Final Report

MetalFlow 2025

MetalFlow 2025 estimates the quantity of aluminium and steel packaging placed on the market and recycled from 2017 to 2025 and the probability of compliance with national and European recycling targets

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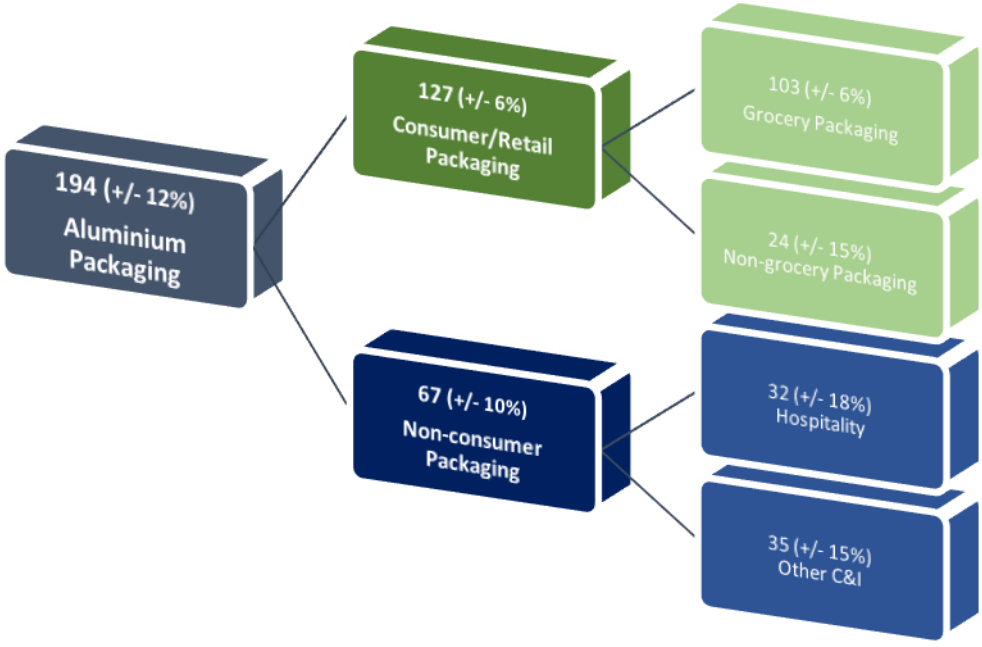
Executive summary

MetalFlow 2025 has been produced to support Defra in its understanding of current levels of UK aluminium and steel packaging placed on the market (POM), how much is recycled and potential future levels to 2025. This report also estimates the associated UK and European compliance implications of projected aluminium and steel packaging POM and recycling. Defra is keen to ensure that the estimates being used for its packaging policy work are as accurate as possible and this report has been prepared with this in mind. Error margins and robustness assessments have been used and provided wherever possible. The base year for the analysis is 2017.

Project Conclusions - Aluminium Flow

The project estimate for aluminium packaging POM in 2017 is 194k tonnes (+/-12%)
This has been derived by calculating obligated metal packaging POM from data reported in the National Packaging Waste Database (NPWD) by obligated producers using the net pack fill method. Estimates of 1% non-obligated packaging for aluminium were added to the obligated packaging POM to generate the total aluminium POM estimate. The results of this method have been cross-checked against secondary research and data/information provided by the project's industry Steering Group.

Figure ES1 Aluminium Packaging POM by Sector (k tonnes)



The final project estimate for aluminium packaging POM in the consumer sector is 127k tonnes (+/-6%)
This method was based on primary data alongside reliable market share data. No other method was used for deriving consumer data as this method is considered the most robust available and is accepted by industry (in particular by the Steering Group of both MetalFlow and other material flow updates).

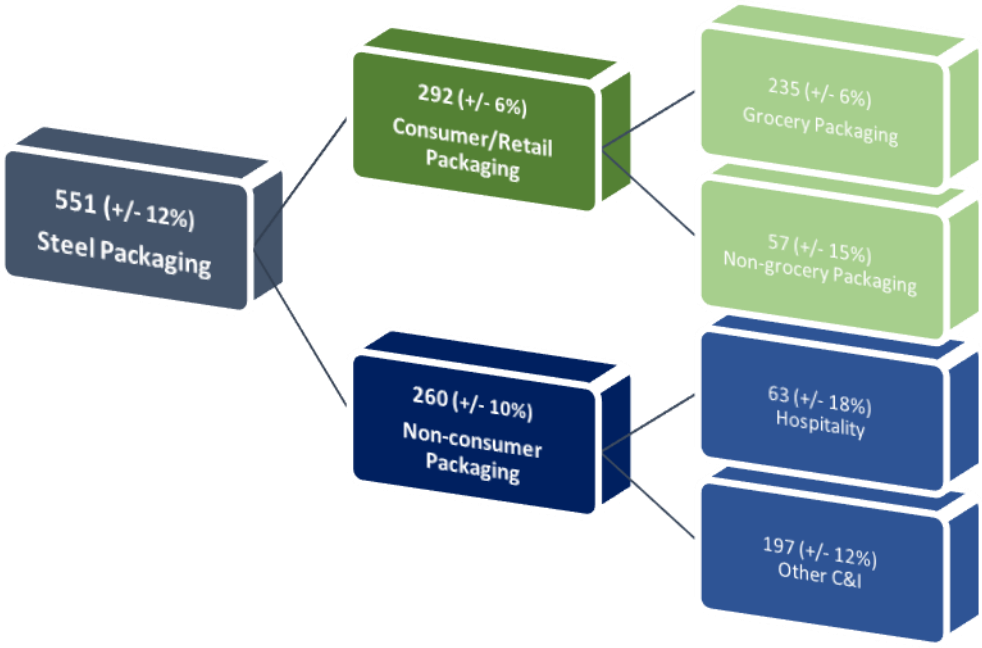
The final project estimate for aluminium packaging POM in the non-consumer sector is 67k tonnes (+/-10%)

This estimate partly comprises an estimate of hospitality packaging, based on primary and market share data. In addition, separate quantities of direct sales of soft and alcoholic drinks were calculated based on industry figures. C&I packaging comprises the remaining part of non-consumer POM and is the residual tonnage once consumer and hospitality POM are deducted from total POM. There were no figures available to cross-check this data, which may include any missed tonnages of grocery, non-grocery and/or hospitality POM.

Project Conclusions - Steel Flow

The final project estimate for steel packaging POM in 2017 is 551k tonnes (+/-12%)
This was derived from reported obligated data and cross-checked as much as possible using a bottom-up methodology. This took data from various sources for each sector and combined the results. Data provided by the project's Steering Group was also incorporated.

Figure ES2 Steel Packaging POM by Sector



The final project estimate for steel packaging POM in the consumer sector is 292k tonnes (+/-6%)
This method was based on primary data alongside reliable market share data. No other method was used for deriving consumer data, as this method is considered the most robust available and is accepted by industry (in particular by the Steering Group of both MetalFlow and other material flow updates).

The final project estimate for steel packaging POM in the non-consumer sector is 260k tonnes (+/-10%)
This estimate partly comprises an estimate of hospitality packaging, based on primary and market share data. In addition, separate quantities of direct sales of soft and alcoholic drinks were calculated based on industry figures. C&I packaging comprises the remaining part of non-consumer POM and is the residual tonnage once consumer and hospitality POM are deducted from total POM. This residual figure was cross-checked using a bottom-up approach, whereby estimates were made of industrial packaging types using secondary research and industry/Steering Group knowledge. This estimate came within 8% of the residual tonnage (despite some missing packaging that could not be quantified).

Project Conclusions – Aluminium Recycling

UK aluminium packaging recycled (recorded and unrecorded) is estimated to be 127k tonnes
This includes recorded recycling (94k tonnes, NPWD) and an estimate for unrecorded recycling (33k tonnes). Based on the POM calculated in this project, an overall recycling rate of 65% was achieved. The recorded recycling rate of aluminium packaging (NPWD) is 48%.

67k tonnes of aluminium packaging is not recycled; of which 13k tonnes (19%) is estimated to be lost during energy recovery and 54k tonnes to landfill (88%)
This was based on an estimated total of 32k tonnes of consumer aluminium and 35k tonnes of non-consumer not being recycled.

Project Conclusions – Steel Recycling

UK steel packaging recycled (recorded and unrecorded) is estimated to be 541k tonnes
This includes recorded recycling (431k tonnes, NPWD) and an estimate for unrecorded recycling (110k tonnes). Based on the POM calculated in this project, an overall recycling rate of 98% was achieved. The recorded recycling rate of steel packaging (NPWD) is 78%.

All steel packaging is assumed to be recovered from Incinerator Bottom Ash (IBA), either in the UK or overseas via exports of Refuse Derived Fuel (RDF). The remaining 11k tonnes of unrecycled steel packaging is believed to be landfilled.

Project Conclusions - Projections and Compliance (Aluminium)

The scenario projection for aluminium POM projects an increase from 194k tonnes in 2018 to 203k tonnes in 2020, and to 223k tonnes in 2025
This represents an increase of just under 30k tonnes or 15% in 2025 compared to 2018.

The scenario projection for aluminium packaging recycling is an increase from 112k tonnes in 2018, to 131k tonnes in 2020 and to 161k tonnes in 2025
This represents an increase of 49k tonnes or 44% in 2025 compared to 2018.

Accredited aluminium packaging recycling is expected to meet national equivalents of the business targets in 2018, 2019 and 2020 and the European Commission's Circular Economy Package (CEP) target in 2025
With projected accredited recycling exceeding the required recycling, to meet the targets, and the implied recycling rates being above the targets in each year.

There are no business targets or national equivalent targets for aluminium packaging set beyond 2020; the scenario assumption is a 70% target in 2025 for accredited aluminium packaging recycling, which is also expected to be met.

Project Conclusions - Projections and Compliance (Steel)

The scenario projection for steel packaging POM is projected to remain stable at 551k tonnes to 2020 and then to decline slightly to 550k tonnes in 2025
This represents a decline of 1k tonnes, or 0.3% in 2025 compared to 2018.

The scenario projection for steel packaging recycling projects a decrease from 422k tonnes in 2018 to 417k tonnes in 2020 and to 411k tonnes in 2025
This represents a decrease of 11k tonnes, or 2.6% in 2025 compared to 2018.

Accredited steel packaging recycling is expected to meet national equivalents of the business targets in 2018 and 2019, but to fall short in 2020
The estimated probability of meeting this target is 42%.

There are no targets for steel packaging set beyond 2020 and it is estimated that steel packaging is already meeting the proposed CEP recycling target of 70%
The assessment in this report assumes a target of 77% for 2025 and it is estimated that steel packaging recycling is likely to fall below this target in 2025 (the estimated probability of meeting this assumed target is 40%).

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Figures

Glossary

Alupro	The Aluminium Packaging Recycling Organisation
AFH	Away-from-home
b	Billion
BAMA	British Aerosol Manufacturers Association
BCGA	British Compressed Gas Association
BSDA	British Soft Drinks Association
BBPA	British Beer & Pub Association
CA	Civic Amenity
C&I	Commercial & Industrial
DRS	Deposit Return Scheme
EA	Environment Agency (EA)
EfW	Energy from Waste
EPIC	Environmental Product Information Centre
HWRC	Household waste recycling centre
IPA	Industrial Packaging Association
IBA	Incinerator Bottom Ash
k	Thousand
LA	Local Authority
M	Million
MPMA	Metal Packaging Manufacturing Association
MRF	Materials Recovery Facility
NPWD	National Packaging Waste Database
MSW	Municipal solid waste
ONS	Office of National Statistics
OTG	On-the-Go
PERN	Packaging Export Recovery Note
POM	Placed on the Market
PERN	Packaging Export Recovery Note
PRN	Packaging Recovery Note
Primary Packaging	Any packaging that the customer will take home, remove and throw away e.g. aluminium can, plastic bottle
RDF	Refuse Derived Fuel
Secondary Packaging	Inner packaging used to transport or display goods to/in store, usually cardboard boxes or shelf-ready packaging
t	Tonnes
Transit/Tertiary Packaging	Any transit packaging e.g. pallets, shrink wrap, staples or strapping
UBCs	Used Beverage Cans
WDF	Waste Data Flow

Acknowledgements

Valpak Limited and WRAP would like to thank the following organisations for their contribution to the MetalFlow 2025 project:

Steering Group

- Environment Agency;
- Metal Packaging Manufacturers Association;
- Tata Steel;
- Alupro;
- Steering Committee on Packaging (ACP);
- Defra.

Industry Stakeholders

- British Beer & Pub Association;
- British Compressed Gas Association;
- Industrial Packaging Association.

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 accurate as possible. To support Defra and other industry stakeholders, this work focuses on generating the most robust estimates of UK aluminium and steel packaging placed on the market (POM)[1] as possible. The report also considers the levels of UK metal packaging recycling, both in the UK and abroad, and provides some insight into the end markets and products that UK recycled metal packaging are used in.

Using as much historical data as possible, future metal packaging flows and recycling rates have also been projected. These recycling rates have been set against UK and European packaging recycling targets, where they exist, and the statistical probability of the UK achieving national and European compliance has been calculated.

1.2 Objectives

The set objectives for MetalFlow 2025 are to:

- Provide updated (and cross-checked) baseline estimates of metal packaging placed on the UK market, by packaging:
  - Format e.g. drinks can, food can, aerosol
  - Stream e.g. consumer, non-consumer
  - Source e.g. obligated, non-obligated producer
- Estimate the quantities of metal packaging collected through CA sites, kerbside and bring collections and other collection types, by stream
- Estimate the quantities of metal packaging recovered and recycled; sent for incineration with energy recovery; sent to landfill, for both UK and overseas end destinations
- Project metal packaging POM and recycling rates year by year up to 2025
- Assess likely compliance performance, per year, up to 2025
- Provide estimates of the quantities of obligated metal packaging that is recycled but does not generate a packaging recovery note (PRN), and quantities of non-obligated metal packaging that is recycled

1.3 Methodology

In order to calculate metal packaging recycling rates, the quantity of metal packaging recycled is divided by the quantity of waste arisings. However, it is commonly accepted, and indeed is accepted by the EU, that establishing packaging POM is an appropriate method of estimating packaging waste arisings. Using packaging POM as an estimate of packaging waste arisings has recently been called in to question by Eunomia (2018)[2], particularly as estimates of waste arisings established through composition analyses applied to waste data collated from multiple sources, tend to present higher results. This report claims that the PRN data is likely to be subject to systematic underestimation, as companies have a vested interest in under-reporting their POM. It suggests that this might have resulted in an underreporting of POM and an overestimate of the recycling rate.

[1] Plastic packaging placed on the market means all household and non-household plastic packaging used around products within the UK.

[2] *Eunomia:Plastic Packaging – Shedding Light on the UK Data, http://www.eunomia.co.uk/reports-tools/plastic-packaging-shedding-light-on-the-uk-data/*

Whilst the approach is valid, it (like any methodology) has a number of significant limitations in it's reliance on accurate data for:

- The composition of household waste;
- Waste arisings from local authorities; and
- Waste arisings and composition from commerce and industry.

The justification of the use of POM data over alternatives is provided in full in section 1.3.1 of PlasticFlow 2025[3]. **An overview of how the POM and recycling rates were calculated for this project is provided below.**

1.3.1 POM

Metal packaging POM was estimated using an assessment of the metal packaging POM reported on the National Packaging Waste Database (NPWD) by obligated producers. The results of this method have been cross-checked against secondary research and data/information provided by the project's industry Steering Group. The baseline year was 2017 however where 2017 data was not available the most recent available data was used.

1.3.1.1 POM – NPWD Net Pack Fill Method

This estimate is thought to capture the vast majority of the relevant quantity, but does omit the metal packaging handled by non-obligated companies, free-riders (those companies who are above the packaging obligation threshold by having a turnover of £2 million and handling 50 tonnes of packaging or more but are not registered with the relevant agency) and packaging for internal company use, which is non-obligated packaging under the regulations.

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 the NPWD website[4]:

Net Pack Fill	=	**Packing/Filling** table 1 of pack filling	+	**Imports** table 3A showing imported for the purpose of selling	+	**Imports** table 3B of packaging removed from around imports	-	**Exports** table 2A add table 2B minus pack filling

1.3.2 Recycling

NPWD was used as the source for accredited (recorded) recycling of metal packaging. Representatives from industry (including those involved in sorting, smelting and exporting metal) were consulted on the amount of recycled metal packaging that might not, for whatever reason, be reported on NPWD. The output of these discussions was used to estimate a figure for non-accredited (unrecorded) recycling.

The total recycling figure, consisting of recorded and unrecorded recycling, was then split into consumer and non-consumer recycling. Waste Data Flow (WDF), with adjustments for consumer metal packaging in incinerator bottom ash (IBA) and refuse derived fuel (RDF), was used as the source for the consumer recycling data with the difference between the WDF total and the overall total assumed to be non-consumer recycling.

[3] http://www.wrap.org.uk/content/plasticflow-2025-plastic-packaging-flow-data-report

[4] www.npwd.environment-agency.gov.uk

1.3.3 Projections and Scenario Analysis

The final section of the report documents a historical analysis of metal packaging POM and levels recycled. This is used to inform projections of future levels of material POM and recycling from 2018 to 2025.

1.3.4 Data Robustness and Margins of Error

As there are levels of uncertainty around the data used to establish the various elements that are combined to cross-check the total POM, consumer, non-consumer and total packaging POM are presented with error margins, providing a range around the estimate. The robustness scores established for each data piece used are presented in Appendix I; these have been converted into a percentage and related to appropriate margins of error[5], as shown below. The respective margins of error are provided throughout the report.

Figure 3 Relating robustness scores to appropriate margins of error

Robustness			Error Margin	
96%	to	100%	+/-	3%
91%	to	95%	+/-	6%
86%	to	90%	+/-	9%
81%	to	85%	+/-	12%
76%	to	80%	+/-	15%
71%	to	75%	+/-	18%
66%	to	70%	+/-	21%

The method used to calculate the margin of error for the total POM used the margins of error for the elements that made up the total POM to convert this to a tonnage, and then using the Root of Sum of Squares (since we are dealing with the error of a sum) it was expressed as a percentage.

[5] These are assumed estimates of error margin and not the outputs of statistical calculation.

2.0 Metal Packaging POM

POM refers to the flow of metal packaging onto the UK market. Consumption of goods using metal as packaging can occur both in the consumer (in the home and on the move) and non-consumer (by business) streams.

Metal packaging typically enters the market in the following formats:

- Drink cans – both steel and aluminium (in 2017), used for both soft and alcoholic drinks. Production of steel beverage cans ceased in the UK in 2018, but imports of steel beverage containers continue;
- Food cans – mainly steel, used to package a wide range of products such as soups, meats, vegetables and pet food;
- Aerosol cans – both aluminium and steel, used predominantly to package beauty & personal care and cleaning products;
- Other – all other forms, such as foil containers and trays, plain foils, tins and closures.

This section of the report presents an estimate of metal packaging POM, derived using the net pack fill methodology, which has then been cross-checked with available industry data in a 'bottom up approach'.

2.1 Metal POM Estimates from Net Pack Fill

The 2017 UK flow of metal packaging was calculated using the packaging weights reported to the EA by registered producers and publicly available on the NPWD website. The calculation is shown in Section 1.3.1.1 above.

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 the Steering Group believe[6] that there would be fewer unobligated packers in comparison to unobligated sellers, due to the larger size and lesser number of packer fillers. In addition, raw material manufacturing includes process losses - not everything manufactured will be converted or pack filled, so it is expected that obligated tonnage is likely to decline as we move further down the supply chain.

Using this method, the total obligated metal POM in 2017 is 192k tonnes for aluminium and 501k tonnes for steel packaging (as shown in Figure 4)[7]. It is important to stress that the net pack fill estimates are themselves open to the possibility of a degree of error, 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, as there is a legal obligation for companies to submit data that is as accurate as reasonably possible to them, which is then audited by the regulating body. This data is used by policy makers and their agencies.

[6] *No evidence data is available.*
[7] *As reported by businesses in 2018.*

Figure 4 Obligated packaging (net pack fill total) 2017[8,9]

	Aluminium k tonnes	**Steel** k tonnes
Table 1 Pack fill (UK pack filling)	164	393
Imports:		
3A Selling (filled imports)	50	168
3B (packaging removed from imports)	<1	39
Total	**215**	**600**
2A P/F (direct exports)	20	94
2B P/F (third party exports)	3	5
Total Exported	**22**	**99**
Net pack fill	**192**	**501**

This method does 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 or £2 million turnover;
- Free-riders – those obligated to register but not doing so; and
- Illegal importers.

There is no way of robustly quantifying the unreported quantity of packaging. Based on the feedback from the stakeholder group, it is believed that the majority of unobligated producers import filled packaging. Estimates of the unobligated quantities (aluminium 2k tonnes, 1% of POM and steel 50k tonnes, 9.15% of POM) have been carried forward from the previous MetalFlow[10] project.

To provide some context, the ratio of unobligated imports (assumed to be filled imports) to obligated filled imports were calculated and compared to other materials. For aluminium, unobligated filled imports represent 4% of obligated filled imports which compares closely to glass (also predominantly beverage packaging) at 5%. For steel, which is predominantly used to package food (drinks only make up a small proportion), unobligated filled imports represent 30% of obligated filled imports. This is much higher than the glass/aluminium packaging ratio, but considerably lower than plastic packaging, which is used for a wider variety of products, at 82%.

The Steering Group agreed to maintain the unobligated percentages, although it was believed that they could be high. This was particularly the case for steel; however, a bottom-up cross-check of POM (see Sections 3.0 and 4.0 below) illustrated the existence of enough packaging to justify a 9.15% unobligated figure.

Combining the estimated tonnages of obligated and non-obligated packaging gives **total MetalFlow project POM** estimates of **194k tonnes (+/- 12%)**Error! Bookmark not defined. **of Aluminium packaging** and **551k tonnes (+/- 12%)**Error! Bookmark not defined. **of steel packaging**.

[8] *Data correct in February 2019. Amendments to the 2017 data are still possible.*
[9] *Totals may not sum due to rounding.*

[10] *http://www.wrap.org.uk/content/metal-packaging-market-study-metal-flow-2014*

2.1.1 Steering Group Data

Members of the MetalFlow Steering Group[11] and wider industry stakeholders were able to provide confidential data on the flow of metal packaging onto the UK market. All data received was considered to be broadly in line with the projects' 2017 estimates of POM, one estimate being within 5.5% of the project's total aluminium POM.

It was also possible to compare metal packaging consumption per person in the UK with equivalent data reported from other European countries on Eurostat[12]. Based on the project POMs, consumption of metal packaging (both steel and aluminium) in the UK is 11.22kg/capita. This compares to a European average of 8.91kg/capita, with the UK sitting between Belgium (10.45kg/capita) and Germany (11.64kg/capita). Few European countries report aluminium and steel packaging POM separately, therefore a meaningful comparison by metal was not possible.

2.1.2 Metal POM Cross-check

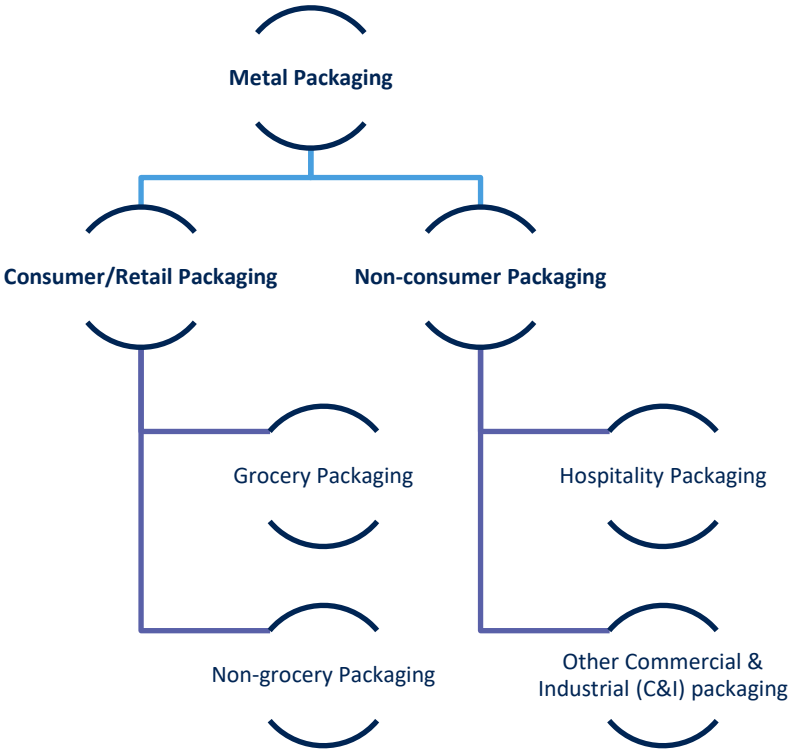
This section of the report provides an overview of how metal packaging flows onto the UK market and provides a cross-check for the net pack fill methodology used in Section 2.1.

The cross-check splits the POM into different elements as shown in **Figure 5** below. Initially, the Consumer Grocery packaging was identified, as this dataset is believed to be the most robust. Secondly, the consumer non-grocery packaging element was identified (using a bottom-up approach, whereby individual sector tonnages were identified and combined). The Consumer Grocery and Non-grocery figures were then combined to establish a Total Consumer/Retail Packaging.

The Non-consumer packaging total was established by subtracting the Consumer/Retail Packaging figure from the Total figure. Within Non-consumer packaging, the Hospitality Packaging element was identified (due to the data available) and subtracted from the Non-consumer figure to establish Other C&I. The Other C&I element is therefore a residual figure and Other C&I may contain any tonnages of grocery, non-grocery or hospitality packaging that have been missed.

[11] A list of Steering Group members can be found in the acknowledgements of this report.
[12] This was extracted and updated in November 2018.

Figure 5 Metal sector breakdown



Packaging is considered aluminium if it is the predominant material by weight in a composite, or steel if that is the predominant material by weight in a composite [13].

2.2 Consumer Aluminium and Steel POM

For the purposes of this report, the consumer sector has been broken down into grocery and non-grocery. The addition of these two sub-sectors equates to the total consumer sector.

2.2.1 Grocery POM

To estimate the amount of packaging POM by the grocery retail market, aggregated Environment Agency (EA) data was used. The data provided by the EA was 2017 aluminium and steel packaging quantities reported in table 1 selling from NPWD for 95% of UK grocery retailers. This data was scaled up to 100% of the UK grocery market and resulted in an **estimated aluminium grocery packaging POM for 2017 of 103k tonnes (+/-6%)**Error! Bookmark not defined. **error margin and steel grocery packaging POM for 2017 of 235k tonnes (+/-6%)**Error! Bookmark not defined. **error margin**. Appendix I provides a detailed assessment of relative levels of confidence in the data.

The aluminium consumer grocery retail figure of 103k tonnes is within ~2% of the 2012 estimate of 101k tonnes and therefore seemingly remains unchanged (due to potential margins of error). Steel packaging in the grocery retail sector has declined ~18% since 2012, when it was estimated to be 286k tonnes. This decline is most likely due to loss of

[13] The EA definitions of composite and multi-layered packaging are defined in, the 'Agreed position and technical interpretations – producer responsibility for packaging'. 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 separated 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.

market share i.e. switching to other packaging materials such as aluminium beverage cans, pouches and trays. Some light-weighting of steel packaging may also have occurred, but this is believed to be less significant.

2.2.2 Composition of metal grocery packaging

The composition of aluminium and steel packaging in the grocery stream in 2017, as identified through Valpak's EPIC database, are illustrated in **Figure 6** and **Figure 7** below.

Figure 6 Composition of Aluminium Grocery Packaging

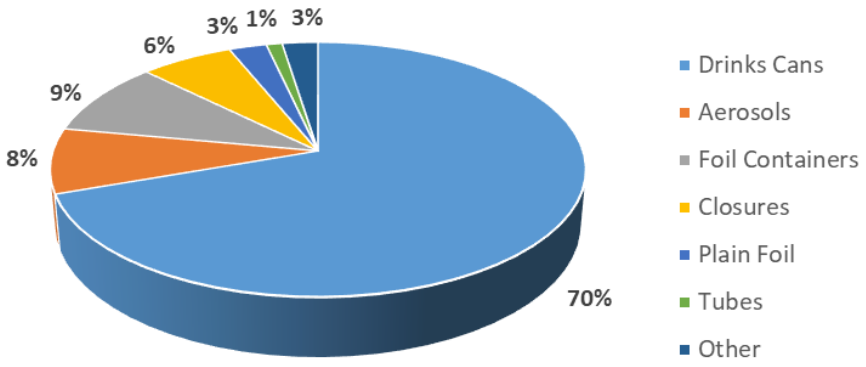
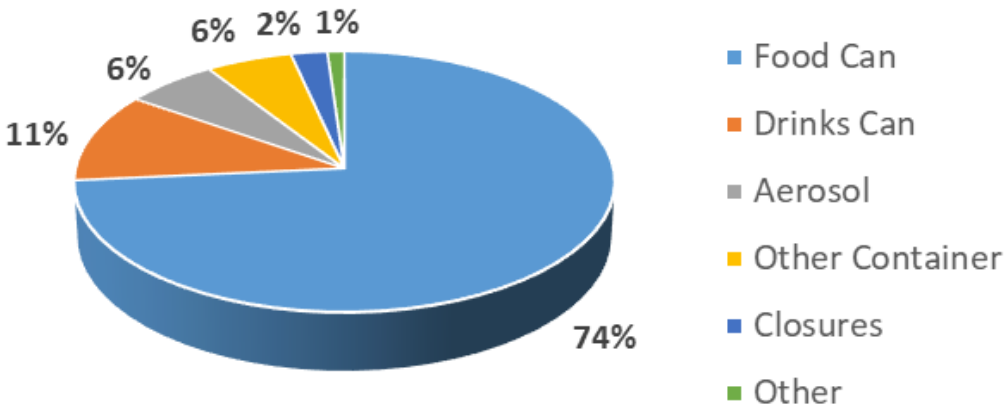


Figure 7 Composition of Steel Grocery Packaging



2.2.3 Non-grocery

Key categories of products using metal packaging and sold through non-grocery retailers were identified as Beauty & Personal Care (B&PC), DIY and Petcare, as per previous MetalFlow reports, but also Food, Drink and Other Grocery. This sector has been included in MetalFlow 2017 due to the quantity of food, drink and other (such as cleaning) products that are also sold through non-grocery retailers, such as chemists and discounters.

Beauty & Personal Care (B&PC)

Valpak's EPIC data suggests that 8% of aluminium packaging and 3% of steel packaging (by weight) is used to package B&PC products. When applied to total grocery POM (see Section 2.2.1), this gives 9k tonnes aluminium packaging and 5k tonnes steel packaging. Using 2017 market data[14] that 38% of B&PC items are purchased at supermarkets (grocery retail)[15], this suggests that the remaining 62%, or 14k tonnes of aluminium and 10k tonnes of steel are purchased from non-grocery stores.

In comparison to 2012 MetalFlow estimates, aluminium packaging has increased by ~3k tonnes (25%), while steel B&PC packaging is broadly stable. Feedback from the Steering Group suggested that the 2017 aluminium estimate of 14k tonnes was high – a similar view was expressed by the Steering Group for the MetalFlow 2014 project.

It is possible that the 38% supermarket share is an underestimate for metal packaged B&PC products which are predominantly deodorant aerosols; many glass and plastic packaged B&PC products hold a considerably higher sales value, such as perfume and make-up. These types of products are more commonly bought in non-grocery outlets such as department stores, chemists and duty-free shops, than deodorant aerosols.

For this reason, scaling up the grocery share of B&PC products was also undertaken using the supermarket share of sales of Food, Drink and Other[16] grocery products, which could be more representative of the sales of deodorants. Supermarkets sell a much higher proportion of grocery products, at approximately 85%[17]. This method generates very low estimates of 1k tonnes each of aluminium and steel non-grocery packaging.

For this report a midpoint was taken between the two sets of estimates, to best represent metal packaging in the B&PC sector, as illustrated in **Figure 8** below.

Figure 8: Beauty & Personal Care – Metal Packaging 2017 (k tonnes)[9]

	Grocery Retail k tonnes	**Non-grocery Retail** k tonnes	**Total Retail** k tonnes
Aluminium	9	8	16
Steel	6	5	11
Total Metal Packaging	**15**	**13**	**28**

[14] *Mintel*

[15] *This is unchanged from that used in MetalFlow 2014*

[16] *Other refers to other grocery products excluding B&PC and Petcare which have been analysed separately*

[17] *IGD https://www.igd.com/about-us/media/press-releases/press-release/t/uk-food-and-grocery-market-to-grow-148-by-282bn-by-2023/i/19052. Supermarket share has been estimated as Hypermarkets + Supermarkets + Convenience + 50% Discounters and 50% online sales*

DIY
In order to estimate non-grocery DIY steel packaging, known market shares of Valpak members and POM data from their 2017 data submissions were used. This provided an estimate of 8k tonnes of steel packaging from DIY stores, ~3k tonnes lower than the 2012 MetalFlow estimate. This reduction is likely to be due to material substitution (for example steel to plastic paint pots) and steel packaging light weighting.

There is a negligible amount of aluminium packaging used in DIY.

Petcare
Market data suggests that 75% of pet food is purchased at the supermarket (grocery retail), with the remaining 25% being purchased from specialist stores, garden centres or from a vets/breeders[18]. Using this split and the quantity of aluminium and steel pet food packaging sold in grocery retail (proportion of Petcare packaging in EPIC applied to scaled-up EA grocery data, see Section 2.2.1), the quantity of pet food packaging sold outside of grocery retail was calculated. This analysis is provided in **Figure 9**.

Figure 9: Pet Food – Metal Packaging 2017 (K tonnes)[9]

	Grocery Retail k tonnes	**Non-grocery Retail** k tonnes	**Total Retail** k tonnes
Aluminium	2	1	2
Steel	27	9	36
Total Metal Packaging	**29**	**10**	**39**

In comparison to 2012 Petcare data reported in MetalFlow 2014, quantities of aluminium petcare packaging appear to have remained similar in both the grocery and non-grocery sectors. However, steel packaging has shown a marked decrease in both grocery (by 9k tonnes) and non-grocery (by 11k tonnes). Both a growth in supermarket share of petcare sales (63% to 75%) and material switching (predominantly wet food in steel cans to trays and pouches, and switching to dry food in bags) could account for this drop.

Food, Drink and Other Grocery Products[19]
This is a new category which wasn't previously split out in MetalFlow 2014. In order to estimate sales through grocery and non-grocery stores, 2017 IGD market data[20] was used. This suggests that around 85% of food and grocery products are bought from supermarkets and around 15% are bought from non-grocery outlets. Using this split and the quantity of aluminium and steel pet food packaging sold in grocery retail (proportion of food, drink and grocery packaging in EPIC applied to scaled-up EA grocery data, see Section 2.2.1, minus any Petcare or B&PC products), the quantity of food, drink and other grocery products sold outside of grocery retail was calculated. This analysis is provided in **Figure 10**.

[18] *Euromonitor International/Mintel*
[19] *Other Grocery Products excludes B&PC and Petcare, which have been analysed and reported separately*
[20] https://www.igd.com/Portals/0/Downloads/Infographics/UK-food-and-grocery.pdf

Figure 10: Food, Drink & Other Grocery – Metal Packaging 2017 (k tonnes)[9]

	Grocery Retail k tonnes	Non-grocery Retail k tonnes	Total Retail k tonnes
Aluminium	92	16	108
Steel	202	35	236
Total Metal Packaging	**294**	**51**	**345**

2.2.4 Total Retail or Consumer POM (Grocery + Non-grocery POM)

In summary, the following key estimates were established for retail metal packaging consumption in the consumer sector in 2017:

- Total aluminium consumer POM was 127k tonnes (+/- 6%)**Error! Bookmark not defined.**
  - 103k tonnes (+/- 6%) grocery
  - 24k tonnes (+/- 15%) non-grocery

- Total steel consumer POM was 292k tonnes (+/- 12%)**Error! Bookmark not defined.**
  - 235k tonnes (+/- 6%) grocery
  - 57k tonnes (+/- 15%) non-grocery

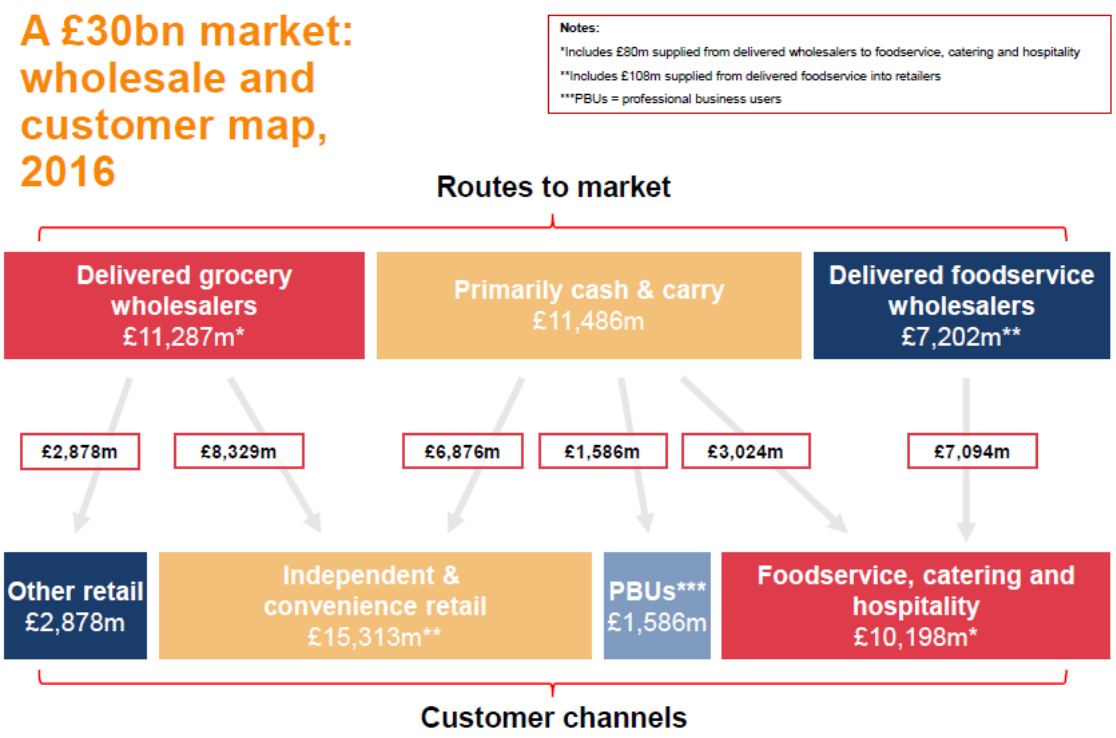
2.3 Non-consumer Aluminium and Steel POM

To complete the breakdown of aluminium and steel POM totals, an estimate of non-consumer packaging was required. Non-consumer packaging has been split into two key sectors: hospitality and other C&I.

2.3.1 Hospitality

Initial estimates of metal packaging used in the hospitality industry were made using newly available Valpak EPIC data relating to 34% of the cash and carry and delivered foodservice industry. Market share information for the companies included in the sample was used to scale up the resulting tonnage to represent the whole foodservice, catering and hospitality sector, as depicted in **Figure 7**.

Figure 11 Overview of the Foodservice, Catering & Hospitality Sector[9,21]



This method provided estimates of 12k tonnes of aluminium hospitality packaging and 38k tonnes of steel hospitality packaging. However, it was also identified that there are considerable quantities of soft and alcoholic drinks that are sold directly to bars and restaurants which were missing from our initial calculations. For this reason, further research was undertaken and the following additional tonnages identified:

Figure 12 Breakdown of Hospitality Packaging by Source[9]

	Aluminium k tonnes	**Steel** k tonnes
Wholesale and Foodservice (scaled-up from EPIC)	12	38
Additional direct sales of soft drinks	14	21
Additional direct sales of alcoholic drinks	6	5

21 https://www.igd.com/Portals/0/Downloads/Events/UKGroceryFoodserviceWholesaling2017.pdf

Total Metal Packaging in Hospitality	**32** (+/- 18%)**Error! Bookmark not defined.**	**63** (+/- 18%)**Error! Bookmark not defined.**

Additional direct sales of soft drink cans were estimated by taking the total volume sales of soft drinks and the proportion sold in metal packaging. Valpak's EPIC grocery split of aluminium to steel drinks cans was then used as a proxy to proportion the metal soft drinks cans, giving the total volume (litres) of aluminium and steel soft drink cans. EPIC data was then also used to provide a proxy for litres per gram of packaging, which gave a total of 133k tonnes aluminium soft drinks packaging and 55k tonnes steel soft drinks packaging. Subtracting the already identified quantities of packaging from these totals, left the 'missing' packaging of 14k tonnes aluminium soft drinks packaging and 21k tonnes steel soft drinks packaging.

To calculate additional direct sales of alcoholic drinks packaging, we were provided the total number of beer cans sold into pubs in 2017 by the British Beer & Pub Association, from which we subtracted the number of alcoholic drinks cans units already accounted for. The hospitality aluminium/steel can unit split established in Drinks Recycling OTG[22] was used to estimate the number of aluminium and steel cans and an average hospitality can weight was applied[22] for each. This generated estimates of 6k tonnes of missing alcoholic aluminium drinks cans and 5k tonnes missing alcoholic steel drinks cans. These estimates are considered low/minimum as they relate only to beer and pubs; not all alcoholic drinks are sold to all hospitality outlets.

2.3.2 Other C&I

This stream is the residual tonnage once the grocery, non-grocery and hospitality streams are subtracted from total POM. It should be noted that as this stream is a residual tonnage, it may include any missed tonnages of grocery, non-grocery and hospitality packaging, thus not necesserily only Other C&I.

Minimal data exists on C&I packaging outside of hospitality, in particular for aluminium. It is known that aluminium is used to some extent in the manufacturing of gas canisters, drums and industrial aerosols however figures to illustrate these quantities weren't available. The total Other C&I estimate for aluminium was 35k tonnes (+/- 15%)**Error! Bookmark not defined.** [23].

For steel C&I packaging outside of hospitality, it was possible to undertake a crude bottom-up approach, to cross-check whether the 197k tonnes residual estimate was appropriate. The tonnage breakdown of results is unable to be published due to the confidential nature of some of the estimates; however, a total of 193k tonnes was identified. The breakdown included broad estimates of the following:

- Steel Drums (UK manufactured & imported);
- Transit Packaging;
- C&I aerosols;
- Empty steel C&I packaging imports – small;

[22] WRAP Drinks Recycling On-the-Go 2018, http://www.wrap.org.uk/consumption-recycling-and-disposal-go-drinks-containers.

[23] Due to lack of data it has been assumed that the error margin around the residual Other C&I figure is the same as the combined error margins of grocery, non-grocery and hospitality estimates (which are subtracted from total POM to estimate Other C&I). Refer to footnote 2.

- Gas Cylinders;
- Intermediate Bulk Containers (IBCs).

As for aluminium, to establish the steel Other C&I error margin, the combined error margin of steel grocery, non-grocery and hospitality POM was used, as Other C&I is the residual figure once these three streams are subtracted from the total POM. This means the Other C&I steel packaging estimate was 197k tonnes (+/- 12%)**Error! Bookmark not defined.**.

2.4 Consumer – Type Metal Packaging

It was considered of interest to provide a POM estimate for that which could be defined as 'consumer-type' metal packaging. This would include the total consumer packaging POM identified in Section 2.2, plus that identified as hospitality packaging in Section 2.3.1. This is because hospitality packaging is primarily 'household-like' in its nature. This would result in an aluminium packaging consumer-type POM of **159k tonnes** (+/- 6%)**Error! Bookmark not defined.** error margin and a steel packaging consumer-type POM of **355k tonnes** (+/- 6%)**Error! Bookmark not defined.**.

2.5 Metal POM Results and Breakdown

The project estimate for aluminium packaging POM in 2017 is 194k tonnes (+/- 12%) Error! Bookmark not defined..
This was derived from reported obligated data (EA, NPWD) and cross-checked using a bottom-up methodology. This took data from various sources for each sector and combined the results. Data provided by the project's Steering Group was also incorporated.

The final project estimate for aluminium packaging POM in the consumer sector is 127k tonnes (+/-6%) Error! Bookmark not defined.
This method was based on primary data alongside reliable market share data. No other method was used for deriving consumer data as this method is considered the most robust available and is accepted by industry.

The final project estimate for aluminium packaging POM in the non-consumer sector is 67k tonnes (**+/-10%)**Error! Bookmark not defined.
This was partly comprised of an estimate of hospitality packaging, based on primary and market share data. In addition, separate quantities of direct sales of soft and alcoholic drinks were calculated based on industry figures. C&I packaging comprises the remaining part of non-consumer POM and is the residual tonnage once consumer and hospitality POM are deducted from total POM. There were no figures available to cross-check this data, which may include any missed tonnages of grocery, non-grocery and/or hospitality POM.

The project estimate for steel packaging POM in 2017 is 551k tonnes (+/- 12%) Error! Bookmark not defined.
This was derived from reported obligated data (EA, NPWD) and cross-checked as much as possible using a bottom-up methodology. This took data from various sources for each sector and combined the results. Data provided by the project's Steering Group was also incorporated.

The final project estimate for steel packaging POM in the consumer sector is 292k tonnes (+/-6%) Error! Bookmark not defined.

This method was based on primary data alongside reliable market share data. No other method was used for deriving consumer data as this method is considered the most robust available and is accepted by industry.

The final project estimate for steel packaging POM in the non-consumer sector is 260k tonnes (**+/-10%)**Error! Bookmark not defined.
This estimate is partly comprised of an estimate of hospitality packaging, based on primary and market share data. In addition, separate quantities of direct sales of soft and alcoholic drinks were calculated based on industry figures. C&I packaging comprises the remaining part of non-consumer POM and is the residual tonnage once consumer and hospitality POM are deducted from total POM. This residual figure was cross-checked using a bottom-up approach, whereby estimates were made of industrial packaging types using secondary research and industry/Steering Group knowledge. This estimate came within 8% of the residual tonnage (with known missing elements).

Figure 13 Breakdown of Total Metal Packaging POM, by Stream[9]

	Aluminium		Steel	
	tonnes	Error margin	tonnes	Error margin
Consumer Retail Grocery	103k	+/-6%	235k	+/-6%
Consumer Retail Non-grocery	24k	+/-15%	57k	+/-15%
Total Consumer Retail	**127k**	**+/-6%**	**292k**	**+/-6%**
Non-consumer Hospitality	32k	+/-18%	63k	+/-18%
Non-consumer Other C&I	35k	+/-15%	197k	+/-12%
Total Non-consumer	**67k**	**+/-10%**	**260k**	**+/-10%**
Total Metal Packaging POM (NPF)	**194k**	**+/-12%**	**551k**	**+/-12%**

3.0 Collection and Reprocessing of Metal Packaging

3.1 Aluminium Packaging Recycling

This section of the report examines the levels of aluminium packaging waste collected in the UK and then recycled, either in domestic smelters or overseas. The collections are split between consumer (Local Authority managed collections from households) and non-consumer collections. Waste Data Flow (WDF), combined with adjustments for consumer aluminium in incinerator bottom ash (IBA) and refuse derived fuel (RDF), is used to estimate household recycling, and data from NPWD is used for total accredited (recorded) recycling. However, NPWD figures do not account for unaccredited (unrecorded) recycling, therefore this project has also completed a separate analysis on this element to provide an estimate of the total recycling figure.

3.1.1 Recorded Recycling of Aluminium Packaging

NPWD was used to identify the total recorded recycling of aluminium packaging, both in the UK and of exports for recycling overseas. For 2017, this shows 94k tonnes of recycling of aluminium packaging, of which 48k tonnes (51%) took place in the UK. Of the total (UK and exports), 69k tonnes (73%) relates to the recycling of aluminium cans and associated packaging, 24k tonnes (26%) is from the recycling of aluminium packaging in incinerator bottom ash (IBA) and <1k tonnes (1%) is from other protocols agreed with the Regulators.

Based on the total aluminium POM estimated in this report (194k tonnes), the total recorded recycling figure of 94k tonnes gives a recycling level of 48% for 2017.

3.1.2 Unrecorded Recycling of Aluminium Packaging

It is important to recognise that not all aluminium recycling is captured on NPWD. To identify the scale of unrecorded recycling, conversations were held with the Steering Group as well as UK operators and exporters handling recovered aluminium packaging. Firstly, conversations focused on any unaccredited recycling or export of the key grades of aluminium packaging (excluding IBA). In particular, this relates to the recycling of aluminium cans and associated packaging (such as aerosols and foils), but also to other grades, such as caps and closures generated from the glass recycling sector.

The general feeling was that much of the aluminium packaging recycling of this type is being captured because key players specialising in packaging recycling are accredited and there is an economic incentive to keep grades, such as used beverage cans (UBCs), separate from other streams of aluminium. However, it was felt that some aluminium packaging is being lost (in terms of data capture), for example, at large metal yards where smaller quantities of aluminium packaging might be accepted, but where the scale of the operation means that it is not practical to keep it as a separate grade and so it is mixed with non-packaging aluminium. In addition, there was evidence of at least one smelter not being accredited to issue PRNs in 2017 handling a relatively significant quantity of aluminium packaging.

Based on input from industry, it was estimated that the recorded recycling of key grades of aluminium packaging (excluding IBA) on NPWD in 2017 was 92%. That is to say that the data on NPWD accounts for 92% of the actual recycling of these grades of aluminium. For exports, the estimate was a little higher at 95%.This equates to 4kt of unrecorded recycling in the UK and 1kt for exports.

A second area of investigation was recycling of the non-ferrous metal fraction recovered from IBA. For this grade of non-ferrous metal there are two national PRN protocols in place: one for unprocessed non-ferrous IBA metal, where there is a protocol of 70% aluminium

packaging in place, and the other for partly processed non-ferrous IBA metal, where an 87.5% protocol is used. Conversations with industry suggested that not all recycling of this grade was captured on NPWD in 2017, so an estimate of the missing tonnage was made. To do this, a figure of 2.2MT[24] of IBA generation in 2017 was used combined with an assumed non-ferrous metal content of 2%[25]. This gives a total non-ferrous metal generation from IBA of 44k tonnes in 2017 and a total aluminium packaging content of 31k tonnes using the 70% protocol. On NPWD, 24k tonnes of aluminium packaging recycling from IBA was recorded (79% of the estimated total), leaving a difference between the two figures of 6k tonnes (21% of the estimated total). On the assumption that all IBA is treated and the non-ferrous content recovered, there was 6k tonnes of unrecorded aluminium packaging recycling related to IBA.

Finally, UK RDF exports and the aluminium packaging content was investigated. As with Energy from Waste Plants (EfW) in the UK, it has been assumed that any RDF exported to mainland Europe will be treated in a plant where the IBA is processed and the non-ferrous metal content recycled. In 2017, 3,564,164 tonnes of RDF was exported from the UK[26] with an estimated aluminium packaging content of 0.75%[27]. However, there is a loss of aluminium packaging during incineration that must be taken into consideration. This varies depending on the thickness of the aluminium and therefore the mix of packaging that makes up the 0.75%. It has been assumed that the transfer rate during incineration is 80% with a loss of 20%. This figure is approximate, but takes into consideration transfer rate research by the European Aluminium Association and Alufoil[28] and input from Alupro. Based on these assumptions, the unrecorded recycling rate estimate of aluminium packaging in RDF is 21k tonnes.

It should be noted that there was some discussion with the Steering Group on the assumed percentage of aluminium packaging in RDF. The original figure used in the modelling was 0.5%, however evidence was presented to suggest it should be higher (and potentially higher still than the 0.75% adopted). A key reason an aluminium packaging percentage higher than 0.75% was not used was that the tonnage of aluminium packaging recycled from IBA derived from exported RDF would become very high compared to what would be generated if the RDF was sent to EfW plants in the UK and the IBA protocol used.

Taking into consideration all of the aforementioned factors, the total unrecorded (unaccredited) recycling of aluminium packaging in 2017 was estimated to be 33k tonnes.

3.1.3 Total Recycling of Aluminium Packaging (recorded and unrecorded)

Total aluminium packaging recycling can be calculated by combining the recorded recycling on NPWD with estimated unrecorded recycling:

Total aluminium packaging recycled	=	Total recorded recycling	+	Total unrecorded recycling

[24] Tolvic Consulting UK Energy, from Waste Statistics 2017

[25] Assumptions on ferrous (7%) and non-ferrous (2%) content in IBA were based on conversations with industry and desk research. Data from Defra UK Statistics of Waste (07.03.19) shows that in 2017 189k tonnes of metals from bottom ash was recycled. When combining this with Tolvic's IBA generation figure of 2.2MT in 2017, this would give a metals content of 8.6%, which is broadly in line with the combined metals total being used (9%).

[26] This is based on data from the Environment Agency, National Resources Wales (Contains Natural Resources Wales information © Natural Resources Wales and Database Right. All rights Reserved), the Department of Agriculture, Environment and Rural Affaires in Northern Ireland, and the Scottish Environment Protection Agency. The data from England and Wales is subject to the Open Government License (http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/ .

[27] Metal content percentages in RDF were based on in-house information and conversations with industry.

[28] European Aluminium Association / Alufoil: Fact Sheet

This gives a total recycling rate for aluminium packaging of 127k tonnes. Based on the POM calculated in this report (194k tonnes), this would be a recycling rate of 65%.

3.2 Consumer and Non-consumer Aluminium Packaging Recycling

3.2.1 Consumer Recycling of Aluminium Packaging

Consumer recycling data was extracted from WDF where figures are reported based on the financial year 2016/17. This means there is some degree of inconsistency between the collection figures for April 2016 - March 2017 and the consumption figures for January 2017 - December 2017[29]. A summary of aluminium packaging collections is shown in Figure 14 .

Figure 14 Aluminium Packaging WDF Data 2016/17

	Total	Kerbside	Bring	CA
Aluminium Packaging Collected	58kt	56kt	1kt	1kt

A significant proportion of the aluminium in the total above is generated from *mixed cans;* it has been assumed, based on WDF analysis, that the aluminium content is 20%, with the remainder steel tins and cans.

The WDF data shown above does not include figures for consumer aluminium packaging recycled from IBA or RDF - estimates were made for these. For IBA, Tolvic reports[24] that of the 10.89M tonnes of waste inputs to UK energy for waste plants in 2017, that 83% was MSW and the remainder C&I. This 83% has been used as a proxy for consumer waste, although it is recognised that it will include some household-like waste from non-households. It was also assumed that the aluminium content in both the MSW and C&I would be similar. We have therefore expected that 83% of the aluminium packaging recycled from IBA is consumer, which amounts to approximately 26k tonnes (83% of 31k tonnes). RDF is typically produced with a mix of household and C&I waste to achieve target specifications for EfW plants. We have assumed that an average of 50% of the aluminium recycled is from consumer sources, which amounts to approximately 11k tonnes.

Combining the above, we estimate that there is 95k tonnes of aluminium packaging recycling from consumer sources. Based on the calculated consumer POM figure (127k tonnes), this gives a recycling rate of 75% for consumer aluminium packaging.

3.2.2 Non-consumer recycling of aluminium packaging

Non-consumer recycling was estimated as follows:

[29] *Cleansed and partially analysed WDF data provided by WRAP*

Figure 15 Non-consumer Aluminium Packaging Recycling Calculation

Non-consumer recycling	=	Total aluminium packaging recycled	-	Consumer recycling

Total UK aluminium packaging recycled (2017)	127k tonnes
Aluminium consumer Recycled	95k tonnes
Aluminium Non-Consumer Recycled	33k tonnes

This gives a non-consumer aluminium packaging recycling level of 33k tonnes in 2017, and therefore a recycling rate of 48%, based on the calculated non-consumer POM. It should be noted that this figure is likely to be low due to the presence of some non-consumer aluminium packaging, both in that reported on WDF and in the MSW supplied to UK EfW plants.

3.3 Aluminium Packaging not Recycled

By subtracting the consumer and non-consumer recycling totals from the respective POMs, we are left with the non-recycled tonnages for each stream.

For consumer aluminium packaging, the non-recycled total is 32k tonnes. For aluminium not recycled, we have included an estimate for the aluminium lost during incineration both in UK EfW plants and those overseas accepting UK derived RDF. A transfer rate of 80% has been assumed, with a loss of 20% of the aluminium during the process. This accounts for 9k tonnes of the total. The remaining 23k tonnes is an estimate of consumer aluminium packaging contained in residual waste sent for landfill.

For non-consumer aluminium packaging, the non-recycled total is 35k tonnes. As for consumer aluminium packaging, an estimate was made for loss during incineration both in the UK and overseas using the same methodology. This accounts for approximately 4k tonnes of the total. The remaining 31k tonnes is an estimate of non-consumer aluminium packaging contained in residual waste sent for landfill.

3.4 Steel Packaging Recycling

3.4.1 Recorded Recycling of Steel Packaging

NPWD was used to identify the total recorded recycling of steel packaging, both in the UK and of exports for recycling overseas. For 2017, this shows 431k tonnes of recycling of steel packaging, of which 273k tonnes (63%) took place in the UK. Of the total (UK and exports), 238k tonnes (55%) relates to the recycling of steel cans and associated packaging, 154k tonnes (36%) is from the recycling of other steel grades with national protocols (where one might expect to find mainly non-consumer packaging, such as UK grades, 1, 2 and 3b) and the remaining 39k tonnes (9%) is on grades where individual protocols have been agreed with the Regulators.

Based on the total POM calculated in this report, the total recorded recycling figure of 431k tonnes gives a recorded recycling level of 78% in 2017.

3.4.2 Unrecorded Recycling of Steel Packaging

It is important to recognise that not all of the recycling of steel packaging might be captured on NPWD. To try and identify the scale of unrecorded recycling, conversations were held with the Steering Group, UK operators and exporters handling recovered steel packaging.

Firstly, conversations focused on any unaccredited recycling or export of the key grades of steel packaging (excluding IBA). Discussions focused on the recycling of steel cans and associated packaging (such as aerosols) and also other grades where a national protocol exists (for example for UK grades 1 & 2 and fragmentised light steel). The general feeling was that a high percentage of the steel packaging recycling that falls into these categories is being captured. For cans, this was due to the main UK steel mills being accredited and exports being limited. For other grades, it was felt that data on NPWD suggests much is being captured and, also, the size of shipments means there is a strong incentive for exporters to get accredited. Based on input from industry, it was estimated that the recorded recycling of key grades of steel packaging (excluding IBA) on NPWD in 2017 was 98% (the same figure was used for recorded exports of steel packaging). This equates to 8k tonnes of unrecorded recycling from these sources.

A second area of investigation was the recycling of the ferrous metal fraction recovered from IBA. Unlike aluminium, there is no national protocol for steel packaging recovered from IBA and individual agreements must be made between UK mills or exporters and the Regulators. In 2017, approximately 38.5k tonnes of PRNs were issued based on local protocols from a flow of steel scrap of just over 56k tonnes. The average rate of the protocol was therefore 69%, whilst there were no locally agreed protocols on exports in 2017. Interestingly, even as the 69% is an average and it is possible that some protocols are low and others high, a relatively significant proportion of this tonnage was identified as being related to this issuing of PRNs on steel packaging in IBA. However, despite this, discussions with industry indicated that a relatively large percentage of the IBA ferrous fraction was not having PRNs issued on it and so an attempt was made to calculate how much might be missing. To do this, a figure of 2.2MT[24] of IBA generation in 2017 was used combined with an assumed ferrous metal content within this of 7%[25]. This gives a total ferrous metal generation from IBA of 154k tonnes in 2017.

Next, an average steel packaging content in the ferrous IBA was estimated as no protocol exists. Here, we know the average locally agreed protocol is 69%, and discussions with industry suggest that this is close to the expected level of packaging content. However, discussions also suggested that some of the ferrous IBA fraction may be finding its way into fragmentised light steel. Whilst IBA ferrous is technically not permitted in this grade, there is an economic incentive for this to happen. As the protocol on this grade is low as a percent (4.1%) and this figure would not account for any IBA content (as the protocol was developed prior to any significant recovery of ferrous from IBA) the inclusion of some IBA ferrous would increase the tonnage of this grade and therefore have some very marginal impact on PRNs issued (in that they are not all 'lost'). As a result, the 69% figure was reduced very slightly to reflect this - by 1%. We have therefore used 68% as being the average steel packaging content in the ferrous IBA fraction.

If we use a 68% steel packaging content in the 154k tonnes of ferrous in IBA, then we have a maximum PRNable content of 105k tonnes. As we have identified a significant proportion of the PRNs issued against locally agreed protocols are from IBA, we are assuming that the remainder is from this source also. This is supported by the fact that the average locally agreed protocol percentage is close to that used for steel packaging in IBA. On NPWD, a little under 39k tonnes of PRNs were recorded for steel packaging from locally agreed protocols (37% of the estimated steel packaging content in IBA), leaving a difference between the two figures of 66k tonnes (63% of the steel packaging content in IBA). On the

assumption that all IBA is treated and the ferrous content recovered, the unrecorded recycling total related to IBA is estimated to be 66k tonnes.

Finally, the export of RDF from the UK and its steel packaging content was investigated. As with Energy from Waste Plants (EfW) in the UK, it has been assumed that any RDF exported to mainland Europe will be treated in a plant where the IBA is processed and the ferrous metal content recycled. In 2017, 3,564,164 tonnes of RDF were exported from the UK[26] and it was estimated that within the RDF the steel packaging content is 1%[27] on average. This gives an unrecorded recycling rate for steel packaging in RDF of 36k tonnes.

Taking into consideration all of these aforementioned factors, the total unrecorded (unaccredited) recycling of steel packaging in 2017 was estimated to be 110k tonnes.

3.4.3 Total Recycling of Steel Packaging (recorded and unrecorded)

The total steel packaging can be calculated by combining the recorded recycling on NPWD with the estimate for unrecorded recycling:

Total steel packaging recycled	=	Total recorded recycling	+	Total unrecorded recycling

This gives a total recycling rate for steel packaging of 541k tonnes. Based on the POM calculated in this report, this would be a recycling rate of 98%.

3.5 Consumer and Non-consumer Steel Packaging Recycling

3.5.1 Consumer recycling of steel packaging

Consumer recycling data based on the financial year 2016/17 was extracted from WDF. This means there is some degree of inconsistency between the collection figures for April 2016 - March 2017 and the consumption figures for January 2017 - December 2017[29]. A summary of steel packaging collections is shown in **Figure 16**.

Figure 16 Steel Packaging WDF Data 2016/17

	Total	Kerbside	Bring	CA
Steel Packaging Collected	227kt	219kt	1kt	7kt

A significant proportion of this steel in the total shown above is generated from *mixed cans*; it has been assumed, based on an analysis of data in WDF, that the steel content is 80%, with the remainder being aluminium cans and associated packaging.

The WDF data shown above does not include figures for consumer steel packaging recycled from IBA or RDF - estimates were made for these. For IBA, Tolvic report[1] that of the 10.89M tonnes of waste inputs to UK energy for waste plants in 2017, 83% was MSW and the remainder C&I. This 83% has been used as a proxy for consumer waste, although it is recognised that it will include some *household-like* waste from non-households. It was also expected that the steel content in both the MSW and C&I would be similar. We have therefore assumed that 83% of steel packaging recycled from IBA is consumer, which amounts to approximately 87k tonnes (83% of 105k tonnes). RDF is typically produced with

a mix of household and C&I waste to achieve target specifications for EfW plants. We have also assumed that an average of 50% of the steel recycled from RDF is from consumer sources, which amounts to approximately 18k tonnes (50% of 36kt).

Combining the above (Local Authority collected + IBA + RDF), we estimate that there is approximately 332k tonnes of steel packaging recycling from consumer sources. Based on the calculated POM figure (292k tonnes), this gives a recycling rate of 114% for steel packaging from consumer sources. Clearly this cannot be correct, so the reasoning behind this will be explored in Section 3.7.

3.5.2 Non-consumer Recycling of Steel Packaging

Non-consumer recycling was estimated as follows:

Figure 17 Non-consumer Steel Packaging Recycling Calculation

Non-consumer recycling	=	Total steel packaging recycled	-	Consumer recycling

Total UK steel packaging recycling (2017)	541k tonnes
Steel consumer Recycling	332k tonnes
Steel Non-Consumer Recycling	209 k tonnes

This gives a non-consumer recycling rate for steel packaging of 209k tonnes in 2017. Based on the calculated non-consumer POM (260k tonnes), this gives a recycling rate of 80%.

3.6 Steel Packaging not Recycled 2017

By taking the consumer and non-consumer recycling totals from the respective POMs, we are left with the non-recycled tonnages.

For consumer steel packaging, the non-recycled total is negative due to the recycling rate being over 100%. This is explored further in Section 3.7.

For non-consumer steel packaging, the non-recycled total is 51k tonnes. As we are assuming that all the steel packaging in IBA is recycled, in both the UK and generated by RDF overseas, then this would be the figure contained in landfilled waste.

3.7 Possible Explanations for a Consumer Steel Recycling Figure over 100%

Current recorded recycling rates for steel packaging are already high at 78%, based on the POM calculated for this report. It is perhaps therefore not surprising that the calculated figure for the total steel packaging recycled is as high as 98%, when you include unrecorded recycling, particularly from IBA.

However, when looking at consumer recycling we have a recycling level greater than the POM, at 114%. In addition, non-consumer recycling appears potentially low, based on feedback from the Steering Group, at 80%. One possible explanation is the assumption being made that all steel packaging reported on WDF is consumer, as some may be collected by Local Authorities from non-household sources. In addition, the percentage of MSW entering EfW plants is used as a proxy for consumer waste entering these facilities. However, this waste will include some household like waste from non-household sources. The split between consumer and non-consumer steel recycling is fairly sensitive to

adjustments of these figures. For example, if we assume that 15% of the steel packaging reported on WDF and that the MSW delivered to EfW plants is from non-household sources, we bring the consumer recycling rate down to 98% and increase the non-consumer recycling rate to 99%. These recycling levels, of being very high for both consumer and non-consumer recycling, are in line with the expectations of the Steering Group.

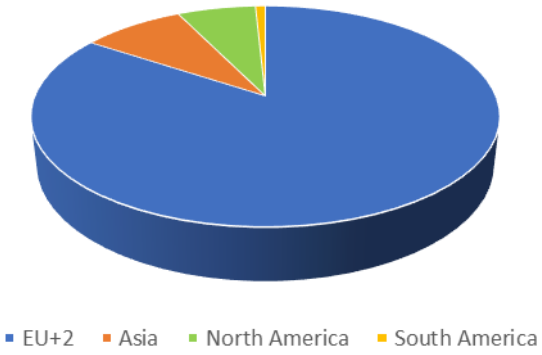
4.0 Metal End Markets

4.1 Aluminium Packaging End Markets

Recycled aluminium used beverage cans (UBC) packaging typically goes back into rolled aluminium products, including new cans. For example, most other grades of recycled aluminium, such as that derived from IBA or from foils or from caps and closures, is currently used in cast applications. Based on NPWD figures for 2017, 51% of the recorded recycling took place in the UK and 49% overseas. A freedom of information request was made to the Environment Agency to determine where aluminium packaging was exported to for recycling, by tonnage. These figures exclude any non-aluminium packaging that might be present. It can be seen from the breakdowns given below that a large proportion of exports were to the EU+2 (84%) with the remainder primarily split between Asia and North America.

Figure 18 Aluminium Packaging Exports (tonnes) – Destination Regions (2017)

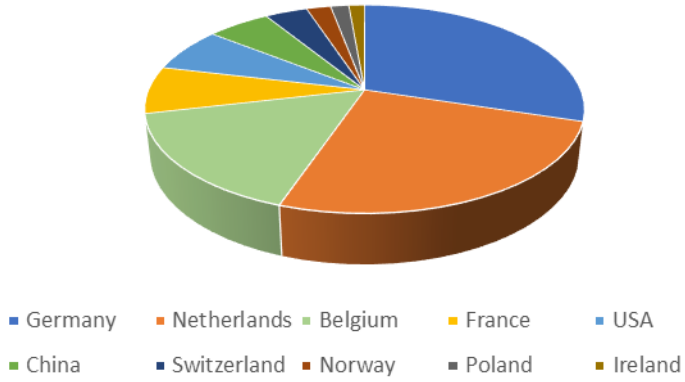
Export Regions	
Region	**% of Exports**
EU+2	84%
Asia	8%
North America	6%
South America	1%



In terms of destination countries, then 67% went to the top 3 destinations, Germany, the Netherlands and Belgium.

Figure 19 Aluminium Packaging Exports (% by weight) – Destination Countries (2017)[30]

Top 10 export destinations	
Country	**% of exports**
Germany	28.0
Netherlands	23.9
Belgium	15.1
France	6.9
USA	6.5
China	5.2
Switzerland	3.5
Norway	2.0
Poland	1.5
Ireland	1.3



Data source: UK Environment Agency. Freedom of Information request
Data Manipulation: Verde Research and Consulting Ltd

4.2 Steel Packaging End markets

Recycled steel packaging is used in a wide range of different products once recycled, including in construction, automotive and packaging applications. Based on NPWD figures for 2017, 63% of the recorded recycling took place in the UK and 37% overseas. A freedom of information request was also made for this to the Environment Agency to determine where steel packaging was exported to for recycling, by tonnage. These figures exclude any non-steel packaging that might be present. It can be seen from the breakdowns given below that the Middle East is a key export destination, notably Turkey, as well as North America and countries in mainland Europe, including Spain and Germany. Referring to NPWD, we can see that the vast majority of exports (89% in 2017) are of protocol grades that do not typically contain household packaging. These include fragmentised old light steel and old steel grades 1 and 2. Steel tins and cans tend to be recycled in the UK (93% in 2017).

[30] Contains public sector information licensed under the Open Government License v3.0 http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

Figure 20 Steel Exports (% by weight) – Destination Regions (2017)

Export Regions	
Region	**% of exports**
Middle East	39
EU+2	26
N America	15
South Asia	16
SE Asia	2
NW Africa	1
East Asia	1

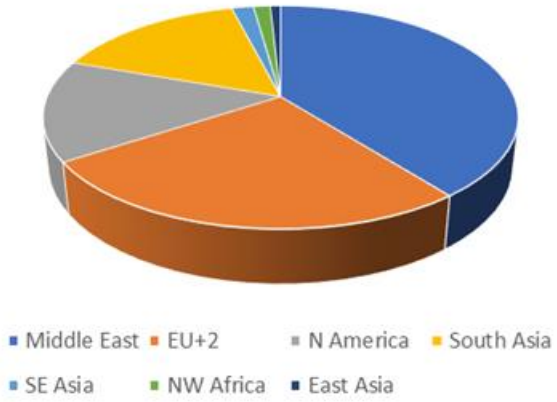
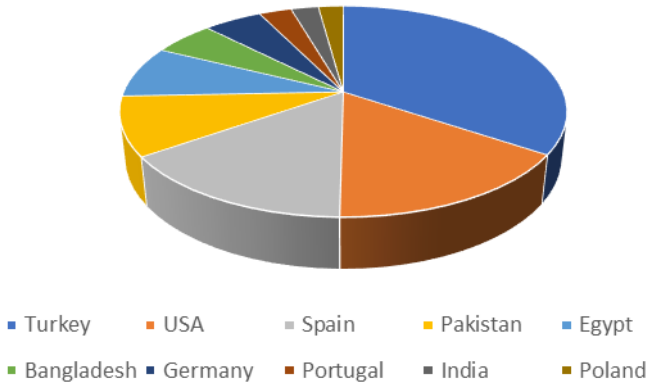


Figure 21 Steel Packaging Exports (% by weight) – Destination Countries (2017)[31]

Top 10 export destinations	
Country	**% of exports**
Turkey	31.9
USA	14.7
Spain	14.0
Pakistan	8.4
Egypt	7.4
Bangladesh	4.9
Germany	4.7
Portugal	2.6
India	2.2
Poland	2.0



Data source: UK Environment Agency. Freedom of Information request
Data Manipulation: Verde Research and Consulting Ltd

[31] Contains public sector information licensed under the Open Government License v3.0 http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

5.0 Metal Packaging Projections and Compliance

This section of the report reviews the historical data and trends for metal packaging (aluminium and steel are assessed separately) placed on the market (POM) in the UK, and accredited metal packaging recycling as reported by accredited reprocessors and exporters.

Based on the data, univariate time-series models (linear trend and autoregressive models) are estimated and, based on these statistical models, a range of scenarios for metal packaging POM and metal packaging accredited recycling are projected forward to 2025. The intention here is to provide a range of plausible possible futures for metal packaging POM and accredited recycling to inform policymakers and other stakeholders. For aluminium packaging accredited recycling, a scenario based on projected IBA metals tonnages (and non-IBA routes) is also considered.

Then, assuming these scenarios represent plausible possible futures for metal packaging POM and accredited recycling, a compliance assessment of packaging recycling versus the recycling targets to 2020, and the CEP target in 2025 is made.

5.1 Metal Packaging POM and Projections

Historically, the tonnage of metal packaging POM has been estimated by a process of consultation and periodic review with industry and stakeholders (for example the MetalFlow 2020, MetalFlow supplementary report 2016, the PackFlow 2017, and PackFlow 2012 reports). In the PackFlow methodologies, metal packaging POM was established using assumed growth rates from a historical baseline, with the growth rates and resultant POM quantities discussed and agreed with industry, government and stakeholders before being adopted by policymakers for target setting.

There isn't a long historical time series (suitable for statistical modelling) available for metal POM tonnages because past estimates of POM tonnages were established by a process reflecting a mixture of data and expert judgement, and therefore may not necessarily accurately reflect actual trends in materials being placed on the market. However, the EA's NPWD does provides a data source from which to assess trends over time in aluminium packaging placed onto the UK market by businesses that are obligated to comply with the packaging regulations. Obligated businesses are required to report their packaging tonnages data into NPWD each year. Therefore, historical data on the quantities of metal packaging handled by obligated producers ('obligated' metal packaging POM) is available for trend analysis.

The quantity of unregistered metal packaging, or in other words packaging handled by businesses who are 'de minimis' or who are for whatever reason 'free-riders', is not known. However, once a total POM is established, this can be straightforwardly estimated. If, in the past, the proportion of unregistered packaging POM was small and/or fairly constant over time, then it seems reasonable that trends observed in obligated packaging POM can be expected to closely mirror trends in overall POM.

That said, the tonnages reported by obligated producers in NPWD are impacted, for example, by businesses coming into the regime that were previously 'free-riding'. And, since the packaging regulations were introduced, there have been instances of changes to legislation that may also affect POM tonnages; for example, there being no obligation for the use of the packaging status 'internal use only'. However, it is likely that over time,

businesses have gained a better understanding of the requirements of the legislation, which itself is likely to have improved the accuracy of data reported into NPWD.

Below, it is assumed that the metal packaging (aluminium and steel are assessed separately) net pack fill tonnages from 1997 to 2017 (calculated using NPWD data as described in Section 2.1 of this report) are the best available data to use to:

- Assess trends in the overall quantity of metal packaging POM;
- Estimate empirical models of metal packaging POM; and,
- Project plausible possible future scenarios for metal packaging POM.

Statistical models using the historical net pack fill data for metal packaging are estimated and, based on the preferred model selected on statistical criteria, scenarios for metal packaging POM are projected to 2025. Full details of the methodology used to estimate the models can be found in Appendix 2.

This methodology assumes that the factors which influenced past trend growth in metal packaging net pack fill (and hence by assumption POM) will inform future projections. Whilst this projection is 'data based', it is not intended to be sophisticated. For example, it doesn't account for potential substitution effects within metal packaging, nor between metal packaging and other packaging materials (which is likely given the recent backlash against plastic packaging, but to an unknown extent), reform of extended producer responsibility, uncertainty due to EU exit, or changes in future trends in light-weighting of packaging.

All projections are subject to uncertainty; however, the uncertainty around projections based on statistical models, such as those estimated here, can be estimated using the modelled standard error from the statistical analysis. Assuming a normal distribution, 95% confidence intervals are calculated as the upper and lower bounds to the projection shown in **Figure 22**.

5.1.1 Aluminium Packaging POM and Projections

This section reviews the historical data and trends for aluminium packaging placed on the market (POM) in the UK based on net pack fill calculated from NPWD data. Based on these, univariate time-series models (linear trend and autoregressive models) are estimated and a scenario for aluminium packaging POM based on the preferred model is projected forward to 2025.

Figure 22 shows the historical data for aluminium packaging net pack fill calculated from NPWD data. The past outturns for net pack fill show a steady increase from 1997 to 2003 before reducing to 138k tonnes in 2005. Steady growth resumed up to 2012 before a slight reduction in 2014. Since 2012, aluminium packaging net pack fill has increased, reaching 192k tonnes in 2017.

Figure 22 Aluminium Packaging Net Pack Fill, Projection and 95% Confidence Interval (k tonnes)

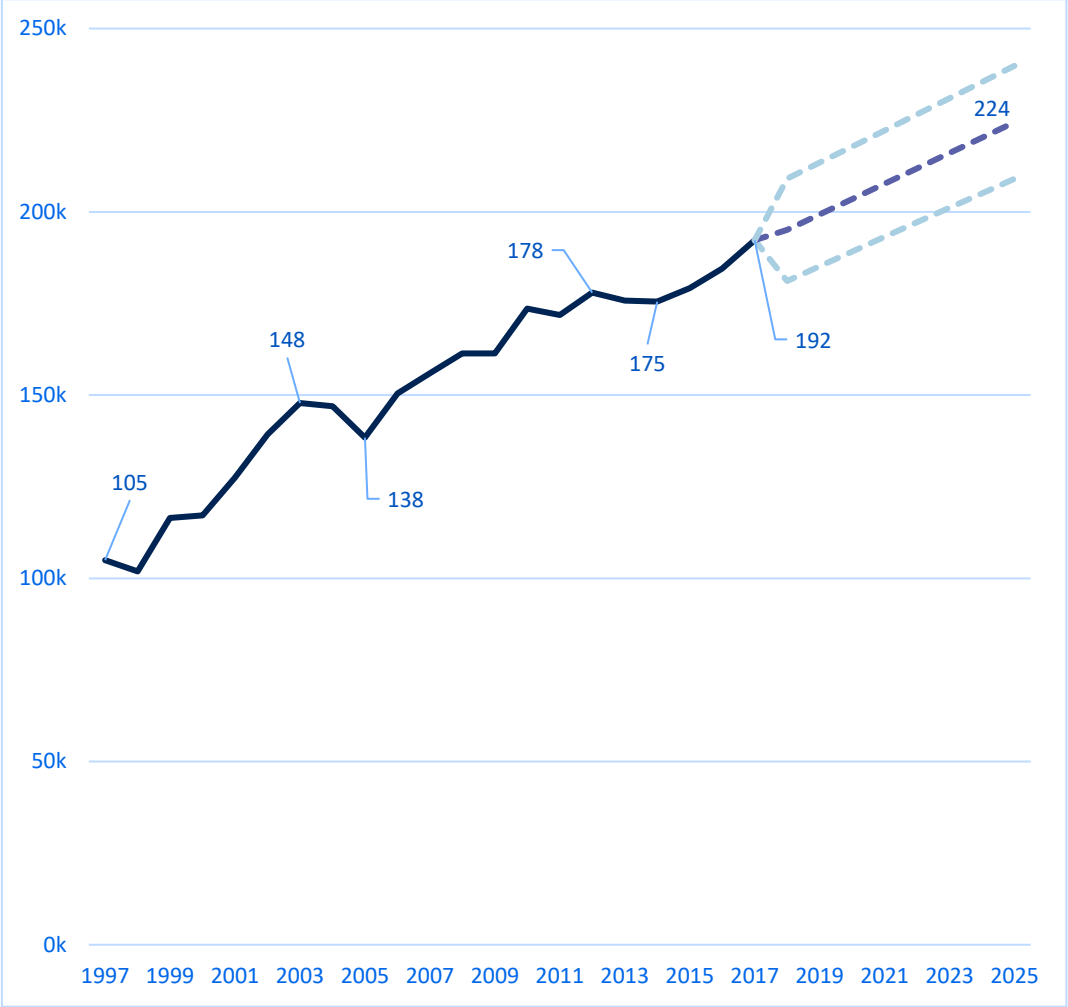


Figure 23 compares the level and growth of aluminium net pack fill to other indicators of economic activity such as GDP, population and retail sales. Over the two decades to 2017, trend growth in aluminium packaging POM (as indicated by net pack fill) has been at a stronger pace than growth in GDP[32], population[33] and retail sales[34].

[32] *Office for Budget Responsibility (OBR), October 2018 forecast of UK GDP growth 2018 to 2023, GDP growth rates in 2024 and 2025 are assumed equal to the OBR forecast of UK GDP growth in 2023.*

[33] *Office for National Statistics, UK population projections published 26 October 2017*

[34] *Retail sales growth projected 2018 to 2025 based on estimated linear statistical model.*

Figure 23 Aluminium Packaging Net Pack Fill Versus Economic Activity Indicators

	1997-2017		2014-2017		2018 - 2020		2018 - 2025	
	Level	Average Growth	Level	Average Growth	Level	Average Growth	Level	Average Growth
Net Pack Fill	81.9%	3.6%	8.8%	2.8%	4.3%	2.1%	15.0%	2.0%
GDP	49.0%	2.0%	6.0%	2.0%	3.1%	1.5%	11.2%	1.5%
Population	13.2%	0.6%	2.2%	0.7%	1.2%	0.6%	3.7%	0.5%
Retail Sales	69.0%	2.7%	10.5%	3.4%	2.0%	1.0%	11.1%	1.5%

Since 2014, the increase in aluminium packaging net pack fill has slowed and has been closer to (although still above) growth in retail sales and GDP.

Statistical models are estimated based on historic NPWD data for aluminium packaging net pack fill. The preferred statistical model is chosen based on statistical selection criteria. For the trend in aluminium packaging net pack fill, the linear model is preferred and used to project scenarios to 2025. This is shown in **Figure 22**, with upper and lower 95% confidence intervals as an indication of the range of uncertainty surrounding the projection (assuming a normal distribution). Full details of the methodology used to estimate the models can be found in Appendix 2.

The scenario projection for aluminium packaging POM, reported in **Figure 24**, is based on the projected growth rates of aluminium net pack fill from the preferred statistical model. The projection for aluminium packaging POM for 2018 to 2025 is slightly stronger than that expected for GDP growth and retail sales growth (**Figure 23**).

The Steering Group noted that future *growth* in aluminium packaging POM seemed sensible and that growth rates in the order of 1% to 2% per annum for aluminium packaging POM is a plausible expectation.

Figure 24 assumes the 2018 POM figure (the first year of the projection scenario) for aluminium packaging is the same as the 2017 POM figure of 194k tonnes developed in this project. Under this scenario, aluminium packaging POM is projected to increase from 194k tonnes in 2018 to 203k tonnes in 2020 and to 223k tonnes in 2025: an increase of 15% (just under 30k tonnes) in 2025 compared to 2018. Average annual growth in aluminium packaging POM over the projection horizon is 2%.

Figure 24 Aluminium Packaging POM, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
POM	194	198	203	207	211	215	219	223
% Change	-	2.1	2.1	2.1	2.0	2.0	1.9	1.9

5.1.2 Steel Packaging POM and Projections

This section reviews the historical data and trends for steel packaging placed on the market (POM) in the UK based on the net pack fill calculation from NPWD data. Based on these data, univariate time-series models (linear trend and autoregressive models) are estimated and a scenario for steel packaging POM based on the preferred statistical model is projected forward to 2025.

Figure 25 presents the historical data for steel packaging UK net pack fill. The past outturns for steel packaging net pack fill tonnages show a relatively continuous decline from 1997 to 2012 before a flattening out, albeit with some modest growth since 2012.

Figure 25 Steel Packaging Net Pack Fill, Projection and 95% Confidence Interval (k tonnes)

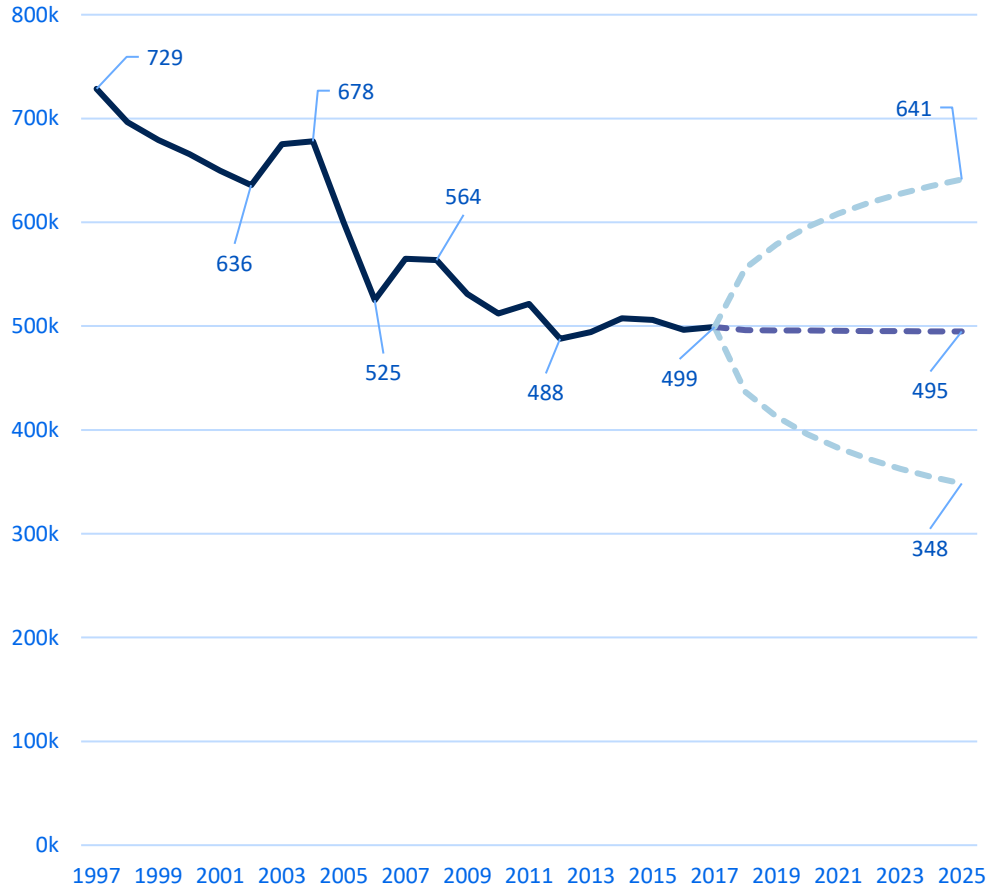


Figure 26 compares the level and growth of steel net pack fill to other indicators of economic activity such as GDP, population and retail sales. The main observation from this comparison is that steel net pack fill as an indicator of the trend in steel packaging POM has declined substantially since 1997 and has decoupled from other key economic indicators.

Figure 26 Steel Packaging Net Pack Fill Versus Economic Activity Indicators

	1997-2017		2014-2017		2018 - 2020		2018 - 2025	
	Level	Average Growth	Level	Average Growth	Level	Average Growth	Level	Average Growth
Net Pack Fill	-31.5%	-1.9%	-1.6%	-0.6%	-0.1%	-0.1%	-0.3%	0.0%
GDP	49.0%	2.0%	6.0%	2.0%	3.1%	1.5%	11.2%	1.5%
Population	13.2%	0.6%	2.2%	0.7%	1.2%	0.6%	3.7%	0.5%
Retail Sales	69.0%	2.7%	10.5%	3.4%	2.0%	1.0%	11.1%	1.5%

Using the historical net pack fill data for steel packaging statistical models, univariate time-series models (a linear trend model and two autoregressive models) are estimated and, based on the preferred AR(1) model that was selected on statistical criteria, a scenario for steel packaging net pack fill is projected to 2025. Full details of the methodology used to estimate the models can be found in Appendix 2.

Figure 27 illustrates the projection for steel packaging net pack fill and, assuming a normal distribution, also shows the 95% confidence intervals as upper and lower bounds to the projection as an indication of the range of uncertainty surrounding the projection. The scenario for steel packaging POM to 2025 reported in **Figure 24** is based on the projected growth rates of steel packaging net pack fill and was discussed with the project Steering Group.

It assumes the 2018 figure (the first year of the projection scenario) for steel packaging POM is the same as the 2017 POM figure of 551k tonnes developed in this project.

Under this scenario, steel packaging POM is projected to remain stable at around 551k tonnes to 2020 and decline slightly to 550k tonnes in 2025: a decline of 1k tonnes or 0.3% in 2025 compared to 2018.

Figure 27 Steel Packaging POM Projection, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
POM	551	551	551	551	550	550	550	550
% Change	-	-0.1%	-0.05%	-0.04%	-0.04%	-0.03%	-0.03%	-0.02%

5.2 Metal Packaging Accredited Recycling Projections

This section reviews the historical data and trends for the quantity of accredited metal packaging (aluminium and steel packaging are assessed separately) recycling reported by UK accredited reprocessors/exporters into NPWD. It therefore omits metal packaging that is recycled by non-accredited reprocessors/exporters and/or metal packaging that is recycled but not recorded as accredited recycling by accredited reprocessors/exporters. It is

recognised that unrecorded tonnages for metal packaging are substantial, hence a key issue is that accredited recycling underestimates true levels of metal packaging recycling.

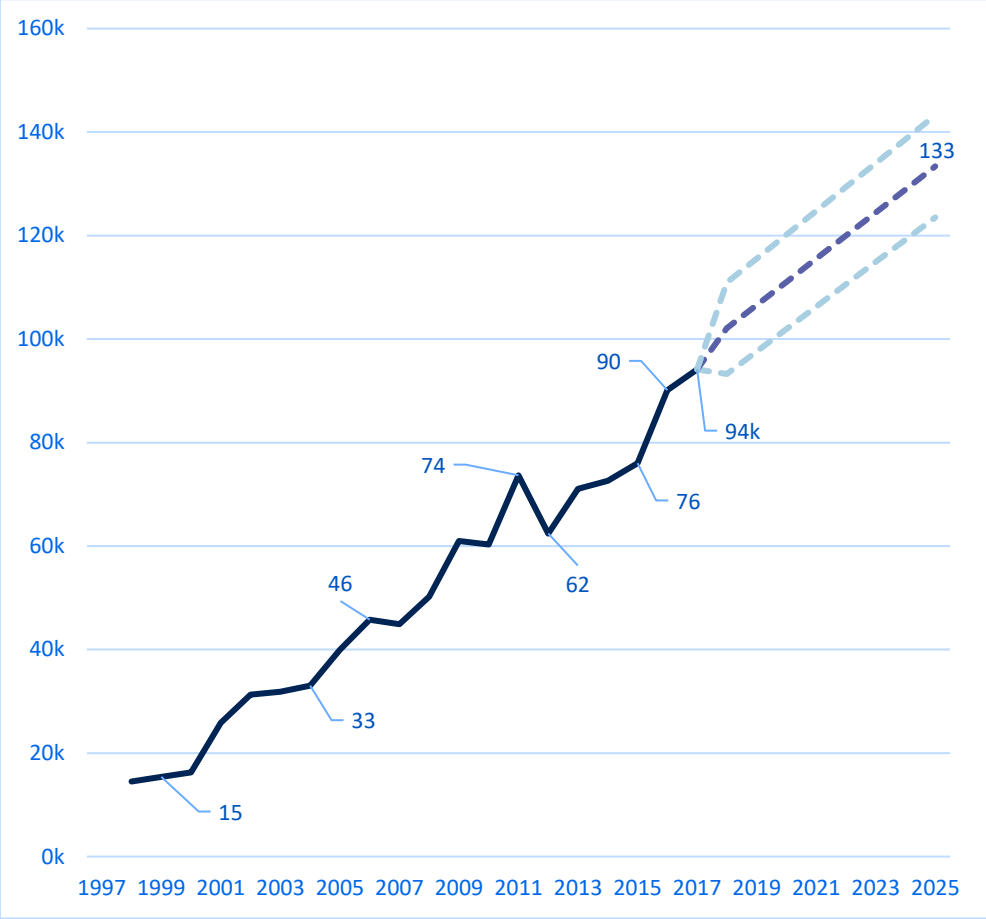
To establish scenarios for accredited metal packaging recycling to 2025 statistical models, univariate time series models (linear trend and auto-regressive models) are estimated. Based on the preferred model, selected on statistical criteria, scenarios for metal packaging accredited recycling are projected to 2025. Full details of the methodology used to estimate the models can be found in Appendix 2.

This projection methodology extends both the trend observed in historical accredited recycling and, by assumption, factors driving past performance into the future. As discussed above, whilst this approach is 'data based' and intended to be plausible, the projections are not intended to be sophisticated. In addition to any factors potentially impacting on the weight of metal packaging POM discussed above, it ignore factors such as expected developments of collection systems (such as the introduction of DRS); the timing and extent of potential future policy initiatives, such as reform of extended packaging producer responsibility; possible changes in legislation; the impact of possible targets for packaging recycling beyond 2020 and other potential external influences that might impact on recycling markets. This could include, for example, the potential for investment in UK reprocessing and collections, and potential changes to the protocols.

5.2.1 Accredited Aluminium Packaging Recycling and Projections

This section reviews the historical data and trends for the quantity of accredited aluminium packaging recycling reported by UK accredited reprocessors/exporters into NPWD. It therefore omits aluminium packaging that is recycled by non-accredited reprocessors/exporters, and aluminium packaging that is recycled but not recorded as accredited recycling by accredited reprocessors/exporters.

Figure 28 Aluminium Packaging Accredited Recycling, Projection and 95% Confidence Interval (k tonnes)



Provisional 2018 figures for accredited aluminium packaging recycling are available for 2018 Q1 to Q3 from NPWD. Accredited aluminium packaging recycling is reported as 23k tonnes for 2018Q1, 25k tonnes for 2018Q2 and 28k tonnes in 2018Q3. This means that, for January to September 2018, a total of 77k tonnes of aluminium packaging is recorded as accredited recycling, which is an increase of 8% compared to the same period in 2017. Accredited aluminium packaging recycling registered quarter on quarter growth in 2018Q1 to 2018Q3, and the 2018 full year estimate of 102k tonnes assumes accredited aluminium packaging recycling growth continued in 2018Q4.

Based on the historical accredited recycling for aluminium packaging statistical models, univariate time-series models (a linear trend model and two autoregressive models) were estimated. A scenario based on the preferred model (the linear model) is projected to 2025.

In this scenario (Scenario 1) the estimated 2018 full year figure overrides the model-based projection. The annual projections from 2019 to 2025 are based on the estimated model projections for accredited aluminium packaging recycling; the projection is shown in **Figure 28** together with 95% confidence intervals as indicative upper and lower bounds to the projection.

Figure 29 reports the scenario projected tonnages for accredited aluminium packaging recycling to 2025. In Scenario 1, aluminium packaging increases from 102k tonnes in 2018 to 111k tonnes in 2020, and to 133k tonnes in 2025, which is an increase of 31k tonnes or 31% in 2025 compared to 2018.

Figure 29 Accredited Aluminium Packaging Recycling Projection, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
Scenario 1 Recycling	102	107	111	116	120	124	129	133
% Change	8.5%	4.4%	4.2%	4.0%	3.9%	3.7%	3.6%	3.5%

In 2018, Alupro published a report[35] which included detailed modelling and scenario projections for aluminium drinks cans recycling and for all aluminium packaging recycling, including aluminium packaging recovered from IBA and RDF. In the baseline projection to 2030, the recycling rate for aluminium packaging is estimated to be 79% in 2020 and 93% in 2030, much of which is expected to come from aluminium packaging recovered from IBA. Important to note is that the scope in the Alupro research is aluminium packaging recovery/recycling from *all* activities (not just accredited aluminium packaging).

Discussions with the Steering Group suggested that a similar approach could be developed for this report based on the potential for accredited aluminium packaging recycling tonnages registered through the IBA metals protocol, and the potential for accreditation of aluminium packaging recycling via RDF exports. The protocol for accredited aluminium packaging recycling was established in 2015 and significant tonnages of aluminium packaging have been accredited via the protocol. In 2017, the IBA protocol for aluminium packaging contributed 24,390 tonnes (or 26%) to total accredited recycling of aluminium packaging.

The methodology used to develop an alternative scenario in this report is as follows. In 2017, 10.89 million tonnes of UK waste was processed by incineration, which was an increase of 7.8% on 2016: this produced 2.2 million tonnes (or 20.6%) of IBA. IBA from incineration is projected based on Tolvik's 2018 forecast[36] of developments in UK operational incineration capacity, which is expected to reach 14.8 million tonnes in 2020 and 15.7 million tonnes in 2022. It is assumed that 90% of available incineration capacity is utilised, and that there is no new incineration capacity coming on line beyond 2022.

The quantity of UK waste sent to incineration (throughput) is assumed to increase in-line with anticipated increases in operational incineration capacity, and it is assumed that 20.6% of incinerator throughput tonnage is available as IBA. The non-ferrous metals content in IBA is assumed to be 2% of IBA tonnage and the protocol applies 70% to this to determine the tonnage of accredited aluminium packaging recycling from the IBA protocol. In 2017, 78% of available aluminium packaging in IBA was accredited via the protocol; in the projection it is supposed that this is 95% in 2019 and 100% from 2020 onwards.

RDF exports are expected to reduce as operational incineration capacity increases (but with each tonne of incineration capacity diverting 0.5 tonnes from RDF exports and 0.5 tonnes from landfill). The scenario model assumes 0.6% of RDF is aluminium packaging, and that the potential for accreditation of this tonnage is 10% of the aluminium packaging in RDF in 2019, increasing 5% points a year to 40% in 2025. Note that the IBA metals protocol for aluminium is an established and agreed mechanism. The accreditation of aluminium packaging recycling from RDF is currently much less certain, but feedback from the Steering Group indicated that one business was close to establishing an agreed mechanism with the EA.

[35] *Achieving an 85% recycling rate within 2 years – Alupro https://alupro.org.uk/achieving-an-85-recycling-rate-within-two-years/*

[36] *UK Energy from Waste Statistics – 2017, published June 2018, Tolvik Consulting*

The projection for non-IBA non-RDF accredited aluminium packaging recycling is based on a statistical model (a linear model being the preferred model based on statistical selection criteria). Further details of how this model was estimated can be found in Appendix 2.

Whilst the methodology and assumptions in the alternative scenario developed here are not identical to the Alupro study, they are similar. In particular, the approach to modelling aluminium packaging recovery from IBA, the growth in incineration capacity, and RDF exports and the potential for accreditation of aluminium packaging recycling from RDF are consistent. In the Alupro study the projected growth in residual waste treatment capacity includes EfW and other advanced thermal treatment technologies, such as gasification, and it is assumed that all plants with planning consent or in construction come online as planned in the projection. The scenario in this report adopts Tolvik's 2018 forecast for incineration capacity (with or without EfW).

Comparing the Alupro projection of incineration (with or without EfW) to the Tolvik projection shows stronger growth pre-2020 and weaker growth beyond 2020. But average annual growth rates for incineration capacity between 2018 and 2025 are similar (4.7% in the Alupro study and 4.1% in the Tolvik projection used in this alternative scenario). As a sense check, using the Alupro study's growth rates in incineration capacity in the scenario developed here gives an average of 40k tonnes per year (2018 to 2025) of aluminium packaging from IBA compared to 39.7k tonnes per year based on the Tolvik projection.

The alternative scenario here includes aluminium packaging recycled overseas via export of RDF which, for example, could yield a further 3k to 4k tonnes of aluminium packaging recycling per year to 2020.

Figure 30 reports the scenario based on the IBA protocol. The increase in aluminium from IBA via the protocol reflects growth in incinerator throughput tonnages, growth in the use of the IBA protocol by existing facilities, new accreditation (the Steering Group noted that a new accreditation was expected to accredit substantial tonnage of aluminium packaging via the RDF accreditation route from 2019 onwards) and growth in accredited aluminium packaging recycling from other routes.

Figure 30 Scenario for Accredited Aluminium Packaging Recycling from IBA and RDF, 2018 to 2025 (k tonnes, %)

	2017	2018	2019	2020	2021	2022	2023	2024	2025
UK waste to incineration	10,890	11,646	12,455	13,320	13,719	14,130	14,553	14,989	15,438
IBA recovery	2,243	2,399	2,566	2,744	2,826	2,911	2,998	3,088	3,180
IBA metal (k tones)	189	202	216	231	238	245	253	260	268
IBA metal % of IBA	8.4%	8.4%	8.4%	8.4%	8.4%	8.4%	8.4%	8.4%	8.4%
IBA metal % of waste incinerated	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
Non-ferrous metals in IBA (k tonnes)									
Non-ferrous metals in IBA	45	48	51	55	57	58	60	62	64
Aluminium packaging in IBA	31	34	36	38	40	41	42	43	45
Accredited aluminium packaging recycling									
IBA protocol	24	28	34	38	40	41	42	43	45
Recycling (excl IBA)	70	84	86	90	95	100	104	108	112
Recycling (inc IBA)	94	112	120	129	134	140	146	151	157
Recycling (inc IBA and RDF export)		112	122	131	138	144	150	155	161
Accredited aluminium packaging recycling from RDF exports									
UK RDF exported		3,564	3,362	2,944	2,628	2,425	2,216	2,002	1,780
Aluminium in RDF exports		21.4	20.2	17.7	15.8	14.6	13.3	12.0	10.7
Aluminium recycling from RDF export		0.0	2.0	2.6	3.2	3.6	4.0	4.2	4.3

In 2018, the scenario projection is 28k tonnes of aluminium packaging accredited recycling through the IBA protocol, increasing to 34k tonnes in 2019 and 38k tonnes in 2020. In 2025, the projection is for 45k tonnes of aluminium packaging accredited recycling through the IBA protocol. The scenario assumes, accredited aluminium recycling from RDF exports at 2k tonnes in 2019, 2.6k tonnes in 2020 and 4.3k tonnes in 2025. Total accredited aluminium packaging recycling is projected at 112k tonnes in 2018, increasing to 131k tonnes in 2020 and 161k tonnes in 2025: an increase of 49k tonnes or 44% in 2025 compared to accredited aluminium packaging recycling in 2018.

This alternative scenario (Scenario 2) for aluminium packaging accredited recycling tonnages is used in the compliance assessment in Section 5.3.1.

5.2.2 Steel Packaging Accredited Recycling and Projections

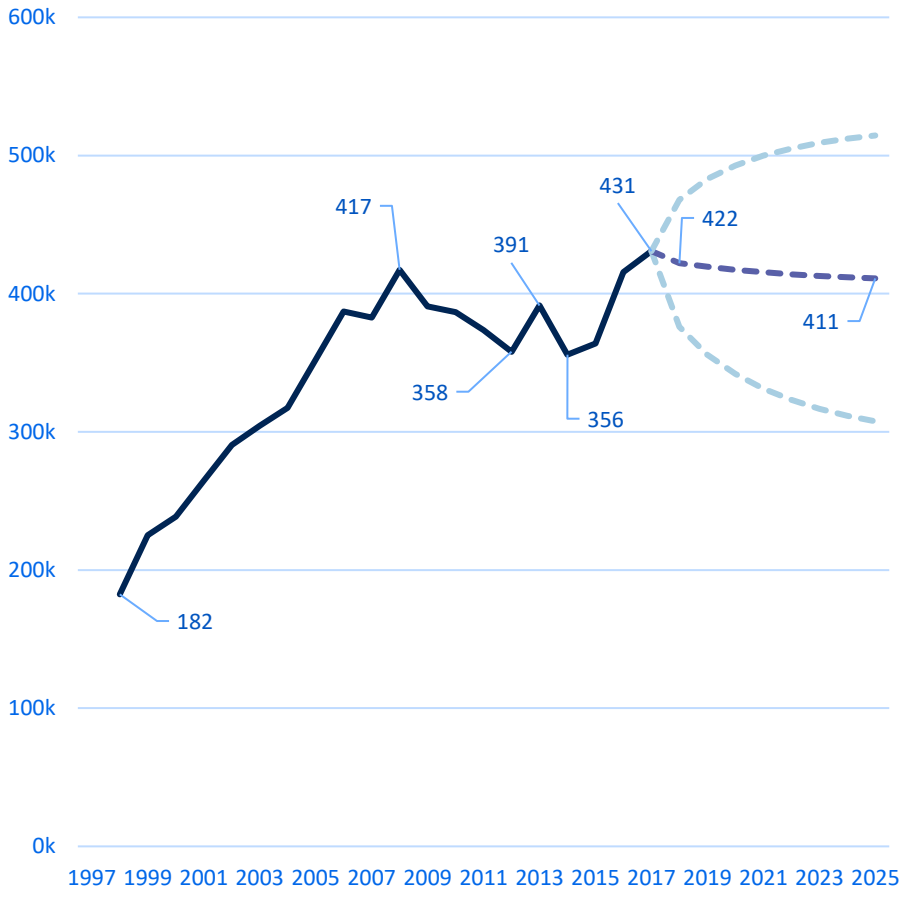
This section reviews the historical data and trends for the quantity of accredited steel packaging recycling reported by UK accredited reprocessors/exporters into NPWD. It therefore omits steel packaging that is recycled by non-accredited reprocessors/exporters

and steel packaging that is recycled but not recorded as accredited recycling by accredited reprocessors/exporters.

To establish a scenario for accredited steel packaging recycling to 2025, statistical models are estimated. The preferred model selected on statistical criteria is the AR(1) model. Based on this model, a scenario for steel packaging accredited recycling is projected to 2025 and is shown in **Figure 31**, together with 95% confidence intervals (assuming a normal distribution) as indicative upper and lower bounds to the projection. Full details of the methodology used to estimate the models can be found in Appendix 2.

This projection extends the trend observed in historical accredited recycling into the future. By assumption, factors driving past performance are projected into the future. As discussed above, while 'data based' and intended to be plausible, the projection is not intended to be sophisticated.[37]

Figure 31 Accredited Steel Packaging Recycling, Projection and 95% Confidence Interval (k tonnes)



Provisional 2018 figures for accredited steel packaging recycling are available for 2018 Q1 to Q3 from NPWD. Steel packaging recycling is reported as 101k tonnes for 2018Q1, 109k tonnes for 2018Q2 and 106k tonnes in 2018Q3. This means that for January to September 2018, a total of 317k tonnes of steel packaging was recorded as accredited recycling: a decrease of 2.1% compared to the same period in 2017.

[37] *See section 5.2 for further explanation.*

The 2018 full year estimate of 422k tonnes assumes 2018Q4 accredited steel packaging recycling to be the average of 2018Q1 to 2018Q3. The 2018 full year figure estimate represents a decline of 2% in accredited steel packaging recycling compared to the 2017 full year figure.

In the scenario projection, the 2018 full year figure over-rides the model-based projection, but the annual projections from 2019 to 2025 are based on the estimated model projections for accredited steel packaging recycling, which are shown in **Figure 32.**

Figure 32 reports the scenario projected tonnages for accredited steel packaging recycling to 2025. In this scenario, steel packaging decreases from 422k tonnes in 2018 to 417k tonnes in 2020, and to 411k tonnes in 2025, which is a decrease of 11k tonnes or 2.6% in 2025 compared to 2018. This scenario for steel packaging accredited recycling is used in the compliance assessment in section 14.2.

Figure 32 Steel Packaging Accredited Recycling Projection, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
Recycling	422	419	417	416	414	413	412	411
% Change	-2.0%	-0.6%	-0.51%	-0.42%	-0.35%	-0.29%	-0.24%	-0.20%

5.3 Metal Packaging Compliance Assessment

This section reports a compliance assessment based on the scenarios to 2025 for aluminium and steel packaging POM and accredited aluminium and steel packaging recycling reported in Sections 5.1 to 5.2.

For this compliance assessment, the material specific targets on obligated businesses for metal packaging (aluminium and steel are assessed separately) are expressed as equivalents to national (or all material) recycling targets. The CEP targets are 70% for steel and 50% for aluminium in 2025 (the CEP target is assumed to apply to all metal packaging POM). It is estimated that aluminium and steel are already meeting the CEP targets. Therefore, for aluminium, a national target of 70% is assumed in 2025; for steel a 77% target is assumed. There are no business targets set beyond 2020 for aluminium and steel packaging recycling. Here, the targets shown for aluminium in 2021 to 2024 are a linear extrapolation from the 2020 national target to the assumed 2025 target; for steel the targets are set at the 2020 national target in 2021 to 2025.

Based on these targets and the projection scenarios for aluminium and steel packaging POM, the tonnages of recycling required by obligated businesses each year to meet the targets are calculated and compared to the projection scenario tonnages for accredited steel and aluminium packaging recycling.

To assess the likelihood of meeting the targets, the probability of meeting the targets in each year is also calculated[38]. The probability of meeting the target in each year is calculated assuming that in each year the probability distribution around the scenario projection for recycling is normally distributed and centred on the projected figure with a standard deviation estimated by the standard error of the estimated model in each year.

[38] *For steel packaging only, the aluminium packaging recycling scenario is not based on a statistical model projection so the uncertainty surrounding the projection is not known.*

As noted above, there are no targets beyond 2020 other than the CEP target for 2025. This compliance assessment is therefore only meaningful versus the published 2018 to 2020 targets and the assumptions made for CEP targets in 2025.

5.3.1 Aluminium Packaging Compliance Assessment

Figure 33 reports a compliance assessment based on the projected scenario to 2025 for aluminium packaging POM and accredited aluminium packaging recycling under scenario 2 in Section 5.2.1, which is based on accredited tonnages from the IBA protocol and accreditation for aluminium packaging recycling tonnages by other routes.

Assuming the 2018 POM figure of 194k tonnes developed in this project is applicable and that the projections for aluminium packaging POM and accredited aluminium packaging recycling are plausible, then, based on this assessment, the UK is expected to meet[39] the aluminium packaging recycling targets in 2018, 2019 and 2020.

There are no national targets set beyond 2020 and it is estimated that aluminium packaging is already meeting the proposed CEP target of 50% in 2025 for aluminium packaging recycling. A 2025 target of 70% for aluminium packaging recycling is assumed for this scenario.

Figure 33 Accredited Aluminium Packaging Compliance Assessment, 2018 to 2025 (k tonnes, %)

Year	POM* (k tonnes)	National Target (%)	Required Recycling (k tonnes)	Projected Accredited Recycling** (k tonnes)
2018	194	57	112	112
2019	198	60	120	122
2020	203	63	128	131
2021	207	65	134	138
2022	211	66	139	144
2023	215	68	145	150
2024	219	69	151	155
2025	223	70	157	161

*linear model projection as reported in section 5.1.1, ** based on Scenario 2 as reported in section 5.2.15.

Based on these projections, in each year of the projected scenarios, accredited recycling meets or exceeds the expected amount of accredited aluminium recycling required to meet the national target and the implied recycling rates for aluminium packaging are above the targets.

5.3.2 Steel Packaging Compliance Assessment

Figure 34 reports a compliance assessment based on the projected scenario to 2025 for steel packaging POM reported in Section 5.1.2 and accredited steel packaging recycling reported in Section 5.2.2.

[39] *the scenario for aluminium packaging recycling is not based on a statistical model projection, so the uncertainty surrounding the scenario projection is not known and the probabilities of meeting the targets cannot be calculated.*

Assuming the 2018 POM figure of 551k tonnes developed in this project is applicable and that the projections for steel packaging POM and accredited steel packaging recycling are plausible, then, based on this assessment, the UK is likely to meet the steel packaging recycling targets in 2018 and 2019. In 2020, based on the scenarios for this assessment, there is greater likelihood that steel packaging will fall short of the 2020 target (the estimated probability of meeting the target is 42%).

There are no targets set beyond 2020 and it is estimated that steel packaging is already meeting the proposed CEP target of 70% for steel packaging recycling. In **Figure 34**, a target of 77% is assumed for 2025 and it is estimated, based on this scenario, that steel packaging recycling is likely to fall below this target (the estimated probability of meeting this assumed target is 40%).

Figure 34 Accredited Steel Packaging Compliance Assessment, 2018 to 2025 (k tonnes, %)

Year	POM* (k tonnes)	National Target (%)	Required Recycling (k tonnes)	Projected Accredited Recycling** (k tonnes)	Probability of Meeting the Target (%)
2018	551	72	396	422	87
2019	551	74	411	419	61
2020	551	77	425	417	42
2021	551	77	425	416	41
2022	550	77	425	414	41
2023	550	77	425	413	40
2024	550	77	425	412	40
2025	550	77	425	411	40

*AR(1) model projection as reported in section 5.1.2, ** AR(1) model projection as reported in section 5.2.2

5.3.3 Conclusion Metal Packaging Projections and Compliance

The key conclusions from the metal packaging flow, recycling projections, recycling and compliance assessment are:

- Assuming a 2018 POM[40] figure of 194k tonnes for aluminium packaging, aluminium packaging POM is projected to increase from 194k tonnes in 2018 to 203k tonnes in 2020 and to 223k tonnes in 2025: an increase of 15% (just under 30k tonnes) in 2025 compared to 2018.

- Accredited aluminium packaging recycling is projected at 112k tonnes in 2018, increasing to 131k tonnes in 2020 and 161k tonnes in 2025: an increase of 49k tonnes or 44% in 2025 compared to 2018.

- Accredited aluminium packaging recycling is expected to meet national equivalents of the business targets in 2018, 2019 and 2020. There are no targets set beyond 2020; the scenario assumption is a 70% target in 2025 for accredited aluminium packaging recycling, which is also expected to be met.

- Assuming a steel packaging POM figure of 551k tonnes in 2018, steel packaging POM is projected to remain stable at around 551k tonnes to 2020 and decline slightly to 550k tonnes in 2025: a decline of 1k tonnes or 0.3% in 2025 compared to 2018.

- Accredited steel packaging recycling is projected to decrease from 422k tonnes in 2018 to 417k tonnes in 2020 and to 411k tonnes in 2025: a decrease of 11k tonnes or 2.6% in 2025 compared to 2018.

- Accredited steel packaging recycling is likely to meet the national equivalents of the business targets for steel packaging recycling in 2018 and 2019. In 2020, there is greater likelihood that accredited steel packaging recycling will fall short of the 2020

[40] *Compliance year 2018 is data reported in 2018 by obligated companies, this relates to packaging POM in 2017.*

national equivalent of the business target (the estimated probability of meeting this target is 42%).

- There are no targets for steel packaging set beyond 2020 and it is estimated that steel packaging is already meeting the proposed CEP target of 70% for steel packaging recycling. The assessment in this report assumes a target of 77% for 2025 and it is estimated that steel packaging recycling is likely to fall below this target in 2025 (the estimated probability of meeting this assumed target is 40%).

6.0 MetalFlow Conclusions

6.1 Conclusions: MetalFlow POM

The project estimate for aluminium packaging POM in 2017 is 194k tonnes (+/- 12%)
This was derived from reported obligated data (EA, NPWD) and cross-checked as much as possible using a bottom-up methodology. This took data from various sources for each sector and combined the results. Data provided by the project's Steering Group was also incorporated.

The final project estimate for aluminium packaging POM in the consumer sector is 127k tonnes (+/-6%)
This method was based on primary data alongside reliable market share data. No other method was used for deriving consumer data as this method is considered the most robust available and is accepted by industry.

The final project estimate for aluminium packaging POM in the non-consumer sector is 67k tonnes (+/-10%)
This estimate partly comprises an estimate of hospitality packaging, based on primary and market share data. In addition, separate quantities of direct sales of soft and alcoholic drinks were calculated based on industry figures. C&I packaging comprises the remaining part of non-consumer POM and is the residual tonnage once consumer and hospitality POM are deducted from total POM. There were no figures available to cross-check this data, which may include any missed tonnages of grocery, non-grocery and/or hospitality POM.

The project estimate for steel packaging POM in 2017 is 551k tonnes (+/- 12%)
This was derived from reported obligated data (EA, NPWD) and cross-checked as much as possible using a bottom-up methodology. This took data from various sources for each sector and combined the results. Data provided by the project's Steering Group was also incorporated.

The final project estimate for steel packaging POM in the consumer sector is 292k tonnes (+/-6%)
This method was based on primary data alongside reliable market share data. No other method was used for deriving consumer data as this method is considered the most robust available and is accepted by industry.

The final project estimate for steel packaging POM in the non-consumer sector is 260k tonnes (+/-10%)
This estimate partly comprises an estimate of hospitality packaging, based on primary and market share data. In addition, separate quantities of direct sales of soft and alcoholic drinks were calculated based on industry figures. C&I packaging comprises the remaining part of non-consumer POM and is the residual tonnage once consumer and hospitality POM are deducted from total POM. This residual figure was cross-checked using a bottom-up approach, whereby estimates were made of industrial packaging types using secondary research and industry/Steering Group knowledge. This estimate came within 8% of the residual tonnage (with known missing elements).

6.2 Conclusions: MetalFlow Recycling & End Markets

UK aluminium packaging recycled (recorded & unrecorded) is estimated to be 127k tonnes.
This includes recorded recycling (94k tonnes, NPWD) and an estimate for unrecorded recycling (33k tonnes). Based on the POM calculated in this project, an overall recycling rate of 65% was achieved. The recorded recycling rate of aluminium packaging (NPWD) is 48%.

Consumer UK aluminium packaging recycled (recorded & unrecorded) is estimated to be 95k tonnes.
Based on the POM calculated as part of this project, this gives a consumer recycling rate of 75%.

Non-consumer UK aluminium packaging recycled (recorded & unrecorded) is estimated to be 33k tonnes.
This is calculated by subtracting the consumer recycling tonnage from the total recycled. Based on the POM calculated as part of this project, this gives a non-consumer recycling rate of 48%.

67k tonnes of aluminium packaging is not recycled; 13k tonnes (19%) is estimated to be lost to energy recovery and 54k tonnes to landfill (81%)
This was based on an estimated total of 32k tonnes consumer aluminium not being recycled and 35k tonnes non-consumer.

UK steel packaging recycled (recorded & unrecorded) is estimated to be 541k tonnes.
This includes recorded recycling (431k tonnes, NPWD) and an estimate for unrecorded recycling (110k tonnes). Based on the POM calculated in this project, an overall recycling rate of 98% was achieved. The recorded recycling rate of steel packaging (NPWD) is 78%.

Consumer UK steel packaging recycled is estimated to be 332k tonnes.
Based on the POM calculated as part of this project, this gives a consumer recycling rate of over 100% (114%). Inclusion of non-consumer steel packaging recycling recorded on WDF or included in MSW delivered to EfW plants is likely to be a factor in overstating the consumer recycling level.

Non-consumer UK steel packaging recycled is estimated to be 209k tonnes.
This is calculated by subtracting consumer recycling from the total recycled. Based on the POM calculated in this project, a non-consumer recycling rate of 80% is achieved.

All steel packaging is assumed to be recovered from IBA, either in the UK or overseas via exports of RDF. The remaining 11k tonnes of unrecycled steel packaging is believed to be landfilled.

6.3 Conclusions: MetalFlow Projections & Compliance

The scenario projection for aluminium POM projects an increase from 194k tonnes in 2018[41] to 203k tonnes in 2020, and to 223k tonnes in 2025
This represents an increase of just under 30k tonnes or 15% in 2025 compared to 2018.

The scenario projection for aluminium packaging recycling projects an increase from 112k tonnes in 2018 to 131k tonnes in 2020 and to 161k tonnes in 2025
This represents an increase of 49k tonnes or 42% in 2025 compared to 2018.

Accredited aluminium packaging recycling is expected to meet national equivalents of the business targets in 2018, 2019 and 2020 and the CEP target in 2025
With projected accredited recycling exceeding the required recycling to meet the targets and the implied recycling rates being above the targets in each year.

There are no business targets or national equivalent targets for aluminium packaging set beyond 2020; the scenario assumption is a 70% target in 2025 for accredited aluminium packaging recycling, which is also expected to be met.

The scenario projection for steel packaging POM is projected to remain stable at 551k tonnes to 2020 and then to decline slightly to 550k tonnes in 2025
This represents a decline of 1k tonnes or 0.3% in 2025 compared to 2018.

The scenario projection for steel packaging recycling projects a decrease from 422k tonnes in 2018 to 417k tonnes in 2020 and to 411k tonnes in 2025
This represents a decrease of 11k tonnes or 2.6% in 2025 compared to 2018.

Accredited steel packaging recycling is expected to meet national equivalents of the business targets in 2018 and 2019, but to fall short in 2020
The estimated probability of meeting this target is 42%.

There are no targets for steel packaging set beyond 2020 and it is estimated that steel packaging is already meeting the proposed CEP recycling target of 70%
The assessment in this report assumes a target of 77% for 2025 and it is estimated that steel packaging recycling is likely to fall below this target in 2025 (the estimated probability of meeting this assumed target is 40%).

[41] *Compliance year 2018 is data reported in 2018 by obligated companies, this relates to packaging POM in 2017.*

7.0 Recommendations for Further Work

POM: The largest area of uncertainty around metal packaging POM remains to be the quantities of 'other C&I' packaging in the non-consumer stream (i.e C&I packaging, excluding hospitality packaging). This project progressed the quantification of other C&I packaging for steel, but was unable to find much data or evidence of this type of packaging for aluminium. It therefore remains an area in need of further research.

Recycling & compliance: It is apparent for both metals that there are considerable levels of unaccredited (unrecorded) recycling, which, if able to be accredited, would boost recycling rates and achievement of recycling targets in the UK. Further work is required to promote the benefits and need for industry to obtain accreditation and to support the EA in assessing and providing accreditation.

Appendix 1 - 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 level from stakeholders. Questions were asked relating to the evidence and agreement levels of the data used (see the tables later in this section for details) and then the data were scored on each axis. The results are shown in **Figure 35** (Aluminium POM), **Figure 36** (Steel POM) and **Figure 37** (Metal Recycling) and a summary in **Figure 38**, which has been constructed based on analysis completed for each project estimate.

The tables thereafter provide a full breakdown for each project estimate. If the question is answered 'Yes' then a score of 3 is given, if 'No' then a score of 0. A score of 1 or 2 is given when there are reservations.

Figure 35 Data Robustness Assessment Results – Aluminium POM

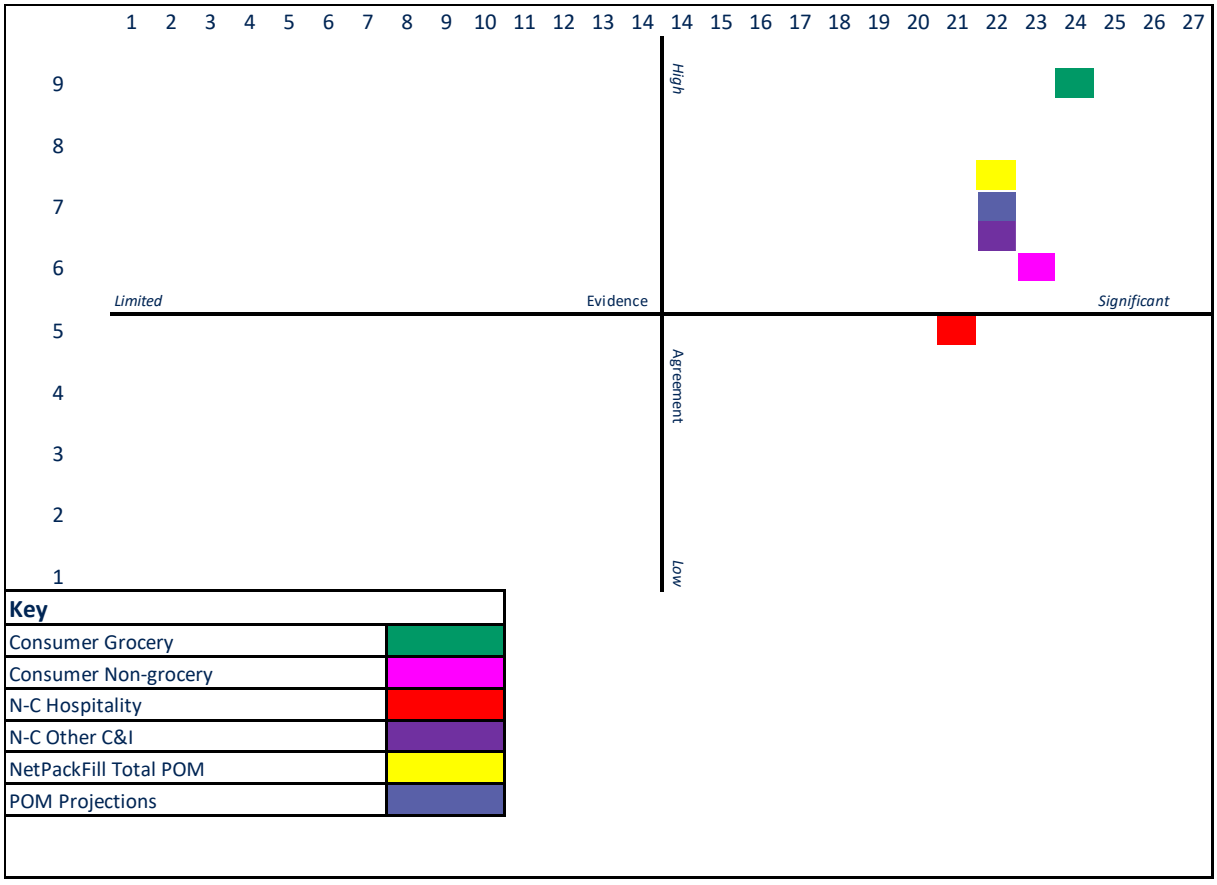


Figure 36 Data Robustness Assessment Results – Steel POM

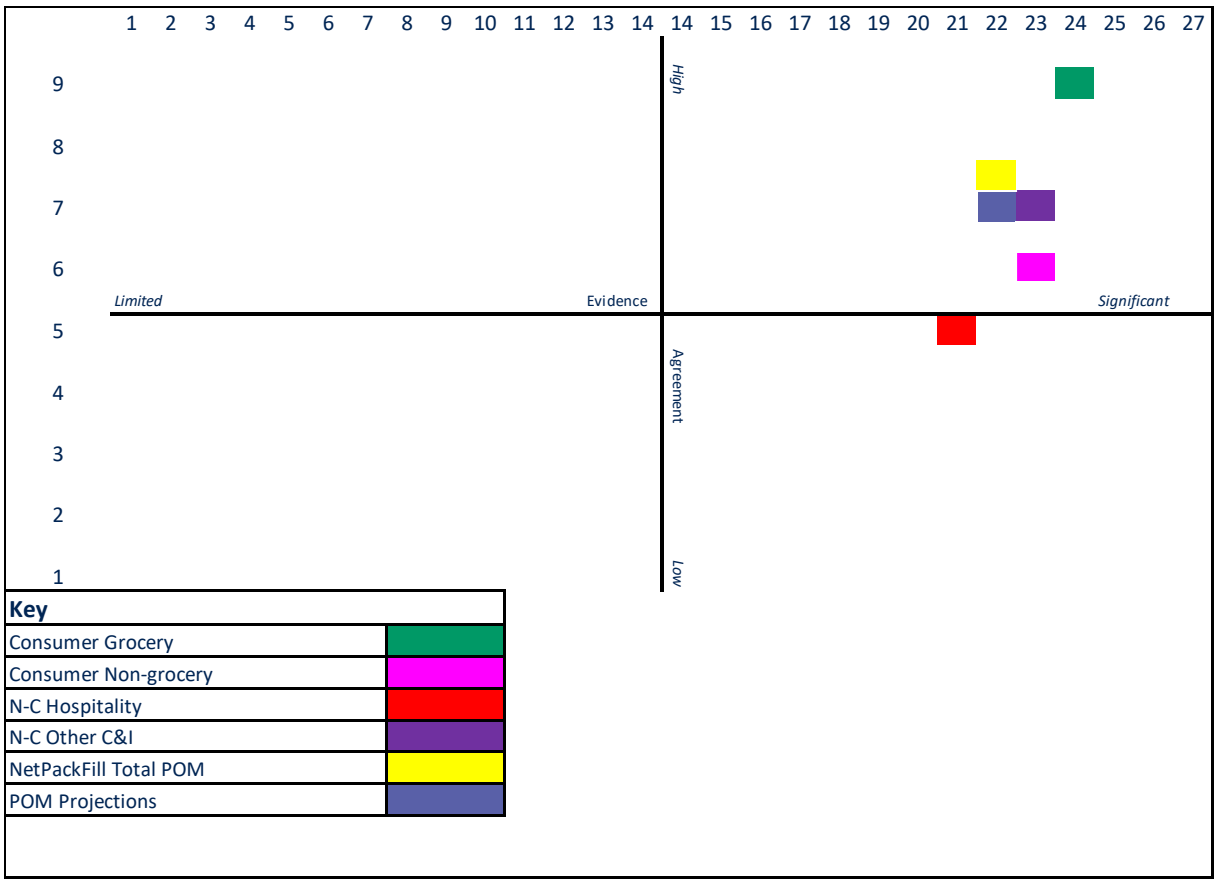
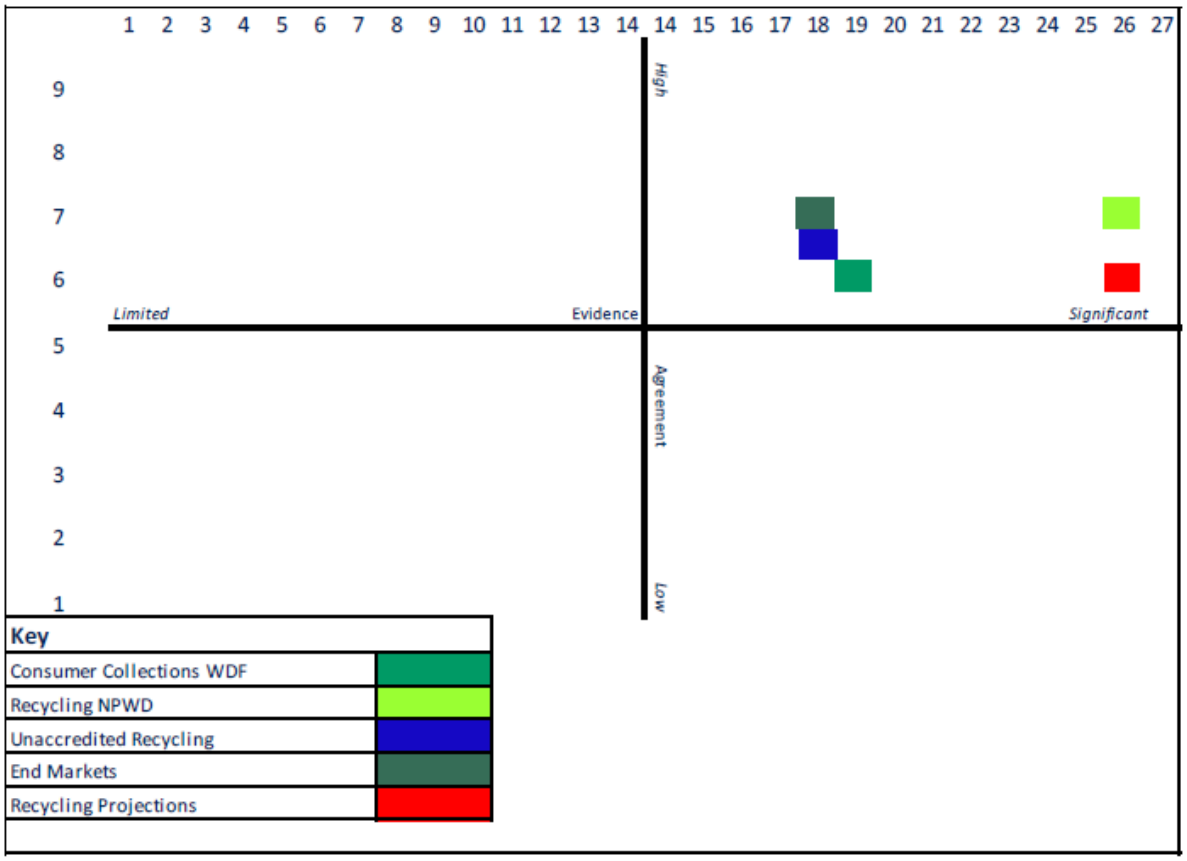


Figure 37 Data Robustness Assessment Results – Metal Recycling



To convert scores to a percentage that could be used to relate to an appropriate error margin[42], the evidence and agreement levels scores were added and the percentage of the total possible score taken.

[42] These are assumed estimates of error margin and not the outputs of statistical calculation

Figure 38 Data Robustness Assessment Results – Summary

		Robustness Scores		Error Margin
	Data & Source	Evidence (Robustness and completeness, max 27):	Degree of agreement around the findings (max 9):	+/-
1	Environment Agency Grocery Retailer Packaging Handled	24	9	6%
2	Valpak Grocery EPIC Data	24	7	9%
3	Mintel Beauty & Personal Care Value Sales by Sales Channel	23	6	9%
4	IGD Grocery Sales Channels	23	6	12%
5	Valpak DIY Compliance submissions 2018 (2017 data)	21	6	18%
6	Insight? Article Mkt share	21	4	21%
7	Euromoniter/Mintel Dog Food Value Sales by Sales Channel	24	6	12%
9	Valpak Hospitality EPIC Data	22	6	15%
10	IGD Hospitality Sales Channels	23	6	12%
11	British Soft Drinks Association	20	4	21%
12	British Beer & Pub Association	19	3	24%
13	NPWD Producer Data 2017	26	6	9%
14	Project Team & Advisory Group Non-obligated estimate Aluminium & Steel	18	8	18%
16	British Aerosol Manufacturers Association (BAMA)	14	3	33%
17	Drum POM: Tata Steel, HMRC & NPWD	21	4	27%
18	HMRC TradeInfo	23	5	15%
19	Baling Wire News article	16	3	30%
20	British Compressed Gas Association (BCGA)	18	4	24%
21	Industrial Packaging Association	18	4	24%
22	House of Commons Library Briefing Paper	14	2	36%
24	NPWD Recycling Data 2017	26	6	9%
25	Verde Research and Consulting Ltd Survey of Recyclers and Exporters 2019	18	7	21%
26	WDF 2016/17	19	6	21%

Data		
Environment Agency Grocery Retailer Packaging Handled		
Source		
Environment Agency Data		
Data Used In:		

Evidence (Robustness and completeness, max 27):	**Scoring (Max 27)**	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	Yes with some reservations	2
Is the methodology/calculation reasonably free from concerns?	Yes with some reservations	2
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**24**

Degree of agreement around the findings (max 9):	**Scoring (Max 09)**	
Does more than one data source confirm the findings (within +/- 5%)?	Yes	3
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**9**

Data		
Estimated Distribution of Spending on Beauty & Personal Care Products 2017		
Source		
Mintel		
Data Used In:		
Non-grocery Estimate		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	More yes than no, but equivocal	1
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**23**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	More yes than no, but equivocal	1
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**6**

Data		
The UK DIY & Gardening Market 2017-2022		
Source		
PR Newswire		
Data Used In:		
Non-grocery Estimate		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	More yes than no, but equivocal	1
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	Yes with some reservations	2
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes with some reservations	2
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**21**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	More yes than no, but equivocal	1
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	More yes than no, but equivocal	1
Total		**4**

Data		
UK Food & Grocery Value 2017		
Source		
IGD		
Data Used In:		
Non-grocery Estimate		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes with some reservations	2
Total		**23**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	More yes than no, but equivocal	1
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**6**

Data		
Valpak DIY Annual Compliance Data Submissions 2017		
Source		
Valpak		
Data Used In:		
Non-grocery		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes with some reservations	2
Have the findings been independently peer-reviewed?	No	0
Is the methodology/calculation reasonably free from concerns?	Yes with some reservations	2
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**21**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**6**

Data		
Valpak EPIC Grocery Data		
Source		
Valpak		
Data Used In:		
Grocery & Non-grocery		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes	3
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes with some reservations	2
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**24**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	More yes than no, but equivocal	1
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**7**

Data		
Estimated Distribution of Spending on Petcare		
Source		
Mintel/Euromonitor (undefined in credit)		
Data Used In:		
Non-grocery Estimate		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**24**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	More yes than no, but equivocal	1
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**6**

Data		
IGD Foodservice, Catering & Hospitality Sector Routes to Market		
Source		
IGD		
Data Used In:		
Non-grocery Estimate		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes with some reservations	2
Total		**23**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**6**

Data		
UK Soft Drinks Report 2017		
Source		
British Soft Drinks Association		
Data Used In:		
Non-grocery		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes with some reservations	2
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	More yes than no, but equivocal	1
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes with some reservations	2
Total		**20**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	More yes than no, but equivocal	1
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	No	0
Total		**4**

Data		
Total Volume by Package		
Source		
British Beer & Pub Association		
Data Used In:		
Non-grocery		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes with some reservations	2
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	Yes with some reservations	2
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0
Total		**19**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	No	0
Total		**3**

Data		
Valpak Hospitality EPIC Data		
Source		
Valpak		
Data Used In:		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	No	0
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes with some reservations	2
Total		**22**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**6**

Data		
Estimating Household/C&I split of Aerosols		
Source		
British Aerosol Manufacturers Association		
Data Used In:		
Non-grocery		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	More yes than no, but equivocal	1
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes with some reservations	2
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes with some reservations	2
Have the findings been independently peer-reviewed?	No	
Is the methodology/calculation reasonably free from concerns?	Yes with some reservations	2
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes with some reservations	2
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0
Total		**14**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	More yes than no, but equivocal	1
Total		**3**

Data		
TradeInfo Import/Arrivals Data 2017		
Source		
HMRC		
Data Used In:		
Other C&I		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	Yes	3
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes with some reservations	2
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	More yes than no, but equivocal	1
Total		**23**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	More yes than no, but equivocal	1
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes with some reservations	2
Total		**5**

Data		
NPWD Producer Data 2017		
Source		
NPWD		
Data Used In:		
Method 2 - POM		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	Yes	3
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**26**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**6**

Data		
Non-obligated estimate Aluminium		
Source		
Project Team & Advisory Group		
Data Used In:		
NPF POM		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	More yes than no, but equivocal	1
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	More yes than no, but equivocal	1
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	More yes than no, but equivocal	1
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**18**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	Yes	3
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**8**

Data		
BARNSLEY BALING WIRE MANUFACTURER EXPANDS WITH BOOMING WASTE PROCESSING INDUSTRY		
Source		
CAPITAL B Media / D R Baling supplies		
Data Used In:		
Other C&I		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	More yes than no, but equivocal	1
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes with some reservations	2
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	More yes than no, but equivocal	1
Have the findings been independently peer-reviewed?	No	0
Is the methodology/calculation reasonably free from concerns?	Yes with some reservations	2
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes with some reservations	2
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**16**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	More yes than no, but equivocal	1
Total		**3**

Data		
UK POM estimate of Steel Gas Cylinders		
Source		
British Compressed Gas Association		
Data Used In:		
Other C&I		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes with some reservations	2
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes with some reservations	2
Have the findings been independently peer-reviewed?	No	0
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0
Total		**18**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes with some reservations	2
Total		**4**

Data		
UK POM estimate of Steel IBCs		
Source		
Industrial Packaging Association		
Data Used In:		
Other C&I		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes with some reservations	2
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes with some reservations	2
Have the findings been independently peer-reviewed?	No	0
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0
Total		**18**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes with some reservations	2
Total		**4**

Data		
UK Share of European Steel Production		
Source		
House of Commons Library Briefing Paper		
Data Used In:		
Other C&I		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes with some reservations	2
Does the data provide complete coverage?	More yes than no, but equivocal	1
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	No	0
Is the methodology/calculation reasonably free from concerns?	More yes than no, but equivocal	1
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	More yes than no, but equivocal	1
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0
Total		**14**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	More yes than no, but equivocal	1
Has feedback from the key stakeholders been incorporated in the reporting of findings?	More yes than no, but equivocal	1
Total		**2**

Data		
WDF Local Authority Collection Data		
Source		
WDF 2016/17		
Data Used In:		
Consumer Recycling		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes with some reservations	2
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes with some reservations	2
Have the findings been independently peer-reviewed?	no	0
Is the methodology/calculation reasonably free from concerns?	Yes with some reservations	2
Have the methodology/calculations been independently checked (internally or externally)?	Yes with some reservations	2
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**19**

Degree of agreement around the findings (max 9):		
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**6**

Data		
Survey of Recyclers and Exporters 2018		
Source		
Verde Research and Consulting Ltd		
Data Used In:		
Recycling & Unaccredited Recycling		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	More yes than no, but equivocal	1
Have the findings been independently peer-reviewed?	No	0
Is the methodology/calculation reasonably free from concerns?	Yes with some reservations	2
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	More yes than no, but equivocal	1
Total		**18**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	Yes with some reservations	2
Do the key stakeholders/experts actively agree with the findings?	Yes with some reservations	2
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**7**

Data		
NPWD Recycling Data 2017		
Source		
NPWD		
Data Used In:		
Recycling Projections		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	Yes	3
Is the methodology/calculation reasonably free from concerns?	Yes	3
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**26**

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	No	0
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3
Total		**6**

Appendix 2 – Technical details of the modelling and scenario projections

Introduction

This appendix reports the detailed estimates of univariate time-series models (linear trend and autoregressive models) based on historical data for aluminium and steel packaging POM and accredited aluminium and steel recycling (aluminium and steel packaging are assessed separately). Based on these models a range of scenarios for aluminium and steel packaging POM and accredited aluminium and steel packaging recycling are projected forward to 2025.

The EA's NPWD (National Packaging Waste Database) provides a data source from which to assess trends over time in aluminium and steel packaging placed onto the UK market by businesses that have are obligated to comply with the packaging regulations. Obligated businesses are required to report their packaging tonnages data into NPWD each year. Therefore, historic data on the quantities of aluminium and steel packaging handled by obligated producers ('obligated' POM) is available for trend analysis. NPWD also reports accredited aluminium and steel packaging recycling tonnages.

The modelling and scenarios assume that aluminium and steel packaging net pack fill tonnages 1997 to 2017 (calculated using NPWD data as described in Section 1.3.1.1 of this report) and NPWD reported accredited aluminium and steel packaging recycling (1998 to 2017) are the best available data to use to:

- Assess trends in the overall quantities of aluminium and steel packaging POM and accredited aluminium and steel packaging recycling;
- Estimate empirical statistical models of aluminium and steel packaging POM and accredited aluminium and steel packaging recycling; and,
- Project plausible possible future scenarios for aluminium and steel packaging POM and accredited aluminium and steel packaging recycling.

Linear trend and auto regressive models

The scenario for POM and accredited recycling are the projections of univariate time-series models (linear trend and autoregressive models) estimated on historical data for aluminium and steel packaging POM and accredited aluminium and steel packaging recycling.

The linear trend model for a time series Y_t is

$$\mathbf{Y_t = \beta_0 + \beta_1 * T + e_t}$$

where T denotes a time trend.

A 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 AR(p) for a time series Y_t is represented as:

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

Regarding the order p of the auto regression within a given sample of data there are trade-offs to consider: too few lags potentially omits information from the more distant lagged

values and too many entails more coefficient estimates than necessary, which introduces greater model error into projections.

Parameters of both models can be straightforwardly estimated using OLS.

The order *p* of the auto-regression can be selected using a range of statistical information criterion, the statistics here are Akaike, Schwarz/BIC, Hannan-Quinn and log-likelihood. To assess the adequacy of alternative models we choose the model which overall minimises the information statistics and maximises the log-likelihood.

Aluminium packaging net pack fill, accredited recycling modelling and projections

This section reviews the historical NPWD data and trends for aluminium packaging POM in the UK and reports detailed estimates of univariate time-series models (linear trend and autoregressive AR models) and scenario projections to 2025.

Detailed estimates of the statistical models for aluminium packaging net pack fill are reported in detail in 1
[43]. The models estimated are univariate time-series models: a linear trend model; an auto-regressive model with 1 lag; and an auto-regressive model with 2 lags.

Figure 39 Aluminium packaging net pack fill (linear and auto-regressive models)

	Linear			AR(1)			AR(2)		
Variable*	**Coeff**	**t-Stat.**	**Prob.**	**Coeff**	**t-Stat.**	**Prob.**	**Coeff**	**t-Stat.**	**Prob.**
Constant	87896	20.0	0.0%	20721	2.4	2.7%	22238	2.6	1.9%
Trend	3865	16.5	0.0%						
Aluminium NPF(-1)				0.8950	16.2	0.0%	0.6310	2.89	1.1%
Aluminium NPF(-2)							0.2613	1.25	23%
R^2	94.1%			93.9%			94.4%		
Adj-R^2	93.8%			93.5%			93.7%		
S.E	5586.273			5703			5611		
F-stat.	273			261			136		
Prob(F-stat.)	0			0			0		

*NPF is aluminium packaging net pack fill, (-1) denotes 1 lag, (-2) denotes 2 lags

To assess the statistical adequacy of these alternative models a range of statistical 'information criteria' are calculated to inform the choice of a preferred model from which to develop a projection scenario for aluminium packaging net pack fill (and hence POM). Information criteria are reported in **Figure 40** (adj-R^2 is included for comparison), based on these criteria the linear model is selected as the preferred model to develop projections.

[43] Auto-regressive models up to order 3 (3 lags) were estimated for the model selection exercise below however since the AR(3) model performed poorly in comparison detailed estimates are not shown.

Figure 40 Aluminium packaging net pack fill statistical model selection criteria

	Linear Trend	AR(1)	AR(2)
Adj R^2	93.8%	93.5%	93.7%
Akaike	20.19	20.23	20.25
Schwarz-Bayes	20.29	20.33	20.40
Hannan-Quinn	20.21	20.25	20.27
Log likelihood	-189.84	-190.23	-189.34

The projection scenario for aluminium packaging net pack fill is reported in **Figure 41**. All projections are subject to uncertainty, however the uncertainty around projections based on statistical models such as this for can be estimated using the modelled standard error from the regression analysis.

Assuming a normal distribution, 95% confidence intervals are calculated as the upper and lower bounds to the aluminium packaging net pack fill projection and are shown in **Figure 41** as indicative upper and lower bounds to the projection.

Figure 41 Aluminium packaging net pack fill, linear model projections and 95% confidence intervals, 2018 to 2025 (k tonnes)

Year	Lower CI	Net Pack Fill	Upper CI
2018	181	195	209
2019	185	199	213
2020	189	203	218
2021	193	208	222
2022	197	212	227
2023	201	216	231
2024	205	220	235
2025	209	224	240

Aluminium packaging POM scenario

The scenario projected for aluminium packaging POM tonnage is based on the projected growth rates from the estimated linear model based on the historic data for aluminium packaging net pack fill.

It is assumed that the aluminium packaging POM projection increases in line with the projected growth rates of aluminium packaging net pack fill in the scenario for POM. The projected scenario for aluminium packaging POM (and growth rates) in each year to 2025 is shown in **Figure 42**. It is assumed that the 2018 POM figure (the first year of the

projection scenario) for aluminium packaging POM is the same as the 2017 POM figure of 194k tonnes developed in this project.

Under this scenario aluminium packaging POM is projected to increase from 194k tonnes in 2018 to 203k tonnes in 2020, and to 223k tonnes in 2025, an increase of 15% (just under 30k tonnes) in 2025 compared to 2018. Average annual growth in aluminium packaging POM over the projection horizon is 2%.

Figure 42 Scenario projection for aluminium packaging POM, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
POM	194	198	203	207	211	215	219	223
% change	-	2.1	2.1	2.1	2.0	2.0	1.9	1.9

Accredited aluminium packaging recycling scenario

This section reports the estimation details of univariate time-series models (linear trend and autoregressive models) based on historical NPWD data for aluminium packaging accredited recycling. The detailed estimation results are reported in **Figure 43**. The models estimated are univariate time-series models: a linear trend model; an auto-regressive model with 1 lag AR(1); and an auto-regressive model with 2 lags AR(2).

Figure 43 Accredited aluminium packaging recycling model estimates

	Linear			AR(1)			AR(2)		
Variable*	Coeff	t-Stat.	Prob.	Coeff	t-Stat.	Prob.	Coeff	t-Stat.	Prob.
Constant	-22142	-5.9	0.0%	5055	1.4	19.3%	5210	1.6	13.7%
Trend	4141	21.3	0.0%						
R(-1)				0.9864	14.4	0.0%	0.5045	2.29	3.7%
R(-2)							0.5227	2.28	4%
R^2	96.6%			92.9%			94.7%		
Adj R^2	96.4%			92.4%			94.0%		
S.E	4273			6192			5513		
F-stat.	455			208			134		
Prob(F-stat.)	0			0			0		

*R is accredited aluminium packaging recycling, (-1) denotes 1 lag, (-2) denotes 2 lags

Details of the statistical information criterion which inform the selection of the preferred model are reported in **Figure 44**. The range of information statistics indicate that the linear model for aluminium packaging accredited recycling is the preferred model for the data sample available. A scenario based on the preferred model (the linear model) is projected to 2025 for accredited aluminium recycling.

Figure 44 Aluminium packaging accredited recycling, model selection criteria

	Linear Trend	AR(1)	AR(2)
Adj R^2	96.4%	92.4%	94.0%
Akaike	19.66	20.40	20.22
Schwarz-Bayes	19.76	20.50	20.37
Hannan-Quinn	19.68	20.42	20.24
Log likelihood	-174.96	-181.64	-178.97

Provisional 2018 figures for accredited aluminium packaging recycling are available for 2018 Q1 to Q3 from NPWD. Accredited aluminium packaging recycling is reported as 23k tonnes for 2018Q1, 25k tonnes for 2018Q2 and 28k tonnes in 2018Q3, so for January to September 2018 a total of 77k tonnes of aluminium packaging is recorded as accredited recycling, an increase of 8% compared to the same period in 2017. Accredited aluminium packaging recycling registered quarter on quarter growth in each of 2018Q1 to 2018Q3 and the 2018 full year estimate of 102k tonnes assumes accredited aluminium packaging recycling growth continued in 2018Q4.

The estimated 2018 full year figure for accredited aluminium recycling over-rides the linear model scenario projection in 2018. The annual projections for 2019 to 2025 are based on the linear model projections for accredited aluminium packaging recycling, the projection is shown in **Figure 45** together with 95% confidence intervals as indicative upper and lower bounds to the projection.

Figure 45 Accredited aluminium packaging recycling projection 2018 to 2025 and 95% confidence interval (k tonnes)

Year	Lower CI	Accredited recycling	Upper CI
2018	93	102	111
2019	98	107	116
2020	102	111	120
2021	106	116	125
2022	111	120	129
2023	115	124	134
2024	119	129	139
2025	124	133	143

Steel packaging net pack fill modelling and projections

This section reviews the historical NPWD data and trends for steel packaging POM in the UK and reports detailed estimates of univariate time-series models (a linear trend model and two autoregressive models) and develops scenario projections to 2025.

Detailed estimates of the statistical models for steel packaging net pack fill are reported in detail in **Figure 46**[44]. The models estimated are univariate time-series models: a linear trend model; an auto-regressive model with 1 lag; and an auto-regressive model with 2 lags.

Figure 46 Steel packaging net pack fill (linear and AR models)

	Linear			AR(1)			AR(2)		
Variable*	Coeff	t-Stat.	Prob.	Coeff	t-Stat.	Prob.	Coeff	t-Stat.	Prob.
Constant	777781	27.7	0.0%	67889	1.2	26.3%	71350	1.2	26.0%
Trend	-11672	-8.0	0.0%						
Steel NPF(-1)				0.8638	8.5	0.0%	0.9481	3.70	0.2%
Steel NPF(-2)							-0.0887	-0.36	72%
R^2	80.0%			81.9%			82.0%		
Adj R^2	78.7%			80.8%			79.7%		
S.E	32140.94			30565			31432		
F-stat.	64			72			34		
Prob(F-stat.)	0.000001			0			0.000003		

*NPF is net pack fill, (-1) denotes 1 lag, (-2) denotes 2 lags

To assess the statistical adequacy of these alternative models a range of statistical 'information criteria' are calculated to inform the choice of a preferred model from which to develop a projection scenario for steel packaging net pack fill (and hence POM). Information criteria are reported in **Figure 47** (adj-R^2 is included for comparison), based on these statistical criteria the AR(1) model was selected as the preferred model to develop scenario projections.

Figure 47 Steel packaging net pack fill statistical model selection criteria

	Linear Trend	AR(1)	AR(2)
Adj R^2	78.7%	80.8%	79.7%
Akaike	23.70	23.60	23.70
Schwarz-Bayes	23.80	23.70	23.85
Hannan-Quinn	23.71	23.61	23.72
Log likelihood	-211.28	-210.38	-210.30

[44] Auto-regressive models up to order 3 (3 lags) were estimated for the model selection exercise below, however since the AR(3) model performed poorly in comparison detailed estimates are not shown.

The projection scenario for steel packaging net pack fill is reported in **Figure 48**. All projections are subject to uncertainty however the extent of which can be estimated using the modelled standard error from the estimation of the statistical models.

Assuming a normal distribution 95% confidence intervals are calculated as the upper and lower bounds to the steel packaging, net pack fill projection are shown in **Figure 48** as indicative upper and lower bounds to the projection.

Figure 48 Steel packaging net pack fill, AR(1) model projections and 95% confidence intervals, 2018 to 2025 (k tonnes)

Year	Lower CI	Net Pack Fill	Upper CI
2018	437	496	556
2019	413	496	579
2020	396	496	595
2021	383	495	608
2022	372	495	619
2023	363	495	628
2024	355	495	635
2025	348	495	641

Steel packaging POM scenario

The scenario projection for steel packaging POM tonnage is based on the projected growth rates from the estimated AR(1) model (the preferred statistical model estimated on NPWD data for steel packaging net pack fill).

It is assumed that the steel packaging POM increases in line with the projected growth rates of steel packaging net pack fill in the scenario. The projected scenario for steel packaging POM (and growth rates) to 2025 is shown in **Figure 49**. It is assumed that the 2018 steel packaging POM figure (the first year of the projection scenario) is the same as the 2017 steel packaging POM figure of 551k tonnes developed in this project.

Figure 49 Steel packaging POM scenario, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
POM	551	551	551	551	550	550	550	550
% change	-	-0.1%	-0.05%	-0.04%	-0.04%	-0.03%	-0.03%	-0.02%

Under this scenario steel packaging POM is projected to remain stable at around 551k tonnes to 2020, and decline slightly to 550k tonnes in 2025, a decline of 1k tonnes or 0.3% in 2025 compared to 2018.

Accredited steel packaging recycling, modelling and scenario

This section reports the estimation details of univariate time-series models (linear trend and autoregressive models) based on historical NPWD data for accredited steel packaging recycling. The detailed estimation results are reported in **Figure 50**. The models estimated are univariate time-series models: a linear trend model; an auto-regressive model with 1 lag AR(1); and an auto-regressive model with 2 lags AR(2).

Figure 50 Accredited steel packaging recycling model estimates

	Linear			AR(1)			AR(2)		
Variable*	Coeff	t-Stat.	Prob.	Coeff	t-Stat.	Prob.	Coeff	t-Stat.	Prob.
Constant	210167	7.1	0.0%	67971	2.1	5.3%	72076	2.1	5.3%
Trend	7924	5.1	0.0%						
Steel recycling(-1)				0.8363	9.0	0.0%	0.7164	2.75	1.5%
Steel recycling(-2)							0.1122	0.49	63%
R^2	62.2%			83.5%			83.7%		
Adj R^2	59.8%			82.4%			81.6%		
S.E	34025			22489			23040		
F-stat.	26			81			39		
Prob(F-stat.)	0.000102			0			0.000001		

* (-1) denotes 1 lag, (-2) denotes 2 lags

Details of the statistical information criterion which inform the selection of the preferred model are reported in **Figure 51**. The range of information statistics indicate that the AR(1) model for accredited steel packaging recycling is the preferred model for the data sample available. A scenario based on the preferred model (the AR(1) model) is projected to 2025 for accredited steel packaging recycling.

Figure 51 Accredited steel packaging recycling model selection criteria

	Linear Trend	AR(1)	AR(2)
Adj R^2	59.8%	82.4%	81.6%
Akaike	23.81	22.98	23.08
Schwarz-Bayes	23.91	23.08	23.23
Hannan-Quinn	23.83	23.00	23.10
Log likelihood	-212.31	-204.86	-204.71

Provisional 2018 figures for accredited steel packaging recycling are available for 2018 Q1 to Q3 from NPWD. Steel packaging recycling is reported as 101k tonnes for 2018Q1, 109k tonnes for 2018Q2 and 106k tonnes in 2018Q3, so for January to September 2018 a total of 317k tonnes of steel packaging was recorded as accredited recycling, a decrease of 2.1% compared to the same period in 2017.

The 2018 full year estimate of 422k tonnes assumes 2018Q4 accredited steel packaging recycling to be the average of 2018Q1 to 2018Q3. The 2018 full year figure estimate represents a decline of 2% in accredited steel packaging recycling compared to the 2017 full year figure.

In the scenario projection the 2018 full year figure overrides the model-based projection, but the annual projections from 2019 to 2025 are based on the estimated model projections for accredited steel packaging recycling. These are shown in **Figure 52 Figure 45** together with 95% confidence intervals (assuming a normal distribution) as indicative upper and lower bounds to the projection.

Figure 52 Accredited steel packaging recycling projection 2018 to 2025 and 95% confidence interval (k tonnes)

Year	Lower CI	Accredited recycling	Upper CI
2018	376	422	468
2019	356	419	483
2020	342	417	493
2021	331	416	500
2022	323	414	505
2023	317	413	509
2024	312	412	512
2025	308	411	515

Figure 53 reports the scenario projected tonnages for accredited steel packaging recycling to 2025. In this scenario steel packaging decreases from 422k tonnes in 2018 to 417k tonnes in 2020, and to 411k tonnes in 2025, a decrease of 11k tonnes or 2.6% in 2025 compared to 2018.

Figure 53 Accredited steel packaging recycling projection, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
Recycling	422	419	417	416	414	413	412	411
% change	-2.0	-0.6	-0.51	-0.42	-0.35	-0.29	-0.24	-0.20

Metal packaging POM and recycling projections conclusion

The key conclusions from the metal packaging flow and recycling projections are:

- Assuming a 2018 POM figure of 194k tonnes for aluminium packaging, aluminium packaging POM is projected to increase from 194k tonnes in 2018 to 203k tonnes in 2020, and to 223k tonnes in 2025, an increase of 15% (just under 30k tonnes) in 2025 compared to 2018.

- Accredited aluminium packaging recycling is projected at 112k tonnes in 2018, increasing to 129k tonnes in 2020 and 157k tonnes in 2025, an increase of 62k tonnes or 66% in 2025 compared to 2018.

- Assuming a steel packaging POM figure of 551k tonnes in 2018, steel packaging POM is projected to remain stable at around 551k tonnes to 2020, and decline slightly to 550k tonnes in 2025, a decline of 1k tonnes or 0.3% in 2025 compared to 2018.

- Accredited steel packaging recycling is projected to decrease from 422k tonnes in 2018 to 417k tonnes in 2020, and to 411k tonnes in 2025, a decrease of 11k tonnes or 2.6% in 2025 compared to 2018.

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recycle