Final Report

Paper and Card Flow 2025

A review of the quantity of paper and card packaging being placed on the market (POM) and recycled in 2017

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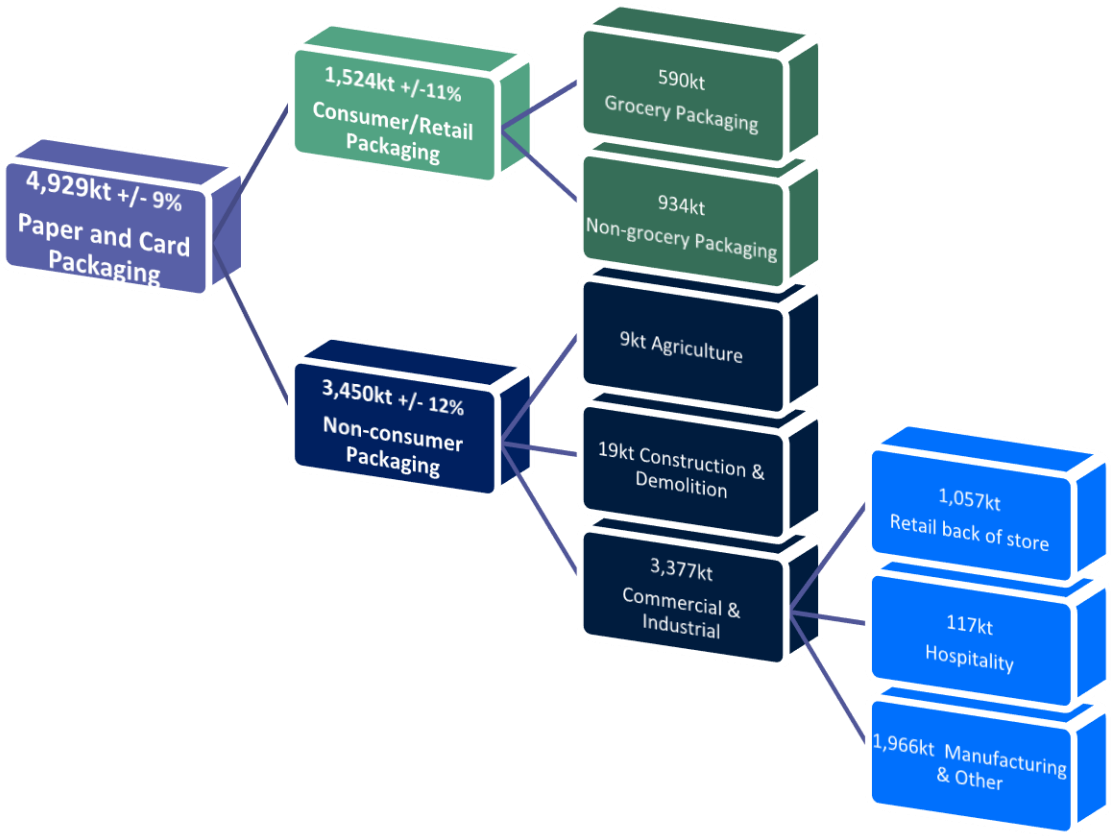
Executive summary

Paper and Card Flow 2025 has been produced to support Defra in its understanding of current levels of UK paper and card packaging placed on the market (POM)[1] and recycled, and potential future levels to 2025. Paper and Card Flow also reports the associated UK and European compliance implications of projected paper and card packaging POM and recycling. Defra is keen to ensure that the estimates being used for its packaging policy work are as accurate as possible; therefore, this report has been prepared with this in mind. Error margins and robustness assessments have been used and provided wherever possible.

Project Conclusions - Material Flow

The project estimate for paper and card packaging POM in 2017 is 4,929k tonnes (+/- 9%): an increase of 4% from the estimated current flow figure (2014). This has been derived using a bottom-up methodology, taking data from various sources for each sector and combining the results. It has been cross-checked with reported obligated data on NPWD and with data provided by the project's Steering Group. It is likely that a significant part of this increase has come from the growth in online sales, which often use forms of paper and card packaging.

Figure ES1 Paper and Card packaging POM by sector



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

The final project estimate for paper and card packaging POM in the consumer sector is 1,524k tonnes (+/- 11%)
This method is 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 there is available and is accepted by industry.

The final project estimate for paper and card packaging POM in the non-consumer sector is 3,405k tonnes (+/- 12%)
This data was derived by applying packaging protocols to the Defra C&I Waste Statistics for 2014. It has been broken down and verified using Valpak EPIC data and that from a retailer survey of back of store waste carried out for this project.

Non-obligated or unregistered flow for paper and card packaging accounted for 16% of POM in 2017 – this represents a decline from that reported in 2014 of 21%
Using data from NPWD, an estimate of the unobligated tonnage (780k tonnes, 16%) has been made by subtracting the net pack fill figure of 4,149k tonnes from the project's final flow estimate of 4,929k tonnes. The unobligated proportion of 16% is a reduction from the 21% identified in the 2014 Paper Flow report. This change could be due to an increase in obligated companies (due to higher sales) and those reporting that previously had been free-riding.

The final project estimate of paper and card packaging POM by type is 3,470k tonnes (70%) corrugated, 1,028k tonnes (21%) carton and other board, 51k tonnes (1%) liquid beverage cartons and 375k tonnes (8%) other packaging
Using primarily information derived from Valpak's EPIC database, the final project estimate by format has been made. This indicates that almost three quarters of paper and card packaging POM is corrugated.

Project Conclusions - Recycling

The total tonnage of UK waste paper and card packaging recycled is estimated to be 3,865k tonnes.
This includes reported (NPWD) and an estimate for unreported recycling (111k tonnes). Based on the POM calculated as part of this project, this gives an overall recycling rate of 78%. Of this, 3,754k tonnes was reported on NPWD, representing a recycling rate of 76%.

The total tonnage of consumer UK waste paper and card packaging recycled is estimated to be 1,027k tonnes.
This is based on WDF. Based on the POM calculated as part of this project, this gives a consumer recycling rate of 67%, down 4% since 2014.

The total tonnage of non-consumer UK waste paper and card packaging recycled is estimated to be 2,838k tonnes.
This is calculated by removing the consumer recycling tonnage from the total tonnage recycled figure. Based on the POM calculated as part of this project, this gives a non-consumer recycling rate of 83%.

Of the total 1,064k tonnes of unrecycled paper and card packaging, 837k tonnes (79%) was sent for energy recovery and 226k tonnes to landfill (21%)
This was based on an estimated total of 487k tonnes consumer paper and card packaging not being recycled and 567k tonnes non-consumer.

Project Conclusions - Projections and Compliance

The scenario projection for paper and card POM projects an increase from 4,929k tonnes in 2018[2] to 4,964k tonnes in 2020, and to 5,246k tonnes in 2025
This represents an increase of 318k tonnes or 6.4% in 2025 compared to 2018.

The scenario projection for paper and card packaging recycling projects an increase from 3,679k tonnes in 2018 to 3,808k tonnes in 2020, and to 4,098k tonnes in 2025
This represents an increase of 419k tonnes or 11.4% in 2025 compared to 2018.

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

T**he associated probabilities of meeting the national equivalents of the business targets for paper and card accredited packaging recycling in 2018, 2019 and 2020 are 100.0%, 100.0% and 99.3%, and 78.1% for the CEP target in 2025**

Project Recommendations

Further surveying of non-consumer POM
The most uncertain element of the POM estimate relates to non-consumer paper and card packaging. In order to improve the accuracy of the data, a more recent data source should be used (the most recent available at the time of writing was for 2014) and one that also splits out packaging and non-packaging.

Reviewing elements of the Packaging Regulations to capture more non-obligated or unregistered tonnage
This could form part of Defra's reform of the Packaging Regulations in 2019 and could include:

- Removal of de minimis - those companies who are below the packaging obligation threshold by having a turnover of under £2 million and handling less than 50 tonnes of packaging
- If the de minimis is not removed, the following could be considered
    - Re-introducing the service provider clause;
    - Investigate the potential for unobligated or unregistered tonnage to be supplied through increasing use of internet "marketplace" arrangements, particularly where products are supplied from other countries;
    - Currently, packaging used internally by an organisation (for example for transporting between or within sites) is exempt from the Regulations. This may be a significant volume for paper and card and therefore its inclusion within the obligated tonnage could be investigated further; and
    - In cases where the brand owner supplies packaging to contract packers free of charge (contract packing), the brand owner is responsible for the

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

obligation. However, it is suspected that this may be overlooked by producers in many cases and as such could be a focus of compliance scheme or enforcement agency auditors to carry out checks and issue reminders.

Recommended accreditation for all recycling activities

If all companies in the UK performing recycling activities on packaging were to become accredited, this would ensure that packaging recovery notes (PRNs) were issued on more of the packaging material recycled, resulting in no unaccredited recycling and simpler compliance for the UK with regulatory targets. All reprocessors becoming accredited for recycling activities could increase the number of PRNs/PERNs generated for recycling by up to 111k tonnes in 2017.

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Appendix II Technical Details of the Modelling and Projection Scenarios

Glossary

bn	Billion
CA	Civic amenity
C&I	Commercial and Industrial
CPI	Confederation of Paper Industries
C&D	Construction and demolition
EA	Environment Agency
EfW	Energy from Waste
EPIC	Environmental Product Information Centre
GDP	Gross Domestic Product
HWRC	Household waste recycling centre
k	Thousand
kt	Thousand tonnes
LA	Local authority
NPWD	National Packaging Waste Database
POM	Placed on the market
Primary Packaging	Any packaging that the customer will take home, remove and throw away e.g. aluminium can, plastic bottle
PRN	Packaging Recovery Note
PERN	Packaging Export Recovery Note
RDF	Refuse Derived Fuel
Secondary Packaging	Inner packaging used to transport or display goods to/in store, usually cardboard boxes or shelf ready packaging
Transit/Tertiary Packaging	Any transit packaging e.g. pallets, shrink wrap, staples or strapping
WDF	Waste Data Flow

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- ACE UK;
- Advisory Committee on Packaging (ACP);
- BPIF Cartons;
- Confederation of Paper Industries (CPI);
- Environment Agency;
- Noa Prism; and
- Recycling Association.

1.0 Introduction

1.1 Background and Existing Data

It is important to ensure that the estimates being used by Defra for its packaging policy work are as accurate as possible. To support Defra, this work focuses on reviewing the estimates of UK paper and card packaging POM and the associated compliance implications.

The existing Defra estimate for 2017 is 4,749k tonnes of paper and card packaging POM. The Paper and Card Flow 2020 project[3] and industry assessment formed the basis for this estimate. The objective behind this Paper and Card Flow 2025 report is to provide an updated baseline estimate of paper and card packaging POM for 2017, a measurement of that which is recycled, and project this to 2025.

1.2 Project Objectives

Paper and Card Flow 2025 had the following key objectives:

- Develop a methodology that utilises and builds on existing approaches to estimate 2017 paper and card packaging POM by format, stream and source;
- Assemble a Steering Group to provide expertise and insights, and guide the project;
- Identify any sources/approaches, where appropriate, to improve and build on net pack fill estimates based on National Packaging Waste Database (NPWD) obligated producer data, to cross-check and estimate non-obligated flow;
- Estimate the quantities of paper and card packaging collected through Civic Amenity sites, kerbside and pick-up collections and other collection types for both consumer and non-consumer sources in 2017;
- Estimate the quantities of paper and card packaging, by format type, and by stream, being: recovered and recycled; sent for incineration with energy recovery, including refuse derived fuel (RDF); sent to landfill, for both UK and overseas end destinations in 2017;
- Project paper and card POM and recycling rates year by year to 2025, based on accepted assumptions and techniques;
- Assess the likely compliance performance, per year, up to 2025;
- Provide estimates of the quantities of obligated paper and card packaging that is recycled but does not generate a PRN/PERN (unaccredited recycling), and quantities of non-obligated paper and card packaging that is recycled;
- Indicate the degree of uncertainty/quality of data associated with each estimate (POM and recycling rates), and key factors influencing temporal variability in the data; and
- Produce a final report detailing the findings of the study, alongside a set of slides to present to key industry groups.

1.3 Methodology

In order to calculate paper and card packaging recycling rates, the quantity of paper and card packaging recycled is divided by the quantity of waste arisings. However, it is commonly

[3] http://www.wrap.org.uk/collections-and-reprocessing/dry-materials/report/paper-card-flow-2020

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)[4], 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.

While the approach is valid, it (like any methodology) has a number of significant limitations, relying 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[5].

An overview of how the POM and recycling rates were calculated for this project is provided below.

1.3.1 POM

Paper and card packaging POM was estimated using a bottom up approach that references a variety of data sources of paper and card packaging products placed on the market, combined with a gathering of data and estimates from industry. The results of this method have been cross-checked against an assessment of the paper and card packaging POM reported on the National Packaging Waste Database (NPWD) by obligated producers and data 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 Method (Bottom Up Approach)

This approach built up the POM figure using a variety of components, based on the key sectors for paper and card packaging including:

- Paper and card packaging around food/drinks/other groceries, including, for example, body care/clothing/DIY products, as sold by supermarkets and other non-grocery retailers, sourced from the Environment Agency and Valpak's Environmental Product Information Centre (EPIC) database[6];
- Paper and card packaging around food/drink as consumed in the hospitality sector, sourced from Valpak's EPIC database[7];
- Paper and card packaging discarded by retailers back of store, obtained through a survey undertaken for the purposes of this study; and

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

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

[6] *The database is based on information collected direct from suppliers as well as information sourced internally, meaning that it holds a wide coverage of information across multiple product ranges. Product specific data collection is completed through site visits, supplier mailings and weighing in-house (purchasing product and collecting used product from staff). All data goes through a comprehensive checking process on receipt and is stored in Valpak's bespoke software Environmental Product Information Centre (EPIC).*

[7] *The database is based on information collected direct from suppliers as well as information sourced internally, meaning that it holds a wide coverage of information across multiple product ranges. Product specific data collection is completed through site visits, supplier mailings and weighing in-house (purchasing product and collecting used product from staff). All data goes through a comprehensive checking process on receipt and is stored in Valpak's bespoke software Environmental Product Information Centre (EPIC).*

- Paper and card packaging used by the non-consumer sector as sourced from Defra's Commercial and Industrial Waste Arisings data publication, relating to 2014[8].

The detail of how the amount of paper and card POM was estimated and cross-checked with wider sources is given in Section 2 of this report.

1.3.1.2 POM Cross-check (Net Pack Fill)

The cross-check compiled paper and card packaging data reported by obligated companies into the NPWD. The estimate is thought to capture the vast majority of the relevant quantity, but does omit the paper and card packaging handled by non-obligated companies, free-riders (those companies who are above the packaging obligation threshold by having an annual turnover of £2 million and handling 50 tonnes of packaging or more per year, 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 below was applied. This calculation uses the total data reported by obligated packaging producers and is available on the NPWD website[9]:

Net Pack Fill	=	**Packing/Filling** table 1 on pack/filling	+	**Imports** table 3A showing that imported for the purpose of selling	+	**Imports** table 3B showing 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 paper packaging and card. Industry, including paper mills and exporters, were consulted on the recycling of paper and card 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) 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. WDF was considered by the Steering Group to be the best available source of consumer recycling data, as it is the most comprehensive and is believed by the Group to not suffer from the significant losses as seen with plastics collections.

1.3.3 *Projections and Scenario Analysis*

The final section of the report documents a historical analysis of paper and card packaging POM and levels recycled, with an aim to inform projected future levels of material POM and reprocessing from 2018 to 2025.

[8] *https://www.gov.uk/government/statistics/uk-waste-data published October 2018*

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

2.0 Establishing Paper and Card Packaging POM (Bottom Up Approach)

2.1 Introduction

This section of the report provides an overview of how paper and card packaging flows onto the UK market. It details the data sources used and final project estimates of the POM for 2017.

2.2 Placed on the Market (POM)

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

Paper and card packaging typically enters the market in the following formats, which have been adopted for the purposes of this report;

- Corrugated board – used widely as secondary packaging and include Kraftliner and test liners. They are made by a conversion process in which three layers of paper (or paperboard) are corrugated during the process and the outer layers (liners) are glued to the peaks[10].
- Carton and other board – used as solid board cases and graphic board. Generally, this scores, folds and bends without splitting and has good printability. It is widely used for food packaging, pharmaceuticals and other end-uses requiring a high quality, fast running print.
- Liquid beverage cartons – often called beverage cartons or Tetrapak (although other brands exist), these multi-layered cartons generally include paper, plastic and aluminium but tend to be categorised as paper and card due to this being the principal material by weight[11]. They are widely used to package fresh food and increasingly used in the ambient aisle[12].
- Other – all other forms of paper and card packaging such as wrappings, paper, shredded paper fillers and mouldings.

The method used for the project splits the POM into different elements and builds a picture from the bottom to the top. The key elements are shown in Figure 1.

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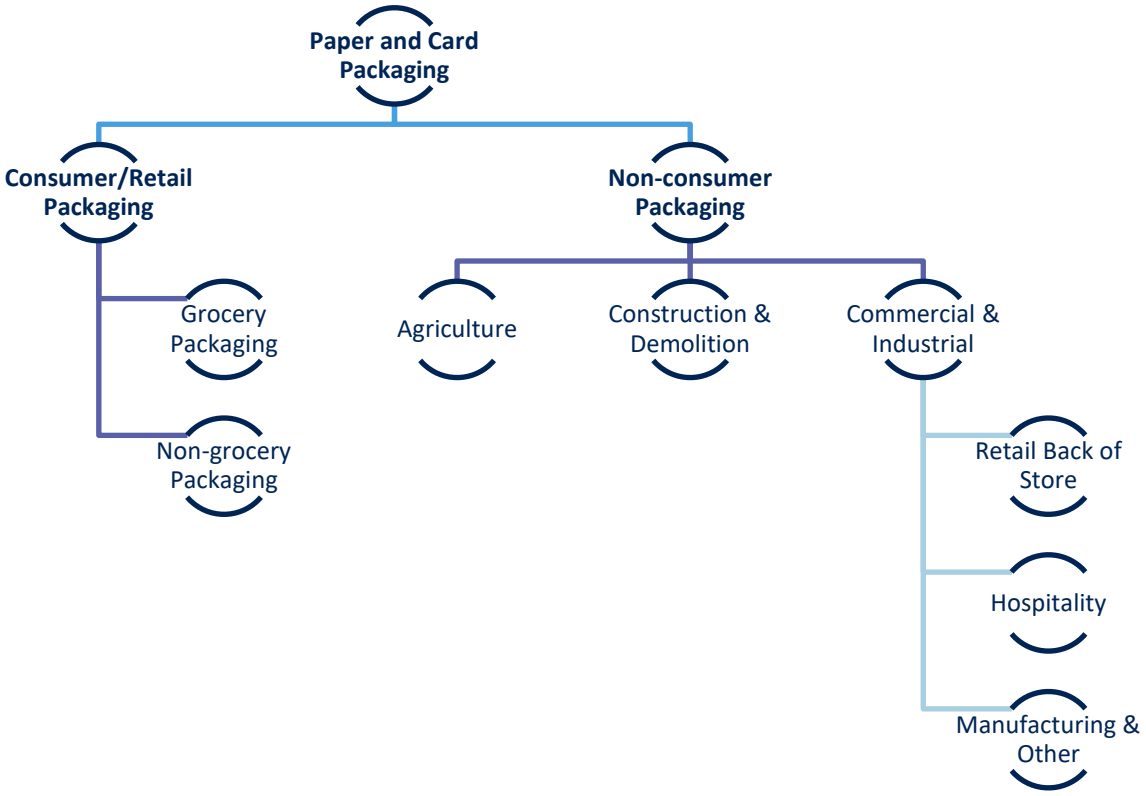
[10] CPI 2014: Descriptions of Paper and Board Fact Sheet: https://paper.org.uk/information/

[11] 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.

12 Ambient (shelf-stable) food can be safely stored at room temperature in a sealed container. This includes foods that would normally be stored refrigerated but which have been processed so that they can be stored at room temperature.

Figure 2 Sector breakdown



As there are levels of uncertainty around the data used to establish the various elements that are combined to make the total POM; consumer, non-consumer and total paper and card 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 and these have been converted into a percentage and related to appropriate margins of error[13], 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

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

using the Root of Sum of Squares (since we are dealing with the error of a sum) it was expressed as a percentage.

2.3 Consumer

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.

2.3.1 Grocery

To estimate the amount of packaging POM by the grocery retail market, aggregated Environment Agency (EA) data was used. The 2017 paper and card quantities reported in table 1 selling from NPWD for 95%[14] of UK grocery retailers was provided by the EA[15]. This data was scaled up to 100% of the UK grocery market and resulted in an estimated paper and card POM for 2017 of 590k tonnes.

This estimate was cross referenced with Valpak's Environmental Product Information Centre (EPIC)[16] which was assessed to provide data on annual sales and packaging weights for all relevant products packaged in paper and card. This was taken from a selection of Valpak's supermarket clients representing a cross-section of grocery retailers in the UK. Using volume market share information from Kantar World Panel (not publicly available) for these supermarkets, which represented 55% of the grocery retail market by sales volume for 2017, the resulting quantity of paper and card packaging was scaled up to represent an estimate for the UK grocery retail market. This method assumes that the paper and card packaging profile of the supermarkets in EPIC is representative of those not represented. The paper and card packaging in the grocery retail sector was estimated to be 530k tonnes in 2017. This represents an 8% decline on the consumer grocery retail figures identified for 2014 of 578k tonnes.

The scaled-up EA data was found to be 11% higher than that produced using EPIC and 2% higher than that identified for 2014[17]. In previous years the EPIC and EA data have been more closely aligned and as such EPIC has been used, due to a greater confidence in the quality of the data, greater detail of paper and card packaging composition and its representation of the full grocery market.

However, based on the EA having higher market coverage than EPIC in 2017 and the increasing market share in the grocery sector of discount retailers (which are not included in the Valpak data, but could have greater packaging use per item) the EA data was selected for use.

The final grocery retail paper and card packaging POM for 2017 was **590k tonnes** (+/-6% error margin was therefore used[18]). This is a tonnage increase of 2% of that identified for 2014. Appendix I provides a detailed assessment of relative levels of confidence in the data.

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[14] *Based on grocery retail market share data as published by Kantar*

[15] *The figure does not include free-riders or non-obligated producers.*

[16] *The database is based on information collected directly from suppliers as well as information sourced internally, meaning that it holds a wide coverage of information across multiple product ranges. Product specific data collection is completed through site visits, supplier mailings and weighing in-house (purchasing product and collecting used product from staff). All data goes through a comprehensive checking process on receipt and is stored in Valpak's bespoke software Environmental Product Information Centre (EPIC).*

[17] http://www.wrap.org.uk/collections-and-reprocessing/dry-materials/report/paper-card-flow-2020

[18] *As described in Figure 2*

2.3.2 *Non-grocery*

To scale up the grocery retail result to represent total UK retail, including non-grocery retail, the Office of National Statistics (ONS) retail sales data was used. This shows that the proportion of grocery spend of total UK retail spend was 43% in 2017.[19]

However, simply scaling up using market share was not considered robust, since it was likely that packaging usage within both sub-sectors differed. Therefore, this difference in paper and card packaging used by the grocery sector and other retail sectors was analysed using Valpak membership's reported data[20]. Analysis involved the following key stages:

- Identification of grocery and non-grocery retail members;
- Gathering of company reported data and information; and
- Calculation of paper and card packaging tonnage per billion-pound turnover for grocery and non-grocery retailers representing 33% of reported tonnage of paper and card packaging in 2017.

The method used assumes the packaging profile of those retailers within the sample is representative of those not in the sample and that turnover is a suitable scaling factor for packaging usage.

The total estimate of non-grocery POM is **934k tonnes (**+/- 18%)[21].

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

In summary, the following key steps were taken to estimate total retail paper and card packaging consumption in the consumer (retail) sector in 2017[22]:

- Total grocery paper and card packaging flow in 2017 was 590k tonnes (see section 2.3.1);
- Proportion of grocery spend of total retail spend in the UK was 43% in 2017[23];
- Total retail paper and card packaging flow, assuming like for like packaging was 1,366k tonnes;
- Paper and card packaging usage calculated as: grocery 3,517 tonnes /£bn and non-grocery as 4,235 tonnes /£bn;
- Non-grocery paper and card packaging tonnes/£bn turnover is 120% of grocery paper and card packaging tonnes/£bn turnover; and
- Applied 120% to the difference in tonnage between grocery (590k tonnes) and total retail (1,366k tonnes).

Therefore, total retail paper and card packaging flow in 2017 was estimated at **1,524k tonnes (**+/-11%)[24]. This is an increase of 7% on the 2014 estimate for consumer paper and

[19] https://www.ons.gov.uk/businessindustryandtrade/retailindustry/datasets/poundsdatatotalretailsales

[20] *Valpak membership represents approximately 50% of all obligated companies, by obligation. The entire NPWD database was considered for analysis; however, for confidentiality reasons it was not possible to gain access to NPWD to conduct the same analysis on the complete dataset.*

[21] *As described in Figure 2*

[22] *All figures subject to rounding*

[23] https://www.ons.gov.uk/businessindustryandtrade/retailindustry/datasets/poundsdatatotalretailsales *In 2013 this was 47%, as whilst both the grocery and non-grocery retail sectors have seen increased sales since 2013, the non-grocery sales have increased to a greater extent. Much of this growth is as a result of an increase in online sales.*

[24] *As described in Figure 2*

card packaging POM of 1,423k tonnes and supports the project Steering Group's view that there has been growth in paper and card consumer POM, based particularly on an increase in online sales and associated outer packaging, although not necessarily the only reason.

2.3.4 Consumer POM Composition

To provide a breakdown by card/paper type of consumer packaging, supermarket packaging composition was used as a proxy for grocery packaging, and a sample of non-grocery retailers was used as a proxy for non-grocery packaging within Valpak's EPIC database.

Figure 4 Grocery and Non-Grocery Consumer Packaging by Format[25]

	Grocery Proportion	Non-Grocery Proportion	Total Retail (k tonnes)
Retail Corrugated	1%	46.5%	443
Retail Carton and Other Board	76%	41.5%	836
Retail Liquid Beverage Cartons	7%	0.5%	46
Retail Other	15%	11.5%	195

2.4 Non-consumer

To avoid duplication between consumer and non-consumer packaging (including packaging within the non-consumer sector that has already been included in the consumer sector), non-consumer waste production is assessed using the bottom-up method[26].

In the Paper and Card Flow 2020 report[27] several sources of data relating to non-consumer packaging were used, including Defra commercial and industrial (C&I) waste statistics from 2010, WRAP construction and demolition (C&D) data from 2005 and EA agricultural waste data from 2003. However, Defra now make available a complete set of C&I data[28] which includes that produced from the C&D and agricultural sectors. This was selected for use for this work because it ensures one single source of data for all non-consumer sectors and due to the latest data release being from 2014, it offered a more up to date data set.

The data provided by Defra is assessed per key industry sector and by material type (paper and card for the purposes of this report), however it does not provide an assessment of the packaging waste and non-packaging waste produced separately. As a result, appropriate protocols needed to be applied to the data to assess the quantity of paper and card packaging waste generated. These were obtained from waste composition analysis[29] and identified that for C&I waste collected, approximately 57% of paper and card is packaging. As the waste composition study in question was an assessment of C&I waste collected by Local Authorities, separate studies were used and applied to the C&D[30] and agricultural[31]

[25] *Based on data held in Valpak's EPIC database relating to grocery and non-grocery primary packaging and definitions set out in Section 2.2 of this report.*

[26] It is assumed that waste production is equal to POM in this case. An example would be where retailer sales is included within consumer but retail back of store waste within the non-consumer sector.

[27] *http://www.wrap.org.uk/collections-and-reprocessing/dry-materials/report/paper-card-flow-2020*

[28] *https://www.gov.uk/government/statistics/uk-waste-data published October 2018*

[29] *http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=18237#RelatedDocuments 2010/11*

[30] *http://www2.wrap.org.uk/downloads/ConstructionSitePackagingWaste.250ebeab.1592.pdf - Establish Tonnages, and Cost Effectiveness of Collection, of Construction Site Packaging Waste, 2005*

[31] *Agricultural Waste Survey 2003, Environment Agency*

sectors, which identified that almost 100% of the paper and card from these sectors is packaging. The results of this analysis are provided in Figure 5.

Figure 5 Non-consumer Paper and Card POM[32]

C&I Sector	Total Paper & Card Waste (k tonnes)	% Packaging	Total Paper and Card Packaging Waste (k tonnes)
Agriculture, forestry and fishing	9	100%	9
Mining and quarrying	2	57%	1
Manufacture of food products, beverages and tobacco products	82	57%	47
Manufacture of textiles, wearing apparel, leather and related products	8	57%	5
Manufacture of wood and of products of wood and cork, except furniture, manufacture of articles of straw and plaiting materials	4	57%	3
Manufacture of paper and paper products, printing and reproduction or recorded media	1024	57%	588
Manufacture of coke and refined petroleum products	1	57%	0
Manufacture of chemical, pharmaceutical, rubber and plastic products	46	57%	26
Manufacture of other non-metallic mineral products	7	57%	4
Manufacture of basic metals and fabricated metal products, except machinery and equipment	14	57%	8
Manufacture of computer, electronic and optical products, electrical equipment, motor vehicles and other transport equipment	52	57%	30
Manufacture of furniture, jewellery, musical instruments, toys, repair and installation or machinery and equipment	42	57%	24
Electricity, gas, steam and air conditioning supply	2	57%	1
Water collection, treatment and supply, sewerage, remediation activities and other waste management services	1	57%	1
Construction	19	100%	19
Services (except wholesale of waste and scrap)	4596	57%	2639
Total	**5908**		**3405**

This analysis resulted in a non-consumer paper and card packaging total of **3,405k tonnes** (+/-12% error margin[33]), which represents a 2% increase from that reported in 2014. In order to compare the composition provided above with data from 2014 and cross check this data, wider sources were also used to assess the quantity of paper and card packaging used by retailers back of store and in the hospitality sectors.

The quantity of paper and card packaging discarded by grocery retailers at back of store was derived from surveying retailers during November 2018, with data collected representing 64% of the grocery retail market and a small sample from the non-grocery sector. Data was then scaled up to UK level using Kantar World Panel market share information. The final

[32] Sourced from Defra 2014 C&I Waste Statistics https://www.gov.uk/government/statistics/uk-waste-data published October 2018. It should be noted that 'Services' includes sectors such as retail back of store, hospitality, wholesale, transport and storage.

[33] As outlined in Figure 2.

figure for retail back of store was **1,057k tonnes** (+/-15% error margin[34]) of paper and card packaging, which represents a 13% decline on 2014 data.

Data for the hospitality sector was extracted from Valpak's EPIC database which since the 2014 PaperFlow report has increased in coverage and now relates to 34% of the cash and carry and delivered foodservice industry[35]. Market share information for the companies included in the sample were used to scale up the resulting tonnage to represent the whole foodservice, catering and hospitality sector. This resulted in an estimate for the sector of **117k tonnes (**+/- 15% error margin[36]) of paper and card packaging. This is 47k tonnes or 68% higher than the 70k tonnes reported in 2014; however based on the increased market share and sector coverage now available within the data, it is considered a more robust estimate than that generated in 2014.

2.4.1 Non-Consumer POM Composition

To provide a breakdown by card/paper type of non-consumer packaging, data from Valpak's EPIC database was used and the proportions applied to the appropriate sub-sectors. This included supermarket secondary/tertiary packaging, hospitality packaging and manufacturing. This resulted in the estimate provided in **Figure 6**.

Figure 6 Non-Consumer Packaging by Format

	Non-Consumer Proportion	Non-Consumer Total (k tonnes)
Corrugated	89%	3,027
Carton and Other Board	6%	193
Liquid Beverage Cartons	0%	5
Other	5%	180

[34] *As outlined in Figure 2.*

[35] *Valpak's EPIC database holds sales data and packaging weights information for clients signed up for the fully managed service. In the 2014 Paper Flow report only data from the cash and carry sector was available but since this time additional data is now available to Valpak to cover the delivered foodservice sector and as such represents an improvement in the robustness of this assessment.*

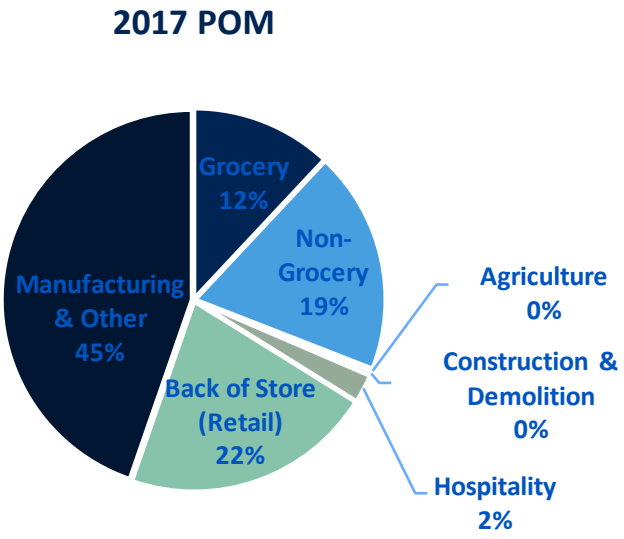
[36] *As outlined in Figure 2.*

2.5 Total POM

The combined consumer and non-consumer paper and card packaging POM are summarised and compared to the 2014 data in **Figure 7**.

Figure 7 Total UK Paper and Card Packaging POM 2017

Stream	Sub-Stream	Total Quantity (k tonnes) 2014	Total Quantity (k tonnes) 2017	Change
Consumer (Retail)	**Paper and Card Packaging**	**1423**	**1524**	**7%**
Non-Consumer	**Paper and Card Packaging**	**3326**	**3405**	**2%**
Full Market	**Paper and Card Packaging**	**4749**	**4929**	**4%**
Consumer (Retail)	*Grocery*	**578**	**590**	2%
Consumer (Retail)	*Non-Grocery*	**845**	**934**	11%
Consumer (Retail)	*Full Market*	**1423**	**1524**	7%
Non-Consumer	*Agriculture*	**10**	**9**	-12%
Non-Consumer	*Construction & Demolition*	**71**	**19**	-74%
Non-Consumer	*Hospitality*	**70**	**117**	68%
Non-Consumer	*Back of Store (Retail)*	**1209**	**1057**	-13%
Non-Consumer	*Manufacturing & Other*	**1966**	**2203**	12%
Non-Consumer	*Full Market*	**3326**	**3405**	2%



The 2017 paper and card packaging POM is estimated to be **4,929k tonnes** (+/- 9% error margin[37]), which is an increase of 4% on that reported in 2014 of 4,749k tonnes. It is possible that this increase in paper and card packaging usage results from a growth in online sales, which tend to use a large amount of paper and card postal packaging. According to the Office of National Statistics (ONS), online sales as a proportion of total retail has increased from 11.3% in 2014 to 16.3% in 2017[38], with non-food online sales rising to over

[37] *As described in Figure 2*

[38] https://www.ons.gov.uk/businessindustryandtrade/retailindustry/timeseries/j4mc/drsi

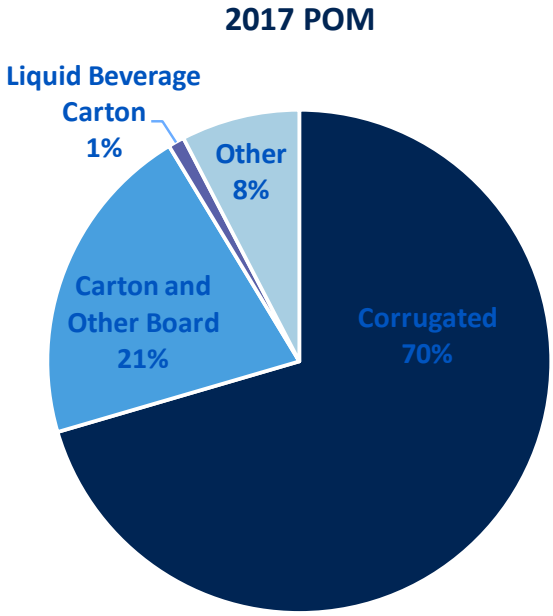
24% of the non-food market in 2017 from 11.6% in 2012. Statistics such as these support the increase in POM for paper and card packaging identified here.

Some sectors have seen large percentage changes in POM since 2014, such as construction and demolition. This decrease is likely due to a change in the data source to a more up to date reference (Defra 2014 vs WRAP 2005). It should however be noted that, as this data is from 2014, it will not account for any changes in, for example, house building, seen from 2015 – 2017. However, as the construction sector represents less than 0.5% of the total paper and card packaging POM it was not investigated further. Hospitality is another sector to see a large percentage swing, again this is a small proportion of the total POM but is explained by an increase in data quality as a result of a higher market share (from 18% to 34%) in the data used for assessment and therefore increased accuracy.

The composition of the 2017 paper and card packaging POM is provided in Figure 8 below.

Figure 8 Total UK Paper and Card Packaging POM Composition 2017

Stream	Packaging Type	Total Quantity (k tonnes)		Change
		2014	2017	
Consumer (Retail)	**Paper and Card Packaging**	**1423**	**1524**	**7%**
Non-Consumer	**Paper and Card Packaging**	**3326**	**3405**	**2%**
Full Market	**Paper and Card Packaging**	**4749**	**4929**	**4%**
Consumer (Retail)	*Corrugated*	**418**	**443**	6%
Non-Consumer	*Corrugated*	**2960**	**3027**	2%
Full Market	*Corrugated*	**3378**	**3470**	3%
Consumer (Retail)	*Carton and Other Board*	**779**	**836**	7%
Non-Consumer	*Carton and Other Board*	**133**	**193**	45%
Full Market	*Carton and Other Board*	**912**	**1028**	13%
Consumer (Retail)	*Liquid Beverage Carton*	**48**	**46**	-4%
Non-Consumer	*Liquid Beverage Carton*	**3**	**5**	45%
Full Market	*Liquid Beverage Carton*	**51**	**51**	0%
Consumer (Retail)	*Other*	**178**	**195**	10%
Non-Consumer	*Other*	**229**	**180**	-22%
Full Market	*Other*	**407**	**375**	-8%



As can be seen in Figure 7, around 70% of the total paper and card packaging POM is corrugated, with about 21% being carton and other board. Since 2014, the amount of corrugated cardboard placed on the market has increased by 3% and by 13% for carton and other board. Some of this increase is considered to be related to an increase in online sales and the associated additional paper and card packaging used but is also due to an increase in data quality and accuracy. This is reflected by the decline in 'other' packaging (by 8%), which in part is due to an improved data quality within the dataset and being able to identify more items as either corrugated or carton board.

2.5.1 Consumer – Type Paper and Card Packaging

It was considered of interest to provide a POM estimate for that which could be defined as 'consumer-type' paper and card packaging. This would include the total consumer packaging POM identified in section 2.3, plus that identified as hospitality packaging in section 2.4. This is because hospitality packaging is primarily 'household-like' in its nature. This would result in a consumer-type POM of **1,642k tonnes** (+/- 9% error margin[39]).

2.6 POM Cross-checks / Net Pack Fill

This section of the report is used as a cross-check of the total paper and card POM in the UK in 2017, based on the data stored on NPWD, as reported to the EA by obligated organisations and that provided by the Paper and Card Steering Group.

2.6.1 Net Pack Fill

The 2017 UK flow of paper and card packaging was calculated using the packaging weights reported to the EA by registered producers and publicly available on the NPWD website. The calculation used is shown below:

[39] *As described in Figure 2*

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

This methodology took the weight reported at the *packing* stage of the supply chain as opposed to the *selling* stage of the supply chain. This was used as it is believed by stakeholders[40] that there would be fewer unobligated packers in comparison to unobligated sellers, due to the likely size of the businesses. In addition, raw material manufacturing will include process losses, i.e. not everything manufactured will be converted or packed/filled, so it is expected that the tonnage goes down as we move down the supply chain.

Using this method, the total obligated paper and card POM in 2017 is **4,149k tonnes** (as shown in Figure 9)[41].

Figure 9 Obligated packaging (Net Pack Fill total) 2017[42]

	Paper and Card (k tonnes)
Table 1 Pack/Fill (UK pack/filling)	2,611
Imports:	
3A Selling (filled imports)	1,341
3B (packaging removed from imports)	618
Total	**4,570**
2A P/F (direct exports)	400
2B P/F (third party exports)	21
Total Exported	**413**
Net Pack Fill	**4,149**

This method does not account for paper and card 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 feedback from the stakeholder group, it is believed that the number of pack/fillers who are unobligated could be large due to the proportion of small importers and online sellers. An estimate of the unobligated tonnage (780k tonnes, 16%) has been made by subtracting the net pack fill figure of 4,149k tonnes from the project's final flow estimate of 4,929k tonnes. The unobligated proportion of 16% is a reduction from the 21% identified in the 2014 Paper Flow report. This change could be due to an increase in obligated companies (due to higher turnover and use of packaging) and those reporting that had previously been free-riding. This proportion was considered appropriate by the Paper and Card Steering Group.

[40] *No evidence data is available to support this.*
[41] *As reported by businesses in 2018.*

[42] *Data correct in February 2019. Amendments to the 2017 data are still possible.*

2.6.2 Steering Group Data

Members of the Paper and Card Steering Group[43] were able to provide confidential data on the flow of paper and card packaging onto the UK market. In some cases, this data related to the UK production of packaging only and as such had to be combined with an estimate of paper and card packaging imported into the UK. Using NPWD data, the proportion of paper and card packaging placed on the market that was imported was estimated to be around 48% and was used with Steering Group data to compare to the overall project POM conclusions.

All data received by the Steering Group was provided early on in the project and following the project's conclusions was compared and considered in line with the project's estimate of 2017 POM of 4,929k tonnes, one estimate being within 1.5% of the projects total POM and other sector specific estimates being within 4% or 5% of the project's estimates[44]. The draft results of the project were also shared with and agreed by the Steering Group in January 2019.

It was also possible to compare paper and card packaging consumption per person in the UK with equivalent data reported (although based on varying methodologies in each country) from other European countries on Eurostat[45]. Based on the project POM, consumption of paper and card packaging in the UK is 74.7kg/capita, this compares to a European average of 69.3kg/capita, with data ranging from 20kg to 98kg/capita. This therefore puts the UK slightly above the European average based on this data source, but within a similar range.

2.7 Results: Final Project Estimate of 2017 Paper and Card Packaging POM

The project estimate for paper and card packaging POM in 2017 is 4,929k tonnes (+/- 9%).
This has been derived using a bottom-up methodology, taking data from various sources for each sector and combining the results. It has been cross-checked with reported obligated data on NPWD and with data provided by the project's Steering Group.

The final project estimate for paper and card packaging POM in the consumer sector is 1,524k tonnes (+/-11%)
This method is 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 there is available and is accepted by industry.

The final project estimate for paper and card packaging POM in the non-consumer sector is 3,405k tonnes (**+/-12%)**
This data was derived by applying packaging protocols to the Defra C&I Waste Statistics for 2014. It has been broken down and verified using Valpak EPIC data and that from a retailer survey of back of store waste carried out for this project.

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[43] A list of Steering Group members can be found in the acknowledgements of this report

[44] Due to the confidential nature of the data provided to the project team, full details of the comparisons were not able to be published

[45] Extracted and updated in November 2018.

Figure 10 Final Project Estimate of Paper and Card POM[46]

	Total (k tonnes)	Corrugated (k tonnes)	Carton & Other Board (k tonnes)	Liquid Beverage Cartons (k tonnes)	Other (k tonnes)
Consumer	1,524 +/-11%	443	836	46	195
Non-consumer	3,405 +/-12%	3,027	193	5	180
Total	**4,929** +/-9%	**3,470**	**1,028**	**51**	**375**

The total POM estimate was found to be 780k tonnes higher than data reported by obligated companies under the Packaging Waste Regulations (using the UK net pack fill calculation method). This suggests that non-obligated companies (handling fewer than 50 tonnes of packaging or with lower than £2 million turnover), account for 16% of paper and card packaging in the UK. This has reduced from the 21% non-obligated POM identified in 2014.

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.

[46] *Totals may not sum due to rounding*

3.0 Collection & Reprocessing of Material

3.1 Introduction

This section of the report examines the levels of paper and card packaging waste collected in the UK and then recycled, either in domestic mills or outside of the UK. The collections are split between consumer (Local Authority managed collections from households) and non-consumer collections. As in the previous Paper Flow project, the data on Local Authority collections, reported on Waste Data Flow (WDF), is used as a proxy for household recycling and data from NPWD is taken as the total accredited (recorded) recycling. However, NPWD figures do not account for unaccredited reprocessing[47], therefore this project has also completed a separate analysis on this element in order to provide an estimate of the total recycling, accounting for that which is unaccredited.

3.2 Total UK Paper and Card Packaging Recycled

Total UK paper and card packaging recycled	=	Total recorded recycling	+	Total unrecorded recycling

NPWD is used to identify the total recorded recycling of paper and card packaging, both in the UK and of exports for recycling overseas. However, not all of the paper and card packaging might be captured on NPWD. To try and identify the scale of this unrecorded recycling, conversations were held with the Steering Group as well as UK recyclers and exporters. Firstly, conversations focused on any unaccredited recycling or export of the key grades that contain packaging materials, cardboard and mixed papers. For these grades, most felt that very little recycling was occurring in UK mills that was not captured and recorded on NPWD. This is due to there being a small number of key industry players, all of whom are known to be accredited. Recycling of packaging grades in some small pulping mills that exist was felt to be at or close to zero. As any unrecorded recycling in UK mills was felt to be minimal, it was assumed in calculations that there was no unaccredited recycling at UK mills.

There was felt to be some unrecorded recycling occurring with exports, where those exporting relatively small tonnages of recovered packaging grades maybe not always having an incentive to register overseas mills. This may happen if volumes being shipped are small one-offs or if a new mill (from the perspective of the exporter) is supplied towards the end of an accreditation year. In the latter scenario, there may be insufficient time to register the mill with the Regulator and / or the administrative burden and cost of registering the mill may not be worthwhile compared to the additional revenue from PERN sales. The loss was felt to be greater with the export of mixed paper as the revenue received by the exporter is only on the packaging content (34.5% of the bale based on an Environment Agency protocol), which reduces the revenue per tonne of recovered fibre shipped. Despite a belief amongst those consulted that some unaccredited recycling in export markets was occurring, it was generally felt to be small as the majority of the recovered fibre exports are through a relatively small number of large companies to specific mills or mill groups. A 98% accredited tonnage capture rate was estimated for the export of recovered cardboard for recycling and 95% capture rate for mixed papers exported for recycling.

The recycling of paper and board packaging materials in grades of recovered fibres where there is no national protocol was also discussed with industry, in particular any packaging content in deinking grades such as newspapers and magazines. Whilst packaging materials

[47] *That which is reprocessed or exported for reprocessing by a company that is not accredited/registered with the EA to raise PRNs/PERNs on packaging reprocessed/exported.*

are not targeted in these grades, and mills typically have maximum tolerance levels of 1.5% in their specifications, feedback from industry suggests that the actual levels of packaging content present are higher than desired. This can occur due to contamination of deinking grades with packaging materials during the sortation of mixed fibre streams at MRFs. The assumed packaging content used in the modelling for this report is 7%, based on the feedback received from industry, including those with experience in buying and selling this grade. The total unrecorded figure for packaging recycled within deinking grades was calculated by taking the total estimated flow of newspapers and magazines and removing the percentage of the flow believed to have packaging content picked up and recorded on NPWD through local protocols agreed with the Regulator. It was then multiplied by 7%.

Taking into consideration all of the aforementioned factors, the total unrecorded (unaccredited) recycling of paper and card packaging in 2017 was estimated to be 111k tonnes. This is a smaller figure than when the last PaperFlow report was completed (367kt). The difference can be explained by a change in methodology and in the national protocol for mixed paper. When calculating the recorded recycling in the previous report a significantly lower national protocol for mixed papers was in place (12.5% as opposed to 34.5% currently). The actual percentage of packaging in mixed paper was most likely higher than 12.5% which would have increased the unrecorded recycling, based on the methodology used at that time.

3.3 Consumer Recycling

Consumer recycling data was extracted from WDF and 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[48]. A summary of the UK LA paper and card packaging collections are shown in **Error! Reference source not found.**.

Figure 11 Paper and Card Packaging WDF data 2016/17

	Total k tonnes	Kerbside	Bring	CA
Consumer Paper and Card Packaging Collected	1,027	821	17	188

As shown in the table**,** 1,027k tonnes of paper and card packaging is reported on WDF by LAs as being collected. However, it should be noted that some (70k tonnes) of the paper and card collected is recorded by Local Authorities on WDF as *mixed paper and card*. This grade includes a mixture of packaging and non-packaging materials and an Environment Agency protocol has been used to estimate the volume of packaging collected within this. After the release of Paper and Card Flow 2020, the packaging content protocol on this grade was increased by the Environment Agency from 12.5% to 34.5% packaging content. Therefore, whilst the previous Paper Flow project reported 1,017k tonnes of paper and card packaging collected by Local Authorities, the increase seen to 2017 is impacted by this protocol change. The protocol was changed due to a year-on-year decrease in newsprint grades entering the market and increased packaging content, in particular from online shopping. In fact, it is generally observed by the Steering Group and reported in the media based on Defra statistics[49] that household collections of paper and card packaging have reduced between 2013 and 2017, although this may be related more to newsprint than packaging, but no data was available to prove this.

[48] *At the time of writing 2016/17 was the most recent full set of WDF data available.*
[49] https://www.rebnews.com/defra-stats-show-90000-tonnes-less-of-paper-and-card-were-collected-from-households/

3.4 Non-consumer Recycling

Non-consumer collections were estimated as follows:

Non-consumer recycling	=	Total UK paper and card packaging recycled	-	Consumer recycling

As covered in section 3.2, total UK paper and card packaging recycling consists of the total tonnage of paper and card packaging recycled and recorded on NPWD[50] combined with the project's estimate for unrecorded recycling.

The total consumer paper and card packaging, taken from WDF as per section 3.3, is removed from the total recycling figure and what remains is assumed to be non-consumer paper and card packaging. The estimate for non-consumer collections is shown in **Error! Reference source not found.**[51]. It should be noted, that the use of WDF as a recycled figure is a simplification as there will be some process loss during sorting at the MRF (where this occurs). This in turn may lead to a slight overstating of the consumer recycling figure and, by the nature of the calculation, a slight understating of the non-consumer recycling figure.

Figure 11 Paper and Card Packaging WDF data 2016/17

	Total		Consumer		Non-Consumer	
	Tonnes	Recycling Rate	Tonnes	Recycling Rate	Tonnes	Recycling Rate
Unrecorded	111k				111k	
NPWD/Recorded	3754k	76%	1027k	67%	2727k	80%
Total Recycled	**3865k**	**78%**	**1027k**	**67%**	**2838k**	**83%**

Based on the tonnages in **Error! Reference source not found.** and the conclusions around consumer and non-consumer paper and card packaging POM made earlier in the report, it is possible to estimate that 67% of consumer and 83% of non-consumer paper and card packaging was recycled in 2017, with an overall recycling rate of 78%. However, when the unrecorded paper and card packaging recycling is removed, this recycling rate drops to 76%.

3.5 End Markets

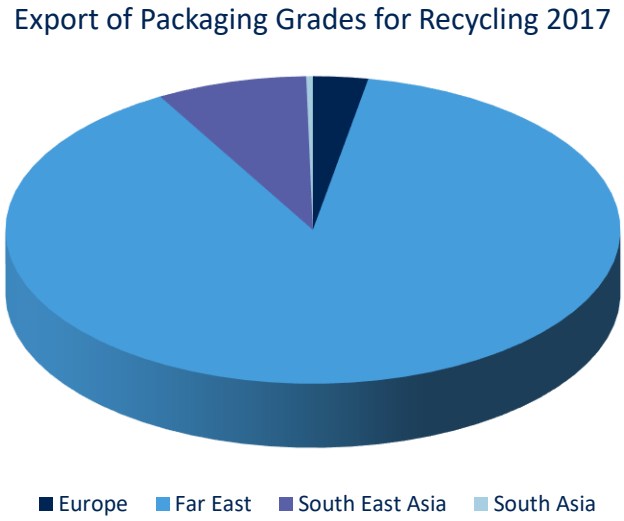
Recovered paper and card packaging is used for the production of new board and cardboard products. Based on NPWD figures for 2017, 34% of the recorded recycling took place in the UK and 66% overseas. This is based on the tonnage of packaging received for recycling in the UK or exported for recycling. For mixed papers, to note is that this is after the packaging content protocol has been applied. A freedom of information request was made to the Environment Agency to determine where the paper and card packaging was exported to for recycling. It can be seen from the breakdowns given below that the vast majority of exports of recovered paper and card packaging for recycling overseas were to mainland

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

[51] *There is a time difference between the NPWD figures (calendar year 2017) and the local authority figures (2016/17 financial year); however, this was the best available data.*

China in 2017. China banned the import of mixed paper at the end of 2017 and also reduced import quotas for other grades of recovered paper, thus the percentage of paper and packaging going to China for recycling has since reduced, although it remains a key market.

Figure 12 Export End Markets (Destination by weight)[52]



Export Regions	
Region	**% of exports**
Europe	2.9
Far East	88.8
South East Asia	7.9
South Asia	0.3

Top 10 export destinations	
Country	**% of exports**
China (mainland)	87.2
Vietnam	4.7
Indonesia	3.1
Taiwan	1.6
Netherlands	1.0
Germany	1.0
Belgium	0.5
India	0.3
France	0.2
Malaysia	0.1

[52] **Data source:** UK Environment Agency. Freedom of Information request **Data Manipulation:** Verde Research and Consulting Ltd. Contains public sector information licensed under the Open Government License v3.0.http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

3.6 Destination of Paper and Card Packaging Not Recycled

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

For consumer paper and card packaging, the non-recycled total is 497k tonnes. An analysis of data on WDF combined with data from Scottish Environment Protection Agency (SEPA), StatsWales and DAERA was used to estimate the percentage of residual household waste that was sent to Energy from Waste (EfW) and landfill. This showed that in 2017 approximately[53] 65% of consumer waste was destined for energy from waste (EfW) and 35% to landfill. The 65% to EfW includes refuse derived fuel (RDF) that is then exported to EfW plants in mainland Europe. Using these percentages, we can estimate that of the total consumer paper and card packaging not recycled, 323k tonnes was sent for energy recovery and 174k tonnes to landfill.

For non-consumer paper and card packaging, the non-recycled total is 567k tonnes. Here, a figure for the paper and card packaging sent for energy recovery was derived by estimating the average paper and card packaging content in both the C&I waste sent for energy recovery in the UK and in the RDF exported to overseas energy recovery plants (15% was assumed in each case). A figure of 1.83mt of C&I waste being sent to UK EfW plants was used. This was based on research by Tolvic[54] on the total tonnage of waste delivered to UK EfW plants in 2017 (10.89m tonnes) and the percentage of this that was C&I waste (16.8%). For RDF exported, an Environment Agency figure of 3.2m tonnes of RDF exports was used with the assumption made that 50% of this was produced from C&I waste. Finally, it was assumed that any non-recycled non-consumer paper and card packaging remaining was sent for landfill. Using these assumptions, we can estimate that of the total non-recycled paper and card packaging, 514k tonnes (91%) was sent for energy recovery and 52k tonnes to landfill (9%).

[53] *The figure is approximate, as data is reported in different ways. Most is for the period April 2016 to March 2017 however the SEPA data reviewed was for 2017. Also, some data was for household waste (used where available) and other data for municipal solid waste.*

[54] *Tolvic Consulting UK Energy from Waste Statistics 2017*

4.0 Material Projections & Compliance

4.1 Introduction

This section of the report reviews the historical data and trends for paper and card packaging POM in the UK, and paper and card accredited packaging recycling as reported by accredited reprocessors and exporters.

Based on these data, univariate time-series models (linear trend and autoregressive models) are estimated and, using these models, a range of scenarios for paper and card packaging POM and paper and card packaging accredited recycling are projected forward to 2025. The intention here is to provide a range of plausible possible futures for paper and card packaging POM and accredited recycling to inform policymakers and other stakeholders.

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

4.2 Paper and Card POM and Projections

Historically, paper and card packaging POM has been estimated by a process of consultation and periodic review with industry and stakeholders (for example the Paper and Card Flow 2020, the PackFlow 2017, and PackFlow 2012 reports). In the PackFlow methodologies paper and card packaging POM was established using assumed growth rates from a historic baseline, with the growth rates and resultant POM tonnages discussed and agreed with industry, government and stakeholders before being adopted for target setting.

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, there isn't a long historic time series (suitable for modelling) available for paper and card POM tonnages.

However, the EA's NPWD does provide a data source from which to assess trends over time in paper and card 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 into NPWD each year. Therefore, historic data on the quantities of paper and card packaging handled by obligated producers ('obligated' POM) is available for trend analysis.

What is not known is the quantity of non-obligated and unregistered packaging, in other words packaging handled by businesses who are 'de-minimis' or who are for whatever reason 'free-riders'. Once a total POM is established this can be straightforwardly estimated. If, in the past, the proportion of non-obligated and 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.

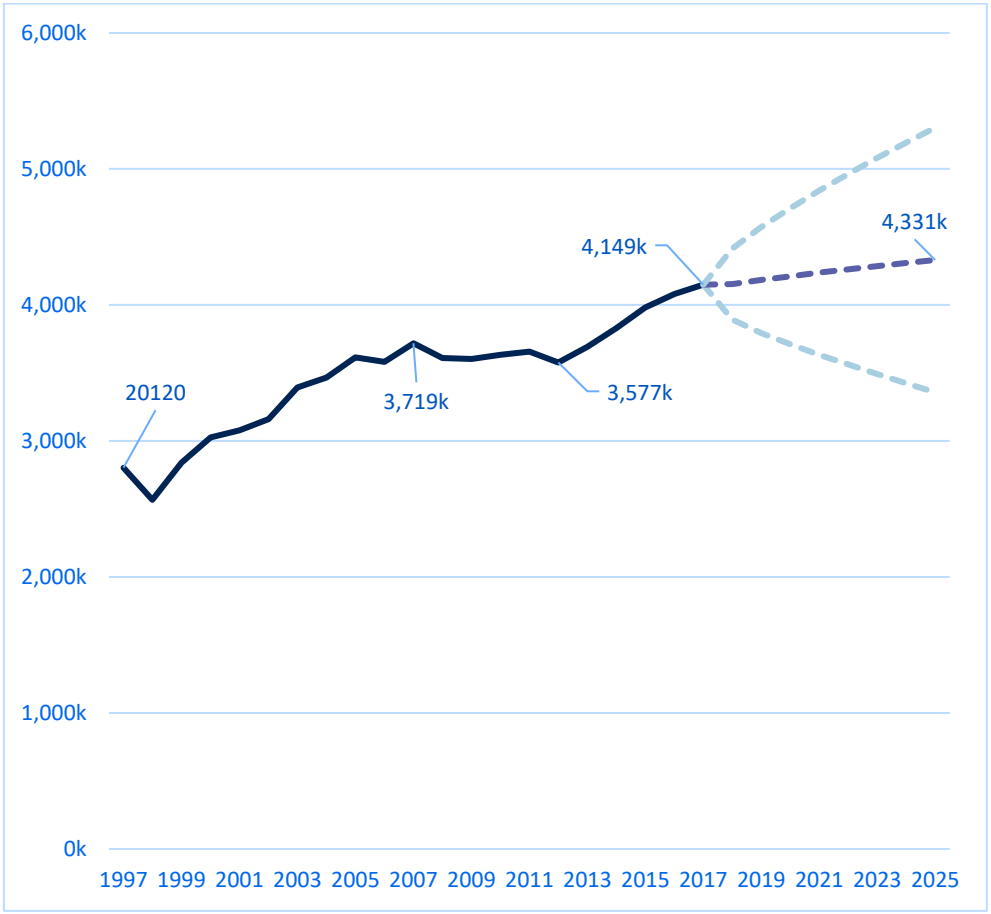
That said, the tonnages reported by obligated producers in NPWD are impacted, for example by businesses coming into the regime that were previously 'free-riding'. Additionally, since the packaging regulations were introduced there have been instances of changes to legislation which may also affect POM tonnages, for example the status of packaging for 'internal use only' being not obligated. However, it is likely that over time businesses have gained a better understanding of the requirements of the legislation which itself has likely improved the accuracy of data reported into NPWD.

Here it is assumed that the paper and card packaging net pack fill tonnages 1997 to 2017 (calculated using NPWD data as described in Section 2.6.1 of this report) are the best available data to use to:

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

Figure 13 shows the historic data for paper and card packaging UK net pack fill. The past outturns for Net Pack Fill show a steady increase from 1997 to 2007 before levelling out around the time of the recession triggered by the financial crisis in 2008/9. Since 2012, paper and card packaging net pack fill has increased at a similar pace (around 3% a year), as observed during the period from 1997 to 2007.

Figure 13 Paper and card Packaging Net Pack Fill, Projection and 95% Confidence Interval



Clearly the recession had an impact on paper and card packaging POM although it is also likely that light-weighting activity has also suppressed paper and card packaging relative to consumption, but the extent to which this has happened is not precisely known. Other factors potentially impacting on POM trend (past and future) are discussed below.

Figure 14 Paper and Card Packaging Net Pack Fill versus Economic Activity Indicators

	1997-2017		2012-2017		2018 - 2020		2018 - 2025	
	Level	Average Growth	Level	Average Growth	Level	Average Growth	Level	Average Growth
Net Pack Fill	48.0%	1.9%	16.0%	3.0%	1.4%	0.7%	4.3%	0.6%[55]
GDP	49.0%	2.0%	11.4%	2.2%	3.1%	1.5%	11.2%	1.5%
POP	13.2%	0.6%	3.7%	0.7%	1.2%	0.6%	3.7%	0.5%
Retail Sales	69.0%	2.7%	16.7%	3.1%	2.0%	1.0%	11.1%	1.5%

Figure 17 compares the level and growth of net pack fill to other indicators of economic activity such as GDP[56], population[57] and retail sales[58]. Over the two decades to 2017, paper and card packaging net pack fill has increased at similar annual growth rates to GDP. The increase in paper and card net pack fill has been stronger than population growth but weaker than retail sales growth. Since 2012 the increase in net pack fill has been more in line with retail sales growth (stronger than GDP growth and population growth) which probably reflects the increase in online sales of products over the more recent period.

Using the historical net pack fill data for paper and card packaging statistical models - univariate time-series models (a linear trend model and two autoregressive models) - are estimated. The AR(1) model was selected as the preferred model based on statistical criteria and with a scenario for paper and card packaging POM projected to 2025 (Scenario 1). Full details of the methodology used to estimate the models can be found in Appendix II.

By assumption, factors driving past trend growth in paper and card packaging net pack fill (and hence by assumption POM) are projected into the future. While this projection is 'data based' it is not intended to be sophisticated. For example, it doesn't account for potential substitution effects within paper and card packaging or between paper and card packaging and other packaging materials (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 these 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** 13.

This scenario for paper and card packaging POM to 2025 was discussed with the project Steering Group. It assumes the 2018 POM figure (the first year of the projection scenario)

[55] *Paper/card net pack fill AR(1) model projected average annual growth rate 2018 to 2025 as in POM scenario 1, in POM scenario 2 the average annual growth 2018 to 2025 is slightly stronger at 0.9% per annum*

[56] *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.*

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

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

for paper and card packaging is the same as the 2017 POM figure of 4,929k tonnes developed in this project.

The scenario for paper and card POM, reported in Figure 15, is based on the projected growth rates of net pack fill from the AR(1) model. The projection for POM growth for 2018 to 2025 is weaker than expected GDP growth and retail sales growth. The advisory group noted that a paper and card POM growth below that expected for GDP seemed sensible, with light-weighting (particularly ongoing in corrugated board products) and initiatives to remove outer boxes from product shipments being possible supporting reasons for this scenario (for example offsetting some of the growth in paper and card packaging POM from growth in online sales).

Under this scenario (Scenario 1), paper and card packaging POM is projected to increase from 4,929k tonnes in 2018[59] to 4,997k tonnes in 2020, and to 5,138k tonnes in 2025, an increase of 210k tonnes or 4.3% in 2025 compared to 2018.

Figure 15 Scenario 1 Paper and Card Packaging POM, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
Scenario 1 POM	4,929	4,964	4,997	5,028	5,058	5,086	5,113	5,138
% change	-	0.7	0.7	0.6	0.6	0.6	0.5	0.5

A second scenario was developed based on discussions with the Steering Group, which suggested that paper and card POM growth could potentially be higher than in Scenario 1 later in the projection horizon. Adopting this suggestion brings projected paper and card POM growth to be more closely aligned to expected GDP growth. To illustrate this scenario, indicative growth rates for paper and card POM were applied (with growth rates increasing from 2021 compared to Scenario 1) to provide a projection to 2025 for Scenario 2 which is shown in Figure 16.

Scenario 2 projects paper and card POM to increase from 4,929k tonnes in 2018 to 5,246k tonnes in 2025 (an increase of 318k tonnes or 6.4%). The Scenario 2 projection for paper and card packaging POM is used in the compliance assessment in section 5.3.

Figure 16 Scenario 2 Paper and Card Packaging POM, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
Scenario 2 POM	4,929	4,964	4,997	5,042	5,092	5,143	5,194	5,246
% change	-	0.7	0.7	0.9	1.0	1.0	1.0	1.0

4.3 Paper and Card Packaging Accredited Recycling Projections

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

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

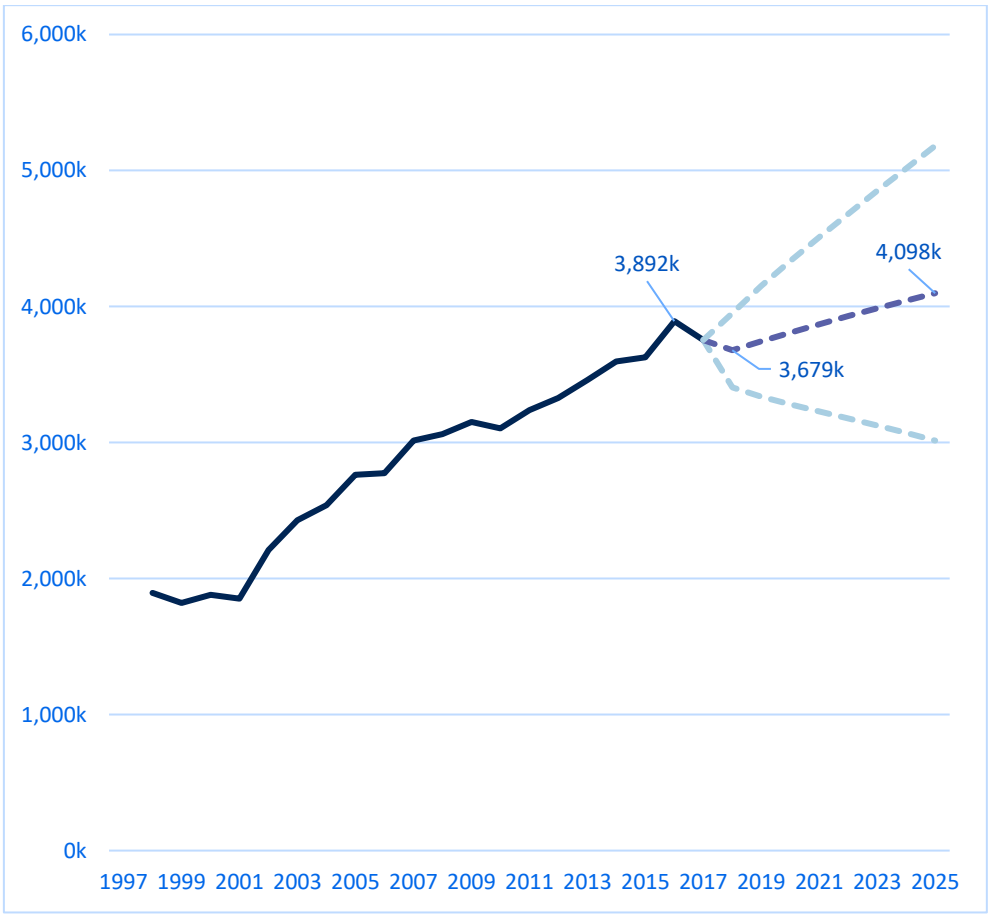
reprocessors/exporters, or paper and card packaging that is recycled, but not recorded as accredited recycling by accredited reprocessors/exporters.

To establish a scenario for accredited paper and card packaging recycling to 2025, statistical models - univariate time series models (linear trend and auto-regressive models) – are estimated. A preferred model is selected on statistical criteria. For accredited paper and card recycling the preferred model is the AR(1) model and it is used to project a scenario for accredited paper and card packaging recycling to 2025. The projection is shown in Figure 17. Full details of the methodology used to estimate the models can be found in Appendix II.

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, whilst 'data based' and intended to be plausible, the projection is not intended to be sophisticated. In addition to factors potentially impacting on the weight of paper and card packaging POM discussed above, it ignores factors such as expected developments of collection systems (such as the introduction of a deposit return system (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, for example, the potential for investment in UK reprocessing and collections, the continued availability of export markets for paper and card packaging and the potential demand for recycled content in paper and card packaging.

Figure 17 Paper and Card Packaging Accredited Recycling, Projection and 95% Confidence Interval



Provisional 2018 figures for accredited paper and card packaging recycling are available for 2018 Q1 to Q3 from NPWD. A total of 2,685k tonnes of paper and card packaging has been recorded as accredited recycling, a decrease of 4.2% compared to the same period in 2017.

The 2018 full year estimate of 3,679k tonnes assumes accredited paper and card packaging recycling growth continues in the 2018 Q4, but the 2018 full year figure estimated is a decline of around 2% compared to the 2017 full year figure. The Steering Group commented that they expected a decline of around 2% (i.e. a smaller decline compared to that implied by the available quarterly accredited recycling figures for paper and card packaging) due to increased quantities in outer packaging to households (from back of store).

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 paper and card packaging recycling, and are shown in Figure 18 together with 95% confidence intervals as indicative upper and lower bounds to the projection.

Figure 18 Paper and Card Packaging Accredited Recycling Projection, 2018 to 2025 (k tonnes, %)

Year	2018	2019	2020	2021	2022	2023	2024	2025
Accredited recycling	3,679	3,744	3,808	3,869	3,929	3,987	4,043	4,098
% change	-2.0	1.8	1.7	1.6	1.5	1.5	1.4	1.3

Figure 18 reports the projected tonnages for accredited paper and card packaging recycling to 2025. In this scenario, paper and card packaging increases from 3,679k tonnes in 2018 to 3,808k tonnes in 2020, and to 4,098k tonnes in 2025 - an increase of 419k tonnes, or 11.4% in 2025 compared to 2018. This scenario for paper and card packaging accredited recycling is used in the compliance assessment in section 4.4.

4.4 Paper and Card Packaging Compliance Assessment

This section reports a compliance assessment based on the scenarios to 2025 for paper and packaging POM and accredited paper and card packaging recycling reported in sections 4.2 and 4.3.

For this compliance assessment, the material specific targets on obligated businesses for paper and card packaging (71% in 2018, 73% in 2019 and 75% in 2020) are expressed as equivalents to national (or all material) recycling targets based on total paper and card packaging POM (60% in 2018, 61% in 2019 and 63% in 2020).

There are no targets set beyond 2020; here the targets shown for 2021 to 2024 are a linear extrapolation from the 2020 national target to the 2025 CEP national target. The CEP target of 75% is assumed in 2025, which equates to a target on obligated businesses of 89% assuming that a constant 16% of paper and card packaging POM is non-obligated or unregistered in each year to 2025 (the CEP target is assumed to apply to all paper and card packaging POM).

Based on these targets and the projection scenarios for paper and card 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 paper and card packaging recycling.

To assess the likelihood of meeting the targets, the probability of meeting the targets in each year is also calculated. 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. Full details of the methodology used can be found in Appendix II.

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 CEP target for 2025.

Figure 19 reports the compliance assessment for the projected scenarios to 2025 for paper and card packaging POM and accredited paper and card packaging recycling.

Assuming the 2018[60] POM figure of 4,929k tonnes developed in this project is applicable, and that the projections for paper and card packaging POM and accredited paper and card packaging recycling are plausible, based on this assessment, the UK is likely to meet the paper and card packaging recycling targets in 2018, 2019 and 2020, and the CEP target in 2025.

Figure 19 Paper and Card Packaging Accredited Recycling Compliance Assessment

Year	POM* (k tonnes)	National target (%)	Accredited recycling required (k tonnes)	Projected accredited recycling** (k tonnes)	Probability of meeting the target (%)	National recycling rate (%)
2018	4,929	60	2,940	3,679	100.0	74.6
2019	4,964	61	3,044	3,744	100.0	75.4
2020	4,997	63	3,148	3,808	99.3	76.2
2021	5,042	65	3,297	3,869	96.0	76.7
2022	5,092	68	3,452	3,929	89.3	77.2
2023	5,143	70	3,610	3,987	80.4	77.5
2024	5,194	73	3,771	4,043	70.8	77.8
2025	5,246	75	3,935	4,098	61.6	78.1

*Scenario 2 projection for POM as reported in section 5.1, ** model-based projection as reported in section 5.2

In each year of the projected scenario, the projection for accredited recycling exceeds the expected amount of accredited recycling required to meet the target, and so the implied recycling rates for paper and card packaging are above the targets.

The associated probabilities of meeting the national equivalents of the business targets in 2018, 2019 and 2020 are 100.0%, 100.0% and 99.3%, and 78.1% for the CEP target in 2025.

4.5 Conclusions

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

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

- The scenario for paper and card POM projects an increase from 4,929k tonnes in 2018[61] to 4,964k tonnes in 2020, and to 5,246k tonnes in 2025, an increase of 318k tonnes or 6.4% in 2025 compared to 2018.

- The scenario for paper and card packaging recycling projects an increase from 3,679k tonnes in 2018 to 3,808k tonnes in 2020, and to 4,098k tonnes in 2025, an increase of 419k tonnes or 11.4% in 2025 compared to 2018.

- Paper and card 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 projection of accredited recycling required to meet the targets, and the implied recycling rates being above the targets in each year.

- In terms of the likelihood of meeting the targets based on this compliance assessment, the associated probabilities of meeting the national equivalents of the business targets for paper and card accredited packaging recycling in 2018, 2019 and 2020 are 100.0%, 100.0% and 99.3%, and 78.1% for the CEP target in 2025.

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

5.0 Conclusions

5.1 Material Flow

The project estimate for paper and card packaging POM in 2017 is 4,929k tonnes (+/- 9%): an increase of 4% from the estimated current flow figure (2014).
This has been derived using a bottom-up methodology, taking data from various sources for each sector and combining the results. It has been cross-checked with reported obligated data on NPWD and with data provided by the project's Steering Group.

The final project estimate for paper and card packaging POM in the consumer sector is 1,524k tonnes (+/- 11%)
This method is 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 there is available and is accepted by industry.

The final project estimate for paper and card packaging POM in the non-consumer sector is 3,405k tonnes (+/- 12%)
This data was derived by applying packaging protocols to the Defra C&I Waste Statistics for 2014. It has been broken down and verified using Valpak EPIC data and that from a retailer survey of back of store waste carried out for this project.

Non-obligated or unregistered flow for paper and card packaging accounted for 16% of POM in 2017 – this represents a decline from that reported in 2014 of 21%
Using data from NPWD, an estimate of the unobligated tonnage (780k tonnes, 16%) has been made by subtracting the net pack fill figure of 4,149k tonnes from the project's final flow estimate of 4,929k tonnes. The unobligated proportion of 16% is a reduction from the 21% identified in the 2014 Paper Flow report. This change could be due to an increase in obligated companies (due to higher sales) and those reporting that previously had been free-riding.

The final project estimate of paper and card packaging POM by type is 3,470k tonnes (70%) corrugated, 1028k tonnes (21%) carton and other board, 51k tonnes (1%) liquid beverage cartons and 375k tonnes (8%) other packaging
Using primarily information derived from Valpak's EPIC database, the final project estimate by format has been made. This indicates that almost three quarters of paper and card packaging POM is corrugated.

5.2 Material Recycling

The total tonnage of UK waste paper and card packaging recycled is estimated to be 3,865k tonnes.
This includes reported (NPWD) and an estimate for unreported recycling (111k tonnes). Based on the POM calculated as part of this project, this gives an overall recycling rate of 78%. Of this, 3,754k tonnes was reported on NPWD, representing a recycling rate of 76%.

The total tonnage of consumer UK waste paper and card packaging recycled is estimated to be 1,027k tonnes.
This is based on WDF. Based on the POM calculated as part of this project the consumer recycling rate is estimated at 67%, down 4 percentage points since 2014.

The total tonnage of non-consumer UK waste paper and card packaging recycled is estimated to be 2,838k tonnes.
This is calculated by removing the consumer recycling tonnage from the total tonnage recycled figure. Based on the POM calculated as part of this project, this gives a non-consumer recycling rate of 83%.

Of the total 1,064k tonnes of unrecycled paper and card packaging, 837k tonnes (79%) was sent for energy recovery and 226k tonnes to landfill (21%)
This was based on an estimated total of 487k tonnes consumer paper and card packaging not being recycled and 567k tonnes non-consumer.

5.3 Material Projections & Compliance

The scenario projection for paper and card POM projects an increase from 4,929k tonnes in 2018[62] to 4,964k tonnes in 2020, and to 5,246k tonnes in 2025
This represents an increase of 318k tonnes (6.4%) between 2018 and 2025.

The scenario projection for paper and card packaging recycling projects an increase from 3,679k tonnes in 2018 to 3,808k tonnes in 2020, and to 4,098k tonnes in 2025
This represents an increase of 419k tonnes (11.4%) between 2018 and 2025.

Paper and card 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.

T**he associated probabilities of meeting the national equivalents of the business targets for paper and card accredited packaging recycling in 2018, 2019 and 2020 are 100.0%, 100.0% and 99.3%, and 78.1% for the CEP target in 2025**

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

6.0 Recommendations for Further Work

Further surveying of non-consumer waste
The most uncertain element of the POM estimate is that relating to non-consumer paper and card packaging. To improve the accuracy of the data, a more recent data source should be used (the most recent available at the time of writing was for 2014) and that which splits out packaging and non-packaging.

At the time of writing a Defra Consultation on the reform of the Packaging Waste Regulations was anticipated. Key areas of improvement to the Regulations that would support improved data reporting and compliance include:

Reviewing elements of the Packaging Regulations to capture more non-obligated or unregistered tonnage
Removal of de minimis - those companies who are below the packaging obligation threshold by having a turnover of under £2 million and handling less than 50 tonnes of packaging

If the de minimis is not removed, the following could be considered:

- Re-introducing the service provider clause. This was originally introduced to capture tonnage sold to small businesses by wholesalers and therefore not captured, as the 'selling' organisation was too small to be obligated. A revised version of this clause could be re-introduced to capture this non-obligated tonnage by placing an obligation on the wholesaler.
- Clauses in the Regulations exist to capture tonnage handled by lessors and franchisors who do not necessarily perform pack filling and selling but are responsible for these activities and as such take on their packaging obligation. This could be extended to cover other organisations, for example businesses performing a "fulfilment service", who either do not perform the packaging activities or do not own the packaging but are responsible for the sales outlet and/or marketing function of the products sold. This business model has become increasingly popular for "online" sales.
- Investigate the potential for unobligated or unregistered tonnage to be supplied through increasing use of internet "marketplace" arrangements, particularly where products are supplied from other countries
- Currently, packaging used internally by an organisation (for example for transporting between or within sites) is exempt from the Regulations. This may be a significant volume for paper and card and therefore its inclusion within the obligated tonnage could be investigated further.
- In cases where the brand owner supplies packaging to contract packers free of charge (contract packing), the brand owner is responsible for the obligation. However, it is suspected that this may be overlooked by producers in many cases and as such could be a focus of compliance scheme or enforcement agency auditors to carry out checks and issue reminders.

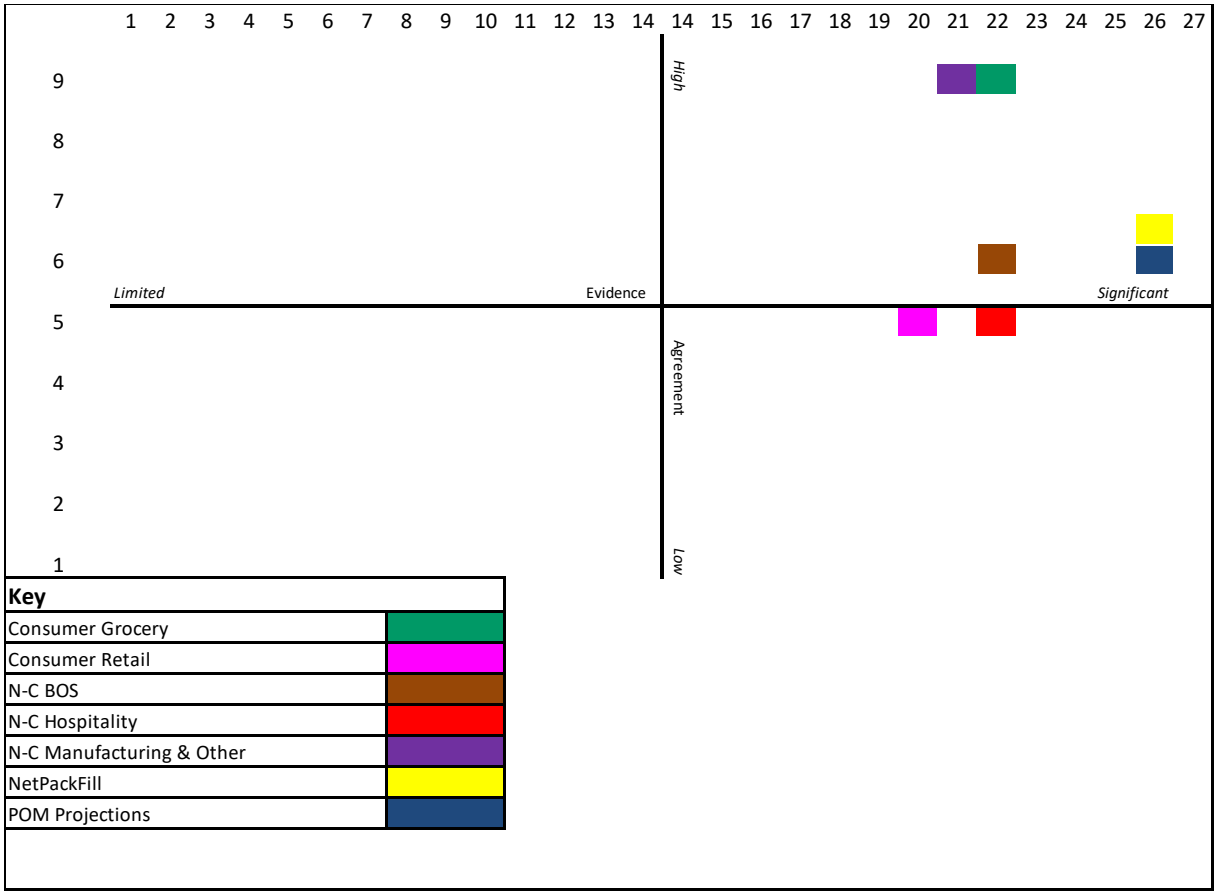
Recommended accreditation for all recycling activities
If all companies in the UK performing recycling activities on packaging were to become accredited, this would ensure that PRNs were issued on more of the packaging material recycled, resulting in no unaccredited recycling and simpler compliance for the UK with regulatory targets. All reprocessors becoming accredited for recycling activities could increase the number of PRNs/PERNs generated for recycling, by up to 367k tonnes in 2014.

Appendix I Robustness Assessment

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 20 (POM), Figure 21 (Recycling) and a summary in Figure 22, 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 depending on the degree of reservation over the robustness.

Figure 20 Data Robustness Assessment Results – POM



To convert scores to a percentage that could be used to relate to an appropriate error margin[63], the evidence and agreement levels scores were added and the percentage of the total possible score taken.

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

Figure 21 Data Robustness Assessment Results – Recycling

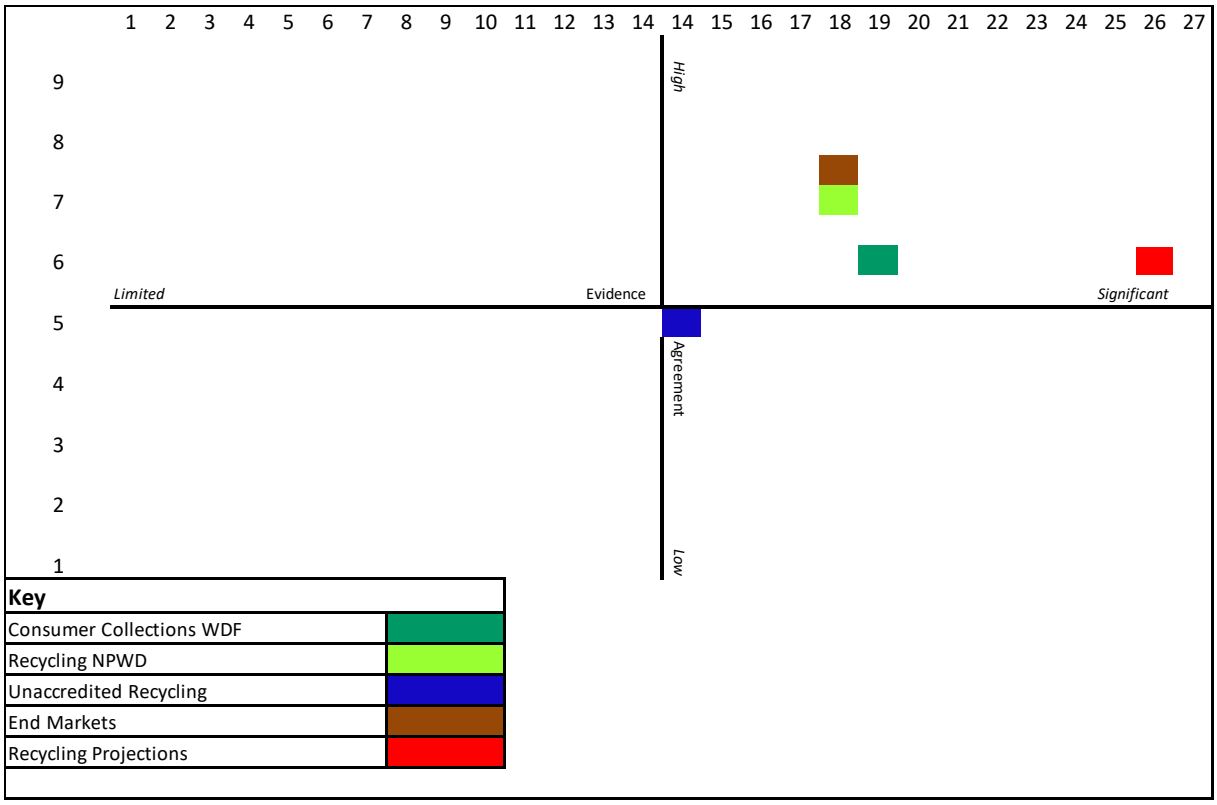


Figure 22 Data Robustness Assessment Results – Summary

	Robustness Scores		
Data & Source	**Evidence (Robustness and completeness, max 27):**	**Degree of agreement around the findings (max 9):**	**Error Margin**
Environment Agency Grocery Retailer Packaging Handled	24	9	6%
Valpak Turnover & Packaging Handled Data	20	6	18%
Valpak Hospitality EPIC Data	22	6	15%
UK AWP Waste Arisings, Defra/Valpak 2007	19	6	21%
NPWD Producer Data 2017	26	6	9%
NPWD Recycling Data 2017	26	6	9%
Verde Research and Consulting Ltd Survey of Recyclers and Exporters 2019	18	7	21%
Survey of Grocery Retailers 2018	22	6	15%
DEFRA C&I Waste Survey 2014	21	9	12%
WDF 2016/17	19	6	21%

Environment Agency Grocery Retailer Packaging Handled

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?	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 with some reservations	2
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		**22**

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**

Valpak Turnover & Packaging Handled Data

Data
Valpak Turnover & Packaging Handled 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)?	No	0
Total		**20**

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**

Valpak Hospitality EPIC Data

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**

UK AWP Waste Arisings, Defra/Valpak 2007

Data		
UK AWP Waste Arisings, Defra/Valpak 2007		
Source		
Defra/Valpak 2007		
Data Used In:		
Method 1 - POM - Hosp.		

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	3
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	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)?	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?	Yes	3
Total		**6**

NPWD Producer Data 2017

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**

Survey of Recyclers and Exporters 2018

Data		
Survey of Recyclers and Exporters 2018		
Source		
Verde Research and Consulting Ltd		
Data Used In:		
Method 1 - Non-consumer Recycling - Agri & Hospitality		

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**

Survey of Grocery Retailers 2018

Data		
Survey of Grocery Retailers 2018		
Source		
Valpak		
Data Used In:		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Y	3
Does the data provide complete coverage?	yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Y	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Y	3
Have the findings been independently peer-reviewed?	N	0
Is the methodology/calculation reasonably free from concerns?	Y	3
Have the methodology/calculations been independently checked (internally or externally)?	Y	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Y	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**

NPWD Recycling Data 2017

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**

DEFRA C&I Waste Survey 2014

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	no	0
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?	yes	3
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		**21**

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**

WDF 2016/17

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**

Appendix II Technical details of the modelling and projection scenarios

1. Introduction

This appendix reports the detailed estimates of univariate time-series models (linear trend and autoregressive models) based on historical data for paper and card packaging POM and paper and card packaging accredited recycling.

Based on these models a range of scenarios for paper and card packaging POM and accredited recycling are projected forward to 2025. A compliance assessment of potential paper and card packaging accredited recycling versus the paper and card packaging accredited recycling rate targets to 2020, and the CEP target in 2025 is made.

2. Linear Trend and Auto Regressive Models

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, 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 the models we choose the model which minimises the information statistics and maximises the log-likelihood.

3. Paper and Card Packaging Net Pack Fill, Modelling and Projections

The EA's NPWD (National Packaging Waste Database) provides a data source from which to assess trends over time in paper and card 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, historic data on the quantities of paper and card packaging handled by obligated producers ('obligated' POM) is available for trend analysis.

Here it is assumed that the paper and card packaging net pack fill tonnages 1997 to 2017 (calculated using NPWD data as described in Section 2.6.1 of this report) are the best available data to use to:

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

The historic data for paper and card packaging UK net pack fill show a steady increase from 1997 to 2007 before flattening out around the time of the recession triggered by the financial crisis in 2008/9. Since 2012 paper and card packaging net pack fill has increased at a similar pace (around 3% a year) as average growth during 1997 to 2007.

Detailed estimates of the statistical models for paper and card packaging net pack fill - univariate time-series models (a linear trend model and two autoregressive models) - are reported in detail in Figure 23[64].

[64] *Auto regressive models up to order 3 were estimated for the model selection exercise below, since the AR(3) model performed poorly detailed estimates are not shown.*

Figure 23 Paper and Card Packaging Net Pack Fill (linear and AR models)

Model	Linear			AR(1)			AR(2)		
Variable	Coeff	t-stat.	Prob.	Coeff	t-stat.	Prob.	Coeff	t-stat.	Prob.
C	2540196	24.4	0.0%	555061	3.0	0.8%	548206	2.9	1.2%
Trend	56717	10.2	0.0%						
NPF(-1)				0.8639	16.2	0.0%	0.8013	4.63	0.0%
NPF(-2)							0.0658	0.38	71%
R^2	86.1%			93.9%			94.0%		
Adj-R^2	85.2%			93.6%			93.2%		
S.E	132183			87194			89473		
F-stat.	105			263			125		
Prob(F-stat.)	0			0			0		

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 paper and card packaging net pack fill (and POM). Information criteria are reported in Figure 24 (adj-R2 is also included for comparison), based on these the auto-regressive model with 1 lag (AR(1)) model[65] is selected as the preferred model.

Figure 24 Paper and card Packaging Net Pack Fill, Model Selection Criteria

Information criteria	Linear Trend	AR(1)	AR(2)	AR(3)
Adj-R^2	85.2%	93.6%	93.2%	90.7%
Akaike	26.52	25.69	25.79	25.92
Schwarz-Bayes	26.62	25.79	25.93	26.11
Hannan-Quinn	26.54	25.71	25.81	25.94
Log-likelihood	-249.95	-242.05	-241.96	-229.24

The projection scenario for paper and card packaging pack fill is reported in Figure 25. 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.

[65] *For the AR(1) model chow break point statistics against a null hypothesis of no structural break in 2007 are (F-statistic 0.1062, Log-likelihood 0.2637, Wald-statistic 0.2124). All show no statistical significance and do not reject the null hypothesis of no structural break.*

Assuming a normal distribution, 95% confidence intervals are calculated as the upper and lower bounds to the projection and are shown in Figure 25 as indicative upper and lower bounds to the projection.

Figure 25 Paper and Card Packaging Net Pack Fill, AR(1) Model Projections and 95% Confidence Intervals[66]

Year	Lower CI	Net Pack Fill	Upper CI
2018	3,893k	4,154k	4,415k
2019	3,794k	4,183k	4,573k
2020	3,711k	4,211k	4,712k
2021	3,634k	4,238k	4,841k
2022	3,562k	4,263k	4,963k
2023	3,492k	4,287k	5,081k
2024	3,424k	4,309k	5,194k
2025	3,358k	4,331k	5,303k

4. Paper and Card Packaging POM Scenario Projection

The projected scenario for paper and card packaging POM is based on the projected growth rates from the estimated AR(1) model using the historic data for paper and card packaging net pack fill.

It is assumed that the paper and card packaging POM projections increases in line with the projected growth rates of paper and card packaging net pack fill in the scenario for POM. The projected scenario for paper and card packaging POM (and growth rates) in each year to 2025 is shown in Figure 26. Under this scenario, paper and card packaging POM is projected to increase from 4,929k tonnes in 2018[67] (assuming the 2017 POM figure developed in this project applies) to 4,997k tonnes in 2020, and to 5,138k tonnes in 2025, an increase of 210k tonnes or 4.3% in 2025 compared to 2018.

Figure 26 Projected Scenario for Paper and Card Packaging POM[68]

Year	2018	2019	2020	2021	2022	2023	2024	2025
POM	4,929k	4,964k	4,997k	5,028k	5,058k	5,086k	5,113k	5,138k
% change	-	0.7%	0.7%	0.6%	0.6%	0.6%	0.5%	0.5%

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

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

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

5. Paper and Card Packaging Accredited Recycling, Modelling and Projections

This section reports the estimation details of univariate time-series models (linear trend and autoregressive models) based on historical data for paper and card packaging accredited recycling. The estimation results are reported in detail in Figure 27.

Figure 27 Paper and Card Packaging Accredited Recycling, Model Estimates

Model	Linear			AR(1)			AR(2)		
Variable	Coeff	t-stat.	Prob.	Coeff	t-stat.	Prob.	Coeff	t-stat.	Prob.
C	907514	8.0	0.0%	274276	2.0	6.0%	274655	2.0	6.0%
Trend	112122	18.9	0.0%						
R(-1)				0.9419	20.4	0.0%	0.6783	2.70	1.7%
R(-2)							0.2741	1.07	30%
R2	95.7%			96.3%			96.6%		
Adj-R2	95.4%			96.1%			96.0%		
S.E	130618			121123			120610		
F-stat.	357			418			211		
Prob(F-stat.)	0			0			0		

The range of information statistics indicates that a first-order autoregressive model AR(1) for paper and card packaging accredited recycling is the best model for data sample available.

Details of the statistical information criterion which inform the selection of the preferred model are reported in Figure 28 and indicate that the estimated AR(1) model for paper and card packaging accredited recycling is the preferred model on the basis of these information criteria.

Figure 28 Paper and Card Packaging Accredited Recycling, Model Selection Criteria

Information criteria	Linear Trend	AR(1)	AR(2)	AR(-3)
Adj R^2	95.4%	96.1%	96.0%	95.8%
Akaike	26.50	26.35	26.39	26.37
Schwarz-Bayes	26.60	26.45	26.54	26.54
Hannan-Quinn	26.52	26.37	26.41	26.37
Log-likelihood	-236.52	-235.16	-234.51	-219.95

Provisional 2018 figures for accredited paper and card packaging recycling are available for 2018 Q1 to Q3 from NPWD. Paper and card packaging recycling is reported as 838k tonnes for 2018 Q1, 905k tonnes for 2018 Q2 and 895k tonnes in 2018 Q3, so for January to September 2018 a total of 2,685k tonnes of paper and card packaging has been recorded as accredited recycling, a decrease of 4.2% compared to the same period in 2017.

Accredited paper and card packaging recycling posted quarter on quarter growth in 2018 Q2 & 2018 Q3. The 2018 full year estimate of 3,679k tonnes assumes accredited paper and card

packaging recycling growth continues in the 2018 Q4, but the 2018 full year figure estimated results in a decline of around 2% compared to the 2017 full year figure.

The annual projections from 2019 onwards in each of the scenarios are the AR(1) model-based projections for accredited paper and card packaging recycling. The projection scenarios and 95% confidence intervals for paper and card packaging accredited recycling in the linear and autoregressive models are reported in Figure 29.

Figure 29 Paper and Card Packaging Accredited Recycling Projected Scenario 2018 to 2025, and 95% Confidence Intervals (tonnes)[69]

Year	Lower CI	Accredited recycling	Upper CI
2018	3,754k	3,754k	3,754k
2019	3,407k	3,679k	3,951k
2020	3,337k	3,744k	4,152k
2021	3,281k	3,808k	4,335k
2022	3,229k	3,869k	4,510k
2023	3,177k	3,929k	4,681k
2024	3,125k	3,987k	4,849k
2025	3,071k	4,043k	5,016k

6. Paper and Card Packaging Compliance Assessment

This section reports a compliance assessment based on the scenarios to 2025 for paper and packaging POM and accredited paper and card packaging recycling reported in sections 4.2 and 4.3. For this compliance assessment, the material specific targets on obligated businesses for paper and card packaging (71% in 2018, 23% in 2019 and 75% in 2020) are expressed as equivalents to national (or all material) recycling targets based on total paper and card packaging POM, these are 60% in 2018, 61% in 2019 and 63% in 2020. The CEP target of 75% is assumed in 2025 which equates to a target on obligated businesses of 89% assuming that a constant 16% of paper and card packaging POM is non-obligated or unregistered in each year to 2020 (the CEP target is assumed to apply to all paper and card packaging POM). There are no targets set beyond 2020, here the targets shown for 2021 to 2024 are a linear extrapolation from the 2020 national target to the 2025 CEP national target.

Based on these targets and the projection scenarios for paper and card 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 paper and card packaging recycling. To assess the likelihood of meeting the targets the probability of meeting the targets in each year is also calculated. 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

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

with a standard deviation estimated by the standard error of the estimated model in each year.

Figure 30 Compliance Assessment 2018 to 2025 Paper and Card POM and Accredited Recycling Projected Scenario[70]

Year	POM*	National target	Accredited recycling required	Projected accredited recycling**	Probability of meeting the target	National recycling rate
2018	4,929k	60	2,940k	3,679k	100.0%	74.6%
2019	4,964k	61	3,044k	3,744k	100.0%	75.4%
2020	4,997k	63	3,148k	3,808k	99.3%	76.2%
2021	5,042k	65	3,297k	3,869k	96.0%	76.7%
2022	5,092k	68	3,452k	3,929k	89.3%	77.2%
2023	5,143k	70	3,610k	3,987k	80.4%	77.5%
2024	5,194k	73	3,771k	4,043k	70.8%	77.8%
2025	5,246k	75	3,935k	4,098k	61.6%	78.1%

Figure 30 reports the compliance assessment for each of the projection scenarios to 2025 for paper and card packaging POM against the paper and card accredited recycling scenario.

Assuming the 2018[71] POM figure of 4,929k tonnes developed in this project is applicable, and that the projections for paper and card packaging POM and accredited paper and card packaging recycling are plausible, based on this assessment the UK is likely to meet the paper and card packaging recycling targets in 2018, 2019 and 2020, and the CEP target in 2025.

In each year of the projected scenario the projection for accredited recycling exceeds the expected amount of accredited recycling required to meet the target, and the implied recycling rates for paper and card packaging are above the targets.

The associated probabilities of meeting the national equivalents of the business targets in 2018, 2019 and 2020 are 100.0%, 100.0% and 99.3%, and 78.1% for the CEP target in 2025.

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

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

www.wrap.org.uk/relevant link

recycle