Final Report

Wood Flow 2020

A review of the quantity of wood packaging being placed on the market (POM) and recycled in 2014 with projections to 2020

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Front cover photography: Wood Packaging

Executive Summary

Background

This project was commissioned by WRAP and carried out by Valpak Consulting, with support from Paul Davidson (Specialist Consultant), Ricardo Energy & Environment and a dedicated Steering Group of industry experts. The objective was to review the quantity of wood packaging being placed on the market (POM) and recycled in 2014. The project also projected future POM figures and recycling rates to 2020.

The methodology to achieve this involved primary and secondary research with engagement of the stakeholder Steering Group. The group comprised Defra, Environment Agency, Advisory Committee on Packaging (ACP), Wood Recyclers Association, Wood Panel Industries Federation, Scotch Whiskey Association, Valpak and WRAP.

Project Key Conclusions: POM

- The project's final estimate of UK wood packaging POM for 2014 is **1,310k tonnes**: an increase of 276k tonnes compared to the 2014 figure used by Defra, which is based on PackFlow. Elements of the final project estimate have been verified using data from a combination of sources such as Timcon, Confor and Unit Pallets Ltd/Federation of European Manufacturers of Wooden Pallets & Packaging (FEFPEB) and wider Valpak data. The Steering Group for the project was supportive of the methodology adopted and key findings;
- Unobligated or unregistered flow of wood packaging accounted for 8% of POM in 2014; and
- The projected trend between 2014 and 2020 in wood packaging POM is 4.3% growth over the period. This projection is based on reviewing past performance of obligated flow and growth in the construction sector, which show a strong correlation.

Project Key Conclusions: Recycling

- Using the new POM estimate of 1,310k tonnes, the UK achieved a **31%** recycling rate in 2014, with **412k tonnes** of wood packaging recycled by accredited *reprocessors/ exporters;*
- In 2008, there were 940k tonnes of accredited recycling; however, by 2014 this had dropped to 412k tonnes. The project team believes this decrease in accredited recycling is largely due to waste wood packaging being used in end markets which have not raised PRNs such as in biomass. And to a lesser extent due to the PRN value being low in the recent past, meaning some recyclers may not have registered to issue PRNs;
- There was an estimated 372k tonnes of unaccredited wood packaging recycling in 2014 (47% of total recycling);
- Recycling projections predict a decrease in accredited recycling (down from 412k tonnes in 2014 to 324k tonnes in 2020), but a slow-down in the rate of decrease

compared to the previous six years. Based on the projected POM estimate for 2020, the UK would achieve a 24% recycling rate in 2020; and

- Wood packaging recycling is projected to continue to comply with the Directive target (15%) currently in place to 2020. However, future revisions of this target could put UK compliance at risk.

Project Recommendations

- This work identified that there was a difference in obligated wood producers listed on the NPWD compared to industry databases (detailed in Appendix IV). This work identified that there could be organisations listed on industry databases that are of a sufficient size by turnover and core business activity, and which therefore should potentially be registered. As such, this should be investigated further, as this could result in a significant tonnage of obligated wood POM being missed;
- Encouraging a greater number of wood recyclers to become accredited for all recycling activities could increase the number of PRNs/PERNs generated for recycling;
- Work should be done to ensure that data used to identify wood flow estimates is up to date and as accurate as possible. An example of this would be to work with Timcon to ensure it updates its reports/surveys for years (such as in 2014) in which POM flows are required to be identified or verified. New ways of working between Government and industry could be examined to update these types of datasets on a regular basis; and
- A factor which could help wood packaging meet any future circular economy recycling targets is re-use. As there is a significant quantity of wood pallets and other items such as wooden barrels being re-used, this should be investigated to identify the contribution this could make to future targets.

Data Sources

The amount of wood packaging POM and recycled was calculated using several methods and data sources including UK Government databases such as the EA National Packaging Waste Database (NPWD), HMRC and regulatory bodies. It also used data from trade associations, published reports and Valpak internal data.

Data Uncertainties and Appropriate Confidence in Estimates

The data presented in this report represents the best estimate possible, given the available data. However, owing to uncertainties inherent in many of the data sources and assumptions used, it is important to caveat the robustness of the estimates. Appendix IX includes an assessment of the robustness of the estimates.

Contents

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Glossary

CA – Civic Amenity
CfD – Contract for Difference
C&D – Construction and Demolition
C&I – Commercial and Industrial
CITB – Construction Industry Training Board
CONFOR – Confederation of Forest Industries (UK)
CWR – Community Wood Recycling Group
DECC – Department for Energy and Climate Change
EA – Environment Agency
EfW – Energy from Waste
EPIC – Environmental Product Information Centre
FEFPOEB – Fédération Européenne des Fabricants de Palettes et Emballages en Bois (European Federation of Wooden Pallet and Packaging Manufacturers)
GDP – Gross Domestic Product
GHG – Greenhouse Gas
GVA – Gross Value Added
HMRC – Her Majesty's Revenue and Customs
HWRC – Household Waste Recycling Centre
k – Thousand
kt – Thousand tonnes
kWh – Kilowatt-hour
LA – Local Authority
LCCC – Low Carbon Contracts Company
MDF – Medium Density Fibreboard
MRF – Materials Recovery Facility
MSW – Municipal Solid Waste
NPWD – National Packaging Waste Database
ONS – Office for National Statistics
OSB – Oriented Strand Board
PERN – Packaging Export Recovery Note
POM – Placed on the market
PRN – Packaging Recovery Note
Prodcom – PRODuction COMmunautaire (Community Production)
RHI – Renewable Heat Incentive
RO – Renewables Obligation
ROC – Renewables Obligation Certificate
SEPA – Scottish Environment Protection Agency
Timcon – Timber Packaging and Pallet Confederation
TRADA – Timber Research and Development Association
Transit/Tertiary Packaging – Any transit packaging e.g. pallets, shrink wrap, staples or strapping
WDF – Waste Data Flow
WPIF – Wood Panel Industry Federation
WRA – Wood Recyclers Association

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- Advisory Committee on Packaging (ACP);
- Albion Environmental Limited;
- Community Wood Recycling Group (CWR);
- Confor;
- Defra;
- Department of the Environment (Northern Ireland);
- Environment Agency (EA);
- HMRC;
- Natural Resources Wales (NRW);
- Office for National Statistics (ONS);
- Poyry;
- Ricardo Energy & Environment;
- Scotch Whisky Association;
- Scottish Environment Protection Agency (SEPA);
- Timcon;
- UK Forest Products Association;
- Unit Pallets Ltd;
- Wood Panel Industries Federation; and
- Wood Recyclers Association.

1.0 Introduction

1.1 Background and Existing Data

It is important to ensure that the estimates being used by Defra for its packaging policy work are as accurate as possible. To support Defra, this work focuses on reviewing the estimates of UK wood packaging placed on the market (POM)[1] and the associated compliance implications. Accurate and robust assessments of current and future UK wood packaging flows are vital to help inform the setting of UK business targets and also the UK negotiating position in the acceptance of any possible future targets. The devolved administrations of Scotland, Wales and Northern Ireland are also interested in the outcome of this research.

At the time of writing, the Defra estimate for 2014 is 1,034k tonnes of wood packaging POM[2]. The PackFlow[3] project and industry assessment formed the basis of this estimate in 2008. PackFlow derived estimates of the growth in wood packaging (and other packaging materials) from a variety of quantitative and qualitative sources, including dialogue with key stakeholders. The objective of Wood Flow 2020 is to provide an updated baseline estimate of wood packaging placed on the market and recycled/recovered.

1.2 Project Objectives

Wood Flow 2020 had the following key objectives:

- Assemble a Steering Group to provide industry expertise and advice and help guide the project;
- Develop a methodology, based on Valpak's 'best in class' method, to estimate the amount of wood packaging POM and recycled/composted/going to energy recovery/landfilled in 2014;
- Estimate tonnage of consumer and non-consumer wood packaging collected;
- Estimate recycling and recovery by end market;
- Project POM and recycling rate to 2020;
- Quantify the amount of unaccredited wood packaging recycled;
- Assess compliance with recycling targets;
- Assess the quality and uncertainty of all data and assumptions used; and
- Produce a final report and slide set detailing the project findings.

[1] *Wood packaging placed on the market means all household and non-household wood packaging used around products within the UK.*
[2] *https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82437/packaging-ia-120321.pdf, p.20*
[3] *http://www.valpak.co.uk/docs/default-source/environmental-consulting/packflow_2017.pdf?sfvrsn=0*

2.0 Background to Methodology Development for Estimating Packaging Flow

2.1 Rationale

A number of methodologies have been evaluated and used in previous flow projects undertaken jointly by Valpak and WRAP, to best fit the specifics of different packaging materials. These methodologies include:

- Bottom up approach – estimating the POM by sector, such as grocery retail (using Valpak Environmental Product Information Centre (EPIC) data[4]), wider retail, commercial & industrial, construction & demolition, agricultural and other key sectors using published secondary sources. This approach adds together the data for each of the sectors, covering both obligated and unobligated producers, to produce a total POM figure;
- Net Pack Fill – uses data from the National Packaging Waste Database (NPWD) to calculate the obligated POM. This is then added to an estimate of the unobligated/free-rider tonnage to give a total POM; and
- Top down approach – using UK Trade Info data and other statistics from trade associations.

Additionally, other methodologies and datasets have been used to assess recycling levels for each material, such as Waste Data Flow (WDF), NPWD, published waste composition reports, Valpak surveys and those conducted by trade associations as part of projects, and Valpak internal data.

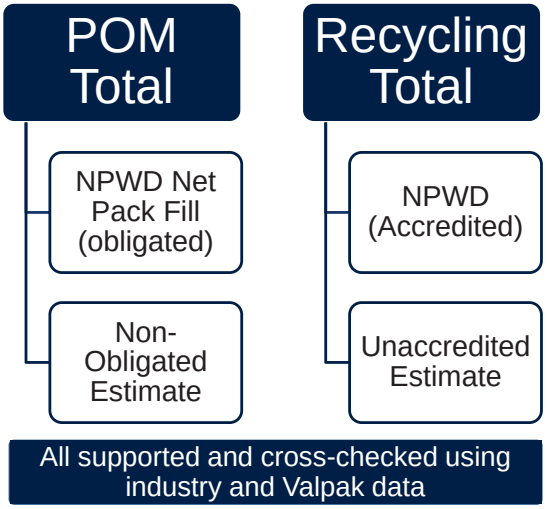
Due to the varying approaches used and the Government's desire to have one 'best in class' methodology that can be used for any packaging material and which could be updated on a more frequent basis, the Paper & Card Flow 2020 project reviewed these methodologies to identify the advantages and disadvantages of each.

2.2 Best in class approach

The review recommendations were used to develop the 'best in class' method statement for packaging flow and recycling calculations. An overview of the proposed 'best in class' methodology is provided in the Figure 1.

[4] *EPIC is Valpak's database of packaging weights, covering over 800,000 products, predominately relating to the grocery sector.*

Figure 1 'Best in Class' Method Overview



Wood Flow 2020 used this approach to identify and sense check POM and recycling estimates. The methodologies for estimating wood POM and recycling in 2014 are discussed later in this report.

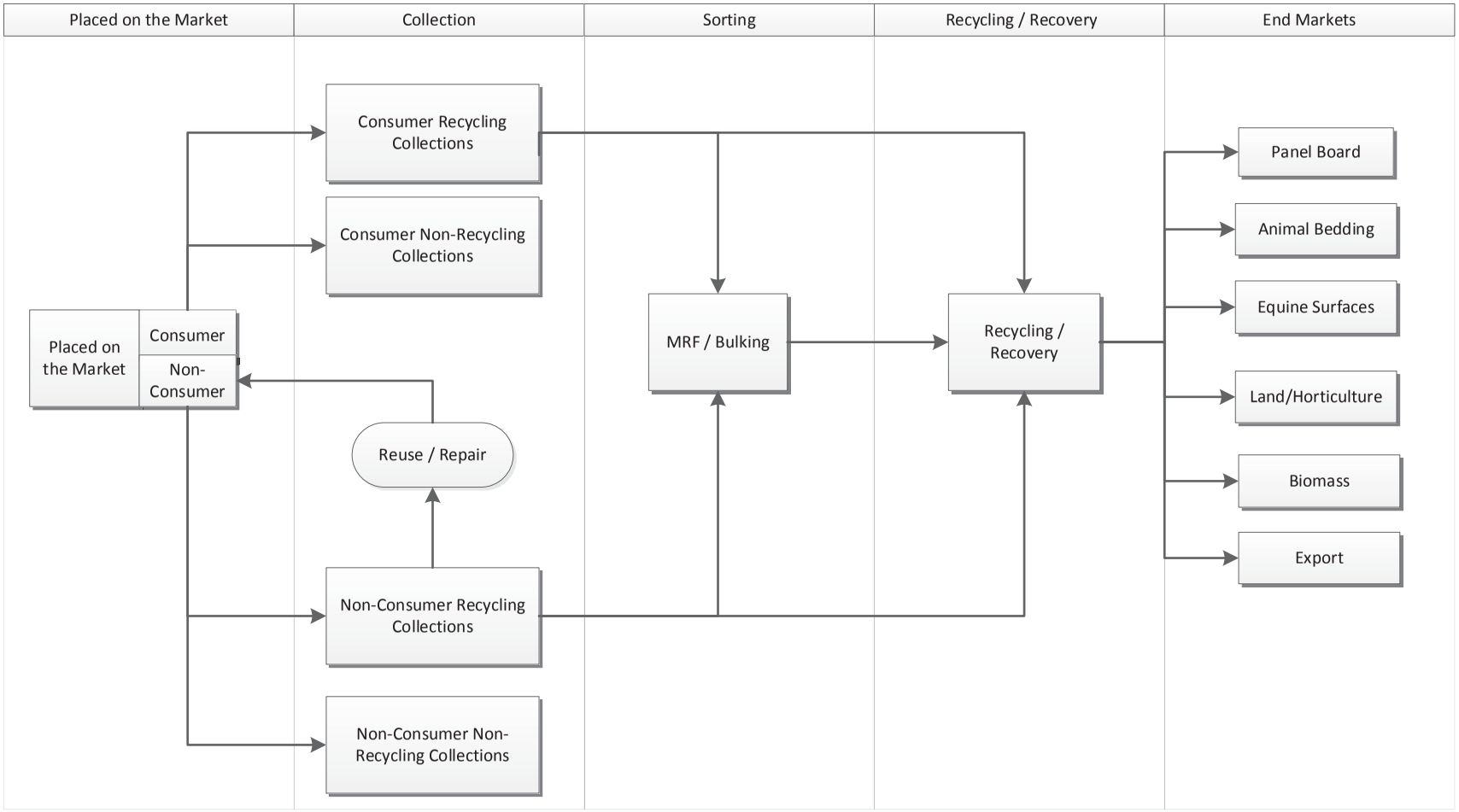
3.0 Wood Packaging Supply Chain

This section of the report provides an overview of how wood packaging flows on and off the UK market through consumption, collection, sorting and recycling to final end market destination. This section is important in understanding the flow of wood packaging on and off the market.

3.1 Supply Chain Map

A map of the wood packaging supply chain is provided in Figure 2.

Figure 2 Wood Packaging Supply Chain Map[5]



[5] *Each stage is explained in the following sections.*

3.2 Placed on the Market

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

Wood packaging typically enters the market in the following formats, which have been adopted for the purposes of this report:

- **Flat pallets** – widely used transit packaging used by industries that transport large quantities of goods and bulky items. Pallets are typically made to standard sizes and are used extensively in large leased pallet pools. Pallets are often repaired several times during their life. This also includes single use pallets for specialist use. Only new wood used for manufacturing pallets and that which is added for repairs is included in the POM estimate;
- **Box pallets and load boards** – box pallets offer further protection to flat pallets and are often used in manufacturing industries to bulk transport components and parts. Load boards are planks of wood used to cushion heavy goods on lorries during transit;
- **Casks, barrels, vats, tubs, & coopers products** – used in the beverage industry to brew, store and transport drinks up to the bottling stage. Wooden coopers products are used in the transportation of wiring;
- **Cases, boxes, crates and drums** – used to store and transport wire and cables, smaller industrial components and specialist food and drink products to consumers; and
- **Other** – all other forms of wood packaging such as wood shaving fillers, wood wool and specialist items not covered above.

3.3 Collection

The next stage in the supply chain, once waste wood packaging is generated from consumption, is its collection. When waste wood packaging is generated, it is collected either in the general waste stream and sent for disposal (typically landfill or Energy from Waste [EfW]), or it is collected for recycling or re-use.

A significant quantity of wood packaging is in the form of pallets, which are designed for multi-use. As such, they will often be re-used several times over their life before they are sent for recycling/disposal (the lifespan of a pallet is on average estimated to be seven years[6]). Pallet pools aim to keep the pallets in circulation for as long as possible; they maintain and repair the pallets to ensure they are fit for purpose and can be re-used for several years.

3.4 Sorting

[6] *http://www.packagingnews.co.uk/equipment/buyersguide/does-wood-make-a-perfect-pallet-03-05-2011*

One of the next steps in the supply chain following the collection of wood packaging is the bulking stage.

At an MRF/bulking facility, wood is typically sorted and bulked until a sufficient quantity is achieved, at which point it will be transported to a recycler/reprocessor.

3.5 Recycling / Recovery

This stage represents the UK recycling/reprocessing of wood packaging, where it is subject to a variety of processes including further sorting, shredding, and grading in order for it to be used as a recyclate feedstock in other products or end markets.

3.6 End Markets

Depending on its quality grade (ranging from good quality Grade A material to poorer quality contaminated wood which is Grade D [see Appendix V]), wood packaging can be used in several end markets such as panel board production and animal bedding. The best quality wood typically will be used in the higher value end markets.

In recent years it has been used increasingly as a recovery feedstock in biomass energy production, both for the UK and export markets. This creates recovery PRNs over wood recycling PRNs.

4.0 Obligated Wood Packaging POM in 2014: Net Pack Fill

4.1 Net Pack Fill

This section of the report identifies the total obligated wood packaging POM in the UK in 2014, based on the data stored on NPWD, as reported to the EA by obligated producers. Obligated producers are those that are above the following threshold: having a turnover of more than £2 million and handling more than 50 tonnes of packaging per year. The Net Pack Fill estimate does not include unobligated producers (producers below the threshold and free-riders).

The 2014 UK flow of obligated wood packaging was calculated using the packaging weights reported to the EA by registered producers and is publicly available on the NPWD website[7]. 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 takes the weight reported at the *packing* stage of the supply chain as opposed to the *selling* stage of the supply chain. This was used as it was the view of stakeholders that there are fewer unobligated packers in comparison to unobligated sellers, due to the likely size of the businesses[8]. Using this method, the total obligated wood packaging POM in 2014 was **1,209k tonnes** (as shown in Figure 3).[9].

Figure 3 Net Pack Fill Results 2014

	Wood Packaging
Table 1 Pack/Fill (UK pack/filling)	858kt
Imports:	
3A Selling (filled imports)	206kt
3B (packaging removed from imports)	394kt
Total	**1,458kt**
2A P/F (direct exports)	240kt
2B P/F (third party exports)	9kt
Total Exported	**249kt**
Net Pack/Fill	**1,209kt**

This method does not account for wood packaging that is unobligated or handled by unregistered producers, which is likely to include the following:

[7] *https://npwd.environment-agency.gov.uk/*
[8] *No evidence data is available to support this.*
[9] *At the time of writing, the NPWD figure was considered final and unlikely to change significantly*

- Unobligated producers – those below the obligation threshold of £2 million turnover and handle 50 tonnes of packaging per year;
- Internal use packaging;
- Free-riders and some regulatory loop holes – those obligated to register but not doing so; and
- Illegal importers[10].

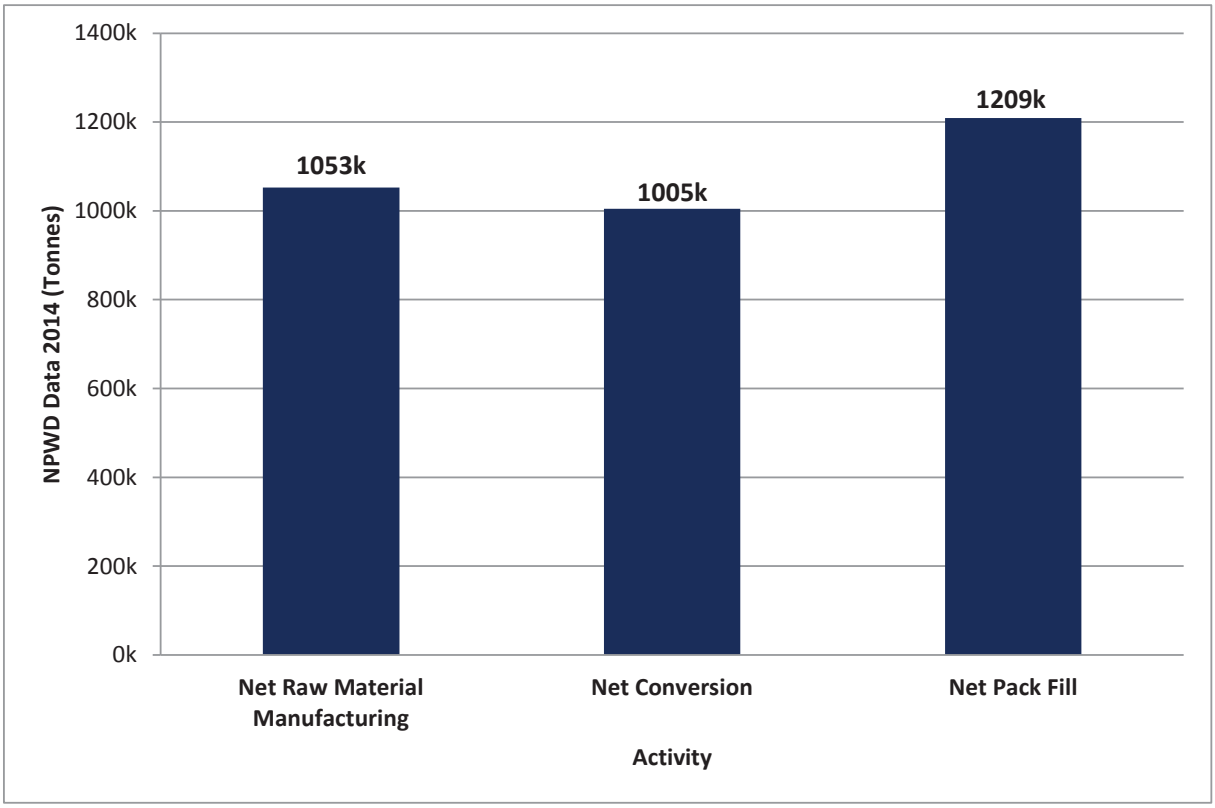
Identifying the amount of wood packaging that is not obligated/reported under the regulations can be difficult to estimate accurately. Therefore, the Net Pack Fill figure was used as a baseline to sense check the final POM figure.

4.2 Data Verification

In order to confirm levels of confidence in the Net Pack Fill calculation, checks were made using the data within the producer packaging data (within NPWD) from other parts of the supply chain. The net calculation was applied to other activity lines: raw material manufacturing and conversion, in addition to pack/filling[11]. The aim was to identify the obligated tonnage at other stages of the supply chain to see how they differ. The results are shown in Figure 4.

[10] *Those importing goods illegally*
[11] *See appendix I for further details on activity lines.*

Figure 4 'Net' Producer Data Table Calculations 2014



This pattern differs from other materials where the manufacturing and conversion columns are comparable or higher than the Net Pack Fill figure. A possible reason for this could be that due to the nature of wood packaging production, producers at the manufacturing stage may not be aware that their wood products are made into packaging further along the supply chain. Also, due to the high quantity of re-use pallets in circulation there could potentially be producers entering these incorrectly into their packaging returns (they should only be declared when entering the market for the first time). Other potential contributory factors could be that there are differing levels of de-minimis and/or free-riders at each stage of the supply chain. It is important to note that this pattern is not peculiar to 2014 for wood, but can be seen in data from 2009 onwards.

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

5.0 Total Wood Packaging POM in 2014

5.1 Total Wood Packaging POM 2014

In order to identify the total flow of wood packaging POM in the UK, the total UK production of wood packaging was added to wood packaging imports and then exports were removed. The methodology used industry data where possible to provide the best coverage of the supply chain (compared to a Net Pack Fill approach, which only includes obligated tonnage). Figure 5 provides an overview of the method and the key sources of data used.

Figure 5 Total Wood Packaging POM Calculation 2014

Obligated Packaging	=	**UK Production** **Timcon UK Pallet Production Data** + **Prodcom UK Non-pallet Production Data**	+	**Imports** **NPWD table 3A - imported for the purpose of pack/filling and selling** + **table 3B - packaging removed from around imports**	-	**Exports** **NPWD table 2A + table 2B – pack/filling**
De-minimis	=		+	**De-minimis Imports**	-	**De-minimis Exports**
TOTAL PACKAGING	=	**Total Production**	+	**Total Imports**	-	**Total Exports**

This methodology allowed for each stage of the supply chain to be considered independently to ensure that the best possible data was used and (where possible) reduce the unobligated proportion. The data sources used for the UK production stage of the supply chain was from the manufacture of final packaging products giving the final weight, which ensured no adjustments were required for process losses.

Using this approach (based on available industry data) meant that the methodology was not confined to data pertaining to one part of the supply chain such as is the case with Net Pack Fill.

Each of these data sources will now be discussed in more detail.

5.1.1 UK Wood Packaging Production

The wood packaging industry has been analysed by segment according to the 16240 Manufacture of Wooden Containers Standard Industrial Classification of Economic Activities (SIC) 2007:

- 16241133 (CN 4415202) - Flat pallets and pallet collars of wood;

- 16241135 (CN 4415209) - Box pallets and load boards of wood excluding: - flat pallets;
- 16241200 (CN 4416) - Casks, barrels, vats, tubs, and coopers products and parts thereof of wood INCLUDING: - staves;
- 16241320 (CN 4415101) - Cases, boxes, crates, drums and similar packings of wood excluding: - cable drums; and
- 16241350 (CN 4415109) - Cable-drums of wood.

Broadly, the industry is divided into two sectors, pallets consisting of 16241133 alone and non-pallet packaging comprising the other codes.

The two principle data sources used in this report are the Timber Packaging and Pallet Confederation & Forestry Commission, Wood Packaging Study (henceforth Timcon) and the Office for National Statistics (ONS), UK Manufacturers' Sales by Product (henceforth Prodcom). In order to identify the total UK production of wood packaging in 2014, the following equation was used.

UK Production	**=**	**TIMCON (Pallets)**	**+**	**PRODCOM (Non-pallets)**

5.1.1.1 Timcon (Pallets)

The Timcon study was produced with the support of the Forestry Commission annually from 2009 to 2013[12]. Although the Timcon studies are entitled "Wood Packaging", in fact they only cover pallets. The purpose of the studies was to quantify the manufacture of UK wood packaging and pallet production (and repair) because of widespread industry concerns that Prodcom was not accurate for pallets and that the discrepancy was too large to be accounted for by a sampling error.

Timcon surveyed both their members and the members of the UK Wood Packaging Marking Program (which it administers for the Forestry Commission). In the case of non-respondents, the survey data was supplemented by the addition of data from the Timcon membership database.

Timcon identified that a major problem was the correct classification of pallet repairs and this has led to a change in the way that ONS has gathered data. A new production heading, 16249999 (refurbished flat pallets and pallet collars of wood), was introduced in 2015 for the 2014 intermediate estimates. However, the project team was not confident that the change had been completely effective and felt that Timcon is a more reliable source for the pallet data.

[12] *Forestry Commission: Wood Packaging Study – Quantification of the Manufacture & Repair of Wood Packaging in the UK*

The mass of wood pallets was calculated by taking the Timcon figures for the volume of new timber used by producers and repairers, and multiplying this by the standard density of 507 kg per cubic metre. The density of wood depends on both species and moisture content. The moisture content of the wooden parts of a pallet will decrease over its lifetime and consequently its mass will vary at different points in the supply chain. To overcome this problem, Timcon agreed the standard density with the EA in 2001. The work was carried out by the Timber Research and Development Association (TRADA) and is based on a basket of timbers representing the mix commonly used in the industry at a moisture content at the end of life. The results are shown in Figure 6.

Figure 6 UK Pallet Production and Repair in 2014

	2011	2012	2013
Number of new pallets	29,681k	30,035k	31,399k
Volume of timber per new pallet (m^3)	0.0326	0.0327	0.0342
Volume of timber used in new pallets (m^3)	968k	981k	1,074k
Number of repaired pallets	35,251k	35,301k	34,753k
Volume of timber per repaired pallet (m^3)	0.0027	0.0028	0.0033
Volume of timber used in repaired pallets (m3)	96k	98k	115k
Total volume of timber used (m^3)	**1064k**	**1079k**	**1189k**
Total timber used for new and repaired pallets (tonnes)	**539k**	**547k**	**603k**

As Timcon figures were not available for 2014[13], the total tonnage was projected forward using the same uplift as is shown in Net Pack Fill between 2013 and 2014[14]. This approach was cross checked comparing the tonnage of timber used for new and repaired pallets to Net Pack Fill for 2011-2013, which showed that pallets accounted for between 47%-54% of Net Pack Fill. Over the three years this could be considered relatively constant, and so it supports the approach used. The report estimates that the total quantity of timber used in the production and repair of pallets in the UK was **650k tonnes in 2014**.

In order to sense check the figures derived from the Timcon data, Unit Pallets Limited was engaged. Unit Pallets Limited is one of the largest pallet producers in the UK and is a subsidiary of James Jones Limited one of the largest sawmillers. Its Managing Director is a past president of Timcon and its European umbrella organisation FEFPEB. Unit Pallets Limited supported the figures for the volume of timber used by UK pallet producers in the Timcon Study. However it should be noted that this is based on opinion rather than another dataset.

5.1.1.2 Prodcom (Non-pallets)

[13] *At the time of writing Timcon data was only available up to 2013. There was no evidence to suggest this work will be updated.*
[14] *This uplift was used as the project team was aware that a high proportion of pallets would be used in the construction sector. Based on work on projections of wood packaging POM it was identified that there is a strong correlation between the construction industry and Net Pack Fill and as such this uplift was agreed to be the best available.*

For wood non-pallet packaging, the only available source of data was Prodcom. The data is presented in different units and was converted into k tonnes[15]. The Prodcom data is shown in Figure 7.

Figure 7 UK Non-pallet Production 2014

	2013	2014
16241135 (CN 4415209) - Box pallets and load boards of wood EXCLUDING: - flat pallets	61k	58k
16241200 (CN 4416) - Casks, barrels, vats, tubs, and coopers products and parts thereof of wood INCLUDING: - staves	6k	6k
16241320 (CN 4415101) - Cases, boxes, crates, drums and similar packings of wood EXCLUDING: - cable drums	159k	157k
16241350 (CN 4415109) - Cable-drums of wood	7k	7k
Total Non-pallet Packaging (Incl. nails)	232k[16]	228k
Total Non-pallet Packaging (Excl. nails)	**227k**	**223k**

It was identified that the Prodcom data would also include the weight of non-wood fasteners. Therefore, the total non-pallet figure was adjusted down to remove the weight of fasteners[17].

Data for earlier years was extracted from Prodcom,however, estimates of cases, boxes, crates, drums and similar were not felt to be consistent. As such, the project team believed (for reasons identified above) that Prodcom had improved the data in recent years. This was demonstrated by ONS upgrading its assessment of the quality of its estimate for 16241320 between the preliminary and intermediate estimates. There is no alternative to Prodcom for non-pallet packaging data. The Prodcom Quality and Methodology Information Report (QMI) provides details of its data collection methods and robustness[18].

5.1.1.3 Total UK Wood Packaging Production 2014

Figure 8 shows that there were 873k tonnes of wood packaging produced in the UK in 2014.

[15] *The mass of wood packaging was calculated for the different SIC codes as follows:*
16241135 – The Prodcom volume unit is Number of Items. This is converted to mass by assuming that there is on average twice as much wood in a box pallet as a conventional timber pallet and using the Timcon average volume of timber per pallet together with the standard density of 507kg per cubic metre.
16241200 – The Prodcom volume unit is kilograms but is suppressed for 2013. The average of the 3 preceding years is substituted (Approx. 6k tonnes).
16241320 – The Prodcom unit is kilograms.
16241350 – There is no Prodcom volume unit. The value of sales is converted to tonnage of wood by assuming an average price of £150 per cable drum and that each drum contains 50kg of wood.
[16] *Do not add up due to rounding*
[17] *Internal industry data shows that fastenings represent no more than 2.3% of the weight of a finished pallet. No data was available for fastenings within non-pallet wooden packaging and therefore it was assumed that the degree of fastenings between pallets and non-pallets was the same.*
[18] *http://webarchive.nationalarchives.gov.uk/20160105160709/http:/www.ons.gov.uk/ons/guide-method/method-quality/quality/quality-information/business-and-energy/quality-and-methodology-information-for-uk-manufacturers--sales-by-product--prodcom-.pdf*

Figure 8 Total UK Wood Packaging Production 2014

		2014 (Tonnes)
Pallets	New Pallets & Pallet Repair	650k
	TOTAL	**650k**
Non-pallets	Box pallets and load boards of wood excluding: - flat pallets	58k
	Casks, barrels, vats, tubs, and coopers products and parts thereof of wood including: - staves	6k
	Cases, boxes, crates, drums and similar packings of wood excluding: - cable drums	157k
	Cable-drums of wood	7k
	Total Non-pallet Packaging (Incl. nails)	228k
	TOTAL (Excl. nails)	**223k**
	TOTAL	**873k**

The above figure was sense checked against the NPWD Table 1 conversion figure of 528k tonnes. Table 1 conversion records the obligated wood that is made into packaging that will be supplied to be packed either in the UK or abroad. The tonnage includes UK sourced and imported wood (any imported wood for conversion should also have been recorded in Table 3a conversion). As there was a significant gap (345k tonnes), this was investigated further to determine whether this gap could be attributed to de-minimis, free-riders or inaccuracies with data. This work identified that there was a significant number of organisations of a sufficient size by turnover and core business activity that potentially should be registered as producers and listed on the EA NPWD that at the time of writing were not. Details of this work are included in Appendix IV. This indicates that the gap between the UK Wood Packaging Production 2014 figure and the NPWD Table 1 conversion figure is made up of de-minimis companies and free-riders. The identified free-riders should be investigated further to confirm if they should be registered as obligated producers.

The UK wood packaging production 2014 figure was also sense checked against the Forestry Commission's Annual Forestry Statistics for the sawmill sector[19]. This identified that the total tonnage of wood used in wood packaging put on the market by domestic sawmill producers from 2012 to 2014 was only 4% less than the Timcon/PRODCOM estimate. CONFOR[20] is a membership organisation of sawmills and other forestry based businesses; it has confirmed that the Forestry Commission statistics are a reliable source of information about the UK sawmilling sector.

[19] *www.forestry.gov.uk/forestry/infd-7zhk85*
[20] *http://www.confor.org.uk/?pid=1*

5.1.1.4 Limitations of the Data

Wood Packaging (Non-pallet)

The wood packaging non-pallet industry is highly fragmented with specialist companies and in-house activity within the despatch functions of manufacturing businesses. The only source of data is the Prodcom survey, which provides data by volume. A number of assumptions must be made because of inconsistent volume units in Prodcom. At every stage efforts were made to confirm these assumptions with industry experts. There is no alternative data source available for sense checking other than the overall check against the Sawmill Survey explained below.

Pallets

For pallets there are two data sources available - Prodcom and Timcon. Due to a lack of confidence in Prodcom data (explained above) Timcon data was used. There are limitations inherent to any survey. However, the Timcon questionnaires were directed to executives within the member companies who had a good knowledge of the detail of their business activities and as such it is believed that the responses were reasonably accurate. Inaccuracies in the pallet data might arise because the estimate does not measure mass directly but uses the volume of timber supplied and multiplies it by the standard density. In its last report, Timcon estimated that 81% of pallets are made from fresh sawn timber and are supplied to the market wet. A pallet made from fresh wood from the sawmill could lose 25% to 50% of its mass after it has dried out from being in use for a few months. The standard density (agreed by the EA) is used within the raw material and conversion sectors of the packaging supply chain. However, it is not known if to what extent it is adopted further along the supply chain.

Sawmill Survey

As a sense check of the total volume of timber used by the two segments combined, the Forestry Commission annual sawmill survey, as recommended by CONFOR, was used. This estimates the volume of sawn wood produced and the percentage supplied to the packaging and pallets sectors. By combining this with the Timcon estimate of percentage of domestic supply, the total volume supplied can be calculated, and, applying the standard density, the mass. This methodology gives an average of 768k tonnes compared with 800k tonnes for Timcon/Prodcom in the years 2012 to 2014. The difference may be because the Timcon domestic percentage was based on pallet production and the packaging trade will traditionally use more imported timber.

5.1.2 Imports

This section identifies imports by obligated producers as well as imports by unobligated organisations.

5.1.2.1 Obligated Imports

The NPWD holds data on wood packaging for obligated producers that is entering the UK, which is not covered by Timcon or PRODCOM data. The data was selected from the 2015 NPWD data, which is reporting the packaging handled by obligated producers in 2014. The data in Table 3a packing/filling (imported empty packaging that remains in the UK) was selected to capture imported empty packaging.

Table 3a selling (packed goods imported for onward selling in the UK) and Table 3b (packaging discarded from direct imports) combined were then added to the imported empty packaging. Table 3a selling and Table 3b provide the amount of wood packaging that contains/holds goods when brought into the UK by obligated producers.

Figure 9 Obligated Imports of Wood Packaging

2015 NPWD Data (2014 Actual Data)	Imports (Tonnes)
Table 3a packing/filling (imported empty packaging that remains in the UK)	11k
Table 3a selling (packed goods imported for onward selling in the UK)	206k
Table 3b (packaging discarded from direct imports)	394k
TOTAL	**611k**

5.1.2.2 De-minimis Imports

NPWD was used for imports/exports data for obligated producers; however, the imports/exports of the smaller wood packaging producers that are below the obligated threshold needed to be identified.

In order to do this, several datasets were reviewed and the ONS was contacted to understand what data was available to identify the imports of goods by size of organisation. Following this exercise, HMRC UK TradeInfo data was used[21], which breaks down the quantity of goods imported /exported by:

- Industry sector;
- Size of business (by number of employees); and
- Value of goods.

The first stage was to cleanse the list of industry sectors to remove those that were not likely to use wood packaging. This was conducted by a specialist consultant with extensive knowledge of the wood packaging industry.

[21] *https://www.uktradeinfo.com/Statistics/NonEUOverseasTrade/AboutOverseastradeStatistics/Pages/PoliciesandMethodologies.aspx*

The second stage was to identify which size of organisations were most likely to be under the obligated threshold. In order to do this, internal Valpak data was reviewed to examine the size of obligated businesses based on their number of employees and turnover. This identified that the majority of businesses that are obligated[22] have 50 employees or more. Based on this evidence, and in the absence of more precise data, a 50 employee threshold was used as a proxy for identifying obligated and unobligated businesses. Organisations with 50 employees or more were considered obligated. As a sense check, the number of registered producers that handle wood packaging was compared to the number of businesses in the HMRC UK TradeInfo, which is broadly supportive of the methodology (see Appendix VIII).

Due to a lack of publicly available data to further cross-check this finding, a sensitivity analysis was conducted to establish the impact on total flow if this employee number cut-off was lower or higher. Details of this analysis can be found in Appendix VIII.

Once this was done, the value of total goods imported/exported by each group by size was combined to give a ratio of imports/exports by small and large organisations as shown in Figure 10. It should be noted that this uses turnover as a proxy for tonnage due to a lack of other more appropriate data.

Figure 10 UK Import / Export Ratios by Size of Organisation by Value

2014	Imports	Exports
Trade by small organisations	15.4%	12.5%
Trade by large organisations	84.6%	87.5%

Once the ratio of imports/exports by small and large organisations was identified, this was applied to the obligated imports to give the figure for the de-minimis imports as shown in Figure 11. The number of free-rider importing companies (those who are obligated but not currently registered) is likely to be significantly smaller than the UK production as wood packaging only makes up part of the packaging brought into the UK. It is also possible that some may be using leasing pools for pallets in particular, which will have already been included in the data above. Appendix VIII provides a sensitivity analysis for de-minimis imports and exports.

Figure 11 Wood Packaging Imported by Small Organisations (De-minimis)

2014	Imports (Tonnes)
Wood packaging imported by small organisations	**111k**

[22] *Obligated producers are those that have a turnover of more than £2 million per year and handle more than 50 tonnes of packaging per year*

5.1.3 Exports

This section identifies exports from obligated producers as well as exports from de-minimis organisations.

5.1.3.1 Obligated Exports

NPWD holds robust data on wood packaging (for obligated producers) that is leaving the UK. The data was selected from the 2015 NPWD data, which is reporting the packaging handled by obligated producers in 2014.

To cover the largest and most accurate selection of wood packaging leaving the UK, Table 2a packing/filling (direct exports) and Table 2b packing/filling (third party exports) were selected. This is packaging that obligated producers add to their products before exporting to customers abroad, or sending to a UK customer that will ultimately export.

There was a large difference between the tonnage of wood packaging exported in the conversion stage compared to the packing/filling stage. Analysis of Valpak's compliance scheme members showed that exported empty packaging was small at the conversion stage and therefore the packing/filling stage is more representative of wood packaging that is exported. There was also concern that to include conversion and packing/filling data would lead to duplication of data in the calculation due to the way packaging is reported in NPWD, as producers are required to fill in Table 2a conversion and packing/filling when performing both activities in the supply chain.

To further investigate exported empty wood packaging, the HMRC UK TradeInfo[23] database was used. This was filtered to identify wood packaging which would be exported empty[24]. This identified that there were potentially 3k tonnes of empty wood packaging exported. However, the database does not distinguish between new and re-use items, and, as such, due to the small quantity and limitations to the database (not able to identify the quantity of new packaging), the new wood packaging which is exported empty was considered negligible.

Figure 12 Obligated Exports of Wood Packaging

2015 NPWD Data (2014 Actual Data)	Exports (Tonnes)
Table 2a packing/filling (direct exports)	240k
Table 2b packing/filling (third party exports)	9k
TOTAL	**249k**

[23] *https://www.uktradeinfo.com/Statistics/BuildYourOwnTables/Pages/Table.aspx*

[24] *SITC 635.11 - Packing cases, boxes, crates, drums and similar packings, of wood; cable-drums of wood. SITC 635.20 –Casks, barrels, vats, tubs and other coopers products and parts thereof of wood (including staves).*

5.1.3.2 De-minimis Exports

Using the same methodology described in Section 5.1.2.2., once the ratio of exports by small and large organisations was identified, this was applied to the obligated exports to give the figure for the de-minimis exports as shown in Figure 13.

Figure 13 Wood Packaging Imported by Small Organisations (De-minimis)

2014	Exports (Tonnes)
Wood packaging exported by small organisations	**36k**

Due to the requirement to factor up from obligated data for imports and exports to estimate de-minimis figures for both, there are limitations in determining the accuracy of these estimates. This is compounded by the fact that the scaling factor used was not specific to wood packaging. Appendix VIII provides a sensitivity analysis of scaling up factors to identify the overall impact on POM.

5.1.4 Total Wood Packaging POM 2014

Figure 14 below shows the methodology used for calculating the total quantity of wood packaging POM in 2014.

Figure 14 Total UK Wood Packaging Production 2014

Obligated Packaging	=	**UK Production** **Timcon UK Pallet Production Data** **(650kT)** **+** **Prodcom UK Non-pallet Production Data** **(223kT)**	+	**Imports** **table 3A - imported for the purpose of pack/filling and selling** **+** **table 3B - packaging removed from around imports** **(611kT)**	-	**Exports** **table 2A + table 2B – pack/filling** **(249kT)**
De-minimis	=		+	**De-minimis Imports** **(111kT)**	-	**De-minimis Exports** **(36kT)**
TOTAL PACKAGING **1,310kT**	=	**Total Production** **873kT**	+	**Total Imports** **721kT***	-	**Total Exports** **284kt**

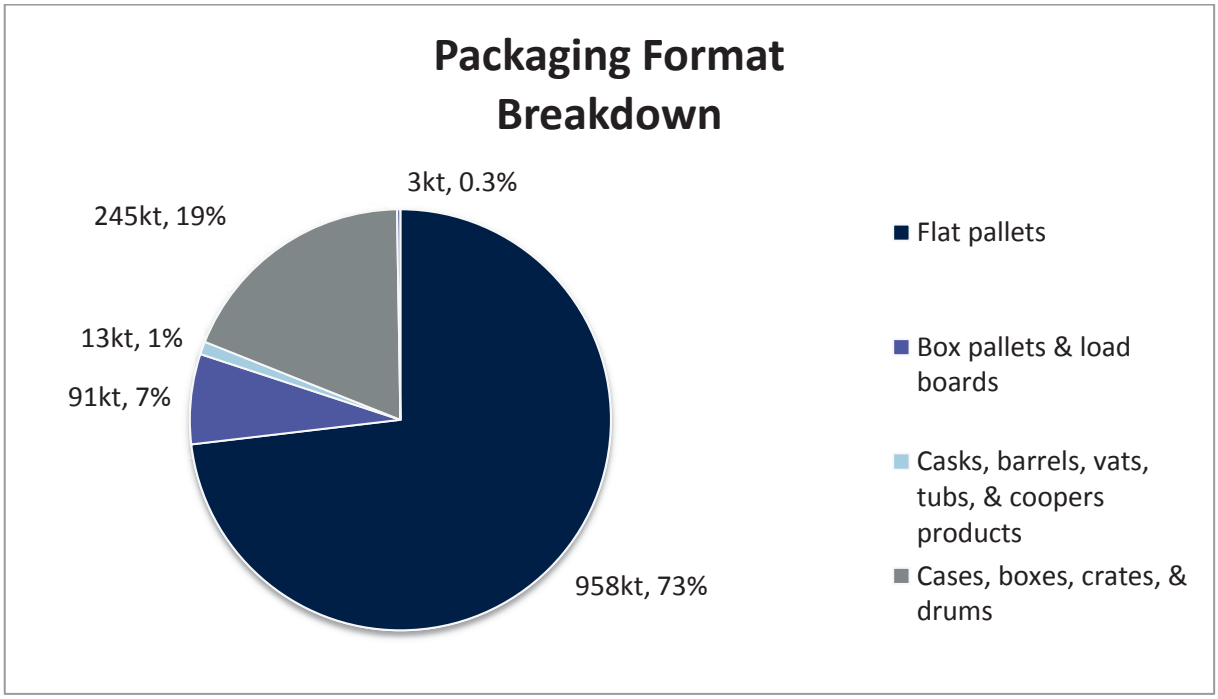
*Does not add due to rounding

This shows that there was a total of **1,310k tonnes** of wood packaging POM in 2014.

5.1.5 Format of Total Wood Packaging POM 2014

Figure 15 shows final project estimate of wood packaging POM in 2014, by format. This highlights that flat pallets account for the largest proportion of wood packaging POM at 73%. This estimate has been derived from a combination of sources including Timcon and Prodcom to cover packaging supplied to business as well as Valpak's EPIC database relating to retail primary packaging supplied to consumers in the UK. The packaging formats for Prodcom and EPIC are based on data for 2014, and as detailed in section 5.1.1.1. Timcon data is factored up from 2013 based on the same uplift experienced in Net Pack Fill from 2013 to 2014.

Figure 15 Total Wood Packaging POM by Format in 2014



5.1.6 Consumer and Non-consumer Proportion of Total POM 2014

The total wood packaging POM 2014 can also be broken down by:

- Consumer; and
- Non-consumer.

The methodology and results of this work are discussed in more detail below.

5.1.6.1 Consumer

Grocery retail

In order to estimate the amount of packaging POM by the grocery retail market, EA aggregated data was used for all major grocery retailers. This estimate uses wood packaging quantities reported by NPWD in Table 1 selling (i.e. supplying packaging to the end-user). This provides a wood packaging figure for all relevant products packaged in wood by obligated grocery retailers in the UK which are supplied to consumers.

Using volume market share information from Kantar World Panel for these obligated grocery retailers (i.e. supermarkets), the resulting quantity of wood packaging was scaled up to represent an estimate for the total UK grocery retail market. An assumption has been made that the wood packaging profile of these supermarkets is representative of those not included. It is the opinion of the project team that wood packaging use is similar in supermarkets that are not included in this dataset, due to the limited wood packaging formats used in this sector. The wood packaging in the grocery retail sector was estimated to be 275 tonnes in 2014.

This estimate was cross referenced with Valpak's EPIC[25] data (annual sales and packaging weights for all relevant products packaged in wood) for a selection of Valpak's supermarket clients representing a cross-section of grocery retailers in the UK. This shows that NPWD was 179 tonnes (65%) higher than EPIC data. Since wood packaging for the grocery sector is small in comparison to the total POM figure, NPWD data was used as it has the larger market share[26].

As the project team was able to view Valpak-held data and interrogate it on a product level[27], for the purpose of the grocery sector analysis, this was used to identify the format of grocery retail packaging[28]. Details of this are provided in Appendix II.

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

Total retail (including non-grocery)

To scale up the grocery retail result to represent total UK retail, including non-grocery retail, retail sales data as reported by the ONS for 2014 was used. This shows that the proportion of grocery spend of total UK retail spend was 45.5% in 2014.[29]

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[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). Over 800,000 supermarket products are recorded in EPIC.

[26] Valpak data was used for other materials flow projects because it provides increased granularity, however for other materials the difference in tonnage was less significant in terms of percentage. For wood, because the percentage difference is greater, and the consumer proportion of total POM is very small, it's less important to see the granularity therefore NPWD data has been used.

[27] Due to increased granularity and visibility, as well as the known inclusion of non-grocery items sold by grocery retailers in the data reported to the EA.

[28] NPWD is the only place where all reported obligated producer data can be viewed, so when looking at the UK in its entirety NPWD can be used. In the case of consumer data, it is possible for Valpak to see specific customers' product and sales data, and scale up using market share, therefore Valpak held data is used.

[29] http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-324908

However, simply scaling up by market share was not considered robust, since it was likely that packaging usage within both sub-sectors differed. Therefore, this difference in wood packaging used by the grocery sector and other retail sectors was analysed using data reported by Valpak members[30]. Analysis involved the following key stages:

- Identification of grocery and non-grocery retail members; and
- Gathering of company reported data and information.

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

Therefore, the following data/key steps were used to estimate total retail wood packaging consumption in the consumer (retail) sector in 2014:

- Total grocery wood packaging flow in 2014 was 275 tonnes (see section 5.1.6.1);
- The proportion of grocery spend of the total retail spend in the UK was 45.5% in 2014[31];
- Total retail wood packaging flow, assuming like for like packaging was 604 tonnes;
- In order to take account of the difference in wood packaging supplied in the non-grocery retail sector, the amount of wood packaging per £bn turnover was calculated;
- Non-grocery wood packaging tonnes/£bn turnover is 47 times greater than grocery wood packaging tonnes/£bn turnover[32] (this is as expected due to non-grocery covering DIY and furniture retailers, as well as garden centres) and
- Accounting for the difference in tonnes/£bn turnover between grocery (275 tonnes) and non-grocery (15.5k tonnes) the **total retail wood packaging flow in 2014 was 16k tonnes**.

To allow for a targeted approach when analysing implications of flow on recycling, this estimate has been broken down into formats. For consumer packaging this was derived by analysing data within the Valpak EPIC database for grocery and non-grocery retailers. Figure 16 shows the breakdown of formats.

Figure 16 Consumer Packaging by Format

	Wood Packaging Format	%
Consumer	Boxes	63
	Cases	13
	Trays	2
	Other	22
	TOTAL Consumer	**100**

[30] Valpak membership represents approximately 46% 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.

[31] http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-324908

[32] Appendix III provides results of sensitivity analysis on this result. The result was deemed reasonable by stakeholders.

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

5.1.6.2 Non-consumer

In order to identify the quantity of non-consumer wooden packaging, the consumer estimate in section 5.1.6.1 (16k tonnes) is taken away from the total estimate (1,310k tonnes). This shows that there was an estimated **1,294k tonnes** of non-consumer wood packaging flowing on to the UK market in 2014. This means that non-consumer wood accounted for 99% of the total wood packaging flowing onto the UK market.

To break down the non-consumer packaging by format, the data was initially separated into pallets and non-pallets. The Prodcom database then allowed for a further breakdown of non-pallet packaging. Figure 17 shows the breakdown of non-consumer wood packaging POM in 2014.

Figure 17 Non-consumer Packaging by Format

	Wood Packaging Format	%
Non-Consumer	Flat pallets	74
	Box pallets & load boards	7
	Cases, boxes, crates, & drums	18
	Casks, barrels, vats, tubs, & coopers products	1
	TOTAL Non-Consumer	**100**

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

6.0 Results: Final Project Estimate of Wood Packaging POM in 2014

The final project estimate for wood packaging POM in 2014 is 1,310k tonnes.

The final wood packaging POM figure is made up of a combination of published data sources and internal Valpak data.

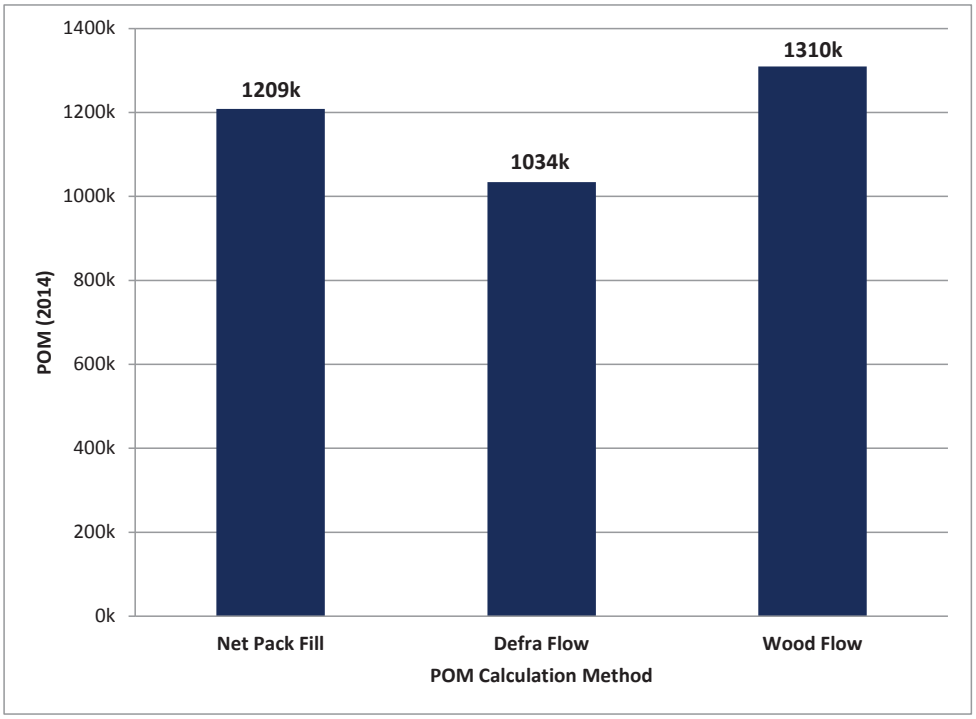
Figure 18 Final Project Estimates of Wood POM in 2014

	Total (k tonnes)
Grocery Retail	–
Non-grocery Retail	16
Total Consumer	**16**
Non-consumer	1,294
Total Non-consumer	**1,294**
TOTAL POM	**1,310**

Elements of the final project estimate of 1,310k tonnes POM have been verified using a combination of sources such as Timcon, Confor and Unit Pallets Ltd/Federation of European Manufacturers of Wooden Pallets & Packaging (FEFPEB), and wider Valpak data.

The reported obligated flow of wood packaging and the project estimated flow (Wood Flow) of wood packaging are shown in Figure 19 alongside Defra's flow estimate at the time of writing as well as Net Pack Fill (obligated flow).

Figure 19 Reported Obligated Flow and Project Final Estimate of POM for 2014



It is important to stress that the Net Pack Fill estimates are themselves open to the possibility of error because they rely on the robustness of the data that is submitted to NPWD. The data does not include companies that should be obligated and are not registered in the system. This is likely to include companies that manufacture wood packaging and companies that import goods in wood packaging. However, the NPWD data is widely recognised as being the best available for total obligated POM as there is a legal obligation for companies to submit data that is as accurate as reasonably possible. This data is then audited by the regulatory body and is used by policy makers and their agencies.

The project has estimated the de-minimis tonnage of imported wood packaging; however, it would be difficult to estimate the number of importer free riders and who they might be (as was done for UK producers, see appendix IV), because this could potentially be any company bringing goods into the UK from abroad.

The final project estimate for wood packaging POM in the consumer sector is 16k tonnes

This estimate is taken from primary data alongside reliable market share data. No other method was used for deriving consumer data as this method is considered the most robust available, and was accepted by the Steering Group.

The final project estimate for wood packaging POM in the non-consumer sector is 1,294k tonnes

This estimate is taken from a combination of secondary data sources for UK wooden pallet production, non-pallet production and imports/exports.

Unobligated tonnage was 8% of total POM

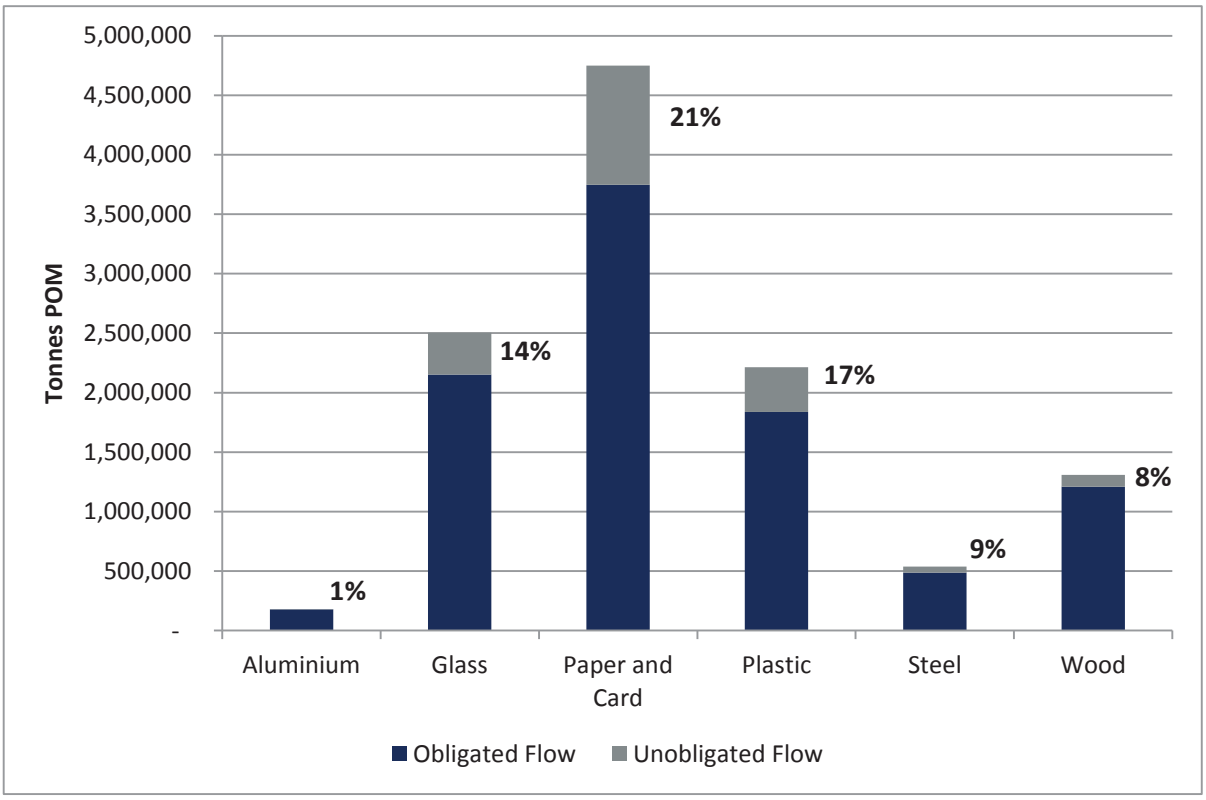
The final project estimate was found to be 101k tonnes higher than data reported by obligated companies under the Packaging Waste Regulations (using the UK Net Pack Fill calculation method). This suggests that unobligated companies or tonnage (relating to the regulation thresholds and packaging definitions) or unregistered tonnage through free-riding, account for 101k tonnes (8%) of wood packaging in the UK.

Unobligated tonnage for wood packaging relatively low compared to other materials

Figure 20 illustrates the obligated versus unobligated flow for all reported materials using the Net Pack Fill calculation (for obligated tonnage). All materials have undergone recent flow analysis. Although each packaging type is characterised by different market structures, the project results highlight that unobligated flow for wood is relatively low compared to other packaging materials, but is comparable with steel, estimated at 9%[33]. This is consistent with stakeholder views that wood packaging, in particular pallets, will be produced in large scale facilities (and more likely to be obligated), with the more specialist bespoke non-pallet packaging being manufactured by smaller producers.

[33] *The project stakeholders accepted this conclusion. The project team has made some suggestions as an explanation for the unobligated proportion, however exactly where unobligated is made up is not possible to verify.*

Figure 20 Obligated Versus Unobligated POM for Packaging Materials



Pallets are the dominant format of wood packaging POM

The final project estimate of wood packaging POM by type is flat pallets 958k tonnes (73%), cases, boxes, crates and drums 245k tonnes (19%), box pallets and load boards 91k tonnes (7%), casks/barrels/vats/tubs and coopers products 13k tonnes (1%), and other packaging 3k tonnes (0.3%).

This estimate has been derived from a combination of sources including Timcon, Prodcom and Valpak's EPIC database.

7.0 Recycling of Wood Packaging in 2014

7.1 Introduction

This section of the report examines the levels of wood packaging waste collected and recycled/reprocessed within the UK or exported. The collections are split between local authorities (LAs) and commercial and industrial (C&I) collections. As with previous flow projects, the levels of collections have been assumed to be equivalent to the levels of recycling; the data on LA recyclate collections is taken from Waste Data Flow (WDF)[34] and is used as a proxy for household recycling, and the number of PRNs being raised (reported on NPWD) for the total accredited UK recycling. However, these figures do not account for unaccredited recycling[35], and, similar to previous flow reports, a separate analysis on this element of recycling has been provided.

7.2 Collections

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

- Kerbside;
- Bring sites; and
- Household waste recycling centres (HWRCs) or civic amenity (CA) sites.

This data is submitted by the LAs to WDF. The C&I collections of wood are usually carried out by private waste management companies or wood recyclers.

7.2.1 Local Authority Collections

LA collections of wood packaging in the UK can be represented as follows:

Total UK Wood Packaging Collected by Local Authorities	=	Kerbside Collection[36]	+	Bring Site Collection	+	HWRC/CA Site Collection

This data was extracted from WDF, and figures reported are for the financial year 2013/14. This means there is some degree of inconsistency between the collection figures for April 2013 - March 2014 and the consumption figures for January 2014 - December 2014[37].

[34] *It should be noted that WDF is based on the collection of data from all LAs in the UK and as such due to the number of those reporting data that there is the risk of inconsistencies in the way LAs interpret the questionnaire and / or report data. However it was used as it was considered the best available dataset at the time of writing for LA collected wood.*
[35] *That which is recycled or exported for recycling by a company that is not accredited / registered with the Environment Agency to raise PRNs / PERNs on packaging reprocessed / exported.*
[36] *Kerbside collections refer to LA(or a waste management company on behalf of a LA) collections from households*
[37] *At the time of writing 2013/14 was the most recent full set of WDF data available.*

It should also be noted that wood data that is reported in WDF refers to all wood waste and does not separately report wood that is packaging. In order to investigate the proportion of wood packaging that is collected in LA wood collections, Albion Environmental was engaged. It has a strong track record of waste composition analysis and regularly works with LAs. It estimated that of all the wood collected by LAs, less than 1% will be packaging[38]. This is supported by waste compositional analysis of mixed waste collected by LAs published by Defra in 2009[39], which concluded that 4% of all LA collected waste (at kerbside, HWRC's and bring sites) is estimated to be wood, of which only 1.48% is untreated wood and is therefore likely to include an element of packaging wood waste.

A summary of the UK LA wood packaging collections is shown in Figure 21.

Figure 21 Wood WDF data 2013/14

	Kerbside	Bring	HWRC/CA	TOTAL
UK Total LA WOOD Collected	5kt	1kt	737kt	**744kt**
UK Total LA WOOD PACKAGING Collected	0kt	0kt	7kt	**7kt**

As shown above, 744k tonnes of wood is reported on WDF by LAs as collected, of which it is estimated **7k tonnes** is wood packaging.

The majority of wood packaging collected by LAs is collected at HWRC/CA sites. However, some may be collected at kerbside, although this is likely to be part of bulky item collections.

7.2.2 C&I Collections

C&I collections were estimated as follows:

Total UK Wood Packaging Recycled	**-**	**Local Authority Collections**	**=**	**Commercial & Industrial Recycled**

The total volume of materials recycled is taken from NPWD[40]. LA collection tonnages (used as a proxy for recycling) are taken from WDF as described in 7.2.1. C&I recycling tonnages are calculated from the total quantity recycled minus the estimate for local authority collections. The estimate for C&I recycling is shown in Figure 22[41].[42]

[38] *E-mail correspondence received (4th February 2016 and 15th February 2016) from Albion Environmental estimating wood packaging within LA collections will be less than 1% by weight.*
[39] *http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=1&ProjectID=15133*
[40] *http://npwd.environment-agency.gov.uk/Public/PublicSummaryData.aspx*
[41] *There is a time difference between the NPWD figures (calendar year 2014) and the LA figures (2013/14 financial year); however, this was the best available data.*

The NPWD figure only covers obligated waste recycled by accredited reprocessors/exporters, and does not include tonnages recycled without a PRN/PERN being generated. Section 7.5 provides information regarding unaccredited reprocessing.

Figure 22 C&I Wood Collections

Wood NPWD data (2014)	412kt
Wood Packaging LA Collections (2013/14)	minus7kt
Wood C&I Recycling	**404kt**

Based on the data reported in Figure 22 and the conclusions around consumer and non-consumer wood packaging POM made earlier in the report, it is possible to estimate that 48% of consumer wood packaging and 31% of non-consumer wood packaging was recycled in 2014.

7.3 Recycling of Wood Packaging

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

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

- Accredited recycling; and
- Unaccredited recycling.

The accredited reprocessing was estimated from NPWD data using the quantity of PRNs (UK reprocessing) and PERNs (exported for reprocessing) issued.

7.4 Accredited Recycling

[42] It is important to highlight that what is collected for recycling is not equal to that which is ultimately recycled. The WDF collection figures will not equal the amount recycled, as many LAs do not robustly account for material rejected by the MRF during the sorting process. Therefore, for simplicity, by assuming that the total collected for recycling equals the total actually recycled, this calculation distorts the representation of contamination and non-target material, accounting for them all upfront (in this case, by default, within the C&I collections estimate). This means that C&I collections as reported here are implicitly underestimated by the combined, unknown level of contamination and non-target material.

Accredited recycling and recovery is undertaken at a reprocessor whose activities are eligible for the organisation to register as an accredited reprocessor and issue Packaging Recovery Notes (PRNs).

Eligible markets for recycling and recovery of wood packaging include:

- Manufacture of wood board, for example, chipboard or orientated strand board (OSB);
- Decorative woodchip;
- Utility chip (including that used in riding arenas etc., and as a biomass fuel); and
- Animal bedding.

There may also be an element of packaging waste (including wood packaging) in mixed municipal waste which is combusted in energy recovery facilities. This material is also eligible for recovery PRNs:

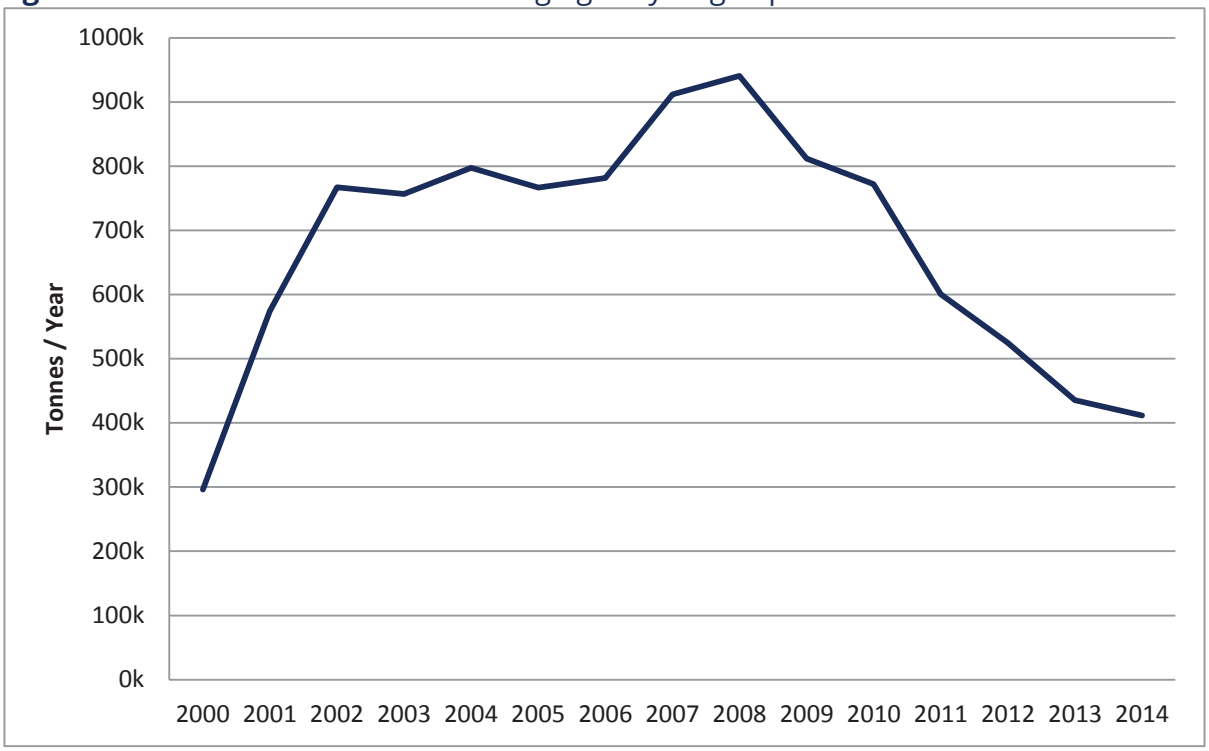
- Energy recovery from packaging waste burnt in a municipal waste incinerator where the energy efficiency meets the requirement of the R1 specification (i.e. with an energy efficiency of 0.6 or above applies to installations permitted before 1 January 2009; for installations permitted after 31 December 2008 the energy efficiency is 0.65 or above).

Recovery PRNs can be issued for 19% of the waste unless the operator of the incinerator proposes an alternative sampling method in the accreditation application to demonstrate the packaging content of these waste streams.

The total quantity of accredited wood packaging recycled (reprocessed in the UK or exported by accredited exporters) from 2000 to 2014 is shown in Figure 23[43].

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

Figure 23 Total Accredited Wood Packaging Recycling/Exports



The quantity of accredited wood packaging recycling has followed two trends. It increased from 2000 up to 2008 when it reached 940k tonnes; it then started to decrease and in 2014 412k tonnes were recycled. It is thought that the decrease from 2009 is due to an increase in wood packaging being used in end markets such as biomass (which is classified as recovery rather than recycling) and the fall in the number of accredited reprocessors[44]. At the time of reporting there are no biomass facilities listed as registered reprocessors with any UK regulatory body[45].

The project team believes that significantly higher quantities of wood packagingare being recycled or recovered but this is taking place without any recycling or recovery evidence being issued and as such is considered unaccredited. Section 7.5 discusses this in more detail.

7.5 Unaccredited Recycling

This section presents analysis to determine the quantity of packaging wood waste recovered for recycling and used in different end markets, in order to identify how much unaccredited recycling occurred in 2014. This involved a two-step process:

[44] *Discussions with Wood Recyclers Association (WRA) on 11/12/2015 and Wood Panel Industries Federation (WPIF) on 07/12/2015*

[45] *Biomass could become accredited; however the regulatory body would consider each application on a case by case basis. The accreditation would depend on the information provided within the Sampling and Inspection Plan and there would need to be a site specific protocol formulated to identify the wood packaging content, as the content of biomass can contain a wide array of materials: virgin wood, energy crops, agricultural residues, food waste, industrial waste and co-products from manufacturing and industrial processes.*

1. Determining current markets for wood waste; and
2. Determining the quantity of packaging waste wood utilised by each market.

There is no fully inclusive and comprehensive source of waste wood statistics for the UK that includes up-to-date and accurate data on waste wood arisings and markets. This is complicated by the fact that a significant quantity of wood waste does not go to final disposal, but instead goes directly to re-use, recycling or recovery. The most recent published reports on waste wood markets include:

- An assessment of the environmental impact of the management options for wood waste, AEA, published by Defra, 2012;
- The business case for wood waste collection hubs, WRAP, 2012;
- 2011 Briefing Report – The UK Waste Wood Market, Tolvik Consulting, 2011;
- Realising the value of recovered wood – Market Situation Report, Pöyry Forest Industry Consulting Ltd, published by WRAP, 2011;
- Annual Data on Wood Recycling – 2011 Market Statistics, Wood Recyclers Association (WRA), 2011;
- Impact Assessment of a Quality Protocol for Waste Wood, Environment Agency, 2011; and
- Wood Waste Market in the UK, Pöyry Forest Industry Consulting Ltd & Oxford Economics Ltd, published by WRAP, 2009.

These data sources were reviewed, and the information drawn from them updated using information on current markets for wood waste from the Wood Recyclers Association and the Wood Panel Industries Federation. Major end markets for waste wood include:

- Panel board manufacture;
- Biomass energy generation; and
- Animal bedding.

Other markets include products where the wood will eventually degrade, i.e. mulches or composting.

To understand how wood waste packaging may be used in different markets, it is first necessary to understand the quality requirements of each market. Wood waste comes from a variety of sources that dictate the level of contamination in the waste wood. The source and level of contamination is used by wood recyclers to grade the quality of the wood waste, providing an indication of the need for processing and potential end markets. This classification has been standardised by the WRA and is used in the Publically Available Standard 111. Essentially there are four grades of waste wood, as summarised in Figure 25 and detailed in Appendix V.

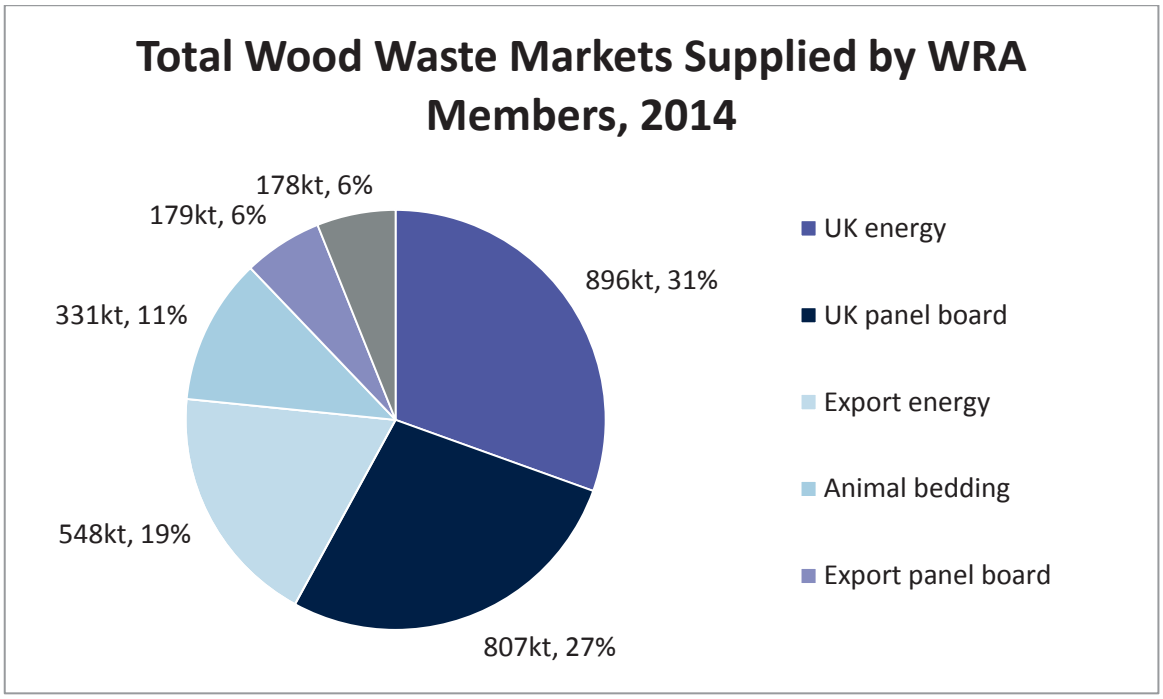
Figure 24 Grades of Wood Waste

Grade	Typical Materials	Typical Markets
Grade A	Packaging waste, scrap pallets, cases and cable drums, process off-cuts from manufacture of untreated products	Animal bedding, horticultural markets, equine surfaces, energy generation in non-IED installations, manufacture of pellets and briquettes
Grade B	As Grade A, may contain up to 60% Grade A material, plus construction and demolition materials	Panel board, energy generation in IED compliant installations
Grade C	All of the above, plus fencing products, flat pack furniture, panel board products	Biomass fuel in IED compliant installations
Grade D	Fencing, transmission poles, railway sleepers, wood from cooling towers	Requires disposal at facilities licensed to accept hazardous waste

This suggests that the main markets for packaging wood waste are predominantly in Grade A applications, i.e., animal bedding, equine surfaces, and also in Grade B applications, i.e., panel board. There will also be packaging wood waste present in mixed wood waste streams, i.e., Grade C and possibly Grade D.

Figure 26 presents the wood waste markets supplied by members of the WRA in 2014. It should be emphasised that this is *all* waste wood, and not just packaging wood waste.

Figure 25 Wood Waste Markets Supplied by WRA Members in 2014



Having identified the total quantity of wood waste utilised by each market, the next stage in the analysis was to estimate how much packaging wood waste is used by each end market (See Figure 28). Where possible, actual data on packaging wood waste by specific markets was utilised, i.e., panel board industry. In other cases, assumptions on the quantity of packaging wood waste used by each market have been made, using guidance from the WRA.

7.5.1 Panel Board

The Wood Panel Industry Federation (WPIF) was established in 1995 and represents the interests of industrial manufacturers in the UK and Ireland of Wood Chipboard, Oriented Strand Board (OSB) and Medium Density Fibreboard (MDF). There are currently six manufacturing companies in the UK, with a total of eight plants:

- SmartPly;
- Norbord;
- Medite Europe Ltd;
- Kronospan Ltd;
- Egger (UK) Ltd; and
- Egger (Barony Ltd).

The WPIF collects detailed annual data from its members on the quantities of recovered wood used. Data for 2010 - 2014 provided by WPIF is included in Figure 27.

Figure 26 Wood Waste used in Panel Board Production

Year	Raw Board Production (k Green tonnes)[46]	Recycled Wood (k Green tonnes)	Amount of Recycled Wood which is Packaging (k tonnes)	Quantity Declared for PRNs (k tonnes)
2010	3,367	1,120	550	504
2011	3,271	952	423	396
2012	3,298	909	345	304
2013	3,117	853	296	274
2014	3,223	812	266	247

In 2014, the UK panel board industry reported 266k tonnes of wood packaging waste was recovered by its members, of which 247k tonnes was accredited.

It should be noted that up until 2014, the amount of recycled wood used that is packaging was higher than the amount declared for PRNs. According to the WPIF, the reason for this is that not all wood was able to be sufficiently identified as packaging wood, in line with the requirements of the PRN system. However, in 2015, all recycled wood was declared as PRNs. The 2014 PRN figure reported by the WPIF member's accounted for 60% of the wood PRNs issued in 2014.

7.5.2 Other markets

Whereas data is available on the quantity of packaging wood waste utilised by the panel board market, there is no such reported data on quantities of wood packaging waste utilised in the remaining markets. Therefore, assumptions were made on the proportion of wood packaging waste that is used in the overall quantities of wood waste used by each end market. These assumptions have been informed by industry understanding of the quality requirements and specifications of each market. For example, the animal bedding market is required to manufacturer its products from clean, high quality wood waste, i.e., Grade A. Grade A will consist predominantly of packaging waste, but may also contain other sources of wood waste, i.e., manufacturing and joinery waste. The WRA estimated that 80% of the wood waste consumed by the animal bedding market is likely to be packaging wood waste. The same estimate applies to equine surfaces. Meanwhile, the WRA estimated that the amount of packaging wood waste utilised in horticultural markets such as mulches and pathways is much lower: 30%, as these are lower value markets. Finally, the proportion of packaging wood waste estimated to be exported for use in the European panel board market is 35%,

[46] *Green tonnes is the weight measurement of timber freshly felled before any natural or artificial drying has occurred.*

which is similar to the proportion of wood packaging waste used by the UK panel board industry in its overall use of wood waste[47].

These estimates and therefore the total estimated quantity of wood packaging recycling is summarised in Figure 28. This includes both information on quantities of wood recycling reported by members of the WRA and estimates that the WRA have made on quantities of wood waste managed by non-members.

The amount of wood packaging waste included in both the UK and export bio-energy markets is thought to be low, with these markets utilising lower grade mixed wood waste streams. In any case, this would not be counted as recycling and so no estimates have been made for the amount of wood packaging waste included in these markets for the purpose of determining unaccredited recycling. Further information on other markets for packaging wood waste can be found in Section 7.5.3.

Figure 27 Wood Packaging Recyed by End Market 2014

Market	WRA members (k tonnes)	Additional % estimated from non-members	Total (k tonnes)	Estimated packaging content (%)	Total packaging recycled (k tonnes)
UK Panel board	807	0	807	n/a	266[48]
UK energy	896	11	992	-	0
Animal bedding	331	18	390	80	312
Equine surfaces	134	18	157	80	126
Mulches, pathways	45	25	56	30	17
Export panel board	179	0	179	35	63
Export Energy	548	0	548	-	0
To other wood recyclers	124	0	124		0
				TOTAL	**784**

[47] *Discussions with the WPIF and WRA have indicated that there are likely to be no other export markets for wood packaging due to the high value of this material in the UK. There may be minimal amounts in waste wood, however this is likely to be lower grade wood packaging.*

[48] *Actual figure from WPIF*

The total quantity of packaging wood waste recycled is estimated at **784k tonnes**. When the accredited recycling figure of 412k tonnes is subtracted from this figure, this gives a total unaccredited recycling figure of **372k tonnes**.

Whilst the data reported by the panel board sector is based on actual tonnes of packaging wood recycled, as outlined above, the data for other sectors is based on estimates and will be subject to a greater degree of uncertainty. The estimates of packaging waste content used by each market in Figure 28 have been informed by both the WPIF and the WRA. For example, the WRA works with a number of organisations to update its annual estimates of markets supplied by non-members. Despite this, the complexities of the waste wood market and the mixed types of wood used by some markets means that there will be a degree of error in the data.

In a Briefing on Regulation of Wood[49] published by the EA, it stated that wood must be effectively segregated into the four grades – A, B, C, and D – before subsequent processing for use. The markets dictate the quality specification, and therefore grade and type of wood that is supplied to them. For example, the use of waste wood permitted for use in equestrian surfaces includes untreated wood only, i.e., packaging wood and process off-cuts from the manufacture of products from untreated timber. This gives confidence to the WRA that the estimates of packaging content in the table above are as accurate as possible.

Further robustness of the estimates could be achieved by more accurate or mandatory reporting of waste wood type received by recyclers/reprocessors, and by the wider adoption of the PAS 111 specification that provides the definitions, minimum requirements and test methods for processing waste wood into materials intended for use in suitable new applications or end products.

7.5.3 Markets supplied by Accredited Reprocessors (May 2016)

As can be seen in Figure 29 below, the accredited wood reprocessors represent the full range of waste wood market types. Some reprocessors specialise whereas others supply multiple markets. The panelboard and animal bedding sectors represent a significant number of the accredited reprocessors. This is to be expected, given the large quantities of recycled packaging wood consumed by these markets.

[49] *Briefing on Regulation of Wood – Our approach to working with the wood recycling sector on the management of waste wood, September 2014*

Figure 28 Wood Packaging Recyed by End Market 2014

Accredited Reprocessor	Markets served
Arden Wood Shavings Ltd	Animal bedding
Boden & Davies	Animal bedding, equine surfaces
Egger (Barony Ltd)	Panelboard
Egger (UK) Limited	Panelboard
Eglinton (Timber Products Ltd)	Pallets
Giffords Property Limited	Pallets
Hadfield Wood Recyclers Ltd	Animal bedding, biomass, panelboard feedstock
Kronospan Ltd	Panelboard
Marlin Industries (Wrexham) Ltd	Cable drum repair, horticulture
Mendip Woodshavings Limited	Animal bedding
Norbord Europe Ltd	Panelboard
Norbord Limited	Panelboard
Tracey Timber Recycling Ltd	Animal bedding, equestrian surfaces, biomass

7.5.4 Other non-recycling disposal route and end markets

Packaging wood waste that is unaccounted for in the total estimate of accredited and unaccredited recycling is likely to be treated, recycled or recovered in the following ways:

Disposed of in landfill

There will be an element of wood packaging waste disposed of in landfill. A recent WRAP report estimates 2.5 million tonnes of waste wood is disposed of in landfill. However, this is likely to mainly consist of mixed waste wood from industry. It is not possible to determine how much of this is wood packaging.

Present in lower grades of wood waste used in bioenergy

Clean wood and wood waste are also used as a biomass fuel as follows:

- Existing infrastructure which run on fossil fuels (co-firing);
- A replacement for, or co-fired with other types of biomass; and
- In specifically constructed wood fuelled biomass plants.

If lower grade wood waste is used, the plant must be compliant with the Industrial Emissions Directive (IED). There is an estimated capacity of over three million tonnes of wood fuelled bioenergy plants in the UK, with a further one million tonnes in construction. However, much

of the existing capacity is using virgin biomass, and the plants that are compliant with the IED are targeting lower grade wood waste which will contain relatively low quantities of packaging wood waste. A database of plants that are compliant with the IED can be found on the GOV.UK website[50].

Present in household and C&I waste treated in Energy from Waste (EfW) facilities

In 2012, there was an estimated 5.2 million tonnes of EfW capacity operating in the UK; this is estimated to increase to 11.9 million tonnes of capacity by 2020[51]. If the composition data for MSW which indicated that 1.48% could be untreated wood, including packaging wood, is applied to the 2012 capacity estimate, this would equate to an estimated 77k tonnes of wood packaging waste being treated in EfW facilities. However, it should be noted that this would only be counted as recovery where it is used in facilities that have been deemed to be compliant with the R1 classification for waste recovery.

Unrecorded but legitimate use in biomass plants which are accredited under the Renewable Heat Incentive (RHI)

Some packaging wood wastes (i.e. pallets) are used as a fuel in small-scale biomass plants including those accredited under the RHI. Whilst participants of the RHI are obligated to keep records of quantities and type of fuel used, this data is not centrally collated.

Used in the manufacture of pellets for biomass plants

Whilst most wood pellets are manufactured from virgin wood, pellets are manufactured from clean waste wood, some of which may include packaging.

Used in non-legitimate (i.e. not adhering to standards) markets of animal bedding, use on land etc.

The WRA report mentions that wood packaging waste may be being used in markets that do not adhere to standards, for example, in animal bedding that is also using lower grade wood waste.

Re-use by the third sector

The third sector plays an important role in facilitating the re-use and recycling of wood waste through the delivery of a wide range of collection, repair and re-use schemes. Community Wood Recycling (CWR) represents a UK wide network of community wood recyclers. The organisation grades wood collected by re-use outcomes, as opposed to the type of wood it is. For example, wood waste collected by its members will be classed as high or low grade. High grade is wood that can be re-used in DIY projects, or made in to furniture or other items. High grade wood includes pallets that can be repaired and sold back to pallet distributors.

[50] *https://www.gov.uk/government/collections/industrial-emissions-directive-ied-environmental-permits-issued*
[51] *http://www.greeninvestmentbank.com/media/25376/gib-residual-waste-report-july-2014-final.pdf*

Low grade wood is wood that is not suitable for re-use, and is subsequently used for fire wood and kindling. Some low grade wood will also be sent to other recyclers for chipping. The CWR has seen a rise in the popularity of using packaging wood from pallets as cladding and decoration in shops and restaurants.

In 2014, CWR recorded 12k tonnes of wood that was collected across its network, of which more than 40% was re-used. Whilst CWR collect detailed data on wood collected, it does not break the data down any further into the type of waste wood. However, CWR estimated that 20% of waste wood collected by weight is packaging wood.

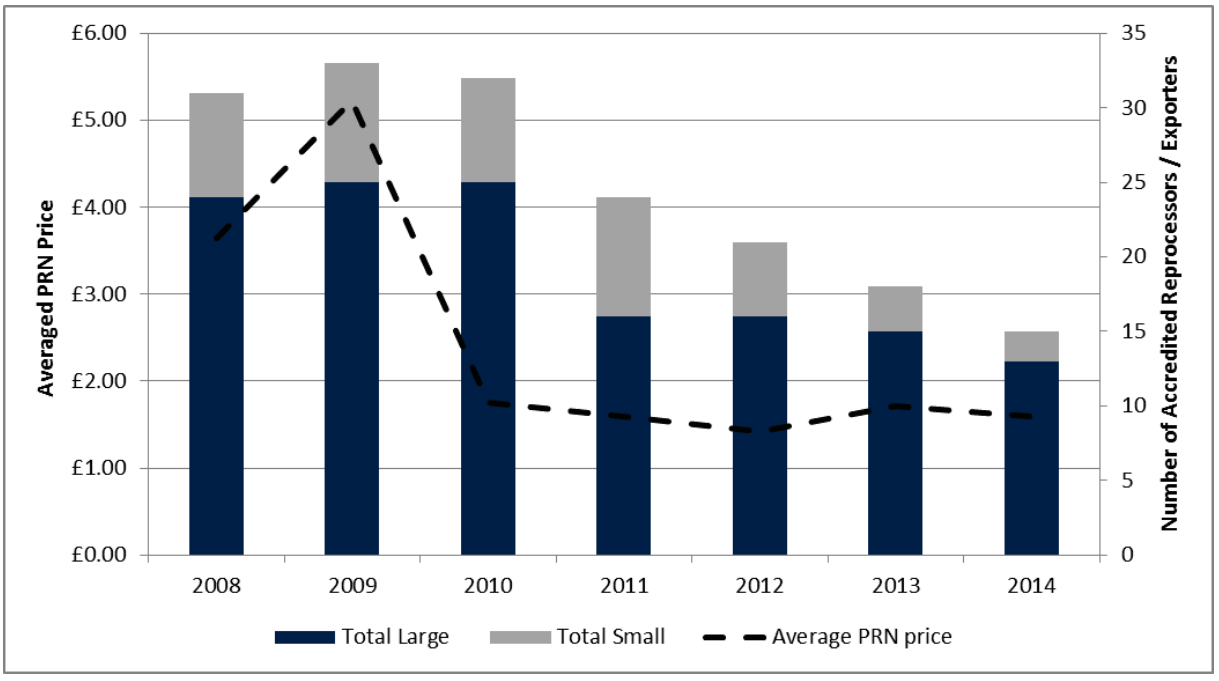
Burned on bonfires and other 'back-yard' burning

Packaging waste may be disposed of in bonfires and other examples of back-yard burning, both by householders and businesses.

7.5.5 Decrease in Accredited Recycling

An analysis was completed on the number of large and small registered reprocessors or exporters for wood packaging, from 2008 to 2014. This was plotted against the average wood PRN price across these years to ascertain what role, if any, the price of a wood PRN has on making it viable for reprocessors to become accredited. This is shown in Figure 30.

Figure 29 Reprocessor / Exporter Accreditations and Wood PRN Price[52]



[52] *Based on the number of active reprocessors / exporters reported on NPWD on 07/07/2015*

This appears to show a spike in the number of registered reprocessors and exporters when the PRN price was high in 2009. Following this, the price drops significantly from just over £5 per tonne in 2009 to just over £1.50 per tonne in 2010, however, the number of reprocessors/exporters declines more gradually. Between 2009 and 2014, 18 companies (predominantly large companies) have foregone their EA accreditation.

For other materials, it has been found that as the PRN price declines a company will only register for accreditation if it handles a significant tonnage. In previous packaging flow projects[53], an assessment of accreditation costs (EA fees and internal administration costs) has helped the identification of the tonnage of unaccredited recycling undertaken based on this economic benefit seen of raising PRNs. Applying the same methodology for wood, this would be around 1.5k tonnes of wood per registered company. It is known that typical companies in the sector on average handle in the region of 26k-27.5k tonnes per year. Therefore this calculation method was not considered appropriate for wood packaging.

The PRN price may have contributed to the decline in registered reprocessors and exporters. However, as the PRN is relatively low compared to the overall value of the material, other factors such as supply/demand, consolidation within the marketplace and the development of new end markets may also have contributed to the decline.

Figure 31 shows how the number of accredited reprocessors has fallen in line with the quantity of accredited recycling. This suggests that whilst the amount of accredited recycling has decreased, this could be due a fall in the number of reprocessors registering for accreditation as opposed to a fall in the throughput of wood waste recycled by the industry. This theory is supported by the fact that there are a number of major players in the wood waste market who were previously accredited but who are no longer accredited in 2014, yet they are still in operation. These include a major supplier of animal and equine bedding manufactured from wood waste and a major supplier of plywood to the panelboard sector.

Figure 30 Accredited Recycling and Reprocessors

Year	2008	2009	2010	2011	2012	2013	2014
Accredited recycling (Tonnes)	940k	882k	772k	601k	525k	436k	412k
No. of Accredited Reprocessors	31	33	32	24	21	18	15

[53] *Metal Flow (http://www.wrap.org.uk/content/metal-packaging-market-study-metal-flow-2014) and Glass Flow (http://www.wrap.org.uk/content/glassflow-2012-report-0)*

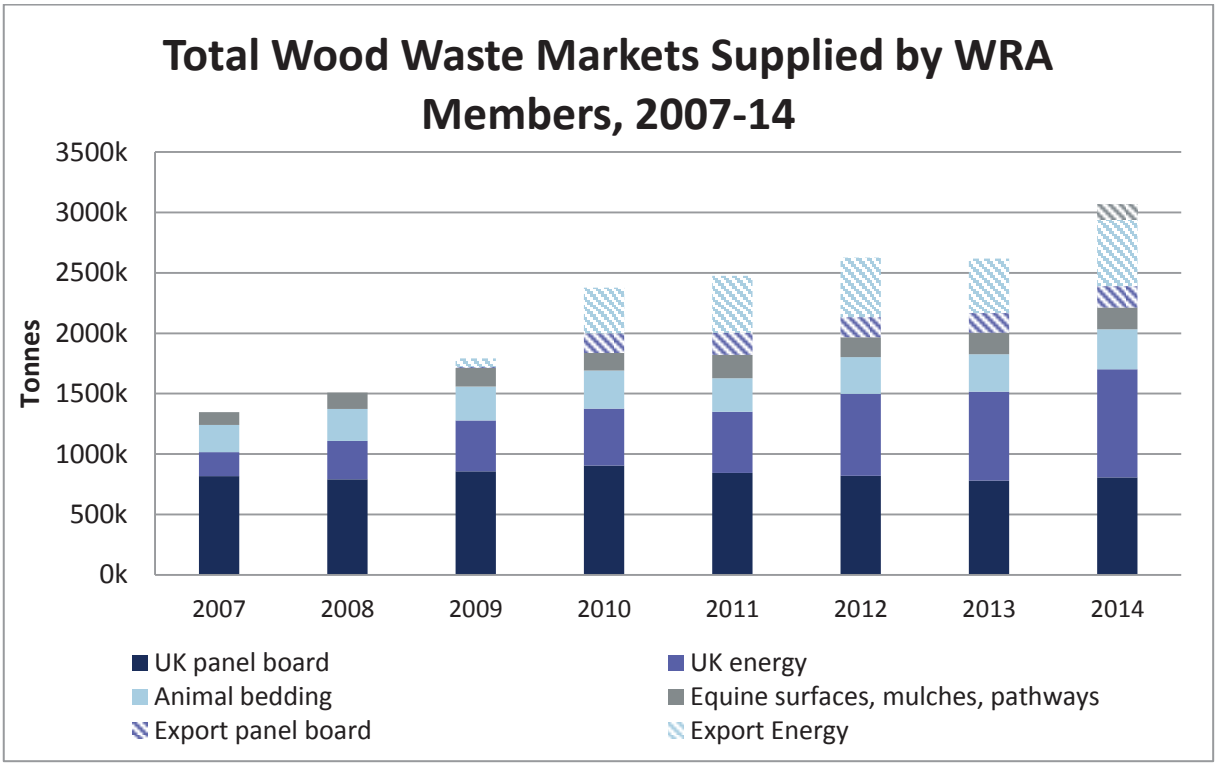
7.6 Wood Packaging Waste Market Dynamics

7.6.1 Trends in Wood Waste Recycling

In 1996, the WRA estimated that less than 4% of wood waste arisings were recycled or recovered. By 2011, that figure had risen to 60% of wood waste arisings (around 2.8 million tonnes) and in 2014 this is estimated to be just over 3 million tonnes.

The growth in wood waste recycling by WRA members from 2007-14 is presented in Figure 32.

Figure 31 Wood Waste Markets Supplied by WRA Members, 2007-14



It should be emphasised that the graph in Figure 32 represents *all* wood waste and not just wood packaging waste. The largest increase has been seen in the UK energy market, rising from 200k tonnes in 2007 to almost 900k tonnes in 2014.

Animal bedding has also seen a steady increase, as has equine surfaces, mulches etc. Use in these markets has grown as wood recyclers sought to diversify from the panel board sector and access higher value markets. Relatively high prices for substitutes, such as straw and hay, are likely to support demand for recovered wood for animal bedding in the near future. Agricultural use, in particular for animal bedding and equine surfaces, also has a large share in the use of wood waste.

Figure 32 represents significant growth and there are a number of drivers that have contributed to this:

- Increased landfill costs (which are still rising);
- Government funding for capital investment in reprocessing facilities (in order to increase recycling to meet recycling and landfill diversion targets);
- Government waste and energy policy (such as encouraging the management of waste in line with the waste hierarchy, and the implementation of the EU Renewable Energy Directive, including government incentives to encourage electricity generation from renewable sources); and
- The associated increase in use of recycled products in panel board and animal bedding markets.

These drivers have resulted in increased wood waste supply and demand, with an associated rapid deployment of reprocessing capacity in the wood waste sector. Historically, reprocessors have invested heavily in the development of wood waste reprocessing[54] in order to increase the amount of wood waste that is recycled and to provide a better product to meet customers' specifications. To date, however, much of the wood waste that is reprocessed and used is high grade (Grades A and B). Typically, this waste wood is of relatively high value and has significant markets outside of the bioenergy market. Such markets include the panel board sector, animal bedding, mulch and land cover.

For some time there was a lower market demand for Grade C wood waste, which meant that it was sent to landfill. It is generally agreed that there is only one viable market for this grade of wood waste and that is in bioenergy facilities. A number of developers have seen an opportunity in Grade C wood waste, and the market for Grade C wood waste fuel for bioenergy is now growing as more facilities are being developed that are IED compliant. This market is further incentivised by fiscal measures.

Figure 32 also shows the emergence of new markets and how others have grown or remained the same. Despite some large panel board plant closures, the total amount of wood waste consumed by the panel board industry has not decreased significantly, although the percentage of wood packaging waste used has fallen due to competing markets.

Growth in the biomass sector has been encouraged by government incentives to increase electricity generation from renewable resources. These include the Renewables Obligation, the Contract for Difference scheme and the Renewable Heat Incentive. Information regarding these fiscal incentives for biomass can be found in Appendix VI.

7.6.2 Market Pricing

Reprocessors are willing to pay for good quality, clean Grade A wood, whereas for lower grades they will charge a gate fee to accept this material. The market reports payments of up to £200 per tonne for Grade A wood for animal bedding markets. Similar quality wood sent to

[54] In 2007 (the earliest reported on NPWD at the time of writing) reprocessors invested £2.7 million of PRN revenue on capacity, which would be to increase their capacity and improve the quality of product for both established and emerging end markets. More recently, although the market is more mature reprocessors continue to invest albeit at lower levels in wood reprocessing infrastructure and capacity as investment from PRNs / PERNs increased by 20% from 2012 (£323k) to 2014 (£388k) as reported in the NPWD.

biomass markets will see prices of £60-£65 per tonne. The panel board industry is reported to pay in the region of £18-£26 per tonne for wood waste that meets its specifications. Therefore, it is clear that Grade A wood waste, i.e., wood that includes packaging wood waste, has a clear price advantage over other grades of wood.

Prices paid or gate fees charged for handling wood waste are a combination of:

- Market prices for the products leaving the site; and
- Reprocessing investment and operating costs.

The price of wood waste is very demand orientated. In a low demand market the wood reprocessors will increase the gate fee to decrease waste wood coming into their site. In a market where there is high demand, the reprocessors may choose to decrease gate fees to attract waste wood to their sites. Prices vary depending on demand, location and specification.

Reprocessors can react quickly to market conditions by altering gate fees, although in the short term they can also change the amount of wood waste stored on site as a temporary smoothing of supply and demand. This means that they can act to ensure that the price of the final product does not vary significantly on short term cycles. However, permit conditions typically mean that reprocessors are not allowed to stockpile waste wood on site indefinitely, nor do they allow for large stock piling. As a result, they will not take in waste wood for which there is no foreseeable market. Conversely, as demand for waste wood increases, they can lower gate fees to attract waste wood into the site. This has proved to be a successful strategy to date for the reprocessors.

7.7 Recycling & Recovery Rates

Throughout Sections 4 to 7 of the report, estimates for wood packaging POM and recycled in 2014 have been made. As such, Figure 33 shows the recycling rates calculated based on these estimates.

Figure 32 Wood Packaging 2014 Recycling Rates

	POM	Accredited Recycling	Total Recycling
Wood Packaging	1,310kt	412kT	784kT
Wood Recycling Rate		31%	60%

Based on the new estimate for wood packaging POM and the current reported recycling through PRNs/PERNs raised, the recycling rate is calculated to be 31% in 2014 (or 60% if unaccredited recycling is included). This is lower than the previous estimate of 40%, due to the increase in the estimated quantity of wood packaging POM.

Using the POM estimate from this study means the UK would have met its 2014 Packaging Regulation material specific policy intention target for wood, which was 21.6%. The EU Packaging Directive target for wood of 15% would also have been met.

8.0 POM and Recycling Scenario Analysis

8.1 Introduction

This section looks at the historical (1997 – 2014) POM and recycling figures for wood packaging in the UK and uses these, combined with wider industry knowledge, to generate projections up to 2020.

8.2 POM Projections

A regression analysis using historical POM data was undertaken to help project future tonnages of wood packaging POM. This was done using the EA NPWD packaging data from 1997 to 2014, and the Net Pack Fill calculation (as described in Section 4 of this report).

This process involves using an independent variable to project POM until 2020. Several variables were considered for this analysis: historical Net Pack Fill, UK Gross Domestic Product (GDP) and the UK construction industry's Gross Value Added (GVA)[55]. In this scenario, the construction industry's GVA was the variable used due to it having the highest correlation with wood packaging POM[56]. A projected growth rate for the construction industry was obtained from the 'Blueprint for the Construction Industry 2015-2019' report by the government backed Construction Industry Training Board (CITB), which is updated on a yearly basis[57]. This takes into account growth in public and private new housing, infrastructure and public non-housing sectors.

Implicit in this regression model is the assumption that the construction industry will grow slowly over the next five years, resulting in an increase in wood packaging. This is supported by the report mentioned above, and evidence from the government of the intent to encourage the building of houses and commercial premises. It is also assumed that the density of wood packaging will remain constant and that other products / materials do not replace wood packaging. The full details of the technique applied are described in Appendix VII of this report.

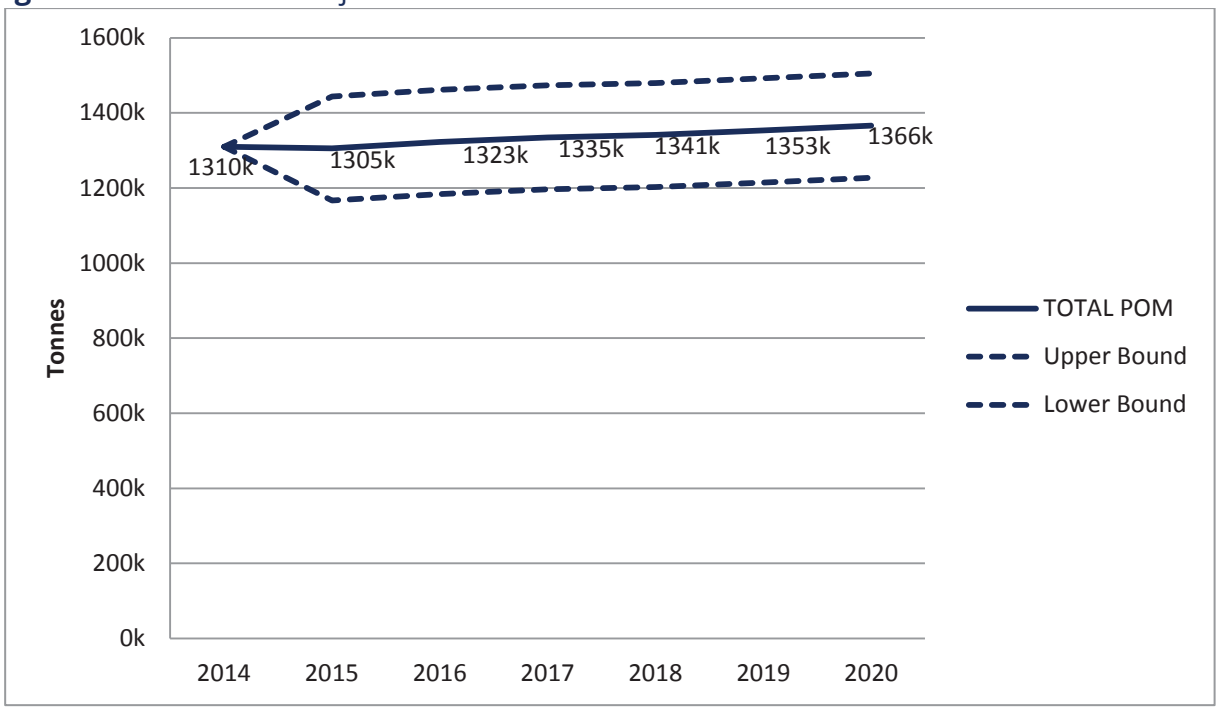
Obligated POM does not represent the full tonnage of wood packaging flowing onto the UK market. Therefore, in order to project forward the total POM figure the same increases/decreases projected for the obligated data forward to 2020 were applied to the total 2014 POM figure and then consecutively to 2020. It was therefore assumed that the forward trend in unobligated tonnage is the same as the obligated tonnage as the Steering Group did not identify why there would be any difference in performance between them. The results are shown in Figure 34.

There is uncertainty around projections, and therefore a range was developed around the POM projection. Assuming a normal distribution and using a 95% confidence interval, a range

[55] *http://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf*
[56] *In 2013 Timcon estimated that 30% of pallets were used by the construction products sector*
[57] *https://www.citb.co.uk/documents/research/csn%20reports%202015-2019/construction-skills-network-uk-2015-2019.pdf*

was calculated and is shown in Figure 34 as the upper and lower bounds. This was completed using the regression standard error resulting from the projection analysis.

Figure 33 Wood POM Projections 2014 to 2020



The projections up to 2020 show that there will be a slight decrease in wood packaging POM in 2015, but overall it will increase from 1,310k tonnes in 2014 to 1,366k tonnes in 2020: an increase of 4.3%.

There are a number of potential factors identified that could affect future POM including changes in construction industry GVA, light-weighting and replacing wooden pallets with plastic pallets.

First, there is not thought to be much scope for light-weighting in wood packaging. Use of design software and commercial pressures have ensured that pallets are optimal in terms of price/performance.

Second, wood also provides a better grip than plastic, especially when wet. Whilst it is possible that plastic may gain market share at the expense of wood there were no signs of this happening at the time of writing.

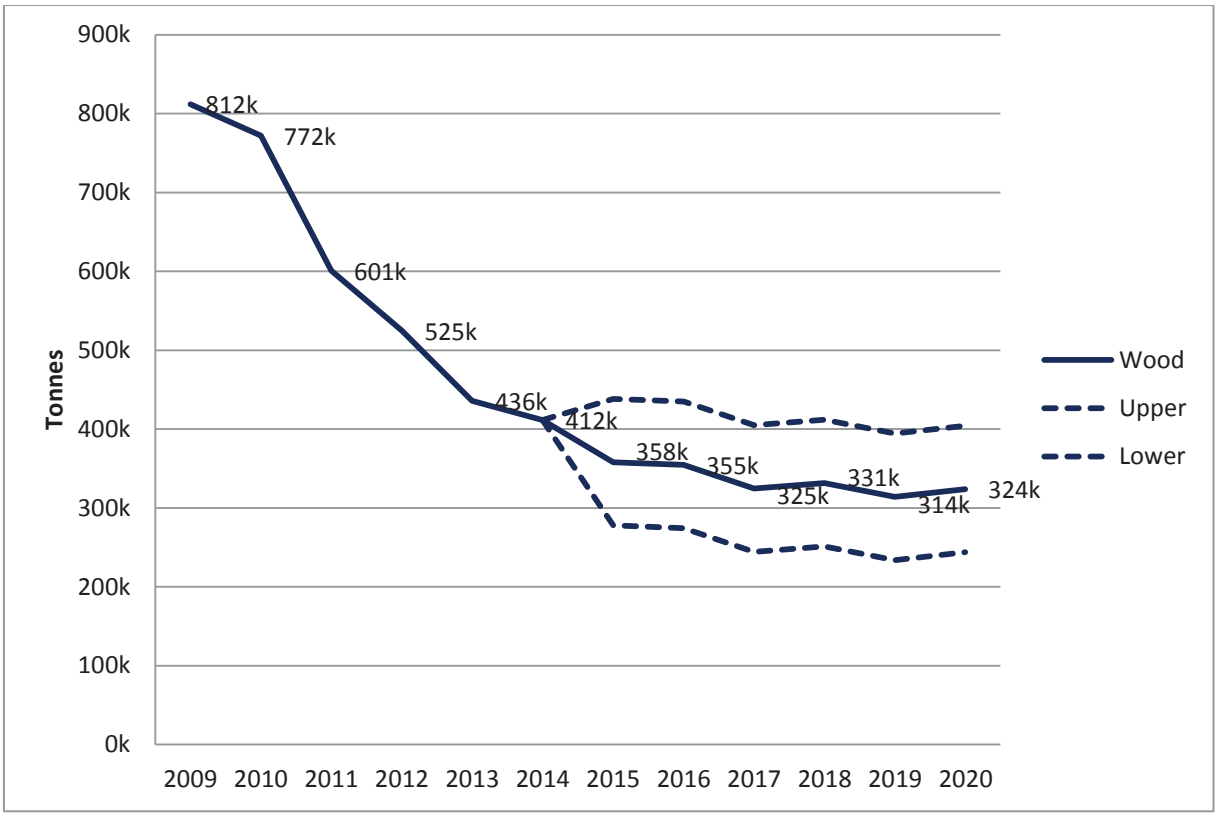
Overall, the Steering Group felt that the growth projected by the model was sensible and that actual POM was likely to fall within the bounds of the projection.

8.3 Accredited Recycling Projections

An analysis of historical recycling data was possible by using PRN/PERNs generated as an estimate of wood recycling rates (i.e. accredited recycling only). Data from 1998 to 2014 was used.

It was tested to determine if the data was suitable for regression analysis. However, it was found that two trends existed in the data, from 1998 to 2008, and then from 2009 to 2014. It is likely this is due to an increase in biomass as an end market for collected wood from 2009 onwards. Due to this structural break, too few data points in the latter trend were available to produce a regression model that would be considered robust. Nevertheless, the output trend of the model looked like it could be a realistic scenario and as such was presented and discussed (along with other scenarios) with key stakeholders[58] to identify, based on their experience of the wood recycling industry, whether they could agree to this being a suitable projection for accredited recycling. This also allowed for them to consider factors (other than historical trends) such as strength and capacity of end markets as well as the price paid by each end market to ensure that as many variables as possible were considered in assessing the model output. Although the output from the regression model was not considered robust in modelling terms, the stakeholders agreed that this was a realistic scenario given their knowledge of the market. The results are shown in Figure 35 below.

Figure 34 Historic Wood Recycling and Projections



[58] *Discussions with Wood Recyclers Association (WRA) on 11/12/2015 and Wood Panel Industries Federation (WPIF) on 07/12/2015*

The projection shows a decrease in recycling tonnage (down from 412k tonnes in 2014 to 324k tonnes in 2020), but a slow-down in the rate of decrease compared to the previous six years. Both the WRA and WPIF state that this is due to the presence of established high value end markets for wood packaging ; i.e., wood recyclers that have good quality wood will continue to send their material to end markets which could pay up to ~£200 per tonne rather than biomass, which attracts a much lower price per tonne. Therefore, although biomass has taken market share from other markets, this is likely to be for packaging that is lower quality or where it is not cost effective to transport to higher value end markets. Although more biomass capacity is expected to come online in the next few years, it is unlikely to displace accredited recycling at the same rate as over the period 2009-14. This is because most of the diplacement to date has been for low-value uses for wood packaging.

It was considered by the Steering Group that there are a number of potential factors that could cause this trend to take a different path. Government policy was highlighted as an important factor in this market. A shift in energy policy away from supporting renewable heat could lead to more wood waste being recycled instead of going to biomass. New fire prevention plan guidance for wood reprocessing facilities could mean that it is harder to store wood waste, therefore leading to less being recycled. Similarly, an increase in the PRN/PERN price (driven by targets) could encourage more recyclers to become accredited, increasing this figure whilst reducing the unaccredited amount.

8.4 Recycling Rate Projections and Implications

Using the POM and recycling tonnage projections identified above, the recycling rates from 2014 to 2020 can be calculated. These are shown in Figure 36.

Figure 35 Wood Recycling Rate Projections

	2014	2015	2016	2017	2018	2019	2020
POM	1,310kt	1,305kt	1,323kt	1,335kt	1,341kt	1,353kt	1,366kt
Recycling	412kt	358kt	355kt	325kt	331kt	314kt	324kt
Recycling Rate	**31%**	**27%**	**27%**	**24%**	**25%**	**23%**	**24%**

Using the POM estimated in this study means the UK would meet its 2014 Packaging Regulation material specific policy intention for wood, which stands at 21.6% until 2017. The EU Packaging Directive target for wood of 15% would also be met.

At the time of writing, the European Commission is proposing in its Circular Economy Package extending recycling targets for packaging materials (including wood) through to 2030. Although the targets have yet to be confirmed, they are likely to be significantly higher than previous targets.

9.0 Conclusions and Recommendations

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 2014 is 1,310k tonnes, an increase of 276k tonnes from the previous Defra estimate

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 wood packaging POM in 2014 was 1,310k tonnes. This figure is 276k tonnes higher than the current Defra estimate of 1,034k tonnes for 2014.

Unobligated or unregistered flow for wood packaging accounted for 8% of POM in 2014

The final project estimate was found to be 101k tonnes higher than data reported by obligated companies under the Packaging Waste Regulations (using the UK Net Pack Fill calculation method). This suggests that unobligated companies or tonnage (relating to the Regulation thresholds and packaging definitions) or unregistered tonnage through free-riding, account for 101k tonnes (8%) of wood packaging in the UK.

Although each packaging type is characterised by different market structures, the project results highlight that unobligated flow for wood is relatively low compared to other packaging materials. However, this is consistent with stakeholder views that wood packaging (in particular, pallets) will be produced in large scale facilities, with the more specialist bespoke non-pallet packaging being manufactured by smaller producers.

The final project estimate of wood packaging POM by format is: flat pallets 958k tonnes (73%), cases/boxes/crates & drums 245k tonnes (19%), box pallets & load boards 91k tonnes (7%), casks/barrels/vats/tubs, & coopers products 13k tonnes (1%) and other packaging 3k tonnes (0.3%)

Using a combination of industry data sources and Valpak's EPIC database for retail packaging sold to the consumer, the final project estimate by format was made. This indicates that almost three quarters of wood packaging POM is flat pallets.

The projected trend for obligated wood packaging POM between 2014 and 2020 is an increase of 4.3%

A regression analysis using historical POM data was undertaken to help project future tonnages of wood packaging POM. This was done using the EA NPWD packaging data from 1997 to 2014. This process involves using an independent variable to project POM until 2020.

In this scenario, the construction industry's Gross Value Added (GVA)[59] was the variable used due to its high correlation with wood packaging POM[60].

By using this, the model suggests that there will be 4.3% growth in wood packaging POM to 2020. This does not consider unobligated flow, which, for 2014, accounts for 8% of POM.

9.2 Conclusions: Recycling

Using the new POM figure of 1,310k tonnes and the accredited recycling figure of 412k tonnes, the UK achieved a 31% recycling rate in 2014

Using the new POM figure, the UK achieved a 31% recycling rate in 2014, which is 9% lower than the previous estimate by Defra.

The quantity of accredited wood packaging recycling in the UK has dropped significantly since 2008

In 2008 there were 940k tonnes of accredited recycling; however, by 2014 this had dropped to 412k tonnes. The project team believes this decrease in accredited recycling has been largely due to material being diverted for use in end markets that have not raised PRNs, i.e., bioenergy, bioenergy exports and panel board exports. Also, there has been a decrease in the number of accredited reprocessors. This is due to the PRN value being relatively low compared to the overall value of the material.

There is an estimated 372k tonnes of unaccredited wood reprocessing

The project estimated some 372k tonnes of wood packaging reprocessed in 2014 did not have a PRN/PERN issued against it. This is 47% of total recycling (accredited and unaccredited).

By including the estimated unaccredited reprocessing, the recycling rate increases to 60%

The recycling rate for wood packaging increases to 60% if the level of unaccredited recycling is included.

Wood recycling projections indicate accredited wood recycling may decrease further

The projections show a decrease in recycling (down from 412k tonnes in 2014 to 324k tonnes in 2020), but a slow-down in the rate of decrease compared to the previous six years. Based on the new POM estimates, this indicates that the UK would achieve a 24% recycling rate in

[59] *http://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf*
[60] *The correlation analysis produced a value of 0.796 since 1997, and 0.892 since 2002. Which was higher than any of the other variables tested.*

2020. However, if this decrease in recycling puts pressure on the market to meet future targets, this could potentially lead to higher PRN/PERN prices, which may increase accredited recycling.

9.3 Recommended Areas for Further Work

Investigate potential unregistered producers to capture more obligated POM tonnage

The total quantity of unregistered wood packaging producers should be investigated. This work has identified a significant number of organisations of a sufficient size by turnover and core business activity that potentially should be registered as producers on the EA NPWD list.

Encourage accreditation of wood recycling activities

If there were greater incentives for companies in the UK performing recycling activities on wood packaging to become accredited, this would encourage more PRNs to be issued on the wood packaging that is recycled, resulting in less unaccredited recycling. It would also help the UK comply with future recycling targets.

Work with other key organisations to collect data important to wood flow estimates

Work should be done to ensure that data that is important for identifying wood flow estimates is as up to date and as accurate as possible. An example of this would be to work with Timcon to ensure it updates its reports/surveys for years in which flows are required to be identified or verified. New ways of working between government and industry could be examined to update these types of datasets on a regular basis.

Potential for re-use contributing towards circular economy recycling targets should be investigated

A factor that could help wood packaging meet any future circular economy recycling targets for 2020 and beyond is re-use. The current EU circular economy package states that 'preparing for re-use and recycling[61]' can contribute towards the target. As there is a significant quantity of wood pallets being re-used, this should be investigated to establish the contribution re-use could make to achieving future targets.

[61] *http://eur-lex.europa.eu/resource.html?uri=cellar:b68494d2-999f-11e5-b3b7-01aa75ed71a1.0019.02/DOC_1&format=PDF*

Appendix I Obligation Reporting Activity Lines

Figure 36 The EA's Data Form – Activity Descriptions

Activity	Description
Raw material manufacturing	Production of raw materials that will be made into packaging
Conversion	Conversion of raw materials into packaging
Packing/filling	Applying packaging to goods
Selling	Supplying packaging to an end user i.e. the company / person who removes the packaging

Appendix II Grocery Retail Cross Reference

To sense-check the validity of the EPIC data for grocery retail, Valpak requested aggregated data from the EA for selected retailers. Table 1 selling data were requested for wood packaging handled in 2014 (2014 sales) for the following retailers:

- Aldi;
- Asda;
- Boots;
- Co-Op;
- Iceland Foods;
- Lidl;
- Marks & Spencer;
- Morrison's;
- Musgrave (Budgens);
- Nisa;
- Sainsbury; and
- Tesco.

These retailers are estimated to represent 85.2% of the UK grocery retail market, based on Kantar World Panel data. As such the EA data was scaled up to represent 100% of the UK market and the table below shows this grocery retail estimate.

Figure 37 Aggregated EA Grocery Retail Packaging Handled (2014)

	Wood (k tonnes)
Grocery Retail	0.275[62]

EPIC data was scaled up to account for the above retailers (using market share information by volume sales for the four supermarkets' data used, provided by Kantar). Figure 39, below, compares the scaled-up EA figures to the scaled-up EPIC data.

Figure 38 Aggregated Grocery Retail Packaging Handled (2014)

	Wood (k tonnes)
EA Grocery Retail	0.275[63]
EPIC Grocery Retail	0.95
Difference	0.179 (65%)

[62] *As reported in December 2015*
[63] *As reported in December 2015*

The EPIC grocery retail tonnage is 65% lower than the EA data, which is a relatively high difference and is likely to be significant. Therefore the EA data has been used to calculate the non-grocery retail sector. Valpak data was used for other materials flow projects because it provides increased granularity, however for other materials the difference in tonnage was less significant in terms of percentage. For wood, because the percentage difference is greater, and the consumer proportion of total POM is very small, it's less important to see the granularity therefore EA data has been used.

Valpak's EPIC data was still used to define the format split for the retail sector as the project team was able to access the raw data and felt that the format would not change considerably between the different retailers covered in the two sets of data.

Appendix III Retail Sensitivity Analysis

In order to assess total retail flow, including non-grocery retailers, analysis was completed on wood packaging tonnes per £bn turnover. The result showed that non-grocery wood packaging tonnes / £bn turnover is 4,713% of grocery wood packaging tonnes / £bn turnover, based on the average for a number of retailers.

Sensitivity analysis has been carried out to establish the impact on total flow if this percentage was 100 percentage points lower or higher. If non-grocery wood packaging tonnes / £bn turnover was 4,613% of that used in the grocery sector, total flow would be 15.450k tonnes (-0.03% below the final project estimate) and if non-grocery wood packaging tonnes / £bn turnover was 4,813% of that used in the grocery sector, total flow would be 16.108k tonnes (+0.03% higher than the final project estimate).

Appendix IV Assessment of De-minimis and Free-riders

There are various databases available that can be used to identify wood packaging manufacturers.

A list was compiled of market participants and estimated their sales (where not published) using the proxies of trade debtors, number of employees and net assets. This was done by searching the Bureau Van Dijk MINT database by SIC code and combining that with the list of members of the UK Wood Packaging Material Marking Program (www.ukwpmmp.org). After cleansing it produced a list of 438 market participants ranked by estimated sales.

Companies on the list with estimated sales of over £2m per annum were compared with the National Packaging Waste database. All of the major industry participants were included but there were 53 companies which were likely to be of sufficient size to require registration but no registration data was available.

Based on industry knowledge it is likely that a wood packaging manufacturer with sales of £2m would purchase 10,000 cubic metres of wood per year which would have a mass of around 5k tonnes. For the 53 companies identified this would equate to potentially over 265k tonnes of material.

This database was also used to estimate that 25% of total turnover is made by companies with turnover of less than £2m. However we have not used this in our calculations as the percentage of wood packaging in this total is unknown.

Appendix V Grades of Wood Waste, as Defined in PAS 111

Figure 39 Grades of Recycled Wood

Grade	Definition
A – Clean wood	Relatively homogenous (hardwood/softwood), primary processed woods. Predominately untreated wood but may contain small particles of paint, surface coatings, nails and metal fixings prior to processing. Example sources: Primarily packaging waste, scrap pallets, and processed off-cuts from the manufacture of untreated products.
B – Mixed grade	May contain up to 60% grade A material, plus building and demolition materials and domestic furniture made from solid wood. Some contaminants present, such as nails and metal fixings, some paints, plastics, glass, grit, coatings, binders and glues. Example sources: Construction and demolition waste, some industrial off cuts, some civic amenity waste (e.g. used furniture, separated DIY waste)
C – Low grade	Contains contaminants as per grade B plus coated and treated timber (not including the treatments described in grade D waste). Mainly suitable only for WID-compliant combustion or landfill. Example sources: mixed grade A and B plus coated and treated timber from Commercial & Industrial waste streams via Waste Transfer Stations, and separated waste wood from Municipal Collections, Recycling Centres, and Civic Amenity Recycling sites.
D - Hazardous	Industrial wood waste – contaminants such as Copper,Chrome,Arsenic (CCA) preservatives and halogenated hydrocarbons, such as those present in creosote. Example sources: Specialist grade D waste, such as railway sleepers and utility pokes, which may be used in landscaping. Other sources include fencing panels and demolition waste from the 1950s-2006, which is only suitable for WID-compliant combustion or specialist landfill.

Appendix VI Fiscal Incentives for Biomass

Renewables Obligation (RO)

The Renewables Obligation (RO) is a support mechanism for renewable electricity generation in the UK. The RO came in to effect in 2002 in England, Scotland and Wales, and places an obligation on UK electricity suppliers to source an increasing proportion of their electricity from renewable sources.

Renewables Obligation Certificates (ROCs) are issued to operators of accredited renewable generating stations for the eligible renewable electricity that they generate. ROCs can be traded with other parties and are bought by suppliers to demonstrate that they have met their obligation.

ROCs are issued per MWh generated (i.e. ROC / MWh) with payments per certificate currently in the region of ~£45. Payment is made on a net power basis, i.e. power that is exported not generated. The RO is to be replaced with Contracts for Difference (CfD) from 1 April 2017.

Facilities need to be commissioned before 31 March 2017 to enter the ROC scheme, although there are some opportunities to apply to the RO after the closure date in a grace period.

Facilities using biomass fuels will only be paid on the renewable / biomass proportion of the fuel used in a given month, on an energy content basis. The biogenic content needs to be determined in a fuel measurement and sampling process (FMS). Many fuelled stations have to undertake this on a monthly basis and the FMS procedures are agreed with Ofgem during the accreditation process.

Figure 41 shows number of certificates that are issued per MWh generated (i.e. ROC / MWh) for the technologies that could be using wood waste.

Figure 40 ROC Bandling Levels for 2014-17

Technology	2014/15	2015/16	2016/17
Co-firing (low-range)	0.3	0.5	0.5
Co-firing (mid-range)	0.6	0.6	0.6
Co-firing (high range)	0.9	0.9	0.9
Co-firing (low-range) with CHP	0.8	1	1
Co-firing (mid-range) with CHP	1.1	1.1	1.1
Co-firing (high-range) with CHP	1.4	1.4	1.4
Dedicated biomass	1.5	1.5	1.4
Dedicated biomass with CHP	2	1.9	1.8
Energy from waste with CHP	1	1	1
Standard gasification/pyrolysis	2	1.9	1.8
Advanced gasification/pyrolysis	2	1.9	1.8

Contracts for Difference

The Contract for Difference (CfD) scheme has been introduced to replace the Renewables Obligation, as part of the Electricity Market Reform. A CfD is a private law contract between a low carbon electricity generator and the Low Carbon Contracts Company (LCCC), a government-owned company. A generator party to a CfD is paid the difference between the 'strike price' – a price for electricity reflecting the cost of investing in a particular low carbon technology – and the 'reference price'– a measure of the average market price for electricity in the GB market. The aim of the CfD is to give greater certainty and stability of revenues to electricity generators by reducing their exposure to volatile wholesale prices. The Government has divided the CfD budget between two groupings:

- Established technologies: onshore wind (>5MW), solar photovoltaic (PV) (>5MW), energy from waste with CHP, Hydro (>5MW and <50MW), landfill gas and sewage gas; and
- Less established technologies: offshore wind, wave, tidal stream, advanced conversion technologies, anaerobic digestion, dedicated biomass with CHP, and geothermal.

The CfD budget allocated for the established technology is defined as Pot 1 and the CfD budget allocated for the less established technologies is defined as Pot 2. There is also a third CfD budget, which is for biomass conversion and this is defined as Pot 3.

The UK is now in a transition phase, where developers can choose between ROCs or CfD, although the timing of getting plants to commissioning means that is now more likely that newer developments will fall under the CfD scheme.

In February 2015, the Department for Energy and Climate Change (DECC) announced the first awards under the CfD system. These projects were those that had bid through an 'allocation round' auction. Budgets were set for different technology types and then projects accepted starting with the lowest bid price, until the budget is exceeded. A 'clearing price' was then awarded to successful bidders at the highest bid price for each year included in the auction. There were no contracts awarded to biomass facilities in the first round.

Renewable Heat Incentive

The Renewable Heat Incentive (RHI) was introduced in 2011 with a budget of £860m over four years, ending in March 2016. The 2015 spending review confirmed that the RHI will continue until at least 2020/21. Eligible technologies include solid biomass, energy from waste and CHP installations.

The RHI pays generators of renewable heat a payment per kWh thermal of heat used (i.e. not heat generated. Payments depend on tariffs, and tiers within each tariff, which will depend on the technology. Eligible heat uses include heating a space or water, or process heat.

From 5 October 2015 all participants generating heat (or heat and power) from biomass must comply with sustainability requirements (greenhouse gas (GHG) emissions limit and specific land criteria.). Waste or fuel wholly derived from waste is considered to meet the sustainability requirements.

The RHI has been instrumental in driving an industry of renewable heat technologies, of which biomass accounts for the majority of installations uses virgin wood pellet or wood chip, but there are many installations utilising wood waste, including pallets, and also wood chip manufactured from wood waste.

However, other users of recovered wood, the panel board sector in particular, have expressed concern that such incentives impair their ability to compete for recovered wood. However, as more UK biomass capacity becomes operational exports of recovered wood may decline.

Appendix VII Regression Model

Introduction

This report conducted a similar analysis carried out for previous flow reports[64]. Two analyses were carried out for this report – one studying changes in obligated wood Net Pack Fill, and the other investigating wood PRNs (as a proxy for recycling rates).

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

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

Net Pack Fill

The data used in this report was the obligated NPWD Net Pack Fill[65] tonnage, rounded to the nearest 1000 tonnes. Data was available reaching back to 1997, allowing for 18 observations in the data set. This is relatively few data points for a regression model, but the annual nature of packaging data reporting means that this number of observations provides the best possible model.

The first hypothesis investigated in this analysis was that Net Pack Fill tonnage is closely related to past Net Pack Fill tonnage. This was considered after looking at the data graphically. To test whether this was the case, a correlation test using Excel's Data Analysis tool between Net Pack Fill and the previous period's Net Pack Fill was conducted. This produced a correlation value of 0.746. Given this is relatively low compared to autoregression correlations carried out for other flow reports, alternative variables were considered that could provide a stronger correlation.

The construction industry was considered as a potential variable influencing wood Net Pack Fill, due to a large proportion of wood packaging being pallets and crates. A correlation test between Construction Industry Gross Value Added (GVA)[66] and wood Net Pack Fill was conducted using Excel's Data Analysis tool. This produced a value of 0.796 since 1997, and a correlation of 0.892 since 2002. Given this higher correlation, a model using construction industry GVA as a variable was used.

A regression model is a tool used to project future outputs for the dependent variable based on past trends with other independent variables. A simple regression with one variable in the current period is represented as shown:

[64] *http://valpak.co.uk/information-zone/white-papers-reports*
[65] *https://npwd.environment-agency.gov.uk/Public/PublicReports.aspx*
[66] *http://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf*

$$Y_t = \beta_0 + \beta_1 X_t + \mu_t$$

Where β_0 is the intercept, β_1 is the effect of a unit change of the X variable on the Y variable, X_t is the independent variable and μ_t is the error term. The model therefore uses the independent variable, either in the current period or previous periods, to predict the value of the dependent variable in the current period. The p^{th} order regression model represents Y_t as a function of *p* lags in the X variable. The number of lags, *p*, is called the order, or lag length, of the regression. The p^{th} order regression model can be represented as below:

$$Y_t = \beta_0 + \beta_1 X_t + \beta_2 X_{t-1} + \ldots + \beta_P X_{t-P} + \mu_P$$

For this analysis, three regressions using lags for the construction industry's GVA were calculated, extending to another period from the current in each model. The optimum number of lags for the X variable, or the value of *p,* needs to be decided upon. The trade-off is as follows: too few lags or regressors are potentially omitting valuable data from the more distant lagged values. However, if there are too many, there will be more coefficient calculations, which in turn will introduce additional estimation error into the forecasts. The way the optimum *p* number is calculated is by minimising an "information criterion". The Bayes information criterion (BIC) is a common tool, which can be calculated as follows:

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

The first term calculates the Sum of the Squared Residuals and so necessarily decreases (or at least does not increase) as lags are added. This is because, as more regressors are added, more (or at least not fewer) is explained by the model (i.e. R^2 will increase). The second term is the number of estimated regression coefficients (the number of lags, p, plus one for the intercept) multiplied by the factor (lnT)/T. This increases as the number of lags is added and so these two opposing forces allow us to choose the p value, which minimizes the BIC. Therefore, the BIC measures the trade-off qualitatively described earlier.

When running the OLS regression when a lag is added, often one fewer year's data can be used when calculating a coefficient. This is because, when running a regression, the number of dependent variable observations needs to be the same as the number of observations for each regressor. Therefore, if one lag is added, there is one fewer observation, as the oldest year's data cannot have an equivalent for the previous year (assuming all observations are used in the first regression).

The Bayes Information Criteria results are as follows:

p	SSR(p)/t	ln(SSR(p)/t)	(p+1)ln(t)/t	BIC (p)
1	4717.963875	8.459132603	0.333319217	**8.79245182**
2	4014.184937	8.297589601	0.519860385	8.817449987
3	3911.651129	8.271714848	0.72214672	8.993861568

The results show that the lowest BIC value, and therefore the optimal model, is only using the current period's construction industry as a variable (no lags). We assume the Ordinary Least Squares assumptions hold, and use this model in our forecasting. The model in general form can be seen below:

$$Y_t = \beta_0 + \beta_1 X_t + \mu_t$$

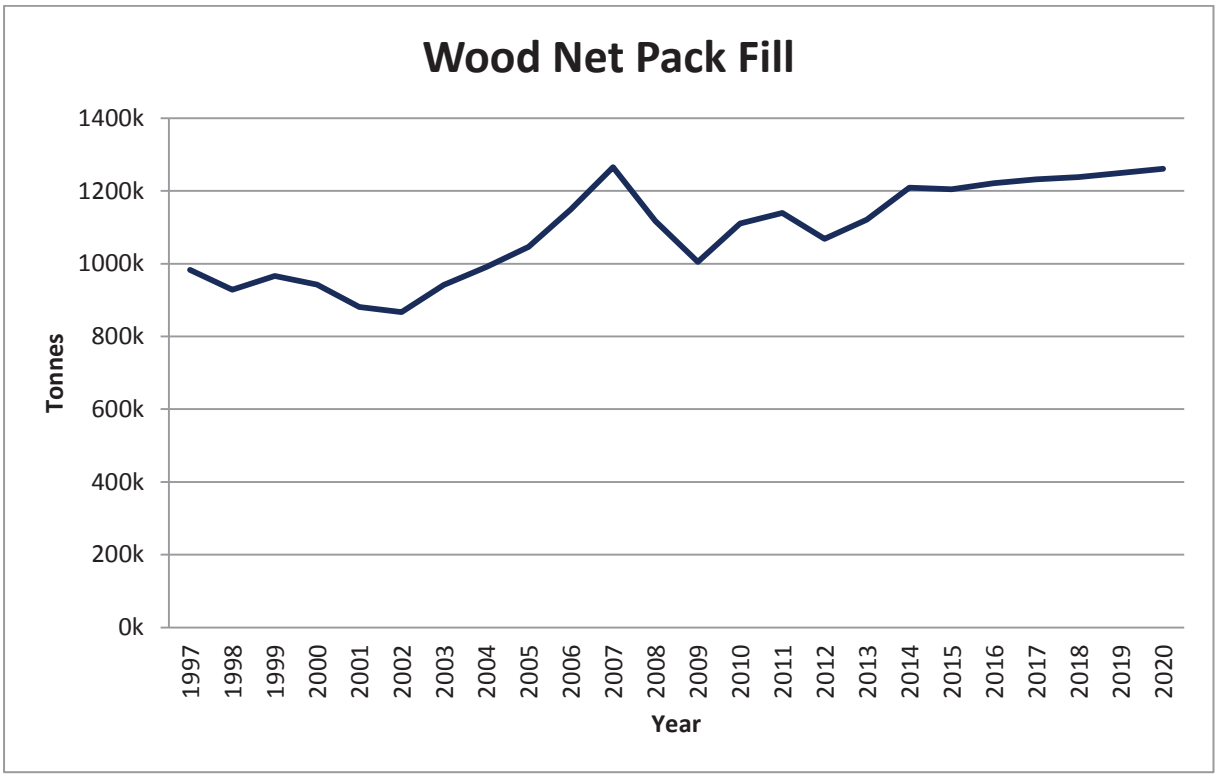
It is assumed that the error term is independently and identically distributed and has a mean of zero. The regression was run in excel and produced the following function for obligated Wood Net Pack Fill:

$$Y_t = 664.209 + 4.996\ X_t$$

The regression had a standard error of 70.801. Projections were calculated using the estimates for construction growth up to 2019 produced by the government backed Construction Industry Training Board (CITB) in their 'Blueprint for Construction 2015-2019'Report[67]. 2020 growth was assumed to be 2%, the same as CITB's 2019 projection.

The figure below shows the results of projecting wood Net Pack Fill using the method described above.

Figure 41 Net Pack Fill Historic and Projections



[67] *https://www.citb.co.uk/documents/research/csn%20reports%202015-2019/construction-skills-network-uk-2015-2019.pdf*

The year on year increases / decreases in Net Pack Fill were applied to the total POM estimate for 2014 and then consecutively until 2020. This assumes that the unobligated tonnage will experience the same increases / decreases as obligated tonnage.

To calculate the bounds, the common method of a 95% confidence interval around each projection was calculated using the regression standard error. However, it is recognised that the bounds will become less certain as we stretch further into the future.

An implicit assumption in this model is that past trends are useful to predict the future. If this was to not be the case, the coefficients in the equation would change, leading to Net Pack Fill following a different trajectory. Similarly, it is assumed that the estimates for construction industry growth over the next five years are reasonable. If the construction industry did not grow at this rate, then the trend in wood packaging would change to reflect this. However, the CITB Report provides the most reliable estimates at the time of writing.

Wood Recycling

The data used in this report for Wood Recycling is PRNs, rounded to the nearest 1000 tonnes. This represented a proxy for total wood recycling, and it is expected that changes to the obligated tonnage will capture the trends in the industry. Data was available reaching back to 1998, allowing for 17 observations in the data set. This is relatively few data points, but the annual nature of the reports means that these observations provide the best current model to predict future PRN tonnage.

The first hypothesis investigated in this analysis was that there are two separate trends in the data. This was decided after considering the data graphically as shown in the figure below.

Figure 42 Historic Wood Recycling

To test whether this was the case, a Chow Test was carried out. A Chow test is an econometric tool to find the statistical probability that the coefficients on two linear regressions are equal, and therefore the entire dataset exhibits the same trend. This is achieved by splitting the data at the expected 'break point', where the new trend begins, and then running a regression analysis on each of these two datasets before comparing the results.

If we split our data into two groups and run regressions on each data set, then we get the general form:

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

and

$$\mathbf{Y_t = \beta_2 + \beta_3 Y_{t-1} + \mu_t}$$

The Chow test asserts a null hypothesis that $\beta_0 = \beta_2$ and $\beta_1 = \beta_3$. We assume that both error terms μ_t are independently and identically distributed with a mean of zero, and therefore omit them from this analysis.

Let S_c be the sum of squared residuals (SSR) from the combined data, S_1 be the sum of squared residuals for the first data set, and S_2 be the sum of squared residuals from the second data set. N_1 and N_2 are the number of observations in each data set, and k are the number of parameters. The test statistic follows an F distribution with k and $N_1 + N_2 - 2k$ degrees of freedom. The Chow test statistic is:

$$\frac{(S_c - (S_1 + S_2)) / (k)}{(S_1 + S_2) / (N_1 + N_2 - 2k)}$$

The data was split between 1998-2008, and 2009-2014. This split was decided by seeing the change in direction of the trend graphically. A regression using one lag was calculated for each individual data set, and for the 'global' data set. This was used to calculate a Chow test statistic, which was compared with the F distribution (2,12). The Chow test statistic resulting from this analysis was 4.357. The 95% confidence value for the relevant F distribution was 3.885, and therefore it was concluded that it was likely there was a break in the data set at this point. Other break points were considered, but these two data sets had the highest probability of being a break in the trend.

Given this analysis, the useful data for forecasting recycling rates forward was from 2009 onwards. As a result of only six data points being available, it was concluded that a full regression analysis would not be useful in forecasting, and industry experts were instead used as the primary source of information. The forecast was generated to provide a basis for discussion.

Appendix VIII De-minimis Imports and Exports Sense Check and Sensitivity Analysis

In order to estimate de-minimis imports and exports using publically available databases, import / export data was used which could break down imports and exports by industry sector, value of goods and company size (by number of staff).

In order to identify a cut-off for staffing levels for obligated and unobligated producers' an analysis of Valpak's internal member data was conducted. This identified that obligated producers were more likely to have 50 staff or more, which in turn meant that unobligated or de-minimis producers had less than 50 staff.

As a sense check the number of registered producers that handle wood packaging was compared to the number of businesses in the HMRC UK TradeInfo.

Figure 43 UK Import / Export Ratios by Size of Organisation

	Number of businesses with 50 or more employees
NPWD registered producers handling wood packaging	4,015
HMRC UK TradeInfo data	6,874

These two datasets are not completely comparable as the HMRC UK TradeInfo data only gives a high level breakdown. Also, as a result of how data is reported into NPWD there will be some companies in the HMRC data that are likely to be registered producers, but won't report any wood packaging because they are part of a leased packaging system and therefore it is not their obligation.

Due to a lack of publicly available data to cross-check this finding a sensitivity analysis was conducted to establish the impact on total flow if this staff cut-off was lower or higher. This identified that if the de-minimis banding is reduced to 0-9 staff then this reduces the de-minimis imports to 42kT from 111kT and exports to 9kT from 36kT. Overall, this reduces the total POM from 1,310kt to 1,268kT, representing a reduction of 3.3%.

If a larger de-minimis banding is used, such as 0-249 staff, this increases the de-minimis imports to 368kT from 111kT and exports to 158kT from 36kT. Overall this increases the total POM from 1,310kt to 1,444kT, representing an increase of 10%. This has a larger impact than the smaller cut-off (0-9 staff) due to it encompassing a far greater number of staff.

Appendix IX 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. The results are shown in Figure 45, which has been constructed based on analysis completed for each project estimate. Questions were created relating to the evidence and agreement levels of the data used.

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. Where a partial score is given, a score 1 or 2 is made and a comment is added to justify this decision.

Figure 44 Data Robustness Assessment Results

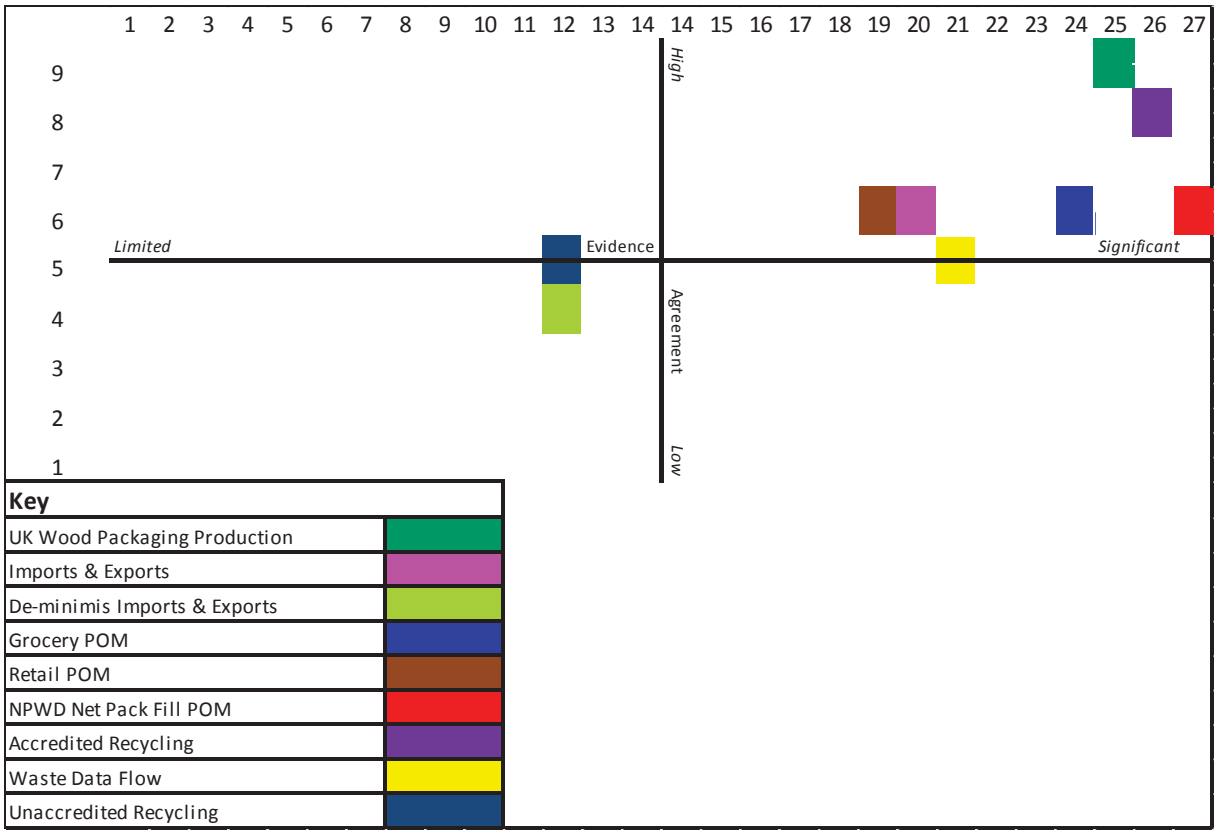


Figure 45 Data Robustness Assessment: UK Wood Packaging Production

Evidence (Robustness and completeness, max 27):	Scoring		Evidence
Does the data cover the correct time-frame?	Most, not all	2	Timcon was updated from 2013
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)?	Most, not all	2	Based on surveys
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	**25**		
Degree of agreement around the findings (max 9):			
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**		

Figure 46 Data Robustness Assessment: Imports & Exports

Evidence (Robustness and completeness, max 27):	Scoring		Evidence
Does the data cover the correct time-frame?	Yes	3	
Does the data provide complete coverage?	Yes, with reservations	2	Scaling for de-minimis was required
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)?	Most, not all	2	Scaling for de-minimis was required
Have the findings been independently peer-reviewed?	Yes	3	
Is the methodology/calculation reasonably free from concerns?	Yes, with reservations	2	Scaling for de-minimis was required
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3	
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes, with reservations	2	Difficult to cross check de-minimis estimates
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0	
Total	**20**		
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**		

Figure 47 Data Robustness Assessment: De-minimis Imports & Exports

Evidence (Robustness and completeness, max 27):	Scoring		Evidence
Does the data cover the correct time-frame?	Yes	3	
Does the data provide complete coverage?	Yes, with reservations	1	To able to determine coverage
Has the data been sourced from credible, up-to-date sources?	Yes, with reservations	1	Not specific to wood packaging
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	No	0	Not specific to wood packaging
Have the findings been independently peer-reviewed?	Yes, with reservations	2	Not specific to wood packaging
Is the methodology/calculation reasonably free from concerns?	Yes, with reservations	1	Not specific to wood packaging
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3	
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes, with reservations	1	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0	
Total	**12**		
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, with reservations	2	Not specific to wood packaging
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes, with reservations	2	Not specific to wood packaging
Total	**4**		

Figure 48 Data Robustness Assessment: Grocery POM

Evidence (Robustness and completeness, max 27):	Scoring		Evidence
Does the data cover the correct time-frame?	Yes	3	
Does the data provide complete coverage?	Yes	3	
Has the data been sourced from credible, up-to-date sources?	Yes	3	
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes	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	3	Checked against EA reported Data
Total	**24**		
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**		

Figure 49 Data Robustness Assessment: Retail POM

Evidence (Robustness and completeness, max 27):	Scoring		Evidence
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	ONS and Valpak member data
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes, with reservations	2	
Have the findings been independently peer-reviewed?	Yes	3	
Is the methodology/calculation reasonably free from concerns?	Yes, with reservations	2	
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3	
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes	3	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0	
Total	**19**		
Degree of agreement around the findings (max 9):			
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**		

Figure 50 Data Robustness Assessment: NPWD Net Pack Fill POM

Evidence (Robustness and completeness, max 27):	Scoring		Evidence
Does the data cover the correct time-frame?	Yes	3	
Does the data provide complete coverage?	Most, not all	3	
Has the data been sourced from credible, up-to-date sources?	Yes	3	The EA is an official data source
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	By the EA
Is the methodology/calculation reasonably free from concerns?	Yes	3	
Have the methodology/calculations been independently checked (internally or externally)?	Yes	3	By the EA
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	Against total flow and gap between obligated and non-obligated is reasonable
Total	**27**		
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**		

Figure 51 Data Robustness Assessment: Accredited Recycling

Evidence (Robustness and completeness, max 27):	Scoring		Evidence
Does the data cover the correct time-frame?	Yes	3	
Does the data provide complete coverage?	Yes	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):			
Does more than one data source confirm the findings (within +/- 5%)?	With 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?	Yes	3	
Total	**8**		

Figure 52 Data Robustness Assessment: Waste Data Flow

Evidence (Robustness and completeness, max 27):	Scoring		Evidence
Does the data cover the correct time-frame?	Yes	3	
Does the data provide complete coverage?	Yes	3	
Has the data been sourced from credible, up-to-date sources?	Yes, with reservations	2	
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes, with reservations	2	
Have the findings been independently peer-reviewed?	Yes	3	
Is the methodology/calculation reasonably free from concerns?	Yes, with 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):			
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 reservations	2	
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3	
Total	**5**		

Figure 53 Data Robustness Assessment: Unaccredited Recycling

Evidence (Robustness and completeness, max 27):	Scoring		Evidence
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 reservations	1	
Is the underlying data reasonably free from concerns (e.g. official data from the ONS)?	Yes, with reservations	2	
Have the findings been independently peer-reviewed?	Yes, with reservations	1	
Is the methodology/calculation reasonably free from concerns?	Yes, with reservations	1	
Have the methodology/calculations been independently checked (internally or externally)?	Yes, with reservations	2	
Is the quantitative evidence well rooted in a wider qualitative understanding of the issue?	Yes, with reservations	2	
Have the findings been sense-checked against credible alternative sources (incl. inconclusively)?	No	0	
Total	**12**		
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, with reservations	2	
Has feedback from the key stakeholders been incorporated in the reporting of findings?	Yes	3	
Total	**5**		

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