Product Carbon Footprinting for Beginners

Guidance for smaller businesses on tackling the carbon footprinting challenge

bsi.

...making excellence a habit.™

Acknowledgements

This Guide was enabled by the Department for Business, Innovation and Skills as part of its ongoing commitment to supporting innovation in the UK.

Department for Business Innovation & Skills

Acknowledgement is given to **Bethany Field** and **Craig Simmons** of **Anthesis Group** who authored the Guide.

Acknowledgement is also given to the following organizations who assisted in its development:

ERM

EuGeos

Seafish

Supported by the Department for Environment, Food and Rural Affairs

Department for Environment Food & Rural Affairs

Contents

1. Introduction

Aims and intended audience

The aim of this Guide is to provide non-technical guidance on product carbon footprinting (PCF)[1] to enable specific sectors or organizations with limited experience (especially small and medium sized enterprises or SMEs) to take the first steps in calculating the carbon footprints[2] of their products. SMEs may find starting a PCF project daunting as they do not always have the capacity or resources to undergo training or to outsource subcontractors. The requirements contained in standards are often very technical, and are sometimes unnecessary for the level of product assessments that some smaller organizations may want to carry out.

In order to address this issue, this document has been developed to provide more practical guidance, through the help of case studies. The guidance is intended to help the reader identify what they need to know and how to get the necessary information. It can be used in planning, conducting and reviewing a carbon footprint. This Guide is not intended for those wishing to undertake more formal life cycle PCFs in accordance with official standards; but instead provides a simple guidance framework for those new to PCF with practical insights on the process, challenges and benefits. Through this process organizations will learn more about the environmental impact of their product or service system and find opportunities to reduce the main impacts within the life cycle.

What is a carbon footprint, and how is it used?

Every product (a good or service) has an impact on the environment. In a world facing multiple crises of resource depletion, the pollution of air, water and soils, and climate change, there is a need to work towards reducing these impacts to make our products fit for a more sustainable future. It is important to be able to measure the carbon intensity specifically in order to understand and reduce the impact on climate change. Greenhouse gas/emissions, which are the sources of climate change, can originate from a number of different processes including those highlighted in **Figure 1**.

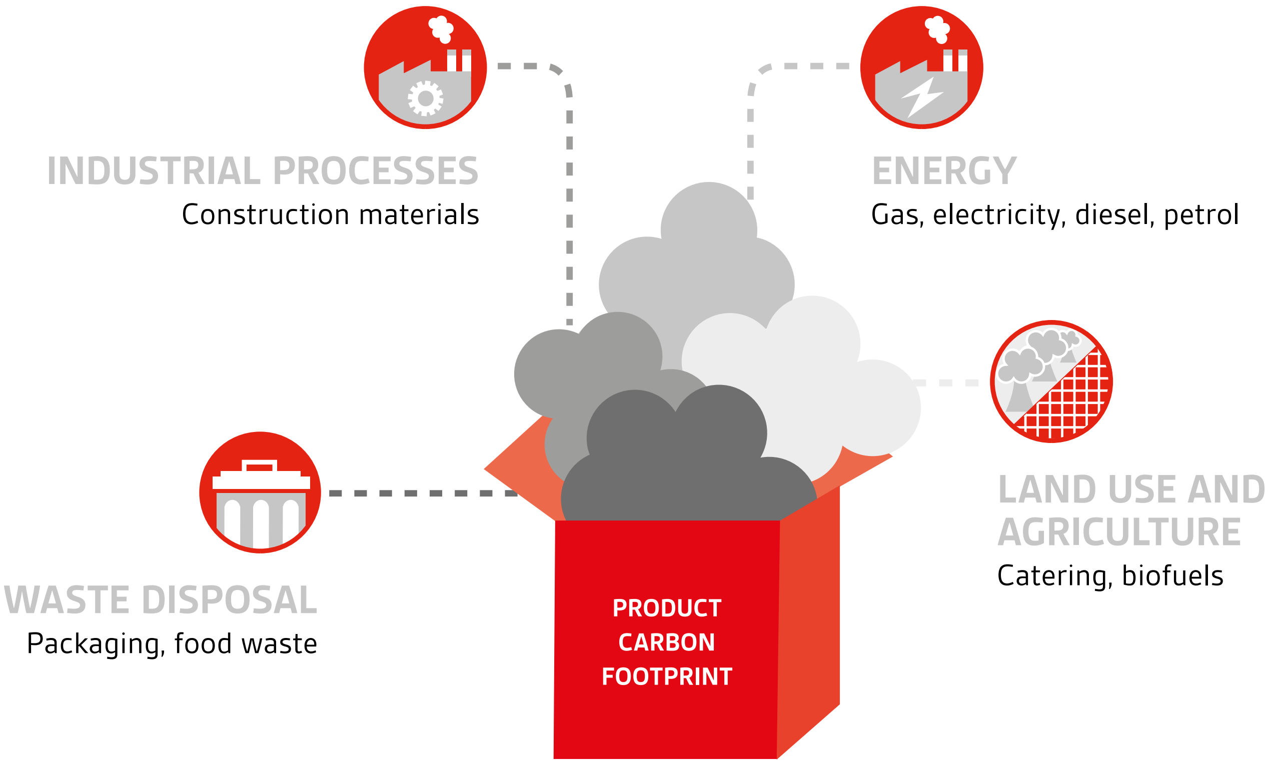
A product carbon footprint communicates the quantity of greenhouse gas emissions that are produced or consumed during the life cycle of a product[3]. The product footprint can be expressed as an annualized impact or on a per use or dosage basis. For example, the footprint of a car could be expressed per year of ownership or per kilometer travelled. A personal care product such as shower gel may be based on the footprint for one typical shower (and include the hot water from the shower not just the production of the gel). No footprint study is ever perfect; they are always a 'best estimate' of the emissions from a particular snapshot in time, based on the available data.

[1] Product carbon footprint (PCF) – a carbon footprint of a product or service rather than an organization.

[2] Carbon Footprint – measurement of global greenhouse gas emissions associated with a product, service, organization, region, industry, nation, etc... Carbon Dioxide (CO_2) is the primary greenhouse gas. Carbon footprints are reported in Carbon Dioxide Equivalents (CO_2e), which measure the global warming potential of the six main reported human-induced greenhouse gases (CO_2, CH_4, NO_2, SF_6, HFCs, PFCs) in relation to CO_2.

[3] Life Cycle – the phases comprising the entire life of a product or service (e.g. sourcing, manufacturing, use and disposal). Life Cycle Assessment (LCA) is the quantification of the environmental impacts across selected categories arising during the life cycle of a product or service. Life Cycle Inventory (LCI) is a list detailing the inputs from nature and the outputs to nature and the techno-sphere of a production process.

Figure 1 – The sources of GHG emissions from the manufacture of a product



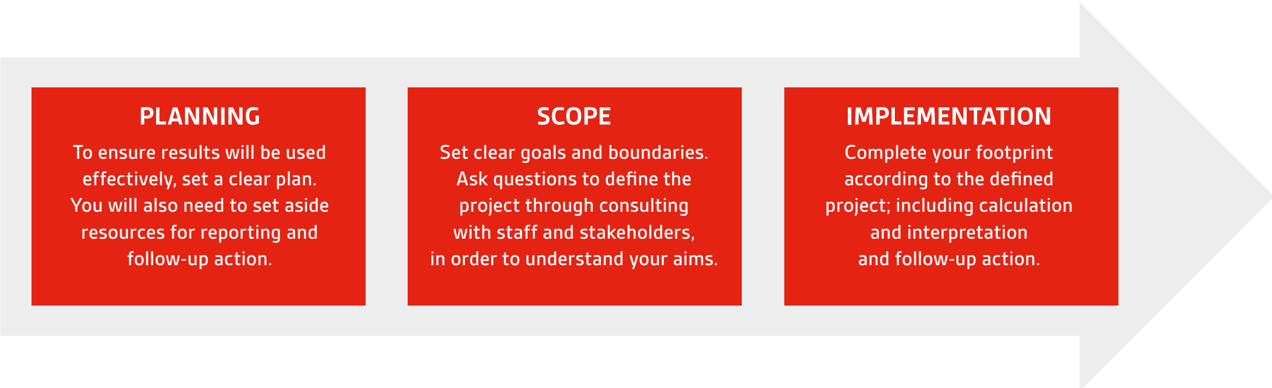
Even a relatively simple analysis of a product's carbon footprint can help frame an action plan to mitigate carbon emissions and deliver efficiency savings. For example, a simple footprint of an electrical product can help determine the relative improvements from addressing energy efficiency in product use, product life extension, manufacturing efficiency or substitution of raw materials. The footprint can be used for a number of different benefits (please refer to Section 3 for the main drivers).

Some of the key challenges, which are covered through case studies in this document, include defining the unit of the study, managing certain accounting and calculation rules (including allocation, conversion of units and analysis of consumer use and end of life), and data sourcing challenges. Data sourcing can often cause significant delays to projects. Interpretation of the data is usually the most rewarding element of the work when the time taken to gather data is converted into tangible results that can be used to find reduction opportunities. There can be challenges in this as often the most high impact areas can be those that are most difficult to control (such as raw material sources or use phase). In these cases, collaboration with suppliers and industry can lead to the most efficient reduction projects.

2. Planning a project

It is important to plan the project well in order to ensure that the aims of your project are met (please refer to Section 3, Business Aims and Goals). The scope and definition of the project will also feed into this planning process; which will then be followed by implementation of the project and follow-up actions.

Figure 2 – Planning a project

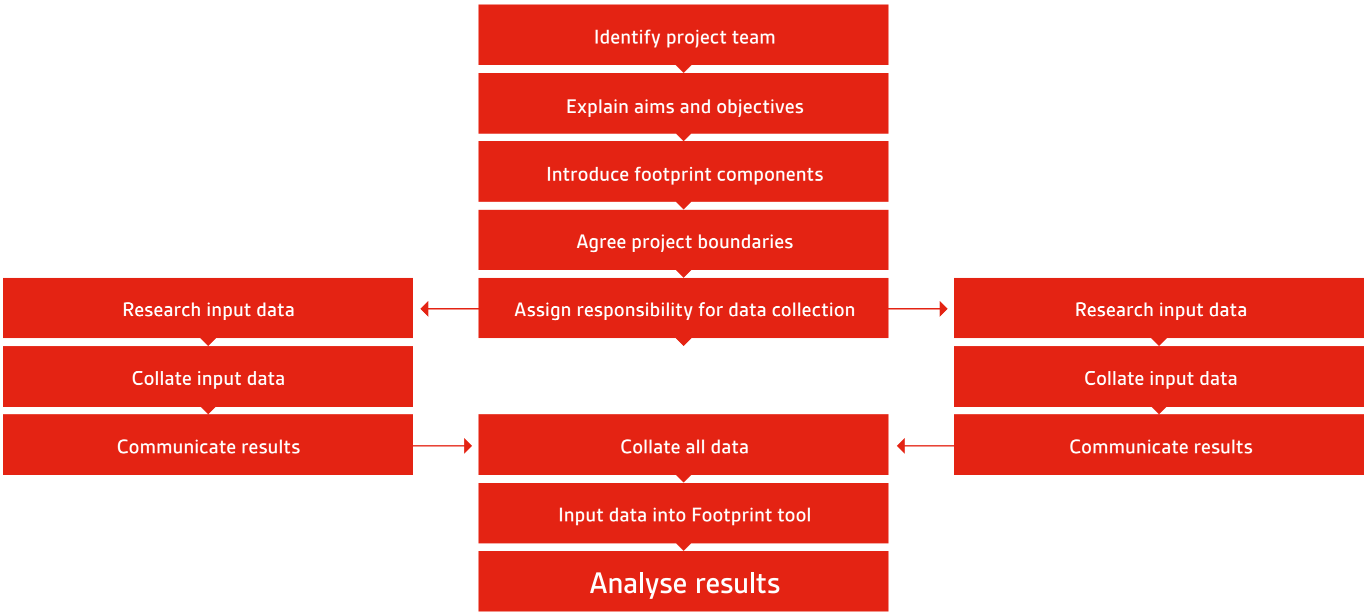


You should expect to devote a full third of the project's resources to interpretation and planning of future actions to gain the full benefit from your project. The actions to plan for will depend on your aims, see Section 3, Business aims and goals for further details. You may also wish to put aside some capacity for dealing with unexpected discoveries. Product carbon footprint studies can uncover many new possibilities, including opportunities for efficiency gains, existing good practice on which you aren't fully capitalizing, and new chances for innovation.

Detailed project process

It is important to plan the project around each core process within footprinting. Figure 3 sets out the overall steps involved and how to plan the project.

Figure 3 – Project process



Allocating resources

The first thing to consider when commissioning the footprint study is: do you have the necessary knowledge and experience amongst your own staff? If so, you may wish to conduct an in-house study. In this case, be sure to allocate enough staff time to carry out the research properly, and utilize training sessions and/or footprinting tools to support this work (see Section 10, Tools and resources section). If you are undertaking a footprint for the first time and are using this guidance document as a reference, it is likely you are going to use internal resources and 'learn on the job'; internal resources can be developed in this area.

In addition to those who are performing the footprint, you will also need to allocate resources to those who are supporting the data capture which is often the most challenging and time consuming phase of the work. Ensuring enough support for this process is important for its success. For example, you may need to work closely with the procurement team to go through the data required on raw materials and utilities procured, i.e. where it can be obtained from and in what time period.

You may decide that you do not have the necessary skills and/or resources within your company, and it would therefore make sense to use an external consultant or academic experts. If you do use a contractor, there are a number of issues to consider. For example, they need to be responsive to your organizations' specific needs, honest about being able to meet your expectations and have a proven track record in your industry sector. Will they tell you upfront if part of your proposal won't work or needs improving? It is also important to ask if they will give you access to their calculation tools or spreadsheets for in-house usage, so you can continue your assessments.

It is important to allocate the necessary resources in terms of time and money if using an external contractor. Either way, you will need to set aside staff capacity for the project; even if the bulk of the work is completed by a contractor your staff will need time to collect and check the data, and to feed into the project's aims and reduction plans.

How long will it take?

A product carbon footprint project could take from 2–3 months for a scoping study and from 6 months to a year for a more detailed footprint which involves primary data collection. Data collection delays are the main cause of project delays, so enough time needs to be allocated to gathering the necessary information. It is important to give staff plenty of warning and support; and set a deadline for data collection so that the project can be completed on schedule. Using a data specification and being clear on exactly what is needed, in which unit and to what level of detail, will avoid delay later. Although this stage can be challenging, it can also provide insights early on, and will help further define the project scope.

What are the barriers?

There are a number of barriers that may be experienced when launching a project. This guidance contains case studies on some specific technical challenges once the study has started, but there are also some other more general challenges at the start, summarized in Figure 4 below. In addition, sourcing of data from suppliers can be a major stumbling block; especially for complex products where full traceability for all materials used is not in place. Therefore working with the procurement team to gather sufficient data from the first level of suppliers is important as they may then be able to engage further down their supply chain. It may not be possible for a small project to gather data further down the supply chain beyond the manufacturers. Data gaps can be managed as described in the data sourcing section (please refer to Section 5).

Figure 4 – Barriers to initiating a PCF project

INSUFFICIENT FINANCIAL RESOURCES

- Source enough finance for an initial scoping study that will highlight potential cost savings as well as environmental benefits.
- This will also help to make a strong case for further research that could work out to be cost efficient in the long term.

LACK OF STAFF ENGAGEMENT

- Talk to staff – why are they reluctant to participate? E.g. extra work, or disillusion with green initiatives.
- How can you ensure they have the necessary support, training and capacity?

FUTURE COMMITMENT

- Staff, customers and other stakeholders may expect you to follow through and tackle your environmental impacts.
- This is positive; there are many potential benefits to taking further action, from efficiency savings to brand enhancement.

3. Business aims and goals

Product carbon footprints allow organizations to understand the climate impact of the items they produce and services they supply. There are a number of good business reasons for undertaking PCFs. For example, a footprint may be used for internal improvement (e.g. for designing in efficiency/cost reduction) or external communication to customers/consumers (e.g. building a brand); or both. Figure 5 identifies some of the key drivers; and the links between the drivers and the definition of the project. This is further explored in Section 4, Determining the scope and boundary.

Customer requirements may be particularly significant for an SME. In general, there is an increase in demand for lower carbon products which drives your customers, who may be retailers, to increase their range on the shelves. According to the Carbon Trust, who conducted a survey into consumer buying habits in 2011, 45% of shoppers would be prepared to stop buying their favourite brands if the brand refused to commit to measuring their product carbon footprint. Brand ethos can also be very important to SMEs, in order to differentiate from the competition. Case study 1 presents a case where this is the driving factor, in order for the company to market green credentials.

This document primarily offers a way to complete a simple and scaled down product carbon footprint in order to find out the minimum you need to know to meet your objective. Not all the drivers listed and the resulting type of project will be supported by this guidance document as the type of footprint required will vary depending on the exact nature of these drivers. For example, one customer will have more stringent requirements on footprint accuracy than another. There are signposts in this document as to where to find further information on certain concepts, which may be required by those who need to complete a more advanced (yet not standard compliant) footprint.

Figure 5 – Key drivers for conducting a product carbon footprint

Company Ethos

Use results of footprint study to manage and reduce negative impacts

- **Organizational strategy and ethics** – Overall approach to sustainability will drive specific projects
- **Employee satisfaction** – The vast majority of employees prefer working for green companies (Gallup)
- **Internal communications** – In order to further motivate internal engagement on sustainability projects

Market Demand

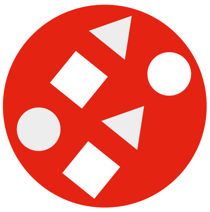
Use footprint for marketing benefits

- **Customer requirements and external communication** – E.g. retailers demand climate information from suppliers
- **Brand differentiation** – Differentiation from competitors has market benefits
- **Reputation risk** – Identify high profile issues and manage these through footprinting and action plans

Legislation and Compliance

Use footprint to meet regulatory requirements

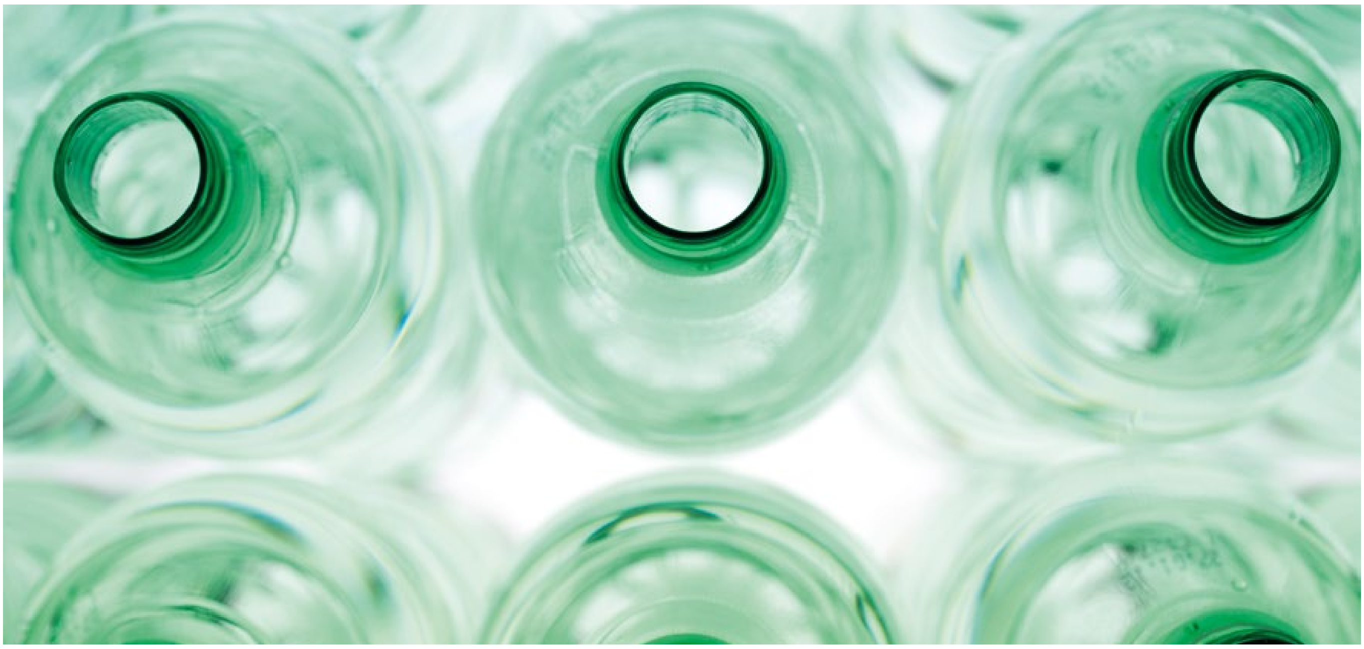
- **Compliance to reporting legislation** – Legislation requires carbon disclosure and this could be at product level in the future



Resource Efficiency

Use footprint to maximize efficiency of resources and save costs

- **Identify resource and cost saving opportunities** – The most significant sources of GHG are often linked to items that cost money e.g. they use more energy
- **Managing resource risk** – Identify key raw materials relied upon and if they are at risk in the future



Case Study 1

Using carbon footprints to differentiate from the competition

Belu: Sustainability as part of the brand identity

Company

Belu is a mineral water company which differentiates itself through reducing environmental impacts, using all profits to fund clean water projects and promoting and supporting various social initiatives.

Project

Belu has always looked to understand and reduce the carbon impacts of its products and the most recent stage of this journey was to footprint their operations for 2012 and categorize the footprint by their three key product groups, which are bottle material: clear glass, green glass and rPet. These three key product groups allowed the company to understand where the material impacts were without going into too much detail that would drown out the main messages. The project succeeded in:

- Identifying the effectiveness of implemented carbon reduction actions;
- Providing the confidence and support to continue to effectively promote their sustainable performance;
- Identifying the best strategy and methodology for carbon reduction for 2014.

Walking the talk – evidence base for sustainability communications

Belu's sustainability credentials are prominently promoted on all communications, whether it is product labels, the company website or press releases. As carbon is a significant part of their sustainability story, it is imperative that their carbon management can withstand the highest scrutiny. Therefore there is a clear and compelling case for the company to invest appropriate resources into the calculation of their footprint, identification of reduction opportunities and effective promotion of their aims and achievements.

Achievements include a 22% reduction in carbon intensity per litre of product from 2010 to 2012, successful engagement with both suppliers and customers on the issue of carbon (and associated resource efficiency) to make Belu the customer/supplier of choice, and various press coverage.

4. Defining the project: scope and boundary

Choosing a product or service

Performing a PCF can be time consuming in terms of the resources and effort required. Hence choosing the product (or process) to footprint can be critical. When choosing a specific product to undergo a PCF it is helpful to take into account a number of criteria (see Table 1). Some companies take a 'product portfolio' approach initially, where this is achievable within resource constraints, in order to identify key products to focus on in more detail. The portfolio approach is a high level screening of all of a company's product range; in order to identify which products cause the biggest impact; either because the product itself is high impact or because of the amount of product manufactured and sold. This approach can provide direction and will save time and resources in the end as the focus area will be targeted. The detailed case study of a paint manufacturer in Section 9 provides an example of where this approach was taken and what the benefits were.

Table 1

Criteria for selecting a product

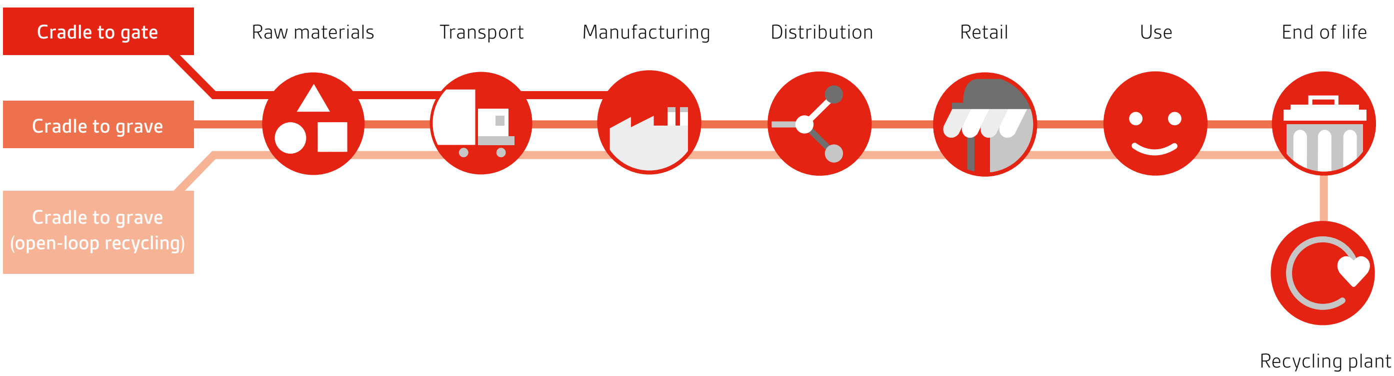
Product visibility – consider choosing a product with significant visibility (e.g. high sales, well-known, flagship). Choosing this type of project is likely to have a bigger reduction impact and positive impact on sales.
Product environmental impacts – through high level portfolio footprinting it may be possible to identify products with the biggest improvement opportunities. Performing a PCF on such a product could make the biggest overall difference on the environmental performance of the organization.
Data availability – consider data availability and where possible choose a product for which the organization has some supply chain visibility from which supplier data can be more easily and accurately obtained.

Determining the scope and boundary

It is important to be clear on what you want to know at the outset and what the boundaries of your study are. One strategy is to **make a list of key business activities and processes** that you definitely wish to include in the study, and a list of 'nice to have' elements to include if possible. This list can then form the basis of discussions with whomever you commission to conduct the study; they should be able to tell you the likely costs (in time and money) of including different things from your list, allowing you to decide what to include and exclude.

In terms of specific life cycle scope for a good or service, the study should, in general, cover all lifecycle stages, from raw material extraction, through transport, manufacture, distribution, retail and use to when the product is recycled or sent to waste management. However, depending on the purpose for which an organisation requires a PCF, boundary setting may vary. Boundary variants can include cradle to gate, cradle to grave and cradle to cradle (see Figure 6).

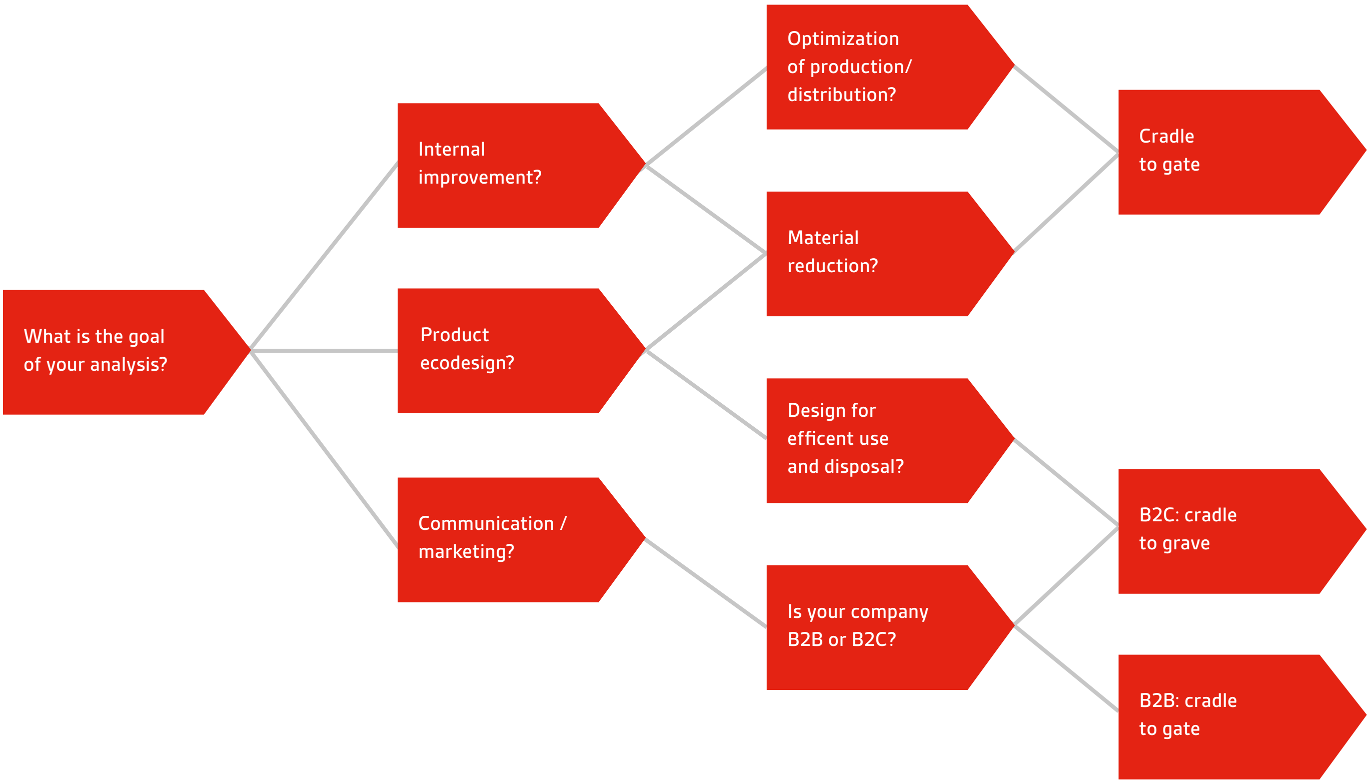
Figure 6 – Main types of product carbon footprint study boundaries



Asking the right questions will help the user to determine the correct scope to be used which is dependent on the goal of analysis. Some examples on the goal and how this impacts the scope are provided in Figure 7.

For example, if the focus is on certain life cycle stages such as the manufacturing processes, an analysis on a cradle to gate (from the raw materials to the product at factory gate) is appropriate.

Figure 7 – Decision tree to determine scope and boundary[4]



A good first step in determining what aspects of the product life cycle are significant is to identify **potential** environmental 'hot spots' using existing studies for similar products to determine where the major impacts are in the product lifecycle. Identification of these hot spots, or high impact areas, will allow organizations to focus on the most significant areas when performing a complete PCF and use the correct scope and boundary for the study.

The resources section provides information where existing studies may be found which can be used as a starting point for determining where major hot spots may occur.

For example, the WRAP Product Sustainability Forum contains multiple hot spot analyses for grocery products in the form of product summaries and a heat map.

[4] B2B: Business to business (partial life cycle or Cradle to gate);
B2C: Business to consumer (full life cycle or Cradle to grave)

Drawing a simple process map

The focus of this step is to physically draw the product system boundary lines thus creating a clear definition of what the product system to be assessed encompasses. The list of processes which you definitely want to include, and the nice to have, can be a starting point for this process map. The process map is a schematic drawing of all the material and energy flows in the life cycle stages of the product being assessed. Besides helping inform the carbon footprint practitioner about the system to be analysed, a process map is also useful to communicate in a visual way what has been included and excluded from the carbon footprint analysis. It helps to visualize the system from the start and ensure that standard requirements are met. Process maps also facilitate system improvements as one can pinpoint exact places where changes need to happen. Figure 8 provides an example of a simple process map for a small manufacturer.

Figure 8 – Mapping the product system

- SKU-level ingredient data (including scrap and giveaway)
- SKU-level data on packaging quantities

- Electricity, natural gas and water usage records
- Waste management records
- SKU production volumes (units, £ and tonnage)

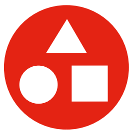
- Product storage and distribution energy data from logistics contractor
- Public sources of GHG emissions associated with activities

- Product consumer use guidelines
- UK average domestic recycling and food wastage rates

There are questions that can be asked when completing a process map which will enable a more detailed process map to be developed (see Table 2). These questions can be used to guide process map development and also to inform questionnaire development which will be needed in order to collect key data for the processes identified in the process map. This includes, for example, questions suppliers can be asked concerning the composition of raw materials and packaging. In some cases, this level of detail may not be required. If the focus is on cradle to gate study for improvement of the carbon footprint of the materials then deeper analysis of the raw materials suppliers would be needed. This would not be necessary if the focus of the study is on optimizing the transportation systems, for example.

Table 2

Development of a process map

Life cycle stage	Brainstorm process map	Refine process map through supply chain interviews
a) Materials 	What are the raw materials that make up your product (including packaging)?	• Weight and composition of raw materials and packaging of your product? • Waste types and waste management of wastes arising from incoming raw materials and packaging (i.e. are raw materials packaged?). • Waste rate of incoming raw materials and packaging (i.e. quality rejects, breakage, etc...)?
b) Logistics 	Which companies supply these raw materials?	• Location of raw material and packaging suppliers? • Method of distribution of raw materials and packaging distributed to production facilities (i.e. packaging, transport mode, distance)?
c) Production Process 	• Which manufacturing processes are undertaken to make or assemble your product? • Which types of energy are used to make or assemble your product: electricity, natural gas, fuel oil, etc...? • Waste is likely to arise throughout the production process, identify where waste arises.	• Do you purchase or generate your own electricity? • For purchased fuels, have you included these within your raw material supply list? • Can waste arising per unit of product studied be allocated? • Any significant non-attributable processes which should be included such as cleaning chemicals, heating or cooling manufacturing area, refrigerant leakage • Any significant process emissions such as decarbonization of lime for glass manufacturing? • Any significant carbon sequestration[5] during manufacturing of the product?

[5] Carbon sequestration – Atmospheric carbon fixed by plants through photosynthesis into the plant structure. Alternatively, atmospheric carbon can be chemically sequestered by cement during its lifetime, or through yet to be developed carbon storage systems.

Life cycle stage	Brainstorm process map	Refine process map through supply chain interviews
d) Logistics	• Once made, how is the product stored before and during distribution? • Is distribution of your product performed by a third party?	• Characteristics of storage and warehousing? • Is storage climate controlled? • Is lighting required? • Does waste arise during storage (damage, out of date, etc.)? • Method of distribution of finished product to your customers (i.e. packaging, transport mode, distance)?
e) In Use	• Is your product ready for retail or do you supply another organization? • What energy types or additional materials are required to use your product, e.g. electricity, water and detergent are required to use a washing machine?	• Existing model to describe the use phase for your product? • If not, is there an industry standard that specifies the normal operating conditions of your product?
f) End of Life	What are the likely disposal routes of the product once it reaches the end of its useful life: re-use, recycling, landfill, etc...?	• Any legal requirements for the disposal of your product? Is recycling required (i.e. batteries)?

Defining the functional unit

Do you want to know the impact **per tonne** of product, **per unit** produced, or **per yearly** service period?

A functional unit[6] (FU) is a measure of the function of the system to be analysed and provides a reference to which the inputs and outputs of the system can be related. The FU will be informed by the system boundaries put in place and by the product system map drawn.

A functional unit is usually defined as a specific amount of product or service delivered to the customer, for example:

- **Mass (weight)** – 1 kg apples at home,
- **Units** – 1,000 disposable paper cups,
- **Service** – 1 year of car use,
- **System** – protecting 1m^2 of wall for ten years

The FU allows comparing two different systems with the same function. There is the potential to use existing documentation to inform the choice and application of the functional unit; however this is often sector and category dependent. Additional guidance available includes Product Category Rules (PCR's) which identify a specific FU to use for a specific product type (please refer to Section 10, Tools and Resources).

Case study 2 is an example of the importance of this process from an industry perspective to ensure products can be compared in an accurate manner. If comparison with other products on the market is not a primary objective, then the functional unit is less critical but needs to be fit for purpose to ensure a meaningful estimate of carbon emissions is provided.

Case Study 2

Defining an FU

Fernox: Change in FU

Company

Fernox produces and markets domestic and commercial water treatment products throughout Europe.

Project

Fernox calculated the embodied life cycle greenhouse gas (GHG) emissions of five of the company's products in 2010; two cleaners, two inhibitors, and one filter. It covered the full supply chain from raw material extraction to distribution and use, including the distribution of the finished product to several UK and European distribution centres and retailers.

Changes to the FU

Several organizations dedicated to the manufacture of central heating system water treatments have analysed their products. To ensure comparability amongst different products with the same function, a functional unit which is relevant to the system being analysed was chosen. Originally, it was suggested that the functional unit be 'per litre of product', however, different manufacturers concentrate their products to different levels and each litre of product does not have the same effectiveness in treating heating system water. Discussion with the Domestic Water Treatment Association and other stakeholders resulted in redefining the functional unit as 'per litre of system fluid treated at the manufacturer's declared minimum dosage rate', which allows comparison between products at different concentrations.

[6] Functional unit - The amount, weight and quality of the specific product investigated.

Introduction to allocation methods

Many product systems have more than one output, (e.g. a low value by-product, such as cocoa shells in the production of cocoa powder, which can be used in fertilizer; or a co-product in a production line such as cocoa butter). This section of the Guide explains how to define and document underlying assumptions and methods in this situation.

Allocation is essentially the division of the environmental impacts according to how much the product costs/weighs, or other relevant quantity, and is used where there are multiple outputs in a product system. It should be noted that allocation can be a complex area and will generally be used by more advanced practitioners to get to a further level of accuracy. If the user requires more detailed information on allocation, it is recommended they refer to the relevant PCF standards. A brief overview is however provided here to introduce this topic, with some examples (please refer to **Section 10**, Tools and Resources).

There are a number of methods that can be used to calculate the environmental impact when more than one product is produced (joint production) in one process. Hierarchies of allocation types are presented in the different PCF standards available. Where possible, it is generally recommended that:

- allocation is avoided by separating out processes specific to the product; or when this is not possible,
- allocation is based on the mass or economic value of the co-products; or lastly,
- allocation is based on system expansion.

Separating out production processes

Organizations usually produce more than one product and these are often manufactured at the same site. Obtaining product specific data can be achieved by sub-metering production lines and recording energy use per production batch. It is also possible to undertake water and waste surveys and associate results with production batches. This will lead to the highest level of accuracy but is not often possible due to lack of availability of process specific data.

Physical allocation

This entails dividing consumption data, e.g. energy and waste, by the quantity of product manufactured. Physical allocation or mass allocation should be based on reasonable assumptions around how energy use and production waste are affected by the quantity produced. For example, if an organization fills 1l and 1.5l bottles with fizzy drink, it may be better allocated on a per bottle filled basis than on a per volume filled basis. All assumptions should be clearly documented.

Physical allocation, e.g. electricity

Total annual electricity consumption at filling line = 320 kWh

Total number of 1 l bottles filled = 20,000 (or 20,000 l)

Total number of 1.5 l bottles filled = 30,000 (or 45,000 l)

Allocation by number of bottles filled:

1l bottles = 40% of 320 kWh = **128** kWh
1.5l bottles = 60% of 320 kWh = **192** kWh

Allocation by quantity of litres filled:

1l bottles = 31% of 320 kWh = **99** kWh
1.5l bottles = 69% of 320 kWh = **221** kWh

Organizations should understand their production process and be able to clearly state why they have chosen one allocation over the other.

Economic allocation

When co-products have very different economic values, economic allocation can be used. The lesser valued product is usually termed a by-product. For example, a gold mining operation has found a use as road fill for the rubble resulting from gold extraction. The mass of extracted gold is miniscule when compared to the mass of extracted rubble, but the value of extracted gold is much larger than the value of extracted rubble. An economic allocation is performed in order to assign the correct proportion of emissions to the gold, as the primary product is gold. All assumptions should be clearly documented.

Economic allocation, e.g. fuels

Total annual fuel oil consumption at mine = 12,500 l

Total annual diesel consumption at mine = 25,000 l

Total value of gold extracted = £1,000,000 (or 40 kg)

Total value of rubble extracted = £60,000 (or 4,000 t)

Economic allocation:

Fuel oil allocation for gold = 94% of 12,500 l = 11,793 l

Diesel allocation for gold = 94% of 25,000 l = 23,585 l

AND

Fuel oil allocation for rubble = 6% of 12,500 l = 707 l

Diesel allocation for rubble = 6% of 25,000 l = 1,415

Expanding the product system

System expansion assumes co-products are alternatives to other products on the global market (e.g. in meat production, manure is a by-product that can replace fertilizer) and the more co-product produced the less of the alternative product is needed. The system is then expanded to include the system of processes, which are involved in the production of the marginal product (fertilizer).

System expansion is often used when examining recycled materials and analysing design changes, such as the substitution of one material for another. For example, a chicken farm produces chicken meat, and chicken manure which is used as fertilizer. 2 kg of manure replaces 1 kg of fertilizer (2:1). The emissions from producing the 1 kg of fertilizer can be subtracted (as it has been replaced by manure) from the total impact of producing both the chicken meat and the manure. This will be the emissions associated with chicken meat production.

Expanding the product system

Baseline GHG emissions:

Total annual GHG emissions arising from chicken farm = 105 t CO_2e

Total annual quantity of chicken manure produced = 60 t

GHG emissions from production of 1 kg chemical fertilizer = 1.5 kg CO_2e

System expansion:

60 t of chicken manure will substitute 30 t of fertilizer (2:1)

Emissions avoided from not producing 30 t of fertilizer = 45 t CO_2e

Total annual carbon footprint associated with chicken farm:

Chicken farm annual emissions – avoided emissions = Annual GHG impact

105 – 45 = 60 t CO_2e

Case Study 3

Managing allocation issues

Belu: Allocation challenges

Belu, a mineral water bottling company, is committed to gaining as good an understanding of their carbon footprint as is economically feasible. Therefore, in the process of completing the 2012 footprint a number of calculations and assumptions needed to be made. For example the company's bottle suppliers do not meter each production line within their plant, and do not only supply to Belu. So to generate accurate figures, the proportion of factory products that were for Belu were determined and used to calculate the energy use of the factory that should be included in their footprint (physical allocation). Similarly, only the total amount of waste produced in the plant was known; the same ratio was used to allocate a portion of the waste footprint to the company's products. Another example is that it is not possible to measure the exact time that each bottle spends in a fridge at the consumer use phase. It was assumed that half of the products were stored in a full fridge of average efficiency for 2 days.

Processes like this, with complete transparency, ensured that Belu could be confident in the robustness of the figures even though some of these could not be measured directly.

5. Guidance on data sourcing

Data collection is one of the key challenges (and sometimes a barrier) to completing a carbon footprint, especially for a product where data is needed down the supply chain and not just for company activities. It is important to check who in your organization has access to the necessary data. Are they primed and ready to collect or collate it? If you need data from outside your own organization, e.g. from your supply chain, will they be willing to share it with you?

Data used for product carbon footprinting can be divided into two main categories:

- Primary (own company), and
- Secondary data (outside your company).

Primary data are physical data directly attributable to the specific product being investigated. Secondary data are proxies and assumptions, based on industry average data. Secondary data includes emission factors[7] which can be used in calculations to determine GHG emissions per unit.

Example: Primary and secondary data

Primary data: the component of a product is a 300g piece of aluminium

Secondary data: the average emissions associated with the production of 1kg of virgin aluminium are 10.49 $kgCO_2e$

- Carbon footprint result: 0.3 kg aluminium of 10.49 $kgCO_2e/kg$ = 3.15 $kgCO_2e$

In this example, both primary and secondary data are required in combination. As industry average data and emission factors for raw materials can be good approximations, using an emission factor for calculating the impact of aluminium is usually preferable to gathering physical data from the supply chain on the production process of the metal and can still lead to reasonably accurate results.

Table 3

Primary data	Secondary data
Direct measurements and records	Emission factors
Usually own operations	Externally sourced, e.g. 3rd party databases
E.g. litres of fuel; kWh of electricity	E.g. $kgCO_2/kg$ of feed at farm

Primary data

The gathering of physical data for footprint calculations can be challenging as it cannot generally be drawn directly from accounting records or procurement specifications. The data required for the analysis involves units such as weight, distances and energy consumption, while standard records tend to be focused on financial records.

Successful data gathering requires an organization to assign time and human resources to the data gathering process. It is common for primary data to be gathered from different departments within the organization, so it is good practice to assign a coordinator to the process. Data can be gathered over a particular period of time, typically a year, to smooth out seasonal variations in the data.

Specific primary data required for a PCF may be retrieved using the following sources. Setting up a simple data questionnaire (see Figures 8, 9 and 10) is usually the most efficient way to gather data efficiently in one place, if it has not already collected. It can then be transferred to a calculation tool.

Utilities

Data on electricity consumption (kWh), natural gas use (kWh or m3), and water (l) can be obtained from utility bills or meter records. In some cases, consumption quantities can be obtained from sub-metering of product specific processes where these are available.

[7] Emission factor – Is the average emission rate of a given GHG from a given source, relative to a unit of consumption, e.g. $kgCO_2/km$ car travel.

Figure 9 – Example extract from a data questionnaire, energy use

	Units	Amount	Other Information
Energy			
for example... (natural gas)	*m^3*	*3,000*	*annual consumption*
for example... (machine/ process 1)	*w*	*1,200*	*engaged for 200 hours*
Electricity	kWh or m^3		
Gas oil	l		
Petrol	l		
Other?			

Transport

Data on incoming and outgoing freight transport can be obtained from expenses claims, vehicle records, fuel cards, or surveys. Desk research into distances between locations is often helpful. Expenses claims can be directly associated with fuel costs and hence with fuel consumed. If vehicle types are known, average fuel use rates could be multiplied by known distances to obtain total fuel consumption.

Fuel consumption could also be calculated from surveying the transport fleet over a representative period of time. Although fuel consumption data is more accurate, there is publicly available secondary data from Defra which models the UK freight system. These data can be used to calculate GHG impact of transport knowing the distance covered.

Figure 10 – Example extract from a data questionnaire, transport of materials

	Units	Amount	Transport information. Please indicate how the material was transported. Provide the distance if known.			
Total Materials			Air (km)	Road (km)	Ship (km)	Other transport
for example... (material A)	*kg*	*84*		*80*		*120 km/rail*
Paper virgin	kg					
Paper recycled	kg					
Kraft paper	kg					
EVOH	kg					
PE	kg					
Glue	kg					
Stretch film for final product packaging	kg					

Calculating transport impacts with Defra factors

Product is transported 200 km in a diesel powered, averagely laden 20 t rigid lorry: Defra emission factor = HGV (all diesel), Rigid (>17 t) = 0.832 $kgCO_2e/km$

Transport emissions = 200 km × 0.832 $kgCO_2e/km$ = 166 $kgCO_2e$

Materials

Materials used during the manufacturing process include not only raw materials used to make the product, but also auxiliary materials which are attributable to the product process. These can include product packaging, fuels not accounted for in utilities, cleaning chemicals, etc...
Data on composition and weight of material is preferred and can be obtained from product specification, bill of materials or invoices. When it is not possible or practical to collect physical data, financial data can be used as a proxy. This entails knowing the cost pre-VAT of materials bought in order to multiply these values by factors which correlate GHG emissions to industry sector costs.
These are called Input-Output (I/O) emission factors.

Waste

Waste data required includes the material type, weight of waste, and the waste management option used (e.g. landfill, recycled). Data can typically be obtained from waste contractor records. When these are not available a waste survey can be undertaken over a representative period of time to determine the type, weight and management of waste.

Financial proxy (I/O)

Using I/O can be useful to obtain a quick estimate of the carbon footprint of a product in, for example, a hotspot analysis. However, caution is required when using I/O emission factors. I/O factors are usually found at industry sector level (e.g. agricultural products, man-made fibres, plastic products), so they are not granular enough to differentiate between raw materials in the same industry category (e.g. potatoes and milk from a farm). Furthermore, I/O factors are not useful for calculating improvements in emissions. A lower cost will result in lower impact when conducting I/O analysis, so substituting an impacting but low-cost material for a less-impacting but more expensive material will increase the footprint.

Defra 2009 I/O factor for textiles = 0.32 kgCO_2e/£

Conventional cotton t-shirt (£10 pre-VAT) = 3.2 kgCO_2e

Organic cotton t-shirt (£20 pre-VAT) = 6.4 kgCO_2e

Figure 11 – Example extract from a data questionnaire, waste

	Units	Waste Treatment			
Waste		Landfilled	Recycled	Incinerated	Unknown
for example... (Paper)	*kg*	*600*	*2,400*	*2,400*	
Paper virgin	kg				
Paper recycled	kg				
Ink	kg				
Chemicals	l				
General Plastic	l				
Glue	kg				
Cardboard	kg				
Other(?)					

Secondary data

The gathering of secondary data for footprint calculations involves researching available databases and other data sources in order to compile the necessary data for the PCF. Secondary data can be sub divided into

- secondary activity data, and
- emission factors.

Secondary activity data relates to the amount of energy, materials or cost required to undertake a certain process, such as kWh of natural gas used to make 1 kg of glass, or several kg of feldspar required to make 1 kg of glass.

In the case of secondary data, this is not gathered directly from a production process, but industry averages and approximations are used.

Emission factors define data which attributes a specific environmental impact per unit of product or activity, such as amount of GHG in kg emitted to make 1 kg of glass, or amount of GHG in kg emitted from transporting 1 kg of glass for 1 km. Case study 4 highlights how secondary emission factors can be used as approximations to fill in data gaps and still meet the objective of the project.

Case Study 4

Challenges related to sourcing secondary data

Seacourt: Environmental Printing

Seacourt uses various chemicals during the printing process. Collecting detailed data on quantity per type of chemical is a lengthy process, so as an initial step the total quantity of chemical was collected. When calculating the footprint, a generic emission factor was used (inorganic chemical from the EcoInvent database). The preliminary results showed that the impact of the chemicals was 10 times lower than that of the paper. Therefore getting more accuracy on the types of chemicals and finding specific emission factors for each of them would not have any significant impact on the total result whilst requiring significant work to be done. The footprint shows that paper is the material that drives the greenhouse gas emissions, and this is where the focus of any initiative should be.

Activity data

One of the main challenges in obtaining quality activity data is that organizations have a tendency to keep good and accurate financial records but do not keep records of energy and material flows to the required level of detail and quality for an accurate PCF. Additionally, there are processes outside of the organizations' control for which primary data may not be possible or practical to collect, such as retail emissions.

Example

Secondary data: 'high level' activity data, e.g. kWh electricity

In the absence of primary data, secondary data/ assumptions can be used to make a 'high level' product carbon footprint estimate, e.g. kWh electricity to make a computer.

Secondary sources of data

Quality secondary sources can be obtained from industry bodies, government publications, regional and national statistics, peer reviewed studies, Environmental Product Declarations, databases, verified carbon footprints, LCAs, published data from other sources.

Table 4

Secondary data sources

Data type	Summary	Sources
Industry bodies	Specific data for an industry sector is available from specialist organizations. For example: • British Glass for carbon footprint for virgin and recycled glass manufacture; • DairyCo for carbon footprints of milk and beef.	http://www.britglass.org.uk/information-centre http://www.dairyco.org.uk/resources-library/research-development/environment/#.Us2CWLSK6Ep
Emission factors	There are many sources of emission factors data, of varying quality (see Section 10). There are two main types of emission factors: • **Process**, e.g. $kgCO_2e/kWh$; • **Input–output**, e.g. $kgCO_2e$/£ spent on electricity.	• **Government publications**, e.g. Defra/DECC; • **Licensed 3rd party** databases, e.g. Ecoinvent; • **Peer-reviewed** studies; • **International organizations**, e.g. IPCC.
Utilities and road fuels	When only financial data is available for utilities and road fuel use, it is possible to understand what the physical consumption is associated with the financial costs reported. For financial costs incurred within the UK, national statistics on energy and fuel prices are available from the Department of Energy and Climate Change (DECC).	**Industrial energy prices** – Statistics include: data on price of fuels purchased by the manufacturing industry, industrial energy price indices, gas and electricity prices in the non-domestic sector and international industrial energy prices. Available at: https://www.gov.uk/government/collections/industrial-energy-prices **Road fuel and other petroleum product prices** – Statistics include: weekly, monthly and annual data on road fuel prices. Available at: https://www.gov.uk/government/collections/road-fuel-and-other-petroleum-product-prices

Data type	Summary	Sources
Warehousing emissions	Warehouses usually consume electricity, natural gas and refrigerant gases for both lighting and climate control. Values are usually reported in kWh per square metre and per annum, so data on the amount of space required for warehousing and the time products are in the warehouse is required.	**Chartered Institution of Building Services Engineers (CIBSE), *Guide F: Energy Efficiency in Buildings*** Data is free of charge for CIBSE members and available at: http://www.cibse.org/knowledge
Use profiles	If the boundaries of the study are cradle-to-grave, a requirement exists to model the product use phase. **Product Category Rules (PCRs)** are developed by stakeholders and establish full life cycle profiles (termed Environmental Production Declarations (EPDs)), including: normal usage rates, energy and water use, waste, additional materials and other use characteristics for a specific product.	http://environdec.com/en/ gives PCRs and EPDs for a wide range of products. Data can often be obtained from industry bodies which detail common usage features of the studied product. Alternatively, the use phase can be modelled using the manufacturer's use instructions and data on domestic energy use, including energy use of standard appliances, which can be found on the Government website: https://www.gov.uk/government/publications/energy-consumption-in-the-uk
End of life	Design and consumer information can increase the recyclability of a product but, in general, end users make the final decision regarding the end-of-life of the product. National waste statistics by product type can be used to develop the end-of-life scenario. On a European level, packaging waste statistics are published annually by Eurostat. If no product specific end-of-life profile data is available, it is best practice to assume all disposed product and product packaging is sent to landfill, in order to be conservative in GHG emission estimates.	http://www.statistics.gov.uk/hub/agriculture-environment/environment/waste-and-recycling http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Packaging_waste_statistics

Data quality review

Both primary and secondary data sources have varying degrees of associated quality. Data quality is usually assessed across five key criteria which evaluate the appropriateness of the data chosen for each specific aspect of the PCF. A data quality assessment can be required when performing PCFs against specific standards; however it is not essential for a rough carbon footprint estimate performed for internal use. Some guidance is provided here; if the user requires a higher level of accuracy for their footprint then they can refer to relevant sections in the PCF standards.

Data quality can be assessed based on five key characteristics:

- **Relevance** – the extent to which data is applicable and helpful for the task at hand.
- **Completeness** – measures the degree to which all required data is known, this includes coverage and occurrence.
- **Accuracy** – the degree of conformity of a measure to a standard or a true value, that is, the level of precision or detail.
- **Credibility** – the extent to which data is regarded as true and believable.
- **Timeliness** - measures the degree to which up-to-date data is available when knowledge workers or processes require it.

Data quality challenges

Common challenges relating to data quality include having accurate enough data to ensure accuracy to a level high enough that can be audited. This is not covered in this Guide, which is for beginners. Further detail on data quality can be found in existing standards including PAS 2050, Specification for the assessment of the life cycle greenhouse gas emissions of goods and services and GHG Protocol's Product Life Cycle Accounting and Reporting Standard. A further challenge relates to management of data gaps to ensure that the data used where no primary activity data is available is of sufficient quality. The user is referred to the section on data sourcing which includes a case study on data sourcing challenges and different sources of proxy data that can be used in certain situations.

6. Guidance on calculation of a PCF

This section provides an introduction to the basic concept for a carbon footprint calculation. A more complex example is then explored before looking in further detail at some specific technical calculation challenges for more advanced users of this document, including land use change and calculating impacts associated with the use of a product.

Footprinting basics

The following calculation outlines an example of how a footprint is developed using the consumption data collected by your company and the relevant emission factor, for example from the Defra emission factor database.

Figure 12 – Footprint calculation

Consumption data	x	Emission factor	=	Footprint
1,000 kWh (electricity)	x	0.537 kgCO_2/kWh (emission factor)	=	537 kgCO_2

Figure 13 provides an example of how this calculation should look in a footprint calculation spreadsheet.

These are official emission factors

Figure 13 – Footprint calculation in a spreadsheet

Taxi, Bus, Rail and Ferry Passenger Transport Conversion Factors					
Method of Travel		Passenger kms travelled (pkm)	x	kg CO_2 per pkm	Total kg CO_2
Taxi	Regular taxi		x	0.1593	
	Black cab		x	0.1720	
Bus	Local bus		x	0.1158	
	London bus		x	0.0818	
	Average bus		x	0.0173	
	Coach		x	0.0290	
	Average bus and coach		x	0.0686	
Rail	National rail		x	0.0602	
	International rail (Eurostar)		x	0.0177	
	Light rail and tram		x	0.0780	
	London Underground		x	0.0650	
Ferry (Large RoPax)	Passengers and Vehicles		x	0.1152	
Total					0

Consumption data goes here

Multiply them together and you get a footprint!

Case Study 5

Calculation: Coffee roasting in UK

This example explores a case study of a company who wanted to understand the climate impact of: cultivating coffee beans in tropical regions; shipping them to the UK, where they are roasted using natural gas; and packaged ready to be distributed to business customers, such as coffee shops, within the Oxford area.

The primary data obtained for the coffee roasting operation included:

- Natural gas required to roast enough green beans to obtain 1 t of medium roasted beans = 1680 kWh
- Weight of aluminium foil bag to package 1 kg roasted beans = 31 g
- Weight of aluminium foil bag to package 3 kg roasted beans = 52 g
- The amount of waste in aluminium bags from packaging operations = 2%
- A 20% weight loss occurs when roasting beans, so to obtain 1 t of roasted beans 1.25 t of green beans are required.

Several assumptions had to be made to fill data gaps:

- Average distance green beans are transported via Tillsbury Docks to Oxford = 5000 km by sea and 500 km by road
- Assume if 1 kg bag weighs 31 g and a 3 kg bag weighs 52 g, on average 1 t of coffee is packaged in bags weighing 48 kg
- Assume on average 120 km transport distance for coffee delivery.

Emission factors are obtained from the secondary sources outlined in Table 5.

Emission factors are obtained from the secondary sources outlined in Table 5.

Table 5

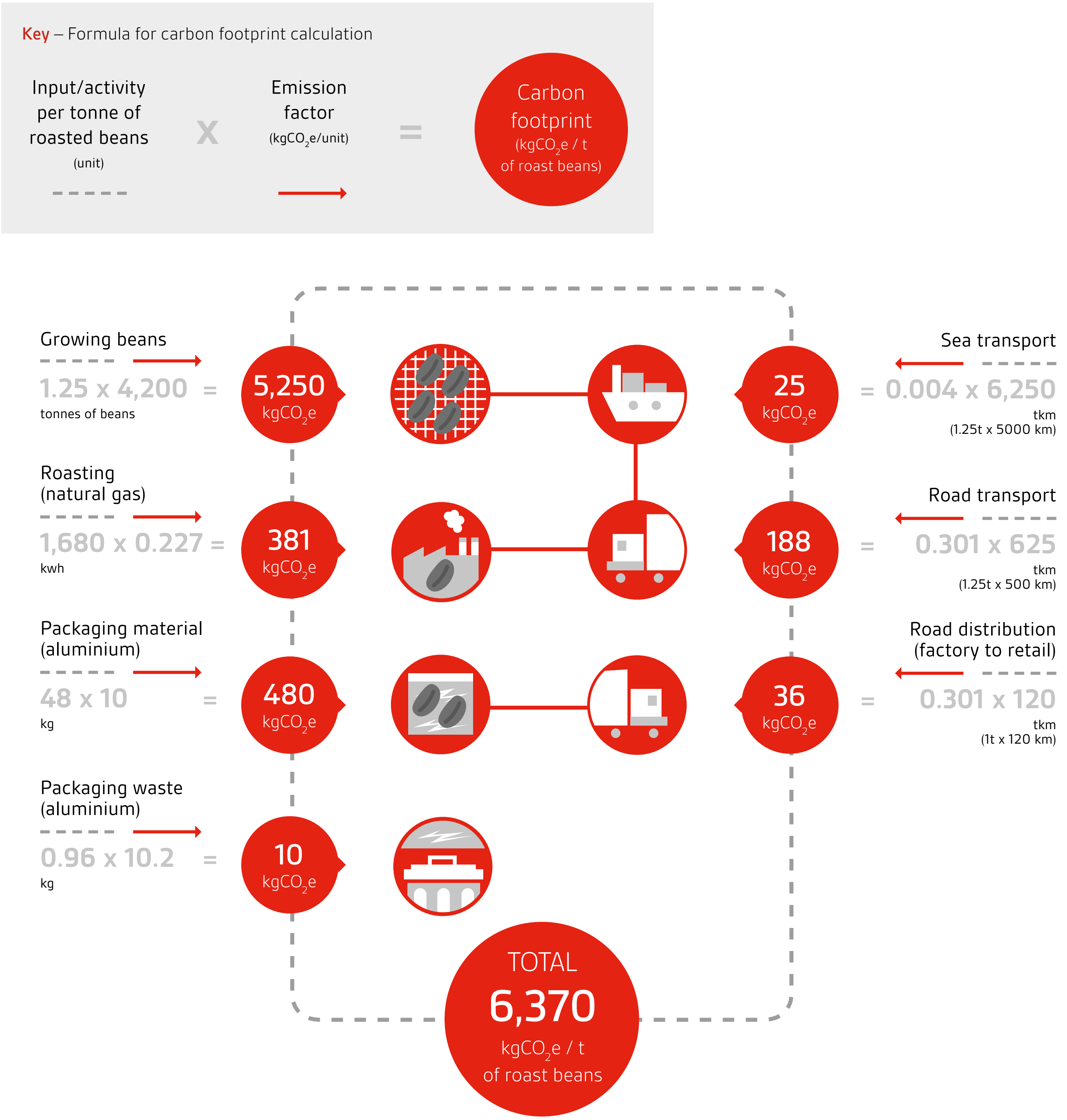
Emission factor sources for coffee production

Name	$kgCO_2e$/unit	Secondary Data Description
Direct measurements and records Emission factors	0.227	DEFRA 2012: Data from UK Greenhouse Gas inventory 2010
Green Beans at farm (t)	4,200	Humbert, S. et al, 2009. Journal of Cleaner Production 17 1351-1358
Average UK rigid lorry (tkm)	0.301	DEFRA 2012: Department for Transport 2012
Average Bulk Carrier (tkm)	0.004	DEFRA 2012: Department for Transport 2012
Aluminium foil (kg)	10	DEFRA 2012: Wrap 2012
Aluminium foil to landfill (kg)	10.2	DEFRA 2012: Wrap 2012 + transport to landfill

To calculate the PCF of 1 t of roasted beans packaged in 1 and 3 kg bags and delivered to coffee shops, primary activity data should be multiplied by secondary emission factors to obtain the total climate impact of the product. Figure 11 summarizes the calculation process.

This business to business carbon footprint example does not include use-phase emissions, as this life cycle stage is not within the scope of the analysis.

Figure 14 – Calculating the carbon footprint of coffee roasting



Specific technical challenges

Some specific technical challenges may arise for certain sectors, such as: dealing with land use change in the production of agricultural raw materials; and calculating use-phase impacts where this is considered a hot spot in the life cycle and so cannot be ignored.

Further details on specific rules around these areas can be found within the major standards. A simplified summary of some key technical challenges is provided here with some examples, in case the user feels that due to the potential impact within the life cycle, these challenges cannot be ignored.

Land use change

Land use change is often a significant component of agricultural products. Land use change is time constrained, and standards such as PAS 2050:2011 require accounting for land use change occurring within the past 20 years only. There are lists of typical land use change emissions per hectare per year for transforming forest and grassland to annual or perennial crop land by country within the Appendix C (IPCC factors). An example of how to calculate the potential land use change impact of soya is found below.

Land use change for Argentinian soya

A company purchases soya from Argentina to produce soya meal for animal feed and is looking to understand the annual carbon footprint of their product. The company knows the land where soya is grown was grassland ten years ago.

Typical soya yield per hectare in Argentina = 2.36 tonnes/hectare/year

Transforming Argentinian grassland to annual cropland = 2.2 tonnes CO_2e/hectare/year

Land use change emissions calculations:
Values : 2.2 / 2.36 = 0.9

Units : tonnes CO_2e/t soya

Biogenic carbon

Some product carbon footprinting standards include biogenic carbon emissions and removals throughout the life cycle of the product, e.g. wood products.
This is unusual because most GHG activity is focused on reducing human-induced climate change, which occurs through the addition of fossil carbon emissions to the biologically based carbon cycle. Biogenic carbon is emitted and removed by biologically based materials, which is different from the additional carbon emitted by fossil fuels, peat and mineral sources.

Biogenic carbon emitted during the life cycle of the product is not usually accounted as part of the total climate impact, as it is biologically based. However, it may be required and then be deducted to give a net total climate impact. Alternatively, biogenic carbon may be removed (or sequestered) within the product, e.g. wood in a table, in which case it may be considered a carbon credit[8] .

Consumer impacts (use phase)

The use phase can be difficult to define and it is usual for statistical sources to be used to model this life cycle stage. Case study 6 details how this can be achieved in the case of detergent products.

[8] Carbon credit, where used, are normally written as a negative number, e.g. –5 tCO_2e per kg per year per table.

Case Study 6

Use phase modelling

Ecover: Modelling the use phase

Ecover wanted to know how different ways of assessing the 'use phase' of its product affected the carbon footprint of its detergents. The objective of the study was to evaluate the impact when different washing temperatures were used.

Ecover examined the carbon footprint of using common (A and B energy rated) household washing machines in the UK at three discreet washing temperatures (20 °C, 30 °C, and 40 °C) along with non-bio washing powder. Data for washing machine energy and water consumption were derived from the UK Energy Research Centre (UKERC), Defra's Market Transformation Programme (MTP), and the Institute for Applied Ecology (Öko-Institut). Data on emissions of the company's non-bio integrated washing powder were derived from a previous study which analysed the product's carbon footprint.

Most publicly available data gives values of energy consumption for 90 °C and 40 °C washes.
The Öko-Institute has publicly available data for 30 °C washes. This study explored energy consumption reductions at 40 °C, 30 °C, and 20 °C, so extrapolations of data were performed to construct new scenarios.
The study concluded that reducing temperatures from 40 °C to 30 °C and from 30 °C to 20 °C has tangible benefits to reducing the impact from laundry washing.

Conversion of units

Conversion of units between for example volume and waste can present challenges to be overcome; in general this can be overcome by consulting relevant industry data sources, website research or through physical tests. Case study 7 provides an example of how this challenge can be overcome.

Case Study 7

Conversion of units

Seacourt: managing unit conversion

Waste production and treatment are part of the indirect/supply chain emissions of the company. Data on waste had already been collected during the environmental audit the company went through to reach environmental management system certification.

The quantity of waste produced by the company was only available in volumes, whilst the weight is required to calculate the footprint. Several methods can be used to convert the volume into weight, such as weighting the waste in one sample bin of known volume. It is also possible to use available information on average weights of various waste types, as published in a Defra survey of commercial and industrial waste in 2010 or by the US Environment Protection Agency.

In this case, data on typical container weights of office waste and mixed plastics were taken from a report of the DETR 2000 study.

Total volume of waste plastics: 7,000 l

Density: 220 kg/m3

Total weight: 7,000 / 1,000 × 220 = 1,540 kg

Source: Department of the Environment, Transport and the Regions with the Scottish Executive and the National Assembly for Wales, Environmental Reporting: Guidelines for Company Reporting on Waste, June 2000.

7. Reducing your impact through carbon footprinting

Identifying key hotspots

Within carbon footprinting, hotspots are the most relevant inputs or phases influencing resource and energy use in the life cycle of a product as they relate to climate impact. It is useful for identifying key areas which may require more in-depth analysis but cannot be used for comparing products as hotspots are a rough overview of relevant aspects of the product life cycle. Hotspots are identified per life cycle stage, where aluminium is the most impacting input for both the raw material life cycle stage and for the entire footprint (as shown in Figure 15). Within manufacture, electricity is the component with the largest footprint, although there are components in other life cycle stages (such as raw materials – steel) which have a larger footprint than electricity. For the transport life cycle stage, road transport has a larger footprint than sea transport although four times more distance is covered by ship than by lorry.

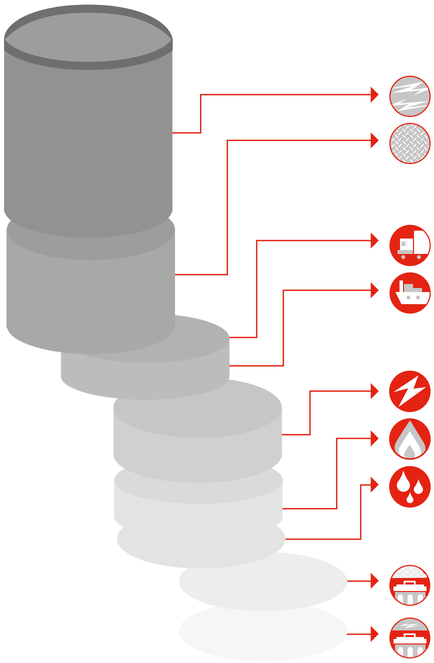
Table 6

Example: **production of 1 t of drink cans (30% Al, 70% Steel) at factory gate**

Life cycle stage	Component	Input per t of can	Emission factor	Result (kgco2e/t of cans)
Raw Material	Steel	710 kg	× 2.5	= 1775
Raw Material	Aluminium	305 kg	× 10	= 3050
Transport	incoming (sea)	1.015 t × 2000 km = 2030 tkm	× 0.004	= 8
Transport	incoming (road)	1.015 t × 500 km = 508 tkm	× 0.301	= 153
Manufacture	natural gas	1800 kWh	× 0.227	= 409
Manufacture	electricity	1400 kWh	× 0.560	= 784
Manufacture	water	1.5 m3	× 0.9	= 1
Manufacture	Steel waste	10 kg	× 0.2	= 2
Manufacture	Aluminium waste	5 kg	× 0.2	= 1
TOTAL				6,183

Note: waste disposal includes only impact from transporting waste to the waste management plant; manufacturing impacts are accounted for in the raw materials life cycle stage.

Figure 15 – Carbon footprint hot spots of aluminium can



	GHG emission/tonnes of can	
Raw materials	4,825 kgCO_2	**78%**
Aluminium	3,050 kgCO_2	49%
Steel	1,775 kgCO_2	29%
Transport	161 kgCO_2	3%
Road	153 kgCO_2	2%
Sea	8 kgCO_2	<1%
Manufacturing utilities	1,194 kgCO_2	**19%**
Electricity	784 kgCO_2	13%
Natural Gas	409 kgCO_2	7%
Water	1kg CO_2	<1%
Manufacturing waste	3kg CO_2	**<1%**
Steel Waste	2kg CO_2	<1%
Aluminium Waste	1kg CO_2	<1%

Reduction improvements

Hotspots can highlight areas for carbon reduction improvements and help concentrate reduction efforts in those areas which are likely to see the greatest benefits.

In the above example, it would be reasonable to invest resource to design a drinks can which can be made by substituting part of the aluminium used with another material. It is worth noting, that in this particular case, the logical substitute, steel, is heavier than aluminium, so any substitution by volume would result in a higher weight of metal required. Estimating the benefits from material substitution or eco-design would require in-depth analysis.

Different shipping routes which can reduce the distance required to be travelled by road would significantly reduce the transport footprint; however, this would be a small contribution to the total product carbon footprint, as transport only accounts for 2.6% of the estimated climate impact of drinks cans.

For the manufacturing footprint, looking at how natural gas can substitute electricity requirements would be a starting point for reducing the product carbon footprint. Although waste reduction is important from a resource perspective, it is not significant, in this example, from a carbon perspective.

In most cases, using recycled material to make a product is preferable, from a climate impact perspective, to using virgin material. Some materials, such as aluminium, show very significant carbon footprint reductions when recycled without compromising the structural characteristics of the metal. The process of manufacturing aluminium from bauxite requires large amounts of energy. However, re-melting scrap aluminium to make recycled aluminium requires only 5% of the energy used to produce aluminium from ore. Sourcing aluminium with a high recycled content, in the above example, could reduce the raw material footprint by about 60% of the aluminum can.

The case studies below provide examples of how reduction measures identified through carbon footprint hot spots can be successfully implemented, in two very different cases. Case study 8 shows an example of how product reformulation and material substitution can result in an improved carbon footprint. Case study 9 shows an example of how collaboration and engagement with suppliers and industry peers can help reduce supply chain emissions in the often high impact agricultural phase of grocery products.

Case Study 8

Implementing reduction measures based on hot spots

Fernox: Identifying reduction measures for water treatment products

During the first analysis it was found that the most significant contributor to the carbon footprint of the product studied was raw materials, followed by manufacturing. More than 60% of the product carbon footprint can be attributed to two chemical ingredients.

Raw materials include: ingredient (raw material); manufacturing and packaging; manufacturing by the company's suppliers; and manufacturing waste and process water used. Manufacture includes utilities used during product manufacture along with emissions arising from raw material transport into the company.

Fernox has different levels of influence over the production stages; however, they were able to pinpoint key reduction measures. Within raw materials, a significant component of all four liquid products is a specific chemical ingredient. A slight re-formulation of the products which has not affected function, but reduced the amount of the chemical required, has allowed for an overall reduction in GHG emissions associated with raw materials.

Case Study 9

Collaboration with suppliers to reduce emissions

Tesco dairy farmers reducing the carbon and cost of operations

Carbon footprints – Raising awareness and helping dairy farmers

In 2009, Tesco became the first retailer to inform its customers of the carbon footprint of its milk, through carbon labelling. This highlighted that around three quarters of the greenhouse gas emissions associated with milk are linked to the dairy farm, largely due to emissions of methane (a potent greenhouse gas) from dairy cattle. With a clear commitment to reduce carbon in its supply chain by 30% by 2020, Tesco, through the Tesco Sustainable Dairy Group (TSDG), decided to implement a three year programme to help dairy farmers to reduce their carbon emissions.

Clear benefits for Tesco's farmers

This year, over 400 TSDG farmers will receive their second report providing their own farm's carbon footprint and a set of best practice guidelines, with indicative carbon and cost savings, aimed at helping them reduce greenhouse gas emissions and save money (based on practices employed on the best performing farms). For example, the work has shown that removing soya from the diet of low-yielding cows would save the average farm 89 t of carbon (CO_2e) and over £2,500 per year with minimal impact on the cows' milk yield. In addition to this, Tesco will also set up farmers' workshops to discuss the challenges and opportunities that arise from each farmer's specific situation. This work is made possible through close collaboration between: Tesco; the milk processors, Muller Wiseman and Arla; the agricultural consultancy, Promar International; and the environmental consultancy, Environmental Resources Management (ERM).

The carbon footprints are calculated from accurate information on the 'inputs' to the farm (e.g. feed types and volumes) which is taken from the farm's financial records. Furthermore, for this second report, farmers have also been asked to fill in a short questionnaire allowing further precision of the results and more data from which to base reduction suggestions. The diagram at the bottom of this page shows the carbon footprint information provided to each farm, broken down by source and benchmarked against the rest of the group. This is calculated by running the 'inputs' data from the farms' financial records through a bespoke model created by ERM. Promar can then take this data, draw conclusions from trends and tailor each report. Therefore by providing readily available information on their farms, TSDG farmers are provided with an accurate assessment of how their carbon footprint compares to the average, the reduction opportunities for their farms and the potential benefits and savings that can be achieved.

Learnings and next steps

The three year programme concludes at the end of 2014 and Tesco are already reviewing the programme and consulting farmers who have participated in the programme to assess how to develop it for the future. Feedback so far indicates that farmers appreciate the support from Tesco in helping them improve their environmental performance and save money.

8. Guidance on communication and reporting

It is important to consider communication of the product carbon footprint, as communicating on progress will drive deeper engagement with stakeholders. This can help your oganization to meet its goals, enhance profits and reputation; and ensure a good return on investment on your project. Promoting high levels of transparency and interpretation can inspire confidence in results, enables the proper use of figures both B2B and B2C and mitigates against potential criticism SMEs may face on the dissemination of their results.

Public communication means the footprint is communicated to the consumer market (B2C), but also to other interested parties. This can be used to distinguish your organization and can be done through point of sale, reporting, advertising and labelling. Public communication of results next to the product, through a label or green claim would often require a higher level of accuracy (to enable product to product comparisons, for example). External reporting can include a summary of the results of the project on a website or in a CSR (corporate social responsibility) report, where the audience will include both consumers but more likely investors in your company and other interested stakeholders. Detailed results and evidence may not be required in these cases.

Another form of communication is passing of information down the supply chain when this data is requested by a customer of your product (in a B2B situation). In these situations, the accuracy level required can vary from a screening or estimated footprint to an accurate specific footprint. Engaging and communicating up the supply chain also means that information gathered during the process can help suppliers reduce their emissions and thus the footprint of your product.

If the objective is internal reporting only to ensure a product team is meeting environmental targets, the accuracy level required is likely to be lower. Internal communication within the company will help engage employees to achieve their goals, but it is also important at the start of the project to convey the business case to those who are sponsoring the project and those affected by it.

There are some issues to consider before releasing any public information, such as:

- Is this sensitive information? How much do you reveal?
- Is there a loss of intellectual property?
- Data quality, methods and assumptions can all be challenged.

'Verification' can help to address some concerns. This involves checking that the product carbon footprint conforms to the standard, when a declaration/claim of conformity is made. Verification is usually recommended by certain standards to increase the credibility of the communication of the footprint externally, for example, through a label on the product. It provides different assurance levels of the results depending on the chosen form of verification, i.e. self-verified declarations, second party verification (e.g. peer reviewed) or independent third party certification. Whilst not all organizations opt to label their product/services, an appropriate level of verification can be a valuable tool, as it will help ensure a carbon footprint measurement is robust.

Complying with certain standards will also include set 'reporting' requirements, varying from guidance on what to include, right through to set templates to complete. Please refer to relevant standards for further information – including *GHG Protocol's Product Life Cycle Accounting and Reporting Standard*.

9. Detailed case study

Crown Paints

Company

Crown Paints is one of the UK's largest and most successful paint manufacturers. They are committed to sustainability and have received a number of sustainability awards for their work.

Drivers for project – footprinting the entire product portfolio to support reduction activities

Crown Paints have been calculating emissions of their product range since 2008 and have piloted a product footprint methodology which enabled them to assess environmental impacts of their entire product range covering over 1000 products. This helped them to understand the emissions of individual products groups and gave them insight into environmental hotspots. The results helped them to set reduction targets, undertake reduction activities and supported their engagement with suppliers and buyers.

Planning and resource allocation

Crown appointed a specialist consultancy to help them with the footprint assessment as the company did not have the necessary expert knowledge. Using a specialist consultancy ensured that the project was completed cost effectively and that the accuracy of the footprint assessment was of a very high level. The project was managed by internal people who were trained to interpret the results and perform analyses.

Defining the scope and boundary

The overall scope included the entire product range. In order to calculate this footprint, individual product groups had to be defined within the scope of the assessment, which covered: production and transport of raw materials; manufacture of the paint and packaging, and transport to store. The assessment also covered the use phase and end of life for which average data were used due to the lack of publicly available information.

Data sourcing

Due to the nature of the product, secondary, or indirect, data was very important because to obtain direct first hand data on manufacturing of the raw materials was not feasible for all products. This presented the challenge of finding relevant data that was a close enough match.

1. A number of ingredients with no readily available factors

Crown Paints use numerous raw materials to produce paint products. Even the most comprehensive of databases does not cover every single ingredient used by the company. To enable footprint calculation, Crown Paints have:

- reviewed the materials and emission factors available in databases (e.g. Ecoinvent);
- used the relevant emission factors from databases which corresponded to materials to assess their environmental impact;
- for materials for which suitable emission factors were not available, undertaken further research by obtaining information from producers and industry bodies to gain a better understanding of materials used. This helped them identify proxy factors in the databases, which were then used for assessment.

2. Incoming transport and distribution

Crown Paints source raw materials from a number of suppliers and also distribute final products through a number of distribution routes. For a number of incoming distribution routes data on loads was not available. Similarly for distribution of final products, specific information on actual loading was not available (e.g. when the product is distributed with other products). Crown applied average loads and corresponding emission factors from relevant databases in order to overcome the problem, thus providing sufficient data to understand portfolio footprint hotspots and for informing reduction activities.

Calculation

Data sourced was input into a software tool that was specifically designed to calculate footprints of product portfolios. The main challenges were:

- to upload all the relevant product data with: significant number of raw materials, transport modes and routes, packaging types; and
- mapping these activity data to relevant emission factors.

Interpretation and use of results: hot spots and choosing priority products for further investigation

Through analysis of the full product portfolio, Crown Paints were able to identify that the scale of impact varied greatly between products when considered on an individual basis. Closer inspection identified that those products with a higher individual impact are those usually required to provide a specific level of protection or added functionality. By looking at the entire product range however, rather than taking each product in isolation, the company identified that high volume products, while they may not have the highest individual product footprint, comprise the biggest part of the footprint as a whole. The decision was then taken to target further analysis and reductions to those processes and raw materials that influence the footprint in a broader sense in the next phase of the project, to be continued.

Communication and reporting

The results were published in CSR reports and communicated in various publications and presented at conferences. For their sustainable development programme incorporating their footprinting activities, Crown was awarded: the Green Apple Award, the Lancashire Business Environment Award for Sustainable Large Businesses and the British Coatings Federation's Sustainable Innovation Award.

10. Tools and resources

If your organization needs further references to support the carbon footprint process, then this section can provide the right signposts.

Carbon footprint standards for products

Both national and international agencies have developed carbon footprinting standards, based on a full life cycle approach. They specify the scope, boundary, and data requirements for performing carbon footprints, as well as identifying requirements for clear and concise reporting of results, implementation of reduction opportunities and validation. The details are not provided in this document; as it is assumed that users of this document are new to the subject and will not be referring to standards at this stage. Further information can be obtained from the following websites for relevant product footprint standards: BSI, ISO and GHG Protocol.

Other tools and resources

There are a number of resources which offer guidance and support for carbon footprinting. Many of these are freely available although access to some emission factor databases need to be purchased. In addition to databases for emission factors; there are also some freely available tools to calculate footprints. The type of tool you choose is dependent on level of expertise. In general, an internally developed Excel tool with emission factors added is sufficient for a basic footprinting project and can also be used for more advanced projects if an expert has helped to develop this. However some software systems provide more reliable platforms less prone to error as the calculations can be automated.

Emission factor sources

To perform Product Carbon Footprints it is usually necessary to use secondary sources (third party conversion factors) to determine and calculate emissions arising from a particular activity. For example, a company may know how much diesel it consumes (i.e. activity data), but a third party emission factor is required to determine the amount of carbon emissions emitted from the burning of that diesel. There are many publically available databases which define these emission factors (often published by Government departments or international agencies) and a good selection is available at GHG Protocol's website. The website includes guidance on how to approach the selection of your emission factor and lists attributes for each database, including 'data type'[9] , 'languages' and 'geography'.

The databases listed on the GHG Protocol website include some freely available industry and country databases such as Plastics Europe, the European Alumni Association (EAA) , Danish Food LCA and the UK DEFRA emission factors.
The European Commission Joint Research Centre also provides some free data from business associations and other sources through the ELCD database.
Some commonly used and wide ranging databases which are not freely available include Ecoinvent
Ecoinvent and the BUWAL packaging database

Resources

1. European Environment Agency: they have a useful page of further information on Life Cycle Assessments (LCAs). **http://ew.eea.europa.eu/ManagementConcepts/LCA**
2. European Commission: free to download footprinting software **http://www.openlca.org/**
3. The Global Footprint Network: Resources and advice for measuring ecological footprints. **http://www.footprintnetwork.org**
4. The Product Sustainability Forum: Contains general advice on product sustainability from a range of companies and organizations and product summaries showing hot spots of 50 grocery products. **http://www.wrap.org.uk/content/product-sustainability-forum**
5. UK Government DECC/DEFRA carbon reporting guidelines: **http://www.defra.gov.uk/publications/2012/07/06/ghg-2012-conversion-factors-reporting**/
6. PEF World Forum website has guidance on Product Carbon Footprint initiatives, with information on resources, FAQs and relevant updates on the latest developments in both standard implementations and improvements. **http://www.pef-world-forum.org/**
7. Product Category Rules – establish criteria for product categorization and use profiles necessary when performing cradle-to-grave carbon footprint analyses. **http://www.environdec.com/en/PCR/**

[9] 'Data type' refers to the calculation method used to create the emission factors. 'Process' is a physical calculation approach, 'Input-Output' is a financial based calculation approach and 'Hybrid' is a mixture of the two.

BSI Group
389 Chiswick High Road
London, W4 4AL
United Kingdom

T: +44 845 086 9001
E: cservices@bsigroup.com
bsigroup.com