PRODUCT SUSTAINABILITY FORUM | IMPROVING THE ENVIRONMENTAL PERFORMANCE OF PRODUCTS

Final Report – March 2013

An initial assessment of the environmental impact of grocery products

Latest review of evidence on resource use and environmental impacts across grocery sector products in the United Kingdom

Project code: RPD002-004
Research date: March 2011-December 2012
ISBN:
Date: March 2013

The PSF is a collaboration of 80+ organisations made up of grocery and home improvement retailers and suppliers, academics, NGOs and UK Government representatives. It's a platform for these organisations to measure, reduce and communicate the environmental performance of the grocery and home improvement products bought in the UK.

Further information about the Forum can be found at www.wrap.org.uk/psf.

Written by: Karen Fisher and Keith James (WRAP), Richard Sheane (Best Foot Forward), Jayne Nippress (URS Infrastructure & Environment UK Ltd), Stephen Allen, Jean-Yves Cherruault and Matt Fishwick (Sustain Ltd), Rob Lillywhite and Carla Sarrouy (Warwick Crop Centre).

Front cover photography: Photo of shopping trolley and shopping aisle with groceries

Executive summary

Overview
This report presents a series of analyses with the common purpose of establishing which grocery products are likely to contribute most to the environmental impacts (GHG (greenhouse gas) emissions, embedded energy, water, materials use and waste) associated with UK household consumption. The intention is that understanding and prioritising these will enable reduction actions, interventions and further research to be directed more effectively at those products with the greatest potential to influence overall consumption impacts.

What is the Product Sustainability Forum (PSF)?
This is a study undertaken and informed by members of the Product Sustainability Forum (PSF). The PSF is a collaboration of more than 80 organisations made up of grocery and home improvement retailers and suppliers, academics, NGOs and UK Government representatives. It provides a platform for these organisations to understand, improve and communicate the environmental performance of the grocery and home improvement products bought in the UK[1]. Further information about the PSF and its members can be found at www.wrap.org.uk/psf.

What is in this Report?
This report collates information from more than 150 studies, providing the most comprehensive summary of its kind and an invaluable information source on the environmental impact of grocery products.

Top-level household environmental impacts (GHG and resource use) are summarised using data from the European Commission research project into the Environmental Impact of Products (EIPRO) (Tukker et al, 2006).

Retail grocery product impacts are then considered in more detail, presenting:

- An assessment of cradle-to-retail GHG emissions using the latest product carbon footprint data available.
- An assessment of cradle-to-retail embedded energy values, based on the report of the Defra project FO0415 *Energy Dependency and Food Chain Security* (Lillywhite et al. 2012).
- An assessment of the green, blue and grey[2] water footprint impacts of food and drink product ingredients, based on Water Footprint Network crop and livestock data, import volumes (volumes produced in the UK and import volumes from different geographies) and weightings to take account of relative water scarcity by geography.
- A summary of available and forthcoming information on product-level materials use and waste, including a summary of avoidable consumer food waste reported by WRAP.

[1] *Note – this report focuses specifically on grocery products. Home improvement products are the focus of a series of further research reports that will be published in spring 2013 (see Section 1.1).*

[2] *Blue water = volume of fresh surface and groundwater consumed as a result of the production of the product (not returned to the same catchment); Green water = volume of precipitation evaporated, or taken up by crops, during the production process; Grey water footprint = volume of freshwater that is required to assimilate pollutants (i.e. a measure of the impact of polluted water). (Water Footprint Network)*

A final section summarises key findings and proposes a basket of products for prioritisation, based on the evidence presented. This prioritisation is to inform the PSF of where to focus research and other activities; and to help businesses understand product impacts and inform reduction strategies.

Detailed results and data sources are also provided in comprehensive appendices, which contain product-level information for over 200 grocery products.

Approach and Limitations

The detailed assessments of retail grocery product impacts sought to combine data on UK product sales for 2010 (kg per year) with data on the cradle-to-retail carbon, water and energy footprint of each product (kg CO_2e/kg, litres/kg and MJ/kg respectively). This combination provides an estimate of the cradle-to-retail impact associated with each product sold each year in the UK. It allows the products with the largest contribution to grocery sector impacts to be identified, and reduction efforts focused accordingly[3].

As with any research of this kind, the study has a number of limitations and results should be interpreted with this in mind. Data quality and limitations are discussed in detail within the report and, where possible, ranges are presented, based on known variations in product impacts. However, it is important to note that the findings are not intended to set an impact baseline for the grocery sector, nor can the information contained within be considered to have sufficient accuracy to undertake a sound comparison of the environmental impact of one product type with another.

Despite the limitations of the analysis and inherent uncertainties associated with collating and generalising product life cycle impact data, the authors are confident that the priorities identified highlight those grocery products that contribute significantly to household consumption impacts (GHG emissions, embedded energy and water) in the UK market.

Findings

Analyses of top-level household environmental impacts show the production and sale of grocery products to contribute between 21-33% to household consumption GHG emissions and approximately 24% to abiotic resource depletion impacts[4] (Tukker et al, 2006; Defra, 2012).

The subsequent findings from detailed assessments of grocery product impacts indicate that the following groups of product (listed alphabetically) are dominant with regard to the potential environmental impact (GHG emissions, embedded energy, water) associated with UK consumption and serve as initial priorities for further PSF research.

- **Alcoholic drinks**: Cider and perry; Lager; Spirits; Wine
- **Ambient**: Breakfast cereals; Canned fish and seafood; Canned meat products; Canned vegetables, soups, pasta and noodles; Cat food and dog food; Chocolate; Coffee; Crisps (potato); Processed snacks; Rice; Sugar confectionery; Tea
- **Bakery**: Biscuits (sweet); Bread and rolls; Cakes, pastries and morning goods
- **Dairy**: Butter; Cheese; Milk and cream; Yogurt

[3] Note – at the time of undertaking the assessment, it was not possible to take the same approach for materials and waste, due to the paucity of consistent information at product level across the grocery sector. Currently only a summary of avoidable consumer food waste is included.

[4] Abiotic resource depletion is the "consumption of non-renewable resources, such as zinc ore and crude oil, thereby lowering their availability for future generations" (EC JRC glossary). Thus it is a measure of the impact of resource usage, and provides an indicator of material consumption.

- **Fruit and vegetables**: Bananas; Onions; Potatoes; Tomatoes
- **Household**: Dishwashing products; General purpose and toilet cleaners; Laundry detergents; Toilet paper and kitchen rolls
- **Meat, fish, poultry and eggs**: Beef (chilled and frozen); Deli food; Eggs; Fish and seafood (chilled and frozen); Lamb (chilled and frozen); Pork (chilled and frozen); Poultry (chilled and frozen)
- **Non-alcoholic drinks**: Carbonates; Concentrates; Juices
- **Other chilled and frozen**: Frozen vegetables and potato products; Ice cream and frozen desserts; Margarine; Pizza (chilled and frozen); Pre-packed sandwiches; Ready meals (chilled and frozen)
- **Personal care**: Bath and shower products and shampoos; Deodorants; Nappies

These products are an initial 'Top 50' that will be reviewed and expanded in future iterations of the PSF's prioritisation efforts – in particular when the PSF's work on water impacts for non-food and drink products has been undertaken and when further supply chain waste data have been collated. It is estimated that together these 'Top 50' comprise approximately 80% of the GHG emissions associated with producing, transporting and retailing the grocery products consumed in the UK.

Next Steps

It is important to note that the results presented in this document are indicative estimates of the potential scale of product impacts and should not be interpreted as the definitive, final 'answer'. It is anticipated that, as well as identifying priorities for further PSF research, this provides a starting point from which organisations can focus efforts in developing more detailed measurement and reduction strategies which are specific to their own circumstances and supply chains.

The research and findings in this report will also continue to be updated and improved, through future research and input from PSF members.

A number of potential areas for further work have been identified during the course of this study and are summarised within this report. This will be used to inform a range of other PSF and member activities, as well as the PSF's work with its international partners[5].

In particular, the PSF's on-going research is seeking to identify those interventions which have the greatest potential to reduce grocery product impacts, and to produce detailed action plans, or implementation guidance to support companies trying to realise these savings. Where further evidence is needed, or collaborative activity would be of benefit, 'Pathfinder' projects will be undertaken to trial solutions in real supply chains, identify ways of supporting wider action and remove existing barriers to change.

The PSF is also developing slide decks for each of the product groups identified above, outlining life cycle impact hotspots, potential interventions and existing initiatives and resources to support organisations taking action.

These materials are available on the PSF Knowledge Base, a searchable web-based platform, along with all of the raw data and published sources used to inform the analysis summarised within this report. This provides the PSF membership with a comprehensive body of

[5] The PSF is liaising with a number of organisations globally to ensure that efforts are made to maximise collaboration and reduce replication. The purpose and benefits of this collaboration is to: share data, insight and wider learnings; co-create and co-invest in research; prevent duplication of effort; and take collective action on impact reduction.

evidence on grocery product environmental impacts and opportunities to reduce these impacts.

**The PSF Knowledge Base will be made publicly available after testing later in 2013.*

Contents

Acknowledgements

The authors would like to acknowledge the support of a very large number of individuals at WRAP and within organisations supporting the Product Sustainability Forum[6]. In particular we would like to thank Mark Barthel and Tom Quested at WRAP for providing advice and support. We would also like to thank organisations supporting the Product Sustainability Forum for providing feedback on outputs throughout the project.

[6] *A list of organisations involved in the PSF's work can be found at: http://www.wrap.org.uk/sites/files/wrap/PSF%20Members%20Listing%2C%2002%20July%202012_0.pdf*

1.0 Introduction

1.1 Objectives of the Product Sustainability Forum's Product-related Research

The principal objective of the Product Sustainability Forum (PSF) research to date has been to establish which grocery and home improvement products are likely to contribute the most to the environmental impacts associated with UK household consumption. The intention is that understanding and prioritising these will enable reduction actions, interventions and further research to be directed more effectively at those products with the greatest potential to influence overall consumption impacts.

This report focuses on the detailed analysis undertaken for grocery sector products in this respect – and reports on those products which can be considered as priorities on which to focus further research efforts. **It does not aim to set an impact baseline for the grocery sector, nor can the information contained within be considered to have sufficient accuracy to undertake a sound comparison of the environmental impact of one product type with another.**

A secondary objective of this research has been to collate information on which life cycle stages (e.g. cultivation, processing, packaging production, distribution, retail, use, end-of-life) are of greatest significance for different products and environmental impacts. This learning has fed into the development of a number of other PSF research outputs, including:

- *Product Category Sustainability Summary documents*, summarising the category (e.g. 'dairy', 'fresh fruit & veg'), key life cycle impacts, references and information gaps);
- *Product Impact Hotspots and Reduction Opportunities* slide decks outlining product-specific (e.g. milk, cheese, potatoes, tomatoes) life cycle impact hotspots, potential interventions and existing initiatives and resources to support organisations taking action.

These materials are available on the PSF Knowledge Base, a searchable web-based platform, along with all of the raw data and published sources used to inform the analysis summarised within this report. This provides the PSF membership with a comprehensive body of evidence on grocery product environmental impacts and opportunities to reduce these impacts. * *The PSF Knowledge Base will be made publicly available after testing later in 2013.*

The PSF's ongoing research is seeking to identify those interventions which have the greatest potential to reduce grocery product impacts, and to produce detailed action plans, or implementation guidance to support companies trying to realise these savings. Where further evidence is needed, or collaborative activity would be of benefit, 'Pathfinder' projects will be undertaken to trial solutions in real supply chains, identify ways of supporting wider action and remove existing barriers to change.

Figure 1.1 provides an overview of the PSF research programme and its outputs.

Please note that, whilst this research, report and other outputs focuses on grocery sector products, similar analyses have been undertaken for electrical products and home products. This information is recorded in a separate series of reports that will be published in spring 2013:

- Reducing the Environmental and Cost Impacts of Electrical Products (Results Report; Category Summaries; Methodology Report); and
- Opportunities for Reducing the Impacts of Home Products (Summary Report and Product Opportunity Summaries).

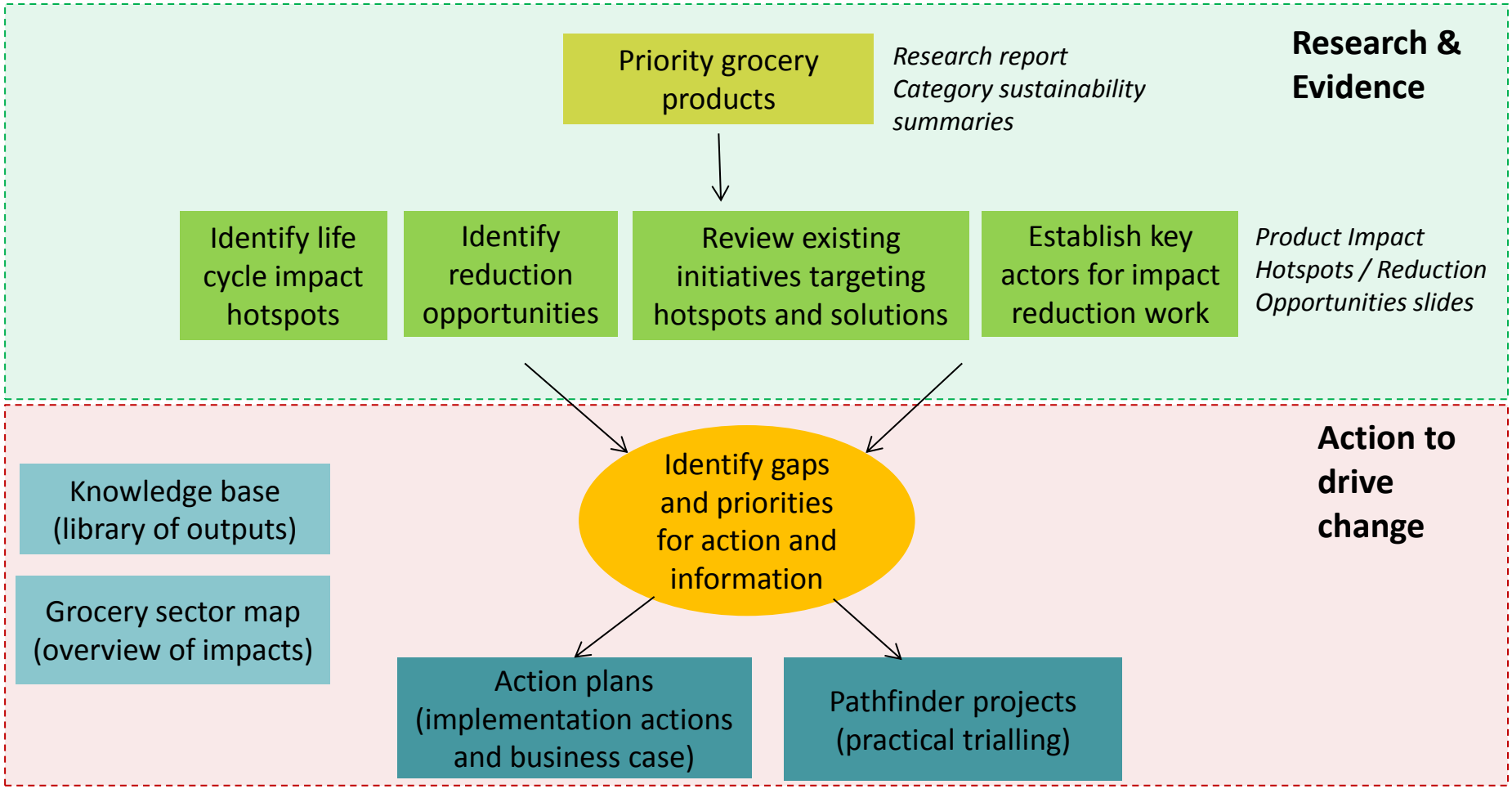


Figure 1.1 Summary of PSF research programme and outputs

1.2 What is a 'Product' in the Context of this Research?

Throughout this report, the term 'product' refers to a product category, principally defined at the Datamonitor[7] 'category' level. Exceptions to this were where this level did not give sufficient detail for the objectives of the project (for example, in the grocery category, 'meat' was disaggregated into beef, lamb, etc.). This was considered to be the level of categorisation that provided a balance between being too generic (e.g. dairy products) and too specific (e.g. semi-skimmed milk).

Appendix 1 provides some further discussion on the product classification system used.

1.3 What Environmental Impacts and Metrics were considered in the Analysis?

The PSF membership agreed in late 2010 that the focus of its work must go 'beyond greenhouse gases', to ensure that best practice strives to implement resource efficiency across multiple measures of product environmental sustainability. The group agreed this should comprise: greenhouse gas emissions, energy use, waste production (solid & liquid), water use and material use. A watching brief was also advised on biodiversity.

It is important to note that, while methods for measuring some of these attributes are becoming increasingly mature (e.g. GHG emissions), there are a number of different ways of quantifying some of the other metrics (in particular water and material use). Whilst the PSF continues to monitor developments in international standards and methodology; and to consider the most appropriate ways to quantify these impacts, it has used the following approaches so far.

- **Greenhouse gases** – kg CO_2 equivalents (Global Warming Potential 100 years). The term 'carbon footprint' is used throughout this report to describe the 'cradle-to-retail'[8] GHG emissions associated with individual products (in kg CO_2e per kg of product). The term 'GHG emissions' is used to describe the market-wide GHG impact of products.
- **Energy** – MJ delivered energy. The term 'embedded energy' is used throughout this report to describe the cradle-to-retail energy requirement of individual products (in MJ per kg of product). The term 'total energy' is used to describe the market-wide embedded energy across products.
- **Water** – litres of green, blue and grey water[9] (Water Footprint Network approach), including weightings to take account of relative water scarcity. The term 'Water Footprint Impact Indicator' is used throughout this report to describe the scarcity-weighted green, blue, grey or total water footprint of products.
- **Materials** – both kg of material intensity and abiotic resource depletion indices (kg antimony equivalents) are discussed in this report. However, the difficulty of collecting consistent and meaningful information against this metric for grocery products is noted, and discussed further in Section 6.0.

---

[7] http://about.datamonitor.com/

[8] *Cradle-to-retail' refers to all of the activities that occur across a product life cycle, from the extraction or cultivation of raw materials, to the point at which a product is made available to a consumer at a retail outlet. 'Cradle-to-grave' impacts are also discussed in Section* ***Error! Reference source not found.****. These include impacts associated with consumer use and anagement of the product and packaging at end-of-life.*

[9] *Blue water = volume of fresh surface and groundwater consumed as a result of the production of the product (not returned to the same catchment); Green water = volume of precipitation evaporated, or taken up by crops, during the production process; Grey water footprint = volume of freshwater that is required to assimilate pollutants (i.e. a measure of the impact of polluted water). (Water Footprint Network)*

- **Waste** – kg waste. The difficulty of collecting consistent information on waste at the product level is also noted. Information on product-level waste at different life cycle stages is being collated by WRAP and will be used to update this analysis (see Section 6.0). Currently this report only includes data on avoidable consumer food & drink waste.

Equally, it is important to note that currently 'GHG emissions' is the only metric which provides an estimate of environmental impact. Other metrics quantify amounts of inputs and outputs from the product supply chain (see Figure 1.2 below) – although the water metric does also include a measure of scarcity and water pollution. There is scope for extending some of these to more explicitly include a measure of impact. For example waste could be weighted to include a measure of hazard. However, with increasing sophistication comes more complexity of data collection, modelling and stakeholder concerns on what assumptions should or should not be used.

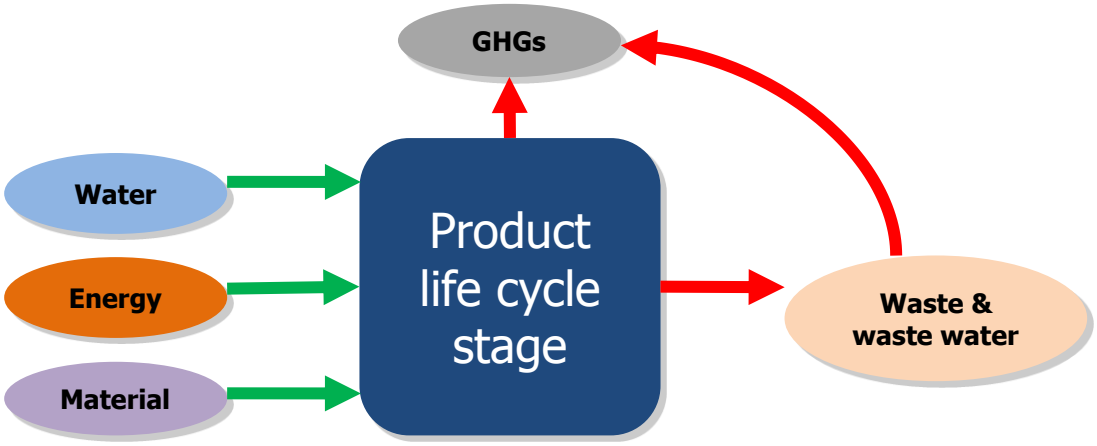


Figure 1.2 Relationship between metrics currently examined within the PSF

Figure 1.2 also shows the inter-linkage between the different PSF metrics. 'Waste', for example, requires management and results in GHG emissions. It is also inextricably linked to the consumption of resources (e.g. materials, energy, water and associated GHG emissions), being the output of a discrete activity across the life cycle. In fact, waste could more accurately be considered as a 'lost resource', because of the need to consume more materials, energy or water to achieve a given level of product output. This loss, and related GHG emissions, increases in magnitude across the product life cycle, as the activities (and consumptions and emissions) accumulate. For example, Table 1.1 shows the estimated GHG impact of a tonne of food and drink waste arising at each stage in the food supply chain.

Supply Chain Stage	Per unit impact, including end-of-life treatment (t CO_2e/t food waste)
Agriculture and Manufacturing	2.4
Distribution	2.8
Retail	3.2
Household	3.8

Table 1.1 Estimated UK annual carbon impact of waste in the UK retail food and drink supply chain (Source: WRAP (2010) Food Waste Arisings)

This report does not attempt to compare between metrics or weight the importance of one over another, but their interdependence is a point of note.

1.4 Sources of Evidence, Data Quality and Limitations

The research has principally drawn on the following sources of information, which are fully referenced within this document.

- WRAP research.
- Defra science research.
- European Commission research.
- Corporate publications (assured and non-assured environmental information).
- Confidential corporate life cycle results – shared anonymously to support the PSF.
- Peer reviewed journals e.g. International Journal of Life Cycle Assessment.
- Trade association and global sustainability initiative publications.
- Environmental claims data e.g. eco-labels, environmental product declarations.
- Information sources from other product sustainability initiatives – e.g. the Beverage Industry Environmental Roundtable (BIER).

In total, the analysis collates information from more than 150 studies, providing the most comprehensive summary of its kind. However, caution is required when comparing life cycle data from different studies due to inevitable methodological differences and uncertainties. For this reason, results presented in this document should be interpreted not as the definitive, final 'answer' – but rather as indicative estimates of the potential scale of product impacts. It is anticipated that, as well as identifying priorities for further PSF research, this provides a starting point from which organisations can focus efforts in developing more detailed measurement and reduction strategies which are specific to their own circumstances and supply chains.

Data quality is considered in more detail, as relevant, in the specific sections outlining GHG, energy, water, materials and waste analyses (Sections 3.0 to 6.0 respectively). However, a number of general points regarding the limitations and uncertainties associated with this appraisal are important to note.

- **Product categorisation** is a subjective process and how products are grouped will influence their position within the 'prioritisation' process. Appendix 1 provides further discussion on the classification system used in this analysis. Products were grouped at a level that was considered to be most useful for businesses and at which interventions would be made. For example, rather than a broad category of 'red meat' (which some studies use), products were separated out into major groups (e.g. beef, lamb), but not into further sub-categories (e.g. beef mince, legs of lamb). This results in a manageable number of grocery 'products' (230) for which UK sales volume data have been sourced (see Appendix 2). However, even at this level of detail there are groupings that remain too broad to give an accurate picture across the sector. For example, the 'ready-meals' category will contain products as diverse as prepared vegetables or a meat-based dinner, which makes generalisations difficult. New product development within this expanding sector will also continue to present challenges in this respect.

- The detailed assessment is underpinned by **UK retail sales volume data** derived principally from the Datamonitor database[10] and supported by a number of other data sources. These are outlined in Appendix 2. To support the PSF's objectives it was considered important that a consistent product classification and sales volume was used across the research, but we note that there is considerable uncertainty associated with volume estimates, and that this has implications for the findings presented across all of the metrics. The principal implication is that, whilst we are confident that the right 'priority products' have been identified, we do not propose that the findings provide for accurate comparisons between products.

- **Production systems for grocery products (in particular food & drink products) are very variable.** Whilst we have provided information on the range of potential impacts in order to explore the implications of this variability (where possible), the actual impact for a product will depend on the market and supply chain characteristics, such as product varieties or production locations, which may change over time. A full market characterisation of each product type (identifying the percentage market share of the different variants of the same product and using this to calculate overall impact) was not possible within the scope of this research.

- The **sample size for individual products shows a large variation**. Every-day and popular products are generally well represented in the literature (e.g. milk). However, some items are poorly studied, with only a single study identified, or no specific data available. This makes it difficult to make any sound comparison between products, and we would discourage readers from doing so. Where possible, the number of data points used to inform a product estimate has been reported to provide transparency in this respect. The PSF will continue to seek to improve the evidence base, in particular to fill key knowledge gaps that have been identified – drawing on the growing body of product sustainability evidence being created by businesses, governments and global initiatives.

- The values provided in this report represent **cradle-to-retail impacts**, in the majority[11]. It was not considered possible to consider a full appraisal of cradle-to-grave impacts, because of the significant variability and uncertainty associated with product use and the lack of consistent data available. As a result, some products which require significant consumer cooking or chilling (e.g. potatoes, frozen foods), or hot water (e.g. laundry, shampoo) may appear lower on the priority list. This has been taken into account in considering the on-going prioritisation of PSF research (see Section 7.1). The PSF is also investigating the potential to develop common 'use phase scenarios' for key products in conjunction with its international collaborative partners.

- Whilst not specifically relevant to the outputs of this research, it is important to continue to be aware of the potential for burden-shifting when considering the improvement of the sustainability performance of individual products. This could include the shifting of

[10] *Datamonitor Interactive Consumer Database exported 9th May 2011.*

[11] With the exception of materials and waste, for which a only a summary of avoidable consumer food waste was available at the time of drafting, due to the paucity of consistent information at product level across the grocery sector.

burdens to other stages in the value chain, other environmental and social burdens and/or other products.

1.5 Peer Review

To provide additional assurance of the results presented in this document a peer review was undertaken by Environmental Resources Management (ERM). The aims of the review were to evaluate the outputs and on-going efforts of the research; to report this evaluation; and to make recommendations for improvement.

The review did not include a detailed editorial review of the documents provided, nor did reviewers attempt to validate all of the data contained within the secondary research reports that were collated. This was not possible within the time allocated to the review. However, checks were made that the data used were of a reasonable order and a recommendation was made that high level sensitivity testing should be undertaken in order to explore the potential for changes in priority should alternative data points be used where there is known variability. This work has been undertaken by Sustain Ltd and is incorporated into this study within the work described in Section 3.0.

1.6 Summary of Report Contents

This document sets out evidence in a number of sections.

In the first section (Section 2.0), **top-level household environmental impacts** are summarised using data from the European Commission research project into the Environmental Impact of Products (EIPRO) (Tukker et al, 2006). Impacts from this study of most relevance to the PSF are GHG emissions and abiotic depletion – both of which are presented and summarised.

The following sections examine **retail grocery** product impacts in more detail, presenting:

- **Section 3.0:** An assessment of cradle-to-retail GHG emissions using the latest product carbon footprint data available and information on retail sales volumes in 2010.
- **Section 4.0:** An assessment of cradle-to-retail embedded energy values based on the report of the Defra project FO0415 Energy Dependency and Food Chain Security (Lillywhite et al. 2012) and information on retail sales volumes in 2010.
- **Section 5.0:** An assessment of the water footprint impacts of food and drink products, based on Water Footprint Network crop and livestock data, 2010 sales volumes, 2010 import volumes (volumes produced in the UK and import volumes from different geographies) and weightings to take account of relative water scarcity by geography.
- **Section 6.0:** A summary of available and forthcoming information on product-level materials consumption and waste, including a summary of avoidable consumer food waste reported by WRAP.

A final section (Section 6.0) summarises key findings and proposes a basket of products for prioritisation, based on the evidence presented.

In addition to these sections, and to ensure transparency, detailed results and data sources are provided in comprehensive appendices.

2.0 A High Level View of Total Household Environmental Impacts

Results from a study for the European Commission by Tukker et al. (2006) on the Environmental Impacts of Products (EIPRO) were used to establish an overview of GHG emissions and abiotic resource depletion[12] associated with goods and services consumed by typical European households[13].

As part of this work a major literature review was undertaken to assess similar studies and learn from their approaches. The final methodology and results were also discussed with experts and stakeholders in a series of workshops and meetings – and so it is considered to represent a reliable source. It covers both grocery and home improvement sectors so allows an understanding of the relative scale of each area of consumption. For example, how does furniture compare with milk? It also provides perspectives on how these goods fit into broader household impacts e.g. healthcare, personal travel, etc.

The main drawbacks with this source are; firstly, that it represents a European average, and although results are reported in reasonable detail, there is limited visibility in some product categories (which do not align with commonly used categories understood by businesses and consumers). Secondly, it allows double counting between categories (e.g. the impact of transporting grocery products is captured under both grocery and transportation). Comparisons between related products should therefore be viewed with caution. To use the data in this project, EIPRO results were mapped onto a PSF-relevant classification (see Appendix 3).

2.1 Findings

Figure 2.1 overleaf shows the headline results for total household consumption, showing grocery products to contribute approximately 24% to abiotic depletion and 33% of GHG emissions.

The authors also note that, during a revision of this report, recent research from Defra (2012)[14] was identified, which can be compared with the European EIPRO data. It indicates that grocery products represent 21% of the total GHG emissions associated with UK household consumption[15]. This figure is a similar order of magnitude to the European data, suggesting that EIPRO is reasonably representative of the significance of grocery products in the UK.

---

[12] According to the EC JRC glossary the depletion of abiotic resources is the "consumption of non-renewable resources, such as zinc ore and crude oil, thereby lowering their availability for future generations". Thus it is a measure of the impact of resource usage, and provides an indicator of material consumption in accordance with the PSF metrics. However, this indicator can be dominated by the contribution from fossil fuels. As GHG emissions are also dominated by carbon dioxide from fossil fuel use, the hotspots are often similar for both metrics.

[13] This information was not available for other PSF metrics (water, energy, materials or waste).

[14] See http://www.defra.gov.uk/statistics/environment/green-economy/scptb01-ems/

[15] It is noted here that the product categorisation used by Defra differs from that used by EIPRO, therefore in order to compare studies in was necessary to group Defra data by the categorisation system used by EIPRO. Data were matched to the most appropriate category but it should be noted that this was a subjective process.

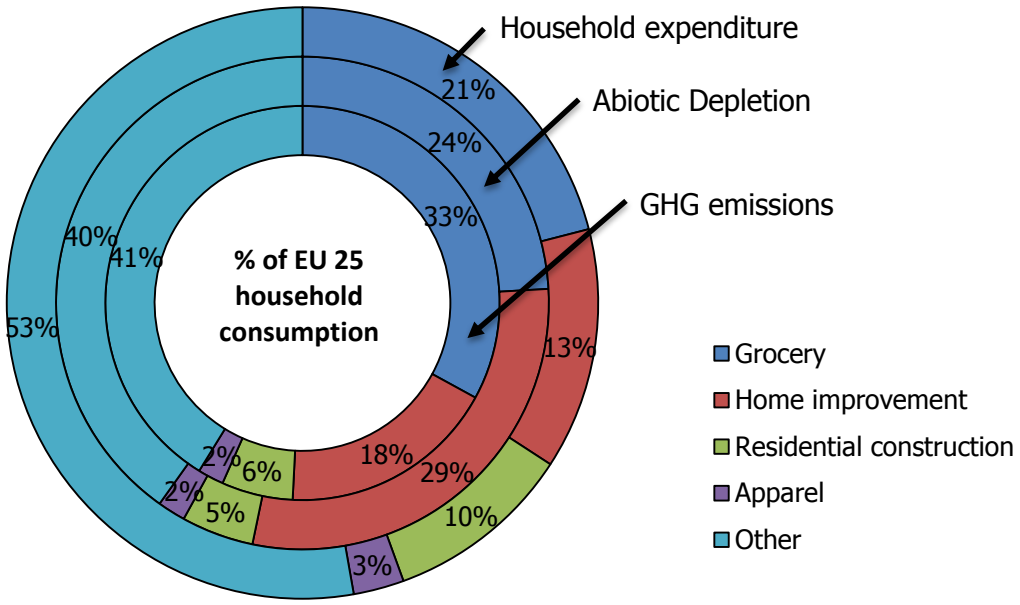


Figure 2.1 GHG emissions and abiotic depletion of EU 25 household expenditure
* 'other' includes car driving, professional services, telecommunications, banking, etc.

The EIPRO study further shows that, in grocery, the dominant source of GHG emissions are food products, contributing 84% of the sector total (see Figure 2.2). Major sources within food were meat products, dairy products and bread and cereal products. Personal and household goods (e.g. laundry detergent and shampoo) contribute just over 4% of grocery GHG emissions, however it is important to highlight that the consumer energy use impacts associated with the life cycle use of these products are not included here (e.g. washing machines, showering). Instead they are attributed to appliances in the home improvement sector results[16]. A fuller digest of EIPRO results are available in Appendix 3.

[16] *The reason for doing this is this is for ease of interpretation. For example, if washing machine energy were to be attributed to associated consumer products, as is often done in product life cycle assessments, then a subjective decision would need to be made on the share apportioned to a washing powder, fabric conditioner, clothing. It is, however, important to understand the importance of these product systems.*

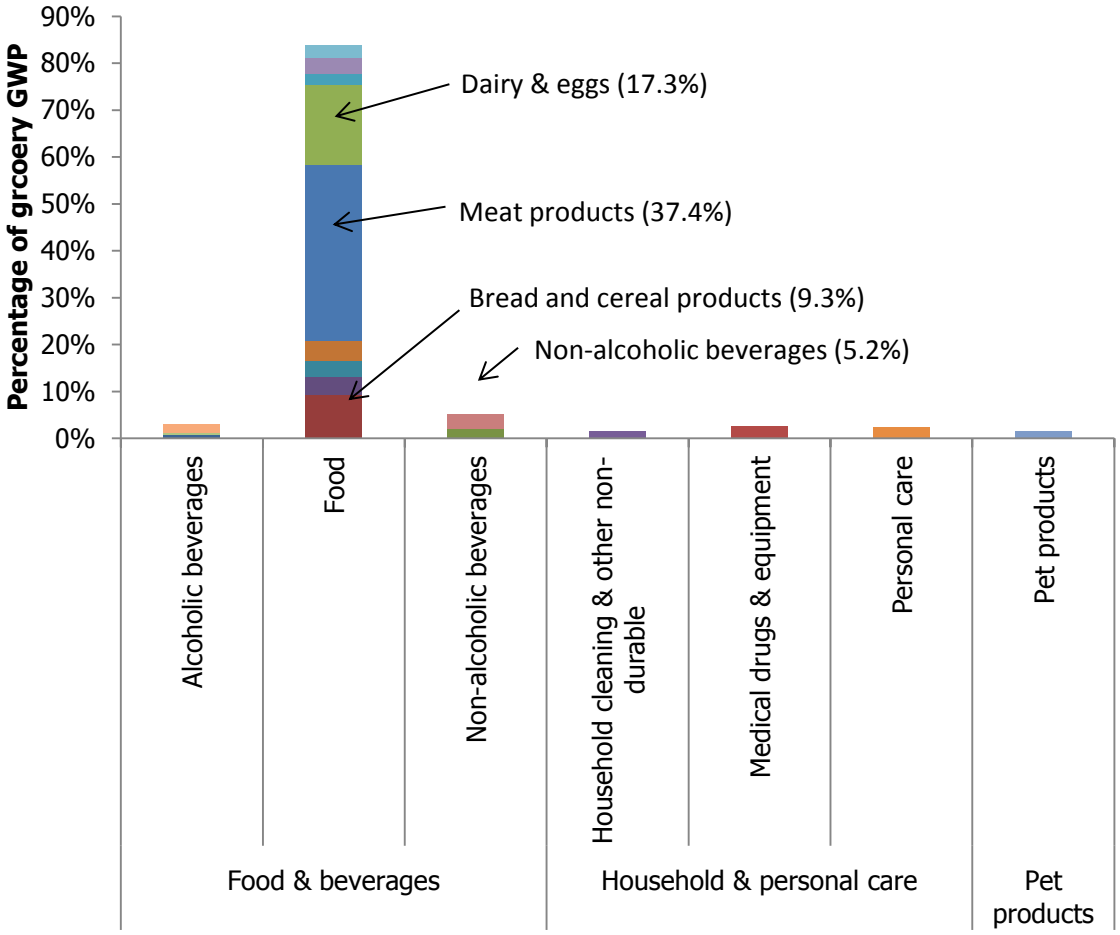


Figure 2.2 Contribution of individual grocery products to sector GHG emissions (not including consumer use)

The results for Abiotic Depletion are presented in Figure 2.3 overleaf and do not differ significantly from those for GHG emissions. It is assumed this is because of two factors: the importance of fossil fuel use in driving both of these measures of environmental impact; and the importance of the scale of consumption in driving impacts. No discussion of this was found in the original source of data (Tukker, et al. 2006).

It is worth noting, however, that meat and dairy products are marginally less important, while those products with higher energy-related inputs (e.g. bread and cereals, beverages) are marginally more significant.

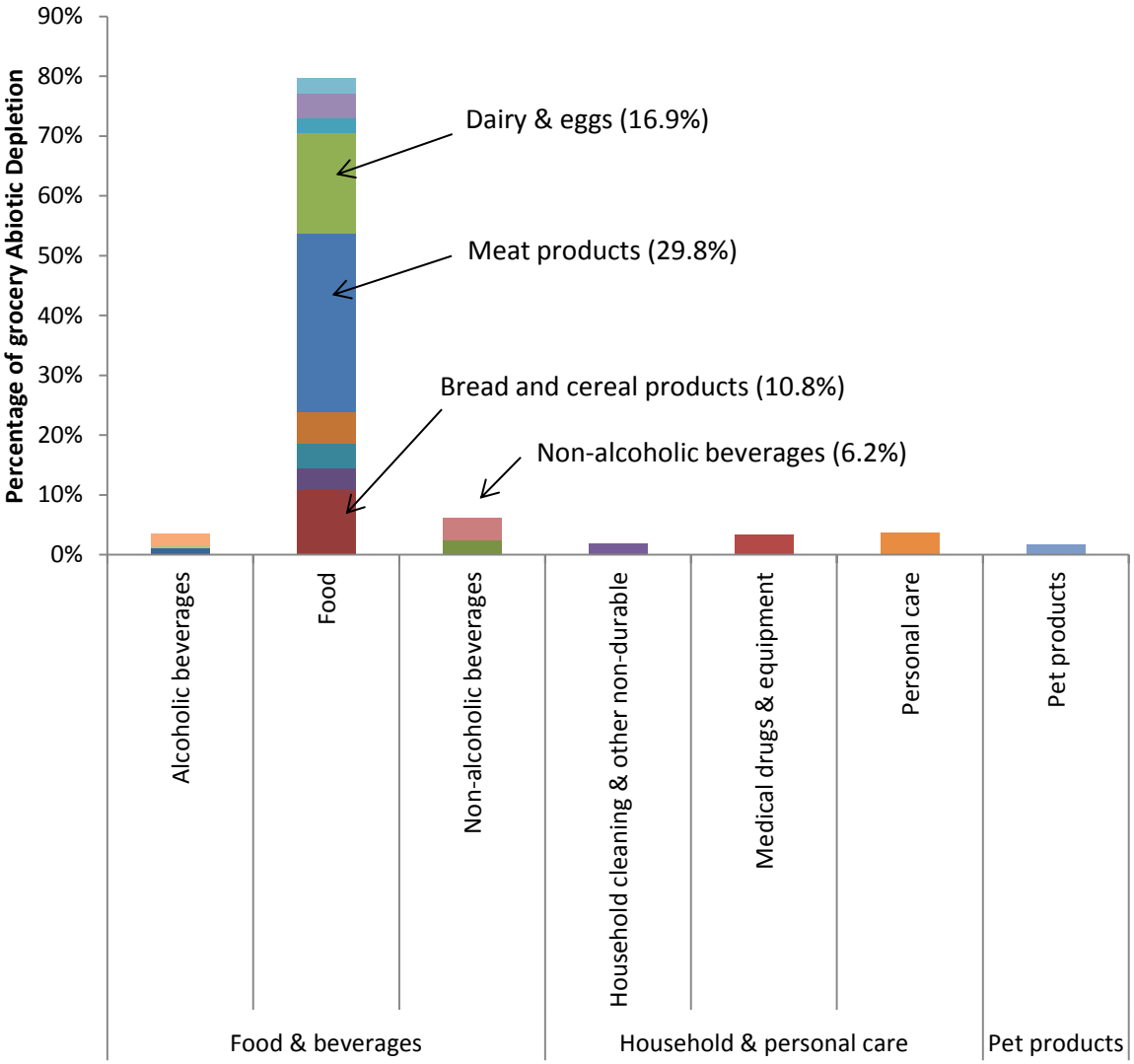


Figure 2.3 Contribution of individual grocery products to sector Abiotic Resource Depletion (not including consumer use)

3.0 Cradle-to-retail Greenhouse Gas (GHG) Emissions

3.1 Method

An updated assessment of the GHG impacts associated with grocery products consumed in the UK was commissioned by WRAP in order to further support the identification of priority products against this metric. This work was undertaken by Sustain Ltd in autumn 2012, and builds on research originally undertaken by Best Foot Forward in 2011.

The assessment sought to combine data on UK grocery product sales for 2010 (kg per year) with data on the cradle-to-retail carbon footprint of each product (kg CO_2e/kg). This combination provides an estimate of the cradle-to-retail GHG emissions associated with each product sold each year in the UK (measured in kg CO_2e per year). It allows the products with the largest contribution to grocery sector GHG emissions to be identified, and reduction efforts focused accordingly. A similar 'bottom-up' approach has been previously used by researchers (Wallen et al., 2004; Audsley et al., 2009).

Retail sales volume data were sourced for 230 food and drink, personal care and household products sold in the UK to develop such a 'bottom-up' analysis. The classification of these grocery products followed the Datamonitor system (see Appendix 1). For each of the 230 grocery products, product-specific carbon footprint data were sought from a variety of sources (e.g. peer reviewed journals, industry studies, government reports, eco-labels). Data collection effort was prioritised on those products with larger sales volumes. A breakdown of the predominant data source used for each product is provided in Appendix 4.

In total 1,887 data points describing the carbon footprint of 191 grocery products were found. However, this data set comprised a variety of system boundaries: cradle-to-farm gate, cradle-to-RDC (retail distribution centre), cradle-to-retail and cradle-to-grave. Although more than 1,000 cradle-to-grave data points were found in this research, they only cover 80 grocery products. Cradle-to-retail data, which were available for a much wider variety of products, were therefore focused upon in the main analysis presented below. A discussion of further life cycle stages, particularly the use phase, is provided in Section 3.4.

Cradle-to-farm gate and cradle-to-RDC data were categorised as being equivalent, or closely equivalent, to cradle-to-retail data. This was considered to be a reasonable estimate as, for the majority of products, the GHG emissions associated with activities occurring between farm gate and retail (storage, distribution etc.) are relatively low in comparison with production emissions[17]. In total, 684 data points describe the cradle-to-retail carbon footprint of 174 grocery products.

In some cases, no suitable data could be found for a grocery product. Where possible, suitable proxies were used in these instances; for example, data for shampoo were used as a proxy for conditioner. Where a suitable proxy could not be found, a carbon footprint of 5 kg CO_2e/kg was used as a 'worst-case' estimation. This estimation approach was only used for a small number of products sold in quantities less than 30 million kg per year[18].

Including proxy data, a total of 727 cradle-to-retail data points were produced, covering 217 of the 230 grocery products; an average of three data points per product. For the remaining

[17] *Checks were made that these data sets did not reflect products that are typically air freighted, as the converse would be true.*

[18] *Products sold in quantities below 30 million kg per year represents less than 0.1% of total mass of grocery products sold (~46,000 million kg per year). Therefore it was thought acceptable to use an estimated GHG emission factor in the absence of suitable data or proxy data.*

13 grocery products no suitable proxy could be found, so they were not represented in this study. These 13 grocery products are listed in Appendix 4.

For each grocery product, the sales volume for 2010 (kg per year) was multiplied by product carbon footprint data (kg CO_2e per kg) to indicate the market-wide GHG emissions (kg CO_2e per year). Wherever multiple carbon footprint data were available for each product, multiple values for market-wide GHG emissions were produced, giving a range of potential emissions. This approach is useful because the true value for the carbon footprint of each kilogram of a product sold in the UK is unknown, and therefore the market-wide GHG emissions is also unknown and can only be estimated. Providing a range of estimates based on known variations in the carbon footprint of a product gives a greater likelihood that the true value of GHG emissions is represented, and hence provides greater confidence in the conclusions subsequently drawn.

The spread of GHG emission values for each product is shown in this study by the interquartile range (see Figure 3.2). The interquartile range shows all values between the lower quartile (below which the lowest 25% of values reside) and the upper quartile (above which the highest 25% of values reside). It therefore shows where the central 50% of values are concentrated. The middle value of the interquartile range, and the data set as a whole, is known as the median. It describes the central tendency of the data and was used in this study as the representative value with which to position products and calculate the overall cradle-to-retail GHG emissions of the UK's grocery product sector. Appendix 4 shows further descriptive information about the data set, including the number of data points used for each product and their predominant source (e.g. peer-reviewed journal, eco-label etc.).

3.2 Results – Cradle-to-Retail GHG Emissions of Grocery Products

Figure 3.1 provides an overview of the cradle-to-retail GHG emissions of products across the UK grocery sector. It shows the high-level product categories and sub-categories "chilled and frozen" and, within that, "dairy", "meat and poultry" and so on. Figure 3.1 shows that the "chilled and frozen" category represents the largest source of cradle-to-retail GHG emissions. The combined cradle-to-retail emissions of the 217 grocery products summarised in Figure 3.1 is 82 Mt CO_2e.

Figure 3.2 shows a more detailed breakdown of the 70 grocery products with the largest cradle-to-retail GHG emissions. The selection of the top 70 and the ranking shown is based upon the median value for each product, shown as a black line. The lighter blue bar shows the interquartile range of the estimates, based on the total number of data points listed on the chart[19]. A more detailed table of results is provided in Appendix 4, showing further information, such as the cumulative contribution of each product to the combined cradle-to-retail GHG emissions of all products. It shows that, using median values, the top 70 grocery products shown in Figure 3.2 account for 87% of the total cradle-to-retail GHG emissions of grocery products, and that the remaining 147 products account for just 13%. Appendix 4 also shows that the top 70 account for 80% of the sales volume (mass of sales in kg).

[19] *The Microsoft Excel 'quartile' function was used to calculate the lower quartile, median and upper quartile values. Where necessary, Excel uses linear interpolation to calculate these values, for example when there are an even number of data points, or fewer than five data points.*

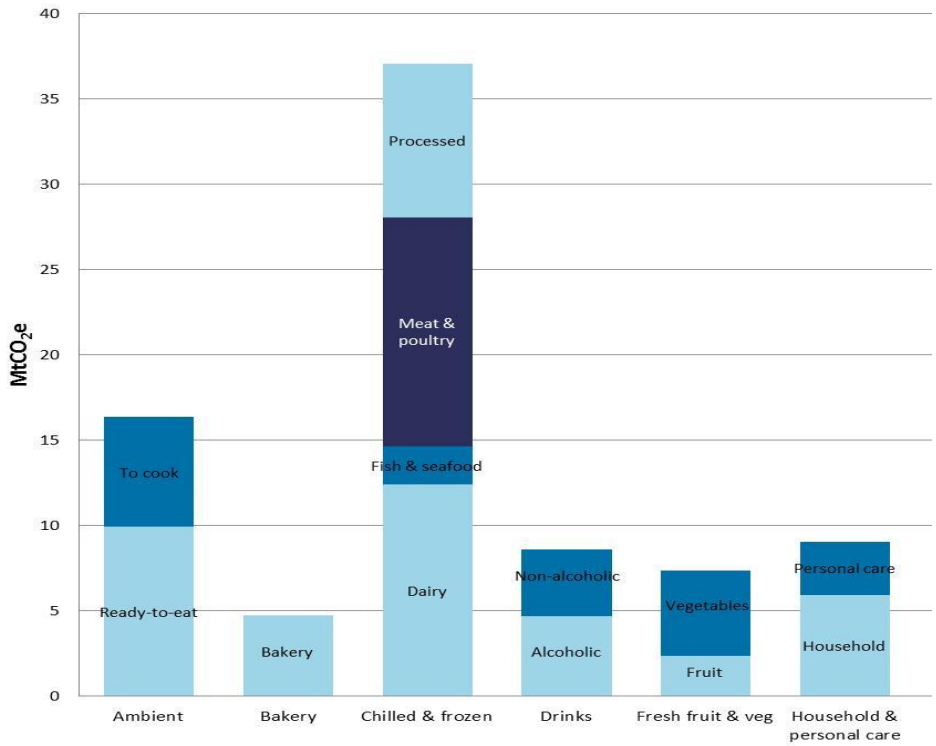


Figure 3.1 Breakdown of annual cradle-to-retail grocery GHG emissions by category[20]

The interquartile ranges shown in Figure 3.2 indicate the sensitivity of the ranking to known variations in the carbon footprints of each product[21]. As is apparent from the figure, the ranges of GHG emissions overlap for some products, such as liquid milk and fresh beef. The variability of market-wide GHG emissions is such that the relative 'position' of each product is uncertain and an exact ranking for each product cannot be fixed. However, more general conclusions, such as the fact that liquid milk and fresh beef are within the top few grocery products, can be derived.

The ranges of GHG emissions shown in Figure 3.2 are caused by two main factors, the relative importance of which can be dependent on product type:

- Methodological differences within chosen studies (e.g. allocation method, inclusion or exclusion of Land Use Change emissions (e.g. conversion of forest to agricultural production) and assumptions regarding this, such as production location).
- Real variation in the carbon footprint of each product type, caused, for example, by: different variants of product within the same category (e.g. full fat milk, skimmed milk); different source locations (e.g. tomatoes from Spain or grown in the UK); or differences in production method (e.g. organic versus conventional).

While a complete analysis of variability was beyond the scope of this work, some insights on the drivers of the more significant ranges shown in Figure 3.2 are given in Table 3.1.

[20] *Ambient products include those food items that are transported and sold at ambient temperatures, e.g. canned foods, breakfast cereals, and pasta. Based on 2010 sales data (see Appendix 2)*

[21] *The range of market-wide GHG emissions presented in this study is a consequence of variations in the carbon footprint of each product. There are also likely to be variations in annual sales volumes of grocery products but this has not been investigated in this study.*

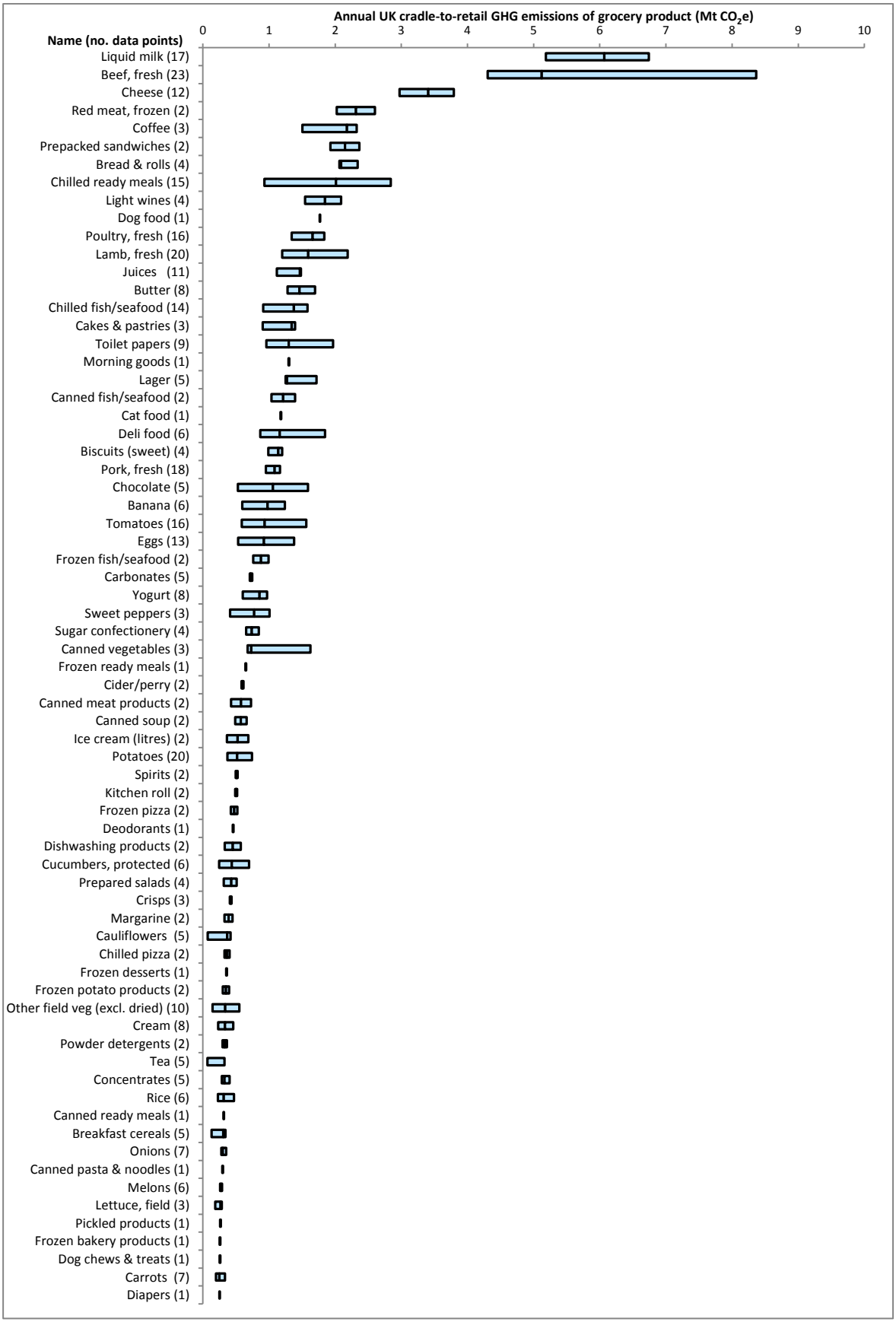


Figure 3.2 Top 70 grocery products contributing to annual cradle-to-retail GHG emissions (Mt CO_2e), based on 2010 sales data. The box shows the interquartile range with median values shown as a black line. The full data set is presented in Appendix 4.

Product	Explanation for range
Liquid Milk	17 data points for the cradle-to-retail carbon footprint of liquid milk were taken from eight different data sources. One explanation for the range in carbon footprint values for liquid milk is due to the method of production. A number of factors, from yield to feed regime and manure management system employed will influence the resulting footprint. Another explanation for the difference in liquid milk carbon footprint values is that milk has a number of different variants: full fat milk, semi-skimmed milk and skimmed milk. The carbon footprint of raw milk is usually allocated to dairy products based on fat-content, with those products containing the highest fat content (e.g. cream, full fat milk) receiving the largest allocation of impact. For example, Flysjö (2012) reports carbon footprint values of full fat milk, semi-skimmed milk and skimmed milk as 1.2, 1 and 0.9 kg CO_2e per kg, respectively.
Beef, fresh	23 data points for the cradle-to-retail carbon footprint of fresh beef were taken from nine different data sources. One explanation for the differences in the carbon footprint of fresh beef is the country of production and the associated differences in farming practices used in each country. ADAS (2009) report a carbon footprint of 40 kg CO_2e per kg for Brazilian beef and 10 kg CO_2e per kg British beef reared intensively. The difference can be explained by high slaughter ages and long calving intervals resulting in lower yields at the Brazilian farms studied[22]. There is also a wide variety of emissions associated with different production systems within any one country, making generalisations difficult. There are a number of products considered as fresh beef, which also contributes to the range in carbon footprint data observed. Some studies provide the carbon footprint of beef in terms of the finished carcass, whereas others provide data for individual cuts of beef. The carbon footprint of a whole beef carcass is generally apportioned to cuts of meat based on an economic allocation; whereby the more valuable cuts (e.g. sirloin) receive the largest allocation per kg than less valuable cuts (e.g. mince).
Chilled ready meals	15 data points for the cradle-to-retail carbon footprint of chilled ready meals were taken from six different data sources. A likely cause of the range in carbon footprint values for chilled ready meals is the large variety of product types that this category contains. Within this category there are ready meals that contain ingredients with high carbon footprints (e.g. beef) and ready meals that contain ingredients with low carbon footprints (e.g. root vegetables).
Tomatoes	16 data points for the cradle-to-retail carbon footprint of tomatoes were taken from six different data sources. The difference in carbon footprint values for tomatoes can be explained by the different production methods by which tomatoes are grown. For example, Williams et al (2009) report carbon footprint values for classic loose tomatoes grown under glasshouse in the UK as 2.2 kg CO_2e per kg and that for classic loose tomatoes grown in fields in Spain as 0.7 kg CO_2e per kg. The large difference in values is likely to be due to the additional energy requirements for heating glasshouses in the UK.

Table 3.1 Explanation of the range in carbon footprint values for key product categories

[22] *It is also noted that land use change was not considered in either British or Brazilian beef carbon footprints in this example. Land use change can result in a change in the amount of carbon stored by that land. For example, a change from rainforest to pasture land would result in a net loss of carbon, as a hectare of grass stores less carbon than a hectare of trees. If land use change were to be considered, the carbon footprint of Brazilian beef is likely to be significantly higher than the figure stated above. Land use change in Brazil is also generally more likely to result is a greater loss of carbon than land use change in the UK. This is because the majority of pasture in the UK was converted many years ago whereas in Brazil, as a worst case, Amazonian rainforest might be cleared for pasture or arable land to grow cattle feed.*

3.3 Data Quality

Any assessment of data quality is often difficult and can be subjective. This is discussed and illustrated further in Section 4.3, which concludes that, given the nature of this study, a data quality assessment would not be reliable or meaningful. However, to give context to the data presented in this study, the data sources that were used (peer-reviewed journals, eco-labels, etc.) are summarised in Appendix 4, and the predominant source used for each product is described. This enables the reader to see whether the data for each product is from a peer-reviewed journal, for example, or whether it is based on a proxy data point. Figure 3.2 and Appendix 4 also indicate the number of data points on which the findings for each product are based.

3.4 Cradle-to-grave GHG Emissions of Grocery Products

It is important to note that Figure 3.2 is a cradle-to-retail representation, and that the inclusion of further life cycle stages could change the positioning of products shown. The use phase, for example, has been identified in studies as significant for some products, as discussed later. However, although more than 1,000 cradle-to-grave data points were found in this research, they cover only 80 of the 230 product categories. They did not, therefore, allow an overview and analysis of grocery products in the manner shown by Figure 3.2 and Appendix 4. Nevertheless, some general comments on the significance of consumer energy use, and some case study examples of cradle-to-grave data, can be provided.

The use phase of grocery products is inherently uncertain, since it depends on variable consumer behaviour. A high-level indication of the magnitude of use-phase GHG emissions of grocery products can be provided by considering data on consumer energy use in UK households and the associated GHG emissions, published by the government (DECC, 2010). This is shown in Figure 3.3, with further discussion on consumer energy use provided in Appendix 5. Figure 3.3 shows that the use of appliances in the home that relate to grocery products represent a significant source of GHG emissions; a total of 61 Mt CO_2e. This compares to 82 Mt CO_2e for the total cradle-to-retail GHG emissions of the 217 products represented in this analysis.

It was beyond the scope of this work to allocate emissions from consumer energy use across all grocery products. This would be a complex exercise that would require a number of assumptions regarding the use of each product, including, for example, whether a food product is chilled or frozen in the home, whether it is incorporated into a meal alongside other ingredients, the type and length of cooking, and so on. However, the cradle-to-grave carbon footprint values gathered during this work do provide some examples of the relative importance of the use phase for some products, discussed below.

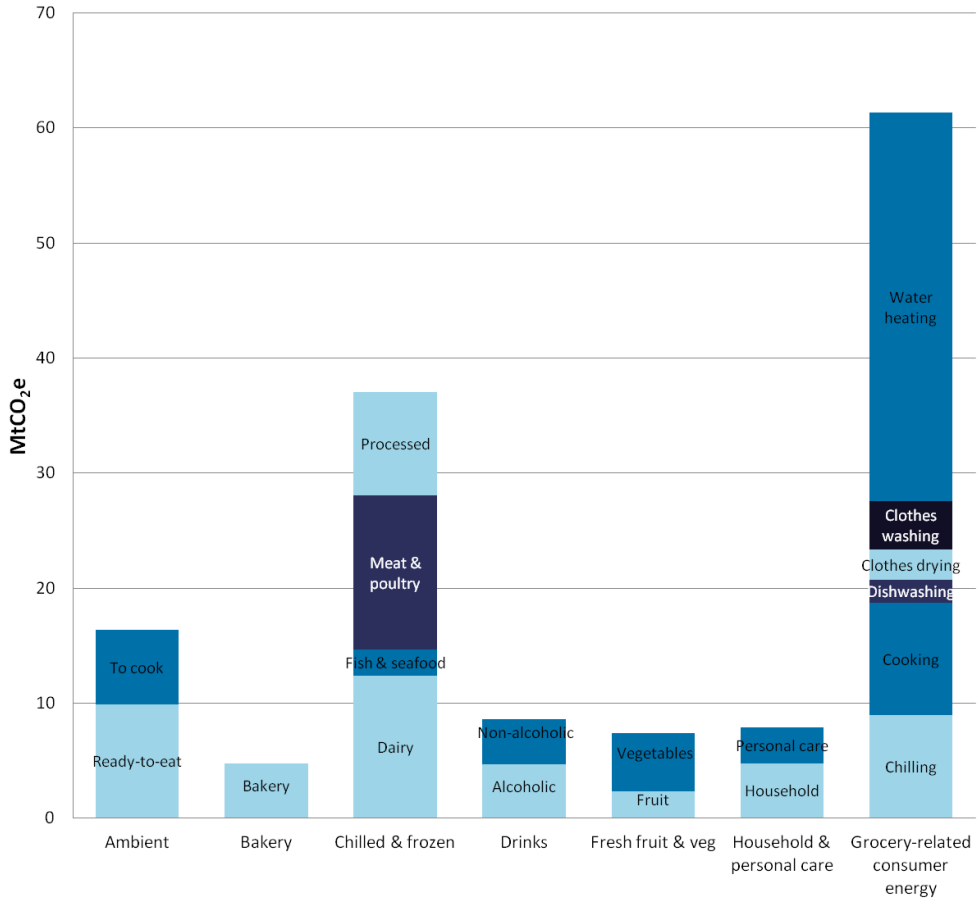


Figure 3.3 Breakdown of annual cradle-to-retail grocery GHG emissions by category[23],[24]

The following are examples of grocery products for which the use phase represents a large proportion of total life cycle emissions.

- **Bread and rolls** – Kingsmill report a cradle-to-grave carbon footprint for white bread of 1 kg CO_2e per loaf. Of this, the use phase represents 30%.
- **Bath and shower products** – A combination of cradle-to-grave data is available for bath and shower products. Use phase contribution is in the order of 80-90%.
- **Liquid detergents** – Tesco reported a cradle-to-grave footprint for 'Tesco Non Biological Liquid Wash' of 0.70 kg CO_2e per wash. Of this, the use phase represents 73%[25].
- **Potatoes** – Tesco reported a cradle-to-grave carbon footprint for 'King Edwards' of 0.16 kg CO_2e per 250g serving. Of this, the use phase represents 56%[26].

[23] *Ambient products include those food items that are transported and sold at ambient temperatures, e.g. canned foods, breakfast cereals and pasta.*

[24] *The energy uses shown in the figure are those that relate to grocery products. For example, water heating would be associated with showering and cleaning dishes, and hence with the use of soaps, shampoo and so on. Energy uses that are not associated with grocery products, such as space heating, are excluded from the figure.*

[25] http://www.tesco.com/assets/greenerliving/content/documents/pdfs/carbon_label_findings.pdf

[26] http://www.tesco.com/assets/greenerliving/content/documents/pdfs/carbon_label_findings.pdf

The rank order of these, and other similar types of product, would likely increase if the use phase were to be incorporated into Figure 3.2, but without data for a greater proportion of grocery products it is not possible to substantiate this. Further work would be required in this area if a clearer view of the use phase and/or full cradle-to-grave emissions is needed. A working group could explore whether there is strategic need for such further work, and the likelihood of being able to realise reductions in product environmental impacts from this perspective. The nature of this work would depend on its aims, which could include:

- Engaging with consumers and encouraging them to reduce consumer energy use, for example by showering for shorter periods of time, by using energy-efficiency appliances, etc.
- Engaging with grocery product manufacturers to encourage them to design products to have reduced 'in-use' impacts.
- Engaging with consumer appliance manufacturers to reduce the impact of consumer use, for example through improved appliance efficiency.

3.5 Comparison with other Analyses

The findings from this analysis were sense-checked against other publically available studies that have used a similar multi-product assessment. These included Tukker et al. (2006), Audsley et al. (2009) and Booths (2010).

The Tukker et al. (2006) study is the environmental assessment of EU goods and services introduced in Section 2.0 (EIPRO). Even though some of the product classifications in this study were of a higher level (e.g. all fruits are included in one category), many similar findings are evident. These include the importance of meat, dairy, bread, coffee, laundry products, carbonated drinks and wines.

Audsley et al. (2009) was of limited use by way of a direct comparison, as it modelled UK food GHG emissions from a raw ingredient perspective (i.e. cereal crops appear as a key category but in reality feed into beers, bread, cakes, morning goods, etc.). However, this study also confirms the importance of meat and dairy products.

Booths (2010) was the most similar assessment, being a GHG assessment of a UK supermarket, using product sales and life cycle data. Even though some of the product classifications were different to those used in this study, there was generally good agreement with the priority products listed above. Booths additionally found floristry products to be positioned highly. This category of products was not examined in this study and could be a potential future target for the PSF's future work.

Overall, total cradle-to-retail grocery product GHG emissions (ca. 82 $MtCO_2e$) were slightly lower than reported elsewhere (e.g. Audsley et al. (2009) report approximately 100 $MtCO_2e$ for similar stages excluding land use change[27]). The exact reasons for differences are unclear, although the following reasons are most likely:

- Inevitably there are differences in study boundaries – for instance, this analysis only considers retail supply chains, whereas other studies may include food service sector;
- The total sales volumes used in this study may differ between studies.

[27] *Based on interpretation of main report tables (Pg 39 and 40 of Audsley et al (2009))*

3.6 Limitations

There are limitations to this study that mean that care should be taken when interpreting the results. In particular:

- Grocery production systems are very variable and although the range of GHG emission estimates given for many products increases confidence that their actual impacts are represented, the carbon footprint values used may not reflect the majority of product sold.
- The sample size varies across the grocery products analysed in Figure 3.2 and Appendix 4. While some products are represented by up to 25 data points, some products have only one data point. This in itself is less of a limitation than the representativeness of the sample: if a single study well represents the products on sale in the UK, this would provide better insight than 25 studies on niche products that don't accurately represent the product in question. However, the known variability across many grocery production systems, as noted above, is such that the insight from a larger number of studies is considered to be of value.
- The consumer stage is important, but could not be represented across the 217 products investigated.

3.7 Summary

This study has estimated the cradle-to-retail GHG emissions of 217 products (kg CO_2e), by multiplying the 2010 sales volume of each product (kg per year) with data on the cradle-to-retail carbon footprint of each product (kg CO_2e/kg). Based on median values, the total annual cradle-to-retail emissions of the 217 products assessed is estimated to be 82 Mt CO_2e. The top 70 products represent 87% of these total emissions, while the remaining 147 products account for just 13%. Despite some continued data gaps (e.g. no data available for the 14 products listed in Appendix 4), Figure 3.2 and Appendix 4 give a cradle-to-retail GHG positioning of products that is based on a substantial quantity of data collated during this study, and are therefore considered to be a reasonable basis for use by the PSF to prioritise research and GHG reduction efforts.

The life cycle stages beyond the retail stage – particularly the consumer use phase – can result in significant GHG emissions. A full analysis was not possible during the present study because of a lack of use-phase and cradle-to-grave data. Further work would be required if a clearer view of the use phase and/or full cradle-to-grave emissions is needed. The PSF could convene a working group discussion to explore whether there is strategic need for such further work. The nature of such work would depend on its aims, for example whether it is used to engage with consumers or with industry.

4.0 Cradle-to-Retail Embedded Energy

4.1 Method

An assessment of the cradle-to-retail embedded energy impacts associated with commonly consumed grocery products in the UK was compiled by Warwick University in order to further support the identification of priority products against this metric[28]. The majority of the results are based on the Defra project FO0415 'Energy dependency and food chain security' (Lillywhite et al., 2012) and supplemented where necessary (predominantly for non-food products) with other published data.

In a similar way as described for the GHG assessment (Section 3.0), the assessment sought to combine data on UK grocery product sales for 2010 (kg per year) with data on the cradle-to-retail embedded energy consumption for each product (MJ/kg). This combination provides an estimate of the cradle-to-retail embedded energy associated with each product sold each year in the UK (measured in MJ per year). It allows the products with the largest contribution to grocery sector embedded energy consumption to be identified, and reduction efforts focused accordingly.

Product embedded energy values were extracted from peer-reviewed academic literature and other published studies (Defra, DECC, WRAP, NGOs, etc.) following a literature search to identify energy use associated with the production of different foods and household items. For many products, this subsequently allowed an estimation of the variation due to different production practices to be included.

All energy values presented within this section are on a 'delivered' basis – meaning that losses of energy associated with energy conversion and transmission are excluded from the analysis (e.g. losses when converting natural gas into electricity and delivering this to point of use). Only the energy consumed at point of use is quantified. This is a pragmatic approach that allows multiple users to engage with the results, but it is important to remember that products whose production relies mainly on electricity will have a higher 'primary' (feedstock) energy use than reported in this study.

The spread of embedded energy values for each product is shown in this study by the interquartile range (see Figure 4.1). The interquartile range shows all values between the lower quartile (below which the lowest 25% of values reside) and the upper quartile (above which the highest 25% of values reside). It therefore shows where the central 50% of values are concentrated. The middle value of the interquartile range, and the data set as a whole, is the median value. It describes the central tendency of the data and was used in this study as the representative value with which to position products, in the same way as for GHG emissions (Section 3.0). Table 4.1 and Appendix 6 provide further descriptive information about the data set, including the number of data points used for each product and their predominant source (e.g. peer-reviewed journal).

A further Appendix (Appendix 7) presents a discussion on the role and potential contribution of renewable energy in the production of grocery products.

[28] *Note that the products identified in this research reflect commonly purchased products but are not statistically representative of market share*

4.2 Results

Table 4.1 and Figure 4.1 show the most significant products contributing to grocery sector embedded energy use from those included in the study. The top ten products account for 38% of total energy use and the top twenty products for 59%.

Overall, total market energy use is dominated by every-day food and drink products, e.g. milk and other dairy products, bread, beef, chicken and soft drinks. However, care must be exercised with the interpretation of some results due to differences in production systems and data availability and analysis, which limit comparisons between different products.

Product name	Predominant Source Type	Median Product Embedded Energy MJ/kg	Sales volume Million kg	Annual UK Market Energy Use TJ
Bread & rolls	PRJ	12.10	2,769	33,500
Liquid Milk	PRJ/AR	5.10	5,186	26,400
Chocolate	PRJ	43.00	589	25,300
Tomatoes	D	42.39	477	20,200
Cheese	PRJ	51.80	387	20,000
Spirits	PRJ	82.50	215	17,700
Poultry, fresh	D	40.35	435	17,600
Carbonates	PRJ	5.63	2,960	16,600
Frozen Fish/seafood	AR	94.90	170	16,100
Juice	PRJ	10.20	1,481	15,100
Beef, fresh	PRJ	50.71	291	14,800
Chilled Fish/seafood	PRJ	54.50	229	12,500
Dog Food	OCR	15.45	802	12,400
Light Wines	PRJ	14.00	882	12,300
Powder Detergent	PRJ	30.42	386	11,700
Nappies	IR	82.50	140	11,600
Biscuits	PRJ	23.00	480	11,000
Toilet papers	AR	20.75	493	10,200
Canned vegetables	PRJ	17.35	560	9,700
Household Paper	AR	165.44	58	9,600
Sugar confectionery	AR	34.00	252	8,600
Eggs	IR/D	27.20	314	8,500
Cakes & pastries	PRJ	16.00	516	8,300
Cat Food	OCR	15.45	534	8,300
Cucumbers	PRJ	42.00	190	8,000
Mushrooms	IR	47.63	156	7,400
Potato chips	D/IR	37.00	178	6,600
Yogurt	D/PRJ	13.65	479	6,500
Lamb, fresh	PRJ	67.00	92	6,200
Morning goods	PRJ	18.50	332	6,100
Pork, fresh	AR	35.10	172	6,000
Wet Cooking Sauces	D	24.00	246	5,900
Margarine	PRJ	23.20	241	5,600
Frozen Vegetables	AR	19.50	284	5,500
Butter	PRJ	32.00	172	5,500
Lager	PRJ	3.50	1,563	5,500
Canned Fish/seafood	AR/PRJ	19.50	277	5,400
Beans (excl. dried)	IR	90.30	59	5,300
Breakfast Cereals	PRJ	15.50	343	5,300
Tea	AR	65.45	81	5,300

Bananas	PRJ	5.40	974	5,300
Coffee	PRJ	74.50	66	4,900
Ice cream	PRJ	15.00	312	4,700
Frozen Potato Products	PRJ	9.80	445	4,400
Potato	AR/D	2.17	1,925	4,200
Ale	PRJ	18.75	221	4,100
Bottled Water	IR	2.92	1,292	3,800
Other Field Veg (excl. dried)	IR	10.70	306	3,300
Canned Soup	D/IR	18.46	174	3,200
Apples	PRJ	4.74	665	3,200
Chilled Ready-meals	PRJ	7.30	428	3,100
Liquid Detergents	PRJ/IR	31.05	100	3,100
Processed Snacks	D	14.59	181	2,600
Frozen Pizza	D	22.54	110	2,500
Milk (concentrate & powder)	PRJ/IR	62.50	39	2,400
Other Fruit	PRJ	23.00	103	2,400
General Purpose Cleaners	PRJ	16.15	146	2,400
Toilet care	PRJ	66.85	33	2,200
Dried Pasta/noodles	IR	14.50	152	2,200
Grapes	PRJ	8.75	244	2,100
Rice	PRJ	14.93	141	2,100
Onions	AR	2.90	721	2,100
Carrot	AR	2.80	715	2,000
Bath & shower products	PRJ	13.65	145	2,000
Strawberries	PRJ	12.70	148	1,900
Table Sauces	PRJ	15.96	111	1,800
Lettuce, field	IR	6.00	267	1,600
Sparkling Wines	IR	36.38	43	1,600
Canned Fruit	AR	13.00	118	1,500
Crackers (savoury biscuits)	PRJ	15.50	93	1,400

Table 4.1 Top 70 grocery products contributing to annual embedded energy, based on 2010 sales data.

Legend:
PRJ: Peer Reviewed Journal
AR: Academic Research
IR: Industry Research
D: Defra Research
OCR: Other Corporate Research

Figure 4.1 shows a graphical breakdown of the 70 grocery products with the largest cradle-to-retail embedded energy. The selection of the top 70 and the ranking shown is based upon the median value for each product, shown as a black line in Figure 4.1. The lighter blue bar shows the interquartile range of the estimates, based on the total number of data points listed on the figure[29]. This indicates the sensitivity of the ranking to known variations in the embedded energy associated with each product, as discussed in Section 3.2. The variability of market-wide GHG emissions is such that the relative 'position' of each product is uncertain and an exact ranking for each product cannot be fixed. However, more general conclusions, such as the types of product that show greater embedded energy use, can be derived.

[29] *The Microsoft Excel 'quartile' function was used to calculate the lower quartile, median and upper quartile values. Where necessary, Excel uses linear interpolation to calculate these values, for example when there are an even number of data points, or fewer than five data points.*

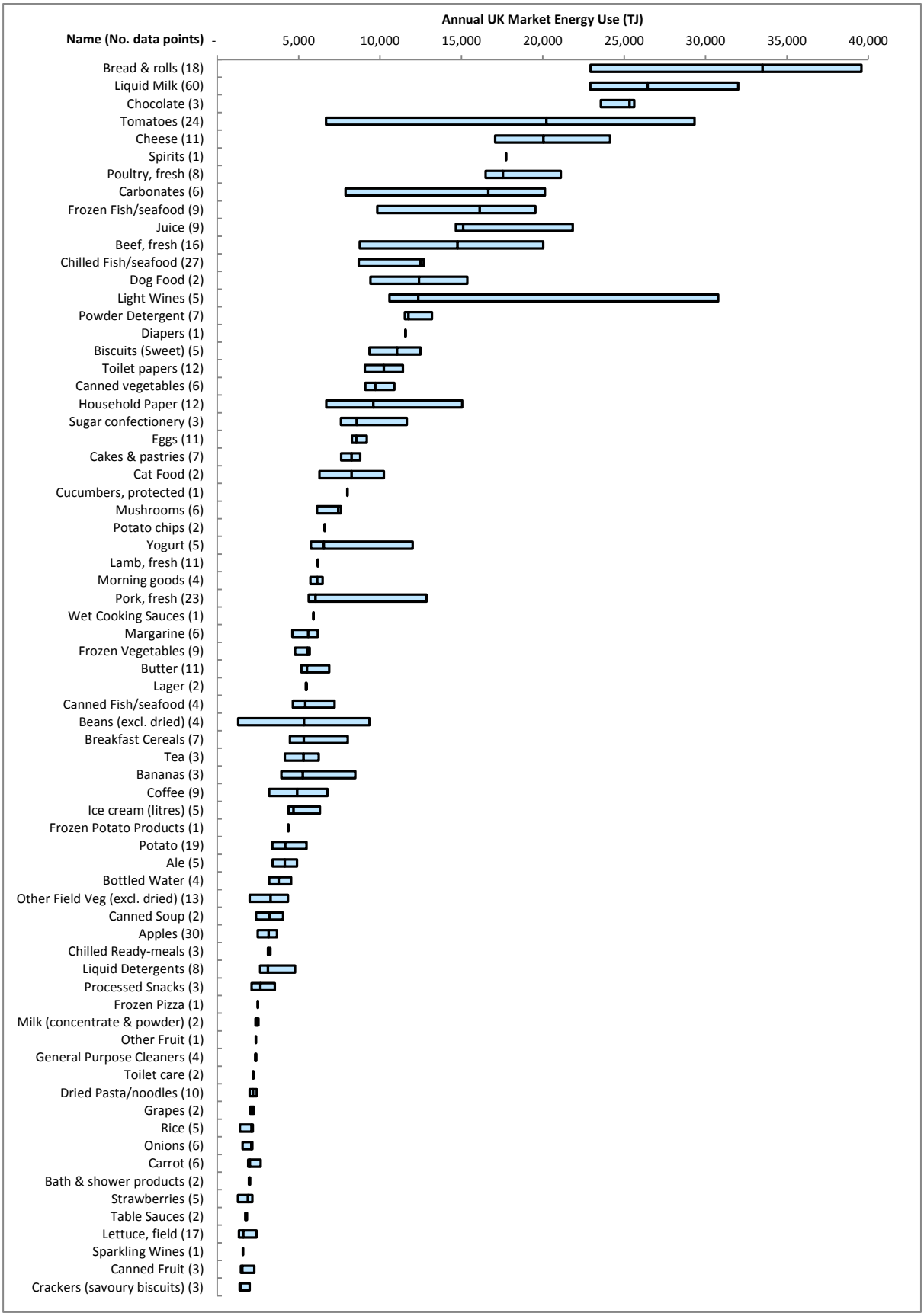


Figure 4.1 Top 70 grocery products contributing to annual cradle-to-retail embedded energy, based on 2010 sales data. The box shows the interquartile range with median values shown as a black line. The full data set is presented in Appendix 6.

The authors note that the 'top 10' contains results for three products that should be viewed with caution and the following caveats, as discussed below.

- For chocolate, the issue is one of identifying the exact boundary conditions that apply to its embedded energy value, as the embedded energy of one kilo of cocoa beans is different to one kilo of cocoa solids or one kilo of retail chocolate (where the cocoa content can vary considerably).
- The market energy use for alcoholic spirits is based on a single data sample and will not be representative of the whole sector.
- For both of these products, a 'common-sense' check suggests that their embedded energy values appear high in comparison to other products. However, the values are used here since no alternatives are available.
- The tomato dataset is based on a large sample size but one that contains examples of niche production systems which the authors acknowledge could skew the median value considerably. For tomatoes, an alternative approach, based on the classic round tomato sold loose, would probably result in an embedded energy value nearer 15 MJ/kg rather than 42 MJ/kg as used in this analysis, with a subsequent fall in total market energy usage and a fall in the 'position' to around twenty-sixth.

The latter issue of identifying the 'typical' product embedded energy value, rather than the median, applies to all products with a large range of reported values, e.g. bread, carbonated soft drinks, frozen seafood, beef, light wines, paper and yoghurt to name but a few and is a limitation in this type of analysis. The solution is identify the percentage market share of the different variants of the same product and to calculate overall energy usage on that basis. Unfortunately this approach is time consuming and beyond the scope of this project. However, for some popular products, i.e. bread and rolls, tomatoes and beef, it may be worth undertaking in future iterations of this research, to illustrate the variation between a typical value and the category median.

Beverages (excluding milk and bottled water) make a significant contribution to overall energy use accounting for six items in the top 50 products and using 13% of the total energy. The majority of energy use is within the production stage, although packaging can also be significant.

Household products, e.g. toilet paper, detergents etc. contribute little to the overall embedded energy analysis. It is important to note, however, that the inclusion of further life cycle stages could change the positioning of some household (and food and drink) products. Energy consumption during a product's use in particular has been identified in studies as significant for some products, as discussed in Section 3.4.

A more complete analysis, presented in Appendix 6, shows energy use across the different stages of the supply chain (cradle-to-retail). The results show that it is the agricultural, or primary production, stage that is the largest contributor to embedded energy for the majority of food products; with a smaller contribution from food processing and manufacture post farm-gate. This is with the exception of some baked products, e.g. bread, for which processing is the largest contributor. For other products, e.g. those in aluminium tins or glass jars, packaging can require considerable energy. The transport stage is rarely a major contributor; only very bulky items, e.g. toilet tissue, or items that are imported by air require significant energy usage. Only food products that are frozen influence retail energy use, although energy use at retail is increasing with the use of in-store bakeries.

4.3 Data Quality

A comparison of embedded energy for different products is limited by the inherent variability in the data available, limited sample size for some products and limited understanding of the market characteristics surrounding the production and supply of many products across their entire supply chain (e.g. energy sources used, technologies applied). This makes it difficult to identify a suitable approach to data quality appraisal.

This point is well illustrated by examination of tomato and alcoholic spirits. The production of tomatoes can principally be divided into field and glasshouse production and then further sub-divided into type (classic, plum, cherry, on/off vine ripening etc.) and then into conventional or organic production. Each of these categories will have a different energy requirement but are all contained within a single category in this analysis. This gives rise to a huge range of embedded energy values: from 5 MJ/kg to 500 MJ/kg across a sample size of 24. In this instance, it is likely that the variation surrounding the mean or median value is far greater than the error associated with any one single value.

Alcoholic spirits demonstrates the other extreme. The market value is based on a single sample, which, given the huge range of spirits available, is likely to have considerable variation associated with it. However, a single sample provides no understanding of how large that variation might be, so allocating a quality parameter to it would be erroneous itself. The danger involved in allocating a quality parameter to a source is that it can become accepted as true over the long term based on usage rather than accuracy.

In summary, this form of analysis, where a mean or median value (and the difference between the two can be considerable; over 30% for some products) is multiplied by market volume is open to the introduction of error. The results, although useful, should be regarded as a best estimate rather than an actual value. However, we recognise that some context is useful so the sample size and dominant data source are identified alongside the results (see Appendix 6, Figure A6-1 for details). The data sources used within the energy analysis are: peer reviewed journal (PRJ); academic research (AR); industry research (IR); Defra science projects (D) and other corporate research (OCR). However, it must be stressed that the identity of the source material is not itself a sound indicator quality.

4.4 Research Limitations

There are a number of limitations of this analysis which, it should be recognised, affect both the results and their interpretation.

- The results are presented on a delivered energy basis, and so losses of energy associated with energy conversion (e.g. at a power plant) and transmission to point of use are not taken into account – only the amount of energy consumed at point of use is included. For those products that rely on electricity, their actual 'primary' energy use (the energy within feedstock material) may be up to three times greater than reported and any impact is likely to be disproportional and difficult to quantify. This scenario can occur in situations where multiple fuels types can be used to undertake the same task. For example, on-farm grain drying can be fuelled by either gas or electricity and in a wet year, the extra energy required to dry grain to an acceptable moisture content can be considerable. Although the 'delivered' energy use would be similar, drying using electricity would require greater 'primary' energy. It is very difficult to quantify these differences because of a lack of underlying data on different use systems.

- Food production systems are very variable and the range of embedded energy values might not be a true reflection of the majority sector. For example, field grown conventional loose tomatoes produced in Italy may have an embedded energy value around 5 MJ/kg while organic vine ripened tomatoes grown in a heated glasshouse in the UK may have a value of 500 MJ/kg. In this example, the median value is likely to over-estimate the energy requirement which distorts the total market value.
- The consumer stage (not included within the energy analysis) can disproportionally affect energy usage. Energy use within post-retail transport, storage, preparation and cooking can dominate a product's individual energy profile (see Section 3.4 for further discussion on consumer use impacts).
- The sample size for individual products shows a large variation. Every-day and popular products are generally well represented in the literature, e.g. milk with a sample size of 60. However, some items are poorly studied, e.g. only a single study was identified for alcoholic spirits and nappies. Great care should be exercised when interpreting and extrapolating from these results.

4.5 Summary for Embedded Energy

This section has estimated the cradle-to-retail embedded energy value for different grocery products and calculated their total market energy use based on 2010 sales data. The results confirm that it is common every-day products that dominate energy usage, e.g. milk, bread, drinks and meat. In terms of mitigation and energy saving strategies, the top ten products account for 38% of total energy use and the top twenty products for 59%, so it is these products which should be the focus of research and development.

The type and range of data to support this analysis was very variable. Some products, e.g. milk are well represented with 60 data points but many others rely on just one or two data points. The range of data values is also very variable and not always directly related to the range of items within a single product category. This variability needs to be treated with respect since it has considerable influence on overall interpretation of the results. However, the results are a useful and reasonable approach to highlight the dominant products within the UK market. A more detailed assessment would need to be undertaken at the product category level if this approach is to be used for mitigation strategy development.

5.0 Food and Drink Ingredient Water Impacts

A new assessment of the water footprint impacts of grocery products was commissioned by WRAP in order to further support the identification of priority products against this metric. This work was undertaken by URS Infrastructure & Environment UK Ltd (URS) in 2011/2012. The main output of the study comprises a series of excel based datasets, with selected information exported into the PSF's online Knowledge base. The sections below summarise the approach taken, results to date and key limitations. A full project report "*Environmental Data & Hotspot Impact Research - Water Metric Feedback Report*" will be separately published by WRAP in summer 2013, following a series of additional research tasks (discussed later in this Section).

5.1 Method

The approach used to determine priority products from a water consumption perspective was firstly to determine 'Water Footprint Impact Indicators' for individual grocery products and then to combine these with annual UK product sales data, in the same way as undertaken for GHG cradle-to-retail emissions (Section 3.0) and embedded energy (Section 4.0). Key principles were to use the best available data from published sources (predominantly those published by the Water Footprint Network), focusing on the most significant water components within the life cycle of each product and considering, wherever possible, the location from which products originate. Further details of the main method steps are outlined below.

Step 1 – Definition of the key life cycle components of each product. The following simplified life cycle stages were considered in the assessment. Notably, the consumer use phase was not included, consistent with the approach taken for GHG emissions and energy.

- Raw material production (e.g. crop cultivation, rearing of livestock, primary processing of materials)
- Packaging production
- Manufacture of finished product

Step 2 – Collation of appropriate green, blue and grey water footprint factors (litres water per kg of product, material etc.)[30] for each product. Where available, green, blue and grey water footprint data specific to the product, country of origin and life cycle stage were collated.

Step 3 – Determination of product locations - the primary countries that supply raw material, component parts and finished goods to the UK.

Step 4 – Calculation of the green, blue and grey water footprint per product (based on country of origin).

For each product and life cycle stage, the water footprint was calculated for the top five countries from which the UK imports each product (based on % of total UK imports of each product). In addition the global average water footprint and UK water footprint was also calculated per product.

[30] Blue water = volume of fresh surface and groundwater consumed as a result of the production of the product (not returned to the same catchment); Green water = volume of precipitation evaporated, or taken up by crops, during the production process; Grey water footprint = volume of freshwater that is required to assimilate pollutants (i.e. a measure of the impact of polluted water). (Water Footprint Network)

The following documents published by the Water Footprint Network provide a good coverage of water footprint factors for a large number of crops and livestock (and their products and some process stages and countries). These, therefore provided the main source of information for many of the products included in the study.

- Mekonnen, M.M. and Hoekstra, A.Y. (2010). The green, blue and grey water footprint of crops and derived crop products, Value of Water Research Report Series No. 47, UNESCO-IHE, Delft, the Netherlands. Appendix II. Water footprint per ton of crop or derived crop product at national and sub-national level (1996-2005).
- Mekonnen, M.M. and Hoekstra, A.Y. (2010). The green, blue and grey water footprint of farm animals and animal products, Value of Water Research Report Series No. 48, UNESCO-IHE, Delft, the Netherlands. Appendix V. Water footprint of animal products. Period 1996-2005.
- Ercin, A.E., Aldaya, M.M. and Hoekstra, A.Y. (2009). A pilot in corporate water footprint accounting and impact assessment: The water footprint of a sugar-containing carbonated beverage, Value of Water Research Report Series No.39, UNESCO-IHE.
- Chapagain, A.K., and Hoekstra, A.Y. (2007). The water footprint of coffee and tea consumption in the Netherlands, Ecological Economics 64(1): 109-118.
- Bradley G. Ridoutt, Stephan Pfister (2010). A revised approach to water footprinting to make transparent the impacts of consumption and production on global freshwater scarcity.

For many crop products it is assumed by the Water Footprint Network that the processing water requirement is relatively small compared to the water consumption of the primary crop, and this is excluded in the data available regarding the water footprint of processed crop products. Therefore, most of the water data available falls into the 'Raw Material' life cycle stage. For some products limited data are available for other life cycle stages e.g. product manufacturing. However, where this information is available, it is not normally country specific.

Where possible, for products where a product-specific water footprint factor had not been determined, an appropriate similar product was selected (e.g. potato flakes used for crisps). Similarly for more complex products, where possible a water footprint factor was determined using the water footprint factors of the individual key raw ingredients (if available). For example the water footprint factor of sponge cake =
0.2kg refined sugar WF + 0.2kg butter WF +0.16kg eggs WF +0.4kg wheat flour WF

Step 5 - Addition of an allowance for water scarcity in each country, resulting in the generation of a 'Water Footprint Impact Indicator accounting for water scarcity'.

Country-specific water scarcity factors were developed on the basis of the following parameters, derived from the World Business Council for Sustainable Development's Global Water Tool[31]:

- The total renewable water availability per capita for each country in 2025, developed by the Water Resources Institute from 1995 data, extrapolated on the basis of population growth to 2025. (A water availability of >1700 m3/day is defined as "sufficient", while anything lower is considered a stressed or scarcity situation);
- Population trends. (With increasing population predicted over the next 25 years, there will be a decline in water resource availability); and

[31] *http://www.wbcsd.org/work-program/sector-projects/water/global-water-tool.aspx*

- Total water withdrawn from the available supply. (A large withdrawal can indicate that there may be ecological damage as a result of the withdrawals).

In addition, social factors have been included in the development of a scarcity factor: the proportion of the population with access to clean water and sanitation facilities. Although not necessarily a measure of scarcity, this is potentially a measure of the impact of the water footprint of UK consumption.

From this analysis, country specific scarcity factors (ranging from 0.5 to 1.5) were developed to account for water stress and social factors prevailing in each country (these are detailed in Appendix 9). This scarcity factor was used to "inflate" (or decrease if relevant) the water footprint to numerically account for the global variations in water availability. Countries where water is scarce, population is growing and water supply and sanitation facilities are poor have a scarcity factor greater than 1 but countries where water availability is sufficient and have a stable population, etc. have a factor less than or equal to 1.

For each of the individual grocery products assessed, a series of values were calculated:
- An Internal Water Footprint Impact Indicator – based on growing or sourcing the product in the UK;
- An External Water Footprint Impact Indicator – a weighted average based on the share of UK imports of each product from the top five import countries and the global average water footprint (for the remainder of imports); and
- A Weighted Water Footprint Impact Indicator – based on the share of volumes produced in the UK, plus imports.

Step 6 – Development of a preliminary list of priority products, by combining the Weighted Water Footprint Impact Indicator data (scarcity weighted litres/kg product) with annual UK sales data (total kg, 2010). The result from this step was a Weighted Annual Water Footprint Impact Indicator for each product, which has been used to identify the principal contributors to the UK grocery sector's water impacts.

5.2 Results

Based on best available data and methodology, the food and drink products that are significant in terms of their contribution to the total water footprint impact and represent potential priorities are presented in Table 5.1 and Figure 5.1. Please note that, at the time of drafting, Water Footprint Impact Indicator data were only available for 103 grocery products (all food and drink products), and filling information gaps continues to be an area of on-going research activity. Appendix 8 lists the products for which data were not available, and so are not represented in this study.

Despite the data limitations (discussed in Section 5.3), it is considered that the products presented in Table 5.1 are a good representation of priority grocery products worthy of further focus within the PSF. These can be broadly grouped as follows:
- **Meat and dairy products (e.g. beef, deli food, canned meat)**. Per kilogram of product, animal products generally have a larger water footprint than crop products, due to the water footprint of the feed consumed by the animal throughout its lifetime (i.e. water required to grow animal feed crops and the generally poor conversion efficiency between the volume of animal feed required to produce the same volume of meat).

- **Concentrated products (e.g. juice, seasonings, dressings (olive oil))**. For example concentrated juice has a higher annual Total Water Footprint Impact Indicator compared to fresh juice due to greater concentration of fruit.
- **Products originating from counties with inherently high evapotranspiration and crop water requirements** and therefore high green water footprint (e.g. chocolate from Ivory Coast, coffee originating from Brazil and bananas originating from Ghana and Brazil).
- **Products grown in countries with high water scarcity** (e.g. rice sourced from India and Pakistan and tea sourced from Kenya and India).
- **Products driven by high sales** (e.g. bread and rolls, milk, carbonated drinks and juice) where, although water impact per kg is relatively low, annual kg consumption is high. For example, the water footprint of wheat grown or imported into the UK is typically far below the global average. However, sales of bread and rolls represent 9% of total UK grocery sales.

The 'total' water footprint impact indicator numbers presented in Table 5.1 and Figure 5.1 are largely dominated by green water, due to the high percentage of green water in the water footprint of food and agricultural products. Separate green, blue and grey product prioritisation is, however, useful in order to identify potential intervention and reduction opportunities.

It is considered that the best way to manage our shared water resources, and the only way to reduce the water footprint impact of foods, is to maximise green water use and then top up (only if absolutely necessary) with efficient and responsible blue water irrigation. Green water is typically considered as a more efficient use of water in comparison to blue water irrigation. Blue water withdrawals usually cause greater ecological harm due to energy used for the withdrawal and also because the ecosystems from which the water is taken are sensitive to changing water volumes and flows. Blue water use is also often inefficient e.g. overwatering during irrigation, evaporation losses.

The priority products for blue water therefore represent those products where there could be significant opportunity to maximise efficiencies and recycling of irrigation and process water, whereas for green water there is a wider perspective relating to planting crops suitable to the local climate, soil management and cultivation, competing water demands within a local catchment and ultimately production and sourcing patterns.

Grey water is a measure of the impact of water pollution and is an indicator of how effluents result in a reduced assimilation capacity within freshwater bodies. For crop production this would be the volume of dilution to reduce agrichemicals leaching from soils to agreed standards. For industrial production this is the dilution of discharged effluent to agreed water quality standards (although this is complicated by the use of downstream municipal treatment plant). The priority products for grey water therefore represent products with potential to reduce wastewater through increased water recycling or reuse and treatment of wastewater before disposal. In agriculture, the grey water footprint can be reduced by optimum use of chemicals (artificial fertilizers, pesticides) or using substances that are less toxic or more easily degradable, and apply fertilizers or compost in a form, time or via techniques that allows easy uptake, so that leaching and run-off are reduced.

TOTAL			Green			Blue			Grey		
Rank	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**
1	11,200,000	Chocolate	1	11,100,000	Chocolate	1	201,000	Concentrated juice	1	249,000	Bread & rolls
2	3,920,000	Concentrated juice	2	3,520,000	Concentrated juice	2	155,000	Rice	2	238,000	Liquid Milk
3	1,850,000	Coffee	3	1,770,000	Coffee	3	118,000	Carbonated drinks	3	199,000	Concentrated juice
4	1,840,000	Liquid Milk	4	1,520,000	Liquid Milk	4	106,000	Sugar confectionery	4	127,000	Beef, fresh
5	1,260,000	Beef, fresh	5	1,090,000	Beef, fresh	5	93,500	Dressings	5	107,000	Deli food
6	1,010,000	Bread & rolls	6	752,000	Carbonated drinks	6	83,500	Liquid Milk	6	98,600	Poultry, fresh
7	903,000	Carbonated drinks	7	740,000	Bread & rolls	7	76,900	Light Wines	7	80,500	Pork, fresh
8	836,000	Deli food	8	737,000	Juices	8	69,100	Banana	8	73,600	Cider/perry
9	802,000	Juices	9	676,000	Deli food	9	53,400	Deli food	9	73,100	Chocolate
10	706,000	Canned meat products	10	629,000	Canned meat products	10	50,500	Small oranges	10	68,100	Light Wines
11	683,000	Red Meat, Frozen	11	595,000	Red Meat, Frozen	11	48,900	Oranges	11	67,600	Cakes & pastries
12	660,000	Banana	12	568,000	Banana	12	48,000	Cakes & pastries	12	67,400	Coffee
13	646,000	Poultry, fresh	13	533,000	Poultry, fresh	13	42,700	Apples	13	67,100	Red Meat, Frozen
14	632,000	Pork, fresh	14	509,000	Pork, fresh	14	41,800	Pork, fresh	14	55,900	Canned meat products
15	592,000	Dressings	15	497,000	Tea	15	41,700	Juices	15	52,300	Eggs
16	561,000	Cider/perry	16	497,000	Dressings	16	38,200	Cider/perry	16	49,300	Cheese
17	559,000	Tea	17	449,000	Cider/perry	17	37,500	Beef, fresh	17	41,600	Juices
18	512,000	Cheese	18	430,000	Cheese	18	36,400	Wet cooking	18	35,400	Butter

TOTAL			Green			Blue			Grey		
Rank	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**
								sauces			
19	502,000	Cakes & pastries	19	386,000	Cakes & pastries	19	34,700	Margarine	19	33,200	Onions
20	449,000	Light Wines	20	382,000	Lamb, fresh	20	32,800	Tea	120	32,700	Potatoes
21	415,000	Sugar confectionery	21	329,000	Seasonings	21	31,900	Cheese	22	32,600	Carbonated drinks
22	412,000	Lamb, fresh	22	304,000	Light Wines	22	28,400	Lamb, fresh	22	31,800	Seasonings
23	383,000	Rice	23	285,000	Eggs	23	23,600	Chocolate	23	31,400	Rice
24	381,000	Seasonings	24	284,000	Sugar confectionery	24	22,000	Grapes	24	29,100	Tea
25	350,000	Eggs	25	277,000	Butter	25	21,800	Canned meat products	25	28,600	Canned vegetables
26	330,000	Butter	26	196,000	Rice	26	21,000	Bread & rolls	26	28,000	Apples
27	247,000	Apples	27	177,000	Margarine	27	20,800	Red Meat, Frozen	27	26,200	Sugar confectionery
28	212,000	Margarine	28	176,000	Apples	28	20,100	Seasonings	28	25,400	Lager
29	206,000	Yogurt	29	168,000	Yogurt	29	19,600	Lemons and Limes	29	25,300	Yogurt
30	162,000	Onions	30	139,000	Breakfast cereals	30	19,300	Spirits	30	23,400	Banana
31	144,000	Breakfast cereals	31	116,000	Poultry, frozen	31	19,100	Dates and Figs	31	21,400	Poultry, frozen
32	142,000	Small oranges	32	110,000	Onions	32	18,700	Pickled products	32	20,800	Grapes
33	142,000	Potatoes	33	110,000	Nuts & seeds	33	18,600	Onions	33	20,500	Small oranges
34	140,000	Poultry, frozen	34	100,000	Spirits	34	17,200	Butter	34	18,900	Dried Pasta / noodles
35	136,000	Spirits	35	99,500	Dried Pasta /	35	16,500	Potatoes	35	17,000	Spirits

TOTAL			Green			Blue			Grey		
Rank	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**
					noodles						
36	131,000	Dried Pasta / noodles	36	92,900	Potatoes	36	14,500	Poultry, fresh	36	16,000	Canned pasta & noodles
37	131,000	Grapes	37	88,600	Grapes	37	14,200	Other Fruit	37	15,200	Other field veg
38	131,000	Oranges	38	85,700	Lager	38	13,500	Canned vegetables	38	15,100	Frozen vegetables
39	127,000	Canned vegetables	39	85,300	Canned vegetables	39	13,000	Dried Pasta / noodles	39	15,000	Wet cooking sauces
40	115,000	Lager	40	84,300	Canned pasta & noodles	40	12,800	Yogurt	40	14,900	Frozen potato products
41	114,000	Nuts & seeds	41	71,300	Small oranges	41	12,300	Eggs	41	12,900	Oranges
42	111,000	Canned pasta & noodles	42	69,300	Oranges	42	12,300	Avocado	42	12,700	Carrots
43	87,800	Pickled products	43	68,500	Pickled products	43	12,200	Other Citrus Fruits	43	10,800	Potato chips
44	71,100	Smoothies	44	61,500	Smoothies	44	11,100	Plums	44	9,240	Sweet Peppers
45	69,800	Other Fruit	45	51,300	Milk (concentrate & powder)	45	11,000	Canned pasta & noodles	45	8,430	Frozen bakery products
46	67,200	Other field veg (excl. dried)	46	49,800	Other Fruit	46	9,620	Coffee	46	8,090	Milk (concentrate & powder)
47	65,700	Frozen potato	47	48,300	Cream	47	8,760	Carrots	47	7,580	Cream

TOTAL			Green			Blue			Grey		
Rank	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**	**Rank**	**Annual Total WF Impact Indicator (scarcity weighted unit)**	**Product Name**
		products									
48	65,000	Frozen vegetables	48	46,500	Other field veg (excl. dried)	48	8,020	Frozen potato products	48	6,470	Plums
49	62,300	Milk (concentrate & powder)	49	43,900	Frozen vegetables	49	7,660	Pears	49	5,900	Flavoured milk
50	58,500	Cream	50	42,800	Frozen potato products	50	7,260	Sweet Peppers	50	5,780	Other Fruit

Table 5.1 Calculated Total, Green, Blue and Grey Water Footprint Impact Indicator Values (first 50 food and drink products only)

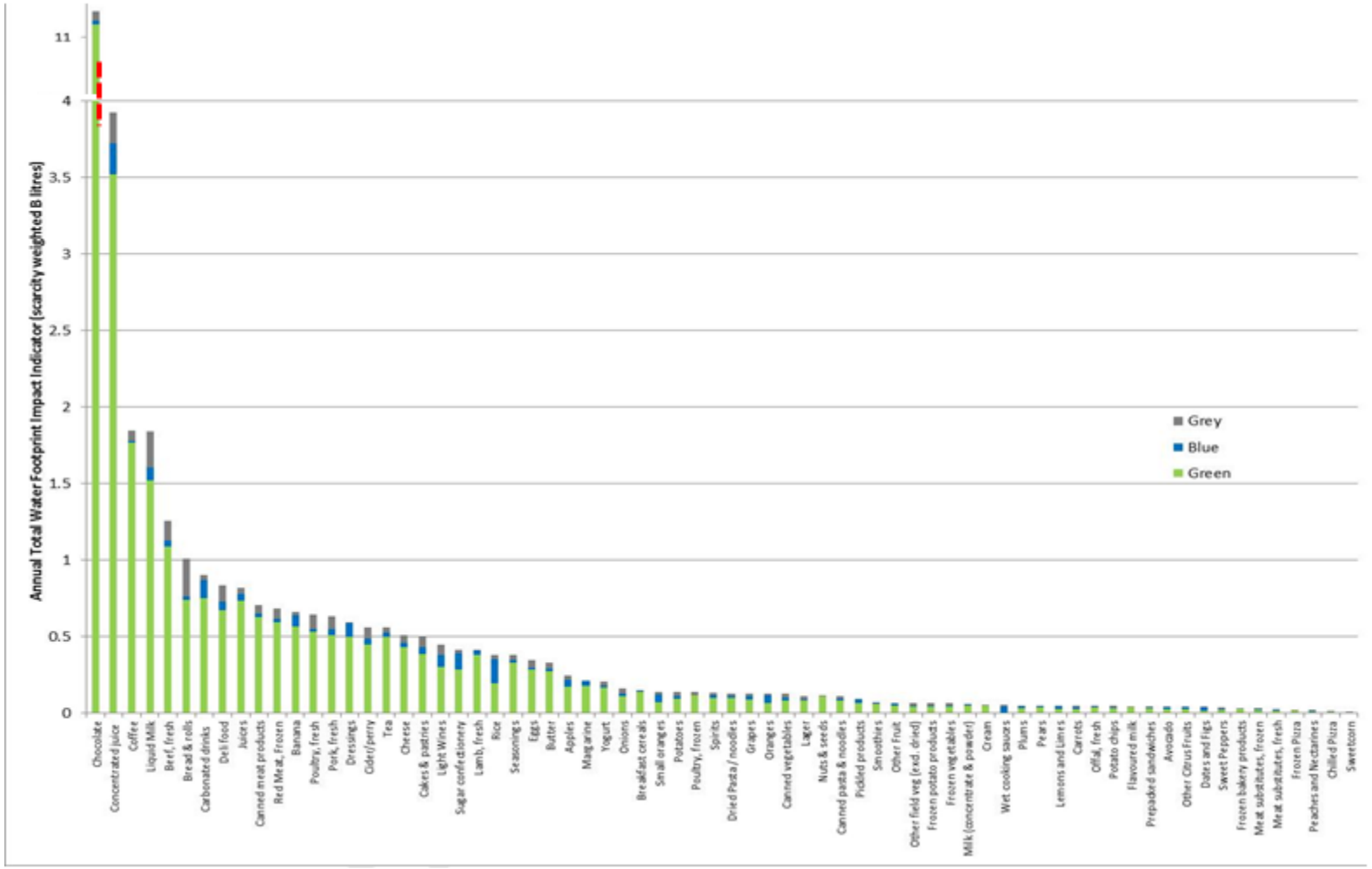


Figure 5.1 Annual Total Water Footprint Impact Indicator Values for Key Grocery Products (with green/blue/grey split)
* Please note variable y-axis for chocolate

5.3 Limitations of the Analysis and Data Quality

Identifying impacts relating to the water use during product growth, manufacture and consumption is not a straightforward task. The impact of water consumption depends on many factors including climatic, social and environmental, and not just the volume of water that is used or polluted. The approach that has been adopted for this study is consistent with that developed for the other environmental metrics (cradle-to-retail GHG emissions and energy use). However, it should be noted that there are debates about the best way to measure water impacts, and there could be significant local impacts from the consumption of some products that are not highlighted as priorities, because the total consumption is low.

For example, the water required to grow oranges, and other fruit, makes the water footprint of concentrated juice high, but there may be limited social and environmental impacts arising from the orange production. Contrary to this, the total water embedded in tea consumption is significantly lower than orange juice, but there may be significant social and environmental impacts related to the irrigation of a tea plantation in China, India or any other tea growing nation. In undertaking the study, URS developed a scarcity factor (ranging from 0.5 to 1.5) to account for water stress and social factors prevailing in each country[32]. This scarcity factor is used to "inflate" (or decrease if relevant) the water footprint to numerically account for the global variations in water availability. However, actual and more complete impact identification would warrant a more detailed drill down into each product, and the PSF is commissioning research in order to explore this further.

Within the Water Footprint Network, there is considerable debate on the issue of grey water within water footprinting. The aim of including grey water is to account for the impact of the pollution of water in product manufacture. The method adopted currently includes the calculation of the water volumes required to dilute waste flows to such extent that the quality of the water remains at, or below, agreed water quality standards. However, the method to translate the impacts of pollution into water requirements has not yet been fully debated, as acknowledged by the water footprint method architects, Gerbes-Leenes and Hoekstra (2008).

The evidence base currently only covers food and drink products. The authors note that developing water footprints for household and personal care products was more challenging than for food and drink products, due to the paucity of existing data and wide variety of products. It was originally proposed to follow a similar approach to some of the more complex food products, whereby URS determined a product water footprint based on the key ingredients (raw materials) and the percentage composition of the finished product. However, during the course of the study it became apparent that that it would be very time consuming to define a water footprint for each individual household and personal care product. The approach taken was therefore to conduct research to determine the water footprint of key generic raw materials likely to be present in the products (i.e. the building blocks in estimating the water footprint of each product) – to enable an individual to determine for themselves the water footprint of a desired product from the percentage composition of each individual raw material. This is described in more detail in the full project report, with supporting data and information available in the PSF Knowledge Base. A further phase of work is also being undertaken to further develop Water Footprint Impact Indicators for household and personal care products.

The project report also contains a full list of data sources, limitations and uncertainties. In summary, these include:

[32] *See Appendix 9*

- Availability of Water Footprint Impact Indicator data. Specific data were not available for all grocery products and so, where possible, proxies were used (e.g. 'cured swine meat' used for 'deli food' and 'fresh poultry' used for 'frozen poultry'). For 59 food and drink products no suitable water data or proxy was available (e.g. dog treats, fish and seafood, ready meals). These 59 products are listed in Appendix 8. However, the 103 products included in the water calculations represent 84% of total sales (kg). The Total Water Footprint Impact Indicator in Table 5.1 and Figure 5.1 was calculated using the best available data from published sources (predominantly those published by the Water Footprint Network). A five-category assessment of the data type that underpins the assessment was developed to provide an indication of the relative availability of information for different products. This 'category rating' is provided for each product in Appendix 8:
  - Category 5 = Product specific water footprint data from the Water Footprint Network
  - Category 4 = URS Calculation / assumption based on data from the Water Footprint Network e.g. water footprint of potato flakes used as water footprint for crisps,
  - Category 3 = URS Calculation based on data from another reputable source e.g. company CSR report
  - Category 2 = URS assumption or estimate
  - Category 1 = No data or not possible to estimate

- Uncertainties associated with UK import statistics used to determine the locations where the products consumed in the UK are produced, in particular for juice, carbonated drinks and processed foods.
- Caution should be taken when comparing the Water Footprint Impact Indicator values for different products and using such comparisons for decision making. Although the Water Footprint Impact Indicator (i.e. scarcity weighted litres/kg product) of one product may be larger compared to another product, this is a weighted average based on multiple countries of origin and the comparison may be very different for specific countries due to variations in local climate, farming practices and local water scarcity. Country specific numbers should therefore be referred to for decision making.
- There was limited data availability regarding the water footprint of the processing and manufacturing stages of many of the products included in the study. However a further phase of work is currently being undertaken to collate further processing, manufacturing and packaging water footprint data.
- Uncertainties inherent within the Water Footprint Network embedded water factors (e.g. use of country averages, average crop yields and theoretical irrigation requirements, etc.).
- Uncertainties regarding scarcity factors. URS has developed a scarcity factor to account for water stress and social factors prevailing in each country. This scarcity factor has been used to "inflate" (or decrease if relevant) the water footprint to numerically account for the global variations in water availability, and is included within the Water Footprint Impact Indicator values. However, water availability can vary greatly across a single country. A further phase of work has been commissioned to review opportunities to improve the granularity of the water scarcity factors used (e.g. to a regional level).
- Product impacts have been calculated based on annual total kg sold for each product and do not take account of the number of servings of each product per kg. For example although concentrated juice has a higher annual Total Water Footprint Impact Indicator compared to fresh juice, the number of consumer servings in one kg of concentrated juice is significantly greater compared to one kg of fresh juice.

6.0 Food and Drink Materials and Waste

WRAP is undertaking a range of activities which will further support the identification of priority products based on the resources used in producing a unit of food and drink, and the amount of waste throughout the life-cycle of these products. The work is summarised below. It is anticipated that all the data described will be available by the end of 2013.

6.1 Resource Inputs

To produce 1kg of food which reaches the consumer requires a large quantity of resources in the supply chain. For example, Mekkonen and Hoekstra (2010) suggest that to produce 1kg of beef, on average 47kg of feed are required. In addition to this, resources may also be invested in a product in a supply chain (e.g. in preparation of ready-meals).

Some data on the quantity of abiotic (non-renewable resources such as fossil fuels) and biotic (renewable resources such as compost) resources required to produce a unit of food are available. Section 2.0 summarises the data on abiotic resource depletion available via EIPRO (Tukker, et al. 2006), expressed in terms of kilogrammes of antimony equivalent. Data on the quantity of abiotic and biotic resources used in the production of food and drink products is also available via the Material Input Per Service unit (MIPS) methodology (Ritrhoff et al, 2002). The latest available material intensity factors for relevant items are reproduced in Figure 6.1. Factors are only available for approximately 30 grocery products, with further factors available for crop products such as barley. Due to the limited availability, the factors have not been mapped onto UK sales data.

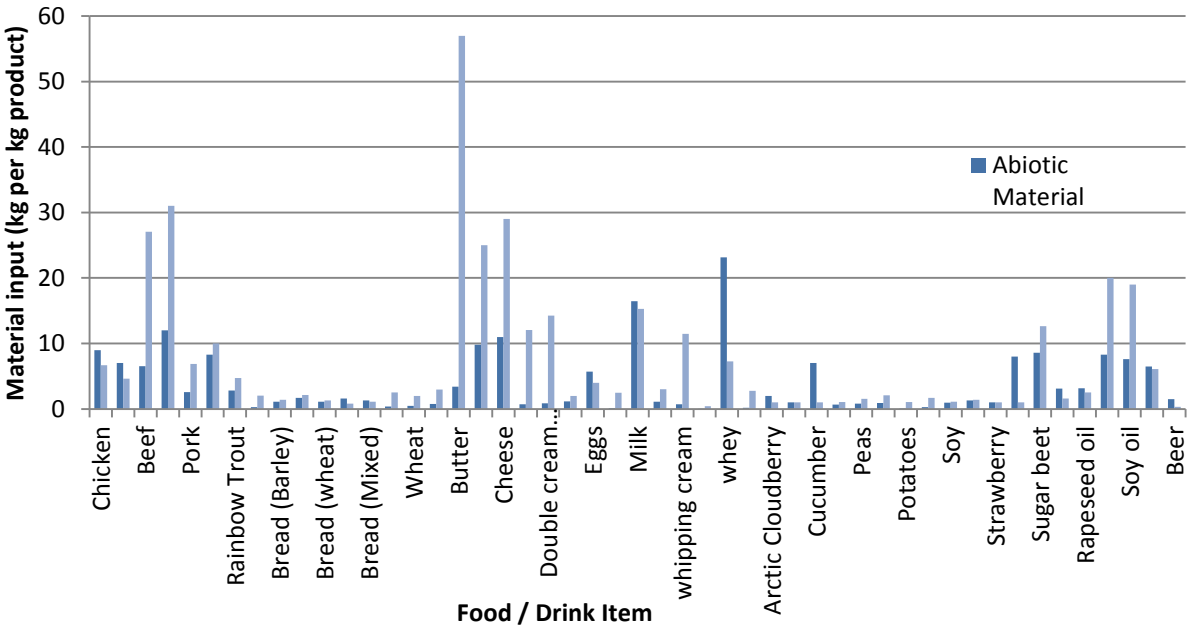


Figure 6.1 Material Intensity of Food and Drink Products (Source: Wuppertal Institut 2011)

The data used are based on food and drink production in Germany and Finland. For some products information is available for both countries, and shows significant differences. For example, the reported Material Intensity of wheat flour is twice as high in Germany as Finland. The reason for these differences is not clear. Possible explanations include genuine differences, differences in allocation between co-products and variable data. However, despite these issues and the different methodology employed, as with EIPRO the results

suggest that meat and dairy products are important for abiotic material use. In addition to this, the information also suggests that meat and dairy products require significant inputs of biotic resources, and that the quantity of biotic inputs is often higher than abiotic inputs. Abiotic resource depletion as an indicator may not therefore accurately reflect the material intensity of producing food and drink.

6.2 Waste

Waste arises throughout the supply chain of grocery products, from field to fork. Gustavsson et al (2011) estimate that food losses in industrialized countries are as high as in developing countries, but whereas in developing countries more than 40% of the food losses occur at post-harvest and processing levels, more than 40% of the food losses in industrialised nations occur at retail and consumer levels. The following sections describe the information available / to be available shortly for each stage in the product supply chain.

6.2.1 Pre-Farm gate / Fishing Losses

Crops may be wasted on-farm for a variety of reasons. These may be systematic (e.g. harvesting practices) or stochastic (i.e. random events such as weather and disease). Losses on farm or in the fishing process are not captured in waste statistics as the lost product is returned to the farm / sea (e.g. it may be ploughed back into the soil, discarded back to the sea). They may however be estimated through different means. Crop residues may be quantified via a harvest index.

At present, no PSF research is planned to identify waste at a product level on farm. In a survey of 16 large commercial fruit and vegetable growers and packers in California, Milepost (2012) estimated that up to 30% of crops may not be harvested, up to 4% were left in the field after harvesting and up to 30% were lost during packing. Common drivers cited include overplanting, variable market prices, labour shortages, imperfect products, anticipatory packing and shelf life / spoilage issues.

Losses through fishing by-catch are relatively well documented. An assessment by Kelleher (2005) by fishery type is summarised in Table 6.1. Based on this and data from Eurostat (2012), the average EU discard rate appears to be around 10%. However, Davies et al (2009) estimate that the true level of discard and by-catch may be up to 50% in the Mediterranean, and 20% in the North-East Atlantic. To address this, in June 2012 the EU Agriculture and Fisheries Council agreed to ban discards of mackerel and herring before 2014, with a ban on discard of excess cod, haddock, plaice and sole to follow (EC, 2012).

Fishery	Landings	Discards	Weighted Average Discard Rates (%)	Range of discard rates (%)
Shrimp trawl	1,126,267	1,865,064	62.3	0–96
Demersal fin fish	16,050,978	1,704,107	9.6	0.5–83
Tuna and HMS longline	1,403,591	560,481	28.5	0–40
Midwater (pelagic) trawl	4,133,203	147,126	3.4	0–56
Tuna purse seine	2,673,378	144,152	5.1	0.4–10
Multigear and multispecies	6,023,146	85,436	1.4	n.a.
Mobile trap/pot	240,551	72,472	23.2	0–61
Dredge	165,660	65,373	28.3	9–60
Small pelagic purse seine	3,882,885	48,852	1.2	0–27
Demersal longline	581,560	47,257	7.5	0.5–57
Gillnet (surface/bottom/trammel)	3,350,299	29,004	0.5	0–66
Handline	155,211	3,149	2.0	0–7
Tuna pole and line	818,505	3,121	0.4	0–1
Hand collection	1,134,432	1,671	0.1	0–1
Squid jig	960,432	1,601	0.1	0–1
Total	42,700,098	4,778,866	11%	

Table 6.1 Summary of discards by major types of fishery (tonnes) (Kelleher, 2005)

6.2.2 Processing / Manufacturing, Distribution and Warehousing and Retail

The report, 'Waste arisings in the supply of food and drink to UK households' published by WRAP in 2010 is regarded as the most authoritative and comprehensive analysis of food and packaging waste in the retail supply chain. The report brings together data from several studies on food waste conducted across the UK with the results from a survey of the industry to provide the best estimates of retail supply chain waste for 2008.

WRAP is currently in the process of updating the findings of this research, using new and more recent data sources and will publish revised headline data in summer 2013.

Five resource maps have been undertaken to date by WRAP which cover some of the product categories included in this study: fruit and vegetables, fresh meat, fish, and drinks have been published and pre-prepared chilled and frozen foods will be published in spring 2013. The reviews contain a mix of quantitative and qualitative data and can be used to provide insights into the composition of waste across the supply chain. In combination with this, WRAP are also analysing a series of waste prevention reviews carried out across UK manufacturing sites, which will identify the drivers of waste and potential means of addressing these. The review will be published in spring 2013.

The existing reports highlight that businesses do not consistently use the same definitions of waste and materials which are legally by-products (e.g. category 3 animal by-products). It is therefore necessary to critically assess and correctly describe the information collated.

WRAP are also assessing the extent and root causes of, as well as potential solutions to, supply chain product waste associated with the distribution and retail sectors of the food and drink grocery supply chain.

As part of the discussions on the Courtauld Commitment, it is proposed that reporting by signatories will evolve to include optional information on product category level waste

arisings; an appropriate format for this would be decided with signatories. This would also enable a better understanding of supply chain waste and opportunities for intervention.

6.2.3 Hospitality and Food Service

To complement the report on waste in the profit sector, WRAP has commissioned work on the cost sector. This will be ready for publication in spring 2013, as will a report which will provide an overview of food (& other) waste across cost and profit sectors (updating the latter to include waste sent to recycling).

6.2.4 Household

Good product-level data does exist on the quantities of post-consumer food and drink waste arising in the UK (WRAP, 2011a). Avoidable household food and drink waste[33] represents the greatest opportunity for reductions (NB some unavoidable food waste could also be indirectly prevented through reductions in avoidable food waste). Table 6.2 shows the quantity of household food and drink arising. Given evidence on the quantity and types of consumer stage food waste, this will remain one of the key areas to focus interventions.

Food type	Total annual tonnes	Unavoidable tonnes	Possibly avoidable tonnes	Avoidable tonnes	% of avoidable tonnes
Standard bread	660,000	<1,000	120,000	540,000	10%
Composite meal	510,000	<1,000	23,000	490,000	9%
Milk	360,000	<1,000	<1,000	360,000	7%
Potato	770,000	<1,000	480,000	290,000	6%
Carbonated soft drink	280,000	<1,000	<1,000	280,000	5%
All other drink[34]	290,000	60,000	<1,000	230,000	4%
Apple	260,000	31,000	53,000	180,000	3%
Fruit juice and smoothies	160,000	<1,000	<1,000	160,000	3%
Other condiments, sauces, herbs, spices	140,000	<1,000	6,000	130,000	2%
All other processed vegetables and salad	100,000	<1,000	<1,000	100,000	2%
All other cake and desserts	100,000	<1,000	<1,000	100,000	2%
Pork / ham / bacon	120,000	5,000	20,000	93,000	2%
Cakes / gateaux / doughnuts / pastries	91,000	<1,000	<1,000	91,000	2%
Tea waste[35]	450,000	370,000	<1,000	86,000	2%

Table 6.2 Food types which contribute most to avoidable consumer food waste (WRAP, 2009[36]) (see Appendix 10 for full list)

[33] Food and drink thrown away that was, at some point prior to disposal, edible (e.g. slice of bread, apples, meat).

[34] *Includes lager, beer, cider, wine, other alcohol, coffee, hot chocolate, milkshake and other milk drinks*

[35] *unused tea bags plus milk/sugar added to tea that has been prepared but not consumed (added water is not included)*

[36] WRAP announced a reduction in total household food and drink waste of 1.1 million tonnes in November 2011. Avoidable food and drink waste reduced by 950,000 tonnes, and the associated value and environmental impact figures have been updated. Research to update our estimates for individual food and drink categories has not yet been carried out, and therefore all figures relating to the breakdown of avoidable food waste should be regarded as approximate. These remain however the best estimates currently available.

6.3 Summary

This study has reviewed available data on resources used and waste associated with the food and drink supply chain. In terms of Abiotic Resource Depletion, Tukker et al (2006) identify that meat and dairy products account for almost half of the resource requirements for the food and drink supply chain. Using the MIPS methodology, the Wuppertal Institute (2011) suggest that the material intensity of meat and dairy products is high both in terms of abiotic resource use and biotic resource requirements per unit of food and drink produced.

In addition to cradle-to-retail waste arisings, consumer waste data has also been identified. Whilst good data exists on waste from households at a product level, existing data within the supply chain is not currently in the public domain. Within the value chain it is considered likely that the more significant arisings will be at the household and manufacturing stages, with retail and distribution much less significant. A number of projects are currently underway to address the waste data gaps for food manufacture and retail, but no plans currently exist to investigate pre-farm gate losses in detail, which remain a significant data gap.

7.0 Conclusions

This report presents a series of analyses with the common purpose of establishing which grocery products are likely to contribute most to the environmental impacts (GHG emissions, embedded energy, water, materials use and waste) associated with UK household consumption. The intention is that understanding and prioritising these will enable reduction actions, interventions and further research to be directed more effectively at those products with the greatest potential to influence overall consumption impacts.

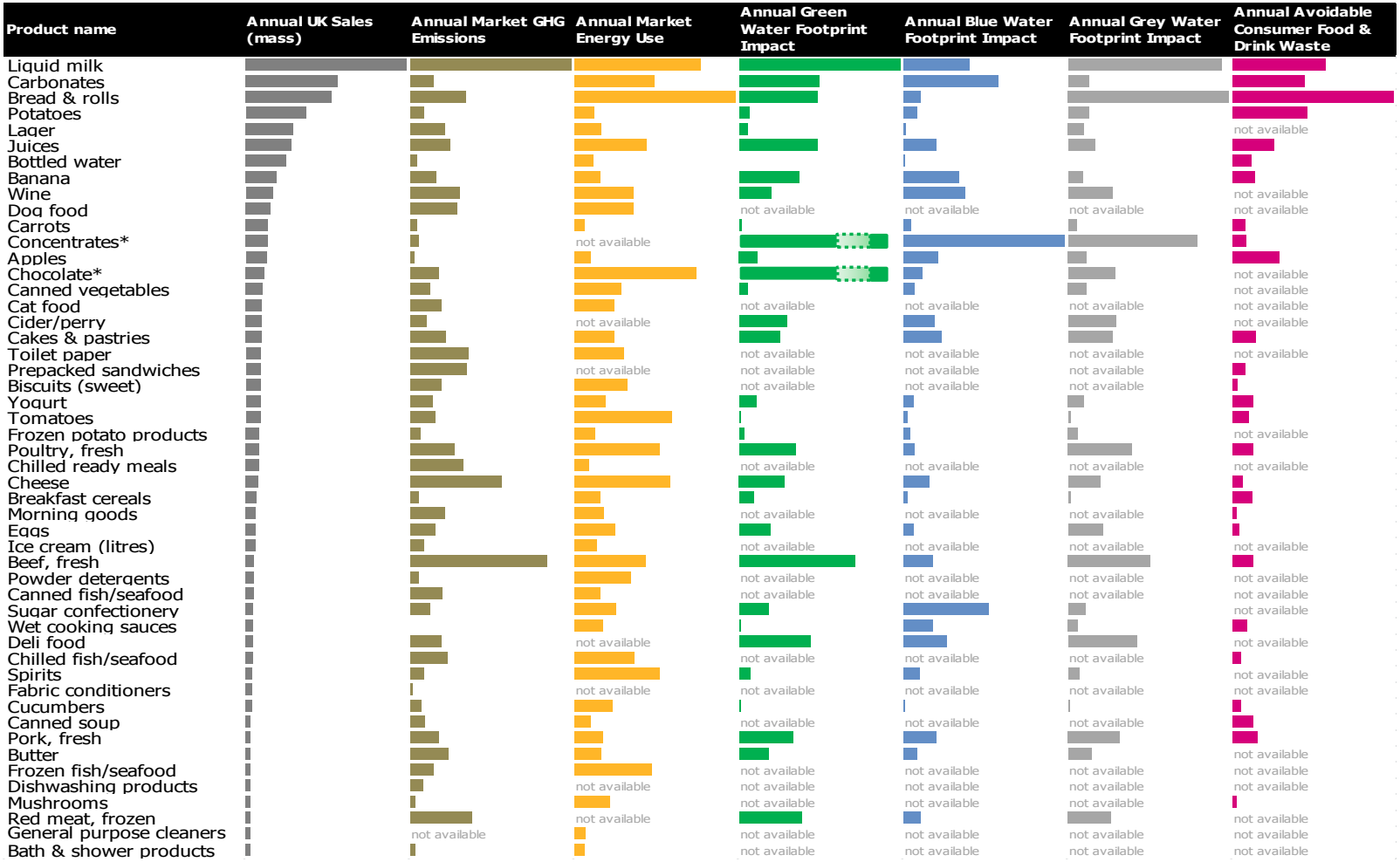
Table 7.1 provides a consolidation of the findings from this research – showing the relative scale of impacts reported across GHG, energy, water and consumer waste metrics for the 50 grocery products with greatest annual sales volume (based on 2010 sales and median values). Apparent from Table 7.1 is that the positioning of those products with the greatest contribution differs across environmental metrics. With this in mind, a systematic approach was developed in order to identify a series of 'priority products' on which to focus the PSF's on-going research activities (identification of life cycle impact hotspots, reduction opportunities, action plans and pathfinder projects - see Section 1.0). This approach is outlined in Section 7.1 below, along with the currently identified priorities.

Despite the limitations of the analysis (see Section 7.2) and inherent uncertainties associated with collating and generalising product life cycle impact data, the authors have confidence that the priorities identified highlight the dominant products within the UK market.

With regard to GHG emissions, cradle-to-retail impacts were estimated for 217 grocery products. Of these, the top 70 products contribute 87% of the total market emissions, while the remaining 147 products account for just 13%. Despite some continued data gaps, the findings are based on a substantial quantity of data collated, and are considered to be a reasonable basis for use by the PSF to prioritise GHG reduction efforts.

In terms of energy saving strategies, the top ten products identified for embedded energy account for 38% of total energy use and the top twenty products for 59%, so it is these products which should be the focus of research and development.

The priority products identified for blue water represent those products where there could be significant opportunity to maximise efficiencies and recycling of irrigation and process water, whereas for green water there is a wider perspective relating to planting crops suitable to the local climate, soil management and cultivation, competing water demands within a local catchment and ultimately production and sourcing patterns. The priority products for grey water represent products with potential to reduce wastewater through increased water recycling/reuse and treatment of wastewater before disposal. In agriculture, the grey water footprint can be reduced by optimal use of chemicals (artificial fertilizers, pesticides) or substances that are less toxic or more easily degradable, and applying fertilizers or compost in a form, time or via techniques that allows easy uptake, so that leaching and run-off are reduced.



Product name	Annual UK Sales (mass)	Annual Market GHG Emissions	Annual Market Energy Use	Annual Green Water Footprint Impact	Annual Blue Water Footprint Impact	Annual Grey Water Footprint Impact	Annual Avoidable Consumer Food & Drink Waste
Liquid milk							
Carbonates							
Bread & rolls							
Potatoes							
Lager							not available
Juices							
Bottled water							
Banana							
Wine							not available
Dog food				not available	not available	not available	not available
Carrots							
Concentrates*			not available				
Apples							
Chocolate*							not available
Canned vegetables							not available
Cat food				not available	not available	not available	not available
Cider/perry			not available				not available
Cakes & pastries							
Toilet paper				not available	not available	not available	not available
Prepacked sandwiches			not available	not available	not available	not available	
Biscuits (sweet)				not available	not available	not available	
Yogurt							
Tomatoes							
Frozen potato products							not available
Poultry, fresh							
Chilled ready meals				not available	not available	not available	not available
Cheese							
Breakfast cereals							
Morning goods				not available	not available	not available	
Eggs							
Ice cream (litres)				not available	not available	not available	not available
Beef, fresh							
Powder detergents				not available	not available	not available	not available
Canned fish/seafood				not available	not available	not available	not available
Sugar confectionery							not available
Wet cooking sauces							
Deli food			not available				not available
Chilled fish/seafood				not available	not available	not available	
Spirits							not available
Fabric conditioners			not available	not available	not available	not available	not available
Cucumbers							
Canned soup				not available	not available	not available	
Pork, fresh							
Butter							not available
Frozen fish/seafood				not available	not available	not available	not available
Dishwashing products			not available	not available	not available	not available	not available
Mushrooms				not available	not available	not available	
Red meat, frozen			not available				not available
General purpose cleaners		not available		not available	not available	not available	not available
Bath & shower products				not available	not available	not available	not available

Table 7.1 Relative GHG, embedded energy and total water footprint impact (cradle-to-retail) and consumer waste for the 50 grocery products with greatest annual sales volume (based on 2010 sales and median values). Bars show relative position within any one column (not between columns).

* bars for chocolate and concentrates water footprint have been shortened, as these are significantly larger than and prevented visibility of detail for other products

7.1 Identifying 'Priority Products' to Inform On-going PSF Work

A systematic approach was developed in order to identify a series of 'priority products' on which to focus the PSF's on-going research, piloting and implementation activities, taking into account the findings from the analyses presented in this report. The following steps describe the approach taken. An initial prioritisation of 50 grocery products was made (the 'Top 50'). This will continue to be updated and further developed - in particular when the PSF's work on water impacts for non-food and drink products has been undertaken and when further supply chain waste data have been collated. It is estimated that, in combination, the impacts associated with this 'Top 50' comprise approximately 80% of the GHG emissions associated with producing, transporting and retailing UK grocery products.

Step 1: Similar products were grouped
Similar products were grouped, where appropriate. This grouping was undertaken where life cycle hotspots, impact drivers and reduction opportunities are likely to be similar, and served as a means to consolidate the product categories where sensible to do so. For example, 'chilled beef' was combined with 'frozen beef'; and 'canned vegetables' were combined with 'canned soups'. This was done on the basis of expert judgement. Products were also combined where their function was very similar and consideration of both in combination might be more useful to PSF members (e.g. liquid and powder laundry detergents).

The products (and groups of products) were 'ranked' for total GHG emissions, embedded energy and Water Footprint Impact Indicator. The total impact of a product 'group' was calculated by summing the component totals within this group (e.g. total for liquid laundry detergent and powder laundry detergent).

Note - as product-level supply chain waste or material use data were not available at the time of drafting (see Section 6.0), it was not possible to include these metrics in the ranking process. However, a review of WRAP consumer waste data was undertaken to ensure that those products that contribute significantly to consumer waste arising (and supply chain waste, where known) are also represented in the final priority listing.

Step 2: An average rank was calculated for each product
An average rank was calculated by taking the average of the GHG, energy and water ranks, where data were available (e.g. where no water data were available, an average of the energy and GHG ranks was used). While the rankings based on an incomplete number of metrics are less complete, they ensure that some products with potentially significant impacts are not discounted because of a lack of data across all metrics.

Step 3: Inclusion of household & personal care products with significant consumer footprints
While products associated with domestic laundry and dishwashing were included in the 'priority products' on the basis of their cradle-to-retail footprint, it was noted that the exclusion of consumer energy and water use results in bath & shower products not appearing in the 'Top 50'. Resource use and emissions associated with these consumer activities have been demonstrated to be significant (see Section 3.4), and so two related products were included within the priority listing: Bath & shower products and Shampoos.

Step 4: Final results
The Top 50 product groups were identified as those being ranked most highly, on average. These are listed as follows (ordered alphabetically by category):

- **Alcoholic drinks:** Cider and perry; Lager; Spirits; Wine

- **Ambient:** Breakfast cereals; Canned fish and seafood; Canned meat products; Canned vegetables, soups, pasta and noodles; Cat food and dog food; Chocolate; Coffee; Crisps (potato); Processed snacks; Rice; Sugar confectionery; Tea
- **Bakery:** Biscuits (sweet); Bread and rolls; Cakes, pastries and morning goods
- **Dairy:** Butter; Cheese; Milk and cream; Yogurt
- **Fruit and vegetables:** Bananas; Onions; Potatoes; Tomatoes
- **Household:** Dishwashing products; General purpose and toilet cleaners; Laundry detergents; Toilet paper and kitchen rolls
- **Meat, fish, poultry and eggs:** Beef (chilled and frozen); Deli food; Eggs; Fish and seafood (chilled and frozen); Lamb (chilled and frozen); Pork (chilled and frozen); Poultry (chilled and frozen)
- **Non-alcoholic drinks:** Carbonates; Concentrates; Juices
- **Other chilled and frozen:** Frozen vegetables and potato products; Ice cream and frozen desserts; Margarine; Pizza (chilled and frozen); Pre-packed sandwiches; Ready meals (chilled and frozen)
- **Personal care:** Bath and shower products and shampoos; Deodorants; Nappies

All metrics were given equal consideration in deriving this list, as they have been given equal prominence within the PSF to date and to apply weightings can be a subjective exercise. It is a noted limitation that a significant component of the GHG footprint is energy-related (from fossil fuel combustion). As such, there may be greater emphasis on energy intensive products in the priority list. This will be considered further in future iterations of the PSF's prioritisation efforts.

It is also worth outlining (and further considering) those products which appeared as a high priority against one or two metrics, but feature outside of the 'Top 50' as a result of being a low priority on remaining metric(s):

- GHG only: Sweet peppers #31
- Energy only: Cucumbers #24, Cooking sauces #30 and Beans (veg) #35
- Water only: Dressings #13, Seasonings #23 and Apples #26

Of further note is that, overall, the Top 50 products ranked using the total or blue Water Footprint Impact Indicator were very similar. This was also found to be the case when undertaking the ranking using green and grey water values. This is partly due to the importance of total product sales volume in driving sector-level footprints (i.e. impact is a combination of both intensity and volume consumed). Three products are in the Top 50 when considering the total Water Footprint Impact Indicator, but not when using the blue Water Footprint Impact Indicator rank only: Onions; Pizza (Fresh and frozen); Processed snacks. Products which would be included in the Top 50 if considering blue Water Footprint Impact Indicator only would include cucumbers and apples. These are further targets for potential future consideration.

7.2 Limitations and Further Research

As with any research of this kind, the study has a number of limitations and results should be interpreted with this in mind. In particular, the findings are not intended to set an impact baseline for the grocery sector, nor can the information contained within be considered to have sufficient accuracy to undertake a sound comparison of the environmental impact of one product type with another.

In total, the analysis collates information from more than 150 studies, providing the most comprehensive summary of its kind. However, caution is required when comparing life cycle data from different studies due to inevitable methodological differences and uncertainties. For this reason, results presented in this document should be interpreted only as indicative estimates of the potential scale of product impacts.

The following sets out some potential areas for further research. It is considered that the 'priority products' identified are unlikely to change significantly as a result of follow-on work. However, this may influence the relative positioning of some products reported within the detailed analyses presented in this report and appendices. Of specific note is that the research and findings in this report will continue to be updated and improved, through future research and input from PSF members.

- **UK Grocery Sales Volume** – consistent data regarding sales volume, comparable with the Datamonitor dataset, could not be found for a number of food and drink products, and these represent targets for further research. In particular the following are significant data gaps: home baking ingredients (e.g. flour, sugar); and edible oils (e.g. vegetable, sunflower and olive oils). There are a number of uncertainties with regard to sales data for household and personal care products and this is a further target for improvement, or sense-checking the values used. Given the variability of product types and production methods within some categories, such as 'fish and shellfish', a later iteration of this analysis would also benefit from further disaggregation of some categories into major sub-groups e.g. farmed fish.
- **GHGs** — results are cradle-to-retail only due to limited data on consumer impacts. The life cycle stages beyond the retail stage – particularly the consumer use phase – can result in substantial GHG emissions. Further work could be undertaken to engage with consumers or with industry in this respect.
- **Embedded Energy**— as for the GHG metric, results are cradle-to-retail only, due to limited data on consumer impacts, and would benefit from further use phase research in the same way as for the GHG metric. Only delivered energy is considered in the analysis, due to the availability of existing information (drawing on a research project undertaken for Defra by Warwick University). To extend this to a full analysis of primary energy may not add considerable value, given that products that are significant in this respect are also likely to be significant against the GHG metric.
- **Water** — the analysis currently examines ingredients only, and is focused on food and drink products. Further work is currently being undertaken to explore water impacts across other life cycle stages (in particular processing and packaging), and to undertake an analysis of a range household and personal care products – with a view to identifying a more comprehensive, but feasible, approach for these products.
- **Waste** — currently only consumer waste data are reported. Further waste data are currently being compiled at a product level. Although the indicative life cycle hotspot stages are known (household>manufacturing>retail>distribution) the specifics at a product level are to be identified during 2013 through review of existing literature and primary data.

Appendix 1 – Product Classification

The Datamonitor[37] structure has been used as the preferred framework for classifying products within this analysis and the PSF's wider research. It had been initially proposed that the research follow the Global Product Classification[38] system as it is globally recognised and has been used by other initiatives (e.g. The Sustainability Consortium). However, the Datamonitor structure was used for reasons explained in Table A1-1. Principal among these is that WRAP has access to sales volume data for this classification (see Appendix 2).

System	Pros	Cons
Datamonitor	■ It is UK-centric ■ It is designed for use by retail businesses and so should align with existing conventions ■ WRAP has access to sales value and volume data for this classification ■ WRAP has access to market information reports which align more with this classification ■ The 'Category' level provides good level of granularity and product homogeneity for product prioritisation and on-going work	■ Unclear whether based on international standard & stakeholder led ■ Does not include some products (e.g. fruit & vegetables) – so a classification for these products has been drawn from other sources, which also provide sales data (see Appendix 2)
GPC	■ It is an international standard used by The Sustainability Consortium ■ It is developed with the advice and guidance of users from every part of the supply chain from many industries ■ Deals with all products in the economy so could be used if there is future desire to align with other parts of WRAP/PSF research	■ Datamonitor sales information would need to be mapped onto the GPC structure, which would be a subjective and imprecise exercise ■ Product descriptions at 'Class level' are less useful than Datamonitor 'Category' level for high level prioritisation purposes ■ TSC uses 'Brick' level for their work, which is too detailed for the purposes of WRAP project (i.e. almost 1,000 products)

Table A1-1: Pros and cons of Datamonitor and GPC product classification systems

Table A1-2 shows the top-level structure for both systems, including the number of components within each level (in brackets) and a similar example for both systems. In general there are many similarities between the two, although they could not be considered the same classification.

[37] http://www.datamonitor.com/

[38] http://www.gs1.org/gdsn/gpc

The Datamonitor 'category' was selected as the preferred level to use in the analysis, although an exception was made in some instances, in order to enable greater granularity. This affected the following categories:

- 'Chilled meat products' were disaggregated into types of meat (e.g. beef, pork, poultry, etc.);
- 'Pre-packed sandwiches & salads' were disaggregated into component parts; and
- 'Spreadable fats' were disaggregated into margarine and butter.

Level	Datamonitor	Global Product Classification
1	Industry (8) e.g. Food	Segment (6) e.g. Food/Bev/Tobacco
2	Market (39) e.g. Dairy food	Family (47) e.g. Milk/Butter/Cream/Yogurts/Cheese
3	Category (219) e.g. Milk	Class (192) e.g. Milk/Milk Substitutes
4	Segment* (478) e.g. Fresh liquid milk	Brick (996) e.g. Milk/Milk Substitutes (Perishable)

Table A1-2: Comparison of GPC structure with examples and number of components
*Segments only available for some categories

To enable quick comparison with GPC and support the transferability of on-going work, another output of the PSF's on-going work will be to cross-match GPC 'Class' name(s) against the Datamonitor 'Category'/'Segment' names (these are at similar category levels). This may mean that GPC Class names appear against multiple Datamonitor Categories in some instances (e.g. GPC 'Milk/Milk Substitutes' Class will appear against Datamonitor 'Milk' and 'Soy products' Categories). However, it will enable an initial cross-comparison.

Appendix 2 – UK Grocery Sales Volume

UK Food and Drink Product Sales Volume

The principal data source for UK food and drink product sales volume was the Datamonitor Interactive Consumer Database. A data year of 2010 was preferred as this was the latest year for which a wide range of information was available at the start of the project (in 2011). Hence 2010 product sales data (mass) were extracted from the database for the majority of food and drink products. However, this source did not provide sales tonnages for a number of key food & product types and so alternate sources were needed. These are summarised in Table A2-1.

Grocery product	Data source
Milk	Mintel (2010) Milk and Cream, Market Intelligence
Alcoholic drinks	WSTA (2011) UK Wine & spirit Market Overview
Non-alcoholic drinks	Britvic (2011) Soft Drinks Report
Meat products	Mintel (2010) Red Meat, Market Intelligence
Household & personal care products	Estimate based on sales value – see section below
Fruit & vegetables, excl. potatoes	Defra Basic Horticultural Statistics 2010
Potatoes	Potato Council, GB Potato Market Intelligence (2010/11)
Eggs	British Eggs - http://www.egginfo.co.uk/page/eggfacts

Table A2-1: Data sources for products not covered by Datamonitor database

The resulting annual sales tonnage values used in the analysis are shown in the results tables for the individual metric analyses (GHG, energy and water), reported in Appendix 4, Appendix 6 and Appendix 7 respectively.

Data Gaps and Recommendations for Further Research

Remaining food and drink data gaps

Robust data regarding sales volume could not be found for a number of food and drink products, and these represent targets for further research. In particular we note the following as significant data gaps: home baking ingredients (e.g. flour, sugar); and edible oils (e.g. vegetable, sunflower and olive oils).

Category disaggregation

Given the variability of product types and production methods within some categories, such as 'fish and shellfish' and 'frozen red meat' a later iteration of the analysis would benefit from further disaggregation of some categories into major sub-groups e.g. farmed fish, etc.

Household & personal care (HPC) product estimates

No data source was identified that reported tonnages of household and personal care (HPC) products sold – likely because this is not a common metric used within the sector (e.g. tonnes of shower gel). To fill this data gap, information on the financial value of HPC products sold in 2010 was sourced from the Datamonitor Interactive Consumer Database[39] and converted to mass using typical £ per kg estimates. These were derived from a review of the corporate websites of major brands and retailers in relevant HPC categories (see Table A2-2).

[39] *Export from Datamonitor Interactive Consumer Database (May 9th 2011)*

Specific values for the top 80% of HPC product sales were researched (31 products). Values for the bottom 20% of GPC product sales (37 products) were estimated using the average of the top 80% (£5.29/kg). A list of all the £/kg assumptions are provided in Table A2-2.

Although there are acknowledged uncertainties in using this approach, it was considered a sufficient estimate for the overall objective of the project: to identify priority products. It is, however, a key area for improvement in the future (for instance, time could be spent engaging with individual industry trade-bodies to source more appropriate tonnage data).

Product	Retail sales value (£m)[40]	£/kg, at retail	Source of £/kg	Sales mass, million kg
Toilet papers	£1,217	£2.5	Review of major retailer website typical prices and product mass (content weights)	493
Facial care	£990	£8.3		119
Female fragrances	£723	£99.3		7
Nappies	£641	£4.6		140
Deodorants	£568	£6.2		91
Cough and cold preparations	£564	£194.4		3
Powder detergents	£561	£2.0		286
Analgesics	£517	£222.2		2
Face make-up	£512	£14.4		35
Dishwashing products	£462	£2.8		165
Male razors and blades	£455	£69.0		7
Bath & shower products	£420	£2.9		145
Toothpaste	£401	£17.1		23
Liquid detergents	£400	£4.0		100
Male fragrances	£392	£17.2		23
Medicated skin products	£390	£16.7		23
Shampoo	£378	£4.6		83
Eye make-up	£374	£14.4		26
Vitamins and minerals	£372	£14.5		26
General purpose cleaners	£362	£2.5		146
Household paper	£359	£6.2		58
Other OTC healthcare products	£336	£3.4		98
Air fresheners	£335	£9.8		34
Body care	£333	£99.5		3
Toothbrushes	£311	£12.2		26
Fabric conditioners	£302	£1.5		198
Baby Toiletries	£279	£3.7		76
Conditioner	£263	£5.2		50
Hair colorants	£261	£14.1		19
Topical OTC medicines	£259	£3.4		75
Styling agents	£257	£12.8		20
Cosmetic tissues	£234	£5.6		42
Stain removers and other additives	£234	£5.3		44

[40] *Export from Datamonitor Interactive Consumer Database (May 9th 2011)*

Product	Retail sales value (£m)[40]	£/kg, at retail	Source of £/kg	Sales mass, million kg
Suncare	£233	£5.3	Average £/kg calculated for the above 32 products was used for low value products	44
Soap	£231	£5.3		44
Lip make-up	£214	£5.3		40
Detergent tablets	£197	£5.3		37
Traditional medicines	£187	£5.3		35
Toilet care	£176	£5.3		33
Mouthwash	£172	£5.3		32
Indigestion preparations	£141	£5.3		27
Bleach	£139	£5.3		26
Sanitary Pads	£135	£5.3		25
Insecticides	£122	£5.3		23
First aid kits	£115	£5.3		22
Tampons	£111	£5.3		21
Male Shaving Preparations	£109	£5.3		21
Nail make-up	£107	£5.3		20
Hand care	£76	£5.3		14
Limescale Preventers	£75	£5.3		14
Plasters & Bandages	£71	£5.3		13
Laundry Bleach	£61	£5.3		12
Pantiliners and shields	£55	£5.3		10
Denture care	£44	£5.3		8
Depilatories	£43	£5.3		8
Scouring products	£37	£5.3		7
Fabric Fresheners	£35	£5.3		7
Dental floss	£34	£5.3		6
Make-up remover	£33	£5.3		6
Furniture & Floor Polish	£28	£5.3		5
Other detergents	£28	£5.3		5
Shoe polish	£26	£5.3		5
Male Shaving Aftercare	£25	£5.3		5
Table napkins	£24	£5.3		5
Carpet Cleaners	£23	£5.3		4
Unisex fragrances	£23	£5.3		4
Internal Cleansers	£20	£5.3		4
Perms & relaxers	£11	£5.3		2

Table A2-2: Retail sales value and assumed weight per kg for HPC products

Appendix 3 – EIPRO Data

This appendix details the results of the 'EIPRO' study used in this report to provide an overview of household environmental impacts.

Table A3-1 below shows normalised environmental impact scores of consumption activities (global warming potential and abiotic depletion) for the EU 25. Percentage of household expenditure is also provided. Totals of all columns sum to 100%.

It is adapted from Page 174 of the Annex Report of Environmental Impact of Products (EIPRO). It is available to download from the European Commission website: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1429

Additional sector and sub-sector classification has been added by Best Foot Forward to aid interpretation and communication.

Products which are irrelevant to Product Sustainability Forum are entered as 'Other', but have been included here for completeness.

Table description

- Product name – Codes are those created by EIPRO project
- CEDA code – The Comprehensive Environmental Database (CEDA) EU-25 is based on OECD IO tables for European countries with a resolution of several dozen sectors, and European totals for environmental extensions.

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Grocery	Food	[A1] Dairy farm products	*10100*	*0.02%*	*0.01%*	*0.01%*
Grocery	Food	[A10] Fruits	*20401*	*0.51%*	*0.52%*	*0.40%*
Other	Tobacco	[A100] Chewing and smoking tobacco and snuff	*150103*	*0.03%*	*0.03%*	*0.08%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A106] Carpets and rugs	*170100*	*0.31%*	*0.31%*	*0.33%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A109] Cordage and twine	*170900*	*0.01%*	*0.01%*	*0.01%*
Grocery	Food	[A11] Tree nuts	*20402*	*0.05%*	*0.04%*	*0.04%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A110] Nonwoven fabrics	*171001*	*0.04%*	*0.04%*	*0.04%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A111] Textile goods, n.e.c.	*171100*	*0.00%*	*0.00%*	*0.00%*
Apparel	Clothing	[A112] Women's hosiery, except socks	*180101*	*0.08%*	*0.08%*	*0.10%*
Apparel	Clothing	[A113] Hosiery, n.e.c.	*180102*	*0.05%*	*0.05%*	*0.06%*
Apparel	Clothing	[A115] Apparel made from purchased materials	*180400*	*1.64%*	*1.42%*	*2.27%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A116] Curtains and draperies	*190100*	*0.08%*	*0.07%*	*0.12%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A117] Housefurnishings, n.e.c.	*190200*	*0.24%*	*0.21%*	*0.30%*
Apparel	Accessories	[A118] Textile bags	*190301*	*0.01%*	*0.01%*	*0.01%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A119] Canvas and related products	*190302*	*0.02%*	*0.02%*	*0.03%*
Grocery	Food	[A12] Vegetables	*20501*	*0.71%*	*0.43%*	*0.72%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A120] Pleating and stitching	*190303*	*0.04%*	*0.03%*	*0.06%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A121] Automotive and apparel trimmings	*190304*	*0.11%*	*0.10%*	*0.16%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A122] Schiffli machine embroideries	*190305*	*0.00%*	*0.00%*	*0.00%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A123] Fabricated textile products, n.e.c.	*190306*	*0.12%*	*0.11%*	*0.18%*
Other	Other	[A133] Mobile homes	*200703*	*0.04%*	*0.03%*	*0.05%*
Home improvement	DIY materials	[A136] Wood products, n.e.c.	*200903*	*0.01%*	*0.01%*	*0.02%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A139] Wood household furniture, except upholstered	*220101*	*0.27%*	*0.25%*	*0.45%*
Grocery	Food	[A14] Miscellaneous crops	*20503*	*0.00%*	*0.00%*	*0.00%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A140] Household furniture, n.e.c.	*220102*	*0.02%*	*0.02%*	*0.02%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A141] Wood television and radio cabinets	*220103*	*0.00%*	*0.00%*	*0.00%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A142] Upholstered household furniture	*220200*	*0.22%*	*0.19%*	*0.31%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A143] Metal household furniture	*220300*	*0.08%*	*0.07%*	*0.09%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A144] Mattresses and bedsprings	*220400*	*0.13%*	*0.11%*	*0.17%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A145] Wood office furniture	*230100*	*0.09%*	*0.09%*	*0.14%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A148] Wood partitions and fixtures	*230400*	*0.12%*	*0.11%*	*0.19%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A149] Partitions and fixtures, except wood	*230500*	*0.27%*	*0.23%*	*0.26%*
Grocery	Food	[A15] Oil bearing crops	*20600*	*0.01%*	*0.01%*	*0.01%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A150] Drapery hardware and window blinds and shades	*230600*	*0.06%*	*0.06%*	*0.09%*
Home improvement	Furniture & furnishings, carpets and other floor coverings	[A151] Furniture and fixtures, n.e.c.	*230700*	*0.08%*	*0.07%*	*0.17%*
Other	Newspapers, books and stationery	[A153] Envelopes	*240400*	*0.01%*	*0.01%*	*0.01%*
Grocery	Personal care	[A154] Sanitary paper products	*240500*	*0.29%*	*0.27%*	*0.31%*
Other	Newspapers, books and stationery	[A155] Paper coating and glazing	*240701*	*0.02%*	*0.02%*	*0.02%*
Other	Newspapers, books and stationery	[A156] Bags, except textile	*240702*	*0.05%*	*0.05%*	*0.05%*
Other	Newspapers, books and stationery	[A158] Stationery, tablets, and related products	*240705*	*0.01%*	*0.01%*	*0.01%*
Other	Newspapers, books and stationery	[A159] Converted paper products, n.e.c.	*240706*	*0.04%*	*0.03%*	*0.03%*
Grocery	Food	[A16] Greenhouse and nursery products	*20702*	*0.15%*	*0.18%*	*0.49%*
Other	Newspapers, books and stationery	[A161] Paperboard containers and boxes	*250000*	*0.01%*	*0.01%*	*0.01%*
Other	Newspapers, books and stationery	[A162] Newspapers	*260100*	*0.17%*	*0.17%*	*0.41%*
Other	Newspapers, books and stationery	[A163] Periodicals	*260200*	*0.19%*	*0.17%*	*0.39%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Other	Newspapers, books and stationery	[A164] Book publishing	*260301*	*0.23%*	*0.21%*	*0.51%*
Other	Newspapers, books and stationery	[A166] Miscellaneous publishing	*260400*	*0.02%*	*0.02%*	*0.05%*
Other	Newspapers, books and stationery	[A167] Commercial printing	*260501*	*0.01%*	*0.01%*	*0.01%*
Other	Newspapers, books and stationery	[A169] Blankbooks, looseleaf binders and devices	*260602*	*0.01%*	*0.01%*	*0.01%*
Home improvement	DIY materials	[A17] Forestry products	*30001*	*0.18%*	*0.16%*	*0.27%*
Other	Newspapers, books and stationery	[A170] Greeting cards	*260700*	*0.03%*	*0.03%*	*0.06%*
Other	Garden chemicals	[A175] Nitrogenous and phosphatic fertilizers	*270201*	*0.11%*	*0.32%*	*0.08%*
Home improvement	Garden chemicals	[A176] (Household use of) pesticides and agricultural chemicals, n.e.c.	*270300*	*0.44%*	*0.57%*	*0.48%*
Other	Garden chemicals	[A177] Gum and wood chemicals	*270401*	*0.08%*	*0.08%*	*0.07%*
Other	Newspapers, books and stationery	[A178] Adhesives and sealants	*270402*	*0.02%*	*0.02%*	*0.01%*
Grocery	Food	[A18] Commercial fishing	*30002*	*0.15%*	*0.17%*	*0.23%*
Home improvement	DIY materials	[A182] Chemicals and chemical preparations, n.e.c.	*270406*	*0.04%*	*0.05%*	*0.03%*
Grocery	Medical drugs & equipment	[A187] Drugs	*290100*	*0.75%*	*0.71%*	*0.97%*
Grocery	Personal care	[A188] Soap and other detergents	*290201*	*0.21%*	*0.27%*	*0.24%*
Home improvement	DIY materials	[A189] Polishes and sanitation goods	*290202*	*0.03%*	*0.04%*	*0.04%*
Other	Other	[A19] Agricultural, forestry, and fishery services	*40001*	*0.01%*	*0.02%*	*0.01%*
Grocery	Personal care	[A191] Toilet preparations	*290300*	*0.31%*	*0.37%*	*0.50%*
Home improvement	DIY materials	[A192] Paints and allied products	*300000*	*0.01%*	*0.01%*	*0.01%*
Other	Other	[A194] Lubricating oils and greases	*310102*	*0.04%*	*0.19%*	*0.04%*
Home improvement	DIY materials	[A195] Products of petroleum and coal, n.e.c.	*310103*	*0.00%*	*0.00%*	*0.00%*
Apparel	Footwear	[A199] Rubber and plastics footwear	*320200*	*0.06%*	*0.06%*	*0.07%*
Grocery	Food	[A2] Poultry and eggs	*10200*	*0.48%*	*0.34%*	*0.27%*
Home improvement	Glass, tableware & utensils	[A200] Fabricated rubber products, n.e.c.	*320300*	*0.05%*	*0.06%*	*0.06%*
Home improvement	Glass, tableware & utensils	[A201] Miscellaneous plastics products, n.e.c.	*320400*	*0.27%*	*0.28%*	*0.26%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Apparel	Accessories	[A202] Rubber and plastics hose and belting	*320500*	*0.01%*	*0.01%*	*0.01%*
Home improvement	Glass, tableware & utensils	[A203] Gaskets, packing, and sealing devices	*320600*	*0.00%*	*0.00%*	*0.01%*
Apparel	Footwear	[A205] Boot and shoe cut stock and findings	*340100*	*0.00%*	*0.00%*	*0.00%*
Apparel	Footwear	[A206] Shoes, except rubber	*340201*	*0.20%*	*0.15%*	*0.14%*
Apparel	Footwear	[A207] House slippers	*340202*	*0.01%*	*0.00%*	*0.01%*
Apparel	Accessories	[A208] Leather gloves and mittens	*340301*	*0.01%*	*0.00%*	*0.00%*
Apparel	Accessories	[A209] Luggage	*340302*	*0.04%*	*0.04%*	*0.05%*
Apparel	Accessories	[A210] Women's handbags and purses	*340303*	*0.01%*	*0.01%*	*0.01%*
Apparel	Accessories	[A211] Personal leather goods, n.e.c.	*340304*	*0.01%*	*0.01%*	*0.01%*
Apparel	Accessories	[A212] Leather goods, n.e.c.	*340305*	*0.01%*	*0.01%*	*0.01%*
Home improvement	Glass, tableware & utensils	[A213] Glass and glass products, except containers	*350100*	*0.07%*	*0.07%*	*0.07%*
Home improvement	Glass, tableware & utensils	[A214] Glass containers	*350200*	*0.01%*	*0.01%*	*0.01%*
Home improvement	Glass, tableware & utensils	[A221] Vitreous china table and kitchenware	*360701*	*0.00%*	*0.00%*	*0.00%*
Home improvement	Glass, tableware & utensils	[A222] Fine earthenware table and kitchenware	*360702*	*0.00%*	*0.00%*	*0.00%*
Home improvement	Glass, tableware & utensils	[A224] Pottery products, n.e.c.	*360900*	*0.01%*	*0.02%*	*0.02%*
Home improvement	DIY materials	[A226] Concrete products, except block and brick	*361100*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A230] Cut stone and stone products	*361500*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A231] Abrasive products	*361600*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A233] Minerals, ground or treated	*361900*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A236] Nonmetallic mineral products, n.e.c.	*362200*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A239] Steel wiredrawing and steel nails and spikes	*370103*	*0.00%*	*0.00%*	*0.00%*
Other	Other	[A24] Coal	*70000*	*0.00%*	*0.01%*	*0.00%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Home improvement	DIY materials	[A243] Primary metal products, n.e.c.	*370402*	*0.00%*	*0.00%*	*0.00%*
Other	Other	[A25] Crude petroleum and natural gas	*80001*	*0.15%*	*0.45%*	*0.07%*
Home improvement	DIY materials	[A250] Nonferrous wiredrawing and insulating	*381000*	*0.00%*	*0.00%*	*0.00%*
Home improvement	Household EUPs	[A257] (Household heating with) heating equipment, except electric and warm a furnaces	*400300*	*4.73%*	*18.70%*	*2.32%*
Home improvement	DIY materials	[A263] Prefabricated metal buildings and components	*400901*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A265] Screw machine products, bolts, etc.	*410100*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A267] Crowns and closures	*410202*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A268] Metal stampings, n.e.c.	*410203*	*0.02%*	*0.01%*	*0.02%*
Home improvement	Glass, tableware & utensils	[A269] Cutlery	*420100*	*0.01%*	*0.01%*	*0.02%*
Home improvement	Other household tools and equipment (non-EUP)	[A270] Hand and edge tools, except machine tools and handsaws	*420201*	*0.01%*	*0.01%*	*0.02%*
Home improvement	Other household tools and equipment (non-EUP)	[A271] Saw blades and handsaws	*420202*	*0.00%*	*0.00%*	*0.01%*
Home improvement	Other household tools and equipment (non-EUP)	[A272] Hardware, n.e.c.	*420300*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A275] Miscellaneous fabricated wire products	*420500*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A276] Steel springs, except wire	*420700*	*0.00%*	*0.00%*	*0.00%*
Home improvement	DIY materials	[A277] Pipe, valves, and pipe fittings	*420800*	*0.02%*	*0.01%*	*0.02%*
Home improvement	DIY materials	[A278] Metal foil and leaf	*421000*	*0.01%*	*0.01%*	*0.01%*
Home improvement	DIY materials	[A279] Fabricated metal products, n.e.c.	*421100*	*0.01%*	*0.01%*	*0.01%*
Home improvement	Household EUPs	[A281] Internal combustion engines, n.e.c.	*430200*	*0.01%*	*0.01%*	*0.02%*
Home improvement	Household EUPs	[A283] Lawn and garden equipment	*440002*	*0.03%*	*0.02%*	*0.03%*
Home	Household EUPs	[A294] Power-driven handtools	*470401*	*0.01%*	*0.01%*	*0.02%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
improvement						
Home improvement	Garden chemicals	[A30] Chemical and fertilizer minerals	*100000*	*0.00%*	*0.00%*	*0.00%*
Home improvement	Household EUPs	[A307] Blowers and fans	*490300*	*0.02%*	*0.02%*	*0.03%*
Residential construction	Residential	[A31] New residential 1 unit structures, nonfarm	*110101*	*3.19%*	*2.67%*	*5.92%*
Home improvement	Glass, tableware & utensils	[A314] Scales and balances, except laboratory	*500300*	*0.01%*	*0.01%*	*0.02%*
Other	Household EUPs	[A316] Calculating and accounting machines	*510102*	*0.01%*	*0.00%*	*0.02%*
Home improvement	Household EUPs	[A317] (use of) Electronic computers	*510103*	*0.24%*	*0.17%*	*0.55%*
Home improvement	Household EUPs	[A318] (use of) Computer peripheral equipment	*510104*	*0.18%*	*0.13%*	*0.40%*
Other	Household EUPs	[A319] Office machines, n.e.c.	*510400*	*0.01%*	*0.00%*	*0.02%*
Residential construction	New residential	[A32] New residential 2-4 unit structures, nonfarm	*110102*	*0.10%*	*0.06%*	*0.14%*
Residential construction	New additions & alterations	[A33] New additions & alterations, nonfarm, construction	*110105*	*1.82%*	*1.49%*	*2.95%*
Home improvement	Household EUPs	[A331] (use of) Household cooking equipment	*540100*	*1.00%*	*1.07%*	*0.55%*
Home improvement	Household EUPs	[A332] (use of) Household refrigerators and freezers	*540200*	*1.77%*	*1.17%*	*0.86%*
Home improvement	Household EUPs	[A333] (Washing with) household laundry equipment	*540300*	*2.37%*	*1.64%*	*1.27%*
Home improvement	Household EUPs	[A334] (use of) Electric housewares and fans	*540400*	*0.20%*	*0.15%*	*0.13%*
Home improvement	Household EUPs	[A335] (use of) Household vacuum cleaners	*540500*	*0.23%*	*0.17%*	*0.16%*
Home improvement	Household EUPs	[A336] (use of) Household appliances, n.e.c.	*540700*	*0.95%*	*0.78%*	*0.88%*
Home improvement	Household EUPs	[A337] (use of) Electric lamp bulbs and tubes	*550100*	*1.23%*	*0.80%*	*0.55%*
Home improvement	Household EUPs	[A338] Lighting fixtures and equipment	*550200*	*0.02%*	*0.02%*	*0.02%*
Home improvement	Other household tools and equipment (non-EUP)	[A339] Wiring devices	*550300*	*0.00%*	*0.00%*	*0.00%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Residential construction	New residential	[A34] New residential garden and high-rise apartments construction	*110108*	*0.66%*	*0.45%*	*1.12%*
Home improvement	Household EUPs	[A340] (use of) Household audio and video equipment	*560100*	*1.15%*	*0.76%*	*0.69%*
Other	Audio-visual, photographic and information processing equipment	[A341] Prerecorded records and tapes	*560200*	*0.01%*	*0.01%*	*0.03%*
Other	Other	[A342] (use of) Telephone and telegraph apparatus	*560300*	*0.10%*	*0.07%*	*0.11%*
Other	Other	[A343] (use of) Communication equipment	*560500*	*0.11%*	*0.07%*	*0.11%*
Other	Audio-visual, photographic and information processing equipment	[A346] Other electronic components	*570300*	*0.00%*	*0.00%*	*0.00%*
Home improvement	Other household tools and equipment (non-EUP)	[A347] Storage batteries	*580100*	*0.02%*	*0.02%*	*0.03%*
Home improvement	Other household tools and equipment (non-EUP)	[A348] Primary batteries, dry and wet	*580200*	*0.02%*	*0.02%*	*0.03%*
Other	Highways & bridges	[A35] New highways, bridges, and other horizontal construction	*110400*	*0.01%*	*0.02%*	*0.02%*
Other	Audio-visual, photographic and information processing equipment	[A350] Magnetic and optical recording media	*580600*	*0.01%*	*0.01%*	*0.01%*
Other	Other	[A352] Truck and bus bodies	*590100*	*0.13%*	*0.10%*	*0.15%*
Other	Other	[A353] Truck trailers	*590200*	*0.03%*	*0.03%*	*0.03%*
Other	Other	[A354] (Driving with) motor vehicles and passenger car bodies	*590301*	*15.00%*	*15.40%*	*8.76%*
Other	Other	[A356] Aircraft	*600100*	*0.06%*	*0.05%*	*0.12%*
Other	Other	[A357] Aircraft and missile engines and engine parts	*600200*	*0.01%*	*0.01%*	*0.03%*
Other	Other	[A359] Ship building and repairing	*610100*	*0.01%*	*0.01%*	*0.01%*
Residential construction	New residential	[A36] New farm residential construction	*110501*	*0.08%*	*0.07%*	*0.15%*
Other	Other	[A360] Boat building and repairing	*610200*	*0.03%*	*0.02%*	*0.03%*
Other	Other	[A362] Motorcycles, bicycles, and parts	*610500*	*0.14%*	*0.11%*	*0.21%*
Other	Other	[A363] Travel trailers and campers	*610601*	*0.01%*	*0.01%*	*0.01%*
Other	Other	[A364] Motor homes	*610603*	*0.01%*	*0.01%*	*0.02%*
Other	Other	[A365] Transportation equipment, n.e.c.	*610700*	*0.01%*	*0.01%*	*0.02%*
Other	Other	[A366] Search and navigation equipment	*620101*	*0.14%*	*0.11%*	*0.39%*
Other	Other	[A373] Watches, clocks, watchcases, and parts	*620700*	*0.00%*	*0.00%*	*0.01%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Home improvement	Other household tools and equipment (non-EUP)	[A377] Instruments to measure electricity	*621100*	*0.07%*	*0.06%*	*0.16%*
Grocery	Medical drugs & equipment	[A378] Ophthalmic goods	*630200*	*0.09%*	*0.09%*	*0.21%*
Other	Audio-visual, photographic and information processing equipment	[A379] Photographic equipment and supplies	*630300*	*0.06%*	*0.06%*	*0.14%*
Other	Other	[A380] Jewelry, precious metal	*640101*	*0.04%*	*0.04%*	*0.06%*
Other	Other	[A381] Jewelers' materials and lapidary work	*640102*	*0.02%*	*0.01%*	*0.04%*
Other	Other	[A382] Silverware and plated ware	*640104*	*0.00%*	*0.00%*	*0.00%*
Other	Other	[A383] Costume jewelry	*640105*	*0.01%*	*0.01%*	*0.02%*
Other	Other major durables for recreation and culture	[A384] Musical instruments	*640200*	*0.01%*	*0.01%*	*0.04%*
Other	Other recreational equipment	[A385] Games, toys, and children's vehicles	*640301*	*0.07%*	*0.07%*	*0.10%*
Other	Other recreational equipment	[A386] Dolls and stuffed toys	*640302*	*0.01%*	*0.01%*	*0.02%*
Other	Other recreational equipment	[A387] Sporting and athletic goods, n.e.c.	*640400*	*0.06%*	*0.05%*	*0.10%*
Other	Newspapers, books and stationery	[A388] Pens, mechanical pencils, and parts	*640501*	*0.01%*	*0.01%*	*0.01%*
Other	Newspapers, books and stationery	[A389] Lead pencils and art goods	*640502*	*0.01%*	*0.01%*	*0.01%*
Other	Newspapers, books and stationery	[A390] Marking devices	*640503*	*0.00%*	*0.00%*	*0.00%*
Other	Newspapers, books and stationery	[A391] Carbon paper and inked ribbons	*640504*	*0.00%*	*0.00%*	*0.00%*
Other	Newspapers, books and stationery	[A392] Fasteners, buttons, needles, and pins	*640700*	*0.00%*	*0.00%*	*0.00%*
Grocery	Household cleaning & other non-durable	[A393] Non-durable household goods	*640800*	*0.52%*	*0.47%*	*0.72%*
Other	Newspapers, books and stationery	[A396] Signs and advertising specialties	*641100*	*0.03%*	*0.03%*	*0.07%*
Other	Other	[A398] Railroads and related services	*650100*	*0.29%*	*0.37%*	*0.39%*
Other	Other	[A399] Local and suburban transit and interurban highway passenger transportation	*650200*	*0.44%*	*1.07%*	*0.67%*
Grocery	Food	[A4] Miscellaneous livestock	*10302*	*0.34%*	*0.22%*	*0.15%*
Other	Other	[A400] Trucking and courier services, except air	*650301*	*0.04%*	*0.05%*	*0.05%*
Other	Other	[A401] Warehousing and storage	*650302*	*0.00%*	*0.00%*	*0.01%*
Other	Other	[A402] Water transportation	*650400*	*0.08%*	*0.05%*	*0.07%*
Other	Other	[A403] Air transportation	*650500*	*0.32%*	*0.65%*	*0.37%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Other	Other	[A406] Arrangement of passenger transportation	*650702*	*0.00%*	*0.00%*	*0.01%*
Other	Other	[A407] Telephone, telgraph communications, and communications services n.e.c.	*660100*	*1.34%*	*1.06%*	*3.58%*
Other	Other	[A408] Cable and other pay television services	*660200*	*0.24%*	*0.18%*	*0.48%*
Other	Other	[A409] Radio and TV broadcasting	*670000*	*0.03%*	*0.02%*	*0.06%*
Other	Other	[A413] Water supply and sewerage systems	*680301*	*0.67%*	*0.73%*	*0.83%*
Other	Other	[A416] Banking	*700100*	*0.05%*	*0.04%*	*0.20%*
Other	Other	[A417] Credit agencies other than banks	*700200*	*0.01%*	*0.01%*	*0.05%*
Other	Other	[A418] Security and commodity brokers	*700300*	*0.04%*	*0.03%*	*0.15%*
Other	Other	[A419] Insurance carriers	*700400*	*1.13%*	*0.94%*	*4.73%*
Other	Other	[A42] Maintenance and repair of farm and nonfarm residential structures	*120101*	*0.69%*	*0.75%*	*1.41%*
Other	Other	[A422] Real estate agents, managers, operators, and lessors	*710201*	*0.41%*	*0.34%*	*0.66%*
Other	Other	[A424] Hotels	*720101*	*0.57%*	*0.49%*	*0.95%*
Other	Other	[A425] Other lodging places	*720102*	*0.42%*	*0.33%*	*0.44%*
Other	Other	[A426] Laundry, cleaning, garment services, and shoe repair	*720201*	*0.27%*	*0.35%*	*0.37%*
Other	Other	[A427] Funeral service and crematories	*720202*	*0.01%*	*0.02%*	*0.03%*
Other	Other	[A428] Portrait photographic studios, and other miscellaneous personal services	*720203*	*0.29%*	*0.29%*	*0.48%*
Other	Other	[A429] Electrical repair shops	*720204*	*0.14%*	*0.14%*	*0.28%*
Other	Other	[A430] Watch, clock, jewelry, and furniture repair	*720205*	*0.13%*	*0.14%*	*0.21%*
Other	Other	[A431] Beauty and barber shops	*720300*	*1.16%*	*1.11%*	*1.41%*
Other	Other	[A432] Miscellaneous repair shops	*730101*	*0.04%*	*0.05%*	*0.09%*
Other	Other	[A433] Services to dwellings and other buildings	*730102*	*0.02%*	*0.02%*	*0.05%*
Other	Other	[A434] Personnel supply services	*730103*	*0.00%*	*0.00%*	*0.01%*
Other	Other	[A436] Detective and protective services	*730106*	*0.00%*	*0.00%*	*0.01%*
Other	Other	[A437] Miscellaneous equipment rental and leasing	*730107*	*0.24%*	*0.25%*	*0.36%*
Other	Other	[A438] Photofinishing labs and commercial photography	*730108*	*0.03%*	*0.03%*	*0.07%*
Other	Other	[A439] Other business services	*730109*	*0.23%*	*0.30%*	*0.54%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Other	Other	[A442] Advertising	*730200*	*0.00%*	*0.00%*	*0.00%*
Other	Other	[A443] Legal services	*730301*	*0.05%*	*0.05%*	*0.16%*
Other	Other	[A444] Engineering, architectural, and surveying services	*730302*	*0.03%*	*0.03%*	*0.06%*
Other	Other	[A445] Accounting, auditing and bookkeeping, and miscellaneous services, n.e.c.	*730303*	*0.00%*	*0.00%*	*0.00%*
Other	Other	[A446] Eating and drinking places	*740000*	*8.08%*	*6.17%*	*8.23%*
Other	Other	[A447] Automotive rental and leasing, without drivers	*750001*	*0.56%*	*0.49%*	*0.75%*
Other	Other	[A448] Automotive repair shops and services	*750002*	*1.22%*	*1.15%*	*2.06%*
Other	Other	[A449] Automobile parking and car washes	*750003*	*0.09%*	*0.09%*	*0.22%*
Other	Other	[A450] Motion picture services and theaters	*760101*	*0.07%*	*0.06%*	*0.15%*
Other	Other	[A451] Video tape rental	*760102*	*0.07%*	*0.05%*	*0.13%*
Other	Other	[A452] Theatrical producers (except motion picture), bands, orchestras and entertainers	*760201*	*0.06%*	*0.05%*	*0.13%*
Other	Other	[A453] Bowling centers	*760202*	*0.01%*	*0.01%*	*0.02%*
Other	Other	[A454] Professional sports clubs and promoters	*760203*	*0.02%*	*0.01%*	*0.05%*
Other	Other	[A455] Racing, including track operation	*760204*	*0.03%*	*0.03%*	*0.07%*
Other	Other	[A456] Physical fitness facilities and membership sports and recreation clubs	*760205*	*0.12%*	*0.11%*	*0.23%*
Other	Other	[A457] Other amusement and recreation services	*760206*	*0.91%*	*0.78%*	*2.16%*
Other	Other	[A458] Doctors and dentists	*770100*	*0.44%*	*0.42%*	*2.01%*
Other	Other	[A459] Hospitals	*770200*	*0.17%*	*0.16%*	*0.24%*
Other	Other	[A460] Nursing and personal care facilities	*770301*	*0.11%*	*0.10%*	*0.25%*
Other	Other	[A461] Other medical and health services	*770303*	*0.13%*	*0.15%*	*0.46%*
Other	Other	[A462] Veterinary services	*770304*	*0.04%*	*0.03%*	*0.05%*
Other	Other	[A464] Elementary and secondary schools	*770401*	*0.11%*	*0.09%*	*0.28%*
Other	Other	[A465] Colleges, universities, and professional schools	*770402*	*0.27%*	*0.23%*	*0.78%*
Other	Other	[A466] Private libraries, vocational schools, and educational services, n.e.c.	*770403*	*0.08%*	*0.08%*	*0.25%*
Other	Other	[A467] Business associations and professional membership organizations	*770501*	*0.01%*	*0.01%*	*0.01%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Other	Other	[A468] Labor organizations, civic, social, and fraternal associations	*770502*	*0.03%*	*0.03%*	*0.06%*
Other	Other	[A469] Religious organizations	*770503*	*0.03%*	*0.02%*	*0.11%*
Other	Other	[A470] Other membership organizations	*770504*	*0.06%*	*0.05%*	*0.08%*
Other	Other	[A471] Job training and related services	*770600*	*0.03%*	*0.03%*	*0.07%*
Other	Other	[A472] Child day care services	*770700*	*0.04%*	*0.04%*	*0.08%*
Other	Other	[A473] Residential care	*770800*	*0.04%*	*0.03%*	*0.07%*
Other	Other	[A474] Social services, n.e.c.	*770900*	*0.13%*	*0.13%*	*0.17%*
Other	Other	[A475] Postal Service	*780100*	*0.58%*	*0.66%*	*0.25%*
Other	Other recreational equipment	[A49] Small arms	*130500*	*0.01%*	*0.01%*	*0.01%*
Other	Other recreational equipment	[A50] Small arms ammunition	*130600*	*0.01%*	*0.01%*	*0.01%*
Grocery	Food	[A52] Meat packing plants	*140101*	*5.54%*	*3.01%*	*1.98%*
Grocery	Food	[A53] Sausages and other prepared meat products	*140102*	*2.52%*	*1.42%*	*0.83%*
Grocery	Food	[A54] Poultry slaughtering and processing	*140105*	*3.93%*	*2.53%*	*1.63%*
Grocery	Food	[A55] Creamery butter	*140200*	*0.15%*	*0.11%*	*0.08%*
Grocery	Food	[A56] Natural, processed, and imitation cheese	*140300*	*2.11%*	*1.47%*	*0.87%*
Grocery	Food	[A57] Dry, condensed, and evaporated dairy products	*140400*	*0.56%*	*0.41%*	*0.33%*
Grocery	Food	[A58] Ice cream and frozen desserts	*140500*	*0.15%*	*0.12%*	*0.08%*
Grocery	Food	[A59] Fluid milk	*140600*	*2.38%*	*1.72%*	*1.09%*
Grocery	Food	[A60] Canned and cured fish and seafoods	*140700*	*0.35%*	*0.33%*	*0.27%*
Grocery	Food	[A61] Canned specialties	*140800*	*0.09%*	*0.07%*	*0.08%*
Grocery	Food	[A62] Canned fruits, vegetables, preserves, jams, and jellies	*140900*	*0.38%*	*0.31%*	*0.30%*
Grocery	Food	[A63] Dehydrated fruits, vegetables, and soups	*141000*	*0.13%*	*0.12%*	*0.10%*
Grocery	Food	[A64] Pickles, sauces, and salad dressings	*141100*	*0.08%*	*0.06%*	*0.07%*
Grocery	Food	[A65] Prepared fresh or frozen fish and seafoods	*141200*	*0.57%*	*0.49%*	*0.37%*
Grocery	Food	[A66] Frozen fruits, fruit juices, and vegetables	*141301*	*0.75%*	*0.61%*	*0.48%*
Grocery	Food	[A67] Frozen specialties, n.e.c.	*141302*	*0.24%*	*0.17%*	*0.15%*
Grocery	Food	[A68] Flour and other grain mill products	*141401*	*0.08%*	*0.07%*	*0.05%*

Sector	Sub-sector	Product name	CEDA code	% of Global Warming Potential	% of Abiotic Depletion	% of EU household expenditure
Grocery	Food	[A69] Cereal breakfast foods	*141402*	*0.49%*	*0.42%*	*0.37%*
Grocery	Pet products	[A7] Feed grains	*20202*	*0.02%*	*0.02%*	*0.02%*
Grocery	Food	[A70] Prepared flour mixes and doughs	*141403*	*0.41%*	*0.33%*	*0.24%*
Grocery	Pet products	[A71] Dog and cat food	*141501*	*0.39%*	*0.32%*	*0.23%*
Grocery	Pet products	[A72] Prepared feeds, n.e.c.	*141502*	*0.10%*	*0.07%*	*0.05%*
Grocery	Food	[A75] Bread, cake, and related products	*141801*	*0.89%*	*0.75%*	*1.09%*
Grocery	Food	[A76] Cookies and crackers	*141802*	*0.40%*	*0.35%*	*0.42%*
Grocery	Food	[A77] Frozen bakery products, except bread	*141803*	*0.22%*	*0.18%*	*0.14%*
Grocery	Food	[A78] Sugar	*141900*	*0.13%*	*0.11%*	*0.07%*
Grocery	Food	[A79] Chocolate and cocoa products	*142002*	*0.03%*	*0.03%*	*0.02%*
Grocery	Food	[A80] Salted and roasted nuts and seeds	*142004*	*0.05%*	*0.03%*	*0.03%*
Grocery	Food	[A81] Candy and other confectionery products	*142005*	*0.49%*	*0.43%*	*0.42%*
Grocery	Alcoholic beverages	[A82] Malt beverages	*142101*	*0.30%*	*0.27%*	*0.40%*
Grocery	Alcoholic beverages	[A84] Wines, brandy, and brandy spirits	*142103*	*0.56%*	*0.50%*	*0.62%*
Grocery	Alcoholic beverages	[A85] Distilled and blended liquors	*142104*	*0.08%*	*0.08%*	*0.16%*
Grocery	Non-alcoholic beverages	[A86] Bottled and canned soft drinks	*142200*	*0.91%*	*0.79%*	*0.73%*
Grocery	Non-alcoholic beverages	[A87] Flavoring extracts and flavoring syrups, n.e.c.	*142300*	*0.08%*	*0.08%*	*0.12%*
Grocery	Non-alcoholic beverages	[A92] Roasted coffee	*142800*	*0.71%*	*0.62%*	*0.44%*
Grocery	Food	[A93] Edible fats and oils, n.e.c.	*142900*	*1.29%*	*0.88%*	*0.65%*
Grocery	Food	[A94] Manufactured ice	*143000*	*0.00%*	*0.00%*	*0.01%*
Grocery	Food	[A95] Macaroni, spaghetti, vermicelli, and noodles	*143100*	*0.07%*	*0.06%*	*0.05%*
Grocery	Food	[A96] Potato chips and similar snacks	*143201*	*0.53%*	*0.45%*	*0.51%*
Grocery	Food	[A97] Food preparations, n.e.c.	*143202*	*0.26%*	*0.22%*	*0.21%*
Other	Tobacco	[A98] Cigarettes	*150101*	*0.74%*	*0.68%*	*1.38%*
Other	Tobacco	[A99] Cigars	*150102*	*0.03%*	*0.03%*	*0.05%*

Table A3-1 Summary of EIPRO data

Appendix 4 – GHG Emissions Data

Retail sales volume data were sourced for 230 food and drink, personal care and household products sold in the UK. The preferred data year was 2010 (see Appendix 2).

Product-specific carbon footprint data were sought for all 230 grocery products, to be multiplied by the sales volume and thus estimate market-wide GHG emissions. In total 1,887 data points were found for 191 of these products. However, this data set comprised a variety of system boundaries: cradle-to-farm gate, cradle-to-RDC, cradle-to-retail and cradle-to-grave. To provide a complete data set with consistent boundaries, only cradle-to-retail data were used in the main analysis presented in the table below. In total, 684 data points describe the cradle-to-retail carbon footprint of 174 grocery products.

Where possible, suitable proxies were used for products where no data could be found (e.g. data for shampoo was used as a proxy for conditioner) and, for a small number of products sold in quantities <30 million kg per year, a conservative GHG emission factor (5 kg CO_2e/kg) was used[41]. With the addition of proxy data, a total of 727 data points were cradle-to-retail, covering 217 of the 230 grocery products. The remaining 13 products that are not represented in this study are:

- Air fresheners;
- Cosmetic tissues;
- Face make-up;
- Facial care;
- General purpose cleaners;
- Hand care;
- Lip make-up;
- Mouthwash;
- Other OTC healthcare products;
- Processed snacks;
- Styling agents;
- Suncare; and
- Toilet care.

Table A4-1 below shows the complete ranking of all 217 grocery products contributing to annual cradle-to-retail greenhouse gas emissions. The table describes the number of carbon footprint data points collated for each product, and the predominant source of those data. It also provides the sales volume (for the year 2010). Each carbon footprint data point was multiplied by the sales volume to estimate the total cradle-to-retail GHG emissions for each product. In many cases this provided a range of estimates, and this range is described in the table by the minimum, lower quartile, median, upper quartile and maximum values for each grocery product. The median value was used as representative to estimate the total GHG emissions of all products (82 Mt CO_2e), to rank the products, and to calculate the cumulative contribution of each product to total emissions. Rank and cumulative contribution is given in Table A4-1.

[41] *Products sold in quantities below 30 million kg per year represents less than 0.1% of total mass of grocery products sold (~46,000 million kg per year). Therefore it was thought acceptable to use an estimated GHG emission factor in the absence of suitable data or proxy data.*

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Liquid milk	17	Peer reviewed journal	5186	1.90	5.19	6.07	6.74	11.75	7%	12%	1
Beef, fresh	23	Academic research	291	2.91	4.31	5.12	8.37	11.67	14%	12%	2
Cheese	12	Peer reviewed journal	387	1.61	2.97	3.41	3.79	4.64	18%	13%	3
Red meat, frozen	2	Industry research	149	1.74	2.02	2.31	2.60	2.89	21%	13%	4
Coffee	3	Equal data points from Defra, eco-label and peer reviewed journal	66	0.83	1.50	2.18	2.33	2.47	24%	14%	5
Pre-packed sandwiches	2	Equal data points from academic research and other corporate research	488	1.71	1.93	2.15	2.37	2.59	26%	15%	6
Bread & rolls	4	Equal data points from Defra and peer reviewed journal	2769	2.02	2.06	2.09	2.34	3.05	29%	21%	7
Chilled ready meals	15	Defra	137	0.28	0.93	2.01	2.84	8.25	31%	21%	8
Light wines	4	Academic research	882	0.88	1.54	1.85	2.09	2.56	34%	23%	9
Dog food	1	Other corporate research	802	1.76	1.76	1.76	1.76	1.76	36%	25%	10
Poultry, fresh	16	Academic research	435	1.13	1.34	1.66	1.83	3.00	38%	26%	11
Lamb, fresh	20	Industry research	92	0.93	1.20	1.59	2.19	3.59	40%	26%	12
Juices	11	Academic research	1481	0.44	1.12	1.47	1.48	2.81	42%	29%	13
Butter	8	Peer reviewed journal	172	0.17	1.28	1.46	1.69	2.06	43%	30%	14
Chilled fish/seafood	14	Academic research	229	0.44	0.91	1.37	1.58	1.73	45%	30%	15
Cakes & pastries	3	Equal data points from eco-label, academic research and peer reviewed journal	516	0.47	0.91	1.34	1.39	1.44	47%	31%	16

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Toilet papers	9	Eco-label	737	0.89	0.96	1.30	1.97	2.01	48%	33%	17
Morning goods	1	Eco-label	332	1.29	1.29	1.29	1.29	1.29	50%	34%	18
Lager	5	Eco-label	1563	1.05	1.25	1.27	1.72	2.19	52%	37%	19
Canned fish/seafood	2	Equal data points from eco-label and academic research	277	0.86	1.04	1.21	1.39	1.57	53%	38%	20
Cat food	1	Other corporate research	534	1.17	1.17	1.17	1.17	1.17	54%	39%	21
Deli food	6	Academic research	236	0.78	0.87	1.16	1.85	2.28	56%	39%	22
Biscuits (sweet)	4	Defra	480	0.72	0.99	1.14	1.20	1.20	57%	41%	23
Pork, fresh	18	Academic research	172	0.62	0.95	1.08	1.17	1.70	59%	41%	24
Chocolate	5	Academic research	589	0.44	0.53	1.06	1.59	2.00	60%	42%	25
Banana	6	Academic research	974	0.44	0.59	0.98	1.24	1.30	61%	44%	26
Tomatoes	16	Defra	477	0.08	0.59	0.93	1.56	8.30	62%	45%	27
Eggs	13	Defra	314	0.41	0.53	0.92	1.38	1.73	63%	46%	28
Frozen fish/seafood	2	Equal data points from academic research and WRAP	170	0.65	0.76	0.88	0.99	1.11	65%	47%	29
Carbonates	5	WRAP	2960	0.64	0.71	0.86	0.89	1.62	66%	53%	30
Yogurt	8	Industry research	479	0.52	0.60	0.86	0.97	2.16	67%	54%	31
Sweet peppers	3	Academic research	132	0.05	0.41	0.78	1.01	1.24	68%	54%	32
Sugar confectionery	4	Academic research	252	0.60	0.66	0.74	0.85	0.97	69%	55%	33
Canned vegetables	3	Eco-label	560	0.62	0.68	0.73	1.63	2.52	69%	56%	34
Frozen ready meals	1	Provided by PSF member	137	0.64	0.64	0.64	0.64	0.64	70%	57%	35

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Cider/perry	2	Equal data points from academic research and WRAP	521	0.57	0.59	0.60	0.61	0.63	71%	58%	36
Canned meat products	2	Equal data points from academic research and eco-label	88	0.27	0.42	0.58	0.73	0.88	72%	58%	37
Canned soup	2	Equal data points from academic research and peer reviewed journal	174	0.40	0.49	0.57	0.66	0.75	72%	58%	38
Ice cream (litres)	2	Equal data points from industry research and peer reviewed journal	312	0.20	0.36	0.53	0.69	0.85	73%	59%	39
Potatoes	20	Defra	1925	0.23	0.37	0.52	0.74	2.91	74%	63%	40
Spirits	2	Equal data points from academic research and WRAP	215	0.48	0.50	0.51	0.52	0.54	74%	64%	41
Kitchen roll	2	Eco-label	231	0.48	0.49	0.50	0.52	0.53	75%	64%	42
Frozen pizza	2	Eco-label	110	0.37	0.42	0.47	0.52	0.57	76%	65%	43
Deodorants	1	Eco-label	91	0.45	0.45	0.45	0.45	0.45	76%	65%	44
Dishwashing products	2	Eco-label	165	0.21	0.33	0.45	0.57	0.70	77%	65%	45
Cucumbers	6	Equal data points from academic research and peer reviewed journal	190	0.07	0.25	0.44	0.70	0.83	77%	66%	46
Prepared salads	4	Equal data points from academic research and peer reviewed journal	122	0.05	0.31	0.43	0.51	0.67	78%	66%	47
Crisps	3	Academic research	178	0.39	0.41	0.42	0.43	0.45	78%	66%	48

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Margarine	2	Equal data points from academic research and peer reviewed journal	241	0.27	0.33	0.39	0.45	0.51	79%	67%	49
Cauliflowers	5	Academic research	189	0.06	0.07	0.37	0.42	0.45	79%	67%	50
Chilled pizza	2	Eco-label	85	0.29	0.33	0.37	0.40	0.44	80%	67%	51
Frozen desserts	1	Product category average	131	0.35	0.35	0.35	0.35	0.35	80%	68%	52
Frozen potato products	2	Equal data points from academic research and provided by PSF member	445	0.25	0.30	0.35	0.40	0.45	80%	69%	53
Other field veg (excl. dried)	10	Academic research	306	0.07	0.15	0.34	0.55	0.68	81%	69%	54
Cream	8	Industry research	92	0.04	0.23	0.34	0.46	0.70	81%	69%	55
Powder detergents	2	Eco-label	111	0.26	0.30	0.33	0.36	0.40	82%	70%	56
Tea	5	Defra	80	0.07	0.07	0.33	0.33	0.91	82%	70%	57
Concentrates	5	Eco-label	707	0.14	0.29	0.33	0.40	0.53	83%	71%	58
Rice	6	Academic research	141	0.06	0.23	0.32	0.47	0.95	83%	72%	59
Canned ready meals	1	Product category average	135	0.31	0.31	0.31	0.31	0.31	83%	72%	60
Breakfast cereals	5	Equal data points from academic research and eco-label	343	0.04	0.13	0.31	0.34	1.55	84%	73%	61
Onions	7	Equal data points from academic research and Defra	721	0.10	0.28	0.30	0.35	0.43	84%	74%	62
Canned pasta & noodles	1	Product category average	128	0.29	0.29	0.29	0.29	0.29	84%	75%	63

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Melons	6	Academic research	188	0.21	0.26	0.29	0.29	0.33	85%	75%	64
Lettuce	3	Academic research	267	0.11	0.19	0.27	0.29	0.31	85%	76%	65
Pickled products	1	Defra	69	0.26	0.26	0.26	0.26	0.26	85%	76%	66
Frozen bakery products	1	Product category average	94	0.25	0.25	0.25	0.25	0.25	86%	76%	67
Dog chews & treats	1	Product category average	115	0.25	0.25	0.25	0.25	0.25	86%	76%	68
Carrots	7	Academic research	715	0.10	0.20	0.25	0.34	1.03	86%	78%	69
Nappies	1	Eco-label	140	0.25	0.25	0.25	0.25	0.25	87%	78%	70
Crackers (savoury biscuits)	1	Academic research	93	0.25	0.25	0.25	0.25	0.25	87%	78%	71
Bottled water	8	Industry research	1292	0.14	0.17	0.24	0.25	0.80	87%	81%	72
Chilled desserts	1	Academic research	148	0.24	0.24	0.24	0.24	0.24	88%	82%	73
Poultry, frozen	2	Academic research	94	0.21	0.22	0.23	0.23	0.24	88%	82%	74
Offal, fresh	1	Product category average	23	0.23	0.23	0.23	0.23	0.23	88%	82%	75
Other hot drinks	9	Defra	23	0.02	0.09	0.21	0.53	0.99	88%	82%	76
Canned fruit	1	Academic research	118	0.21	0.21	0.21	0.21	0.21	89%	82%	77
Baby Toiletries	1	Proxy	76	0.20	0.20	0.20	0.20	0.20	89%	82%	78
Dried pasta/noodles	4	Eco-label	152	0.12	0.17	0.19	0.24	0.37	89%	83%	79
Pineapples	3	Defra	145	0.19	0.19	0.19	0.22	0.26	89%	83%	80
Bath & shower products	2	Eco-label	145	0.18	0.18	0.19	0.19	0.19	90%	83%	81
Flavoured milk	1	Eco-label	129	0.18	0.18	0.18	0.18	0.18	90%	84%	82

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Chilled Soup	2	Equal data points from academic research and hotspot product category average	51	0.14	0.16	0.18	0.20	0.22	90%	84%	83
Rodent food	1	Product category average	80	0.18	0.18	0.18	0.18	0.18	90%	84%	84
Mushrooms	3	Academic research	156	0.16	0.16	0.17	0.41	0.64	90%	84%	85
Liquid detergents	1	Eco-label	100	0.16	0.16	0.16	0.16	0.16	91%	85%	86
Ales	2	Equal data points from WRAP and eco-label	221	0.14	0.15	0.16	0.17	0.18	91%	85%	87
Frozen vegetables	6	Defra	284	0.03	0.11	0.15	0.25	2.67	91%	86%	88
Calabrese	1	Academic research	77	0.15	0.15	0.15	0.15	0.15	91%	86%	89
Insecticides	2	Industry research	23	0.11	0.13	0.15	0.16	0.18	91%	86%	90
Table sauces	1	Academic research	111	0.15	0.15	0.15	0.15	0.15	92%	86%	91
Apples	10	Academic research	665	0.05	0.08	0.15	0.27	0.60	92%	88%	92
Strawberries	4	Academic research	148	0.12	0.13	0.15	0.17	0.21	92%	88%	93
Indigestion preparations	1	Proxy	27	0.13	0.13	0.13	0.13	0.13	92%	88%	94
Functional drinks	1	WRAP	445	0.13	0.13	0.13	0.13	0.13	92%	89%	95
Jams & preserves	2	Equal data points from academic research and peer reviewed journals	66	0.05	0.09	0.13	0.17	0.21	92%	89%	96
Bleach	1	Proxy	26	0.13	0.13	0.13	0.13	0.13	93%	89%	97
Eye make-up	1	Proxy	26	0.13	0.13	0.13	0.13	0.13	93%	89%	98
Vitamins and minerals	1	Proxy	26	0.13	0.13	0.13	0.13	0.13	93%	89%	99
Toothbrushes	1	Proxy	26	0.13	0.13	0.13	0.13	0.13	93%	89%	100

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Sanitary Pads	1	Proxy	25	0.13	0.13	0.13	0.13	0.13	93%	89%	101
Other savoury snacks	1	Academic research	50	0.13	0.13	0.13	0.13	0.13	93%	90%	102
Cabbages	6	Academic research	249	0.05	0.07	0.12	0.12	0.16	94%	90%	103
Dips	1	Product category average	45	0.12	0.12	0.12	0.12	0.12	94%	90%	104
Toothpaste	1	Proxy	23	0.12	0.12	0.12	0.12	0.12	94%	90%	105
Medicated skin products	1	Proxy	23	0.12	0.12	0.12	0.12	0.12	94%	90%	106
Laundry Bleach	1	Proxy	12	0.11	0.11	0.11	0.11	0.11	94%	90%	107
Male fragrances	1	Proxy	23	0.11	0.11	0.11	0.11	0.11	94%	90%	108
Other non-alcoholic drinks	5	Eco-label	195	0.05	0.06	0.11	0.15	0.20	94%	91%	109
First aid kits	1	Proxy	22	0.11	0.11	0.11	0.11	0.11	95%	91%	110
Tampons	1	Proxy	21	0.10	0.10	0.10	0.10	0.10	95%	91%	111
Fromage frais	1	Academic research	52	0.10	0.10	0.10	0.10	0.10	95%	91%	112
Male Shaving Preparations	1	Proxy	21	0.10	0.10	0.10	0.10	0.10	95%	91%	113
Grapes	3	Equal data points from academic research, peer reviewed journals and Defra	244	0.10	0.10	0.10	0.17	0.24	95%	92%	114
Small oranges	2	Equal data points from academic research and peer reviewed journals	250	0.08	0.09	0.10	0.11	0.13	95%	92%	115
Nail make-up	1	Proxy	20	0.10	0.10	0.10	0.10	0.10	95%	92%	116
Styling agents	1	Proxy	20	0.10	0.10	0.10	0.10	0.10	95%	92%	117

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Solid fats	1	Product category average	36	0.10	0.10	0.10	0.10	0.10	96%	92%	118
Savoury spreads	1	Product category average	44	0.10	0.10	0.10	0.10	0.10	96%	92%	119
Cereal bars	1	Product category average	43	0.09	0.09	0.09	0.09	0.09	96%	93%	120
Detergent tablets	1	Proxy	37	0.09	0.09	0.09	0.09	0.09	96%	93%	121
Hair colorants	1	Proxy	19	0.09	0.09	0.09	0.09	0.09	96%	93%	122
Meat substitutes, frozen	1	Product category average	34	0.09	0.09	0.09	0.09	0.09	96%	93%	123
Ready-to-drink (alcoholic)	1	Product category average	59	0.09	0.09	0.09	0.09	0.09	96%	93%	124
Household paper	4	Equal data points from industry research and eco-label	58	0.05	0.07	0.09	0.13	0.23	96%	93%	125
Chilled fresh pasta	1	Eco-label	36	0.09	0.09	0.09	0.09	0.09	96%	93%	126
Milk (concentrate & powder)	1	Product category average	39	0.09	0.09	0.09	0.09	0.09	97%	93%	127
Dried ready meals	2	Equal data points from peer reviewed journal and Product category average	50	0.06	0.07	0.09	0.10	0.12	97%	93%	128
Infant Formula	1	Product category average	34	0.08	0.08	0.08	0.08	0.08	97%	93%	129
Oranges	4	Academic research	279	0.05	0.07	0.08	0.10	0.14	97%	94%	130
Soap	3	Eco-label	44	0.04	0.06	0.08	0.09	0.11	97%	94%	131
Fabric conditioners	1	Eco-label	198	0.08	0.08	0.08	0.08	0.08	97%	94%	132
Other Fruit	25	Academic research	41	0.02	0.04	0.07	0.10	0.18	97%	95%	133

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Meat substitutes, fresh	1	Product category average	27	0.07	0.07	0.07	0.07	0.07	97%	95%	134
Stout	2	Equal data points from academic research and Product category average	49	0.07	0.07	0.07	0.07	0.07	97%	95%	135
Limescale Preventers	1	Proxy	14	0.07	0.07	0.07	0.07	0.07	97%	95%	136
Gum	1	Product category average	31	0.07	0.07	0.07	0.07	0.07	97%	95%	137
Plasters & Bandages	1	Proxy	13	0.07	0.07	0.07	0.07	0.07	98%	95%	138
Fortified wine	1	Product category average	43	0.06	0.06	0.06	0.06	0.06	98%	95%	139
Beans (excl. dried)	10	Industry research	59	0.01	0.03	0.06	0.08	0.09	98%	95%	140
Canned desserts	1	Product category average	25	0.06	0.06	0.06	0.06	0.06	98%	95%	141
Celery, field	2	Defra	110	0.06	0.06	0.06	0.06	0.06	98%	95%	142
Dressings	6	Academic research	70	0.03	0.04	0.05	0.08	0.29	98%	96%	143
Nuts & seeds	16	Academic research	52	0.02	0.05	0.05	0.10	0.15	98%	96%	144
Sparkling wines	2	Industry research	43	0.05	0.05	0.05	0.06	0.06	98%	96%	145
Pantiliners and shields	1	Proxy	10	0.05	0.05	0.05	0.05	0.05	98%	96%	146
Lemons and Limes	1	Academic research	99	0.05	0.05	0.05	0.05	0.05	98%	96%	147
Shampoo	1	Eco-label	83	0.05	0.05	0.05	0.05	0.05	98%	96%	148
Pears	6	Academic research	139	0.02	0.03	0.04	0.06	0.12	98%	97%	149
Stain removers and other additives	2	Academic research	46	0.03	0.04	0.04	0.05	0.06	98%	97%	150

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Denture care	1	Proxy	8	0.04	0.04	0.04	0.04	0.04	98%	97%	151
Garlic, leeks	4	Academic research	66	0.04	0.04	0.04	0.05	0.06	98%	97%	152
Depilatories	1	Proxy	8	0.04	0.04	0.04	0.04	0.04	98%	97%	153
Bottled Baby Food	1	Product category average	17	0.04	0.04	0.04	0.04	0.04	99%	97%	154
Turnips & swedes	1	Academic research	106	0.04	0.04	0.04	0.04	0.04	99%	97%	155
Female fragrances	1	Proxy	7	0.04	0.04	0.04	0.04	0.04	99%	97%	156
Seasonings	7	Academic research	40	0.01	0.03	0.03	0.06	0.27	99%	97%	157
Other protected veg	16	Academic research	16	0.00	0.01	0.03	0.05	0.09	99%	97%	158
Scouring products	1	Proxy	7	0.03	0.03	0.03	0.03	0.03	99%	97%	159
Dry cooking sauces	1	Product category average	15	0.03	0.03	0.03	0.03	0.03	99%	97%	160
Male razors and blades	1	Proxy	7	0.03	0.03	0.03	0.03	0.03	99%	97%	161
Dental floss	1	Proxy	6	0.03	0.03	0.03	0.03	0.03	99%	97%	162
Make-up remover	1	Proxy	6	0.03	0.03	0.03	0.03	0.03	99%	97%	163
Peaches, Nectarines	5	Academic research	69	0.01	0.02	0.03	0.03	0.06	99%	97%	164
Plums	4	Academic research	79	0.03	0.03	0.03	0.04	0.07	99%	98%	165
Other (soft) fruit	1	Product category average	41	0.03	0.03	0.03	0.03	0.03	99%	98%	166
Conditioner	1	Proxy	50	0.03	0.03	0.03	0.03	0.03	99%	98%	167
Asparagus	4	Academic research	13	0.02	0.02	0.03	0.03	0.03	99%	98%	168
Furniture & Floor Polish	1	Proxy	5	0.03	0.03	0.03	0.03	0.03	99%	98%	169

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Parsnips	2	Equal data points from Defra and Product category average	86	0.00	0.01	0.03	0.04	0.05	99%	98%	170
Shoe polish	1	Proxy	5	0.02	0.02	0.02	0.02	0.02	99%	98%	171
Other Citrus Fruit	5	Academic research	48	0.02	0.02	0.02	0.02	0.03	99%	98%	172
Cat treats & milk	1	Product category average	11	0.02	0.02	0.02	0.02	0.02	99%	98%	174
Dessert mixes	1	Product category average	11	0.02	0.02	0.02	0.02	0.02	99%	98%	173
Male Shaving Aftercare	1	Proxy	5	0.02	0.02	0.02	0.02	0.02	99%	98%	175
Canned Baby Food	1	Product category average	10	0.02	0.02	0.02	0.02	0.02	99%	98%	176
Carpet Cleaners	1	Proxy	4	0.02	0.02	0.02	0.02	0.02	99%	98%	177
Unisex fragrances	1	Proxy	4	0.02	0.02	0.02	0.02	0.02	99%	98%	178
Raspberries	1	Academic research	25	0.02	0.02	0.02	0.02	0.02	99%	98%	180
Champagne	1	Product category average	14	0.02	0.02	0.02	0.02	0.02	99%	98%	179
Condiment sauces	2	Academic research	9	0.01	0.02	0.02	0.03	0.03	99%	98%	181
Nut-based spreads	1	Product category average	9	0.02	0.02	0.02	0.02	0.02	100%	98%	182
Internal Cleansers	1	Proxy	4	0.02	0.02	0.02	0.02	0.02	100%	98%	183
Dried soup	1	Product category average	8	0.02	0.02	0.02	0.02	0.02	100%	98%	186
Popcorn	1	Product category average	8	0.02	0.02	0.02	0.02	0.02	100%	98%	185
Bird food	1	Product category average	8	0.02	0.02	0.02	0.02	0.02	100%	98%	184
UHT Soup	1	Academic research	4	0.02	0.02	0.02	0.02	0.02	100%	98%	187

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Honey	1	Academic research	17	0.02	0.02	0.02	0.02	0.02	100%	99%	188
Body care	1	Proxy	3	0.02	0.02	0.02	0.02	0.02	100%	99%	189
Brussels sprouts/Other	1	Academic research	71	0.02	0.02	0.02	0.02	0.02	100%	99%	190
Chocolate spreads	1	Product category average	7	0.02	0.02	0.02	0.02	0.02	100%	99%	192
Baby Snacks	1	Product category average	7	0.02	0.02	0.02	0.02	0.02	100%	99%	191
Wet cooking sauces	2	Defra	246	0.02	0.02	0.02	0.02	0.02	100%	99%	193
Smoothies	1	Product category average	50	0.02	0.02	0.02	0.02	0.02	100%	99%	194
Avocados	1	Academic research	34	0.01	0.01	0.01	0.01	0.01	100%	99%	195
Cough and cold preparations	1	Proxy	3	0.01	0.01	0.01	0.01	0.01	100%	99%	196
Other Baby Foods	1	Product category average	6	0.01	0.01	0.01	0.01	0.01	100%	99%	197
Aubergines	2	Equal data points from industry research and industry research	19	0.00	0.01	0.01	0.02	0.02	100%	100%	198
Frozen fruit	3	Equal data points from Defra, industry research and Product category average	5	0.01	0.01	0.01	0.01	0.01	100%	100%	199
Other detergents	1	Proxy	5	0.01	0.01	0.01	0.01	0.01	100%	100%	200
Baby Cereals	1	Product category average	6	0.01	0.01	0.01	0.01	0.01	100%	100%	201
Analgesics	1	Proxy	2	0.01	0.01	0.01	0.01	0.01	100%	100%	202

Product name	No. of carbon footprint data points	Predominant data source	Annual Sales Volume (Million kg)	Annual GHG emissions (Mt CO_2e)					Cumulative GHG contribution (based on median)	Cumulative sales volume contribution	Rank
				Min	Lower Quartile	Median	Upper Quartile	Max			
Rhubarb	1	Product category average	19	0.01	0.01	0.01	0.01	0.01	100%	100%	203
Sweetcorn	4	Equal data points from academic research and Product category average	23	0.01	0.01	0.01	0.01	0.01	100%	100%	204
Peas (excl. dried & for processing)	8	Academic research	14	0.00	0.01	0.01	0.01	0.02	100%	100%	205
Perms & relaxers	1	Proxy	2	0.01	0.01	0.01	0.01	0.01	100%	100%	206
Courgettes	1	Industry research	29	0.01	0.01	0.01	0.01	0.01	100%	100%	207
Lettuce, protected	2	Academic research	7	0.01	0.01	0.01	0.01	0.01	100%	100%	208
Frozen soup	2	Equal data points from academic research and Product category average	2	0.01	0.01	0.01	0.01	0.01	100%	100%	209
Cherries	4	Academic research	18	0.01	0.01	0.01	0.01	0.02	100%	100%	210
Dates and Figs	3	Academic research	15	0.00	0.01	0.01	0.02	0.04	100%	100%	211
Table napkins	1	Proxy	5	0.01	0.01	0.01	0.01	0.01	100%	100%	212
Beetroot	1	Industry research	55	0.00	0.00	0.00	0.00	0.00	100%	100%	213
Soy desserts	1	Product category average	1	0.00	0.00	0.00	0.00	0.00	100%	100%	214
Fabric Fresheners	1	Proxy	7	0.00	0.00	0.00	0.00	0.00	100%	100%	215
Watercress	1	Product category average	2	0.00	0.00	0.00	0.00	0.00	100%	100%	216
Celery	1	Defra	2	0.00	0.00	0.00	0.00	0.00	100%	100%	217

Table A4-1 Complete ranking of all 217 grocery products contributing to annual cradle-to-retail GHG emissions

Publically available literature used to support the GHG assessment

- A.G. Williams et al (2008) Comparative life-cycle assessment of food commodities procured for UK consumption through a diversity of supply chains - FO0103
- Acqua Minerale San Benedetto S.p.A. Environmental Product Declaration Acqua Minerale Naturale Oligominerale San Benedetto In 0,5 l, 1,5 l, 2,0 l PET bottles
- ADAS (2009) FO0404 Scenario building to test and inform the development of a BSI method for assessing greenhouse gas emissions from food - Main report & technical annex. Defra
- Andersson, Ohlsson and Ohlsson (1998) Screening life cycle assessment (LCA) of tomato ketchup: a case study. Journal of Cleaner Production 6, 277
- Anna Flysjö (2012) Greenhouse Gas emissions in milk and dairy product chains, improving the carbon footprint of dairy products
- Audsley, E., Brander, M., Chatterton, J., Murphy-Bokern, D., Webster, C., and Williams, A. (2009). How low can we go? An assessment of greenhouse gas emissions from the UK food system and the scope to reduce them by 2050. FCRN-WWF-UK. (available http://www.fcrn.org.uk/sites/default/files/WWF_How_Low_Report.pdf Page 37 Table 13).
- Australian Egg Corporation: http://www.fcrn.org.uk/research-library/food-and-its-life-cycle/other-studies/australian-lca-egg-production?utm_source=FCRN+Mailing&utm_campaign=766ce40afb-FCRN-Mailing-25-Jan&utm_medium=email
- Barilla (2011). EPD of durum wheat semolina dried pasta in paperboard box
- Büsser, S., Jungbluth N. (2009). LCA of Chocolate Packed in Aluminium Foil Based Packaging [online] ESU-services.
- Casey and Holden (2006) Quantification of GHG emissions from sucker-beef production in Ireland
- Casino, Carbon footprint of plain yoghurt (4x125g pots)
- Cederberg C, Meyer D and Flysjö (2009) Life cycle inventory of greenhouse gas emissions and use of land and energy in Brazilian beef production
- Cerelia S.r.l. Environmental Product Declaration Cerelia Natural Mineral Water
- Co-op (2011) http://www.co-operative.coop/Corporate/sustainability/2011/downloads/sr2011_Ecological_sustainability.pdf
- Consorzio Interprovinciale Vini. (2008). Bottled red sparkling wine "Grasparossa Righi".
- Cranfield (2006) Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities
- Derived from data in Lillywhite, R., Chandler, D., Grant, W., Lewis, K., Firth, C., Schmutz, U., Halpin, D., (2007). Environmental Footprint and Sustainability of Horticulture (including Potatoes) – A Comparison with other Agricultural Sectors. Warwick HRI, University of Warwick.
- Dole (2009), Carbon footprint of bananas
- EBLEX, Beef & sheep roadmap, Phase 3
- Eco- quantum (2011) Greenhouse Gas Life Cycle Assessment of Canning Peaches and Pears grown in Northern Victoria
- Environmental performance of wild-caught North Sea whitefish A comparison with aquaculture and animal husbandry using LCA (2012) LEI, part of Wageningen UR, The Hague

- Espinoza-Orias, N. Stichnothe, H., Azapagic, N., The carbon footprint of bread. International Journal of LCA. Volume 16, Number 4, 351-365
- Fuentes C. & Carlsson-Kanyama A (2006) Environmental information in the food supply system
- Garnet (2006) Fruit and Vegetables and UK Greenhouse Gas Emissions: Exploring the Relationship
- Goldberg (2008) The Carbon Footprints of Beef and Lamb, A Lifecycle Approach to Measuring the Sustainability of New Zealand's Primary Produce
- Hospido, A., Milà i Canals, L., McLaren, S., Truniger, M., Edward-Jones, G., Clift, R., 2009. The role of seasonality in lettuce consumption: a case study of environmental and social aspects. International Journal of Life Cycle Assessment, 14 (2009) pp. 381-391.
- Coca-cola (2012) http://www.coca-cola.co.uk/environment/what-s-the-carbon-footprint-of-a-coca-cola.html
- http://www.foi.life.ku.dk/Publikationer/FOI_serier/~/media/Foi/docs/Publikationer/Rapporter/Nummererede%20rapporter/2010/FOI_report_207.ashx
- http://www.imok.ufl.edu/biofuel/111009/spreen.pdf
- James, R., Archer, M., Henderson, J., Garrett, A. (2010). Resource Maps for Fish across Retails and Wholesale Supply Chains. Confidential.
- Katarina Nilsson & Anna Flysjö & Jennifer Davis & Sarah Sim & Nicole Unger & Simon Bell (2010) Comparative life cycle assessment of margarine and butter consumed in the UK, Germany and France. Int J Life Cycle Assess (2010) 15:916–926
- Kingsmill (2012) from http://www.kingsmillbread.com/fresh-thinking/environment/carbon-footprint/
- Lantmannen-Unibake (2011) Croissant climate declaration
- Llorenc Mila I Canals (2008) Life Cycle Assessment of Domestic vs Imported Vegetables. Case studies on broccoli, salad crops and green beans
- M. Berners-Lee, C.Hoolohan, H.Cammack, C.N.Hewitt (Dec 2011) "The relative green house gas impacts of realistic dietary choices" Lancaster Environment Centre, Lancaster University
- Mars, Carbon footprint of Dolmio Tomato Pasta Sauce, 575g jar
- Mey Selections (2012) http://www.mey-selections.com/03_climate_labelling.html
- Migros, Carbon footprint of Twist Hobby kitchn roll
- Milà i Canals, S., Sim, S., García-Suárez, T., Neuer, G., Herstein, K., Kerr, C., Rigarlsford, G., King, H. (2011). Estimating the greenhouse gas footprint of Knorr, International Journal of Life Cycle Assessment, 16, pp.50-58.
- Nilsson K., Sund V., Florén B., (2011 . The environmental impact of the consumption of sweets, crisps and soft drinks
- Otarian (2012) http://www.otarian.com/love-food/menu-uk.html
- Pepsico http://www.walkerscarbonfootprint.co.uk/pdf/qa.pdf
- Quantis (2012) Présentation du référentield'évaluation de l'impact environnemental des produits laitiers en France
- Randi Dalgaard, Niels Halberg & John E. Hermansen (2007) Danish pork production - An environmental assessment
- RD&T (2012) Carbon emissions from chilled and frozen cold chains for a typical UK Sunday roast chicken meal (Energy CO_2e emissions only - rough estimate)

- Referenced in Mordini, M., Nemecek, T., and Gaillard, G. (2009). Carbon and Water Footprint of Oranges and Strawberries. A Literature Review. Zurich: Agroscope Reckenholz-Tänikon Research Station ART.
- Sebastien Humbert, Yves Loerincik, Vincent Rossi, Manuele Margni, Olivier Jolliet (2009) Life cycle assessment of spray dried soluble coffee and comparison with alternatives (drip filter and capsule espresso) Journal of Cleaner Production 17 (2009) 1351–1358
- Sheane et al (2011) Identifying opportunities to reduce the carbon footprint associated with the Scottish dairy supply chain - Main report. Edinburgh: Scottish Government
- Swedish Study, 2009 (Cradle to Gate) http://www.sik.se/matoklimat
- Tesco (2012) http://www.tescoplc.com/assets/files/cms/Tesco_Product_Carbon_Footprints_Summary(1).pdf
- Thomas Nemecek, Karin Weiler, Katherina Plassmann and Julian Schnetzer (2011) Geographical extrapolation of environmental impact of crops by the MEXALCA method
- Tynelius G. (2008). Klimatpåverkan från Axa havregryn i ett LCA-perspektiv. Lantmännen.
- Tynelius G. (2009). Climate impact from Lantmännen Unibake´s Danish pastry Maple pecan. Lantmännen
- Wallén, A., Brandt, N., Wennersten, R. (2004). Does the Swedish consumer's choice of food influence greenhouse gas emissions? Environmental Science and Policy, 7 pp.525-535.
- WRAP (2012) Grocery & home improvement environmental hotspots
- WRAP (2010), Tool for Identification of Environmental Hotspots for Drinks consumed in the UK (.xlsx file). Scenarios extracted.
- Yoshikawa, N., Amano, K., and Shimada, K., 2006. The quantitative Evaluation of Environmental Load on Fruits and Vegetables Consumption and its Reduction Potential. Environmental Systems Research, 34 pp. 245-251.

Appendix 5 – Consumer Energy Use

The availability of life cycle studies that included the impacts of consumer use of products was generally poor across the grocery category – with the exception of those non-food items which are well known for having indirect energy use associated with them e.g. shower products, washing powder.

To fill this gap – and to provide some comparison with cradle-to-retail GHG emissions of products – data was extracted from Department for Energy and Climate Change statistics. These are presented below: first total energy use and then focusing on electricity.

Total energy

Total energy use in the home is reported by DECC across four broad areas – see Table A5-1 below and Figure A5-1. To convert from 'Thousand tonnes of oil equivalent' (toe) to MWh a conversion factor of 11.63 MWh was used (IEA/OECD). To convert to greenhouse gas emissions, full life cycle conversion factors were used from Defra/DECC (2010).

Energy type	Space heating	Water (heating)	Cooking (Ovens & hobs)	Lighting & Appliances	Total
Solid fuel	596	155	3	0	753
Gas	21,887	8,357	668	3	30,916
Electricity	1,455	1,501	625	7,236	10,818
Oil	2,305	725	3	0	3,033
Total	26,244	10,738	1,300	7,239	45,521

Table A5-1 Domestic energy use, Thousand tonnes of oil equivalent (2008), DECC (2010)

Energy type	$kgCO_2e/kWh$	Description
Solid fuel	0.39275	domestic coal, life cycle (Gross Calorific Value)
Gas	0.20322	natural gas, life cycle (Gross Calorific Value)
Electricity	0.61707	consumed, life cycle
Oil	0.30786	burning oil (kerosene), life cycle

Table A5-2 Energy greenhouse gas conversion factors (Defra/DECC, 2010)

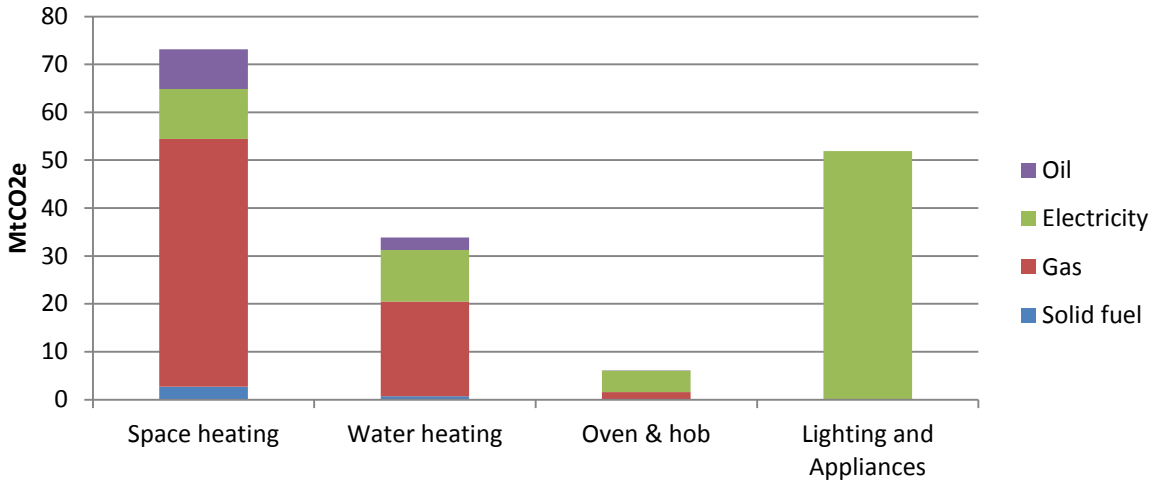


Figure A5-1 Greenhouse gas emissions by energy type and area of usage

Electricity

DECC also publishes electricity consumption data (also in thousand tonnes of oil equivalent) by end use in the home. This information was converted into greenhouse gas emissions using energy and carbon conversion factors described in the section above.

Type	Description	1000 tonnes oil equivalents	MWh	$MtCO_2e$
Light	Standard Light Bulb	637	7,408,438	4.6
Light	Halogen	404	4,702,416	2.9
Light	Fluorescent Strip Lighting	119	1,380,594	0.9
Light	Energy Saving Light Bulb	188	2,183,046	1.3
Light	LED	8	93,602	0.1
Cold	Chest Freezer	124	1,445,824	0.9
Cold	Fridge-freezer	720	8,370,430	5.2
Cold	Refrigerator	176	2,049,700	1.3
Cold	Upright Freezer	225	2,621,922	1.6
Wet	Washing Machine	376	4,368,487	2.7
Wet	Washer-dryer	202	2,347,601	1.4
Wet	Dishwasher	277	3,223,772	2.0
Wet	Tumble Dryer	370	4,308,594	2.7
Consumer electronics	TV	718	8,351,322	5.2
Consumer electronics	Set Top Box	317	3,691,074	2.3
Consumer electronics	DVD/VCR	266	3,098,487	1.9
Consumer electronics	Games Consoles	54	633,426	0.4
Consumer electronics	Power Supply Units	431	5,010,635	3.1
Computing	Desktops	332	3,860,330	2.4
Computing	Laptops	61	707,853	0.4
Computing	Monitors	130	1,509,431	0.9
Computing	Printers	15	176,222	0.1
Computing	Multi-Function Devices 3	18	206,864	0.1
Cooking	Electric Oven	281	3,272,456	2.0
Cooking	Electric Hob	275	3,202,822	2.0
Cooking	Microwave	211	2,455,744	1.5
Cooking	Kettle	372	4,329,221	2.7

Table A5-3 Electricity use and greenhouse gas emissions by domestic appliance

Appendix 6 – Embedded Energy Data

Ranking	Product Name	No. data points	Predominant Data Source*	Product Embedded Energy (Median) MJ/kg	Primary Production MJ/kg	Processing MJ/kg	Transport MJ/kg	Packaging MJ/kg	Storage/ Retail MJ/kg	Annual Sales Volume Million kg	Annual UK Market Energy Use (Median) TJ	Annual UK Market Energy Use (Min-Max) TJ	Cumulative Annual UK Market Energy Use %
1	Bread & rolls	18	PRJ	12.10	1.95	6.00	0.69	1.12	4.20	2,769	33,500	10356 - 123968	6%
2	Liquid Milk	60	PRJ/AR	5.10	2.64	0.89	0.29	1.00	0.07	5,186	26,400	17622 - 41488	11%
3	Chocolate	3	PRJ	43.00						589	25,300	21793 - 25916	15%
4	Tomatoes	24	D	42.39	107.05		2.00		0.91	477	20,200	1536 - 45315	19%
5	Cheese	11	PRJ	51.80	33.50	9.10	7.30	1.80	2.65	387	20,000	13816 - 25929	23%
6	Spirits	1	PRJ	82.50						215	17,700	17738 - 17738	26%
7	Poultry, fresh	8	D	40.35	15.15	2.79	2.27	6.00	8.60	435	17,600	16095 - 28928	29%
8	Carbonates	6	PRJ	5.63	1.42	0.08	0.27	1.77	0.12	2,960	16,600	2397 - 22196	32%
9	Frozen Fish/seafood	9	AR	94.90	72.00	9.00	1.00	2.02	27.30	170	16,100	2720 - 25500	35%
10	Juice	9	PRJ	10.20	14.80	4.71	1.12			1,481	15,100	10515 - 30553	38%
11	Beef, fresh	16	PRJ	50.71	22.30	5.08	5.95		2.20	291	14,800	4947 - 21592	41%
12	Chilled Fish/seafood	27	PRJ	54.50	41.00	0.35	3.69			229	12,500	4901 - 13612	43%
13	Dog Food	2	OCR	15.45	10.80	1.75		2.90		802	12,400	6440 - 18342	45%
14	Light Wines	5	PRJ	14.00	7.53	6.16	4.13	7.23	0.14	882	12,300	8119 - 32634	47%
15	Powder Detergent	7	PRJ	30.42	24.63	3.30	0.90	2.23		386	11,700	10389 - 15081	49%
16	Nappies	1	IR	82.50						140	11,600	11550 - 11550	52%
17	Biscuits (Sweet)	5	PRJ	23.00	17.49	1.60				480	11,000	7440 - 13056	54%
18	Toilet papers	12	AR	20.75						493	10,200	7888 - 12572	55%
19	Canned vegetables	6	PRJ	17.35	4.50	4.40				560	9,700	7840 - 22344	57%
20	Household Paper	12	AR	165.44						58	9,600	3884 - 22059	59%
21	Sugar confectionery	3	AR	34.00	22.10	19.00	1.70	3.40		252	8,600	6628 - 14717	60%
22	Eggs	11	IR/D	27.20	14.10		2.67	3.13	1.04	314	8,500	8007 - 9813	62%
23	Cakes & pastries	7	PRJ	16.00						516	8,300	5986 - 9804	64%
24	Cat Food	2	OCR	15.45	10.80	1.75				534	8,300	4288 - 12213	65%
25	Cucumbers	1	PRJ	42.00						190	8,000	7980 - 7980	66%
26	Mushrooms	6	IR	47.63	30.33		3.62	8.72	5.40	156	7,400	5670 - 7662	68%

Ranking	Product Name	No. data points	Predominant Data Source*	Product Embedded Energy (Median) MJ/kg	Primary Production MJ/kg	Processing MJ/kg	Transport MJ/kg	Packaging MJ/kg	Storage/ Retail MJ/kg	Annual Sales Volume Million kg	Annual UK Market Energy Use (Median) TJ	Annual UK Market Energy Use (Min-Max) TJ	Cumulative Annual UK Market Energy Use %
27	Potato chips	2	D/IR	37.00		5.00				178	6,600	6586 - 6586	69%
28	Yogurt	5	D/PRJ	13.65	3.30	3.60	4.10	8.30	0.05	479	6,500	5269 - 17723	70%
29	Lamb, fresh	11	PRJ	67.00	22.65		2.03			92	6,200	6164 - 6164	71%
30	Morning goods	4	PRJ	18.50						332	6,100	4980 - 6972	72%
31	Pork, fresh	23	AR	35.10	22.60	2.20	2.85	4.46	2.70	172	6,000	5528 - 14190	74%
32	Wet Cooking Sauces	1	D	24.00	10.00	1.60	0.30	12.10		246	5,900	5904 - 5904	75%
33	Margarine	6	PRJ	23.20						241	5,600	4097 - 8917	76%
34	Frozen Vegetables	9	AR	19.50	3.15	5.40	2.40	0.60	4.70	284	5,500	2147 - 7867	77%
35	Butter	11	PRJ	32.00	38.15	5.40	7.50	0.60	3.40	172	5,500	2167 - 11524	78%
36	Lager	2	PRJ	3.50		1.93		0.33		1,563	5,500	5424 - 5502	79%
37	Canned Fish/seafood	4	AR/PRJ	19.50	10.50	3.00	3.00			277	5,400	2770 - 12188	80%
38	Beans (excl. dried)	4	IR	90.30						59	5,300	1186 - 9375	81%
39	Breakfast Cereals	7	PRJ	15.50	20.56		1.87	6.36	0.93	343	5,300	3704 - 12691	82%
40	Tea	3	AR	65.45	54.55		1.82	9.09		81	5,300	2997 - 7160	83%
41	Bananas	3	PRJ	5.40						974	5,300	2610 - 11688	83%
42	Coffee	9	PRJ	74.50	39.90	13.95	8.20	12.90		66	4,900	2442 - 8342	84%
43	Ice cream (litres)	5	PRJ	15.00	3.75	0.65			0.13	312	4,700	1412 - 11544	85%
44	Frozen Potato Products	1	PRJ	9.80						445	4,400	4361 - 4361	86%
45	Potato	19	AR/D	2.17	1.20	0.35	0.67	0.35	0.23	1,925	4,200	2876 - 5852	87%
46	Ale	5	PRJ	18.75		3.52				221	4,100	2652 - 5636	88%
47	Bottled Water	4	IR	2.92	2.39	0.56	0.05		0.21	1,292	3,800	2584 - 5698	88%
48	Other Field Veg (excl. dried)	13	IR	10.70	4.00	1.00	3.00	0.85	1.70	306	3,300	588 - 6120	89%
49	Canned Soup	2	D/IR	18.46	9.97	1.56	1.57	4.32	1.40	174	3,200	1552 - 4872	89%
50	Apples	30	PRJ	4.74	1.10		2.03	0.65	0.79	665	3,200	1643 - 7382	90%
51	Chilled Ready-meals	3	PRJ	7.30	4.49	1.74	0.20	1.15	0.03	428	3,100	3099 - 3407	91%
52	Liquid Detergents	8	PRJ/AR	31.05	22.49	1.84	0.06	5.66		100	3,100	1400 - 8250	91%
53	Processed Snacks	3	D	14.59	6.25	4.54	1.70	0.10		181	2,600	1573 - 4435	92%
54	Frozen Pizza	1	D	22.54	15.10	2.14	1.30	4.00		110	2,500	2479 - 2479	92%
55	Milk (concentrate & powder)	2	PRJ/IR	62.50						39	2,400	2262 - 2613	92%

Ranking	Product Name	No. data points	Predominant Data Source*	Product Embedded Energy (Median) MJ/kg	Primary Production MJ/kg	Processing MJ/kg	Transport MJ/kg	Packaging MJ/kg	Storage/ Retail MJ/kg	Annual Sales Volume Million kg	Annual UK Market Energy Use (Median) TJ	Annual UK Market Energy Use (Min-Max) TJ	Cumulative Annual UK Market Energy Use %
56	Other Fruit	1	PRJ	23.00						103	2,400	2369 - 2369	93%
57	General Purpose Cleaners	4	PRJ	16.15	4.23	1.07		10.84		146	2,400	2248 - 2482	93%
58	Toilet care	2	PRJ	66.85	17.45	1.22		48.17		33	2,200	2162 - 2251	94%
59	Dried Pasta/noodles	10	IR	14.50	5.50	5.50	1.89	2.20	0.40	152	2,200	1318 - 3177	94%
60	Grapes	2	PRJ	8.75						244	2,100	1903 - 2367	94%
61	Rice	5	PRJ	14.93	8.80	0.47	4.60	4.50	0.40	141	2,100	1382 - 2508	95%
62	Onions	6	AR	2.90	0.98	0.05	0.55	0.75	3.02	721	2,100	697 - 2711	95%
63	Carrot	6	AR	2.80	0.87		0.92	2.02	1.10	715	2,000	1294 - 2914	96%
64	Bath & shower products	2	PRJ	13.65	2.07	0.93		10.65		145	2,000	1914 - 2044	96%
65	Strawberries	5	PRJ	12.70	10.65		2.95			148	1,900	918 - 4292	96%
66	Table Sauces	2	PRJ	15.96	1.26	7.02	0.90	6.78		111	1,800	1675 - 1868	97%
67	Lettuce, field	17	IR	6.00	3.60	0.50	3.00		0.71	267	1,600	721 - 2670	97%
68	Sparkling Wines	1	IR	36.38	6.31	17.79	12.28			43	1,600	1564 - 1564	97%
69	Canned Fruit	3	AR	13.00	7.33		0.49	2.93	0.73	118	1,500	1355 - 3009	97%
70	Crackers (savoury biscuits)	3	PRJ	15.50						93	1,400	1302 - 2530	98%

Table A6-1 Product embedded energy and market total energy use values.

*** Table legend:**
PRJ: Peer Reviewed Journal
AR: Academic Research
IR: Industry Research
D: Defra Research
OCR: Other Corporate Research

References used to support embedded energy assessment

- Andersson, K., Ohlsson, T. (1999) Life cycle assessment of bread produced on different scales. The International Journal of Life Cycle Assessment 4, 25-40.
- Andersson, K., Ohlsson, T., Olsson, P. (1998) Screening life cycle assessment (LCA) of tomato ketchup: a case study. Journal of Cleaner Production 6, 277-288.
- Ayer, N.W., Tyedmers, P.H. (2009) Assessing alternative aquaculture technologies: life cycle assessment of salmonid culture systems in Canada. Journal of Cleaner Production 17, 362-373.
- Basset-Mens, C., Ledgard, S., Boyes, M. (2009) Eco-efficiency of intensification scenarios for milk production in New Zealand. Ecological Economics 68, 1615-1625.
- Basset-Mens, C., Ledgard, S., Carran, A., (2005) First life cycle assessment of milk production from New Zealand dairy farm systems, in: Australian New Zealand Society for Ecological Economics (Ed.), The Australian and New Zealand Ecological Economics in Action, Palmerston North, New Zealand, pp. 258-265.
- Basset-Mens, C., van der Werf, H.M.G. (2005) Scenario-based environmental assessment of farming systems: the case of pig production in France. Agriculture, Ecosystems, Environment 105, 127-144.
- Basset-Mens, C., Van der Werf, H.M.G., (2003) Environmental assessment of contrasting pig farming systems, in: Halberg, N. (Ed.), 4th International Conference on Life Cycle Assessment in the Agri-food sector, Bygholm, Denmark.
- Beccali, M., Cellura, M., Iudicello, M., Mistretta, M. (2010) Life cycle assessment of Italian citrus-based products. Sensitivity analysis and improvement scenarios. Journal of Environmental Management 91, 1415-1428.
- Berlin, J. (2002) Environmental life cycle assessment (LCA) of Swedish semi-hard cheese. International Dairy Journal 12, 939-953.
- Berlin, J., Sonesson, U., Tillman, A.-M. (2008) Product Chain Actors' Potential for Greening the Product Life Cycle. Journal of Industrial Ecology 12, 95-110.
- Blanke, M.M., Burdick, B. (2005) Food (miles) for thought - energy balance for locally-grown versus imported apple fruit. Environ Sci Pollut Res Int 12, 125-127.
- Blengini, G.A., Busto, M. (2009) The life cycle of rice: LCA of alternative agri-food chain management systems in Vercelli (Italy). Journal of Environmental Management 90, 1512-1522.
- Braschkat, J., Patyk, A., Quirin, M., Reinhardt, G.A., (2003) Life cycle assessment of bread production - a comparison of eight different scenarios in: Halberg, N. (Ed.), 4th International Conference on Life Cycle Assessment in the Agri-food sector, Bygholm, Denmark, pp. 9-16.
- Büsser, S., Jungbluth, N., (2011) LCA of Ready-to-Serve Goulash Soup Packed in Stand-Up Pouches. ESU Services, Uster, Switzerland.
- Büsser, S., Steiner, R., Jungbluth, N., (2008) LCA of Packed Food Products – the function of flexible packaging. Case Study: Coffee. ESU Services, Uster, Switzerland.
- Carlsson-Kanyama, A. (1998a) Climate change and dietary choices — how can emissions of greenhouse gases from food consumption be reduced? Food Policy 23, 277-293.
- Carlsson-Kanyama, A., (1998b) Energy consumption and emissions of greenhouse gases in the life-cycle of potatoes, pork meat, rice and yellow peas. Methods, data and results from a study of some food consumed in Sweden. With arable land use and re-calculated

consumption and emissions of greenhouse gases for carrots and tomatoes - Technical Report. Institutionen foer Systemekologi, Stockholms Universitet, Stockholm, p. 67.
- Carlsson-Kanyama, A., Bostrom-Carlsson, K., (2001) Energy Use for Cooking and Other Stages in the Life Cycle of Food: A study of wheat, spaghetti, pasta, barley, rice, potatoes, couscous and mashed potatoes. Environmental Strategies Research Group and Swedish Consumer Agency Stockholm.
- Carlsson-Kanyama, A., Faist, M., (2000a) Energy Use in the Food Sector: A data survey. Stockholm University and Swiss Federal Institute of Technology (ETH Zürich), Stockholm, Sweden and Zurich, Switzerland.
- Carlsson-Kanyama, A., Faist, M., (2000b) Energy Use in the Food Sector: A data survey. Appendices. Stockholm University and Swiss Federal Institute of Technology (ETH Zürich), Stockholm, Sweden and Zurich, Switzerland.
- Cederberg, C., (2003) Life cycle assessment of animal products, in: Mattsson, B., Sonesson, U. (Eds.), Environmentally-friendry food processing. Woodhead Publishing, Cambridge.
- Cederberg, C., Flysjö, A., (2004a) Environmental assessment of future pig farming systems. The Swidish institute for Food and Biotechnology, Stockholm, p. 69.
- Cederberg, C., Flysjö, A., (2004b) Life Cycle inventory of 23 dairy farms in South-Western Sweden, SIK Report No. 728. The Swedish Institute for food and biotechnology, Göteborg, Sweden pp. 1-59.
- Cederberg, C., Mattsson, B. (2000) Life cycle assessment of milk production — a comparison of conventional and organic farming. Journal of Cleaner Production 8, 49-60.
- Cederberg, C., Meyer, D., Flysjö, A., (2009) Life cycle inventory of greenhouse gas emissions and use of land and energy in Brazilian beef production. The Swidish institute for Food and Biotechnology, Stockholm, p. 77.
- Cederberg, C., Stadig, M. (2003) System expansion and allocation in life cycle assessment of milk and beef production. The International Journal of Life Cycle Assessment 8, 350-356.
- Coltro, L., Mourad, A., Kletecke, R., Mendonça, T., Germer, S. (2009) Assessing the environmental profile of orange production in Brazil. The International Journal of Life Cycle Assessment 14, 656-664.
- Coltro, L., Mourad, A., Oliveira, P., Baddini, J., Kletecke, R. (2006) Environmental Profile of Brazilian Green Coffee (6 pp). Int J LCA 11, 16-21.
- Cordella, M., Tugnoli, A., Spadoni, G., Santarelli, F., Zangrando, T. (2008) LCA of an Italian lager beer. The International Journal of Life Cycle Assessment 13, 133-139.
- Davis, J., Sonesson, U. (2008) Life cycle assessment of integrated food chains—a Swedish case study of two chicken meals. The International Journal of Life Cycle Assessment 13, 574-584.
- de Boer, I.J.M. (2003) Environmental impact assessment of conventional and organic milk production. Livestock Production Science 80, 69-77.
- De Saxce, M., Pesnel, S., Perwuelz, A. (2012) LCA of bed sheets – some relevant parameters for lifetime assessment. Journal of Cleaner Production 37, 221-228.
- Dekker, S.E.M., Boer, I.J.M.d., Aarnink, A.J.A., Groot Koerkamp, P.W.G., (2008) Environmental hotspot identification of organic egg production, Proceedings of the 6th International Conference Life Cycle Assessment in the Agri-food sector, 12 - 14 November, 2008, Zurich, Switzerland.

- Deng, L., Babbitt, C.W., Williams, E.D. (2011) Economic-balance hybrid LCA extended with uncertainty analysis: case study of a laptop computer. Journal of Cleaner Production 19, 1198-1206.
- Dewaele, J., Pant, R., Schowanek, D., (2006) Comparative Life Cycle Assessment (LCA) of Ariel "Actif à froid" (2006), a laundry detergent that allows to wash at colder wash temperatures, with previous Ariel laundry detergents (1998, 2001). Procter & Gamble, Brussels, p. 109.
- Dutilh, C.E., Kramer, K.J. (2000) Energy Consumption in the Food Chain: Comparing alternative options in food production and consumption. Ambio 29, 98-101.
- Eide, M. (2002) Life cycle assessment (LCA) of industrial milk production. The International Journal of Life Cycle Assessment 7, 115-126.
- Ellingsen, H., Aanondsen, A. (2006) Environmental impacts of wild caught cod and farmed salmon - A comparison with chicken. International Journal of Life Cycle Assessment 11, 60-65.
- Erzinger, S., Dux, D., Zimmermann, A., Badertscher, R., (2003) LCA of Animal Products from Different Housing Systems: Relevance of Feedstuffs, Infrastructure and Energy Use, 4th International Conference on Life Cycle Assessment in the Agri-food sector, Horsens.
- Feschet, P., Loeillet, D., (2009) ACV simplifiée des productions agricoles d'exportation des DOM - Le cas du melon - Résumé. Etude ODEADOM-Cirad. CIRAD, Montpellier.
- Foster, C., Audsley, E., Williams, A., Webster, S., Dewick, P., Green, K., (2007) The Environmental, Social and Economic Impacts Associated with Liquid Milk Consumption in the UK and its Production A Review of Literature and Evidence - Defra Project Code EVO 2067. Defra, The University of Manchester, EuGeos, Delta-innovation and Cranfield University, London.
- Foster, C., Green, K., Bleda, M., Dewick, P., Evans, B., Flynn, A., Mylan, J., (2006) Environmental impacts of food production and consumption: a report to the Department for Environment, Food and Rural Affairs. Manchester Business School and Defra, London.
- Four Elements, (2011) Life Cycle Envronmental Impact Study. HP LaserJet Toner Cartridges vs. Remanufactured Cartridges in Europe. Summary Report prepared for Hewlett Packard Company. Four Elements Consulting, LLC.
- Fuentes, C., Carlsson-Kanyama, A., Biel, A., Bergstrom, K., Lagerberg-Fogelberg, C., Shanahan, H., Soler, C., Grankvist, G., (2006) Environmental information in the food supply system. FOI - Swedish Defence Research Agency, Stockholm.
- Gaines, L.L., Stodolsky, F., (1996) Is recycling the best policy option? Insights from Life Cycle Analysis. Energy Systems Division, Argonne National Laboratory, Illinois, p. 15.
- Grönroos, J., Seppälä, J., Voutilainen, P., Seuri, P., Koikkalainen, K. (2006) Energy use in conventional and organic milk and rye bread production in Finland. Agriculture, Ecosystems & Environment 117, 109-118.
- Haas, G., Wetterich, F., Köpke, U. (2001) Comparing intensive, extensified and organic grassland farming in southern Germany by process life cycle assessment. Agriculture, Ecosystems & Environment 83, 43-53.
- Hospido, A., Milà i Canals, L., McLaren, S., Truninger, M., Edwards-Jones, G., Clift, R. (2009) The role of seasonality in lettuce consumption: a case study of environmental and social aspects. The International Journal of Life Cycle Assessment 14, 381-391.
- Hospido, A., Moreira, M.T., Feijoo, G. (2003) Simplified life cycle assessment of galician milk production. International Dairy Journal 13, 783-796.

- Humbert, S., Loerincik, Y., Rossi, V., Margni, M., Jolliet, O. (2009) Life cycle assessment of spray dried soluble coffee and comparison with alternatives (drip filter and capsule espresso). Journal of Cleaner Production 17, 1351-1358.
- INCPEN, (2009) Table for One: the energy cost to feed one person. Industry Council for Packaging and the Environment (INCPEN), Reading.
- Ingwersen, W.W. (2012) Life cycle assessment of fresh pineapple from Costa Rica. Journal of Cleaner Production 35, 152-163.
- Katajajuuri, J.-M., Grönroos, J., Usva, K., (2009) Environmental impacts and related improvement options of supply chain of chicken meat, in: Nemecek, T., Gaillard, G. (Eds.), 6th International Conference on Life Cycle Assessment in the Agri-Food Sector – Towards a sustainable management of the Food chain. Agroscope Reckenholz-Tänikon Research Station ART, Zurich, Switzerland.
- Kim, S., Dale, B., Jenkins, R. (2009) Life cycle assessment of corn grain and corn stover in the United States. The International Journal of Life Cycle Assessment 14, 160-174.
- Koehler, A., Wildbolz, C. (2009) Comparing the Environmental Footprints of Home-Care and Personal-Hygiene Products: The Relevance of Different Life-Cycle Phases. Environmental Science & Technology 43, 8643-8651.
- Kooijman, J. (1993) Environmental assessment of packaging: Sense and sensibility. Environmental Management 17, 575-586.
- Labouze, E., Schultzem, A., Benito, P., (2008) Eco-Emballages. Analyses de Cycle de Vie de produits vendus préemballés, à la coupe et en vrac. Etude de cas : champignons. Rapport Final. Bio Intelligence Service, Ivry-sur-Seine, p. 132.
- Lafontaine, M., Gilbert, D., Saad, R., Margni, M., Reveret, J.-P., (2012) Environmental Life Cycle Assessment of Milk in Canada, in: Corson, M.S., Van der Werf, H.M.G. (Eds.), Proceedings of the 8th International Conference on Life Cycle Assessment in the Agri-Food Sector. INRA, St. Malo, France, pp. 327-332.
- Leonardi, R., Giacomazzi, M., (2008) Environmental Product Declaration: Bottled Red Sparkling Wine "Grasparossa Righi". Consorzio Interprovinciale Vini, Modena.
- Lillywhite, R.D., Sarrouy, C., Davidson, J., (2012) Energy dependency and Food Chain Security. Final report of Defra Project FO0415. University of Warwick/Defra, London.
- Liu, Y., Langer, V., Høgh-Jensen, H., Egelyng, H. (2010) Life Cycle Assessment of fossil energy use and greenhouse gas emissions in Chinese pear production. Journal of Cleaner Production 18, 1423-1430.
- Madsen, J., (2007) Life Cycle Assessment of Tissue Products. Environmental Resources Management (ERM), Frankfurt, Germany, p. 135.
- Manda, B.M.K., Blok, K., Patel, M.K. (2012) Innovations in papermaking: An LCA of printing and writing paper from conventional and high yield pulp. Science of The Total Environment 439, 307-320.
- Mattsson, B., Wallen, E. (2003) Environmental Life Cycle Assessment (LCA) of organic potatoes. Acta Horticulturae 619, 427-435.
- Milà i Canals, L., Burnip, G.M., Cowell, S.J. (2006a) Evaluation of the environmental impacts of apple production using Life Cycle Assessment (LCA): Case study in New Zealand. Agriculture, Ecosystems & Environment 114, 226-238.
- Milà i Canals, L., Cowell, S., Sim, S., Basson, L. (2007) Comparing domestic versus imported apples: A focus on energy use. Environmental Science and Pollution Research - International 14, 338-344.

- Milà i Canals, L., Cowell, S.J., Hospido, A., Jones, D., Koerber, G., Cross, P., Hounsome, B., Edwards-Jones, G., (2006b) LCA of Horticultural Crops including Indicator of Pesticides Rating. Centre for Environmental Strategy, university of Surrey, Surrey.
- Milà i Canals, L., Munoz, I., Hospido, A., Plassmann, K., McLaren, S., (2008) Life Cycle Assessment (LCA) of domestic vs. imported vegetables. Case study on broccoli, salad crops and green beans. Centre for Environmental Strategy, Guildford.
- Nemecek, T., Weiler, K., Plassmann, K., Schnetzer, J., (2011) Geographical extrapolation of environmental impact of crops - Unilever-ART project no. CH-2009-0362 0 Final report phase 2. Agroscope Art, Zurich.
- Nilsson, K., Flysjö, A., Davis, J., Sim, S., Unger, N., Bell, S. (2010) Comparative life cycle assessment of margarine and butter consumed in the UK, Germany and France. The International Journal of Life Cycle Assessment 15, 916-926.
- Nilsson, K., Sund, V., Floren, B., (2011) The environmental impact of the consumption fo sweets, crisps and soft drinks. Nordic Council of Ministers, Copenhagen.
- Papatryphon, E., Petit, J., Van der Werf, H.M.G., Kaushik, S.J., (2003) Life Cycle Assessment of trout farming in France: a farm level approach, in: Halberg, N. (Ed.), 4th International Conference on Life Cycle Assessment in the Agri-food sector, Bygholm, Denmark, pp. 71-77.
- Pelletier, N., Tyedmers, P., Sonesson, U., Scholz, A., Ziegler, F., Flysjo, A., Kruse, S., Cancino, B., Silverman, H. (2009) Not All Salmon Are Created Equal: Life Cycle Assessment (LCA) of Global Salmon Farming Systems. Environmental Science & Technology 43, 8730-8736.
- Peters, G.M., Rowley, H.V., Wiedemann, S., Tucker, R., Short, M.D., Schulz, M. (2010) Red Meat Production in Australia: Life Cycle Assessment and Comparison with Overseas Studies. Environmental Science & Technology 44, 1327-1332.
- Point, E., Tyedmers, P., Naugler, C. (2012) Life cycle environmental impacts of wine production and consumption in Nova Scotia, Canada. Journal of Cleaner Production 27, 11-20.
- Refsgaard, K., Halberg, N., Kristensen, E.S. (1998) Energy utilization in crop and dairy production in organic and conventional livestock production systems. Agricultural Systems 57, 599-630.
- Renouf, M., (2006) LCA of Queensland cane sugar – Lessons for the application of LCA to cropping systems in Australia, 5th Australian Conference on Life Cycle Assessment. Achieving business benefits from managing life cycle impacts, Melbourne, Australia.
- Rose, B.J., (2010) GHG-Energy Calc Background Paper.
- Ruini, L., (2012) Environmental Product Declaration of durum wheat semolina dried Pasta in paperboard box (brand Barilla). Barilla Group, Parma.
- San Benedetto Spa, Breedveld, L., (2010) Environmental Product Declaration Acqua Minerale Naturale Oligominerale San Benedetto on 0.5l, 1.5l, 2.0l PET bottles. San Benedetto Spa, Scorzé, Italy.
- Saunders, C., Barber, A., Taylor, G. (2006) Food miles - comparative energy / emissions performance of New Zealand's agriculture industry. Lincoln University. Agribusiness and Economics Research Unit., Canterbury, N.Z.
- Scholz, A., Sonesson, U., Tyedmers, P. (2009) Global Salmon LCA: Closed-containment aquaculture. Ecotrust, The Swedish Institute for Food and Biotechnology and Dalhousie University, Stockholm.

- Sonesson, U., Mattsson, B., Nybrant, T., Ohlsson, T. (2005) Industrial processing versus home cooking: an environmental comparison between three ways to prepare a meal. Ambio 34, 414-421.
- Thomassen, M.A., van Calker, K.J., Smits, M.C.J., Iepema, G.L., de Boer, I.J.M. (2008) Life cycle assessment of conventional and organic milk production in the Netherlands. Agricultural Systems 96, 95-107.
- Thrane, M., (2004) Environmental impacts from Danish fish products: Hot spots and environmental policies, Department of Development and Planning. Aalborg University, Aalborg, Denmark, p. 535.
- Tzilivakis, J., Jaggard, K., Lewis, K.A., May, M., Warner, D.J. (2005a) Environmental impact and economic assessment for UK sugar beet production systems. Agriculture, Ecosystems & Environment 107, 341-358.
- Tzilivakis, J., Warner, D.J., May, M., Lewis, K.A., Jaggard, K. (2005b) An assessment of the energy inputs and greenhouse gas emissions in sugar beet (Beta vulgaris) production in the UK. Agricultural Systems 85, 101-119.
- Van Hoof, G., Schowanek, D., Feijtel, T.C.J. (2003) Comparative Life-Cycle Assessment of Laundry Detergent Formulations in the UK. Tenside Surf. Det . 40, 266-276.
- Wallén, A., Brandt, N., Wennersten, R. (2004) Does the Swedish consumer's choice of food influence greenhouse gas emissions? Environmental Science & Policy 7, 525-535.
- Wiedemann, S.G., McGahan, E.J., (2011) Environmental Assessment of an Egg Production Supply Chain using Life Cycle Assessment. Final Project Report AECL Publication No 1FS091A. Australian Egg Corporation Limited, Sydney.
- Williams, A., Audsley, E., Sandars, D.L., (2012) A systems-LCA model of the stratified UK sheep industry, in: Corson, M.S., Van der Werf, H.M.G. (Eds.), Proceedings of the 8th International Conference on LCA in the Agri-Food Sector, St. Malo, France, pp. 304-309.
- Williams, A.G., Audsley, E., Sandars, D.L., (2006) Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities, Main Report. Defra Research Project IS0205. Cranfield University and Defra, Bedford.
- Williams, A.G., Pell, E., Webb, J., Moorhouse, E., Audsley, E., (2009) Strawberry and tomato production for the UK compared between the UK and Spain, in: Nemecek, T., Gaillard, G. (Eds.), 6th International Conference on LCA in the Agri-Food Sector – Towards a sustainable management of the Food chain. Agroscope Reckenholz-Tänikon Research Station ART, Zurich, Switzerland, pp. 254-262.
- Williams, E. (2004) Energy Intensity of Computer Manufacturing: Hybrid Assessment Combining Process and Economic Input–Output Methods. Environmental Science & Technology 38, 6166-6174.
- Ziegler, F., Eichelsheim, J.L., Emanuelsson, A., Flysjö, A., Ndiaye, V., Thrane, M., (2009) Life cycle assessment of southern pink shrimp products from Senegal: An environmental comparison between artisanal fisheries in the Casamance region and a trawl fishery based in Dakar. Food and Agriculture Organization of the United Nations, FAO, Rome, p. 21.
- Ziegler, F., Hansson, P.-A. (2003) Emissions from fuel combustion in Swedish cod fishery. Journal of Cleaner Production 11, 303-314.
- Ziegler, F., Nilsson, P., Mattsson, B., Walther, Y. (2003) Life Cycle assessment of frozen cod fillets including fishery-specific environmental impacts. The International Journal of Life Cycle Assessment 8, 39-47.

Appendix 7 – The Role of Renewable Energy

This Appendix addresses the role and potential contribution of renewable energy, where renewable energy is defined as originating from wind, solar, bioenergy (biogas from anaerobic digestion of organic wastes, biomass, biodiesel, bioethanol) and tidal sources.

It was drafted by Warwick University and draws principally from the Defra project FO0415 'Energy dependency and food chain security' (Lillywhite et al., 2012).

Two areas are examined: renewable energy available at a national level (electricity, natural gas and biofuels); and energy generated on-site. National level renewable energy includes electricity generated by wind turbines that is fed into the national supply, methane rich biogas fed into the national gas supply and biodiesel and bioethanol which are incorporated in all road fuels in the UK. Although some energy contracts allow a choice to be made between conventional and renewable energy, in the majority of cases renewable fuels are made available through regulation and are available to everyone. The 2009 Renewable Energy Directive sets a target for the UK to achieve 15% of its energy consumption from renewable sources by 2020 (EC, 2009). This directive and other Government strategies on renewable energy form the basis to supply renewable energy at a national level.

National level supply is supplemented by on-site generation by individuals and companies. This area will be the focus on the rest of this discussion and will be considered by the different stages of a product's life cycle.

Primary production of food is an agricultural activity and farmers probably have the greatest scope to use on-site generation of energy within their businesses. Farms tend to have the space and isolation required to install the more sensitive renewable technologies, i.e. wind and anaerobic digesters and the land area required to provide feedstock materials. Farms also tend to have plentiful roof areas for installing solar panels. A recent NFU/Nat West survey[42] suggests that 30% of farmers in England Wales will be involved in some form of renewable energy production by the end of 2012. The biggest barrier to installation was seen to be gaining planning permission and then securing capital investment.

The processing and manufacturing sector isn't as well placed as the agricultural sector for two distinct reasons: physical location and capital investment. Many companies have examined renewable energy technologies but little has been installed. For many, physical constraints prevent further investigation but if this can be overcome, other issues arise. Electricity generated from wind turbines is often dismissed as being inconsistent with company financial payback constraints, although family-run companies fare better than public shareholder-driven companies. A number of small-scale solar projects have been implemented, but these are often as part of a learning exercise rather than as a project to deliver significant savings. Many companies dismiss solar energy after a cost/benefit analysis and have no plans to re-examine the option until the payback time for investment could be reduced. Anaerobic digestion plant are currently being installed by a number of companies, especially those food companies that generate large volumes of organic wastes, although the financial payback period and access to feedstock materials are quoted as constraints. In general, larger companies tend to have the resource, both people and financial capital, to

[42] *www.nfuonline.com/Our-work/Environment/Renewable-energy/30--of-farmers-invest-in-renewables/*

experiment with renewable energy, and the reserves to cover any short-term financial loss. Small and micro companies less often have the financial flexibility to try unproved technologies, or those that are unlikely to offer a satisfactory payback (Lillywhite et al., 2012).

The energy use of logistics companies tends to be dominated by road fuels, which already contain a proportion of renewable energy, and electricity for warehousing. Given the huge roof areas, the installation of solar panels to generate electricity would seem to be an opportunity, although there is little evidence to suggest that much is being installed.

The retail sector is very much a contrast to the logistics sector. The drive to install renewable energy may be reputational as much as ethical. The multiples have adopted solar[43], anaerobic digestion[44], geothermal[45] and biomass[46] to varying degrees and have demonstrated what can be achieved.

All sectors have the ability to expand their generation of renewable energy, although the potential is perhaps greatest within the agricultural and retail sectors. These two sectors are already well engaged with renewable energy and are able to support a range of different technologies and given a stable regulatory framework and pricing structure will undoubtedly continue to expand. The processing and manufacturing sector has the potential to generate renewable energy on-site but physical space (and the associated difficulty of obtaining planning permission) and payback period on investment are both limiting factors. These same factors, although to a less limited extent, also apply to the logistics sector.

It is difficult to estimate the contribution that on-site generation of renewable energy could make to overall demand since it is 'hidden' from national accounts, but the potential to increase generation remains large. The agriculture sector with perhaps a 30% uptake is the market leader but even here the installation of renewables technology is low and the potential of agricultural holding to become energy exporters is far from being realised. The other sectors have taken tentative steps in their installation and use of renewable energy but even together they are only scratching the surface of what is possible.

[43] *www.ukti.gov.uk/lps/environmentenergy/renewableenergy/item/411120.html*

[44] *www.nnfcc.co.uk/news/sainsburys-becomes-biggest-retailer-to-embrace-anaerobic-digestion*

[45] *www.j-sainsbury.co.uk/media/latest-stories/2012/20120719-sainsburys-and-partners-roll-out-renewable-energy-to-supermarkets/*

[46] *www.ibtimes.co.uk/articles/20110301/biomass-bring-energy-tok-supermarket.html*

Appendix 8 – Water Impact Indicator Data

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
Chocolate	589	100%	0%	Green	18,787	0	Chocolate	11,069,300	0	18,787	11,069,300	1	31%	5
				Blue	40	0		23,568	0	40	23,568			
				Grey	124	0		73,061	0	124	73,061			
				TOTAL	***18,951***	***0***		***11,165,929***	***0***	***18,951***	***11,165,929***			
Concentrated juice	707	100%	0%	Green	4,981	0	Orange Juice (10x concentration)	3,519,575	0	4,981	3,519,575	2	11%	4
				Blue	284	0		200,674	0	284	200,674			
				Grey	282	0		199,261	0	282	199,261			
				TOTAL	***5,547***	***0***		***3,919,510***	***0***	***5,547***	***3,919,510***			
Coffee	66	100%	0%	Green	37,295	0	Coffee, roasted, not decaff - instant	1,768,539	0	26,756	1,768,539	3	5%	5
					16,216	0	Coffee, roasted, not decaff - bean							
				Blue	203	0	Coffee, roasted, not decaff - instant	9,618	0	146	9,618			
					88	0	Coffee, roasted, not decaff - bean							
				Grey	1,420	0	Coffee, roasted, not decaff - instant	67,356	0	1,019	67,356			
					618	0	Coffee, roasted, not decaff - bean							
				TOTAL	***27,920***	***0***	Coffee, roasted, not decaff - bean & instant (average)	***1,845,512***	***0***	***27,920***	***1,845,512***			
Liquid Milk	5,186	1%	99%	Green	324	292	Milk not concentrated & unsweetened ≥1%	16,803	1,499,183	292	1,515,986	4	5%	5
				Blue	26	16		1,348	82,147	16	83,495			
				Grey	32	46		1,660	236,173	46	237,832			

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				TOTAL	***382***	***354***	≤6% fat	***19,811***	***1,817,503***	***354***	***1,837,314***			
Beef, fresh	291	18%	82%	Green	3,625	2,998	Bovine cuts bone in, fresh or chilled	228,672	861,446	3,746	1,090,119	5	4%	5
					5,106	4,222	Bovine cuts boneless, fresh or chilled							
				Blue	153	96	Bovine cuts bone in, fresh or chilled	9,717	27,800	129	37,517			
					218	137	Bovine cuts boneless, fresh or chilled							
				Grey	190	402	Bovine cuts bone in, fresh or chilled	11,969	115,496	438	127,465			
					267	566	Bovine cuts boneless, fresh or chilled							
				TOTAL	***4,780***	***4,211***	Bovine cuts boneless & bone in, fresh or chilled (average)	***250,358***	***1,004,742***	***4,313***	***1,255,101***			
Bread & rolls	2,769	11%	89%	Green	481	241	Wheat bread	146,481	593,816	267	740,297	6	3%	5
				Blue	69	0		21,013	0	8	21,013			
				Grey	96	89		29,235	219,293	90	248,528			
				TOTAL	***646***	***330***		***196,730***	***813,108***	***365***	***1,009,838***			
Carbonated drinks	2,960	100%	0%	Green	254	222	Sugar containing carbonated drinks - from sugar beet	751,713	0	254	751,713	7	3%	5
				Blue	40	1		118,380	0	40	118,380			
				Grey	11	7		32,555	0	11	32,555			
				TOTAL	***305***	***230***		***902,648***	***0***	***305***	***902,648***			
Deli food	236	48%	52%	Green	3,126	2,626	Swine meat cured, other	353,813	321,990	2,866	675,803	8	2%	4
				Blue	256	199		28,975	24,401	226	53,376			
				Grey	434	471		49,122	57,752	453	106,874			

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				TOTAL	***3,816***	***3,296***		***431,910***	***404,142***	***3,546***	***836,052***			
Juices	1,481	100%	0%	Green	498	0	Orange - fresh	737,438	0	498	737,438	9	1%	4
					498	0	Orange - from concentrate							
				Blue	28	0	Orange - fresh	41,757	0	28	41,757			
					28	0	Orange - from concentrate							
				Grey	28	0	Orange - fresh	41,629	0	28	41,629			
					28	0	Orange - from concentrate							
				TOTAL	***554***	***0***	Orange from concentrate & fresh (average)	***820,825***	***0***	***554***	***820,825***			
Canned meat products	88	18%	82%	Green	17,388	4,875	Meat, meat offal or blood, prepared or preserved, other	276,052	352,580	7,127	628,631	10	2%	5
				Blue	660	156		10,478	11,283	247	21,761			
				Grey	544	653		8,637	47,228	633	55,864			
				TOTAL	***18,592***	***5,684***		***295,167***	***411,090***	***8,007***	***706,256***			
Red Meat, Frozen	149	18%	82%	Green	4,746	2,998	Bovine cuts bone in, frozen	153,495	441,662	3,989	595,157	11	2%	5
					6,685	4,222	Bovine cuts boneless, frozen							
				Blue	202	96	Bovine cuts bone in, frozen	6,553	14,253	139	20,806			
					286	137	Bovine cuts boneless, frozen							
				Grey	244	402	Bovine cuts bone in, frozen	7,882	59,214	450	67,097			
					343	566	Bovine cuts boneless, frozen							
				TOTAL	***6,253***	***4,211***	Bovine cuts boneless & bone in,	***167,931***	***515,129***	***4,578***	***683,060***			

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
							frozen (average)							
Banana	974	100%	0%	Green	583	0	Bananas including plantains, fresh or dried	567,808	0	583	567,808	12	2%	5
				Blue	71	0		69,150	0	71	69,150			
				Grey	24	0		23,375	0	24	23,375			
				TOTAL	**678**	**0**		**660,333**	**0**	**678**	**660,333**			
Poultry, fresh	435	23%	77%	Green	1,463	1,154	Domestic fowl, duck, goose & guinea fowl meat & meat offal	146,340	386,443	1,225	532,783	13	2%	5
				Blue	58	26		5,802	8,707	33	14,508			
				Grey	229	226		22,906	75,681	227	98,587			
				TOTAL	***1,750***	***1,406***		***175,047***	***470,831***	***1,485***	***645,879***			
Pork, fresh	172	48%	52%	Green	3,229	2,713	Hams & cuts prepared or preserved	266,590	242,654	2,961	509,244	14	2%	5
				Blue	275	214		22,704	19,140	243	41,845			
				Grey	448	486		36,987	43,468	468	80,456			
				TOTAL	***3,952***	***3,413***		***326,282***	***305,263***	***3,672***	***631,545***			
Dressings	70	100%	0%	Green	7,144	0	Olive oil, virgin	496,508	0	7,144	496,508	15	2%	5
				Blue	1,346	0		93,547	0	1,346	93,547			
				Grey	27	0		1,877	0	27	1,877			
				TOTAL	***8,517***	***0***		***591,932***	***0***	***8,517***	***591,932***			
Cider / perry	521	68%	32%	Green	519	1,593	Fermented beverages other (for example, cider, perry, mead, etc)	183,801	265,483	863	449,284	16	2%	5
				Blue	108	0		38,248	0	73	38,248			
				Grey	101	227		35,769	37,831	141	73,599			
				TOTAL	***728***	***1,820***		***257,817***	***303,314***	***1,077***	***561,131***			
Tea	80	100%	0%	Green	6,187	0	Black tea (fermented) & partly fermented tea in packages ≤3 kg	496,816	0	6,187	496,816	17	2%	5
				Blue	409	0		32,843	0	409	32,843			
				Grey	362	0		29,069	0	362	29,069			
				TOTAL	***6,958***	***0***		***558,727***	***0***	***6,958***	***558,727***			
Cheese	387	62%	38%	Green	1,253	881	Cheese, fresh	300,800	129,627	1,112	430,427	18	1%	5

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				Blue	103	49	(including whey cheese) unfermented, & curd	24,727	7,210	82	31,936			
				Grey	124	133		29,768	19,569	127	49,337			
				TOTAL	***1,480***	***1,063***		***355,295***	***156,406***	***1,322***	***511,700***			
Cakes & pastries	516	11%	89%	Green	1,090	707	Sponge Cake (200g sugar, 200g butter, 160g eggs & 400g flour)	61,832	324,494	749	386,326	19	1%	4
				Blue	159	85		9,020	39,013	93	48,032			
				Grey	139	130		7,885	59,666	131	67,552			
				TOTAL	***1,388***	***922***		***78,737***	***423,173***	***973***	***501,910***			
Light Wines	882	98%	2%	Green	326	1,297	Grape wines	281,622	22,866	345	304,488	20	1%	5
				Blue	89	0		76,884	0	87	76,884			
				Grey	75	185		64,790	3,262	77	68,052			
				TOTAL	***490***	***1,482***		***423,296***	***26,128***	***510***	***449,424***			
Sugar confectionery	252	100%	0%	Green	1,125	0	Refined sugar, in solid form, containing added flavouring or colouring matter	283,500	0	1,125	283,500	21	1%	5
				Blue	419	0		105,588	0	419	105,588			
				Grey	104	0		26,208	0	104	26,208			
				TOTAL	***1,648***	***0***		***415,296***	***0***	***1,648***	***415,296***			
Lamb, fresh	92	12%	88%	Green	6,190	3,878	Sheep cuts, boneless, fresh or chilled	68,371	314,115	4,155	382,486	22	1%	5
				Blue	389	297		4,297	24,057	308	28,353			
				Grey	12	8		133	648	8	781			
				TOTAL	***6,591***	***4,183***		***72,800***	***338,820***	***4,472***	***411,619***			
Rice	141	100%	0%	Green	1,396	0	Rice, semi-milled or wholly milled	196,278	0	1,396	196,278	23	1%	5
				Blue	1,105	0		155,363	0	1,105	155,363			
				Grey	223	0		31,354	0	223	31,354			
				TOTAL	***2,724***	***0***		***382,994***	***0***	***2,724***	***382,994***			
Seasonings	40	100%	0%	Green	8,300	0	Pepper of the genus Piper, except cubeb pepper, crushed or	328,680	0	8,300	328,680	24	1%	5
				Blue	508	0		20,117	0	508	20,117			
				Grey	802	0		31,759	0	802	31,759			

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				TOTAL	***9,610***	***0***	ground	***380,556***	***0***	***9,610***	***380,556***			
Eggs	314	18%	82%	Green	1,354	812	Eggs, bird, in shell, fresh, preserved or cooked	76,484	208,952	910	285,435	25	1%	5
				Blue	127	20		7,174	5,147	39	12,320			
				Grey	193	161		10,902	41,430	167	52,332			
				TOTAL	***1,674***	***993***		***94,559***	***255,529***	***1,116***	***350,088***			
Butter	172	52%	48%	Green	1,691	1,539	Butter	150,803	126,690	1,618	277,494	26	1%	5
				Blue	114	85		10,167	6,997	100	17,164			
				Grey	172	244		15,339	20,086	207	35,425			
				TOTAL	***1,977***	***1,868***		***176,309***	***153,774***	***1,925***	***330,083***			
Apples	665	68%	32%	Green	307	174	Apples, fresh	138,820	37,026	264	175,846	27	1%	5
				Blue	94	1		42,505	213	64	42,718			
				Grey	54	17		24,418	3,617	42	28,035			
				TOTAL	***455***	***192***		***205,744***	***40,856***	***371***	***246,600***			
Margarine	241	52%	48%	Green	735	735	Margarine	92,187	85,095	735	177,282	28	1%	5
				Blue	144	144		18,061	16,672	144	34,733			
				Grey	0	0		0	0	0	0			
				TOTAL	***879***	***879***		***110,248***	***101,767***	***879***	***212,015***			
Yogurt	479	31%	69%	Green	397	329	Yogurt	58,926	108,692	350	167,618	29	1%	5
				Blue	46	18		6,828	5,947	27	12,774			
				Grey	55	52		8,164	17,179	53	25,343			
				TOTAL	***498***	***399***		***73,917***	***131,818***	***430***	***205,736***			
Onions	721	51%	49%	Green	100	208	Onions & shallots, fresh or chilled	36,759	73,461	153	110,220	30	<1%	5
				Blue	38	13		13,969	4,591	26	18,560			
				Grey	46	46		16,909	16,246	46	33,155			
				TOTAL	***184***	***267***		***67,637***	***94,298***	***225***	***161,935***			
Breakfast cereals	343	11%	89%	Green	3,675	0	Cereal from wheat	138,617	0	404	138,617	31	<1%	4

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				Blue	125	0		4,715	0	14	4,715			
				Grey	10	0		377	0	1	377			
				TOTAL	***3,810***	***0***		***143,709***	***0***	***419***	***143,709***			
Small oranges	250	100%	0%	Green	285	0	Mandarins (tangerine & satsuma) clementines, fresh/dried	71,264	0	285	71,264	32	<1%	5
				Blue	202	0		50,510	0	202	50,510			
				Grey	82	0		20,504	0	82	20,504			
				TOTAL	***569***	***0***		***142,279***	***0***	***569***	***142,279***			
Potatoes	1,925	4%	96%	Green	150	44	Potatoes, fresh or chilled other	11,550	81,312	48	92,862	33	<1%	5
				Blue	22	8		1,694	14,784	9	16,478			
				Grey	41	16		3,157	29,568	17	32,725			
				TOTAL	***213***	***68***		***16,401***	***125,664***	***74***	***142,065***			
Poultry, frozen	94	23%	77%	Green	1,463	1,154	Domestic fowl, duck, goose & guinea fowl meat & meat offal	31,731	83,793	1,225	115,524	34	<1%	5
				Blue	58	26		1,258	1,888	33	3,146			
				Grey	229	226		4,967	16,410	227	21,377			
				TOTAL	***1,750***	***1,406***		***37,956***	***102,091***	***1,485***	***140,047***			
Spirits	215	100%	0%	Green	466	1,593	Spirits obtained by distilling grape wine or grape marc	100,004	0	466	100,004	34	<1%	5
				Blue	90	0		19,314	0	90	19,314			
				Grey	79	227		16,953	0	79	16,953			
				TOTAL	***635***	***1,820***		***136,271***	***0***	***635***	***136,271***			
Dried Pasta / noodles	152	57%	43%	Green	943	278	Dry Pasta	81,433	18,110	657	99,543	36	<1%	5
				Blue	151	0		13,040	0	86	13,040			
				Grey	141	103		12,176	6,710	125	18,886			
				TOTAL	***1,235***	***381***		***106,648***	***24,820***	***868***	***131,469***			
Grapes	244	100%	0%	Green	363	1,115	Grapes, fresh	88,624	0	363	88,624	37	<1%	5
				Blue	90	0		21,973	0	90	21,973			
				Grey	85	159		20,752	0	85	20,752			

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				TOTAL	***538***	***1,274***		***131,349***	***0***	***538***	***131,349***			
Oranges	279	100%	0%	Green	248	0	Oranges, fresh or dried	69,304	0	248	69,304	38	<1%	5
				Blue	175	0		48,904	0	175	48,904			
				Grey	46	0		12,855	0	46	12,855			
				TOTAL	***469***	***0***		***131,063***	***0***	***469***	***131,063***			
Canned vegetables	560	51%	49%	Green	124	182	Vegetables, other & mixtures prepared or preserved	35,402	49,923	152	85,325	39	<1%	5
				Blue	28	20		7,994	5,486	24	13,480			
				Grey	55	47		15,702	12,892	51	28,595			
				TOTAL	***207***	***249***		***59,098***	***68,301***	***228***	***127,399***			
Lager	1,563	14%	86%	Green	103	47	Lager from Malt	22,540	63,181	55	85,720	40	<1%	5
				Blue	17	0		3,720	0	2	3,720			
				Grey	18	16		3,939	21,508	16	25,447			
				TOTAL	***138***	***63***		***30,199***	***84,689***	***74***	***114,888***			
Nuts & seeds	52	100%	0%	Green	2,102	0	Ground-nuts in shell not roasted or otherwise cooked	109,724	0	2,102	109,724	41	<1%	5
				Blue	45	0		2,349	0	45	2,349			
				Grey	40	0		2,088	0	40	2,088			
				TOTAL	***2,187***	***0***		***114,161***	***0***	***2,187***	***114,161***			
Canned pasta & noodles	128	57%	43%	Green	943	278	Dry Pasta	68,963	15,337	657	84,300	42	<1%	4
				Blue	151	0		11,043	0	86	11,043			
				Grey	141	103		10,311	5,682	125	15,994			
				TOTAL	***1,235***	***381***		***90,317***	***21,019***	***868***	***111,336***			
Pickled products	69	51%	49%	Green	1,936	0	Olives, provisionally preserved	68,523	0	987	68,523	43	<1%	5
				Blue	528	0		18,688	0	269	18,688			
				Grey	18	0		637	0	9	637			
				TOTAL	***2,482***	***0***		***87,848***	***0***	***1,266***	***87,848***			
Smoothies	50	100%	0%	Green	1,238	0	Mixtures of juices	61,529	0	1,238	61,529	44	<1%	5

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				Blue	133	0		6,610	0	133	6,610			
				Grey	59	0		2,932	0	59	2,932			
				TOTAL	***1,430***	***0***		***71,071***	***0***	***1,430***	***71,071***			
Other Fruit	103	51%	49%	Green	948	0	Fruits, fresh other	49,835	0	483	49,835	45	<1%	5
				Blue	270	0		14,194	0	138	14,194			
				Grey	110	0		5,783	0	56	5,783			
				TOTAL	***1,328***	***0***		***69,811***	***0***	***677***	***69,811***			
Other field veg (excl. dried)	306	51%	49%	Green	123	182	Vegetables, fresh or chilled other	19,181	27,269	152	46,451	46	<1%	5
				Blue	17	20		2,651	2,997	18	5,648			
				Grey	52	47		8,109	7,042	50	15,151			
				TOTAL	***192***	***249***		***29,942***	***37,308***	***220***	***67,250***			
Frozen potato products	445	4%	96%	Green	300	88	Potatoes, frozen	5,334	37,486	96	42,819	47	<1%	5
				Blue	43	17		771	7,246	18	8,017			
				Grey	81	31		1,445	13,445	33	14,890			
				TOTAL	***424***	***136***		***7,549***	***58,177***	***148***	***65,726***			
Frozen vegetables	284	51%	49%	Green	128	182	Mixtures of vegetables, frozen	18,566	25,363	154	43,928	48	<1%	5
				Blue	22	20		3,191	2,787	21	5,978			
				Grey	59	47		8,558	6,550	53	15,107			
				TOTAL	***209***	***249***		***30,314***	***34,700***	***229***	***65,014***			
Milk (concentrate & powder)	39	1%	99%	Green	1,458	1,315	Milk powder ≤1.5% fat	569	50,772	1,316	51,341	49	<1%	5
				Blue	116	73		45	2,819	73	2,864			
				Grey	143	208		56	8,031	207	8,087			
				TOTAL	***1,717***	***1,596***		***670***	***61,622***	***1,597***	***62,291***			
Cream	92	1%	99%	Green	583	526	Milk and cream not concentrated and unsweetened ≥6%	534	47,736	527	48,271	50	<1%	5
				Blue	46	29		42	2,632	29	2,674			
				Grey	57	83		52	7,533	83	7,585			

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				TOTAL	***686***	***638***	fat	***629***	***57,901***	***638***	***58,529***			
Wet cooking sauces	246	51%	49%	Green	25	25	Dolmio pasta sauce	3,134	3,011	25	6,145	51	<1%	4
				Blue	148	148		18,553	17,825	148	36,378			
				Grey	61	61		7,647	7,347	61	14,994			
				TOTAL	***234***	***234***		***29,334***	***28,183***	***234***	***57,517***			
Plums	79	51%	49%	Green	629	256	Plums & sloes, fresh	25,297	9,892	446	35,189	52	<1%	5
				Blue	274	2		11,020	77	141	11,097			
				Grey	134	28		5,389	1,082	82	6,471			
				TOTAL	***1,037***	***286***		***41,706***	***11,051***	***669***	***52,757***			
Pears	139	51%	49%	Green	338	225	Pears & quinces, fresh	23,976	15,335	283	39,311	53	<1%	5
				Blue	107	1		7,590	68	55	7,658			
				Grey	60	22		4,256	1,499	41	5,756			
				TOTAL	***505***	***248***		***35,823***	***16,902***	***379***	***52,725***			
Lemons and Limes	99	100%	0%	Green	269	0	Lemons & limes, fresh or dried	26,599	0	269	26,599	54	<1%	5
				Blue	198	0		19,578	0	198	19,578			
				Grey	50	0		4,944	0	50	4,944			
				TOTAL	***517***	***0***		***51,121***	***0***	***517***	***51,121***			
Carrots	715	51%	49%	Green	60	18	Carrots & turnips, fresh or chilled	21,892	6,310	39	28,202	55	<1%	5
				Blue	24	0		8,757	0	12	8,757			
				Grey	28	7		10,216	2,454	18	12,670			
				TOTAL	***112***	***25***		***40,865***	***8,764***	***69***	***49,629***			
Offal, fresh	23	18%	82%	Green	3,504	2,925	Bovine edible offal, fresh or chilled	8,631	32,935	1,788	41,566	56	<1%	5
					622	531	Swine edible offal, fresh or chilled							
				Blue	148	94	Bovine edible offal, fresh or chilled	414	1,267	72	1,682			
					50	39	Swine edible offal,							

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
							fresh or chilled							
				Grey	181	392	Bovine edible offal, fresh or chilled	559	4,641	224	5,200			
					86	95	Swine edible offal, fresh or chilled							
				TOTAL	***2,296***	***2,038***	Bovine & Swine edible offal, fresh or chilled (average)	***9,604***	***38,844***	***2,084***	***48,448***			
Potato chips	178	4%	96%	Green	545	160	Potato flakes	3,880	27,341	175	31,221	57	<1%	4
				Blue	79	31		562	5,297	33	5,860			
				Grey	148	57		1,054	9,740	61	10,794			
				TOTAL	***772***	***248***		***5,497***	***42,378***	***269***	***47,875***			
Flavoured milk	129	1%	99%	Green	324	292	Milk not concentrated & unsweetened ≥1% ≤6% fat	417	37,219	292	37,636	58	<1%	5
				Blue	26	16		33	2,039	16	2,073			
				Grey	32	46		41	5,863	46	5,904			
				TOTAL	***382***	***354***		***492***	***45,122***	***354***	***45,614***			
Prepacked sandwiches	488	51%	49%	Green	110	28	Cheese sandwich. Assume 10g cheese & 60g wheat (2 slices bread) - External = Global average	27,354	6,690	70	34,044	59	<1%	4
				Blue	22	1		5,471	239	12	5,710			
				Grey	15	8		3,730	1,911	12	5,642			
				TOTAL	***147***	***37***		***36,555***	***8,840***	***93***	***45,396***			
Avocado	34	100%	0%	Green	813	0	Avocados, fresh or dried	27,686	0	813	27,686	60	<1%	5
				Blue	361	0		12,294	0	361	12,294			
				Grey	92	0		3,133	0	92	3,133			
				TOTAL	***1,266***	***0***		***43,113***	***0***	***1,266***	***43,113***			
Other Citrus Fruits	48	100%	0%	Green	561	0	Citrus fruits, fresh or dried, other	27,190	0	561	27,190	61	<1%	5
				Blue	251	0		12,165	0	251	12,165			
				Grey	65	0		3,150	0	65	3,150			

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				TOTAL	***877***	***0***		***42,505***	***0***	***877***	***42,505***			
Dates and Figs	15	100%	0%	Green	985	0	Dates fresh /dried	17,834	0	1,205	17,834	62	<1%	5
					1,425	0	Figs fresh / dried							
				Blue	1,150	0	Dates fresh / dried	19,055	0	1,288	19,055			
					1,425	0	Figs fresh / dried							
				Grey	105	0	Dates fresh / dried	2,361	0	160	2,361			
					214	0	Figs fresh / dried							
				TOTAL	***2,652***	***0***	Dates & Figs, fresh or dried (average)	***39,250***	***0***	***2,652***	***39,250***			
Sweet Peppers	132	100%	0%	Green	158	9	Peppers of the genus Capsicum or of the genus Pimenta, fresh or chilled	20,856	0	158	20,856	63	<1%	5
				Blue	55	1		7,260	0	55	7,260			
				Grey	70	2		9,240	0	70	9,240			
				TOTAL	***283***	***12***		***37,356***	***0***	***283***	***37,356***			
Frozen bakery products	94	11%	89%	Green	497	241	Wheat bread	5,117	20,076	269	25,193	64	<1%	4
				Blue	75	0		772	0	8	772			
				Grey	99	89		1,019	7,414	90	8,433			
				TOTAL	***671***	***330***		***6,909***	***27,490***	***368***	***34,399***			
Meat substitutes, frozen	34	51%	49%	Green	1,342	0	Soya beans	23,544	0	684	23,544	65	<1%	4
				Blue	230	0		4,035	0	117	4,035			
				Grey	128	0		2,246	0	65	2,246			
				TOTAL	***1,700***	***0***		***29,825***	***0***	***867***	***29,825***			
Meat substitutes, fresh	27	51%	49%	Green	1,342	0	Soya beans	18,479	0	684	18,479	66	<1%	4
				Blue	230	0		3,167	0	117	3,167			
				Grey	128	0		1,763	0	65	1,763			
				TOTAL	***1,700***	***0***		***23,409***	***0***	***867***	***23,409***			
Frozen Pizza	110	11%	89%	Green	242	129	Pizza Margherita	2,931	12,641	141	15,571	67	<1%	4
				Blue	33	3		400	294	6	694			

Product	UK Sales Million kg (2010)	% of UK sales - imported products	% of UK sales - products originating in the UK	Green, Blue, Grey WF	External WF Impact Indicator (scarcity weighted litres / kg)	Internal WF Impact Indicator (scarcity weighted litres / kg)	Description of WF Factor used	Annual Total External WF Impact Indicator (scarcity weighted unit)	Annual Total Internal WF Impact Indicator (scarcity weighted unit)	Weighted WF Impact Indicator (scarcity weighted litres / kg)	Annual Total WF Impact Indicator (scarcity weighted unit)	Rank	% of total	Data quality*
				Grey	42	36		509	3,528	37	4,036			
				TOTAL	***317***	***168***		***3,839***	***16,462***	***184***	***20,301***			
Peaches and Nectarines	69	51%	49%	Green	322	0	Peaches, including nectarines, fresh	11,315	0	164	11,315	68	<1%	5
				Blue	158	0		5,552	0	81	5,552			
				Grey	71	0		2,495	0	36	2,495			
				TOTAL	***551***	***0***		***19,361***	***0***	***281***	***19,361***			
Chilled Pizza	85	11%	89%	Green	242	129	Pizza Margherita	2,271	9,793	141	12,064	69	<1%	4
				Blue	33	3		310	228	6	537			
				Grey	42	36		394	2,733	37	3,127			
				TOTAL	***317***	***168***		***2,974***	***12,754***	***184***	***15,728***			
Sweetcorn	23	51%	49%	Green	402	0	Sweet corn, frozen	4,695	0	205	4,695	70	<1%	5
				Blue	120	0		1,401	0	61	1,401			
				Grey	96	0		1,121	0	49	1,121			
				TOTAL	***618***	***0***		***7,218***	***0***	***315***	***7,218***			
TOTAL	**31,633**							**26,999,177**	**8,700,774**		**35,699,951**			

Table A7-1 Water Impact Indicator Results for Principal Food & Drink Items

* 'Data quality' categories:

- Category 5 = Product specific water footprint data from the Water Footprint Network
- Category 4 = URS Calculation / assumption based on data from the Water Footprint Network e.g. water footprint of potato flakes used as water footprint for crisps,
- Category 3 = URS Calculation based on data from another reputable source e.g. company CSR report
- Category 2 = URS assumption or estimate
- Category 1 = No Data or not possible to estimate

As discussed in Section 5.0, water footprint data for 103 of the total 162 food and drink products were found during this research (or represented by proxies). The remaining 59 products that are not represented in this study are as follows:

- Baby Cereals
- Baby Snacks
- Biscuits (sweet)
- Bottled Baby Food
- Calabrese
- Canned desserts
- Canned Baby Food
- Canned fish / seafood
- Canned Ready Meal
- Canned Soup
- Cat Food
- Cat treats & milk
- Celery
- Cereal Bars
- Chilled desserts
- Chilled fish / seafood
- Chilled Ready Meals
- Chilled Soup
- Chocolate spreads
- Courgettes
- Crackers (savoury biscuits)
- Dessert mixes
- Dips
- Dog chews & treats
- Dog Food
- Dried ready meals
- Dried soup
- Dry cooking sauces
- Fortified wine
- Fromage frais
- Frozen desserts
- Frozen fish / seafood
- Frozen Ready Meals
- Frozen soup
- Functional Drinks
- Gum
- Honey
- Ice Cream
- Infant Formula
- Lettuce
- Morning Goods
- Mushrooms
- Nut-based spreads
- Other Baby Foods
- Other hot drinks
- Other non-alcoholic drinks
- Other protected veg
- Other savoury snacks
- Parsnips
- Processed snacks
- Ready-to-drink (alcoholic)
- Rodent food
- Rhubarb
- Savoury spreads
- Solid fats
- Table sauces
- UHT Soup
- Watercress

Appendix 9 – Water Scarcity Factors

The following country specific water scarcity factors were developed from parameters derived from the World Business Council for Sustainable Development's Global Water Tool[47] to account for water stress and social factors prevailing in each country.

Country	Factor
Afghanistan	1.27
Albania	0.77
Algeria	1.20
American Samoa	0.67
Andorra	0.67
Angola	1.10
Anguilla	0.67
Antartica	0.67
Antigua and Barbuda	0.90
Argentina	0.77
Armenia	0.80
Aruba	0.67
Australia	0.67
Austria	0.67
Azerbaijan	1.00
Bahamas	1.00
Bahrain	1.13
Bangladesh	0.90
Barbados	1.00
Belarus	0.67
Belgium	0.80
Belize	0.70
Benin	1.00
Bermuda	0.67
Bhutan	0.83
Bolivia	0.90
Bosnia and Herzegovina	0.67
Botswana	0.83
Brazil	0.77
British Virgin Islands	0.67
Brunei Darussalam	0.70
Bulgaria	0.67
Burkina Faso	1.20
Burundi	1.00
Cambodia	0.97
Cameroon	0.93
Canada	0.67
Cape Verde	1.23
Cayman Islands	0.67
Central African Republic	0.97
Chad	1.10

[47] http://www.wbcsd.org/work-program/sector-projects/water/global-water-tool.aspx

Country	Factor
Chile	0.77
China	0.93
Christmas Island	0.67
Cocos (Keeling) Islands	0.67
Colombia	0.80
Comoros	0.97
Congo	0.93
Cook Islands	0.67
Costa Rica	0.77
Côte d'Ivoire	0.97
Croatia	0.67
Cuba	0.73
Cyprus	0.87
Czech Republic	0.73
Denmark	0.73
Djibouti	1.23
Dominica	0.67
Dominican Republic	0.80
Ecuador	0.77
Egypt	1.00
El Salvador	0.77
Equatorial Guinea	0.77
Eritrea	1.23
Estonia	0.70
Ethiopia	1.17
Falkland Islands (Malvinas)	0.67
Faroe Islands	0.67
Fiji	0.70
Finland	0.67
France	0.67
French Guiana	0.77
French Polynesia	0.67
Gabon	0.90
Gambia	0.90
Georgia	0.70
Germany	0.67
Ghana	0.97
Gibraltar	0.67
Greece	0.67
Greenland	0.67
Grenada	0.70
Guadeloupe	0.67
Guam	0.67
Guatemala	0.83
Guinea	1.00
Guinea-Bissau	1.03
Guyana	0.70
Haiti	1.03
Holy See	0.67
Honduras	0.80

Country	Factor
Hungary	0.67
Iceland	0.67
India	1.07
Indonesia	0.90
Iran, Islamic Republic of	0.87
Iraq	0.97
Ireland	0.67
Israel	1.07
Italy	0.67
Jamaica	0.70
Japan	0.67
Jordan	1.20
Kazakhstan	0.87
Kenya	1.30
Kiribati	0.67
Korea Democratic People's Republic of	0.67
Korea Republic of	0.73
Kuwait	1.07
Kyrgyzstan	0.87
Lao People's Democratic Republic	1.03
Latvia	0.67
Lebanon	0.87
Lesotho	0.97
Liberia	1.03
Libyan Arab Jamahiriya	1.17
Liechtenstein	0.67
Lithuania	0.67
Luxembourg	0.67
Macedonia	0.67
Madagascar	1.10
Malawi	1.17
Malaysia	0.70
Maldives	1.10
Mali	1.10
Malta	1.07
Marshall Islands	0.77
Martinique	0.67
Mauritania	1.03
Mauritius	0.73
Mexico	0.80
Micronesia, Federated States of	0.67
Moldova Republic of	0.77
Monaco	0.67
Mongolia	0.93
Montenegro	0.73
Montserrat	0.67
Morocco	1.13
Mozambique	1.03
Myanmar	0.80
Namibia	0.90

Country	Factor
Nauru	0.67
Nepal	0.90
Netherlands	0.67
Netherlands Antilles	0.67
New Caledonia	0.67
New Zealand	0.67
Nicaragua	0.90
Niger	1.17
Nigeria	1.10
Niue	0.67
Norfolk Islands	0.67
Northern Mariana Islands	0.70
Norway	0.67
Oman	1.17
Pakistan	1.20
Palau	0.67
Palestine Territory, Occupied	1.27
Panama	0.83
Papua New Guinea	1.03
Paraguay	0.80
Peru	0.83
Peru	0.83
Philippines	0.80
Pitcairn	0.67
Poland	0.73
Portugal	0.67
Puerto Rico	0.70
Qatar	1.07
Réunion	0.67
Romania	0.70
Russian Federation	0.70
Rwanda	1.23
Saint Helena	0.67
Saint Kitts and Nevis	1.03
Saint Lucia	0.70
Saint Pierre and Miquelon	0.67
Saint Vincent and the Grenadines	0.67
Samoa	0.67
San Marino	0.67
Sao Tome and Principe	0.90
Saudi Arabia	1.13
Senegal	1.03
Serbia	0.67
Sierra Leone	1.10
Singapore	1.13
Slovakia	0.67
Slovenia	0.67
Solomon Islands	0.70
Somalia	1.20
South Africa	1.03

Country	Factor
Spain	0.73
South Africa	1.03
Sri Lanka	0.80
Sudan	1.20
Suriname	0.77
Swaziland	1.00
Sweden	0.67
Switzerland	0.67
Syrian Arab Republic	0.97
Macedonia	0.67
Tajikistan	0.90
Tanzania United Republic of	1.17
Thailand	0.80
Timor-Leste	0.93
Togo	1.10
Tokelau	0.67
Tonga	0.67
Trinidad and Tobago	0.70
Tunisia	1.20
Turkey	0.73
Turkmenistan	0.83
Turks and Caicos Islands	0.70
Tuvalu	0.67
Uganda	1.10
Ukraine	0.73
United Arab Emirates	1.13
United Kingdom	0.67
United States of America	0.67
Virgin Islands, USA	0.80
Uruguay	0.67
Uzbekistan	0.87
Vanuatu	0.67
Venezuela (Bolivarian Republic of)	0.70
Viet Nam	0.80
Wallis and Futuna Islands	0.67
Western Sahara	0.67
Western Sahara	0.67
Yemen	1.47
Zambia	1.03
Zimbabwe	1.07

Appendix 10 – Consumer Food Waste Data

The table below ranks products by the total estimated avoidable food waste in the home. It is based on tables presented in WRAP (2009)[48].

Product	Total tonnes	Unavoidable	Possibly avoidable	Avoidable	% avoidable tonnes	Cumulative % of avoidable waste
Standard bread	660,000	<1,000	120,000	540,000	10%	10%
Composite meal	510,000	<1,000	23,000	490,000	9%	20%
Milk	360,000	<1,000	<1,000	360,000	7%	27%
Potato	770,000	<1,000	480,000	290,000	6%	32%
Carbonated soft drink	280,000	<1,000	<1,000	280,000	5%	37%
All other drink	290,000	60,000	<1,000	230,000	4%	42%
Apple	260,000	31,000	53,000	180,000	3%	45%
Fruit juice and smoothies	160,000	<1,000	<1,000	160,000	3%	48%
All other condiments, sauces, herbs & spices	140,000	<1,000	6,000	130,000	2%	51%
All other processed vegetables and salad	100,000	<1,000	<1,000	100,000	2%	53%
All other cake and desserts	100,000	<1,000	<1,000	100,000	2%	55%
Pork / ham / bacon	120,000	5,000	20,000	93,000	2%	56%
Cakes / gâteaux / doughnuts / pastries	91,000	<1,000	<1,000	91,000	2%	58%
Tea waste	450,000	370,000	<1,000	86,000	2%	60%
Banana	310,000	230,000	<1,000	83,000	2%	61%
Poultry	300,000	190,000	33,000	81,000	2%	63%
Speciality bread	81,000	<1,000	<1,000	80,000	2%	64%
Soup	80,000	<1,000	<1,000	80,000	2%	66%
Yoghurt / yoghurt drink	80,000	<1,000	<1,000	80,000	2%	67%
All other meat and fish (likely to be beef)	120,000	17,000	24,000	79,000	2%	69%
Breakfast cereal	75,000	<1,000	<1,000	75,000	1%	70%
Bottled water	69,000	<1,000	<1,000	69,000	1%	72%
Rice	64,000	<1,000	<1,000	64,000	1%	73%
All other fresh fruit	130,000	49,000	24,000	62,000	1%	74%
Lettuce	67,000	4,000	2,000	61,000	1%	75%
Tomato	63,000	<1,000	2,000	61,000	1%	76%
Cook in sauce	57,000	<1,000	<1,000	57,000	1%	78%
All other fresh vegetables & salads	86,000	18,000	13,000	55,000	1%	79%

[48] *WRAP announced a reduction in total household food and drink waste of 1.1 million tonnes in November 2011. Avoidable food and drink waste reduced by 950,000 tonnes, and the associated value and environmental impact figures have been updated. Research to update our estimates for individual food and drink categories has not yet been carried out, and therefore all figures relating to the breakdown of avoidable food waste should be regarded as approximate. These remain however the best estimates currently available.*

Product	Total tonnes	Unavoidable	Possibly avoidable	Avoidable	% avoidable tonnes	Cumulative % of avoidable waste
Squash	53,000	<1,000	<1,000	53,000	1%	80%
Cabbage	85,000	18,000	14,000	53,000	1%	81%
Orange	130,000	84,000	<1,000	49,000	1%	82%
Mixed vegetable	250,000	7,000	200,000	48,000	1%	82%
Sandwich	49,000	<1,000	1,000	47,000	1%	83%
Carrot	120,000	6,000	65,000	46,000	1%	84%
Savoury products	45,000	<1,000	<1,000	45,000	1%	85%
All other bakery	44,000	<1,000	<1,000	44,000	1%	86%
Stone fruit	67,000	23,000	<1,000	43,000	1%	87%
Pasta	42,000	<1,000	<1,000	42,000	1%	88%
Soft / berry fruit	44,000	3,000	<1,000	41,000	1%	88%
Cheese	38,000	<1,000	<1,000	38,000	1%	89%
Onion	130,000	93,000	<1,000	36,000	1%	90%
Leafy salad	37,000	<1,000	<1,000	36,000	1%	90%
Fish and shellfish	43,000	7,000	3,000	32,000	1%	91%
Cucumber	44,000	10,000	3,000	31,000	1%	92%
Coleslaw and hummus	30,000	<1,000	<1,000	30,000	1%	92%
Melon	100,000	74,000	<1,000	30,000	1%	93%
Sweetcorn / corn on the cob	43,000	18,000	1,000	24,000	0.5%	93%
Egg	77,000	54,000	<1,000	24,000	0.5%	94%
All other dairy and eggs	24,000	<1,000	<1,000	24,000	0.5%	94%
Chocolate and sweets	24,000	<1,000	<1,000	24,000	0.5%	95%
All other staple foods	23,000	<1,000	<1,000	23,000	0.4%	95%
Savoury snacks	26,000	4,000	<1,000	23,000	0.4%	96%
Other root vegetables	49,000	23,000	4,000	22,000	0.4%	96%
Bean (all varieties)	29,000	6,000	2,000	22,000	0.4%	96%
Broccoli	41,000	1,000	18,000	21,000	0.4%	97%
Total Oil and fat	90,000	5,000	64,000	20,000	0.4%	97%
Remaining 'other'	160,000	<1,000	140,000	20,000	0.4%	98%
Other citrus	45,000	25,000	2,000	19,000	0.4%	98%
Sweet biscuits	18,000	<1,000	<1,000	18,000	0.3%	98%
Pepper	24,000	8,000	<1,000	16,000	0.3%	99%
Morning goods	15,000	<1,000	<1,000	15,000	0.3%	99%
Mushroom	16,000	<1,000	3,000	14,000	0.3%	99%
Gravy	12,000	<1,000	<1,000	12,000	0.2%	99%
Cauliflower	40,000	26,000	3,000	10,000	0.2%	100%
Leek	20,000	11,000	<1,000	8,000	0.2%	100%
Lamb	32,000	20,000	4,000	8,000	0.2%	100%
Spring onion	8,000	2,000	<1,000	6,000	0.1%	100%
All other confectionery & snacks	2,000	<1,000	<1,000	2,000	0.0%	100%
Drainings from canned food	140,000	<1,000	140,000	1,000	0.0%	100%

Consolidated References

- Acqua Minerale San Benedetto S.p.A. Environmental Product Declaration Acqua Minerale Naturale Oligominerale San Benedetto In 0,5 l, 1,5 l, 2,0 l PET bottles
- ADAS (2009) FO0404 Scenario building to test and inform the development of a BSI method for assessing greenhouse gas emissions from food - Main report & technical annex. Defra
- Andersson, K., Ohlsson, T. (1999) Life cycle assessment of bread produced on different scales. The International Journal of Life Cycle Assessment 4, 25-40.
- Andersson, K., Ohlsson, T., Olsson, P. (1998) Screening life cycle assessment (LCA) of tomato ketchup: a case study. Journal of Cleaner Production 6, 277-288.
- Anna Flysjö (2012) Greenhouse Gas emissions in milk and dairy product chains, improving the carbon footprint of dairy products
- Audsley, E., Brander, M., Chatterton, J., Murphy-Bokern, D., Webster, C., and Williams, A. (2009). How low can we go? An assessment of greenhouse gas emissions from the UK food system and the scope to reduce them by 2050. FCRN-WWF-UK. (available http://www.fcrn.org.uk/sites/default/files/WWF_How_Low_Report.pdf Page 37 Table 13).
- Australian Egg Corporation: http://www.fcrn.org.uk/research-library/food-and-its-life-cycle/other-studies/australian-lca-egg-production?utm_source=FCRN+Mailing&utm_campaign=766ce40afb-FCRN-Mailing-25-Jan&utm_medium=email
- Ayer, N.W., Tyedmers, P.H. (2009) Assessing alternative aquaculture technologies: life cycle assessment of salmonid culture systems in Canada. Journal of Cleaner Production 17, 362-373.
- Barilla (2011). EPD of durum wheat semolina dried pasta in paperboard box
- Basset-Mens, C., Ledgard, S., Boyes, M. (2009) Eco-efficiency of intensification scenarios for milk production in New Zealand. Ecological Economics 68, 1615-1625.
- Basset-Mens, C., Ledgard, S., Carran, A., (2005) First life cycle assessment of milk production from New Zealand dairy farm systems, in: Australian New Zealand Society for Ecological Economics (Ed.), The Australian and New Zealand Ecological Economics in Action, Palmerston North, New Zealand, pp. 258-265.
- Basset-Mens, C., van der Werf, H.M.G. (2005) Scenario-based environmental assessment of farming systems: the case of pig production in France. Agriculture, Ecosystems, Environment 105, 127-144.
- Basset-Mens, C., Van der Werf, H.M.G., (2003) Environmental assessment of contrasting pig farming systems, in: Halberg, N. (Ed.), 4th International Conference on Life Cycle Assessment in the Agri-food sector, Bygholm, Denmark.
- Beccali, M., Cellura, M., Iudicello, M., Mistretta, M. (2010) Life cycle assessment of Italian citrus-based products. Sensitivity analysis and improvement scenarios. Journal of Environmental Management 91, 1415-1428.
- Berlin, J. (2002) Environmental life cycle assessment (LCA) of Swedish semi-hard cheese. International Dairy Journal 12, 939-953.
- Berlin, J., Sonesson, U., Tillman, A.-M. (2008) Product Chain Actors' Potential for Greening the Product Life Cycle. Journal of Industrial Ecology 12, 95-110.

- Berners-Lee, M C.Hoolohan, H.Cammack, C.N.Hewitt (Dec 2011) "The relative green house gas impacts of realistic dietary choices" Lancaster Environment Centre, Lancaster University
- Blanke, M.M., Burdick, B. (2005) Food (miles) for thought - energy balance for locally-grown versus imported apple fruit. Environ Sci Pollut Res Int 12, 125-127.
- Blengini, G.A., Busto, M. (2009) The life cycle of rice: LCA of alternative agri-food chain management systems in Vercelli (Italy). Journal of Environmental Management 90, 1512-1522.
- Booths (2010) The Greenhouse Gas Footprint of Booths. Full Report
- Braschkat, J., Patyk, A., Quirin, M., Reinhardt, G.A., (2003) Life cycle assessment of bread production - a comparison of eight different scenarios in: Halberg, N. (Ed.), 4th International Conference on Life Cycle Assessment in the Agri-food sector, Bygholm, Denmark, pp. 9-16.
- Büsser, S., Jungbluth N. (2009). LCA of Chocolate Packed in Aluminium Foil Based Packaging [online] ESU-services.
- Büsser, S., Jungbluth, N., (2011) LCA of Ready-to-Serve Goulash Soup Packed in Stand-Up Pouches. ESU Services, Uster, Switzerland.
- Büsser, S., Steiner, R., Jungbluth, N., (2008) LCA of Packed Food Products – the function of flexible packaging. Case Study: Coffee. ESU Services, Uster, Switzerland.
- Casey and Holden (2006) Quantification of GHG emissions from sucker-beef production in Ireland
- Casino, Carbon footprint of plain yoghurt (4x125g pots)
- Cederberg C, Meyer D and Flysjö (2009) Life cycle inventory of greenhouse gas emissions and use of land and energy in Brazilian beef production
- Cerelia S.r.l. Environmental Product Declaration Cerelia Natural Mineral Water
- Co-op (2011) http://www.co-operative.coop/Corporate/sustainability/2011/downloads/sr2011_Ecological_sustainability.pdf
- Consorzio Interprovinciale Vini. (2008). Bottled red sparkling wine "Grasparossa Righi".
- Cranfield (2006) Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities
- Carlsson-Kanyama, A. (1998a) Climate change and dietary choices — how can emissions of greenhouse gases from food consumption be reduced? Food Policy 23, 277-293.
- Carlsson-Kanyama, A., (1998b) Energy consumption and emissions of greenhouse gases in the life-cycle of potatoes, pork meat, rice and yellow peas. Methods, data and results from a study of some food consumed in Sweden. With arable land use and re-calculated consumption and emissions of greenhouse gases for carrots and tomatoes - Technical Report. Institutionen foer Systemekologi, Stockholms Universitet, Stockholm, p. 67.
- Carlsson-Kanyama, A., Bostrom-Carlsson, K., (2001) Energy Use for Cooking and Other Stages in the Life Cycle of Food: A study of wheat, spaghetti, pasta, barley, rice, potatoes, couscous and mashed potatoes. Environmental Strategies Research Group and Swedish Consumer Agency Stockholm.
- Carlsson-Kanyama, A., Faist, M., (2000a) Energy Use in the Food Sector: A data survey. Stockholm University and Swiss Federal Institute of Technology (ETH Zürich), Stockholm, Sweden and Zurich, Switzerland.

- Carlsson-Kanyama, A., Faist, M., (2000b) Energy Use in the Food Sector: A data survey. Appendices. Stockholm University and Swiss Federal Institute of Technology (ETH Zürich), Stockholm, Sweden and Zurich, Switzerland.
- Cederberg, C., (2003) Life cycle assessment of animal products, in: Mattsson, B., Sonesson, U. (Eds.), Environmentally-friendry food processing. Woodhead Publishing, Cambridge.
- Cederberg, C., Flysjö, A., (2004a) Environmental assessment of future pig farming systems. The Swidish institute for Food and Biotechnology, Stockholm, p. 69.
- Cederberg, C., Flysjö, A., (2004b) Life Cycle inventory of 23 dairy farms in South-Western Sweden, SIK Report No. 728. The Swedish Institute for food and biotechnology, Göteborg, Sweden pp. 1-59.
- Cederberg, C., Mattsson, B. (2000) Life cycle assessment of milk production — a comparison of conventional and organic farming. Journal of Cleaner Production 8, 49-60.
- Cederberg, C., Meyer, D., Flysjö, A., (2009) Life cycle inventory of greenhouse gas emissions and use of land and energy in Brazilian beef production. The Swidish institute for Food and Biotechnology, Stockholm, p. 77.
- Cederberg, C., Stadig, M. (2003) System expansion and allocation in life cycle assessment of milk and beef production. The International Journal of Life Cycle Assessment 8, 350-356.
- Coca-cola (2012) http://www.coca-cola.co.uk/environment/what-s-the-carbon-footprint-of-a-coca-cola.html
- Coltro, L., Mourad, A., Kletecke, R., Mendonça, T., Germer, S. (2009) Assessing the environmental profile of orange production in Brazil. The International Journal of Life Cycle Assessment 14, 656-664.
- Coltro, L., Mourad, A., Oliveira, P., Baddini, J., Kletecke, R. (2006) Environmental Profile of Brazilian Green Coffee (6 pp). Int J LCA 11, 16-21.
- Cordella, M., Tugnoli, A., Spadoni, G., Santarelli, F., Zangrando, T. (2008) LCA of an Italian lager beer. The International Journal of Life Cycle Assessment 13, 133-139.
- Dalgaard, R Niels Halberg & John E. Hermansen (2007) Danish pork production - An environmental assessment
- Davis, J., Sonesson, U. (2008) Life cycle assessment of integrated food chains—a Swedish case study of two chicken meals. The International Journal of Life Cycle Assessment 13, 574-584.
- Davies RWD, Cripps, SJ, Nickson, A, and Porter G. Defining and estimating global marine fisheries by-catch. Marine Policy (2009), doi:10.1016/j.marpol.2009.01.003
- de Boer, I.J.M. (2003) Environmental impact assessment of conventional and organic milk production. Livestock Production Science 80, 69-77.
- DECC (2010) Energy Consumption in the UK, Domestic data tables, 2010 Update http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx
- Defra (2011) Food Statistics Pocketbook. http://www.defra.gov.uk/statistics/
- De Saxce, M., Pesnel, S., Perwuelz, A. (2012) LCA of bed sheets – some relevant parameters for lifetime assessment. Journal of Cleaner Production 37, 221-228.
- Dekker, S.E.M., Boer, I.J.M.d., Aarnink, A.J.A., Groot Koerkamp, P.W.G., (2008) Environmental hotspot identification of organic egg production, Proceedings of the 6th International Conference Life Cycle Assessment in the Agri-food sector, 12 - 14 November, 2008, Zurich, Switzerland.

- Deng, L., Babbitt, C.W., Williams, E.D. (2011) Economic-balance hybrid LCA extended with uncertainty analysis: case study of a laptop computer. Journal of Cleaner Production 19, 1198-1206.
- Dewaele, J., Pant, R., Schowanek, D., (2006) Comparative Life Cycle Assessment (LCA) of Ariel "Actif à froid" (2006), a laundry detergent that allows to wash at colder wash temperatures, with previous Ariel laundry detergents (1998, 2001). Procter & Gamble, Brussels, p. 109.
- Dole (2009), Carbon footprint of bananas
- Dutilh, C.E., Kramer, K.J. (2000) Energy Consumption in the Food Chain: Comparing alternative options in food production and consumption. Ambio 29, 98-101.
- EBLEX, Beef & sheep roadmap, Phase 3
- EC (2009). Directive 2009/28/EC of the European Parliament and of the Council. The promotion of the use of energy from renewable sources. European Commission, Brussels.
- EC (2012) EU Ministers reach general compromise on the main proposals for reforming the Common Fisheries Policy http://ec.europa.eu/commission_2010-2014/damanaki/headlines/press-releases/2012/06/20120612-1_en.html
- Eco- quantum (2011) Greenhouse Gas Life Cycle Assessment of Canning Peaches and Pears grown in Northern Victoria
- Eide, M. (2002) Life cycle assessment (LCA) of industrial milk production. The International Journal of Life Cycle Assessment 7, 115-126.
- Ellingsen, H., Aanondsen, A. (2006) Environmental impacts of wild caught cod and farmed salmon - A comparison with chicken. International Journal of Life Cycle Assessment 11, 60-65.
- Erzinger, S., Dux, D., Zimmermann, A., Badertscher, R., (2003) LCA of Animal Products from Different Housing Systems: Relevance of Feedstuffs, Infrastructure and Energy Use, 4th International Conference on Life Cycle Assessment in the Agri-food sector, Horsens.
- Espinoza-Orias, N. Stichnothe, H., Azapagic, N., The carbon footprint of bread. International Journal of LCA. Volume 16, Number 4, 351-365
- Feschet, P., Loeillet, D., (2009) ACV simplifiée des productions agricoles d'exportation des DOM - Le cas du melon - Résumé. Etude ODEADOM-Cirad. CIRAD, Montpellier.
- Foster, C., Audsley, E., Williams, A., Webster, S., Dewick, P., Green, K., (2007) The Environmental, Social and Economic Impacts Associated with Liquid Milk Consumption in the UK and its Production A Review of Literature and Evidence - Defra Project Code EVO 2067. Defra, The University of Manchester, EuGeos, Delta-innovation and Cranfield University, London.
- Foster, C., Green, K., Bleda, M., Dewick, P., Evans, B., Flynn, A., Mylan, J., (2006) Environmental impacts of food production and consumption: a report to the Department for Environment, Food and Rural Affairs. Manchester Business School and Defra, London.
- Four Elements, (2011) Life Cycle Envronmental Impact Study. HP LaserJet Toner Cartridges vs. Remanufactured Cartridges in Europe. Summary Report prepared for Hewlett Packard Company. Four Elements Consulting, LLC.
- Fuentes, C., Carlsson-Kanyama, A., Biel, A., Bergstrom, K., Lagerberg-Fogelberg, C., Shanahan, H., Soler, C., Grankvist, G., (2006) Environmental information in the food supply system. FOI - Swedish Defence Research Agency, Stockholm.
- Garnet (2006) Fruit and Vegetables and UK Greenhouse Gas Emissions: Exploring the Relationship

- Gaines, L.L., Stodolsky, F., (1996) Is recycling the best policy option? Insights from Life Cycle Analysis. Energy Systems Division, Argonne National Laboratory, Illinois, p. 15.
- Goldberg (2008) The Carbon Footprints of Beef and Lamb, A Lifecycle Approach to Measuring the Sustainability of New Zealand's Primary Produce
- Grönroos, J., Seppälä, J., Voutilainen, P., Seuri, P., Koikkalainen, K. (2006) Energy use in conventional and organic milk and rye bread production in Finland. Agriculture, Ecosystems & Environment 117, 109-118.
- Gustavsson, J., Cederberg, C., Sonesson, U., Otterdijk, R. v., and Meybeck, A. (2011). Global Food Losses and Food Waste. FAO Rome, Italy Retrieved August 29, 2012, from
- http://www.fao.org/docrep/014/mb060e/mb060e00.pdf
- Haas, G., Wetterich, F., Köpke, U. (2001) Comparing intensive, extensified and organic grassland farming in southern Germany by process life cycle assessment. Agriculture, Ecosystems & Environment 83, 43-53.
- Hospido, A., Milà i Canals, L., McLaren, S., Truninger, M., Edwards-Jones, G., Clift, R. (2009) The role of seasonality in lettuce consumption: a case study of environmental and social aspects. The International Journal of Life Cycle Assessment 14, 381-391.
- Hospido, A., Moreira, M.T., Feijoo, G. (2003) Simplified life cycle assessment of galician milk production. International Dairy Journal 13, 783-796.
- Hospido, A., Milà i Canals, L., McLaren, S., Truniger, M., Edward-Jones, G., Clift, R., 2009. The role of seasonality in lettuce consumption: a case study of environmental and social aspects. International Journal of Life Cycle Assessment, 14 (2009) pp. 381-391.
- Humbert, S., Loerincik, Y., Rossi, V., Margni, M., Jolliet, O. (2009) Life cycle assessment of spray dried soluble coffee and comparison with alternatives (drip filter and capsule espresso). Journal of Cleaner Production 17, 1351-1358.
- INCPEN, (2009) Table for One: the energy cost to feed one person. Industry Council for Packaging and the Environment (INCPEN), Reading.
- Ingwersen, W.W. (2012) Life cycle assessment of fresh pineapple from Costa Rica. Journal of Cleaner Production 35, 152-163.
- James, R., Archer, M., Henderson, J., Garrett, A. (2010). Resource Maps for Fish across Retails and Wholesale Supply Chains. Confidential.
- Kingsmill (2012) from http://www.kingsmillbread.com/fresh-thinking/environment/carbon-footprint/
- Katajajuuri, J.-M., Grönroos, J., Usva, K., (2009) Environmental impacts and related improvement options of supply chain of chicken meat, in: Nemecek, T., Gaillard, G. (Eds.), 6th International Conference on Life Cycle Assessment in the Agri-Food Sector – Towards a sustainable management of the Food chain. Agroscope Reckenholz-Tänikon Research Station ART, Zurich, Switzerland.
- Kelleher, K. (2005) Discards in the world's marine fisheries. An update. FAO Fisheries Technical Paper. No. 470. Rome, FAO ftp://ftp.fao.org/docrep/fao/008/y5936e/y5936e01.pdf
- Milepost (2012) Left-Out An Investigation of the Causes & Quantities of Crop Shrink Natural Resources Defense Council, New York http://www.nrdc.org/food/crop-shrink.asp
- Kim, S., Dale, B., Jenkins, R. (2009) Life cycle assessment of corn grain and corn stover in the United States. The International Journal of Life Cycle Assessment 14, 160-174.
- Koehler, A., Wildbolz, C. (2009) Comparing the Environmental Footprints of Home-Care and Personal-Hygiene Products: The Relevance of Different Life-Cycle Phases. Environmental Science & Technology 43, 8643-8651.

- Kooijman, J. (1993) Environmental assessment of packaging: Sense and sensibility. Environmental Management 17, 575-586.
- Labouze, E., Schultzem, A., Benito, P., (2008) Eco-Emballages. Analyses de Cycle de Vie de produits vendus préemballés, à la coupe et en vrac. Etude de cas: champignons. Rapport Final. Bio Intelligence Service, Ivry-sur-Seine, p. 132.
- Lafontaine, M., Gilbert, D., Saad, R., Margni, M., Reveret, J.-P., (2012) Environmental Life Cycle Assessment of Milk in Canada, in: Corson, M.S., Van der Werf, H.M.G. (Eds.), Proceedings of the 8th International Conference on Life Cycle Assessment in the Agri-Food Sector. INRA, St. Malo, France, pp. 327-332.
- Lantmannen-Unibake (2011) Croissant climate declaration
- Leonardi, R., Giacomazzi, M., (2008) Environmental Product Declaration: Bottled Red Sparkling Wine "Grasparossa Righi". Consorzio Interprovinciale Vini, Modena.
- Lillywhite, R.D., Sarrouy, C., Davidson, J., (2012) Energy dependency and Food Chain Security. Final report of Defra Project FO0415. University of Warwick/Defra, London.
- Liu, Y., Langer, V., Høgh-Jensen, H., Egelyng, H. (2010) Life Cycle Assessment of fossil energy use and greenhouse gas emissions in Chinese pear production. Journal of Cleaner Production 18, 1423-1430.
- Madsen, J., (2007) Life Cycle Assessment of Tissue Products. Environmental Resources Management (ERM), Frankfurt, Germany, p. 135.
- Manda, B.M.K., Blok, K., Patel, M.K. (2012) Innovations in papermaking: An LCA of printing and writing paper from conventional and high yield pulp. Science of The Total Environment 439, 307-320.
- Mars, Carbon footprint of Dolmio Tomato Pasta Sauce, 575g jar
- Mattsson, B., Wallen, E. (2003) Environmental Life Cycle Assessment (LCA) of organic potatoes. Acta Horticulturae 619, 427-435.
- Mekonnen, M.M. and Hoekstra, A.Y. (2010) The green, blue and grey water footprint of farm animals and animal products, Value of Water Research Report Series No.48, UNESCO-IHE.
- Mey Selections (2012) http://www.mey-selections.com/03_climate_labelling.html
- Migros, Carbon footprint of Twist Hobby kitchn roll
- Milà i Canals, S., Sim, S., García-Suárez, T., Neuer, G., Herstein, K., Kerr, C., Rigarlsford, G., King, H. (2011). Estimating the greenhouse gas footprint of Knorr, International Journal of Life Cycle Assessment, 16, pp.50-58.
- Milà i Canals, L., Burnip, G.M., Cowell, S.J. (2006a) Evaluation of the environmental impacts of apple production using Life Cycle Assessment (LCA): Case study in New Zealand. Agriculture, Ecosystems & Environment 114, 226-238.
- Milà i Canals, L., Cowell, S., Sim, S., Basson, L. (2007) Comparing domestic versus imported apples: A focus on energy use. Environmental Science and Pollution Research - International 14, 338-344.
- Milà i Canals, L., Cowell, S.J., Hospido, A., Jones, D., Koerber, G., Cross, P., Hounsome, B., Edwards-Jones, G., (2006b) LCA of Horticultural Crops including Indicator of Pesticides Rating. Centre for Environmental Strategy, university of Surrey, Surrey.
- Milà i Canals, L., Munoz, I., Hospido, A., Plassmann, K., McLaren, S., (2008) Life Cycle Assessment (LCA) of domestic vs. imported vegetables. Case study on broccoli, salad crops and green beans. Centre for Environmental Strategy, Guildford.

- Nemecek, T., Weiler, K., Plassmann, K., Schnetzer, J., (2011) Geographical extrapolation of environmental impact of crops - Unilever-ART project no. CH-2009-0362 0 Final report phase 2. Agroscope Art, Zurich.
- Nilsson, K., Flysjö, A., Davis, J., Sim, S., Unger, N., Bell, S. (2010) Comparative life cycle assessment of margarine and butter consumed in the UK, Germany and France. The International Journal of Life Cycle Assessment 15, 916-926.
- Nilsson, K., Sund, V., Floren, B., (2011) The environmental impact of the consumption fo sweets, crisps and soft drinks. Nordic Council of Ministers, Copenhagen.
- Otarian (2012) http://www.otarian.com/love-food/menu-uk.html
- Pepsico http://www.walkerscarbonfootprint.co.uk/pdf/qa.pdf
- Papatryphon, E., Petit, J., Van der Werf, H.M.G., Kaushik, S.J., (2003) Life Cycle Assessment of trout farming in France: a farm level approach, in: Halberg, N. (Ed.), 4th International Conference on Life Cycle Assessment in the Agri-food sector, Bygholm, Denmark, pp. 71-77.
- Pelletier, N., Tyedmers, P., Sonesson, U., Scholz, A., Ziegler, F., Flysjo, A., Kruse, S., Cancino, B., Silverman, H. (2009) Not All Salmon Are Created Equal: Life Cycle Assessment (LCA) of Global Salmon Farming Systems. Environmental Science & Technology 43, 8730-8736.
- Peters, G.M., Rowley, H.V., Wiedemann, S., Tucker, R., Short, M.D., Schulz, M. (2010) Red Meat Production in Australia: Life Cycle Assessment and Comparison with Overseas Studies. Environmental Science & Technology 44, 1327-1332.
- Point, E., Tyedmers, P., Naugler, C. (2012) Life cycle environmental impacts of wine production and consumption in Nova Scotia, Canada. Journal of Cleaner Production 27, 11-20.
- Quantis (2012) Présentation du référentield'évaluation de l'impact environnemental des produits laitiers en France
- RD&T (2012) Carbon emissions from chilled and frozen cold chains for a typical UK Sunday roast chicken meal (Energy CO_2e emissions only - rough estimate)
- Refsgaard, K., Halberg, N., Kristensen, E.S. (1998) Energy utilization in crop and dairy production in organic and conventional livestock production systems. Agricultural Systems 57, 599-630.
- Renouf, M., (2006) LCA of Queensland cane sugar – Lessons for the application of LCA to cropping systems in Australia, 5th Australian Conference on Life Cycle Assessment. Achieving business benefits from managing life cycle impacts, Melbourne, Australia.
- Ritthoff, M., Rhon, H., Liedtke, C., (2002) Calculating MIPS Resource Productivity of products and services, Wuppertal Institute for Climate, Environment and Energy North Rhine-Westphalia Germany http://www.econstor.eu/bitstream/10419/59294/1/485276682.pdf
- Rose, B.J., (2010) GHG-Energy Calc Background Paper.
- Ruini, L., (2012) Environmental Product Declaration of durum wheat semolina dried Pasta in paperboard box (brand Barilla). Barilla Group, Parma.
- San Benedetto Spa, Breedveld, L., (2010) Environmental Product Declaration Acqua Minerale Naturale Oligominerale San Benedetto on 0.5l, 1.5l, 2.0l PET bottles. San Benedetto Spa, Scorzé, Italy.
- Saunders, C., Barber, A., Taylor, G. (2006) Food miles - comparative energy / emissions performance of New Zealand's agriculture industry. Lincoln University. Agribusiness and Economics Research Unit., Canterbury, N.Z.

- Scholz, A., Sonesson, U., Tyedmers, P. (2009) Global Salmon LCA: Closed-containment aquaculture. Ecotrust, The Swedish Institute for Food and Biotechnology and Dalhousie University, Stockholm.
- Sheane et al (2011) Identifying opportunities to reduce the carbon footprint associated with the Scottish dairy supply chain - Main report. Edinburgh: Scottish Government
- Sonesson, U., Mattsson, B., Nybrant, T., Ohlsson, T. (2005) Industrial processing versus home cooking: an environmental comparison between three ways to prepare a meal. Ambio 34, 414-421.
- Tesco (2012) http://www.tescoplc.com/assets/files/cms/Tesco_Product_Carbon_Footprints_Summary(1).pdf
- Thomassen, M.A., van Calker, K.J., Smits, M.C.J., Iepema, G.L., de Boer, I.J.M. (2008) Life cycle assessment of conventional and organic milk production in the Netherlands. Agricultural Systems 96, 95-107.
- Thrane, M., (2004) Environmental impacts from Danish fish products: Hot spots and environmental policies, Department of Development and Planning. Aalborg University, Aalborg, Denmark, p. 535.
- Tukker, A. Huppes, G., Guinée, J., Heijungs, R., de Koning, A., van Oers, L., Suh, S. Geerken, T., Van Holderbeke, M., Jansen, B., Nielsen, P. (2006) Environmental Impact of Products (EIPRO) - Analysis of the life cycle environmental impacts related to the final consumption of the EU-25. Annex Report. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1429
- Tynelius G. (2008). Klimatpåverkan från Axa havregryn i ett LCA-perspektiv. Lantmännen.
- Tynelius G. (2009). Climate impact from Lantmännen Unibake´s Danish pastry Maple pecan. Lantmännen
- Tzilivakis, J., Jaggard, K., Lewis, K.A., May, M., Warner, D.J. (2005a) Environmental impact and economic assessment for UK sugar beet production systems. Agriculture, Ecosystems & Environment 107, 341-358.
- Tzilivakis, J., Warner, D.J., May, M., Lewis, K.A., Jaggard, K. (2005b) An assessment of the energy inputs and greenhouse gas emissions in sugar beet (Beta vulgaris) production in the UK. Agricultural Systems 85, 101-119.
- Van Hoof, G., Schowanek, D., Feijtel, T.C.J. (2003) Comparative Life-Cycle Assessment of Laundry Detergent Formulations in the UK. Tenside Surf. Det . 40, 266-276.
- Wallén, A., Brandt, N., Wennersten, R. (2004) Does the Swedish consumer's choice of food influence greenhouse gas emissions? Environmental Science & Policy 7, 525-535.
- Wiedemann, S.G., McGahan, E.J., (2011) Environmental Assessment of an Egg Production Supply Chain using Life Cycle Assessment. Final Project Report AECL Publication No 1FS091A. Australian Egg Corporation Limited, Sydney.
- Williams, A., Audsley, E., Sandars, D.L., (2012) A systems-LCA model of the stratified UK sheep industry, in: Corson, M.S., Van der Werf, H.M.G. (Eds.), Proceedings of the 8th International Conference on LCA in the Agri-Food Sector, St. Malo, France, pp. 304-309.
- Williams, A.G., Audsley, E., Sandars, D.L., (2006) Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities, Main Report. Defra Research Project IS0205. Cranfield University and Defra, Bedford.
- Williams et al (2008) Comparative life-cycle assessment of food commodities procured for UK consumption through a diversity of supply chains - FO0103

- Williams, A.G., Pell, E., Webb, J., Moorhouse, E., Audsley, E., (2009) Strawberry and tomato production for the UK compared between the UK and Spain, in: Nemecek, T., Gaillard, G. (Eds.), 6th International Conference on LCA in the Agri-Food Sector – Towards a sustainable management of the Food chain. Agroscope Reckenholz-Tänikon Research Station ART, Zurich, Switzerland, pp. 254-262.
- Williams, E. (2004) Energy Intensity of Computer Manufacturing: Hybrid Assessment Combining Process and Economic Input–Output Methods. Environmental Science & Technology 38, 6166-6174.
- WRAP (2009) Household Food and Drink Waste in the UK. http://www.wrap.org.uk/downloads/Household_Food_and_Drink_Waste_in_the_UK_Nov_2011.1e40584f.8048.pdf
- WRAP (2010) Waste in the supply of food and drink to households in the UK
- WRAP (2010), Tool for Identification of Environmental Hotspots for Drinks consumed in the UK (.xlsx file). Scenarios extracted.
- WRAP (2011a) New Estimates for Household Food and Drink Waste in the UK
- WRAP (2011b) The Nature and Scale of Waste Generated by the UK Hospitality and Food Service Industry: Completing the Evidence Base WRAP, Banbury
- http://www.wrap.org.uk/content/hospitality-and-food-service-wraps-work-0
- WRAP (2012) Reducing the environmental & cost impacts of electrical products. RNF200-001
- WRAP/Valpak (2012) Packaging pyramid (Unpublished)
- Wuppertal Institute (2011) Material intensity of materials, fuels, transport services, food Wuppertal Institute for Climate, Environment and Energy North Rhine-Westphalia Germany http://wupperinst.org/uploads/tx_wupperinst/MIT_2011.pdf
- Yoshikawa, N., Amano, K., and Shimada, K., 2006. The quantitative Evaluation of Environmental Load on Fruits and Vegetables Consumption and its Reduction Potential. Environmental Systems Research, 34 pp. 245-251.
- Ziegler, F., Eichelsheim, J.L., Emanuelsson, A., Flysjö, A., Ndiaye, V., Thrane, M., (2009) Life cycle assessment of southern pink shrimp products from Senegal : An environmental comparison between artisanal fisheries in the Casamance region and a trawl fishery based in Dakar. Food and Agriculture Organization of the United Nations, FAO, Rome, p. 21.
- Ziegler, F., Hansson, P.-A. (2003) Emissions from fuel combustion in Swedish cod fishery. Journal of Cleaner Production 11, 303-314.
- Ziegler, F., Nilsson, P., Mattsson, B., Walther, Y. (2003) Life Cycle assessment of frozen cod fillets including fishery-specific environmental impacts. The International Journal of Life Cycle Assessment 8, 39-47.

Product Sustainability Forum

The Old Academy
21 Horse Fair
Banbury, Oxon
OX16 0AH

Tel: 01295 819 900
Fax: 01295 819 911

Helpline freephone
0808 100 2040

www.wrap.org.uk/psf

recycle