Carbon Impact of Office Furniture Reuse

Office Desk and Office Chair

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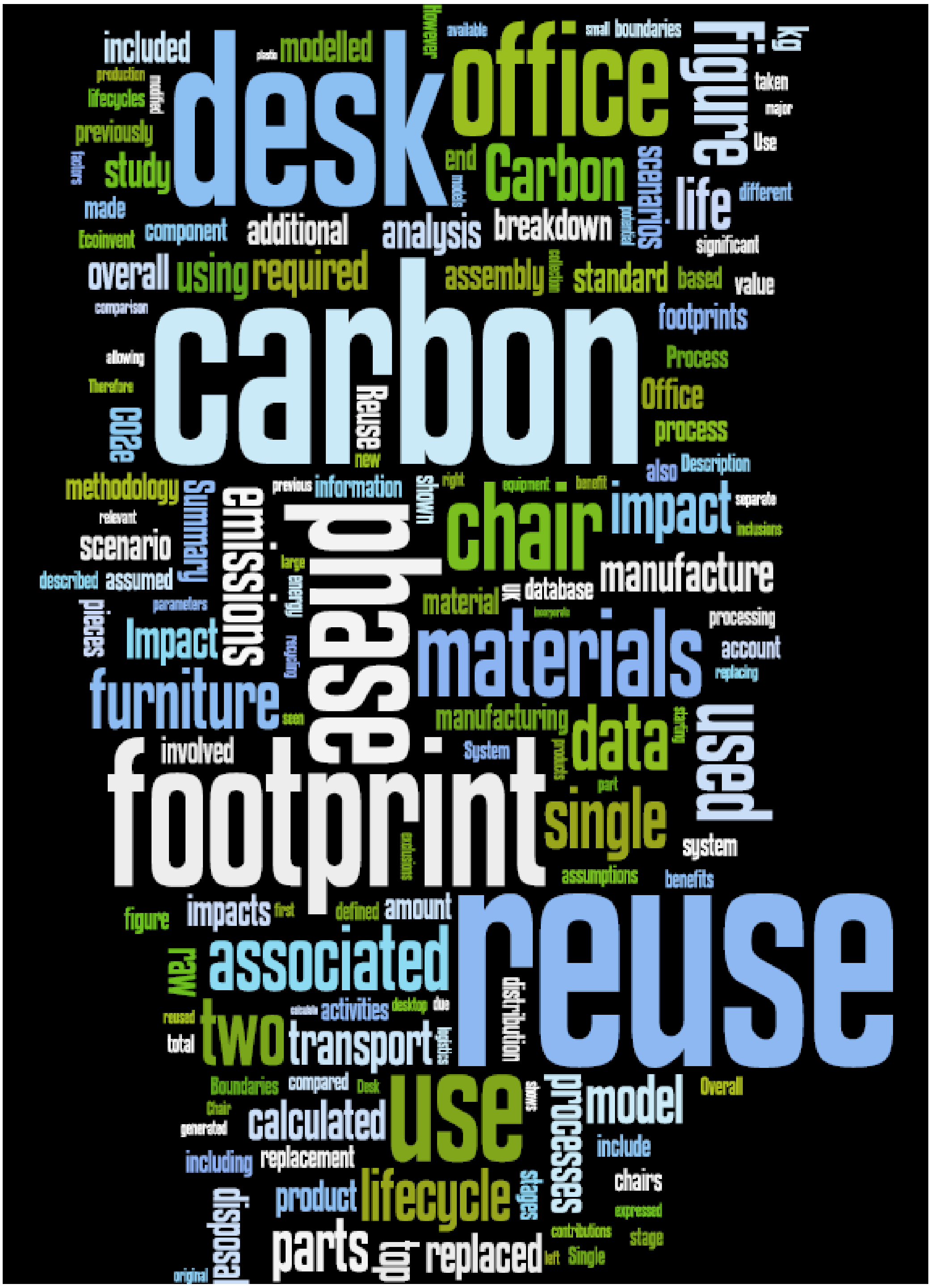
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Glossary

CO_2e	The net emissions of the life-cycle expressed as the equivalent amount of carbon dioxide.
Ecoinvent	Industry-recognised database containing life-cycle phase impacts for numerous materials and products.
GWP	Global Warming Potential. A measure of a substances contribution to global warming referenced against carbon dioxide. (Calculated over a specific time interval).

1. Summary

The CRR has identified office furniture as having excellent potential for reuse, as it is often disposed of in an easily refurbishable state. Commercially and environmentally it makes sense to reuse this furniture in further lifecycles.

The aim of this report is to quantify the environmental benefits generated by the reuse of this equipment as an alternative to using new furniture. This assessment is accomplished through the calculation of the carbon footprint associated with the standard lifecycles of two common pieces of office furniture; a standard office desk and chair. Initially the footprints calculated for original use provide a baseline footprint for later comparison. Further analysis, modelling of reuse scenarios was conducted for both pieces of furniture.

The analysis described above was conducted using real world data collected from manufacturers and furniture reuse practitioners based in the UK. The gathered information was used to develop a model for both pieces of furniture to model manufacture from raw materials, assembly distribution and disposal (a use phase was not included as it was not considered relevant for this furniture). These models included materials, energy, transport logistics, and typical disposal and waste. The reuse phase was then added into these models taking into account different reuse ratios for different parts. Carbon emissions factors were taken from the from Ecoinvent database (v2.1). The assessment was based on the methodology outlined by PAS2050.

A standard office desk (1.6m x 0.8m) and a standard five point office chair (aluminium construction) were chosen as the functional units; further information about this equipment is given below. Many other pieces of office furniture can be reused, however, these two pieces represent some of the most common furniture, therefore they are appropriate for this study.

Outputs from this process indicated that the reuse of office furniture can considerably lower the carbon footprint of these products. Our findings indicate that when two full lifecycles are taken into account, simple reuse of an office desk can cut its carbon footprint by up to 36% from 292 to 187 kg CO_2e. Replacement of a major component, such as the desk top, reduces the benefit. However, carbon savings of at least 18% are still seen. In the case of the office chair, when reuse involves the replacement of minor components such as the foam seat and arm rests, reuse reduces the carbon footprint from 192 to 94 kg CO_2e, representing a saving of 45%.

Overall, these figures indicate that large savings in carbon emissions can result from the reuse of office furniture. Therefore, due the quantity of furniture used companies, large savings in carbon emissions could result from increasing the quantity and expanding number of office furniture products which are reused.

2. Introduction

In this study the environmental benefits of office furniture reuse are quantified by use of a carbon footprint.

In a carbon footprint analysis, material and energy requirements are used to calculate the total emissions attributable to a product throughout its life. The systems used include all processing stages such as materials extraction, manufacturing, transport, use and end of life disposal. The total carbon footprint of a product is expressed in carbon dioxide equivalents (CO_2e), this value uses the global warming potential (GWP) over 100 years as a reference value. Different environmental impacts can be expressed in terms of CO_2e using published data, [a] allowing summary all emissions in a single figure.

Initially, the carbon footprints of two commonly used pieces of office furniture (an office chair and office desk) are assessed for a single use, starting from manufacture of raw materials through to end of life disposal. This generated a carbon footprint for the one time use of each piece of furniture. This methodology was then modified to incorporate a reuse phase, allowing measurement of the impact of reuse on the carbon emissions. In this context 'reuse' simply involved a further use phase of a piece of furniture when it is not longer required at its original location and is assumed to double the useable life of this furniture.

Process stages which are included in the boundary of the analysis include raw material extraction, transportation, processing, and final disposal of products and by-products. The use phase was omitted as, due to the nature of these products, it will have little or no impact on the overall carbon footprint.

This methodology allows the use and reuse of the modelled office furniture to be directly compared and any benefits quantified.

[a] For example the Ecoinvent database v2.1

3. Office Desk

The type of office desk modelled in this study was a standard 1.6m x 0.8m desk consisting of a metal frame, laminated chipboard top and modesty board and a selection of plastic fittings. The basic materials composition used and the related parts can be seen in the inventory below.

Material	Part	Weight (kg)
Low alloy steel	Frame	9.05
MFC*	Top and Modesty Board	38.32
ABS Plastic	Fittings	0.44
Lacquer	Surface Finish	0.14
Total		47.95

* Melamine Faced Chipboard

The origins and manufacturing processes involved for each component were determined. This data was used in conjunction with information gathered about the assembly, distribution and end of life phases allowing an accurate model to be developed.

3.1. Description of Process and System Boundaries

It is important that system boundaries used to generate carbon footprints are accurately and clearly defined, as this allows capture and assignment of all impacts associated with a particular product or activity.

The boundaries used for calculating the carbon footprint of the desk include all major activities required for raw materials production, parts manufacture, assembly, distribution and disposal. Each material contained a significant amount of recycled material, this was taken into account using the '100:0' methodology; (i.e. the benefit was assigned to the starting materials).

Figure 1 provides a visual representation of the system boundary and depicts the major processes involved within the assessed lifecycle of a single use. Further systems are described later for the models which include a reuse phase.

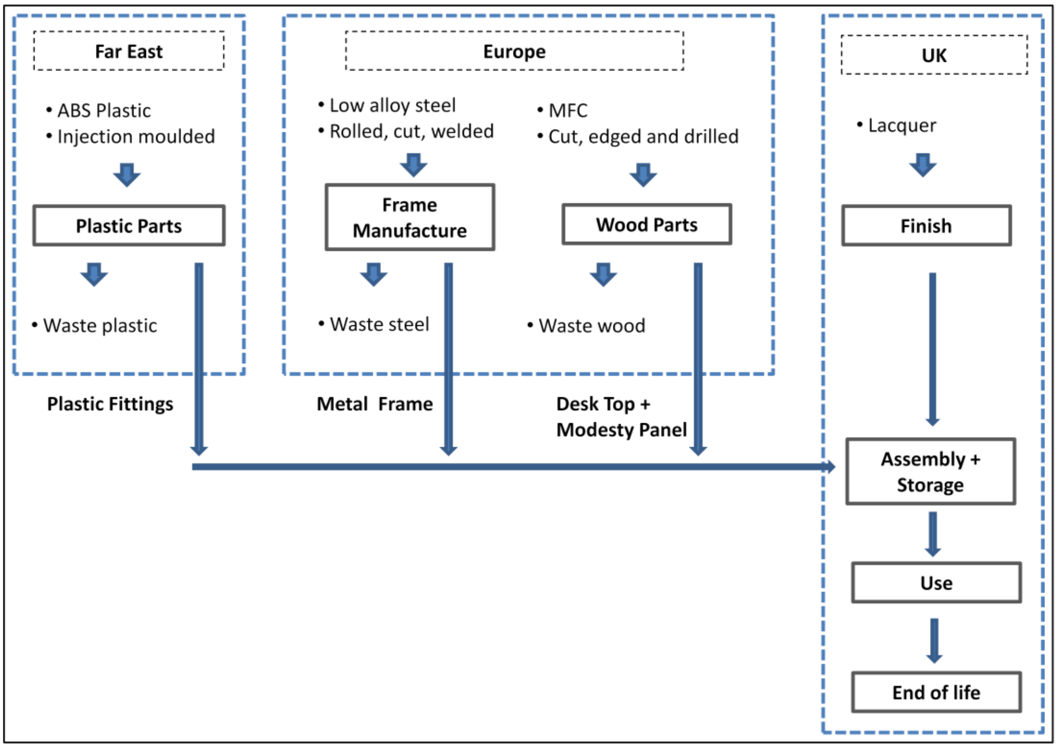

Figure 1: Schematic of the system used to calculate the carbon footprint of an office desk.

Major model inclusions and exclusions

The following are included in the calculation of the carbon footprints for desks:

- Materials and energy
- Transport covering the whole supply chain and including entire transport life cycle rather than the operation
- End of life including detailed recycling ratios for each part.
- Packaging

The followings are excluded in this study:

- Any emissions arising from the use phase (not applicable).

Key assumptions and Limitations

Following assumptions are made for this study:

- OEM manufacture occurs either in the Far East (plastic parts) or the EU (other parts).

- Carbon impacts of raw materials were taken from the EcoInvent database; these included relevant recycling rates which were assumed match commercial values.

- To avoid double counting, the benefits of recycling were only accounted for in the impact of input materials rather than in the disposal stage.

- Manufacturing stages were accounted for using applicable EcoInvent data; these included all factors such as wastage.

- Standard distances were defined for each logistics stage, these were:

  - Far East to UK – 15,000km sea freight

  - EU to UK – 500km road haulage

  - Within UK – 200km road haulage

  Appropriate modes of transport and other logistics parameters were applied at each stage.

- Due to lack of available data, estimations for the assembly and storage phase were made, based data available from similar processes.

- The usage phase of a desk lasts for 5 years before it is replaced. The impact of this phase was assumed to be zero.

- Reuse is assumed to account for a further 5 year usage phase, and is equivalent to the original use.

Following limitations applies for this study:

- The carbon impact data used in this study was obtained from Ecoinvent[b] database version 2.1. This is arguably the most comprehensive database for such data but the quality of each data will influence the outcome.

- Estimations of the amount of packaging required were made. This data is incorporated in the overall analysis.

3.2. Carbon Impact of Single Use

The lifecycle of the desk was modelled using the system and parameters described above. The carbon footprint arising from the lifecycle of a desk was calculated to be 146 kg CO_2e per desk. A breakdown of the composition of this footprint is shown in Figure 2.

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[b] http://www.ecoinvent.ch/

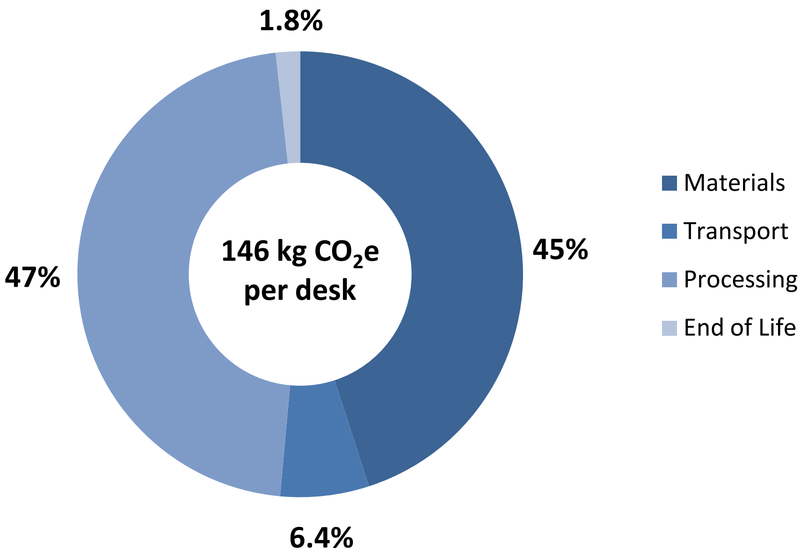

Figure 2: Carbon footprint of an office desk with no reuse

The manufacture and assembly of the desk accounts for over 90% of this desk's impact, with transport and end of life activities accounting for a small proportion of the overall figure. This indicates that the raw materials and manufacturing processes involved in constructing a desk are the most important in terms of carbon emissions.

This figure is used as a baseline for comparison with the reuse scenarios below.

3.3. Carbon Impact of Reuse

The previous model of single use was modified to incorporate a reuse phase into the product lifecycle. The product lifecycle was modified to allow for this process, this was achieved by inserting the processes involved with reuse directly after the first use phase, and feeding into the same end of life process.

Two reuse scenarios were modelled for the desk.

Scenerio 1. A simple reuse occurring after the use phase. This includes collection, re-finishing the desk surface, and redistribution. After the second use phase the desk follows the same end of life fate as single use scenario.

Scenerio 2. A more complex reuse phase which includes the replacement of the desk top with new. This follows the same process chain as reuse scenario 1, with the desk top replaced after the collection stage. The replaced desk top follows the typical end of life processing for this material

Both these scenarios assume that the reuse phase extends the product lifetime by additional use phase - in effect doubling its useable life. Therefore, the figures generated by this model should be compared with the equivalent of two single desk uses.

Scenario 1 – Simple reuse

Figure 3 shows the carbon footprint calculated for the office desk with an additional reuse phase; breakdown of the impacts associated with reuse is also shown.

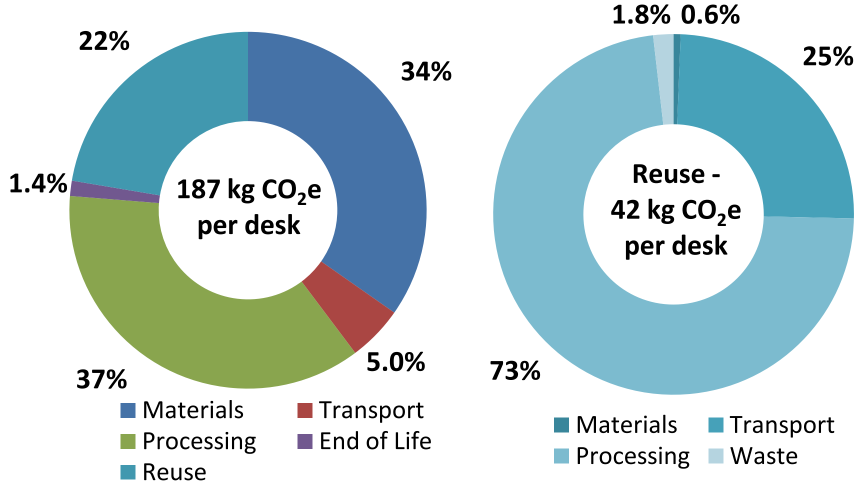

Figure 3: Overall carbon footprint of a desk's lifecycle with a reuse phase (left) and breakdown of contributions to the reuse phase (right).

The total carbon footprint for this desk with an additional reuse phase is calculated to be 187 kg CO_2e. The reuse phase adds a further 42 kg CO_2e to the carbon footprint.[c] The majority of these emissions are associated with the additional processing activities, such as disassembly, storage and reconditioning the surfaces. The transport associated with collecting and redistributing this equipment also contributes a significant amount of carbon emissions.

Scenario 2 - Reuse with replacement of desk top

Figure 4 shows the carbon footprint calculated for the desk, with a reuse phase after replacing the desk top. A break-down of the contributing factors is also shown to demonstrate where the additional carbon impact is originating.

Replacing the desktop makes a large impact on the reuse phase, and the overall carbon footprint. Almost three quarters of the carbon emissions associated with reuse arise from the additional materials required to make the new desktop. This is unsurprising as the desk top weighs over 30kg, and forms the largest component of the desk. Additional transport emissions are also associated with the transport of this bulky part, increasing this more than the contribution seen in the previous reuse scenario.

[c] This reuse phase is reliant on the primary use phase. Therefore while this value is indicative of the carbon footprint of reuse, fair comparison can only be made between the overall figure and two single use lifecycles.

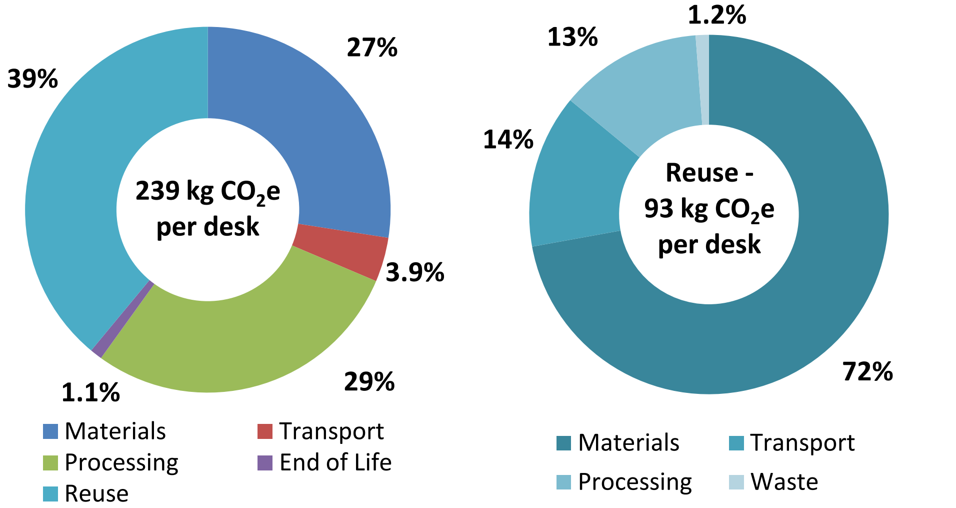

Figure 4: Overall carbon footprint of a lifecycle with a reuse phase, including the replacement of the desk top (left) and breakdown of contributions the reuse phase (right)

Overall, this reuse scenario results in a much larger carbon footprint than scenario 1 due to the extra materials and energy required to produce and transport a new desktop. However, a significant reduction is still observed when compared to using a completely new desk.

3.4. Summary

Figure 5 compares the carbon footprints associated with each of the scenarios modelled above. To allow fair comparison, the reuse scenarios are assumed to account for two of the single use lifecycles.

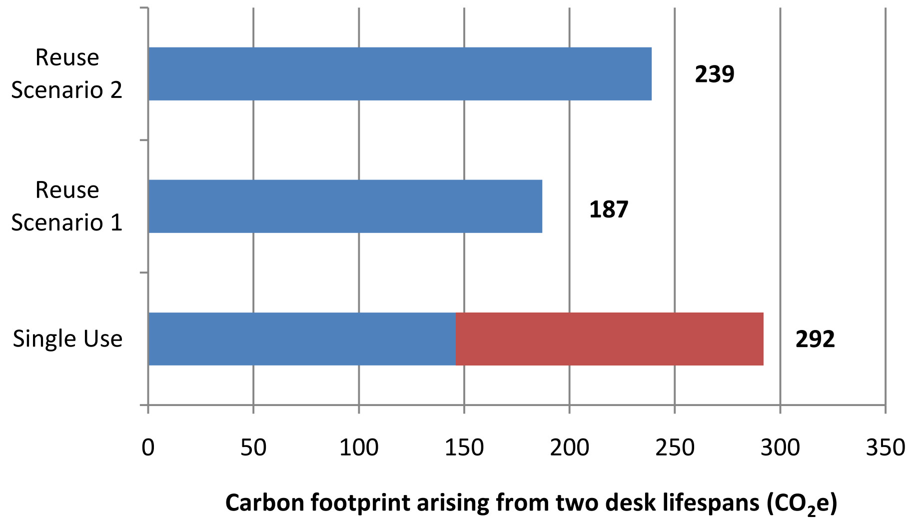

Figure 5: Comparison of the carbon footprints associated supplying a desk for two use phases

The data above demonstrates the environmental benefit of desk reuse. If all parts of the desk can be reused, (with only minor refurbishment work), the total carbon footprint over two lifecycles can be reduced by almost 36%. This benefit is reduced to around 18% when the desk top is replaced (the component with the highest individual contribution). Clearly the replacement of more parts reduces the benefit of reuse to a certain extent. However, this data demonstrates that reuse is worthwhile even when major parts replace, though care should be taken to ensure this.

4. Office Chair

The office chair modelled in this study is a standard 5 point base office chair made from a combination of aluminium, steel, nylon, polypropylene and foam parts. The materials composition and manufacturing information used in the calculations are not described within the report due to the commercially sensitive nature of this data. However, the information used is accurate and comprehensive. Therefore, while the exact specifications of this chair are not described in detail, the footprint provided can be seen indicative for all chairs of this type.

4.1. Description of Process and System Boundaries

The carbon footprint for the office chair was calculated using the same methodology as that used previously for the office desk. Appropriate system boundaries and processes were defined for this product, initially modelling a single use. Therefore the lifecycle was defined in an analogous way to the previously modelled office desk.

The boundaries drawn captured the carbon footprint of all activities required for raw materials production, parts manufacture, assembly, distribution and disposal. As before, each material contained a significant amount of recycled material, this was taken into account using the '100:0' methodology; (i.e. the benefit was assigned to the starting materials).

Major model inclusions and exclusions

The same inclusions and exclusions were used in this model as used previously for the desk model, (section 3.1). In this case transport stages were uniquely characterised for each component and distribution phase.

Key assumptions and Limitations

The same assumptions and limitations were used in this model as used previously for the desk model, (section 3.1).

4.2. Carbon Impact of Single Use

The carbon footprint associated with a single lifecycle of the office modelled chair was calculated to be 82 kg CO_2e. A breakdown of this figure is shown in Figure 6: **Carbon footprint of an office chair with no reuse**

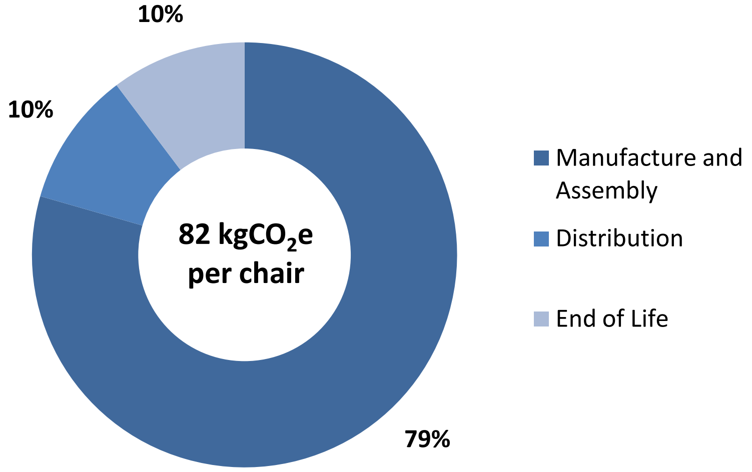

Figure 6: Carbon footprint of an office chair with no reuse

As observed with the office desk, the majority of the carbon footprint is associated with manufacture and assembly processes (these are calculated as a single value as it is not possible to differentiate them in this case. This figure also includes transport of the raw materials which could not be decoupled from this value).

4.3. Carbon Impact of Reuse

The overall reuse process was incorporated into the lifecycle in the same manor as previously, described with the desk reuse methodology. The reuse process model involved the collection of the chair from is first use site, the replacement of foam sections (seat and arm rests) with a small amount of refurbishment (e.g. cleaning and touching up of paintwork) and redistribution. The reused chair was assumed to be identical to the single use scenario. Therefore the end of life process was used for both.

Figure 7 shows the carbon footprint calculated for the office chair with an additional reuse phase. A breakdown of the impacts associated different activities, including reuse, is also shown.

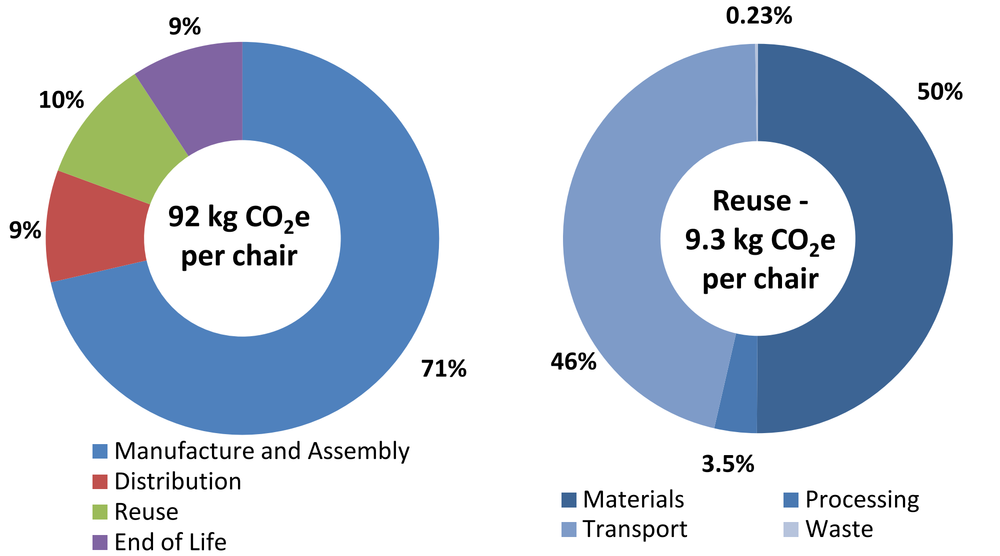

Figure 7: Overall carbon footprint of lifecycle with a reuse phase (left) and a breakdown of contributions of the reuse phase (right).

The overall figure calculated from this model is 92 kg CO_2 per chair, which is represents to two normal lifecycles. Reuse accounts for approximately 10% of this value, demonstrating the large carbon benefits associated with reuse of this product. Half of the reuse value is associated with the production of replacement materials; as relatively small sections of the chair were replaced this indicates a heavy reliance on the quantity of parts replaced. However, overall the carbon footprint is dominated by the initial materials and processing required to manufacture the chair. Therefore, even with extensive parts replacement reuse is still likely to produce carbon benefits.

4.4. Summary

Figure 8 compares the carbon footprint resulting from the use and reuse of a chair with the use of two separate chairs.

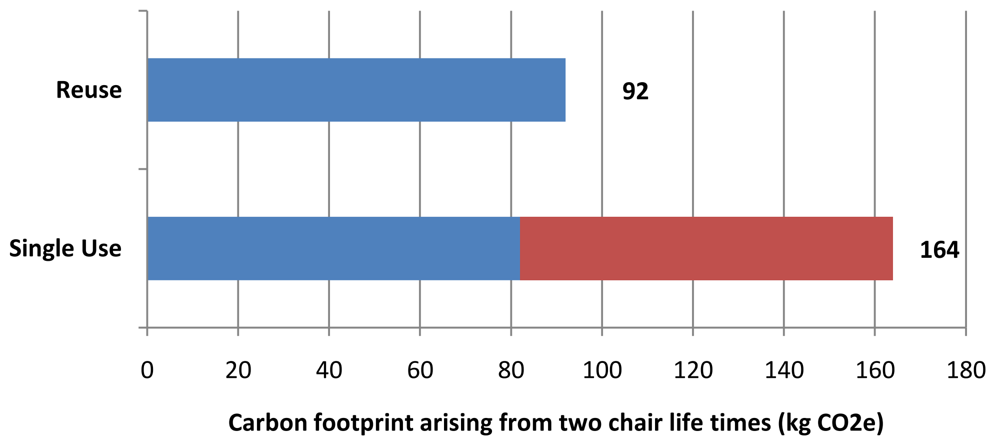

Figure 8: Comparison of the different carbon footprints associated with the use of two separate single use chairs and the reuse of a chair.

From this data it is clear that the reuse of chairs of this variety significantly reduce the overall carbon impact. Over two lifecycles reuse lowers the carbon footprint by almost 45%. Even if other parts are replaced or other renewal processes required, reuse is still likely to present significant emissions savings.

5. Conclusions

Life cycle analysis of the single use and subsequent reuse of a standard office desk and chair was conducted. The impact of these was quantified by the calculation of a carbon footprint.

This analysis was mainly based on the data available on Ecoinvent for processes and the data collected from relevant sources. Based on our analysis following conclusions are made:

- Reusing office furniture present large carbon emissions savings.
- Compared to the single use desk scenario, the carbon impact of reusing an office desk is 36% lower over two lifecycles when no parts are replaced, and 18% lower when the desk top is replaced.
- Over two lifecycles the reuse of an office chair can reduce the carbon emission by around 45% when compared to using two separate chairs.
- The largest impacts for both original manufacture and reuse occur from the materials and manufacturing stages.
- Further benefits are likely to occur through the reduction of resource use. These have not been described within this study.