
UK	11,858	12,258	13,864
USA	3,776	5,578	7,266
Australia	3,569	4,661	5,654
Others	3,768	4,617	4,317
Total	22,971	27,114	31,101

Table 18 New Zealand Wine Exports (ML)

4.5.2 Glass Manufacture

ACI operate the only glass container facility in New Zealand. The plant is located in Auckland and operates 2 furnaces which are able to produce seven colours: flint or clear glass, amber glass, blue glass and four varieties of green. New Zealand currently recovers more glass than its glass plant can handle. In 2004 around 95,000 tonnes of used glass was collected, about half of the glass packaging used in this country. The ACI plant can recycle about 70,000 tonnes in its production of new glass. The remainder has been stockpiled or sent to Australia for processing.

The glut of glass, in particular the clear variety, resulted in the price being offered by ACI plummeting during late 2005. A voluntary accord among members of the glass packaging industry had been subsidising the price to allow recycling to continue but this has now lapsed. Consequently it is now considered to be uneconomic to send clear glass to ACI for which they are only prepared to pay $10 a tonne. ACI have greater need for green glass and corresponding price paid for coloured glass is $75 a tonne.

The supply of flint cullet to the local glass manufacturers exceeds demand and thus a switch from green to flint glass for wine production would be beneficial as it would enable more of the recovered flint glass to be directed to the environmentally sound route of re-melting.

Figure 9 provides details of the wine making regions and the location of New Zealand's glass manufacturing plants.

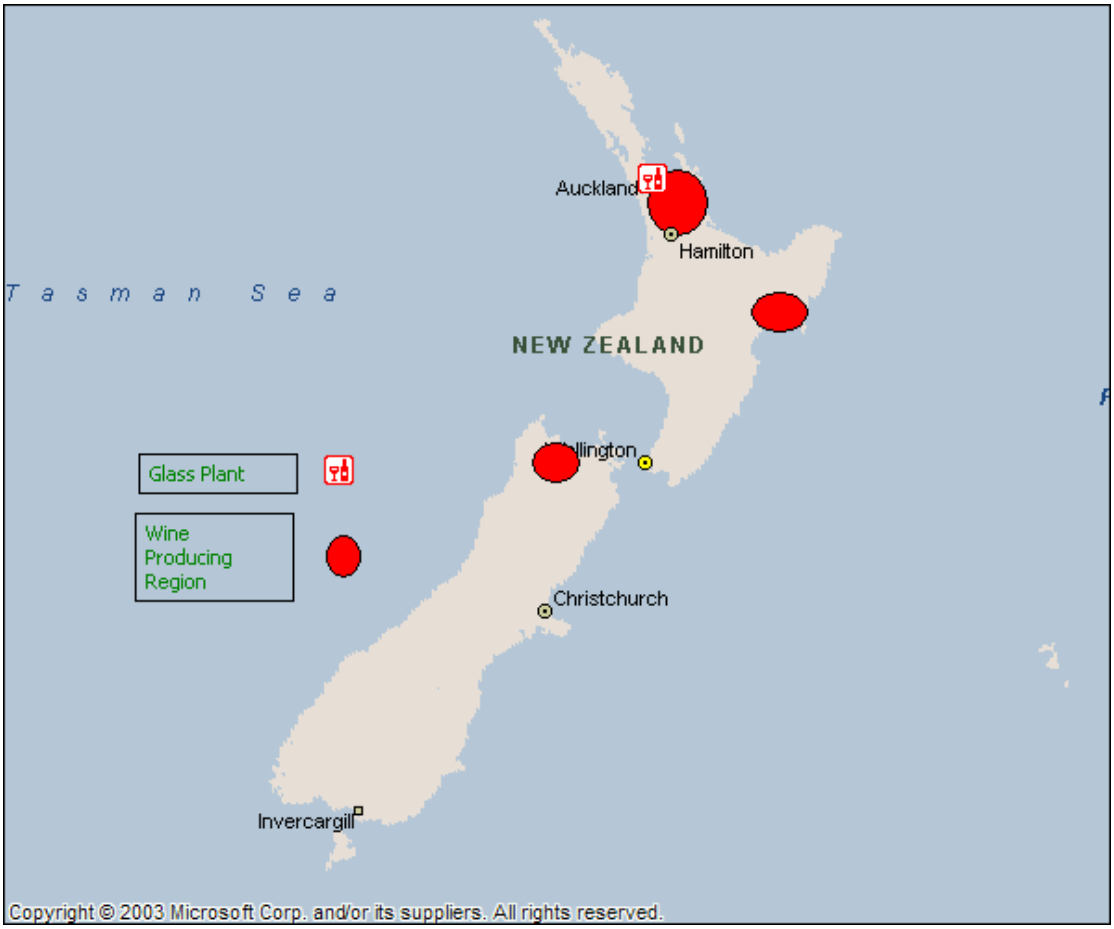


Figure 9 New Zealand Wine Regions and Glass Manufacturing Sites

4.6 Argentina

4.6.1 Wine Production

Despite the recent economic crisis Argentina's wine trade has not suffered too much. Wine making was brought to Argentina by Spanish conquistadores in the sixteenth century. In the 1990's investment in the wine industry brought the wineries into the twentieth century and now Argentina is beginning to compete with South American rival Chile in the export market.

In 2004 the total area planted with grapes reached 210,000 hectares. Over the past few years this figure has increased by 2% annually. The most planted grape is Malbac with 20,000 hectares planted area, Bonarda and Cabernet Sauvignon are the next most planted varieties with 16,000 and 15,000 hectares respectively. Due to rain prior to harvest production is forecast at 14.1 million hectolitres (HL), down from 15.5 HL from 2004.

Exports for 2004 dropped 14% from the 2003, but high quality fine/premium wine exports increased 37% in value. An increase in sparkling wine exports was seen in 2004, but table, premium/fine and other wine exports decreased, although the export volumes were higher than in 2002, as shown in Table 19. The export values are seen in Table 20.

Kind / Year	2002	2003	2004
Wine	1,219,000	1,827,000	1,529,000
Sparkling	13,476	15,474	18,988
Others	2,278	9,351	5,499
Total	1,234,754	1,851,825	1,553,487

Table 19 Argentine Wine Exports (HL)

Kind / Year	2002	2003	2004
Wine	121,142,000	163,707,000	224,219,000
Sparkling	7,100,000	4,969,000	6,528,000
Others	161,000	474,000	735,000
Total	128,403,000	169,150,000	231,482,000

Table 20 Argentine wine export values (US$)

The US is the top importer of Argentine wines in volume and value with purchases in 2004 of 237 HL for US$45 million. The UK follows with US$33 million. In volume terms, Paraguay is the second largest importer of Argentine wine with 223,000 HL, but the majority of this is low priced table wine, US$11 million in value. Table 21 shows the top export destinations.

Destination	2003	2004
US	145,591	236,563
Paraguay	192,849	222,452
UK	174,867	198,987
Russian Fed.	279,383	154,113
Others	1,059,570	741,276
TOTAL	1,852,260	1,553,391

Table 21 Wine export destinations (HL)

5 Impact of imported wine on UK waste glass stream

5.1 UK glass flows

5.1.1 UK production

Currently the UK produces 1.96 million tonnes of packed glass; the colour split of the glass manufactured and the amounts of recycled, colour sorted glass that were remelted in 2004 are given below in Table 22.

	Flint	Green	Amber
Production (tonnes packed)	1,246,000	396,000	314,000
Production (%)	64	20	16
Remelted (tonnes)	277,000	310,000	71,000
Cullet levels (%)	22	78	22

Table 22 UK container glass production and recycled content.

5.1.2 Glass in the Waste Stream

DEFRA returns calculate the total amount of glass in the waste stream at 2.5 million tonnes of which some 39 % or 945,000 tonnes are estimated to be green.
Table 23 provides details of the container glass in circulation in the UK waste stream and the current levels of that glass which is recovered for return to the melting furnaces.

	Glass in Circulation	Glass Remelted	Recovery Rate
	(tonnes)	(tonnes)	(%)
Clear	1,302,409	277,240	21
Green	944,922	310,240	32
Amber	255,807	71,133	28

Table 23 Colour profile of waste glass stream

5.1.2 Remelting capacity of container furnaces

Whilst it is technically possible to operate a furnace at close to 100% recycled glass (cullet), in practice the cullet will not be perfectly colour sorted and this, along with customer specifications, determines the upper levels that can be accommodated. Based on operational experience the practical upper levels of cullet that can be melted are given below in Table 24.

	Flint	Green	Amber
Production (tonnes packed)	1,246,000	396,000	314,000
Maximum cullet ratio (%)	50	90	50
Maximum cullet (tonnes)	623,000	356,400	157,000
Colour sorted (tonnes)	277,000	310,000	71,000
2004 shortfall (tonnes)	346,000	46,400	86,000

Table 24 Maximum cullet levels practicably achievable in container furnaces

5.1.4 Waste glass collection

Waste glass is collected by a number of systems. Returning the glass to the melting furnaces is considered to be a good environmental option however, the glass manufacturers require colour separated glass. Some glass is colour sorted at the collection point e.g. bottle banks and much of this glass is purchased by the glass manufacturers. However, an increasing volume of glass is collected with no colour segregation i.e. mixed and if this glass is to be used in the furnaces it must first be processed at a colour sorting facility. The relative volumes and colour profiles of the glass collected by the colour-sorted and the mixed collection systems are given in Table 25.

Colour Component		Flint	Green	Amber
Total glass	(tonnes)	1,302,000	945,000	246,000
Colour sorted	(tonnes)	419,000	514,000	115,000
Mixed glass	(tonnes)	146,000	314,000	63,000

Table 25 Colour profile of waste glass

5.1.4.1 Mixed glass collection

Mixed glass originates from 2 sources; the domestic stream, which contains a very high proportion of wine bottles and as a consequence green glass predominates, and from commercial sources in which case flint glass in the major component. The domestic stream is the larger, so when the 2 streams are mixed the green glass still represents the largest fraction. The composition of the mixed glass was given in the preceding table. Ideally the mixed glass would be fully sorted into its constituent colours to provide feedstock for the melting furnaces. However, the colour sorting technology is not 100% efficient and in practice current sorting technology "loses" between 6 to 8% within the flint and amber fractions, the losses being retained within the green fraction. Thus colour sorting of the current profile of mixed colour glass yields approximately 20% flint, 5% amber and 75 % residual nominally green glass. The apparent change in the colour profile of mixed glass that has been colour sorted is given below in Table 26. The green component is seen to grow as it is able to accept limited colour contamination from the flint and amber streams.

Colour Component	Flint	Green	Amber
Glass in Mix (%)	28	60	12
Glass Recovered (%)	20	75	5
Recovery Efficiency (%)	71	125 [a]	42

[a] green recovery includes process losses from other streams

Table 26 Colour profile of mixed glass

5.2 Green Glass Flows

5.2.1 New World glass inputs

Table 27 details the glass inflows into the UK as a result of the wine trade and is derived from the analysis of the weights and colours of the glass bottles used to package the imported wines which were given in section 3.

Wine Producer	Total Glass Imports (tonnes/annum)	Green Glass Imports (tonnes/annum)
Australia	135,000	120,000
USA	77,000	55,000
South Africa	50,000	50,000
Chile	40,000	40,000
New Zealand	10,000	10,000
Argentina	10,000	10,000
Total	322,000	285,000

Table 27 Net glass inflows

Using the data given in the previous tables it is possible to estimate the contributions that the various sources of green glass make to the waste stream. These are given below in Table 28.

Green Glass (tonnes)	Total Glass (tonnes/annum)	(%)
Total in waste stream	945,000	100
Domestic production	396,000	42
New world imports	285,000	30
Balance (other wines + beers)	264,000	28

Table 28 Green glass in the waste stream

As can be seen from the above data the demand for green is substantially satisfied by the glass provided by the schemes delivering colour sorted glass, but these same sources provide only 22% of the flint requirement. However, if the shortfall in melters' demand is provided by colour sorting the mixed glass, the supply of green glass rapidly moves into surplus. Essentially, for each tonne of flint glass that is sorted, some 3.75 tonnes of green will arise; the consequence being that once 100,000 tonnes of mixed glass are processed the demand for green glass will have been exceeded whilst the demand for flint will still stand at over 326,000 tonnes. Conversely, in order to satisfy the demand for flint glass approximately 1.7 million tonnes of mixed glass would need to be processed but this would produce a surplus of approximately 1.2 million tonnes of green. The effect is demonstrated below in Fig 10.

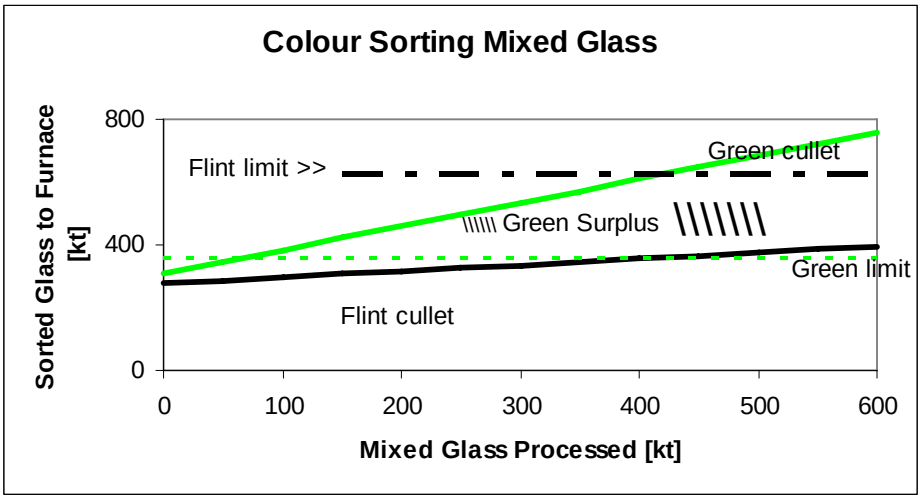


Fig 10 Processed Mixed Colour Glass and Furnace Requirements

The contribution of wine bottles to the waste stream is very significant. Data compiled for the Colourite study estimates that by 2008 wine bottles will contribute 814,000 tonnes to the waste stream. The bulk of these bottles will be green glass. If some of this wine could be bottled in flint glass then the profile of the resultant waste glass would be changed and benefit the recycling effort. This switch could be achieved either by persuading the wine growers to bottle and ship their product in flint glass or to ship the wine in bulk and bottle in the UK with domestic bottles.

A detailed model has been developed which considers the effects on the UK's glass recycling industry of such a switch. The model uses projections of waste glass arisings to 2008 and considers the sources from which the glass manufacturing industry will have to recover glass in order to meet its targets under the Packaging Waste Directive. The model further considers the effect on the glass waste stream that would result if more wine were to be shipped to the UK in bulk for subsequent packaging in UK produced green bottles. Essentially this would help reduce the projected excess of green cullet by increasing the UK's production of green glass and hence its requirement for green cullet.

5.3 Bulk imports of wine

A significant proportion of UK wine imports arrive as bulk imports shipped from the producer country in large containers for subsequent bottling in the UK or Europe. Bulk wine is usually shipped in either flexi tanks which hold the wine in a disposable plastic liner held within a rigid outer container or in industry standard steel ISO tanks. Both systems deliver in quantities up to 24,000 litres.
Bulk imports are an increasing feature of the UK wine trade, the activity being driven by the price conscious retailers. Total bulk imports into the UK currently stand at around 210 million litres. Bulk imports from Australia, USA and South Africa are estimated at 112 million litres. Bulk imports from the smaller producers will increase this total above 130 million litres.

The leading importers of bulk wine into the UK include:

- Constellation
- Corby Bottlers
- Broadlands
- Waverley Vintners

Cost advantages associated with bulk shipments include:

- Reduced shipping costs are a major advantage and savings of 40% were cited by the fillers canvassed.
- UK bottle prices are often lower than those found in the producer country; this reflects the very competitive nature of the UK industry which contrasts with often non-existent competition found in the new world e.g. of the 6 plants in Australia, 5 are operated by O-I.
- The new Quinn facility will have an added advantage as it will incur no domestic transport costs to bring the empty bottles to the filling line.
- The EU's common custom tariff is levied at a lower rate on containers with a volume exceeding 2 litres

Other advantages include:

- Wine shipped in bulk and bottled locally gives the filler flexibility to quickly respond to rapidly changing market demands including retail promotions. The profile of the shipment of bottled wine, in terms of size of bottle filled, is obviously fixed once loaded. Furthermore, the wine will be in transit for some weeks.
- Major retailers need to comply with the requirements of the European Food Safety Inspection Agency Service (EFSIS) and a UK-based operation can be more readily audited.

Disadvantages associated with bulk shipments include:

- Possible cheapening of the brand image - though these concerns are not considered to be a major issue with the wines that occupy the cheaper, mass selling portion of the market.
- Legal barriers - the Rioja judgement which concluded that Spanish regulations requiring that this regional product must be bottled locally, were not in contravention of EU Single Market law.

5.4 UK capacity to meet increased bulk imports

A survey of the leading importers and fillers of bulk wine produced a good consensus on this issue. Essentially the UK has little spare capacity to fill wine available at this time; the Quinn facility will help alleviate this shortage. However, all the major fillers are forecasting increases in the bulk market and are anticipating that they will expand their capacity to meet the demand.

The option to import wine to fillers located on continental Europe was discussed with the UK operators. The prevailing opinion was that as the UK is and will remain the main market for the produce it is the logical place to locate the filling facilities. Additionally whilst EU importation rules should apply equally in all member states in practice the large wine producing nations do not welcome wine imports and may make the bureaucratic processes more cumbersome than those operating in the UK.

Notwithstanding these difficulties at least 1 major supplier is importing into the UK via continental Europe. Blossom Hill, the leading Californian brand, is currently shipping bulk wine to Italy where it is bottled and distributed; the UK being the principal market.

6 Reducing the Impact of imported wine

The impact on the waste glass stream arising from the large-scale importation of wine into the UK has been outlined. This impact could be lessened by a number of measures including:

- Persuading overseas wine growers to bottle their UK bound product in clear bottles.
- Importing wine in bulk into the UK for subsequent filling into green lightweight bottles.
- Persuading overseas wine growers to package their product in lightweight bottles.
- Increasing the glass collected by colour segregating schemes.

6.1 Base Data

The following analysis is based on data gathered during interviews with key stakeholders within the glass recycling sector and the data from three key reports;

- The Recycled Glass Market Study and Standards Review, 2004 update. WRAP by Enviros May 2004.
- The Colourite Project: Maximising Cullet Additions in the Glass Container Industry. Interim Report 1. WRAP by Glass Technology Services Ltd. 2005.
- PackFlow 2008. Volume 1: Project Report. Valpak by David Davies Associates, July 2005.

The following base data was required to enable scenario testing to be undertaken;

1. The level of container glass waste arisings in the UK and the recycling targets
2. The projected split of cullet collected through mixed and segregated systems and the quantity of material recovered from bottom ash
3. The yield rate of the colour sorting process
4. The cullet capacity of the container manufacturers
5. The colour split and proportion of wine bottles in collected cullet

6.1.1 The level of container glass waste arisings in the UK and the recycling targets

Table 29 shows the actual and projected future consumption and recycling targets for glass packaging in the UK. The table shows that the UK must maintain the growth in recycling achieved between 2002 and 2004 if it is to meet its 2008 recycling target of 60%. PackFlow project that although the UK will more than meet its obligation in 2005 a shortfall will arise in 2006 and the deficit will grow in 2007 and 2008.

Glass packaging	Actual			Projected			
	2002	2003	2004	2005	2006	2007	2008
Total glass packaging in waste stream (Mt)	2.191	2.300	2.400	2.500	2.600	2.650	2.700
Glass recycled or required to be recycled (Mt)	0.747	0.862	1.049	1.088	1.370	1.505	1.633
Recycling rate (%)	34.1	37.5	43.7	43.5	52.7	56.8	60.5
PackFlow estimated performance				0.103	(0.091)	(0.144)	(0.185)

Table 29 Glass waste stream and projected recycling targets

6.1.2 The projected split of cullet collected through mixed and segregated systems and the quantity of material recovered from bottom ash

Figure 6 shows a schematic of cullet recovery. Cullet was traditionally recovered colour segregated since this is the simplest form for the reprocessors to prepare as production ready feedstock for the remelt industry. The material collected in mixed form requires the additional operation of colour sorting if it is to be used for remelt and the cullet recovered from Energy from Waste (EfW) bottom ash is not suitable for use in remelt.

Figure 11 shows the projected trends in cullet recovery methods. The analysis uses assumptions made in the Colourite study that by 2008 mixed collection will account for all cullet from the Commercial and Industrial (C&I) sector and 60% of Municipal Solid Waste (MSW). Figure 12 shows that mixed cullet collection will account for 72% (1,171,039 tonnes) of total collected cullet in 2008 and the segregated collection of the much sought after clear cullet will decline from 26% (272,932 tonnes) in 2004 to 11% (182,926 tonnes) in 2008.

From a collection perspective this trend is due to such factors as;

- Growth in kerbside collection and the need to minimise the number of recyclate containers required in some types of households.
- Reduced cost and simplicity of collecting mixed as opposed to colour segregated glass.
- The targets within the packaging waste regulations and the statutory performance standards for recycling and composting are noncolour specific and hence encourages the least cost option to be developed.
- The growth in the development of non colour sensitive applications.

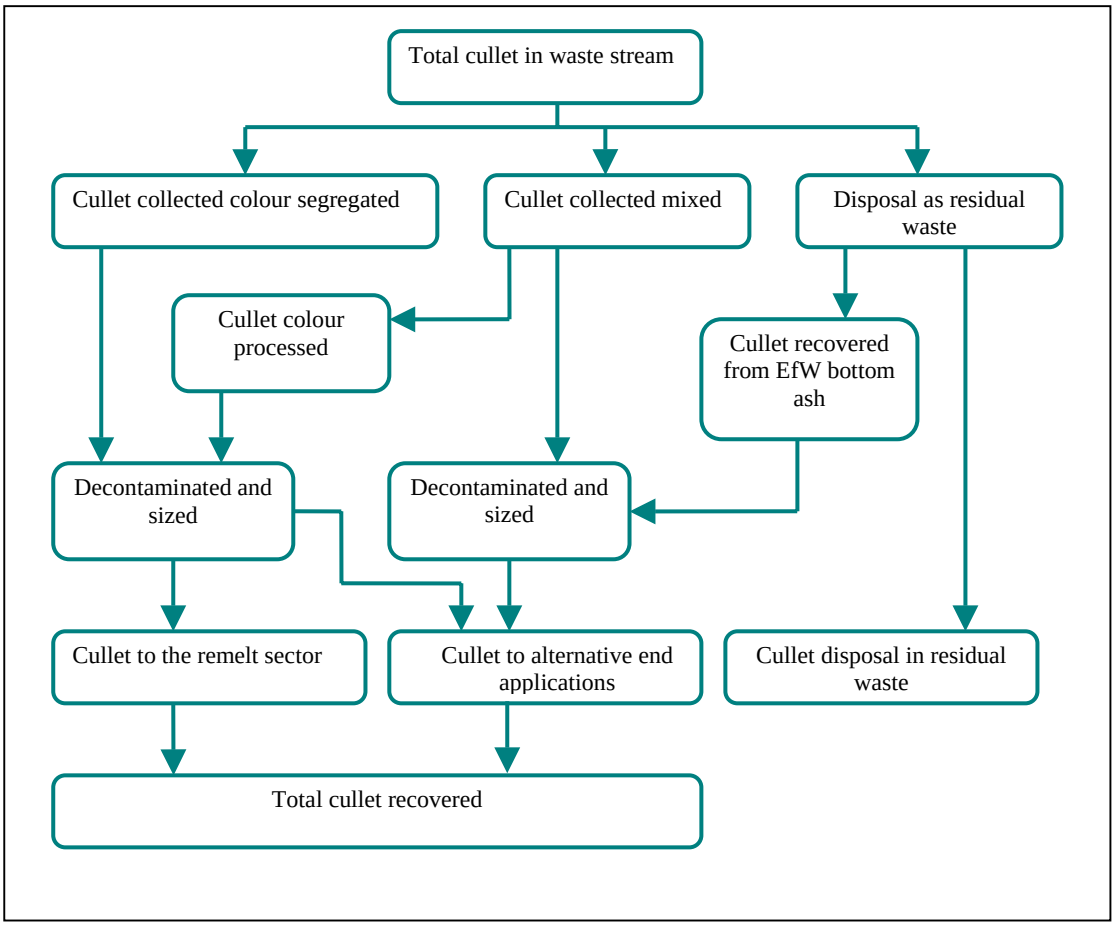


Figure 11 Schematic of cullet recovery

Although the quantities of cullet recovered from bottom ash will remain quite modest, namely 10,000 tonnes in 2004 to 85,000 tonnes in 2008, it does reduce the proportion of recovered cullet suitable for use in remelt from an historic figure of 100% to 95% in 2008.

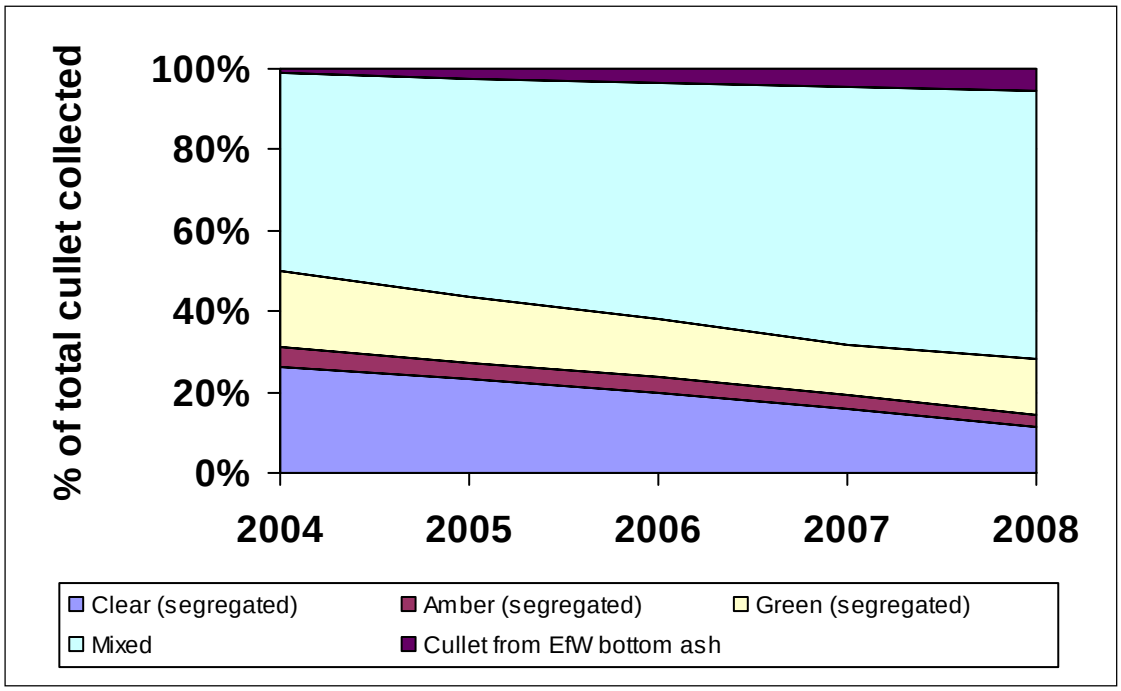


Figure 12 Projected trends in cullet recovery methods

6.1.3 The yield rate of the colour sorting process

The quantity of the higher value clear cullet that can be recovered from mixed cullet by colour sorting is a measure used by reprocessors to determine the viability of colour sorting. Glass Recycling UK (GRUK) and Berryman's both stress that it is not currently viable to colour sort mixed cullet if the proportion of clear cullet is less than 25%. The current reported yield of clear cullet varies from 22% to 29% meaning that some loads are not deemed viable to colour sort and hence will be sent to alternative end markets. The process of rejecting loads adds additional handling costs to the operation and the impact that conversion will have on the yield rate of the colour sorting process is a consideration.

Berryman's and GRUK report that the yield losses during colour sorting varies from 6% when clear cullet accounts for less than 40% of the mixed cullet to 7 – 8% when more than 40%. The yield losses in clear and amber cullet are captured in the "residue" which can be used in the remelt of green cullet or is sent to alternative uses.

Table 30 shows the total quantities of cullet that could be recovered for remelt before the capacity of the remelt sector is taken into consideration. The analysis is based on the assumption that all mixed cullet was sent for colour sorting and 100% of colour segregated cullet was captured for remelt. The figures were derived within the Colourite study using a yield rate of 20% for clear cullet and 5% for amber. This is in line with the anticipated yields reported by the industry since subtracting the 6% yield losses from the clear cullet, which accounts for 27.3% of the mixed cullet and amber 11.2%, gives figures of 21.3% and 5.2% respectively.

		2004	2005	2006	2007	2008
Clear	Total colour segregated	272,932	274,982	263,908	236,348	182,926
	Total from mixed stream	104,733	134,885	166,093	202,002	234,023
	Total	377,665	409,867	430,002	438,350	416,949
Amber	Total colour segregated	52,487	51,883	50,752	47,270	48,379
	Total from mixed stream	26,183	33,721	41,523	50,501	58,506
	Total	78,670	85,605	92,275	97,770	106,885
Green	Total colour segregated	199,450	191,968	192,856	184,351	224,085
	Total from mixed stream	392,749	505,819	622,849	757,508	877,585
	Total	592,200	697,787	815,706	941,859	1,101,670
Total	Total colour segregated	524,869	518,833	507,516	467,969	455,390
	Total from mixed stream	523,666	674,426	830,467	1,010,010	1,170,114
	Total	1,048,535	1,193,259	1,337,983	1,477,979	1,625,504

Table 30 Cullet available for re-melting

This analysis does not take into consideration the quantity of cullet recovered from EfW bottom ash which cannot be used for remelt. This would reduce the theoretical maximum for 2008 from 1,625,505 tonnes to 1,548,000 tonnes.

6.1.4 The cullet capacity of the (remelt) container manufacturers

Table 31 shows the capacity of remelt in 2008 as projected in the three cited reports. The Table shows that there is a significant level of discrepancy between the three studies and hence for this study the mean of the three studies will be taken as the base capacity of the sector. This shows that in theory remelt could accommodate circa 70% (1,141,500t remelt capacity/1,633,000t recycling target) of the cullet recovered in 2008.

	WRAP market study	PackFlow	Colourite project	Mean of 3 studies
Clear	719,700	630,000	580,000	643,200
Green	295,800	330,000	350,000	325,300
Amber	189,100	140,000	190,000	173,000
Total	1,204,600	1,100,000	1,120,000	1,141,500

Table 31 Re-melting capacity in 2008

Table 32 shows the projected utilisation of remelt capacity with respect to colour sorting activity. The assessment shows that the total remelt capacity shown in Table 31 cannot be utilised, even if all mixed glass was sent to colour processing, due to the limited quantities of clear and amber cullet in the system. The maximum quantity of cullet that can be used is circa 850,000 tonnes, equating to a capacity utilisation efficiency of 74%. The green cullet capacity is fully utilised with only 20% of mixed cullet colour sorted and increased colour sorting simply increases the quantities of surplus green glass being generated for which an alternative market must be sought. The surplus green cullet being generated when 100% colour sorting results in only 52% of the cullet produced being used for remelt in the UK. In addition, at 100% colour sorting only 64.8% of the clear cullet remelt capacity would be utilised and 61.8% of amber cullet.

The data on which these projections were made did not include provision for the new Quinn plant in Cheshire as no details were available and reflect a situation in which green manufacturing capacity broadly matches demand. Currently it is anticipated that the Quinn site will host a dedicated green furnace adding approximately 160,000 tonnes to capacity and thus a theoretical ability to absorb around 140,000 tonnes of green cullet. However, the construction of a green tank will not in itself generate a demand for green glass

unless it can attract new business e.g. bottling imported bulk wine. Assuming that by 2008 the Quinn plant is manufacturing 120 million bottles (90 million litres) which are to be filled on site then, at an average bottle weight of 350g and at a maximum of 90% cullet, the plant would be able to reprocess approximately 40,000 tonnes additional green glass per year.

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	182,926	48,379	224,085	0	*455,390*
100	10	206,328	54,230	311,844	0	*572,401*
100	20	229,731	60,080	325,300	74,302	*615,111*
100	30	253,132	65,931	325,300	162,061	*644,364*
100	40	276,535	71,781	325,300	249,819	*673,617*
100	50	299,938	77,632	325,300	337,578	*702,870*
100	60	323,340	83,483	325,300	425,336	*732,122*
100	70	346,742	89,333	325,300	513,095	*761,375*
100	80	370,144	95,184	325,300	600,853	*790,628*
100	90	393,547	101,034	325,300	688,612	*819,881*
100	*100*	*416,949*	*106,885*	*325,300*	*776,370*	*849,134*

Table 32 Projected utilisation of re-melting capacity in 2008

Figure 13 plots the price the glass manufacturers paid for the various colours of cullet and it provides evidence that the green cullet remelt capacity has already been reached. In October 2004 the price of green cullet dropped from a mean of £19 per tonne to a mean of £10 per tonne signalling that the high value remelt market was saturated with green cullet and that alternative lower value applications were needed to take the surplus green cullet. Based on the composition of the cullet shown for 2004 in Table 30 this price drop caused the price per tonne of cullet reprocessed to drop from circa £23 per tonne to circa £18 per tonne.

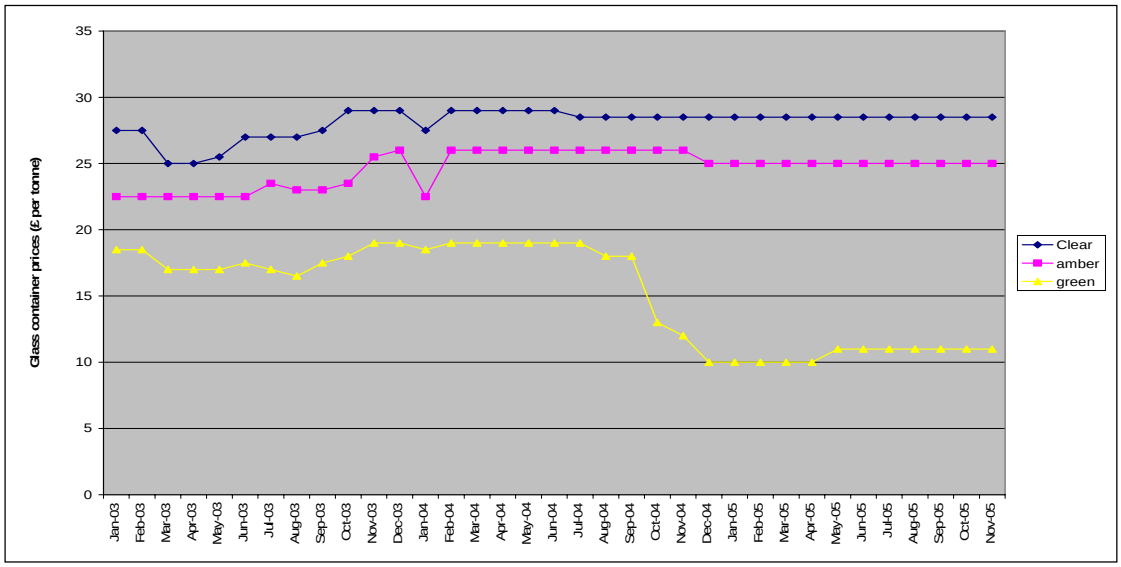


Figure 13 Cullet prices

PRNs can support the market but in their nature they are volatile. This can cause difficulties in cases where clients such as local authorities require long, fixed value contracts. The gate price revenue from the remelt industry represents a stable revenue stream and hence the reprocessors would wish to maximise the quantities flowing to these markets as opposed to the less stable, PRN driven lower value markets. This

study will investigate the impact the conversion of green glass has on the level of surplus green or residue cullet generated.

6.1.5 The colour split and proportion of wine bottles in collected cullet

Figure 14 shows that wine bottles are a major contributor to the quantity of green cullet in the UK waste stream. In addition, the contribution of wine to green glass arisings is projected to increase steadily accounting for 48% of green glass arisings in 2002 increasing to 53% by 2008.

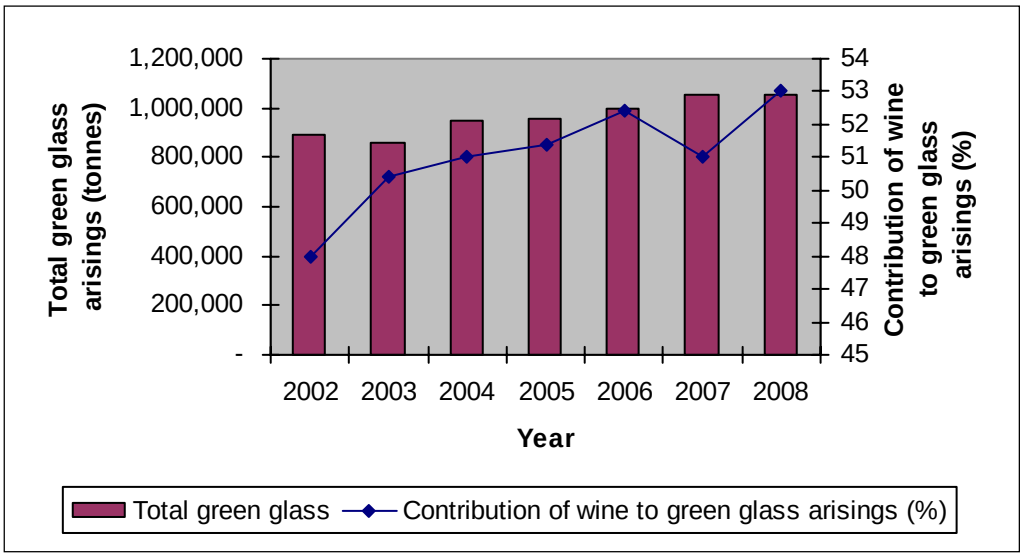


Figure 14 Contribution of wine bottles to the green glass waste stream

Wine bottles have historically represented a major proportion of the containers being recycled. Berryman's estimate that historically wine bottles have accounted for circa 70% of the cullet being recovered. However, the Colourite study indicates that 813,782 tonnes of wine bottles will be in the waste stream in 2008 and hence wine bottles will at most account for 50% of the 1,627,429 tonnes targeted in 2008. Assuming in 2008 that wine bottles will still be the most recycled container with a projected recycling rate of 80% Table 33 shows the estimated waste mix. This analysis shows that wine containers will account for 56.2% of green cullet recovered (447,985 tonnes of recovered green wine containers / 797,440 tonnes of total green cullet recovered). Recovered clear wine containers would account for 31.2% (203,040 tonnes of recovered clear wine containers / 650,972 tonnes of total clear cullet recovered).

	Clear	Green	Total
Wine glass in waste stream (tonnes)	253,801	559,981	813,782
Wine glass in cullet @ 80% recovery (tonnes)	203,040	447,985	651,025
% of total cullet in waste stream	31.2	56.2	40

Table 33 Estimated waste mix

6.2 Switching overseas suppliers to clear bottles

Having gathered the necessary data it is now possible to model the impact that converting green wine bottles to clear glass will have on recycling. The key indicators that will be evaluated are:

- Total cullet to remelt (tonnes).
- Total clear cullet to remelt.
- Total clear cullet collected colour segregated.
- Clear cullet yield rate of colour sorting.
- Total surplus green or residue generated.

This analysis will focus on the recycling scenarios in 2008 if the following conversions were undertaken:

Scenario 1: 5% of wine in green glass converted to clear glass.
Scenario 2: 10% of wine in green glass converted to clear glass.
Scenario 3: 20% of wine in green glass converted to clear glass.
Scenario 4: 50% of wine in green glass converted to clear glass.

The model will consider how much colour sorted glass will be available under the various scenarios. The model makes the assumption that all colour sorted glass collected from the bring sites will be dispatched to the melting furnaces. The model then refines the calculation by considering the impact of colour sorting the glass that will be collected as a mixed fraction. These detailed calculations are given in Appendix A1 and have been undertaken by increments of 10% of mixed glass processed i.e. from 0% of mixed glass colour sorted to 100% of mixed glass being sorted.

6.2.1 Summary of findings

Table 34 summarises the detailed data presented in Appendix A1.

	Business As Usual	Conversion rate			
		5 %	10 %	20 %	50 %
Total cullet to remelt; @ 50% colour sorting @ 100% colour sorting	 702,870 849,134	 717,206 871,534	 731,540 893,932	 760,212 938,731	 846,225 1,073,127
Clear cullet to remelt; Colour segregated @ 50% colour sorted @100% colour sorted	 182,926 299,938 416,949	 189,198 314,274 439,349	 195,469 328,608 461,747	 208,013 357,280 506,546	 245,644 443,293 640,942
Clear cullet yield rate from colour sorting (%)	20%	21.4%	22.8%	25.6%	34%
Surplus green cullet; @ 50% colour sorted @ 100% colour sorted	 337,578 776,370	 323,242 753,970	 308,907 731,572	 280,236 686,773	 194,222 552,377

Table 34 Summary of conversion scenarios

6.3 Bulk Importation and UK Bottling

This section focuses on the recycling scenarios in 2008 if the following changes in the bottling of wine were undertaken:

Scenario 1: 5% of the wine currently imported in bottles to be bottled in the UK.
Scenario 2: 10% of the wine currently imported in bottles to be bottled in the UK.
Scenario 3: 20% of the wine currently imported in bottles to be bottled in the UK.
Scenario 4: 50% of the wine currently imported in bottles to be bottled in the UK.

The same assumptions regarding sorting efficiency and the relative proportions of glass arising from initially mixed and colour sorted sources have been made. As in the previous section detailed calculations have been performed in increments of 10% of mixed glass processed and these are given in Appendix A2.

6.3.1 Summary of findings

Table 35 summarises the detailed data presented in Appendix A2:

	Business As Usual	Conversion rate			
		5%	10%	20%	50%
Total cullet to remelt; @ 50% colour sorting @ 100% colour sorting	 702,870 849,134	 720,981 867,245	 739,824 886,088	 775,314 921,578	 922,433 1,068,697
Clear cullet to remelt; Colour segregated @ 50% colour sorted @100% colour sorted	 182,926 299,938 416,949	 182,926 299,938 416,949	 182,926 299,938 416,949	 182,926 299,938 416,949	 182,926 299,938 416,949
Clear cullet yield rate from colour sorting (%)	20%	20%	20%	20%	20%
Surplus green cullet; @ 50% colour sorted @ 100% colour sorted	 337,578 776,370	 319,467 758,259	 300,624 739,416	 265,134 703,926	 118,015 556,807

Table 35 Summary of wine importation scenarios

6.4 Lightweighting Bottles

This section focuses on the recycling scenarios in 2008 if the following changes in the weight of wine bottles were undertaken;

Scenario 1: Mean bottle weight reduced to 450g.
Scenario 2: Mean bottle weight reduced to 400g.
Scenario 3: Mean bottle weight reduced to 350g.
Scenario 4: Mean bottle weight reduced to 300g.

The analysis is based on the assumption that the current mean bottle weight is 500g.

The same assumptions regarding sorting efficiency and the relative proportions of glass arising from initially mixed and colour sorted sources have been made. As in the previous section detailed calculations have been performed in increments of 10% of mixed glass processed and these are given in Appendix A3.

6.4.1 Summary of findings

Table 36 summarises the detailed data presented in Appendix A3.

	Business As Usual	Lightweighting (mean bottle weight)			
		450g	400g	350g	300g
Total cullet to remelt;					
@ 50% colour sorting	702,870	689,875	676,881	663,886	651,392
@ 100% colour sorting	849,134	828,830	808,526	788,222	768,918
Clear cullet to remelt;					
Colour segregated	182,926	177,241	171,556	165,871	160,186
@ 50% colour sorted	299,938	286,943	273,949	260,954	248,460
@100% colour sorted	416,949	396,645	376,341	356,037	336,733
Clear cullet yield rate from colour sorting (%)	20%	20%	20%	20%	20%
Surplus green cullet;					
@ 50% colour sorted	337,578	308,907	280,236	251,565	222,894
@ 100% colour sorted	776,370	731,572	686,773	641,975	597,176

Table 36 Summary of lightweighting data

6.5. Increased segregated collection schemes

This section focuses on the recycling scenarios in 2008 if the following changes in the method of collection were undertaken;

Scenario 1: A 5% increase in colour segregated collection.
Scenario 2: A 10% increase in colour segregated collection.
Scenario 3: A 20% increase in colour segregated collection.
Scenario 4: A 50% increase in colour segregated collection.

The same assumptions regarding sorting efficiency and the relative proportions of glass arising from initially mixed and colour sorted sources have been made. As in the previous section detailed calculations have been performed in increments of 10% of mixed glass processed and these are given in Appendix A4.

6.5.1 Summary of findings

Table 37 summarises the detailed data presented in Appendix A4.

	Business As Usual	Increase in segregated collection			
		5%	10%	20%	50%
Total cullet to remelt; @ 50% colour sorting @ 100% colour sorting	 702,870 849,134	 711,589 855,007	 720,308 860,880	 737,746 872,625	 790,061 907,863
Clear cullet to remelt; Colour segregated @ 50% colour sorted @100% colour sorted	 182,926 299,938 416,949	 192,072 306,807 421,541	 201,219 313,677 426,134	 219,511 327,415 435,318	 274,389 368,631 462,873
Clear cullet yield rate from colour sorting (%)	20%	20%	20%	20%	20%
Surplus green cullet; @ 50% colour sorted @ 100% colour sorted	 337,578 776,370	 340,243 770,497	 342,909 764,624	 348,241 752,879	 364,235 717,641

Table 37 Summary of increased colour segregation data

6.6 Discussion and Conclusions from Scenario Analysis

This section focuses on 4 key areas;

- What contribution can the container industry make towards the UK recovery targets in each option?
- What quantities would need to be sent to alternative end applications?
- What quantities would be sent to the container manufacturers?
- What would be the yield rate of the colour sorting process?

The first two questions are important from a UK recovery perspective. Question 3 is important for container manufacturers and question 4 is relevant from a reprocessor's perspective.

6.6.1 What contribution can the container industry make towards the UK recovery targets in each option?

This section compares the minimum case and maximum case scenarios for each of the options. Table 38 shows a summary of the scenarios and the analysis is based on the assumption that 100% of the cullet collected colour segregated and 50% of mixed cullet will be sent to remelt and that recovery targets in 2008 are 60% of waste arisings. The "50% colour sorting" is considered to represent the realistic projection since the "centralised" remelt industry will find it difficult to compete against alternative end markets in some geographic areas.

Options	Conversion Scenario	
	Minimum Case	Maximum Case
Business as Usual		
Conversion	5%	50%
Bulk containers	5%	50%
Lightweighting	Mean bottle weight 450g	Mean bottle weight 300g
Segregation	5%	50%

Table 38 Summary of scenarios

Figure 15 shows the contribution remelt can make to the 2008 recycling target within each of the options and also shows that tackling the colour imbalance has a significant benefit on the quantity of cullet sent to remelt, since the top two approaches "bulk containers" and "conversion" both address this issue. However, it is stressed that the benefits from the use of bulk containers in the context of its impact on colour imbalance is only gained if the bottles to be filled are produced in the UK. This is due to the increase in the production of green bottles in the UK and hence the increased green cullet capacity being the significant reason for its position at the top of the options.

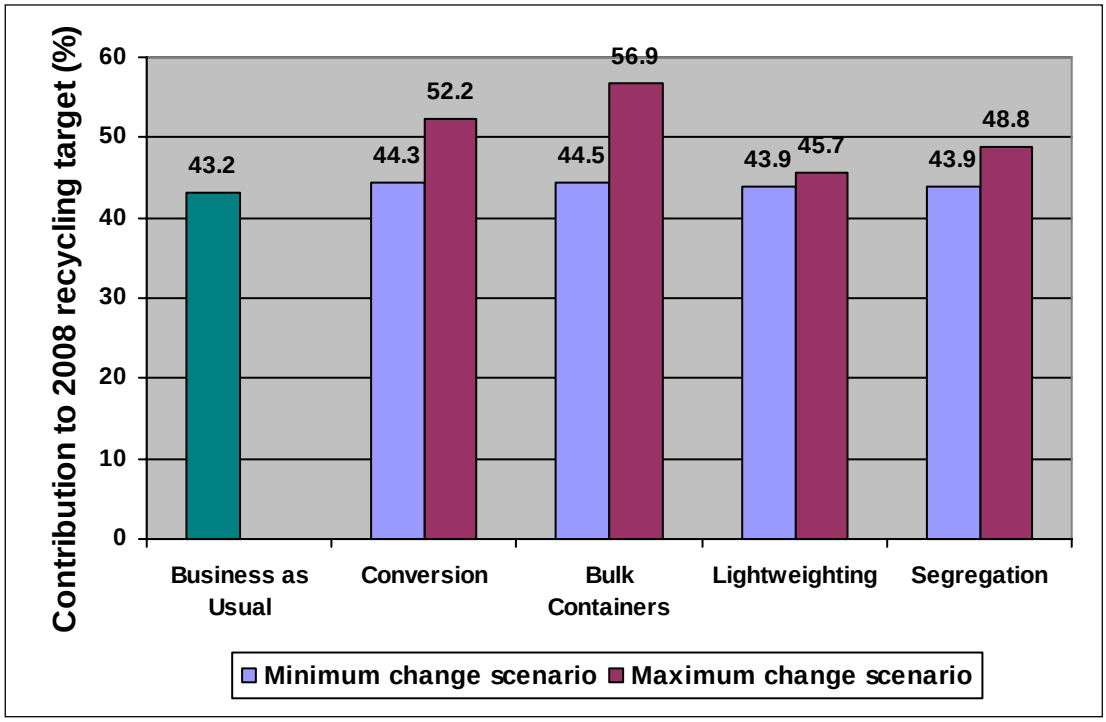


Figure 15 Container industry's contribution to meeting 2008 targets

6.6.2 What quantities would need to be sent to alternative end applications?

Figure 16 shows the quantity of cullet recovered through alternative applications in each of the scenarios. The analysis shows that within the minimum change scenario lightweighting has the greatest impact, reducing the quantities to be recovered through alternative applications by 36,000 tonnes. Lightweighting is unique amongst the options being analysed in that it is the only option that has an impact on the quantity of waste arisings and hence the UKs recovery obligation. The minimum case scenario would reduce the obligation by 48,830 tonnes and the maximum case scenario by 195,300 tonnes. However, in the maximum case scenario it is "bulk containers" which shows a clear advantage.

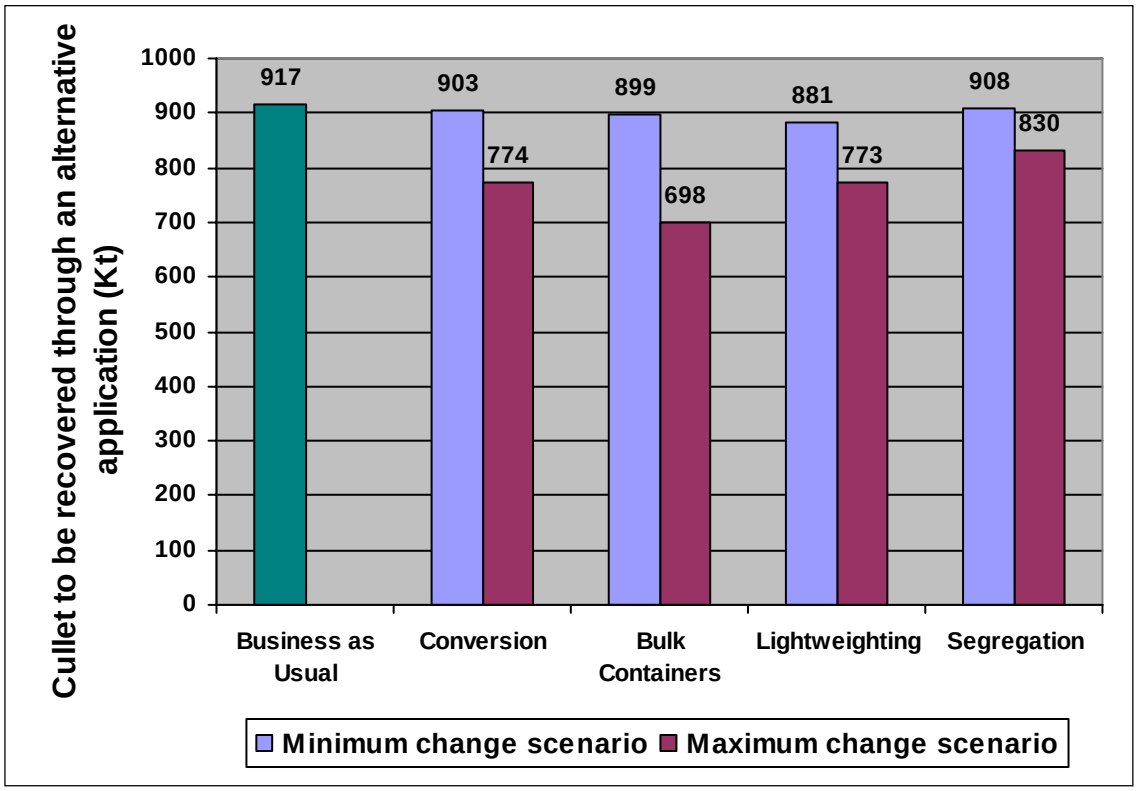


Figure 16 Cullet recovered through alternative applications

6.6.3 What quantities would be sent to the container manufacturers?

Figure 17 shows the cullet that would be sent to remelt from each of the scenarios. As in the case of Figure 10 bulk containers and conversion top the list. In addition, the chart shows that with 50% more colour segregated collection an additional 87,000 tonnes can be sent to remelt.

Lightweighting is, due to the nature of the option, the only case that shows a decrease from the business as usual case. This could be viewed as a negative environmental impact in terms of the impact on the UK container manufacturing industry since it would mean that virgin material would be needed to substitute for the loss of cullet. However this would need to be compared with the reduced raw material feedstock required by international container manufacturers in the production of the containers to establish the net environmental impact.

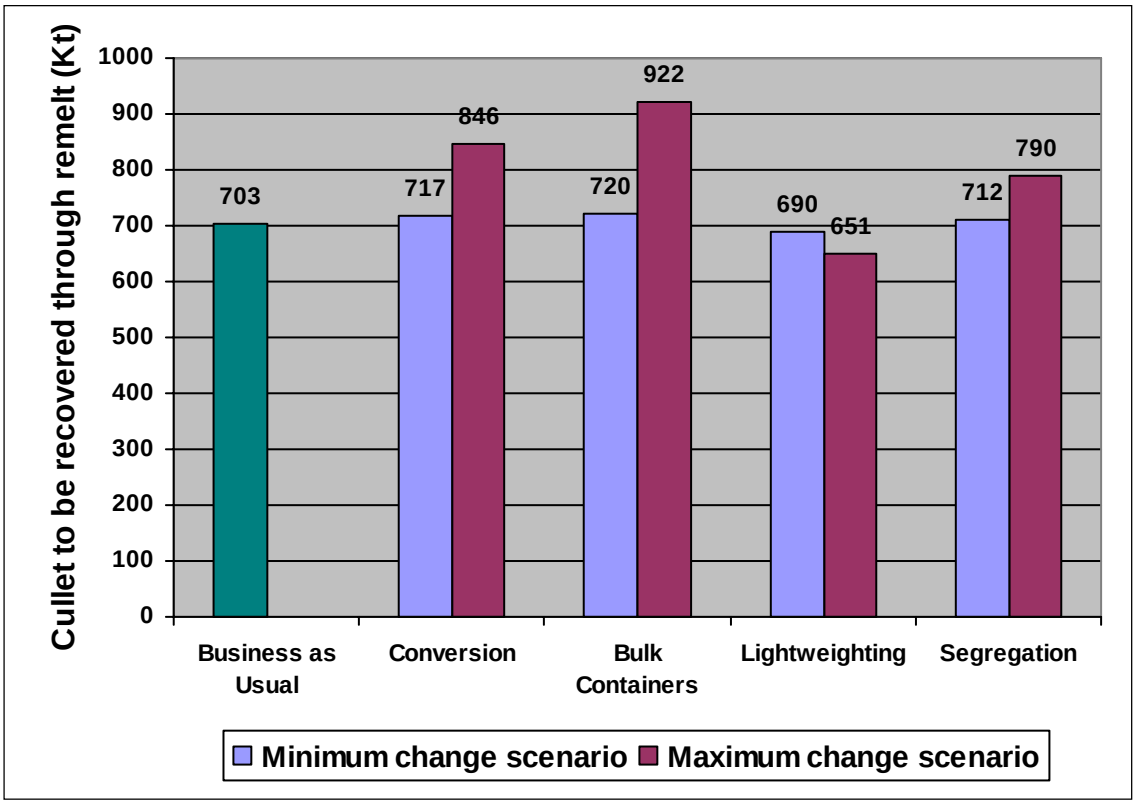


Figure 17 Cullet to re-melt by various options

6.6.4 What would be the yield rate of the colour sorting process?

Figure 18 shows the yield rates in terms of the proportion of cullet being colour sorted that can go to remelt. The analysis shows that again "bulk containers" and "conversion" shows the most benefit if the level of conversion was sufficiently high.

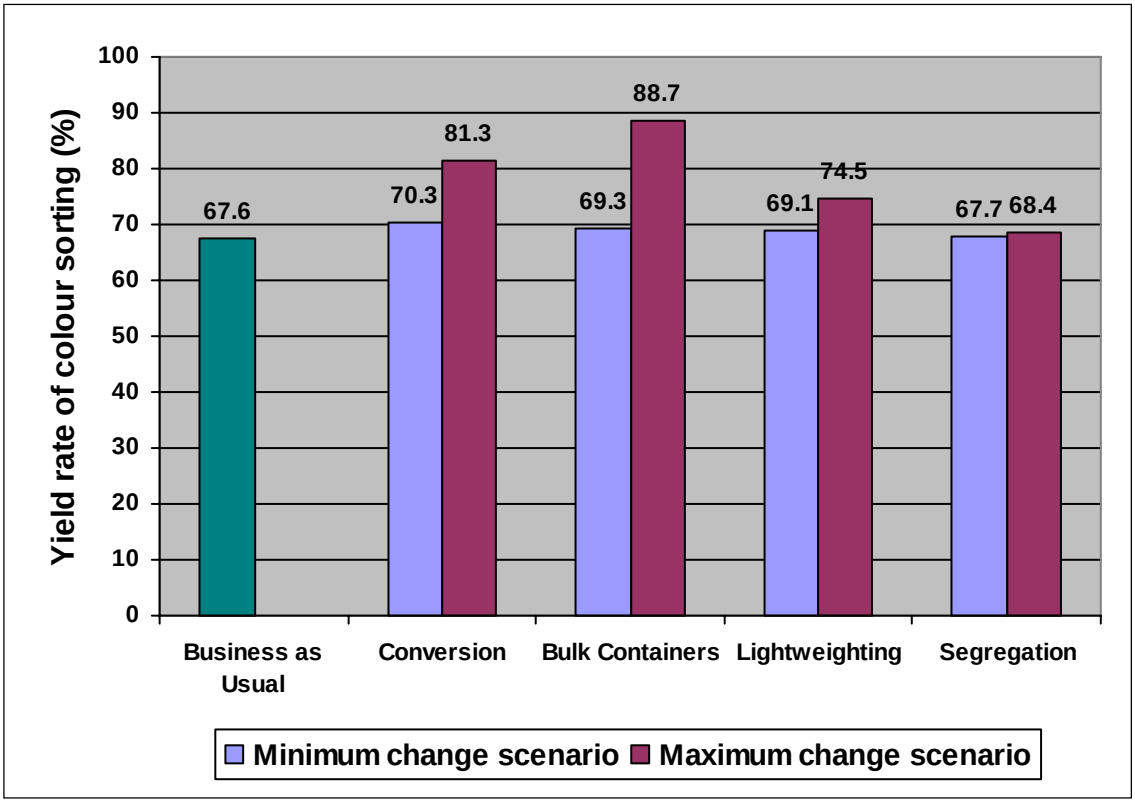


Figure 18 Yield rates of colour sorted schemes by various options

6.6.5 Impact on PRN

The PRN system works on the same basic principle of any conventional supply and demand market mechanism. The combination of challenging recovery targets and a projected shortfall in recovery makes the prediction that there will be a high demand for PRNs and hence increases in PRN value in 2008 an unarguable base assumption. Figure 19 shows the historic performance of glass PRNs with the mean monthly value fluctuating between £7 per tonne in July 2003 to £25 per tonne in June 2004. The increase seen in January 2003 represents an example where challenging targets were announced causing a significant increase in PRN value and December 2004 represents an example of low demand through less challenging targets being set.

It is ill advised to predict future PRN values but the rises seen in other materials such as steel and aluminium are unlikely since PRN values of £25 to £40 would improve the economics of collection from the relatively untapped C&I sector and would also attract end markets with significant capacity, such as the aggregates market. Increasing the recovery of cullet to remelt would reduce rather than fully close the demand gap. This is likely to delay and reduce the increase in PRN rather than prevent an increase arising.

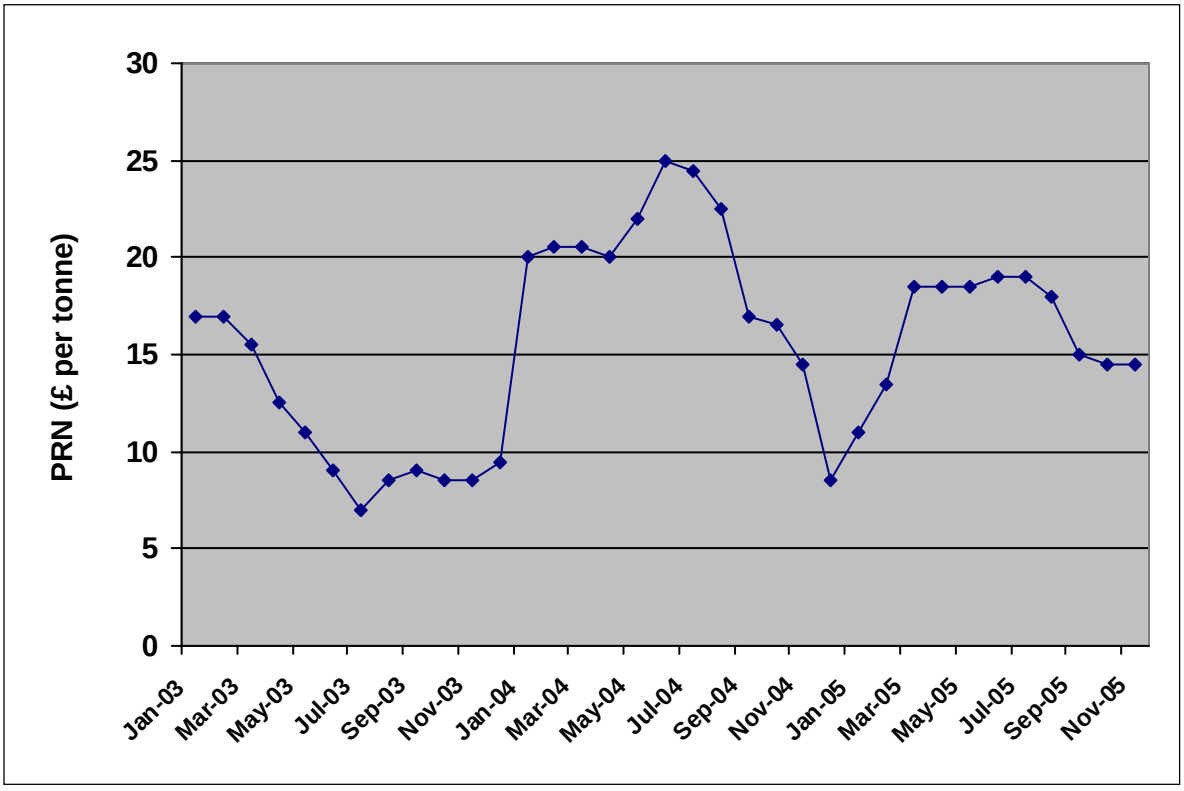


Figure 19 Historic performance of glass PRNs

6.6.6 The revenue generated per tonne of reprocessed cullet

Figure 20 shows that for every 5% of green glass converted the revenue to the reprocessors increases by 26p per tonne. For an industry reprocessing 700,000 tonnes of cullet this equates to £182,000. An additional benefit to reprocessors is that the proportion of revenue from the sale of the surplus green or residue cullet to the alternative markets that are sensitive to PRN price fluctuations reduces by 1.1%. This is of benefit when negotiating long term contracts with such clients as local authorities where projections in PRN values must be included and can influence the collection economics.

In addition, the increase in the yield of clear cullet from the colour sorting process and the reduction in surplus green cullet will reduce the costs of handling materials as a result of the reduction in rejection rates of batches at colour sort.

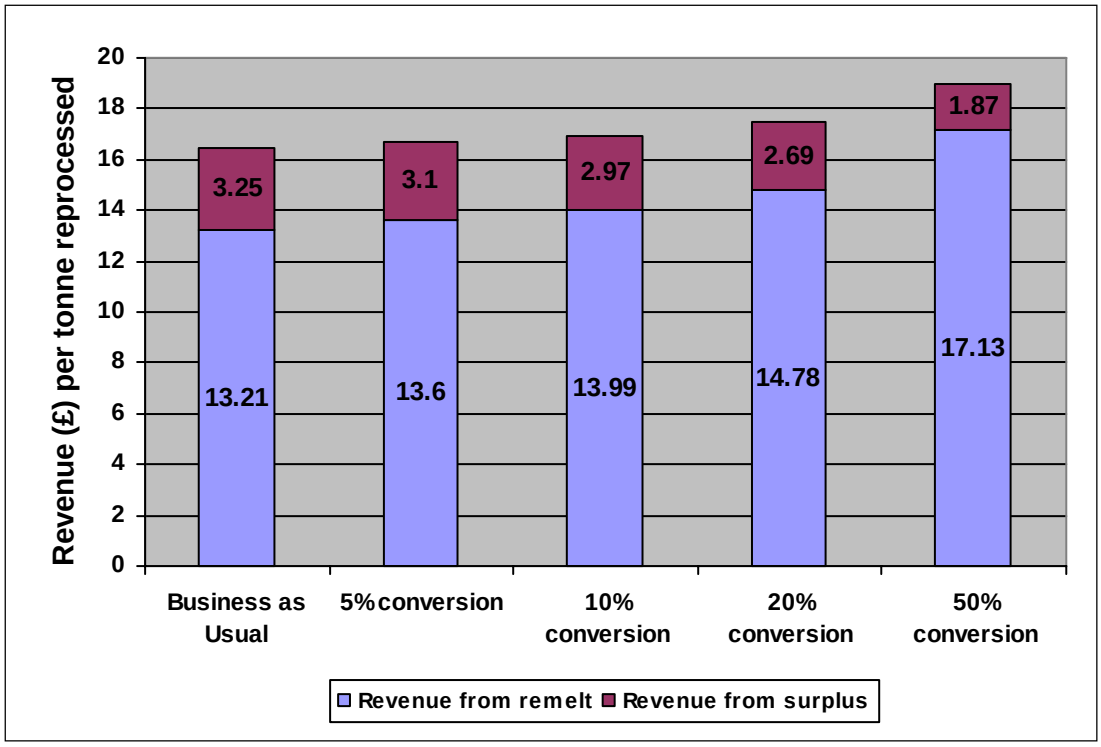


Figure 20 Revenue generated by glass conversion

7. Technical Assessment

This section of the report looks at the technical issues related to protecting wine from light degradation. The reaction between light and wine is detailed, along with experimental results quantifying the effect of light degradation on different wines in different coloured glass. The report concludes by looking at potential technical solutions to limit light-struck flavours of wine in flint bottles.

Glass has been the material of choice for wine bottles due to its premium image and its chemical inertness and impermeability to gases. For premium drinks such as spirits flint glass is the glass of choice due to the clarity it provides to display its contents. But for wine, especially red and champagne, flint glass has been avoided due to its transparency to UV radiation. Figure 21 shows the UV to visible transmission curves for flint, green and amber glass.

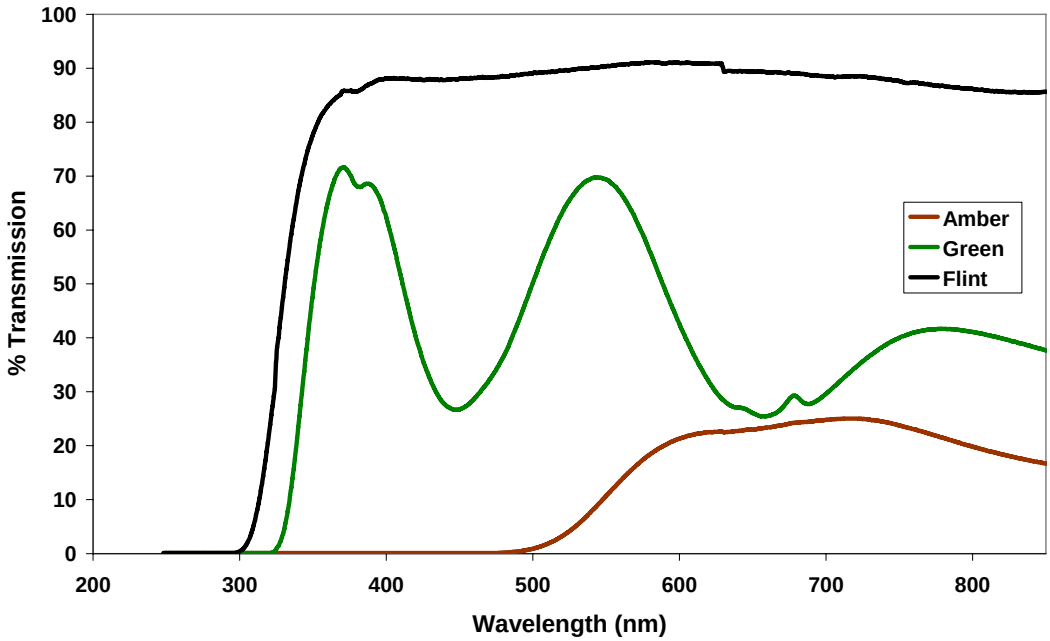


Figure 21 UV to visible light transmission of flint, green and amber glasses as measured by GTS.

The difference in colour of glass bottles is due to the different absorbencies of the glass bottles in the electromagnetic spectrum. The visible part of the spectrum is from 400 nm to 750 nm. Flint glass absorbs very little light between these wavelengths, which is why it is colourless, while green and amber glass absorb light, which is why they appear coloured. But flint and green absorb light in the ultra-violet, UV, region, 10 nm to 400 nm. As the human eye cannot see UV light this has no effect on the colour of the glass. But UV radiation has an adverse effect on the quality of wine, so flint and a standard green bottle do not provide UV protection for the wine. Amber glass does not transmit light between 280 nm and 450 nm and offers excellent protection from light degradation. But amber glass does not display the contents of the bottle as well as flint or green glass.

7.1. The Effect of Light on Wine

7.1.1. Light-Struck Reactions

Exposure of wine to light results in what is known as light-struck flavours and aromas. Most of the work into the reactions and interactions of light and wine have been done by Maujean [1-3] at the Unviersity of Reims in the heart of the Champagne region. Maujean's work focussed on the effect of light on Champagne. The reaction was found to be between sulphur containing amino acids, such as methionine and cysteine, and a photochemical activator such as riboflavin (B2) or pantothenic acid (B5), to yield volatile compounds such as dimethyldisulphide (DMDS), dimethylsulphide (DMS) and hydrogen sulphide (H_2S).

Amino acid (Sulphur containing) $\xrightarrow[\text{Riboflavin/Pantothenic acid}]{\text{UV}}$ Volatile compounds + NH_3 + CO_2 (DMDS, DMS, H_2S)

Riboflavin is sensitive to UV light at 375 nm and 440 nm and sunlight, which contains both these wavelengths, excites the riboflavin. The riboflavin then transforms back to its unexcited state, transferring its energy to other constituents of the wine. This causes oxidation and degradation of the amino acids to the volatile sulphide compounds.

It is often quoted that tannins are a natural preventative of the odours and flavours associated with light degradation. Tannins, which are present in dark grape skins as well as seeds and stems, are a phenolic compound. Work by Kolb, et al [4], showed that the phenolics in white grapes efficiently shielded UV-A radiation, but only provided incomplete UV-B shielding. This helps to explain why red wine is less susceptible to light-struck flavours than white wine as red wine has a higher phenolic content due to the dark coloured grape skins, despite having a higher riboflavin and pantothenic acid content. Recameles, et al, [5] showed that light radiation does not have an effect on the phenolic composition and colour of white wine.

7.1.2. Experimental Results of the Effect of Light on Wine

A sensory study by Dozon and Noble [6] investigated the effect of fluorescent lighting on sparkling and still wine. Bottles were placed 35 centimetres away from two 40 watt fluorescent bulbs in a room at a constant temperature, and were exposed to the lighting for 0, 24 and 72 hours. The results showed that UV radiation gave an increase in sulphur compounds in the wine, leading to odours described as cooked cabbage and wet dog. Wine in the flint bottles showed a significant difference in aroma after only 3.4 and 3.3 hours for still and sparkling wine respectively. In the green bottles significant differences were detected after 18 and 31.1 hours for still and sparkling wine respectively. Dozon's conclusion was that white wine is extremely sensitive to light and should not be bottled in flint, unless a UV-screening agent is used.

A number of tests have been done to try and simulate the effect lights in supermarkets have on wine. Beech [7] used a light that emitted very little UV light (0.007 % below 420 nm) and found that there was no significant differences between the red wines stored in green or flint containers after 12 months. MacPherson [8] ran an accelerated test for 200 and 500 hours on white, rose and red wine using fluorescent lighting replicating shop lighting. Tastings of the wines showed that all wines were inferior in quality. The white wine had deteriorated more than the red wine. The amber bottle was found to give better protection than the green and flint.

The production of wine also affects its sensitivity to light. La Follette [9] investigated the difference in aging chardonnay on the lees versus racked wines. The wines aged on the lees deteriorated faster than the racked wines, but the lees wines deterioration was slowed down by bottling in green, or wrapping the bottle in foil, rather than bottling in flint.

7.2 UV Protection for Flint Glass

Amber glass is the best choice for providing UV protection, but it does not display the contents of the bottle and does not help solve the current colour imbalance of cullet available in the UK. Table 39 shows the absorption of different colour bottles.

Colour	Absorption %
Amber	97-98
Dead leaf green	49-55
Emerald green	13-14
Champagne green	26-50
Flint	10

Table 39. Absorption of different coloured bottles between 350-450 nm, from Henfling [10]

There are other alternatives available apart from changing the colour of the glass to provide UV protection. For example, it is possible to make a UV absorbing flint glass. There are three possible ways of doing this, by applying UV absorbing organic coatings, by changing the glass chemistry or by wrapping the bottle in a plastic or foil sheath.

7.2.1. UV Absorbing Organic Coatings

Companies such as Ferro [11] and Deco-Glas [12] have organic UV protective coatings on the market. Ferro have developed their SpecTruLite UV blocking organic coating, curves (B) and (C) in figure 2 shows the light transmission curve for the coating on a flint bottle. Curve (B) is opaque to UV light, but at the threshold of the visible region becomes transparent. Curve (C) blocks out all the UV and the highest energy visible regions, but is pale yellow in colour.

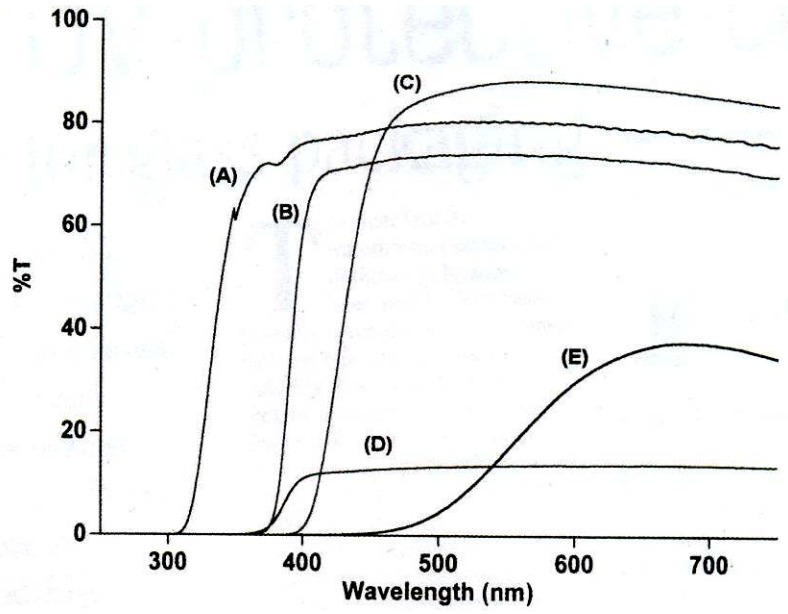


Figure 22 Light transmission curves

The data used in Figure 22 is taken from Kapp [11] where (A) is a commercial flint glass, (B), (C) and (D) are flint glasses coated with SpecTruLite UV blocking coatings, and (E) is a is a commercial amber glass.
Recent work by Mahltig [13] has found optimum UV protection can be obtained by combining organic and inorganic UV absorbers. Commercially available organic absorbers Tinuvin 213™ and SEMA 20613™ were

embedded into TiO_2 sol-gel coatings and the UV to visible spectrum transmission was measured. Complete protection in the UV region at wavelengths under 400 nm was not obtained, but a model has been created that predicts recipes to give the optimum UV protection.

7.2.2. UV Absorbing Glass Chemistry

The chemistry of the glass can be changed to decrease the UV absorption. Cerium in the range of 2-4 % can be added to container glasses to give protection from chemically active light, as seen in figure 23. Cerium absorbs strongly in the UV region, while not affecting the visible region. Experiments [14] have shown that for a glass with 5 % CeO_2 and 1 millimetre thick, UV radiation is absorbed up to a wavelength of 352 nm and for 10 % CeO_2 up to a wavelength of 362 nm. Cerium glasses are often used for special spectacle glasses for protecting the eyes from UV radiation. Currently cerium is being used in flint glass as a decolouriser, so current flint bottles manufactured in the UK will have a slightly increased tolerance of UV radiation. But this also shows that cerium is currently available as an economic batch material.

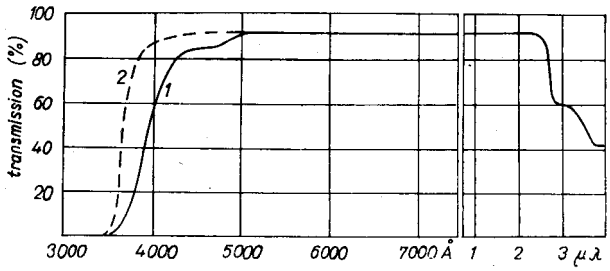


Figure 23 Light transmission curves

Curve 2 above represents a 2 % addition of cerium to container glass (taken from Volf [14])

Vanadium and titanium also absorb UV radiation. After chromium, vanadium is the most effective absorber of UV radiation. According to Volf [14] 1 % of V_2O_5 is equivalent to 5 % CeO_2 or 22-25 % TiO_2. But vanadium adds a green colour to the glass and only below 0.1 % concentration is the glass not distinctly coloured. Figure 24 shows a light transmission curve for vanadium, from which the excellent UV protection can be seen, but also absorbance at the beginning of the vision region in the blue region.

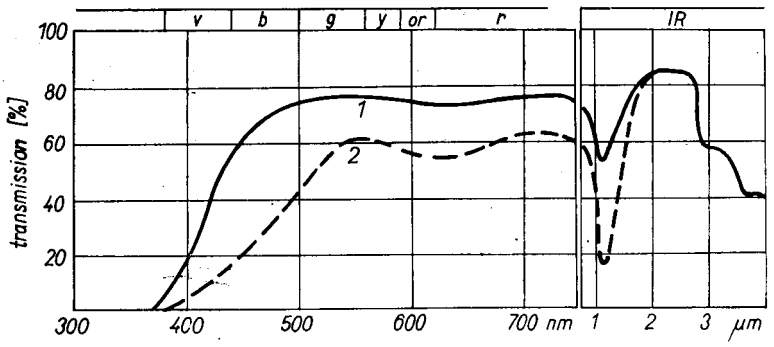


Figure 24 Light transmission curves

Figure 24 shows a 4 % addition of vanadium to container glass, with glass 1 being melted under oxidising conditions and glass 2 under reducing conditions (taken from Volf [14]).

7.2.3. Protective Sleeves

A protective plastic or foil sleeve could be wrapped around the bottle to provide protection from light radiation. The contents of the bottle would not necessarily be visible through the sleeve. This may put off the traditional wine buyer, but it may give New World wines an opportunity to reach out to a market of drinkers through radical contemporary designs. This would allow flint bottles to be used with no loss of quality of the wine and it would help solve the colour imbalance of cullet available in the UK.

7.3 Summary

- Flint glass and most shades of green glass transmit UV light.
- Light struck flavours are produced by the degradation of amino acids to volatile sulphur compounds. This reaction is catalysed by the B vitamins which have being excited by exposure to UV light
- White wines and champagne are more susceptible to light struck flavours than red wines.
- A reduction in the UV transmission of glass is possible: organic coatings are currently available on the market; the glass chemistry can be changed by the addition of ceria or vanadium; or wrapping the bottle in a plastic sleeve.

7.4 Further Work

Organic coatings preventing UV transmission and plastic sleeves are already on the market. Any research into plastic sleeves would need to be a marketing survey rather than a technical investigation. The area worthy of further work is UV protecting glass chemistry.

A benchmarking study assessing the UV protection of current bottles available on the UK market could be carried out. This would show the current UV transmission of bottles and could produce an interesting set of results as ceria is currently being trialled as a decolouriser. Once the current situation is benchmarked then a laboratory investigation could be conducted into the addition of ceria and vanadium and other UV absorbing additives into current UK container glass compositions. The UV to visible spectra would be measured to assess the UV protection provided by the new batch additives and recommendations for industrial development would be made.

1. Maujean, A., Haye, C., and Feuillat, M., Connaissance de la Vigne et du Vin., 1978, **12**, (4), p277-290
2. Maujean, A. and Seguin, N., Sci. Aliment., 1983, **3**, p589-601
3. Maujean, A. and Seguin, N., Sci. Aliment., 1983, **3**, p603-613
4. Kolb, C., Kopecky, J., Riederer, M., and Pfundel, E., Functional Plant Biology, **30**, (12), p1177-1186)
5. Recamales, A., Sayago, A., Gonzalez-Miret, M., and Hernanz., D., Food Research International, 2005
6. Dozon, N. and Noble, A., Am J. Enol. Vitric., 1989, **4**, p265-271
7. Beech, F. W., Seventh Wine Subject Day on Shelf Life, 1982, Long Ashton Research Station
8. MacPherson. C., Seventh Wine Subject Day on Shelf Life, 1982, Long Ashton Research Station
9. La Follette, G., Stambor, J., and Aiken, J., Vitic. Enol. Sci., 1993, **48**, p208-210
10. Henfling, D., PWV, 1996, p31-37
11. Kapp, D. C, and Maitland, P., Glass, 2003, *March*, p58-59
12. Böttger, P., Glass Int., 1989, *March*, p41
13. Mahltig, B., Böttcher, H., Rauch, K., Dieckmann, U., Nitsche, R., and Fritz, T., Thin Solid Films, 2005, **485**, p108-114
14. Volf, M. B., Chemical approach to glass, 1984, Elsevier Science Publishing Company, p322-3, 330-1, 400-1

8 Conclusions

The UK is the world's largest importer of wines shipping in over 1,100 litres which have a retail value of around £7.6 billion. Wines from the New World comprise approximately half this total; Australia and the USA being the principal suppliers.

The majority of wine is bottled in the country of origin and shipped in predominantly 75cl green glass bottles. These bottles display a large variation in weight which in itself offers potential to reduce packaging waste by encouraging the use of "best in class" bottle. Currently the average weight of a wine bottle is 535g yet no technical barriers exist to reduce bottles to 300g.

Bulk exports of wine account for approximately 210 million litres of which approximately 130 million litres comes from New World sources. Bulk delivery is significantly more cost effective and offers other advantages; it does however reduce the demand for locally produced bottles and can be seen to cheapen the brand.

Over 70 percent of wine by volume is sold through the off-license trade and, whilst supermarkets represent only 23% of the estimated 46,000 off-licences, they account for over 80% of sales. The large retailers dominate the choice of wines offered and their use of promotional offers largely determines brand leadership, with approximately 60 per cent of all the wine sold by these outlets being that offered on promotion at a 'special' discount.

The UK produces 1.96 million tonnes of packed glass of which approximately 400,000 tonnes or 20% is green. The UK's waste stream contains approximately 2.5 million tonnes of glass of which some 39% or 945,000 tonnes are estimated to be green. Thus there exists a chronic imbalance in the potential supply of green glass. Currently the demand for green glass is substantially satisfied by the glass provided by the schemes delivering colour sorted glass, but these same sources provide only 22% of the flint requirement. Additional quantities of flint glass must be extracted from mixed colour sources, but for each tonne of flint glass that is sorted, some 3.75 tonnes of green will arise. Thus measures that address the fundamental problem of the colour imbalance will prove to be the most beneficial to the recycling effort.

The influx of green bottles is largely responsible for the UK's colour imbalance in its waste glass stream and it is a growing trend. By 2008 wine bottles will contribute 814,000 tonnes to the waste stream, the bulk of which will be green. The trend towards the collection of mixed glass further exacerbates the situation.

The negative impact of these imported bottles could be lessened by several measures including:

- Persuading overseas wine growers to bottle their UK bound product in clear bottles.
- Importing wine in bulk into the UK for subsequent filling into green lightweight bottles.
- Persuading overseas wine growers to package their product in lightweight bottles.
- Increasing the glass collected by colour segregating schemes.

The work detailed in this report considers the impacts of making incremental changes to the above parameters.

The analysis has shown that the growth in mixed glass collection is likely to have a significant impact on the quantities of cullet being used in the remelt sector. Estimates made in the last two years suggest that between 800,000 tonnes and 1,060,000 tonnes will be used in the remelt sector in 2008. However, this study shows that 700,000 tonnes is the more realistic figure based on the assumption that 50% of mixed glass will be sent to colour processing. This increases the current projected shortfall in cullet recovery in 2008.

This study concludes that **"bulk containerisation" has the greatest potential** benefit on cullet recovery in the UK. The benefits will be maximised if the required wine bottles can be produced in the UK. The UK is not the sole recipient of imported wine but fortunately, as our domestic production of wine is almost

negligible, our seemingly insatiable thirst for the product should make the UK the natural choice for a European hub for wine imports. The UK has in place the necessary bottle manufacturing capacity and, whilst filling capacity is currently described as "tight", the leading fillers are anticipating growth and planning accordingly. Thus it is concluded that bulk shipments of wine to the UK could be increased without any difficulty. In addition to the benefits to the UK's waste stream, bulk shipping also reduces the environmental impact of transport. Quantifying these benefits is outside the scope of this report, but significant CO_2 savings would accrue as fewer containers and thus ship voyages would be required to import the same volume of wine.

Persuading wine producers to bottle their product in flint rather than green glass has the second largest impact in terms of UK cullet recovery and benefit to stakeholders (container manufacturers and reprocessors). An increase in the proportion of flint bottles in the waste stream would be welcomed by the operators of the colour sorting facilities who receive premium prices for the flint glass. Currently many loads contain insufficient clear glass to make the sorting process economically viable. The study also considered the impact this option would have on the producer country's glass industry and conclude that in most cases it would have little or no negative impact. Green glass does however have some advantages over flint in respect of protection from UV light; prolonged exposure to which can impair the taste of the wine. The study has investigated technical solutions to this problem and found that commercially available solutions in the form of organic coatings and plastic sleeves have been developed. A more elegant solution could be achieved by imparting UV protection to clear glass by the addition of rare earths to the melting process.

The relative impacts of the measures considered are shown below in Figure 17 (reproduced from section 6.6.3).

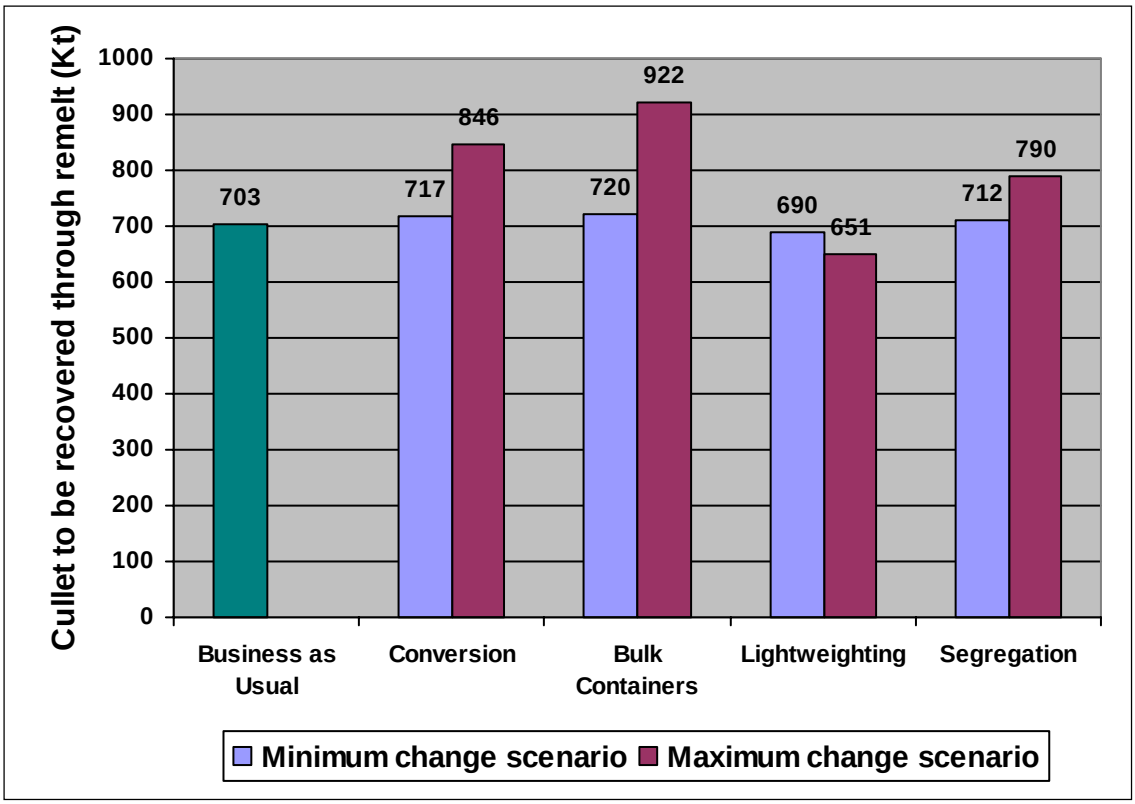


Figure 17 Cullet to re-melt by various options

It is evident from the study that the major retail outlets would be the best vehicle with which to effect a change in wine market. The retailers are generally reticent to admit that they have a direct influence on their suppliers in many areas. However, as this issue essentially relates to packaging materials, it would appear to come within the scope of the Courtauld Commitment and as such should attract support from the group. The importation of bulk wine should be of particular interest to this group as the cost savings could be passed on to their customers.

Furthermore, the importer of bottled wine picks up the 15% obligation under the Packaging Waste Regulations that would have been the responsibility of the bottle manufacturer had the item been made in the UK. Bulk importation would relieve the importer of this obligation as this would now fall on the UK glass manufacturer.

9 Recommendations

WRAP has correctly identified that the importation of wine bottles is a significant contributor to the colour imbalance currently being experienced in the UK cullet supply market. This study has determined that significant environmental benefits can be gained if certain changes to the wine trade can be encouraged.

It is therefore recommended that:

- ✓ The practice of importing wine in bulk should be encouraged. The active participation of the major retailers must be engendered by discussions at senior levels; perhaps under the auspices of the Courtauld Commitment.
- ✓ A rigorous assessment should be made to quantify the environmental benefits of bulk wine shipments.
- ✓ A comprehensive audit should be undertaken by brand and by retailer of the weights and colours of wine bottles currently in use. This audit could be extended to cover a wider range of food containers if required.
- ✓ Where bulk import is not desired, wine producers should, wherever practicable, be encouraged to bottle at source in flint glass. A pilot scheme involving a (smaller?) retailer should be instigated; perhaps using the opportunity to re-launch a particular branch. The trial could be augmented by perception studies or possibly by having the wines sold in both clear and green bottles.
- ✓ A better understanding of the role of coloured glass in providing UV protection should be acquired. A benchmarking study to assess the UV protection offered by current bottles should be completed. More work should also be undertaken into the feasibility of improving the UV protection afforded by clear glass by changes to glass composition.

Appendix A1

Switching Overseas Suppliers to Clear Bottles

A1.1 Scenario 1 5% of wine in green glass converted to clear glass.

Table A1.1 shows the impact the conversion of 5% of wine from green bottles would have on the colour split of the recovered cullet and Table A1.2 shows the detailed analysis. The increase in clear cullet would increase colour sorting yield rates to 21.4%.

	Clear	Green	*Total*
Business as usual Wine glass in waste stream (tonnes)	253,801	559,981	*813,782*
5% conversion (tonnes)	+28,000	-28,000	*0*
Change in colour mix in cullet (tonnes) @ 80% recovery	+22,400	-22,400	*0*
Change in cullet collected segregated@ 28% of cullet collected	+6,272	-6,272	*0*
Change in cullet collected mixed@ 72% of cullet collected	+16,128	-16,128	*0*

Table A1.1 5% green bottle conversion

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		*Total to remelt*
				Remelt	Surplus	
100	0	189,198	48,379	217,813	0	*455,390*
100	10	214,213	54,230	303,959	0	*572,401*
100	20	239,228	60,080	325,300	64,804	*624,608*
100	30	264,243	65,931	325,300	150,950	*655,474*
100	40	289,258	71,781	325,300	237,096	*686,340*
100	50	314,274	77,632	325,300	323,242	*717,206*
100	60	339,289	83,483	325,300	409,387	*748,071*
100	70	364,304	89,333	325,300	495,533	*778,937*
100	80	389,319	95,184	325,300	581,679	*809,803*
100	90	414,334	101,034	325,300	667,824	*840,668*
100	*100*	*439,349*	*106,885*	*325,300*	*753,970*	*871,534*

Table A1.2 Colour distribution resulting from a 5% conversion

A1.2 Scenario 2 10% of wine in green converted from green to clear glass.

Table A1.3 shows the impact the conversion of 10% of wine from green bottles would have on the colour split of the recovered cullet and Table A1.4 shows the detailed analysis. The increase in clear cullet would increase colour sorting yield rates to 22.8%.

	Clear	Green	Total
Business as usual Wine glass in waste stream (tonnes)	253,801	559,981	813,782
10% conversion (tonnes)	+55,998	-55,998	0
Change in colour mix in cullet (tonnes) @ 80% recovery	+44,798	-44,798	0
Change in cullet collected segregated@ 28% of cullet collected	+12,543	-12,543	0
Change in cullet collected mixed@ 72% of cullet collected	+32,255	-32,255	0

Table A1.3 10% green bottle conversion

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	195,469	48,379	211,542	0	455,390
100	10	222,097	54,230	296,075	0	572,401
100	20	248,725	60,080	325,300	55,308	634,105
100	30	275,352	65,931	325,300	139,841	666,583
100	40	301,980	71,781	325,300	224,374	699,062
100	50	328,608	77,632	325,300	308,907	731,540
100	60	355,236	83,483	325,300	393,440	764,018
100	70	381,864	89,333	325,300	477,973	796,497
100	80	408,491	95,184	325,300	562,506	828,975
100	90	435,119	101,034	325,300	647,039	861,454
100	100	461,747	106,885	325,300	731,572	893,932

Table A1.4 Colour distribution resulting from a 10% conversion

A1.3 Scenario 3 20% of wine in green converted from green to clear glass.

Table A1.5 shows the impact the conversion of 20% of wine from green bottles would have on the colour split of the recovered cullet and Table A1.6 shows the detailed analysis. The increase in clear cullet would increase colour sorting yield rates to 25.6%.

	Clear	Green	Total
Business as usual Wine glass in waste stream (tonnes)	253,801	559,981	813,782
20% conversion (tonnes)	+111,996	-111,996	0
Change in colour mix in cullet (tonnes) @ 80% recovery	+89,597	-89,597	0
Change in cullet collected segregated@ 28% of cullet collected	+25,087	-25,087	0
Change in cullet collected mixed@ 72% of cullet collected	+64,510	-64,510	0

Table A1.5 20% green bottle conversion

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	208,013	48,379	198,998	0	455,390
100	10	237,866	54,230	280,305	0	572,401
100	20	267,720	60,080	325,300	36,313	653,100
100	30	297,573	65,931	325,300	117,621	688,804
100	40	327,426	71,781	325,300	198,928	724,508
100	50	357,280	77,632	325,300	280,236	760,212
100	60	387,133	83,483	325,300	361,543	795,915
100	70	416,986	89,333	325,300	442,851	831,619
100	80	446,839	95,184	325,300	524,158	867,323
100	90	476,693	101,034	325,300	605,466	903,027
100	100	506,546	106,885	325,300	686,773	938,731

Table A1.6 Colour distribution resulting from a 20% conversion

A1.4 Scenario 4 50% of wine in green converted from green to clear glass.

Table A1.7 shows the impact the conversion of 50% of wine from green bottles would have on the colour split of the recovered cullet and Table A1.8 shows the detailed analysis. The increase in clear cullet would increase colour sorting yield rates to 34%.

	Clear	Green	Total
Business as usual Wine glass in waste stream (tonnes)	253,801	559,981	813,782
50% conversion (tonnes)	+279,991	-279,991	0
Change in colour mix in cullet (tonnes) @ 80% recovery	+223,993	-223,993	0
Change in cullet collected segregated@ 28% of cullet collected	+62,718	-62,718	0
Change in cullet collected mixed@ 72% of cullet collected	+161,275	-161,275	0

Table A1.7 50% green bottle conversion

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	245,644	48,379	161,367	0	455,390
100	10	285,174	54,230	232,998	0	572,401
100	20	324,704	60,080	304,629	0	689,413
100	30	364,233	65,931	325,300	50,960	755,464
100	40	403,763	71,781	325,300	122,591	800,845
100	50	443,293	77,632	325,300	194,222	846,225
100	60	482,823	83,483	325,300	265,853	891,605
100	70	522,353	89,333	325,300	337,484	936,986
100	80	561,882	95,184	325,300	409,115	982,366
100	90	601,412	101,034	325,300	480,746	1,027,747
100	100	640,942	106,885	325,300	552,377	1,073,127

Table A1.8 Colour distribution resulting from a 50% conversion

Appendix A2

Bulk Importation and UK Bottling

A2.1 Scenario 1 5% of wine currently imported in bottles bottled in the UK.

Table A2.1 shows the impact the bulk importation of an additional 5% of wine would have on production capacity. Table A2.2 shows the detailed analysis.

	Clear	Amber	Green	Total
Business as usual wine glass in waste stream (tonnes)	253,801	0	559,981	813,782
Additional production volume @ 5% of wine (tonnes)	12,690	0	27,999	40,689
Business as usual production volumes (tonnes)	1,705,599	331,935	502,900	2,540,434
Revised production volumes (tonnes)	1,718,289	331,935	530,899	2,581,123
Projected cullet utilisation rate	0.377	0.521	0.647	
Revised cullet capacity	647,986	173,000	343,411	1,164,397

Table A2.1 Impact of 5% wine importation in bulk

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	182,926	48,379	224,085	0	455,390
100	10	206,328	54,230	311,844	0	572,401
100	20	229,731	60,080	343,411	56,191	633,222
100	30	253,133	65,931	343,411	143,950	662,475
100	40	276,535	71,781	343,411	231,708	691,728
100	50	299,938	77,632	343,411	319,467	720,981
100	60	323,340	83,483	343,411	407,225	750,233
100	70	346,742	89,333	343,411	494,984	779,486
100	80	370,144	95,184	343,411	582,742	808,739
100	90	393,547	101,034	343,411	670,501	837,992
100	100	416,949	106,885	343,411	758,259	867,245

Table A2.2 Colour distribution resulting from a 5% conversion

A2.2 Scenario 2 10% of wine currently imported in bottles bottled in the UK.

Table A2.3 shows the impact the bulk importation of an additional 10% of wine would have on production capacity. Table A2.4 shows the detailed analysis.

	Clear	Amber	Green	Total
Business as usual wine glass in waste stream (tonnes)	253,801	0	559,981	813,782
Additional production volume @ 10% of wine (tonnes)	25,380	0	55,998	81,378
Business as usual production volumes (tonnes)	1,705,599	331,935	502,900	2,540,434
Revised production volumes (tonnes)	1,730,979	331,935	559,898	2621,812
Projected cullet utilisation rate	0.377	0.521	0.647	
Revised cullet capacity	652,579	173,000	362,254	1,187,833

Table A2.3 Impact of 10% wine importation in bulk

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	182,926	48,379	224,085	0	455,390
100	10	206,328	54,230	311,844	0	572,401
100	20	229,731	60,080	362,254	37,348	652,064
100	30	253,133	65,931	362,254	125,107	681,318
100	40	276,535	71,781	362,254	212,865	710,571
100	50	299,938	77,632	362,254	300,624	739,824
100	60	323,340	83,483	362,254	388,382	769,076
100	70	346,742	89,333	362,254	476,140	798,329
100	80	370,144	95,184	362,254	563,899	827,582
100	90	393,547	101,034	362,254	651,658	856,835
100	100	416,949	106,885	362,254	739,416	886,088

Table A2.4 Colour distribution resulting from a 10% conversion

A2.3 Scenario 3 20% of wine currently imported in bottles bottled in the UK.

Table A.2.5 shows the impact the bulk importation of an additional 20% of wine would have on production capacity. Table A.2.6 shows the detailed analysis.

	Clear	Amber	Green	Total
Business as usual wine glass in waste stream (tonnes)	253,801	0	559,981	813,782
Additional production volume @ 20% of wine (tonnes)	50,760	0	111,996	162,756
Business as usual production volumes (tonnes)	1,705,599	331,935	502,900	2,540,434
Revised production volumes (tonnes)	1,756,359	331,935	614,896	2,703,190
Projected cullet utilisation rate	0.377	0.521	0.647	
Revised cullet capacity	662,342	173,000	397,744	1,233,086

Table A2.5 Impact of 20% wine importation in bulk

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	182,926	48,379	224,085	0	455,390
100	10	206,328	54,230	311,844	0	572,401
100	20	229,731	60,080	397,744	1,858	687,555
100	30	253,133	65,931	397,744	89,617	716,808
100	40	276,535	71,781	397,744	177,375	746,061
100	50	299,938	77,632	397,744	265,134	775,314
100	60	323,340	83,483	397,744	352,892	804,566
100	70	346,742	89,333	397,744	440,651	833,819
100	80	370,144	95,184	397,744	528,409	863,073
100	90	393,547	101,034	397,744	616,168	892,325
100	100	416,949	106,885	397,744	703,926	921,578

Table A2.6 Colour distribution resulting from a 20% conversion

A2.4 Scenario 4 50% of wine currently imported in bottles bottled in the UK.

Table A2.7 shows the impact the bulk importation of an additional 50% of wine would have on production capacity. Table A2.8 shows the detailed analysis.

	Clear	Amber	Green	Total
Business as usual wine glass in waste stream (tonnes)	253,801	0	559,981	813,782
Additional production volume @ 50% of wine (tonnes)	126,901	0	279,991	406,891
Business as usual production volumes (tonnes)	1,705,599	331,935	502,900	2,540,434
Revised production volumes (tonnes)	1,832,500	331,935	782,891	2,947,325
Projected cullet utilisation rate	0.377	0.521	0.647	
Revised cullet capacity	691,056	173,000	544,863	1,408,919

Table A2.7 Impact of 50% wine importation in bulk

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	182,926	48,379	224,085	0	455,390
100	10	206,328	54,230	311,844	0	572,401
100	20	229,731	60,080	399,602	0	834,674
100	30	253,133	65,931	487,360	0	863,927
100	40	276,535	71,781	544,863	30,256	893,180
100	50	299,938	77,632	544,863	118,015	922,433
100	60	323,340	83,483	544,863	205,773	951,685
100	70	346,742	89,333	544,863	293,532	980,938
100	80	370,144	95,184	544,863	381,290	1,010,191
100	90	393,547	101,034	544,863	469,049	1,039,444
100	100	416,949	106,885	544,863	556,807	1,068,697

Table A2.8 Colour distribution resulting from a 50% conversion

Appendix A3

Lightweighting Bottles

A3.1 Scenario 1 Mean bottle weight was reduced to 450g.

Table A3.1 shows the impact of the light weighting of bottles to 450g. Table A3.2 shows the detailed analysis.

	Clear	Amber	Green	Total
Business as usual wine glass in waste stream (tonnes)	253,801	0	559,981	813,782
Reduction in wine glass in waste stream (tonnes)	25,380	0	55,998	81,378
Current tonnage of cullet in waste stream (tonnes)	1,383,315	271,238	1,057,829	2,712,382
Revised tonnage of cullet in waste stream (tonnes)	1,357,935	271,238	1,001,831	2,631,004
Reduction in cullet recovered. - of which collected segregated - of which collected mixed	20,304 5,685 14,619	0 0 0	44,798 12,543 32,255	65,102 18,229 46,873
Revised tonnage collected segregated (tonnes)	177,241	48,379	211,542	437,162
Revised colour separation yields (tonnes)	219,404	58,506	845,330	1,123,240
Total recovered segregated or mixed (tonnes)	396,645	106,885	1,056,872	1,560,402

Table A3.1 reduction of bottle weight to 450g

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	177,241	48,379	211,542	0	437,162
100	10	199,181	54,230	296,075	0	549,486
100	20	221,122	60,080	325,300	55,308	606,502
100	30	243,062	65,931	325,300	139,841	634,293
100	40	265,003	71,781	325,300	224,374	662,084
100	50	286,943	77,632	325,300	308,907	689,875
100	60	308,883	83,483	325,300	393,440	717,666
100	70	330,824	89,333	325,300	477,973	745,457
100	80	352,764	95,184	325,300	562,506	773,248
100	90	374,705	101,034	325,300	647,039	801,039
100	100	396,645	106,885	325,300	731,572	828,830

Table A3.2 Colour distribution resulting from a 450 g bottle

A3.2 Scenario 2 Mean bottle weight was reduced to 400g.

Table A3.3 shows the impact of the light weighting of bottles to 400g. Table A3.4 shows the detailed analysis.

	Clear	Amber	Green	Total
Business as usual wine glass in waste stream (tonnes)	253,801	0	559,981	813,782
Reduction in wine glass in waste stream (tonnes)	50,760	0	111,996	162,756
Current tonnage of cullet in waste stream (tonnes)	1,383,315	271,238	1,057,829	2,712,382
Revised tonnage of cullet in waste stream (tonnes)	1,332,555	271,238	945,833	2,549,626
Reduction in cullet recovered. - of which collected segregated - of which collected mixed	40,608 11,370 29,238	0 0 0	89,597 25,087 64,510	130,205 36,457 93,748
Revised tonnage collected segregated (tonnes)	171,556	48,379	198,998	418,933
Revised colour separation yields (tonnes)	204,785	58,506	813,075	1,076,366
Total recovered segregated or mixed (tonnes)	376,341	106,885	1,012,073	1,495,299

Table A3.3 reduction of bottle weight to 400g

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	171,556	48,379	198,998	0	418,933
100	10	192,035	54,230	280,306	0	526,570
100	20	212,513	60,080	325,300	36,313	597,893
100	30	232,992	65,931	325,300	117,621	624,222
100	40	253,470	71,781	325,300	198,928	650,551
100	50	273,949	77,632	325,300	280,236	676,881
100	60	294,427	83,483	325,300	361,543	703,210
100	70	314,906	89,333	325,300	442,851	729,539
100	80	335,384	95,184	325,300	524,158	755,868
100	90	355,863	101,034	325,300	605,466	782,197
100	100	376,341	106,885	325,300	686,773	808,526

Table A3.4 Colour distribution resulting from a 400 g bottle

A3.3 Scenario 3 Mean bottle weight was reduced to 350g.

Table A3.5 shows the impact of the light weighting of bottles to 350g. Table A3.6 shows the detailed analysis.

	Clear	Amber	Green	Total
Business as usual wine glass in waste stream (tonnes)	253,801	0	559,981	813,782
Reduction in wine glass in waste stream (tonnes)	76,140	0	167,994	244,135
Current tonnage of cullet in waste stream (tonnes)	1,383,315	271,238	1,057,829	2,712,382
Revised tonnage of cullet in waste stream (tonnes)	1,307,175	271,238	889,835	2,468,247
Reduction in cullet recovered. - of which collected segregated - of which collected mixed	60,912 17,055 43,857	0 0 0	134,395 37,631 96,764	195,308 54,686 140,622
Revised tonnage collected segregated (tonnes)	165,871	48,379	186,454	400,704
Revised colour separation yields (tonnes)	190,166	58,506	780,821	1,029,493
Total recovered segregated or mixed (tonnes)	356,037	106,885	967,275	1,430,197

Table A3.5 reduction of bottle weight to 350g

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	165,871	48,379	186,454	0	400,704
100	10	184,888	54,230	264,536	0	503,653
100	20	203,904	60,080	325,300	17,318	589,284
100	30	222,921	65,931	325,300	95,400	614,152
100	40	241,937	71,781	325,300	173,482	639,019
100	50	260,954	77,632	325,300	251,565	663,886
100	60	279,971	83,483	325,300	329,647	988,753
100	70	298,987	89,333	325,300	407,729	713,620
100	80	318,004	95,184	325,300	485,811	738,488
100	90	337,020	101,034	325,300	563,893	763,355
100	100	356,037	106,885	325,300	641,975	788,222

Table A3.6 Colour distribution resulting from a 350 g bottle

A3.4 Scenario 4 Mean bottle weight was reduced to 300g.

Table A3.7 shows the impact of the light weighting of bottles to 300g. Table A3.8 shows the detailed analysis.

	Clear	Amber	Green	Total
Business as usual wine glass in waste stream (tonnes)	253,801	0	559,981	813,782
Reduction in wine glass in waste stream (tonnes)	101,520	0	223,992	325,513
Current tonnage of cullet in waste stream (tonnes)	1,383,315	271,238	1,057,829	2,712,382
Revised tonnage of cullet in waste stream (tonnes)	1,281,795	271,238	833,837	2,386,869
Reduction in cullet recovered. - of which collected segregated - of which collected mixed	81,216 22,740 58,476	0 0 0	179,194 50,174 129,020	260,410 72,915 187,495
Revised tonnage collected segregated (tonnes)	160,186	48,379	173,911	382,476
Revised colour separation yields (tonnes)	176,547	58,506	748,565	983,618
Total recovered segregated or mixed (tonnes)	336,733	106,885	922,476	1,366,094

Table A3.7 reduction of bottle weight to 300g

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	160,186	48,379	173,911	0	382,476
100	10	177,841	54,230	248,768	0	480,838
100	20	195,495	60,080	323,624	0	579,200
100	30	213,150	65,931	325,300	73,181	604,381
100	40	230,805	71,781	325,300	148,037	627,886
100	50	248,460	77,632	325,300	222,894	651,392
100	60	266,114	83,483	325,300	297,750	674,897
100	70	283,769	89,333	325,300	372,607	698,402
100	80	301,424	95,184	325,300	447,463	721,907
100	90	319,078	101,034	325,300	522,320	745,413
100	100	336,733	106,885	325,300	597,176	768,918

Table A3.8 Colour distribution resulting from a 300 g bottle

Appendix A4

Increased segregated collection schemes

A4.1 Scenario 1 5% increase in colour segregated collection.

Table A4.1 shows the impact of increasing colour segregation by 5%. Table A4.2 shows the detailed analysis.

	Clear	Amber	Green	Mixed	Total
Business as usual cullet collected (tonnes)	182,926	48,379	224,085	1,170,114	1,625,504
5% increase in segregated collection (tonnes)	192,072	50,798	235,289	1,147,345	1,625,504
Revised colour separation yields (tonnes)	229,469	57,368	860,508	-	1,147,345
Total recovered segregated or mixed (tonnes)	421,541	108,166	1,095,797	-	1,625,504

Table A4.1 5% increase in colour segregation

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	192,072	50,798	235,289	0	478,159
100	10	215,019	56,535	321,340	0	592,893
100	20	237,966	62,272	325,300	82,091	625,537
100	30	260,913	68,008	325,300	168,141	654,221
100	40	283,860	73,745	325,300	254,192	682,905
100	50	306,807	79,482	325,300	340,243	711,589
100	60	329,753	85,219	325,300	426,294	740,272
100	70	352,700	90,956	325,300	512,345	768,956
100	80	375,647	96,692	325,300	598,395	797,640
100	90	398,594	102,429	325,300	684,446	826,323
100	100	421,541	108,166	325,300	770,497	855,007

Table A4.2 Colour distribution resulting from a 5% increase

A4.2 Scenario 2 10% increase in colour segregated collection.

Table A4.3 shows the impact of increasing colour segregation by 10%. Table A4.4 shows the detailed analysis.

	Clear	Amber	Green	Mixed	Total
Business as usual cullet collected (tonnes)	182,926	48,379	224,085	1,170,114	1,625,504
10% increase in segregated collection (tonnes)	201,219	53,217	246,494	1,124,574	1,625,504
Revised colour separation yields (tonnes)	224,915	56,229	843,430	-	1,124,574
Total recovered segregated or mixed (tonnes)	426,134	109,446	1,089,924	-	1,625,504

Table A4.3 10% increase in colour segregation

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	201,219	53,217	246,494	0	500,930
100	10	223,711	58,840	325,300	5,537	607,850
100	20	246,202	64,463	325,300	89,880	635,965
100	30	268,694	70,086	325,300	174,223	664,079
100	40	291,185	75,709	325,300	258,566	692,194
100	50	313,677	81,332	325,300	342,909	720,308
100	60	336,168	86,954	325,300	427,252	748,422
100	70	358,660	92,577	325,300	511,595	776,537
100	80	381,151	98,200	325,300	595,938	804,651
100	90	403,643	103,823	325,300	680,281	832,766
100	100	426,134	109,446	325,300	764,624	860,880

Table A4.4 Colour distribution resulting from a 10% increase

A4.3 Scenario 3 20% increase in colour segregated collection.

Table A4.5 shows the impact of increasing colour segregation by 20%. Table A4.6 shows the detailed analysis.

	Clear	Amber	Green	Mixed	Total
Business as usual cullet collected (tonnes)	182,926	48,379	224,085	1,170,114	1,625,504
20% increase in segregated collection (tonnes)	219,511	58,055	268,902	1,079,036	1,625,504
Revised colour separation yields (tonnes)	215,807	53,952	809,277	-	1,079,036
Total recovered segregated or mixed (tonnes)	435,318	112,007	1,078,179	-	1,625,504

Table A4.5 20% increase in colour segregation

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	219,511	58,055	268,902	0	546,468
100	10	241,092	63,450	325,300	24,530	629,842
100	20	262,672	68,845	325,300	105,457	656,818
100	30	284,253	74,241	325,300	186,385	683,794
100	40	305,834	79,636	325,300	267,313	710,770
100	50	327,415	85,031	325,300	348,241	737,746
100	60	348,995	90,426	325,300	429,168	764,721
100	70	370,576	95,821	325,300	510,096	791,697
100	80	392,157	101,217	325,300	591,024	818,673
100	90	413,737	106,612	325,300	671,951	645,649
100	100	435,318	112,007	325,300	752,879	872,625

Table A4.6 Colour distribution resulting from a 20% increase

A4.4 Scenario 4 50% increase in colour segregated collection.

Table A4.7 shows the impact of increasing colour segregation by 50%. Table A4.8 shows the detailed analysis.

	Clear	Amber	Green	Mixed	Total
Business as usual cullet collected (tonnes)	182,926	48,379	224,085	1,170,114	1,625,504
50% increase in segregated collection (tonnes)	274,389	72,569	336,128	942,418	1,625,504
Revised colour separation yields (tonnes)	188,484	47,121	706,813	-	942,418
Total recovered segregated or mixed (tonnes)	462,873	119,690	1,042,941	-	1,625,504

Table A4.7 50% increase in colour segregation

% of colour segregated to remelt	% of mixed glass colour sorted	Clear	Amber	Green		Total to remelt
				Remelt	Surplus	
100	0	274,389	72,569	325,300	10,828	672,258
100	10	293,237	77,281	325,300	81,509	695,819
100	20	312,086	81,993	325,300	152,191	719,379
100	30	330,934	86,705	325,300	222,872	742,940
100	40	349,783	91,417	325,300	293,553	766,500
100	50	368,631	96,130	325,300	364,235	790,061
100	60	387,479	100,842	325,300	434,916	813,621
100	70	406,328	105,554	325,300	505,597	837,182
100	80	425,176	110,266	325,300	576,278	860,742
100	90	444,025	114,978	325,300	646,960	884,303
100	100	462,873	119,690	325,300	717,641	907,863

Table A4.8 Colour distribution resulting from a 50% increase