Ensure Your Compliance

Manage Your Costs

Build Your Knowledge

Enhance Your Reputation

GlassFlow 2012

October 2013

Final Report

wrap valpak

Written by: Dr Hugh McCoach, Gordon Francey and Sarah Mann

Executive Summary

Background

During 2012 the UK experienced a lot of volatility in the glass packaging recycling sector. Low recycling figures published in the first half of the year meant there would have to be a considerable increase in recycling in the latter half of the year to ensure the UK would meet its glass packaging recycling target for the year.

In 2012, the UK needed to recycle 1,652k tonnes of glass packaging to meet the EU Directive (Directive on Packaging and Packaging Waste (94/62/EC), amended by Directive 2004/12/EC) target of 60%, based on the PackFlow[1] mid-point estimate of glass packaging consumption in the UK. However, with low quantities of glass being accepted for reprocessing in the first three quarters of the year, this put significant pressure on the market to increase glass recycling in the last quarter. Although recycling tonnages increased substantially in the last quarter, the total quantity recycled was just under the target for the year indicating that the UK had achieved a recycling rate of 59% in 2012; just short of its EU target for glass packaging recycling. Also, the market volatility and depressed levels of recycling in the first half of the year put pressure on the glass PRN (Packaging Recovery Note) market, which saw prices rise from around £10 per tonne early in the year to approximately £75 per tonne towards the end of the year, meaning that the cost of compliance to obligated glass packaging producers who were purchasing PRN/PERNs later in the year increased significantly.

These market conditions highlighted a need to examine in detail why this market volatility occurred and to ensure that estimates of glass packaging flowing onto the UK market are as robust and accurate as possible, because it is from these estimated tonnages that recycling targets and recycling rates are derived. Accordingly, the GlassFlow project was set up to review the flow of glass packaging through the UK supply chain and to identify and evaluate the key market risks that could prevent the UK from meeting its glass packaging recycling targets.

Glass Consumption

A methodology for estimating the flow of glass packaging onto the UK market was identified and agreed with key industry stakeholders to calculate the total tonnage of glass packaging consumed in the UK for each year between 2008 and 2012. These new estimates were compared to the PackFlow estimates, which are currently used to calculate recycling rates for producers obligated for glass packaging. The new estimates are presented including and excluding illegal imports. This project has estimated that approximately 100k tonnes of the glass packaging consumed in the UK consists of packaging around illegal imports of alcohol. Some of this glass is likely to end up being collected for recycling and therefore contributes towards the PRN recycling target; it is therefore included implicitly in the 2012 PRNs produced. The question arises of how to account for this in the consumption estimates; including illegal imports arguably means greater consistency with the tonnages recycled. However, it also implicitly inflates the consumption total, which translates into a greater recycling obligation for UK businesses, despite them not being responsible for this tonnage. It is therefore important that this report presents estimates of consumption that include and exclude illegal imports. By definition, estimating illegal

[1] PackFlow 2017, March 2012, Valpak Ltd, http://www.valpak.co.uk/Libraries/Environmental_Consulting_Documents/PackFlow_2017_Final_Report_09_11_12.sflb.ashx. PackFlow is a series of reports providing estimates of the amount of packaging materials consumed in the UK for the various packaging materials falling under the UK's producer responsibility regime for packaging, including glass. The latest edition is PackFlow 2017, which was published in 2012 and based on work carried out in 2011.

imports of alcohol (and the associated glass packaging) involves a substantial degree of uncertainty. This is attempted here for completeness but it is important to stress that many of the assumptions used and the resulting estimates are difficult to sense-check meaningfully so the results are presented with caution.

Figure ES1: UK Packaging Glass Consumption: GlassFlow estimates v PackFlow estimates (T)

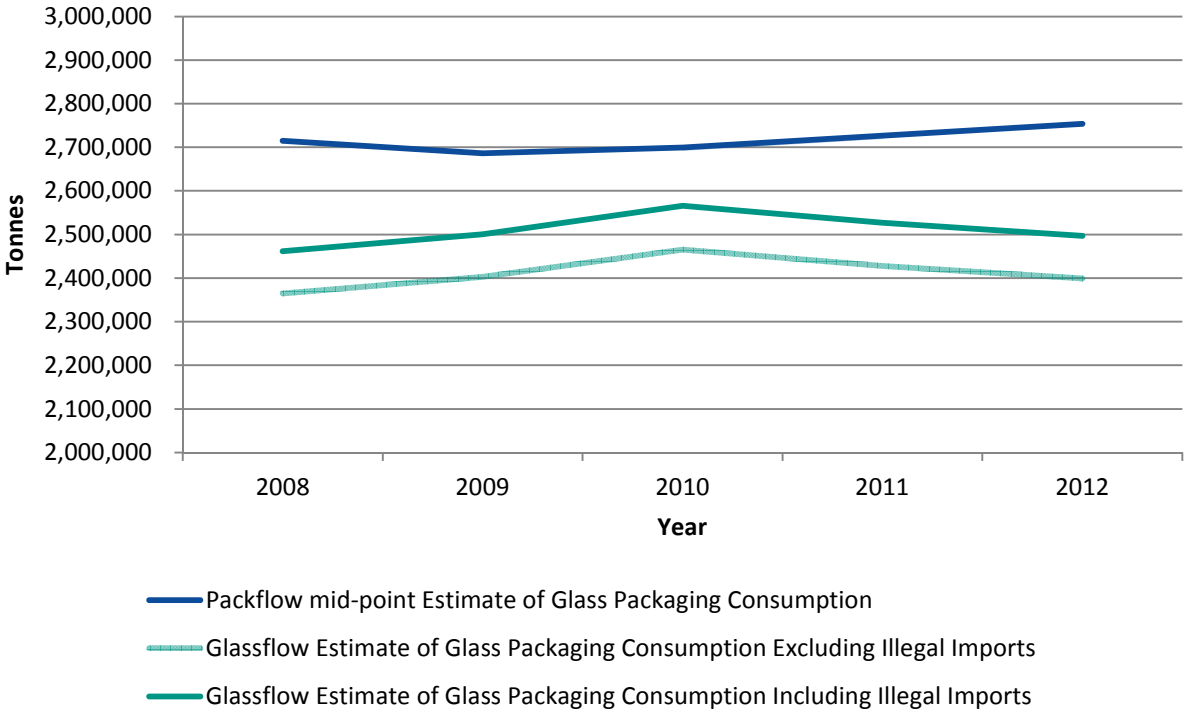


Figure ES1 shows that the revised flow (or consumption) of glass packaging onto the UK market[2] calculated by the methodology developed by the GlassFlow project is significantly lower than that estimated earlier in the PackFlow study. The main implication of the lower revised flow of glass packaging is that it significantly affects the UK's packaging glass recycling rate in 2012, assuming the recycling tonnages actually recorded through PRN/PERNs in 2012 are unchanged. Figure ES2 shows the UK performance in terms of glass packaging recycling if the revised flow figure is used.

Figure ES2: Revised UK Glass Packaging Performance versus EU Directive Target of 60% (T)[3]

	Excluding illegal imports	Including illegal imports
Revised Flow for 2012	2,399,235	2,496,332
2012 PRNs produced	1,624,088	1,624,088
Revised 2012 UK performance	68%	65%

This would suggest that based on the revised flow, the UK over achieved against the EU directive of 60% by 8% or 185k tonnes of glass packaging. Additionally, if the illegal imports are included the revised performance is still greater than 60%.

[2] The report also calculates figures for Scotland and Wales separately.

[3] The reported number of PRNs/PERNs produced in 2012 is used here; however, the total amount of glass packaging recycled in the UK is 2.5k tonnes higher, the difference being glass packaging that was recycled but didn't have a PRN/PERN issued against it.

In order to hit a 60% EU target in 2012, the UK Government set a target of 81% for obligated businesses for glass packaging[4]. It is possible to calculate the business target that would be necessary to meet the EU Directive 60% target based on the revised flow in 2012. As shown in Figure ES3 a business target of 70% (excluding illegal imports) and 73% (including illegal imports) compared with the actual target of 81% would be sufficient to hit the 60% EU target. Although it should be noted that, unlike the current 81% target, this does not include any buffer to allow for some margin for error and ensure that the 60% is securely met.

Figure ES3: Revised UK Glass Packaging Performance 2012 versus Obligated Business Target (81%) (T)

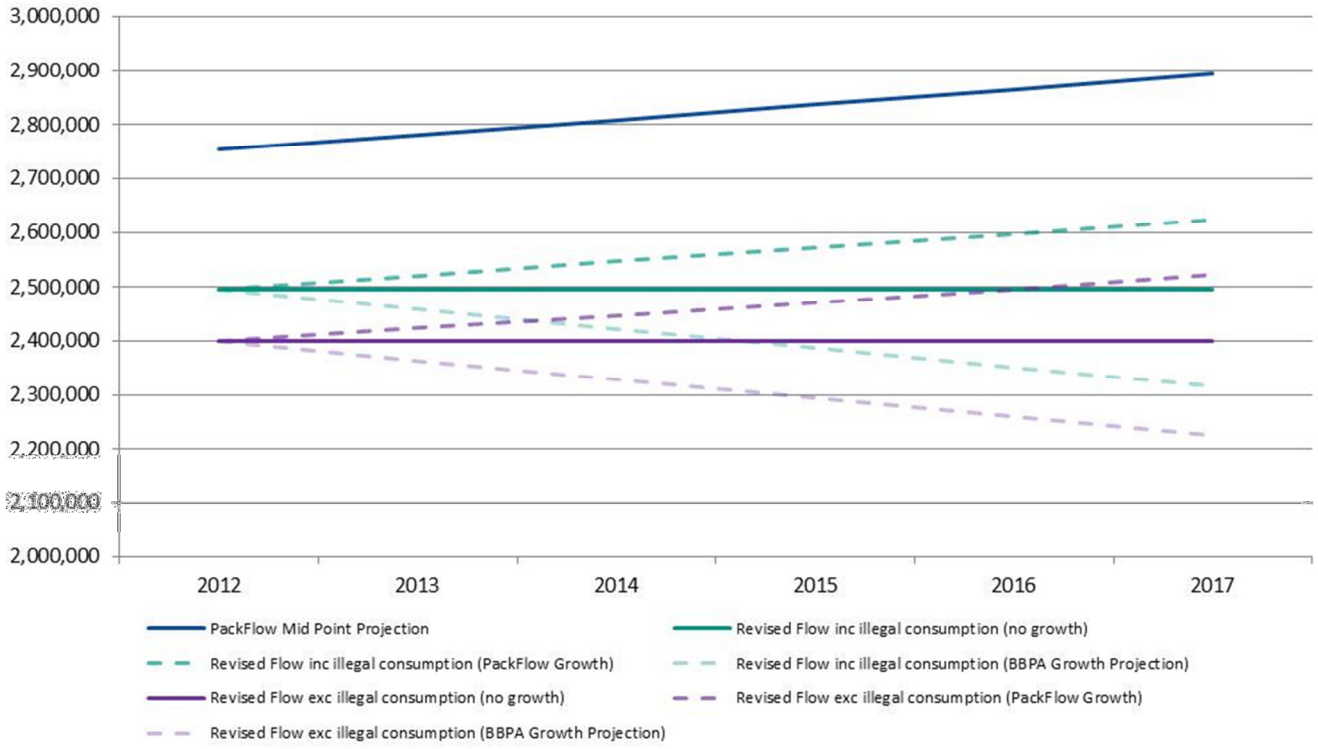
	Excluding Illegal Imports	Including Illegal Imports
Revised Consumption	2,399,235	2,496,332
Packaging Handled by Producers in 2012	2,049,180	2,049,180
Requirement to meet 60% EU target	1,439,541	1,497,799
Minimum Business Target	70%	73%

Scenarios for Future Glass Consumption in the UK

Stemming from the revised flow figure established above, a range of projections for the UK for the period 2013 to 2017, starting from the GlassFlow 2012 estimate, were calculated (as shown in Figure ES4). It is assumed that there is no growth in consumption of glass packaging in the UK between 2013 and 2017 (this was the case between 2008 and 2012 and further period of flat growth is deemed possible by the trade associations engaged for the GlassFlow project). Additionally, ranges were estimated using the PackFlow 1% growth figure as a high flow, and the British Beer and Pub Association (BBPA) provided an alternative scenario of reduced growth as a low flow. In all cases the gap between the revised flow and the PackFlow flow will increase every year or stay at the same level.

[4] See government guidance on criteria defining obligated businesses https://www.gov.uk/packaging-waste-producer-supplier-responsibilities/overview

Figure ES4: Scenarios for Future UK Packaging Glass Consumption in the UK (T)



Other key findings from the GlassFlow project are discussed below.

Increase in Co-mingled Glass Collections

The proportion of local authority glass being collected co-mingled has increased from 27% in 2009/10 to 40% in 2011/12. This means there has been an increase in mixed glass collected in the UK that needs to be colour sorted if it is to be used by the container manufacturing remelt sector. The quality of some of the glass collected co-mingled is also considered to be poor quality by the reprocessors interviewed for this project and as such needs a greater lever of processing to prepare it for end markets.

End of Waste Criteria for Glass

An implication of the introduction of the end of waste criteria (adopted in December 2012 and which came into force in June 2013) will be that it may influence the point in the supply chain where the Packaging Recovery Note (PRN) can be raised. Currently, PRNs for glass cullet going into the remelt sector are issued by the organisation undertaking the remelt activity. The end of waste criteria for glass cullet may lead to the issuing of PRNs at an earlier point in the recycling chain, which means that potentially a greater amount of revenue from PRNs may be generated at the glass recycling/reprocessing stage, which is more central in the supply chain and may help glass recyclers/reprocessors invest more in the collection and treatment of glass for recycling.

In order to comply with the end of waste criteria for glass, a new producer must be independently assessed and certified by a Conformity Assessment Body (CAB) to ensure they comply with the end of waste regulation on glass. CABs are accredited by the United Kingdom Accreditation Service (UKAS). At the time of writing, the EA indicated that no CAB had completed the accreditation process, however they were progressing some applications. Therefore, it is not expected this will impact the industry until 2014.

PRN/PERN spending increases for infrastructure and capacity

The way in which PRN revenue is being spent has changed in the last few years. According to figures published on the NPWD website, PRN/PERN spending on infrastructure and capacity for glass packaging recycling has increased from 13% of total spend in 2008 to 17% in 2012. This may be due to an increase in investment in new equipment to process glass, which is increasingly being collected co-mingled.

Also, due to the high PRN/PERN prices experienced in 2012, PRN/PERN spending increased from £14.1M in 2011 to £44.7M in 2012 representing a threefold increase.

Cullet cost effective in glass manufacturing process

There can be significant cost savings from using recycled glass cullet compared to virgin batch materials in the glass packaging manufacturing process. By including the potential savings from energy, the Climate Change Levy and carbon emissions, using glass cullet in the production of glass can potentially save container glass manufacturers between £19 - £26 per tonne for clear glass and £21 - £34 for green glass.

Fraudulent Issue of PRNs

It was estimated, due to fraud, that between 2009 and 2010 the UK overstated its glass recycling by 100k to 200k tonnes. Therefore, in 2011 and 2012 this reported recycling tonnage would have dropped out of the system. It is also important to note that this is likely to be a low estimation of the level of fraud in the system as this figure only relates to the fraud that has actually been uncovered. Additionally, if other organisations are committing fraud following the outcome of the Nationwide Recycling Ltd case, it is possible that they may now be more inclined to reduce/stop any fraudulent activities. As a result, the amount of fraudulent reporting of glass recycling in the UK could be reducing.

Data Uncertainty

The data used in this report to estimate packaging glass consumption has been appropriately referenced throughout and cross checked with alternative sources where available. Potential error margins around the estimates are acknowledged, particularly concerning the split between consumer and non-consumer consumption of glass packaging. However, while not possible to quantify fully, the error margin in the estimate of total glass packaging consumption will be smaller than that in the split between consumer and non-consumer. Throughout the project a steering group of key stakeholders was consulted to review the research and guide the choice of methodology and data sources. All data used in this report was deemed reliable, robust and the best available, accordingly the estimates of packaging glass are as accurate and robust as possible notwithstanding the data limitations. Key uncertainties discussed in the main body of the report include: a lack of alternative data sources for meaningful sense-checks; the impact of using scale factors to gross up sample data; and difficulties in producing reliable estimates of illegal imports of alcohol and the associated glass packaging.

Table of Contents

1. Introduction **1**

1.1 Background 1

1.2 Objectives 3

2. Glass Packaging Supply Chain **4**

2.1 Introduction 4

2.2 Supply Chain Map 4

3. Glass Packaging Consumption **12**

3.1 Introduction 12

3.2 Consumption Methodology 12

3.3 Results 25

4. Collection of Glass **26**

4.1 Introduction 26

4.2 Collection Methodology 26

4.3 Results 28

5. MRF Sortation and UK Capacity **31**

5.1 Introduction 31

5.2 MRF UK 31

6. Reprocessing **32**

7. Cullet Imports **33**

7.1 Introduction 33

8. UK End Markets **34**

8.1 Introduction 34

8.2 Remelt 34

8.3 Non Remelt 36

8.4 Export 36

9. Model Outputs **37**

9.1 Introduction 37

9.2 Output 37

10. Stakeholder Engagement **40**

10.1 Introduction 40

10.2 General Background 40

10.3 Trends 40

10.4 Recycling Targets 41

10.5 Specific Issues for the Future 42
10.6 End of Waste Criteria 42
10.7 Support from Government 42
11. Key Market Issues 43
11.1 Introduction 43
11.2 Reduced Consumption 43
11.3 Increase in Co-mingled Collections 48
11.4 Recycled Content 49
11.5 End of Waste Criteria 50
11.6 Batch v Cullet 51
11.7 PRN Spend 54
11.8 Fraud 55
12. Scenario Development 57
12.1 Introduction 57
12.2 Baseline Projections 57
12.3 Reduced Consumption 59
12.4 Increased Co-mingled Collections 61
13. National Breakdown: Scotland & Wales 63
13.1 Introduction 63
13.2 Country Split Methodology 63
13.3 Scotland 67
13.4 Wales 74
14. Conclusions 80
14.1 Reduced Consumption 80
14.2 Increase in Co-mingled Collection 80
14.3 End of Waste Criteria for Glass 81
14.4 PRN Investment 81
14.5 Cullet vs. Batch Materials 81
14.6 Fraud 82
14.7 Projections 82

Appendices

Appendix I Production Data Cross Reference
Appendix II Exports (empty) Cross Reference
Appendix III Exports (filled) Cross Reference
Appendix IV Imports (empty) Cross Reference
Appendix V Obligated Imports (filled) Cross Reference
Appendix VI Consumption Cross Reference
Appendix VII UK Accredited Reprocessors and Exporters
Appendix VIII Model Outputs
Appendix IX Questionnaire
Appendix X Autoregression

Figures

Figure 1 2012 – PRN Price (£) per tonne of Glass 1
Figure 2 Glass Packaging Supply Chain Map 5
Figure 3 British Glass - UK Glass Container Production 2008 – 2012 (T) 13
Figure 4 British Glass – UK Exports (empty) 2008 – 2012 (T) 13
Figure 5 National Packaging Waste Database – UK Exports (filled) 2008 – 2012 (T) 14
Figure 6 National Packaging Waste Database – UK Exports (filled) 2008 – 2012 (T) with Uplift 14
Figure 7 British Glass – Imports (empty) 2008 – 2012 (T) 14
Figure 8 National Packaging Waste Database – Filled Imports (T) 15
Figure 9 Obligated Tonnage 2008 – 2012 (T) 16
Figure 10 Unobligated / Unregistered Imports 2008 – 2012 (T) 16
Figure 11 Cross Border Shopping 2012 17
Figure 12 Cross Border Shopping 2008 – 2012 (T of glass packaging) 17
Figure 13 UK Grocery Retailing Glass Packaging Sales 2011-2012 (T) 19
Figure 14 Total Consumer Glass Packaging 2011-2012 (T) 20
Figure 15 Beer, Spirit and Wine Consumer Glass Packaging Breakdown 2011-2012 (T) 20
Figure 16 Consumer Glass packaging Consumption Associated with Legal v Illegal Alcohol Sales (T) 21
Figure 17 Legal Glass Packaging Consumption 2008 – 2012 (T) 21
Figure 18 Legal Glass Packaging Consumption 2008 – 2012 (T) 22
Figure 19 Legal Non-Consumer Glass Packaging Consumption - Alcohol Breakdown 2011 – 2012 (T) 22
Figure 20 Legal v Illegal Alcoholic Non-Consumer Glass Packaging 2011 – 2012 (T) 22
Figure 21 Legal v Illegal Alcoholic Glass Packaging 2008 – 2012 (T) 23
Figure 22 Glass Packaging Consumption 2008 – 2012 (T) 24
Figure 23 Glass Packaging Consumption (Consumer v Non-Consumer) 2008 – 2012 (T) 24
Figure 24 UK Glass Consumption (T) Excluding and Including Illegal Imports 25
Figure 25 Local Authority Glass Collections (T) 27
Figure 26 C&I Glass Collections (T) 27
Figure 27 Local Authority Glass Collected at Kerbside (T) – 2011/12 28
Figure 28 Local Authority Glass Collected at Bring Sites (T) – 2011/12 28
Figure 29 Local Authority Glass Collected at CA Sites (T) – 2011/12 29
Figure 30 UK C&I Collections (T) 29
Figure 31 Summary of UK Glass Collections (T) 29
Figure 32 UK Recycling Rate 2012 – PackFlow and Revised 30
Figure 33 Cullet Imports 2011 – 2012 (T) 33
Figure 34 Remelt 2009 – 2012 (T) 34
Figure 35 Remelt 2009 – 2012 (T) 35

Figure 36 Remelt Container Manufacturing Cullet Use by Colour 35
Figure 37 Non Remelt Proportions 36
Figure 38 Glass Exports 2009 - 2012 (T) 36
Figure 39 Model – UK Compliance 38
Figure 40 PackFlow v Revised Flow 2008 – 2012 (T) 44
Figure 41 PackFlow v Revised Flow 2013 – 2017 (T) 45
Figure 42 Revised Performance v EU Directive Target (60%) (T) 45
Figure 43 Revised Performance (inluding illegal imports) v EU Directive Target (60%) (T) 45
Figure 44 Revised Performance v Obligated Business Target (81%) (T) 46
Figure 45 Revised Performance Total Flow v Obligated Flow (exc illegal imports) Illustration 46
Figure 46 Proportion of Total Flow that is Unobligated 47
Figure 47 Local Authority Glass Collected by Collection Method 48
Figure 48 Format of Local Authority Glass Collected 49
Figure 49 2012 Quantity of Waste Accepted by Reprocessors 51
Figure 50 Batch Costs for Virgin Glass 52
Figure 51 Glass Cullet Production Costs 53
Figure 52 Glass Production Costs 54
Figure 53 PRN Revenue Spend (2012) 54
Figure 54 PRN Fraud 2009 – 2010 55
Figure 55 PackFlow Consumption Projections (T) 57
Figure 56 Collection Projections 1998 – 2017 (T) 58
Figure 57 Baseline Projections Recycling Rates (T) 58
Figure 58 Consumption Projections 2013-2017 (T) 59
Figure 59 Consumption Projections Recycling Rates 60
Figure 60 Collection Proportions 2009/10 – 2011/12 61
Figure 61 Collection Proportions 2009/10 - 2017 62
Figure 62 Increased Co-mingled Collections (T) 62
Figure 63 UK Household Projections 2013-2033 (thousand households) 63
Figure 64 Regional Sales Volume Of Alcoholic Drinks 2011 (UK Off Trade) 64
Figure 65 Weighted Regional Breakdown of Alcoholic Sales 64
Figure 66 Food & Beverage Service Activities Breakdown 65
Figure 67 Weighted Food & Beverage Service Activities Breakdown 65
Figure 68 UK License Numbers 66
Figure 69 Scotland Glass Consumption (T) Excluding and Including Illegal Imports 67
Figure 70 Scottish Local Authority Glass Collected at Kerbside (T) 68
Figure 71 Scottish Local Authority Glass Collected at Bring Sites (T) 68
Figure 72 Scottish Local Authority Glass Collected at CA Sites (T) 68
Figure 73 Scotland C&I Collections (T) 69
Figure 74 Summary of Scottish Glass Collections (T) 69
Figure 75 Scotland Recycling Rate 2012 69
Figure 76 MRFs Scotland 70
Figure 77 Accredited Reprocessors and Exporters - Scotland 71
Figure 78 Scottish End Markets 72
Figure 79 Model – Scotland Compliance 73
Figure 80 Wales Glass Consumption (T) Excluding and Including Illegal Imports 74
Figure 81 Welsh Local Authority Glass Collected at Kerbside (T) 75
Figure 82 Welsh Local Authority Glass Collected at Bring Sites (T) 75
Figure 83 Welsh Local Authority Glass Collected at CA Sites (T) 76
Figure 84 Wales C&I Collections (T) 76
Figure 85 Summary of Welsh Glass Collections (T) 76
Figure 86 Welsh Recycling Rate 2012 77
Figure 87 MRFs Wales 77

Figure 88 Accredited Reprocessors and Exporters – Wales 78
Figure 89 Welsh End Markets 78
Figure 90 Model – Wales Compliance 79
Figure 91 Prodcom - UK Glass Container Production 2008 – 2011 84
Figure 92 National Packaging Waste Database - UK Glass Container Production 2008 – 2012 (T) 84
Figure 93 UK Glass Container Production 2008 – 2012 (T) 85
Figure 94 National Packaging Waste Database – UK Exports (empty) 2008 – 2012 (T) 87
Figure 95 UK Exports (empty) 2008 – 2012 87
Figure 96 HMRC – Beverage Exports 2008 – 2012 (T) 88
Figure 97 British Glass – UK Exports (filled) 2008 – 2012 (T) 90
Figure 98 UK Exports (filled) 2008 – 2012 90
Figure 99 HMRC – Beverage Exports 2008 – 2012 (T) 90
Figure 100 National Packaging Waste Database – Imports (empty) 2008 – 2012 (T) 92
Figure 101 Imports (empty) 2008 – 2012 (T) 92
Figure 102 HMRC – Beverage Imports 2008 – 2012 (T) 94
Figure 103 National Packaging Waste Database – Plastic, Steel & Aluminium Imports 2008 – 2012 (T) 94
Figure 104 Office of National Statistics – Retail Sales of Alcohol 96
Figure 105 Valpak Data Soultions – Retail Sales of Alcohol in Glass Packaging 96
Figure 106 Alcohol Sales Against 2009 Baseline 97
Figure 107 Accredited Reprocessors and Exporters 99
Figure 108 Model – UK Consumption 102
Figure 109 Model – Scotland Consumption 103
Figure 110 Model – Wales Consumption 104
Figure 111 Model – UK Collection 106
Figure 112 Model – Scotland Collection 107
Figure 113 Model – Wales Collection 108
Figure 114 Model – UK Collection Destination 109
Figure 115 Model – UK MRF Sortation 110
Figure 116 Model – UK Glass Recycler/Reprocessor Input 111
Figure 117 Model – UK Glass Recycler/Reprocessor Output 112
Figure 118 Model – UK Import 113
Figure 119 Model – UK Remelt (Container) 113
Figure 120 Model – UK Remelt (Fibreglass) 114
Figure 121 Model – UK Filtration 114
Figure 122 Model – UK Shotblasting 115
Figure 123 Model – UK Aggregates 115
Figure 124 Model – UK Export 116

Acknowledgements

Valpak and the Waste and Resources Action Programme (WRAP) would like to thank the following organisations for their contribution to the GlassFlow 2012 project:

- Advisory Committee on Packaging;
- British Beer & Pub Association;
- British Glass;
- British Retail Consortium;
- British Soft Drinks Association;
- Defra;
- Environment Agency;
- Food and Drink Federation;
- Scotch Whisky Association;
- Wastepack Ltd; and
- Wine & Spirit Trade Association.

Disclaimer

Whilst Valpak Ltd and WRAP have tried to make sure this report is accurate, we cannot accept responsibility or be held legally responsible for any loss or damage arising out of or in connection with this information being inaccurate, incomplete or misleading. This material is copyrighted. You can copy it free of charge as long as the material re-produced is accurate and is not used in a misleading context. You must identify the source of the material and acknowledge our copyright. You must not use material to endorse or suggest we have endorsed a commercial product or service. For more details please see terms and conditions on the WRAP website at www.wrap.org.uk.

Glossary

Batch – The raw materials mixture for glass manufacturing
CCL – Climate Change Levy
C&I – Commercial & Industrial
Consumer Packaging – Packaging consumed in the household
Cullet – Crushed glass prepared for use in the glass manufacturing process
DCLG – Department for Communities and Local Government
EA – Environment Agency
EPIC – Environmental Product Information Centre
Glass Recycler / Reprocessor – Organisation which processes glass to prepare it for end markets such as remelt (container and fibreglass manufacturing), filtration, shotblasting, aggregates and export
HMRC – Her Majesty's Revenue and Customs
k – Thousand
LA – Local Authority
M – Million
MRF – Materials Recovery Facility
Non-consumer Packaging – Packaging consumed in the commercial/industrial sector (away from home or on the go in hotels, bars, restaurants and businesses
NPWD – National Packaging Waste Database
Off-trade – Sold in off-licences, corner shops, retailers, wholesalers and cash & carry
ONS – Office of National Statistics
On-trade – Sold in pubs, clubs, hotels, and restaurants
PERN – Packaging Export Recovery Note
PRN – Packaging Recovery Note
RTP – Returnable Transit Packaging
VDS – Valpak Data Solutions
WDF – WasteDataFlow
WRAP – Waste and Resources Action Programme
ZWS – Zero Waste Scotland

1. Introduction

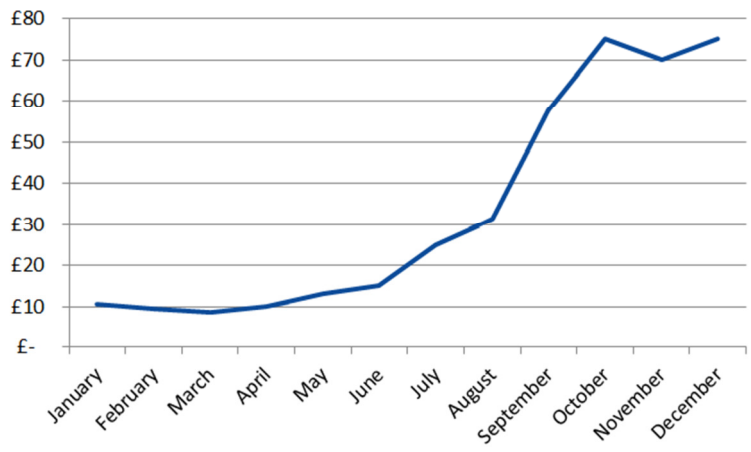
1.1 Background

The GlassFlow project was set up to review the flow of glass through the UK supply chain and investigate the key risks to the UK meeting its glass recycling targets. The compliance risks are due to several factors, which are discussed in turn below. Within the UK, the glass packaging recycling industry is subject to a variety of regulatory and market dynamics that can affect the quantity and quality of glass collected.

In December 2011, Defra released a consultation seeking views on proposals for extending packaging recovery and recycling targets for the period 2013 to 2017. The outcome of this was that glass recycling targets for obligated businesses were to remain at 81% until 2017; however, an additional outcome was the introduction of split targets for glass recycling. This means that from 2013, 63% of glass recycling will need to come from remelt end markets, rising to 64% in 2016[5].

In 2012, the UK experienced a lot of volatility in the glass recycling sector. Based on a PackFlow[6] mid-point, the UK was required to recycle 1,652k tonnes to meet the EU directive target of 60% in 2012. However, with low quantities of glass being accepted for domestic or overseas reprocessing in Q1 (363k tonnes), Q2 (351k tonnes) and then Q3 (351k tonnes)[7], there was significant pressure on the market to increase glass recycling in the last quarter. This subsequently put in doubt whether UK producers would meet their obligation in 2012 and in turn put pressure on the PRN market, which saw prices rise from £9 - £12 per tonne in January 2012 to £75 in October, and staying more or less at this level for the rest of 2012, as shown in **Figure 1**.

Figure 1 2012 – PRN Price (£) per tonne of Glass[8]



[5] https://www.gov.uk/government/policies/reducing-and-managing-waste/supporting-pages/packaging-waste-producer-responsibility-regimes, Accessed (12 / 06 / 13)

[6] http://www.valpak.co.uk/Libraries/Environmental_Consulting_Documents/PackFlow_2017_Final_Report_09_11_12.sflb.ashx, Accessed (23 / 07 / 13)

[7] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (23 / 07 / 13)

[8] http://www.letsrecycle.com/prices/prn/prns-prices-archive/prices?subCategory=2012, Accessed (23 / 07 / 13)

In the last quarter of the year, the UK recycled 562k tonnes[9], which, based on the PackFlow mid-point would indicate the UK achieved a 59% recycling rate for 2012, meaning that it failed to achieve its EU glass recycling target.

It was speculated that the relatively large quarter four glass recycling figures were in part due to stockpiled material being put through the system, which may have required a high PRN price to pay for the processing of poor quality glass. This means that stocks of glass may be lower in 2013 and as such the UK may not be able to rely on this going forward to the same extent to meet targets.

Also, in 2012 producers had a surplus carry over from 2011 of 57k tonnes. The total glass packaging handled was 2,049,180 and the total glass recycling including carry over was 1,665,387[10], which equates to an obligated business recycling rate of 81%. The carryover from 2012 into 2013, however, is down to just 17k tonnes[11]. This means that although the packaging recovery and recycling business targets for glass are to remain flat at 81% for the period 2013 to 2017, it could be more challenging to meet the recycling target for 2013.

The GlassFlow project was set up to review the flow of recycled glass through the UK supply chain and investigate the key risks to the UK meeting its targets. The project was set up to identify as accurately as possible a method for identifying the quantity of packaging glass flowing on and off the UK market.

The project also aimed to investigate whether the UK would meet its recycling targets in 2013 and for subsequent years until 2017. At the time of writing, in 2013, the UK has recycled and recovered 337k tonnes (Q1) and 410k tonnes (Q2) giving a total figure of 747k tonnes for the first half of the year. This means the UK has achieved 47% of the projected total obligated target of 1,584k tonnes for 2013[12].

Other key issues affecting the glass recycling industry were also investigated. These included the introduction of split targets for remelt/non-remelt, the introduction of the end of waste criteria for glass and the increase in co-mingled glass collections. In recent years, the UK has witnessed an increase in the number of local authorities collecting glass in co-mingled collections. This means that there has been an increase in mixed glass collected in the UK that needs to be colour sorted if it is to be used by the container manufacturing remelt sector. The quality of some of the glass collected co-mingled is also considered to be poor by the reprocessors interviewed for this project, and as such, needs a greater lever of processing to clean it up for end markets.

The UK's ability to meet its glass recycling targets could also be influenced by recycling infrastructure going offline. The changing condition of glass being collected in the UK means that glass recyclers increasingly have to invest in new technologies to process the glass. However, the installation of new equipment can often mean a facility being closed to allow for the new equipment to be installed. An example of this is the new £9M investment by Berrymans to upgrade its colour sorting equipment, which means that section of the facility may be closed for up to ten weeks[13]. This, plus any further delays in getting the new technology online, could increase pressure on achieving compliance in 2013.

All these factors have highlighted the risks the UK faces in meeting its current and future glass packaging recycling targets. The GlassFlow project was set up to investigate these issues and assess the UK's ability to meet its glass recycling targets.

[9] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (23 / 07 / 13)
[10] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (30 / 07 / 13)
[11] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (23 / 07 / 13)
[12] http://npwd.environment-agency.gov.uk/Public/PublicDEFRAReport.aspx, Accessed (24 / 07 / 13)
[13] http://www.letsrecycle.com/news/latest-news/glass/berryman-to-invest-ps9m-in-glass-recycling-sites, Accessed (23 / 04 / 13)

1.2 Objectives

The GlassFlow project had the following key objectives:

- Assess the total quantity of glass packaging (broken down by colour) being placed onto the UK, Scottish and Welsh markets;
- Assess the quantity of glass packaging being collected in the UK, Scotland and Wales;
- Assess the quantity of glass PRNs and PERNs issued against the quantities of glass being collected in 2012 and historically;
- Estimate consumption and collection quantities of glass packaging until 2017 for the UK, Scotland and Wales;
- Highlight potential steps that need to be taken in order to potential compliance gaps;
- Conduct a stakeholder engagement exercise to identify end market issues and future trends within the UK, Scottish and Welsh markets; and
- Conduct wider market analysis of the glass industry to improve market transparency for glass recovery and recycling.

2. Glass Packaging Supply Chain

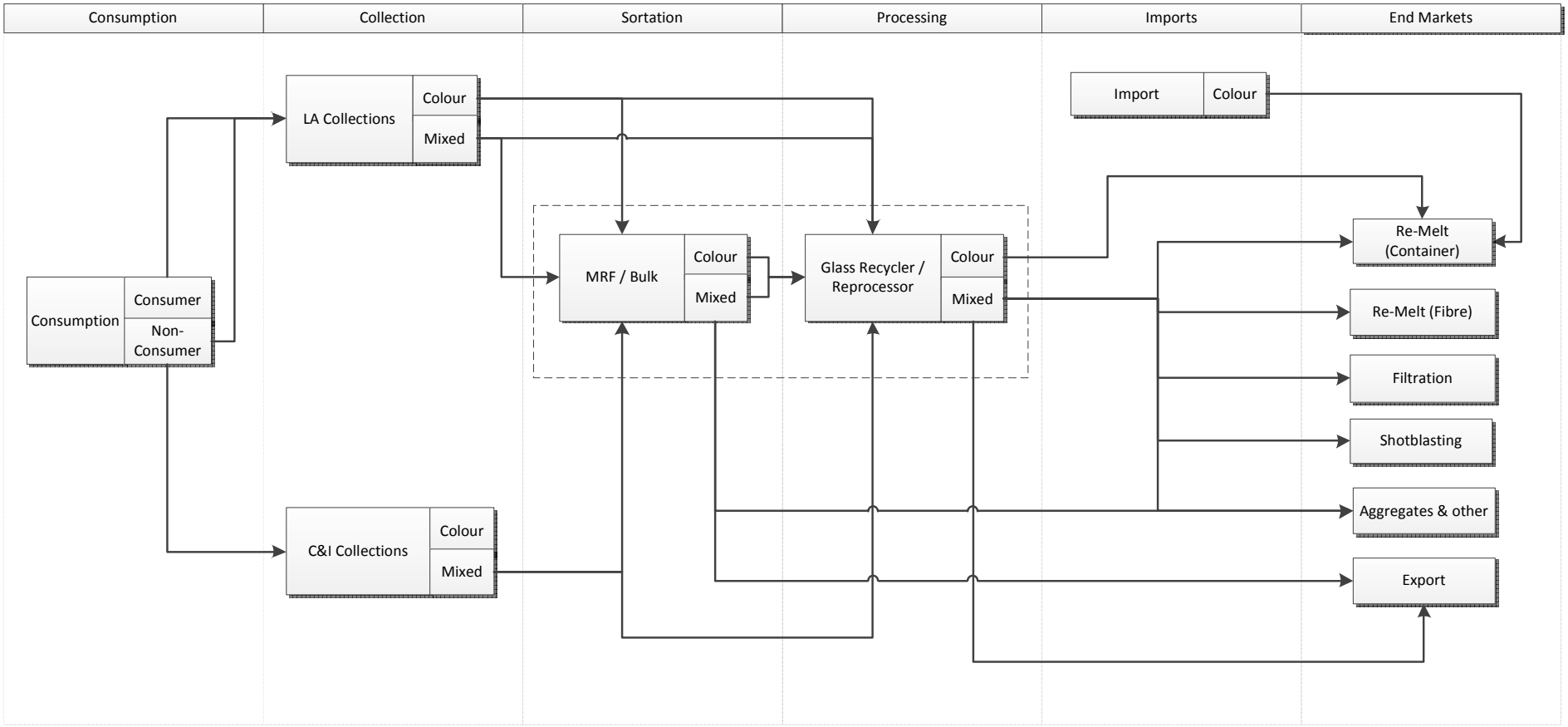
2.1 Introduction

This section of the report provides an overview of how glass packaging flows on and off the UK market through consumption, collection, sortation and reprocessing to final end market destination. This section is important in setting the scene for the development of the GlassFlow model and outlines the structure used. Each stage of the supply chain map and data sources used in the model is detailed later in the report.

2.2 Supply Chain Map

A map of the glass packaging supply chain is provided in **Figure 2**. This is accompanied by a brief summary of each stage to explain the function of each section of the supply chain map.

Figure 2 Glass Packaging Supply Chain Map



Consumption

Consumption refers to the flow of glass onto the UK market. Consumption of goods using glass as packaging can occur both domestically (in the home) and in the commercial/industrial sector (in hotels, bars, restaurants and businesses), both of which will generate waste packaging glass.

Glass packaging typically enters the market in the form of bottles (for wine, beer and spirits etc.) and jars (foods and sauces etc.). Glass packaging is predominantly manufactured in three colours: green, amber and flint (clear). Other colours of packaging glass are also manufactured; however, these are typically in smaller quantities.

Glass packaging can also enter the UK marketplace in the form of 'grey glass', which is a term used to describe glass that has been brought into the UK illegally or glass that is not accounted for in any regulatory targets or reporting. It is difficult to quantify the glass entering the UK in this way as it is not regulated.

Collection

The next stage in the supply chain once waste glass is generated from consumption is its collection. When waste glass is generated, it is either collected within the general waste stream and sent for disposal (typically landfill) or is collected for recycling, which is the key focus of this study.

Waste glass for recycling is typically collected by local authorities (LAs), private organisations or the third sector (although this is on a smaller scale and often conducted on behalf of a local authority). This is often dependent upon the source of glass and local contractual arrangements.

There are several factors which affect the collection of waste glass such as the type of glass, source, collection method and end market. Waste glass is typically collected:

- **Separately (from other dry recyclate):**
    - **Colour segregated**: each colour of glass is collected individually, which can be beneficial for some end markets such as the remelt sector;
    - **Mixed colour**: mixed colour glass can often be collected separately from other dry recyclate materials; however, with it being mixed colour, it may require further sortation to separate the glass by colour, depending on the end market; and
- **Co-mingled**: this is when the glass is collected mixed with other dry recyclate materials such as plastics and metals. Glass collected in this way requires sortation to separate it from the other dry recyclate materials. Once separated from the other materials, the glass will still be mixed colour and depending on the end market may need further sortation to separate the glass by colour.

The majority of waste glass in the UK is typically collected by local authorities and private waste management/recycling organisations.

Local Authority Collections

A local authority (LA) will principally collect waste glass from the householder/public. They typically collect glass from three main sources:

- Kerbside;
- Bring Banks; and
- Household Waste Recycling Centres (HWRCs).

There are advantages and disadvantages to each collection source. Glass collected at kerbside can either be collected separately or co-mingled with other dry recyclate materials such as plastic bottles or metal cans. Where glass is collected co-mingled it can be sorted at kerbside; however, this can be time consuming, costly and has implications on void space within the collection vehicle. It can also be sorted at a Materials Recovery Facility (MRF). Unless the glass is colour sorted at this stage it will enter the MRF/bulking facility or recyclers reprocessors as mixed glass.

Bring sites can be a good way of collecting large volumes of colour segregated glass, and they are generally considered less expensive than kerbside collections due to the collector being able to collect a larger quantity of glass from a single source. HWRCs offer the same benefits as bring sites.

Many private waste management/recycling organisations also carry out the collection of glass on behalf of local authorities.

Once the glass is collected (depending on which type of organisation is collecting the glass and local contractual agreements), it will be taken to one of the following stages of the supply chain:

- MRF/Bulking Point; or
- Glass Recycler/Reprocessor.

Commercial & Industrial (C&I) Collections

The collection of glass from commercial and industrial sources is typically performed by private waste management/recycling organisations. The glass is collected from premises such as hotels, restaurants, bars and offices. Due to space restrictions on site, the glass is predominantly collected mixed colour from these sources.

Some LAs also collect glass from C&I sources; however, this is on a smaller scale to the glass collected from kerbside, bring and HWRCs. Some C&I glass may end up in the LA collection infrastructure due to some small businesses using the collection network of bring banks/HWRCs for the recycling of their C&I waste glass.

Once the glass is collected, it is typically taken to:

- MRF/Bulking Facility; or
- Glass Recycler/Reprocessor.

Materials Recovery Facility (MRF)/Bulking Facility

One of the next steps in the supply chain following the collection of waste glass is the MRF/bulking stage.

At an MRF/bulking facility, glass is typically sorted from other co-mingled recyclate materials such as plastics and metals (if collected co-mingled) and then stored and bulked until a sufficient quantity is achieved, at which point it will be transported to the next stage. The glass output from this process is typically mixed colour glass.

If the waste glass has been collected separately, the glass will normally still be taken to an MRF/bulking facility; however, it does not need to be processed through the MRF sortation facility, but rather it is purely taken to the facility for storing and bulking.

Once the glass leaves this stage of the supply chain it is typically sent to a glass recycler/reprocessor for further processing or will be sent direct to end markets, such as aggregates or export.

Glass Recycle/Reprocessor

Once glass has been collected it will either be taken directly to the glass recycler/reprocessor or will be bulked (and potentially sorted from other dry recyclate) at an MRF. It will then be taken directly to an end market such as aggregates or export; however, the majority will end up being taken to a glass recycler/reprocessor for further processing.

At a glass recycler/reprocessor, glass is typically crushed (reduced in size), contaminants removed (such as metals, plastics and paper) and then graded by size and quality. The glass may also be sorted by colour at this stage. The glass recycler/reprocessor essentially processes glass to supply a variety of end markets such as remelt (container and fibreglass manufacturing), filtration, shotblasting, aggregates and export.

This has traditionally been the point in the supply chain where only an 'accredited reprocessor' could issue Packaging Recovery Notes (PRNs) when supplying glass into non-remelt end markets. However, with the introduction of the European Union's 'End of Waste' criteria being adopted for glass, if glass cullet is produced and is of a quality suitable for remelt (container and fibreglass manufacturing), then the PRN can be raised at this point. The criteria places limits on the amount of contaminants such as metals, organics and stones that can be found in glass cullet in order for it to be classed as a secondary raw material[14]. This may have an impact on the section of the glass supply chain at which the PRN/PERN is raised.

Import

Glass cullet can also enter the UK supply chain through imports of cullet, which is brought into the UK to supplement glass that is collected in the UK to meet the demand from the remelt sector for specific colours of glass, such as flint and green, depending on supply and demand. This glass is typically transported directly to the remelt organisations on its arrival in the UK.

Remelt (Container Manufacturing)

The largest end market for waste glass in the UK is remelt (glass container and fibreglass manufacturing), with the glass container manufacturing sector being the larger of the two (78%). In order to manufacture glass containers, the glass is typically sourced from MRFs (LA and private owned), glass recyclers/reprocessors or imports.

[14] http://ec.europa.eu/dgs/jrc/index.cfm?id=1410&dt_code=NWS&obj_id=15880&ori=RSS, Accessed (23/04/13)

By the time the glass reaches this end market it is processed and colour sorted to meet the end market specification. However, it should be noted that some remelt organisations also have treatment/colour sortation facilities and as such can refine the glass to meet their specification.

Once the glass meets the specification suitable for the container manufacturers, the glass is fed into furnaces to make new glass products. Glass can be recycled in this way many times without any loss in quality, and as such, this end market represents a 'closed-loop' recycling option for recycling packaging glass.

One issue in the UK for recycling glass into this end market is the colour imbalance between the colour of filled glass bottles imported into the UK (mostly green and amber glass from wine and beer bottles) and the glass which is principally manufactured in the UK (mostly clear glass for whisky and food containers). British Glass has indicated that this trend is reducing because some products that were historically filled in green/amber glass are now being imported (or subsequently filled) in clear glass in the UK. However, there is still an imbalance, and as such, some remelt organisations continue to import glass cullet into the UK.

Remelt (Fibreglass)

Fibreglass is another remelt end market following the glass recycler/reprocessor stage of the supply chain. The main fibreglass application that uses recycled glass is building insulation fiberglass. It is estimated that approximately half the raw materials in the fiberglass manufacturing process could be replaced with recycled glass, which reduces the need for quarried virgin materials.

Fibreglass manufacturers typically source glass cullet that has the least amount of contamination. The fibreglass production process relies largely on technologies that are sensitive to contamination and work in a similar way to a wool bobbin. The molten glass flows from the furnace (temperature ~1550ºC) and the fibres are spun out of small holes which are then wound. When contamination is present, it can block the holes from which the fibres are spun and can subsequently close the plant for several days for cleaning, which can be costly to the facility. Due to these factors, the industry has typically used flat glass, which is known for containing fewer contaminants than packaging glass. However, in recent years, the PRN value, coupled with advances in processing technology, has increased the desirability of using glass packaging in this application. This end market also has the flexibility to utilise any colour of glass.

Filtration

Another end market following the glass recycler/reprocessor stage of the supply chain is for glass to be used as a filtration media. This end market requires glass to be processed to a very strict specification and as such would always need to follow the glass recycler/reprocessor stage of the supply chain.

Glass can be utilised in filtration systems as a direct replacement for filtration sand without any modification to equipment. Filtration applications that could use glass include:

- Drinking Water;
- Sewage Treatment;
- Aquariums;
- Aquaculture;
- Swimming Pools; and
- Industrial Water.

Shotblasting

Shotblasting is another end market following the glass recycler/reprocessor stage of the supply chain. Similar to filtration, this end market requires glass to be processed to a strict specification and as such would also need to follow on from the glass recycler/reprocessor stage of the supply chain.

The shotblasting industry has traditionally used materials such as steel shot, metal slag and silica sand. However, increasing environmental pressures, coupled with health and safety legislation, has meant the industry has had to evolve and start to use more environmentally sustainable shot blast media than those traditionally used. Shotblasting was one of the first alternative markets to be developed for recycled glass in the UK.

Aggregates and Other

Aggregates are another end market following the glass recycler/reprocessor stage of the supply chain. However, the processing of glass can also be performed at this stage of the supply chain by aggregates producers, and as such, they can also source glass directly from C&I or LA collections.

Traditionally, with limited end markets for mixed glass in the UK, there has been a significant rise in the use of recycled glass as an aggregate. Glass can be used in the following aggregate applications:

- Fill Materials;
- Highway Construction;
- Concrete Applications;
- Decorative Aggregates; and
- Fluxing Agent.

The main benefit of using glass as an aggregate is that it is not colour specific and as such can accept mixed colour glass. However, some decorative applications may require particular colours of glass.

Although the value of glass in construction applications is low, the PRN value for recycling packaging glass has traditionally generated extra revenue that can be used to subsidise the use of recycled glass in this application. With the introduction of the Government's split target for glass that stipulates 63% of the glass recycling/recovery target must come from remelt, rising to 64% in 2016[15], going forward, a greater proportion of PRNs will be generated from remelt than aggregates. This will limit the proportion of glass being used in this end market going forward with a greater proportion ending up in remelt end markets.

Export

Glass collected in the UK can also be exported. The glass is typically mixed colour and is exported to remelt end markets. Export becomes viable when the value offered from export markets is greater than that offered in the UK.

The proportion of recovered packaging glass that was exported rose between 2000 and 2009, but after that fell before rising again (22% was exported in 2009, 16% in 2010, 17% in 2011 and 19% in 2012 – based on EA data). British Glass believe the increase in exports has been due to several factors including

[15] https://www.gov.uk/government/policies/reducing-and-managing-waste/supporting-pages/packaging-waste-producer-responsibility-regimes, Accessed (23 / 04 / 13)

the pound to euro exchange rate, convenience of not requiring processing, the increase in co-mingled collection and the high PRN price (at end of 2012).

Glass is also exported due to some glass manufacturing organisations being multi-national, and as such glass can be transferred between facilities to cover internal supply/demand.

3. Glass Packaging Consumption

3.1 Introduction

This section of the report reviews the total glass consumption in the UK in 2012. This is then broken down for Scotland and Wales individually, which is included in a separate section at the end of the report. The consumption is split between consumer and non-consumer; for the purposes of this report consumer is defined as what is consumed at home (if this is alcohol this is termed as 'off-trade') and non-consumer is what is consumed at pubs, clubs, restaurants etc (if this is alcohol this is termed as 'on-trade').

In particular, it is important to note that the report later calculates consumer consumption through grocery sales, such that all glass packaging around groceries counts towards the 'consumer' flow. This method will in effect include goods purchased in supermarkets by some of the smaller pubs, clubs, restaurants, etc. for consumption on their premises.

This section includes a series of sense checks against the data being used; the majority of these are included as appendices.

The packaging recycling targets are currently based on a percentage requirement of what is flowing onto the market: the EU directive is 60% of the total flow. In order to achieve this, companies in the UK that handle over 50 tonnes of packaging annually and have a turnover in excess of £2M are obligated to contribute to this, with a target of 81% of their flow to be recycled[16]. Therefore, the requisite number of PRNs that need to be issued is a direct function of the consumption.

This section first looks at the methodology for calculating the amount of glass packaging flowing onto the market.

3.2 Consumption Methodology

The methodology for calculating the consumption of glass packaging in the UK is:

Total UK glass packaging consumption	=	Total Production	-	Exports (empty)	-	Exports (filled)	+	Imports (empty)	+	Imports (filled)

The following provides a detailed description of how each of these elements is calculated.

3.2.1 Production

The production data was provided by British Glass and is summarised in **Figure 3**. This data was provided by all six glass container manufacturers in the UK, all of which are members of British Glass. They are: Allied Glass Containers, Beatson Clark, Ardagh Glass, Owens-Illinois, Quinn Glass and Stölzle Flaconnage.

[16] The business target of 81% was set up with a buffer against the 60% total recovery target. Therefore, 81% of the business flow will be higher than the 60% of total flow.

Figure 3 British Glass - UK Glass Container Production 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Glass Container Production	2,161,769	2,094,374	2,193,935	2,193,481	2,173,803
% Change from prev. year	N/A	-3%	5%	-0.02%	-1%

This shows that over the period 2008 to 2012, glass container production increased by approximately 1% (or 12k tonnes), with falls in every other year almost offsetting the one year of growth. Within this report the principal period of study is 2008 to 2012 because all sources provide data that refer back to this time period, allowing for a more complete comparison. Appendix I provides information regarding a sense check of this data against Prodcom[17] (Eurostat statistics on the production of manufactured goods) and Environment Agency (EA)[18]. It is important to note that the EA figures for the 2012 consumption are 'live', i.e. they may change until the end of the calendar year when re-submissions are finalised. Therefore when EA data is used the date it was taken is provided, it is not believed the EA data will vary significantly from the figures used in this report.

However, for the purposes of this report, the British Glass data was used as they were provided directly from all six container manufacturers in the UK. It is important to note that what is produced in 2012 is similar to that produced in 2008, suggesting there has been almost no growth in glass packaging production volumes over that period. Although the overall levels of production in 2012 are similar to those in 2008, the proportion of production categories may be different. For instance, it was suggested that there may be more wine bottles produced in the UK, which may have made up for drops in other categories.

3.2.2 Exports (empty)

British Glass also provided empty exports data. The empty exports data was provided by their members; the data is shown in **Figure 4**.

Figure 4 British Glass – UK Exports (empty) 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Exports (empty)	210,553	174,831	209,552	232,915	195,269
% Change from prev. year	N/A	-17%	20%	11%	-16%

There has been an oscillation between positive and negative growth between 2008 and 2012. However, empty exports are down ~15k tonnes in 2012 from 2008. Following cross referencing against NPWD data and HMRC beverage exports (detailed in Appendix II), the British Glass figures were used.

[17] http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/data/tables_excel, Accessed (17 / 06 / 13)
[18] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (19 / 06 / 13)

3.2.3 Exports (filled)

The export filled data was taken from NPWD data table 2b conversion[19]. This data is shown in **Figure 5**.

Figure 5 National Packaging Waste Database – UK Exports (filled) 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Exports (filled) - Table 2b Conversion	707,149	639,619	659,660	718,691	688,378
% Change from prev. year	N/A	-10%	3%	9%	-4%

It was recognised that this figure could exclude glass sourced in the UK that is subsequently exported to Eire; using Valpak member data submissions it was possible to calculate a figure for this. However, this only applies to Valpak members and so is considered a minimum figure. As this was only calculated for 2012, for 2008 – 2011 an estimate was made applying the proportion of the 2012 figures; this is summarised in **Figure 6**.

Figure 6 National Packaging Waste Database – UK Exports (filled) 2008 – 2012 (T) with Uplift

	2008	2009	2010	2011	2012
Table 2b Conversion	707,149	639,619	659,660	718,691	688,378
Excluded EIRE Exports	7,700	6,965	7,183	7,826	7,496
Exports (filled)	714,849	646,584	666,843	726,517	695,874

There is a cross referencing exercise against British Glass figures and HMRC exports (detailed in Appendix III).

3.2.4 Imports (empty)

British Glass also provided data for empty imports from their members. These are shown in **Figure 7**.

Figure 7 British Glass – Imports (empty) 2008 – 2012 (T)

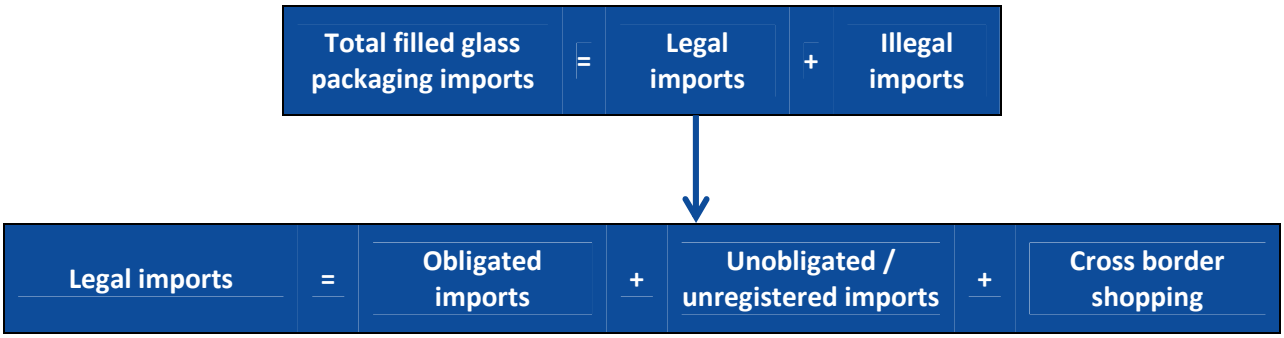
	2008	2009	2010	2011	2012
Imports (empty)	107,553	80,283	117,116	158,159	130,871
% Change from prev. year	N/A	-25%	46%	35%	-17%

There has been an increase of ~23k tonnes from 2008 to 2012; however, there was a drop in 2012 from 2011 of 17%. These figures were also cross referenced against NPWD figures, which are included in Appendix IV.

[19] Only conversion was used as the way the data form is submitted, based on Valpak experience, the numbers for raw material manufactures are the same as conversion and so are not included

3.2.5 Imports (filled)

The filled imports are more complicated to calculate. To estimate this, the following calculation is used[20]:



3.2.5.1 Legal Imports

Obligated Imports

As shown, the legitimate imports are made up of the obligated imports (those covered by the packaging regulations), unobligated/unregistered imports and cross border shopping.

It is possible to calculate the obligated imports using information provided by the NPWD: table 3a: packaging imported into the UK for the purpose of an activity. The obligated businesses are those that handle over 50 tonnes of packaging annually and have a turnover in excess of £2M. The EA table 3a is shown in **Figure 8**[21].

Figure 8 National Packaging Waste Database – Filled Imports (T)

	Glass
Imported for Selling	902,156
Add on Known Missing Tonnage	30,000
Total Imported for Selling	932,156

This shows the obligated filled imports based on the EA data is 902k tonnes. However, based on Valpak internal knowledge, this excludes ~30k tonnes from obligated producers, whose figures were not yet included in the EA figures at the time of writing. Therefore, the total obligated imports are 932k tonnes for 2012. The historical data from the EA is summarised in **Figure 9**.

[20] It is important to note that it is possible that the obligated imports could include a small proportion of illegal imports. To account for the possible effect of this, calculations were made upon the obligated imports to this effect. Depending on the proportion of these obligated imports that are alcohol it was estimated that between 32k – 36k of the 930k obligated imports in 2012 could be illegal. However going forward this report assumes that the illegal imports are separate to the obligated imports. Additionally as it is not possible to identify where these illegal imports are arising they have been separated and the consumption is always presented with and without the estimated illegal imports for this reason.

[21] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (19 / 06 / 13)

Figure 9 Obligated Tonnage 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Obligated Tonnage	956,980	985,535	967,061	981,692	932,156

It is believed that the lower figure in 2012 may have been due to obligated members improving their measurements and weights due to the higher PRN price in 2012. Previously, and based on Valpak dialogue with their members, obligated organisations may have used weights from previous years for their data submission, i.e., not implemented a continuous weighing program for a lot of their packaging. Therefore, with a higher price to pay per tonne of obligated packaging in 2012, it would have been in their interests to review the accuracy of their weights in order to benefit from any light-weighting that may have taken place. A cross reference against HMRC and NPWD (plastic, steel and aluminium) is included in Appendix V.

Unobligated / Unregistered Imports

The unobligated importers are those that import filled glass packaging; however, they fall below the packaging regulations threshold for turnover and packaging tonnage handled; these are known as *de-minimis*. It is assumed that those that fall below the packaging regulations threshold are less likely to import filled glass packaging as they are not large enough to benefit from the economies of scale offered. However, local ethnic shops (Polish, Chinese etc.) that import specialist products will be counted in this category. This could also include local wine clubs that import from specific vineyards etc. There are also those that are obligated under the regulations but that are not registered: free riders. This will include those that do not register either through lack of knowledge of the regulations (where there is confusion around who the importer is, for example) and those that deliberately avoid the regulations.

Valpak made an estimation of this figure using market knowledge of free riders and *de-minimis* organisations based on the estimated number of free riders and their typical tonnages plus the number of *de-minimis* and their typical tonnage[22]. This figure was thought to be approximately 50k tonnes in 2012. This number is thought to be fairly consistent; therefore, 50k tonnes was also used in 2011. However, previous to 2011 there was a known quantity of 10k tonnes that had been free riding. Therefore, for 2008, 2009 and 2010 a quantity of 60k tonnes were used. Therefore, the 10k tonnes difference in 2011 and 2012 is being picked up in the obligated imports. This is shown in **Figure 10**.

Figure 10 Unobligated / Unregistered Imports 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Unobligated / Unregistered Imports	60,000	60,000	60,000	50,000	50,000

It is important to note that this figure of 50,000 represents those that are unobligated or unregistered but are paying duty, and are therefore classified as legal imports in the context of this study. The illegal imports are those who are not paying duty (excluding cross border shopping).

[22] This is internal Valpak information and is confidential

Cross border shopping

Figure 11 summarises the estimate for cross border shopping.

Figure 11 Cross Border Shopping 2012

	Air	Sea	Rail - Eurostar	Rail - Le Shuttle	Total
Total Passengers	200,331,803	19,679,558	9,900,000	10,000,000	239,911,361
Inbound Passengers	100,165,902	9,839,779	4,950,000	5,000,000	119,955,681
Passenger Purchase Ratio	2%	40%	1%	54%	N/A
Passengers Purchasing Duty Free	2,003,318	3,935,912	49,500	2,675,000	8,663,730
Proportion Glass Purchases	82%	82%	82%	82%	82%
Av Bottle Weight (kg)	0.5	0.5	0.5	0.5	N/A
Total Imported (tonnes)	820	1,612	20	1,095	3,548

The passenger numbers were taken from a variety of sources: air[23], sea[24], Eurostar[25] and Le Shuttle[26]. As this is by full journeys (return trips), the passenger numbers were halved to determine all inbound journeys. The number of passengers buying alcohol was based on figures from Keynote[27] and it is assumed one glass bottle of alcohol purchased per buying passenger, with an average weight of 0.5kg. This is applied to the proportion of these alcoholic purchases that are packaged in glass, using the retail sales figures from the Valpak Data Solutions (VDS) database. **Figure 12** summarises the results for cross border shopping from 2008 to 2012[28]. The estimates depend on the assumptions set out above; therefore there is some uncertainty around the quantities. However, they represent a relatively small proportion of the overall total, compared with the more robust estimates of production, exports, etc.

Figure 12 Cross Border Shopping 2008 – 2012 (T of glass packaging)

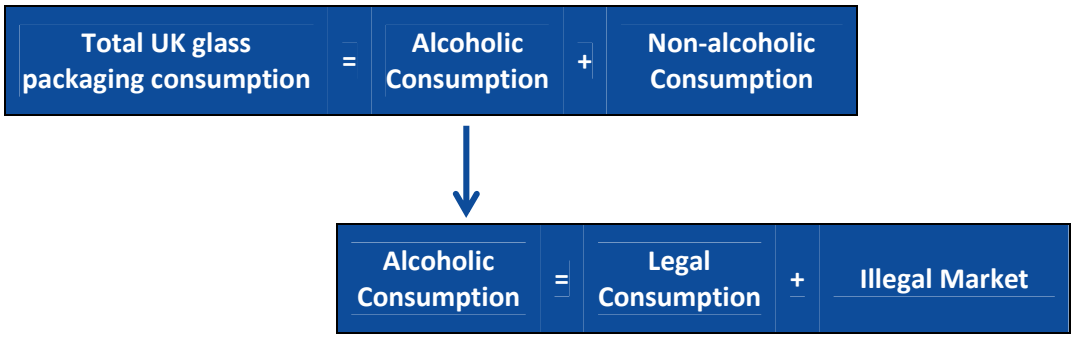
	2008	2009	2010	2011	2012
Cross Border Shopping	3,963	3,793	3,783	3,757	3,548

3.2.5.2 Illegal Imports

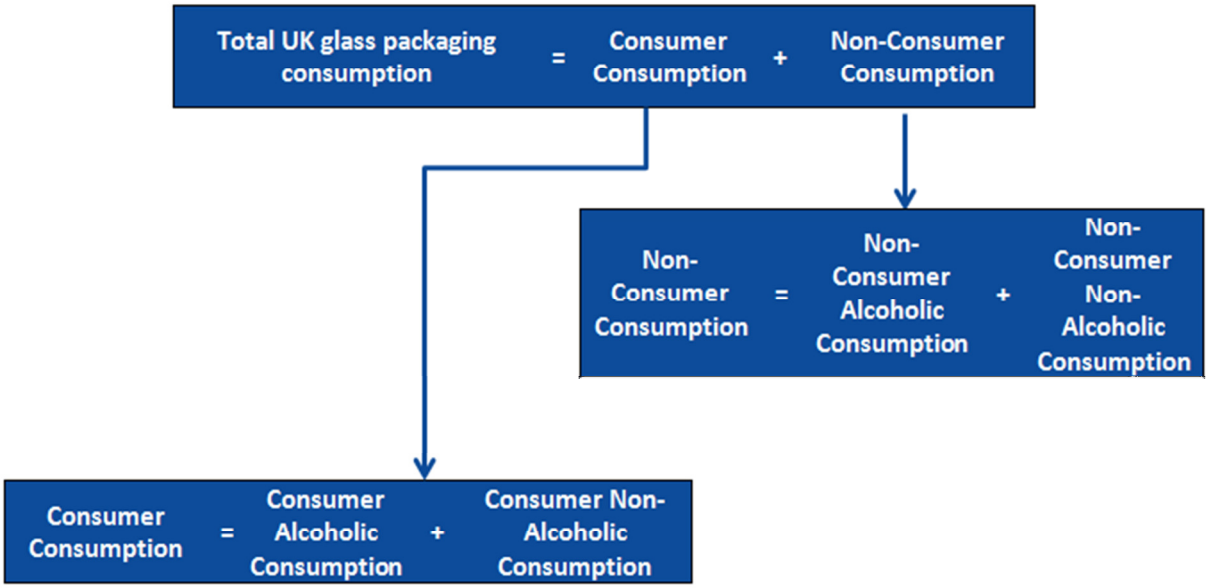
By definition, estimating illegal imports of alcohol (and the associated glass packaging) involves a substantial degree of uncertainty. This is attempted here for completeness however it is important to note that many of the assumptions used and the resulting estimates are difficult to sense-check meaningfully so the results are presented with caution.

[23] http://www.caa.co.uk/default.aspx?catid=80&pagetype=88&pageid=3&sglid=3, Accessed (04 / 06 / 13)
[24] https://www.gov.uk/government/publications/sea-passenger-statistics-2011, Accessed (04 / 06 / 13)
[25] http://www.eurostar.com/uk-en/about-eurostar, Accessed (04 / 06 / 13)
[26] http://www.eurotunnelgroup.com/uk/home/, Accessed (04 / 06 / 13)
[27] KeyNote: Cross Border Shopping (2000)
[28] 2008, 2009, 2010 and 2011 were calculated using the same methodology and factors as 2012, but using passenger numbers for that particular year.

The illegal imports are imports into the UK of alcohol on which no duty is paid (excluding the cross border shopping). Although there may be illegal imports of non-alcoholic items packaged in glass (such as pharmaceuticals and other food and drink), it was assumed that these would be minimal and so were excluded from the analysis. This is estimated based on HMRC data calculated as part of their tax gap analysis in 2012[29], in addition to the British Beer and Pub Association and KPMG report on the economic review of HMRC's beer tax gap estimates[30]. This data provides the proportion of alcoholic consumption that is illegal. Therefore, the following formula was used:

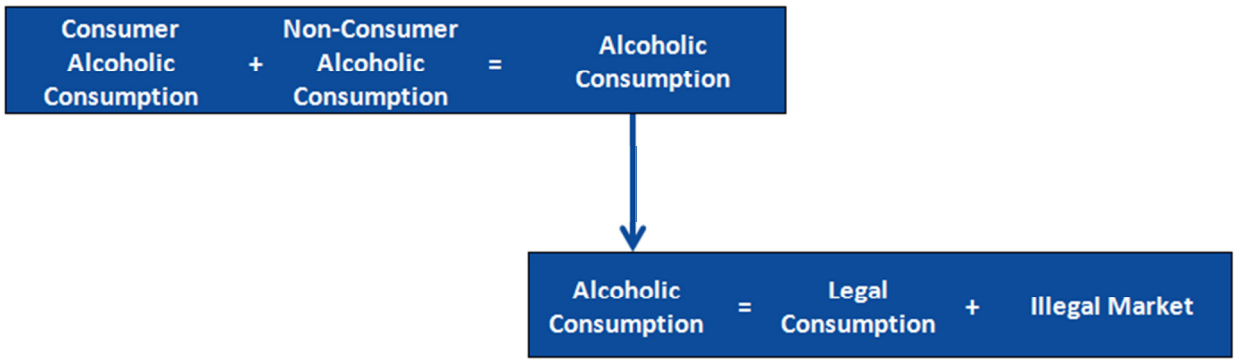


However, to work out alcoholic consumption there is a need to break the total UK glass packaging consumption down between consumer (consumed at home) and non-consumer (consumed at pubs, clubs, restaurants, hotels etc.). Therefore, the following formula is used:



[29] http://www.hmrc.gov.uk/statistics/tax-gaps/mtg-2012.pdf, Accessed (03 / 06 / 13)
[30] http://s3.amazonaws.com/bbpa-prod/attachments/documents/uploads/21638/original/not-st-Review%20of%20HMRC%20Beer%20Tax%20Gap-FINAL%20REPORT-11-05-2012.pdf?1342431470, Accessed (18 / 06 / 13)

This will allow a calculation for the illegal market using the following formula:



Consumer

In order to gain a better understanding of consumer household glass packaging, the VDS database was used. The VDS database is based on information collected direct from customers and suppliers as well as source information in house, meaning that it holds a wide coverage of information across multiple product ranges. Product specific data collection is completed through site visits, supplier mailings and weighing in house (purchasing product and collecting used product from staff). All data goes through a comprehensive checking process on receipt and is stored in their bespoke innovative software Environmental Product Information Centre (EPIC). The VDS data is most robust for the years 2012 and 2011 when the database process was updated. The VDS annual sales and packaging weights data included using information from a selection of VDS supermarket clients, representing a cross-section of grocery retailers in the UK. The market share information[31] (covering all grocery retailers including drinks specialists) was then used to scale up the packaging data to estimate the tonnage of UK grocery retail glass packaging sold in 2011 and 2012. This is summarised in **Figure 13**.

Figure 13 UK Grocery Retailing Glass Packaging Sales 2011-2012 (T)

	2011	2012
UK Grocery Retail Glass Packaging	1,855,179	1,873,045

It is then possible to apply the proportion of alcohol related glass packaging sold in supermarkets to the total consumer glass packaging consumption. However, the total glass packaging includes drinks specialists (such as off-licences) where it is assumed all glass packaging is alcohol. Therefore, using information from Euromonitor[32] on the proportion of the grocery retail market that is specialist drink retailers, it is possible to calculate the total glass packaging that is alcohol (accounting for the higher proportion of alcohol being sold in off-licences). This is summarised in **Figure 14**.

[31] http://www.kantarworldpanel.com, Accessed (27 / 06 / 13)
[32] Euromonitor: Grocery Retailers in the United Kingdom (2013)

Figure 14 Total Consumer Glass Packaging 2011-2012 (T)

	2011	2012
Total Consumer Consumption (incl illegal imports)	1,855,179	1,873,045
Total Consumer that is Drink Specialists Glass Packaging	124,770	120,346
Total Consumer Sold at Non Drink Specialists	1,730,409	1,752,699
Proportion of Glass Packaging Sold (excl Drinks Specialists) that is Alcohol	69%	69%
Consumer (excl Drinks Specialists) that is Alcohol	1,197,164	1,201,002
Total Consumer Glass Packaging that is Alcohol	1,321,934	1,321,348

The VDS database provided splits for beer, spirits and wine for 2011 and 2012, and these were applied to the total consumer alcohol glass packaging tonnage to provide a breakdown by each[33].

Figure 15 Beer, Spirit and Wine Consumer Glass Packaging Breakdown 2011-2012 (T)

	2011	2012
Beer	509,161	511,491
Spirits	147,315	156,895
Wine	665,458	652,962

It is possible to work out the illegal consumption based on the information on illegal market shares. For beer, the HMRC report: stated that the proportion of beer sales in the UK that were illegal was between 14% and 5%. However, the KPMG report, "An Economic Review of HMRC's beer tax gap analysis"[34], critiquing this information stated that the methodology for the upper number was robust, but the data used was not. It also stated that the methodology for the lower estimate was not robust. The BBPA has estimated that the illegal imports amount to between 3 and 4% of beer sales in the UK; this was also supported by the other trade associations. Therefore, for beer, it was assumed that 3.5% of all beer sales are illegal imports.

The HMRC report stated that, based on the latest available data, the spirits' illicit market share is 5% and this is what was used in the GlassFlow estimation; however, there is no available data or methodologies to address this issue for wine. Therefore, as suggested by HMRC, a figure of 7.5% was used. Using this it is possible to calculate the breakdown for consumer consumption of glass packaging associated with both legal and illegal alcohol sales. This is shown in **Figure 16**.

[33] There is a proportion of the alcoholic consumption that is not beer, wine or spirits; however, that has been excluded for this part of the analysis as there is no tax gap analysis completed on these and it is a minimal amount

[34] http://s3.amazonaws.com/bbpa-prod/attachments/documents/uploads/21638/original/not-st-Review%20of%20HMRC%20Beer%20Tax%20Gap-FINAL%20REPORT-11-05-2012.pdf?1342431470, Accessed (18 / 07 / 13)

Figure 16 Consumer Glass packaging Consumption Associated with Legal v Illegal Alcohol Sales (T)

	2011		2012	
	Legal	Illegal	Legal	Illegal
Beer	491,340	17,821	493,589	17,902
Spirit	139,949	7,366	149,050	7,845
Wine	615,549	49,909	603,990	48,972
Total	**1,246,838**	**75,096**	**1,246,629**	**74,719**

Non-Consumer

The legal non-consumer consumption is calculated by taking the residual figure from the total legal consumption from the consumer consumption. The legitimate flow between 2008 and 2012 is shown below.

For the avoidance of doubt, the consumption of packaging glass itself is not illegal. The terminology 'illegal' and 'legal' consumption, below, refers to consumption of packaging glass around goods where the goods either include illegal imports of alcohol (this is what is referred to here as illegal consumption) or exclude them (this is what is referred to here as legal consumption).

Figure 17 Legal Glass Packaging Consumption 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Production (incl exports)	2,161,769	2,094,374	2,193,935	2,193,481	2,173,803
Exports (empty)	210,553	174,831	209,552	232,915	195,269
Exports (filled)	714,849	646,584	666,843	726,517	695,874
Imports (empty)	107,553	80,283	117,116	158,159	130,871
Filled Imports (obligated)	956,980	985,535	967,061	981,692	932,156
Filled Imports (unregistered / unobligated)	60,000	60,000	60,000	50,000	50,000
Filled Imports (cross border selling)	3,963	3,793	3,783	3,757	3,548
Legal Consumption	**2,364,862**	**2,402,570**	**2,465,500**	**2,427,657**	**2,399,235**

The non-consumer consumption is then taken as a residual from the total legal consumption minus the legal consumer consumption[35]. This is summarised in **Figure 18**[36].

[35] There is only consumer consumption information for the years 2011 and 2012. Therefore, for the years 2008, 2009 and 2010 the proportion of the legal flow that is consumer for 2011 was applied

[36] This trend in the drop of non-consumer consumption is supported up by the Office of National Statistics report Statistics on Alcohol: England, 2013, which states that there has been a reduction in the overall volume of alcoholic drinks purchased for consumption outside the home (non-consumer). It states this reduction is mainly due to decrease in the volume of beer purchased. Data provided by the British Beer & Pub Association (http://www.beerandpub.com/statistics) backs this up by indicating there was a reduction of 1.4% of beer sold on trade (non-consumer) in 2011 with a further reduction of 4.1% in 2012. They also state there has been a decline in the total number of pubs in the UK from 51,178 in 2010 to 50,395 in 2011.

Figure 18 Legal Glass Packaging Consumption 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Legal Consumption	2,364,862	2,402,570	2,465,500	2,427,657	2,399,235
Legal Consumer Consumption	1,734,039	1,761,688	1,807,832	1,780,083	1,798,326
Legal Non-Consumer Consumption	630,823	640,882	657,668	647,574	600,909

Internal WRAP data was used to estimate what proportion is alcohol (and beer, spirit and wine) for 2011 and 2012 (these years are used as the consumer breakdown data only goes back that far). Therefore when estimates are made on the illegal market between 2008 and 2010, average proportions are used from 2011 and 2012).

Figure 19 Legal Non-Consumer Glass Packaging Consumption - Alcohol Breakdown 2011 – 2012 (T)

	2011	2012
Non-Consumer Consumption	647,574	600,909
Qty that is Alcohol	425,343	394,692
Beer	193,316	179,386
Spirit	60,059	55,731
Wine	171,967	159,575

It is therefore possible to work out the illegal consumption based on the information on illegal market shares. Using the same illegal proportions for beer, spirit and wine as before and using the 2011 and 2012 alcoholic consumer and non-consumer data the illegal figures were calculated. This is summarised in **Figure 20**.

Figure 20 Legal v Illegal Alcoholic Non-Consumer Glass Packaging 2011 – 2012 (T)

	2011		2012	
	Legal	Illegal	Legal	Illegal
Beer	193,316	7,011	179,386	6,506
Spirit	60,059	3,161	55,731	2,933
Wine	171,967	13,943	159,575	12,938
Total	**425,343**	**24,116**	**394,692**	**22,378**

For the years 2008 to 2010 the average proportion of glass packaging that is alcohol was taken for 2011 and 2012 and applied to the total legal flow between 2008 and 2010. The same was done for the proportion of Beer, Spirit and Wine. This data is summarised in **Figure 21**.

Figure 21 Legal v Illegal Alcoholic Glass Packaging 2008 – 2012 (T)

	2008		2009		2010		2011		2012	
	Legal	Illegal	Legal	Illegal	Legal	Illegal	Legal	Illegal	Legal	Illegal
Total Glass Alcohol	1,660,191	96,219	1,686,663	97,753	1,730,841	100,313	1,672,181	99,212	1,716,040	97,097
Beer	674,070	24,448	684,818	24,838	702,755	25,489	684,656	24,832	690,877	24,408
Spirit	202,140	11,715	205,363	11,902	210,743	12,214	200,009	10,527	212,626	10,778
Wine	783,981	45,437	796,482	46,161	817,344	47,370	787,516	63,853	812,537	61,911

The total flow is summarised in **Figure 22**. The illegal imports have been added to the glass consumption total as a separate addition; as although it is believed they exist, there is no record of their existence. Therefore, it has been deemed prudent to separate them from the rest of the glass consumption.

Figure 22 Glass Packaging Consumption 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Glass Consumption	2,364,862	2,402,570	2,465,500	2,427,657	2,399,235
Estimated Illegal Consumption	96,219	97,753	100,313	99,212	97,097
Glass Consumption (incl estimated illegal consumption)	2,461,081	2,500,323	2,565,813	2,526,869	2,496,332

This would suggest that the flow has remained fairly constant between 2008 and 2012 (only increasing by ~30 tonnes). Based on the assumption that the illegal consumption split between consumer and non-consumer is the same as the legal flow, it gives the results show in **Figure 23**.

It is worth noting that there are several ways of arriving at the estimates below, depending on the basis on which VDS data is grossed up, the definition of the grocery market used, how one allocates the illegal imports across categories, etc.

The overall total glass packaging consumption varies relatively little across these different methodologies. However, the individual levels for consumer and non-consumer flows can vary significantly depending on the assumptions made. The estimates presented below are those arising from the assumptions set out above. Different sets of assumptions would yield a similar overall total but result in different splits.

Figure 23 Glass Packaging Consumption (Consumer v Non-Consumer) 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Glass Consumption (incl estimated illegal consumption)	2,461,081	2,500,323	2,565,813	2,526,869	2,496,332
Consumer	1,806,869	1,835,680	1,883,761	1,855,179	1,873,045
Legal	*1,734,039*	*1,761,688*	*1,807,832*	*1,780,083*	*1,798,326*
Illegal	*72,830*	*73,992*	*75,930*	*75,096*	*74,719*
Non-Consumer	654,212	664,643	682,052	671,690	623,287
Legal	*630,823*	*640,882*	*657,668*	*647,574*	*600,909*
Illegal	*23,388*	*23,761*	*24,384*	*24,116*	*22,378*

A cross referring exercise was completed with ONS data, and this is provided in Appendix VI.

3.2.6 Colour Split

The consumer colour splits used were estimates agreed with British Glass and were as follows:

- Clear (45%)
- Amber (10%)
- Green (45%)

The non-consumer splits used were taken from internal WRAP reports and were as follows:

- Clear (57%)
- Amber (15%)
- Green (27%)

3.3 Results

As noted before by definition, estimating illegal imports of alcohol (and the associated glass packaging) involves a substantial degree of uncertainty. This is attempted here for completeness but it is important to stress that many of the assumptions used and the resulting estimates are difficult to sense-check meaningfully so the results are presented with caution.

The total glass flow on the UK market is shown in **Figure 24** excluding and including the illegal imports.

Figure 24 UK Glass Consumption (T) Excluding and Including Illegal Imports

	2008	2009	2010	2011	2012
Total Consumption (excl illegal imports)	2,364,862	2,402,570	2,465,500	2,427,657	2,399,235
Total Consumer Consumption	1,734,039	1,761,688	1,807,832	1,780,083	1,798,326
Clear	*780,317*	*792,760*	*813,524*	*801,037*	*809,247*
Amber	*173,404*	*176,169*	*180,783*	*178,008*	*179,833*
Green	*780,317*	*792,760*	*813,524*	*801,037*	*809,247*
Total Non-Consumer Consumption	630,823	640,882	657,668	647,574	600,909
Clear	*361,948*	*367,720*	*377,351*	*371,559*	*344,784*
Amber	*96,558*	*98,098*	*100,667*	*99,122*	*91,979*
Green	*172,317*	*175,064*	*179,650*	*176,892*	*164,145*

	2008	2009	2010	2011	2012
Total Consumption (incl illegal imports)	2,461,081	2,500,323	2,565,813	2,526,869	2,496,332
Total Consumer Consumption	1,806,869	1,835,680	1,883,761	1,855,179	1,873,045
Clear	*780,317*	*792,760*	*813,524*	*801,037*	*809,247*
Amber	*173,404*	*176,169*	*180,783*	*178,008*	*179,833*
Green	*780,317*	*792,760*	*813,524*	*801,037*	*809,247*
Total Non-Consumer Consumption	654,212	664,643	682,052	671,690	623,287
Clear	*361,948*	*367,720*	*377,351*	*371,559*	*344,784*
Amber	*96,558*	*98,098*	*100,667*	*99,122*	*91,979*
Green	*172,317*	*175,064*	*179,650*	*176,892*	*164,145*

4. Collection of Glass

4.1 Introduction

This section of the report examines the levels of glass collected within the UK. This is then broken down for Scotland and Wales individually, which is included in a separate section at the end of the report. The glass packaging that is collected for recycling is collected either colour separated, mixed colour or mixed with other dry recyclate (co-mingled). The collections are split between local authorities (LAs) and commercial and industrial (C&I) collections. For the purpose of this report, the total amount collected for recycling (LA + C&I) equals the total amount actually recycled, as per PRN/PERN evidence. Process losses are implicitly accounted for upfront for simplicity (see Section 4.2.2).

When glass is collected by LAs it is typically collected from:

- Kerbside;
- Bring sites (bottle banks); and
- Civic amenity sites (household waste recycling centres).

There are also non-household sources of glass collected by LAs (pubs using bring banks, for example), which can end up being reported as household waste.

The C&I collections of glass are typically done by private waste management companies or glass recyclers. The glass is collected from premises such as hotels, restaurants, bars and offices.

4.2 Collection Methodology

The methodology for calculating the collection of UK glass packaging (for recycling) is based on the following formula:

Total UK glass packaging collected	=	Local Authority Collections	+	Commercial & Industrial Collections

Following is a description of how each of these is calculated.

4.2.1 Local Authority Collections

The methodology for calculating local authority collections of glass packaging in the UK is based on the following formula:

Total UK glass packaging collected by local authorities	=	Kerbside Collection	+	Bring Site Collection	+	CA Site Collection

This data was extracted from WasteDataFlow (WDF). It is important to note that the WDF figures are reported based on the financial year and the latest figures available were for 2011/12. For the purposes of this report, the figures for 2011/12 were used. This means there is some degree of inconsistency between the collection figures that cover the period April 2011 through to March 2012 and the consumption figures that cover the period January 2012 through to December 2012. A summary of the UK local authority glass collections is shown in **Figure 25**.

Figure 25 Local Authority Glass Collections (T)

	Total	Kerbside	Bring	CA
UK Total Glass Packaging Collected	1,308,044	966,250	275,700	66,095

4.2.2 C&I Collections

The equation below was used for calculating C&I collections.

Total UK Glass Packaging Collected	-	Local Authority Collections	=	Commercial & Industrial Collections

The total tonnages recycled are taken from NPWD[37] and used as a proxy for the total tonnages collected for recycling. LA collections tonnages are taken from WDF. C&I collection tonnages are then calculated as the remaining amount (total recycled from NPWD minus LA collection tonnages).

It is important to note that these are not on a like-for-like basis (i.e. collected for recycling isn't in fact equal to recycled).

Indeed the WDF collection figures will not equal the amount collected for recycling as many do not robustly account for material rejected by the MRF during the sorting process. DEFRA is currently amending guidance to local authorities to clarify that they should provide robust information on reject rates when reporting recycling rates to WDF.

Therefore, by assuming for simplicity, that the total collected for recycling equals the total actually recycled, this calculation distorts the representation of process losses, accounting for them all upfront (in this case, by default, within the C&I collections estimate).

This means that C&I collections as reported here are implicitly underestimated by the combined, unknown level of process losses.

It is also important to note, additionally, that the NPWD collection figures only cover obligated waste by accredited agents, and so, miss out on tonnages recycled without a PRN/PERN being generated. The best estimate for C&I collections are shown in **Figure 26**[38].

Figure 26 C&I Glass Collections (T)

NPWD Collections	1,626,588
Local Authority Collections	1,308,044
C&I Collections	**318,544**

[37] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (01 / 07 / 13)

[38] It is important to note that there is a time difference between the NPWD figures (calendar year 2012) and the Local Authority figures (2011/12 financial year); however, this was the best available data.

4.3 Results

Using WDF for 2011/12, glass collection data has been collated by collection method and colour format of glass. See Section 11.3 for a discussion of the changes in trends over recent years.

4.3.1 Kerbside

Figure 27 shows the quantity of glass collected in the UK at kerbside.

Figure 27 Local Authority Glass Collected at Kerbside (T) – 2011/12[39]

	Kerbside					
	Co-mingled	Mixed Colour	Colour Separated			Total
			Green	Brown	Clear	
England	489,785	286,340	41,530	7,129	33,407	**858,191**
N. Ireland	-	8,219	57	36	81	**8,393**
Scotland	1,818	25,431	7,779	2,697	8,721	**46,445**
Wales	22,940	30,281	-	-	-	**53,220**
UK Total Glass Packaging Collected	**514,542**	**350,271**	**49,366**	**9,861**	**42,209**	**966,250**

This shows that the majority of glass collected at kerbside by local authorities in the UK is collected co-mingled.

4.3.2 Bring Sites

Figure 28 shows the quantity of glass collected in the UK at bring sites.

Figure 28 Local Authority Glass Collected at Bring Sites (T) – 2011/12

	Bring Sites					
	Co-mingled	Mixed Colour	Colour Separated			Total
			Green	Brown	Clear	
England	5,286	123,578	41,379	9,171	33,550	**212,964**
N. Ireland	-	7,534	-	-	-	**7,534**
Scotland	1,113	11,375	13,002	4,292	13,176	**42,958**
Wales	242	9,066	1,335	617	984	**12,243**
UK Total Glass Packaging Collected	**6,641**	**151,553**	**55,716**	**14,079**	**47,710**	**275,700**

This shows that the majority (55%) of glass collected by local authorities in the UK from bring sites is collected mixed colour. Colour sorted glass still makes up a high proportion of glass collected from bring sites at 42.6%.

[39] It should be noted that Northern Ireland does not report co-mingled collections in WDF, even when they are collected co-mingled.

4.3.3 CA Sites

Figure 29 shows the quantity of glass collected in the UK at CA sites.

Figure 29 Local Authority Glass Collected at CA Sites (T) – 2011/12

	CA Sites					
			Colour Separated			
	Co-mingled	Mixed	Green	Brown	Clear	Total
England	769	33,106	4,020	1,208	4,459	**43,563**
N. Ireland	-	6,017	-	-	-	**6,017**
Scotland	1,011	959	2,381	1,011	2,687	**8,050**
Wales	4,100	3,427	235	190	512	**8,465**
UK Total Glass Packaging Collected	**5,881**	**43,510**	**6,636**	**2,409**	**7,659**	**66,095**

This shows that the majority of glass collected at CA sites by LAs in the UK is collected mixed colour, accounting for 66% of the glass collected from this source.

4.3.4 C&I Collection

The total C&I collections for the UK is shown in **Figure 30**. This was taken as the remainder from the NPWD total glass packaging collected.

Figure 30 UK C&I Collections (T)

C&I Collections	318,544

4.3.5 Total

The total UK glass collections are summarised in **Figure 31**. As set out above, the total amount labelled as collected for recycling is equal to the amount recycled as evidenced by PRNs/PERNs.

Figure 31 Summary of UK Glass Collections (T)

	Total	Kerbside	Bring	CA
England	**1,114,718**	858,191	212,964	43,563
N. Ireland	**21,944**	8,393	7,534	6,017
Scotland	**97,453**	46,445	42,958	8,050
Wales	**73,928**	53,220	12,243	8,465
C&I Collections	**318,544**	0	0	0
UK Total Glass Packaging Collected	**1,626,587**	966,250	275,700	66,095

This shows that 1,627k tonnes of glass were collected for recycling in the UK in 2011/12.

Figure 32 shows the UK glass recycling rate in 2012. This shows the revised consumption (excluding and including illegal imports) and the PackFlow consumption figure.

Figure 32 UK Recycling Rate 2012 – PackFlow and Revised

	PackFlow	Revised Consumption (excl illegal imports)	Revised Consumption (incl illegal imports)
Consumption	2,753,500	2,399,235	2,496,332
Total Collections	1,626,587		
Recycling Rate	59%	68%	65%

5. MRF Sortation and UK Capacity

5.1 Introduction

This section of the report discusses the potential UK MRF capacity and the route co-mingled glass takes through the supply chain.

5.2 MRF UK

Glass that is collected co-mingled needs to be separated from the other dry recyclate materials it is collected with. It is estimated that in 2011/12, 527k tonnes of glass was collected co-mingled. The majority of this (515k tonnes) was collected co-mingled at the kerbside. It is worth noting that a WRAP review of WDF co-mingled tonnage data identified that some local authorities are known to collect glass separately but report it as part of their co-mingled tonnages. This amounted to approximately 40k tonnes of glass in 2011/12.

WRAP and Valpak attempted to estimate the amount of glass being sorted at MRFs to track the route taken by co-mingled tonnages, that is, glass mixed with other dry recyclate. Data on glass tonnages at MRFs is not directly available at present, and therefore estimates are arrived at by inference and require a number of assumptions. A variety of methods were used including using WRAP's online Local Authority Waste and Recycling Information Portal and a variety of surveys conducted with MRFs by WRAP and Valpak.

The analysis yielded a series of estimates, smaller than the tonnages collected co-mingled. It is possible that some tonnages transit via transfer stations or in some cases may go more directly to the reprocessor/recycler. Responses from the reprocessor/recycler survey and anecdotal information from British Glass could be interpreted to imply this is the case although no specifics were mentioned and no hard evidence was put forward. Secondary research would suggest some accept glass with other materials[40]. Overall, the analysis of this segment of the supply chain remains inconclusive.

For the purposes of the model, for simplicity, all co-mingled glass was assumed to go to an MRF initially before being sent to a glass recycler/reprocessor, aggregates or export. Although this does not affect the end market totals, it is used as a working assumption with the caveat that some co-mingled material may follow a different route to a glass recycler/reprocessor.

[40] http://www.recresco.com/recycling/Glass.ashx, Accessed (26 / 07 / 13)

6. Reprocessing

This section of the report identifies organisations that are accredited for reprocessing and exporting glass in the UK. This is important in understanding the model outputs and identifying the key organisations that were surveyed as part of this project. The reprocessors and exporters receive glass direct from collectors as well as from MRFs, and are closer to the end markets in the glass packaging supply chain, as highlighted earlier in the report.

The full list of organisations accredited for reprocessing and exporting glass is included in Appendix VII. Reprocessors will typically recycle glass ready for input to end markets such as remelt (container manufacturing and fibreglass), aggregates, shotblasting, filtration media and other decorative applications. The process will involve a range of activities to turn mixed colour glass or colour separated glass into a suitable format, for instance; size reduction, decontamination (and material recovery, e.g. metals, plastics, labels), removal of ceramics, stones, quality control and colour separation .

7. Cullet Imports

7.1 Introduction

As well as cullet from domestic sources, UK glass manufacturers use cullet from imported sources. This section of the report identifies the import of glass cullet into the UK. The remelt (container) sector is the only importer of glass cullet into the UK. **Figure 33** identifies the quantity of glass cullet imported in 2011 and 2012.

Figure 33 Cullet Imports 2011 – 2012 (T)

Year	Flint	Amber	Green	Total
2012	53,085	25,765	52,595	131,445
	40.4%	19.6%	40.0%	
2011	38,155	18,771	10,185	67,110
	56.9%	28.0%	15.2%	

This data is provided to British Glass by the glass manufacturers. The majority of glass cullet imported to the UK is from the Republic of Ireland. Cross checks with data were made, however with no cross border controls; it is believed the actual import figure for glass cullet is higher than that reported on the HM Revenue & Customs UK TradeInfo website.

The increase from 2011 to 2012 is believed to be due to the increase in co-mingled collections, meaning a reduction in the quality of cullet ready glass in the UK.

Some cullet is also sourced from other destinations such as Finland and Norway.

8. UK End Markets

8.1 Introduction

This section of the report provides an overview on the amount of glass going to each of the main end markets for recycled glass. The end markets include:

- Remelt (container and fibreglass);
- Aggregates;
- Shotblasting;
- Filtration; and
- Export.

The breakdown in quantities provided are used in the GlassFlow model that maps the flow of material from consumption to end markets. The majority of the information in this section was provided by the EA (Tonnages of UK Waste Glass Remelt v Non-remelt & Glass Export Data 2009 – 2012).

8.2 Remelt

The largest end market for waste glass in the UK is the remelt sector (glass container and fibreglass manufacturing), with the glass container manufacturing sector being the larger of the two. Data provided by the EA[41] on the amount of glass sent to UK reprocessors for remelt applications is shown in **Figure 34**.

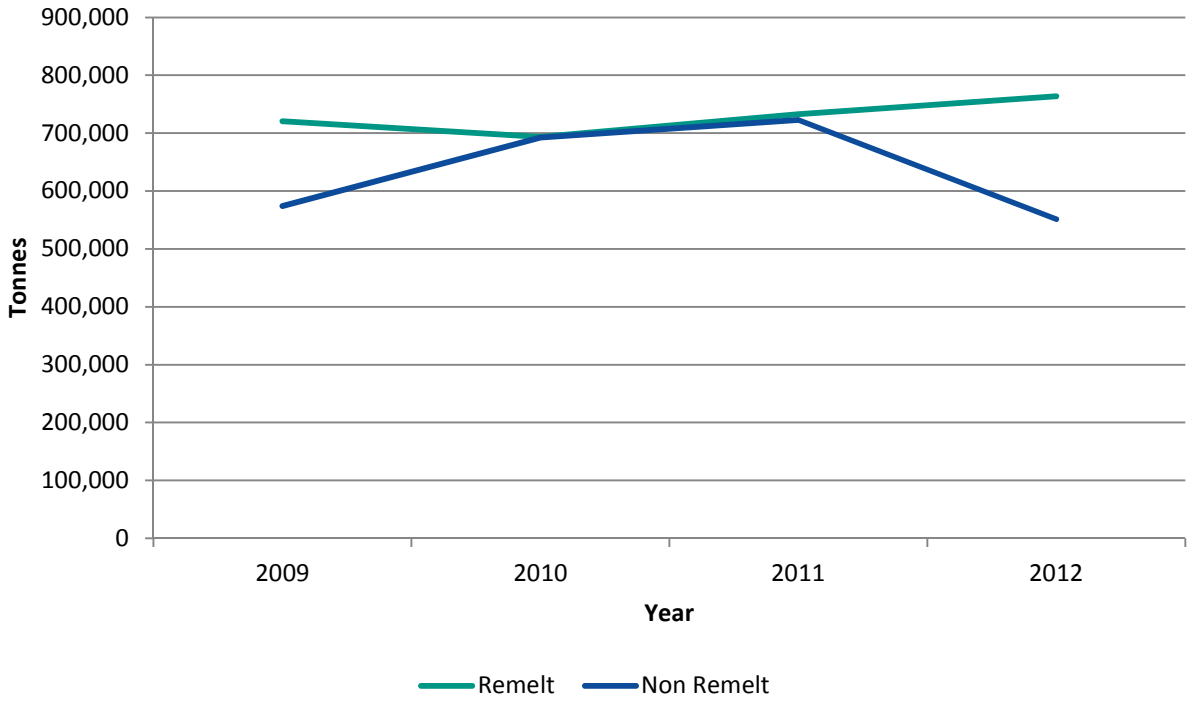
Figure 34 Remelt 2009 – 2012 (T)

	2009	2010	2011	2012
Remelt	720,440	693,745	732,557	763,713

The amount of glass sent to remelt applications has increased since 2010; this trend is shown **Figure 35**.

[41] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (29 / 05 / 13)

Figure 35 Remelt 2009 – 2012 (T)



8.2.1 Remelt (Container)

The larger of the remelt sectors is container glass manufacturing. It is estimated that 78% of the remelt sector is container manufacturing[42]. In terms of the colour of cullet used in the process, green glass and clear glass are most commonly used, with amber and mixed being used less often. An estimated breakdown is provided in **Figure 36**.

Figure 36 Remelt Container Manufacturing Cullet Use by Colour

Glass Colour	%
Clear	40
Amber	11
Green	47
Mixed	2

8.2.2 Remelt (Fibreglass)

The remaining remelt input goes to fibreglass applications, approximately 170k tonnes in 2012. The fibreglass input is mixed glass.

[42] Based on discussions with British Glass

8.3 Non Remelt

The rest of the glass, which is not exported or sent to remelt, goes to the following end markets:

- Aggregates;
- Shotblasting; and
- Filtration.

The majority of this is aggregates, as shown in **Figure 37**.

Figure 37 Non Remelt Proportions[43]

Non Remelt	%*
Aggregates	99%
Shotblasting	0.7%
Filtration	0.4%

*Rounded up

8.4 Export

The rest of the UK waste glass packaging is exported. Glass export figures were supplied by the EA. **Figure 38** shows the amount of glass exported since 2009 has fluctuated; however, there was a significant increase in the amount of UK glass exported in Q4 2012, indicating the requirement for PERNs at the end of 2012. In previous years less glass was exported in Q4.

Figure 38 Glass Exports 2009 - 2012 (T)

	2009	2010	2011	2012
Q1	107,760	61,556	95,316	72,226
Q2	72,725	92,370	72,249	68,960
Q3	106,463	84,236	68,827	61,943
Q4	77,312	23,859	60,047	108,462
Total	**364,260**	**262,022**	**296,439**	**311,590**

It is assumed that 80% of the export (and of aggregates) is from glass recyclers/reprocessors and 20% from MRFs[44].

[43] Proportions estimated following discussions with British Glass
[44] Proportions estimated following discussions with British Glass

9. Model Outputs

9.1 Introduction

This section of the report briefly summarises the findings from the glass packaging supply chain model developed for the GlassFlow project; a more detailed breakdown is included in Appendix VIII – Model Outputs. The model was based on the findings discussed throughout this report, and also includes a breakdown by colour and analysis on destination splits. It is important to note that the estimated illegal imports are included in the model.

9.2 Output

The model includes a summary compliance section. This includes the recycling rates by colour and is summarised in **Figure 39**.

Figure 39 Model – UK Compliance

Compliance

Consumption

	Clear	*Amber*	*Green*	***Total***
Consumer	843 kt	187 kt	843 kt	**1,873** kt
Non-Consumer	358 kt	95 kt	170 kt	**623** kt
Total	**2,496** kt			

Collection

Local Authority

	Clear	*Amber*	*Green*	*Mixed*	*Co-mingled*	***Total***
Kerbside	42 kt	10 kt	49 kt	350 kt	515 kt	**966** kt
Bring	48 kt	14 kt	56 kt	152 kt	7 kt	**276** kt
CA	8 kt	2 kt	7 kt	44 kt	6 kt	**66** kt

	Mixed	***Total***
C & I	319 kt	**319** kt
Total	**1,627** kt	

MRF

	Co-mingled	***Total***
MRF	527 kt	**527** kt

Recycler / Reprocessor

Recycler / Reprocessor	*Clear*	*Amber*	*Green*	*Mixed*	*Co-mingled*	***Total***
	98 kt	26 kt	112 kt	1220 kt	0 kt	**1,358** kt

End Markets (exc imports)

	Clear	*Amber*	*Green*	*Mixed*	***Total***
remelt (container)	253 kt	69 kt	263 kt	12 kt	**597** kt
remelt (fibreglass)	0 kt	0 kt	0 kt	166 kt	**166** kt
Filtration	0 kt	0 kt	0 kt	2 kt	**2** kt
Shotblasting	0 kt	0 kt	0 kt	4 kt	**4** kt
Aggregates	0 kt	0 kt	0 kt	545 kt	**545** kt
Total	**1,315** kt				

(Cullet) Import

	Clear	*Amber*	*Green*	*Mixed*	***Total***
(Cullet) Import	53 kt	26 kt	53 kt	0 kt	**131** kt

Export

	Clear	*Amber*	*Green*	*Mixed*	***Total***
Export	0 kt	0 kt	0 kt	312 kt	**312** kt

PRN / PERN Raised

	remelt	*Aggregate*	*Export*	*Total*
	764 kt	551 kt	312 kt	1,627 kt
	47 %	34 %	19 %	

Untapped

	Clear	*Amber*	*Green*	***Total***
	547 kt	103 kt	220 kt	**870** kt

Recycling Rates

Clear	*Amber*	*Green*	***Total***
54 %	63 %	78 %	65 %

This shows that there is 870k tonnes of glass packaging that is currently untapped, or is being sent to landfill each year in the UK (assuming illegal imports are what we have estimated). The recycling rate across the three colours varies between 55-77%. Additionally 34% of PRNs are raised at the aggregates stage, and 66% at re-melt or export. The quantity of untapped glass was sense checked against residual waste arisings in the UK of 27.7M tonnes[45] (municipal solid waste and C&I) using a composition range of 3.9% – 4.9%[46] for glass, which gives a figure of between 1,053k and 1,348k tonnes of glass potentially remaining in the residual waste stream. However, as glass only arises in any significant quantities in the hospitality sector of the C&I waste stream, taking this into account would significantly reduce the top line estimated range to be more in line with the GlassFlow figure of 870k tonnes.

[45] http://www.eunomia.co.uk/documents/Eunomia_Residual_Waste_Infrastructure_Review_High-level_Version.pdf, Accessed (25 / 07 / 13)
[46] http://www.wrapcymru.org.uk/content/composition-municipal-solid-waste-wales-0, Accessed (25 / 07 / 13)

10. Stakeholder Engagement

10.1 Introduction

This section of the report provides the results from a stakeholder survey completed as part of this project. This offers a qualitative analysis to support the quantitative findings from the model.

Key stakeholders including recyclers/reprocessors, manufacturers (remelt and non-remelt) and aggregate processors were interviewed during the process to gather opinion on current and future trends in the glass recycling industry and the key issues the industry faces in meeting the current and future recycling targets. The questionnaire is included in Appendix IX - Questionnaire.

The comments have been grouped together to keep them confidential, and any common themes have been documented below.

10.2 General Background

Respondents were asked about the maximum incoming capacity for glass for recycling or glass cullet for recycling. The information ranged from 80k tonnes per annum to 450k tonne per annum; however, many respondents did mention this was dependent on quality of glass and availability of glass from MRFs and reprocessors. Respondents were asked about the cost (per tonne) for processing glass; however, the responses to this were limited and therefore not included in this report.

Respondents were then asked about what they believe is a fair PRN price; the information ranged from £20-35 per tonne. Letsrecycle.com provides archived PRN prices by year and month[47], and this range seems to correspond with the average price seen in 2010 and mid-way through 2012. It was felt by many respondents that this price would allow for investment into UK glass recycling but also keep the industry competitive. Some respondents also thought the split PRN price for aggregates/remelt would be beneficial and may further benefit with an additional target for export. However, it should be noted that the PRN system is a market based instrument and therefore the price cannot be 'set' under the current system. As such, the price of a PRN will vary depending on supply and demand conditions.

Only a few respondents commented on PRN purchasing and planning. Some organisations stated they purchase their PRNs in the second quarter of each year to reduce the risk of expensive PRNs and panic buying towards the end of the year. Suggestions included first splitting down the forecast obligations for companies and spreading it equally across all the months of the year and then forcing obligated companies to purchase 80% of their monthly PRNs at the end of each month. This would enable planning in the industry and allow the reprocessing of glass to occur.

10.3 Trends

Respondents were asked about the UK almost failing to meet the 2012 glass recycling target and what they believed were the reasons. The main responses were:

- Quality/co-mingled glass collections;
- Stockpiling; and
- Removal of fraud.

[47] http://www.letsrecycle.com/prices/prn/prns-prices-archive, Accessed (01 / 07 / 13)

The majority of respondents stated that they had witnessed an increase in co-mingled or mixed glass collections, which they indicated had a negative impact on the quality of glass. However, it was also stated that many glass recyclers/reprocessors had improved or are investing in technologies (such as colour sortation equipment) to adapt their facilities to improve the quality of glass output. They believed that, due to the increase in co-mingled material and subsequent quality decrease perceived by some, they would ideally need to have specific glass sorting technology and be able process at least 20 tonnes of glass per hour and that this investment would cost several million pounds. Additionally, it was highlighted that some LAs still do not collect glass at kerbside, which is limiting the quantity of glass being collected.

The changing recycling options advertised by LAs and the different collection methods were discussed. It was felt more LAs have opted for glass kerbside collections and removed many bottle banks. Respondents stated this approach to recycling has reduced the quantity of higher quality colour separated glass being sent to remelt. As LAs across the UK have different methods for glass collections, respondents stated this causes confusion amongst the public and one practice should be adopted throughout the UK. It was felt that budget pressures being placed on LAs were also influencing their decision making, and as such, the quality of glass being collected is not high on their agenda.

Stockpiling of glass was also a common answer and it was stated by some that this could have potentially contributed to the UK almost failing to meet its target. Some respondents said stockpiling only occurred as it was not economically sustainable to process the material and stockpiles are being restored this year. When the PRN price was low (ranging from between £9 -£15 per tonne between January and June 2012[48]), it was uneconomical to colour sort the material. It was suggested that by having an average PRN price, all parties involved in the glass market would benefit.

Removal of fraud from the system was also cited as a reason for the UK struggling to meet the glass recycling target. However, not everyone agreed on this point, with some respondents stating that it did not affect the market at all.

Many of the comments on how to prevent the 2012 situation occurring again included: increased enforcement from the EA, tighter controls on compliance schemes being allowed to dictate the market and providing increased visibility and transparency. It was suggested that the EA needs to implement a more stringent audit process and have tighter controls over who can issue PRNs/PERNs to reduce fraud and reduce the opportunities for small companies to make 'quick money' from the market when it is at its peak. It was also felt the communication in the supply chain is poor and artificial, with many 'playing the market'; therefore, a more transparent process with priority end markets should be pursued.

10.4 Recycling Targets

Respondents were asked if they thought the UK would meet the recycling target in 2013. The general response was 'yes'; however, they felt it could be quite challenging due to reduced stockpiles and uncertainties of the implementation of the split aggregate/remelt recycling target. Many respondents said that the remelt target might be harder to meet compared to the aggregate target as the quality of glass for the remelt sector is poor. One respondent stated the UK would not hit the recycling target in 2013.

It was also suggested the split recycling target was a step in the right direction; however, further changes were still needed to be made to reduce the quantity of glass going to aggregate and support UK manufacturing and alternative end markets. One suggestion included enforcing all colour separated

[48] http://www.letsrecycle.com/prices/prn/prns-prices-archive/prices?subCategory=2012, Accessed (01 / 07 / 13)

glass going to remelt with other dirty glass from MRFs or glass below a certain size should go to aggregates. It was suggested there are too many small 'skip companies' collecting separated glass and sending it to aggregates or exports to make 'quick easy money' from the PRN system. It was felt this needs to be prevented to increase higher quality cullet going to end markets such as remelt.

10.5 Specific Issues for the Future

It was stated that although some of the highly contaminated glass can go to aggregates, with an aggregate restriction, this is putting pressure on the recyclers and processors to process the cullet further to enable a higher quality output to be used in the other sectors. However, this has an economic impact due to the additional processing required. Some respondents discussed the high cullet specifications they must achieve for the remelt sector, and with the increase in co-mingled collections in the UK, achieving the specification is extremely difficult. It was also identified that glass recyclers/reprocessors have pressure from end customers to produce a high quality output. Some businesses stressed their concern at meeting customers' targets and objectives; if they were not met some felt their business structure could be affected in the future.

Respondents were then asked if they believe producers may switch from using glass packaging and start using other packaging materials if the PRN price keeps increasing. The question had mixed answers; one respondent said they believed there could be a change of material type to metal packaging rather than plastic and another respondent believed a material switch was already occurring. It was also stated that if PRN prices remain high, food producers may move the production of the goods and packaging overseas to keep costs low. Other respondents said they would not expect to see a change in material type.

10.6 End of Waste Criteria

Respondents were asked what impact the change in end of waste criteria would have and all stated they did not believe it would affect them. It was felt that the current available guidance is poor, and as a consequence respondents reported they are yet to fully understand the potential impact (since the survey DEFRA has issued further guidance). Many glass recyclers/reprocessors and manufacturers have long term contracts in place for PRNs therefore they believe it will not affect them at this time.

10.7 Support from Government

Respondents were asked what support or intervention the Government or WRAP could potentially provide to increase glass packaging recycling in the UK. Responses included legislation/target changes by DEFRA and increased EA enforcement to improve the auditing of companies. It was suggested that any changes should be gradual, but actions taken by the EA and DEFRA should be promoted to increase confidence in the market.

End markets should be prioritised and the aggregate/export markets should have tighter controls. Although some glass will be used in these end markets, there should be more emphasis on UK end markers such as remelt and other higher value end markets.

11. Key Market Issues

11.1 Introduction

This section of the report details the key market issues affecting the glass recycling industry:

- Reduced Consumption;
- Increase in Co-mingled Collections;
- End of Waste Criteria;
- Batch v Cullet; and
- PRN Spend.

11.2 Reduced Consumption

The consumption section of the report identified that the flow of glass onto the UK market may have previously been overestimated.

One of the principal aims of this project was to systematically review each component of the flow (production, exports and imports) to calculate a robust figure for the flow of packaging glass flowing onto the UK market.

Previously, flow estimates were taken from Packflow: a project conducted to quantify flows of all packaging materials. The flow onto the market figure used by Defra at the time of writing was taken from a point between the previously calculated PackFlow high and low figures[49]. The comparison of the revised flow, with and without the illegal consumption, and these PackFlow figures, is shown in **Figure 40**.

49 http://www.valpak.co.uk/Libraries/Environmental_Consulting_Documents/PackFlow_2017_Final_Report_09_11_12.sflb.ashx, Accessed (26 / 06 / 13)

Figure 40 PackFlow v Revised Flow 2008 – 2012 (T)

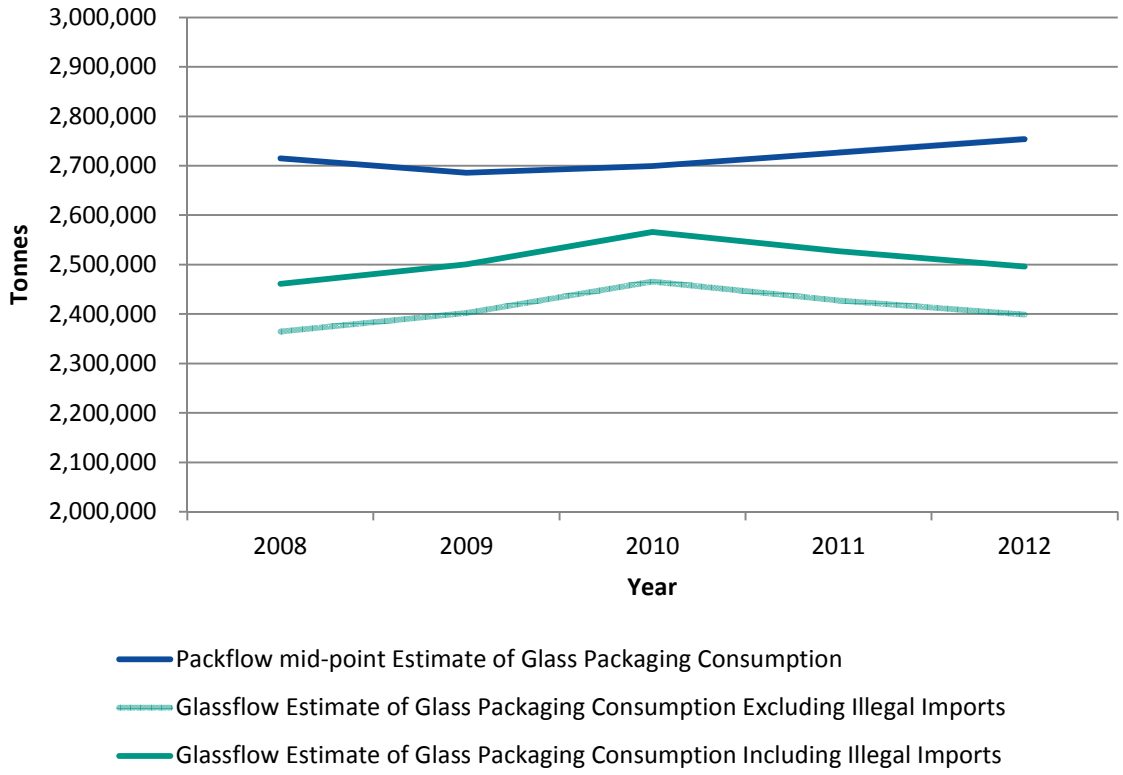
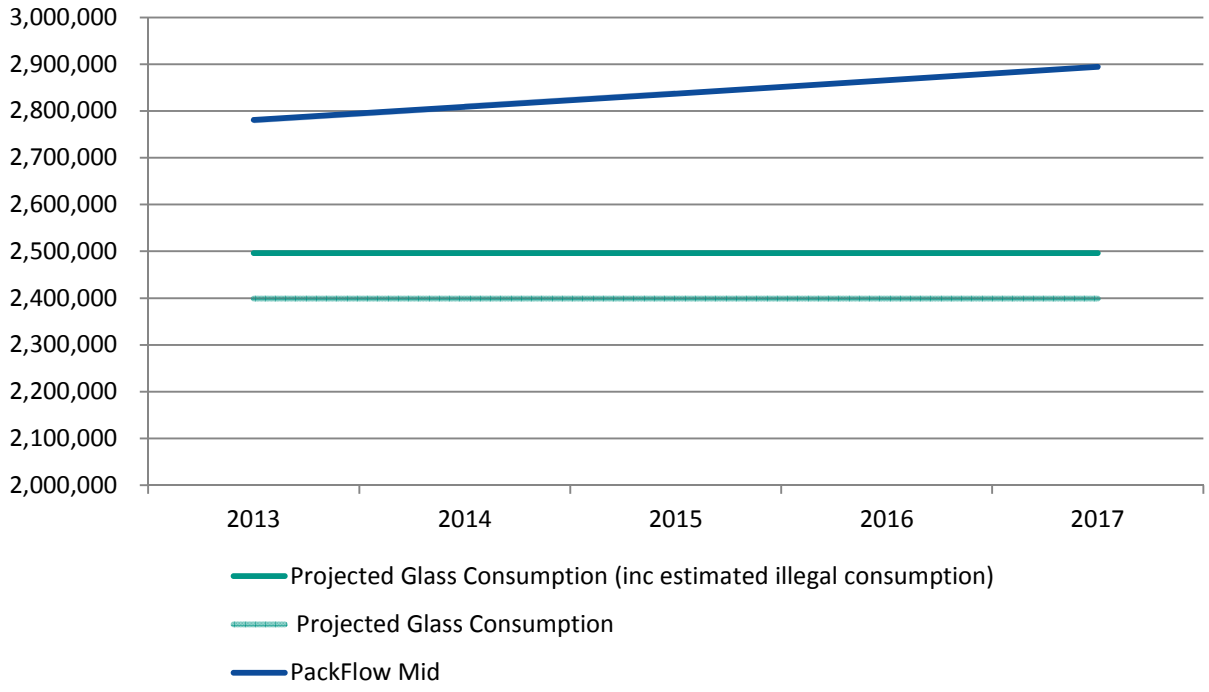


Figure 40 shows the revised flow of glass onto the UK market calculated by the GlassFlow project is lower than PackFlow.

The revised profile of the flow over time also differs from PackFlow. This means that the total (revised) arising in 2012 is at a similar level to 2008 (a difference of 34-36k tonnes if illegal imports are excluded or included).

In the latest report (Packflow 2017), the PackFlow flow figures are projected to increase 1% annually until 2017, based on consultation with British Glass. Therefore, if the revised flow were to remain flat (as it broadly has from 2008 – 2012 (apart from a spike in 2010 that British Glass speculates as being attributable to stock clearing), then the gap between the revised flow and the PackFlow flow will increase each year. Scenarios for future growth are discussed in Section 12. This is shown in **Figure 41**.

Figure 41 PackFlow v Revised Flow 2013 – 2017 (T)



The main impact of the revised flow is that it significantly affects the UKs glass recycling rate. **Figure 42** shows the UK performance in terms of recycling rate, if the revised flow is used.

Figure 42 Revised Performance v EU Directive Target (60%) (T)[50]

Revised Flow for 2012 (excluding illegal imports)	2,399,235
2012 PRNs produced	1,624,088
Revised 2012 UK performance (glass packaging recycling rate)	68%

This would suggest that, based on the revised flow, the UK over achieved against the EU directive of 60% by 8% or 185k tonnes. However, it is important to note that as there is illegal glass flowing onto the market, some of which will have PRNs raised against it. Therefore, the figures shown in **Figure 42** exclude it from consumption, but not recycling.

Additionally, if the illegal imports are included, the revised performance is still greater than 60%; this is shown in **Figure 43**.

Figure 43 Revised Performance (inluding illegal imports) v EU Directive Target (60%) (T)

Revised Flow for 2012 (including illegal imports)	2,496,332
2012 PRNs produced	1,624,088
Revised 2012 UK performance (glass packaging recycling rate)	65%

[50] The number of PRNs produced is used here; however, the total glass packaging recycled is 2.5k higher and this difference is the material recycled that didn't have a PRN raised on it

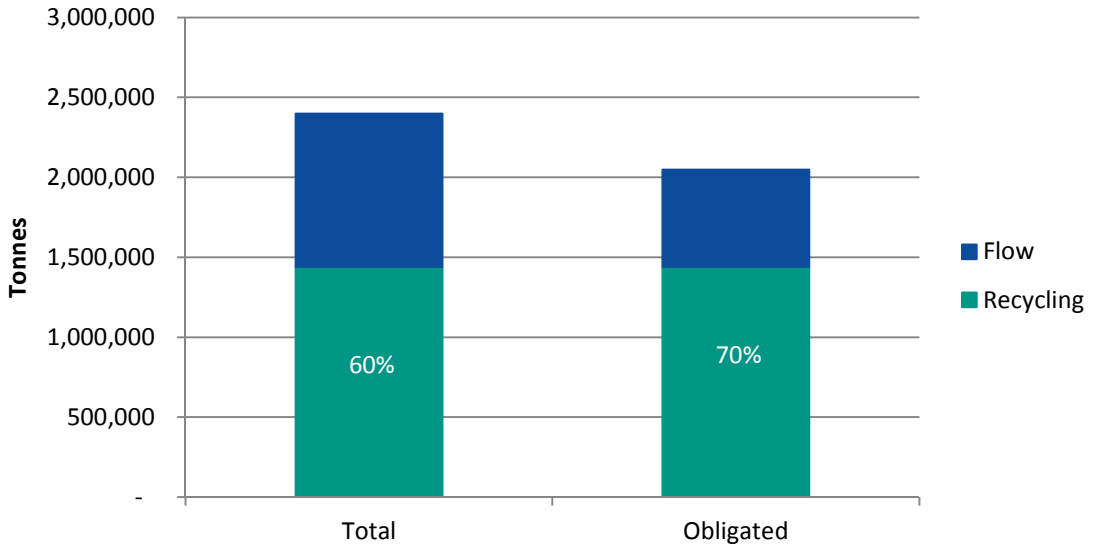
As set out previously, in order to hit a 60% EU target, the Government has set an 81% target for obligated businesses (which builds in a buffer to meet the UK target). It is possible to calculate the business target that would be necessary to meet the EU Directive 60% target based on the revised flow in 2012. **Figure 44** shows that a business target of 70% excluding illegal imports and 73% including illegal imports (compared with the actual target of 81%) would be sufficient to hit the 60% EU target. This is shown in **Figure 45**.

However, it is important to point out that it makes sense to allow for some margin for error; therefore, based on the revised flow, an obligated business target of 70% or 73% (depending on whether if you exclude or include illegal imports respectively) can be thought of as the **minimum** target that would allow the 60% EU target to be met.

Figure 44 Revised Performance v Obligated Business Target (81%) (T)

	Including Illegal Imports	Excluding Illegal Imports
Consumption	2,399,235	2,496,332
Packaging Handled by Producers in 2012	2,049,180	2,049,180
Requirement to meet 60% EU target	1,439,541	1,497,799
Minimum Business Target	70%	73%

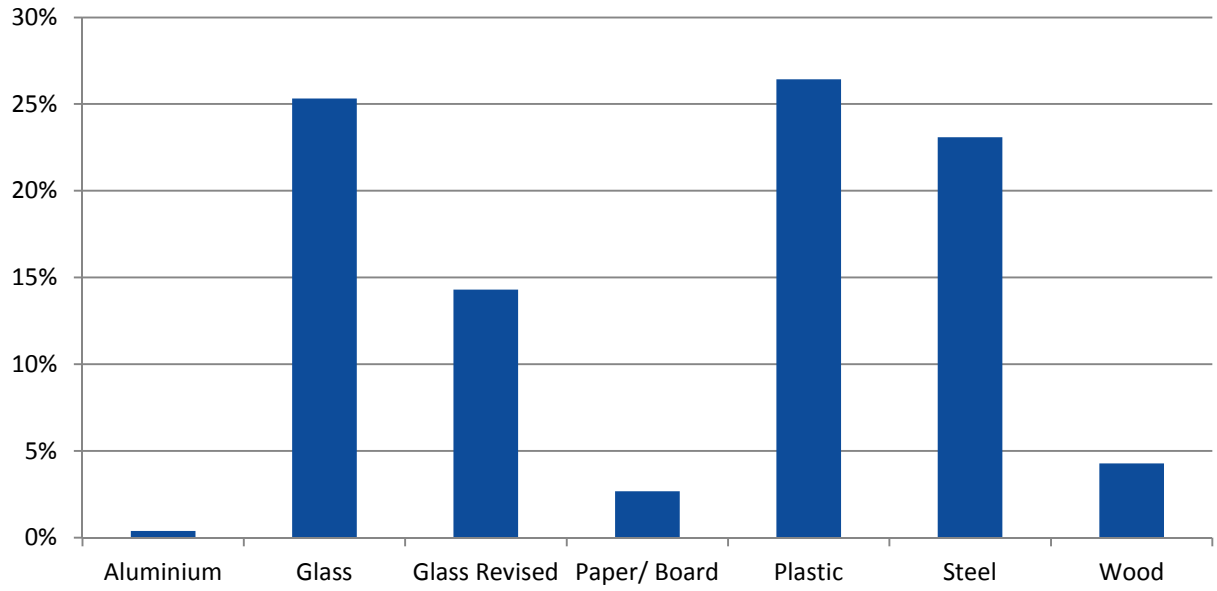
Figure 45 Revised Performance Total Flow v Obligated Flow (exc illegal imports) Illustration



This highlights that, based on the revised flow, a lower obligated business target could still help the UK achieve its EU target of 60% recycling of glass.

It is also useful to place glass in context of other materials. **Figure 46** shows, for each primary packaging material, the proportion of the total flow that is not obligated.

Figure 46 Proportion of Total Flow that is Unobligated[51]



The larger the proportion of unobligated flow, i.e., the more exempt businesses there are, the higher the business target needs to be for businesses that are obligated, to hit the overall EU target. The calculations are based on the current flow of glass (from PackFlow), and show glass as having one of the largest proportions of unobligated flow.

With the revised flow, this reduces from 25% to 14%. This is still large compared to other materials, and when presented to the industry, stakeholders agreed there was no obvious reason why the glass market should have a larger proportion of de-minimums/free riders than other materials.

[51] The revised glass figure is based on illegal imports being excluded

11.3 Increase in Co-mingled Collections

Glass recyclers state that the quality of co-mingled glass is reduced due to contamination from other recyclate as well as the extra sortation required to sort it from other dry recyclate materials (often it is negatively sorted, which means that the other recyclate materials are targeted as a priority and the glass is the remainder). Co-mingled glass and mixed glass collections in the UK have prompted several glass recyclers such as Recresco and Berryman to invest in new glass colour sort technologies.

In order to understand how glass is collected in the UK and if there are trends that could potentially affect the quality of glass being collected, data from WasteDataFlow was examined from 2009 to 2012. **Figure 47** shows the quantity of glass collected by collection method.

Figure 47 Local Authority Glass Collected by Collection Method

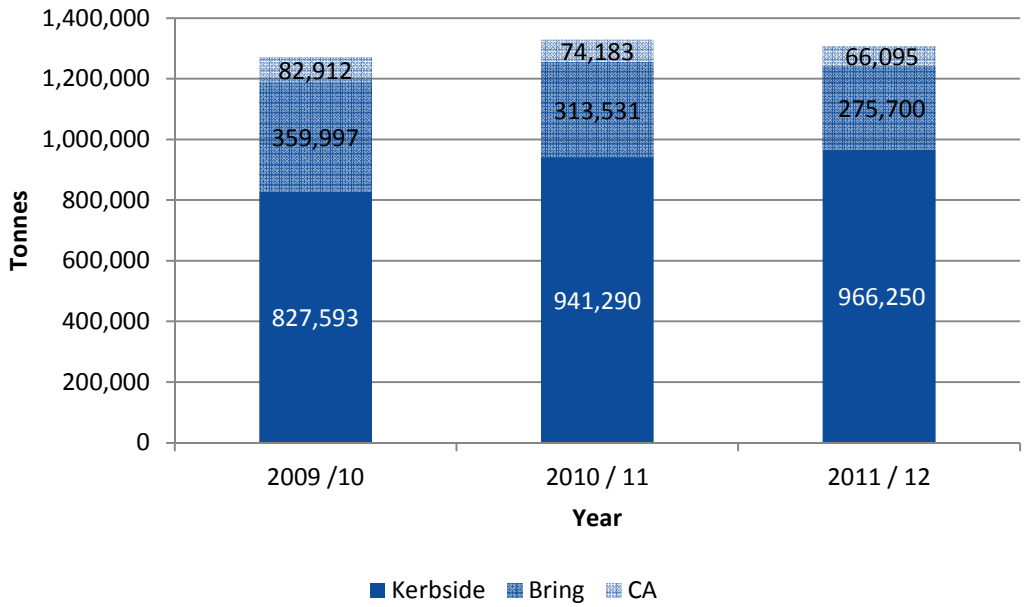


Figure 47 shows that there has been a steady increase in the quantity of local authority glass collected at kerbside. At the same time, the quantity of glass collected at CA sites and bring sites has been decreasing. This shows that over the past three years there has been a shift in how glass is collected in the UK, with more glass now being collected at kerbside.

In order to identify if this change in how glass is collected is affecting the quality of glass, based on the feedback from the stakeholder interviews that co-mingled glass is of a lower quality than colour separated glass; WasteDataFlow was examined to identify the format of glass collected. **Figure 48** shows the format of glass collected from 2009 to 2012.

Figure 48 Format of Local Authority Glass Collected

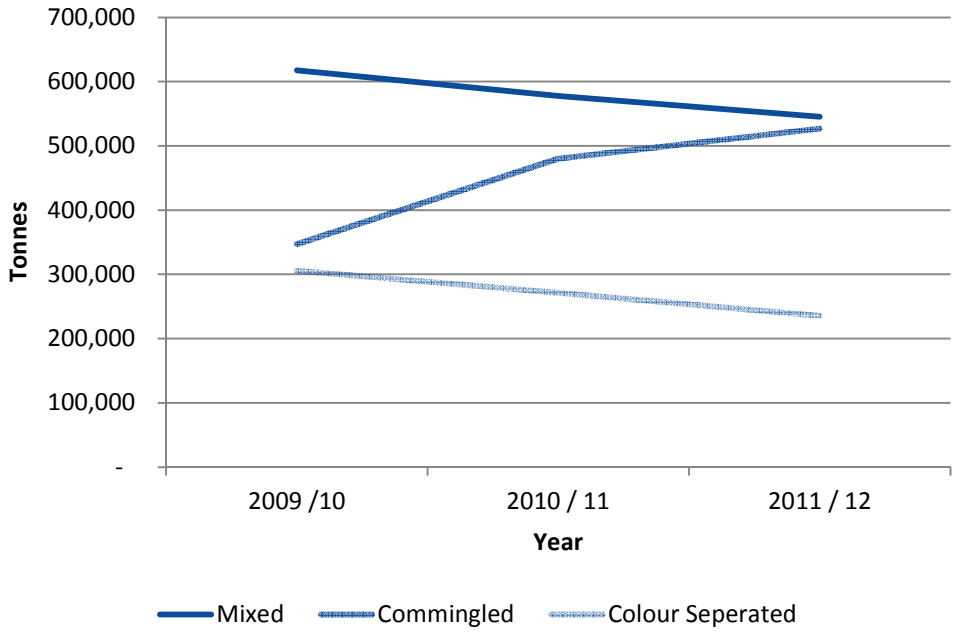


Figure 48 shows that quantity of colour separated and mixed colour glass collected has been steadily decreasing, whilst glass collected co-mingled has been increasing. The views of some reprocessors interviewed were that this has a negative effect on the quality of glass collected in the UK. One interpretation is that, this means not only will it require to be sorted from the other dry recyclate materials, but it will also need to be processed to reduce it in size, remove contaminants and sort by colour (if required) in order for it to meet cullet standards required by the remelt sector (container and fibreglass manufacturing). Essentially, this is pushing the sortation of glass further up the supply chain from the collectors to the glass recyclers/reprocessors. This means that glass recyclers/reprocessors may have to adapt their facilities to accept this material. This increase in co-mingled glass has also seen several glass recyclers such as Recresco and Berryman invest in new glass colour sortation technologies.

11.4 Recycled Content

Another issue that affects glass recycling in the UK is the capacity to which the container remelt sector can utilise glass cullet. This varies by colour; it is estimated that green glass has the highest capacity for including recycled glass with a maximum tolerance of 95%, followed by amber at 65% and clear at 60%[52].

Based on British Glass sales splits by colour (as they do not record production by colour) applied to total glass packaging production and current recycled content percentages of 81.1% (Green), 30.4% (Clear) and 20.2% (Amber) it would indicate that 397k tonnes of cullet was used in clear glass, 304k tonnes in green glass and 93k tonnes in amber glass, giving a total of 795k tonnes of cullet potentially being used. This means that the UK container manufacturing sector could still potentially utilise a further 387k tonnes of clear, 207k tonnes of amber and 52k tonnes of green glass. However, this will depend on the quality of the cullet and cost compared to batch materials.

[52] http://www2.wrap.org.uk/downloads/14975-04_Smart_Guide_Phase_2_-_Sec_5_-_Spec_Rec_Glass.b5961fef.4479.pdf, Accessed (25 / 07 / 13)

It should be noted that the 795k tonnes is higher than the 728k tonnes estimated by GlassFlow and the actual figure may lie somewhere between these estimates. To calculate the 728k the remelt container manufacturing (597k) was added to the imports of glass cullet (131k).

11.5 End of Waste Criteria

This section discusses the change to the end of waste criteria definition and the potential impact of this on the UK glass recycling industry. This specific issue was raised in the stakeholder interviews as having a potential impact going forward; however, the respondents felt that any implications would not be immediate.

The new end of waste regulation for glass cullet (EU Regulation No 1179/2012[53]) sets out criteria for determining when glass cullet destined for remelting processes ceases to be waste.

The regulation states that glass cullet shall cease to be waste where, upon transfer from the producer to another holder, all of the following conditions are fulfilled:

- The cullet resulting from the recovery operation complies with the criteria set out in Section 1 of Annex I;
- The waste used as input for the recovery operation complies with the criteria set out in Section 2 of Annex I;
- The waste used as input for the recovery operation has been treated in accordance with the criteria set out in Section 3 of Annex I;
- The producer has satisfied the requirements set out in Articles 4 and 5; and
- The glass cullet is destined for the production of glass substances or objects in remelt processes.

This essentially means glass will cease to be waste when it meets these criteria and is of a quality suitable for remelt end markets.

The new regulation was adopted on 10th December 2012 and came into force for all EU member states on the 11th June 2013. It will mean that once glass meets the specified criteria it will no longer be considered waste and can therefore be traded between EU member states and exported from the EU as a product that is not subject to waste management controls.

Another implication of this will be that it may influence the point in the supply chain where the PRN can be raised. Currently, the majority of PRNs for glass cullet going into the remelt sector are issued by the remelt organisation undertaking the remelt activity. However, the end of waste criteria for glass cullet may lead to PRNs being issued earlier in the glass packaging supply chain[54], potentially by the glass recycler/reprocessor.

However, in order to comply with the end of waste criteria for glass, a new producer must be independently assessed and certified by a Conformity Assessment Body (CAB) to ensure they comply with the end of waste regulation for glass. CABs are accredited by the relevant national accreditation body to carry out this role, which in the UK is the United Kingdom Accreditation Service (UKAS).
At the time of writing, the EA indicated that no CAB had completed the accreditation process; however, some were progressing their application. This makes it unlikely that many producers will be able to have

[53] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:337:0031:0036:EN:PDF, Accessed (05 / 07 / 13)
[54] http://npwd.environment-agency.gov.uk/, Accessed (05 / 07 /13)

their quality management system certified in 2013. As such, the End of Waste Regulation for glass cullet is not likely to have a significant impact in 2013; rather, any real changes, if they occur, are likely to be seen in 2014 and beyond.

In order to monitor the impact of the end of waste criteria, the EA advises that the quantity of waste accepted by reprocessors, measured by remelt, non-remelt and export should be monitored for several years starting from a base year prior to the introduction of the criteria. **Figure 49** shows baseline data for 2012, from which future changes can be monitored.

Figure 49 2012 Quantity of Waste Accepted by Reprocessors[55]

	Remelt	Non-remelt	Export	Total
Q1	191,447	98,935	72,226	362,609
Q2	176,091	105,485	68,960	350,536
Q3	182,983	106,108	61,943	351,034
Q4	213,192	240,757	108,462	562410
Total	**763,713**	**551,285**	**311,590**	**1,626,588**
%	**46.95%**	**33.89%**	**19.16%**	**100%**

By monitoring the percentage of waste accepted by reprocessors at the remelt and non-remelt stages, the movement in the point of where PRNs are issued can be monitored. The EA cannot break down the remelt/non-remelt categories further due to commercial sensitivities.

Further guidance on the end of waste criteria has been provided by Defra (Adoption of the EU End of Waste Regulations for Glass Cullet and the Implications for the UK Packaging Waste System), and can be found on the following website: http://npwd.environment-agency.gov.uk/.

11.6 Batch v Cullet

Due to the sensitivities around the use of cullet compared to virgin raw materials (batch), a comparison between batch materials and cullet was conducted to identify the point at which it becomes viable to use cullet in the glass manufacturing process. To do this, the costs of producing glass using cullet must be compared to using virgin raw materials (batch). The production of clear and green glass using both cullet and batch materials was examined. By using clear and green glass as examples, a range of costs involved in the production process can be identified.

Batch Costs

The main raw materials used in the production of glass are:

- Soda ash;
- Silica sand;
- Limestone; and
- Dolomite.

Figure 50 shows the costs of the main batch materials in June 2013, used in the production of glass and the quantities of each material required for each type of glass.

[55] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (05 / 07 /13)

Figure 50 Batch Costs for Virgin Glass

Material	Price (£/T)	Clear		Green	
		% Required[56]	Batch Cost (£/T)	% Required[57]	Batch Cost (£/T)
High silica sand	£16.50[58]	60%	£9.90	21%	£3.47
Low silica sand	£12.70[58]	0%	£0.00	42%	£5.33
Soda ash	£198.36[58]	20%	£39.67	19%	£37.69
Limestone	£41.00[58]	14%	£5.74	12%	£4.92
Dolomite	£45.00[59]	6%	£2.70	6%	£2.70
Total batch cost per input tonne			**£58.01**		**£54.11**
Batch cost per output tonne			**£69.61**		**£64.93**

*Note: Producing 1 tonne of glass requires 1.2 tonnes of virgin materials (batch)

This table shows that the material costs for the quantities of batch materials required in the manufacturing process to produce one tonne of glass are £69.61 per tonne (clear glass) and £64.93 per tonne (green glass). British Glass advised that minimal processing of batch materials is required prior to feeding it into the furnace.

Glass Cullet Costs

The principal costs involved in producing glass cullet are:

- Gate price; and
- Processing costs.

British Glass estimates the cost of processing good quality colour separated glass to a cullet standard is approximately £20 per tonne; however, this will depend on the quality of material and type of processing required. This was also verified by Valpak's Recycling Services as a typical processing cost for glass.

[56] http://www.wrap.org.uk/sites/files/wrap/Glass%20Update%20Market%20Situation%20Report%20Autumn%202008.pdf, Accessed (05 / 06 / 13)

[57] http://www.wrap.org.uk/sites/files/wrap/Glass%20Update%20Market%20Situation%20Report%20Autumn%202008.pdf, Accessed (05 / 06 / 13)

[58] British Glass (04 / 07 / 13)

[59] Sibelco (04 / 07 / 13)

Figure 51 shows cost of producing glass cullet.

Figure 51 Glass Cullet Production Costs

Material	Gate Price[60] (£/T)	Processing Costs (£/T)	Total (£/T)
Clear Glass	35 – 42	20	55 – 62
Green Glass	22 – 35	20	42 – 55

It should be noted that the gate price may contain an element of PRN value; however, this is difficult to confirm, and if so, to what level.

Other Costs

Another significant cost incurred in the production of glass is the cost of energy. It is estimated that the total energy required to make a tonne of glass is 1,288 KWh and that using glass cullet rather than virgin materials can save 25% of the energy required to produce glass, which is equivalent to 322 KWh per tonne of glass[61].

By using energy prices at the time of writing, this would indicate that the savings from using recycled cullet could be as high as £8.05 per tonne[62]. Another benefit of using glass cullet is that the furnace can operate at lower temperatures, which places less pressure on the furnace and as such can potentially extend its life. However, it is difficult to estimate the exact cost savings from this benefit.

In addition to direct energy savings from using recycled glass, the glass manufacturing industry has also agreed a voluntary target until 2023 for reducing their energy consumption under the Climate Change Levy (CCL). The CCL is a tax on the taxable supply of specified energy products for use as fuels for lighting, heating and power, by business consumers. By agreeing to these targets, they receive a 65% discount off the full rate of the levy. The use of glass cullet helps the industry meet these targets.

The savings under the CCL can be calculated based on the total energy per tonne used to make glass[63]. If this is multiplied by the levy of £0.00182 per kilowatt hour[64], then a levy of £2.34 per tonne is paid using virgin materials. However, if the industry meets its target using glass cullet and receives the discount of 65%, then this reduces the levy to £0.82 per tonne, achieving a saving of £1.52 per tonne.

Another cost potentially incurred during the glass manufacturing process is from carbon emissions. Under the EU emissions trading scheme, if installations exceed their allowances, they must purchase further allowances to meet their emissions obligations. British Glass estimates that using virgin materials to produce glass generates 843 kg CO_2/tonne, whereas using cullet produces 529 kg CO_2/tonne[65]. Therefore, if a glass manufacturer has to purchase allowances, based on carbon prices at the time of writing, they could cost £5.75 per tonne[66]; however, by using recycled glass and the subsequent drop in emissions, it could be worth £1.81 per tonne.

[60] http://www.letsrecycle.com/prices/glass, Accessed (05 / 06 / 13)
[61] http://www.britglass.org.uk/Files/CarbonTrust-Cullet-Energy.pdf, Accessed (13 / 04 / 13)
[62] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/208286/qep_june_2013.pdf, Accessed (04 / 07 / 13)
[63] http://www.wrap.org.uk/downloads/Glass_MSR_update_online.74c6002a.6009.pdf, Accessed (23 / 03 / 13)
[64] http://www.hmrc.gov.uk/budget2008/bn84.pdf, Accessed (23 / 03 / 13)
[65] www.packagingfedn.co.uk/images/reports/Enviros_Report.pdf, Accessed (08 / 07 / 13)
[66] http://www.bloomberg.com/news/2012-12-31/eu-carbon-has-yearly-slump-as-slow-economic-output-cuts-demand.html, Accessed (05 / 07 / 13)

Summary of Costs

Figure 52 shows the material/regulatory costs that vary between the batch materials and glass cullet.

Figure 52 Glass Production Costs

		Material Costs	Energy	CCL	Carbon Emissions	Total Cost
Batch Costs	Clear	£69.61	£32.20	£2.34	£4.85	£109.00
	Green	£64.93	£32.20	£2.34	£4.85	£104.32
Cullet	Clear	£62 - 55	£24.15	£0.82	£3.04	£90 - 83
	Green	£55 - 42	£24.15	£0.82	£3.04	£83 - 70

Figure 52 shows that there are significant cost savings from using recycled glass cullet compared to batch materials. By including the potential savings from energy, the Climate Change Levy and carbon emissions, using glass cullet in the production of glass can potentially save container glass manufacturers between £19 - £26 per tonne for clear glass and £21 – £34 for green glass. However, it should be noted that these calculations are based on processing costs for colour sorted glass, and as such, if the glass is heavily contaminated or mixed colour then the processing costs may be higher, bringing it more in line with the cost of using batch materials.

It should be noted that no direct revenue from the PRN has been considered at this point to allow for a direct comparison between batch and cullet materials. However, the PRN value will further increase the cost effectiveness of using glass cullet in the manufacturing process.

11.7 PRN Spend

Due to the changing format of glass being collected in the UK and the high PRN prices witnessed at the end of 2012, the areas where PRN/PERN revenues are being invested was reviewed. Data was extracted from the National Packaging Waste Database: 2012 Reprocessor and Exporter UK Revenue Report. **Figure 53** shows the areas where PRN/PERN revenues from glass were invested in 2012.

Figure 53 PRN Revenue Spend (2012)

Material	Infrastructure and capacity	Funding collection	Reduction in price and developing new markets	Costs of complying with the regulations	Retained for future investment	Developing communication strategies	TOTAL
Glass (Rep) (£k)	4,266	8,680	9,463	680	3,564	247	£26,900
Glass (Exp) (£k)	3,278	6,969	3,761	104	3,728	6	£17,847
Total (£k)	**7,543**	**15,650**	**13,224**	**784**	**7,292**	**254**	**£44,747**
Total (%)	**17%**	**35%**	**30%**	**2%**	**16%**	**1%**	**100%**

In order to determine if there are any trends in PRN/PERN revenue investment, the 2012 data was compared with 2008 data; the last year of available data.

Figure 53 shows the funding of collections received the greatest proportion of PRN/PERN revenue investment in 2012 at 35%. However, if this is compared to 2008, the funding of collections received 73% of the investment. This may be due to the collection infrastructure now being mature or may reflect the cost savings from collecting the glass co-mingled.

In comparison to 2008, infrastructure and capacity has increased from a share of 13% in 2008 to 17% in 2012. This may be due to an increase in investment in new equipment to process glass, which is increasingly being collected in co-mingled collections, as shown earlier in the report. This trend looks set to continue in 2013 as demonstrated by announcements about investment in capacity by some of the UK's largest reprocessors. This includes the new recycling plant that Recresco are locating in Swanscome. This plant will be able to take 40 tonnes of glass an hour for cleaning and sorting, before removing materials such as ceramics and paper to produce furnace ready cullet to distribute to glass manufacturers[67].

Another investment recently announced is by Berryman, which is set to invest £9 million in improving its operations. The investment is being split between two sites: Knottingley and South Kirkby, although the bulk of the investment will be spent on upgrading the colour separation equipment at the firm's Knottingley site to improve cullet quality[68].

Another significant increase from 2008 to 2012 is seen in the reduction of price and developing new markets. This has risen from a proportion of 2% in 2008 to 30% in 2012.

11.8 Fraud

An issue that was raised in the stakeholder interviews, and was also identified at the start of the project, was the issue of fraudulent PRNs being issued. In October 2012, Nationwide Recycling Limited admitted falsifying the amount of glass they said they had recycled between 2009 and 2010[69]. These activities were thought to have brought in more than £2 million in PRN revenue for non-existent recycled material. Therefore, the amount of recycling being reported through issued PRNs was artificially high. **Figure 54** provides an estimate of how much recycling was overstated in this period.

Figure 54 PRN Fraud 2009 – 2010

Fraudulent PRN Revenue	£2,000,000
Average Glass PRN Price (High)	£20
Average Glass PRN Price (Low)	£10
Estimated Fraudulent PRNs (High) (T)	100,000
Estimated Fraudulent PRNs (Low) (T)	200,000

Assuming that the fraudulent PRN revenue was £2,000,000 and taking an average high and low PRN price of between £20 - £10 per tonne of Glass between 2009 and 2010[70], it is estimated that the UK overstated its glass recycling by between 100k and 200k. Therefore, in 2011 and 2012 this reported recycled tonnage would have dropped out of the system, which is another factor that made it harder to meet the 2012 glass recycling target. At the time of writing, the trial of Nationwide Recycling is still on-going; however, with the case being high-profile it sends out a message to the rest of the industry about the real dangers of participating in fraudulent activity.

It is also important to note that this is likely to be a low estimation of the level of fraud in the system because this figure only relates to the fraud that has actually been uncovered. Additionally, if other

[67] http://www.letsrecycle.com/news/latest-news/glass/recresco-glass-recycling-plant-set-for-kent, Accessed (08 / 07 / 13)
[68] http://www.letsrecycle.com/news/latest-news/glass/berryman-to-invest-ps9m-in-glass-recycling-sites, Accessed (08 / 07 / 13)
[69] http://www.letsrecycle.com/news/latest-news/glass/guilty-pleas-in-glass-recycling-case, Accessed (05 / 07 / 13)
[70] http://www.letsrecycle.com/prices/prn/prns-prices-archive/prices?subCategory=2009, Accessed (05 / 07 / 13)

organisations are committing fraud and are following this case and its outcomes, it is possible that they may now be more inclined to reduce/stop any fraudulent activities. As a result, the amount of fraudulent reporting of glass recycling in the UK could be reducing.

12. Scenario Development

12.1 Introduction

In this section of the report, scenarios were developed to project future potential glass recycling levels in the UK. Three scenarios developed were:

- Baseline Projections;
- Reduced Consumption; and
- Increased Co-mingled Collections.

The details of these are explored in the following sections. They have been projected forward until 2017 as this is the timeframe for the current packaging recovery targets.

12.2 Baseline Projections

The first of the scenarios is a baseline projection. This uses the PackFlow 2017[71] projections for the consumption figures. This is shown in **Figure 55**.

Figure 55 PackFlow Consumption Projections (T)

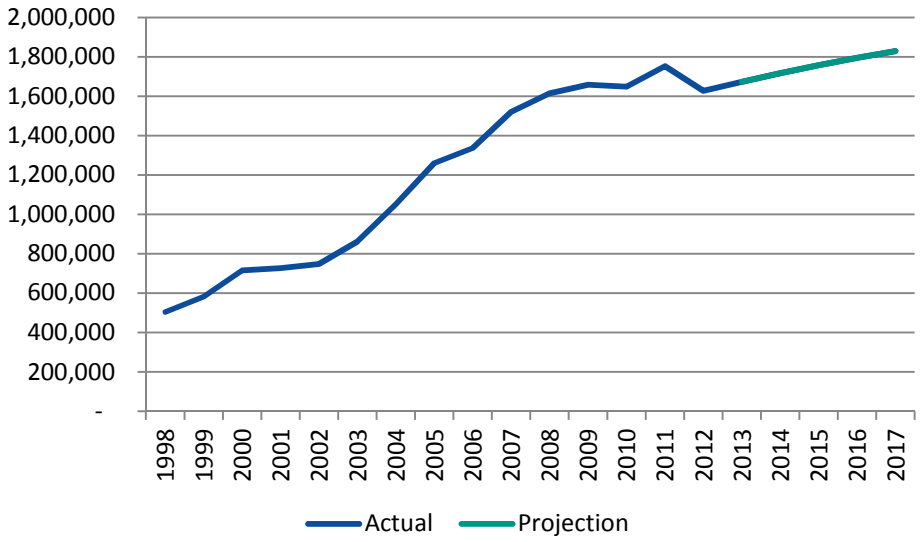
	2013	2014	2015	2016	2017
PackFlow Mid Point	2,781,000	2,809,000	2,837,000	2,865,500	2,894,000

Although it is believed that the actual consumption is lower than the PackFlow numbers, these figures are used to set the targets and are therefore included in the baseline projection scenario.

PackFlow 2017 also includes projections for collections. These are calculated using a time series regression technique known as autoregression. This method is further detailed in Appendix X and instead of looking for patterns and possible correlation between recycling levels and other variables; the process involves regressing the current recycling tonnages against the historical recycling tonnages. This forecasting method therefore anticipates the future, based on the immediate past. A variety of lags were modelled but, using the Bayes information criterion, the regression was run with one lag as this was the most appropriate. The latest data for collections in Packflow 2017 was for the year 2010. As per this present report, there is now data for 2011/12. Therefore, the autoregression-based forecasts were updated to take account of the most up-to-date data to produce revised collection projections. As before, in this section, tonnages 'collected for recycling' equal tonnages recycled as evidenced by PRN/PERN. It is important to note that no allowance was made for potentially overstated collection figures, due to fraud as discussed in Section 11.8, for the years 2009 and 2010. This would reduce the collection figures and therefore the revised projection would be lower than has been calculated. The revised collection projections are shown in **Figure 56**.

71 http://www.valpak.co.uk/Libraries/Environmental_Consulting_Documents/PackFlow_2017_Final_Report_09_11_12.sflb.ashx, Accessed (08 / 07 / 13)

Figure 56 Collection Projections 1998 – 2017 (T)



The approach taken here develops a mechanical projection based on a simple regression model with a one year lag structure. The implication of this is that projected growth in glass collection is linear and equal to growth in the previous year. Therefore, this methodology does not provide a particularly sophisticated projection and ignores factors such as: the maturity of the collection system, where if collection systems were believed to be mature, then growth would be expected to level off; the timing of potential future policy interventions in recycling markets or the timing of possible changes in legislation; other potential external influences which might impact on the glass recycling market.

As shown in **Figure 56**, it is projected that total collections will increase slowly between 2013 and 2017, following the drop in collection tonnages in 2012 from 2011. Indeed, on this basis it is only in 2016 and 2017 that collection levels will be above the level of 2011. It is assumed that for the period 2013-2017 the 2012 split between consumer and non-consumer will remain the same (75% and 25% respectively). Additionally, it is assumed for the baseline projection that the co-mingled, mixed colour and colour separated splits will remain the same as they were in 2012 (53%, 36% and 10% respectively). The summary of the baseline projection is shown in **Figure 57**.

Figure 57 Baseline Projections Recycling Rates (T)

	2013	2014	2015	2016	2017
Consumption	2,781,000	2,809,000	2,837,000	2,865,500	2,894,000
Collection	1,673,153	1,716,491	1,756,828	1,794,370	1,829,312
Consumer Collection	1,252,225	1,284,661	1,314,849	1,342,947	1,369,098
Co-mingled	*666,828*	*684,101*	*700,177*	*715,139*	*729,065*
Mixed Colour	*453,939*	*465,697*	*476,641*	*486,826*	*496,306*
Colour Separated	*131,458*	*134,863*	*138,032*	*140,982*	*143,727*
Non-Consumer Collection	420,928	431,831	441,979	451,423	460,214
Recycling Rate	60%	61%	62%	63%	63%

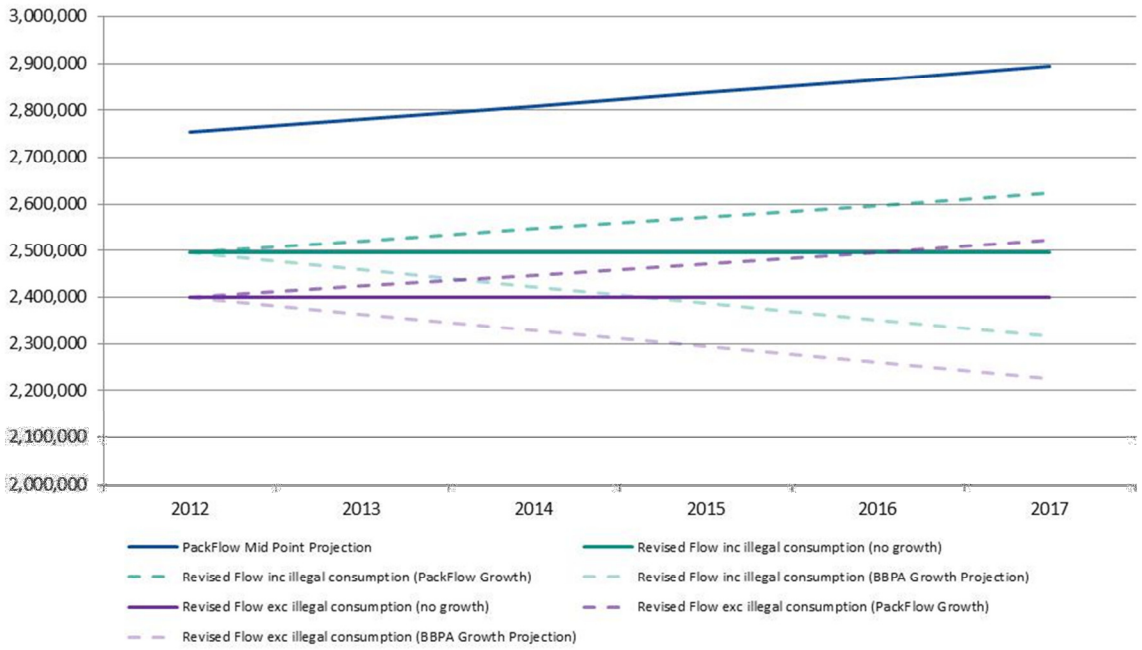
As shown, even assuming the PackFlow higher consumption, the EU directive target of 60% will be met each year under the projected collection levels. However, the target is only just met (over achieving by <1% to 3%), which leaves little margin for error. Therefore, if the collection figures deviate slightly from what is projected, there is a risk the recycling targets will not be met.

12.3 Reduced Consumption

The second scenario is based on the reduced flow calculated in this report. This GlassFlow report has demonstrated that the PackFlow consumption figure for 2012 (and before) is potentially higher than the actual consumption of glass packaging.

A range of reduced flows projections for the period 2013 to 2017 have been calculated. The middle projection takes the consumption figure in 2012 excluding and including illegal growth and projects this forward until 2017 with zero growth. Zero growth was assumed as the revised flow showed little growth between 2008 and 2012, and was agreed to be the most likely scenario, following discussions with trade bodies at GlassFlow stakeholder meetings. The upper range adopts the PackFlow 2017 assumption that consumption would average 1% annual growth; therefore, this was also applied to the revised flow figure in 2012. This is supported by a Visiongain report[72] that states that the glass packaging market is forecast to record 'modest continuous growth' over the next decade, although this was at a global level. The lower band projection was based on information from the BBPA that have projections on the different beer markets. From that, the proportion of the respective markets that are currently glass were weighted and assumed to stay the same. The range of these projections until 2017 is shown in **Figure 58**.

Figure 58 Consumption Projections 2013-2017 (T)



As shown, if there is no growth between 2013 and 2017 (as was the case between 2008 and 2012 and deemed likely by the trade associations), then the gap between the revised flow and the PackFlow will increase every year. This means that the gap between the actual flow of glass and the projected PackFlow estimates, currently used to calculate obligated producer targets, will continue to increase.

[72] http://www.visiongain.com/Report/950/Global-Glass-Packaging-Market-2013-2023, Accessed (08 / 07 / 13)

Collection projections are as per the 'baseline projections' scenario in section 12.2. **Figure 59** highlights the recycling rates associated with each flow for the projection period. This is assuming the collection tonnages match those in **Figure 57**.

Figure 59 Consumption Projections Recycling Rates

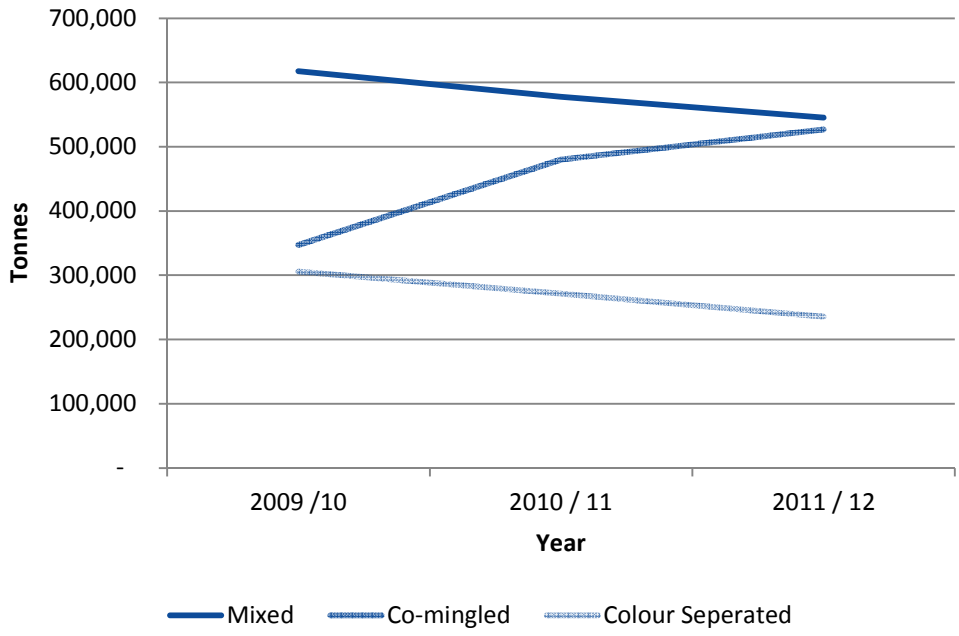
	2012	2013	2014	2015	2016	2017
PackFlow Mid Point	2,753,500	2,781,000	2,809,000	2,837,000	2,865,500	2,894,000
Recycling Rate	*59%*	*60%*	*61%*	*62%*	*63%*	*63%*
Revised Flow (1% annual growth)	2,399,235	2,423,227	2,447,460	2,471,934	2,496,653	2,521,620
Recycling Rate	*68%*	*69%*	*70%*	*71%*	*72%*	*73%*
Revised Flow incl illegal imports (1% annual growth)	2,496,332	2,521,295	2,546,508	2,571,973	2,597,693	2,623,670
Recycling Rate	*65%*	*66%*	*67%*	*68%*	*69%*	*70%*
Revised Flow (no growth)	2,399,235	2,399,235	2,399,235	2,399,235	2,399,235	2,399,235
Recycling Rate	*68%*	*70%*	*72%*	*73%*	*75%*	*76%*
Revised Flow incl illegal imports (no growth)	2,496,332	2,496,332	2,496,332	2,496,332	2,496,332	2,496,332
Recycling Rate	*65%*	*67%*	*69%*	*70%*	*72%*	*73%*
Revised Flow (BBPA Projection)	2,399,235	2,363,482	2,328,262	2,293,567	2,259,389	2,225,720
Recycling Rate	*68%*	*71%*	*74%*	*77%*	*79%*	*82%*
Revised Flow incl illegal imports (BBPA Projection)	2,496,332	2,459,132	2,422,487	2,386,388	2,350,827	2,315,795
Recycling Rate	*65%*	*68%*	*71%*	*74%*	*76%*	*79%*

As shown, the revised flow leads to higher recycling rates and reduces the likelihood of the UK not achieving the EU directive target of 60%.

12.4 Increased Co-mingled Collections

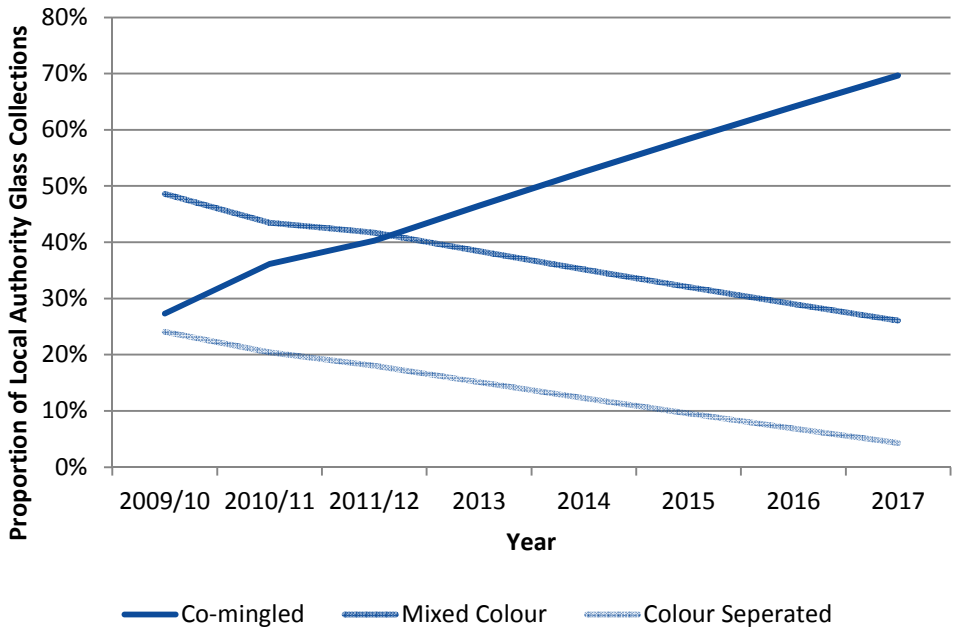
The third scenario is based on the proportion of collections made up of co-mingled material. As previously identified in the key findings section of the report, the proportion of co-mingled glass collected by local authorities is increasing. This is shown in **Figure 60**.

Figure 60 Collection Proportions 2009/10 – 2011/12



This is based on WDF data and shows the proportion of co-mingled material increasing. This trend was projected forward until 2017 (by simple linear extrapolation); this is shown in **Figure 61**.

Figure 61 Collection Proportions 2009/10 - 2017



These proportions are then applied to the collection figures; this is summarised in **Figure 62**. Total collection levels and consumption levels (assuming flat growth post 2012) are as per section 12.3. This scenario simply illustrates the potential scale of the relative collection types.

Figure 62 Increased Co-mingled Collections (T)

	2013	2014	2015	2016	2017
Collection	1,673,153	1,716,491	1,756,828	1,794,370	1,829,312
Consumer Collection	1,252,225	1,284,661	1,314,849	1,342,947	1,369,098
Co-mingled	*582,297*	*657,853*	*731,330*	*802,813*	*872,382*
Mixed Colour	*223,500*	*204,773*	*186,561*	*168,844*	*151,601*
Colour Separated	*33,785*	*27,488*	*21,364*	*15,406*	*9,607*
Non-Consumer Collection	420,928	431,831	441,979	451,423	460,214

This shows that if the trend of increasing co-mingled collections is projected forward until 2017, there will be nearly 900k tonnes of glass packaging collected co-mingled in the UK.

13. National Breakdown: Scotland & Wales

13.1 Introduction

The consumption and collection figures were split down to a Scottish and Welsh level[73]. Additionally, the level of sortation, reprocessing and end markets within each country is identified.

13.2 Country Split Methodology

The consumption of packaging is broken down into consumer flow and non-consumer flow; both having different characteristics. Therefore, different country split methodologies were investigated for each.

13.2.1 Consumer

The consumer split was based on the quantity of households in each country. The Department for Communities and Local Government (DCLG)[74] holds projections for household numbers in the UK until 2033. The sources for the projections were DCLG, Welsh Government, Scottish Executive and the Northern Ireland Statistics Research Agency. This information is summarised in **Figure 63**.

Figure 63 UK Household Projections 2013-2033 (thousand households)

		2013	2018	2023	2028	2033
UK		27,407	28,870	30,284	31,621	32,849
Scotland	#	2,440	2,550	2,645	2,732	2,813
	%	8.9%	8.8%	8.7%	8.6%	8.6%
Wales	#	1,366	1,440	1,509	1,569	1,620
	%	5.0%	5.0%	5.0%	5.0%	4.9%

This analysis would suggest applying an 8.9% and 4.98% split to the UK flow in order to calculate the Scottish and Welsh flows, respectively. However, household numbers are not a perfect proxy for glass flowing onto the market as spending habits vary between households, with some buying more products packaged in glass than others. Therefore, an analysis was completed on household spending patterns by country.

As previously discussed, the majority of the consumer consumption of glass packaging is alcohol packaging (75%). Therefore, alcohol consumption was treated as a proxy for glass packaging consumption.

A study by Nielsen investigated the sales of alcoholic beverages within the UK in 2011. This broke down the sales volume of alcoholic beverages by region for off trade sales. The volume equates to glass packaging consumption and off trade equates to consumer sales. The figures are shown in **Figure 64**[75].

[73] This a joint funded report, through WRAP, by the four governments and there was interest, in addition to the UK-wide focus of the report, in including a separate breakdown for Wales and Scotland

[74] http://webarchive.nationalarchives.gov.uk/20121108165934/http://communities.gov.uk/corporate/, Accessed (03 / 07 / 13)

[75] Nielsen (Wales and West region broken down by ONS data)

Figure 64 Regional Sales Volume Of Alcoholic Drinks 2011 (UK Off Trade)

	Proportion of sales volume (%)			
Region	Beer	Spirits	Cider	Wine
Scotland Off Trade	9.4	14.1	10.1	9.4
Wales Off Trade	4.8	4.3	6.9	4.9
GB Off Trade	100.0	100.0	100.0	100.0

The VDS sales proportion for beer, spirits, cider and wine was applied to the regional splits of alcoholic sales volume. This is shown in **Figure 65**.

Figure 65 Weighted Regional Breakdown of Alcoholic Sales

	Proportion of sales volume (%)				
	Beer	Spirits	Cider	Wine	Total
Weight	40%	12%	1%	47%	100%
Region					
Scotland Off Trade	9.4	14.1	10.1	9.4	
Wales Off Trade	4.8	4.3	6.9	4.9	
UK Off Trade	100.0	100.0	100.0	100.0	
Weighted Region					
Scotland Off Trade	3.7	1.7	0.1	4.4	10.0
Wales Trade	1.9	0.5	0.1	2.3	4.8
UK Off Trade	39.8	12.1	1.1	47.1	100.0

Therefore, Scotland has a 10% weighting and Wales is weighted at 4.8% for the consumer flow.

13.2.2 Non-Consumer

In order to split out the non-consumer flow, an analysis of business activity in the UK was completed. The Office of National Statistics (ONS) produced a bulletin of UK Business: Activity, Size and Location, 2012[76]. This included information on the number of local units in VAT and/or PAYE based enterprises in 2012 broken down by standard industrial classification (UK SIC 2007) by both region and employment size.

On the assumption that the non-consumer flow would be primarily from pubs, clubs and restaurants, the SIC code investigated was *56: Food and beverage service activities.* This data is summarised in **Figure 66**.

[76] http://www.ons.gov.uk/ons/rel/bus-register/uk-business/2012/index.html, Accessed (03 / 07 / 13)

Figure 66 Food & Beverage Service Activities Breakdown

Food and beverage service activities	Employment size								
	0 - 4	5 - 9	10 - 19	20 - 49	50 - 99	100 - 249	250 - 499	500 +	TOTAL
North East	2,420	1,450	925	485	80	10	0	5	5,375
North West	7,240	3,950	2,230	1,475	220	55	5	10	15,185
Yorkshire and The Humber	5,600	3,050	1,760	975	165	25	5	0	11,580
East Midlands	4,655	2,530	1,370	850	105	35	0	0	9,545
West Midlands	5,805	2,875	1,485	1,040	150	25	10	10	11,400
East	6,600	3,425	1,825	1,045	155	40	5	0	13,095
London	10,805	5,770	3,925	2,615	515	150	15	10	23,805
South East	9,830	5,650	3,230	1,890	275	60	15	5	20,955
South West	6,230	3,875	2,390	1,270	135	30	5	5	13,940
Wales	3,760	1,935	990	510	90	15	0	0	7,300
Scotland	5,465	3,330	1,965	1,055	180	30	5	0	12,030
Northern Ireland	1,690	1,265	740	305	65	10	0	0	4,075
TOTAL	**70,100**	**39,105**	**22,835**	**13,515**	**2,135**	**485**	**65**	**45**	**148,285**

It is also assumed that those companies with a higher employment size will contribute more to the C&I glass flow. Therefore, the average employment size was calculated (500+ assumed as 500) and given an equivalent weighting. The weighted numbers were then calculated for each region. The numbers are summarised below.

Figure 67 Weighted Food & Beverage Service Activities Breakdown

Employment Size	0 - 4	5 - 9	10 - 19	20 - 49	50 - 99	100 - 249	250 - 499	500 +	Total (%)
Ave Employment Size	2	7	15	35	75	175	375	500	
Weighting	0%	1%	1%	3%	6%	15%	32%	42%	
Wales Bus #	3,760	1,935	990	510	90	15	-	-	
Scotland Bus #	5,465	3,330	1,965	1,055	180	30	5	-	
UK Bus #	70,100	39,105	22,835	13,515	2,135	485	65	45	
Wales (weighted number)	6	11	12	15	6	2	-	-	4.15%
Scotland (weighted number)	9	20	24	31	11	4	2	-	7.97%
UK (weighted number)	119	232	280	395	135	72	21	19	100.00%

As shown, using this methodology, Scotland has a 7.97% weighting and Wales is weighted at 4.15% for the non-consumer flow. This was compared to the number of licensed premises in each country. This is shown below[77].

Figure 68 UK License Numbers

	UK	Scotland	Wales
Number of Licences	187,707	16,296	10,899
Proportion of Licences	100%	8.68%	5.81%

As shown, there is a slight difference in the weighting with each method, so an average between the two was used. Therefore, Scotland has an 8.33% weighting and Wales is weighted at 4.98% for the non-consumer flow.

[77] Source: British Beer and Pub association (number of Ireland licences not available so this was scaled up based on ONS population data to get an estimate for the UK total).

13.3 Scotland

13.3.1 Glass Packaging Consumption

Based on the country splits for Scotland, the consumption is summarised in **Figure 69**.

Figure 69 Scotland Glass Consumption (T) Excluding and Including Illegal Imports

	2008	2009	2010	2011	2012
Total Consumption	225,305	228,897	234,893	231,287	229,218
Total Consumer Consumption	172,757	175,512	180,109	177,345	179,162
Clear	*77,741*	*78,980*	*81,049*	*79,805*	*80,623*
Amber	*17,276*	*17,551*	*18,011*	*17,734*	*17,916*
Green	*77,741*	*78,980*	*81,049*	*79,805*	*80,623*
Total Non-Consumer Consumption	52,548	53,385	54,784	53,943	50,056
Clear	*30,150*	*30,631*	*31,433*	*30,951*	*28,721*
Amber	*8,043*	*8,172*	*8,386*	*8,257*	*7,662*
Green	*14,354*	*14,583*	*14,965*	*14,735*	*13,673*

	2008	2009	2010	2011	2012
Total Consumption	234,509	238,248	244,489	240,778	238,526
Total Consumer Consumption	180,013	182,883	187,674	184,826	186,606
Clear	*81,006*	*82,298*	*84,453*	*83,172*	*83,973*
Amber	*18,001*	*18,288*	*18,767*	*18,483*	*18,661*
Green	*81,006*	*82,298*	*84,453*	*83,172*	*83,973*
Total Non-Consumer Consumption	54,496	55,365	56,815	55,952	51,920
Clear	*31,268*	*31,767*	*32,599*	*32,103*	*29,790*
Amber	*8,342*	*8,475*	*8,696*	*8,564*	*7,947*
Green	*14,886*	*15,124*	*15,520*	*15,284*	*14,183*

13.3.2 Collection of Glass

The WDF data is broken down by LA, so it is possible to extract WDF data specific to Scotland. In terms of C&I collections this was sourced from Zero Waste Scotland[78]. The LA collections by source are presented below.

Kerbside

Figure 70 shows the quantity of glass collected in Scotland at kerbside.

[78] http://www.zerowastescotland.org.uk/sites/files/wrap/ZWS%20Glass%20Options%20Appraisal%20IMR001-002_2.pdf, Accessed (18 / 04 / 13)

Figure 70 Scottish Local Authority Glass Collected at Kerbside (T)

	Kerbside					
	Co-mingled	Mixed	Colour Separated			Total
			Green	Brown	Clear	
Scotland	1,818	25,431	7,779	2,697	8,721	**46,445**
UK Total Glass Packaging Collected	514,542	350,271	49,366	9,861	42,209	**966,250**

This shows that the majority of glass collected by local authorities in Scotland at kerbside is mixed glass. It also shows that Scotland accounts for 4.81% of the glass collected at kerbside in the UK. It is also worth noting that Scotland collects a proportionally high amount of glass that is colour separated, in comparison to the rest of the UK.

Bring Sites

Figure 71 shows the quantity of glass collected in Scotland at bring sites.

Figure 71 Scottish Local Authority Glass Collected at Bring Sites (T)

	Bring					
	Co-mingled	Mixed	Colour Separated			Total
			Green	Brown	Clear	
Scotland	1,113	11,375	13,002	4,292	13,176	**42,958**
UK Total Glass Packaging Collected	6,641	151,553	55,716	14,079	47,710	**275,700**

This shows that the majority of glass collected by local authorities in Scotland at bring sites is colour segregated, accounting for 71% of glass collected from this source. A further 26% is collected mixed colour and 3% co-mingled. It also shows that Scotland accounts for 15.6% of the glass collected at bring sites in the UK.

CA Sites

Figure 72 shows the quantity of glass collected in Scotland at CA sites.

Figure 72 Scottish Local Authority Glass Collected at CA Sites (T)

	CA Sites					
	Co-mingled	Mixed	Colour Separated			Total
			Green	Brown	Clear	
Scotland	1,011	959	2,381	1,011	2,687	**8,050**
UK Total Glass Packaging Collected	5,881	43,510	6,636	2,409	7,659	**66,095**

This shows that the majority of glass collected by local authorities in Scotland from CA sites is colour segregated, accounting for 76% of glass collected from this source. A further 12% is collected mixed colour and 13% co-mingled. It also shows that Scotland accounts for 12% of the glass collected at CA sites in the UK.

C&I Collections

The total C&I collections for Scotland is shown in **Figure 73**. This was taken from Zero Waste Scotland[79].

Figure 73 Scotland C&I Collections (T)

C&I Collections	38,000

A summary of collected glass by source in Scotland is shown in **Figure 74**.

Figure 74 Summary of Scottish Glass Collections (T)

	Total	Kerbside	Bring	CA
Local Authority Collections	**97,453**	46,445	42,958	8,050
C&I Collections	**38,000**	0	0	0
Scotland Total Glass Packaging Collected	**135,453**	46,445	42,958	8,050

This shows that during 2011/12 there were 135k tonnes of glass collected for recycling in Scotland. Scottish LAs collected 97k tonnes of glass. Of this, 48% was collected at kerbside, 44% from bring sites and 8% from CA sites. C&I collections accounted for 38k tonnes. **Figure 75** shows the recycling rate for Scotland, which is 59-57% (depending on whether illegal imports are included or not).

Figure 75 Scotland Recycling Rate 2012

Revised Consumption (excl illegal imports)	229,218
Revised Consumption (incl illegal imports)	238,526
Total Collections	135,453
Recycling Rate (excl illegal imports)	59%
Recycling Rate (incl illegal imports)	57%

It is important to note that this is slightly higher than the Zero Waste Scotland figures[80] in terms of recycling rate, which suggested a 52% recycling rate. This was based on a higher total consumption of 277k (against a GlassFlow consumption of 240k) and a collection figure of 144k (against a GlassFlow collection figure of 135k). Additionally, Zero Waste Scotland believes there will be an increase in glass collections of ~72k tonnes based on new legal duties within the Waste (Scotland) Regulations 2012, as currently proposed.

[79] http://www.zerowastescotland.org.uk/sites/files/wrap/ZWS%20Glass%20Options%20Appraisal%20IMR001-002_2.pdf, Accessed (18 / 04 / 13)
[80] http://www.zerowastescotland.org.uk/sites/files/wrap/ZWS%20Glass%20Options%20Appraisal%20IMR001-002_2.pdf, Accessed (18 / 04 / 13)

13.3.3 MRF Sortation

Figure 76 provides a summary of Scottish MRFs accepting glass and their estimated quantities of glass received per annum.

Figure 76 MRFs Scotland[81]

Name of Facility	Location	Glass Inputs and Outputs	Approx. Annual Tonnage	Market
Alloa Community Enterprises	Alloa	Colour sorted	1,500	OI - Alloa
Barr Environmental	Ayr	Colour sorted	100	OI - Alloa
ChangeWorks Recycling	Edinburgh	Mixed colour	150	Viridor - Bonnyrigg
East Ayrshire Council	Kilmarnock	Mixed colour	3,000	Viridor - Bonnyrigg
Eilean Siar (Western Isles Council)	Western Isles	Mixed colour	500	Siar Glass (decorative)
Glasgow City Council	Glasgow	Mixed colour	6,500	Viridor - Bonnyrigg
Inverclyde Council	Inverclyde	Mixed colour	1,000	OI - Alloa
Lowmac Alloys - North Ayrshire	Irvine	Both	1,500	Viridor - Bonnyrigg
Shanks, Blochairn MRF	Glasgow	Mixed colour	550	Viridor - Bonnyrigg
Shanks	West Lothian	Mixed colour	1,700	Viridor - Bonnyrigg
Shetland Gremista	Shetlands	Mixed colour	600	Enviroglass aggregates and filtration media
Viridor at Bargeddie	Glasgow	Both	9,200	Viridor - Bonnyrigg
Viridor Gilmerton	Edinburgh	Both	1,800	Viridor - Bonnyrigg
Viridor Glass - Bonnyrigg	Bonnyrigg	Both	100,000*	Fibre glass, concrete blocks, remelt and aggregates
William Tracy - Linwood	Paisley	Both	4,500	OI - Alloa

*This is estimated capacity (not throughput)

It is estimated that 27.5k tonnes of glass goes to typical MRF facilities in Scotland for bulking or sortation, with the remainder going direct to glass recycler/reprocessor facilities that have specialist glass processing technologies. An example of this is the facility owned by Viridor in Bonnyrigg, which is a specialist glass reprocessing facility that has invested in sortation and capacity.

It is important to note that there are some MRFs in Scotland that don't handle glass at their sites, due to contamination and the cost of investment.

[81] http://www.wrap.org.uk/content/glass-collection-re-processing-options-appraisal-scotland-0, Accessed (18 / 04 / 13)

13.3.4 Reprocessing

The companies registered as accredited Scottish glass reprocessors and exporters are listed by size, location, primary function and end market and shown in **Figure 77**.

Figure 77 Accredited Reprocessors and Exporters - Scotland

Company	Size	Site Address	Function	End Market
Comhairle Nan Eilean Siar	Small	Isle of Lewis	Reprocessor	Aggregates
Shetland Amenity Trust	Small	Cunningsburgh	Reprocessor	Aggregates
Viridor Glass Recycling Ltd	Large	Bonnyrigg	Reprocessor & Exporter	Remelt, Aggregates & Export
William Tracey Ltd	Large	Linwood	Reprocessor	Glass bead / grain applications
Ardagh Glass Ltd	Large	Irvine	Reprocessor	Remelt (Container Manufacturing)
O-I Manufacturing UK Ltd	Large	Alloa	Reprocessor	Remelt (Container Manufacturing)
Superglass Insulation Ltd	Large	Stirling	Reprocessor	Remelt (Fibreglass)

Within Scotland there are seven reprocessors/exporters. The two small reprocessors are located on islands, meaning that they have limited access to the larger end markets for glass on the mainland. This has encouraged them to develop local end markets for their glass such as using it in aggregates applications.

Viridor Glass Recycling Ltd and William Tracey Ltd process glass for a variety of end markets including remelt, aggregates and shotblasting.

Ardagh Glass Ltd, O-I Manufacturing UK Ltd and Superglass Insulation Ltd represent the remelt end markets within Scotland and they will source glass cullet from the other reprocessors, or in the case of O-I Manufacturing UK Ltd, which has a clean-up facility on site, can accept glass direct from the consumer or C&I sources and prepare it for use in their own remelt furnaces.

13.3.5 End Markets

In Scotland, end markets for recycled glass have an estimated capacity of 420k tonnes per annum. **Figure 78** shows glass end markets in Scotland are currently using approximately 165k tonnes of glass cullet per annum.

Figure 78 Scottish End Markets

Company	Feedstock	Maximum cullet intake (T/Yr)	Known throughput of cullet (T/Yr)	Location	Product(s)
AllGlass	Mixed	15,000	~4,500	Linwood	Filtration, abrasion and aggregates
Ardagh Glass	Clear, green, amber	187,500	~80,000	Irvine	Containers
Brand and Rae	Mixed	17,000	~10,000	Fife	Construction blocks
Dryden Aqua	Mixed	20,000	~1,500	Bonnyrigg	Filtration media
Owens Illinois	Clear, green, amber	110,000	~40,000	Alloa	Containers
Superglass	Clear, mixed	70,000	~30,000	Stirling	Fibreglass insulation

13.3.6 Model Outputs

All the flow and collection data was fed into the GlassFlow model. The consumption and collection is split for Scotland is summarised in **Figure 79**.

Figure 79 Model – Scotland Compliance

Compliance

Consumption

	Clear		*Amber*		*Green*		***Total***	
Consumer	84	kt	19	kt	84	kt	**187**	kt
Non-Consumer	30	kt	8	kt	14	kt	**52**	kt
Total	**239**	kt						

Collection

Local Authority

	Clear		*Amber*		*Green*		*Mixed*		*co-mingled*		***Total***	
Kerbside	9	kt	3	kt	8	kt	25	kt	2	kt	**46**	kt
Bring	13	kt	4	kt	13	kt	11	kt	1	kt	**43**	kt
CA	3	kt	1	kt	2	kt	1	kt	1	kt	**8**	kt

	Clear		*Amber*		*Green*	*Mixed*		***Total***	
C & I	0	kt	0	kt	0	38	kt	**38**	kt
Total	**135**	kt							

Untapped

Clear		*Amber*		*Green*		***Total***	
53	kt	11	kt	39	kt	103	kt

Recycling Rates

Clear	*Amber*	*Green*	***Total***
53 %	60 %	60 %	57 %

As shown, the recycling rate in Scotland would appear to be just lower than the UK average. This is due to a higher than proportional flow (based on the country split for the consumption) compared to population, coupled with a lower local authority recycling rate (based on WDF). In Scotland, there would also appear to be a higher variance in the recycling rates by colour: amber has a higher recycling rate and green has a lower recycling rate when compared with the overall UK rates for these colours of glass.

13.4 Wales

13.4.1 Glass Packaging Consumption

Based on the country splits for Wales the consumption is summarised in **Figure 80**.

Figure 80 Wales Glass Consumption (T) Excluding and Including Illegal Imports

	2008	2009	2010	2011	2012
Total Consumption	114,485	116,311	119,357	117,525	116,075
Total Consumer Consumption	83,070	84,395	86,605	85,276	86,150
Clear	*37,382*	*37,978*	*38,972*	*38,374*	*38,767*
Amber	*8,307*	*8,439*	*8,661*	*8,528*	*8,615*
Green	*37,382*	*37,978*	*38,972*	*38,374*	*38,767*
Total Non-Consumer Consumption	31,415	31,916	32,752	32,249	29,925
Clear	*18,025*	*18,312*	*18,792*	*18,504*	*17,170*
Amber	*4,809*	*4,885*	*5,013*	*4,936*	*4,581*
Green	*8,581*	*8,718*	*8,947*	*8,809*	*8,174*

	2008	2009	2010	2011	2012
Total Consumption	119,139	121,039	124,209	122,324	120,769
Total Consumer Consumption	86,559	87,939	90,243	88,874	89,729
Clear	*38,952*	*39,573*	*40,609*	*39,993*	*40,378*
Amber	*8,656*	*8,794*	*9,024*	*8,887*	*8,973*
Green	*38,952*	*39,573*	*40,609*	*39,993*	*40,378*
Total Non-Consumer Consumption	32,580	33,099	33,966	33,450	31,040
Clear	*18,693*	*18,991*	*19,489*	*19,193*	*17,810*
Amber	*4,987*	*5,066*	*5,199*	*5,120*	*4,751*
Green	*8,900*	*9,041*	*9,278*	*9,137*	*8,479*

13.4.2 Collection of Glass

The WDF data is broken down by LA so it is possible to extract it specific to Welsh local authority glass collections. In terms of C&I collections, for Wales, in the absence of any recent data[82], the amount of C&I glass collected was taken as a proportion of the UK collections, using the non-consumer consumption country splits. The LA collections by source are presented below.

[82] http://wales.gov.uk/docs/desh/publications/120713wastecimannexen.pdf, Accessed (23 / 04 / 13) Included some estimations, however the data for C&I was from 2007 and did not include a full packaging breakdown for glass.

Kerbside

Figure 81 shows the quantity of glass collected in Wales at kerbside.

Figure 81 Welsh Local Authority Glass Collected at Kerbside (T)

	Kerbside					
			Colour Separated			
	Co-mingled	Mixed	Green	Brown	Clear	Total
Wales	22,940	30,281	-	-	-	**53,220**
UK Total Glass Packaging Collected	514,542	350,271	49,366	9,861	42,209	**966,250**

This shows that the majority of glass collected by local authorities in Wales at kerbside is mixed glass at 57% with the remaining 43% being collected co-mingled. No glass was reported as collected colour segregated at kerbside.

It also shows that Wales accounts for 5.5% of the glass collected at kerbside in the UK.

Bring Sites

Figure 82 shows the quantity of glass collected in Wales from bring sites.

Figure 82 Welsh Local Authority Glass Collected at Bring Sites (T)

	Bring Sites					
			Colour Separated			
	Co-mingled	Mixed	Green	Brown	Clear	Total
Wales	242	9,066	1,335	617	984	**12,243**
UK Total Glass Packaging Collected	6,641	151,553	55,716	14,079	47,710	**275,700**

This shows that the majority of glass collected by local authorities in Wales at bring sites is mixed colour, accounting for 74% of glass collected from this source. A further 24% is collected colour segregated and 2% co-mingled. It also shows that Wales accounts for 4.4% of the glass collected at bring sites in the UK.

CA Sites

Figure 83 shows the quantity of glass collected in Wales at CA sites.

Figure 83 Welsh Local Authority Glass Collected at CA Sites (T)

	CA Sites					
			Colour Separated			
	Co-mingled	Mixed	Green	Brown	Clear	Total
Wales	4,100	3,427	235	190	512	**8,465**
UK Total Glass Packaging Collected	5,881	43,510	6,636	2,409	7,659	**66,095**

This shows that the majority of glass collected by local authorities in Wales at CA sites is co-mingled, accounting for 48% of glass collected from this source. A further 41% is collected mixed colour and 11% co-mingled. It also shows that Wales account for 13% of the glass collected at CA sites in the UK.

C&I Collection

The total C&I collections for Wales is shown in **Figure 84**. This was taken as a proportion (4.98%) of the C&I collections for the UK. This split was based on the country splits covered in the consumption section. The same caveats apply, see Section 4.2.2.

Figure 84 Wales C&I Collections (T)

C&I Collections	15,863

A summary of collected glass collected by source in Wales is shown in **Figure 85**.

Figure 85 Summary of Welsh Glass Collections (T)

	Total	Kerbside	Bring	CA
Local Authority Collections	**73,928**	53,220	12,243	8,465
C&I Collections	**15,863**	0	0	0
Wales Total Glass Packaging Collected	**89,791**	53,220	12,243	8,465

This shows that during 2011/12 there were 89,791 tonnes of glass collected in Wales. Welsh LAs collected 74k tonnes of glass. Of this, 72% was collected at kerbside, 16.6% at bring sites and 11.5% at CA sites. C&I collections accounted for 16k tonnes.

Figure 86 shows the recycling rate for Wales, which is between 74% and 77% depending on whether illegal imports are included or not. In Wales, although there is a greater proportion of material collected co-mingled, the overall recycling rate is higher than the UK, which contrasts with the lower recycling rate in Scotland.

Figure 86 Welsh Recycling Rate 2012

Revised Consumption (excl illegal imports)	116,075
Revised Consumption (incl illegal imports)	120,769
Total Collections	89,791
Recycling Rate (excl illegal imports)	77%
Recycling Rate (incl illegal imports)	74%

It is important to note that this compares favourably with the 55% recycling rate calculated by the Welsh Government[83]. However, it should be noted that the period to which the Welsh Government work refers is 2009 (for LA collections) and 2007 for C&I collections. This was based on an estimated consumption of 116k (against a GlassFlow consumption of 121k) and collection of 82k (against a GlassFlow collection of 90k). They also based their collections on what was collected for recycling, not actually recycled as was done here (working backwards from the NPWD figure). They projected the recycled rate to increase to 75% in 2015/16, assuming no preventative action is taken.

13.4.3 MRF Sortation

Based on the latest information provided in WRAP's Local Authority Waste and Recycling Information Portal, eight MRFs accept glass in Wales; these are shown in **Figure 87**.

Figure 87 MRFs Wales

Owner	Operator	Location
AJ Recycling	AJ Recycling	Boncath
Biffa	Biffa	Cardiff
CWM Environmental	CWM Environmental	Carmarthen
Rhondda Cynon Taff County Borough Council	Amgen Cymru (the Council's LAWDC)	Llwydcoed
SITA	SITA	Withyhedge
Site Serv Ltd	Site Serv Ltd	Cowbridge
Swansea	LAWDC	Swansea
The Recycling Co UK Ltd	The Recycling Co UK Ltd	Bridgend

The MRFs vary in size (with an approximate annual capacity of between 6,000 and 76,000 tonnes), with the majority situated in South Wales in close proximity to the larger towns and cities.

The Welsh MRF capacity was calculated using information from WRAP's Local Authority Waste and Recycling Information Portal and the 2013 UK Recycling Market Sentiment project. On average, glass represented 13% of the total material input (including the residual sent to landfill or incineration). This proportion was applied to the total Welsh MRF capacity to estimate that Wales has a glass sortation capacity of approximately 28k tonnes, all of which is mixed glass. The total amount of co-mingled material sorted in Wales was also 28k.

[83] http://wales.gov.uk/docs/desh/publications/120713wastecimannexen.pdf, (Accessed 23 / 04 / 13)

13.4.4 Reprocessing

The companies registered as accredited glass reprocessors in Wales are listed below. These are shown in **Figure 88**.

Figure 88 Accredited Reprocessors and Exporters – Wales

Wales	Size	Site Address	Function	End Market
Glass Tech Recycling Ltd	Large	SWANSEA	Reprocessor	Remelt (Fibreglass) & Aggregates
Recresco Ltd	Large	CWMBRAN	Reprocessor	Remelt (Container manufacturing), Aggregates, Blast and Filtration Media.
Knauf Insulation Ltd	Large	CWMBRAN	Reprocessor	Remelt (Fibreglass)

Glass Tech Recycling Ltd and Recresco Ltd collect glass and process it for recycling in a variety of end markets. Recresco Ltd has another facility in the UK that has accredited exporter status and as such can potentially export glass.

The main end market in Wales for recycling glass is the Knauf Insulation Ltd facility which is a remelt (fibreglass) end market.

A significant quantity of glass collected in Wales is transported to other facilities in the UK such as Glass Recycling (UK) Ltd, Reuse Collections Ltd t/a Berryman and Viridor Waste Management Ltd for processing to meet a variety of end markets[84].

13.4.5 End Markets

The data shown in **Figure 89** is from a Welsh report on end destination of waste collected for recycling by local authorities in 2011/12[85]. The total amount of glass sent to a reprocessor, MRF, treatment facility, transfer station or other in 2011/12 by LAs, either direct or post MRF was estimated to be 71k tonnes. The reprocessors included Reuse Collections Ltd, Berryman, Viridor Glass Recycling and Recresco Ltd.

Figure 89 Welsh End Markets

End Destination of Collected Waste in Wales 2011/12	(T/Yr)
Reprocessor	52,217
Transfer Station	7,058
Other/Exempt	5,796
Treatment Facility	3,434
MRF	2,335
Total	**70,840**

Figure 89 shows the majority of glass in 2011/12 was sent to a reprocessor, either directly or post-MRF (74%). 'Other / exempt' is where a local authority has used a permitted exempt site or facility that has not been identified in WDF.

[84] http://wales.gov.uk/docs/desh/publications/130322end-destinations-report-en.pdf, Accessed (27/ 06 / 13)
[85] http://wales.gov.uk/docs/desh/publications/130322end-destinations-report-en.pdf, Accessed (02 / 06 / 13)

13.4.6 Model Outputs

All the flow and collection data was fed into the GlassFlow model. The consumption and collection is split for Wales and is summarised in **Figure 90**.

Figure 90 Model – Wales Compliance

Compliance

Consumption

	Clear	*Amber*	*Green*	***Total***
Consumer	40 kt	9 kt	40 kt	**90** kt
Non-Consumer	18 kt	5 kt	8 kt	**31** kt
Total	**121** kt			

Collection

Local Authority

	Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	***Total***
Kerbside	0 kt	0 kt	0 kt	30 kt	23 kt	**53** kt
Bring	1 kt	1 kt	1 kt	9 kt	0 kt	**12** kt
CA	1 kt	0 kt	0 kt	3 kt	4 kt	**8** kt

	Clear	*Amber*	*Green*	*Mixed*	***Total***
C & I	0 kt	0 kt	0	16 kt	16 kt
Total	**90** kt				

Untapped	*Clear*	*Amber*	*Green*	***Total***
	18 kt	4 kt	9	31 kt

Recycling Rates	*Clear*	*Amber*	*Green*	***Total***
	69 %	68 %	82 %	74 %

As shown, the recycling rates in Wales would appear to be higher than the UK. This is due to a higher proportion of local authority collections (based on WDF).

14. Conclusions

14.1 Reduced Consumption

UK glass packaging consumption is lower than currently estimated.

The revised consumption excluding the estimated illegal imports is 2,399,235 tonnes in 2012, and 2,496,332 tonnes including the illegal imports. This is lower than the PackFlow 2017 estimate of 2,753,500.

UK recycling performance in 2012 was 68%, exceeding the EU directive packaging target of 60%.

The EU directive packaging target is 60% of total consumption, and based on a reduced flow against what was recycled in 2012, the UK achieved a 68% glass recycling rate in 2012. This decreases to 65% if the illegal consumption is included.

A business target of 70% would have delivered UK compliance in 2012; lower than the actual 81% target.

To achieve an overall recycling rate of 60% in the UK, obligated businesses would only have needed to recycle 70% in 2012; lower than the current business target of 81%. This increases to 73% if the illegal consumption is excluded.

Glass packaging around illegal imports could account for up to 4% of total UK consumption of glass packaging.

In 2012 it was estimated that 97k tonnes of filled glass packaging was illegally imported into the UK.

The UK is a net importer of glass packaging.

In 2012 the UK imported 1,214k tonnes of glass packaging (excluding cullet but including packaging around goods and illegal imports), but only exported 891k.

14.2 Increase in Co-mingled Collection

Only 14% of the glass collected in the UK is colour separated.

The majority of local authority glass is collected mixed colour (42%) or co-mingled (40%).

The amount of glass being collected co-mingled is increasing.

The proportion of local authority glass being collected co-mingled has increased from 27% in 2009/10 to 40% in 2011/12.

A larger than UK average proportion of glass is collected colour separated in Scotland.

Only 4% of glass collected by local authorities in Scotland is co-mingled, which is lower than the 40% UK average; however there is a higher proportion of glass collected using bring sites in Scotland.

14.3 End of Waste Criteria for Glass

The point in the supply chain where PRNs are raised may change.

A potential implication of the introduction of the end of waste criteria for glass will be that it may influence the point in the supply chain where the Packaging Recovery Note (PRN) is raised. Currently, PRNs for glass cullet going into the remelt sector are issued at the end of that recycling chain by the accredited reprocessor undertaking the remelt activity. The end of waste criteria for glass cullet may lead to the issuing of PRNs at an earlier point in that recycling chain, at the glass recycler stage.

Impact of end of waste not expected until 2014.

In order to comply with the end of waste criteria for glass, a producer must be independently assessed and certified by a Conformity Assessment Body (CAB). At the time of writing, the EA indicated that no CAB had gone through the accreditation process. This means that it is unlikely that any reprocessors will have their quality management system certified in 2013.

14.4 PRN Investment

PRN/PERN spending increases for infrastructure and capacity.

When compared to 2008, infrastructure and capacity has increased from 13% in 2008 to 17% in 2012 of PRN/PERN spending. This may be due to an increase in investment in new equipment to process glass, which is increasingly being collected co-mingled.

Increased investment in colour sortation technologies.

Investment in infrastructure and capacity looks set to continue in 2013 as demonstrated by announcements from some of the UK's largest reprocessors. This includes the new Recresco recycling facility in Swanscome and the Berryman investment in Knottingley and South Kirkby.

Funding of collections receives the greatest PRN/PERN investment.

The funding of collections receives the greatest proportion of PRN/PERN revenue investment at 35% in 2012. However, if this is compared to 2008, this proportion has decreased which may be due to the collection infrastructure now being mature or may reflect the cost savings from collecting glass co-mingled.

14.5 Cullet vs. Batch Materials

Cullet cost effective in glass manufacturing process.

There can be significant cost savings from using recycled glass cullet compared to batch materials in the glass manufacturing process. By including the potential savings from energy, the Climate Change Levy and carbon emissions, using glass cullet in the production of glass can potentially save container glass manufacturers between £19 – £26 per tonne for clear glass and £21 – £34 for green glass.

14.6 Fraud

The amount of Glass recycling was overstated by at least 100k-200k between 2009 and 2010.

This was calculated based on the Nationwide Recycling Ltd case and their fraudulent revenue of £2 million. However it is assumed that if one company is convicted of fraud it could potentially have the impact of encouraging other fraudulent companies to reduce or cease their illegal reporting. Therefore, the level of fraudulent reporting of glass recycling in the UK could potentially be reducing.

14.7 Projections

Based on the existing (PackFlow) consumption projections and increased collections, the UK is expected to exceed a 60% recycling rate for glass between 2013 and 2017.

Based on the lower estimate of the 2012 flow, the revised projections could lead to recycling rates of up to 82% across this period (based on varying growth rate assumptions).

If current trends continue, local authority co-mingled glass collections could reach 70%.

Applying forward the trend in LA glass collections from the previous three years, in 2017 LA co-mingled glass collections will be 70%, 26% mixed colour and only 4% colour separated.

Appendix I – Production Data Cross Reference

The production data was cross referenced with data from Prodcom[86] (Eurostat statistics on the production of manufactured goods) and Environment Agency (EA)[87].

The latest available Prodcom data is from 2011 and only gives the number of container units produced. Therefore an average weight was applied to the number of units and this was calculated using the average weight of glass packaging (taken from the Valpak Data Solutions database[88]) which was 0.383kg. The Prodcom data is summarised in **Figure 91** and the quantities match that of British Glass, within ~10% for the years 2008, 2009 and 2011. However, the 2010 data is suddenly much lower - this may be due to data exclusion for confidentiality issues within the Prodcom data. Given the issues with the 2010 data, the potential for data exclusion in other years too becomes apparent and the added uncertainty introduced by the need to convert data from number of items to tonnes, the British Glass data was preferred (the Prodcom data-derived tonnage data also does not include any light weighting effects as it uses a consistent packaging weight for the years 2008-2011).

Figure 91 Prodcom - UK Glass Container Production 2008 – 2011

	2008	2009	2010	2011
Prodcom - # of Items	5,985,044,000	6,151,282,000	3,220,159,277	6,092,702,365
Estimated Tonnage	2,292,272	2,355,941	1,233,321	2,333,505

Another cross reference for the British Glass production data was the NPWD figures taken from Table 1 Conversion. This will include all obligated companies and the glass packaging they handle and convert. This is summarised in the table below for the years 2008 – 2012[89]. This data is summarised in **Figure 92**.

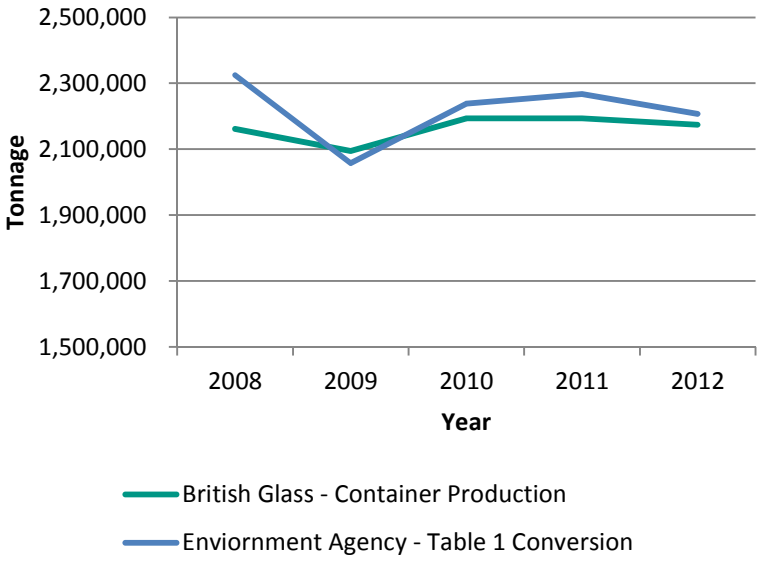
Figure 92 National Packaging Waste Database - UK Glass Container Production 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Table 1 Conversion	2,324,938	2,057,521	2,238,044	2,267,285	2,207,466

Both the British Glass and EA data are summarised in **Figure 93** with a graphical representation of the trends.

[86] http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/data/tables_excel, Accessed (17 / 06 / 13)
[87] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (19 / 06 / 13)
[88] Valpak's Data Solutions database is one of the largest packaging databases in the country. Valpak work with over 70 companies including Tesco, Sainsbury's, Marks & Spencer and Mothercare and hold significant market coverage across many top retail sectors as well as distributors, brand owners and the retail supply chain. Data Solutions collect information direct from customers, suppliers as well as source information in house meaning that they hold a wide coverage of information across multiple product ranges. Product specific data collection is completed through site visits, supplier mailings and weighing in house (purchasing product and collecting used product from staff). All data goes through a comprehensive checking process on receipt and is stored in their bespoke innovative software Environmental Product Information Centre (EPIC).
[89] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (19 / 06 / 13)

Figure 93 UK Glass Container Production 2008 – 2012 (T)



	2008	2009	2010	2011	2012
British Glass - Container Production	2,161,769	2,094,374	2,193,935	2,193,481	2,173,803
Environment Agency - Table 1 Conversion	2,324,938	2,057,521	2,238,044	2,267,285	2,207,466

This shows that the British Glass and EA figures follow a similar trend over the period. However, there is a slight discrepancy between the numbers. It is important to note that the EA will include non-container glass that is used for decorative purposes, glass vials, glass balls and other uses which would explain why their numbers are higher (except for 2009). However, since the British Glass figures are member submissions from the six producers in the UK and account for breakages as it is sales data, this was the data used.

Appendix II – Exports (empty) Cross Reference

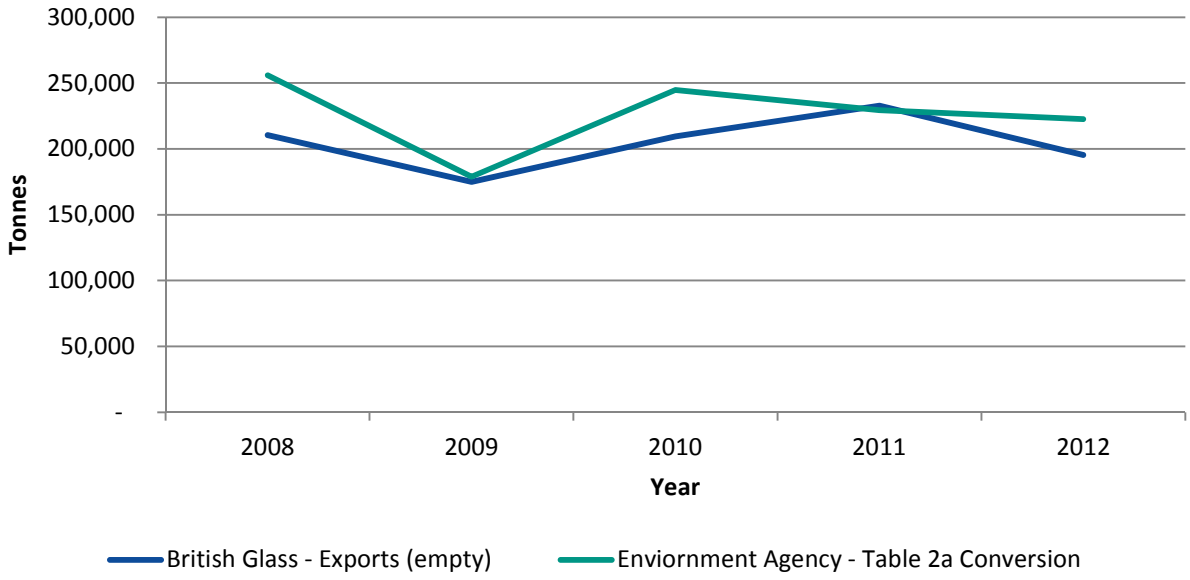
The empty export figures were cross referenced against NPWD data, from table 2a conversion[90] and this is provided in **Figure 94**[91].

Figure 94 National Packaging Waste Database – UK Exports (empty) 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Exports (empty) - Table 2a Conversion	255,845	178,901	244,713	229,477	222,480
% Change from prev. year	N/A	-30%	37%	-6%	-3%

As with the British Glass figures, these oscillate between negative and positive growth; however, the 2008 figure is higher than 2012. A graphical representation of the trends is provided in **Figure 95**.

Figure 95 UK Exports (empty) 2008 – 2012



As shown, the NPWD figures follow a similar trend to British Glass. Following discussions with British Glass it was agreed to use their figures as it is based on monthly member submissions.

The export trends were checked against the HMRC trade data[92] for beverage exports as shown in **Figure 96**. It is worth noting that this is only partly indicative as this includes beverages exported regardless of packaging types, i.e. including beverages exported in glass bottles, but also cans, etc. However it does show exports rising between 2011 and 2012, when both the British Glass figures and NPWD showed a drop.

[90] Only conversion was used as the way the data form is submitted, based on Valpak experience, the numbers for raw material manufactures are the same as conversion and so are not included
[91] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (20 / 06 / 13)
[92] www.uktradeinfo.com, Accessed (05 / 06 / 13)

Figure 96 HMRC – Beverage Exports 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Net mass (kg) (Export + Dispatch)	2,020,430,298	1,908,267,574	1,992,674,116	2,170,723,853	2,424,966,840

Appendix III – Exports (filled) Cross Reference

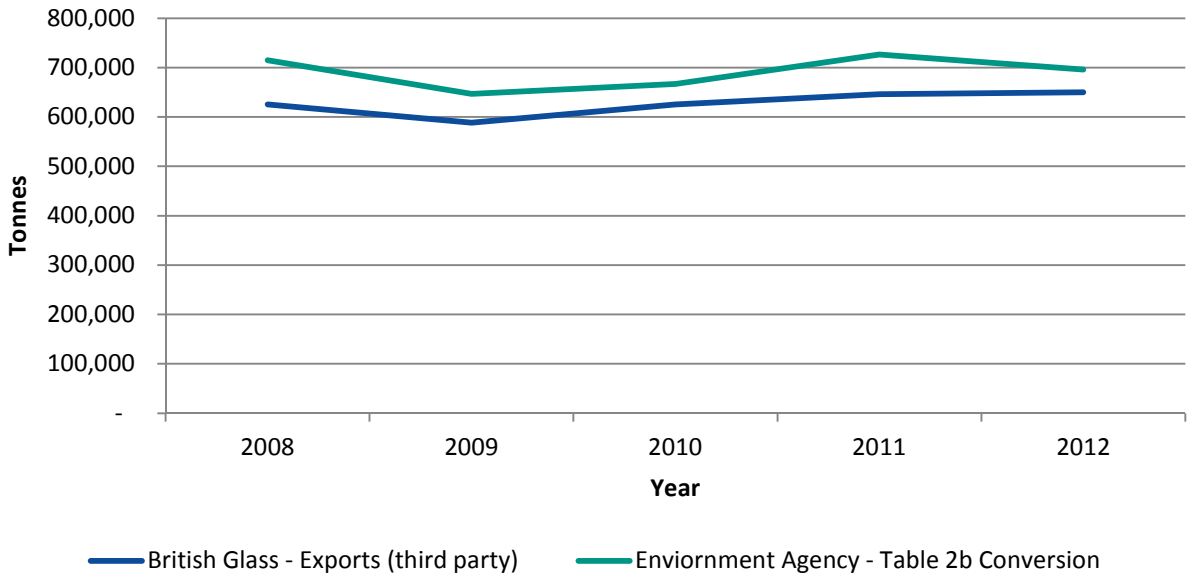
British Glass provided filled exports estimations. These were based on protocols approved by the EA (i.e. x% of all home sales of beer are exported). The data is shown in **Figure 97**.

Figure 97 British Glass – UK Exports (filled) 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Exports (filled)	625,460	588,259	625,130	645,969	649,921
% Change from prev. year	N/A	-6%	6%	3%	1%

As with the British Glass figures, these oscillate between negative and positive growth; however, the 2008 figure is higher than 2012. A graphical representation of the trends is provided in **Figure 98**.

Figure 98 UK Exports (filled) 2008 – 2012



As shown the British Glass figures are consistently below the EA figures. Following discussions with British Glass it was agreed that the EA figures could be more realistic as the protocols British Glass were using were considered dated. The export trends were also generally supported by another data check, against the HMRC trade data[93] for beverage exports, as shown in **Figure 99**. It is worth noting that this is only partly indicative as this includes beverages exported regardless of packaging types, i.e. including beverages exported in glass bottles, but also cans, etc. This trend more closely matches the filled exports in comparison to the empty exports as it shows a rise between 2009 and 2012.

Figure 99 HMRC – Beverage Exports 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Net mass (kg) (Export + Dispatch)	2,020,430,298	1,908,267,574	1,992,674,116	2,170,723,853	2,424,966,840

[93] www.uktradeinfo.com, Accessed (05 / 06 / 13)

Appendix IV – Imports (empty) Cross Reference

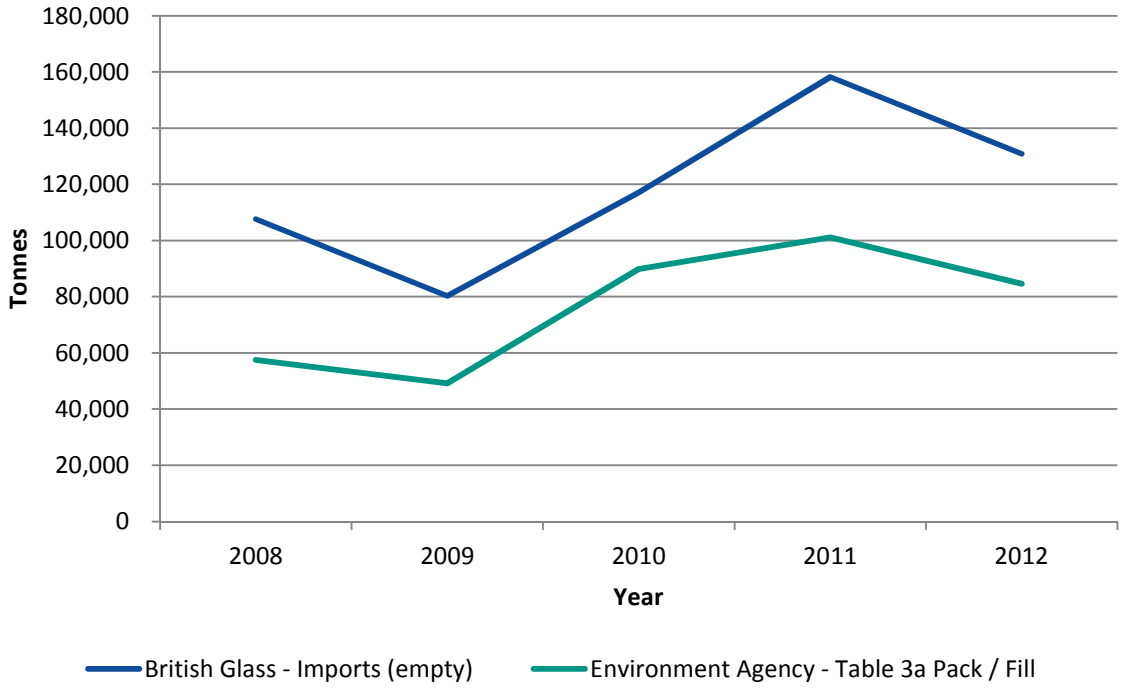
The British Glass figures for imports (empty) were cross referenced against NPWD table 3a pack/fill[94]. However it is important to note that the EA figures were lower as there is a proportion being re-exported that is netted out of the figures[95]. The EA figures are summarised in **Figure 100**.

Figure 100 National Packaging Waste Database – Imports (empty) 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Imports (empty) - Table 3a Pack / Fill	57,488	49,110	89,879	101,151	84,613
% Change from prev. year	N/A	15%	-83%	-13%	16%

Both of these sources (British Glass and NPWD) are summarised in **Figure 101** by a graphical representation of the trends.

Figure 101 Imports (empty) 2008 – 2012 (T)



	2008	2009	2010	2011	2012
British Glass - Imports (empty)	107,553	80,283	117,116	158,159	130,871
Environment Agency - Table 3a Pack / Fill	57,488	49,110	89,879	101,151	84,613

As discussed, the NPWD figure is lower than the British Glass figure; however the trend follows a similar pattern.

[94] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (20 / 06 / 13)
[95] This data is included in Table 3c, however it is not separated by empty/filled and as such is not included

Appendix V – Obligated Imports (filled) Cross Reference

The obligated filled imports estimate was cross referenced against HMRC trade data[96], although as mentioned these figures are only used for a sense check as it is believed they are too broad and had potential consistency issues in terms of categorisation. The beverage imports are shown below for the years 2008 to 2012.

Figure 102 HMRC – Beverage Imports 2008 – 2012 (T)

	2008	2009	2010	2011	2012
Net mass (kg) (Import + Arrival)	3,594,608,322	3,357,422,752	3,803,941,802	3,582,917,881	4,163,027,111

This show an increase between 2011 and 2012; however, **Figure 102** will include non-glass packaging, and if imports of beverages are increasing but glass imports are decreasing, could represent a switch from glass beverage packaging to plastic/metal packaging. However, the EA shows a decrease for plastic and steel between 2011 and 2012 (**Figure 103**) and although aluminium has increased, it is by less than 1k tonnes. Another potential explanation is that it could be due to bulk importation of wine to be bottled in the UK.

Figure 103 National Packaging Waste Database – Plastic, Steel & Aluminium Imports 2008 – 2012 (T)[97]

	2008	2009	2010	2011	2012
Environment Agency - Table 3a Plastic	418,655	399,301	413,135	425,784	415,587
Environment Agency - Table 3a Steel	178,154	170,298	164,458	177,615	153,822
Environment Agency - Table 3a Aluminium	32,063	32,081	35,179	36,595	37,328

[96] www.uktradeinfo.com, Accessed (05 / 06 / 13)
[97] http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx, Accessed (08 / 06 / 13)

Appendix VI – Consumption Cross Reference

There was also a cross referencing exercise completed with data from the Office of National Statistics (ONS) Blue Book 2013[98] and the VDS database to compare this to alcohol sales.

The ONS data estimates use a wide range of sources to make their estimation. Two of the largest sources of data in consumer trends are the Retail Sales Inquiry and the Living Costs and Food Survey; however a number of other administrative and survey sources are used in the compilation of Household Final Consumption Expenditure estimates. The chained volume of alcohol beverage sales was taken, and as this excludes money spent on hotels, restaurants, cafes etc was thought to be a closer proxy for consumer spending. The chained volume of sales for alcoholic beverages between 2008 and 2012 are shown below[99].

Figure 104 Office of National Statistics – Retail Sales of Alcohol

	2008	2009	2010	2011	2012
ONS - Chained Volume of Alcohol Sales	104.28	100.00	99.74	98.15	98.09

This would suggest a small drop in consumer flow (and total flow) would be expected across this period as alcoholic drinks make up a large proportion of the glass packaging flow. However, the VDS database has sales quantity data for specific members between 2008 and 2012 for glass items that are alcohol. In order to compare this to the ONS data, the 2009 was given an index of 100, shown in **Figure 105**. The relevant market shares[100] were applied to account for a decrease in alcohol sales for one member just being an outcome of a reduced market share.

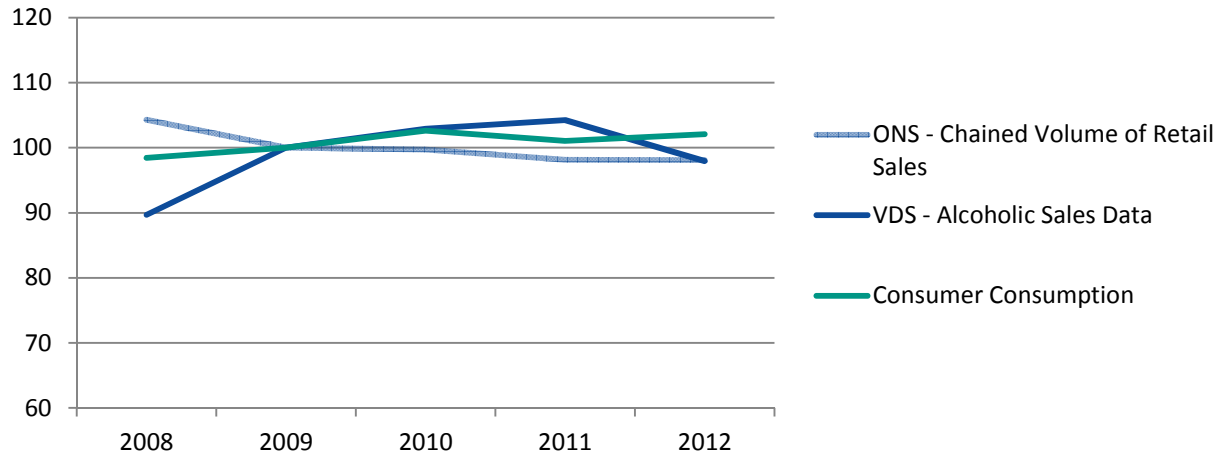
Figure 105 Valpak Data Soultions – Retail Sales of Alcohol in Glass Packaging

	2008	2009	2010	2011	2012
VDS - Sales Data	89.68	100.00	102.92	104.24	97.95

In order to compare the trends of the ONS and VDS sales to the total consumer consumption, an index to 2009 was also applied. This is shown by a combined graphical representation, **Figure 106**.

[98] http://www.ons.gov.uk/ons/rel/consumer-trends/consumer-trends/q1-2013/blue-book-2013--improvements-to-household-expenditure-estimates.html, Accessed (11 / 09 / 13)
[99] Index 2009=100
[100] http://www.kantarworldpanel.com, Accessed (27 / 06 / 13)

Figure 106 Alcohol Sales Against 2009 Baseline



	2008	2009	2010	2011	2012
ONS - Chained Volume of Alcohol Sales	104.28	100	99.74	98.15	98.09
VDS - Alcoholic Sales Data	89.68	100.00	102.92	104.24	97.95

There are a number of possible explanations for the differences between the ONS and the VDS data.

One could be that the drop in the alcohol sales may be affecting the specialist alcoholic retailers more than the big retailers (the Valpak members). If so, the estimate in this report (which uprates the supermarket-based estimate of glass packaging around alcohol by a fixed ratio of off-licence to supermarket sold alcohol) possibly overstates the glass packaging associated with alcohol.
Another reason is that the ONS data covers all sales of alcohol irrespective of packaging material, whereas the VDS data above covers only alcohol sales in glass packaging. It is possible that sales of alcohol in cans or plastic containers have followed a different trend.

Finally, in comparing the VDS data with the estimate of glass packaging (consumer) consumption trends, it is worth noting that, although alcohol represents the majority of the glass packaging, **Figure 106** suggests that the increase in glass packaging between 2011 and 2012 was driven by glass packaging around non-alcoholic items. However, it is important to note that the VDS alcohol sales data shown has been pulled from only two Valpak members. This is because these are the only two members for whom the data is broken down by alcohol as far back as 2008, and a comparison was required for the longer time period to allow a fair comparison. Therefore, the VDS alcohol sales data shown in Figure 106 is less robust than the data used to calculate consumer glass packaging consumption in 2012 (which was extracted from data for supermarkets accounting for more than half of the market), and shows a rise from 2011 to 2012. Indeed, the other VDS members show an increase in alcohol sales between 2011 and 2012.

Appendix VII – UK Accredited Reprocessors and Exporters

The companies registered as accredited UK glass reprocessors and exporters are listed below[101]. Each has been listed by size, location and primary function (shown in **Figure 107**).

Figure 107 Accredited Reprocessors and Exporters

England	Size	Site Address	Function
Day Group Ltd	Large	CHARLTON	Reprocessor & Exporter
Direct Material Supplies Enviro Ltd	Large	STAFFORDSHIRE	Reprocessor
G OBRIEN & SONS (NDC) LTD	Small	SOUTH TYNESIDE	Reprocessor
Glass Recycling (UK) Ltd	Large	BARNSLEY	Reprocessor & Exporter
Green Future Recycling Ltd	Large	BLACKPOOL	Reprocessor
HOPE CEMENT Ltd	Small	COUPLE	Reprocessor
HOPE CEMENT Ltd	Small	WEST GORTON	Reprocessor
INGS ENVIRONMENTAL Ltd	Large	SCUNTHORPE	Reprocessor & Exporter
Lafarge Aggregates Ltd	Small	BARHAM	Reprocessor
Lafarge Aggregates Ltd	Small	DERBY	Reprocessor
Lafarge Aggregates Ltd	Large	FINNINGLEY	Reprocessor
Lafarge Aggregates Ltd	Small	NEWMARKET	Reprocessor
Lafarge Aggregates Ltd	Large	RADLETT	Reprocessor
Lafarge Aggregates Ltd	Large	WEST CORNFORTH	Reprocessor
Recresco Ltd	Large	SOUTHAMPTON	Reprocessor
Recresco Ltd	Large	NOTTINGHAMSHIRE	Reprocessor & Exporter
Recresco Ltd	Large	ELLESMERE PORT	Reprocessor
Reuse Collections Ltd t/a Berryman	Large	SOUTH KIRKBY	Reprocessor & Exporter
Viridor Waste (Greater Manchester) Ltd	Small	MANCHESTER	Reprocessor
Viridor Waste Management Ltd	Large	ST. HELENS	Reprocessor
Viridor Waste Management Ltd	Large	SHEFFIELD	Reprocessor
Viridor Waste Management Ltd	Large	WEST SUSSEX	Reprocessor
Viridor Waste Management Ltd	Small	LANCASHIRE	Reprocessor
Viridor Waste Management Ltd	Large	DARTFORD	Reprocessor
Ward Recycling Ltd	Large	MIDDLESBROUGH	Reprocessor
Wastecycle Ltd	Large	NOTTINGHAM	Reprocessor
Allied Glass Containers	Large	KNOTTINGLEY	Reprocessor
Allied Glass Containers	Large	LEEDS	Reprocessor
Ardagh Glass Ltd	Large	DONCASTER	Reprocessor
Ardagh Glass Ltd	Large	BARNSLEY	Reprocessor
Ardagh Glass Ltd	Large	KNOTTINGLEY	Reprocessor
Beatson Clark Plc	Large	ROTHERHAM	Reprocessor
BPB United Kingdom Ltd	Small	RUNCORN	Reprocessor
Green Future Recycling Ltd	Large	BLACKPOOL	Reprocessor
Knauf Insulation Ltd	Large	ST HELENS	Reprocessor
O-I Manufacturing Ltd	Large	HARLOW	Reprocessor & Exporter
Quinn Glass Ltd	Large	ELTON	Reprocessor

[101] Source: NPWD, Accessed (03 / 07 / 13)

Recycled Glass Company Ltd	Small	HIGHBRIDGE	Reprocessor
Stolzle Flaconnage Ltd	Small	KNOTTINGLEY	Reprocessor
Viridor Resource Management Ltd	Large	WEST MALLING	Exporter
Biffa Waste Services Ltd	Large	HIGH WYCOMBE	Exporter
Eurokey Recycling Ltd	Large	LEICESTER	Exporter
McCarthy (UK) Ltd	Large	MARLOW	Exporter
Silica Developments Ltd	Large	REDHILL	Exporter
SITA Metal Recycling Ltd	Large	BERKSHIRE	Exporter
Valpak Recycling (North West) Ltd	Small	PRESTON	Exporter
Valpak Recycling Ltd	Large	STRATFORD-UPON-AVON	Exporter
Scotland	**Size**	**Site Address**	**Function**
Comhairle Nan Eilean Siar	Small	ISLE OF LEWIS	Reprocessor
Shetland Amenity Trust	Small	CUNNINGSBURGH	Reprocessor
Viridor Glass Recycling Ltd	Large	BONNYRIGG	Reprocessor & Exporter
William Tracey Ltd	Large	LINWOOD	Reprocessor
Ardagh Glass Ltd	Large	IRVINE	Reprocessor
O-I Manufacturing UK Ltd	Large	ALLOA	Reprocessor
Superglass Insulation Ltd	Large	STIRLING	Reprocessor
Wales	**Size**	**Site Address**	**Function**
Glass Tech Recycling Ltd	Large	SWANSEA	Reprocessor
Recresco Ltd	Large	CWMBRAN	Reprocessor
Knauf Insulation Ltd	Large	CWMBRAN	Reprocessor
Northern Ireland	**Size**	**Site Address**	**Function**
Glassdon Recycling	Large	TOOMEBRIDGE	Reprocessor
Re-Gen Ltd	Small	NEWRY	Reprocessor
Quinn Glass Ltd	Large	DERRYLIN	Reprocessor
RecyCo	Large	OMAGH	Exporter
Re-Gen Ltd	Small	NEWRY	Exporter

Appendix VIII – Model Outputs

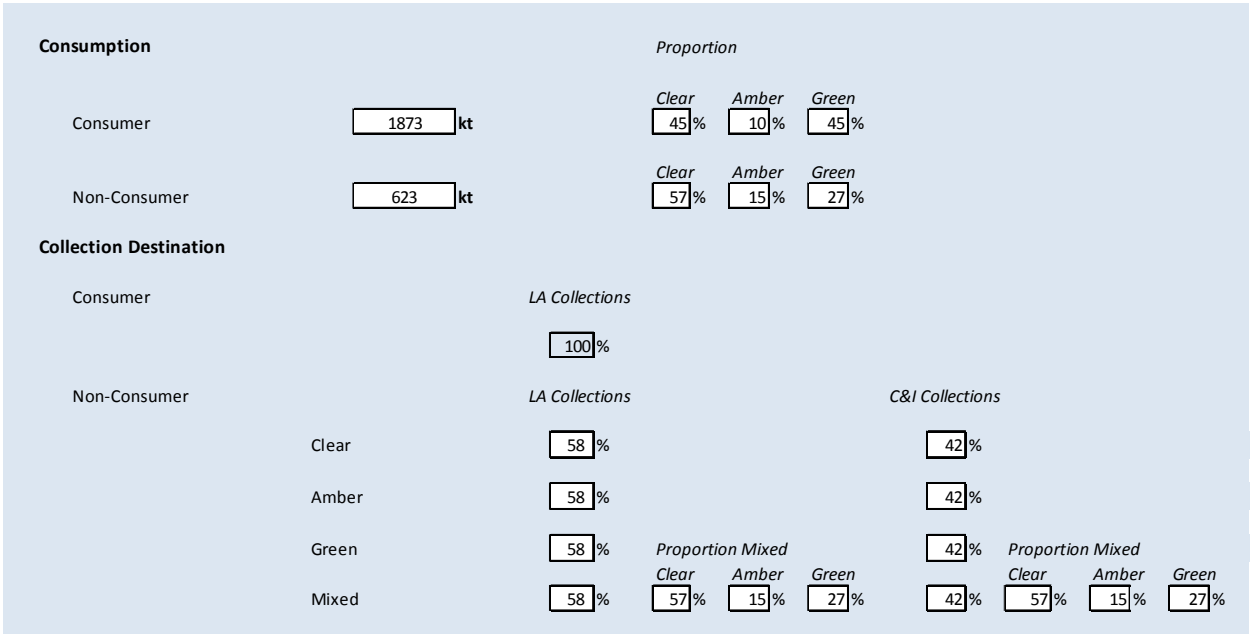
Consumption

The first section of the model is the consumption with totals coming from the work discussed in the Consumption section. As discussed, this section of the model is also broken down to the Scottish and Welsh levels.

UK

Figure 108 shows the model output for the UK consumption.

Figure 108 Model – UK Consumption



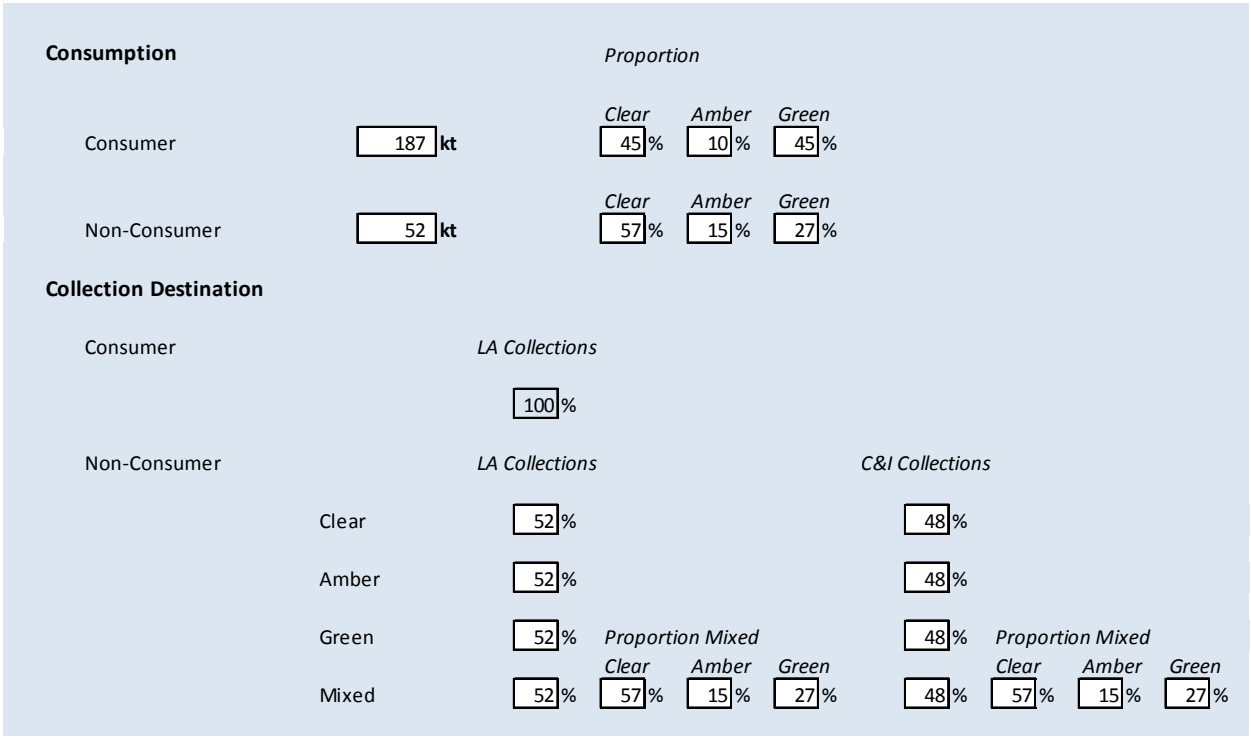
The colour breakdown for the consumer and non-consumer flow is based on information provided by British Glass and internal WRAP reports. As shown in the glass supply chain map, it is assumed that 100% of consumer glass is collected by local authorities. Additionally, the model shows that of the non-consumer, some is collected by LAs and some by C&I collections. The split of 58% and 42% was calculated based on the assumption that 14% of local authority collections are from non-household sources[102].

[102] http://www.zerowastescotland.org.uk/sites/files/wrap/ZWS%20Glass%20Options%20Appraisal%20IMR001-002_2.pdf, Accessed (25 / 06 / 13)

Scotland

Figure 109 shows the model output for Scottish consumption.

Figure 109 Model – Scotland Consumption



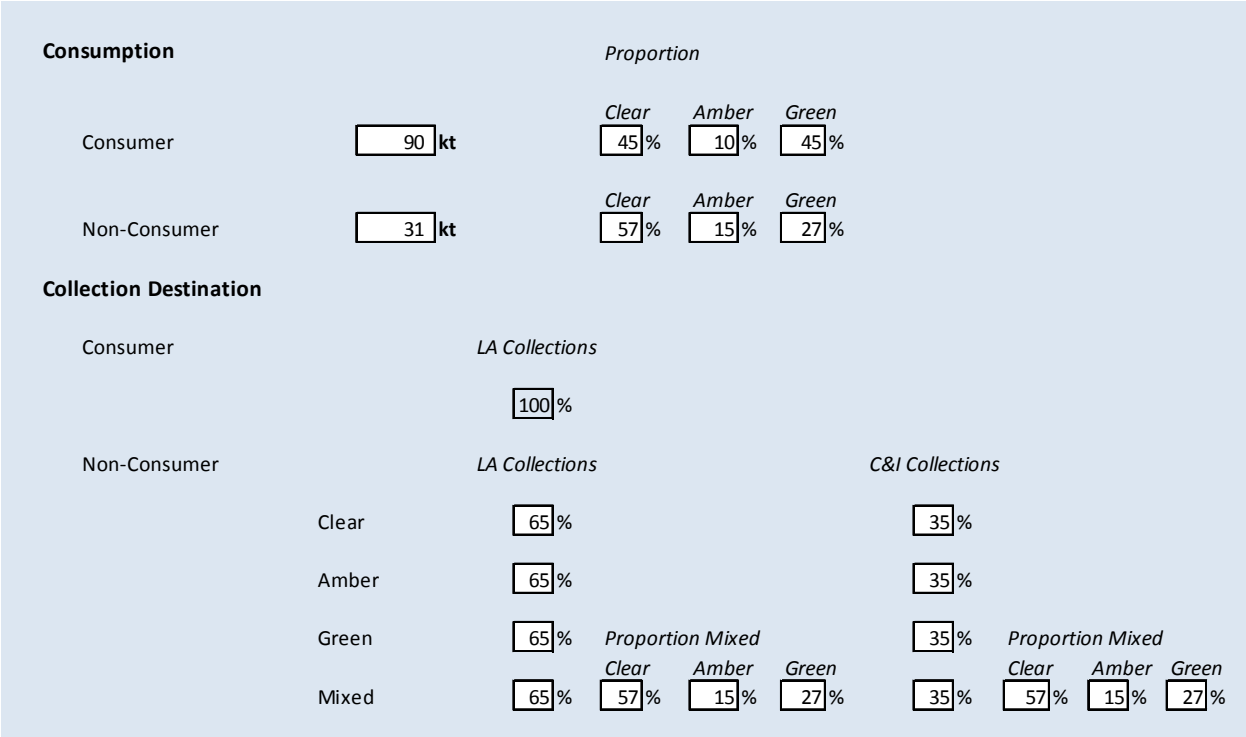
The consumption in Scotland is taken as a proportion of the UK total, based on the country split calculations completed in the Consumption section of this report. The colour breakdown for the consumer and non-consumer flow is based on information provided by British Glass and internal WRAP reports. The split of 52% and 48% was calculated based on the assumption that 14% of LA collections are from non-household sources[103].

[103] http://www.zerowastescotland.org.uk/sites/files/wrap/ZWS%20Glass%20Options%20Appraisal%20IMR001-002_2.pdf, Accessed (18 / 04 / 13)

Wales

Figure 110 shows the model output for Welsh consumption.

Figure 110 Model – Wales Consumption



The consumption in Wales is taken as a proportion of the UK total, based on the country split calculations completed in the Consumption section of this report. The colour breakdown for the consumer and non-consumer flow is based on information provided by British Glass and internal WRAP reports. The split of 65% and 35% was calculated based on the assumption that 14% of LA collections are from non-household sources[104].

[104] http://www.zerowastescotland.org.uk/sites/files/wrap/ZWS%20Glass%20Options%20Appraisal%20IMR001-002_2.pdf, Accessed (18 / 04 / 13)

Collection

The second stage in the model is the collection phase. As discussed, this section of the model is also broken down to the Scottish and Welsh levels.

UK

Figure 111 shows the model output for UK collection.

Figure 111 Model – UK Collection

Collection

Local Authority

Total Local Authority	1,308 kt									Proportion Mixed / co-mingled		
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*
Kerbside	966 kt	4%	1%	5%	36%	53%	40%	11%	49%
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*
Bring	276 kt	17%	5%	20%	55%	2%	40%	11%	49%
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*
CA	66 kt	12%	4%	10%	66%	9%	40%	11%	49%

C & I

										Proportion Mixed / co-mingled		
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*
Total C & I	319 kt	0%	0%	0%	100%	0%	57%	15%	27%

The local authority collection figure is taken from WDF, as is the breakdown by collection format and colour[105]. The C&I collections were calculated by taking the difference between the LA collections and total UK waste collected figure from the NPWD. It is assumed that all C&I collections are mixed.

[105] An industry mixed colour protocol is applied to both the mixed and co-mingled collections

Scotland

Figure 112 shows the model output for Scottish collection.

Figure 112 Model – Scotland Collection

Collection

Local Authority

Total Local Authority	97 kt						*Proportion Mixed / co-mingled*				
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*		
Kerbside	46 kt	19 %	6 %	17 %	55 %	4 %	45 %	10 %	45 %		
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*		
Bring	43 kt	31 %	10 %	30 %	26 %	3 %	45 %	10 %	45 %		
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*		
CA	8 kt	33 %	13 %	30 %	12 %	13 %	45 %	10 %	45 %		

C & I

							Proportion Mixed / co-mingled				
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*		
Total C & I	38 kt	0 %	0 %	0 %	100 %	0 %	57 %	15 %	27 %		

As with the UK Collection, the LA collection figure is taken from WDF, as is the breakdown by collection format and colour[106]. The C&I collections were calculated by working out the proportion of UK C&I collections, based on the non-consumer country split calculations completed in the Consumption section of this report. It is worth noting that Scotland has a lower proportion of glass collected co-mingled than the UK.

[106] An industry mixed colour protocol is applied to both the mixed and co-mingled collections

Wales

Figure 113 shows the model output for Welsh collection.

Figure 113 Model – Wales Collection

Collection

Local Authority

								Proportion Mixed / co-mingled		
Total Local Authority	74 kt									
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*
Kerbside	53 kt	0 %	0 %	0 %	57 %	43 %	45 %	10 %	45 %
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*
Bring	12 kt	8 %	5 %	11 %	74 %	2 %	45 %	10 %	45 %
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*
CA	8 kt	6 %	2 %	3 %	40 %	48 %	45 %	10 %	45 %

C & I

							Proportion Mixed / co-mingled		
		Clear	*Amber*	*Green*	*Mixed*	*co-mingled*	*Clear*	*Amber*	*Green*
Total C & I	16 kt	0 %	0 %	0 %	100 %	0 %	57 %	15 %	27 %

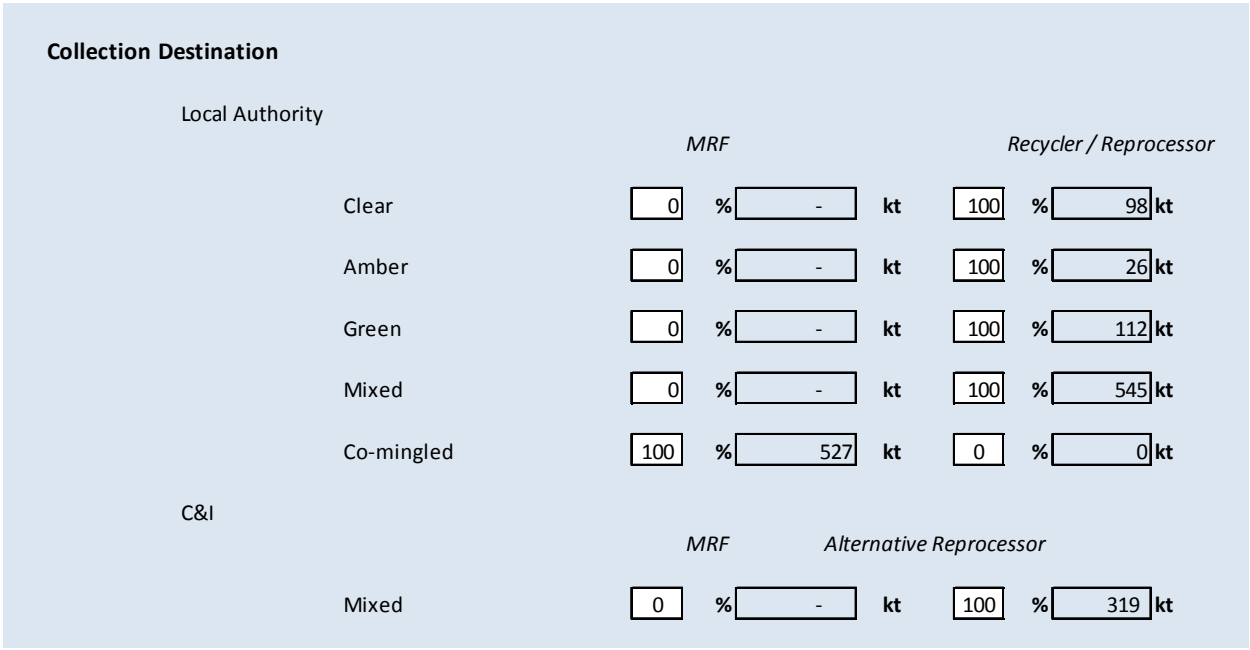
As with the UK Collection, the LA collection figure is taken from WDF, as is the breakdown by collection format and colour[107]. The C&I collections were calculated by working out the proportion of UK C&I collections, based on the non-consumer country split calculations completed in the Consumption section of this report. It is worth noting that no glass is collected colour separated from kerbside in Wales.

[107] An industry mixed colour protocol is applied to both the mixed and co-mingled collections

Collection Destination

The next section of the model details the location of the material collected by LAs or from private C&I collections. This is shown in **Figure 114**.

Figure 114 Model – UK Collection Destination



Collection Destination

Local Authority

	MRF				*Recycler / Reprocessor*			
Clear	0	%	-	kt	100	%	98	kt
Amber	0	%	-	kt	100	%	26	kt
Green	0	%	-	kt	100	%	112	kt
Mixed	0	%	-	kt	100	%	545	kt
Co-mingled	100	%	527	kt	0	%	0	kt

C&I

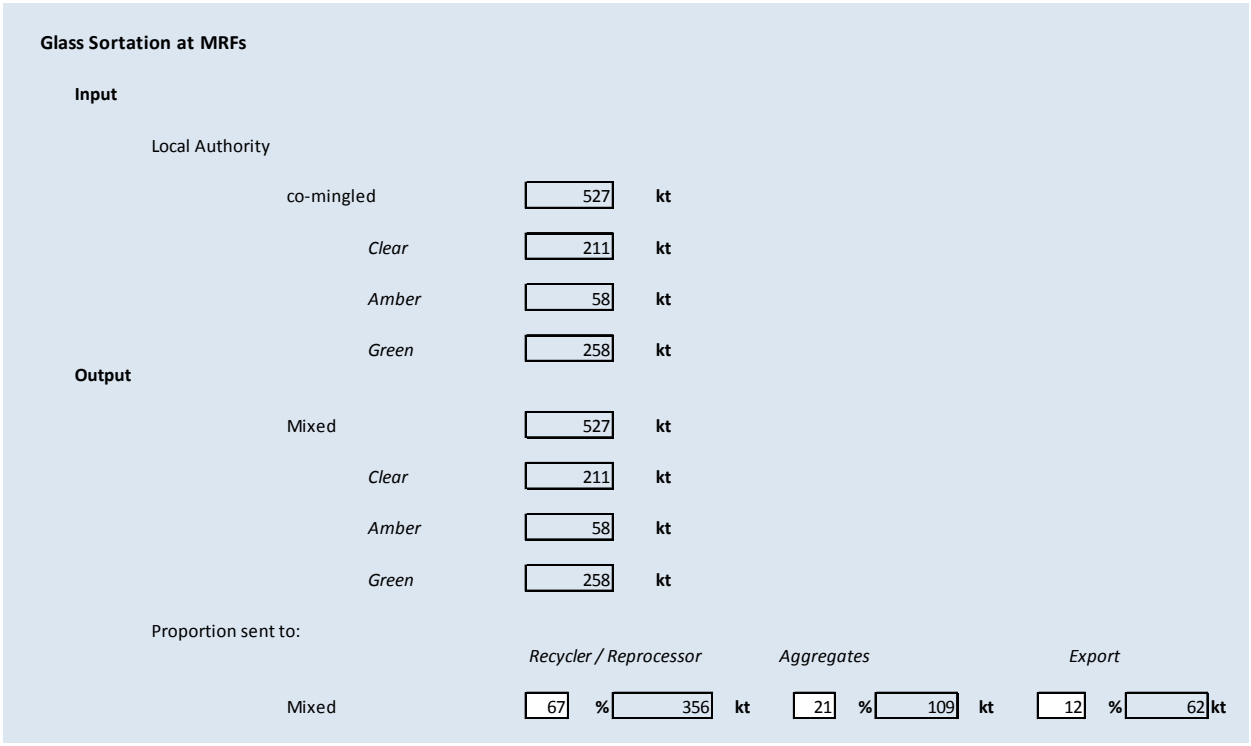
	MRF				*Alternative Reprocessor*			
Mixed	0	%	-	kt	100	%	319	kt

For the purposes of the model, as discussed in Section 5, it is assumed all co-mingled material is sent to MRFs. It is believed that some of this material will be sent to glass recyclers/reprocessors.

Sortation at MRFs

The next section of the model details the co-mingled glass that is sent to MRFs for sortation (excluding material only sent for bulking), and its destination following sortation. This is shown in **Figure 115**.

Figure 115 Model – UK MRF Sortation



It is important to note that, for the purpose of the model, the input tonnages equal the output tonnages. This arises from the way the collection figures were calculated, i.e. working out the C&I collection figures from NPWD, which is the tonnage that is successfully recycled. In that sense, any process loss has already been accounted for, implicitly, within the C&I estimate. This is a simplification for the purpose of the model, which gets around the need to estimate separate process losses for each stream and to derive a methodology for estimating the C&I collection figure independently. This also means the C&I collection estimate effectively under-estimates the actual level of C&I glass collected by the combined amount of the C&I and LA tonnages process losses.

This also ties in with the issue set out in the main part of the report, of estimating how much co-mingled glass goes through MRFs.

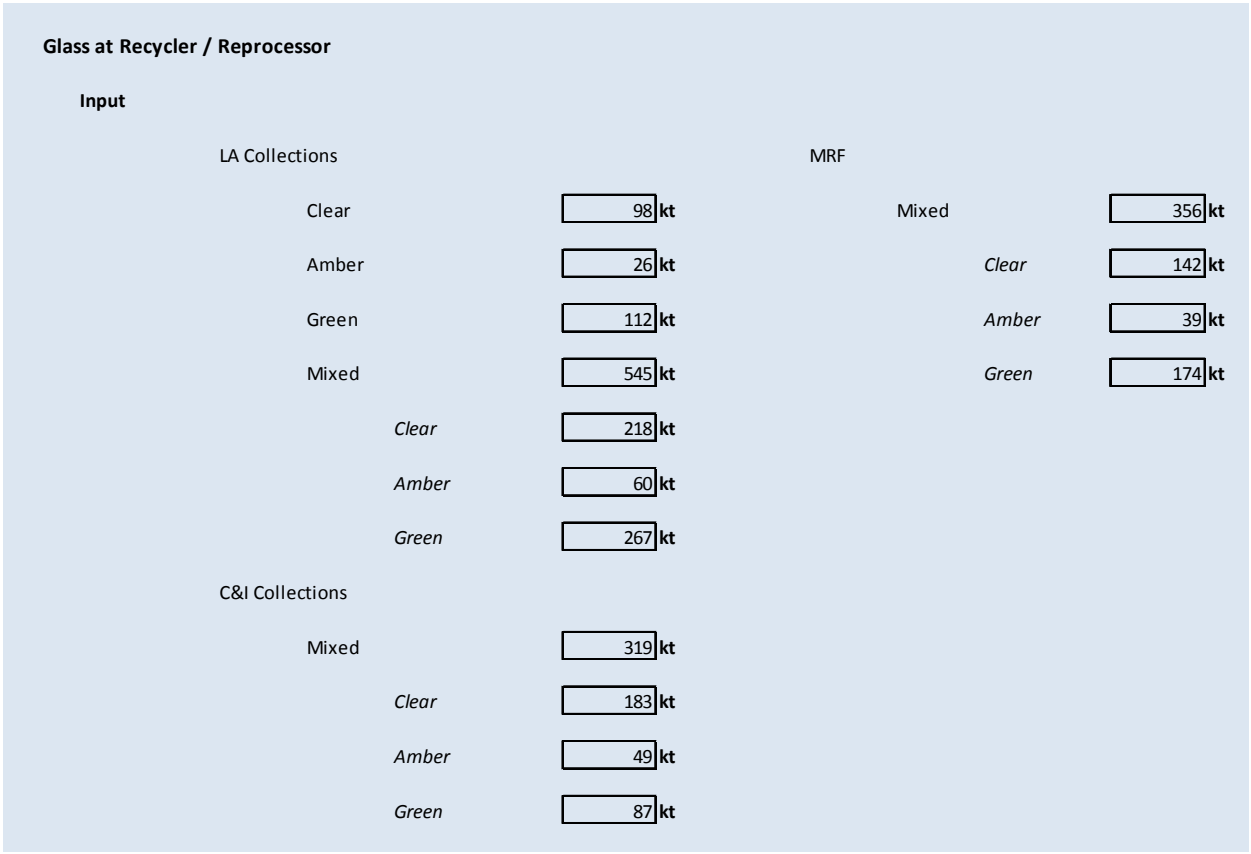
The upshot is that the model overstates output MRF tonnage and compensates by an equal under-statement implicitly in the C&I tonnage, such that the overall tonnages are consistent with the NPWD data but the breakdown at the sub-flow level (e.g. C&I and LA) is subject to self-cancelling under/over-statements.

As shown, it is assumed that what enters the MRF is LA co-mingled collections. At this stage the glass is removed from the other dry recyclate and what is sent out is mixed colour glass. The proportions sent to aggregates and export are calculated based on the assumption that 80% of aggregate and export input is from glass recyclers/reprocessors and 20% from MRFs. The remaining proportion of the material from MRFs not sent to aggregates or export is sent to glass recyclers/reprocessors.

Glass Recyclers/Reprocessors

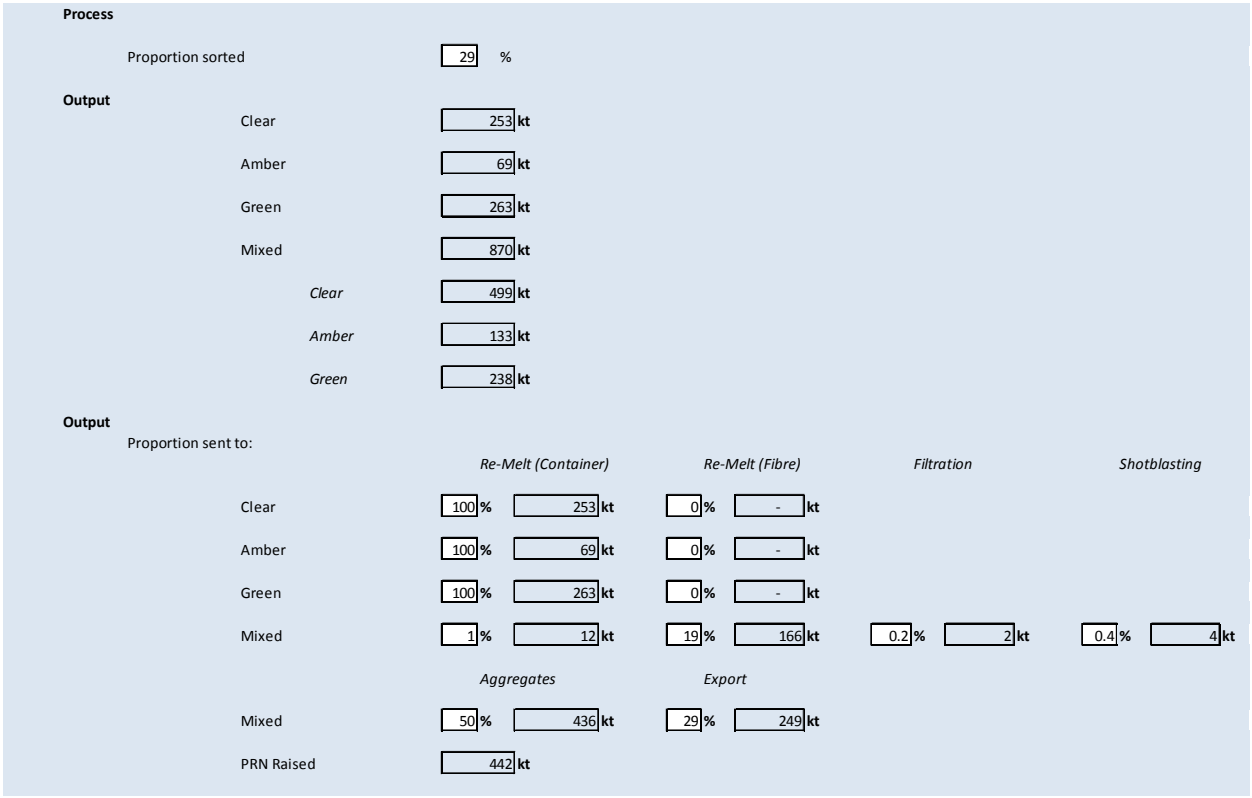
The next stage in the glass packaging supply chain is the material sent to the glass recycler/reprocessor. Glass recyclers / reprocessors take material from LAs (colour separated and mixed colour), MRFs (mixed colour) and C&I collections (mixed colour). This is summarised in **Figure 116**.

Figure 116 Model – UK Glass Recycler/Reprocessor Input



A proportion of the material is colour sorted at the glass recycler/reprocessor stage. The material is then sent to end markets such as remelt (container), remelt (fibreglass), filtration, shotblasting, aggregates or export. This is summarised in **Figure 117**.

Figure 117 Model – UK Glass Recycler/Reprocessor Output



All the colour separated glass from the glass recycler/reprocessor is assumed to be sent to remelt (container). Using an EA breakdown of the number of remelt/non-remelt/export PRNs raised in 2012 it is possible to determine how much material is sent to remelt. An estimated proportion split between remelt container and remelt fibreglass is then applied to know how much material is sent to remelt container. This split is discussed in the end markets section of this report. It is assumed that remelt container will have in an input of 2% mixed glass, and it is therefore possible to calculate the proportion of glass that is colour sorted (as all MRF colour sorted material will be sent to remelt container).

Using the EA breakdown of the number of remelt/non-remelt/export PRNs and estimates between filtration, shot blasting and aggregates, (this split is discussed in the end markets section) it is possible to calculate how much glass is sent to these end markets from glass recyclers/reprocessors [108].

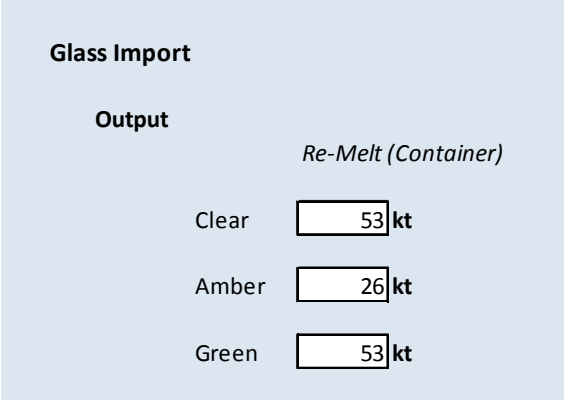
The model includes an estimate of how many PRNs are raised by glass recyclers/reprocessors, which is assumed to be the material sent to filtration, shot blasting and aggregates. The other material has a PRN raised on it further down the supply chain, under the current regulations.

Import

The model also includes imports of cullet to the UK. This is shown in **Figure 118**.

[108] Still assuming that 80% of input from glass recycler / reprocessor and export comes from glass recycler / reprocessor and 20% from MRF

Figure 118 Model – UK Import



This is based on the work completed in the (Cullet) imports section of this report.

End Markets

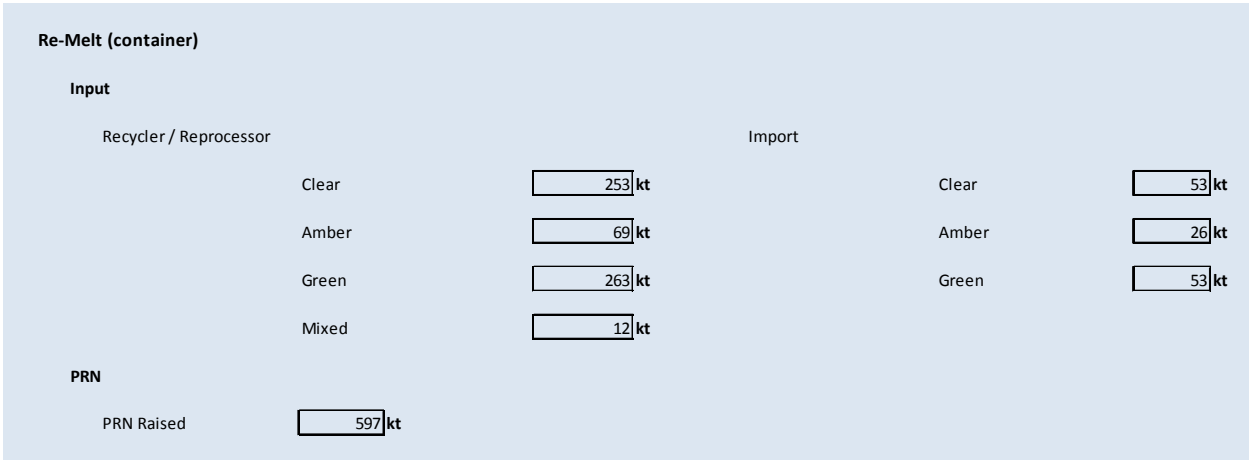
The model includes the material that is sent to the following end markets:

- Remelt (Container);
- Remelt (Fibreglass);
- Filtration;
- Shotblasting; and
- Aggregates.

Remelt (Container)

Remelt (container) takes material from glass recyclers/reprocessors as well as importing cullet. This is summarised in **Figure 119**.

Figure 119 Model – UK Remelt (Container)

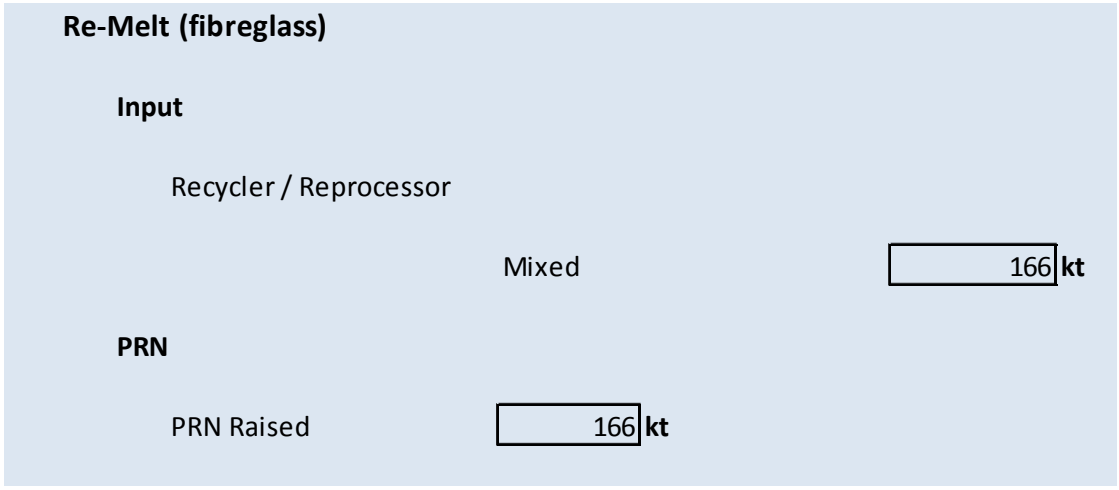


The model includes the number of PRNs raised at this point in the supply chain. It is important to note that only material from the glass recycler/reprocessor has a PRN raised on it (not imported cullet).

Remelt (Fibreglass)

Remelt (fibreglass) takes colour mixed glass from glass recyclers/reprocessors. This is summarised in **Figure 120**.

Figure 120 Model – UK Remelt (Fibreglass)

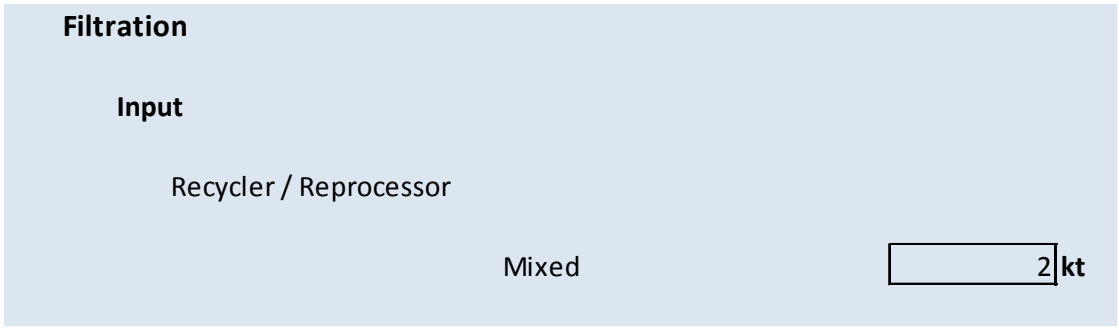


The model includes the number of PRNs raised at this point in the supply chain.

Filtration

Filtration takes colour mixed glass from glass recyclers/reprocessors. This is summarised in **Figure 121**.

Figure 121 Model – UK Filtration

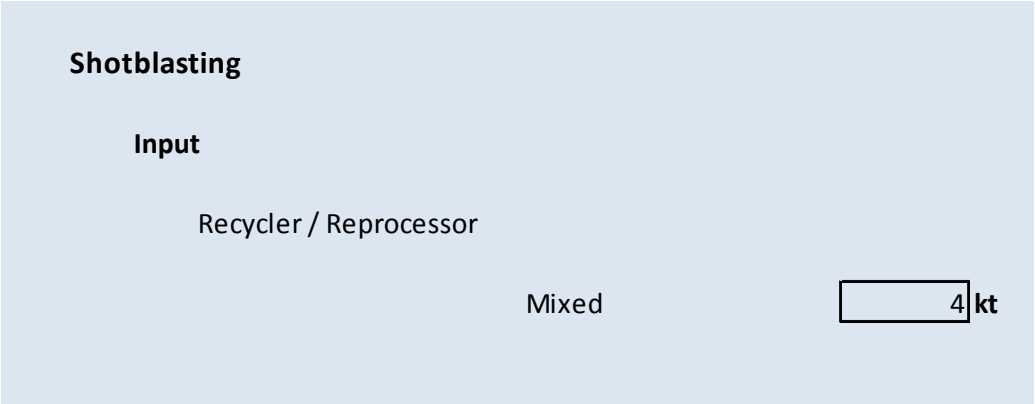


The model includes the number of PRNs raised at this point in the supply chain; however, the PRN has already been raised on the material at this point by the glass recycler/reprocessor.

Shotblasting

Shotblasting takes mixed colour glass from glass recyclers/reprocessors. This is summarised in **Figure 122**.

Figure 122 Model – UK Shotblasting

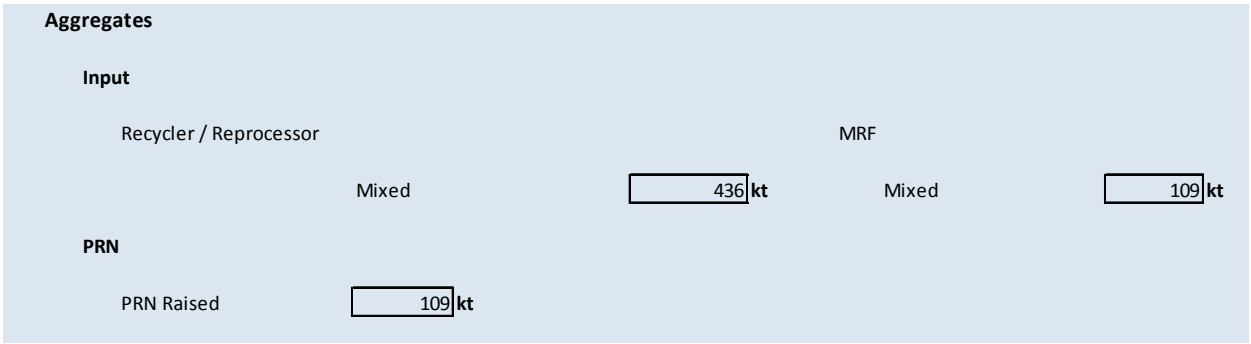


The model includes the number of PRNs raised at this point in the supply chain; however the PRN has already been raised on the material at this point by the glass recycler/reprocessor.

Aggregates

Aggregates take mixed colour glass from glass recyclers/reprocessors and MRFs (this model assumed a split of 80/20 respectively). This is summarised in **Figure 123**.

Figure 123 Model – UK Aggregates

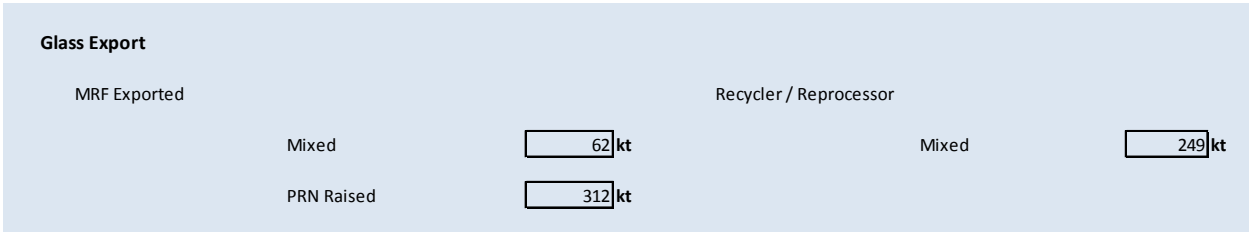


The model includes the number of PRNs raised at this point in the supply chain, however the PRN has already been raised on the material at this point by the glass recycler/reprocessor so only material from the MRF has a PRN raised on it at this point.

Export

The model includes the export of glass. This is done by both MRFs and glass recyclers/reprocessors (assuming a 20/80 split respectively). This is summarised in **Figure 124**.

Figure 124 Model – UK Export



The model includes the number of PERNs raised by exporters.

Appendix IX - Questionnaire

Introduction

WRAP and Valpak Consulting have teamed up to investigate the current and future trends in glass recycling. As a key stakeholder, we would like to gain your views and experiences of glass recycling and the key issues the industry faces in meeting current and future recycling targets.

The report we produce based on this information will be published, therefore if there is any specific information you would like to share with us and WRAP should remain confidential, please let us know as we proceed through the interview.

Company: **Contact Name:**

Telephone No: **Date:**

Email:

Organisation Activities (Please tick all that apply):

- ☐ **Recycler / Reprocessor (Prepares glass for remelt or other end markets – normally stage before end market)**
- ☐ **Glass Manufacturer (Remelt – packaging manufacturing)**
- ☐ **Glass Manufacturer (Remelt – fibreglass manufacturing)**
- ☐ **Aggregate Producer**
- ☐ **Other, please specify:**

_____.

Background

Answers to this section should be provided by **COLOUR OF GLASS**

Please provide an overview of your organisation and key processes? Looking for an overview of the facility and its capabilities in terms of for example colour sort, particle size needed, throughput times etc. (All respondents)	

What is your maximum incoming capacity for glass for recycling (if reprocessor / recycler / aggregate producer)? **OR** **What is your maximum incoming capacity for glass cullet for use in the manufacturing process (if glass manufacturer)?**	

What is your current throughput for recycled packaging glass (tonnage or % of capacity)? (All respondents)	

Do you receive the glass colour sorted or mixed-colour? If both please indicate the split between each. (All respondents)	**Colour Sorted (%):** **Mixed Colour (%):**

Do you have any plans to increase / decrease your capacity for using recovered glass packaging? Please specify (All respondents)	

What end markets do you use for your recovered glass packaging? **<u>Please specify for each colour of glass!</u>** (All respondents)	Market	✓	Supplied per Annum (by tonnage / %)				Notes
			Clear	Green	Brown	Mixed	
	Remelt packaging manufacturing						
	Remelt Fibreglass						
	Aggregates						
	Shotblasting						
	Filtration						
	Decorative Applications						
	Export (Glass for recycling)						
	Other (Please Specify):						

Processing Costs

What is your cost (per tonne) for processing glass? Please specify what this includes (All respondents)	

What price range do you believe the PRN should be and why? (Last year the price ranged from ~£10 – 20 then jumped up to ~£70 in the second half of the year with many indicating this price can't be sustainable) (All respondents)	

What would help you increase the amount of recovered glass packaging you reprocess? Please specify (All respondents)	

Trends

Achieving Recycling Target Risks

	Cause	Comments	How to prevent
Last year was a turbulent year for the glass industry with the UK almost failing to meet its glass recycling target **What do you believe were the reasons for this? What are your views on it being caused by the following** (All respondents)	**Reduction in the amount of glass going onto the market and therefore available for recycling** (Is there any possibility the recycling targets are too high - as the assumed flow onto the market figure for glass is greater than the actual tonnage)		
	Stockpiling (Holding ready to go material back until the market increases the value of PRNs)		

	Co-mingled or mixed glass collections negatively impacting on the quality glass collected		
	Processing of poor quality glass only when PRN price makes it economical? (Which can be done when PRN hits a trigger point which supports the clean-up of poor quality material) **If so, please explain the reason why the glass was of poor quality?**		
	Removal of fraud from the system		

	Reprocessing capacity going offline		
	Other, please specify		

Do you believe the UK will meet the recycling targets this year? Please specify. (All respondents)	

Have you increased the amount of recovered glass packaging you export? **If so why, please specify** **What would be required for you to recycle this material in the UK rather than export it?** **Please specify** (Glass recyclers / reprocessors)	

Specific Issues

Introduction to Issues Surrounding Various Collection Methods

We're now going to ask a few questions to get an understanding the quality impact from mixed glass collections to determine the difference between co-mingled collections v non-colour sorted glass collections.

Co-mingled Collections (Glass collected mixed with other dry recyclate such as plastic bottles and metal cans)

Do you accept (or collect) glass co-mingled with other dry recyclate materials? If so, what weight of your glass input is this? I.e. glass, plastic, cans.	

Have you seen an increase or decrease in the quantity of glass you receive which is sourced from co-mingled collections? (Glass recycler / reprocessors only)	

What would you consider to be the quality of this material? (Glass recycler / reprocessors only)	

If poor, what is it that makes it poor? Please provide information as to what causes the quality to be as such i.e. if poor quality then what causes it to be poor?	

How do you typically recycle this material? Please specify. i.e. can this be put into remelt and if so what % (Glass recycler / reprocessors only)	

Non-colour Sorted Glass Collections (Glass collected mixed colour but collected separate from other recyclate materials)

Have you seen an increase or decrease in the quantity of glass you receive which is mixed colour? (Glass recycler / reprocessors only)	

What would you consider to be the quality of this material? Please provide information as to what causes the quality to be as such i.e. if poor quality then what causes it to be poor, is it because it's been collected mixed? (Glass recycler / reprocessors only)	

How do you typically recycle this material? Please specify. i.e. can this be put into remelt and if so what % (Glass recycler / reprocessors only)	

New Split Recycling Target

What do you think the impact will be of the new split target for remelt (63%) and aggregates (37%)? Please specify. (Impact of potential impact of increase in co-mingled / mixed colour glass collections – i.e. outcome from judicial review) (All respondents)	

End of Waste Definition

What impact do you believe the change to the 'end of waste' definition will have? Please specify. (This could change the point at which PRNs can be raised with them now potentially being raised further back in the supply chain. This could lead to confusion of issuing PRNs and double issuing or PRNs disappearing due to people not knowing they could/should be raising them). (All respondents)	

Changes in Material

Do you think producers may stop using glass and start using other materials such as plastic if the high PRN / compliance costs experienced at the end of 2012 continue? (All respondents)	

Future Threats & Support Required

Future Glass Recycling Collections

	Cause	Comments	How to prevent
What do you see as the greatest threat to glass recycling in the UK in the coming years? **Please specify.** (All respondents)			

Government / WRAP Support

What support or intervention do you think the government or WRAP could provide to help encourage increased glass packaging recycling? (All respondents)	

Thank you for participating in the survey; if the project team has any other questions relating to this project would it be alright for them to contact you again?

Appendix X - Autoregression

The observation on the time series made at date t is denoted Y_t and the total number of observations is denoted T. Therefore, the interval between the observations, that is the difference between t and t+1, is one year.

The value of Y in the previous period is called its *first lagged value* or, more simply its *first lag*, and is denoted Y_{t-1}. Its j^{th} lagged value (or j^{th} lag) is its value at *j* periods, which is Y_{t-j}. Additionally Y_{t+1} denotes the value of Y one period in the future. The change in the value of Y between periods *t* and *t* - 1 ($Y_t - Y_{t-1}$) is known as the first difference in Y_t.

When testing the validity of the model, the data is analysed after computing the logarithm. This is because that time series exhibits growth that is approximately exponential, that is it grows by a certain percentage per year on average, and so the logarithm of the series will grow approximately linearly. The standard deviation is also expressed as a percentage of the level of the series; and so the standard deviation of the logarithm of the series will be constant.

The total glass recycling collection rate for next year needs to be estimated. The first order autoregression model is a simple Ordinary Least Squares regression on the change from Y_t to Y_{t-1}. The regression was run in excel and the produced the following function:

$$\mathbf{Y_t = 159245.8122 + 0.930725403\ Y_{t-1}}$$

This is known as the first order autoregression as only one lag is included as a regressor. The typical first order regression is abbreviated to AR(1), with 1 representing the number of lags included, and is represented as shown:

$$\mathbf{Y_t = \beta_0 + \beta_1 Y_{t-1} + \mu_t}$$

The AR(1) uses Y_{t-1} to forecast Y_t but this is ignoring potentially important data in the more distant past. We can include this information by introducing additional regressors into the OLS function which are also lags of Y_t. The p^{th} order autoregressive model represents Y_t as a function of *p* of its lagged values. The number of lags, *p*, included in an AR(p) model is called the order, or lag length, of the regression. The p^{th} order autoregressive model (the AR(p)) can be represented as below:

$$\mathbf{Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots + \beta_P Y_{t-P} + \mu_P}$$

There is scope to add additional predictors to the autoregressive time series regression. However, it is best to concentrate first on predicting the total aluminium recycling collection tonnes on its own lags. The optimum number of lags, or the value of *p,* needs to be decided upon. The trade-off is as follows: too few lags or regressors is potentially omitting valuable data from the more distant lagged values. However, if there are too many there will be more coefficient calculations than necessary, which in turn will introduce additional estimation error into the forecasts. The way the optimum *p* number is calculated is by minimizing an "information criterion", by using Bayes information criterion (BIC) which can be calculated as follows:

$$\mathbf{BIC(p) = \ln((SSR(p)) / T) + (p+1) \ln T / T}$$

The first term calculates the Sum of the Squared Residuals and so necessarily decreases (or at least does not increase) as lags are added. This is because as more regressors are added, more (or at least not fewer) is explained by the model (i.e. R2 will increase). The second term is the number of estimated regression coefficients (the number of lags, p, plus one for the intercept) multiplied by the factor (lnT)/T. This increases as the number of lags is added and so these two opposing forces allow us to choose the p value which minimizes the BIC. When running the OLS regression when a lag is added one fewer year's

data can be used when calculating a coefficient. This is because when running a regression, the number of dependent variable observations needs to be the same as the number of observations for each regressor. Therefore, if we add one lag is added there is one fewer observation, as the oldest year's data cannot have an equivalent for the previous year. Adding a second lag means that for each year's total tonnage collected the regression model will require the previous two years' data. This means that the last two years of data cannot be included in the regression as they do not have any data for their respective lags.

Bearing in mind that for the total recycling tonnages there are only data for 11 previous observations, adding too many lags will severely reduce the data set being used to make the predictions. When the regression was run with five lags (six observations could be used and 5 coefficients and an intercept needed to be calculated) the output was not properly calculated in the program. Therefore, the BIC calculation was only be used to investigate up to the 3rd order of autoregression. The results are summarised below showing 1 lag should be used:

p	SSR(p) / T	ln(SSR(p) / T	(p+1)ln(T)/T	BIC(p)
1	7009620288	22.67054937	0.394607593	23.06515696
2	7123828539	22.68671113	0.621226662	23.3079378
3	7232369720	22.70183258	0.871961917	23.5737945