Final Report

Methodology for assessing the climate change impacts of packaging optimisation under the Courtauld Commitment Phase 2

Methodology for measuring the packaging target:
"…to reduce the carbon impact of grocery packaging by 10% by the end of 2012, against a 2009 baseline."

Date: December 2010

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Front cover photography: Blue Sky

Executive summary

The goal of this document is to set out an agreed methodology for developing indicators for all packaging materials commonly used by Courtauld signatories. This includes:

- Agreeing the goal and scope of the assessment with signatories;
- Agreeing the life cycle stages to be included (and excluded);
- Agreeing secondary data sources to be used;
- Agreeing issues not clarified in existing standards (e.g. the allocation methodology to be used); and
- Agreeing the carbon conversion factors to apply to improvements made under the auspices of this agreement.

The proposed methodology is designed to highlight the consequences of making changes to the packaging system. It is not designed to provide a 'carbon footprint' of any item of packaging or product. In its approach, it therefore varies from PAS 2050, but remains in the spirit of this and other standards.

The intention is to build on the existing success of the Courtauld Commitment in optimising packaging and to recognise other environmental improvements made in packaging; for example, increasing the use of recycled content and / or raising recycling rates.

As with actions to meet weight-based targets, carbon-based thinking needs to be grounded in reality; changing packaging at the expense of adequate product protection will not yield environmental or economic benefits. It is therefore envisaged that the methodology will be used to inform decisions, but that further investigations will have to be undertaken by affected parties before any changes are made.

The strategy is informed by life cycle thinking, but is not a strict life cycle assessment. As with all work of this nature, it is essential that double-counting is avoided. Therefore, some life cycle stages have been excluded from this method, with the intention that they will be incorporated into other areas of work (i.e. household food and drink, supply chain product wastes, and in developing a target relating to grocery products under Phase 3 of the Courtauld Commitment). Avoiding under-counting is also important, in order to avoid, for example, under-estimating the benefits of closed loop recycling.

Due to its strategic nature, the factors used are unlikely to be the same as those identified in specific work undertaken by signatories and their supply chains. This is to be expected given varying mixes of primary and secondary data, boundaries, allocation approaches and information sources. However, the data used herein is believed to be representative at a UK level.

This methodology is designed to identify the consequences of changes in the system, rather than attribute a footprint to an item. Of key interest is the need to highlight the difference in impact between different recycling routes; and the potential benefits which closed loop recycling can offer over alternative options. The purpose is to maximise the benefits of recycling and achieve genuine increases rather than moving recyclate from one product to another without any additional environmental benefit.

All the carbon dioxide equivalent (CO_2eq) emissions figures are quoted per tonne of packaging material. As different packaging formats have different weights, the figures should not be interpreted as indicating that one packaging material is "better" than another. Pack weight will remain an issue of importance under this agreement.

Figures showing how a 10% reduction in CO_2 equivalent emissions may be achieved for each material against the baseline are reproduced in the table below. These have been derived using available data and the responses obtained through the consulation process. It is not the total footprint which is important; rather, it is how we can reduce the impact through different means, such as increasing recycling rates. The impact of recycling is based on current practice. Best practice would yield greater savings earlier. Information on best practice assumptions is also shown below. Section 9 of the report discusses the sensitivity of these figures to a range of assumptions and exclusions. The baseline is based upon 2009 recycling rates.

Table 1 Carbon emissions per tonne of packaging material

Material	Baseline $KgCO_2e$ / tonne[1]	A 10% reduction could be achieved by either:			
		Increasing recycled content by	Increasing recycling rate by:		Right-weighting packaging (without changing recycled content)
			Current practice	Best practice[2]	
Aluminium	6960	N/A	8%	8%	10%
Cardboard (including corrugate and carton board)	1040	Near optimal in average stock	Increases in the recycling rate will not yield 10% reduction due to high baseline level		10%
Wrapping Papers	1020	TBC	TBC	TBC	10%
Liquid Beverage Cartons	2110	N/A	TBC	TBC	10%
Glass	750	20%	30%	0%	10%
PE Bags / Film	2700	26%	28%	0%	10%
PET Bottles	4190	23%	24%	24%	10%
PET Rigids	4060	20%	21%	21%	10%
HDPE Bottles	2660	22%	24%	24%	10%
HDPE Rigids (Boxes / Crates)	3190	33%	37%	37%	10%
PP Rigids (Boxes / Crates)	3640	36%	38%	0%	10%
PP Film / Bags	2690	26%	40%	0%	10%
HIPS Rigids (Yoghurt Pots)	5130	23%	40%	0%	10%
Other Plastics	3470	33%	35%	0%	10%
Average Plastics	3070	26%	28%	15%	10%
Steel	1870	N/A	11%	11%	10%
Wood	430		7%	7%	10%

[1]Based on UK average recycling rate, 2009 [2]Based on increasing closed loop recycling

Before implementing changes informed by this methodology, signatories must check for unintended consequences. For example, if a change affects the filling speed of packaging or shelf life of a product, it is vital that this is understood. If this negates any of the benefits identified above, it is clearly inadvisable to make this change.

These carbon values will be updated on an annual basis to take account of the consequences of the previous year's activity.

The difference between the different recycling options highlighted is the market to which the recyclate is sent. Under the current practice scenario for glass, approximately 1/3 of glass collected for recycling is used in aggregate production, and 2/3 in remelt. The benefit of sending glass to remelt is considerably higher (in terms of CO_2eq emissions) than sending it to aggregate. Under this scenario, recycling rates must increase by 37% to reduce overall emissions by 10%. If however, all glass collected for recycling was sent to remelt (i.e. that sent to aggregate was diverted to closed loop applications) then the overall recycling rate would only have to increase by 5% to deliver a 10% reduction in emissions.

As the recycling rate, and recycled content, for cardboard packaging is already so high, any increases in recycling rate on their own will not change the footprint of the packaging by 10%.

For plastics, there are significant differences between the figures for several of the forms of packaging. The reason for this is to do with the collection method, and the offset materials. Bags and bottles are assumed to be source segregated for recycling, whereas other plastics are assumed to be collected mixed. The mixed plastics require extra processing to allow them to be recycled, and whilst there is still a benefit to doing this, it is much reduced relative to source segregates materials. Furthermore, the polymers segregated through mixed plastics may be sent to a variety of open and closed loop applications. These are discussed in Annex 3.

Link to other initiatives

This methodology links with many existing schemes. This can be illustrated by the following examples.

PAS 2050 (2008)

The figures used in this methodology could contribute to a PAS2050 assessment, but do not cover the life cycle of the product and packaging. They do not represent the full life cycle of goods and services. This document describes the way in which Courtauld targets will be assessed and reported, and is not appropriate for reporting at a company level.

Climate Change Agreements

We recognise the work of DECC and many trade associations in establishing Climate Change Agreements which seek to reduce energy use and associated greenhouse gas emissions. These are an important contribution to reducing the impacts of goods.

The methodology is designed to reflect changes in factors which Waste & Resources Action Programme (WRAP) can influence with signatories: weight, recycled content, recycling rates and cubic efficiency of packaged product. Using a baseline representing current activity, the objective is to reduce greenhouse gas emissions through actions in these areas relative to this baseline. Calculation of carbon equivalents for grocery packaging is based upon a material-specific carbon equivalent factor expressed in tonnes CO_2e. It is recognised that, through initiatives undertaken within each material sector, these factors may reduce over time due to process and supply chain improvements. It is WRAP's intention to revise the baseline to reflect these improvements throughout the course of Phase 2 of the Commitment. In many cases work under the Courtauld Commitment will assist companies in reducing emissions reported under Climate Change Agreements.

Whilst this methodology focuses on measuring a reduction in the carbon impacts of packaging systems it is WRAP's intention to estimate the carbon savings associated with the other two targets contained within Phase 1 of the Courtauld Commitment: the household food and drink waste reduction target and the supply chain product waste reduction target. The approach that WRAP intends to take to provide these estimations will be shared with signatory companies at a later date.

Courtauld Commitment Phase 3 (Post-2012)

In our discussions with signatories, it has become obvious that there is a collective desire within signatory companies, WRAP and the UK Governments to move away from the weight-based targets set in the original Courtauld Commitment to using resource and carbon reduction targets in the second phase of Courtauld that provide a better proxy for the environmental impacts associated with grocery products and the packaging systems that support them. However, the majority of those involved in the development of the new Commitment were also of the view that a move to resource and carbon based metrics and targets were but a stepping stone to the development of a measurement and reporting methodology that factors in a broader range of environmental parameters (e.g. water use and natural resource depletion).

As such it is our intention to development a wider environmental impacts methodology for products and product portfolios during the three calendar years from 2010 to the end of 2012 to underpin discussions on the third phase of the Courtauld Commitment from 2013 onwards. We also hope to that this work will help us develop the second phase of WRAP's Home Improvement Agreement from 2013 onwards.

During this timeframe we also expect to see a wider adoption of product carbon foot-printing using PAS 2050, the WRI / WBCSD GHG Protocol and the upcoming ISO Standard on Product Carbon Footprinting.

All of these developments will help us to gain a better understanding of what is required to move to Phase 3 of the Courtauld Commitment.

Summary of Critical Review

This methodology was peer-reviewed by the Carbon Trust Footprinting Company.
Below is a summary of their final report:

In general, the methodology document presents a pragmatic, workable approach to monitoring improvements in the carbon impact of packaging. As such, it can be considered fit for the purpose of monitoring progress towards the Courtauld 2 target. There are, nevertheless, areas for improvement, as indicated above, which would result in the following improvements:

- Increased accuracy of carbon impact measurement
- Better internal consistency of the methodology
- Greater consistency with other footprinting approaches, notably PAS2050, facilitating a more consistent approach to carbon footprinting
- Facilitation of future aims anticipated under Courtauld 3

The methodology document acknowledges that use of primary data should be preferred over the current use of secondary data sources (section 8.3). The plan to allow PAS2050 compliant values certified to Footprint Expert as an input should be leveraged to benefit all parties. It is expected that this will be the predominant source of reliable and consistent primary carbon impact data and consistency between the Courtauld methodology and Footprint Expert would, therefore, bring significant benefits to Courtauld signatories, as well as WRAP and CTFC.

A copy of the full peer-review report can be sent on request.
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Contents

Figures

Acknowledgements

We are grateful to all those who responded through the consultation process. In particular, we would like to thank the following organisations for their assistance in providing data and feedback on the formula used in calculating the carbon factors for the different materials:

Alupro
APEAL (The Association of European Producers of Steel for Packaging)
British Glass
The Carbon Trust Footprinting Company
CPI (Confederation of Paper Industries)
Corus
European Aluminium Association (EAA)
GDA Gesamtverband der Aluminiumindustrie e.V.
PlasticsEurope
Procarton
World Steel Association

We are particularly grateful for the advice of Bernie Thomas and Jonna Fry at ERM on waste management and discussion of the recycling calculation, and to Philippe Pernstich at Carbon Trust Advisory Services for formally peer reviewing this work

Amendment Log

Amendment Date	Reviewer	Changes
November 2010	K James	Error in recycling calculation corrected. Change affects total emissions figures per tonne of material and changes in recycled content / recycling rate to deliver a 10% reduction in greenhouse gas emissions.

1.0 Introduction, background and history to the Courtauld Commitment

The Courtauld Commitment is a voluntary agreement between WRAP and major UK grocery businesses that supports less packaging and food waste ending up in household bins. It has proved to be a powerful vehicle for change; and in 2008 has led to zero growth in UK grocery packaging despite increases in sales volumes and the UK population.

The current Courtauld Commitment agreement finishes in 2010. For the past 18 months WRAP has been discussing the potential for a new post-2010 agreement with the UK Governments, existing signatories and a growing body of new companies wishing to work with WRAP under the Courtauld umbrella.

The new agreement – the Courtauld Commitment Phase 2 (Courtauld 2) - will cover the three calendar years from 2010 to 2012, with final reporting for the calendar year 2012 taking place in 2013. The phasing and evolution of the targets contained in the new agreement set out a clear trajectory to:

- move away from solely weight-based targets (as per the existing Courtauld Commitment) to resource and carbon reduction targets and ultimately targets based on a balanced range of environmental metrics;
- introduce targets for the calendar years 2010 to 2012 that seek to realise the resource and carbon benefits of waste prevention in the UK retail grocery supply chain, including the packaging and food and drink waste arising in UK households;
- develop a carbon measurement and reporting methodology and an initial baseline by the end of 2011 to support a move to reducing the carbon and wider environmental impacts of traditional grocery products from 2013 onwards (forming the basis for Courtauld 3); and
- agree the final baseline and a challenging target by the end of 2012 to reduce the carbon and wider environmental impacts associated with traditional grocery products from 2013 onwards[1] under Courtauld 3.

Under the new agreement retailer signatories will be responsible for their own-label products and direct sourced / private label brands (including supporting packaging systems); whilst brand-owners will be responsible for their own product portfolios. Retailer signatories would work in partnership with their suppliers to reduce the resource / carbon impacts of their products.

This document sets out the methodology by which WRAP is to measure progress against the packaging target contained in the new Commitment. A separate methodology to cover the household food and drink and supply chain product waste targets is currently under development.

1 *Following discussions with the Governments, signatories and trade bodies we have chosen not to set an end date for the new agreement at this stage but rather agree the baseline, target and the duration of the agreement when we have the data available to us at the end of 2011.*

2.0 How to use this methodology

The first proposed target for the Courtauld Commitment is:

- To reduce the weight, increase recycling rates and increase the recycled content of grocery packaging, as appropriate. Through these measures, the aim is to reduce the carbon impact of this grocery packaging by 10% by the end of 2012, against a 2009 baseline.

The methodology outlines how the greenhouse gas emissions savings made by signatories to this target will be estimated, based on information reported by signatories. The impact on greenhouse gas emissions would be reported collectively. The methodology is not designed to be used to report reductions in emissions made by individual signatories, or to allow individual signatories to make claims.

3.0 Calculating the environmental burden

The approach proposed in this document builds on life cycle thinking, rather than strict life cycle assessment. Whilst it is informed by standards on life cycle assessment, it does not use an approach which is compliant with such standards for the purposes of making environmental claims about specific products or packaging. Nonetheless, it is considered appropriate for the purposes of taking measures which will lead to reductions in the environmental impact of packaging.

Life cycle thinking is essential when considering environmental impacts associated with all goods and services. By considering all stages in the life of a product, from extraction of raw materials through to the end of its life, we can ensure that measures taken at one stage do not lead to unintended consequences in another. This life cycle thinking is already implicit in the way companies have used weight-based targets for reducing packaging. For example, packaging may be made thinner, but if it no longer protects the product as well then this would be an inappropriate development.

Using a life cycle approach can also help to ensure that an improvement in one environmental indicator does not lead to an adverse impact in another category. This is obviously dependent on the categories being considered.

Recent European research[2] has found that although our use of materials has been decoupling from economic growth in relative terms, in absolute terms they have remained constant for a decade. In absolute terms, this level of resource use is still unsustainably high, and many of the burdens associated with using these resources have been shifted abroad as the balance of trade itself has shifted. The consumption of these resources has a negative impact on the environment, be it via air emissions, emissions to water, solid waste, the extraction of raw materials and / or through the use of energy.

At the same, time, the UK Government has set a target through the Climate Change Act (2008) to ensure that the net UK carbon account for the year 2050 is at least 80% lower than the 1990 baseline; with an interim target to reduce greenhouse gas emissions by 34% by 2020[3]. There is therefore a need to both reduce the amount of resources we consume, and reduce the emissions associated with this.

While the valuable role that packaging plays, and the fact that its impact on climate change is usually significantly less than the product it contains, is widely recognised, both policy makers and consumers are concerned about its environmental impact, UK Governments recently published a new packaging strategy 'Making the most of packaging – a strategy for a low carbon economy'[4] which clearly sets out the ambition of developing a successor to the Courtauld Commitment to cover all supply chain wastes, including packaging, which will also pilot a carbon-based approach.

The objective of Courtauld 2 is to deliver improvements against these concerns. Reducing resource consumption and recycling and reusing those resources that are used will reduce the environmental impacts from the extraction of primary raw materials and from the transformation of primary raw materials in production processes. Waste management is therefore part of the life-cycle of resource use and constitutes an integral part of its management.

Examples of life cycle thinking in European Union policies include the Integrated Product Policy Communication (COM(2003)302) , as well as the two Thematic Strategies on the Sustainable Use of Natural Resources (COM(2005)670), and on the Prevention of Recycling and Waste (COM(2005)666). The Sustainable Consumption and Production Action Plan (SCP) integrates these and other related policies, aiming to reduce the overall environmental impact and consumption of resources associated with the complete life cycles of goods and services (products).

[2] *Moll, S., Bringezu, S., and Schutz, H. (2005)* Resource Use In European Countries*, Copenhagen: European Topic Centre on Waste and Material Flows*

[3] *The Scottish Government is also currently consulting on its Climate Change (Scotland) Bill, which contains equally challenging targets for reductions in greenhouse gas emissions.*

[4] *Defra, June 2009*

3.1 Life cycle greenhouse gas emissions as an approximation for environmental impact

All goods and services have a range of environmental impacts. For each item, different environmental impacts may be viewed as more or less significant by society.

In Life Cycle Assessment, a commonly used set of environmental indicators have been developed by the Centre of Environmental Science (CML) at Leiden University, The Netherlands. These indicators cover resource depletion, climate change, acidification potential and many others. Box 3.1 provides more detail on these.

Box 3.1 Commonly Used Mid-point indicators of environmental impact.

Depletion of abiotic resources
This impact category indicator is related to extraction of minerals and fossil fuels due to inputs in the system. The Abiotic Depletion Factor (ADF) is determined for each extraction of minerals and fossil fuels (kg antimony equivalents/kg extraction) based on concentration reserves and rate of deaccumulation.

Climate change
The characterisation model for climate change, as developed by the Intergovernmental Panel on Climate Change (IPCC), is selected for development of characterisation factors. Factors are expressed as Global Warming Potential (GWP) for a time horizon of 100 years (GWP100), in kg carbon dioxide equivalent/kg emission.

Toxicity indicators addressing human toxicity and aquatic eco-toxicity.
Characterisation factors, expressed as Toxicity Potentials, are calculated with USES-LCA, describing fate, exposure and effects of toxic substances for an infinite time horizon. For each toxic substance the toxicity potentials are expressed as 1,4-dichlorobenzene equivalents/ kg emission.

Photo-oxidant formation
Photochemical Ozone Creation Potential (POCP) (also known as summer smog) is implicated in impacts such as crop damage and increased incidence of asthma, for emissions of substances to air. It is calculated with the UNECE Trajectory model (including fate), and expressed in kg ethylene equivalents/kg emission.

Acidification
Acidification has direct and indirect damaging effects, such as nutrients being washed out of soils, increased solubility of metals into soils, and damage to stone buildings. But even buildings and building materials can be damaged. Acidification Potentials (AP) is expressed as kg SO_2 equivalents/ kg emission.

Eutrophication
Eutrophication is the addition of organic or inorganic fertiliser to land or water. Excessive growth (and death) of plants and algae can lead to decreased oxygen levels in water, creating conditions which cannot support diverse life. Nutrification potential (NP) is based on the stoichiometric procedure of Heijungs (1992), and expressed as kg PO43- equivalents/ kg emission.

Several other indicators may be used covering other environmental issues. In addition, much of the data input to derive these factors may be of direct interest, such as Cumulative Energy Demand and operational or embedded water use.

No single indicator can holistically cover environmental impact, and for different materials, different environmental factors will be the dominant concern. If we take the example of nuclear energy, it produces few greenhouse gas emissions, does not produce gases which lead to acidification, and does not produce much solid waste. It is the nature of the resultant waste materials - and the concerns over the effects of radiation - which are considered more important by society in this context.

The proposal for a target centred on greenhouse gas emissions is based on a number of drivers. The Stern Review[5] concludes that climate change is "the greatest and widest-ranging market failure ever seen." To correct this failure, and to allow the UK to meet the targets set in the Climate Change Act, we need not only to review

[5] *Stern, N. (2006)* The Economics of Climate Change*, London: HM Treasury*

the resources we use to provide our power and goods, but also to use these more effectively. In this sense, weight may be seen as a useful indicator, showing the tonnes of material used to deliver a desired output. However, on its own, weight does not provide an indication of other environmental impacts associated with the packaging or product it contains.

There are a number of reasons for considering climate change as a proxy for a wider range of environmental issues. As previously discussed, use of a carbon indicator can drive behaviour required under a range of other targets and initiatives, such as the EU Landfill Directive targets on biodegradable municipal waste, recycling targets, reductions in packaging weight and the Integrated Product Policy Directive (see below).

The calculation of greenhouse gas emissions are a function of the materials and energy used to manufacture packaging, as well as the disposal routes utilised. By reducing energy consumption, using alternative sources of energy and reducing materials consumed / increasing recycled content and recycling rates, efforts to reduce carbon impacts can also reduce resource use and energy use, as well as associated emissions such as those emitted when fossil fuel is combusted. Although the relationship is by no means perfect or direct, use of a carbon target in conjunction with weight targets could be seen as a step towards a more sustainable production and consumption system.

Climate change also covers more than energy production and use; approximately half of the emissions from the production of primary aluminium come from direct emissions; whilst hardly any emissions from plastic manufacture are directly from the process, and come instead from energy use. Considering only energy use rather than climate change would mask these issues.

The use of targets in a complementary fashion can facilitate the delivery of a range of policy, strategy and operational outcomes, and can lead to more informed decision-making. Through the use of methodologies for Life Cycle Assessment and Carbon Footprinting, the relationship between product and packaging may be reviewed in tandem by businesses to optimise their production systems to cover a number of issues. As with the reporting mechanism under the Kyoto Protocol, under Courtauld 2 there would be a need to agree factors for greenhouse gases and use these consistently, whilst at the same time allowing for improvements in our collective understanding of them over time.

The consideration of more environmental issues would lead to more informed decision-making, but would also require collation and interpretation of more data. In practice this would make the targets complicated to understand and monitor, and costly for companies to administer.

If CO_2 equivalent emissions are chosen as the indicator of choice for packaging targets, then there will be a need to recognise the carbon and other environmental impacts of the product protected by the packaging. In practice this already occurs in the weight based targets, since no organisation wishes to increase product damage, product loss or reduce the shelf life or durability of a product. Efforts in packaging have been towards reducing weight to the lowest acceptable level rather than the lowest conceivable. In the same way, efforts to reduce greenhouse gas emissions would also have to consider both packaging and product. In the majority of cases, it is anticipated that the greenhouse gas emissions associated with the product will exceed those associated with its packaging. This should be borne in mind, but does not represent a reason for inaction. Rather, it represents a motivation for packaging optimisation, to protect and deliver the contents using the optimum packaging configuration.

The methodology is not designed for use in mapping of carbon "hot spots" (these will be identified in separate pieces of research to be commissioned in support of the new commitment). Although the methodology identifies the pathways of individual natural resources, from their extraction to their multiple uses for products of many kinds and other purposes, and back into the environment as either pollutants or waste, the data come from secondary sources which may not reflect the climate change characteristics of individual businesses or supply chains. Furthermore, many of the data sources are commercial in nature - so we are not able to publish data on certain stages in isolation without infringing copyright. **See section 6 for information on the use of data held by signatories from primary sources**.

3.2 Methodology behind the commitment

The goal of this document is to set out an agreed methodology for developing indicators for all packaging materials commonly used by Courtauld signatories. This includes:

- Agreeing the goal and scope of the assessment with signatories;
- Agreeing the life cycle stages to be included (and excluded);
- Agreeing secondary data sources to be used;
- Agreeing issues not clarified in existing standards (e.g. the allocation methodology to be used); and
- Agreeing the carbon conversion factors to apply to improvements made under the auspices of this agreement.

The assessment methodology is underpinned by the following standards:

ISO 14040:2006: Environmental management — Life cycle assessment — Principles and framework
ISO 14044:2006: Environmental management — Life cycle assessment — Requirements and guidelines
PAS 2050 (2008): Specification for the assessment of the life cycle greenhouse gas emissions of goods and services
The WRI / WBCSD Greenhouse Gas Protocol Initiative www.ghgprotocol.org

It also draws on the work undertaken by Sevenster et al (2007)[6] in the Netherlands, which at the time of writing is under revision.

3.3 Conversion factors

The conversion factors used to communicate global warming potential in CO_2 equivalent are the latest available from the IPCC Fourth Assessment Report[7]. Other conversion factors are taken from the IPCC Emissions Factor Database[8]. Key conversion factors are reproduced in Annex 4. General data sources are covered in section 6.1.

3.4 Rounding

Due to the high level nature of the agreement, it is inappropriate to quote carbon factors to the nearest kilogram, especially when discussing the signatory's achievements collectively. It is therefore proposed that all figures are rounded to the nearest 10kg per tonne of material, and for reporting purposes to three significant figures. This approach would not recognise the benefits of incremental improvements on site which may yield carbon savings, but would recognise changes which occur at a sectoral level.

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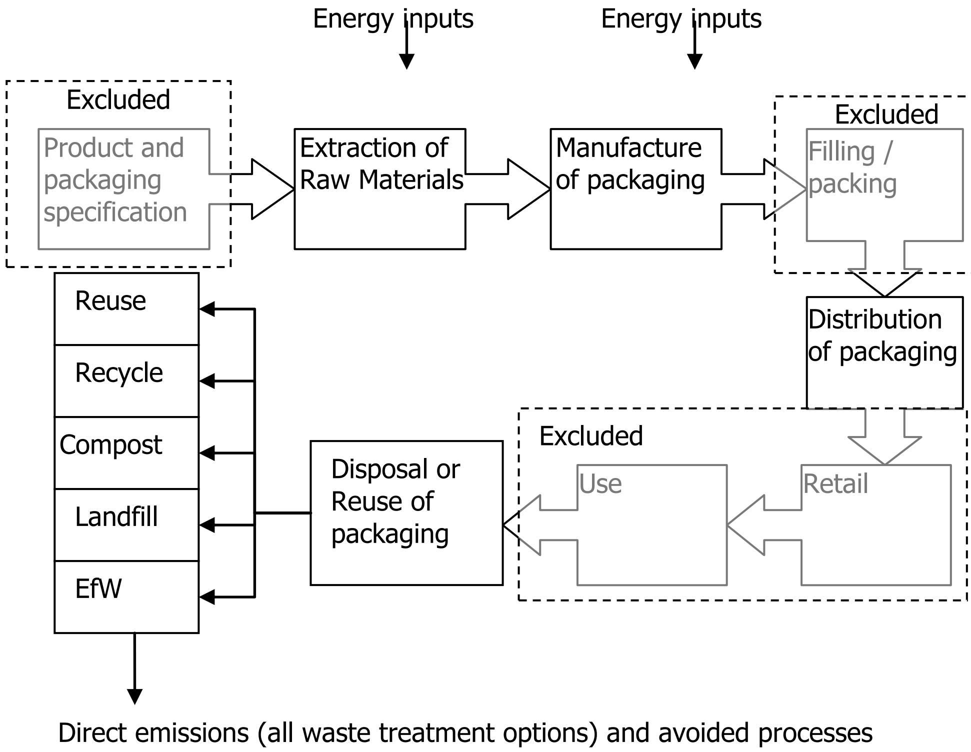
6 *Sevenster, M., Wielders, L., Bergsma, G., Vroonhof, J., (2007)* Environmental indices for the Dutch packaging tax *Delft, The Netherlands, CE Delft*

7 *Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.) (2007)* Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change *Cambridge University Press, Cambridge, United Kingdom Table 2.14.* Lifetimes, radiative efficiencies and direct (except for CH4) global warming potentials (GWP) relative to CO2 *http://www.ipcc.ch/ipccreports/assessments-reports.htm*

8 *http://www.ipcc-nggip.iges.or.jp/EFDB/main.php*

3.5 Packaging system boundaries

It is proposed that the following steps are included in / excluded from the carbon calculation for the purposes of the Courtauld Commitment.



Product and packaging design is the most influential stage in the life cycle of packaging and product, since it determines many of the features of both (e.g. material, weight, cost). However, in terms of direct impacts, this stage is not assumed to contribute significant emissions.

For this methodology, the stages associated with filling packaging with a product, distributing the product and in-store impacts are allocated to the product rather than the packaging. If a signatory engages in activity, such as lightweighting or increasing recycled content, it is unlikely that this would affect the emissions associated with filling. Furthermore, the impacts associated with filling will depend on the product properties (e.g. chilled, hot, liquid, solid contents). As such, they are excluded from the assessment of packaging. The intention is that all of these factors will be addressed by the Courtauld Commitment, but that more work is required at this stage to develop suitable information on these impacts and their management.

It is however important to note that this should be considered before making any changes to the packaging to ensure that there are no unintended consequences.

3.6 Treatment of Biogenic Carbon

When considering the extraction and disposal of materials, there is a need to distinguish between the carbon dioxide which arises from fossil fuels (so-called "long cycle" carbon or "fossil CO_2") and that which is taken up by plants and released when the plant degrades ("short cycle" carbon or biogenic CO_2).

By extracting and burning fossil fuels, fossil carbon is being moved from one store (underground) to another (the atmosphere). This creates an imbalance and leads to an increase in atmospheric carbon. In contrast, the biogenic carbon can be said to be in a short cycle, as carbon is taken up from the atmosphere, whilst flora and fauna are alive, and released at the end of their life (i.e. inputs equal outputs). This has the effect that, in a sustainable production system, over the whole life of the material the carbon account can be considered neutral. The burning of fossil fuels releases stored carbon into the atmosphere and cannot be considered neutral.

Where a production system is unsustainable (e.g. clear-felling of forests), biogenic CO_2 uptake and emissions may not be balanced, and use of renewable materials may cause CO_2 to be emitted to the atmosphere.

There is a specific challenge in addressing biogenic CO_2 emissions with respect to wood and wood-derived products, and the relationship to recycling. This centres on recognising existing and potential sustainable and unsustainable timber harvesting.

The PEFC Council (Programme for the Endorsement of Forest Certification schemes) identify that only 8% of the total global forest area is covered by certification schemes covering sustainability criteria, with the majority of certified forests located in developed countries.[9] Approximately half of these are covered by Forest Stewardship Council (FSC) schemes.[10] Chain of Custody Certificates allow purchasers to demonstrate that their supplies have come from sources which are managed in a sustainable manner, but there is clearly significant potential for unsustainable harvesting of wood. WWF estimates that up to 50% of timber from the Congo Basin and Russia is illegal (and unsustainable), and for Indonesia the figure rises to 80%

CEPI (2007) shows that Europe uses 119.3 million tonnes of wood to make 43.5 million tonnes pulp input to paper and board, plus imports and minus exports. It also uses 49.6 million tonnes recycled paper and card to provide an almost identical input. Whilst accepting that loss rates are different in both systems, if we did not recycle paper and card, we would require an additional 119 million tonnes of wood per year. This increased demand would lead to unsustainable forestry practices, since all sustainably managed resources are currently contracted, and do not meet current demand. Therefore, recycling wood, paper and card avoids massive land use change and associated emissions caused by removing forests. However, this is not to say that this saving should be considered against sustainably sourced material, one of the purposes of which is to avoid detrimental land use change.

PAS 2050 requires the consideration of biogenic CO_2 where more than 50% of the mass of carbon of biogenic origin in the product remains removed from the atmosphere for one year or more following production of the product. It also requires that if a product is disposed of in a manner that prevents some or all of the biogenic carbon being re-emitted to the atmosphere within the 100-year assessment period, the portion of biogenic carbon not re-emitted to the atmosphere shall be treated as "stored" carbon.

This differs to the greenhouse gas accounting methods developed by the Intergovernmental Panel on Climate Change, under which biogenic carbon is part of the natural carbon balance and is not considered to contribute to atmospheric concentrations of carbon dioxide[11], unless biomass raw materials are not being sustainably produced.

In this methodology, biogenic CO_2 is excluded from the calculations, and it is assumed that biomass is derived from sustainable sources. Other biogenic greenhouse gases (methane and nitrous oxide) are accounted for. As an illustration, this would mean that CO_2 absorbed by trees as they grow is not counted, but when paper is disposed of by landfill or energy recovery, CO_2 emissions are not counted either, but methane emissions are.

For information only, biogenic CO_2eq per tonne taken up and emitted at end of life will be shown at the beginning and end of life, but these figures are not used as part of the assessment and should be treated with caution. They will be added to inform debate in this area. Emissions from combusting renewable fuels will appear counterintuitive, as they have a lower calorific value than fossil fuels, and so including biogenic CO_2 means that emissions per kWh electricity generated from paper will be higher than electricity generated from fossil fuels.

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9 *Who gains from FSC's latest effort to undermine other forest certification systems? 30th October 2009) http://www.pefc.org/internet/html/news/4_1154_65/5_1105_2112.htm*

10 *Tracer (2009)* The Guide to Traceable Certified Forest Products

11 *Intergovernmental Panel on Climate Change (2006).* 2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Vol. 5, Pg. 3.6, Paris France).* http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html

Intergovernmental Panel on Climate Change (1997). Greenhouse Gas Inventory Reference Manual: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Vol. 3, Pg. 6.1, Paris France).* http://www.ipcc-nggip.iges.or.jp/public/gl/invs6.html

3.7 Transport

The following transportation distances and vehicle types have been assumed for this methodology. The impact of transporting the raw material (e.g. forestry products, granules, glass raw materials, etc.) is already included in the manufacturing profile for all raw materials:

Table 3.7.1 Average transportation distances

Destination / Intermediate Destination	One Way Distance	Mode of transport	Source
Plastic granules – convertor	112km	Average, all HGVs	DfT (2009)[12] Based on average haulage distance for all commodities, not specific to the materials in the first column.
Aluminium sheet – can forming			
Steel coil – can forming			
Paper mill – box converting			
Saw mill – pallet converting			
Converted product – filling plant	112km		DfT (2009)
Distribution to Retail Distribution Centre & to retailer	95km		McKinnon (2007)[13] IGD (2009)[14]

All transport distances are subject to sensitivity analysis and discussion in section 9.

For glass all bottles are manufactured on the same site at which molten glass is produced. For all other materials, the forming of packaging occurs at a separate site. For all materials it is assumed that they are converted at a separate site to be filled. However, this is not necessarily the case. Many producers of milk, sodas and other drinks have integrated plant which form and fill packaging. We recognise this as a gap in the methodology.

For all transport calculations it is essential that we consider whether vehicle movements are weight or volume limited, i.e. whether they are filled until they reach the legal weight limit for the vehicle or until the space available is filled. For 32-38 tonne vehicles, Herriot Watt University estimate 40-50% of journeys are volume limited, and 10% are weight limited. However, this includes all goods movements, including low density automotive distribution. It is expected that distribution of retail goods would have a different profile. Earlier work suggests that the average weight-based load factor, at 53%, was very similar to this average cube utilisation value.[15] Loading factors also vary significantly by vehicle type. Loading factors for articulated vehicles of 43% and 60% are reported for 3.5-33 and over 33 tonne vehicles respectively, with further variations by sector[16].

Vehicle utilisation is described by lading factor and empty running. Lading factor is a ratio of the tonne-kms that a vehicle actually carries to the tonne-kms it could have carried if it was running at its maximum gross weight. Empty running is expressed as a percentage of the total lorry kilometres run.

12 *DfT (2009)* Transport Statistics Bulletin: Road Freight Statistics 2008 *National Statistics Table 1.14d* http://www.dft.gov.uk/pgr/statistics/datatablespublications/freight/goodsbyroad/roadfreightstatistics2008

13 *McKinnon, A.C. (2007)* Synchronised Auditing of Truck Utilisation and Energy Efficiency: A Review of the British Government's Transport KPI Programme http://www.sml.hw.ac.uk/logistics/downloads/efficiency/Review%20of%20Transport%20KPI%20programme%20(WCTR%202007).pdf

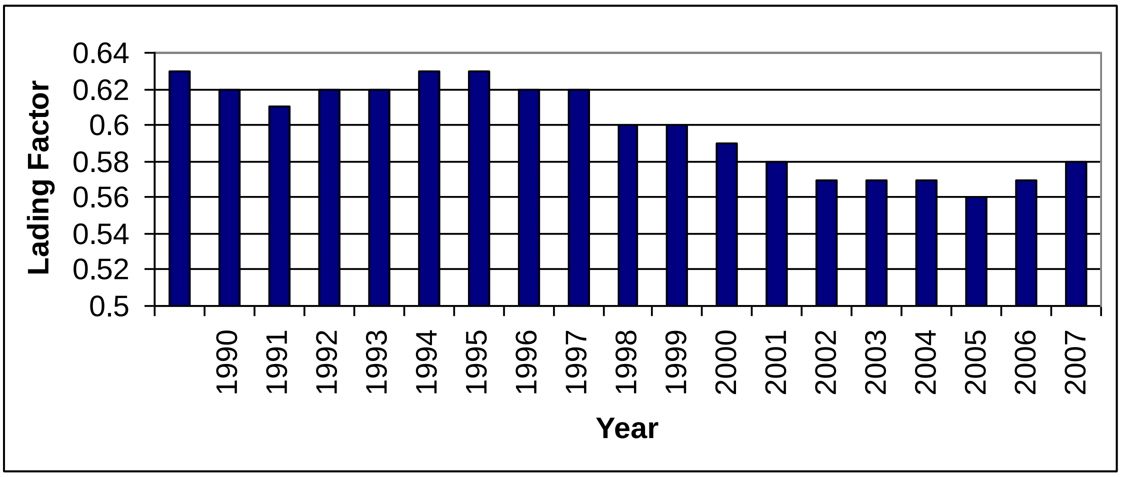
14 *IGD (2009)* UK Food & Grocery Retail Logistics Overview *Date Published: 24/11/2009* http://www.igd.com/index.asp?id=1&fid=1&sid=17&tid=0&folid=0&cid=223

15 *McKinnon, A., Ge, Y., and Leuchars, D. (2003)* Analysis of Transport Efficiency in the UK Food Supply Chain, *Logistics Research Centre: Edinburgh* http://www.sml.hw.ac.uk/logistics/pdf/Kpi2003.pdf

16 *DfT (2009)* Transport Statistics Bulletin: Road Freight Statistics 2008 *National Statistics Table 1.15* *http://www.dft.gov.uk/pgr/statistics/datatablespublications/freight/goodsbyroad/roadfreightstatistics2008*

Over time, it come as a surprise that the lading factor has reduced, i.e. today vehicles are carrying less weight per journey. There are a number of factors behind this which we do not propose to discuss here, but would suggest the references at the bottom of this page for further insight.

Figure 3.7.2 Road Haulage Lading Factor for all vehicles 1990-2008



The high proportion of journeys which are volume limited highlight a potential opportunity for increasing the efficiency of transportation through altering the packaging: product ratio. Making changes to the packaging which allow more goods to be transported per journey, whilst maintaining product quality, could significantly reduce emissions associated with haulage.

A further discussion on the loading factors used takes place at the end of this section.

DEFRA[17] and GHG Protocol[18] guidelines on vehicle emissions have been used for most vehicle emission factors. The 2009 DEFRA update provides emissions factors for the non-CO_2 greenhouse gases methane (CH4) and nitrous oxide (N_2O) as well, based upon the emission factors used in UK Greenhouse Gas Inventory (GHGI). These have been amended to ensure consistency with the Fourth Assessment Report. However, please note that this makes a difference of less than 1 gram CO_2 equivalent per tonne kilometre to the published figures. Emissions associated with the production and transportation of the fuel have been provided by the Carbon Trust.

Figures for Refuse Collection Vehicles have been taken from the Environment Agency's Waste and Resource Assessment Tool for the Environment (WRATE).

Transport distances for waste were estimated using a range of sources, principally data supplied by the Environment Agency for use in the WRATE tool (2005). The distances adopted are shown below. The percentage exported is outlined in section 3.8.1.

17 http://www.defra.gov.uk/environment/business/reporting/conversion-factors.htm

18 http://www.ghgprotocol.org/downloads/calcs/co2-mobile.pdf

Table 3.7.3 Average transport distances for waste

Destination / Intermediate Destination	One Way Distance	Mode of transport	Source
Household, commercial and industrial landfill	25km by Road	26 Tonne Refuse Collection Vehicle, maximum capacity 12 tonnes	WRATE (2005)
Inert landfill	10km by Road		WRATE (2005)
Transfer station / CA site	10km by Road		WRATE (2005)
MRF	25km by Road		WRATE (2005)
MSW incinerator	50km by Road		WRATE (2005)
Cement kiln	50km by Road		WRATE (2005)
Paper and Card	41% 250km by Road, 59% 250km by road plus 18000km by Boat to Guangdong plus 50km by road	Average, all HGVs	WRAP (2008)[19]
Glass (Container - Clear and Amber)	50km by Road		DEFRA (2009)
Glass (Container Green) 24% total	50km by road and 390km by Boat		DEFRA (2009) WRAP (2008)
Glass - construction aggregate	50km by Road		DEFRA (2009)
Aluminium	50% 250km by Road, 50% 50km by road and 390km by Boat	Average, all HGVs, 5000-10,000 TEU capacity vessel. For China, the vehicle is assumed to be 32 tonne vehicle meeting Euro II emissions criteria	WRAP estimate based on Hull - Rotterdam
Steel/Iron	34% 250km by Road, 66% 50km by road and 390km by Boat		
Plastics	33% 250km by Road, 67% 250km by road, mixed plastics 17600km by Boat to Hong Kong, PET 19000km by Boat to Shanghai, HDPE 18000km by Boat to Tianjin, then 150km by road (80km for mixed plastic)		WRAP (2008)
Wood	50km by Road	Average, all HGVs	DEFRA (2009)
Inert recycling	10km by Road		
Autoclave fibre recycling	50km by Road		
Liquid Beverage Cartons	50km by road and 884km by boat Hull – Malmo	Average, all HGVs	DEFRA (2009)

All distances are shown one way, but obviously transport vehicles do not only travel one way.

The assumptions regarding emissions from transportation are as follows:

Road vehicles are volume limited rather than weight limited. For all HGVs, an average loading factor (including return journeys) of 56% is used based on DEFRA (2009)[20]. For waste vehicles, they obviously leave a depot empty and return fully laden. A 50% loading assumption reflects the change in load over a collection round which could be expected.
For international sea freight, there is a trade imbalance between Europe and the Far East. This means that vessels may return empty (but with ballast), or partially empty, unless they were carrying materials for recycling. In these circumstances, it would be appropriate to consider only the marginal emissions, i.e. those incurred by moving the additional weight of the freight, but not of the vessel itself.

[19] *WRAP (2008)* CO_2 impacts of transporting the UK's recovered paper and plastic bottles to China*; Banbury, WRAP.*

[20] http://www.defra.gov.uk/environment/business/reporting/conversion-factors.htm

3.8 End of Life

It is proposed that the methodology for end of life is bespoke for each material, building upon the work of PAS 2050 and ISO14040. This is discussed in further detail in Annex 3. Different approaches are proposed for each material with regard to accounting for recycled content and recycling rates. These reflect the nature of the recycling markets for these products (e.g. whether they are supply or demand limited, recycling route taken). For the avoidance of doubt, process waste is excluded from recycled content calculations for all materials.

Annex 2 discusses issues associated with calculating the impact of energy recovery of different materials. For energy recovery, it is assumed that the net conversion of energy to electricity is 23%. This figure is liable to change over time as technology improves.

In landfill, it is assumed that as biogenic materials degrade, they will release greenhouse gases, including methane. A proportion of this is captured for flaring or electricity generation (Note: in the UK landfill sites currently produce more electricity than combustion plant). In this methodology, we assume that 71% of methane is captured, of which 46% (i.e. 32% of total methane generated)[21] is used for electricity generation, at a generation efficiency of 35%. 10% of uncaptured methane is assumed to be oxidised at the cap. These figures are also liable to change over time.

Emissions from the landfill of different materials are calculated on the basis of the IPCC First Order Decay Models.

3.8.1 Imported packaging and end-of-life packaging exported for recycling

The majority of packaging used in the UK is manufactured in the UK and remains within the country. Table 3.8.1 below shows data by packaging material. The figures were generated by the National Packaging Waste Database (June 2009). Perhaps unsurprisingly, the greatest proportion of packaging imported by material is wooden (transit) packaging.

Although most packaging material collected for recycling is recycled within the UK, this is not true of all materials. Based on data for 2008[22], the National Packaging Waste Database suggests the proportions of packaging by material are exported for reprocessing are as in table 3.8.2.

Many of these proportions will change over time due to the work of organisations, such as WRAP, market forces, etc.

The international nature of the market for key recyclables and packaging means that it would not be possible to know with certainty the exact use of exported recyclate, or the recycled content in all imported packaging. It may be that material exported from the UK for recycling returns to the UK within packaging, or it may go to other uses. In this methodology we must therefore make assumptions about these options.

For materials imported into the UK, it is assumed that the level of recycled content is the same as that in UK produced packaging. The potential unintended consequences of this approach are that too little or too much credit is given for the benefit of recycling / use of recyclate overseas.

[21] *Jackson J, Choudrie S, Thistlethwaite G, Passant N, Murrells T, Watterson J, Mobbs D, Cardenas L, Thomson A, Leech A (2009) UK Greenhouse Gas Inventory, 1990 to 2007: Annual Report for submission under the Framework Convention on Climate Change Annex 3*
http://www.naei.org.uk/reports.php?list=GHG

[22] *https://npwd.environment-agency.gov.uk/Public/PublicDEFRAReport.aspx*

Table 3.8.1 Total Percentage Activity carried out on packaging handled[23]

Total Percentage Activity carried out on packaging handled							
	Paper	Glass	Aluminium	Steel	Plastic	Wood	Other
Total packaging handled (tonnes)	2,712,801	1,967,311	137,570	497,378	1,608,868	768,110	15,573
Packaging / Packaging Materials Imported	730,589	508,351	26,056	106,173	307,111	108,517	3,839
Imported Transit Packaging	470,759	360	358	34,918	84,180	334,844	2,328
Packaging / Packaging Materials Exported	338,723	383,671	17,652	103,719	138,433	205,145	3,430
Total (export deducted)	3,575,426	2,092,351	146,332	534,750	1,861,726	1,006,326	18,310
Total (export included)	4,252,872	2,859,693	181,636	742,188	2,138,592	1,416,616	25,170
Imported	1,201,348	508,711	26,414	141,091	391,291	443,361	6,167
Percentage Imported	34%	24%	18%	26%	21%	44%	34%

[23] https://npwd.environment-agency.gov.uk/filedownload.ashx?fileid=4aea5fa0-9048-439a-9675-7251935ed544

Table 3.8.2 Packaging exported for reprocessing (2008)

Packaging Material	% recyclate / scrap exported for reprocessing
Paper/board	59%
Glass	24%
Aluminium	49%
Steel	66%
Plastic	67%
Wood	0%
Total Recyclate Exported	43%

For materials exported for recycling the following assumptions are made:

Table 3.8.3 Assumptions on Packaging exported for reprocessing

Packaging Material	% exported for closed loop recycling	% exported for open loop recycling
Paper/board	100%	0%
Glass	100%	0%
Aluminium	100%	0%
Steel	100%	0%
Plastic	50%	50%
Wood	N/A	N/A

The definition of closed and open loop recycling used is discussed in Annex 3, but closed loop essentially covers where the recycled material substitutes the same primary material in a similar quality application. In many cases this would be back into packaging but this may not be practical in all cases (see Annex 3).

4.0 Bulk importing of goods for packaging / re-packaging in UK

WRAP is working with the wine industry to encourage bulk exporting of wine and bottling in lightweight bottles in the UK. This can save costs and improve the industry's carbon emissions profile. Where a signatory is considering this measure, potential savings may be identified through WRAP's ready reckoner.

http://winebottles.wrap.org.uk/savings/

For reporting purposes, we would require signatories to provide information on changes in bulk importation during the reporting period and the country of origin from which primary packaging has been avoided. Appropriate benefits can then be calculated.

5.0 Reusable packaging

A number of factors can influence the potential consequences of switching to reusable packaging systems. These include transportation distances, cleaning processes, loss rates, and impacts on the product.

As part of WRAP project RHI007, a draft tool has been developed to assess the relative merits of reusable packaging and single trip / use packaging. The factors within this tool are compatible with those described in this methodology.

The potential impact of reusable packaging on the product has not been included in this calculation. In trials with WRAP, B&Q has switched to reusable packaging for kitchen work surfaces[24]. The switch has resulted in a reduction in the amount of product wasted. However, in carbon terms, the benefits of such actions are a function of the packaging system and the product contained. As with filling, this impact is excluded from this methodology.

[24] *http://www.wrap.org.uk/retail/case_studies_research/case_study_1.html*

6.0 Data Issues

6.1 Data Sources

The methodology is based on published greenhouse gas emission data rather than data collected from signatories or packaging companies directly. These include eco-profiles for plastics developed by Plastics Europe (2005), the global steel industry database held by the World Steel Association (2008), the European Aluminium Association data on aluminium production (EAA, 2008), and data held by FEFCO and Pro Carton on cardboard (2009).

This is supplemented with data from the Ecoinvent database and reports / data from other trade associations (e.g. British Glass) and third parties (e.g. academic journals, Intergovernmental Panel on Climate Change). Data on wood is taken from published life cycle assessments as no trade association eco-profile is available. Data sources for transport are referenced in section 3.7. Data on waste management options has been modelled using SimaPro and WRATE. Assumptions are identified in the material chapters and annexes on waste.

6.2 Data Quality Indicators

Data used in this methodology should meet the following data quality indicators:

Data Quality Indicator	Requirement	Comments
Time-related coverage	Data less than 5 years old	Ideally data should represent the year of study. However, the secondary data in material eco-profiles is only periodically updated.
Geographical coverage	Data should be representative of the packaging placed on the market in the UK	Many datasets reflect European average production. This is in line with the majority of packaging used in the UK.
Technology coverage	Average technology	A range of information is available, covering best in class, average and pending technology. Average is considered the most appropriate but may not reflect individual supply chain organisations.
Precision / variance	No requirement	Many datasets used provide average data with no information on the range. It is therefore not possible to identify the variance.
Completeness	All datasets must be reviewed to ensure they cover inputs and outputs pertaining to the life cycle stage	
Representativeness	The data should represent UK conditions	This is determined by reference to the above data quality indicators
Consistency	The methodology has been applied consistently.	
Reproducibility	An independent practitioner should be able to follow the method and arrive at the same results.	
Sources of data	Data will be derived from credible sources and databases	Where possible data in public domain will be used. All data sources referenced
Uncertainty of the information		Many data sources come from single sources. Uncertainty will arise from assumptions made and the setting of the system boundaries. Before making decisions on the basis of data, signatories and their supply chains will need to make their own assessment and be satisfied there are no unintended consequences.
Transparency	The process for deriving factors should be readily understood.	Independent practitioners should be able to derive the same results by following the steps described.

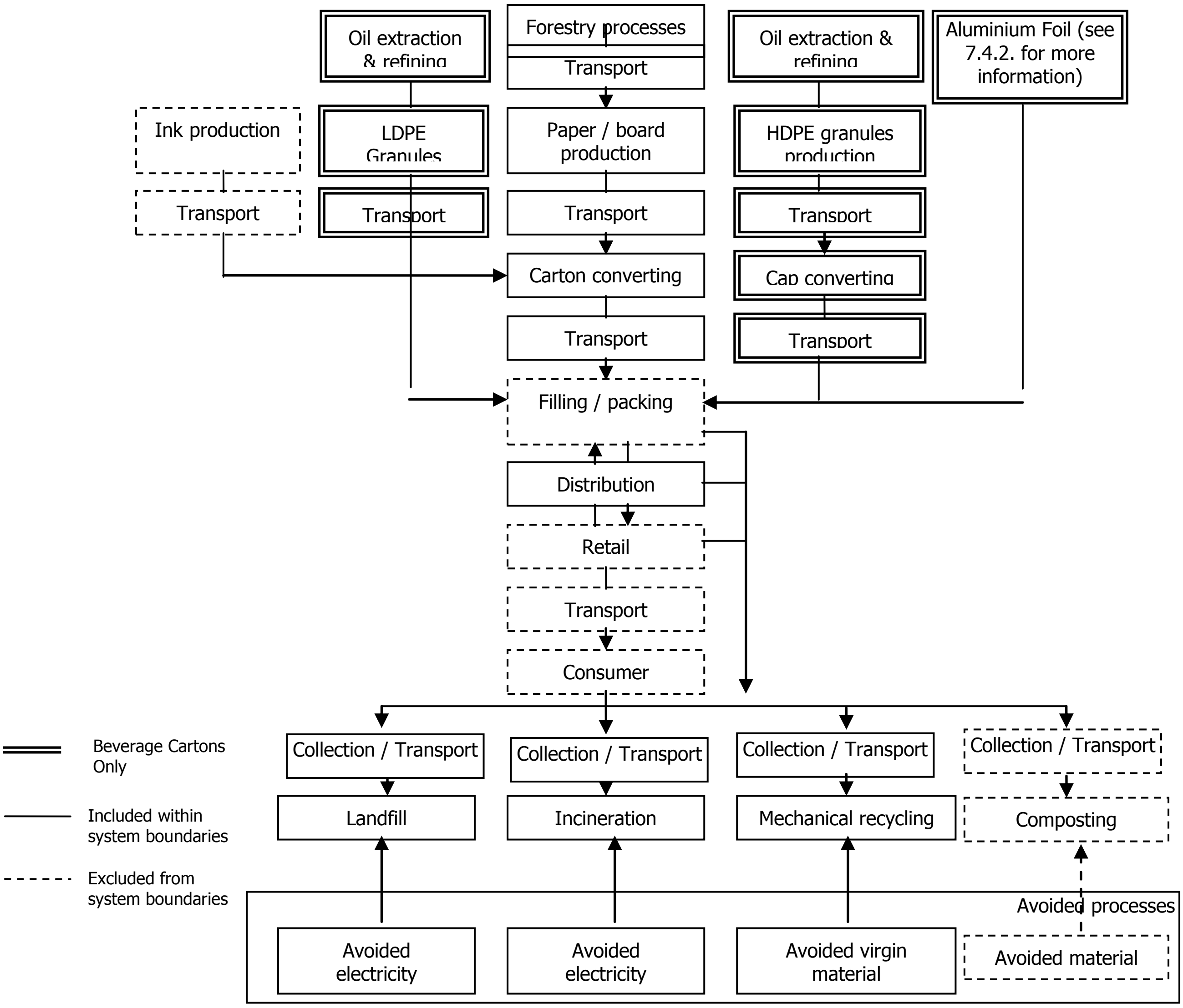
7.0 Data on individual packaging materials

7.1 General strategy and procedure

For each of the materials covered by this methodology, an illustrative system boundary diagram is provided in each following section, together with information on the assumed losses through recycling systems.

7.2 Paper/board

Figure 7.2.1 System boundary diagram for paper & board



The following sub-groups of board are identified by CEPI[25]. Each sub-group in itself may cover several types of board:

- Corrugated board
- Carton Board (Also known as white line chipboard, solid board, folding box board, boxboard or carrier board).
- Wrappings (up to 125 g/m^2)
- Other Papers mainly for Packaging Purposes (all paper and board mainly for packaging purposes other than those listed above).

In addition to these, beverage cartons must also be considered by the agreement.

[25] *CEPI (2008)* Key Statistics 2007: European Pulp and Paper Industry *Brussels: CEPI*

With the exception of beverage cartons, CEPI maintain annual data on European recycling rates and recycled content utilisation for each of these grades of board. On a UK basis, data on recycling is collected via the PRN system at a category level (e.g. for all cardboard).

Different boards have different levels of recycled content and are derived from processes which may be powered by either renewable energy or fossil fuels. At the end of their lives, they also have different recycling rates. These variations mean that the actual level of greenhouse gas emissions associated with the production of board can vary from mill-to-mill, and from country to country.

Following discussion with the industry, these materials are treated as follows with Courtuald 2: Cardboard, covering corrugated board (commonly used for secondary or transit packaging), cartonboard (commonly used for primary packaging); wrapping papers and; liquid cartonboard.
Using CEPI data, the consumption of cardboard in Europe is 78% corrugate and 22% cartonboard.

7.2.1 UK Supply chain for cardboard packaging

The supply chain for cardboard packaging starts with forestry activities, through pulp production and processing of the pulp to board, delivered to packaging producers on reels or in sheets. This semi-finished material is then cut and printed to create the box or package, which is then sent to the filler and subsequently marketed. Some of these steps are integrated and take place at one and the same facility. In that case the data have not been broken down. For all the sub-materials, average losses amount to 8%.

7.2.2 Beverage Cartons

Although there are many variations in the nature of beverage carton design, all cartons come under two categories:

- Chilled cartons, consisting of a combination of about 11% PE and 89% board and used for packaging dairy products[26].
- Aseptic cartons, consisting of a combination of about 5% aluminium, 20% PE and 75% board and used for packaging longer-life products.

The cardboard (liquid packaging board, LPB) is produced from 100% primary raw materials in Scandinavia. Lamination, which takes place in the UK or European importers, involves applying a PE coating to both sides of the board (by extrusion). In the case of aseptic beverage cartons, there is a thin layer of aluminium on the inside, between the board and the PE. The laminate is sent to the packager on reels for filling and subsequent marketing.

In recent years the ease with which beverage cartons may be recycled has increased, through the efforts of the industry in installing recycling banks across the UK.

In 2008-09 beverage cartons collected for recycling were exported to Scandinavia, where the paper fraction was used in the production of paper products, and the plastic and aluminium fraction sent either for open-loop recycling or for energy recovery.

Emission factors and data for production of the board used in beverage cartons and for laminate production have been taken from the Ecoinvent Database. When aseptic beverage cartons are incinerated, the aluminium they contain may burn (in contrast to solid aluminium packaging) and contributes to power and heat generation.

It is assumed that the avoided virgin fibres are in the form of sulphate pulp, and that one tonne of secondary fibres replaces 900 kg of sulphate pulp.

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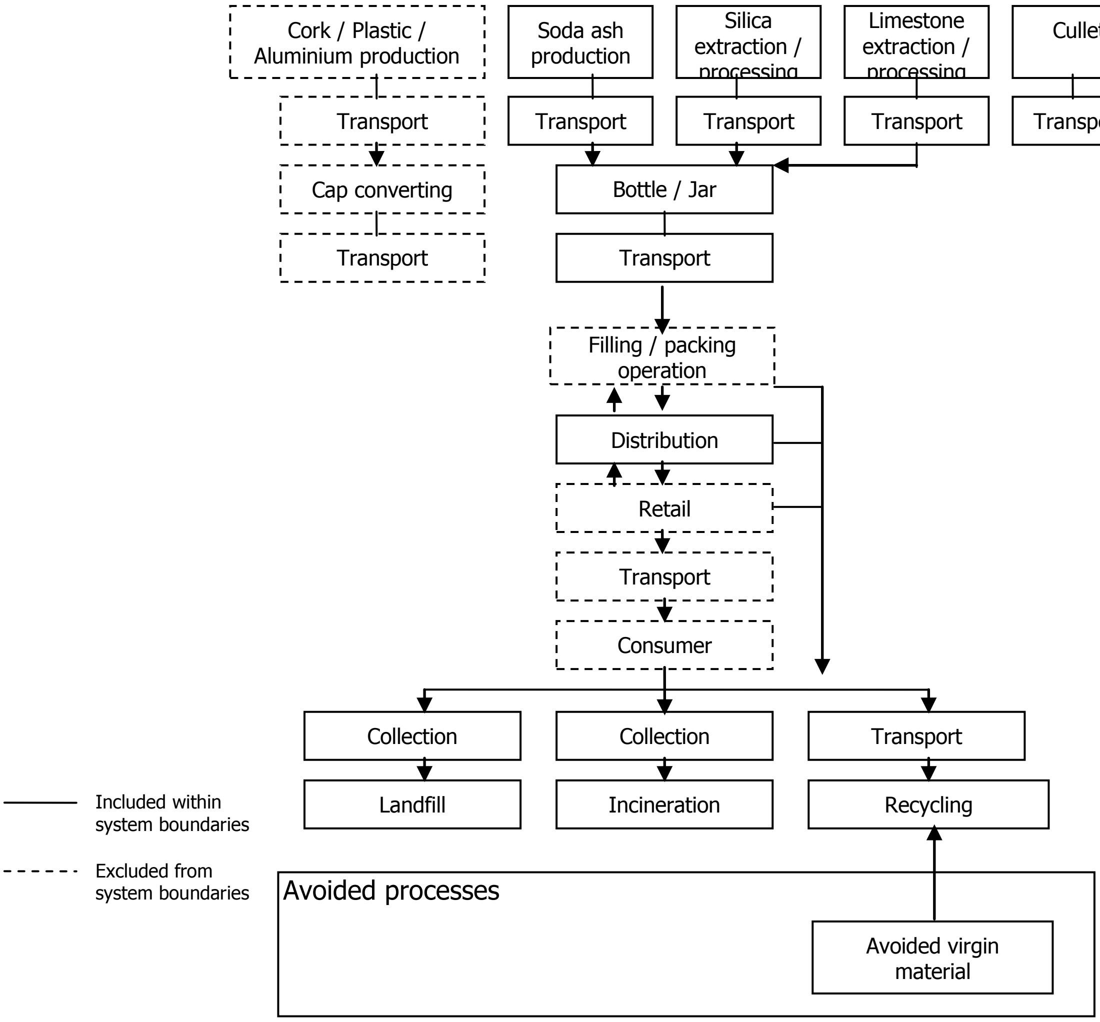
26 *http://www.ace-uk.co.uk/beverage.html*

7.3 Glass

The main raw materials used in the manufacture of glass are silica (sand), soda ash and limestone. These are melted together in a furnace to form glass. Bottle and jars are produced from molten glass in cast iron forming moulds, where compressed air is blown into the glass to achieve the required shape.

Figure 7.3.1 System boundary diagram for glass



Data on glass production is collected by British Glass, the UK trade association for glass manufacturers. Greenhouse gas emissions associated with UK glass manufacture and recycling were published by British Glass in 2004, and they continue to monitor associated issues with relation to the Climate Change Levy Agreement covering the sector.

Cook (1978)[27] suggests that 1 kg of recycled cullet is required to replace 1.2Kg of raw materials

[27] *Cook, R.F. (1978) The collection and recycling of waste glass (cullet) in glass container manufacture,* Conservation & Recycling *Volume 2, Issue 1, 1978, Pages 59-69*

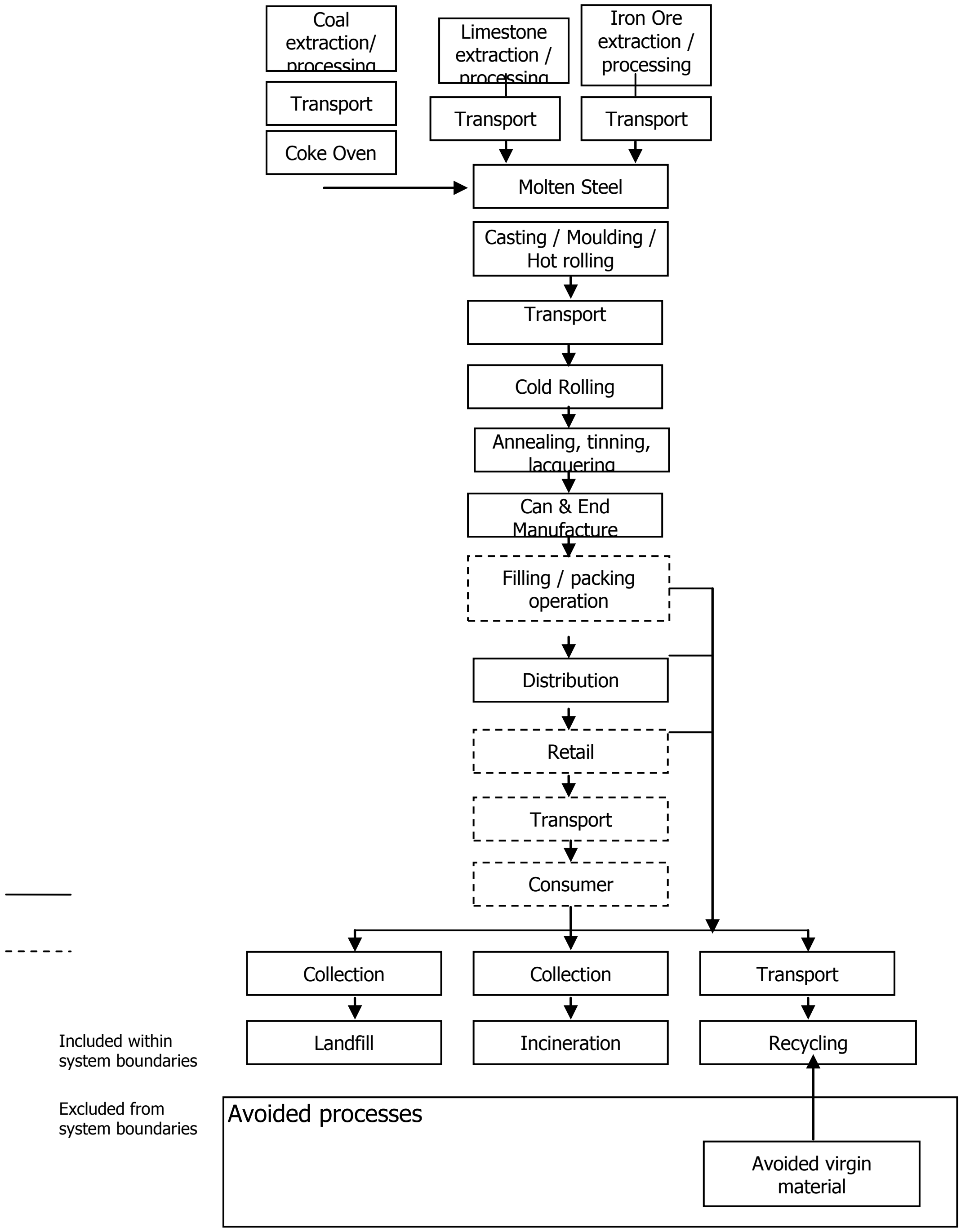
7.4 Metals

There are two key metals associated with packaging in the UK, steel and aluminium.

For both materials, the can manufacturing operation follows a similar process. Once formed, aluminium / steel coils are delivered to a can manufacturing plant and fed through a cupping press which blanks and draws shallow cups. Each cup is then rammed through a series of tungsten carbide rings. This process (ironing) redraws, thins and raises the walls of the cans into their final can shape. The edge is then trimmed and surplus material recycled. The trimmed can is washed and dried. If the can is going to be printed upon, it is then lacquered and dried in a hot air oven. The can is then printed and varnished. The inside of the can is lacquered to prevent corrosion. The can is then shaped and palletised before dispatch to filling plant (source: Beverage Can Makers Europe (BCME)).

7.4.1 Steel

Figure 7.4.1.1 System boundary diagram for steel



Steel, especially stainless steel, needs a low carbon content. Excess carbon associated with primary steel is commonly converted to CO_2 by blowing oxygen through the molten steel. The CO_2 subsequently leaves the steel as it solidifies. Separately collected recyclate (once de-tinned) is also added to the oxygen process, but already has a low carbon content. By comparison, steel recovered following energy recovery may have a high carbon content and require the removal of excess carbon.

In the UK generally three types of steel for packaging are used: tinplate coil and tin free coil, although in some cases uncoated black-plate. Approximately 88% of packaging on the market in the UK is tinplate and 12% is tin free (Source: pers. comm. MPMA).

Tinplate coil (electrolytic tin plated steel) and tin free coil (Electrolytic Chrome Coated Steel - ECCS) are made by electro plating a thin finished cold rolled coil with a thin layer of tin / chrome respectively. An additional polymer coating/laminate may be applied depending on the final application. The coils of steel are then further processed into finished products by packaging manufacturers. Tinplate and tin free coil are chiefly used in food and drinks cans or industrial packaging.

It has been assumed that steel packaging in the UK is made either of tin plated or tin free steel. CO_2 equivalent emissions data for steel production and end-of-life recycling was obtained from the World Steel Association, using 2009 EU average life cycle inventory LCI data for tinplate and tin free coil (worldsteel 2009[28]). Coil, or rolled sheet, is the semi-finished product from which the packaging is made.

Cans are assumed to be the most common form of steel packaging and these have therefore been taken as approximately representative of the whole spectrum of steel packaging. Data on the energy input involved in producing cans from rolled sheet were adopted from BUWAL data on can making (1996, best available data).

Of the steel which is not recycled, most will be sent to landfill. The steel sent to energy from waste plant in mixed waste is largely recovered, via mechanical separation and reprocessing of the bottom ash.

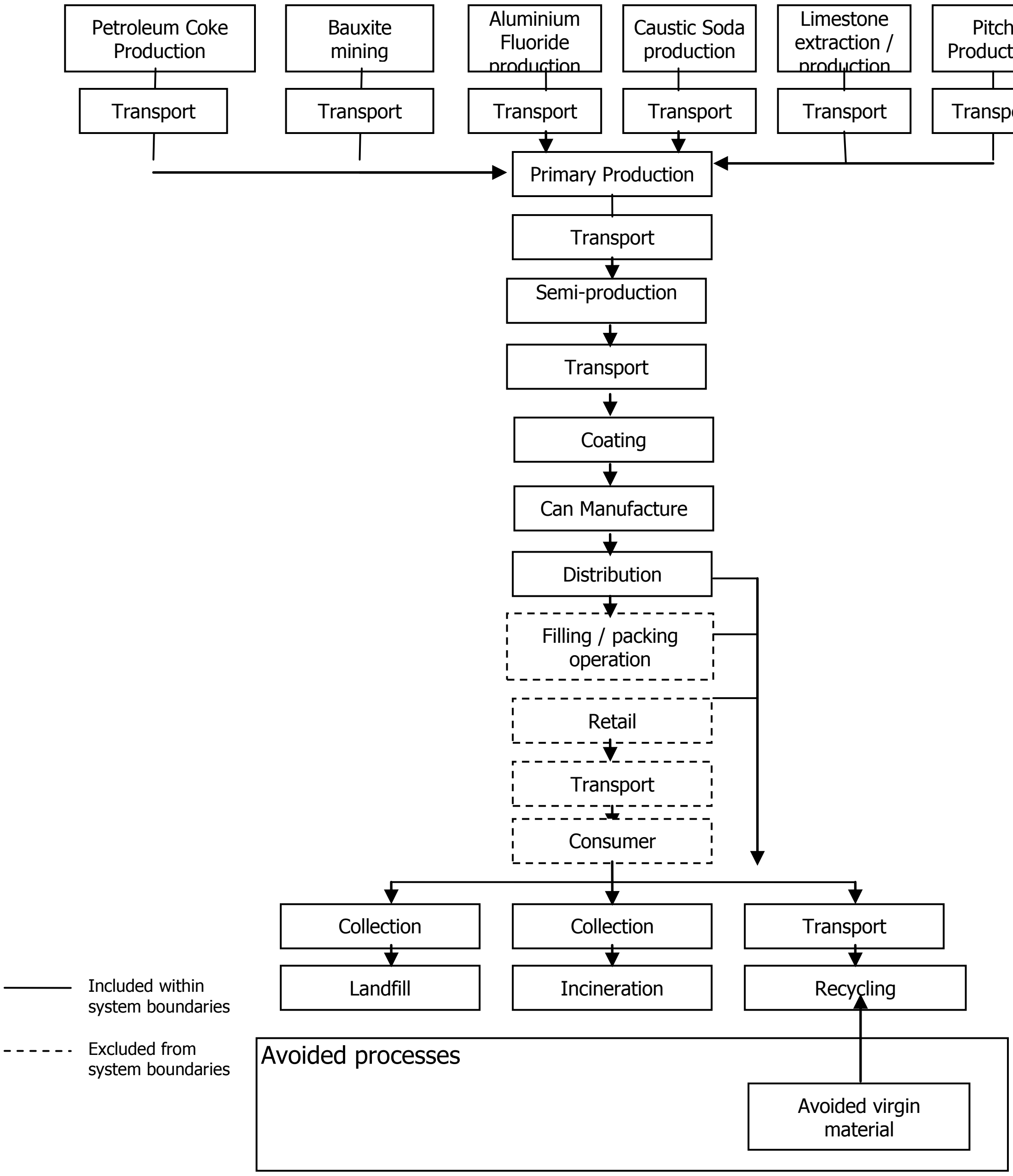
Worldsteel estimate that 1.09 kg of steel scrap is needed for the production of 1 kg of steel.[29]

[28] *Worldsteel (2009) Life Cycle Inventory data for tinplate coil & tin free coil, World Steel Association.*

[29] *Worldsteel (2009) Life Cycle Inventory data for EAF steel slab*

7.4.2 Aluminium

Figure 7.4.2.1 System boundary diagram for aluminium



There are two main grades of aluminium in use, cast and wrought. Wrought aluminium is used in many applications, including transport, packaging, and building.

Aluminium packaging may take the form of cans, foils, aerosols or composites. In this methodology, cans are used to represent all aluminium packaging. Drinks cans account for 62% of aluminium packaging by weight, foil 18%, with the remainder an assortment of formats.[30]

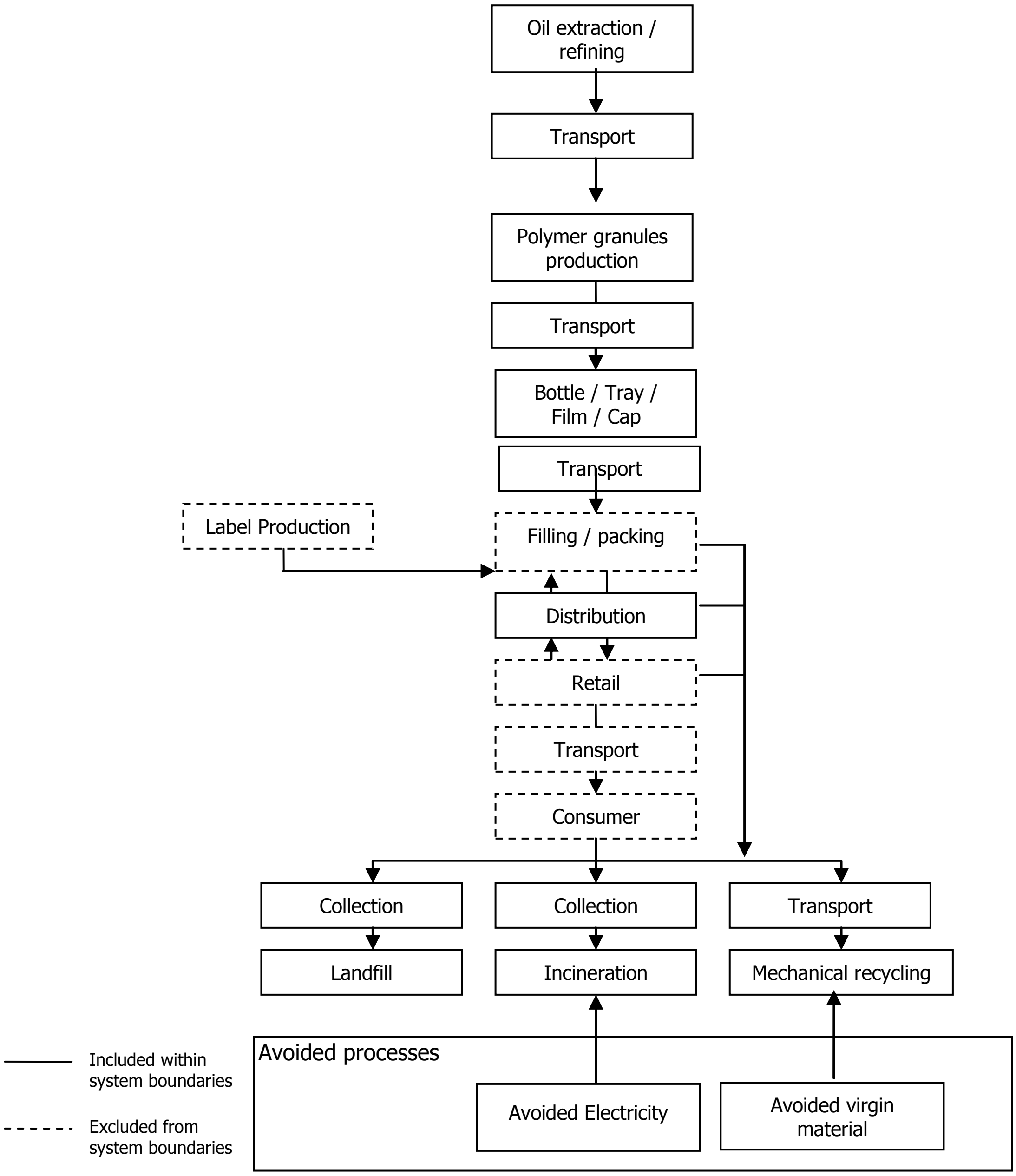
Data collated by the European Aluminium Association provides average CO_2eq conversion factors for primary and recycled aluminium used across Europe. This covers the extraction, extrusion and sheet manufacture, as well as re-melting and recycling.

For secondary production it is estimated that 1.02 kg of recycled aluminium is needed for the production of 1 kg of aluminium.[31]

[30] *DEFRA (2008) figures, quoted by alupro http://www.alupro.org.uk/facts-and-figures.html*

7.5 Plastics

Figure 7.5.1 System boundary diagram for plastics



Several polymers are currently used in packaging in the UK. These may be used in isolation, or used in laminated products, which make use of the combined properties of different polymers.

The main polymers used in plastic packaging are polyethylenes (LDPE and HDPE), Polyethylene terephthalate (PET), Polypropylene (PP) Polyvinyl Chloride (PVC) and either expanded or high impact polystyrene (EPS & HIPS respectively).

Polymers are put through a variety of moulding processes depending on the polymer and the product to be made. For bottles, blow moulding or stretch blow moulding are used depending on the polymer. For rigid containers (e.g. trays), injection moulding is more appropriate. Expanded polystyrene is put through a foaming process, and bags and films are extruded.

[31] Boin U.M.J. and Bertram M., 2005. *Melting Standardized Aluminium Scrap: A Mass Balance Model for Europe*. JOM 57 (8), pp. 26–33.

Data on the manufacture of plastic granules to appropriate grades is taken from Plastics Europe Eco-Profiles. These are available by polymer from the Plastics Europe website, and were last updated during 2005. Data on the various moulding processes is taken from the Ecoinvent database (2008).

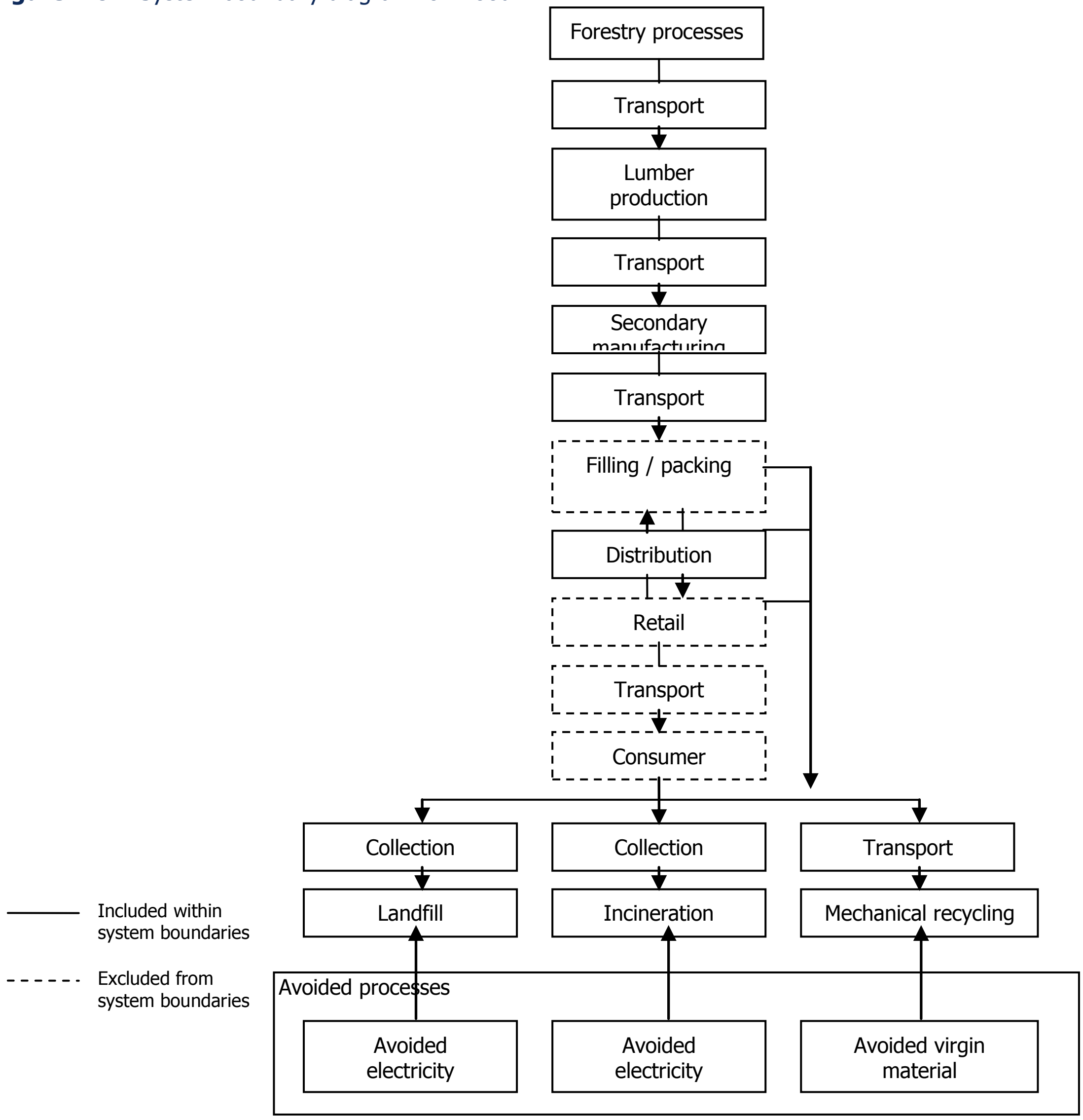
In reporting on plastics, information is required by format. 52% of bottles are understood to be PET and 48% HDPE. Trays are assumed to be made from polypropylene (PP). Yoghurt pots are assumed to be made from high impact polystyrene (HIPS). All other polymers and formats are grouped under 'other'.

For HDPE recycling it is estimated that 1.2 kg of waste HDPE avoids the production of 1 kg virgin HDPE. For PET recycling, 1.3kg of waste PET avoids 1kg of virgin PET (source: WRATE). For mixed waste plastics (which covers all other polymers), it is assumed that one tonne of waste plastics avoids the extraction and production of 666 kg virgin polymers. This is based on the WRAP LCA of Mixed Waste Plastic Management Options (WRAP 2008)[32] with the inclusion of use of plastic film, which is not positively sorted in the study. Residual waste from the process is sent to landfill.

[32] *WRAP (2008)* LCA of Mixed Waste Plastic Management Options Banbury*: WRAP*

7.6 Wood

Figure 7.6.1 System boundary diagram for wood



- No trade association produces eco-profiles for wooden packaging. There is therefore no central source of data on the manufacture of wooden packaging. Instead, data on wood is taken from a variety sources, includingKellenberger D. (2007) Life Cycle Inventories of Building Products Ecoinvent, EMPA
- ERM (2008) Streamlined Life Cycle Assessment of the iGPS Pallet, the Typical Pooled Wooden Pallet, and the Single-Use Wooden Pallets Intelligent Global Pooling Systems (iGPS) Company LLC
- Gasol, C.M., Farreny, R., Gabarrell, X., & Rieradevall, J. (2008) Life cycle assessment comparison among different reuse intensities for industrial wooden containers International Journal of Life Cycle Assessment (2008) 13:421–431
- Work undertaken by the Construction Emissions Community of Practice, lead by Davis Langdon

Reuse is a significant route for much of the wooden packaging on the market. Recycling is often open loop (e.g. chipping or composting) rather than closed loop due to the nature of the material. Parts of one item of wooden packaging may be used to repair other items.

7.7 Other Materials

At this stage it is not anticipated that the methodology will cover other packaging formats. This may be reviewed in future.

8.0 Results: emissions of individual packaging materials

8.1 Carbon emissions per tonne

The relevant trade associations have been, and will continue to be, consulted upon the emissions factors to be used in this methodology. Their input is essential to ensuring that figures meet the data quality requirements outlined in section 6.2.

The following data have been derived to date and further refinement may still occur as new data becomes available:

Table 8.1.1 Carbon emissions per tonne of packaging material

Material	Baseline $KgCO_2e$ / tonne[1]	A 10% reduction could be achieved by either:			
		Increasing recycled content by	Increasing recycling rate by:		Right-weighting packaging (without changing recycled content)
			Current practice	Best practice[2]	
Aluminium	6960	N/A	9%	9%	10%
Cardboard (including corrugate and carton board)	1040	Near optimal in average stock	Increases in the recycling rate will not yield 10% reduction due to high baseline level		10%
Wrapping Papers	1020	TBC	TBC	TBC	10%
Liquid Beverage Cartons	2110	N/A	TBC	TBC	10%
Glass	750	20%	30%	0%	10%
PE Bags / Film	2700	26%	28%	0%	10%
PET Bottles	4190	23%	24%	24%	10%
PET Rigids	4060	20%	21%	21%	10%
HDPE Bottles	2660	22%	24%	24%	10%
HDPE Rigids (Boxes / Crates)	3190	33%	37%	37%	10%
PP Rigids (Boxes / Crates)	3640	36%	38%	0%	10%
PP Film / Bags	2690	26%	40%	0%	10%
HIPS Rigids (Yoghurt Pots)	5130	23%	40%	0%	10%
Other Plastics	3470	33%	35%	0%	10%
Average Plastics	3070	26%	28%	15%	10%
Steel	1870	N/A	11%	11%	10%
Wood	430		7%	7%	10%

[1]Based on UK average recycling rate, 2009 [2]Based on increasing closed loop recycling

Table 8.1.2 UK Recycling Achievement 2009

Paper	83.9%
Glass	61.7%
Aluminium	41.3%
Steel	57.8%
Metal	54.9%
Plastic	24.1%
Wood	76.9%
Total recycling	61.8%

Before implementing changes informed by this methodology, signatories must check for unintended consequences. For example if a change affects the filling speed of packaging or shelf life of a product, it is vital that this is understood. If this negates any of the benefits identified above, it is clearly inappropriate to make this change.

These figures will be updated on an annual basis to take account of the consequences of the previous year's activity.
All the carbon dioxide equivalent (CO_2eq) emissions figures are quoted per tonne of packaging material. As different packaging formats have different weights, the figures should not be interpreted as indicating that one packaging material is "better" than another. Pack weight will remain an issue of importance under this agreement.

The difference between the different recycling options highlighted is the market to which the recyclate is sent. Under the current practice scenario for glass, approximately 1/3 of glass collected for recycling is used in aggregate production, and 2/3 in remelt. The benefit of sending glass to remelt is considerably higher (in terms of CO_2eq emissions) than sending it to aggregate. Under this scenario, recycling rates must increase by 37% to reduce overall emissions by 10%. If however, all glass collected for recycling was sent to remelt (i.e. that sent to aggregate was diverted to closed loop applications) then the overall recycling rate would only have to increase by 5% to deliver a 10% reduction in emissions.

As the recycling rate, and recycled content, for cardboard packaging is already so high, any increases in recycling rate on their own will not change the footprint of the packaging by 10%.

For plastics, there are significant differences between the figures for several of the forms of packaging. The reason for this is to do with the collection method. Bags and bottles are assumed to be source segregated for recycling, whereas other plastics are assumed to be collected mixed. The mixed plastics require extra processing to allow them to be recycled, and whilst there is still a benefit to doing this, it is much reduced relative to source segregates materials.

8.2 Using the calculated values

The values derived from this methodology are considered appropriate for use at a sectoral level, but are not appropriate for claims by individual signatories pertaining to their supply chains. It is essential that increases in recycling / use of recyclate occur at a sector level, rather than moving the procurement of recyclate from one customer to another.

In addition, it is also stressed that the target and methodology must be seen in the context of the other Courtauld targets relating to products. Before taking action, unintended consequences (e.g. increased product damage) must be assessed. As in the case of the home improvement example, there may be additional benefits to products from changes in packaging which reduce greenhouse gas emissions associated with both.

8.3 Recommended for development of the Courtauld Commitment.

The methodology here relates to packaging only. Further developments on the greenhouse gas emissions associated with products will allow the life cycle stages excluded from this study to be addressed in future - in line with Courtauld 2 targets to reduce household food and drink wastes and supply chain product wastes and the Courtauld 3 objective to reduce the environmental impacts of products.

The emissions associated with Energy from Waste allow for avoided emissions from marginal electricity production (by gas). These figures exclude fuel preparation and transport. Values for this were recommended by the Carbon Trust, but could not be incorporated into the model at this time. These will be included in future iterations of this document.

Although this methodology currently relies on secondary data relating to greenhouse gas emissions, the use of primary data is to be preferred, and is likely to play an increasingly important role in the Courtauld Commitment as it evolves.

9.0 Sensitivity Analysis

The figures used in this document evidently rely on a series of assumptions. It is essential that we assess the potential for these assumptions to influence the figures quoted, to understand how sensitive the results are to these.

Issues which have been raised through the consultation process have been the assumptions on transport distances in delivering goods, and alternative ways recyclate may be collected and transported. The allocation procedure for export of material for recycling will also be examined. Finally, a partial assessment of the sensitivity of the results to the assumptions on recycled content of imported packaging will also be investigated for glass.

9.1 Transportation distances

Section 3.7 covers the transport distances assumed for raw materials and products. The impact of doubling or halving these distances has been assessed.

Table 9.1.1 Impact of the transport distances on total emissions

Destination / Intermediate Destination	One Way Distance		Mode of transport	Total Emissions tonnes CO_2eq per tonne	
	Low	High		Low	High
Plastic granules – convertor	55km	250km	Average, all HGVs	7.5	34
Aluminium sheet – can forming					
Steel coil – can forming					
Paper mill – box converting					
Saw mill – pallet converting					
Converted product – filling plant	55km	250km		7.5	34
Distribution to Retail Distribution Centre & to retailer	47.5km	190km		6.5	26

Aluminium, paper and glass were tested for their sensitivity to changes in the transportation distances as, per tonne, they represent extremes in the results. For aluminium the low and high transportation scenarios were found to make a difference of 0.3% and 0.7% respectively to the baseline figure. For paper and card packaging the results varied by 0.5% to 0.75%. It may therefore be concluded that aluminium, paper and card are not sensitive to the transport assumptions made.

For glass, the low and high scenarios altered the baseline figure by 1.3% and 2.7% respectively. As the Courtauld Commitment target is a 10% reduction in CO_2 eq emissions associated with packaging, the impact of the high transportation scenario on the actions required to reduce emissions associated with glass by 10% were investigated further.

Under the high transportation scenario, the quantity of glass which must be recycled to deliver a 10% CO_2 reduction decreases to 36% (i.e. a 1% decrease on the guide figure). This is because the recycling carried out now replaces primary materials associated with a slightly higher transport emissions. There was no change in required recycling rates under the low transportation scenario.

Assuming recycling transportation requirements are constant, the required level of recycling decreases as transportation distances for primary materials increase. However, for the distances modelled the difference will be less than 1% from the baseline figure suggested.

9.2 Recycling route

The baseline figure is based upon all material being collected in a RCV through a source-separated system, which is then taken to a transfer station for bulking and onward transport. In reality, a number of means of recycling exist. The following have therefore been tested as a sensitivity:

A: Changes to distance travelled
B: Changes to collection method.

The emissions associated with collection and transport of recyclable material were varied as follows:
Aluminium, paper and glass collected through a bring scheme rather than collected from point of disposal (high transportation scenario)
Wood collected through a Civic Amenity Site and processed through a MRF (high transportation scenario.

The emissions figures for these were taken from:

Wilmshurst, N., Anderson, P., and Wright, D., (2006) WRT142 Final Report Evaluating The Costs Of 'Waste To Value' Management DEFRA: London

In addition, the emissions associated with collection vehicles contained herein were used for a low emission recycling scenario. The figures used are reproduced in the table below:

Table 9.2.1 Impact of the collection method on total emissions

Process/Transport Activities	Average CO_2 Kg Equiv. Per Tonne processed/ transported
Transfer Station	2.4
MRF	16.8
CA Site	2.4
Household Collection	4.9
Transport from Transfer Station	2.6
Transport from MRF	7.7
Collection from Bring Site	24.7
Transport from CA Sites	5.5

Wilmshurst, N., Anderson, P., and Wright, D., (2006) WRT142 Final Report Evaluating The Costs Of 'Waste To Value' Management DEFRA: London

For aluminium, the changes in recycling infrastructure and routes used make a difference of less than 0.1% to the baseline figures. For paper and card, the difference is less than 0.25%.

Glass and wood are found to be more sensitive to the assumptions around collection. The baseline figure for glass varies by up to 1.4% under the low and high transport scenarios modelled using the above data. The emissions associated with wood recycling decrease by 2% under the low transportation scenario, and increase by 1% under the high transportation scenario.

Glass and wood are therefore more sensitive to the assumptions made regarding collection method. However, as under the previous sensitivity, these changes do not affect the actions required to reduce emissions associated with these packaging formats by 10%. The Courtauld Commitment Target and methodology are therefore not sensitive to these assumptions.

9.3 Allocation of emissions from export of recyclate

In the baseline figures above, the marginal shipping emissions associated with export of recyclate have been used. There are a number of alternative ways these emissions may be accounted for. The first of these to allocate all emissions from the journey from the UK to the recyclate's destination to the recyclate. This approach measures absolute emissions.

However, a trade balance exists between Europe and the Far East, meaning that vessels have to return to the Far East even if they are not full. As an indication of this, in 2009 imports to Rotterdam, the busiest European port, were 272 million tonnes, whilst exports on vessels were 113 million tonnes, The baseline has therefore utilised the marginal emissions incurred through shipping the incremental cargo of recyclate. As a sensitivity average emissions have been estimated for paper and card using the highest emissions factors (CO_2 only) from WRAP (2008)[33].

Under the absolute emissions scenario, the figures for paper recycling vary by up to 6.7%. The choice of methodology does therefore have a significant effect on the results. The result also alters the effect on emissions of recycling. The choice of method for ascertaining the impact of shipping is therefore an important consideration.

9.4 Recycled Content of Imported Packaging: Glass

The level of recycled content in imported packaging is assumed to be equal to that of UK-manufactured packaging. As this is uncertain, a sensitivity analysis around the UK figure has been used. Please note that this is not a complete sensitivity analysis, as the emissions data used is for UK manufacturing, including inter alia the use of UK fuels. The choice of fuels in glass manufacture in another country may not be the same as this.

By altering the recycled content of the glass by 10% above or below the UK figure (33%), the baseline figure varies by up to ±5%. However, imported glass accounts for only 24% of the market (see table 3.8.1). Therefore, the baseline would vary by ±1.25% depending upon these variations. Notwithstanding the limitations of this assessment, the results do not appear sensitive to the level of recycled content in imported glass.

[33] *WRAP (2008) CO_2 impacts of transporting the UK's recovered paper and plastic bottles to China*

Appendix 1: Synopsis of input from industry and peer review

30 responses were received from signatories, trade associations and other bodies over the course of the consultation period, which was extended in length at the request of consultees.

Of these, 11 were from current signatories and 19 were from non-signatories. Responses to the questions were mixed in their suggestions and level of detail.

Many responses challenged the need for a target on packaging, whilst welcoming the proposed expansion of the agreement to cover products. Some respondents consider that they have a good understanding of the emissions associated with their products and packaging whilst others have no experience to draw upon. Very few signatories had attempted to use PAS 2050, or shared plans to use this, suggesting that any agreement must have a common framework, rather than asking signatories to report their carbon emissions in general using PAS 2050, ISO 14040, or the WRI / WBCSD GHG Protocol.

A very small number of respondents, and, in particular, signatories, had data which they were willing to share in support of an agreement. Most agreed filling should be excluded although many made strong representations for its inclusion as part of a target addressing packaging and product. However, no response committed to share data to support this.

There was mixed support for the inclusion of biogenic CO_2, and so the proposal herein is to report this separately, but not to use it as part of targets or baselines.

Broad agreement was expressed with the approach to two and single stage packaging, and for the transportation and loading factors. However, some concerns were expressed about using weight limited (rather than volume limited) figures. We have tried to account for these. Some additional data on waste transport was provided by one signatory, which we have used to inform the modelling.

Clarification was requested on the nature of bulk importing; whether it covered liquids only or also items such as fruit.

Strong interest was shown in the reusable packaging tool and many respondents requested sight of this before responding to this question.

Publically available secondary data was the preference of the vast majority of respondents, who also wished to see transparency in the calculations.

The questions on grades of cardboard and plastic polymers elicited mixed responses, with brands favouring separate reporting. It is not clear from the responses at which level the majority of signatories are able to report. We have proceeded on the basis that they are able to report different types and form, but this may require revision, particularly in light of the discussion on recycling data sources (see below).

The definition of closed and open loop recycling was hotly debated with many different references suggested. The intention is to continue to use the definition in ISO14040.

Finally, the recycling percentages to be used were questioned. The proposal was to use PRN data; however, this reports by material rather than grade or format. It would not therefore be possible to use this data to identify the recycling of aluminium cans and foil, plastic bottles and film, corrugated board and cartonboard etc. Further comments and suggestions are welcome on this to improve the methodology in future.

A peer review of this methodology has been conducted by the Carbon Trust. A summary of their findings will be incorporated once it is available.

Appendix 2: Energy from Waste

A range of energy recovery technologies exist which could convert packaging materials to energy at end of life. These include combustion (electricity only or combined heat and power), gasification, pyrolysis and anaerobic digestion.

Despite the potential for the different technologies, combustion with electricity generation is the most prevalent technology, and will continue to be in the short-term.

The efficiency with which the incinerator converts energy in the packaging waste into electricity is an important factor affecting the results of this study, as it determines to what degree the impacts of the incineration process are offset by avoided the need to produce electricity from primary fuels. Published studies give a wide range of values for the efficiency of power generation from municipal waste incinerators.

This variation arises due to a number of factors including:

- Type and nature of the waste feedstock;
- Output options – potential to use electricity, water, steam produced;
- Technology applied;
- Whether internal energy consumption of the process is accounted for; and
- Whether gross calorific values (GCV) or net calorific values (NCV) are used in the calculations (in some reports it is not clear which is used).

Examples of values quoted in recent studies are given below:

- A 2006 study by the USEPA[34] gives an efficiency of 17.8% for electricity generated from mass burn incineration (not clear whether these figures are based on NCV or GCV).
- A 2001 report for the European Commission[35] indicates that efficiencies for power generation range from 15–22% in thermal treatment plants based on NCV.
- The 2006 BAT standard for incineration[36] quotes efficiencies ranging from 15-30% for thermal plants producing electricity only (not clear whether these figures are based on NCV or GCV).
- A 2003 Biffaward study carried out by C-Tech Innovation[37] reports a figure of 25.4% based on NCV.
- Fichtner, in a 2004 report[38] for ESTET, state that "For a modern plant based combustion technology, the net electrical efficiency is in the range 19 to 27%" based on NCV.
- A 2003 good-practice guide produced by CIWM[39] reports efficiency of generation of 22%-25% (not clear whether these figures are based on NCV or GCV).

The default assumption for this work is that a conversion efficiency (NCV) of 23%, which is midway between the extremes reported in the literature, is typical for modern incinerators.

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34 USEPA (2006) Solid Waste Management and Greenhouse Gases – A Life-cycle Assessment of Emissions and Sinks, 3rd Edition

35 Smith, A. et al. (2001) Waste Management Options and Climate Change, Final Report to the European Commission

36 European Integrated Pollution Prevention and Control Bureau (2006) Integrated Pollution Prevention and Control Reference Document on the Best Available Techniques for Waste Incineration

37 *C-Tech Innovation for Biffaward (2003) Thermal Methods of Municipal Waste Treatment*

38 Fichtner Consulting Engineers Limited (2004) The Viability Of Advanced Thermal Treatment Of MSW In The UK, ESTET

39 *CIWM (2003) Energy from Waste: A Good Practice Guide, Northampton: IWM Business Services Group*

Appendix 3: Approach to Recycling

For the avoidance of doubt, recycled content refers to the incorporation of material which has been recovered from post-consumer or post-commercial sources.

The approach to recycling and recycled content is informed by PAS 2050 but is not identical. The reason for building on the formula is the different purpose of the methodology to PAS 2050.

The Courtauld Commitment methodology is designed to identify the consequences of changes in the system, rather than attribute a footprint to an item. Of key interest is the need to highlight the difference in impact between different recycling routes, and the potential benefits which closed loop recycling can offer over alternative options. The purpose is to maximise the benefits of recycling and achieve genuine increases rather than moving recyclate from one product to another without additional environmental benefit.

Several allocation procedures exist for dealing with reuse and recycling. The methodology is in line with the spirit of ISO 14044 (2006), which proposes that allocation procedures for recycling can be addressed as follows:

A: "A closed-loop allocation procedure applies to closed-loop product systems. It also applies to open-loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials. However, the first use of virgin materials in applicable open-loop product systems may follow an open-loop allocation procedure outlined in b).
B: An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties."

Under example (a), aluminium packaging may be recycled into aluminium packaging or other applications. In either case, where it substitutes for primary aluminium, the environmental benefit is the same. Where plastic is used in place of wood, an open-loop allocation procedure is more appropriate.

For card products, it is not true to say that all products in one category are recycled back into that category. For example, carton board may be recycled and made into corrugate. Although the fibres may be shortened through the recycling process, the net environmental impact is the same regardless of whether the material goes to corrugate or cartonboard manufacture, and it is therefore inappropriate to only recognise the benefit of one alternative as closed loop in nature.

Calculation of emissions arising from recyclable material inputs:

Where the life cycle of a product includes a material input with recycled content originating from the same product or material system, the emissions arising from that material shall reflect the product specific recycle content and/or recycling rate based on the calculation given below.

$$\text{Emissions / unit} = (1 - R1) \times EV + (R1 \times ER1) + (R3 \times ER2) + (1 - R2) \times ED$$

For metals the following formula would be applied:

$$\text{Emissions / unit} = (1 - R2) \times EV + (R2 \times ER2) + (1 - R2) \times ED$$

Where

R1 = proportion of recycled material input (i.e. closed loop recycling),
R2 = proportion of material in the product that is recycled at end-of-life,
R3 = proportion of material which enters alternative recycling system at end-of-life.
ER1 = emissions arising from recycled material input, per unit of material,
ER2 = emissions arising from open loop recycling process (end of life recycling for metals), per unit of material,
EV = emissions arising from virgin material input, per unit of material,
ED = emissions arising from disposal of waste material, per unit of material

As the Courtauld Commitment progresses, there will be a need to revisit these formulae to account for any circumstances which are not adequately addressed, depending upon feedback from partners and signatories.

Recycled content or recycling rate?

The objective of the Courtauld 2 is to reduce greenhouse gas emissions by a number of means, including increasing closed loop recycling. This should be achieved through a genuine increase in recycling rates rather than by diverting recyclate from one use to another. Frees (2008)[40] finds that primary production is always avoided by recycling, and recommends that "avoided production of primary aluminium is credited when recycling a used aluminium product." This approach is in line with system expansion, a common approach in LCA.

In 2007 the metals industry[41] published a "Declaration by the Metals Industry on Recycling Principles". This states that:

"For purposes of environmental modelling, decision-making, and policy discussions involving recycling of metals, the metals industry strongly supports the end-of-life recycling approach over the recycled content approach."

For metals, the methodology effectively recognises the metals industry position and only considers the recycling rate rather than recycled content.

For plastics and glass, there are existing closed and open loop recycling options for these materials. For glass alternative markets include use in aggregates (open loop) and fibre-glass (closed loop). For plastics, open loop options include wood plastic composites, clothing, carpets, stationery and many other products. For these materials, it is not appropriate to assume that the recycling rate is equal to the recycled content. Recycling into other products such as carpets may be either open or closed loop recycling depending on the material being substituted for.

Plastics Europe consider that future increases in recycling bottles, the main format currently collected for recycling in the UK, are likely to come from closed loop applications[42].

In the case of open-loop recycling, when assigning burdens to primary and secondary life cycles, Plastics Europe (2009)[43] consider that the 50:50 rule should be adopted as a default, and 100:0 for closed loop recycling. This is different to the approach advocated by the metals industry, and in the case of the Courtauld Commitment would mean allocating part of the impact within the methodology and placing part of it outside of the methodology. This would mask the potential impacts which open-loop recycling has. It is therefore proposed that the whole impact of open loop recycling be accounted for as per the formula above.

67% of plastic packaging was exported for recycling in 2008, leaving just 160,000 tonnes for recycling in the UK. However, since this time the domestic recycling capacity has increased dramatically, with approximately 278,000 tonnes capacity installed by the end of 2008[44], and 5 new plants planned. This is in addition to plants dealing with plastics sourced from WEEE and other products. All of these plants intend to supply packaging / food grade packaging. Table A3.1 summarises common recycling applications for plastics.

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40 *Frees, N (2008) Crediting Aluminium Recycling in LCA by Demand or by Disposal* International Journal of Life Cycle Assessment *13 (3) 212 – 218*

41 *Atherton (2007) Declaration by the Metals Industry on Recycling Principles* International Journal of Life Cycle Assessment *12 (1) 59 – 60 (2007)*

42 *Plastics Europe (2008)* The Compelling Facts About Plastics 2007*, Belgium; Brussels*

43 *PlasticsEurope (May 2009)* Eco-profiles & Environmental Declarations _ Methodology, PCR & Protocol *, Belgium; Brussels*

44 AMA Research (2009) *Plastics Recycling Market UK 2009-2013*, UK; Cheltenham

Table A3.1 Common recycling applications for plastic packaging

Polymer	Common Recycling Applications	Material replaced
HDPE / LDPE	Bottles (non-food and food), boxes, crates, bins and underground pipes.	Virgin HDPE, LDPE
PP	Crates, boxes, chemical containers	Virgin PP
EPS	Loose fill packaging, stationery, garden furniture, building products	Virgin EPS, other polymers, wood, concrete
PET	Fibre for stuffing, carpets etc., packaging	Natural and synthetic fibres, Virgin PET
PVC	Building products, medical products (e.g. gloves)	Virgin PVC

Based on the above information, the methodology assumes that separately collected polymers are used for closed loop applications. This applies to PET and HDPE containers. All other plastics are assumed to be collected through a mixed collection route. Where plastics are collected as a mix of polymers, PET, PP and HDPE are modelled to replace the same polymers, but not in the same applications. For EPS and other plastics, 50% of packaging which is recycled is modelled as used in closed loop applications, although this rate varies significantly by polymer. Increases in collections for recycling should lead to an increase in material available for closed loop recycling, replacing an equivalent polymer in the same application. For open-loop recycling, it is assumed that 50% of this replaces the same polymer in another application, and 50% replaces wood.

The methodology assumes that 62.5% of glass is recycled in closed loop applications[45]. The remainder is assumed to be used in aggregates.

Table A3.2 Glass Recycled (2008)

Recyclate collected	Remelt UK	Remelt Abroad	Aggregates, UK
1,613,000	665,561	337,000*	600,000*

*Approximation

For card and paper, the recycled content and recycling rate reflect the information provided by the industry on actual performance for different grades of packaging.

Recycling rate

Because the Courtauld Commitment applies to packaging placed on the market in the UK, and seeks to increase the recycling of / use of recyclate in packaging, it is proposed that the UK packaging recycling rate is used for all materials. This will be obtained from PRN returns to the Environment Agency.

[45] http://www.britglass.org.uk/NewsEvents/BGNewsCurrent/HanktheSingingBottledraws.html
http://www.britglass.org.uk/NewsEvents/BGNewsCurrent/GlassRecyclingExceedsExpe.html

Appendix 4: Conversion Factors for Selected Greenhouse Gases

Industrial Designation or Common Name	Chemical Formula	Lifetime (years)	Radiative Efficiency (Wm-2 ppb-1)	Global Warming Potential (100 year time horizon)	Possible source of emissions
Carbon Dioxide	CO2		1.4 x10-5	1	Combustion of fossil fuels
Methane	CH4	12	3.7 x 10-4	25	Decomposition of biodegradable material, enteric emissions.
Nitrous Oxide	N2O	114	3.03 x 10-3	298	N2O arises from Stationary Sources, mobile sources, manure, soil management and agricultural residue burning, sewage, combustion and bunker fuels
Sulphur hexafluoride	SF6	3200	0.52	22800	Leakage from electricity substations, magnesium smelters, some consumer goods
HFC 134a (R134a refrigerant)	CH2FCF3	14	0.16	1430	Substitution of ozone depleting substances, refrigerant manufacture / leaks, aerosols, transmission and distribution of electricity.
Dichlorodifluoromethane CFC 12 (R12 refrigerant)	CCl2F2	100	0.32	10900	
Difluoromonochloromethane HCFC 22 (R22 refrigerant)	CHClF2	12	0.2	1810	

No single lifetime can be determined for carbon dioxide. For a calculation of lifetimes and a full list of greenhouse gases and their global warming potentials please see:

Solomon, S., D. Qin, D., Manning, M.,. Chen, Z., Marquis, M., Avery, K.B., Tignor M., and Miller, H.L. (eds.) (2007) Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom Table 2.14. Lifetimes, radiative efficiencies and direct (except for CH4) global warming potentials (GWP) relative to CO_2
http://www.ipcc.ch/ipccreports/assessments-reports.htm

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