Final Report

PlasticFlow 2025

Plastic Packaging Flow Data Report

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

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WRAP's vision is a world in which resources are used sustainably.

Our mission is to accelerate the move to a sustainable resource-efficient economy through re-inventing how we design, produce and sell products; re-thinking how we use and consume products; and re-defining what is possible through re-use and recycling.

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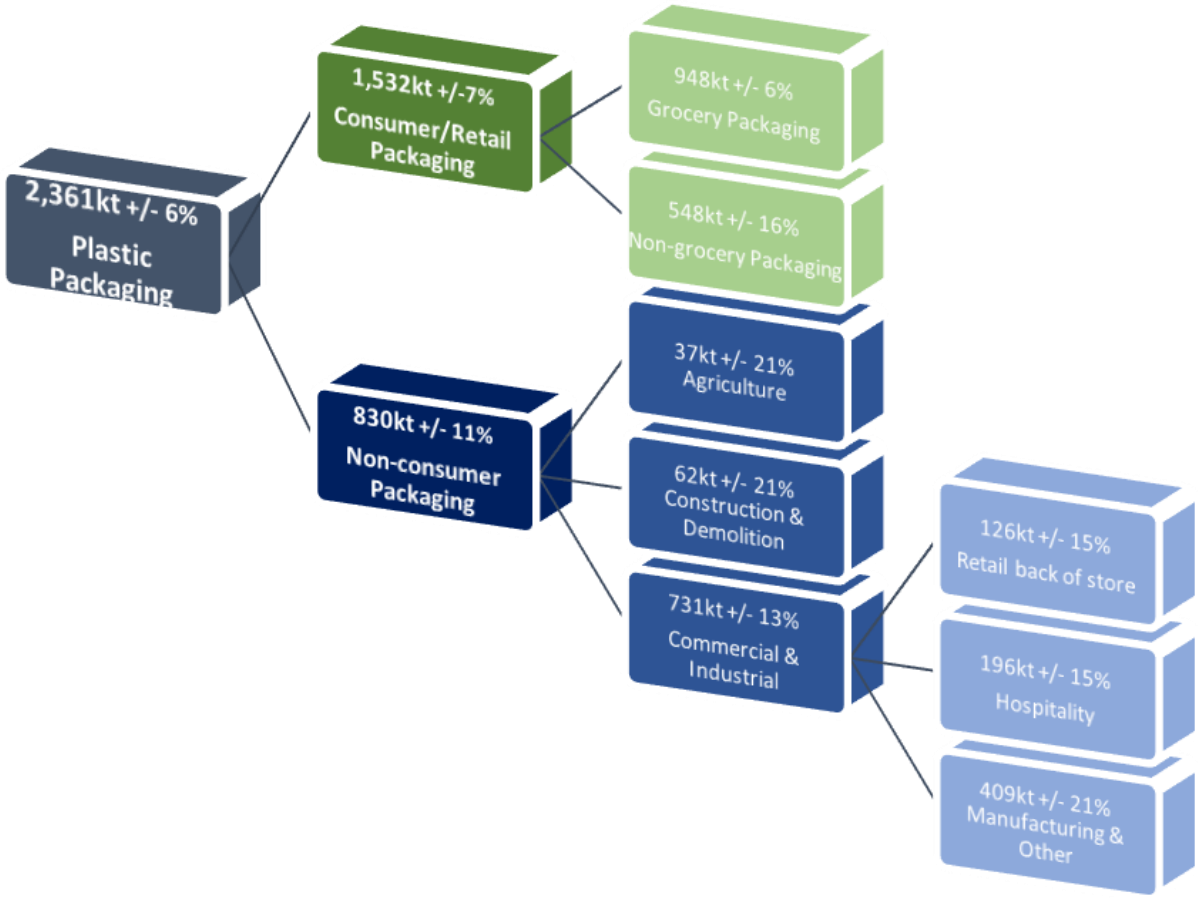
Executive summary

Introduction
PlasticFlow 2025 has been produced to support Defra in its understanding of current levels of UK plastic packaging placed on the market (POM)[1] and recycled, and potential future levels to 2025. PlasticFlow also reports the associated UK and European compliance implications of projected plastic 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.

Plastic Packaging POM
PlasticFlow 2025 estimates UK plastic POM for 2017 at 2,361k tonnes +/- 6%. This represents a potential small increase of 141k tonnes[2] from the estimated current flow figure of 2,220k tonnes (2014). It is likely that increased product sales have been offset by packaging material light-weighting. The final project estimate for plastic packaging POM in the consumer sector is 1,532k tonnes +/- 7% and 830k tonnes +/- 11% for POM in the non-consumer sector. Further breakdown of these sectors is shown in Figure below.

Figure ES1 Plastic packaging POM by sector



[1] Plastic packaging placed on the market means all household and non-household plastic packaging used around products within the UK.
[2] 141k tonnes is an increase of just over 6%. As the error margin around the total plastic POM figure is 6%, it is possible that there has been no real increase in POM

The plastic POM figure was built up using a variety of components, based on the key sectors for plastic packaging including:

- Plastic packaging around food/drinks/other groceries, including body care/clothing/DIY products etc., as sold by supermarkets and other non-grocery retailers, sourced from the Environment Agency and Valpak's EPIC database[3];
- Plastic packaging around drinks (milk and soft drinks) sold directly/indirectly by manufacturers to retail and hospitality outlets, but not included in supermarket, wholesale or foodservice sales[4];
- Plastic packaging around food/drink as consumed in the hospitality sector, sourced from Valpak's EPIC database[5];
- Plastic packaging discarded by retailers back of store, obtained through a survey undertaken for the purposes of this study;
- Plastic packaging used by the construction industry, based on secondary research sources, such as the Green Construction Board and BRE;
- Plastic packaging used in the manufacturing industry, sourced from Steering Group member data and that collected in a survey as part of the Valpak/WRAP 2015 C&I Plastic Packaging[6] project;
- Plastic packaging used in agricultural sector, based on Valpak report, 'UK AWP Waste Arisings, Valpak 2007', based on 2006 data; and
- Engaging industry to provide estimates of UK and overseas production figures for plastic film packaging placed on the UK market for use in the non-consumer sector.

The total plastic POM estimate was cross-checked and found to be 463k 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 17% of plastic packaging in the UK. This has not changed from the 17% non-obligated POM identified in 2013. It is important to stress that the net pack/fill estimates are themselves subject to a degree of error because they rely on the robustness of the data 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, which is then audited by the regulating body. This data is used by policy makers and their agencies.

Polymer/Format Composition of Plastic POM

The estimated composition of consumer plastic packaging in the UK is shown below. The category 'Other' includes elements of packaging such as caps & lids, toothpaste tubes, chocolate/sweet wrappers, egg boxes, blister packs and clothing hangers.

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[3] *The Valpak EPIC 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).*

[4] *The White Paper Dairy UK 2017 and UK Soft Drinks Report 2017, British Soft Drinks Association*

[5] *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).*

[6] *http://www.wrap.org.uk/sites/files/wrap/Rigid_Plastic_Packaging_report_0.pdf*

Figure ES2 Consumer plastic packaging by format and polymer (2017)

CONSUMER (Grocery & Non-grocery Combined)										
	HDPE	LDPE	PE	PET	PP	PS	PVC	Other	Grand Total	
Film	89kt	119kt	21kt	28kt	110kt	2kt	9kt	17kt	**395kt**	*26%*
Carrier Bags	*18kt*	*9kt*							*26kt*	
Bottles	268kt	0kt	1kt	347kt	17kt	0kt	0kt	0kt	**634kt**	*41%*
PTTs	9kt	1kt	4kt	155kt	85kt	32kt	13kt	2kt	**301kt**	*20%*
Other	55kt	23kt	1kt	40kt	76kt	3kt	2kt	0kt	**202kt**	*13%*
Grand Total	**421kt**	**143kt**	**28kt**	**570kt**	**288kt**	**38kt**	**24kt**	**20kt**	**1532kt**	
	27%	*9%*	*2%*	*37%*	*19%*	*2%*	*2%*	*1%*		

To provide a breakdown by format and polymer of consumer plastic packaging, supermarket packaging composition was used as a proxy for grocery packaging, but only the non-grocery categories of supermarket packaging (around toys, electrical, clothing, etc.) were used as a proxy for non-grocery packaging. In addition to non-grocery items, a certain quantity of drinks are sold through non-grocery retailers and so allowances have been made for these non-grocery drinks sales in the non-grocery composition.

This methodology of estimating non-grocery packaging composition differs from the methodology used in Valpak/WRAP's 2013 (2011 data) plastic packaging composition study where, due to lack of non-grocery data, all categories of supermarket packaging were used as a proxy for non-grocery packaging. **This variation in methodology makes it difficult to directly compare 2017 and 2011 data**.

There are much fewer data sources to estimate non-consumer POM than consumer POM and the levels of uncertainty around the data are greater. This is even more true of format and polymer composition data and therefor the splits in the below summary table should be regarded as indicative, with a high level of uncertainty.

Figure ES3 Summary of Indicative Total Non-consumer POM Composition

Non-Consumer	HDPE	LDPE	PE	PET	PP	PS	PVC	Other	Grand Total	
Film	9kt	245kt	82kt	3kt	23kt	0kt	0kt	2kt	**364kt**	*44%*
Bottle	217kt	0kt	0kt	95kt	0kt	0kt	0kt	0kt	**313kt**	*38%*
PTT	17kt	0kt	8kt	14kt	77kt	25kt	0kt	0kt	**141kt**	*17%*
Other	7kt	0kt	0kt	0kt	3kt	1kt	1kt	0kt	**13kt**	*2%*
Grand Total	**251kt**	**245kt**	**90kt**	**113kt**	**103kt**	**26kt**	**0.7kt**	**2kt**	**830kt**	
	30%	*30%*	*11%*	*14%*	*12%*	*3%*	*0%*	*0%*		

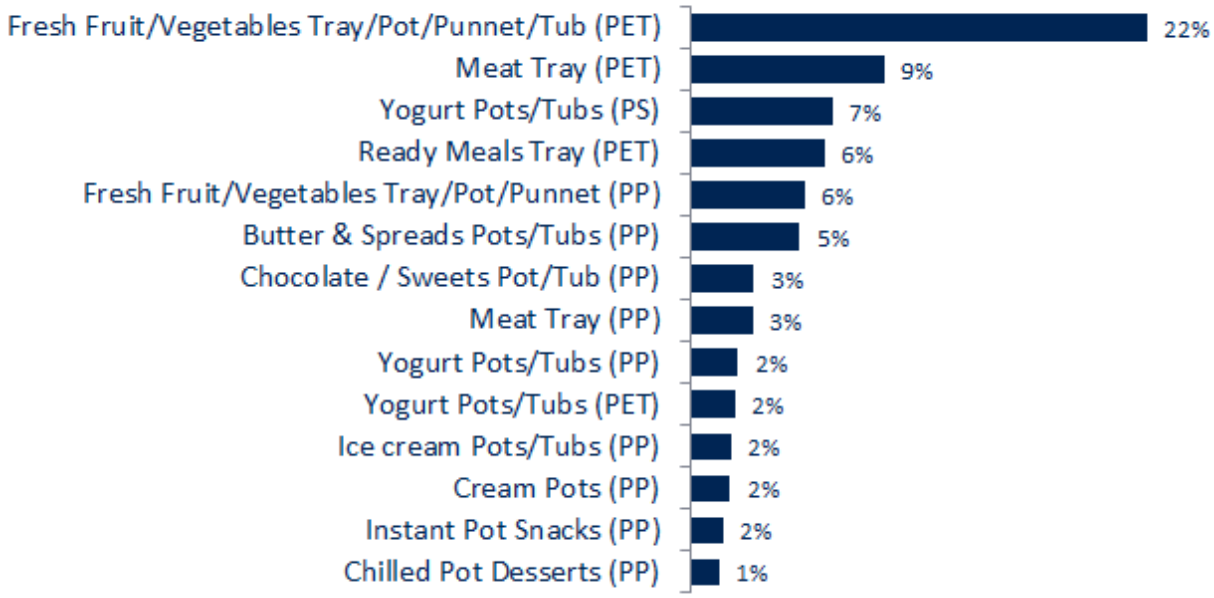
Although this non-consumer POM composition is indicative, it does illustrate some commonly known trends, such as the increasing use of HDPE bottles (shown four times higher than 2011 composition study), increased use of PP (over 50% higher) and reduced use of PS (nearly one-third more) and PVC (now negligible).

Due to the quantity of packaging data available in Valpak's EPIC database, further analysis was undertaken on consumer POM as part of PackFlow 2025[7]. This included an assessment by format and polymer type of consumer pots, tubs and trays (PTTs) and of consumer drinks packaging.

[7] *https://www.valpak.co.uk/docs/default-source/environmental-consulting/valpak_packflow-2025-summary-report.pdf*

The dominant polymer in consumer PTTs remains PET, with just over half (53%) of PTTs being made of PET. The second most popular polymer is PP, constituting around one third of PTTs in the UK[8]. In terms of usage, the most common category of PTTs (PET, PP) is fresh fruit and vegetable packaging, by a considerable margin. This is illustrated in Figure ES4 below. Combined with meat trays (PET, PP) and yogurt pots (PS, PP, PET), these three categories account for approximately half of all consumer PTTs by weight.

Figure ES4 Key PTT applications 2017



With the announcements that there is an intention to develop a Deposit Return Scheme (DRS) in both Scotland and England, it was considered of interest to present the plastic primary packaging data relating to the drinks market. This is shown in Figure ES5 below.

Figure ES5 Plastic Drinks Packaging POM 2017

Drinks	Total Consumer	Non Consumer	Total
HDPE	103k	15k	**118k**
PET	224k	94k	**317k**
Other	6k	2k	**8k**
Total	**332k**	**111k**	**443k**

The analysis indicates that in 2017 there were 443k tonnes of plastic drinks packaging placed onto the UK market[9]. In order to verify this data, Dairy UK data relating to the milk market was assessed, with total milk sales for the UK in litres and by each key market, such as retail

[8] Polymer composition of PTTs as given in this analysis vary slightly from those provided in the overall POM composition table. This is due to the film element of PTTs (closures, lids, etc) being included as part of PTTs in this analysis, but being included within the film category of the overall POM composition table. Including the film element of PTTs in this analysis allowed for comparison with previous work undertaken.

[9] Including all caps and labels.

and hospitality, being identified[10]. Furthermore, for milk bottles[11], two industry estimates were provided, both which were within +/- 8% of Valpak's estimate.

Plastic Packaging Recycling

PackFlow 2025 estimates the quantity of accredited UK plastic packaging recycled to have been between 1,026k tonnes and 1,111k tonnes in 2017. A range is used to express recycling levels as the point at which recycling is measured can vary and therefore we have presented the quantities as a maximum (recovered plastic in[12]) and a minimum (recycled polymer out[13]). The estimates are shown below in Figure ES6, including a breakdown of consumer (461-525kt[14]) and non-consumer (565-586kt) recycling, and UK recycling (340-425kt) and exports (686kt, taken as a proxy from NPWD PERN data).

Figure ES6 Total plastic packaging UK recycling & export

Stream	Recovered plastic IN (kt)	Recycled polymer OUT (kt)
Consumer UK Recycling	226	162
Consumer Export	299	299
Non-consumer UK Recycling (films)	144	123
Non-consumer UK Recycling (rigids)	55	55
Non-consumer Export (films)	287	287
Non-consumer Export (rigids)	100	100
TOTAL Recycled or Exported	**1111kt - 1026kt**	

UK recycling estimates were made primarily from the findings of a survey and discussions with over twenty UK reprocessors and exporters. Overall, based on the estimates for plastic packaging tonnage processed, just under a third of the market was spoken to directly, with around 85% of the information coming from recyclers themselves or industry experts operating in the same field. Much of the remaining market consisted of recyclers classified as small reprocessors of packaging waste, as defined by the Environment Agency (400 tonnes or less of PRNs issued). This industry information was used in combination with NPWD PERN data and RECOUP's latest survey forecast for 2018[15] of the quantity of plastic packaging collected for recycling from the consumer sector.

The total quantity of plastic packaging recycled in the UK was cross-checked with the number of PRNs that were raised on plastic packaging according to the NPWD. For 2017, NPWD reports accredited UK recycling to have been 358k tonnes, (PackFlow 2025 estimates 340- 425kt).

The number of PERNs issued in 2017 was used as a proxy for the tonnage of plastic packaging exported for recycling at 686k tonnes. However, it should be noted that in principal **exporters are required to disregard any non-target plastic packaging waste (including contamination) from export tonnages prior to issuing PERNs**.

[10] *http://www.dairyuk.org/images/documents/publications/THE-WHITE-PAPER-2017.pdf*

[11] *Not including caps and labels*

[12] Plastic packaging waste accepted for recycling (input)

[13] Recycled polymer produced (output)

[14] *Consumer Recycling (IN) calculated using RECOUP's 2017 plastic packaging collection estimate and Recycled Polymer (OUT) estimated from survey research*

[15] RECOUP's most recent survey based on 2017 data was not published at the time of writing this report; however, Recoup provided estimates for the purpose of this project.

Accredited reprocessing is likely to be an underestimation as it is related to the level of PRNs raised and additional recycling (unaccredited) may be carried out without a PRN being raised. The unaccredited reprocessing was estimated by using the number of reprocessors and exporters that were believed to be operational but not accredited in 2017, and the packaging they would normally handle as a proxy, providing a minimum quantity. It was also estimated using responses from the reprocessor/exporter survey of reprocessors and recyclers.

PackFlow 2025 therefore estimates UK plastic packaging recycling rates to be between 43% and 47% for 2017. A consumer collection/recycling rate of 30%-34% was identified and a non-consumer recovery/recycling rate of 68%-71%.

Figure ES7 Summary of UK plastic packaging recycling rates 2017

Stream	2017							
	POM	Collected	Recovered Plastic IN	Recycled Polymer OUT	Collection Rate	Recycling Rate (In)	Recycling Rate (Out)	*Relevant Report Sections*
Consumer Total	**1532k**	**525k**	**525k**	**461k**	**34%**	**34%**	**30%**	***5.2.5, 5.2.6, 5.2.8***
Consumer PTTs/Bottles	*935k*	*509k*	*509k*	*445k*	*54%*	*54%*	*48%*	
Consumer Film	*395k*	*16k*	*16k*	*16k*	*4%*	*4%*	*4%*	
Consumer Other	*202k*	-	-	-	-	-	-	
Non-consumer Total	**830k**	**-**	**586k**	**565k**	**-**	**71%**	**68%**	***5.2.7, 5.2.9***
Non-consumer Rigids	*153k*	-	*155k*	*155k*	-	*101%*	*101%*	
Non-consumer Film	*364k*	-	*431k*	*410k*	-	*118%*	*113%*	
Non-consumer Other	*830k*	-	-	-	-	-	-	
Grand Total	**2361k**	**-**	**1111k**	**1026k**	**-**	**47%**	**43%**	***5.4***

As can be seen from above table in Figure ES7, there is a discrepancy in the recycling rates of non-consumer film (113-118%). This could be due to either the incorrect allocation of PRN/PERNs against either non-packaging film or non-UK packaging, or it could suggest that the non-consumer film POM estimate is low. Further research would be required to confirm or reject these possibilities. Based on knowledge from the industry, a more feasible recycling rate of 70-80% recycling of non-consumer film would leave 80-130k tonnes of non-consumer film recycling that cannot be identified.

It is suggested further research is required to fully understand why there is a mismatch of this size. Research is recommended both into non-consumer film POM and the incorrect issuing of PRNs.

End Markets for UK Plastic Packaging

Figure ES8 provides a summary of areas of usage of UK recycled polymer. The breakdown of how recycled polymer produced in the UK is used is based on in-house knowledge and discussions with industry; primarily recyclers, but also a major film manufacturer (using r-polymer) and industry experts. For PET, the recycled polymer is produced from bottles and trays (consumer and non-consumer from the hospitality sector). For HDPE the largest volume of recycled polymer comes from bottles/household trays, but around 20% comes from rigid C&I packaging. For PP there is a roughly equal split between recycled polymer produced from bottles/trays and PP from rigid C&I packaging. Recycled LDPE is nearly all derived from C&I and manufacturing films.

Figure ES8 Summary of end markets for UK recycled plastic packaging

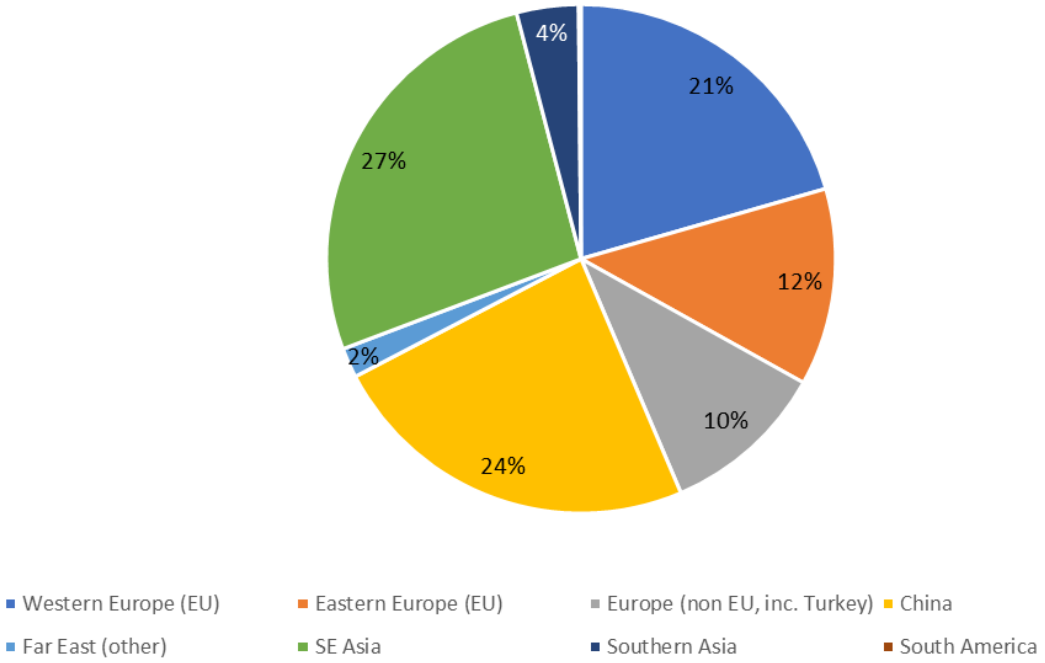
PET		
Application	**Examples**	**Indicative usage**
Sheet manufacture	Used to make packaging trays, etc.	65%
Bottles	Food contact applications, such as drinks bottles.	30%
Fibre	Polyester fibre for fill	5%
HDPE		
Application	**Examples**	**Indicative usage**
Packaging	Food and non-food bottles.	25%
Construction	Pipes, chambers, roof spacers, plumbing items.	35%
Horticultural & outdoors	Compost bins, water butts, wheel bins, garden furniture, watering cans.	20%
Other	Wide range of items including inclusion in plastic wood applications, garden furniture, household items such as boxes and buckets.	20%
PP		
Application	**Examples**	**Indicative usage**
Automotive	Interior design items, wheel arches, ducting, battery cases, mudguards.	40%
Packaging	Paint pots, pallets, crates, trays, boxes	40%
Other	Wide range of items including inclusion in plastic wood items, plant pots, etc.	20%
LDPE		
Application	**Examples**	**Indicative usage**
Construction films	Damp proof membranes, building films for temporary protection, gas barrier protection	40%
Plastic bags & sacks	Refuse sacks, recycling sacks, bags for life.	20%
Agricultural films	Crop cover (mulch film)	15%
Other	Packaging, rigid / semi-rigid products, plastic wood.	25%

Applications in export markets sometimes differ, in particular in non-EU destinations. For example, in Asia discussions with recyclers and traders of PET flake suggest that the majority of recycled PET is used in the production of polyester fibre whereas in Europe this end market has been declining in recent years. Also, recycled LDPE polymer in agricultural film

production is more prevalent in Asia (notably China) than in the UK where it is used in foamed LDPE applications.

A Freedom of Information Act request was made to the Environment Agency for information on where UK waste plastic packaging was exported to in 2017. Reproduction of this data is subject to the conditions set out in the Open Government License version 3.0. Please see conditions here: http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

Figure ES9 Export destinations for UK plastic packaging waste by region 2017



UK Plastic Packaging Projections and Compliance

Historical data and trends for plastic packaging POM and plastic packaging recycling as reported by accredited reprocessors and exporters were used to estimate univariate time-series models (linear trend and autoregressive models) and a range of scenarios for plastic packaging POM and recycling projected forward to 2025. The outputs provide a range of possible futures for plastic packaging POM and recycling to inform policymakers and other stakeholders. These scenarios enabled a compliance assessment of potential plastic packaging recycling rate versus the plastic packaging recycling rate targets to 2020, and the CEP target in 2025.

These scenarios are not intended to be sophisticated, but follow a 'business as usual' approach. In particular, they ignore factors such as expected developments of collection systems (such as the introduction of DRS), the timing of potential future policy initiatives in plastic packaging recycling markets, the timing of possible changes in legislation, the impact of possible targets for plastic packaging recycling to and beyond 2020 and all other potential external influences that might impact on the plastic reprocessing, for example the potential for investment in UK reprocessing and collections, the availability of domestic and export markets for reprocessing and the potential demand for recycled content in packaging.

The plastic packaging POM projections assume that plastic packaging POM increases in line with the projected growth of net pack fill (see Section 8.2) in the estimated models. Due to a break in trend in the historic data around 2004, two linear trend models are estimated: one

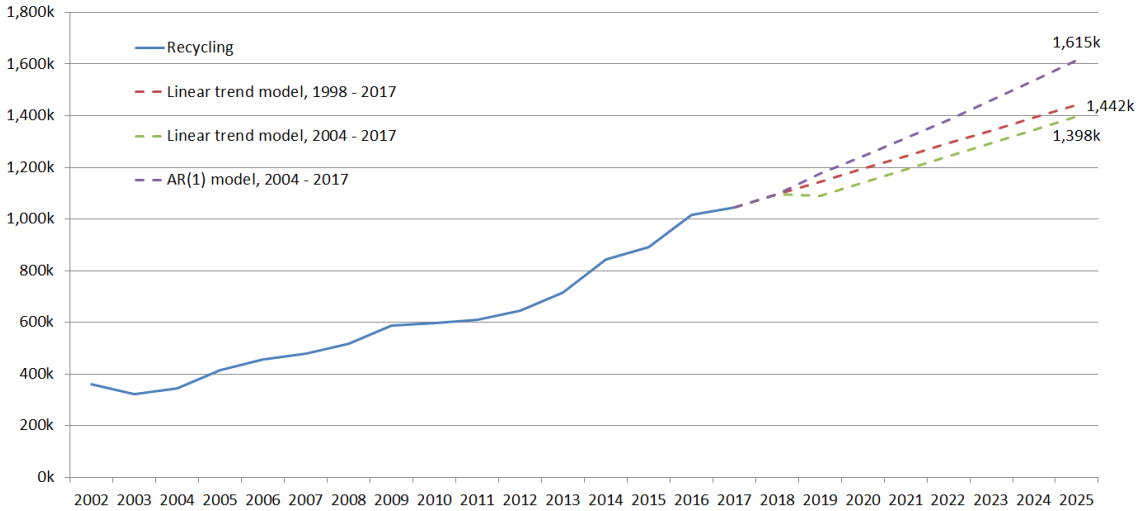
over the full data period (1997 to 2017); and one over the period 2004 to 2017. The auto-regressive model (1 lag) was estimated over the full period. The results are given in Figure ES10 below and show that with no growth POM would remain at 2,361k tonnes, but based on the three scenarios presented above, it would grow to 2,610kt, 2,411kt or 2,410kt by 2025.

Figure ES10 UK Plastic Packaging POM Projections to 2025 (tonnes)

	Based on zero growth	Based on a linear trend model for net pack fill, 1997 - 2017		Based on a linear trend model for net pack fill, 2004 - 2017		Based on AR(1) model for net pack fill, 1998 to 2017	
	Tonnes	Tonnes	% y/y	Tonnes	% y/y	Tonnes	% y/y
2018	2,361k	2,361k		2,361k		2,361k	
2019	2,361k	2,395k	1.42%	2,368k	0.30%	2,371k	0.44%
2020	2,361k	2,428k	1.41%	2,375k	0.30%	2,380k	0.38%
2021	2,361k	2,463k	1.40%	2,382k	0.30%	2,388k	0.33%
2022	2,361k	2,497k	1.39%	2,389k	0.30%	2,395k	0.28%
2023	2,361k	2,531k	1.38%	2,396k	0.30%	2,401k	0.24%
2024	2,361k	2,566k	1.37%	2,404k	0.30%	2,406k	0.21%
2025	2,361k	2,601k	1.36%	2,411k	0.29%	2,410k	0.18%

Three possible future scenarios to 2025 for plastic packaging recycling were also developed based on historical plastic packaging recycling performance (PRN/PERN tonnage data reported by accredited plastic reprocessors/exporters). These are illustrated in Figure ES11 below.

Figure ES11 Plastic Packaging Recycling Projections to 2025 (tonnes)



The linear trend (central) projection based on the full sample period shows plastic packaging recycling increasing to 1,442k tonne by 2025, an increase of 397k tonnes (or 38%) compared to 2017. The linear trend projection based on the more recent sample period shows plastic packaging recycling increasing to 1,398k tonnes by 2025, an increase of 353k tonnes (or 32%) compared to 2017, and the projection from the auto regressive model shows plastic packaging recycling increasing to 1,615 k tonnes in 2025, an increase of 571k tonnes (or 52%) compared to 2017.

Based on the scenario projections for plastic packaging POM and plastic recycling given above, Figure ES12 presents scenarios to 2025 for national plastic packaging recycling rates against national targets. In addition, the statistical probability of meeting national targets is given.

Figure ES12 Plastic packaging POM and recycling projections versus targets

	POM	National recycling target	Recycling required to meet the national target	Projected annual recycling*	Probability of meeting the national target
Scenario 1: Plastic POM projected at zero growth					
2018	2,361k	44.0%	1,039k	1,098k	83.9%
2019	2,361k	45.7%	1,078k	1,146k	87.0%
2020	2,361k	47.3%	1,117k	1,195k	89.9%
2021	2,361k	47.8%	1,130k	1,244k	96.7%
2022	2,361k	48.4%	1,142k	1,294k	99.2%
2023	2,361k	48.9%	1,155k	1,343k	99.8%
2024	2,361k	49.5%	1,168k	1,392k	100.0%
2025	2,361k	50.0%	1,181k	1,442k	100.0%
Scenario 2: Plastic POM growth based on linear trend model for net pack fill, 1999 - 2017					
2018	2,361k	44.0%	1,039k	1,098k	83.9%
2019	2,395k	45.7%	1,093k	1,146k	80.8%
2020	2,428k	47.3%	1,149k	1,195k	77.4%
2021	2,463k	47.8%	1,178k	1,244k	85.6%
2022	2,497k	48.4%	1,208k	1,294k	91.2%
2023	2,531k	48.9%	1,238k	1,343k	94.8%
2024	2,566k	49.5%	1,269k	1,392k	97.0%
2025	2,601k	50.0%	1,300k	1,442k	98.3%
Scenario 3: Plastic POM growth based on linear trend model for net pack fill, 2004 - 2017					
2018	2,361k	44.0%	1,039k	1,098k	83.9%
2019	2,368k	45.7%	1,081k	1,146k	85.8%
2020	2,375k	47.3%	1,124k	1,195k	87.8%
2021	2,382k	47.8%	1,140k	1,244k	95.4%
2022	2,389k	48.4%	1,156k	1,294k	98.5%
2023	2,396k	48.9%	1,172k	1,343k	99.6%
2024	2,404k	49.5%	1,189k	1,392k	99.9%
2025	2,411k	50.0%	1,205k	1,442k	100.0%
Scenario 4: Plastic POM growth based on AR(1) model for net pack fill, 1998 to 2017					
2018	2,361k	44.0%	1,039k	1,098k	83.9%
2019	2,371k	45.7%	1,083k	1,146k	85.2%
2020	2,380k	47.3%	1,126k	1,195k	86.9%
2021	2,388k	47.8%	1,143k	1,244k	94.9%
2022	2,395k	48.4%	1,159k	1,294k	98.4%
2023	2,401k	48.9%	1,175k	1,343k	99.6%
2024	2,406k	49.5%	1,190k	1,392k	99.9%
2025	2,410k	50.0%	1,205k	1,442k	100.0%

Assuming that the 2018 POM figure of 2,361k tonnes applies, based on these projections of plastic packing POM and recycling, the UK would probably meet packaging recycling targets in 2018, 2019 and 2020, and the CEP target in 2025. The probabilities of meeting the national equivalents of the business targets in 2018, 2019 and 2020 are 84%, 87% and 90%, and 100% for the CEP target in 2025. However, without further actions, The UK Plastics Pact target, of 70% of plastic packaging effectively recycled or composted by 2025, would be missed. WRAP is working with The UK Plastics Pact members and supporters to develop and implement the required actions. WRAP is working with UK Plastics Pact members to develop and implement the required actions.

Conclusions and Recommendations for Further Works

Conclusions: POM

The project's final best estimate of UK flow for 2017 is 2,361k tonnes +/- 6%: an increase of 141kt tonnes[16] from the estimated current flow figure (2014)

The most robust estimate that could be derived, using a variety of the most authoritative methods, including industry estimates, Valpak data and publicly available data, suggests that the quantity of plastic packaging POM in 2017 was 2,361k tonnes. This estimate is 141k tonnes[16] higher than the 2014 industry estimate of 2,220k tonnes.

The final project estimate for plastic packaging POM in the consumer sector is 1,532k tonnes +/- 7%

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 plastic packaging POM in the non-consumer sector is 830k tonnes +/- 11%

For film, this method is based on a combination of primary (survey) data, secondary research, published 2017 NPWD data on filled imports and information (2013 sales data) provided by the project Steering Group. For rigids, this is based on the findings of the WRAP/Valpak report into rigid packaging in the C&I sector and on secondary research.

It is likely that increased sales have been offset by light-weighting activity

The plastics packaging industry has believed for some time that packaging producer activity to light-weight plastic packaging[17] has negated any potential growth in consumption and the results of this work would seem to support this assumption. Industry members have provided evidence of this to the project team; however, the information is considered to be commercially sensitive and therefore cannot be provided in this report.

Plastic drinks packaging is estimated to account for 443kt of the total POM

Using Valpak EPIC data and additional market data, suggests that 86% of this tonnage is sold via the retail or consumer market and 14% via the non-consumer or hospitality sector, with 118kt being HDPE, 317kt PET and 8kt other polymers. This has been cross-checked with industry and published data.

[16] 141k tonnes is an increase of just over 6%. As the error margin around the total plastic POM figure is 6%, it is possible that there has been no real increase in POM

[17] Including down-gauging activity.

Conclusions: Recycling

The recycling performance of the UK in 2017 is between 43-47%

If measuring recycling on entry to reprocessing, the UK's plastic packaging recycling rate is estimated at 47% (1111k tonnes recycled). If measured after conversion on the exit of reprocessing the rate would be lower at 43% (1026k tonnes recycled).

The consumer plastic packaging recycling performance of the UK in 2017 is between 30-34%

If measuring recycling on entry to reprocessing, the UK's consumer plastic packaging recycling rate is estimated at 34% (525k tonnes recycled). If measured after conversion on the exit of reprocessing the rate would be lower at 30% (461k tonnes recycled).

The non-consumer plastic packaging recycling performance of the UK in 2017 is between 68-71%

If measuring recycling on entry to reprocessing, the UK's consumer plastic packaging recycling rate is estimated at 71% (586k tonnes recycled). If measured after conversion on the exit of reprocessing the rate would be lower at 68% (565k tonnes recycled).

The non-consumer film recycling rate for the UK in 2017 is unfeasibly high

The recycling rates of non-consumer film are estimated at 113-118%. Based on a more feasible recycling rate of 70-80%, there remains 80-130kt of non-consumer film recycling that cannot be identified. One explanation for this could be the incorrect allocation of PRN/PERNs against either non-packaging film for non-UK packaging. Alternatively, or in addition, it could suggest that the non-consumer film POM estimate is low.

Conclusions: Plastic Packaging End Markets

The main application for UK recycled PET is in sheet applications such as trays

Approximately 65% of UK recycled PET is made into sheet, which in turn is used for applications such as plastic trays. The majority of PET not used in this way is used to make new plastic bottles.

UK recycled HDPE is used comprehensively in a variety of applications, such as packaging, construction, horticultural and outdoors

Approximately 30% of UK recycled HDPE is used in the packaging sector, a further 30% in the construction sector and 20% in horticultural & outdoors applications. The remainder is used in a variety of products such railway sleepers, garden furniture and boxes.

UK recycled PP is predominantly used to make automotive products and packaging

Approximately 40% of UK recycled PP is used in automotive products and a further 40% in packaging.

UK recycled LDPE is mainly used to make new films for construction, bags, sacks and agriculture

Approximately 40% of UK recycled LDPE is used for construction films, 20% for plastic bags & sacks and around 15% for agricultural films.

Much of the higher quantities of recovered plastic being shipped to SE Asia, once recycled, is finding its way to China as recycled pellet

Discussions with recyclers/traders in Asia suggest that much of the increase in recovered plastic being shipped to SE Asia, in particular Malaysia but also to an extent to countries such as Vietnam and Thailand, once recycled is finding its way to China in the form of recycled pellet. This demand is being driven by the loss of domestically produced recycled pellet in China, historically generated from imports of recovered plastics from overseas.

Conclusions: Plastic Packaging Compliance

The UK is likely to meet packaging recycling targets in 2018, 2019 and 2020

Assuming that the 2018 POM figure of 2,361k tonnes applies, based on this report's projections of plastic packing POM and plastic packaging recycling, the UK is likely to meet packaging recycling targets in 2018, 2019 and 2020, and the CEP target in 2025.

The probabilities of meeting UK recycling targets[18] in 2018, 2019 and 2020 are high, as is the probability of achieving the 2025 CEP target

The probabilities of meeting the national equivalents of the business targets in 2018, 2019 and 2020 are 84%, 87% and 90% respectively, and 100% for the CEP target in 2025. However, without further actions, The UK Plastics Pact target, of 70% of plastic packaging effectively recycled or composted by 2025, would be missed. WRAP is working with The UK Plastics Pact members and supporters to develop and implement the required actions. WRAP is working with UK Plastics Pact members to develop and implement the required actions.

Recommendations for Further Work

C&I plastic packaging film/rigids

The estimate of C&I film packaging appears low in comparison to the rigids figure. Furthermore, non-consumer film POM as a whole appears low when used to calculate non-consumer film recycling rates.

Non-consumer film being allocated PRN/PERNs

In 2017 there was an unaccounted 80-130k tonnes of non-consumer film recycled: this may in part be due to a low POM estimate, but may also be due to the incorrect allocation of PRN/PERNs to non-packing films or non-UK packaging film.

[18] *The national equivalent of business recycling targets*

Contents

Figures

Glossary

ACP – Advisory Committee on Packaging
BPF – British Plastics Federation
BPI - British Polythene Industries
BRE – Building Research Establishment
C&I – Commercial & Industrial
C&D – Construction & Demolition
DRS – Deposit Return Scheme
EA – Environment Agency (EA)
EPIC – Environmental Product Information Centre
GCB – Green Construction Board
HDPE – high-density Polyethylene
LA – Local Authority
MRF – Materials Recovery Facility
NPWD – National Packaging Waste Database
ONS – Office of National Statistics
PAFA – Plastics and Films Association
PE – Polyethylene
PERN – Packaging Export Recovery Note
PET - Polyethylene Terephthalate
POM – Placed On the Market
PP – Polypropylene
PRN – Packaging Recovery Note
PS – Polystyrene
PTT – Pots, Tubs and Trays
PVC – Polyvinyl Chloride
VDS – Valpak Data Solutions
WDF – Waste Data Flow

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- Defra;
- Environment Agency (EA);
- INCPEN;
- The British Plastic Federation (BPF);
- The Foodservice Packaging Association; and
- Plastics Europe.

1.0 Introduction

1.1 Background and Existing Data

Defra is keen to ensure that the estimates being used for its packaging policy work are as accurate as possible. To support Defra, this work focuses on reviewing the estimates of UK plastic packaging placed on the market (POM)[19] and the associated compliance implications. Accurate and robust assessments of current and future UK plastic packaging flows are vital to help inform the UK negotiating position in the acceptance of targets. The devolved administrations of Scotland, Wales and Northern Ireland are also interested in the outcome of this research.

The existing Defra estimate for 2017 is 2,220k tonnes of plastic packaging POM. The PlasticFlow 2014[20] and Rigid Plastic Packaging in the Commercial & Industrial Sectors (2015) [21]projects and industry assessment formed the basis for this estimate. The objective behind this PlasticFlow 2025 report is to provide an updated baseline estimate of plastic packaging placed on the market, that which is recycled and project this to 2025.

1.2 Objectives

The PlasticFlow 2025 project had the following key objectives:

- Develop a methodology that utilises and builds on existing approaches to estimate 2017 plastic packaging POM by format (bottle, film etc.), stream (consumer or non-consumer), polymer and source (obligated or non-obligated etc.);
- 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 in order to cross-check and estimate non-obligated flow;
- Estimate the quantities of plastic 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 plastic packaging, by polymer and format type, and by stream being: recovered and recycled; sent for incineration with energy recovery (including RDF); sent to landfill, for both UK and overseas end destinations in 2017;
- Project plastic packaging 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 plastic packaging that is recycled but does not generate a PRN (or a PERN), and quantities of non-obligated plastic 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.

[19] Plastic packaging placed on the market means all household and non-household plastic packaging used around products within the UK.
[20] http://www.wrap.org.uk/content/plastic-packaging-market-study-plastic-flow-2014-0
[21] http://www.wrap.org.uk/sites/files/wrap/Rigid_Plastic_Packaging_report_0.pdf

1.3 Methodology

In order to calculate plastic packaging recycling rates, the quantity of plastic packaging recycled is divided by the quantity of waste arisings. However, it is commonly accepted, and indeed is accepted by the EU, that establishing packaging POM is an appropriate method of estimating packaging waste arisings.

1.3.1 Estimating waste arisings from sample composition data

Using plastic packaging POM as an estimate of plastic packaging waste arisings has recently been called in to question by Eunomia (2018)[22], 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 plastic POM and an overestimate of the recycling rate.

While this hypothesis warrants further study, the argument that the alternative method used is preferable is not convincing. 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
- Waste arisings and composition from commerce and industry

1.3.1.1 Household waste composition

Estimates of packaging waste arising can be derived by combining compositional estimates with data on waste collections reported by Local authorities on the quantities of materials they collect and report into WasteDataFlow. This approach requires accurate and reliable data on the composition of household waste, collected through waste composition analysis. While waste composition data is useful, a number of factors limit its accuracy and suitability for this type of work.

Waste composition analyses are time consuming and costly, and this limits the extent and robustness of their coverage. In particular:

- They tend to be undertaken infrequently and cover only a small (and not necessarily representative) proportion of the population. Sample sizes in individual studies are often small, and the most commonly used approaches use convenience sampling (based on semi-random "quota" sampling from pre-selected waste collection rounds [typically omitting flats] or bulk sampling from vehicles).
- They represent a snapshot in time (often a single week or a single collection cycle). Even multi-season waste composition studies (which are in the minority) cannot capture the full extent of seasonal (let alone week-to-week) variation.

Further, this type of study relies on *in situ* weighing of the material as presented. It is typically carried out on waste management premises under difficult conditions; the equipment used is frequently dirty, which can affect accuracy, and one would expect human and instrumental errors to be more significant under these circumstances than in a production or design environment (i.e. calculating weights based on a known package weight and number of units). There can also be issues with contamination being weighed along with the materials, and this is likely to be a significant factor when considering plastic films.

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

1.3.1.2 Waste arising from local authorities

The results also depend on the accuracy of the data in WasteDataFlow, and the Eunomia report fails to consider that this could be subject to the same or similar inaccuracies as reporting under the PRN system. Accurate WasteDataFlow returns are dependent on:

- Accurate and reliable collation and entry of data by the local authority. While there is no reason to believe that this is not done diligently, local authorities and local authority staff are under many pressures that are not dissimilar to those faced by businesses.
- Provision of accurate data to the local authority by the waste management company. This is likely to be more challenging than accurately quantifying the quantity of product placed on the market, again involving *in situ* weighing of materials (with multiple potential for human and instrumental error) that may be subject to contamination.

When comparing the likely accuracy of such data with data from the National Packaging Waste Database, the primary weakness of the latter is that it excludes internal use packaging, non-obligated, free-riders and illegal imports, with the result that these need to be estimated separately or omitted from the scope. The primary strength is that it is much less prone to human, instrumental and sampling errors.

There is little evidence to support the contention that the NPWD is likely to suffer from systematic underreporting from obligated parties. Deliberately providing false or misleading data is a criminal offence for which companies reporting their data directly and/or through compliance schemes can be prosecuted and the legislation requires that data reporting is signed off by a company director as being "as accurate as reasonably possible". In addition compliance schemes are required through their operating approval to audit the returns of member companies so that every company is audited at least once every three years.

On balance, for obligated producers, there are strong reasons to believe that NPWD/EPIC[23] data should be considerably more robust than modelling based on waste composition studies and WasteDataFlow. Valpak's EPIC database holds sales data and packaging weights information for clients signed up for the fully managed service.

1.3.1.3 Commercial & industrial waste arisings

Waste collection data reported by local authorities also includes tonnage of waste collected from commercial premises, offices, schools, and hospitals etc. Calculating the quantity of plastic packaging requires reliable estimates of the proportion of plastic packaging from waste composition analysis of these streams. However, waste composition studies typically focus on household analysis (kerbside and residual) and less on municipal. As a result estimates of plastic packaging in non-kerbside streams (litter, HWRC, Trade) are often not available and where they are they are typically unreliable due to small and unrepresentative samples.

In addition to a general lack of robustness, local authority waste collected from commercial premises is highly unlikely to be representative of overall commercial and industrial waste. Applying compositional fractions based on municipal studies to the commercial and industrial sector is likely to produce systematic bias in the results.

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[23] 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).

Official statistics for commercial and industrial waste are regarded as highly uncertain and subject to substantial revision and changes in methodology. Defra commercial and industrial waste survey results have predominantly been based on economic modelling since the last major fieldwork was conducted in 1999.

The 2014 Defra dataset used in the Eunomia report (2016 Statistics on Waste) has already been revised down for 2014 and is undergoing further revisions. The 2018 Statistics on Waste reports a 24% reduction in 2014 C&I waste compared to the 2016 publication. In comparison, analysis based on EPIC/NPWD uses data that covers all obligated businesses, which has been collected under a regulatory framework and has been subject to audit.

1.3.2 POM

Plastic packaging POM was estimated using a bottom up approach, that references a variety of data sources of plastic 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 plastic packaging POM reported on the National Packaging Waste Database (NPWD) by obligated producers. The baseline year was 2017. However, where 2017 data was not available the most recent available data was used.

1.3.2.1 POM Method (Bottom Up Approach)

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

- Plastic packaging around food/drinks/other groceries, including body care/clothing/DIY products etc., as sold by supermarkets and other non-grocery retailers, sourced from the Environment Agency and Valpak's EPIC database[24];
- Plastic packaging around food/drink as consumed in the hospitality sector, sourced from Valpak's EPIC database[25];
- Plastic packaging discarded by retailers back of store, obtained through a survey undertaken for the purposes of this study;
- Plastic packaging used by the construction industry, based on secondary research sources, such as the Green Construction Board and BRE;
- Plastic packaging used in the manufacturing industry, sourced from Steering Group member data and that collected in a survey as part of the Valpak/WRAP 2015 C&I Plastic Packaging[26] project ;
- Plastic packaging used in agricultural sector, based on Valpak report, 'UK AWP Waste Arisings, Valpak 2007', based on 2006 data; and
- Engaging industry to provide estimates of UK and overseas production figures for plastic film packaging placed on the UK market for use in the non-consumer sector.

The detail of how the amount of rigid and film plastic were estimated is given in Section 2.

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[24] *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).*

[25] *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).*

[26] *http://www.wrap.org.uk/sites/files/wrap/Rigid_Plastic_Packaging_report_0.pdf*

1.3.2.2 POM Cross-check (Net Pack Fill)

The cross-check compiled plastic 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 plastic packaging handled by non-obligated companies, free-riders (those companies who are above the packaging obligation threshold by having a turnover of £2 million and handling 50 tonnes of packaging or more but are not registered with the relevant agency) and packaging for internal company use, which is non-obligated packaging under the regulations.

To estimate the amount of packaging placed on the UK market by obligated companies, the calculation set out below was applied. This calculation uses the total data reported by obligated packaging producers and is available on the NPWD website[27]:

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

1.3.2.3 POM Other Data Sources

Other sources of data investigated included Prodcom, UK Trade Info and market research reports. However, further analysis and consideration validated the need to have greater reliance on other data sources for the following reasons:

- Prodcom
  Latest data available at the time of reporting was '2012 Provisional'. The data did not allow for calculating total tonnage and only covers UK manufacturing and empty imports.
- UK Trade Info
  This requires information searches on product types rather than packaging types; i.e., the need to identify key product sectors such as soft drinks. In addition, the SIC codes in UK Trade Info do not extend to packaging material level; i.e., it is possible to look at imports/exports of soft drinks, but not of soft drinks in plastic bottles.

1.3.3 Recycling

The level of accredited reprocessing (that which is eligible to raise a PRN/PERN) was established using a combination of a bottom up (UK recycling and all format/polymer splits) and a top down approach (exports). Collection, recovery in[28] and recycling out[29] estimates were made for plastic packaging recycled in the UK from consumer and non-consumer waste streams. PERNs reported as issued in 2017 in NPWD were used as a proxy for plastic packaging exported for recycling.

Primarily, UK recycling estimates (and export polymer/format splits) were made from the findings of a survey and discussions with over twenty UK reprocessors and exporters. All gathered information and internal project team knowledge were input into an Excel model, which was used to generate estimates. Recoup's latest survey forecast for 2018[30] of the

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

[28] Plastic packaging waste accepted for recycling (input)

[29] Recycled polymer produced (output)

[30] Recoup's most recent survey based on 2017data was not published at the time of writing this report; however, Recoup provided estimates for the purpose of this project.

quantity of plastic packaging collected for recycling from the consumer sector were also fed into the model. The estimate for plastic packaging recycled in the UK was cross-checked with the number of PRNs that were raised on plastic according to figures submitted to NPWD.

Accredited reprocessing is likely to be an underestimation as it is related to the level of PRNs raised; however, some additional recycling (unaccredited) may be carried out without a PRN being raised. The unaccredited reprocessing was estimated by using the number of reprocessors and exporters that were believed to be operational but not accredited in 2017, and the packaging they would normally handle as a proxy, providing a minimum quantity. It was also estimated using responses from the reprocessor/exporter survey of reprocessors and recyclers.

1.3.4 Projections and Scenario Analysis

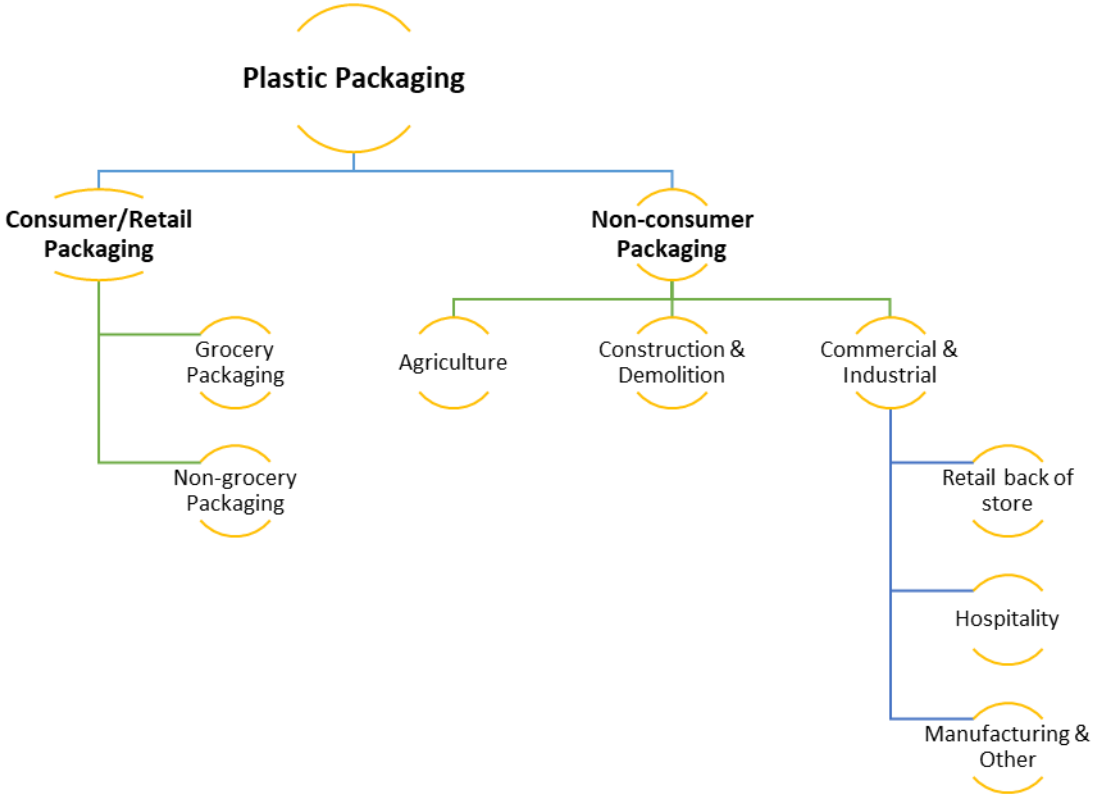
The final section of the report documents a historical analysis of plastic packaging POM and levels recycled in order to inform estimations of the future levels of material POM and reprocessing from 2018 to 2025.

2.0 Establishing Plastic Packaging POM (Bottom Up Approach)

2.1 Introduction

This section of the report provides an explanation of the method used to review the total plastic packaging POM in the UK in 2017. This method splits the POM into different elements and builds a picture from the bottom to the top. The key elements are shown in Figure 13.

Figure 13 Sector breakdown



Packaging is considered plastic if plastic is the predominant material by weight in a composite[31].

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 plastic 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 III and these have been converted into a percentage and related to appropriate margins of error[32], as shown below. The respective margins of error are provided throughout the report.

[31] The EA definitions of composite and multi-layered packaging are defined in, the 'Agreed position and technical interpretations – producer responsibility for packaging[31]'. 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.

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

Figure 14 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 on a total made up of tonnages with differing margins of errors was to convert each percentage error to a tonnage and use the Root of Sum of Squares (since we are dealing with the error of a sum). This was then expressed as a percentage of the total.

2.2 Consumer

2.2.1 Grocery Retail

In order to estimate the amount of packaging POM by the grocery retail market, aggregated Environment Agency (EA) data was used. The data provided by the EA was 2017 plastic quantities reported in table 1 selling from NPWD for 95% of UK grocery retailers[33]. This data was scaled up to 100% of the UK grocery market and resulted in an estimated plastic POM for 2017 of 948k tonnes.

This estimate was cross referenced with Valpak's Environmental Product Information Centre (EPIC)[34] which was assessed to provide data on annual sales and packaging weights for all relevant products packaged in plastic. 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 plastic packaging was scaled up to represent an estimate for the UK grocery retail market. This method assumes that the plastic packaging profile of the supermarkets in EPIC is representative of those not represented. The plastic packaging in the grocery retail sector was estimated to be 880k tonnes in 2017. This represents a 10% decline on the 2013 consumer grocery retail figures identified for 2013 of 981k tonnes.

The EA data was found to be 7% higher than that produced using EPIC and 1% lower than that identified in 2013[35]. In previous years the EPIC and EA data have been much more closely aligned and as such EPIC has been used, due to a greater confidence in the quality of the data, greater detail of plastic packaging composition and its representation of the full grocery market. However, based on the EA having higher market coverage and the increasing market share in the grocery sector of discount retailers such as Aldi and Lidl,

[33] The figure does not include free-riders or non-obligated producers.
[34] 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).
[35] http://www.wrap.org.uk/content/plastic-packaging-market-study-plastic-flow-2014-0

which are not included in the Valpak data and could have greater packaging use per item, the EA data was selected for use.

The final grocery retail plastic packaging POM for 2017 of **948k tonnes** +/-6% error margin was therefore used. This is a tonnage decrease of less than 1% of that identified for 2013; such a small difference in tonnage is within the likely margin of error of the estimate and so consumer plastic packaging POM is considered to have remained at the same level as 2013. Appendix III provides a detailed assessment of relative levels of confidence in the data.

2.2.2 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.[36]

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 plastic packaging used by the grocery sector and other retail sectors was analysed using Valpak membership's reported data[37]. Analysis involved the following key stages:

- Identification of grocery and non-grocery retail members;
- Gathering of company reported data and information; and
- Calculation of plastic packaging tonnage per billion pound turnover for grocery and non-grocery retailers representing 41% of reported tonnage of plastic packaging in 2017[38].

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.

In addition to wholesale supply of soft drinks to non-grocery retailers (estimated through EPIC), soft drinks are also supplied to outlets directly from manufacturers, or indirectly from manufacturers through distribution companies. It is estimated that the tonnage of PET soft drinks bottles unaccounted for using Valpak EPIC data only is approximately 7k tonnes and this has been included in the Total Non-grocery POM figure provided below. Valpak were able to establish this estimate through work being undertaken on drinks packaging of all material types, whereby it was possible to compare the estimated proportion of units sold of soft drinks in plastic/glass/metal/cartonboard established in EPIC, with the proportion of soft drinks volume sold in plastic/glass/metal/cartonboard[39].

The total estimate of non-grocery POM is **584k tonnes** +/- 16%.

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

In summary the following key steps were taken to estimate total retail plastic packaging consumption in the consumer (retail) sector in 2017:

- Total grocery plastic packaging flow in 2017 was 948k tonnes (see section 2.2.1);

[36] https://www.ons.gov.uk/businessindustryandtrade/retailindustry/datasets/poundsdatatotalretailsales
[37] 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.
[38] Assuming this is a random sample, the sample size allows 99% confidence that it represents the population as a whole with an error margin of 0.14%.
[39] *UK Soft Drinks Report 2017, British Soft Drinks Association*

- Proportion of grocery spend of total retail spend in the UK was 43% in 2017[40];
- Total retail plastic packaging flow, assuming like for like packaging was 2,194k tonnes;
- Plastic packaging usage calculated as: grocery 4,195 tonnes /£bn and non-grocery as 1,941 tonnes /£bn;
- Non-grocery plastic packaging tonnes/£bn turnover is 46% of grocery plastic packaging tonnes/£bn turnover; and
- Applied 46% to the difference in tonnage between grocery (948k tonnes) and total retail (2,194k tonnes) and added in 7kt direct from manufacturer soft drinks sales

Therefore, total retail plastic packaging flow in 2017 was estimated at **1,532k tonnes** +/- 7%. This is very similar to the 2013 estimate for consumer plastic packaging POM of 1,534k tonnes and supports the project Steering Group's view that any growth in sales has been negated by packaging light-weighting.

2.3 Consumer POM Composition

2.3.1 Methodology

To provide a breakdown by format and polymer of consumer plastic packaging, supermarket packaging composition was used as a proxy for grocery packaging, but only the non-grocery categories of supermarket packaging (around toys, electrical, clothing, etc.) were used as a proxy for non-grocery packaging.

In addition to non-grocery items, a certain quantity of drinks are sold through non-grocery retailers, although far less than is sold through supermarket groceries. For example, drinks are sold in shops such as Boots, Poundland and Wilko and milk is also sold direct to consumers from farms and through doorstep delivery. Allowances have been made for these non-grocery drinks sales in the non-grocery composition. For further details on drinks composition, please see Section 0.

This methodology of estimating non-grocery packaging differs from the methodology used in Valpak/WRAP's 2013 (2011 data) plastic packaging composition study where, due to lack of non-grocery data, all categories of supermarket packaging were used as a proxy for non-grocery packaging. **This variation in methodology makes it difficult to directly compare 2017 and 2011 data and any comparison should be regarded with caution**.

In order to verify the composition analysis, cross-checks were undertaken, including one on the quantity of natural HDPE bottles used to package fresh milk: Valpak's packaging weight fell within 10% of both industry figures provided and indeed in between the two of them.

[40] 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 has increased to a greater extent. Much of this growth is as a result of an increase in online sales.

2.3.2 Results

The estimated composition of consumer plastic packaging in the UK is shown below.

Figure 15 Consumer plastic packaging by format and polymer (2017)

CONSUMER (Grocery & Non-grocery Combined)										
	HDPE	LDPE	PE	PET	PP	PS	PVC	Other	Grand Total	
Film	89kt	119kt	21kt	28kt	110kt	2kt	9kt	17kt	**395kt**	*26%*
Carrier Bags	*18kt*	*9kt*							*26kt*	
Bottles	268kt	0kt	1kt	347kt	17kt	0kt	0kt	0kt	**634kt**	*41%*
PTTs	9kt	1kt	4kt	155kt	85kt	32kt	13kt	2kt	**301kt**	*20%*
Other	55kt	23kt	1kt	40kt	76kt	3kt	2kt	0kt	**202kt**	*13%*
Grand Total	**421kt**	**143kt**	**28kt**	**570kt**	**288kt**	**38kt**	**24kt**	**20kt**	**1532kt**	
	27%	*9%*	*2%*	*37%*	*19%*	*2%*	*2%*	*1%*		

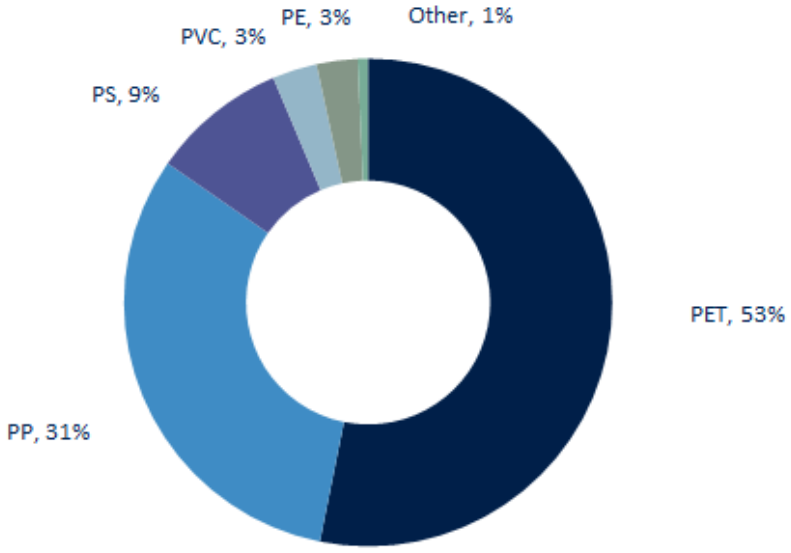
The category 'Other' includes elements of packaging such as caps & lids, toothpaste tubes, chocolate/sweet wrappers, egg boxes, blister packs and clothing hangers.

Since 2011 there has been a reduction in the proportion of film packaging from 32% (556kt) to 26% (395kt) of consumer plastic packaging. Whilst caution is required in drawing this conclusion, analysing quantities of carrier bags used/sold shows that approximately 78kt[41] less carrier bags (and hence film) were used in 2017 as a result of carrier bag taxes coming into force across the UK. Furthermore, light weighting of all packaging, including film, continues with examples of film down-gauging provided by the project Steering Group of 5-19%.

2.4 Consumer PTT composition update

After interrogating and analysing data from Valpak's EPIC database, we found that just over half (53%) of PTTs are made of PET. The second most popular polymer is PP, constituting around one third of PTTs in the UK[42].

Figure 16 Polymer split UK PTTs (2017)

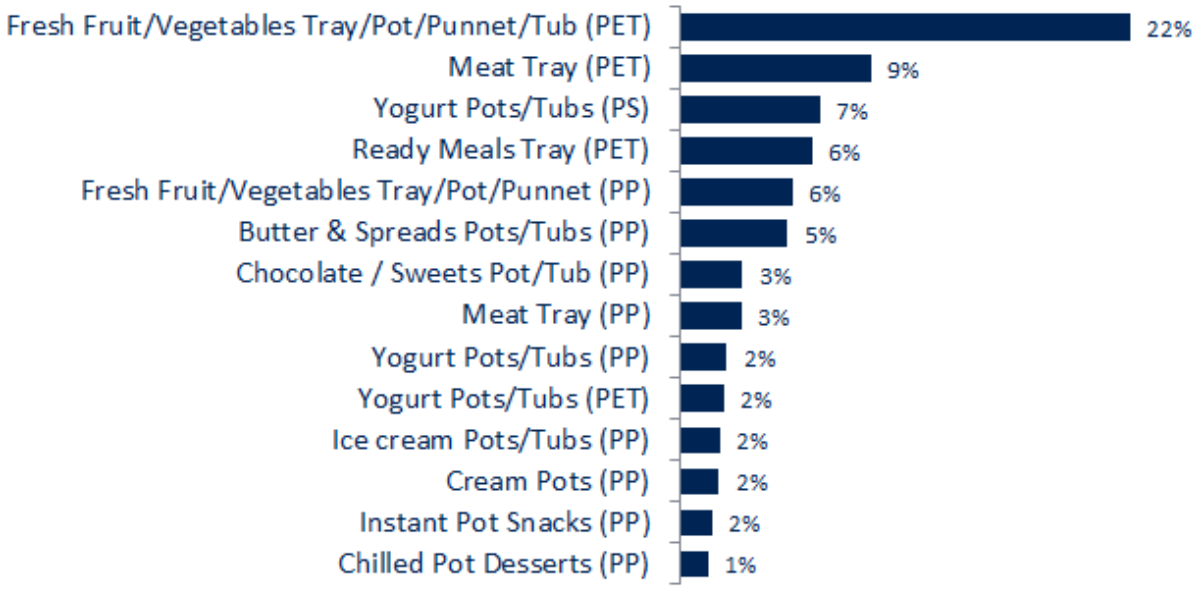


[41] *Valpak EPIC data 2017. Cross checked by number of units with Defra data (80kt)*

[42] *Polymer composition of PTTs as given in this analysis vary slightly from those provided in the overall POM composition table. This is due to the film element of PTTs (closures, lids, etc) being included as part of PTTs in this analysis, but being included within the film category of the overall POM composition table. Including the film element of PTTs in this analysis allowed for comparison with previous work undertaken.*

Further interrogation of the database showed that nearly half of PET used in PTT is used to package fruit and vegetables. Fruit and vegetable punnets, butter and spread tubs, confectionery tubs and meat trays account for just over half of PP PTTs.

Figure 17 Key PTT applications 2017



PET PTTs are considered 'less recyclable' even though they are readily collected in the UK (by ~74% of LAs). Clear PTTs are best recycled separately to PET bottles. This is ideally requires an expensive extra separation step or will represent a risk to the quality of PET bottle bales (if PTTs account for more that 10-15%). Also, black PTTs cannot be automatically separated. What is more, the UK has not yet developed PET PTT recycling capacity or end markets.

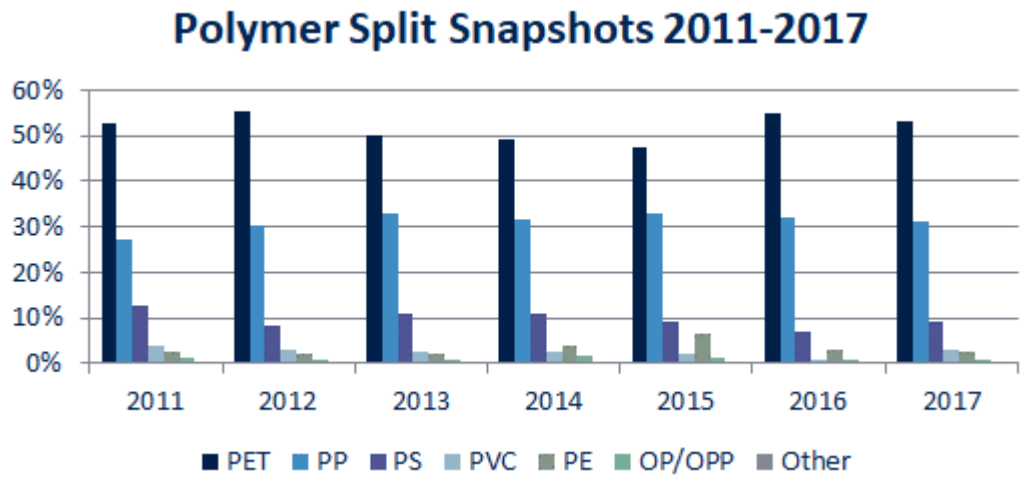
PP is currently a 'more recyclable' polymer as it is readily collected in the UK. PP bottles and PTTs can be reprocessed together and capacity exists to reprocess PP. Furthermore, rPP is in high demand from end markets at home and abroad, such as the packaging (albeit non-food), construction and automotive industries.

The other commonly found polymers in PTTs are PS (e.g. yogurt pots), PE (e.g. cleaning products) and PVC (e.g. meat trays). There are less clear end markets for these smaller volume polymers.

2.4.1 Polymer switching trends

Comparing 2015 EPIC data to snapshots taken in 2011 through to 2017, there is a reducing proportion of PS and PVC used in PTTs.

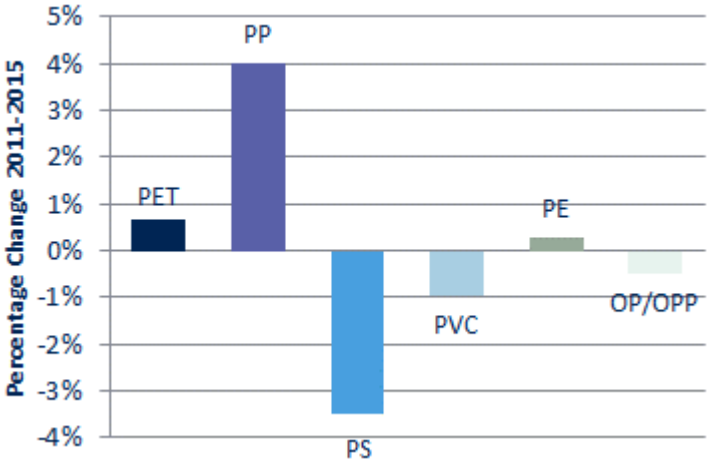
Figure 18 Polymer split snapshots 2011-2017



This data also shows an increase in the proportion of the 'more recyclable' polymer PP between 2011 and 2013.

Figure 19 Change in PTT polymer usage 2011-2017

It is impossible to say from our data set whether these changes represent switching from one polymer type to another, as factors such as light weighting may also have had an impact.



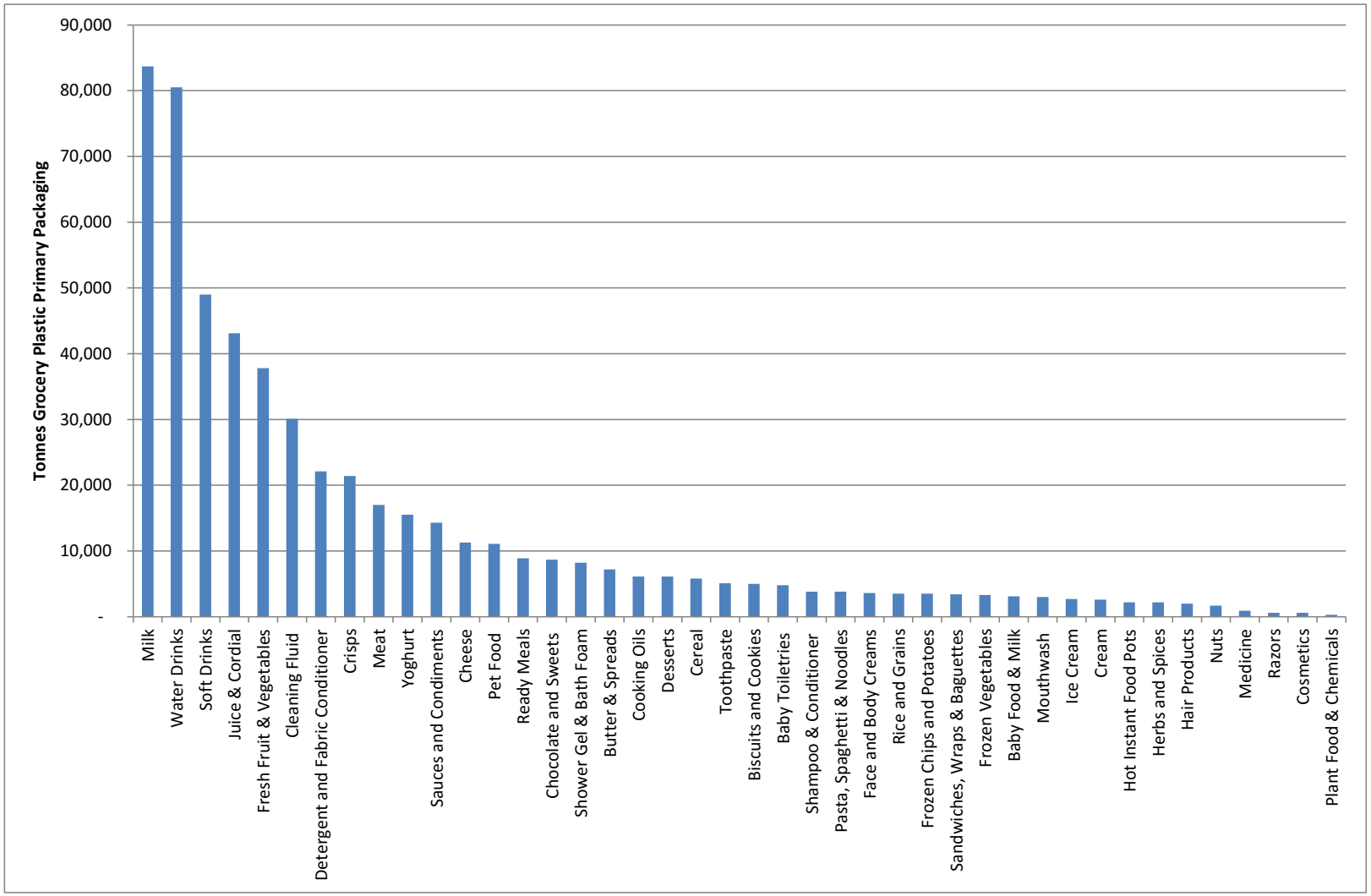
2.5 Grocery plastic packaging POM by category

It was considered of interest to identify the plastic primary packaging POM used for key product categories. Valpak used its EPIC database covering 50.7% of the UK grocery market and scaled this up to represent 100% of grocery sales[43]. The data presented in the chart covers all plastic primary packaging attributed to each of the identified categories sold via the grocery market[44].

[43] *Data included in the chart relates to the grocery market only, not total sales made to consumers or those made through the hospitality sector for example.*

[44] *This is a selection of categories of interest and does not account for all plastic primary packaging handled by the sector.*

Figure 20 Grocery plastic packaging POM by category



The chart indicates that drink products represent the largest tonnage of plastic primary packaging POM by the grocery sector of those categories covered, accounting for around 256kt, with fruit and vegetables representing 38kt, cleaning and washing 52kt and toiletries 32kt.

2.6 Non-consumer

In order to avoid duplication between consumer and non-consumer packaging (i.e. 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[45].

The non-consumer sector is broken down into sub-sectors:

- Construction and demolition (C&D);
- Agricultural; and
- Commercial and Industrial (C&I).

2.6.1 Construction & Demolition

To quantify plastic packaging consumption within the construction industry, a variety of secondary research sources were used, including the finding from UK construction companies surveyed in 2014 that estimated approximately 15% of packaging used in the sector is plastic[46].

In 2014 the BRE Smartwaste Portal was reviewed and using information for data for projects across all industry sectors (commercial, industrial, houses etc.) showed an average 0.3 tonnes of packaging per £100k spend[47]. If this quantity of packaging per spend is applied to the total construction spend of **£137 billion[48] (22% higher than in 2013) in the UK estimated for 2017[48], this results in an estimate of** 415k tonnes of packaging used in the sector. Applying the estimated plastic composition of 15% as per the finding reported above, gives a figure of plastic packaging arising in the sector in 2017 of 62k tonnes.

Research commissioned by the Green Construction Board[49] (GCB) estimates that 289k tonnes of packaging (all materials) arose in the UK construction sector in 2009. Based on the estimate of total packaging arising in the sector, this would equate to approximately 40k-45k tonnes of plastic packaging. If we use the 22% increase in construction spend reported above as a proxy for growth, this provides an estimate of 55k to 61k tonnes of plastic packaging in construction.

No more recent data was found on plastic packaging in the construction sector, however it has been reported in the construction press that 'we are seeing a general increase in plastic packaging, partly because more products are being manufactured offsite, from air-handling units to entire classrooms, which need a lot of protection due to the high value of the

[45] 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. The justification for assessing the POM in this way is included in Section 1 of this report.
[46] It is recognised that estimating the proportion of plastic packaging used in construction is very challenging, even for those companies active in the sector.
[47] *Derived independently of the other similar estimate above using different data.*
[48] *INDUSTRY INSIGHTS, Construction Skills Network Forecasts 2017–2021, CITB in association with Experian* *https://www.citb.co.uk/documents/research/csn%202017-2021/csn-national-2017.pdf*
[49] Internal research only.

products, compared to individual component parts'[50]. This being the case we would expect 2017 estimates to be higher than those reported in 2014 (50k tonnes).

The final project estimate for the construction sector is therefore **62k tonnes**, +/-21% error margin. The film/rigid split identified in the WRAP/Valpak 2011 plastics packaging composition study[51] has been applied to provide an indicative film (56kt) and rigid (6kt) packaging split. It is also possible to derive an indicative polymer split from the compositional study and this is illustrated below:

Figure 21 Indicative Composition of Plastic packaging in C&D

Polymer	Format	% of Arisings	Approximate Tonnage	*Film*	*Rigids*
PE	Film	86%	54kt	*54kt*	
PP	Pots	10%	6kt		*6kt*
HDPE	Pots & Bags	4%	2kt	*2kt*	*0.3kt*
Total			62kt	*56kt*	*6kt*

Appendix III provides a detailed assessment of relative levels of confidence in the data.

2.6.2 Agricultural

As per the 2014 report, figures relating to plastic packaging used around goods consumed in the agricultural sector are derived from the Valpak report, 'UK AWP Waste Arisings, Valpak 2007', based on 2006 data. The total for rigids and film is **37k tonnes** +/- 21%. This dataset is relatively old and evidence would suggest[52] that total crop output has increased by 17% since 2006. However, as there has also been down-gauging of most non-consumer films and light weighting of rigid plastic containers, it is believed[53] the total tonnage remains about the same.

The film/rigid split identified in the WRAP/Valpak 2011 plastics packaging composition study[54] has been applied to provide an indicative film (30kt) and rigid (7kt) packaging split. It is also possible to derive an indicative polymer split from the compositional study and this is illustrated below:

Figure 22 Indicative Composition of Plastic packaging in Agriculture

Polymer	Format	% of Arisings	Approximate Tonnage	*Film*	*Rigids*
PE	Film	56%	21kt	*21kt*	
PP	Film	26%	10kt	*10kt*	
HDPE	Bottles	14%	5kt		*5.2kt*
HDPE	Cores	4%	1kt		*1kt*
Total			37kt	30kt	7kt

Appendix III provides a detailed assessment of relative levels of confidence in the data.

[50] *http://www.constructionmanagermagazine.com/insight/how-can-construction-kick-its-plastics-habit/*
[51] *http://www.wrap.org.uk/sites/files/wrap/Plastics%20Composition%202011%20Report.pdf*
[52] *https://www.gov.uk/government/statistical-data-sets/agriculture-in-the-united-kingdom - volume of cereals harvested has increased by 16% since 2006.*
[53] *Plastic Packaging Data Flow Project Steering Group*
[54] *http://www.wrap.org.uk/sites/files/wrap/Plastics%20Composition%202011%20Report.pdf*

2.6.3 Commercial & Industrial

For the purposes of this work, the commercial and industrial sectors were broken down into three key sub-sectors:

- Retail back of store;
- Hospitality; and
- Manufacturing and other.

2.6.3.1 Retailer Back of Store

The quantity of plastic packaging discarded by grocery retailers at back of store was derived from surveying retailers during June 2018, with data collected representing 61% of the grocery retail market. Data was then scaled up to UK level for grocery. The final figure for grocery retail back of store was 78k tonnes of plastic packaging, which represents an increase of 2% since 2013 (77k tonnes).

This was then scaled up to include the non-grocery retail back of store plastic packaging. 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 plastic packaging used by the grocery sector and other retail sectors was analysed using Valpak membership's reported data[55]. Analysis involved the following key stages:

- Identification of grocery and non-grocery retail members;
- Gathering of company reported data and information; and
- Calculation of plastic packaging tonnage per billion pound turnover for grocery and non-grocery retailers representing 41% of reported tonnage of plastic packaging in 2017[56].

The method used assumes the packaging profile of those retailers within the sample is representative of those not in the sample.

Therefore, the following key steps were taken to estimate total back of store retail plastic packaging consumption in the consumer (retail) sector in 2017:

- Total grocery plastic packaging flow in 2017 was 78k tonnes;
- Proportion of grocery spend of total retail spend in the UK was 43% in 2017[57];
- Total retail plastic packaging flow, assuming like for like packaging was 181k tonnes;
- Plastic packaging usage calculated as: grocery 4,195 tonnes /£bn and non-grocery as 1,941 tonnes /£bn;
- Non-grocery plastic packaging tonnes/£bn turnover is 46% of grocery plastic packaging tonnes/£bn turnover; and
- Therefore, applying 46% to the difference in tonnage between grocery (78k tonnes) and total retail (181 k tonnes) means total retail plastic packaging flow in 2017 was **126k tonnes** +/-15%.

Confidential survey data from two retailers estimated the split between rigid and film packaging resulting in 2k tonnes rigids and 124k tonnes film. In order to provide an indicative breakdown by polymer type, Valpak/Verde internal knowledge was used, resulting

[55] 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.
[56] Assuming this is a random sample, the sample size allows 99% confidence that it represents the population as a whole with an error margin of 0.14%.
[57] 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 has increased to a greater extent. Much of this growth is as a result of an increase in online sales.

in a film split of 90% LDPE, 5% PP and 5% HDPE. For rigids a simple 50:50 split was applied between the two most likely polymers of PET and PP[58]. The indicative composition of plastic packaging in the Retail BoS sector is shown below.

Figure 23 Indicative Composition of Plastic packaging in Retail BoS

	HDPE	LDPE	PET	PP	Grand Total
Bottle					**-**
Film	6197	111551		6197	**123,945**
Other					**-**
Rigids			805	805	**1,610**
Grand Total	**6,197**	**111,551**	**805**	**7,002**	**125,555**

Appendix III provides a detailed assessment of relative levels of confidence in the data.

2.6.3.2 Hospitality

Hospitality plastic packaging is plastic packaging that is primarily 'household-type', but includes both primary and secondary packaging and is consumed in pubs, cafés, hospitals etc. and tertiary packaging found at back of wholesale store of associated distribution centres. The household-type packaging is generally similar in type as that consumed at home, but may not be collected by a local authority for recycling or disposal, and includes some non-household type packaging such as large tubs and buckets used for items such as oils and sauces.

In PlasticFlow 2014 the amount of plastic packaging POM by the hospitality sector was based on the WRAP report 'Waste in the UK Hospitality and Food Service Sector, 2011[59]'and was reported as 164k tonnes, including 71k tonnes of film and 93k tonnes of rigids in 2013. However, the Steering Group associated with the original project raised concerns that this estimate appeared high and was replaced in the subsequent Rigid Plastic report, based on Valpak data, to 71kt film and 44kt rigids, totalling 115kt plastic packaging POM[60].

2017 estimates for the quantity of rigid and film plastic packaging used in the hospitality sector have been updated using newly available Valpak EPIC data relating to 34% of the cash and carry and delivered foodservice industry[61]. 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, as depicted in the following diagram.

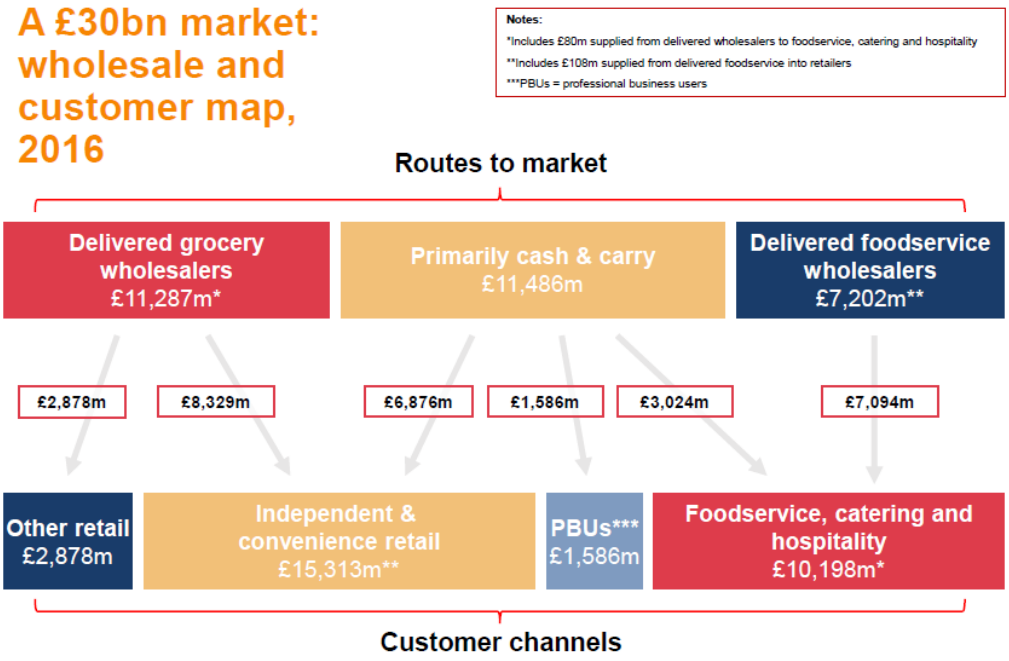
[58] *No further data was available to provide a split between PP and PET, therefore 50:50 was used.*

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

[60] http://www.wrap.org.uk/sites/files/wrap/Rigid_Plastic_Packaging_report_0.pdf

[61] *Valpak's EPIC database holds sales data and packaging weights information for clients signed up for the fully managed service. In the Rigid Plastic 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.*

Figure 24 Overview of the Foodservice, Catering & Hospitality Sector62



In addition to foodservice, hospitality and catering suppliers, soft drinks are also supplied to hospitality outlets directly from manufacturers, or indirectly from manufacturers through distribution companies. It is estimated that the tonnage of PET soft drinks bottles unaccounted for using Valpak EPIC data only is approximately 62k tonnes and this has been included in the Total Hospitality figure provided below. Valpak were able to establish this estimate through work being undertaken on drinks packaging of all material types, whereby it was possible to compare the estimated proportion of units sold of soft drinks in plastic/glass/metal/cartonboard established in EPIC, with the proportion of soft drinks volume sold in plastic/glass/metal/cartonboard[63]. This comparison highlighted a gap equating to approximately 62k tonnes of PET plastic bottles.

This assessment resulted in a total plastic packaging POM for the hospitality sector of **196k tonnes** +/- 15%, approximately 20% higher than the PlasticFlow 2014 report (164kt). This increase was supported by the project Steering Group which indicated that consumers eating habits are changing and that consumption of takeaway meals (and consequently the packaging associated with takeaways) are increasing significantly. The Takeaway Economy Report 2017 reports confirms this, illustrating a 12.5% increase in spend on takeaway meals between 2012 and 2016 due to greater choice and more convenience for consumers.

Based on the data held by Valpak relating to 34% of the foodservice, catering and hospitality sector, 36kt of this total was film and 90kt was rigid packaging. This represents a change from the 2014 estimates (71k tonnes and 44k tonnes respectively); however the 2017 data used cash and carry and foodservice sectors, opposed to cash and carry only in 2014, and an increased market share of the sector.

62 https://www.iqd.com/Portals/0/Downloads/Events/UKGroceryFoodserviceWholesaling2017.pdf

63 *UK Soft Drinks Report 2017, British Soft Drinks Association*

It was also noted from the data that 84% of the plastic packaging identified for the sector was primary or consumer packaging and 16% was secondary/tertiary packaging. The figure below illustrates the film and rigid tonnages, broken down by polymer as per Valpak's EPIC hospitality dataset.

Figure 25 Indicative Composition of Plastic packaging in Hospitality

	HDPE	LDPE	Other	PE	PET	PP	PS	PVC	Grand Total
Bottle	19,927	0	0	4	93,402	243	0	0	**113,576**
Film	934	15,924	1,768	7,365	3,253	7,289	0	39	**36,573**
PTT	5,736	93	0	265	371	2,776	1,316	512	**11,070**
Other	34	0	2	8,457	3,743	18,521	3,682	121	**34,560**
Grand Total	**26,631**	**16,017**	**1,770**	**16,092**	**100,770**	**28,829**	**4,998**	**672**	**195,780**

Appendix III provides a detailed assessment of relative levels of confidence in the data.

2.6.3.3 Manufacturing & Other

The manufacturing sector includes the following sub-sectors[64]:

- Food, drink & tobacco;
- Textiles/wood/paper/publishing;
- Power and utilities;
- Chemicals/non-metallic minerals manufacturing;
- Metals manufacturing;
- Machinery & equipment (other manufacturing);
- Transport & storage; and
- Other Services.

The rigid packaging element of C&I Manufacturing and Other was the focus of a dedicated project undertaken by WRAP and Valpak in 2015. Manufacturing industry's plastic packaging usage is notoriously difficult to quantify, and the PlasticFlow 2014 project failed to provide a robust estimate for the sector.

This project is therefore adopting the Manufacturing and other rigid plastic packaging figure of 292k tonnes established in the 2015 C&I Plastic Packaging[65] project, as it was not felt worthwhile to repeat the work so soon and that the timescales available to undertake the required survey were not suitable for achieving a high level of survey respondents and data quality.

Due to no new data being available, a film figure of 117k tonnes for C&I Manufacturing has been established by subtracting the sum of the other non-consumer sectors' film tonnages (247k tonnes) from an updated PlasticFlow 2014 total non-consumer film tonnage (364k tonnes). See Figure 26 below for summary of non-consumer sectors and total tonnage of film.

Previously for PlasticFlow 2014, a cross-section of industry stakeholders, including members of the steering group and others, collated estimates of non-consumer film production from UK and non-UK producers (which export material to the UK) to provide an overall non-consumer film estimate of 348k tonnes. The current 2017 Plastics Data Flow Project Steering Group believed that whilst sales of plastic film packaging may have increased since 2014,

[64] Commercial and Industrial Waste Survey 2009: Final Report. Defra, 2010.
[65] http://www.wrap.org.uk/sites/files/wrap/Rigid_Plastic_Packaging_report_0.pdf

this would have been offset predominantly by the downgauging of the film itself. However, film around filled imports was believed to have increased and this proved to be the case when an updated analysis of NPWD import data was undertaken, resulting in an additional 16kt of total non-consumer film in 2017.

Consequently, the quantity of film left that has been allocated to C&I Manufacturing & Other is 117k tonnes. This figure is low in comparison to the 2014 Manufacturing & Other film estimate of 247kt. It is believed that some of the transport and logistics film tonnage that should sit within this category has been included in the retailer and wholesaler back of store figures (20kt-30kt), as these can sometimes include film tonnages from distribution centres too. However, when all non-consumer film estimates are combined, this provides a 2017 non-consumer film estimate of 364k tonnes, which in itself appears low when compared to the 410kt-431kt that has been identified as being recycled or exported for recycling in 2017. It is recommended that further work (out with the scope of this project) is undertaken to verify the total non-consumer film estimate and to investigate potential incorrect issuing of PRN/PERNs.

The final project estimate for the manufacturing & other sector is therefore **409k tonnes**, +/-21% error margin.

Appendix III provides a detailed assessment of relative levels of confidence in the data.

2.6.3.4 Total Non-consumer POM Results

A summary of the sectoral estimates for non-consumer POM in 2017 are given in the table below. The final total non-consumer POM estimate is **830k tonnes** +/- 11%. Please see Section 2.1 of this report for the method used to establish the margin of error on a total derived from tonnages with differing margins of error.

Figure 26 Summary of Non-consumer Plastic Packaging POM by Sector

Non-consumer POM 2017					
Sector	**Film**	**Rigid**	**Total**	**Error Margin**	
Agri	30kt	7kt	37kt	+/-	21%
C&D	56kt	6kt	62kt	+/-	21%
C&I Retail	124kt	2kt	126kt	+/-	15%
C&I Hospitality	37kt	159kt	196kt	+/-	15%
C&I Manufact. & Other	117kt	292kt	409kt	+/-	21%
Total	**364kt**	**466kt**	**830kt**	+/-	**11%**
Lower Total	- 11% margin of error		**736kt**		
Upper Total	+ 11% margin of error		**924kt**		

This estimate is 6% (42kt) higher than that of 2014 consumer plastic packaging POM estimate (726k tonnes); it does not necessarily mean that POM has increased by 6% since 2014 as at least some of the additional tonnage may be due to changes in POM methodology, as was the case for rigid packaging in hospitality. Real growth has come from plastic film around filled imports (16k tonnes).

2.7 Summary of Indicative Non-consumer POM Composition

Summing the indicative non-consumer sectors' compositions gives the below indicative total non-consumer POM composition:

Figure 27 Summary of Indicative Total Non-consumer POM Composition

	HDPE	LDPE	PE	PET	PP	PS	PVC	Other	Grand Total
Bottle	217kt		0kt	95kt	0kt				**313kt**
Film	9kt	245kt	82kt	3kt	23kt		0kt	2kt	**364kt**
PTT	17kt		8kt	14kt	77kt	25kt	0kt	0kt	**141kt**
Other	7kt	0kt	0kt	0kt	3kt	1kt	1kt		**13kt**
Grand Total	**243kt**	**245kt**	**90kt**	**112kt**	**100kt**	**25kt**	**0.2kt**	**2kt**	**830kt**

Although this non-consumer POM composition is indicative, it does illustrate some commonly known trends, such as the increasing use of HDPE bottles (shown four times higher than 2011 composition study), increased use of PP (over 50% higher) and reduced use of PS (nearly one-third more) and PVC (negligible).

The lower LDPE film figure (almost half) is unlikely to be a real reduction and suggests that this non-consumer film estimation could be too low. Although there has been down gauging and reduced use of carrier bags (non-consumer trade), there have also been increased sales, which were believed by the project steering group to have balanced off light-weighting. This is an area of work that needs further research.

2.8 Total Plastic Packaging POM

The combined consumer and non-consumer plastic packaging POM are summarised in Figure 28 below.

Figure 28 Total UK plastic packaging POM composition 2017

TOTAL Plastic Packaging POM										
	HDPE	LDPE	PE	PET	PP	PS	PVC	Other	Grand Total	
Film	98kt	363kt	103kt	31kt	133kt	2kt	9kt	19kt	**759kt**	*32%*
Bottles	485kt	0kt	1kt	443kt	17kt	0kt	0kt	0kt	**947kt**	*40%*
PTTs	26kt	1kt	12kt	168kt	161kt	57kt	13kt	2kt	**441kt**	*19%*
Other	63kt	23kt	2kt	41kt	79kt	5kt	2kt	0kt	**214kt**	*9%*
Grand Total	**671kt**	**388kt**	**118kt**	**683kt**	**391kt**	**64kt**	**25kt**	**22kt**	**2361kt**	
	28%	16%	5%	29%	17%	3%	1%	1%		

The 2017 total plastic packaging POM is estimated at **2,361k tonnes** with film accounting for 32%. The remaining 68% is mainly rigids, however the consumer 'Other' category contains packaging such as toothpaste tubes. Consumer accounts for 65% of plastic packaging POM and non-consumer 35%. The 2017 total plastic packaging POM estimate of 2,361k tonnes is slightly higher than the 2014 estimate of 2,220k tonnes, but still within the +/-6% margin of error.

There is a good degree of confidence in the estimates for the consumer sector with an estimated error margin of only +/-7%. There is, however, a much lower level of confidence in the estimates for the non-consumer sector and an error margin of +/-11% for the total non-consumer figure has been estimated. This is due to the fact that many of the estimates have been derived from single sources (often with small data sets) and it has not been possible to cross-reference them. Appendix III provides a detailed assessment of relative levels of confidence in the data.

2.8.1 Total Drinks Packaging

With the announcements that there is an intention to develop a Deposit Return Scheme (DRS) in both Scotland and England, it was considered of interest to present the plastic primary packaging data relating to the drinks market as a separate category. This data has been derived from the following sources:

- Consumer:
  - Drinks packaging sold via the grocery market has been estimated using Valpak's EPIC database, covering 50.7% of the UK grocery sales[66]. Drinks packaged in plastic have been identified and the total tonnage scaled up to represent the UK. Some further drinks packaging was identified as sold via non-grocery retailers and this has also been estimated using Valpak's database and included.
  - 1kt of HDPE has been included to represent sales of milk through a traditional milkman and 1kt through direct sales from farmers to consumers, which would not otherwise have been included using only Valpak's EPIC database[67].
- Non-Consumer:
  - Drinks packaging sold via the hospitality sector were estimated using Valpak's EPIC database relating to 34% of the cash and carry and delivered foodservice industry and scaled up to represent the UK.
  - Additionally, it was identified that in some cases this sector purchase milk direct from dairies and soft drinks via distributors rather than from the foodservice sector. As such, data relating to 39% of the milk market was used to estimate consumption of milk purchased directly and scaled to represent the UK. This equated to around 7.5kt of milk packaging. For soft drinks, data relating to the full market in litres[68] was used to estimate the proportion sold via distributors, which was estimated to be approximately 62kt[69].

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[66] Valpak's EPIC database represents 55% of UK grocery sales, but based on the assessments made in this project and EA data, it is believed that it represents 50.7% of UK grocery plastics primary packaging tonnage.

[67] 1% of HDPE milk sales were found to be through a traditional milkman and 1% direct from farmers. Average packaging weights have been applied to calculate the tonnage of HDPE this relates to http://www.dairyuk.org/images/documents/publications/THE-WHITE-PAPER-2017.pdf

[68] BSDA 2017 UK Soft Drinks Report http://www.britishsoftdrinks.com/write/MediaUploads/Publications/BSDA_Drinks_Report_2017.pdf

[69] The total soft drinks market in litres was compared to that covered by the data held by Valpak for the retail and hospitality sector and the difference assumed to be that sold directly via distributors (12% or 62kt) and was added onto the total.

Figure 29 Plastic Drinks Packaging POM 2017

Drinks	Total Consumer	Non Consumer	Total
HDPE	103k	15k	**118k**
PET	224k	94k	**317k**
Other	6k	2k	**8k**
Total	**332k**	**111k**	**443k**

The analysis indicates that in 2017 there was 443k tonnes of plastic drinks packaging placed onto the UK market[70]. In order to verify this data, Dairy UK data relating to the milk market was assessed, with total milk sales for the UK in litres and by each key market, such as retail and hospitality, being identified[71]. This revealed that approximately 85% of milk is sold in the UK (after exports have been excluded) via the retail sector, direct from farmers or via a milkman and 15% through the hospitality sector[72]. This compares to Valpak's estimate of 86% of all milk packaging being sold through retail markets and 14% through hospitality. Using this data and average packaging weights, a total milk packaging estimate of 115kt was made, this compares to Valpak's estimate of 106kt[73], which is 8% lower than found using average weights and litres sold data. For milk bottles only[74], two industry estimates were provided, both which were within +/- 8% of Valpak's estimate. These industry data therefore support the results of the analysis presented here.

[70] *Including all caps and labels.*

[71] *http://www.dairyuk.org/images/documents/publications/THE-WHITE-PAPER-2017.pdf*

[72] *Including caps and labels*

[73] *Including caps and labels*

[74] *Not including caps and labels*

3.0 Plastic Packaging POM Cross-check (Net Pack Fill)

3.1 Introduction

This section of the report is used as a cross-check of the total plastic POM in the UK in 2017, based on the data stored on NPWD, as reported to the EA by obligated organisations.

This method is not used to estimate total flow as it does not include non-obligated businesses or those not reporting in the system as described below, but to provide a sense check on the total flow and allow for non-obligated flow to be estimated.

3.2 Net Pack Fill

The 2017 UK flow of plastic 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:

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[75] 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 pack/filled, so it is expected that the tonnage goes down as we move down the supply chain.

Using this method, the total obligated plastic POM in 2017 is **1,898k tonnes** (as shown in **Error! Reference source not found.**).

Figure 30 Obligated packaging (Net Pack/Fill total) 2017[76]

	Plastic
Table 1 Pack/Fill (UK pack/filling)	1,507k
Imports:	
3A Selling (filled imports)	474k
3B (packaging removed from imports)	98k
Total	**2,079k**
2A P/F (direct exports)	170k
2B P/F (third party exports)	11k
Total Exported	**181k**
Net Pack/Fill	**1,898k**

[75] *No evidence data is available to support this.*
[76] *Data correct in June 2018. Amendments to the 2017 data are still possible.*

lThis method does not account for plastic 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 is small due to the likely volumes handled by the types of companies performing this activity. An estimate of the unobligated tonnage (463k tonnes, 17%) has been made by subtracting the Net Pack Fill figure of 1,898k tonnes from the project's final flow estimate of 2,361k tonnes. Further details are provided in section 4 of this report.

4.0 Results: Final Project Estimate of 2017 Plastic Packaging POM

The project estimate for plastic packaging POM in 2017 is 2,361k tonnes.
This is made up of a combination of top down (non-consumer total film) and bottom-up (consumer, non-consumer rigid packaging and non-consumer film sector breakdown) methods. It has been cross-checked with reported obligated data on NPWD.

The final project estimate for plastic packaging POM in the consumer sector is 1,532k tonnes
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 plastic packaging POM in the non-consumer sector is 830k tonnes
For film, this method is based on a combination of primary (survey) data, secondary research, published 2017 NPWD data on filled imports and information (2013 sales data) provided by the project Steering Group. For rigids, this is based on the findings of the WRAP/Valpak report into rigid packaging in the C&I sector and on secondary research.

Figure 31 Final Project Estimate of Plastic POM[77]

	Total (k tonnes)	Bottles/PTTs (k tonnes)	Film (k tonnes)	Other (k tonnes)
Consumer	1,532 +/-7%	935	395	202
Non-consumer	830 +/-11%	453	364	13
Total	**2,361** +/-6%	**1388**	**759**	**214**

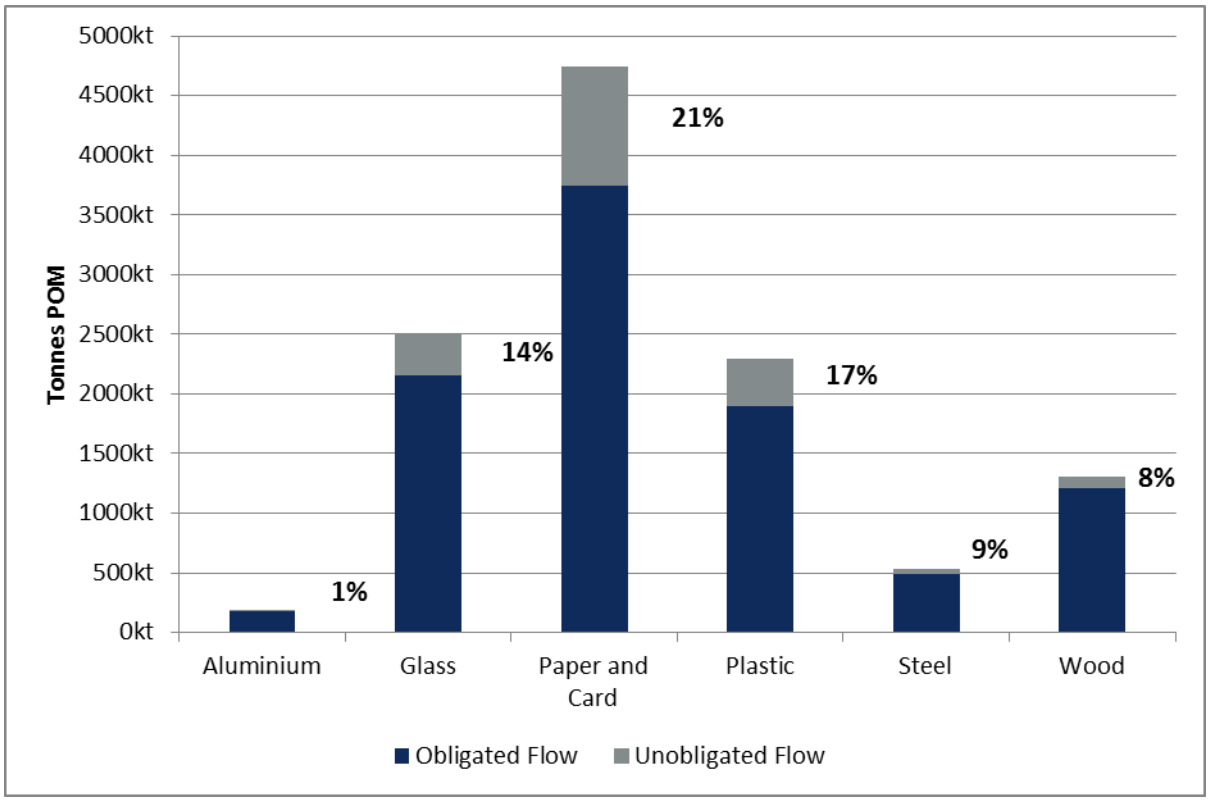
The total POM estimate was found to be 463k tonnes higher than data reported by obligated companies under the Packaging Waste Regulations (using the UK net pack/fill calculation method). This suggests that non-obligated companies (handling fewer than 50 tonnes of packaging or with lower than £2 million turnover), account for 17% of plastic packaging in the UK. This has not changed from the 17% non-obligated POM identified in 2013.

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.

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

Figure 32 illustrates the obligated versus non-obligated flow for all reported materials. Although each packaging type is characterised by different market structures, the project results highlight that non-obligated flow for plastic is consistent with other reported materials, in particular glass.

Figure 32 Obligated Versus Non-Obligated POM for Packaging Materials 2017



5.0 Collection and Reprocessing of Plastic Packaging in 2017

5.1 Introduction

The levels of plastic packaging collected for recycling within the UK in 2017 were assessed. Plastic packaging collections and recycling are split into consumer and non-consumer waste streams. Each stream is then broken down into the following:

- Consumer bottles and PTTs;
- Consumer film;
- Non-consumer bottles;
- Non-consumer other rigids; and
- Non-consumer film.

NPWD, UK reprocessor and exporter discussions/survey and RECOUP's latest survey forecast for the 2017[78] quantity of plastic packaging collected for recycling from the consumer sector were fed into an Excel model to quantify the collection and recycling of UK plastic packaging. The results are provided below. Appendix I[79] provides the details of an alternative method with which the results were sense-checked.

5.2 2017 Survey of Recyclers and Exporters

5.2.1 Introduction

The basis for this method was the identification of recyclers handling packaging waste in the UK, combined with an assessment of how much recovered plastic packaging waste each accepted for recycling (input) and how much recycled polymer each produced (output).

The Environment Agency list of plastic reprocessors accredited to issue PRNs was used to identify recyclers processing plastic packaging wastes in the UK. Using in-house knowledge, discussions with 20+ industry stakeholders, and for some of the smaller recyclers web searches, the polymers recycled by each were identified.

Where possible, information was obtained directly from the recycler, but information was also obtained from third party industry experts familiar with the market for each of the polymers. The analysis focused on how much recyclers were processing as opposed to the technical capacity of the facility.

Overall, based on the estimates for plastic packaging tonnage processed, just under a third of the market was spoken to directly and around 85% of the information either came from the recyclers themselves or industry experts operating in the same field, as shown in Figure 33 below. Much of the remainder was for recyclers classified as small reprocessors of packaging waste, as defined by the Environment Agency (400tonnes or less of PRNs issued).

[78] Recoup's most recent survey based on 2017data was not published at the time of writing this report; however, Recoup provided estimates for the purpose of this project.

[79] *Due to the quantity of recycling being less than the accredited recycling figure and uncertainty around the format breakdown within the manufacturing and other sector (due to the small sample size) this methodology for estimating the total plastic packaging recycled in 2017 was used purely as a sense-check.*

Figure 33 Recycling industry survey

	Tonnage (input)	Percent
Recycler spoken to directly	130	31%
Estimates from industry	233	55%
No contact or estimates	60	14%
	423	

Some recyclers had processing lines for different polymers and some recycled different polymers on the same processing line. The latter was particularly the case for HDPE, PP and PS. In each of these instances, an attempt was made to break down the different polymers handled by each recycler. The point of PRN issue was deemed the point at which material was recycled. Estimates were also made of the polymer being recycled by:

- Consumer or non-consumer packaging;
- Format type: bottles / trays, films, other rigid; and
- Sector from which the waste was derived for non-consumer plastic packaging: C&I, agricultural and C&D.

Identifying the sector from which the waste plastic packaging was derived was very challenging for recyclers as they are not typically involved in the collection of the waste. For example, a recycler of PET bottles would not be able to identify how much of the feedstock they receive is from household collections or C&I collections in the hospitality sector. For simplicity, it has been assumed that all bottles and PTT recycled in the UK are from consumer sources, however, in reality there will be some hospitably derived bottles and PTT recycled in the UK, although at relatively low levels compared to household (consumer) derived bottles and PTT. Recyclers of films and rigid C&I grades often also handled non-packaging grades, such as production waste or agricultural films. During discussions with industry it was made clear that only throughput related to the processing of packaging wastes were of interest and that non-packaging should be excluded from any estimates.

5.2.2 Assumptions

The outputs from recyclers were calculated based on discussions with industry and allow for removal of:

- Non-target recyclables, e.g. coloured PET bottles. These may be recycled by others or exported and so show up elsewhere in the analysis;
- By-products, such as the polyolefin float fraction (caps, labels from PET recycling). As with the above, this fraction may be recycled by others and so show up elsewhere in the analysis;
- Process loss;
- Non-plastic waste.

Following discussions with UK plastic recyclers as part of the research work, the following conversion rates (percentage of r-polymer out compared to recovered plastic in) were assumed:

- PET bottles: 65%
- HDPE bottles: 80%
- PP bottles / trays from households: 75%
- LDPE film C&I: 85%.
- LDPE film (agricultural and C&D): 75%
- C&I other rigids: 100%.

Clearly, there can be differences based on what the recycler is targeting and input quality, but these are felt to be a reasonable average across the sector. The LDPE film conversion rate reflects the fact that it is predominantly the higher grades of packaging film that are recycled in the UK. C&I other rigids recycled in the UK are assumed to be items such as crates and other large plastic items with minimal contamination and process loss.

The Environment Agency list of plastic reprocessors accredited to issue PRNs splits into two sizes of reprocessors, small (able to issue up to 400 tonnes of PRNs per annum) and large (able to issue over 400 tonnes per annum). Effort was focused on identifying how much those defined as large recyclers processed, in particular those believed to be handling more than 10kt per annum. It was assumed that all small recyclers (as defined by the Environment Agency) processed 300 tonnes of packaging waste per annum.

5.2.3 UK Recycling Cross-check

The final figures from this exercise, in relation to output of recycled polymer, were sense checked against PRNs issued in the UK in 2017. The total recycled output was calculated to be 338kt and PRNs issued in 2017 were 358kt, and so they are reasonably close when considering the use of generalised assumptions for conversion rates.

5.2.4 Export

An analysis of the export market is made difficult due to the wide range of waste plastic packaging grades exported and the number of exporters. The number of PERNs issued in 2017 was used as a proxy for the tonnage of waste plastic exported for recycling: 686kt. However, it should be noted that in principal exporters are required to remove any non-target plastic packaging waste (including contamination) from the tonnage of recovered plastic packaging they export prior to issuing PERNs. The following approach was taken for breaking exports down by polymer/format.

Firstly, the Recoup LA Collection Survey data was used as a basis for household (consumer) waste plastic packaging collected in the UK. Having produced an estimate for how much of the collected material was recycled in the UK, it was assumed the remainder was exported for recycling. In doing this, the assumption was made that any loss of collected material during polymer sorting (most notably this would be in the PTT fraction) was balanced by the export of the PTT residual fraction and inclusion of non-target contamination in the sorted polymer. Where mixed polymer material (unsorted) such as mixed bottles is exported directly then the loss would occur overseas. Due to these assumptions the figures used are clearly approximations only.

Secondly, an estimate was then made of non-consumer rigid waste plastic packaging which is exported. Here a very wide range of grades is collected in the UK and then exported making estimates particularly difficult. Including bottles and trays from non-consumer sources (hospitality) it was estimated that 100kt of this type of material is exported. This is an in-house estimate based on experience and conversations with exporters over recent

years related to the types and grades of recovered plastics exported. Due to the large number of plastic exporters and the wide range of grades handled by each, a comprehensive study of the export market would be required to get a more accurate assessment of this flow (out with the scope of this project).

Thirdly, it was then assumed that the remainder of the material exported (based on PERNs issued) was films, known to be a key component of waste plastic exported from the UK. Large volumes of LDPE films are produced in the UK from C&I sources; however, it is only the highest quality grades that are recycled domestically, typically the higher grades of 98:2 film and above. The majority of these C&I films, grades 70:30 to 98:2, are exported.

The findings derived from the aforementioned methodology, resulted in the following 2017 outputs:

- Consumer Collections
- Consumer recycling (in/out)
- Non-consumer UK recycling (in/out)
- Consumer exports
- Non-consumer exports
- Total recycling

Each of these are discussed in more detail below.

5.2.5 Consumer Collections 2017

The consumer (local authority) collection figure of plastic packaging in the UK in 2017 was provided as an estimate by RECOUP[80]. Details of the collection figures can be found in Figure 34.

Figure 34 Consumer Plastic Packaging Collected 2017[80]

	Total (k tonnes)
UK Total Bottles	350
UK Total Plastic Pots, Tubs & Trays[81]	175

The figure above splits the consumer collections into bottles and mixed plastics, as in the RECOUP collections report. In the plastic pots, tubs and trays (PTTs) fraction it is likely that a small amount of this material is consumer film as some Local Authorities are now collecting this stream. Using data available from a small sample of local authorities[82] and supermarkets[83], it has been estimated that up to 16k tonnes of the mixed plastics collected in 2017 could have been consumer film: this represents around a 4% recycling rate for this stream[84]. Based on this, Figure 35 shows the collection tonnages, with PTTs and film split out, and the associated collection rates of all consumer streams in 2017.

80 At the time of report writing the RECOUP 2018 survey was not published, therefore RECOUP provided estimates for the purposes of this report.
81 Including PTTs and household film.
82 As calculated during Plastics 2017 extension project, December 2013.
83 Supermarket back of store data, Valpak surveys, 2014.
84 This is based on local authority data, including http://www.wrapcymru.org.uk/content/composition-municipal-solid-waste-wales-0 and that provided directly by local authorities and supermarkets for this project. This has then been scaled up to represent UK collections based on supermarket market share data for front of store collections and the number of households with a film collection service for kerbside collections. Based on some data being provided in confidence, detailed calculations cannot be provided here.

Figure 35 Consumer Plastic Packaging Collection Rates 2017

Stream	2017 Consumer Collection Rate		
	POM	Collected	Collection Rate
Consumer Total	**1532k**	**525k**	**34%**
Consumer PTTs/Bottles	*935k*	*509k*	*54%*
Consumer Film	*395k*	*16k*	*4%*
Consumer Other	*202k*	-	-

This shows that 525k tonnes of consumer plastics were collected for recycling in 2017. Compared to 2013 this represents an increase in bottles of 2%, 4% for PTTs and a <1% decrease for film collected compared to 2014.

RECOUP data are used rather than WasteDataFlow (WDF) as they are considered more appropriate: RECOUP receive more timely data which is relevant to the same time period as the POM. WDF data relating to 2017 is not yet released[85]. RECOUP is also able to calculate more appropriate splits where plastic packaging data is reported co-mingled with other materials (WDF is mainly based on averages). Where data gaps exist, RECOUP fill them[86] with their best estimates.

However, WDF data was used as a sense-check, which supported this estimate[87]. It was also used to identify where plastic packaging is collected and showed that the majority of consumer plastics are collected at kerbside with 91%, followed by CA sites at 9% and bring sites 1%[88].

Appendix III provides a detailed assessment of relative levels of confidence in the data.

Based on the methodology set out above, the volumes of recovered plastics packaging recycled in the UK were calculated. The results are shown in the tables below. The robustness of the data for each of the polymers was defined based on the percentage of the recycling market that had either been spoken to directly or where information had been received by third-party industry experts. Where this was over 75% of the market this was defined as high. Between 50-75% of the market this was defined as medium. For less than 50% of the market this was defined as low. The robustness for each polymer, or group of polymers, was concluded to be:

Figure 36 Robustness of polymer estimations for packaging recycled in the UK

Polymer	Robustness score
PET	High
HDPE, PP, PS	High
LDPE	Medium

[85] *At time of reporting*
[86] *WDF was used as a sense check and identified 554kt collected, which is 6% higher than the Recoup estimate. This supports the Recoup estimate.*
[87] *The latest published WasteDataFlow (WDF) figures (2015/16) were used to sense check the Recoup estimates for consumer plastics collected. Using WDF data there were 554k tonnes of consumer plastics collected for recycling. This is within 6% of the Recoup figure which supports this estimate.*
[88] *WDF data (2015/16)*

5.2.6 Consumer Recycling

We estimate that 226kt of consumer waste plastic packaging was recycled in the UK during 2017, of which all was rigid material (bottles and PTT). RECOUP estimate that there was 509kt of rigid consumer plastic collected in that year. This would mean that 44% of rigid consumer waste plastic packaging was recycled in the UK. Of the small amount of consumer films collected, none was identified as being recycling in the UK.

Figure 37 Consumer UK recycling estimates

Recovered plastic	Recovered plastic IN (kt)	Recycled polymer OUT (kt)
Rigid PET (bottles, trays)	110	72
Rigid HDPE (bottles, trays)	86	69
Rigid PP (bottles, trays)	30	23
Films	0	0
Totals	226	164

For non-consumer recycling in the UK, the largest fraction being recycled is LDPE films, just over 70% of the total. The packaging films being recycled in the UK tend to be the higher quality grades, typically the highest quality C&I films such as 98:2 and 99:1 / 100% clear and coloured grades.

5.2.7 Non-Consumer Recycling UK 2017

Figure 38 Non-Consumer Recycling (films)

Recovered plastic	Recovered plastic IN (kt)	Recycled polymer OUT (kt)
Films (agricultural)	1	0.75
Films (C&D)	1	0.75
Films (C&I)	142	121
Totals	144	122.5

Rigid C&I plastic packaging recycled in the UK tends to be relatively clean HDPE and PP material, including items such as crates, pallets, trays and drums. Some polyolefin plastics packaging material also arises in mixed rigid plastics from civic amenity sites. It has been assumed this has come from C&I sources (for example, small businesses and restaurants), although some will also have come from consumer sources. C&I rigid plastics plastic that do not require washing can be processed using relatively inexpensive equipment and as a result recycling of this stream is relatively dispersed.

Figure 39 Non-Consumer Recycling (Rigids)

Recovered plastic	Recovered plastic IN (kt)	Recycled polymer OUT (kt)
Rigid (agricultural)	0	0
Rigid (C&D)	0	0
Rigid (C&I)	55	55
Totals	55	55

For the rigid C&I fraction, it was estimated that 29kt was PP, 18kt HDPE and 8kt PS packaging.

5.2.8 Consumer Export 2017

All polymer sorted grades of consumer rigid plastics are exported for recycling, including PET, HDPE and PP. In addition, unsorted mixed bottles are also exported for polymer sorting and recycling overseas. As mentioned above, the export figure is the balance of the RECOUP collection figure not believed to be recycled in the UK.

Figure 40 Consumer Export

Recovered plastic	Tonnage exported
Bottles and PTT	283
Film	16
Totals	299

5.2.9 *Non-Consumer Export 2017*

It is believed that the vast majority of the LDPE films exported are C&I films sitting in the grade range of 70:30 to 98:2. These exports are driven by lower costs of processing overseas, in particular, due to the level of manual intervention required to remove non-target items and labels. Exports from this category include nearly all film produced back of store in the grocery sector and the majority from other retailers. Whilst some of the higher grades of film in this range can now recycled in the UK, such as 98:2 from distribution centres, much was still exported in 2017 as deep sea markets focused on these higher quality grades which were available at relatively attractive prices. Some C&D film is known to be exported, both to Europe and deep-sea destinations and so an estimate for this was included. However, the vast majority of films exported is believed to be from the C&I sector.

Figure 41 Non-Consumer Export (films)

Recovered plastic	Recovered plastic IN (kt)
Films (agricultural)	0
Films (C&D)	10
Films (C&I)	265
Totals	287

C&I rigids include items such as HDPE drums, PP crates & pallets, PP bulk bags other PRNable scrap from C&I supply chains, such discarded bottles, trays, etc. It also contains bottles and PTT derived from the hospitality sector.

Figure 42 Non-Consumer Export (rigids)

Recovered plastic	Recovered plastic IN (kt)
Rigid (agricultural)	0
Rigid (C&D)	0
Rigid (C&I)	100
Totals	100

5.3 Unaccredited Recycling 2017

Unaccredited recycling is when plastic packaging is recycled without a PRN/PERN being raised for it.

Two methods were used to quantity this. Firstly, based on analysis of the average price of a PRN in 2017 and the cost of accreditation (plus the internal administration cost), it was identified that a 'small' facility would need to recycle 31 tonnes of plastics and a 'large' facility 94 tonnes in 2017 to breakeven against accreditation costs. However as large reprocessors recycle 400 tonnes (and above) it is assumed that all unaccredited reprocessors are small based on the assumption that it's a cost decision. The figures indicate that it is clearly cost effective for large reprocessors to be accredited.

The breakeven figure for small reprocessors was then applied to the number of reprocessors estimated to be unaccredited (using Valpak market knowledge and NPWD). As a result, up to 1.1k tonnes of plastic packaging could have been recycled by unaccredited recycling facilities in the UK in 2017 but not contributing to the national packaging recycling rates due to the costs of accreditation. Secondly, during the survey of reprocessors and exporters they were also asked to provide insight into how much plastic packaging was recycled with no PRN/PERN being issued. This identified that approximately 25k tonnes of plastic packaging could potentially be unaccredited. This is down from 50k tonnes in 2013 based on average PRN prices for those years. The higher PRN price in 2017 would make it difficult for unaccredited reprocessors/exporters to compete for material, and as such, this may have contributed towards more reprocessors/exporters becoming accredited. Further information about the unaccredited recycling estimates can be found in Appendix II.

Using these two approaches it is believed that there was between 1.1k to 25k tonnes of unaccredited plastic packaging recycling in 2017. Based on the accredited recycling being 1,044k tonnes in 2017 this would mean that unaccredited recycling accounts for 0.1% to 2.3% of the total plastic packaging recycling.

Unaccredited recycling is difficult to verify and due to it not being reported, does not count towards the UK's recycling achievement. Therefore it has not been included in any of the total recycling analysis in the following sections of this report.

5.4 Total Recycling 2017

Figure 43 Total plastic packaging UK recycling & export

Stream	Recovered plastic IN (kt)	Recycled polymer OUT (kt)
Consumer UK Recycling	226	162
Consumer Export	299	299
Non-consumer UK Recycling (films)	144	123
Non-consumer UK Recycling (rigids)	55	55
Non-consumer Export (films)	287	287
Non-consumer Export (rigids)	100	100
TOTAL Recycled or Exported	**1111kt - 1026kt**	

6.0 Plastic Packaging Recycling Rates

Figure 44 Summary of UK plastic packaging recycling rates 2017

Stream	2017						
	POM	Collected	Recovered Plastic IN	Recycled Polymer OUT	Collection Rate	Recycling Rate (In)	Recycling Rate (Out)
Consumer Total	**1532k**	**525k**	**525k**	**461k**	**34%**	**34%**	**30%**
Consumer PTTs/Bottles	*935k*	*509k*	*509k*	*445k*	*54%*	*54%*	*48%*
Consumer Film	*395k*	*16k*	*16k*	*16k*	*4%*	*4%*	*4%*
Consumer Other	*202k*	-	-	-	-	-	-
Non-consumer Total	**830k**	**-**	**586k**	**565k**	**-**	**71%**	**68%**
Non-consumer Rigids	*153k*	-	*155k*	*155k*	-	*101%*	*101%*
Non-consumer Film	*364k*	-	*431k*	*410k*	-	*118%*	*113%*
Non-consumer Other	*830k*	-	-	-	-	-	-
Grand Total	**2361k**	**-**	**1111k**	**1026k**	**-**	**47%**	**43%**

As can be seen from the above table, there is a discrepancy in the recycling rates of non-consumer film (113-118%). Based on a more feasible recycling rate of 70-80% recycling of non-consumer film, there remains 80-130kt of non-consumer film recycling that cannot be identified. One explanation for this could be the incorrect allocation of PRN/PERNs against either non-packaging film or non-UK packaging. Alternatively, or in addition, it could suggest that the non-consumer film POM estimate is low.

It is suggested further research is required to fully understand why there is a mismatch of this size. Research is recommended both into non-consumer film POM and the incorrect issuing of PRNs.

7.0 Plastic Packaging End Markets

7.1 Introduction

This section looks at the key uses for recycled polymer produced in the UK from packaging waste. A summary of areas of usage by polymer is shown below. The breakdown in the tables that follow is based on estimates of how recycled polymer produced in the UK is used, based on in-house knowledge and discussions with industry; primarily recyclers, but also a major film manufacturer (using r-polymer) and industry experts. For PET, the recycled polymer is produced from bottles and trays (consumer and non-consumer from the hospitality sector). For HDPE the largest volume of recycled polymer comes from bottles / household trays, but around 20% comes from rigid C&I packaging. For PP there is a roughly equal split between recycled polymer produced from bottles / trays and PP from rigid C&I packaging. Recycled LDPE is nearly all derived from C&I and manufacturing films.

r-PET is used in relatively few well defined markets making it easier to assess. For HDPE and PP, there are a wide range of different products manufactured from recycled polymer which makes it difficult to provide a detailed split across all applications. Here discussions with recyclers focused on the key market sectors and examples of products in each. HDPE and PP polymers are also sometimes blended to produce products and, in addition, recyclers may not always know the application for which they are being used. Percentages shown in the table below should therefore be treated as indicative. The vast majority of LDPE is used to make film products of different types, although some is used to make semi-rigid and rigid items (such as plastic wood). Products tend to be those where a small degree of discoloration, which can occur with the use of r-LDPE, does not cause any concerns amongst users, or where the film is often coloured. Hence, the construction and agricultural sectors being key users of film produced with recycled content.

7.2 PET

A key application is the production of PET sheet which is then used to produce packaging items, such as trays. The use of PET in food contact applications, notably bottles, also remains an area of high demand.

Figure 45 End Markets for PET Recycled in the UK

Application	Examples	Indicative usage
Sheet manufacture	Used to make packaging trays, etc.	65%
Bottles	Food contact applications, such as drinks bottles.	30%
Fibre	Polyester fibre for fill	5%

7.3 HDPE

Pipe manufacture is a key use of recycled HDPE polymer, in particular for coloured HDPE pellet. Another key use of recycled HDPE, from consumer sources, is the production of bottles. This includes food contact applications, such as the production of milk bottles, but also increasingly to produce non-food contact bottles. Natural HDPE pellet, produced from milk and juice bottles, are typically preferred in these applications.

Figure 46 End Markets for HDPE Recycled in the UK

Application	Examples	Indicative usage (%)
Packaging	Food and non-food bottles.	25
Construction	Pipes, chambers, roof spacers, plumbing items.	35
Horticultural & outdoors	Compost bins, water butts, wheel bins, garden furniture, watering cans.	20
Other	Wide range of items including inclusion in plastic wood applications, garden furniture, household items such as boxes and buckets.	20

7.4 PP

The automotive sector is a key user of recycled PP polymer. It is used in an increasing range of applications both in the car's interior (dash, etc), under the bonnet (battery cases, ducting) and externally (wheel arches, mudguards). The production of packaging is also a major use of recycling PP polymer, for example to produce crates, pallets, paint pots, etc.

Figure 47 End Markets for PP Recycled in the UK

Application	Examples	Indicative usage (%)
Automotive	Interior design items, wheel arches, ducting, battery cases, mudguards.	40%
Packaging	Paint pots, pallets, crates, trays, boxes	40%
Other	Wide range of items including inclusion in plastic wood items, plant pots, etc.	20%

7.5 LDPE

The construction sector is a key user of recycled LDPE polymer. The production of damp proof membranes is perhaps the largest user of recycled LDPE within the sector but it is also used to produce gas protection film (laid under the house to act as a barrier for radon gas) and also general-purpose film used on building sites, such as to cover and protect part completed structures and materials. Recycled LDPE is also widely used in the production of refuse and recycling bags.

Figure 48 End Markets for LDPE Recycled in the UK

Application	Examples	Indicative usage
Construction films	Damp proof membranes, building films for temporary protection, gas barrier protection	40%
Plastic bags & sacks	Refuse sacks, recycling sacks, bags for life.	20%
Agricultural films	Crop cover (mulch film)	15%
Other	Packaging, rigid / semi-rigid products, plastic wood.	25%

7.6 Export Markets

It is worth noting that applications in export markets sometimes differ, in particular in non-EU destinations. For example, in Asia discussions with recyclers and traders of PET flake suggest that the majority of recycled PET is used in the production of polyester fibre whereas in Europe this end market has been declining in recent years. Also, recycled LDPE polymer in agricultural film production is more prevalent in Asia (notably China) than in the UK as its uses in foamed LDPE applications.

7.7 Export Destinations for UK Waste Plastic Packaging Waste.

A Freedom of Information Act request was made to the Environment Agency for information on where UK waste plastic packaging was exported to in 2017. Reproduction of this data is subject to the conditions set out in the Open Government License version 3.0. Please see conditions in the attached link:

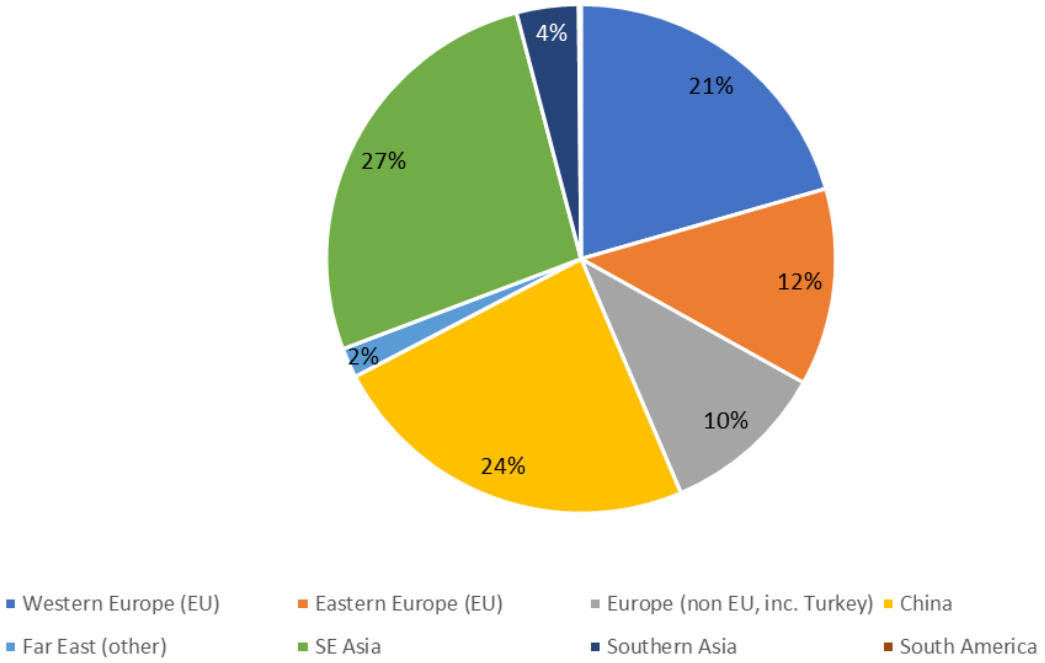
http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

The data provided by the Environment Agency was analysed to produce the pie chart and list of top 10 destinations below. The tonnages shown in the breakdowns below relate to PERNs issued, and as such the actual tonnage shipped may be slightly higher as any non-UK derived plastic packaging waste in the shipment should have been removed prior to PERNs being issued.

Of particular note is the lower volume of waste plastic packaging exported to China than in the previous year, around 100kt less (based on the same information for 2016 also provided by the Environment Agency). This will have further significantly reduced in 2018 following the ban on imports of post-consumer waste plastic into China implemented at the end of 2017. This is supported by HMRC UK Trade info data. Discussions with recyclers and traders in Asia suggest that much of the increase in recovered plastic being shipped to SE Asia, in particular Malaysia but also to an extent to countries such as Vietnam and Thailand, once recycled is ultimately finding its way to China in the form of recycled pellet. This demand is being driven by the loss in domestically produced recycled pellet in China, historically generated from imports of recovered plastics from overseas.

The pie chart below shows the top 10 export destinations for UK derived waste plastic packaging waste by region.

Figure 49 Export destinations for UK plastic packaging waste by region 2017



The table below shows the top 10 destinations for UK derived waste plastic packaging waste.

Figure 50 Top 10 destinations for UK plastic packaging waste 2017

Destination country	Tonnage exported (kt)
China	163
Malaysia	78
Poland	76
Turkey	72
Vietnam	58
Netherlands	55
Indonesia	43
Germany	38
India	27
France	13

Source: Environment Agency

8.0 Plastic Packaging Flow, Recycling Scenarios

8.1 Introduction

This section reviews the historical data and trends for plastic packaging placed on the market (POM) in the UK, and plastic 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 on these models, a range of scenarios for plastic packaging POM and plastic packaging recycling are projected forward to 2025. The intention here is to provide a range of possible futures for plastic packaging POM and recycling to inform policymakers and other stakeholders.

Next, assuming that these scenarios represent plausible possible futures for plastic packaging POM and recycling, a compliance assessment of potential plastic packaging recycling rate versus the plastic packaging recycling rate targets to 2020, and the CEP target in 2025 is made.

8.2 Plastic Packaging POM and Projections

Because there are no available figures for POM tonnages, historically, plastic packaging POM has been estimated by a process of consultation and periodic review with industry and stakeholders (see for example the PackFlow 2012, PackFlow 2017 reports)[89]. For example, in the previous PackFlow exercises plastic packaging POM was set 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.

As a consequence, past estimates of POM tonnages established by such a process are a mixture of data and expert judgement and therefore may not necessarily accurately reflect actual trends in materials being placed on the market.

The EA's NPWD (National Packaging Waste Database) provides a data source from which to assess trends in plastic packaging placed onto the market by businesses that have an obligation 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 quantity of plastic packaging handled by obligated producers ('obligated' POM) is available for trend analysis.

What is not known is the quantity of non-obligated plastic packaging ie plastic packaging handled by businesses who are 'de minimis' or 'free-riders'. But once a total POM is established this can be straightforwardly estimated. If, in the past, the proportion of non-obligated plastic packaging POM was small and/or fairly constant over time, then trends observed in obligated plastic packaging POM would be expected to closely mirror trends in overall POM.

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

[89] *https://www.valpak.co.uk/information-zone/reports/valpak-flow-reports*

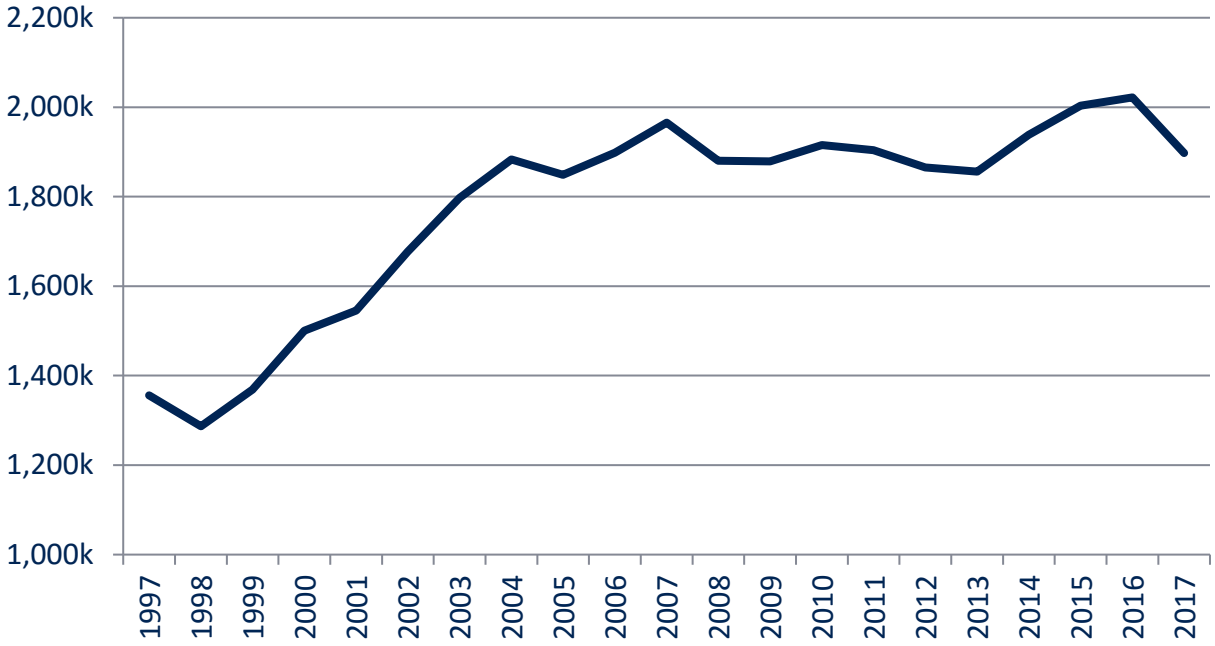
understanding of the requirements of the legislation which itself has likely improved the accuracy of data reported into NPWD.

Here it is assumed that the plastic packaging net pack fill tonnages 1997 to 2017 (calculated using NPWD data as described in Section 1.3.1.3 of this report) are the best available data to use in order to:

- assess trends in the overall quantity of plastic packaging POM;
- estimate empirical models of plastic packaging POM; and,
- project plausible possible future trends in plastic packaging POM.

Figure 51 shows the historic data for plastic packaging UK net pack fill. The past outturns for net pack fill show a strong increase from 1997 to around 2003/4 and then a clear break in this trend from then on with plastic packaging net pack fill being broadly stable from 2004 to 2013.

Figure 51 UK Plastic Packaging Net pack fill (tonnes)2017



While the precise reasons for the approximately zero growth during this period are unknown, the stakeholder group for the Plastic Market Flow 2014 study considered it feasible that any increase in plastic packaging consumption over this period could have been negated by packaging light weighting activity, with a key factor driving light-weighting being increasing virgin plastic prices. Net pack fill increased markedly in 2014, peaked in 2016, and then declined in 2017 to close to its 2013 level.

Using the historical data for plastic packaging net pack fill – the best available indicator of trends in plastic packaging POM - univariate time-series models (linear trend models and autoregressive models) are estimated and, based on these models, a range of scenarios for plastic packaging POM are projected to 2025.

The plastic packaging POM projections and growth rates in each year to 2025 are shown in figure 52 in addition to a zero growth POM projection. Apart from the zero growth projection, the plastic packaging POM projections are based on projections from the estimated linear trend and auto-regressive models using the historic data for plastic packaging UK net pack fill.

The plastic packaging POM projections assume that plastic packaging POM increases in line with the projected growth of net pack fill in the estimated models. Given the observed break in trend in the historic data two linear trend models are estimated: one over the full data period (1997 to 2017); and, one on the sample period from 2004 to 2017. The auto-regressive model (1 lag) estimated on the full sample period 1998 to 2017.

Figure 52 UK Plastic Packaging POM and Projections (tonnes)

	Based on zero growth	Based on a linear trend model for net pack fill, 1997 - 2017		Based on a linear trend model for net pack fill, 2004 - 2017		Based on AR(1) model for net pack fill, 1998 to 2017	
	Tonnes	Tonnes	% y/y	Tonnes	% y/y	Tonnes	% y/y
2018	2,361k	2,361k		2,361k		2,361k	
2019	2,361k	2,395k	1.42%	2,368k	0.30%	2,371k	0.44%
2020	2,361k	2,428k	1.41%	2,375k	0.30%	2,380k	0.38%
2021	2,361k	2,463k	1.40%	2,382k	0.30%	2,388k	0.33%
2022	2,361k	2,497k	1.39%	2,389k	0.30%	2,395k	0.28%
2023	2,361k	2,531k	1.38%	2,396k	0.30%	2,401k	0.24%
2024	2,361k	2,566k	1.37%	2,404k	0.30%	2,406k	0.21%
2025	2,361k	2,601k	1.36%	2,411k	0.29%	2,410k	0.18%

By assumption, factors driving past outturns and trend in plastic packaging net pack fill (and hence by assumption POM) are projected into the future.

The projections are not intended to be sophisticated. In particular, they don't account for potential substitution effects within plastics packaging or between plastic packaging and other packaging materials, the potential impact of possible future changes to the extended producer responsibility or other legislation, or changes in future trends in light-weighting of plastic packing.

Regarding the POM projections based on the linear models, the full sample trend estimate places some weight on net pack fill outturns before 2004 while the trend estimated on 2004 to 2017 historic data does not take into account pre 2004 outturns. The POM projection based on the auto-regressive model is driven by the net pack fill data (and projection) values in the preceding year.

Assuming the 2018 POM figure of 2,361k tonnes developed in this project, the POM projections based on the full sample the linear trend model projections are: 2,395k tonnes in 2019 (up 1.42%); 2,428k tonnes in 2020, and 2,601k tonnes in 2025. In 2025, plastic packaging POM, is projected to increase by 240k tonnes (or 10%) compared to 2018.

The projection from the linear trend model on the more recent sample shows plastic packaging POM increasing slightly to 2,368 k tonnes in 2019 (or 0.3%). In 2025, plastic POM is projected to be 2,411 k tonnes, an increase of 50k tonnes (or 2%) compared to 2018. The auto-regressive model projects an increase in plastic packaging POM to 2,371k tonnes in 2019 (up 0.3%). In 2025, plastic POM is projected to be 2,410k tonnes, an increase of 49k tonnes (up circa 2%) compared to 2018.

All projections are subject to uncertainty, however the uncertainty around projections based on statistical models such as these for can be estimated using the modelled standard error

from the regression analysis. Assuming a normal distribution 95% confidence intervals are calculated as the upper and lower bounds to the projections shown in Figure 53

Figure 53 Plastic packaging POM projections and 95% confidence intervals (tonnes)

	Linear trend model , 1998 - 2017			Linear trend model, 2004 - 2017			AR(1) model , 1999 to 2017		
	Lower	Projection	Upper	Lower	Projection	Upper	Lower	Projection	Upper
2018	981k	1,098k	1,214k	983k	1,098k	1,213k	986k	1,098k	1,209k
2019	1,027k	1,146k	1,264k	972k	1,090k	1,208k	993k	1,175k	1,357k
2020	1,075k	1,195k	1,315k	1,020k	1,141k	1,263k	989k	1,243k	1,497k
2021	1,123k	1,244k	1,366k	1,068k	1,193k	1,317k	981k	1,313k	1,645k
2022	1,170k	1,294k	1,417k	1,115k	1,244k	1,373k	968k	1,386k	1,803k
2023	1,217k	1,343k	1,469k	1,162k	1,295k	1,428k	949k	1,460k	1,971k
2024	1,264k	1,392k	1,520k	1,209k	1,346k	1,483k	923k	1,536k	2,150k
2025	1,312k	1,442k	1,572k	1,256k	1,398k	1,539k	889k	1,615k	2,342k

8.3 Plastic Packaging Recycling and Projections

This section reviews the historical data and trends for the quantity of plastic packaging recycling that is reported by accredited reprocessors/exporters into the EA's NPWD. As such it does not include plastic packaging recycling that is either undertaken by non-accredited reprocessors/exporters or not reported by accredited reprocessors/exporters.

It is estimated that plastic packaging recycling by non-accredited reprocessors/exporters is between 2.5k tonnes and 25k tonnes a year (see Appendix II). This would mean that unaccredited and/or unreported plastic packaging recycling could account for an additional 0.2% to 2.3% of the total plastic packaging recycling based on the reported 1,044k tonnes of plastic packaging recycling in 2017.

Three possible future scenarios to 2025 for plastic packaging recycling are developed based on projections from univariate time series regression models estimated on the historical (accredited) recycling data. The first is based on a linear trend model estimated on the full sample of historic data for plastic packaging recycling from 1998 to 2017. The second is a linear trend model estimate on a more recent sample from using 2004 to 2017 data, the third is a first order auto regressive model estimated on the available full sample data from 1999 to 2017.

These projections extend the trend observed in historical accredited recycling into the future. By assumption, factors driving past performance are projected into the future.

These are not intended to be sophisticated. In particular, they ignore factors such as expected developments of collection systems (such as the introduction of DRS), the timing of potential future policy initiatives in plastic packaging recycling markets, the timing of possible changes in legislation, the impact of possible targets for plastic packaging recycling to and beyond 2020 and all other potential external influences that might impact on the plastic reprocessing, for example the potential for investment in UK reprocessing and collections, the availability of domestic and export markets for reprocessing and the potential demand for recycled content in packaging.

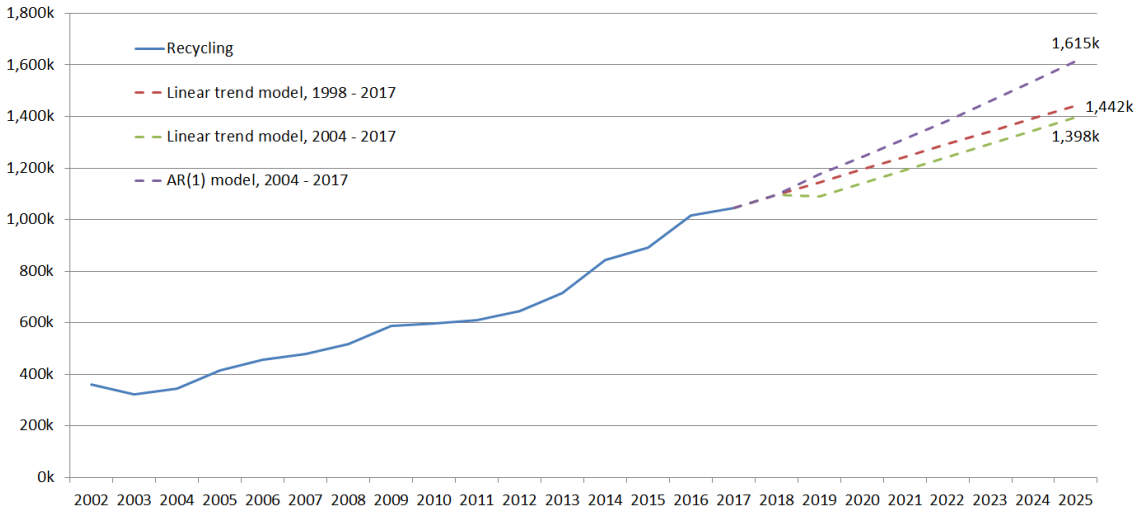
Provisional 2018 figures for accredited plastic recycling are available for January to June 2018 from NPWD. Plastic packaging recycling is reported as 253k tonnes for 2018Q1 and 285k tonnes for 2018Q2, so for the first half of 2018 a total of 538k tonnes of plastic packaging has already been recycled, an increase of 5.1% compared to the first half 2017. The 2018 full year projection assumes recycling growth continues at the same pace during the second half of 2018, with recycling in 2018 projected at 1,098k tonnes for the full year (ie a year on year increase of 5.1%).

Therefore, the 2018 level of plastic packaging recycling in each of the projections is set based on actual recycling data January to June and an assumed growth rate for recycling July to December and over-rides the model based projection. The annual projections from 2019 onwards in each of the scenarios are the model based projections for recycling.

Figure 40 illustrates historical plastic packaging recycling performance (PRN/PERN tonnage data reported by accredited plastic reprocessors/exporters) and three projection scenarios to 2025 for plastic packaging recycling.

The linear trend (central) projection based on the full sample period shows plastic packaging recycling increasing to 1,442k tonne by 2025, an increase of 397k tonnes (or 38%) compared to 2017. The linear trend projection based on the more recent sample period shows plastic packaging recycling increasing to 1,398k tonnes by 2025, an increase of 353k tonnes (or 32%) compared to 2017, and the projection from the auto regressive model shows plastic packaging recycling increasing to 1,615 k tonnes in 2025, an increase of 571k tonnes (or 52%) compared to 2017.

Figure 54 Plastic Packaging Recycling Scenarios (tonnes)



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 regression analysis. For the full sample linear projection model the model standard error is 54k tonnes and for the linear model on the 2004-2017 sample the model standard error is 51k tonnes. For the auto regressive projection the model standard error is 50k tonnes.

Assuming a normal distribution, 95% confidence intervals are calculated as the upper and lower bounds to each of the projections as shown in Figure 55.

Figure 55 Plastic packaging recycling projections and 95% confidence intervals (tonnes)

	Linear trend model , 1998 - 2017			Linear trend model, 2004 - 2017			AR(1) model , 1999 to 2017		
	Lower	Projection	Upper	Lower	Projection	Upper	Lower	Projection	Upper
2018	981k	1,098k	1,214k	983k	1,098k	1,213k	986k	1,098k	1,209k
2019	1,027k	1,146k	1,264k	972k	1,090k	1,208k	993k	1,175k	1,357k
2020	1,075k	1,195k	1,315k	1,020k	1,141k	1,263k	989k	1,243k	1,497k
2021	1,123k	1,244k	1,366k	1,068k	1,193k	1,317k	981k	1,313k	1,645k
2022	1,170k	1,294k	1,417k	1,115k	1,244k	1,373k	968k	1,386k	1,803k
2023	1,217k	1,343k	1,469k	1,162k	1,295k	1,428k	949k	1,460k	1,971k
2024	1,264k	1,392k	1,520k	1,209k	1,346k	1,483k	923k	1,536k	2,150k
2025	1,312k	1,442k	1,572k	1,256k	1,398k	1,539k	889k	1,615k	2,342k

8.4 Plastic Packaging Recycling Scenarios and Compliance Assessment

This section presents scenarios to 2025 for national plastic packaging recycling rates based on the scenario projections for plastic packaging POM and plastic recycling reported in sections 8.2 and 8.3.

For the compliance assessment, the targets on obligated businesses 2018, 2019 and 2020 are converted to equivalent national recycling targets based on total plastic packaging POM (the CEP target of 50% in 2025 and The UK Plastics Pact target of 70% in 2025 are assumed to be national targets based on POM). Using these targets and the projection scenarios for plastic packaging POM the tonnages of recycling required each year to meet the targets are calculated and compared to the projection scenarios for plastic packaging recycling.

To assess the likelihood of meeting the targets the probability of meeting the targets in each year is also calculated.

The compliance assessment is only meaningful versus the published 2018 to 2020 business targets and the CEP target for 2025. The UK Plastics Pact target is for 70% of plastic packaging to be 'effectively recycled or composted' by 2025 and included for comparison.

The targets on obligated businesses (53% for 2018, 55% for 2019, and 57% for 2020) are converted to national average recycling rates assuming that in each year of the projections 83% of total plastic packaging POM is obligated POM. This implies that the equivalent national plastic recycling targets are 44.0% for 2018, 45.7% for 2019 and 47.3% for 2020. The recycling rate figures for 2021 to 2024 are based on a linear extrapolation and are shown as indicative.

The probability of meeting the target in each year is calculated assuming that in each year the probability distribution of recycling outturns is normally distributed and centred on the model projected level of recycling with a standard deviation estimated by the standard error of the model in each year for each of the variant projection scenarios for plastic packaging recycling.

Figure 56 reports the compliance assessment for each of the projection scenarios to 2025 for plastic packaging POM against the plastic recycling scenario projections based on the full sample linear projection model (the latter is a 'best case' scenario as it produces the highest probabilities of meeting the national targets in 2018, 2019, 2020 and CEP target in 2025 across all the scenarios considered here for plastic packaging POM and recycling. Details of the other scenarios are reported in Appendix IV).

Assuming that the 2018 POM figure of 2,361k tonnes applies, based on these projections of plastic packing POM and plastic packaging recycling the UK would meet probably packaging recycling targets in 2018, 2019 and 2020, and the CEP target in 2025.

The probabilities of meeting the national equivalents of the business targets in 2018, 2019 and 2020 are 83.9%, 87.0% and 89.9%, and 100% for the CEP target in 2025. However, without further actions, The UK Plastics Pact target, of 70% of plastic packaging effectively recycled or composted by 2025, would be missed. WRAP is working with The UK Plastics Pact members and supporters to develop and implement the required actions. WRAP is working with UK Plastics Pact members to develop and implement the required actions.

Figure 56 Plastic packaging POM and recycling projections versus targets

	POM	National recycling target	Recycling required to meet the national target	Projected annual recycling*	Probability of meeting the national target
Scenario 1: Plastic POM projected at zero growth					
2018	2,361k	44.0%	1,039k	1,098k	83.9%
2019	2,361k	45.7%	1,078k	1,146k	87.0%
2020	2,361k	47.3%	1,117k	1,195k	89.9%
2021	2,361k	47.8%	1,130k	1,244k	96.7%
2022	2,361k	48.4%	1,142k	1,294k	99.2%
2023	2,361k	48.9%	1,155k	1,343k	99.8%
2024	2,361k	49.5%	1,168k	1,392k	100.0%
2025	2,361k	50.0%	1,181k	1,442k	100.0%
Scenario 2: Plastic POM growth based on linear trend model for net pack fill, 1999 - 2017					
2018	2,361k	44.0%	1,039k	1,098k	83.9%
2019	2,395k	45.7%	1,093k	1,146k	80.8%
2020	2,428k	47.3%	1,149k	1,195k	77.4%
2021	2,463k	47.8%	1,178k	1,244k	85.6%
2022	2,497k	48.4%	1,208k	1,294k	91.2%
2023	2,531k	48.9%	1,238k	1,343k	94.8%
2024	2,566k	49.5%	1,269k	1,392k	97.0%
2025	2,601k	50.0%	1,300k	1,442k	98.3%
Scenario 3: Plastic POM growth based on linear trend model for net pack fill, 2004 - 2017					
2018	2,361k	44.0%	1,039k	1,098k	83.9%
2019	2,368k	45.7%	1,081k	1,146k	85.8%
2020	2,375k	47.3%	1,124k	1,195k	87.8%
2021	2,382k	47.8%	1,140k	1,244k	95.4%
2022	2,389k	48.4%	1,156k	1,294k	98.5%
2023	2,396k	48.9%	1,172k	1,343k	99.6%
2024	2,404k	49.5%	1,189k	1,392k	99.9%
2025	2,411k	50.0%	1,205k	1,442k	100.0%
Scenario 4: Plastic POM growth based on AR(1) model for net pack fill, 1998 to 2017					
2018	2,361k	44.0%	1,039k	1,098k	83.9%
2019	2,371k	45.7%	1,083k	1,146k	85.2%
2020	2,380k	47.3%	1,126k	1,195k	86.9%
2021	2,388k	47.8%	1,143k	1,244k	94.9%
2022	2,395k	48.4%	1,159k	1,294k	98.4%
2023	2,401k	48.9%	1,175k	1,343k	99.6%
2024	2,406k	49.5%	1,190k	1,392k	99.9%
2025	2,410k	50.0%	1,205k	1,442k	100.0%

Figure 57 Projected Increase in Plastic Packaging Recycling required to meet the targets in 2019, 2020 and 2025

	Increase in recycling required to meet the national target	Projected increase in recycling		
Scenario 1: Plastic POM projected at zero growth				
		Based on Linear trend, 1998-2017	Based on Linear trend, 2004-2017	Based on AR(1), 1999-2017
2019	39k	48k	-8k	77k
2020	78k	97k	44k	145k
2025	142k	344k	300k	518k
Scenario 2: Plastic POM growth based on linear trend model for net pack fill, 1999 - 2017				
2019	55k	48k	-8k	77k
2020	110k	97k	44k	145k
2025	262k	344k	300k	518k
Scenario 3: Plastic POM growth based on linear trend model for net pack fill, 2004 - 2017				
2019	42k	48k	-8k	77k
2020	85k	97k	44k	145k
2025	167k	344k	300k	518k
Scenario 4: Plastic POM growth based on AR(1) model for net pack fill, 1998 to 2017				
2019	44k	48k	-8k	77k
2020	88k	97k	44k	145k
2025	167k	344k	300k	518k

Figure 57 compares the required *increase* in recycling required to meet the targets across the scenarios for plastic packaging POM and recycling. Based on the central projections for plastic packing POM and recycling in the compliance years 2019,2020 and 2025 the table highlights where the scenario projected increase in recycling falls short of the increase in recycling required to meet the target under various scenarios for plastic packaging POM.

8.5 Conclusion: flow and recycling scenarios and Compliance Assessment

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

- The low growth scenarios for plastic packaging POM project POM at: 2,368k tonnes to 2,371k tonnes in 2019; 2,375 tonnes to 2,380k tonnes in 2020; and, 2,411k tonnes to 2,410k tonnes in 2025.
- The high growth scenario for POM project plastic packaging POM at: 2,395k tonnes in 2019; 2,428k tonnes in 2020; and, 2,601k tonnes in 2025.
- The low growth scenarios for plastic packaging recycling project recycling at: 1,090k tonnes to 1,146k tonnes in 2019; 1,141 tonnes to 1,195k tonnes in 2020; and, 1,398k tonnes to 1,442k tonnes in 2025.

- The high growth scenario for plastic packaging recycling projects recycling at: 1,175k tonnes in 2019; 1,243k tonnes in 2020; and, 1,615k tonnes in 2025.

- Assuming that the 2018 POM figure of 2,361k tonnes applies, based on these projections of plastic packing POM and plastic packaging recycling the UK would meet probably packaging recycling targets in 2018, 2019 and 2020, and the CEP target in 2025.

- The probabilities of meeting the national equivalents of the business targets in 2018, 2019 and 2020 are 83.9%, 87.0% and 89.9%, and 100% for the CEP target in 2025. However, without further actions, The UK Plastics Pact target, of 70% of plastic packaging effectively recycled or composted by 2025, would be missed. WRAP is working with The UK Plastics Pact members and supporters to develop and implement the required actions. WRAP is working with UK Plastics Pact members to develop and implement the required actions.

9.0 Conclusions & Recommendations of Further Work

This section details the conclusions of the project and details the main areas recommended for further work.

9.1 Conclusions: Flow

The project's final best estimate of UK flow for 2017 is 2,361k tonnes +/- 6%: an increase of 141kt tonnes[90] from the estimated current flow figure (2014)

The most robust estimate that could be derived, using a variety of the most authoritative methods, including industry estimates, Valpak data and publicly available data, suggests that the quantity of plastic packaging POM in 2017 was 2,361k tonnes. This estimate is 141k tonnes[90] higher than the 2014 industry estimate of 2,220k tonnes.

The final project estimate for plastic packaging POM in the consumer sector is 1,532k tonnes +/- 7%

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 plastic packaging POM in the non-consumer sector is 830k tonnes +/- 11%

For film, this method is based on a combination of primary (survey) data, secondary research, published 2017 NPWD data on filled imports and information (2013 sales data) provided by the project Steering Group. For rigids, this is based on the findings of the WRAP/Valpak report into rigid packaging in the C&I sector and on secondary research.

It is likely that increased sales have been offset by light-weighting activity

The plastics packaging industry has believed for some time that packaging producer activity to light-weight plastic packaging[91] has negated any potential growth in consumption and the results of this work would seem to support this assumption. Industry members have provided evidence of this to the project team; however, the information is considered to be commercially sensitive and therefore cannot be provided in this report.

Plastic drinks packaging is estimated to account for 443kt of the total POM

Using Valpak EPIC data and additional market data, suggests that 86% of this tonnage is sold via the retail or consumer market and 14% via the non-consumer or hospitality sector, with 118kt being HDPE, 317kt PET and 8kt other polymers. This has been cross-checked with industry and published data.

9.2 Conclusions: Recycling

The recycling performance of the UK in 2017 is between 43-47%

If measuring recycling on entry to reprocessing, the UK's plastic packaging recycling rate is estimated at 47% (1111k tonnes recycled). If measured after conversion on the exit of reprocessing the rate would be lower at 43% (1026k tonnes recycled).

The consumer plastic packaging recycling performance of the UK in 2017 is between 30-34%

[90] 141k tonnes is an increase of just over 6%. As the error margin around the total plastic POM figure is 6%, it is possible that there has been no real increase in POM

[91] Including down-gauging activity.

If measuring recycling on entry to reprocessing, the UK's consumer plastic packaging recycling rate is estimated at 34% (525k tonnes recycled). If measured after conversion on the exit of reprocessing the rate would be lower at 30% (461k tonnes recycled).

The non-consumer plastic packaging recycling performance of the UK in 2017 is between 68-71%

If measuring recycling on entry to reprocessing, the UK's consumer plastic packaging recycling rate is estimated at 78% (586k tonnes recycled). If measured after conversion on the exit of reprocessing the rate would be lower at 75% (565k tonnes recycled).

The non-consumer film recycling rate for the UK in 2017 is unfeasibly high

The recycling rates of non-consumer film are estimated at 113-118%. Based on a more feasible recycling rate of 70-80%, there remains 80-130kt of non-consumer film recycling that cannot be identified. One explanation for this could be the incorrect allocation of PRN/PERNs against either non-packaging film for non-UK packaging. Alternatively, or in addition, it could suggest that the non-consumer film POM estimate is low.

9.3 Conclusions: Plastic Packaging End Markets

The main application for UK recycled PET is in sheet applications such as trays

Approximately 65% of UK recycled PET is made into sheet, which in turn is used for applications such as plastic trays. The majority of PET not used in this way is used to make new plastic bottles.

UK recycled HDPE is used comprehensively in a variety of applications, such as packaging, construction, horticultural and outdoors

Approximately 30% of UK recycled HDPE is used in the packaging sector, a further 30% in the construction sector and 20% in horticultural & outdoors applications. The remainder is used in a variety of products such railway sleepers, garden furniture and boxes.

UK recycled PP is predominantly used to make automotive products and packaging

Approximately 40% of UK recycled PP is used in automotive products and a further 40% in packaging.

UK recycled LDPE is mainly used to make new films for construction, bags, sacks and agriculture

Approximately 40% of UK recycled LDPE is used for construction films, 20% for plastic bags & sacks and around 15% for agricultural films.

Much of the higher quantities of recovered plastic being shipped to SE Asia, once recycled, is finding its way to China as recycled pellet

Discussions with recyclers/traders in Asia suggest that much of the increase in recovered plastic being shipped to SE Asia, in particular Malaysia but also to an extent to countries such as Vietnam and Thailand, once recycled is finding its way to China in the form of recycled pellet. This demand is being driven by the loss of domestically produced recycled pellet in China, historically generated from imports of recovered plastics from overseas.

9.4 Conclusion: Plastic Packaging Compliance

The UK is likely to meet packaging recycling targets in 2018, 2019 and 2020

Assuming that the 2018 POM figure of 2,361k tonnes applies, based on this report's projections of plastic packing POM and plastic packaging recycling, the UK is likely to meet packaging recycling targets in 2018, 2019 and 2020, and the CEP target in 2025.

The probabilities of meeting UK recycling targets[92] in 2018, 2019 and 2020 are high, as is the probability of achieving the 2025 CEP target

The probabilities of meeting the national equivalents of the business targets in 2018, 2019 and 2020 are 84%, 87% and 90% respectively, and 100% for the CEP target in 2025. However, without further actions, The UK Plastics Pact target, of 70% of plastic packaging effectively recycled or composted by 2025, would be missed. WRAP is working with The UK Plastics Pact members and supporters to develop and implement the required actions. WRAP is working with UK Plastics Pact members to develop and implement the required actions.

9.5 Recommendations for Further Work

C&I plastic packaging film/rigids

The estimate of C&I film packaging appears low in comparison to the rigids figure. Furthermore, non-consumer film POM as a whole appears low when used to calculate non-consumer film recycling rates.

Non-consumer film being allocated PRN/PERNs

In 2017 there was an unaccounted 80-130k tonnes of non-consumer film recycled: this may in part be due to a low POM estimate, but may also be due to the incorrect allocation of PRN/PERNs to non-packing films or non-UK packaging film.

[92] *The national equivalent of business recycling targets*

Appendix I – UK Plastic Packaging Recycling Bottom-up Method

This method used a variety of data/key industry insight from a range of sources including Valpak, Recoup, RPC BPI group, recyclers/exporters as well other key stakeholders and combined it with secondary research to provide an estimate of UK recycling broken down into the following sectors:

- Consumer
- Non-consumer
    - C&D
    - Agricultural
    - C&I – Hospitality
    - C&I – Retail BOS
    - C&I – Manufacturing & Other

This aimed to provide detailed estimates for each of these sectors in order to build up to a total UK plastics packaging figure; however due to lack of robust data in some sectors this methodology was not used as the main methodology to quantify UK plastic packaging recycling.

Consumer Collections 2017

The consumer (local authority) collection figure of plastic packaging in the UK in 2017 was provided as an estimate by RECOUP[93].

Figure 58 Consumer (local authority) collection of plastic packaging 2017

Stream	Collected (Tonnes)
Consumer Total	**525k**
Consumer Bottles	*350k*
Consumer PTTs	*159k*
Consumer Film	*16k*

Non-consumer Recycling 2017

In order to quantify non-consumer plastic packaging recycling and allow for a more granular analysis of where the material is sourced for recycling a bottom up approach was also used.

This used a combination of methodologies used in the 'Plastic Packaging Market Study (PlasticFlow) 2014' and 'Rigid plastic packaging in the commercial & industrial sectors' reports. The latter piece of work was undertaken due to the 2014 report failing to establish a robust estimate of commercial and industrial (C&I) rigid plastic packaging consumption and recycling.

[93] At the time of report writing the RECOUP 2018 survey was not published, therefore RECOUP provided estimates for the purposes of this report.

In order to quantify the non-consumer plastic packaging recycling estimates for the following industry sectors were established and summed to provide a total estimate:

- C&D;
- Agricultural
- C&I
    - Hospitality
    - Retail BOS
    - Manufacturing & Other

Each of these are discussed in more detail below.

C&D

The quantity of plastic packaging waste generated by the C&D sector was quantified based on packaging generated by spend in the sector and then identifying the quantity that is plastic packaging.

In order to estimate the quantity recycled the Plastics Europe report 'Analysis of recovery of plastic waste in the building and construction sector (2010)[94]' was used, which reports that plastic recycling on a UK level in this sector is 32%. This was sense checked with the European Commission report 'Service Contract on Management of Construction and Demolition Waste – SR1 (2011)', which confirms that the UK estimate seems sensible[95].

Applying this recycling rate to plastic packaging (as a single stream) indicates that **20k tonnes** of plastic packaging is recycled from the C&D sector. Industry experts from PlasticFlow 2014 project estimated that all plastic packaging in the sector was film.

Agricultural

The 'Plastic Packaging Market Study (PlasticFlow) 2014' report identified the total plastic packaging POM is 13k tonnes. To report separates the figure into film and rigid using the EA's Agricultural Waste Survey 2003[96] and concluded there were with 11k tonnes of film and 2k tonnes of rigid plastic packaging POM in this sector[97]. Correspondence with the RPC BPI Group[98] suggests that although some materials have experienced downgauging, and as such, has reduced the proportion of material used per product, this has been offset by increased sales. Therefore the estimate for agricultural plastic packaging POM is 13k tonnes (11k tonnes of film and 2k tonnes of rigid plastic).

The Plastic Packaging Market Study (PlasticFlow) 2014 report estimated the agricultural sector has a 32% recycling rate based on the WRAP 'UK Plastics Waste – A review of supplies for recycling, global market demand, future trends and associated risks[99]' report and that it could also be applied to plastics packaging as a single stream.

A survey of recyclers/exporters by Verde Research and Consulting Ltd provided an update on recycling rates in this sector, with estimates at 5% for bottles and other rigids and 20% for

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[94] https://wip-kunststoffe.de/wip/fileadmin/user_upload/news_downloads/Summary_of_Plastic_B_C_waste_management_analysis160312.pdf

[95] *The European Commission report 'Service Contract on Management of Construction and Demolition Waste – SR1 (2011)95', states that Flanders has a 34% plastic recycling rate.* http://ec.europa.eu/environment/waste/pdf/2011_CDW_Report.pdf

[96] *This is the most recent data available to the project team for agricultural plastics.*

[97] *This is based on 1998 splits however in the absence of more up to data this has been used.*

[98] *Various correspondence with Mike Baxter (RPC BPI Group) during the course of the project.*

[99] http://www.wrap.org.uk/sites/files/wrap/UK%20Plastics%20Waste.pdf

film. Applying these to the POM figures indicates there was **2k tonnes** of Agricultural plastic packaging recycled in 2017.

C&I – Hospitality

Estimates for the quantity of rigid and film plastic packaging POM in the hospitality sector were updated using the Valpak data relating to 34% of the cash and carry and delivered foodservice industry[100]. Market share information for the companies included was used to scale up the resulting tonnage to represent the whole foodservice, catering and hospitality sector. This assessment resulted in a total plastic packaging POM for the hospitality sector of 119k tonnes. This is made up of 45k tonnes of bottles, 45k tonnes of other rigids and 30kt of film.

The WRAP 'The Composition of Waste Disposed of by the UK Hospitality Industry[101]' states that the hospitality sector has a recycling rate of 47%, however this is an overall recycling rate and not specific to plastic packaging. However a survey of recyclers/exporters by Verde Research and Consulting Ltd provided estimates for plastic packaging recycling rates in this sector, with estimates at 30% for bottles and other rigids and 5% for film. Applying these to the POM figures indicates there was a total of **28k tonnes** of plastic packaging was recycled in this sector in 2017. This is made up of 13kt of bottles, 13kt of other rigids and 1k tonnes of film.

It should be noted that at the time of writing there was a lack of published data regarding recycling in this sector. This could possibly be due to the sector being made up of a high proportion of small businesses (fewer than ten employees), producing low quantities of recyclate making it less commercially attractive to collect[102]. Where material is collected for recycling, it is likely that much of the packaging is lost within the non-packaging stream, in which case PRNs will not be raised since identifying the packaging element is too onerous and difficult. At the time of writing responses from other key industry stakeholders were still to be received which may provide further insight into this sector[103].

C&I – Retail BOS

As detailed in Section 2.6.3.1, the quantity of plastic packaging discarded by grocery retailers at back of store was derived from surveying retailers during June 2018. This identified that the final figure for grocery retail back of store was 78k tonnes of plastic packaging.

This was then scaled up (taking into account the difference in packaging produced by each sector) to include the non-grocery retail back of store plastic packaging. This identified the total retail plastic packaging flow in 2017 was **126k tonnes**. This is made up of 124k tonnes film and 2k tonnes other rigids.

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[100] Valpak's EPIC database holds sales data and packaging weights information for clients signed up for the fully managed service. In the Rigid Plastic 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.

[101] http://www.wrap.org.uk/sites/files/wrap/The_Composition_of_Waste_Disposed_of_by_the_UK_Hospitality_Industry_FINAL_JULY_2011_GP_EDIT.54efe0c9.11675.pdf

[102] Discussions with Valpak Recycling Services

[103] At the time of writing responses were still to be received from SEPA and Recycling Services

Commercial & Industrial – Manufacturing & Other

Primary collection data[104] was used for 19 companies in the sector and Valpak's Recycling Services team were asked to provide industry insight into the percentage of organisations that recycle plastic packaging in the sector based on their size. This was then scaled up using Office of National Statistics (ONS) total number of businesses in the UK[105]. In terms of confidence levels, the sample size means 95% confidence that the result sits within +/- 22%.

The study estimates that **326k tonnes** of plastic packaging is recycled in the C&I manufacturing and other sector in 2017. This is made up of 219k tonnes of other rigids, 74k tonnes of film and 34k tonnes of bottles.

Total UK Plastic Packaging Recycling Bottom-up Approach

The table below shows the total quantity of recycling by format and sector using the bottom up approach.

Figure 59 Total Quantity of recycling by format and sector 2017

Stream	Format (T)			Total (T)
Consumer Plastics	Bottles	PTTs	Film	
	350k	159k	16k	**525k**
Total	**350k**	**159k**	**16k**	**525k**
Non-Consumer	Bottles	Other Rigids	Film	
C&D	0	0	20k	20k
Agricultural	0	0	2k	2k
C&I – Hospitality	13k	14k	1k	28k
C&I – Retail BOS	0	124k	2k	126k
C&I – Manufacturing & Other	34k	219k	74k	327k
Total	**48k**	**356k**	**99k**	**503k**
TOTAL	**398k**	**515k**	**115k**	**1,028k**

The total plastic packaging recycled using this method is 1,028k tonnes in 2017. This is 16k tonnes less than the accredited recycling figure of 1,044k tonnes. Due to the quantity of recycling being less than the accredited recycling figure and uncertainty around the format breakdown within the manufacturing and other sector (due to the small sample size) this methodology for estimating the total plastic packaging recycled in 2017 is not used in this report to provide the total estimate.

[104] *From Valpak Recycling Services*
[105] *Office of National Statistics (ONS) UK Business: Activity, Size and Location - 2017*

Appendix II – Unaccredited Reprocessing

The accredited reprocessing was estimated from NPWD data using the quantity of PRNs and PERNs issued. However it is understood that there is additional recycling that takes place where a PRN or PERN is not raised on the packaging. This is referred to as unaccredited recycling, and due to it not being reported, does not count towards the UK's recycling achievement.

During the PlasticFlow 2014 project an assessment was made into the possible tonnage of plastic packaging that may be being recycled by unaccredited reprocessors. It was estimated that 50 facilities in the UK were recycling plastics, but were unaccredited in 2011. However this was at a time when the average PRN price was £4.64 per tonne. Since then the PRN price has increased to an average price of £48.92 per tonne in 2017, which makes it more cost effective for reprocessors to become accredited.

The decision to become accredited (or not) was assumed to be based on a financial cost-benefit comparison of gaining accreditation, namely the breakeven point between average PRN revenue and accreditation fees/administration costs. This was based on Valpak's market knowledge, but was corroborated by assessing the number of accredited reprocessors/exporters against the average plastic PRN price. The results did give an indication that following a year with an inflated PRN price, such as 2008, 2013, the general trend is that reprocessor accreditations increase, and when the PRN price is depressed, such as in 2009 and 2010, the number of facilities becoming accredited decreases. Since 2013, the PRN price has been consistently above £30 per tonnes and although the price has fluctuated above this level there has been a steady increase in the number of accredited reprocessors/exporters.

Based on analysis of the average price of a PRN in 2017 and the cost of accreditation, it was identified that a 'small' facility would need to recycle 31 tonnes of plastics and a 'large' facility 94 tonnes in 2017 to breakeven against accreditation costs. However as large reprocessors are accredited to recycle 400 tonnes (and above) it is assumed that all unaccredited reprocessors are small based on the assumption that the decision to become accredited is based on cost. The figures indicate that it is clearly cost effective for large reprocessors to be accredited.

The breakeven figure for small reprocessors was then applied to the number of reprocessors estimated to be unaccredited (using Valpak market knowledge and NPWD). As a result, up to 1.1k tonnes of plastic packaging could have been recycled by unaccredited recycling facilities in the UK in 2017 but not contributing to the national packaging recycling rates due to the costs of accreditation. This is down from 50k tonnes in 2013 based on average PRN prices for those years (PlasticFlow 2014). The higher PRN price in 2017 would make it difficult for unaccredited reprocessors/exporters to compete for material, and as such, this may have contributed towards more reprocessors/exporters becoming accredited.

However estimating unaccredited recycling in this way may not take into account all examples of plastic packaging recycling being undertaken, without a PRN being raised. Other instances where this could happen include:

- New entrants to the marketplace that are not included in the quantity of organisations identified as reprocessing plastics but not accredited;
- Export to non-accredited sites. Maybe a trial load that does not result in ongoing business, and as such, is not worth doing the paperwork and paying the fee to get the site accredited. Or perhaps when the market is in 'crisis' and the priority is moving

material and it turns out afterwards the site does not have the paperwork needed to get registered;
- Start-up businesses that have not worked out how the system works;
- Small non-waste businesses that may export waste but may not be aware that PERNs can be issued;
- Overseas buyers that may not have a UK presence and so cannot get registered to issue PERNs; and
- Packaging material in non-packaging material at levels where it is not worth the effort to sample the material and work out how much is packaging so as to be able to issue PRNs. An example here would be seed sacks (packaging) in silage wrap (non-packaging).

For these reasons the 1.1k tonnes of plastic packaging that is recycled by unaccredited facilities is considered a minimum figure and another method to quantify the quantity of unaccredited plastic packaging recycling was used. During the survey of reprocessors and exporters they were also asked to provide insight into how much plastic packaging was recycled with no PRN/PERN being issued. Responses indicated that this is difficult to accurately quantify; however through this exercise it was identified that approximately 25k tonnes of plastic packaging could potentially be unaccredited.

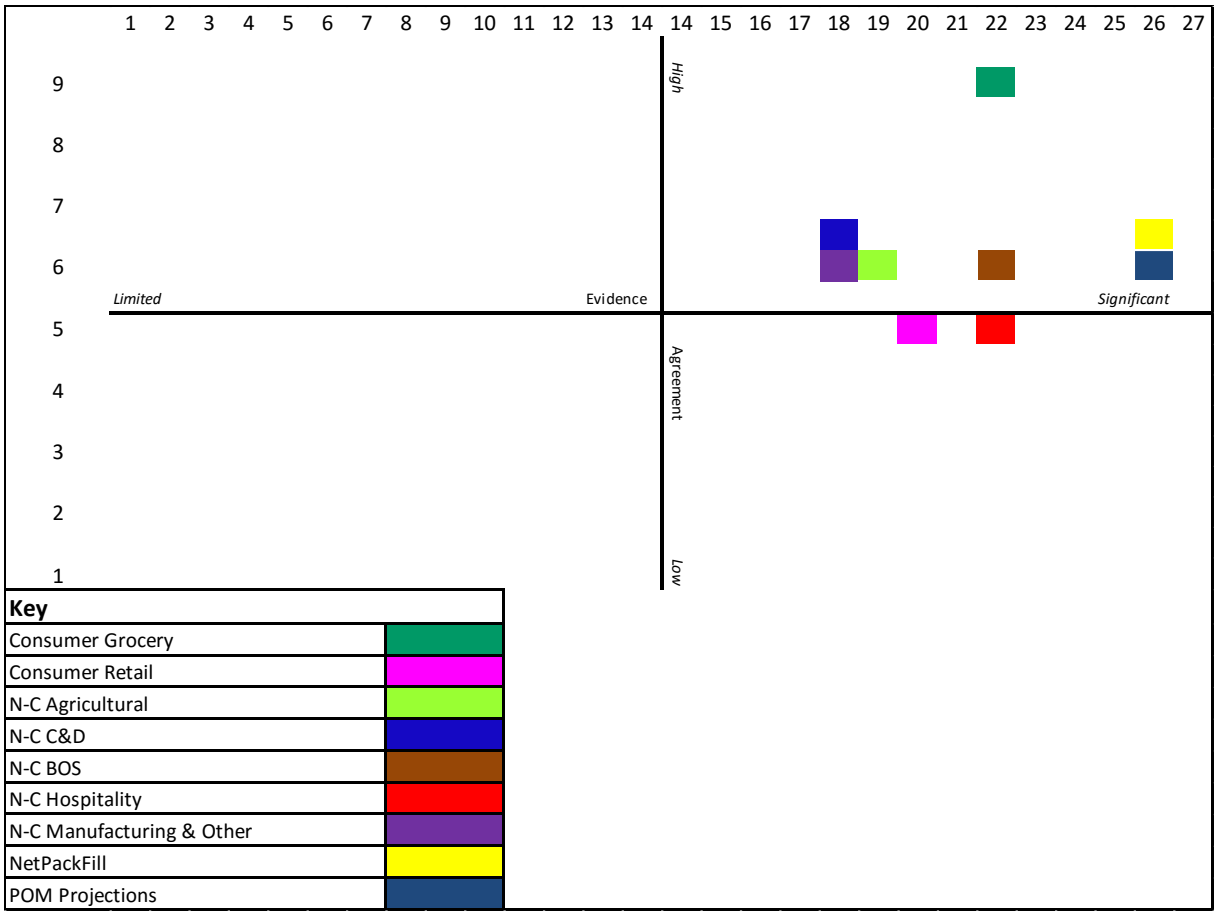
Using these two approaches it is believed that there was between 1.1k to 25k tonnes of unaccredited plastic packaging recycling in 2017. Based on the accredited recycling being 1,044k tonnes in 2017 this would mean that unaccredited recycling accounts for 0.1% to 2.3% of the total plastic packaging recycling.

Appendix III – Data Robustness

A robustness analysis was completed on the data sources used. This was developed to highlight the level of uncertainty for each data source by scoring the data sources on the evidence and agreement level from stakeholders. Questions were asked relating to the evidence and agreement levels of the data used (see the tables later in this section for details) and then the data were scored on each axis. The results are shown in Figure 60 (POM), Figure 61 (Recycling) and a summary in Figure 62, 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.

Figure 60 Data Robustness assessment results - POM



To convert scores to a percentage that could be used to relate to an appropriate error margin[106], the evidence and agreement levels scores were added and the percentage of the total possible score taken.

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

Figure 61 Data robustness assessment results - recycling

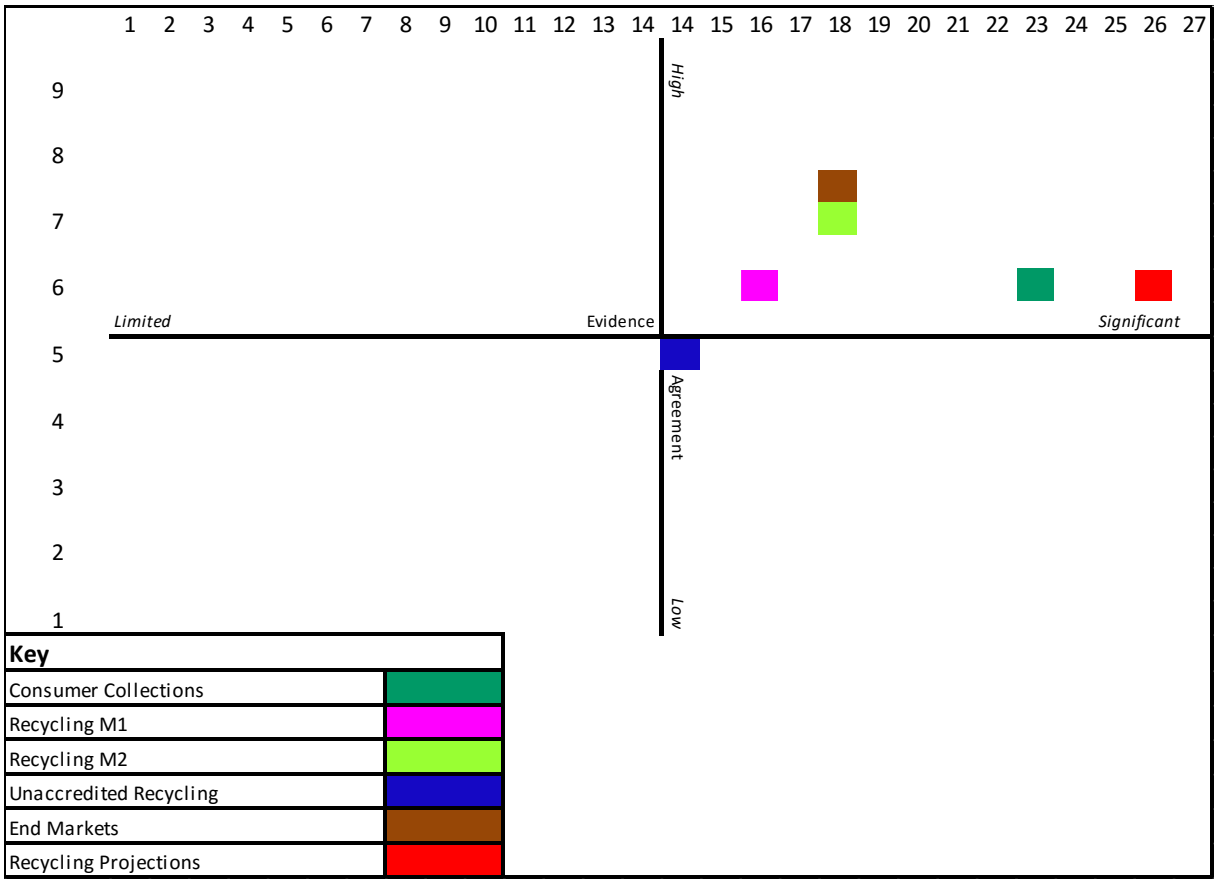


Figure 62 Data robustness assessment results – summary

		Robustness Scores	
	Data & Source	Evidence (Robustness and completeness, max 27):	Degree of agreement around the findings (max 9):
1	Environment Agency Grocery Retailer Packaging Handled	24	9
2	Valpak Turnover & Packaging Handled Data	20	6
3	The White Paper Dairy UK 2017	21	5
4	UK Soft Drinks Report 2017	20	4
5	Valpak Hospitality EPIC Data	22	6
6	UK AWP Waste Arisings, Defra/Valpak 2007	19	6
7	Primary Research by the C&I Rigid Plastic Packaging Report Team, 2014	18	6
8	NPWD Producer Data 2017	26	6
9	NPWD Recycling Data 2017	26	6
10	Letsrecycle PRN Values 2008-17	14	5
11	Internal research by the Green Construction Board, 2009	18	6
12	Recoup Survey 2018	23	6
13	Analysis of recovery of plastic waste in the building and construction sector (2010)	17	6
14	Survey of Construction Companies (2014)	17	6
15	Industry Insights - Construction Skills Network Forecasts 2017-2021	19	6
16	BRE Smartwaste Portal	9	5
17	Verde Research and Consulting Ltd Survey of Recyclers and Exporters 2018	18	7
18	Survey of Grocery Retailers 2018	22	6
19	Survey of Valpak Recycling Clients in Manufacturing Sector	14	3

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**

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?	Yes	3
Does the data provide complete coverage?	No	0
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)?	More yes than no, but equivocal	1
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**

The White Paper Dairy UK 2017

Data
The White Paper Dairy UK 2017
Source
Dairy UK
Data Used In:

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	Yes with some reservations	2
Is the methodology/calculation reasonably free from concerns?	Yes with some reservations	2
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0
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 with some reservations	2
Do the key stakeholders/experts actively agree with the findings?	Yes	3
Has feedback from the key stakeholders been incorporated in the reporting of findings?	No	0
Total		**5**

UK Soft Drinks Report 2017

Data		
UK Soft Drinks Report 2017		
Source		
British Soft Drinks Association		
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 with some reservations	2
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	More yes than no, but equivocal	1
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes with some reservations	2
Total		**20**

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

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**

Industry Insights - Construction Skills Network Forecasts 2017-2021

Data		
Industry Insights - Construction Skills Network Forecasts 2017-2021		
Source		
CITB		
Data Used In:		
Method 1 - POM - C&D		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	More yes than no, but equivocal	1
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	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**

Survey of Construction Companies (2014)

Data		
Survey of Construction Companies (2014)		
Source		
WRAP		
Data Used In:		
Method 1 - POM - C&D		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	More yes than no, but equivocal	1
Does the data provide complete coverage?	Yes	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)?	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	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		**17**

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**

Internal research by the Green Construction Board, 2009

Data		
Internal research by the Green Construction Board, 2009		
Source		
Green Construction Board		
Data Used In:		
Method 1 - POM - C&D		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	More yes than no, but equivocal	1
Does the data provide complete coverage?	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?	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		**18**

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

Primary Research by the C&I Rigid Plastic Packaging Report Team, 2014

Data		
Primary Research by the C&I Rigid Plastic Packaging Report Team, 2014		
Source		
C&I Rigid Plastic Packaging Report Team, 2014		
Data Used In:		
Method 1 - POM - Manuf.		

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

Degree of agreement around the findings (max 9):	Scoring (Max 09)	
Does more than one data source confirm the findings (within +/- 5%)?	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**

Recoup Consumer Collections

Data		
Recoup Consumer Collections		
Source		
Recoup Survey 2018		
Data Used In:		
Consumer Recycling		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	Yes with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	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	3
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		**23**

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**

Analysis of recovery of plastic waste in the building and construction sector (2010)

Data		
Analysis of recovery of plastic waste in the building and construction sector (2010)		
Source		
Plastics Europe		
Data Used In:		
Method 1 - Non-consumer Recycling - C&D		

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 with some reservations	2
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	More yes than no, but equivocal	1
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	More yes than no, but equivocal	1
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	Yes	3
Total		**17**

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 Construction Companies (2014)

Data		
Survey of Construction Companies (2014)		
Source		
WRAP		
Data Used In:		
Method 1 - Non-consumer Recycling - C&D		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	More yes than no, but equivocal	1
Does the data provide complete coverage?	Yes	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)?	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	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		**17**

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**

Industry Insights - Construction Skills Network Forecasts 2017-2021

Data		
Industry Insights - Construction Skills Network Forecasts 2017-2021		
Source		
CITB		
Data Used In:		
Method 1 - Non-consumer Recycling - C&D		

Evidence (Robustness and completeness, max 27):	Scoring (Max 27)	
Does the data cover the correct time-frame?	Yes	3
Does the data provide complete coverage?	More yes than no, but equivocal	1
Has the data been sourced from credible, up-to-date sources?	Yes	3
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	3
Have the findings been independently peer-reviewed?	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**

BRE Smartwaste Portal

Data		
BRE Smartwaste Portal		
Source		
BRE		
Data Used In:		
Method 1 - Non-consumer Recycling - C&D		

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 with some reservations	2
Has the data been sourced from credible, up-to-date sources?	Yes with some reservations	2
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	More yes than no, but equivocal	1
Have the findings been independently peer-reviewed?	More yes than no, but equivocal	1
Is the methodology/calculation reasonably free from concerns?	More yes than no, but equivocal	1
Have the methodology/calculations been independently checked (internally or externally)?	More yes than no, but equivocal	1
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	More yes than no, but equivocal	1
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0
Total		**9**

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

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**

Survey of Valpak Recycling Clients in Manufacturing Sector

Data
Survey of Valpak Recycling Clients in Manufacturing Sector
Source
Valpak Recycling Survey 2018
Data Used In:
Valpak Recycling Survey 2018

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?	No	0
Has the data been sourced from credible, up-to-date sources?	More yes than no, but equivocal	1
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	More yes than no, but equivocal	1
Have the findings been independently peer-reviewed?	No	0
Is the methodology/calculation reasonably free from concerns?	More yes than no, but equivocal	1
Have the methodology/calculations been independently checked (internally or externally)?	Yes 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		**14**

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

Letsrecycle PRN Values 2008-17

Data
Letsrecycle PRN Values 2008-17
Source
Letsrecycle
Data Used In:
Unaccredited Recycling

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

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

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**

Appendix VII Technical details of the modelling and projection scenarios

Introduction

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

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

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 is selected using a range of information criterion (the statistics are Akaike, Schwarz/BIC and Hannan-Quinn) to assess the adequacy of alternative the models. The optimum order p of the auto-regression is the value p which minimises the information statistic.

Plastic packaging net pack fill, modelling and projections

The EA's NPWD (National Packaging Waste Database) provides a data source from which to assess trends in plastic packaging placed onto the market by businesses that have an obligation 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 quantity of plastic packaging handled by obligated producers ('obligated' POM) is available for trend analysis.

Here it is assumed that the plastic packaging net pack fill tonnages 1997 to 2017 (calculated using NPWD data as described in Section 1.3.1.3 of this report) are the best available data to use in order to:

- assess trends in the overall quantity of plastic packaging POM;
- estimate empirical models of plastic packaging POM; and,
- project plausible possible future trends in plastic packaging POM.

The historic data for plastic packaging UK net pack fill show a strong increase from 1997 to around 2003/4 and then a clear break in this trend from then on with plastic packaging net pack fill being broadly stable from 2004 to 2013 before increasing markedly to a peak in 2016 and a decline in 2017 to close to its 2013 level.

Chow break point statistics against a null hypothesis of no structural break in 2004 are (F-statistic 43.318, Log-likelihood 37.961, Wald-statistic 86.635). All are statistically significant at 5% and strongly reject the null hypothesis of no structural break in 2004.

Given the observed break in trend in the historical data for plastic packaging net pack fill, two linear trend models are estimated: one over the full data sample (1997 to 2017); and, one on the sample period from 2004 to 2017. Details of the estimated linear trend models for net pack fill, projections and 95% confidence intervals 2018 to 2025 and are reported in Figure .

Figure AIV 1 Plastic packaging net pack fill (linear model estimates), projections 2018 to 2025 and 95% confidence intervals (tonnes)

Model	Net pack fill: linear trend							
Sample	1997 – 2017				2004 - 2017			
Variable	Coeff.	s.e	t-stat	Prob. t	Coeff.	s.e	t-stat	Prob. t
Constant	1469983.0	52383.5	28.06	0.000	1831988.0	45834.1	39.97	0.0000
Trend	30572.6	4480.9	6.82	0.000	5871.0	3253.2	1.80	0.0963
Adj. R^2		69.5%				14.8%		
S.E		124,339				49,068		
F-stat		46.6				3.3		
Prob.F		0				0		

Model	Net pack fill: linear trend					
Sample	1997 - 2017			2004 - 2017		
	Lower	Projection	Upper	Lower	Projection	Upper
2018	1,845k	2,112k	2,380k	1,845k	1,955k	2,066k
2019	1,872k	2,143k	2,413k	1,848k	1,961k	2,074k
2020	1,899k	2,173k	2,447k	1,850k	1,967k	2,084k
2021	1,926k	2,204k	2,482k	1,853k	1,973k	2,093k
2022	1,952k	2,234k	2,516k	1,855k	1,979k	2,102k
2023	1,979k	2,265k	2,551k	1,857k	1,985k	2,112k
2024	2,005k	2,295k	2,586k	1,859k	1,991k	2,122k
2025	2,031k	2,326k	2,621k	1,861k	1,996k	2,132k

The auto-regressive model for plastic packaging net pack fill is estimated on the full sample period 1998 to 2017. The first step is to determine the order of the AR model based on the information criteria for models up to order 3. The range of information statistics indicates that a first-order autoregressive model for plastic packaging net pack fill is the best model for data sample available for plastic packaging net pack fill.

Details of the information criterion, the estimated AR(1) model for plastic packaging net pack fill, projections and 95% confidence intervals are reported in **Error! Reference source not found.**.

Figure AIV 2 Plastic packaging net pack fill (AR model) estimates, projections 2018 to 2025 and 95% confidence intervals (tonnes)

Information criterion	AR(1)	AR(2)	AR(3)
Akaike	24.7	24.9	24.9
Schwarz/BIC	24.8	25.0	25.1
Hannan-Quinn	24.8	24.9	24.9

Model	Net pack fill: AR(1)			
Sample	1998 - 2007			
Variable	Coeff.	s.e	t-Stat	Prob. t

Constant	266377.6	120855.3	2.204104	0.041
NPF(-1)	0.864776	0.067758	12.76279	0.000
Adj. R^2		89.5%		
S.E		67,682		
F-stat		162.9		
Prob.F		0		

Model Sample	Net pack fill: AR(1) 1998 - 2017		
	Lower	Projection	Upper
2018	1,771k	1,908k	2,045k
2019	1,729k	1,916k	2,103k
2020	1,702k	1,923k	2,144k
2021	1,682k	1,930k	2,177k
2022	1,667k	1,935k	2,203k
2023	1,654k	1,940k	2,225k
2024	1,644k	1,944k	2,243k
2025	1,636k	1,947k	2,259k

Plastic packaging POM scenario projections

The plastic packaging POM projections are based on projections from the estimated linear trend and auto-regressive models using the historic data for plastic packaging net pack fill.

It is assumed that the plastic packaging POM projections increase in line with the projected growth of plastic packaging net pack in each of the scenarios for POM. The projection scenarios for plastic packaging POM (and growth rates) in each year to 2025 are shown in **Error! Reference source not found.**.

Figure AIV 3 Plastic packaging POM projection scenarios 2018 to 2025 (tonnes, %y/y)

Model	Plastic packaging POM: linear trend				Plastic packaging POM: AR(1)	
Sample	1997 - 2017		2004 - 2017		1998 - 2017	
	tonnes	% y/y	tonnes	% y/y	tonnes	% y/y
2018	2,361k		2,361k		2,361k	
2019	2,395k	1.42%	2,368k	0.30%	2,371k	0.44%
2020	2,428k	1.41%	2,375k	0.30%	2,380k	0.38%
2021	2,463k	1.40%	2,382k	0.30%	2,388k	0.33%
2022	2,497k	1.39%	2,389k	0.30%	2,395k	0.28%
2023	2,531k	1.38%	2,396k	0.30%	2,401k	0.24%
2024	2,566k	1.37%	2,404k	0.30%	2,406k	0.21%
2025	2,601k	1.36%	2,411k	0.29%	2,410k	0.18%

Plastic packaging 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 plastic packaging recycling.

Three possible future scenarios to 2025 for plastic packaging recycling are developed based on projections from the models estimated on the historical data for (accredited) packaging recycling.

The first is based on a linear trend model estimated on the full sample of historic data for plastic packaging recycling from 1998 to 2017. The second is a linear trend model estimate on a more recent sample from using 2004[107] to 2017 data. Details of the linear trend recycling models are reported in **Error! Reference source not found.**.

Figure AIV 4 Plastic packaging recycling (linear trend model estimates)

Model	Recycling: linear trend							
Sample	1998 - 2017				2004 - 2017			
Variable	Coeff.	s.e	t-Stat	Prob. t	Coeff.	s.e	t-Stat	Prob. t
Constant	55230.0	25069.9	2.20	0.041	-38002.8	47720.3	-0.80	0.441
Trend	45081.8	2092.8	21.54	0.00	51273.1	3387.1	15.14	0.00
Adj. R^2		96.1%				94.6%		
S.E		53,968				51,087		
F-stat		464				229		
Prob.F		0				0		

The auto-regressive model for plastic packaging recycling is estimated on the full sample period 1998 to 2017. The first step is to determine the order of the AR model based on the information criteria for models up to order 3. The range of information statistics indicates that a first-order autoregressive model for plastic packaging recycling is the best model for data sample available for plastic packaging recycling. Details of the information criterion, the estimated AR(1) model for plastic packaging recycling are reported in **Error! Reference source not found.**.

Provisional 2018 figures for accredited plastic recycling are available for January to June 2018 from NPWD. Plastic packaging recycling is reported as 253k tonnes for 2018Q1 and 285k tonnes for 2018Q2, so for the first half of 2018 a total of 538k tonnes of plastic packaging has already been recycled, an increase of 5.1% compared to the first half 2017.

The 2018 full year projection assumes recycling growth continues at the same pace during the second half of 2018, with recycling in 2018 projected at 1,098k tonnes for the full year (ie a year on year increase of 5.1%). Therefore, the 2018 level of plastic packaging recycling in each of the projections is set based on actual recycling data January to June and an assumed growth rate for recycling July to December and over-rides the model based projections.

Figure AIV 5 Plastic packaging recycling (AR model estimates)

Information criterion	AR(1)	AR(2)	AR(3)

[107] *For the time-series of plastic packaging recycling the Chow break point statistics against a null hypothesis of no structural break in 2004 are: F-statistic 2.707, Log-likelihood 5.829, Wald-statistic 5.414. All are statistically significant at 5%, at this level of significance the null hypothesis of no structural break in 2004 is rejected.*

Akaike	24.6	24.6	24.6
Schwarz/BIC	24.7	24.8	24.8
Hannan-Quinn	24.6	24.6	24.6

Model	**Recycling: AR(1)**			
Sample	**1999 - 2007**			
Variable	**Coeff.**	**s.e**	**t-Stat**	**Prob. t**
Constant	33603.73	26100.71	1.287464	0.215
R(-1)	1.029426	0.046833	21.98075	0.000
Adj. R^2		96.4%		
S.E		49,650		
F-stat		483		
Prob.F		0		

The annual projections from 2019 onwards in each of the scenarios are the model based projections for recycling. The projection scenarios and 95% confidence intervals for plastic packaging recycling in the linear and autoregressive models are reported in **Error! Reference source not found.**.

Figure AIV 6 Plastic packaging recycling projection scenarios 2018 to 2025, and 95% confidence intervals (tonnes)

Model	Recycling: linear trend						Recycling: AR(1)		
Sample	1998 - 2017			2004 - 2017			1999 to 2017		
	Lower	Projection	Upper	Lower	Projection	Upper	Lower	Projection	Upper
2018	981k	1,098k	1,214k	983k	1,098k	1,213k	986k	1,098k	1,209k
2019	1,027k	1,146k	1,264k	972k	1,090k	1,208k	993k	1,175k	1,357k
2020	1,075k	1,195k	1,315k	1,020k	1,141k	1,263k	989k	1,243k	1,497k
2021	1,123k	1,244k	1,366k	1,068k	1,193k	1,317k	981k	1,313k	1,645k
2022	1,170k	1,294k	1,417k	1,115k	1,244k	1,373k	968k	1,386k	1,803k
2023	1,217k	1,343k	1,469k	1,162k	1,295k	1,428k	949k	1,460k	1,971k
2024	1,264k	1,392k	1,520k	1,209k	1,346k	1,483k	923k	1,536k	2,150k
2025	1,312k	1,442k	1,572k	1,256k	1,398k	1,539k	889k	1,615k	2,342k

Plastic packaging recycling scenarios and compliance versus the targets

This section reports projection scenarios to 2025 for national plastic packaging recycling based on the scenario projections above for plastic packaging POM and plastic recycling.

For the compliance assessment, the targets on obligated businesses 2018, 2019 and 2020 are converted to equivalent national recycling targets based on total plastic packaging POM (the CEP target of 50% in 2025 and The UK Plastics Pact target of 70% in 2025 are assumed to be national targets based on POM). Using these targets and the projection scenarios for plastic packaging POM the tonnages of recycling required each year to meet the targets are calculated and compared to the projection scenarios for plastic 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 of recycling outturns is normally distributed and centred on the model projected level of recycling with a standard deviation estimated by the standard error of the model in each year for each of the variant projection scenarios for plastic packaging recycling.

Error! Reference source not found. reports the compliance assessment for each of the projection scenarios to 2025 for plastic packaging POM against the plastic recycling scenario projections based on the recycling linear projection model estimated on the sample 2004 to 2017 (the compliance assessment for the linear recycling projection based on the full sample is reported in Section 8).

Assuming that the 2018 POM figure of 2,361k tonnes applies, based on these projections of plastic packing POM and plastic packaging recycling the UK would probably meet its packaging recycling targets in 2018, 2019 and 2020, and the CEP target in 2025.

The probabilities of meeting the national equivalents of the business targets in 2018, 2019 and 2020 are 84.3%, 58.0% and 65.3%, and 99.9% for the CEP target in 2025. However, without further actions the 70% UK Plastics Pact target for 2025 would be missed (the probability of meeting The UK Plastics Pact target of 70% effectively recycled or composted by 2025 would be zero, based on extrapolation from previous trends). WRAP is working with UK Plastics Pact members to develop and implement the required actions.

Figure AIV 7 Compliance assessment 2018 to 2025 versus plastic recycling projections (linear trend model, 2004 – 2017) (tonnes, %)

	POM	National recycling target	Recycling required to meet the national target	Projected annual recycling	Probability of meeting the national target
Scenario 1: Plastic POM projected at zero growth					
2018	2,361k	44.0%	1,039k	1,098k	84.3%
2019	2,361k	45.7%	1,078k	1,090k	58.0%
2020	2,361k	47.3%	1,117k	1,141k	65.3%
2021	2,361k	47.8%	1,130k	1,193k	83.8%
2022	2,361k	48.4%	1,142k	1,244k	93.9%
2023	2,361k	48.9%	1,155k	1,295k	98.1%
2024	2,361k	49.5%	1,168k	1,346k	99.5%
2025*	2,361k	50.0%	1,181k	1,398k	99.9%
2025**	2,361k	70.0%	1,653k	1,398k	0.0%
Scenario 2: Plastic POM growth based on linear trend model for net pack fill, 1999 - 2017					
2018	2,361k	44.0%	1,039k	1,098k	84.3%
2019	2,395k	45.7%	1,093k	1,090k	47.9%
2020	2,428k	47.3%	1,149k	1,141k	45.1%
2021	2,463k	47.8%	1,178k	1,193k	58.9%
2022	2,497k	48.4%	1,208k	1,244k	70.7%
2023	2,531k	48.9%	1,238k	1,295k	79.9%
2024	2,566k	49.5%	1,269k	1,346k	86.5%
2025*	2,601k	50.0%	1,300k	1,398k	91.1%
2025**	2,601k	70.0%	1,821k	1,398k	0.0%
Scenario 3: Plastic POM growth based on linear trend model for net pack fill, 2004 - 2017					
2018	2,361k	44.0%	1,039k	1,098k	84.3%
2019	2,368k	45.7%	1,081k	1,090k	55.9%
2020	2,375k	47.3%	1,124k	1,141k	61.2%
2021	2,382k	47.8%	1,140k	1,193k	79.6%
2022	2,389k	48.4%	1,156k	1,244k	90.9%
2023	2,396k	48.9%	1,172k	1,295k	96.5%
2024	2,404k	49.5%	1,189k	1,346k	98.8%
2025*	2,411k	50.0%	1,205k	1,398k	99.6%
2025**	2,411k	70.0%	1,687k	1,398k	0.0%
Scenario 4: Plastic POM growth based on AR(1) model for net pack fill, 1998 - 2017					
2018	2,361k	44.0%	1,039k	1,098k	84.3%
2019	2,371k	45.7%	1,083k	1,090k	54.9%
2020	2,380k	47.3%	1,126k	1,141k	59.6%
2021	2,388k	47.8%	1,143k	1,193k	78.3%
2022	2,395k	48.4%	1,159k	1,244k	90.2%

2023	2,401k	48.9%	1,175k	1,295k	96.2%
2024	2,406k	49.5%	1,190k	1,346k	98.7%
2025*	2,410k	50.0%	1,205k	1,398k	99.6%
2025**	2,410k	70.0%	1,687k	1,398k	0.0%

*CEP Target 2025

**UK Plastics Pact Target

Error! Reference source not found. reports the compliance assessment for each of the projection scenarios to 2025 for plastic packaging POM against the plastic recycling scenario projections based on the AR(1) projection model estimated on the sample 1999 to 2017.

Assuming that the 2018 POM figure of 2,361k tonnes applies, based on these projections of plastic packing POM and plastic packaging recycling the UK would probably meet its packaging recycling targets in 2018, 2019 and 2020, and the CEP target in 2025.

The probabilities of meeting the national equivalents of the business targets in 2018, 2019 and 2020 are 85.0%, 85.3% and 83.5%, and 88.0% for the CEP target in 2025. However, based on the AR(1) projection scenario for plastic packaging recycling the 70% UK Plastics Pact target for 2025 is likely to be missed (although the probability of meeting The UK Plastics Pact target under the AR(1) projection model is higher in comparison to the other recycling projection scenarios it is less than 46%).

Figure AIV 8 Compliance assessment 2018 to 2025 versus recycling projections (AR(1) model) (tonnes, %)

	POM	National recycling target	Recycling required to meet the national target	Projected annual recycling	Probability of meeting the national target
Scenario 1: Plastic POM projected at zero growth					
2018	2,361k	44.0%	1,039k	1,098k	85.0%
2019	2,361k	45.7%	1,078k	1,175k	85.3%
2020	2,361k	47.3%	1,117k	1,243k	83.5%
2021	2,361k	47.8%	1,130k	1,313k	86.1%
2022	2,361k	48.4%	1,142k	1,386k	87.3%
2023	2,361k	48.9%	1,155k	1,460k	87.9%
2024	2,361k	49.5%	1,168k	1,536k	88.0%
2025*	2,361k	50.0%	1,181k	1,615k	88.0%
2025**	2,361k	70.0%	1,653k	1,615k	46.0%
Scenario 2: Plastic POM growth based on linear trend model for net pack fill, 1999-2017					
2018	2,361k	44.0%	1,039k	1,098k	85.0%
2019	2,395k	45.7%	1,093k	1,175k	81.1%
2020	2,428k	47.3%	1,149k	1,243k	76.6%
2021	2,463k	47.8%	1,178k	1,313k	78.7%
2022	2,497k	48.4%	1,208k	1,386k	79.8%
2023	2,531k	48.9%	1,238k	1,460k	80.2%
2024	2,566k	49.5%	1,269k	1,536k	80.3%

2025*	2,601k	50.0%	1,300k	1,615k	80.2%
2025**	2,601k	70.0%	1,821k	1,615k	29.0%
Scenario 3: Plastic POM growth based on linear trend model for net pack fill, 2004 - 2017					
2018	2,361k	44.0%	1,039k	1,098k	85.0%
2019	2,368k	45.7%	1,081k	1,175k	84.4%
2020	2,375k	47.3%	1,124k	1,243k	82.2%
2021	2,382k	47.8%	1,140k	1,313k	84.7%
2022	2,389k	48.4%	1,156k	1,386k	85.9%
2023	2,396k	48.9%	1,172k	1,460k	86.5%
2024	2,404k	49.5%	1,189k	1,536k	86.6%
2025*	2,411k	50.0%	1,205k	1,615k	86.6%
2025**	2,411k	70.0%	1,687k	1,615k	42.3%
Scenario 4: Plastic POM growth based on AR(1) model for net pack fill, 1998 - 2017					
2018	2,361k	44.0%	1,039k	1,098k	85.0%
2019	2,371k	45.7%	1,083k	1,175k	84.0%
2020	2,380k	47.3%	1,126k	1,243k	81.7%
2021	2,388k	47.8%	1,143k	1,313k	84.3%
2022	2,395k	48.4%	1,159k	1,386k	85.6%
2023	2,401k	48.9%	1,175k	1,460k	86.3%
2024	2,406k	49.5%	1,190k	1,536k	86.6%
2025*	2,410k	50.0%	1,205k	1,615k	86.6%
2026**	2,410k	70.0%	1,687k	1,615k	42.3%

*CEP Target 2025

**UK Plastics Pact Target