Final Report

MetalFlow 2014

Project code: MKE014-001 **Date:** February 2015
Research date: March - June 2014 (revisions to 2013 estimates as of January 2015)

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Front cover photography: Collected mixed metals

Executive summary

Background
This project was commissioned by WRAP and Valpak to provide support for material estimates in Defra's packaging policy work. Its aim was to review the quantity of aluminium and steel packaging being both placed on the market (POM) and reprocessed for the year 2012 (and 2013 where data was available), and to provide a scenario analysis for each of the materials going forward to 2020. To achieve this, this project engaged a stakeholder group that provided input and expert market knowledge at all stages of the process. The group comprised organisations such as Defra, the Environment Agency, Alupro, the Metal Packaging Manufacturers Association and Tata Steel, amongst others. This spread of group members ensured that the project team had access to the best market knowledge available.

Aluminium packaging
The most robust estimate that could be derived, based on publicly available data, suggests that the quantity of aluminium packaging POM in 2012 was 178k tonnes and 174k tonnes in 2013 (subject to revisions of National Packaging Waste Database (NPWD) data, which was updated in January 2015). This is a threshold estimate as there was an element of packaging being POM by smaller organisations that was unaccounted for within this estimation. However, discussions with the steering group suggest this may be fairly minimal for aluminium. In 2012, the level of aluminium reprocessed by accredited reprocessors (those registered with the Environment Agency) was 62k tonnes, suggesting a recycling rate of 35%. However, for aluminium it was highlighted that a large element of reprocessing was unaccredited (i.e. by reprocessors not registered with the Environment Agency); this was estimated to be 19k tonnes. Including this would have increased the recycling rate from 35% to 46% in 2012.

Steel packaging
The most robust estimate that could be derived, based on publicly available data, suggests that the quantity of steel packaging POM in 2012 was 524k tonnes and 529k tonnes in 2013 (subject to revisions of National Packaging Waste Database (NPWD) data, which was updated in January 2015). This includes an element of packaging being POM by smaller organisations. Discussions with the steering group suggested this may be more significant for steel than for aluminium, and following a brief consultation with Tata Steel and the Metal Packaging Manufacturers Association, it was assumed to be 7.5%. This is a working assumption, based on the expert knowledge of Tata Steel and the MPMA but not rooted in any robust data. As such, a more robust methodology for identifying the quantity of steel placed on the market by smaller organisations that is unreported should be developed. There was broad agreement from industry representatives on the total POM estimate. In 2012, the level of steel reprocessed by accredited reprocessors (those registered with the Environment Agency) was 358k tonnes, suggesting a recycling rate of 68%. There was an element of reprocessing for steel that was unaccredited (i.e. by reprocessors not registered with the Environment Agency), although this was estimated to be minimal at 9k tonnes in comparison with 19k tonnes for aluminium. Including this would have increased the recycling rate only by 2% to 70%.

Meeting the EU metal recycling target
Bringing together these estimates of the amount of metal packaging POM and reprocessed shows that across the range of estimates, the EU recycling target of 50% for metal packaging was met in 2012. At best, it is exceeded by 14%, at worst by 10% when combining the estimated quantity of aluminium and steel packaging being POM with the estimates of recycling. These findings are based on a number of assumptions which are detailed elsewhere in this report.

Metal packaging placed on the market data

The estimation of the amount of metal packaging POM was based on the data reported to the Environment Agency by obligated organisations (those handling at least 50 tonnes of packaging and with a £2 million turnover are obligated) and stored on the NPWD. A methodology using this information which is termed "net UK pack fill", focuses on the quantity of packaging reported at the *packing/filling* stage of the supply chain, as opposed to the *selling* stage of the supply chain (a *pack/fill process is* where goods are put into packaging or packaging is put around goods and a *sell* process is one that supplies packaged goods to the end user). It is believed that there are fewer unobligated packer/fillers in comparison to unobligated sellers. However, there will remain in all likelihood some unobligated packaging activity that is being missed. Since estimating the amount of unobligated packaging is notoriously difficult, a lack of data and resulting uncertainty means it cannot be estimated reliably for metal packaging. Notwithstanding these caveats, the net pack fill methodology using publically available data was deemed to be the best available methodology for metal packaging.

It is important to stress that the net pack fill estimates are themselves subject to a degree of uncertainty because they rely on the robustness of the data that is submitted to NPWD. The NPWD data is widely recognised as being the best available of its kind and scope, and is used by policymakers and their agencies. However, it is not within the scope of this report to review the accuracy of the NPWD data.

Two alternative methodologies to estimate the amount of metal packaging POM were also investigated to provide comparisons. The first attempted to build-up a total figure from adding up estimates of packaging POM in various market segments (for example the amount of metal packaging sold in supermarkets, pet stores, body care stores etc.). The second was based on building an aggregate UK view (using data sources other than NPWD) of net metal packaging supply, i.e., packaging produced in the UK (plus imports less exports). However, for various reasons that are detailed in the report, the associated estimates derived from these methodologies were not deemed to be as robust as the net pack fill estimate.

Metal packaging reprocessed data issues

The accredited reprocessing figures were based on those that were published by the Environment Agency from NPWD returns. In addition to this, an analysis was required to estimate the amount of unaccredited reprocessing. This was calculated using the estimated number of reprocessors and exporters that were known to be operating but not accredited in 2012, and the quantity of material they would normally handle. However, this is an imperfect measure in that it misses out packaging handled by reprocessors that have never sought accreditation. There is also anecdotal evidence of accredited reprocessors who might not raise PRNs on all of their reprocessed metal packaging (although this might be marginal).

Scenario analysis

Scenarios were developed for the quantities of aluminium and steel packaging POM and the amounts being reprocessed covering the period from 2013 to 2020. A range of alternative projections for the amount of packaging POM were calculated based on; historical trends in the net pack fill estimates, the assumed growth rates in PackFlow, Defra's estimated growth rates, and growth assumptions from industry consultation. Accepting that there are inevitable uncertainties in such projections, based on the more robust scenarios the amount of aluminium packaging POM could increase to 187k tonnes by 2020 while the amount of steel packaging POM could decrease to 493k tonnes by 2020. Combined with technical 'autoregressive' projections of the amount of reprocessing (broken down between accredited and unaccredited reprocessing) the recycling rate could increase to a minimum of 46% by 2020 for aluminium and to 81% for steel. In all of these scenarios, the EU target would be exceeded in each year to 2017.

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Glossary

ACP – Advisory Committee on Packaging
C&I – Commercial & Industrial
CP – Current Prices
EA – Environment Agency (EA)
EPIC – Environmental Product Information Centre
EWC – European Waste Catalogue
GDP – Gross Domestic Product
HaFS – Hospitality and Food Service
IPA – Industrial Packaging Association
ISSB – International Steel Statistics Bureau
LA – Local Authority
MPMA – Metal Packaging Manufacturers Association
MRF – Materials Recovery Facility
NPWD – National Packaging Waste Database
ONS – Office of National Statistics
POM – Placed On the Market
PRN – Packaging Recovery Note
SA – Seasonally Adjusted
VDS – Valpak Data Solutions
WDF – Waste Data Flow
WDI – Waste Data Interrogator

Acknowledgements

Valpak and the Waste and Resources Action Programme (WRAP) would like to thank the following organisations for their contribution to the MetalFlow 2014 project:

- 360 Environmental;
- Alupro;
- AMG Resources;
- British Beer and Pub Association (BBPA);
- British Metals Recycling Association (BMRA).
- Defra;
- Environment Agency (EA);
- Metal Packaging Manufacturers Association (MPMA);
- Tata Steel; and
- Wastepack.

1.0 Introduction

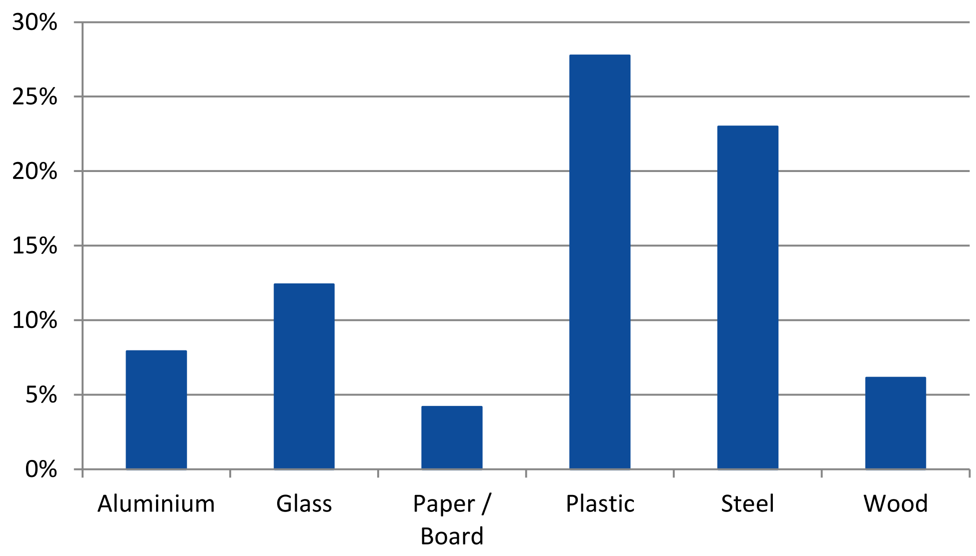
1.1 Background and existing data

Defra is keen to ensure that the estimates being used for its packaging policy work are as robust as possible. To support Defra, this report focuses on reviewing these estimates of UK steel and aluminium packaging placed on the market (POM) and the associated compliance implications.

The existing Defra estimates for 2012 are: 162k tonnes of aluminium packaging and 645k tonnes of steel packaging. The Packflow[1] project and industry engagement formed the basis for these estimates.

By way of context, it is worth highlighting that informal stakeholder discussions with groups such as the Advisory Committee of Packaging (ACP)[2], as well as an initial analysis of the primary packaging materials and the proportion of their total POM that was unobligated[3], revealed noticeable differences across packaging materials as shown in **Figure 1**.

Figure 1: Proportion of Unobligated POM for Packaging Materials 2012



As shown, aluminium has a smaller proportion of unobligated POM than steel. This suggests that relatively more aluminium packaging used in the UK is handled by obligated organisations. For steel, it appears that 23% of the total POM is unobligated (~150k tonnes). However this was based on PackFlow, which is now outdated.

In addition to this, the recycling targets are increasing from 40% (2012) to 55% (2017) for aluminium and 71% (2012) to 76% (2017) for steel. With rising targets, the estimation on

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[1] http://www.valpak.co.uk/Libraries/Environmental_Consulting_Documents/PackFlow_2017_Final_Report_09_11_12.sflb.ashx
[2] Completed as part of the GlassFlow 2012 project.
[3] The total POM is made up of material that is obligated and unobligated. The obligated material POM is by those organisations in the UK that handle over 50 tonnes of packaging annually and have a turnover in excess of £2M (these organisations have to pay to recover the material through the purchase of recycling evidence: PRNs). Therefore, the unobligated proportion will be higher when there are a greater number of smaller organisations involved in that material market. The total POM was taken from Defra estimations, PackFlow and GlassFlow reports and the obligation was taken from NPWD.

the quantity of packaging POM needs to be as robust as possible to correctly calculate the quantity of packaging materials that will require to be recovered.

Projected figures for reprocessing were presented in PackFlow and were last updated in 2010. The comparison between the PackFlow projected recycling estimates and the actual levels[4] are shown in **Figure 2**.

Figure 2: PackFlow Projected Recycling Figures Versus Actual Recycling Figures

Aluminium Recycling	2010	2011	2012
PackFlow	60k	79k	91k
Actual	60k	74k	62k
Steel Recycling	2010	2011	2012
PackFlow	387k	392k	396k
Actual	387k	374k	358k

This highlights that the projected recycling figures have deviated from the actual figures in 2011 and 2012; this project looks to review these going forward to 2020.

1.2 Objectives

The MetalFlow project had the following key objectives:

- Review of aluminium and steel packaging POM, collection and recycling figures;
- Analysis of economic indicators and their relationship with aluminium and steel packaging POM, collection and recycling;
- Updated scenario analysis for aluminium and steel until 2020;
- Produce a report for publication, including an Executive Summary, highlighting caveats as necessary, in particular reflecting the relative degrees of uncertainty between instances where it has been possible to undertake robust statistical analysis and instances where there was very limited data; and
- Engagement with a steering group of relevant key stakeholders such as Alupro, the Metal Packaging Manufacturers Association (MPMA), Tata Steel, British Metals Recycling Association (BMRA), British Beer and Pub Association (BBPA), AMG, Defra, Environment Agency (EA), 360 Environmental, The Industrial Packaging Association, Valpak, WRAP and Wastepak.

1.3 Methodology

1.3.1 POM

The work identified three possible ways to estimate the total metal packaging POM in the UK: one bottom up and two top down approaches. The baseline year was 2012; however, where possible, 2013 data was also gathered.

1.3.1.1 POM Methodology 1 (Bottom Up Approach)

This approach built up the POM figure using a variety of components, based on the main applications for metal packaging including:

[4] *Based on NPWD data for recycling*

- Metal packaging around food/drinks/other groceries including body care/pet food/DIY products (such as paint),as sold by supermarkets and other more specialist retailers such as pet stores, body care stores and DIY stores;
- Metal packaging around food/drink as consumed in the hospitality sector;
- Metal packaging around food/drink as consumed by airlines;
- Metal packaging around alcohol from cross border shopping;
- Commercial and industrial packaging; and
- Metal packaging around illegal imports of alcohol[5].

In order to estimate the amount of packaging consumed by the grocery retail market, the Environmental Product Information Centre (EPIC, the Valpak Data Solutions [VDS] database[6]) provided data on annual sales and packaging weights for all relevant products packaged in metal. This was taken from a selection of VDS supermarket clients representing a cross-section of grocery retailers in the UK. Using market share information (from Kantar World Panel[7]) for these supermarkets, which represented 54% of the grocery retail market the resulting quantity of metal packaging was scaled up to represent a UK grocery retail market wide estimate.

For metal packaging around goods sold by grocery retailers, another data source was used to act as a cross check: aggregated EA metal packaging compliance data for a selection of grocery retailers. The data provided by the EA was 2013 steel and aluminium tonnages reported in table 1 selling from NPWD, representing 91% of the grocery retail market. This data was scaled up to represent the whole market, again using Kantar World Panel data.

For metal packaging around goods sold by specialist retailers (pet stores, body care and DIY), the approach involved using EA metal packaging compliance data for key players in each area (the EA provided aggregated data only), which was scaled up using market share data. Where this was not possible, estimations were made for these based on the retail data gathered. For the body care and pet stores, market reports (appropriately referenced in later sections of the report) were used to estimate sales in specialist stores against retail sales for these sectors. This, combined with the retail data, allowed an estimate of specialist store sales. For the DIY stores, Valpak used annual sales and packaging weights data from a selection of VDS DIY clients, representing a cross-section of the DIY sectors in the UK. Market share information was then used to scale up the data to achieve a market wide estimation.

Trade associations also made their own calculations to estimate the quantity of cans on the market by consumers (food and drink cans etc., excluding the hospitality sector and C&I), and the findings were presented to the steering group for feedback and cross-checking.

The amount of metal packaging POM by the hospitality sector was based on an existing report on the hospitality sector ('Waste in the UK Hospitality and Food Service Sector[8]'), which estimates the arisings and composition of waste in the hospitality sector. The packaging waste arisings were used as a proxy for packaging POM.

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[5] *Packaging around imported goods that did not have duty paid on them*

[6] *The database is based on information collected direct from suppliers as well as information sourced internally, 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 Valpak's bespoke software Environmental Product Information Centre (EPIC). Over 800,000 supermarket products are recorded in EPIC.*

[7] http://www.kantarworldpanel.com/global

[8] http://www.wrap.org.uk/content/overview-waste-hospitality-and-food-service-sector

Cross border shopping was also included as it is believed that consumers may be bringing aluminium and steel alcohol packaging into the UK when returning from abroad. This was estimated by taking incoming passenger numbers, an estimate of alcohol purchases and an estimated proportion of these purchases likely to be packaged in aluminium or steel and an estimate of the average weight of packaging used by these products. Out-going passengers POM was not included in these calculations as this material would arise outside of the UK and, as such, would not contribute to the quantity of steel or aluminium packaging POM.

Metal packaging used around food/drinks served by airlines was an estimate derived from the likely level of waste arising from incoming international and domestic flights alongside waste composition data.

The metal packaging around illegal imports of alcohol was estimated by taking figures for alcohol sold in the UK packaged in steel and aluminium and the proportion of this that was illegally imported, based on HMRC and KPMG analysis (appropriately referenced in later sections of the report).

For metal packaging used around goods consumed in the Commercial & Industrial (C&I) waste stream, estimates were developed from Defra C&I survey data[9] and EA waste protocols.

1.3.1.2 POM Methodology 2 (Net Pack Fill)

This methodology compiled metal packaging data reported by obligated net pack fill companies into the National Packaging Waste Database (NPWD). The estimate is thought to capture the vast majority of the relevant tonnage but does miss out the quantity of metal packaging handled by non-obligated net pack fill companies, free-riders (those companies who are above the packaging obligation threshold by having a turnover of £2M and handling 50 tonnes of packaging but are not registered with the relevant agency) and packaging for internal company use.

To estimate the amount of packaging placed on the UK market by obligated companies, the calculation set out below was applied. This calculation uses the total data reported by obligated packaging producers and is available on NPWD:

1.3.1.3 POM Methodology 3 (Top Down Approach)

The third method of estimating the quantity of metals POM was based on the methodology developed in GlassFlow (shown below).

Total UK Alu / Steel packaging POM	=	Total Production	-	Exports (empty)	-	Exports (filled)	+	Imports (empty)	+	Imports (filled)

[9] https://www.gov.uk/government/publications/commercial-and-industrial-waste-generation-and-management

Sources investigated included Prodcom and the International Steel Statistics Bureau (ISSB), UK Tradeinfo and statistics from the trade associations.

1.3.2 Collections

The collections were firstly broken down between Local Authority (LA) collections and commercial collections. The LA collections were estimated using data from WasteDataFlow (which is presented with relevant ranges where there is uncertainty over the data) and the commercial collections estimated through data from NPWD as a proxy (which is an underestimation as it is equivalent to the level of recycling, not collection). It was also envisaged that the EA Waste Data Interrogator (WDI) tool would be utilised; however, as the data in this database was incomplete for the purpose of providing estimates for this report, this source was not used.

1.3.3 Reprocessing

The level of accredited reprocessing (that which is eligible to raise a PRN) was estimated through the number of PRNs that were raised on aluminium and steel. The unaccredited reprocessing was estimated by using the number of reprocessors and exporters who were operational (and previously accredited to handle aluminium and steel packaging) but not accredited in 2012, and the packaging they would normally handle as a proxy.

1.3.4 Scenario Analysis

The final section of the report completed a historic analysis of the metal packaging being POM. A scenario analysis, using a variety of techniques, was then developed to inform the level of material being POM and the level of reprocessing (accredited and unaccredited) from 2013 to 2020.

2.0 Metal Packaging POM – Methodology 1

2.1 Introduction

This section of the report is the review of the total metal packaging POM in the UK in 2012, based on methodology 1. The 2013 data was available but not finalised at the time of writing; therefore, it is not included in this methodology. This method splits the POM into different elements. These were as follows:

- Grocery Retail;
- Pet stores;
- Body Care stores;
- DIY;
- Hospitality;
- Airline;
- Cross Border Shopping;
- Commercial & Industrial; and
- Illegal Imports.

Alupro provided the composition of aluminium packaging across all retail sectors (e.g. grocery, body care, hospitality). The splits are provided below:

- Drinks cans – 66%;
- Foil container – 10%;
- Aluminium in laminates, composites – 10%;
- Plain foil (e.g. dairy lids, chocolate) – 4%;
- Imported premium pet food trays – 2%;
- Aerosols – 3%;
- Closures – 3%; and
- Food cans – 2%.

Within the EA, the 'Agreed position and technical interpretations – producer responsibility for packaging[10]' composite and multi-material packaging is described as being different. Composite packaging is: 'multi-layered sheets of dissimilar materials which are bonded together and cannot be separated by hand', such as laminated paperboard, whereas multi-material packaging is: 'packages constructed of assembled components of different material', such as a blister pack made from cardboard and plastic and can be separable by hand. Within the technical interpretations guidance, the packaging weight for laminate packaging 'should be recorded under the predominant material by weight', compared to multi-material packaging weights, which should be recorded separately, by the different component materials.

One of the largest composite materials declared in aluminium laminates/composites is steel cans with aluminium ends. It is not clear how sellers and packer/fillers declare this information and so it would be beneficial to investigate this further with producers.

[10] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/298036/LIT_4976_51cdc7.pdf

2.2 Grocery Retail

In order to estimate the metal packaging consumed at grocery retail in the UK in 2012, the EPIC database was used[11]. The EPIC data is most robust for the years following 2011 when the database was cleansed. The EPIC database annual sales and packaging weights data included information from a selection of VDS supermarket clients representing a cross-section of grocery retailers in the UK. The market share information provided by Kantar World Panel was then used to scale up the packaging data to estimate the quantity of UK grocery retail metal packaging sold in 2012.

The aluminium packaging in the grocery retail sector was estimated to be **101k tonnes in 2012**. Based on EPIC data, the largest types of aluminium packaging sold in the grocery retail market in the UK in 2012, by weight were:

- Alcohol (including cans and closures) – 40%;
- Soft Drinks – 26%;
- Aerosols (beauty) – 7%;
- Food Cans – 5%;
- Ready meal trays – 3%; and
- Other (pet food, chocolate tins / wrappers, sauces, caps, closures, laminates, air fresheners) – 19%.

This estimation was cross referenced with aggregated EA data to check the validity of the EPIC data for grocery retail. Details of this are provided in Appendix I. This shows that either route (EA data or EPIC data, uprated) yield very similar estimates. It was also estimated that laminate packaging accounted for approximately 16k tonnes of aluminium[12]. The information was provided by Alupro, and by weight this included:

- Lids on steel drink cans – 31%;
- Foil in drink cartons – 28%;
- Other (e.g. confectionary, pouches) – 25%; and
- Foil in pharmaceutical products – 16%.

The steel packaging in the grocery retail sector was estimated to be **286k tonnes in 2012**. Based on EPIC data, the largest types of steel packaging sold in the grocery retail market in the UK in 2012, by weight were:

- Canned Food – 57%;
- Pet Food – 12%;
- Alcohol (including cans and closures) – 8%;
- Soft Drinks – 5%;
- Chocolate & Biscuit tins – 5%;
- Aerosols (including beauty and air freshener) – 3%; and
- Other (including paint pots, caps & closures, clips) – 10%.

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[11] The database is based on information collected direct from customers and suppliers as well as sourced information internally, 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 Valpak's bespoke innovative software EPIC.
[12] Source: Alupro

This estimation was cross referenced with aggregated EA data and details of this are provided in Appendix I. This shows that either route (EA data or EPIC data, uprated) yield very similar estimates.

As an additional sense-check, further analysis was undertaken to establish an equivalent quantity of alcoholic and soft drinks. To do this, the quantity of beverage container sales was taken from the EPIC data and an average beverage container weight was calculated. This showed that, uprated to the total UK market using Kantar market shares, the estimated total quantity of metal packaging sold in grocery retail in the UK in 2012 included 4,905,852k beverage containers. Of this, 2,525,954k units were beer containers. These figures are summarised in **Figure 3**.

Figure 3: Grocery Retail – Beverage Containers

	Total
Beverage Containers	4,904,852k
Beer Containers	2,525,954k

It has been difficult to verify the consistency of the overall beverage container figure (above) as existing alternative data is not directly comparable. However, the beer containers estimate (as reported in Figure 3, with the addition of the estimated beverage containers arising in the hospitality sector, airlines and cross border shopping) was within 5% of the independent industry estimate, suggesting a reasonable degree of consistency. Further details of this analysis are provided in Appendix II.

2.3 Pet Stores

Market Data suggests that 63% of pet food is purchased at the supermarket (grocery retail), with the remaining 37% being purchased from specialist stores, garden centres or from a vets/breeders[13]. Using this split and the quantity of aluminium and steel pet food packaging sold in grocery retail (from EPIC scaled up as described in Section 2.2.1), the quantity of pet food packaging sold outside of grocery retail was calculated. This analysis is provided in **Figure 4**.

Figure 4: Pet Food – Metal Packaging 2012 (T)

	Grocery Retail	Other (Specialist Pet Food Stores etc)
Aluminium	2k	1k
Steel	36k	20k
Total Metal Packaging	**38k**	**21k**

Validation of these estimates was difficult due to lack of comparable data. There were too few relevant companies for the EA to be in a position to share specific data for this sector in the way that was done for the grocery sector. Details of this are provided in Appendix III.

[13] *Market Assessment 2013 – Pet Market (Keynote).*

2.4 Body Care

Market data[14] for 2012 suggests that 34% of body care items are purchased at supermarkets (grocery retail), with the remaining 66% being purchased from non-grocery retail and non-retail channels. Using this split and the quantity of body care packaging sold in grocery retail (from EPIC scaled up as described in Section 2.2.1), the quantity of body care packaging sold outside of grocery retail sector can be calculated. Any retailer classed as a both a grocery retailer and a total body care specialist was subtracted from the total body care estimation to avoid double counting. This analysis is provided in **Figure 5**.

Figure 5: Body Care – Metal Packaging 2012 (T)

	Grocery Retail	Other (Specialist Body Care Stores etc)
Aluminium	7k	11k
Steel	7k	10k
Total Metal Packaging	**14k**	**21k**

Industry believed that the aluminium figure of 11k was too high for 2012 due to light weighting in aerosols. This estimation was cross referenced with aggregated EA data to check the validity of the EPIC data. The cross-check suggested that the EPIC data was a good approximation for body care packaging not sold in grocery retail in the UK. Further details of this are provided in Appendix IV.

2.5 DIY

In order to make an estimation of the DIY store packaging weight, the EPIC database was used (the metal packaging for DIY principally comprises steel packaging). This process included scaling up the weight from the EPIC database, based on market share information[15], to achieve steel packaging arisings in the DIY sector of 11k tonnes in 2012. By weight, the following items were the predominant types of steel packaging sold in the DIY market in the UK in 2012:

- Paint Pots – 95%;
- Aerosols and sprays e.g. oil, cleaning spray – 2%;
- Fillers & gas canisters – 1%[16]; and
- Other (e.g. clips, banding, closures) – 2%.

Based on stakeholder feedback, it was suggested that the 11k tonnes estimate for the DIY sector was too low, potentially due to paint cans being underreported. This estimation was cross referenced with aggregated EA data and details of this are provided in Appendix IV. Due to market share data being publically unavailable for the DIY sector, the EA data was not scaled up; as such it was difficult to compare EPIC data to the EA data. Further details of this are provided in Appendix IV.

[14] *Beauty and Personal Care in the United Kingdom (Euromonitor).*
[15] *The UK Decorative DIY Market to 2016 (Companies & Markets).*
[16] *This figure may increase as in 2013 refillable steel gas cylinders and fire extinguishers are classified as packaging where they were not previously*

2.6 Hospitality

This is metal packaging that is 'household-type', but is consumed in pubs, cafés, hospitals etc. It is generally the same as that consumed at home, but due to the location it is not always collected by a local authority for recycling or disposal.

Hospitality metal packaging estimates were derived from waste arising estimates in the Hospitality and Food Service (HaFS) sector. These were then broken down into the following sub sectors[17]:

- Restaurants;
- Pubs;
- Education;
- Healthcare;
- Hotels;
- Quick Service Restaurants;
- Services;
- Leisure; and
- Staff catering.

A recent report completed by WRAP estimated that there were 1,298k tonnes of packaging (all materials) generated by the HaFS sector in 2013, as shown in **Figure 6**.

Figure 6: Hospitality Waste Arisings UK (T)

	Packaging
Restaurants	502k
Pubs	461k
Education	131k
Healthcare	62k
Hotels	32k
Quick Service Restaurants	45k
Services	28k
Leisure	12k
Staff Catering	25k
Total	**1,298k**

The data was broken down to show the proportion of aluminium and steel packaging for the following sectors:

- Restaurants;
- Pubs;
- Hotel;
- Quick Service Restaurants; and
- Leisure.

For the remaining four sectors, an average was taken as the data was not broken down into metal packaging. This is summarised in **Figure 7**.

[17] http://www.wrap.org.uk/content/overview-waste-hospitality-and-food-service-sector

Figure 7: Hospitality Waste Arisings UK – Aluminium and Steel Packaging (T)

	Aluminium Packaging				Steel Packaging		
	Cans	Foil	Aerosol	Other	Cans	Aerosol	Other
Restaurants	1k	1k	<1k	<1k	8k	1k	2k
Pubs	4k	2k	<1k	1k	6k	<1k	2k
Education	2k	2k	<1k	1k	8k	<1k	1k
Healthcare	1k	1k	<1k	<1k	4k	<1k	1k
Hotels	<1k	1k	<1k	<1k	3k	<1k	1k
Quick Service Restaurants	<1k	<1k	<1k	<1k	3k	<1k	<1k
Services	<1k	<1k	<1k	<1k	2k	<1k	<1k
Leisure	1k	<1k	<1k	1k	1k	<1k	<1k
Staff Catering	<1k	<1k	<1k	<1k	1k	<1k	<1k
Total	**10k**	**7k**	**<1k**	**3k**	**36k**	**1k**	**8k**

Key stakeholders raised concerns that the foil arisings might not be packaging and in fact might be tin foil used to cover food (which is not classed as packaging); however, the report does not provide this level of detail.

As a sense-check, the above tonnages for metal containers were translated into an estimate of the number of containers, using the different aluminium and steel container weights from EPIC. As well as traditional cans, the can tonnages, above, included industrial sized food cans (such as baked beans), but the data was not disaggregated enough to account for this in the estimated number of cans. Therefore, the latter was an upper estimation of the number of beverage containers in the hospitality sector.

It has been difficult to verify the consistency of the overall beverage container figure as existing alternative data is not directly comparable. A sense-check on an estimate of beer cans within that overall total suggested a reasonable degree of consistency with industry estimates, at least for beer cans. Details are provided in Appendix II.

The potential for error margins around the original HaFS estimates used here, plus the lack of data to verify the assumptions needed to fully split the HaFS data into steel and aluminium packaging, combined with a lack of data to sense-check the resulting estimates (other than beer cans) suggest a degree of caution over the HaFS metal packaging estimates, especially as they form a non-negligible proportion of the total. There is less confidence in this estimate than there is in the grocery metal packaging estimate. See Appendix VII for a more detailed assessment of relative levels of confidence in the data.

2.7 Airline

The composition of aircraft waste varies depending on the length of the flight and whether it is low cost or full service. However, by weight, newspapers and magazines make up the majority of the waste stream (71%), compared to cans and foil, which make up 2%[18]. British Airways tries to recycle as much as possible on board and is working with its catering partners to reduce product and packaging waste[19]. It has been reported that Cathay Pacific

[18] http://www.sustainableaviation.co.uk/wp-content/uploads/aircraftcabinwasterecyclingguide.pdf
[19] http://www.onedestination.co.uk/environment/resource-management/waste-management/

recycled 33 tonnes of aluminium cans in 2010[20]. A waste composition analysis completed in 2002 (by Li et al) states that aluminium cans account for 2% of the total in-flight waste stream[21]. This data is summarised in **Figure 8**, suggesting that 1k tonnes of aluminium packaging was generated through Aircraft Waste in 2012.

Figure 8: Aluminium Packaging Generated on Flights 2012 (T)

	2012
Number of Incoming International Passengers	91,150k
Waste Generation per Long Haul Flight (kg per passenger)	0.56
Number of Domestic Passengers	37,300k
Waste Generation per Short Haul Flight (kg per passenger)	0.4
% Waste Generated Aluminium Packaging	2%
Total Aluminium Packaging (T)	**1k**

No data was found to further sense-check this estimate (although it fed into the overall beverage/beer can cross-check in Appendix II.

2.8 Cross Border Shopping

Another source of metal packaging placed onto the UK market is packaging around goods brought back from abroad by travelling consumers; most likely to be beer cans. Data was provided by the British Beer and Pub Association on the approximate number of beer cans purchased overseas and brought back to the UK. Using an average beer can packaging weight for both aluminium and steel, an estimate of cross border shopping was calculated: 780 tonnes for aluminium and 240 tonnes for steel. The data is for 2011 and not for 2012; however, the 2011 figure has been used in this report because more recent data was not available at the time of writing.

Figure 9: Cross Border Shopping (T)

	Aluminium	Steel
2011 Beer Cans Purchased overseas	1k	<1k

No data was found to further sense-check this estimate (although it fed into the overall beverage/beer can cross-check in Appendix II).

2.9 Commercial & Industrial

This element includes items such as drums and bale wire and mostly comprises secondary and tertiary packaging[22]. These streams have been reported separately due to their differences in terms of ease of recovery, levels of contamination and potential as untapped material for recycling.

[20] http://www.cathaypacific.com/cx/en_GB/about-us/environment/waste.html
[21] http://www.ucdenver.edu/academics/colleges/Engineering/research/CenterSustainableUrbanInfrastructure/LowCarbonCities/Documents/X%20Li/waste%20reduction.pdf
[22] *Secondary packaging being that outside the primary packaging and tertiary packaging is typically used for shipping, bulk handling and warehouse storage.*

This section reviews the current available data for this type of packaging and estimates the potential relevant weight. The last large scale project that aimed to estimate this was the Commercial and Industrial Waste Survey in 2009[23]. There are limitations to this data because it is based on 2009 statistics and only includes an analysis of the commercial and industrial sector in England. It also includes non-packaging streams and elements already picked up via the Hospitality sector (which could result in duplication).

The hospitality analysis included the following sectors:

- Restaurants;
- Pubs;
- Education;
- Healthcare;
- Hotels;
- Quick Service Restaurants;
- Services;
- Leisure; and
- Staff catering.

Therefore, the following sectors were excluded, as shown in **Figure 10**.

Figure 10: Commercial & Industrial Metallic Waste Arisings (Excluding Hospitality) – England 2009 (T)

Business Sector	Total	Metallic Waste
Textiles/wood/paper/publishing	3,449k	76k
Power & utilities	5,719k	48k
Chemicals / non-metallic minerals manufacture	3,848k	103k
Metal manufacturing	4,236k	895k
Machinery & equipment (other manufacture)	2,165k	902k
Retail & wholesale	9,211k	169k
Transport & storage	2,189k	246k
Other	5,401k	92k
Total	**36,218k**	**2,531k**

Additional work was completed for the CIWM in 2013: "Commercial and Industrial Waste in the UK and Republic of Ireland"[24], and this work completed a review of available datasets. This work highlighted that the English waste arisings equated to 82% of the overall waste arisings in the UK for this sector. The Welsh figure was primarily based on a study completed in 2007 by Urban Mines, managed by Environment Agency Wales, and funded by Welsh Assembly Government[25]. The Scottish and Northern Ireland figures were based upon relevant employment forecasts.

[23] http://archive.defra.gov.uk/evidence/statistics/environment/waste/documents/commercial-industrial-waste101216.pdf
[24] http://www.ricardo-aea.com/cms/commercial-and-industrial-waste-arisings-management-and-capacity-gaps/
[25] http://www.environment-agency.gov.uk/static/documents/Research/Survey_of_Industrial_and_Commercial_Waste_Arisings_in_Wales_2007.pdf

Scaling up the remaining quantity of metallic waste gave a UK figure of 3,077k tonnes based on the splits developed for the CIWM. There is internal Valpak knowledge, developed from previous projects, which suggested that 25% of the metallic waste was aluminium and 66% was steel. Therefore, the estimated total aluminium waste in the waste stream would be equivalent to approximately 769k tonnes of aluminium and approximately 2,031k for steel. However, only a proportion of this would be packaging: based on discussions with industry representatives around the EA protocols, it was estimated that the proportion of aluminium packaging would be negligible while the proportion of steel packaging was estimated to be 7%. Therefore, it is estimated that the level of commercial and industrial steel packaging POM was 142k tonnes[26] in 2012, assuming that C&I metallic waste arisings stood at a broadly similar level to waste arisings in 2009, when the survey was conducted. Nevertheless, information gleaned from stakeholders indicated that this estimation could actually be too high.

This estimation was cross referenced with data from the EA's WDI tool. This analysis is provided in Appendix VI; however, it was felt that this tool's estimate was not robust enough to draw any firm conclusions.

The caveats around the use of the C&I survey and around the additional assumptions needed to draw specific aluminium and steel packaging estimates, together with the lack of data available for meaningful sense-checks and the lack of consistency with industry expectations suggest concern over the robustness of this estimate. This is worth noting as the commercial and industrial estimate forms a non-negligible proportion of the total. There is less confidence in this estimate than there is in the grocery metal packaging estimate. See Appendix VII for a more detailed assessment of relative levels of confidence in the data.

2.10 Illegal Imports

Estimating illegal imports of alcohol (and the associated aluminium and steel packaging) involves a substantial degree of uncertainty. It is attempted here for completeness; however, many of the assumptions used and the resulting estimates are difficult to sense-check meaningfully, which means that the results should be interpreted with caution.

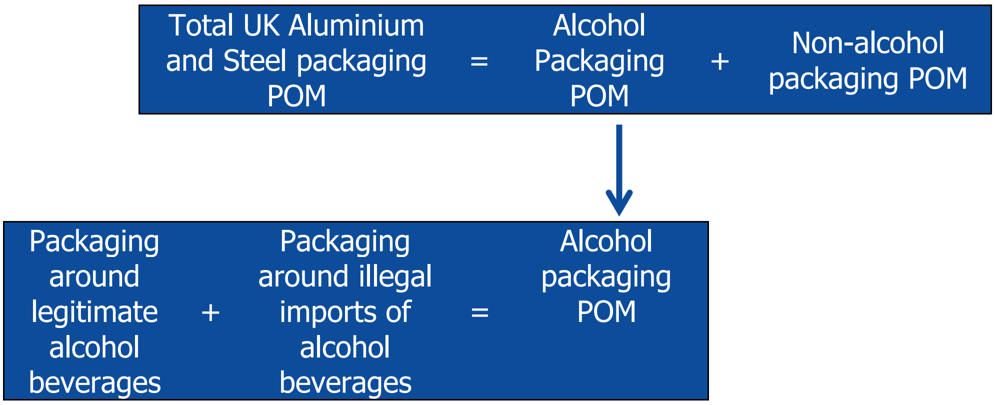
The illegal imports are imports into the UK of alcohol on which no duty is paid (excluding the cross border shopping and those purchased on flights). Although there may be illegal imports of non-alcohol items packaged in aluminium and steel, it was assumed that these would be minimal and so were excluded from the analysis. This is estimated based on HMRC data calculated as part of their tax gap analysis in 2012[27], in addition to the British Beer and Pub Association and KPMG report on the economic review of HMRC's beer tax gap estimates[28]. This data provides the proportion of alcohol consumption that is illegal. Therefore, the following formula was used:

---

[26] *This figure was based on 2009 data; however, PackFlow projected annual growth of negative 0.5% to 0% between 2009 and 2012 for steel commercial and industrial packaging. Here, 0% growth in overall C&I waste, metallic waste and steel C&I packaging is used.*

[27] *http://www.hmrc.gov.uk/statistics/tax-gaps/mtg-2012.pdf*

[28] *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*



Using the estimated level of alcohol packaging POM, it is possible to work out the proportion of this that is illegally imported using relevant market data. An HMRC report stated that of all beer sales in the UK, between 5% and 14% was illegally imported in 2012. However, a KPMG report[29] critiquing this estimation stated that the methodology for the HMRC upper number was robust, but the data used was not. It also stated that the methodology for the lower estimate was not robust. Based on this, it is estimated that the illegal imports account for between 3% and 4% of beer sales in the UK; this was also supported by the relevant trade associations. Therefore, for the purpose of this report, it was assumed that 3.5% of all beer sales are illegally imported.

In order to estimate how much metal packaging was illegally imported in 2012, the quantity of alcohol packaged in aluminium and steel POM in 2012 was calculated. It was assumed that this packaging arises in the following two areas:

- Grocery Retail; and
- Hospitality.

The estimation on the volume of beer cans sold in grocery retail was based on the EPIC database. The same split was used to calculate the quantity arising in the hospitality sector. The total quantity of illegal imports is shown in **Figure 11**.

Figure 11: Illegal Imports of Aluminium and Steel Packaging 2012 (T)

	Aluminium	Steel
Illegal Imports (3.5%)	**1k**	**1k**

[29] 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

2.11 Results

The results are shown in **Figure 12**.

Figure 12: Methodology 1 Results – Metal Packaging in 2012

	Aluminium	Steel
Grocery Retail	101k	286k
Pet Stores	1k	20k
Body Care	11k	10k
DIY Stores	-	11k
Hospitality	20k	45k
Aircraft Waste	1k	-
Cross Border Shopping	1k	0k
Commercial & Industrial	-	142k
Total Including Illegal Imports (Method 1)	**135k**	**516k**
Illegal Imports	(1k)	(1k)
Total Excluding Illegal Imports (Method 1)	**134k**	**515k**

Overall, this suggests that the aluminium and steel packaging POM was 134k and 515k tonnes respectively (excluding illegal imports), based on methodology 1.

The three main component parts are, in order of magnitude, metal packaging found in grocery, commercial and industrial (for steel) and hospitality. There is a reasonable degree of confidence in the estimates for the grocery sector. There is, however, a much lower level of confidence in the estimates for the other two areas. The data used for these is subject to more uncertainty; a number of additional assumptions were necessary which couldn't necessarily be verified and there was not enough data to provide meaningful sense-checks. See Appendix VII for a more detailed assessment of relative levels of confidence in the data.

This methodology is reported in full here to provide a detailed record of the avenues pursued, successful or otherwise, to help inform any future work in this area. However, as a result of the uncertainty surrounding the estimates, this methodology is not recommended for further use as a means of estimating total steel and aluminium packaging, unless the estimates of HaFS and C&I packaging can be strengthened.

3.0 Metal Packaging POM – Methodology 2

3.1 Introduction

This section of the report is the review of the total metal POM in the UK in 2012 and 2013, based on methodology 2. This estimation, net pack fill, is based on the data stored on the NPWD, as reported to the EA by obligated organisations. This project used the data published on the NPWD in January 2015.

3.2 Net Pack Fill

The 2012 and 2013 UK flow of packaging was calculated using packaging handled weights as reported to the EA by registered producers; this information is available on the NPWD. The calculation used is shown below:

Net pack fill	=	Packing/Filling (Table 1 - pack/filling)	+	Imports (Table 3A - Imported for the purpose of Selling)	+	Imports (Table 3B - packaging removed from around imports)	-	Exports (Table 2A + Table 2B – pack/filling)

This methodology took the weight reported at the packing stage of the supply chain – as opposed to the selling stage of the supply chain. This was used as it was believed there would be fewer unobligated packers in comparison to unobligated sellers. Using this methodology, the total aluminium and steel POM in 2012 was 178k tonnes and 488k tonnes respectively (as shown in **Figure 13**).

Figure 13: Methodology 2 Results – Metal Packaging in 2012

	Aluminium	Steel
Table 1 Pack/Fill (UK pack/filling)	170k	398k
Imports:		
3A Selling (filled imports)	39k	156k
3B (packaging removed from imports)	1k	32k
Total	**210k**	**586k**
2A P/F (direct exports)	27k	91k
2B P/F (third party exports)	5k	7k
Total Exported	**32k**	**98k**
Net Pack/Fill	**178k**	**488k**

The 2013 figures, which became available at the end of the project and updated in January 2015, are shown in **Figure 14**. The packaging POM in 2013 was 174k tonnes for aluminium and 492k tonnes for steel.

Figure 14: Methodology 2 Results – Metal Packaging in 2013

	Aluminium	Steel
Table 1 Pack/Fill (UK pack/filling)	164k	398k
Imports:		
3A Selling (filled imports)	40k	162k
3B (packaging removed from imports)	<1k	34k
Total	**205k**	**593k**
2A P/F (direct exports)	27k	94k
2B P/F (third party exports)	3k	7k
Total Exported	**30k**	**101k**
Net Pack/Fill	**174k**	**492k**

The aluminium and steel packaging estimates are broadly stable.

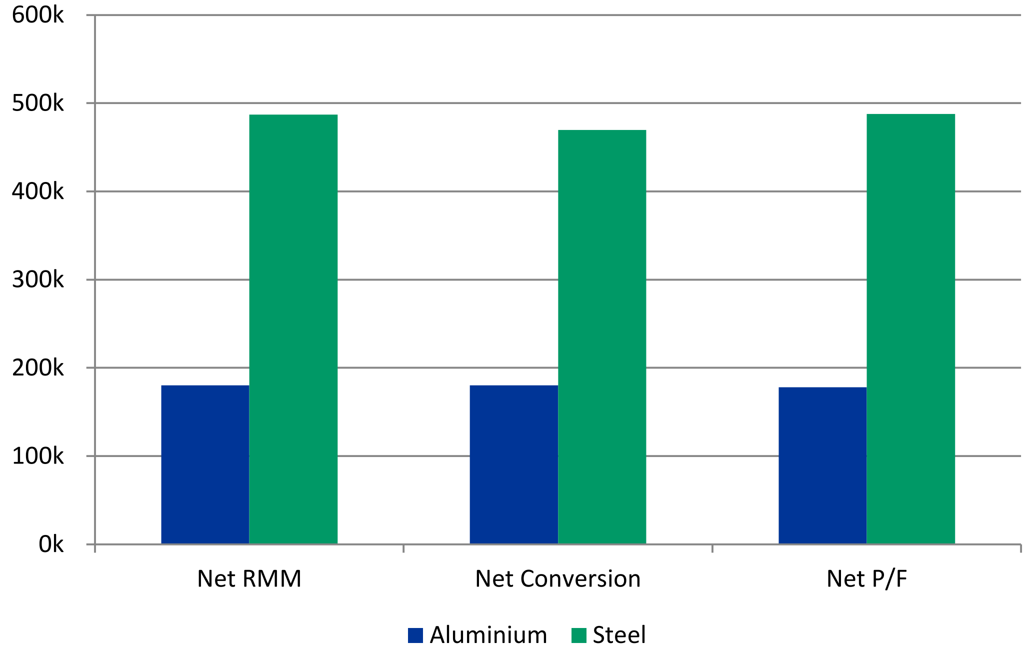
A review of data used was conducted by the Environment Agency and Alupro. This involved using the net converter figures from NPWD to compare the Alupro and EA data (i.e. any aluminium handled by a producer who is undertaking a conversion function minus that which they export). Converter data was used because this was a smaller sample to validate representing a large % of the total aluminium going onto the UK market. The review looked at all registered company data down to individual company level and compared on a like for like basis with the Alupro data. The review identified that the figures for UK conversion are broadly comparable therefore recommend using the pack fill data from NPWD as the key data to reflect the Aluminium placed on the market position.

The steering group was extensively consulted on these estimates and various checks were performed, as reported in the sections below.

3.3 Verification checks

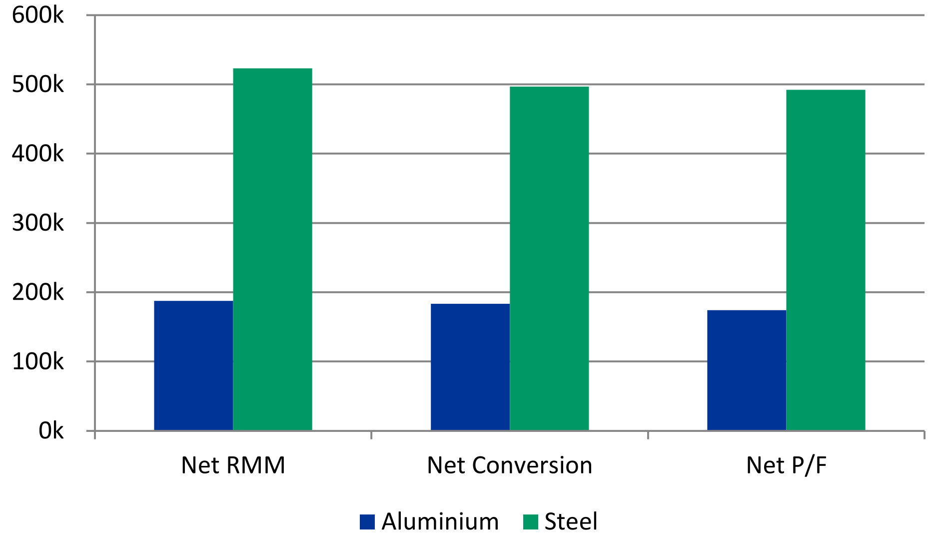
In order to confirm levels of confidence in this methodology, checks were made using the data within the producer packaging data tables. The net calculation was applied to other activity lines of the tables: raw material manufacturing and conversion, in addition to pack/filling. The aim was to identify whether a similar net weight resulted from this calculation being applied to the other lines. The results indicated that similar weights are in fact reported, as shown in **Figure 15** for 2012 and **Figure 16** for 2013.

Figure 15: Methodology 2 Results – 'Net' Producer Data Table Calculations 2012



Net Producer Data		
	Aluminium	Steel
Net Raw Material Manufacturing (RMM)	180k	487k
Net Conversion	180k	470k
Net Pack/Filling (P/F)	178k	488k

Figure 16: Methodology 2 Results – 'Net' Producer Data Table Calculations 2013



Net Producer Data		
	Aluminium	Steel
Net RMM	187k	523k
Net Conversion	183k	497k
Net P/F	174k	492k

Notwithstanding the 2013 data that is still subject to revision, this data shows a degree of consistency and helps to provide a level of confidence in the NPWD producer data. Variations in the net numbers suggest an incomplete covering of registered producers and/or variations in the quality of data provided.

3.4 Unreported quantity: non-obligated producers and free-riders

This method did not account for metal packaging handled by unregistered producers, which was likely to include the following:

- Non-obligated producers – those below the registration thresholds of 50 tonnes of packaging and £2 million turnover; and
- Free-riders – those obligated to register but not doing so; and
- Illegal importers.

There is no easy way of quantifying this potentially unreported quantity of packaging. Based on feedback from the stakeholder group, it is believed that there are little or no number of pack/fillers who are unobligated for aluminium. Reasons for this include (but are not limited to) the investment in canning equipment being too capital intensive for small businesses.

For steel the quantity of unreported POM was believed to be higher than for aluminium. A brief consultation with Tata Steel and the Metal Packaging Manufacturers Association suggested the unreported quantity could be approximately 7.5%. This is a working assumption, based on the expert knowledge of Tata Steel and the MPMA but not rooted in any robust data. As such, a more robust methodology for identifying the quantity of steel placed on the market by smaller organisations that is unreported should be developed. This would lead to a placed onto the market figure of 524k in 2012 and 529k in 2013.

3.4.1 Environment Agency Producer Data

Using data provided by the EA, it was possible to analyse how many producers contributed to the top 90% of weights declared by all obligated producers, within selected lines of the data submission tables. A lower number of contributing producers in a given line (such as pack/fill or selling) implied a lower quantity of unreported packaging or a de-minimis. This is because if smaller organisations are contributing a relativley low volume to the total quantity of packaging being POM, then the de-minimis element will necessarily be smaller. The results are shown in **Figure 17**.

Figure 17: 2012 Producer Number Breakdown

	Aluminium				
	90% of tonnage			**All tonnage**	
	No. producers	% of total		No. producers	% of total
Table 1 P/F	38	7%	Table 1 P/F	38	7%
Table 1 Selling	53	5%	Table 1 Selling	53	5%
Table 3a P/F	28	21%	Table 3a P/F	28	21%
Table 3a Selling	91	19%	Table 3a Selling	91	19%

	Steel				
	90% of tonnage			**All tonnage**	
	No. producers	% of total		No. producers	% of total
Table 1 P/F	145	13%	Table 1 P/F	145	13%
Table 1 Selling	203	10%	Table 1 Selling	203	10%
Table 3a P/F	41	24%	Table 3a P/F	41	24%
Table 3a Selling	124	14%	Table 3a Selling	124	14%

The results show that a very small percentage of producers make up 90% of the tonnage declared in table 1 packing/filling and selling. As it is generally accepted that the largest producers are registered, this analysis indicates that any small, unregistered producers would not contribute much at all to the overall obligation; therefore, the unreported quanitity is likely to be minimal. The percentage is higher in steel than aluminium, suggesting that the assumption of low unregistered tonnage is most robust in aluminium, using this method.

In addition to this, any free-riders or non-obligated pack/fillers or sellers would have to be handling additional packaging not already declared by other converters or pack/fillers in order for it to be missing from the total submitted data, unless there are unregistered converters, which is unlikely.

The percentage of producers making up 90% of the imported weights (table 3a pack/filling and selling) in **Figure 17** is higher than in table 1. This could mean that the volume of unreported imports is higher and/or that the weights handled by importers are more evenly spread across those producers.

3.4.2 Exports

It was suggested by the stakeholder group that exports declared by producers are potentially too low. This was specifically the 3rd party exports, which they feel is being under reported. If this is the case, the quantity of packaging remaining in the UK may be lower than estimated. It is often difficult for producers to report all third party exports (exports by their customer or further down the sales chain) because they are required to have evidence of the export taking place. Also, the end destination of the packaging may change without the producer knowing it may be exported. This is common to all material types.

Analysis of producer data available on NPWD was completed in order to look for variations in export data trends that might identify decreased export data from one year to the next. The results of this were inconclusive and could not justify an adjustment. **Figure 18** shows the pattern of aluminium and steel exports in the conversion lines over the last seven years. The conversion was used instead of the net pack fill export calculation as it is the largest reported tonnage of the data form and the stakeholder group felt it would provide the most robust analysis.

Figure 18: Historic Export Analysis

3.5 Results

Figure 19 and **Figure 20** display the total quantity of aluminium and steel packaging POM in 2012 and 2013. When compared to the PackFlow mid-point and the Defra estimation, aluminium is higher; whereas steel packaging is lower.

Figure 19: Methodology 2 2012 Summary Results

	Aluminium	Steel
Net Pack Fill (Uplifted for Steel)	178k	524k
PackFlow 2012 Mid-Point	150k	649k
Defra Estimation	162k	645k

Figure 20: Methodology 2 2013 Summary Results

	Aluminium	Steel
Net Pack Fill (Uplifted for Steel)	174k	529k
PackFlow 2012 Mid-Point	151k	647k
Defra Estimation	164k	642k

Difference from PackFlow

The PackFlow figures were originally estimated through a data gathering exercise and industry consultation. These were assumed to be the most accurate at the time and were agreed upon by industry, however it is felt that the latest analysis provides a more robust figure.

2013 Uncertainty

It should be stated that the 2013 net pack fill estimations are calculated using the latest EA figures and are subject to change until all resubmissions and new registrants are finalised for the year. The data used for this report was published on NPWD in January 2015.

Industry Agreement

The net pack fill steel packaging estimate is broadly in line with industry expectations. It is also broadly consistent with the estimate from Methodology 1 (+/-2%), notwithstanding the substantial caveats around the latter. For aluminium, again, the methodology produces an estimate consistent with industry expectations for both 2012 and 2013. Alupro base their estimate on actual member data and the work suggests that this is consistent with their estimate.

The industry estimate is underpinned by methodology/data that could not be shared with the Steering Group for this work due to commercial confidentiality. However a review of methodology/data used was conducted by the Environment Agency and Alupro for aluminium to sense check Methodology 2. The review recommended using the net pack fill data from NPWD as the key data to reflect the aluminium placed on the market position. For the purposes of this report, the net pack fill estimates are considered to be the most reliable estimates based on publicly available data. The net pack fill calculation is considered to be the most appropriate section of the supply chain to use to calculate POM as it gives more coverage of producers. Also, raw material manufacturing and conversion will include some amount of process loss; therefore it is expected to be higher than using the pack fill line to conduct the net calculation. Also it is generally expected that there would be fewer non-obligated producers conducting the pack fill activity than selling activity, therefore, of the four lines net pack fill is considered to represent best the total flow of packaging on the market.

See Appendix VII for a more detailed assessment of relative levels of confidence in the data.

4.0 Metal Packaging Consumption – Methodology 3

The third methodology to estimate the metal packaging flow onto the market was based on the following formula:

Total UK Aluminium/Steel Packaging Consumption	=	Total Production	-	Exports (empty)	-	Exports (filled)	+	Imports (empty)	+	Imports (filled)

In order to estimate the total production, Prodcom data was analysed. However, there were concerns over the usability of the data. In particular, it was not clear from the way the data is classified if it is possible to reliably isolate and incorporate all relevant packaging, potentially leading to an under estimate. In addition, several (some known to be significant proportions) data-points are suppressed by Prodcom for data confidentiality reasons (further detail provided in Appendix VIII).

As a result of these concerns, Prodcom data was not explored further. Other sources, such as the ISSB, were investigated. Despite these additional investigations, the available data was not found to be robust enough to complete an analysis to a sufficient level. Consideration was given to analysing production data for individual packaging formats, such as cans, to build up a production figure that way. However, because the number of can manufacturers available was limited (potentially making the data commercially sensitive), this line of investigation was not pursued further. Therefore, in the absence of a robust production figure, no estimation was made for metal POM based on methodology 3.

5.0 Collection and Reprocessing of Metal Packaging

5.1 Introduction

This section of the report examines the levels of metal packaging collected and reprocessed within the UK. The collections are split between LAs and commercial and industrial (C&I) collections. In previous work, the levels of collection have been assumed to be equivalent to the levels of reprocessing; the data on LA recyclate collections (from Waste Data Flow [WDF]) being used as a proxy for household recycling and the number of PRNs being raised as the total recycling level. However, these figures do not account for process loss from collection to recycling or unaccredited reprocessing. Therefore, a key aim of this report was to complete a separate analysis on each of collections and recycling in order to provide a more robust analysis.

5.2 Collections

When metal packaging is collected by LAs, and private collectors on behalf of LAs, it is generally collected from:

- Kerbside;
- Bring sites; and
- Household waste recycling centres.

This data is submitted by the local authorities to WDF. The C&I collections of metal are usually done by private waste management companies or metal recyclers.

5.2.1 Local Authority Collections

Local authority household collections of metal packaging in the UK can be represented as follows:

Total UK Metal Packaging Collected by Local Authorities	=	Kerbside Collection[30]	+	Bring Site Collection	+	CA Site Collection

This data was extracted from WDF, and figures are reported based on the financial year 2012/13. This means there is some degree of inconsistency between the collection figures for April 2012 - March 2013 and the consumption figures for January 2012 - December 2012. A summary of the UK local authority metal packaging collections is shown in **Figure 21**. Here, data for kerbside collections is presented in ranges using splits from 2012/13 and from 2011/12, which caters for possible outcomes of an on-going review of the WDF data.

Figure 21: Local Authority Metal Packaging Collected (T)

	Total	Kerbside	Bring	CA
UK Total Aluminium Packaging Collected	49k – 50k	45k[31]	3k	2k
UK Total Steel Packaging Collected	202k – 205k	193k – 197k	3k	5k

[30] *Kerbside collections refer to local authority (or a waste management company on behalf of a local authority) collections from households*

[31] *Actual range is 44,512 – 45,361 tonnes households*

5.2.2 Kerbside, Bring Sites and CA Sites Collection Data

Figure 22: Local Authority Metal Packaging Collected by Collection Method (T)

	Kerbside		Bring Sites		CA Sites	
	Separate	Co-mingled	Separate		Separate	Co-mingled
Aluminium	11k	33k – 34k	2k		11k	33k – 34k
Steel	48k	145k – 149k	3k		48k	145k – 149k

The quantity of metal packaging collected in the UK at kerbside, bring sites and CA sites is shown in **Figure 22**. In the absence of specific material splits for tonnages collected co-mingled at bring sites and CA sites, total co-mingled tonnages at those sites (across all materials) were broken down into aluminium and steel packaging, using the kerbside splits. This is also what was done for the existing Packflow work, although it is clear there are significant issues with this as the type and relative proportion of each material at these sites can be very different from that which is collected at kerbside: caution is required when interpreting and using these estimates. Mitigating this, the vast majority of metal packaging is in fact collected by LAs at kerbside (less than 10% is collected at bring and CA sites based on the above estimates). It should also be noted that there may be a small quantity of C&I material collected through the household collection network.

5.2.3 C&I Collections

C&I collections were estimated as follows:

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

The total volume of materials recycled is taken from NPWD[32] and used as a proxy for the total tonnage collected. LA collections tonnages are taken from WDF, as per section 5.2.1. C&I collection tonnages are then calculated as the residual from the total quantity, which is reported as recycled on NPWD minus the WDF estimation. The estimate for C&I collections are shown in **Figure 23**[33]. As noted before, it is important to highlight that these are not the same figure as what is collected for recycling isn't equal to what is recycled.

Indeed, the WDF collection figures will not equal the amount collected for recycling as many LAs do not robustly account for material rejected by the MRF during the sorting process. Therefore, for simplicity, by assuming 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 that the NPWD collection figures only cover obligated waste by accredited agents, and so do not include tonnages recycled without a PRN/PERN being generated.

[32] *http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx*

[33] *There is a time difference between the NPWD figures (calendar year 2012) and the local authority figures (2012/13 financial year); however, this was the best available data.*

Figure 23: C&I Metal Collections (T)

Aluminium NPWD Collections (2012)	62k
Aluminium Local Authority Collections (2012/13)	49k[34]
Aluminium C&I Collections	13k

Steel NPWD Collections	357k
Steel Local Authority Collections	204k[35]
Steel C&I Collections	154k

5.2.4 Collection Summary

Using WDF for 2012/13, metal collection data has been collated by collection method. **Figure 24** shows a summary of the data, including LA and C&I data, with caveats as set out above

Figure 24: Summary of Metal Packaging Collections (T)

	Total	Kerbside	Bring	CA	C&I
Aluminium	**62k – 63k**	45k	3k	2k	13k
Steel	**355k – 359k**	193k – 197k	3k	5k	154k

See Appendix VII for an assessment of relative levels of confidence in the data.

5.3 Reprocessing of Metal Packaging

This section of the report examines the levels of metal packaging recycling within the UK. This is different from the material that is collected because it specifically examines the material that is successfully reprocessed. Reprocessing is where the process results in the creation of a new product from recovered metal packaging material.

In order to calculate the level of metal reprocessing that is taking place, the reprocessing activity was split into two categories:

- Accredited Reprocessing; and
- Unaccredited Reprocessing.

The accredited reprocessing was estimated from NPWD data using the quantity of PRNs and PERNs issued. An estimation was made of the level of unaccredited reprocessing based on an average weight per reprocessor and the estimated number of unaccredited reprocessors.

5.3.1 Accredited Reprocessing

The total weights reprocessed for aluminium and steel are taken from NPWD[36], and are shown in **Figure 25** and **Figure 26** respectively.

[34] *Used average of 49k & 50k*
[35] *Used average of 202k & 205k*
[36] *http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx*

Figure 25: Total UK Aluminium Packaging Recycling

	Total	PRNs	PERNs
2008	50k	24k	26k
2009	61k	35k	26k
2010	60k	36k	24k
2011	74k	50k	23k
2012	62k	41k	21k
2013	71k	48k	23k

*Equals 74K due to rounding up of PRN and PERN figures

The quantity of UK aluminium packaging recycling has been steadily increasing from 2008 until 2011 when it reached 74k tonnes; however, in 2012 it decreased to 62k tonnes before rising again in 2013. This can be attributed to the closure of the Novelis recycling plant in Warrington for an upgrade during part of 2012.

Figure 26: Total UK Steel Packaging Recycling

	Total	PRNs	PERNs
2008	417k	228k	189k
2009	391k	109k	282k
2010	387k	184k	203k
2011	374k	199k	174k
2012	358k	177k	181k
2013	390k	234k	156k

This shows that the quantity of UK steel packaging recycling steadily decreased between 2008 and 2012, before spiking in 2013. In 2012, there was 358k recycled compared to 417k in 2008, representing a decrease of 14%. This drop could be explained by a fall in quantity which is being POM (the equivalent drop in POM was 13% between 2008 and 2012).

5.3.1.1 Metal Packaging Exported for Recycling

In order to investigate the UK's reliance on export recycling markets for metal packaging, the proportion of this material that is exported has been compared with the total quantity recycled.

Figure 27: Total UK Aluminium Exports 2008 – 2013

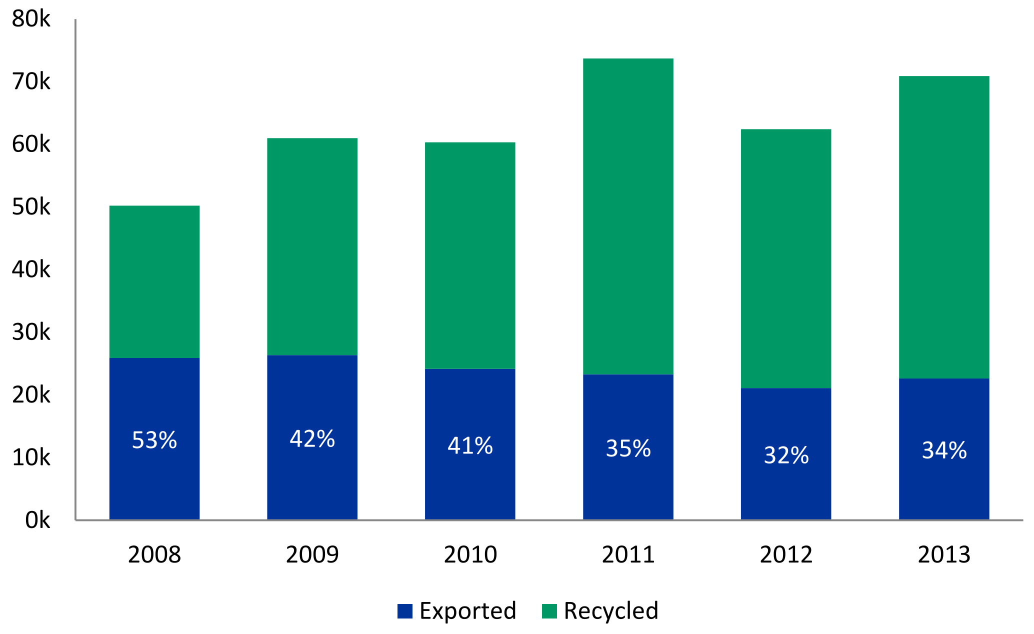


Figure 28: Total UK Steel Exports 2008 – 2013

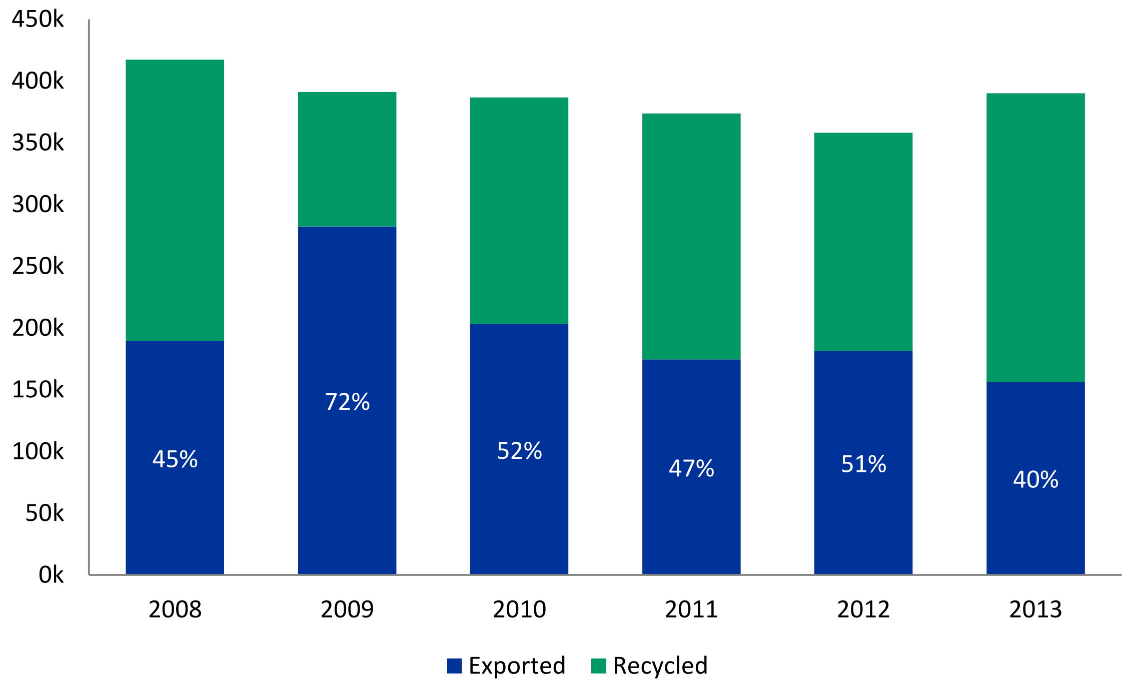


Figure 28 shows that a significant proportion of steel is exported for recycling. The proportion of steel exported for recycling peaked in 2009 at 74%. However, since then it has slowly decreased to 42% in 2013.

5.3.2 Unaccredited Reprocessing

The stakeholder discussion highlighted a belief that there is a level of unaccredited reprocessing happening within the UK and via exporters. The main value from reprocessed metal is from the material itself, rather than the PRN. Therefore, if the PRN value drops to a certain level, reprocessors may not register because the cost of registration would exceed the revenue generated by issuing PRNs.

An anlaysis was completed on the number of large and small registered reprocessors or exporters for aluminium and steel, respectively, from 2008 to 2013. This was plotted against the average PRN price across these years. This is shown for aluminium and steel in **Figure 29** and **Figure 30** respectively.

Figure 29: Aluminium - Reprocessor/Exporter Accreditations & PRN Price[37]

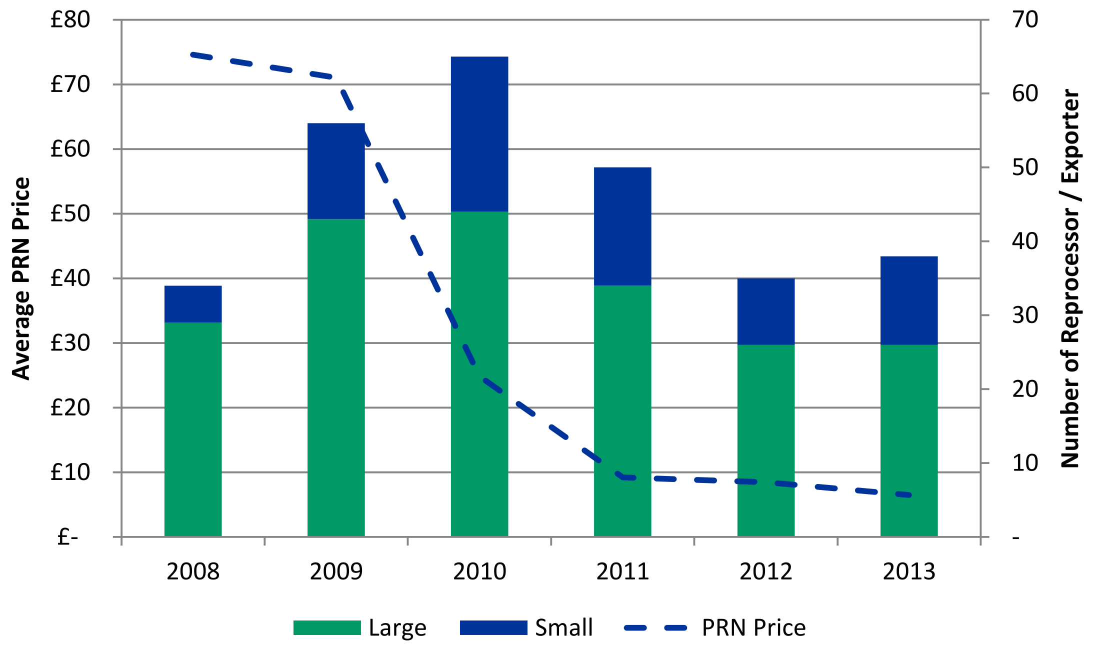
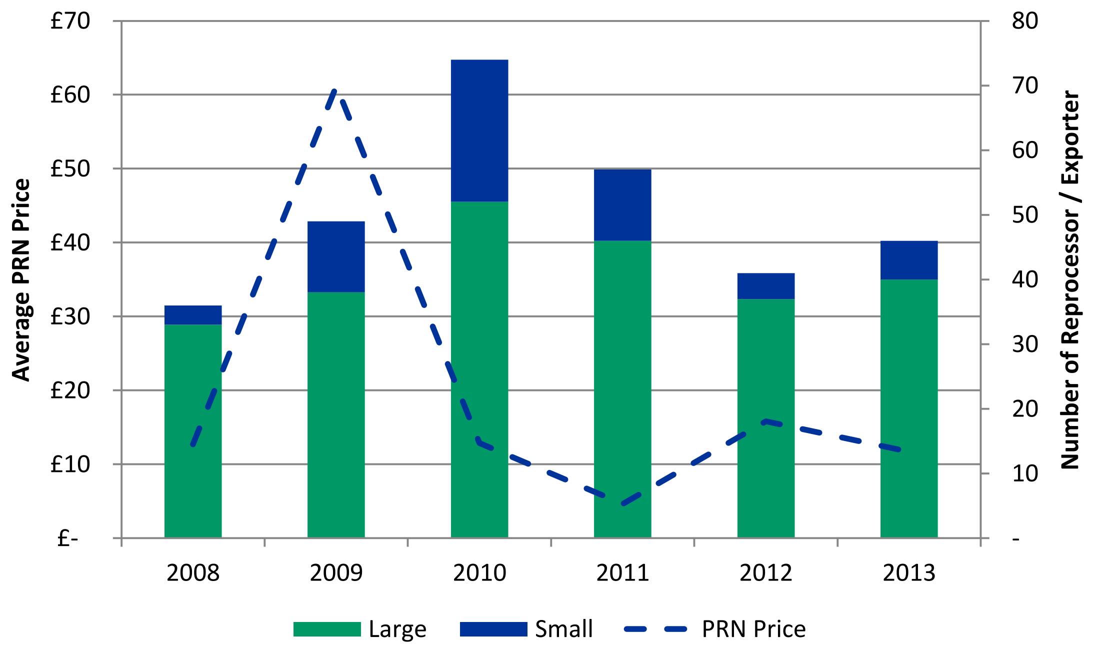


Figure 30: Steel - Reprocessor/Exporter Accreditations & PRN Price[38]



[37] *Based on the number of active reprocessors/exporters reported on NPWD on 28/02/2014.*
[38] *Based on the number of active reprocessors/exporters reported on NPWD on 28/02/2014.*

This appears to show a spike in the number of registered reprocessors and exporters following relatively high PRN prices (most notably in 2009 and 2010). The assumed accreditation costs are shown in **Figure 31**.

Figure 31: Accreditation Costs[39]

Accreditation Costs	Small (<400t)	Large (>400t)
Environment Agency Fee	£505	£2,616
Internal Administration Cost	£1,000	£2,000
Total Annual Cost	£1,505	£4,616

In 2012, the average PRN cost was £8 for aluminium and £16 for steel. Therefore, a small aluminium reprocessor would need to issue 178 PRNs in order to break even, and a large reprocessor would need to issue 709 PRNs. The average steel PRN price in 2012 dictated that a small reprocessor would need to issue 95 PRNs and a large reprocessor would have to issue 394 PRNs to break even.

The analysis identified that there were 100 reprocessors and exporters[40] (50 aluminium and 50 steel) who were unaccredited in 2012, but that were accredited at some point between 2008 and 2014. Using secondary research and Valpak internal knowledge, it is believed that 36 of the aluminium and 33 of the steel reprocessors and exporters were operational in 2012. If it is assumed that they were operational in 2012 and were at a maximum capacity before accreditation became economically viable at that point in time, then it is possible to estimate the upper level of unaccredited metal packaging reprocessing in 2012 This estimation is shown in **Figure 32**.

Figure 32: Unaccredited Reprocessing 2012

	Aluminium	**Steel**
Number of unaccredited Small sites	13	14
Small site tonnes	178	95
Number of unaccredited Large sites	23	19
Large site tonnes	709	394
Total Unaccredited Tonnes	**19k**	**9k**

The stakholder group concluded that the methodology used to calculate the unaccredited reprocessing resulted in areasonable estimation. Nevertheless, there may be a higher level of unaccredited reprocessing from organisations who have never been reigstered, organisations that registered later in the year and organisations that are registred but do not obtain PRNs for all of their reprocessed metal packaging.

5.3.3 Reprocessing Summary

The total reprocessing in 2012 is shown in **Figure 33**.

[39] *The annual charge depends on the volume of ePRNs and ePERNs the reprocessor plans to issue for the UK waste packaging they reprocess or export for reprocessing.*

[40] *50 were aluminium: 31 large and 19 small. 50 were steel: 29 large and 21 small.*

Figure 33: Total Reprocessing 2012 (T)

	Aluminium	Steel
Accredited Reprocessing	62k	358k
Unaccredited Reprocessing	19k	9k
Total Reprocessing	**81k**	**367k**

Figure 34 shows the recycling rates for the PackFlow estimation, the Defra estimation and net pack fill. The higher recycling rates include the unaccredited recycling.

Figure 34: Recycling Rates 2012

		Aluminium	Steel
PackFlow Mid Flow	POM	150k	649k
	Recycling Rate	42-54%	55-57%
Defra	POM	162k	645k
	Recycling Rate	38-50%	55-57%
Methodology 2	POM	178k	524k
	Recycling Rate	35-46%	68-70%

The estimation for unaccredited recycling was to be cross referenced with data from the EA WDI tool. However, the data analysed did not allow for a suitable sense-check (see Appendix VI for more details).

See Appendix VII for an assessment of relative levels of confidence in the data.

6.0 Scenario Analysis

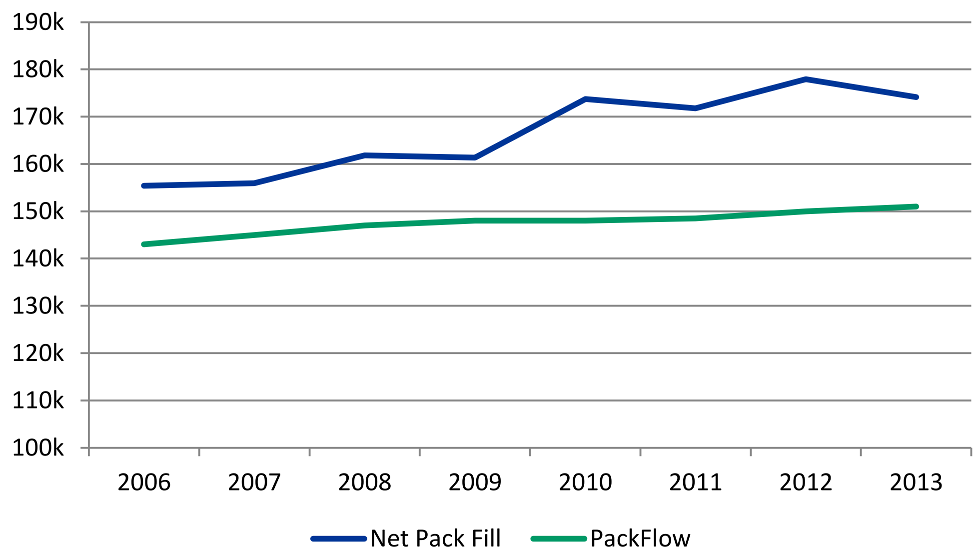
6.1 Introduction

This section looks at the historic (2008 – 2013) POM figures for both aluminium and steel packaging in the UK. This is achieved using the net pack fill figure (as detailed in Section 3 – Metal Packaging Consumption – Methodology 2) and seeing how this compares with the PackFlow figures over the same period. A scenario analysis for the level of packaging being POM and that which is reprocessed until 2020 is also made. The section concludes with an overview of the recycling rates under various scenarios.

6.2 Historic Analysis and Projections

The existing POM figure was taken from PackFlow, which projected the figure forward until 2017. The PackFlow figure has been analysed against a historic net pack fill analysis that was completed for the years 2006 to 2013, for aluminium and steel[41]. This comparison is shown in **Figure 35** and **Figure 36** respectively.

Figure 35: Aluminium Historic Net Pack Fill v PackFlow 2006 – 2013 (T)



[41] *This was as far back as the data allowed.*

Figure 36: Steel Historic Net Pack Fill v PackFlow 2006 – 2013 (T)

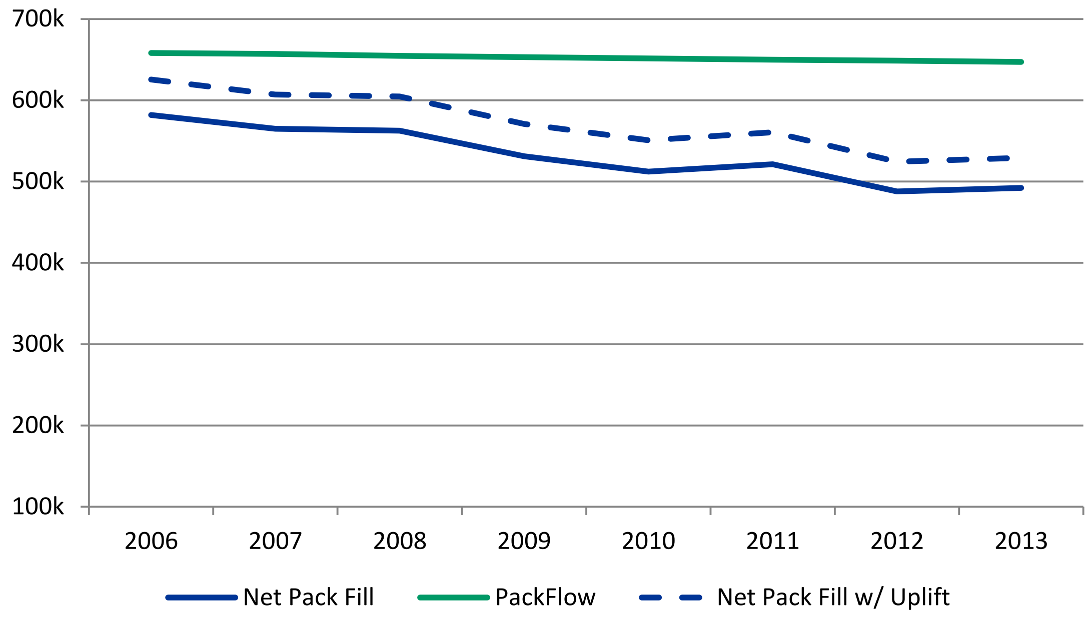


Figure 37: Metal Historic Net Pack Fill v PackFlow 2006 – 2013 (T)

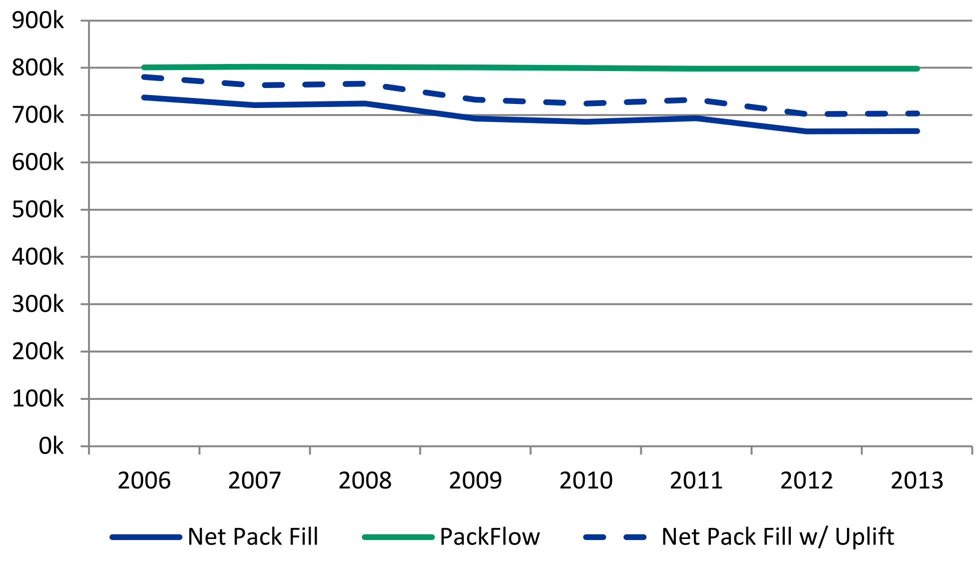


Figure 35 and **Figure 36** show that the net pack fill estimates sit above the Packflow estimate for aluminium and below Packflow estimate for steel. It shows a gradual decline in the use of steel packaging historically, with, however, a small rise in steel packaging from 2012 to 2013. There is no evidence of whether it is an anomaly or a change in the trend but it is worth noting that the 2013 EA data is still subject to revisions, so the 2013 net pack fill estimate may yet be revised. **Figure 37** highlights the combined metal packaging difference between PackFlow and Net Pack Fill. They also show the divergence between the PackFlow POM figure and the net pack fill figure has increased from 2006 to 2013 (increasing from 12k to 14k for aluminium and 76k to 166k for steel). The combined metal packaging POM compared with PackFlow also shows a divergence between Net Pack Fill and PackFlow. The stakeholder group highlighted that the PackFlow estimation was made with the best available data at the time and was agreed with industry.

6.2.1 POM Scenario Analysis

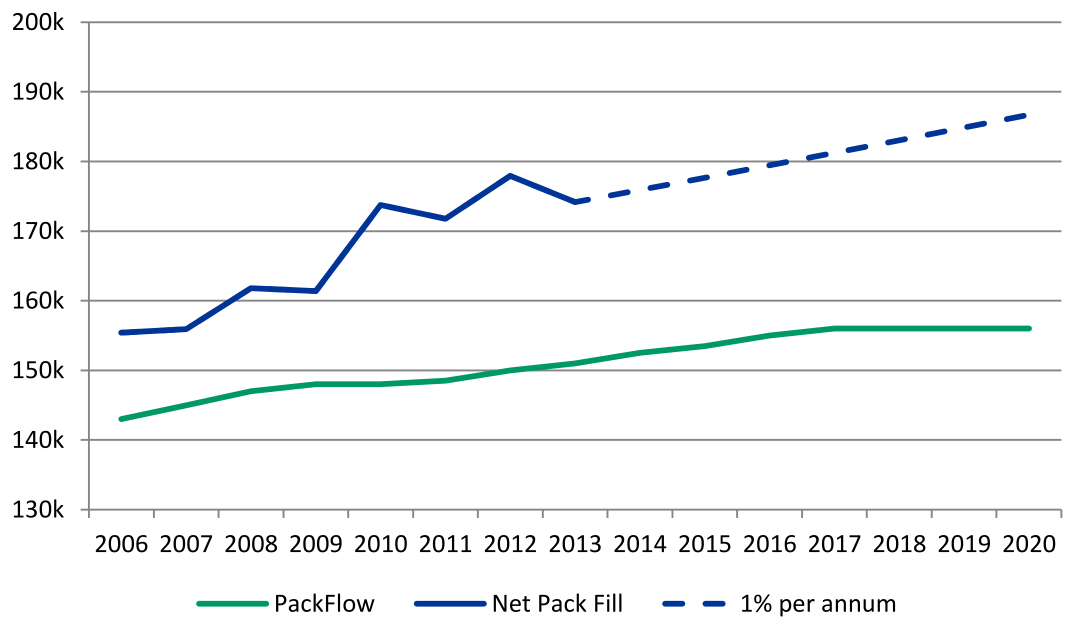
The analysis shown in **Figure 38** and **Figure 39** compare scenarios for future growth. In terms of the projected POM, growth rates were applied. Various aluminium growth rates are available: PackFlow estimates 0.8% growth per year and in 2011 Defra estimated 1% annual growth[42]. The average net pack fill growth for aluminium between 2006 and 2013 was 0.98%. Therefore, a growth rate of 1% was used for aluminium. However, this is hard to forecast as although sales may increase, there is a focus on resource efficiency and light weighting of cans, which may reduce the quantity of material being POM.

For steel, the PackFlow growth was estimated at -0.25%, which is the same as the Defra estimation. However, the average net pack/fill growth from 2012 and 2013 was -1%. Following consultation from industry, a negative growth of 1% was used for steel. However this will vary over time due to changing market conditions and as such should not be used beyond 2020. These growth rates are summarised in **Figure 38** and **Figure 39**.

Econometric modelling was outside the scope of this project, and using past average growth rates alone as predictors of future trends (as is done here) without further econometric analysis, is a simplistic approach. There are many reasons why this provides only a partial view; for instance, this may not take full account of emerging trends (e.g. substitution between packaging materials) or the wider macroeconomic outlook. The forward-looking trends presented here are therefore shown as scenario analysis and not as forecasts.

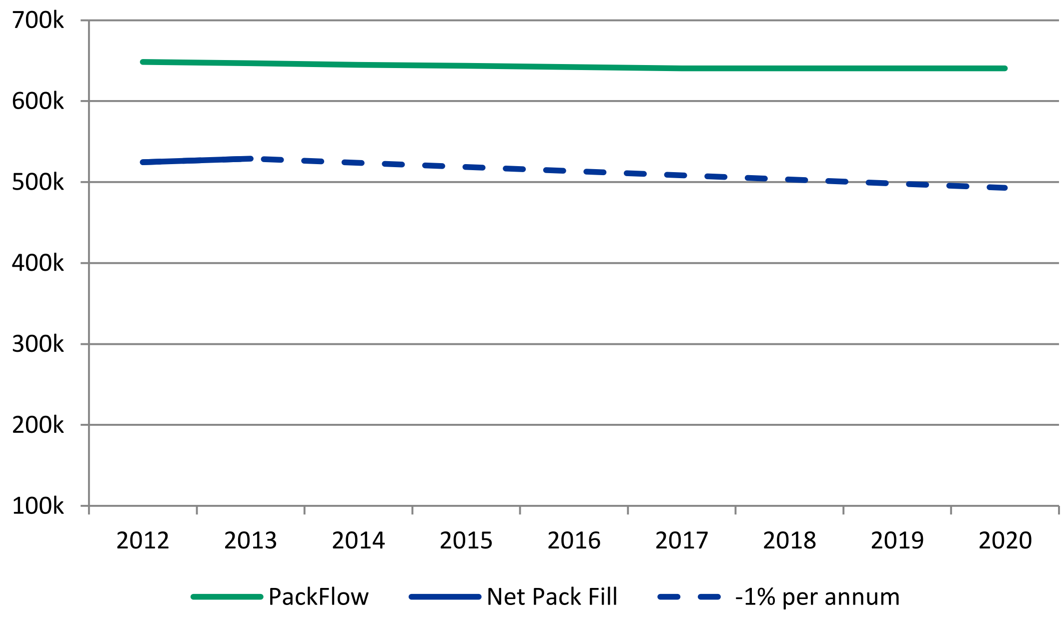
The interpretation of the trends is subject to this caveat. In effect, this section shows the level of metal packaging being POM in 2020 should it continue to grow at the rate assumed. Secondary research identified a keynote report[43] providing forecasts for metal packaging. These forecasts suggested that, as the economic climate improves, metal packaging in the UK will grow 3.5% in 2014, 5% in 2015 and 6.2% in 2016. However, because these projections are by value they incorporate any price effects (whereas this report focuses on tonnages alone).

Figure 38: Aluminium Scenario Analysis 2006 – 2020 (T)



[42] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82440/packaging-consult-doc.pdf
[43] KeyNote – Packaging (Metals & Aerosols) Market Report 2012

Figure 39: Steel Scenario Analysis 2012 – 2020 (T) [44]



6.2.2 Reprocessing Projection

The previous collection projection, from PackFlow 2017[45], was calculated using a time series regression technique known as Autoregression. This method is further detailed in Appendix IX, and instead of looking for patterns and possible correlation between recycling levels and other variables, the process involves regressing the reprocessing figures against the historical reprocessing figures. This forecasting method thereby anticipates the future, based on the immediate past. A variety of lags were modelled in the original PackFlow work (and were not re-tested) but, using the Bayes information criterion, the selected lag structure was two most recent lags for aluminium and one most recent lag for steel. The Autoregression based forecasts were updated to take account of the most up-to-date data to produce revised reprocessing projections. The projections were done based on accredited weights from NPWD as well as including an estimate for unaccredited weights (as per section 5). This was done by using the Autoregression technique on the actual data and then using an uplift for the unaccredited reprocessing. It was also assumed that the proportion of unaccredited reprocessing versus accredited reprocessing would remain the same as it was in 2012.

There is uncertainty around projections and therefore a range was developed around the reprocessing projection. This was done using the standard error of the relevant regressions, with the standard error being the estimate of the standard deviation of the underlying errors. Therefore, it gives an indication of how large the errors made by using the regression could potentially be. Assuming a normal distribution and using a 95% confidence interval[46] a range around the projections was calculated.

The resulting reprocessing projections are shown in **Figure 40** and **Figure 41**.

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[44] *No historic Net Pack Fill figures are shown as the uplift was only agreed for Steel in 2012 and 2013*
[45] *http://www.valpak.co.uk/Libraries/Environmental_Consulting_Documents/PackFlow_2017_Final_Report_09_11_12.sflb.ashx*
[46] *With a standard error of 1.96*

Figure 40: Aluminium Reprocessing Projections 1998 – 2017 (T)

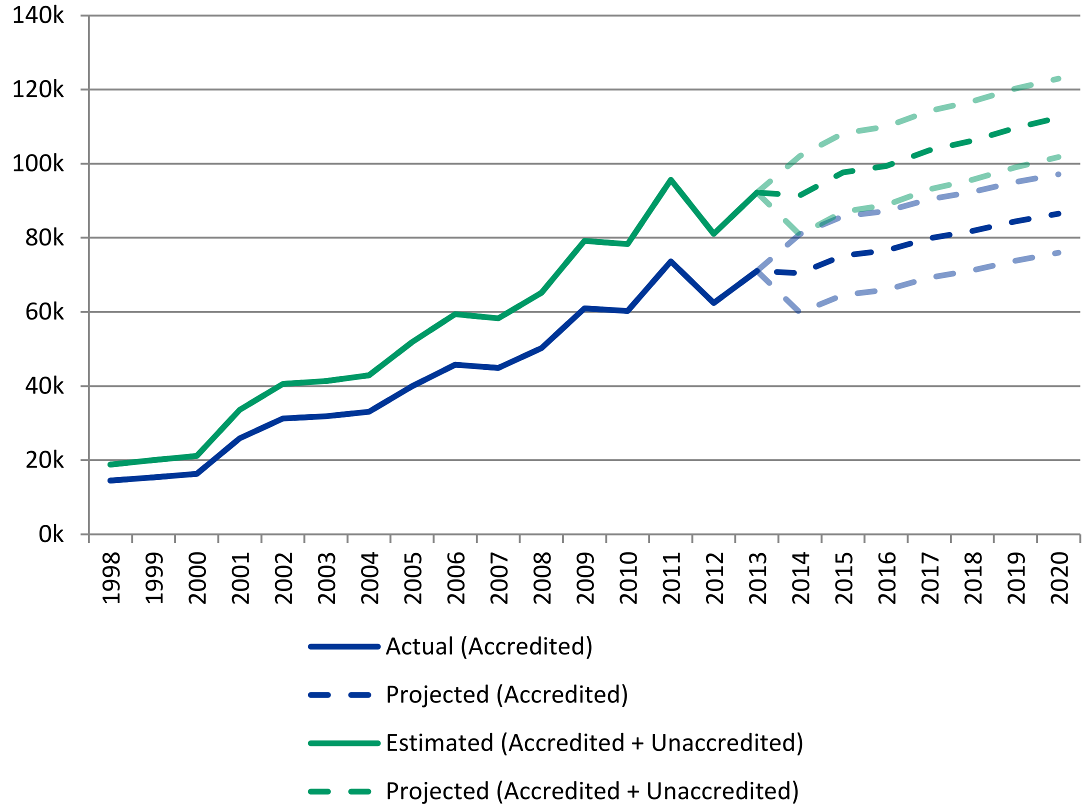
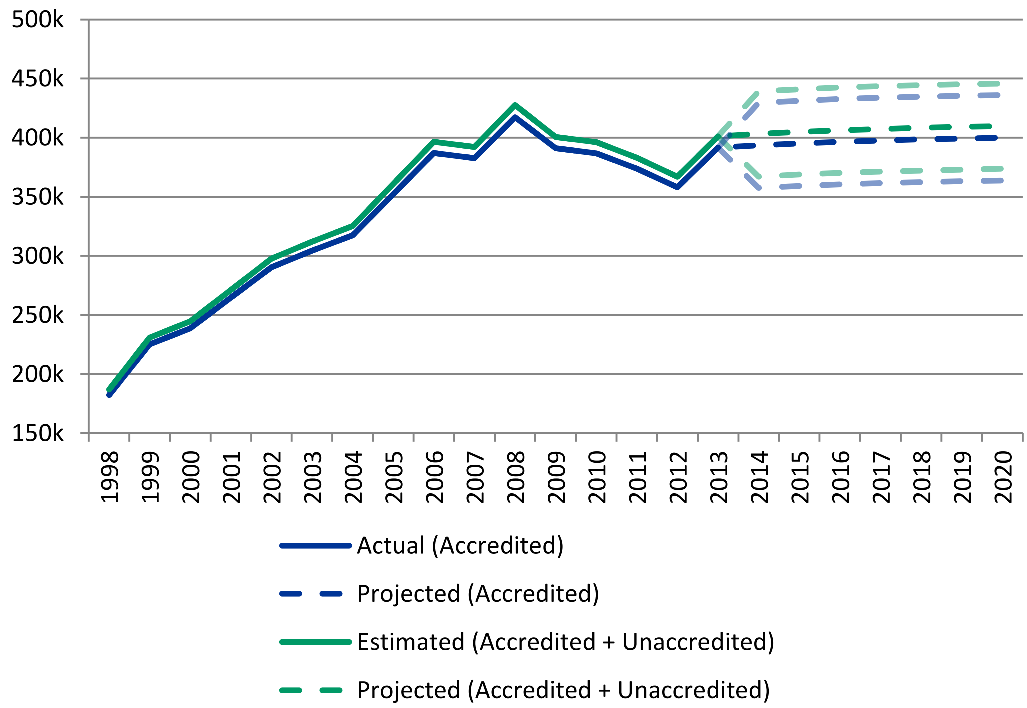


Figure 41: Steel Reprocessing Projections 1998 – 2017 (T)



The approach taken here develops a mechanical projection based on a simple regression model with a two year and one year lag structure. This methodology is based on historical data/trends and does not provide a particularly sophisticated projection and ignores future factors such as: the maturity of the collection system (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, the timing of possible changes in legislation and any other potential external influences that might impact on the aluminium and steel reprocessing market.

6.2.3 Scenario Analysis Summary

The scenario analysis for POM and 'recycling' levels has been collated to show recycling rates in **Figure 42** for aluminium and **Figure 43** for steel.

Figure 42: Aluminium Recycling Rate Scenario Analysis 2012 – 2017

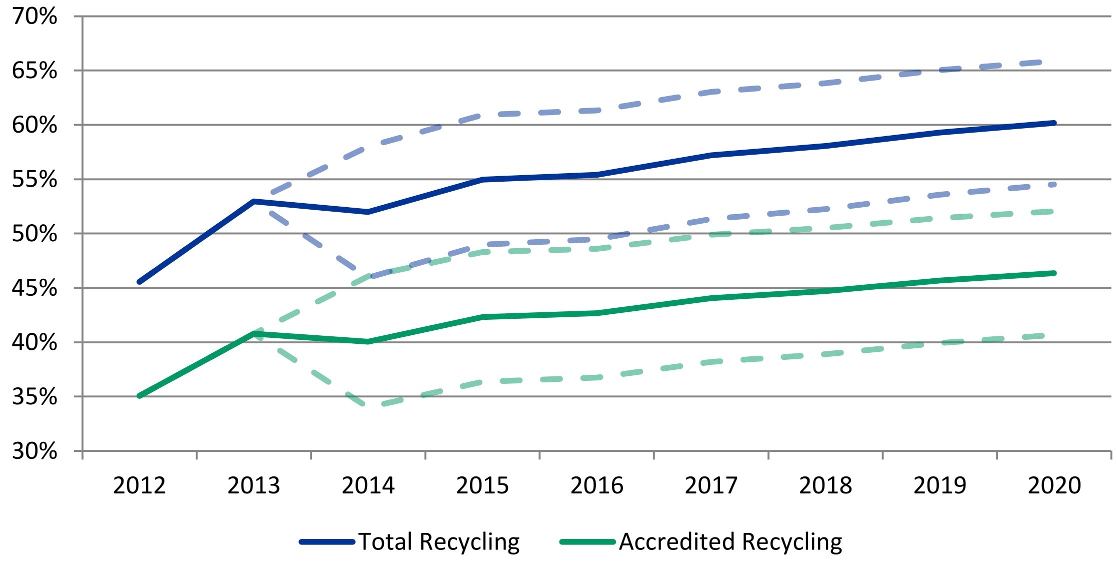
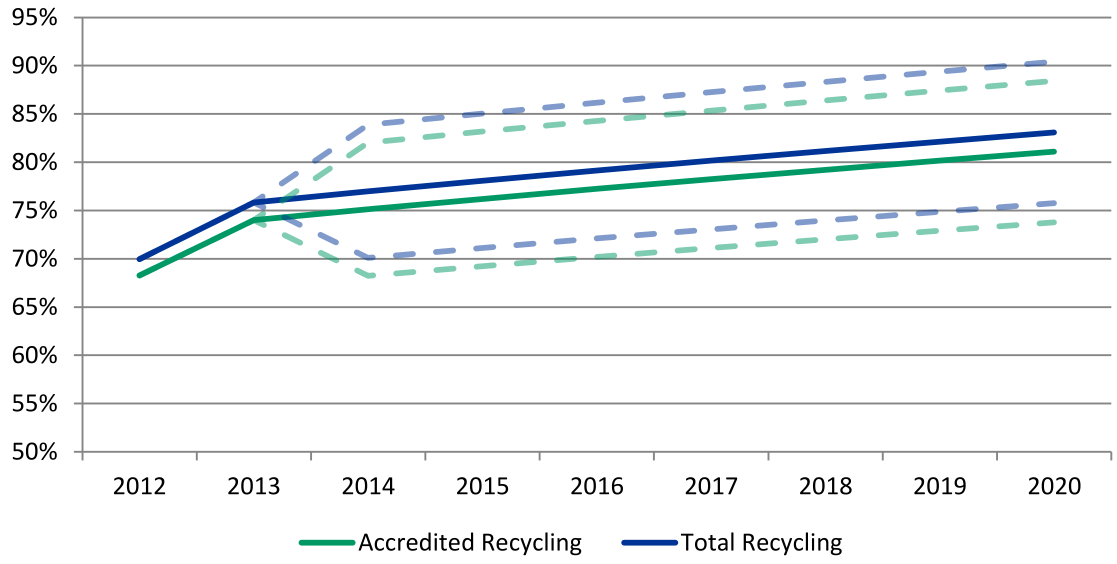


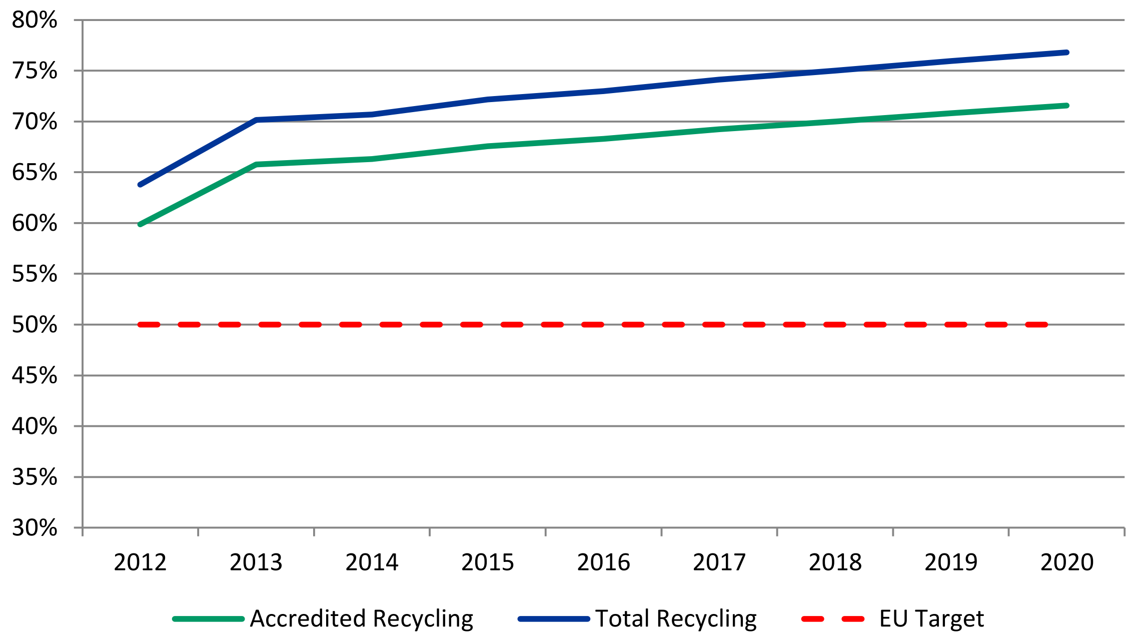
Figure 43: Steel Recycling Rate Scenario Analysis 2012 – 2017



Based on the analysis in section 5.3.2 on unaccredited reprocessing, the level of unaccredited reprocessing impacts the recycling rates more for aluminium than it does for steel (10% in 2012 in comparison to 2% in 2012 respectively). This impact also flows through to the scenario analysis.
The range of possible estimates of the overall recycling rate, as shown earlier, highlights a degree of uncertainty, partly linked to some degree of uncertainty over the quantities POM but also linked to the impact of unaccredited reprocessing. It is also important to note that as the collection/recycling system matures that the increase in recycling levels may slow going forward.

In this context, it is important to consider the EU targets for recycling of metal packaging. At the time of writing, the target is a rolling annual target of 50% and with both materials combined this target is exceeded in all scenarios. However, the European Commission is in the early stages of reviewing these targets[47], which could result in them being updated. The potential combined metal packaging recycling rates are shown in **Figure 44**.

Figure 44: Metal Recycling Rate Scenario Analysis 2012 – 2017



This highlights that over the period 2012 to 2020, the metal packaging recycling rates are always above the EU target of 50%. A table with these figures, including a mid-point projection are included in Appendix X

[47] http://ec.europa.eu/environment/waste/target_review.htm

7.0 Conclusions & Recommendations

This section details the key findings of the project before detailing the main areas for further work.

7.1 Key Findings

The most robust methodology using publicly available data for calculating the total aluminium and steel packaging in the UK is the net pack/fill methodology (Methodology 2).

The net pack fill estimates (including an uplift for steel) suggested that in 2012 there were 178k tonnes of aluminium (174k in 2013) and 524k tonnes of steel (529k in 2013) packaging POM. This is an increase on the previous PackFlow and Defra estimation for aluminium and a decrease for steel. There is industry agreement on these flow estimates.

There was uncertainty around estimating the packaging POM using a bottom up approach (methodology 1). This approach is not recommended given the current state of data availability.

An estimation for the metal packaging being POM highlighted gaps in the data. These gaps were to be found in metal packaging within the hospitality sector as well as the commercial and industrial sector.

It is believed there is a level of unaccredited reprocessing for both aluminium and steel.

The report estimated some 19k tonnes of aluminium packaging that is reprocessed but does not have a PRN issued against it. This appears to be a less significant issue for steel packaging, where there appears only to be 9k tonnes of unaccredited reprocessing.

Based on the net pack fill estimates, new ranges of recycling rates can be calculated that are higher than existing ones for steel and lower for aluminium packaging.

In comparison to using the PackFlow and Defra estimations, the recycling rate for aluminium, based on the accredited and unaccredited recycling is 35-46% using the net pack fill POM figure. For steel, the equivalent figure is 68-70%. This indicates that both the UK and EU metal recycling targets are met.

By including the estimated unaccredited reprocessing, the recycling rates increases.

The recycling rate for aluminium packaging increases to 46% if the level of unaccredited recycling is included. For steel, this increases from 68% to 70%.

The recycling rates for both aluminium and steel are expected to increase through to 2020 if current trends continue.

Using accredited recycling figures only, the aluminium recycling rate could reach 46% in 2020. This rises to 60% when the level of unaccredited reprocessing is included. For steel, the level of accredited reprocessing could reach 81% in 2020, rising to 83% if the unaccredited reprocessing is included. These rates are based on the assumption that current trends will continue and are mid-points within a wider range.

7.2 Areas for Further Work

There is a high level of uncertainty around the quantity of commercial and industrial steel packaging, which may benefit from being investigated.

This was highlighted as a key area of uncertainty when trying to construct the level of packaging being POM for steel. A possible way forward might include a survey process with key stakeholders in the commercial and industrial packaging industry and their members, such as the Industrial Packaging Association (IPA). Tata Steel and the Metal Packaging Manufacturers Association also believe that this could be accompanied by work to ensure the commercial and industrial estimate for POM takes into account protocols used for determining the quantity of steel recycling in commercial and steel recycling to ensure that the quantity reported as recycled does not exceed the POM.

Steel protocols should be reviewed

As above, it was recommended that the steel protocols should be reviewed. The steel protocols were originally developed back in 1998, and as such, due to changes in market conditions and collection infrastructure they could now be reviewed and if necessary updated.

There was uncertainty around the level of packaging within the hospitality sector.

Similar to the commercial and industrial sector, the work highlighted a level of uncertainty around the level of packaging arising in the hospitality sector. Although there have already been several surveys completed in this sector looking at waste arisings, a project focussing specifically on levels of packaging arisings would build on existing data and reports.

A more robust methodology for estimating unreported POM should be developed.

For steel the quantity of unreported POM was believed to be higher than for aluminium. A brief consultation with Tata Steel and the Metal Packaging Manufacturers Association suggested the unreported quantity could be approximately 7.5%. This is a working assumption, based on the expert knowledge of Tata Steel and the MPMA but not rooted in any robust data. As such, a more robust methodology for identifying the quantity of steel placed on the market by smaller organisations that is unreported should be developed.

A more robust method for estimating the level of unaccredited reprocessing in the UK should be developed.

The stakeholders in the project identified that there is a level of unaccredited reprocessing in the UK for both aluminium and, to a lesser extent, steel. Although estimations were made for this as part of this project, it could be explored further to derive more robust data. This could be done via a survey of identified reprocessors and exporters that are not accredited in any given year. This would help identify reprocessors which legitimately recycle material but due to the quantities they recycle and the cost of EA accreditation they do not become accredited and therefore the material recycled is unreported.

Appendix I: Grocery Retail Cross Reference

To cross-check the validity of the EPIC data for grocery retail, Valpak requested aggregated data from the EA for selected retailers. Table 1 selling data were requested for aluminium and steel packaging handled in 2013 (2012 sales) for the following retailers:

- Tesco;
- Asda;
- Sainsbury;
- Morrisons;
- Iceland;
- Co-Op;
- Boots;
- M&S;
- Aldi;
- Lidl;
- Nisa; and
- Musgrave (Budgens).

The table below shows the information supplied by the EA.

Figure 45: Aggregated EA Grocery Retail Packaging Handled (2013) (T)

	Aluminium	Steel
Grocery Retail	89k	259k

EPIC data was scaled up to account for the above retailers (market share information, provided by Kantar). **Figure 46**, below, compares the scaled-up EA figures to the scaled-up EPIC data.

Figure 46: Aggregated Grocery Retail Packaging Handled (2013) (T)

	Aluminium	Steel
EA Grocery Retail	98k	284k
EPIC Grocery Retail	101k	282k
Difference	3k	2k

Figure 46 shows the tonnage difference between the scaled up EA grocery retail and EPIC grocery retail tonnage. As the EPIC grocery retail tonnage is only between two and three thousand tonnes of a difference and consistent with the EA data, Valpak is confident with the data and market share information used in this calculation and would suggest the EPIC data is a good approximation for grocery retail packaging.

Appendix II: Beverage Containers Cross Reference

The data on the number of containers arisings in the grocery retail, hospitality sector, airlines and cross border shopping is shown in **Figure 47**.

Figure 47: Beverage Containers[48]

	Total
Grocery Retail – Beverage Containers	4,904,852k
Hospitality - Beverage Containers	1,713,851k
Airline - Beverage Containers	82,438k
Cross Border Shopping - Beverage Containers	56,000k
Total - Beverage Containers	**6,757,140k**
Grocery Retail - Beer Containers	2,525,954k
Hospitality - Beer Containers	739,125k
Airline - Beer Containers	45,170k
Cross Border Shopping - Beer Containers	56,000k
Total - Beer Containers	**3,366,249k**

The Grocery retail beverage containers estimate is taken directly from EPIC data, grossed up to the overall grocery sector using Kantar market shares. The Hospitality Beverage containers estimate is derived from the tonnage of HaFS metal packaging. This is broken down into beverage containers based on the relative proportions of food versus drink containers in the grocery sector, as a proxy, in the absence of a relative breakdown specific to the HaFS sector. The HaFS tonnage estimation provided does include industrial sized food cans (such as baked beans) as well as beverage containers, and the HaFS data wasn't sufficiently disaggregated to account for this in the estimated number of cans. In that sense, this is an upper estimation of the number of beverage containers in the hospitality sector. The airline and cross border shopping beverage containers estimation were proportioned from the same proportion of food v drink containers in the grocery sector. In total, this amounts to 6.7bn beverage cans. The beer can estimate was calculated using EPIC data on the proportion of beer cans versus drinks containers sold in the grocery sector. This was applied to the HaFS, airline and cross border shopping tonnage. In total, this amounts to 3.4bn beer cans.

There are various estimates in the public domain, such as data from the Can Makers trade body, on 'deliveries' of beverage cans, i.e. empty cans for filling but no data was found on a sufficiently like-for-like basis for total beverage cans that take account of all beverage cans only consumed in the UK (i.e. excluding exports and including imports).

A sense-check was possible, however, for beer cans specifically, which suggests a reasonable degree of consistency with industry estimates: The British Beer and Pub Association estimated that there were 3,196 million beer cans POM, which is slightly under the estimation of 3,366 million (within 5%). Neilson also estimated that the number of beer cans

[48] *Based on the average weight of a can calculated from the EPIC database.*

sold in supermarkets was 1,855 million against the estimation of 2,526 million sold in the grocery retail sector. It should be noted that the Kantar definition of grocery retail includes more than supermarkets, which could explain the higher estimation (as it includes supermarkets but also independent stores etc).

Appendix III: Pet Stores Cross Reference

To cross-check the validity of the Pet Store retail calculation, Valpak requested aggregated data from the EA for selected pet store retailers. Due to the limited number of pet food retailers, the EA could not provide this data and no meaningful cross check could be performed.

Appendix IV: Body Care Cross Reference

To cross-check the validity of the EPIC data for body care specialist retail, Valpak requested aggregated data from the EA for selected body care retailers. Table 1 selling data were requested for aluminium and steel packaging handled in 2013 (2012 sales) for the following retailers:

- Boots;
- The Perfume Shop;
- G.R. & M.M. Blackledge plc;
- Superdrug Stores Plc;
- The Body Shop International Plc;
- Lush Ltd;
- Lloyds Pharmacies Ltd;
- Dudley Taylor Pharmacies Ltd;
- Clear Pharmacy;
- H J Everett (Chemist) Ltd;
- W.R.Evans (Chemist)Ltd;
- Clear Pharmacy; and
- Savers Health and Beauty Ltd.

Figure 48: Aggregated EA Body Care Retail Packaging Handled (2013) (T)

	Aluminium	Steel
Body Care Retail	5k	4k

Market data and EPIC data was used to calculate the body care packaging sold outside of grocery retail. Market data[49] suggested that grocery retail accounted for 34% of the body care items sold. Of this remaining 66%, 40% was sold in specialist health and beauty retailers. It was assumed that this is a proxy for the EA figures. The EA data was then scaled up appropriately to provide an estimation of the total body care packaging sold outside of grocery retail in the UK. **Figure 49**, below, compares the EA figures to the scaled-up EPIC data and suggests that the EPIC data is a good approximation for body care packaging not sold in grocery retail in the UK.

Figure 49: Aggregated Body Care Retail Packaging Handled (2013) (T)

	Aluminium	Steel
EA Body Care Retail	12k	9k
EPIC Body Care Retail	11k	10k
Difference	<1k	<1k

[49] *Beauty and Personal Care in the United Kingdom (Euromonitor)*

Appendix V: DIY Cross Reference

To cross-check the validity of the EPIC data for DIY specialist retail, Valpak requested aggregated data from the EA for selected DIY retailers. Table 1 selling data were requested for aluminium and steel packaging handled in 2013 (2012 sales) for the following retailers:

- B&Q;
- Travis Perkins;
- Topp Tiles;
- Screwfix Direct;
- Wilkinson Hardware Stores;
- Robert Dyas;
- Builders Suppliers (West Coast Ltd);
- Rawle Gammon & Baker Holdings;
- Notcutts;
- Carboclass Ltd;
- Clas Ohlson Ltd;
- Coopers (Great Yarmouth) Ltd;
- Haldane Fisher Ltd;
- Homeleigh Timber And Building Supplies Ltd;
- Ace Fixings Ltd;
- M.P. Moran & Sons Ltd;
- Robert Keys & Company Ltd;
- Toolstation Ltd; and
- Argos Ltd.

Figure 50, below, compares the EA figures and scaled up EPIC data. Due to market share data being publically unavailable for the DIY sector, the EA data was not scaled up and the 7k is a minimum estimation.

Figure 50: Aggregated DIY Retail Packaging Handled (2013) (T)

	Aluminium	Steel
EA DIY Retail	-	7k
EPIC DIY Retail	-	11k
Difference	-	4k

A 4k tonnage difference can be seen between the EA and EPIC data; however, the 7k is a minimum estimation.

Appendix VI: Waste Data Interrogator Commercial and Industrial Steel Estimation

The WDI tool contains a record of all waste management site returns for England and Wales that are kept by the EA. The information in the WDI is derived from the EA's RATS (Regis Appended Tonnage System) database, which contains information from the licences issued for waste management facilities. It was hoped that this could be used to complete a cross reference check on the commercial and industrial steel packaging estimation and potentially the level of unaccredited metal recycling.

The WDI data used for the commercial and industrial steel estimation was that which was submitted in 2012. The data can be broken down into the following disposal facility types (there are several sub headings to each of the headings below):

- Landfill;
- Land disposal;
- Transfer;
- Treatment; and
- Metal Recycling Sites.

The analysis involved calculating the total steel packaging ending up in each of the disposal facilities, which would provide a proxy for the total steel packaging POM. Taking the remainder away provides an estimation for the commercial and industrial steel packaging. The waste is broken down by European Waste Catalogue (EWC) code and the data analysed was EWC Code 15 - *WASTE PACKAGING; ABSORBENTS, WIPING CLOTHS ETC N.O.S*. The packaging description included metallic packaging and mixed packaging, both of which could include steel packaging. The total waste received at each of the sites is shown in **Figure 51**.

Figure 51: WDI Waste Received Outputs (England and Wales) (T)

	Metallic Packaging	Mixed Packaging
Landfill	<1k	23k
Transfer	19k	284k
Treatment	13k	164k
Metal Recycling Facility	35k	<1k
Total	**67k**	**471k**

As these figures only account for England and Wales, they were scaled up for Scotland and Northern Ireland, based on population[50] , to provide the estimation shown in **Figure 52**.

[50] http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-319259

Figure 52: WDI Waste Received Outputs (UK) (T)

	Metallic Packaging	Mixed Packaging
Landfill	<1k	26k
Transfer	22k	320k
Treatment	14k	185k
Metal Recycling Facility	39k	<1k
Total	**75k**	**531k**

However, it is clear that this analysis does not include all steel packaging. This is because the non-commercial and industrial estimation for steel packaging being POM is 508k tonnes (and the total is 649k tonnes based on the net pack fill method). Given that the metallic packaging includes aluminium packaging and mixed packaging includes all other packaging types, it seems that the figures provided in WDI do not include all metal packaging.

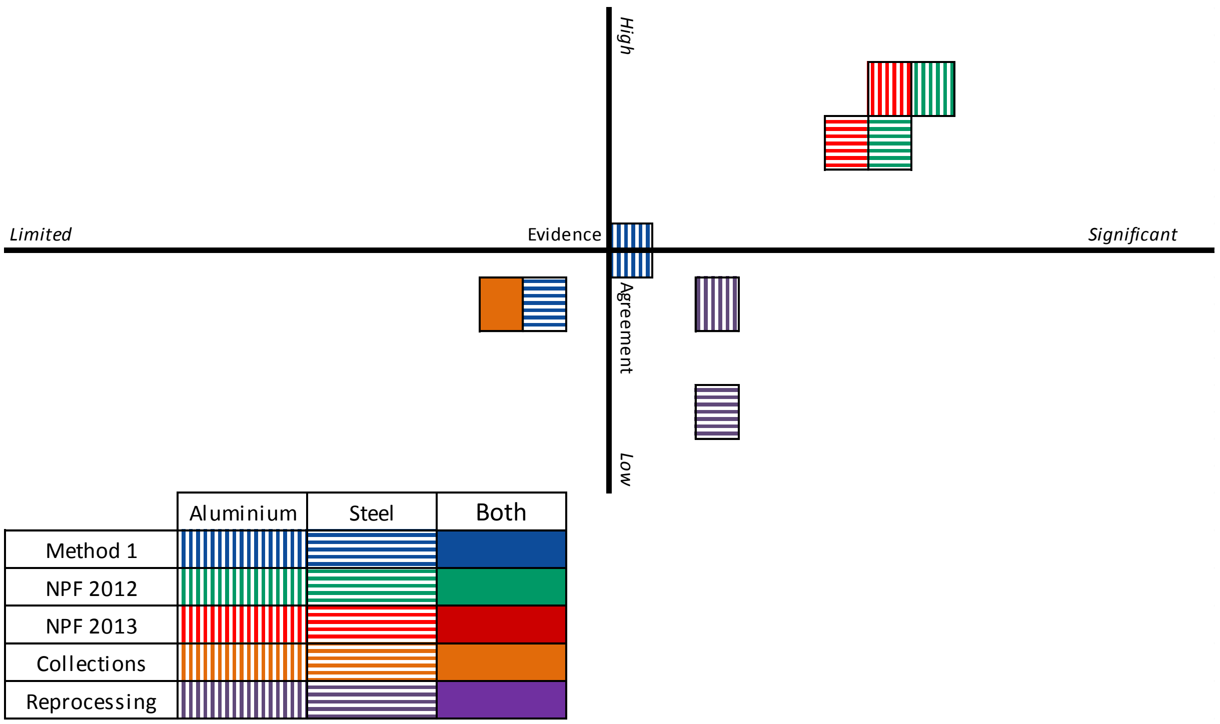
Part of the reason for this is that there is no waste management data for registered exempt sites (key areas include metals recovery, secondary aggregates and spreading to land) and that waste from small producers/small quantities of waste is often not recorded.

Further analysis was completed using the EWC code 20 01 40 (Metals from Municipal Sources). However, this total came to ~4M tonnes, which suggests packaging making up 17% of this total. Therefore, with packaging making up only a proportion of this, for the purposes of this report, it was not felt to be a suitable proxy for a metal packaging estimation.

Appendix VII: Data Robustness

A robustness analysis was completed on the data sources used. This was developed to highlight the level of uncertainty for each data source by scoring the data sources on the evidence and agreement from stakeholders. This is shown in the table below:

Figure 53: Data Robustness Assessment Results



This was based on an analysis completed for each estimation and material. Questions were created relating to the evidence and agreement on the data used. Following is the full breakdown for each estimation and material; where a partial score is given, a comment is made to justify this decision.

Figure 54: Data Robustness Assessment – Methodology 1 (Grocery Retail)

GROCERY RETAIL Evidence (Robustness and completeness, max 27):	Aluminium		Steel		Evidence
Does the data cover the correct time-frame?	Y	3	Y	3	This is a 2012 estimation.
Does the data provide complete coverage?	Y	3	Y	3	Actual data scaled with market shared information.
Has the data been sourced from credible, up-to-date sources?	Y	3	Y	3	EPIC Data and Kantar market share.
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Y	2	Y	2	
Have the findings been independently peer-reviewed?	N	0	N	0	
Is the methodology/calculation reasonably free from concerns?	Y	3	Y	3	
Have the methodology/calculations been independently checked (internally or externally)?	Y	1	Y	1	Internal checks on EPIC data. Other checks made within the project team.
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Y	3	Y	3	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Y	3	Y	3	Cross checked against EA data and scaled up.
Total	21		21		
Degree of agreement around the findings (max 9):					
Does more than one data source confirm the findings (within +/- 5%)?	Y	3	Y	3	Within 5% of EA data.
Do the key stakeholders/experts actively agree with the findings?	Y	1	Y	1	Broadly in line with industry expectations, however they did not have an equivalent figure to sense check.
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Y	2	Y	2	No specific concerns raised.
Overall	6		6		

Figure 55: Data Robustness Assessment – Methodology 1 (C&I)

C&I Evidence (Robustness and completeness, max 27):	**Aluminium**		**Steel**		**Evidence**
Does the data cover the correct time-frame?	N	0	N	0	Estimate based on survey data from 2009 as this was the best available.
Does the data provide complete coverage?	Y	2	Y	2	Survey data does cover all of the C&I sectors, however assumptions were made to avoid potential overlap with hospitality.
Has the data been sourced from credible, up-to-date sources?	Y	1	Y	1	Defra survey data, however dating back to 2009. Also used internal data to breakdown estimations.
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Y	1	Y	1	Score reflects concerns over applicability of data for this project.
Have the findings been independently peer-reviewed?	N	0	N	0	
Is the methodology/calculation reasonably free from concerns?	Y	1	Y	1	Concerns with breaking down data.
Have the methodology/calculations been independently checked (internally or externally)?	Y	1	Y	1	Checked within the project team.
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Y	3	Y	3	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Y	3	N	0	Cross checked against aluminium industry data. For steel, no such publically available data was available.
Total	12		9		
Degree of agreement around the findings (max 9):					
Does more than one data source confirm the findings (within +/- 5%)?	Y	2	N	0	Aluminium agreed there was almost no aluminium C&I packaging.
Do the key stakeholders/experts actively agree with the findings?	Y	2	N	0	Aluminium agreed there was almost no aluminium C&I packaging. Steel industry representatives actively disagreed.
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Y	3	Y	3	
Overall	7		3		

Figure 56: Data Robustness Assessment – Methodology 1 (Hospitality)

Evidence (Robustness and completeness, max 27):	Aluminium		Steel		Evidence
Does the data cover the correct time-frame?	N	0	N	0	Amalgamated survey pulled data from several year.
Does the data provide complete coverage?	Y	3	Y	3	All sectors are covered.
Has the data been sourced from credible, up-to-date sources?	Y	1	Y	1	The survey data is the most credible and up-to date available
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	N	0	N	0	Not official data and various surveying techniques were used
Have the findings been independently peer-reviewed?	N	0	N	0	
Is the methodology/calculation reasonably free from concerns?	Y	1	Y	1	It was not possible to calculate confidence intervals on the full survey data.
Have the methodology/calculations been independently checked (internally or externally)?	Y	1	Y	1	Checked within the project team.
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Y	3	Y	3	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	N	0	N	0	No alternative sources available.
Total	9		9		
Degree of agreement around the findings (max 9):					
Does more than one data source confirm the findings (within +/- 5%)?	N	0	N	0	
Do the key stakeholders/experts actively agree with the findings?	N	0	Y	1	Aluminium industry representative felt this was an underestimation. Steel industry representative concerned industrial sized packaging was not included.
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Y	3	Y	3	
Overall	3		4		

Figure 57: Data Robustness Assessment – Methodology 1 (Other: Pet Stores, Body Care, DIY, Airline, Cross Border Shopping and Illegal Imports)

Evidence (Robustness and completeness, max 27):	Aluminium		Steel		Evidence
Does the data cover the correct time-frame?	Y	2	Y	2	Some elements were using the correct year, some were not.
Does the data provide complete coverage?	Y	1	Y	1	Actual data attempted to be scaled up using variety of sources.
Has the data been sourced from credible, up-to-date sources?	Y	2	Y	2	Some elements were using the correct year, some were not.
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Y	1	Y	1	Some elements used official EA data, some used other sources.
Have the findings been independently peer-reviewed?	N	0	N	0	
Is the methodology/calculation reasonably free from concerns?	Y	1	Y	1	Estimations were the made on the best available data, however there were limitations (as detailed in the report).
Have the methodology/calculations been independently checked (internally or externally)?	Y	1	Y	1	Checked within the project team.
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Y	3	Y	3	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Y	1	Y	1	Some elements were cross checked, however for some it was not possible to do so as there was no credible like-for-like alternatives.
Total	12		12		
Degree of agreement around the findings (max 9):					
Does more than one data source confirm the findings (within +/- 5%)?	N	0	N	0	There was no credible like-for-like alternatives to sense-check against for most of these.
Do the key stakeholders/experts actively agree with the findings?	N	0	N	0	Industry were not able to provide sense check as their data is not broken down in the same way.
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Y	3	Y	3	
Overall	3		3		

Figure 58: Data Robustness Assessment – Methodology 1 (Weighted Average)

Evidence (Robustness and completeness, max 27):	Aluminium	Steel
Does the data cover the correct time-frame?	1.25	1.25
Does the data provide complete coverage?	2.25	2.25
Has the data been sourced from credible, up-to-date sources?	1.75	1.75
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	1	1
Have the findings been independently peer-reviewed?	0	0
Is the methodology/calculation reasonably free from concerns?	1.5	1.5
Have the methodology/calculations been independently checked (internally or externally)?	1	1
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	3	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	1.75	1
Total	13.5	12.75
Degree of agreement around the findings (max 9):		
Does more than one data source confirm the findings (within +/- 5%)?	1.25	0.75
Do the key stakeholders/experts actively agree with the findings?	0.75	0.5
Has feedback from the key stakeholders been incorporated in the reporting of findings?	2.75	2.75
Overall	4.75	4

Figure 59: Data Robustness Assessment – Methodology 2

	Aluminium				Steel				
	2012		2013		2012		2013		Evidence
Evidence (Robustness and completeness, max 27):									
Does the data cover the correct time-frame?	Y	3	Y	3	Y	3	Y	3	
Does the data provide complete coverage?	Y	2	Y	2	Y	1	Y	1	Missing unobligated tonnages but reasonably strong evidence and industry agreement this isn't a large amount. Evidence would suggest that this is more of an issue for Steel than Aluminium.
Has the data been sourced from credible, up-to-date sources?	Y	3	Y	2	Y	3	Y	2	The EA is an official data source. The 2013 data is subject to change.
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Y	2	Y	2	Y	2	Y	2	The EA data is as received by the EA, there are unexplained variations from one year to the next and there are reasonable concerns over the accuracy of some of the components (e.g. exports). Data is continuously updated until the cut off point.
Have the findings been independently peer-reviewed?	N	0	N	0	N	0	N	0	
Is the methodology/calculation reasonably free from concerns?	Y	3	Y	3	Y	3	Y	3	
Have the methodology/calculations been independently checked (internally or externally)?	Y	3	Y	3	Y	3	Y	3	
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Y	3	Y	3	Y	3	Y	3	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Y	2	Y	2	Y	2	Y	2	This was cross referenced with methodology 1 and industry estimates where

									possible. However these checks were not conclusive.
Total	21		20		20		19		
Degree of agreement around the findings (max 9):									
Does more than one data source confirm the findings (within +/- 5%)?	Y	3	Y	3	Y	2	Y	2	Steel industry representatives were happy that the estimated figure was broadly in line with their expectations (although they had concerns on how this was broken down i.e. C&I). Aluminium industry representatives were happy with the figure although it was slightly different from their expectations.
Do the key stakeholders/experts actively agree with the findings?	Y	2	Y	2	y	2	y	2	See comment above.
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Y	3	Y	3	Y	3	Y	3	
Overall	8		8		7		7		

Figure 60: Data Robustness Assessment – Collections

Evidence (Robustness and completeness, max 27):	Aluminium		Steel		Evidence
Does the data cover the correct time-frame?	Y	2	Y	2	WDF data is financial year (march to march), excluding Scotland, so broadly the correct time frame.
Does the data provide complete coverage?	Y	2	Y	2	See section 5.2.
Has the data been sourced from credible, up-to-date sources?	Y	3	Y	3	
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	N	0	N	0	
Have the findings been independently peer-reviewed?	N	0	N	0	
Is the methodology/calculation reasonably free from concerns?	Y	2	Y	2	The estimation for the non local authority collection is not complete (See section 5.2.)
Have the methodology/calculations been independently checked (internally or externally)?	N	0	N	0	
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Y	3	Y	3	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	N	0	N	0	
Total	12		12		
Degree of agreement around the findings (max 9):					
Does more than one data source confirm the findings (within +/- 5%)?	N	0	N	0	
Do the key stakeholders/experts actively agree with the findings?	Y	2	Y	2	Aware that this was the way collections were estimated, but t agreed the issue in using the NPWD data (See section 5.2.)
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Y	2	Y	2	No specific feedback recovered other than agreement with NPWD data issue ((See section 5.2.).
Overall	4		4		

Figure 61: Data Robustness Assessment – Reprocessing

Evidence (Robustness and completeness, max 27):	Aluminium		Steel		Evidence
Does the data cover the correct time-frame?	Y	3	Y	3	
Does the data provide complete coverage?	Y	2	Y	2	Provides an attempt at estimating unaccredited reprocessing. This was from certain reprocessors who were previously registered. But not from those who are registered and those who have never been registered.
Has the data been sourced from credible, up-to-date sources?	Y	3	Y	3	Data from NPWD, official industry source. Plus our own estimations for unaccredited reprocessing.
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Y	2	Y	2	NPWD data relatively free from concerns, our estimations have uncertainty around them.
Have the findings been independently peer-reviewed?	N	0	N	0	
Is the methodology/calculation reasonably free from concerns?	Y	2	Y	2	Estimation for unaccredited reprocessing does not include under reporting of those who are registered and those who have

					never been registered
Have the methodology/calculations been independently checked (internally or externally)?	Y	1	Y	1	Cross checked internally within project team.
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Y	3	Y	3	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	N	0	N	0	
Total	16		16		
Degree of agreement around the findings (max 9):					
Does more than one data source confirm the findings (within +/- 5%)?	N	0	N	0	
Do the key stakeholders/experts actively agree with the findings?	Y	2	Y	2	Acknowledged the estimation for unaccredited reprocessing and limitations with this approach.
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Y	2	Y	2	No specific feedback
Overall	4		4		

Appendix VIII: Prodcom Analysis

An initial analysis was completed on the Prodcom data[51] to see if it could be used to accurately identify the level of aluminium and steel packaging being manufactured in the UK. Prodcom is a European Commission database that provides statistics on the production of manufactured goods in the member states.

However, it was difficult to single out only and all of the packaging categories. Additionally, there were also a number of categories where data was not available. These issues were discussed at the stakeholder meetings where it was agreed that Prodcom would not be used for the purposes of the project.

[51] http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/introduction

Appendix IX: Autoregression

The following reproduces the analysis carried out for PackFlow report[52] to determine the lag structure of the auto-regression model used to project the levels of recycling, based on past trends. The analysis was repeated for this project and the same lag structure was used.

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 aluminium and steel reprocessing level 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 produced the following function for aluminium and steel respectively:

$$\mathbf{Y_t = 5706.92799958416 + 0.952064830473347\ Y_{t-1}}$$

$$\mathbf{Y_t = 72011.2417664741 + 0.821186338694316\ Y_{t-1}}$$

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 and steel reprocessing quantity 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,

[52] http://www.valpak.co.uk/docs/default-source/environmental-consulting/packflow_2017.pdf?sfvrsn=0

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:

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 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 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.

For the total recycling quantity 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 used to investigate up to the 3rd order of autoregression. The results are summarised for aluminium and steel, below, showing that 2 lags and 1 lag should be used respectively:

Figure 62: Autoregression Results

Aluminium				
p	SSR(p) / T	ln(SSR(p) / T	(p+1)ln(T)/T	BIC(p)
1	31681307	17.27124	0.346574	17.61781
2	21458854	16.88165	0.54161	17.42326
3	18635741	16.74059	0.754016	17.49461
Steel				
p	SSR(p) / T	ln(SSR(p) / T	(p+1)ln(T)/T	BIC(p)
1	275976442	19.43583	0.346574	19.7824
2	284053830	19.46467	0.54161	20.00628
3	294991666	19.50246	0.754016	20.25647

Appendix X: Scenario Analysis Summary

Figure 63: Scenario Analysis Results (Caveats apply, see main body of the text)

		2012	2013	2014	2015	2016	2017	2018	2019	2020
Aluminium POM		178 k	174 k	176 k	178 k	179 k	181 k	183 k	185 k	187 k
Accredited Recycling	Tonnes	62 k	71 k	70 k	75 k	77 k	80 k	82 k	84 k	87 k
	Recycling Rate	35%	41%	40%	42%	43%	44%	45%	46%	46%
Unaccredited Recycling	Tonnes	81 k	92 k	91 k	98 k	99 k	104 k	106 k	110 k	112 k
	Recycling Rate	46%	53%	52%	55%	55%	57%	58%	59%	60%

		2012	2013	2014	2015	2016	2017	2018	2019	2020
Steel POM		524 k	529 k	524 k	519 k	513 k	508 k	503 k	498 k	493 k
Accredited Recycling	Tonnes	358 k	391 k	393 k	395 k	396 k	398 k	399 k	399 k	400 k
	Recycling Rate	68%	74%	75%	76%	77%	78%	79%	80%	81%
Unaccredited Recycling	Tonnes	367 k	401 k	403 k	405 k	406 k	407 k	408 k	409 k	410 k
	Recycling Rate	70%	76%	77%	78%	79%	80%	81%	82%	83%

		2012	2013	2014	2015	2016	2017	2018	2019	2020
Metal (High Growth)		702 k	703 k	700 k	696 k	693 k	689 k	686 k	683 k	680 k
Accredited Recycling	Tonnes	420 k	462 k	464 k	470 k	473 k	477 k	480 k	484 k	486 k
	Recycling Rate	60%	66%	66%	68%	68%	69%	70%	71%	72%
Unaccredited Recycling	Tonnes	448 k	493 k	495 k	502 k	506 k	511 k	515 k	519 k	522 k
	Recycling Rate	64%	70%	71%	72%	73%	74%	75%	76%	77%

Waste & Resources
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