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A STUDY INTO THE FEASIBILITY OF

BENCHMARKING CARBON FOOTPRINTS OF FURNITURE PRODUCTS

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This study has been produced by FIRA International Ltd. on behalf of the Furniture Industry Research Association.

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Foreword

The furniture industry has long demonstrated its commitment to environmental and sustainability issues, primarily through industry developed schemes such as the Furniture Industry Sustainability Programme (FISP).

Organisations are increasingly expected to assess and reduce their environmental impact. In this respect; Carbon Footprinting has a significantly raised profile over the last decade. Full carbon footprinting of furniture products has been considerably expensive, putting it outside of the reach of many businesses. In addition, the lack of any third party validation of product footprints has made the carbon impact comparison of products by manufacturers and specifiers very difficult.

There are a wide range of decisions to be made, and a lot of knowledge to acquire for a company to 'go it alone' in preparing an organisational or product footprint. In recognition of this, FIRA has worked with environmental experts to simplify and standardise the process for the furniture industry, resulting in a simple, low cost and user friendly carbon calculator (Furniture Footprinter™). In this regard FIRA's study into the feasibility of generating comparable carbon footprints using the Furniture Footprinter™ tool and a consistent methodology is to be applauded.

This study shows that the carbon footprinting of products is a complex subject, with a number of difficulties that need to be overcome before the benchmarking of products can be adopted.

However, the furniture industry should embrace this report and its findings and look to understand the impact of their products and how to reduce them.

Michael Powell
Chairman of the Furniture Industry Research Association

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Climate change is one of the most important environmental challenges facing governments, organisations and individuals. To address the causes of climate change, governments around the world have agreed targets for the reduction of damaging greenhouse gas (GHG) emissions. A number of greenhouse gases impact negatively on the environment, and the most significant of these is carbon dioxide. Therefore the majority of greenhouse gas emission reduction commitments are expressed in the form of carbon reduction. In this context the term carbon is used to mean carbon dioxide equivalent (CO_2e) – a measurement that expresses the environmental effect of a number of GHGs in terms of the equivalent amount of carbon dioxide (CO_2) that would cause the same effect. The effect of a business, process, product or service can then be evaluated in terms of the GHG emissions it generates; this is commonly referred to as a 'carbon footprint'.

The UK furniture manufacturing industry is of a substantial size and, similar to many other manufacturing industries, generates carbon emissions. Therefore there is great scope for the industry to assess and reduce its carbon impact. Whilst the importance of carbon emissions is recognised across the industry, there is considerable potential for confusion in the regarding its practical use. As a result, companies engaging in carbon footprinting often do so unilaterally, utilising different boundaries and methodologies in assessing their businesses and products.

The lack of credible and consistent assessment means that any data produced is not comparable. Hence, the aim of this project was to assess the feasibility of producing product footprint benchmarks for the furniture industry. In doing so companies wishing to make green claims would have a standard method and benchmarkable data set. It would also allow purchasers to make informed decision about carbon related environmental benefits. The benefits of such an exercise are clear however successful product benchmarking should ensure that the data is truly comparable and consistent.

The project was designed to undertake this work using a consistent methodology assessing the impact of materials and processes from the extraction of raw materials to the manufacturer's factory gate (a 'cradle to gate' assessment). The project was designed to be cost effective, using existing company data and a low cost, online carbon calculator – the Furniture Footpriner™ tool.

A major challenge was to establish a footprinting methodology that would be applicable to all companies (across a diverse industry sector) that was cost effective yet accurate enough to generate comparable data. Whilst some companies have been collating data for some time, this data often relates to differing accounting boundaries and is subject to gaps, or missing data. These inconsistencies only served to demonstrate the complexities of data collection for accurate carbon footprinting and the potential pitfalls when trying to benchmark products or organisations.

The project identified a number of concerns relating to the methodology used, the number of products assessed, and the difficulty in getting accurate data from the global furniture supply chain. Key to this was that the 'cradle to gate' assessment makes no allowance for life span, or the ability to re-use or recycle at the end of a product's life cycle.

The report therefore concluded that at this point in time the production of product carbon footprint benchmarks utilising the selected methodology is not currently desirable.

It is, therefore, important to note that the results presented in this study are not appropriate for a furniture manufacturer, specifier or consumer to make an informed decision on the selection of a product based on its carbon footprint. In addition, the results presented in this study do not allow anyone to accurately establish that a product is better or worse than an industry average.

This study into the feasibility of setting product benchmarks for the furniture industry does, however, make an important contribution to the understanding of furniture product carbon footprints. It is expected that as greater volumes of products are footprinted and the project methodology is revised and improved, the accuracy of carbon footprint data for furniture products will improve.

One of the major stimuli for commissioning this research project was the lack of understanding and fragmented approach to carbon footprinting in the industry. This lack of consistency can create uncertainty around green claims whether they are aimed at specifiers or consumers. In this respect, the results of the project allowed to provide advice to the UK furniture industry and furniture specifiers as well as manufacturers.

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1.0

A key finding from the report is that in the majority of furniture ranges examined, the embedded carbon contained within the materials and processes used for the manufacture of the product were the highest contributors to the product's carbon footprint, rather than company factors such as utilities or transportation. Thus reducing the materials used in a product, or opting for lower impact materials can considerably reduce a product's carbon footprint.

The report's key conclusion is that carbon footprinting is a very useful tool for the furniture industry. The more the furniture industry understands the make up of its products footprints the more it can look to reduce it in targeted, intelligent and innovative ways.

One of the major stimuli for commissioning this research project was the lack of understanding and fragmented approach to carbon footprinting in the industry.

2.0

For the purposes of this report, the following terms and definitions apply:

Boundaries
The limit of emissions associated with the manufacture of a product, or delivery of a service, that are included within a carbon footprint.

Carbon
Throughout the report the term carbon shall mean Carbon Dioxide Equivalent (CO_2e).

Carbon dioxide equivalent (CO_2e)
A unit which expresses the emissions of carbon dioxide and other greenhouse gases in terms of their global warming potential relative to carbon dioxide.

Carbon footprint
An estimate the total emission of greenhouse gases (GHG) from the operation of an organisation or the manufacture of a product, expressed in carbon dioxide equivalents.

Greenhouse gases (GHG)
A collection of gases that have been attributed with increasing climate change set out by the IPCC and including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons and perfluorocarbons.

Introduction

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3.1 Background

Climate change is recognised as one of the greatest challenges facing governments and nations across the world. An increasing body of evidence[1] suggests that it is human activity, such as the burning of fossil fuels or emissions from manufacturing processes, that is the biggest cause of climate change. It has been stated that the current level of greenhouse gas emissions (GHG) could result in an increase of 6˚C in average global temperatures by the end of the century[2]. The consequences of this might include effects such as extreme weather changes resulting in floods or droughts and possibly leading to regional, social and political instabilities.

In order to tackle the problem of climate change, governments around the world have agreed targets for the reduction of damaging GHG emissions. Many of these commitments are expressed in the form of carbon reduction. In this context the term carbon is used to mean carbon dioxide equivalent (CO_2e) – a measurement that expresses the environmental effect of a number of green house gases in terms of the equivalent amount of carbon dioxide (CO_2) that would cause the same effect.

The UK government's response has been the adoption of the Climate Change Act (2008), which has set a target of reducing the UK's carbon emissions in 2050 to a level 80% below the 1990 levels. To help meet these targets, several policies have been introduced.

- **The CRC Energy Efficiency Scheme**, formerly the Carbon Reduction Commitment. This is a mandatory carbon emissions reporting and pricing scheme to cover all organisations using more than 6,000MWh per year of electricity.
- **The EU Emissions Trading Scheme (EU ETS).** This is designed to put a cap on the carbon emitted by certain businesses (i.e. energy activities, production and processing of ferrous metals, mineral industries and some other industries such as production of pulp, paper and board) and create a market and price for carbon allowances.
- **Climate Change Levy & Agreements.** Climate Change Levy (CCL) is a charge on energy usage for business and the public sector with the aim of encouraging energy efficiency. Related to this, Climate Change Agreements (CCAs) allow energy intensive organisations (e.g. paper, steel, glass and chemicals industries) a discount on the levy provided that energy efficiency targets are met.

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In addition to such government related drivers, there are other incentives for businesses to consider when managing their carbon impact:

- By taking action to reduce carbon emissions, businesses can make substantial savings in their material and energy use, often resulting in considerable financial savings. Indeed, the rising price of energy is becoming an increasingly important driver for businesses to review their energy consumption[3].
- The demand for low carbon products and services, particularly in the business to business market is increasing. Many businesses are endeavouring to enhance their green credentials and reduce their own carbon emissions by procuring low carbon products/services.

To service this increasing demand, and to gain a market advantage, businesses are using environmental performance as a key marketing message.

By taking action to reduce carbon emissions, businesses can make substantial savings in their material and energy use, often resulting in considerable financial savings.

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3.2 What is a carbon footprint?

For a business to reduce its carbon emissions, it first needs to be able to measure how much carbon it is using and where it is using it. In this respect, it is the 'carbon footprint' of a business that would give an indication of its carbon impact.

Whilst the term 'carbon footprint' has varying definitions[4], for the purposes of assessing products it is widely accepted that 'carbon footprinting is the methodology to estimate the total emissions of greenhouse gases (GHG) in carbon equivalents from a product across its life cycle from the production of raw material used in its manufacture to the disposal of the finished product'[5]. These emissions may be caused directly or indirectly by a person, organisation, event or product.

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Two key forms of carbon footprint for businesses are:

- **An organisational footprint.** This may consist of emissions from all the activities across an organisation, including buildings, energy use, industrial processes and company vehicles, depending on the organisational boundaries selected.
- **A footprint of a product or process.** This consists of emissions over the life of a product or service, and may include all emissions from the extraction of raw materials and manufacturing of the product, potentially extending right through to its use and final reuse, recycling or disposal.

Key to the carbon footprinting process is the determination of what boundaries are used to assess an organisation, or product; in other words what factors that affect a footprint are included in the calculation of the footprint. For example, some organisational footprints may include the carbon emissions associated with the employees' commute to work, whilst others may exclude this. Some product footprints may include the transportation impact of delivering a product from the manufacturer to the customer, whilst others may choose to stop their analysis at the factory gates. These differences in boundaries between studies mean that not all company and product footprints are directly comparable.

There are several publications that provide advice on measuring the carbon impact of an organisation. In the UK, Department for Environment, Food and Rural Affairs (DEFRA)[6] and the Carbon Trust[7] have published guidelines for assessing an organisational footprint, and these have been widely accepted, with a number of simple online tools available using this as a basis for carbon footprint calculation.

Product footprinting is a more complex process. The British Standards Institute (BSI), along with the Carbon Trust and DEFRA, has published the Publicly Available Specification (PAS) 2050[8] which gives guidelines on how to carry out a product footprint. However as a PAS it does not have the same weight as a British Standard, and carrying out a full product carbon footprint in accordance with PAS 2050, through the whole product supply chain, can be a very expensive and time consuming process.

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It should be noted that PAS 2050 only addresses the impact of global warming and does not consider other economic and environmental impacts associated with a product (e.g. non-greenhouse gas emissions, toxicity, biodiversity, and acidification). Therefore carbon footprints of products that are calculated using PAS 2050 do not provide an indication of the total overall environmental impact of a product. PAS 2050 studies provide valuable tool for assessing the carbon footprint of goods and services.

Globally there continues to be developments aiming to standardize the methodologies used for the carbon footprinting of products. The International Standards Organisation (ISO) is currently working on a new standard for "Carbon Footprints of Products" for the quantification and communication of carbon emissions associated with goods and services. This standard will build on the existing ISO standards for life cycle assessments (ISO 14040/44)[9,10] and environmental labels and declarations (ISO 14025)[11]. Publication of this ISO standard is expected in 2012.

Also worthy of note is the new GHG Protocol Product Life Cycle Standard[12] published by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) in October 2011. This standard can be used to understand the full life cycle emissions of a product and focus efforts on the greatest GHG reduction opportunities, whilst another publication by the same organisation, the new GHG Protocol Corporate Value Chain (Scope 3) Standard[13] allows companies to assess their entire value chain emissions impact and identify the most effective ways to reduce emissions.

The FIRA carbon footprint benchmarking project

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The UK furniture manufacturing industry is of considerable importance to the UK economy. It generates in excess of £8.3 billion of factory gate sales, and employs nearly one hundred thousand people[14]. Furniture manufacturing, similar to many other manufacturing industries, generates carbon emissions, and as such, there is a great scope for industry to assess and reduce its carbon impact. Currently, those companies within the industry engaging in carbon footprinting do so independently, utilising differing boundaries and methodologies to assess their businesses and products. The lack of consistent assessment boundaries means that the data produced cannot always be considered comparable.

With the increasing profile of carbon footprinting, and anecdotal evidence that specifiers are starting to request both company and product carbon footprints in tender documents, The Furniture Industry Research Association (FIRA), as the UK's leading Association for the furniture industry, initiated a project in 2010 to investigate the feasibility of developing a carbon footprinting benchmarking scheme for the UK furniture industry.

The project required the establishment of a consistent methodology using defined boundary conditions that could be adopted by the UK furniture manufacturing.

When using this methodology, in conjunction with a simple, low cost, footprinting tool (FIRA's Furniture Footprinter™), comparable carbon footprints could be produced, that would address the relative feasibilities of:

- **Manufacturers** calculating meaningful carbon footprints to inform and measure their own carbon usage and reductions.
- **Manufacturers** comparing the carbon impact of their products with those of their competitors.
- **Specifiers** procuring low carbon furniture products based on a benchmarking scheme.

In investigating the feasibility of developing carbon footprinting benchmarks for the UK furniture industry a number of project objectives were set including:

Objective 1

To develop and critique a cost effective methodology, from which UK furniture producers could calculate the carbon footprint of their products.

Objective 2

To examine the viability of comparing the carbon footprint of similar furniture products on a like for like basis.

Objective 3

To identify furniture sectors and product categories suitable for carbon footprint comparisons.

Objective 4

To provide industry carbon footprint benchmarks for appropriate products.

Objective 5

To provide advice to the UK furniture industry and furniture specifiers on the interpretation of product carbon footprint claims.

To fulfil the aim and objectives of this project, and to give a snapshot of product footprints in several of the UK furniture industries, a range of items across the furniture sector were selected. Key furniture items from Upholstery, Kitchens, Bedding, Office Furniture and Contract Furniture sectors were examined in terms of their carbon footprint. For example, in the office sector, desks, chairs and pedestals were investigated.

Participating companies included…

boss design

NESS

broadstock

orangebox

Connection

paula rosa.

flexiform

rixonway kitchens

GODFREY

Sealy Posturepedic

Gower

senator

LEE & PLUMPTON

sigma3 kitchens bedrooms home office

Magnet group

Silentnight

moores

Westbridge

Project methodology

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5.1 Introduction

The furniture industry is a diverse industry sector, with large variations in business size and products produced. Preliminary visits to project participants showed that the existing methods of carbon footprinting and data collection varied quite dramatically. These approaches were taken into consideration when defining the final project methodology. Overall, the biggest challenge of the project was to establish a footprinting method that would be applicable to all companies within a diverse industry sector, which was cost effective, yet accurate enough to generate comparable data.

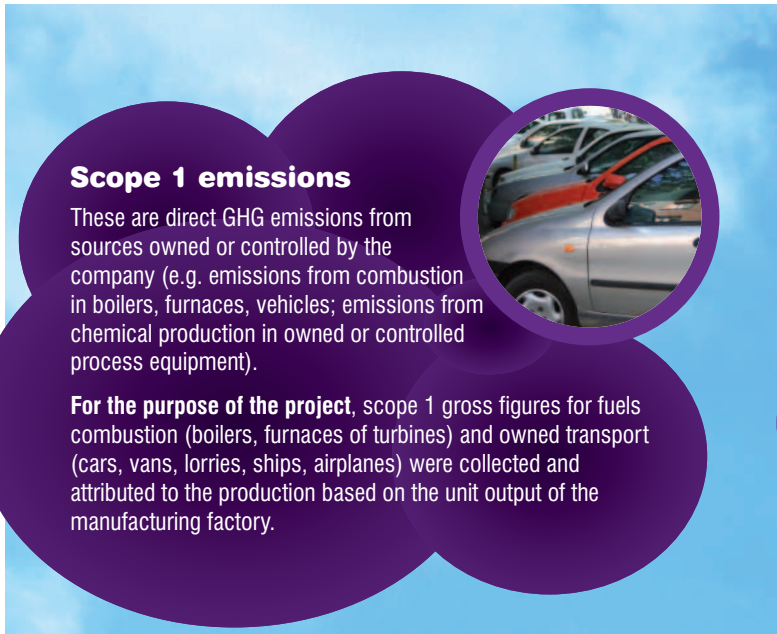
5.2 Project boundaries

There are several approaches to assessing the carbon footprint of a product. These can include as little or as much of a product's lifecycle as desired, and thus it is important to pick an approach which is fit for the intended purpose. A product carbon footprint boundary can include the whole life cycle, often called Cradle to Grave or Cradle to Cradle assessment, or as a partial assessment, either a Cradle to (Factory) Gate assessment or a Gate to Gate assessment (i.e. in and out of a factory).

For the purposes of this project it was decided to use a Cradle to Gate assessment. Cradle to Gate assessment includes all carbon impacts from resource extraction of raw materials ('cradle') to the factory gate (i.e. before a product is transported to the next customer). The use and disposal phases of the product's lifecycle are omitted in this case. The prime reason for selecting the Cradle to Gate assessment was due to the fact that it is within this stage of a product's life cycle that is under the manufacturer's direct control, giving greater confidence in data accuracy and therefore a better possibility of benchmarkable data.

Within the discipline of carbon footprinting there are other boundaries that need to be defined. First, there are 2 basic types of emissions that a company should consider when calculating their carbon footprints; direct and indirect green house gas (GHG) emissions.

- Direct GHG emissions are from sources that are owned or controlled by the company.
- Indirect GHG emissions on the other hand are the consequences of the activities of the company but occur at sources owned or controlled by another company.



Summary of project scope 1, 2 and 3 emissions

These direct and indirect emissions are further categorised under 3 "scopes" (scope 1, scope 2 and scope 3). This categorisation is designed to improve transparency and consistency within GHG accounting and reporting[6] can be summarised as above.

The study included full scope 1 and 2 emissions as well as scope 3 emissions that are attributable to a product's cradle to gate impact.

The physical boundary for the companies assessed within the project was defined as the site where the item was manufactured. Therefore some aspects that are traditionally included in a Cradle to Gate assessment such as emissions from the transport of products to the first customer' site, all activities once the product has arrived at the first customer (i.e. additional manufacturing steps, final product distribution) were omitted.

Scope 2 emissions

These are GHG emissions from the generation of purchased electricity, heat, steam and cooling consumed by the company. Scope 2 emissions physically occur at the facility where electricity is generated.

For the purpose of the project, scope 2 gross figures for the consumption of purchased electricity were collected and attributed to the product based on the unit output of the factory. Scope 1 and 2 assessment denotes the basic organisational footprint of a business as well as being used in the final product carbon footprint.

Scope 3 emissions

These are a consequence of the activities of the company, but occur from sources not owned or controlled by the company (e.g. extraction and production of purchased materials; transportaion of purchased fuels; and use of sold products and service.

For the purpose of the project, scope 3 gross figures for purchased materials i.e. materials used directly in the product including extraction/processing and production), transport-related activities (i.e. distribution including bringing in materials and components) and outsourcing were collected.

To summarise, the full list of emissions included in the carbon footprinting benchmark assessments were:

- Raw materials and components entering the premises
- Delivery of raw materials from the first supplier
- Energy usage (e.g. fuel, electricity)
- Manufacturing processes onsite
- Manufacturing service consumables
- Outsourced activities
- Business and administration support activities such as sales, operation of the premises, cars and travel
- Packaging materials, both temporary and permanent
- Storage of a product on site / or an associated facility including transport on site

5.3 Units of analysis

GHG emissions tell only part of the story with regard to environmental impact and risk. However, they have been given a strong policy focus by governments nationally and internationally, are now within the focus of corporate boardrooms, and therefore resonate well with industry and wider stakeholders. For the purposes of this report, the term carbon is taken to mean carbon dioxide equivalent, or CO_2e. The outputs from this project are thus reported in $kgCO_2e$, or the amount of carbon dioxide equivalent in kilograms attributable to a final product.

Carbon dioxide equivalent as a unit includes the emissions of carbon dioxide gas and other greenhouse gases described in terms of their global warming potential relative to carbon dioxide. The best way to explain this is through an example. Like carbon dioxide, methane is a greenhouse gas but methane has a 'potency' that is 25 times greater than that of carbon dioxide when it comes to its global warming potential. For this reason 1kg of methane released would be represented in carbon footprint calculations as 25 $kgCO_2e$[15].

For the purposes of this project the mass of carbon to be reported is per functional unit (i.e. per item of furniture).

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5.4 Project assumptions and exemptions

As previously mentioned, establishing a footprinting method that would be applicable to all companies (within a diverse industry sector) but was cost effective yet accurate enough to generate comparable data was the biggest challenge of this project. It was understood quite early on in the project that there was a huge variation in the way companies recorded and kept data as well as in their willingness in supplying the project with the required information.

The variation unavailability of data and the ease of extracting relavent data in a cost effective way influenced the final project methodology. To overcome these issues number of project assumptions had to be made which in some cases deviated from the guidance given in documents such as PAS 2050[8].

- **Assumption 1:** Average per product utility consumption is representative of the utilities used in the manufacturing of individual products, i.e. the organisation's total utilily footprint is divided by the total number of products produced, regardless of product type, to obtain an allocation of utilies per product. Whilst this a deviation from PAS 2050, it allowed the company and utility usage to be allocated to a product by a simple calculation, rather than expensive research and monitoring.

- **Assumption 2:** Transport emissions regarding the transport of raw materials only include distances from the first link in the supply chain, i.e. the transport contribution is only from the organisation's supplier, such as a local distributer, rather than from source, which may be overseas. In many cases manufacturers may not be aware of the origin of a component, and research down the supply chain can be expensive, in addition it is generally accepted that the transport of raw materials forms only a small percentage of the total carbon impact of a product.

- **Assumption 3:** Data included in the methodology represents an estimate of a cradle to gate carbon footprint.

- **Assumption 4:** The average emissions factor data used by the Furniture Footprinter™ tool are representative of the embedded carbon seen in materials used within the UK furniture industry.

- **Assumption 5:** Waste was accounted for in terms of starting materials using a wastage factor. However the processes used in the disposal of waste generated during the production of a product including transport of the waste from its point of post-sale use to the point of disposal or recycling were not accounted for. The weights of material used in the calculations are those in the final product and no excess is accounted for. This is another deviation from guidance given in documents such as PAS 2050, however for ease of data collection product information was taken from Bills of Materials and Parts Lists, which do not highlight wastage.

In addition to these, the following emissions were excluded from project assessments:

- Manufacture and ongoing maintenance of capital goods, such as plant machinery, transport equipment, electricity generating plant, office furniture for internal use.
- All office materials (stationery) and equipment (computers, printers).
- The building and maintenance of premises.
- Staff commute to and from their place of work.
- Immaterial emissions (individual elements contributing less than 1% of a footprint provided that these elements, when combined, do not contribute 5% or more towards the total footprint).

Image courtesy of Best Foot Forward

5.5 Project tool

All carbon footprints calculated for this project were produced using the FIRA Furniture Footprinter™ tool. This tool was developed by FIRA in partnership with environmental experts Best Foot Forward. The Furniture Footprinter™ is an online carbon footprint calculator designed specifically for the furniture industry.

FIRA furnitureFootprinter™

It allows the furniture supply chain to quickly and easily generate and compare carbon footprints for their businesses and products. The tool was originally specified for use by manufacturers, to provide a simple means of evaluating GHG emissions and track reductions achieved over time. Throughout this project, FIRA sought to determine whether further extending the application of this tool for industry benchmarking was feasible.

5.6 Data collection

To ensure that all carbon footprints were comparable every attempt was made to ensure that data collection was consistent. However, manufacturers collate manufacturing information in different ways and it was, therefore, inevitable that there were variations in the data used for the project. Whilst this detracted from the overall carbon assessments, it also identified potential problems in the feasibility of producing furniture product benchmarks.

5.6.1 Utilities

Under Defra's greenhouse gas scopes utilities fall under scope 1 and 2, either direct combustion on site or bought in electricity, heat, steam and cooling. Therefore the Utilities data for the project was primarily data directly collected from utilities bills and readings from the site. This data was collected as a year total then attributed to the product footprint as a proportion of the total production output of the factory.

This data included bought in electricity, natural gas supplied to the premises and any gas/fuel oil or LPG bought in and stored on site. Utilities omitted from the project were onsite wood burning boilers and mains water supply.

5.6.2 Transport

The impact of transport was captured from two sources. The sales activities of the company are designed to sell product and therefore sales visits / company car usage and business travel are part of each product's carbon footprint. The business travel element of this collection includes not only cars but also flights and rail journeys. Due to the nature of some companies' record keeping practices some of these values were estimated.

The second transport impact recorded by the project is the incoming components' transport from suppliers to the factory. The distance components were brought in was multiplied by their weight in tonnes to provide an input of tonne kilometres. The Furniture Footprinter™ tool then has the ability to display the amount of carbon generated per tonne kilometre for a variety of average modes of transport. For consistency, haulage transport was taken from a list of averages for that mode of transport. For example, all articulated lorries were assessed using the UK average for articulated lorries rather than by a specific weight category. This decision was made because often the type of articulated lorry varied from delivery to delivery and data records were not consistently available.

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5.6.3 Materials

In the majority of cases Furniture Footprinter™ requests the user to record the materials content of products by weight. These values were collected in two ways. The starting point was always the bill of materials for the product. Some companies kept weight information as part of their bill of materials and in these cases data was transposed into an intermediary spreadsheet and collated into a format that could easily be put into the tool. In other cases the bill of materials was used as a guide and each element of the product was weighed manually.

The Furniture Footprinter™ does not contain data for all raw materials. Selecting how to categorise composite materials was more challenging. Where possible, materials were put into the tool on a percentage content basis. For example if a fabric was 50% polyester and 50% cotton based, the weight of that fabric was split 50/50 between those two input categories.

For categories where data on further processing was available this was also added to the materials input. For example where steel was powder coated this impact was added to the metal input category.

5.6.4 Packaging

Packaging was given its own section in the analysis because it was important to understand its carbon impact in relation to the furniture concerned. A variety of different packaging was assessed including plastic packaging, wood packaging, EG pallets, cardboard packaging, foam packaging. Similar to the approach used for materials (Section 5.6.3), these values were collected either as weight information as part of a bill of materials and transposed into the tool or the bill of materials was used as a guide and each element of the product was weighed manually.

5.6.5 Others

The others section includes inputs over and above basic materials included in items of furniture or specific furniture componentry. Items included in the others section include gas lifts for chairs, edge banding and adhesives. Similar to materials and packaging, these items, on majority, were estimated using the weight information as part of a bill of materials or by weighing each product manually.

5.7 Final project methodology

Once the project methodology and boundaries were defined the data collection and footprint calculation methods were finalised. As previously discussed, there are two main types of carbon footprinting data; the organisational footprint of a company and the footprint of individual products. A total footprint comprises of the organisational footprint of a company plus the footprint attributable to its products.

The carbon footprint of a product was estimated by producing an organisational carbon footprint utilising scope 1 and 2 emissions and adding product materials procurement and processes to this total. Product specific elements are the materials used in the production of the furniture item and, where applicable the production processes and finishes.

The company data was compiled from one year's utilities figures and one year's business travel. This aggregated footprint data was then attributed to individual products by dividing the totals by the number of products manufactured by the company in that year.

A total footprint comprises of the organisational footprint of a company plus the footprint attributable to its products

Kitchens

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Results - Kitchens

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6.1 Introduction

The UK has a strong kitchen manufacturing sector. In 2009 there were 1,200 kitchen manufacturers in the UK, and the kitchen sector recorded sales in the region of £1.2 billion, with imports making up just 20% of this total[16]. The manufacture of kitchen units in the UK predominately focuses on the manufacture of cabinets, utilising imported frontals and hardware.

The manufacture of kitchen units in the UK predominately focuses on the manufacture of cabinets, utilising imported frontals and hardware.

6.2 Product selection

Unlike many other furniture products, kitchen carcasses are normally manufactured to a standard size format, allowing for inter-changeability. This has the additional bonus of allowing for easier comparison between products. Table 1 shows the different products selected for assessment, which are representative of items found in a typical kitchen. The average carbon footprint for each product, as well as the number of products assessed and the number of manufacturers participating in the project is also shown in this table.

Full data sets for all kitchen items are in Appendix 1. However for the purposes of detailed analysis, four key items were chosen. These key items represent high volume products:

- 1000mm kitchen wall unit. A wall hanging carcass unit 1000mm in width with a set of double doors and at least one shelf.
- 500mm wall unit. Similar in carcass construction to the 1000mm wall unit but half the width. Due to its smaller size it also only has a single door.
- 1000mm drawer line unit. A base unit normally featuring a cutlery drawer, a door and at least one shelf.
- 500mm drawer line unit. Similar in carcass construction to the 1000mm drawer line unit but half the width. Due to its smaller size it also only has a single door.

Table 1 Product data for kitchen items

Item	Number of products	Number of manufacturers	Estimated average carbon footprint ($kgCO_2e$)
1000mm kitchen wall unit	5	4	25
500mm kitchen wall unit	9	7	18
1000mm drawer line unit	4	3	40
500mm drawer line unit	8	6	29
Full height base unit	4	4	17
1000mm storage unit	3	2	42
500mm storage unit	4	3	40
Worktops	4	1	26
Appliance housing	4	4	35
Base sink unit	1	1	22

6.3 Carbon footprint analysis

The makeups of the average total carbon footprint of the four key items of products are detailed in Figure 1.

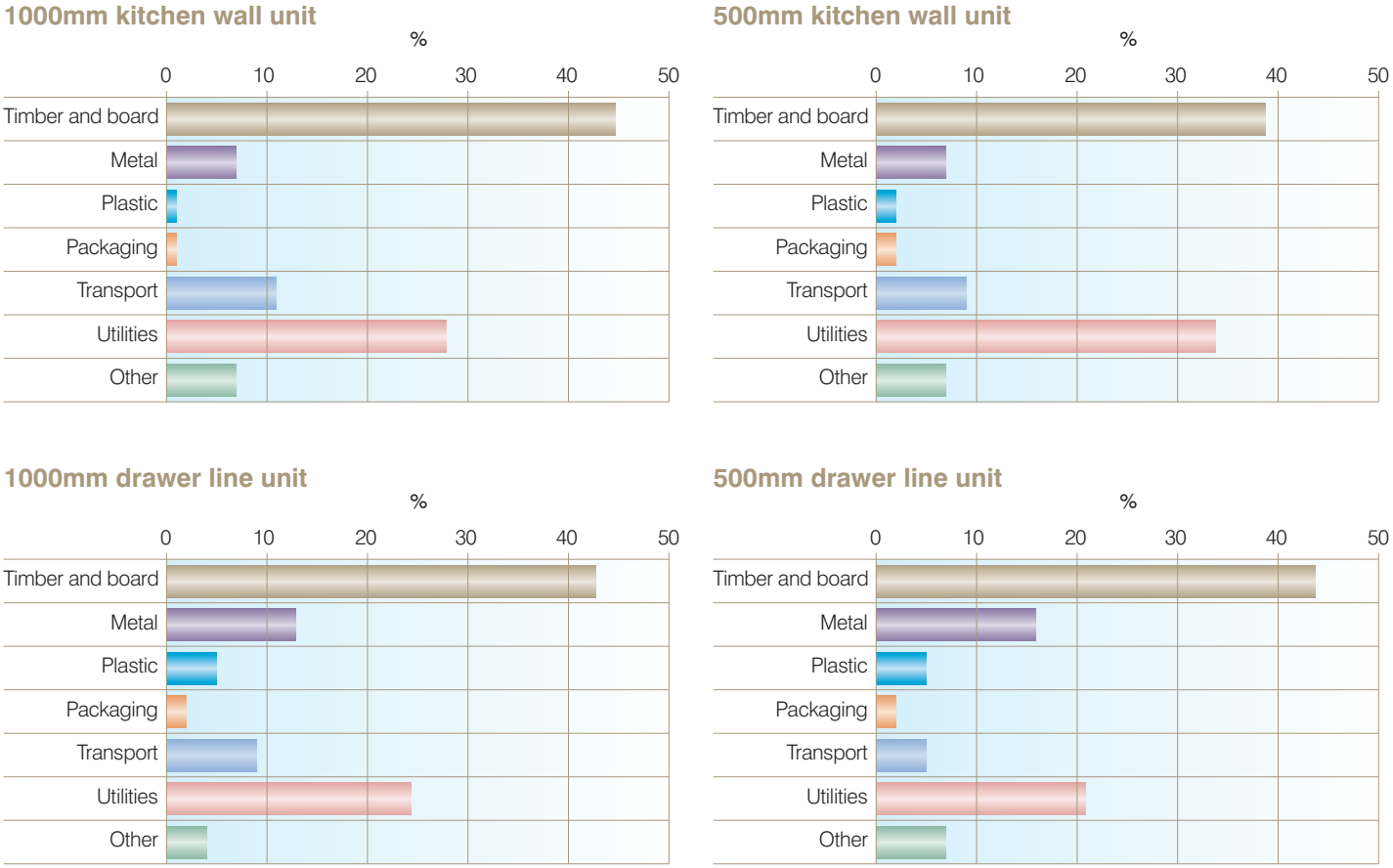

Figure 1 The average total carbon footprint of kitchen items

The carbon footprints follow similar patterns, with the largest carbon impact being the raw material content, primarily the timber and board used in the product. The second highest carbon contributor is the onsite company utilities usage (which also makes up some of the organisational footprint). However this should be analysed in the context that has been described before regarding utility allocation of data.

The results also show that:

- For 500mm and 1000mm drawer line units, the third largest carbon contributor is the metal content of the product. The metal content relates to the hinges and drawer runners used.
- The 1000mm drawer line unit has the highest footprint of all the units as this item as it has the highest raw material volumes.
- The 500mm wall unit is physically half the size of the 1000mm wall unit, however, its carbon footprint is not half the magnitude of the 1000mm wall unit. This is probably due to the material content in the smaller unit being more than half of the larger unit. It may also indicate that the project methodology in allocating proportion of the utilities may not justified. However the implications of this should be fairly insignificant because the utility is not the largest component of the overall carbon footprint.

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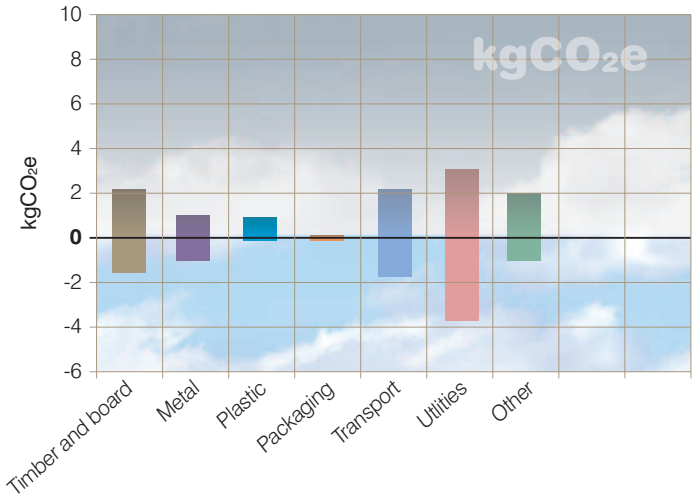
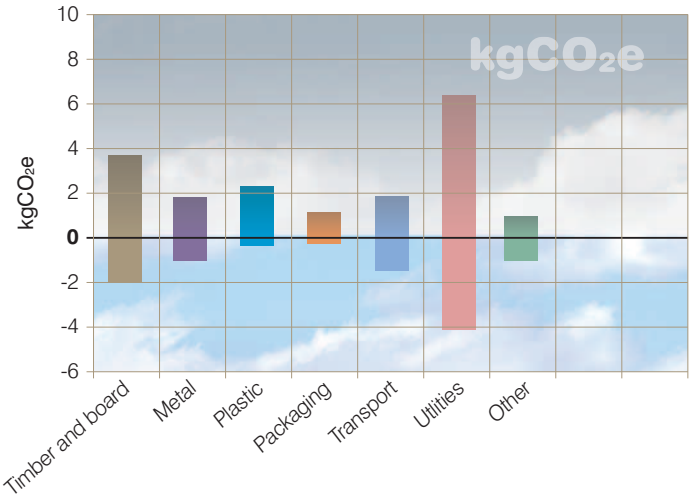
Figure 2 shows further analysis of the product data and highlights the variation of the individual emission categories that make up a total carbon footprint. This analysis shows which emission categories have the highest variation and highlights differences in manufacturing methods.

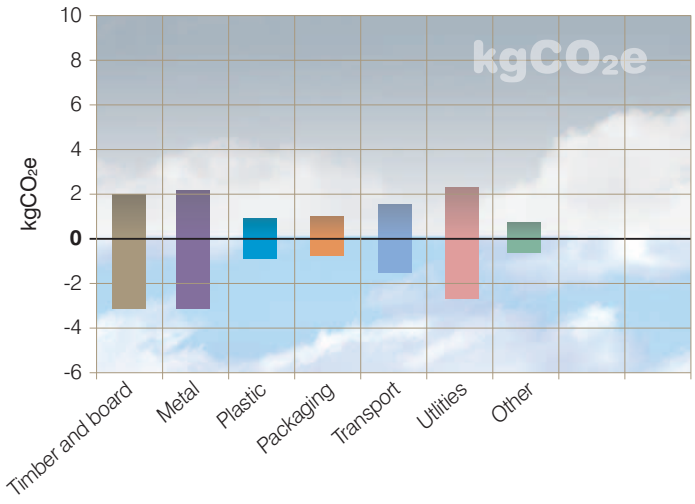
1000mm wall unit



500mm wall unit



1000mm drawer line unit



500mm drawer line unit

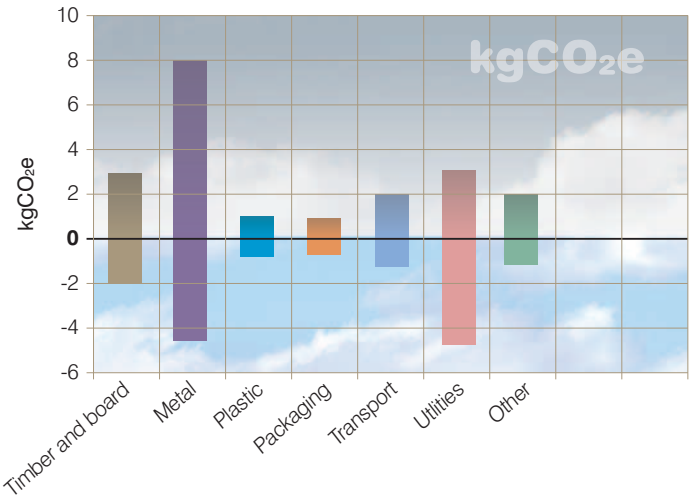


Figure 2 Data variation for each category of carbon footprint input relative to the average carbon footprint for the key kitchen products. The data variation graphs represent the maximum and minimum variation in the data relative to the average value. The zero value on the graph represents the average carbon footprint.

For all units, but especially the wall units, there was significant variation in the energy used in the manufacture of the product. There is, therefore, a potential opportunity for some manufacturers to implement energy efficiency measures to reduce the total carbon footprint of their products. An added advantage of a focus on energy efficiency is that it is very likely to result in costs savings and increased competitiveness over the medium to long term. However it is important to note that the methodology used in this project for allocating utility use does not highlight this.

When examining the drawer line units it was noted that the variation in data for raw materials (i.e. metal and timber/board) was more pronounced compared to that for the wall units. The variation in timber/board may be due to differences in styles, or differences in the thickness of board used. Variation in metal content is primarily due to some units featuring a metal box type drawer construction, whilst others utilise an MDF drawer with smaller runners.

Product variation within similar looking items will also be a function of price point. For example, more expensive ranges may have sturdier construction with more timber support within the unit.

Different price ranges and designs may also include slightly different materials make-ups. For example the inclusion of Medium Density Fibreboard (MDF) supports or sections can influence the final footprint. Whilst the predominant material used in kitchen manufacturing is Melamine Faced Chipboard (MFC), MDF was also identified as a manufacturing material in some units. The use of MDF instead of MFC is important because the carbon footprint of MDF is estimated to be 24% higher than that of MFC. MDF is often used in more expensive products.

In conclusion, the data collected indicates that manufacturers and designers looking to reduce the embedded carbon within their product should look to minimise the amount of board materials and metal within their products, and review the type of drawer construction used. This is, however, only part of the story as product life is also important. A thicker carcass and more durable hardware may result in a longer life span, which may reduce the overall environmental impact of the product. However it should be noted that product lifespan is not in the scope of this project.

In conclusion, the data collected indicates that manufacturers and designers looking to reduce the embedded carbon within their product should look to minimise the amount of board materials and metal within their products, and review the type of drawer construction used.

Domestic

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7.1 Introduction

The UK has a strong bedding manufacturing industry, predominately focusing on mattresses, divan units and headboards. Bed frames, however are often imported in a flat pack state and then assembled. In 2009 there were 114 UK based companies manufacturing mattresses and divans. The sector recorded sales of nearly £600 million, with imports accounting for approximately 13% of this[16].

7.2 Product selection

The bedding items selected for analyses were those commonly manufactured in the UK, and are shown in Table 2. The average carbon footprint for each product, as well as the number of products assessed, and the number of manufacturers participating in the project, are also shown in Table 2.

Table 2 Product data for bedding items

Item	Number of products	Number of manufacturers	Estimated average carbon footprint ($kgCO_2e$)
Double mattress	19	4	79
Single divan	2	1	33
Double divan	6	3	35
Headboard	2	2	22

7.3 Carbon footprint analysis

Full data sets for all bedding items are in Appendix 2. For the purposes of detailed analysis, only two key items were chosen as insufficient data was gathered for single divans and headboards to allow valid comparisons to be made.

The average total carbon footprint of double mattresses and double divans along with the makeup of the carbon footprints are shown in Figure 3.

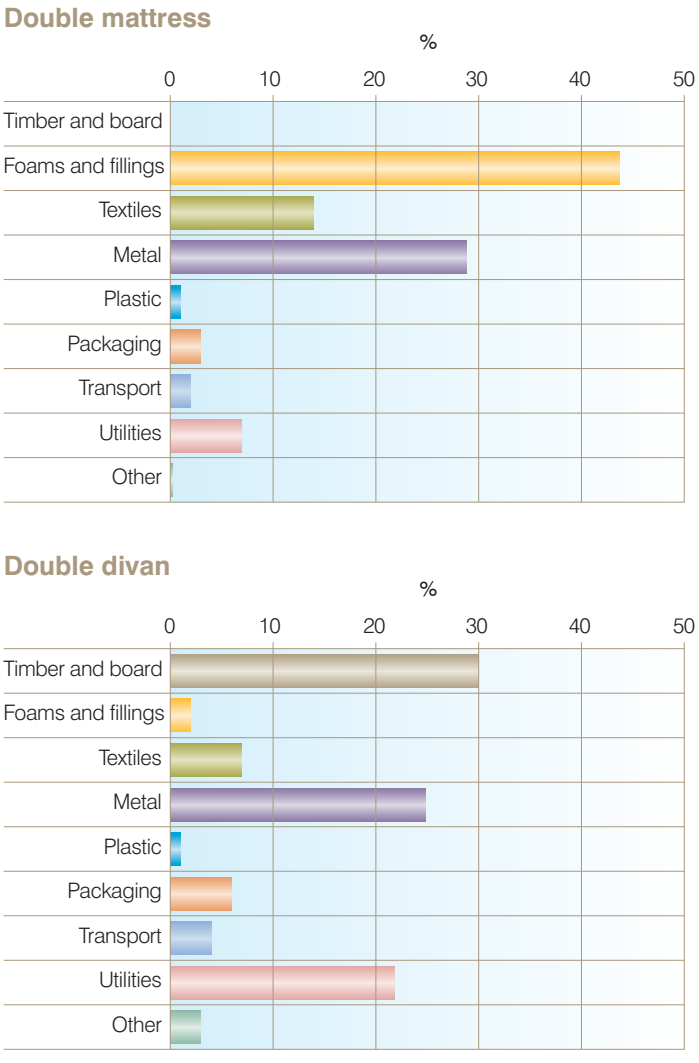

Figure 3 The average total carbon footprint of bedding items

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The footprints of double mattresses and double divans are quite different from each other.

For mattresses, the carbon impact of raw materials (i.e. foams and fillings, textiles and metals) has the biggest impact.

For double divans, whilst the carbon impact of the raw materials was also high, the utilities used in the manufacturing process appeared to have a more significant impact. This may be a true indication of the energy used to make a double divan. However it may also be that the project methodology in allocating a proportion of the utilities to double divan manufacture and a proportion to mattress manufacture may not be justified in this case.

Figure 4 shows further analysis of the product data and highlights the variation of the individual emission categories that make up a total carbon footprint. This analysis shows which emissions categories have the highest variation and highlights differences in manufacturing methods/products.

The results show that for double divans, the largest variation in carbon impact was found in metal content. This variation, however, was due to data relating to one product assessed that featured a sprung edge.

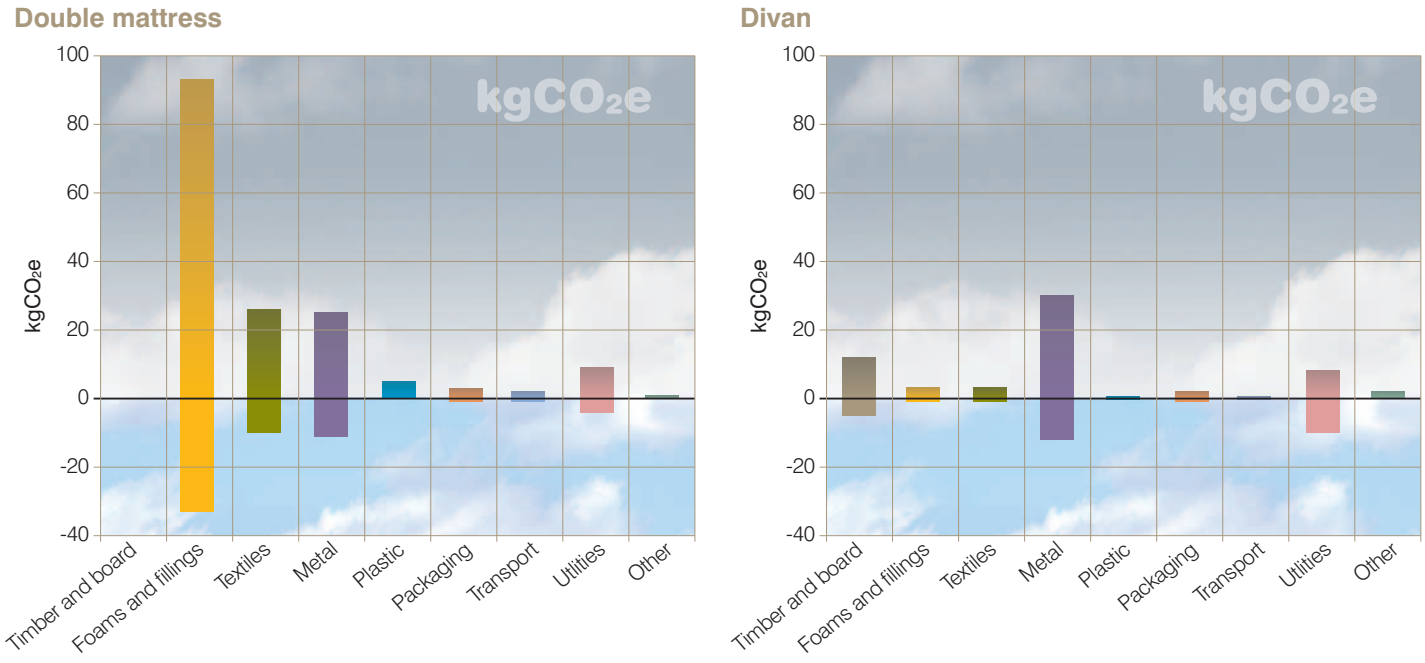

Figure 4 - Data variation for each category of carbon footprint input to the average carbon footprint for the key bedding products. The data variation graphs represent the maximum and minimum variation in the data relative to the average value. The zero value on the graph represents the average carbon footprint.

For mattresses, the greatest variation in carbon impact was found in the foams and fillings used.

The second largest variation was shown to be the timber content. The basic wooden frame of a simple divan is usually standard in nature from company to company assuming an item of equal size. However, the data contains divans of different styles, some of sturdier construction, some including draws or some including sprung edge designs. This variation in design plays a large role in determining the timber footprint of a divan.

For mattresses, the greatest variation in carbon impact was found in the foams and fillings used. Mattresses come in a number of designs including sprung, pocket sprung and foam. In addition, price points are determined by thickness and comfort which also relates to the volume of materials in a product.

The project analysed all types of mattress, and this affected the spread of results. For example, two foam mattresses were examined. These have much higher foam content than spring mattresses and therefore affect the average and variation for all items. In addition, the foam mattresses have no springs, which again affect the variation, and average for all mattress products.

Higher variation in textiles' footprints might have been expected due to the range of double mattresses that were considered but this was not the case.

The design of products has a significant effect on carbon footprints. For example, the carbon footprint of a double mattress depended most on the amount and type of foam/filling used with larger amounts of filling leading to higher carbon footprints.

In terms of the specific foams/fillings, polyester wadding is estimated to have a carbon impact that is more than double that of cotton based wadding. Wool is considered a textile rather than a filling, making comparison with other fillings difficult; however the wool textile is estimated to be more carbon intensive than both polyester and cotton wadding. The use of felt, however, is a relatively carbon efficient method of padding a mattress as it is estimated to have has a carbon intensity that is a quarter of the intensity of polyester wadding.

Similarly, the tool indicates that polyurethane foam has an estimated lower footprint than that of Visco-elastic foam, by approximately 20% assuming the same weight. The data indicates that polyester wadding is used much more widely than cotton wadding. Frequently fillings are made up of a blend of polyester and cotton. In this case increasing the percentage of cotton in a filling allows a manufacturer/designer to reduce the total carbon footprint of the mattress.

The design of products has a significant effect on carbon footprints. For example, the carbon footprint of a double mattress depended most on the amount and type of foam/filling used with larger amounts of filling leading to higher carbon footprints.

Results - Upholstery

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8.1 Introduction

In 2009 the sector recorded sales of over £1.3 billion, with imports accounting for approximately 43% of this[16].

8.2 Product selection

The most common upholstery items were selected for assessment and are listed in Table 3. The average carbon footprint for each product, as well as the number of products assessed and the number of manufacturers participating in the project is also shown in the table.

Table 3 Product data for upholstery items

Item	Number of products	Number of manufacturers	Estimated average carbon footprint ($kgCO_2e$)
Sofa	11	3	90
Arm chair	5	3	43
Footstool	1	1	17
Electric chair	1	1	75
Sofa bed	1	1	88

8.3 Carbon footprint analysis

Full data sets for all the upholstery items are in Appendix 3. However, for the purposes of detailed analysis, only two key items were chosen as insufficient data was gathered for footstools, electric chairs and sofa beds to allow comparisons to be made. Additionally, sofas and armchairs represent the majority of the production for most of the manufacturers who participated in the project.

Figure 5 illustrates the average total carbon footprint of the two key items of upholstered furniture and the makeups of this carbon footprint.

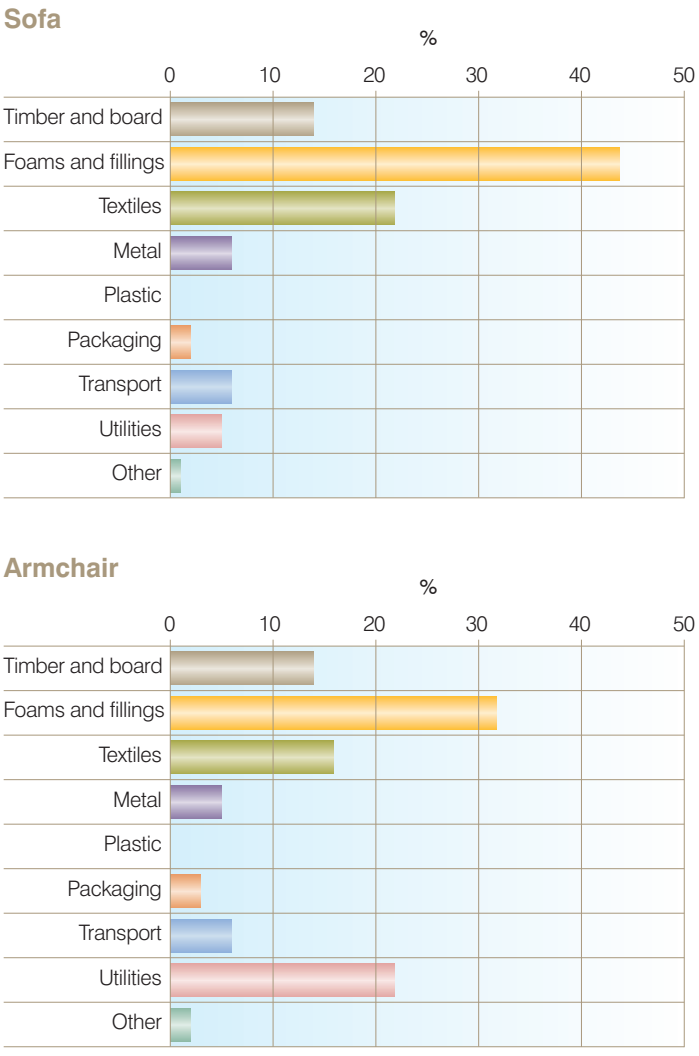
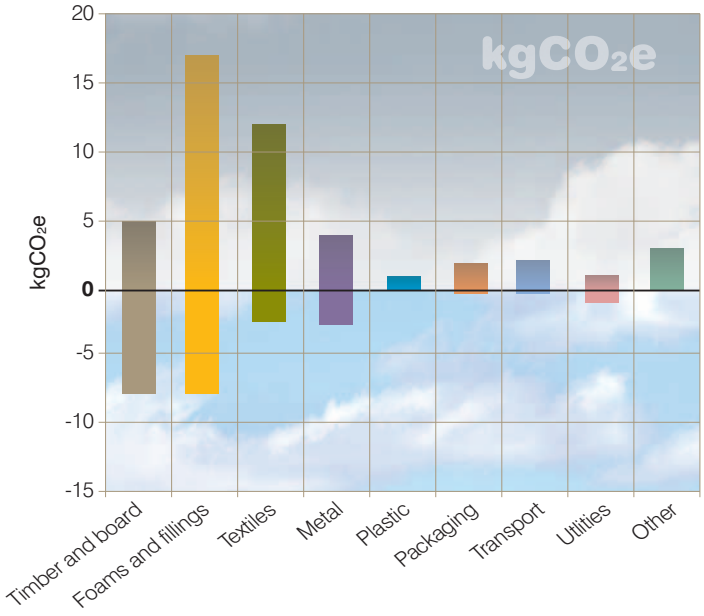


Figure 5 The average total carbon footprint of key upholstery items

Sofa



Armchair

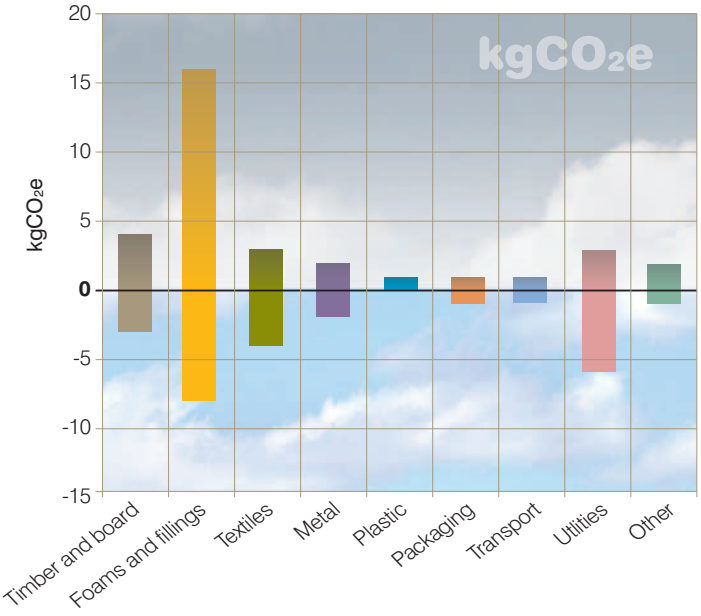


Figure 6 Data variation for each category of carbon footprint input to the average carbon footprint for the key upholstery items. The data variation graphs represent the maximum and minimum variation in the data relative to the average value. The zero value on the graph represents the average carbon footprint.

The largest contributor to total carbon footprint for both items is material content, in particular foams and fillings. Other emissions categories of importance are the fabric content and frame material, which in the majority of cases is wood.

Figure 6 shows variation of data analysis for sofas and armchairs to allow conclusions as to what area a manufacturer can focus on to reduce the carbon footprint of their products.

For an armchair, the impact of company specific utilities and transport elements are more significant than for the sofa. This may indicate that the energy needed to make an armchair is similar to that needed to make a sofa, as the same production processes are used, despite the smaller size of the product. However it may also be that the project methodology in allocating proportion of the utilities may not be justified in this case. The figure for utilities is averaged out across all the products so the methodology suggests by its very nature that a sofa, armchair and footstool all require the same energy to manufacture. However, it is not possible to assess the validity of this assumption due to the methodology adopted in this research.

Figure 6 shows that the largest variation of data for both upholstered items is its raw material content, particularly foams and fillings. This indicates that significant reductions in the carbon footprint of a sofa can be achieved by minimizing the amount of fillings used, or by switching to fillings with the least carbon impact. The carbon footprint of polyurethane foam is estimated to be approximately 20% lower than that of visco-elastic foam.

Office

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9.1 Introduction

There are many players within the UK office seating industry. Manufacturers of seating vary from those that design and build their own products in the UK to those who effectively assemble a kit of parts, predominately sourced from outside the UK. However the majority of manufacturers would be a combination of the two.

In 2009 the sector recorded sales of over £250 million, with imports accounting for over 60% of this[16].

9.2 Product selection

Two different types of chairs were assessed for this study and these are shown in Table 4. A task chair is a chair with a seat height adjustment mechanism designed to be used with a desk and a computer, while a visitor chair is a side chair for occasional/meeting use. The average carbon footprint for each product, as well as the number of products assessed and the number of manufacturers participating in the project are shown in Table 4.

Table 4 Product data for office chairs

Item	Number of products	Number of manufacturers	Estimated average carbon footprint ($kgCO_2e$)
Task chair	13	6	72
Visitor chair	3	3	36

9.3 Carbon footprint analysis

Full data sets for both types of chairs are contained in Appendix 4. The average carbon footprints of both chairs and the makeups of the average total carbon footprints are shown in Figure 7.

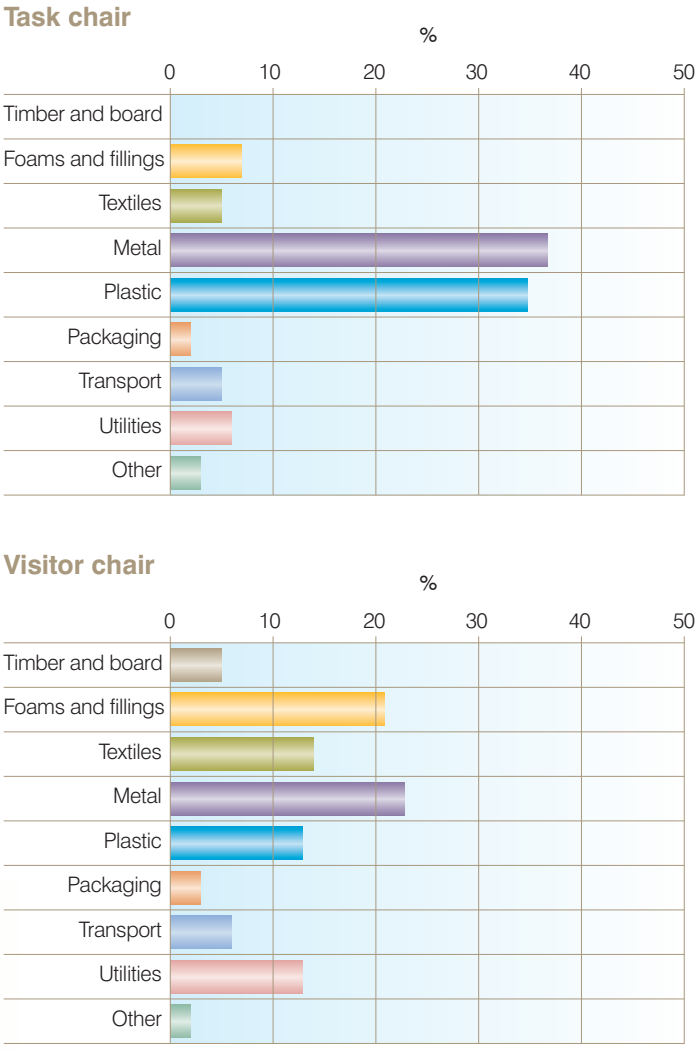

Figure 7 The average total carbon footprint of key office chair items

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For a task chair, the two major contributors to the final product footprint are the carbon embodied within just two materials; metal and plastic. These two materials account for approximately 70% of the total footprint of a task chair. The shape of the carbon footprint of a visitor chair is more uniform with all the components having an impact on the overall footprint.

The variation of data for the footprints of a task chair and visitor chair are illustrated in Figure 8.

For a task chair, the greatest variation is within the key construction materials, i.e. metal and plastic. The largest variation between footprints is attributable to metal content. Many chairs, especially those assembled from a kit of parts have a predominantly plastic construction, with minimal metal content restricted to the gas lift cylinder and seat reclining mechanism. However, more design-led products often use metal components as a style feature, particularly in the base of the product.

Significant carbon footprint reductions can be achieved by minimising metal content, followed by plastic and then other materials.

Visitor chairs vary significantly in design from simple wooden or metal framed side seats, to heavily upholstered side chairs. This explains why there are significant carbon emissions variations between the base materials. The largest variation was within foams and fillings components. This suggests that fully upholstered chairs will have a higher carbon impact than other designs.

As with the analysis of the kitchen sector the carbon footprints produced for the office seating sector only look at the carbon embedded in the product, and do not consider the life span of a product. Metal components may give a longer life span than plastic components, and are potentially easier to re-cycle.

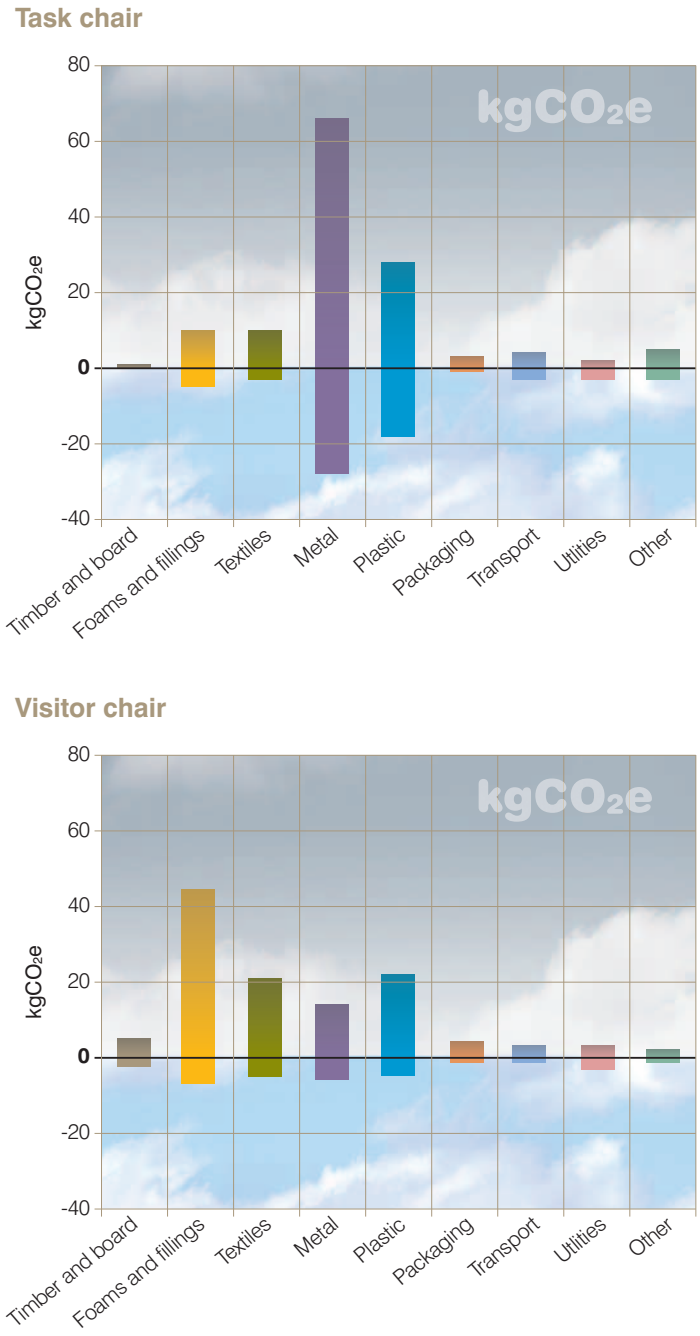

Figure 8 Data variation for each category of carbon footprint input to the average carbon footprint for the key office chair items. The data variation graphs represent the maximum and minimum variation in the data relative to the average value. The zero value on the graph represents the average carbon footprint.

10.1 Introduction

There are two main types of office storage manufacturers, those that focus predominantly on metal storage and those that are constructed from both board and metal. In 2009, the sector recorded sales of over £578 million, with imports accounting for 24% of this[16].

10.2 Product selection

A number of different storage products commonly found in an office were assessed for this study. These are shown in Table 5 together with the average carbon footprint for each product, as well as the number of products assessed and the number of manufacturers participating in the project.

Table 5 Product data for office storage

Item	Number of products	Number of manufacturers	Estimated average carbon footprint ($kgCO_2e$)
Desk high pedestal	7	5	28
Bookcase	3	3	18
Wooden filing cabinet	2	1	48
Tambour	2	2	50
Steel pedestal	1	1	44
Cupboard	2	2	31

10.3 Carbon footprint analysis

Full data sets for all office storage items are in Appendix 5. For the purposes of detailed analysis, two key items were chosen. These key items are the desk high pedestal and bookcase. Insufficient data was gathered for the other products to allow comparisons to be made

The average carbon footprints of the 2 key items of office storage furniture and the makeups of the average carbon footprints are shown in Figure 9.

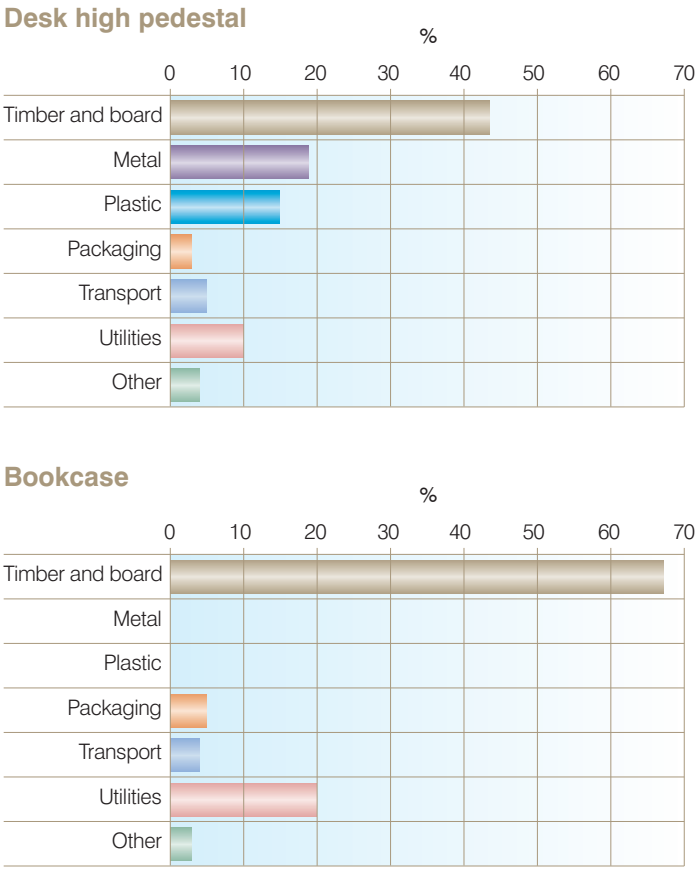

Figure 9 The average total carbon footprint of key office storage items.

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Whilst a desk high pedestal is normally of a standard size, bookcases can vary considerably in size. While every effort was made to ensure that the products selected were similar in size, it was not always possible to achieve this, and this point needs to be taken into account when reviewing the bookcase footprint.

For both items, the largest carbon contribution is found in the timber and board content. This is particularly true for bookcases, which were constructed almost entirely from timber based materials.

For the desk high pedestal, the carbon impact of metal and plastic content are also high compared with other emissions. These relate to the drawer runners and castors that are sometimes fitted to the products. In contrast, the contribution from the manufacturer's utilities is much lower than the embodied carbon in the board, metal and plastic.
The variation of the carbon footprint data for the desk high pedestal and the bookcase is shown in Figure 10.

For desk high pedestals, the greatest variation in the carbon footprint is in the timber and board, metal and plastic categories. This variation can be attributed to the fact that not all desk high pedestals are manufactured from the same materials. Some pedestals feature a predominately metal construction, whilst others are manufactured from board. It was noted that those products that featured metal or plastic in place of board materials had a higher overall carbon footprint.

For the bookcases, the main variables are the timber/board and company utilities components of the footprint. Despite the bookcases not being of standard sizes the data variation was quite low compared to the variation in desk high pedestal carbon footprints. Since the amount of timber/board used in a wooden bookcase would be fairly constant, this may suggest that utilities contribution has a significant impact. However it is important to note that the methodology used to attribute the whole company utility usage to a product is not accurate enough to make any definite conclusions regarding the effect of utilities in a product's carbon footprint.

As with all other sectors, it should be remembered that the product footprints produced take no account of the life span of a product, and that different designs and/or materials may extend the usable life of a product despite containing more initial embedded carbon.

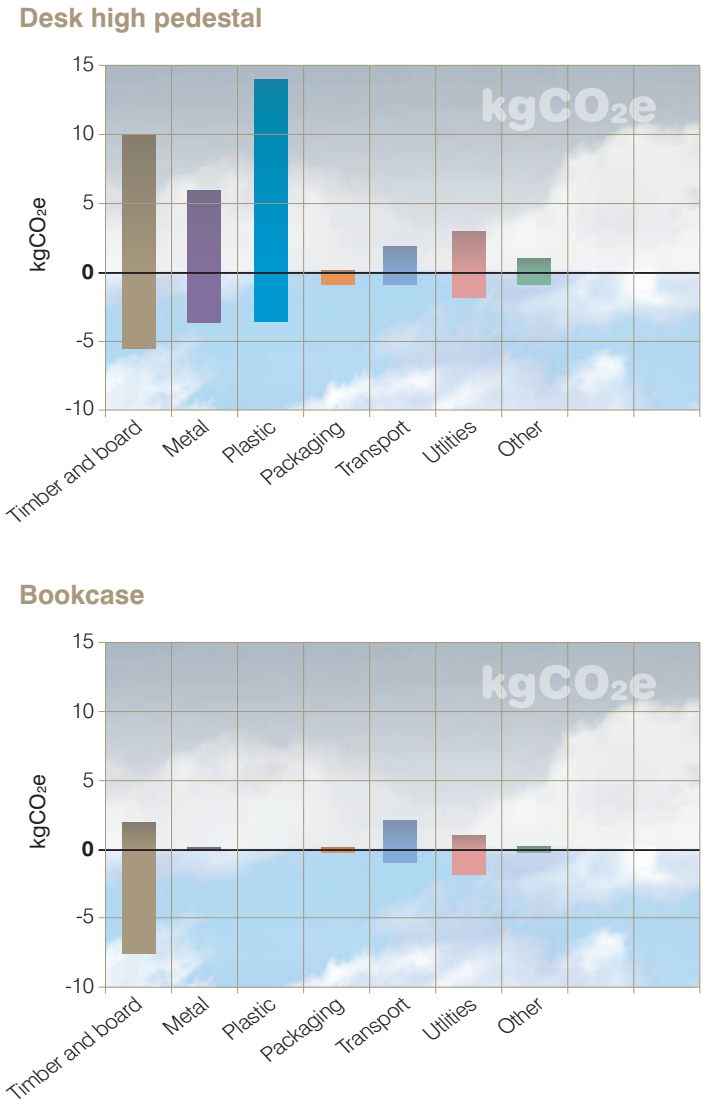

Figure 10 Data variation for each category of carbon footprint input to the average carbon footprint for the key office storage items. The data variation graphs represent the maximum and minimum variation in the data relative to the average value. The zero value on the graph represents the average carbon footprint.

11.1 Introduction

Office desk manufacturers in the UK supply large amounts of product to the contract sector and often install desking systems as well as selling pre-made or flat packed desks. These companies frequently offer whole office solutions including seating and storage. Similar to figures for office storage (Section 10.0), in 2009, the sector recorded sales of over £578 million (excluding seating), with imports accounting for 24% of this[16].

11.2 Product selection

The UK desking manufacturing industry tends to produce desks with standard worktop sizes, to meet both customer demand, and to allow some interchangeability of products in the work place. Table 6 shows the most common office desk types selected for assessment in this study.
The average carbon footprint, the number of products used for this carbon footprint and the number of manufacturers are also shown in Table 6.

11.3 Carbon footprint analysis

The full data sets for all the desk items can be found in Appendix 6. However, for the purposes of the detailed analysis, the 1600mm x 800mm rectangular desk was chosen. Made up of an MFC top and metal supports, this desk is one of the most common desk sizes marketed in the UK.

The average carbon footprints, and its component parts, of these desks are shown in Figure 11.

Unsurprisingly the results show that the two largest contributors to the product's final footprint are timber/board and metal.

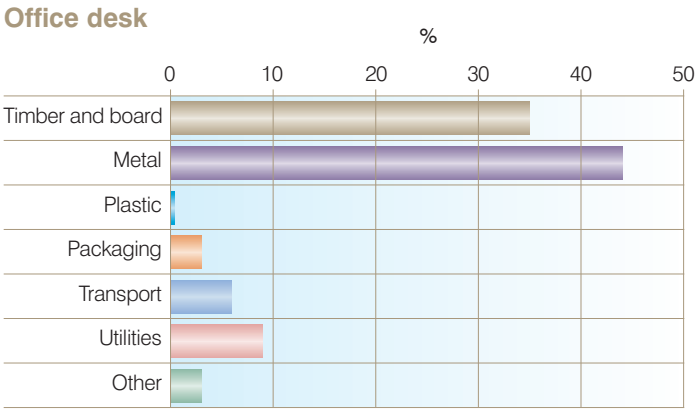

Figure 11 The average total carbon footprint of a 1600mm x1800mm rectangular desk.

Table 6 Product data for office desks

Item	Number of products	Number of manufacturers	Estimated average carbon footprint ($kgCO_2e$)
1600mm x 1800mm rectangular desk	8	6	35
6 people bench desk	2	2	228
1600mm x 800mm wave desk	1	1	63
1600mm x 1200mm work station	1	1	45

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Figure 12 shows the variation of data for the individual emission categories that make up the total carbon footprint.

The large variation for metal is attributable to desk design. Metal supports (e.g. four standard legs or a cantilever configuration) result in a greater footprint than the use of MFC panel legs.

The desks are manufactured to a defined table top size, with similar materials, and, as such, there was very little variance between products.

Unlike all other products, the second largest footprint variation is attributable to transport.

It is important to note that the methodology followed for the calculation of the transport impact (i.e. considering first supplier only) may significantly under estimate this effect for some manufacturers. Two manufacturers imported significant amounts of product from their European manufacturing base, skewing the transport figures considerably, whilst others declared the transport impact of purchased materials only from a local agent.

Office desks

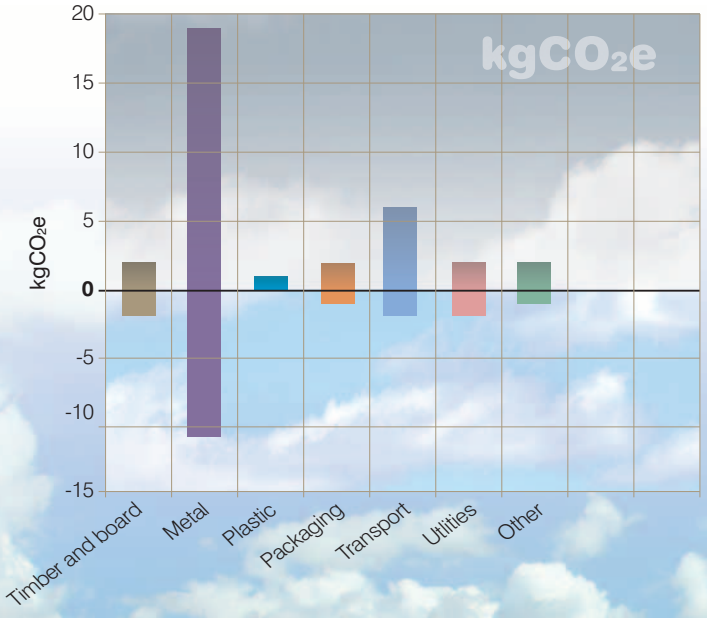

Figure 12 Data variation for each category of carbon footprint input to the average carbon footprint for the rectangular desk. The zero value on the graph represents the average carbon footprint.

Contract

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Results - Contract furniture

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12.1 Introduction

Contract furniture extends wider than the office sector, although some items referred to as contract cross over to the office sector. It includes supply to commercial premises such as hotels, restaurants, conference centres, schools and care homes

12.2 Product selection

Producing averages for furniture sold into the contract sector is challenging because standard items are rare. In many cases the items made for this sector are bespoke and designed to fulfil a specific contract. For this reason, the high volume products from each manufacturer were assessed. These items are shown in Table 7 together with the average carbon footprint for each product, as well as the number of products assessed and the number of manufacturers participating in the project.

Table 7 Product data for contract furniture

Item	Number of products	Number of manufacturers	Estimated average carbon footprint ($kgCO_2e$)
Dining table	3	3	25
Dining chairs	3	1	27
Waiting room beam seating	2	1	66

12.3 Carbon footprint analysis

Full data sets for contract furniture are in Appendix 6. For the purposes of detailed analysis, two key items were chosen. These key items are dining tables and dining chairs. Insufficient data was gathered for waiting room beam seating to allow any comparisons to be made.

The products' average carbon footprints and component parts are in Figure 13.

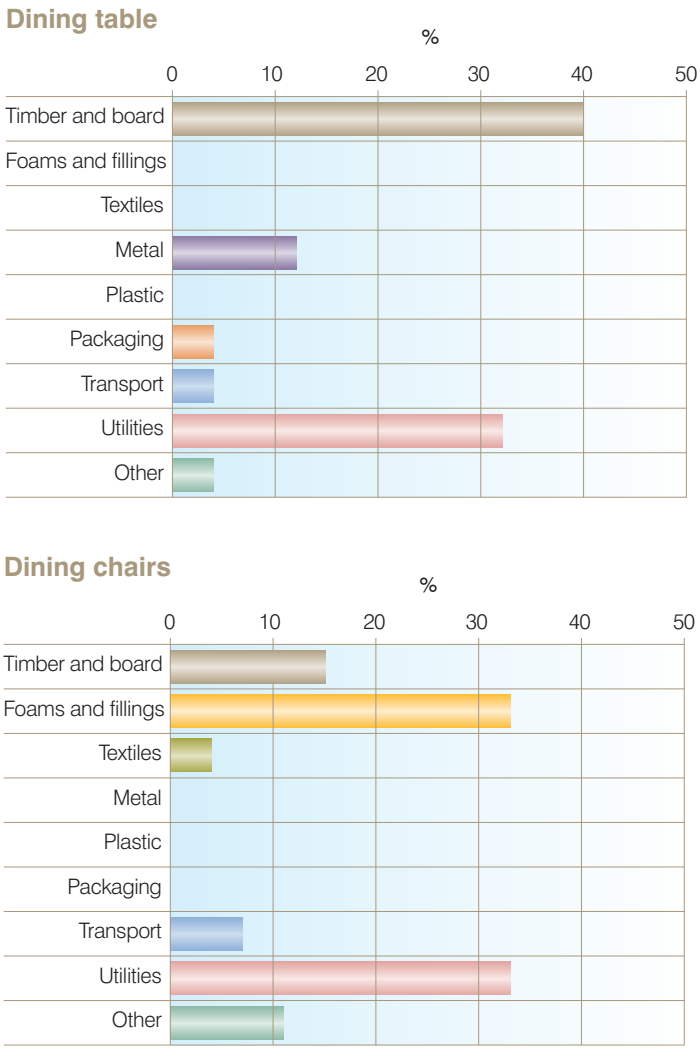


Figure 13 The average total carbon footprint of key contract furniture items

For both products, the raw material content is responsible for the largest carbon impact; timber and board for dining tables and foams and fillings for dining chairs. The results also indicate the significant impact of utilities. However the methodology used to attribute the whole company utility usage to a product is not accurate enough to make any definite conclusions regarding the effect of utilities in the product's carbon footprint.

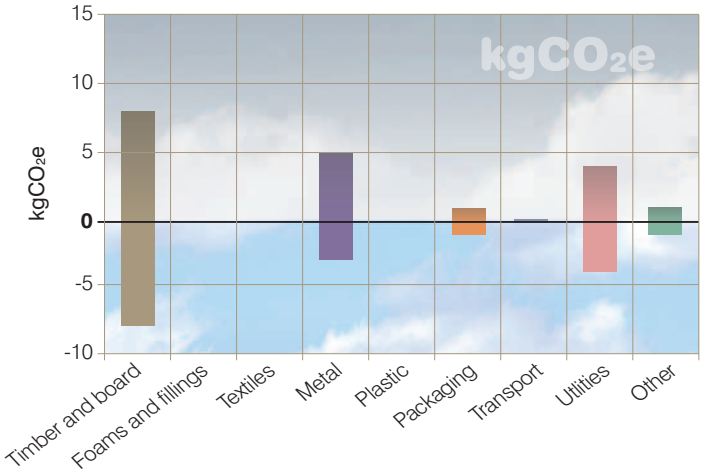
A range of different sized dining tables were assessed hence, as expected, the largest footprint variation is attributable to the timber / board components.

Dining chair footprints are governed by the style of the chair. Heavily upholstered chairs tend to exhibit higher footprints. This reflects the trend for other upholstered products (Section 8.0).

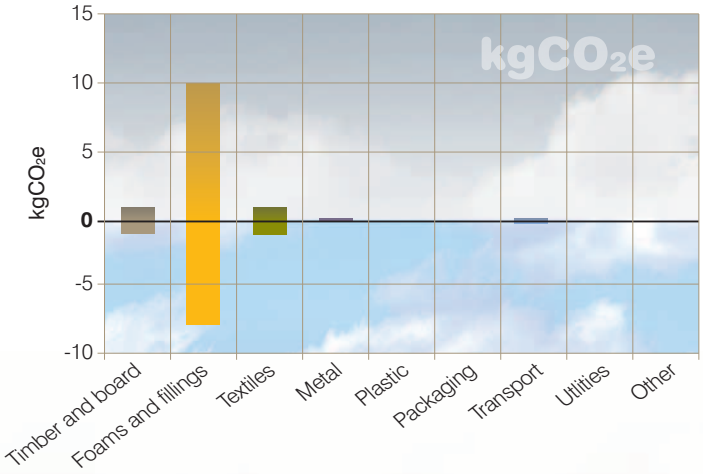
Reductions in the carbon footprint of a contract dining chair can be achieved by minimizing the amount of fillings used, or by switching to fillings with the least carbon impact. However, it is important to note that due to the bespoke nature of contract furniture, product design is influenced by the end user and design changes will not be as simple as in, for example, the office sector.

Figure 14 Data variation for each category of carbon footprint input to the average carbon footprint for the key contract furniture items. The data variation graphs represent the maximum and minimum variation in the data relative to the average value. The zero value on the graph represents the average carbon footprint.

Contract dining tables



Contract dining chairs



Uncertainty

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Carbon footprinting is a complex science. Full product footprint analysis, where the complete product supply chain is examined in detail, certainly has merit in terms of it increased accuracy but has significant cost implications.

The analyses within this report are based on average emissions values for raw materials. This inevitably introduces a degree of uncertainty, but is a cost effective alternative to assessing the actual footprint of each material within a product. Using such data encourages industry engagement in a concept that might previously have been considered to be prohibitively expensive.

Other uncertainties for raw materials are also likely such as:

- Footprints for some materials are not available and a closest fit approximation has to be made using data for a similar material;
- Determining the exact make up of composite products can be difficult and this has been addressed by estimating the average makeup of the materials in a product (such as a castor). However overall, the number of composite products that were minimal so any uncertainty from this should be very small;
- All materials figures are UK based averages. e.g. a piece of steel is assigned the same footprint whether manufactured in China or the UK which may result in over or under-estimating the true carbon footprint of a steel component;
- Uncertainty in estimating the impact of transportation is due to the limit of transport data collection only extending to the first supplier. If a company is buying through local distributors the true carbon impact of bringing raw materials to site will be underestimated.

Potential uncertainties in estimating the impact of Utilities can be attributed to the following factors:

- Business model – different business models and levels of manufacturing affect the utilities usage. The amount of manufacturing one company does compared to another varies considerably across the industry. A company may essentially assemble furniture or construct it from raw materials. In addition a utilities figure for one company might include office and warehouse facilities where as other companies figures may relate only to dedicated manufacturing sites. This creates a problem both internally within a sector but also externally when comparing cross sector products.
- Utilities averaged across different product types – when a manufacturer makes several product types, methodological choices mean that they all have the same utilities footprint. Consequently a footstool appears to require the same energy to manufacture as a 3 seat sofa.
- Companies record their total manufacturing output in different ways. A unit is not always a complete item of furniture. This will lead to some inconsistency in attributing company values to individual products.

Feasibility of benchmarking of furniture products

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The aim of this project was to assess the feasibility of producing product footprint benchmarks for the furniture industry. In doing so companies wishing to make green claims would have a standard method and benchmarkable data set. It would also allow purchasers to make informed decision about carbon related environmental benefits.

The benefits of such an exercise are clear however successful product benchmarking should ensure that the data is truly comparable and consistent.

Figure 15 shows the average total carbon footprint, and within product variations, for the products highlighted within this report. The number of products that the data are derived from (i.e. n) is also shown.

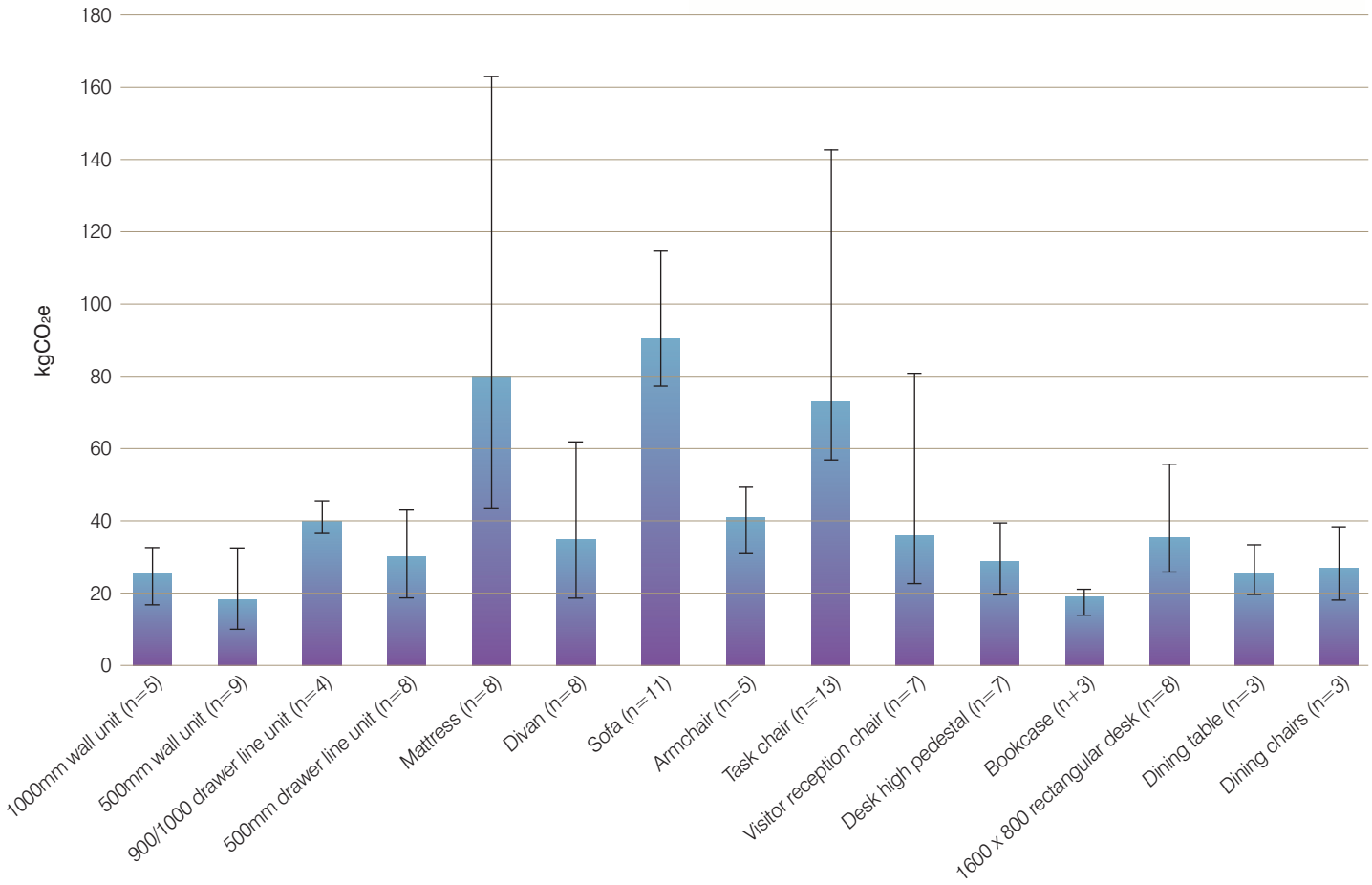

Figure 15 Summary of total average carbon footprints for all key items of furniture. The error bars denote the variation of data and n stands for the number of products that the data are derived from.

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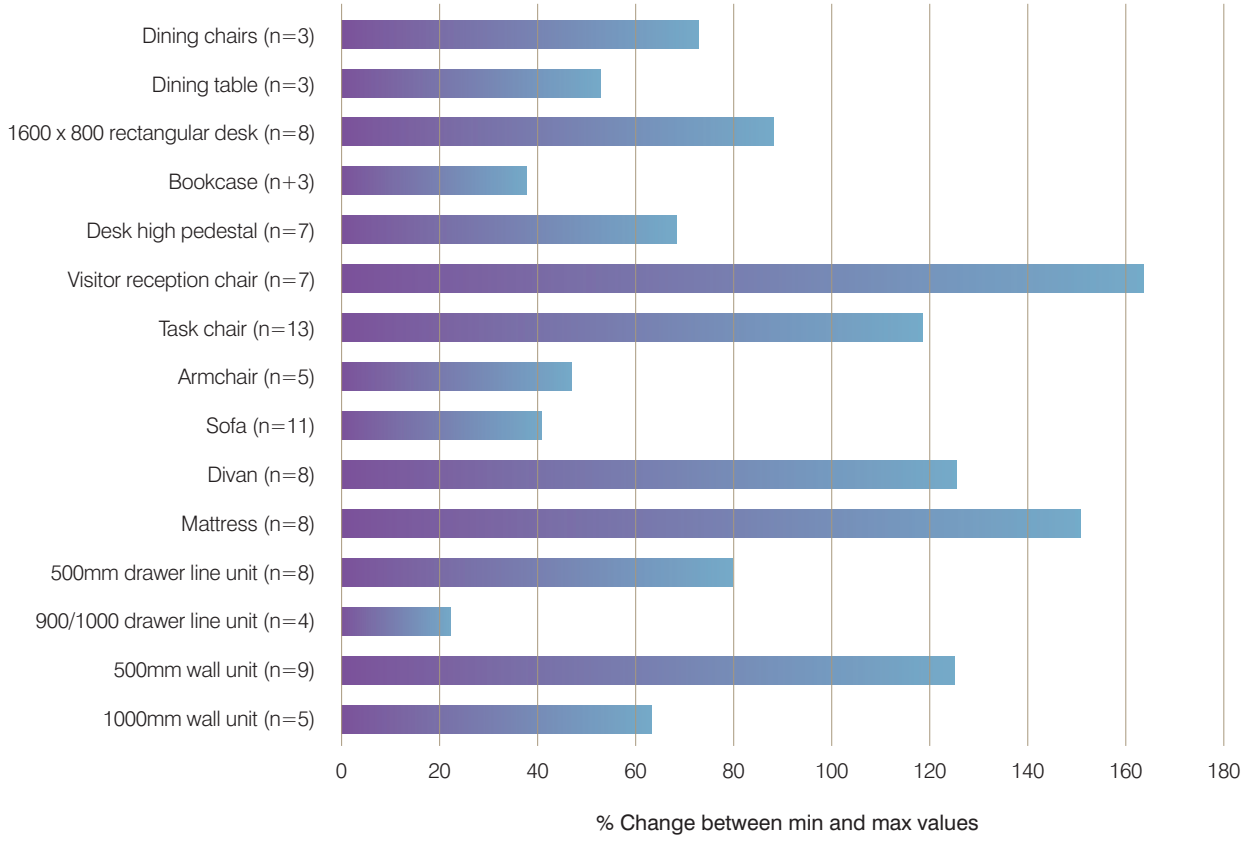

Figure 16 Summary of % change between minimum and maximums carbon footprints for all key items of furniture, n stands for the number of products that the data are derived from.

Figure 16 shows the difference between the minimum and maximum carbon footprint for all key items as a percentage of the average carbon footprint.

The key component that makes up the carbon footprint of an item of furniture is the amount and type of material used in a product.

In the kitchen sector the variation of products is relatively small, as products are all of the same design, and manufactured in the same materials.

In other sectors the large variation in footprints shown in Figure 16 predominately relates to product design.

An office chair featuring a metal base and mesh fabric could have a significantly higher carbon footprint than a simple, predominantly plastic design, despite fulfilling the same purpose.

The carbon footprint for mattresses varies considerably. However, a consumer could make an informed decision on what mattress to select, by balancing the carbon impact of the product against its comfort in use. Similarly a designer of an office chair could look to replace as many metal components with plastic in order to ensure that his product has a low carbon footprint when placed on the market.

However the study identified some fundamental issues with the methodology used which affect the feasibility of initiating a carbon footprint benchmarking scheme at this time.

- Where variation in footprints within product types is large it is difficult to define an average, poor or good carbon footprint. This is particularly the case when sample numbers are low. The remedy is to undertake a larger number of product assessments, thus ensuring greater statistical certainty to any published data.
- Despite the best intentions of the researchers, it was extremely difficult to ensure consistency of data input and comparable boundaries (for example errors associated with the distance from first suppliers and relative contributions of "business wide footprints").
- The emissions factors selected for inclusion in the Furniture Footprinter™ tool used for the project only account for emissions applicable to products manufactured in the UK. It is not suitable for estimating the carbon impact of product manufactured in Europe, the US or Far East, where the embedded carbon values for both materials and utilities will be considerably different. As approximately 40% of products sold in the UK are imported16, it is not feasible to compare and ratify the footprints of all products on the market without up stream supply chain data collection.
- Similarly when components and hardware are purchased from overseas manufacturers the carbon impact is only assessed based on UK data for the base material (rather than the actual data for the country of manufacture), and contains no energy usage component. This may mean a manufacturer using imported components may be assigned a lower or higher footprint than is actually the case.
- A conscious decision was made to include UK average materials emissions factors to maximise simplicity and usability in the Furniture Footprinter™ tool. This does, however create a problem when comparing product footprints including components or materials from several countries. This fact removes the incentive in switching to a supplier with a lower carbon footprint if showing a calculated reduction in your product carbon footprint is your primary motivating factor. This is particularly significant because the results show that the materials component of the overall footprint for most products is very significant. Therefore, the accounting methodology permits tacking of only two of three key options to address this impact: design out either material weight or high carbon intensity materials. However, while this is a problem, it is clear that a company that is serious about reducing its materials footprint needs to invest in further investigation of those elements that will have a significant impact.
- Externally sourced materials and components are sometimes bought in bulk directly from an overseas supplier, (carbon emissions attributable to transport are thus declared), whereas others are sourced from a local agent, and only the transport impact from the local agent is declared, thus distorting the comparative carbon footprints. However the data gathered showed that the impact of transport is relatively insignificant in the product footprint and hence not a huge factor.
- It is important to note that the methodology used in this project does not currently fully account any pre-manufacturing processes that are involved in the components of an item like a task chair. This may result in a company that brings in the components of a product rather than manufacturing them in-house to underestimate the carbon footprint of the final product. A more detailed and lengthy, and hence expensive, methodology would have to employed in order to map the carbon impact of manufacturing a unit of furniture.

The key component that makes up the carbon footprint of an item of furniture is the amount and type of material used in a product.

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The use of carbon footprinting data has advantages, in that it is relatively widely known and understood, however it is only one element of the total assessment of the environmental impact. Carbon footprinting only assesses embedded carbon of materials, manufacturing and company processes.

A more inclusive assessment of environmental impact should include such elements as:

- The toxicity of any substances used in manufacture or production
- Product life span
- Recyclability and reusability
- Biodegradability of non-recyclable or reusable components

For example, by using the Cradle to Gate assessment methodology, a product could be designed to have a very low footprint, by minimising the volume of materials used in its construction. However it is possible that such a product may have a short life span, and need replacing more frequently that a more robustly manufactured product, and the ultimate carbon impact is for the low carbon product over its life span. Cradle to cradle methodologies, and more in depth environmental analysis may provide a better indication of the overall environmental impact of a product.

Carbon footprinting addresses a high profile and particularly important environmental issue, enabling businesses to address a key area of cost and risk. However, it should be remembered that is only one of many important environmental metrics.

As illustrated previously, there are obvious shortcomings when attempting to use a simple, low cost carbon footprinting methodology as a method of benchmarking products particularly if purchasing decisions are predicated on inconsistent comparisons arising out of variable source data.

ANEC the European consumer voice in standardisation makes a similar point in a document released in 2010[21].

"A static Product Carbon Footprint stand-alone label providing a total CO_2 footprint on products does not make sense and is not very relevant for consumer decision making. Although consumers are increasingly aware of the relevance of climate impacts resulting from their purchasing behaviour and usage of products, the display of a total CO_2e footprint figure alone would not be of much help to them."

The document states that releasing this kind of figure suggests an accuracy and certainty not demonstrable with current methodologies. Releasing product carbon footprints for some products without guiding benchmarks risks consumers be they public or business, forming the opinion that a product with the footprint displayed will have a lower footprint than a product without such a label.

Whilst the ANEC observation has some merit, it is important to note that organisations that are willing to invest effort in producing accurate company and product footprints should be encouraged to use these for carbon reduction policies and to promote their successes.

Carbon footprinting addresses a high profile and particularly important environmental issue, enabling businesses to address a key area of cost and risk.

Benchmarking carbon footprints of furniture products

Advice to manufacturers

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The results of the study showed that embodied carbon in the raw materials used in furniture manufacture is the most significant contributor to the carbon footprint of a product. This indicates that the furniture industry, in order to bring about the largest reductions in carbon emissions, must consider design options to reduce the amount of raw materials that are used, or to select alternative lower carbon materials for use in their products. It is, however, important not to use this information in isolation as other environmental considerations should also be considered. Some of these considerations include the end of life characteristics, toxicity, durability and the availability of sustainable sources of material.

It is also important to continually evaluate the availability of new environmentally friendly materials as they become available. This could include anything from natural and renewable fabrics, sustainable timber alternatives or steel compounds designed not to require degreasing processes.

Whilst the data produced in the course of the project indicated that the carbon impact from utility usage and transport had a limited impact on a product footprint, reducing the utility usage and transport costs should not be ignored. Indeed when addressing any environmental concern a company should always look internally first and identify efficiency measures. These efficiency measures should include an examination of utilities usage, transportation practices and manufacturing waste reduction. These areas can often be looked at as part of lean manufacture, energy assessments, environmental management systems and transport management programmes. Often successful businesses will address all these areas as a matter of course because greater efficiency increases competitiveness. The reductions made in these areas are also easy to track report on.

It is important to recognise that the outsourcing of carbon intensive activities should not be regarded as a way of reducing the carbon footprint of the business or products. This practice simply displaces that carbon elsewhere in the supply chain. The carbon impact of furniture needs to be seen in a global light, displacing emissions to other nations does not address the fundamental problem.

Once a company has addressed its energy efficiency performance and considered design aspects, the next step is the consideration of greening their supply chain. The key to successfully greening a supply chain is to form partnerships and work closely with suppliers to achieve the desired results. When looking to form supplier or customer partnerships it is important to involve them early. The reason for this being that in many cases long lead times necessitate early sourcing and supplier involvement in green product development. Similarly customers need to be buying product with its full life cycle in mind. In this context, it is important to look the chain and provide customers waste saving proposals and initiatives.

Benchmarking carbon footprints of furniture products

Advice to specifiers

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The requirement for manufacturers to declare both their organisational and product carbon footprints is featuring increasingly in tenders for the supply of furniture and related services.

In the absence of any carbon footprint benchmarks in the furniture industry for either individual products or for businesses, and with the danger of inconsistent representation of source data, it is impossible to make legitimate quantitative comparisons solely based on manufacturer's self declarations when evaluating tender submissions.

The purpose of this project was to investigate the viability of benchmark average data that would allow specifiers to make an informed decision on the environmental impact of a product based on its carbon footprint. The results clearly indicate the difficulties associated with this concept and that further research would be required to enable well sourced benchmarks to be established:

- Large volumes of data are needed to produce statistically accurate average values.
- Carbon footprinting methodologies require accurate assessment boundaries.
- Benchmarking within the UK has its problems but widening this on a global level to incorporate imports creates greater challenges.

Product life span, re-use, recyclability, toxicity are all important selection criteria. The carbon footprint impact of a product should be considered in conjunction with such environmental considerations.

Specifiers are encouraged to ask suppliers to measure, review and improve the carbon footprint of their businesses and / or products.

Evidence of these activities should be sought either through first party declaration or third party verification. It should be noted that carbon offsetting should be seen as the route of last resort when looking to reduce carbon impact, and not the easiest option.

When assessing a supplier's environmental credentials there are other avenues which can be considered to ensure the supplier adheres to all relevant environmental regulations, and are committed to the continuous improvement of its environmental performance. For example, selecting a company who has an effective Environmental Management System, such as ISO 14001 offers a level of re-assurance. Similarly selecting a supplier who is a full member of the Furniture Industry Sustainability Programme (FISP) indicates that that supplier is addressing wider sustainability issues than just carbon reduction or environmental management.
In conclusion, it is good practice to ensure that suppliers strive towards reducing the carbon footprint of their activities. It is inadvisable, however, to rely on quantitative product benchmarking at this point in time for choosing between alternate products.

Conclusions

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The main aim of the project was the investigation of the feasibility of developing carbon footprinting benchmarks for the UK furniture industry based on current readily available information from the industry. The research shows that, when using the simple standardised methodology, comparison of product carbon footprints is not currently recommended within the furniture industry.

The 'Cradle to Gate' methodology used does not adequately assess all the environmental and sustainability impact of a product, and therefore may be misleading when used to establish the green credentials of a product. A more in depth 'Cradle to Cradle' assessment may provide more accurate results; however this is likely to be considerably more expensive to produce as not all data needed will necessarily be available to the manufacturer.

Further objectives were also set for the project.

Develop and critique a cost effective methodology, from which UK furniture producers could calculate the carbon footprint of their products

A carbon footprinting methodology for the furniture industry needs to be accessible to companies of all sizes and types. In this respect, a cost effective methodology was successfully developed which enabled data to be collected from a variety of different UK furniture manufacturers. All footprints were ensured to contain, where practicable, the same emissions sources at the same level of detail.

However, whilst some companies have been collating data for some time, this data often relates to differing accounting boundaries and is subject to gaps, or missing data. These inconsistencies only served to demonstrate the complexities of data collection for accurate carbon footprinting and the potential pitfalls when trying to benchmark products or organisations.

Examine the viability of comparing the footprint of similar furniture products on a like for like basis and to identify furniture sectors and product categories that are suitable for comparison

Provide industry benchmarks for appropriate products

The furniture industry is diverse in nature and it is recognised that a one size fits all approach may not be appropriate for all sectors within the industry. The results of the study showed this to be the case and despite the use of a standard methodology, comparison of furniture products on a like for like basis is not realistically achievable within the UK furniture industry. The results are not suitable for a stakeholder to make an informed decision on the selection of a product based on its carbon footprint. In this respect, the results presented in this study do not allow a company to establish that their product is better or worse than an industry average.

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Provide advice to the UK furniture industry and furniture specifiers on the interpretation of product carbon footprint claims

One of the major stimuli for commissioning this research project was the lack of understanding and fragmented approach to carbon footprinting in the industry. This lack of consistency can create uncertainty around green claims whether they are aimed at specifiers or consumers. In this respect, the results of the project allowed to provide advice to the UK furniture industry and furniture specifiers as well as manufacturers. The key message was that carbon footprinting as a tool has value in understanding the makeup of a product's footprint, and then allowing it to be evaluated to see what can be done to reduce the footprint.

It is clear that much of this data was much harder to collate than was originally envisaged and that widespread valid benchmarking under the current business environment would prove difficult.

However, this does not mean that the industry should ignore the benefits to be gained from improving its carbon impact, and efforts need to continue to be made to develop viable techniques that will measure a company's carbon performance. Companies should be encouraged to start by measuring the footprint of their activities and focus on the continuous improvement of their carbon impact.

It is therefore important to remember that carbon footprinting can be a very useful tool for the furniture industry. The more the furniture industry understands the footprint of its products the more it can look to reduce it in targeted, intelligent and innovative ways. Such carbon reductions can also lead to significant cost savings for manufacturers.

To take benchmarking forward, a number of issues need to be addressed:

- Any carbon footprinting methodology for the furniture industry needs to be accessible to companies of all sizes and types.
- Greater consistency in the way that companies record data is needed.
- A larger amount of data needs to be generated to enable statistically valid comparisons.
- How to easily address the impacts of imports and components should be considered.
- Reporting footprints on per kg or per product cost, or other basis to create more realistic comparisons could be considered.
- Ways of incorporating other environmental criteria within a footprinter calculation should be established (i.e. re-use, recyclability, life span).

When reviewing the data obtained during the research, a key finding from the report was that in the majority of furniture ranges examined, the embedded carbon contained within the materials and processes used for the manufacture of the product were the highest contributers to the product's carbon footprint, rather than company factors such as utilities or transportation.

Similar conclusions have been identified by other manufacturing industries. For example the computer industry has identified that only around 10% of the carbon emissions attributed to the manufacture of a computer relate to direct sources, such as utilities, whilst the carbon embedded in purchased parts were the largest components of their cradle to gate footprints. Other examples include motor vehicle manufacture which has a similar 90% figure for embedded emissions and the newspaper industry where the figure is 60% embedded emissions[18].

It is therefore important to remember that carbon footprinting can be a very useful tool for the furniture industry. The more the furniture industry understands the footprint of its products the more it can look to reduce it in targeted, intelligent and innovative ways. Such carbon reductions can also lead to significant cost savings for manufacturers.

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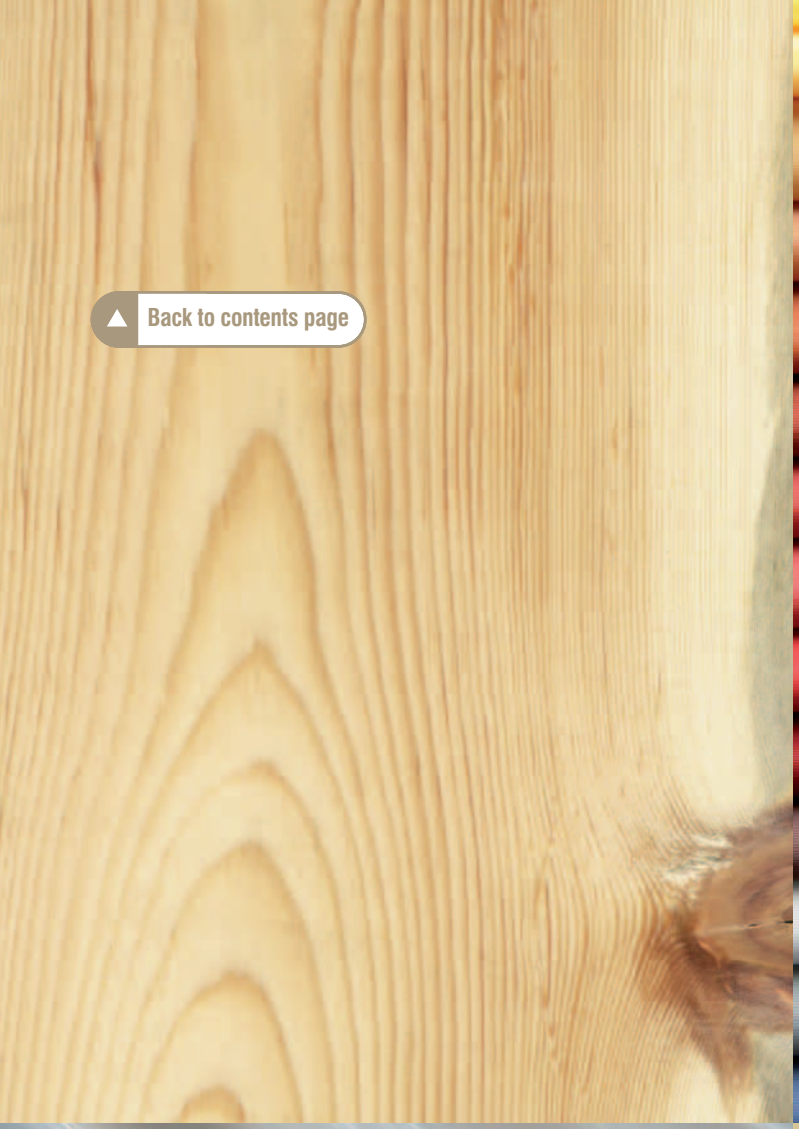

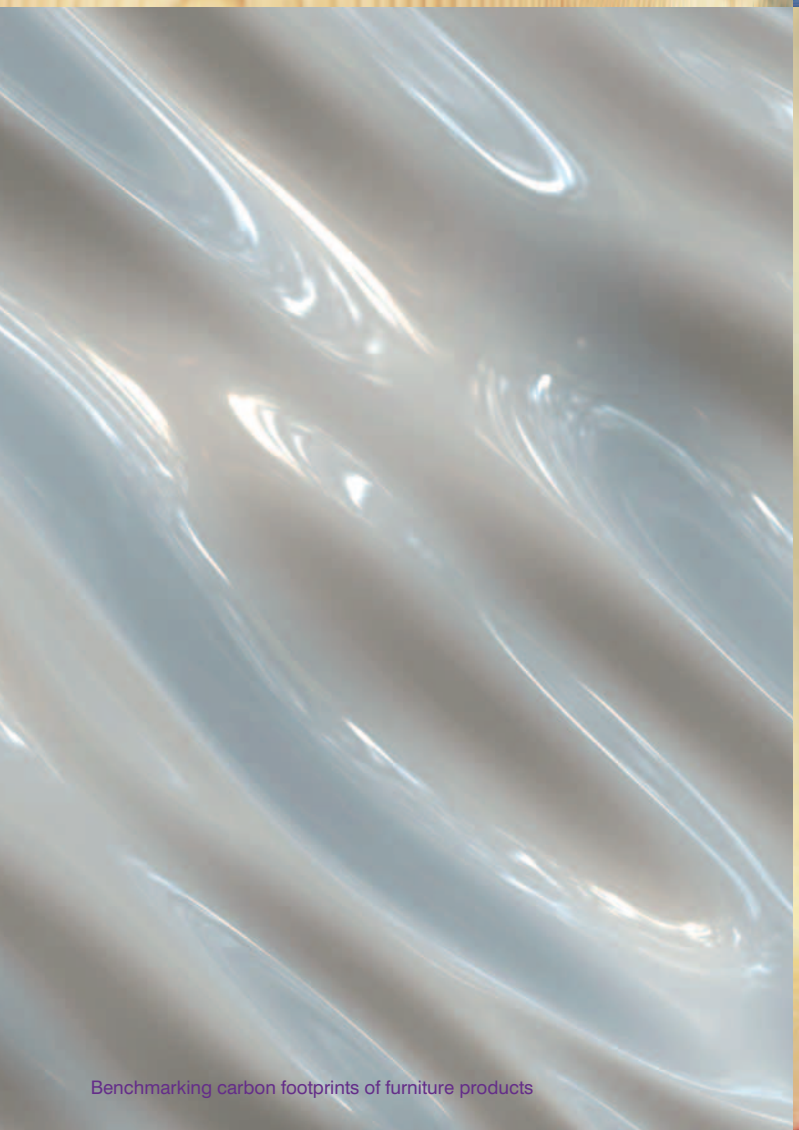

Breakdown of kitchen furniture carbon footprint data

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1000mm wall unit	Total footprint	Timber & board	Metal	Plastic	Packaging	Transport	Utilities	Other
Product A	**26.46**	13.68	1.13	1.17	0.41	2.03	7.26	0.78
Product B	**32.25**	13.20	2.66	0.02	0.21	4.83	9.91	1.42
Product C	**28.09**	9.99	2.04	0.02	0.21	3.95	9.91	1.97
Product D	**16.26**	9.99	0.62	0.03	0.38	1.50	3.00	0.74
Product E	**22.46**	10.80	1.77	0.00	0.31	0.97	4.93	3.68
500mm wall unit								
Product A	**16.73**	6.23	0.35	0.03	0.20	1.84	7.26	0.83
Product B	**16.75**	10.27	0.64	0.07	0.54	0.53	2.57	2.14
Product C	**23.89**	7.63	1.72	0.02	0.10	3.48	9.91	1.02
Product D	**24.01**	6.76	2.35	0.02	0.10	3.51	9.91	1.37
Product E	**9.70**	4.40	0.31	0.03	0.38	1.13	3.00	0.45
Product F	**31.37**	7.24	2.99	2.73	1.55	3.40	12.56	0.90
Product G	**10.58**	5.98	1.18	0.04	0.28	0.23	1.56	1.30
Product H	**12.22**	6.52	0.95	0.78	0.30	0.22	1.56	1.90
Product I	**13.49**	4.87	1.03	0.00	0.21	0.65	4.93	1.80
1000mm drawer line unit								
Product A	**40.73**	18.34	7.43	2.68	0.81	3.21	7.26	0.99
Product B	**40.82**	19.37	3.93	1.28	0.21	5.11	9.91	1.01
Product C	**35.97**	17.80	2.03	1.28	0.21	2.51	9.91	2.22
Product D	**45.03**	14.21	7.54	2.73	1.69	4.14	12.56	1.60
500mm drawer line unit								
Product A	**26.61**	10.37	3.52	1.72	0.00	2.43	7.26	1.32
Product B	**32.65**	13.74	3.89	1.28	0.06	2.18	9.91	1.58
Product C	**29.94**	13.10	1.98	1.28	0.06	1.99	9.91	1.63
Product D	**41.82**	15.86	4.50	2.73	1.55	3.62	12.56	1.00
Product E	**19.12**	13.11	0.29	1.26	0.30	0.29	1.56	2.33
Product F	**17.73**	10.91	0.69	1.63	0.30	0.23	1.56	2.41
Product G	**33.08**	13.02	10.81	0.64	1.22	0.62	2.57	4.20
Product H	**34.59**	12.44	12.93	0.84	0.21	0.78	4.93	2.46
Full height base unit								
Product A	**11.92**	6.14	0.36	0.08	0.38	1.18	3.00	0.77
Product B	**15.07**	8.01	1.99	1.27	0.29	0.32	1.56	1.63
Product C	**21.43**	11.66	0.47	1.26	0.55	0.58	2.57	4.35
Product D	**18.09**	9.56	0.17	0.81	0.21	0.60	4.93	1.82

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500mm storage unit	Total footprint	Timber & board	Metal	Plastic	Packaging	Transport	Utilities	Other
Product A	**48.05**	28.21	2.21	1.34	0.15	3.29	9.91	2.93
Product B	**46.56**	26.13	1.59	1.34	0.15	3.45	9.91	3.98
Product C	**39.32**	14.00	2.99	2.73	1.55	3.65	12.56	1.84
Product D	**25.03**	8.84	6.68	0.85	0.21	0.80	4.93	2.73
1000mm storage unit								
Product A	**41.05**	14.90	2.99	2.73	1.69	4.11	12.56	2.07
Product B	**46.29**	19.61	2.99	2.73	1.69	4.59	12.56	2.12
Product C	**39.38**	16.19	13.55	1.52	0.54	0.67	2.57	4.35
Worktops								
Product A	**20.36**	14.95	0.38	1.33	3.00	0.70	20.36	14.95
Product B	**25.83**	20.28	0.38	1.46	3.00	0.70	25.83	20.28
Product C	**25.47**	19.93	0.38	1.45	3.00	0.70	25.47	19.93
Product D	**32.76**	27.05	0.38	1.63	3.00	0.70	32.76	27.05
Appliances housing								
Product A	**45.60**	19.05	2.99	2.73	1.55	4.60	12.56	2.12
Product B	**29.17**	20.14	2.16	1.60	0.11	0.58	1.56	3.01
Product C	**22.04**	12.94	4.35	1.39	0.32	0.37	1.56	1.10
Product D	**42.09**	19.99	14.32	1.67	1.46	1.04	2.57	1.05
Base sink unit								
Product A	**21.76**	8.80	2.90	5.26	0.30	0.32	1.56	2.63

Breakdown of bedding furniture carbon footprint data

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Mattress	Total footprint	Timber & board	Foams & fillings	Textiles	Metal	Plastic	Packaging	Transport	Utilities	Other
Product A	**43.71**	0	23.77	6.48	7.16	0.00	2.81	1.20	2.14	0.14
Product B	**65.88**	0	25.05	17.46	16.13	0.00	2.81	2.15	2.14	0.14
Product C	**43.38**	0	23.73	6.20	7.16	0.00	2.81	1.20	2.14	0.14
Product D	**163.63**	0	128.18	27.33	0.00	0.00	2.81	3.03	2.14	0.14
Product E	**61.85**	0	18.82	10.20	27.76	0.00	1.04	0.58	3.40	0.05
Product F	**51.08**	0	9.60	8.54	27.73	0.00	1.04	0.54	3.40	0.22
Product G	**85.63**	0	39.35	5.98	34.90	0.00	1.04	0.69	3.40	0.28
Product H	**82.58**	0	42.01	10.74	23.69	0.00	1.04	1.01	3.40	0.70
Product I	**81.04**	0	36.06	6.16	32.82	0.00	1.04	0.70	3.40	0.88
Product J	**83.00**	0	68.23	4.67	0.16	0.51	4.87	1.12	3.40	0.05
Product K	**71.09**	0	17.55	20.52	27.77	0.00	1.04	0.76	3.40	0.05
Product L	**67.00**	0	2.00	17.00	30.00	0.00	2.00	1.00	15.00	0.00
Product M	**63.00**	0	9.00	3.00	33.00	0.00	2.00	1.00	15.00	0.00
Product N	**102.00**	0	29.00	37.00	17.00	0.00	2.00	2.00	15.00	0.00
Product O	**125.00**	0	48.00	12.00	47.00	0.00	2.00	1.00	15.00	0.00
Product P	**82.98**	0	46.34	0.74	24.16	3.15	1.90	1.44	4.93	0.33
Product Q	**104.64**	0	36.81	2.84	48.37	5.68	3.17	1.56	4.93	1.29
Product R	**41.37**	0	14.25	1.10	16.45	1.16	1.87	1.29	4.93	0.33
Product S	**90.85**	0	49.99	10.29	16.64	4.52	2.70	1.45	4.93	0.33
Single/double divan										
Product A	**18**	4	1	4	0	0	1	1	3	3
Product B	**31**	7	3	2	10	1	1	1	3	2
Product C	**62**	1	0	5	38	0	3	1	15	0
Product D	**37**	13	0	3	1	0	4	1	15	0
Product E	**36**	22	0	0	4	0	2	2	5	1
Product F	**26**	15	0	1	0	1	2	2	5	1
Product G	**25**	13	0	1	1	1	2	2	5	1
Product H	**42**	24	0	0	7	1	2	2	5	1
Headboard										
Product A	**31.00**	7.00	1.00	6.00	0.00	0.00	1.00	1.00	15.00	0.00
Product B	**12.41**	3.28	2.95	1.70	0.13	0.00	0.56	0.41	3.40	0.00

Breakdown of upholstery furniture carbon footprint data

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Appendix 3

Sofa	Total footprint	Timber & board	Foams & fillings	Textiles	Metal	Plastic	Packaging	Transport	Utilities	Other
Product A	**119.76**	14.99	57.38	25.00	7.71	0.00	3.44	5.51	5.60	0.13
Product B	**105.65**	13.64	49.03	22.39	6.86	0.00	3.16	4.85	5.60	0.13
Product C	**81.51**	12.19	32.41	18.66	5.16	0.00	3.16	4.21	5.60	0.13
Product D	**110.83**	16.85	45.08	24.66	7.71	0.00	3.44	7.37	5.60	0.13
Product E	**117.90**	15.13	49.01	28.27	9.07	0.00	3.64	7.07	5.60	0.13
Product F	**86.33**	9.39	40.55	21.35	3.63	0.77	1.20	2.73	3.40	3.32
Product G	**72.30**	8.73	38.91	10.13	3.42	0.74	1.20	4.50	3.40	1.28
Product H	**103.22**	12.09	37.90	31.78	4.74	0.00	3.16	7.51	5.60	0.44
Product I	**65.00**	12.00	32.00	9.00	4.00	0.00	0.00	5.00	3.00	0.00
Product J	**65.00**	12.00	32.00	12.00	4.00	0.00	0.00	2.00	3.00	0.00
Product K	**64.00**	8.00	31.00	13.00	3.00	0.00	0.00	6.00	3.00	0.00
Armchair										
Product A	**50.77**	9.21	20.11	7.01	3.54	0.00	1.94	3.23	5.60	0.13
Product B	**41.80**	7.02	13.03	7.02	4.43	0.00	1.94	2.63	5.60	0.13
Product C	**41.83**	7.02	13.03	7.02	4.43	0.00	1.94	2.66	5.60	0.13
Product D	**49.28**	2.91	30.10	2.40	0.18	0.00	0.19	2.23	8.56	2.71
Product E	**30.04**	4.64	6.29	9.74	1.93	0.60	0.64	1.14	3.40	1.68
Footstool										
Product A	**17.41**	2.74	3.88	1.77	0.57	0.00	1.75	1.04	5.60	0.06
Electric chair										
Product A	**75.16**	11.42	14.37	3.00	28.21	2.65	0.74	3.50	8.56	2.71
Sofa bed										
Product A	**87.62**	9.55	7.46	19.76	35.87	1.03	0.64	7.38	3.40	2.54

Breakdown of office furniture - chairs carbon footprint data

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Office task chair	Total footprint	Timber & board	Foams & fillings	Textiles	Metal	Plastic	Packaging	Transport	Utilities	Other
Product A	**77.80**	0.00	4.24	8.53	18.03	26.65	4.44	5.26	6.14	4.53
Product B	**59.75**	0.00	3.39	5.14	28.28	11.58	0.00	4.69	6.14	0.54
Product C	**143.10**	0.00	3.18	13.24	93.30	13.54	4.44	6.54	6.14	2.72
Product D	**106.98**	0.00	15.21	8.53	55.13	11.13	3.50	4.10	6.14	3.25
Product E	**61.40**	0.25	3.73	0.01	28.65	7.71	0.95	7.01	6.14	6.96
Product F	**93.20**	0.00	3.77	0.93	43.55	41.38	0.12	2.36	0.89	0.20
Product G	**40.30**	0.00	5.55	0.97	8.86	22.00	0.12	1.71	0.89	0.20
Product H	**64.72**	0.00	2.82	1.05	8.09	48.28	0.19	0.93	3.04	0.32
Product I	**55.71**	0.74	0.03	0.56	37.29	12.40	0.40	0.93	3.04	0.32
Product J	**50.13**	0.00	1.04	1.05	0.00	38.46	0.30	1.24	4.63	3.41
Product K	**56.00**	0.00	2.00	1.00	20.00	20.00	1.00	6.00	3.00	3.00
Product L	**54.00**	0.00	11.00	2.00	10.00	23.00	0.00	2.00	3.00	3.00
Product M	**77.00**	0.00	6.00	2.00	8.00	53.00	0.00	2.00	3.00	3.00
Office visitor reception chair										
Product A	**80.86**	7.36	5.79	25.58	25.48	0.46	4.44	5.19	6.14	0.41
Product B	**34.25**	0.46	5.49	4.24	4.01	5.78	4.44	3.69	6.14	0.00
Product C	**63.46**	2.93	5.09	17.05	25.98	0.59	2.96	2.19	6.14	0.54
Product D	**22.65**	2.56	4.88	0.01	2.75	0.00	0.95	2.31	6.14	3.06
Product E	**64.32**	3.95	25.99	17.05	3.47	0.13	3.50	3.56	6.14	0.54
Product F	**22.50**	1.25	2.37	1.57	7.42	0.00	0.23	0.89	7.58	1.19
Product G	**46.71**	0.65	3.96	1.23	6.52	22.64	0.23	1.02	7.58	2.87
Product H	**46.77**	0.65	3.61	1.23	9.51	19.91	0.23	1.19	7.58	2.87
Product I	**21.32**	0.51	1.94	1.05	5.65	0.91	0.23	1.00	7.58	2.46
Product J	**70.00**	0.00	52.00	6.00	7.00	0.00	0.00	2.00	3.00	0.00
Product K	**27.00**	1.00	3.00	3.00	5.00	11.00	0.00	1.00	3.00	0.00
Product L	**22.00**	0.00	0.00	0.00	4.00	14.00	0.00	1.00	3.00	0.00
Product M	**24.00**	5.00	5.00	2.00	8.00	0.00	0.00	1.00	3.00	0.00
Product N	**30.00**	0.00	2.00	1.00	9.00	14.00	0.00	1.00	3.00	0.00
Product O	**9.00**	0.00	0.00	0.00	4.00	0.00	0.00	2.00	3.00	0.00
Product P	**25.00**	3.00	6.00	1.00	10.00	0.00	0.00	2.00	3.00	0.00
Product R	**27.00**	3.00	6.00	3.00	10.00	0.00	0.00	2.00	3.00	0.00
Product S	**27.00**	2.00	4.00	6.00	8.00	1.00	0.00	3.00	3.00	0.00
Product T	**22.00**	2.00	4.00	2.00	8.00	1.00	0.00	2.00	3.00	0.00

Breakdown of office furniture - storage carbon footprint data

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Appendix 5

Desk high pedestal	Total footprint	Timber & board	Metal	Plastic	Packaging	Transport	Utilities	Other
Product A	**34.77**	6.70	3.78	18.22	0.88	2.45	0.89	1.85
Product B	**19.57**	11.46	4.02	0.56	1.19	0.55	1.68	0.10
Product C	**39.12**	13.89	10.88	7.61	0.34	3.44	0.89	2.09
Product D	**22.95**	11.99	5.35	0.11	0.95	0.76	3.04	0.74
Product E	**28.64**	14.73	8.05	0.11	0.95	0.82	3.04	0.93
Bookcase								
Product A	**20.00**	13.00	0.00	0.00	1.00	0.00	5.00	1.00
Product B	**13.39**	9.86	0.23	0.00	1.06	1.07	1.08	0.10
Product C	**21.03**	14.16	0.00	0.00	0.62	1.15	4.63	0.47
Tambour								
Product A	**38.00**	18.76	4.84	9.44	1.45	1.73	1.68	0.10
Product B	**62.27**	17.90	2.12	32.75	0.53	1.43	4.63	2.91
Steel pedestal								
Product A	**44.22**	0.00	35.40	0.00	3.90	3.14	1.68	0.10
Wood filing cabinet								
Product A	**39.00**	22.00	5.00	2.00	3.00	1.00	5.00	1.00
Product B	**57.00**	34.00	5.00	1.00	5.00	2.00	5.00	5.00
Cupboard								
Product A	**25.00**	15.00	1.00	0.00	3.00	0.00	5.00	1.00
Product B	**37.52**	26.06	5.94	0.04	1.54	2.15	1.68	0.10

Breakdown of office furniture - desks carbon footprint data

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1600mm x 1800mm rectangular desk	Total footprint	Timber & board	Metal	Plastic	Packaging	Transport	Utilities	Other
Product A	**25.00**	10.00	5.00	1.00	3.00	0.00	5.00	1.00
Product B	**25.00**	12.00	4.00	0.00	2.00	0.00	5.00	2.00
Product C	**38.42**	10.79	19.12	0.00	0.00	7.27	0.89	0.36
Product D	**37.45**	12.72	18.05	0.00	2.34	2.55	1.68	0.10
Product E	**30.56**	14.38	14.16	0.00	0.00	0.78	0.89	0.36
Product F	**29.66**	13.49	10.17	0.27	1.13	0.71	3.04	0.85
Product G	**38.71**	12.13	16.19	0.46	0.62	1.26	4.63	3.41
Product H	**56.08**	12.76	34.41	0.39	0.00	1.27	5.76	1.50
6 people bench desk								
Product A	**270.55**	54.55	185.82	7.66	18.19	0.95	3.04	0.32
Product B	**185.02**	53.39	119.94	0.00	0.00	2.53	5.76	3.40
1600mm x 800mm wave desk								
Product A	**62.96**	11.39	38.70	0.00	2.50	8.58	1.68	0.10
1600mm x 1200mm work station								
Product A	**44.68**	16.72	19.28	0.18	0.00	1.25	5.76	1.50

Breakdown of contract furniture carbon footprint data

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Appendix 7

Dining table	Total footprint	Timber & board	Foams & fillings	Textiles	Metal	Plastic	Packaging	Transport	Utilities	Other
Product A	**23.78**	10.96	0.09	0.00	0.18	1.27	8.56	2.71	23.78	10.96
Product B	**17.53**	2.23	7.54	0.00	0.62	1.07	4.63	1.45	17.53	2.23
Product C	**33.00**	18.00	0.00	0.00	2.00	1.00	12.00	0.00	33.00	18.00
Dining chairs										
Product A	**18.01**	3.06	1.17	0.60	0.18	0.00	0.19	1.55	8.56	2.71
Product B	**26.14**	5.36	5.82	1.20	0.09	0.00	0.19	2.21	8.56	2.71
Product C	**37.94**	3.29	19.03	2.40	0.35	0.00	0.19	1.41	8.56	2.71
Waiting room beam seating										
Product A	**75.00**	0.00	16.00	56.00	1.00	75.00	0.00	Unknown	3.00	0.00
Product B	**57.00**	6.00	8.00	40.00	1.00	57.00	6.00	Unknown	3.00	0.00


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